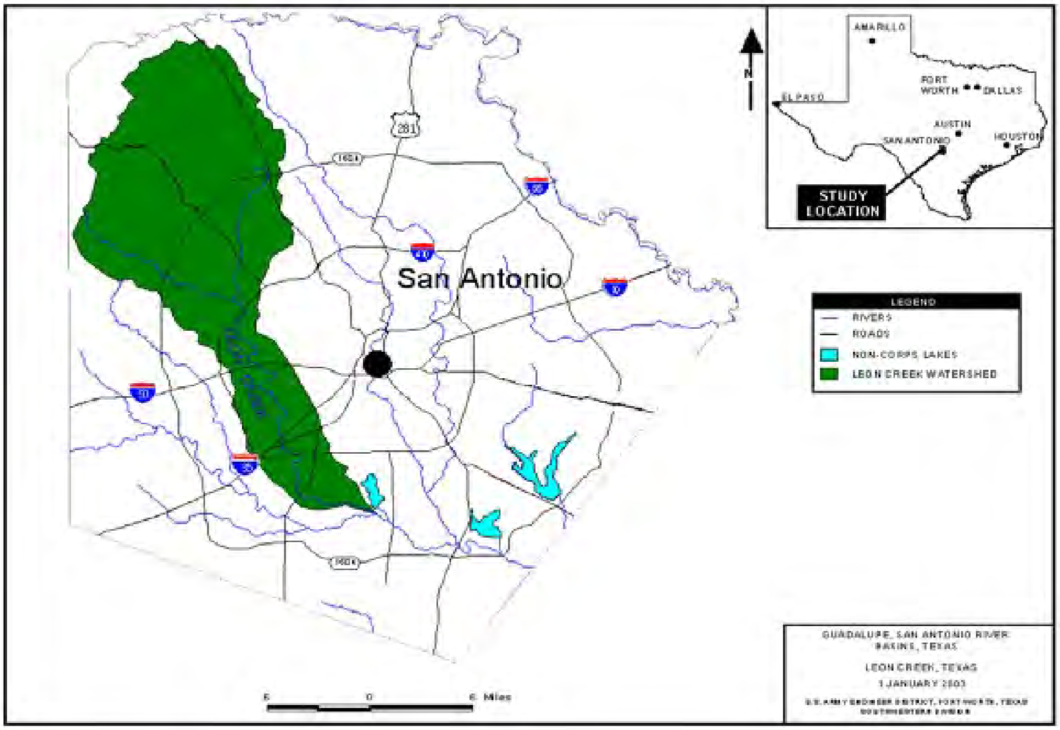
U.S. Army
Corps of Engineers
Fort Worth District

Leon Creek Watershed, Texas Interim Feasibility Report and Integrated Environmental Assessment

Guadalupe-San Antonio River Basin, Texas
Study Partner: San Antonio River Authority



Final Report Version
April 2014

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EXECUTIVE SUMMARY

Leon Creek is an important drainage system on the western side of San Antonio in Bexar County Texas. There are an estimated 4,360 structures located what is commonly referred to as the 500-year floodplain also referred to as the 0.2 percent annual exceedance probability flood event. The flood risk along Leon Creek is generally associated with infrequent, high-intensity rainfall events that result in extremely rapid but relatively short-duration flood peaks associated with high velocity stream flows. In May 2013, rainfall amounts of 10 inches to 15 inches were received in the upper portions of the Leon Creek watershed in somewhat just over 12 hours. Runoff from this event created a peak flood elevation at the Leon Creek/I-35 gage of 27 feet, more than 12 feet over flood stage. Leon Creek inundated the Jet Engine Test Facility at Port San Antonio, a large industrial complex at the site of the former Kelly Air Force Base, with almost seven feet of floodwater. Flood damages within the watershed are estimated at approximately $13,834,000 annually (FY14 dollars).

The Feasibility Study and Environmental Assessment for Leon Creek examined an array of alternatives to reduce flood risks. Consideration was initially given to additional measures for ecosystem restoration and recreation as ancillary to flood risk reduction; however, no nationally significant or economically justified National Ecosystem Restoration (NER) or recreation measures were identified, and no ecosystem restoration or recreation components are included in the Recommended Plan.

The Recommended Plan provides for construction of an approximately 3,700-foot levee designed to protect against the 1 percent AEP event for the Jet Engine Test Cell located in Area of Interest-2, near the downstream end of the watershed. This feature includes approximately 2,850 linear feet of channelization immediately downstream of the levee to mitigate for slight rises in water surface elevations caused by the levee. The channel work will utilize natural design parameters, including in-channel habitat components, in order to be self-mitigating in terms of aquatic impacts with 15.75 acres of riparian vegetation being installed in conjunction with the natural channel design. The Recommended Plan also includes the permanent evacuation of 4 single-family homes and 32 townhomes located within the 4 percent AEP floodplain. The Recommended Plan results in a $2,143,000 reduction in Equivalent Annual Damages.

The total project first cost for the Recommended Plan is estimated at $28,175,000 and provides total annual net benefits of $859,000 with a benefit-to-cost ratio of 1.7-to-1. The San Antonio River Authority is identified as the non-Federal sponsor for implementation of the recommended plan. Federal participation in the project is estimated at $18,314,000 or 65 percent of the total project cost. Non-Federal participation in the project is estimated at $9,861,000 or 35 percent of the total project cost.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) was asked by the San Antonio River Authority (SARA) to partner in a Water Resources Planning study for the Leon Creek Watershed in San Antonio and Bexar County, Texas. This draft feasibility report and integrated environmental assessment documents the Feasibility phase of the study initiated to investigate and recommend solutions to water resources problems in the study area.

Section 1 describes the Leon Creek study in terms of the need identified and defines the study purpose and scope as required under the National Environmental Policy Act (NEPA) for a feasibility report with integrated environmental assessment. This section also provides a general description of the study area and concludes with statements regarding governmental authorization for the study and the collaborating Federal, state, and local agencies.

STUDY AUTHORITY

The Leon Creek Feasibility Study is in partial response to the Guadalupe and San Antonio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, March 11, 1998, which reads:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session, and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply, and allied purposes on the Guadalupe and San Antonio Rivers in Texas.*

STUDY PARTICIPANTS/COLLABORATIVE PLANNING

Engineering Circular 1105-2-409, “Planning in a Collaborative Environment,” provides guidance for USACE to follow while conducting feasibility level studies in a collaborative planning environment. The Leon Creek Interim Feasibility Study uses collaborative planning to develop flood damage reduction measures and investigate the potential for ecosystem restoration that would ultimately restore degraded fish and wildlife habitat in the uplands and aquatics, and recharge the Edwards and Trinity Aquifers to provide habitat for up to seven endangered species.

STUDY SCOPE AND PURPOSE

The scope of this Interim Feasibility Study is to: identify problems, needs, and opportunities; develop and evaluate alternatives; select a recommended plan; and provide a feasibility level design of the recommended plan and a feasibility report and integrated environmental assessment. It will serve as a decision document for Congressional Authorization of a project to reduce flood damages within the Leon Creek Watershed located on the west side of the city of San Antonio, Bexar County, Texas. The primary focus of the Leon Creek Interim Feasibility Study is to reduce the risk of flooding within the Leon Creek Watershed.

STUDY NEED

A Guadalupe and San Antonio River Basins, Texas, Section 905(b) Analysis, dated December 2000, demonstrated a Federal Interest and a need to further investigate the water resources problems, needs, and opportunities and to evaluate alternatives to offer flood damage reduction, ecosystem restoration, watershed management and more effective water management in the Leon Creek Watershed.

South-Central Texas, including the Leon Creek watershed, is one of the most flood prone areas of the United States (Ockerman, 2009). In October 1998, as much as 30 inches of rain occurred in the area in a two day period. The 1998 flood is believed to be the worst flood event experienced. Thirty-two lives were lost, and property damage was estimated to be $500 million in the region. Since the October 1998 flash flood, ongoing development in the Leon Creek watershed and, subsequently, an increase in impervious cover have increased the risk of flood damage. The flood event of 2013 produced in excess of 15 inches of rain in less than 24 hours within the city limits of San Antonio.

STUDY AREA

Leon Creek watershed is in western Bexar County in the greater San Antonio area. It originates in northwestern Bexar County and runs south-southeast for about 57 miles to its confluence with the Medina River which flows into the San Antonio River. The drainage area of the Leon Creek watershed is approximately 238 square miles.

The study area includes outcrops of two major aquifers, Trinity and Edwards. Thin, rocky soils and fairly steep slopes characterize both areas. The Edwards Aquifer outcrop generally exhibits greater permeability and infiltration of rainfall than the Trinity Aquifer outcrop. Stream channels within both outcrops lose flow to karst features, such as fractures, sinkholes, and caves. Where it crosses the recharge zone, flow within the channel is relatively infrequent because of the loss of flow that percolates through the channel bottom to recharge the aquifer.

While the entire watershed is the study area, the flood risk management and ecosystem restoration measures are limited to the 0.2 percent annual exceedance probability (AEP) floodplain of Leon Creek and its tributaries (Figure 1-1). The 0.2 percent AEP floodplain (often referred to as the “500-year event”) contains approximately 32 square miles.

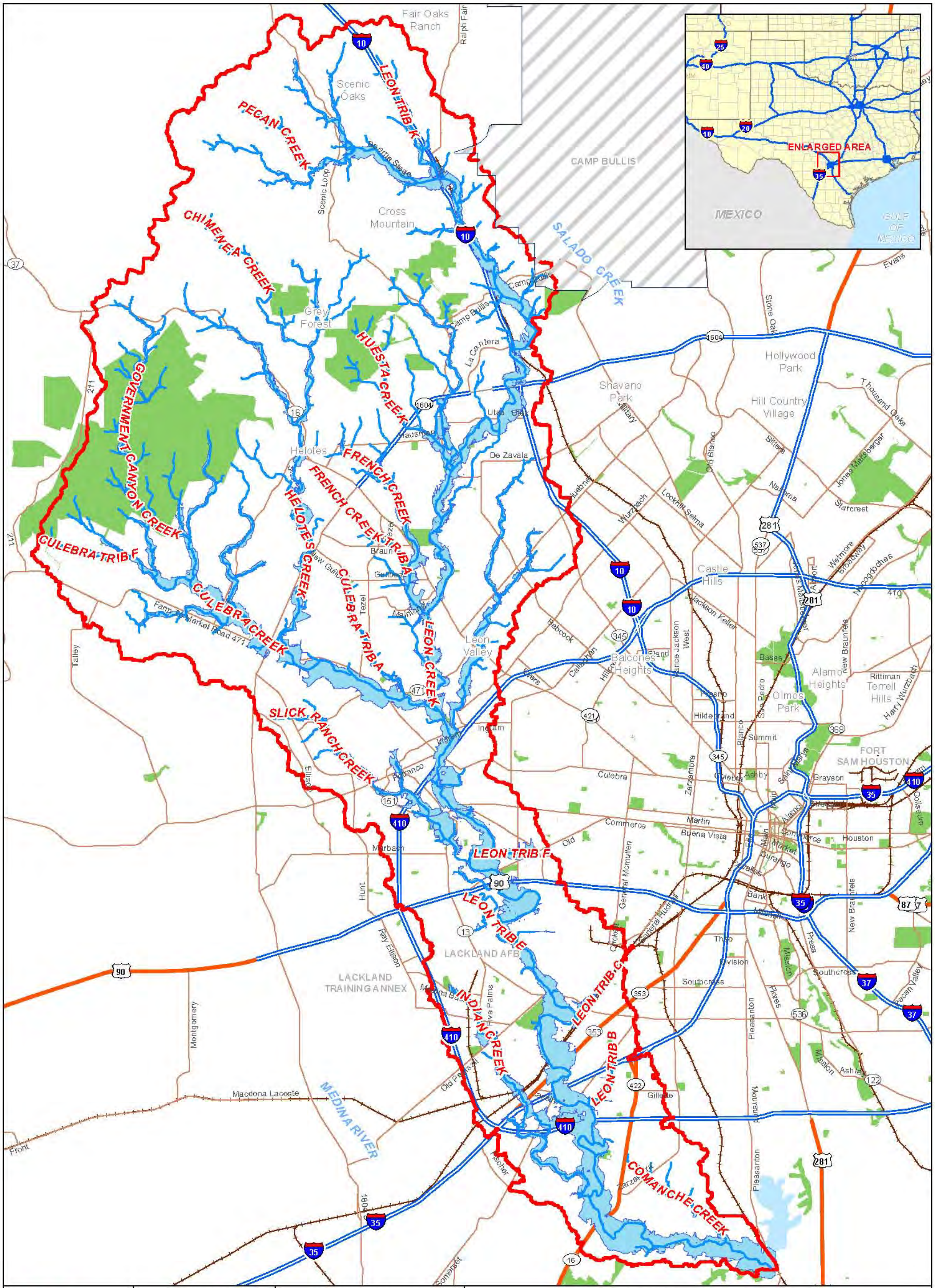
STUDY PARTICIPANTS, COOPERATING AGENCIES, AND CONGRESSIONAL DISTRICTS

USACE conducted this Leon Creek Interim Feasibility Study in cooperation with the San Antonio River Authority (SARA), which is the major non-Federal sponsor.

A number of agencies were asked to participate as cooperating entities in the Leon Creek study (see Appendix C “Agency Coordination and Correspondence”). USACE has and will continue to coordinate with Federal and State natural resource and other agencies, including the following:

- United States Fish and Wildlife Service (USFWS)
- United States Geological Survey (USGS)
- Natural Resource Conservation Service (NRCS)
- United States Environmental Protection Agency (EPA)
- Federal Aviation Administration (FAA)
- Federal Emergency Management Agency (FEMA)
- Texas Parks and Wildlife Department (TPWD)
- Texas Commission on Environmental Quality (TCEQ)
- State Historic Preservation Officer (SHPO)

The study area lies within the jurisdiction of Texas Congressional Districts 20 and 28, which are represented in the U.S. Congress by the Honorable Charles A. Gonzalez and the Honorable Henry Cuellar, respectively. The U.S. Senators for Texas are the Honorable John Cornyn and the Honorable Ted Cruz.



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Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 19, 2012
Author: Lucas Daniels
Location: \\swf-fs1\fbgis\projects\cvljobs\LeonCreek\Documents\

REFERENCE:
ESRI BASE DATASET
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PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

LEON CREEK
SAN ANTONIO, TEXAS

INTERIM FEASIBILITY STUDY
FIGURE 1-1. STUDY AREA

Legend

- Streams/Rivers
- Lakes/Reservoirs
- Leon Creek Watershed / Leon Creek Study Area
- 500-Year Floodplain
- ▨ Military Installations

Miles
0 1.25 2.5 5 7.5 10

PRIOR STUDIES AND REPORTS

A number of previously published studies and reports, prepared by USACE (Fort Worth District) and other entities, were used in developing this feasibility report. This section lists the reports and describes their relevance to the Water Resources Planning study for the Leon Creek Watershed.

U.S. Army Corps of Engineers

Guadalupe and San Antonio River Basins, Texas Section 905(b) Analysis. U.S. Army Corps of Engineers, Fort Worth District, December 2000. This report identified potential projects within the Guadalupe and San Antonio River Basins that have a potential Federal interest. Study purposes were to investigate flood risk management, ecosystem restoration, watershed management, and water supply alternatives.

Leon Creek Interim Feasibility Study Alternative Description Report. *Halff Associates, Inc., June 2009. This alternative evaluation report, prepared under contract to USACE, evaluated preliminary flood risk management alternatives for the Leon Creek Interim Feasibility Study.*

Others

Simulation of Streamflow and Water Quality in the Leon Creek Watershed, Bexar County, Texas, 1997-2004. U.S. Geological Survey Scientific Investigations Report, 2009. This report documented the use of the Hydrologic Simulation Program in Fortran (HSPF) model to simulate streamflow and water quality.

Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas, SIR 2004-5277. U.S. Department of the Interior, U.S. Geological Survey, 2004. This report documented historic recharges into the Edwards Aquifer.

Diffuse-flow Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas, SIR 2006-5319. U.S. Department of the Interior, U.S. Geological Survey, 2006. This report also documented recharges into the Edwards Aquifer.

Draft Edwards Aquifer Habitat Conservation Plan. Hicks & Company/RECON, March 2005. Prepared for the Edwards Aquifer Authority, this document outlines a habitat conservation plan for the threatened and endangered species associated with the Edwards Aquifer.

Leon Creek Watershed Master Plan Phase I – Final Report. AECOM, September 2008. This report documented the regional watershed planning by the San Antonio River Authority, City of San Antonio, and Bexar County to develop a comprehensive watershed management plan. Phase I of this effort analyzed possible detention alternatives in the Leon Creek Watershed. This report was used to screen detention alternatives that were not economically justified.

South Central Texas Regional Water Plan, Texas Water Development Board. 2011. This report documents the regional water planning to meet future water supply demand for a 21-county area including San Antonio.

Stream and Aquifer Biology of South-Central Texas - A Literature Review, 1973-97. Open File Report 99-243. U.S. Department of the Interior, U.S. Geological Survey, 2000. This report documented the biological resources within the streams and aquifers of Leon Creek.

SECTION TWO

AFFECTED ENVIRONMENT

Section 2 establishes a baseline for each of the following resources within the study area; climate; geology, soils, and topography; land use; groundwater; hydrology and hydraulics; terrestrial resources; aquatic resources; threatened and endangered species; cultural resources; hazardous, toxic, and radioactive waste; recreational resources; and other social concerns.

Based on the environment as described, future Without-Project conditions were projected for the study period of analysis (50 years beginning in 2018). The section concludes with descriptions of these “no action” conditions, which will be used as a baseline for measuring the impacts and benefits of alternative plans.

LOCATION AND DESCRIPTION

Leon Creek originates seven miles northeast of Leon Springs in northwestern Bexar County and runs southeast for 57 miles through Leon Valley and the western portion of San Antonio to its mouth on the Medina River, just west of Cassin. The study area encompasses the entire watershed, as shown in Figure 1-1.

At its headwaters, Leon Creek is a small stream with large-grained rocks, boulders, and limestone cliffs typical of a stream in the Edwards Aquifer Recharge Zone. It is a clear-running perennial stream from several springs located in the headwaters. As the creek transverses the Edwards Plateau, it becomes a flood-dominated, ephemeral creek with a few persistent pools, but does not flow most of the year. Upon entering the Texas Blackland Prairie, Leon Creek again becomes perennial and slower moving, supporting aquatic life year round. The channel does not become a wide, deep meandering channel until near its confluence with the Medina River. The Leon Creek Watershed includes several major tributaries including: Culebra Creek, Huebner Creek, French Creek, Slick Ranch Creek, Indian Creek, Helotes Creek, Babcock Tributary, Huesta Creek, and numerous smaller tributaries.

The Leon Creek Watershed is located entirely within the western section of Bexar County, stretching from the county’s northwestern limits to the confluence of Leon Creek with the Medina River southwest of the city of San Antonio. The middle portion of the watershed lies inside the San Antonio city limits and is highly urbanized. This portion of the watershed has experienced extensive ecosystem degradation and flooding as a result of the urbanization. The upper and lower portions of the watershed are in relatively undeveloped areas.

The total drainage area of this watershed is approximately 152,320 acres (238 square miles). The upper half of the Leon Creek watershed averages ten miles in width and the lower half averages four miles. Elevations within the watershed range from 1,900 feet National Geodetic Vertical Datum (NAVD88) in the headwaters to 456 feet NAVD88 at the confluence with the Medina River. Climate

The study area has a subtropical, subhumid climate characterized by hot summers and mild, dry winters. Average monthly low temperatures range from 38.6 degrees F. in January to 74.0 degrees F. in July. Heaviest rainfall tends to occur in spring and early summer, and fall. The average annual rainfall is approximately 34 inches per year. Spring is the wettest season, with April and May often the wettest months. Spring thunderstorms generally are caused by successive frontal systems that move across Texas. The hills and associated elevation increases along the Balcones Escarpment assist in the uplift of air masses and formation of storms. Many large thunderstorms form along the escarpment, where they can stall and produce extreme precipitation. The USGS has identified a dozen or more storms during the past 70 years in this area with precipitation depths exceeding 15inches over a few days. Of the 13 storms recorded worldwide for the greatest depth of precipitation in a single event, two occurred along the Balcones escarpment in the vicinity of the study area.

FLOODING HISTORY

There are significant flood risks in and around the city of San Antonio along Leon Creek and its tributaries. The flood risk is generally associated with infrequent, high-intensity rainfall events which result in extremely rapid but relatively short-duration flood peaks associated with high velocity stream flows. Of the 13 storms recorded worldwide for the greatest depth of precipitation in a single event, two occurred along the Balcones escarpment in the vicinity of the study area. A 1978 storm centered over Medina, Texas produced almost 30 inches of rainfall in 24 hours, while the 1935 storm in D’Hanis produced 22 inches of rainfall in less than 3 hours (Slade and Patton, 2002). More recently, a storm in May of 2013 produced in excess of 15 inches of rain in less than 24 hours within the San Antonio city limits. Two weeks later, a similar storm deposited more than 17 inches of rain in Maverick County and environs over a 36 hour period, an amount just shy of that area’s average annual precipitation (CNN.com).

Most of the large storms in Central Texas have occurred during the months of May to July or September to October with many unevenly distributed in time throughout sites in Central Texas. More recently, the storms of August 2007 and May 2013 are typical examples of the flood risk faced by study area residents. Within a 24-hour period in August 2007, large portions of the Leon Creek watershed received between 12 and 16 inches of rain, with almost the entire watershed receiving 6 to 10 inches in that same period. (Jackson, undated). Velocities were sufficient to sweep at least one automobile off Grissom Road in the central portion of the watershed. Main traffic lanes on Interstate 10, as well as US Highway 90 and State Highway 16 (both of which cross Leon Creek) were all closed due to the flood hazard. Eleven persons died within the city of San Antonio.

In August of 2007, the portion of the Leon Creek watershed near the I-35 intersection reported in excess of 8.25 inches of rain in 24 hours due to flooding associated with Tropical Storm Erin. The event achieved a peak rainfall intensity of 2.25 inches per hour while the Helotes Creek sub-watershed just to the north reported total rainfall amounts of almost 7 inches with a peak rainfall intensity of 3.8 inches per hour (SARA, 2007). In May 2013, rainfall amounts of 10 inches to 15 inches were received in the upper portions of the Leon Creek watershed in just over 12 hours. Runoff from this event resulted in a peak flood elevation at the Leon Creek/I-35 gage peaked at 27 feet, more than 12 feet over flood stage. During the storm, Leon Creek inundated the Jet Engine Test facility at Port San Antonio, a large industrial complex, located on the site of the former Kelly Air Force Base, with almost seven feet of floodwater. Historic records show that flood events have impacted facilities at Port San Antonio dating back as far as 1913 during the early days when the property was operated as Kelly AFB. Flood events in 1986 and 1987 caused over $476,000 in damages leading to the construction of the present earthen levee to provide a low level of protection, less than the 4 percent AEP event (25-year). Damages from a 2002 event caused an estimated $300,000 in damages not including revenues losses or damages to the levee itself. The May 2013 event put the facility out of operation for two weeks costing the facility approximately $100,000 in lost revenue from leased holding space. The event itself caused roughly $1 million in damages to the Jet Engine Test Cell and an additional $600,000 in damage to other Port San Antonio facilities.

The hydrograph in Figure 3-1 shows that Leon Creek rose from within-bank levels to its peak flood stage in approximately six hours, tapering off somewhat more slowly but returning to within-bank conditions in less than 24 hours.

High velocities present the primary flood concern with respect to safety. Three persons lost their lives during the May 2013 flood from being swept from their vehicles because of swiftly flowing water. Most flood damages are associated directly with out-of-bank flow. Seven feet of water flowed through the Jet Engine Test facility at Port San Antonio for a short duration, according to a media report (KSAT.com, May 15, 2013). Backwater flooding is limited to a few areas along Leon Creek Trib F.

Approximately 4,629 structures would be expected to receive damage from a 0.2 percent Annual Exceedance Probability (AEP) event, and existing average annual damages in the watershed are estimated at just over $13 million. More than 1,500 single-family homes are located within the 1 percent AEP flood plain, and within several isolated pockets, damageable properties are located within the 50 percent AEP floodplain. Not only is it a large economic burden when flooding occurs, but there is concern for public health and safety. In sharp contrast, this same watershed can experience periods of low or almost nonexistent flow in certain areas, resulting in degradation of the channel and its environs.

GEOLOGY, SOILS, AND TOPOGRAPHY

Balcones Escarpment

San Antonio and Bexar County are on the boundary between the Gulf Coastal and Great Plains physiographic provinces. Dividing these two provinces in this region of Texas is the Balcones Escarpment, part of the Balcones Fault Zone. The escarpment extends from near Del Rio, Texas, northeast through Bexar County to Austin. Remnants of the escarpment extend as far north as Waco. The Balcones Escarpment rises approximately 1,000 feet above the coastal prairie to the south and east, creating a marked influence on the area’s environment. Northwest of the escarpment lies the Edwards Plateau area of the Great Plains Province. Since the plateau’s formation, it has eroded, becoming a rugged, hilly region dissected by numerous small streams with elevations ranging from 1,100 to 1,900 feet. Southeast of the escarpment and running along the base lies the Blackland Prairie area of the Gulf Coastal Province, with its gently rolling hills. The potential incidence of high-magnitude flooding is greater in the Balcones Escarpment area than in any other region of the United States. Rates of precipitation and discharge per unit drainage area approach the largest ever recorded. The intensity of rainstorms is compounded by rapid runoff and limited infiltration, producing episodic flooding.

The study area lies within the Balcones Fault Zone, which is characterized by numerous parallel and *en echelon* faults, downthrown to the south. The topography is characterized by a gently rolling land surface that slopes southeast toward the Gulf of Mexico. Four predominant geologic formations or groups of formations crop out in the watershed: From north to south according to the San Antonio sheet of the “Geologic Atlas of Texas” (Brown and others, 1983), the surficial rocks primarily are

(1) Glen Rose Limestone

(2) Edwards Group undivided

(3) Navarro Group and Marlbrook Marl, Pecan Gap Chalk, and Austin Chalk

(4) Leona Formation and fluviatile terrace deposits.

The outcropping Glen Rose Limestone is characterized by shallow, rocky, and clayey soils with relatively low to moderate infiltration capacity based on the Bexar County Soil Survey. The outcropping Edwards Group undivided is characterized by shallow- to moderate-depth clayey soils with relatively high infiltration largely because of faults, sinkholes, and other karst features. The outcropping Navarro Group and Marlbrook Marl, Pecan Gap Chalk, and Austin Chalk are characterized by deep clayey soils with moderate infiltration capacity. The outcropping Leona Formation and fluviatile terrace deposits are characterized by deep clayey and sandy loam soils with relatively high infiltration.

Soils

The San Antonio and Bexar County area is composed of several general soil associations. Two major soil associations classified by the United States Department of Agriculture (USDA) occur along Leon Creek. They are the Trinity series found above the Commerce Street Bridge and the Frio series below.

The Trinity series consists of alluvial soils that are deep, dark colored, and nearly level. These soils are on the bottomland in the eastern and southwestern parts of the county. The Frio series consists of limy alluvial soils that are moderately deep, grayish brown or dark grayish brown, and nearly level.

Portions of the Leon Creek watershed contain prime farmland soils as defined by the Farmland Protection Policy Act (FPPA).

Topography

Elevation in the Leon Creek watershed ranges from about 460 to 1,930 feet above sea level. Land slopes generally are steeper in the northern (upstream) part of the watershed than in the southern (downstream) part. Overall, the Leon Creek stream channel slope is about 18 feet per mile. Some stream slopes in the northern part of the watershed (upper Culebra Creek and upper Helotes Creek) are greater than 60 feet per mile.

LAND USE

Land in the northwestern part of the Leon Creek watershed, upstream of Loop 1604 (SH 1604) is largely undeveloped rangeland and juniper and oak forests. It includes the Government Canyon State Natural Area (GCSNA), a roughly 8,600-acre area containing karst features and critical habitat for a number of threatened or endangered species. The lands in the upper northeast portion of the watershed are generally grasslands that have been highly degraded by grazing activities and/or urbanization. Land in the southern part of the watershed below SH-90 to the confluence with the Medina River is largely agricultural and includes Lackland Air Force Base. The central area of the watershed is comprised of relatively intense residential and commercial development. Within the watershed, undeveloped lands are undergoing conversion to suburban residential and commercial land use. The 2010 population in the study area was 340,133, an increase of 43 percent from 2000. Figure 2-1, depicts the land use in the 0.2 percent AEP in Leon Creek watershed. Land use has continued to shift to more urbanized development since 2010.

AIR QUALITY

The study area is located in Bexar County, which is currently in attainment status for all National Ambient Air Quality Standards (NAAQS) criteria pollutants with the exception of a pending status for Particulate Matter ($PM_{2.5}$) as established and monitored by the EPA.

NOISE

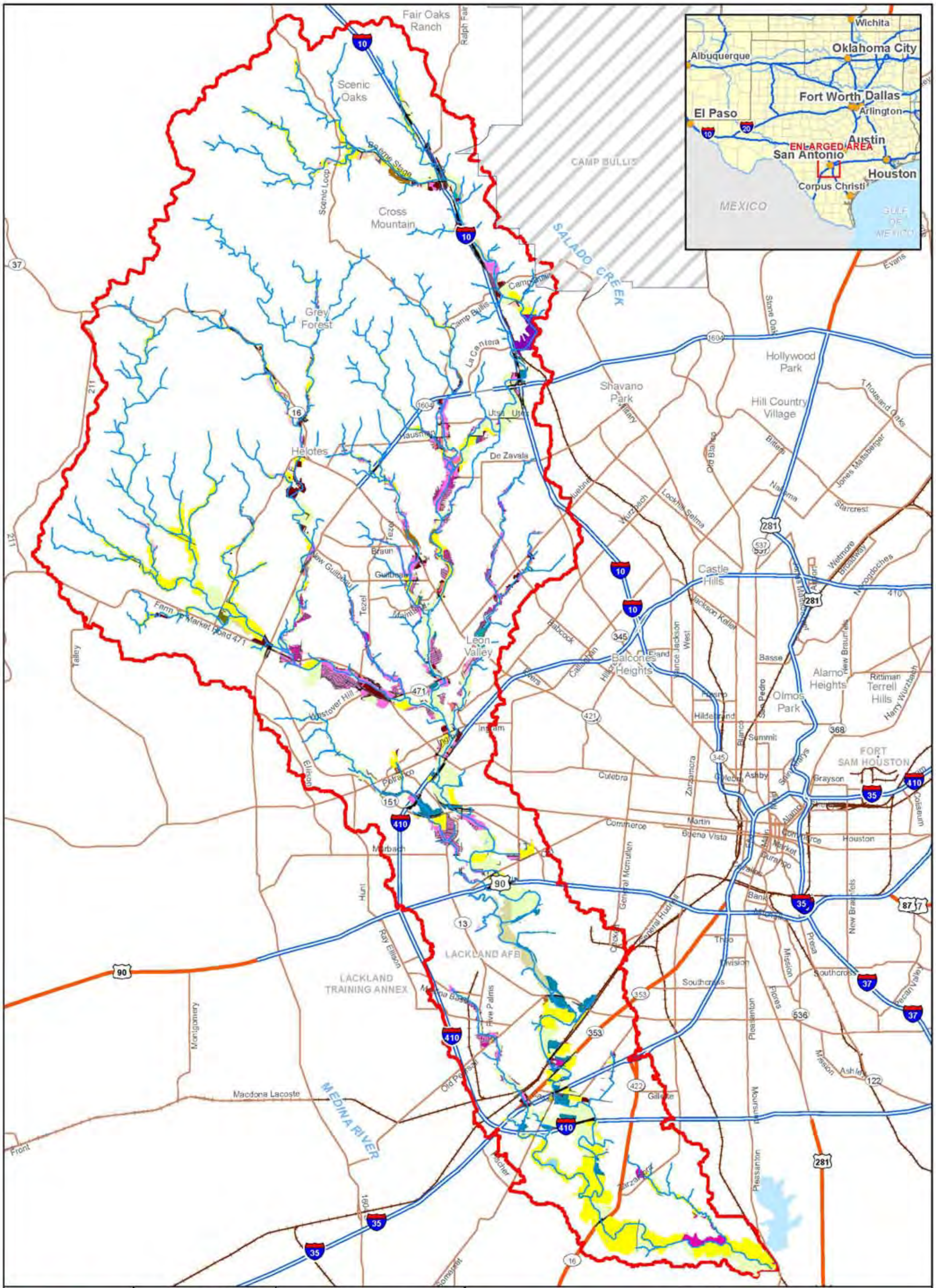
Pursuant to Chapter 21, Article III of the City Municipal Code, maximum permissible noise levels depend on the land use of the property that contains the noise source (e.g., industrial, commercial, or residential) and the land use of the property receiving that noise. Maximum permissible noise levels range from the 63 A-frequency weighted decibels (dBA) in residential zoning districts to 85 dBA in the entertainment zoned districts. Baseline noise levels within the watershed are typical of those found in rural and urbanized areas, as applicable.

GROUNDWATER

Leon Creek contributes recharge to two major aquifers, Trinity and Edwards, as shown in Figure 2-2. The Trinity Aquifer extends in a band through the central part of the State from the Red River to the eastern edge of Bandera and Medina Counties. The Trinity is the primary water source for much of the Texas Hill Country. Most water consumers in northern Bexar, Bandera, Kendall, Comal, and Kerr Counties get their water from the Trinity. All of Bandera County, most of Kerr and Kendall Counties, and large parts of Comal and Bexar Counties serve as drainage or catchment area that recharges the Edwards Aquifer which serves as the primary source of water for the San Antonio metropolitan region. So even though water consumers in the Hill Country use a different aquifer, they are intricately tied to Edwards Aquifer issues, especially with regard to restrictions on development or discharges that could affect the quality of water that ends up as Edwards recharge.

Edwards Aquifer System

Part of the Leon Creek Watershed lies over the Edwards Aquifer Recharge Zone. The Edwards Aquifer, and its catchment area in the San Antonio region, are approximately 8,000 square miles and include all or part of 13 counties in south-central Texas. The aquifer is a limestone formation associated with the Balcones Fault Zone. The aquifer is divided into three main parts: drainage area, recharge, and artesian zones, as shown in Figure 2-3. The Edwards provides valuable threatened and endangered species habitat. In addition, the Edwards Aquifer is the primary water supply source for the city of San Antonio.



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USGS NHD DATASET

PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
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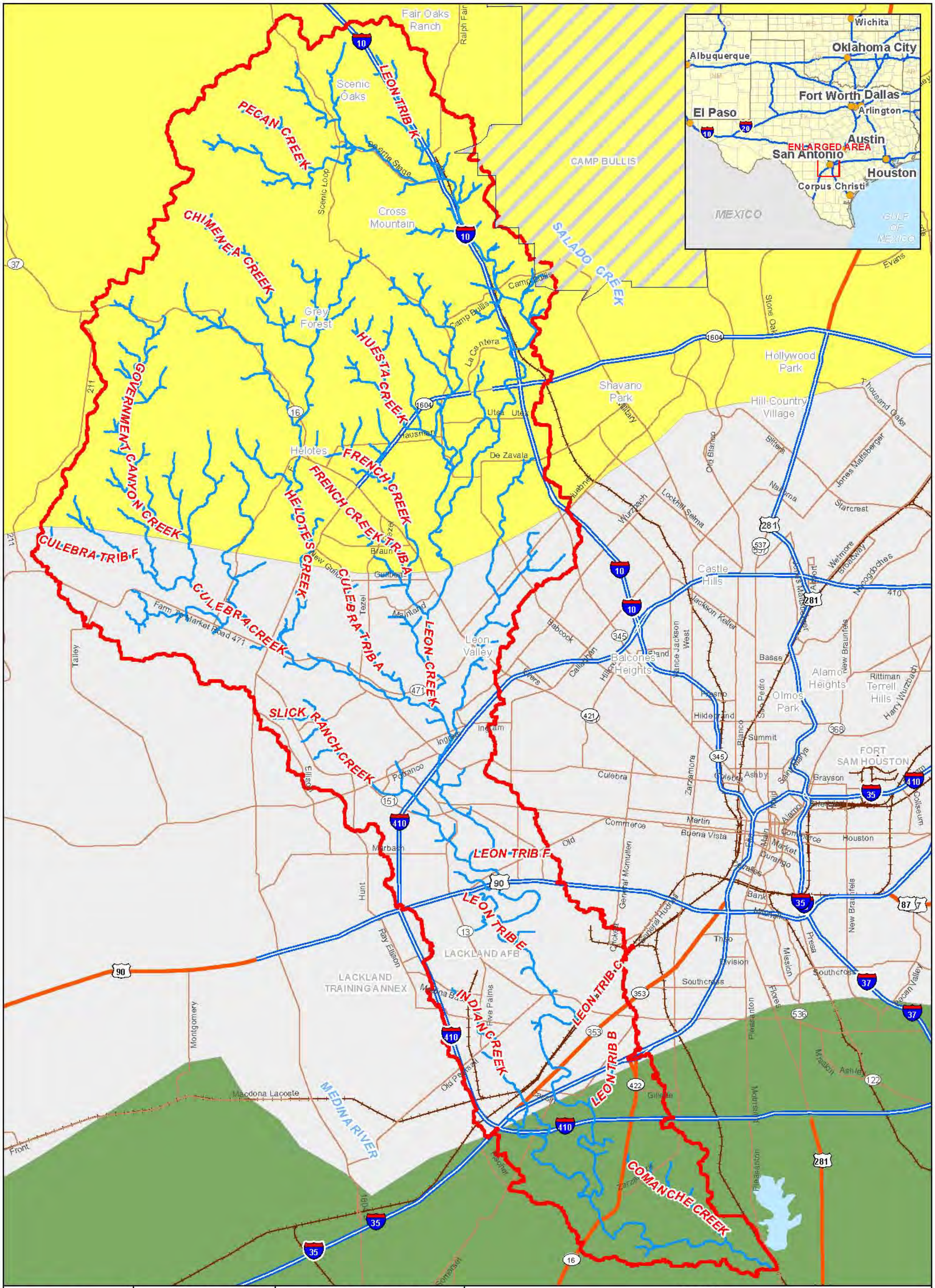
LEON CREEK
SAN ANTONIO,
TEXAS

INTERIM FEASIBILITY
STUDY
FIGURE 2-1.
LAND USE



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LEON CREEK
SAN ANTONIO, TEXAS

INTERIM FEASIBILITY STUDY
FIGURE 2-2.
GROUNDWATER AQUIFERS

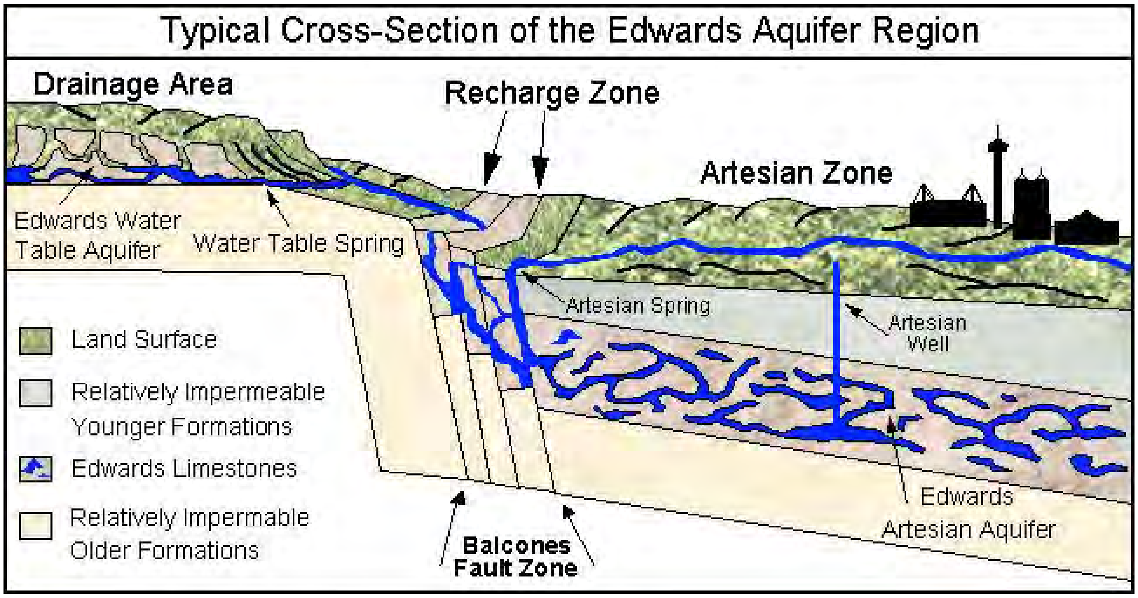
Legend

- Streams/Rivers
- Military Installations
- Lakes/Reservoirs
- Study Area

Texas Aquifers

- Mississippi embayment aquifer system
- Blaine aquifer
- Seymour aquifer
- High Plains aquifer
- Edwards-Trinity aquifer system
- Texas coastal uplands aquifer system
- Coastal lowlands aquifer system
- Pecos River Basin alluvial aquifer
- Rio Grande aquifer system
- Other rocks

Figure 2-3. Edwards Aquifer Zones



Source: Eckhardt, 2007

Discharge from the aquifer is from both springs and artesian wells. The natural discharge of the aquifer is primarily from five major springs: San Marcos, Comal, Leon, San Antonio, and San Pedro. None of the springs listed above occur in the study area. Generally, the water in the Edwards Aquifer is of high quality. It meets all state standards for groundwater. Water quality of the Edwards Aquifer is affected by many factors, including increased pumping, degraded or polluted water entering the aquifer, non-point and point source pollution, and decreased recharge. Floodwaters entering the Edwards Aquifer normally carry many suspended solids and debris; the transmissivity of the aquifer is low purifying the water in the process. Figure 2-3 displays the aquifer zones of the Edwards.

The Edwards Aquifer is the primary source of groundwater within the study area. It is a Federally-designated sole source aquifer, a source of drinking water for the city of San Antonio. Because it is the sole source aquifer, and there has been increased demand for water supply without increased recharge, a successful lawsuit resulted in pumping restrictions on the Edwards Aquifer. The suit, filed under the Endangered Species Act, cited threats to threatened and endangered species in the Edwards Aquifer and the associated springs.

Trinity Aquifer System

Unlike the Edwards, the Trinity Aquifer recharges very slowly. Only 4–5 percent of water that falls as rain over the area ends up recharging the Aquifer, and water moves through the Trinity much more slowly than through the Edwards. The Trinity contributes a large amount of water as recharge for the Edwards, generally by faults in areas where the layers are juxtaposed by faults or where the Trinity underlies the Edwards. There are actually several aquifers that make up the Trinity system. The Trinity is a group of geologic deposits divided into several distinct formations, and each formation is in turn composed of several layers. In the vicinity of the Leon Creek Watershed, the formation is known as the Glen Rose formation. This formation, which is most familiar to the water users in south central Texas, is composed mainly of limestone which thickens toward the Gulf and is divisible into upper and lower members. Indications are that the Glen Rose formation of the Trinity Aquifer has been overused in many places.

HYDROLOGY AND HYDRAULICS

Appendix G.1 contains the detailed hydrologic and hydraulic analysis of the study area, including discharges at specific locations within the Leon Creek Watershed. The major tributaries to Leon Creek are: Culebra Creek (82.3 square miles), Huebner Creek (12 square miles), French Creek (11.6 square miles), Slick Ranch Creek (11.5 square miles), and Indian Creek (11 square miles).

The Leon Creek basin does not fit a “typical” watershed shape. The portion of the watershed upstream of Huebner Creek is relatively steep and wide, with an average width of approximately 10 miles and a length of about 32 miles. The portion of the watershed downstream of Huebner Creek is relatively flat and narrow, with an average width of approximately four miles and a length of about 25 miles.

Datum

Water surface profiles developed for each creak and stream in the watershed are referenced using North American Vertical Datum of 1988 (NAVD88). Water surface profiles within this watershed range from 456 to 1,600 feet (NAVD88).

Existing Conditions Hydrology

A watershed runoff model was developed using the USACE HEC-Hydrologic Modeling System (HEC-HMS), version 3.0, software. Data preprocessing and parameter generation was done using HEC-GeoHMS. The upstream study limit on each tributary was set at one square mile.

SARA provided a land use raster dataset to assist in developing initial parameters for the hydrologic model. Parameters were further refined using storm reproductions and frequency analyses.

The final product from this analysis was a Peak Discharges Summary table, which lists the 50, 20, 10, 4, 2, 1, 0.4, and 0.2 percent Annual Exceedance Probability (AEP) discharges for each location required to support the hydraulic analysis. For the complete table of more than 400 discharge locations, see Appendix G.1 “Hydrologic and Hydraulic Analyses.”

Existing Conditions Hydraulics

A standard-step, backwater model was developed using the USACE HEC-River Analysis System (HEC-RAS), version 3.1.2, for Leon Creek and tributaries with a contributing drainage area of at least one square mile. Data preprocessing and initial parameter generation was done using HEC-GeoRAS. To achieve accurate model results suitable for use in evaluating problems and opportunities identified during the plan formulation phase, each stream was modeled independently.

Floodplain Delineation

Water surface elevations were exported from each HEC-RAS model to ESRI ArcMap. HEC-GeoRAS tools were used to delineate the floodplains. The final product from this phase of analysis is a set of flood plain delineations were developed for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2 percent AEP events for each stream studied.

Existing Conditions Results

Water surface profiles were developed for each stream in the watershed that was studied in detail. From this analysis, significant flood depths were found to occur on several stream reaches with the potential for damaging structures. Streams that were carried forward in to plan formulation are discussed in the next section.

EXISTING CONDITIONS FLOOD RISK MANAGEMENT

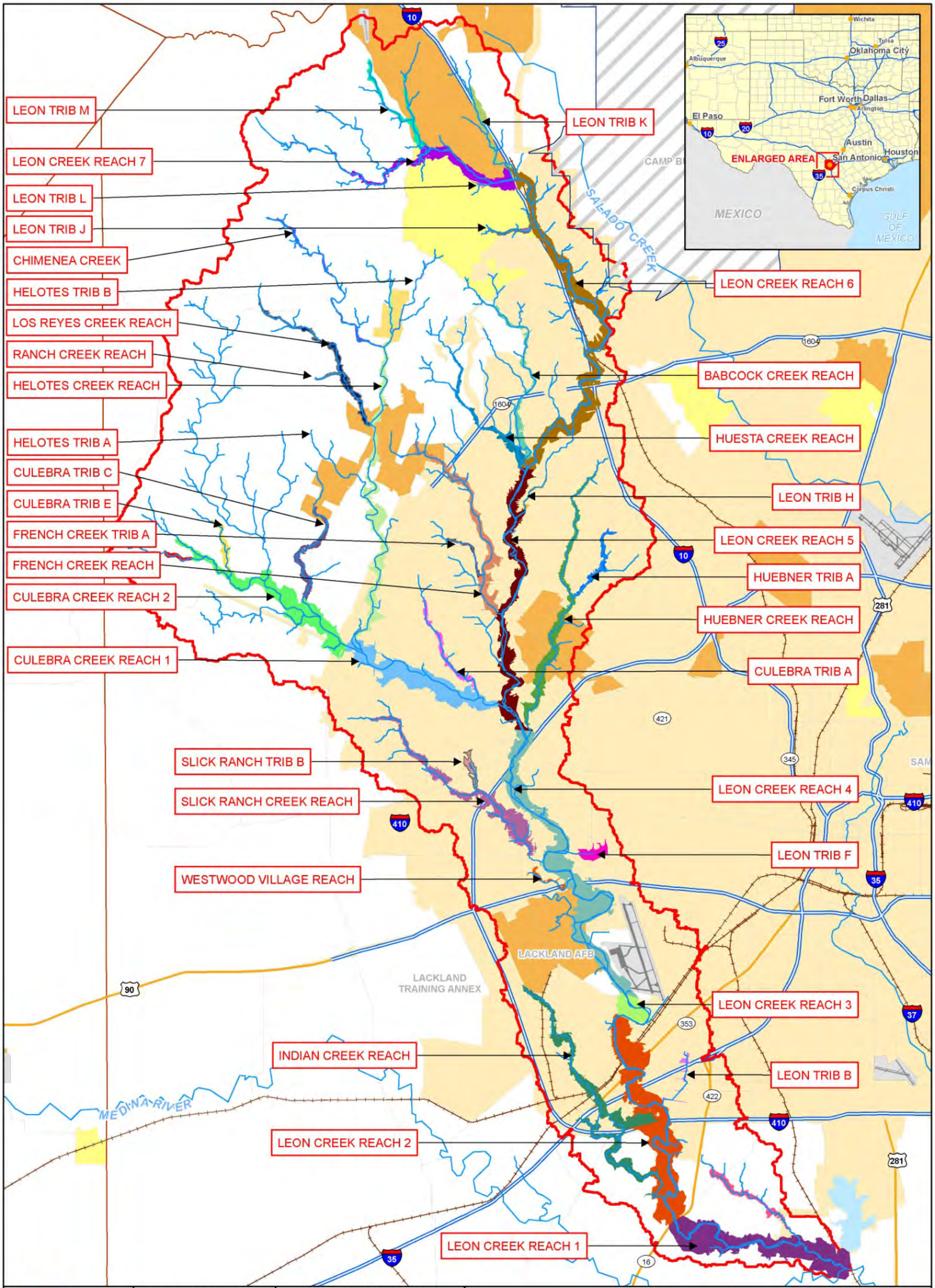
For a detailed socioeconomic flood damage and cost analysis, see Appendix A “Economic Analysis.”

Economic Reaches

Economic reaches were used as the basic framework for analysis of flood risk management alternatives, since both damages and benefits are computed by economic reach. As depicted in Table 2-1, the study area was initially divided into 35 economic damage reaches, based on the locations of confluences of Leon Creek with its tributaries and of major road crossings. Figure 2-4 shows the geographic locations of all 35 reaches

Table 2-1. Existing Average Annual Damages by Economic Reach
(October 2013 Prices - $000)

Reach	Commercial	Multi-Family Residential	Mobile Homes	Public	Privately Owned Vehicles	Single-Family Residential	Total AAD
Babcock Trib	$5	$100	$0	$4	$173	$24	$306
Chimenea Creek	<1	0	0	0	<1	1	2
Culebra Creek R1	170	0	0	2	665	1,571	2,408
Culebra Creek R2	56	0	3	0	21	13	93
Culebra Trib A	0	0	0	0	30	66	96
Culebra Trib C	11	0	<1	0	7	14	32
Culebra Trib E	3	0	0	0	3	13	19
French Creek	127	1	0	10	41	120	299
French Trib A	0	0	0	0	0	<1	<1
Helotes Creek	80	0	0	12	124	325	541
Helotes Trib A	47	0	0	0	<1	2	49
Helotes Trib B	0	0	0	0	<1	<1	1
Huebner Creek	9	21	<1	31	137	333	531
Huebner Trib A	58	0	0	0	19	51	128
Huesta Creek	0	7	4	0	90	26	127
Indian Creek	16	0	<1	<1	22	55	93
Leon Creek R1	0	0	1	3	<1	0	5
Leon Creek R2	74	0	99	<1	189	121	483
Leon Creek R3	1,702	0	0	0	0	0	1,702
Leon Creek R4	648	168	<1	124	33	194	1,168
Leon Creek R5	305	228	0	0	309	661	1,503
Leon Creek R6	1018	0	3	43	79	73	1,216
Leon Creek R7	40	0	2	2	321	790	1,155
Leon Trib B	0	0	0	0	<1	<1	<1
Leon Trib F	0	0	0	1	42	65	108
Leon Trib H	0	0	0	0	0	<1	<1
Leon Trib J	0	0	0	0	0	<1	<1
Leon Trib K	180	0	0	0	0	0	180
Leon Trib L	0	0	0	0	0	0	0
Leon Trib M	0	0	0	0	0	0	0
Los Reyes Creek	16	0	0	<1	5	9	30
Ranch Creek	0	0	0	0	0	0	0
Slick Ranch	132	35	0	0	222	545	934
SR Trib B	89	<1	0	0	5	2	96
WW Village	3	0	0	0	3	3	9
Total	**$4,789**	**$561**	**$113**	**$232**	**$2,540**	**$5,081**	**$13,316**



US Army Corps of Engineers®
Fort Worth District
Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 19, 2012
Author: Lucas Daniels
Location: \\swf-fs1fbgis\projects\cvljobs\LeonCreek\Documents\

REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET

PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

LEON CREEK
SAN ANTONIO, TEXAS

INTERIM FEASIBILITY STUDY
FIGURE 2-4.
ECONOMIC DAMAGE REACHES

Legend

- Streams/Rivers
- Lakes/Reservoirs
- ▨ Military Installations
- Study Area

Miles
0 1.25 2.5 5 7.5 10

Based on economic viability-- those reaches that showed potential to produce positive net benefits, that warranted further investigation are listed below.

Leon Creek Economic Reaches

1 Confluence of Leon Creek with Medina River to downstream of State Highway 16

2 Downstream of State Highway 16 to downstream of the Jet Engine Test Cell facility located at Port San Antonio (formerly Kelly Air Force Base)

3 Downstream of the Test Cell Facility to just upstream of S.W. Military Drive

4 Upstream of S.W. Military Drive to just upstream of confluence with Huebner Creek

5 Upstream of confluence with Huebner Creek to upstream of Babcock Road

6 Upstream of Babcock Road to upstream of I-10

7 Upstream of I-10 to end of study area

Culebra Creek Economic Reaches

1 Confluence of Culebra Creek with Leon Creek to downstream of Loop 1604

2 Downstream of Loop 1604 to end of study area

Additional Economic Reaches

1 Babcock Tributary

2 Culebra Creek Tributary A

3 Culebra Creek Tributary C

4 Culebra Creek Tributary E

5 French Creek

6 Helotes Creek

7 Huebner Creek

8 Huebner Creek Tributary A

9 Huesta Creek

10 Indian Creek

11 Leon Creek Tributary F

12 Leon Creek Tributary K

13 Los Reyes Creek

14 Slick Ranch Creek.

Value of Floodplain Inventory

The 0.2 percent AEP floodplain contains 4,630 structures valued at $1,157,588,000 using January 2008 price levels. The structures are composed of 3,757 (81.1 percent) single-family structures, 56 (1.2 percent) multi-family residential structures, 193 (4.2 percent) mobile homes, 513 (11 percent) commercial structures, and 111 (2.4 percent) public structures. Total valuation of single-family residential structures is estimated at $812,722,000 (70.2 percent); for multi-family residential, $72,029,000 (6.2 percent); mobile homes, $4,797,000 (0.4 percent); commercial structures, $248,559,000 (21.5 percent); and public structures, $19,481,000 (1.7 percent). There are also an estimated 4,133 privately owned automobiles with a total valuation of $81,768,000.

Single Event Damages

Economic damages were assessed for the floodplain structures that lie within each reach. The following provides a description of the structure values and privately owned vehicles for each reach in the study area. A detailed table of the specific structure inventory is provided in Table 3-2. Single-event structure damages are depicted in Table A-16 of the Economics Appendix.

Damages in the floodplain begin to accrue with the 50 percent AEP event involving eight structures and damages estimated at $63,000, using January 2008 price levels. With the 10 percent AEP, a total of 408 structures receive damages estimated at $11.5 million. Single-family residential makes up 45 percent of the structures and 33 percent of the damages. Commercial structures account for 28 percent of total structures and 59 percent of the damages.

With a 4 percent AEP event, 846 structures are projected to experience damages totaling $31.9 million. Of these structures, 52 percent are single-family residential and 26 percent commercial. Single-family residential makes up 34 percent of total damages, while commercial structures account for 58 percent of total damages.

The 1 percent AEP event is projected to generate $97.2 million in damages to 1,971 structures. Seventy-one percent of the structures are single-family residential, which accounts for 37 percent of the damages. Commercial structures account for 17 percent of the total structures and 54 percent of total damages.

In the 0.2 percent AEP event, 4,629 structures are projected to experience damages totaling $245.4 million. Eighty-one percent of the structures are single-family residential and 11 percent are commercial. Single-family residential structures account for 51 percent of total damages, while commercial structures represent 41 percent of total damages.

Average Annual Damages

The overall existing average annual damages (AAD) for the watershed are estimated at $13,316,000. Single-family residential structures account for 37 percent of total EAD, commercial structures account for 37 percent, privately owned vehicles 19 percent, public structures 2 percent, multi-family residential structures 4 percent, and mobile homes about 1 percent. Table 2-1 shows the EAD for each reach in the study.

Terrestrial Resources

Vegetation

The Leon Creek Watershed is located within three vegetational areas of Texas, as shown in Figure 2-5. This section provides a general description of the two predominant vegetation areas: Blackland Prairies and Edwards Plateau. The third vegetational area (not described), South Texas Plains, comprises less than 1 percent of the study area.

Blackland Prairies

The Blackland Prairies area located in the central region of Bexar County was historically a large grassy plain. Now, the "prairie" has timber along the streams including a variety of oak (*Quercus* sp.), pecan (*Carya illinoiensis*), cedar elm (*Ulmus crassifolia*), and mesquite (*Prosopis glandulosa*).

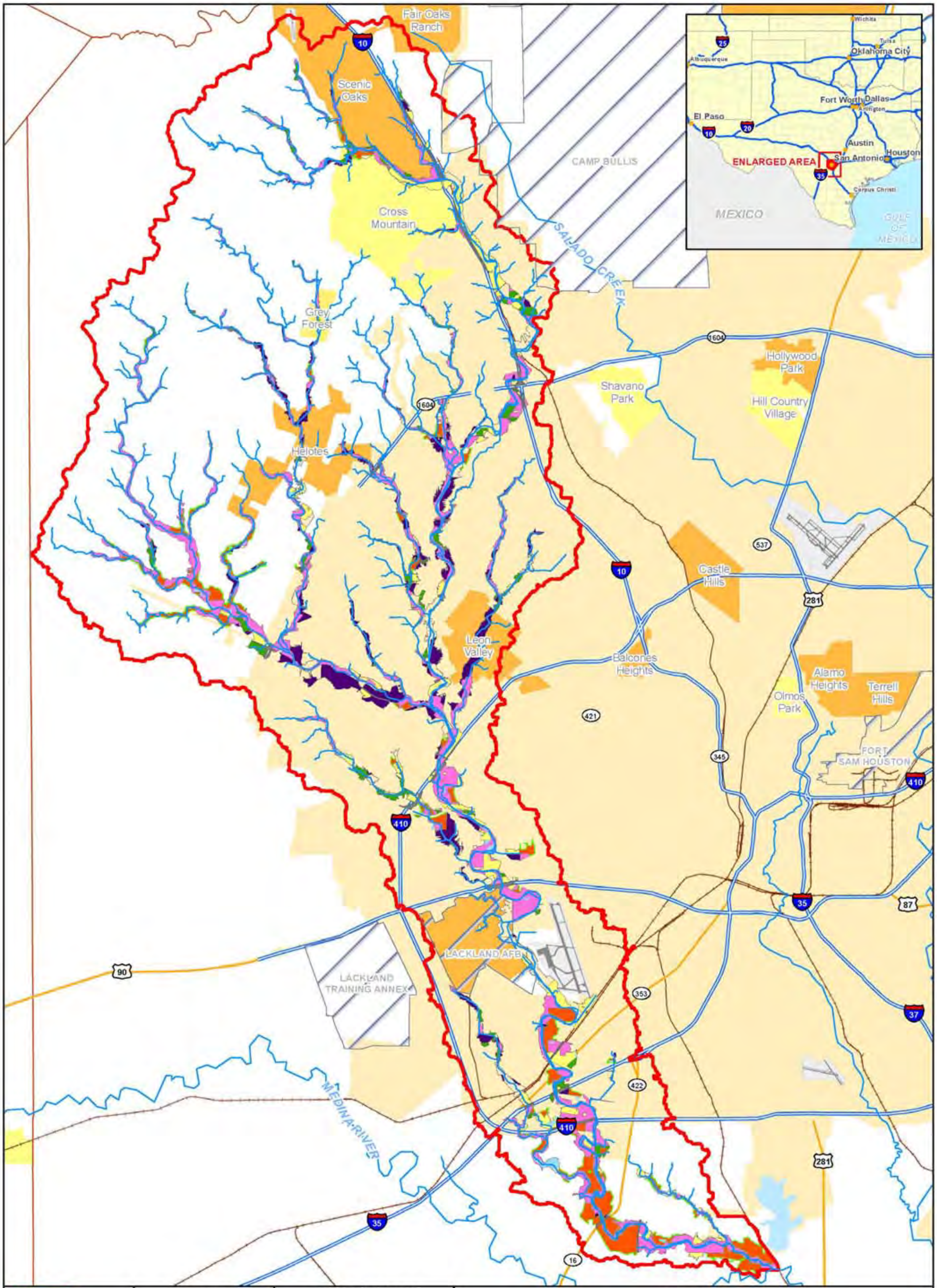
Most of this fertile area has been cultivated, and only small acreages of meadowland remain in original vegetation. In heavily grazed pastures, buffalo grass (*Buchloe dactyloides*), Texas grama (*Bouteloua rigidiseta*), and other less productive grasses have replaced the tall bunchgrasses. Mesquite and other woody plants have invaded the grasslands.

The original grass vegetation included big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum),* sideoats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), tall dropseed (*Sporobolus asper*), Texas winter grass (*Stipa leucotricha*), and buffalo grass. Non-grass vegetation is largely legumes and composites.

Edwards Plateau

In the South Central Texas region, the Edwards Plateau vegetation area includes the northern portions of Bexar County. The soils are shallow, ranging from sands to clays, and are calcareous. This area is predominantly rangeland, with cultivation confined to the deeper soils.

The principal grasses are several species of bluestem (*Schizachyrium* and *Andropogon* spp.), grama (*Bouteloua* spp.), Indian grass , common curly mesquite (*Hilaria belangeri*), buffalo grass , and Canadian wild rye (*Elymus canadensis*). The rocky areas support tall or mid grasses with an overstory of live oak (*Quercus virginiana*) and other oaks (*Q. fusiformis, Q. buckleyi, Q. sinuata* var. *breviloba*), cedar elm , and mesquite . The heavy clay soils have a mixture of buffalo grass (*Buchloe dactyloides*), sideoats grama, and mesquite . However, with lack of fire and large-scale landscape management, Ashe juniper (*Juniperus ashei*) has become one of the predominant plants within the Edwards Plateau, as Figure 2-5 entitled "Leon Creek Vegetation Classification" illustrates.



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PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

LEON CREEK
SAN ANTONIO, TEXAS

INTERIM FEASIBILITY STUDY
FIGURE 2-5.
VEGETATION CLASSIFICATION

Study Area Vegetation

In 2008, vegetation was digitized in the 0.2 percent annual exceedance probability event (500-year floodplain) within the Leon Creek Watershed, from the headwaters to its confluence with the Medina River, to determine the cover type and acreage of each vegetation classification. The information was ground-truthed by the USACE, USFWS, and TPWD, and a total of seven different types of ground cover were identified for use within this area. Table 2-2 displays those classifications with their respective acreages.

Table 2-2. Vegetation Classification of the Leon Creek 0.2 percent Annual Exceedance Probability Event (500-Year Floodplain)

Vegetation Class	Acreage
Streambed	1,061
Grassland	2,045
Urban	5,600
Agricultural	2,727
Riparian Woodland	9,038
Total	20,471

USACE, USFWS, and TPWD staff visited various sites along Leon Creek from the headwater of Leon Creek to its confluence with the Medina River. During the site visits, native vegetation at the majority of sites was found to be very diverse and dominated by mixed deciduous trees, such as black willow (*Salix nigra*), sycamore (*Platanus occidentalis*), oak (*Quercus spp*.), elm (*Ulmus spp.*), pecan (*Carya illinoiensis*), sugarberry (*Celtis laevigata*), Ashe juniper (*Juniperus ashei*), and honey mesquite (*Prosopis glandulosa*). Scrub-shrub type vegetation included lotebush (*Ziziphus obtusifolia*), agarita (*Berberis trifoliata*), buttonbush (*Cephalanthus occidentalis*), Texas Mountain Laurel (*Sophora secundiflora*), and Texas persimmon (*Diospyros texana*). Some of the forbs found on site included: snow on the mountain (*Croton marginatus and C. monanthogynus*), and giant ragweed (*Ambrosia trifida*). Grasses observed were buffalo grass (*Buchloe dactyloides*), Virginia wild rye (*Elymus virginicus*), silver bluestem (*Bothriochloa laguroides*), King Ranch bluestem (*B. ischaemum*), little bluestem (*Schizachyrium scoparium*), foxtail (*Cetaria sp.*), sedge (*Carex sp)*, and switchgrass (*P. virgatum*). Flatsedges (*Cyperus erythrorhizos and C. peseudovegetus*) were also found (USFWS 2008a). Aquatic vegetation is discussed in the subsection below entitled “Aquatic Habitat.”

The original vegetation within the Upper and Urban Leon Creek, Culebra Creek, and Helotes Creek segments is described as a savanna that was rich in tall and mid-grasses with interspersed clumps of live oak and shin oak. However, overgrazing by livestock and the desire to suppress naturally occurring range fires has promoted a tremendous increase in the abundance of woody species. Such species include Ashe juniper, honey mesquite, huisache, and others that were historically restricted to the steep slopes of canyons, ridges, and ravines where fires could not reach them (Buechner, 1944).

Much of the watershed is still being used for agricultural purposes, such as grazing, row cropping, and hay production. However, a recent increase in population has promoted residential growth throughout much of the area. This development has resulted in clearing of large tracts of land for homes, businesses, and utility lines. A common practice observed is the clearing of brush and understory and leaving stands of oak species. The implications of increased impervious cover and the conversion to Ashe juniper and other prolific hydrophytic (water-loving) species from native grasslands or savannas is that there is less water infiltration into the soils and more runoff. This results in shorter durations of flows in the creeks, which in turn results in less recharge into the aquifers. In addition, if hydrophytic vegetation gets established, their roots extend to the aquifer and deplete shallow aquifer levels.

The historic vegetation of the Lower Leon Creek segment is rolling to nearly level plains of the Northern Blackland Prairie ecoregion, with mostly fine-textured, dark, calcareous, and productive Vertisol soils. Historical vegetation was dominated by little bluestem, big bluestem, yellow Indian grass, and tall dropseed. Common forbs included asters, prairie bluet, prairie clover, and black-eyed susan. Stream bottoms were often wooded with bur oak, Shumard oak, sugar hackberry, elm, ash, eastern cottonwood, and pecan. Most of the prairie has been converted to cropland, non-native pasture, and expanding urban uses around San Antonio, which is a significant contributing factor to the water quality issues in the basin.

Habitat Value

The vegetation within the study area plays an important role in providing wildlife habitat. To measure the existing condition value of the vegetation as wildlife habitat, USACE, along with TPWD and USFWS, used the Habitat Evaluation Procedures (HEP) developed by the USFWS. Value is measured on a scale of 0.0 to 1.0, with 1.0 being the highest possible value. Appendix B “Ecosystem Evaluation” describes HEP methodologies in detail. Table 2-3 shows the results of the HEP assessment.

Table 2-3. Summary of Existing Habitat Suitability Index (HSI) and Habitat Units (HU) by Environmental Segment

Cover Type	**Riparian Woodlands**			**Grassland**		
Environ. Segment	**Acres**	**HSI**	**HU**	**Acres**	**HSI**	**HU**
Upper Leon	878	0.47	413	408	0.80	326
Urban Leon	2,730	0.33	901	945	0.81	765
Culebra Creek	1,680	0.30	504	229	0.73	167
Helotes Creek	928	0.30	278	117	NA	NA
Lower Leon	2,822	0.32	903	346	0.60	208
Total	9,038		2,999	2,045		1,466

Wildlife

Overall, the Leon Creek Watershed provides good quality wildlife habitat, but some specific areas including GCSNA provide some of the most pristine native habitats in Texas. Wildlife populations within the undeveloped segments of the watershed represent a typical south-central Texas wildlife community. The animals are largely those commonly associated with farming areas. The farms in the watershed are relatively small. The fencerows and roadsides, when vegetation is allowed to grow on them, provide habitat for birds and smaller mammals. Common types of wildlife found in the area include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), armadillo (*Dasypus novemcinctus*), cottontail (*Sylvilagus*), jackrabbit (*Lepus*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), American beaver (*Castor canadensis*), mourning dove (*Zenaida macroura*), wild turkey (*Meleagris gallopavo*), Virginia opossum (*Didelphis virginiana*), and several species of skunk (*Spilogale* spp). Due to urbanization and influences of man, the larger predators, such as the coyote (*Canis latrans*) and bobcat (*Lynx rufus*), have been reduced in numbers from the urban areas. However, they are common in remote areas of the watershed, such as within Camp Bullis Military Base. Various amphibians and reptiles including numerous species of frog (*Rana* spp), toad (*Scaphiliopus* spp), turtle (*Chrysemys* spp), lizard, and snake are also found in the creek and the watershed.

Migratory songbirds, such as American robin (*Turdus migratorius*) and cedar waxwing (*Bombycilla cedrorum*), are also commonly found. Over 400 bird species have been observed within the study area, including the State and Federally Listed endangered species mentioned earlier, golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapillus*) (Hawkins et al., 1997). Lack of large-scale suitable habitat for migratory waterfowl and shorebirds indicates that the area does not represent a major migratory stopping point. However, wetlands associated with the Leon Creek watershed can provide stopover habitat during migration.

During site visits, a variety of birds were observed along the Leon Creek watershed, including the canyon wren (*Catherpes mexicanus*), Bewick’s wren (*Thryomanes bewickii*), painted bunting (*Passerina ciris*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), cardinal (*Cardinalis cardinalis*), yellow-billed cuckoo (*Coccyzus americanus*), purple martin (*Progne subis*), barn swallow (*Hirundo rustica*), cliff swallow (*Petrochelidon pyrrhonota*), scissor-tailed flycatcher (*Tyrannus foficatus*), great-crested flycatcher (*Myiachus crinitus*), spotted sandpiper (*Actitis macularia*), cattle egret (*Bubulcus ibis*), little blue heron (*Egretta caerulea*), great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*) (USFWS, 2008a).

AQUATIC RESOURCES

Leon Creek Watershed Characteristics

Due to the ephemeral nature of much of Leon Creek as it crosses the Edwards limestone formation, there is not an abundant amount of surface water in the watershed in the upper Leon Creek area. There are no reservoirs on the mainstem of Leon Creek. The remainder of the creek upstream of US

Highway 90 in the recharge zone is dry except during rainfall events. Below or downstream of US Highway 90, Leon Creek is perennial in nature and is characterized by slow flows, large lagoons, pools, and riffle areas. These stream characteristics provide aquatic habitat for a variety of species.

Leon Creek receives water from spring flow, rainfall, storm water discharge, and return flows from sewage treatment plants. The creek generally flows south and enters the main portion of Port San Antonio from the northwest, near the intersection of Billy Mitchell Road and Westover Road. Leon Creek drains a highly urbanized residential area and the Lackland and former Kelly Air Force bases.

The Texas Commission on Environmental Quality (TCEQ) breaks Leon Creek into two segments: Upper Leon Creek (Segment 1907) and Lower Leon Creek (Segment 1906). Segment 1907 is about 25 miles long and extends from 110 yards upstream of SH-16 northwest of San Antonio in Bexar County to a point 5.6 miles upstream of Scenic Loop Road north of Helotes. Segment 1906 is approximately 32 miles long and extends from the confluence with the Medina River to a point 110 yards upstream of SH-16 northwest of San Antonio. The aquatic habitat in the Upper Leon Creek segment is considered diverse. The headwater originates from spring flow and is classified as an ephemeral stream through this segment, with varying levels of available water dependent on its location above or upon the Edwards Aquifer Recharge Zone. The segment provides habitat for fisheries and other aquatic species. The substrate is rocky with cobble. Although many small man-made check dams hold water and fill with cobble, the creek has clear water with a diversity of aquatic in-stream vegetation and structure that provide fair aquatic habitat. There are a variety of flows, pools, and riffle complexes.

Ecologically, Lower Leon Creek can be subdivided into two subsegments: a middle or urban segment and lower rural segment. The middle segment of Leon Creek is not as diverse as the upper segment. This area is composed of very rocky substrate with boulder-size particles and a bedrock channel. Fractures in limestone outcrops are common and serve to recharge the aquifer. The creek is intermittent with most flows being the result of high-intensity rainfall events. Urban lawn irrigation may support a few persistent pools. The decrease in persistent water is attributed to several things, including groundwater pumping, growth of hydrophytic plants in the contributing watershed, and increases in impervious cover. The riparian zone in this area is narrower and is dominated by more scrub-shrub species, including Ashe juniper, mesquite, cedar elm, and live oak. The major degradation to this segment is due to the decrease and/or lack of base flow within the creeks, damage from channelization projects, and narrowing of the riparian corridor within this urban environment.

Important tributaries to Leon Creek within the study area include Culebra Creek and Helotes Creek. The Culebra Creek segment emerges from spring flow at its headwaters and traverses through the Edwards Aquifer Recharge Zone until its confluence with Leon Creek. Two tributaries in this segment begin in Government Canyon State Natural Area, which covers approximately 8,622 acres in Bexar County, just west of San Antonio. This area is a pristine, highly sensitive ecosystem due to the karst features and critical habitat identified for several endangered species.

The Culebra Creek segment is consistent with the Upper Leon Creek segment in terms of available water, riparian zones, substrate, and aquatic habitat. As the stream flows through the Edwards Aquifer Recharge Zone, available water remains only in persistent pools, and the riparian areas become narrower as it moves through the urban areas until its confluence with Leon Creek. A housing development is currently being built in the headwaters with a storm drain channeled into a culvert, which will add water to the small stream during rain events. From the confluence with Helotes Creek to the confluence with Leon Creek, Culebra Creek is surrounded by development on both sides. Stream functions in this area are greatly altered and degraded.

The Helotes Creek segment is categorized as an ephemeral stream and is similar in nature to upper Leon and Culebra Creek segments. The headwaters of Los Reyes, Chimenea, and Helotes Creeks are spring fed and converge to create Helotes Creek, which has varying amounts of water depending on the location as it crosses the Edwards Aquifer Recharge Zone. Along much of this segment, the riparian corridor remains intact. North of the confluence of the three creeks, a great deal of this segment is listed as in or closely adjacent to Karst Habitat Zone 1 or 2. (For a discussion of karst zone definitions and their existence in the study area, see subsection entitled “Caves and Karst Species”).

The lower segment of Leon Creek again becomes a perennial stream that provides riverine aquatic habitat, as this segment is below the aquifer recharge zone. Aquatic vegetation species are the same species reflected in the other four segments, and the adjacent riparian areas again become wider with more bottomland hardwood species. In addition to spring flow, reuse water from the Lackland Air Force Base, Port San Antonio Test Cell Facility, and a San Antonio Water System (SAWS) wastewater recycling facility are discharged in this segment. This provides for higher levels of base flow; however, water quality is slightly impaired because of these facilities. In addition to water quality problems from the treatment plant, much of the area is agricultural lands which affect the water quality due to herbicide and pesticide runoff into this Leon Creek segment.

Water Quality

Water quality in Leon Creek is primarily the result of interaction between natural background conditions, industrial/municipal wastewater discharges, and urban storm water. The 2008 Texas Water Quality Inventory and [Clean Water Act Section] 303(d) List summarizes the status of the state’s surface waters, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources:

1. Water bodies that do not meet the standards set for their use, or are expected not to meet their use standards in the near future

2. Pollutants that are responsible for the failure of a water body to meet standards

3. Water bodies that are targeted for clean-up activities within the next two state fiscal years

Development of a Total Maximum Daily Load (TMDL) is required for pollutants that exceed established water quality standards. A TMDL is an estimate of the maximum amount of pollution a body of water can receive and still meet the water quality standards set for its use. To determine whether a water body meets the standard for its use, the major parameter pollutants that are measured are metals, organics, fecal coliform bacteria, dissolved oxygen, and dissolved solids.

Based on the Texas 2008 Water Quality Inventory Section 303(d) List, Upper Leon Creek (Segment 1907 as defined by TCEQ) met the water quality standard for dissolved oxygen from 1996 through 2002. There was no future listing for Segment 1907 in the 303(d) List. However, in 2008 the San

Antonio Water System (SAWS) listed Segment 1907 as unable to support contact recreation use due to elevated levels of fecal coliform bacteria. The 2012 303 (d) List does not include any water quality impairments for Segment 1907.

In 2006, Lower Leon Creek (Segment 1906) did not meet the water quality standards for polychlorinated biphenyls (PCBs) in edible fish tissues nor for bacteria. TCEQ contracted with the Texas Department of State Health Services (DSHS) to collect fish samples through November of 2007 to verify PCBs in fish tissue. DSHS collected 50 fish tissue samples at five stations along the Lower Leon Creek. Also, the U.S. Geological Survey and City of San Antonio Metro Health were to collect sediment samples to confirm or deny the presence of PCBs in sediment (TCEQ, 2009).

In 2008, Segment 1906 failed to meet water quality standards for bacteria, PCBs in edible fish tissues, and dissolved oxygen. Recent data noted a "Concern" for dissolved oxygen (average). A carry-forward was added, for depressed dissolved oxygen. The 2012 303 (d) List removed the water quality impairment due to bacteria from Segment 1906. This water body will remain on the 303(d) List for depressed dissolved oxygen. The impairment has been assigned to Category 5c, meaning the water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.

TCEQ will develop a total maximum daily load (TMDL) project to address the consumption advisory. A review of the water quality standards for water bodies designated as 5c will be conducted before a TMDL project is scheduled. The goal of the project will be to reduce contaminant concentrations in fish tissue to levels that constitute an acceptable risk to consumers.

Aquatic Habitat

For comparative purposes, the aquatic habitat is described by the same segments used for the vegetation description (see Table 2-4).

To establish a baseline existing condition, USACE, along with TPWD and USFWS, quantified the value of the aquatic resources using the physical aquatic habitat portion of the EPA's Rapid Bioassessment Protocols (RBP). The analysis measures ten physical habitat parameters. Each parameter is given a score from 1 to 20, and the scores are summed for a total possible score of 200, with 200 being a pristine aquatic habitat. Table 2-4 lists the results of the assessment. A discussion of the aquatic habitat in each segment follows.

Table 2-4. EPA Aquatic Habitat Assessment Existing Conditions Scores – By Environmental Segment

Habitat Parameter	Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Epifaunal Substrate	14	8	16	14	18
Embeddedness / Pool Substrate	15	8	12	12	17
Velocity/Depth Regime / Pool Variability	12	10	14	13	15

Habitat Parameter		Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Sediment Deposition		13	12	16	14	16
Channel Flow Status		2	2	6	5	16
Channel Alteration		16	9	13	16	14
Frequency of Riffles / Channel Sinuosity		18	12	15	16	16
Bank Stability	Left Bank	7	6	7	7	5
	Right Bank	8	5	7	9	5
Vegetative Protection	Left Bank	8	5	8	9	6
	Right Bank	9	6	7	8	6
Riparian Zone Width	Left Bank	8	5	8	10	7
	Right Bank	8	6	6	8	7
Total		138	94	135	141	148

Values for all creek zones are an average of multiple points. For individual results, see Appendix B "Ecosystem Evaluation."

In-stream vegetation observed during site visits included: buttonbush (*Cephalanthus occidentalis*), water willow (*Justicia americana*), duckweed (*Spirodela polyrhiza*), fern, pennywort (*Hydrocotyle sp.*), pondweed (*Potamogeton illinoensis*), sedge (*Carex sp.*), smartweed (*Polygonum hydropiperiode*s), spadderdock (*Nuphar luteum*), needle spikerush (*Eleocharis acicularis*), switchgrass (*Panicum virgatum*), and water star grass (*Heternanthera dubia*).

In addition, the riparian vegetation is composed of hardwood species including, black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), cedar elm (*Ulmus crassifolia*), oak (*Quercus sp.*), sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), and Ashe Juniper (*Juniperus ashei*). Exotic woody species observed included Chinaberry (*Melia azedarach*), Chinese privet (*Ligustrum sinense*), and Chinese tallow (*Sapium sebiferum*). These hardwood species provide an essential function to the aquatic environment. They help maintain stream banks, provide structure for cover, provide organic nutrients, and prevent erosion and sediment deposition. A large percentage of all wildlife species depend on riparian areas for some portion of their life cycle (Thomas et al., 1979; Johnson et al., 1977).

Aquatic Species

Aquatic macroinvertebrates and fish were present at all of the sites in the upper and lower Leon Creek segments, and some small fish and macroinvertebrates were present in the persistent pools in the middle segment. Below US Highway 90 and above State Highway Loop 1604, Leon Creek is good warm-water fish habitat. Several different species of fish were observed during site visits to the area including: largemouth bass (*Micropterus salmoides*), sunfish (*Lepomis spp.*), catfish (*Ictalurus spp.*), and minnow.

The tables in the Ourso and Hornig publication (2000) cover most or all of the species found in Leon Creek. Only the American green tree frog (*Hyla cinerea*), Blotched Water Snake (*Nerodia* *erythrogaster*), green anole (*Anolis carolinensis*), and a Texas Spiny Lizard (*Sceloporus olivaceus*) were found during the site visits. However, South Central Texas is one of the most diverse areas in the nation for reptiles and amphibians (Dixon, 2000).

Jurisdictional Waters Including Wetlands

Under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403), USACE has the responsibility to regulate *all work or structures in or affecting the course, condition or capacity of navigable waters of the United States*. Within Bexar County the San Antonio River and its tributaries are not considered to be Navigable Waters of the United States and are not regulated by Section 10; therefore, no further discussions on Section 10 will occur.

Under Section 404 of the Clean Water Act (33 USC 1344), Congress directed USACE *to regulate the discharge of dredged and fill material into all waters of the United States including wetlands*.

Therefore, activities that result in a discharge of dredged or fill material into Leon Creek or one of its tributaries would be regulated activities under Section 404. Currently, the National Wetland Inventory (NWI) maps for Bexar County show riverine wetlands. It is hard to quantify the wetlands because they are site-specific and normally very small. These wetlands are limited to within the stream banks and are classified as bottomland hardwood. The channel of Leon Creek would be considered a jurisdictional water; however, no jurisdictional wetlands immediately adjacent to the channel have been identified.

THREATENED AND ENDANGERED SPECIES

Leon Creek Watershed Species

According to the U.S. Fish and Wildlife Service, there are 19 Federally Listed Threatened and Endangered species that have the potential to occur in Bexar County, including the Leon Creek Watershed. These species are listed in Table 2-5.

Most species listed are associated with karst topography within the extreme Upper Leon Creek study segment. In addition to the Federal list, the State of Texas has provided a list of species of concern for consideration in evaluation of project impacts and for avoidance if possible. That list is maintained in project files.

Table 2-5. Federally-Listed Threatened and Endangered Species

Common Name	Scientific Name	Listing Status	Potential to Occur within the Study Area
[Unnamed] Ground Beetle	Rhadine infernalis	Endangered	Yes
[Unnamed] Ground Beetle	Rhadine exilis	Endangered	Yes
Black-capped Vireo	Vireo atricapilla	Endangered	Yes
Braken Bat Cave Meshweaver	Cicurina venii	Endangered	Yes
Cokendolpher Cave Harvestman	Texella cokendolpheri	Endangered	Yes
Comal Springs Dryopid Beetle	Stygoparnus comalensis	Endangered	No
Comal Springs Riffle Beetle	Heterelmis comalensis	Endangered	No
Fountain Darter	Etheostoma fonticola	Endangered	No
Golden-cheeked Warbler	Dendroica chrysoparia	Endangered	Yes
Government Canyon Bat Cave Meshweaver	Cicurina vespera	Endangered	Yes
Government Canyon Bat Cave Spider	Neoleptoneta microps	Endangered	Yes
Helotes Mold Beetle	Batrisodes venyivi	Endangered	Yes
Madla’s Cave Meshweaver	Cicurina madla	Endangered	Yes
Peck’s Cave Amphipod	Stygobromus pecki	Endangered	Yes
Robber Baron Cave Meshweaver	Cicurina baronia	Endangered	Yes
San Marcos Salamander	Eurycea nana	Threatened	No
Texas Blind Salamander	Typhlomolge rathbuni	Endangered	No
Texas Wild Rice	Zizania texana	Endangered	No
Whooping Crane	Grus americana	Endangered and Experimental Population, Non-essential	Migrant only

Caves and Karst Species

USFWS has designated five karst zones in the Bexar County area, based on geology, distribution of known caves, distribution of cave fauna, and primary factors that determine the presence, size, shape, and extent of caves with respect to cave development. These zones are depicted in Figure 2-6. The five zones reflect the likelihood of finding a karst feature that will provide habitat for endemic invertebrates, as follows:

1. Areas known to contain one or more of the nine invertebrates
2. Areas having a high probability of suitable habitat for the invertebrates
3. Areas that probably do not contain the invertebrates
4. Areas that require further research but are generally equivalent to Zone 3, although they might include sections that could be classified as Zone 2 or Zone 5
5. Areas that do not contain the invertebrates

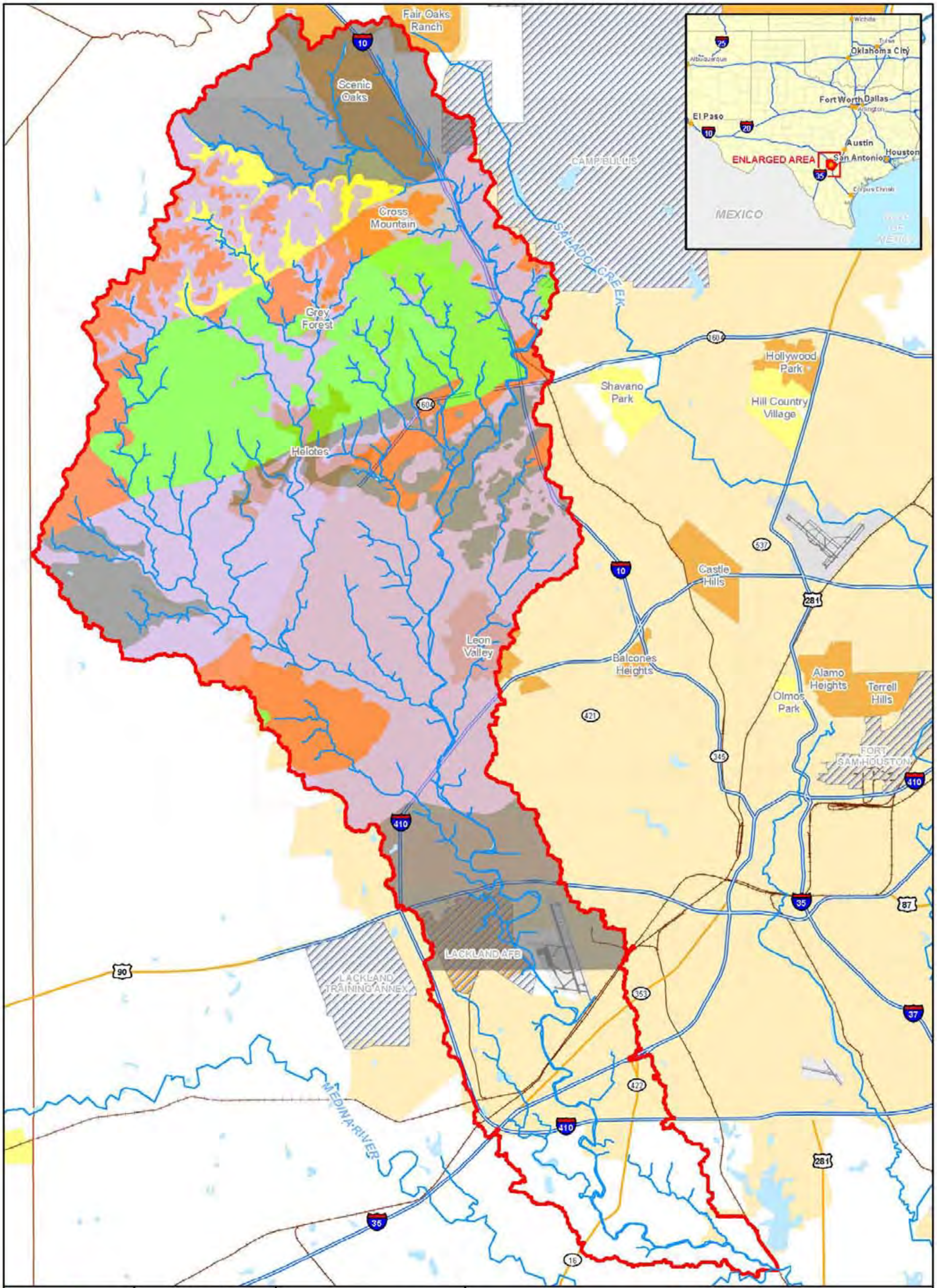
Locations within the study area that may support karst invertebrates include:

- The lower portions of the Upper Leon Creek segment support Zones 1 and 2 in various places, but the majority of the segment contains Zone 3.
- Within the Urban Leon Creek segment, a few areas support Zone 1 and Zone 2 designations:
  - Headwaters of Slick Ranch Creek
  - Upper most portions of the Urban Leon Creek mainstem
- The entire upper portions of the Culebra Creek segment support Zone 1 and 2 designations, while the lower reaches of the Culebra Creek segment supports mostly Zone 3 with some Zone 2 on the southwest side.
- The Helotes Creek segment supports some Zone 1 and Zone 2 areas and four critical habitat designations, but is mostly made up of Zone 3, especially in the lower parts of this segment.
- The Lower Leon Creek segment does not contain any karst zones or critical habitat.

Any proposed project alternatives or plans identified within Karst Zones 1–4 would require the ESA Section 7 consultation process with the USFWS.

CULTURAL RESOURCES

Cultural resources include properties of traditional cultural significance, such as burial sites and cemeteries, above ground resources as buildings and structures, and archaeological sites. Under the National Historic Preservation Act of 1966, as amended, the Federal Government must identify cultural resources within the Area of Potential Effect for any undertaking. Further, the government must assess the potential of adverse effects to resources meeting the criteria for inclusion in the National Register of Historic Places (NRHP) as defined in 36 CFR Part 60(4). Because of the large size of the Leon Creek watershed, data collection has been limited to previously recorded sites within the watershed as an indicator of the level of effort that will be necessary to fully investigate the site of



US Army Corps of Engineers®

Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 19, 2012
Author: Lucas Daniels
Location: \\swf-fs1\gis\projects\cvljobs\LeonCreek\Documents\

REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET

PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

LEON CREEK
SAN ANTONIO, TEXAS

INTERIM FEASIBILITY STUDY
FIGURE 2-6.
KARST ZONES

Legend

- Streams/Rivers
- Lakes/Reservoirs
- ▨ Military Boundaries
- Study Area

Karst Zones

- 🟩 Zone 1
- 🟧 Zone 2
- 🟪 Zone 3
- 🟨 Zone 4
- ⬛ Zone 5

Miles
0 1.25 2.5 5 7.5 10

the Recommended Plan. Because of the large size of the Leon Creek watershed, data collection to date has been limited to previously recorded sites within the vicinity of the proposed project features as an indicator of the level of effort that will be necessary to fully investigate alternative project locations. During the Preconstruction Engineering and Design (PED) Phase of this study, a detailed cultural resources survey will be undertaken to identify and evaluate cultural resources that may be affected by the Recommended Plan. This approach has been concurred with by the SHPO.

Archaeological Resources

Given the broad nature of the Leon Creek Watershed study, only blanket generalization of cultural resources sites is feasible. Numerous cultural resources sites and properties are currently known and recorded for this expansive area. Some of the areas under consideration have been surveyed for cultural resources properties. For example, due to the large amount of survey done there, nearly one-third of the recorded sites within the Leon Creek Watershed are located within the Government Canyon State Natural Area. The recorded cultural resources sites include historic sites, such as old inns, homesteads, churches, historic artifact scatters, standing historic structures, burials and cemeteries, as well as prehistoric Native American sites, such as lithic scatters, villages, burials and possible cemeteries, hunting and butchering sites, and alluvially buried archaeological deposits. The number of cultural resources sites known to be associated with the study area is limited by the amount of work previously done. The full extent of cultural resource sites for the entire area is unknown pending full archaeological surveys of the proposed project locations.

Architectural Resources

In addition to the archaeological sites, many unrecorded potential historic resources are located in the Leon Creek study area. These are primarily historic farms and ranches that have been documented in the Texas Historical Survey. A thorough reconnaissance of the structures within specifically identified project areas will need to be conducted to determine if any standing building, bridges, or other structures might be eligible for the National Register of Historic Places (NRHP).

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

At the request of USACE, Environmental Data Resources, Inc. (EDR, Inc.) conducted a search of available environmental records for sites along Leon Creek in San Antonio, Texas. The purpose of the search was to identify any sites where hazardous, toxic, or radioactive waste (HTRW) or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water, and which might be encountered during construction of flood control projects in the subject area. EDR, Inc. produced two final reports, according to the requirements of American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments, E1527-05. Submitted separately on February 5, 2007 and April 23, 2007, the reports listed all sites found in the records search. The first report addresses the upper portion of Leon Creek north and west of I-410 in San Antonio; the second report addresses the lower portion south and east of I-410. The complete search area extended in a half-mile wide corridor, beginning at the headwaters of Leon Creek northwest of

San Antonio at latitude (north) 29.67884 degrees and longitude (west) 98.71734 degrees, and ending downstream at the confluence of Leon Creek and the Medina River south of San Antonio at latitude (north) 29.26443 degrees and longitude (west) 98.49435 degrees.

Sites were identified in the reports that could impact the design and construction of flood control projects for Leon Creek. Locations of these sites relative to the current channel of Leon Creek are shown on the accompanying EDR report figures in Appendix F, “HTRW Analysis.” Sites of greatest concern were found in the following databases, which EDR searched to create the list in their reports:

- TCEQ Solid Waste Facility/Landfill (SWF/LF)
- TCEQ Closed Landfill Inventory (CLI)
- TCEQ Leaking Underground Storage Tank Incident Reports (LTANKS)
- EPA Emergency Response Notification System (ERNS)
- EPA Hazardous Materials Incident Report System (HMIRS)
- TCEQ Spills (TX SPILLS)
- TCEQ Enforcement (ENF)

Other sites of possible concern in this report include those listed in the ERNS, HMIRS, TX SPILLS, and ENF databases.

- An unknown type of oil was spilled at one site listed in the ERNS database. Uncovered barrels of motor oil and antifreeze released onto the ground were reported at another.
- Two sites were listed in the HMIRS database. However, further information regarding any potential residual contamination was not found.
- Abandoned drums released an estimated 115 gallons of cement additives at one site listed in the TX SPILLS database, and a spill of an estimated 280 gallons of diesel fuel occurred at another, with cleanup at each reported as inadequate.
- The Texas Commission on Environmental Quality (TCEQ) issued formal written Notices of Violation for waste violations at two sites listed in the ENF database.

RECREATION RESOURCES

There are multiple Federal, state, and local parks and recreation facilities within the Leon Creek Watershed and the San Antonio Metropolitan area. The section describes regional as well as local recreation demand. This information is important to facilitate planning for a potential multi-purpose project and to design relevant recreational facilities.

The 2001 Texas Tech University survey for Texas Parks and Wildlife Department (TPWD) evaluated the total Texas population’s rates of participation (at least once in the past 12 months) in various outdoor activities. Table 2-6 lists the survey results.

Table 2-6. Texas Population Participation in Outdoor Recreation Activities

Activity	Participation
Picnicking	45%
Visit Historic Sites	41%
Swimming in Natural Waters	39%
Fishing	38%
Visit Park or Natural Area within one mile of home	35%
Trips or Outings to View Wildlife	34%
Visit Texas State Park	33%
Motorboating (excluding jet skis)	30%
Camping	27%
Bicycling	20%
Hiking	19%
Hunting	16%
Jet Skiing	12%
Canoeing/Kayaking	6%
Mountain Biking	5%
Rock Climbing	5%
Sailing	4%

Source: *Texas Parks and Wildlife for the 21st Century*, 2001Local Recreation Demand

The City of San Antonio's Parks Department has recently prepared the *Leon Creek Greenway Master Plan,* which identifies specific locations for recreation. This recreation assessment recommends that military family and partnership potentials be considered in the recreation planning.

SOCIO-ECONOMIC CONDITIONS

The Leon Creek study area is primarily located in a heavily urbanized area, with some rural areas in the upper headwaters. The western portions of the study area are a mix of rural and urban areas, with residential and commercial development underway.

The population in the study area is predominantly minority, with approximately 57 percent being of Hispanic origin. Within Bexar County, the population is expected to grow 57 percent from 2015 to 2050. In the study area, 86 percent of the population had achieved education beyond a high school diploma, indicating a well educated population. Fewer than 10 percent had less than a high school education. The study area tends to have lower unemployment rates than the county as a whole.

There are an estimated 13,851 business establishments in the study area, with approximately 12 percent being retail, 9 percent construction, 6 percent health care, and 4.5 percent accommodation and food services. For the Alamo Workforce Development area, trade was expected to grow by 19 percent through 2014, education services by 27 percent and leisure and hospitality by 13 percent.

Overall, the study area had a slightly higher average household income ($53,413) compared to Bexar County ($44,718). Approximately 13 percent of the population in the study area is below the poverty level, compared to 16 percent in Bexar County.

Low Income and Minority Populations

In accordance with Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” USACE conducted an analysis to identify minority and low-income populations within the study area. Data were collected using U.S. Census Bureau Data to examine both population and income in the study area at the most detailed level possible.

- There were 112 census block groups that intersect the study area, but only 110 with reported populations. Of these 110 census block groups, 71 have populations that are 50 percent or more minorities with regard to race and Hispanic origin. That represents 65 percent of the census block groups with reported population.
- For the study area as a whole, 59.2 percent of the population is minority. Of the 110 census block groups, 53 had total minority populations greater than 59.2 percent.
- In Bexar County, 64.4 percent of the population is minority. Of the 110 census block groups in the study area, 46 had total minority populations greater than 64.4 percent.

In assessing the existence of low-income populations for the study area, median household incomes for all 112 census blocks for the study area were examined. Based on a poverty threshold for a family size of three (considering that average number of persons per household for Bexar County is 2.84) an income of $13,738 was used as comparison. Using this poverty threshold, only one census block group (181806.1) fell below this level. This area contains structures from two damage reaches, Babcock Tributary and Leon Creek Reach 6.

LIGHT

The Leon Creek study area is primarily located in a heavily urbanized area, with some rural areas in the upper headwaters. The western portions of the study area are a mix of rural and urban areas, with residential and commercial development underway. Artificial light sources in the study area are typical of urban sources resulting from residential, industrial, and commercial land uses.

PUBLIC FACILITY AND SERVICE

Public facilities and services within the watershed are typical of a metropolitan area. Although no critical infrastructure such as fire or police stations, or hospitals are impacted by the modeled 0.2 percent AEP event, one school is located in this event.

FUTURE WITHOUT-PROJECT CONDITIONS

To effectively evaluate alternatives for any proposed project improvements that might be implemented, it was necessary to forecast the most probable future conditions if no Federal action is taken to solve the water resource problems and opportunities. These conditions are known as the future Without-Project conditions. All project alternatives are measured against the future Without-Project conditions. For the purposes of this study, the period of analysis is 50 years.

Climate

Climate models indicate that average temperatures will rise significantly over the coming decades, from 1 degrees F by 2019 to 4 degrees F by 2059 (Nielson-Gammon, 2012). While climate models tend to agree on changes to global precipitation patterns, a high-level of uncertainty currently exists in predicting future precipitation probabilities at a smaller, sub-global scale such as Texas. Although the average future precipitation may be more or less than what occurs present-day, it is the consensus of climatologists that future precipitation will occur with higher intensities separated by longer periods of drought. Therefore, areas at risk for flash floods, such as the Leon Creek study area, could be subjected to an increased risk of flooding in the future.

Flooding

Even though climate models predict a decrease in precipitation within the region, increased urbanization is expected to contribute to the potential for flooding in the future. As discussed later, the population will continue to grow and land use patterns will continue to change with urbanization.

Geology, Soils, and Topography

The geology of the study area will not change. Urbanization of the watershed is expected to continue in the future, thereby increasing impervious cover and making the watershed “flashier” in terms of water discharging into creeks and leading to increased soil erosion. With the increases in urbanization, conversion of prime farmlands into non-agricultural uses will continue.

Land Use and Urbanization

Land use in the study area will continue to change as urbanization occurs. Effects of urbanization may be superimposed on meteorologic and physiographic factors, thereby increasing flood hazards in metropolitan areas throughout the region. Urbanization can increase impervious cover, reduce channel storage and increase channel obstruction, and floodplain development. Urbanization can compound the natural tendency of Central Texas streams to produce damaging floods with greater frequency than do comparable basins elsewhere.

According to Ultimate Land Use data provided by SARA, the existing urban land use acreages per segment are expected to increase over the 50-year project life at rates that range from 17 percent in the

Upper Leon Creek segment to 30 percent in the Lower Leon Creek segment. Urbanization is seen as being the primary driver in changing land use in the future.

Air Quality

Future air quality conditions within the San Antonio MSA are difficult to project. The introduction of more fuel efficient vehicles, alternative energy development, and continued air quality regulations should result in higher air quality in the future. However, the continued growth of the area may place an increasing number of vehicles on the road and more industrial businesses in the area, potentially offsetting these benefits.

Noise

The study area is located in developed areas of San Antonio. Noise levels would continue to reflect the urbanized nature of the surroundings and would be subject to the San Antonio noise ordinances.

Groundwater

Groundwater has been and will continue to be affected by the changes in land use and vegetative cover. The increased impervious cover and increased residential subdivisions would continue to impact the Edwards Aquifer and its associated springs. Increased impervious cover increases runoff and affects infiltration into the aquifer. Under these conditions, the quality of water in the aquifer and the springs would be expected to degrade.

The Edwards Aquifer Authority (EAA) is directed to conserve, protect, and enhance the groundwater resources of the Edwards Aquifer and has developed the Edwards Aquifer Protection Plan as a strategy to reduce degradation of water quality within the aquifer system. The EAA helps to limit impacts to these resources, but impacts occur nonetheless. Although impervious cover regulations over the recharge zone help reduce these impacts, continued degradation is still projected under the Future Without-Project Conditions.

In the Leon Creek Watershed, there has been and will continue to be a general trend toward increased ecosystem degradation due to conversion of savannas to woodlands and increases in impervious Ashe juniper cover. These trends will have a negative impact on recharge, water quality, general ecosystem health and habitat value, and flooding. Lack of understory may contribute to a quicker runoff rate with a corresponding reduction of infiltration. This results in higher peak flows with shorter durations, which increases flood events and reduces aquifer recharge.

Flood Risk Management

In the absence of any Federal flood-risk management reduction project, the existing and future flood damages and other adverse impacts caused by continued potential flooding of the 4,630 structures within the 0.2 percent AEP floodplain in the study area would continue and likely increase. Although flood insurance would partially compensate for future flood losses, the damages would still occur at an estimated average rate of $13.8 million annually (includes damages to privately owned vehicles) at October 2013 price levels. In addition, the costs for flood fighting and recovery, public damages, the potential loss of life, and the overall threat to human health and safety would continue. Small, localized flood control projects would probably be constructed to address localized events, but the large floods would continue to cause extensive flood damages and possible loss of life.

The City of San Antonio and Bexar County both have a “no rise” ordinance which requires that the increased runoff resulting from the proposed development will not produce a significant adverse impact to other properties to a point 2,000 feet downstream. The City provides a Fee In Lieu Of (FILO) payment to the regional storm water fund in lieu of on-site detention as a mitigation option. Developers who wish to participate submit an adverse impact analysis or storm water management plan. Once City staff verify the development will not have any adverse impact 2,000 feet downstream, then the developer can opt to participate in the Regional Storm Water Management Program (RSWMP) by paying a fee in lieu of detention. All developers participate in the RSWMP by paying the FILO, except in mandatory detention areas; by construction of on-site or off-site detention; or by participation in a regional off-site regional storm water facility to mitigate increase in runoff. The FILO is based on the type of development and the increase in impervious cover. Any development that has an increase of impervious cover greater than 100 square-feet is subject to the FILO. The City is giving credit to developers who implement Low Impact Development (LID) best management practices. These BMPs can include rain gardens, bio-swales, vegetated filter strips, green roofs, rain cisterns, and tree boxes to name a few. SARA is actively coordinating with the City on reviewing the LID plans for those who wish to get credit. These measures are intended to limit the effect of future urbanization and increases in impervious cover on the timing and amount of urban runoff. While the "no rise" ordinance along with the FILO and the LID BMPs will not entirely mitigate the impacts of increased urbanization, they will, in conjunction lessen these impacts. These programs were considered in the hydrologic and hydraulic modeling for the existing and future without-project condition.

Using aerial imagery economic reaches were determined by the planning, economics, and H&H PDT members, with reaches determined by stream confluences or intersections of major highways or roads where bridge crossings would provide a reasonable change in reaches for both H&H modeling and economics. The mainstem of Leon Creek was divided into seven reaches, Culebra Creek into two reaches, and the remaining streams each as a single reach.

The areas of interest where measures were to be considered were driven by damages. Using single-event output from HEC-FDA, structures were color coded if they were being damaged up to the 1 percent AEP flood event. those structures damaged at the 0.4 percent and 0.2 percent events were not coded since measures to address those would not be considered economically justified. Maps were printed out with the colored structures superimposed over aerial. Based on the judgment of planning, economics and H&H PDT members, clusters of these coded structures were identified as areas of interest where potential measures could be considered. These clusters of structures, or areas of interest, were numbered consecutively from downstream to upstream within the watershed. The following table outlines the flows and the corresponding water surface elevations at the index point for the 1 percent AEP of each the modeled reaches described in Table 2-8. A map depicting the location of these index points is in Figure 2-7. This information along with of the existing damages observed in the watershed helped direct the early plan formulation efforts.

Table 2-7. Existing Flow and Water Surface Elevation at the 1% AEP By Economic Reach

Reach	Index Point	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	10,000	1,017.97	1,026.97	9.00
Chimenea Creek	16,224.00	11,400	1,202.98	1,218.31	15.33
Culebra Creek 1	13,961.00	82,100	798.56	823.48	24.92
Culebra Creek 2	44,257.00	15,100	913.79	926.88	13.09
Culebra Trib A	9,112.00	5,900	826.44	833.33	6.89
Culebra Trib C	10,833.00	5,800	917.42	922.39	4.97
Culebra Trib E	5,149.00	3,080	966.45	970.88	4.43
French Creek	15,966.00	15,000	878.44	891.31	12.87
French Trib A	4,255.00	5,220	872.40	876.68	4.28
Helotes Creek	34,369.00	40,800	978.25	998.78	20.53
Helotes Trib A	4,042.00	2,950	990.45	996.63	6.18
Helotes Trib B	6,273.00	4,230	1,145.43	1,159.43	14.00
Huebner Creek	22,330.00	15,100	823.61	832.86	9.25
Huebner Trib A	6,300.00	6,500	866.85	875.76	8.91
Huesta Creek	11,206.00	9,230	983.60	994.75	11.15
Indian Creek	24,551.00	10,200	597.83	611.73	13.90
Leon Creek 1	16,302.00	116,300	489.36	534.71	45.35
Leon Creek 2	58,342.00	116,100	570.85	598.42	27.57
Leon Creek 3	86,710.00	116,000	616.09	640.82	24.73
Leon Creek 4	118,221.00	115,300	668.28	700.26	31.98
Leon Creek 5	163,183.00	46,200	789.34	811.18	21.84
Leon Creek 6	224,604.00	44,000	1,018.49	1,040.66	22.17
Leon Creek 7	276,101.00	21,600	1,213.61	1,237.04	23.43
Leon Trib B	4,565.00	4,780	610.60	619.97	9.37
Leon Trib F	4,097.00	3,430	704.99	715.51	10.52
Leon Trib H	4,009.00	3,690	894.46	899.96	5.50
Leon Trib J	3,775.00	4,500	1,126.76	1,135.36	8.60
Leon Trib K	8,446.00	7,860	1,157.66	1,168.24	10.58
Leon Trib L	-	-	-	-	-
Leon Trib M	9,081.00	6,720	1,242.14	1,250.57	8.43
Los Reyes Creek	14,816.00	12,400	1,119.87	1,139.51	19.64
Ranch Creek	2,115.00	6,170	1,095.51	1,107.54	12.03
Slick Ranch	18,540.00	10,500	756.71	770.10	13.39
Slick Ranch Trib B	2,145.00	6,310	757.08	767.14	10.06
WW Village	4,570.00	4,090	689.49	705.39	15.90

For this study, future conditions represent the fully developed floodplain, estimated to occur 25 years after the base for existing conditions. Hydraulic and hydrological estimates for the Future Without-

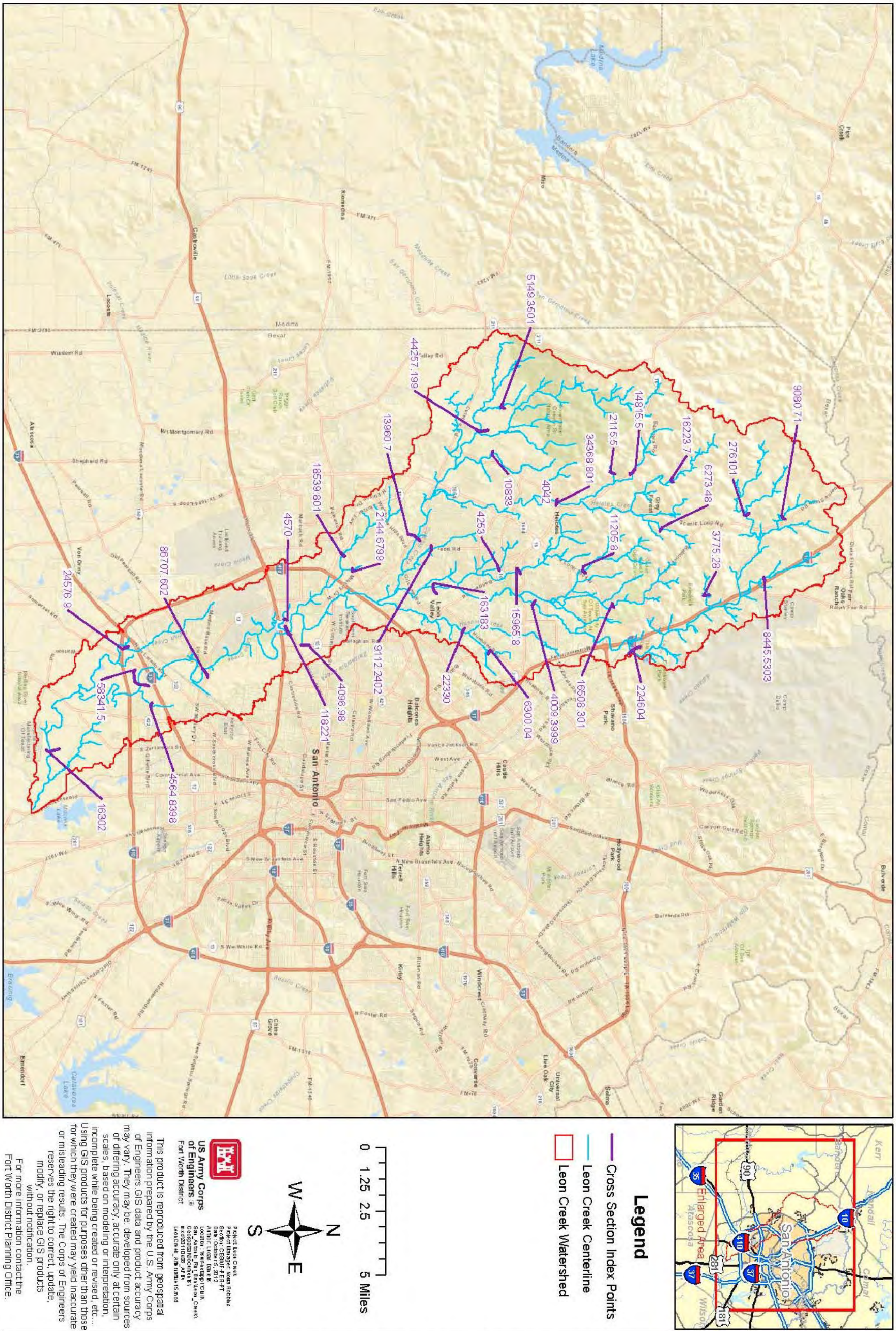
Project Conditions were entered into HEC-FDA to calculate expected annual damages for the future condition. As described in Appendix G.1 “Hydrologic and Hydraulic Analysis,” future conditions generally show increased flows and damages, but some reaches experienced a decrease in flows. Table 2-8 shows the EAD values for Future Without-Project Conditions by economic reach alongside the existing conditions EADs for comparison.

To determine any potential benefits from alternatives, these two EAD values were used to create average annual equivalents (AAE) or equivalent annual damages. Equivalent Annual Damages are the summation of the base year (2018) expected annual damages plus the discounted value of the most likely future year (2043) expected annual damages. The future expected annual damages shown here are discounted over the project life of 50 years at a Federal discount rate of 3 1/2 percent.

Table 2-8. Existing and Future Without-Project Expected Annual Damages and Without-Project Average Annual and Equivalent Annual By Economic Reach (October 2013 Prices - $000)

Reach	Existing Without-Project AAD	Future Without -Project AAD	Without-Project EAD
Babcock Trib	$306	$475	$405
Chimenea Creek	2	2	2
Culebra Creek 1	2,408	1,812	2,059
Culebra Creek 2	93	89	90
Culebra Trib A	96	108	103
Culebra Trib C	32	42	38
Culebra Trib E	19	19	19
French Creek	299	267	280
French Trib A	<1	<1	<1
Helotes Creek	541	552	548
Helotes Trib A	49	50	50
Helotes Trib B	1	<1	1
Huebner Creek	531	465	493
Huebner Trib A	128	133	130
Huesta Creek	127	133	132
Indian Creek	93	95	94
Leon Creek 1	5	4	4
Leon Creek 2	483	609	557
Leon Creek 3	1,702	2,126	1,950
Leon Creek 4	1,168	1,233	1,206
Leon Creek 5	1,503	1347	1,411
Leon Creek 6	1,216	1,659	1,475
Leon Creek 7	1,155	1,214	1,189
Leon Trib B	<1	<1	<1
Leon Trib F	108	165	142
Leon Trib H	<1	<1	<1

Reach	Existing Without-Project AAD	Future Without -Project AAD	Without-Project EAD
Leon Trib J	<1	<1	<1
Leon Trib K	180	202	193
Leon Trib L	0	0	0
Leon Trib M	0	0	0
Los Reyes Creek	30	43	38
Ranch Creek	0	0	0
Slick Ranch	934	1,237	1112
Slick Ranch Trib B	96	110	104
WW Village	9	8	9
Total	**$13,316**	**$14,201**	**$13,834**



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For more information contact the Fort Worth District Planning Office.

Figure 2-7. Leon Creek- Cross Section Index Points

Terrestrial Resources

Encroaching urban and rural development activities are expected to negatively impact the watershed's vegetation. The existing forested riparian vegetation zone in much of the watershed is already narrow with several grass and shrub openings. The number and size of openings would continue to grow, and there would be fewer acres of forest. Loss of habitat, particularly riparian woodlands, would reduce the number of wildlife and bird species in the watershed. Migratory songbirds are particularly susceptible to loss of habitat along their migration routes.

Aquatic Resources

Eventual construction of subdivisions will lead to the building of new roads, parking lots, and structures that will cause increased runoff and less infiltration into the ground, which will affect aquatic resources. With increased construction, there will be increased sediment loading in the creeks, which will negatively affect the aquatic resources in the creeks and the aquifer.

The increase in peak flows, increased construction, and increase of impervious cover would be expected to contribute to increases in sediment transport and turbidity from construction activities. These increases are not expected to affect the existing riparian zone to the point that riparian woodland restoration activities would not be sustainable. To the contrary, riparian woodland restoration would help offset some of these impacts from future impervious cover. Water quality in Leon Creek is expected to degrade from slight to moderate as Bexar County continues to develop. The construction of new residences and businesses would produce additional sediment load from site runoff. After completion, increases in impervious surface area, traffic, lawn fertilizing, and other human activities would adversely impact the creeks. Degradation of water quality would reduce the number of aquatic biota. According to USFWS, the overall diversity of fishes and other aquatic species is already low; further loss of aquatic biota would be damaging to the aquatic ecosystem.

With increased urbanization, there will be continued reduction in the riparian zone width. People tend to want to move close to creeks for their aesthetically pleasing atmosphere and distance from neighbors. When riparian zones are decreased, valuable wildlife habitat and corridors and aquatic resources are destroyed. The aquatic ecosystem needs the allochthonous inputs and shade that riparian habitat provides. The Urban Leon segment north of US Highway 90 and south of State Highway Loop 1604 has experienced historical development within the floodplain; additional development is expected to be limited and proper storm water controls will most likely be implemented, because the area is within city limits. However, the riparian vegetation within much of this area has been lost to clearing for city parks, roads, and golf courses. It is expected that this area will continue to be managed at its current state. In addition, because the habitat is disturbed, invasive species will become established in the area, and the remaining intact riparian areas will decline over time. For a more detailed analysis, see Appendix B.

Cultural Resources

Cultural resources in the study area would remain undisturbed unless future development activities uncovered the resources.

Socio-Economic Conditions

Population

Stated earlier, the Leon Creek study area is located primarily in a heavily urbanized area with some rural areas in the upper headwaters. The area will continue to see increases in population based on population projections for Bexar County which is expected to grow by 57 percent between 2015 and 2050.

Recreation Resources

The San Antonio area would see continued construction of recreational facilities as the city grows; however, it is expected that the growth rate in some of these communities will not allow for recreation infrastructure to keep pace. Therefore, there will always be a demand for additional recreational facilities, especially for activities people tend to do close to home such as walking and picnicking.

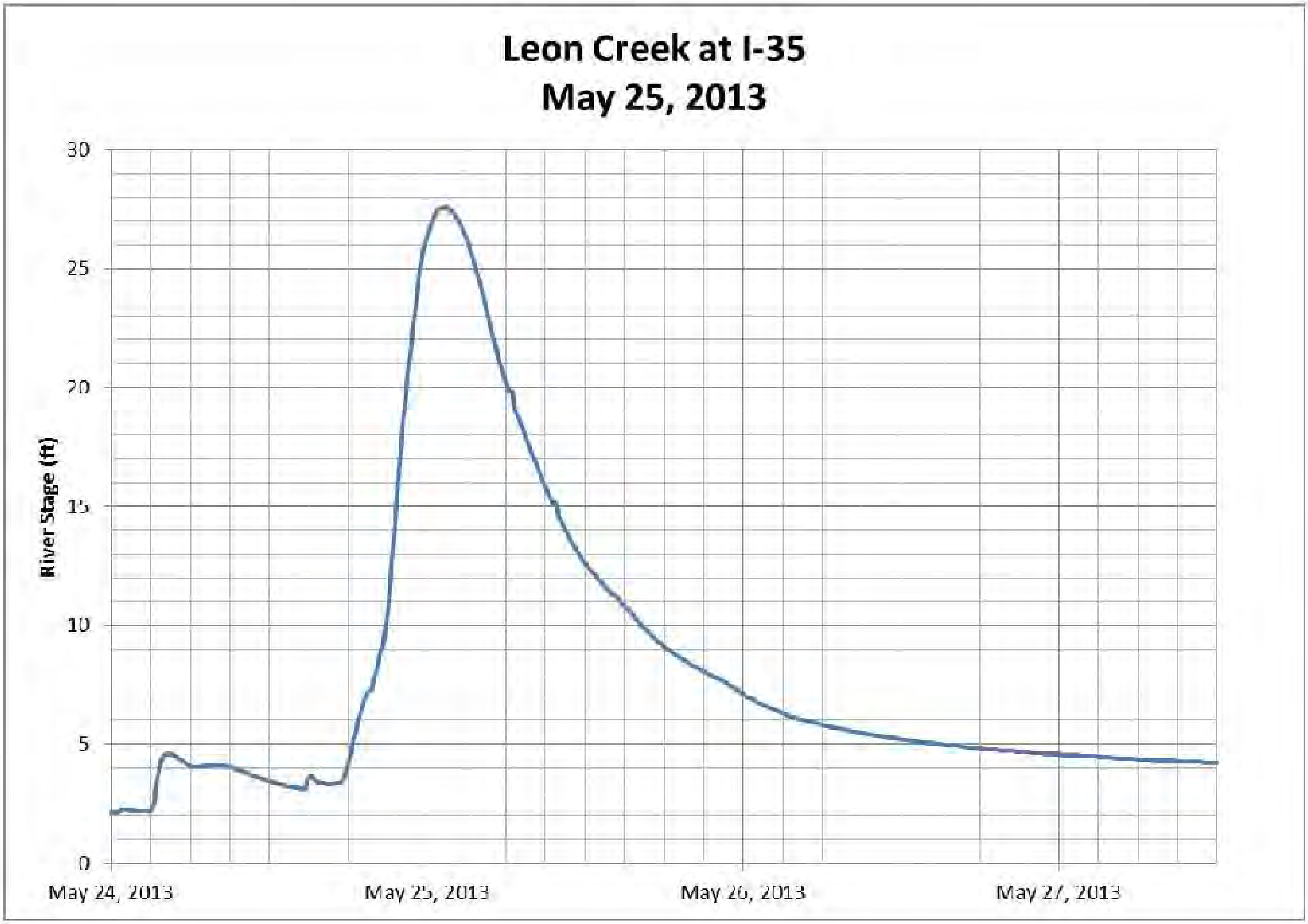
PLAN FORMULATION AND DEVELOPMENT OF ALTERNATIVES

Leon Creek is primarily a flood risk management (FRM) project. Early in the study process, consideration was given to the incorporation of ecosystem restoration and recreation features where opportunities might be complementary to flood risk reduction. The strategy was to first to identify areas where FRM measures and alternatives could be implemented, and then to consider ecosystem restoration (ER) and/or recreation opportunities that might exist in these same areas. This constrained approach is a different paradigm than looking broadly throughout the watershed for stand-alone ER or recreation opportunities.

PROBLEMS AND OPPORTUNITIES IDENTIFICATION

As noted in previous sections, significant flood risks exist in and around the city of San Antonio along Leon Creek and its tributaries with the flood risk being associated with infrequent, high-intensity rainfall events with short durations and high velocities. The storms of August 2007 and May 2013 are typical of the flood risk with the ability to sweep vehicles off roads. Eleven persons died within the city of San Antonio. As discussed in the previous section, flooding associated with Tropical Storm Erin led to 8.25 inches of rain in 24 hours in August of 2007 with a peak rainfall intensity of 2.25 inches per hour while the Helotes Creek sub-watershed just to the north reported total rainfall amounts of almost 7 inches with a peak rainfall intensity of 3.8 inches per hour. In May 2013, the upper portions of the Leon Creek watershed received rainfall amounts of 10 inches to 15 inches in just over 12 hours with runoff from this leading to a peak flood elevation of 27 feet at the Leon Creek/I-35 gage—12 feet over flood stage. Leon Creek also inundated the Jet Engine Test Cell facility at Port San Antonio located on the site of the former Kelly Air Force Base, with almost seven feet of floodwater.

As discussed previously, the hydrograph (Figure 3-1) below, Leon Creek rose from within-bank levels to its peak flood stage in approximately six hours, tapering off somewhat more slowly but returned to within-bank conditions in less than 24 hours.



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Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 10 2012
Author: Lucas Daniels
Location: \\swf-fs1\gis\projects\cw\jobs\LeonCreek\Documents

Figure 3-1. Leon Creek Hydrograph

Also discussed previously are the approximately 4,629 structures that would be expected to receive damage from a 0.2 percent Annual Exceedance Probability (AEP) event, and existing average annual damages in the watershed estimated at just over $13 million. Public health and safety is also a concern since the watershed can experience periods of low or almost nonexistent flow in certain areas leading to degradation of the channel and its environs. Despite these problems, there are potential opportunities to reduce flood damages as well as restore balance to the area’s water resources.

There are problems for the Leon Creek ecosystem as well. Because the riparian woodlands of the watershed have been severely degraded due to residential development and urbanization, there is a need to restore this valuable riparian woodland habitat to improve the overall aquatic character and habitat of the creek. Potential multiple ecosystem restoration opportunities exist in the Leon Creek study area, ranging from restoration of riparian and aquatic ecosystems to improvement of endangered species habitat.

The major problems and opportunities of the Leon Creek study area are summarized in Table 3-1.

Table 3-1. Leon Creek Watershed Problems and Opportunities

	PROBLEM	OPPORTUNITY
1	Substantial flood damage threats exist for the study area, with more than 1,900 total structures likely to be affected (damages of nearly $97 million) by a 1 percent AEP flood event in and around the city of San Antonio.	Reduce risk of flood damages in the Leon Creek Watershed.
2	Short warning times and high velocity flood flows present significant risk to human safety during flood events.	Contribute to greater public awareness of the hazard presented by flood flows.
3	Leon Creek and its tributaries often dry up entirely, without even minimal flow.	Restore natural hydraulic conditions in the Leon Creek Watershed.
4	Within much of the Leon Creek Watershed, development has encroached to the extent that riparian areas have vanished, or become too degraded to support quality aquatic and terrestrial habitats.	Where compatible with flood risk reduction measures, restore riparian vegetation along Leon Creek and its tributaries.
5	Aquatic habitat has become degraded or totally lost within Leon Creek and its tributaries.	Where compatible with flood risk reduction measures, restore natural low-flow, riffle/pool/run sequences and stabilize stream banks within the Leon Creek watershed.
6	Residents of the urbanized portion of the Leon Creek watershed lack adequate opportunities for open space enjoyment and outdoor recreation activities within their neighborhoods.	See opportunities to incorporate open space and recreational amenities where compatible with flood risk reduction measures.

RESOURCE PLANNING

This section describes the goals, objectives, and constraints in planning for projects to address the identified problems and opportunities in the Leon Creek Watershed.

Goals

Corps policy requires that Federal water and related land resources planning be directed so as to contribute to the principle of National Economic Development (NED) and/or contribute to the National Ecosystem Restoration (NER).

- Contributions to NED are economic benefits—increases to the net value of the nation's goods and services, expressed in monetary units. NED contributions must also consider the environmental effects of proposed changes on ecological, cultural, and aesthetic attributes of natural and cultural resources.
- Contributions to NER are environmental benefits—increases to the net value of the nation's significant habitat, expressed in habitat units or other values.

The goals of this study are to contribute to NED by reducing flood damages and providing ancillary recreation opportunities where appropriate. While ecosystem opportunities exist as well as opportunities for the area's water resources, flood risk management remains the primary objective.

Objectives

Plans formulated during this study were evaluated based on their contributions to NED, consistent with protection of the Nation's environment. In addition to these National objectives, additional planning objectives evolved from meetings with area residents, contact with the local sponsors, state and Federal agencies, and from observations made in the area. Specific needs, desires, and goals of the community were identified. The following planning objectives for this study were identified during the initial stages:

1. Reduce risk of flood damages within the Leon Creek Watershed. Performance of alternatives in achieving this objective would be measured by the predicted annualized value of flood damages over a 50-year planning horizon.

2. Reduce risk to life, health, and welfare of Leon Creek Watershed residents by decreasing flood risk to the extent practicable. Performance of alternatives in achieving this objective would be assessed qualitatively over a 50-year planning horizon.

3. Restore ecosystems to a more diverse and sustainable natural condition by increasing aquatic and riparian habitat. Performance of alternatives against this objective would be measured by improvements to both the quantity and quality of habitat units or other functional equivalent over a 50-year planning horizon.

4. Increase opportunities for public use and recreation to residents of the Leon Creek Watershed and surrounding areas. Enhance connections between new and existing recreation. Performance of

alternatives against this objective would be measured by opportunities for recreation visits provided and/or the economic value of the recreation opportunities provided over a 50-year planning horizon.

As discussed in the introduction, the Project Delivery Team initially sought opportunities to address identified ecosystem restoration and recreation problems where compatible with flood risk reduction objectives. During the formulation process, it became apparent that large-scale measures to address flood risks would not be economically justified and that opportunities to address nationally significant ecosystem restoration problems in conjunction with development of localized flood risk reduction alternatives would be limited due primarily to the relatively small scale of the areas with which to work and the fact that these areas are isolated from each other. Additionally, the non-Federal sponsor was no longer interested in participating in ecosystem restoration as a project objective. Recreational opportunities were evaluated where it made sense. In particular, two nonstructural areas of interest were analyzed for potential recreation amenities due to their being adjacent to each other but were dropped due to not being economically justified.

Constraints

Constraints are restrictions that limit the planning process, and they include legal and policy constraints that apply to every USACE study, as well as study-specific constraints that only apply to this study. To provide direction for the plan formulation efforts, the following constraints were taken into account:

1. Avoid impacts to natural water features, such as springs, seeps, and wetlands. These features provide significant contribution to ecological functions and quality of life within the Leon Creek Watershed and protection/avoidance of these features is of high priority to the project sponsor.

2. Avoid disruption to the natural character of the floodplains, where present in the Leon Creek Watershed, to the extent practicable.

3. Government Canyon State Natural Area is hydraulically connected to Leon Creek and the Edwards Aquifer. Actions that adversely impact water resources and create significant project controversy should be avoided or mitigated. These effects would include interruptions to water flow and decreases in water quality and/or quantity.

4. Lackland Air Force Base is located adjacent to Leon Creek. Ecosystem restoration projects that can attract wildlife, such as wetlands and riparian woodland restoration, may increase the potential for a wildlife-aircraft collision and must be coordinated with the FAA. Provisions of the Memorandum of Agreement between the FAA, U.S. Air Force, U.S. Army, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service and U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes (2003), the Corps of Engineers agreed to extensive coordination and cooperation with the FAA in order to minimize possibilities of aircraft strikes.

5. Portions of the study area, particularly the Government Canyon Natural Area provide habitat suitable for Federally listed threatened or endangered species. In addition, karst invertebrates are

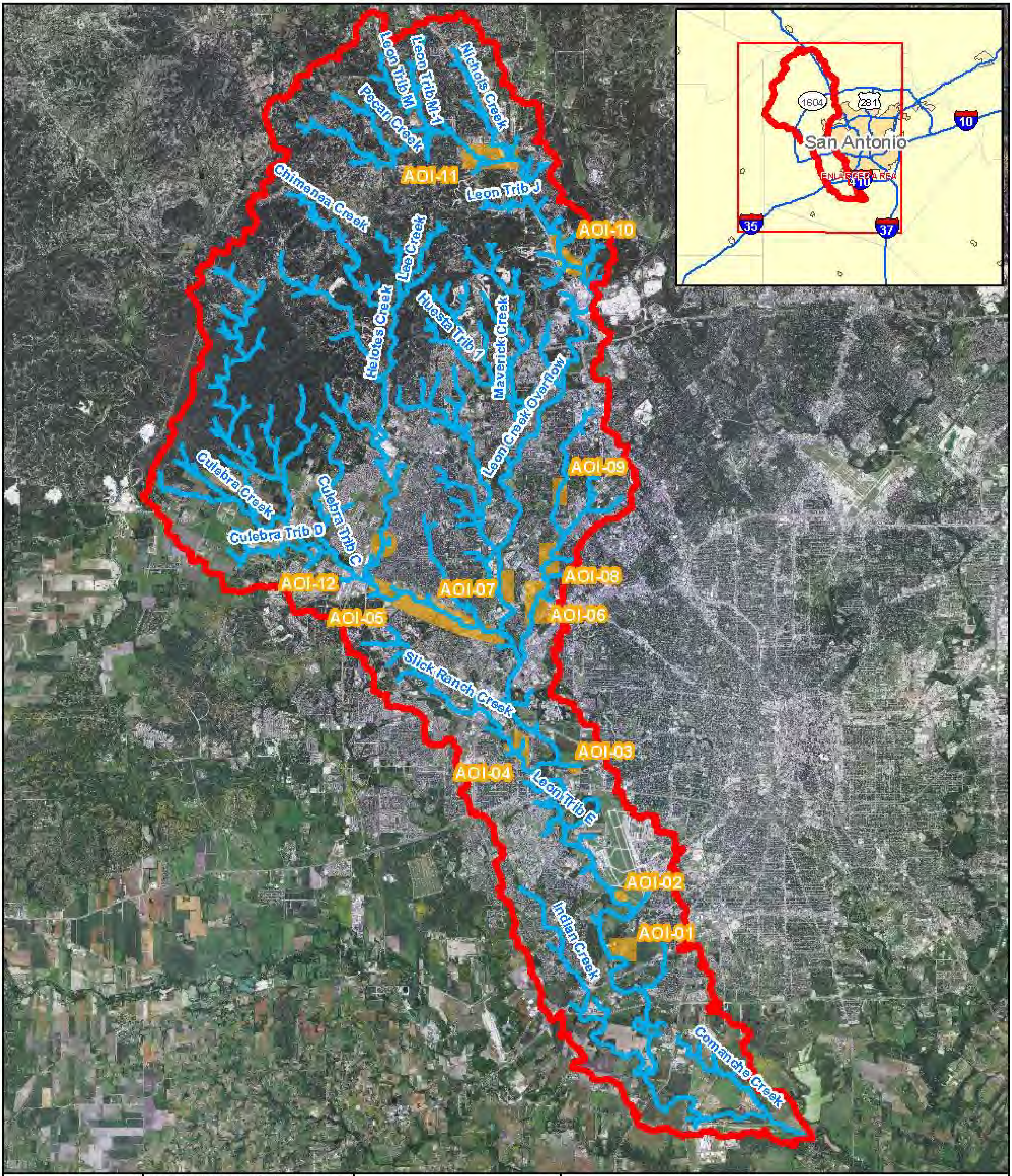
known to inhabit the Edwards Aquifer system underlying portions of the Leon Creek watershed. Impacts to these species should be avoided, minimized, and/or mitigated to the extent possible.

INITIAL SCREENING OF STRUCTURAL MEASURES

Many of the measures included in the initial array were taken from prior work and work being done in conjunction with this study. Much of the work was being done by the Non-Federal Sponsor - SARA, the City of San Antonio, and Bexar County all of whom are very familiar with the nature of flooding and have extensive experience working in the area. Many of these initial measures in the report originated from the Leon Creek Watershed Master Plan developed as a result of a series of workshops conducted between May 2008 and August 2009. These initial workshops assessed damage centers warranting further investigation and identified potential measures worthy of additional analysis. Some of these measures include on- and off-channel regional stormwater facilities, drainage projects, bridge improvements, natural waterway conveyance, enhanced conveyance, and several iterations of combinations of measures in addition to many of the measures incorporated into this feasibility report. The measures identified as part of the Leon Creek Master Plan were screened based on a “flood reduction ratio” based on annualized costs and the reduction in the estimated annual damages. Many of the "recommended projects" coming out of the workshops are included in some fashion into the initial array of structural alternatives listed in Table 3-14. Many of the measures investigated as part of the Leon Creek Watershed Master Plan consisted of detention structures which show to be effective in addressing the "flashy" type of flooding that occurs in the watershed. Due to issues such as endangered species and economics, these options were not viable or implementable.

Areas of Interest

Flood damages are not uniformly distributed throughout the watershed but are concentrated in specific locations where damageable properties are located in floodplains of varying frequencies. Twelve such areas of interest (concentrations of damageable structures) were identified early in the study process and are shown in Figure 3-2. Generally speaking, the Areas of Interest (AOIs) are located inside Loop 1604 and are found along Culebra Creek and Helotes Creek as well as the main stem of Leon Creek. Table 3-2 presents a cross-walk of the AOIs with the economic reaches contained in the Flood Damage Assessment model (HEC-FDA) and indicates the number and value of damageable properties located in each AOI.



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Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: \\swf-fs1\gis\projects\cw\jobs\LeonCreek\Documents\

Figure 3-2.
Areas of Interest
Structural Analysis

N

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Table 3-2 Damageable Property in each Area of Interest
(October 2013 price level - $000)

		50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
	Reach/Structure Type	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**
AOI-1	Leon Creek 2																
	Single-Family	0	0	10	1,099	26	3,076	32	3,374	33	3,398	33	3,398	34	3,555	36	3,871
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	64	759	95	1,784	116	2,954	117	2,971	117	2,971	117	2,971	118	2,979
	Commercial	0	0	25	1,289	36	1,386	41	1,455	43	1,579	50	2,213	58	2,968	61	3,313
	Public	0	0	0	0	0	0	2	9	3	14	3	14	3	14	3	14
AOI-1	**Total**	**0**	**0**	**99**	**3,147**	**157**	**6,246**	**191**	**7,792**	**196**	**7,962**	**203**	**8,596**	**212**	**9,508**	**218**	**10,177**
AOI-2	Leon Creek 3L and 3R																
	Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	2	355	5	36,617	5	36,617	5	36,617	5	36,617	6	36,638	6	36,638
	Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-2	**Total**	**0**	**0**	**2**	**355**	**5**	**36,617**	**5**	**36,617**	**5**	**36,617**	**5**	**36,617**	**6**	**36,638**	**6**	**36,638**
AOI-3	Leon Trib F																
	Single-Family	0	0	0	0	0	0	16	2,417	26	3,529	59	6,612	81	7,970	100	9,540
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	1	75	1	75	1	75	1	75	1	75
AOI-3	**Total**	**0**	**0**	**0**	**0**	**0**	**0**	**17**	**2,492**	**27**	**3,604**	**60**	**6,687**	**82**	**8,045**	**101**	**9,615**
AOI-4	Slick Ranch																
	Single-Family	0	0	44	6,418	104	15,365	140	20,691	155	23,030	170	25,280	209	31,139	255	38,075
	Multi-Family	0	0	0	0	1	347	4	1,389	5	1,736	6	2,084	6	2,084	6	2,084
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	0	0	0	0	0	0	5	16,319	5	16,319	8	17,530
	Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-4	**Total**	**0**	**0**	**44**	**6,418**	**105**	**15,712**	**144**	**22,080**	**160**	**24,766**	**181**	**43,683**	**220**	**49,542**	**269**	**57,689**

		50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
	Reach/Structure Type	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**
AOI - 5	Culebra Creek 1																
	Single-Family	0	0	0	0	6	1,491	68	16,895	199	52,785	360	96,463	697	180,646	972	247,785
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	1	62	8	666	10	1,057	19	1,816	52	13,902	65	19,769
	Public	0	0	0	0	0	0	0	0	0	0	0	0	1	225	2	274
AOI - 5	**Total**	**0**	**0**	**0**	**0**	**7**	**1,553**	**76**	**17,561**	**209**	**53,842**	**379**	**98,279**	**750**	**194,773**	**1,039**	**267,828**
AOI-5/7	Leon Creek 5L and 5R																
	Single-Family	0	0	0	0	0	0	0	0	42	7,317	142	24,556	246	43,299	328	57,892
	Multi-Family	0	0	0	0	0	0	1	2,783	8	19,689	13	28,322	17	38,693	17	38,693
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	1	162	9	3,478	14	8,842	16	9,422	19	9,735	24	11,563	36	36,905
	Public	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1
AOI-5/7	**Total**	**0**	**0**	**1**	**162**	**9**	**3,478**	**15**	**11,625**	**66**	**36,428**	**174**	**62,613**	**289**	**93,555**	**384**	**133,491**
AOI-6/8/9	Huebner Creek																
	Single-Family	0	0	2	31	10	1,589	50	10,525	100	20,567	170	36,669	290	65,589	360	82,355
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	2	1,329	10	11,553
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	1	25	2	79	3	238	3	238	5	489	6	500	7	514
	Public	1	96	2	108	5	176	10	257	13	917	15	2,602	15	2,602	16	2,660
AOI-6/8/9	**Total**	**1**	**96**	**5**	**164**	**17**	**1,844**	**63**	**11,020**	**116**	**21,722**	**190**	**39,760**	**313**	**70,020**	**393**	**97,082**
AOI-10/11	Leon Creek 6																
	Single-Family	0	0	0	0	2	498	6	1,475	25	7,574	45	14,611	68	22,697	89	30,659
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	8	274	15	539	25	685	40	945
	Commercial	0	0	3	30	26	3,324	52	35,542	66	38,815	77	47,953	89	59,960	97	62,358
	Public	0	0	0	0	5	721	13	2,180	16	2,705	22	2,992	27	3,205	30	3,445
AOI-10/11	**Total**	**0**	**0**	**3**	**30**	**33**	**4,543**	**71**	**39,197**	**115**	**49,368**	**159**	**66,095**	**209**	**86,547**	**256**	**97,407**
AOI-11	Leon Creek 7 and Leon Trib L																

		50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
	Reach/Structure Type	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**	**No.**	**Val.**
	Single-Family	1	121	7	2,624	46	17,870	104	39,819	156	63,353	184	72,956	216	87,018	239	94,670
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	1	129	1	129	1	129	1	129	1	129
	Commercial	0	0	0	0	8	745	8	745	10	1,740	13	2,681	20	7,214	23	9,162
	Public	0	0	0	0	2	69	2	69	2	69	2	69	2	69	2	69
AOI-11	**Total**	**1**	**121**	**7**	**2,624**	**56**	**18,684**	**115**	**40,762**	**169**	**65,291**	**200**	**75,835**	**239**	**94,430**	**265**	**104,030**
AOI-12	Helotes Creek																
	Single-Family	0	0	0	0	5	2,196	11	4,123	30	7,835	106	22,534	162	34,220	233	48,116
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	4	50	17	1,241	29	2,310	39	3,218	42	3,562	44	4,114	53	5,007
	Public	0	0	0	0	0	0	0	0	0	0	4	68	4	68	19	4,003
AOI-12	**Total**	**0**	**0**	**4**	**50**	**22**	**3,437**	**40**	**6,433**	**69**	**11,053**	**152**	**26,164**	**210**	**38,402**	**305**	**57,126**

Measures Considered

A wide variety of structural measures was initially considered in an attempt to identify economically justified flood risk reduction strategies. The array of initial measures available for consideration included channel modification, bypass channels, levees, local detention, regional detention, and overbank storage. Based on site visits, review of aerial photography and prior technical reports (including the Bexar County Flood Insurance Study and the SARA regional stormwater detention master plan), and best professional judgment, a number of potential alternatives from these measures were screened from consideration in specific Areas of Interest.

In general, the initial screening process employed a hierarchical approach; detention strategies, whether regional in nature or on-site, were generally considered first. The primary reason for this preference is that much of the Leon Creek flooding results from peak-on-peak flooding from tributaries, and a detention approach was highly applicable. Detention would also be expected to improve conditions in damage centers further downstream as well as in the immediate vicinity of its location and was thought to provide the maximum opportunity to benefit multiple portions of the study area simultaneously. Where detention was infeasible, channelization options were considered next, with levees considered only where the other options were not expected to be effective. Table 3-3 portrays the results of this largely qualitative screening process and indicates that detention was initially considered as a measure for all damage centers except 3 and 4, which are located on very small tributaries with insufficient storage capacity.

Channelization was considered as a viable measure for damage centers 4, 7, 9, and 12. It was not considered for AOIs 1 and 2 because the extremely large flow quantities would require dropping the channel bottom an estimated 6 to 8 feet, and excavation of that magnitude was not considered to be feasible. Flooding in AOI-3 results primarily from Leon Creek backwaters, and channelization was estimated to be ineffective for that condition. In AOI-5, Culebra Creek is already channelized from back-of-house to back-of-house and down to bedrock; additional channelization was not considered feasible. Similarly, AOIs 6,7, 8, and 10 were estimated to have insufficient grade, or insufficient room (or both) for channelization to be effective. Leon Creek in AOI-11 is already channelized to bedrock.

Because of the urban nature of the watershed (in consideration of both space requirements and the possibility of overtopping) levees were considered only for very specific applications. In AOI -2, a levee is already present -- it simply is not large enough to be effective. In AOI-3, levees were considered to be the only effective means of preventing backwater out of structures. In AOI-7, the channelization option was expected to be constrained by a landfill and would be insufficient to prevent significant flood damages making levees a potential alternative. Consideration of a levee in AOI-11 was specifically requested by the Sponsor. Levees were configured in order to maximize benefits and to adequately address long-term risk and the uncertainties inherent in the specific AOIs where this measure was considered. In the case of AOI-2 for example, the future without project water surface elevations for the 1 percent AEP range from 639.12 to 646.6 feet. The levee elevation would range from 640 on the downstream end to 649 on the upstream end. In all cases, levee performance was considered on the basis of addressing specific annual exceedance probabilities with an eye on long-term risk.

A bypass channel was considered in AOI-2 because there was a bend in channel (natural oxbow) specifically in a location that was subject to flooding. Similarly, AOI-1 was the only damage center having a suitable location for overbank storage, so that option was considered in the initial screening for that location.

Table 3-3 identifies the initial group of measures (21) evaluated for economic justification with locations for each measure are being shown in Figure 3-3.

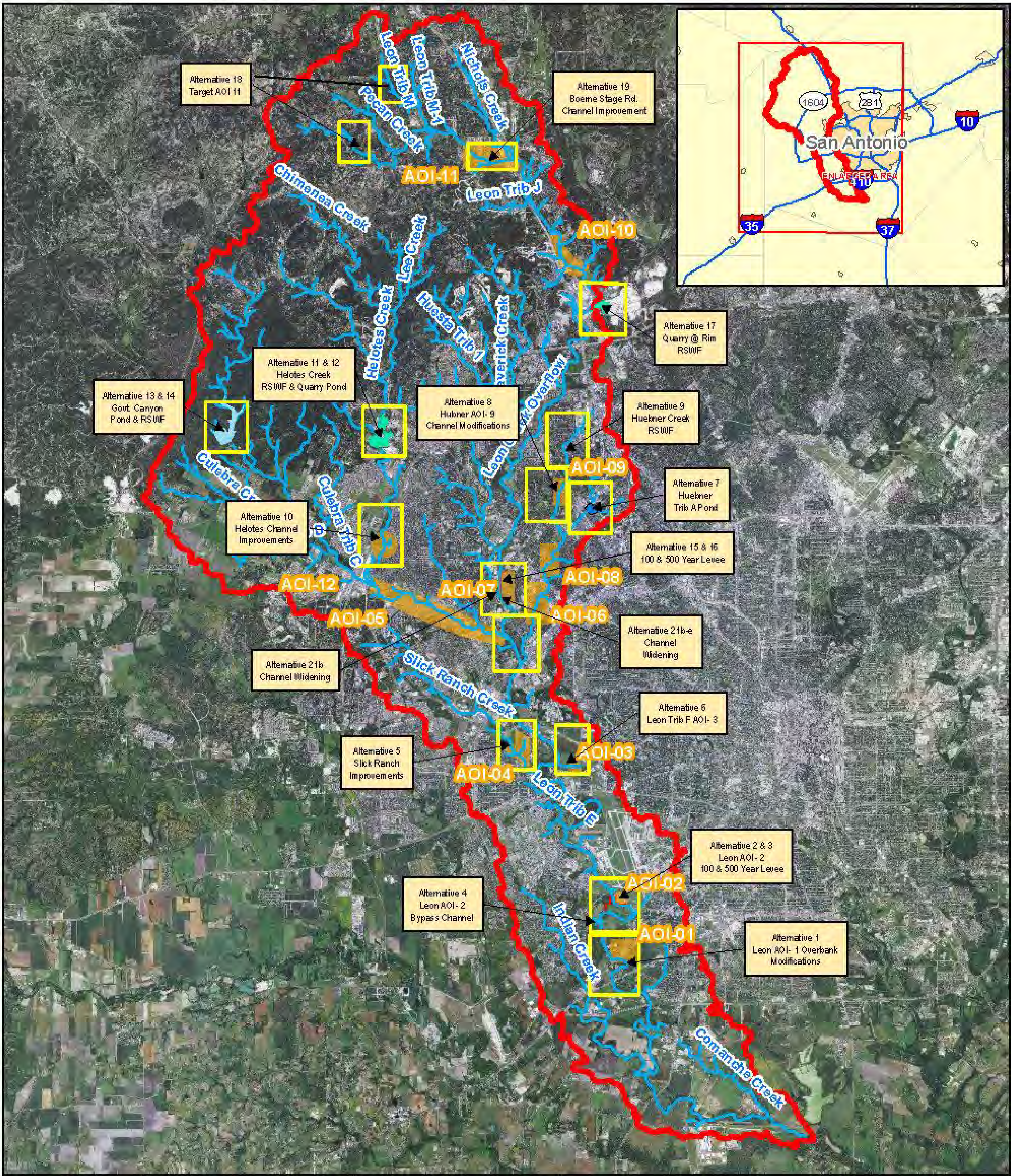
Table 3-3. Initial Array of Measures

	Regional Detention	Local Detention	Channel Modification	Levee	Bypass Channel	Overbank Storage
AOI-1	#11,12,13,14,17					#1
AOI-2	#11,12,13,14,17			#2,3	#4	
AOI-3				#6		
AOI-4			#5			
AOI-5	#11,12,13,14					
AOI-6	#9	#7				
AOI-7	#17		#20, 21	#15, 16		
AOI-8	#9	#7				
AOI-9	#9		#8			
AOI-10		#18				
AOI-11		#18		#19		
AOI-12	#11	#12	#10			

It should be noted that the alternatives listed in Table 3-3, which comprises a number of different management measures including levees, channel modifications, detention ponds, and bypass channels of the initial suite of structural alternatives could all act as stand-alone alternatives. Those alternatives that are not economically justified are dropped at each round of screening. If an AOI has no economically viable alternatives, that AOI is dropped from further consideration. For those AOIs that do have economically justified alternatives, varying scales and combinations with other features are analyzed until an economically optimized alternative is realized. The final recommended plan will be some combination of those AOIs that possess economically optimized alternatives.

Economic Analysis – Initial Suite of Alternatives

The economic analysis of the initial suite of alternatives is discussed in detail in Appendix A, Economic Analysis. Water surface profiles were developed for each alternative and compared individually to those of without-project future condition. Future average annual damages were computed using HEC-FDA, with an interest rate of 4.125 percent (the Federal interest rate in effect at the time of the analysis) and an analysis horizon of 50 years. Total Annual Benefits are the dollar amount of flood damages reduced by the specific alternative, as indicated by the difference in average annual equivalent (damages) in the without-project and the with-project condition. Table 3-4 provides a summary of the economic performance of the initial suite of alternatives (October 2010 price levels, 4.125 percent Federal Interest Rate). The table is organized by measure beginning with the detention structures, which can potentially have impacts to larger areas, down to those measures that have more targeted impacts. This follows the general approach to the project's structural plan formulation process.



US Army Corps of Engineers ®
Fort Worth District

Project: Leon Creek
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Figure 3-3. Initial Array of Alternatives

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Table 3-4 Economic Performance - Initial Suite of Alternatives by Measure

Alternative	Name	Without-Project EAD ($)	With-Project EAD ($)	Total Annual Benefits ($)	Total Annual Costs ($)	Net Benefits ($)
	Regional Detention					
9	Huebner Creek RSWF**	13,593,450	13,565,200	28,250	279,300	-251,050
11	DC-12 Helotes Creek RSWF	13,593,450	12,091,260	1,502,190	678,000	824,190
12	Helotes Quarry Pond	13,593,450	11,566,850	2,026,600	498,000	1,528,600
13	Government Canyon RSWF	13,593,450	12,138,410	1,455,040	1,630,500	-175,460
14	Government Canyon RSWF	13,593,450	11,671,520	1,921,930	858,000	1,063,930
17	Quarry at the Rim	13,593,450	13,199,770	393,680	1,342,600	-948,920
	Local Detention					
7	Huebner Trib A Pond	13,593,450	13,319,190	274,260	1,028,400	-754,140
18	AOI-11 Ponds	13,593,450	12,538,300	1,055,150	1,054,100	1,050
	Channel Modification					
5	Slick Ranch Crk Channel Mod	13,593,450	13,392,860	200,590	*	*
8	Huebner Channel Mod	13,593,450	13,577,210	16,240	78,700	-62,460
10	Helotes Channel Mod	13,593,450	13,486,660	106,790	431,200	-324,410
20	300’BW Channel – Leon R5	13,593,450	13,273,280	320,170	920,400	-600,230
21	200’BW Channel – Leon R5	13,593,450	13,283,160	310,290	352,800	-42,510
	Levee					
2	Leon Creek 100-Year Levee	13,593,450	12,543,800	1,049,650	593,700	455,950
3	Leon Creek 500-Year Levee	13,593,450	11,659,930	1,933,520	789,300	1,144,220
6	Leon Trib F 500-Year Levee	13,593,450	13,474,430	119,020	73,700	45,320
15	Leon 100-Year Levee	13,593,450	13,291,180	302,270	1,204,500	-902,230
16	Leon 500-Year Levee	13,593,450	13,322,910	270,540	414,500	-143,960
19	Boerne Stage Rd Improvement	13,593,450	***	***	***	***
	Bypass Channel					
4	Leon Creek Bypass Channel	13,593,450	12,466,140	1,127,310	239,600	887,710
	Overbank Storage					
1	Leon Creek Overbank Mod	13,593,450	13,444,070	149,380	987,000	-837,620

*Costs not calculated for this alternative
** Regional Storm Water Facility
*** Analysis consisted of incorporating the Boerne Stage Road Improvements (constructed by others) into the HEC-RAS model. No significant effect on water surface profiles observed.

As Table 3-4 shows, for the regional detention alternatives, the best economically performing are the Helotes Quarry Pond and the Government Canyon RSWF with $1,528,600 and $ 1,063,930 in net benefits respectively. Only one of the local detention structures produced positive net benefits while all of the channel modifications were not economically viable. Three of the levee alternatives produced positive net benefits; the 100- and 500-year levees on the main stem of Leon Creek and 500-year levee on Trib F of Leon. The last alternative showing positive economic benefits is the Leon Creek Bypass Channel with $887,710.

Note that the initial analysis of Alternatives 5 and 19 was truncated. Alternative 5 consists of incorporating a channel modification project already constructed by the City of San Antonio in the Slick Ranch Creek segment of the watershed. The original thinking was that the sponsor might seek credit for this work as a part of the Federal project. Benefits for this alternative were estimated, but the Sponsor decided not to proceed with additional investigations in this area. Alternative 19 consisted of incorporating an already-constructed road improvement project in the vicinity of AOI-11 into the model to determine the degree to which the road improvements might function as a levee and provide ancillary protection. No significant effect on water surface profiles was observed with the road improvement in place and no additional analysis was conducted.

Additional "First-Generation" Alternatives

During the later phases of the initial screening, the team developed and screened several additional concepts. Alternative 22 was developed to address damages in AOIs 6, 8, and 9. The alternative represented a combination of Alternative 7 (localized detention on Huebner Trib A) and Alternative 9 (localized detention on Huebner Creek at Prue Road.) The marginal increase in benefits by combining the alternatives was minor and resulted in significant negative net benefits.

Alternative 23 was developed to address damages in the lower end of AOI-5, at the confluence of Culebra and Leon Creeks. Several variations of channel modifications were formulated; however, all had negative net benefits.

Assessment of Initial Screening

Based on the initial screening, the team focused their attention on those damage centers where it appeared that an economically justified project could be developed. In AOI-2, Alternatives 2, 3, and 4 all had positive net benefits, suggesting that further analysis was warranted in this area. All four regional detention options upstream of AOI-5, as well as local detention in the vicinity of AOI-11 (Alternatives 11, 12, 14, 18) demonstrated positive net benefits, suggesting additional evaluation.

Finally, a comparison between the performance of Alternative 20 and 21 (AOI-7) indicated that reducing the channel bottom-width significantly improved project performance, and suggested that evaluation of additional (smaller) alternatives might result in positive net benefits.

REFINEMENT OF STRUCTURAL ALTERNATIVES

Based on the assessment of the initial screening results, additional analysis was conducted in order to refine and optimize promising alternatives. This effort was focused in AOI-2 (Leon Creek Reach 3), AOI-5 (Culebra Reach 1 and Leon Reach 5), and AOI-7 (Leon Creek Reach 5). As in the initial screening, the focus of this phase of plan formulation and identification was NED benefits. The PDT observed changes in water surface elevations created by the initial implementation of the levees (AOI-2) which raised water surface elevations by approximately a foot. In order to address these, the PDT analyzed the potential that hydraulic conveyance might provide in the form of modification of the Leon Creek main channel. Additional analysis was done using the 1 percent AEP levee with interior drainage (Alternative 2B) as the starting point. This channel modification was then added to analyze its impact on benefits to determine if this additional component could be an economically justified increment to create Alternative 2B+. The benefits for these two alternatives are depicted in Table 3-5. Annual Benefits increase from $1,520,880 for Alternative 2B to $1,749,500 for Alternative 2B+ for a difference of $228,620. Annual costs increase from $637,400 to $828,700 for a difference of $191,300. This results in an increase in net benefits of $37,320 making it an economically justified increment with a benefit-to-cost ratio of 1.2.

This phase of the analysis used a 4.125 percent interest rate, which was the Federal interest rate in effect at the time and a 50-year period of analysis. The refinement process was initially conducted for each damage center (Area of Interest) individually. Potential combinations of optimized alternatives for multiple Areas of Interest are discussed in the subsequent sections of this report. The following also outlines conditions that exist in some AOIs that constrain the number of potential alternatives.

AOI-1 (Leon Reach 2)

AOI-1 is located on Leon Creek in between Quintana Road on the north and extends south past New Laredo Highway. A detention pond and levee were initially considered for this AOI but preliminary modeling showed it was insufficient to contain the 20 percent AEP storm without overtopping, resulting in minimal reductions in flow. The levee was screened out because it would require a significant enclosure along the upstream side to prevent water from getting behind the levees, and would therefore not be economically viable. Overbank storage was also considered but was not economically justified.

AOI-2 (Leon Reach 3)

AOI-2 is located on Leon Creek just downstream of S.W. Military Drive. The primary structures in this AOI are a large Jet Engine Test Cell Facility and a mix of commercial properties. This area is located on part of what is now know as Port San Antonio; a multi-purpose, 1,900-acre facility established to serve as an aerospace complex and industrial hub. Port San Antonio occupies the former Kelly Air Force Base and was redeveloped through the Base Realignment and Closure process in 1995. The Port is a quasi-governmental development authority that is a political subdivision of the State of Texas with a Board appointed by the San Antonio City Council. Major tenants include Boeing, Lockheed Martin, Pratt & Whitney, CDI Technology Services, and Standard Aero. Since the area is a relatively small component of the overall Port, the District investigated the potential of having a single entity benefit from a Federal project. ER 1105-2-100 states, "The Corps will not participate in structural flood damage reduction for a single private property" with the caveat that the Corps can consider participating in "measures protecting a single, non-Federal, public property." The single-beneficiary issue is not a concern since the Port is a non-Federal public entity and the Jet Engine Test Cell Facility has multiple tenants.

The Jet Engine Test Cell facility is located at Port San Antonio and is operated by one of the Port’s anchor tenants, Kelly Aviation Center, a subsidiary of Lockheed Martin providing jet engine testing primarily for the Department of Defense. An additional tenant, Custom Fabrication also occupies space at the Test Cell facility. The Jet Engine Test Cell Facility itself is only one of two facilities of its kind. An existing levee/berm is located between the test facility and Leon Creek but is insufficient to prevent overtopping by frequent events. Flood damages start around the 20 percent AEP event. The initial screening evaluated levee alternatives as well as channel modifications. Both types of measures were carried forward into more detailed analysis.

The initial bypass channels began just downstream of the crossing of Leon Creek and S.W. Military Drive and extended 2,738 feet in a south-southwesterly fashion, transferring flood flows across rather than along the oxbow in Leon Creek. The generic alignment of the bypass channel is depicted in Figure 3-4. During refinement of this alternative, the team identified a 48-inch sewer main that would require relocation. In response, the bypass channel alignment was modified slightly to avoid the high cost associated with this activity. Three scales of this alternative (100-feet, 40-feet, and 25-feet bottom-width) were evaluated. The economic performance of the refined bypass channel options is shown in Table 3-5 (4A, 4B, and 4C).

The initial levee concepts (Alternatives 2 and 3 from Table 3-4) consisted of replacing a levee along Leon Creek from cross-section 85024 to 87627 along the east side of Leon Creek in order to reduce damages up to the 0.2 percent AEP event. A levee reducing damages up to the 1 percent AEP levee would have a maximum height of approximately 17 feet, while a 0.2 percent AEP levee would have a maximum height of approximately 20 feet. The generic levee alignment is shown in Figure 3-3. A key element of the refinement of the levee alternatives for AOI-2 was the development of an internal drainage plan to mitigate storm flows behind the levee. This plan consisted of a storm drain and ditches which drain to a sump area. The sump area includes an outlet culvert protected by a flap gate to create Alt. 2B. The total interior drainage area inside the proposed levee is approximately 43 acres. Interior runoff would drain through the levee via a gravity sluice structure. Since these are considered minimal facilities, no pumps are assumed for evacuating floodwaters from the interior of the proposed levee. This interior drainage feature increased net benefits by just over $427,530 making it economically justified. The economic performance of these levee alternatives is shown in Table 3-5.

In an effort to reduce increases to upstream water surface elevations caused by the levees, two approaches were analyzed. Policy requires that in the event of induced damages, mitigation should be investigated and recommended if appropriate. In specific upstream areas, water surface elevations were as much as 1.5 feet higher with the 1 percent AEP levee than under the Future Without-Project Condition. The first approach was to combine the levee alternatives with the best economically performing bypass channel (4C) to form combinations (i.e. Alternative 2B & 4C Combo). This concept increased net benefits but did not mitigate induced damages to the degree anticipated. Under the second approach to address these upstream inducements, the main channel of Leon Creek would be modified to provide hydraulic mitigation and this additional channelization would be include in the levee alternatives. The refinements and the specifics of the hydraulic mitigation are described below and portrayed in Figures 3-5 and 3-6.

- 1 percent AEP Levee and Hydraulic Mitigation (Alt. 2B+). This alternative consists of adding a levee along Leon Creek from cross-section 85024 to 87627 for a length of just over 2,600 feet. The levee would run along the east side of Leon Creek in order to prevent damages from occurring for the 1 percent AEP storm event in AOI-2. The levee elevation would range from 640 feet on the downstream end to 649 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is 16.87 feet. In addition, for mitigation purposes, the channel was widened upstream of the S.W. Military Drive bridge. From its origin, a 40-foot bottom width channel would run to a point immediately downstream of this bridge, and transition to 80-foot bottom width adjacent to the levee. Based on evaluation of the water surface profiles, the upstream channel modifications are sufficient to eliminate the induced increase in water surface elevations upstream of the levee.

- 1 percent AEP Levee and Hydraulic Mitigation and Bypass Channel (Alt. 2B+ & 4C). This alternative consists of the 1 percent AEP levee/hydraulic modification described above with the addition of a 2,738-foot bypass channel on Leon Creek to divert flows away from AOI-2. The bypass channel would follow a south-southwest direction and pass some of the flows beyond the oxbow in Leon Creek before tying back into Leon Creek. The bypass channel would begin just downstream of the crossing of Leon Creek and S.W. Military Drive around Leon cross-section 87864 and tie back into Leon between cross-sections 78641 and 77693. The bypass channel would have a bottom width of 40 feet and a constant slope of 0.53 percent. Adding the bypass channel to the levee with the hydraulic mitigation was considered to see if additional benefits might be realized.

- 0.2 percent AEP Levee and Hydraulic Mitigation (Alt. 3+). This alternative consists of a larger levee along Leon Creek from cross section 85024 to 87627 along the east side of Leon Creek. The levee elevation would range from 644 feet on the downstream end to 653 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is approximately twenty feet. This levee was combined with the hydraulic mitigation upstream of the S.W. Military Drive bridge as described above. However, inspection of the water surface profiles for this configuration revealed that the upstream channel modification alone was insufficient to reduce the increase in water surfaces induced by the larger levee and that induced damages remained. Accordingly, this configuration was dropped from further evaluation and an economic analysis was not performed.

- 0.2 percent AEP Levee and Hydraulic Mitigation and Bypass Channel (Alt. 3+ & 4C). This alternative consists of the same features described above -- the larger levee along Leon Creek from cross-section 85024 to 87627 and the hydraulic mitigation upstream of the S.W. Military Drive bridge – plus the bypass channel from S.W. Military Drive to the vicinity of Leon Creek cross sections 78641-77693.

Table 3-5. Economic Performance of Refined Alternatives – AOI-2 (October 2010 Price Levels/4.125 percent Federal Interest Rate)

ID	Description	Annual Benefits	Annual Costs	Net Benefits
2B	1% AEP Levee w/int drainage	$1,520,880	$637,400	$883,480
2B & 4C	Levee 2B & Channel 4C Combo	$1,751,490	$795,300	$956,190
2B+	1% AEP Levee & Hydraulic Mitigation	$1,749,500	$828,700	$920,800
3+	0.2% AEP Levee	$1,933,800	$789,300	$1,144,500
2B+ & 4C	1% AEP Levee & Hydraulic Mit & Bypass	$1,750,260	$1,001,600	$748,660
3 + & 4C	0.2% AEP Levee & Hydraulic Mit & Bypass	$1,938,090	$1,154,300	$783,790
4A	25-ft BW Channel	$455,730	$152,800	$302,930
4B	40-ft BW Channel	$545,640	$165,800	$379,840
4C	100-ft BW Channel	$701,140	$220,300	$480,840

This analysis indicates that the bypass channel and the hydraulic mitigation add benefits as does the larger levees. The alternatives without the hydraulic mitigation still produced increases to water surface elevations upstream in some cases by up to 2 feet in select locations while the alternatives with the hydraulic mitigation did not induce damages upstream of the project area through a comparison of the with- and without-project water surface profiles. The net annual benefits can be seen for comparison in Table 3-5.

Additional refinements were done to those alternatives given serious consideration for inclusion in a tentatively selected plan. These refinements included updated M2 cost estimates and updated real estate costs to ensure that the alternatives moved forward actually performed as anticipated since the performance of some of these was very close. These included those alternatives identified in Table 3-5 for AOI-2 as well as two additional scales of levee projects in that same location (2 percent AEP and 0.4 percent AEP). These additional scales were evaluated in order to further enhance the understanding of how net benefits might change as the project increased or decreased in size and to assist in selecting the scale of project generating optimum net benefits. Estimates to account for flowage easements were made for those alternatives that did not include hydraulic mitigation and still increased water surface elevations upstream. These refined numbers are in Table 3-8 below. The alternative with the highest net benefits is the 1 percent AEP levee with the hydraulic mitigation. A close second is the 0.4 percent AEP levee with hydraulic mitigation, followed by the 0.2 percent AEP levee in combination with the 100-foot bottom width by pass channel. These results are in the Table 3-8.

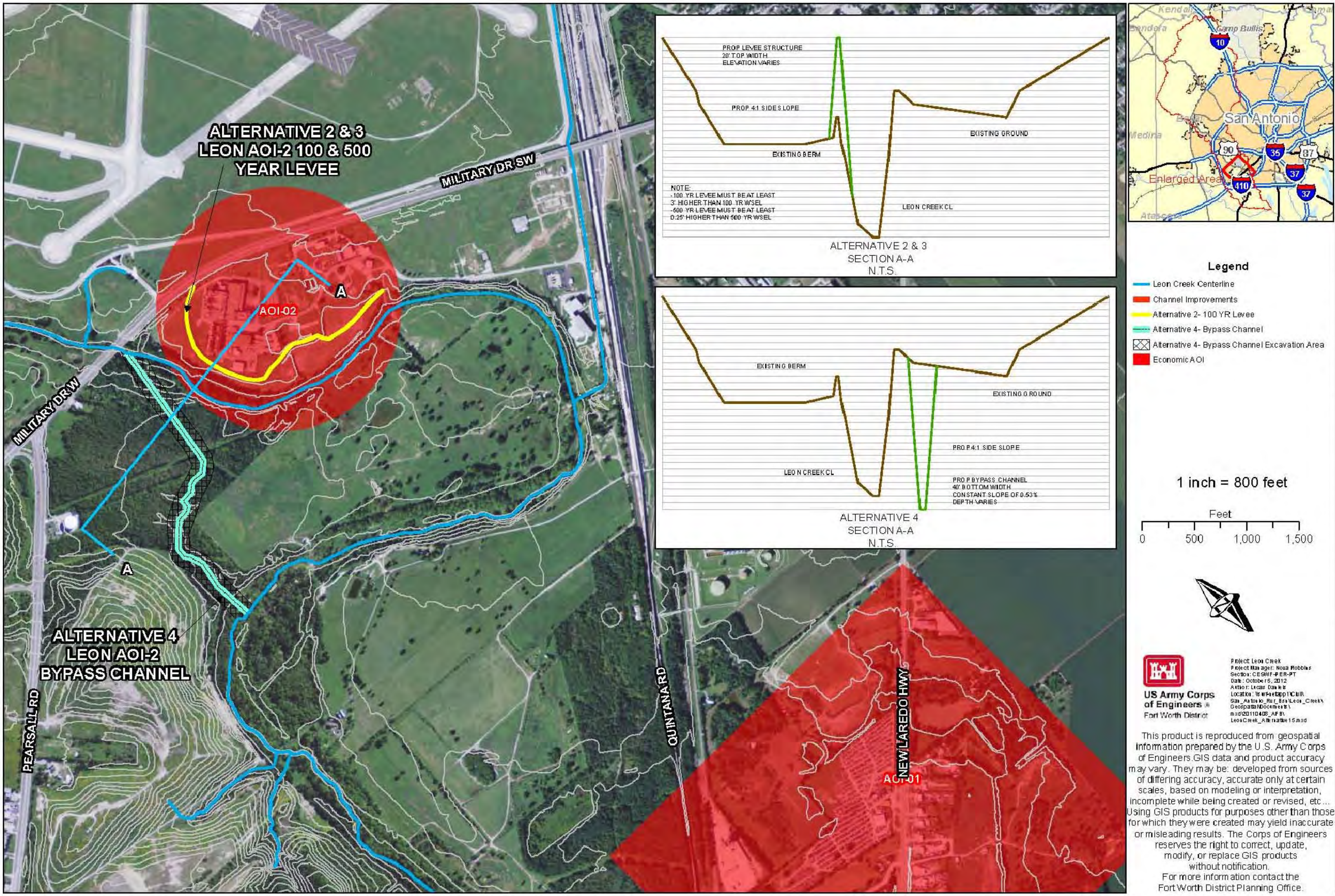

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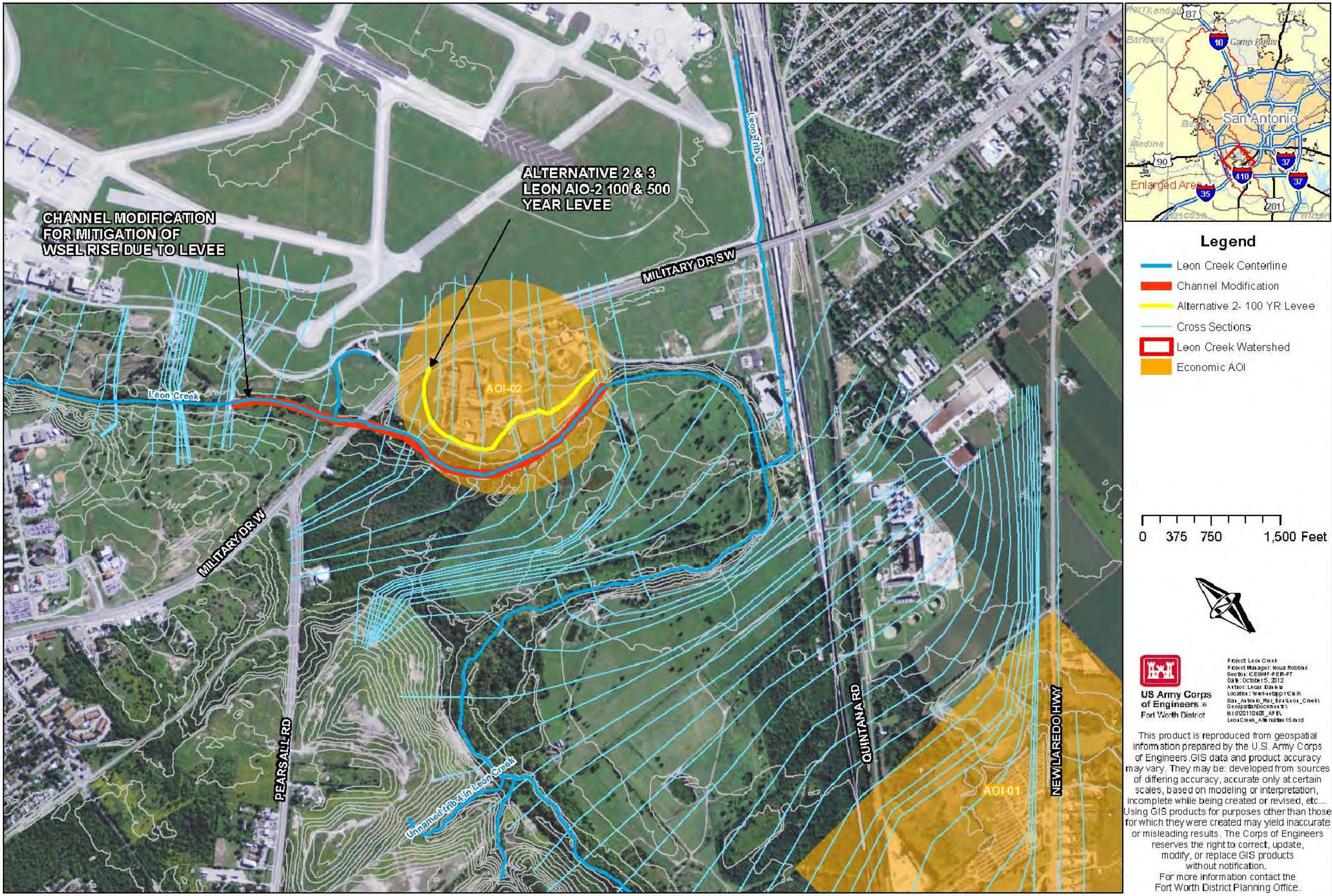
Figure 3-4 AlternativesEvaluated- AOI- 2



Project: Leon Creek
Project Manager: Noua Robbins
Section: CESWF-PER-PT
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Figure 3-5. Levee Alignment with Hydraulic Mitigation

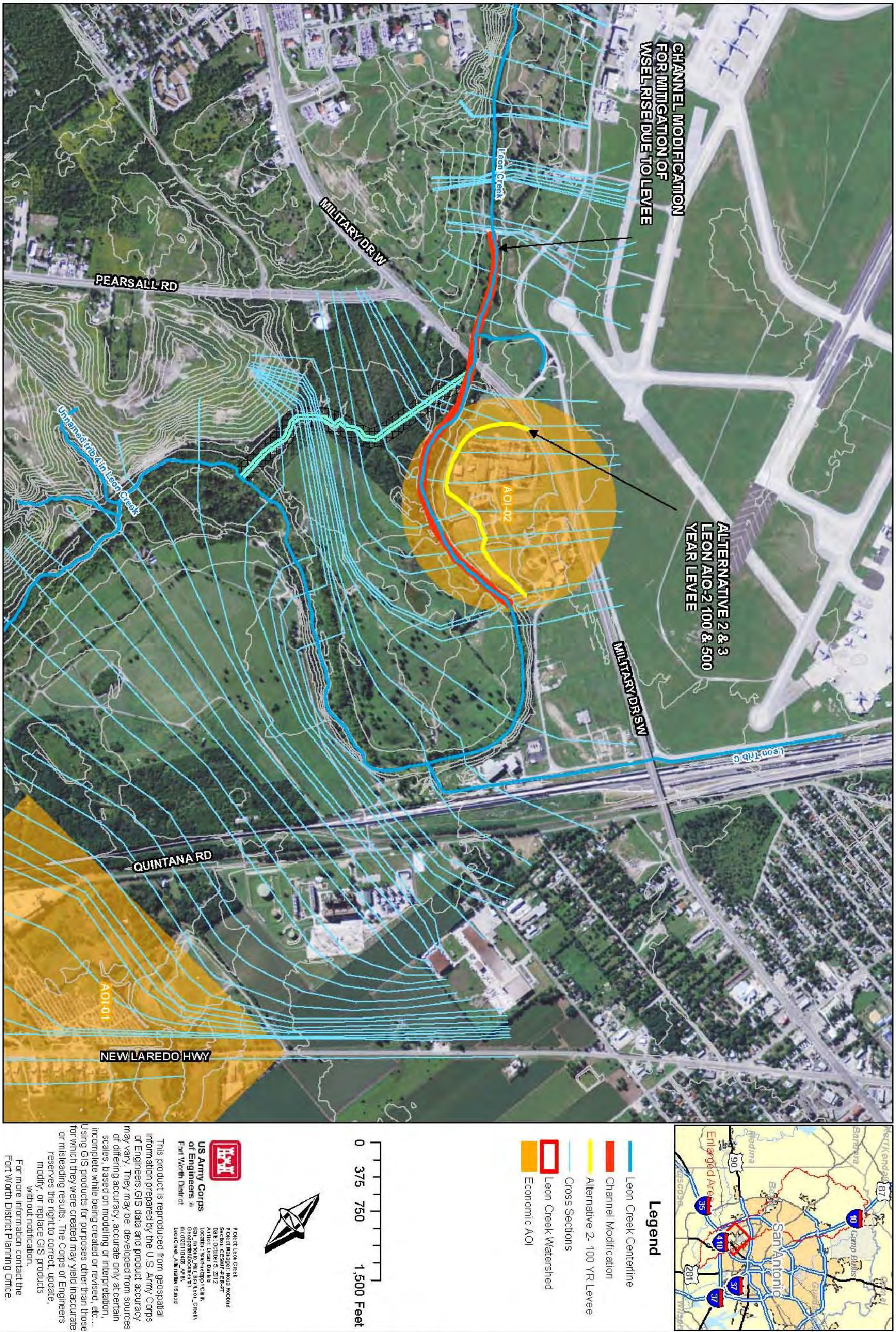


Figure 3-6. Levee Alignment with Hydraulic Mitigation and Bypass Channel

Based on this analysis, the PDT elected to move all of the alternatives listed in Table 3-5 with the exception of the stand-alone bypass channels for further refinement as perspective NED alternatives for this AOI.

Due to potential disturbances in this AOI a mitigation plan would need to be developed. Consultation between team members and resource agencies indicates that reconstruction of the existing levee would result in insignificant impacts to the natural environment. The area in its current condition is heavily disturbed grassland that is frequently mowed. It appears that any needed relocation of existing utilities including an electrical power transmission line could be accomplished without impacting riparian vegetation along Leon Creek. Environmental impacts associated with the channel modifications would require environmental mitigation. However, in comparison with the stand-alone channelization alternatives, the extent and severity of potential in-channel impacts would be less for the levee alternatives. With respect to the choice between the levee configurations, the two levee scales both include the same upstream channel modification, and accordingly would carry the same mitigation requirement. As a result, the PDT was able to conclude that the screening of alternatives to reduce flood risks for this portion of the study area was not sensitive to mitigation costs. Additional discussion of environmental mitigation requirements is included in subsequent sections of the report.

AOI-3 (Leon Trib F)

AOI-3 is located on Leon Trib F, which has damages located west of the Callaghan Road crossing. Measures considered but screened early were a weir structure and flap gate and detention ponds. The weir structure was eliminated because it increased localized flooding along Leon Creek Trib F. The detention pond was eliminated due to the size required making it not cost effective. Alternative 6 had positive net benefits but was not evaluated further based on coordination with the sponsor that benefits may be overstated and would therefore not be economically viable.

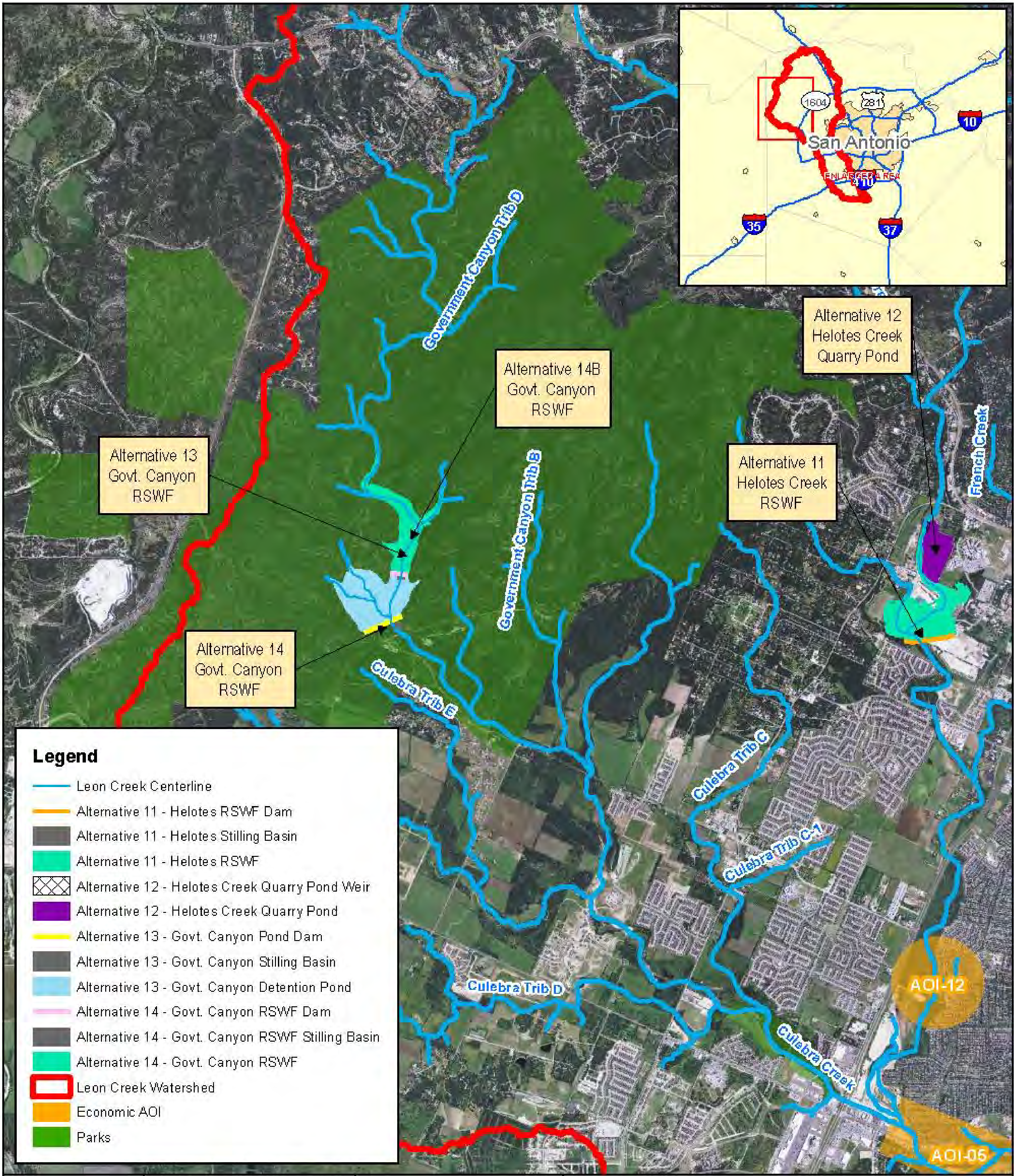
AOI-4 (Slick Ranch)

AOI-4 is located along Slick Ranch Creek upstream of Marbach Road, downstream of Highway 151, and west of Pinn Road. Channel improvements were initially considered for this AOI due to results produced during analysis for Letters of Map Revisions (LOMR). Subsequent analysis using updated hydrology showed lower discharges that did not result in any significant reductions. These channel improvements were not costed out for further analysis.

AOI-5 (Culebra Reach 1 and Leon Reach 5)

AOI-5 is located along Culebra Creek from inside of Loop 1604 down to the confluence with Leon Creek. AOI-5 constitutes one of the largest concentrations of damageable structures in the study area. Over 360 residential structures and 19 commercial structures are susceptible to damage from the 1 percent AEP event. Most structures in the damage center are located along Culebra Creek, but the damage center also includes structures on Leon Creek in the immediate vicinity of the Culebra Creek confluence. In the initial screening analysis, regional-scale detention was demonstrated to be the most promising strategy to reduce flood risks for this damage center. Four detention alternatives upstream of AOI-5 were evaluated. Two sites were located on Helotes Creek in addition to two sites in Government Canyon. An additional configuration in Government Canyon was evaluated during the more detailed planning iteration. These locations are shown in Figure 3-7. Note that all alternatives in Government Canyon are located within Government Canyon State Park.

Alternative 13 would consist of a detention facility created by a 60-foot high, 350-foot wide dam to be located on Culebra Creek approximately 1.5 miles upstream of the park entrance. This alternative would provide approximately 5,600 acre-feet of storage. Alternative 14 would consist of a 51-foot high dam located upstream of the Alternative 13 site with maximum storage of approximately 6,900 acre-feet. In the initial screening, Alternative 14 generated positive net benefits. Because of the environmental and cultural significance of the Government Canyon area, a smaller version of Alternative 14 (Alternative 14B) was added. However, as shown in Table 3-6, this detention option did not yield positive net benefits.



US Army Corps of Engineers ®
Fort Worth District

Project: Leon Creek
Project Manager: Noua Robbins
Section: CESWF-PER-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: \\swf-fs1\gis\projects\cw\jobs\LeonCreek\Documents\

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Figure 3-7. Detention Locations Upstream of AOI 5

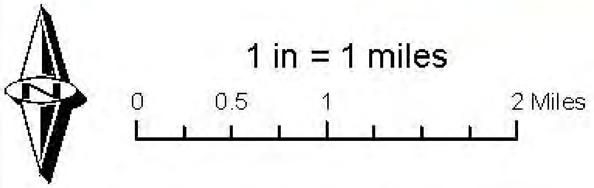


Table 3-6. Economic Performance of Refined Alternatives – AOI-5 (October 2010 Price Levels/4.125 percent Federal Interest Rate)

ID	Description	Annual Benefits	Annual Costs	Net Benefits
11	DC-12 Helotes Creek RSWF	$1,540,530	$678,000	$862,530
12	Helotes Quarry Pond	$2,026,620	$498,000	$1,528,600
12	Helotes Quarry Pond (Upper Bracket)	$2,060,580	$3,791,810	-$1,731,230
13*	Gov't Canyon Site 1 (5,600 ac-ft)	$1,455,040	$1,630,500	-$175,460
14*	Gov’t Canyon Site 2a (6,870 ac-ft)	$1,921,930	$858,000	$1,063,930
14B	Gov’t Canyon Site 2b (1,845 ac-ft)	$541,840	$984,300	-$442,460

* Alternatives 13 and 14 presented unchanged from initial screening

It is important to note that the initial cost estimates did not include environmental or cultural resource mitigation costs. All Government Canyon sites present significant environmental concerns, to include significant endangered species implications. Based on these considerations, regional detention in Government Canyon was not considered further.

In comparison to the Government Canyon sites, both Helotes Creek sites (Alternatives 11 and 12) generated positive net benefits in the initial screening. However, the difference between Alternatives 11 and 12 is both a matter of scale and location. In comparing the two, Alternative 12 has both higher benefits and lower costs, suggesting that it is located at the better site. Indeed, it takes advantage of an existing 50-acre quarry site (soon to be abandoned) that has been excavated to 100 feet below natural grade. This alternative would divert flood flow via a lateral weir into the quarry to take advantage of the 5,000 acre-feet of storage provided therein. This alternative would also include a pump station to evacuate stored flood waters from the detention site at a controlled rate after peak flood flows have passed.

With respect to project scale at the Alternative 12 site, development of a smaller-scale project at this site can be demonstrated qualitatively to be inferior in performance to the 5,000 acre-foot scale. The storage is provided essentially “free” with acquisition of the site. Utilizing less of the available storage would significantly reduce benefits without achieving any appreciable cost savings. On the other hand, consideration of a larger-scale plan would most likely require blasting or other excavation, which would be expected to increase costs substantially.

To validate this expectation, the PDT developed an option at the Helotes Quarry site which would store more water than Alternative 12 and would be expected to provide a greater reduction in flood risk. The “Larger Helotes Quarry” alternative would divert and store an additional 2,400 acre-feet of floodwaters. In order to provide this storage, excavation and blasting would be required. As a result, estimated first costs increased from just over $10,000,000 to more than $70,000,000 with only a negligible increase in benefits. A detailed economic assessment is included in Appendix A. Based on this analysis, the PDT determined that the optimum scale of storage is full utilization of the existing quarry at the existing scale (sufficient to contain the 0.04 percent AEP discharge) as conceptualized in Alternative 12 and depicted in Figure 3-8.

Unlike a levee or channelization strategy, the detention approach to flood risk reduction incorporates a need to evacuate the detention site after a flood event in order to regain the storage. As with a reservoir, the possibility exists that a second flood event might occur before full storage has been regained, however the team considered that the quarry has sufficient capacity to accommodate the remote probability of the occurrence of back-to-back flood events.

Environmental mitigation costs for the Helotes quarry detention alternative are minimal since there is very limited land needed beyond the quarry pit itself. Analysis of the quarry including berm but excluding pump pad - which could be constructed on previously disturbed lands - indicates that approximately 4.5 acres of forest would be impacted by the project. It is estimated that 1.11 average annual habitat units associated with the forest would be lost for the life of the project prior to environmental mitigation. Subsequent analysis indicates acquiring 4 acres of woodlands along the edge of the existing quarry near the creek channel with appropriate management would be sufficient to mitigate forest impacts.

Operation of the detention quarry to provide flood risk management benefits has been evaluated for potential impacts to aquatic resources. The evacuation pump has been sized to drain the quarry sufficiently for it to capture additional flood flows during subsequent runoff events. The rate of flow necessary to evacuate would not produce erosive flows to the intermittent Helotes Creek channel or banks nor would they adversely impact aquatic life. Therefore, no aquatic mitigation is required for this project alternative.

Overall, the cost of anticipated mitigation is relatively small and is not viewed by the PDT as a significant variable in the screening of alternatives for this portion of the study area. With annual net benefits of $1,471,995 and a benefit-to-cost ratio of 3.65 to 1.0, the Helotes Quarry Detention Pond (Alternative 12) is identified as the highest-performing alternative for AOI-5 and recommended for inclusion in the final array of alternatives.

US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Marie Vanderpool
Section: CESWF-PER-PT
Date: June 3, 2011
Author: Fawn Tran
Location: \\swf-fs1\gis\projects\cw\jobs\LeonCreek\Documents\

**Figure 3-8.
Alternative 12
Helotes Quarry
Detention Site**

**PROJECTION:
SOUTH CENTRAL TEXAS
STATE PLANE
FIPS 4204 FEET**

Feet
0 250 500 750 1,000

AOI-6 (Huebner Creek)

AOI-6 is located along Huebner Creek from Bandera Road on the north downstream past Crystal Run. This segment of Huebner Creek has already been channelized. Additional channelization was investigated but was eliminated from further consideration due to the extent of existing channelization and lack of grade and right-of-way to develop drop structures or wider banks. Regional and local detention facilities were considered (Alternatives 7 and 9) but neither were economically justified during the initial screening of alternatives and subsequently dropped from further consideration.

AOI-7 (Leon Reach 5)

AOI-7 is located along Leon Creek upstream of Grissom Road, upstream of the Leon Creek/Culebra Creek confluence and consists of both single and multi-family residences with a mix of commercial structures. During the initial screening, five structural alternatives to reduce flood risk were evaluated. This suite of alternatives included two levee scales (Alternatives 15 and 16), a detention option (Alternative 17), and channelization (Alternative 20 and 21). Neither of the levee scales produced positive net benefits during the initial evaluation and were dropped from consideration.

Alternative 17 was developed to address damages in AOI-7, located in Leon Creek Reach 5, but benefits were anticipated to downstream reaches of Leon Creek as well. The alternative consists of diverting flows from Leon Creek into a quarry. The location is part of the Leon Creek Master Plan and is located north of Loop 1604 and east of IH-10. A lateral weir would divert some flood flows to a diversion channel which in turn would drain into the detention facility. Unlike the quarry on Helotes Creek, however, the Quarry at the Rim facility is a working quarry with an estimated economic life of 25 or more additional years of operation. When costs adequate to cover the condemnation value of the property’s future income stream are included in the analysis, this alternative fails to generate positive net benefits. Additionally, the local Sponsor has indicated that they are not willing to pursue condemnation of a working commercial establishment, and this alternative was dropped from further consideration.

Alternative 20 was initially suggested by the Bexar County Flood Control District and consists of approximately 6,125 feet of channel deepening and widening, using a bottom width of 300 feet to contain the 0.2 percent AEP event. Alternative 21 consisted of a shorter (3,820 feet) and smaller channel (200-foot bottom-width) to contain the 1 percent AEP event. While both alternatives failed to generate positive net benefits, economic performance improved significantly for the smaller channel. Accordingly, a number of increasingly smaller channels were evaluated, each reducing the amount of negative net benefits, until an optimal size was achieved with the 85-foot bottom-width channel. The results of this analysis are shown in Table 3-7.

Table 3-7. Economic Performance of Refined Alternatives – AOI-7 Channel Plans*
(October 2010 Price Levels/4.125 percent Federal Interest Rate)

ID	Description	Annual Benefits	Annual Costs	Net Benefits
20	300’-BW Channel	$320,170	$920,400	-$600,230

ID	Description	Annual Benefits	Annual Costs	Net Benefits
21	200’-BW Channel	$310,290	$352,800	-$42,510
21C	150’-BW Channel	$315,570	$352,500	-$36,930
21D	100’-BW Channel	$291,540	$262,000	$29,540
21E	85’-BW Channel	$273,770	$238,100	$35,670

* Alternatives 20 and 21 presented unchanged from initial screening

Alternative 21E was tentatively identified by the team as the NED plan for AOI-7. (The naturally-occurring channel within the project footprint of Alternative 21E is approximately 80 feet in width. A smaller scale would conceptually involve filling in the channel, which seemed counter-intuitive and was not evaluated.)

Based on the tentative identification of Alternative 21E as the NED plan, updated and refined cost estimates were prepared, specifically, Corps Real Estate and Cost Estimating personnel updated preliminary real estate and construction costs for screening purposes. As a result of this effort, the estimate of annual costs for the alternative increased to $291,404. This increase in costs resulted in negative annual net benefits in the amount of $17,634. Additional detail is provided in Appendix A (Economics) and Appendix H (Cost Estimates).

Due to lack of positive net benefits, Alternative 21E was dropped from further consideration. Ultimately, no structural alternatives were found to be justified in terms of reducing flood risk in AOI-7.

AOI-8 (Huebner Creek)

AOI-8 is located on Huebner Creek from Apple Green Road on the north down to Bandera Road on the south. Just as in AOI-6, this area already has been extensively channelized. Additional channelization was investigated but was eliminated from further consideration due to the extent of existing channelization and lack of grade and right-of-way to develop drop structures or wider banks. Regional and local detention facilities were considered (Alternatives 7 and 9) but neither were economically justified during the initial screening of alternatives and subsequently dropped from further consideration.

AOI-9 (Huebner Creek)

AOI-9 is located on Huebner Creek from Babcock Road to the north down to Whitby Road on the south. Regional detention Alternative 9 would also impact this AOI. Due to available right-of-way and flexible channel elevations, channelization was investigated for this AOI with Alternative 8 which was not economically justified during the initial screening.

AOI-10 (Leon Reach 6-7)

AOI-10 is located on Leon Creek east of IH-10 from just north of Raymond R Russell Park down past Old Camp Bullis Road on the south. Channelization and levees were initially considered for this AOI but due to the lack of right-of-way and existing development were deemed as infeasible. During the initial screening, Alternative 18 generated positive net benefits. Alternative 18 was developed to address damages in AOIs-10 and 11, located on Leon Creek Reaches 6 and 7. The alternative consists of two ponds located upstream of AOI-11 in AOI-10. Leon Trib M Pond is an inline pond located approximately 4,000 feet upstream of the northernmost crossing of Boerne Stage Road. It has a 42-foot high 300-foot wide dam providing storage of approximately 350 acre-feet. Leon XS 285313 Pond is an inline pond approximately 1.3 miles upstream of the crossing of Leon Creek and Huntress Lane. It has a 38-foot high 350-foot wide dam providing storage of approximately 450 acre-feet.

During the refinement stage, minor cost adjustments were made to Alternative 18, resulting in average annual equivalent of $12,538,300 and annual benefits of $1,055,150. Annual costs are estimated at $1,054,100, yielding net annual benefits of $1,050 and a benefit-to-cost ratio of 1.00. With minimal annual benefits, and believing the area to have historical significance, the local sponsor chose to not move forward with this alternative. No other alternatives evaluated to reduce flood risks for this area generated positive net benefits, and the PDT recommends no structural alternatives for AOI-10.

AOI-11 (Leon Reach 6-7)

AOI-11 is located on Leon Creek and runs along Boerne Stage Road from IH-10 on the east and proceeds west on Boerne Stage Road. Stated earlier, Alternative 19 consisted of incorporating an already-constructed road improvement project in the vicinity of AOI-11 into the model to determine the degree to which the road improvements might function as a levee and provide ancillary protection. No significant effect on water surface profiles was observed with the road improvement in place and no additional analysis was conducted.

AOI-12 (Helotes Creek)

AOI-12 is located on Helotes Creek south of Loop 1604. Alternatives 11 and 12, previously discussed in AOI-5 impact this AOI as well. Alternative 10, a channel modification was also analyzed for this AOI but was not economically viable.

Further Refinement of Structural Alternatives

Additional refinements were done to those alternatives given serious consideration for inclusion in a tentatively selected plan. These refinements included updated M2 cost estimates and updated real estate costs to ensure that the alternatives moved forward actually performed as anticipated since the performance of some of these was very close. These included those alternatives identified in Table 3-5 for AOI-2 as well as two additional scales of levee projects in that same location (2 percent AEP and 0.4 percent AEP). These additional scales were evaluated in order to further enhance the understanding of how net benefits might change as the project increased or decreased in size and to assist in selecting the scale of project generating optimum net benefits. Estimates to account for flowage easements were made for those alternatives that did not include hydraulic mitigation and still increased water surface elevations upstream. These refined numbers are in Table 3-8 below. The alternative with the highest net benefits at AOI-2 is the 1 percent AEP levee with the hydraulic mitigation. A close second is the 0.4 percent AEP levee with hydraulic mitigation, followed by the 0.2 percent AEP levee in combination with the 100-foot bottom width by pass channel. At AOI-5, the alternative with the greatest net benefits is Helotes Quarry Pond. These results are in the table below.

Table 3-8. Final Economic Performance of Refined Structural Alternatives (October 2010 Price Levels/4.125 percent Federal Interest Rate)

ID	Description	Annual Benefits	Annual Costs	Net Benefits
2B	1% AEP Levee w/int drainage*	$1,520,880	$907,600	$613,280
2B & 4C	Levee 2B/Channel 4C Combo	$1,751,490	$976,200	$775,290
	2% AEP Levee and Hydraulic Mitigation	$1,634,340	$681,642	$952,698
2B +	1% AEP Levee and Hydraulic Mitigation	$1,749,500	$682,387	$1,067,113
2B+ & 4C	1% AEP Levee and Hydraulic Mitigation and Bypass	$1,750,260	$866,343	$883,917
3+	0.2% AEP Levee	$1,933,800	$1,329,800	$604,000
	0.4%AEP Levee and Hydraulic Mitigation and Bypass	$1,935,420	$879,228	$1,056,192
3 + 4C	0.2% AEP Levee and Hydraulic Mitigation and Bypass	$1,938,090	$937,227	$1,000,863
12	Helotes Quarry Pond	$2,026,620	$554,625	$1,471,995
12	Helotes Quarry Pond (Upper Bracket)	$2,060,580	$3,791,810	-$1,731,230

*Costs for this alternative reflect an earlier level of refinement

The screening and refinement of structural alternatives discussed in the previous section resulted in the identification of two alternatives with the highest positive net benefits with the others being eliminated from further consideration based on economic performance. These alternatives would provide a reduction in flood risk in two separate damage centers within the Leon Creek watershed. Table 3-9 shows the flood damages remaining in the Leon Creek watershed with either Alternative 2B With Mitigation or Alternative 12 in-place. Price levels and interest rates shown are those in effect at the time this analysis was conducted.

Table 3-9 With-Project Damages throughout the Leon Creek Study Area
(October 2010 Price Levels/4.125 percent Federal Interest Rate)

Reach		Alternative 2b+Hyd Mitigation			Alternative 12		
	Without-Project	With Project	Benefits	Residual AAE	With Project	Benefits	Residual AAE
Babcock Trib	382.11	382.11	0.00	382.11	382.11	0.00	382.11
Chimenea Creek	1.57	1.57	0.00	1.57	1.57	0.00	1.57
Culebra Creek Reach 1	1,977.59	1,977.59	0.00	1,977.59	662.73	1,314.86	662.73
Culebra Creek Reach 2	85.68	85.68	0.00	85.68	81.39	4.29	81.39
Culebra Creek Trib A	97.94	97.94	0.00	97.94	97.94	0.00	97.94
Culebra Creek Trib C	36.12	36.12	0.00	36.12	36.12	0.00	36.12
Culebra Creek Trib E	18.18	18.18	0.00	18.18	18.18	0.00	18.18
French Creek	266.43	266.43	0.00	266.43	266.43	0.00	266.43
French Creek Trip A	0.01	0.01	0.00	0.01	0.01	0.00	0.01
Helotes Creek	521.52	521.52	0.00	521.52	338.22	183.30	338.22
Helotes Creek Trib A	46.93	46.93	0.00	46.93	46.93	0.00	46.93
Helotes Creek Trib B	0.52	0.52	0.00	0.52	0.52	0.00	0.52
Huebner Creek	471.36	471.36	0.00	471.36	471.36	0.00	471.36
Huebner Creek Trib A	123.45	123.45	0.00	123.45	123.45	0.00	123.45
Huesta Creek	126.47	126.47	0.00	126.47	126.47	0.00	126.47
Indian Creek	89.50	89.50	0.00	89.50	89.50	0.00	89.50
Leon Creek Reach 1	4.14	4.14	0.00	4.14	3.17	0.97	3.17
Leon Creek Reach 2	528.93	528.93	0.00	528.93	486.81	42.12	486.81
Leon Creek Reach 3 Right	0.22	0.19	0.03	0.19	0.16	0.06	0.16
Leon Creek Reach 3 Left	1,937.56	188.52	1,749.04	188.52	1,715.21	222.35	1,715.21
Leon Creek Reach 4	1,165.58	1,165.15	0.43	1,165.15	964.96	200.62	964.96
Leon Creek Reach 5 Right	1,034.32	1,034.32	0.00	1,034.32	976.41	57.91	976.41
Leon Creek Reach 5 Left	310.79	310.79	0.00	310.79	310.67	0.12	310.67
Leon Creek Reach 6	1,388.08	1,388.08	0.00	1,388.08	1,388.08	0.00	1,388.08
Leon Creek Reach 7	1,131.71	1,131.71	0.00	1,131.71	1,131.71	0.00	1,131.71
Leon Creek Trib B	0.32	0.32	0.00	0.32	0.32	0.00	0.32
Leon Creek Trib F	133.75	133.75	0.00	133.75	133.75	0.00	133.75
Leon Creek Trib H	0.21	0.21	0.00	0.21	0.21	0.00	0.21
Leon Creek Trib J	0.09	0.09	0.00	0.09	0.09	0.00	0.09
Leon Creek Trib K	181.87	181.87	0.00	181.87	181.87	0.00	181.87
Leon Creek Trib M	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Reach		Alternative 2b+Hyd Mitigation			Alternative 12		
	Without-Project	With Project	Benefits	Residual AAE	With Project	Benefits	Residual AAE
Los Reyes Creek	35.44	35.44	0.00	35.44	35.44	0.00	35.44
Ranch Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slick Ranch	1,388.67	1,388.67	0.00	1,388.67	1,388.67	0.00	1,388.67
Slick Ranch Trib B	98.29	98.29	0.00	98.29	98.29	0.00	98.29
Westwood Village Creek	8.10	8.10	0.00	8.10	8.10	0.00	8.10
Total (Positive Benefits)	**13,593.45**	**11,843.95**	**1,749.50**	**11,843.95**	**11,566.85**	**2,026.60**	**11,566.85**

As shown in this table, the refined 2B alternative provides benefits to only one economic reach (Leon Creek Reach 3, Left Bank) while the Helotes Quarry alternative reduces flood risks to at least some degree in nine of the economic reaches. However, 25 of the economic reaches in the study area are unaffected by either alternative. Substantial annual damages remain in a number of reaches, Leon Reaches 4-7 and Slick Ranch, in particular. In addition to these areas, Leon Reach 2 (AOI-1) has a number of single family and mobile homes within the 20 percent AEP delineation. While the previously described analyses indicated that structural alternatives to reduce flood risk in these reaches could not be economically justified, additional evaluation regarding the possibility of nonstructural alternatives was made.

NONSTRUCTURAL ALTERNATIVES

Evaluation of nonstructural alternatives focused primarily on removal of susceptible properties from the floodplain (floodplain evacuation). Other types of nonstructural alternatives are either being implemented independently by SARA or were estimated to be relatively ineffective in dealing with flood damages. For example, a sophisticated real-time flood warning system was developed by SARA in partnership with Bexar County; the Leon Creek portion of this flood warning system became operational in 2013. The flood warning system will be linked to the City and County Emergency Operations Center(s) and will provide updated information every 15 minutes during storm events. The deployment of this system should significantly reduce the risk to human health and safety during flood events, but will have limited effect on the damage caused by flooding to property. Best Management Practices to reduce or manage stormwater outside the floodplain are being encouraged and incentivized for new development by SARA and its jurisdictional partners as discussed in Section 2 previously. Flood proofing of structures in place was not supported by the Sponsor, in part because of concerns related to emergency access by first responders and concerns for placing both residents and those first responders at risk.

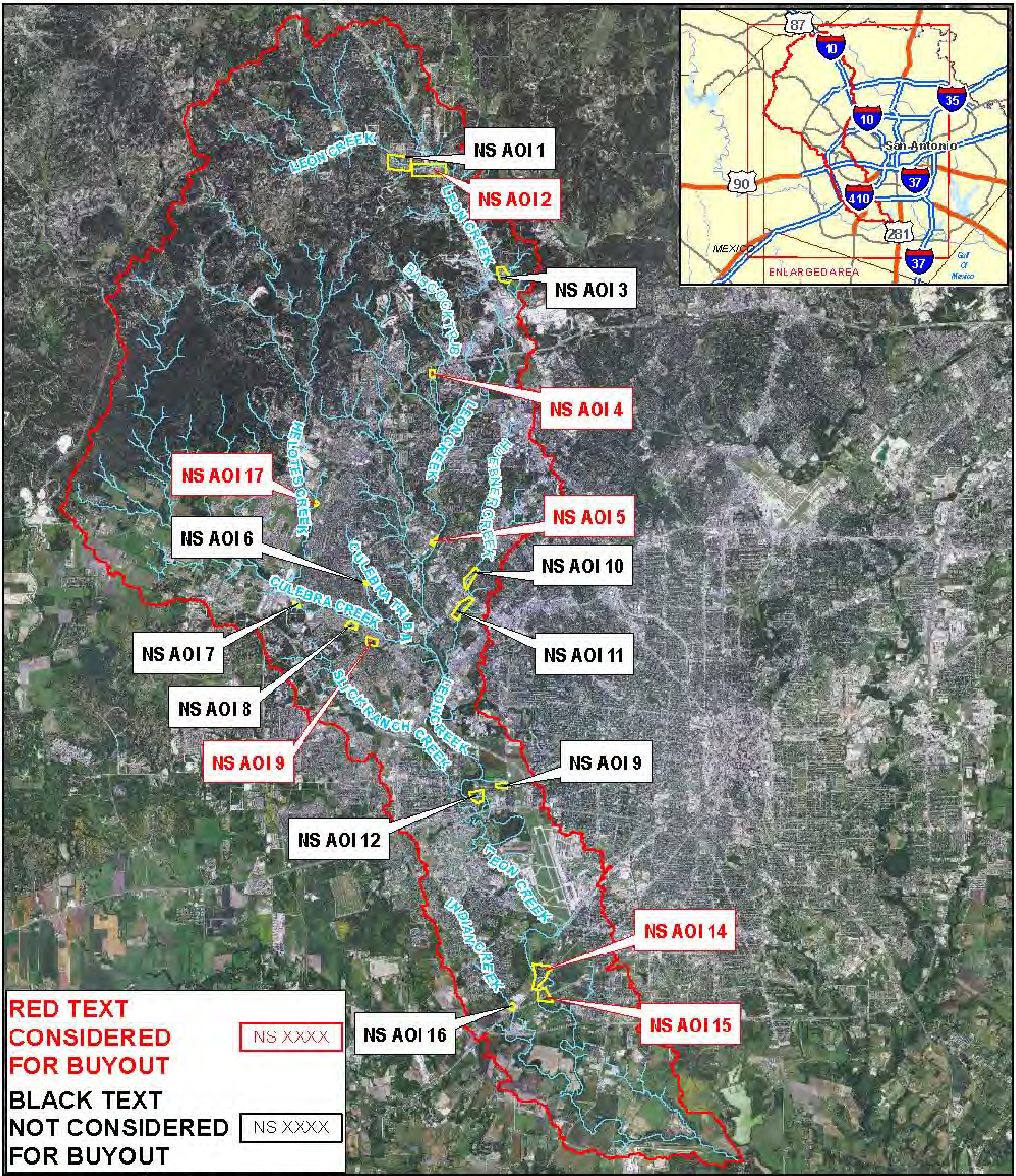
Initial screening for floodplain buyout alternatives was conducted by identifying (for each structure in the study area) the most frequent event which resulted in water surface elevations which exceeded the first floor elevation. The subset of the structure file for which the 50 percent, 20 percent, 10 percent and 4 percent AEP events resulted in water surfaces higher than the first floor elevation were color-coded and mapped for further consideration. This analysis resulted in identification of 16 “clusters” of highly susceptible properties (Areas of Interest) which are displayed in Figure 3-9. Note: The numbering convention for the Areas of Interest is not the same as the Areas of Interest for the structural evaluation and is distinguished by the “NS” nomenclature utilized for this discussion.

Preliminary real estate and demolition costs were developed for the initial set of seventeen AOIs. A total of nine scales were evaluated. Six alternatives in three NS AOIs (4, 15, and 17) generated positive net benefits. The 10-year buyout in NS AOI -17 was dropped from consideration because it was a single land owner and the parcel was isolated from all other nonstructural areas of interest leaving AOIs -4 and -15 as being carried forward. The preliminary screening of nonstructural alternatives is depicted in the following table.

Two alternatives in NS AOI -14, one alternative in NS AOI -5, and one alternative in NS AOI- 9 were also carried forward even though they did not have positive net benefits, because they involved large tracts of land, were located adjacent to NS AOI -15, and their potential for recreation benefits was to be considered. More precise cost estimates were developed for these remaining alternatives. The final array of nonstructural alternatives is depicted in Table 3-12. At this level of analysis, NS AOI-4 produced positive net benefits, while NS AOI-14 and NS AOI-15 were not economically justified. The District did a preliminary analysis for NS AOIs -14 and -15 examining the potential for recreational features in these areas. These features include the following;

Feature	Number	LG/Area	Unit
Multi Use Trails		3.083	Miles
Picnic Areas	18	0.05	Acres
Playground Areas	2	0.05	Acres
Multi-Use Playfield Area (Open Space)	2	39.48	Acres
Parking Lots	2	6.57	Acres

Costs for recreation amenities on the two NS AOIs were estimated to be approximately $2.8 million. Utilizing recreation unit day values and recreation demand data available from Texas Parks and Wildlife Department, benefit-to-cost ratios were developed for the various recreation alternatives. Achieving unity (BCR = 1.0) required an assumption that the recreation facility would attract virtually all of the potential recreational demand in the area, which is not a reasonable assumption. Finally, the recreation was combined with the FRM to create FRM/Recreation alternatives. The analysis was performed on the combined FRM/Recreation alternatives and analyzed utilizing varying demand sensitivity scenarios. The results for the combined alternatives had BCRs ranging from 0.7 to 1.0-to-1.0 depending on which demand scenario was utilized in the analysis. Based on the analysis, the two NS AOIs and their associated recreation were dropped from further consideration. An additional discussion on the recreational methodology is in the Economic appendix.



RED TEXT CONSIDERED FOR BUYOUT NS XXXX

BLACK TEXT NOT CONSIDERED FOR BUYOUT NS XXXX

US Army Corps of Engineers®
Fort Worth District

Project: Leon Creek
Project Manager: Moua Robbins
Section: CESWF-PER-PT
Date: June 23, 2011
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Figure 3-9.
Non Structural
Areas of Interest

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

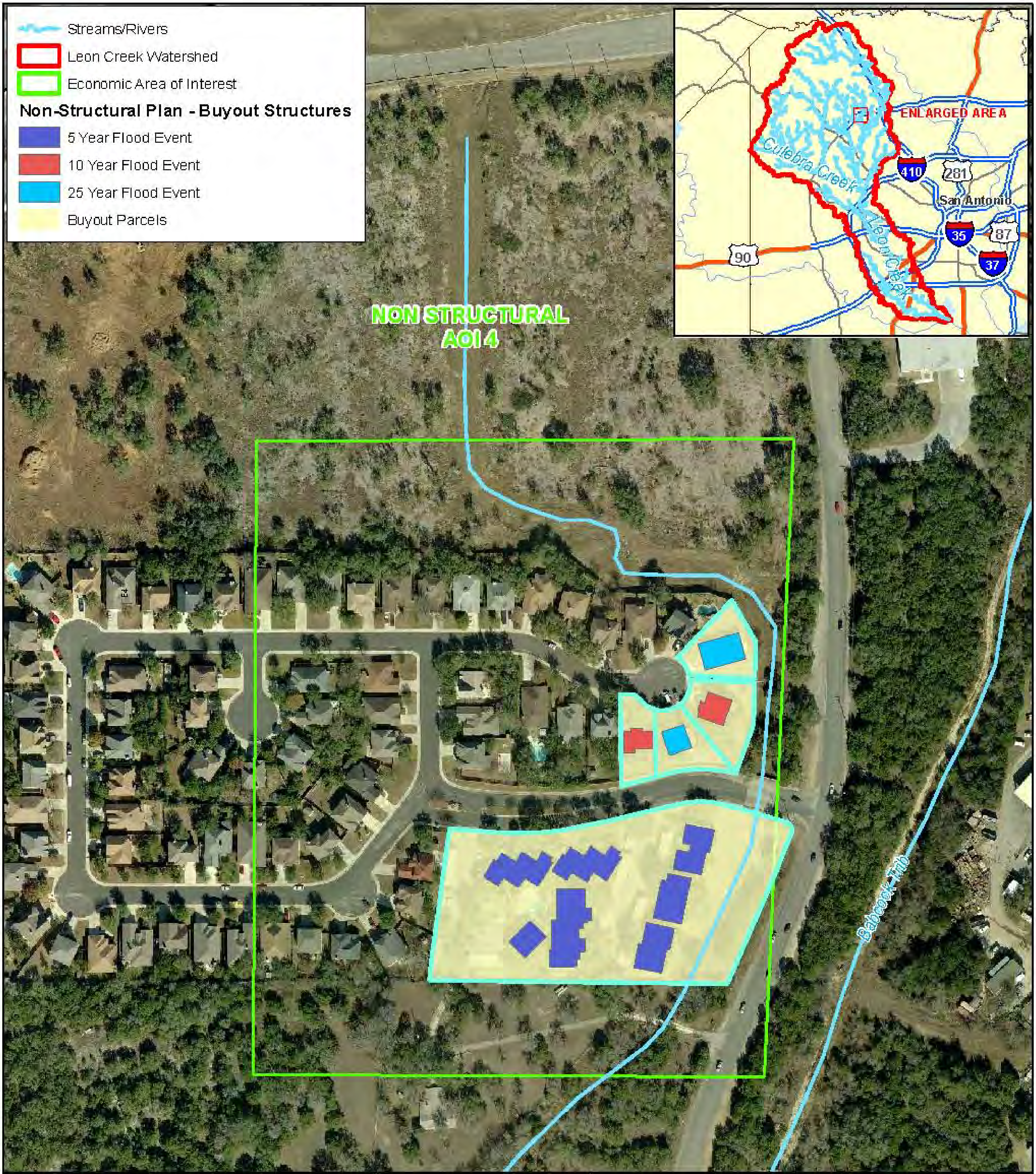
Table 3-10
Preliminary Screening of Nonstructural Alternatives

Nonstructural Area of Interest	AEP Event	Annual Benefits	Annual Costs	Annual Net Benefits	Benefit-to-Cost Ratio
NS AOI 1	10	$265,790	$278,410	($12,620)	0.95
	25	637,580	1,070,659	($433,079)	0.60
NS AOI 2	10	26,060	122,164	($96,104)	0.21
	25	919,270	969,036	($49,766)	0.95
NS AOI 3	25	59,780	162,101	($102,321)	0.37
NS AOI 4	5	71,468	55,298	$16,170	1.29
	10	98,832	98,192	$640	1.01
	25	358,580	135,111	$223,469	2.65
NS AOI 5	25	258,690	286,421	($27,731)	0.90
NS AOI 6	10	22,770	38,650	($15,880)	0.59
	25	36,990	106,034	($69,044)	0.35
NS AOI 7	25	17,510	49,647	($32,137)	0.35
NS AOI 8	25	171,400	325,183	($153,783)	0.53
NS AOI 9	10	50,640	64,038	($13,398)	0.79
	25	156,970	273,679	($116,709)	0.57
NS AOI 10	25	40,340	131,148	($90,808)	0.31
NS AOI 11	25	48,800	150,291	($101,491)	0.32
NS AOI 13	25	73,020	267,730	($194,710)	0.27
NS AOI 14	10	275,490	369,235	($93,745)	0.75
	25	293,620	411,416	($117,796)	0.71
NS AOI 15	10	30,440	61,245	($30,805)	0.50
	25	141,710	127,609	$14,101	1.11
NS AOI 16	5	910	62,821	($61,911)	0.01
	25	1,520	100,847	($99,327)	0.02
NS AOI 17	10	47,430	26,640	$20,790	1.78

Table 3-11 Final Array of Nonstructural Alternatives
(October 2010 Price Levels/4.125 percent Federal Interest Rate)

	AOI 4 20% AEP	**AOI 4 10% AEP**	**AOI 4 4% AEP**	**AOI 5 4% AEP**	**AOI 9 10% AEP**	**AOI 14 10% AEP**	**AOI 14 4%AEP**	**AOI 15 10% AEP**	**AOI 15 4% AEP**
INVESTMENT									
ESTIMATED FIRST COST	$1,174,157	$2,048,758	$2,801,744	$9,455,887	$1,851,643	$8,569,969	$9,387,157	$1,455,581	$3,663,906
ANNUAL INTEREST RATE	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125
PERIOD OF ANALYSIS (years)	50	50	50	50	50	50	50	50	50
CONSTRUCTION PERIOD (months)	24	24	24	24	24	24	24	24	24
COMPOUND INTEREST FACTOR	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97
CAPITAL RECOVERY FACTOR	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551
INTEREST DURING CONSTRUCTION	$46,708	$81,500	$111,454	$376,159	$73,659	$340,916	$373,425	$57,904	$145,752
INVESTMENT COST	$1,220,865	$2,130,258	$2,913,198	$9,832,046	$1,925,302	$8,910,885	$9,760,582	$1,513,485	$3,809,658
ANNUAL CHARGES									
INTEREST	$50,361	$87,873	$120,169	$405,572	$79,419	$367,574	$402,624	$62,431	$157,148
AMORTIZATION	$7,693	$13,423	$18,356	$61,952	$12,131	$56,147	$61,501	$9,536	$24,005
OPERATION/MAINTENANCE ($/year)	$0	$0	$0	$0	$0	$0	$0	$0	$0
REPLACEMENTS	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	**$58,053**	**$101,296**	**$138,525**	**$467,524**	**$91,550**	**$423,722**	**$464,125**	**$71,968**	**$181,153**
ANNUAL BENEFITS									
FLOOD DAMAGE REDUCTION BENEFITS	$71,468	$98,832	$358,580	$258,690	$50,460	$275,490	$293,620	$30,440	$141,710
RECREATION BENEFITS	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL BENEFITS	**$71,468**	**$98,832**	**$358,580**	**$258,690**	**$50,460**	**$275,490**	**$293,620**	**$30,440**	**$141,710**
NET BENEFITS	$13,415	($2,464)	$220,055	($208,834)	($41,090)	($148,232)	($170,505)	($41,528)	($39,443)
BENEFIT-TO-COST RATIO	**1.23**	**0.98**	**2.59**	**0.55**	**0.55**	**0.65**	**0.63**	**0.42**	**0.78**

NS AOI-4 is located south of Loop 1604 and west of Babcock Road. It is subject to flooding from Babcock Creek. The proposed buyout alternatives includes four single-family residential structures (two subject to damages from the 10 percent AEP event and two subject to damages from the 4 percent AEP event) and 32 townhouses, all subject to damages from the 20 percent AEP event. The structures are located on five tracts totaling 3.85 acres. The NS AOI-4 buyout plan is shown in detail in Figure 3-10.



US Army Corps of Engineers®
Fort Worth District

Project: Leon Creek
Project Manager: Nous Robbins
Section: CESWF-PER-PT
Date: July 25, 2011
Author: Fawn Tran
Location: \\swf-fs1\gis\projects\cw\jobs\LeonCreek\Documents\

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Figure 3-10.
NS AOI-4
Buyout
Alternative

PROJECTION:
SOUTH CENTRAL TEXAS
STATE PLANE
FIPS 4204 FEET

1 inch = 200 feet

Feet
0 250 500

Nonstructural AOI-4 buyout has a first cost of $2,801,744 (October 2010 price levels.) The total annual benefits for this alternative are estimated at $358,580, while the annual costs (at 4.125 percent interest rate) are $138,525. Net benefits are $220,055 annually with a Benefit-to-Cost ratio (BCR) of 2.6.

Preliminary coordination with resource agencies indicates that the buyout of townhouses and residential structures included in this alternative would result in only minimal temporary adverse impacts to the natural environment. Trees adjacent to the structures would be preserved to extent possible, and following demolition and removal of debris, the disturbed areas would be replanted with grasses to stabilize the soil against erosion. Approximately 3.85 acres of floodplain lands would be available for use by the sponsor for open space uses. This alternative is not expected to require environmental mitigation other than compliance with best management practices during demolition to control dust emissions and surface erosion into the aquatic environment.

The PDT has identified the NS AOI-4 buyout as the NED plan for this portion of the study area and recommended its inclusion in the final plan due to annual net benefits of $220,055.

DEVELOPMENT OF THE RECOMMENDED PLAN

Previous sections of this report have described efforts to identify economically justified alternatives to reduce flood risks in various portions of the Leon Creek watershed. Combination of these alternatives to form comprehensive alternatives requires additional analysis and consideration.

Next-added Increment Analysis

While the three economically justified alternatives are located in different parts of the watershed, the possibility exists that the hydraulic or economic effects of one alternative may interact with those of another, affecting the performance and justification of one or more component. To evaluate this possibility, the PDT conducted a Next-Added Increment analysis.

Of the three alternatives combined to form the final array of alternatives, the Helotes Creek Detention alternative has the most far-ranging effect. Located on an upstream tributary, it can be expected to modify water surface profiles downstream of the Leon Creek confluence and potentially affect the benefits of the AOI-2 levee alternative. Accordingly, the Helotes Creek Detention alternative was considered as the “first-added” increment in the plan. As previously discussed, it is justified as a stand-alone alternative, with net benefits of $1,471,995 and a BCR of 3.65.

The other alternative affecting water surface profiles is the 1 percent AEP event (100-year) Levee with Hydraulic Mitigation in AOI-2. This alternative was considered as the “second-added” increment, forming the two-component alternative. The screening-level analysis of alternatives for AOI-2 did not include mitigation costs, as plan selection was not felt to be sensitive to this cost issue. However, for purposes of ensuring incremental justification of this alternative, a conservative estimate of mitigation costs was developed and included in the incremental analysis. The mitigation estimate was based on use of a mitigation bank to compensate for potential in-stream impacts associated with the channelization included as hydraulic mitigation in this alternative. Credits to mitigate one mile of aquatic channel cost approximately $2.5 million per mile in geographically-comparable mitigation banks. Based on this, an estimate of $2.2 million for aquatic mitigation was added to the AOI-2 alternative. This cost increase resulted in an increase in the annual charges to $794,496 (compared to $682,387) and a reduction of its net benefits, on a stand-alone basis, to $955,004 (as compared to $1,067,113).

Water surface profiles were developed for a with-project condition of the two-component alternative and economic justification assessed. The results are displayed in Table 3-12.

Table 3-12
NED Analysis of Helotes Quarry + AOI-2 Levee
(October 2010 Price Levels/4.125 percent Federal Interest Rate)

Investment		
	Estimated First Cost	$24,613,988
	Interest Rate	.04125
	Period of Analysis (years)	50
	Construction Period (months)	18
	Interest During Construction	$1,763,785
	Investment Cost	$26,377,774
Annual Charges		
	Interest	$1,088,083
	Amortization	$166,206
	Operation and Maintenance	$50,000
	Replacements	$0
	Total Annual Charges	**$1,034,290**
Annual Benefits		
	Flood Risk Mgmt Benefits	$3,513,500
	Recreation Benefits	$0
	Total Annual Benefits	**$3,513,500**
	Net Benefits	**$2,209,210**
	Benefit-to-Cost Ratio	**2.7**

Based on this analysis, the marginal benefits of the AOI-2 Levee alternative are $737,215, representing the difference between the annual net benefits of the two-component alternative from Table 3-12 above and the annual net benefits of the one-component alternative (first-added increment) ($1,471,995). This is slightly less (9 percent) than the net benefits for this alternative when estimated as a stand-alone project, indicating that upstream detention does have some effect as far downstream as AOI-2. However, the marginal net benefits for this increment are larger than its annual costs, yielding revised net benefits of $54,828 annually and indicating that the alternative comprised of the Helotes Quarry alternative and the AOI-2 levee alternative is incrementally justified.

By definition, the nonstructural increment in NS AOI-4 is not expected to have an effect on the hydraulic profiles, only on the economic assessment of damages. As a check, however, the same process described above was followed, using the NS AOI-4 as the third-added increment (3-component alternative). Results are shown in Table 3-13. Note that the project construction period is modified to 24 months to accommodate the slower buyout process.

Table 3-13
NED Analysis of Helotes Quarry + AOI-2 Levee + NS AOI-4
(October 2010 Price Levels/4.125 percent Federal Interest Rate)

Investment		
	Estimated First Cost	$27,415,733
	Interest Rate	.04125
	Period of Analysis (years)	50
	Construction Period (months)	24
	Interest During Construction	$2,266,494
	Investment Cost	$29,682,227
Annual Charges		
	Interest	$1,224,392
	Amortization	$187,028
	Operation and Maintenance	$50,000
	Replacements	$0
	Total Annual Charges	**$1,461,420**
Annual Benefits		
	Flood Risk Mgmt Benefits	$3,872,080
	Recreation Benefits	$0
	Total Annual Benefits	**$3,872,080**
	Net Benefits	**$2,410,660**
	Benefit-to-Cost Ratio	**2.7**

The marginal benefits of the nonstructural alternative is $201,450, estimated by the difference between the annual net benefits of the three-component alternative displayed in Table 3-13 and the two-component alternative displayed in Table 3-12. The annual net benefits for the nonstructural alternative as analyzed on its own are estimated at $205,340 -- a negligible difference likely due to the nature of the risk-based calculation with uncertainty within HEC-FDA. This indicates that the nonstructural component is incrementally justified as a third-added increment. Figure 3-11displays the location of each of these plan components.

Development of the Mitigation Plan

Of the three alternatives discussed above, only the 1 percent AEP levee (with its hydraulic mitigation component) requires environmental mitigation. Provided that construction activities are properly monitored and managed (additional detail is provided in Section 6, Project Implementation), no adverse effects are anticipated. The other structural alternative of the NED plan is the Helotes Quarry Pond in AOI-5. This is a highly disturbed site that will not require mitigation.

With respect to mitigation for the AOI-2 Levee Component, the construction staging area would temporarily impact approximately 10.4 acres of grasslands which would be replanted with grass following construction with no mitigation required. Modification of the channel itself would permanently impact both aquatic and riparian resources for a total impact of 2.25 acres (2,800 linear feet) of in-stream habitat and 15.75 acres of urban riparian woodlands. An initial conservative estimate for the tentatively selected plan was developed and included in the incremental analysis for purposes of ensuring incremental justification of this alternative.

Aquatic Habitat Mitigation

The Qualitative Habitat Evaluation Index (QHEI) is approved for one-time use for Leon Creek to assess the quality of the aquatic habitat and establish aquatic mitigation requirements. Three sites, spread out along the length of the creek, were evaluated within the project area (Figure 1). QHEI scores for the three sites were 56, 55, and 53 with a mean of 54.67. Although, the riparian habitat scored relatively high for Leon Creek, the absence of riffles and run habitats in this reach of Leon Creek limited the QHEI scores. This disruption of the sediment transport mechanism of the creek results in high sedimentation and extensive embeddedness of the creek’s substrate, limiting aquatic diversity. Using the average QHEI value of 55, average annual habitat units (AAHU) were calculated, and are presented in Table 3-14.

Table 3-14. Existing Condition Aquatic Average Annual Habitat Units

Target Year	0	1	15	25	50	Cumulative HU	AAHU
Interval (Years)	0	1	14	10	25		
HSI	0.55	0.55	0.55	0.55	0.55		
Acres	2.25	2.25	1.25	2.25	2.25		
Target Year HU	1.24	1.24	1.24	1.24	1.24		
Interval HU		1.24	17.36	12.4	31	62	1.2

Based on this analysis, any mitigation plan chosen would need to create minimally 1.2 AAHUs and achieve a QHEI score of 55 for riparian aquatic habitat over the 50-year life of the project.

Riparian Habitat Mitigation

As reported in the existing conditions section of this document, the riparian zones in of the Lower Leon Creek study area are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash, black willow, and cedar elm trees in the upper portions of the segment. The proposed channel improvements are located in the upper portion of this segment. The HSI values for the fox squirrel and Barred Owl for the Lower Leon Creek segment were both 0.12 providing limited habitat for each of these species. The factors limiting the quality of the riparian woodland include:

- Barred Owl habitat was poor (0.12), due to the low average diameter at breast height (dbh) of overstory trees less than 10 inches, which reduces cover and reproductive values.

- Fox squirrel habitat value (0.12) was reduced by the lack of mast producing trees for available food.

The riparian woody vegetation mitigation measure would address the lack of mast producing trees by planting hard mast species such as pecan along the riparian corridor, which would improve the value of the habitat for fox squirrel and other wildlife species. In addition, site-specific native vegetation such as bald cypress and pecan would eventually reach diameters larger than 10 inches dbh, which would increase the HSI values for Barred Owls and other wildlife species. The riparian woodland plantings would assist in mitigating temporary impacts to aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. Table 3-15 presents the existing condition cumulative and average annual habitat units which would have be achieved by the mitigation alternative.

Table 3-15. Existing Condition Riparian Woody Vegetation Average Annual Habitat Units

Target Year	0	1	15	25	50	Cumulative HU	AAHU
Interval (Years)	0	1	14	10	25		
HSI	0.12	0.12	0.2	0.2	0.2		
Acres	15.75	15.75	15.75	15.75	15.75		
Target Year HU	1.89	1.89	3.15	3.15	3.15		
Interval HU		1.89	44.1	31.5	78.75	156.24	3.1

Using professional judgment, five mitigation alternatives were identified, as described below:

Option 1 – Onsite Natural Stream Design Channel. Over the last decade, several FRM projects in the City of San Antonio such as the Mission Reach and Eagleland segments of the San Antonio River have been reconstructed to restore the aquatic and riparian ecological function to the channelized streams. For the aquatic mitigation this option would utilize the same Natural Channel Design (NCD) concepts used for Mission Reach project studies to “self mitigate” impacts to waters of the U.S. The NCD methods utilize vertical and horizontal structures in the form of cross vanes, rock weirs, J-hooks, or other natural material structures to maintain a neutral sediment transport balance for the creek. The NCD structures also recreate pool and riffle habitats with proper substrate to support a diverse community of aquatic organisms. The NCD methodology develops a functional, self-sustaining system providing valuable hydraulic transport, along with geomorphic and ecological functions. Costs for this option were initially estimated to be $297,000.

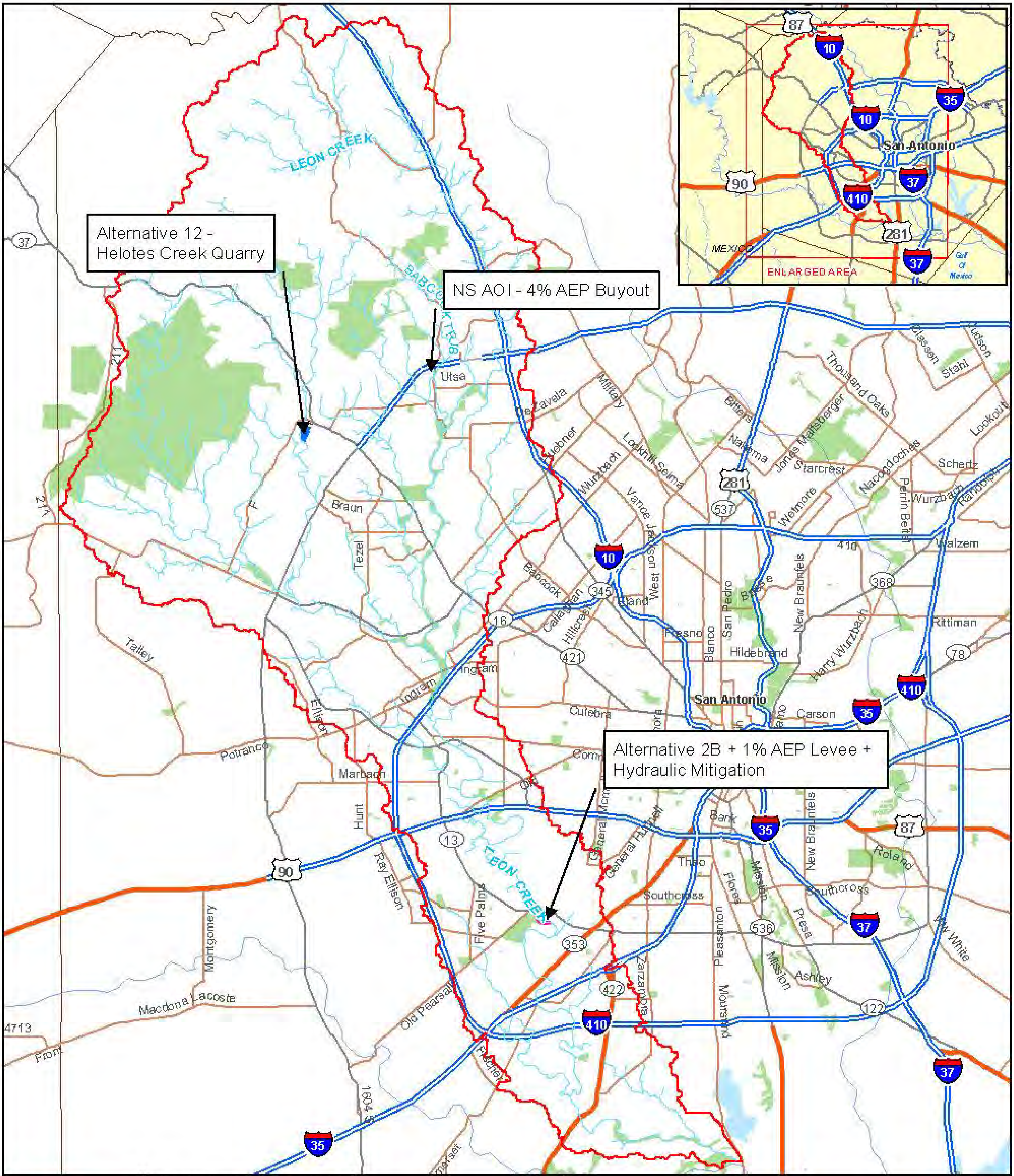
The natural channel design stream restoration described above was designed to accommodate the planting of woody vegetation along each bank of Leon Creek for the length of the improvements. In order to ensure that the hydraulic mitigation required by the modified channel is preserved, the natural channel design was modeled utilizing a Manning's *N* value of 0.065 and 0.035. These Manning's *N* values account for the hydraulic friction that would be expected from a riparian woodland with a density of 30 stems per acre and native, herbaceous grasslands with a height between 12- and 18-inches. Site investigations at riparian reference areas in the San Antonio area confirm that mature bald cypress and pecan bottomlands have a similar tree density; therefore, the mitigation strategy was to approximate reference conditions. For the riparian woodlands, site-specific native herbaceous plant species would be also be established in the understory and are accounted for in the Manning's *N*.

Option 2 – within Leon Creek Watershed. Since the area of impact for channelization is at the upper end of the Lower Leon Creek segment, the only segment of the Creek considered a perennial stream, the mitigation for aquatic impacts within the Leon Creek watershed would be limited to the area downstream of the channelization site to the Creek's confluence with the Medina River. Two factors make this area problematic for use as stream mitigation. First, the existing aquatic habitat quality in this segment is considered high with an overall Rapid Bioassessment Protocols Index (RBPI) of 0.74 (the highest value within the watershed), so to further increase the functional value to an even higher value would require mitigation for a length at least 3 to 5 times greater than the area of impact (8,700-14,500 linear feet). The second limiting factor in this segment is the projected urbanization of the Lower Leon Creek segment in the future that would preclude being able to realize the functional lift in habitat value needed to mitigate the impacts during the 50-year life of the project.

Although riparian woodland mitigation opportunities are available on the Lower Leon Creek segment, any proposed mitigation would require real estate acquisition, thereby increasing mitigation costs over Option 1. Due to these issues, no cost estimates were pursued.

Option 3 – Mitigation Bank. Mitigation banking credits incorporate riparian buffers in the calculation of stream credits. Therefore, the use of a mitigation bank would address both impacts to aquatic and riparian woodland habitats.

The Straus Medina Mitigation Bank is the only stream/wetland mitigation bank proposed within the study area. The mitigation bank prospectus was submitted to the Fort Worth District (SWF) on 1 June 2011, the Draft Mitigation Bank Instrument was submitted on 20 July 2012, and the Final Mitigation Bank Instrument was submitted on 28 January 2013. Since then, the mitigation bank sponsor has put the project on hold as a result of new mitigation bank permitting guidelines limiting the designation of in-stream mitigation credits established by CESWF in September 2013. Based on these new guidelines, it is possible that the sponsor may revise or withdraw the mitigation bank proposal. If the sponsor decides to proceed with the mitigation bank proposal, there are still several uncertainties about the applicability of the use of the bank for the mitigation of stream impacts to Leon Creek. The Straus Medina Mitigation Bank is located on one side of the Medina River and does not have the authority to control land use activities along the opposite bank. As current Fort Worth District (SWF) guidance requires the sponsor to have control of both sides of a stream, creek, or river to be able to generate stream credits for perennial waters, the mitigation bank may not be able to provide compensation for the stream impacts for Leon Creek. Should these issues be resolved and the mitigation bank is able to provide stream credits, a high level of uncertainty remains regarding mitigation credit costs as there are no other established or proposed mitigation banks in the region and no competition to keep the costs of the mitigation credits in check. However, the highest level of uncertainty regarding the use of the mitigation bank centers on when and if the mitigation bank completes the application process. Based on input from the Fort Worth District Regulatory Branch, the estimated mitigation cost for this option is $2.2 million. However, the availability of this option is very uncertain.



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Noua Robbins
Section: CESWF-PER-PT
Date: June 23, 2011
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Location: \\swf-fs1\gis\projects\
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**Figure 3-11.
Leon Creek
All Inclusive**

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Option 4 – Martinez Creek. The restoration of Martinez Creek was originally evaluated as part of the Westside Creeks Ecosystem Restoration Study, currently in development. Of the four Westside Creeks, Martinez Creek was the only creek where the restoration of the stream channel was not justified by the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) and alternative selection process. This option would provide mitigation for both aquatic and riparian woodland impacts. Martinez Creek provides 2.8 miles of potential stream channel restoration opportunities from the headwaters to the confluence with Alazan Creek. The restoration of the natural stream channel design for Martinez Creek provides the hydraulic capacity to include the restoration of riparian woodlands within portions of the 50 acres of the Martinez Creek riparian corridor. The primary reason the Martinez Creek segment was eliminated from the suite of alternatives was due to the cost of utility relocations required to construct the natural stream channel. However, the San Antonio Water System (SAWS) agreed to a Consent Decree with EPA to address waste-water infrastructure and maintenance. The Consent Decree would result in SAWS investing an additional $492 million (compared to a 10 year average of $600 million) over the next 10 years to rehabilitate and maintain its sewer infrastructure. The cost of the Martinez Creek restoration without the utility costs would be approximately $3.3 million.

Option 5 – Use of one of SARA's Identified Mitigation Sites. SARA has produced a technical report entitled "Stream and Wetland Mitigation Feasibility Report in the San Antonio Basin" dated April 2010 investigating the environmental and financial benefits of sponsoring mitigation banks within a four county jurisdictional area (Bexar, Wilson, Karnes and Goliad). The study identified potential mitigation sites and ranked them based on criteria developed by analyzing GIS data and performing field investigations. The most promising sites were evaluated further to assess existing conditions. The study estimated the type and amount of restoration needed for each, calculated potential stream credits based on preliminary geomorphic/biologic investigations and regulatory guidance, analyzed the potential revenue, costs, profit, market demand, etc. and made recommendations for SARA. The study suggests that SARA is in a favorable position to pursue stream mitigation banking in the San Antonio River Basin. Four of the sites investigated have a relatively high potential to serve as potential mitigation banking sites based on linear feet of stream, mitigation potential, landowner interest, distance to development and geographical service area. As stated previously under Option 3, a mitigation bank would provide mitigate both aquatic and riparian impacts. To date, SARA has only had informal discussions with the Fort Worth District Regulatory Branch mitigation banking point of contact and SARA has not submitted a Mitigation Banking Proposal for USACE review. As a result, no timeline exists for when these sites may be available.

For comparison of the mitigation plans, a target of 1.2 AAHU was set based on the existing conditions for the aquatic habitat. First costs were annualized using a 3.5 percent Federal Interest Rate and a 50-year period of analysis. The objective of mitigation efforts is to identify the least costly way to mitigate loss in habitat units caused by the project. Therefore the incremental benefit, or output, evaluated is the 1.2 AAU required to mitigate to existing conditions. Table 3-16 provides the summary of the incremental cost analysis for the identified mitigation alternatives.

Table 3-16. Incremental Cost Analysis of Potential Mitigation Plans (October 2013 Price Levels/3.5 percent Federal Interest Rate)

Mitigation Option	First Cost	Annual Cost	Aquatic AAHU	Incremental Cost per Output
Option 1	$297,423	$12,882	1.2	$10,735
Option 2	$297,423 plus real estate		1.2	
Option 3	$2,200,000	$95,289	1.2	$79,408
Option 4	$3,300,000	$142,934	1.2	$119,113
Option 5	Option not feasible without timeline of availability			

*Each option mitigates for both aquatic and terrestrial impacts

Due to the high uncertainty regarding the impacts of climate change on precipitation patterns in Texas (Schmandt et al., 2011), the impacts of climate change on the success of restoration efforts is unknown. The proposed project would utilize site-specific native plant species that have evolved to cyclical drought patterns. Construction measures would utilize management and irrigation strategies to ensure the successful establishment of vegetation in the project area. The composition of the native vegetative community would be better adapted to weather extremes anticipated as the result of climate change. The effects of climate change on stream flows are similarly uncertain as prolonged drought periods would adversely impact aquatic resources in Leon Creek and the region.

Costs were not developed for Options 2 and 5. Since Option 2 would have similar instream mitigation costs, but would require significant additional real estate acquisition, its incremental costs would always be greater than Option 1. No attempt was made to develop first costs for Option 5, since there was no certainty of availability of those sites in the near future. In comparing the remaining three options, the incremental cost per unit of output to achieve the 1.2 AAHU target is Option 1, with an incremental annual cost of $10,735. Option 1 would be the recommended option. Additional details on the mitigation are available in the environmental appendix.

From an HTRW perspective, during the course of the study, the District identified at the site of the Jet Engine Test Cell facility the location of several sites could potentially impact any proposed alternatives. Included were former Industrial Wastewater Treatment Plant (IWTP) structures and an Environmental Process Control Facility (EPCF) which replaced the IWTP which the Air Force continues to operate. Although it is possible that residual soil or groundwater contamination may remain in areas to be impacted by any proposed action at this site, any contamination in situ should not be at hazardous levels from an environmental standpoint. As noted in the HTRW Appendix, there is little, if any, evidence that potential contamination is significant.

Evaluation of Alternative Plans

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, more commonly known as the Principles and Guidelines (P&G), specify four evaluation criteria for comparison of alternative plans. These criteria are Acceptability, Completeness, Effectiveness, and Efficiency. These criteria were used by the Project Delivery Team to develop a recommendation and are discussed further below.

Acceptability.

Within the context of the Principles and Guidelines, acceptability refers to the viability of an alternative plan with respect to acceptance by Federal and non-Federal entities. Compatibility with existing laws, regulations, and policies is also an important dimension of acceptability. Acceptability played a major role in the evaluation and screening of alternatives, as discussed previously in this report. For example, marginally-performing alternatives in Government Canyon were dropped from consideration fairly early in the screening process based on documented concerns about the acceptability of detention features within this important natural resource. Another example of the role played by the acceptability criterion is the consideration given to the non-Federal sponsors concerns about the application of flood –proofing as a nonstructural response specific to the Leon Creek flooding concern. All of the economically-justified alternatives used in the development of the alternative plans were considered by the PDT to be “acceptable” in the context of P&G evaluation. That is, they would be implementable, supported by the Local Sponsor, and compliant with laws, regulation, and policy. All three of the final alternatives are comprised entirely of “acceptable” alternatives and were, accordingly, considered to be “acceptable” as well.

Completeness.

Planning guidance describes “completeness” as the extent to which a given alternative plan provides for all necessary investments and actions to ensure realization of the expected result. In general, the alternatives evaluated by the Leon Creek team were formulated to ensure the completeness of each alternative as a stand-alone project increment. An example would be the inclusion of hydraulic mitigation as a feature of the AOI-2 levee to compensate for changes in upstream flood stages induced by the levee. Consideration of “completeness” is likewise shown in the evaluation of downstream effects from channelization. This effort ensured that the channel component did not likewise require additional features to compensate for other unanticipated consequences. Because all measures comprising the alternative plans are considered “complete” in and of themselves, the three alternatives in the final array are likewise considered “complete.”

Effectiveness.

The effectiveness criterion addresses the degree to which an alternative plan alleviates the problems or achieves the objectives developed for the project. To be completely “effective” a given alternative for Flood Risk Management would virtually eliminate existing and future flood damages. In the case of the Leon Creek watershed, the suite of alternatives to reduce flood damages which could be economically justified was limited, and substantial flood damages would continue to occur after project implementation. However, the project recommend for implementation by the team is the most comprehensive (effective) alternative in the final array. That is, the alternative comprised of all three economically justified alternatives (the AOI-2 levee, the Helotes Quarry, and the buyout in NS-AOI -4) is more “effective” in reducing flood risks than the two-component or single component alternatives.

Efficiency.

The Efficiency criterion describes the degree to which an alternative plan is the most cost-effective means of alleviating the project’s problems and/or achieving the project’s objectives. This criterion is largely incorporated into the evaluation of measures and alternatives through the identification of the National Economic Development (NED) plan – that is the alternative that maximizes net benefits economic benefits consistent with protecting the Nation’s environment. In almost all cases, the NED plan would also be considered the most “efficient” alternative. In the case of the Leon Creek project, each alternative carried forward by the team to build alternative plans was incrementally justified and was the alternative that maximized the NED benefits for that particular portion of the study area. The Next-Added Increment analysis presented in the previous section demonstrates that the addition of each alternative to a plan increases the total net benefits of the project, and that the three-component plan has greater net benefits than either of the other two alternatives in the final array. This indicates that the three-component plan, including required environmental mitigation, is the NED plan as well as the “most efficient” alternative.

Based on consideration of the Principles and Guidelines criteria, the Project Delivery Team recommends implementation of the three-component alternative, comprised of the 1 percent AEP event (100-year) levee in AOI-2 with hydraulic mitigation and environmental mitigation, the Helotes Creek quarry, and the buyout (permanent floodplain evacuation) of four single-family homes and 32 townhomes in NS AOI-4.

Description of the Recommended Plan

As described above, the alternative initially brought forward for consideration as the Selected Plan consisted of the 1 percent AEP event (100-year) Levee with Hydraulic Mitigation in AOI-2, the Helotes Creek Detention site, and the buyout (permanent floodplain evacuation) of four single-family homes and 32 townhomes in NS AOI-4. Following the completion of the Alternative Formulation Briefing, detailed development of the Selected Plan was initiated, which included a site visit in the summer of 2013. During the site visit, the PDT made several discoveries resulting in the Helotes Detention portion of the plan being no longer economically viable. First, existing conditions had significantly changed in and around the immediate vicinity of the Helotes Quarry area (Figure 3-11). The 2010 aerial photo shows a tributary of Helotes entering the quarry property from the west and following the southwestern boundary of the property before flowing into Helotes Creek to the south. Between 2010 and 2012, this tributary was channelized to the northeast in order to facilitate expansion of the quarry operations with the tributary now joining the creek at a perpendicular angle. Aerial photographs of the quarry after the channelization of the tributary indicate that floodwaters originating from the tributary’s watershed may have compromised Helotes Creek’s northern bank at the confluence with the tributary. The site visit also confirmed the lack of stability in the creek bank as quarry operations had recently reestablished the creek bank utilizing fill material. Under this revised existing conditions, Helotes Creek now utilizes the Helotes Quarry as an overflow area during higher storm events. Furthermore, the quarry owner indicated that water is pumped out, albeit at a slower rate, so that operations can resume and making flood storage available during subsequent flood events. Thus, the majority of the benefits initially credited to this portion of the plan are now already being captured and could no longer be counted on for this plan component. Second, preliminary costs used in the formulation of the plan had severely underestimated the costs of the Helotes component. For example, costs associated with structural appurtenances costing millions, such as a chute and spillway to drop the flows over 100 feet into the quarry, were off by over one order of magnitude. Together, the lower potential benefits available to the Helotes Quarry component, coupled with the significantly higher cost of the Helotes Quarry portion of the plan, led the PDT to conclude that this portion of the plan should be eliminated as part of its recommendation. As a final option, the PDT revisited an alternative considered during the preliminary formulation phase (known as Alternative 11 - DC-12 Helotes Creek RSWF in Chapter 3). Given current conditions, this also proved not to be economically justified. From this point forward, the Helotes Creek Quarry was no longer part of the Recommended Plan.

The Recommended Plan consists of the 1 percent AEP event (100-year) Levee with Hydraulic Mitigation in AOI-2, as described above, in combination with the buyout in NS-AOI-4. The proposed earthen levee at AOI-2 extends approximately 3,700 linear feet from high ground on the southeast side of the Test Cell area and wraps around to S.W. Military Drive. The existing levee/berm would be removed. This configuration is different from the levee configuration described on page 62. The configuration on page 62 incorporated a floodwall to extend from the levee’s end on the north up to S.W. Military Drive. Two different floodwall options were considered with one using drilled shaft piers and another using sheet piles. The PDT adopted a levee configuration that would extend it up to S.W. Military Drive based on the cost estimates and the feasibility of incorporating a floodwall. The levee elevation would range from 640 feet on the downstream end to 649 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is 16.87 feet. A twelve-foot top width will provide a maintenance/patrol access route along the top with 3.5:1 (H:V) side slopes. The levee is aligned to provide adequate benching between the riverside toe and the Leon Creek channelization for stability reasons, as well as to avoid existing buildings on the Test Cell site. The grading of landside toe ditches to a proposed sump area will convey interior runoff. Also, included at the Test Cell area is a soil-bentonite slurry wall to provide additional seepage control along the full length of the levee. Channelization at Leon Creek will extend approximately 2,850 linear feet and reduced to a 60-foot bottom width with no impacts to hydraulic conveyance. The proposed channel has a 60-foot bottom width with variable side slopes.

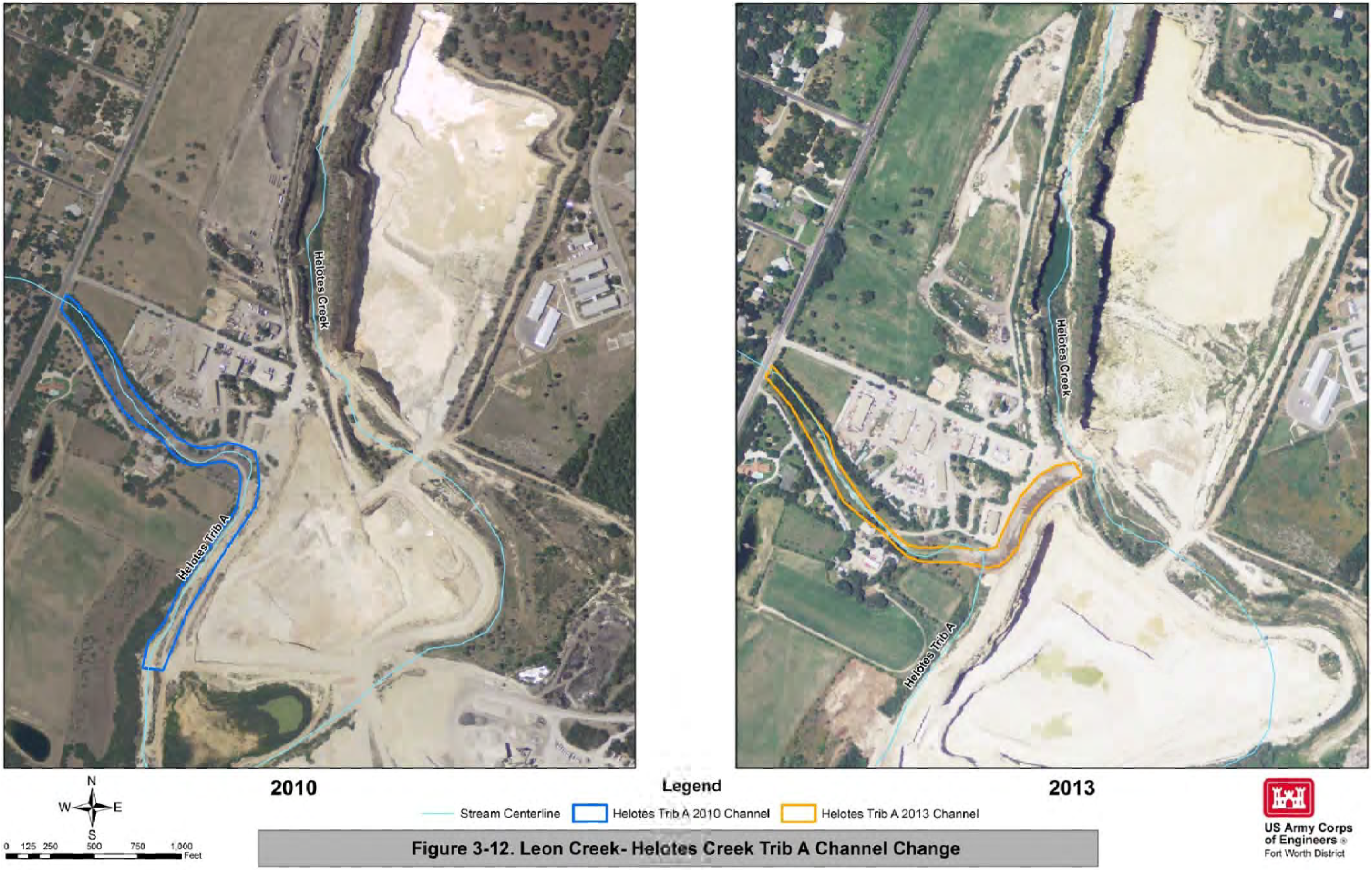

Figure 3-12. Leon Creek- Helotes Creek Trib A Channel Change

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The Recommended Plan includes mitigation for aquatic impacts associated with the channelization work in AOI-2. This mitigation plan would utilize the same Natural Channel Design (NCD) concepts used in the Mission Reach and the Westside Creeks project to “self-mitigate” impacts to waters of the U.S. The NCD methods use vertical and horizontal structures in the form of cross vanes, rock weirs, J-hooks, or other natural material structures to maintain a neutral sediment transport balance for the creek. The NCD structures also recreate pool and riffle habitats with proper substrate to support a diverse community of aquatic organisms. Woodland vegetation would also be placed along the riparian corridor in order to mitigate for impacts to riparian woodlands (Figure 3-13). The channel work included in the Recommended Plan will include 2,850 linear feet of naturally-designed channel, including one large and four small in-stream structures, and approximately 15.75 acres of riparian vegetation planting and invasive species control. Details of the mitigation plan and NCD concepts can be found in the Environmental Appendix (Appendix B).

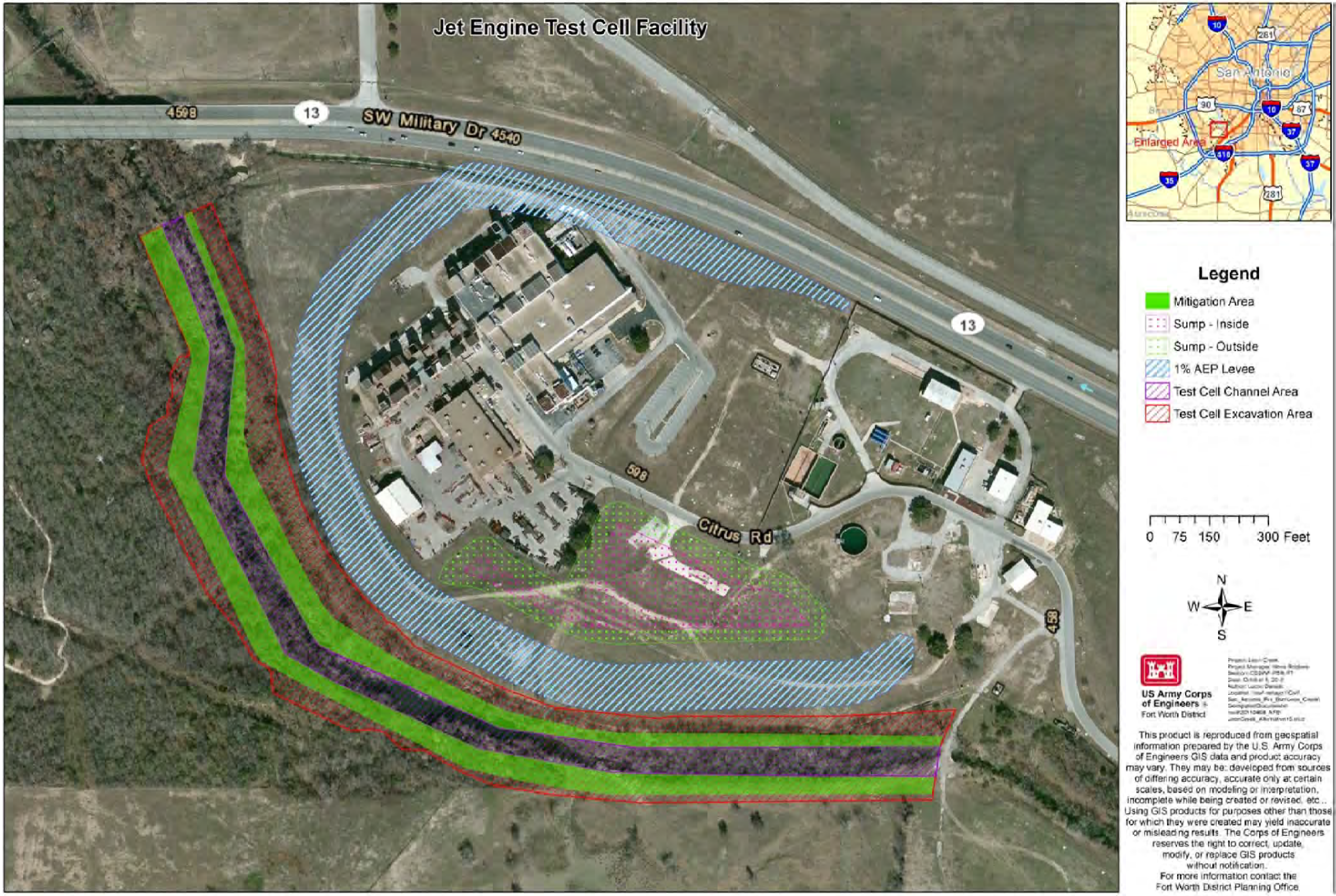
Dewatering will be necessary for construction of an inspection trench and all locations requiring the removal of soft material beneath the proposed levee embankment will be identified. Sufficient contingencies are in the current cost estimate that should cover any potential cost increase due to dewatering efforts. Based on the existing boring data, only one location exists with soft materials beneath the proposed levee embankment but the limits of soft material is undetermined and will be identified during PED. Overexcavation of soft material beneath the proposed levee embankment will be necessary to ensure embankment stability and will be removed.

The Recommended Plan has an estimated first cost of $28,175,000 and produces flood risk reduction benefits estimated at $2,143,000 annually with net benefits of $859,000. The Recommended Plan minimizes damages at the 1 percent AEP level for the Test Cell area (AOI-2), and reduces flood damages at the 4 percent AEP level in NS AOI-4. It has only minor environmental effects and a benefit-to-cost ratio of 1.7 to 1.0. Identification of this plan is consistent with the emphasis on sustainability embodied in the Corps’ updated Environmental Operating Principles. The following tables show the costs and benefits of the recommended plan, first as separable elements and then combined at both the FY14 interest rate and at 7 percent.

Regional Economic Development (RED) and Other Social Effects (OSE) of Port San Antonio

As stated earlier, the Jet Engine Test Cell Facility is part of a 1,900-acre multi-purpose aerospace complex and industrial facility at the former site of Kelly Air Force Base on what is now known as Port San Antonio. The Port is located at the center of the North American Free Trade Agreement (NAFTA) corridor and is designated as a Foreign Trade Zone. Private entities and Air Force organizations have created 13,000 jobs at the Port with 6,500 of those being with the Air Force, 4,000 with the various aerospace companies at the Port, and the remaining 2,500 being in logistics, business services and other fields. In 1995, the year Kelly AFB was included in the Base Realignment and Closure Commission (BRAC), economic impact of Kelly AFB was $2.5 billion. By 2010, Port San Antonio’s impact on the local economy had grown to more than $4.2 billion a year. The Port has also invested significantly in infrastructure totaling $476 million as well as renovating and building facilities on a real estate platform totaling 13 million square feet. The Port has also invested in educational opportunities geared towards aerospace careers. The Port has provided land and facilities for the development of the Southwest campus of St. Philip’s College and the Port’s Alamo Aerospace Academy has graduated over 300 students since 2002, of which 60 percent have been employed by entities at the Port.

The Jet Engine Test Cell Facility has performed maintenance, repair and overhaul on more than 2,000 engines at the Port on C-5s, C-130s, and P-3s in support of troops and humanitarian efforts around the world. The facility is capable of handling up to 1,000 engines a year. Beginning in 2003, work was expanded to include building, inspecting, and testing new F110 engines which power F-15 and F-16 fighter jets. Stated earlier in the report, flooding in May of 2013 put the facility out of operation for two weeks. Not only do events of this nature have implications beyond the monetary damages associated with direct flood damage to property and equipment and revenue losses, these events can also impact the readiness of the aircraft the facility services having potential impacts to national security.



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For more information contact the Fort Worth District Planning Office.

Figure 3-13. Leon Creek- Test Cell Area

Table 3-17
AOI-2 Levee
(October 2013 Price Levels/3.5 percent Federal Interest Rate)

	at 3.50%	at 7.0%
Investment		
Estimated First Cost	$22,303,000	$22,303,000
Relocation Assistance	$0	$0
Economic Cost	$22,303,000	$22,303,000
Interest Rate	0.035	0.070
Period of Analysis (years)	50	50
Construction Period (months)	18	18
Interest During Construction	$553,000	$1,105,000
Investment Cost	$22,856,000	$23,408,000
Annual Charges		
Interest	$800,000	$1,639,000
Amortization	$174,000	$58,000
Operation and Maintenance	$50,000	$50,000
Replacements	$0	$0
Total Annual Charges	**$1,024,000**	**$1,747,000**
Annual Benefits		
Flood Risk Mgmt Benefits	$1,763,000	$1,698,000
Recreation Benefits	$0	$0
Total Annual Benefits	**$1,763,000**	**$1,698,000**
Net Benefits	$739,000	($49,000)
Benefit-to-Cost Ratio	**1.7**	**1.0**

NS AOI-4

	at 3.50%	at 7%
Investment		
Estimated First Cost	$5,872,000	$5,872,000
Relocation Assistance	($363,000)	($363,000)
Economic Cost	$5,509,000	$5,509,000
Interest Rate	0.035	0.07
Period of Analysis (years)	50	50
Construction Period (months)	24	24
Interest During Construction	$186,000	$373,000
Investment Cost	$5,694,000	$5,882,000
Annual Charges		
Interest	$199,000	$412,000
Amortization	$43,000	$14,000
Operation and Maintenance	$9,000	$9,000
Replacements	$0	$0
Total Annual Charges	**$251,000**	**$435,000**
Annual Benefits		
Flood Risk Mgmt Benefits	$380,000	$357,000
Recreation Benefits	$0	$0

Total Annual Benefits	**$380,000**	**$357,000**
Net Benefits	$129,000	($78,000)
Benefit-to-Cost Ratio	**1.5**	**0.8**

AOI-2 Levee + NS AOI-4

	at 3.50%	at 7.0%
Investment		
Estimated First Cost	$28,175,000	$28,175,000
Relocation Assistance	($363,000)	($363,000)
Economic Cost	$27,812,000	$27,812,000
Interest Rate	0.035	0.07
Period of Analysis (years)	50	50
Construction Period (months)	24	24
Interest During Construction	$938,000	$1,886,000
Investment Cost	$28,750,000	$29,697,000
Annual Charges		
Interest	$1,006,000	$2,079,000
Amortization	$219,000	$73,000
Operation and Maintenance	$59,000	$59,000
Replacements	$0	$0
Total Annual Charges	**$1,284,000**	**$2,211,000**
Annual Benefits		
Flood Risk Mgmt Benefits	$2,143,000	$2,056,000
Recreation Benefits	$0	$0
Total Annual Benefits	**$2,143,000**	**$2,056,000**
Net Benefits	**$859,000**	**($155,000)**
Benefit-to-Cost Ratio	**1.7**	**0.9**

Risk and Uncertainty Assessment

Engineer Regulation 1105-2-101 states that risk and uncertainty are intrinsic in water resources planning and design with inaccuracy in all measured or estimated values in project planning and design to some varying degrees. Invariably the true values are different from any single, point values presently used in project formulation, evaluation, and design. The best estimates of key variables, factors, parameters, and data components in the planning and design of flood damage reduction projects are considered the "most likely" values. These values however are frequently based on small periods of record, sample sizes and measurements that are subject to error.

The ER also states that risk analyses “captures and quantifies the extent of the risk and uncertainty in the various planning and design components of an investment project. The total effect of uncertainty on the project's design and economic viability can be examined and conscious decisions made reflecting an explicit tradeoff between risks and costs. Risk analysis can be used to compare plans in terms of the variability of their physical performance, economic success, and residual risks.”

Engineer Manual 1110-2-1619 identifies a number of potential sources of uncertainty. These include (1) uncertainty about future hydrologic events such as streamflow and rainfall; (2) uncertainty arising from the use of simplified models to describe complex hydraulic phenomena; (3) economic and social uncertainty, particularly the relationship between depth and inundation damage, inaccuracies in estimates of structure values and locations, and the predictability of how the public will respond to a flood; and (4) uncertainty about structural and geotechnical performance of water-control measures when subjected to rare storm events.

Uncertainty in the hydrology and hydraulics is addressed primarily by utilizing graphical exceedance probability functions which sets confidence limits for discharges at each discrete exceedance probability based on the equivalent record length. Uncertainty for hydrology and hydraulics is also addressed by assigning distributions to stage-damage functions. In the case of this study, the equivalent record length is set at 30 years and the error for the stage-damage functions is set at 0.5 feet. No fragility curves are assigned to the proposed levee since flooding durations are short and it would be overtopped regardless for those rare events. Economic uncertainties are similarly managed with normal distributions with standard errors assigned to the depth-damage functions and by defining uncertainty parameters for first floor corrections, structure and content values. Uncertainties are further handled by changing, if necessary, the number of Monte Carlo simulations and by varying the range of ordinates in the aggregated stage-damage functions.

HEC-FDA produces project performance reports to display the hydrologic and hydraulic performance of a particular plan. Table 3-18 shows the project performance for the proposed Test Cell levee and its impact on risk for the main stem of Leon Creek. The Leon Creek Reach 3 is the reach predominantly impacted by implementation of the proposed levee feature in AOI-2. For the Future Without-Project Condition, significant damages begin at approximately the 4 percent AEP event based on the annual expected target stage of 634.3. Putting in the proposed levee reduces the recurrence interval to approximately a 0.76 percent (132-year) event. Long-term performance shows that this levee would have an approximately 7 percent chance of being exceeded in 10 years, a 17 percent chance of being exceeded in 30 years, and thirty-two percent chance of being exceeded in 50 years. The project performance report also shows that the proposed levee would have a 99 percent chance of containing the 10 percent AEP (10-year) event, a 95 percent chance of containing the 4 percent AEP (25-year) event, an 88 percent chance of containing the 2 percent AEP (50-year) event, an 80 percent chance of containing the 1 percent AEP (100-year) event, 66 percent for the 0.4 percent AEP (250-year) event, and 52 percent for the 0.2 percent AEP (500-year) event. From a sensitivity perspective, a direct risk comparison of the initial 1 percent AEP and 0.2 percent AEP levees is also displayed on the table. For the left overbank on Reach 3, the initial 1 percent AEP levee has a recurrence interval of a 1.6 percent (63-year) event. The 0.2 percent AEP levee has a recurrence interval of 0.01 percent (10,000 years) for the left overbank.

While the risk of finding a cultural resource during survey is moderately high, the risk to the overall project schedule and cost is very low. The cost of the survey has been incorporated into the overall project cost. Only sites determined to be significant under the criteria set forth in 36 CFR Part 800 require further work to avoid, reduce or mitigate impacts from project implementation. The likelihood of finding a significant site are quite low given the limits and location of the construction footprint. Contingencies have been included in the project cost to cover the cost of mitigation should a significant resource be found and impacts are unavoidable. By completing the survey early in PED, concurrent with other detailed design work, the project schedule is at very low risk. All cultural resources survey and mitigation activities can be completed within 18-24 months and can be done concurrent with most PED activities further reducing risk to project schedule.

The District completed a Phase I Environmental Site Assessment in November 2013. There is no direct evidence of groundwater contamination in areas impacted by the proposed construction of the levee and sump or other indications that a Phase II ESA should be undertaken. A very low probability of past migration of groundwater with constituents at detectable levels cannot be excluded based on available data, however the only precaution indicated is appropriate due diligence during future construction activities if unexpected materials are encountered. Environmental Regulation ER 1165-2-132 requires the sponsor to provide the District with an uncontaminated construction site. If the Contractor encounters contaminated areas during its construction activities, its construction plans will, in accordance with the ER, require it to stop its activities in the suspect area(s) pending completion of the sponsor’s remedial activities which will result in an uncontaminated site. As stated in Section 4 of the HTRW appendix, although a low potential for contamination from groundwater exists at this site, there is little evidence warranting additional investigation. Costs for a full survey and contingencies are accounted for in the project implementation schedule.

Table 3-8
Risk Performance of Proposed Levee

Without-Project

		Long-Term Risk (years)			Assurance by Event					
Damage Reach	**Expected AEP**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LC R1	3.1%	27.1%	54.7%	79.5%	93.8%	71.5%	52.8%	36.9%	21.7%	12.2%
LC R2	27.2%	95.8%	100.0%	100.0%	2.8%	0.5%	0.2%	0.1%	0.0%	0.0%
LC R3R	10.1%	65.4%	93.0%	99.5%	52.9%	23.9%	13.1%	7.6%	3.4%	1.5%
LC R3L	26.9%	95.7%	100.0%	100.0%	3.0%	0.5%	0.2%	0.1%	0.0%	0.0%
LC R4	19.3%	88.3%	99.5%	100.0%	13.9%	3.5%	1.4%	0.6%	0.2%	0.1%
LC R5R	13.6%	76.8%	97.4%	99.9%	34.7%	11.4%	4.6%	1.8%	0.6%	0.2%
LC R5L	4.4%	35.9%	67.2%	89.2%	87.9%	60.4%	39.4%	24.1%	11.7%	5.9%
LC R6	10.5%	67.1%	93.8%	99.6%	49.1%	16.1%	7.4%	3.6%	1.2%	0.5%
LC R7	15.8%	82.2%	98.7%	100.0%	29.3%	14.9%	8.6%	5.3%	2.7%	1.6%

With Project - AOI-2 Levee w/Hydraulic Mitigation

		Long-Term Exceedance Probability (years)			Assurance by Event					
Damage Reach	**Expected AEP**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LC R1	3.1%	27.4%	55.0%	79.8%	93.6%	71.2%	52.4%	36.5%	21.5%	12.0%
LC R2	27.2%	95.8%	100.0%	100.0%	2.8%	0.4%	0.2%	0.1%	0.0%	0.0%
LC R3R	9.2%	61.8%	91.0%	99.2%	58.0%	27.4%	15.2%	9.1%	4.1%	1.8%
LC R3L	0.8%	7.3%	17.3%	31.7%	99.5%	95.2%	88.2%	79.6%	66.0%	51.8%
LC R4	19.4%	88.5%	99.6%	100.0%	13.4%	3.4%	1.4%	0.6%	0.2%	0.1%
LC R5R	15.9%	82.3%	98.7%	100.0%	24.9%	6.9%	2.5%	1.0%	0.3%	0.1%
LC R5L	5.0%	39.9%	72.0%	92.1%	84.6%	55.0%	34.3%	20.2%	9.4%	4.6%
LC R6	10.7%	67.8%	94.1%	99.7%	47.9%	15.4%	7.0%	3.3%	1.1%	0.5%
LC R7	16.5%	83.6%	98.9%	100.0%	27.0%	13.4%	7.6%	4.7%	2.3%	1.4%

Table 3-18
Risk Performance of Proposed Levee (cont'd)

1 Percent vs. 0.2 Percent Levee

		Long-Term Exceedance Probability (years)			Assurance by Event					
Damage Reach	**Expected AEP**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
1 Percent										
LC R3R	16.7%	83.8%	99.0%	100.0%	22.1%	6.5%	2.8%	1.4%	0.5%	0.2%
LC R3L	1.6%	14.8%	33.0%	55.1%	97.9%	87.4%	75.1%	63.0%	45.0%	30.0%
0.2 Percent										
LC R3R	16.2%	83.0%	98.8%	100.0%	23.5%	7.1%	3.1%	3.1%	0.6%	0.2%
LC R3L	0.0%	0.1%	0.2%	0.5%	100.0%	99.9%	99.8%	99.7%	99.5%	99.3%

Change		**Long-Term Risk (years)**			**Assurance by Event**					
Damage Reach	**Expected AEP**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LC R1	0.6%	0.8%	0.6%	0.4%	-0.1%	-0.4%	-0.7%	-0.9%	-1.2%	-1.3%
LC R2	0.2%	0.0%	0.0%	0.0%	-1.1%	-2.2%	0.0%	-11.1%	0.0%	0.0%
LC R3R	-8.8%	-5.5%	-2.1%	-0.3%	9.7%	14.7%	16.8%	18.8%	20.1%	20.1%
LC R3L	-97.2%	-92.3%	-82.7%	-68.3%	3204.7%	18558.8%	46326.3%	79530.0%	0.0%	0.0%
LC R4	0.9%	0.3%	0.0%	0.0%	-3.2%	-4.0%	-4.9%	-4.7%	-4.5%	-10.0%
LC R5R	16.9%	7.2%	1.3%	0.1%	-28.2%	-38.9%	-45.1%	-47.0%	-50.9%	-47.6%
LC R5L	13.8%	10.9%	7.1%	3.3%	-3.7%	-9.0%	-13.0%	-16.1%	-19.0%	-21.2%
LC R6	1.9%	1.1%	0.4%	0.0%	-2.5%	-4.2%	-5.7%	-7.0%	-5.9%	-9.3%
LC R7	4.3%	1.7%	0.2%	0.0%	-7.8%	-9.8%	-11.4%	-11.9%	-14.1%	-14.2%

Residual Risk

While the Recommended Plan includes all alternatives identified by the team as economically justified, substantial flood risk will remain after the project is constructed and operational. Table 3-19 indicates the residual damages predicted to be remaining in the study area after the project is implemented.

Table 3-19
Residual Damages – Project Implementation
October 2013 Price Level 3.50 percent ($1,000s)

	Full Project Implementation			
Reach	**Without-Project**	**With Project**	**Benefits**	**Residual EAD**
Babcock Trib	404.81	24.99	379.82	24.99
Chimenea Creek	1.65	1.65	0	1.65
Culebra Creek Reach 1	2,059.28	2,059.28	0	2,059.28
Culebra Creek Reach 2	90.17	90.17	0	90.17
Culebra Creek Trib A	103.06	103.06	0	103.06
Culebra Creek Trib C	38.29	38.29	0	38.29
Culebra Creek Trib E	19.15	19.15	0	19.15
French Creek	279.95	279.95	0	279.95
French Creek Trip A	0.01	0.01	0	0.01
Helotes Creek	547.75	547.75	0	547.75
Helotes Creek Trib A	49.7	49.7	0	49.70
Helotes Creek Trib B	0.53	0.53	0	0.53
Huebner Creek	492.75	492.75	0	492.75
Huebner Creek Trib A	130.26	130.26	0	130.26
Huesta Creek	132.12	132.12	0	132.12
Indian Creek	93.98	93.98	0	93.98
Leon Creek Reach 1	4.34	4.34	0	4.34
Leon Creek Reach 2	556.8	556.8	0	556.80
Leon Creek Reach 3 Right	0.23	0.2	0.03	0.20
Leon Creek Reach 3 Left	1,949.86	187.44	1,762.42	187.44
Leon Creek Reach 4	1,205.79	1,205.35	0.44	1,205.35
Leon Creek Reach 5 Right	1,086.98	1,086.98	0	1,086.98
Leon Creek Reach 5 Left	324.39	324.39	0	324.39
Leon Creek Reach 6	1,474.98	1,474.98	0	1,474.98
Leon Creek Reach 7	1,189.16	1,189.16	0	1,189.16
Leon Creek Trib B	0.34	0.34	0	0.34

		Full Project Implementation		
Reach	**Without-Project**	**With Project**	**Benefits**	**Residual EAD**
Leon Creek Trib F	141.65	141.65	0	141.65
Leon Creek Trib H	0.22	0.22	0	0.22
Leon Creek Trib J	0.09	0.09	0	0.09
Leon Creek Trib K	193.2	193.2	0	193.20
Leon Creek Trib M	0	0	0	0.00
Los Reyes Creek	37.66	37.66	0	37.66
Ranch Creek	0	0	0	0.00
Slick Ranch	1,111.56	1,111.56	0	1,111.56
Slick Ranch Trib B	104.4	104.4	0	104.40
Westwood Village Creek	8.5	8.5	0	8.50
Total	**13,833.61**	**11,690.90**	**2,142.71**	**11,690.90**

Substantial annual damages, approaching or exceeding one million dollars, remain in each of the Leon Creek 4, 5, 6, and 7 reaches as well as the Slick Ranch Creek reach. Numerous other reaches have residual damages amounting to several hundred thousand dollars annually.

Floodplain management is highly effective in controlling future development of the floodplain and assuring that existing flood risks do not increase. The City of San Antonio and Bexar County presently participate in the National Flood Insurance Program and enforce zoning regulations for development in the floodplain. Best Management Practices for stormwater and Low Impact Development (LID) are encouraged and incentivized. However, floodplain management cannot, by itself, significantly reduce existing flooding conditions within a highly urbanized floodplain. San Antonio’s floodplain management program can be expected to complement the Leon Creek flood risk reduction projects by stabilizing future damage conditions and preventing significant future increases in residual risk.

Implementation of the Recommended Plan will substantially reduce monetary flood damages in the Leon Creek watershed but will do relatively little to modify the fundamental nature of the flood hazard in the watershed. As a consequence, the risk to human health and safety resulting from the “flashy” nature of flooding in the study area is reasonably unchanged in the with-project condition. It will be critically important for the local sponsor to proactively communicate remaining flood hazards to residents and stakeholders within the watershed.

The project sponsor, SARA, is currently in the process of implementing a regional flood warning system. This system includes real-time weather and stream gage information and directly links to local emergency response communications and specified media outlets. The intent is to provide real-time information as to the location and severity of the flash flood hazards that pose the greatest risk to human health and safety during rainfall events. This flood warning system is being implemented independent of the Leon Creek project and became operational in 2013.

The redundancy and resiliency of the Leon Creek project is substantially enhanced by the implementation of the sponsor's Flood Warning System. Additional design features to enhance robustness and safety assurance will be explored during the design phase of the project.

Value Engineering

A Value Management Study was conducted 31 March – 1 April 2011 with the following objectives:

- Validate that the PDT is on the right track relative to design strategies
- Gather information to help prepare the Alternative Formulation Briefing (AFB) report.
- Consider whether anything has been missed in the analysis
- Identify a list of evaluation criteria for use in rating alternative solutions

Per the study report, the team determined that all creative ideas had been previously identified during the prior project phase. The VE team identified four key project functions that are affected by each of the alternatives considered. These functions are:

- Divert Flow
- Bypass Flow
- Maintain or Improve Environment
- Detain Flow

The team then discussed each of the project alternatives considered during the preliminary analysis of alternatives and how they perform relative to the functions identified. This analysis confirmed that the preliminary analysis of alternatives had been effective in narrowing down the list of alternatives to those most likely to fulfill project objectives. The team further determined that there were no additional alternatives that should have been considered. Finally, the team identified seven criteria to be used in the future detailed investigation of alternatives:

- Downstream inducements
- Adverse impacts
- Environmental justice (fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income)
- Sponsor expectations
- Construction feasibility (constructability)
- Risk of flooding
- Recreational benefits

ALTERNATIVE IMPACT ASSESSMENT

As described in previous sections of this report, a wide variety of alternatives to reduce flood risks within the Leon Creek watershed have been considered. These alternatives were screened for economic justification and potentially unacceptable or problematic environmental effects. The alternatives carried forward for final consideration were all determined to be economically justified (i.e. have annual benefits greater than the annual costs) and environmentally acceptable. Based on the “next-added increment” analysis, the alternatives were established to be economically justified in combination with each other as well as on a stand-alone basis. The alternative plan with the greatest net benefits was identified as the combination of the 1 percent AEP levee protecting the Jet Cell Test Facility in AOI-2, including the hydraulic mitigation for that levee, in combination with a buyout of the 4 percent AEP event (25-year floodplain) in NS AOI-4. This plan is referred to in the analysis below as the Proposed Action. For purposes of compliance with the National Environmental Policy Act, the reasonably foreseeable consequences of the Proposed Action are compared and contrasted with the final array of both structural and nonstructural alternatives along with the No Action alternative. The final array of structural alternatives includes the following. The impacts of the final array of nonstructural alternatives are uniform across all resources.

- 1% AEP Levee with Internal Drainage
- Levee 2B/Channel 4C Combo
- 2% AEP Levee and Hydraulic Mitigation
- 1% AEP Levee and Hydraulic Mitigation
- 1% AEP Levee, Hydraulic Mitigation, and Bypass
- 0.2% AEP Levee
- 0.4% AEP Levee and Hydraulic Mitigation
- 0.2% AEP Levee, Hydraulic Mitigation, and Bypass

The impact of an alternative on a resource is essentially the same unless otherwise specified.

PRIME FARMLAND SOILS

No Action

Under the No Action alternative, conversion of farmlands, rangelands and undeveloped lands to urban use is expected to continue and may adversely impact prime farmland soils.

Proposed Action - Levee Component

Implementation of any of the levee alternatives would occur within the boundary of the former Kelly AFB and within the city limits of San Antonio. Section 1541(b) of the Farmland Protection Policy Act (FPPA) of 1980 and 1995, 7 U.S.C. 4202(b), does not apply to urban areas; therefore, no prime farmland soils covered by FPPA would be adversely affected by implementation of the levee alternative.

Proposed Action - Buyout Component

The proposed site for the buyout component of the proposed alternative is located with an urban residential area in the city limits of San Antonio and, similar to above, the FPPA does not apply to urban areas so there would be no adverse impact to prime farmland soils as a result of implementation of the buyout component.

For both the structural and non-structural components, the conversion of farmlands within the basin, but outside the construction footprint, would be similar to the no action plan.

LAND USE

No Action

Under the No Action alternative, changes in the land use within the proposed project area would continue to occur since increased urbanization is expected.

Proposed Action - Levee Component

After completion of any of the levee alternatives, including the Proposed Action, the Jet Engine Test facility would continue to operate within the proposed project area and Leon Creek would be restored to a naturally functioning stream system. No changes in land use would occur due to the project, however increased urbanization is expected in the basin.

Proposed Action - Buyout Component

Land use within the proposed AOI-4 buyout area would change from residential to open space. The acquired land would function as a floodplain and provide localized water quality benefits by capturing sediments and nutrients from stormwater runoff and floodwaters. Increased urbanization would be expected in the basin, outside the buyout area.

AIR QUALITY

No Action

Under the No Action alternative, there would be no changes to air quality within the study area different from those predicted for the Future Without-Project Condition.

Proposed Action - Levee Component

For each levee alternative, construction of the levee, modification of the Leon Creek pilot channel, and construction of a bypass channel, if applicable, would result in short-term impacts to air quality. Construction would generate fugitive dust from ground disturbing activities (e.g., excavation, grading, soil piles, etc.) in addition to the emissions of all criteria pollutants from the combustion of fuels in construction equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions and construction equipment emissions from a construction site would be proportional to the area of land being worked (Table 4-1) and the level of construction activity. Emissions would be temporary in nature. The use of Best Management Practices (BMPs) during construction (e.g. application of water for dust control, use of cleaner-burning fuels, energy efficient equipment) would minimize these emissions.

Table 4-1
Material Displacement (Construction Activity) for the Levee Alternatives

	Material Displacement (ft^3)		
Alternative	**Channel Excavation**	**Levee Construction**	**Total**
No Action	0	0	0
1% AEP Levee with Internal Drainage	0	190,512	190,512
Levee 2B/Channel 4C Combo	171,449	190,512	361,961
2% AEP Levee and Hydraulic Mitigation	21,508	135,423	156,931
1% AEP Levee and Hydraulic Mitigation	21,508	190,512	212,020
1% AEP Levee, Hydraulic Mitigation, and Bypass	192,957	190,512	383,469
0.2% AEP Levee	0	251,223	251,223
0.4% AEP Levee and Hydraulic Mitigation	21,508	232,078	253,586
0.2% AEP Levee, Hydraulic Mitigation, and Bypass	192,957	251,223	444,180

Proposed Action - Buyout Component

During demolition of the buyout area, short-term, inconsequential impacts to air quality would occur. Construction activities would generate fugitive dust resulting from demolition and ground disturbing activities (e.g., demolition, grading, soil piles, etc.) in addition to the emissions of all criteria pollutants from the combustion of fuels in construction equipment. Fugitive dust emissions would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site would be proportional to the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of BMPs during construction (e.g. application of water for dust control, use of cleaner-burning fuels, energy efficient equipment) would minimize these emissions.

NOISE

No Action

Under the No Action alternative, there would be no changes to noise within the study area different from those expected under the Future Without-Project Condition.

Proposed Action - Levee Component

Construction equipment such as backhoes, front-end loaders, and cement and dump trucks would cause short-term, localized increases in noise levels. These short-term increases are expected to be in compliance with City noise ordinances and not expected to substantially affect adjacent noise sensitive receptors. Construction activities would increase noise levels temporarily at locations immediately adjacent to the study area, but impacts would be attenuated by distance, topography, and vegetation. Similar to air quality, noise level impacts for each alternative would be proportional to the level and duration of construction activity. Since the volume of material displacement can be considered a measure of construction activity, the duration of construction noise would be expected to increase with an increase in material displacement (Table 4-1).

Proposed Action - Buyout Component

Construction equipment such as front-end loaders and dump trucks would cause short-term, localized increases in noise levels. Although noise levels to receptors in the adjacent community would temporarily increase during demolition activities, construction activities would comply with City noise ordinances.

GROUNDWATER

No Action

Under the No Action alternative, existing water demands in the study area would continue to draw upon the groundwater resources in the San Antonio area. Groundwater usage and restrictions would continue to be regulated by the Edwards Aquifer Authority to prevent unacceptable drawdown of the aquifer or degradation of groundwater quality.

Proposed Action – Levee component

The construction of the levee foundation for each levee alternative, including those with a bypass channel, if applicable, would temporarily impede site-specific subsurface flows from the project area, before reaching areas influenced by subsurface flows associated with Leon Creek. However, AOI-2, where the levee area is located, is outside of the contributing and recharge zones of the Edward’s Aquifer. Therefore, the proposed project would not substantially affect groundwater resources in the project area.

Proposed Action - Buyout Component

The acquisition and demolition of properties within the AOI-4 site would have no impact on groundwater resources within the project area.

HYDROLOGY AND HYDRAULICS

No Action

Under the No Action alternative, no impacts are expected to the hydrology and hydraulics of Leon Creek. However, flooding would still occur throughout the watershed and damages would continue to occur at the proposed levee site (AOI-2) and the proposed buyout area (AOI-4).

Proposed Action - Levee Component

For each levee alternative, the construction of the levee at the Jet Engine Test Cell facility would affect the hydraulics of Leon Creek by increasing the water surface elevations outside of the areas protected by the proposed levee. In order to maintain existing water surface elevations outside of the levee area, the Leon Creek channel would be widened from S.W. Military Drive to approximately 2,850 linear feet downstream. The channel modifications would mitigate the impacts that the proposed levee would have on the hydraulics of Leon Creek.

Proposed Action - Buyout Component

The removal of the structures from the properties within the AOI-4 site would have an undetectable impact on the hydrology and hydraulics of Leon Creek.

TERRESTRIAL RESOURCES

Wildlife

No Action

Under the No Action alternative, the wildlife habitat conditions associated with Leon Creek would remain unchanged from the Future Without-Project Condition.

Proposed Action - Levee Component

Depending on the alternative, the channel modifications would impact low to moderate quality upland forest/grassland habitats (Table 4-2). The Proposed Action would impact approximately 28 acres of wildlife habitat. Urban wildlife within the areas planned for construction would be temporarily displaced due to noise and other disturbances to adjacent habitats during the construction process. Such displacement would result in increased competition for breeding, nesting, cover, and foraging habitat in adjacent undisturbed habitats. However, the planned replacement of woody vegetation along the channelized portion of Leon Creek as part of the environmental mitigation plan would restore the wildlife habitat within the proposed project area back to, or better than, existing conditions.

Table 4-2
Wildlife Habitat Impacts of Levee Alternatives

Alternative	Impacted Habitats (acres)			
	Grassland	Riparian Woodland	Woodland	Total
No Action	0.0	0.0	0.0	0.0
1% AEP Levee with Internal Drainage	10.0	0.0	0.0	10.0
Levee 2B/Channel 4C Combo	10.0	0.5	13.0	23.5
2% AEP Levee and Hydraulic Mitigation	10.0	18.0	0.0	28.0
1% AEP Levee and Hydraulic Mitigation	10.0	18.0	0.0	28.0
1% AEP Levee, Hydraulic Mitigation, and Bypass	10.0	18.0	13.0	41.0
0.2% AEP Levee	12.3	0.0	0.0	12.3
0.4% AEP Levee and Hydraulic Mitigation	11.2	18.0	0.0	29.2
0.2% AEP Levee, Hydraulic Mitigation, and Bypass	12.3	18.0	13.0	43.3

Proposed Action - Buyout Component

The buyout component of the Recommended Action would return approximately 3.85 acres of residential area to native floodplain habitats. Wildlife in adjacent areas would immigrate into restored habitats and the buyout area would provide buffer habitats for species utilizing the aquatic and riparian corridor of Leon Creek. This component is in Karst Zone 2 identified in Section 2 but there is not expected to be any impact.

Threatened and Endangered Species

A number of threatened or endangered species were identified as having the potential to occur in Bexar County, including the Leon Creek watershed. However, no Ashe juniper woodlands, karst features, or other threatened or endangered species habitats were identified during field observations; therefore, no Federal or State-listed species are expected to occur within the proposed project area. Impacts to threatened and endangered species resulting from the proposed project alternatives are not anticipated under either the No Action alternative or the Proposed Action.

AQUATIC RESOURCES

Water Quality

No Action

As described in Section 2, Segment 1906 (Lower Leon Creek) exceeds State water quality standards for bacteria, PCBs in edible fish tissues, and dissolved oxygen. Stormwater, which is important to surface water quality, has the potential to introduce sediments and other contaminants (petroleum products, chemicals, etc.) into lakes, rivers, and streams. Generally, higher densities of development (i.e. urban areas such as the Westside Creeks study area) require greater degrees of storm water management due to higher proportions of impervious surfaces, and rapid runoff that occurs following a storm. Under the No Action alternative, these trends are expected to continue.

Proposed Action - Levee Component

The channel modifications associated with the hydraulic mitigation feature of the levee alternatives would directly impact surface waters in the project area during construction as a result of the excavation and recontouring of pilot channels and development of riffle/run/pool complexes. During the construction period, these impacts are expected to temporarily degrade water quality as a result of ground disturbing activities. Erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt revegetation of disturbed areas would be required during construction to reduce and control siltation or erosion impacts. In addition, every construction project poses a potential contamination risk from petroleum or chemical spills. The contractor would be required to prepare and follow a site specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination. Thus, impacts to surface waters during construction are considered to be temporary and not substantial.

The proposed pilot channel would be constructed utilizing natural channel design principles and revegetated with native aquatic, wetland, and riparian species. The reestablishment of aquatic plants and revegetation of the stream banks with native grasses, forbs, and woody species would act as an effective vegetative filter. The restored aquatic system would reduce the amount of sediments and other contaminants that would otherwise flow directly into/through Leon Creek in the immediate area back to existing conditions. However, overall water quality of Leon Creek (Segment 1906) would remain substantially unchanged.

The proposed levee and sump will be designed so that BMPs associated with the existing National Pollutant Discharge Elimination System (NPDES) permit for the Port Authority of San Antonio are not compromised. The release of stormwater runoff collected in the proposed sump of the Test Cell area will be in compliance with the requirements of the NPDES permit.

Proposed Action - Buyout Component

Implementation of the buyout would not impact surface waters in the study area during demolition. Indirect impacts associated with stormwater runoff from the site would be mitigated by utilizing erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt revegetation of disturbed areas after demolition. The contractor would be required to prepare and follow a site specific Spill Prevention Plan during demolition activities, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination. Therefore, no impacts to surface waters during demolition activities are anticipated.

AQUATIC HABITAT

No Action

Under the No Action alternative, aquatic habitats associated with Leon Creek are expected to degrade slightly as a result of urbanization. Reduction in riparian corridor scope and functionality and increases in the presences of invasive species are anticipated.

Proposed Action - Levee Component

The channel modifications associated with the hydraulic mitigation feature of the levee alternatives would temporarily impact aquatic habitat during construction activities. Fish and aquatic organisms would be displaced into adjacent upstream or downstream habitats during construction; however, the construction of the pool/riffle/run/glide habitats of the natural stream design channel would restore the aquatic habitat back to a condition generally better than under existing conditions. In addition, the reestablishment of site-specific native plant species would restore the aquatic habitat for aquatic organisms.

For the alternatives that included a bypass channel, aquatic habitat would also be impacted by the channel bypass where hardened structures would be constructed at the upstream and downstream transitions with Leon Creek. These alternatives would convert an additional 0.2 acres (approximately) of aquatic habitat to hardened surfaces comprising the outfall structures.

Proposed Action - Buyout Component

The Buyout Component of the Proposed Action would occur in upland areas; therefore, aquatic habitats associated with Leon Creek within the proposed project AOI-4 area would not be impacted.

Wetlands and Waters of the U.S.

No Action

Under the No Action alternative, wetland habitats associated with Leon Creek within the proposed project area would not be impacted.

Proposed Action - Levee Component

Leon Creek is a jurisdictional water of the U.S., and activities that would disturb the creek would be subject to Section 404 of the Clean Water Act. Section 404 requires mitigation for impacts to waters of the U.S. by avoiding, minimizing, and then compensating for any unavoidable impacts. For the levee alternatives that incorporate the hydraulic mitigation feature, impacts to Leon Creek were minimized by limiting the channelization activities to a 2,850-foot section of Leon Creek below S.W. Military Drive. Although the modifications to the Leon Creek channel would impact waters of the U.S., the restoration of Leon Creek utilizing natural stream channel design would return the creek to existing or better condition. Therefore, impacts to waters of the U.S. would be temporary and the proposed channelization of Leon Creek in the proposed project area would be considered “self-mitigating”. See Appendix J, 404 (b)(1) Analysis for additional detailed information.

For alternatives that include the construction of the bypass channel, the construction of the outfall structures would impact approximately 0.2 acres waters of the U.S. and require compensatory mitigation.

Proposed Action - Buyout Component

The Buyout Component is comprised of actions entirely located in upland areas. No wetland habitats associated with Leon Creek in the proposed AOI-4 project area would be impacted by activities associated with this component of the Proposed Action.

CULTURAL RESOURCES

No Action

Under the No Action alternative, no impacts to cultural resources within the proposed project area are anticipated.

Proposed Action - Levee Component

Archaeological Resources. A search of the Texas Historical Commission's Archaeological Sites Atlas reveals that many cultural resources investigations have been conducted within a mile of the proposed levee project area, especially on the former Kelly Air Force Base. Four archaeological sites have been identified within a one-mile radius of the project area; however, the eligibility of these resources for inclusion in the National Register of Historic Places (NRHP) is undetermined at this time. These four were identified in 2012 when a linear survey for a sewer line was conducted along the eastern edge of the proposed levee location. While the sites are outside of the construction footprints of any of the levee alternatives, this survey indicates a high probability of finding archaeological sites in the area.

During the Preconstruction Engineering and Design (PED) Phase of this study, a detailed cultural resources survey will be undertaken to identify and evaluate cultural resources that may be affected by the Recommended Plan. This survey will occur early in PED, but only after enough design has been completed so that the footprint of impacts can be evaluated. By limiting the area of survey, USACE is able to minimize impacts to resources that would not otherwise be affected by construction. In addition, features such as a slurry wall that require deep excavation for construction would require analogous deep excavation for cultural resources survey. Excavating a deep trench in a location other than that of the slurry wall or other deeply buried feature would result in destabilizing an area that would otherwise not be excavated. Therefore, USACE has decided that it is best to wait on a greater level of design before conducting the cultural resources survey to minimize the impacts the survey may have on the project area.

Should any archeological properties be identified, coordination with the State Historic Preservation Officer will be initiated to determine the significance of those resources. Efforts to avoid, minimize or mitigate impacts to significant resources will be determined in consultation with SHPO and executed prior to construction.

Architectural Resources. In addition to the archaeological sites, the federal government must evaluate above-ground resources such as buildings and structures that may be of historical significance within the project footprint or that may be indirectly affected by the project. (An example of an indirect impact may be a change to the property viewshed that diminishes the historical integrity, setting or feel of the property.) The buildings and structures within one-half mile of the proposed levee that would be potentially indirectly impacted by its construction date from the mid-1990s. As such, these resources do not meet the criteria for inclusion in the NRHP. No above-ground historic properties will be impacted by any of the levee alternatives.

Proposed Action - Buyout Component

Archaeological Resources. There has been no archaeological survey conducted in the area proposed for buyout; however, the acquisition and removal of structures from the floodplain in this area would not be expected to impact archeological resources since cultural deposits that may have existed would have been destroyed by the construction of the structures involved in the buyout.

Architectural Resources. The buildings and structures located within the buyout area date to 1995 and newer. As such, these above ground resources do not meet the criteria for inclusion in the NRHP. No above ground historic properties will be impacted by the buyout alternative.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

No Action

No specific threats related to hazardous, toxic, and radioactive wastes are expected in the project area under the No Action alternative.

Proposed Action - Levee Component

The various structures (abandoned utilities, active utilities, small structures, concrete slabs, etc.) are only expected to require routine demolition as part of construction. Provided that construction activities are properly managed, no impacts or concerns related to hazardous, toxic, and radioactive wastes are expected to occur in the project area during implementation of any of the levee alternatives, including the Proposed Action. The following description is illustrative of the actions that would comprise “proper management” from an HTRW perspective:

To minimize potential impacts from hazardous and regulated materials during construction, all fuels, waste oils, and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein. The refueling of machinery would be done following accepted guidelines, and all vehicles would have drip pans, when not in use, to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of five gallons or more would be contained immediately within an earthen dike, and the application of an absorbent (e.g., granular, pillow, sock, etc.) would be used to absorb and contain the spill. Any major spill of a hazardous or regulated substance would be reported immediately to SARA and USACE environmental personnel who would notify appropriate Federal and State agencies. Additionally, all construction personnel would be briefed as to the correct procedures for preventing and responding to a spill. All waste oil and solvents would be recycled if practicable. All non-recyclable hazardous and regulated wastes would be collected, characterized, labeled, stored, transported, and disposed of in *accordance with all Federal, State, and local regulations*, *including proper waste manifesting* procedures. A Spill Prevention Plan would be in place prior to the start of construction, and all personnel shall be briefed on the implementation and responsibilities of this plan. Adoption and full implementation of the construction measures described above would reduce adverse hazardous/regulated substances impacts to insignificant levels.

Proposed Action – Buyout Component

Demolition activities associated with the Buyout component of the Proposed Action would be managed consistent with the procedures out lined above, and are not expected to present concerns in that project area relative to hazardous, toxic, and radioactive wastes.

RECREATIONAL RESOURCES

No Action

Under the No Action alternative, recreational opportunities would essentially remain the same as predicted for the Future Without-Project Condition.

Proposed Action – Levee Component

Pearsall Park is located adjacent to the proposed channel modifications, southwest of the Jet Engine Test Cell Facility. Recreational features associated with Pearsall Park include a dog park, restroom facilities, a playscape, 0.33 miles of trail, and off-street parking. The trail is located more than 450 feet from the closest area of the proposed channel modifications associated. In addition, the trail is located on an approximately 25-30-foot high bluff above Leon Creek, thereby obscuring the levee and creek from the viewshed of the trail. In addition, the channel modifications do not encroach upon or impact any of the proposed park features based on the 2012 Master Plan site map for Pearsall Park. Since the project does not encroach on features, there will be no loss of recreational benefits. Therefore, a Unit day Value (UDV) analysis is not warranted.

No recreational measures are proposed for any of the levee alternatives and the Proposed Action is not expected to have any positive or negative effects on the recreation resources of the neighborhoods proximate to this portion of the proposed action.

Proposed Action – Buyout Component

No recreational measures are proposed for the buyout component. However, the removal of structures associated with the buyout would provide limited open space suitable for recreational opportunities if developed by the Sponsor or others at some future date.

SOCIOECONOMICS

No Action

Under the No Action alternative, damages from flooding would continue especially at the Jet Engine Test Cell facility including economic losses within the proposed project area as described in the Future Without-Project Condition. Other socio-economic trends would likewise remain unchanged.

Proposed Action - Levee Component

The project area for any of the levee alternatives, including the Proposed Action, is located primarily on lands already dedicated to industrial uses or open space. Economic losses due to flooding at the Jet Engine Test Cell facility would be substantially reduced. Although acquisition of a small portion of property would be required for the modification to the Leon Creek stream channel adjacent to the Jet Engine Test Cell property, no residential or commercial relocations would be required.

Proposed Action - Buyout Component

This alternative would reduce economic damages associated with frequent flooding by removal of four single-family residences and seven multi-family structures contained in the 4 percent AEP event (25-year floodplain). Removal of these structures would reduce risks to health and safety as well as reducing the need for emergency services in the event of flooding. In accordance with Federal requirements, individuals directly affected by the buyout would be eligible for relocation assistance in addition to compensation for any real estate interest they may have in the purchased property.

The structures targeted for removal are in an area that does not have significant minority or low-income populations that could be disproportionately impacted by evacuation. Consistent with the provisions of Executive Order 12898, the proposed project would not substantially affect human health or the environment in a negative manner. Furthermore, the proposed project would not have the effect of excluding persons from participation in, deny persons the benefit of, or subject persons to discrimination under the proposed project because of their race, color, or national origin.

LIGHT

No Action

Under the No Action alternative, no changes in ambient lighting levels from the Future Without-Project Condition are anticipated.

Proposed Action - Levee Component

Components of any of the levee alternatives would not introduce additional lighting to the Leon Creek project area. Construction would occur during daylight hours, and no construction lighting would be required. Therefore, no adverse impacts from lighting would be anticipated.

Proposed Action - Buyout Component

The Buyout Component of the Proposed Action would not introduce additional lighting to the Leon Creek project area. Demolition would occur during daylight hours and no construction lighting would be required. Therefore, no adverse impacts from lighting would be anticipated.

PUBLIC FACILITY AND SERVICE

No Action

Under the No Action alternative, San Antonio and Bexar County “first responders” would continue to respond to emergency needs for traffic control, search and rescue, and other public services during flood events.

Proposed Action - Levee Component

During construction of any of the levee alternatives, including the Proposed Action, short-term, insignificant impacts to traffic volumes would be a result of haul traffic and other construction activities. Local roads are well designed and are capable of handling a large volume of vehicles. However, during construction, traffic congestion could occur, particularly during the morning and evening rush hour as construction vehicles enter and exit the proposed project area. Road closures or restricted access would not be anticipated; however, temporary detours or traffic control may be needed during working hours. A traffic control plan would be prepared by the construction contractor and submitted for approval to Federal and local officials prior to the start of any construction activities.

Proposed Action - Buyout Component

Short-term, insignificant impacts to traffic volumes would be expected during demolition activities associated with the Buyout Component of the Proposed Action. Local roads are well designed and are capable of handling a large volume of vehicles. However, during construction, traffic congestion could occur, particularly during the morning and evening rush hour as construction vehicles enter and exit the proposed project area. Road closures or restricted access would not be anticipated; however, temporary detours or traffic control may be needed during working hours. A traffic control plan would be prepared by the construction contractor and submitted for approval to Federal and local officials prior to the start of any demolition activities.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed project would not entail any substantial irretrievable or irreversible commitments of resources. Construction activities would require minor consumption of petroleum products, and importing of materials such as rock, soil, gravel, and vegetation. However, the proposed project would entail long-term commitment and environmental stewardship to ensure long-term sustainability of the levee and channel modifications.

CUMULATIVE IMPACTS

The CEQ regulations to implement NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as the impacts on the environment that result from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions (40 CFR Section 1508.7). Cumulative impacts can result from individually minor but collectively substantial actions taking place over a period of time. Cumulative impacts result when the impacts of an action are added to or interact with other impacts in a particular place and within a particular time period. The combination of such impacts and any resulting environmental consequences should be the focus of a cumulative impact analysis. Therefore, this cumulative impacts assessment and analysis focuses on the combination of past, present, and reasonable foreseeable actions, how they are connected, and their resulting collective effects in conjunction with the Proposed Action, regardless of the source of the actions. The initial step of the cumulative impacts analysis uses information derived from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. The 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 a cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, the cumulative impact analysis for Leon Creek was focused on those resources that were substantially directly or indirectly impacted by the study 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: riverine habitat (riparian and aquatic vegetation and pool/riffle/run complexes) and fish and wildlife. Each of these resources would be directly and/or indirectly impacted by the proposed channel improvements of Leon Creek associated with the construction of the levee. For the purposes of this cumulative impact analysis, the resource study area for riverine habitat and wildlife is the floodplains of Leon Creek and other tributaries associated with the San Antonio River within Bexar County, Texas.

Past, present and reasonably foreseeable future projects influencing riverine habitats and wildlife in the cumulative study area are presented in Table 4-3. Transportation, utility, development, and other construction projects have occurred in the past and impacted riverine resources in the Leon Creek cumulative study area. After 1972, certain of these impacts that might require dredging or the placement of fill in wetlands or waters of the United States would have been regulated by the USACE under Section 404 of the Clean Water Act or the Rivers and Harbors Act of 1899. These types of development projects continue to occur currently and would be expected to continue in the future. For those projects regulated through the USACE permitting process, it would be expected that any negative impacts to aquatic resources would be mitigated.

Table 4-3: Past, Present, and Future Projects Impacting Rivierine Habitats in the Leon Creek Study Area

Projects	**Riverine Resources Cumulative Impact**[1]	**Wildlife Resources Cumulative Impact**[1]
Past Projects		
SACIP[2]	-	-
Eagleland Section 1135 Ecosystem Restoration Project[2]	+	+
Mitchell Lake Improvements Project	+	+
Creation of Elmendorf and Woodlawn Lakes	-	0
Salitrillo Creek Demonstration Project	+	+
Construction of Fort Sam	-	-
Honey Creek Demonstration Project	+	+
Camp Bullis Military Reservation	0	-
Randolph Air Force Base	0	0
Lackland Air Force Base	0	0
Lackland Air Force Base Wetland Restoration Project	+	+
Kelly Air Force Base	0	0
Present Projects		
San Antonio River Channel Improvement Project Ecosystem Restoration and Recreation (Mission Reach)[2]	+	+
Fort Sam Medical Facilities	0	0+
San Antonio River Improvement Project, Section 408	+	+
Reasonably Foreseeable Projects		
Westside Creeks Ecosystem Restoration Study	+	+
Straus Medina Mitigation Bank	+	+
Future Fort Sam Construction Activities	0	0
Elmendorf and Woodlawn Lakes Improvements	0	0
Olmos Creek Section 206 Ecosystem Restoration Project[2]	+	+

[1] A negative symbol (-) denotes a negative impact, a zero (0) denotes no impact, and a positive symbol (+) denotes a positive impact.

[2] USACE Civil Works Project

Riverine Habitat

The health and historic context of the riverine habitat and fish and wildlife resources utilizing these habitats, has been described in previous sections of this report (Existing Conditions, Alternative Formulation, and Consequences). Over the past 125 years, pristine riverine habitats in Bexar County have been lost due to demand for natural resources, agriculture, urbanization, channelization to address flood risks, and the introduction of non-native invasive species. As urban sprawl incorporates the remaining areas of Bexar County, the importance of riverine habitats and their associated floodplains in the outer areas of the county has been realized. With the exception of some non-cultivated agricultural areas, much of the riparian buffers surrounding these stream channels have been severely degraded. Several restoration projects have been and are currently under construction including the Eagleland and Mission Reach projects on the San Antonio River. The conservation of riverine resources in Bexar County continues to be a priority and initiatives by the City of San Antonio, SARA (including the Westside Creeks Ecosystem Restoration Study), San Antonio Water System, Bexar County, TPWD, and non-profit conservation organizations such as the Nature Conservancy and the Texas Land Conservancy are making progress in increasing the extent of restored and protected riverine habitats. Although future restoration and conservation initiatives will undoubtedly continue, the City of San Antonio and Bexar County are one of the top ten urban growth centers in the U.S. As a result, urban pressures would continue to encroach on the County’s suburban and rural riverine ecosystems. Because of projected future population growth and subsequent urbanization, the sustainability and ecological viability of riverine habitats for fish and wildlife as well as human uses, highlights one of the greatest ecological needs of the County. Although the channel improvements would initially result in adverse impacts to riverine habitats and fish and wildlife resources that could contribute to the cumulative impacts on riverine habitats, the natural channel design of the channelization and the proposed vegetative mitigation measures would mitigate these cumulative impacts upon maturation of the mitigated habitat.

Wildlife

Fish and wildlife inhabiting Leon Creek prior to urbanization of Bexar County would have consisted of a diverse community of native invertebrate, fish, amphibian, reptile, mammal, and bird species. As the area urbanized, wildlife species intolerant of urban impacts such as the Texas tortoise, indigo snakes, bobcat, and black bear migrated out of the area over time and tolerant species such as raccoons, opossums, and Great-tailed Grackles now thrive. After channelization of the San Antonio River and other streams in Bexar County, the aquatic habitat that supported a diverse community of amphibians and aquatic invertebrates also disappeared, further reducing wildlife diversity in the urbanized areas. Finally, the introduction of non-native fish and wildlife species such as tilapia, tetras, house mice, Norway rats, European Starlings, Rock Doves, and feral cats and vegetative species such as Johnsongrass, Bermuda grass, KR bluestem, and giant cane have further reduce habitat values. Although non-native plant species such as Chinaberry and Chinese privet are present in the vicinity of the proposed channel improvements and the area is artificially impounded, the area supports relatively diverse riverine resources.

In the earlier Environmental Consequences discussions, it was recognized that there would be direct impacts to wildlife habitat, which would be temporarily lost during the channel modification activities, and indirect impacts to wildlife species, which would temporarily relocate to surrounding areas due to increased activity and noise associated with construction. In addition, the emigration of wildlife from the project area would indirectly affect wildlife populations in adjacent areas as the impacted populations would encroach on established territories increasing stress associated with limited food and cover supplies. These impacts would be temporary as the mitigation measures associated with the natural channel design and reestablishment of woody vegetation within the floodplain would restore the impacted habitats.

Although the channel improvements associated with the construction of the levee would temporarily impact the riverine habitats and local fish and wildlife resources, the proposed mitigation to restore the natural function of the riverine ecosystem would not contribute to the cumulative impacts to riverine or fish and wildlife resources in the cumulative effects study area.

PROJECT IMPLEMENTATION

STATUS OF ENVIRONMENTAL COMPLIANCE

Table 5-1 presents the status of compliance with all environmental laws and regulations for the Proposed Action.

Table 5-1. 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	Compliant
Archeological Resources Protection Act, 1979, as amended	Compliant
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	Compliant
Fish and Wildlife Coordination Act, 1958, as amended*	Compliant
Magnuson Fisheries Conservation and Management Act	Not Applicable
Migratory Bird Treaty Act, 1918, as amended	Compliant
National Environmental Policy Act, 1969, as amended	Compliant
National Historic Preservation Act, 1966, as amended	Compliant
Native American Graves Protection and Repatriation Act, 1990	Compliant
Rivers and Harbors Act, 1899	Compliant
Wild and Scenic Rivers Act, as amended	Compliant
Executive Orders	
Environmental Justice (E.O. 12898)*	Compliant
Flood Plain Management (E.O. 11988)	Compliant
Protection of Wetlands (E.O. 11990)	Compliant
Protection of Children from Environmental Health Risks (E.O. 13045)	Compliant
Invasive Species (E.O. 13112)*	Compliant
Migratory Birds (E.O. 13186)*	Compliant
Others	
FAA Advisory Circular 150-5200-33*	Compliant

* For additional information, see the following sections

Environmental Justice, Executive Order 12898

The permanent evacuations in the recommended plan do not disproportionately target or impact minority populations within the project area. Comparable housing availability should not be an issue. Housing of last resort, which may involve the use of replacement housing payments that exceed Uniform Act amounts or other methods of providing comparable decent, safe, and sanitary housing within a person’s financial means, might be necessary however, to provide adequate replacements for those being permanently evacuated.

Invasive Species, Executive Order 13112

Executive Order (EO) 13112 recognizes the significant contribution native species make to the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of the invasion of non-native plants and wildlife species in the United States. This EO establishes processes to deal with invasive species, and among other items establishes that Federal agencies “will not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.”

The riparian and aquatic vegetation associated with the revegetation of the Leon Creek channel adjacent to the levee would be comprised of plant species native to the San Antonio area. Similarly, revegetation of the demolition site of the proposed buyout area would utilize site-specific native vegetation. During establishment of the native vegetation, invasive species control measures, chemical and/or mechanical, would be in place to reduce the chance of non-native species becoming established in revegetated areas. Because of slope and soils stability requirements, Bermudagrass (*Cynodon dactylon*) may be required to stabilize the levee slopes. Should a native plant species be identified that meets the levee vegetation stability requirements, the use of the native species will be considered in compliance EO 13112.

Clean Water Act

USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the United States, including wetlands. Although USACE does not issue itself permits for construction activities that would affect waters of the United States, USACE must meet the legal requirement of the CWA. The buyout alternative would not result in the discharge of dredged and fill material into waters of the U.S. However, the channel modifications associated with the levee alternative would require the disturbance of approximately 2,850 linear feet of Leon Creek. The proposed natural channel design of the channel modifications and the restoration of aquatic and riparian vegetation would result in no net loss of wetlands or waters of the U.S. and no net loss of aquatic function to Leon Creek. Discussion with the Fort Worth USACE Regulatory staff concur that the proposed aquatic and riparian habitat mitigation would result in the “self” mitigation of the action. A section 404(B)(1) was drafted and is included in Appendix J. Water quality certification under Section 401 of the Clean Water Act has been coordinated with TCEQ. Water quality certification was obtained on February 20, 2014.

Section 176(c) Clean Air Act

Federal agencies are required by this Act to review all air emissions resulting from Federal funded projects or permits to ensure conformity with the State Implemented Plans (SIP) in non-attainment areas. The San Antonio metropolitan area is currently in attainment for all air emissions; therefore, the proposed study would be in compliance with the Clean Air Act.

Section 106 Compliance

Letters were mailed to the State Historic Preservation Office and appropriate Indian Tribes in February 2008 to initiate Section 106 coordination (see Appendix C “Agency Coordination and Correspondence”). No responses have been received to date. In addition, letters, along with a Notice of Availability, were sent to the SHPO and appropriate Indian Tribes at the initiation of the required public review period prior to finalization of the NEPA process. The District received no responses.

Advisory Circular - Hazardous Wildlife Attractants on or Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife in the vicinity of public-use airports. The circular provides guidance on wetlands in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife.

In response to the Advisory Circular, the United States Army as well as other Federal agencies, signed a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States.

The proposed action would not result in an increase of the extent of aquatic or riparian habitat that would attract hazardous wildlife. Because the land use and habitat types would not change, no increased aircraft-wildlife strikes are anticipated. USACE has coordinated with the FAA and the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture to ensure the proposed action complies with the Advisory Circular.

Fish and Wildlife Coordination Act

USACE and the U.S. Fish and Wildlife Service have been coordinating in accordance with the Fish and Wildlife Coordination Act. USFWS is part of the project delivery team and has attended several meetings and field trips, as discussed under the subsection entitled “Resource Agency Coordination.” Coordination with USFWS has been ongoing and will continue to be so throughout the study.

- In March 2009, USACE received a draft Planning Aid Letter from USFWS in regard to the habitat evaluations completed by USACE, USFWS, and TPWD.
- On November 13, 2009, USACE received further comments and planning assistance in an official letter from USFWS. This letter stressed the ecological significance the Government Canyon area and the highlighted the concern that USACE and TPWD have with potential alternatives that would impact this area.
- On March 11, 2014, USFWS provided the Fish and Wildlife Coordination Act Report supporting the recommended plan.

Migratory Bird Treaty Act/Executive Order 13186

The importance of migratory non-game birds to the nation is embodied in numerous laws, executive orders, and partnerships. The Fish and Wildlife Conservation Act demonstrates the Federal commitment to conservation of non-game species. Amendments to the Act adopted in 1988 and 1989 direct the Secretary to undertake activities to research and conserve migratory non-game birds. EO13186 directs Federal agencies to promote the conservation of migratory bird populations, including restoring and enhancing habitat. In order to ensure compliance with the Migratory Bird Treaty Act, the clearing of vegetation associated with Leon Creek channel modifications and demolition activities associated with the buyout alternative would occur outside of the migratory bird nesting season (March through August).

Endangered Species Act

USACE and the U.S. Fish and Wildlife Service have been coordinating regarding the Endangered Species Act. No threatened and endangered species or critical habitats occur within the area of the Proposed Action but coordination will continue regarding Section 7 of the Endangered Species Act (ESA).

Executive Order 11988

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 flood plains and to avoid direct and indirect support of flood plain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities.” The Water Resources Council Flood plain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the flood plain. The eight steps reflect the decision-making process required in Section 2(a) of the EO. The eight steps and responses to them are summarized below.

1. Determine if the proposed action is in the base flood plain.

The proposed project is entirely located in the 100-year flood plain. It includes the construction of a 100-year levee in AOI-2, located at Port San Antonio just south of Lackland Air Force Base and S.W. Military Drive, with hydraulic and environmental mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses in NS AOI-4, located just south of Loop 1604 and west of Babcock Road, subject to damages from a 4 percent annual exceedance probability event.

2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to the location of the action in the base flood plain.

The proposed project is entirely located within the 100-year flood plain. Chapter 3 describes the plan formulation process. Fundamentally, since the primary objective of the proposed project is to reduce flood risks, formulation of measures and plans was focused on areas subject to flood risk, i.e. located in floodplains. Early plan formulation efforts looked at potential measures such as regional and local detention, channel modifications, levees, bypass channels, and overbank storage. All of these potential measures require location in the floodplain in order to be effective at reducing flooding risks, particularly for those more frequent flooding events. Many of these early alternatives reduced the flood risk but were screened out due to higher costs relative to the benefits produced. Nonstructural measures that would not result in adverse modifications to the floodplain were also fully considered and are included in the recommended plan where economically justified. As described above and in the early sections of the report, actions by other entities in the Leon Creek watershed that do not impact the floodplain but are effective at reducing the flood risk include the full compliance with the requirements of the NFIP, and the promotion of stabilization of future flood hazards through “no rise” ordinances and the adoption of Low Impact Development (LID) strategies throughout the watershed by the San Antonio River Authority (SARA). In addition, the real-time flood warning system SARA developed with Bexar County and the City of San Antonio provides another means of managing the potential flood risk without directly impacting or changing the floodplain.

3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

Public involvement activities are described in detail later in this report section. The initial public meeting was held in March 2009 prior to the formal kickoff of the feasibility study. Three public scoping meetings were held during the spring and summer of 2009; the general concern from these meetings were the concern related to any alternative that would involve construction in the Government Canyon area. This feedback provided significant guidance to the planning process. A progress meeting was held in June 2011, and a meeting to receive comments on the draft report was held in December of 2013. There were no comments received from the public on the proposed action during the 45-day comment period on the Leon Creek Watershed Interim Feasibility Study and Integrated Environmental Assessment.

4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.

The potential impacts associated with the recommended plan are summarized in Section Four of the project report. The recommended plan comprises two components in two distinct areas of interest. AOI-2 is characterized as a highly industrialized consisting of a former Air Force Base that is part of Port San Antonio. The primary structures in this area are a large Jet Engine Test Cell facility along with a mix of commercial properties. NS AOI-4 is residential with a mix of both single- and multi-family housing. The recommended plan is expected to have no significant adverse impact to natural and beneficial flood plain values since in the case of AOI-2, significant consideration was given to measures that would mitigate for any potential impacts to water surface elevations. The proposed levee in AOI-2 includes a channelization component that mitigates increases in water surfaces due to the levee. The evacuation of structures in NS AOI-4 takes properties out of the floodplain and does not lead to any losses in the floodplain. In general, the flood plain is highly urbanized, and actions associated with project implementation are not expected to degrade existing resources. Minor aquatic impacts associated with construction of the AOI-2 levee will be fully mitigated, and the buyout component provides the opportunity to create a small pocket of floodplain open space in an area that is currently urbanized.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.

The recommended plan will not induce development in the base flood plain. The portion of the watershed that would be protected by the AOI-2 levee is highly industrialized and is already fully developed. The floodplain buyout component does not change the flood hazard for adjacent areas in any way-it simply reduces flood damages by permanently removing susceptible structures. The City of San Antonio and Bexar County presently participate in the National Flood Insurance Program and enforce zoning regulations for development in the floodplain. Due to the history and nature of flooding in the area, programs designed to regulate development of the watershed in addition to the NFIP include Bexar Regional Watershed Management—an interlocal agreement between SARA, the County, the city of San Antonio and 20 other municipalities and the Leon Creek Watershed Master Plan which also looks at alternative development techniques. As discussed in the report, Best management Practices and Low Impact Development are encouraged and incentivized.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative.

The recommended plan includes features such as hydraulic mitigation (channel widening) to mitigate for changes in upstream flood levels induced by the AOI-2 levee. It likewise includes full mitigation for the minor aquatic impacts associated with the channel feature. As discussed in Section three of the project report, this measure is fully justified as a comprehensive package. The buyout feature enhances natural floodplain values through the permanent creation of open space.

7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.

The Draft Feasibility Report with integrated EA describing the recommended plan was released for public review between October and mid-December 2013. The study findings and impacts were described in Sections three and four. There were no comments received from the public.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

The objective of the project is to reduce the probability and consequences of flood risk and associated damages in the study area. The project is responsive to the EO 11988 objective of “avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain, and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative” because the proposed features focus on reducing the threat of flooding to the existing urban area by altering a very small footprint within the flood plain. The proposed features would reduce the hazard and risk associated with floods, thereby minimizing both the probability and the consequences of flooding within the urban area and would preserve the natural and beneficial values of the base flood plain.

Residual Risk

1. Vulnerabilities.

The Leon Creek study area is located primarily in a heavily urbanized area with some rural areas at the upper headwaters. The western portions of the study area are a mix of rural and urban areas with residential and commercial development currently underway. The 2010 population was 340,133 in the study area, an increase of 43 percent from 2000. In 2000, the study area’s population accounted for approximately 20 percent of total population for Bexar County. Fifty-nine percent of the study area population is minority compared with 64 percent for the County but the study area has a slightly higher per capita income than Bexar County and a poverty rate roughly three points lower than the County.

The study area has 1,971structures (1,562 residential, 343 commercial, and 66 public) in the 1 percent AEP event and 4,629 structures (4,005 residential, 513 commercial, and 111 public) in the 0.2 percent AEP event. Although flood insurance would partially compensate for future flood losses, damages would still occur at an estimated average rate of $13.8 million annually (including damages to privately owned vehicles) at October 2013 price levels. Costs for flood fighting and recovery, public damages, the potential loss of life, and the overall threat to human health and safety would continue. Small, localized flood control projects would still be constructed to address localized events, but the large floods would continue to threaten property and human safety.

Under existing conditions in the watershed, discharge at the 1 percent AEP event is 3,000 cubic feet per second for the smaller tributaries but as high as 116,000 cubic feet per second for several of the reaches on the main stem. Discharges at the 0.2 percent AEP event is 4,000 cubic feet per second in the tributaries and up to 182,000 cubic feet per second on the main stem. Depths relative to structures can be as high as 18 feet at the 1 percent AEP event and 22 feet at the 0.2 percent AEP event. As stated in Section Three of the report, the hydrograph from the gage station at Leon Creek and I-35 for the storm event in May 2013 is indicative of the area's flashy flooding nature. Leon Creek rose from within-bank levels to its peak flood stage in approximately six hours, tapering off somewhat more slowly but returned to within-bank conditions in less than 24 hours. These flooding velocities, depths, and durations are expected to continue even after implementation of the Recommended Plan. Structures are removed from the threat of flooding with the nonstructural component of the plan but the nature of flooding is not changed. Likewise, the structural component has localized impacts to the immediate area of the proposed levee but it too does not change the overall flooding characteristics of the watershed.

2. Residual Risk.

While the recommended plan includes alternatives identified as economically justified, substantial flood risk will remain after the project is constructed and operational. The recommended plan reduces annual flood damages by just over $2 million. Of the $2 million annual reduction, almost $1.7 million occurs in AOI-2, which is a location within the highly industrialized area at Port San Antonio. The remaining reduction in annual flood damages comes from the evacuation of flood prone properties in the residential area, NS-AOI-4.

From a project performance standpoint, significant damages in AOI-2 begin at the four-year event based on the annual expected target stage of 634.3 feet. Putting in the proposed levee reduces the recurrence interval to a 132-year event. Long-term performance shows that this levee would have a seven percent chance of being exceeded in 10 years, a 17 percent chance of being exceeded in 30 years, and a 32 percent chance of being exceeded in 50 years. Additionally, the levee would have an 80 percent chance of containing the 1 percent AEP, a 66 percent chance of containing the 0.4 percent AEP, and a 52 percent chance of containing the 0.2 percent AEP.

3. Managing Residual Risk.

Floodplain management is highly effective in controlling future development of the floodplain and assuring that existing flood risks do not increase. Stated earlier, the City of San Antonio and Bexar County presently participate in the National Flood Insurance Program and enforce zoning regulations for development in the floodplain. Best Management Practices for stormwater and Low Impact Development (LID) are encouraged and strongly promoted. Additionally, other programs exist in the study area for public entities to promote responsible floodplain management including the Leon Creek Watershed Master Plan and the Bexar Regional Watershed Management agreement. However, floodplain management cannot, by itself, significantly reduce existing flooding conditions within a highly urbanized floodplain. San Antonio's floodplain management program can be expected to complement the Leon Creek flood risk reduction projects by stabilizing future damage conditions and preventing significant future increases in residual risk. Any remaining residual risk can also be effectively managed with the implementation and utilization of the real-time flood warning system being jointly developed by SARA and Bexar County. Additionally, the City of San Antonio has developed a public education and flood preparedness program called SAFE (San Antonio Flood Emergency) which provides early notification during major flood events and public education on actions necessary to protect lives and property.

C. Conclusion

The project is in compliance with EO 11988. Implementation of the recommended plan will substantially reduce monetary flood damages in the Leon Creek watershed but will not fundamentally modify the nature of the flood hazard in the watershed. Decisions on which alternatives to ultimately pursue were driven primarily by those that optimized on the basis of economic justification. As a consequence, the risk to human health and safety resulting from the “flashy” nature of flooding in the study area is reasonably unchanged from the with-project condition. It will be critically important for the local sponsor to proactively communicate remaining flood hazards to residents and stakeholders within the watershed, but the proposed action does not result in induced flooding impacts to the natural and beneficial floodplain. The structural component mitigates for any potential inducements that may be caused by the proposed levee while the nonstructural component creates a pocket of open space in a highly urbanized area. The proposed action in conjunction to the other ongoing activities in the watershed will be a step in the right direction towards effectively managing the flooding risk.

PROJECT IMPLEMENTATION

Project implementation is composed of two phases: Pre-construction Engineering and Design (PED) and Construction. This section describes these phases, which would occur according to the Project Implementation Schedule, developed under the assumption that Federal and local funds will be available.

Preconstruction Engineering and Design

After the project has been approved for construction by a Water Resources Development Act (WRDA) or other authorization and funds have been appropriated for the pre-construction engineering and design (PED) phase, a number of activities would take place, including completion of a design agreement, detailed design report, and value engineering study, development of plans and specifications, and development of a Project Partnership Agreement.

Design Agreement

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

Detailed Design Report

The Detailed Design Report (DDR) includes completing the project feature final design. As part of the DDR, remaining ground surveys, utility surveys, and cultural surveys will be completed. The final weir, recreation amenity, and maintenance road locations will be verified based on the final hydraulic analyses. Design parameters for all project features will be defined for development of the plans and specifications. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design. The DDR will be completed within one year of the initiation of PED.

Value Engineering Study

As stated earlier, ER 11-1-321 provides for the execution of the Value Engineering (VE) elements within the Project Management Business Process (PMBP) of the U.S. Army Corps of Engineers and that Value Management (VM) shall be done by implementing the Value Management Plan (REF8023G) from the U.S. Army Corps of Engineers Business Process Manual. A Value Engineering Study will be conducted during the design and construction phase in accordance to ER 11-1-321.

Plans and Specifications

Plans and specifications (P&S) include the development of project construction drawings, project construction specifications, estimation of final quantities, and the government cost estimate. These documents (with the exception of the government cost estimate) are made available to contractors interested in bidding on the construction of the proposed project. It is anticipated that up to four sets of P&S will be developed for the demolition of structures, construction of the levee, and construction of the channel improvements and mitigation features.

Project Partnership Agreement and Items of Non-Federal Responsibility

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

- Provide a minimum of 35 percent, but not to exceed 50 percent, of total flood risk management costs attributable to the structural alternative and 35 percent of total flood risk management costs attributable to the non-structural alternative, s further specified below:

    1. Pay, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

    2. Pay, during construction, 5 percent of total flood risk management costs attributable to the structural alternative;

    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands,

easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

4. Pay, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total flood risk management costs;

- Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- Not less than once each year, inform affected interests of the extent of protection afforded by the project;

- Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

- Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

- Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project’s proper function;

- Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

- For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project’s authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

- Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

- Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

- Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army”; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

- Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

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

Real Estate Acquisition

The non-Federal sponsor is responsible for acquiring all privately owned, as well as local government or publicly owned, lands, easements, rights-of-way, relocations, and disposal areas (LERRD) required for project construction, operation, and maintenance. Following the execution of the PPA, the non-Federal sponsor will be provided a map delineating the right-of-way to be acquired for project purposes. The non-Federal sponsor will coordinate the real estate acquisition with the Corps, and the Corps will certify all LERRDs prior to issuing a construction contract advertisement.

PROJECT CONSTRUCTION

Contract Advertisement and Award

After the PPA is executed, a set of plans and specifications have been developed, and LERRDs have been certified, the Corps will issue a solicitation and award a construction contract. Prior to awarding the contract, the non-Federal sponsor must provide any applicable cash contribution. Per the implementation schedule on page 128, several construction contracts might be required to accomplish the work.

The first contract would be for demolition of structures. The second contract would be to plant in disturbed areas. A third contract would be to construct the channel modification, plantings, and construct drainage improvements, slurry wall, sump, and levee construction. The fourth contract would put in the mitigation features for the test cell channelization. Some of these contracts may run concurrently or may ultimately be combined or split into smaller contracts due to timing and need constraints. Additional contracts will be necessary for the clearing and grubbing and the planting of trees.

Construction contract language will require compliance with Stormwater Pollution Prevention requirements to control runoff and protect water quality. Standard requirements also include control of invasive vegetation on disturbed areas during and immediately following construction.

MONITORING AND ADAPTIVE MANAGEMENT

ER 1105-2-100 allows for project monitoring and adaptive management during and after construction. Adaptive management for complex, specifically authorized projects may be recommended, particularly those projects that include Ecosystem Restoration as a project purpose. Monitoring and adaptive management measures are being proposed for the environmental mitigation associated with the proposed at the Port San Antonio Jet Engine Test Cell facility. The specifics for these measures are outlined in Ecosystem Evaluation Appendix B.

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

Under the terms of the Project Partnership Agreement, the San Antonio River Authority would accept the project following completion of construction and ensure its operation, maintenance, repair, rehabilitation, and replacement (OMRRR), in accordance with Federal regulations. The major OMRRR items include the following:

- Regular maintenance of levee and channel improvements
- Debris cleanup
- Selective trimming in the natural channel design areas

OMRR&R costs are currently estimated at $59,000 per year. After completion of the project, an Operation and Maintenance Manual for the River Authority would be prepared by the Corps, and periodic inspections would be conducted to ensure that all required maintenance was being performed. The following table a breakdown of the OMRR&R costs.

Table 5-2
Annual OMRR&R Costs for Recommended Plan in October 2013 Prices

Project Cost Items	Cost
Structural	
Regular Maintenance (Debris Cleanup)	$15,000
Grounds Maintenance	$15,000
Equipment Maintenance	$10,000
Riparian Measures	$10,000
Total Structural O&M	**$50,000**
Nonstructural	
Grounds Maintenance	$9,000
Total Nonstructural O&M	**$9,000**
Total O&M	**$59,000**

PROJECT IMPLEMENTATION SCHEDULE

Work to be done by Contract		**Start Year**	**End Year**	**Duration**
Planning and Design		2015	2017	
Relocations		2017	2017	
Channel Modification		2017	2018	
Levee		2018	2019	
Fish and Wildlife (includes 2 yr adaptive Management)		2017	2020	
Construction Management		2017	2019	
	Non - Structural Buyout Area			
Work Completed				
Planning and Design		Mar-15	Feb-17	
Relocations (Demo buildings and cap Utilities)		May-17	Jul-17	10 Weeks (Assume a 5 - 3 man crews)
Fish and Wildlife (Grass plantings in disturbed areas)		Jul-17	Sep-17	5 Weeks (Assume a 3 - 2 man crews)
Construction Management		May-17	Sep-17	
	Test Cell Area			
Planning and Design		Mar-15	Feb-17	
Utility Relocation		May-17	Jun-17	6 Weeks (Assume 2 - 5man crews)
Channel Modification		Jul-17	Oct-18	
Site Work (Prep and Demo)		Jul-17	Oct-17	14 weeks (Assume 4 - 3 man crews)
Channel Improvement		Oct-17	Apr-18	27 weeks (Assume 3 - 4 man crews)
Storm Drainage Improvements/ Sluice Gate		Apr-18	Jun-18	9 Weeks (Assume 2 - 5 man crews)
Sump		Apr-18	Oct-18	25 Weeks (Assume 4 - 4man crews)
Fish and Wildlife		Oct-17	May-20	
Excavation		Oct-17	Nov-17	3 weeks (Assume 4 - 4 man crews)

In-stream Structures		Apr-18	Apr-18	2 days (Assume 1 - 4 man crew)
Trees		Apr-18	May-18	5 weeks (Assume 2 - 2 man crews)
Clearing and grubbing (Is included in Site Work Prep)				
Adaptive Management		May-18	May-20	2 years
Levee		Oct-18	Mar-20	73 weeks (Assume 4 - 3 man crews)
Construction Management		May-17	Mar-20	

TOTAL PROJECT COST

The total project cost for the Recommended Plan is $28,175,000. This includes $5,872,000 for the nonstructural alternative and $22,303,000 for the structural alternative at the Jet Engine Test Cell facility. The base cost of the Recommended Plan $23,177,000 with a contingency $4,998,000.

COST SHARING

The provisions of the Water Resources Development Act of 1986 as amended by the Water Resources Development Act 1996 stipulates cost sharing requirements that local sponsors must meet for the Federal government to be involved with water resource projects. This section outlines the cost sharing provisions for flood risk management purposes.

Under the provisions set forth in Public Law 104-303, as amended, the designated Sponsor, in this case the San Antonio River Authority, is required to formally approve the recommendations of the Feasibility Report before initiating the Preconstruction, Engineering, and Design Phase of the project.

For nonstructural flood risk management projects, the non-Federal cost would be at least 35 percent of the total project flood risk management costs. The non-Federal sponsor would be responsible for 100 percent of the operation, maintenance, repair, rehabilitation, and replacement costs for the flood risk management portion of the project. The apportionment of costs is portrayed in Table 5-3 below.

Table 5-3
Cost Apportionment
October 2013 Prices

Feature	Federal	Non-Federal	Total
Non Structural Measure			
Lands & Damages		$4,779,000	$4,779,000
Demolition	$742,000		$742,000
Fish and Wildlife	$98,000		$98,000
Preconstruction, Engineering & Design	$154,000		$154,000
Construction Management	$99,000		$99,000
Unadjusted Total	$1,092,000	$4,779,000	$5,871,000
Adjustment to Achieve 65/35	$2,724,000	-$2,724,000	
Non Structural Subtotal	**$3,816,000**	**$2,055,000**	**$5,871,000**
Structural Measure			
Lands & Damages		$2,617,000	$2,617,000
Utility Relocations		$619,000	$619,000
Channels and Canals	$9,065,000		$9,065,000
Levee and Floodwalls	$5,685,000		$5,685,000
Fish and Wildlife Facilities	$204,000		$204,000
Preconstruction, Engineering & Design	$2,506,000		$2,506,000
Construction Management	$1,607,000		$1,607,000

Feature	Federal	Non-Federal	Total
Unadjusted Total	$19,067,000	$3,236,000	
5% Cash Contribution	-$1,115,000	$1,115,000	$0
Adjustment to Achieve 65/35	$14,497,000	$7,806,000	$22,303,000
Structural Subtotal	**$14,497,000**	**$7,806,000**	**$22,303,000**
Total Cost Apportionment	**$18,314,000**	**$9,861,000**	**$28,175,000**
Cost Percentage	**65%**	**35%**	**100%**

FINANCIAL CAPABILITY ASSESSMENT

Sponsor Self-Certification of Financial Capability

The non-Federal sponsor, the San Antonio River Authority, is to provide a statement that attests to their capability to meet their financial responsibilities related to this project as agreed and described in this report. This section will contain that information as soon as SARA provides it to the Corps.

FULLY FUNDED COST ESTIMATE

The fully funded cost estimate is intended to provide an indication of total project costs when inflation is taken into account. Inflation rates are based on rates developed as part of the Corps budgeting process. The estimated first cost is $28,175,000, and the fully funded cost estimate for the Recommended Plan is $30,328,000. See Table 5-4 below for the detailed annual costs.

Table 5-4
Fully Funded Cost Estimate

Feature	Total	Mid-Point Date	Inflation	Fully Funded Cost
Relocations	$1,361,000	2017Q3	6.9%	$1,454,000
Fish & Wildlife Facilities	$304,000	2018Q2	8.4%	$329,000
Channels & Canals	$9,064,000	2018Q2	8.4%	$9,825,000
Levees & Floodwalls	$5,685,000	2019Q3	11.0%	$6,309,000
Construction Estimate Subtotals	**$16,414,000**			**$17,917,000**
Lands and Damages	$7,396,000	2013Q4	0.0%	$7,396,000
Planning, Engineering, & Design				
Project Management	$296,000	2015Q4	6.9%	$316,000
Planning & Environmental Compliance	$148,000	2015Q4	6.9%	$158,000
Engineering & Design	$922,000	2015Q4	6.9%	$986,000
Reviews, ATRs, IEPRs, VE	$148,000	2015Q4	6.9%	$158,000
Life Cycle Updates (cost, schedule, risks)				
Contracting & Reprographics	$148,000	2015Q4	6.9%	$158,000
Contracting & Reprographics	$148,000	2015Q4	6.9%	$158,000
Engineering During Construction	$444,000	2018Q4	21.2%	$538,000
Planning During Construction	$259,000	2018Q4	21.2%	$314,000
Project Operations	$148,000	2015Q4	6.9%	$158,000
Planning, Engineering, & Design Subtotal	**$2,661,000**			**$2,944,000**

Construction Management				
Construction Management	$1,137,000	2018Q4	9.4%	$1,379,000
Project Operation:	$285,000	2018Q4	9.4%	$345,000
Project Management	$284,000	2018Q4	9.4%	$344,000
Construction Management Subtotal	**$1,706,000**			**$2,068,000**
Fully Funded Cost Total	**$28,175,000**			**$30,326,000**

VIEWS OF THE LOCAL SPONSOR

The local sponsor, San Antonio River Authority (SARA), has been an integral team member and has actively participated in plan formulation, alternative screening, and plan selection. The local sponsor supports the Recommended Plan and intends to participate in its implementation. A Letter of Intent stating their support and their intention to participate in the project implementation will be included in the Final Report.

RESOURCE AGENCY COORDINATION

The EPA, USFWS, and TCEQ were invited to be Cooperating Agencies, because they have been conducting relevant work within the Edwards Plateau and specifically, the Leon Creek Watershed. The Kiowa Tribe of Oklahoma was also invited to participate. Scoping letters were mailed to the resource agencies in February 2008 (see Appendix C “Agency Coordination and Correspondence”).

Several meetings and site visits have been held with the resource agencies, specifically Texas Parks and Wildlife Department (TPWD) and USFWS. Field site visits for the Habitat Evaluation Procedures (HEP) were conducted March 18–20, 2008, and included staff from the USFWS and TPWD. Subsequent conversations and emails occurred in regard to the HEP results. Appendix C “Agency Coordination and Correspondence” contains the official Planning Aid Letter from USFWS.

The resource agencies have been invited to the monthly working meetings and have participated at a few of these meetings. Correspondence by e-mail and phone with the resource agencies has also occurred throughout study development. The USFWS submitted the final Fish and Wildlife Coordination Act Report on March 11, 2014, documenting support for the recommended action (Appendix C).

PUBLIC INVOLVEMENT

USACE and SARA have held multiple public communication events with local citizens regarding the Leon Creek Watershed Integrated Feasibility Study (IFS). Details regarding some of the public involvement activities that have already taken place are presented below along with a summary of the remaining steps to be completed as part of the NEPA process.

Pre-Study Public Involvement

Even before the formal outset of the present feasibility study, the results of Phase I of the sponsor’s Leon Creek Watershed Master Plan (LCWMP) and initial plans for the feasibility study were aired in a public forum held on March 7, 2009 at Government Canyon State Natural Area. The meeting was a monthly meeting held between SARA and USACE; but for this particular meeting, representatives of TPWD, USFWS, and Friends of Government Canyon (FOGC – a citizens' environmental group) were also invited and in attendance. The focus of this meeting was to share information about the Regional Storm Water Detention Facilities (RSWFs) identified in the LCWMP Phase I report, which identified Government Canyon as potential site for such a facility. A flood detention facility in this location could provide significant FRM benefits downstream, and possible aquifer recharge benefits. These potential benefits would risk environmental consequences, however. Government Canyon, home to several endangered species and site of critical habitat for these species, has been set aside as a State Natural Area. There is also likelihood that there are significant cultural resources in Government Canyon. The primary objective of this meeting was therefore to ensure that interested parties were informed that the feasibility study would weigh the possibility of a Governmental Canyon FRM alternative, at least preliminarily.

Public Scoping Meetings

For initiation of the Leon Creek Watershed IFS, three Public Scoping meetings were held to ensure that as many interested citizens as possible would be able to attend. Each of these meetings featured presentations by USACE, SARA, and city of San Antonio. Meeting 1 was on May 26, 2009 at Helotes Elementary School; Meeting 2 was on June 2, 2009 at Leon Springs Elementary School. A total of approximately 70 local citizens attended these two meetings. A third meeting, also well attended, was held on July 1, 2009 at the Woodlawn Theatre, where a large number of members of the FOGC organization appeared and spoke out against any alternative that would negatively affect Government Canyon.

During the Scoping meetings, the results of the Phase I of the LCWMP and plans for the feasibility study were again reviewed for the public. Though various concerns were brought up by citizens in attendance, the primary concern voiced was: Why is money being spent studying flooding problems, while additional construction in floodplains is being allowed?

Mid-Study Public Involvement

An additional Public Meeting was held on June 8, 2011 at the SARA main office in San Antonio. The purpose of this meeting was to inform the public of study progress to date by reviewing goals and objectives of the study, methodology, synopsis of projects with Federal interest, and next steps. Presentations were made by SARA, USACE, and Halff Associates. Like some of the previous meetings, opposition to a Government Canyon FRM alternative was expected, so an additional agenda item was discussion of this possibility. USACE's presentation stated that, due to potential environmental and cultural impacts and likely mitigation costs, the Federal government would not pursue an FRM alternative in Government Canyon as part of the present study. On the other hand, the sponsor indicated that they will continue to evaluate Government Canyon as a potential RSWF site, despite the Federal position.

Public Review Period

A copy of the draft report and integrated environmental assessment, along with a copy of the Notice of Availability (NOA) will be mailed to the following resource agencies for review and comment in accordance with requirements as set forth by NEPA: Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, Environmental Protection Agency (Region 6), the Texas Historical Commission, and the Texas Commission on Environmental Quality as well as appropriate Indian tribes. In addition, a Notice of Availability was mailed to large group of local citizens and stakeholders who have indicated an interest in receiving and reviewing the document. The public comment was extended by 15 days. No comments were received. Agency Coordination Letters and the NOA are included in Appendix C.

ENVIRONMENTAL OPERATING PRINCIPLES

The Corps' seven Environmental Operating Principles encourage Corps of Engineers employees to consider the environment in everything they do. They set the direction for the Corps to achieve greater synergy between sustainability and execution of its projects and programs. Within the Civil Works planning arena, the Environmental Operating Principles guide the identification, evaluation, and selection of plan components to encourage implementation of productive and sustainable projects. The Recommended Plan for the Leon Creek watershed embodies this approach and philosophy. Each principle is discussed in more detail below.

- **Foster Sustainability as a way of life throughout the organization**

The Recommended plan includes a buyout component that removes susceptible properties from the floodplain and allows for development of open space and a more natural environment in an area that currently houses residential development. Sustainability principles will also be incorporated into the construction and demolition contracts of project features to minimize emissions, control runoff, and take advantage of recycling opportunities for construction debris.

- **Proactively consider environmental consequences of all Corps activities and act accordingly**

The environmental consequences of measures to reduce flood risks in the Leon Creek watershed have been carefully considered during the planning process. Measures within the Government Canyon portion of the watershed were dropped from consideration as a result of resource agency and public feedback indicating the high value of the existing resources. Minor aquatic impacts associated with the AOI-2 channel feature will be fully mitigated.

- **Create mutually supporting economic and environmentally sustainable solutions**

The buyout feature of the Recommended Plan demonstrates mutually supportive economic and environmental solutions, simultaneously reducing flood damages and risks by removing susceptible properties from the floodplain and providing the opportunity to restore a small portion of the floodplain to a more natural condition. Likewise, the mitigation features of the AOI-2 levee demonstrate that economic development and ecosystem functions need not be mutually exclusive.

- **Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments**

As discussed in Sections Four and Five of this report, the Recommended Plan fully complies with legal and policy requirements to consider the impact of Corps of Engineers' projects on the human and natural environment.

- **Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs**

Risk, uncertainty, and residual flood hazards are discussed in detail in Section 3 of this report. The analysis concludes that, notwithstanding the predictive errors and uncertainty inherent in water resources planning, we can be confident that the Recommended Plan is economically justified and consistent with the Federal objective to contribute to national economic development consistent with protecting the Nation's environment. Substantial risks affecting the quality of the human environment will remain after project implementation and will continue to be addressed by the project Sponsor through floodplain regulation, incentives for Low Impact Development, and operation of a regional flood warning system.

- **Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner**

Throughout the Leon Creek Watershed study, the PDT has consulted with resource agencies, local governments, and consultant firms in order to ensure that the best-available information was used in the planning process. Feedback received during the collaboration was utilized extensively in the screening process and in development of the project's mitigation features.

- **Employ an open, transparent process that respects view of individuals and groups interested in Corps activities**

Numerous public meetings and workshops have been held during the study process. Stakeholder groups and homeowners have been invited to participate and provide feedback. During the public meeting held in December 2013 to discuss the Draft Report and study recommendations, the input received was universally supportive of project implementation.

CHIEF OF ENGINEERS CAMPAIGN PLAN

In 2006, the Chief of Engineers released 12 Actions for Change, as set of actions that the Corps of Engineers will focus on to transform its priorities, process and planning. These Actions for Change have been incorporated into the Chief of Engineers' Campaign Plan under the umbrella goal of modernization of the Civil Works process. Four themes of this modernization initiative are discussed below.

- **Effectively Implement a Comprehensive Systems Approach**

The Leon Creek study comprehensively evaluated flood risks throughout the watershed. The formulation framework employed gave preference to measures (e.g. regional detention) that more comprehensively addressed existing flood risks, and moved to site-specific measures only when the preferred measures could not be economically justified. The Recommended Plan represents the most comprehensive plan that could be identified as consistent with the Federal Objective and Corps policy.

- **Risk Informed Decision Making**

At each level of decision making, the PDT considered existing and future risks as well as uncertainty in the plan process. Risk, uncertainty, and residual flood hazards are discussed in detail in Section 3 of this report. The analysis concludes that, notwithstanding the predictive errors and uncertainty inherent in water resources planning, we can be confident that the Recommended Plan is economically justified and consistent with the Federal objective to contribute to national economic development consistent with protecting the Nation's environment.

- **Communication of Risk to the Public**

Substantial risks affecting the quality of the human environment will remain after project implementation. In addition to five public meetings, the PDT has collaborated with resource agencies and the project Sponsor to clearly articulate residual flood risk. This issue will continue to be addressed by the project Sponsor through floodplain regulation, incentives for Low Impact Development, and operation of a regional flood warning system.

- **Professional and Technical Expertise**

Throughout the Leon Creek Watershed study, the PDT has consulted with resource agencies, local governments, and consultant firms in order to ensure that the best-available information was used in the planning process. Feedback received during the collaboration was utilized extensively in the screening process and in development of the project's mitigation features.

CONCLUSIONS

The following conclusions were reached based on the results of the investigations conducted for this study.

1. A significant need exists to provide flood risk management alternatives within the Leon Creek study area.

2. The Recommended Plan offers a solution consisting of structural and nonstructural alternatives with an estimated first cost of approximately $28.175 million, with a Federal cost share of approximately $18.314 million (65 percent) and a non-Federal cost share of approximately $9.861 million (35 percent). The Recommended plan has an annual cost of $1,284,000 and annual net benefits of $859,000.

3. Upon successful completion of the Chief's Report, and subsequent to Federal funds being allocated for the Preconstruction, Engineering and Design phase, the San Antonio River Authority supports continuation of the project with execution of a Design Agreement.

4. Additional evaluation, including Value Engineering, will be conducted during the preconstruction, engineering and design phase. The results of these studies may alter the project materials, design, costs, and cost apportionment or the amount of Federal participation in the project.

DRAFT FINDING OF NO SIGNIFICANT IMPACT

Leon Creek is located in Bexar County, Texas originating in northwestern Bexar County and flowing south to the confluence with the Medina River. At the request of the San Antonio River Authority, and under authority of the Guadalupe and San Antonio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, 11 March 1998, the Fort Worth District Corps of Engineers conducted an interim feasibility study to evaluate potential flood risk management solutions associated with Leon Creek in Bexar County. Study results are presented in an Interim Feasibility Study with Integrated Environmental Assessment (EA).

Structural and nonstructural alternatives were evaluated for consideration including flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels at 35 Areas of Interest (AOI). The recommended plan includes the construction of a 1 percent annual exceedance probability (AEP) at the Jet Engine Test Cell facility in AOI-2. This levee is approximately 3,700 feet in length and 21 feet high near the existing low point at Station 21+50 with approximately 2,850 feet of channel improvements utilizing natural channel design concepts. As described in the mitigation plan, the restoration of the 2,850 linear feet of Leon Creek with natural channel design features and riparian vegetation would mitigate for impacts to the aquatic and riparian habitats. In addition, recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses in a neighborhood located south of Loop 1604 and west of Babcock Road (NS AOI-4) subject to damages from a 4 percent AEP flood event.

The recommended plan would have no effect on federally listed threatened and endangered resources. The channel improvement measure of the recommended plan would impact waters of the United States and is subject to provisions of Section 404 of the Clean Water Act. Because the channel improvements would utilize natural channel design and incorporate the restoration of native riparian vegetation along the channel, the channel improvements would restore the structure and function of the waters of the United States and there would be no adverse impacts to waters of the U.S.

In accordance with 36 CFR Part 800.6(b), should adverse impacts to any cultural or historic resources throughout the project corridor be unavoidable, an appropriate mitigation plan will be sought in consultation with the Texas Historical Commission and other interested parties and agencies, and fully implemented prior to project construction. Cultural resources compliance issues for the project area have been coordinated with the Texas State Historic Preservation Office (SHPO) in accordance with Section 106 of the National Historic Preservation Act.

Based on a review of the information, it is determined that the implementation of the Proposed Action is not a major federal action which would significantly affect the quality of the human environment within the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended. Therefore, the preparation of an Environmental Impact Statement is not required.

______________________________ ________________________

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Date

RECOMMENDATIONS

I recommend that the Recommended Plan for the Leon Creek study area be authorized for construction. This recommendation is made with the provision that prior to project implementation; the non-Federal sponsors shall enter into a binding Project Partnership Agreement (PPA) with the Secretary of the Army to perform the items of local cooperation, as specified under “Project Partnership Agreement and Items of Non-Federal Responsibility section.”

Leon Creek is an important drainage system on the western side of San Antonio in Bexar County, Texas with an estimated 4,360 structures located in the 0.2 percent annual exceedance probability event and annual flood damages estimated at $13,834,000 annually in FY14 dollars. The Recommended Plan provides for construction of a 3,700-foot levee designed to protect against the 1 percent AEP event for the Jet Engine Test Cell located in Area of Interest-2, near the downstream end of the watershed. This feature also includes 2,850 linear feet of channel improvements immediately downstream of the levee to mitigate for slight rises in water surface elevations caused by the levee. The channel work will utilize natural design parameters, including in-channel habitat components, in order to be self-mitigating in terms of aquatic impacts. Approximately 15.75 of riparian vegetation will be installed in conjunction with the natural channel design. The costs for this feature is $297,000. The Recommended Plan also includes the permanent evacuation of 4 single-family homes and 32 townhomes located within the 4 percent AEP floodplain. The project cost for the structural component of the Recommended Plan is estimated at $22,303,000 and reduces annual damages by $1,763,000. Project costs for the nonstructural component of the Recommended Plan are estimated at $5,509,000 and reduce annual damages by $380,000. Total project cost is $28,175,000 and provides total annual net benefits of $739,000 for the structural component and $129,000 for the nonstructural component for a total of $859,000 and a benefit-to-cost ratio of 1.7-to-1. The San Antonio River Authority is identified as the non-Federal sponsor for implementation of the recommended plan. Federal participation in the project is estimated at $18,314,000 or 65 percent of the total project cost. Non-Federal participation in the project is estimated at $9,861,000 or 35 percent of the total project cost.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgetary priorities inherent to the formulation of a National Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded the opportunity to comment further.

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Charles H. Klinge, Jr.

Colonel, Corps of Engineers

District Engineer

REPORT PREPARERS

The people who were primarily responsible for contributing to the preparation of this Interim Feasibility Report and Integrated Environmental Impact Statement are listed in Table 6-1. Table 6-2 lists the Agency Technical Review (ATR) team members.

Table 6-1. List of Preparers

Name	Discipline / Expertise	Experience	Role In Document
Nancy Parrish	Archeologist	10 years, Corps of Engineers	Cultural Resources
Nova Robbins	Project Manager	7 years, Corps of Engineers	Project Management
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Danny Allen	Environmental Resource Specialist	3 years, Corps of Engineers	EA Preparation, Environmental Analysis
Jodie Foster	Plan Formulation	11 years, Corps of Engineers	Plan Formulation, Report Preparation
Efren Martinez	Civil Engineer	30 years, Corps of Engineers	Civil Engineering
Craig Loftin	Hydraulic Engineer	33 years, Corps of Engineers	H&H Analysis
Lucas Daniels	GIS Specialist	5 years, Corps of Engineers	GIS Support
Jennifer Holland	GIS Specialist	6 years, Corps of Engineers	GIS Support
Marcia Hackett	Environmental Resources Specialist	15 years, Corps of Engineers	Environmental Analysis
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Table 6-2. List of Agency Technical Review Team Members

Name	Discipline	District
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Robert Browning	Economics/Risk	Albuquerque
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Jeff Hanson	Cost Estimating	St. Paul
Charles Bishop	Geotechnical	Rock Island
Andrew Richter	H&H Analysis	St. Louis
Michael Henry	HTRW	St. Louis
Darren Mulford	Civil Engineering	St. Louis

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SOCIO-ECONOMIC APPENDIX

INTRODUCTION

This appendix provides socioeconomic and flood risk management analysis in support of the feasibility study for the Leon Creek Watershed in Bexar County, Texas.

Purpose

The purpose of the socioeconomic analysis is to describe the socioeconomic characteristics of the study area under both without-project (existing and future conditions) and with-project (alternatives) conditions, and to identify those characteristics that can have an impact on plan formulation, evaluation, and selection of a recommended plan. Socioeconomic characteristics include but are not limited to population, demographics, per capita income, employment, land use, economic activity and development, and public safety and welfare. The socioeconomic analysis is used as part of the flood damage and cost reduction analysis, environmental impact analysis, social justice, and recreation analysis.

The purpose of the flood damage and cost analysis is to quantify expected flood damages and costs that occur under without-project (existing and future) conditions and with-project conditions (alternatives formulated to reduce expected flood damages and costs). The without-project damages and costs are compared to the residual damages and costs expected to occur under with-project conditions (alternatives), the difference being the economic (monetary) benefit attributable to the alternative.

Study Area

The project study area is defined as the Leon Creek Watershed including its tributaries located in northwestern Bexar County, Texas. The watershed extends from the northwestern boundary of the county to the creek’s confluence with the Medina River southwest of San Antonio. The watershed’s total drainage area consists of approximately 238 square miles. In addition to the mainstem of Leon Creek, the watershed includes several major tributaries including Babcock Creek, Helotes Creek, Huesta Creek, French Creek, Culebra Creek, Chimenea Creek, Los Reyes Creek, Ranch Creek, Huebner Creek, Slick Ranch Creek, Westwood Village Creek, Indian Creek, Government Canyon Creek, Wildcat Canyon Creek, Pecan Creek, Comanche Creek, and their tributaries. The watershed also defines the hydrological study area for this project.

For socioeconomic analysis, the study area is defined as Bexar County, and where data is available, the census block groups contained by the 500-year floodplains of the streams. In addition to unincorporated parts of the county, this study area includes all or portions of San Antonio, Leon Valley, Grey Forest, and Helotes.

For flood damage analysis, the study area is defined as the 500-year floodplain around Leon Creek and its tributaries. On the next page, Figure A-1 shows the watershed and 500-year floodplain.

STUDY AREA DEMOGRAPHICS

The socioeconomic characteristics of the study area are important to understand in the process of alternative formulation and making choices among the alternatives. This section provides a narrative of the socioeconomic makeup of the study area and surrounding county.

Population

According to the Bureau of the Census, the population of Bexar County in 2010 was 1,392,931, which represented growth of 23 percent from 2000. In the study area, the 2010 population was 340,133, an increase of 43 percent from 2000. In 2000, the study area's population accounted for approximately 20 percent of total population for Bexar County. Table A-1 compares population characteristics of the study area and Bexar County.

Table A-1. County and Study Area Population by Sex and Race or Hispanic Origin

	Bexar County				Study Area			
	2000		2010		2000		2010	
Population	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	1,392,931		1,714,773		238,448		340,133	
Male	677,541	48.6	840,840	49.0	117,379	49.2	167,959	49.4
Female	715,390	51.4	873,933	51.0	121,069	50.8	172,174	50.6
White	959,122	68.9	1,250,252	72.9	164,477	69.0	252,324	74.2
Black	100,025	7.2	128,892	7.5	14,397	6.0	19,903	5.9
Asian, Hawaiian, Pacific Islander	23,889	1.7	44,089	2.6	5,866	2.5	12,107	3.6
Other	247,979	17.8	217,389	12.7	42,100	17.7	40,270	11.8
American Indian	11,193	0.8	14,475	0.8	1,726	.7	2,451	0.7
Two or More Races	50,723	3.6	59,676	3.5	9,883	4.1	12,455	3.7
Hispanic Origin	757,033	54.3	1,006,958	58.7	122,503	51.4	194,188	57.1

In terms of race and ethnicity, the study area's 2010 composition was similar to the overall county population. In both geographies, the largest race component was the White population, with 72.9 percent of the county's population and 74.2 percent of the study. The second largest component was Some Other Race, with 12.7 percent of the county's population and 11.8 percent of the study area population. About 59 percent of the county's population identified themselves as of Hispanic Origin, and in the study area, 57 percent.

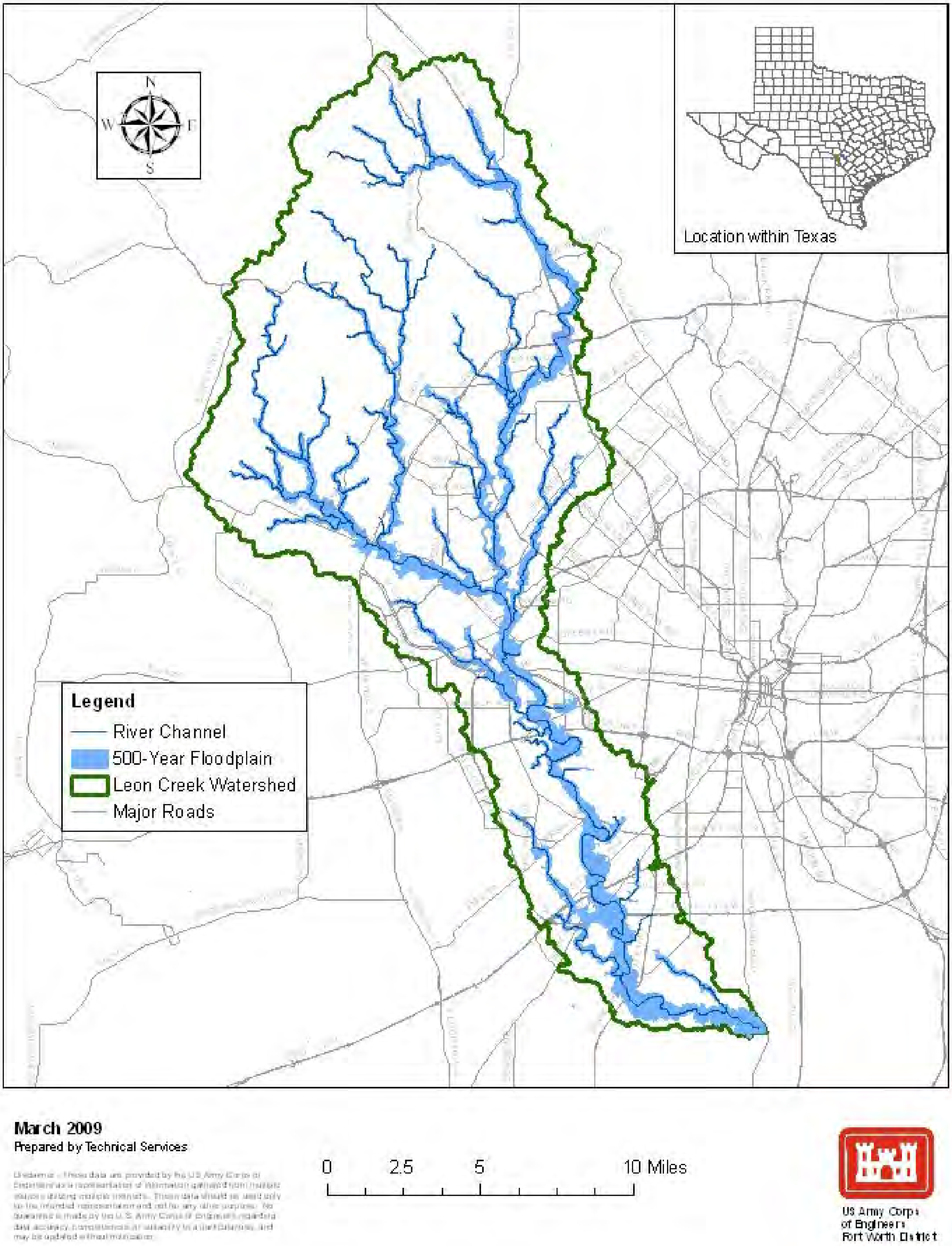


Figure A-1. Leon Creek Watershed

Although projections are not available for the study area, we can get an idea of the potential growth by examining the state and county population projections. As urbanization continues to occur outward from San Antonio, much of the growth will be in areas within the Leon Creek Watershed.

Figure A-2 shows the projected percent population growth for Texas and Bexar County for 2015 through 2050, as calculated from year 2010 population figures. Over this 40-year period, the state's population is expected grow by 64 percent, while the county's growth over the same period is projected to be about 57 percent.

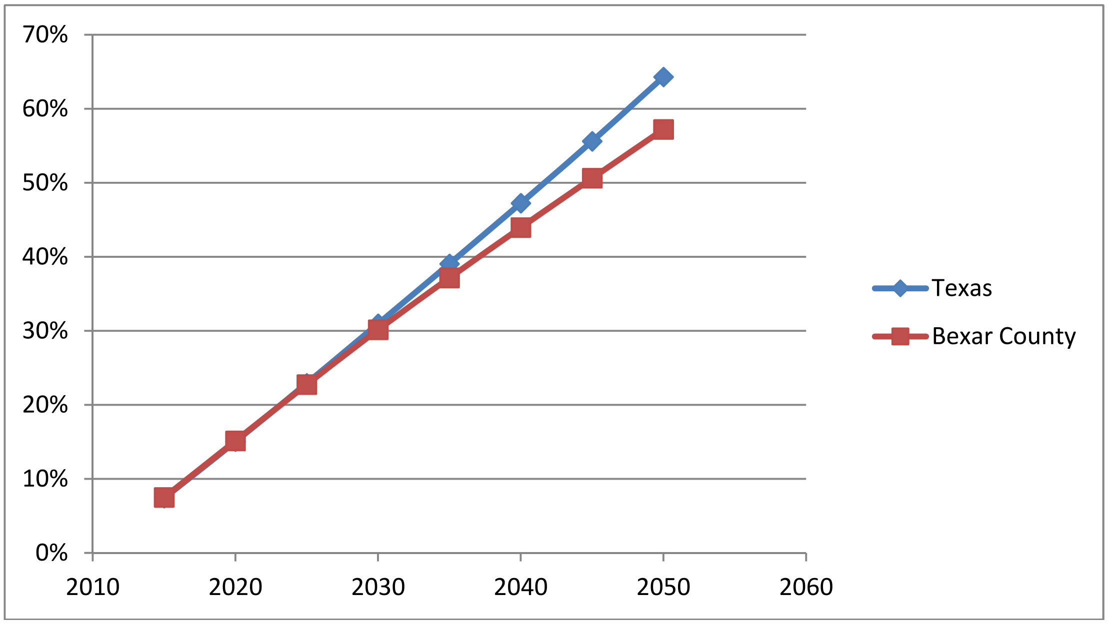


Figure A-2. Population Growth from 2015 to 2050

Source: U.S. Department of Commerce, Bureau of the Census

Housing

Table A-2 provides housing characteristics from the 2010 Census for the county and study area.

Table A-2. County and Study Area Housing Statistics

Housing Characteristic	Bexar County	Study Area
Total Units	662,872	119,723
Occupied Units	608,931	113,171
Vacant Units	53,941	6,552
Owner Occupied	368,638	75,843
Renter Occupied	240,293	37,328
Owner Occupied (Percent of Total Occupied)	60.5%	67.0%
Renter Occupied (Percent of Total Occupied)	39.5%	33.0%
Vacancy Rate	8.1%	5.4%

Source: U.S. Department of Commerce, Bureau of the Census

- In Bexar County, there were 662,872 housing units. In the study area, there were 119,723 housing units, 18 percent of the county's total.
- In the county, 8.1 percent of the units were vacant compared to 5.4 percent in the study area.
- Of the occupied units, 60.5 percent were owner-occupied in the county, while 67.0 percent were such in the study area.

Education

Figure A-3 shows the education attainment in the population ages 25 years and older, based on the 2000 Census for the county and study area. Current (2010 Census) values were not available for the study area, therefore 2000 data was used.

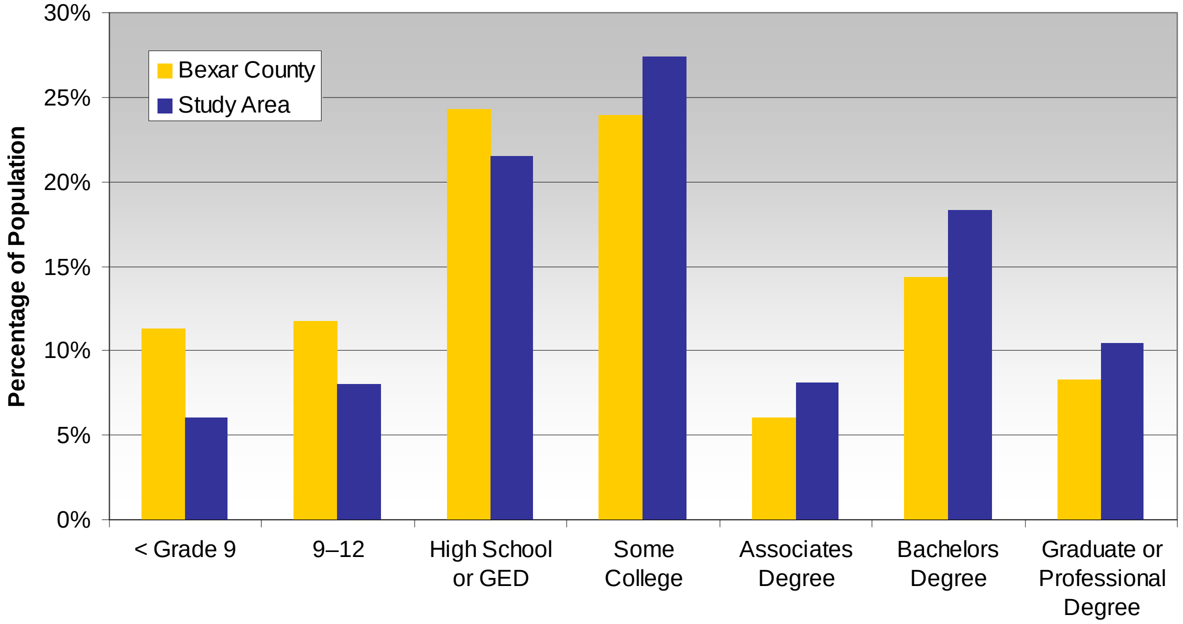


Figure A-3. Education Attainment, Bexar County and Study Area

Source: U.S. Department of Commerce, Bureau of the Census

In percentage terms, the study area showed a higher level of education attainment than the county overall. Among the county's population, 24 percent of the population's highest attainment was a high school diploma or GED; 23 percent of the population had less than a high school diploma or GED; and 53 percent had some education beyond the high school level, with 29 percent having some level of college degree. Comparatively, in the study area, only 14 percent had less than a high school degree or GED; 22 percent had only a high school degree or GED; and 64 percent had education beyond high school with 37 percent receiving some level of college degree.

Employment

Although more current data is not available at the study area level, Table A-3 provides 2012 labor force characteristics for Texas, Bexar County, and San Antonio.

Table A-3. 2012 Labor Force

Labor Force Characteristic	Texas	Bexar County	San Antonio
Total	12,597,465	815,285	628,882
Employed	11,742,600	731,612	588,290
Unemployed	854,865	53,673	40,592
Unemployment Rate	6.8%	6.6%	6.5%

Source: Texas Workforce Commission

In 2012, the county labor force was 815,285. The labor force in San Antonio was 628,882, which accounts for 77.1 percent of the total county labor force. Unemployment rates were similar in the county and city, at 6.6 and 6.5 percent, respectively. These rates were slightly lower than the state's unemployment rate of 6.8 percent.

Table **A-4** presents civilian employment by North American Industry Classification System (NAICS) sector for the county and study area from the 2005-2009 American Community Survey.

Table A-4. 2005-2009 ACS Civilian Employment by NAICS Sector

	Bexar County		Study Area	
Sector	Number	Percent	Number	Percent
Total	700,217	100.0	140,265	100.0
Agricultural, Forestry, Fishing, and Hunting	2,172	0.3	335	0.2
Mining	2,087	0.3	362	0.3
Construction	58,120	8.3	9,572	6.8
Manufacturing	42,702	6.1	7,703	5.5
Wholesale Trade	23,064	3.3	3,741	2.7
Retail Trade	83,274	11.9	16,067	11.5
Transportation and Warehousing	27,004	3.9	4,162	3.0
Utilities	5,869	0.8	1,010	0.7
Information	18,070	2.6	3,948	2.8
Finance and Insurance	51,620	7.4	14,876	10.6
Real Estate, Rental and Leasing	16,197	2.3	2,398	1.7
Professional, Scientific Services	40,115	5.7	8,204	5.8
Management of Companies and Enterprises	703	0.1	150	0.1
Administrative, Support, Waste Management, and Remediation Services	33,700	4.8	5,829	4.2
Educational Services	65,710	9.4	14,293	10.2
Health Care and Social Assistance	87,878	12.6	19,052	13.6
Arts, Entertainment, and Recreation	10,274	1.5	2,425	1.7
Accommodation and Food Services	59,311	8.5	11,182	8
Other Services (except Public Administration)	35,820	5.1	6,236	4.4
Public Administration	36,527	5.2	8,722	6.2

Source: U.S. Department of Commerce, Bureau of the Census

Comparison of the percent of total employment for each sector shows that the study area's employment composition was almost identical to the county overall. The largest sectors for employment are health care and social assistance, retail trade, and educational services and finance and insurance. This indicates that the area's economy was service-sector driven.

Table A-5 provides establishment data from the 2012 ESRI Community Analyst for Bexar County and the study area. Consistent with the employment data, the number of establishments was highest in the service-producing sectors for both the county and study area. The largest sector was retail services followed by health care and social assistance.

Table A-5. 2012 Establishments by NAICS Sector

	Bexar County		Study Area	
Sector	Number	Percent	Number	Percent
Total Establishments	87,347	100.0	13,851	100.0
Agricultural, Forestry, Fishing	808	0.9	116	0.8
Mining	229	0.3	10	0.1
Utilities	64	0.1	10	0.1
Construction	7,294	8.4	1,274	9.2
Manufacturing	2,663	3.0	413	3.0
Wholesale Trade	3,851	4.4	599	4.3
Retail Trade	10,446	12.0	1,722	12.4
Transportation and Warehousing	2,076	2.4	346	2.5
Information	1,617	1.9	274	2.0
Finance and Insurance	3,800	4.4	485	3.5
Real Estate	3,832	4.4	603	4.4
Professional, Scientific Services	11,467	13.1	1,705	12.3
Management of Companies and Enterprises	246	0.3	42	0.3
Administrative, Support, Waste Management, and Remediation Services	15,769	18.1	2,852	20.6
Educational Services	1,492	1.7	259	1.9
Health Care and Social Assistance	6,366	7.3	827	6.0
Arts, Entertainment, and Recreation	1,553	1.8	265	1.9
Accommodation and Food Services	4,410	5.0	623	4.5
Other Services (except Public Administration)	8,704	10.0	1,335	9.6
Public Administration	660	0.8	101	0.7

Source: ESRI Community Analyst

Income

Per capita income for Bexar County in 2012 was $23,024. The study area had a slightly higher per capita income at $23,636.

Table A-6 compares the study area's median household income to that of the county. The study area shows a higher median household income of $53,413 relative to the county's median household income of $44,718.

Table A-6. 2012 Household Income

Household Characteristic	Bexar County	Study Area
Total Households	608,931	113,171
Median Income	44,718	53,413

Source: U.S. Department of Commerce, Bureau of the Census

Table A-7 displays the poverty characteristics of the Bexar County population, based on 2005-2009 American Household Survey data. In the study area, 12.6 percent of the population was below the poverty level, which is lower than in the county, where 16.0 percent of the population was below the poverty level over the 2005-2009 period.

Table A-7. Poverty Status

Population Characteristic	Bexar County	Study Area
Total Households	540,332	98,730
Total Above Poverty Level	453,675	86,300
Total Below Poverty Level	86,657	12,430
Percent Above Poverty Level	84.0%	87.4%
Percent Below Poverty Level	16.0%	12.6%

Source: U.S. Department of Commerce, Bureau of the Census

Environmental Justice

In accordance with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," data was compiled to help assess the potential impacts to minority and low-income populations within the study area. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. To meet this goal, the population's racial and ethnic makeup and incomes will be looked up for the project areas and compared to the county level data to see if there is a significantly larger minority or low income areas that may need additional attention. If such areas are found, outreach was offered through public meetings to ensure these populations are well informed of any proposed project.

On the following pages, Tables A-8 and A-9 examine the study area population and income, respectively, at the most detailed levels possible.

Table A-8. Distribution of Population by Race/Ethnicity per Census Block Group

Census Block Group	Total Population	Race / Ethnicity (percent)					
		White	Hispanic	Black	American Indian	Asian and Pacific Islander	Other
151900.2	1,227	13.0	86.3	0.0	0.7	0.0	0.0
152000.1	715	14.0	79.3	2.2	0.0	3.1	1.4
152100.2	1,972	15.8	81.4	0.0	0.9	0.0	1.9
160900.7	1,565	2.9	93.4	1.2	0.0	2.5	0.0
161000.1	1,432	8.3	91.7	0.0	0.0	0.0	0.0
161000.3	527	11.2	88.8	0.0	0.0	0.0	0.0
161100.2	1,137	1.7	98.3	0.0	0.0	0.0	0.0
161100.3	1,698	0.5	99.1	0.0	0.0	0.5	0.0
161100.5	1,737	3.7	95.7	0.0	0.0	0.0	0.6
161100.6	849	0.0	94.1	0.0	0.0	5.9	0.0
161200.1	984	6.6	89.3	0.9	1.2	0.0	1.9
161200.2	1,008	30.3	69.7	0.0	0.0	0.0	0.0
161301.1	184	29.9	70.1	0.0	0.0	0.0	0.0
161301.3	3,497	4.9	90.4	4.4	0.0	0.0	0.3
161301.4	2,414	4.2	89.9	3.5	0.0	0.0	2.4
161301.5	2,451	5.4	89.0	0.7	1.3	1.5	2.1
161302.1	4,458	9.2	84.7	2.8	0.0	0.9	2.5
161401.1	7,511	59.0	14.1	18.3	0.6	4.2	3.8
161402.1	1,939	57.0	17.8	19.0	0.1	2.0	4.1
161501.3	1,070	33.3	47.4	14.2	0.0	5.1	0.0
161501.4	1,235	6.5	85.2	7.1	0.0	0.4	0.8
161502.1	1,097	14.9	83.1	1.2	0.0	0.0	0.7
161502.2	2,403	12.7	79.9	7.5	0.0	0.0	0.0
161502.5	1,154	27.9	65.1	7.0	0.0	0.0	0.0
161600.1	1,349	26.3	63.6	7.4	0.0	0.0	2.7
161600.3	0	0	0	0	0	0	0
171600.1	1,235	0.6	84.9	14.4	0.0	0.0	0.0
171600.2	1,840	4.3	93.3	1.3	0.0	1.1	0.0
171600.3	1,002	1.5	98.5	0.0	0.0	0.0	0.0
171600.4	1,974	4.2	90.4	3.5	0.0	1.9	0.0
171700.1	1,978	8.0	84.4	7.2	0.0	0.4	0.0
171700.2	1,306	21.6	73.7	0.9	0.0	3.8	0.0
171700.3	1,017	14.2	77.7	4.0	0.0	0.0	4.1
171700.4	1,033	24.4	60.7	10.8	0.0	0.0	4.1
171700.6	909	18.6	56.0	14.6	0.0	9.8	1.0
171700.7	0	0	0	0	0	0	0
171801.3	1,421	21.0	69.5	6.3	0.0	0.0	3.2
171802.3	1,474	10.5	83.7	3.4	0.0	1.4	0.9
171902.1	2,861	33.9	45.7	13.1	0.0	2.2	5.0
171906.1	4,292	40.2	42.7	11.6	0.3	3.0	2.3
171911.1	2,577	35.9	47.1	6.8	0.0	8.5	1.6
171911.4	6,950	26.4	52.7	15.0	0.3	2.1	3.4

		Race / Ethnicity (percent)					
Census Block Group	Total Population	White	Hispanic	Black	American Indian	Asian and Pacific Islander	Other
171912.1	3,993	25.2	57.4	9.8	0.1	4.9	2.6
172001.1	8,788	54.0	34.4	6.3	0.4	3.4	1.5
181401.3	2,518	47.5	38.6	5.9	0.0	4.8	3.2
181401.4	938	61.9	28.5	8.7	0.0	0.0	0.9
181503.1	4,552	51.9	37.9	4.7	0.0	3.3	2.2
181505.1	1,102	44.4	52.2	0.0	0.0	1.9	1.5
181506.1	687	54.3	35.4	6.1	0.0	2.6	1.6
181506.2	1,305	59.8	32.6	2.1	0.0	4.3	1.1
181602.1	816	30.0	62.3	5.0	0.0	2.7	0.0
181701.1	1,722	52.9	37.9	4.4	0.0	2.9	1.9
181701.2	100	51.0	44.0	0.0	0.0	5.0	0.0
181703.1	2,001	67.6	24.2	2.6	0.0	5.5	0.0
181703.2	1,322	55.4	38.8	5.3	0.0	0.5	0.0
181704.1	809	52.4	45.9	1.7	0.0	0.0	0.0
181704.2	1,601	49.0	42.6	2.4	0.0	2.8	3.1
181704.3	1,862	32.2	54.4	3.2	0.0	4.4	5.8
181704.4	963	12.4	82.1	0.0	0.0	0.7	4.8
181705.1	1,288	41.8	41.5	11.0	0.0	5.1	0.6
181705.2	350	67.4	32.6	0.0	0.0	0.0	0.0
181705.3	555	28.1	58.0	9.7	0.0	4.1	0.0
181706.1	1,832	30.3	56.9	7.9	0.0	1.4	3.5
181706.2	2,037	29.0	59.9	8.2	0.6	2.3	0.0
181706.3	2,242	28.2	50.3	11.5	0.0	5.8	4.2
181711.1	4,737	43.9	41.1	8.3	0.2	5.3	1.2
181712.1	1,926	48.2	43.8	3.3	0.0	0.3	4.4
181712.2	1,637	52.0	35.6	6.2	0.0	4.3	1.9
181713.1	1,748	47.8	41.9	10.1	0.0	0.3	0.0
181713.2	1,452	44.0	41.3	4.6	0.0	5.4	4.8
181713.3	2,183	55.2	36.4	2.9	0.5	2.8	2.2
181713.4	1,692	28.7	56.9	12.6	0.0	0.4	1.5
181714.1	6,105	41.2	45.7	8.7	0.1	2.4	1.8
181714.2	1,520	58.0	34.4	6.1	0.0	0.5	1.0
181714.3	3,664	39.2	50.7	5.5	0.0	4.6	0.0
181715.1	5,287	34.2	56.3	4.6	0.8	1.4	2.8
181715.2	1,420	26.9	59.0	9.8	0.0	4.3	0.0
181716.1	7,301	32.0	60.2	4.1	0.0	1.1	2.6
181717.1	2,890	45.1	39.6	11.6	0.7	2.8	0.3
181717.3	3,394	42.9	41.7	10.8	0.0	2.3	2.4
181717.4	1,012	52.2	28.4	6.6	2.3	1.2	9.4
181719.1	5,367	49.1	40.1	6.8	0.0	2.5	1.5
181801.1	1,677	64.2	21.6	1.9	0.0	7.5	4.8
181803.1	1,754	48.0	38.2	4.7	1.1	6.6	1.4
181803.2	3,680	51.2	43.0	2.9	1.7	0.4	0.8
181803.3	1,134	57.0	20.4	0.0	0.0	20.6	2.0
181806.1	1,686	33.2	50.7	7.4	0.0	5.3	3.4

Census Block Group	Total Population	Race / Ethnicity (percent)					
		White	Hispanic	Black	American Indian	Asian and Pacific Islander	Other
181806.2	469	61.8	10.7	17.1	0.0	10.4	0.0
181806.3	2,522	53.3	40.5	2.3	0.0	3.0	0.9
181807.1	6,820	55.1	33.7	3.4	1.1	4.2	2.6
181808.1	970	38.9	44.3	6.1	0.7	0.0	10.0
181809.1	1,962	45.8	47.1	4.7	0.0	2.4	0.0
181809.2	1,292	48.1	39.7	7.8	0.0	0.0	4.4
181809.3	1,185	58.7	35.9	2.4	0.0	3.0	0.0
181809.4	1,166	30.1	56.3	3.6	0.0	2.3	7.7
181810.1	2,434	51.1	35.3	3.2	0.9	8.4	1.2
181810.3	953	33.4	50.9	12.9	0.0	2.8	0.0
181810.4	1,748	53.1	37.3	4.0	0.3	5.2	0.0
181811.1	3,480	61.2	33.0	0.3	0.0	3.3	2.2
181812.1	1,639	67.2	26.7	1.8	0.0	3.3	1.0
181812.2	9,922	49.6	37.8	5.0	0.3	4.3	2.9
181900.1	1,139	72.2	20.7	3.6	0.0	3.5	0.0
181900.2	1,164	62.7	29.8	3.3	0.0	4.2	0.0
181900.3	2,556	57.7	28.8	4.7	0.5	4.7	3.7
182000.1	1,900	76.4	20.2	0.2	0.6	1.2	1.5
182000.2	1,968	64.9	26.6	1.1	0.1	4.7	2.6
182101.1	4,196	89.8	7.7	1.8	0.0	0.0	0.6
182102.1	3,313	83.2	15.1	0.0	1.0	0.0	0.8
182103.1	1,751	76.1	23.2	0.0	0.0	0.7	0.0
182104.1	3,180	72.8	25.3	0.4	0.0	0.6	1.0
191803.1	2,170	67.2	28.8	0.0	0.0	1.6	2.3
191803.2	96	100.0	0.0	0.0	0.0	0.0	0.0

Source: U.S. Department of Commerce, Bureau of the Census

Of the 112 census block groups that intersect the study area, 110 had reported populations.

- Seventy-one of the 110 census block groups had populations that are 50 percent or more minority with regard to race and Hispanic origin. That represents 65 percent of the census block groups with reported population.
- For the study area as a whole, 59.2 percent of the population is minority. Of the 110 census block groups, 53 had total minority populations greater than 59.2 percent.
- In Bexar County, 64.4 percent of the population is minority. Of the 110 census block groups in the study area, 46 had total minority populations greater than 64.4 percent.

To identify areas within the study area where income levels could warrant further actions with regard to environmental justice, the populations below poverty levels from the 2000 Census for census block groups in the 500-year floodplain were compared to the populations of Bexar County.

Table A-9 provides a summary of populations below and above the poverty level for each of the 112 census block groups that intersect the 500-year floodplain, as well as for the city of San Antonio, Bexar County, State of Texas, and United States.

Table A-9. Populations Below and Above Poverty Level by Census Block Group

Bold = Census Block Group with below-poverty-level ratios higher than Bexar County's 15.9 percent

Geographic Area	Total Population from Which Poverty is Determined	Income Below Poverty		Income Above Poverty	
		Population	Percent	Population	Percent
U.S.	273,882,232	33,899,812	12.4	239,982,420	87.6
Texas	20,287,300	3,117,609	15.4	17,169,691	84.6
Bexar County	1,359,271	215,736	15.9	1,143,535	84.1
San Antonio	1,122,736	193,731	17.3	929,005	82.7
480291519002	**1,219**	**437**	**35.8**	782	64.2
480291520001	**535**	**227**	**42.4**	308	57.6
480291521002	1,961	218	11.1	1,743	88.9
480291609007	**1,542**	**495**	**32.1**	1,047	67.9
480291610001	**1,432**	**584**	**40.8**	848	59.2
480291610003	**527**	**95**	**18.0**	432	82.0
480291611002	**1,137**	**287**	**25.2**	850	74.8
480291611003	**1,698**	**371**	**21.8**	1,327	78.2
480291611005	**1,737**	**401**	**23.1**	1,336	76.9
480291611006	**849**	**140**	**16.5**	709	83.5
480291612001	984	43	4.4	941	95.6
480291612002	**1,008**	**357**	**35.4**	651	64.6
480291613011	**184**	**71**	**38.6**	113	61.4
480291613013	**3,473**	**1,482**	**42.7**	1,991	57.3
480291613014	**2,414**	**798**	**33.1**	1,616	66.9
480291613015	**2,444**	**753**	**30.8**	1,691	69.2
480291613021	**4,450**	**1,175**	**26.4**	3,275	73.6
480291614011	994	76	7.6	918	92.4
480291614021	1,408	84	6.0	1,324	94.0
480291615013	1,036	155	15.0	881	85.0
480291615014	**1,235**	**417**	**33.8**	818	66.2
480291615021	**1,097**	**346**	**31.5**	751	68.5
480291615022	**2,401**	**873**	**36.4**	1,528	63.6
480291615025	1,148	65	5.7	1,083	94.3
480291616001	**1,327**	**223**	**16.8**	1,104	83.2
480291616003	0	0	0.0	0	0.0
480291716001	**1,235**	**431**	**34.9**	804	65.1
480291716002	**1,825**	**504**	**27.6**	1,321	72.4
480291716003	**981**	**309**	**31.5**	672	68.5
480291716004	**1,955**	**702**	**35.9**	1,253	64.1
480291717001	**1,978**	**611**	**30.9**	1,367	69.1
480291717002	**1,306**	**294**	**22.5**	1,012	77.5
480291717003	1,013	149	14.7	864	85.3
480291717004	1,033	141	13.6	892	86.4
480291717006	**892**	**234**	**26.2**	658	73.8
480291717007	0	0	0.0	0	0.0
480291718013	**1,421**	**431**	**30.3**	990	69.7

Geographic Area	Total Population from Which Poverty is Determined	Income Below Poverty		Income Above Poverty	
		Population	Percent	Population	Percent
480291718023	**1,474**	**448**	**30.4**	1,026	69.6
480291719021	2,851	272	9.5	2,579	90.5
480291719061	4,274	72	1.7	4,202	98.3
480291719111	2,568	136	5.3	2,432	94.7
480291719114	6,944	384	5.5	6,560	94.5
480291719121	3,968	151	3.8	3,817	96.2
480291720011	8,783	476	5.4	8,307	94.6
480291814013	**2,400**	**382**	**15.9**	2,018	84.1
480291814014	795	119	15.0	676	85.0
480291815031	4,443	552	12.4	3,891	87.6
480291815051	1,102	58	5.3	1,044	94.7
480291815061	687	82	11.9	605	88.1
480291815062	1,305	157	12.0	1,148	88.0
480291816021	**816**	**204**	**25.0**	612	75.0
480291817011	1,656	20	1.2	1,636	98.8
480291817012	100	0	0.0	100	100.0
480291817031	2,001	159	7.9	1,842	92.1
480291817032	1,322	120	9.1	1,202	90.9
480291817041	809	26	3.2	783	96.8
480291817042	1,592	90	5.7	1,502	94.3
480291817043	**1,862**	**306**	**16.4**	1,556	83.6
480291817044	963	131	13.6	832	86.4
480291817051	1,288	52	4.0	1,236	96.0
480291817052	291	0	0.0	291	100.0
480291817053	555	40	7.2	515	92.8
480291817061	1,829	216	11.8	1,613	88.2
480291817062	2,037	263	12.9	1,774	87.1
480291817063	2,242	41	1.8	2,201	98.2
480291817111	4,737	41	0.9	4,696	99.1
480291817121	1,918	0	0.0	1,918	100.0
480291817122	1,523	85	5.6	1,438	94.4
480291817131	1,748	0	0.0	1,748	100.0
480291817132	1,452	39	2.7	1,413	97.3
480291817133	2,158	66	3.1	2,092	96.9
480291817134	**1,685**	**611**	**36.3**	1,074	63.7
480291817141	6,095	113	1.9	5,982	98.1
480291817142	1,520	17	1.1	1,503	98.9
480291817143	3,642	201	5.5	3,441	94.5
480291817151	5,280	406	7.7	4,874	92.3
480291817152	1,420	104	7.3	1,316	92.7
480291817161	7,266	748	10.3	6,518	89.7
480291817171	2,873	94	3.3	2,779	96.7
480291817173	3,394	85	2.5	3,309	97.5
480291817174	1,012	0	0.0	1,012	100.0
480291817191	5,367	78	1.5	5,289	98.5
480291818011	1,677	26	1.6	1,651	98.4
480291818031	1,754	74	4.2	1,680	95.8
480291818032	3,680	452	12.3	3,228	87.7

Geographic Area	Total Population from Which Poverty is Determined	Income Below Poverty		Income Above Poverty	
		Population	Percent	Population	Percent
480291818033	1,134	101	8.9	1,033	91.1
480291818061	**1,223**	**894**	**73.1**	329	26.9
480291818062	469	57	12.2	412	87.8
480291818063	2,522	377	14.9	2,145	85.1
480291818071	6,790	418	6.2	6,372	93.8
480291818081	**970**	**210**	**21.6**	760	78.4
480291818091	1,962	161	8.2	1,801	91.8
480291818092	1,281	175	13.7	1,106	86.3
480291818093	1,185	74	6.2	1,111	93.8
480291818094	1,166	46	3.9	1,120	96.1
480291818101	2,434	38	1.6	2,396	98.4
480291818103	953	18	1.9	935	98.1
480291818104	1,748	192	11.0	1,556	89.0
480291818111	3,466	272	7.8	3,194	92.2
480291818121	1,639	62	3.8	1,577	96.2
480291818122	9,849	438	4.4	9,411	95.6
480291819001	1,122	12	1.1	1,110	98.9
480291819002	1,153	84	7.3	1,069	92.7
480291819003	**2,556**	**661**	**25.9**	1,895	74.1
480291820001	1,900	29	1.5	1,871	98.5
480291820002	1,968	51	2.6	1,917	97.4
480291821011	4,196	39	0.9	4,157	99.1
480291821021	3,313	127	3.8	3,186	96.2
480291821031	1,751	68	3.9	1,683	96.1
480291821041	3,178	57	1.8	3,121	98.2
480291918031	2,170	48	2.2	2,122	97.8
480291918032	96	0	0.0	96	100.0

Source: U.S. Department of Commerce, Bureau of the Census

On the next page, Figure A-3 shows the census block groups with ratios greater than 15.9 percent of population below the poverty level.

- In the U.S. overall, 12.4 percent of the 2000 population recorded was below the poverty level.
- In Texas and Bexar County, the ratios were 15.4 and 15.9 percent, respectively.
- Within the city of San Antonio, 17.3 percent of the population was below the poverty level.

Given that the study area comprises areas both inside and outside the city limits of San Antonio, the value for Bexar County was chosen for comparison to identify which block groups might have income sensitive areas. Of the 112 census block groups, 35 had ratios of population below the poverty level that are greater than the 15.9 percent for Bexar County. This represents 31 percent of the census block groups, but only 7.1 percent of the total population in all of the study area, or 16,764 persons. (These block groups are bold in Table A-12, page A-12.) One block group, 1818.061, had more than half of its population below the poverty level, with 73.1 percent.

After comparing population and income data from the census blocks within the project area, there were no areas where minority populations would be effected in any greater way than the overall populations. However one census block group, 1818,061 was significantly higher with regards to below poverty level incomes, and as such, may require additional actions through public meetings to ensure this sub-population is aware of any impacts of a project should a project take place in that immediate area.

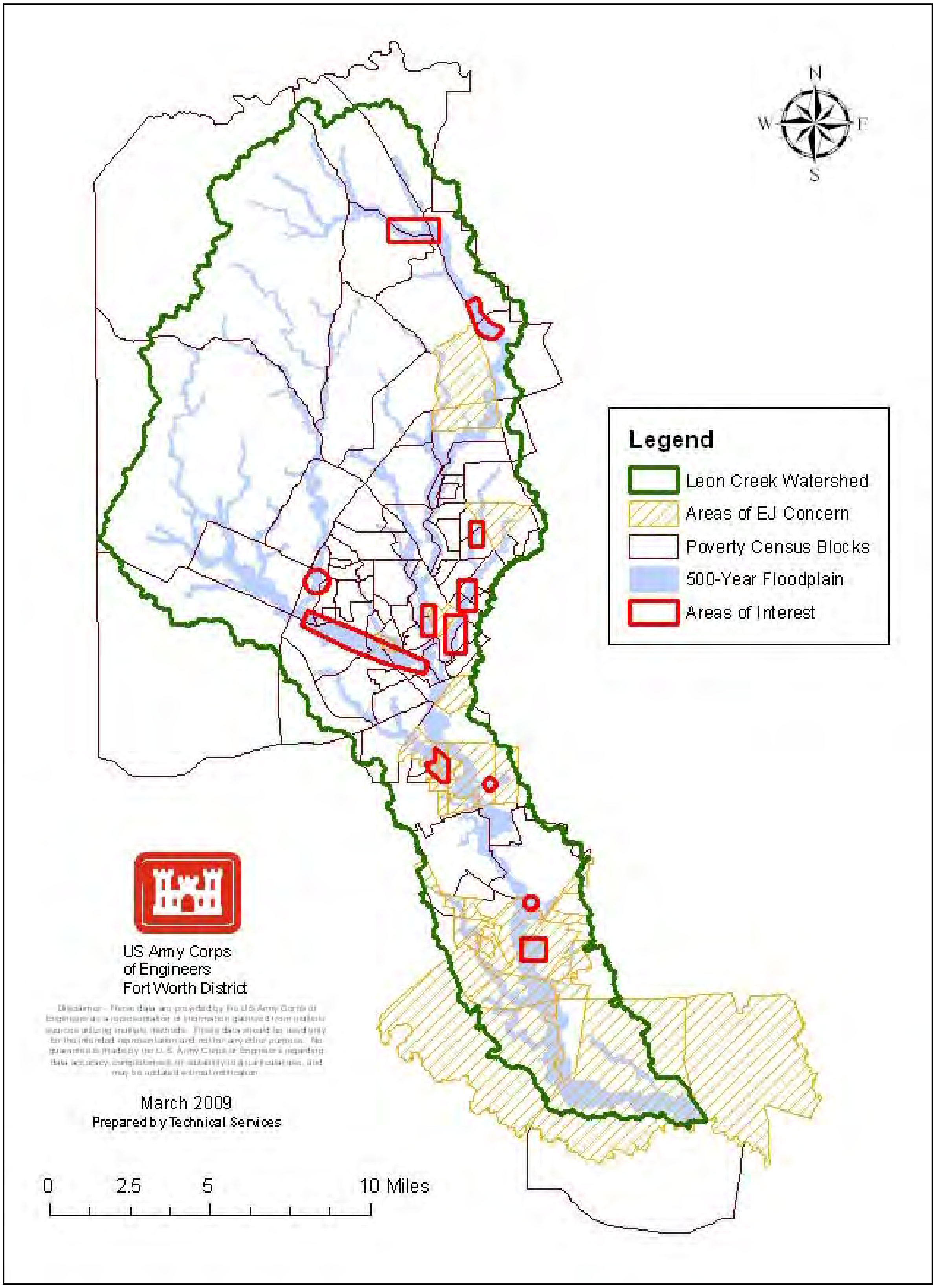


Figure A-3. Areas of Concern for Environmental Justice (EJ)

WITHOUT-PROJECT FLOOD DAMAGES AND COSTS

Overview

Key to alternative formulation is an understanding of the monetary damages caused by flooding and the number and makeup of damaged structures. This section provides the analysis of the number of structures in the floodplain, presents damages to these structures by frequency event under existing conditions, expected annual damages by damage reach, and a preliminary comparison of with- and without-project equivalent annual damages for initial alternatives.

Methodology

The theoretical computation of flood damages is relatively simple. It is based on the depth of flooding for various flood events (exceedance probabilities), and a relationship between the depth of flooding and the estimated damages based on a percentage of the structure and content value or value of privately owned vehicles (POV). The nomenclature used in this appendix to describe the relative risk reflects the actual probability, rather than the average recurrence interval, of flood events. For example, the commonly used term “100-year frequency flood,” meaning that flood which stands a one-percent chance of being equaled or exceeded in any given one-year period, will hereafter be known as the “1-percent annual exceedance probability (AEP) flood.” Damages to the various structures, accumulated by frequency of events, produce a frequency-damage function. Using this frequency-damage data, an integration process calculates estimates of expected annual damages. This involves aggregating the multiplication of the mean damage between each pair of flood events by the difference in exceedance probabilities. This is then repeated for the range of flood events in each damage category.

Hydrologic Engineering Center - Flood Damage Assessment Program

The Hydrologic Engineering Center - Flood Damage Assessment (HEC-FDA) software program is used to compute flood damages under without- and with-project conditions. The program integrates hydrologic, hydraulic, and floodplain characteristics through application of a Monte Carlo simulation method, and computes single event damages and expected annual damages (EAD), while accounting for uncertainty in the values of structures and contents. Damage susceptibility factors used by the program to estimate flood damages include: number and type of structures, structure and content values, elevation where the structure begins to sustain measurable damages, and flood depth-to-percent damage relationship.

Inventory of Floodplain Structures

An inventory of properties lying within the limits of the 0.2% AEP (500-year) floodplain was conducted to determine the number and type of structures, values of structures and contents, and ground and finished floor elevations (elevation where water enters the structure). Structures were initially identified and digitized in GIS using digital orthoquads as base maps. A field survey was then conducted to determine condition and quality of the structures, number of floors, construction materials (roofing and exterior walls) and to identify the first floor elevation. Square footage was acquired from the appraisal district databases. In addition, the survey identified the applicable relationship of flood depth to percent damage for each structure type. Last, the number of POVs susceptible to flood was estimated. The following paragraphs describe each inventory item in detail.

- **Depreciated Structure Value/Replacement Cost**. Structure values were obtained from the Bexar County Appraisal District to use as a base value. To accurately reflect replacement cost less depreciation to the existing structures in compliance with ER-1105-2-101, values for a sample of nine commercial structures were calculated using Marshall and Swift cost estimating software, based on the information collected during a field survey. This sample represents 10 percent of residential and commercial structures in the study area. Characteristics were collected in the field included exterior wall construction, roofing materials, condition and quality. These values along with square footage take from the appraisal information were entered into the Marshall & Swift software along with zip codes to determine the depreciated replace value. A ratio between the Marshall Swift valued sample structures and their appraisal values was then calculated to adjust all structures in the database. Residential structures including multi-family were also adjusted, based on a 10-percent sample of one- and two-story structures. Replacement cost is the cost of physically replacing (reconstructing) the structure. Depreciation accounts for deterioration that occurred prior to flooding and variations in remaining useful life of the structure. Premanufactured homes were classified as mobile residence because of similar construction and finished floor elevations. In the presentation of data that follows, this would make mobile residence values seem higher than the atypical mobile residence.

  Structure values for single- and multi-family residential were adjusted upward by 28.6 percent; commercial properties were adjusted upward by 11.2 percent. This adjustment was also applied to mobile residences. Values per square footage for public structures were based on the applicable estimates produced by Marshall and Swift. Uncertainty distributions associated with estimating the depth to percent damage functions, structure values, content ratios, and first flood stage are used to develop the total aggregated stage-damage uncertainty function by damage categories for each damage reach.

- **Content Value**. Content values for residential structures were not specifically collected. Residential content values are embedded in the depth to percent damage relationship (see “Depth to Percent Damage Relationships”). For non-residential structures, personal business property obtained from the county appraisal district database was used, when available. These values represent values of equipment and inventory. Where personal business property was not available, estimates based on structure value and occupancy type are incorporated into the non-residential depth damage functions used by the Fort Worth District.

- **Ground and First Floor Elevations**. Topographic maps compiled from aerial photography served as base maps to identify flood prone properties and estimate ground elevations. First floor elevations were visually inspected for each structure. For each Monte Carlo simulation, the *first floor stage with uncertainty* is computed from the first floor stage, uncertainty distribution, and uncertainty parameters. The uncertainty parameters are the same units as for the first floor stage. The uncertainty in the first floor stage is modeled using the normal distribution with a standard deviation of 0.5 foot.

- **Depth to Percent Damage Relationships**. Flood depth to percent damage relationships relate the depth of flooding relative to the structure first floor to the dollar amount of flood damages as a percent of the estimated structure value. For residential structure types, these relationships were compiled by the USACE Institute of Water Resources (IWR), based on data collected from flooding events in various parts of the United States between 1996 and 2001. Damage relationships for commercial and public structures also reflect the results of analyses of historical data collected from major flood events across the United States, and were supplemented based on the findings of subsequent economic field surveys of floodplain properties in the Fort Worth District, considering such factors as the design of the structure and nature of the structure contents. As described in EM 1110-2-1619—Risk-Based Analysis for Flood Damage Reduction Studies, there are risks and uncertainties associated to the parameters including valuation, elevation and depth-damage percentages. Uncertainties can rise from analytical errors in assigning these parameters or from the uncertainty of exact values when, for instance, assigning content valuation. To address uncertainties, standard deviations are used in the Monte Carlo simulations, where higher values of standard deviation are used where the uncertainties of the parameters are greater. The uncertainty associated with residential structures and contents is modeled using a normal distribution with a standard deviation of 5 percent. Commercial and public structures are similarly modeled with a standard deviation of 10 percent. These values are the default values used in HEC-FDA and are used in the Forth Worth District flood risk management studies unless a greater uncertainty of the parameter values is determined to exist and a larger standard deviation warranted.

- **Privately Owned Vehicles**. Damages for automobiles were estimated based on the average number of vehicles per residence characteristic of the study area and the probability of their being present at the time of a flood. An analysis was made of registered motor vehicles per occupied housing unit for counties within Metropolitan Statistical Areas (MSA) in Texas, using data from the U.S. Census and the Texas State Department of Highways and Public Transportation. The number of registered vehicles per occupied housing unit in the MSA clusters around a mean value of 2.48. Given that not all registered motor vehicles are associated with private residences and some housing units are unoccupied, an average of 2.0 vehicles per residence is assumed for this analysis. It is anticipated that 1.5 of these would be present during non-work hours (128 hours per week) and 0.5 present during work hours (40 hours per week). Therefore, the expected number of vehicles present at any given time that a flood might occur is derived as follows:

$$((128/168) * 1.5) + ((40/168) * 0.5)$$

or 1.26 vehicles per residence

Values for vehicles associated with single-family homes as well as multi-family and mobile residences were based on the national average price of new and used vehicles as reported by the U.S. Bureau of Transportation Statistics (BTS). Prices for new vehicles are calculated by subtracting CNW Marketing Research vehicle leasing data from Bureau of Economic Analysis data that combines sales and leases. Used car sales data is derived from sales from franchised dealers, independent dealers, and casual sales. The average new and used sales price also includes leased vehicles. The most recent price reported by BTS is $12,774. Under the assumption that a family's purchase of a vehicle is a function of income, this average price can be adjusted down to the Census block level based on Census Bureau data for median family income. From the 2000 U.S. Census, the median household income is $41,994 nationally. Median household income for the census blocks that intersect the study area ranges from $19,069 to $109,424. This translates into valuation for vehicles located at residential structures within the study area of $7,800 to $44,759. The value represents the valuation of 1.26 vehicles at each structure. Therefore, the value of an individual vehicle would range from $6,190 to $35,523.

Hydrology and Hydraulic Characteristics

Flood Profiles and Probability of Flood Events

A range of without-project water surface profiles were developed. They include the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% AEP flood events (or the 2-, 5-, 10-, 25-, 50-, 100-, 250-, and 500-year floods, respectively). The profiles were used to delineate the floodplain (and damage) limits and to determine the relationship of damageable properties to both elevation and frequency of flood occurrence. As mentioned earlier, the computation of flood damages is based on the depth of flooding for various flood events and a relationship between the depth of flooding and the estimated damages based on a percentage of the structure and contents value or vehicle value.

Flood Profile Stationing

This study adopts stations along the stream, denoted as feet above the mouth of the stream. Stationing is attached to structures by assigning the structure to the closest cross-section.

Damage Reaches

The PDT divided the study area into 35 damage reaches, based on the locations of confluences of Leon Creek with its tributaries and of major road crossings. The mainstem of Leon Creek was divided into seven economic damage reaches; Culebra Creek was divided into two reaches; and the remaining 26 tributaries were each defined as a single reach.

For Leon Creek, the reaches are defined as follows:

- Reach 1 - Confluence of Leon Creek with Medina River to downstream of State Highway 16
- Reach 2 - Downstream of State Highway 16 to downstream of the Jet Engine Test Cell Facility located at Kelly USA (formerly Kelly Air Force Base)
- Reach 3 - Downstream of the Test Cell Facility to just upstream of SW Military Drive (During preliminary alternative formulation, this reach was divided to segregate structures protected by a levee alternative. Reach 3L indicates structures behind the levee, reach 3R represents structures not protected by the levee.)

- Reach 4 - Upstream of SW Military Drive to just upstream of confluence with Huebner Creek
- Reach 5 - Upstream of confluence with Huebner Creek to upstream of Babcock Road (During preliminary alternative formulation, this reach was divided so segregate structures protected by a levee alternative. Reach 5L indicates structures behind the levee, reach 5R represents structures not protected by the levee.)
- Reach 6 - Upstream of Babcock Road to upstream of I-10
- Reach 7 - Upstream of I-10 to end of study

For Culebra Creek, the reaches were defined as:

- Reach 1 - Confluence of Culebra Creek with Leon Creek to downstream of Loop 1604
- Reach 2 - Downstream of Loop 1604 to end of study

On page A-22, Figure A-4 provides a geographic representation of the economic reaches.

Value of Floodplain Properties

On page A-23, Table A-10 provides the number, valuation, and structure type for each of the single event categories for each reach in the study area. Valuations for each occupancy category include structure and contents. The table shows that the 0.2% AEP floodplain contains 4,630 structures valued at $1,218,342,000. The structures are composed of 3,757 (81.1%) single-family structures, 56 (1.2%) multi-family residential structures, 193 (4.2%) mobile homes, 513 (11%) commercial structures, and 111 (2.4%) public structures.

For single family residences, a typical structure was of frame construction with brick veneer or hardboard siding and built on slab on grade foundations with no basements. Commercial properties were evenly distributed among concrete block construction and metal frame buildings with metal siding, and typically slab on grade foundations.

Total valuation of single-family residential structures is estimated at $855,377,000 (70.2%); for multi-family residential, the valuation is $75,809,000 (6.2%); for mobile homes, the valuation was $5,049,000 (0.4%); for commercial structures, $261,604,000 (21.5%); and for public structures, valuation is $20,503,000 (1.7%).

In addition to structures in the 0.2% AEP, there are an estimated 4,133 privately owned automobiles with a total valuation of $86,301. See Table A-12 on page A-42.

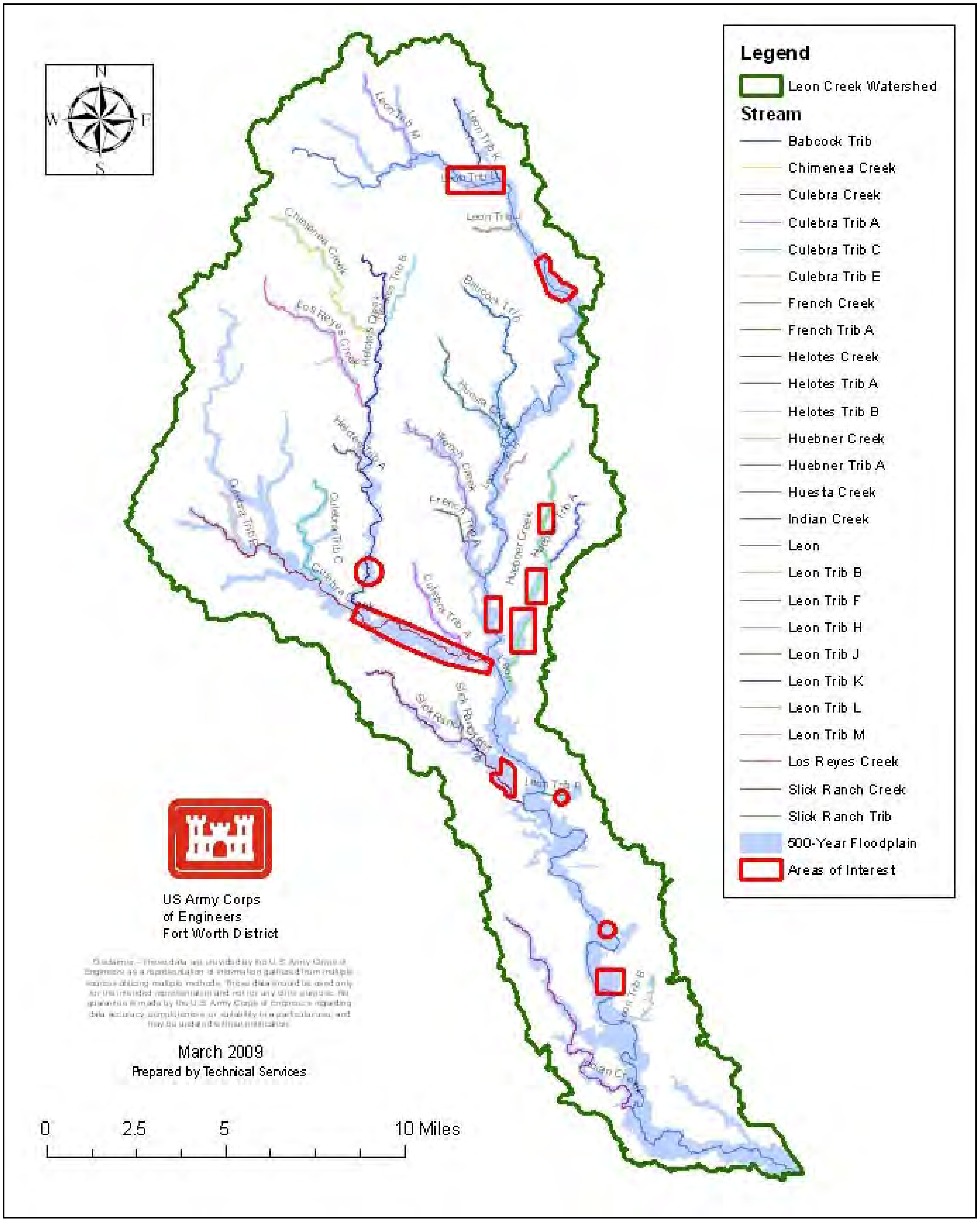


Figure A-4. Leon Creek Economic Reaches

Table A-10. Number and Value of Floodplain Properties (October 2010 Prices - $000)

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Babcock Trib																
Single-Family	0	$ 0	0	$ 0	2	$ 653	4	$ 1,009	7	$ 1,814	8	$ 2,082	11	$ 2,957	11	$2,294
Multi-Family	2	323	7	1,131	7	1,131	7	1,131	7	1,131	7	1,131	7	1,131	7	1,131
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	2	6	6	96	7	106	8	108
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	634
Total	2	323	7	1,131	9	1,784	11	2,140	16	2,951	21	3,309	25	4,194	27	4,167
Chimenea Creek																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	1	459	1	459
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	1	2	1	2	1	2	3	16
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	1	2	1	2	2	461	4	475
Culebra Creek 1																
Single-Family	0	0	0	0	6	1,443	68	16,355	199	51,099	360	93,381	697	174,874	972	239,868
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	1	60	8	649	10	1,028	19	1,766	52	13,499	65	9,190
Public	0	0	0	0	0	0	0	0	0	0	0	0	1	218	2	265
Total	0	0	0	0	7	1,503	76	17,004	209	52,127	379	95,147	750	188,591	1,039	259,323
Culebra Creek 2																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	3	680	27	6,939
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	544
Commercial	0	0	0	0	0	0	3	987	5	1,558	11	2,275	11	2,275	12	5,192
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	3	987	5	1,558	11	2.275	14	2,955	44	12,675

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Culebra Creek Trib A																
Single-Family	0	0	0	0	4	906	11	3,326	19	5,306	32	8,477	57	15,042	74	19,893
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	4	906	11	3,326	19	5,306	32	8,477	57	15,042	74	19,893
Culebra Creek Trib C																
Single-Family	0	0	0	0	1	276	1	276	2	557	4	1,189	6	1,910	8	2,928
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	1	16	1	16	1	16	1	16	1	16	1	16
Commercial	0	0	2	60	3	178	3	178	5	179	7	209	10	816	12	822
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	2	60	5	470	5	470	8	782	12	11,414	17	2,742	21	3,766
Culebra Creek Trib E																
Single-Family	0	0	0	0	0	0	1	547	1	547	2	1,064	2	1,064	5	2,854
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	1	3	1	3	2	468
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	547	1	547	3	1,067	3	1,067	7	3,322
French Creek																
Single-Family	0	0	1	665	3	1,781	6	2,690	8	3,575	15	6,508	39	14,862	78	27,127
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	1	144	1	144	3	758	3	758	4	799	8	11,510	10	11,822
Public	0	0	0	0	0	0	0	0	0	0	0	0	1	894	3	2,627
Total	0	0	2	809	4	1,925	9	3,448	11	4,333	19	7,307	48	27,266	91	41,576

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
French Creek Trib A																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helotes Creek																
Single-Family	0	0	0	0	5	2,126	11	3,991	30	7,585	106	21,814	162	33,127	233	46,580
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	17	1,208	29	2,243	39	3,129	42	34,65	44	4,002	53	4,868
Public	0	0	0	0	0	0	0	0	0	0	4	66	4	66	19	3,875
Total	0	0	0	0	22	3,334	40	6,234	69	10,714	152	25,345	210	37,195	305	55,323
Helotes Creek Trib A																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	131
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	5	606	10	1,248	15	2,266	16	2,271	17	2,315	18	2,332	18	2,332
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	5	606	10	1,248	15	2,266	16	2,271	17	2,315	18	2,332	19	2,463
Helotes Creek Trib B																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	408
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	408

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Huebner Creek																
Single-Family	0	0	2	31	10	1,538	50	10,189	100	19,910	170	35,498	290	63,494	360	79,724
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	2	1,287	10	11,184
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Commercial	0	0	1	24	2	77	3	232	3	232	5	478	6	488	7	503
Public	1	93	2	105	5	171	10	249	13	899	15	2,555	15	2,555	16	2,610
Total	1	93	5	160	63	1,786	63	10,670	116	21,041	343	38,531	313	67,824	393	94,021
Huebner Creek Trib A																
Single-Family	1	118	3	636	7	2,010	10	3,050	11	3,249	12	3,405	13	3,507	19	5,686
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	1	62	1	62	1	62	2	951	6	4,509	7	5,477
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	118	3	636	8	2,072	11	3,112	12	3,311	14	4,356	19	8,016	22	11,163
Huesta Creek																
Single-Family	0	0	1	155	1	155	1	155	1	155	1	155	8	2,708	19	5,686
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	1	12	6	138	6	138	9	176	28	362	25	470
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	155	2	167	7	293	7	293	10	331	26	3,070	44	6,156
Indian Creek																
Single-Family	0	0	1	17	2	34	5	344	14	1,597	46	6,073	102	13,934	133	18,090
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	2	73	12	142	15	223	18	298	18	298	19	314	23	422	24	481
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	73	13	159	27	268	23	642	23	1,895	65	6,387	125	14,356	157	18,571

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Leon Creek 1																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	1	89	1	89
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	3	1,475	9	3,465
Total	0	0	0	0	0	0	0	0	0	0	0	0	4	1,564	10	3,554
Leon Creek 2																
Single-Family	0	0	4	474	21	2,225	32	3,266	33	3,289	33	3,289	34	3,441	36	3,747
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	10	115	78	934	116	2,860	117	2,875	117	2,875	117	2,875	118	2,884
Commercial	0	0	5	60	33	1,341	41	1,411	43	1,533	48	1,967	58	2,.877	61	3,212
Public	0	0	0	0	0	0	0	0	3	15	3	15	3	15	3	15
Total	0	0	19	649	132	4,500	189	7,537	196	7,712	201	8,146	212	9,208	218	9,858
Leon Creek 3L																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	4	12,721	5	37,261	5	37,261	5	37,261,	5	37,261	5	37,261	6	37,434
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	4	12,721	5	37,261	5	37,261	5	37,261	5	37,261	5	37,261	6	37,434
Leon Creek 3R																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	1	21	1	21
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	1	21	1	21

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Leon Creek 4																
Single-Family	0	0	1	1,592	2	1,739	4	1,793	8	2,494	22	5,269	44	8,408	66	11,382
Multi-Family	0	0	0	0	0	0	2	5,025	3	7536	4	10,048	5	12,560	16	24,020
Mobile Home	0	0	0	0	0	0	0	0	0	0	3	22	6	43	6	43
Commercial	0	0	1	32	4	225	16	1,541	23	9,287	29	29,259	36	37,406	43	46,276
Public	1	33	6	755	9	926	19	2,258	21	2,731	21	2,731	21	2,731	23	3,685
Total	1	33	8	2,379	15	2,900	41	10,617	55	22,048	79	47,329	112	61,148	154	85,406
Leon Creek 5L																
Single-Family	0	0	0	0	0	0	0	0	6	1,086	78	12,921	216	36,512	307	52,362
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	6	1,086	78	12,921	216	36,512	307	52,362
Leon Creek 5R																
Single-Family	0	0	0	0	0	0	1	293	13	2,566	66	12,997	241	54,652	727	165,353
Multi-Family	0	0	0	0	0	0	0	0	6	13,605	11	23,494	17	37,457	17	37,457
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	3	390	13	7,869	15	9,091	18	9,409	24	11,246	35	35,387
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
Total	0	0	0	0	3	390	14	7,8,162	34	25,262	95	45,900	282	103,355	782	238,198
Leon Creek 6																
Single-Family	0	0	0	0	0	0	6	1,082	22	6,343	39	11,898	62	19,585	88	28,995
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	5	174	13	421	25	663	36	876
Commercial	0	0	3	28	9	270	48	3,411	62	35,968	75	46,146	85	57,893	97	60,666
Public	0	0	0	0	4	295	13	1,963	16	2,627	20	2,758	26	3,075	28	3,148
Total	0	0	3	28	13	565	83	36,456	105	45,112	147	61,223	198	81,216	249	93,685

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Leon Creek 7																
Single-Family	0	0	0	0	15	5,146	69	26,367	118	45,456	154	61,094	188	75,296	210	82,561
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	1	125	1	125	1	125	1	125
Commercial	0	0	0	0	4	372	7	659	7	659	11	1,643	13	2,014	15	3,094
Public	0	0	0	0	1	11	2	66	2	66	2	66	2	66	2	66
Total	0	0	0	0	20	5,529	78	27,092	128	46,306	168	62,928	204	77,501	228	85,846
Leon Trib B																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib F																
Single-Family	0	0	0	0	0	0	16	2,340	26	3,416	59	6,401	81	7,715	100	9,236
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	1	73	1	73	1	73	1	73	1	73
Total	0	0	0	0	0	0	17	2,413	27	3,489	60	6,474	82	7,788	101	9,309
Leon Trib H																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Leon Trib J																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib K																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	7	3	17	6	35	9	3,056	9	3,056	9	3.056	9	3,056	9	3,056
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	7	3	17	6	35	9	3,056	9	3,056	9	3.056	9	3,056	9	3,056
Leon Trib L																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib M																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Los Reyes Creek																
Single-Family	0	0	0	0	0	0	1	107	3	301	5	768	12	4,565	16	6,414
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	2	336	2	336	3	344	4	442	6	448	10	838	13	1,781
Public	0	0	0	0	0	0	0	0	0	0	0	0	1	40	1	40
Total	0	0	2	336	2	336	4	451	7	743	11	1,216	23	5,443	30	8,235
Ranch Creek																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slick Ranch																
Single-Family	0	0	44	6,213	104	14,874	140	20,030	155	22,295	170	24,472	209	30.144	255	36,859
Multi-Family	0	0	0	0	1	336	4	1,345	5	1,681	6	2,018	6	2,018	6	2,018
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	5	16,131	5	6,131	8	17,304
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	44	6,213	105	15,210	144	21,375	160	23,976	181	42,621	220	48,293	269	56,181
Slick Ranch Trib B																
Single-Family	0	0	1	11	2	65	3	119	3	119	3	119	3	119	3	119
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	1	1,758	1	1,758	1	1,758	1	1,758	1	1,758
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	11	2	65	4	1,877	4	1,877	4	1,877	4	1,877	4	1,877

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Westwood Village																
Single-Family	0	0	0	0	0	0	1	56	4	138	5	245	7	453	10	949
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	2	40	3	337	3	337
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	56	4	138	7	285	10	790	13	1,031
Total Watershed																
Single-Family	1	118	58	9,791	185	34,969	441	97,387	783	182,928	1,390	319,117	2,487	569,050	3,757	855,377
Multi-Family	2	323	7	1,131	8	1,468	13	7,501	21	25,007	28	36,691	37	54,453	56	75,809
Mobile Home	0	0	10	115	80	961	123	3,013	130	3.634	144	3.634	169	4,175	193	5,049
Commercial	3	80	43	14,217	116	44,112	226	94,987	272	159,798	343	159,798	437	210,804	513	261,604
Public	2	125	8	860	19	1,401	43	4,610	56	6,412	66	8,264	78	11,209	111	20,503
Grand Total	**8**	**646**	**126**	**26,114**	**408**	**82,911**	**846**	**207,498**	**1,262**	**326,253**	**1,971**	**527,504**	**3,208**	**849,691**	**4,630**	**1,218,342**

- Babcock Tributary contains 27 total structures with a valuation of $4,167,000. These structures comprise 11 (41%) single-family residential structures, seven (26%) multi-family residential structures, eight (30%) commercial structures, and one (4%) public structure. Single-family structures are valued at $2,294,000 (61%), multi-family structures are valued at $1,131,000 (23%), commercial structures are valued at $108,000 (2%), and public structures are valued at $634,000 (13%).
- In the Chimenea Creek, there are a total of four structures: one single-family residence valued at $459,000 and three commercial structures valued at $16,000.
- For reach 1 of Culebra Creek, there were 1,039 structures with a total valuation of $259,323,000. The mix of structures is 972 (94%) single-family residences valued at $239,868,000 (93%); 65 (6%) commercial structures valued at $19,190,000 (7%); and two (0.2%) public structures valued at $265,000 (0.1%).
- In reach 2 of Culebra Creek, there are 44 structures valued at $12,675,000. The mix of structures is 27 (61%) single-family residences valued at $6,939,000 (55%); 5 (11%) mobile homes valued at $544,000 (4%); and 12 (27%) commercial structures valued at $5,192,000 (41%).
- Culebra Creek Trib A contains 74 structures valued at $19,893,000. All of the structures are single-family residential.
- Culebra Creek Trib C contains 21 structures valued at $3,766,000: eight (38%) are single-family residential valued at $2,928,000 (78%); one (5%) mobile home valued at $16,000 (0.4%); and 12 (57%) commercial structures valued at $822,000 (22%).
- Culebra Creek Trib E contains seven structures valued at $3,322,000. Five (71%) of the structures are single-family residential valued at $2,854,000 (86%). Two (29%) of the structures are commercial valued at $468,000 (14%).
- French Creek contains 91 structures valued at $41,576,000. The mix of structures is: 78 (86%) single-family residential valued at $27,127,000 (65%); 10 (11%) commercial structures valued at $11,822,000 (28%); and three (3%) public structures valued at $2,627,000 (6%).
- Helotes Creek contains 305 structures valued at $55,323,000. The structure mix is 233 (76%) single-family residences valued at $46,580,000 (84%); 53 (17%) commercial structures valued at $4,868,000 (9%); and 19 (6%) public structures valued at $3,875,000 (7%).
- Helotes Creek Trib A contains 19 structures valued at $2,463,000. The mix of structures is one (5%) single-family residential valued at $131,000 (5%), and 18 (95%) commercial structures valued at $2,332,000 (95%).
- Helotes Creek Trib B contains two single-family structures valued at $408,000.
- Huebner Creek contains 393 structures valued at $94,021,000. The mix of structures is: 360 (92%) single-family residences valued at $79,724,000 (85%); 10 (3%) multi-family residential structures valued at $11,184,000 (12%); seven (2%) commercial structures valued at $503,000 (0.5%); and 16 (4%) public structures valued at $2,610,000 (3%).

- Huebner Creek Trib A contains 22 structures valued at $11,163,000. Fifteen (68%) of the structures are single-family residential valued at $5,686,000 (42%); seven (32%) are commercial structures valued at $5,477,000 (58%).
- Huesta Creek contains 44 structures valued at $6,156,000. Nineteen (43%) of the structures are single-family residential valued at $5,686,000 (92%), and 25 (57%) of the structures are mobile homes valued at $470,000 (8%).
- Indian Creek contains 157 structures valued at $18,571,000. The mix of structures is: 133 (85%) single-family residential valued at $18,090,000 (97%); and 24 (15%) commercial structures valued at $481,000 (3%).
- Leon Creek 1 contains 10 structures valued at $3,554,000. One (10%) of the structures is a mobile home valued at $89,000 (3%), and nine (90%) are public structures valued at $3,465,000 (97%).
- Leon Creek 2 contains 218 structures valued at $9,858,000. The mix of structures is: 36 (17%) single-family residential valued at $3,747,000 (38%); 119 (54%) mobile homes valued at $2,884,000 (29%); 61 (28%) commercial structures valued at $3,212,000 (33%); three (1%) public structures valued at $15,000 (0.1%).
- Leon Creek 3 Left contains six commercial structures valued at $37,434,000.
- Leon Creek 3 Right contains one public structure valued at $21,000.
- Leon Creek 4 contains 154 structures valued at $85,406,000. The mix of structures is: 66 (43%) single-family residential valued at $11,382,000 (13%); 16 (10%) multi-family residential structures valued at $24,020,000 (28); six (4%) mobile homes valued at $43,000 (0.1%); 43 (28% commercial structures valued at $46,276,000 (54%); 23 (15%) public structures valued at $3,685,000 (4%).
- Leon Creek 5 Left contains 307 single-family residential structures valued at $52,362,000.
- Leon Creek 5 Right contains 782 structures valued at $238,198,000. The mix of structure is: 727 (93%) single-family residential valued at $165,353,000 (69%); 17 (2%) multi-family structures valued at $37,457,000 (16%); and 35 (5%) commercial structures valued at $35,387,000 (15%).
- Leon Creek 6 contains 249 structures valued at $93,685,000. The mix of structures is: 88 (35%) single-family residences valued at $28,995,000 (31%); 36 (15%) mobile homes valued at $876,000 (1%); 97 (39%) commercial structures valued at $60,666,000 (63%); 28 (11%) public structures valued at $3,148,000 (3%).
- Leon Creek 7 contains 228 structures valued at $85,846,000. The mix of structures is: 210 (92%) single-family residences valued at $82,561,000 (96%); one (0.4%) mobile home valued at $125,000 (0.1%); 15 (7%) commercial structures valued at $3,094,000 (4%); two (0.9%) public structures valued at $66,000 (0.1%).
- Leon Trib F contains 101 structures valued at $9,309,000. The mix of structures is: 100 (99%) single-family residences valued at $9,236,000 (99%) and one (1%) public structure valued at $73,000 (1%).

- Los Reyes Creek contains 30 structures valued at $8,235,000. The mix of structures is: 16 (53%) single-family residences valued at $6,414,000 (78%); 13 (43%) commercial structures valued at $1,781,000 (11%); and one (3%) public structure valued at $40,000 (.5%).
- Slick Ranch Creek contains 269 structures valued at $56,181,000. The mix of structures is 255 (95%) single-family residences valued at $36,859,000 (66%); six (2%) multi-family structures valued at $2,018,000 (4%); and eight (3%) commercial structures valued at $17,304,000 (31%).
- Slick Ranch Trib B contains four structures valued at $1,877,000. The mix of structures is three (75%) single-family residences valued at $119,000 (6%); and one (25%) commercial structure valued at $1,758,000 (94%).
- Westwood Village contains 13 structures valued at $1,031,000. The mix of structures is 10 (77%) single-family residences valued at $694,000 (67%), and three (23%) commercial structures valued at $337,000 (33%).

Table A-11 shows the median value of structures and contents by structure category for structures in the database.

Table A-11. Median Value of Structures and Contents (October 2010 Prices - $000)

Structure Category	Median Value of Structure and Contents
Single-Family Residential	$ 220
Multi-Family Residential	1,151
Mobile Residences	15
Commercial Structures	75
Public Structures	63

On the next page, Table A-12 provides the number and valuation for privately owned vehicles per single event category.

Table A-12. Number and Value of Floodplain Privately Owned Vehicles (October 2010 Prices - $000)

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Babcock Trib	2	$147	7	$ 552	9	$ 606	11	$ 643	15	$ 703	17	$ 726	18	$ 737	19	$ 748
Chimenea Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	28
Culebra Creek 1	0	0	0	0	8	171	76	1,644	216	4,669	375	8,101	707	14,981	1,010	21,209
Culebra Creek 2	0	0	0	0	0	0	0	0	1	27	6	165	18	495	46	1,263
Culebra Creek Trib A	0	0	0	0	4	100	11	275	19	476	32	804	57	1,437	74	1,865
Culebra Creek Trib C	0	0	0	0	2	55	2	55	3	89	5	150	8	239	11	326
Culebra Creek Trib E	0	0	0	0	0	0	1	34	1	34	2	68	2	68	5	168
French Creek	0	0	1	33	3	93	6	175	6	175	15	426	40	1,027	78	2,001
French Creek Trib A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helotes Creek	0	0	0	0	4	122	13	398	32	824	107	2,288	164	3,485	237	4,977
Helotes Creek Trib A	0	0	0	0	0	0	0	0	0	0	0	0	1	27	1	27
Helotes Creek Trib B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	65
Huebner Creek	0	0	3	50	24	402	69	1,059	121	1,945	187	3,175	303	5,518	374	7,546
Huebner Creek Trib A	1	18	4	70	8	139	11	192	12	209	12	209	12	209	14	244
Huesta Creek	0	0	8	212	16	425	24	638	26	690	34	902	49	1,319	64	1,725
Indian Creek	0	0	1	11	2	22	6	72	17	217	49	649	111	1,448	143	1,848
Leon Creek 1	0	0	0	0	0	0	0	0	0	0	1	14	1	14	2	27
Leon Creek 2	0	0	74	617	141	1,181	150	1,282	150	1,282	150	1,282	153	1,310	155	1,337
Leon Creek 3L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Creek 3R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Creek 4	0	0	2	21	2	21	7	144	15	293	32	541	55	829	90	1,611
Leon Creek 5L	0	0	0	0	0	0	0	0	6	118	78	1,534	216	4,247	307	6,036
Leon Creek 5R	0	0	0	0	0	0	1	26	19	1,181	78	2,618	259	7,001	746	17,389
Leon Creek 6	0	0	0	0	0	0	21	951	48	1,686	76	2,618	115	3,481	145	4,033
Leon Creek 7	0	0	0	0	16	516	83	2,499	135	3,877	167	4,773	194	5,555	215	6,183
Leon Trib B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13
Leon Trib F	0	0	0	0	14	146	31	322	60	623	82	852	100	1,039	102	1,060
Leon Trib H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Los Reyes Creek	0	0	0	0	0	0	1	34	3	100	5	168	12	403	16	537
Ranch Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slick Ranch	0	0	44	634	105	1,517	144	2,123	160	2,363	176	2,617	215	3,179	261	3,857
Slick Ranch Trib B	0	0	1	21	2	43	3	64	3	64	3	64	3	64	3	64
Westwood Village	0	0	0	0	0	0	1	11	5	52	7	73	7	73	11	114
Total	**3**	**$165**	**145**	**$2,221**	**360**	**$5,559**	**672**	**$12,641**	**1,075**	**$21,697**	**1,696**	**$34,817**	**2,838**	**$58,185**	**4,133**	**$86,301**

Single Event Damages

Damages in the floodplain begin to accrue with the 50% AEP event involving eight structures and damages estimated at $66,000.

- With the 10% AEP, a total of 408 structures receive damages estimated at $12,146,000. Single-family residential properties make up 45 percent of the structures and 33 percent of the damages. Commercial structures account for 28 percent of the structures and 59 percent of the damages.
- With a 4% AEP event, 846 structures are projected to receive damages totaling $33,655,000. Of these structures, 52 percent are single-family residential and 26 percent, commercial. Single-family residential properties make up 34 percent of the total damages, while commercial structures account for 58 percent of the total.
- The 1% AEP event is projected to generate $102,547,000 in damages to 1,971 structures. Seventy-one percent of the structures are single-family residential, which accounts for 37 percent the damages. Commercial structures account for 17 percent of the total number of structures and 54 percent of the total damages.
- In the 0.2% AEP event, 4,629 structures are projected to experience damages totaling $259,237,000. Eighty-one percent of the structures are single-family residential and 11 percent are commercial. Single-family residential structures account for 51 percent of the total damages, while commercial structures represent 41 percent of total damages.

Single Event Damages by Stream and Reach

This section provides summaries of the single event damages projected for each stream / reach, as detailed in Table A-13 on page A-42.

- Babcock Tributary. Damages begin in the 50% AEP along Babcock Tributary with $39,000 of damages to two multi-family residential structures. With a 4% AEP event, damages increase to $415,000 to 11 structures; seven multi-family, and four single-family. A 1% AEP event is estimated to generate $620,000 in damage to eight single-family structures, seven multi-family structures, and six commercial structures. The 0.2% AEP event is projected to cause $838,000 of damage to 27 structures: 11 single-family residential, seven multi-family residential, eight commercial, and one public structure.
- Chimenea Creek. Damages begin in the 2% AEP event, with less than $1,000 of damage to one commercial structure. In the 0.2% AEP event, total damages are expected to be $37,000, involving one single-family residential structure and three commercial structures.
- Culebra Creek 1. Damages begin to accrue with the 10% AEP event totaling $105,000, involving six single-family residential structures and one commercial structure. Damages increase significantly in the 4% AEP event, jumping to $1,701,000, involving 68 single-family residential structures and eight commercial structures. The single-family residential structures account for 89 percent of the total damages. With a 1% AEP event, a total of 379 structures are projected to be

affected with damages of $10,828,000. Ninety-five percent of the structures are single-family residential and five percent are commercial. Single-family residential structures account for 96 percent of the damages, and commercial structures, four percent. With the 0.2% AEP event, 1,039 structures are expected to receive $42,841,000 of damage. Ninety-four percent of the structures are single-family residential, which accounts for 91 percent of the total damages.

- Culebra Creek 2. Damages begin with the 4% AEP event, involving three commercial structures generating $150,000 of damage. With the 1% AEP event, 11 commercial structures are projected to receive $480,000 of damage. A 0.2% AEP event would generate $1,379,000 of damage to 44 structures: 27 single-family residential properties accounting for 24 percent of the damages, five mobile homes accounting for six percent of the damages, and 12 commercial structures accounting for 70 percent of the damages.
- Culebra Creek Tributary A. Damages start with the 10% AEP event, with four single-family residential structures experiencing $61,000 of damage. With a 4% AEP event, $228,000 of damage is projected to occur, affecting 11 single-family residential structures. A 1% AEP event would generate $685,000 of damage to 32 single-family residential structures. In the 0.2% AEP event, 57 single-family residential structures and two public structures are projected to receive $1,717,000 of damage.
- Culebra Creek Tributary C. Damages begin with the 20% AEP event, two commercial structures and projected damages of $8,000. In the 10% AEP event, damages increase to $38,000 affecting one single-family residential structure, one mobile home, and three commercial structures. With a 4% AEP event, the same structures are projected to receive $83,000 of damage. In the 1% AEP event, 12 structures would receive projected damages of $170,000. This includes four single-family residential structures, one mobile home, and seven commercial structures. In a 0.2% AEP event, 21 structures are projected to experience $425,000 of damage. The mix of structures is eight single-family residential, one mobile home, and 12 commercial structures.
- Culebra Creek Tributary E. Damages begin to accrue with the 4% AEP event and would generate $43,000 of damage to one single-family residential structure. A 1% AEP event would create damages of $75,000 to two single-family residential structures and one commercial structure. A 0.2% AEP event would cause $137,000 of damage to five single-family residential structures and two commercial structures.
- French Creek. A 20% AEP event would affect one single-family residential structure and one commercial structure, causing an estimated $47,000 of damage. A 10% AEP event would cause $104,000 of damage to three single-family residential structures and one commercial structure. The 4% AEP event would cause $262,000 of damage to six single-family residential structures and three commercial structures. The 1% AEP event would generate $665,000 of damage to 15 single-family residential structures and four commercial structures. The 0.2% AEP event would cause $3,327,000 of damage to 78 single-family residential structures, 10 commercial structures, and three public structures.
- Helotes Creek. Damages start with the 20% AEP event with $7,000 of damage involving four commercial structures. Damages increase significantly with the 10% AEP event, to $317,000.

Structures involved include five single-family residential structures and 17 commercial structures. The 4% AEP event is expected to damage 11 single-family residential structures and 29 commercial structures in the amount of $1,043,000. The 1% AEP event would generate $3,682,000 of damage to 106 single-family residential structures, 42 commercial structures, and four public structures. The 0.2% AEP event would cause $8,102,000 of damage to 305 structures: 233 single-family residential, 53 commercial, and 19 public.

- Helotes Creek Tributary A. Damages start in the 20% AEP event, with five commercial structures incurring $20,000 of damage. A 10% AEP event is projected to impact 10 commercial structures with $107,000 of damage. The 4% AEP event would cause $157,000 of damage to 15 structures. A 1% AEP event would generate $242,000 of damage to 17 commercial structures. The 0.2% AEP event would generate damages of $344,000, to 19 commercial structures.
- Helotes Creek Tributary B. Damages start with the 0.2% AEP event with $11,000 of damage to two single-family residential structures.
- Huebner Creek. Damages begin with the 50% AEP event, involving one public structure with damages of $16,000. In the 10% AEP event, damages would involve 10 single-family residential structures, two commercial structures, and five public structures with $242,000 of damage. The 4% AEP would generate $884,000 of damage to 63 single-family residences, three commercial structures, and ten public structures. The 0.2% AEP event would cause $12,477,000 of damage to 360 single-family residences, 20 multi-family residences, seven commercial structures, and 16 public structures.
- Huebner Creek Tributary A. Damages begin with the 50% AEP event, with one single-family residence receiving $3,000 of damage. The 10% AEP event generates $127,000 of damage to seven single-family residences and one commercial structure. The 4% AEP event generates damages of $212,000 to 10 single-family structures and one commercial structure. The 1% AEP event is projected to create damages of $627,000 to 12 single-family residential structures and two commercial structures. With a 0.2% AEP event, damages would be $1,450,000, involving 15 single-family residential structures and seven commercial structures.
- Huesta Creek. Damages first begin to accrue with the 20% AEP event, with $12,000 of damage to one single-family residential structure. A 10% AEP event would realize $30,000 of damage to one single-family residential structure and 11 mobile homes. The 4% AEP event would cause $46,000 of damage to one single-family structure and six mobile homes. The 1% event would damage one single-family residence and nine mobile homes, causing $102,000 of damage. The .2% AEP event would cause $689,000 of damage to 19 single-family residences and 25 mobile homes.
- Indian Creek. Along Indian Creek, damages first begin with the 50% AEP event, with projected damages of $5,000 to two commercial structures. In the 10% AEP event, damages totaling $47,000 impact two single-family residential structures and 15 commercial structures. With a 4% AEP event, damages triple to $142,000, involving five single-family residences and 18 commercial structures. In the 1% AEP event, 46 single-family residential structures and 19 commercial structures receive $525,000 of damage. The 0.2% AEP event would generate $1,941,000 in damages, involving 133 single-family residences and 24 commercial structures.

- Leon Creek 1. Damages start with the .04% AEP event, with $92,000 of damage to one mobile home and three public structures. The 0.2% AEP event would create $209,000 of damage to one mobile home and nine public structures.
- Leon Creek 2. Damages begin with the 20% AEP event, impacting four single-family structures, 10 mobile homes, and five commercial structures, with damages estimated at $98,000. The 4% AEP event is projected to cause $1,722,000 in damages to 32 single-family residences, 116 mobile homes, and 41 commercial structures. The 0.2% AEP event would generate $5,006,000 in damages to 36 single-family residences, 118 mobile homes, 61 commercial structures, and three public structures.
- Leon Creek 3 Left. Damages begin with the 20% AEP event, causing $975,000 of damage to four commercial structures. The 4% AEP event would generate $11,280,000 of damage to five commercial structures. The 0.2% AEP event is projected to generate $26,658,000 of damage to six commercial structures.
- Leon Creek 3 Right. Damages begin with the .04% AEP event, causing $5,000 of damage to one public structure. In the .02% AEP, damages increase to $7,000 to the same structure.
- Leon Creek 4. Damages start with the 50% AEP event, with an estimated $3,000 of damage to one public structure. The 4% AEP event would cause $2,656,000 of damage to four single-family residences, two multi-family residential structures, 16 commercial structures, and 19 public structures. A 0.2% AEP event is expected to cause $37,493,000 of damage to 66 single-family residences, 16 multi-family residential structures, six mobile homes, 43 commercial structures, and 23 public structures.
- Leon Creek 5 Left. Damages start with the 2% AEP event, with an estimated $100,000 of damage to six single-family residences. The 1% AEP event would generate $1,444,000 of damage to 78 single-family residences. The 0.2% AEP event is projected to generate $10,934,000 of damage to 307 single-family residences.
- Leon Creek 5 Right. Damages start with the 10% AEP event with $66,000 of damages to three commercial structures. In the 4% AEP event, one single-family residence and 13 commercial structures would receive $1,828,000 of damage. The 1% AEP event would generate $8,154,000 in damages to 66 single-family residences, 11 multi-family residential structures, and 18 commercial structures. The .02% AEP event would generate $37,154,000 of damage to 727 single-family residences, 17 multi-family residential structures, 35 commercial structures, and three public structures.
- Leon Creek 6. Damages start with the 20% AEP event, involving three commercial structures and creating $2,000 of damage. The 4% AEP event is projected to cause $4,246,000 of damage to six single-family residences, 48 commercial structures, and 11 public structures. The 0.2% AEP event involves 88 single-family residences, 36 mobile homes, 97 commercial structures, and 28 public structures, with $37,172,000 of damage.
- Leon Creek 7. Damages begin in the 10% AEP event, causing $538,000 of damage to 15 single-family residences, four commercial structures, and one public structure. The 4% AEP event would generate $2,960,000 of damage to 69 single-family residences, seven commercial structures, and

two public structures. The 0.2% AEP event would cause damage to 210 single-family residences, one mobile home, 15 commercial structures, and two public structures, estimated at a total of $13,853,000.

- Leon Tributary F. Damages start with a 4% AEP event, expected to cause $197,000 of damage to 16 single-family residences and one public structure. The 0.2% AEP event is projected to involve 100 single-family residences and one public structure, with $1,719,000 in damages.
- Leon Tributary K. Damages first occur with the 50% AEP event, with less than $1,000 damage to one commercial structure. The 10% AEP event is expected to generate $154,000 in damages to six commercial structures. The 4% AEP event involves nine commercial structures with $442,000 of damage. The 0.2% AEP event involves nine commercial structures with projected damages of $597,000.
- Los Reyes Creek. Damages begin in the 20% AEP event, with $20,000 of damage to two commercial structures. The 4% AEP event would generate $69,000 of damage to one single-family residence and three commercial structures. The 0.2% AEP event would involve 16 single-family residences and 13 commercial structures, causing $1,041,000 in damages.
- Slick Ranch Creek. Damages start with the 20% AEP event, with $511,000 of damage to 44 single-family residences. The 4% AEP event would cause $2,669,000 of damage to 140 single-family residences and four multi-family residential structures. The 0.2% AEP event is projected to generate $10,764,000 damage to 255 single-family residences, six multi-family residential structures, and eight commercial structures.
- Slick Ranch Tributary B. Damages begin with the 20% AEP event, with estimated damages of $2,000 to one single-family residence. The 4% AEP event involves three single-family residential structures and one commercial, with damages projected at $220,000. The 0.2% AEP event is projected to cause $470,000 of damage to three single-family residential structures and one commercial structure.
- Westwood Village Creek. Damages begin with the 4% AEP event, with $4,000 of damage to one single-family structure. The 0.2% AEP event would create $165,000 damage to 10 single-family residences and three commercial structures.

French Creek Trib A, Leon Creek Tribs B, H, J, M, and Ranch Creek do not generate any significant damages through the 0.2% AEP event.

On page A-51, Table A-14 provides detailed single-event damages to privately owned vehicles by reach.

Table A-13. Structures and Contents Single Event Damages by AEP and Reach (October 2010 Prices - $000)

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Babcock Trib																
Single-Family	0	$ 0	0	$ 0	2	$ 19	4	$ 88	7	$ 159	8	$ 225	11	$ 312	11	$ 375
Multi-Family	2	39	7	210	7	280	7	327	7	359	7	384	7	412	7	432
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	2	<1	6	11	7	15	8	17
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	14
Total	2	39	7	210	9	299	11	415	16	519	21	620	25	739	27	838
Chimenea Creek																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	36
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	1	<1	1	<1	1	<1	3	1
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	1	<1	1	<1	1	<1	4	37
Culebra Creek 1																
Single-Family	0	0	0	0	6	104	68	1,565	199	4,657	360	10,430	697	25,214	972	38,921
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	1	1	8	136	10	274	19	398	52	2,121	65	3,879
Public	0	0	0	0	0	0	0	0	0	0	0	0	1	36	2	41
Total	0	0	0	0	7	105	76	1,701	209	4,931	379	10,828	750	27,371	1,039	42,841
Culebra Creek 2																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	3	112	27	330
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	79
Commercial	0	0	0	0	0	0	3	150	5	213	11	480	11	729	12	970
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	3	150	5	213	11	480	14	841	44	1,379

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Culebra Creek Trib A																
Single-Family	0	0	0	0	4	61	11	228	19	427	32	685	57	1,182	74	1,717
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	4	61	11	228	19	427	32	685	57	1,182	74	1,717
Culebra Creek Trib C																
Single-Family	0	0	0	0	1	13	1	46	2	77	4	117	6	197	8	289
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	1	1	1	2	1	2	1	2	1	3	1	4
Commercial	0	0	2	8	3	24	3	35	5	42	7	51	10	99	12	132
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	2	8	5	38	5	83	8	121	12	170	17	299	21	425
Culebra Creek Trib E																
Single-Family	0	0	0	0	0	0	1	43	1	57	2	74	2	101	5	133
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	1	<1	1	<1	2	4
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	43	1	57	3	75	10	102	7	137
French Creek																
Single-Family	0	0	1	43	3	91	6	191	8	318	15	516	39	1,236	78	2,284
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	1	4	1	13	3	71	3	95	4	149	8	395	10	905
Public	0	0	0	0	0	0	0	0	0	0	0	0	1	38	3	138
Total	0	0	2	47	4	104	9	262	11	413	19	665	48	1,669	91	3,327

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
French Creek Trib A																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helotes Creek																
Single-Family	0	0	0	0	5	237	11	753	30	1,249	106	2,952	162	4,401	233	6,453
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	4	7	17	80	29	290	39	550	42	791	44	933	53	1,236
Public	0	0	0	0	0	0	0	0	0	0	4	1	4	2	19	413
Total	0	0	4	7	22	317	40	1,043	69	1,799	152	3,682	310	5,336	305	8,102
Helotes Creek Trib A																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	38
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	5	20	10	107	15	157	16	186	17	242	18	281	18	306
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	5	20	10	107	15	157	16	186	17	242	18	281	19	344
Helotes Creek Trib B																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Huebner Creek																
Single-Family	0	0	2	18	10	193	50	808	100	1,829	170	3,325	290	6,671	360	10,210
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	2	246	10	1,620
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	1	4	2	13	3	30	3	40	5	62	6	93	7	116
Public	1	16	2	25	5	36	10	46	13	78	15	194	15	381	16	531
Total	1	16	5	47	17	242	63	884	116	1,947	190	3,581	313	7,391	393	12,477
Huebner Creek Trib A																
Single-Family	1	3	3	57	7	122	10	200	11	281	12	363	13	463	15	546
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	1	5	1	12	1	14	2	264	6	746	7	904
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	3	3	57	8	127	11	212	12	295	14	627	19	1,209	22	1,450
Huesta Creek																
Single-Family	0	0	1	12	1	24	1	32	1	38	1	75	8	274	19	594
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	1	6	6	14	6	20	9	27	18	56	25	95
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	12	2	30	7	46	7	58	10	102	26	330	44	689
Indian Creek																
Single-Family	0	0	1	1	2	12	5	77	14	207	46	455	102	1,116	133	1,857
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	2	5	12	27	15	35	18	65	18	68	19	70	23	78	24	84
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	5	13	28	27	47	23	142	32	275	65	525	125	1,194	157	1,941

Reach / Structure Type	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Leon Creek 1																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	1	41	1	83
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	3	51	9	126
Total	0	0	0	0	0	0	0	0	0	0	0	0	4	92	10	209
Leon Creek 2																
Single-Family	0	0	4	69	21	405	32	820	33	1,039	33	.1,198	34	1,392	36	1,611
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	10	20	78	225	116	527	117	802	117	1,092	117	1,564	118	2,170
Commercial	0	0	5	9	33	286	41	375	43	433	48	561	58	955	61	1,220
Public	0	0	0	0	0	0	0	0	3	1	1	3	3	3	3	5
Total	0	0	19	98	132	916	189	1,722	196	2,275	201	2,854	212	3,914	218	5,006
Leon Creek 3L																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	4	975	5	6,249	5	11,280	5	13,985	5	16,701	6	21,549	6	26,658
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	4	975	5	6,249	5	11,280	5	13,985	5	16,701	6	21,549	6	26,658
Leon Creek 3R																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	7
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	7

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Leon Creek 4																
Single-Family	0	0	1	173	2	681	4	934	8	1,075	22	1,463	44	2,421	66	3,661
Multi-Family	0	0	0	0	0	0	2	708	3	1,389	4	2,257	5	3,644	16	6,234
Mobile Home	0	0	0	0	0	0	0	0	3	<1	3	3	6	8	6	18
Commercial	0	0	1	2	4	19	16	326	29	1,610	29	8,297	36	21,851	43	25,918
Public	1	4	6	106	9	300	19	688	21	928	21	1,118	21	1,373	23	1,662
Total	1	4	8	281	15	1,000	41	2,656	55	5,003	79	13,138	112	29,297	154	37,493
Leon Creek 5L																
Single-Family	0	0	0	0	0	0	0	0	6	100	78	1,444	216	5,678	307	10,934
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	6	100	78	1,444	216	5,678	307	10,934
Leon Creek 5R																
Single-Family	0	0	0	0	0	0	1	20	13	329	66	1,715	241	9,118	727	23,932
Multi-Family	0	0	0	0	0	0	0	0	6	1,847	11	3,462	17	5,861	17	7,710
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	3	66	13	1,808	15	2,451	18	2,977	24	3,853	35	5,511
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	<1
Total	0	0	0	0	3	66	14	1,828	34	4,627	95	8,154	282	18,832	782	37,154
Leon Creek 6																
Single-Family	0	0	0	0	0	0	6	145	22	572	39	1,280	62	2,839	88	5,008
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	5	25	13	54	25	97	36	160
Commercial	0	0	3	2	9	36	48	3,774	62	12,316	75	20,477	85	26,888	97	31,174
Public	0	0	0	0	4	26	11	327	16	483	20	589	26	727	28	830
Total	0	0	3	2	13	62	65	4,246	105	13,396	147	22,400	198	30,551	249	37,172

Reach / Structure Type	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Leon Creek 7																
Single-Family	0	0	0	0	15	507	69	2,776	118	4,659	154	6,970	188	10,427	210	13,283
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	1	13	1	16	1	19	1	24
Commercial	0	0	0	0	4	30	7	173	7	214	11	286	13	388	15	531
Public	0	0	0	0	1	<1	2	10	2	12	2	13	2	14	2	15
Total	0	0	0	0	20	538	78	2,960	128	4,898	168	7,285	204	10,848	228	13,853
Leon Trib B																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib F																
Single-Family	0	0	0	0	0	0	16	194	26	441	59	794	81	1,300	100	1,705
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	1	3	1	9	1	12	1	13	1	14
Total	0	0	0	0	0	0	17	197	27	450	60	806	82	1,313	101	1,705
Leon Trib H																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Leon Trib J																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib K																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	<1	3	1	6	154	9	442	9	485	9	520	9	562	9	597
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	.<1	3	1	6	154	9	442	9	485	9	520	9	562	9	597
Leon Trib L																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib M																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Los Reyes Creek																
Single-Family	0	0	0	0	0	0	1	12	3	32	5	76	12	349	16	792
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	2	20	2	43	3	57	4	64	6	84	10	148	13	249
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	2	20	2	43	4	69	7	96	11	160	22	497	29	1,041
Ranch Creek																
Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slick Ranch																
Single-Family	0	0	44	511	104	1,543	140	2,483	155	3,202	155	3,980	209	5,197	255	6,190
Multi-Family	0	0	0	0	1	96	4	186	5	235	6	282	6	351	6	414
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	5	2,177	5	2,313	8	4,160
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	44	511	105	1,639	144	2,669	160	3,437	181	6,439	220	7,861	269	10,764
Slick Ranch Trib B																
Single-Family	0	0	1	2	2	4	3	7	3	9	3	13	3	16	3	18
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	1	213	1	272	1	326	1	419	1	452
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	2	2	4	3	220	4	281	4	339	4	435	4	470

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach / Structure Type	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Westwood Village																
Single-Family	0	0	0	0	0	0	1	4	4	12	5	30	7	61	10	97
Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	2	<1	3	53	3	68
Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	4	4	12	7	31	10	114	13	165
Total Watershed																
Single-Family	1	3	58	886	185	4,015	441	11,427	783	20,769	1,390	38,177	2,487	80,081	3,757	131,078
Multi-Family	2	39	7	210	8	376	13	1,221	21	3,829	28	6,384	37	10,513	56	16,409
Mobile Home	0	0	10	20	80	232	123	542	130	863	144	1,195	169	1,791	193	2,634
Commercial	3	5	43	1,082	116	7,161	226	19,392	272	33,313	343	54,863	437	84,472	513	105,479
Public	2	19	8	132	19	362	43	1,073	56	1,511	66	1,928	77	2,637	110	3,637
Grand Total	**8**	**66**	**126**	**2,330**	**408**	**12,146**	**846**	**33,655**	**1,262**	**60,285**	**1,971**	**102,547**	**3,207**	**179,494**	**4,629**	**259,237**

Table A-14. Privately Owned Vehicles Single Event Damages by AEP and Reach (October 2010 Prices - $000)

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Babcock Trib	2	$68	7	$ 424	9	$ 530	11	$ 594	15	$ 633	17	$ 660	18	$ 681	19	$ 690
Chimenea Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12
Culebra Creek R1	0	0	0	0	8	80	76	975	216	2,682	375	5,425	707	11,129	1,010	15,928
Culebra Creek R2	0	0	0	0	0	0	0	0	1	6	6	62	18	246	46	607
Culebra Creek Trib A	0	0	0	0	4	42	11	121	19	220	32	353	57	609	74	857
Culebra Creek Trib C	0	0	0	0	2	12	2	28	3	46	5	72	8	115	11	164
Culebra Creek Trib E	0	0	0	0	0	0	1	8	1	14	2	20	2	37	5	59
French Creek	0	0	1	15	3	30	6	72	8	112	15	183	40	451	78	893
French Creek Trib A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helotes Creek	0	0	0	0	4	72	13	243	32	451	107	1,188	164	1,868	237	2,828
Helotes Creek Trib A	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	8
Helotes Creek Trib B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14
Huebner Creek	0	0	3	18	24	131	69	422	121	860	187	1,482	303	2,849	374	4,408
Huebner Creek Trib A	1	4	4	25	8	55	11	87	12	111	12	131	12	157	14	180

	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
Reach	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Huesta Creek	0	0	8	88	16	242	24	388	26	476	34	602	49	956	64	1,293
Indian Creek	0	0	1	3	2	11	6	37	17	78	49	217	111	553	143	863
Leon Creek 1	0	0	0	0	0	0	0	0	0	0	1	8	1	14	2	24
Leon Creek 2	0	0	74	359	141	1,008	150	1,215	150	1,255	150	1,271	153	1,292	155	1,320
Leon Creek 3L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Creek 3R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Creek 4	0	0	2	7	2	21	7	93	15	199	32	400	55	690	90	1,281
Leon Creek 5L	0	0	0	0	0	0	0	0	6	34	78	753	216	2,762	307	4,701
Leon Creek 5R	0	0	0	0	0	0	1	28	19	510	78	1,462	259	4,586	746	11,246
Leon Creek 6	0	0	0	0	0	0	21	544	48	1,068	76	1,669	115	2,648	145	3,484
Leon Creek 7	0	0	0	0	16	294	83	1,464	135	2,392	167	3,275	194	4,387	215	5,140
Leon Trib B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Leon Trib F	0	0	0	0	14	56	31	165	60	347	82	548	100	790	102	917
Leon Trib H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leon Trib M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Los Reyes Creek	0	0	0	0	0	0	1	13	3	38	5	79	12	215	16	378
Ranch Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slick Ranch	0	0	44	225	213	724	144	1,173	160	1,471	176	1,784	215	2,237	261	2,609
Slick Ranch Trib B	0	0	0	0	4	13	3	23	3	28	3	34	3	40	3	45
Westwood Village	0	0	0	0	0	0	1	3	5	21	7	37	7	58	11	82
Total	**3**	**$72**	**145**	**$1,164**	**360**	**$3,321**	**672**	**$7,696**	**1,075**	**$13,052**	**1,696**	**$21,715**	**2,820**	**$39,375**	**4,133**	**$60,035**

EXPECTED ANNUAL DAMAGES

Table A-15 shows the expected annual damages (EAD) for each reach in the study. The overall EAD for the watershed is estimated at $13,134,000. Single-family residential structures account for 38 percent of total EAD, commercial structures account for 35 percent, privately owned vehicles account for 19 percent, public structures account for two percent, multi-family residential structures account for four percent, and mobile homes, about one percent.

The damage reach with the greatest impact on EAD is Culebra Creek 1, accounting for 18 percent of the total EAD. Reach 3L of Leon Creek is responsible for 13 percent of the overall EAD. Leon Creek reaches 4, 5R, 6 each make up nine percent of EAD. Reach 7 of Leon Creek accounts for eight percent of total EAD. Slick Ranch accounts for seven percent of EAD. Helotes Creek, Huebner Creek, and Leon Creek 2 each account for four percent. The remaining reaches account for less than four percent each toward total EAD.

This analysis focuses on the existing conditions in the Leon Creek Watershed. Given the large area and number of streams and reaches involved, definitions of reaches and damage centers are expected to change as alternatives are explored. Because of small expected annual damages, some reaches or portions of reaches, could be removed from consideration. Additionally, reaches could be combined, based on cross-reach impacts of alternatives that are developed.

Table A-15. Expected Annual Damages and Potentially Supportable Projects by Reach (October 2010 Prices - $000)

Reach	Commercial	Multi-Family Residential	Mobile Homes	Public	Privately Owned Vehicles	Single-Family Residential	Total EAD
Babcock Trib	$ 4	$ 95	$ 0	$ 4	$ 167	$ 22	$ 292
Chimenea Creek	< 1	0	0	0	0	1	2
Culebra Creek 1	161	0	0	2	640	1,492	2,295
Culebra Creek 2	52	0	3	0	20	13	88
Culebra Trib A	0	0	0	0	28	63	91
Culebra Trib C	11	0	< 1	0	7	13	32
Culebra Trib E	3	0	0	0	3	12	18
French Creek	120	1	0	9	39	114	283
French Trib A	0	0	0	0	0	< 1	<1
Helotes Creek	76	0	0	12	120	309	517
Helotes Trib A	44	0	0	0	< 1	2	47
Helotes Trib B	0	0	0	0	< 1	< 1	1
Huebner Creek	9	20	< 1	30	131	317	508
Huebner Trib A	55	0	0	0	18	48	121
Huesta Creek	0	7	5	0	87	26	125
Indian Creek	16	0	0	< 1	21	52	90
Leon Creek 1	0	0	1	3	<1	0	5
Leon Creek 2	71	0	94	< 1	181	115	462

Reach	Commercial	Multi-Family Residential	Mobile Homes	Public	Privately Owned Vehicles	Single-Family Residential	Total EAD
Leon Creek 3L	1,701	0	0	0	0	0	1,701
Leon Creek 3R	< 1	0	0	0	0	0	< 1
Leon Creek 4	638	159	< 1	118	32	184	1,132
Leon Creek 5L	0	0	0	0	101	242	343
Leon Creek 5R	289	215	0	0	196	385	1,085
Leon Creek 6	964	0	3	41	76	70	1,154
Leon Creek 7	38	0	2	2	308	751	1,101
Leon Trib B	0	0	0	0	< 1	< 1	< 1
Leon Trib F	0	0	0	1	40	62	103
Leon Trib H	0	0	0	0	0	< 1	< 1
Leon Trib J	0	0	0	0	0	< 1	< 1
Leon Trib K	170	0	0	0	0	0	170
Leon Trib L	0	0	0	0	0	0	0
Leon Trib M	0	0	0	0	0	0	0
Los Reyes Creek	15	0	0	< 1	5	9	30
Ranch Creek	0	0	0	0	0	0	0
Slick Ranch	132	53	0	0	305	742	1,232
Slick Ranch Trib B	84	< 1	0	0	5	2	92
WW Village	3	0	0	0	3	3	9
Total	**$4,658**	**$551**	**$111**	**$225**	**$2,537**	**$5,052**	**$13,134**

Future Without-Project Expected Annual Damages and Average Annual Equivalents

For this study, future conditions represent 2043, 25 years beyond the 2018 base for existing conditions. Hydraulic and hydrological estimates for the future without-project conditions were entered into HEC-FDA to calculate expected annual damages for the future condition. The structure database was held constant for computation of future expected annual damages. As described in Appendix G.1 “Hydrologic and Hydraulic Analyses,” future conditions generally show increased flows and damages, but some reaches experienced a decrease in flows. On the next page, Table A-16 shows the EAD values for future without-project conditions by economic reach, along with existing conditions EADs for comparison.

To determine any potential benefits from alternatives, these two EAD values were used to create average annual equivalents (AAE) or equivalent annual damages, because full benefits from any alternative would not begin until 2043. Using a Federal interest rate of 4.125 percent and time horizon of 50 years, average annual equivalents (AAE) were computed within HEC-FDA for each reach. The without-project AAE damages are also included in Table A-16.

Table A-16. Existing and Future Without-Project Expected Annual Damages and Without-Project Average Annual Equivalents
(October 2010 Prices - $000, 4.125% Interest Rate)

Reach	Existing Without-Project EAD	Future Without - Project EAD	Without-Project AAE
Babcock Trib	$ 292	$ 454	$ 382.11
Chimenea Creek	2	2	1.57
Culebra Creek 1	2,295	1,727	1,977.59
Culebra Creek 2	88	84	85.68
Culebra Trib A	91	103	97.94
Culebra Trib C	32	40	36.12
Culebra Trib E	18	18	18.18
French Creek	283	253	266.43
French Trib A	< 1	< 1	0.01
Helotes Creek	517	526	521.52
Helotes Trib A	47	47	46.93
Helotes Trib B	1	<1	0.52
Huebner Creek	508	443	471.36
Huebner Trib A	121	126	123.45
Huesta Creek	125	128	126.47
Indian Creek	90	90	89.50
Leon Creek 1	5	4	4.14
Leon Creek 2	462	582	528.93
Leon Creek 3L	1,701	2,125	1,973.56
Leon Creek 3R	< 1	< 1	0.22
Leon Creek 4	1,132	1,193	1,165.58
Leon Creek 5L	343	285	30.79
Leon Creek 5R	1,085	994	1,034.32
Leon Creek 6	1,154	1,574	1,388.08
Leon Creek 7	1,101	1,157	1,131.71
Leon Trib B	< 1	< 1	0.32
Leon Trib F	103	158	133.75
Leon Trib H	< 1	< 1	0.21
Leon Trib J	< 1	< 1	0.09
Leon Trib K	170	191	181.87
Leon Trib L	0	0	0
Leon Trib M	0	0	0
Los Reyes Creek	30	41	35.44
Ranch Creek	0	0	0

Reach	Existing Without-Project EAD	Future Without - Project EAD	Without-Project AAE
Slick Ranch	1,232	1,512	1,388.67
Slick Ranch Trib B	92	104	98.29
WW Village	9	8	8.10
Total	**$13,134**	**$13,970**	**$13,593.45**

PRELIMINARY STRUCTURAL ALTERNATIVES

This section describes how the team began to narrow the focus of the study as a result of the flood damage and cost analysis. Upon reviewing the damages in the overall watershed, 12 areas of interest (AOI), based on structural *damage centers*, were identified for further study. Then preliminary structural alternatives were developed to address the problems in the areas of interest.

Damages (economic) reaches were identified based on H&H considerations, such as significant highway crossings or significant confluences with other streams, along Leon Creek and Culebra Creek. Other streams were treated as single reaches.

Because of the size of the watershed, a method was needed to identify what areas to focus on. Damage centers based on structure damages were coded using ArcView, and maps prepared. Areas of concentrated damage were identified as areas of interest (AOIs). In some cases, and AOI spans an economic reach because of the confluence of to multiple streams or damages existed on either side of a reach break. AOIs were simply used at a method of focusing in or areas for further study. Damages and benefits are all based on economic reach classifications not AOIs.

Areas of Interest

The damage centers were indicated by clusters of structures that had some significant damage in the same event. An area in the watershed of high or concentrated damage—which can include more than one damage center or areas beyond a particular damage center—determines the location of an AOI. On the next page, Table A-17 describes the geographic location and boundaries of each AOI.

Table A-17. Identified Areas of Interest

Area of Interest	Stream	Original Reach	AOI Location and Bounds
AOI-1	Leon Creek	LC R2	On Leon Creek between Quintana Road and New Laredo Highway
AOI-2	Leon Creek	LC R3	On Leon Creek, just south of its crossing of SW Military Dr
AOI-3	Leon Creek Trib F	LC Trib F	On tributary F of Leon Creek, bounded on the east by S. Callaghan Road, on the south by Old US Highway 90 W, on the west by Gena Road, and on the north by the northern boundary of the tributary’s 500-year flood delineation
AOI-4	Slick Ranch Creek	Slick Ranch	On Slick Ranch Creek, upstream of its confluence with Leon Creek. Bounded on the north by State Highway 151, Pinn Road to the east, Marbach Road to the south, and the stream’s 500-year floodplain delineation to the west
AOI-5	Culebra Creek Leon Creek	Culebra LC R5	On Culebra Creek, from its confluence with Leon Creek in Reach 5, and continuing along Culebra Creek, upstream to its confluence with Helotes Creek
AOI-6	Huebner Creek	Huebner	Along Huebner Creek, bounded on the north at its crossing with Bandera Road, and on the south near Brierbrook, on the east and west by the 500-year floodplain delineation of the stream
AOI-7	Leon Creek	LC R5	Along Leon Creek, from Barryhill Road to the north, Grissom Road to the south, and the stream’s 500-year floodplain delineation on the east and west
AOI-8	Huebner Creek	Huebner	Along Huebner Creek, bounded on the north by Parkland Oaks Drive, to the south by Bandera Road, and on the east and west by the 500-year floodplain delineation of the stream
AOI-9	Huebner Creek	Huebner	Along Huebner Creek from just above Babcock Road on the north, to the crossing at Whitby Road to the south, and on the east and west by the 500-year floodplain delineation
AOI-10	Leon Creek	LC 6	Along Leon Creek, beginning at Mission Cemetery on the north, along the stream parallel to I-10 W, to just south of Old Camp Bullis Road.
AOI-11	Leon Creek Leon Creek Leon Creek Trib L	LC 6 LC 7	Along tributary L of Leon Creek, just southeast of the intersection of Broad Oak Trail and Boerne Stage Road to the northwest, following the stream to its confluence with Leon Creek at I-10 W
AOI-12	Helotes Creek	Helotes	On Helotes Creek, roughly bounded on the north by Pond Road, to the east by Ink Wells and Pine Branch, the south by Village Basin, and to the west by W Loop 1605 N

On page A-58, Figure A-5 shows the location of the 12 areas of interest within the watershed.

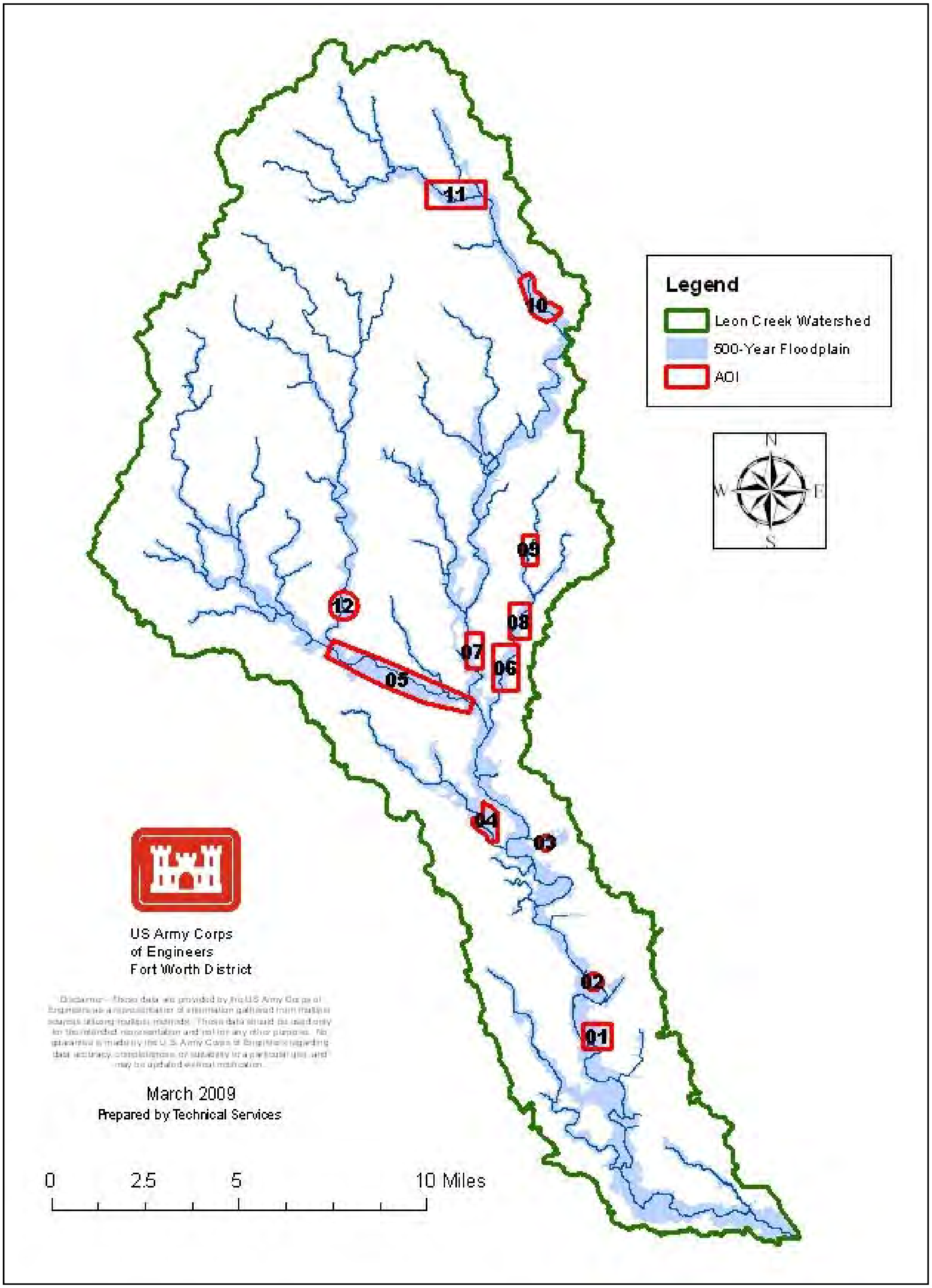


Figure A-5. Leon Creek Areas of Interest

ANALYSIS OF STRUCTURAL MEASURES FLOOD RISK MANAGEMENT BENEFITS, COSTS, AND NET BENEFITS

Alternative 1

Alternative 1 targeted damages in AOI-1, located in reach 2 of Leon Creek with additional impacts to reaches 3L and 3R of Leon Creek. This alternative consisted of removing the high point on one side of the creek to allow overbank storage sufficient enough to contain the 5-year AEP event. The with-project AAE is $13,444,070, resulting in annual benefits of $149,500. Annual costs for this alternative are estimated at $987,000, yielding net annual benefits of -$837,620 and a benefit-to-cost ratio of 0.15. With negative net benefits, this alternative was not carried forward.

Table A-18. Summary of Net Annual Benefits for AOI-1

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
1	$13,444,070	$149,500	$987,000	-$837,620	0.15

Alternative 2, 3, and 4

Alternatives 2 - 4 targeted damages in AOI-2, the test cell facility, located in reach 3 of Leon Creek with additional impacts to reach 4 of Leon Creek. These alternatives consisted of various levees on the left bank of Leon Creek and bypass channels constructed on the right hand bank of Leon Creek.

Alternative 2 is a levee designed to contain the 100-year AEP event. The initial with-project AAE is $12,543,800, resulting in annual benefits of $1,049,650. Annual costs for this alternative are estimated at $593,700, yielding net annual benefits of $455,950 and a benefit-to-cost ratio of 1.77. However, the alternative resulted induced annual damages of $250 upstream related higher water surface elevations. These reported AAE does not include these induced damages. Alternative 2B is a refinement of Alternative 2 to reduce the induced damages and incorporate interior drainage features in the project costs. Alternative 2B has an AAE of $12,072,670 yielding annual benefits of $1,520,880. Annual costs were estimated at $637,400 yielding net annual benefits of $883,480 and a benefit-to-cost ratio of 2.39. With the refinements, $100 of annual induced damages remained. Alternative 2B with Hydraulic Mitigation was a further refinement on Alternative 2B to include upstream channel modifications to address the remaining induced damages. This refined alternative has an AAE of $11,843,950, yielding annual benefits of $1,749,500. Annual costs were estimated at $828,700 yielding net annual benefits of $920,800 and a benefit-to-cost ratio of 2.11. Additionally, induced damages upstream were eliminated. This final refinement of Alternative 2 is carried forward.

Alternative 3 consisted of a levee designed to contain the 500-year AEP event on the left bank. The alternative had an AAE of $11,659,930, yielding an annual benefit of $1,933,520. Annual costs are estimated to be $789,300, yielding net annual benefits of $1,144,220 and a benefit-to-cost ratio of 2.45. The alternative resulted in $280 of annual induced damages upstream, not included in the AAE.

Alternative 4 considered a by-pass channel constructed on the right bank of Leon Creek in reach 3. A preliminary100 ft channel was modeled and giving an AAE of $12,466,140, yielding annual benefits of $1,127,310. Annual costs were estimated at $239,600, yielding annual net benefit of $887,710 and a benefit-to-cost ratio of 4.10. This alternative was carried forward for refinement in modeling and cost estimates, and additional widths were considered. Alternative 4A considered a 25 foot channel, Alternative 4B considered a 40 foot channel, and Alternative 4C considered a refined 100 foot channel from Alternative 4. A summary of the refined alternatives is shown in Table A-23.

Table A-19. Summary of Net Annual Benefits for AOI-2

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
2	$12,543,800	$1,049,650	$593,700	$455,950	1.77
2B	$12,072,670	$1,520,880	$637,400	$883,480	2.39
2B w/ Mit.	$11,843,950	$1,749,500	$828,700	$920,800	2.11
3	$11,659,930	$1,933,520	$789,300	$1,144,220	2.45
4	$12,466,140	$1,127,310	$239,600	$887,710	4.70
4A	$13,137,720	$455,730	$152,800	$302,930	2.98
4B	$13,047,810	$545,640	$165,800	$379,840	3.29
4C	$12,892,321	$701,140	$220,300	$480,840	3.18
2B + 4C	$11,842,220	$1,751,490	$813,300	$938,190	2.15
2B w/ Mit. + 4C	$11,508,610	$1,750,260	$1,001,600	$748,660	1.75
3 w/ Mit. + 4C	$11,320,770	$1,938,090	$1,154,300	$783,790	1.68

While all three variations had positive net annual benefits, none of the three refinements exceeded the net annual benefits of the levee alternatives.

Prior to modeling Alternative 2B with hydraulic mitigation, a combination of the 100 year levee (Alternative 2B) and the 100 foot bypass channel (Alternative 4C) was considered. The combination had an AAE of $11,842,220, yielding annual benefits of $1,751,490. The annual cost of the combination is estimated at $812,100, yielding net annual benefits of $938,190 and a benefit-to-cost ratio of 2.15. While having higher net benefits, the alternative did not reduce the induced damages as intended.

Two additional combinations of alternatives were also analyzed for AO2. The first combination included the 100 year levee with mitigation and the 100’ bypass channel. The annual benefits for this combination is $1,750,250 and annual costs are $1,001,600, yielding net annual benefits of $748,660 and a benefit-to-cost ratio of 1.75. The second combination included the alternative 3, the 500 year levee to include hydraulic mitigation and the 100’ bypass channel. For this combination, annual benefits are $1,938,090 and annual costs are $1,154,300. This yielded net annual benefits of $738,790 and a benefit-to-cost ratio of 1.68.

Alternative 2B (100 year levee with hydraulic mitigation), the combination of alternative 2B and 4C, and the combination of alternative 3 (with hydraulic mitigation) and 4c were carried forward for further consideration with cost refinements.

Alternative 5

Alternative 5 consisted of channel improvements along Slick Ranch Creek to address damages in AOI-4. The AAE for this alternative is $13,392,860, yielding annual benefits of $200,590. During the plan formulation screen process, it was learned that the City of San Antonio and constructed alternatives in the reach after the existing conditions were prepared, and the sponsor felt that damages through the 100-year AEP had been addressed and made the decision to not proceed with additional investigation along this reach.

Table A-20. Summary of Net Annual Benefits for AOI-4

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
5	$13,392,860	$200,590	-	-	-

Alternative 6

Alternative 6 was developed to address damages in AOI-3, located on Leon Creek Trib F. The preliminary alternative consisted of a levee to contain the 500-year AEP event. The AAE for the alternative is $13,474,430, yielding annual benefits of $119,020. An annual cost for the alternative was estimated at $73,700, yielding a net annual benefit of $45,320 and a benefit-to-cost ratio of 1.61. The local sponsor chose not to proceed with investigation of this alternative.

Table A-21. Summary of Net Annual Benefits for AOI-3

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
6	$13,474,430	$119,020	$73,700	$45,320	1.61

Alternative 7

Alternative 7 was developed to address damages in AOI 8 and AOI 6, both located on Heubner Creek. The alternative consisted of detention pond at the confluence of Huebner Trib A and Huebner Trib B. The AAE for the alternative is $13,319,190, yielding annual benefits of $274,260. The annual cost for the alternative is estimated at $1,028,400, yielding net annual benefits of -$754,140. Additionally, the alternative generated $9,780 in annual induced damages. Because of the negative net benefits, the alternative was not carried forward for further analysis or consideration.

Table A22. Summary of Net Annual Benefits for AOI-6 and 8

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
7	$13,319,190	$274,260	$1,028,400	-$754,140	0.27

Alternative 8 and 9

Alternatives 8 and 9 were developed to address damages in AOI 9, located on Huebner Creek. Alternative 8 consisted of a channel modification to widen and deepen Huebner Creek. The AAE for

Alternative 8 is $13,577,210, yielding annual benefits of $16,240. The annual cost is estimated to be $78,700, yielding net annual benefits of -$62,460 and a benefit-to-cost ratio of 0.21. With negative net annual benefits, the alternative was not carried forward.

Alternative 9 consists of a detention pond on Heubner Creek located just upstream of Prue Road. The facility is currently in design phase, with construction by the Bexar County Flood Control District to begin in the late 2012 to 2013 time frame. The alternative is being considered to determine if it might be included the recommended plan resulting from this study. The AAE for this alternative is $13,565,200, yielding annual benefits of $28,250. The annual cost of this alternative is estimated at $279,300, yielding net annual benefits of -$251,050 and a benefit-to-cost ratio of 0.10. Given the negative net annual benefits, the alternative was not carried forward.

Table A-23. Summary of Net Annual Benefits for AOI-9

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
8	$13,577,210	$16,240	$78,700	-$62,460	0.21
9	$13,565,200	$28,250	$279,300	-$251,050	0.10

Alternative 10

Alternative 10 was developed to address damages in AOI 12, located on Helotes Creek. The alternative consists of tree and brush clearing from the channel and overbank area. The AAE for the alternative is $13,486,660, yielding annual benefits of $106,790. An annual cost for this alternative is estimated at $431,200, yielding annual net benefits of -$324,410 and a benefit-to-cost ratio of 0.25. Given negative net benefits, the alternative was not carried forward.

Table A-24. Summary of Net Annual Benefits for AOI-12

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
10	$13,486,660	$106,790	$431,200	-$324,410	0.25

Alternatives 11 and 12

Alternatives 11 and 12 were developed to address damages in AOIs 12, 5, 2 and 1. AOI 12 located on Helotes Creek, AOI 5 located on Culebra Creek Reach 1 and Leon Creek Reach 5, AOI 2 is located on Leon Creek Reach 3, and AOI 1 I located on Leon Creek Reach 2.

Alternative 11 consists of a detention pond with a 28.5 foot high dam located on Helotes Creek south of FM 1560. The AAE for the alternative is $12,091,260, yielding annual benefits of $1,502,190. Annual costs are estimated at $678,000, yielding net annual benefits of $824,190 and a benefit-to-cost ratio of 2.22.

Alternative 12, also a detention pond, utilizes a near-by quarry. Located downstream of FM1560 on Helotes Creek and upstream of Alternative 11, this pond would have a lateral weir to redirect flow and take advantage of approximately 5,000 acre-feet of storage within the quarry. The AAE for the alternative is $11,566,850, yielding annual benefits of $2,026,600. Annual costs are estimated at $498,000, yielding net annual benefits of $1,528,600 and a benefit-to-cost ratio of 4.07. Alternative 12 provides significantly greater net annual benefits over Alternative 11, and therefore will be carried forward.

Table A-25. Summary of Net Annual Benefits for AOI-12, 5, 2 and 1

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
11	$12,091,260	$1,502,190	$678,000	$824,190	2.22
12	$11,566,850	$2,026,600	$498,000	$1,528,600	4.07

Alternatives 13 and 14

Alternatives 13 and 14 were developed to address damages in AOI 5, located on Culebra Reach 1, Culebra Reach 2 and Leon Creek Reach 5. Additional benefits downstream of Leon Creek Reach 5 are also expected. Both alternatives consider detention areas in Government Canyon on Culebra Creek.

Alternative 13 consists of a pond created by a 60-foot high 350-foot wide dam to be located on Culebra Creek approximately 1.5 miles upstream of the Government Canyon park entrance. The pond will provide approximately 5,600 acre-feet of storage. The AAE for Alternative 13 is $12,138,410, yielding annual benefits of $1,455,040. Annual costs are estimated at $1,630,500, yielding net annual benefits of -$175,460 and a benefit-to-cost ratio of 0.89.

Alternative 14 is a Leon Creek Master Plan Detention Site analyzed with USAEP hydrology at the request of the non-Federal sponsor. It consisted of a 51-foot high dam to be located upstream of Alternative 13 with maximum storage of approximately 6,900 acre-feet. The AAE for this alternative is $11,671,520, yielding annual benefits of $1,921,930. Annual costs are estimated at $858,000, yielding net annual benefits of $1,063,930, and a benefit-to-cost ratio of 2.24.

Because of the environmental and cultural significance of the Government Canyon area, a smaller version of Alternative 14 was considered, and is identified as Alternative 14B. The AAE for the alternative is $13,051,610, yielding annual benefits of $541,840. Annual costs are estimated at $984,300, yielding net annual benefits of -$442,460, and a benefit-to-cost ratio of 0.55.

Alternative 14 is the only Government Canyon alternative to provide positive annual benefits. However, the preliminary costs did not include environmental or cultural mitigation costs. It was determined by the PDT that these costs would be significant enough as to diminish any positive net annual benefits, and therefore the alternative was not carried forward.

Table A-26. Summary of Net Annual Benefits for AOI-12, 5, 2 and 1

Alternative	AAE	Annual	Annual Costs	Net Annual	B-C Ratio

		Benefits		Benefits	
13	$12,138,410	$1,455,040	$1,630,500	-$175,460	0.89
14	$11,671,520	$1,921,930	$858,000	$1,063,930	2.24
14B	$13,051,610	$541,840	$984,300	-$442,460	0.55

Alternatives 15, 16, 20 and 21

Alternatives 15, 16, 20 and 21 were developed to address damages in AOI-7, located in reach 5 of Leon Creek. Alternatives 15 and 16 considered levees, while alternatives 20 and 21 considered channel modifications in the same area.

Alternative 15 consists of a levee designed to contain the 100-year AEP event, with the levee on the left bank of the creek. The alternative has AAE of $13,291,180 yielding annual benefits of $302,270. Annual costs are estimated at $1,204,500, yielding net annual benefits of -$902,230 and a benefit-to-cost ratio of 0.25. Initially this alternative indicated positive net annual benefits, but costs to handle interior drainage issues had been not been included. Once those costs were included, net benefits became negative.

Alternative 16 consists of a levee designed to contain the 500-year AEP event, again, with the levee on the left bank of Leon Creek. The AAE for the alternative is $13,322,910, yielding annual benefits of $270,540. The annual costs are estimated at $414,500, yielding net annual benefits of -$143,960.

Alternative 20 consists of a 300 foot channel modification on Leon Creek in Reach 5. The AAE for the alternative is $13,273,280, yielding annual benefits of $320,170. Annual costs are estimated at $920,400, yielding net annual benefits of -$600,230 and a benefit-to-cost ratio of 0.35.

Alternative 21 consists of a 200 foot channel modification on Leon Creek in Reach 5. The AAE for the alternative is $13,283,160, yielding annual benefits of $310,290. Annual costs are estimated at $352,800, yielding net benefits of -$42,510 and a benefit-to-cost ratio of 0.88.

With the benefit-to-cost ratio near unity, the PDT decided to look at a 100 foot channel modification using rough estimates. Preliminary results showed a favorable benefit-to-cost ratio of 1.37, and the PDT chose to consider a refinement of the 100 foot channel modification, along with an 85 foot channel modification and a 150 foot channel modification.

The results of these variations of Alternative 21 are shown in Table A-27.

Table A-27. Summary of Net Annual Benefits for AOI-7

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
15	$13,291,180	$302,270	$1,204,500	-$902,230	0.25

16	$13,322,910	$270,540	$414,500	-$143,960	0.65
17	$13,199,770	$393,680	$1,342,600	-$948,920	0.29
20	$13,273,280	$320,170	$920,400	-$600,230	0.35
21	$13,283,160	$310,290	$352,800	-$42,510	0.88
21C 150 ft.	$13,277,880	$315,570	$352,500	-$36,930	0.90
21D 100 ft.	$13,301,910	291,540	262,000	29,540	1.11
21E 85 ft.	$13,319,680	273,770	238,100	35,670	1.15

Both of the levee alternatives resulted in negative net annual benefits, and were not carried forward. Of the channel modification alternatives, the 85 foot channel modification, Alternative 21E, resulted in the greatest net annual benefits, and will be carried forward.

Alternative 17

Alternative 17 was developed to address damages in AOI 7, located in Leon Creek Reach 5, but benefits were anticipated to downstream reaches of Leon Creek as well. The alternative consists of diverting flows from Leon Creek into a quarry. The location is part of the Leon Creek Master Plan and is located north of Loop 1604 and east of IH-10. The AAE for this alternative are $13,199,770, yielding annual benefits of $393,680. Annual costs are estimated at $1,342,600, yielding net annual benefits of $-948,920 and a benefit-to-cost ratio of .29. Conversations with the quarry owner revealed the quarry was expected to be in operation for approximately 20 years and there was no interest to sale the property. Costs were therefore significant for this alternative, including buying out the potential revenues from the quarry, resulting in negative net benefits.

Alternative 18

Alternative 18 was developed to address damages in AOI 11, located on Leon Creek Reaches 6 and 7. The alternative consists of consisted of two ponds located upstream of AOI-11. Leon Trib M Pond is an inline pond located approximately 4,000 feet upstream of the northernmost crossing of Boerne Stage Road. It has a 42-foot high 300-foot wide dam providing storage of approximately 350 acre-feet. Leon XS 285313 Pond is an inline pond approximately 1.3 miles upstream of the crossing of Leon Creek and Huntress Lane. It has a 38-foot high 350-foot wide dam providing storage of approximately 450 acre-feet. The AAE for the alternative is $12,538,300, yielding annual benefits of $1,055,150. Annual costs are estimated at $1,054,100, yielding net annual benefits of $1,050 and a benefit-to-cost ratio of 1.00. With minimal annual benefits, and believing the area to have historical significance leading to a politically charged environment, the local sponsor chose to not move forward with this alternative.

Table A-28. Summary of Net Annual Benefits for AOI-11

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
18	$12,538,300	$1,055,150	$1,054,100	$1,050	1.00

Alternative 22

Alternative 22 was developed to address damages in AOIs 6, 8 and 9. The alternative is a combination of Alternative 7 (detention on Huebner Trib A) and Alternative 9 (detention on Heubner Creek at Prue Road). The AAE for the alternative is $13,293,700, yielding annual benefits of $311,700. Annual costs for the alternative are estimated at $1,270,100, yielding net annual benefits of -$958,400 and a benefit to cost ratio. Given negative net benefits, the alternative was not carried forward.

Table A-29. Summary of Net Annual Benefits for AOI-6, 8 and 9

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
22	$13,293,700	$311,700	$1,270,100	-$958,400	0.25

Alternative 23

Alternative 23 was developed to address damages in the lower end of AOI 5, at the confluence of Culebra Creek Reach 1 and Leon Creek. The alternative consists of channel modifications to Leon Creek at the confluence. The initial AAE for the alternative is $13,420,060, yielding annual benefits of $173,390. Annual costs for the alternative are estimated at $211,400, yielding net annual benefits of -$32,640 and a benefit-to-cost ratio of 0.85.

A second configuration of this alternative was created to investigate if the net benefits could be shifted in the positive direction. Alternative 23C resulted in an AAE of $13,417,390, yielding annual benefits of $176,060. Annual costs were estimated at $228,100, yielding net annual benefits of -$52,040 and a benefit-to-cost ratio of 0.77.

Table A-30. Summary of Net Annual Benefits for AOI-5

Alternative	AAE	Annual Benefits	Annual Costs	Net Annual Benefits	B-C Ratio
23	$13,420,060	$178,760	$211,400	-$32,640	0.85
23B	$13,417,390	$176,060	$228,100	-$52,040	0.77

ANALYSIS OF NON-STRUCTURAL PERMENANT FLOODPLAIN EVACUTION ALTERNATIVES

Given the size of the study area, a choice was made to identify potential non-structural alternatives by identifying concentrated areas where structures were being inundated by 2-, 5-, 10- and 25-year AEP events. Each structure was given an attribute that indicated the first AEP event where the water surface elevation exceeded the finished floor elevation. Using ArcGIS, structures were color coded by these event assignments and significant clusters of structures that were in the four AEP events were identified. This produced 17 clusters, or non-structural areas of interest. The reach location and composition of each of the NS AOIs is presented in Table A-31.

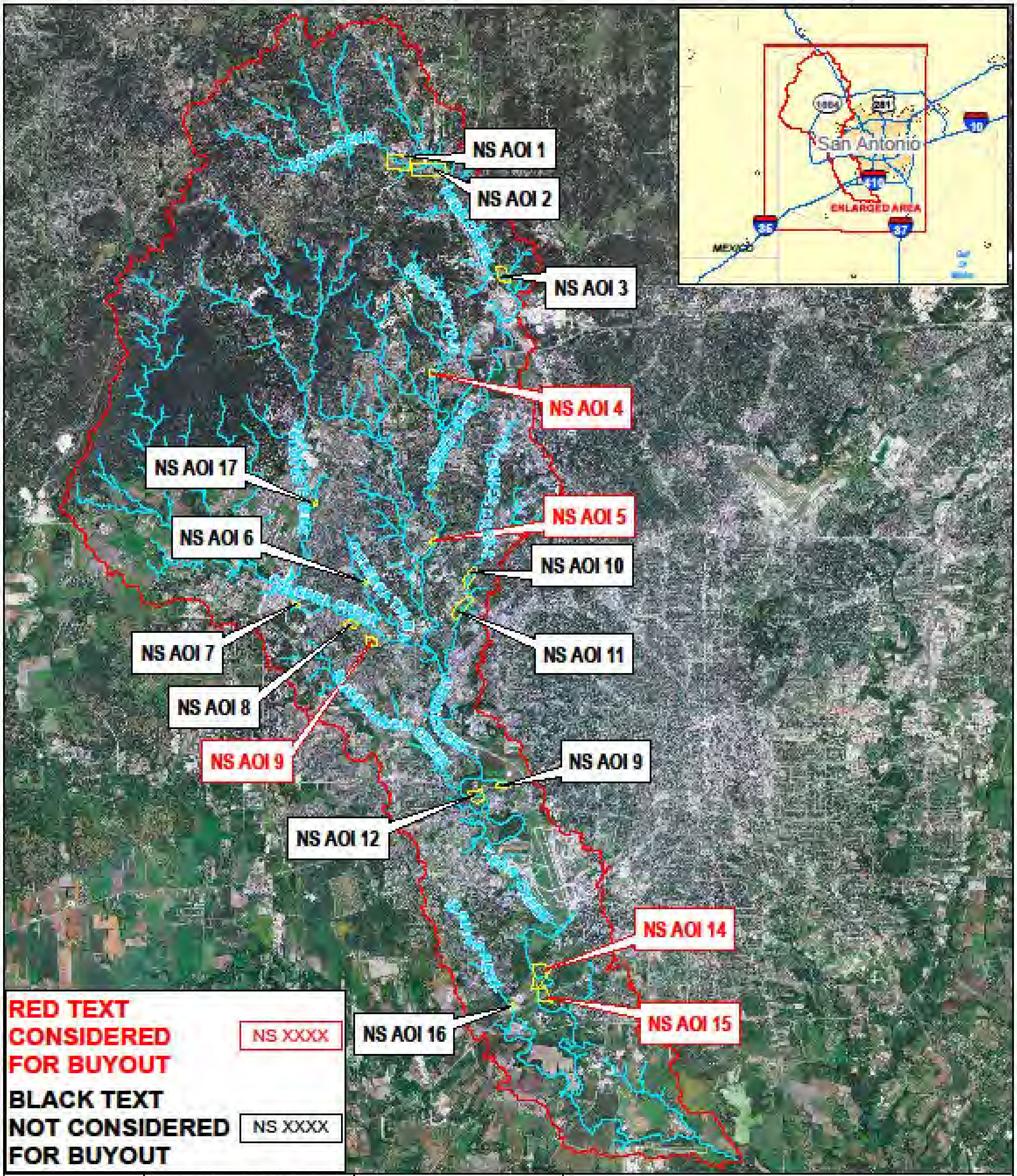
Table A-31 Structures by AEP Event in Non-Structural Areas of Interest

Non-Structural Area of Interest	Stream Reach	Composition Each event is inclusive of the more frequent event)
NS AOI 1	Leon Creek Reach 7	17 single family residential structures in the 10 year event 69 single family residential structures in the 25 year event 1 mobile home in the 25 year event
NS AOI 2	Leon Creek Reaches 6 and 7	4 commercial structures in the 10 year event 1 public structure in the 10 year event 21 commercial structures in the 25 year event 6 public structures in the 25 year event 2 single family residential structures in the 25 year event
NS AOI 3	Leon Creek Reach 6	4 single family residential structures in the 25 year event 17 commercial structures in the 25 year event
NS AOI 4	Babcock Trib	7 multi-family structures in the 5 year event 7 multi-family structures in the 10 year event 2 single family residential structures in the 10 year event 7 multi-family structures in the 25 year event 4 single family residences in the 25year event
NS AOI 5	Leon Creek Reach 5R	13 commercial structures in the 25 year event 1 single family residential structures in the 25 year event
NS AOI 6	Culebra Trib A	4 single family residential structures in the 10 year event 9 single family residential structures in the 25 year event
NS AOI 7	Culebra Creek Reach 1	5 commercial structures in the 25 year event 1 single family residential structure in the 25 year event
NS AOI 8	Culebra Creek Reach 1	33 single family residential structures in the 25 year event
NS AOI 9	Culebra Creek Reach 1	6 single family residential structures in the 10 year event 26 single family residential structures in the 25 year event
NS AOI 10	Huebner Creek	11 single family residential structures in the 25 year event 1 public structure in the 25 year event
NS AOI 11	Huebner Creek	16 single family residential structures in the 25 year event 1 commercial structure in the 25 year event
NS AOI 12	No AOI 12 was actually identified. Number was inadvertently skipped when areas were being selected and named.	
NS AOI 13	Leon Creek Trib F	20 single family residential structures in the 25 year event 1 public structure in the 25 year event
NS AOI 14	Leon Creek Reach 2	10 single family residential structures in the 10 year event 14 commercial structures in the 10 year event 81 mobile homes in the 10 year event 12 single family residential structures in the 25 year event

		19 commercial structures in the 25 year event 85 mobile homes in the 25 year event
NS AOI 15	Leon Creek Reach 2	5 single family residential structures in the 10 year event 6 commercial structures in the 10 year event 13 single family structures in the 25 year event 6 commercial structures in the 25 year event 27 mobile homes in the 25 year event
NS AOI 16	Indian Creek	6 commercial structures in the 5 year event 9 commercial structures in the 25 year event
NS AOI 17	Indian Creek	13 agricultural barns in the 10 year event 1 single family residential structure in the 10 year event

To initially screen the non-structural alternatives for each event for each area of interest, acquisition costs of each structure were based on the value of improvements and land from the county appraisal district database. These values are lower than the actual market value of the properties, so any alternatives that would not generate positive net benefits with these values would not generate positive net benefits from values determined from real estate reconnaissance. Demolition and debris removal costs for each alternative were based on a square foot price taken from costs estimates prepared for other studies in the district.

To determine annual benefits, a separate HEC-FDA run was made for each AEP Event for each non-structural AOI. The resulting equivalent damages for each run would represent the reduction in annual equivalent damages for the alternative, and would therefore be equivalent to the benefits derived from their permanent removal.



US Army Corps of Engineers
Fort Worth District

FIGURE A-9.
LEON CREEK
AFB
ECONOMIC
NON-STRUCTURAL
AREA OF INTEREST

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Table A-32. Annual Net Benefits for Preliminary Screen of Non-Structural Alternatives

Non-Structural Area of Interest	AEP Event	Annual Benefits	Annual Costs	Annual Net Benefits	Benefit-to-Cost Ratio
NS AOI 1	10	$265,790	$278,410	-$12,620	.95
	25	637, 580	1,070,659	-433,079	.60
NS AOI 2	10	26,060	122,164	--96,104	.21
	25	919,270	969,036	-49,766	.95
NS AOI 3	25	59,780	162,101	-102,321	.37
NS AOI 4	5	71,468	55,298	16,170	1.29
	10	98,832	98,192	640	1.01
	25	358,580	135,111	223,469	2.65
NS AOI 5	25	258,690	286,421	-27,731	.90
NS AOI 6	10	22,770	38,650	-15,880	.59
	25	36,990	106,034	-69,044	.35
NS AOI 7	25	17,510	49,647	-32,137	.35
NS AOI 8	25	171,400	325,183	-153,783	.53
NS AOI 9	10	50,640	64,038	-13,398	.79
	25	156,970	273,679	-116,709	.57
NS AOI 10	25	40,340	131,148	-90,808	.31
NS AOI 11	25	48,800	150,291	-101,491	.32
NS AOI 13	25	73,020	267,730	-194,710	.27
NS AOI 14	10	275,490	369,235	-93,475	.75
	25	293,620	411,416	-117,796	.71
NS AOI 15	10	30,440	61,245	-30,805	..50
	25	141,710	127,609	14,101	1.11
NS AOI 16	5	910	62,821	-61,911	.01
	25	1,520	100,847	-99,327	.02
NS AOI 17	10	47,430	26,640	20,790	1.78

Knowing that cost estimates used for preliminary analysis were understated, those alternatives with negative net benefits would not realize an increase in net benefits.

NS AOI 4 (5-, 10-, and 25-year AEP alternatives), NS AOI 5 (25-year), NS AOI 9 (10-year), NS AOI 14 (10-, and 25-year), and NS AOI 15(10-, and 25-year) alternatives were carried forward for because of positive net benefits or the possible potential for adding recreation or ecosystem restoration. NS AOI 17 had positive net benefits, but with further investigation, the structures were on a single isolated parcel with a single land owner and not near any of the other non-structural alternatives. NS AOI 17 was not carried forward.

For those alternatives carried forward, real estate costs were developed at a reconnaissance level and quantities developed by civil engineering for demolition and debris removal were used by cost engineering to develop first costs. Table A.33 presents the net benefit calculated for these alternatives using refined costs.

Table A-33. Evaluation of Non-Structural Alternatives Using Refined Costs

Alternative	First Cost	Annual Cost	Annual Benefit	Net Benefits	Benefit-to-Cost Ratio
NS AOI 4 5 Yr	$1,174,157	$58,053	$71,468	$13,415	1.23
NS AOI 4 10 Yr	2.048,758	101,296	98,832	-2,464	.98
NS AOI 4 25 Yr	2,801,744	138,525	358,580	220,055	2.59
NS AOI 5 15 Yr	9,455,887	467,524	258,690	-208,834	.55
NS AOI 9 10 Yr	1,851,643	91.550	50,460	-41,090	.55
NS AOI 14 10 Yr	8,569,969	423,722	275,490	-148,232	.65
NS AOI 14 25 Yr	9,387,157	464,125	293,620	-170,505	.63
NS AOI 15 10 Yr	1,455,581	71,968	30,440	-41,528	.42
NS AOI 15 25 Yr	3,663,906	181,153	141,710	-39,443	.78

Only alternatives in NS AOI 4 had positive net annual benefits. Of these alternatives, the 25 year AEP alternative had the greatest net annual net benefits and was carried forward for consideration of inclusion in the tentatively selected plan.

The 25-year alternatives in NS AOI 14 and 15 however, also became potential candidates for inclusion in the tentatively selected plan. The two alternatives are adjacent to each other and provide a considerably large tract of land. Late in plan evaluation, the sponsor expressed interest in these areas for recreation purposes because the tracts are adjacent to an existing trail system and would allow extension of the trails to additional neighborhoods and could include additional recreation features. A preliminary screening analysis using existinig information from other studies was used to test the feasibility of recreation increasing the benefit-to-cost ratio above 1.0.

Features shown in table A-34 were used, with an estimated first cost of $2,790,491 developed by the cost estimationg section.

Table A-34. Recreation Features Considered

Feature	Number	LG/Area	Unit
Multi Use Trails		3.083	Miles
Picnic Areas	18	0.05	Acres
Playground Areas	2	0.05	Acres

Multi-Use Playfield Area (Open Space)	2	39.48	Acres
Parking Lots	2	6.57	Acres

Utilizing other feasibility studies in the region, a unit-day value of 3.72. Visitor days adopted from the Texas Outdoor Recreation Plan for trails and picnic sites were weighted for seasonality with a factor of .66 to account for features not being in full use year around. Additionally, visitor days were weighted with demand factors of 0.2, 0.3, 0.4, 0.5 and 0.8 to demonstrate a sensitivity analysis of the recreation benefits by considering only 20 percent, 30 percent, etc, of the assumed visitor days.. Table A-35 shows the estimated number of visitor days and annual benefits for each demand factor scenario. All dollar values are in October 2010 prices.

TableA-35. Visitor Days and Annual Benefits Under Varying Demand Factors

	Recreation Benefits with Varying Demand Factors									
	0.2		0.3		0.4		0.5		0.8	
Feature	Visitor Days	Annual Benefits	Visitor Days	Annual Benefits	Visitor Days	Annual Benefits	Visitor Days	Annual Benefits	Visitor Days	Annual Benefits
Multi Use Trails	22,834	$84,943	34,521	$127,415	45,668	$169,886	57,085	$212,358	91,337	$339,772
Picnic Areas	6,175	22,970	6,175	22,970	6,175	22,970	6,175	22,970	6,175	22,970
Playground and Multi-Use Areas	4,000	14,880	4,000	14,880	4,000	14,880	4,000	14,880	4,000	14,880
Total	33,009	$122,793	44,696	$165,265	55,843	$207,736	67,260	$250,208	101,512	$377,622

The first cost of non-structural measures in AOI 14 and 15 were $13,051,063. When combined with the cost of recreation features, the first cost is $15,841,554. Using a federal interest rate of 4.125 and a 50 year period of analysis, the annual cost including recreation is $849,511. Table A-36 shows the net benefits under each of the demand factor scenarios. Under all of the conditions, net benefits remained less than 0, and not economically justifiable. Recreation measures were screened from further analysis.

Table 36. Combined FRM and Recreation Net Benefits by Demand Factor

Cost/Benefit	NS AOI 14 and 15 Combined	FRM and Recreation Benefits Combined by Demand Factor				
		0.2	0.3	0.4	0.5	0.8
First Cost	$13,051,063	$15,841,554	$15,841,554	$15,841,554	$15,841,554	$15,841,554
Annual Cost	645,278	849,511	849,511	849,511	849,511	849,511
Annual FRM Benefits	435,330	435,330	435,330	435,330	435,330	435,330
Annual Recreation Benefits	0	122,793	162,625	207,736	250,208	377,622
Total Annual Benefits	435,330	558,123	597,955	643,066	685,538	812,952

Net Benefits	-$209,948	-$291,388	-$251,556	-$206,445	-$163,973	-$36,559
Benefit-to-Cost Ratio	0.67	0.66	0.70	0.76	0.81	0.96

Preliminary analysis of the non-structural plan in NS AOI 14 and 15 combined with recreation alternatives showed only marginal increased in net benefits and do not suggest a benefit-to-cost ratio of 1.0 or higher is likely.

WRDA Section 308 Considerations

Parcels in the non-structural plan moving forward were built after the 1991 cut-off date specified in WRDA Section 308 to be considered for economic justification However, evaluation of FIRM maps at the time the structures were built so their location to be outside of the 100 year flood plain delineation.

STRUCTURAL PLANS CARRIED FORWARD

Three structural plans had positive net benefits and were carried forward for consideration for the recommended plan: Alternative 2B with Hydraulic Mitigation, alternative 2B with Hydraulic Mitigation combined with alternative 4C (100'bypass channel), alternative 3 with hydraulic mitigation (500-year levee) combined with 4C (100' bypass channel) alternative 12, and alternative 21E. Costs used in the preliminary screening were based on cost estimates provided by Halff and Associates. For these three structural plans, planning level real estate costs were prepared by the Real Estate Division in the Fort Worth District. For construction costs, quantities were reviewed by SWF Civil Section and new cost estimates prepared by SWF Cost Estimating. A summary table for each alternative is presented below. Dollars are expressed in October 2010 values. A Federal interest rate of 4.125% was used for annualizing costs. Note: these costs include $2.2 million in environmental mitigation costs for the levee alternatives.

Additional evaluation for the 100 Year Levee with Channel Modification was conducted to ensure there were no induced damages downstream of the levee in Leon Creek Reaches 1 and 2. The charts below show the structures plotted at their river station and first floor elevations along with the water surface elevation for the eight AEP events for the with- and without project conditions for the two reaches to demonstrate no increased damages to those structures.

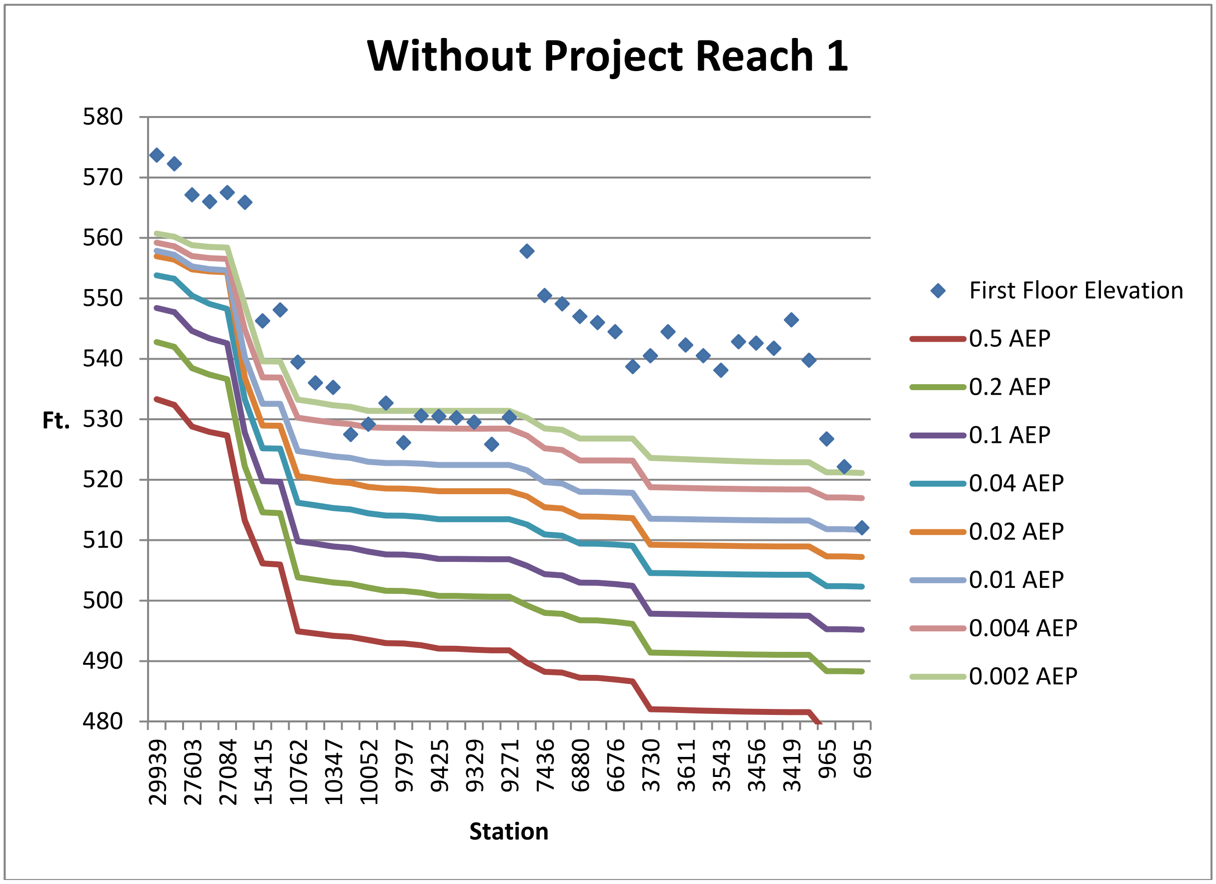


Figure A-10. Without Project Reach 1

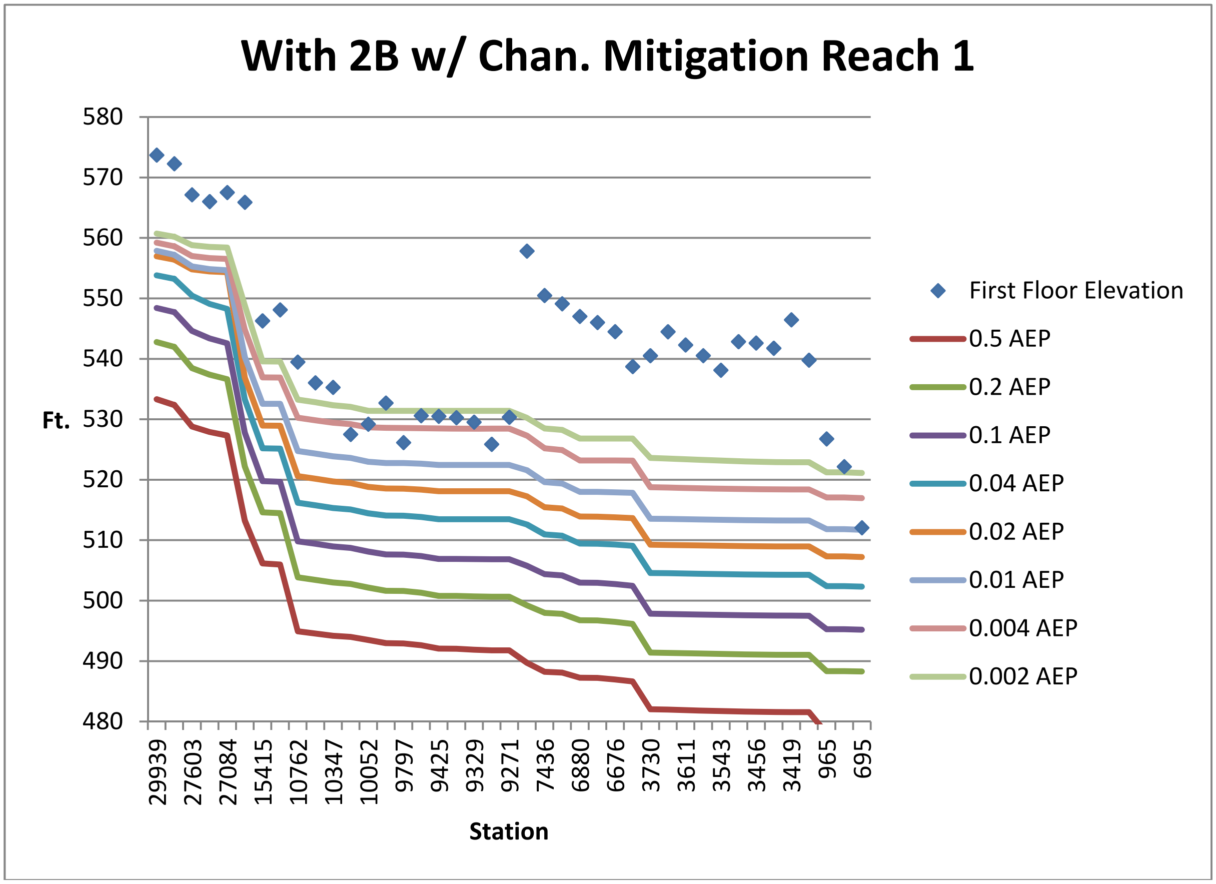


Figure A-11. With Project Reach 1

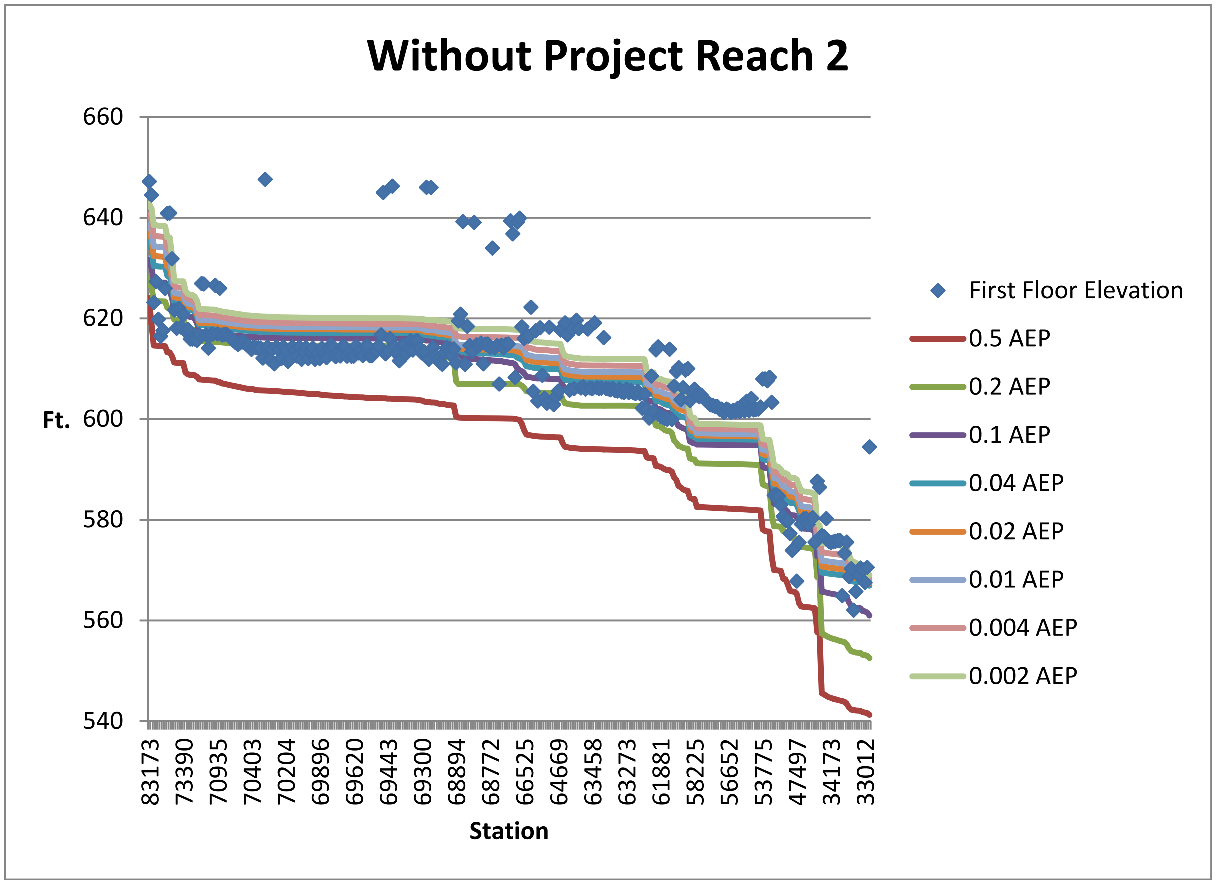


Figure A-12. Without Project Reach 2

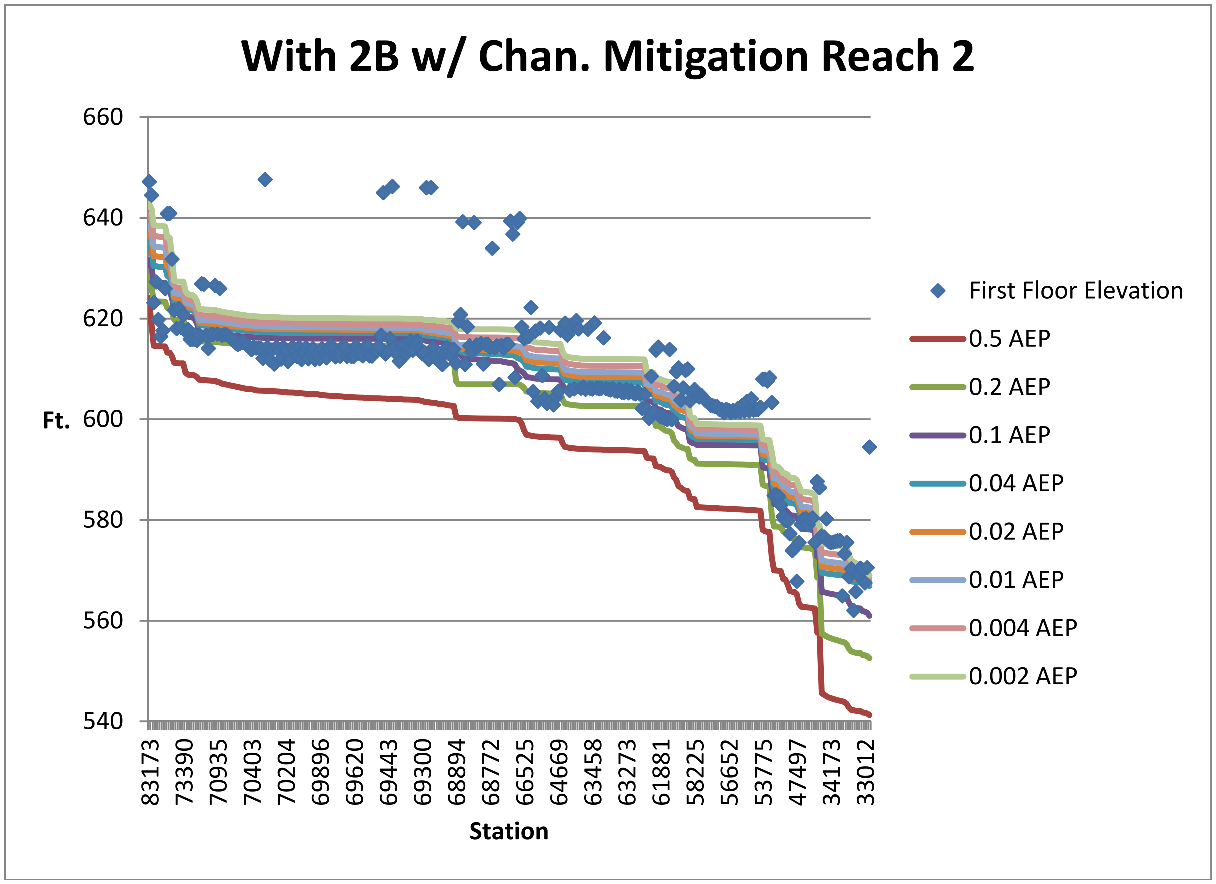


Figure A-13. With Project Reach 2

Alternative 2B: 100 Year Levee with Channel Modifications for Hydraulic Mitigation October 2010 Prices, 4.125% Interest Rate		
INVESTMENT		
	ESTIMATED FIRST COST	$14,609,877
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	18
	COMPOUND INTEREST FACTOR	18.54
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$1,046,912
	INVESTMENT COST	$15,656,789
ANNUAL CHARGES		
	INTEREST	$645,843
	AMORTIZATION	$98,653
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$794,496**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$1,749,500
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$1,749,500**
	NET BENEFITS	$955,004
	BENEFIT-TO-COST RATIO	**2.20**

Alternative 2B: 100 Year Levee with Channel Modifications for Hydraulic Mitigation and Bypass Channel **October 2010 Prices, 4.125% Interest Rate**		
INVESTMENT		
	ESTIMATED FIRST COST	$18,472,644
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	18
	COMPOUND INTEREST FACTOR	18.54
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$1,323,709
	INVESTMENT COST	$19,796,353
ANNUAL CHARGES		
	INTEREST	$816,600
	AMORTIZATION	$124,737
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$991,336**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$1,750,260
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$1,750,260**
	NET BENEFITS	$758,924
	BENEFIT-TO-COST RATIO	**1.77**

Alternative 3: 500 Year Levee with Channel Modifications for Hydraulic Mitigation and Bypass Channel **October 2010 Prices, 4.125% Interest Rate**		
INVESTMENT		
	ESTIMATED FIRST COST	$19,610,811
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	18
	COMPOUND INTEREST FACTOR	18.54
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$1,405,268
	INVESTMENT COST	$21,016,079
ANNUAL CHARGES		
	INTEREST	$866,913
	AMORTIZATION	$132,422
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$1,049,336**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$1,938,090
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$1,938,090**
	NET BENEFITS	$888,754
	BENEFIT-TO-COST RATIO	**1.85**

Of the three alternatives considered for AOI 2, alternative 2B, consisting of the 100 year levee and hydraulic mitigation provided the greatest net annual benefits, $955,004. The combination of alternatives 2B and 4C generated net annual benefits of $758,924, and the combination of alternatives 3 with hydraulic mitigation and 4c generated $888,754 in net annual benefits. Alternative 2B will be an alternative carried forward to the tentatively selected plan.

Additional analysis was done to provide a bracket for the 100 year levee – a levee providing protection for the 50-year event and one for the 250-year event were tested to ensure net benefits were being maximized with the 100 year levee. The 50-year levee had an estimated cost of $12,395,251, yielding an annual cost of $681,642 at the 4.125% federal interest rate. The 50-year levee would generate $1,634,340 in annual benefits, yielding annual net benefits of $952,698 and a benefit-to-cost ratio of 2.40. The 250-year levee measure would require the addition of the bypass channel (as with the 500-

year levee). This measure yielded annual net benefits of $879,228. Given the annual net benefits, the 100-year levee provides the greatest net benefits. The probability that damaged reduced would exceed indicated values is presented in the table below.

Probability Damage Reduced Exceeds Indicated Values Reach	0.75	0.50	0.25
100 Year Levee			
Leon Creek Reach 3 Right	0	0.01	0.04
Leon Creek Reach 3 Left	875.85	1605.18	2520.97
50 Year Levee			
Leon Creek Reach 3 Right	0	0.01	0.04
Leon Creek Reach 3 Left	861.08	1585.85	2346.82
250 Year Levee			
Leon Creek Reach 3 Right	0	0.01	0.04
Leon Creek Reach 3 Left	903.9	1639.32	2659.36

Alternative 12 consisted of utilizing an existing quarry as a detention site. For purposes of bracketing the alternative, costs were developed as well as an additional HEC-FDA model for an enlarged detention area achieved by further excavation of the quarry pit. The larger quarry only provides a small amount of additional annual benefits ($2,060,580 compared to $2,026,620 for the smaller quarry). However, excavation of the quarry dramatically increased annual costs, $3,791,810 compared to $554,625 for the smaller quarry, which led to negative net annual benefits for the larger quarry alternative. The costs for the two alternatives are presented below.

As discussed in the main report, consideration of the Environmental Quality (EQ) Account played a significant role in the screening process. Consideration was given to Other Social Effects, most particularly in the context of risks to human health and safety, and Regional Economic Development. However, these considerations did not significantly alter plan selection.

Alternative 12: Helotes Quarry **October 2010 Prices, 4.125% Interest Rate**		
INVESTMENT		
	ESTIMATED FIRST COST	$10,004,112
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	12
	COMPOUND INTEREST FACTOR	12.23
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$608,175
	INVESTMENT COST	$10,612,287
ANNUAL CHARGES		
	INTEREST	$437,757
	AMORTIZATION	$66,868
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$554,625**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	**$2,026,620**
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$2,026,620**
	NET BENEFITS	$1,471,995
	BENEFIT-TO-COST RATIO	**3.65**

Alternative 12: Large Helotes Quarry **October 2010 Prices, 4.125% Interest Rate**		
INVESTMENT		
	ESTIMATED FIRST COST	$74,180,830
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	12
	COMPOUND INTEREST FACTOR	12.23
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$4,509,635
	INVESTMENT COST	$78,690,466
ANNUAL CHARGES		
	INTEREST	$3,245,982
	AMORTIZATION	$495,829
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$3,791,810**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	**$2,060,580**
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$2,060,580**
	NET BENEFITS	($1,731,230)
	BENEFIT-TO-COST RATIO	**0.54**

Alternative 21e, an 85 foot channel modification on Leon Creek returned negative net benefits of $17,634 after costs were refined. As a result, it will not be carried forward as part of the tentatively selected plan.

Alternative 21e 85 ft. Leon Creek Channel Modification October 2010 Prices, 4.125% Interest Rate		
INVESTMENT		
	ESTIMATED FIRST COST	$5,008,601
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	9
	COMPOUND INTEREST FACTOR	9.12
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$68,134
	INVESTMENT COST	$5,076,735
ANNUAL CHARGES		
	INTEREST	$209,415
	AMORTIZATION	$31,989
	OPERATION/MAINTENANCE ($/year)	$50,000
	TOTAL ANNUAL CHARGES	**$291,404**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$273,770
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$273,770**
	NET BENEFITS	($17,634)
	BENEFIT-TO-COST RATIO	**0.94**

NEXT ADDED INCREMENT OF STRUCTURAL ALTERNATIVES

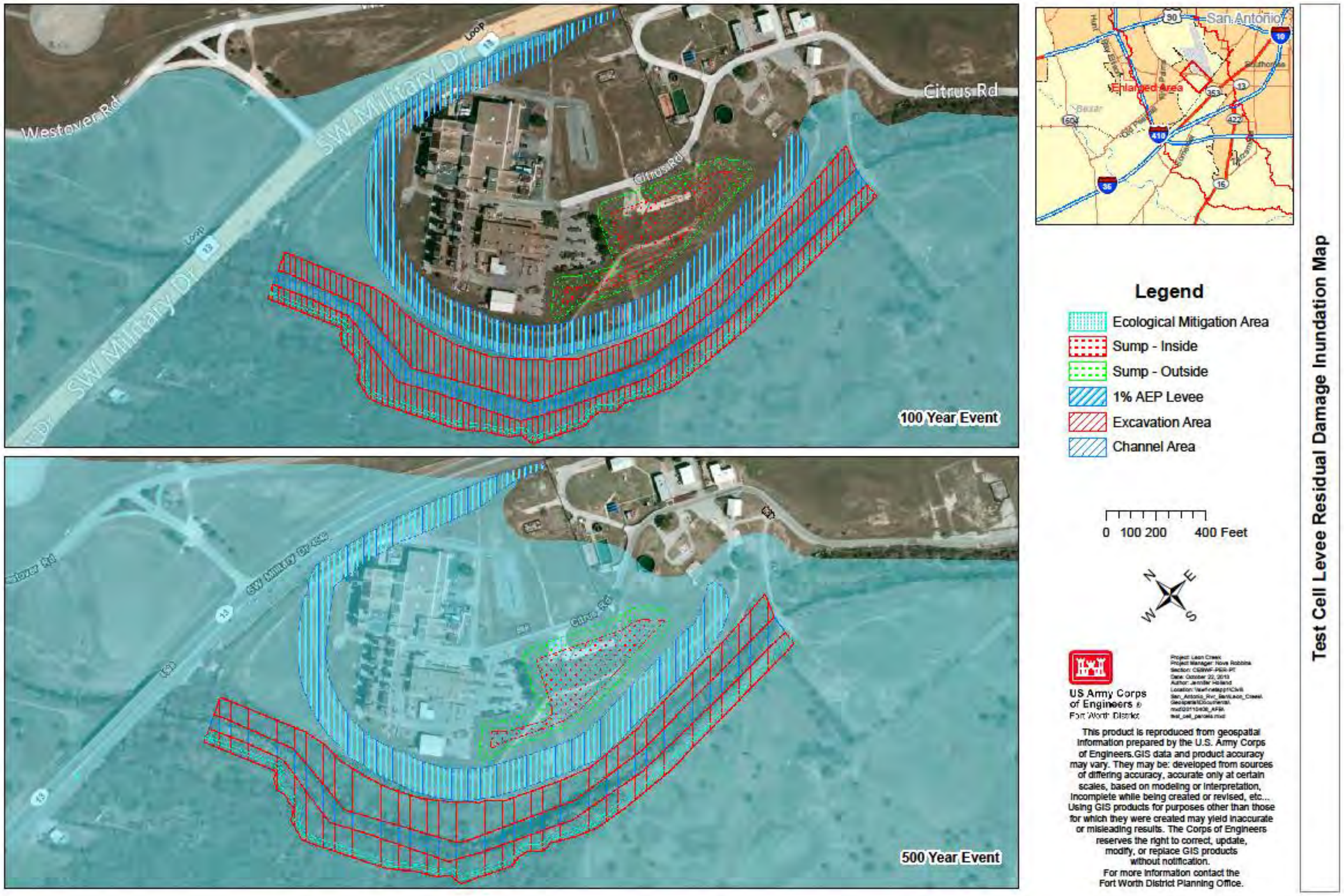
Because the levee alternative in AOI 2 were downstream of alternative 12, the Helotes Quarry, there was some potential that benefits from the quarry alternative could mute some of the benefits from the levee alternative. Additional HEC-FDA models were developed for the two structural alternatives as a combination of alternatives to ensure positive net benefits were still provided by the two alternatives. The annual net benefits of the two structural alternatives as a combined alternative are $2,209,210, and the benefit-to-cost ratio is 2.69.

100 Year Levee with Hydraulic Mitigation at Test Cell and Helotes Quarry **October 2010 Prices, 4.125% Interest Rate**		
INVESTMENT		
	ESTIMATED FIRST COST	$24,613,989
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	18
	COMPOUND INTEREST FACTOR	18.54
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$1,763,785
	INVESTMENT COST	$26,377,774
ANNUAL CHARGES		
	INTEREST	$1,088,083
	AMORTIZATION	$166,206
	OPERATION/MAINTENANCE ($/year)	$50,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$1,304,290**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	**$3,513,500**
	RECREATION BENEFITS	$0
	TOTAL ANNUAL BENEFITS	**$3,513,500**
	NET BENEFITS	$2,209,210
	BENEFIT-TO-COST RATIO	**2.69**

TENTATIVELY SELECTED PLAN

The tentatively selected plan is the National Economic Development (NED) Plan, which is the plan yielding the greatest net annual benefits. Fieldwork conducted by the team subsequent to this event established the fact that flood flows on Helotes Creek and its minor tributaries had resulted in channel movement in the vicinity of the Helotes Quarry project component. As a result of the channel migration, substantial amounts of flow now move into the quarry naturally. After extensive discussion and qualitative assessment, it was determined that most of the benefits estimated for this measure were being achieved without further expenditure. As a result, this measure was not carried forward. However, since the diversion of the stream into the quarry could not be considered a permanent condition, the original without-project were not modified and it is presumed for the model that the quarry storage is not being utilized.

The NED plan consists of Alternative 2B with hydraulic mitigation and one nonstructural buyout alternative on Babcock Trib. Figure A-14 shows an inundation map should the project be exceeded. There would be residual damages for the area protected by the levee. Events beyond the protected areas would experience damages at flooding above the protected height. For the non-structural measure, since structures are removed, there would be no residual damages to those structures, and therefore they were not mapped.


Test Cell Levee Residual Damage Inundation Map
Westover Rd
SW Military Dr
Loop 13
Citrus Rd
100 Year Event
500 Year Event
San Antonio
Enlarged Area
Bexar
Southside
90
10
410
35
13
353
422
16
Legend
Ecological Mitigation Area
Sump - Inside
Sump - Outside
1% AEP Levee
Excavation Area
Channel Area
0 100 200 400 Feet
N
E
W
S
US Army Corps of Engineers ®
Fort Worth District
Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 22, 2013
Author: Jennifer Holland

The calculation of net annual benefits for the tentatively selected plan is shown below.

NED Plan: 100 Year Test Cell Levee with Hydraulic Mitigation, Non-Structural October 2010 Prices, 4.125% Interest Rate		
INVESTMENT		
	ESTIMATED FIRST COST (Less relocation assistance)	$17,411,621
	ANNUAL INTEREST RATE	0.04125
	PERIOD OF ANALYSIS (years)	50
	CONSTRUCTION PERIOD (months)	24
	COMPOUND INTEREST FACTOR	24.97
	CAPITAL RECOVERY FACTOR	0.047551
	INTEREST DURING CONSTRUCTION	$1,439,441
	INVESTMENT COST	$18,851,062
ANNUAL CHARGES		
	INTEREST	$777,606
	AMORTIZATION	$118,781
	OPERATION/MAINTENANCE ($/year)	$59,000
	REPLACEMENTS	$0
	TOTAL ANNUAL CHARGES	**$955,387**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$2,108,080
	RECREATION BENEFITS	$0
	specify	$0
	TOTAL ANNUAL BENEFITS	**$2,108,809**
	NET BENEFITS	**$1,152,693**
	BENEFIT-TO-COST RATIO	**2.21**

The resulting annual net benefits are $1,152,693 with benefit-to-cost ratio of 2.21 using the 2010 price levels and a 4.125 federal interest rate used during plan formulation

Structure and vehicle values were adjusted to October 2013 price levels by taking a sample from the structure file and re-evaluating with Marshall and Swift Residential and Commercial estimating software. Cost estimates were also estimated at October 2013 prices, and annualized at the 3.50% federal interest rate. The following table provides the NED plan at the October 2013 price level and the 3.50% interest rate:

NED Plan: 100 Year Test Cell Levee with Hydraulic Mitigation, Non-Structural, ER Mitigation October 2013 Prices, 3.5% Interest Rate		
INVESTMENT		
	ESTIMATED FIRST COST	27,811,619
	ANNUAL INTEREST RATE	0.03500
	PERIOD OF ANALYSIS (years)	50.00
	CONSTRUCTION PERIOD (months)	24
	COMPOUND INTEREST FACTOR	24.82
	CAPITAL RECOVERY FACTOR	0.042634
	INTEREST DURING CONSTRUCTION	$937,836
	INVESTMENT COST	$28,749,455
ANNUAL CHARGES		
	INTEREST	$1,006,231
	AMORTIZATION	$219,465
	OPERATION/MAINTENANCE ($/year)	$59,000
	TOTAL ANNUAL CHARGES	**$1284,696**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$2,142,710
	TOTAL ANNUAL BENEFITS	**$2,142,710**
	NET BENEFITS	$858,014
	BENEFIT-TO-COST RATIO	**1.67**

For budgeting purposes, the NED plan is also calculated at a 7.0% federal interest rate, as shown below:

NED Plan: 100 Year Test Cell Levee with Hydraulic Mitigation, Non-Structural, ER Mitigation		
INVESTMENT		
	ESTIMATED FIRST COST	$27,811,619
	ANNUAL INTEREST RATE	0.07000
	PERIOD OF ANALYSIS (years)	50.00
	CONSTRUCTION PERIOD (months)	24
	COMPOUND INTEREST FACTOR	25.68
	CAPITAL RECOVERY FACTOR	0.072460
	INTEREST DURING CONSTRUCTION	$1,885,645
	INVESTMENT COST	$29,697,264
ANNUAL CHARGES		
	INTEREST	$2,078,808
	AMORTIZATION	$73,049
	OPERATION/MAINTENANCE ($/year)	$59,000
	TOTAL ANNUAL CHARGES	**$2210,858**
ANNUAL BENEFITS		
	FLOOD DAMAGE REDUCTION BENEFITS	$2,055,860
	TOTAL ANNUAL BENEFITS	**$2,055,860**
	NET BENEFITS	($154,998)
	BENEFIT-TO-COST RATIO	**0.93**

DEPTH-PERCENT DAMAGE FUNCTIONS

Occ Name	Occ Description	Cat_Name	Parameter	Start_Data														
S1	1 STORY RES. SLAB	R	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S1			S	0	0	2.5	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4
S1			SN	0	0	1.3	2	2	1.6	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.7
S1			Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S1			C	0	0	2.4	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2
S1			CN	0	0	2.1	1.5	1.2	1.2	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.3
S1			Struct	N		0.5		N		10		N	100	10			-901	
S1PB	1 STORY RES. PIER AND BEAM	R	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S1PB			S	0	2.5	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4	77.2
S1PB			SN	0	0	1.3	2	2	1.6	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.7
S1PB			Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S1PB			C	0	2.4	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2	39.7
S1PB			CN	0	0	2.1	1.5	1.2	1.2	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.3
S1PB			Struct	N		0.5		N		10		N	100	10			-901	
SV	PRIVATE VEHICLE	POV	Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
SV			S	0	20	50	80	100	100	100	100	100	100	100	100	100	100	100
SV			SN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
SV			Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
SV			C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV			CN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
SV			Struct	N		0.2		N		10		N	0	10			-901	
S2	garage/storage on bottom	R	Stage	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
S2			S	0	3	5	6	7	8	10	13	17	21	31.9	41.8	50.6	58.6	65.6
S2			SN	0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2

S2			Stage		-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
S2			C		0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7
S2			CN		0	3.5	2.9	2.6	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5
S2			Struct	N			0.2		N		5		N	100	10			-901	
S3	2 STORY RES.	R	Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S3			S		0	0	3	9.3	15.2	20.9	26.3	31.4	36.2	40.7	44.9	48.8	52.4	55.7	58.7
S3			SN		0	0	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2
S3			Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S3			C		0	0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	33.4	34.7
S3			CN		0	0	2.9	2.6	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5
S3			Struct	N			0.2		N		5		N	100	10			-901	
S5	cliff dweller with a room on the low side	R	Stage		-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
S5			S		0	3	5	6	7	8	10	13	17	21	31.9	41.8	50.6	58.6	65.6
S5			SN		0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	4.1	3.4	3	2.8	2.9	3.2
S5			Stage		-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4
S5			C		0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7
S5			CN		0	3.5	2.9	2.6	2.5	2.7	3	3.2	3.3	3.5	2.9	2.6	2.5	2.7	3
S5			Struct	N			0.2		N		5		N	100	10			-901	
S4	MOBILE RES.	MR	Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S4			S		0	3	9.3	15.2	20.9	26.3	31.4	54	93	93.5	94	94.5	95	95.5	96
S4			SN		0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2
S4			Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S4			C		0	0	5	8.7	12	23	36	43	55	66	78	86	100	100	100
S4			CN		0	3.5	2.9	2.6	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5
S4			Struct	N			0.2		N		10		N	100	10			-901	
S6	1 STORY APT.	MFR	Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S6			S		0	0	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4	77.2
S6			SN		0	2.7	2	2	1.6	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.7	3
S6			Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12

S6			C		0	0	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2	39.7
S6			CN		0	2.1	1.5	1.2	1.2	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.3	2.6
S6			Struct	N			0.2		N		10		N	100	10			-901	
S7	2 STORY APT.	MFR	Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S7			S		0	0	9.3	15.2	20.9	26.3	31.4	36.2	40.7	44.9	48.8	52.4	55.7	58.7	61.4
S7			SN		0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2
S7			Stage		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
S7			C		0	0	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7
S7			CN		0	3.5	2.9	2.6	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5
S7			Struct	N			0.2		N		10		N	100	10			-901	
1	AIRPORT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1			S		0	0	17	17	20	23	27	28	30	32	34	40	40	40	40
1			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
1			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1			C		0	0	22	30	35	40	53	55	57	57	57	57	70	70	70
1			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
1			Struct	N			0.2		N		15			-901				-901	
3	ANTIQUE SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
3			S		0	0	17	17	18	19	21	23	25	28	32	35	39	43	47
3			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
3			C		0	20	40	78	85	90	95	100	100	100	100	100	100	100	100
3			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3			Struct	N			0.2		N		15			-901				-901	
5	APPLIANCE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
5			S		0	0	17	17	18	19	21	23	25	28	32	35	39	43	47
5			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
5			C		0	0	64	71	90	95	98	100	100	100	100	100	100	100	100

5			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5			Struct	N			0.2		N		15			-901				-901	
7	AUTO DEALERSHIP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
7			S		0	0	17	17	18	19	21	23	25	28	32	35	39	43	49
7			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
7			C		0	10	40	70	90	90	90	90	90	90	90	90	95	95	95
7			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7			Struct	N			1.5		N		37		N	648	37			-901	
9	AUTO JUNKYARD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
9			S		0	0	2	4	5	7	8	10	11	13	14	15	16	16	16
9			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
9			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
9			C		0	0	9	13	16	17	18	19	19	19	19	19	19	20	20
9			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
9			Struct	N			0.2		N		15			-901				-901	
11	AUTO PARTS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
11			S		0	0	5	5	5	5	7	10	14	19	25	32	40	50	57
11			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
11			C		0	0	17	28	56	66	85	94	94	94	94	94	94	94	94
11			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11			Struct	N			0.2		N		15			-901				-901	
13	AUTO REPAIR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
13			S		0	0	3	3	3	4	5	8	12	17	23	31	40	48	56
13			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
13			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
13			C		0	23	53	74	100	100	100	100	100	100	100	100	100	100	100
13			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

13			Struct	N			1.5		N		37		N	71	37			-901	
15	AUTO SERVICE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
15			S		0	0	3	3	3	4	5	8	12	17	23	31	40	48	56
15			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
15			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
15			C		0	10	40	60	85	100	100	100	100	100	100	100	100	100	100
15			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
15			Struct	N			0.2		N		15			-901				-901	
17	AUTO TRANS SVC	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
17			S		0	0	3	3	3	4	5	8	12	17	23	31	40	48	56
17			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
17			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
17			C		0	0	10	20	40	60	100	100	100	100	100	100	100	100	100
17			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
17			Struct	N			0.2		N		15			-901				-901	
19	BAIT STAND	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
19			S		0	0	1	2	5	8	12	17	22	28	36	43	50	58	66
19			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
19			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
19			C		0	0	3	7	11	16	22	29	36	44	52	60	69	79	88
19			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
19			Struct	N			0.2		N		15			-901				-901	
21	BAKERY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
21			S		0	12	17	21	25	28	31	34	36	38	41	43	45	47	48
21			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
21			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
21			C		0	53	63	89	100	100	100	100	100	100	100	100	100	100	100
21			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
21			Struct	N			0.2		N		15			-901				-901	

23	BANK	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
23			S		0	0	11	11	12	13	15	17	19	22	24	28	31	34	37
23			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
23			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
23			C		0	0	50	78	87	100	100	100	100	100	100	100	100	100	100
23			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
23			Struct	N			1.5		N		37		N	39	37			-901	
25	BARBER SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
25			S		0	0	13	17	18	24	31	37	41	45	47	49	50	50	51
25			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
25			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
25			C		0	21	28	38	49	63	79	96	96	96	96	96	96	96	96
25			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
25			Struct	N			0.2		N		15			-901				-901	
27	BATTERY MFG	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
27			S		0	0	3	3	3	4	5	8	10	17	23	31	40	48	48
27			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
27			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
27			C		0	0	10	13	20	23	32	38	42	42	45	45	45	45	55
27			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
27			Struct	N			0.2		N		15			-901				-901	
29	BEAUTY SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
29			S		0	0	10	14	17	23	28	34	38	43	47	50	54	57	61
29			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
29			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
29			C		0	20	46	61	74	100	100	100	100	100	100	100	100	100	100
29			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
29			Struct	N			1.5		N		37		N	74	37			-901	
31	BICYCLE SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

31			S		0	0	20	24	28	32	35	39	43	47	50	55	60	60	60
31			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
31			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
31			C		0	0	17	25	42	57	59	61	63	63	63	63	63	63	63
31			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
31			Struct	N			0.2		N		15			-901				-901	
33	BOAT PARTY FISH	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
33			S		0	10	20	20	20	20	20	20	20	20	20	20	20	20	20
33			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
33			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
33			C		0	27	62	76	76	92	92	92	92	92	92	92	92	92	92
33			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
33			Struct	N			0.2		N		15			-901				-901	
35	BOAT SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
35			S		0	14	20	32	33	34	36	38	42	50	56	60	63	67	70
35			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
35			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
35			C		0	13	24	43	82	95	100	100	100	100	100	100	100	100	100
35			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
35			Struct	N			0.2		N		15			-901				-901	
37	BOAT STALLS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
37			S		0	0	10	19	26	32	40	48	56	64	71	78	85	91	97
37			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
37			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
37			C		0	0	3	6	8	11	13	15	17	19	21	22	24	25	27
37			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
37			Struct	N			0.2		N		15			-901				-901	
39	BOAT STORAGE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
39			S		0	0	4	5	7	10	13	16	22	26	31	37	43	49	55

39			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
39			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
39			C		0	1	4	7	12	18	24	32	40	48	54	58	63	66	68
39			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
39			Struct	N			0.2		N		15			-901				-901	
41	BOILER BUILDING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
41			S		0	0	1	1	13	5	8	12	16	21	26	32	38	45	45
41			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
41			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
41			C		0	0	5	10	10	10	20	20	20	20	20	20	20	20	20
41			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
41			Struct	N			0.2		N		15			-901				-901	
43	BOOK STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
43			S		0	0	2	3	5	8	10	12	15	17	20	23	27	31	35
43			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
43			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
43			C		0	5	10	30	50	70	85	100	100	100	100	100	100	100	100
43			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
43			Struct	N			1.5		N		37		N	40	37			-901	
45	BOWLING ALLEY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
45			S		0	0	4	7	11	15	19	23	27	31	35	39	44	49	53
45			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
45			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
45			C		0	10	30	50	70	85	100	100	100	100	100	100	100	100	100
45			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
45			Struct	N			0.2		N		15			-901				-901	
47	BUSINESS SVCS.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
47			S		0	0	1	2	3	5	8	11	13	16	18	21	25	29	34
47			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

47			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
47			C		0	0	2	6	10	15	19	24	28	33	38	44	49	55	62
47			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
47			Struct	N			0.2		N		15			-901				-901	
49	CABINET MFG	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
49			S		0	0	20	22	24	26	28	30	35	40	43	46	50	50	50
49			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
49			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
49			C		0	40	60	70	80	100	100	100	100	100	100	100	100	100	100
49			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
49			Struct	N			0.2		N		15			-901				-901	
51	CAR WASH	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
51			S		0	0	0	0	2	5	10	10	15	15	20	20	25	25	30
51			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
51			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
51			C		0	0	11	26	40	51	62	76	76	76	76	76	76	76	81
51			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
51			Struct	N			1.5		N		37		N	57	37			-901	
53	CARPET AND PAINT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
53			S		0	0	0	60	60	60	60	60	60	60	60	60	60	80	80
53			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
53			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
53			C		0	0	21	43	65	83	96	97	99	100	100	100	100	100	100
53			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
53			Struct	N			0.2		N		15			-901				-901	
55	CEMETARY COMPLEX	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
55			S		0	0	19	23	25	25	25	26	27	28	31	35	41	50	58
55			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
55			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

55			C		0	0	38	43	79	90	97	97	97	97	97	97	97	97	97
55			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
55			Struct	N			0.2		N		15			-901				-901	
57	CERAMIC CRAFTS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
57			S		0	0	20	22	24	26	27	28	29	30	40	50	50	50	50
57			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
57			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
57			C		0	0	20	60	80	96	96	96	96	96	96	96	96	96	96
57			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
57			Struct	N			0.2		N		15			-901				-901	
59	CHURCH	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
59			S		0	0	10	11	11	12	12	13	14	14	15	17	19	24	30
59			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
59			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
59			C		0	10	38	62	76	87	92	96	98	99	100	100	100	100	100
59			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
59			Struct	N			1.5		N		37		N	11	37			-901	
61	CITY HALL	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
61			S		0	0	1	1	1	2	2	3	4	6	8	12	17	23	31
61			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
61			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
61			C		0	0	35	75	85	95	100	100	100	100	100	100	100	100	100
61			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
61			Struct	N			0.2		N		15			-901				-901	
63	CLEANERS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
63			S		0	0	4	6	6	8	10	13	17	22	28	34	42	50	57
63			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
63			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
63			C		0	0	20	40	60	80	100	100	100	100	100	100	100	100	100

63			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
63			Struct	N			0.2		N		15			-901				-901	
65	CLEANERS SUBSTAION	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
65			S		0	0	4	6	6	8	10	13	17	22	28	34	42	50	57
65			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
65			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
65			C		0	0	47	72	89	100	100	100	100	100	100	100	100	100	100
65			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
65			Struct	N			0.2		N		15			-901				-901	
67	CLINIC: MEDICAL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
67			S		0	0	1	2	2	3	4	6	8	11	14	17	21	25	29
67			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
67			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
67			C		0	10	20	40	60	80	90	95	100	100	100	100	100	100	100
67			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
67			Struct	N			0.2		N		15			-901				-901	
69	CLOTHING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
69			S		0	0	8	10	11	13	15	18	21	24	28	32	37	41	46
69			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
69			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
69			C		0	6	37	49	74	87	100	100	100	100	100	100	100	100	100
69			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
69			Struct	N			0.2		N		15			-901				-901	
71	CLOTHING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
71			S		0	0	15	20	20	20	20	22	24	25	25	25	25	25	25
71			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
71			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
71			C		0	0	19	27	39	49	59	59	59	59	59	59	59	59	59
71			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

71			Struct	N			0.2		N		15			-901				-901	
73	CONCRETE MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
73			S		0	0	30	30	30	30	30	30	30	30	30	30	30	30	30
73			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
73			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
73			C		0	0	20	60	67	74	80	90	100	100	100	100	100	100	100
73			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
73			Struct	N			0.2		N		15			-901				-901	
75	CONTRACTOR: ELEC	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
75			S		0	0	4	7	9	12	13	14	15	15	15	15	18	20	21
75			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
75			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
75			C		0	0	13	25	33	41	46	49	51	52	53	53	56	57	58
75			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
75			Struct	N			0.2		N		15			-901				-901	
77	CONTRACTOR: GENL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
77			S		0	0	14	22	26	29	32	33	34	35	35	35	41	43	45
77			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
77			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
77			C		0	0	25	41	54	63	72	82	91	100	100	100	100	100	100
77			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
77			Struct	N			0.2		N		15			-901				-901	
79	CONTRACTOR: ROOF	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
79			S		0	0	14	21	25	27	28	30	30	30	30	30	32	34	35
79			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
79			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
79			C		0	0	13	25	33	41	46	49	51	52	53	53	56	57	58
79			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
79			Struct	N			0.2		N		15			-901				-901	

81	CONSTRUCTION CO.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
81			S		0	0	10	20	30	40	50	60	70	80	90	100	100	100	100
81			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
81			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
81			C		0	0	25	41	54	63	72	82	91	100	100	100	100	100	100
81			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
81			Struct	N			0.2		N		15			-901				-901	
83	CONVENIENCE STOR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
83			S		0	0	20	22	24	26	28	30	32	34	36	38	39	40	43
83			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
83			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
83			C		0	0	40	50	70	80	95	95	96	96	96	96	96	96	97
83			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
83			Struct	N			1.5		N		37		N	76	37			-901	
85	COOLING TOWER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
85			S		0	0	10	20	20	50	50	60	60	75	75	80	80	80	80
85			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
85			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
85			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
85			Struct	N			0.2		N		15			-901				-901	
87	COUNTRY CLUB/GOLF	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
87			S		0	0	7	8	8	9	10	11	12	13	14	15	18	21	24
87			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
87			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
87			C		0	36	39	42	46	51	55	61	66	73	79	86	93	99	99
87			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
87			Struct	N			0.2		N		15			-901				-901	
89	DAIRY FARM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

89			S		0	0	20	22	24	28	30	32	34	38	42	45	50	55	55
89			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
89			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
89			C		0	0	25	50	75	95	95	95	95	95	95	95	95	95	95
89			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
89			Struct	N			0.2		N		15			-901				-901	
91	DAIRY PROCESSING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
91			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
91			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
91			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
91			C		0	0	8	33	58	66	66	66	66	73	86	86	86	86	86
91			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
91			Struct	N			0.2		N		15			-901				-901	
93	DAY CARE CENTER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
93			S		0	0	15	16	16	20	25	29	33	37	41	44	47	50	53
93			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
93			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
93			C		0	0	24	50	88	100	100	100	100	100	100	100	100	100	100
93			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
93			Struct	N			1.5		N		37		N	22	37			-901	
95	DENTIST OFFICE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
95			S		0	7	35	35	35	35	35	35	36	37	38	39	41	42	44
95			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
95			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
95			C		0	0	22	47	64	76	88	100	100	100	100	100	100	100	100
95			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
95			Struct	N			0.2		N		15			-901				-901	
97	DEODERIZER BLDG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
97			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45

97			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
97			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
97			C		0	0	11	17	23	23	24	29	29	29	30	30	30	30	30
97			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
97			Struct	N			0.2		N		15			-901				-901	
99	DEPARTMENT STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
99			S		0	0	3	7	7	7	9	11	14	17	20	23	26	30	33
99			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
99			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
99			C		0	0	18	33	65	88	95	100	100	100	100	100	100	100	100
99			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
99			Struct	N			0.2		N		15			-901				-901	
101	DOCTOR OFFICE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
101			S		0	0	1	3	4	6	9	11	14	17	20	24	29	35	42
101			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
101			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
101			C		0	10	20	40	60	80	90	95	100	100	100	100	100	100	100
101			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
101			Struct	N			1.5		N		37		N	92	37			-901	
103	DOOR MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
103			S		0	0	14	22	26	29	32	33	34	35	35	35	35	41	43
103			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
103			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
103			C		0	0	17	35	68	90	93	97	98	100	100	100	100	100	100
103			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
103			Struct	N			0.2		N		15			-901				-901	
105	DRAPERY SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
105			S		0	0	15	20	30	35	40	45	50	60	70	80	85	90	95
105			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

105			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
105			C		0	0	18	30	45	63	83	100	100	100	100	100	100	100	100
105			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
105			Struct	N			0.2		N		15			-901				-901	
107	DRUG STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
107			S		0	0	1	5	5	5	7	8	11	14	18	22	27	33	38
107			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
107			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
107			C		0	0	20	50	80	90	100	100	100	100	100	100	100	100	100
107			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
107			Struct	N			0.2		N		15			-901				-901	
109	ELECTRONICS SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
109			S		0	0	13	20	24	27	28	30	30	30	30	30	32	33	34
109			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
109			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
109			C		0	0	25	42	59	76	88	100	100	100	100	100	100	100	100
109			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
109			Struct	N			0.2		N		15			-901				-901	
111	ELECTRONICS MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
111			S		0	0	13	20	24	27	28	30	30	30	30	30	32	33	34
111			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
111			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
111			C		0	0	16	32	48	64	73	82	91	100	100	100	100	100	100
111			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
111			Struct	N			0.2		N		15			-901				-901	
113	ENGINE ROOM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
113			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
113			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
113			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

113			C		0	0	20	25	30	35	40	45	50	55	65	65	65	65	65
113			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
113			Struct	N			0.2		N		15			-901				-901	
115	EQUIP. STORAGE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
115			S		0	0	0	3	5	6	7	8	10	13	17	21	25	30	40
115			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
115			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
115			C		0	5	10	15	20	30	40	50	60	70	80	90	100	100	100
115			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
115			Struct	N			0.2		N		15			-901				-901	
117	FABRICATION SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
117			S		0	0	2	5	10	15	20	25	30	35	40	50	75	75	75
117			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
117			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
117			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80
117			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
117			Struct	N			0.2		N		15			-901				-901	
119	FEED STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
119			S		0	0	20	24	28	32	34	36	38.9	40	42	44	46	48	50
119			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
119			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
119			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80
119			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
119			Struct	N			0.2		N		15			-901				-901	
121	FEED MILL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
121			S		0	0	0	0	0	20	23	27	30	33	37	40	43	47	50
121			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
121			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
121			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80

121			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
121			Struct	N			0.2		N		15			-901				-901	
123	FILTERING PLANT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
123			S		0	0	5	15	30	60	90	90	90	90	90	90	90	90	90
123			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
123			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
123			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80
123			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
123			Struct	N			0.2		N		15			-901				-901	
125	FIREWORKS SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
125			S		0	0	0	10	15	15	15	15	15	15	15	15	15	15	15
125			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
125			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
125			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80
125			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
125			Struct	N			0.2		N		15			-901				-901	
127	FIRE STATION	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
127			S		0	0	1	5	5	5	6	8.7	9	11	14	17	20	24	28
127			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
127			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
127			C		0	0	10	20	30	40	50	60	70	75	80	80	80	80	80
127			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
127			Struct	N			1.5		N		37		N	326	37			-901	
129	FLEA MARKET	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
129			S		0	1	2	2	3	4	4	4	4	4	4	4	4	4	4
129			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
129			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
129			C		0	40	60	80	100	100	100	100	100	100	100	100	100	100	100
129			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

129			Struct	N			0.2		N		15			-901				-901	
131	FLOOR & CARPET	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
131			S		0	0	2	3	4	4	5	7	9	13	18	22	29	35	42
131			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
131			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
131			C		0	0	61	81	91	93	95	97	99	100	100	100	100	100	100
131			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
131			Struct	N			0.2		N		15			-901				-901	
133	FLORIST	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
133			S		0	0	7	7	8	9	11	13	16	19	22	26	30	34	38
133			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
133			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
133			C		0	0	61	81	91	93	95	97	99	100	100	100	100	100	100
133			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
133			Struct	N			0.2		N		15			-901				-901	
135	FOOD PROCESSOR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
135			S		0	0	6	6	6	6	10	14	18	20	20	20	20	20	20
135			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
135			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
135			C		0	0	61	81	91	93	95	97	99	100	100	100	100	100	100
135			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
135			Struct	N			1.5		N		37		N	117	37			-901	
137	FOOD WAREHOUSE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
137			S		0	0	0	10	11	12	13	13	14	14	15	15	17	18	19
137			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
137			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
137			C		0	0	24	39	54	68	83	88	88	88	88	88	88	88	89
137			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
137			Struct	N			0.2		N		15			-901				-901	

139	FOUNDARY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
139			S		0	0	5	10	20	30	30	50	70	70	70	75	75	80	80
139			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
139			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
139			C		0	10	17	24	29	34	38	43	45	50	58	62	66	69	74
139			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
139			Struct	N			0.2		N		15			-901				-901	
141	FRAME SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
141			S		0	0	20	22	24	26	28	30	35	40	43	46	50	50	50
141			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
141			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
141			C		0	0	16	45	80	88	93	95	98	100	100	100	100	100	100
141			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
141			Struct	N			0.2		N		15			-901				-901	
143	FRUIT STAND	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
143			S		0	0	1	2	5	8	28	12	17	22	28	36	43	50	58
143			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
143			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
143			C		0	0	45	80	90	100	100	100	100	100	100	100	100	100	100
143			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
143			Struct	N			0.2		N		15			-901				-901	
145	FUNERAL HOME	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
145			S		0	0	1	5	5	5	6	7	9	11	14	17	20	24	28
145			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
145			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
145			C		0	0	10	30	60	90	100	100	100	100	100	100	100	100	100
145			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
145			Struct	N			1.5		N		37		N	54	37			-901	
147	FURNITURE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

147			S		0	0	2	4	4	5	6	7	9	11	14	17	21	25	29
147			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
147			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
147			C		0	40	60	70	80	100	100	100	100	100	100	100	100	100	100
147			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
147			Struct	N			0.2		N		15			-901				-901	
149	FURNITURE MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
149			S		0	0	10	20	24	28	32	38	42	46	48	50	50	50	50
149			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
149			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
149			C		0	40	60	70	80	100	100	100	100	100	100	100	100	100	100
149			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
149			Struct	N			0.2		N		15			-901				-901	
151	GARAGE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
151			S		0	0	3	5	6	7	8	10	13	17	21	25	30	35	41
151			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
151			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
151			C		0	0	11	17	20	23	25	29	35	42	51	63	77	93	100
151			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
151			Struct	N			0.2		N		15			-901				-901	
153	GAS-BUTANE SUPPL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
153			S		0	17	17	17	17	23	32	45	55	61	66	69	73	76	78
153			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
153			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
153			C		0	0	25	46	65	75	81	86	90	94	96	100	100	100	100
153			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
153			Struct	N			0.2		N		15			-901				-901	
155	GIFT SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
155			S		0	0	5	8	9	9	9	11	14	18	24	31	40	50	58

155			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
155			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
155			C		0	0	54	63	75	88	100	100	100	100	100	100	100	100	100
155			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
155			Struct	N			0.2		N		15			-901				-901	
157	GOLF COURSE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
157			S		0	0	1	4	6	8	9	11	14	17	21	26	31	37	43
157			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
157			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
157			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
157			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
157			Struct	N			0.2		N		15			-901				-901	
159	GREENHOUSE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
159			S		0	0	5	11	16	21	26	31	37	42	47	52	56	61	65
159			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
159			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
159			C		0	0	62	84	96	97	98	99	100	100	100	100	100	100	100
159			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
159			Struct	N			1.5		N		37		N	85	37			-901	
161	GROCERY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
161			S		0	0	3	4	5	6	7	10	14	20	29	37	44	50	55
161			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
161			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
161			C		0	4	31	51	77	97	100	100	100	100	100	100	100	100	100
161			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
161			Struct	N			1.5		N		37		N	282	37			-901	
163	GROCERY: DRIVE-IN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
163			S		0	0	3	4	5	6	7	10	14	20	29	37	44	50	55
163			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

163			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
163			C		0	2	56	69	85	98	100	100	100	100	100	100	100	100	100
163			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
163			Struct	N			0.2		N		15			-901				-901	
165	GUNSHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
165			S		0	0	10	10	10	11	12	13	14	16	18	20	22	25	29
165			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
165			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
165			C		0	21	37	56	85	100	100	100	100	100	100	100	100	100	100
165			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
165			Struct	N			0.2		N		15			-901				-901	
167	HALL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
167			S		0	0	1	5	5	5	5	6	8	9	11	14	18	22	28
167			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
167			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
167			C		0	0	5	8	10	12	14	18	24	32	44	60	85	95	100
167			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
167			Struct	N			0.2		N		15			-901				-901	
169	HARDWARE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
169			S		0	0	12	12	12	12	12	12	14	15	18	21	25	30	35
169			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
169			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
169			C		0	7	29	46	62	68	80	92	93	95	96	97	99	100	100
169			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
169			Struct	N			0.2		N		15			-901				-901	
171	HEALTH CENTER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
171			S		0	0	18	20	20	20	20	20	22	27	33	39	44	49	53
171			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
171			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

171			C		0	0	25	45	75	90	100	100	100	100	100	100	100	100	100
171			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
171			Struct	N			0.2		N		15			-901				-901	
173	HEAT EXCHANGER MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
173			S		0	0	3	4	5	6	20	7	7	7	7	7	8	9	9
173			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
173			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
173			C		0	0	11	18	24	29	33	36	38	41	43	45	50	55	59
173			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
173			Struct	N			0.2		N		15			-901				-901	
175	HWY. MATL. STORAGE	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
175			S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
175			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
175			C		0	0	4	4	8	8	19	19	38	38	38	58	58	58	58
175			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
175			Struct	N			0.2		N		15			-901				-901	
177	HOBBY SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
177			S		0	0	18	20	20	20	20	20	22	27	33	39	44	49	53
177			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
177			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
177			C		0	0	28	53	67	78	88	99	99	99	99	99	99	99	99
177			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
177			Struct	N			0.2		N		15			-901				-901	
179	HOSPITAL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
179			S		0	0	5	10	20	25	30	35	40	43	47	50	53	55	57
179			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
179			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
179			C		0	0	10	15	20	25	35	58	66	74	82	95	95	95	95

179			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
179			Struct	N			1.5		N		37		N	128	37			-901	
181	HOTEL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
181			S		0	0	1	2	2	2	3	5	6	9	11	15	18	22	26
181			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
181			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
181			C		0	0	11	22	28	33	37	41	44	46	49	54	60	69	81
181			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
181			Struct	N			1.5		N		37		N	36	37			-901	
183	IMPORT SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
183			S		0	0	25	30	35	40	42	44	46	48	50	50	65	65	65
183			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
183			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
183			C		0	0	59	65	70	75	80	90	90	90	90	90	90	90	90
183			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
183			Struct	N			0.2		N		15			-901				-901	
185	INSTRUMENT MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
185			S		0	0	5	8	12	14	16	17	19	20	20	20	24	26	28
185			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
185			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
185			C		0	0	59	65	70	75	80	90	90	90	90	90	90	90	90
185			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
185			Struct	N			0.2		N		15			-901				-901	
187	JEWELRY SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
187			S		0	0	1	2	2	2	3	4	6	8	9	12	15	20	25
187			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
187			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
187			C		0	0	22	40	62	81	86	90	92	94	95	96	96	96	96
187			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

187			Struct	N			0.2		N		15			-901				-901	
189	JEWELRY MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
189			S		0	0	20	22	24	26	28	30	32	34	36	36	36	40	40
189			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
189			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
189			C		0	0	22	62	81	81	83	90	92	94	95	96	96	96	96
189			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
189			Struct	N			0.2		N		15			-901				-901	
191	LABORATORY: CHEM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
191			S		0	0	1	3	5	8	12	16	21	26	32	38	45	45	45
191			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
191			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
191			C		0	0	27	28	51	51	60	70	79	89	89	90	90	91	91
191			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
191			Struct	N			0.2		N		15			-901				-901	
193	LAUNDRY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
193			S		0	0	2	5	8	12	15	18	21	23	26	28	31	33	36
193			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
193			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
193			C		0	0	20	55	78	100	86	95	100	100	100	100	100	100	100
193			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
193			Struct	N			0.2		N		15			-901				-901	
195	LAWNMOWER SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
195			S		0	0	12	13	15	16	17	18	21	25	30	35	42	50	57
195			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
195			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
195			C		0	0	9	76	89	91	93	94	96	97	98	100	100	100	100
195			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
195			Struct	N			0.2		N		15			-901				-901	

197	LEATHER GOODS MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
197			S		0	0	9	15	17	21	23	24	25	25	25	25	30	31	33
197			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
197			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
197			C		0	0	4	7	10	13	16	19	22	25	27	30	33	36	39
197			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
197			Struct	N			0.2		N		15			-901				-901	
199	LIBRARY	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
199			S		0	0	1	2	2	2	3	4	6	8	9	12	15	20	25
199			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
199			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
199			C		0	0	35	50	75	95	100	100	100	100	100	100	100	100	100
199			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
199			Struct	N			0.2		N		15			-901				-901	
201	LIQUOR STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
201			S		0	0	1	1	2	2	3	5	6	8	11	16	22	29	39
201			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
201			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
201			C		0	0	19	39	58	79	99	100	100	100	100	100	100	100	100
201			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
201			Struct	N			0.2		N		15			-901				-901	
203	LOADING DOCK: IND.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
203			S		0	0	1	1	1	3	3	5	8	12	16	21	26	32	38
203			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
203			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
203			C		0	0	8	8	8	10	10	14	18	30	30	30	30	30	38
203			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
203			Struct	N			1.5		N		37		N	833	37			-901	
205	LUMBER MILL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

205			S		0	0	3	5	8	10	13	15	18	20	23	25	28	30	33
205			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
205			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
205			C		0	0	0	0	0	0	0	0	0	0	0	0	0	100	100
205			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
205			Struct	N			0.2		N		15			-901				-901	
207	LUMBER YARD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
207			S		0	0	1	1	1	1	1	4	4	5	5	7	9	13	17
207			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
207			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
207			C		0	0	20	30	45	60	75	90	100	100	100	100	100	100	100
207			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
207			Struct	N			0.2		N		15			-901				-901	
209	MARINE SERVICE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
209			S		0	0	1	2	3	4	5	6	7	8	9	10	10	10	10
209			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
209			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
209			C		0	40	52	89	100	100	100	100	100	100	100	100	100	100	100
209			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
209			Struct	N			0.2		N		15			-901				-901	
211	MACHINE SHOP: LT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
211			S		0	0	1	1	1	3	5	8	12	16	21	26	32	38	40
211			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
211			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
211			C		0	0	1	37	47	57	57	58	67	67	68	68	68	69	78
211			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
211			Struct	N			1.5		N		37		N	107	37			-901	
213	MACHINE SHOP: HVY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
213			S		0	0	1	1	1	3	5	8	12	16	21	26	32	38	40

213			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
213			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
213			C		0	0	6	13	20	28	35	42	50	58	67	72	79	84	85
213			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
213			Struct	N			0.2		N		15			-901				-901	
215	MAINT.BLDG.: MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
215			S		0	0	5	10	20	30	50	70	70	70	70	70	70	80	80
215			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
215			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
215			C		0	0	10	15	20	25	35	45	45	45	45	50	50	50	55
215			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
215			Struct	N			0.2		N		15			-901				-901	
217	MFG.: DETERGENT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
217			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	50
217			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
217			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
217			C		0	0	19	28	35	41	47	50	52	55	59	64	81	90	91
217			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
217			Struct	N			0.2		N		15			-901				-901	
219	MEAT MARKET	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
219			S		0	0	10	10	10	11	12	14	17	23	31	38	44	50	55
219			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
219			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
219			C		0	0	84	86	88	93	100	100	100	100	100	100	100	100	100
219			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
219			Struct	N			0.2		N		15			-901				-901	
221	MEAT PACKING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
221			S		0	0	20	23	26	29	32	35	38	41	44	47	50	55	56
221			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

221			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
221			C		0	0	21	21	52	79	83	90	93	97	97	97	97	97	97
221			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
221			Struct	N			0.2		N		15			-901				-901	
223	MEDICAL SUPPLIES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
223			S		0	0	15	23	27	30	32	33	34	35	35	35	41	43	45
223			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
223			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
223			C		0	0	17	33	48	63	67	71	75	80	85	89	93	98	100
223			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
223			Struct	N			0.2		N		15			-901				-901	
225	METAL COATING SV	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
225			S		0	0	18	25	25	25	25	25	25	25	25	25	26	27	27
225			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
225			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
225			C		0	0	37	56	68	78	89	100	100	100	100	100	100	100	100
225			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
225			Struct	N			0.2		N		15			-901				-901	
227	MIXER BLDG.: DTRGNT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
227			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
227			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
227			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
227			C		0	0	15	34	52	69	69	69	69	69	73	73	77	77	81
227			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
227			Struct											0.5				-901	
229	MOTEL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
229			S		0	0	4	7	10	12	15	18	22	26	31	37	43	50	56
229			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
229			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

229			C	0	0	30	48	63	75	90	100	100	100	100	100	100	100	100
229			CN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
229			Struct	N		1.5		N		37		N	36	37			-901	
231	MOTORCYCLE SALES	C	Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
231			S	0	0	20	25	30	35	40	45	50	60	70	80	80	80	80
231			SN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
231			Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
231			C	0	0	45	75	90	90	90	90	90	90	90	90	95	95	95
231			CN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
231			Struct	N		0.2		N		15			-901				-901	
233	MUN. STRG. WHSE.	C	Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
233			S	0	0	1	5	10	10	10	10	20	30	50	50	50	50	55
233			SN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
233			Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
233			C	0	0	11	17	20	22	24	29	36	48	67	85	90	90	90
233			CN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
233			Struct	N		1.5		N		37		N	16	37			-901	
235	MUSIC CENTER	C	Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
235			S	0	5	10	13	14	15	15	15	16	18	23	27	37	50	59
235			SN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
235			Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
235			C	0	0	63	70	75	95	100	100	100	100	100	100	100	100	100
235			CN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
235			Struct	N		0.2		N		15			-901				-901	
237	NEWSPAPER PLANT	C	Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
237			S	0	0	2	3	4	5	6	7	8	8	9	11	14	19	24
237			SN	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
237			Stage	-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
237			C	0	0	5	8	11	13	16	20	25	31	39	48	59	70	82

237			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
237			Struct	N			0.2		N		15			-901				-901	
239	NEWSPAPER OFC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
239			S		0	10	15	18	24	25	25	26	27	28	31	33	36	40	43
239			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
239			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
239			C		0	0	5	11	23	37	77	100	100	100	100	100	100	100	100
239			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
239			Struct	N			0.2		N		15			-901				-901	
241	NURSING HOME	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
241			S		0	10	10	10	14	15	15	16	18	20	23	26	30	34	38
241			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
241			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
241			C		0	0	38	60	73	81	88	94	100	100	100	100	100	100	100
241			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
241			Struct	N			1.5		N		37		N	37	37			-901	
243	NURSERY PLANT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
243			S		0	2	2	3	6	10	15	22	27	32	37	41	46	50	54
243			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
243			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
243			C		0	0	50	65	75	95	100	100	100	100	100	100	100	100	100
243			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
243			Struct	N			0.2		N		15			-901				-901	
245	NURSERY: CHILD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
245			S		0	0	15	16	16	20	25	29	33	37	41	44	47	50	53
245			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
245			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
245			C		0	0	24	50	88	100	100	100	100	100	100	100	100	100	100
245			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

245			Struct	N			0.2		N		15			-901				-901	
247	OFFICE: MFG. FAC	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
247			S		0	0	2	10	15	28	32	39	43	44	45	51	58	62	65
247			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
247			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
247			C		0	0	0	12	20	30	40	48	56	66	78	88	96	96	100
247			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
247			Struct	N			0.2		N		15			-901				-901	
249	OFFICE BUILDING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
249			S		0	0	12	14	17	19	23	27	31	35	40	45	50	55	59
249			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
249			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
249			C		0	0	16	21	24	25	26	28	31	36	42	50	71	84	100
249			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
249			Struct	N			1.5		N		37		N	10	37			-901	
251	OIL STORAGE TANKS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
251			S		0	0	0	0	0	0	0	2	2	2	2	2	2	2	2
251			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
251			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
251			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
251			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
251			Struct	N			0.2		N		15			-901				-901	
253	PAINT STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
253			S		0	0	20	30	37	43	55	60	67	75	80	83	86	90	90
253			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
253			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
253			C		0	0	10	20	40	59	69	72	75	79	79	79	79	79	79
253			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
253			Struct	N			0.2		N		15			-901				-901	

255	PAPER PROD. WHSE.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
255			S		0	0	18	25	25	25	25	25	25	25	25	25	26	27	27
255			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
255			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
255			C		0	0	18	29	38	47	56	64	71	76	82	91	98	100	100
255			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
255			Struct	N			0.2		N		15			-901				-901	
257	PAWN SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
257			S		0	0	20	30	33	36	39	42	45	47	50	50	50	60	60
257			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
257			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
257			C		0	0	19	38	91	91	93	93	94	94	94	94	94	94	94
257			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
257			Struct	N			0.2		N		15			-901				-901	
259	PHOTO STUDIO	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
259			S		0	0	20	25	30	35	40	45	50	60	65	70	75	75	75
259			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
259			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
259			C		0	0	20	40	60	80	100	100	100	100	100	100	100	100	100
259			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
259			Struct	N			0.2		N		15			-901				-901	
261	PHOTO SVC.L AERIAL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
261			S		0	0	11	17	22	24	27	28	29	30	30	30	35	37	39
261			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
261			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
261			C		0	0	72	87	92	95	97	99	99	99	100	100	100	100	100
261			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
261			Struct	N			0.2		N		15			-901				-901	
263	PIERS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

263			S		0	20	40	60	80	85	100	100	100	100	100	100	100	100	100
263			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
263			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
263			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
263			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
263			Struct	N			0.2		N		15			-901				-901	
265	PIER DRILLING Co.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
265			S		0	0	35	35	35	35	41	47	53	60	60	60	60	60	60
265			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
265			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
265			C		0	0	20	23	39	55	55	56	56	57	57	57	57	57	57
265			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
265			Struct	N			0.2		N		15			-901				-901	
267	PIPE THREADER FAC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
267			S		0	0	1	5	10	10	10	20	30	50	50	50	75	75	75
267			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
267			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
267			C		0	0	25	25	50	50	50	50	75	75	75	75	90	90	90
267			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
267			Struct	N			0.2		N		15			-901				-901	
269	PLBG/HTG. CNTRCTR.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
269			S		0	0	0	20	25	30	35	40	45	50	60	60	60	60	60
269			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
269			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
269			C		0	0	40	50	60	70	80	80	80	80	80	80	80	80	80
269			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
269			Struct	N			0.2		N		15			-901				-901	
271	PLASTIC MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
271			S		0	0	12	18	23	24	27	28	29	30	30	30	35	37	39

271			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
271			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
271			C		0	0	40	50	60	70	80	80	80	80	80	80	80	80	80
271			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
271			Struct	N			0.2		N		15			-901				-901	
273	PLUMBING CO.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
273			S		0	0	20	32	40	47	53	57	61	64	67	70	72	74	77
273			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
273			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
273			C		0	0	19	41	51	70	95	95	95	95	95	95	100	100	100
273			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
273			Struct	N			0.2		N		15			-901				-901	
275	POLICE STATION	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
275			S		0	0	12	14	17	19	23	27	31	35	40	45	50	55	59
275			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
275			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
275			C		0	0	5	15	25	35	48	62	78	95	100	100	100	100	100
275			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
275			Struct	N			0.2		N		15			-901				-901	
277	POST OFFICE	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
277			S		0	0	8	15	24	25	26	27	29	32	36	40	45	50	56
277			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
277			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
277			C		0	25	43	63	70	80	100	100	100	100	100	100	100	100	100
277			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
277			Struct	N			1.5		N		37		N	24	37			-901	
279	PRESSURE TEST FAC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
279			S		0	0	1	5	10	10	10	20	30	50	50	50	75	75	75
279			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

279			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
279			C		0	0	20	20	25	25	30	30	40	40	40	40	40	40	40
279			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
279			Struct	N			0.2		N		15			-901				-901	
281	PRINTING: COMMER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
281			S		0	0	20	23	26	29	32	35	39	42	45	47	50	60	60
281			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
281			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
281			C		0	20	40	60	80	100	100	100	100	100	100	100	100	100	100
281			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
281			Struct	N			0.2		N		15			-901				-901	
283	PRIVATE CLUB	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
283			S		0	0	5	8	8	9	9	9	10	12	14	17	21	26	32
283			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
283			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
283			C		0	0	28	36	41	45	50	54	60	66	73	84	92	97	100
283			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
283			Struct	N			0.2		N		15			-901				-901	
285	PRIVATE STORAGE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
285			S		0	0	0	4	8	12	16	20	25	30	35	40	45	50	50
285			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
285			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
285			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
285			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
285			Struct	N			1.5		N		37		N	16	37			-901	
287	QUONSET HUT STRG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
287			S		0	0	2	4	5	8	10	12	15	20	25	35	45	60	70
287			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
287			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

287			C		0	0	11	16	19	21	23	28	35	47	67	85	90	90	90
287			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
287			Struct	N			0.2		N		15			-901				-901	
289	RADIO STATION	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
289			S		0	0	8	15	24	25	26	27	29	32	36	40	45	50	56
289			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
289			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
289			C		0	0	20	40	65	85	95	100	100	100	100	100	100	100	100
289			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
289			Struct	N			0.2		N		15			-901				-901	
291	REAL ESTATE OFC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
291			S		0	0	8	15	24	25	26	27	29	32	36	40	45	50	56
291			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
291			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
291			C		0	12	21	35	55	77	95	100	100	100	100	100	100	100	100
291			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
291			Struct	N			0.2		N		15			-901				-901	
293	RECYCLING: METAL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
293			S		0	0	5	10	20	40	50	60	70	80	100	100	100	100	100
293			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
293			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
293			C		0	0	0	0	10	20	20	20	40	40	40	40	40	40	50
293			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
293			Struct	N			0.2		N		15			-901				-901	
295	RECREATION FAC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
295			S		0	0	0	0	2	5	10	10	15	15	20	20	25	25	35
295			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
295			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
295			C		0	0	15	30	35	53	73	80	80	80	80	80	80	80	80

295			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
295			Struct	N			1.5		N		37		N	69	37			-901	
297	REFINERY: CAUST. MTL.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
297			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
297			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
297			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
297			C		0	0	37	48	73	78	78	78	79	79	79	79	79	79	80
297			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
297			Struct	N			0.2		N		15			-901				-901	
299	REFINERY: LEAD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
299			S		0	0	2	10	15	20	32	39	43	44	45	51	58	62	65
299			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
299			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
299			C		0	0	11	20	30	40	49	59	69	79	81	81	81	81	81
299			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
299			Struct	N			0.2		N		15			-901				-901	
301	REMNANT SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
301			S		0	0	10	15	15	20	25	30	35	40	45	50	55	65	75
301			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
301			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
301			C		0	0	15	22	40	58	77	86	91	95	95	95	95	95	95
301			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
301			Struct	N			0.2		N		15			-901				-901	
303	RENDERING PLANT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
303			S		0	0	12	14	17	19	23	27	31	35	40	45	45	50	50
303			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
303			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
303			C		0	0	17	29	50	67	83	87	87	87	87	87	87	87	87
303			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

303			Struct	N			0.2		N		15			-901				-901	
305	RESEARCH LAB: MACH.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
305			S		0	0	12	14	17	19	23	27	31	35	40	45	50	55	60
305			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
305			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
305			C		0	0	20	32	43	55	60	63	64	65	66	68	68	68	70
305			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
305			Struct	N			1.5		N		37		N	96	37			-901	
307	RESTAURANT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
307			S		0	0	15	18	20	23	25	27	28	30	33	37	43	50	58
307			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
307			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
307			C		0	0	20	40	80	90	92	94	100	100	100	100	100	100	100
307			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
307			Struct	N			1.5		N		37		N	39	37			-901	
309	RESTAURANT: DRIV	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
309			S		0	0	2	4	7	10	14	18	23	28	33	39	44	50	56
309			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
309			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
309			C		0	0	25	50	90	100	100	100	100	100	100	100	100	100	100
309			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
309			Struct	N			1.5		N		37		N	96	37			-901	
311	REUPHOLSTERY SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
311			S		0	0	10	10	10	11	12	13	14	15	20	30	30	30	30
311			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
311			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
311			C		0	0	23	28	36	41	45	50	53	58	58	59	60	60	60
311			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
311			Struct	N			0.2		N		15			-901				-901	

313	SAFETY EQUIPMENT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
313			S		0	0	8	16	23	28	33	37	39	40	40	40	43	44	45
313			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
313			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
313			C		0	0	12	25	37	50	62	75	85	93	97	100	100	100	100
313			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
313			Struct	N			0.2		N		15			-901				-901	
315	SAND & GRAVEL CO	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
315			S		0	0	2	4	6	8	10	11	12	13	14	15	15	15	15
315			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
315			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
315			C		0	0	0	1	5	7	8	9	10	11	12	13	18	23	23
315			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
315			Struct	N			0.2		N		15			-901				-901	
317	SANDBLASTING CO.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
317			S		0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
317			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
317			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
317			C		0	0	15	45	68	90	90	90	90	90	90	90	90	90	90
317			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
317			Struct	N			0.2		N		15			-901				-901	
319	SCHOOL	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
319			S		0	0	8	12	15	15.5	16	17	19	22	25	28	32	36	40
319			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
319			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
319			C		0	10	18	26	45	66	76	88	100	100	100	100	100	100	100
319			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
319			Struct	N			1.5		N		37		N	11	37			-901	
321	SCALE BUILDING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

321			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
321			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
321			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
321			C		0	0	0	5	15	25	40	50	75	85	100	100	100	100	100
321			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
321			Struct	N			0.2		N		15			-901				-901	
323	SEPARATORS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
323			S		0	0	2	2	2	2	2	2	2	2	2	2	2	2	2
323			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
323			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
323			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
323			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
323			Struct	N			0.2		N		15			-901				-901	
325	SERVICE STATION	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
325			S		0	0	1	2	3	5	7	10	13	16	19	23	27	33	38
325			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
325			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
325			C		0	0	13	40	60	90	100	100	100	100	100	100	100	100	100
325			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
325			Struct	N			1.5		N		37		N	156	37			-901	
327	SEWAGE TREATMENT	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
327			S		0	0	2	4	4	4	5	6	8	12	16	21	27	34	42
327			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
327			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
327			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
327			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
327			Struct	N			0.2		N		15			-901				-901	
329	SHEET METAL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
329			S		0	0	30	30	30	30	33	36	39	40	40	40	40	40	40

329			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
329			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
329			C		0	0	29	41	46	58	58	58	58	58	58	58	58	58	58
329			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
329			Struct	N			0.2		N		15			-901				-901	
331	SHOE STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
331			S		0	0	3	6	9	12	15	18	21	24	27	30	33	36	39
331			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
331			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
331			C		0	0	10	23	35	48	59	73	85	98	98	98	98	98	98
331			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
331			Struct	N			0.2		N		15			-901				-901	
333	SKATING RINK	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
333			S		0	0	12	15	15	15	15	15	15	15	15	15	16	16	16
333			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
333			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
333			C		0	0	10	25	50	100	100	100	100	100	100	100	100	100	100
333			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
333			Struct	N			0.2		N		15			-901				-901	
335	SPORTING GOODS WHSE.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
335			S		0	0	10	17	22	24	15	26	27	28	30	30	35	37	39
335			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
335			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
335			C		0	0	10	35	50	63	75	87	100	100	100	100	100	100	100
335			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
335			Struct	N			0.2		N		15			-901				-901	
337	STORAGE: MACH. PARTS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
337			S		0	0	5	10	20	30	50	70	70	70	70	70	70	70	70
337			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

337			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
337			C		0	0	20	30	40	50	50	50	75	75	75	100	100	100	100
337			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
337			Struct	N			0.2		N		15			-901				-901	
339	STORAGE: CHEM.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
339			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
339			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
339			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
339			C		0	0	11	16	22	28	38	48	60	72	80	80	80	80	80
339			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
339			Struct	N			0.2		N		15			-901				-901	
341	SWIMMING POOL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
341			S		0	0	7	7	7	7	7	7	7	7	7	7	7	7	7
341			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
341			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
341			C		0	0	25	50	75	100	100	100	100	100	100	100	100	100	100
341			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
341			Struct	N			0.2		N		15			-901				-901	
343	TAR VAT BUILDING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
343			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	51
343			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
343			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
343			C		0	0	5	10	15	25	35	50	50	60	60	60	60	60	60
343			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
343			Struct	N			0.2		N		15			-901				-901	
345	TAVERN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
345			S		0	0	15	18	20	22	24	27	31	34	38	42	46	50	54
345			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
345			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

345			C		0	38	60	74	89	97	100	100	100	100	100	100	100	100	100
345			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
345			Struct	N			1.5		N		37		N	45	37			-901	
347	TELEPHONE EXCHAN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
347			S		0	0	12	14	17	19	23	27	31	35	40	45	50	55	59
347			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
347			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
347			C		0	0	100	100	100	100	100	100	100	100	100	100	100	100	100
347			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
347			Struct	N			0.2		N		15			-901				-901	
349	THEATER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
349			S		0	0	2	3	4	4	4	5	7	10	13	16	21	25	30
349			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
349			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
349			C		0	0	3	4	5	6	6	6	9	12	16	22	28	37	46
349			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
349			Struct	N			0.2		N		15			-901				-901	
351	THEATER: DRIVE-IN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
351			S		0	0	0	1	1	1	1	2	2	2	3	4	5	5	6
351			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
351			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
351			C		0	0	0	2	2	2	4	5	9	13	18	23	30	37	46
351			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
351			Struct	N			0.2		N		15			-901				-901	
353	TRACTOR SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
353			S		0	0	9	13	18	21	22	23	24	25	25	25	26	27	28
353			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
353			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
353			C		0	0	6	17	29	44	58	69	76	80	83	87	91	94	98

353			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
353			Struct	N			0.2		N		15			-901				-901	
355	TRAILER MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
355			S		0	0	2	2	2	2	3	4	5	6	7	10	10	10	10
355			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
355			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
355			C		0	0	27	30	37	40	40	40	40	40	40	40	40	40	40
355			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
355			Struct	N			0.2		N		15			-901				-901	
357	TRANSPORT CO.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
357			S		0	0	9	11	12	16	20	24	28	30	30	30	30	30	30
357			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
357			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
357			C		0	0	60	75	90	90	90	90	90	90	90	90	90	90	90
357			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
357			Struct	N			0.2		N		15			-901				-901	
359	TRAILER SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
359			S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
359			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
359			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
359			C		0	0	18	37	60	80	100	100	100	100	100	100	100	100	100
359			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
359			Struct	N			0.2		N		15			-901				-901	
361	TRAILER PARTS	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
361			S		0	0	0	5	10	15	20	25	30	32	36	38	40	50	60
361			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
361			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
361			C		0	0	0	7	13	24	27	34	36	39	50	50	50	50	55
361			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

361			Struct	N			0.2		N		15			-901				-901	
363	TRUCK MFG. & SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
363			S		0	0	12	18	23	26	27	28	29	30	30	30	32	33	35
363			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
363			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
363			C		0	0	39	57	63	70	75	80	83	90	91	91	100	100	100
363			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
363			Struct	N			0.2		N		15			-901				-901	
365	TROPHY SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
365			S		0	0	8	9	10	12	15	17	18	18	19	20	23	29	33
365			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
365			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
365			C		0	0	17	26	31	49	62	66	69	71	71	72	73	74	76
365			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
365			Struct	N			0.2		N		15			-901				-901	
367	TV REPAIR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
367			S		0	0	5	10	20	30	40	50	60	70	75	80	80	80	80
367			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
367			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
367			C		0	0	10	15	20	37	54	71	76	80	80	81	81	82	82
367			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
367			Struct	N			0.2		N		15			-901				-901	
369	TV STATION	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
369			S		0	0	1	5	5	5	5	5	6	6	8	10	14	19	25
369			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
369			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
369			C		0	0	20	40	65	85	95	100	100	10	100	100	100	100	100
369			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
369			Struct	N			0.2		N		15			-901				-901	

371	USED APPL. & CLOTHING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
371			S		0	0	10	12	14	16	18	20	23	26	30	40	45	55	55
371			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
371			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
371			C		0	0	18	33	65	88	95	100	100	100	100	100	100	100	100
371			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
371			Struct	N			0.2		N		15			-901				-901	
373	USED FURNITURE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
373			S		0	0	10	20	24	28	32	36	40	44	48	50	50	55	55
373			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
373			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
373			C		0	40	60	70	80	100	100	100	100	100	100	100	100	100	100
373			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
373			Struct	N			0.2		N		15			-901				-901	
375	UTILITY COMPANY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
375			S		0	0	3	5	10	14	18	22	26	30	34	36	38	40	40
375			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
375			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
375			C		0	0	1	1	5	7	10	11	12	13	14	15	15	16	16
375			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
375			Struct	N			0.2		N		15			-901				-901	
377	VACUUM CLEANER SALES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
377			S		0	0	10	15	20	25	30	33	36	40	50	55	60	60	60
377			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
377			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
377			C		0	0	44	58	66	71	74	78	78	78	85	85	85	85	93
377			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
377			Struct	N			0.2		N		15			-901				-901	
379	VACANT BLDG.: CN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

379			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
379			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
379			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
379			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
379			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
379			Struct	N			0.2		N		15			-901				-901	
381	VARIETY STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
381			S		0	0	8	9	10	12	15	17	18	18	19	20	23	26	29
381			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
381			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
381			C		0	10	20	40	70	85	90	95	100	100	100	100	100	100	100
381			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
381			Struct	N			0.2		N		15			-901				-901	
383	VETERINARY CLINI	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
383			S		0	0	1	3	4	6	9	11	14	17	20	24	29	35	42
383			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
383			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
383			C		0	25	50	90	100	100	100	100	100	100	100	100	100	100	100
383			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
383			Struct	N			1.5		N		37		N	41	37			-901	
385	WAREHOUSE: HVY. MACH.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
385			S		0	0	2	4	5	6	7	8	10	13	17	21	25	30	35
385			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
385			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
385			C		0	0	9	24	24	33	38	47	70	71	72	73	74	75	84
385			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
385			Struct	N			0.2		N		15			-901				-901	
387	WAREHOUSE: BEER	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
387			S		0	0	2	4	5	6	7	8	10	13	17	21	25	30	30

387			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
387			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
387			C		0	0	21	84	88	92	96	97	97	97	97	97	97	97	97
387			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
387			Struct	N			0.2		N		15			-901				-901	
389	WAREHOUSE: BTL. GASES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
389			S		0	0	1	2	3	4	5	8	12	16	21	26	32	38	45
389			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
389			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
389			C		0	0	8	8	8	14	16	20	28	28	30	30	30	30	38
389			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
389			Struct	N			0.2		N		15			-901				-901	
391	WAREHOUSE: PETR.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
391			S		0	0	2	4	5	6	7	8	10	13	17	21	25	30	30
391			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
391			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
391			C		0	0	0	0	9	20	40	59	77	77	77	78	78	78	78
391			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
391			Struct	N			0.2		N		15			-901				-901	
393	WAREHOUSE:CEMENT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
393			S		0	0	1	1	3	5	8	12	16	21	26	32	38	45	45
393			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
393			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
393			C		0	0	20	40	60	80	100	100	100	100	100	100	100	100	100
393			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
393			Struct	N			0.2		N		15			-901				-901	
395	WAREHOUSE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
395			S		0	0	0	1	1	1	3	5	8	12	16	21	26	32	38
395			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

395			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
395			C		0	20	30	40	50	60	70	80	90	100	100	100	100	100	100
395			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
395			Struct	N			1.5		N		37		N	176	37			-901	
397	WASHATERIA	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
397			S		0	0	6	6	6	7	8	10	12	15	18	23	27	32	38
397			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
397			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
397			C		0	0	20	55	78	100	86	95	100	100	100	100	100	100	100
397			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
397			Struct	N			0.2		N		15			-901				-901	
399	WATER SUPPLY	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
399			S		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
399			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
399			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
399			C		0	0	0	0	25	25	25	25	25	25	25	25	25	25	25
399			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
399			Struct	N			0.2		N		15			-901				-901	
401	WATER WELL SVC.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
401			S		0	0	5	20	40	60	60	60	60	60	60	60	60	60	60
401			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
401			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
401			C		0	0	0	25	50	50	50	50	50	50	50	50	50	50	50
401			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
401			Struct	N			0.2		N		15			-901				-901	
403	WELDING REPAIR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
403			S		0	17	17	17	17	23	32	45	55	61	66	69	73	76	78
403			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
403			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

403			C		0	0	1	6	15	18	20	21	22	24	27	30	33	37	41
403			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
403			Struct	N			0.2		N		15			-901				-901	
405	WELDING SUPL.: WHLSL	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
405			S		0	17	7	13	18	22	25	27	30	32	34	37	40	44	47
405			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
405			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
405			C		0	0	15	35	45	50	57	66	80	100	100	100	100	100	100
405			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
405			Struct	N			0.2		N		15			-901				-901	
407	WELLHEAD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
407			S		0	0	0	0	0	0	2	2	2	2	2	2	2	2	2
407			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
407			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
407			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
407			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
407			Struct	N			0.2		N		15			-901				-901	
409	WESTERN AUTO STORE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
409			S		0	0	4	6	7	11	11	18	24	30	36	41	46	50	53
409			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
409			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
409			C		0	0	21	46	69	84	97	97	97	98	98	98	99	99	99
409			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
409			Struct	N			0.2		N		15			-901				-901	
411	X-RAY SERVICE	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
411			S		0	0	5	7	12	13	14	15	15	15	15	15	18	19	20
411			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
411			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
411			C		0	0	20	40	80	100	100	100	100	100	100	100	100	100	100

411			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
411			Struct	N			0.2		N		15			-901				-901	
413	YMCA	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
413			S		0	0	25	33	33	33	33	33	33	33	33	33	35	35	35
413			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
413			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
413			C		0	0	0	5	24	50	82	100	100	100	100	100	100	100	100
413			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
413			Struct	N			0.2		N		15			-901				-901	
415	BALL PARK	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
415			S		0	0	10	26	42	52	57	61	66	70	73	77	80	80	80
415			SN		0	10	10	10	10	10	10	10	10	10	10	10	10	10	10
415			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
415			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
415			CN		0	10	10	10	10	10	10	10	10	10	10	10	10	10	10
415			Struct	N			0.2		N		15			-901				-901	
417	BARN	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
417			S		0	0	8	13	18	25	35	45	55	65	72	78	85	85	85
417			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
417			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
417			C		0	0	8	13	18	25	35	45	55	65	72	78	85	85	85
417			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
417			Struct	N			1.5		N		37		N	100	37			-901	
419	TENNIS COURT	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
419			S		0	0	25	29	33	35	35	35	35	35	35	35	35	35	35
419			SN		0	10	10	10	10	10	10	10	10	10	10	10	10	10	10
419			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
419			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
419			CN		0	10	10	10	10	10	10	10	10	10	10	10	10	10	10

419			Struct	N			0.2		N		15			-901				-901	
421	GENL. OFFICE COM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
421			S		0	0	8	10	12	14	17	20	23	26	30	34	38	43	48
421			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
421			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
421			C		0	12	21	55	77	95	100	100	100	100	100	100	100	100	100
421			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
421			Struct	N			0.2		N		15			-901				-901	
423	GENL. RETAIL COM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
423			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
423			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
423			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
423			C		0	0	18	33	65	88	95	100	100	100	100	100	100	100	100
423			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
423			Struct	N			1.5		N		37		N	117	37			-901	
425	GENL. WHLSL. & I	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
425			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
425			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
425			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
425			C		0	0	9	16	21	24	28	31	34	37	41	45	46	47	48
425			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
425			Struct	N			1.5		N		37		N	85	37			-901	
427	GENL. PUB. OPEN SP.	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
427			S		0	0	15	23	30	34	35	37	39	41	43	45	48	50	52
427			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
427			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
427			C		0	4	12	13	21	23	25	26	26	27	28	29	30	31	31
427			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
427			Struct	N			1.5		N		37		N	21	37			-901	

429	GENL. PUB. STRUC	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
429			S		0	0	8	9	11	12	13	14	17	18	21	24	27	30	36
429			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
429			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
429			C		0	3	26	45	59	69	74	79	81	84	87	90	93	96	98
429			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
429			Struct	N			0.2		N		15			-901				-901	
431	ELEC.POWER SUBSTA.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
431			S		0	0	6	12	18	24	27	30	33	36	39	42	45	48	51
431			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
431			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
431			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
431			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
431			Struct	N			1.5		N		37		N	0	37			-901	
433	RAILROAD	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
433			S		0	0	6	12	18	24	27	30	33	36	39	42	45	48	51
433			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
433			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
433			C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
433			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
433			Struct	N			0.2		N		15			-901				-901	
551	AIRCRAFT PARTS MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
551			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
551			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
551			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
551			C		0	0	20	40	60	80	100	100	100	100	100	100	100	100	100
551			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
551			Struct	N			0.2		N		15			-901				-901	
553	CORK AND SEAL MFG.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

553			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
553			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
553			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
553			C		0	0	10	20	35	50	60	70	80	90	95	100	100	100	100
553			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
553			Struct	N			0.2		N		15			-901				-901	
555	SOFT DRINK BOTTLING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
555			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
555			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
555			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
555			C		0	0	20	60	80	100	100	100	100	100	100	100	100	100	100
555			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
555			Struct	N			0.2		N		15			-901				-901	
557	CHEMICAL MFG. CO.	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
557			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
557			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
557			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
557			C		0	0	20	40	68	80	90	100	100	100	100	100	100	100	100
557			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
557			Struct	N			0.2		N		15			-901				-901	
559	RADIO TOWER FACILITY	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
559			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48
559			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
559			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
559			C		0	0	100	100	100	100	100	100	100	100	100	100	100	100	100
559			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
559			Struct	N			0.2		N		15			-901				-901	
561	OIL FIELD SUPPLIES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
561			S		0	1	4	8	10	14	18	23	26	30	33	38	42	46	48

561			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
561			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
561			C		0	0	10	20	40	75	100	100	100	100	100	100	100	100	100
561			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
561			Struct	N			0.2		N		15			-901				-901	
563	OFFICE SUPPLIES	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
563			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
563			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
563			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
563			C		0	0	20	40	65	90	100	100	100	100	100	100	100	100	100
563			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
563			Struct	N			0.2		N		15			-901				-901	
565	CLOCK SHOP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
565			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
565			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
565			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
565			C		0	20	80	83	86	90	93	96	100	100	100	100	100	100	100
565			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
565			Struct	N			0.2		N		15			-901				-901	
567	CAMERAS & PHOTO SUP	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
567			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
567			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
567			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
567			C		0	0	20	40	60	80	100	100	100	100	100	100	100	100	100
567			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
567			Struct	N			0.2		N		15			-901				-901	
569	SHOE & BOOT REPAIR	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
569			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
569			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

569			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
569			C		0	0	10	15	20	60	100	100	100	100	100	100	100	100	100
569			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
569			Struct	N			0.2		N		15			-901				-901	
571	AIR CONDITIONING	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
571			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
571			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
571			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
571			C		0	20	40	60	80	100	100	100	100	100	100	100	100	100	100
571			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
571			Struct	N			0.2		N		15			-901				-901	
573	VIDEO RENTAL STO	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
573			S		0	0	8	10	12	14	16	19	22	25	29	33	38	43	48
573			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
573			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
573			C		0	0	10	20	40	60	80	100	100	100	100	100	100	100	100
573			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
573			Struct	N			0.2		N		15			-901				-901	
575	PARK	P	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
575			S		0	0	10	26	42	52	57	61	66	70	73	77	80	80	80
575			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
575			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
575			C		0	20	40	60	80	100	100	100	100	100	100	100	100	100	100
575			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
575			Struct	N			0.2		N		15			-901				-901	
577	CAMPGROUND	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
577			S		0	0	10	26	42	52	57	61	66	70	73	77	80	80	80
577			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
577			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

577			C		0	20	40	60	80	100	100	100	100	100	100	100	100	100	100
577			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
577			Struct	N			0.2		N		15			-901				-901	
579	PECAN FARM	C	Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
579			S		0	0	8	13	18	25	35	45	55	65	72	78	85	85	85
579			SN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
579			Stage		-0.1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
579			C		0	20	10	40	80	100	100	100	100	100	100	100	100	100	100
579			CN		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
579			Struct	N			0.2		N		15			-901				-901	

ECOSYSTEM EVALUATION

INTRODUCTION

Leon Creek and its tributaries are primarily intermittent streams as they cross over the Edwards Plateau and associated Edwards Aquifer region of the study area and become perennial as they reach the Blackland Prairie region (Lower Leon Creek segment of the environmental study area). According to Zale et al. (1989) intermittent streams are unique habitats essential to the structure and function of ecosystems. Their presence is critical to fish and wildlife populations in the region, an area where perennial streams are rare and separated by great distances. Modification of intermittent streams by channelization, removal of riparian vegetation, grazing, construction of headwater impoundments, siltation, and domestic and industrial effluents is highly destructive to these sensitive habitats and their biota and significantly degrades the quality of adjacent terrestrial habitats. Enhanced protection of intermittent streams is an essential component of natural resource management, especially in light of the neglect of these critically important habitats in past and present land-use planning.

Terrestrial Resources

For central Texas, the wooded uplands, prairie uplands, and riparian corridors work in unison to provide the habitat needs for many species of wildlife. While some species are identified in this report, a more complete reference of species known to utilize the study area is available in project files. Upland areas in this part of the state are mostly prairie with some woodland consisting of legumes and other small and/or short-lived species. These wooded uplands do not typically progress to late successional woodlands, because the climate of the area is not favorable for late successional species except where associated with riparian corridors.

Therefore, many species of birds and other wildlife, which occupy upland habitats exclusively in other areas of the United States, occupy the riparian areas of central Texas exclusively or in conjunction with the upland habitats. Connection to upland woodlands is important to provide the full range of habitat requirements of a species. However, riparian areas of the region are small and less diverse than in areas to the east of this study area. Also, due to fragmentation of upland habitats, a riparian corridor serves as the only travel conduit for species to migrate to other habitats needed to complete their life requisites.

Riparian woodlands serve several important functions in this study area of Texas. According to the *Texas Environmental Almanac* (1995), 189 species of trees and shrubs, 42 woody vines, 75 grasses, and 802 herbaceous plants occur in Texas' bottomlands. They are also known to support 116 species of fish, 31 species of amphibians, 54 species of reptiles, 273 bird species, and 45 mammals. At least 74 species of threatened and endangered animals depend directly on bottomland hardwood systems, and over 50 percent of neotropical songbirds are associated with these systems. Besides providing important wildlife and bird habitat, riparian woodland systems contribute to the state's biodiversity.

They also:

- Serve as catchments and water retention areas in times of flooding,
- Help control erosion,
- Contribute to the nutrient cycle, and
- Play a vital role in maintaining water quality by serving as a depository for sediments, wastes, and pollutants from runoff.

Despite these important functions, riparian woodland ecosystems are one of the most endangered ecosystems in the United States (MacDonald et al., 1979). Prior to European settlement, Texas had approximately 16 million acres of bottomland hardwood riparian habitat. Today, the state has less than 5.9 million acres (Texas Center for Policy Studies, 1995). Riparian woodland systems are considered to be Texas' most diverse ecosystem, but ecosystem degradation has occurred in Leon Creek.

In addition to the direct loss of riparian woodland habitat, further degradation has occurred due to proliferation of invasive plant species such as ligustrum (*Ligustrum spp.*), Chinese tallow (*Triadica sebifera*), and chinaberry (*Melia azedarach*). Non-native species typically occur in disturbed areas where native species take longer to reestablish. Once established, they proliferate and result in monotypic stands of vegetation, which leads to a decrease in diversity and richness.

Interior wetlands, which include bottomland hardwood forests, riparian vegetation, inland freshwater marshes, and the playa lakes of west Texas, account for 80 percent of the total wetland acreage in Texas. According to the *Texas Environmental Almanac* (1995), the vast majority of wetlands are located on private property. In the last 200 years, Texas has lost over 60 percent of these inland wetlands due to agriculture conversion, timber production, reservoir construction, and urban and industrial development. There is a need to restore as many of these wetlands—including riparian woodlands—as possible. This is especially true in urban areas where a large portion of the riparian zone has been lost, and only small, fragmented portions of low quality riparian zones exist today.

Aquatic Resources

A large amount of urban and rural development has occurred in the Leon Creek watersheds within the last fifty years. Much of the land within the study area has been highly disturbed by human activities that have altered the topography of the landscape, including construction of roads and in-stream sewer lines, mining of gravel by commercial business enterprises, and construction activities associated with industries, commercial businesses, residential neighborhoods, and parklands.

Development has reduced the overall width and quality of the riparian corridor in the watersheds, degrading wildlife habitat and aquatic resources. Riparian streambank vegetation improves the aquatic habitat and overall aquatic resources in a riverine system, in the following ways:

- Serve as buffer zones to help remove harmful pollutants and for nutrient loading of an aquatic system.

- Serve as depositories for sediments.
- Help stabilize the banks of creeks to prevent scour and erosion and to decrease sedimentation and turbidity of aquatic resources.
- Provide shade, which lowers water temperatures, which in turn helps keep dissolved oxygen levels higher.
- Serve as spawning and rearing habitat for fisheries.
- Serve as corridors for terrestrial wildlife resources.

The quality and quantity of water that recharges the Edwards Aquifer has degraded over time. Leon Creek contributes recharge to the Edwards Aquifer and contains critical habitat for the nine listed karst invertebrates. Water quality is thought to be a major factor in the threat to the species. Because these species rely on high water quality to survive and are very sensitive to changes in water availability, water quality and space is the most degraded niche of their habitat.

Threatened and Endangered Species

Several species have been Federally listed as endangered or threatened in Bexar County, Texas. The Table B-1(a) provides the names, status and potential for these species to be within the Leon Creek study area. Most species listed are associated with karst topography within the extreme Upper Leon Creek study segment. In addition to the Federal list, the State of Texas has provided a list of species of concern for consideration evaluation of project impacts and for avoidance if possible. That list is maintained in project files.

Table B-1(a) Bexar County Federally-Listed Threatened and Endangered Species.

Common Name	Scientific Name	Listing Status	Potential to Occur within the Study Area
[Unnamed] Ground Beetle	*Rhadine infernalis*	Endangered	Yes
[Unnamed] Ground Beetle	*Rhadine exilis*	Endangered	Yes
Black-capped Vireo	*Vireo atricapilla*	Endangered	Yes
Braken Bat Cave Meshweaver	*Cicurina venii*	Endangered	Yes
Cokendolpher Cave Harvestman	*Texella cokendolpheri*	Endangered	Yes
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	Endangered	No
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Endangered	No
Fountain Darter	*Etheostoma fonticola*	Endangered	No
Golden-cheeked Warbler	*Dendroica chrysoparia*	Endangered	Yes
Government Canyon Bat Cave Meshweaver	*Cicurina vespera*	Endangered	Yes
Government Canyon Bat Cave Spider	*Neoleptoneta microps*	Endangered	Yes
Helotes Mold Beetle	*Batrisodes venyivi*	Endangered	Yes
Madla's Cave Meshweaver	*Cicurina madla*	Endangered	Yes
Peck's Cave Amphipod	*Stygobromus pecki*	Endangered	Yes
Robber Baron Cave Meshweaver	*Cicurina baronia*	Endangered	Yes
San Marcos Salamander	*Eurycea nana*	Threatened	No
Texas Blind Salamander	*Typhlomolge rathbuni*	Endangered	No
Texas Wild Rice	*Zizania texana*	Endangered	No
Whooping Crane	*Grus americana*	Endangered and Experimental Population, Non-essential	Migrant only

Study Area

The Leon Creek study area was broken into five environmental study segments. Based on the vegetational areas of Texas and the overlapping areas of urbanization, the team defined the following environmental segments: Upper Leon Creek, Urban Leon Creek, Lower Leon Creek, Culebra Creek, and Helotes Creek, as shown in Figure B-1.

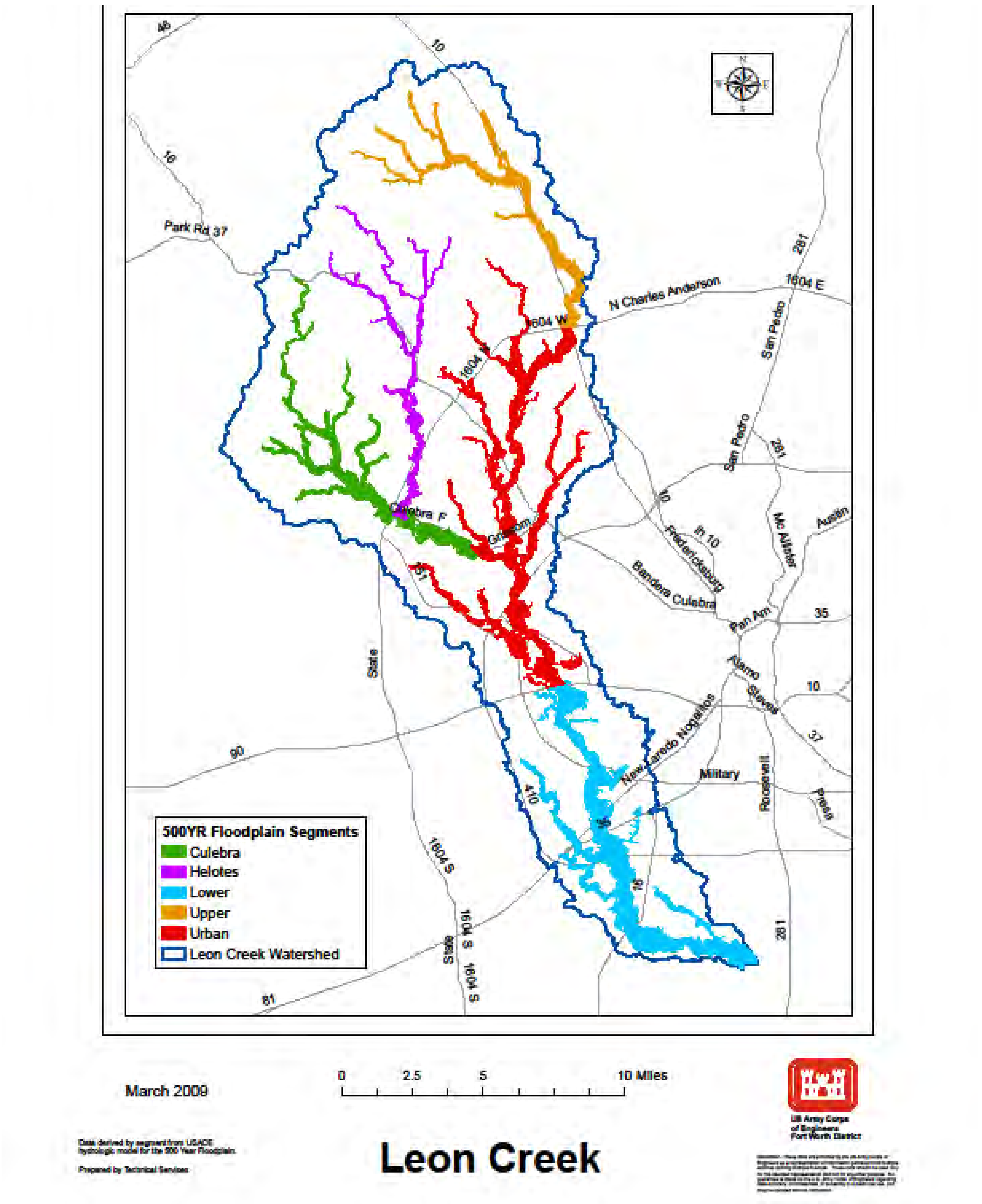


Figure B-1. Leon Creek Watershed Study Area

The Upper Leon Creek environmental segment of Leon Creek mainstem includes the area between its headwaters and Texas State Highway Loop 1604. The following economic reaches are included in this segment: Leon mainstem, Pecan Creek, Leon Tributaries J–N.

The Urban Leon Creek segment extends between Texas State Highway Loop 1604 to Texas State Highway 90 and includes Leon mainstem, Babcock Creek, Huesta Creek, French Creek, Huebner Creek, Slick Ranch Creek and Leon Tributaries G–I. The Lower Leon Creek environmental segment extends from Texas State Highway 90 to the confluence with the Medina River and includes Indian Creek, Comanche Creek, and Leon Tributaries A–E.

The Culebra Creek study segment runs from its confluence with Leon Creek mainstem to Government Canyon and includes Culebra Tributaries A–F. The Helotes segment extends from Helotes Creek mainstem's confluence with Culebra Creek to Helotes Creek headwaters and includes Los Reyes Creek, Chiminea Creek, and Helotes Tributaries A and B.

HABITAT EVALUATIONS

To evaluate terrestrial habitat, the team used the United States Fish and Wildlife Service (USFWS) Habitat Evaluation Procedure (HEP) (USFWS, 1980). Aquatic habitat was evaluated using the Rapid Bioassessment Protocols of the U.S. Environmental Protection Agency (EPA) Habitat Assessment model (Barbour et al., 1999).

Terrestrial and Riparian Habitat

Procedures

To evaluate habitat conditions that would result from alternative plans, first a suitability index (SI) value is determined based on field measurements for existing conditions and on professional judgment for future conditions under alternative plans. The index ranges from 0 to 1.0, with 1.0 representing the highest habitat quality possible. The SI values are aggregated to derive a habitat suitability index (HSI) value for the indicator species.

A habitat unit (HU) is the product of the HSI value multiplied by an area (in acres) of available habitat. HSIs and HUs were developed for different times during the period of analysis (at years 1, 15, 25, and 50). The HUs were annualized to estimate an Average Annual Habitat Unit (AAHU).

This methodology allows future habitat conditions to be estimated for both baseline (without-project) and design (with-project) conditions. Projected long-term effects of a project can be predicted using AAHU values. Based on the AAHU outcomes, alternative designs can be formulated and trade-off analyses can be simulated to promote environmental optimization. As with HUs, AAHUs are determined utilizing the formulas provided by USFWS documentation. Thus, HEP provides information for three general types of wildlife habitat comparisons. The first is the relative value of different areas at the same point in time. The second is the relative value of the same area at future points in time. The use of annualized values allows for comparison of impacts of land and water use changes on wildlife habitat over time.

Evaluation

The USFWS, with assistance from the Texas Parks and Wildlife Department (TPWD) and the USACE Fort Worth District, completed the HEP for the without-project (existing and future) condition of riparian natural resources on Leon Creek. Because the resource agencies are most concerned in the restoration of lost aquatic and riparian habitat functions, the focus was to use models that contain variables that measure important components of riparian corridor structure. The following species which represent guilds important to ecosystems within the Leon Creek watershed were used for terrestrial habitat evaluations.

- Riparian Woodlands: raccoon, barred owl, fox squirrel, green heron
- Grasslands: red-tailed hawk, meadowlark, scissor-tailed flycatcher, eastern cottontail

While these species are relatively common, their habitat suitability index (HSI) models, when averaged cumulatively, serve as good indicators of a healthy, functioning ecosystem and therefore provide a good basis for comparing outputs from alternative plans. However, they should not be used to judge the importance nor significance of these habitats.

Figure B-2 on the next page shows the sites where field surveys were done for the USFWS (HEP). The numbered sites are described according to the closest road or landmark and stream, as listed in Table B-1(b).

Table B-1(b). HEP Map Legend by Segment

HEP Site	Road	Stream	HEP Site	Road	Stream
Upper Leon Creek			Helotes Creek		
1	Huntress Lane	Leon Creek	8	Old Scenic Loop Road	Helotes Creek
2	Scenic Loop Road	Tributary M	9	Scenic Loop Road	Chiminea Creek
3	Flint/Buck Road	Leon Creek	10	Dent Lane	Los Reyes Creek
4	Stonewall Fire Station	Tributary J	11	Leslie Road	Helotes Creek
5	Leon Creek Drive	Leon Creek			
Urban Leon Creek			Lower Leon Creek		
25	Prue Road	Leon Creek	18	Pleasanton Road	Leon Creek
24	Pinn Road	Leon Creek	19	Maurmann Road	Comanche Creek
15	Via Station	Huebner Creek	20	Applewhite Road	Leon Creek
16	Piper Trail	Leon Creek	21	5 Palm Drive	Indian Creek
17	Mystic Park	French Creek	22	Military Road	Leon Creek
7	Dime Street	Huesta Creek	23	Quintana Road	Leon Creek
6	UTSA Blvd.	Babcock Creek			
Culebra Creek					
12	Westwood Park	Culebra Creek			
13	Kalison Road	Culebra Creek			
14	Easterling Road	Culebra Creek			

Note: The sites are listed in the order in which the survey team visited them.

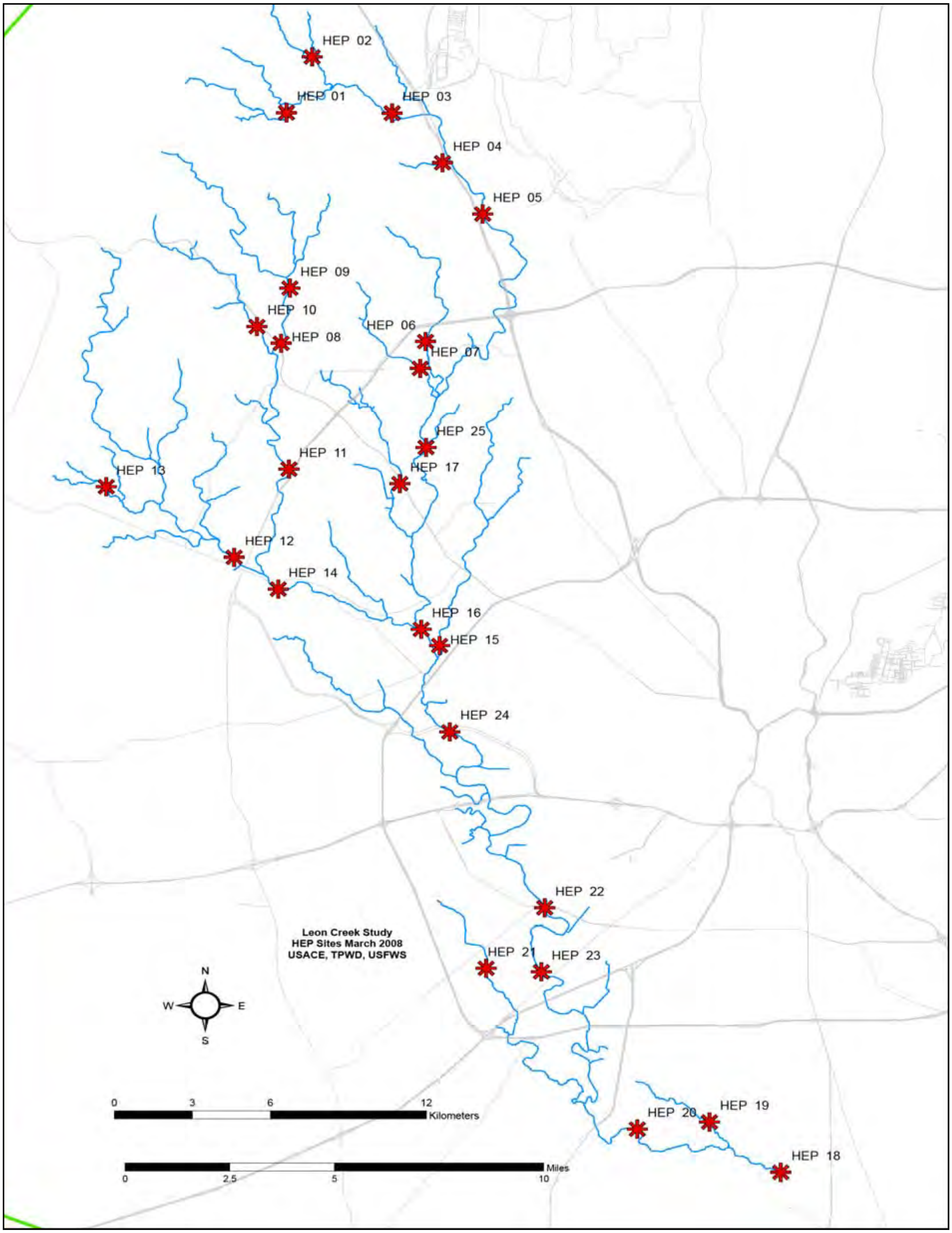


Figure B-2. Survey Sites for HEP Assessment

Table B-2 shows the results of the habitat evaluation for each environmental segment. The overall indices were of average quality except in certain segments where substantial degradation of the riparian zone has occurred due to existing development.

Table B-2. Existing Conditions Wildlife Habitat Values

Habitat / Species	Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Riparian Woodlands					
Raccoon	0.62	0.43	0.45	0.49	0.46
Barred Owl	0.43	0.30	0.16	0.10	0.12
Fox Squirrel	0.49	0.24	0.01	0.11	0.12
Green Heron	0.32	0.35	0.59	0.49	0.58
Overall HSI	0.47	0.33	0.30	0.30	0.32
Grasslands					
Red-tailed Hawk	0.75	0.65	0.65	NA	0.65
Meadowlark	0.43	0.57	0.27	NA	0.71
Scissor-tailed Flycatcher	1.0	1.0	1.0	NA	1.0
Eastern Cottontail	1.0	1.0	1.0	NA	0.04
Overall HSI	0.80	0.81	0.72	NA	0.60

The Corps used ESRI ArcMap to develop a vegetation classification of the 500-year floodplain and to determine acreages by vegetative cover within each segment. These acreages were used, along with the Overall HSI values from the habitat evaluation (Table B-2), to determine the existing habitat units within each cover type (Acreage * HSI value = HU), as shown in Table B-3.

Table B-3. Existing Conditions Habitat Units by Vegetative Cover

Cover Type	Riparian Woodlands			Grasslands		
Study Zone	Acres	HSI	HU	Acres	HSI	HU
Upper Leon	878	.47	413	408	.80	326
Urban Leon	2,730	.33	901	945	.81	765
Culebra Creek	1,680	.30	504	229	.72	167
Helotes Creek	928	.30	278	117	NA	NA
Lower Leon	2,822	.32	903	346	.60	208
Total	9,038		2,999	2,045		1,466

Aquatic Habitat

Procedures

To establish a baseline for project evaluation, the study team quantified the existing value of the aquatic resources. The team analyzed several sites within each environmental segment of the study area. When specific project areas are identified, additional assessments may be needed to more accurately assess the habitat value in those particular areas.

The EPA developed a Habitat Assessment model using Rapid Bioassessment Protocols to analyze the physical characteristics of habitat types (Barbour et al., 1999). For the aquatic habitat assessments, a portion of the EPA Habitat Assessment was used instead of HEP, because HEP provides quality information for aquatic conditions when water is present, but gives low scores (sometimes zero) when water is not present.

The EPA Habitat Assessment is described in detail in *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers*: *Periphyton*, *Benthic Macroinvertebrate*s, *and Fish*, Second Edition (Barbour et al., 1999). Several protocols can be used to complete an in-depth analysis, but only the Habitat Assessment Field Data Sheet was completed for this habitat analysis. Two data sheet survey forms, with slightly different parameters, were used depending on whether the stream was high or low gradient. The analysis measures ten parameters:

- Epifaunal substrate/available cover
- Embeddedness (high-gradient stream) or pool substrate (low-gradient stream) characterization
- Velocity/depth combinations (high-gradient) or pool variability (low gradient)
- Sediment Deposition
- Channel flow status
- Channel alteration
- Frequency of riffles (high-gradient) or channel sinuosity (low gradient)
- Bank stability
- Bank vegetative protection
- Riparian vegetational zone width

Each of the parameters is given a score from 1 to 20 for a possible total score of 200 points for each survey location within a segment. These scores are then averaged to derive a value for the existing conditions per segment.

Evaluation

The team used the same survey sites for the EPA assessment as those for HEP, shown in Figure B-2. Table B-4 provides the results of the field survey for each study segment.

Table B-4. Existing Conditions Aquatic Habitat EPA Survey Scores

Habitat Parameter		Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Epifaunal Substrate		14	8	16	14	18
Embeddedness / Pool Substrate		15	8	12	12	17
Velocity/Depth Regime / Pool Variability		12	10	14	13	15
Sediment Deposition		13	12	16	14	16
Channel Flow Status		2	2	6	5	16
Channel Alteration		16	9	13	16	14
Frequency of Riffles / Channel Sinuosity		18	12	15	16	16
Bank Stability	Left Bank	7	6	7	7	5
	Right Bank	8	5	7	9	5
Vegetative Protection	Left Bank	8	5	8	9	6
	Right Bank	9	6	7	8	6
Riparian Zone Width	Left Bank	8	5	8	10	7
	Right Bank	8	6	6	8	7
Habitat Total Score		138	94	135	141	148
RBPI		.69	.47	.68	.70	.74

To project future without-project conditions, the team predicted the expected changes for years 1, 15, 25, and 50 and completed additional sets of field data sheets to document those expected changes. This process will be repeated to obtain future with-project projections after project features are developed.

- Each segment's score was normalized (converted from the 0–200 scale to a scale where scores range from 0 to 1.0) to produce a Rapid Bioassessment Protocol Index (RBPI). The RBPI is similar to the HSI using HEP.
- The RBPI was multiplied by acres of stream to obtain aquatic RBPUs.
- The remaining runs of the model were accomplished similar to HEP, to produce the Average Annual Rapid Bioassessment Protocol Unit (AARBPU) values.

Using the Ultimate Land Use data provided by the sponsor, San Antonio River Authority (SARA), our projections hold true, in that the remaining segments will experience a similar degradation pattern as the Urban Leon Creek segment has.

EXISTING HABITAT CONDITIONS

This section details the existing environmental setting for each segment of the study area and describes how the vegetative cover types were refined for analysis.

- Because grasslands have a woody component, areas having only low-density shrubland, these areas and their acreages are included in the grasslands discussion.
- Similarly, young or first successional woodland acreages are included in the discussion of riparian woodlands.
- Due to lack of access, inadequate survey locations were available for true shrublands. However, the team felt it was important to keep the shrubland acreages separate for discussion purposes and leave the topic open for future study if necessary.
- Commercial, residential, and road acreages were combined into the urban classification.
- The entire watershed, with the exception of the Lower Leon Creek segment, is ephemeral to intermittent, therefore, *streambed* is used as a description for stream channels that would normally be classified as water.

Although USACE normally would not restore grasslands (in an ecosystem restoration project), the team felt it important to include assessment of these habitats for purposes of evaluating their conversion to riparian forests.

The historic vegetation within the Upper and Urban Leon Creek, Culebra Creek, and Helotes Creek segments is described as savanna that was rich in tall and mid grasses with interspersed clumps of live oak (*Quercus virginiana*) and Texas live oak (*Q. fusiformis*). However, overgrazing by livestock and the desire to suppress naturally occurring range fires have promoted a tremendous increase in the abundance of woody species. Such species include Ashe juniper (*Juniperus ashei*), honey mesquite (*Prosopis glandulosa*), huisache (*Acacia farnesiana*), and others that were historically restricted to the steep slopes of canyons, ridges, and ravines where fires could not reach them (Buechner, 1944).

Much of the watershed is still being used for agricultural purposes, such as grazing, row cropping, and hay production. However, a recent increase in population has promoted residential growth throughout the area. This development has resulted in clearing of large tracts of land for homes, businesses, and utility lines. The City of San Antonio has established ordinances to reduce development in the 100-year floodplain. A common practice is the clearing of brush and understory and leaving stands of oak species. The implications of increased impervious cover and the conversion to Ashe juniper and other prolific hydrophytes (“water loving” species) from native grasslands or savannas is that there is less water infiltration into the soils and more runoff. This results in shorter durations of flow in the creeks, which in turn results in less recharge into the aquifers. In addition, if hydrophytic vegetation gets established, their roots may extend to the aquifer and influence water quantities within shallow aquifers.

The historic vegetation of the Lower Leon Creek segment is rolling to nearly level plains of the Northern Blackland Prairie ecoregion, with mostly fine-textured, dark, calcareous, and productive Vertisol soils.

Historical vegetation was dominated by little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), yellow Indian grass (*Sorghastrum nutans*), and tall dropseed (*Sporobolus asper*). Common forbs included asters, prairie bluet (*Hedyotis nigricans*), prairie clovers (*Lespedeza spp.*), and black-eyed susan (*Rudbeckia hirta*). Stream bottoms were often wooded with bur oak (*Quercus macrocarpa*), Shumard oak (*Q. shumardii*), sugar hackberry (*Celtis laevigatus*), elm (*Ulmus spp.*), ash (*Fraxinus spp.*), eastern cottonwood (*Populus deltoides*), and pecan (*Carya illinoinensis*). Most of the prairie has been converted to cropland, non-native pasture, and expanding urban uses around San Antonio.

Aquatic habitat in the Leon Creek watershed is diverse. The headwater originates from spring flow, and the stream is classified as an ephemeral stream through this segment with varying levels of available water depending on the location above or upon the Edwards Aquifer Recharge Zone. This segment provides riverine riparian habitat for fisheries and other aquatic species for most of the zone. The substrate is rocky with cobble. The creek has clear water with a diversity of aquatic in-stream vegetation and structure that provide aquatic habitat.

As the creek moves south into a transition zone, it becomes less diverse and closely surrounded by an urban environment. This area is composed of very rocky substrate with boulder-size particles and a bedrock channel. Fractures in limestone outcrops are common and serve to recharge the aquifer. The creek is intermittent and only flows during large rain events of more than a couple of inches. The creeks are sometimes dry for several years, except for a small amount of flow attributed to urban lawn irrigation and a few persistent pools. The decrease in persistent water is attributed to several things, including groundwater pumping, growth of hydrophytic plants in the contributing watershed, and increases in impervious cover.

As the stream passes out of the aquifer recharge and transition zone and beyond the urban area, it transitions into a perennial stream that provides riverine aquatic habitat, and the adjacent riparian areas become wider. In addition to spring flow, reuse water from the Lackland Air Force Base Test Cell Facility and a San Antonio Water System (SAWS) wastewater recycling facility are discharged in this zone. While water is more permanent in this reach, water quality is impaired due to bacteria and to PCBs in edible tissue of fish, according to the State of Texas 303(d) 2010 List.

In-stream vegetation observed during site visits included: buttonbush (*Cephalanthus occidentalis*), water willow (*Justicia Americana*), duckweed (*Spirodela polyrhiza*), fern, pennywort (*Hydrocotyle sp*.), pondweed (*Potamogeton illinoensis*), sedge (*Carex sp*.), smartweed (*Polygonum hydropiperiodes*), spadderdock (*Nuphar luteum*), needle spikerush (*Eleocharis acicularis*), switchgrass (*Panicum virgatum*), and water star grass (*Heternanthera dubia*).

Upper Leon Creek

The upper segment of Leon Creek mainstem runs from its headwaters to Texas State Highway Loop 1604 and includes the economic reaches: Leon mainstem, Pecan Creek, Leon Tributaries J–N. This segment has experienced a great deal of urban sprawl. Very little forest cover exists except along the riparian zone of Leon Creek. This segment has rocky soils typical of the Edwards Plateau ecoregion and a large deciduous canopy where it has been left alone. Along several sections of this stream, grazing has left virtually no riparian zone. In other areas, the riparian zone is more than 200 meters wide, dense, and intact. Like the rest of Leon Creek, the grasslands have relatively high HSIs, but are composed mostly of non-native invader species. In general, this segment is highly degraded from urban sprawl and grazing activities and appears to have areas susceptible to erosion due to a non-continuous and low-quality riparian zone.

Figure B-3 shows the vegetative cover types along the Upper Leon Creek segment.

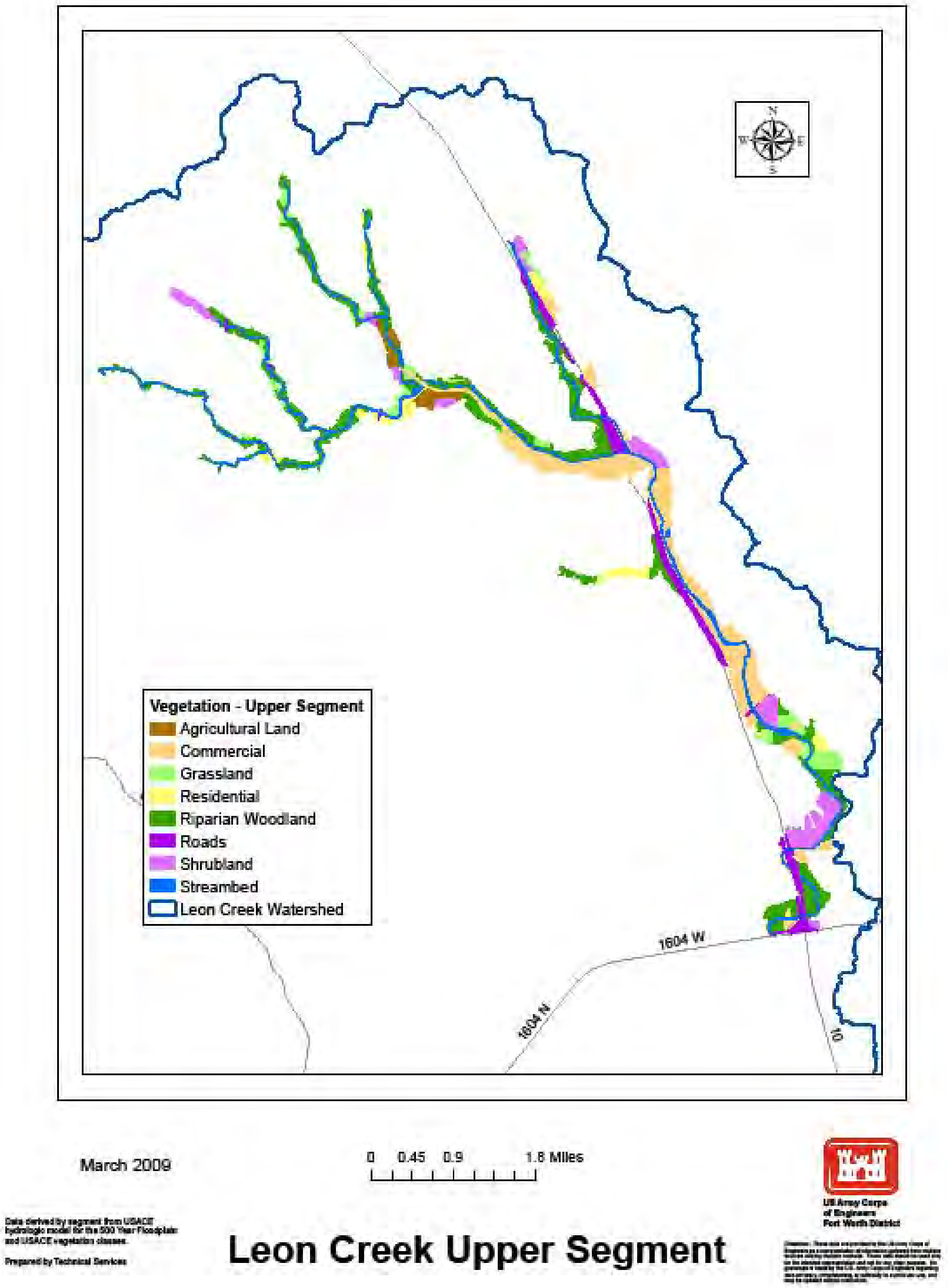


Figure B-3. Upper Leon Creek Segment Vegetation

Terrestrial and Riparian Habitat

The Upper Leon Creek segment covers about 2,456 acres within the 500-year floodplain and contains the following vegetative cover types:

Cover Type	Acreage
Riparian Woodlands	878
Grasslands	408
Agricultural	83
Urban	967
Streambed	120
Total	2,456

The riparian zones in this segment consist of pole-size stands of live oak, Ashe juniper, and cedar elm (*Ulmus crassifolia*) trees. The canopy has an average of 40% closure with 25% shrub understory. As shown in Table B-2 “Existing Conditions Wildlife Habitat Values”, the overall riparian woodland HSI value for the Upper Leon Creek segment is 0.47 which is considered fair quality habitat, providing 412 habitat units.

- The majority of the sites in these riparian areas had more than four trees greater than twenty inches in diameter, which improved the overall habitat rating for raccoon cover and reproduction (0.62).
- Barred owl habitat was fair, though the average diameter at breast height (dbh) of less than 10 inches for overstory trees reduces the cover and reproductive values (0.43).
- Fox squirrel habitat value was reduced by the relatively young overstory and lack of available winter food (0.49).
- The green heron had only a fair score (0.32) because of the rocky substrate and lack of emergent herbaceous cover.

Most of the grassland along Leon Creek has high HSI values with an overall HSI of 0.80, with 326 existing habitat units.

- The grasslands generally had dense ground cover and a mixture of grasses and forbs. The grasslands were adjacent to wooded riparian areas providing good red-tailed hawk nesting and perching. (0.75)
- Because of the lower percentage of grass present, meadowlark habitat value was average (0.43).
- The habitat scored perfect (1.0) for scissor-tailed flycatcher and eastern cottontail at all three sites. There was good ground cover and a good mixture of forbs and grasses. Removing some of the nonnative invasive species and restoring native vegetation to the area could improve the overall diversity of the area.

Aquatic Habitat

The aquatic habitat in the Upper Leon Creek segment is considered diverse. The headwater originates from spring flow and the stream is classified as an ephemeral stream through this segment, with varying levels of available water depending on its location above or upon the Edwards Aquifer Recharge Zone. This segment provides riverine riparian habitat for fisheries and other aquatic species. The substrate is rocky with cobble. Although many small, man-made check dams hold water and fill with cobble, the creek has clear water with a diversity of aquatic in-stream vegetation and structure that provide fair aquatic habitat. There are a variety of flows, pools, and riffle complexes.

For the most part, the upper segment is in good or excellent condition with the exception of the man-made check dams, which are not natural to riverine areas, but it would not be practical to restore these areas. However, the area of Leon Creek main stem that runs along Interstate Highway 10 is degraded and could be restored by increasing the riparian zone along the creek.

These areas had very little running water, but numerous persistent pools. The aquatic habitat RBPI is 0.69 providing 302 RBPUs for excellent to good aquatic habitat. The site locations on Upper Leon Creek scored high: 141 at Huntress, 155 at Flint, and 118 at Leon Creek Drive. The entire area scored a little low due to water availability. If the score had been taken during a high-flow event, it would have been higher. To provide a more accurate assessment, the field experts decided to view streams as if they had water and according to how the flows would traverse the segment for the Velocity/Depth Regime parameter.

The Huntress and Flint sites are relatively pristine with the major loss of points due to the Channel Alteration parameter. Huntress had a man-made check dam located just upstream, and Flint was adjacent to a road.

The Leon Creek Drive site scored a little lower than the first two, but much of that can be attributed to Leon Creek crossing under Interstate 10 and into a more urban environment. There was no water present at the site and the creek bed comprised mostly bedrock. The riparian zone was reduced to 6–12 meters on either side with a moderate amount of non-native vegetation. This site would be vastly improved by replacing the non-native streambank vegetation with native species and increasing the riparian vegetative zone where space permits.

Tributaries M and J scored 139 and 133 respectively and can be categorized together, as their aquatic habitats are similar. These tributaries consist of only small residual pools and are flashy in nature during high-water events. They lack Epifaunal Cover for fisheries and consist of only two of the four Velocity/Depth Regimes. Considering the nature of these tributaries, this is to be expected. The Riparian Zones, Bank Stability, and Vegetative Protection parameters all scored high. The aquatic habitat in these streams is good.

Ecosystem Restoration Opportunities

The Upper Leon Creek segment is unlimited in the number of opportunities for restoration.

Urban Leon Creek

The Urban Leon Creek segment extends between Texas State Highway Loop 1604 to Texas State Highway 90 and includes the economic reaches described as Leon main stem, Babcock Creek, Huesta Creek, French Creek, Huebner Creek, Slick Ranch Creek, and Leon Tributaries G–I. This area has experienced high-density residential and commercial development within the 500-, 100-, and 25-year floodplains, which has reduced the width of the riparian corridor. However, this segment of Leon Creek has average quality riparian areas with pockets of high quality habitat.

Invasive species within the segment, such as Chinese Tallow, ligustrum, and chinaberry, indicate an opportunity for improvement for fish and wildlife species. This area is experiencing erosion due to the vegetation being removed from the tops of the banks, channelization projects, and impervious cover. Reestablishing vegetation on these banks would help stabilize the banks and would benefit the overall habitat in the area. Figure B-4 shows the types of vegetative cover along the Urban Leon Creek segment.

Terrestrial and Riparian Habitat

The Urban Leon Creek segment covers about 6,591 acres within the 500-year floodplain and contains the following vegetative cover types:

Cover Type	Acreage
Riparian Woodlands	2,730
Grasslands	945
Agricultural	340
Urban	2,274
Streambed	302
Total	6,591

The overall HSI value for riparian woodlands in Urban Leon Creek is 0.33 with 901 Habitat Units providing fair habitat.

- The majority of the trees in these riparian areas were less than ten inches in diameter, which lowered the overall habitat rating (0.43) for raccoon cover and reproduction.
- The barred owl habitat was poor (0.30). The relatively thick understory, in conjunction with the lack of overstory trees greater than 20 inches and the dbh of overstory trees being of the pole class, significantly limited the cover and reproductive values.

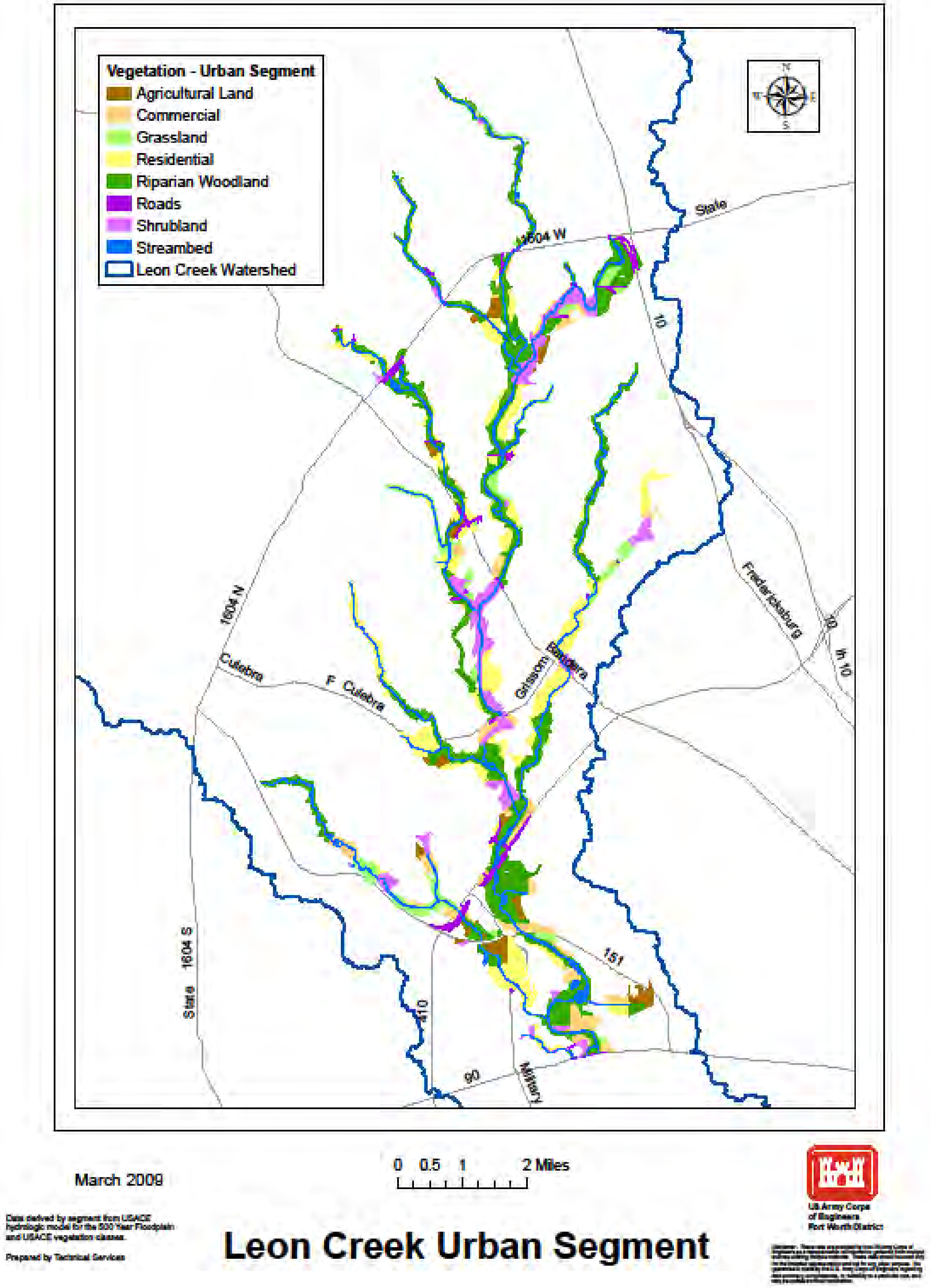


Figure B-4. Urban Leon Creek Segment Vegetation

- Similarly, fox squirrel habitat value (0.24) for cover and reproduction was reduced by the relatively thick understory. Barred owls and fox squirrels require a more open understory.
- Mast producers greater than or equal to six inches dbh were fairly uncommon throughout the woodlands producing low food value for fox squirrels.

The grasslands along Urban Leon Creek are in good condition with an overall HSI value of 0.81, and 765 habitat units.

- The grasslands are adjacent to wooded riparian areas providing good red-tailed hawk nesting and perching habitat. However, the close proximity of residential housing depresses red-tailed nesting success. Therefore, these areas only provide average (0.65) habitat for red-tailed hawks.
- Meadowlark habitat value was similarly lower (0.57) because of the taller herbaceous cover of grass present in the areas.
- The area scored perfect (1.0) scissor-tailed flycatcher and eastern cottontail habitat.

Habitat diversity in these areas could be improved by establishing a few native tall grassland areas along the floodway grassland boundary with scattered shrubs and scattered brush piles.

Aquatic Habitat

The Urban Leon Creek segment is not as diverse as the Upper Leon Creek segment. This area is composed of very rocky substrate with boulder-size particles and a bedrock channel. Fractures in limestone outcrops are common and serve to recharge the aquifer. The creek is intermittent and only flows during large rain events of more than a couple of inches. The creek is sometimes dry for several years, except for limited flow attributed to urban lawn irrigation and a few persistent pools. These permanent pools are essential in ephemeral and intermittent streams, as they provide niche space for the abundance of macroinvertebrates and fishes that inhabit these streams, while providing water for wildlife species that inhabit the riparian corridors. Manipulations that decrease the size or frequency of permanent pools decrease habitat availability and stability and deleteriously affect macroinvertebrate and fish assemblages in intermittent streams (Zale et al., 1989). The decrease in persistent water is attributed to several things, including groundwater pumping, growth of hydrophytic plants in the contributing watershed, and increases in impervious cover. The main degradation to this segment is due to the decrease in water within the creeks, damage from channelization projects, and narrowing of the riparian corridor within this urban environment.

This segment's water regimes are characteristic of the Upper Leon Creek segment, but are located in an urban environment, on or just below the recharge zone, and range from minimal to a complete lack of water. The RBPI value in this segment is .47 and contains 509 RBPUs providing fair aquatic habitat. The urban site locations on Leon Creek scored low, with 63 at Huntress and 97 at Piper Trail. However, the Prue Road site (144) provides an example of the benefits that could be accomplished at poor quality sites.

The Prue Road site had a minimal amount of water and was lacking in epifaunal cover and embeddedness. This is not a major concern because it is located over the aquifer recharge zone and will typically only carry flows during rain events. Although within an urban environment, the area consisted of a good mix of mature trees and shrubs in the riparian area that provides quality aquatic habitat. The Pinn Road site was a channelized segment of Leon Creek, which provides few if any aquatic benefits. It is a mowed channel that has eroded to a bedrock surface. It received a few points for the adjacent riparian grassland and lack of levee erosion. Planting native riparian species along the channel would vastly improve this section. However, any plantings would have to be done in a manner to not adversely impact channel hydraulic performance.

Although scoring low, the Piper Trail site represents a good area for restoration. This site does not have a prominent stream channel and has eroded at multiple locations throughout scrub-shrub brushland. This area has an extensive corridor for project features. Huebner Creek (110), French Creek (55 channelized), Huesta Creek (71), and Babcock Creek (113) all scored low due to limited water, and on all other factors due to their urban nature. A major reason for the low scores is the areas are dry most of the time, with exception of some persistent pools.

The areas are in the Edwards Aquifer Recharge Zone and typical of central Texas recharge streams. The substrate moves during each rain event and is unstable. The substrate compositions have a lot of sediment deposition. Riffles were dry. The Velocity/Depth Regime and Channel Flow were also rated poor because of all four regimes not being present. Stream width was also a limiting factor; the streams appeared to be widening and the streambanks had signs of erosion. The adjacent riparian vegetation width was insufficient and composed of more plant species that do not provide adequate streambank protection. Although this area scored low on the EPA assessment method, there is little room for improvement due to the type of stream and aquatic habitat available. It would be possible in some areas to increase riparian areas to improve stream functions and habitat values.

Ecosystem Restoration Opportunities

Ecosystem restoration opportunities in this area include: riparian woodland restoration, channel restoration/creation, and buyout of flood prone residential subdivisions and implementation of regulations to prevent development within the 25-year floodplain to prevent additional riparian habitat losses and provide base for riparian corridor restoration.

Culebra Creek

This stretch of the Leon Creek watershed study identified as the Culebra Creek segment runs from its confluence with Leon Creek Main stem to Government Canyon and includes Culebra Tribs A–F economic reaches. The Culebra Creek segment emerges from spring flow at its headwaters and traverses through the Edwards Aquifer Recharge Zone until its confluence with Leon Creek. Two tributaries in this segment begin in Government Canyon State Natural Area, which covers approximately 8,622 acres in Bexar County, just west of San Antonio. This area is a pristine, highly sensitive ecosystem due to the karst features and critical habitat identified for several endangered species. Figure B-5 shows the vegetative cover types along the Culebra Creek segment.

Terrestrial and Riparian Habitat

The Culebra Creek segment covers about 3,397 acres within the 500-year floodplain and contains the following vegetative cover types:

Cover Type	Acreage
Riparian Woodlands	1,680
Grasslands	229
Agricultural	527
Urban	806
Streambed	155
Total	3,397

The Culebra Creek segment is dominated by low-quality riparian woodlands, residential, and agricultural land use. The riparian zone is continuous, but ranges from less than 30 meters to greater than 200 meters, with some areas that are mowed and/or cleared up to one bank of the stream. Because there is dense residential development within the riparian zone, this directly contributes to erosion and sedimentation from the steep rocky banks where riparian vegetation has been removed. In general, the riparian zone is poor to fair with many areas that are dominated by first successional species with some higher quality older communities interspersed.

The overall HSI value for the riparian woodlands on Culebra Creek is 0.30, with 504 habitat units providing fair habitat.

- The raccoon and barred owl require large diameter trees, which were fairly uncommon throughout the woodlands. The trees in these riparian areas were less than 20 inches dbh, which reduced the overall habitat rating for raccoon cover and reproduction (0.45) and barred owl habitat (0.16).
- Mast producing trees greater than or equal to six inches dbh were lacking throughout the woodlands producing poor food value for fox squirrels (0.01).
- Green heron habitat rated average with an overall 0.59 HSI.

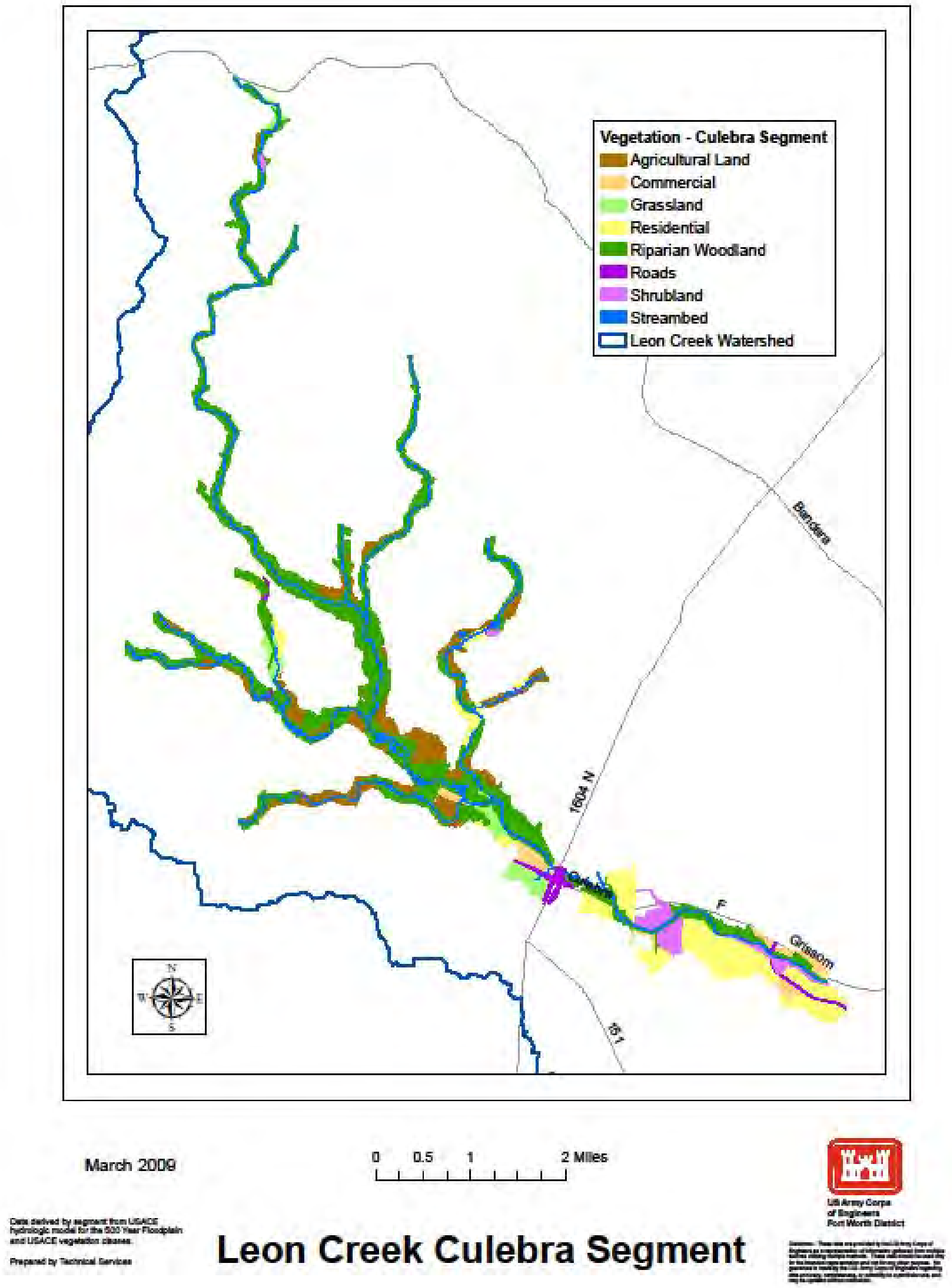


Figure B-5. Culebra Creek Segment Vegetation

The riparian woodlands that are established, although few, are of high quality. However, there are several areas along the creek where the riparian zone has been reduced due to residential growth. The fish and wildlife habitat would benefit from extending the riparian zone and creating a larger buffer zone.

The grasslands along Culebra Creek are in good condition with an overall HSI value of 0.73, with 167 habitat units.

- The grasslands were adjacent to wooded riparian areas providing good red-tailed hawk nesting and perching habitat. However, the close proximity of residential housing within the sample areas depresses red-tailed nesting success, and therefore these areas provide only fair habitat for red-tailed hawks (0.65).
- Meadowlark habitat value was fair (0.27) because of the lower herbaceous cover of grass present in the areas.
- The area was considered perfect (1.0) scissor-tailed flycatcher and eastern cottontail habitat.

Habitat diversity in these areas could be improved by establishing a few native tall grassland areas along the floodway grassland boundary with scattered shrubs and scattered brush piles.

Aquatic Habitat

The Culebra Creek segment is consistent with the Upper Leon Creek segment in available water, riparian zones, substrate, and aquatic habitat. As the stream flows through the Edwards Aquifer Recharge Zone, available water remains only in persistent pools, and the riparian areas become narrower as it moves through the urban areas until its confluence with Leon Creek.. This segment could be improved by protecting stream corridors from urbanization. From the confluence with Helotes Creek to the confluence with Leon Creek, Culebra Creek is surrounded by development on both sides. Stream functions in this area are greatly altered and degraded.

The Culebra Creek segment was assessed at three locations: Kallison Road (135), midpoint at Westwood Park (150) and below the confluence with Helotes Creek at Easterling Road (126). Aquatic resources in this segment consist of good quality aquatic habitat with an RBPI of 0.68 and contain 398 RBPH units.

At the Kallison Road site, Culebra Creek is a low-gradient, spring-fed, slowly meandering, persistent stream. The stream’s limiting factors include its lack of pool variability due to its size, disturbances from the housing development, and vehicle tracks. This area of the stream will change greatly in the future, as the development has constructed a concrete drainage ditch, with a culvert directly into this small stream. The riparian area is first successional grassland converting to shrubland, which provides bank stability and vegetative protection. To slow further degradation, purchase or protection of this area is advisable.

The Westwood Park site is considered quality aquatic habitat with limitations based only on the lack of flow. It does contain persistent pools, which are occupied by several fish species.

The site at Easterling Road was just downstream from a concrete diversion channel project and adjacent to a cement plant on the right bank. The low-flow channel contains fair aquatic habitat in the persistent pools, although the velocity and amount of water during high-water events are widening and moving the channel, which causes the lower score. This site could be improved by creating additional riparian features along the left bank.

Ecosystem Restoration Opportunities

The Culebra Creek segment has low quality existing habitat, as much of the riparian woodlands are first successional and/or converted to residential housing. Riparian woodlands could be restored.

Helotes Creek

The stretch of the Leon Creek watershed study identified as the Helotes Creek segment extends from Helotes Creek mainstem’s confluence with Culebra Creek to Helotes Creek headwaters and includes Los Reyes Creek, Chiminea Creek, and Helotes Tributaries A and B economic reaches. The Helotes Creek segment is categorized as an ephemeral stream and similar in nature to Upper Leon and Culebra Creek segments. The headwaters of Los Reyes, Chiminea, and Helotes Creeks are spring fed and converge to create Helotes Creek, which has varying amounts of water depending on the location as it crosses the Edwards Aquifer Recharge Zone. This segment’s evaluation included two locations on Helotes Creek and one each on Los Reyes Creek and Chiminea Creek. Figure B-6 shows the types of vegetative cover that exist along the Helotes Creek segment.

Terrestrial and Riparian Habitat

Helotes Creek covers about 1,621 acres within the 500-year floodplain and contains the following vegetative cover types:

Cover Type	Acreage
Riparian Woodlands	928
Grasslands	117
Agricultural	29
Urban	417
Streambed	130
Total	1,621

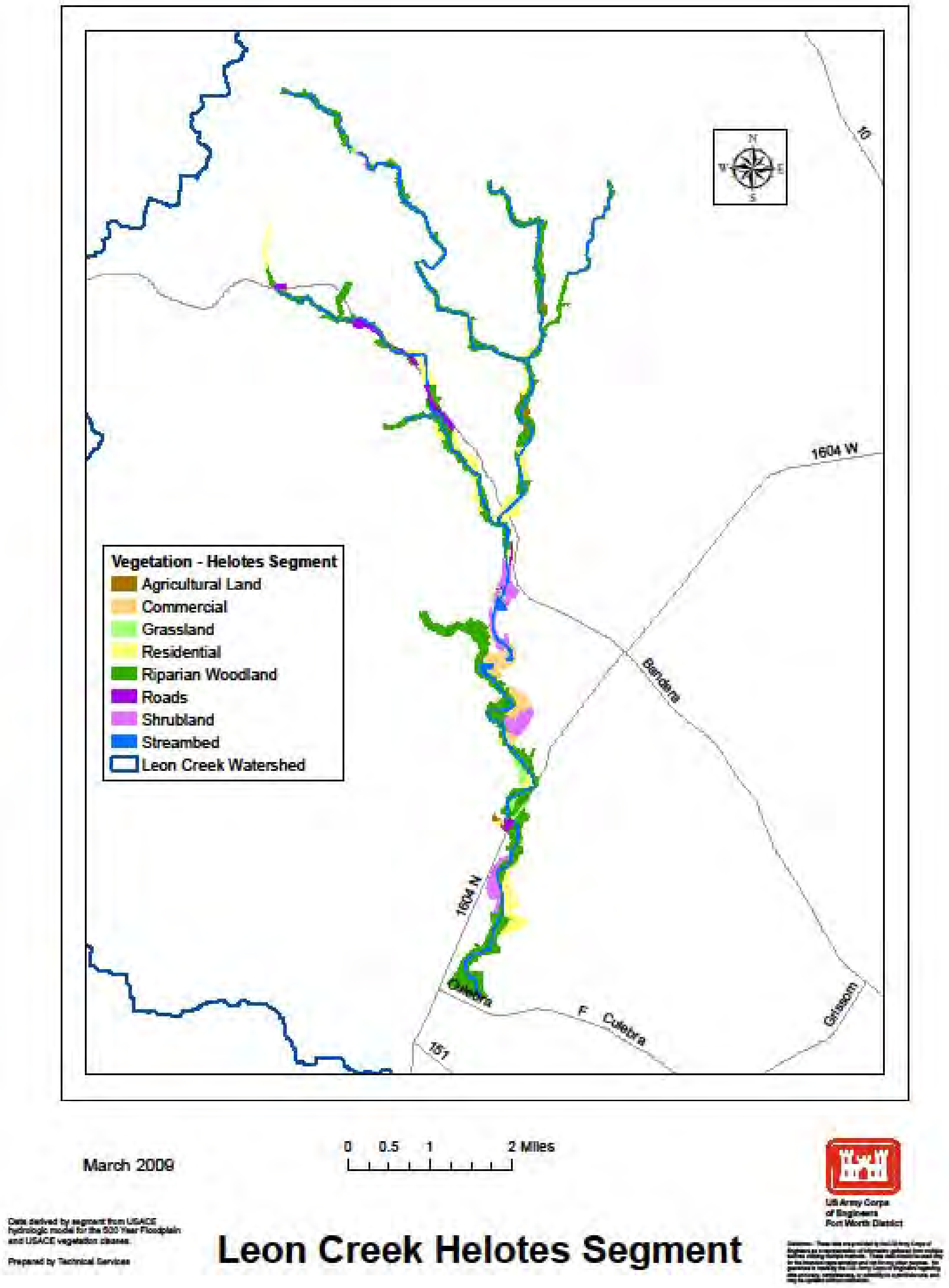


Figure B-6. Helotes Creek Segment Vegetation

The Helotes Creek segment is dominated by average quality riparian woodlands, residential, and agricultural land use. The riparian zone ranges from less than 30 meters to greater than 200 meters, with some areas that are mowed and/or cleared up to one bank of the stream. Riparian habitat is intact in the upper part of the Helotes Creek segment, but the habitat becomes less functional as the segment moves downstream due to dense residential development within the riparian zone. In general, the riparian zone in this area is good, but continued urban sprawl is taxing this segment.

The overall HSI value for the riparian woodlands on Helotes Creek is 0.30, with 278 habitat units providing fair habitat.

- The raccoon and barred owl require large diameter trees, which were fairly uncommon throughout the woodlands. The trees in these riparian areas were less than 20 inches dbh, which reduced the overall habitat rating for raccoon cover and reproduction (0.49) and barred owl habitat (0.10).
- Mast producing trees greater than or equal to six inches dbh were lacking throughout the woodlands, producing poor food value for fox squirrels (0.11).
- Green heron habitat rated average with an overall 0.49 HSI, due to a low food value from the rocky substrate.

The fish and wildlife habitat would benefit from extending the riparian zone and creating a larger buffer zone, although the lower portion of the stream is bottlenecked due to residential neighborhoods.

Aquatic Habitat

The Helotes Creek segment is categorized as an ephemeral stream and is similar in nature to Upper Leon and Culebra Creek segments. The headwaters of Los Reyes, Chiminea, and Helotes Creeks are spring fed and converge to create Helotes Creek, which has varying amounts of water depending on the location as it crosses the Edwards Aquifer Recharge Zone.

Along much of this segment, the riparian corridor remains intact and should be protected. North of the confluence of the three creeks, a great deal of this zone is listed as in or closely adjacent to Karst Habitat Zone 1 or 2, and any proposed project would have to be closely monitored to ensure these areas are avoided. Additionally, Final Critical Habitat models for the nine Bexar County Endangered Invertebrate Species show three karst features that hold the invertebrates; the Helotes Mold Beetle (*Batrisodes venyvivi*) is only located in the three karst regions on the Helotes Creek channel from Scenic Loop Road to approximately one-half mile upstream (Federal Register, 2000). This area should be avoided when planning proposed project features.

The Helotes Creek segment contains 298 RBPUs with an RBPI of 0.70, providing good to excellent aquatic habitat.

- Helotes Creek at Old Scenic Road scored 106 due to lack of water, lack of Epifaunal Substrate, Embeddedness (streambed was primarily rock and boulder sized materials), and Velocity/Depth Regime provided no deep water. On both sides of the stream, residences with mowed yards cause poor bank stability. This site location makes improvements difficult.

- The site at Leslie Road scored 149 and is considered excellent aquatic habitat. Water was present in persistent pools with favorable epifaunal habitat. However, with the stream's ephemeral nature, it scored low. A moderate amount of sediment deposition also contributed to a lower score.
- Chiminea Creek at the confluence with Helotes Creek is a spring-fed stream with permanent, clear channel flow, bass and sunfish present at the site along Scenic Loop Road, and a score of 159. The site would score higher, but a man-made check dam located just upstream from the site slows the natural flow of the stream. Additionally, a small amount of streambank erosion has occurred on the right bank due to the cutting action off of the dam.
- Los Reyes Creek along Dent Lane scored 124. However, the aquatic habitat at this location is favorable except for lack of permanent water.

This stream is also flashy in nature and lacks Epifaunal Substrate and Embeddedness. Only two of the four Velocity/Depth Regimes are present, and sediment deposition is prevalent. It is evident that high water events routinely shift and move sediments through this area. A possible improvement could be to add roughness in this stretch to ease the impact on the natural features of this stream.

Ecosystem Restoration Opportunities

The Helotes Creek segment has several karst features that contain, or have a high probability of containing, the nine karst invertebrates. Critical habitat for several species has been designated within the Helotes Creek basin above Scenic Loop Road (Federal Register, Vol. 77 No. 30, Tuesday February 14, 2012). Helotes Creek offers the opportunity to increase the riparian zones to improve water quality and create features designed to increase water quantity to the aquifer. Heavily disturbed limestone rock mining areas adjacent to the creek downstream of Scenic Loop Road could be considered for opportunities to improve overall ecological conditions in Helotes Creek.

Lower Leon Creek

The Lower Leon Creek segment extends from Texas State Highway 90 to the confluence with the Medina River and includes the Indian Creek, Comanche Creek, and Leon Tributaries A–E economic reaches. The lower segment of Leon Creek returns to a perennial stream that provides riverine aquatic habitat. Aquatic vegetation species are the same species reflected in the other four segments, and the adjacent riparian areas again become wider with more bottomland hardwood species. Agricultural lands become more prevalent, as this segment is listed as Blackland Prairie in the vegetational zones of Texas. The surrounding riparian areas are clay, silt, and sand. The survey sites for the lower segment on Leon Creek included Military Road, Quintana Road, Applewhite Road, and Pleasanton Road locations. Figure B-7 shows the vegetative cover types along the Lower Leon Creek segment.

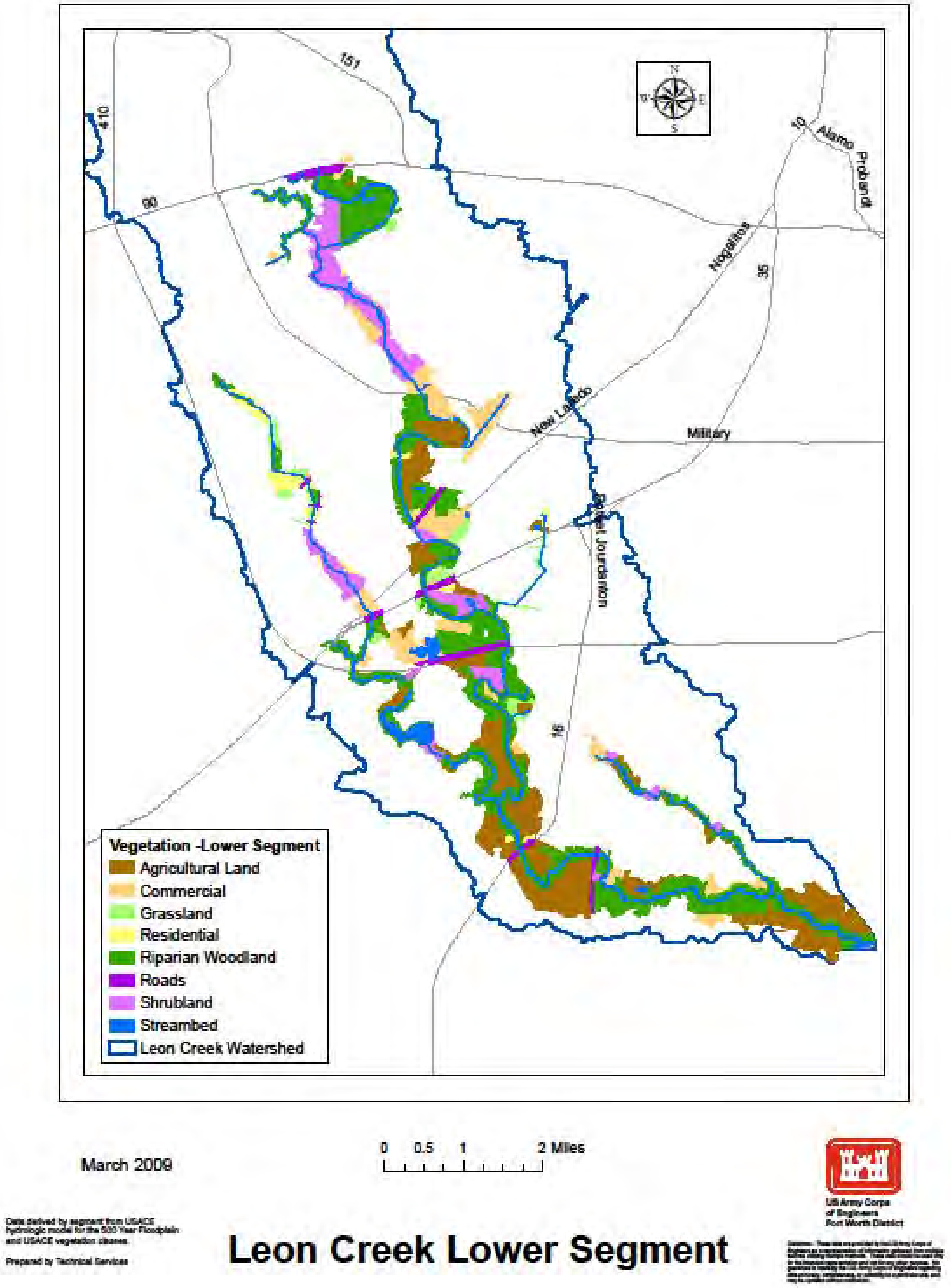


Figure B-7. Lower Leon Creek Segment Vegetation

Terrestrial and Riparian Habitat

The Lower Leon Creek segment covers 6,406 acres within the 500-year floodplain and contains the following types of vegetative cover:

Cover Type	Acreage
Riparian Woodlands	2,822
Grasslands	346
Agricultural	1,748
Urban	1,136
Streambed	354
Total	6,406

The riparian zones in this segment are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash (*Fraxinus pennsylvanicus*), black willow (*Salix nigra*), and cedar elm trees in the upper portions of the segment. The overall riparian woodland HSI value for the Lower Leon Creek segment is 0.32 with 903 habitat units providing fair habitat.

- The majority of the sites in these riparian areas had less than four trees greater than twenty inches in diameter, which reduced the overall habitat rating for raccoon cover and reproduction (0.46).
- Barred owl habitat was poor (0.12), due to the low average dbh of overstory trees less than 10 inches, which reduces cover and reproductive values.
- Fox squirrel habitat value (0.12) was reduced by the lack of mast producing trees for available food.
- The green heron had only a fair score (0.58) because of the lack of emergent herbaceous cover.

The grasslands in Lower Leon Creek have average HSI values with an overall HSI of 0.60, and 208 habitat units. The grasslands generally had dense ground cover and a mixture of grasses and forbs.

- The grasslands were adjacent to wooded riparian areas providing good red-tailed hawk nesting and perching (0.65).
- Meadowlark habitat value was good (0.71) because of the lower percentage of shrub crown cover and high presence of grasses present in the areas.
- Scissor-tailed flycatcher habitat was perfect (1.0) at the sites.
- However, the cottontail habitat was poor (0.04) due to the lack of canopy closure.

Habitat diversity in this area was average due to the non-native invasive plant species. Bermuda grass (*Cynodon dactylon*), used in this area as improved pasture for grazing livestock, dominates the grassland area and limits the habitat potential of these sites. Removing some of the non-native invasive species and restoring native vegetation to the area could improve the overall diversity of the area.

Aquatic Habitat

The Lower Leon Creek segment becomes a perennial stream that provides riverine aquatic habitat, as this segment is below the aquifer recharge zone. Aquatic vegetation species are the same species reflected in the other four segments, and the adjacent riparian areas become wider with more bottomland hardwood species. In addition to spring flow, reuse water from the Lackland Air Force Base Test Cell Facility and a San Antonio Water System (SAWS) wastewater recycling facility are discharged in this zone. This provides for higher levels of base flow, but water quality is slightly impaired because of these facilities. In addition to water quality problems from the treatment plant, much of the area is agricultural lands that affect the water quality due to herbicide and pesticide runoff into this Leon Creek segment.

Because riparian zones link the stream with its terrestrial catchment, they can modify, incorporate, dilute, or concentrate substances before they enter a lotic system. In small to mid-size streams, forested riparian zones can moderate temperatures, reduce sediment inputs, provide important sources of organic matter, and stabilize streambanks (Osborne, 2007). For the most part, the Lower Leon Creek segment is in good or excellent condition, but could be improved by widening the riparian zones to protect the stream from agricultural runoff.

The survey sites for the lower segment on Leon Creek were Military Road, Quintana Road, Applewhite Road, and Pleasanton Road locations, which scored 156, 151, 145, and 142, respectively. These areas consist of excellent aquatic resources with an overall RBPI of .74 containing 655 RBPUs. In each case, the sites lost points for bank stability due to the Blackland Prairie soils' erosive nature and the extreme velocity of water coming from the impervious cover of urban San Antonio, which causes much of this area to have a vertical bank.

Although stream erosion under these parameters can cause problems, the creek would naturally cut and meander over time. However, under the circumstances listed above, it is expected to happen within the project life instead of in geological time. An overbank swale either grass-lined or developed as a complex of wetlands dynamic could be a solution at one of the oxbow regions between Military Road and Interstate 35 to help reduce velocities and in the latter example restore wetland functions in this region.

In addition to the four Leon Creek assessment sites in this segment, two additional sites were surveyed on Comanche Creek at Maurmann Road and Indian Creek on 5 Palm Drive.

- The Indian Creek site was fully channelized, mowed, and provided little to no aquatic benefits with a score of 60. Establishing vegetation along the banks would improve this segment by as much as 40 points.
- Comanche Creek had a score of 147 and lost 40 points due to erosion and a lack of vegetative protection. This area would improve over time, as the vegetation on site was first succession and will mature if left alone.

Ecosystem Restoration Opportunities

The Lower Leon Creek segment is unlimited in the number of opportunities that exist, due to the abundance of space for riparian woodland plantings. Native grassland restoration could be implemented in place of improved pastures. Additionally, the possibilities exist for a chain of wetlands to help reduce peak flows without channelization, while adding valley storage.

FUTURE WITHOUT PROJECT CONDITIONS

To effectively evaluate changes to the environment of Leon Creek if proposed projects were implemented, it is necessary to forecast the likely future environmental conditions if they were not.

Assumptions for Analysis

In the absence of any type of flood damage reduction project, the problems experienced in some Bexar County neighborhoods as a result of Leon Creek flooding would continue. It is anticipated that growth and development in the watersheds would continue. As a result, there would be additional construction and increased amounts of impervious surfaces such as roads, parking lots, and structures. According to information provided by SARA, future impervious cover would increase 45% for Leon Creek over the project life. These factors would add to the runoff within the creeks and would typically increase the severity and/or frequency of the flood problems within neighborhoods that are currently affected by flooding problems and possibly adds to the number of structures inundated. This would lead to continued degradation of the aquatic resources of Leon Creek.

The increase in peak flows, increased construction, and increase of impervious cover would also contribute to increases in sediment transport and turbidity from construction activities. These increases are not expected to affect the existing riparian zone to the point that riparian woodland restoration activities would not be sustainable. To the contrary, riparian woodland restoration would help offset some of these impacts from future impervious cover. Riparian woodlands serve as buffer zones to construction sites to help filter pollutants that enter the waterways.

It is expected that without restoration measures, and probably even with restoration measures to a certain extent, water quality in Leon Creek would degrade slightly to moderately in the future as Bexar County continues to develop. The construction phase of new residences and businesses would produce additional sediment load from runoff from construction sites. After completion, the increases in impervious surface area, traffic, lawn fertilizing, and other human activities would have an adverse impact on the creeks. Degradation of the water quality would reduce the number of aquatic biota in the creeks. The overall diversity of fishes and other aquatic species is already low according to USFWS; further loss of aquatic biota would be damaging to the aquatic ecosystem.

Encroaching urban and rural development activities (projected to go from 5,300 acres of urban use to 10,400 acres) would also be expected to negatively impact the watershed’s existing vegetation. The existing forested riparian vegetation zone within much of the watershed is already very narrow with several grass and shrub openings. The number and size of the openings would continue to increase, and there would be fewer acres of forest in the future. The loss of habitat, particularly the riparian woodlands would reduce the number of wildlife and bird species within the watershed. This is especially true for migratory songbirds listed in the TPWD *Annotated County Lists of Rare Species* (see project files), which are particularly susceptible to the loss of habitat along their migration routes. Furthermore, without additional protective measures as the urban sprawl continues out from the city limits of San Antonio, more critical habitat will be lost for the endangered golden-cheeked warbler and black-capped vireo.

The increased impervious cover and increased residential subdivisions will continue to impact the Edwards Aquifer. Increased impervious cover limits infiltration into the aquifer and reduces storage capacity of the watershed. Leon Creek would see increased peak flows, which would limit aquifer recharge. In addition, water quality would be reduced, and therefore, the quality of water in the aquifer would continue to degrade. Degraded water quality and quantity are major factors that affect the nine endangered karst invertebrates. There are impervious cover regulations over the recharge zone to help reduce these impacts, but continued degradation over time is still projected.

TPWD and USFWS participated in the projection of future without-project conditions for this study. From their opinions as experts, USFWS, TPWD, and USACE agreed on certain assumptions regarding the parameters used in the EPA habitat assessment model. This section presents the assumptions used during analysis and discussion.

Terrestrial and Riparian Habitat

- For future without-project projections, Ultimate Land Use data provided by SARA was used to calculate future acreages in the areas between the boundaries of the 500-year floodplain and the 100-year floodplain. Urban land uses will increase 45% outside of the 100-year floodplain, with a 20% reduction inside the 100-year floodplain for the future without-project.
- Using professional judgment, USFWS, TPWD, and USACE personnel estimated future without-project conditions.
- The progression from existing conditions to ultimate projections is linear over time, because there is no data to indicate otherwise. However, for the Urban Leon Creek segment, the projections indicate that it will be built out in 25 years.
- Riparian Habitat HSIs that remain will continue to degrade measurably over time. City of San Antonio floodplain ordinances do not specifically protect habitats, only against a rise in the floodplain. However, protection against development *will* suppress the effect of fragmentation.
- First successional woodland is included in the discussion of riparian woodland.
- Savanna habitat is included in the grasslands discussion.
- Losses of grassland habitat will be linear over time.

Aquatic Habitat

- Progression of future without-project conditions will be linear over time, as no data exists to suggest otherwise.
- Using professional judgment, USFWS, TPWD, and USACE personnel estimated future without-project conditions. Using the Urban Leon Creek segment as a reference segment, our estimates appear valid. According to our Ultimate Land Use data, future without-project conditions of other segments

will degrade at the rate and fashion that the Urban Leon Creek segment has already incurred in the absence of project, as urbanization moves toward these segments. The Urban Leon Creek segment will be fully built out in 25 years, and other segments will decline linearly toward Urban Leon until the 50-year project life.

- As defined for this study, the aquatic habitat includes the adjacent riparian zone. Although not all inclusive, the approximate 25-year floodplain is described with the aquatic habitat. As the parameters show, riparian vegetation plays an important role in the habitat quality of the aquatic environment, thus it is included in the aquatic resource discussion.
- The habitat model was created for perennial streams, and all segments with the exception of Lower Leon Creek are predominantly ephemeral with pockets of perennial pools. In sections where only standing pools were located, for the parameters of Velocity/Depth Regime and Frequency of Riffles, the stream was analyzed as if water was moving across the system and the score was adjusted.

Upper Leon Creek

This segment has already experienced a great deal of urban sprawl, and very little forest cover exists except along the riparian zone of Leon Creek. Projections from SARA indicate that this will continue as populations move away from San Antonio proper.

Terrestrial and Riparian Habitat

The Upper Leon Creek segment covers about 2,456 acres within the 500-year floodplain. According to Ultimate Land Use data provided by SARA, the existing land use acreages are expected to change as shown in Table B-5. Over the project life, the Upper Leon Creek segment is expected to withstand an increase in urban land use from 39 to 56 percent of the total acreage.

Table B-5. Expected Change in Upper Leon Creek Land Use Acreages

Land Use	**Existing** (acres)	**Ultimate** (acres)
Woodlands	878	602
Agricultural	83	59
Grasslands	408	289
Streambed	120	120
Urban	967 (39%)	1,386 (56%)
Total	2,456	2,456

Table B-6 shows the calculation of habitat units (HU) and average annual habitat units (AAHU) for the Upper Leon Creek segment.

Table B-6. Upper Leon Creek Future Without-Project Terrestrial and Riparian Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Woodlands	HSI	0.47	0.47	0.44	0.41	0.38		
	Acres	878	878	790	711	602		
	Target Year HU	412.7	412.7	347.7	291.6	229.2		
	Interval HU		275.1	5,316.3	3,192.4	6,495.9	15,279.7	**305.6**
Grasslands	HSI	0.80	0.80	0.77	0.74	0.71		
	Acres	408	408	367	330	289		
	Target Year HU	326.4	326.4	282.7	244.6	205.3		
	Interval HU		326.4	4,261.2	2,634.7	5,618.2	12,840.4	**256.8**

The overall riparian woodland HSI value for the Upper Leon Creek segment is 0.47 with 412 HUs providing fair habitat. Due to fragmentation and a lack of recruitment of the existing vegetation, the quality of the woodlands is expected to reduce the overall HSI values over time. The segment will also decline by the loss of 276 acres of woodland habitat to urbanization over the project life. The habitat will contribute 229 HUs in project year 50, with an AAHU value of 305.

Most of the grassland in the Upper Leon Creek segment currently has very high HSI values with an overall value of 0.80 and 326 habitat units. The remaining grassland HSI will decrease in value from overgrazing of livestock, mowing, and infestation of non-native plants. Habitat units will be reduced from the loss of 119 available acres of grassland. Project year 50 will total 205 HUs with an AAHU value of 256.

Aquatic Habitat

As shown in Table B-4. Existing Conditions Aquatic Habitat EPA Survey Scores" on page 11, the existing aquatic habitat RBPI of the Upper Leon Creek segment is 0.69 providing 302 RBPUs, which indicates excellent to good aquatic habitat. Urban expansion will cause reduction to the parameter of Channel Alteration, due to the addition of bridges, storm drains, and additional check dams. Channel Flow Status value will decrease due to expected channelization projects, increasing the frequency and shortening the duration of water in the channel. This will also cause the stream to be much flashier in nature, creating reductions in the parameter for Epifaunal Substrate, as the ultimate removal of riparian area will reduce the amount of debris in the channel. Embeddedness parameter will be reduced, as the rocky/gravel substrate will be washed away and eventually be eroded to bedrock. Sediment Deposition would increase with added construction. Bank Stability will decrease, as the flashy nature of the stream will increase. Vegetative Protection and Vegetative Cover are reduced with the narrowing of the riparian zone width. The parameters of Velocity/Depth Regime/Pool Variability and Frequency of Riffles/ Channel Sinuosity will remain unchanged over time.

As determined by the PDT, these parameter changes are expected to continue throughout the planning period. Rate of reductions will decrease as buildout nears the 50-year project life; much of the degradation will have already taken place. The RBPI at 50 years is expected to be .48, as shown in Table B-7.

Table B-7. Upper Leon Creek Future Without-Project Aquatic Habitat RBPI

Target Year		**0**	**1**	**15**	**25**	**50**
Interval (years)		**0**	**0**	**14**	**10**	**25**
Epifaunal Substrate		14	13.8	11.7	10.0	8.5
Embeddedness / Pool Substrate		15	14.8	12.6	10.7	9.1
Velocity/Depth Regime / Pool Variability		12	12.0	12.0	12.0	12.0
Sediment Deposition		13	12.8	10.9	9.2	7.9
Channel Flow Status		2	1.9	1.6	1.4	1.2
Channel Alteration		16	15.8	13.4	11.4	9.7
Frequency of Riffles / Channel Sinuosity		18	18.0	18.0	18.0	18.0
Bank Stability	Left	7	6.9	5.8	5.0	4.2
	Right	8	7.9	6.7	5.7	4.8
Vegetative Protection	Left	8	7.9	6.7	5.7	4.8
	Right	9	8.9	7.5	6.4	5.4
Riparian Zone Width	Left	8	7.9	6.7	5.7	4.8
	Right	8	7.9	6.7	5.7	4.8
Habitat Total Score		138	136.9	120.8	107.2	95.6
RBPI		**.69**	**.68**	**.60**	**.54**	**.48**

The habitat total scores were normalized to determine the RBPI values shown in the table. The RBPIs were used to calculate the RBPU and AARBPU values shown in Table B-8. At 50 years, the segment's AARBPU is expected to be 246.1.

Table B-8. Upper Leon Creek Future Without-Project Aquatic Habitat RBPU and AARBPU

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative RBPU**	**AARBPU**
Interval (years)	**0**	**0**	**14**	**10**	**25**		
RBPI	0.69	0.68	0.60	0.54	0.48		
Acres	438	438	438	438	438		
Target Year RBPU	302.2	297.8	262.8	236.5	210.2		
Interval RBPU		300.0	3,924.5	2,496.6	5,584.5	12,305.6	**246.1**

Urban Leon Creek

This area has already experienced a high density of residential and commercial development within the 500-, 100-, and 25-year floodplains, which has reduced the width of the riparian corridor and is expected to be totally built out within 25 years. This segment's existing condition provides a snapshot of the future without-project conditions of the other segments if no project is authorized.

Terrestrial and Riparian Habitat

The Urban Leon Creek segment covers about 6,591 acres within the 500-year floodplain. According to Ultimate Land Use data provided by SARA, the existing land use acreages are expected to change as shown in Table B-9. The Urban Leon Creek segment is expected to withstand a change in land use from 34 to 55 percent urban.

Table B-9. Expected Change in Urban Leon Creek Land Use Acreages

Land Use	**Existing** (acres)	**Ultimate** (acres)
Woodlands	2,730	1,926
Agriculture	340	174
Grasslands	945	578
Streambed	302	302
Urban	2,274 (34%)	3,611 (55%)
Total	6,591	6,591

Table B-10 shows the calculation of HUs and AAHUs for the Urban Leon Creek segment.

Table B-10. Urban Leon Creek Future Without-Project Terrestrial and Riparian Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Woodlands	HSI	0.33	0.33	0.29	0.24	0.22		
	Acres	2,730	2,730	2,457	2,088	1,928		
	Target Year HU	900.9	900.9	712.5	501.2	424.1		
	Interval HU		900.9	11,268.5	6,038.1	1,155.9	29,760.5	**595.2**
Grasslands	HSI	0.81	0.81	0.77	0.72	0.70		
	Acres	945	945	803	643	578		
	Target Year HU	765.5	765.5	618.5	462.7	404.8		
	Interval HU		765.4	9,674.4	5,392.5	10,838.5	26,670.9	**533.4**

The overall riparian woodland HSI value for the Urban Leon Creek segment is 0.33, with 901 habitat units providing fair habitat. Due to fragmentation and a lack of recruitment of the existing vegetation, the quality of the woodlands is expected to reduce the overall HSI values through year 25, until buildout has occurred. The segment will also decline by the loss of 804 acres of woodland habitat to urbanization over the project life. The habitat will contribute 424 HUs in project year 50 with an AAHU value of 595.

Most of the grassland on Urban Leon Creek has high HSI values with an overall value of 0.81, with 765 habitat units. The remaining grassland HSI will decrease in value primarily due to mowing and infestation of non-native plants. Habitat units will be reduced by the loss of 119 available acres of grassland. Project year 50 will provide 404 HUs with an AAHU value of 533.

Aquatic Habitat

These areas are characteristic of the Upper Leon Creek segment, but are located in an urban environment, on or just below the recharge zone, and range from minimal to a complete lack of water. The existing condition RBPI value in this segment is 0.47 and contains 509 RBPUs, providing fair aquatic habitat. The signs of urbanization have already been seen in this segment from several channelization projects, which will continue. A portion of the segment does not have a prominent stream channel and is subject to erosion at multiple locations, as the stream's flashiness becomes more prominent due to the buildout of sites upstream. The substrate compositions have a lot of sediment deposition, and the riffles were dry. The substrate moves during each rain event and is unstable, which will increase in the future. The Velocity/Depth Regime and Channel Flow were rated poor, because of all four regimes not being present. The width of the streams was also a limiting factor. The streams in this area appeared to be widening and the stream banks will continue to erode. The adjacent riparian vegetation width was insufficient and composed of more upland species that do not provide adequate streambank protection.

At the rate of urban expansion, this segment is expected to reach total buildout in 25 years, as opposed to the other areas that will build out in 50 years. This segment gives researchers good insight into what the future without-project conditions will be on the other segments, because it is already at year 25 of the 50-year project life. Table B-11 shows that the RBPI at 50 years is expected to be .42.

Table B-11. Urban Leon Creek Future Without-Project Aquatic Habitat RBPI

	Target Year	**0**	**1**	**15**	**25**	**50**
	Interval (years)	**0**	**0**	**14**	**10**	**25**
Epifaunal Substrate		8	7.8	7.4	7.0	7.0
Embeddedness / Pool Substrate		8	7.8	7.4	7.0	7.0
Velocity/Depth Regime / Pool Variability		10	10.0	10.0	10.0	10.0
Sediment Deposition		12	11.7	11.1	10.6	10.5
Channel Flow Status		2	1.9	1.8	1.7	1.7
Channel Alteration		9	8.8	8.3	7.9	7.8
Frequency of Riffles / Channel Sinuosity		12	12.0	12.0	12.0	12.0
Bank Stability	Left	6	5.8	5.5	5.3	5.2
	Right	5	4.9	4.6	4.4	4.3
Vegetative Protection	Left	5	4.9	4.6	4.4	4.3
	Right	6	5.8	5.5	5.3	5.2
Riparian Zone Width	Left	5	4.9	4.6	4.4	4.3
	Right	6	5.8	5.5	5.3	5.2
Habitat Total Score		94	92.5	89.0	85.6	85.4
RBPI		**.47**	**.46**	**.44**	**.43**	**.42**

Table B-12 shows an AARBPU of 470.9 calculated from these RBPI values.

Table B-12. Urban Leon Creek Future Without-Project Aquatic Habitat RBPU and AARBPU

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative RBPU**	**AARBPU**
Interval (years)	**0**	**0**	**14**	**10**	**25**		
RBPI	0.47	0.46	0.44	0.43	0.42		
Acres	1,083	1,083	1,083	1,083	1,083		
Target Year RBPU	509.0	498.2	476.5	465.7	454.9		
Interval RBPU		503.6	6,822.9	4,711.1	11,506.9	23,544.4	**470.9**

Culebra Creek

The Culebra Creek segment is already dominated by low-quality riparian woodlands, residential, and agricultural land use. Terrestrial and riparian habitats will continue to degrade over the project life in absence of a project.

Terrestrial and Riparian Habitat

Culebra Creek covers about 3,397 acres within the 500-year floodplain. According to Ultimate Land Use data provided by SARA, the existing land use acreages are expected to change as shown in Table B-13. This segment is expected to withstand a change in urban land use from 23 to 47 percent.

Table B-13. Expected Change in Culebra Creek Land Use Acreages

Land Use	**Existing** (acres)	**Ultimate** (acres)
Woodlands	1,680	1,178
Agriculture	527	338
Grasslands	229	138
Streambed	155	155
Urban	806 (23%)	1,587 (47%)
Total	3,397	3,397

Table B-14 shows the calculation of HUs and AAHUs for the Culebra Creek segment.

Table B-14. Culebra Creek Future Without-Project Terrestrial and Riparian Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Woodlands	HSI	0.30	0.30	0.27	0.24	0.21		
	Acres	1,680	1,680	1,512	1,361	1,177		
	Target Year HU	504.0	504.0	408.2	326.6	247.2		
	Interval HU		504.0	6,373.9	3,666.6	7,149.3	17,693.8	**353.9**

	Target Year	0	1	15	25	50	Cumulative HU	AAHU
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Grasslands	HSI	0.73	0.73	0.70	0.67	0.64		
	Acres	229	229	197	169	138		
	Target Year HU	167.2	167.2	137.9	113.5	88.6		
	Interval HU		167.2	2,132.9	1,255.3	2,521.6	6,077.0	**121.5**

The overall riparian woodland HSI value for the Culebra Creek segment is 0.30, with 504 habitat units providing fair habitat. Due to fragmentation and a lack of recruitment from the existing vegetation, the quality of the woodlands is predicted to reduce the overall HSI values throughout the project life. The segment will also decline in habitat units by the loss of 502 acres of woodland habitat to urbanization over the project life. This loss of acreage could be more extreme if not for the Government Canyon State Natural Area. The habitat will contribute 247 HUs in project year 50 with an AAHU value of 353.

Most of the grassland along the Culebra Creek segment currently has good HSI values with an overall HSI of 0.73 and 167 habitat units. The remaining grassland HSI will decrease in value from overgrazing of livestock, mowing, and infestation of non-native plants. Habitat units will be reduced by 91 available acres. Project year 50 will provide 88 HUs with an AAHU value of 122.

Aquatic Habitat

The Culebra Creek segment consists of good quality aquatic habitat with an RBPI of .68 and contributes 398 RBPUs. The upper portions of this segment are and will continue to be protected as part of Government Canyon State Natural Area. However, build out is occurring just below the natural area and will continue. From the confluence of Helotes Creek to the confluence with Leon Creek, Culebra is already surrounded by urbanization. The urbanization predicted to continue toward the headwaters will continue to impair this segment. The factors used to estimate future conditions in the Upper Leon Creek segment are also applicable here.

Table B-15 shows that the RBPI at 50 years is expected to be 0.47.

Table B-15. Culebra Creek Future Without-Project Aquatic Habitat RBPI

Target Year		**0**	**1**	**15**	**25**	**50**
Interval (years)		**0**	**0**	**14**	**10**	**25**
Epifaunal Substrate		16	15.8	13.4	11.4	9.7
Embeddedness / Pool Substrate		12	11.8	10.0	8.5	7.2
Velocity/Depth Regime / Pool Variability		14	14.0	14.0	14.0	14.0
Sediment Deposition		16	15.8	13.4	11.4	9.7
Channel Flow Status		6	5.9	5.0	4.2	3.6
Channel Alteration		13	12.8	10.9	9.2	7.9
Frequency of Riffles / Channel Sinuosity		15	15.0	15.0	15.0	15.0
Bank Stability	Left	7	6.9	5.8	5.0	4.2
	Right	7	6.9	5.8	5.0	4.2
Vegetative Protection	Left	8	7.9	6.7	5.7	4.8
	Right	7	6.9	5.8	5.0	4.2
Riparian Zone Width	Left	8	7.9	6.7	5.7	4.8
	Right	6	5.9	5.0	4.2	3.6
Habitat Total Score		135	133.9	118.1	104.8	93.4
RBPI		**0.68**	**0.67**	**0.59**	**0.52**	**0.47**

Table B-16 shows an AARBPU of 321.4 calculated from these RBPI values.

Table B-16. Culebra Creek Future Without-Project Aquatic Habitat RBPU and AARBPU

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative RBPHU**	**AARBPHU**
Interval (years)	**0**	**0**	**14**	**10**	**25**		
RBPI	0.68	0.67	0.59	0.52	0.47		
Acres	586	586	586	586	586		
Target Year RBPU	398.5	392.6	345.7	304.7	275.4		
Interval RBPU		395.6	5,168.5	3,252.3	7,251.8	16,068.1	**321.4**

Helotes Creek

This stretch of the Leon Creek watershed study identified as the Helotes Creek segment is already dominated by average quality riparian woodlands, residential, and agricultural land use.

Terrestrial and Riparian Habitat

Helotes Creek covers about 1,620 acres within the 500-year floodplain. According to Ultimate Land Use data provided by SARA, the existing land use acreages are expected to change as shown in Table B-17. The Helotes Creek segment is expected to be subjected to a change in urban land use from 26 to 48 percent.

Table B-17. Expected Change in Helotes Creek Land Use Acreages

Land Use	**Existing** (acres)	**Ultimate** (acres)
Woodlands	928	620
Agriculture	29	15
Grasslands	117	75
Streambed	130	130
Urban	417 (26%)	781 (48%)
Total	1,620	1,620

Table B-18 shows the calculation of HUs and AAHUs for the Helotes Creek segment.

Table B-18. Helotes Creek Future Without-Project Terrestrial and Riparian Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Woodlands	HSI	0.30	0.30	0.27	0.24	0.21		
	Acres	928	928	835	752	620		
	Target Year HU	278.4	278.4	225.5	180.4	130.2		
	Interval HU		278.4	3,520.8	2025.34	3,866.5	9,691.1	**193.8**

The overall riparian woodland HSI value for this segment is 0.30, with 279 habitat units providing fair habitat. Due to fragmentation and a lack of recruitment from the existing vegetation, the quality of the woodlands is predicted to reduce the overall HSI values throughout the project life. The segment will also decline in habitat units by the loss of 308 acres of habitat to urbanization over the project life. The habitat will contribute 130 HUs in project year 50 with an AAHU value of 193.

Aquatic Habitat

The Helotes Creek segment is categorized as an ephemeral stream and is similar in nature to Upper Leon and Culebra Creek segments. The headwaters of Los Reyes, Chiminea, and Helotes Creeks converge to create Helotes Creek. Like Culebra Creek, the upper portion is relatively pristine in nature and, as it moves toward its confluence with Culebra Creek, it becomes highly urbanized. As the predicted urbanization moves upstream, the effects will create the same conditions, so the same criteria for future without-project conditions as in the Culebra Creek segment were used for Helotes Creek. The Helotes Creek segment currently contains 298 RBPUs with a RBPI of 0.70, providing good to excellent aquatic habitat. Table B-19 shows that the RBPI at 50 years is expected to be 0.48.

Table B-19. Helotes Creek Future Without-Project Aquatic Habitat RBPI

	Target Year	**0**	**1**	**15**	**25**	**50**
	Interval (years)	**0**	**0**	**14**	**10**	**25**
Epifaunal Substrate		14	13.8	11.7	10.0	8.5
Embeddedness / Pool Substrate		12	11.8	10.0	8.5	7.2
Velocity/Depth Regime / Pool Variability		13	13.0	13.0	13.0	13.0
Sediment Deposition		14	13.8	11.7	11.4	9.7
Channel Flow Status		5	4.9	4.2	3.5	3.0
Channel Alteration		16	15.8	13.4	9.2	7.9
Frequency of Riffles / Channel Sinuosity		16	16.0	16.0	16.0	16.0
Bank Stability	Left	7	6.9	5.8	5.0	4.2
	Right	9	8.9	7.5	6.4	5.4
Vegetative Protection	Left	9	8.9	7.5	6.4	5.4
	Right	8	7.9	6.7	5.7	4.8
Riparian Zone Width	Left	10	9.9	8.4	7.1	6.0
	Right	8	7.9	6.7	5.7	4.8
Habitat Total Score		141	139.8	123.2	109.1	97.0
RBPI		**.70**	**.69**	**.62**	**.55**	**.48**

Table B-20 shows an AARBPU of 243.6 calculated from these RBPI values.

Table B-20. Helotes Creek Future Without-Project Aquatic Habitat RBPU and AARBPU

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative RBPHU**	**AARBPHU**
Interval (years)	**0**	**0**	**14**	**10**	**25**		
RBPI	0.7	0.69	0.62	0.55	0.48		
Acres	426	426	426	426	426		
Target Year RBPU	298.2	293.9	264.1	234.3	204.5		
Interval RBPU		296.1	3,906.4	2,492.1	5,484.8	12,179.3	**243.6**

Lower Leon Creek

Under existing conditions, the lower segment of Leon Creek returns to a perennial stream that provides riverine aquatic habitat. Aquatic vegetation species are the same species reflected in the other four segments, and the adjacent riparian areas again become wider with more bottomland hardwood species. Agricultural lands are more prevalent, as this segment is Blackland Prairie in the vegetational zones of Texas. Urbanization is expected to double in this area over the project life thus resulting in conversion of woodlands, agriculture lands and grasslands.

Terrestrial and Riparian Habitat

The Lower Leon Creek segment covers about 6,450 acres within the 500-year floodplain. According to SARA's Ultimate Land Use data, the existing land use acreages are expected to change as shown in Table B-21. The Lower Leon Creek segment is expected to withstand a change in urban land use from 17 to 47 percent.

Table B-21. Expected Change in Lower Leon Creek Land Use Acreages

Land Use	**Existing** (acres)	**Ultimate** (acres)
Woodlands	2,822	1,912
Agriculture	1,748	926
Grasslands	346	229
Streambed	354	354
Urban	1,136 (17%)	2,985 (47%)
Total	6,406	6,406

Table B-22 shows the calculation of HUs and AAHUs for the Lower Leon Creek segment.

Table B-22. Lower Leon Creek Future Without-Project Terrestrial and Riparian Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**0**	**14**	**10**	**25**		
Woodlands	HSI	0.32	0.32	0.29	0.26	0.23		
	Acres	2,822	2,822	2,540	2,235	1,911		
	Target Year HU	903.0	903.0	736.5	581.1	439.5		
	Interval HU		903.0	11,457.3	6,573.0	12,717.3	31,650.7	**633.0**
Grasslands	HSI	0.60	0.60	0.57	0.54	0.51		
	Acres	346	346	298	259	229		
	Target Year HU	207.6	207.6	169.6	139.8	116.8		
	Interval HU		207.6	2,637.1	1,545.1	3,204.3	7,594.0	**151.9**

The riparian zones in this segment are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash, black willow, and cedar elm trees in the upper portions. The overall riparian woodland HSI value for the Lower Leon Creek segment is 0.32 with 903 habitat units providing fair habitat. Due to fragmentation and a lack of recruitment from the existing vegetation, the quality of the woodlands is predicted to reduce the overall HSI values throughout the project life. The segment will also decline in habitat units by the loss of 910 acres of woodland habitat to urbanization over the project life. The habitat will contribute 439 HUs in project year 50 with an AAHU value of 633.

The grasslands in Lower Leon Creek have average HSI values with an overall HSI of 0.60, with 208 habitat units. The remaining grassland HSI will decrease in value from overgrazing of livestock, mowing, and infestation of non-native plants. Habitat units will be reduced by 117 available acres. Project year 50 will provide 116 HUs with an AAHU value of 151.

Aquatic Habitat

The lower segment of Leon Creek returns to a perennial stream that provides riverine aquatic habitat, as this segment is below the aquifer recharge zone. This segment consists of excellent aquatic resources with an overall RBPI of 0.74 and 655 RBPUs. This area is expected to feel the most impact from land use change. The channel already shows signs of meandering and incising due to the Blackland soils that occupy the segment. This problem is expected to continue and worsen as urbanization moves south along its banks with resultant channelization projects and road construction into the current riparian areas. As the water is expedited out of San Antonio, the channel will deepen until it reaches bedrock. Due to channel improvement projects, it will no longer be allowed to meander, which will increase flooding.

Water quality will continue to be an issue, as field crop herbicide and pesticide will be replaced with urban contaminants, and the riparian width which acts as a filter to lateral movement of contaminants is reduced in width. All of the habitat parameters, except Velocity/Depth Regime and Frequency of Riffles, are expected to experience decreases in RBPI values from these changes in land use. Table B-23 shows that the RBPI at 50 years is expected to be 0.46.

Table B-23. Lower Leon Creek Future Without-Project Aquatic Habitat RBPI

	Target Year	**0**	**1**	**15**	**25**	**50**
	Interval (years)	**0**	**0**	**14**	**10**	**25**
Epifaunal Substrate		18	17.8	15.1	12.8	10.9
Embeddedness / Pool Substrate		17	16.8	14.3	12.2	10.3
Velocity/Depth Regime / Pool Variability		15	15.0	15.0	15.0	15.0
Sediment Deposition		16	15.8	13.4	11.4	9.7
Channel Flow Status		16	15.8	3.4	11.4	9.7
Channel Alteration		14	13.8	11.7	10.0	8.5
Frequency of Riffles / Channel Sinuosity		16	13.0	13.0	13.0	13.0
Bank Stability	Left	5	4.9	4.2	3.5	3.0
	Right	5	4.9	4.2	3.5	3.0
Vegetative Protection	Left	6	5.9	5.0	4.2	3.6
	Right	6	5.9	5.0	4.2	3.6
Riparian Zone Width	Left	7	6.9	5.8	5.0	4.6
	Right	7	6.9	5.8	5.0	4.6
Habitat Total Score		148	143	126	112	99
RBPI		**.74**	**.71**	**.63**	**.55**	**.49**

Table B-24 shows an AARBPU of 514.0 calculated from these RBPI values.

Table B-24. Lower Leon Creek Future Without-Project Aquatic Habitat RBPU and AARBPU

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative RBPU**	**AARBPU**
Interval (years)	**0**	**0**	**14**	**10**	**25**		
RBPI	0.74	0.71	0.63	0.55	0.49		
Acres	886	886	886	886	886		
Target Year RBPU	655.6	629.1	558.2	487.3	434.1		
Interval RBPU		642.4	8,310.7	5,227.4	11,518.0	25,698.4	**514.0**

FUTURE WITH PROJECT CONDITIONS

The plan formulation framework for the Leon Creek project has been to place primary emphasis on developing measures/plans to reduce flood risks. The project sponsor has consistently indicated a willingness to consider ecosystem restoration measures in conjunction with, or ancillary to flood risk reduction but has limited interest in stand-alone ecosystem restoration projects, as these generally fall outside their authority and mission. Early in the plan formulation process, consideration was given to ecosystem restoration in the form of enhanced aquifer recharge through the construction of recharge structures in the upstream, relatively undeveloped, portions of the watershed. These structures would have been expected to reduce flood risks concurrently with enhancing recharge. However, locations most suitable for recharge structures were concentrated in the Government Canyon State Park and the immediately surrounding environs. Coordination with resource agencies indicated strong opposition to this concept based on the quality and significance of the habitat that would have been affected. As discussed in the Main Report, consideration of detention-only structures in the same general area was considered in more detail but ultimately dropped as a result of the same environmental concerns.

Development of ecosystem restoration measures in the central and downstream portions of the Leon Creek watershed was limited both by the largely urbanized nature of the habitat in those locations and by the difficulty in identifying economically-justified Flood Risk Reduction measures upon which to build ecosystem components. Ultimately, only three flood risk management alternatives have been developed for inclusion into the recommended plan. One plan, the Helotes Creek detention measure is located within the Upper Leon Creek Segment, the 100-year levee with hydraulic mitigation is located in AOI-2 would provide improved protection for the jet engine test facility and other properties is in Lower Leon Creek Segment, and a non-structural plan, which is a buyout of existing homes and townhouses in AOI-4 south of Loop 1604 and West of Babcock Road is in Urban Leon Creek environment segment. Although numerous opportunities have been identified, no ecosystem restoration alternatives have been formulated based upon planning team guidance.

Helotes Creek Detention

Helotes Creek detention would utilize an existing highly disturbed limestone quarry to capture and provide temporary detention to reduce peaking damages downstream. The Helotes Creek channel within this area has also been extensively damaged and appears to be dry limestone bottom most of the year. Construction impacts would be limited to construction of a weir by cutting a bank segment between the quarry and creek that would remove approximately four acres of shrub vegetation with a few small trees. A pump station will be required to remove water from the quarry in between flood events. Electrical, piping and fencing would also be required.

Analysis of the quarry including weir but excluding pump pad-- which could be constructed on previously disturbed lands-- indicates that approximately 4.5 acres of forest would be impacted by the project. It is estimated that 1.11 AAHUs associated with the forest would be lost for the life of the project prior to environmental mitigation. Analysis indicates acquiring 4 acres of woodlands along the edge of the existing quarry near the creek channel with appropriate management would be sufficient to mitigate forest impacts. Planting a variety of fruit bearing shrubs and mast producing trees would by sufficient for the proposed mitigation lands to produce a net gain that 1.17 AAHUs could be gained over the project life. Environmental mitigation costs for the Helotes quarry detention alternative will be minimal since there is very limited land needed beyond the quarry pit.

Operation of the detention quarry to provide flood risk management benefits has been evaluated for potential impacts to aquatic resources. The evacuation pump has been sized to drain the quarry sufficiently for it to capture additional runoff following sequential runoff events. The rate of flow necessary to evacuate would not produce erosive flows to the intermittent Helotes Creek channel or banks. Velocities would also not cause adverse impacts to aquatic life. Therefore no aquatic mitigation is required for this project measure.

Additional analysis may be required for effects of operation of the quarry on threatened and endangered species. No adverse effects are anticipated from storage of waters in the quarry, however pumping the water out over several weeks period would potentially improve infiltration into the aquifer. Water would have less suspended solids due to the temporary storage in the quarry. This effect will be further evaluated with the USFWS as the study progresses. No effects to the listed karst invertebrates would likely occur as the known habitat including critical habitat for these species is upstream and upslope from this proposed project feature.

Test Cell 100-year Levee and Channel Modification

The 100-year levee at the Test Cell would impact only manicured grasslands and no environmental mitigation would be required. USFWS has concurred with that analysis. However, subsequent analysis has indicated that hydraulic mitigation is required to prevent induced damages. To achieve that goal, channelization of Leon Creek for approximately 2,850 linear feet upstream and adjacent to the levee would be required. Although hydraulic design indicates that the revised channel width would vary from 40 feet to 80 feet, no civil design has yet been provided for detailed impact assessment. Sufficient information from the baseline environmental analysis exists to clearly indicate that environmental impacts associated with the channel modifications would require environmental mitigation. Without environmental mitigation, important riparian resources and aquatic resources within Leon Creek channel proper would be significantly degraded within the footprint of the modification. Leon Creek channel has been identified as ‘waters of the United States” and therefore, requires prior compliance with Section 404 of the Clean Water Act.

Preliminary analysis indicates that potential for polychlorinated biphenyls exist in channel sediments within the proposed modification reach. Depending upon extent and magnitude of these contaminants, cleanup by project sponsor may be required, or special handling during construction may be required to protect against spread of contaminants within the natural environment.

Non Structural Buy-out at AOI-4

The buy-out measure proposed for inclusion in the project plan is located in the Babcock Creek floodplain and lies at the intersection of Babcock Road and Old Cedar Blvd. This measure includes only buy-out of townhouses and residential structures and would result in only minimal temporary adverse impacts to the natural environment. Trees adjacent to the structures would be preserved to extent possible, and following demolition and removal of debris, the disturbed areas would be replanted with grasses to stabilize the soil against erosion. Approximately 3.85 acres of floodplain lands would be available for use by the sponsor as open space. This measure would not require environmental mitigation other than compliance with best management practices during demolition to control dust emissions and surface erosion into the aquatic environment.

No negative impacts to waters of the United States, riparian forest nor threatened or endangered species would occur with implementation of this measure.

Mitigation Plan Selection

Of the three alternatives discussed above, only the 1 percent AEP levee (with its hydraulic mitigation component) requires environmental mitigation. Provided that construction activities are properly monitored and managed (additional detail is provided in Section 6, Project Implementation), no adverse effects are anticipated. The other structural alternative of the NED plan is the Helotes Quarry Pond in AOI-5. This is a highly disturbed site that will not require mitigation.

With respect to mitigation for the AOI-2 Levee Component, the construction staging area would temporarily impact approximately one acre of grasslands and a disposal area would utilize approximately six acres of grassland. The staging area and disposal area would be located on Port Authority lands in close proximity to the proposed project area and would be replanted with grass following construction with no mitigation required. Modification of the channel itself would permanently impact both aquatic and riparian resources for a total impact of 2.25 acres (2,850 linear feet) of in-stream habitat and 15.75 acres of urban riparian woodlands. An initial conservative estimate on the tentatively selected plan was developed and included in the incremental analysis for purposes of ensuring incremental justification of this alternative.

Aquatic Habitat Mitigation

The Qualitative Habitat Evaluation Index (QHEI) is approved for one-time use for Leon Creek to assess the quality of the aquatic habitat and establish aquatic mitigation requirements (Rankin, 1989; State of Ohio, 2006). Three sites, spread out along the length of the creek, were evaluated within the project area (**Figure 1**). QHEI scores for the three sites were 56, 55, and 53 with a mean of 54.67. Although, the riparian habitat scored relatively high for Leon Creek, the absence of riffles and run habitats in this reach of Leon Creek limited the QHEI scores. This disruption of the sediment transport mechanism of the creek results in high sedimentation and extensive embeddedness of the creek's substrate, limiting aquatic diversity. Using the average QHEI value of 55, average annual habitat units (AAHU) were calculated, and presented in Table B-25.

Table B-25. Existing Condition Riparian Aquatic Average Annual Habitat Units

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative**	
Interval (Years)	0	1	14	10	25	**HU**	**AAHU**
HSI	0.55	0.55	0.55	0.55	0.55		
Acres	2.25	2.25	1.25	2.25	2.25		
Target Year HU	1.24	1.24	1.24	1.24	1.24		
Interval HU		1.24	17.36	12.40	31.0	62	1.2

Any mitigation plan chosen would have need to create minimally 1.2 AAHUs and achieve a QHEI score of 55 for riparian aquatic habitat.

Riparian Habitat Mitigation

As reported in the existing conditions section of this document, the riparian zones in of the Lower Leon Creek study area are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash, black willow, and cedar elm trees in the upper portions of the segment. The proposed channel improvements are located in the upper portion of this segment. The HSI values for the fox squirrel and Barred Owl for the Lower Leon Creek segment were both 0.12 providing limited habitat for each of these species. The factors limiting the quality of the riparian woodland include:

- Barred Owl habitat was poor (0.12), due to the low average dbh of overstory trees less than 10 inches, which reduces cover and reproductive values.
- Fox squirrel habitat value (0.12) was reduced by the lack of mast producing trees for available food.

The riparian woody vegetation mitigation measure would address the lack of mast producing trees by planting hard mast species such as pecan along the riparian corridor. In addition, site-specific native vegetation such as bald cypress and pecan would eventually reach diameters larger than 20 inches dbh that would increase the HSI values for Barred Owls and raccoon. The riparian woodland plantings would assist in mitigating temporary impacts to aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. Table B-25 presents the existing condition cumulative and average annual habitat units which would have be achieved by the mitigation alternative.

Table B-25. Existing Condition Riparian Woody Vegetation Average Annual Habitat Units

Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative**	
Interval (Years)	0	1	14	10	25	**HU**	**AAHU**
HSI	0.12	0.12	0.20	0.20	0.20		
Acres	15.75	15.75	15.75	15.75	15.75		
Target Year HU	1.89	1.89	3.15	3.15	3.15	156.24	3.1

Interval HU	1.89	44.10	31.5	78.75

Using professional judgment, five mitigation alternatives were identified, as described below:

Option 1 – Onsite Natural Stream Design Channel. Over the last decade, several FRM projects in the City of San Antonio such as the Mission Reach and Eagleland segments of the San Antonio River have been reconstructed to restore the aquatic and riparian ecological function to the channelized streams. For the aquatic mitigation this option would utilize the same Natural Channel Design (NCD) concepts used for Mission Reach project to “self mitigate” impacts to waters of the U.S. The NCD methods utilize vertical and horizontal structures in the form of cross vanes, rock weirs, J-hooks, or other natural material structures to maintain a neutral sediment transport balance for the creek. The NCD structures also recreate pool and riffle habitats with proper substrate to support a diverse community of aquatic organisms. The NCD methodology develops a functional, self-sustaining system providing valuable hydraulic transport, geomorphic functions, and ecological functions. Costs for this option were initially estimated to be $297,423.

The riparian woodland mitigation would be accomplished by designing the natural channel design stream restoration (described above) to accommodate the planting of woody vegetation along each bank of Leon Creek for the length of the improvements. In order to ensure that the hydraulic mitigation required by the modified channel is preserved, the natural channel design was modeled utilizing a Manning’s *N* value of 0.065 and 0.035. These Manning’s *N* values account for the hydraulic friction that would be expected from a riparian woodland with a density of 30 stems per acre and native, herbaceous grasslands with a height between 12- and 18-inches. Site investigations at riparian reference areas in the San Antonio area confirm that mature bald cypress and pecan bottomlands have a similar tree density; therefore, the mitigation strategy was to approximate reference conditions. For the riparian woodlands, site-specific native herbaceous plant species would be also be established in the understory and are accounted for in the Manning’s *N*.

Option 2 – within Leon Creek Watershed. Since the area of impact for channelization is at the upper end of the Lower Leon Creek segment, the only segment of the Creek considered a perennial stream, the mitigation for stream impacts within the Leon Creek watershed would be limited to the area downstream of the channelization site to the Creek’s confluence with the Medina River. Two factors make this area problematic for use as aquatic mitigation. First, the existing aquatic habitat quality in this entire segment is considered high with an overall Rapid Bioassessment Protocols Index (RBPI) of 0.74 (the highest value within the watershed), so to further increase the functional value to an even higher value would require mitigation for a length at least 3 to 5 times greater than the area of impact (8,700-14,500 linear feet). The second limiting factor in this segment is the projected urbanization of the Lower Leon Creek segment in the future that would preclude being able to realize the functional lift in habitat value needed to mitigate the impacts during the 50-year life of the project.

Although riparian woodland mitigation opportunities are available on the Lower Leon Creek segment, any proposed mitigation would require real estate acquisition, thereby increasing mitigation costs over Option 1.   Due to these issues, no cost estimates were pursued.

Option 3 – Mitigation Bank. Mitigation banking credits incorporate riparian buffers in the calculation of stream credits. Therefore, the use of a mitigation bank would address both impacts to aquatic and riparian woodland habitats.

The Straus Medina Mitigation Bank is the only stream/wetland mitigation bank proposed within the study area. The mitigation bank prospectus was submitted to the Fort Worth District (SWF) on 1 June 2011, the Draft Mitigation Bank Instrument was submitted on 20 July 2012, and the Final Mitigation Bank Instrument was submitted on 28 January 2013. Since then, the mitigation bank sponsor has put the project on hold as a result of new mitigation bank permitting guidelines limiting the designation of in-stream mitigation credits established by CESWF in September 2013. Based on these new guidelines, it is possible that the sponsor may revise or withdraw the mitigation bank proposal. If the sponsor decides to proceed with the mitigation bank proposal, there are still several uncertainties about the applicability of the use of the bank for the mitigation of stream impacts to Leon Creek. The Straus Medina Mitigation Bank is located on one side of the Medina River and does not have the authority to control land use activities along the opposite bank. As current Fort Worth District (SWF) guidance requires the sponsor to have control of both sides of a stream, creek, or river to be able to generate stream credits for perennial waters, the mitigation bank may not be able to provide compensation for the stream impacts for Leon Creek. Should these issues be resolved and the mitigation bank is able to provide stream credits, a high level of uncertainty remains regarding mitigation credit costs as there are no other established or proposed mitigation banks in the region and no competition to keep the costs of the mitigation credits in check. However, the highest level of uncertainty regarding the use of the mitigation bank centers on when and if the mitigation bank completes the application process. Based on input from the Fort Worth District Regulatory Branch, the estimated mitigation cost for this option was $2.2 million. However, the availability of this option is very uncertain.

Option 4 – Martinez Creek. The restoration of Martinez Creek was originally evaluated as part of the Westside Creeks Ecosystem Restoration Study, currently in development. Of the four Westside Creeks, Martinez Creek was the only creek where the restoration of the stream channel was not justified by the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) and alternative selection process. This option would provide mitigation for both aquatic and riparian woodland impacts. Martinez Creek provides 2.8 miles of potential stream channel restoration opportunities from the headwaters to the confluence with Alazan Creek. The restoration of the natural stream channel design for Martinez Creek provides the hydraulic capacity to include the restoration of riparian woodlands within portions of the 50 acres of the Martinez Creek riparian corridor. The primary reason the Martinez Creek segment was eliminated from the suite of alternatives was due to the cost of utility relocations required to construct the natural stream channel. However, the San Antonio Water System (SAWS) agreed to a Consent Decree with EPA to address waste-water infrastructure and maintenance. The Consent Decree would result in SAWS investing an additional $492 million (compared to a 10 year average of $600 million) over the next 10 years to rehabilitate and maintain its sewer infrastructure. The cost of the Martinez Creek restoration without the utility costs would be approximately $3.3 million.

Option 5 – Use of one of SARA's Identified Mitigation Sites. SARA has produced a technical report entitled "Stream and Wetland Mitigation Feasibility Report in the San Antonio Basin" dated April 2010 investigating the environmental and financial benefits of sponsoring mitigation banks within a four county jurisdictional area (Bexar, Wilson, Karnes and Goliad). The study identified potential mitigation sites and ranked them based on criteria developed by analyzing GIS data and performing field investigations. The most promising sites were evaluated further to assess existing conditions. The study estimated the type and amount of restoration needed for each, calculated potential stream credits based on preliminary geomorphic/biologic investigations and regulatory guidance, analyzed the potential revenue, costs, profit, market demand, etc. and made recommendations for SARA. The study suggests that SARA is in a favorable position to pursue stream mitigation banking in the San Antonio River Basin. Four of the sites investigated have a relatively high potential to serve as potential mitigation banking sites based on linear feet of stream, mitigation potential, landowner interest, distance to development and geographical service area. As stated previously under Option 3, a mitigation bank would provide mitigate both aquatic and riparian impacts. To date, SARA has only had informal discussions with the Fort Worth District Regulatory Branch mitigation banking point of contact and SARA has not submitted a Mitigation Banking Proposal for USACE review. As a result, no timeline exists for when these sites may be available.

For comparison of the mitigation plans, a target of 1.2 AAHU was set based on the existing conditions for the aquatic habitat. First costs were annualized using a 3.5% Federal Interest Rate and a 50 year period of analysis. The objective of mitigation efforts is to identify the least costly way to mitigate loss in habitat units caused by the project. Therefore the incremental benefit, or output, evaluated is the 1.2 AAU required to mitigate to existing conditions. Table B-26 provides the summary of the incremental cost analysis for the identified mitigation alternatives.

Table B-26. Incremental Cost Analysis of Potential Mitigation Plans*

Mitigation Option	First Cost	Annual Cost	Aquatic AAHU	Incremental Cost per Output
Option 1	297,423	12,882	1.2	$10,735
Option 2	297,423			
	plus real estate		1.2	
Option 3	2,200,000	95,289	1.2	$79,408
Option 4	3,300,000	142,934	1.2	$119,113
Option 5	Option not feasible without timeline of availability			

*Each option mitigates for both aquatic and riparian impacts

Costs were not developed for Options 2 and 5. Since Option 2 would have similar instream mitigation costs, but would require significant additional real estate acquisition, its incremental costs would always be greater than Option 1. Option 5 was investigated further, since there was no certainty of availability of those sites. In comparing the remaining three options, the incremental cost per unit of output to achieve the 1.2 AAHU target is Option 1, with an incremental annual cost of $10,735. Option 1 would be the recommended option.

Mitigation Plan

Aquatic Resources

Within the Leon Creek study area, most of Leon Creek consists of an intermittent stream; therefore, the instream aquatic component of the EPA Rapid Bioassessment Protocols was not conducted during the habitat characterization of existing conditions. However, the proposed channel modification is located above a low water crossing that perennially pools water in Leon Creek. Therefore to establish existing conditions for mitigation needs, a qualitative assessment of the aquatic habitat was required.

Because the Rapid Bioassessment Protocol model is not a USACE approved model for the quantification of habitat for mitigation needs and the data was not previously collected, the Qualitative Habitat Evaluation Index (QHEI) was used to quantify mitigation requirements. The QHEI is approved for one-time use for Leon Creek to assess the quality of the aquatic habitat and establish aquatic mitigation requirements. Three sites, spread out along the length of the creek, were evaluated within the project area (**Figure 1**). QHEI scores for the three sites were 56, 55, and 53 with a mean of 54.67. Although, the riparian habitat scored relatively high for Leon Creek, the absence of riffles and run habitats in this reach of Leon Creek limited the QHEI scores. This disruption of the sediment transport mechanism of the creek results in high sedimentation and extensive embeddedness of the creek's substrate, limiting aquatic diversity.

Under natural river and creek morphological processes, during channel forming flow events, the longitudinal slope of the river bed is flattened through the natural formation of curves (sinuosity) which lengthens the river and slows water velocities around the outer bends; subsequently, the slower velocities allow sediment to drop from the water column forming natural pools and riffles. As the channel forming flow continues through the river channel the velocities increase around the inside bends of the river and in the straighter sections (runs), and additional sediment is picked up in the water column. The resulting habitat is sustained by morphological processes repeating at each curve of the river creating a series of pool-riffle-run sequences. These pool-riffle-run sequences are the structural foundation of aquatic ecosystem habitat and in combination with the adjacent riparian corridor constitute the riverine ecosystem. Organic materials provided by both the riparian corridor and the aquatic environment are moved through the system largely through the flow of water where the diversity of water velocity along with subtle to dramatic changes in substrates, aquatic vegetation, and river banks cause the organic materials to become trapped and deposited. The process of organic movement, deposition, and decomposition is the foundation of a highly functional riverine ecosystem.

The low water crossing at the lower extent of the project area has interrupted this natural stream forming process and acts as a sediment trap as the slower flows entering the pool habitat lose the energy to carry suspended sediments. The resulting "sediment starved" water flowing over the low water crossing attempts to rebalance the sediment transport mechanism by eroding downstream banks. The proposed aquatic mitigation plan will remove the low water crossing at the lower end of the reach and utilize Natural Channel Design (NCD) principles to restore the sinuosity function and structural diversity of the aquatic habitat component of the riverine system. Specifically, re-construct the creek bed utilizing a pilot channel sized to the channel forming flow. The NCD methods include using vertical and horizontal structures in the form of rock vanes appropriately spaced within the pilot channel to balance the sediment transport function of the creek. The NCD methods also restore pool and riffle habitats with proper substrates to support aquatic organisms. In addition to increasing dissolved oxygen concentrations in the stream, the restoration of the riffle component of this habitat will increase habitat diversity of lower trophic level organisms such as aquatic invertebrates, small fish, and amphibians that in turn would increase diversity of upper trophic level organisms such as mammals and birds. The NCD method develops a functional, self-sustaining system providing valuable hydraulic transport and ecological functions. Thus, NCD creates a stable channel that effectively transports water and sediment while maintaining the structural characteristics necessary to ensure habitat sustainability and biotic productivity across all trophic levels.

Major cost components for establishment of the pilot channel include:

- excavation to accommodate the pilot channel and initial pool depths, and riffle structures;
- grading to form the pilot channel and transition to existing floodway slopes;
- rock constructed in-stream structures;
- natural hard structure bank erosion armoring; and
- utility relocation.

Table B-27. Leon Creek Channel Modification With- and Without-Project Aquatic Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**14**	**10**	**25**		
Existing	HSI	0.55	0.55	0.55	0.55	0.55		
	Acres	2.25	2.25	2.25	2.25	2.25		
	Target Year HU	1.24	1.24	1.24	1.24	1.24		
	Interval HU		1.24	17.36	12.40	31	62	1.2
Proposed NCD	HSI	0.00	0.72	0.77	0.78	0.80		
	Acres	2.25	2.25	2.25	2.25	2.25		
	Target Year HU	0.0	1.62	1.73	1.76	1.8		
	Interval HU		1.62	24.22	17.6	45	88.44	1.8

The aquatic mitigation for Leon Creek channel modifications will consist of replacing the existing 2.25 acres (2,850 linear feet) of homogeneous pool habitat resulting from the low water crossing at the downstream extent of the project area with a natural channel design pilot channel. The natural channel design component will include the placement of five rock cross vane structures (Figure B-8) to create a series of pool and riffle habitats along Leon Creek. The natural channel design concepts incorporated into the modified channel will increase the aquatic habitat quality by re-establishing the sediment transport mechanisms and providing structural habitat for aquatic vertebrate and invertebrate communities. This improvement can be represented by the projected QHEI scores for the channel improvements which would increase from 72 in year one to 80 in year 50. Although, the corresponding increase in AAHUs for the aquatic habitat exceeds the AAHUs required for mitigation, restoring the creek utilizing NCD principles ensure the sustainability of the sediment transport and energy balance of the creek which in turn supports the ecological function of the aquatic ecosystem. Not only do the NCD features of the pilot channel provide ecological benefits and ensure long-term sustainability, they are also the most cost effective mitigation option.

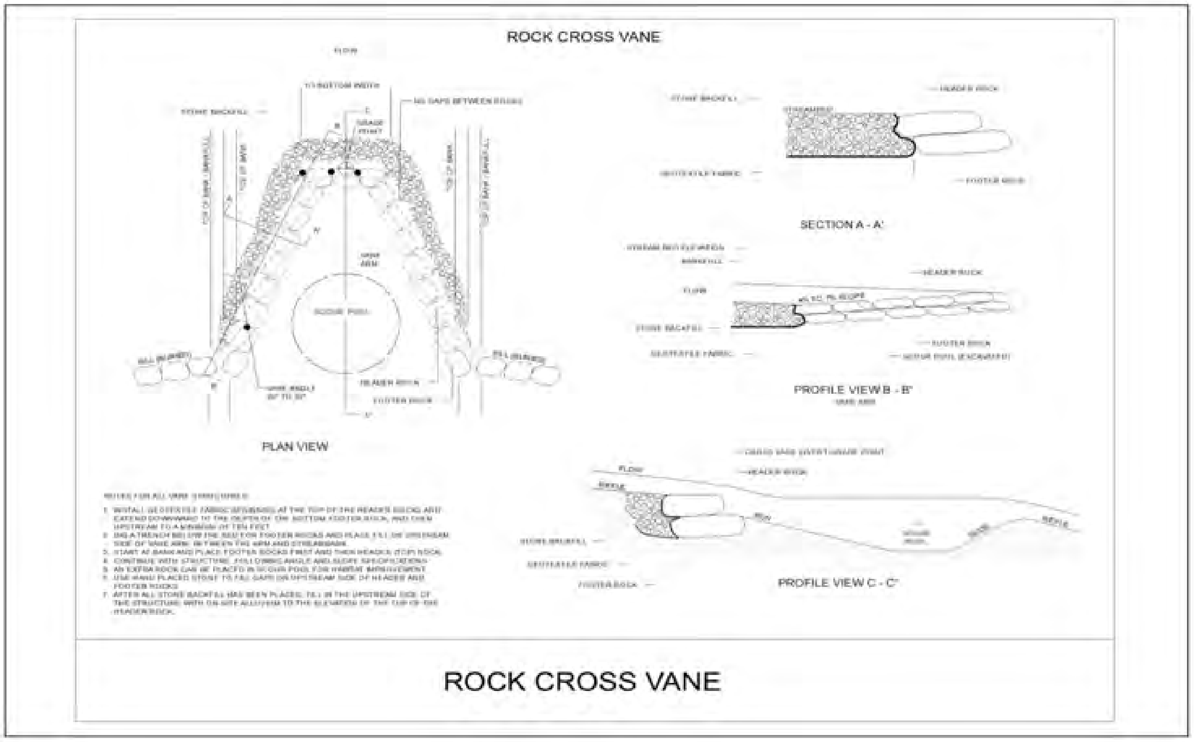


Figure B-8. Rock Cross Vane Schematic

Riparian Woodland

A well developed, age and species diversity of woody riparian habitat provides numerous ecological benefits to the riparian and aquatic components of the riverine system. Woody vegetation provides an important source of allochthonous material to the aquatic environment through leaf drop to small and large woody debris. These allochthonous inputs add energy to the aquatic system required by the organisms lowest on the primary producer and consumer scale, which are at the true base of the system and are required in large sustained numbers of individuals to ensure adequate energy surplus at each trophic level to feed the next higher level through to the upper level consumers. In addition to providing the allochthonous material that is the foundation of the aquatic and riparian food web, the woody vegetation provides nesting, foraging, and cover habitats for a diversity of migratory and breeding birds.

Prior to USACE model certification requirements, the quantification of existing riparian woodlands conducted during the basin-wide habitat evaluations utilized four Habitat Evaluation Procedure (HEP) models: Barred Owl, Green Heron, fox squirrel and raccoon. However, the Green Heron and raccoon HEP models were not included in the suite of HEP models approved for use in habitat evaluations. Therefore, only data from the fox squirrel and Barred Owl models will be to quantify the existing riparian woodland habitats for the proposed Leon Creek channel modifications.

As reported in the existing conditions section of this document, the riparian zones in of the Lower Leon Creek study area are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash, black willow, and cedar elm trees in the upper portions of the segment.

The proposed channel improvements are located in the upper portion of this segment. The HSI values for the fox squirrel and Barred Owl for the Lower Leon Creek segment were both 0.12 providing limited habitat for each of these species. The factors limiting the quality of the riparian woodland include:

- Barred Owl habitat was poor (0.12), due to the low average dbh of overstory trees less than 10 inches, which reduces cover and reproductive values.
- Fox squirrel habitat value (0.12) was reduced by the lack of mast producing trees for available food.

The riparian woody vegetation mitigation measure would address the lack of mast producing trees by planting hard mast species such as pecan along the riparian corridor. In addition, site-specific native vegetation such as bald cypress, pecan, and other hard and soft mast producing species would eventually reach diameters larger than 20 inches dbh that would increase the HSI values for Barred Owl. The riparian woodland plantings would assist in mitigating temporary impacts to aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. After approximately 20-25 years the plantings should reach a diameter of 20 inches dbh producing mast and cover for the fox squirrel and barred owl sentinel species. HSI scores for these species after 20 years should approach a HSI value of 0.55, ultimately approaching 0.65 at maturity.

Of the 15.75 acres of riparian woodland that would be impacted by the proposed channel improvements, 6.44 acres of higher quality, mast producing trees would be restored along the riparian corridor of Leon Creek. The remaining 9.31 acres of existing riparian woodland would be planted with native herbaceous plant species. As shown in Table B-28, the proposed mitigation would mitigate the permanent and temporary impacts associated with the construction of the channel improvements as the Average Annual Habitat Units (AAHU) for the proposed mitigation approximates the without project AAHUs for Leon Creek.

Table B-28: Leon Creek Channel Modification With- and Without-Project Riparian Woodland Habitat

	Target Year	**0**	**1**	**15**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**14**	**10**	**25**		
Existing	HSI	0.12	0.12	0.20	0.20	0.20		
	Acres	15.75	15.75	15.75	15.75	15.75		
	Target Year HU	1.89	1.89	3.15	3.15	3.15		
	Interval HU		1.89	44.10	31.5	78.75	156.24	3.1
Proposed 30 Trees/acre	HSI	0.00	0.10	0.25	0.55	0.65		
	Acres	6.44	6.44	6.44	6.44	6.44		
	Target Year HU	0.0	0.64	1.61	3.54	4.19		
	Interval HU		0.64	22.54	35.43	104.75	163.36	3.3
Proposed 70 Trees/acre	HSI	0.00	0.10	0.35	0.60	0.65		
	Acres	6.44	6.44	6.44	6.44	6.44		
	Target Year HU	0.0	0.64	2.25	3.86	4.19		
	Interval HU		0.64	31.56	38.64	104.75	175.59	3.5

As presented in Table B-28, the AAHU for the 30 trees per acre mitigation feature exceeds the mitigation requirements for riparian woodland impacts. However, a certain level of mortality would be expected to occur during the construction and establishment of these mitigation features. The higher AAHU provided by the 30 trees per acre mitigation feature would ensure that the mitigation requirements would still be met in the event of a 5- to 10-percent tree mortality.

The total mitigation cost for the natural channel design with 30 trees per acre mitigation option is $297,423 compared to a mitigation cost of $334,992 for the 70 trees per acre mitigation option. However, the assumption used in Table B-28 is that the 70 tree per acre density could be incorporated into the existing project limits. In order to model 70 trees per acre, the Manning's *N* value would need to be increased to 0.085 and the assumed hydraulic response would be that fewer acres of trees could be incorporated into the existing project limits. Although not modeled, it is assumed that in order to mitigate the required 3.1 AAHU, additional land would need to be acquired, further increasing mitigation costs for this option. Therefore, because the 30 trees per acre mitigation option fully mitigates the temporary impacts to the riparian woodland habitat at a lower cost and within the existing project limits, it is selected as the mitigation option to be carried forward.

Major cost components for the establishment of the RWV include:

- spot treatment herbicide to remove herbaceous competition in the immediate area around the seedling;
- purchase of saplings in a diverse mix of native riparian trees;
- planting of saplings; and
- provisions for watering/irrigation to aid in quick establishment of plantings.

In accordance with guidance set forth in ER 405-1-12, the mitigation land will be acquired in fee by the non-federal sponsor.

Monitoring and Adaptive Management Plan

Introduction

This section outlines the feasibility level monitoring and adaptive management plan for the Leon Creek mitigation. This plan identifies and describes the monitoring and adaptive management activities proposed for the mitigation project and estimates their cost and duration. This plan will be further developed in the preconstruction, engineering, and design (PED) phase as specific design details are made available.

The Leon Creek mitigation adaptive management plan will describe and justify whether adaptive management is needed in relation to mitigation measures identified in the Feasibility Study. The plan will outline how the results of the project-specific monitoring program would be used to adaptively manage the project, including specification of conditions that will define project success.

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 actions permit estimation of the adaptive management program costs and duration for the Leon Creek mitigation project. This plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Refinements may still be made 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. Refinements 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

Environmental mitigation is required to include a plan for monitoring the success of the mitigation actions (Section 2036, 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 2036 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all mitigation plans.

Project Goals and Objectives

Once alternative formulation identified a preferred alternative, the PDT developed mitigation goals and objectives to be achieved by the restoration measures. The goal of the Leon Creek mitigation plan is to restore structure and function of the riverine habitat of Leon Creek to existing pre-construction condition or better. The resulting objective focuses on the importance of a sustainable riverine habitat based on balancing the sediment transport mechanism of Leon Creek providing valuable habitat for South Central Texas fish and wildlife resources.

Management and Restoration Actions

The PDT then identified potential management measures and restoration actions that address the project mitigation objective. Numerous measures and actions were considered, evaluated, and screened in producing a final mitigation plan. The plan includes a total of 18 acres of native aquatic, riparian woodland, and riparian herbaceous vegetation as follows (Figure 2):

- 6.44 acres of site-specific native tree species planted along the creek at a density of 30 trees per acre;
- 9.31 acres of native grassland
- 2.25 acres (2,850 linear feet) of natural channel design pilot channel including four rock vane-type structures to form a series of pool/riffle complexes.

Implementation

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

Monitoring will focus on evaluating project success and guiding adaptive management actions by determining if the mitigation project has met Performance Standards. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that mitigation objectives 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 mitigation project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives have been tied to original baseline measurements that were collected using Habitat Evaluation Procedures (Barred Owl and Fox Squirrel) and Qualitative Habitat Evaluation Index (QHEI) modeling efforts and are summarized in TableB-29 and discussed below.

Table B-29: Monitoring Criteria, Performance Standards, and Adaptive Management Strategies for the Leon Creek Mitigation Plan

Measurement	Performance Standard	Adaptive Management
Vegetation		
Woody Stem Density	>90-percent survival of trees after 5 years	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 at habitat sampling points after 2 years	Remedial planting/seeding; modification of plant species composition; amending the soil; increased irrigation.
Non-native Vegetation	<5-percent canopy cover of non-native species at habitat sampling points; and no areas >0.25 acres in size with >5-percent non-native species after 5 years	Remedial planting/seeding; modification of plant species composition; amending the soil; increased irrigation; herbicide application; biological control; mechanical removal.
Non-native and NoxiousWeeds	<5-percent canopy cover of non-native or noxious species at habitat sampling points; and no areas >0.25 acres in size with >5-percent non-native or noxious weed species after 5 years	Chemical and mechanical removal.
Hydrology		
Cross-vane Structures	Cross-vane structures functional after a 25-year flood event or after 10 years	Repair of structures; redesign of structures.
Pool-Riffle Complexes	Pool-riffle complexes functionalafter a 25-year flood event or after 10 years	Repair of complexes; redesign of complexes.

Vegetation

Baseline vegetation metrics were compiled during initial site assessments at four habitat sampling sites (one HEP site and three QHEI sites). Terrestrial vegetation metrics included estimates of woody stem density; and percent canopy cover of the overstory, shrub, and herbaceous layers; and other metrics specified in each of the HEP models. Aquatic vegetation parameters were included in the QHEI model.

The success criteria for the establishment of woody vegetation is survival of 90-percent of trees planted at a density of 30 trees per acre. During the first five years of annual monitoring, progress towards meeting this objective will be assessed. If the establishment the woody vegetation is not progressing at a rate that would meet the objective in five years, adaptive management measures will be incorporated to ensure success. . If the success criteria is not met after five years, adaptive management measures will be initiated until the success criteria are attained.Any planted woody vegetation that has died within the warranty period shall be replaced per warranty conditions. Post warranty period, adaptive management measures could include replacement of woody vegetation, modifying the woody species composition or location and allowance of natural succession of native woody species, ensuring density criteria are met.

Restoration of the riparian herbaceous vegetation would be considered successful when the site is generally vegetated along its entire length and when the percent herbaceous canopy at each habitat sampling point is at least 80-percent. Annual monitoring after Years 1 and 2 will provide insight into the need to initiate appropriate adaptive management measures to ensure attainment of the success criteria by Year 3. If the success criteria has not been met by Year 3, adaptive management measures will be implemented until the success criteria have been met. 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 should be less than 5-percent at each habitat sampling point. On an annual basis, or more frequently if needed, areas greater than or equal to 0.25 acres in size that have more the 5-percent areal cover of non-native vegetation shall be treated per the Operations and Maintenance Manual for the Leon Creek project. This typically includes the use of chemical and mechanical methods for management of non-native weeds. Native noxious weeds shall also be monitored with a performance standard of less than or equal to 5-percent. During the first five years of annual monitoring, progress towards meeting this objective will be assessed and adaptive management measures incorporated as necessary. If non-native and invasive vegetation are still present at levels exceeding the success criteria after five years, adaptive management measures will be incorporated to ensure success. Adaptive management measures may include other physical and/or chemical plant treatments or Integrated Pest Management methods.

Hydrology

The NCD of the pilot channel is designed to mimic natural stream processes such as sediment transport, energy dissipation, and channel formation. The proposed cross-vane structures are designed to address these processes in a controlled and constrained system. In addition, the cross-vane structures assist in the formation of pools and riffles that provide habitat for aquatic organisms. The NCD pilot channel transports sediment along the stream and across riffle structures eventually depositing the sediments in the lower velocity pool areas. The NCD pilot channel is designed based on the channel forming flood event (approximately a 1.5 year storm event). During flood events, deposited sediments are flushed from the pools and riffles are reformed with larger and heavier sediment material. Restoration of the aquatic structural habitat would be considered successful after the instream structures and pilot channel remain functional following a 25-year flood event. Because of the flashy nature of flood events in the San Antonio area, the monitoring period will be extended to 10 years or until a 25-year flood event occurs. If a 25-year flood event impacts the functionality of the instream structures, adaptive management measures will be incorporated to ensure attainment of the success criteria.   Although the NCD is designed to function and rebuild during flood events, excessive flood velocities could damage the cross-vane structures, pools, and riffles. Adaptive management wouldincludethe redesign, if necessary, of the cross vane structures, pools and riffles damaged during flooding for storms below the 25-year flood event.

Reporting

Evaluation of the success of the Leon Creek mitigation efforts will be assessed annually utilizing HEP and QHEI 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, TCEQ, 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 Plan 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 under the Leon Creek mitigation plan will utilize centralized data management, data analysis, and reporting functions. 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 (TableB-30). These estimates account for a 1.3-percent inflation rate. The current total estimate for implementing the monitoring and adaptive management plan is $10,300. Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs.

Table B-30: Preliminary Cost Estimates for Implementation of the Monitoring and Adaptive Management Plan for the Leon Creek Mitigation Plan

Category	Activities	# times/year	# years	Cost/Sampling	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures	1	1	$1,000	$1,000
Monitoring: Data Collection	Vegetation	1	5	$750	$3,750
	Hydrology	1	10	$250	$2,500
Data Analysis	Assessment of Monitoring Data and Performance Standards	1	10	$100	$1,000
Adaptive Management Program	Detailed Adaptive Management Plan and Program Establishment			$952	$952
	Management of Adaptive Management Program			$1,000	$1,000
Total					$10,202

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APPENDIX C

AGENCY COORDINATION AND CORRESPONDENCE

TO: Heath McLane, U.S. Army Corps of Engineers, Fort Worth District

FROM: U.S. Fish and Wildlife Service, Austin Ecological Services Office

CC: Tom Heger, Texas Parks and Wildlife Department, Austin

Subject: Draft Comments of U.S. Fish and Wildlife Service on

Leon Creek Interim Feasibility Report and Integrated Environmental Assessment

We have reviewed the draft Leon Creek Interim Feasibility Report, specifically the assumptions and projections about land use, land class, woodlands and grasslands, and habitat values for riparian species (HEP) and aquatics (RBPI). We generally agree with the preliminary assumptions/projections of current and future project conditions for these various resource categories.

We look forward to further discussion on the types of plans under consideration and their relative impacts, if any, to fish and wildlife resources. In general, we support non-structural measures to minimize flood damages, including buyouts, which typically lead to habitat enhancement in the 100-year floodplain and riparian corridor. In the Leon Creek watershed, structural measures such as channelization have been used on multiple creeks. This has resulted in losses of riparian woodland habitats, which have been typically replaced wooded creeks with mowed grasslands forming a broad trapezoidal ditch. Structural measures will vary in terms of their impacts to fish and wildlife habitats depending on the location, areal extent, and design. We would appreciate information on any flood damage reduction measures (including site selection) under consideration. We plan to convey information about areas that planners may want to select or alternatively avoid.

Endangered Species

Depending upon the types and locations of future potential projects within the Leon Creek watershed, impacts upon federally listed species and their habitats should be carefully considered during the preliminary planning phases of specific projects. Impacts to listed species that cannot be avoided may need separate consultation under section 7 of the Endangered Species Act

Bexar County Karst Invertebrates and their Critical Habitat

The following nine Bexar County, Texas, troglobitic invertebrate species were listed as endangered on December 26, 2000 (65 FR 81419): Cokendolpher cave harvestman (*Cicurina venii*), Robber Baron Cave harvestman (*Texella cokendolpheri*), vesper cave spider (*Cicurina vespera*), Government Canyon cave spider (*Neoleptoneta microps*), Madla's cave spider (*Cicurina madla*), Robber Baron cave spider (*Cicurina baronia*), beetle (no common name) (*Rhadine exilis*), beetle (no common name) (*Rhadine infernalis*), and Helotes mold beetle (*Batrisodes venyivi*). These are karst dwelling species of local distribution in north and northwest Bexar County.

Critical habitat units are shown in the attached map. **Please note** that not all caves with listed species were included in the critical habitat designation. Consequently, there are caves on Government Canyon State Natural Area that have listed species but do not have critical habitat associated with them. We recommend further coordination on this particular issue.

The principal, cave-containing rock units of the Edwards Plateau are the upper Glen Rose Formation, Edwards Limestone, Austin Chalk, and Pecan Gap Chalk (Veni 1988). The Edwards Limestone accounts for one-third of the cavernous rock in Bexar County and contains 60 percent of the caves, making it the most cavernous unit in the County. The Austin Chalk outcrop is second to the Edwards in total number of caves. In Bexar County, the outcrop of the upper member of the Glen Rose Formation accounts for approximately one-third of the cavernous rock, but only 12.5 percent of Bexar County caves (Veni 1988). In Bexar County, the Pecan Gap Chalk, while generally not cavernous, has a greater than expected density of caves and passages (Veni 1988).

Veni (1994) delineated six karst areas within Bexar County. The regions were named after places within their boundaries. These karst fauna regions are bounded by geological or geographical features that may represent obstructions to the movement (on a geologic time scale) of troglobites, which has resulted in the present-day distribution of endemic (restricted to a given region) karst invertebrates in the Bexar County area.

These areas have been delineated by Veni (1994) into five zones that reflect the likelihood of finding a karst feature that will provide habitat for the endangered Bexar County invertebrates based on geology, distribution of known caves, distribution of cave fauna, and primary factors that determine the presence, size, shape, and extent of caves with respect to cave development. These five zones are defined as:

Zone 1: Areas known to contain one or more of the nine endangered karst invertebrates;

Zone 2: Areas having a high probability of suitable habitat for the invertebrates;

Zone 3: Areas that probably do not contain the invertebrates;

Zone 4: Areas that require further research but are generally equivalent to zone 3, although they may include sections that could be classified as zone 2 or zone 5; and

Zone 5: Areas that do not contain the invertebrates.

Under contract with the Service, Veni (2002) re-evaluated and, where applicable, redrew the boundaries of each karst zone originally delineated in Veni (1994).

We will provide maps of areas supporting (or potentially supporting) endangered Bexar County karst invertebrates, including critical habitat, the karst zones as delineated by Veni (2002), and if appropriate information on specific caves.

Edwards (Balcones Fault Zone) Aquifer Dependent Species

The recharge zone for the Edwards aquifer covers part of the Leon Creek watershed. We recommend any structural measures in the recharge zone or nearby in the contributing zone be reviewed for potential impacts involving recharge of stormwater containing contaminants. These may include metals, nutrients, detergents, herbicides and pesticides. Certain watersheds currently have limited development. If recharge enhancement is a measure under consideration, we recommend thoroughly reviewing: (1) the current and potential development in that specific watershed to select sites that will maintain high quality recharge in the future and (2) the significance of potential hydrologic alteration of the waterways downstream.

Golden-cheeked Warbler

We recommend that potential impacts to the GCWA be avoided wherever possible. We will also provide maps and GIS layers of oak-juniper woodlands. These woodlands are potentially suitable habitat for the GCWA.

There has been some discussion of the possibility of Leon Creek watershed project measures occurring in Government Canyon State Natural Area (GCSNA). GCSNA habitats were not assessed during our existing conditions field work (HEP and RBPI) in March 2008. Additional field work to assess these new areas would be useful for assessing current and future without (and potentially with) a project measure. A field visit to GCSNA would also help us to make a preliminary determination on potential impacts to federally listed species in Government Canyon SNA early in the project planning phase.

Another measure discussed last year was repairing – rebuilding the flood protection berm around the test cell facility near the Port of San Antonio. Our preliminary view is that repairing this mowed grass berm is a non-issue for fish and wildlife resources.

If you have any questions or comments, please contact Clayton Napier at 512 490-0057 ext. 235.

Thank you for your help in conserving our nation’s trust resources.

Sincerely

Field Supervisor
DRAFT
Attachment

References Cited Veni 1988 Veni 1994 Veni 2002

----- Forwarded by Clayton Napier/R2/FWS/DOI on 03/03/2009 02:09 PM -----

"Tom Heger" <Tom.Heger@tpwd.state.tx.us>

02/26/2009 10:21 AM

To

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cc

<Clayton_Napier@fws.gov>, <Bill_Seawell@fws.gov>, <Luela_Roberts@fws.gov>,
"Newman, Rob SWF" <Rob.Newman@usace.army.mil>

Subject

RE: Leon Creek study area projections

My 2¢:

Riparian Woodlands

I believe your estimation of 20% decrease in acreage of riparian woodland to other habitats or development is reasonable to maybe a bit conservative. In the ordinance, the list of allowable developments within the regulatory 100-year floodplain includes utilities, parks, capital improvements, flood conveyance maintenance, floodplain reclamation of various kinds, parking lots, nonresidential construction, projects that are “in the best interest of the public”. Together with individual “management” acts by adjacent residents, I believe there is a certainty of impacts over the next 50 years from fragmentation and direct loss of woodland.

I don’t believe HSI values will increase or quite hold their own inside or outside the 100-year floodplain overall. Some of the items above, including citizen actions, frequently degrade woodlands without removing them. Factoring in fragmentation and invasive encroachment with urbanization, I believe it is probable that HSI values will decrease somewhat in many areas due to thinning, tree loss, loss of recruitment of desirable species, understory loss, etc. I believe degradation will out-pace maturation/improvement in most areas. Areas currently without woodlands are unlikely to develop them due to maintenance and/or urbanization.

Grasslands & Aquatics

I agree with your assessments of these habitats.

Tom Heger
TPWD

NOV 20 2009

United States Department of the Interior

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FAX 490-0974

NOV 13 2009

Colonel Richard J. Muraski, Jr.
District Engineer
U.S. Army Corps of Engineers
(Attn: CESWF-PER-EE)
P.O. Box 17300
Fort Worth, Texas 76102-0300

Dear Colonel Muraski:

This letter provides supplementary comments and planning assistance for the U.S. Army Corps of Engineers (USACE) on the draft Interim Feasibility Report and Integrated Environmental Assessment (IFRUEA) and draft Preliminary Alternative Analysis (PAA) for Leon Creek in Bexar County, Texas. Specifically, this letter provides supplementary information regarding Alternatives 13 and 14 of the PAA, which are proposed to be located in Government Canyon State Natural Area (GCSNA). It is our understanding that several other specific alternatives are being considered for GCSNA, but were not included in the draft PAA for review.

This planning assistance is provided, in part, by the U.S. Fish and Wildlife Service (Service), pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and is intended to assist in the development of your report. It does not represent a final report of the Secretary of the Interior within the meaning of Section 2(b) of the Act. A complete final Fish and Wildlife Coordination Act report will be prepared after we have reviewed all available pertinent information during the planning process.

Alternatives 13 and 14 of the PAA – Government Canyon State Natural Area

Based on information provided in the PAA, two alternative stormwater retention/detention facilities are currently being considered by the USACE for GCSNA. Alternative 13, the Halff Government Canyon Pond, would be located along Culebra Creek approximately 8,200 feet upstream of the park entrance. The dam would be approximately 60 feet tall with an approximate 350-foot weir, and would have approximately 5,600 acre-feet of storage. This configuration would allow the pond to drain in 36 hours following a 100-year flood event. Alternative 14, the AECOM Government Canyon Regional Storm Water Facility, was initially analyzed using the USACE's hydrology at the request of the local sponsor, the San Antonio River Authority (SARA). Alternative 14's dam is to be located farther upstream of Alternative 13, and has a dam height of 51 feet and a maximum storage of about 6,900 acre-feet.

As previously indicated in our March 13, 2009, draft Planning Aid Letter, the Service's primary concern with any proposed stormwater retention/detention facility alternatives within the boundaries of GCSNA is the potentially significant impacts to the federally-listed endangered golden-cheeked warbler (*Dendroica chrysoparia*)(GCWA) and several federally-listed Bexar County karst invertebrate species and their habitats. The Service recognizes that Alternatives 13 and 14 proposed for GCSNA are still early in the USACE's planning process and feasibility determinations. If feasibility determinations indicate more detailed alternative analysis is warranted, it is very likely that the size, scope, location, and many of the other determining factors for the current and proposed future alternatives may change considerably during that process. Future alternative analysis studies would likely include habitat assessments and presence/absence surveys for the GCWA and karst invertebrate species, which would provide much needed data to evaluate the specific potential impacts of individual projects on the species.

Because project alternatives are likely to change and detailed listed species locations and habitat determinations are very limited, the Service is providing the following general observations. In addition to our general concerns regarding potential impacts to GCWA's and their habitat that may result from any current or proposed future retention/detention facility in GCSNA, Alternative 13 is in close proximity to Government Canyon Bat Cave, which contains four known federally-listed species, the Government Canyon Bat Cave meshweaver (*Cicurina vespera*), Government Canyon Bat Cave spider (*Neoleptoneta microps*), *Rhadine exilis* (ground beetle – no common name), and *Rhadine infernalis* (ground beetle – no common name). Two of the species, the Government Canyon Bat Cave meshweaver and Government Canyon Bat Cave spider, are each known only from Government Canyon Bat Cave and one other karst feature. Flood water impounded by a detention structure in the area could directly adversely affect the cave itself and/or the surrounding surface community upon which the cave fauna depends. Because of the limited distribution of two of the species found in the cave, substantial adverse impacts from a floodwater detention structure due to possible inundation of the cave entrance or cave cricket foraging area around the entrance, as well as changes in surface and subsurface hydrology of the cave system could result in significant impacts to the listed cave species. Because of the limited distribution of these species, inundation of habitat could result in the Service making a determination of jeopardy to the species. Jeopardy is defined as engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). In addition to Government Canyon Bat Cave, a large area of karst zone 1 could be affected by current and/or future proposed impoundments. Other caves containing listed species may be present or discovered in this area after protocol level surveys are conducted and could be potentially impacted.

It is our understanding the Texas Parks and Wildlife Department (TPWD) does not support any proposed detention/retention facility construction within the boundaries of GCSNA. Because of the potential impacts to federally-listed species likely to result from the current alternatives, including the possibility of the project resulting in a jeopardy determination by the Service for listed karst invertebrates within Government Canyon Bat Cave and because of the other natural resources and recreational values in GCSNA, the Service supports TPWD's position on this issue.

Thank you for your help in conserving our nation's trust resources. The Service appreciates the opportunity to assist the USACE Fort Worth District in ecosystem restoration projects like this one at Leon Creek. If you have any questions or comments please contact us at (512) 490-0057.

Sincerely,

Adam Zerrenner
Field Supervisor

cc: Carter Smith, Texas Parks and Wildlife Department, Austin, Texas
Tom Heger, Texas Parks and Wildlife Department, Austin, Texas
Dierdre Hisler, Texas Parks and Wildlife Department, San Antonio, Texas
Richard Mendoza, City of San Antonio, San Antonio, Texas
Joy Nicholopoulos, U.S. Fish and Wildlife Service, Austin, Texas
Dr. Benjamin Tuggle, U.S. Fish and Wildlife Service, Albuquerque, New Mexico

United States Department of the Interior

FISH AND WILDLIFE SERVICE
10711 Burnet Road, Suite 200
Austin, Texas 78758
512 490-0057
FAX 490-0974

Colonel Richard J. Muraski, Jr.
District Engineer
U.S. Army Corps of Engineers
(Attn: CESWF-PER-EE)
P.O. Box 17300
Fort Worth, Texas 76102-0300

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Joy Nicholopoulos, U.S. Fish and Wildlife Service, Austin, Texas
Dr. Benjamin Tuggle, U.S. Fish and Wildlife Service, Albuquerque, New Mexico

National Cave and Karst Research Institute

23 August 2009

Rob Newman
Chief, Planning Section
CESWF-PER-PP
P.O. Box 17300
Fort Worth, Texas 76102-0300

Re: Review of *Draft Preliminary Alternative Analysis, Leon Creek Watershed Feasibility Study San Antonio, Bexar County, Texas*, dated 3 August 2009

Dear Mr. Newman,

I have reviewed the 3 August 2009 version of the *Draft Preliminary Alternative Analysis, Leon Creek Watershed Feasibility Study, San Antonio, Bexar County, Texas*. My comments follow and are focused on the proposed dams for Government Canyon State Natural Area (GCSNA).

I have been involved with GCSNA in many capacities since 1992. I was one of leading organizers of the coalition that acquired GCSNA for purchase and protection by the partnership of the Texas Parks and Wildlife Department, Edwards Underground Water District (which ceded its deeded interest in GCSNA to its successor agency, the Edwards Aquifer Authority), and the City of San Antonio through San Antonio Water System. I served as Vice-President of the Government Canyon Natural History Association for six years and Advisory Board Member for three years. I initiated GCSNA's cave and karst research project and ran it for three years, continued to conduct and assist with research there until moving to New Mexico in 2007, and used it as field site for karst hydrogeology classes I taught from 1998 through 2005.

I believe the proposed dams for GCSNA are not the most effective options nor in the best long-term interests of the community. My concerns fall into three main categories: hydrology, urban planning, and endangered species.

Hydrology. The proposed locations for the Alternative 13 and 14 dams are across Government Canyon in the Edwards Aquifer Recharge Zone. The proposed dam for Alternative 14 would be about 120 m downstream of where the U.S. Geological Survey (USGS) gauged stream flow for several years. I do not have access to those data, but USGS staff told me water was usually recorded in that location only during large storms, only a small portion of the stream flow generated by most storms would flow off the recharge zone because it would instead enter the aquifer, and significant flows exited the recharge zone only during the largest storms. This is consistent with my observations of stream flow behavior, vegetation distribution, and recharge features in the canyon.

The draft analysis does not state which hydrologic model was used to estimate stream flows. Some models do not account for the high recharge rates of karst areas and those that try often underestimate those rates. My many years of observing stream flows and hydrogeologic features in Government Canyon, combined with oral reports of USGS monitoring data, suggest that the proposed dams would only hold significant water following the largest floods. During such events, floodwaters from locations like GCSNA, which are often well upstream of areas needing protection, contribute relatively small amounts of the floodwaters affecting those areas.

Urban planning. Floodwaters have flowed from Government Canyon for many years, but have never been considered a serious problem until recently. Hydrologically, effectively nothing has changed at Government Canyon. Most of its watershed remains undeveloped and is protected from development. However, extensive urban development has resulted in higher percentages of impervious cover in downstream areas, considerable magnifying the effect of flooding. The U.S. Army Corps of Engineers is being asked to fix a problem created by poor urban planning. As each new neighborhood or development is constructed, it should be required to build flood retention basins that would eliminate the hydrologic effect of the impervious cover and maintain natural stream flows and flood conditions. The costs would be relatively small, and paid by the people buying those developed properties, not by the general public. While this point is somewhat philosophical, the U.S. Army Corps of Engineers is uniquely positioned to persuade local government agencies to control flooding with small structures designed to mitigate their impacts. These structures could often be designed as green space, park, or recreational areas to enhance the aesthetic and economic value of the area, rather than degrade increasingly rare undegraded spaces like GCSNA.

Endangered species. Two federally listed endangered species of bird occur in the GCSNA region. I know at least one is significantly present, but can't address the potential presence of either in the areas affected by the proposed dams. However, I can address the presence of the endangered karst invertebrates that occur in caves and associated underground spaces at GCSNA. My 2002 report for the U.S. Fish and Wildlife Service (*Delineation of hydrogeologic areas and zones for the management and recovery of endangered karst invertebrate species in Bexar County, Texas*) listed seven caves with endangered invertebrates and a total of five different endangered invertebrate species at GCSNA. Four of the five species occur in Government Canyon Bat Cave, located about 700 m downstream of the upper end of the Alternative 13 reservoir. The cave's entrance is on a hillside and the bottom of the cave extends to within about 10 m of the maximum reservoir elevation. While the cave will not be directly impacted by the dam, its fauna will likely be indirectly impacted.

The footprint of the proposed Alternative 14 dam is entirely in Karst Zone 1. The footprint of proposed Alternative 13 dam and the area to be flooded by both dams is in Karst Zone 1 and Zone 2. I delineated those zones for U.S. Fish and Wildlife Service in my above mentioned report and respectively defined them as areas where the listed invertebrate species are known to occur or have a highly probability of being present. While the listed invertebrates are primarily found in caves, they also occur in spaces far too small for human entry. There is no doubt they occur under much of the proposed reservoir areas. Further study and excavation of karst features in those areas may categorically prove their presence by opening caves that could then be biologically surveyed. The greater frequency and duration of flooding would adversely impact the species below this flooded area, although the degree of impact is not yet clear. Consultation with U.S. Fish and Wildlife Service and potential studies and mitigation could significantly increase the cost of the flood control project.

I hope you find these comments helpful. If you need additional information, please contact me.

Cordially,

G. Veni

George Veni, Ph.D.
Executive Director

cc: Deirdre Hisler, Superintendent, GCSNA

EDWARDS AQUIFER
AUTHORITY

4-B-3/1-2.7

September 23, 2009

Mr. Rob Newman
Chief, Planning Section
U.S. Army Corps of Engineers – Fort Worth District
CESWF-PER-PP
PO Box 17300
Fort Worth, Texas 76102-0300

RE: Feasibility Studies in the Leon Creek Watershed by the U.S. Army Corps of Engineers (COE) and Bexar Regional Watershed Management (BRWM), Bexar County, Texas

Dear Mr. Newman:

The purpose of this letter is to clarify the position of the Edwards Aquifer Authority (Authority) regarding flood control feasibility studies being conducted in the Leon Creek Watershed, Bexar County, Texas. Specifically, the Authority wishes to comment on a study site being evaluated on Government Canyon Creek within Government Canyon State Natural Area (GCSNA).

Two flood control feasibility studies are being conducted in the Leon Creek Watershed. One study is being conducted by the COE with the San Antonio River Authority (SARA) as the local sponsor. The second study is being conducted by SARA, the City of San Antonio, and Bexar County as partners in the BRWM program. It is our understanding that these studies are intended to collect scientific data related to the feasibility of constructing dams or other facilities at various sites in the watershed. The Authority is interested in the feasibility study site in GCSNA because the site is located on the Edwards Aquifer Recharge Zone and because the Authority holds a conservation easement on a portion of GCSNA, including the area of interest in the referenced feasibility studies. The conservation easement agreement includes a covenant that gives the Authority the right to construct a recharge facility on the property if such a project is mutually agreeable to all parties of the easement agreement.

The Authority supports the collection of scientific data, given their potential to benefit all parties with an interest in the appropriate uses of GCSNA. The Authority also believes that the owner of GCSNA, Texas Parks and Wildlife, and those conducting the feasibility study must agree on the scope of the data collection activities to ensure that all important environmental considerations are addressed and to ensure a balanced evaluation of the site. Furthermore, please note that if the feasibility study concludes that a structure for recharge and flood control purposes is viable, it is the Authority's board of directors solely, which can decide if the Authority wishes to pursue the conservation easement covenant to construct a recharge structure at GCSNA.

1615 N. St. Mary's Street San Antonio, Texas 78215-1415 (210) 222-2204 (800) 292-1047
www.edwardsaquifer.org

If you have questions regarding these comments, please contact Mr. John Hoyt, P.G., Assistant General Manager – Aquifer Management, at (210) 477-5136 or by e-mail at jhoyt@edwardsaquifer.org.

Sincerely,

for

Velma R. Danielson
General Manager

VRD:JH/eb

cc: Edwards Aquifer Authority Board of Directors
Ms. Deirdre Hisler, Park Manager, GCSNA
Mr. Steve Graham, P.E., Assistant General Manager, SARA
Mr. Majed A. Al-Ghafry, Director of Public Works, City of San Antonio

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

February 1, 2008

Planning, Environmental, and Regulatory Division

Mr. F. Lawerence Oaks
State Historic Preservation Officer
Texas Historical Commission
1511 Colorado Street
Austin, Texas 78701

Dear Mr. Oaks:

This letter is initiate consultation and to inform you that the U.S. Army Corps of Engineers (USACE) is conducting the Leon Creek Interim Feasibility Study to assess the potential of a multipurpose project for ecosystem restoration, flood damage reduction and/or recreation development within the Leon Creek Watershed located entirely in Bexar County. The non-Federal sponsor for the study is the San Antonio River Authority (SARA). The United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS) and United States Fish and Wildlife Service (USFWS) have also been providing technical support.

The Leon Creek Interim Feasibility Study is a holistic watershed study being prepared in partial response to Guadalupe and San Antonio Rivers and Tributaries, Texas resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547 dated 11 March 1998, which reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session, and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply, and allied purposes on the Guadalupe and San Antonio Rivers in Texas.*

A full suite of alternatives will be considered during the feasibility study to address the aquatic resource problems, opportunities and needs including best management practices that could be implemented in the uplands. We will be in the process of developing alternatives in 2008 and it is anticipated that an environmental impact statement (EIS) will be required and will be integrated with the feasibility report which is scheduled to be released for public review in April 2009. A notice of intent to prepare an EIS will be prepared and published in the Federal Register in the near future.

A very general overview of existing archeological sites has been conducted since the feasibility study covers such a large area. Once more defined project areas are identified, more in-depth cultural surveys will be conducted to avoid impacts. With this letter, and in accordance with 36 CFR 800.1(c), we wish to initiate the Section 106 consultation process. If you have any questions or comments on this project, please feel free to contact Ms Ann Chancey at (817) 886-1719 or by mail at CESWF-PER-EC, PO Box 17300, 819 Taylor St, Fort Worth, Texas 76102-0300. Thank you for your cooperation in this matter.

Sincerely,

Mark C. Harberg

For William Fickel, Jr.
Chief, Planning, Environmental, and
Regulatory Division

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

February 1, 2008

Planning, Environmental, and Regulatory Division

Honorable Billy Evans Horse, Chairman
Kiowa Tribe of Oklahoma
Hwy 9 West
Carnegie, OK 73015

Dear Chairman Evans Horse:

This letter is initiate consultation and to inform you that the U.S. Army Corps of Engineers (USACE) is conducting the Leon Creek Interim Feasibility Study to assess the potential of a multipurpose project for ecosystem restoration, flood damage reduction and/or recreation development within the Leon Creek Watershed located entirely in Bexar County. The non-Federal sponsors for the study is the San Antonio River Authority (SARA). The United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS) and United States Fish and Wildlife Service (USFWS) have also been providing technical support.

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DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA

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

February 1, 2008

Planning, Environmental, and Regulatory Division

Honorable Wallace Coffey, Chairman
ATTN: Ms. Ruth Toahty
Comanche Nation
584 NW Bingo Rd
HC 32 Box 908
Lawton, Oklahoma 73502

Dear Chairman Coffey:

This letter is initiate consultation and to inform you that the U.S. Army Corps of Engineers (USACE) is conducting the Leon Creek Interim Feasibility Study to assess the potential of a multipurpose project for ecosystem restoration, flood damage reduction and/or recreation development within the Leon Creek Watershed located entirely in Bexar County. The non-Federal sponsors for the study is the San Antonio River Authority (SARA). The United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS) and United States Fish and Wildlife Service (USFWS) have also been providing technical support.

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

February 1, 2008

Planning, Environmental, and Regulatory Division

Honorable Mark Chino, President, Mescalero Apache Tribe
ATTN: Ms. Holly Houghten, Cultural Affairs Office
124 Chiricahua Plaza
Mescalero, New Mexico 88340

Dear President Chino:

This letter is initiate consultation and to inform you that the U.S. Army Corps of Engineers (USACE) is conducting the Leon Creek Interim Feasibility Study to assess the potential of a multipurpose project for ecosystem restoration, flood damage reduction and/or recreation development within the Leon Creek Watershed located entirely in Bexar County. The non-Federal sponsor for the study is the San Antonio River Authority (SARA). The United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS) and United States Fish and Wildlife Service (USFWS) have also been providing technical support.

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DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

February 1, 2008

Planning, Environmental, and Regulatory Division

Honorable Anthony E. Street, President
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonkawa, OK. 74653

Dear President Street:

This letter is initiate consultation and to inform you that the U.S. Army Corps of Engineers (USACE) is conducting the Leon Creek Interim Feasibility Study to assess the potential of a multipurpose project for ecosystem restoration, flood damage reduction and/or recreation development within the Leon Creek Watershed located entirely in Bexar County. The non-Federal sponsor for the study is the San Antonio River Authority (SARA). The United States Geological Survey (USGS), Natural Resources Conservation Service (NRCS) and United States Fish and Wildlife Service (USFWS) have also been providing technical support.

The Leon Creek Interim Feasibility Study is a holistic watershed study being prepared in partial response to Guadalupe and San Antonio Rivers and Tributaries, Texas resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547 dated 11 March 1998, which reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session, and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply, and allied purposes on the Guadalupe and San Antonio Rivers in Texas.*

A full suite of alternatives will be considered during the feasibility study to address the aquatic resource problems, opportunities and needs including best management practices that could be implemented in the uplands. We will be in the process of developing alternatives in 2008 and it is anticipated that an environmental impact statement (EIS) will be required and will be integrated with the feasibility report which is scheduled to be released for public review in April 2009. A notice of intent to prepare an EIS will be prepared and published in the Federal Register in the near future.

A very general overview of existing archeological sites has been conducted since the feasibility study covers such a large area. Once more defined project areas are identified, more in-depth cultural surveys will be conducted to avoid impacts. With this letter, and in accordance with 36 CFR 800.1(c), we wish to initiate the Section 106 consultation process. In addition, if you have any information regarding Traditional Cultural Properties within the region, we respectfully request that you provide whatever information you can so that we make take them into consideration during the planning process. If you have any questions or comments on this project, please feel free to contact Ms Ann Chancey at (817) 886-1719 or by mail at CESWF-PER-EC, PO Box 17300, 819 Taylor St, Fort Worth, Texas 76102-0300. Thank you for your cooperation in this matter.

Sincerely,

Mark C. Harberg

For William Fickel, Jr.
Chief, Planning, Environmental, and
Regulatory Division

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF

Regional Planning and Environmental Center

Mr. Mark Wolfe
State Historic Preservation Officer
Texas Historical Commission
P.O. Box 12276, Capitol Station
Austin, Texas 78711

Dear Mr. Wolfe:

The U.S. Army Corps of Engineers (USACE), Fort Worth District and our non-Federal sponsor the San Antonio River Authority (SARA) have conducted a Flood Risk Management study along Leon Creek in Bexar County, Texas. This effort began in earnest after the execution of the initial Feasibility Cost Share Agreement on September 14, 2004, and has slowly progressed until now. Recently, USACE formulated a Recommended Plan (Alternative 2B) which is described in the draft "*Leon Creek Watershed Interim Feasibility Study and Integrated Environmental Assessment, San Antonio, Texas,*" and was made available for public review in November 1, 2013. Enclosure 1 displays the recommended project location.

The Recommended Plan consists of a 100-year levee with hydraulic mitigation (i.e., in-stream channelization), as depicted in Enclosure 2, in combination with a residential buyout area referred to as NS AOI-4 on Enclosure 3. The proposed earthen levee will possess 3.5:1 (H:V) side slopes and extends approximately 3,700 linear feet from high ground on the southeast side of the Jet Engine Test Cell area, wrapping around to SW Military Drive. The levee also possesses a twelve-foot wide levee crown providing maintenance and patrol access. The levee is aligned to provide adequate benching between the riverside toe and the Leon Creek channelization for stability reasons, as well as to avoid existing buildings on the Test Cell site. The grading of landside toe ditches to a proposed sump area will convey interior runoff. Included at the Test Cell area is a soil-bentonite slurry wall to provide additional seepage control along the full length of the levee. In-stream channelization at Leon Creek will extend approximately 2,850 linear feet and reduce to a 60-foot bottom width with no impacts to hydraulic conveyance.

The buyout area is located south of Loop 1604 and west of Babcock Road (see Enclosures 3 and 4) and subject to flooding from Babcock Creek. The proposed buyout includes four single-family residential structures and 32 townhouses. Structures identified for the buyout was built between 1994 and 1995 and as such do not meet the minimum criteria for inclusion in the National Register of Historic Places (NRHP).

Archaeological surveys conducted near the proposed levee location by San Antonio Water System located three archaeological sites within one-half mile of the project area. USACE will conduct archaeological investigations during project design to identify any cultural resources within the project Area of Potential Effects. If any properties are located which meet the criteria for inclusion in the NRHP, an appropriate mitigation plan will be developed in consultation with your office, and other interested parties, and executed prior to construction.

If you have any questions on this study or our proposed activities, please contact Ms. Nancy Parrish, Archeologist, 817-886-1725 or nancy.a.parrish@usace.army.mil. We look forward to your participation in the Section 106 consultation process on this study.

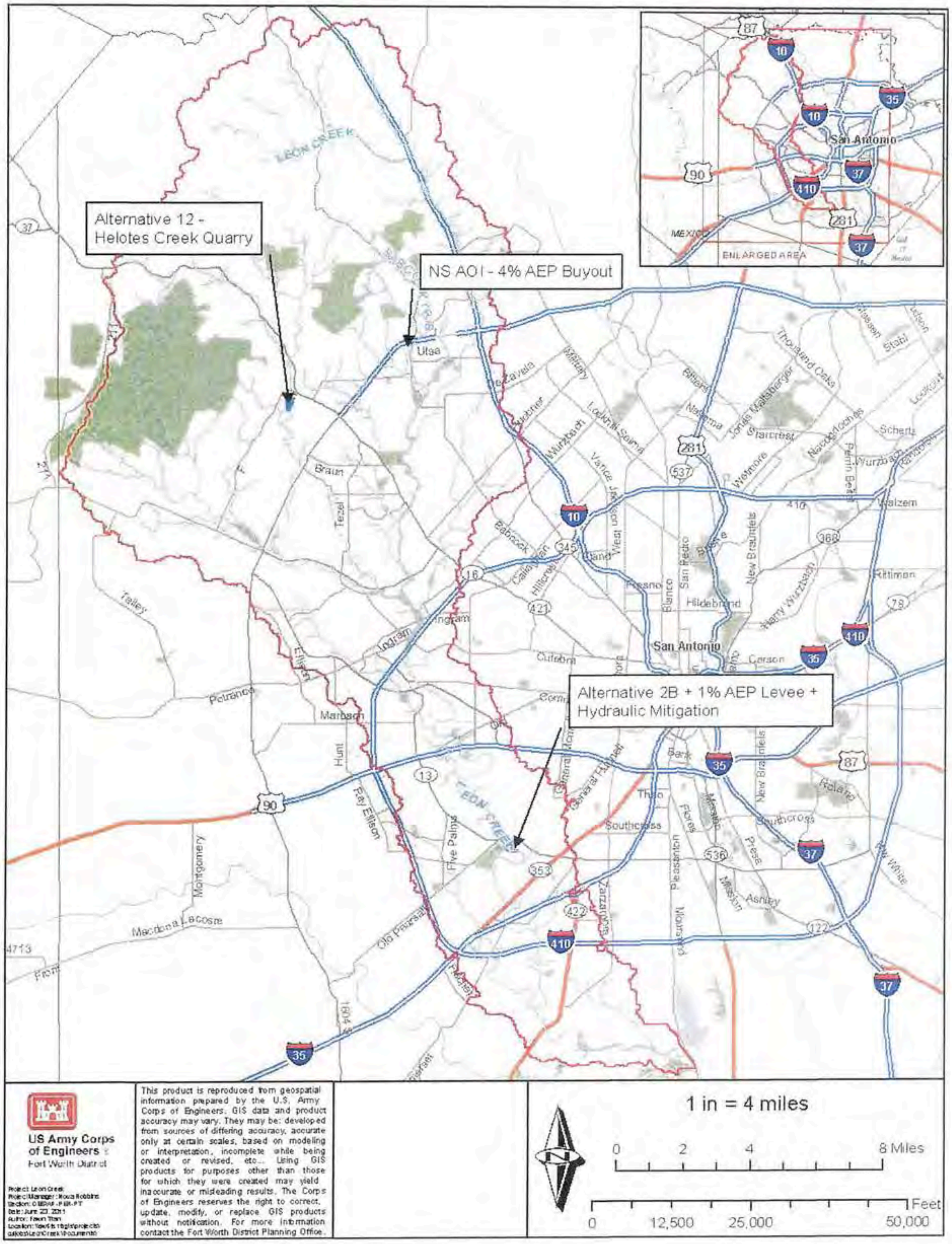
Sincerely,

E. W. Verw

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

Enclosure 1
Project Location Map



Alternative 12 - Helotes Creek Quarry

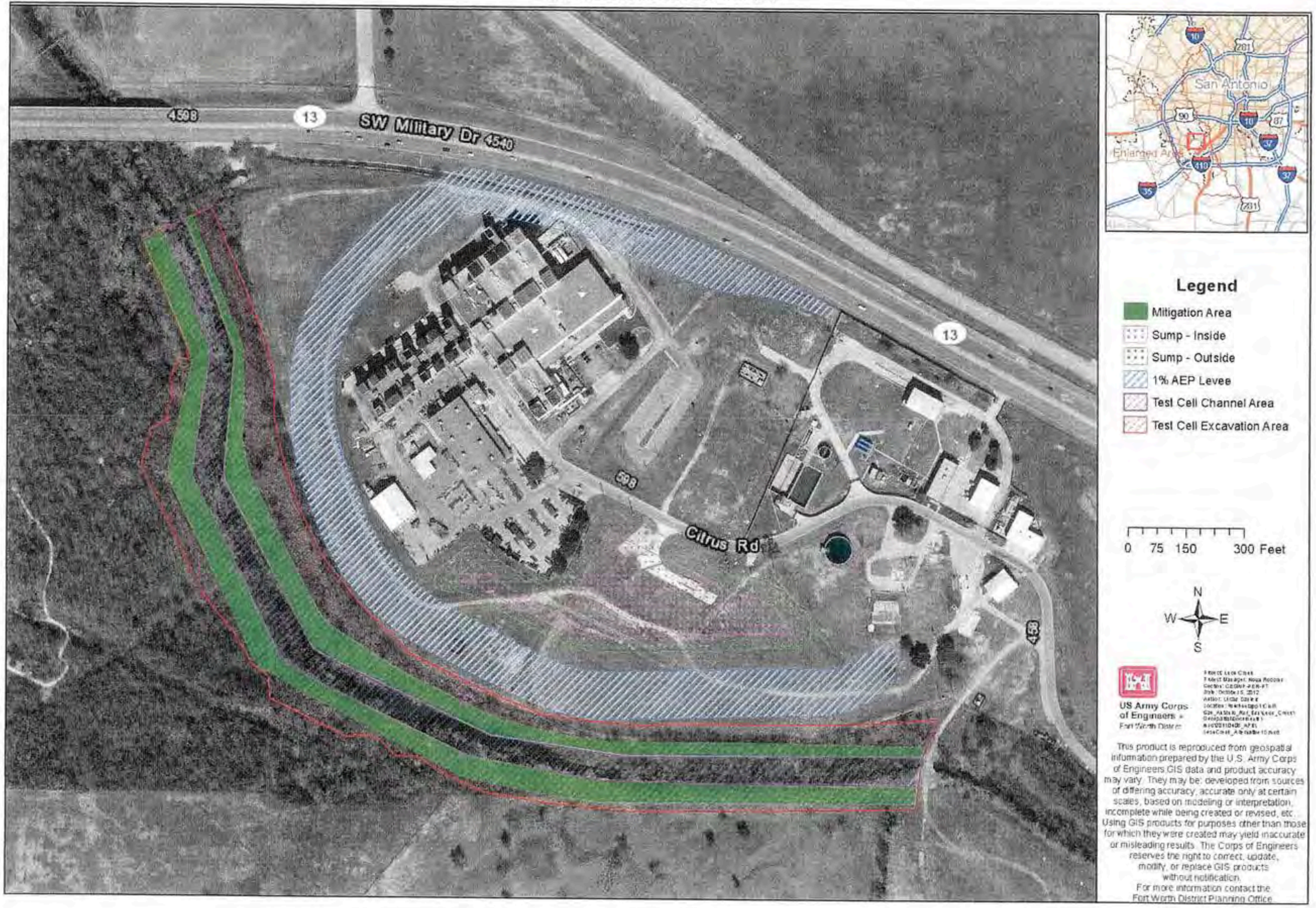
NS AOI - 4% AEP Buyout

Alternative 2B + 1% AEP Levee + Hydraulic Mitigation

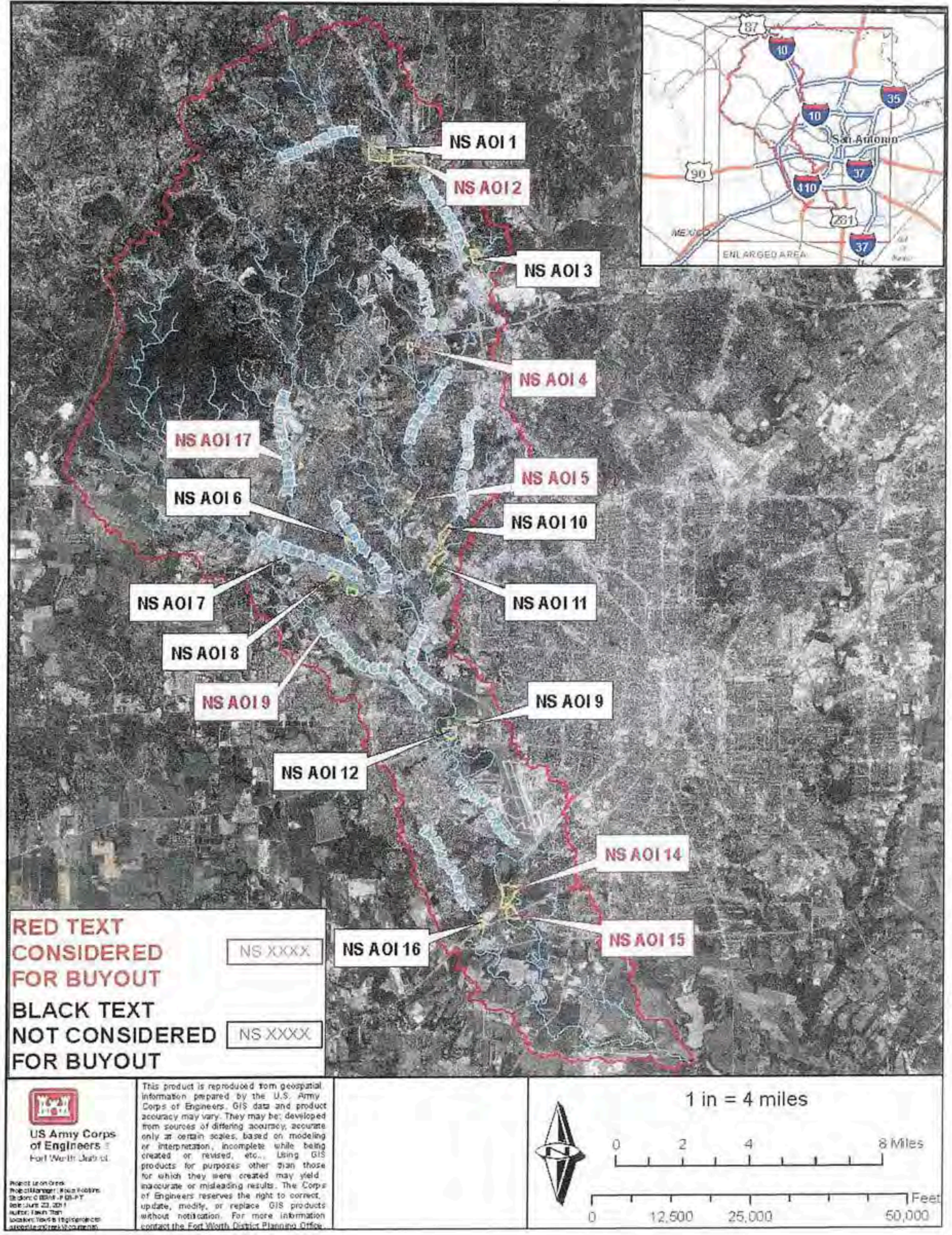
US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: June 23, 2011
Author: Fawn Tran
Location: \\swf-fs1\gis\projects\lakes\LeonCreek\Documents

Enclosure 2
Recommended Plan



Enclosure 3
Buyout Area Location (NS AOI4)

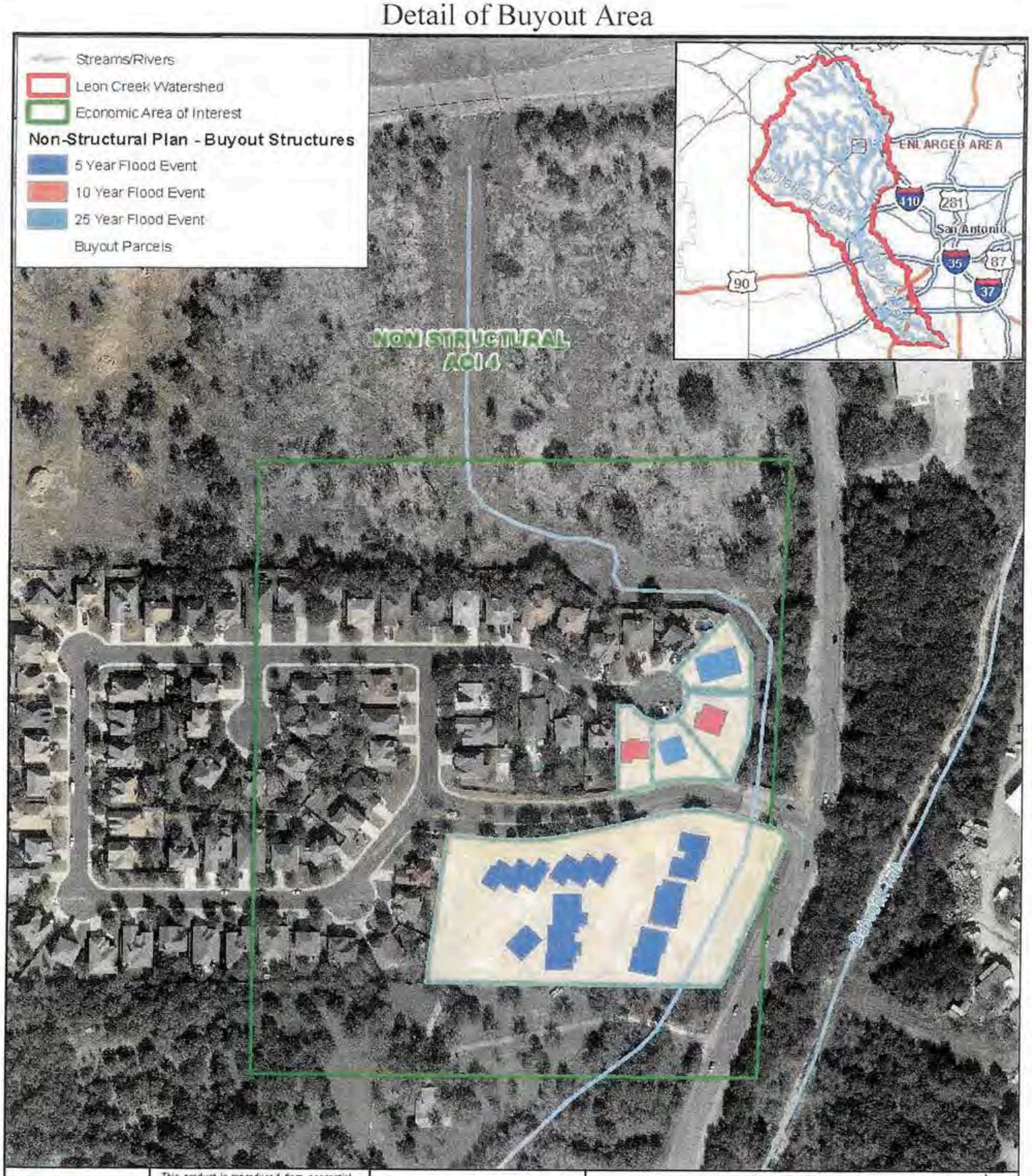


US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: [illegible]
Section: [illegible]
Date: June 23, 2011
Author: [illegible]
Location: [illegible]

This product is reproduced from geospatial information prepared by the U.S. Army Corps of Engineers. GIS data and product accuracy may vary. They may be: developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc.. Using GIS products for purposes other than those for which they were created may yield inaccurate or misleading results. The Corps of Engineers reserves the right to correct, update, modify, or replace GIS products without notification. For more information contact the Fort Worth District Planning Office.

Enclosure 4
Detail of Buyout Area



US Army Corps of Engineers ®
Fort Worth District

Project: Leon Creek
Project Manager: Rous Robbins
Section: CESWF-PER-PT
Date: July 25, 2011
Author: Fawn Tran
Location: \\swf-fs1\sgs\projects\
civilworks\LeonCreek\Documents\

This product is reproduced from geospatial information prepared by the U.S. Army Corps of Engineers. GIS data and product accuracy may vary. They may be: developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc... Using GIS products for purposes other than those for which they were created may yield inaccurate or misleading results. The Corps of Engineers reserves the right to correct, update, modify, or replace GIS products without notification. For more information contact the Fort Worth District Planning Office.

PROJECTION:
SOUTH CENTRAL TEXAS
STATE PLANE
FIPS 4204 FEET

1 inch = 200 feet

Feet
0 250 500

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Mr. Mark Wolfe
State Historic Preservation Officer
1511 Colorado Street
Austin, Texas 78701

Dear Mr. Wolfe:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

Structural and nonstructural alternatives were evaluated for consideration, which included flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels. The recommended plan includes the construction of a 100-year levee with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses.

A Public Notice has been prepared to notify the public of this action and to solicit comments. The Public Notice, draft FONSI, and IFS/EA are enclosed with this communication for your review and to solicit any additional comments or concerns your agency may have regarding this action. We will consider any comments that we receive from you by the close of the comment period as indicated on the Public Notice. Please address any comments you may have to the contact indicated in the Public Notice. Thank you for your cooperation in this matter.

Sincerely,

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Honorable Mark Chino, President
Mescalero Apache Tribe
124 Chiricahua Plaza
Mescalero, New Mexico 88340

Dear Honorable Chino:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

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Sincerely,

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Honorable Wallace Coffey, Chairman
ATTN: Mr. James Arterberry
Comanche Nation
584 NW Bingo Road
HC 32 Box 908
Lawton, Oklahoma 73502

Dear Mr. Arterberry:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

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Sincerely,

E. W. Ver

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Honorable Ron Twohatchet, Chairman
Kiowa Tribe of Oklahoma
Hwy 9 West
Carnegie, Oklahoma 73015

Dear Honorable Twohatchet:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

Structural and nonstructural alternatives were evaluated for consideration, which included flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels. The recommended plan includes the construction of a 100-year levee with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses.

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Sincerely,

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Honorable Don Paterson, President
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonkawa, Oklahoma 74653

Dear Honorable Paterson:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

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Chief, Planning, Environmental, and
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UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Mr. Mark Denton
Texas Historical Commission
1511 Colorado Street
Austin, Texas 78701

Dear Mr. Denton:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

Structural and nonstructural alternatives were evaluated for consideration, which included flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels. The recommended plan includes the construction of a 100-year levee with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses.

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Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

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DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Mr. Michael Jansky
Office of Planning and Coordination
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Mail Stop 6ENXP
Dallas, Texas 75202

Dear Mr. Jansky:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

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Sincerely,

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Ms. Julie Wicker
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Dear Ms. Wicker:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

Structural and nonstructural alternatives were evaluated for consideration, which included flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels. The recommended plan includes the construction of a 100-year levee with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses.

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Sincerely,

E. W. Ver

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Gregg Easley, Leader
Standards Implementation Team, Water Quality Division
Texas Commission on Environmental Quality
12100 Park Circle 35, Building F
P.O. Box 13087, Capitol Station
Austin, Texas 78711

Dear Mr. Easley:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

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Sincerely,

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

Mr. Adam Zerrenner
U.S. Fish and Wildlife Service
10711 Burnet Rd., Suite 200
Austin, Texas 78758

Dear Mr. Zerrenner:

The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, are evaluating the potential environmental consequences resulting from flood risk management solutions associated with Leon Creek in Bexar County. USACE has prepared a Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA).

Structural and nonstructural alternatives were evaluated for consideration, which included flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels. The recommended plan includes the construction of a 100-year levee with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, the recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses.

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Sincerely,

E.W. Verwers

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Enclosures

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

REPLY TO
ATTENTION OF:

October 31, 2013

Planning, Environmental, and Regulatory Division

NOTICE OF AVAILABILITY

DRAFT FONSI AND ENVIRONMENTAL ASSESSMENT FOR THE LEON CREEK FLOOD RISK MANAGEMENT PROJECT, SAN ANTONIO, TEXAS

The public is hereby notified of the availability of the Draft Finding of No Significant Impact (FONSI) and Draft Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA) for Flood Risk Management opportunities within the Leon Creek watershed, in Bexar County, San Antonio, Texas. The United States Army Corps of Engineers, Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, have prepared the Draft Leon Creek IFS/EA and Draft FONSI to identify, evaluate, and disclose all associated impacts that would result from the proposed flood risk management alternatives for Leon Creek watershed.

This project would result in a direct impact of greater than three acres of waters of the state or 1,500 linear feet of streams (or a combination of the two is above the threshold), and as such would not fulfill Tier I criteria for the project. Therefore, Texas Commission on Environmental Quality (TCEQ) certification is required. Concurrent with USACE processing of this Department of the Army application, the TCEQ is reviewing this application under Section 401 of the Clean Water Act, and Title 30, Texas Administrative Code Section 279.1-13 to determine if the work would comply with State water quality standards. By virtue of an agreement between the USACE and the TCEQ, this public notice is also issued for the purpose of advising all known interested persons that there is pending before the TCEQ a decision on water quality certification under such act. Any comments concerning the Section 401 Water Quality Certification application may be submitted to the Texas Commission on Environmental Quality, 401 Coordinator, MSC-150, P.O. Box 13087, Austin, Texas 78711-3087. The TCEQ may conduct a public meeting to consider all comments concerning water quality if requested in writing. A request for a public meeting must contain the following information: the name, mailing address, application number, or other recognizable reference to the application; a brief description of the interest of the requestor, or of persons represented by the requestor; and a brief description of how the application, if granted, would adversely affect such interest.

The Draft FONSI and IFS/EA will be available for review at the following locations:

San Antonio River Authority
100 East Guenther St.
San Antonio, Texas 78205

Central Library
600 Soledad
San Antonio, Texas 78204

TCEQ
12100 Park 35 Circle
Austin, Texas 78753

The Draft FONSI and IFS/EA can also be viewed via the Internet on the Fort Worth District and SARA websites at the following addresses: www.swf.usace.army.mil and www.sara-tx.org.

A 35-day public comment period begins with publication of this Notice of Availability. Please address any comments regarding the Section 401 Water Quality Certification to TCEQ at the aforementioned address. Please address all other comments to Mr. Daniel Allen, Attn: CESWF-PER-EC, P. O. Box 17300, Fort Worth, Texas 76102-0300, or daniel.allen@usace.army.mil.

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

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

REPLY TO
ATTENTION OF:

December 5, 2013

Planning, Environmental, and Regulatory Division

NOTICE OF AVAILABILITY EXTENSION

DRAFT FINDING OF NO SIGNIFICANT IMPACT AND INTERIM FEASIBILITY STUDY WITH AN INTEGRATED ENVIRONMENTAL ASSESSMENT FOR THE LEON CREEK FLOOD RISK MANAGEMENT PROJECT, SAN ANTONIO, TEXAS

The public is hereby notified that the public comment period for the Draft Finding of No Significant Impact (FONSI) and Interim Feasibility Study with an Integrated Environmental Assessment (IFS/EA) for the Leon Creek Flood Risk Management Project, San Antonio, Texas is extended. The United States Army Corps of Engineers (USACE), Fort Worth District and the San Antonio River Authority (SARA), the non-federal sponsor, have prepared the Draft Leon Creek IFS/EA and Draft FONSI to identify, evaluate, and disclose all associated impacts that would result from the proposed flood risk management alternatives for the Leon Creek watershed.

This project would result in a direct impact of greater than three acres of waters of the state or 1,500 linear feet of streams (or a combination of the two is above the threshold), and as such would not fulfill Tier I criteria for the project. Therefore, Texas Commission on Environmental Quality (TCEQ) certification is required. Concurrent with USACE processing of this Department of the Army application, the TCEQ is reviewing this application under Section 401 of the Clean Water Act, and Title 30, Texas Administrative Code Section 279.1-13 to determine if the work would comply with State water quality standards. By virtue of an agreement between the USACE and the TCEQ, this public notice is also issued for the purpose of advising all known interested persons that there is pending before the TCEQ a decision on water quality certification under such act. Any comments concerning the Section 401 Water Quality Certification application may be submitted to the Texas Commission on Environmental Quality, 401 Coordinator, MSC-150, P.O. Box 13087, Austin, Texas 78711-3087. The TCEQ may conduct a public meeting to consider all comments concerning water quality if requested in writing. A request for a public meeting must contain the following information: the name, mailing address, application number, or other recognizable reference to the application; a brief description of the interest of the requestor, or of persons represented by the requestor; and a brief description of how the application, if granted, would adversely affect such interest.

The Draft FONSI and IFS/EA will be available for review at the following locations:

San Antonio River Authority
100 East Guenther Street
San Antonio, Texas 78205

Central Library
600 Soledad
San Antonio, Texas 78204

TCEQ
12100 Park 35 Circle
Austin, Texas 78753

The Draft FONSI and IFS/EA can also be viewed via the Internet on the Fort Worth District and SARA websites at the following addresses: www.swf.usace.army.mil and www.sara-tx.org.

The public comment period is extended until December 20, 2013. Please address any comments regarding the Section 401 Water Quality Certification to TCEQ at the aforementioned address. Please address all other comments to Mr. Daniel Allen, Attn: CESWF-PER-EC, P. O. Box 17300, Fort Worth, Texas 76102-0300, or email daniel.allen@usace.army.mil.

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

Bryan W. Shaw, Ph.D., P.E., *Chairman*
Toby Baker, *Commissioner*
Zak Covar, *Commissioner*
Richard A. Hyde, P.E., *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

February 20, 2014

Mr. Eric Verwers, Branch Chief
U.S. Army Corps of Engineers
Regulatory Branch CESWF-PER-EC
P.O. Box 17300
Fort Worth, Texas 76102-0300

Attention: Mr. Daniel Allen

Re: Draft FONSI and Environmental Assessment for the Leon Creek Flood Risk Management Project, San Antonio, Texas

Dear Mr. Verwers:

This letter is in response to the U.S. Army Corps of Engineers (Corps) and the San Antonio River Authority (SARA) Draft Finding of No Significant Impact and Environmental Assessment for the Leon Creek Flood Risk Management Project, San Antonio, Texas (EA).

The Texas Commission on Environmental Quality (TCEQ) has reviewed the EA. Based on our evaluation of the information contained in these documents, the TCEQ certifies that there is reasonable assurance that the project will be conducted in a way that will not violate water quality standards.

The EA was made available by way of a Notice of Availability, dated October 31, 2013. The Corps and SARA prepared this document to identify, evaluate, and disclose all associated impacts that would result from the proposed flood risk management alternatives for the Leon Creek watershed. After consideration of numerous alternatives and factors, the preferred alternative involves construction of a levee, with hydraulic mitigation in the form of stream deepening and widening upstream of the levee.

Mitigation for impacts to wetlands and waters in the state include utilization of natural channel design techniques including stream habitat structures, floodplain benches, and riparian plantings.

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • tceq.texas.gov

No review of property rights, location of property lines, nor the distinction between public and private ownership has been made, and this certification may not be used in any way with regard to questions of ownership.

If you require additional information or further assistance, please contact Mr. Peter Schaefer of the Water Quality Division MC-150, P.O. Box 13087, Austin, Texas 78711-3087. Mr. Schaefer may also be contacted by e-mail at *peter.schaefer@tceq.texas.gov*, or by telephone at (512) 239-4372.

Sincerely,

David W. Galindo, Director
Water Quality Division

DWG/PS/gg

United States Department of the Interior

FISH AND WILDLIFE SERVICE
10711 Burnet Road, Suite 200
Austin, Texas 78758
512 490-0057
FAX 490-0974

MAR 1 1 2014

Colonel Charles H. Klinge
District Engineer
U.S. Army Corps of Engineers
(Attn: CESWF-PEC)
P.O. Box 17300
Fort Worth, Texas 76102-0300

Dear Colonel Klinge:

This letter constitutes the U.S. Fish and Wildlife Service's (Service) final report on the U.S. Army Corps of Engineers' (Corps) Interim Feasibility Report and Integrated Environmental Assessment (FREA) for Leon Creek in Bexar County, Texas in accordance Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Our report has been coordinated with Tom Heger of the Texas Parks and Wildlife Department (TPWD).

Background

The Corps Authority to study Leon Creek is a Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, March 11, 1998. The Corps initiated the study at the request of the San Antonio River Authority (SARA) to examine opportunities to reduce flood damages within the Leon Creek Watershed located on the west side of the city of San Antonio, Bexar County, Texas. The *Draft Interim Feasibility Report and Integrated Environmental Assessment dated October 2013*, investigated flooding damages for the entire Leon Creek Watershed.

The Service assisted the Corps in assessing this project by attending team meetings, conducting site visits, and completing baseline habitat assessments. The Service submitted the following documents to the Corps identifying the fish and wildlife resources within the study area.

- **Draft Comments on the Leon Creek Interim Feasibility Report and Integrated Environmental Assessment.** March 3, 2009
- **Planning Aid Letter – Leon Creek, Bexar County.** March 19, 2009
- **Planning Aid Letter – Leon Creek, Bexar County Supplement.** November 10, 2009

Evaluation Methodology

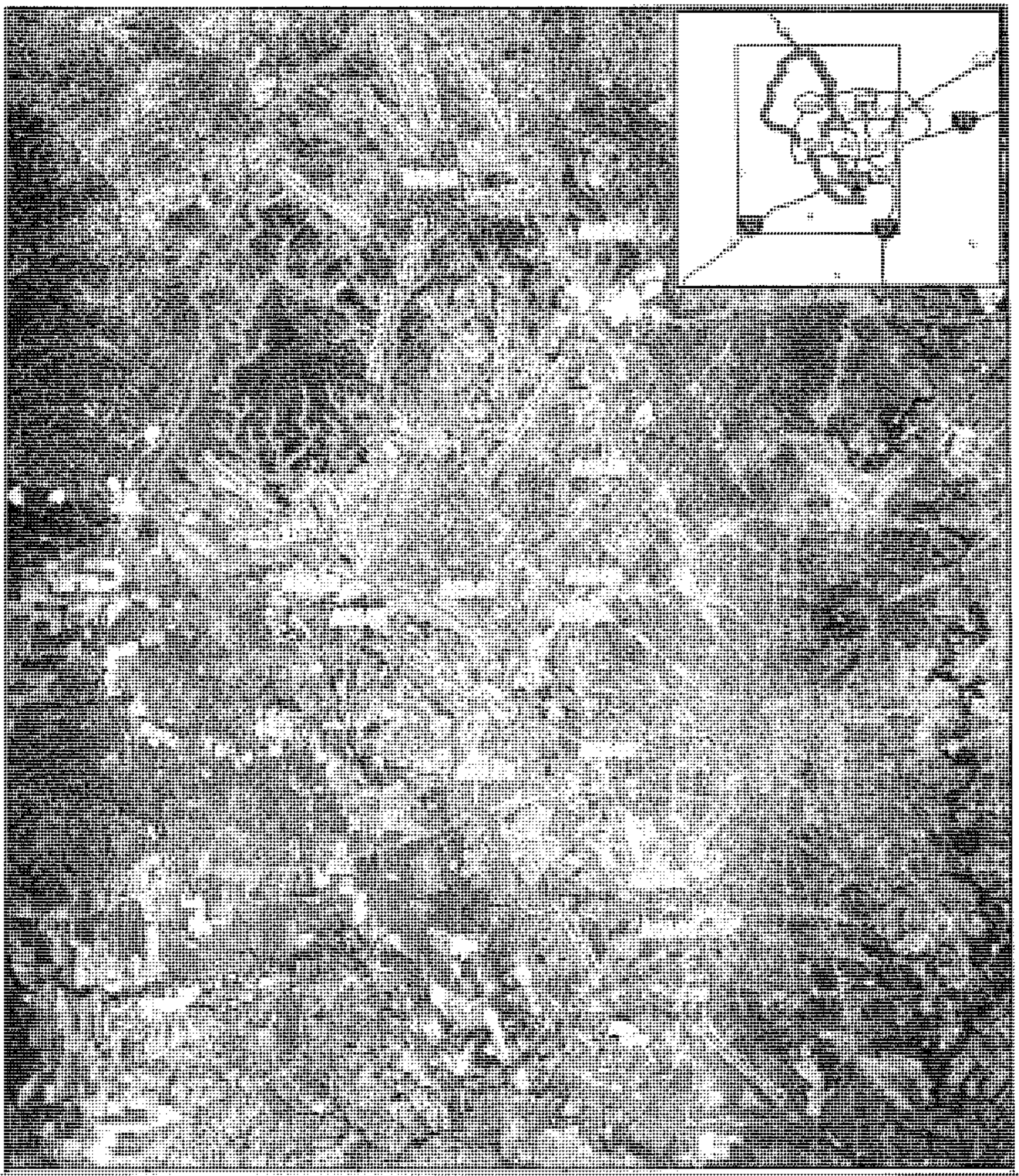
The Service's *Habitat Evaluation Procedures (HEP) (USFWS 1980)* was used to evaluate the existing terrestrial habitats in the study area to give an overall assessment of habitat quality. The Fox Squirrel and the Barred owl models were utilized for this study.

Once the project areas were identified the Corps utilized the *Ohio Environmental Protection Agency's Qualitative Habitat Evaluation Index (QHEI)* to determine existing riparian aquatic habitat value and mitigation requirements due to it being approved for one time use for this study. The QHEI is very similar to the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol, which was used for the overall existing conditions, but had not been approved by the Corps for this study. The QHEI measures the Channel substrate, instream cover, channel morphology, riparian zone, pool quality, riffle quality, and map gradient.

The Service has evaluated this project in accordance with the guidelines and directives contained in its Fish and Wildlife Mitigation Policy (Federal Register 46(15):7644-7663; January 23, 1981). The Mitigation Policy is the basis by which the Service makes recommendations, in order of priority, to avoid, minimize, rectify, reduce, or eliminate the loss over time, or compensate for project related impacts to fish and wildlife resources. Our recommendations are based on the value and relative abundance of the affected habitats to the evaluation species. The policy includes four Resources Categories (1-4) to provide a consistent value for wildlife habitats. Based on Habitat Suitability Index (HSI) values and Qualitative Habitat Evaluation Index (QHEI) evaluations, the Service has designated a Resource Category for each terrestrial and aquatic habitat in the project area.

Project Alternatives and Proposed Action

Twelve (12) Areas of Interest with concentrated flood damages were identified for further evaluation. Alternatives for all but Area of Interests 2 and 4 were ruled out for either lack of sponsorship or the alternatives that were proposed did not meet the Corps' economic justification.



No Action

Under the no action alternative, the Corps would not recommend any flood risk management features for Area of Interest 2 and 4. Flood damages for these two areas would continue to persist under the No Action Alternative, and the existing conditions habitat values would remain.

Proposed Action

The Proposed Action Recommended Plan consists of the 1 percent AEP event (100-year) Levee with Hydraulic Mitigation in AOI-2. In addition, it would include a nonstructural buyout in AOI-4.

Proposed Action –Levee Component

The proposed earthen levee at AOI-2 extends approximately 3,700 linear feet from high ground on the southeast side of the Test Cell area and wraps around to S.W. Military Drive. Two different floodwall options were considered with one using drilled shaft piers and another using sheet piles. The PDT adopted a levee configuration that would extend it up to S.W. Military Drive based on the cost estimates and the feasibility of incorporating a floodwall. A twelve-foot top width will provide a maintenance/patrol access route along the top with 3.5:1 (H:V) side slopes. The levee is aligned to provide adequate benching between the riverside toe and the Leon Creek channelization for stability reasons, as well as to avoid existing buildings on the Test Cell site. The grading of landside toe ditches to a proposed sump area will convey interior runoff. Also, included at the Test Cell area is a soil-bentonite slurry wall to provide additional seepage control along the full length of the levee. In order to mitigate hydraulic impacts from improving the Levee, Leon Creek would be channelized for approximately 2,850 linear feet and reduced to a 60-foot bottom width.

QHEI was used to assess the quality of the aquatic habitat and establish aquatic mitigation requirements due to the project channelization. Three sites, spread out along the length of the creek, were evaluated within the project area. QHEI scores (out of a possible 100) for the three sites were 56, 55, and 53 with a mean of 54.67. Although, the riparian habitat scored relatively high for Leon Creek, the absence of riffles and run habitats in this reach of Leon Creek limited the QHEI scores. This disruption of the sediment transport mechanism of the creek results in high sedimentation and extensive embeddedness of the creek's substrate, limiting aquatic diversity. Using the average QHEI value of 55, average annual habitat units (AAHU) were calculated, and presented in Table 1.

Table 1. Riparian Aquatic Average Annual Habitat Units (AAHU)

Target Year	0	1	15	25	50	Cumulative HU	AAHU
Interval (Years)	0	1	14	10	25		
HSI	0.55	0.55	0.55	0.55	0.55		
Acres	2.25	2.25	2.25	2.25	2.25		
Target Year HU	1.24	1.24	1.24	1.24	1.24		
Interval HU		1.24	17.36	12.40	31.0	62	1.2

The Service has designated the aquatic habitat within AOI-2 as Resource Category 3. Category 3 habitat is of high to medium value for the evaluation species and is relatively abundant on a national basis. The mitigation planning goal for this category is no net loss of habitat value while minimizing loss of in-kind values. Impacts to these aquatic resources should be avoided, minimized and/or compensated. Therefore, any mitigation plan chosen would need to create at least 1.2 AAHUs of riparian aquatic habitat.

The riparian zones in the Lower Leon Creek study area are diverse and range from mature stands of bottomland hardwood species to the south to pole-size stands of green ash, black willow, and cedar elm trees in the upper portions of the segment. The proposed channel improvements are located in the upper portion of this segment. The HSI values for the fox squirrel and Barred Owl for the Lower Leon Creek segment were both 0.12 providing limited habitat for each of these species. The factors limiting the quality of the riparian woodland include:

- Barred Owl habitat was poor (0.12), due to the low average dbh of overstory trees less than 10 inches, which reduces cover and reproductive values.

- Fox squirrel habitat value (0.12) was reduced by the lack of mast producing trees for available food.

Although it is of relatively low quality, the Service has designated the riparian woody vegetation habitat within AOI-2 as Resource Category 3 as well. Table 2 demonstrates that 3.1 AAHU's of riparian woody vegetation would be required for any mitigation plan.

Table 2. Riparian Woody Vegetation Average Annual Habitat Units (AAHU)

Target Year	0	1	15	25	50	Cumulative HU	AAHU
Interval (Years)	0	1	14	10	25		
HSI	0.12	0.12	0.20	0.20	0.20		
Acres	15.75	15.75	15.75	15.75	15.75		
Target Year HU	1.89	1.89	3.15	3.15	3.15		
Interval HU		1.89	44.10	31.5	78.75	156.24	3.1

Aquatic Mitigation

The aquatic mitigation for Leon Creek channel modifications will consist of replacing the existing 2.25 acres (2,850 linear feet) of homogeneous pool habitat resulting from the low water crossing at the downstream extent of the project area with a natural channel design pilot channel. The natural channel design component will include the placement of four rock vane structures to create a series of pool and riffle habitats along Leon Creek. The natural channel design concepts incorporated into the modified channel will increase the aquatic habitat quality by re-establishing the sediment transport mechanisms and providing structural habitat for aquatic vertebrate and invertebrate communities. Table 3 demonstrates that these improvements are expected to result in establishment of 1.8 AAHU of aquatic habitat.

Table 3: Natural Channel Design Expected AAHU

	Target Year	0	1	15	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	14	10	25		
Proposed NCD	HSI	0.00	0.72	0.77	0.78	0.80		
	Acres	2.25	2.25	2.25	2.25	2.25		
	Target Year HU	0.0	1.62	1.73	1.76	1.8		
	Interval HU		1.62	24.22	17.6	45	88.44	1.8

Riparian Woodland Mitigation

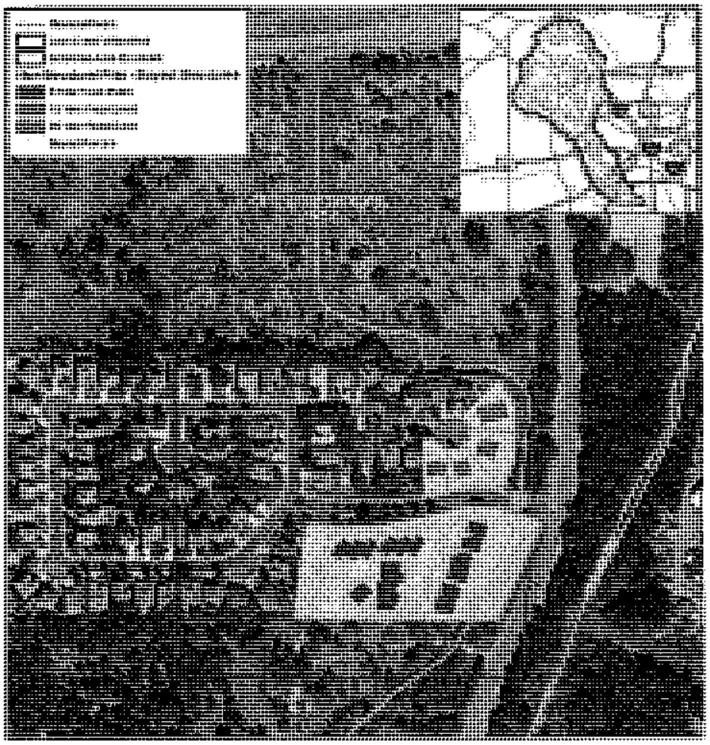
The mitigation of the riparian woodland would include replanting 6.44 acres of high quality, mast producing trees along the riparian corridor of Leon Creek. Table 4 demonstrates that the proposed mitigation would provide 3.3 AAHU of riparian woody vegetation habitat. These mast producing trees would provide adequate mast and cover for the fox squirrel and Barred owl.

Table 4: Natural Channel Design Expected AAHU

	Target Year	0	1	15	25	50	Cumulative HU	AAHU
	Interval (years)	0	1	14	10	25		
Proposed 30 Trees/acre	HSI	0.00	0.10	0.25	0.55	0.65		
	Acres	6.44	6.44	6.44	6.44	6.44		
	Target Year HU	0.0	0.64	1.61	3.54	4.19		
	Interval HU		0.64	22.54	35.43	104.75	163.36	3.3

Proposed Action –Buyout Component

AOI-4 is located south of Loop 1604 and west of Babcock Road. The area is subject to flooding from Babcock Creek. The proposed buyout alternative includes four single-family residential structures and 32 townhouses, all subject to damages from the 20 percent AEP event. The structures are located on five tracts totaling 3.85 acres (See Figure below).



The buy-outs would result in only minimal temporary adverse impacts to the natural environment. Trees adjacent to the structures should be preserved to extent possible, and following demolition and removal of debris, the disturbed areas should be replanted with grasses to stabilize the soil against erosion. Approximately 3.85 acres of floodplain lands would be available for use by the sponsor for open space uses.

Summary and Recommendations

The Service appreciates the efforts made by the Corps to consider fish and wildlife resources affected by the proposed action and does not object to the proposed action moving forward for the Leon Creek Interim Feasibility Study. The proposed mitigation plan would compensate for the implementation of the Levee Component of the proposed action. The Service and TPWD would like to request the opportunity to continue to work with the Corps during the design phase to further enhance the riparian woodland mitigation for the proposed actions.

The Service supports nonstructural alternatives whenever they are possible and agrees that the buy-out is not expected to require environmental mitigation other than compliance with best management practices during demolition to control dust emissions and surface erosion into the aquatic environment. Large trees should be avoided to the extent possible during demolition of the structures.

The Corps was considering a detention alternative in Government Canyon. The Service recommended not proceeding with a detention alternative in Government Canyon in our

November 10, 2009 PAL. The Service supports the recommendation of the Corps to remove this area from consideration for a structural alternative.

The Service has determined that there are no federally listed species within the current project area since the project area is limited to AOI-2 and AOI-4; therefore no adverse affects to listed species are expected to occur with implementation of the proposed action.

The Service appreciates the opportunity to assist in the planning of this project. If you have any questions or comments please contact Patrick Connor at (512) 490-0057.

Sincerely,

for Adam Zerrenner
Field Supervisor

Enclosures

cc: Tom Heger, Texas Parks and Wildlife Department, Austin, Texas

References Cited

Ohio Environmental Protection Agency. Qualitative Habitat Evaluation Index. http://tycho.knowlton.ohio-state.edu/qhei.html

U.S. Fish and Wildlife Service. 1980. The Habitat Evaluation Procedures. USDI Fish and Wildlife Service, Ecological Services Manual

CULTURAL RESOURCES

Under the National Historic Preservation Act of 1963, as amended, for any proposed undertaking the USACE must consider the impacts of that undertaking on cultural resources. Cultural resources include properties of traditional cultural significance, above ground resources such as buildings and structures, and archaeological sites. These resources must be identified, evaluated against the criteria set forth in 36CFR Part 60.4, and determined eligible for inclusion in the National Register of Historic Places (NRHP). The government must then assess the potential of the undertaking to have an adverse effect to resources meeting the criteria for inclusion in the NRHP. Because of the large size of the Leon Creek watershed, data collection to date has been limited to previously recorded sites within the vicinity of the proposed project features as an indicator of the level of effort that will be necessary to fully investigate alternative project locations. During the Preconstruction Engineering and Design (PED) Phase of this study, a detailed cultural resources survey will be undertaken to identify and evaluate cultural resources that may be affected by the Recommended Plan. This survey will occur early in PED, but only after enough design has been completed so that the footprint of impacts can be evaluated. By limiting the area of survey, USACE is able to minimize impacts to resources that would not otherwise be affected by construction. In addition, features such as a slurry wall that require deep excavation for construction would require deep excavation for cultural resources survey. Excavating a deep trench in a location other than that of the slurry wall or other deeply buried feature would result in destabilizing an area that would otherwise not be excavated. Therefore, USACE has decided that it is best to wait on a greater level of design before conducting the cultural resources survey.

Several sites have been found in close proximity to the project area; however only one has potential to be considered significant. The likelihood of finding small cultural resources sites within the project area are high, however, the likelihood of finding a significant site within the construction footprint is much lower. The cost of the survey has been accounted for in the overall project cost. Further, contingencies have been included in the project cost to cover the cost should significant cultural resources be found that must be mitigated.

Limited consultation has been conducted with the State Historic Preservation Office (SHPO) or with Native American Tribes who historically used the region. Initial letters informing these stakeholders of USACE's plan to study the flooding issues in the region were sent in February of 2008. USACE has consulted with SHPO on the recommended plan. SHPO has concurred with USACE's plan to conduct a cultural resources survey early in PED. Both SHPO and the tribes will be consulted during PED about the findings of the survey and any action USACE may be required to take as a result of the survey.

RECOMMENDED PLAN

Non Structural Elements

The Non Structural element of the Recommended Plan for the Leon Creek study consists of the buy-out of four single family residences and 32 townhomes. The buildings and structures identified in the buy-out date from between 1994 and 1995. As such, they do not meet the criteria for inclusion in the NRHP and further cultural resources evaluation will not be required for the above ground cultural resources. An archaeological survey is not likely to be necessary for this buy out. An archaeological survey seeks to discover intact soil deposits that may contain evidence of past human activity. The construction of these homes and townhouses will have disturbed any shallow deposits. The purchase and remove of the structure in turn will not disturb the ground deeper than the original construction already has. Therefore, intact soils are not likely to be encountered.

Structural Alternatives

The structural portion of the Recommended Plan consists of adding a levee along Leon Creek from cross-section 85024 to 87627. The levee would run along the east side of Leon Creek in order to prevent damages from occurring for the 1% Annual Exceedance Probability (AEP) storm. The levee elevation would range from 640 feet on the downstream end to 649 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is 16.87 feet. In addition, for mitigation purposes, the channel was widened upstream of the Military Highway Bridge. From its origin, a 40-foot bottom width channel would run to a point immediately downstream of this bridge, and transition to 80-foot bottom width adjacent to the levee.

Archaeological Resources: The area surrounding the portion of the channel to be improved under this alternative is relatively undisturbed. Improvements within the channel required for hydraulic mitigation will remain within the existing channel and consist of creating a uniform channel width through the removal of interior benches or shelves. However, the area should be surveyed, including an examination of the cut bank, to ensure no significant archaeological resources are present prior to modification of the channel.

Construction of the levee has a higher potential to impact buried cultural resources than the channel modification. Deep excavations will be necessary for the footer of the levee. The area should be surveyed using a backhoe to look for deeply buried archaeological sites prior to construction. In addition, if borrow material for the levee is taken from anywhere other than a commercial borrow site, the planned borrow area must be surveyed for cultural resources, as well.

Architectural Resources: Previous investigations conducted by USACE on the Leon Creek watershed indicate that two potential historic resources exist within ½ mile of the proposed Recommended Plan location. Both resources consist of domestic structures dating at least to 1903 and may date to the mid 1800s. However, neither resource will be physically impacted by the proposed construction nor should adverse impacts to viewshed result from the channel modification or levee construction. No architectural surveys should be required to implement the Recommended Plan.

APPENDIX E
REAL ESTATE PLAN

LEON CREEK FLOOD RISK MANAGEMENT FEASIBILITY PROJECT

SAN ANTONIO RIVER AUTHORITY
CITY OF SAN ANTONIO (BEXAR COUNTY) TEXAS

DATE OF REPORT

January 29, 2014

PREPARED BY

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

This Real Estate Plan has been prepared in accordance with ER 405-1-12 dated 1 May 1998.

PREPARED BY:

Thurman Schweitzer
Chief, Realty Services Section
Fort Worth District, Corps of Engineers

RECOMMENDED BY:

Roger Jennings
Chief, Planning & Appraisal Branch
Fort Worth District, Corps of Engineers

PURPOSE

This Real Estate Plan has been prepared in support of the feasibility study that describes the lands, easements, right of way, relocation, and disposal (LERRD) required for the Leon Creek Flood Risk Management Feasibility Study in the City of San Antonio (Bexar County) Texas. The project includes both structural and non-structural alternatives, located at two locations along Leon Creek or its tributaries. In general Leon Creek is located on the north and west side of San Antonio.

- Alternative (2B) is structural and located in the southwest quadrant of the intersection of Southwest Military Drive (Highway 13) and Quintana Road, immediately west of the Port Authority of San Antonio and Lackland Air Force Base. This alternative entails the construction of a levee and modification to the Leon Creek channel. The standard estates for this alternative are: fee simple, channel improvement easement, flowage easement (occasional flooding), drainage ditch easement, and temporary work area easement.

The Recommended Plan for Alternative (2B) provides for the construction of a levee designed to protect against the 1% AEP event. This feature includes 2,850 linear feet of channelization immediately downstream of the levee to mitigate for slight rises in water surface elevations caused by the levee. The channel work will utilize natural design parameters, including in-channel habitat components, in order to be self-mitigating in terms of aquatic impacts.

- Alternative AOI-4 is non-structural and includes the acquisition of 4 single family residences and 32 condominiums that are adjacent to Huesta Creek. This alternative is located south of Loop 1604 and west of Babcock Road. The standard estate for this alternative is fee simple.

The Recommended Plan for Alternative AOI-4 includes the permanent removal of 4 single-family homes and 32 condominiums located within the 4% AEP floodplain.

The San Antonio River Authority (SARA) is the local sponsor and will acquire all LERRD. The feasibility study is authorized by the Guadalupe and San Antonio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, dated 11 March 1998, which reads:

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session, and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply, and allied purposes on the Guadalupe and San Antonio Rivers in Texas."*

LAND, EASEMENTS, AND RIGHTS-OF-WAY FOR THE RECOMMENDED PLAN

The subject property is located within the City of San Antonio in Bexar County, Texas. The recommended plan is a combination of structural and non-structural alternatives, located at two separate areas along Leon Creek or its tributaries.

- The first alternative is structural and located in the southwest quadrant of the intersection of Southwest Military Drive (Highway 13) and Quintana Road, immediately west of the Port Authority of San Antonio. This alternative entails the construction of a levee, development of a sump area, modification to the Leon Creek channel, mitigation land (in the channel), a drainage ditch, and includes staging, temporary work areas, and disposal site. This alternative includes 55.939 acres as identified below:

- 6.441 acres in fee (mitigation land)
    - Public ownership
        - San Antonio River Authority
        - Port Authority of San Antonio
    - Private ownership
        - Ruiz
        - Maples
- 4.48 acres in flowage easement (occasional flooding) – sump area
    - Public ownership
        - Port Authority of San Antonio
- 9.837 acres in channel improvement easement
    - Public ownership
        - San Antonio River Authority
        - Port Authority of San Antonio
    - Private ownership
        - Ruiz
        - Maples
- 22.747 acres in flood Protection levee easement
    - Public ownership
        - Port Authority of San Antonio
- 0.034 acres in drainage ditch easement
    - Public ownership
        - Port Authority of San Antonio
- 12.4 acres in temporary work area easement (staging, disposal, sump, and drainage areas)
    - Public ownership
        - Port Authority of San Antonio

- Alternative (AOI-4) is non-structural and totals 3.85 acres that includes the fee simple acquisition of 4 single family residences and 32 condominiums that are adjacent to Huesta Creek. This alternative is located south of Loop 1604 and west of Babcock Road.
    - Single Family – 0.82 acres
    - Condominiums – 3.03 acres

The following standard estates are applicable to this project.

- 1. Fee Simple
- 6. Flowage Easement (Occasional Flooding)
- 8. Channel Improvement Easement
- 9. Flood Protection Levee Easement
- 10. Drainage Ditch Easement
- 15. Temporary Work Area Easement

Access to both alternatives is from public roads.

COST SHARE OF PROJECT

The cost-share for the project is estimated at 65% Federal and 35% local. The estate to be acquired by the local sponsor is fee simple, channel improvement easement, and/or temporary work area easement. Table 1 identifies the estates, number of acres in each, and estimated value of the land that will be acquired by SARA.

TABLE 1
LAND, EASEMENTS, and RIGHTS OF WAY
Leon Creek Flood Risk Management Project
San Antonio (Bexar County) Texas

PROJECT PURPOSE: Flood Risk Management

PROJECT FEATURE: Flood Risk Management

ESTATE	ACRES	ESTIMATED VALUE
Non-Structural Alternative		
Fee Simple	3.85	$3,266,615
Structural Alternative		
Fee Simple	6.441	$15,458*
Flood Protection Levee Easement	22.747	$1,177,157
Channel Improvement Easement	9.837	$19,674
Temporary Work Area Easement	12.4	$310,500
Flowage Easement (Occasional Flooding)	4.48	$231,840
Drainage Ditch Easement	0.034	$1,760

*Includes Damages/Severances

NON-STANDARD ESTATES

This project does not have a non-standard estate.

EXISTING FEDERAL PROJECT

There is no other existing Federal project.

FEDERALLY OWNED LAND

There is no federally owned land associated with this project.

NAVIGATIONAL SERVITUDE

Although Leon Creek may be considered navigable under the State of Texas definition, it is not navigable for commerce. As such, Federal Navigational Servitude is not applicable.

PROJECT AREA

Maps depicting the project area are attached.

FLOODING OF PROJECT AREA

There is no induced flooding as a result of the project.

BASELINE COST ESTIMATE FOR REAL ESTATE

Values included in the baseline cost estimate are taken from the Gross Appraisal, Leon Creek Flood Risk Management, dated September 12, 2013.

01	Land & Damages
01.23	Construction Contract Documents
01.23.03	Real Estate Analysis Documents
01.23.03.01	Real Estate Planning Documents, 25% based on reasonable cost estimates
01.23.03.02	Real Estate Acquisition Documents, 25% based on reasonable certainty
01.23.03.03	Real Estate Condemnation Documents, 20% based on the expectation of at least 10% will be condemned
01.23.03.05	Real Estate Appraisal Documents, 20% based on reasonable certainty of contract costs
01.23.03.06	Real Estate PL 91-646 Asst. Documents, 10% based on reasonable certainty
01.23.03.13	Real Estate Facility/Utility Relocation, 42.26% based on reasonable certainty
01.23.03.15	Real Estate Payment Documents, based on contingencies (20%) assigned by the Appraiser in the Gross Appraisal
01.23.03.17	Real Estate LERRD Accounting Documents, 20% based on reasonable certainty regarding accounting requirements

Cost estimates for the land needed for the project is presented in Table 2. The estimates are presented in the standard Code of Accounts from M-CACES Model Database, October 1994.

Table 2
Real Estate Cost Estimates
Project: Leon Creek Flood Risk Management
Location: San Antonio (Bexar County) Texas

ACCOUNT	DESCRIPTION	ESTIMATE	CONTINGENCIES
01	Land & Damages		
01.23	Construction Contracts Documents		
01.23.03	Real Estate Analysis Documents		
01.23.03.01	Real Estate Planning Documents		
	Planning by Non Federal Sponsor	$39,000	$9,750
	Review of Non Federal Sponsor	$15,600	$3,900
01.23.03.02	Real Estate Acquisition Documents		
	Acquisitions by Sponsor	$312,000	$78,000
	Review of Sponsor	$15,600	$3,900
01.23.03.03	Real Estate Condemnation Documents		
	Condemnation by Sponsor	$120,000	$12,000
	Review of Sponsor	$2,000	$200
01.23.03.05	Real Estate Appraisal Documents		
	Appraisal by Sponsor	$195,000	$39,000
	Review of Sponsor	$15,600	$3,120
01.23.03.06	Real Estate PL 91 646 Asst Documents		
	PL 91-646 Asst by Sponsor	$68,000	$6,800
	Review of Sponsor	$13,600	$1,360
01.23.03.13	Real Estate Facility/Utility Relocation		
	Payment by Sponsor	$450,239	$190,271
	Review of Sponsor	$11,200	$2,800
01.23.03.15	Real Estate Payment Documents		
	Payment by Sponsor(LERRD)	$5,023,004	$1,004,601
	Payment by Sponsor (PL 91-646)	$302,500	$60,500
	Review of Sponsor	$15,600	$3,120
01.23.03.17	Real Estate LERRD Credit Documents	$15,600	$3,120
	Total Admin & payment	$6,614,543	
	Total contingencies		$1,422,442
	Grand Total	$8,036,985	

RELOCATION ASSISTANCE PROGRAM PL 91-646

The non-structural alternative will include the buy-out of 4 single family residences (thought to be owner occupied) and 32 condominiums (tenant occupied). No businesses will be acquired. All relocation will be in accordance with PL 91-646.

MINERAL AND TIMBER ACTIVITY

There is no known mineral exploration or extraction activity in the area. Because of the limited potential for production in the area, the value of the mineral estate is considered nominal and is included in the value of the land. There is no merchantable timber present.

NON-FEDERAL SPONSOR'S CAPABILITY TO ACQUIRE LERRD

The local sponsor (SARA) is responsible for acquiring LERRD. A checklist has been prepared in accordance with Chapter 12 of ER 405-1-12 and is attached. The local sponsor is aware of the requirements of PL 91-646, as amended, and the requirements for documenting expenses for the purpose of LERRD credit. The local sponsor will also be advised of the risks associated with acquiring LERRD before execution of the PCA. The Corps will work with the sponsor throughout the project, to the extent appropriate and allowable; to ensure that there is understanding of the Federal real estate principles. Action will also be taken to address any policy issues that could significantly impact the project.

ZONING ORDINANCES

There are no special Zoning Ordinances proposed for enactment with the project.

MILESTONES FOR REAL ESTATE ACQUISITION

Milestones are based on the Project Partnership Agreement being signed.

• Transmittal of ROW drawings	30 days after PPA signed
• Obtain title evidence	60 days after transmittal of ROW drawings
• Obtain appraisals & review	45 days after obtaining title evidence
• Start negotiations	30 days after obtaining appraisals & review
• Conclude negotiations	90 days after start of negotiations
• Conclude closings	45 days after concluding negotiations
• Conclude condemnations	180 days after condemnation process started
• Certify availability of LERRD	20 days after condemnations concluded
• Review LERRD credit request	10 days after receiving LERRD certification
• Approve LERRD credit	45 days after receiving all LERRD documentation

FACILITY OR UTILITY RELOCATIONS

The Non-Structural portion of the plan indicates that all residential utilities will be capped and no facility or utility relocations will occur. The structural portion of the plan indicates that 28 utilities will be relocated. Pursuant to guidance in Real Estate PGL No. 31, the estimated cost of utility relocations does not exceed 30% of the total project cost, therefore in lieu of an attorney s opinion of compensability, the following real estate assessment is provided. The utility facilities affected by the project have been determined to be the type that generally would be eligible for compensation under the substitute facilities doctrine. In addition, sufficient data (see attached Utility Map) has been provided to demonstrate that the identified owner may have a compensable interest in the property. For these reasons, the cost of providing substitute facilities is included in this Real Estate Plan. The non-Federal sponsor is advised that the inclusion of the substitute facilities costs in the REP or other use feasibility study estimates is for planning and budgeting purposes only and does not constitute a preliminary or final determination of compensability by the agency regardless of whether the cost of substitute facilities are reflected in the feasibility study documents. Use of this real estate assessment does not eliminate the need to obtain a final attorney's opinion of compensability prior to execution of the PPA.

CONTAMINANTS ON REAL ESTATE ACQUISITIONS

Reports dated February 5, 2007 and April 23, 2007, prepared in accordance with ASTM E1527-05 (American Society for Testing and Materials, Standard Practice for Environmental Site Assessments) indicate that there is no known or suspected hazardous, toxic, and/or radioactive waste (HTRW) sites requiring remediation. Although none are expected, due diligence requires that actual field testing, conducted during demolition, could reveal that some of the structures contain materials for which special handling and disposal would be required.

OPPOSITION BY LANDOWNERS IN PROJECT AREA

No opposition has been stated by property owners.

OTHER REAL ESTATE ISSUES

No other Real Estate issues are known to exist.

CHECKLIST TO ACQUIRE LERRD (SARA)

I. Legal Authority

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes**
b. Does the sponsor have the power of eminent domain for this project? **Yes**
c. Does the sponsor have "quick-take" authority for this project? **Yes**
d. Are any of the lands/interested in land required for the project, located outside the sponsor's political boundary? **No**
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **No**

II. Human Resource Requirements

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended? **No**
b. If the answer to II (a) is yes, has a reasonable plan been developed to provide such training? **Not applicable**
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes**
d. Is the sponsor's projected in-house staffing level sufficient considering other work load, if any, and the project schedule? **Yes**
e. Can the sponsor obtain contractor support, if required, in a timely fashion? **Yes**
f. Will the sponsor likely request USACE assistance in acquiring real estate? **No**

III. Other Project Variables

a. Will the sponsor's staff be located within reasonable proximity to the project site? **Yes**
b. Has the sponsor approved the project/real estate schedule/milestones? **Pending**

IV. Overall Assessment

a. Has the sponsor performed satisfactorily on other USACE projects? **Yes**
b. With regard to this project, the sponsor is anticipated to be: **Fully Capable**

V. Coordination

a. Has this assessment been coordinated with the sponsor? **Yes**
b. Does the sponsor concur with this assessment? **Pending**

Information provided to Mr. Claude Harding (Real Estate Manager) - SARA

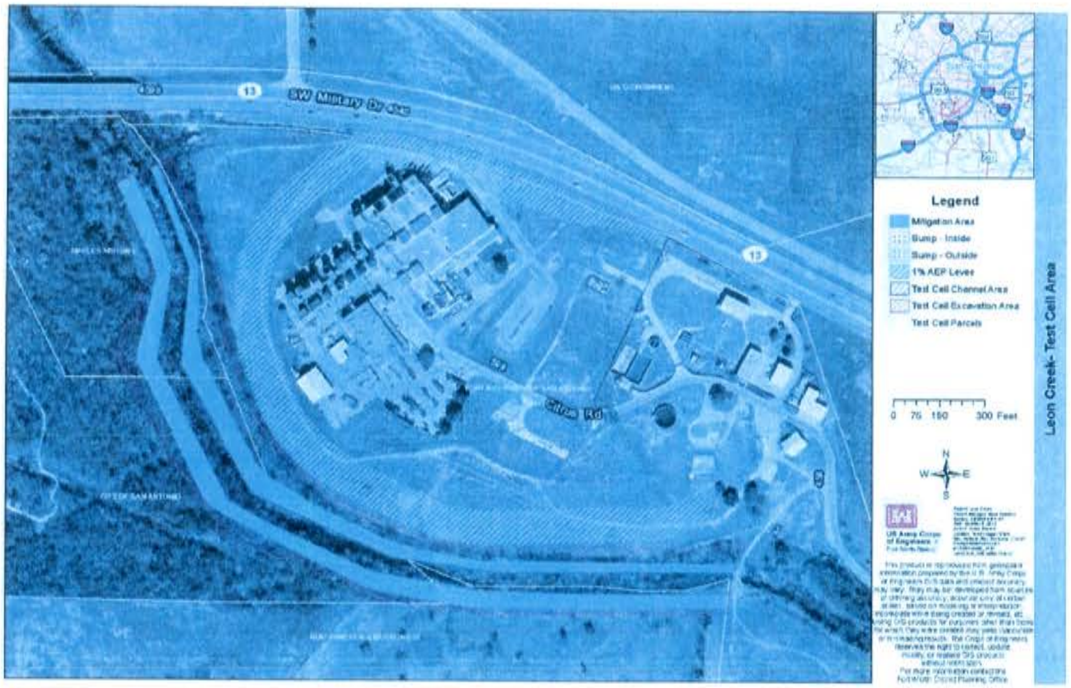
Prepared by

Thurman Schweitzer
Chief, Realty Services Section

Reviewed and approved by:

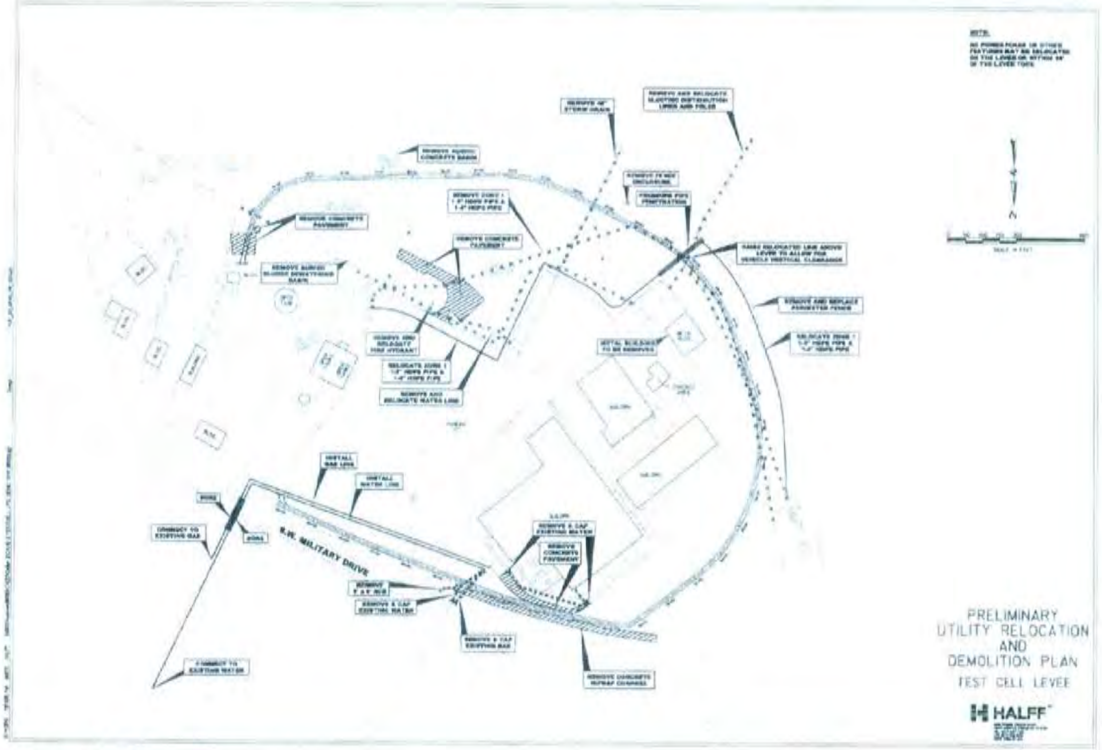
Roger Jennings
Chief, Planning & Appraisal Branch

Project Maps



Structural Alternative

Non-Structural Alternative



Utility Relocation Map

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

REPLY TO
ATTENTION OF

CESWF-RE-P

30 January 2014

MEMORANDUM FOR CESWF-PM-C

SUBJECT: Transmittal of Updated Real Estate Plan for Leon Creek Flood Risk Management Feasibility Study in San Antonio (Bexar County), TX

1. As requested by Nova Robbins, CESWF-PM-C, enclosed is the Real Estate Plan (REP) for the subject project.

2. The REP has approved. If there are questions, please contact Thurman Schweitzer at 817-886-1238.

Encl
1. Leon Creek REP

ROGER JENNINGS
Chief, Planning and Appraisal Branch
Real Estate Division

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

1.0 A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR, Inc.) along Leon Creek in San Antonio, Texas at the request of the U.S. Army Corps of Engineers, Fort Worth District, Environmental Design Branch (CESWF-PER-D). The purpose of the search was to identify any sites where hazardous substances or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water which might be encountered during construction of flood control projects in the subject area. Two final reports listing all sites found in the records search were submitted on February 5, 2007 and April 23, 2007 by EDR, Inc. according to requirements of ASTM Standard Practice for Environmental Site Assessments, E1527-05, and are included as an attachment to this report. The two EDR reports respectively address the upper portion of Leon Creek north and west of IH 410 in San Antonio, and the lower portion south and east of IH 410. The complete search area extended in a 1/2 mile wide corridor, beginning at the headwaters of Leon Creek northwest of San Antonio at latitude (north) 29.67884 degrees and longitude (west) 98.71734 degrees, and ending downstream at the confluence of Leon Creek and the Medina River south of San Antonio at latitude (north) 29.26443 degrees and longitude (west) 98.49435 degrees.

2.0 Sites were identified in the reports that could impact the design and construction of flood control projects for Leon Creek. Locations of these sites relative to the current channel of Leon Creek are shown on the accompanying EDR report figures. Some sites are of greater concern and should be avoided in the design and construction of any flood control improvements if possible. Sites of greatest concern were noted in the following databases listed in the EDR reports: Solid Waste Facility/Landfill (SWF/LF), Closed Landfill Inventory (CLI), Emergency Response Notification System (ERNS), Hazardous Materials Incident Report System (HMIRS), Leaking Underground Storage Tank Incident Reports (LTANKS), Spills (TX SPILLS), Texas Voluntary Cleanup Program (TX VCP) and Enforcement (ENF). These sites are listed in Section 4.0 at the end of this report with reference to inclusion in the EDR reports as either being in the upper (north) portion or the lower (south) portion of Leon Creek.

Sites which should specifically be avoided if possible are those listed in the SWF/LF, CLI, and LTANKS databases. Unknown material placed in these closed or inactive landfill sites could negatively impact construction as well as be potentially hazardous pending further characterization. Residual soil or groundwater contamination by petroleum products may remain at leaking underground storage tank sites listed in the LTANKS database, and although contamination in situ may not be at hazardous levels from an environmental standpoint, construction activities impacting these sites might require implementation of supplemental worker protection measures and special handling of excavated material.

Other sites of possible concern in this report include those listed in the ERNS, HMIRS, TX SPILLS, and ENF databases. An unknown type of oil was spilled at one site listed in the ERNS database, and uncovered barrels of motor oil and antifreeze released onto the ground were reported at another. Two sites were listed in the HMIRS database, however further information regarding any potential residual contamination was not found. Abandoned drums released an estimated 115 gallons of cement additives at one site listed in the TX SPILLS databases and a spill of an estimated 280 gallons of diesel fuel occurred at another, with cleanup at each reported as inadequate. Formal written Notices of Violation were issued by the Texas Commission on Environmental Quality (TCEQ) at two sites listed in the ENF database for waste violations.

3.0 The point of contact with CESWF-PER-D regarding this report is Barry Vercoe, 817-886-1876.

4.0 Site Summary List

SWF/LF, CLI Sites (North)

Map Location: 26-20
Address: 5930 Heliport Drive, San Antonio, TX 78228
Property Name: N/A
Status: 5 acres, waste types unknown
Latitude/Longitude: N29.450000, W98.633333

SWF/LF, CLI Sites (South)

Map Location: 7-1
Address: 9800 West Commerce Street, San Antonio, TX 78227
Property Name: N/A
Status: 36 acres, waste types unknown
Latitude/Longitude: N29.430833, W98.616667

SWF/LF Sites (South)

Map Location: 24-7
Address: 8423 Quintana Road, San Antonio, TX 78211
Property Name: Darling International Liquid Transfer Station
Status: Inactive
Latitude/Longitude: N29.3378300, W98.58550

Map Location: 30-9
Address: 9782 Somerset Road, San Antonio, TX 78211
Property Name: Somerset Road Recycling Center
Status: Active
Latitude/Longitude: N29.3211111, W98.58527

CLI Sites (South)

Map Location: 3-1
Address: 9800 West Commerce Street, San Antonio, TX 78227
Property Name: West S.A. #53
Status: N/A
Latitude/Longitude: N29.435833 W98.622833

Map Location: 10-1
Address: 1210 Pinn Road, San Antonio, TX 78227
Property Name: N/A
Status: 8.80 acres, waste types unknown
Latitude/Longitude: N29.429167, W98.619167

ERNS Sites (North)

Map Location: 34-20
Address: 4706 Hidden Creek, San Antonio, TX 78238
Property Name: N/A

ERNS Sites (South)

Map Location 20-7
Address: 4648 Southwest Military Drive, San Antonio, TX 78242
Property Name: ATI Automotive

HMIRS Sites (North)

Map Location: 35-20,21
Address: 6850 Ingram Road, San Antonio, TX 78238
Property Name: Ingram Mart

Map Location: 41-21
Address: 7131 Culebra, San Antonio, TX 78251
Property Name: Phillips Petroleum Company

LTANKS Sites (North)

Map Location: 4-4
Address: 24152 IH 10, Leon Springs, TX 78257
Property Name: Rudolphs Grocery
Status: Soil contamination only, requires full site assessment and RAP
Final concurrence issued, case closed

Map Location: 10-10
Address: 6448 Camp Bullis Road, Leon Springs, TX 78257
Property Name: Fisher Millwork
Status: No groundwater contamination, no apparent threats or impacts to receptors
Final concurrence issued, case closed

Map Location: 18-18
Address: 8022 Bandera Road, San Antonio, TX 78250
Property Name: Joe W. Conrad
Status: Soil contamination only, requires full site assessment and RAP
Final concurrence issued, case closed

Map Location: 21-18

Address: 7101 Eckhert Road, San Antonio, TX 78238
Property Name: Tony McComas Inc.
Status: Soil contamination, no remedial action plan required
Final concurrence issued, case closed

Map Location: 27-20
Address: 5411 Grissom, San Antonio, TX 78238
Property Name: SNG Diamond Shamrock 2468
Status: Assessment incomplete, no apparent threats or impacts to receptors
Final concurrence issued, case closed

Map Location: 39-21
Address: 7203 Culebra Road, San Antonio, TX 78251
Property Name: Potranco Exxon Shop 62018
Status: Groundwater impacted, no apparent threats or impacts to receptors
Final concurrence issued, case closed

Map Location: 40-21
Address: Potranco Road, San Antonio, TX
Property Name: Rodger Ranch
Status: Soil contamination only, requires full site assessment and RAP
Final concurrence issued, case closed

Map Location: 43-21
Address: 7038 Culebra Road, San Antonio, TX 78238
Property Name: Fire Station 35
Status: Soil contamination only, requires full site assessment and RAP
Final concurrence issued, case closed

LTANKS Sites (South)

Map Location: 6-1 (2 Sites)

Address: 440 Pinn Road, San Antonio, TX 78227
Property Name: Olmos Construction, Inc.
Status: Impacted groundwater within 500 feet - 1/4 mile to the southwest
Final concurrence Issued, case closed

Address: 440 Pinn Road, San Antonio, TX 78227
Property Name: Pinn Road Landfill
Status: Minor soil contamination, does not require a RAP
Final concurrence Issued, case closed

Map Location: 18-4 (8 Sites)

Address: Lackland Air Force Base, Building 2886, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: No groundwater impact, no apparent threats or impacts to receptors
Final concurrence Issued, case closed

Address: Lackland Air Force Base, Building 5008A, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: Groundwater impacted, no apparent threats or impacts to receptors
Final concurrence Issued, case closed

Address: Lackland Air Force Base, Building 1525, San Antonio, TX 78236
Property Name: Lackland Air Force Base AAFES Service Station ST26
Status: Groundwater impact, public/domestic water supply well within 1/4 - 1/2 mile
Site assessment

Address: Lackland Air Force Base, Building 5023, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: Groundwater impacted, no apparent threats or impacts to receptors
Final concurrence pending documentation of well plugging

Address: Lackland Air Force Base, Building 5005, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: Groundwater impact, public/domestic water supply well within 1/4 - 1/2 mile
Final Concurrence Issued, case closed

Address: Lackland Air Force Base, Building 9269, San Antonio, TX 78227
Property Name: Lackland Air Force Base
Status: Soil contamination only, requires full site assessment and RAP
Final concurrence Issued, case closed

Address: Lackland Air Force Base, Building 4895, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: No groundwater impact, no apparent threats or impacts to receptors
Site assessment

Address: Lackland Air Force Base, Building 1415, San Antonio, TX 78236
Property Name: Lackland Air Force Base
Status: Groundwater impacted, no apparent threats or impacts to receptors
Final concurrence Issued, case closed

Map Location: 28-9
Address: 9089 New Laredo Highway, San Antonio, TX 78208
Property Name: Welcome Travelers
Status: Soil contamination, no remedial action required
Final concurrence issued, case closed

TX SPILLS Sites (North)

Map Location: 25-20
Address: 6449 Low Bid Lane, San Antonio, TX 78250
Property Name: N/A

TX SPILLS Sites (South)

Map location 16-3

Address: 6428 Marcum Drive, San Antonio, TX 78227
Property Name: Hall Trucking

TX VCP Sites (South)

Map Location: 17-4
Address: 5827 Highway 90 West, San Antonio, TX 78227
Property Name: Levi Strauss & Company Facility 614F

ENF Sites (North)

Map Location: 17-18
Address: 8030 Mainland Drive, San Antonio, TX 78250
Property Name: Econo Auto Painting

ENF Sites (South)

Map Location: 8-1
Address: 543 Pinn Road, San Antonio, TX 78227
Property Name: Stop N Go 1543

In April 2008 PER-D personnel retained the services of Environmental Data Resources (EDR) to conduct a data base search of the Jet Engine Test Cell, located near SW Military Drive and Leon Creek. EDR conducted the search in accordance with ASTM E1527. The EDR search identified numerous areas of concern occupied by holding tanks or which may have been spill sites.

In 2013 PER-D conducted an on-site Phase I Environmental Site Assessment to determine if the areas of concern merit additional attention. The Ph I ESA report assessing the site conditions follows. Based on the data base searches and additional materials included in the report no further investigations are warranted.

Leon Creek Interim Feasibility Study
Kelly Aviation Center Jet Engine Test Cell Facility
Port San Antonio
Environmental Site Assessment
November 2013

1.0 A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR, Inc.) in the vicinity of the Kelly Aviation Center Jet Engine Test Cell facility (Test Cell) located along Leon Creek in San Antonio, Texas at the request of the U.S. Army Corps of Engineers, Fort Worth District, Regional Planning and Environmental Center (CESWF-PEC). The purpose of the records search was to identify any sites where hazardous substances or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water which might be encountered for a proposed flood protection project for the Test Cell facility. The proposed project includes construction of an earthen levee, concrete floodwall, and surface water drainage sump on the subject property and channel improvements along Leon Creek adjacent to the property. A final report listing all such sites found in the records search was submitted on October 29, 2013 by EDR, Inc. according to requirements of ASTM Standard Practice for Environmental Site Assessments, E1527-05, and is included in Appendix C of this report. The complete search area extended in a one mile radius of the Test Cell facility and was centered at latitude (north) 29.36370 degrees and longitude (west) 98.58350 degrees.

2.0 Sites were identified in the report that could impact the design and construction of the proposed flood control project. Details on these sites and their locations relative to the Test Cell facility (target property) are provided in the EDR Radius Map Report included in Appendix C of this report.

The facility itself, identified on the EDR Overview and Detail Maps at location "A", was reported in the Resource Conservation and Recovery Act – Small Quantity Generator (RCRA-SQG), Facility Index System/Facility Registry System (FINDS), and Industrial and Hazardous Waste (Ind. Haz Waste) databases. These listings indicate that this facility generates between 100 kg and 1000 kg of hazardous waste per month and is included in the RCRA national information system (RCRAInfo) administered by the U.S. Environmental Protection Agency (EPA) and in records maintained in the Texas Commission on Environmental Quality – Agency Central Registry (TX-TCEQ ACR). No release of hazardous substances or petroleum products to the environment by the facility was reported within these listings.

The facility and surrounding property was depicted on the EDR Overview and Detail Maps as being entirely within Department of Defense (DOD) site boundaries and reported as being under DOD ownership or administration. As part of the redevelopment of Kelly Air Force Base, closed in 2001 by order of the Base Realignment and Closure (BRAC) Commission in 1995, the property is now under the jurisdiction of Port San Antonio and the Test Cell facility operates as part of the Lockheed Martin Kelly Aviation Center.

Several sites were reported in the Closed Landfill Inventory (CLI) database maintained by the TCEQ within a ¼ to ½ mile radius of the target property. The nearest closed landfills, identified as Leon Creek/Military and Schiek, are depicted respectively on the EDR Overview and Detail Maps at locations “4” and “5” within ¼ mile of the Test Cell facility. The Leon Creek/Military site was reported to have accepted household waste, construction demolition debris, and brush, and as such should not have negatively impacted the target property or Leon Creek. The Alamo Area Council of Governments (AACOG) indicates the location of this site to have been across SW Military Drive from the target property, depicted on their map included in Appendix C of this report, with the designation “U2799” as per TCEQ listings of unnumbered municipal solid waste (MSW) landfills. The Schiek site was reported to have opened in 1959 and the waste types disposed thereon were not listed. Since this site was located across Leon Creek from the target property, any potential negative impacts should be limited only to the area in which channel improvements are proposed. Two other closed landfills, identified as the Pearsall Road Landfill and Kelly 13 D-3 SWMU4, are depicted respectively on the EDR Overview Map at locations “7” and “8” within ½ mile of the test cell facility. The Pearsall Road Landfill was reported to have closed in 1969 and the waste types disposed thereon were not listed. Since this site was located across Leon Creek and at some distance from the target property, no potential impacts to any aspects of the proposed project should be expected. The Kelly 13 D-3 SWMU 4 site, located across Leon Creek and on the opposite side of SW Military Drive from the target property, was reported to have opened in 1945 and to have accepted household waste, construction demolition debris, industrial waste, and agricultural waste, some of which was likely hazardous. This site was previously identified as an Installation Restoration Program (IRP) site and was the subject of a Remedial Investigation (RI) according to a Decision Document (DD) prepared by Halliburton NUS Environmental Corporation in August 1992, which identified this site as “D-8” and is included in Appendix B of this report. Although results of the RI indicated organic and inorganic contaminants in the soil at this site, little impact to groundwater at the site and no impact to surface water in Leon Creek immediately downstream of the site was found, so no potential impacts to the proposed project should be expected.

One site was reported in the EDR Historical Auto Stations database within ¼ mile of the target property. This site, identified as 4648 W Military Dr and depicted on the EDR Overview and Detail Maps at location “6”, did not have any further information reported and was listed on the basis of an EDR search of business directories. Since this site was located across Leon Creek from the target property, any potentially negative impacts should be limited only to the area in which channel improvements are proposed.

A Historical Topographic Map Report and Aerial Photo Decade Package were submitted by EDR, Inc. on October 28, 2013 and October 30, 2013 respectively for the area in the vicinity of the target property and are included in Appendix C of this report. No additional sources of potential environmental contamination of the property were noted on the topographic maps or aerial photographs beyond those identified in the Radius Map Report.

3.0 A site visit was conducted at the target property with Mr. Joe Tellez, Project Geologist with TEAM Integrated Engineering, Inc. on November 7, 2013 by Dr. David Bowersock and Mr. Barry Vercoe from CESWF-PEC. Mr. Tellez identified the location of IRP sites and former Industrial Wastewater Treatment Plant (IWTP) structures, the Environmental Process Control Facility (EPCF) which replaced the IWTP, and groundwater recovery system wells and associated piping that could potentially impact construction of the proposed earthen levee and surface water drainage sump. Surface concrete pavement and slabs remaining from former IWTP structures were found as shown on the Preliminary Utility Relocation and Demolition Plan prepared by Halff Associates, Inc. Photographs of features and conditions noted at the property during the site visit are included in Appendix A of this report.

A nonstructural component is proposed in addition to the levee sand the channel modification at the Jet Engine Test Cell Facility. The nonstructural component consists of the permanent evacuation of four single-family residences and 32 townhouses. Demolition activities associated with the Buyout component of the Proposed Action would be managed consistent with the procedures out lined above, and are not expected to present concerns in that project area relative to hazardous, toxic, and radioactive wastes.

A Technical Memorandum prepared by Science Applications International Corporation in August 2000, summarizing an EPCF/600 Area Fill Study, was provided by Mr. Tellez and is included in Appendix B of this report. This memorandum indicates that IRP Sites IWTP, SD-1, SD-2, SA-2, and FC-2 were located in areas that could be disturbed by construction of the levee and/or sump. The DD for Site IWTP, prepared by the San Antonio - Air Logistics Center, Directorate of Environmental Management (SA-ALC/EMRO) at Kelly Air force Base in August 1992 and included in Appendix B of this report, reported elevated levels of organic and inorganic contaminants in soil and groundwater, but not at concentrations requiring remedial measures. The groundwater contamination beneath the IWTP site was attributed primarily to a release from IRP Site E-3, an open chemical evaporation pit operated from 1969 to 1980 that was located hydraulically upgradient from the IWTP site. According to the DD for Site E-3, prepared by SA-ALC/EMRO in March 1993 and included in Appendix B of this report, remediation of downgradient contamination was the purpose for the placement of the groundwater recovery system observed during the current site visit in and near the project area. Also the DD for Site E-3 indicated that sludge drying beds at Site SD-1 were used for IWTP operations until 1984 when they were replaced by an upgraded sludge dewatering facility. An IRP Fact Sheet, prepared by SA-ALC/EMRO in January 1999 and included in Appendix B of this report, reported that Site SD-1 was used from the early 1960s until 1982, and Site SA-2 was used as an industrial waste sludge lagoon from 1962 to 1980 when Site SD-1 was inoperative. Both sites had contaminated soil removal actions completed respectively in 1986 and 1985 prior to closure under Texas Natural Resource Conservation Commission (TNRCC) regulations effective at the time. The DD for Site SD-2, prepared by SA-ALC/EMRO in August 1992 and included in Appendix B of this report, reported that sludge drying beds at this site operated during the 1940s and 1950s, and that this site was used for the upgraded sludge dewatering facility that replaced Site SD-1 in 1984. Elevated concentrations of inorganic contaminants were reported in soil and groundwater, but not at concentrations requiring remedial measures. The Final Confirmation Sampling and Analysis Report for IRP Site FC-2 prepared by Parsons Engineering Science, Inc. in March 1999 and included in Appendix B of this report, indicated organic and inorganic contaminants had been released to soil and groundwater by fire control training exercises conducted at the site from the 1950s through 1981. Although the report indicated natural attenuation and bioventing projects conducted at the site from 1992 through 1998 reduced organic contaminant levels, inorganic contaminants remained in soil at concentrations exceeding TNRCC regulatory limits effective at the time.

4.0 The various structures presented in Appendix A are only expected to require routine demolition as part of construction. There is no direct evidence of groundwater contamination in areas impacted by the proposed construction of the levee and sump or other indications that a Phase II ESA should be undertaken. A very low probability of past migration of groundwater with constituents at detectable levels cannot be excluded based on available data, however the only precaution indicated is appropriate due diligence during future construction activities if unexpected materials are encountered.

5.0 Further information regarding the content, conclusions, and recommendations in this report may be obtained from:

Dr. David Bowersock
robert.d.bowersock@usace.army.mil
(817) 886-1881

Mr. Barry Vercoe
mark.vercoe@usace.army.mil
(817) 886-1876.

Appendix A

Site Photographs
November 2013

Site Photograph A-1
Concrete remaining from former Industrial Wastewater Treatment Plant
to be removed for proposed levee access drive, gate, and patrol road at station 12+00

Site Photograph A-2
Concrete remaining from former Industrial Wastewater Treatment Plant
to be removed for proposed levee side slope near station 12+60

Site Photograph A-3
Concrete wall at former sludge dewatering basin near station 14+00

Site Photograph A-4
Valves along proposed levee side slope near station 15+30

Site Photograph A-5
Plugged groundwater recovery well near proposed levee station 14+00

Site Photograph A-6
High water mark on perimeter fence from May 2013 flooding along Leon Creek
near proposed levee station 19+50

Site Photograph A-7
Metal Building along proposed levee side slope and surface drainage ditch near station 28+00

Site Photograph A-8
Groundwater collection line marker near proposed levee station 24+00

Site Photograph A-9
Former fire control training area (IRP Site FC-2) and industrial waste sludge spreading area (IRP Site SA-2) in proposed sump and levee construction area

Site Photograph A-10
Groundwater recovery well along proposed levee side slope near station 27+00

Site Photograph A-11
Recycled water valve box along proposed levee side slope near station 28+60

Site Photograph A-12
Close-up view of recycled water valve box along proposed levee side slope near station 28+60

Site Photograph A-13
Corrugated metal drainage pipe (≈18” diameter) along proposed levee side slope near station 31+00

Site Photograph A-14
Abandoned utility trench along proposed floodwall

Site Photograph A-15

Existing water and gas valves along proposed floodwall

Site Photograph A-16

Underground fuel storage tank location near proposed floodwall and water/gas line relocation area

Site Photograph A-17
Communication manhole near proposed floodwall and water/gas line relocation area

Site Photograph A-18
Property at end of proposed floodwall

Site Photograph A-19
Reinforced concrete drainage pipe (48” diameter) to be outfalled into proposed sump

Site Photograph A-20
Concrete from former Industrial Wastewater Treatment Plant to be removed for proposed sump at former sludge drying beds/dewatering facility (IRP Site SD-2)

Photograph A-21
Concrete and structures to be removed for proposed sump

Photograph A-22
HDPE pipe and metal conduit for groundwater recovery system
along existing flood control berm to be removed for proposed sump

HYDROLOGIC AND HYDRAULIC ANALYSES

INTRODUCTION

Hydrologic and hydraulic analyses were conducted as part of the feasibility study to develop existing condition models for the Leon Creek Watershed. The model analyses will be used as the baseline for comparison with the future without-project conditions for alternative analysis and plan selection.

Study Area

The Leon Creek Watershed is located in the northwestern portion of Bexar County, stretching from the northwest limits of the County to the confluence of Leon Creek with the Medina River southwest of the city of San Antonio. The total drainage area of this watershed is approximately 238 square miles. Elevations within this watershed range from 1,600 to 456 feet National Geodetic Vertical Datum (NAVD88).

This watershed includes several major tributaries to Leon Creek, including Culebra Creek (82.3 square miles), Huebner Creek (12 square miles), French Creek (11.6 square miles), Slick Ranch Creek (11.5 square miles), Indian Creek (11 square miles), and numerous smaller tributaries. Plate 1 on the next page provides a general watershed map.

The shape of the Leon Creek Watershed is unique in that the portion upstream of Huebner Creek is relatively wide and the portion downstream of Huebner Creek is relatively narrow. The upper portion has an average width of approximately 10 miles and a length of about 32 miles. The portion of the watershed downstream of Huebner Creek has an average width of approximately four miles and a length of about 25 miles.

A variety of types and intensity of development exist within the Leon Creek Watershed. The portion of the watershed upstream of the upper Interstate Highway 10 crossing is relatively undeveloped with scattered residential and agricultural structures. Downstream of the upper I-10 crossing, the watershed is composed of extensive residential and commercial development. Lackland Air Force Base is situated within the watershed. Government Canyon, a tributary of Culebra Creek, is designated a State Natural Area, which permanently protects its land, water, and wildlife from suburban development.

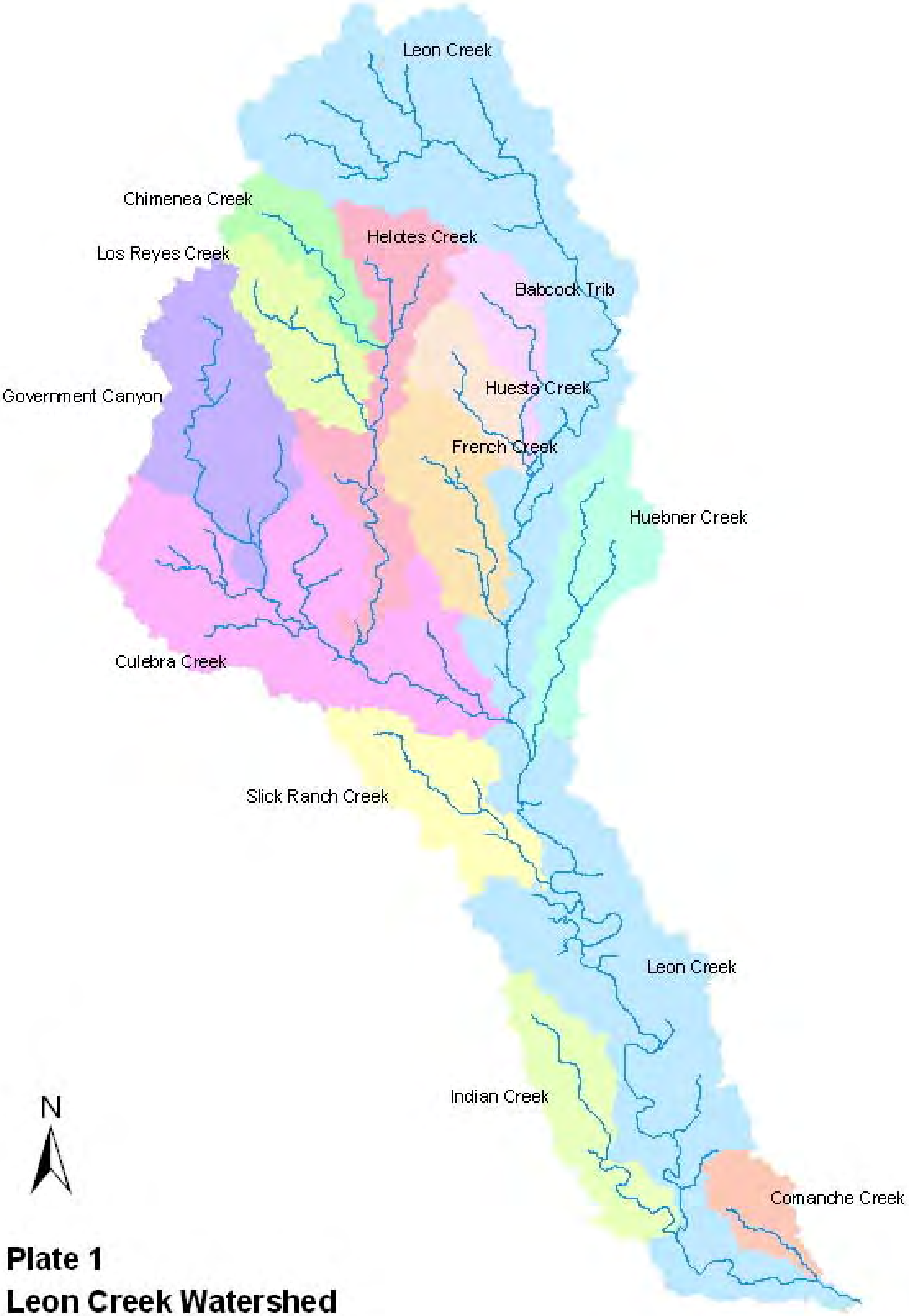


Plate 1
Leon Creek Watershed

HYDROLOGIC ANALYSIS

To develop discharge-frequency relationships for Leon Creek and tributaries for both existing and future without-project conditions, the study team performed a detailed hydrologic analysis of the Leon Creek Watershed.

Drainage Basin Area Delineation

Leon Creek and tributaries were delineated based on an upper limit of study of one square mile. The San Antonio River Authority (SARA) provided a 2003 Digital Elevation Model (DEM). Based on five-foot contours generated from the DEM, the USACE Hydrologic Engineering Center - Geospatial Hydrologic Modeling System (HEC-GeoHMS Version 1.1 running on ArcView 3.3) was used to generate the subbasin parameters of drainage area, stream length, stream length from the subbasin outflow point to the subbasin centroid, and stream slope.

Boundary Modification

After the subbasins were delineated in HEC-GeoHMS, the outside boundary was checked for accuracy using the DEM data and aerial photography. Because of errors in DEM, the boundary conflicted with the actual topography. For a few areas of the Leon Creek Watershed, delineations were hand-drawn to replace the computer-generated delineations, particularly the outer boundary on the northwest portion of the watershed. The updated outside boundary was used for the development of the hydrologic model.

Precipitation Data

Theoretical point rainfall data for the area was updated for the Bexar County Digital Flood Insurance Rate Map (DFIRM) effort described in the technical report, “Development of Design Rainfall Information,” dated 3 March 2005. The update was based on the United States Geological Survey (USGS) report, “Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas” (Scientific Investigations Report 2004-5041). The City of San Antonio also replaced the updated values in their Unified Development Code (UDC).

For consistency in the San Antonio area DFIRM studies, the updated values were used in this feasibility study. Table G.1–1 presents the hypothetical precipitation array for the study area. The standard annual chance exceedance (ACE) frequency-related events are more commonly known as those having recurrence intervals of 2, 5, 10, 25, 50, 100, 250, and 500 years, respectively.

Table G.1–1. Point Rainfall Depths (inches)

Annual Chance Exceedance	Recurrence Interval (years)	Storm Duration							
		5 min	15 min	1 hr	2 hrs	3 hrs	6 hrs	12 hrs	24 hrs
50%	2	0.53	1.07	1.84	2.20	2.41	2.80	3.2	3.6
20%	5	0.68	1.40	2.35	2.92	3.28	3.83	4.4	5.0
10%	10	0.78	1.60	2.76	3.55	3.95	4.60	5.4	6.0
4%	25	0.93	1.80	3.32	4.35	4.90	5.70	6.4	7.5
2%	50	1.04	2.10	3.85	5.10	5.70	6.50	7.5	9.0
1%	100	1.13	2.50	4.35	5.80	6.60	7.50	8.8	10.0
0.4%	250	1.33	2.90	5.19	7.00	8.00	9.00	10.4	11.8
0.2%	500	1.52	3.30	5.80	8.10	9.40	10.60	12.4	13.7

EXISTING CONDITIONS

Existing conditions discharge-frquency relationships were developed based on topography, current land use values, current precipitation data, and existing conditions urbanization and impervious percentages.

Model Development

Using the USACE HEC-HMS version 3.0 software, a watershed runoff model was developed. The Leon Creek Watershed was subdivided into 363 subbasins, which required the designation of 443 junctions and the development of routing data for 191 reaches. Points of interest in the watershed included the confluence of Leon Creek with all tributaries whose total drainage area exceeded one square mile, major road crossings, and USGS gage locations. The subbasins and junctions were defined to obtain detailed flow information (flood hydrographs) at all points of interest. A six-minute computation interval was used in the model to provide detail (shaping) of the unit hydrograph applied at the smaller subbasins in the analysis.

Aereal Reduction Factors

Values from the National Weather Service (NWS) Technical Paper 40 (TP40), Figure 15 “Depth-Area-Duration” curves, were used to adjust the point rainfall to representative average values over the contributing watershed size at each point of interest.

Initial Abstractions and Infiltration Rates

Based on storm reproductions and frequency analysis, minimum losses were found to best calibrate the rare flood events. The values used are reasonable and are similar to those used in other models developed for the San Antonio area. Loss rates vary by frequency to reflect antecedent soil moisture conditions for rarer flood events. This variation reflects the availability of watershed surface storage and the degree of surface soil saturation expected to exist at the onset of the flood-producing storm event.

- For frequent runoff events, the assumption is that there is a low probability of an antecedent storm, thus higher initial loss and infiltration rates.
- For the rarer flood events, there is a higher probability of an antecedent storm capable of at least partially occupying the available watershed surface storage areas and saturating the surface soils.

Table G.1-2 shows the loss rates used in the hydrologic study for the Leon Creek Watershed.

Table G.1-2. Loss Rates

Annual Chance Exceedance	Recurrence Interval (years)	Initial Loss (inches)	Infiltration (inches/hour)
50%	2	2.00	0.20
20%	5	1.80	0.18
10%	10	1.60	0.16
4%	25	1.40	0.14
2%	50	1.20	0.12
1%	100	1.00	0.10
0.4%	250	0.80	0.08
0.2%	500	0.60	0.06

Land Use

A land use raster dataset was provided by SARA for this study. A technical memorandum, “General Hydrologic and Hydraulic Modeling Tasks: Development of Land Use Information for Hydraulic Modeling,” dated 15 April 2005, describes in detail the development of the land use dataset. The digital dataset was based on information obtained from City of San Antonio 2005 zoning coverage, Bexar County 2004 parcel coverage, 1992 USGS National Land Cover Dataset (NLCD), and the USGS National Hydrographic Dataset (NHD). The resulting dataset provides an existing condition San Antonio River Basin (SARB) composite land classification data layer, appropriate for the derivation of hydrologic modeling parameters.

Table G.1-3 shows land use types and associated impervious cover percentages. The major land use categories include classification codes for Undeveloped, Residential, Commercial, Industrial, Transportation, Extraction, Open Space, Services, and Water. Each land use type is associated with a value for the percent of impervious cover.

Table G.1-3. Composite Land Use Classification

Class	Classification	SARB Land Use	UDC Zoning	Governor Code	NLCD Code (1992)	Impervious Cover %	Urban. %
1	Undeveloped						
11	Meadow	UM	FR, ED, NP, MR, PUD	D1, D3, D5, A2, M3, E1	81	0	0
12	Brush	UB	ED, NP, MR, PUD, RE, R-20, C3 ERZD	D4, G, A2, M3, E1, J7	51, 61	0	0
13	Woods	UW	ED, MR, NP, MPCD, GC-1, NCD-3	D2, A2	41, 42, 43, 71	0	0
2	Residential						
21	Dispersed	RD	RP, RE, MR, NP, R-20	A1, A2		10	20
22	Low Density	RL	R-15, R-20, RE, MH, ED, NP, MR, PUD	A1, A2		25	30
23	Medium Density	RM	R-6, RM-6, UD, ED, MH, NP, MR, PUD, UD	A1, O1, A2	21	38	80
24	High Density	RH	R-4, R-5, RM-4, RM-5, MH, NP, MR, PUD	A1, A2	22	65	90
25	Multi-Family	RMF	MF (MF-25, MF-33, MF-40, MF-50)	B1		75	95
26	Edwards Aquifer Regulated Zone	EARZ				15	0
3	Commercial						
31	Commercial	C	NC, O (O-1, O-2), C (C-1, C-2, C-2P, C-2NA, C-3, C-3R, C-3NA), D, ED, NP, PUD, UD, RE	F1, A2		90	90
4	Industrial						
41	Industrial	I	L, I-1, I-2, MI-I, DZ, MR, PUD, RE, R-20	F2, J4	23	72	95
5	Transportation						
51	Transportation	T	MR			90	90
6	Extraction						
61	Mining	M	QD		32	0	0
7	Open Space						
71	Urban	OU	ED, MH, NP, MR, PUD	C1, E1	31, 33, 85	0	0
72	Cultivated	OC	MR, NP, RD	D6, FR, E1	82, 83, 84	0	0
73	Easements	EA		Z0		10	10
8	Services						
81	Utilities	U	PUD	J1, J2, J7		80	70
82	Mixed-Use	MX	PUD	Z0		40	50
9	Water						
91	Lakes, Ponds, Streams, Wetlands	W			11, 91, 92	100	100
10	Mixed-Use						
101	Residential/Commercial Developments	MRC				51	90

Urbanization and Imperviousness

For each subbasin, the values of percent urbanization and percent imperviousness were developed.

- Urbanization is the percentage of a subbasin that has been developed and improved with channelization and/or a storm collection network. This value affects the Snyder's unit hydrograph lag time (t_p).
- Imperviousness is the percentage of a subbasin hydraulically connected to the drainage network that is covered with impervious material. This value affects the volume of rainfall lost through interception and infiltration.

The urbanization and imperviousness values for each subbasin are based on the land use dataset described under "Land Use." Each land use type was assigned a value for urbanization and one for imperviousness. Using Environmental Systems Research Institute (ESRI) ArcGIS, the subbasin layer developed in the HEC-GeoHMS process (see "Drainage Basin Area Delineation," page G.1-3) was overlaid on the land use dataset. Net values for each subbasin were derived by weighting the land uses within each subbasin.

Development of Unit Hydrographs

For consistency with previous studies in the region, Snyder's unit hydrograph method was used. The Snyder's unit hydrograph peaking coefficient, "CP640" of 400 (cp = 0.625), was derived from the Snyder Unit Hydrograph Parameter Guidelines provided by SARA, dated 27 May 2005. Snyder's unit hydrographs were developed for each subbasin, based on the specific physical measurements produced by GeoHMS.

Lag Time Parameters

Snyder's lag time (t_p) for each subbasin was calculated using the measurements produced by GeoHMS, which include the following:

- Length (L) of the major stream
- Distance from the subbasin outflow point to the location of the subbasin centroid (L_{ca})
- Weighted slope (S_{st}) of the major stream that shows the best representation of the valley slope
- Percent urbanization

The following reports describe the methodology used to calculate the Snyder's unit hydrograph lag time for each subbasin:

- *Synthetic Hydrograph Relationships*, *Trinity River Tributaries*, *Fort Worth-Dallas Urban Area*, T.L. Nelson, 1970.
- *Effects of Urbanization on Various Frequency Peak Discharges*, Paul K. Rodman, October 1977.

The Snyder’s lag time is computed using the following equation:

$$\log (t_p) = .3833\log (L*L_{ca}/(S_{st} \wedge .5))+\log(0.92)-(.266*Urban./100)$$

where:

t_p = Snyder’s lag time

L = Longest stream length within subbasin (miles)

L_{ca} = Distance along stream from subbasin centroid to outlet (miles)

S_{st} = Stream slope over reach between 10% and 85% of L (ft/mile)

Urban. = Urbanization factor (percent)

Snyder’s lag time values ranged from a minimum of 0.04 hours to a maximum of 1.28 hours for subbasins in the Leon Creek Watershed. The mean value was 0.40 hours. Table G.1-4 contains the unit hydrograph data for each subbasin.

Table G.1-4. Snyder's Lag Time Computation

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
BT-1 headwaters	1.024	1.556	0.537	105.60	2.8242	0.346	0.35	2.7324
BT-2 ab BT-UNT1	0.377	1.302	0.723	137.28	6.1466	0.337	0.34	5.8663
BT-3 ab BT-UNT2	2.193	3.765	1.742	47.52	12.4578	0.836	0.84	10.0741
BT-4 ab LC	0.676	2.908	1.454	31.68	62.9656	0.561	0.56	38.0487
BT-UNT1	0.995	2.018	0.827	95.04	3.9129	0.457	0.46	3.5159
BT-UNT2	0.940	2.946	1.518	79.20	26.8783	0.599	0.60	18.8787
CC-1 headwaters	1.057	2.388	1.201	116.16	0.0281	0.554	0.55	0.0281
CC-10 ab CC-UNT2	0.679	2.282	1.110	47.52	80.6023	0.383	0.38	56.4269
CC-11 ab CC-A	1.008	2.419	1.107	52.80	63.2940	0.426	0.43	45.2057
CC-12 ab LC	0.532	2.125	0.798	36.96	53.0195	0.408	0.41	36.2657
CC-2 ab CC-F	0.482	1.540	0.829	42.24	2.7605	0.485	0.48	2.7605
CC-3 ab CC-E	1.463	4.068	0.719	31.68	6.8614	0.686	0.69	6.1240
CC-4 ab GC	0.849	2.832	1.310	31.68	9.3888	0.740	0.74	8.5616
CC-5 ab CC-D	0.827	2.347	1.385	26.40	2.0926	0.762	0.76	2.0926
CC-6 ab CC-C	0.077	0.627	0.270	36.96	0.0037	0.233	0.23	0.0018
CC-7 ab CC-B	0.748	2.165	1.317	36.96	35.1758	0.555	0.55	32.6827
CC-8 ab HE	0.321	1.967	1.058	79.20	46.6675	0.396	0.40	45.1978
CC-9 ab CC-UNT1	1.894	3.079	1.577	47.52	57.0178	0.567	0.57	40.7761
CC-A-1 headwaters	1.079	2.022	0.949	58.08	81.6123	0.329	0.33	53.6713
CC-A-2 at Tezel Rd	0.972	1.864	1.045	63.36	76.7690	0.335	0.34	52.9999
CC-A-3 ab CC	1.194	2.376	1.119	42.24	77.6721	0.406	0.41	48.6018
CC-B-1 headwaters	1.017	2.318	1.339	63.36	10.1059	0.603	0.60	8.4020
CC-B-2 ab CC-B-UNT1	0.008	0.135	0.076	132.00	2.4085	0.062	0.06	2.4085
CC-B-3 ab CC	0.015	0.308	0.104	89.76	80.4389	0.063	0.06	80.4389
CC-B-UNT1	0.682	2.557	1.382	63.36	11.6672	0.627	0.63	9.0894

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
CC-C-1 headwaters	1.000	2.373	1.153	105.60	13.8882	0.509	0.51	9.9788
CC-C-2 ab CC-C-UNT1	1.015	2.379	0.909	42.24	13.2889	0.556	0.56	10.9218
CC-C-3 ab CC-C1	0.517	2.352	1.253	26.40	12.1650	0.690	0.69	11.6928
CC-C-4 ab CC	0.989	2.790	1.311	26.40	8.3060	0.768	0.77	7.8051
CC-C-UNT1	0.875	2.233	1.148	58.08	1.7095	0.600	0.60	1.6090
CC-C1-1 headwaters	1.005	2.449	1.007	52.80	9.0661	0.575	0.58	7.3233
CC-C1-2 ab CC-C	0.478	1.456	0.676	36.96	14.7393	0.418	0.42	13.4149
CC-D-1 headwaters	0.726	2.905	1.445	26.40	5.1948	0.825	0.82	5.1896
CC-D-2 ab CC-D-UNT2	0.013	0.213	0.075	100.32	0.0000	0.078	0.08	0.0000
CC-D-3 ab CC-D-UNT3	0.337	1.530	0.721	79.20	1.0982	0.410	0.41	0.7991
CC-D-4 at Culebra Rd	1.156	1.797	1.353	63.36	32.9709	0.477	0.48	32.6554
CC-D-5 ab UNT4	0.623	2.107	0.621	36.96	4.7476	0.496	0.50	4.6381
CC-D-6 ab CC	0.076	0.621	0.280	58.08	18.4331	0.193	0.19	12.3584
CC-D-UNT1	0.604	2.087	1.050	36.96	1.8504	0.615	0.62	1.7044
CC-D-UNT2	0.448	1.200	0.621	84.48	1.0067	0.349	0.35	0.7479
CC-D-UNT3	0.895	2.599	1.401	31.68	4.6017	0.757	0.76	4.5416
CC-D-UNT4	0.617	1.679	0.860	105.60	2.2922	0.428	0.43	1.7689
CC-E-1 headwaters	1.024	2.038	0.943	121.44	1.4857	0.467	0.47	0.9841
CC-E-2 ab CC	0.656	2.431	1.281	31.68	9.4406	0.692	0.69	7.1015
CC-F-1 headwaters	0.997	2.629	1.616	73.92	10.2369	0.660	0.66	7.5084
CC-F-2 at dam	0.386	1.416	0.545	36.96	0.2645	0.416	0.42	0.2645
CC-F-3 ab CC	0.078	0.618	0.210	58.08	0.0050	0.193	0.19	0.0050
CC-F-UNT1	0.394	1.342	0.744	52.80	0.6417	0.428	0.43	0.6417
CC-UNT1	0.923	2.861	1.306	26.40	83.5313	0.488	0.49	57.1851
CC-UNT2	1.214	2.925	1.191	26.40	48.8630	0.588	0.59	33.5162
CHI-1 headwaters	0.736	1.550	0.698	126.72	0.0000	0.375	0.37	0.0000
CHI-2 ab CHI-UNT2	0.090	0.520	0.180	374.88	0.0000	0.119	0.12	0.0000
CHI-3 ab CHI-UNT3	1.245	2.475	1.091	89.76	1.3598	0.564	0.56	1.1609
CHI-4 at dam	0.586	1.387	0.374	174.24	7.1747	0.255	0.25	6.0091
CHI-5 ab CHI-UNT4	1.148	3.084	1.332	52.80	0.8313	0.736	0.74	0.6569
CHI-6 ab HE	0.423	1.393	0.640	116.16	1.6504	0.350	0.35	1.1801
CHI-UNT1	0.462	1.300	0.671	168.96	0.9536	0.325	0.32	0.9536
CHI-UNT2	0.360	1.119	0.535	190.08	0.0000	0.276	0.28	0.0000
CHI-UNT3	0.981	1.973	0.858	126.72	0.3699	0.444	0.44	0.3699
CHI-UNT4	0.512	1.242	0.588	242.88	0.0007	0.285	0.28	0.0007
COM-1 headwaters	1.140	2.618	1.085	36.96	39.7109	0.539	0.54	29.7569
COM-2 ab COM-UNT2	0.355	1.339	0.590	36.96	12.1357	0.391	0.39	9.4266
COM-3 ab COM-UNT3	0.140	0.739	0.047	36.96	1.5402	0.126	0.13	1.4723
COM-4 ab COM-UNT4	0.603	1.633	0.860	47.52	2.4112	0.493	0.49	2.4043
COM-5 ab LC	0.461	1.743	0.740	42.24	32.7179	0.405	0.41	25.4111
COM-UNT1	0.614	1.978	0.912	42.24	30.4276	0.467	0.47	23.1527

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)		Rounded	Imperv. Cover (%)
						Computed t_p (hours)		
COM-UNT2	0.355	1.970	0.985	36.96	19.4295	0.527	0.53	13.1628
COM-UNT3	0.618	1.904	1.029	36.96	0.1264	0.596	0.60	0.0850
COM-UNT4	0.388	2.087	0.933	21.12	7.2402	0.633	0.63	4.9706
FR-1 headwaters	0.741	2.186	1.169	89.76	54.1517	0.400	0.40	40.6179
FR-2 ab FR-UNT2	0.019	0.294	0.118	79.20	25.6854	0.094	0.09	21.2906
FR-3 ab FR-C	0.227	1.405	0.662	47.52	29.8939	0.355	0.36	24.5539
FR-4 ab FR-B	0.063	0.617	0.408	31.68	8.2381	0.266	0.27	7.1038
FR-5 be Prue Rd	0.768	1.884	0.876	47.52	49.0768	0.394	0.39	31.5207
FR-6 at Bandera Rd	1.037	2.230	0.745	47.52	52.9510	0.386	0.39	33.5656
FR-7 ab FR-A	0.729	3.324	1.393	58.08	66.8859	0.505	0.50	48.2437
FR-8 ab LC	0.550	1.588	0.623	26.40	58.3285	0.342	0.34	38.9731
FR-A-1 headwaters	1.047	1.782	0.772	63.36	80.5528	0.287	0.29	61.0903
FR-A-2 at Braun Rd	0.311	1.179	0.551	79.20	72.2587	0.217	0.22	49.8300
FR-A-3 ab FR-A1	0.223	1.446	0.557	58.08	78.4058	0.240	0.24	45.9801
FR-A-4 ab FR	0.005	0.229	0.121	36.96	53.1654	0.084	0.08	37.4368
FR-A1	1.021	1.910	0.670	73.92	72.3675	0.285	0.28	45.6246
FR-B-1 headwaters	1.142	2.155	1.082	79.20	15.4703	0.501	0.50	14.6349
FR-B-2	0.115	1.358	0.674	47.52	58.6859	0.296	0.30	55.3909
FR-B-3 ab FR-B-UNT1	0.079	0.640	0.198	47.52	27.1019	0.169	0.17	17.6801
FR-B-UNT1	0.680	1.779	0.846	42.24	37.5630	0.417	0.42	26.4598
FR-C-1 headwaters	0.902	2.243	1.031	31.68	46.6957	0.491	0.49	40.4248
FR-C-2 ab FR	0.594	2.082	1.820	52.80	63.8979	0.485	0.48	59.7263
FR-UNT1	0.521	1.623	0.844	126.72	21.7510	0.359	0.36	16.6204
FR-UNT2	0.858	2.567	1.185	95.04	23.9821	0.508	0.51	17.0699
GC-1 headwaters	1.074	1.589	0.633	121.44	8.5221	0.349	0.35	8.3086
GC-10 ab GC-B	0.380	1.721	0.843	73.92	0.2436	0.465	0.46	0.2436
GC-11 ab GC-A	0.032	0.479	0.185	52.80	0.0000	0.170	0.17	0.0000
GC-12 ab CC	0.821	1.834	0.906	31.68	0.7718	0.574	0.57	0.7718
GC-2 ab GC-UNT1	0.217	0.966	0.507	63.36	8.8675	0.299	0.30	8.0207
GC-3 ab GC-UNT2	0.705	1.688	0.773	105.60	5.3163	0.404	0.40	4.2581
GC-4 ab GC-E	0.188	0.768	0.361	195.36	0.0000	0.205	0.20	0.0000
GC-5 ab GC-D	0.254	0.984	0.523	89.76	0.0000	0.301	0.30	0.0000
GC-6 ab GC-UNT3	0.955	2.030	1.108	68.64	0.0036	0.558	0.56	0.0018
GC-7 ab WC	0.592	1.748	0.762	95.04	0.0000	0.429	0.43	0.0000
GC-8 ab GC-C	0.356	1.359	0.473	121.44	0.0000	0.310	0.31	0.0000
GC-9 ab GC-UNT4	0.343	1.896	1.067	31.68	0.1358	0.621	0.62	0.1358
GC-A-1 headwaters	1.118	1.604	0.706	168.96	0.0008	0.361	0.36	0.0008
GC-A-2 ab GC-A-UNT1	0.079	0.582	0.310	549.12	0.0000	0.142	0.14	0.0000
GC-A-3 ab GC-A-UNT2	0.474	1.718	0.872	84.48	0.0007	0.459	0.46	0.0007
GC-A-4 ab GC	0.349	2.097	1.138	47.52	0.6534	0.610	0.61	0.6534
GC-A-UNT1	0.241	0.902	0.442	242.88	0.0450	0.226	0.23	0.0450

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
GC-A-UNT2	0.273	1.046	0.454	237.60	1.4289	0.240	0.24	1.1923
GC-B-1 headwaters	0.971	2.451	1.289	100.32	0.0002	0.591	0.59	0.0002
GC-B-2 ab GC-B-UNT2	0.192	1.420	0.756	95.04	0.0000	0.395	0.39	0.0000
GC-B-3 ab GC	0.032	0.348	0.164	58.08	0.0000	0.141	0.14	0.0000
GC-B-UNT1	0.430	1.926	0.943	142.56	0.0000	0.447	0.45	0.0000
GC-B-UNT2	0.389	1.805	0.961	95.04	0.0000	0.475	0.47	0.0000
GC-C-1 headwaters	0.989	1.888	1.073	142.56	0.0000	0.466	0.47	0.0000
GC-D-1 headwaters	1.000	1.787	0.698	126.72	0.1325	0.396	0.40	0.1259
GC-D-2 ab GC-D-UNT1	0.066	0.466	0.151	316.80	0.0000	0.110	0.11	0.0000
GC-D-3 ab GC	0.165	0.863	0.386	285.12	0.0000	0.204	0.20	0.0000
GC-D-UNT1	0.437	1.235	0.647	211.20	0.0020	0.303	0.30	0.0020
GC-E-1 headwaters	0.710	2.353	1.133	116.16	8.5619	0.511	0.51	7.5590
GC-E-2 ab GC	0.032	0.402	0.170	126.72	0.0000	0.130	0.13	0.0000
GC-E-UNT1	0.601	2.140	1.061	126.72	11.5180	0.464	0.46	11.0617
GC-UNT1	0.972	2.628	1.370	100.32	1.6461	0.615	0.62	1.4393
GC-UNT2	0.504	1.857	0.986	121.44	8.4950	0.439	0.44	7.0297
GC-UNT3	0.761	1.397	0.685	195.36	3.0314	0.323	0.32	2.4286
GC-UNT4	0.445	2.091	1.184	84.48	0.0000	0.556	0.56	0.0000
HB-1 headwaters	1.009	1.890	0.777	26.40	83.8525	0.341	0.34	73.4228
HB-2 ab HB-UNT1	0.122	0.830	0.282	142.56	93.0588	0.115	0.12	72.7994
HB-3 ab HB-UNT2	0.214	0.850	0.364	63.36	73.8089	0.169	0.17	54.4021
HB-4 ab HB-UNT3	0.020	0.320	0.150	100.32	33.9761	0.096	0.10	22.5149
HB-5 ab Babcock Rd	0.728	1.864	0.695	42.24	56.5806	0.351	0.35	38.2439
HB-6 ab HB-A	1.278	2.559	1.250	42.24	63.7831	0.474	0.47	45.9419
HB-7 at Bandera Rd	1.697	2.633	1.018	31.68	72.8043	0.443	0.44	59.7927
HB-8 ab LC	2.329	4.129	1.964	31.68	49.4160	0.782	0.78	41.5953
HB-A-1 headwaters	0.617	2.061	1.188	68.64	70.8969	0.373	0.37	63.8518
HB-A-2 ab HB-A-UNT2	0.317	1.024	0.477	84.48	31.6682	0.246	0.25	23.2651
HB-A-3 ab HB-A-UNT3	0.114	0.726	0.294	105.60	66.0490	0.139	0.14	59.8732
HB-A-4 ab HB	0.857	1.892	0.935	52.80	72.4873	0.343	0.34	62.5507
HB-A-UNT1	0.490	1.092	0.836	95.04	45.0370	0.282	0.28	30.8573
HB-A-UNT2	0.687	1.828	0.785	79.20	73.6856	0.291	0.29	64.6670
HB-A-UNT3	0.740	2.082	0.975	89.76	76.2228	0.320	0.32	65.4918
HB-UNT1	0.280	1.169	0.523	79.20	81.9090	0.200	0.20	59.9392
HB-UNT2	0.195	1.100	0.514	79.20	85.0364	0.190	0.19	56.1847
HB-UNT3	0.258	1.001	0.439	63.36	84.6405	0.180	0.18	56.5465
HE-1 headwaters	1.001	2.205	0.882	121.44	0.2979	0.472	0.47	0.2914
HE-2 ab HE-UNT1	0.134	0.628	0.261	295.68	0.8701	0.154	0.15	0.4747
HE-3 ab HE-UNT2	0.544	1.456	0.842	121.44	1.6317	0.393	0.39	1.0615
HE-4 ab HE-B	0.670	1.828	0.826	121.44	17.4907	0.386	0.39	12.9941
HE-5 ab CHI	0.343	1.002	0.351	200.64	19.7699	0.198	0.20	14.2286

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
HE-6 ab LR	1.688	3.281	1.407	42.24	14.3414	0.739	0.74	12.5856
HE-7 ab HE-A	1.704	2.821	1.520	68.64	34.9208	0.577	0.58	32.3061
HE-8 ab HE-UNT3	3.332	5.470	2.310	31.68	44.6777	0.954	0.95	33.9842
HE-9 ab CC	0.069	0.705	0.369	68.64	10.3945	0.229	0.23	8.9005
HE-A-1 headwaters	1.010	2.083	1.105	121.44	0.9535	0.502	0.50	0.7331
HE-A-2 ab HE	0.561	2.283	1.327	63.36	20.5298	0.560	0.56	16.2158
HE-B-1 headwaters	0.741	1.769	0.833	79.20	8.5014	0.438	0.44	6.8240
HE-B-2 ab HE-B-UNT2	0.821	2.435	1.102	73.92	6.4331	0.566	0.57	4.7204
HE-B-3 ab HE	0.101	0.713	0.337	195.36	23.2356	0.168	0.17	16.2884
HE-B-UNT1	0.586	1.380	1.163	132.00	8.6454	0.410	0.41	7.2664
HE-B-UNT2	0.678	2.049	0.854	126.72	2.3831	0.444	0.44	2.3139
HE-UNT1	0.339	1.148	0.538	195.36	0.6515	0.277	0.28	0.4347
HE-UNT2	0.821	2.487	1.291	100.32	3.7635	0.581	0.58	3.1042
HE-UNT3-1	1.011	2.875	1.465	21.12	35.0582	0.718	0.72	30.5423
HE-UNT3-2	0.307	1.633	0.911	36.96	36.8026	0.428	0.43	33.3710
HUE-1 headwaters	1.029	1.717	0.912	110.88	1.1983	0.440	0.44	1.1983
HUE-2 ab HUE-UNT1	0.014	0.242	0.120	649.44	2.7955	0.067	0.07	2.7955
HUE-3 ab HUE-B	0.423	1.346	0.558	68.64	3.0616	0.360	0.36	2.9790
HUE-4 ab HUE-A	0.561	1.915	0.987	63.36	21.2476	0.466	0.47	18.0880
HUE-5 ab HUE-UNT2	0.200	1.021	0.573	36.96	48.3846	0.279	0.28	38.5611
HUE-6 ab LC	0.451	2.117	1.307	31.68	64.6770	0.472	0.47	50.0093
HUE-A	0.972	2.625	1.300	79.20	22.7751	0.554	0.55	15.2270
HUE-B	1.102	2.086	1.070	110.88	0.4102	0.506	0.51	0.4102
HUE-UNT1	0.556	1.495	0.780	121.44	10.5317	0.365	0.36	10.0376
HUE-UNT2	0.756	2.539	1.343	63.36	59.2621	0.462	0.46	40.6215
IN-1 headwaters	0.553	1.456	0.472	52.80	59.9700	0.258	0.26	39.9977
IN-10 at dam	0.647	1.320	0.455	63.36	14.5626	0.312	0.31	14.5539
IN-11 ab IN-UNT9	0.922	2.003	1.133	26.40	0.5531	0.670	0.67	0.4443
IN-12 ab LC	0.091	0.794	0.422	105.60	0.0000	0.248	0.25	0.0000
IN-2 ab IN-UNT2	0.173	0.955	0.386	63.36	42.3696	0.219	0.22	28.6712
IN-3 ab IN-UNT3	0.020	0.425	0.208	89.76	70.9266	0.099	0.10	44.4948
IN-4 ab IN-UNT4&5	1.006	2.631	0.899	42.24	64.9543	0.419	0.42	45.4189
IN-5 ab IN-UNT6	0.508	1.718	1.005	52.80	67.4483	0.351	0.35	42.4217
IN-6 ab IN-UNT7	0.353	1.258	0.249	68.64	64.1801	0.177	0.18	39.2280
IN-7 ab IN-A	0.904	2.410	1.125	31.68	57.9899	0.487	0.49	42.6604
IN-8 at Somerset Rd	0.467	1.485	0.645	36.96	15.2452	0.413	0.41	15.1893
IN-9 ab IN-UNT8	0.379	1.299	0.594	15.84	6.1319	0.473	0.47	6.1052
IN-A-1 headwaters	0.724	2.521	1.347	42.24	35.6369	0.577	0.58	32.1308
IN-A-2 ab IN	0.154	1.130	0.639	47.52	36.5621	0.310	0.31	30.1737
IN-A-UNT1	0.434	1.918	1.054	42.24	35.7604	0.472	0.47	24.2095
IN-UNT1	0.406	1.586	0.650	42.24	32.2628	0.373	0.37	26.3690

	Area	L	L_{ca}	S_{st}	Urban.		Rounded	Imperv. Cover
Subbasin	(sq. mi.)	(miles)	(miles)	(fpm)	(%)	Computed t_p (hours)		(%)
IN-UNT2	0.206	0.986	0.474	79.20	51.9619	0.216	0.22	36.0260
IN-UNT3	0.284	1.118	0.694	95.04	65.8781	0.233	0.23	41.8764
IN-UNT4	0.391	1.376	0.701	68.64	40.4975	0.315	0.31	29.3201
IN-UNT5	0.356	1.848	1.072	47.52	72.7583	0.365	0.37	45.2233
IN-UNT6	0.688	2.593	1.740	58.08	60.3001	0.520	0.52	45.2065
IN-UNT7	0.344	1.501	0.789	68.64	36.5354	0.349	0.35	19.4955
IN-UNT8	0.261	1.122	0.451	52.80	4.3510	0.323	0.32	4.3296
IN-UNT9	0.700	2.482	1.065	36.96	1.4132	0.663	0.66	1.1317
LC -1 headwater	0.746	1.752	0.773	153.12	0.0974	0.394	0.39	0.0974
LC-10 at Camp Bullis	3.909	3.166	1.036	47.52	30.5097	0.574	0.57	21.9679
LC-11 ab Loop1604	3.971	5.332	3.156	31.68	14.1864	1.283	1.28	12.5139
LC-12 ab LT-I	1.384	2.800	1.385	31.68	32.9039	0.652	0.65	29.7256
LC-13 ab BT	0.851	2.828	1.286	36.96	46.2242	0.569	0.57	27.4311
LC-14 ab HUE	0.002	0.122	0.079	110.88	80.8979	0.038	0.04	42.6692
LC-15 ab LT-H	1.120	2.421	0.763	47.52	74.2685	0.352	0.35	49.9170
LC-16 ab FR	2.889	4.901	1.836	26.40	56.2222	0.808	0.81	40.4112
LC-17 ab LFR	1.309	2.950	1.642	42.24	61.4282	0.564	0.56	46.0083
LC-18 ab CC	0.856	2.403	1.282	31.68	56.7985	0.516	0.52	38.5995
LC-19 ab HB	0.794	2.013	1.023	26.40	58.7009	0.452	0.45	40.0200
LC-2 ab UNT2	0.125	0.674	0.284	364.32	3.0634	0.155	0.15	3.0634
LC-20 ab LT-G	0.926	2.516	1.186	47.52	58.1577	0.467	0.47	48.1133
LC-21 ab LT-F	1.785	4.045	1.805	21.12	42.7164	0.846	0.85	32.4696
LC-22 ab SR	0.471	1.976	0.393	26.40	34.7932	0.360	0.36	25.2573
LC-23 ab WV	0.448	1.816	0.395	21.12	21.8602	0.395	0.39	15.5478
LC-24 ab LT-E	2.324	4.179	1.832	21.12	43.5448	0.857	0.86	34.7190
LC-25 ab LT-D	0.382	1.364	0.583	42.24	17.1802	0.370	0.37	14.6129
LC-26 at Military Dr	3.818	3.780	2.225	47.52	63.6577	0.672	0.67	48.1179
LC-27 ab LT-C	0.266	1.365	0.617	31.68	56.3265	0.315	0.31	43.6289
LC-28 at New Laredo	2.001	3.562	1.149	15.84	36.8646	0.742	0.74	29.1509
LC-28A	0.694	2.050	0.919	84.48	36.8646	0.400	0.40	29.1509
LC-29 ab LT-B	1.709	3.157	1.477	26.40	27.1540	0.751	0.75	22.8097
LC-3 ab UNT3	0.542	1.755	0.646	190.08	0.0000	0.353	0.35	0.0000
LC-30 ab LT-A	1.902	3.197	1.729	21.12	18.7280	0.880	0.88	15.5809
LC-31 ab IN	0.483	1.929	0.798	31.68	38.5850	0.442	0.44	29.4476
LC-32 at Applewhite	2.176	3.219	1.807	21.12	13.6941	0.926	0.93	11.3403
LC-33 ab COM	2.879	4.830	2.397	26.40	14.9606	1.146	1.15	11.3748
LC-34 ab Medina Riv	0.952	3.020	1.370	21.12	0.0014	0.884	0.88	0.0010
LC-4 ab LT-N	0.504	1.522	0.864	58.08	0.1180	0.469	0.47	0.1151
LC-5 ab PC	1.204	2.031	1.122	121.44	1.7377	0.497	0.50	1.3074
LC-6 ab LT-M	1.495	2.387	1.018	84.48	14.2281	0.506	0.51	11.1023
LC-7 ab LT-L	1.778	2.848	1.319	36.96	14.9838	0.698	0.70	11.2082

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LC-8 ab LT-K	0.600	1.434	0.544	63.36	32.0191	0.310	0.31	27.8079
LC-9 ab LT-J	1.318	2.178	1.030	31.68	29.9321	0.538	0.54	22.8692
LC-N-1 headwater	1.002	2.410	1.255	126.72	0.1507	0.556	0.56	0.1507
LC-UNT1	0.646	1.746	0.873	132.00	0.9095	0.422	0.42	0.8922
LC-UNT2	0.482	1.498	0.744	142.56	0.6636	0.369	0.37	0.5270
LC-UNT3	0.348	1.293	0.632	105.60	0.0989	0.348	0.35	0.0989
LFR-1 headwaters	0.681	1.962	0.985	52.80	66.6925	0.368	0.37	47.9809
LFR-2 ab LC	0.156	0.698	0.247	36.96	39.1349	0.185	0.18	29.9029
LFR-UNT1	0.347	1.029	0.454	105.60	61.5831	0.193	0.19	40.4862
LR-1 headwaters	1.081	1.687	0.683	137.28	0.0000	0.378	0.38	0.0000
LR-2 at Bandera Rd	0.895	1.435	0.545	168.96	10.6026	0.294	0.29	10.0578
LR-3 ab LR-A	0.679	1.658	0.768	110.88	9.7296	0.386	0.39	8.9220
LR-4 at Bandera Rd	0.923	1.526	0.589	126.72	5.7073	0.337	0.34	5.4521
LR-5 ab RC	0.519	1.417	0.660	68.64	15.5950	0.362	0.36	14.0867
LR-6 ab LR-UNT1	0.360	1.319	0.729	121.44	14.6400	0.330	0.33	11.1337
LR-7 ab UNT2	0.116	0.960	0.459	153.12	31.6668	0.211	0.21	29.1040
LR-8 ab HE	0.157	0.694	0.476	137.28	28.0120	0.197	0.20	22.8240
LR-A-1 headwaters	0.594	1.493	0.711	163.68	4.0627	0.346	0.35	3.4243
LR-A-2 ab LR	0.208	1.211	0.589	168.96	23.7292	0.262	0.26	21.7063
LR-A-UNT1	0.448	1.217	0.575	132.00	6.8593	0.302	0.30	5.7073
LR-UNT1	0.671	1.802	0.933	89.76	14.9807	0.433	0.43	12.9363
LR-UNT2	0.642	1.790	0.916	116.16	5.8403	0.431	0.43	4.4469
LT-A-1 headwaters	1.004	2.246	1.006	26.40	75.1710	0.424	0.42	58.6734
LT-A-2 ab LT-A-UNT1	0.078	0.762	0.364	52.80	61.0285	0.181	0.18	45.6337
LT-A-3 at Durette Dr	0.163	0.842	0.286	31.68	4.1597	0.268	0.27	2.7181
LT-A-4 ab LC	0.269	1.188	0.597	52.80	38.2294	0.298	0.30	24.3357
LT-A-UNT1	0.479	2.457	1.369	26.40	80.1725	0.479	0.48	66.4489
LT-B-1 headwaters	0.976	2.540	1.297	10.56	88.1603	0.539	0.54	67.2171
LT-B-2 ab LT-B-UNT2	0.035	0.428	0.224	42.24	79.9139	0.112	0.11	62.6199
LT-B-3 ab IH35	0.300	0.951	0.274	31.68	51.5508	0.207	0.21	42.7784
LT-B-4 ab LT-B-UNT3	0.467	1.551	0.611	36.96	71.5847	0.291	0.29	54.1041
LT-B-5 ab LC	0.134	1.153	0.486	42.24	38.4619	0.284	0.28	30.3804
LT-B-UNT1	0.214	0.852	0.414	42.24	89.0849	0.175	0.17	71.4166
LT-B-UNT2	0.243	1.022	0.505	15.84	35.4773	0.338	0.34	27.6426
LT-B-UNT3	0.254	1.251	0.768	31.68	88.0455	0.272	0.27	66.7291
LT-C-1 headwaters	1.145	3.491	1.728	15.84	94.9999	0.603	0.60	72.0003
LT-C-2 ab LC	0.125	1.001	0.471	21.12	92.9493	0.217	0.22	73.2729
LT-C-UNT1	1.088	3.006	1.310	15.84	93.6945	0.516	0.52	72.4916
LT-D-1 headwaters	0.970	2.309	1.250	21.12	82.6922	0.464	0.46	63.0545
LT-D-2 ab LC	0.195	1.208	0.642	26.40	55.3064	0.318	0.32	42.0888
LT-E-1 headwaters	1.122	2.147	1.070	42.24	56.1468	0.438	0.44	45.8686

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LT-E-2 (da 1.3)	0.196	1.228	0.718	73.92	38.8551	0.303	0.30	31.8061
LT-E-3 ab LT-E-1	0.251	1.509	0.369	84.48	6.8843	0.301	0.30	5.8496
LT-E-4 ab LC	0.179	0.862	0.233	36.96	1.1115	0.247	0.25	0.9263
LT-E1-1 headwaters	0.630	2.021	0.850	26.40	35.2677	0.487	0.49	27.7618
LT-E1-2 at Kenley Av	0.053	0.540	0.246	52.80	30.0000	0.165	0.17	25.0000
LT-E1-3 (da 1.13)	0.113	0.521	0.204	89.76	30.0000	0.137	0.14	25.0000
LT-E1-4 ab LT-E	0.180	1.025	0.548	126.72	28.0362	0.246	0.25	23.4131
LT-E1-UNT1	0.338	1.372	0.537	21.12	31.8773	0.375	0.38	27.0338
LT-F-1 headwaters	0.985	2.632	0.949	36.96	39.4803	0.514	0.51	31.0005
LT-F-2 ab UNT2	0.011	0.413	0.199	10.56	59.4733	0.156	0.16	30.8461
LT-F-3 ab LC	0.018	0.356	0.178	31.68	34.7919	0.133	0.13	18.5766
LT-F-UNT1	0.181	1.028	0.527	15.84	31.3333	0.354	0.35	27.0663
LT-F-UNT2	0.495	1.890	0.891	26.40	16.8483	0.541	0.54	13.0880
LT-G-1 headwaters	1.011	2.426	1.183	73.92	66.7768	0.401	0.40	47.4825
LT-G-2 ab LC	0.324	1.462	0.768	42.24	32.0472	0.386	0.39	19.7798
LT-H-1 headwaters	1.008	2.440	1.198	31.68	45.4075	0.542	0.54	32.7846
LT-H-2	0.464	1.176	0.594	63.36	76.4135	0.227	0.23	56.6642
LT-H-3 ab LC	0.332	1.512	0.857	42.24	67.4344	0.328	0.33	47.5212
LT-I-1 headwaters	1.005	2.469	1.239	84.48	22.8853	0.525	0.52	17.0417
LT-I-2 ab LC	0.318	1.094	0.390	84.48	22.3891	0.247	0.25	15.0650
LT-J-1 headwaters	0.762	1.827	0.912	116.16	4.9048	0.436	0.44	4.2532
LT-J-2 ab LT-UNT2&3	0.315	1.223	0.469	121.44	7.2371	0.284	0.28	5.4275
LT-J-3 ab LC	0.182	1.024	0.384	163.68	15.6497	0.220	0.22	13.4692
LT-J-UNT1	0.384	1.139	0.586	174.24	3.6640	0.287	0.29	2.8196
LT-J-UNT2	0.264	1.167	0.675	174.24	0.1028	0.312	0.31	0.0827
LT-J-UNT3	0.228	1.140	0.587	179.52	21.7793	0.255	0.26	14.5766
LT-J-UNT4	0.394	1.515	0.998	137.28	65.9745	0.280	0.28	46.7694
LT-K-1 headwaters	1.047	2.133	1.074	79.20	20.6231	0.482	0.48	18.1836
LT-K-2 ab LT-K-UNT1	0.103	0.683	0.356	174.24	20.2684	0.176	0.18	18.0490
LT-K-3 ab LT-K-UNT2	0.280	1.828	0.929	52.80	29.2869	0.440	0.44	24.4121
LT-K-4 ab LT-K2	0.498	1.661	0.897	73.92	20.8375	0.414	0.41	15.4133
LT-K-5 ab LT-K1	0.452	1.559	0.700	105.60	31.3020	0.322	0.32	29.6967
LT-K-6 ab LC	0.021	0.287	0.152	68.64	90.0000	0.071	0.07	90.0000
LT-K-UNT1	0.939	2.509	1.129	63.36	20.9909	0.544	0.54	14.6445
LT-K-UNT2	0.825	2.274	1.153	73.92	33.4335	0.476	0.48	22.3866
LT-K1	1.019	1.943	1.140	84.48	20.0274	0.472	0.47	13.8380
LT-K2-1 headwaters	1.143	3.182	1.580	63.36	10.0996	0.725	0.73	8.6997
LT-K2-2 ab LT-K	0.030	1.134	0.576	63.36	74.7444	0.223	0.22	74.7444
LT-K2-UNT1	0.431	1.765	0.841	95.04	8.3644	0.425	0.42	7.2922
LT-L-1 headwater	0.796	2.306	0.853	116.16	10.8229	0.449	0.45	8.3165
LT-L-2 ab LC	0.137	0.799	0.454	258.72	19.7448	0.191	0.19	18.8473

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LT-L-UNT1	0.379	1.362	0.624	137.28	10.4523	0.316	0.32	8.8637
LT-M-1headwaters	0.910	2.155	0.695	47.52	16.7960	0.462	0.46	15.1390
LT-M-2 ab UNT2	0.345	1.200	0.504	121.44	5.1444	0.293	0.29	4.1473
LT-M-3 ab LT-M1	0.966	2.043	0.841	95.04	17.1947	0.426	0.43	12.8960
LT-M-4 ab LC	0.599	1.532	1.072	79.20	11.5558	0.449	0.45	9.9905
LT-M-UNT1	0.434	1.460	0.729	137.28	0.1126	0.367	0.37	0.0939
LT-M-UNT2	0.709	2.097	0.990	132.00	0.6820	0.476	0.48	0.4483
LT-M1-1 headwater	0.908	1.812	0.791	73.92	26.9000	0.393	0.39	20.8765
LT-M1-2 ab UNT2	0.130	0.748	0.283	200.64	14.4452	0.168	0.17	10.1476
LT-M1-3 ab UNT3	0.140	0.645	0.178	195.36	29.2671	0.122	0.12	21.8309
LT-M1-4 ab LT-M	0.195	0.720	0.135	279.84	7.0991	0.122	0.12	5.9022
LT-M1-UNT1	0.397	1.361	0.678	116.16	30.2585	0.298	0.30	22.8291
LT-M1-UNT2	0.288	1.128	0.573	132.00	35.6802	0.245	0.25	25.9865
LT-M1-UNT3	0.371	1.139	0.468	147.84	9.3918	0.262	0.26	7.8121
LT-N-2 ab LC	0.155	0.819	0.534	264.00	0.8510	0.229	0.23	0.8510
LT-N-UNT1	0.315	1.122	0.518	232.32	0.0000	0.263	0.26	0.0000
PC-1 headwater	1.078	1.636	0.856	137.28	1.0447	0.405	0.41	0.8351
PC-2 ab UNT1	0.724	1.741	0.750	100.32	2.2588	0.415	0.42	2.2445
PC-3 ab LC	0.893	2.243	1.268	79.20	3.7243	0.581	0.58	2.8364
PC-UNT1	0.489	1.455	0.482	95.04	0.5027	0.335	0.33	0.4942
RC-1 headwaters	0.843	1.577	0.480	147.84	0.1794	0.317	0.32	0.1755
RC-2 ab LR	0.353	1.174	0.513	258.72	19.7751	0.231	0.23	17.6824
RC-UNT1	0.693	1.665	0.833	121.44	8.0153	0.396	0.40	7.1953
SR-1 headwaters	1.002	1.771	0.658	52.80	40.0506	0.357	0.36	35.9398
SR-10 ab LC	0.523	1.685	0.757	31.68	81.6961	0.316	0.32	56.3962
SR-2 ab SR-UNT1	0.190	0.860	0.394	110.88	21.0808	0.216	0.22	17.5537
SR-3 ab SR-unt2	0.818	1.646	0.807	58.08	38.7723	0.371	0.37	26.3757
SR-4 ab SR-UNT3	0.325	1.390	0.586	47.52	17.7234	0.364	0.36	13.7800
SR-5 ab SR-UNT4	0.131	0.988	0.527	47.52	7.5254	0.327	0.33	6.5173
SR-6 ab SR-B	0.416	1.964	1.136	36.96	37.1912	0.499	0.50	31.1310
SR-7 ab SR-UNT5	0.307	1.391	0.645	21.12	67.8386	0.325	0.32	54.6407
SR-8 ab SR-A	0.433	1.530	0.781	42.24	72.8546	0.308	0.31	46.4914
SR-9 ab SR-UNT6	0.072	0.635	0.314	68.64	83.2691	0.132	0.13	51.5124
SR-A	0.808	2.367	1.531	31.68	78.4614	0.481	0.48	59.4817
SR-B-1 headwaters	0.948	2.272	0.927	58.08	75.8229	0.353	0.35	55.5526
SR-B-2 ab SR-B-UNT2	0.027	0.475	0.215	47.52	27.3031	0.155	0.15	23.7537
SR-B-3 ab SR	0.372	1.664	0.698	52.80	33.6459	0.371	0.37	26.2505
SR-B-UNT1	0.318	1.413	0.794	52.80	21.0297	0.395	0.40	13.9356
SR-B-UNT2	0.616	2.387	1.110	47.52	68.2166	0.420	0.42	48.3225
SR-B-UNT3	0.107	0.740	0.378	73.92	64.9150	0.166	0.17	52.6953
SR-UNT1	0.307	1.214	0.581	84.48	41.1650	0.267	0.27	34.0048

	Area	L	L_{ca}	S_{st}	Urban.		Rounded	Imperv. Cover
Subbasin	(sq. mi.)	(miles)	(miles)	(fpm)	(%)	Computed t_p (hours)		(%)
SR-UNT2	0.883	1.873	0.809	84.48	37.7140	0.366	0.37	35.0697
SR-UNT3	0.472	1.722	1.186	79.20	19.2955	0.465	0.47	15.5528
SR-UNT4	0.253	1.524	0.683	84.48	40.0285	0.312	0.31	36.8811
SR-UNT5	1.820	3.184	1.330	42.24	40.2164	0.610	0.61	32.5354
SR-UNT6	0.381	2.207	1.029	10.56	71.5504	0.517	0.52	52.8265
WC-1 headwaters	1.026	2.047	0.945	137.28	0.0000	0.461	0.46	0.0000
WV-1 headwaters	0.990	2.643	1.120	15.84	83.0762	0.494	0.49	53.4905
WV-2 at Old Hwy 90	0.296	1.172	0.558	31.68	80.3530	0.246	0.25	51.8850
WV-3 ab LC	0.205	1.143	0.633	58.08	42.3773	0.288	0.29	37.1413
WV-UNT1	0.348	1.531	0.705	47.52	82.9702	0.272	0.27	52.0781

Channel Routing Procedures

The Modified Puls routing method was used for all routing reaches. The valley storage versus discharge relationships were derived from backwater analyses using USACE Hydrologic Engineering Center – River Analysis System (HEC-RAS), version 3.1.2. For a more detailed description of the hydraulic modeling process, see “Hydraulic Analysis” beginning on page G.1-63.

Development of Discharge-Frequency Relationships

The precipitation runoff process for the watershed was modeled using the HEC-HMS 3.0 watershed model. The Snyder’s unit hydrograph at each subbasin was applied to each block of excess rainfall to develop the hypothetical flood hydrographs. These hydrographs were combined and then routed downstream. On the next page, table G.1-5 presents the discharges for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% ACE storms or storms that have recurrence intervals of 2, 5, 10, 25, 50, 100, 250, and 500 years, respectively.

Table G.1-5. Peak Discharges (cfs) – Existing Conditions

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Creek headwaters	JLC001	1.392	390	1,880	2,710	3,360	3,950	4,550	5,430	6,160
Leon Creek above LC-UNT2	JLC002	1.517	400	1,970	2,870	3,570	4,190	4,820	5,760	6,530
Leon Creek below LC-UNT2	JLC003	1.999	540	2,340	3,800	4,730	5,550	6,390	7,630	8,650
Leon Creek above LC-UNT3	JLC005	2.541	570	3,070	4,600	5,780	6,810	7,860	9,370	10,600
Leon Creek below LC-UNT3	JLC006	2.889	630	3,410	5,180	6,500	7,650	8,830	10,500	11,900
Leon Creek above Leon Trib N	JLC007	3.393	500	3,460	5,450	6,990	8,160	9,380	11,200	12,700
Leon Creek below Leon Trib N	JLC008	4.865	600	4,520	7,190	9,350	11,000	12,500	15,000	17,000
Leon Creek above Pecan Creek	JLC009	6.069	570	4,880	7,990	10,700	12,700	14,500	17,100	19,300
Leon Creek below Pecan Creek	JLC010	9.253	880	7,010	11,500	15,600	18,600	21,600	25,800	29,400
Leon Creek above Leon Trib M	JLC011	10.748	860	7,250	12,200	16,800	20,100	23,300	28,000	32,000
Leon Creek below Leon Trib M	JLC012	17.140	1,710	11,400	19,100	26,300	31,500	36,500	44,100	50,300
Leon Creek above Leon Trib L	JLC013	18.918	1,590	9,710	17,300	25,700	31,000	36,500	44,700	51,300
Leon Creek below Leon Trib L	JLC014	20.230	1,580	9,710	17,500	26,100	31,500	37,200	45,700	52,700
Leon Creek above Leon Trib K	JLC016	20.830	1,560	9,570	16,000	24,900	30,600	35,900	44,500	51,700
Leon Creek below Leon Trib K	JLC017	27.618	1,810	10,700	18,500	30,200	37,200	43,900	54,400	63,700
Leon Creek above Leon Trib J	JLC018	28.936	1,800	10,700	17,900	29,500	36,700	43,600	54,300	64,100
Leon Creek below Leon Trib J	JLC019	31.465	2,050	10,700	18,000	29,900	37,300	44,600	55,700	65,800
Leon Creek at Camp Bullis	JLC020	35.374	2,120	10,700	17,300	28,700	36,200	44,000	55,700	67,000
Leon Creek at Loop 1604	JLC021	39.345	2,070	10,500	16,800	26,400	34,000	41,300	54,200	66,300
Leon Creek above Leon Trib I	JLC022	40.729	2,040	10,500	16,600	25,900	33,500	40,900	52,700	65,100
Leon Creek below Leon Trib I	JLC023	42.052	2,030	10,500	16,600	25,800	33,500	40,900	52,700	65,200
Leon Creek above Babcock Trib	JLC025	42.903	1,980	10,400	16,400	25,500	33,000	40,300	52,000	64,500
Leon Creek below Babcock Trib	JLC026	49.108	2,090	10,500	16,500	25,600	33,300	40,800	53,000	65,900
Leon Creek above Huesta Creek	JLC027	49.110	2,090	10,500	16,500	25,600	33,300	40,800	52,800	65,900
Leon Creek below Huesta Creek	JLC028	55.174	2,100	10,500	16,500	25,600	33,400	41,100	53,100	66,600
Leon Creek above Leon Trib H	JLC029	56.294	2,070	10,500	16,400	25,400	33,000	40,700	52,400	65,800
Leon Creek below Leon Trib H	JLC030	58.098	2,080	10,500	16,500	25,400	33,000	40,800	52,500	65,900

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Creek above French Creek	JLC032	60.987	2,110	10,400	16,400	25,100	32,600	40,500	52,000	65,400
Leon Creek below French Creek	JLC033	72.619	3,300	12,500	20,500	30,300	38,200	45,900	58,200	70,100
Leon Creek above Lower French Creek	JLC035	73.928	3,310	12,500	20,400	30,400	38,300	46,200	58,900	71,100
Leon Creek below Lower French Creek	JLC036	75.112	3,330	12,600	20,500	30,500	38,400	46,400	59,200	71,500
Leon Creek above Culebra Creek	JLC037	75.968	3,300	12,500	20,300	30,100	38,000	45,800	58,600	71,100
Leon Creek below Culebra Creek	JLC038	158.277	4,630	26,700	48,500	73,000	91,100	109,600	139,700	167,100
Leon Creek above Huebner Creek	JLC040	159.071	4,580	26,400	48,100	72,500	90,900	109,400	139,100	166,800
Leon Creek below Huebner Creek	JLC041	171.023	5,890	27,400	50,400	75,800	95,100	113,800	145,200	176,700
Leon Creek above Leon Trib G	JLC043	171.949	5,870	27,200	50,000	75,500	94,800	113,600	144,800	176,200
Leon Creek below Leon Trib G	JLC044	173.284	5,890	27,200	50,100	75,500	94,900	113,700	145,000	176,500
Leon Creek above Leon Trib F	JLC046	175.069	5,870	26,900	49,600	75,100	94,800	113,600	144,700	176,100
Leon Creek below Leon Trib F	JLC047	176.759	5,880	26,900	49,600	75,200	94,900	113,800	144,900	176,400
Leon Creek above Slick Ranch Creek	JLC048	177.230	5,870	26,800	49,500	75,100	94,800	113,800	144,800	176,400
Leon Creek below Slick Ranch Creek	JLC049	188.759	6,190	27,000	50,000	75,900	96,000	115,400	146,800	179,300
Leon Creek above Westwood Village	JLC050	189.207	6,190	26,900	49,600	75,400	96,000	115,300	146,600	179,100
Leon Creek below Westwood Village	JLC051	191.046	6,240	27,000	49,600	75,500	96,100	115,500	146,800	179,500
Leon Creek above Leon Trib E	JLC053	193.370	6,260	26,700	49,200	75,200	95,900	115,500	146,600	179,100
Leon Creek below Leon Trib E	JLC054	196.432	6,300	26,700	49,300	75,200	96,100	115,700	146,900	179,700
Leon Creek above Leon Trib D	JLC056	196.814	6,290	26,600	49,100	75,200	96,000	115,700	146,800	179,500
Leon Creek below Leon Trib D	JLC057	197.979	6,310	26,600	49,200	75,200	96,100	115,800	146,900	179,700
Leon Creek at Military Drive	JLC058	201.797	6,350	26,600	48,900	75,000	96,000	116,000	147,000	179,900
Leon Creek above Leon Trib C	JLC059	202.063	6,350	26,500	48,900	74,900	85,900	115,900	146,900	179,700
Leon Creek below Leon Trib C	JLC060	204.421	6,390	26,500	48,900	75,000	96,100	116,100	147,200	180,100
Leon Creek below Test Cell Facility	JLC061	205.115	6,380	26,500	48,900	74,900	96,000	116,100	147,100	180,100
Leon Creek at New Laredo	JLC062	207.810	6,370	26,300	48,200	74,500	95,500	116,200	147,200	180,200
Leon Creek above Leon Trib B	JLC063	209.519	6,350	26,100	47,900	74,200	95,200	116,100	147,000	180,100
Leon Creek below Leon Trib B	JLC064	212.142	6,390	26,100	48,000	74,300	95,300	116,300	147,300	180,500
Leon Creek above Leon Trib A	JLC066	214.044	6,360	26,000	47,200	73,700	94,600	116,200	146,900	180,100
Leon Creek below Leon Trib A	JLC067	216.037	6,380	26,000	47,200	73,700	94,700	116,300	147,000	180,000

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Creek above Indian Creek	JLC069	216.520	6,370	26,000	46,800	73,500	94,400	116,100	146,800	180,000
Leon Creek below Indian Creek	JLC070	227.491	6,580	26,200	47,100	74,000	95,200	117,600	148,800	183,100
Leon Creek at Applewhite	JLC072	229.667	6,550	26,100	46,600	73,300	94,600	117,500	148,500	182,900
Leon Creek above Comanche Creek	JLC074	232.546	6,520	25,900	46,300	72,300	93,800	116,300	147,500	181,500
Leon Creek below Comanche Creek	JLC075	237.220	6,540	26,000	46,300	72,300	93,900	116,500	147,800	182,000
Leon Creek above Medina River	JLC076	238.172	6,510	25,600	46,100	71,700	93,400	114,900	146,600	180,900
Leon Trib N headwaters	JLTN01	1.317	290	1,380	2,070	2,640	3,120	3,590	4,310	4,900
Leon Trib N above Leon Creek	JLTN02	1.472	330	1,580	2,370	3,020	3,560	4,120	4,930	5,620
Pecan Creek headwaters	JPE01	1.078	300	1,450	2,090	2,600	3,050	3,520	4,200	4,760
Pecan Creek above PC-UNT1	JPE02	1.802	340	1,770	2,770	3,630	4,320	5,020	6,120	7,040
Pecan Creek below PC-UNT1	JPE03	2.291	410	2,210	3,470	4,580	5,470	6,360	7,760	8,890
Pecan Creek above Leon Creek	JPE04	3.184	390	2,400	3,920	5,360	6,480	7,560	9,250	10,700
Leon Trib M headwaters	JLTM01	1.344	450	1,750	2,490	3,110	3,640	4,200	5,020	5,690
Leon Trib M above LT-M-UNT2	JLTM02	1.689	400	1,780	2,700	3,430	4,050	4,690	5,650	6,450
Leon Trib M below LT-M-UNT2	JLTM03	2.398	540	2,520	3,790	4,910	5,810	6,720	8,080	9,200
Leon Trib M above Leon Trib M1	JLTM04	3.364	540	2,790	4,530	5,990	7,150	8,320	10,100	11,600
Leon Trib M below Leon Trib M1	JLTM05	5.793	1,120	4,780	7,700	10,330	12,300	14,270	17,300	19,800
Leon Trib M above Leon Creek	JLTM06	6.392	1,150	4,920	7,930	10,810	13,000	15,110	18,400	21,200
Leon Trib M1 headwaters	JLTM101	1.305	600	2,000	2,800	3,410	4,000	4,620	5,490	6,220
Leon Trib M1 above LT-M1-UNT2	JLTM102	1.435	570	1,910	2,770	3,440	4,050	4,660	5,580	6,330
Leon Trib M1 below LT-M1-UNT2	JLTM103	1.723	680	2,320	3,300	4,110	4,840	5,610	6,700	7,620
Leon Trib M1 above LT-M1-UNT3	JLTM104	1.863	630	2,460	3,180	4,020	4,740	5,480	6,610	7,560
Leon Trib M1 below LT-M1-UNT3	JLTM105	2.234	730	2,570	3,790	4,840	5,720	6,620	7,980	9,100
Leon Trib M1 above Leon Trib M	JLTM106	2.429	700	2,470	3,680	4,810	5,710	6,600	7,990	9,140
Leon Trib L headwaters	JLTL01	1.175	380	1,570	2,230	2,770	3,250	3,760	4,480	5,090
Leon Trib L above Leon Creek	JLTL02	1.312	440	1,740	2,530	3,140	3,690	4,260	5,080	5,770
Leon Trib K headwaters	JLTK001	1.047	390	1,300	1,850	2,310	2,710	3,130	3,740	4,240
Leon Trib K above LT-K-UNT1	JLTK002	1.150	400	1,330	1,910	2,390	2,810	3,240	3,900	4,420
Leon Trib K below LT-K-UNT1	JLTK003	2.089	690	2,380	3,420	4,290	5,050	5,820	6,980	7,930

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Trib K above LT-K-UNT2	JLTK005	2.369	660	2,390	3,530	4,470	5,290	6,170	7,450	8,380
Leon Trib K below LT-K-UNT2	JLTK006	3.194	800	3,000	4,440	5,640	6,730	7,860	9,510	10,700
Leon Trib K above Leon Trib K2	JLTK007	3.692	810	3,000	4,590	6,000	7,120	7,310	10,200	11,600
Leon Trib K below Leon Trib K2	JLTK008	5.296	1,040	3,930	6,100	8,180	9,710	11,300	13,900	15,900
Leon Trib K above Leon Trib K1	JLTK010	5.748	1,080	3,950	6,070	8,390	10,100	11,800	14,500	16,700
Leon Trib K below Leon Trib K1	JLTK011	6.767	1,190	4,310	6,620	9,310	11,300	13,300	16,300	19,000
Leon Trib K above Leon Creek	JLTK012	6.788	1,190	4,300	6,600	9,300	11,300	13,200	16,300	19,000
Leon Trib K2 headwaters	JLTK201	1.574	370	1,440	2,130	2,750	3,250	3,750	4,510	5,150
Leon Trib K2 above Leon Creek	JLTK203	1.604	380	1,470	2,160	2,800	3,310	3,820	4,590	5,240
Leon Trib K1 headwaters	LT-K1	1.047	350	1,260	1,810	2,270	2,660	3,070	3,670	4,170
Leon Trib J headwaters	JLTJ01	1.146	340	1,550	2,260	2,800	3,290	3,800	4,530	5,150
Leon Trib J above LT-J-UNT2&3	JLTJ02	1.461	350	1,750	2,630	3,320	3,910	4,500	5,360	6,110
Leon Trib J below LT-J-UNT2&3	JLTJ03	1.953	470	2,330	3,590	4,510	5,300	6,130	7,300	8,280
Leon Trib J above Leon Creek	JLTJ05	2.529	600	2,560	4,090	5,390	6,400	7,380	8,860	10,100
Leon Trib I headwaters	JLTI01	1.005	350	1,190	1,690	2,120	2,490	2,870	3,430	3,900
Leon Trib I above Leon Creek	JLTI02	1.323	460	1,560	2,230	2,800	3,290	3,790	4,540	5,150
Babcock Trib headwaters	JBT01	1.024	320	1,520	2,190	2,690	3,150	3,640	4,330	4,920
Babcock Trib above BT-UNT1	JBT02	1.401	360	1,760	2,600	3,300	3,910	4,560	5,490	6,220
Babcock Trib below BT-UNT1	JBT03	2.396	610	2,940	4,340	5,490	6,490	7,530	9,050	10,300
Babcock Trib above BT-UNT2	JBT05	4.589	780	3,650	5,570	7,270	8,620	10,000	12,000	13,800
Babcock Trib below BT-UNT2	JBT06	5.529	860	4,130	6,330	8,290	9,880	11,500	13,900	15,900
Babcock Trib above Leon Creek	JBT07	6.205	770	3,890	6,120	8,200	9,670	11,200	13,700	15,800
Huesta Creek headwaters	JHU001	1.029	270	1,290	1,890	2,370	2,780	3,220	3,840	4,360
Huesta Creek above HUE-UNT1	JHU002	1.043	270	1,290	1,900	2,380	2,800	3,230	3,860	4,380
Huesta Creek below HUE-UNT1	JHU003	1.599	460	2,080	3,000	3,730	4,380	5,050	6,030	6,840
Huesta Creek above Huesta Trib B	JHU004	2.022	440	2,180	3,350	4,250	5,000	5,770	6,890	7,820
Huesta Creek below Huesta Trib B	JHU005	3.124	660	3,340	5,070	6,510	7,680	8,870	10,600	12,000
Huesta Creek above Huesta Trib A	JHU006	3.685	590	3,360	5,340	6,900	8,140	9,230	11,000	12,600
Huesta Creek below Huesta Trib A	JHU007	4.657	710	4,100	6,530	8,430	9,950	11,300	13,500	15,500

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Huesta Creek above HUE-UNT2	JHU008	4.857	670	3,990	6,390	8,370	9,870	11,200	13,400	15,400
Huesta Creek below HUE-UNT2	JHU009	5.613	760	4,410	7,120	9,360	11,000	12,500	15,000	17,300
Huesta Creek above Leon Creek	JHU011	6.064	960	4,450	7,220	9,710	11,500	13,100	15,600	18,000
Huesta Trib B above Huesta Creek	HUE-B	1.102	260	1,260	1,850	2,340	2,750	3,170	3,800	4,310
Huesta Trib A above Huesta Creek	HUE-A	0.972	310	1,080	1,560	1,970	2,320	2,680	3,200	3,640
Leon Trib H headwaters	JLTH01	1.008	470	1,210	1,670	2,090	2,450	2,820	3,370	3,820
Leon Trib H Area 2	JLTH02	1.472	600	1,500	2,120	2,720	3,210	3,690	4,460	5,050
Leon Trib H above Leon Creek	JLTH03	1.804	720	1,750	2,530	3,340	3,960	4,590	5,550	6,350
French Creek headwaters	JFR001	1.262	680	1,900	2,600	3,180	3,720	4,300	5,110	5,790
French Creek above FR-UNT2	JFR002	1.281	660	1,840	2,580	3,180	3,720	4,280	5,060	5,730
French Creek below FR-UNT2	JFR003	2.139	950	2,830	3,990	4,960	5,810	6,690	7,950	9,010
French Creek above French Trib C	JFR004	2.366	890	2,660	3,880	4,870	5,730	6,610	7,950	9,040
French Creek below French Trib C	JFR005	3.862	1,560	4,250	6,150	7,780	9,160	10,500	12,600	14,400
French Creek above French Trib B	JFR006	3.925	1,470	4,200	6,010	7,580	8,610	9,880	12,200	14,000
French Creek below French Trib B	JFR007	5.941	1,820	5,510	7,930	10,000	11,400	13,000	16,000	18,300
French Creek at Prue Road	JFR008	6.709	1,920	6,080	9,010	11,700	13,500	15,000	18,600	21,500
French Creek at Bandera Road	JFR010	7.746	1,790	5,740	8,780	11,800	14,000	15,700	19,200	22,400
French Creek above French Trib A	JFR012	8.475	1,710	5,590	8,760	12,200	14,500	16,400	19,800	23,000
French Creek below French Trib A	JFR013	11.082	1,960	5,920	9,330	13,300	15,900	18,100	21,900	25,400
French Creek above Leon Creek	JFR015	11.632	2,230	5,810	9,180	13,300	16,500	19,100	23,400	27,100
French Trib C headwaters	JFTC01	0.902	500	1,190	1,610	2,000	2,340	2,690	3,210	3,650
French Trib C above French Creek	JFTC03	1.496	940	2,010	2,700	3,320	3,880	4,470	5,330	6,040
French Trib B headwaters	JFTB01	1.142	390	1,400	1,970	2,470	2,900	3,350	4,000	4,550
French Trib B Area 2	JFTB03	1.257	450	1,520	2,110	2,570	2,940	3,410	4,300	4,920
French Trib B above French Creek	JFTB04	1.336	450	1,540	2,150	2,630	3,010	3,500	4,410	5,090
French Trib A headwaters	JFTA01	1.047	1,070	2,080	2,640	3,140	3,660	4,240	5,010	5,670
French Trib A at Braun Road	JFTA03	1.358	1,210	2,440	3,210	3,850	4,510	5,220	6,180	6,970
French Trib A	JFTA05	1.581	1,370	2,840	3,730	4,470	5,240	6,070	7,190	8,110

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
French Trib A above French Creek	JFTA06	2.602	1,220	2,460	3,250	3,960	4,650	5,380	6,470	7,330
French Trib A1	FR-A1	1.021	830	1,950	2,570	3,080	3,590	4,160	4,910	5,570
Lower French Creek headwaters	JLFR01	1.028	760	1,790	2,370	2,850	3,330	3,850	4,560	5,170
Lower French Creek above Leon Creek	JLFR02	1.184	870	2,170	2,840	3,410	3,980	4,600	5,450	6,170
Culebra Creek headwaters	JCC001	1.057	230	1,110	1,670	2,130	2,510	2,900	3,470	3,950
Culebra Creek above Culebra Trib F	JCC003	1.539	250	1,490	2,300	2,970	3,500	4,110	4,940	5,630
Culebra Creek below Culebra Trib F	JCC004	3.394	440	2,900	4,480	5,930	7,040	8,060	9,090	10,400
Culebra Creek above Culebra Trib E	JCC006	4.857	530	3,650	5,840	7,870	9,420	10,900	12,700	14,500
Culebra Creek below Culebra Trib E	JCC007	6.537	660	4,590	7,460	10,100	12,100	14,100	16,600	19,000
Culebra Creek above Government Canyon	JCC009	7.386	650	4,640	7,700	10,800	13,000	15,100	17,900	20,700
Culebra Creek below Government Canyon	JCC010	25.559	1,300	11,600	20,000	29,400	36,000	42,600	52,400	61,000
Culebra Creek above Culebra Trib D	JCC011	26.386	1,220	11,100	19,200	28,700	35,700	42,100	52,200	60,900
Culebra Creek below Culebra Trib D	JCC012	31.881	1,230	12,500	21,600	32,900	40,900	48,400	59,900	70,200
Culebra Creek above Culebra Trib C	JCC013	31.958	1,210	12,400	21,500	32,500	40,700	48,200	59,700	70,000
Culebra Creek below Culebra Trib C	JCC014	37.837	1,240	13,600	23,700	36,700	46,300	55,200	68,600	80,600
Culebra Creek above Culebra Trib B	JCC015	38.585	1,220	13,300	23,400	36,100	44,300	54,200	67,700	80,100
Culebra Creek below Culebra Trib B	JCC016	40.307	1,200	13,300	23,500	36,400	44,600	54,800	68,600	81,100
Culebra Creek above Helotes Creek	JCC017	40.628	1,190	13,000	23,300	35,800	44,000	54,000	67,800	80,300
Culebra Creek below Helotes Creek	JCC018	72.814	1,520	21,100	37,000	55,100	69,200	83,300	104,300	118,800
Culebra Creek above CC-UNT1	JCC020	74.708	1,720	20,700	36,000	53,800	67,200	82,100	103,300	118,100
Culebra Creek below CC-UNT1	JCC021	75.631	1,770	20,700	36,000	53,800	67,200	82,100	103,300	118,200
Culebra Creek above CC-UNT2	JCC022	76.310	1,750	20,500	35,800	53,500	66,700	80,600	101,900	117,000
Culebra Creek below CC-UNT2	JCC023	77.524	1,780	20,400	35,800	53,500	66,700	80,600	101,900	117,200
Culebra Creek above Culebra Trib A	JCC024	78.532	1,760	20,200	35,600	53,100	66,100	79,900	101,000	116,300
Culebra Creek below Culebra Trib A	JCC025	81.777	1,940	20,200	35,700	53,200	66,200	80,100	101,300	116,900
Culebra Creek above Leon Creek	JCC027	82.309	1,910	19,900	35,600	52,900	65,900	79,400	99,900	115,500
Culebra Trib F headwaters	JCTF01	1.391	330	1,370	2,030	2,600	3,080	3,550	4,260	4,850
Culebra Trib F at dam	JCTF02	1.777	330	1,520	2,300	3,040	3,610	4,190	5,080	5,830
Culebra Trib F above Culebra Creek	JCTF03	1.855	220	1,490	2,290	3,040	3,610	4,110	4,690	5,310

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Culebra Trib E headwaters	JCTE01	1.024	260	1,210	1,800	2,260	2,660	3,080	3,680	4,180
Culebra Trib E above Culebra Creek	JCTE02	1.680	160	1,080	1,800	2,470	2,960	3,430	4,190	4,960
Government Canyon headwaters	JGC001	1.074	390	1,620	2,300	2,820	3,310	3,830	4,550	5,160
Government Canyon above GC-UNT1	JGC002	1.291	380	1,620	2,390	3,030	3,560	4,100	4,960	5,660
Government Canyon below GC-UNT1	JGC003	2.263	580	2,560	3,760	4,800	5,650	6,530	7,860	8,980
Government Canyon above GC-UNT2	JGC005	2.968	670	3,000	4,580	5,930	7,080	8,190	9,870	11,300
Government Canyon below GC-UNT2	JGC006	3.472	740	3,390	5,200	6,770	8,070	9,320	11,200	13,000
Government Canyon above GC Trib E	JGC007	3.660	720	3,340	5,160	6,740	8,080	9,410	11,400	13,100
Government Canyon below GC Trib E	JGC008	5.003	920	4,310	6,710	8,910	10,600	12,400	15,100	17,400
Government Canyon above GC Trib D	JGC009	5.257	890	4,270	6,700	8,960	10,700	12,500	15,100	17,400
Government Canyon below GC Trib D	JGC010	6.925	1,070	5,300	8,420	11,400	13,600	15,800	19,200	22,200
Government Canyon above GC-UNT3	JGC012	7.880	1,110	5,780	9,210	12,600	15,100	17,400	21,300	24,500
Government Canyon below GC-UNT3	JGC013	8.641	1,110	6,000	9,600	13,200	15,800	18,400	22,500	26,000
Government Canyon above Wildcat Canyon	JGC014	9.233	1,050	6,020	9,690	13,400	16,100	18,800	23,100	26,800
Government Canyon below Wildcat Canyon	JGC015	10.259	1,060	6,320	10,300	14,300	17,300	20,200	24,800	28,800
Government Canyon above GC Trib C	JGC017	10.615	1,020	6,310	10,300	14,400	17,400	20,400	25,100	29,200
Government Canyon below GC Trib C	JGC018	11.604	1,010	6,560	10,800	15,100	18,400	21,500	26,500	31,000
Government Canyon above GC-UNT4	JGC019	11.947	940	6,400	10,600	15,000	18,300	21,500	26,400	30,900
Government Canyon below GC-UNT4	JGC020	12.392	940	6,470	10,700	15,200	18,600	21,900	26,900	31,500
Government Canyon above GC Trib B	JGC021	12.772	930	6,450	10,800	15,400	18,800	22,100	27,300	32,000
Government Canyon below GC Trib B	JGC022	14.786	960	7,010	11,800	17,000	20,900	24,600	30,500	35,700
Government Canyon above GC Trib A	JGC023	14.818	950	6,970	11,800	17,000	20,900	24,600	30,400	35,600
Government Canyon below GC Trib A	JGC024	17.352	1,070	8,160	13,900	20,200	24,900	29,200	36,200	42,100
Government Canyon above Culebra Creek	JGC025	18.173	1,010	8,020	13,800	20,300	25,100	29,700	36,800	43,000
GC Trib E headwaters	JGCTE01	1.311	390	1,570	2,250	2,830	3,330	3,850	4,600	5,240
GC Trib E above Government Canyon	JGCTE02	1.343	380	1,520	2,240	2,830	3,330	3,840	4,610	5,250
GC Trib D headwaters	JGCTD01	1.000	280	1,390	1,990	2,460	2,890	3,330	3,970	4,500
GC Trib D above GC-D-UNT1	JGCTD02	1.066	280	1,350	1,970	2,500	2,940	3,410	4,070	4,630
GC Trib D below GC-D-UNT1	JGCTD03	1.503	400	1,970	2,870	3,600	4,220	4,880	5,870	6,670

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
GC Trib D above Government Canyon	JGCTD04	1.668	370	1,920	2,920	3,710	4,390	5,070	6,110	7,000
Wildcat Canyon above Government Canyon	WC-1	1.026	250	1,230	1,830	2,300	2,700	3,120	3,730	4,240
GC Trib C above Government Canyon	GC-C-1	0.989	240	1,170	1,730	2,190	2,570	2,970	3,550	4,040
GC Trib B headwaters	JGCTB01	1.401	300	1,470	2,200	2,800	3,300	3,810	4,570	5,200
GC Trib B above GC-B-UNT2	JGCTB03	1.593	290	1,550	2,370	3,070	3,630	4,210	5,070	5,780
GC Trib B below GC-B-UNT2	JGCTB04	1.982	350	1,870	2,890	3,740	4,420	5,140	6,280	7,160
GC Trib B above Government Canyon	JGCTB05	2.014	310	1,780	2,800	3,670	4,350	5,050	6,160	7,060
GC Trib A headwaters	JGCTA01	1.118	320	1,600	2,330	2,880	3,370	3,910	4,650	5,280
GC Trib A above GC-A-UNT1	JGCTA02	1.197	290	1,530	2,300	2,870	3,390	3,910	4,670	5,300
GC Trib A below GC-A-UNT1	JGCTA03	1.438	340	1,850	2,730	3,450	4,060	4,750	5,690	6,460
GC Trib A above GC-A-UNT2	JGCTA04	1.912	290	1,860	2,960	3,870	4,640	5,410	6,540	7,540
GC Trib A below GC-A-UNT2	JGCTA05	2.185	300	1,990	3,190	4,230	5,090	5,910	7,160	8,240
GC Trib A above Government Canyon	JGCTA06	2.534	250	1,820	3,050	4,220	5,060	5,980	7,330	8,500
Culebra Trib D headwaters	JCTD01	1.330	260	1,140	1,710	2,230	2,640	3,040	3,660	4,190
Culebra Trib D above CC-D-UNT2	JCTD02	1.343	260	1,140	1,710	2,240	2,650	3,060	3,690	4,220
Culebra Trib D below CC-D-UNT2	JCTD03	1.791	350	1,530	2,300	3,010	3,570	4,110	4,980	5,670
Culebra Trib D above CC-D-UNT3	JCTD05	2.128	410	1,840	2,800	3,690	4,380	5,060	6,110	6,980
Culebra Trib D below CC-D-UNT3	JCTD06	3.023	570	2,570	3,900	5,090	6,050	6,980	8,430	9,630
Culebra Trib D at Culebra Road	JCTD07	4.179	670	2,870	4,570	6,190	7,530	8,740	10,700	12,400
Culebra Trib D above CC-D-UNT4	JCTD08	4.802	630	2,830	4,480	6,330	7,720	9,110	11,300	13,200
Culebra Trib D below CC-D-UNT4	JCTD09	5.419	630	2,930	4,700	6,700	8,240	9,770	12,200	14,400
Culebra Trib D above Culebra Creek	JCTD10	5.495	630	2,880	4,600	6,610	8,130	9,640	12,100	14,300
Culebra Trib C headwaters	JCTC01	1.000	300	1,180	1,690	2,130	2,510	2,880	3,450	3,920
Culebra Trib C above CC-C-UNT1	JCTC02	2.015	300	1,220	2,040	2,850	3,510	4,220	5,240	6,060
Culebra Trib C below CC-C-UNT1	JCTC03	2.890	480	1,980	2,900	3,970	4,910	5,800	7,320	8,560
Culebra Trib C above Culebra Trib C1	JCTC05	3.407	520	2,200	3,340	4,730	5,840	6,860	8,540	9,970
Culebra Trib C below Culebra Trib C1	JCTC06	4.890	780	3,410	5,190	7,050	8,600	10,000	12,300	14,300
Culebra Trib C above Culebra Creek	JCTC08	5.879	860	3,800	5,960	8,160	9,920	11,600	14,400	16,700
Culebra Trib C1 headwaters	JCTC101	1.005	260	1,050	1,540	1,970	2,320	2,680	3,210	3,650

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Culebra Trib C1 above Culebra Trib C	JCTC102	1.483	280	1,260	1,940	2,520	2,980	3,430	4,130	4,700
Culebra Trib B headwaters	JCTB01	1.017	270	1,060	1,540	1,960	2,320	2,670	3,210	3,650
Culebra Trib B above CC-B-UNT1	JCTB02	1.025	270	1,060	1,550	1,970	2,330	2,680	3,220	3,660
Culebra Trib B below CC-B-UNT1	JCTB03	1.707	440	1,730	2,530	3,240	3,820	4,390	5,280	6,010
Culebra Trib B above Culebra Creek	JCTB04	1.722	440	1,720	2,530	3,240	3,820	4,410	5,300	6,040
Helotes Creek headwaters	JHE001	1.001	250	1,180	1,760	2,210	2,300	3,010	3,600	4,090
Helotes Creek above HE-UNT1	JHE002	1.135	250	1,220	1,830	2,310	2,740	3,170	3,800	4,310
Helotes Creek below HE-UNT1	JHE003	1.474	340	1,610	2,450	3,110	3,680	4,260	5,130	5,840
Helotes Creek above HE-UNT2	JHE005	2.018	440	2,100	3,200	4,150	4,920	5,700	6,850	7,840
Helotes Creek below HE-UNT2	JHE006	2.839	610	2,880	4,400	5,690	6,740	7,790	9,370	10,700
Helotes Creek above Helotes Trib B	JHE007	3.509	570	2,920	4,550	5,990	7,150	8,250	9,960	11,500
Helotes Creek below Helotes Trib B	JHE008	6.436	1,020	5,410	8,430	11,100	13,200	15,300	18,500	21,200
Helotes Creek above Chimenea Creek	JHE009	6.779	1,010	5,430	8,520	11,300	13,500	15,600	18,900	21,700
Helotes Creek below Chimenea Creek	JHE010	13.322	1,150	8,120	14,000	19,700	23,700	27,500	33,300	38,600
Helotes Creek above Los Reyes Creek	JHE011	15.010	1,000	7,660	13,100	19,600	23,900	28,100	34,300	39,800
Helotes Creek below Los Reyes Creek	JHE012	24.192	1,590	11,900	19,400	28,200	34,500	40,800	50,800	59,800
Helotes Creek above Helotes Trib A	JHE014	25.896	1,380	11,700	19,100	28,200	34,900	40,900	42,800	47,600
Helotes Creek below Helotes Trib A	JHE015	27.467	1,380	11,900	19,400	28,800	35,700	42,200	43,400	47,900
Helotes Creek above HE-UNT3	JHE016	30.779	1,110	11,200	18,600	27,300	34,400	41,200	44,100	46,900
Helotes Creek below HE-UNT3	JHE017	32.117	1,240	11,200	18,700	27,300	34,500	41,400	44,500	47,100
Helotes Creek above Culebra Creek	JHE018	32.186	1,190	11,100	18,600	27,200	34,400	41,300	44,500	47,100
Helotes Trib B headwaters	JHETB01	1.327	420	1,750	2,510	3,120	3,660	4,230	5,040	5,720
Helotes Trib B above HE-B-UNT2	JHETB02	2.148	430	2,180	3,360	4,310	5,130	5,940	7,130	8,140
Helotes Trib B below HE-B-UNT2	JHETB03	2.826	530	2,790	4,280	5,610	6,650	7,680	9,230	10,500
Helotes Trib B above Helotes Creek	JHETB04	2.927	510	2,740	4,270	5,590	6,620	7,680	9,270	10,600
Chimenea Creek headwaters	JCH01	1.198	360	1,760	2,560	3,140	3,690	4,270	5,080	5,760
Chimenea Creek above CHI-UNT2	JCH02	1.288	360	1,790	2,560	3,160	3,730	4,320	5,150	5,870
Chimenea Creek below CHI-UNT2	JCH03	1.648	460	2,310	3,400	4,190	4,930	5,710	6,790	7,730
Chimenea Creek above CHI-UNT3	JCH04	2.893	530	3,090	4,750	5,990	7,040	8,130	9,940	11,300

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Chimenea Creek below CHI-UNT3	JCH05	3.874	670	4,010	6,520	7,850	9,220	10,600	13,000	14,900
Chimenea Creek at dam	JCH06	4.460	610	4,180	6,590	8,450	9,950	11,400	13,900	16,000
Chimenea Creek above CHI-UNT4	JCH07	5.608	510	4,280	7,130	9,570	11,300	13,000	15,800	18,200
Chimenea Creek below CHI-UNT4	JCH08	6.120	500	4,400	7,340	9,930	11,800	13,600	16,600	19,100
Chimenea Creek above Helotes Creek	JCH09	6.543	460	4,190	7,160	9,940	11,900	13,800	16,800	19,400
Los Reyes Creek headwaters	JLR01	1.081	310	1,510	2,190	2,720	3,190	3,690	4,400	4,990
Los Reyes Creek at Bandera Road	JLR02	1.976	490	2,550	3,760	4,700	5,540	6,400	7,590	8,590
Los Reyes Creek above Los Reyes Trib A	JLR03	2.655	610	3,030	4,630	5,880	6,940	7,990	9,540	10,800
Los Reyes Creek below Los Reyes Trib A	JLR04	3.905	960	4,620	6,970	8,780	10,300	11,900	14,200	16,000
Los Reyes Creek at Bandera Road	JLR05	4.828	920	4,430	6,350	8,260	10,400	12,400	15,400	18,000
Los Reyes Creek above Ranch Creek	JLR06	5.347	870	4,150	6,010	7,830	9,550	11,500	14,500	17,300
Los Reyes Creek below Ranch Creek	JLR07	7.236	1,010	4,780	6,830	9,000	11,200	13,600	17,600	21,100
Los Reyes Creek above LR-UNT1	JLR09	7.596	1,000	4,810	6,960	9,640	11,200	13,600	17,500	21,000
Los Reyes Creek below LR-UNT1	JLR10	8.267	1,030	4,980	7,370	10,200	12,000	14,200	18,400	22,000
Los Reyes Creek above LR-UNT2	JLR12	8.383	1,030	4,990	7,420	10,300	12,100	14,100	18,300	22,100
Los Reyes Creek below LR-UNT2	JLR13	9.025	1,050	5,160	7,960	11,100	13,100	15,000	19,100	23,100
Los Reyes Creek above Helotes Creek	JLR14	9.182	1,050	5,170	7,970	11,000	13,100	15,000	19,000	22,900
Los Reyes Trib A headwaters	JLRTA01	1.042	360	1,650	2,340	2,850	3,340	3,860	4,590	5,200
Los Reyes Trib A above Los Reyes Creek	JLRTA02	1.250	390	1,720	2,520	3,140	3,660	4,160	4,920	5,570
Ranch Creek headwaters	JRC01	1.536	490	2,260	3,270	4,020	4,710	5,450	5,480	7,350
Ranch Creek above Los Reyes Creek	JRC03	1.889	540	2,480	3,650	4,540	5,340	6,170	7,380	8,410
Helotes Trib A headwaters	JHETA01	1.010	250	1,180	1,720	2,170	2,560	2,950	3,530	4,020
Helotes Trib A above Helotes Creek	JHETA02	1.571	190	1,280	2,010	2,670	3,230	3,790	4,640	5,330
Culebra Trib A headwaters	JCTA01	1.079	900	1,910	2,470	2,980	3,470	4,000	4,740	5,360
Culebra Trib A at Tezel Road	JCTA02	2.051	1,390	2,840	3,760	4,540	5,210	5,900	6,930	7,760
Culebra Trib A above Culebra Creek	JCTA03	3.245	1,360	2,990	4,160	5,270	6,180	7,040	8,400	9,530
Huebner Creek headwaters	JHB01	1.009	1,060	1,840	2,300	2,760	3,210	3,700	4,380	4,960
Huebner Creek above HB-UNT1	JHB02	1.131	1,110	1,920	2,420	2,910	3,430	3,890	4,530	5,110
Huebner Creek below HB-UNT1	JHB03	1.411	1,390	2,450	3,080	3,710	4,360	5,020	5,890	6,560

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Huebner Creek above HB-UNT2	JHB04	1.625	1,340	2,410	3,130	3,830	4,490	5,140	6,100	6,870
Huebner Creek below HB-UNT2	JHB05	1.820	1,450	2,650	3,430	4,210	4,960	5,720	6,800	7,690
Huebner Creek above HB-UNT3	JHB06	1.840	1,450	2,640	3,450	4,240	4,990	5,710	6,780	7,660
Huebner Creek below HB-UNT4	JHB07	2.098	1,590	2,970	3,920	4,850	5,710	6,580	7,830	8,860
Huebner Creek above Babcock Road	JHB08	2.826	1,680	3,330	4,510	5,710	6,740	7,760	9,360	10,700
Huebner Creek above Huebner Trib A	JHB09	4.104	1,360	2,790	3,900	5,200	6,190	7,370	9,230	10,900
Huebner Creek below Huebner Trib A	JHB10	7.926	2,960	6,410	8,660	10,900	13,000	15,100	18,300	21,100
Huebner Creek at Bandera Road	JHB11	9.623	2,740	6,010	8,760	11,500	13,600	15,600	19,000	22,600
Huebner Creek above Leon Creek	JHB13	11.952	3,140	6,920	9,940	13,100	15,700	18,200	22,000	26,000
Huebner Trib A headwaters	JHBTA01	1.107	850	1,930	2,510	3,030	3,530	4,070	4,820	5,460
Huebner Trib A above HB-A-UNT2	JHBTA02	1.424	790	1,830	2,490	3,110	3,660	4,210	5,060	5,780
Huebner Trib A below HB-A-UNT2	JHBTA03	2.111	1,220	2,720	3,770	4,710	5,530	6,390	7,660	8,720
Huebner Trib A above HB-A-UNT3	JHBTA05	2.225	1,230	2,740	3,800	4,780	5,630	6,500	7,810	8,890
Huebner Trib A below HB-A-UNT3	JHBTA06	2.965	1,840	3,890	5,310	6,650	7,800	8,980	10,800	12,200
Huebner Trib A above Huebner Creek	JHBTA08	3.822	2,350	4,880	6,620	8,270	9,690	11,200	13,400	15,300
Leon Trib G headwaters	JLTG01	1.011	710	1,590	2,080	2,530	2,960	3,400	4,040	4,570
Leon Trib G above Leon Creek	JLTG03	1.335	850	2,060	2,730	3,330	3,890	4,470	5,320	6,020
Leon Trib F headwaters	JLTF01	1.166	540	1,470	2,040	2,530	2,970	3,430	4,090	4,640
Leon Trib F above LT-F-UNT2	JLTF02	1.177	520	1,380	1,900	2,360	2,820	3,260	3,850	4,300
Leon Trib F below LT-F-UNT2	JLTF03	1.672	670	1,920	2,670	3,330	3,950	4,620	5,460	6,090
Leon Trib F above Leon Creek	JLTF04	1.690	660	1,920	2,680	3,350	3,980	4,620	5,480	6,130
Slick Ranch Creek headwaters	JSR01	1.002	610	1,590	2,150	2,310	3,050	3,230	4,190	4,750
Slick Ranch Creek above SR-UNT1	JSR02	1.192	570	1,530	2,160	2,690	3,160	3,660	4,390	5,030
Slick Ranch Creek below SR-UNT1	JSR03	1.499	680	1,850	2,630	3,300	3,890	4,500	5,430	6,240
Slick Ranch Creek above SR-UNT2	JSR05	2.317	920	2,630	3,830	4,860	5,720	6,600	7,970	9,240
Slick Ranch Creek below SR-UNT2	JSR06	3.200	1,190	3,420	5,010	6,430	7,590	8,740	10,600	12,200
Slick Ranch Creek above SR-UNT3	JSR08	3.525	1,220	3,530	5,180	6,720	7,950	9,160	11,100	12,800
Slick Ranch Creek below SR-UNT3	JSR09	3.997	1,300	3,870	5,730	7,430	8,780	10,100	12,300	14,300
Slick Ranch Creek above SR-UNT4	JSR11	4.128	1,270	3,830	5,720	7,460	8,820	10,200	12,200	14,100

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Slick Ranch Creek below SR-UNT4	JSR12	4.381	1,300	3,940	5,900	7,710	9,110	10,500	12,700	14,600
Slick Ranch Creek above Slick Ranch Trib B	JSR13	4.797	1,270	3,950	6,010	7,990	9,410	10,900	13,200	15,000
Slick Ranch Creek below Slick Ranch Trib B	JSR14	7.185	1,710	5,240	8,170	11,200	13,400	15,300	18,900	21,700
Slick Ranch Creek above SR-UNT5	JSR15	7.492	1,690	5,190	7,910	10,700	13,000	15,200	18,800	21,800
Slick Ranch Creek below SR-UNT5	JSR16	9.312	2,150	6,070	9,150	12,400	15,100	18,100	22,500	26,100
Slick Ranch Creek above Slick Ranch Trib A	JSR17	9.745	2,120	6,080	9,170	12,500	15,000	17,700	22,000	25,400
Slick Ranch Creek below Slick Ranch Trib A	JSR18	10.553	2,310	6,400	9,600	13,100	15,600	18,500	23,100	26,700
Slick Ranch Creek above SR-UNT6	JSR20	10.625	2,320	6,410	9,610	13,100	15,600	18,500	23,100	26,400
Slick Ranch Creek below SR-UNT6	JSR21	11.006	2,410	6,570	9,840	13,500	16,000	19,000	23,700	27,000
Slick Ranch Creek above Leon Creek	JSR23	11.529	2,460	6,670	9,970	13,600	16,200	19,000	23,400	26,000
Slick Ranch Trib B headwaters	JSRTB01	1.266	880	2,050	2,730	3,310	3,860	4,460	5,290	5,990
Slick Ranch Trib B above UNT2 & UNT3	JSRTB02	1.293	830	1,860	2,480	3,040	3,560	4,100	4,870	5,510
Slick Ranch Trib B below UNT2 & UNT3	JSRTB03	2.016	1,280	2,890	3,830	4,700	5,500	6,310	7,520	8,500
Slick Ranch Trib B above Slick Ranch Creek	JSRTB05	2.388	1,400	3,250	4,390	5,420	6,300	7,210	8,480	9,550
Slick Ranch Trib A above Slick Ranch Creek	SR-A	0.808	590	1,130	1,480	1,810	2,120	2,440	2,900	3,290
Westwood Village headwaters	JWV01	1.338	930	1,890	2,480	3,040	3,550	4,090	4,860	5,520
Westwood Village at Old Hwy 90	JWV02	1.634	980	1,980	2,490	2,980	3,450	3,930	4,680	5,340
Westwood Village above Leon Creek	JWV03	1.839	940	1,800	2,280	2,830	3,440	4,010	4,820	5,530
Leon Trib E headwaters	JLTE01	1.122	710	1,610	2,140	2,630	3,070	3,540	4,210	4,770
Leon Trib E Area 2	JLTE02	1.318	710	1,640	2,230	2,790	3,280	3,770	4,520	5,140
Leon Trib E above Leon Trib E1	JLTE03	1.569	690	1,680	2,380	3,030	3,570	4,110	4,940	5,640
Leon Trib E below Leon Trib E1	JLTE04	2.883	1,070	2,850	4,150	5,410	6,410	7,410	8,960	10,200
Leon Trib E above Leon Creek	JLTE06	3.062	1,090	3,000	4,360	5,680	6,750	7,770	9,240	10,300
Leon Trib E1 headwaters	JLTE101	0.968	450	1,300	1,800	2,220	2,600	3,000	3,580	4,060
Leon Trib E1 at Kenley Avenue	JLTE102	1.021	470	1,350	1,870	2,320	2,710	3,120	3,720	4,220
Leon Trib E1 Area 3	JLTE103	1.134	510	1,450	2,020	2,510	2,950	3,400	4,060	4,600
Leon Trib E1 above Leon Trib E	JLTE105	1.314	610	1,760	2,440	3,030	3,550	4,090	4,870	5,520
Leon Trib D headwaters	JLTD01	0.970	760	1,420	1,830	2,230	2,600	2,990	3,560	4,030

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Trib D above Leon Creek	JLTD03	1.165	890	1,730	2,240	2,730	3,180	3,660	4,350	4,920
Leon Trib C headwaters	JLTC01	2.233	1,730	2,950	3,760	4,600	5,370	6,160	7,340	8,320
Leon Trib C above Leon Creek	JLTC03	2.358	1,470	2,410	3,140	3,960	4,670	5,440	6,810	7,810
Leon Trib B headwaters	JLTB01	1.190	850	1,490	1,920	2,370	2,760	3,160	3,780	4,270
Leon Trib B above LT-B-UNT2	JLTB02	1.225	870	1,510	1,950	2,410	2,810	3,210	3,840	4,340
Leon Trib B below LT-B-UNT2	JLTB03	1.468	1,000	1,880	2,450	3,020	3,540	4,060	4,840	5,490
Leon Trib B at IH35	JLTB05	1.768	1,180	2,180	2,590	2,900	3,140	3,420	3,780	4,460
Leon Trib B above LT-B-UNT3	JLTB07	2.235	1,460	2,800	3,400	3,910	4,360	4,780	5,380	5,840
Leon Trib B below LT-B-UNT3	JLTB08	2.489	1,670	3,190	4,000	4,640	5,210	5,760	6,530	7,140
Leon Trib B above Leon Creek	JLTB10	2.623	1,730	3,410	4,240	4,930	5,510	6,090	6,920	7,540
Leon Trib A headwaters	JLTA01	1.004	790	1,550	2,010	2,440	2,850	3,270	3,890	4,400
Leon Trib A above LT-A-UNT1	JLTA02	1.082	840	1,640	2,120	2,580	3,010	3,460	4,110	4,650
Leon Trib A below LT-A-UNT1	JLTA03	1.561	1,210	2,320	3,000	3,650	4,260	4,890	5,820	6,580
Leon Trib A at Durette Drive	JLTA04	1.724	1,270	2,550	3,300	4,030	4,700	5,400	6,430	7,280
Leon Trib A above Leon Creek	JLTA05	1.993	1,270	2,690	3,570	4,420	5,170	5,960	7,180	8,130
Indian Creek headwaters	JIN01	0.959	600	1,640	2,200	2,660	3,100	3,600	4,260	4,830
Indian Creek above IN-UNT2	JIN02	1.132	600	1,640	2,310	2,840	3,330	3,840	4,580	5,190
Indian Creek below IN-UNT2	JIN03	1.338	710	1,930	2,680	3,330	3,920	4,530	5,420	6,160
Indian Creek above IN-UNT3	JIN04	1.358	710	1,940	2,710	3,350	3,930	4,520	5,410	6,140
Indian Creek below IN-UNT3	JIN05	1.642	870	2,350	3,300	4,110	4,840	5,610	6,700	7,600
Indian Creek above IN-UNT4 & IN-UNT5	JIN07	2.648	1,210	3,080	4,420	5,460	6,310	7,150	8,470	9,520
Indian Creek below IN-UNT4 & IN-UNT5	JIN08	3.395	1,540	3,820	5,590	7,000	8,100	9,210	10,900	12,200
Indian Creek above IN-UNT6	JIN10	3.903	1,620	4,000	5,750	7,410	8,700	9,840	11,700	13,000
Indian Creek below IN-UNT6	JIN11	4.591	1,920	4,650	6,670	8,630	10,100	11,500	13,700	15,300
Indian Creek above IN-UNT7	JIN13	4.944	1,870	4,670	6,670	8,510	10,000	11,500	13,800	15,600
Indian Creek below IN-UNT7	JIN14	5.288	1,940	4,900	7,000	8,940	10,500	12,100	14,500	16,500
Indian Creek above Indian Trib A	JIN16	6.192	1,820	4,350	5,860	7,470	8,660	10,200	13,400	16,400
Indian Creek below Indian Trib A	JIN17	7.504	1,970	4,640	6,140	7,810	9,010	10,900	14,600	18,200
Indian Creek at Somerset Road	JIN19	7.971	1,930	4,600	6,110	7,790	9,000	10,800	14,400	18,100

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Indian Creek above IN-UNT8	JIN21	8.350	1,830	4,500	6,020	7,710	8,920	10,600	13,900	17,600
Indian Creek below IN-UNT8	JIN22	8.611	1,830	4,500	6,030	7,720	8,930	10,600	13,900	17,600
Indian Creek at dam	JIN23	9.258	1,750	4,410	5,960	7,690	8,910	10,600	13,900	17,600
Indian Creek above IN-UNT9	JIN25	10.180	1,660	4,230	5,810	7,470	8,740	10,300	13,200	16,400
Indian Creek below IN-UNT9	JIN26	10.880	1,650	4,230	5,810	7,480	8,770	10,400	13,300	16,600
Indian Creek above Leon Creek	JIN27	10.971	1,640	4,210	5,800	7,450	8,750	10,400	13,300	16,500
Indian Trib A headwaters	JITA01	1.158	500	1,370	1,900	2,370	2,790	3,200	3,830	4,350
Indian Trib A above Indian Creek	JITA03	1.312	490	1,380	1,960	2,500	2,960	3,420	4,120	4,700
Comanche Creek headwaters	JCO01	1.754	750	2,120	2,940	3,670	4,310	4,950	5,920	6,720
Comanche Creek above COM-UNT2	JCO02	2.109	670	2,020	2,950	3,810	4,510	5,200	6,270	7,160
Comanche Creek below COM-UNT2	JCO03	2.464	740	2,300	3,390	4,380	5,180	5,980	7,240	8,270
Comanche Creek above COM-UNT3	JCO05	2.604	730	2,280	3,390	4,410	5,240	6,070	7,360	8,430
Comanche Creek below COM-UNT3	JCO06	3.222	810	2,740	4,100	5,410	6,420	7,420	9,000	10,300
Comanche Creek above COM-UNT4	JCO08	3.825	860	3,080	4,720	6,290	7,500	8,660	10,500	12,100
Comanche Creek below COM-UNT4	JCO09	4.213	910	3,330	5,120	6,870	8,190	9,480	11,600	13,300
Comanche Creek above Leon Creek	JCO10	4.674	820	3,290	5,130	6,990	8,380	9,750	11,900	13,700

USGS Stream Gage Sites

The United States Geological Survey maintains two stream flow gages in the Leon Creek watershed: Leon Creek at I-35 and Helotes Creek at Helotes. Information on each stream gage is published annually in the USGS *Water Resources Data* report for the State of Texas. Data from these gages was used to compute a statistical peak discharge-frequency analysis and flood hydrograph reproductions for hydrologic model verification.

Leon Creek at Interstate Highway 35

The following gage description and data were published by USGS in *Water Resources Data – Texas*, 2002, Volume 5, page 166.

> The Leon Creek at I-35 at San Antonio, TX gage (station number 08181480) is located on the left bank between bridges on I-35 in San Antonio, 1.7 miles northeast of the intersection of I-35 and Loop 410, and 11.8 miles upstream from the mouth.

Drainage area of Leon Creek at the gage is 219 square miles. Discharge data is available for the period October 1984 to present. Maximum discharge observed at this gage was 93,300 cfs on October 17, 1998 (an indirect measurement from a floodmark of 29.31 feet).

The USGS produced a paper, “Summary of Estimated Discharge,” to discuss the October 1998 storm. The paper discussed the process used to estimate the peak flow rate during this event, including identifying an acceptable cross-section location and high-water mark to estimate the flow rate. The cross-section location was approximately two miles upstream of the I-35 crossing. The paper rated this discharge estimate as fair (10–15 percent error).

Helotes Creek at Helotes

Information for the Helotes Creek at Helotes gage was published in the *Water Resources Data – Texas*, 2002, Volume 5, page 162.

> The Helotes Creek at Helotes, TX gage (station number 08181400) is located 42 feet to the left and 44 feet downstream from the centerline of the bridge on State Highway 16, 0.1 miles northwest of Helotes, and 8.6 miles upstream from the mouth.

The drainage area at the gage is 15.0 square miles. Discharge data is available from June 1968 to present. The maximum discharge at this gage of 12,600 cfs (from a rating curve extended above the discharge measurement of 4,960 cfs) occurred on October 18, 1998. Peak stage was 15.21 feet (from floodmark).

Statistical Peak Discharge-Frequency Analysis

To verify hydrologic modeling parameters and loss rates, a statistical peak discharge frequency analysis was performed. The USACE Flood Frequency Analysis (HEC-FFA) software was used in the statistical evaluation of peak discharges at the two USGS gages in the Leon Creek Watershed. These analyses followed guidance provided in the U.S. Water Resources Council Bulletin Number 17B, “Guidelines for Determining Flood Flow Frequency,” dated September 1981. When a station’s systematic record exhibited a standard deviation in excess of 0.5, its generalized skew coefficient was reduced in accordance with Southwestern Division USACE guidance dated December 1985. The generalized skew coefficient is reduced to prevent exaggeration of the projected peak discharges for the rarer flood events, when the standard deviation of the log-transformed annual peak discharge series exceeds 0.5. The statistical effect is to reduce the upward curvature at the rare end of the projected discharge-frequency curve.

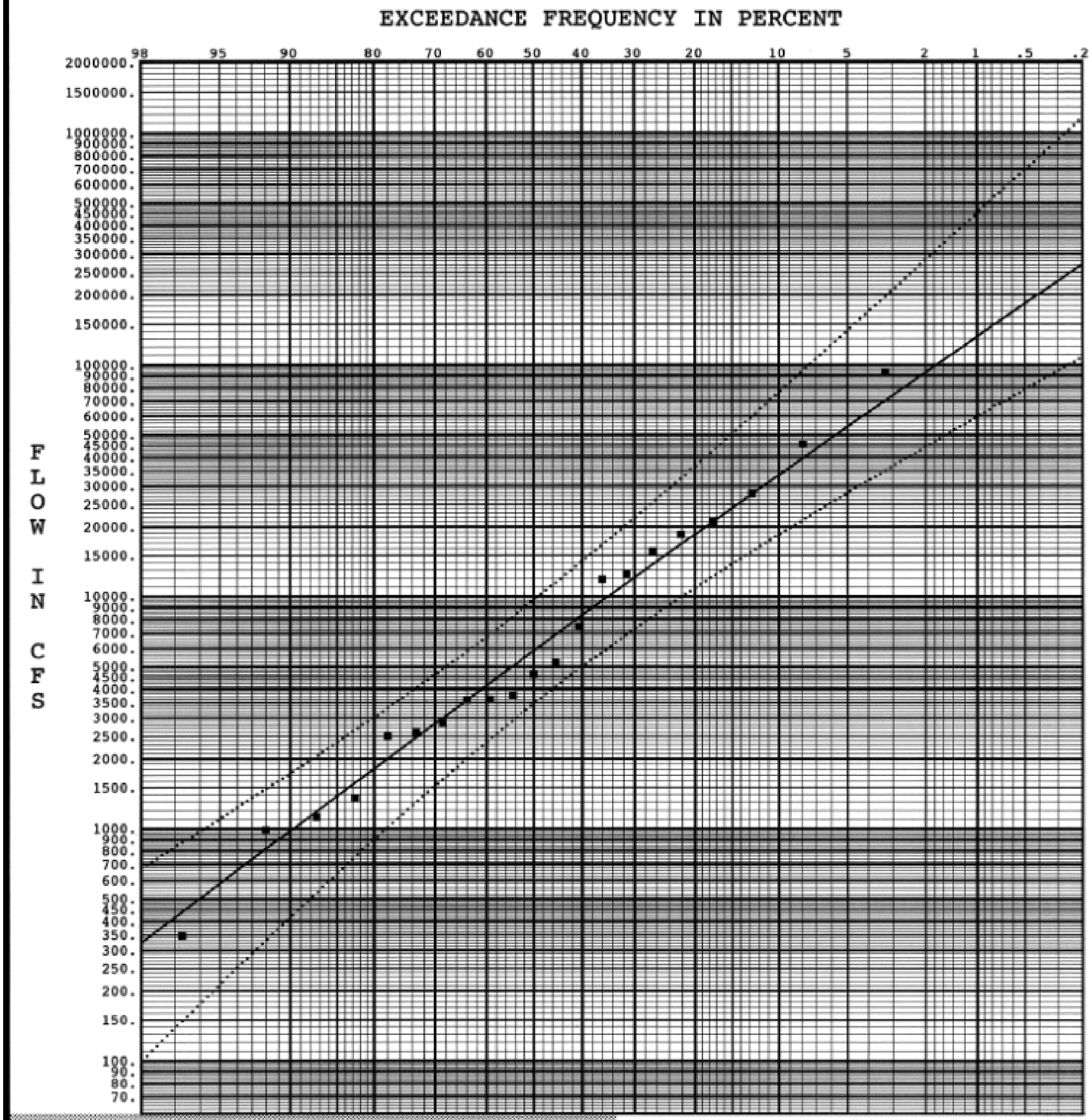
Leon Creek at I-35 Gage

The annual peak series available at the Leon Creek gage extends from 1985 to present. For the purpose of establishing an estimate of the 100-year peak discharge, this 21-year period-of-record is short but does provide a meaningful indication for the more frequent events. The extreme annual peaks in this record include readings of 93,300 cfs (17 October 1998), 45,600 cfs (02 July 2002), and 27,900 cfs (22 June 1997). Frequency analyses based upon the systematic 21-year record produced a 100-year peak discharge estimate of 133,000 cfs.

Helotes Creek at Helotes Gage

The annual peak series available at the Helotes Creek gage extends from 1969 to present. For the purpose of establishing an estimate of the 100-year peak discharge, this 37-year period-of-record is sufficient. The more extreme annual peaks in this record include 12,600 cfs (18 October 1998), 10,900 cfs (02 July 2002), 7,680 cfs (16 July 1973), and 7,140 cfs (11 June 1987). Frequency analyses based upon the systematic 37-year record produced a 100-year peak discharge estimate of 33,400 cfs. Extending the record to consider the longest known period over which the October 1998 discharge level has not been exceeded (since 1923 in this case) lowers this projection to 30,200 cfs.

On the following pages, Plates 2A and 2B show graphical results of the frequency analyses for the Leon Creek at I-35 gage and the Helotes Creek at Helotes gage, respectively.



—— FLOW Frequency (without Exp. Prob.)

■ Median Plotting Positions

······· 5% and 95% Confidence Limits

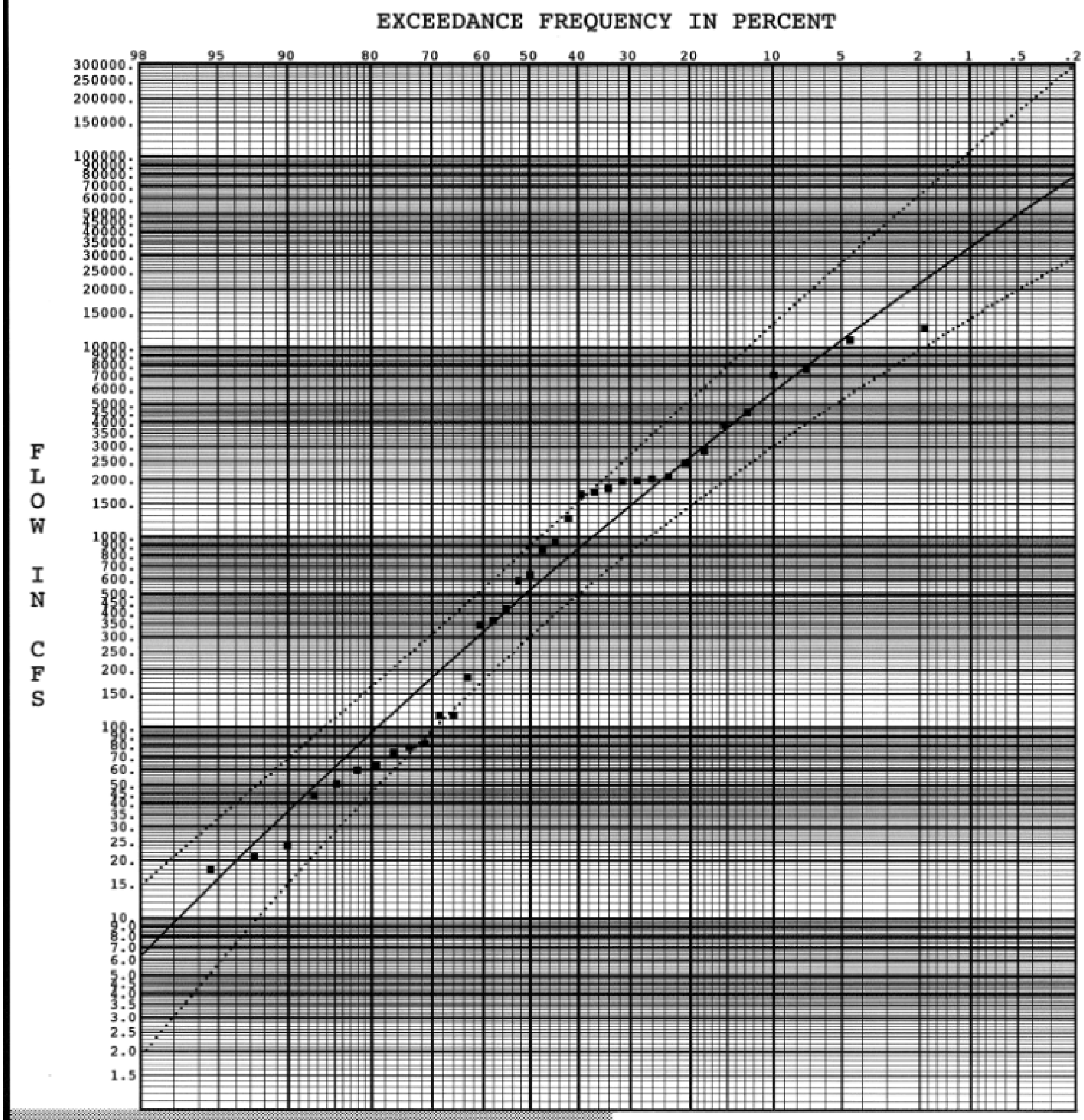
FREQUENCY STATISTICS

LOG TRANSFORM OF FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.7610	HISTORIC EVENTS	0
STANDARD DEV	.5985	HIGH OUTLIERS	0
SKEW	.0709	LOW OUTLIERS	0
REGIONAL SKEW	-.2600	ZERO OR MISSING	0
ADOPTED SKEW	-.0694	SYSTEMATIC EVENTS	21

DISCHARGE VS. FREQUENCY CURVE

Leon Creek at IH 35
Drainage Area = 219 sq.miles
Systematic Record
Water Years: 1985-2005

PLATE 2A



—— FLOW Frequency (without Exp. Prob.)
■ Median Plotting Positions
········ 5% and 95% Confidence Limits

FREQUENCY STATISTICS
LOG TRANSFORM OF FLOW, CFS

NUMBER OF EVENTS

MEAN	2.6860	HISTORIC EVENTS	0
STANDARD DEV	.8610	HIGH OUTLIERS	0
SKEW	-.1848	LOW OUTLIERS	0
REGIONAL SKEW	-.4200	ZERO OR MISSING	0
ADOPTED SKEW	-.2593	SYSTEMATIC EVENTS	37

DISCHARGE VS. FREQUENCY CURVE

Helotes Creek at Helotes
Drainage Area = 15.0 sq.miles
Systematic Record
Water Years: 1969-2005

PLATE 2B

Table G.1-6 presents a comparison of the computed (simulated) 1% ACE discharge and the statistical analysis.

Table G.1-6. Comparison of Simulated and Frequency Analysis

Gage Site	1% ACE Simulated	1% ACE Frequency Analysis
Leon Creek at I-35	116,000 cfs	133,000 cfs
Helotes Creek at Helotes	28,100 cfs	30,200 cfs

Flood Hydrograph Reproduction

The USGS published gage readings for several significant flood events for both the Leon Creek at I-35 gage and the Helotes Creek at Helotes gage. Of particular note were the storms of June 1997, October 1998, and July 2002. However, according to the USGS, the recorded data from these events is of questionable reliability.

SARA obtained rainfall data for these major storms from OneRain, Inc. This 15-minute interval rainfall data was input to the HEC-HMS watershed model, and a storm reproduction was performed for all three significant events. Table G.1-7 shows a comparison between the observed flood peaks at the Leon Creek at I-35 and Helotes Creek at Helotes gages and the simulated flood peaks produced by HEC-HMS.

Table G.1-7. Comparison of Observed and Simulated Flows (cfs)

	June 1997		October 1998		July 2002	
Gage Site	Observed	Simulated	Observed	Simulated	Observed	Simulated
Leon Creek at I-35	27,900	51,448	93,300	82,416	45,600	38,783
Helotes Creek at Helotes	4,560	11,754	12,600	7,887	10,900	5,402

Model Verification

Because the data for the significant floods of record was of questionable reliability according to the USGS, more emphasis was placed on the frequency analysis to verify the watershed modeling parameters of initial loss and infiltration rates, Snyder’s lag time (t_p), and Snyder’s peaking coefficient (c_p).

Conclusion

The recent high flows that have occurred, the results of the frequency analyses, along with the increased urbanization in the Leon Creek Watershed, justify the higher discharges computed for the feasibility study. The without-project discharges will be used as the baseline for comparison with the future without-project condition discharges.

FUTURE CONDITIONS HYDROLOGIC ANALYSIS

Future without-project conditions discharge-frequency relationships were developed based on anticipated changes in land use, urbanization, and impervious percentage values. Future hydrologic parameters based on land use, such as lag time, were projected to year 2035. While climate models indicate that average temperatures in central Texas will rise significantly over the coming decades, there is a high level of uncertainty in precipitation predictions at the watershed scale. Future precipitation in central Texas may be more or less than present day; therefore, rainfall values in the hydrologic model were kept the same for existing and future conditions.

Future Land Use

A future land use raster dataset was provided by the San Antonio River Authority (SARA). Major categories include land use codes for undeveloped, residential, commercial, industrial, transportation, extraction, open space, services, water, and mixed use. Each land use type is associated with an impervious cover percent and a percent urbanization. Land use types, associated impervious cover, and percent urbanization are shown in table G.1-3 on page G.1-6.

Upon inspection of the future land use dataset, SARA and USACE determined that portions of the land use dataset were incorrectly classified. SARA, USACE, and Halff Associates agreed to modify the future land use data file to correctly reflect the future conditions. The major modifications consisted of changing parks classified as Commercial to Undeveloped. Other minor modifications were made in smaller subbasins to show the correct hydrologic results.

Lag Time Parameters

Snyder's lag time (t_p) was calculated using future conditions urbanization in the same manner as lag time was calculated for existing conditions (see "Lag Time Parameters" on page G.1-7). Table G.1-8 contains the unit hydrograph data for future conditions. Snyder's lag time values ranged from a minimum of 0.04 hours to a maximum of 0.96 hours for subbasins in the Leon Creek Watershed. The mean value was 0.32 hours.

Table G.1-8. Unit Hydrograph Data – Future Modified

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
BT-1 headwaters	1.024	1.556	0.537	105.60	77.76	0.218	0.22	46.37
BT-2 ab BT-UNT1	0.377	1.302	0.723	137.28	54.46	0.251	0.25	34.16
BT-3 ab BT-UNT2	2.193	3.765	1.742	47.52	65.75	0.603	0.60	48.22
BT-4 ab LC	0.676	2.908	1.454	31.68	79.89	0.505	0.51	49.32
BT-UNT1	0.995	2.018	0.827	95.04	41.49	0.363	0.36	22.62
BT-UNT2	0.940	2.946	1.518	79.20	65.40	0.473	0.47	38.96
CC-1 headwaters	1.057	2.388	1.201	116.16	10.12	0.521	0.52	6.20
CC-10 ab CC-UNT2	0.679	2.282	1.110	47.52	86.15	0.370	0.37	63.73

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
CC-11 ab CC-A	1.008	2.419	1.107	52.80	84.21	0.375	0.37	57.30
CC-12 ab LC	0.532	2.125	0.798	36.96	83.09	0.339	0.34	51.72
CC-2 ab CC-F	0.482	1.540	0.829	42.24	58.16	0.345	0.35	30.00
CC-3 ab CC-E	1.463	4.068	0.719	31.68	58.36	0.501	0.50	34.55
CC-4 ab GC	0.849	2.832	1.310	31.68	54.09	0.563	0.56	31.12
CC-5 ab CC-D	0.827	2.347	1.385	26.40	38.42	0.610	0.61	23.74
CC-6 ab CC-C	0.077	0.627	0.270	36.96	55.60	0.166	0.17	26.41
CC-7 ab CC-B	0.748	2.165	1.317	36.96	75.36	0.434	0.43	55.27
CC-8 ab HE	0.321	1.967	1.058	79.20	89.59	0.304	0.30	87.83
CC-9 ab CC-UNT1	1.894	3.079	1.577	47.52	86.40	0.474	0.47	65.95
CC-A-1 headwaters	1.079	2.022	0.949	58.08	83.83	0.325	0.32	54.35
CC-A-2 at Tezel Rd	0.972	1.864	1.045	63.36	84.77	0.319	0.32	57.52
CC-A-3 ab CC	1.194	2.376	1.119	42.24	82.30	0.394	0.39	51.62
CC-B-1 headwaters	1.017	2.318	1.339	63.36	88.77	0.372	0.37	55.14
CC-B-2 ab CC-B-UNT1	0.008	0.135	0.076	132.00	90.00	0.036	0.04	89.24
CC-B-3 ab CC	0.015	0.308	0.104	89.76	90.00	0.060	0.06	90.00
CC-B-UNT1	0.682	2.557	1.382	63.36	88.95	0.391	0.39	52.84
CC-C-1 headwaters	1.000	2.373	1.153	105.60	68.92	0.399	0.40	37.42
CC-C-2 ab CC-C-UNT1	1.015	2.379	0.909	42.24	57.27	0.425	0.42	33.54
CC-C-3 ab CC-C1	0.517	2.352	1.253	26.40	57.27	0.524	0.52	35.82
CC-C-4 ab CC	0.989	2.790	1.311	26.40	59.43	0.561	0.56	35.08
CC-C-UNT1	0.875	2.233	1.148	58.08	73.03	0.387	0.39	36.45
CC-C1-1 headwaters	1.005	2.449	1.007	52.80	28.35	0.466	0.47	17.67
CC-C1-2 ab CC-C	0.478	1.456	0.676	36.96	70.97	0.296	0.30	42.55
CC-D-1 headwaters	0.726	2.905	1.445	26.40	70.53	0.553	0.55	41.03
CC-D-2 ab CC-D-UNT2	0.013	0.213	0.075	100.32	45.65	0.059	0.06	21.68
CC-D-3 ab CC-D-UNT3	0.337	1.530	0.721	79.20	71.43	0.267	0.27	34.98
CC-D-4 at Culebra Rd	1.156	1.797	1.353	63.36	75.79	0.367	0.37	55.93
CC-D-5 ab UNT4	0.623	2.107	0.621	36.96	63.91	0.345	0.35	37.21
CC-D-6 ab CC	0.076	0.621	0.280	58.08	56.17	0.153	0.15	31.35
CC-D-UNT1	0.604	2.087	1.050	36.96	76.89	0.388	0.39	41.10
CC-D-UNT2	0.448	1.200	0.621	84.48	78.67	0.217	0.22	46.65
CC-D-UNT3	0.895	2.599	1.401	31.68	68.62	0.511	0.51	42.05
CC-D-UNT4	0.617	1.679	0.860	105.60	88.99	0.251	0.25	51.45
CC-E-1 headwaters	1.024	2.038	0.943	121.44	2.93	0.463	0.46	1.64
CC-E-2 ab CC	0.656	2.431	1.281	31.68	54.09	0.526	0.53	30.21
CC-F-1 headwaters	0.997	2.629	1.616	73.92	18.01	0.629	0.63	15.50
CC-F-2 at dam	0.386	1.416	0.545	36.96	61.79	0.286	0.29	31.30
CC-F-3 ab CC	0.078	0.618	0.210	58.08	55.29	0.138	0.14	26.29
CC-F-UNT1	0.394	1.342	0.744	52.80	7.26	0.411	0.41	16.57
CC-UNT1	0.923	2.861	1.306	26.40	85.32	0.483	0.48	58.35
CC-UNT2	1.214	2.925	1.191	26.40	84.80	0.472	0.47	57.06

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)		Rounded	Imperv. Cover (%)
						Computed t_p (hours)		
CHI-1 headwaters	0.736	1.550	0.698	126.72	79.85	0.230	0.23	37.96
CHI-2 ab CHI-UNT2	0.090	0.520	0.180	374.88	80.00	0.073	0.07	38.00
CHI-3 ab CHI-UNT3	1.245	2.475	1.091	89.76	69.91	0.371	0.37	33.73
CHI-4 at dam	0.586	1.387	0.374	174.24	66.47	0.177	0.18	34.30
CHI-5 ab CHI-UNT4	1.148	3.084	1.332	52.80	67.88	0.488	0.49	32.52
CHI-6 ab HE	0.423	1.393	0.640	116.16	66.72	0.235	0.24	32.08
CHI-UNT1	0.462	1.300	0.671	168.96	80.02	0.200	0.20	38.53
CHI-UNT2	0.360	1.119	0.535	190.08	80.00	0.169	0.17	38.00
CHI-UNT3	0.981	1.973	0.858	126.72	78.99	0.274	0.27	37.72
CHI-UNT4	0.512	1.242	0.588	242.88	74.74	0.180	0.18	35.50
COM-1 headwaters	1.140	2.618	1.085	36.96	89.32	0.398	0.40	79.18
COM-2 ab COM-UNT2	0.355	1.339	0.590	36.96	94.60	0.236	0.24	72.68
COM-3 ab COM-UNT3	0.140	0.739	0.047	36.96	94.83	0.071	0.07	72.18
COM-4 ab COM-UNT4	0.603	1.633	0.860	47.52	94.86	0.280	0.28	72.10
COM-5 ab LC	0.461	1.743	0.740	42.24	94.91	0.277	0.28	72.33
COM-UNT1	0.614	1.978	0.912	42.24	92.59	0.319	0.32	76.43
COM-UNT2	0.355	1.970	0.985	36.96	94.46	0.333	0.33	73.93
COM-UNT3	0.618	1.904	1.029	36.96	94.96	0.333	0.33	72.14
COM-UNT4	0.388	2.087	0.933	21.12	94.97	0.370	0.37	72.11
FR-1 headwaters	0.741	2.186	1.169	89.76	55.14	0.397	0.40	42.04
FR-2 ab FR-UNT2	0.019	0.294	0.118	79.20	25.16	0.094	0.09	20.67
FR-3 ab FR-C	0.227	1.405	0.662	47.52	56.36	0.302	0.30	42.43
FR-4 ab FR-B	0.063	0.617	0.408	31.68	86.13	0.165	0.16	60.06
FR-5 be Prue Rd	0.768	1.884	0.876	47.52	82.73	0.320	0.32	49.95
FR-6 at Bandera Rd	1.037	2.230	0.745	47.52	82.58	0.322	0.32	50.40
FR-7 ab FR-A	0.729	3.324	1.393	58.08	85.93	0.449	0.45	66.75
FR-8 ab LC	0.550	1.588	0.623	26.40	81.16	0.298	0.30	48.35
FR-A-1 headwaters	1.047	1.782	0.772	63.36	86.17	0.277	0.28	61.32
FR-A-2 at Braun Rd	0.311	1.179	0.551	79.20	86.19	0.199	0.20	60.57
FR-A-3 ab FR-A1	0.223	1.446	0.557	58.08	82.04	0.235	0.24	48.61
FR-A-4 ab FR	0.005	0.229	0.121	36.96	80.67	0.071	0.07	41.49
FR-A1	1.021	1.910	0.670	73.92	82.86	0.267	0.27	51.54
FR-B-1 headwaters	1.142	2.155	1.082	79.20	67.39	0.364	0.36	49.39
FR-B-2	0.115	1.358	0.674	47.52	89.69	0.245	0.24	87.36
FR-B-3 ab FR-B-UNT1	0.079	0.640	0.198	47.52	85.99	0.118	0.12	70.32
FR-B-UNT1	0.680	1.779	0.846	42.24	84.20	0.314	0.31	54.80
FR-C-1 headwaters	0.902	2.243	1.031	31.68	68.24	0.431	0.43	55.82
FR-C-2 ab FR	0.594	2.082	1.820	52.80	84.36	0.428	0.43	75.49
FR-UNT1	0.521	1.623	0.844	126.72	22.12	0.358	0.36	19.17
FR-UNT2	0.858	2.567	1.185	95.04	39.32	0.463	0.46	27.66
GC-1 headwaters	1.074	1.589	0.633	121.44	65.78	0.246	0.25	36.69
GC-10 ab GC-B	0.380	1.721	0.843	73.92	10.47	0.436	0.44	6.65

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)		Rounded	Imperv. Cover (%)
						Computed t_p (hours)		
GC-11 ab GC-A	0.032	0.479	0.185	52.80	35.30	0.137	0.14	17.49
GC-12 ab CC	0.821	1.834	0.906	31.68	59.05	0.402	0.40	29.87
GC-2 ab GC-UNT1	0.217	0.966	0.507	63.36	31.96	0.260	0.26	22.15
GC-3 ab GC-UNT2	0.705	1.688	0.773	105.60	15.60	0.379	0.38	9.16
GC-4 ab GC-E	0.188	0.768	0.361	195.36	0.00	0.205	0.20	0.00
GC-5 ab GC-D	0.254	0.984	0.523	89.76	0.00	0.301	0.30	0.00
GC-6 ab GC-UNT3	0.955	2.030	1.108	68.64	0.00	0.558	0.56	0.02
GC-7 ab WC	0.592	1.748	0.762	95.04	0.00	0.429	0.43	0.00
GC-8 ab GC-C	0.356	1.359	0.473	121.44	0.00	0.310	0.31	0.00
GC-9 ab GC-UNT4	0.343	1.896	1.067	31.68	0.09	0.621	0.62	0.31
GC-A-1 headwaters	1.118	1.604	0.706	168.96	0.00	0.361	0.36	0.00
GC-A-2 ab GC-A-UNT1	0.079	0.582	0.310	549.12	0.00	0.142	0.14	0.00
GC-A-3 ab GC-A-UNT2	0.474	1.718	0.872	84.48	0.29	0.458	0.46	0.23
GC-A-4 ab GC	0.349	2.097	1.138	47.52	47.80	0.457	0.46	25.07
GC-A-UNT1	0.241	0.902	0.442	242.88	0.12	0.225	0.23	0.12
GC-A-UNT2	0.273	1.046	0.454	237.60	21.86	0.212	0.21	11.49
GC-B-1 headwaters	0.971	2.451	1.289	100.32	0.00	0.591	0.59	0.00
GC-B-2 ab GC-B-UNT2	0.192	1.420	0.756	95.04	34.55	0.320	0.32	19.79
GC-B-3 ab GC	0.032	0.348	0.164	58.08	39.48	0.111	0.11	18.75
GC-B-UNT1	0.430	1.926	0.943	142.56	0.07	0.447	0.45	0.28
GC-B-UNT2	0.389	1.805	0.961	95.04	47.79	0.354	0.35	24.80
GC-C-1 headwaters	0.989	1.888	1.073	142.56	0.00	0.466	0.47	0.00
GC-D-1 headwaters	1.000	1.787	0.698	126.72	0.16	0.395	0.40	0.88
GC-D-2 ab GC-D-UNT1	0.066	0.466	0.151	316.80	0.00	0.110	0.11	0.00
GC-D-3 ab GC	0.165	0.863	0.386	285.12	0.00	0.204	0.20	0.00
GC-D-UNT1	0.437	1.235	0.647	211.20	0.00	0.303	0.30	0.00
GC-E-1 headwaters	0.710	2.353	1.133	116.16	27.51	0.455	0.46	20.61
GC-E-2 ab GC	0.032	0.402	0.170	126.72	0.00	0.130	0.13	0.00
GC-E-UNT1	0.601	2.140	1.061	126.72	14.94	0.455	0.45	18.40
GC-UNT1	0.972	2.628	1.370	100.32	68.05	0.410	0.41	33.52
GC-UNT2	0.504	1.857	0.986	121.44	30.35	0.384	0.38	17.43
GC-UNT3	0.761	1.397	0.685	195.36	2.82	0.323	0.32	6.30
GC-UNT4	0.445	2.091	1.184	84.48	0.00	0.556	0.56	0.06
HB-1 headwaters	1.009	1.890	0.777	26.40	91.26	0.325	0.33	80.48
HB-2 ab HB-UNT1	0.122	0.830	0.282	142.56	93.77	0.115	0.11	73.97
HB-3 ab HB-UNT2	0.214	0.850	0.364	63.36	89.91	0.153	0.15	66.93
HB-4 ab HB-UNT3	0.020	0.320	0.150	100.32	80.89	0.072	0.07	42.65
HB-5 ab Babcock Rd	0.728	1.864	0.695	42.24	63.13	0.337	0.34	39.51
HB-6 ab HB-A	1.278	2.559	1.250	42.24	69.37	0.458	0.46	47.78
HB-7 at Bandera Rd	1.697	2.633	1.018	31.68	75.30	0.436	0.44	61.58
HB-8 ab LC	2.329	4.129	1.964	31.68	75.59	0.666	0.67	59.44
HB-A-1 headwaters	0.617	2.061	1.188	68.64	86.01	0.340	0.34	78.81

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
HB-A-2 ab HB-A-UNT2	0.317	1.024	0.477	84.48	36.78	0.238	0.24	27.89
HB-A-3 ab HB-A-UNT3	0.114	0.726	0.294	105.60	88.33	0.121	0.12	81.39
HB-A-4 ab HB	0.857	1.892	0.935	52.80	87.22	0.314	0.31	78.81
HB-A-UNT1	0.490	1.092	0.836	95.04	53.78	0.267	0.27	36.19
HB-A-UNT2	0.687	1.828	0.785	79.20	89.83	0.264	0.26	81.39
HB-A-UNT3	0.740	2.082	0.975	89.76	89.76	0.294	0.29	75.80
HB-UNT1	0.280	1.169	0.523	79.20	90.01	0.190	0.19	64.68
HB-UNT2	0.195	1.100	0.514	79.20	84.95	0.190	0.19	55.68
HB-UNT3	0.258	1.001	0.439	63.36	85.48	0.180	0.18	56.76
HE-1 headwaters	1.001	2.205	0.882	121.44	79.12	0.291	0.29	37.74
HE-2 ab HE-UNT1	0.134	0.628	0.261	295.68	79.40	0.095	0.10	37.78
HE-3 ab HE-UNT2	0.544	1.456	0.842	121.44	68.90	0.260	0.26	33.02
HE-4 ab HE-B	0.670	1.828	0.826	121.44	58.10	0.301	0.30	32.58
HE-5 ab CHI	0.343	1.002	0.351	200.64	50.97	0.163	0.16	28.99
HE-6 ab LR	1.688	3.281	1.407	42.24	41.45	0.626	0.63	26.18
HE-7 ab HE-A	1.704	2.821	1.520	68.64	42.37	0.551	0.55	36.82
HE-8 ab HE-UNT3	3.332	5.470	2.310	31.68	82.43	0.757	0.76	61.93
HE-9 ab CC	0.069	0.705	0.369	68.64	89.68	0.141	0.14	83.10
HE-A-1 headwaters	1.010	2.083	1.105	121.44	1.19	0.501	0.50	0.83
HE-A-2 ab HE	0.561	2.283	1.327	63.36	41.85	0.492	0.49	27.90
HE-B-1 headwaters	0.741	1.769	0.833	79.20	56.54	0.327	0.33	31.76
HE-B-2 ab HE-B-UNT2	0.821	2.435	1.102	73.92	59.75	0.408	0.41	30.15
HE-B-3 ab HE	0.101	0.713	0.337	195.36	40.79	0.151	0.15	24.67
HE-B-UNT1	0.586	1.380	1.163	132.00	49.16	0.320	0.32	27.57
HE-B-UNT2	0.678	2.049	0.854	126.72	63.71	0.305	0.31	31.91
HE-UNT1	0.339	1.148	0.538	195.36	78.40	0.172	0.17	37.36
HE-UNT2	0.821	2.487	1.291	100.32	67.92	0.392	0.39	33.79
HE-UNT3-1	1.011	2.875	1.465	21.12	82.32	0.537	0.54	61.04
HE-UNT3-2	0.307	1.633	0.911	36.96	85.78	0.317	0.32	69.33
HUE-1 headwaters	1.029	1.717	0.912	110.88	10.91	0.415	0.41	5.94
HUE-2 ab HUE-UNT1	0.014	0.242	0.120	649.44	67.35	0.045	0.05	31.99
HUE-3 ab HUE-B	0.423	1.346	0.558	68.64	64.78	0.247	0.25	38.54
HUE-4 ab HUE-A	0.561	1.915	0.987	63.36	86.21	0.313	0.31	57.77
HUE-5 ab HUE-UNT2	0.200	1.021	0.573	36.96	82.68	0.226	0.23	51.25
HUE-6 ab LC	0.451	2.117	1.307	31.68	89.33	0.405	0.41	70.39
HUE-A	0.972	2.625	1.300	79.20	70.91	0.413	0.41	45.51
HUE-B	1.102	2.086	1.070	110.88	17.59	0.456	0.46	10.02
HUE-UNT1	0.556	1.495	0.780	121.44	61.60	0.267	0.27	34.89
HUE-UNT2	0.756	2.539	1.343	63.36	83.77	0.398	0.40	56.76
IN-1 headwaters	0.553	1.456	0.472	52.80	82.88	0.224	0.22	57.60
IN-10 at dam	0.647	1.320	0.455	63.36	90.00	0.197	0.20	90.00
IN-11 ab IN-UNT9	0.922	2.003	1.133	26.40	90.00	0.387	0.39	90.00

	Area	L	L_{ca}	S_{st}	Urban.		Rounded	Imperv. Cover
Subbasin	(sq. mi.)	(miles)	(miles)	(fpm)	(%)	Computed t_p (hours)		(%)
IN-12 ab LC	0.091	0.794	0.422	105.60	88.72	0.144	0.14	83.50
IN-2 ab IN-UNT2	0.173	0.955	0.386	63.36	70.02	0.184	0.18	48.25
IN-3 ab IN-UNT3	0.020	0.425	0.208	89.76	82.50	0.092	0.09	49.63
IN-4 ab IN-UNT4&5	1.006	2.631	0.899	42.24	83.65	0.374	0.37	53.55
IN-5 ab IN-UNT6	0.508	1.718	1.005	52.80	82.59	0.320	0.32	51.04
IN-6 ab IN-UNT7	0.353	1.258	0.249	68.64	81.79	0.159	0.16	46.85
IN-7 ab IN-A	0.904	2.410	1.125	31.68	81.61	0.422	0.42	61.16
IN-8 at Somerset Rd	0.467	1.485	0.645	36.96	90.07	0.261	0.26	89.74
IN-9 ab IN-UNT8	0.379	1.299	0.594	15.84	90.00	0.283	0.28	90.00
IN-A-1 headwaters	0.724	2.521	1.347	42.24	66.31	0.478	0.48	60.45
IN-A-2 ab IN	0.154	1.130	0.639	47.52	82.13	0.234	0.23	71.59
IN-A-UNT1	0.434	1.918	1.054	42.24	56.88	0.415	0.42	39.44
IN-UNT1	0.406	1.586	0.650	42.24	32.26	0.373	0.37	26.82
IN-UNT2	0.206	0.986	0.474	79.20	54.99	0.212	0.21	37.92
IN-UNT3	0.284	1.118	0.694	95.04	83.09	0.210	0.21	51.64
IN-UNT4	0.391	1.376	0.701	68.64	85.60	0.239	0.24	58.06
IN-UNT5	0.356	1.848	1.072	47.52	83.05	0.343	0.34	52.66
IN-UNT6	0.688	2.593	1.740	58.08	85.18	0.447	0.45	63.90
IN-UNT7	0.344	1.501	0.789	68.64	81.21	0.265	0.27	42.33
IN-UNT8	0.261	1.122	0.451	52.80	90.00	0.191	0.19	90.00
IN-UNT9	0.700	2.482	1.065	36.96	87.16	0.392	0.39	76.07
LC -1 headwater	0.746	1.752	0.773	153.12	79.42	0.242	0.24	37.78
LC-10 at Camp Bullis	3.909	3.166	1.036	47.52	63.31	0.470	0.47	37.88
LC-11 ab Loop1604	3.971	5.332	3.156	31.68	62.13	0.957	0.96	54.27
LC-12 ab LT-I	1.384	2.800	1.385	31.68	88.44	0.464	0.46	81.06
LC-13 ab BT	0.851	2.828	1.286	36.96	80.96	0.460	0.46	47.63
LC-14 ab HUE	0.002	0.122	0.079	110.88	80.80	0.038	0.04	42.17
LC-15 ab LT-H	1.120	2.421	0.763	47.52	85.17	0.330	0.33	56.09
LC-16 ab FR	2.889	4.901	1.836	26.40	72.87	0.730	0.73	50.18
LC-17 ab LFR	1.309	2.950	1.642	42.24	74.01	0.522	0.52	56.25
LC-18 ab CC	0.856	2.403	1.282	31.68	81.01	0.445	0.44	57.75
LC-19 ab HB	0.794	2.013	1.023	26.40	83.54	0.388	0.39	53.45
LC-2 ab UNT2	0.125	0.674	0.284	364.32	69.16	0.103	0.10	34.45
LC-20 ab LT-G	0.926	2.516	1.186	47.52	88.67	0.388	0.39	79.98
LC-21 ab LT-F	1.785	4.045	1.805	21.12	90.79	0.630	0.63	69.28
LC-22 ab SR	0.471	1.976	0.393	26.40	82.06	0.270	0.27	46.29
LC-23 ab WV	0.448	1.816	0.395	21.12	82.46	0.272	0.27	49.00
LC-24 ab LT-E	2.324	4.179	1.832	21.12	77.77	0.695	0.69	60.40
LC-25 ab LT-D	0.382	1.364	0.583	42.24	17.37	0.370	0.37	14.79
LC-26 at Military Dr	3.818	3.780	2.225	47.52	64.95	0.667	0.67	49.28
LC-27 ab LT-C	0.266	1.365	0.617	31.68	65.76	0.297	0.30	51.83
LC-28 at New Laredo	2.001	3.562	1.149	15.84	80.54	0.568	0.57	60.58

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LC-28A	0.694	2.050	0.919	84.48	59.37	0.348	0.35	43.33
LC-29 ab LT-B	1.709	3.157	1.477	26.40	67.20	0.587	0.59	54.78
LC-3 ab UNT3	0.542	1.755	0.646	190.08	61.81	0.242	0.24	31.55
LC-30 ab LT-A	1.902	3.197	1.729	21.12	91.07	0.565	0.57	79.84
LC-31 ab IN	0.483	1.929	0.798	31.68	91.15	0.320	0.32	84.69
LC-32 at Applewhite	2.176	3.219	1.807	21.12	91.81	0.574	0.57	67.73
LC-33 ab COM	2.879	4.830	2.397	26.40	94.93	0.702	0.70	72.24
LC-34 ab Medina Riv	0.952	3.020	1.370	21.12	95.00	0.494	0.49	72.00
LC-4 ab LT-N	0.504	1.522	0.864	58.08	70.11	0.305	0.31	33.37
LC-5 ab PC	1.204	2.031	1.122	121.44	67.74	0.332	0.33	32.78
LC-6 ab LT-M	1.495	2.387	1.018	84.48	45.12	0.419	0.42	27.17
LC-7 ab LT-L	1.778	2.848	1.319	36.96	47.73	0.571	0.57	28.61
LC-8 ab LT-K	0.600	1.434	0.544	63.36	66.53	0.251	0.25	61.41
LC-9 ab LT-J	1.318	2.178	1.030	31.68	80.86	0.394	0.39	43.26
LC-N-1 headwater	1.002	2.410	1.255	126.72	80.00	0.341	0.34	38.08
LC-UNT1	0.646	1.746	0.873	132.00	78.00	0.263	0.26	37.54
LC-UNT2	0.482	1.498	0.744	142.56	77.39	0.231	0.23	37.01
LC-UNT3	0.348	1.293	0.632	105.60	51.28	0.255	0.25	29.30
LFR-1 headwaters	0.681	1.962	0.985	52.80	80.60	0.338	0.34	58.64
LFR-2 ab LC	0.156	0.698	0.247	36.96	64.73	0.158	0.16	59.04
LFR-UNT1	0.347	1.029	0.454	105.60	66.43	0.187	0.19	43.75
LR-1 headwaters	1.081	1.687	0.683	137.28	79.99	0.232	0.23	38.00
LR-2 at Bandera Rd	0.895	1.435	0.545	168.96	68.97	0.205	0.21	39.28
LR-3 ab LR-A	0.679	1.658	0.768	110.88	19.54	0.363	0.36	20.24
LR-4 at Bandera Rd	0.923	1.526	0.589	126.72	50.81	0.256	0.26	28.49
LR-5 ab RC	0.519	1.417	0.660	68.64	49.47	0.294	0.29	31.66
LR-6 ab LR-UNT1	0.360	1.319	0.729	121.44	19.37	0.321	0.32	13.62
LR-7 ab UNT2	0.116	0.960	0.459	153.12	34.52	0.207	0.21	30.66
LR-8 ab HE	0.157	0.694	0.476	137.28	35.81	0.188	0.19	26.76
LR-A-1 headwaters	0.594	1.493	0.711	163.68	75.69	0.223	0.22	37.43
LR-A-2 ab LR	0.208	1.211	0.589	168.96	55.59	0.215	0.22	39.38
LR-A-UNT1	0.448	1.217	0.575	132.00	66.45	0.210	0.21	34.00
LR-UNT1	0.671	1.802	0.933	89.76	54.38	0.340	0.34	34.32
LR-UNT2	0.642	1.790	0.916	116.16	13.24	0.412	0.41	7.94
LT-A-1 headwaters	1.004	2.246	1.006	26.40	89.65	0.388	0.39	69.30
LT-A-2 ab LT-A-UNT1	0.078	0.762	0.364	52.80	90.00	0.152	0.15	90.00
LT-A-3 at Durette Dr	0.163	0.842	0.286	31.68	90.00	0.158	0.16	90.00
LT-A-4 ab LC	0.269	1.188	0.597	52.80	85.78	0.223	0.22	66.81
LT-A-UNT1	0.479	2.457	1.369	26.40	88.67	0.454	0.45	73.91
LT-B-1 headwaters	0.976	2.540	1.297	10.56	89.22	0.536	0.54	70.77
LT-B-2 ab LT-B-UNT2	0.035	0.428	0.224	42.24	89.16	0.106	0.11	72.24
LT-B-3 ab IH35	0.300	0.951	0.274	31.68	92.33	0.161	0.16	76.40

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LT-B-4 ab LT-B-UNT3	0.467	1.551	0.611	36.96	89.10	0.261	0.26	68.62
LT-B-5 ab LC	0.134	1.153	0.486	42.24	74.34	0.228	0.23	57.48
LT-B-UNT1	0.214	0.852	0.414	42.24	90.07	0.173	0.17	72.75
LT-B-UNT2	0.243	1.022	0.505	15.84	93.30	0.237	0.24	72.20
LT-B-UNT3	0.254	1.251	0.768	31.68	88.46	0.272	0.27	66.44
LT-C-1 headwaters	1.145	3.491	1.728	15.84	95.00	0.603	0.60	72.00
LT-C-2 ab LC	0.125	1.001	0.471	21.12	93.45	0.217	0.22	73.59
LT-C-UNT1	1.088	3.006	1.310	15.84	93.70	0.516	0.52	72.87
LT-D-1 headwaters	0.970	2.309	1.250	21.12	92.03	0.438	0.44	70.71
LT-D-2 ab LC	0.195	1.208	0.642	26.40	66.56	0.296	0.30	51.36
LT-E-1 headwaters	1.122	2.147	1.070	42.24	68.92	0.405	0.40	61.98
LT-E-2 (da 1.3)	0.196	1.228	0.718	73.92	39.13	0.302	0.30	32.01
LT-E-3 ab LT-E-1	0.251	1.509	0.369	84.48	7.16	0.301	0.30	6.08
LT-E-4 ab LC	0.179	0.862	0.233	36.96	1.30	0.247	0.25	1.02
LT-E1-1 headwaters	0.630	2.021	0.850	26.40	35.19	0.487	0.49	27.79
LT-E1-2 at Kenley Av	0.053	0.540	0.246	52.80	30.00	0.165	0.17	25.00
LT-E1-3 (da 1.13)	0.113	0.521	0.204	89.76	30.00	0.137	0.14	25.00
LT-E1-4 ab LT-E	0.180	1.025	0.548	126.72	27.97	0.246	0.25	23.35
LT-E1-UNT1	0.338	1.372	0.537	21.12	31.87	0.375	0.38	27.03
LT-F-1 headwaters	0.985	2.632	0.949	36.96	84.00	0.391	0.39	69.05
LT-F-2 ab UNT2	0.011	0.413	0.199	10.56	81.09	0.137	0.14	43.96
LT-F-3 ab LC	0.018	0.356	0.178	31.68	69.17	0.108	0.11	35.19
LT-F-UNT1	0.181	1.028	0.527	15.84	93.99	0.241	0.24	75.62
LT-F-UNT2	0.495	1.890	0.891	26.40	50.76	0.440	0.44	40.69
LT-G-1 headwaters	1.011	2.426	1.183	73.92	88.11	0.352	0.35	67.20
LT-G-2 ab LC	0.324	1.462	0.768	42.24	91.06	0.269	0.27	64.41
LT-H-1 headwaters	1.008	2.440	1.198	31.68	86.74	0.421	0.42	60.63
LT-H-2	0.464	1.176	0.594	63.36	86.72	0.213	0.21	64.47
LT-H-3 ab LC	0.332	1.512	0.857	42.24	85.21	0.294	0.29	57.56
LT-I-1 headwaters	1.005	2.469	1.239	84.48	88.40	0.351	0.35	81.22
LT-I-2 ab LC	0.318	1.094	0.390	84.48	81.28	0.172	0.17	44.68
LT-J-1 headwaters	0.762	1.827	0.912	116.16	58.88	0.314	0.31	31.41
LT-J-2 ab LT-UNT2&3	0.315	1.223	0.469	121.44	48.39	0.220	0.22	34.26
LT-J-3 ab LC	0.182	1.024	0.384	163.68	75.97	0.152	0.15	45.22
LT-J-UNT1	0.384	1.139	0.586	174.24	71.97	0.189	0.19	35.23
LT-J-UNT2	0.264	1.167	0.675	174.24	47.44	0.234	0.23	31.74
LT-J-UNT3	0.228	1.140	0.587	179.52	38.80	0.230	0.23	24.13
LT-J-UNT4	0.394	1.515	0.998	137.28	73.05	0.268	0.27	54.54
LT-K-1 headwaters	1.047	2.133	1.074	79.20	41.48	0.424	0.42	41.86
LT-K-2 ab LT-K-UNT1	0.103	0.683	0.356	174.24	57.09	0.140	0.14	57.41
LT-K-3 ab LT-K-UNT2	0.280	1.828	0.929	52.80	56.61	0.373	0.37	55.09
LT-K-4 ab LT-K2	0.498	1.661	0.897	73.92	31.44	0.388	0.39	30.45

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
LT-K-5 ab LT-K1	0.452	1.559	0.700	105.60	65.33	0.261	0.26	66.39
LT-K-6 ab LC	0.021	0.287	0.152	68.64	90.00	0.071	0.07	90.00
LT-K-UNT1	0.939	2.509	1.129	63.36	26.95	0.525	0.52	23.79
LT-K-UNT2	0.825	2.274	1.153	73.92	35.77	0.469	0.47	24.44
LT-K1	1.019	1.943	1.140	84.48	45.05	0.405	0.40	27.19
LT-K2-1 headwaters	1.143	3.182	1.580	63.36	44.14	0.589	0.59	35.01
LT-K2-2 ab LT-K	0.030	1.134	0.576	63.36	81.32	0.214	0.21	82.62
LT-K2-UNT1	0.431	1.765	0.841	95.04	19.65	0.397	0.40	23.80
LT-L-1 headwater	0.796	2.306	0.853	116.16	57.27	0.338	0.34	32.06
LT-L-2 ab LC	0.137	0.799	0.454	258.72	60.04	0.149	0.15	40.03
LT-L-UNT1	0.379	1.362	0.624	137.28	36.20	0.371	0.37	31.83
LT-M-1headwaters	0.910	2.155	0.695	47.52	45.56	0.388	0.39	31.42
LT-M-2 ab UNT2	0.345	1.200	0.504	121.44	55.10	0.216	0.22	30.16
LT-M-3 ab LT-M1	0.966	2.043	0.841	95.04	56.06	0.336	0.34	32.25
LT-M-4 ab LC	0.599	1.532	1.072	79.20	43.74	0.368	0.37	28.14
LT-M-UNT1	0.434	1.460	0.729	137.28	79.23	0.226	0.23	37.79
LT-M-UNT2	0.709	2.097	0.990	132.00	70.56	0.310	0.31	34.25
LT-M1-1 headwater	0.908	1.812	0.791	73.92	36.20	0.371	0.37	31.83
LT-M1-2 ab UNT2	0.130	0.748	0.283	200.64	33.39	0.150	0.15	25.92
LT-M1-3 ab UNT3	0.140	0.645	0.178	195.36	40.31	0.114	0.11	31.05
LT-M1-4 ab LT-M	0.195	0.720	0.135	279.84	33.88	0.104	0.10	24.89
LT-M1-UNT1	0.397	1.361	0.678	116.16	33.58	0.292	0.29	25.31
LT-M1-UNT2	0.288	1.128	0.573	132.00	56.21	0.216	0.22	36.00
LT-M1-UNT3	0.371	1.139	0.468	147.84	28.16	0.234	0.23	22.73
LT-N-2 ab LC	0.155	0.819	0.534	264.00	72.91	0.147	0.15	35.07
LT-N-UNT1	0.315	1.122	0.518	232.32	80.00	0.161	0.16	38.00
PC-1 headwater	1.078	1.636	0.856	137.28	72.12	0.262	0.26	35.58
PC-2 ab UNT1	0.724	1.741	0.750	100.32	48.79	0.312	0.31	28.87
PC-3 ab LC	0.893	2.243	1.268	79.20	59.16	0.414	0.41	30.52
PC-UNT1	0.489	1.455	0.482	95.04	75.18	0.212	0.21	36.41
RC-1 headwaters	0.843	1.577	0.480	147.84	8.33	0.302	0.30	4.08
RC-2 ab LR	0.353	1.174	0.513	258.72	26.12	0.223	0.22	20.80
RC-UNT1	0.693	1.665	0.833	121.44	13.38	0.383	0.38	11.26
SR-1 headwaters	1.002	1.771	0.658	52.80	90.03	0.263	0.26	89.42
SR-10 ab LC	0.523	1.685	0.757	31.68	85.63	0.308	0.31	63.09
SR-2 ab SR-UNT1	0.190	0.860	0.394	110.88	89.23	0.143	0.14	86.24
SR-3 ab SR-unt2	0.818	1.646	0.807	58.08	88.08	0.275	0.27	75.65
SR-4 ab SR-UNT3	0.325	1.390	0.586	47.52	86.41	0.239	0.24	71.29
SR-5 ab SR-UNT4	0.131	0.988	0.527	47.52	82.80	0.206	0.21	52.27
SR-6 ab SR-B	0.416	1.964	1.136	36.96	90.21	0.361	0.36	82.50
SR-7 ab SR-UNT5	0.307	1.391	0.645	21.12	92.63	0.279	0.28	80.54
SR-8 ab SR-A	0.433	1.530	0.781	42.24	83.71	0.288	0.29	51.11

Subbasin	Area (sq. mi.)	L (miles)	L_{ca} (miles)	S_{st} (fpm)	Urban. (%)	Computed t_p (hours)	Rounded	Imperv. Cover (%)
SR-9 ab SR-UNT6	0.072	0.635	0.314	68.64	82.97	0.133	0.13	50.04
SR-A	0.808	2.367	1.531	31.68	86.48	0.458	0.46	71.07
SR-B-1 headwaters	0.948	2.272	0.927	58.08	84.82	0.334	0.33	55.92
SR-B-2 ab SR-B-UNT2	0.027	0.475	0.215	47.52	85.81	0.108	0.11	60.97
SR-B-3 ab SR	0.372	1.664	0.698	52.80	89.36	0.264	0.26	74.27
SR-B-UNT1	0.318	1.413	0.794	52.80	80.61	0.274	0.27	40.86
SR-B-UNT2	0.616	2.387	1.110	47.52	83.65	0.382	0.38	55.47
SR-B-UNT3	0.107	0.740	0.378	73.92	91.59	0.141	0.14	75.33
SR-UNT1	0.307	1.214	0.581	84.48	89.40	0.199	0.20	84.76
SR-UNT2	0.883	1.873	0.809	84.48	89.55	0.266	0.27	86.44
SR-UNT3	0.472	1.722	1.186	79.20	87.69	0.306	0.31	74.55
SR-UNT4	0.253	1.524	0.683	84.48	86.49	0.235	0.24	68.94
SR-UNT5	1.820	3.184	1.330	42.24	88.96	0.453	0.45	74.35
SR-UNT6	0.381	2.207	1.029	10.56	89.00	0.465	0.46	64.01
WC-1 headwaters	1.026	2.047	0.945	137.28	0.00	0.461	0.46	0.00
WV-1 headwaters	0.990	2.643	1.120	15.84	83.52	0.492	0.49	55.49
WV-2 at Old Hwy 90	0.296	1.172	0.558	31.68	83.35	0.242	0.24	54.36
WV-3 ab LC	0.205	1.143	0.633	58.08	90.25	0.215	0.21	81.80
WV-UNT1	0.348	1.531	0.705	47.52	83.04	0.272	0.27	52.08

Channel Routing Procedures

The modified Puls routing method was used for all routing reaches. The valley storage versus discharge relationships were derived from backwater analyses using HEC-RAS, version 3.1.2. For a more detailed description of the hydraulic modeling process, see “Hydraulic Analysis” beginning on page G.1-62. The future conditions discharges exceeded the limits on the existing routing. Modifications were made to the existing channel routing in 14 reaches due to the increased discharges in the future conditions. These modifications consisted of linearly extrapolating the tables so the future discharges fall within the limits of the tables.

Future Condition Discharge-Frequency Relationships

On the next page, Table G.1-9 presents the discharges for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% ACE storms for future conditions.

Table G.1-9. Peak Discharges (cfs) – Future Without-Project

	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
Discharge Location			2	5	10	25	50	100	250	500
Leon Creek headwaters	JLC001	1.392	1,030	2,820	3,700	4,420	5,150	5,960	7,040	7,970
Leon Creek above LC-UNT2	JLC002	1.517	1,100	2,920	3,890	4,650	5,390	6,240	7,360	8,320
Leon Creek below LC-UNT2	JLC003	1.999	1,450	3,930	5,210	6,220	7,220	8,360	9,870	11,200
Leon Creek above LC-UNT3	JLC005	2.541	1,590	4,370	5,870	7,090	8,280	9,540	11,300	12,800
Leon Creek below LC-UNT3	JLC006	2.889	1,760	4,870	6,510	7,890	9,250	10,700	12,700	14,300
Leon Creek above Leon Trib N	JLC007	3.393	1,690	4,790	6,650	8,090	9,430	10,800	12,900	14,500
Leon Creek below Leon Trib N	JLC008	4.865	2,170	6,080	8,690	10,700	12,400	14,200	16,800	18,900
Leon Creek above Pecan Creek	JLC009	6.069	2,310	6,640	9,610	12,200	14,300	16,100	18,700	21,000
Leon Creek below Pecan Creek	JLC010	9.253	3,270	9,340	13,800	17,600	20,800	23,800	28,500	32,300
Leon Creek above Leon Trib M	JLC011	10.748	3,310	9,830	14,600	19,000	22,500	25,800	30,800	34,900
Leon Creek below Leon Trib M	JLC012	17.140	4,960	15,100	22,500	29,500	35,000	40,300	48,200	54,800
Leon Creek above Leon Trib L	JLC013	18.918	4,600	12,200	21,000	28,400	34,000	39,900	48,300	55,400
Leon Creek below Leon Trib L	JLC014	20.230	4,600	12,300	21,200	28,800	34,400	40,600	49,300	56,700
Leon Creek above Leon Trib K	JLC016	20.830	4,550	12,000	19,400	27,500	33,100	38,900	47,700	56,700
Leon Creek below Leon Trib K	JLC017	27.618	5,360	13,200	23,500	33,100	40,300	47,400	58,200	69,400
Leon Creek above Leon Trib J	JLC018	28.936	5,240	13,100	22,300	32,400	39,600	46,800	57,900	68,100
Leon Creek below Leon Trib J	JLC019	31.465	5,270	13,100	22,400	32,800	40,100	47,700	59,300	69,700
Leon Creek at Camp Bullis	JLC020	35.374	5,070	13,000	20,900	31,400	38,900	46,700	59,000	70,100
Leon Creek at Loop 1604	JLC021	39.345	4,900	12,800	19,500	28,800	35,900	43,200	56,400	68,400
Leon Creek above Leon Trib I	JLC022	40.729	4,860	12,800	19,300	28,300	35,400	42,600	54,900	67,100
Leon Creek below Leon Trib I	JLC023	42.052	4,870	12,800	19,400	28,300	35,400	42,700	54,900	67,200
Leon Creek above Babcock Trib	JLC025	42.903	4,800	12,700	19,200	27,800	34,900	42,100	54,100	66,300
Leon Creek below Babcock Trib	JLC026	49.108	4,900	12,900	19,300	28,000	35,200	42,500	54,700	67,400
Leon Creek above Huesta Creek	JLC027	49.110	4,900	12,900	19,300	28,000	35,200	42,500	54,700	67,400
Leon Creek below Huesta Creek	JLC028	55.174	4,920	12,900	19,400	27,900	35,300	42,800	55,000	68,100
Leon Creek above Leon Trib H	JLC029	56.294	4,900	12,900	19,300	27,700	34,900	42,300	54,200	67,300
Leon Creek below Leon Trib H	JLC030	58.098	5,030	13,000	19,300	27,700	34,900	42,400	54,300	67,400

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Creek above French Creek	JLC032	60.987	5,250	13,500	19,700	27,400	34,600	42,100	53,700	66,900
Leon Creek below French Creek	JLC033	72.619	6,910	17,500	25,900	34,900	42,900	51,000	62,700	74,700
Leon Creek above Lower French Creek	JLC035	73.928	6,900	17,400	25,700	35,100	42,900	51,200	63,400	75,600
Leon Creek below Lower French Creek	JLC036	75.112	6,930	17,500	25,800	35,200	43,100	51,400	63,800	76,000
Leon Creek above Culebra Creek	JLC037	75.968	6,880	17,300	25,300	34,700	42,400	50,600	63,200	75,400
Leon Creek below Culebra Creek	JLC038	158.277	10,500	35,700	55,300	78,400	94,700	113,000	142,100	168,600
Leon Creek above Huebner Creek	JLC040	159.071	10,400	35,300	55,100	78,100	94,600	112,800	141,500	168,200
Leon Creek below Huebner Creek	JLC041	171.023	11,900	36,800	57,800	81,900	99,200	117,500	148,200	179,500
Leon Creek above Leon Trib G	JLC043	171.949	11,800	36,500	57,700	81,600	99,000	117,300	147,900	178,900
Leon Creek below Leon Trib G	JLC044	173.284	11,900	36,600	57,800	81,700	99,100	117,400	148,100	179,200
Leon Creek above Leon Trib F	JLC046	175.069	11,700	36,200	57,600	81,400	99,100	117,400	147,700	178,700
Leon Creek below Leon Trib F	JLC047	176.759	11,800	36,300	57,700	81,500	99,200	117,600	147,900	179,100
Leon Creek above Slick Ranch Creek	JLC048	177.230	11,700	36,200	57,700	81,500	99,200	117,600	147,900	179,100
Leon Creek below Slick Ranch Creek	JLC049	188.759	12,200	36,700	58,600	82,500	100,700	119,300	150,000	182,100
Leon Creek above Westwood Village	JLC050	189.207	12,200	36,400	58,300	82,200	100,700	119,300	149,900	181,900
Leon Creek below Westwood Village	JLC051	191.046	12,300	36,400	58,400	82,300	100,800	119,500	150,200	182,300
Leon Creek above Leon Trib E	JLC053	193.370	12,200	36,100	58,100	82,000	100,800	119,500	149,900	181,900
Leon Creek below Leon Trib E	JLC054	196.432	12,200	36,200	58,200	82,100	101,000	119,800	150,300	182,400
Leon Creek above Leon Trib D	JLC056	196.814	12,200	36,100	58,100	82,000	100,900	119,800	150,100	182,300
Leon Creek below Leon Trib D	JLC057	197.979	12,200	36,100	58,200	82,100	101,000	119,900	150,300	182,500
Leon Creek at Military Drive	JLC058	201.797	12,200	36,000	57,900	81,900	101,100	120,100	150,400	182,800
Leon Creek above Leon Trib C	JLC059	202.063	12,200	35,900	57,900	81,800	101,000	120,100	150,300	182,500
Leon Creek below Leon Trib C	JLC060	204.421	12,200	36,000	57,900	81,900	101,200	120,300	150,600	182,900
Leon Creek below Test Cell Facility	JLC061	205.115	12,200	35,900	57,900	81,800	101,100	120,300	150,600	182,900
Leon Creek at New Laredo	JLC062	207.810	12,200	35,500	57,100	81,600	101,200	120,500	150,700	183,100
Leon Creek above Leon Trib B	JLC063	209.519	12,100	35,300	56,800	81,300	100,900	120,500	150,600	183,100
Leon Creek below Leon Trib B	JLC064	212.142	12,200	35,400	56,900	81,400	101,100	120,700	150,900	183,500
Leon Creek above Leon Trib A	JLC066	214.044	12,200	35,000	56,200	81,000	100,400	120,600	150,700	183,100
Leon Creek below Leon Trib A	JLC067	216.037	12,200	35,100	56,200	81,100	100,600	120,800	150,900	183,400

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Creek above Indian Creek	JLC069	216.520	12,200	35,000	55,800	80,900	100,300	120,700	150,700	183,100
Leon Creek below Indian Creek	JLC070	227.491	12,500	35,300	56,300	81,700	101,600	122,400	152,900	186,500
Leon Creek at Applewhite	JLC072	229.667	12,500	35,300	55,900	81,200	101,300	122,400	152,800	186,400
Leon Creek above Comanche Creek	JLC074	232.546	12,500	35,100	55,600	80,600	100,300	121,900	151,900	185,100
Leon Creek below Comanche Creek	JLC075	237.220	12,500	35,200	55,700	80,800	100,600	122,200	152,400	185,700
Leon Creek above Medina River	JLC076	238.172	12,500	35,200	55,500	80,300	100,200	121,100	151,500	184,700
Leon Trib N headwaters	JLTN01	1.317	870	2,210	2,980	3,600	4,200	4,860	5,760	6,530
Leon Trib N above Leon Creek	JLTN02	1.472	980	2,560	3,410	4,120	4,800	5,560	6,580	7,460
Pecan Creek headwaters	JPE01	1.078	760	2,110	2,800	3,350	3,910	4,520	5,340	6,060
Pecan Creek above PC-UNT1	JPE02	1.802	910	2,440	3,470	4,390	5,230	6,120	7,420	8,490
Pecan Creek below PC-UNT1	JPE03	2.291	1,140	3,050	4,340	5,480	6,510	7,610	9,240	10,700
Pecan Creek above Leon Creek	JPE04	3.184	1,120	3,140	4,660	6,080	7,330	8,560	10,600	12,100
Leon Trib M headwaters	JLTM01	1.344	790	2,160	2,910	3,540	4,140	4,770	5,660	6,410
Leon Trib M above LT-M-UNT2	JLTM02	1.689	770	2,160	3,080	3,830	4,500	5,200	6,250	7,130
Leon Trib M below LT-M-UNT2	JLTM03	2.398	1,100	3,100	4,460	5,580	6,580	7,580	9,080	10,400
Leon Trib M above Leon Trib M1	JLTM04	3.364	1,200	3,480	5,190	6,700	7,990	9,240	11,200	12,800
Leon Trib M below Leon Trib M1	JLTM05	5.793	1,990	5,880	8,760	11,300	13,400	15,500	18,800	21,500
Leon Trib M above Leon Creek	JLTM06	6.392	2,010	5,930	8,910	11,700	14,100	16,400	19,900	22,700
Leon Trib M1 headwaters	JLTM101	1.305	730	2,130	2,890	3,510	4,100	4,730	5,610	6,360
Leon Trib M1 above LT-M1-UNT2	JLTM102	1.435	690	2,020	2,830	3,500	4,100	4,720	5,640	6,390
Leon Trib M1 below LT-M1-UNT2	JLTM103	1.723	840	2,430	3,400	4,230	4,980	5,760	6,870	7,820
Leon Trib M1 above LT-M1-UNT3	JLTM104	1.863	780	2,290	3,240	4,090	4,840	5,600	6,740	7,700
Leon Trib M1 below LT-M1-UNT3	JLTM105	2.234	910	2,680	3,890	4,920	5,810	6,720	8,110	9,270
Leon Trib M1 above Leon Trib M	JLTM106	2.429	890	2,600	3,810	4,890	5,790	6,670	8,080	9,270
Leon Trib L headwaters	JLTL01	1.175	700	2,000	2,670	3,240	3,780	4,360	5,170	5,850
Leon Trib L above Leon Creek	JLTL02	1.312	790	2,210	3,000	3,630	4,240	4,910	5,820	6,600
Leon Trib K headwaters	JLTK001	1.047	650	1,550	2,070	2,530	2,960	3,400	4,050	4,580
Leon Trib K above LT-K-UNT1	JLTK002	1.150	670	1,550	2,090	2,560	3,010	3,500	4,190	4,740
Leon Trib K below LT-K-UNT1	JLTK003	2.089	1,030	2,670	3,650	4,510	5,290	6,090	7,290	8,280

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Trib K above LT-K-UNT2	JLTK005	2.369	940	2,720	3,750	4,670	5,550	6,410	7,700	8,760
Leon Trib K below LT-K-UNT2	JLTK006	3.194	1,080	3,410	4,710	5,900	7,020	8,090	9,760	11,200
Leon Trib K above Leon Trib K2	JLTK007	3.692	1,100	3,400	4,880	6,240	7,390	8,560	10,500	12,000
Leon Trib K below Leon Trib K2	JLTK008	5.296	1,480	4,420	6,430	8,480	10,100	11,600	14,200	16,400
Leon Trib K above Leon Trib K1	JLTK010	5.748	1,610	4,300	6,520	8,690	10,500	12,100	14,800	17,100
Leon Trib K below Leon Trib K1	JLTK011	6.767	1,600	4,280	6,480	8,650	10,400	12,000	14,700	17,000
Leon Trib K above Leon Creek	JLTK012	6.788	1,600	4,280	6,480	8,650	10,400	12,000	14,700	17,000
Leon Trib K2 headwaters	JLTK201	1.574	720	1,870	2,570	3,220	3,770	4,330	5,180	5,880
Leon Trib K2 above Leon Creek	JLTK203	1.604	10	230	360	460	540	620	760	870
Leon Trib K1 headwaters	LT-K1	1.047	520	1,520	2,070	2,540	2,970	3,420	4,070	4,600
Leon Trib J headwaters	JLTJ01	1.146	750	2,170	2,910	3,490	4,070	4,710	5,570	6,310
Leon Trib J above LT-J-UNT2&3	JLTJ02	1.461	820	2,370	3,290	3,990	4,650	5,350	6,390	7,220
Leon Trib J below LT-J-UNT2&3	JLTJ03	1.953	1,090	3,210	4,450	5,400	6,290	7,230	8,620	9,740
Leon Trib J above Leon Creek	JLTJ05	2.529	1,260	3,420	4,900	6,230	7,330	8,470	10,200	11,600
Leon Trib I headwaters	JLTI01	1.005	1,130	1,830	2,270	2,710	3,160	3,630	4,300	4,860
Leon Trib I above Leon Creek	JLTI02	1.323	1,390	2,420	3,020	3,610	4,210	4,860	5,750	6,510
Babcock Trib headwaters	JBT01	1.024	940	2,300	2,950	3,490	4,060	4,700	5,540	6,270
Babcock Trib above BT-UNT1	JBT02	1.401	1,010	2,460	3,370	4,100	4,840	5,630	6,640	7,440
Babcock Trib below BT-UNT1	JBT03	2.396	1,460	3,950	5,440	6,630	7,800	9,060	10,800	12,100
Babcock Trib above BT-UNT2	JBT05	4.589	2,120	5,010	6,850	8,630	10,300	11,800	14,000	15,900
Babcock Trib below BT-UNT2	JBT06	5.529	2,320	5,580	7,700	9,720	11,600	13,300	15,800	18,000
Babcock Trib above Leon Creek	JBT07	6.205	2,130	5,240	7,310	9,290	11,000	12,600	15,300	17,500
Huesta Creek headwaters	JHU001	1.029	330	1,410	2,010	2,490	2,920	3,370	4,010	4,550
Huesta Creek above HUE-UNT1	JHU002	1.043	330	1,410	2,030	2,510	2,940	3,390	4,050	4,590
Huesta Creek below HUE-UNT1	JHU003	1.599	620	2,290	3,260	4,000	4,690	5,430	6,460	7,320
Huesta Creek above Huesta Trib B	JHU004	2.022	650	2,390	3,540	4,450	5,230	6,000	7,160	8,090
Huesta Creek below Huesta Trib B	JHU005	3.124	980	3,650	5,400	6,780	7,970	9,200	11,000	12,500
Huesta Creek above Huesta Trib A	JHU006	3.685	960	3,640	5,530	7,060	8,270	9,370	11,300	12,800
Huesta Creek below Huesta Trib A	JHU007	4.657	1,230	4,460	6,810	8,690	10,200	11,600	13,800	15,700

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Huesta Creek above HUE-UNT2	JHU008	4.857	1,230	4,350	6,670	8,640	10,200	11,500	13,700	15,800
Huesta Creek below HUE-UNT2	JHU009	5.613	1,640	4,860	7,500	9,700	11,400	12,900	15,400	17,700
Huesta Creek above Leon Creek	JHU011	6.064	1,860	5,020	7,680	10,200	12,000	13,700	16,300	18,700
Huesta Trib B above Huesta Creek	HUE-B	1.102	360	1,370	1,980	2,480	2,910	3,360	4,020	4,560
Huesta Trib A above Huesta Creek	HUE-A	0.972	650	1,480	1,960	2,390	2,790	3,200	3,810	4,310
Leon Trib H headwaters	JLTH01	1.008	820	1,570	2,020	2,460	2,860	3,290	3,910	4,420
Leon Trib H Area 2	JLTH02	1.472	1,010	1,940	2,590	3,220	3,790	4,330	5,180	5,870
Leon Trib H above Leon Creek	JLTH03	1.804	1,120	2,230	3,030	3,830	4,530	5,240	6,280	7,130
French Creek headwaters	JFR001	1.262	710	1,910	2,610	3,180	3,720	4,300	5,110	5,800
French Creek above FR-UNT2	JFR002	1.281	680	1,860	2,590	3,190	3,730	4,280	5,070	5,730
French Creek below FR-UNT2	JFR003	2.139	1,070	2,960	4,130	5,100	5,970	6,870	8,160	9,230
French Creek above French Trib C	JFR004	2.366	1,000	2,780	3,940	4,950	5,840	6,740	8,100	9,190
French Creek below French Trib C	JFR005	3.862	1,850	4,450	6,280	7,930	9,340	10,800	13,000	14,700
French Creek above French Trib B	JFR006	3.925	1,780	4,380	6,130	7,690	8,700	10,100	12,400	14,200
French Creek below French Trib B	JFR007	5.941	2,400	5,890	8,290	10,500	11,700	13,200	16,200	18,500
French Creek at Prue Road	JFR008	6.709	2,690	6,530	9,290	12,100	13,800	15,400	18,700	21,600
French Creek at Bandera Road	JFR010	7.746	2,580	6,260	9,110	12,100	14,200	16,000	19,500	22,600
French Creek above French Trib A	JFR012	8.475	2,490	6,170	9,180	12,500	14,700	16,700	20,200	23,300
French Creek below French Trib A	JFR013	11.082	2,650	6,620	9,960	13,800	16,500	18,800	22,600	26,100
French Creek above Leon Creek	JFR015	11.632	2,710	6,590	9,890	14,000	17,100	19,900	24,400	28,200
French Trib C headwaters	JFTC01	0.902	680	1,360	1,780	2,170	2,530	2,900	3,450	3,910
French Trib C above French Creek	JFTC03	1.496								
French Trib B headwaters	JFTB01	1.142	850	1,880	2,470	2,990	3,490	4,030	4,780	5,420
French Trib B Area 2	JFTB03	1.257	950	1,950	2,480	2,900	3,420	4,090	5,060	5,830
French Trib B above French Creek	JFTB04	1.336	980	2,000	2,520	2,960	3,440	4,170	5,120	5,820
French Trib A headwaters	JFTA01	1.047	1,060	2,080	2,670	3,170	3,700	4,280	5,050	5,720
French Trib A at Braun Road	JFTA03	1.358	1,250	2,510	3,260	3,900	4,570	5,280	6,250	7,050
French Trib A	JFTA05	1.581	1,420	2,920	3,790	4,540	5,310	6,150	7,270	8,200

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
French Trib A above French Creek	JFTA06	2.602	1,270	2,480	3,280	4,000	4,690	5,420	6,500	7,370
French Trib A1	FR-A1	1.021	910	2,030	2,630	3,140	3,660	4,240	5,000	5,660
Lower French Creek headwaters	JLFR01	1.028	900	1,940	2,500	3,000	3,490	4,040	4,770	5,410
Lower French Creek above Leon Creek	JLFR02	1.184	1,050	2,310	2,960	3,530	4,110	4,750	5,620	6,360
Culebra Creek headwaters	JCC001	1.057	290	1,210	1,760	2,220	2,610	3,010	3,610	4,100
Culebra Creek above Culebra Trib F	JCC003	1.539	420	1,650	2,480	3,160	3,730	4,310	5,180	5,890
Culebra Creek below Culebra Trib F	JCC004	3.394	780	3,100	4,620	6,020	7,150	8,260	9,410	10,600
Culebra Creek above Culebra Trib E	JCC006	4.857	1,030	4,120	6,230	8,270	9,850	11,400	13,600	15,300
Culebra Creek below Culebra Trib E	JCC007	6.537	1,120	4,840	7,580	10,400	12,400	14,400	17,100	19,400
Culebra Creek above Government Canyon	JCC009	7.386	1,210	5,000	7,940	11,000	13,300	15,400	18,600	21,200
Culebra Creek below Government Canyon	JCC010	25.559	2,260	12,400	20,700	29,700	36,200	42,700	52,600	61,300
Culebra Creek above Culebra Trib D	JCC011	26.386	2,110	12,100	20,100	29,100	35,900	42,300	52,300	61,100
Culebra Creek below Culebra Trib D	JCC012	31.881	2,210	13,500	22,400	33,000	40,800	48,100	59,500	69,600
Culebra Creek above Culebra Trib C	JCC013	31.958	2,190	13,400	22,200	32,800	40,600	47,900	59,300	69,500
Culebra Creek below Culebra Trib C	JCC014	37.837	3,220	14,600	24,200	36,500	45,500	54,300	67,600	79,400
Culebra Creek above Culebra Trib B	JCC015	38.585	3,210	14,400	23,900	35,900	43,900	53,400	66,800	78,800
Culebra Creek below Culebra Trib B	JCC016	40.307	3,320	14,400	24,000	36,100	44,000	53,700	67,200	79,500
Culebra Creek above Helotes Creek	JCC017	40.628	3,310	14,200	23,800	35,600	43,500	53,100	66,600	78,600
Culebra Creek below Helotes Creek	JCC018	72.814	5,760	26,100	41,400	58,300	73,000	86,600	103,400	117,700
Culebra Creek above CC-UNT1	JCC020	74.708	5,520	25,600	40,600	56,900	70,100	85,500	102,200	116,900
Culebra Creek below CC-UNT1	JCC021	75.631	5,520	25,600	40,600	56,900	70,100	85,500	102,300	117,100
Culebra Creek above CC-UNT2	JCC022	76.310	5,490	25,500	39,900	56,600	69,500	83,700	100,800	116,000
Culebra Creek below CC-UNT2	JCC023	77.524	5,490	25,500	39,900	56,600	69,500	83,700	100,900	116,200
Culebra Creek above Culebra Trib A	JCC024	78.532	5,440	25,300	39,700	56,100	68,800	82,500	100,000	115,500
Culebra Creek below Culebra Trib A	JCC025	81.777	5,470	25,400	39,800	56,300	68,900	82,700	100,400	116,100
Culebra Creek above Leon Creek	JCC027	82.309	5,420	25,200	39,700	56,000	68,500	81,900	99,100	114,800
Culebra Trib F headwaters	JCTF01	1.391	440	1,480	2,140	2,710	3,190	3,670	4,400	5,010
Culebra Trib F at dam	JCTF02	1.777	460	1,570	2,290	3,010	3,570	4,130	5,000	5,730
Culebra Trib F above Culebra Creek	JCTF03	1.855	410	1,540	2,290	3,000	3,570	4090	4,670	5,290

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Culebra Trib E headwaters	JCTE01	1.024	270	1,240	1,830	2,300	2,700	3,120	3,730	4,240
Culebra Trib E above Culebra Creek	JCTE02	1.680	300	1,060	1,740	2,400	2,870	3,340	4,100	4,840
Government Canyon headwaters	JGC001	1.074	780	2,170	2,850	3,410	3,970	4,600	5,430	6,150
Government Canyon above GC-UNT1	JGC002	1.291	770	2,050	2,880	3,500	4,100	4,760	5,770	6,530
Government Canyon below GC-UNT1	JGC003	2.263	1,280	3,460	4,780	5,840	6,830	7,890	9,510	10,800
Government Canyon above GC-UNT2	JGC005	2.968	1,310	3,820	5,450	6,920	8,160	9,440	11,400	13,000
Government Canyon below GC-UNT2	JGC006	3.472	1,450	4,270	6,180	7,830	9,240	10,700	12,900	14,800
Government Canyon above GC Trib E	JGC007	3.660	1,410	4,160	6,080	7,730	9,240	10,700	13,000	14,900
Government Canyon below GC Trib E	JGC008	5.003	1,750	5,340	7,840	10,200	12,100	13,900	16,900	19,500
Government Canyon above GC Trib D	JGC009	5.257	1,710	5,240	7,790	10,100	12,100	14,000	17,000	19,400
Government Canyon below GC Trib D	JGC010	6.925	1,990	6,500	9,790	12,800	15,200	17,600	21,400	24,700
Government Canyon above GC-UNT3	JGC012	7.880	1,930	6,940	10,600	13,900	16,500	19,100	23,300	26,600
Government Canyon below GC-UNT3	JGC013	8.641	1,950	7,190	11,000	14,500	17,400	20,100	24,500	28,100
Government Canyon above Wildcat Canyon	JGC014	9.233	1,860	7,130	11,000	14,600	17,600	20,400	24,900	28,700
Government Canyon below Wildcat Canyon	JGC015	10.259	1,870	7,490	11,600	15,600	18,700	21,700	26,600	30,900
Government Canyon above GC Trib C	JGC017	10.615	1,810	7,430	11,600	15,600	18,800	21,900	26,900	31,200
Government Canyon below GC Trib C	JGC018	11.604	1,810	7,680	12,100	16,400	19,800	23,000	28,300	33,000
Government Canyon above GC-UNT4	JGC019	11.947	1,680	7,420	11,700	16,100	19,500	22,800	28,000	32,800
Government Canyon below GC-UNT4	JGC020	12.392	1,680	7,500	11,900	16,400	19,900	23,200	28,500	33,500
Government Canyon above GC Trib B	JGC021	12.772	1,650	7,490	11,900	16,500	20,000	23,400	28,800	33,900
Government Canyon below GC Trib B	JGC022	14.786	1,710	8,050	12,900	18,100	22,000	25,700	31,600	37,400
Government Canyon above GC Trib A	JGC023	14.818	1,690	7,980	12,900	18,100	21,900	25,700	31,600	37,300
Government Canyon below GC Trib A	JGC024	17.352	1,840	9,190	15,000	21,100	25,700	30,200	37,000	43,300
Government Canyon above Culebra Creek	JGC025	18.173	1,730	8,950	14,800	21,000	25,700	30,300	37,300	43,700
GC Trib E headwaters	JGCTE01	1.311	520	1,690	2,390	2,980	3,490	4,030	4,800	5,450
GC Trib E above Government Canyon	JGCTE02	1.343	500	1,670	2,350	2,940	3,450	3,970	4,750	5,390
GC Trib D headwaters	JGCTD01	1.000	290	1,390	1,990	2,470	2,890	3,340	3,980	4,510
GC Trib D above GC-D-UNT1	JGCTD02	1.066	290	1,360	1,980	2,500	2,940	3,410	4,070	4,630
GC Trib D below GC-D-UNT1	JGCTD03	1.503	410	1,980	2,870	3,600	4,230	4,880	5,870	6,680

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
GC Trib D above Government Canyon	JGCTD04	1.668	380	1,930	2,930	3,720	4,390	5,080	6,120	7,010
Wildcat Canyon above Government Canyon	WC-1	1.026	260	1,230	1,830	2,300	2,710	3,130	3,740	4,250
GC Trib C above Government Canyon	GC-C-1	0.989	250	1,170	1,740	2,190	2,580	2,980	3,560	4,050
GC Trib B headwaters	JGCTB01	1.401	310	1,480	2,200	2,810	3,310	3,820	4,570	5,200
GC Trib B above GC-B-UNT2	JGCTB03	1.593	320	1,560	2,390	3,080	3,630	4,200	5,080	5,800
GC Trib B below GC-B-UNT2	JGCTB04	1.982	390	1,860	2,850	3,710	4,390	5,100	6,210	7,070
GC Trib B above Government Canyon	JGCTB05	2.014	370	1,780	2,780	3,650	4,330	5,020	6,110	6,980
GC Trib A headwaters	JGCTA01	1.118	330	1,600	2,340	2,880	3,380	3,910	4,650	5,280
GC Trib A above GC-A-UNT1	JGCTA02	1.197	290	1,530	2,300	2,870	3,390	3,920	4,680	5,310
GC Trib A below GC-A-UNT1	JGCTA03	1.438	340	1,860	2,730	3,450	4,070	4,760	5,690	6,460
GC Trib A above GC-A-UNT2	JGCTA04	1.912	300	1,870	2,970	3,870	4,650	5,410	6,560	7,540
GC Trib A below GC-A-UNT2	JGCTA05	2.185	300	1,980	3,160	4,180	5,040	5,850	7,100	8,160
GC Trib A above Government Canyon	JGCTA06	2.534	260	1,790	2,990	4,130	4,970	5,870	7,210	8,360
Culebra Trib D headwaters	JCTD01	1.330	750	1,760	2,380	2,940	3,440	3,960	4,720	5,360
Culebra Trib D above CC-D-UNT2	JCTD02	1.343	750	1,750	2,370	2,920	3,440	3,950	4,710	5,360
Culebra Trib D below CC-D-UNT2	JCTD03	1.791	1,020	2,350	3,200	3,990	4,670	5,400	6,430	7,290
Culebra Trib D above CC-D-UNT3	JCTD05	2.128	1,170	2,790	3,830	4,760	5,640	6,510	7,800	8,840
Culebra Trib D below CC-D-UNT3	JCTD06	3.023	1,650	3,930	5,320	6,610	7,810	9,020	10,800	12,300
Culebra Trib D at Culebra Road	JCTD07	4.179	1,770	4,130	5,920	7,710	9,190	10,700	13,000	14,900
Culebra Trib D above CC-D-UNT4	JCTD08	4.802	1,690	3,910	5,680	7,590	9,190	10,800	13,400	15,500
Culebra Trib D below CC-D-UNT4	JCTD09	5.419	1,730	4,030	5,860	7,890	9,640	11,300	14,100	16,500
Culebra Trib D above Culebra Creek	JCTD10	5.495	1,700	3,930	5,730	7,750	9,430	11,100	14,000	16,300
Culebra Trib C headwaters	JCTC01	1.000	380	1,250	1,790	2,230	2,620	3,020	3,610	4,100
Culebra Trib C above CC-C-UNT1	JCTC02	2.015	560	1,480	2,010	2,760	3,420	4,130	5,140	5,970
Culebra Trib C below CC-C-UNT1	JCTC03	2.890	1,060	2,800	3,770	4,750	5,770	6,730	8,160	9,460
Culebra Trib C above Culebra Trib C1	JCTC05	3.407	1,120	2,980	4,120	5,350	6,500	7,570	9,230	10,800
Culebra Trib C below Culebra Trib C1	JCTC06	4.890	1,760	4,630	6,390	8,170	9,800	11,400	13,800	15,900
Culebra Trib C above Culebra Creek	JCTC08	5.879	1,930	4,970	7,160	9,260	11,200	13,100	16,000	18,400

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Culebra Trib C1 headwaters	JCTC101	1.005	610	1,540	2,060	2,510	2,940	3,380	4,020	4,540
Culebra Trib C1 above Culebra Trib C	JCTC102	1.483	680	1,720	2,400	3,000	3,510	4,020	4,780	5,410
Culebra Trib B headwaters	JCTB01	1.017	810	1,670	2,180	2,640	3,080	3,550	4,210	4,770
Culebra Trib B above CC-B-UNT1	JCTB02	1.025	820	1,660	2,140	2,600	3,030	3,480	4,130	4,670
Culebra Trib B below CC-B-UNT1	JCTB03	1.707	1,330	2,730	3,540	4,300	5,010	5,780	6,840	7,720
Culebra Trib B above Culebra Creek	JCTB04	1.722	1,330	2,760	3,580	4,360	5,060	5,820	6,920	7,780
Helotes Creek headwaters	JHE001	1.001	730	1,910	2,500	2,980	3,490	4,040	4,780	5,410
Helotes Creek above HE-UNT1	JHE002	1.135	740	1,920	2,300	3,170	3,700	4,260	5,040	5,660
Helotes Creek below HE-UNT1	JHE003	1.474	960	2,470	3,400	4,150	4,910	5,690	6,720	7,580
Helotes Creek above HE-UNT2	JHE005	2.018	1,140	3,000	4,180	5,140	6,040	6,950	8,420	9,650
Helotes Creek below HE-UNT2	JHE006	2.839	1,550	4,100	5,640	7,020	8,280	9,590	11,700	13,300
Helotes Creek above Helotes Trib B	JHE007	3.509	1,540	3,970	5,580	7,120	8,390	9,630	11,800	13,400
Helotes Creek below Helotes Trib B	JHE008	6.436	2,570	7,100	10,100	13,000	15,300	17,600	21,300	24,400
Helotes Creek above Chimenea Creek	JHE009	6.779	2,580	7,130	10,300	13,100	15,500	17,900	21,500	24,500
Helotes Creek below Chimenea Creek	JHE010	13.322	3,840	11,500	17,200	22,700	26,900	30,900	37,500	43,200
Helotes Creek above Los Reyes Creek	JHE011	15.010	3,560	10,600	16,400	22,400	27,000	31,400	38,200	44,100
Helotes Creek below Los Reyes Creek	JHE012	24.192	5,160	15,400	23,400	31,700	38,300	45,000	55,500	65,400
Helotes Creek above Helotes Trib A	JHE014	25.896	4,970	15,200	23,200	31,800	38,800	41,500	46,300	52,600
Helotes Creek below Helotes Trib A	JHE015	27.467	5,020	15,500	23,600	32,600	39,900	42,900	46,800	53,000
Helotes Creek above HE-UNT3	JHE016	30.779	4,570	14,800	22,100	30,400	37,800	42,700	45,600	52,200
Helotes Creek below HE-UNT3	JHE017	32.117	730	1,910	2,500	2,980	3,490	4,040	4,780	5,410
Helotes Creek above Culebra Creek	JHE018	32.186	4,510	14,700	22,100	30,400	37,700	42,900	45,700	52,000
Helotes Trib B headwaters	JHETB01	1.327	770	2,250	3,030	3,670	4,280	4,940	5,860	6,640
Helotes Trib B above HE-B-UNT2	JHETB02	2.148	910	2,730	3,910	4,950	5,850	6,750	8,090	9,220
Helotes Trib B below HE-B-UNT2	JHETB03	2.826	1,150	3,460	5,050	6,360	7,490	8,670	10,500	11,900
Helotes Trib B above Helotes Creek	JHETB04	2.927	1,140	3,430	4,980	6,370	7,550	8,730	10,500	12,000
Chimenea Creek headwaters	JCH01	1.198	950	2,670	3,450	4,090	4,760	5,500	6,490	7,350
Chimenea Creek above CHI-UNT2	JCH02	1.288	980	2,630	3,500	4,170	4,870	5,660	6,710	7,590
Chimenea Creek below CHI-UNT2	JCH03	1.648	1,250	3,470	4,550	5,420	6,320	7,330	8,680	9,830

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Chimenea Creek above CHI-UNT3	JCH04	2.893	1,590	4,270	5,760	7,020	8,250	9,660	11,800	13,400
Chimenea Creek below CHI-UNT3	JCH05	3.874	2,060	5,490	7,600	9,270	10,900	12,700	15,400	17,500
Chimenea Creek at dam	JCH06	4.460	2,060	5,660	7,970	9,820	11,500	13,300	16,100	18,400
Chimenea Creek above CHI-UNT4	JCH07	5.608	2,030	5,870	8,600	11,000	12,900	14,900	18,000	20,500
Chimenea Creek below CHI-UNT4	JCH08	6.120	2,060	6,000	8,840	11,300	13,300	15,300	18,600	21,300
Chimenea Creek above Helotes Creek	JCH09	6.543	1,950	5,810	8,650	11,300	13,300	15,300	18,700	21,500
Los Reyes Creek headwaters	JLR01	1.081	830	2,320	3,020	3,590	4,180	4,830	5,700	6,460
Los Reyes Creek at Bandera Road	JLR02	1.976	1,350	3,590	4,780	5,750	6,700	7,720	9,090	10,300
Los Reyes Creek above Los Reyes Trib A	JLR03	2.655	1,490	4,010	5,630	6,890	8,060	9,280	11,000	12,400
Los Reyes Creek below Los Reyes Trib A	JLR04	3.905	2,260	6,200	8,460	10,400	12,100	13,900	16,400	18,400
Los Reyes Creek at Bandera Road	JLR05	4.828	2,120	5,440	7,100	9,510	11,600	14,100	17,300	20,400
Los Reyes Creek above Ranch Creek	JLR06	5.347	1,990	5,010	6,570	8,580	10,500	12,600	15,800	18,700
Los Reyes Creek below Ranch Creek	JLR07	7.236	2,240	5,720	7,440	9,980	12,300	15,100	19,200	23,000
Los Reyes Creek above LR-UNT1	JLR09	7.596	2,220	5,730	7,680	9,990	12,300	14,900	19,100	22,700
Los Reyes Creek below LR-UNT1	JLR10	8.267	2,270	5,900	8,240	10,900	12,700	15,500	19,900	23,800
Los Reyes Creek above LR-UNT2	JLR12	8.383	2,260	5,900	8,280	10,900	12,700	15,500	19,800	23,800
Los Reyes Creek below LR-UNT2	JLR13	9.025	2,290	6,170	8,880	11,800	13,700	16,100	20,600	24,900
Los Reyes Creek above Helotes Creek	JLR14	9.182	2,270	6,170	8,880	11,800	13,700	16,000	20,500	24,600
Los Reyes Trib A headwaters	JLRTA01	1.042	800	2,340	3,020	3,580	4,160	4,820	5,680	6,440
Los Reyes Trib A above Los Reyes Creek	JLRTA02	1.250	880	2,350	3,190	3,780	4,340	4,990	5,890	6,850
Ranch Creek headwaters	JRC01	1.536	570	2,430	3,420	4,170	4,880	5,640	6,700	7,600
Ranch Creek above Los Reyes Creek	JRC03	1.889	620	2,620	3,750	4,640	5,490	6,390	7,670	8,720
Helotes Trib A headwaters	JHETA01	1.010	250	1,190	1,730	2,180	2,560	2,960	3,540	4,020
Helotes Trib A above Helotes Creek	JHETA02	1.571	260	1,270	1,990	2,630	3,190	3,750	4,590	5,270
Culebra Trib A headwaters	JCTA01	1.079	930	1,970	2,540	3,050	3,550	4,090	4,850	5,480
Culebra Trib A at Tezel Road	JCTA02	2.051	1,460	2,930	3,850	4,630	5,310	6,020	7,060	7,900
Culebra Trib A above Culebra Creek	JCTA03	3.245	1,430	3,030	4,200	5,300	6,220	7,090	8,440	9,570
Huebner Creek headwaters	JHB01	1.009	1,170	1,900	2,350	2,810	3,270	3,760	4,450	5,030
Huebner Creek above HB-UNT1	JHB02	1.131	1,210	1,970	2,450	2,960	3,460	3,920	4,580	5,160

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Huebner Creek below HB-UNT1	JHB03	1.411	1,500	2,510	3,160	3,770	4,400	5,100	5,970	6,650
Huebner Creek above HB-UNT2	JHB04	1.625	1,450	2,470	3,160	3,850	4,510	5,150	6,100	6,870
Huebner Creek below HB-UNT2	JHB05	1.820	1,570	2,720	3,480	4,270	5,020	5,780	6,860	7,750
Huebner Creek above HB-UNT3	JHB06	1.840	1,570	2,720	3,490	4,280	5,020	5,760	6,840	7,740
Huebner Creek below HB-UNT4	JHB07	2.098	1,720	3,070	4,000	4,920	5,780	6,650	7,910	8,940
Huebner Creek above Babcock Road	JHB08	2.826	1,800	3,420	4,590	5,770	6,800	7,830	9,480	10,900
Huebner Creek above Huebner Trib A	JHB09	4.104	1,460	2,870	3,960	5,250	6,230	7,420	9,310	11,000
Huebner Creek below Huebner Trib A	JHB10	7.926	3,560	6,810	9,020	11,300	13,400	15,600	18,900	21,800
Huebner Creek at Bandera Road	JHB11	9.623	3,200	6,490	9,130	11,800	13,900	16,000	19,400	23,000
Huebner Creek above Leon Creek	JHB13	11.952	3,730	7,380	10,400	13,500	16,000	18,500	22,400	26,400
Huebner Trib A headwaters	JHBTA01	1.107	1,040	2,040	2,590	3,110	3,620	4,170	4,930	5,580
Huebner Trib A above HB-A-UNT2	JHBTA02	1.424	930	1,930	2,590	3,200	3,760	4,320	5,190	5,910
Huebner Trib A below HB-A-UNT2	JHBTA03	2.111	1,440	2,830	3,820	4,770	5,610	6,460	7,740	8,800
Huebner Trib A above HB-A-UNT3	JHBTA05	2.225	1,460	2,870	3,860	4,840	5,690	6,550	7,870	8,940
Huebner Trib A below HB-A-UNT3	JHBTA06	2.965	2,200	4,150	5,510	6,850	8,030	9,270	11,100	12,700
Huebner Trib A above Huebner Creek	JHBTA08	3.822	2,870	5,260	6,870	8,490	9,930	11,500	13,800	15,700
Leon Trib G headwaters	JLTG01	1.011	970	1,780	2,260	2,720	3,160	3,650	4,320	4,890
Leon Trib G above Leon Creek	JLTG03	1.335	1,310	2,400	3,040	3,660	4,250	4,900	5,800	6,560
Leon Trib F headwaters	JLTF01	1.166	1,120	1,990	2,520	3,040	3,540	4,070	4,830	5,460
Leon Trib F above LT-F-UNT2	JLTF02	1.177	1,040	1,780	2,240	2,750	3,290	3,750	4,310	4,700
Leon Trib F below LT-F-UNT2	JLTF03	1.672	1,320	2,460	3,160	3,870	4,630	5,290	6,120	6,730
Leon Trib F above Leon Creek	JLTF04	1.690	1,320	2,480	3,160	3,890	4,600	5,290	6,120	6,740
Slick Ranch Creek headwaters	JSR01	1.002	1,440	2,200	2,680	3,160	3,670	4,240	5,000	5,650
Slick Ranch Creek above SR-UNT1	JSR02	1.192	1,300	2,040	2,530	3,060	3,590	4,130	5,010	5,670
Slick Ranch Creek below SR-UNT1	JSR03	1.499	1,580	2,460	3,070	3,750	4,400	5,090	6,170	7,090
Slick Ranch Creek above SR-UNT2	JSR05	2.317	2,170	3,570	4,500	5,490	6,420	7,430	9,090	10,400
Slick Ranch Creek below SR-UNT2	JSR06	3.200	2,790	4,600	5,850	7,180	8,400	9,650	11,800	13,600
Slick Ranch Creek above SR-UNT3	JSR08	3.525	2,850	4,740	6,060	7,470	8,750	10,100	12,300	14,200
Slick Ranch Creek below SR-UNT3	JSR09	3.997	3,090	5,150	6,590	8,140	9,550	11,000	13,600	15,600

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Slick Ranch Creek above SR-UNT4	JSR11	4.128	1,580	5,090	6,560	8,150	9,540	11,000	13,300	15,300
Slick Ranch Creek below SR-UNT4	JSR12	4.381	3,100	5,230	6,780	8,440	9,880	11,400	13,700	15,900
Slick Ranch Creek above Slick Ranch Trib B	JSR13	4.797	3,090	5,270	6,910	8,680	10,100	11,800	14,200	15,900
Slick Ranch Creek below Slick Ranch Trib B	JSR14	7.185	3,890	7,180	9,670	12,400	14,600	16,700	20,400	23,200
Slick Ranch Creek above SR-UNT5	JSR15	7.492	3,830	7,000	9,540	11,800	14,200	16,600	20,400	23,200
Slick Ranch Creek below SR-UNT5	JSR16	9.312	4,330	8,050	11,000	13,400	16,400	19,400	24,000	27,500
Slick Ranch Creek above Slick Ranch Trib A	JSR17	9.745	4,300	8,030	10,900	13,400	16,100	18,900	23,400	26,600
Slick Ranch Creek below Slick Ranch Trib A	JSR18	10.553	4,490	8,440	11,400	14,000	16,900	19,900	24,600	28,100
Slick Ranch Creek above SR-UNT6	JSR20	10.625	4,480	8,450	11,400	14,100	16,900	19,800	24,400	27,900
Slick Ranch Creek below SR-UNT6	JSR21	11.006	4,570	8,650	11,700	14,400	17,200	20,300	24,900	28,500
Slick Ranch Creek above Leon Creek	JSR23	11.529	4,610	8,760	11,800	14,700	17,400	20,300	24,400	27,400
Slick Ranch Trib B headwaters	JSRTB01	1.266	1,060	2,280	2,940	3,540	4,120	4,750	5,620	6,360
Slick Ranch Trib B above UNT2 & UNT3	JSRTB02	1.293	980	2,050	2,670	3,250	3,790	4,360	5,170	5,830
Slick Ranch Trib B below UNT2 & UNT3	JSRTB03	2.016	1,530	3,120	4,050	4,930	5,750	6,590	7,840	8,830
Slick Ranch Trib B above Slick Ranch Creek	JSRTB05	2.388	1,800	3,570	4,720	5,760	6,680	7,590	8,870	9,960
Slick Ranch Trib A above Slick Ranch Creek	SR-A	0.808	700	1,210	1,540	1,870	2,180	2,500	2,980	3,370
Westwood Village headwaters	JWV01	1.338	950	1,900	2,490	3,040	3,550	4,090	4,870	5,520
Westwood Village at Old Hwy 90	JWV02	1.634	1,000	1,990	2,490	2,970	3,450	3,920	4,670	5,330
Westwood Village above Leon Creek	JWV03	1.839	970	1,810	2,280	2,820	3,410	3,970	4,760	5,470
Leon Trib E headwaters	JLTE01	1.122	970	1,830	2,340	2,830	3,300	3,780	4,490	5,080
Leon Trib E Area 2	JLTE02	1.318	950	1,850	2,450	3,030	3,540	4,070	4,870	5,490
Leon Trib E above Leon Trib E1	JLTE03	1.569	920	1,920	2,590	3,250	3,830	4,410	5,290	6,000
Leon Trib E below Leon Trib E1	JLTE04	2.883	1,340	3,150	4,450	5,680	6,700	7,710	9,280	10,600
Leon Trib E above Leon Creek	JLTE06	3.062	1,360	3,280	4,620	5,920	7,000	8,030	9,550	10,600
Leon Trib E1 headwaters	JLTE101	0.968	460	1,300	1,800	2,230	2,610	3,010	3,580	4,060
Leon Trib E1 at Kenley Avenue	JLTE102	1.021	480	1,360	1,870	2,320	2,720	3,130	3,730	4,230
Leon Trib E1 Area 3	JLTE103	1.134	520	1,460	2,020	2,520	2,950	3,400	4,060	4,610
Leon Trib E1 above Leon Trib E	JLTE105	1.314	610	1,760	2,450	3,030	3,550	4,090	4,880	5,530

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Leon Trib D headwaters	JLTD01	0.970	860	1,500	1,900	2,300	2,680	3,080	3,660	4,140
Leon Trib D above Leon Creek	JLTD03	1.165	1,020	1,820	2,310	2,800	3,270	3,750	4,450	5,030
Leon Trib C headwaters	JLTC01	2.233	860	1,460	1,860	2,290	2,670	3,060	3,650	4,140
Leon Trib C above Leon Creek	JLTC03	2.358	1,480	2,420	3,150	3,970	4,670	5,440	6,810	7,810
Leon Trib B headwaters	JLTB01	1.190	890	1,510	1,930	2,370	2,770	3,170	3,780	4,280
Leon Trib B above LT-B-UNT2	JLTB02	1.225	900	1,530	1,960	2,410	2,820	3,220	3,840	4,350
Leon Trib B below LT-B-UNT2	JLTB03	1.468	1,160	1,990	2,560	3,120	3,640	4,190	4,980	5,660
Leon Trib B at IH35	JLTB05	1.768	1,460	2,240	2,620	2,920	3,180	3,470	3,880	4,500
Leon Trib B above LT-B-UNT3	JLTB07	2.235	1,810	2,920	3,490	4,010	4,430	4,860	5,440	5,920
Leon Trib B below LT-B-UNT3	JLTB08	2.489	2,040	3,400	4,100	4,740	5,280	5,830	6,620	7,310
Leon Trib B above Leon Creek	JLTB10	2.623	2,160	3,570	4,380	5,080	5,680	6,300	7,160	7,720
Leon Trib A headwaters	JLTA01	1.004	950	1,670	2,120	2,560	2,980	3,440	4,070	4,610
Leon Trib A above LT-A-UNT1	JLTA02	1.082	1,010	1,790	2,270	2,740	3,190	3,680	4,360	4,930
Leon Trib A below LT-A-UNT1	JLTA03	1.561	1,430	2,470	3,140	3,790	4,420	5,090	6,040	6,840
Leon Trib A at Durette Drive	JLTA04	1.724	1,590	2,730	3,460	4,190	4,880	5,610	6,660	7,530
Leon Trib A above Leon Creek	JLTA05	1.993	1,660	2,900	3,720	4,540	5,300	6,100	7,290	8,230
Indian Creek headwaters	JIN01	0.959	750	1,780	2,360	2,830	3,300	3,820	4,510	5,120
Indian Creek above IN-UNT2	JIN02	1.132	760	1,740	2,350	2,880	3,380	3,910	4,680	5,310
Indian Creek below IN-UNT2	JIN03	1.338	890	2,040	2,810	3,470	4,070	4,700	5,620	6,370
Indian Creek above IN-UNT3	JIN04	1.358	890	2,050	2,800	3,470	4,090	4,730	5,650	6,400
Indian Creek below IN-UNT3	JIN05	1.642	1,100	2,570	3,480	4,290	5,040	5,820	6,940	7,860
Indian Creek above IN-UNT4 & IN-UNT5	JIN07	2.648	1,450	3,290	4,510	5,560	6,400	7,230	8,540	9,590
Indian Creek below IN-UNT4 & IN-UNT5	JIN08	3.395	1,890	4,030	5,680	7,170	8,310	9,420	11,100	12,500
Indian Creek above IN-UNT6	JIN10	3.903	1,990	4,240	5,950	7,550	8,890	10,100	11,900	13,200
Indian Creek below IN-UNT6	JIN11	4.591	2,410	4,970	6,890	8,880	10,500	11,900	14,100	15,700
Indian Creek above IN-UNT7	JIN13	4.944	2,380	5,010	6,900	8,710	10,300	11,800	14,200	15,900
Indian Creek below IN-UNT7	JIN14	5.288	2,480	5,250	7,220	9,130	10,800	12,400	14,900	16,800
Indian Creek above Indian Trib A	JIN16	6.192	2,290	4,570	6,040	7,590	8,790	10,400	13,500	16,700
Indian Creek below Indian Trib A	JIN17	7.504	2,480	4,860	6,320	7,910	9,110	11,000	14,700	18,400

Discharge Location	HMS Hydrologic Element	Drainage Area (sq miles)	Recurrence Interval (years)							
			2	5	10	25	50	100	250	500
Indian Creek at Somerset Road	JIN19	7.971	2,460	4,870	6,310	7,910	9,120	11,000	14,400	18,200
Indian Creek above IN-UNT8	JIN21	8.350	2,390	4,810	6,240	7,850	9,070	10,800	14,000	17,600
Indian Creek below IN-UNT8	JIN22	8.611	2,410	4,830	6,260	7,880	9,100	10,800	14,000	17,600
Indian Creek at dam	JIN23	9.258	2,370	4,800	6,240	7,870	9,110	10,800	14,000	17,600
Indian Creek above IN-UNT9	JIN25	10.180	2,320	4,690	6,140	7,700	8,940	10,500	13,200	16,200
Indian Creek below IN-UNT9	JIN26	10.880	2,340	4,720	6,180	7,740	9,000	10,600	13,200	16,300
Indian Creek above Leon Creek	JIN27	10.971	2,330	4,710	6,170	7,720	8,980	10,600	13,200	16,200
Indian Trib A headwaters	JITA01	1.158	800	1,660	2,190	2,670	3,120	3,590	4,280	4,850
Indian Trib A above Indian Creek	JITA03	1.312	780	1,640	2,200	2,730	3,210	3,700	4,460	5,060
Comanche Creek headwaters	JCO01	1.754	1,850	3,060	3,830	4,590	5,340	6,150	7,280	8,240
Comanche Creek above COM-UNT2	JCO02	2.109	1,640	2,810	3,600	4,420	5,170	5,950	7,120	8,110
Comanche Creek below COM-UNT2	JCO03	2.464	1,840	3,140	4,050	5,020	5,910	6,780	8,130	9,240
Comanche Creek above COM-UNT3	JCO05	2.604	1,830	3,120	4,070	5,060	5,950	6,830	8,200	9,330
Comanche Creek below COM-UNT3	JCO06	3.222	2,140	3,700	4,840	6,080	7,150	8,210	9,910	11,300
Comanche Creek above COM-UNT4	JCO08	3.825	2,480	4,370	5,750	7,260	8,550	9,840	11,900	13,600
Comanche Creek below COM-UNT4	JCO09	4.213	2,710	4,830	6,330	8,030	9,480	11,000	13,300	15,100
Comanche Creek above Leon Creek	JCO10	4.674	2,640	4,720	6,290	8,060	9,540	11,000	13,300	15,200

Comparison with Existing Conditions

Computed hypothetical frequency discharges were compared with the existing discharges provided by the USACE.

The future conditions of Leon Creek Watershed are more urbanized than the existing conditions, thus most discharges are higher than the existing conditions discharges. However, some discharges decreased due to timing issues. The Feasibility Study discharges exceeded those in existing conditions by an average of nine percent (median of five percent). Extreme changes range from a 71-percent increase at a node on Huesta Tributary A to a three-percent decrease at a node on Culebra Tributary E. On the next page, Table G.1–10 presents a comparison of 100-year existing and future flows at selected locations in the watershed.

The increased urbanization in the Leon Creek Watershed justifies the higher discharges computed for the future without-project conditions, while timing issues reduced discharges at a few nodes. The future without-project discharges will be used as the baseline for comparison with the future with-project condition discharges.

Table G.1–10. Comparison of 100-year Future Without-Project and Existing Flows

Discharge Location	HMS Hydrologic Element	Q Break Station	Drainage Area (sq miles)	100-year Discharge (cfs)			
				Future	Existing	Future – Existing	Change
Leon Creek at Loop 1604	JLC021	221468	39.345	43,200	41,300	1,900	4.60%
Leon Creek below Leon Trib I	JLC023	202660	42.052	42,700	40,900	1,800	4.40%
Leon Creek below Huesta Creek	JLC029	188437	56.294	42,300	40,700	1,600	3.93%
Leon Creek below French Creek	JLC033	168201	72.619	51,000	45,900	5,100	11.11%
Leon Creek below Culebra Creek	JLC038	151954	158.277	113,000	109,600	3,400	3.10%
Leon Creek below Huebner Creek	JLC041	147620	171.023	117,500	113,800	3,700	3.25%
Leon Creek below Slick Ranch Creek	JLC049	123319	188.759	119,300	115,400	3,900	3.38%
Leon Creek at Military Drive	JLC058	91521	201.797	120,100	116,000	4,100	3.53%
Leon Creek below Test Cell Facility	JLC061	76884	205.115	120,300	116,100	4,200	3.62%
Leon Creek below Indian Creek	JLC070	35989	227.491	122,400	117,600	4,800	4.08%
Leon Creek above Medina River	JLC076	4643	238.172	121,100	114,900	6,200	5.40%
Babcock Trib above Leon Creek	JBT07	4854	6.205	12,600	11,200	1,400	12.50%
Huesta Creek above Leon Creek	JHU011	2441	6.064	13,700	13,100	600	4.58%
French Creek above Leon Creek	JFR015	2619	11.632	19,900	19,100	800	4.19%
Culebra Creek below Government Canyon	JCC010	43882	25.559	42,700	42,600	100	0.23%
Culebra Creek below Helotes Creek	JCC018	25268	72.814	86,600	83,300	3,300	3.96%
Culebra Creek above Leon Creek	JCC027	2637	82.309	81,900	79,400	2,500	3.15%
Government Canyon above Culebra Creek	JGC025	2380	18.173	30,300	29,700	600	2.02%
Helotes Creek above Culebra Creek	JHE017	3062	32.117	42,900	41,400	1,500	3.62%
Huebner Creek above Leon Creek	JHB13	5714	11.952	18,500	18,200	300	1.65%
Slick Ranch Creek above Leon Creek	JSR23	1436	11.529	20,300	19,000	1,300	6.84%
Indian Creek above Leon Creek	JIN27	776	10.971	10,600	10,400	200	1.92%
Comanche Creek above Leon Creek	JCO10	2152	4.674	11,000	9,750	1,250	12.82%

HYDRAULIC ANALYSIS

The goal of this phase of the Leon Creek Feasibility Study was to provide an assessment of without-project conditions for the mainstem of Leon Creek and all tributaries with at least one square mile of contributing drainage area. Discharges were computed for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% ACE probability events. These discharges were used to perform backwater modeling to obtain water surface profiles for Leon Creek and its tributaries.

Industry standard tools, methodology, and best engineering judgment were used to evaluate all data collected, perform analyses, and develop the required discharges and computed water surface elevation profiles. Methodology outlined in EM 1110-2-1419 Hydrologic Engineering Requirements for Flood Damage Reduction Studies (USACE, 1995) was followed in developing baseline, future without project and with project conditions. Stage-discharge and stage-frequency functions and uncertainties for all conditions were defined based on methodology outlined in this EM. The analyses will be used as the baseline for comparison with the future without-project conditions for alternative analysis and plan selection.

Mapping Data

The San Antonio River Authority (SARA) provided mapping data for hydraulic modeling During the Bexar County Digital Flood Insurance Rate Map (DFIRM) effort, SARA's contractor performed aerial photography and aerial triangulation, which was used to produce two-foot interval contour maps, three-dimensional mass points and breaklines, and planimetric features. The same contractor performed detailed field survey to obtain bridge, culvert, and road crossing data.

Backwater Model Development

Standard USACE Hydrologic Engineering Center – River Analysis System (HEC-RAS) version 3.1.2, backwater models were developed for Leon Creek and all tributaries with a contributing drainage area of at least one square mile. Due to the large size of the watershed and the number of tributaries, each stream was modeled independently. For all streams, the reach boundary condition in the hydraulic model, was set at normal depth and a slope was calculated based on geometric data of the stream. Confluences were analyzed to insure backwater effects from the main stream were accounted for in tributary water surface profiles.

Cross-sections

Stream and valley cross-section data were developed from the detailed topographic mapping discussed in "Hydrologic Analysis" on page G.1-3. Environmental Systems Research Institute (ESRI) ArcMap, Version 9.1, software was used to develop the three-dimensional terrain modeling. Triangulated Irregular Network (TIN) representations were developed with ArcMap, using the available mass points and the terrain surface break lines.

USACE HEC-GeoRAS software was used to accomplish the following steps:

- Develop stream stationing along the Leon Creek channel and all tributary channels.
- Develop preliminary measurements for channel and overbank reach lengths between cross-sections.
- Identify preliminary channel bank stations at each cross-section.
- Extract the cross-section data points (elevation versus section station).
- Populate each of the associated input data fields within the preliminary HEC-RAS models.

Locations and Layout Considerations

The locations for cross-sections were identified to capture the critical hydraulic features within the study reach. Because these models are also used in the DFIRM effort, the cross-sections were located as recommended by SARA to achieve spacing of not more than 1,000 feet between the cross-sections in rural areas and not more than 500 feet of spacing in urban areas.

- The spacing of cross-sections was reduced as necessary to model significant hydraulic features such as bridges, low water crossings, dams, or to capture expected flow change locations.
- Cross-sections were extended to capture the 0.2% ACE (500-year) floodplain.
- Locations of tributaries that contribute to the study streams were also considered for choosing the appropriate cross-section locations.
- Cross-section location and orientation were in accordance with EM 1110-2-1416 River Hydraulics (USACE, 1993).

Structures

Railroad and roadway bridges were incorporated within the HEC-RAS models for each stream in the study according to EM 1110-2-1416 River Hydraulics (USACE, 1993). All bridge data was field surveyed and provided by SARA through their surveying contractor.

Manning’s Roughness Coefficients

Manning’s *n* values were developed based on the land use data set discussed in “Hydrologic Analysis,” page G.1-3. Each land use was assigned a value for Manning’s *n* and values for each cross-section were extracted using ArcMap. Table G.1-11 shows the *n* value for each land use code.

Table G.1-11. Correlation of Land Use to Manning’s *n* Value

Land Use Code	*n* Value
Commercial	0.070
Industrial	0.060
Lightly Wooded	0.070
Moderately Wooded	0.085

Land Use Code	*n* Value
Heavily Wooded	0.100
Low Density Residential	0.080
High Density Residential	0.100
Multi-Family Residential	0.060
Golf Course	0.045
Meadow	0.045
Pasture	0.055
Quarry	1.000
Rock Quarry	1.000
Transportation	0.015
Water Body	0.026

Manning's *n* values varied horizontally for each cross-section, thus capturing the variation in land use along the cross-section. Values ranged from 0.015 to 0.1 in the overbanks and 0.015 to 0.085 for the channel. These Manning's n values were developed in accordance with guidance in EM 1110-2-1416 River Hydraulics (USACE, 1993) and EM 1110-2-1601 Hydraulic Design of Flood Control Channels (USACE, 1994).

Modeling Considerations

Using existing condition cross-sections, structure data, and Manning's *n* values, the team developed hydraulic models for each stream in the study area.

Water Surface Elevations

Hydraulic models developed for each stream studied used the flow data obtained from the hydrologic study. The normal depth method was used as the downstream boundary condition to determine the starting water surface elevations for the hydraulic models, based upon estimated downstream friction slopes.

Structure/Road Crossings

The existing bridges and culverts were included in the hydraulic models to determine their effect on water surface profiles and the resulting floodplain. All required bridge and culvert parameters and dimensions were obtained from the detailed field surveys that SARA provided. The values recommended in HEC-RAS for entrance/exit loss coefficients and Manning's n values for the top and bottom of pipes were used. These coefficients were developed in accordance with EM 1110-2-1416 River Hydraulics (USACE, 1993) and EM 1110-2-1601 Hydraulic Design of Flood Control Channels (USACE, 1994). The upstream and downstream inverts for all culverts were also obtained from the detailed field surveys.

Ineffective Flow Areas

To define the appropriate limits for the areas of effective flow, ineffective flow areas were designated around structures according to the HEC-RAS modeling standards and EM 1110-2-1416 River Hydraulics (USACE, 1993). Ineffective flow was also designated for that portion of cross-sections where flow was not effectively conveyed downstream.

Model Calibration

Hydraulic models can be calibrated using observed high-water marks, measured profiles, and stage information at stream gages during high-flow events. However, there is insufficient data of this type to use for calibration of the model. As discussed in “Introduction,” there are only two USGS stream gages in the Leon Creek Watershed. According to the USGS, data for the October 1998 and July 2002 storms are of questionable reliability for these two gages. Therefore, they were not used to calibrate the hydraulic models. No other high-water marks or calibration data were available.

Water Surface Profiles

Water surface profiles were developed for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% ACE probability flood events for each stream studied. Beginning on page G.1-69, Plates 3A–3W show the water surface profiles for streams with an AOI or streams with a potential project.

Floodplain Delineation

Water surface elevations were exported from each HEC-RAS model to ArcMap. HEC-GeoRAS tools were used to delineate the floodplains.

FUTURE CONDITIONS HYDRAULIC ANALYSIS

Future conditions hydraulic models were developed by changing the flows to convert the existing HEC-RAS models to future conditions. A new flow file containing the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% ACE probability was created for the RAS model. The flow values in the new flow file are from the USACE future conditions HEC-HMS model, which was developed by adjusting for projected future land uses. All parameters were kept the same in the RAS models, except for the changes made for the future condition flows. As shown in Table G.1-12 on the next page, an expected increase in water surface elevations is seen throughout the watershed.

Conclusion

Discharge-frquency relationships were developed for Leon Creek and tributaries for both existing and future without-project conditions. Due to anticipated development in the watershed, discharges for future without-project conditions increased by an average of nine percent over existing conditions discharges. Discharge-stage relationships were developed based on the existing condtions and future without-project conditions hydraulic modeling. As expected, an increase in water surface elevations for future without-project conditions is seen throughout the watershed.

Table G.1-12. Comparison of 100-year Future Without-Project and Existing Water Surface Elevations (WSEL)

Discharge Location	HMS Hydrologic Element	Q Break Station	Drainage Area (sq miles)	100-year WSEL (ft)			
				Future	Existing	Future – Existing	Change
Leon Creek at Loop 1604	JLC021	221468	39.345	1,024.35	1,024.15	0.20	0.02%
Leon Creek below Leon Trib I	JLC023	202660	42.052	953.33	953.06	0.27	0.03%
Leon Creek below Huesta Creek	JLC029	188437	56.294	898.02	897.67	0.35	0.04%
Leon Creek below French Creek	JLC033	168201	72.619	824.27	823.70	0.57	0.07%
Leon Creek below Culebra Creek	JLC038	151954	158.277	778.92	778.54	0.38	0.05%
Leon Creek below Huebner Creek	JLC041	147620	171.023	768.15	767.86	0.29	0.04%
Leon Creek below Slick Ranch Creek	JLC049	123319	188.759	705.99	705.32	0.67	0.09%
Leon Creek at Military Drive	JLC058	91521	201.797	654.11	653.68	0.43	0.07%
Leon Creek below Test Cell Facility	JLC061	76884	205.115	635.12	634.75	0.37	0.06%
Leon Creek below Indian Creek	JLC070	35989	227.491	572.37	572.19	0.18	0.03%
Leon Creek above Medina River	JLC076	4643	238.172	514.02	512.87	1.15	0.22%
Babcock Trib above Leon Creek	JBT07	4854	6.205	939.69	938.97	0.72	0.08%
Huesta Creek above Leon Creek	JHU011	2441	6.064	931.53	931.29	0.24	0.03%
French Creek above Leon Creek	JFR015	2619	11.632	840.65	840.49	0.16	0.02%
Culebra Creek below Government Canyon	JCC010	43882	25.559	923.49	923.48	0.01	0.00%
Culebra Creek below Helotes Creek	JCC018	25268	72.814	855.54	855.13	0.41	0.05%
Culebra Creek above Leon Creek	JCC027	2637	82.309	781.88	781.57	0.31	0.04%
Government Canyon above Culebra Creek	JGC025	2380	18.173	933.09	933.00	0.09	0.01%
Helotes Creek above Culebra Creek	JHE017	3062	32.117	865.05	864.82	0.23	0.03%
Huebner Creek above Leon Creek	JHB13	5714	11.952	790.50	790.38	0.12	0.02%
Slick Ranch Creek above Leon Creek	JSR23	1436	11.529	714.53	711.72	2.81	0.39%
Indian Creek above Leon Creek	JIN27	776	10.971	551.91	551.78	0.13	0.02%
Comanche Creek above Leon Creek	JCO10	2152	4.674	508.10	507.27	0.83	0.16%

WITH PROJECT CONDITIONS

Project Alternatives Considered

Once the first phase of the study, describing the without project conditions for hydrology and hydraulics, was completed, the Leon Creek Feasibility Study moved into the phase of evaluating potential project alternatives. Initially, 37 Economic Reaches were identified for analysis as potential project areas. Once existing conditions economics were analyzed, twelve Areas of Interest (AOI) were identified in the Leon Creek watershed. A map showing the twelve AOIs is shown in Plate 4. Identified AOIs and their corresponding Economic Reach are described in Table G.1-13. Alternatives were identified and analyzed to reduce or mitigate flooding in each of the AOIs according to EM 1110-2-1419 Hydrologic Engineering Requirements for Flood Damage Reduction Studies (USACE, 1995), in particular Appendix B. Alternatives were identified and analyzed to reduce or mitigate flooding in each of the AOIs.   For each AOI several alternatives were investigated until a feasible and viable alternative was developed. Alternatives included detention ponds, channelization, levees, bypass channels, increased overbank storage, removal of obstructions, and weir structures.

Table G.1-13. Identified Areas of Interest

Area of Interest	Stream	Original Reach	AOI Location and Bounds
AOI-1	Leon Creek	LC R2	On Leon Creek between Quintana Road and New Laredo Highway
AOI-2	Leon Creek	LC R3	On Leon Creek, just south of its crossing of SW Military Dr
AOI-3	Leon Creek Trib F	LC Trib F	On tributary F of Leon Creek, bounded on the east by S. Callaghan Road, on the south by Old US Highway 90 W, on the west by Gena Road, and on the north by the northern boundary of the tributary's 500-year flood delineation
AOI-4	Slick Ranch Creek	Slick Ranch	On Slick Ranch Creek, upstream of its confluence with Leon Creek. Bounded on the north by State Highway 151, Pinn Road to the east, Marbach Road to the south, and the stream's 500-year floodplain delineation to the west
AOI-5	Culebra Creek Leon Creek	Culebra LC R5	On Culebra Creek, from its confluence with Leon Creek in Reach 5, and continuing along Culebra Creek, upstream to its confluence with Helotes Creek
AOI-6	Huebner Creek	Huebner	Along Huebner Creek, bounded on the north at its crossing with Bandera Road, and on the south near Brierbrook, on the east and west by the 500-year floodplain delineation of the stream
AOI-7	Leon Creek	LC R5	Along Leon Creek, from Barryhill Road to the north, Grissom Road to the south, and the stream's 500-year floodplain delineation on the east and west
AOI-8	Huebner Creek	Huebner	Along Huebner Creek, bounded on the north by Parkland Oaks Drive, to the south by Bandera Road, and on the east and west by the 500-year floodplain delineation of the stream
AOI-9	Huebner Creek	Huebner	Along Huebner Creek from just above Babcock Road on the north, to the crossing at Whitby Road to the south, and on the east and west by the 500-year floodplain delineation
AOI-10	Leon Creek	LC 6	Along Leon Creek, beginning at Mission Cemetery on the north, along the stream parallel to I-10 W, to just south of Old Camp Bullis Road.
AOI-11	Leon Creek Leon Creek Leon Creek Trib L	LC 6 LC 7	Along tributary L of Leon Creek, just southeast of the intersection of Broad Oak Trail and Boerne Stage Road to the northwest, following the stream to its confluence with Leon Creek at I-10 W
AOI-12	Helotes Creek	Helotes	On Helotes Creek, roughly bounded on the north by Pond Road, to the east by Ink Wells and Pine Branch, the south by Village Basin, and to the west by W Loop 1605 N

AOI Descriptions and Initial Alternatives Investigated

Initial alternatives analyzed are shown on Plate 5.

AOI-1(Leon Creek Reach 2) is located on Leon Creek between Quintana Road on the north extending south past New Laredo Highway. Damages in this area can be caused by the 20% Annual

Exceedance Probability (AEP) storm event. Damages consist of Commercial, Mobile Homes, Privately Owned Vehicles, and Single Family Residential.

A detention pond was considered in one of the upstream oxbows in order to reduce and possibly mitigate flood damages in some of the low frequency storm event flows. However, due to significantly high flow volumes in the lower frequency storm events, the proposed pond was determined to be insufficient to contain the 20% AEP storm without overtopping the weir, which resulted in minimal flow reductions. A levee structure was considered on the eastern side of this area. However, due to the width of the floodplain, the levee would need a significant enclosure along the upstream side of this area to keep flood waters from getting behind the levee.

Channel overbank storage was the selected alternative due to the ability to significantly reduce water surface elevations (WSEL) in this AOI and surrounding areas. This portion of Leon Creek may also benefit from storm water reduction in the upper reaches.

AOI-2(Leon Creek Reach 3) is located on Leon Creek just downstream of Southwest Military Drive. The San Antonio Port Authority Jet Engine Test Cell facility is located in this AOI, and damages have occurred during low frequency storm events such as the 20% AEP storm event. Damaged properties in this area are primarily Commercial. Contents (jet engines) contribute significantly to the damages. There is an existing levee located between the facility and Leon Creek, but the levee is not of sufficient height and overtopped by low frequency storm events.

Just like AOI-1, detention in this area is not feasible due to the fact that discharges are so large. Therefore, levees that provide 1% and 0.2% AEP levels of protection and a bypass channel were the selected alternatives to reduce damages in this AOI. This portion of Leon Creek may also benefit from storm water reduction in the upper reaches.

AOI-3(Leon Creek Trib F Reach) is located on Leon Trib F, which has damages located west of the Callaghan Road crossing. Damages in this area are caused by the 0.4 and 0.2% AEP storm events. The 0.2% AEP storm event on Leon Creek will back up into Leon Trib F and have negative impacts for a significant portion of the tributary. Damages consist of Public, Privately Owned Vehicles, and Single Family Residential.

A weir structure with flap gates was placed near the confluence of Leon Trib F and Leon Creek. While this would protect the area from Leon Creek backwater, this alternative made the localized flooding caused by Leon Trib F considerably worse. A detention pond upstream of Callaghan Road was also considered to reduce flooding in the area. Since flooding in this area is caused by the high frequency storm events, this pond would have to be very significant in size, making this alternative not cost effective.

The proposed levee structure along the south side of Leon Trib F was the selected alternative and will consist of simply raising an existing gravel road by 2 to 3 feet. In addition, other alternatives upstream that lower the water surface elevations of Leon Creek will possibly have an impact on AOI-3 by reducing the backwater situation observed.

AOI-4(Slick Ranch Creek Reach) is located along Slick Ranch Creek upstream of Marbach Road, downstream of Highway 151, and west of Pinn Road. Damages in this AOI are caused by the 10% AEP storm event. Damages consist of Commercial, Multi Family Residential, Privately Owned Vehicles, and Single Family Residential.

The selected alternative for this AOI consisted of recent channel improvements and a Letter Of Map Revision (LOMR) by the City of San Antonio (COSA), which were incorporated into the USACE hydraulic model. Using the USACE hydrology, these improvements did not result in significant reductions as previously modeled in the LOMR. This is due to the significantly lower discharges used in the LOMR model. Since this area is developed with recent channel improvements, there were no other alternatives considered at this time.

AOI-5(Culebra Creek Reach 1) is located along Culebra Creek from inside of Loop 1604 down to the confluence with Leon Creek. Culebra Creek has been channelized in this area and there is a regional detention pond, Culebra Creek Regional Stormwater Facility (RSWF), currently being constructed by the COSA. This detention pond was incorporated into the Future Conditions HMS model as an off line weir to reduce development discharges. This facility does not significantly reduce discharges and there are still potential damages downstream to consider. Potential damages occur at the 0.4% AEP storm event and consist of Public, Privately Owned Vehicles, and Single Family Residential.

The alternatives analyzed for this AOI include the Government Canyon Detention and Helotes Creek Detention sites. Both of these alternatives have a USACE plan and a plan submitted by San Antonio River Authority (SARA) as part of the Leon Creek Watershed Master Plan.

AOI – 5A(Leon Creek Reach 5) is located at the confluence of Leon and Culebra Creeks, just upstream of Ingram Road. This area was originally part of AOI-3, but was determined that the flooding source was not actually Culebra Creek, but in fact was due to backwater from Leon Creek.

A levee structure along Leon and Culebra Creeks was considered, but the cost was too great to warrant the project. Off-line detention was also considered in order to shave the peak of the major flooding events. However, the majority of the damages due to flooding are caused by lower event storms. Therefore, this was not a feasible option. Channel modification was chosen in this area to mitigate the effects of private structural damages which occur in this reach.

AOI-6(Huebner Creek Reach) is located along Huebner Creek from Bandera Road on the north downstream past Crystal Run. This segment of Huebner Creek was previously channelized. Potential damages occur in the 10% AEP storm event. Damages consist of Commercial, Mobile Homes, Privately Owned Vehicles, and Single Family Residential.

Additional channelization was investigated, but then removed from consideration, due to the extent of existing channelization and the lack of grade and right-of-way to develop drop structures or wider banks.

The Huebner Trib A pond alternative was analyzed for this AOI. In addition, the LC-15 Huebner RSWF as proposed by Bexar County is expected to have a large impact on this site as well.

AOI-7(Leon Creek Reach 5) is located along Leon Creek upstream of Grissom Road. This area was previously channelized into what was observed to be bedrock. Most of the potential damages occur on the east side of Leon Creek and primarily occur at the 2% AEP storm event and higher. Potential damages consist of Privately Owned Vehicles and Single Family Residential.

Channelization was investigated, but removed from consideration, due to the existing condition of Leon Creek in this area. A detention pond located upstream at the confluence of Babcock Creek and Leon Creek was also considered as an alternative for this AOI. While there is an ample amount of open space to fit a pond in this area, the amount of excavation required rendered this alternative unfeasible. Due to the significant flows in this area, a significantly sized pond structure would be required.

The selected alternatives for this area are two alternative levee structures, providing protection for the 1% and 0.2% AEP storm events. In addition, the Quarry Pond may have a large impact on this site as well.

AOI-8(Huebner Creek Reach) is located on Huebner Creek bounded by Apple Green Road on the north down to Bandera Road on the south. This area was previously channelized throughout most of the reach. Potential damages occur at the 4% AEP storm event. Potential damages consist of Public, Privately Owned Vehicles, and Single Family Residential.

Additional channelization was investigated, but then removed from consideration, due to the extent of existing channelization and lack of grade and right-of-way to develop drop structures or wider banks.

The Huebner Trib A pond was the selected alternative for this area. In addition, the LC-15 Huebner RSWF as proposed by Bexar County has a large impact on this site as well.

AOI-9(Huebner Creek Reach) is located on Huebner Creek bounded by Babcock Road on the north down to Whitby Road on the south. Potential damages occur at the 4% AEP storm event and consists of Privately Owned Vehicles and Single Family Residential properties.

Due to available ROW and flexible channel elevations, channelization was analyzed for this area. Channelization consists of channel widening and deepening through AOI-9. In addition, the LC-15 Huebner RSWF as proposed by Bexar County has a large impact on this site as well.

AOI-10(Leon Creek Reach 6) is located on Leon Creek east of IH-10 from just north of Raymond R Russell Park down past Old Camp Bullis Road on the south. Potential damages occur at the 4% AEP storm event and consist of Commercial, Mobile Homes, Public, Privately Owned Vehicles, and Single Family Residential properties.

Channelization, levees, and ponds were considered for this AOI, but due to the lack of right of way and existing development conditions in the area, all three were not considered feasible.

The Target AOI-11 Ponds which are located in the upper areas of this watershed were analyzed for this AOI.

AOI-11(Leon Creek Reaches 6 and 7) is located on Leon Creek and runs along Boerne Stage Road from IH-10 on the east and proceeds west on Boerne Stage Road. Potential damages occur at the 10% AEP storm event and consist of Commercial, Mobile Homes, Public, Privately Owned Vehicles, and Single Family Residential properties. This section of Leon Creek was previously channelized.

Additional channelization was considered but was ruled out due to limited right of way and the existing development conditions of Leon Creek in the area. There is also a large backwater issue from IH-10, which was determined to cause a large portion of the problems for this AOI. Any alternative that would alleviate this backwater issue would have to be mitigated immediately, due to the negative impacts it would have downstream of the structure.

Leon Trib M Pond and Leon XS 285313 Pond were considered and modeled separately with minimal results. However, when they were modeled in combination, the results reflected some reduction in damages.

The Target AOI-11 Ponds are the selected alternatives for this area, which consist of both Leon Trib M Pond and Leon XS 285313 Pond.

AOI-12(Helotes Creek Reach) is located on Helotes Creek south of Loop 1604. Potential damages occur at the 4% AEP storm event and consist of Public, Privately Owned Vehicles, and Single Family Residential properties. This section of Helotes Creek was observed to be heavily vegetated with significant blockages to the conveyance of flows.

The alternative analyzed for this AOI consists of maintenance of the channel and clearing trees and brush along this stretch of Helotes Creek, reducing the Manning’s n-value which results in significantly lower WSEL. In addition, the Helotes Creek Pond also significantly impacts this area. Both of the aforementioned alternatives were chosen for this AOI.

SELECTED ALTERNATIVE DESCRIPTIONS

Selected alternatives were chosen for further analysis based upon preliminary costs and benefits to be gained. During the course of this analysis, additional alternatives were developed and analyzed and are described in this section.

Alternative 1 - Leon AOI-1 Overbank Modifications (Impacts AOI-1)

This alternative consists of adding channel storage in the overbanks from cross-sections 71115 to 66551. New Laredo Highway divides the upper section and the lower section, both of which have different modifications. For the upper section, from cross-section 71115 to 69321, modifications were made in the left overbank, on the east side of Leon Creek. The modifications consisted of having a 0.5% slope extend outward from the channel banks to intersect at 4:1 side slope coming down from the existing ground near Plumnear Street. For the lower section, from cross-section 68856 to 66551, the right overbank, west of Leon Creek, will be excavated. A slope of 0.5% will slope from the banks of an existing drainage channel towards Leon Creek. The high point in between the channel and Leon Creek will be removed in order to gain channel storage in the overbanks. This additional storage will enable Leon Creek to contain the 20% AEP storm event in AOI-1. Excavation will be required on this alternative. Effects of this alternative impact only AOI-1 and surrounding areas. See Table G.1-14. This alternative did not reduce water surface elevations for the less frequent events and in some locations a rise in water surface elevation was seen. This alternative was eliminated from further consideration due to the hydraulic impacts and because it was shown to have negative net benefits.

Alternative 2 - Leon AOI-2 1% AEP Levee (Impacts AOI-2)

This alternative consists of adding a levee along Leon Creek from cross-section 85024 to 87627. The levee would run along the east side of Leon Creek in order to prevent damages from occurring for the 1% AEP storm event in AOI-2. The levee elevation would range from 640 on the downstream end to 649 on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is approximately 16.87’. Effects of this alternative impact only Leon Creek around AOI-2. See Table G.1-15. While this alternative initially showed a small increase in water surface elevations upstream of the levee (greatest increase was 1.24 feet), the team felt that this alternative was worth pursuing if these inducements could be mitigated.

Alternative 3 - Leon AOI-2 0.2% AEP Levee (Impacts AOI-2)

This alternative consists of adding a levee along Leon Creek from cross-section 85024 to 87627. The levee would run along the east side of Leon Creek in order to prevent damages from occurring for the 0.2% AEP storm event in AOI-2. The levee elevation would range from 644 on the downstream end to 653 on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is approximately 19.94’. Effects of this alternative impact only Leon Creek around AOI-2. See Table G.1-16. This alternative was also carried forward for optimization.

Alternative 4 - Leon AOI-2 Bypass Channel (Impacts AOI-2)

This alternative consists of adding a 2,738 foot bypass channel on Leon Creek to divert flows away from AOI-2. The bypass channel flows in a south-southwest direction and diverts some of the flow past the oxbow in Leon Creek before tying back into Leon Creek downstream of AOI-2. The bypass channel begins just downstream of the crossing of Leon Creek and Military Drive around Leon cross-section 87864 and ties back into Leon Creek between cross-sections 78641 and 77693. The bypass channel has a bottom width of 40’ and a constant slope of 0.53%. Excavation will be required on this alternative. The by-pass channel will contain the 2% AEP storm and will reduce, but not eliminate, existing flooding for each event. Effects of the bypass channel impact only Leon Creek around AOI-2. See Table G.1-17. Due to the reduction in water surface elevations provided by this alternative, it was selected to be optimized during the next phase of the study.

Alternative 5 - Slick Ranch Improvements (Impacts AOI-4)

This alternative consists of adding channel improvements to the Slick Ranch Creek HEC-RAS models. Data for these improvements came from a HEC-RAS model received from SARA which reflects a project named Slick Ranch Regional Stormwater Detention Facility. Cross-sections 6632 to 2490 were copied from SARA’s HEC-RAS model and incorporated into the USACE model. The cross-section stationing was also modified for those cross-sections brought into the HEC-RAS model in order for HEC-RAS to recognize them. The cross-sections in the Hydraulic Comparison Table do not match up exactly, but represent cross-sections in close proximities to each other. Excavation will be required for this alternative. Effects of this alternative impact Slick Ranch around AOI-4. See Table G.1-18. The original thinking was that the sponsor might seek credit for this work as part of the Federal project. As the study progressed, the sponsor decided not to proceed with seeking credit and the analysis was truncated.

Alternative 6 - Leon Trib F AOI-3 0.2% AEP Levee (Impacts AOI-3)

This alternative consists of adding a levee along Leon Trib F from Callaghan Road continuing west about 2,611 feet. The levee would consist of raising an existing privately owned dirt road which runs parallel and along the south side of Leon Trib F to protect AOI-3 from both the Leon Creek 0.2% AEP WSEL (717.12) and Leon Trib F 0.2% AEP WSEL (717.83 at downstream face of Callaghan Road Bridge). This levee would be set at a minimum elevation of 717.5 for most of the channel and raised to 718 for the upstream segment (spanning about 186’). The dirt road would need to be raised 2.75 feet at its lowest elevation in order to keep AOI-3 from having any further flooding issues. Effects of this alternative impact only Leon Trib F, and the water surface elevations in this area are increased slightly (<0.02’ for 0.2% AEP storm event). See Table G.1-19. While this alternative has positive net benefits, it was not investigated further due to lack of sponsor support.

Alternative 7 - Huebner Trib A Pond (Impacts AOI-8, AOI-6)

This alternative consists of placing an inline pond at the confluence of Huebner Trib A and Huebner Trib B, located upstream of the crossing of Huebner Trib A and Babcock Road. This pond consists of a 14 foot tall dam structure with a 200’ weir, and storage of approximately 295 acre-feet. This pond was designed to contain the 4% AEP storm event without overtopping the weir. Excavation will be needed to obtain the storage for this alternative. Positive effects of this alternative continue downstream of this pond along Huebner Trib A and Huebner Creek until Huebner Creek confluences with Leon Creek. Leon Creek water surface elevations are raised slightly by this alternative (<0.05’ for the 1% AEP storm event) from its confluence with Huebner Creek downstream to the confluence of Leon Creek with the Medina River. See Table G.1-20. This alternative was selected for optimization in order to determine if the inducements could be eliminated.

Alternative 8 - Huebner AOI-9 Channel Modifications (Impacts AOI-9)

This alternative consists of approximately 3,800 feet of channel modifications along Huebner Creek between Whitby Road and Hollyhock Road. Channel modifications consist of channel widening and deepening. The channel bottom width varies from 50 feet on the lower end to 30 feet on the upper end. The slopes vary for this alternative with three segments, 0.45%, 0.51%, and 0.68%. Excavation will be required for this alternative. The effects of this alternative are only in the location of the channel modifications. Negative impacts can be mitigated through channel storage near the confluence of Huebner and Leon Creeks. See Table G.1-21. Due to the inducements caused by this alternative, as well as the fact that it produced negative net benefits, this project was eliminated from consideration.

Alternative 9 – LC-15 Huebner @ Prue RSWF (Impacts AOI-9, 8, 6)

This alternative consists of adding the LC-15 Huebner at Prue RSWF, as proposed in the Leon Creek Watershed Master Plan developed by SARA, to the USACE Future Conditions HMS Model. The RSWF is located on Huebner Creek just upstream of Prue Road. This alternative consists of partially blocking one of the 9X6 box culverts. Effects of this alternative can be observed downstream on Huebner Creek to the confluence of Leon Creek, and from there down the rest of Leon Creek slight impacts (<0.01' for 0.2% AEP storm event) can be observed. See Table G.1-22. Since this project was already under construction and the sponsor would possibly seek credit for it, this alternative was carried forward for consideration as part of the Federal project.

Alternative 10 - Helotes Channel Improvements (Impacts AOI-12)

For this alternative (Helotes Creek Channel Improvements) the wooded area downstream of Loop 1604 (XS 13795 to 5108) is cleared to have more open space or grassland area in order to reduce the Manning's n-value. The n-value in this area was reduced to 0.045 which represents the area being cleared to have more open space. Effects of this alternative impact only AOI-12 and surrounding areas. See Table G.1-23. This alternative was eliminated from further analysis due to significant negative net benefits.

Alternative 11 – DC-12 Helotes Creek RSWF (Impacts AOI-12, 5, 2, 1)

This alternative consists of adding the DC-12 Helotes Creek RSWF, as proposed in the Leon Creek Watershed Master Plan provided by SARA, to the USACE Future Conditions HMS Model. The RSWF is located on Helotes Creek at an existing quarry site northwest of Loop 1604 and south of FM 1560. The dam is approximately 28.5' tall and the maximum storage of this RSWF is 2,608 acre-feet. Effects of this alternative continue down Helotes, Culebra, and Leon Creek. See Table G.1-24. This alternative provided significant reductions in water surface elevation as well as significant net benefits. However, it was not considered for further analysis when compared with Alternative 12 which took advantage of an existing quarry, thus reducing costs and producing greater net benefits.

Alternative 12 - Halff Helotes-Quarry Pond (Impacts AOI-12, 5, 2, 1)

This alternative consists of a pond being located at an existing quarry along Helotes Creek northwest of Loop 1604 and south of FM 1560. Currently there is a 50 acre quarry site that is excavated to 100 feet below natural grade. This alternative diverts flow via a lateral weir into the pond and takes advantage of the 5000 acre-feet of storage. The weir structure would be a 500 foot lateral weir. Some earthwork would be required on the site. Effects of this alternative are observed throughout Helotes, Culebra and Leon Creeks. See Table G.1-25. This alternative was carried forward in to the optimization phase due to its significant reductions in water surface elevations and positive net benefits.

Alternative 13 - Halff Government Canyon Pond (Impacts AOI-5, AOI-2, AOI-1)

This alternative consists of a pond being located in Government Canyon State Park. This pond would be located approximately 8,200 feet upstream (7,600 feet straight-line northwest) of the park entrance. This pond consists of a 60 foot tall dam with a 350 foot weir, and storage of approximately 5,583 acre-feet. This pond was designed to contain the 0.2% AEP storm event without overtopping the weir. The weir serves the purpose of allowing the dam to function in the event of back to back major storms (i.e. one 0.2% AEP storm event followed by another 0.2% AEP storm event before the first can completely drain). With this configuration this pond will drain completely in approximately 36 hours for the 1% AEP event. Excavation will not be needed in order to obtain the desired storage for this alternative. Effects of this alternative continue downstream and can be observed as far as the confluence of Leon Creek with the Medina River.

The location of this pond was selected in order to optimize the storage. This pond also can be significantly modified in regards to height and outlet structure in order to increase or decrease size and efficiency due to the amount of elevation relief in this particular area. According to the contours in the area, the dam has the potential to increase in height upwards of 50+ feet by making it longer and shifting the alignment slightly. This could significantly increase storage and allow a smaller outlet structure, thus decreasing flows downstream as well. See Table G.1-26. This alternative produced negative net benefits and was eliminated from further analysis.

Alternative 14 – Government Canyon RSWF (Impacts AOI-5, AOI-2, AOI-1)

This alternative consists of adding the Government Canyon RSWF, as proposed in the Leon Creek Watershed Master Plan provided by SARA, to the USACE Future Conditions HMS Model. The RSWF is located within Government Canyon State Park. The RSWF consists of a 51 foot tall dam structure and a maximum storage of approximately 6,870 ac-ft. The maximum discharge from this outlet structure is 1,000 cfs. Effects of this alternative can be observed down the rest of Government Canyon, Culebra Creek, and Leon Creek. See Table G.1-27. This alternative was located in a state natural preserve area and presents significant cultural and environmental concerns, including endangered species implications.

Alternative 14b – Government Canyon U.S. Pond (Impacts AOI-5)

Because of the cultural and environmental significance of the Government Canyon area, a smaller version of Alternative 14 was considered. This alternative uses the same location as the pond described in Alternative 14, but new outlet structure and storages have been calculated for this area. The dam will remain at 51 feet tall and the maximum discharge will be approximately 25,000 cfs. The maximum storage of this pond is 1,845 ac-ft. See Table G.1-28. This alternative produced significant negative net benefits and because of this, along with the cultural and environmental concerns, it was eliminated from further consideration.

Alternative 15 - Leon AOI-7 1% AEP Levee (Impacts AOI-7)

This alternative consists of adding a levee along Leon Creek from cross-section 161047 to 164568. The levee is on the eastern side of Leon Creek to prevent damages from occurring for the 1% AEP storm event in AOI-7. The levee elevation would range from 801 on the downstream end to 814.5 on the upstream end. The greatest difference between levee elevation and existing ground elevation is approximately 5.1 feet. Effects of this alternative impact only Leon Creek in the vicinity of AOI-7. See Table G.1-29. This alternative was selected for further optimization to include interior drainage.

Alternative 16 - Leon AOI-7 0.2% AEP Levee (Impacts AOI-7)

This alternative consists of adding a levee along Leon Creek from cross-section 159661 to 164568. The levee is on the eastern side of Leon Creek to prevent damages from occurring for the 0.2% AEP storm event in AOI-7. The levee elevation would range from 801 on the downstream end to 820 on the upstream end. The greatest difference between levee elevation and existing ground elevation is approximately 10.6 feet. Effects of this alternative impact only Leon Creek in the vicinity of AOI-7. See Table G.1-30. This alternative was selected for further optimization to include interior drainage.

Alternative 17 – Quarry at the Rim RSWF (Impacts AOI-7, AOI 2, AOI-1)

This alternative consists of adding the Quarry at the RIM RSWF, as proposed in the Leon Creek Watershed Master Plan provided by SARA, to the USACE Future Conditions HMS Model. The location of this RSWF is at an existing quarry site located along Leon Creek. The site is located north of Loop 1604 and east of IH-10. A lateral weir will divert some of the flows to a diversion channel which will in turn drain into the Quarry at the Rim RSWF. Effects of this alternative can be observed downstream to the confluence of Leon Creek with the Medina River. See Table G.1-31. This alternative produced some net benefits and reduced water surface elevations downstream. However, the Quarry at the Rim is a working quarry with an estimated economic life of 25 or more additional years of operation. The owner is not currently interested in selling, and the real estate costs used in the initial screening most likely are not adequate to cover the condemnation value of the property’s future income stream. The local sponsor has indicated that they are not willing to purse condemnation of a working commercial establishment. Therefore, this alternative was eliminated from further consideration.

Alternative 18 - Target AOI-11 Ponds (Impacts AOI-11, AOI-10)

This alternative consists of two ponds located upstream of AOI-11. Leon Trib M Pond is an inline pond located along Leon Trib M approximately 4,030 feet upstream (northwest) of the northern-most crossing of Boerne Stage Road. Leon XS 285313 Pond is an inline pond located along Leon Creek approximately 1.3 miles upstream (west) of the crossing of Leon Creek and Huntress Lane. Leon Trib M Pond consists of a 42 foot tall dam with a 300 foot weir, with storage of approximately 348 acre-feet. Leon XS 285313 Pond consists of a 38 foot tall dam with a 350 foot weir, with storage of approximately 455 acre-feet. Both of these ponds were designed to contain the 4% AEP storm events without overtopping the weirs. No excavation will be needed to obtain the storage for either of these two ponds for this alternative. Effects of this alternative can be observed down Leon Creek to its confluence with French Creek.

These two ponds were run in conjunction as an alternative due to the greater impacts found downstream in both AOI-11 and AOI-10. In order to have any impact on these areas of interest, the project needs to be located upstream of these areas and the ponds reduce flow and upset the timing of the hydrographs in order to reduce water surface elevations downstream. See Table G.1-32. This alternative produced positive net benefits, albeit very small, with a benefit to cost ratio 1.0. The area also has historical significance which could lead to a politically charged environment. Therefore, the sponsor elected not to pursue this alternative any further.

Alternative 19 – Boerne Stage Road Improvements (Impacts AOI-11)

This alternative was requested by the Bexar County Flood Control District. This alternative consists of incorporating the Boerne Stage Road Improvements (developed by others) into the USACE HEC-RAS model. The road improvements consist of widening and raising Boerne Stage Road from Cross Mountain Road on the west to IH 10 frontage road on the east. This road would then act as a levee. Effects of this alternative can be observed only in AOI-11. See Table G.1-33. No significant effect on water surface profiles was observed with the road improvement in place and no additional analysis was conducted per sponsor request.

Alternative 20 – AOI-7 Channel Modifications – 300' Bottom Width (Impacts AOI-7)

This alternative was requested by the Bexar County Flood Control District. This alternative consists of approximately 6,125 feet of channel deepening and widening, using a bottom width of 300 feet, to contain the 0.2% AEP storm event. Effects of this alternative can be observed only in AOI-7. See Table G.1-34. This alternative had significant negative net benefits and was modified (see Alternative 21 description).

Alternative 21 – AOI-7 Channel Modifications – 200' Bottom Width (Impacts AOI-7)

This alternative was developed after investigating Alternative 20 and realizing the need to develop a smaller alternative to contain the 1% AEP storm event. This alternative consists of approximately 3,820 feet of channel deepening and widening, using a bottom width of 200 feet. Effects of this alternative can be observed only in AOI-7. See Table G.1-35. Further refinements were made to this alternative to determine if a smaller channel would produce positive net benefits. See Alternative 21b.

Alternative 21b – AOI-7 Channel Modifications – 100' Bottom Width (Impacts AOI-7)

This alternative was developed after running the economics on Alternative 21. Alternative 21 had a BCR of approximately 0.9, and Alternative 21 was optimized to produce a higher BCR. After investigating Alternative 21 further, the 100' bottom width channel alleviates the 1% AEP flooding within this area. This alternative consists of approximately 3,820 feet of channel deepening and widening, using a bottom width of 100 feet. Effects of this alternative can be observed only in AOI-7. See Table G.1-36. This alternative was selected for further analysis to determine the optimal size channel to reduce water surface elevations and gain the most net benefits.

Alternative 22 – LC-15 HB@Prue & Huebner Trib A Pond (Impacts AOI-9, 8, 6)

This alternative was requested by the Bexar County Flood Control District. This alternative consists of combining two previous alternatives, Alternative 7 & 9. The two ponds, LC-15 Huebner @ Prue RSWF and Huebner Trib A Pond, were run in unison in the HMS model to develop new flows. See Table G.1-37. This alternative was selected for further analysis and would use the optimized Alternative 7 & 9 features.

Alternative 23 – Leon Creek AOI-5A Channel Modifications (Impacts AOI-5A)

This alternative was requested by the Bexar County Flood Control District. This alternative consists of approximately 2,500 feet of channel modifications located upstream of Ingram Road, with varying depths and bottom widths. The channel bottom will be cut to the lowest elevation within the channel bottom and no cut will occur to the existing side slopes. See Table G.1-38. Further refinements were made to this alternative to determine if a smaller channel would produce positive net benefits. See Alternative 23b.

Alternative 23b – Leon Creek AOI-5A Channel Modifications (Impacts AOI-5A)

This alternative was developed after running the economics on Alternative 23. Alternative 23 had a BCR of approximately 0.9, and an alternative was developed to achieve a higher BCR. This alternative consists of approximately 1,935 feet of channel modifications located upstream of Ingram Road, with varying depths and bottom widths. The channel bottom will be cut to the lowest elevation within the channel bottom and no cut will occur to the existing side slopes. See Table G.1-39. This alternative was selected for further analysis to determine the optimal size channel to reduce water surface elevations and gain the most net benefits.

Selected Alternatives' Optimization

After more detailed economic analysis, the alternatives selected for further evaluation, by virtue of having a Benefit-Cost Ratio greater than 1, are the following: Alternative 2 and 3 – Test Cell Levees, Alternative 4 – Test Cell By Pass, Alternative 7 - Huebner Trib A Pond, Alternative 9 – Huebner Creek RSWF at Prue Road, Alternative 12 – Helotes Quarry Pond, Alternative 15 and 16 – Leon Creek Levees, Alternative 22- Alt 7 and 9 combo, Alternative 21b – Leon Creek Channel Improvements, Alternative 23b – Leon Creek at Culebra Creek Channel Improvements.

Alternatives 2 and 3 (Test Cell Levees) – The original alternatives consisted of 1% and 0.2% AEP flood protection levees, respectively. After examining the currently-effective FEMA Flood Insurance Study (FIS) Base Flood Elevation (BFE) it was determined that the FEMA 1% AEP water surface elevation, plus the three feet of required freeboard, was less than the applied 1% AEP levee height for Alternative 2, without any additional freeboard. This difference relates to differences in magnitude of FEMA's and this Feasibility Study's projected 1% AEP peak discharges along Leon Creek. The Local Sponsor requested that levee alternatives be limited to those with sufficient height to achieve National Flood Insurance Program (NFIP) compliance, unless there are demonstrative reductions in expected inundation damages when considering more-elevated levee options; therefore only the 1% AEP levee height was evaluated further.

With this alternative, an interior drainage plan was developed to mitigate for the otherwise captured storm runoff behind the levee. This plan consisted of storm drains and ditches which drain to a sump area. The outlet (sluice) culvert at the sump area was configured with a flap gate, to prevent surging Leon Creek channel flows from entering the sump.

While this levee alternative produced significant positive net benefits at the Test Cell, upstream hydraulic inducements were found to be a residual concern. Additional refinements would be needed to fully mitigate for these hydraulic inducements. See Alternative 2 and 4 Combo and Alternative 2 with Channel Improvements (Mitigation) for additional details in this regard.

Alternative 2 with Channel Improvements (Mitigation) – This alternative is the same as Alternative 2, but channel improvements were now introduced to mitigate for increases in water surface elevations due to the constriction in the Leon Creek flow area along the Test Cell (levee) reach. Refer to Plate 6 for the location of this alternative. The improvements would consist of a 40-foot bottom width channel upstream of the Military Highway bridge and a transition to an 80-foot channel downstream of the bridge and adjacent to the levee reach. See Table G.1-40. This channel modification was found to be sufficient to eliminate the induced increases in water surface elevations upstream of the proposed (levee) project. Because this reconfigured alternative has significant net benefits and eliminates upstream inducements, it will be carried forward as part of the recommended plan.

Alternative 4 (Test Cell Bypass) – This alternative was altered slightly from the original version. After further investigation, it was noted that a large 48-inch sewer main would have to be relocated under the original alignment; therefore, the bypass channel alignment was modified slightly to obtain physical clearance. The dimensions of this alternative were subsequently economically optimized, considering 100-, 40-, and 25-foot bottom widths. See Tables G.1-41, G.1-42, and G.1-43 for the computed results for these three scenarios. All three sizes of this alternative produce positive net benefits with the 100-foot channel providing the greatest net benefit. However, since none of these channel improvement measures performed as well as the levee alternative, the stand-alone version of this alternative was eliminated from further consideration.

Alternative 2 and 4 Combo – This alternative simply combines Alternative 2 and Alternative 4 (with the 100-foot bottom width bypass channel). See Table G.1-44. It increases net benefits but does not eliminate the induced damages caused by the constriction in the Leon Creek flow area along the Test Cell (levee) reach; therefore, it was also eliminated from further consideration. See Plate 7 for the location of these alternatives.

Alternative 2 with Mitigation and 4 Combo – This alternative combines Alternative 2 with hydraulic mitigation and Alternative 4 (with the 100-foot bottom width bypass channel). The analysis indicates that the addition of the bypass channel to Alternative 2 with mitigation had only a very small effect upon flood damage reduction benefits, while adding substantially to implementation cost; therefore, this alternative was eliminated from further consideration.

Alternative 7 (Huebner Trib A Pond) – Alternative 7 is a detention pond that was optimized by changing the size, location and outfall configuration. It was determined that the outfall and size of the pond were already generally optimized, but the physical location could be modified slightly, in order to reasonably minimize real estate costs. Refer to Table G.1-20. Due to the significant negative net benefits, this alternative was eliminated from further consideration.

Alternative 9 (Huebner Creek RSWF at Prue Road) – This alternative is currently slated for construction as a Bexar County Flood Control Project. The hydrologic and hydraulic models, as well as the cost estimate, were provided by the local sponsor and were incorporated into this study. The project went through a PER and other alternatives were investigated by the sponsor, thus no optimization was performed on this site. This alternative produced significant negative net benefits, and was therefore eliminated from further consideration.

Alternative 22 – This alternative is a combination of an optimized Alternative 7 and Alternative 9. See Table G.1-45. The marginal increase in benefits by combining the alternatives was minor and insufficient to provide positive net benefits. Therefore, this alternative was eliminated from further consideration.

Alternative 12 (Helotes Quarry Pond) – The economic efficiency of Alternative 12 primarily relates to the fact that it could take advantage of an existing topographic feature adjacent to the Helotes Creek floodplain, as shown on Plate 8. This so-called pond is actually an excavated rock quarry pit that extends approximately 120 feet below the natural ground surface and has potential to provide approximately 5000 acre-feet of flood storage. In order to reasonably optimize this alternative, both smaller- and larger-scale projects were also evaluated. Development of a smaller-scale project at this site can be demonstrated qualitatively to be inferior in performance to the 5000 acre-foot scale. The readily-available storage is provided essentially for free with real estate acquisition of the site. Attempting to utilize only a fraction of the available storage would significantly reduce benefits without achieving any cost savings. Conversely, a larger-scale plan, which would store more flood water than Alternative 12 and thus be expected to provide a greater reduction in downstream flood damages, was also considered. The tested larger plan would divert and store an additional 2400 acre-feet of floodwaters. In order to provide this additional storage, excavation and limestone-blasting would be required, along with implementation of a larger diversion weir and floodwater evacuation pumping system. As a result, costs would increase significantly, rendering this larger-scale plan less economically feasible. The obviously optimum scale of storage is full utilization of the existing quarry (5000 acre-feet of storage) space. Due to the reductions in water surface elevations on Helotes Creek, Culebra Creek, and Leon Creek and the associated positive net benefits from this alternative, it is being carried forward as part of the recommended plan.

Alternative 15 and 16 (Leon Creek Levees) **-** The original alternatives consisted of 1% and 0.2% AEP flood protection levees, respectively. After examining the currently-effective FEMA Flood Insurance Study (FIS) Base Flood Elevation (BFE) it was determined that the FEMA 1% AEP water surface elevation, plus the three feet of required freeboard, was less than the applied 1% AEP levee height for Alternative 15, without any additional freeboard. This difference relates to differences in magnitude of FEMA's and this Feasibility Study's projected 1% AEP peak discharges along Leon Creek. The Local Sponsor requested that levee alternatives be limited to those with sufficient height to achieve National Flood Insurance Program (NFIP) compliance, unless there are demonstrative reductions in expected inundation damages when considering more-elevated levee options; therefore only the 1% AEP levee height was evaluated further.

With this alternative, an interior drainage plan was developed to mitigate for the otherwise captured storm runoff behind the levee. This plan consisted of storm drains and ditches which drain to a sump area. The outlet (sluice) culvert at the sump area was configured with a flap gate, to prevent surging Leon Creek channel flows from entering the sump.

These levee alternatives produced negative net benefits and were thus eliminated from further consideration.

Alternative 21b (Leon Creek Channel Improvements) – Alternative 21B was further evaluated, for purposes of economically optimizing its channel size. Channel plans with bottom widths of 85, 100, and 150 feet were assessed. The longitudinal scale (length) was also varied among these plans, but the slope of each plan was maintained as equal to that of the existing channel, in order to avoid utility conflicts. Cost of utility relocations was accounted for in this alternative. See Tables G.1-46 and G.1-47 for results for the 85- and 150- foot channel options. The 100-foot channel was previously presented in Table G.1-36.

The 85-foot channel was subsequently identified as likely representing the economically-optimized solution. Updated and refined cost estimates were then prepared. Preliminary real estate and construction costs, provided by the Local Sponsor, were updated by USACE real estate and cost estimating personnel. Total costs for this alternative were found to have increased substantially above the preliminary estimates, rendering this alternative infeasible; therefore, it was eliminated from consideration.

Alternative 23b (Leon Creek at Culebra Creek Channel Improvements) - Alternative 23B was further evaluated, for purposes of economically optimizing its channel size. The slope of the channel would have been modified slightly, but this plan is primarily comprised of the removal of large quantities of gravelly sedimentation that has occurred along this reach of Leon Creek. See Table G.1-39, presented previously, for results with this alternative. Since this alternative produces negative net benefits, it was eliminated from further consideration.

RECOMMENDED PLAN

Two structural alternatives are recommended for inclusion as parts of the NED plan for Leon Creek. These are Alternative 2 with Channel Modifications (for mitigation of upstream hydraulic impacts caused by the constriction at the Test Cell reach) and Alternative 12 – the Helotes Quarry Pond. Both of these alternatives reduce flood risks in the Leon Creek watershed and are economically justified as stand-alone projects. Combination of these measures into a complete NED plan entailed additional analysis and consideration as follows.

Next-Added Increment Analysis

While the two recommended structural alternatives are located in distinctly different parts of the watershed, the possibility exists that the hydrologic and/or hydraulic effects of one measure may interact with those of another, materially affecting the performance and potentially the very economic justification of one or more elements. To assess this situation, a so-called Next-Added Increment analysis was undertaken. In this instance, each of the two recommended alternatives (projects) was measured with regards to how they add or detract from the performance characteristics of the other.

Structural alternatives at the Test Cell reach along Leon Creek have a direct impact on frequency-based water surface profiles only in the vicinity of the Test Cell reach. This is true for both channelization and levee solutions in that area. With or even without hydraulic mitigation, impacts (of those alternatives) upon water surface profiles diminish to zero a short distance upstream from the Test Cell area. There is absolutely zero potential impact upon hydrologic and/or hydraulic performance for any alternative on Helotes Creek, located several river miles further upstream.

Conversely, a floodwater detention project on Helotes Creek, such as the recommended Helotes Creek Quarry Plan (Alternative 12), significantly reduces frequency-based flood discharges all the way from the detention site, downstream along Helotes Creek, Culebra Creek, and Leon Creek. As such, the Helotes Creek Quarry Plan is capable of reducing flood damages in the Test Cell reach. Treated as a stand-alone alternative, this plan would get credit for producing a measurable expected annual flood damage reduction benefit in that Test Cell reach. However, when also treated as a stand-alone alternative, the Test Cell Levee Plan (with upstream hydraulic mitigation) even more substantially reduces expected annual flood damages in that same Test Cell reach. The issue is that both project elements "compete" for some of the same expected annual damage reduction benefits in that reach.

As was expected, the required "next-added" economic analyses clearly indicate that there is only a very minor overlap in flood damage reduction benefits afforded by the proposed simultaneous combination of the two elements of the recommended plan, when compared to treating the two elements in stand-alone fashion. The "shared" flood damage reduction benefits under the combined-plans scenario are sufficiently small so as to not impact the economic optimization of either element of the recommended plan.

Results of the associated hydraulic modeling performed for the combination of these two structural alternatives are shown in Table G.1-48.

Recommended Plan

The Helotes Creek Quarry Plan, which is capable of reducing frequency-based peak discharges in the Test Cell reach by 4 to 8 percent, provides for a slightly enhanced level-of-performance of the Test Cell Levee Plan. Nonetheless, both elements of this combined plan are economically optimized from a National Economic Development (NED) standpoint, when treated as either stand-alone projects or as a combined project.

Table G.1-14

Alternative 1: Leon AOI-1 Overbank Modifications

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		87864	648.96	648.96	0	646.92	646.92	0	644.13	644.13	0
	AOI 2	87627	648.51	648.51	0	646.6	646.6	0	643.8	643.8	0
	AOI 2	86710	644.28	644.28	0	640.87	640.88	-0.01	639.42	639.42	0
	AOI 2	85691	643.38	643.38	0	639.41	639.41	0	636.59	636.54	0.05
	AOI 2	84973	643.09	643.09	0	639.03	639.03	0	636.05	635.99	0.06
	u/s Leon Trib C	82969	642.68	642.68	0	638.47	638.47	0	635.07	634.97	0.1
	d/s Leon Trib C	82554	642.63	642.63	0	638.4	638.4	0	634.98	634.87	0.11
		79435	641.02	641.02	0	636.56	636.56	0	632.48	632.4	0.08
		75582	636.36	636.36	0	632.23	632.24	-0.01	628.69	628.54	0.15
		74009	629.09	629.1	-0.01	626.31	626.36	-0.05	624.27	623.91	0.36
		72887	626.83	626.86	-0.03	624.48	624.57	-0.09	622.85	622.26	0.59
	u/s Quintana Rd / AOI 1	71561	624.78	624.83	-0.05	622.93	623.07	-0.14	621.77	620.88	0.89
	d/s Quintaa Rd / AOI 1	71115	621.91	622.28	-0.37	619.74	620.45	-0.71	618.66	615.02	3.64
	u/s New Laredo Hwy / AOI 1	69321	619.99	618.58	1.41	618.16	616.93	1.23	617.06	615.39	1.67
	d/s New Laredo Hwy / AOI 1	68856	618	616.33	1.67	614.8	613	1.8	613.65	610.42	3.23
	AOI 1	67795	617.18	616.37	0.81	613.97	613.14	0.83	611.54	610.71	0.83
		66551	617.04	616.35	0.69	613.82	613.13	0.69	611.39	610.7	0.69
		64262	614.54	614.54	0	611.74	611.74	0	609.59	609.59	0
		63541	612.01	612.01	0	609.39	609.39	0	607.36	607.38	-0.02

Table G.1-15

Alternative 2: Leon AOI-2 100 Year Levee

			500 WSEL (ft)	500 WSEL (ft)	Difference	100 WSEL (ft)	100 WSEL (ft)	Difference	25 WSEL (ft)	25 WSEL (ft)	Difference
Stream	Location / AOI #	Cross-section	FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)
Leon Creek		95755	665.12	665.13	-0.01	660.33	660.16	0.17	656.53	656.55	-0.02
		95690	665.46	665.47	-0.01	660.71	660.61	0.1	657.02	657.04	-0.02
		94824	665.12	665.13	-0.01	660.35	660.24	0.11	656.63	656.65	-0.02
		94802	665.09	665.11	-0.02	660.32	660.21	0.11	656.61	656.63	-0.02
		94293	664.92	664.93	-0.01	660.15	660.04	0.11	656.42	656.45	-0.03
		94274	664.89	664.9	-0.01	660.12	660.01	0.11	656.4	656.43	-0.03
		93810	664.72	664.73	-0.01	659.95	659.84	0.11	656.21	656.23	-0.02
		93798	664.7	664.71	-0.01	659.94	659.83	0.11	656.18	656.21	-0.03
		93047	664.08	664.09	-0.01	659.32	659.19	0.13	655.5	655.53	-0.03
		93032	663.83	663.84	-0.01	659.07	658.93	0.14	655.25	655.28	-0.03
		92368	660.84	660.86	-0.02	656.66	656.64	0.02	653.38	653.43	-0.05
		92350	659.64	659.68	-0.04	655.87	655.91	-0.04	652.69	652.75	-0.06
		90894	656.97	657.03	-0.06	653.84	653.9	-0.06	650.98	651.07	-0.09
		90875	656.87	656.92	-0.05	653.83	653.89	-0.06	650.96	651.05	-0.09
		90266	656.43	656.49	-0.06	653.32	653.39	-0.07	650.65	650.75	-0.1
		90248	655.79	655.87	-0.08	652.82	652.9	-0.08	650.52	650.62	-0.1
		90179	655.72	655.79	-0.07	652.7	652.78	-0.08	650.3	650.41	-0.11
		90158	655.61	655.68	-0.07	652.64	652.72	-0.08	650.25	650.36	-0.11
		89670	654.41	654.53	-0.12	651.66	651.79	-0.13	649.2	649.38	-0.18
		89593	653.92	654.07	-0.15	651.29	651.36	-0.07	648.85	649.06	-0.21
		88636	652.7	652.94	-0.24	650.44	650.53	-0.09	648.32	648.55	-0.23
		87864	648.96	650.03	-1.07	646.92	647.38	-0.46	644.13	645.25	-1.12
		87627	648.51	649.64	-1.13	646.6	647.05	-0.45	643.8	644.93	-1.13
		87518	648.18	648.8	-0.62	646.37	646.27	0.1	643.52	644.26	-0.74
		87210	645.43	646.04	-0.61	642.05	642.95	-0.9	640.4	641.15	-0.75
		86710	644.28	644.75	-0.47	640.87	642.11	-1.24	639.42	640.75	-1.33
		86207	643.5	643.46	0.04	639.47	639.25	0.22	636.62	637.92	-1.3
		85866	643.41	643.44	-0.03	639.45	639.48	-0.03	636.64	636.69	-0.05
		85691	643.38	643.4	-0.02	639.41	639.43	-0.02	636.59	636.64	-0.05
		85024	643.16	643.15	0.01	639.12	639.11	0.01	636.19	636.17	0.02
		84973	643.09	643.09	0	639.03	639.03	0	636.05	636.05	0
		83663	642.8	642.8	0	638.63	638.63	0	635.33	635.33	0
		82554	642.63	642.63	0	638.4	638.4	0	634.98	634.98	0
		80352	642.08	642.08	0	637.81	637.81	0	634.21	634.21	0

Table G.1-16

Alternative 3: Leon AOI-2 500 Year Levee

Stream	Location / AOI #	Cross-section	500 WSEL (ft)	500 WSEL (ft)	Difference	100 WSEL (ft)	100 WSEL (ft)	Difference	25 WSEL (ft)	25 WSEL (ft)	Difference
			FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)
Leon Creek	u/s Leon Trib D	97465	668.37	668.37	0	663.85	663.85	0	660.53	660.62	-0.09
	d/s Leon Trib D	96588	666.23	666.24	-0.01	661.77	661.77	0	658.27	658.48	-0.21
	u/s Galaxy Rd	95755	665.12	665.12	0	660.3	660.31	-0.01	656.5	656.55	-0.05
	d/s Galaxy Rd	95690	665.46	665.46	0	660.71	660.72	-0.01	657.02	657.1	-0.08
		94949	665.16	665.16	0	660.39	660.41	-0.02	656.68	656.78	-0.1
		94274	664.89	664.89	0	660.12	660.14	-0.02	656.41	656.51	-0.1
		93543	664.48	664.48	0	659.75	659.77	-0.02	655.98	656.1	-0.12
		92368	660.84	660.84	0	656.66	656.7	-0.04	653.39	653.58	-0.19
		91051	657.96	657.98	-0.02	654.49	654.67	-0.18	651.5	651.53	-0.03
		90196	655.9	655.92	-0.02	652.89	653.16	-0.27	650.49	650.88	-0.39
		89769	654.38	654.41	-0.03	651.65	652.06	-0.41	649.2	649.84	-0.64
		89157	652.99	653.05	-0.06	650.56	651.14	-0.58	648.38	649.15	-0.77
	u/s Military Dr W	88636	652.7	652.76	-0.06	650.44	651	-0.56	648.32	649.1	-0.78
	d/s Military Dr W	87864	648.96	649.3	-0.34	646.92	648.99	-2.07	644.13	647.03	-2.9
	AOI 2	87518	648.18	648.29	-0.11	646.37	646.66	-0.29	643.52	645.33	-1.81
	AOI 2	86207	643.5	643.51	-0.01	639.47	639.65	-0.18	636.62	638.43	-1.81
	AOI 2	85024	643.16	643.16	0	639.12	639.11	0.01	636.19	636.18	0.01
	u/s Leon Trib C	82969	642.68	642.68	0	638.47	638.47	0	635.07	635.07	0
	d/s Leon Trib C	82554	642.63	642.63	0	638.4	638.4	0	634.98	634.98	0

Table G.1-17

Alternative 4: Leon AOI-2 Bypass Channel

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		99980	672.74	672.74	0	668.21	668.18	0.03	665.4	665.4	0
		96588	666.23	666.22	0.01	661.77	661.63	0.14	658.27	658.28	-0.01
		95319	665.22	665.21	0.01	660.46	660.34	0.12	656.78	656.8	-0.02
		94007	664.74	664.74	0	659.97	659.85	0.12	656.22	656.25	-0.03
	d/s Kelly St	92579	662.38	662.37	0.01	658.11	657.94	0.17	654.55	654.59	-0.04
		91051	657.96	657.94	0.02	654.49	654.4	0.09	651.5	651.59	-0.09
		90196	655.9	655.86	0.04	652.89	652.75	0.14	650.49	650.61	-0.12
	u/s Bypass Channel (inlet)	88636	652.7	652.58	0.12	650.44	650.07	0.37	648.32	648.59	-0.27
	d/s Bypass Channel (inlet) / AOI 2	87864	648.96	646.55	2.41	646.92	643.36	3.56	644.13	640.2	3.93
	AOI 2	87627	648.51	646.36	2.15	646.6	643.07	3.53	643.8	639.5	4.3
	AOI 2	87210	645.43	643.35	2.08	642.05	639.79	2.26	640.4	637.86	2.54
	AOI 2	86207	643.5	642.01	1.49	639.47	637.45	2.02	636.62	634.41	2.21
	AOI 2	85691	643.38	642.07	1.31	639.41	637.67	1.74	636.59	634.04	2.55
	AOI 2	84973	643.09	641.89	1.2	639.03	637.43	1.6	636.05	633.67	2.38
		84720	643.02	641.85	1.17	638.93	637.37	1.56	635.87	633.49	2.38
		82969	642.68	641.66	1.02	638.47	637.09	1.38	635.07	632.93	2.14
		80352	642.08	641.35	0.73	637.81	636.76	1.05	634.21	632.57	1.64
	u/s Bypass Channel (outlet)	78641	640.17	640.29	-0.12	635.69	635.79	-0.1	631.59	631.66	-0.07
	d/s Bypass Channel (outlet)	77693	639.57	639.57	0	635.21	635.21	0	631.17	631.17	0
		76046	637.63	637.63	0	633.47	633.47	0	629.7	629.7	0

Table G.1-18

Alternative 5: Slick Ranch Improvements

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Slick Ranch		8523	744.55	744.55	0	743.82	743.82	0	742.77	742.78	-0.01
		6878 - 6996	737.23	736.73	0.5	736.91	736.26	0.65	736.45	736.06	0.39
		5386 - 5406	731.04	729.81	1.23	730.37	728.63	1.74	729.69	727.65	2.04
		4124 - 4133	727.42	725.85	1.57	726.72	725.04	1.68	726.04	724.29	1.75
		3356 - 3631	726.14	723.80	2.34	725.43	722.77	2.66	724.75	721.93	2.82
	u/s of Marbach	2490 - 2492	720.21	720.30	-0.09	719.52	719.64	-0.12	719.21	719.17	0.04
	d/s of Pinn	1204	715.17	715.17	0	713.57	713.57	0	711.9	711.90	0

Table G.1-19

Alternative 6: Leon Trib F AOI-3 500 Year Levee

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Trib F	u/s Callaghan Rd	4241	717.83	717.83	0	717.14	717.15	-0.01	716.38	716.38	0
	d/s Callaghan Rd	4097	717.55	717.55	0	716.31	716.32	-0.01	714.53	714.53	0
	AOI 3	3911	717.36	717.36	0	716.1	716.11	-0.01	714.45	714.45	0
	AOI 3	3742	717.18	717.18	0	715.92	715.92	0	714.23	714.23	0
	AOI 3	3482	716.92	716.92	0	715.58	715.58	0	713.84	713.84	0
	AOI 3	3209	716.38	716.38	0	715.27	715.27	0	713.53	713.53	0
	AOI 3	2925	716.45	716.45	0	714.98	714.98	0	713.22	713.22	0
	AOI 3	2713	716.47	716.47	0	714.83	714.83	0	713.07	713.07	0
	AOI 3	2491	716.45	716.45	0	714.64	714.64	0	712.88	712.88	0
		2286	716.05	716.05	0	714.52	714.52	0	712.77	712.77	0
		2090	715.31	715.31	0	713.88	713.88	0	712.23	712.23	0
		1876	714.9	714.9	0	713.51	713.51	0	711.91	711.91	0
		1655	714.58	714.58	0	713.2	713.2	0	711.62	711.62	0
		1486	714.37	714.37	0	713.01	713.01	0	711.44	711.44	0
		1223	712.81	712.81	0	711.51	711.51	0	710.04	710.04	0
	u/s conflunce Leon Creek	1009	711.18	711.18	0	709.96	709.96	0	708.56	708.56	0

Table G.1-20

Alternative 7: Huebner Trib A Pond

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Huebner Trib A	d/s Huebner Trib A Pond	5206	871.1	871.1	0	870.63	870.63	0	870.15	870.15	0
	u/s Babcock Rd	4629	866.75	866.75	0	866	866.00	0	865.35	865.35	0
	d/s Babcock Rd	4470	864.87	864.87	0	864.44	864.44	0	864.06	864.06	0
	u/s Eckhert Rd	2654	854.29	854.25	0.04	853.58	853.55	0.03	852.66	852.61	0.05
	d/s Eckhert Rd	2579	851.95	851.88	0.07	851.44	851.39	0.05	850.91	850.86	0.05
	u/s confluence w/Huebner Crk	326	838.75	837.51	1.24	838.26	837.13	1.13	837.75	836.82	0.93
Huebner Creek	**Column1**	**Column2**	**Column3**	**Column4**	**Column5**	**Column6**	**Column7**	**Column8**	**Column9**	**Column10**	**Column11**
	d/s Huebner Trib A	23532	839.44	838.43	1.01	838.76	837.67	1.09	837.92	836.73	1.19
	u/s Apple Green Rd	22929	839.23	838.2	1.03	838.54	836.63	1.91	837.67	835.66	2.01
	d/s Apple Green Rd	22778	833.42	832.46	0.96	832.76	831.84	0.92	832.03	831.18	0.85
	AOI 8	21610	831.44	830.51	0.93	830.82	829.86	0.96	830.06	829.13	0.93
	u/s Evers Rd / AOI 8	18498	824.22	823.64	0.58	823.79	823.31	0.48	823.38	822.91	0.47
	d/s Evers Rd / AOI 8	18390	823.92	823.26	0.66	823.45	822.86	0.59	822.95	822.39	0.56
	AOI 8	15969	814.79	814.26	0.53	814.39	813.93	0.46	813.93	813.53	0.4
	u/s Bandera Rd / AOI 6	14267	811.45	810.87	0.58	811.02	810.4	0.62	810.4	809.62	0.78
	d/s Bandera Rd / AOI 6	14017	808.34	807.42	0.92	807.62	806.87	0.75	806.87	806.14	0.73
	AOI 6	12264	799.97	799.19	0.78	799.38	798.61	0.77	798.61	798.16	0.45
	AOI 6	10195	794.96	794.36	0.6	794.46	794.01	0.45	794	793.63	0.37
	AOI 6	7282	792.34	791.4	0.94	791.34	790.58	0.76	790.32	789.58	0.74
	u/s Timberhill Dr	5000	789.73	788.86	0.87	788.52	787.82	0.7	787.29	786.56	0.73
	d/s Timberhill Dr	4877	789.67	788.79	0.88	788.5	787.74	0.76	787.2	786.51	0.69
	u/s Ingram Rd	1724	766.3	765.57	0.73	765.33	764.68	0.65	765.19	764.7	0.49
	d/s Ingram Rd	1636	760.72	760.13	0.59	759.94	759.43	0.51	759.06	758.54	0.52
Leon Creek	u/s Huebner Creek	148048	768.76	768.77	-0.01	767.36	767.38	-0.02	765.69	765.69	0
	d/s Huebner Creek	147620	767.93	767.94	-0.01	766.57	766.58	-0.01	764.95	764.95	0
	u/s Culebra Rd	145073	761.08	761.1	-0.02	759.56	759.6	-0.04	757.94	757.94	0
	d/s Culebra Rd	144862	761.03	761.05	-0.02	759.47	759.5	-0.03	757.84	757.84	0
	u/s SW Loop 410	142963	758.76	758.78	-0.02	757.15	757.2	-0.05	755.65	755.65	0
	d/s SW Loop 410	142391	748.71	748.73	-0.02	747.01	747.03	-0.02	745.17	745.17	0
		141639	745.85	745.87	-0.02	743.88	743.89	-0.01	741.82	741.82	0
	u/s Leon Trib G	139942	743.79	743.82	-0.03	741.99	742	-0.01	739.95	739.95	0
	d/s Leon Trib G	139336	743.75	743.77	-0.02	741.95	741.95	0	739.91	739.91	0
	u/s TX Hwy 151	136389	736.91	736.94	-0.03	735.03	735.04	-0.01	732.95	732.95	0
	d/s TX Hwy 151	135790	733.28	733.3	-0.02	731.83	731.84	-0.01	730.28	730.28	0
	u/s Pinn Rd	134897	732.54	732.56	-0.02	731.01	731.02	-0.01	729.33	729.33	0
	d/s Pinn Rd	134762	732.26	732.28	-0.02	730.77	730.78	-0.01	729.14	729.14	0
	u/s Old Hwy 90 W	118873	703.14	703.18	-0.04	701.7	701.71	-0.01	700	700	0
	d/s Old Hwy 90 W	118757	702.39	702.44	-0.05	700.62	700.64	-0.02	698.65	698.65	0
	u/s US Hwy 90 W	117144	696.37	696.4	-0.03	695.28	695.29	-0.01	694.26	694.26	0

Table G.1-21

Alternative 8: Huebner AOI-9 Channel Modifications

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Huebner Creek	u/s Lockhill Rd.	36146	910.46	910.46	0	910.04	910.04	0	909.6	909.6	0
	d/s Lockhill Rd.	36089	910.33	910.33	0	909.9	909.9	0	909.47	909.47	0
	u/s White Bonned Rd	35768	909.41	909.41	0	908.84	908.84	0	908.24	908.24	0
	d/s White Bonned Rd	35696	909.43	909.43	0	908.89	908.89	0	908.28	908.28	0
		34939	906.33	906.33	0	905.85	905.85	0	905.21	905.21	0
		34290	903.03	903.03	0	902.54	902.54	0	902.02	902.02	0
	most u/s XS w/in Chan Mod	33578	899.49	899.49	0	898.96	898.96	0	898.41	898.41	0
	u/s Babcock Rd / AOI 9	32884	896.42	896.42	0	895.86	895.86	0	895.26	895.25	0.01
	d/s Babcock Rd / AOI 9	32782	895.67	895.66	0.01	895.22	895.21	0.01	894.72	894.71	0.01
	u/s Hollyhock Rd / AOI 9	32032	891.04	890.01	1.03	890.63	889.5	1.13	890.16	888.9	1.26
	d/s Hollyhock Rd / AOI 9	31954	890.92	890.01	0.91	890.52	889.52	1	890.06	888.93	1.13
	AOI 9	31068	885.79	882.21	3.58	885.28	881.7	3.58	884.71	881.15	3.56
	AOI 9	30096	879.96	876.83	3.13	879.51	876.33	3.18	879	875.79	3.21
	most d/s w/in Chan Mod / AOI 9	28870	872.47	871.18	1.29	872.08	870.73	1.35	871.64	870.19	1.45
		28627	870.77	869.93	0.84	870.39	869.43	0.96	869.98	868.94	1.04
		28369	869.14	867.8	1.34	868.69	867.43	1.26	868.26	867	1.26
	u/s Whitby Rd / d/s AOI 9	28230	868.23	868.2	0.03	867.82	867.79	0.03	867.32	867.3	0.02
	d/s Whitby Rd	28123	867.71	867.71	0	867.3	867.3	0	866.85	866.85	0
	u/s Eckhert Rd	26672	858.79	858.79	0	858.13	858.13	0	857.21	857.21	0
	d/s Eckhert Rd	26522	857.39	857.39	0	856.86	856.86	0	856.34	856.34	0
	u/s Huebner Rd	24548	842.45	842.45	0	842.03	842.03	0	839.77	839.77	0
	d/s Huebner Rd	24417	840.57	840.57	0	840	840	0	839.41	839.41	0
	u/s Huebner Trib A	23830	839.84	839.84	0	839.17	839.17	0	838.37	838.37	0
	d/s Huebner Trib A	23532	839.44	839.44	0	838.76	838.76	0	837.92	837.92	0
	u/s Apple Green Rd	22929	839.23	839.23	0	838.54	838.54	0	837.67	837.67	0

Table G.1-22

Alternative 9: AECOM LC-15 Huebner @ Prue RSWF

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Huebner Creek	u/s Prue Rd	37467	918.24	918.24	0	918.01	918.01	0	917.77	917.77	0
	d/s Prue Rd	37408	916.6	916.60	0	916.26	916.26	0	915.9	915.90	0
	u/s Lockhill Rd	36146	910.46	910.35	0.11	910.04	909.97	0.07	909.6	909.57	0.03
	d/s Lockhill Rd	36089	910.33	910.21	0.12	909.9	909.83	0.07	909.47	909.43	0.04
	u/s Babcock Rd / AOI 9	32884	896.42	895.53	0.89	895.86	895.12	0.74	895.26	894.68	0.58
	d/s Babcock Rd / AOI 9	32782	895.67	894.95	0.72	895.22	894.6	0.62	894.72	894.23	0.49
	u/s Hollyhock Rd	32032	891.04	890.38	0.66	890.63	890.05	0.58	890.16	889.7	0.46
	d/s Hollyhock Rd	31954	890.92	890.27	0.65	890.52	889.95	0.57	890.06	889.6	0.46
	AOI 9	31068	885.79	884.98	0.81	885.28	884.57	0.71	884.71	884.14	0.57
	AOI 9	30379	882.21	881.58	0.63	881.82	881.24	0.58	881.36	880.87	0.49
	AOI 9	29469	875.55	874.81	0.74	875.09	874.47	0.62	874.59	874.1	0.49
	AOI 9	28870	872.47	871.84	0.63	872.08	871.53	0.55	871.64	871.13	0.51
	u/s Whitby Rd	28230	868.23	867.56	0.67	867.82	867.21	0.61	867.32	866.8	0.52
	d/s Whitby Rd	28123	867.71	867.08	0.63	867.3	866.75	0.55	866.85	866.38	0.47
	u/s Eckhert Rd	26672	858.79	858.13	0.66	858.13	857.61	0.52	857.21	856.75	0.46
	d/s Eckhert Rd	26522	857.39	856.9	0.49	856.86	856.53	0.33	856.34	856.07	0.27
	u/s Huebner Rd	24548	842.45	842.06	0.39	842.03	840.19	1.84	839.77	839.57	0.2
	d/s Huebner Rd	24417	840.57	840.45	0.12	840	839.89	0.11	839.41	839.28	0.13
	u/s Huebner Trib A	23830	839.84	839.93	-0.09	839.17	839.23	-0.06	838.37	838.41	-0.04
	d/s Huebner Trib A	23532	839.44	839.44	0	838.76	838.76	0	837.92	837.91	0.01
	u/s Apple Green Rd	22929	839.23	839.23	0	838.54	838.54	0	837.67	837.67	0
	d/s Apple Green Rd	22778	833.42	833.42	0	832.76	832.76	0	832.03	832.03	0
Leon Creek	u/s Huebner Creek	148048	768.76	768.78	-0.02	767.36	767.37	-0.01	765.69	765.7	-0.01
	d/s Huebner Creek	147620	767.93	767.95	-0.02	766.57	766.58	-0.01	764.95	764.96	-0.01
	u/s Culebra Rd	145073	761.08	761.1	-0.02	759.56	759.57	-0.01	757.94	757.95	-0.01
	d/s Culebra Rd	144862	761.03	761.06	-0.03	759.47	759.47	0	757.84	757.85	-0.01
	u/s SW Loop 410	142963	758.76	758.78	-0.02	757.15	757.16	-0.01	755.65	755.66	-0.01
	d/s SW Loop 410	142391	748.71	748.72	-0.01	747.01	747.02	-0.01	745.17	745.19	-0.02
		141639	745.85	745.85	0	743.88	743.89	-0.01	741.82	741.83	-0.01
	u/s Leon Trib G	139942	743.79	743.79	0	741.99	742	-0.01	739.95	739.97	-0.02
	d/s Leon Trib G	139336	743.75	743.74	0.01	741.95	741.95	0	739.91	739.92	-0.01
	u/s TX Hwy 151	136389	736.91	736.93	-0.02	735.03	735.04	-0.01	732.95	732.97	-0.02
	d/s TX Hwy 151	135790	733.28	733.3	-0.02	731.83	731.84	-0.01	730.28	730.28	0
	u/s Pinn Rd	134897	732.54	732.57	-0.03	731.01	731.02	-0.01	729.33	729.34	-0.01
	d/s Pinn Rd	134762	732.26	732.27	-0.01	730.77	730.78	-0.01	729.14	729.15	-0.01
	u/s Old Hwy 90 W	118873	703.14	703.16	-0.02	701.7	701.7	0	700	700	0
	d/s Old Hwy 90 W	118757	702.39	702.41	-0.02	700.62	700.63	-0.01	698.65	698.65	0
	u/s US Hwy 90 W	117144	696.37	696.38	-0.01	695.28	695.29	-0.01	694.26	694.26	0
	d/s US Hwy 90 W	116690	690.11	690.11	0	689.06	689.06	0	687.82	687.82	0
	u/s Leon Trib E	102466	670.25	670.25	0	668.8	668.8	0	667.23	667.24	-0.01
	d/s Leon Trib E	102236	670.29	670.29	0	668.84	668.84	0	667.27	667.28	-0.01
	u/s Leon Trib D	97465	663.85	663.84	0.01	662.32	662.32	0	660.53	660.54	-0.01
	d/s Leon Trib D	96588	661.77	661.74	0.03	660.18	660.17	0.01	658.27	658.29	-0.02
	u/s SW Millitary Dr	88636	650.44	650.44	0	649.49	649.49	0	648.32	648.32	0
	d/s SW Millitary Dr	87864	646.92	646.92	0	645.66	645.66	0	644.13	644.13	0
	u/s Leon Trib C	82969	638.47	638.47	0	636.93	636.94	-0.01	635.07	635.08	-0.01
	d/s Leon Trib C	82554	638.4	638.41	-0.01	636.86	636.86	0	634.98	634.98	0

Table G.1-23

Alternative 10: Helotes Channel Improvements

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Helotes Creek		15905	919.66	919.66	0	919.32	919.32	0	918.49	918.49	0
		14316	918.94	918.94	0	918.68	918.68	0	917.97	917.97	0
	d/s SW Loop 1604	13795	909.72	907.33	2.39	909.28	907.07	2.21	908.14	906.35	1.79
		12631	907.1	904.65	2.45	906.45	904.11	2.34	904.76	902.76	2
		11477	903.76	901.31	2.45	903.17	900.75	2.42	901.49	899.3	2.19
		10305	901.56	899.32	2.24	900.98	898.74	2.24	899.34	897.3	2.04
	AOI 12	9407	898.47	896.2	2.27	897.82	895.37	2.45	896.2	893.48	2.72
	AOI 12	8499	895.71	893.23	2.48	894.67	892.16	2.51	892.83	890.44	2.39
	AOI 12	7731	890.51	887.79	2.72	889.66	886.46	3.2	887.84	885.01	2.83
	AOI 12	6606	887.83	884.84	2.99	886.99	883.13	3.86	885.12	881.21	3.91
		5108	879	879.24	-0.24	877.9	878.19	-0.29	876.22	876.61	-0.39
		4777	876.09	876.09	0	874.83	874.83	0	873.14	873.14	0
		4617	875.97	875.97	0	874.7	874.7	0	872.99	872.99	0

Table G.1-24

Alternative 11: AECOM DC-12 Helotes Creek RSWF

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Helotes Creek	d/s Helotes RSWF	26428	962.09	961.08	1.01	961.64	959.98	1.66	960.28	958.92	1.36
	u/s Braun Rd	21806	955.51	954.47	1.04	954.94	953.29	1.65	953.86	952.15	1.71
	d/s Braun Rd	21577	955.37	954.26	1.11	954.75	953.06	1.69	953.64	951.98	1.66
	u/s SW Loop 1604	14111	918.85	918.28	0.57	918.59	917.74	0.85	917.88	914.42	3.46
	d/s SW Loop 1604	13795	909.72	908.76	0.96	909.28	907.91	1.37	908.14	907	1.14
	AOI 12	9407	898.47	897.22	1.25	897.82	895.94	1.88	896.2	894.53	1.67
	AOI 12	7731	890.51	889.26	1.25	889.66	887.76	1.9	887.84	885.95	1.89
	AOI 12	6267	886.44	884.83	1.61	885.36	883.35	2.01	883.44	881.56	1.88
	u/s confluence Culebra Crk / AOI 5	702	849.22	848.43	0.79	848.65	847.8	0.85	847.84	847.18	0.66
Culebra Creek	d/s confluence Helotes Creek / AOI 5	24901	854.75	852.72	2.03	852.88	851.21	1.67	850.73	849.45	1.28
	u/s Culebra Rd / AOI 5	24033	853	850.91	2.09	851.09	849.23	1.86	848.71	847.31	1.4
	d/s Culebra Rd / AOI 5	23896	852.46	850.39	2.07	850.57	848.8	1.77	848.33	846.97	1.36
	AOI 5	15208	824.77	823.45	1.32	823.38	822.64	0.74	822.4	820.02	2.38
	AOI 5	9168	808.15	806.7	1.45	806.57	805.65	0.92	805.35	804.28	1.07
	u/s Culebra Trib A / AOI 5	5742	793.62	792.63	0.99	792.51	791.91	0.6	791.64	790.64	1
	d/s Culebra Trib A / AOI 5	5310	790.02	789.01	1.01	788.88	788.02	0.86	787.66	786.28	1.38
	u/s confluence Leon Creek / AOI 5	1927	775.77	774.34	1.43	774.16	773.31	0.85	772.94	771.79	1.15
Leon Creek	d/s confluence Culebra Creek	151954	778.44	777.39	1.05	776.5	775.74	0.76	774.5	773.34	1.16
	u/s SW Loop 410	142821	758.54	757.8	0.74	756.78	755.9	0.88	755.06	754.42	0.64
	d/s SW Loop 410	142600	758.5	757.79	0.71	756.79	755.8	0.99	754.7	753.87	0.83
	u/s Leon Trib G	139942	743.79	743.07	0.73	741.99	741.16	0.83	739.95	738.82	1.13
	d/s Leon Trib G	139336	743.75	743.02	0.74	741.95	741.12	0.83	739.91	738.78	1.13
	u/s TX Hwy 151/Stotzer Frwy	136282	735.82	735.12	0.7	734.07	733.31	0.77	732.15	731.1	1.05
	d/s TX Hwy 151/Stotzer Frwy	136045	735.47	734.79	0.68	733.77	733.03	0.75	731.9	730.88	1.02
	u/s Leon Trib F	127612	714.31	713.91	0.4	713.27	712.79	0.47	712.05	711.35	0.7
	d/s Leon Trib F	126859	714.06	713.67	0.39	713.04	712.58	0.46	711.85	711.16	0.69
	u/s US Hwy 90 W	116958	693.29	693.27	0.02	693.01	692.69	0.32	692.45	692.2	0.25
	d/s US Hwy 90 W	116825	688.52	688.34	0.18	688	687.75	0.25	687.28	686.76	0.52
		110862	680.72	680.17	0.55	679.22	678.56	0.66	677.2	676.22	0.98
	u/s Leon Trib E	102466	670.25	669.69	0.56	668.8	668.21	0.59	667.23	666.49	0.74
	d/s Leon Trib E	102236	670.29	669.75	0.54	668.84	668.25	0.59	667.27	666.54	0.73
	u/s Leon Trib D	97465	663.85	663.29	0.57	662.32	661.69	0.64	660.53	659.67	0.86
	d/s Leon Trib D	96588	661.77	661.18	0.61	660.18	659.54	0.66	658.27	657.37	0.9
	u/s Military Dr SW	88636	650.44	650.13	0.31	649.49	649.09	0.4	648.32	647.37	0.95
	d/s Military Dr SW / AOI 2	87864	646.92	646.5	0.42	645.66	645.13	0.53	644.13	643.43	0.7
	AOI 2	86207	639.47	638.97	0.5	638.04	637.46	0.58	636.62	636.3	0.32
	AOI 2	84973	639.03	638.53	0.49	637.63	637.09	0.54	636.05	635.19	0.86
	u/s New Laredo Hwy	69321	618.16	618.08	0.08	617.74	617.49	0.25	617.06	616.75	0.31
	d/s New Laredo Hwy	68856	614.8	614.38	0.42	614.08	613.93	0.15	613.65	613.48	0.17
	u/s IH 35 S	62942	608.67	608.38	0.29	607.8	607.44	0.36	606.77	606.34	0.43
	d/s IH 35 S	62806	608.11	607.82	0.28	607.23	606.87	0.36	606.23	605.81	0.42
	u/s Leon Trib B	57417	597.39	597.23	0.16	596.93	596.74	0.19	596.21	595.88	0.33
	d/s Leon Trib B	56444	596.97	596.83	0.14	596.57	596.42	0.15	595.92	595.61	0.31
	u/s SE Loop 410	55095	596.3	596.19	0.11	596.02	595.92	0.1	595.46	595.17	0.29
	d/s SE Loop 410	54631	594.64	594.38	0.26	593.78	592.1	1.68	591.87	591.66	0.21
	u/s Leon Trib A	51940	590.49	590.26	0.23	589.1	588.75	0.35	587.31	586.19	1.12
	d/s Leon Trib A	51046	587.1	586.81	0.29	586.16	585.81	0.35	585.04	584.5	0.54
	d/s Indian Creek	36743	572.86	572.49	0.37	571.64	571.22	0.42	570.37	570.03	0.34
	u/s Indian Creek	35989	572.56	572.19	0.37	571.35	570.94	0.4	570.1	569.79	0.31
	u/s Palo Alto Rd	32858	567.79	567.66	0.13	567.33	567.2	0.13	566.85	567.06	-0.21
	d/s Palo Alto Rd	32681	562.49	562.18	0.31	561.4	560.94	0.46	559.91	559.01	0.9
	u/s Comanche Creek	9432	522.15	520.84	1.31	517.92	516.58	1.34	513.41	511.85	1.56
	d/s Comanche Creek	8907	522.44	521.09	1.35	518.09	516.72	1.37	513.46	511.84	1.62
		1770	511.32	509.96	1.36	506.79	505.36	1.43	501.91	500.25	1.66
		426	511.55	510.21	1.34	507.07	505.64	1.43	502.18	500.51	1.67

Table G.1-25

Alternative 12: Halff Helotes-Quarry Pond

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Helotes Creek	d/s Helotes RSWF	26428	962.09	957.72	4.37	961.64	957.39	4.25	960.28	956.75	3.53
	u/s Braun Rd	21806	955.51	949.11	6.4	954.94	948.08	6.86	953.86	946.38	7.48
	d/s Braun Rd	21577	955.37	948.92	6.45	954.75	947.88	6.87	953.64	946.18	7.46
	u/s SW Loop 1604	14111	918.85	911.68	7.17	918.59	910.91	7.68	917.88	909.51	8.37
	d/s SW Loop 1604	13795	909.72	905.95	3.77	909.28	905.64	3.64	908.14	905.06	3.08
	AOI 12	9407	898.47	892.88	5.59	897.82	892.26	5.56	896.2	891.27	4.93
	AOI 12	7731	890.51	884.72	5.79	889.66	884.06	5.6	887.84	883.26	4.58
	AOI 12	6267	886.44	880.1	6.34	885.36	879.28	6.08	883.44	878.27	5.17
	u/s confluence Culebra Crk / AOI 5	702	849.22	846.6	2.62	848.65	846.19	2.46	847.84	845.73	2.11
					0			0			0
Culebra Creek	d/s confluence Helotes Creek / AOI 5	24901	854.75	852.18	2.57	852.88	850.66	2.22	850.73	849.25	1.48
	u/s Culebra Rd / AOI 5	24033	853	850.35	2.65	851.09	848.64	2.45	848.71	847.1	1.61
	d/s Culebra Rd / AOI 5	23896	852.46	849.83	2.63	850.57	848.26	2.31	848.33	846.76	1.57
	AOI 5	15208	824.77	823.11	1.66	823.38	822.39	0.99	822.4	819.76	2.64
	AOI 5	9168	808.15	806.28	1.87	806.57	805.36	1.21	805.35	804.1	1.25
	u/s Culebra Trib A / AOI 5	5742	793.62	792.36	1.26	792.51	791.68	0.83	791.64	790.47	1.17
	d/s Culebra Trib A / AOI 5	5310	790.02	788.66	1.36	788.88	787.71	1.17	787.66	786.1	1.56
	u/s confluence Leon Creek / AOI 5	1927	775.77	773.97	1.8	774.16	772.99	1.17	772.94	771.58	1.36
					0			0			0
Leon Creek	d/s confluence Culebra Creek	151954	778.44	777.45	0.99	776.5	775.83	0.67	774.5	773.43	1.07
	u/s SW Loop 410	142821	758.54	757.99	0.55	756.78	756.03	0.75	755.06	754.56	0.5
	d/s SW Loop 410	142600	758.5	757.98	0.52	756.79	756	0.79	754.7	754.03	0.67
	u/s Leon Trib G	139942	743.79	743.25	0.54	741.99	741.36	0.63	739.95	739.08	0.87
	d/s Leon Trib G	139336	743.75	743.21	0.54	741.95	741.32	0.63	739.91	739.03	0.88
	u/s TX Hwy 151/Stotzer Frwy	136282	735.82	735.29	0.53	734.07	733.47	0.6	732.15	731.32	0.83
	d/s TX Hwy 151/Stotzer Frwy	136045	735.47	734.96	0.51	733.77	733.19	0.58	731.9	731.1	0.8
	u/s Leon Trib F	127612	714.31	714.01	0.3	713.27	712.89	0.38	712.05	711.5	0.55
	d/s Leon Trib F	126859	714.06	713.77	0.29	713.04	712.67	0.37	711.85	711.31	0.54
	u/s US Hwy 90 W	116958	693.29	693.28	0.01	693.01	692.71	0.3	692.45	692.26	0.19
	d/s US Hwy 90 W	116825	688.52	688.4	0.12	688	687.81	0.19	687.28	686.88	0.4
		110862	680.72	680.33	0.39	679.22	678.7	0.52	677.2	676.44	0.76
	u/s Leon Trib E	102466	670.25	669.86	0.39	668.8	668.34	0.46	667.23	666.67	0.56
	d/s Leon Trib E	102236	670.29	669.91	0.38	668.84	668.39	0.45	667.27	666.71	0.56
	u/s Leon Trib D	97465	663.85	663.44	0.41	662.32	661.83	0.49	660.53	659.85	0.68
	d/s Leon Trib D	96588	661.77	661.32	0.45	660.18	659.68	0.5	658.27	657.55	0.72
	u/s Military Dr SW	88636	650.44	650.21	0.23	649.49	649.18	0.31	648.32	647.55	0.77
	d/s Military Dr SW / AOI 2	87864	646.92	646.61	0.31	645.66	645.24	0.42	644.13	643.6	0.53
	AOI 2	86207	639.47	639.13	0.34	638.04	637.59	0.45	636.62	636.4	0.22
	AOI 2	84973	639.03	638.7	0.33	637.63	637.21	0.42	636.05	635.4	0.65
	u/s New Laredo Hwy	69321	618.16	618.09	0.07	617.74	617.52	0.22	617.06	616.8	0.26
	d/s New Laredo Hwy	68856	614.8	614.5	0.3	614.08	613.97	0.11	613.65	613.55	0.1
	u/s IH 35 S	62942	608.67	608.47	0.2	607.8	607.51	0.29	606.77	606.43	0.34
	d/s IH 35 S	62806	608.11	607.9	0.21	607.23	606.94	0.29	606.23	605.9	0.33
	u/s Leon Trib B	57417	597.39	597.27	0.12	596.93	596.73	0.2	596.21	595.95	0.26
	d/s Leon Trib B	56444	596.97	596.87	0.1	596.57	596.39	0.18	595.92	595.68	0.24
	u/s SE Loop 410	55095	596.3	596.23	0.07	596.02	595.87	0.15	595.46	595.23	0.23
	d/s SE Loop 410	54631	594.64	594.45	0.19	593.78	593.53	0.25	591.87	591.72	0.15
	u/s Leon Trib A	51940	590.49	590.32	0.17	589.1	588.79	0.31	587.31	586.78	0.53
	d/s Leon Trib A	51046	587.1	586.88	0.22	586.16	585.85	0.31	585.04	584.64	0.4
	d/s Indian Creek	36743	572.86	572.6	0.26	571.64	571.29	0.35	570.37	570.23	0.14
	u/s Indian Creek	35989	572.56	572.3	0.26	571.35	571.01	0.34	570.1	570	0.1
	u/s Palo Alto Rd	32858	567.79	567.71	0.08	567.33	567.23	0.1	566.85	567.36	-0.51
	d/s Palo Alto Rd	32681	562.49	562.26	0.23	561.4	561	0.4	559.91	559.19	0.72
	u/s Comanche Creek	9432	522.15	520.97	1.18	517.92	516.67	1.25	513.41	511.97	1.44
	d/s Comanche Creek	8907	522.44	521.22	1.22	518.09	516.8	1.29	513.46	511.97	1.49
		1770	511.32	510.05	1.27	506.79	505.43	1.36	501.91	500.36	1.55
		426	511.55	510.29	1.26	507.07	505.72	1.35	502.18	500.62	1.56

Table G.1-26

Alternative 13: Halff Government Canyon Pond

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Govt Canyon Creek	d/s Proposed Pond	17345	1023.83	1023.83	0	1022.27	1022.27	0	1021.06	1021.06	0
		14403	1002.79	1002.73	0.06	1001.73	1001.67	0.06	1000.51	1000.46	0.05
		12367	990.94	981.7	9.24	990.17	981.53	8.64	989.2	981.33	7.87
		10144	978.4	970.75	7.65	977.79	970.67	7.12	976.85	970.55	6.3
	u/s Govt Canyon Trib B	7930	964.71	960.87	3.84	964.17	960.57	3.6	963.39	960.21	3.18
	d/s Govt Canyon Trib B	7595	962.22	958.86	3.36	961.62	958.48	3.14	960.97	957.91	3.06
	u/s Govt Canyon Trib A	6429	955.35	952.65	2.7	954.65	952.21	2.44	953.95	951.74	2.21
	d/s Govt Canyon Trib A	6038	953.41	950.65	2.76	952.65	950.2	2.45	951.92	949.76	2.16
		3685	941.93	939.45	2.48	941.35	939.07	2.28	940.64	938.56	2.08
		2380	933.09	929.97	3.12	932.31	929.22	3.09	931.44	928.29	3.15
	u/s confluence w/Leon Crk	94	925.89	923.61	2.28	925.33	923.19	2.14	924.69	922.63	2.06
					0			0			0
Culebra Creek	d/s Govt Canyon Creek	43882	923.49	921.91	1.58	922.85	921.36	1.49	922.09	920.65	1.44
	u/s FM 1560	37375	900.72	899.46	1.26	900.22	898.99	1.23	899.58	898.29	1.29
	d/s FM 1560	37200	898.63	896.89	1.74	897.96	896.25	1.71	897.07	895.4	1.67
	u/s Culebra Trib C	33377	886.41	885.27	1.14	885.61	884.59	1.02	884.72	883.59	1.13
	d/s Culebra Trib C	32968	885.78	884.64	1.14	884.97	883.88	1.09	884.08	882.96	1.12
	u/s Culebra Trib B	28686	871.22	868.84	2.38	869.31	867.45	1.86	867.65	865.49	2.16
	d/s Culebra Trib B	28422	870.03	867.27	2.76	867.8	865.88	1.92	866.07	864.04	2.03
	u/s SW Loop 1604	28004	864.46	862.34	2.12	862.84	861.3	1.54	861.46	859.83	1.63
	d/s SW Loop 1604	27827	863.89	861.86	2.03	862.34	860.86	1.48	861.02	859.45	1.57
	u/s Helotes Creek / AOI 5	25489	856.59	855.1	1.49	854.91	853.32	1.59	852.99	851.85	1.14
	d/s Helotes Creek / AOI 5	24901	854.75	853.06	1.69	852.88	851.07	1.81	850.73	849.49	1.24
	u/s Culebra Rd / AOI 5	24033	853	851.27	1.73	851.09	849.08	2.01	848.71	847.36	1.35
	d/s Culebra Rd / AOI 5	23896	852.46	850.75	1.71	850.57	848.67	1.9	848.33	847.01	1.32
	AOI 5	19870	838.55	836.88	1.67	836.69	835.45	1.24	835.16	833.84	1.32
	AOI 5	15582	825.03	823.8	1.23	823.66	822.89	0.77	822.69	820.61	2.08
	u/s Tezel Rd / AOI 5	13259	821.2	820.34	0.86	820.23	819.7	0.53	819.57	815.77	3.8
	d/s Tezel Rd / AOI 5	13109	818.34	816.71	1.63	816.5	815.44	1.06	815.15	813.91	1.24
	u/s Timber Path / AOI 5	9773	810.19	809.39	0.8	809.25	808.77	0.48	808.63	808.05	0.58
	d/s Timber Path / AOI 5	9663	810.99	809.79	1.2	809.61	808.61	1	808.33	807.21	1.12
	AOI 5	5742	793.62	792.66	0.96	792.51	791.87	0.64	791.64	790.72	0.92
	u/s confluence Leon Creek / AOI 5	1927	775.77	774.38	1.39	774.16	773.27	0.89	772.94	771.89	1.05
Leon Creek	d/s confluence Culebra Creek	151954	778.44	777.78	0.66	776.5	775.93	0.57	774.5	773.67	0.83
	u/s Ingram Rd	148983	769.61	769.26	0.35	768.19	767.75	0.44	766.55	765.9	0.65
	d/s Ingram Rd	148848	769.15	768.82	0.33	767.73	767.29	0.44	766.03	765.36	0.67
	u/s Huebner Creek	148048	768.76	768.46	0.3	767.36	766.94	0.42	765.69	765.02	0.67
	d/s Huebner Creek	147620	767.93	767.63	0.3	766.57	766.16	0.41	764.95	764.31	0.64
	u/s Culebra Rd	145073	761.08	760.72	0.36	759.56	759.06	0.5	757.94	757.41	0.53
	d/s Culebra Rd	144862	761.03	760.67	0.36	759.47	758.96	0.51	757.84	757.31	0.53
	u/s SW Loop 410	142963	758.76	758.37	0.39	757.15	756.6	0.55	755.65	755.24	0.41
	d/s SW Loop 410	142391	748.71	748.34	0.37	747.01	746.53	0.48	745.17	744.5	0.67
	u/s Leon Trib G	139942	743.79	743.38	0.41	741.99	741.45	0.54	739.95	739.25	0.7
	d/s Leon Trib G	139336	743.75	743.33	0.42	741.95	741.41	0.54	739.91	739.2	0.71
	u/s TX HWY 151	136389	736.91	736.48	0.43	735.03	734.48	0.55	732.95	732.22	0.73
	d/s TX HWY 151	135790	733.28	732.94	0.34	731.83	731.42	0.41	730.28	729.73	0.55
	u/s Leon Trib F	127612	714.31	714.09	0.22	713.27	712.95	0.32	712.05	711.6	0.45
	d/s Leon Trib F	126859	714.06	713.84	0.22	713.04	712.73	0.31	711.85	711.41	0.44
	u/s Slick Rach	124054	706.1	705.97	0.13	705.53	705.37	0.16	704.83	704.61	0.22
	d/s Slick Rach	123319	705.36	705.09	0.27	703.99	703.61	0.38	702.41	701.87	0.54
	u/s Westwood Village Creek	117896	697.65	697.44	0.21	696.75	696.6	0.15	695.75	695.32	0.43
	d/s Westwood Village Creek	117405	697.2	696.97	0.23	696.13	695.97	0.16	694.94	694.55	0.39
	u/s US Hwy 90 W	117144	696.37	696.13	0.24	695.28	695.19	0.09	694.26	693.86	0.4
	d/s US Hwy 90 W	116690	690.11	689.9	0.21	689.06	688.75	0.31	687.82	687.41	0.41
	u/s Leon Trib E	102466	670.25	669.97	0.28	668.8	668.41	0.39	667.23	666.77	0.46
	d/s Leon Trib E	102236	670.29	670.02	0.27	668.84	668.46	0.38	667.27	666.81	0.46
	u/s Leon Trib D	97465	663.85	663.52	0.33	662.32	661.91	0.41	660.53	659.98	0.55
	d/s Leon Trib D	96588	661.77	661.4	0.37	660.18	659.76	0.42	658.27	657.7	0.57
	u/s Elmore Hall Blvd	95755	660.3	659.87	0.43	658.5	658.01	0.49	656.5	655.82	0.68
	d/s Elmore Hall Blvd	95690	660.71	660.33	0.38	659.01	658.55	0.46	657.02	656.33	0.69
	u/s Military Dr SW	88636	650.44	650.26	0.18	649.49	649.23	0.26	648.32	647.66	0.66
	u/s Military Dr SW	87864	646.92	646.69	0.23	645.66	645.31	0.35	644.13	643.7	0.43
	AOI 2	87627	646.6	646.38	0.22	645.29	645.02	0.27	643.8	643.36	0.44
	AOI 2	86207	639.47	639.21	0.26	638.04	637.66	0.38	636.62	636.43	0.19
	AOI 2	84973	639.03	638.78	0.25	637.63	637.27	0.36	636.05	635.51	0.54
	u/s Leon Trib C	82969	638.47	638.2	0.27	636.93	636.54	0.39	635.07	634.32	0.75
	d/s Leon Trib C	82554	638.4	638.13	0.27	636.86	636.46	0.4	634.98	634.21	0.77
	u/s Quintana Rd	71561	622.93	622.82	0.11	622.32	622.14	0.18	621.77	621.42	0.35
	d/s Quintans Rd	71115	619.74	619.64	0.1	619.12	618.9	0.22	618.66	618.4	0.26
	u/s New Laredo Hwy / AOI 1	69321	618.16	618.11	0.05	617.74	617.55	0.19	617.06	616.85	0.21
	d/s New Laredo Hwy / AOI 1	68856	614.8	614.57	0.23	614.08	613.99	0.09	613.65	613.57	0.08
	u/s IH 35 S	63024	609.12	608.95	0.17	608.19	607.97	0.22	607.11	606.82	0.29
	d/s IH 35 S	62672	607.67	607.51	0.16	606.81	606.57	0.24	605.81	605.54	0.27
	u/s Leon Trib B	57417	597.39	597.3	0.09	596.93	596.77	0.16	596.21	596	0.21
	d/s Leon Trib B	56444	596.97	596.89	0.08	596.57	596.43	0.14	595.92	595.72	0.2
	u/s SE Loop 410	55095	596.3	596.24	0.06	596.02	595.91	0.11	595.46	595.27	0.19
	d/s SE Loop 410	54631	594.64	594.49	0.15	593.78	593.57	0.21	591.87	591.75	0.12
	u/s Leon Trib A	51940	590.49	590.36	0.13	589.1	588.85	0.25	587.31	586.89	0.42
	d/s Leon Trib A	51046	587.1	586.93	0.17	586.16	585.91	0.25	585.04	584.72	0.32
	u/s Indian Creek	36743	572.86	572.66	0.2	571.64	571.35	0.29	570.37	570.41	-0.04
	d/s Indian Creek	35989	572.56	572.35	0.21	571.35	571.07	0.28	570.1	570.18	-0.08
	u/s Palo Alto Rd	32858	567.79	567.73	0.06	567.33	567.24	0.09	566.85	567.63	-0.78
	d/s Palo Alto Rd	32681	562.49	562.31	0.18	561.4	561.08	0.32	559.91	559.47	0.44
	u/s Applewhite Rd	25143	553.37	552.94	0.43	553.51	551.94	1.57	545.03	544.1	0.93
	d/s Applewhite Rd	25092	550.86	550.1	0.76	547.05	546.19	0.86	543.29	542.35	0.94
	u/s Comanche Creek	9432	522.15	521.25	0.9	517.92	516.91	1.01	513.41	512.29	1.12
	d/s Comanche Creek	8907	522.44	521.51	0.93	518.09	517.06	1.03	513.46	512.31	1.15
	most d/s Leon Creek	426	511.55	510.6	0.95	507.07	505.99	1.08	502.18	500.97	1.21

Table G.1-27

Alternative 14: AECOM Government Canyon RSWF

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Govt Canyon Creek	d/s Govt Canyon RSWF	19917	1044.71	1044.71	0	1043.67	1043.67	0	1042.51	1042.51	0
	u/s Govt Canyon Trib C	18525	1034.77	1034.77	0	1033.52	1033.52	0	1031.89	1031.89	0
	d/s Govt Canyon Trib C	18014	1029.09	1029.09	0	1027.83	1027.83	0	1026.35	1026.35	0
		16005	1012.58	1012.58	0	1011.69	1011.69	0	1010.71	1010.71	0
		14085	1000.77	1000.68	0.09	999.6	999.49	0.11	998.27	998.16	0.11
		11463	986	973.68	12.32	985.31	973.43	11.88	984.34	973.15	11.19
	u/s Govt Canyon Trib B	7930	964.71	960.2	4.51	964.17	959.97	4.2	963.39	959.82	3.57
	d/s Govt Canyon Trib B	7595	962.22	958.19	4.03	961.62	957.74	3.88	960.97	957.09	3.88
	u/s Govt Canyon Trib A	6429	955.35	952.14	3.21	954.65	951.76	2.89	953.95	951.31	2.64
	d/s Govt Canyon Trib A	6038	953.41	950.14	3.27	952.65	949.79	2.86	951.92	949.36	2.56
		3573	941.41	938.59	2.82	940.86	938.19	2.67	940.15	937.71	2.44
	u/s confluence Leon Crk	94	925.89	923.15	2.74	925.33	922.68	2.65	924.69	921.96	2.73
Culebra Creek	d/s confluence Govt Canyon Crk	43882	923.49	921.61	1.88	922.85	921.02	1.83	922.09	920.42	1.67
		41613	911.65	909.79	1.86	910.99	909.23	1.76	910.25	908.59	1.66
		39536	905.21	903.14	2.07	904.54	902.78	1.76	903.69	901.72	1.97
		39430	904.37	902.2	2.17	903.64	901.55	2.09	902.74	900.72	2.02
	u/s FM 1560	37375	900.72	899.2	1.52	900.22	898.69	1.53	899.58	897.91	1.67
	d/s FM 1560	37200	898.63	896.53	2.1	897.96	895.88	2.08	897.07	894.97	2.1
	u/s Culebra Trib D	36050	893.79	892.1	1.69	893.1	891.38	1.72	892.22	890.63	1.59
	d/s Culebra Trib D	35335	892.45	890.88	1.57	891.82	890.22	1.6	890.94	889.54	1.4
	u/s Culebra Trib C	33377	886.41	885.02	1.39	885.61	884.27	1.34	884.72	883.41	1.31
	d/s Culebra Trib C	32968	885.78	884.39	1.39	884.97	883.62	1.35	884.08	882.8	1.28
	u/s Westwood Loop	29583	874.69	872.62	2.07	873.42	871.45	1.97	872.03	870.28	1.75
	d/s Westwood Loop	29457	873.63	871.48	2.15	872.31	870.19	2.12	870.86	868.84	2.02
	u/s Culebra Trib B	28686	871.22	868.45	2.77	869.31	866.9	2.41	867.65	865.17	2.48
	d/s Culebra Trib B	28422	870.03	866.86	3.17	867.8	865.37	2.43	866.07	863.75	2.32
	u/s SW Loop 1604	28004	864.46	862	2.46	862.84	860.87	1.97	861.46	859.59	1.87
	d/s SW Loop 1604	27827	863.89	861.52	2.37	862.34	860.45	1.89	861.02	859.22	1.8
	u/s Helotes Creek / AOI 5	25268	855.54	853.64	1.9	853.8	851.9	1.9	851.85	850.44	1.41
	d/s Helotes Creek / AOI 5	24901	854.75	852.7	2.05	852.88	850.78	2.1	850.73	849.21	1.52
	u/s Culebra Rd	24033	853	850.9	2.1	851.09	848.76	2.33	848.71	847.05	1.66
	d/s Culebra Rd	23896	852.46	850.37	2.09	850.57	848.37	2.2	848.33	846.72	1.61
		19491	836.12	834.31	1.81	834.39	833.49	0.9	833.45	831.97	1.48
	u/s Tezel Rd / AOI 5	13259	821.2	820.18	1.02	820.23	819.6	0.63	819.57	815.29	4.28
	d/s Tezel Rd / AOI 5	13109	818.34	816.4	1.94	816.5	815.21	1.29	815.15	813.57	1.58
	u/s Timber Path / AOI 5	9773	810.19	809.22	0.97	809.25	808.66	0.59	808.63	807.87	0.76
	d/s Timber Path / AOI 5	9663	810.99	809.53	1.46	809.61	808.39	1.22	808.33	806.92	1.41
	u/s Old Grissom Rd / AOI 5	7743	800.97	799.72	1.25	799.76	798.82	0.94	798.72	797.45	1.27
	d/s Old Grissom rd / AOI 5	7587	800.86	799.71	1.15	799.75	798.87	0.88	798.79	797.59	1.2
	u/s Culebra Trib A / AOI 5	5742	793.62	792.48	1.14	792.51	791.72	0.79	791.64	790.49	1.15
	d/s Culebra Trib A / AOI 5	5310	790.02	788.84	1.18	788.88	787.76	1.12	787.66	786.09	1.57
	u/s confluence Leon Crk / AOI 5	1927	775.77	774.13	1.64	774.16	773.05	1.11	772.94	771.61	1.33

Table G.1-27

Alternative 14: AECOM Government Canyon RSWF

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	d/s confluence Culebra Creek	151954	778.44	777.46	0.98	776.5	775.75	0.75	774.5	773.39	1.11
	u/s Ingram Rd	148983	769.61	769.14	0.47	768.19	767.59	0.6	766.55	765.69	0.86
	d/s Ingram Rd	148848	769.15	768.69	0.46	767.73	767.13	0.6	766.03	765.15	0.88
	u/s Huebner Creek	148048	768.76	768.33	0.43	767.36	766.78	0.58	765.69	764.82	0.87
	d/s Huebner Creek	147620	767.93	767.51	0.42	766.57	766	0.57	764.95	764.11	0.84
	u/s Culebra Rd	145073	761.08	760.59	0.49	759.56	758.89	0.67	757.94	757.25	0.69
	d/s Culebra Rd	144862	761.03	760.53	0.5	759.47	758.79	0.68	757.84	757.15	0.69
	u/s NW Loop 410	142821	758.54	757.98	0.56	756.78	755.93	0.85	755.06	754.54	0.52
	d/s NW Loop 410	142600	758.5	757.96	0.54	756.79	755.88	0.91	754.7	753.99	0.71
	u/s Commerce St W	137060	740.12	739.55	0.57	738.23	737.44	0.79	736.07	735.06	1.01
	d/s Commerce St W	136902	740.01	739.4	0.61	738.1	737.31	0.79	735.93	734.93	1
	u/s TX hwy 151/Stotzer Frwy	136282	735.82	735.26	0.56	734.07	733.37	0.7	732.15	731.26	0.89
	d/s TX hwy 151/Stotzer Frwy	136045	735.47	734.92	0.55	733.77	733.09	0.68	731.9	731.04	0.86
	u/s Pinn Rd	134897	732.54	732.1	0.44	731.01	730.4	0.61	729.33	728.56	0.77
	d/s Pinn Rd	134762	732.26	731.8	0.46	730.77	730.17	0.6	729.14	728.38	0.76
	u/s Leon Trib F	127612	714.31	713.99	0.32	713.27	712.83	0.44	712.05	711.47	0.58
	d/s Leon Trib F	126859	714.06	713.75	0.31	713.04	712.61	0.43	711.85	711.29	0.56
	u/s Slick Ranch Creek	124054	706.1	705.91	0.19	705.53	705.29	0.24	704.83	704.51	0.32
	d/s Slick Ranch Creek	123319	705.36	704.97	0.39	703.99	703.45	0.54	702.41	701.72	0.69
	u/s Old Hwy 90 W	118873	703.14	702.73	0.41	701.7	701.12	0.58	700	699.22	0.78
	d/s Old Hwy 90 W	118757	702.39	701.88	0.51	700.62	699.95	0.67	698.65	697.84	0.81
	u/s US Hwy 90	116958	693.29	693.28	0.01	693.01	692.71	0.3	692.45	692.25	0.2
	d/s US Hwy 90	116825	688.52	688.4	0.12	688	687.78	0.22	687.28	686.87	0.41
	u/s Leon Trib E	102466	670.25	669.81	0.44	668.8	668.26	0.54	667.23	666.65	0.58
	d/s Leon Trib E	102236	670.29	669.86	0.43	668.84	668.3	0.54	667.27	666.69	0.58
	u/s Kelly St	100040	668.32	667.92	0.4	666.98	666.48	0.5	665.54	665.02	0.52
	d/s Kelly St	99980	668.21	667.81	0.4	666.86	666.35	0.51	665.4	664.87	0.53
	u/s Leon Trib D	97465	663.85	663.39	0.46	662.32	661.73	0.59	660.53	659.83	0.7
	d/s Leon Trib D	96588	661.77	661.27	0.5	660.18	659.58	0.6	658.27	657.54	0.73
	u/s Military Dr SW	88636	650.44	650.18	0.26	649.49	649.13	0.36	648.32	647.52	0.8
	d/s Military Dr SW	87864	646.92	646.58	0.34	645.66	645.17	0.49	644.13	643.57	0.56
	AOI 2	86207	639.47	639.09	0.38	638.04	637.51	0.53	636.62	636.39	0.23
	AOI 2	85024	639.12	638.75	0.37	637.73	637.25	0.48	636.19	635.5	0.69
	u/s Leon Trib C	82969	638.47	638.07	0.4	636.93	636.38	0.55	635.07	634.06	1.01
	d/s Leon Trib C	82554	638.4	638	0.4	636.86	636.3	0.56	634.98	633.95	1.03
	u/s Quintana Rd / AOI 1	71561	622.93	622.77	0.16	622.32	622.07	0.25	621.77	621.35	0.42
	d/s Quintana Rd / AOI 1	71115	619.74	619.6	0.14	619.12	618.83	0.29	618.66	618.32	0.34
	u/s New Laredo Hwy / AOI 1	69321	618.16	618.09	0.07	617.74	617.5	0.24	617.06	616.78	0.28
	d/s New Laredo Hwy / AOI 1	68856	614.8	614.46	0.34	614.08	613.95	0.13	613.65	613.56	0.09
	u/s IH 35 S	62942	608.67	608.41	0.26	607.8	607.47	0.33	606.77	606.41	0.36
	d/s IH 35 S	62806	608.11	607.85	0.26	607.23	606.91	0.32	606.23	605.88	0.35
	u/s Leon Trib B	57417	597.39	597.26	0.13	596.93	596.79	0.14	596.21	595.94	0.27
	d/s Leon Trib B	56444	596.97	596.85	0.12	596.57	596.46	0.11	595.92	595.66	0.26
	u/s SE Loop 410	55095	596.3	596.21	0.09	596.02	595.97	0.05	595.46	595.22	0.24
	d/s SE Loop 410	54631	594.64	594.43	0.21	593.78	592.1	1.68	591.87	591.72	0.15
	u/s Leon Trib A	51940	590.49	590.3	0.19	589.1	588.75	0.35	587.31	586.75	0.56
	d/s Leon Trib A	51046	587.1	586.85	0.25	586.16	585.81	0.35	585.04	584.62	0.42
	u/s Indian Creek	36743	572.86	572.55	0.31	571.64	571.25	0.39	570.37	570.2	0.17
	d/s Indian Creek	35989	572.56	572.25	0.31	571.35	570.97	0.38	570.1	569.96	0.14
	u/s St Hwy 16	32858	567.79	567.69	0.1	567.33	567.26	0.07	566.85	567.31	-0.46
	d/s St Hwy 16	32681	562.49	562.23	0.26	561.4	560.92	0.48	559.91	559.15	0.76
	u/s Applewhite Rd	25143	553.37	552.86	0.51	553.51	546.84	6.67	545.03	543.64	1.39
	d/s Applewhite Rd	25092	550.86	549.67	1.19	547.05	545.86	1.19	543.29	542.08	1.21
	u/s Comanche Creek	9432	522.15	520.89	1.26	517.92	516.54	1.38	513.41	511.96	1.45
	d/s Comanche Creek	8907	522.44	521.14	1.3	518.09	516.68	1.41	513.46	511.96	1.5
		1770	511.32	509.99	1.33	506.79	505.31	1.48	501.91	500.36	1.55
		850	511.83	510.5	1.33	507.31	505.82	1.49	502.39	500.81	1.58
		426	511.55	510.23	1.32	507.07	505.59	1.48	502.18	500.62	1.56

Table G.1-28

Alternative 14b: Government Canyon Pond

			100 WSEL (ft)	100 WSEL (ft)	Difference	50 WSEL (ft)	50 WSEL (ft)	Difference	25 WSEL (ft)	25 WSEL (ft)	Difference
Stream	Location / AOI #	Cross-section	FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)	FC w/o Project	FC wtih Project	(w/o - w/Proj)
Govt Canyon Creek	d/s Proposed Pond	17345	1023.83	1020.91	2.92	1022.27	1020.49	1.78	1021.06	1019.82	1.24
		14403	1002.79	1000.36	2.43	1001.73	999.93	1.8	1000.51	999.23	1.28
		12367	990.94	989.23	1.71	990.17	988.85	1.32	989.2	988.15	1.05
		10144	978.4	976.88	1.52	977.79	976.49	1.3	976.85	975.93	0.92
	u/s Govt Canyon Trib B	7930	964.71	963.48	1.23	964.17	963.13	1.04	963.39	962.55	0.84
	d/s Govt Canyon Trib B	7595	962.22	961.06	1.16	961.62	960.7	0.92	960.97	960.23	0.74
	u/s Govt Canyon Trib A	6429	955.35	954.35	1	954.65	953.92	0.73	953.95	953.38	0.57
	d/s Govt Canyon Trib A	6038	953.41	952.33	1.08	952.65	951.88	0.77	951.92	951.37	0.55
		3685	941.93	941.08	0.85	941.35	940.6	0.75	940.64	940.12	0.52
		2380	933.09	932.01	1.08	932.31	931.46	0.85	931.44	930.81	0.63
	u/s confluence w/Leon Crk	94	925.89	925.11	0.78	925.33	924.71	0.62	924.69	924.24	0.45
Culebra Creek	d/s Govt Canyon Creek	43882	923.49	922.99	0.5	922.85	922.49	0.36	922.09	921.75	0.34
	u/s FM 1560	37375	900.72	900.33	0.39	900.22	899.87	0.35	899.58	899.31	0.27
	d/s FM 1560	37200	898.63	898.11	0.52	897.96	897.46	0.5	897.07	896.71	0.36
	u/s Culebra Trib C	33377	886.41	886.08	0.33	885.61	885.29	0.32	884.72	884.44	0.28
	d/s Culebra Trib C	32968	885.78	885.45	0.33	884.97	884.66	0.31	884.08	883.78	0.3
	u/s Culebra Trib B	28686	871.22	870.27	0.95	869.31	868.84	0.47	867.65	867.15	0.5
	d/s Culebra Trib B	28422	870.03	868.82	1.21	867.8	867.27	0.53	866.07	865.6	0.47
	u/s SW Loop 1604	28004	864.46	863.76	0.7	862.84	862.37	0.47	861.46	861.07	0.39
	d/s SW Loop 1604	27827	863.89	863.22	0.67	862.34	861.89	0.45	861.02	860.64	0.38
	u/s Helotes Creek / AOI 5	25489	856.59	856.31	0.28	854.91	854.5	0.41	852.99	852.76	0.23
	d/s Helotes Creek / AOI 5	24901	854.75	854.42	0.33	852.88	852.4	0.48	850.73	850.48	0.25
	u/s Culebra Rd / AOI 5	24033	853	852.66	0.34	851.09	850.57	0.52	848.71	848.44	0.27
	d/s Culebra Rd / AOI 5	23896	852.46	852.12	0.34	850.57	850.09	0.48	848.33	848.07	0.26
	AOI 5	19870	838.55	838.18	0.37	836.69	836.36	0.33	835.16	834.97	0.19
	AOI 5	15582	825.03	824.67	0.36	823.66	823.45	0.21	822.69	822.55	0.14
	u/s Tezel Rd / AOI 5	13259	821.2	820.8	0.4	820.23	820.08	0.15	819.57	819.48	0.09
	d/s Tezel Rd / AOI 5	13109	818.34	817.97	0.37	816.5	816.23	0.27	815.15	814.96	0.19
	u/s Timber Path / AOI 5	9773	810.19	809.96	0.23	809.25	809.15	0.1	808.63	808.55	0.08
	d/s Timber Path / AOI 5	9663	810.99	810.74	0.25	809.61	809.37	0.24	808.33	808.17	0.16
	AOI 5	5742	793.62	793.4	0.22	792.51	792.37	0.14	791.64	791.53	0.11
	u/s confluence Leon Creek / AOI 5	1927	775.77	775.45	0.32	774.16	773.97	0.19	772.94	772.8	0.14
Leon Creek	d/s confluence Culebra Creek	151954	778.44	778.23	0.21	776.5	776.4	0.1	774.5	774.37	0.13
	u/s Ingram Rd	148983	769.61	769.5	0.11	768.19	768.12	0.07	766.55	766.45	0.1
	d/s Ingram Rd	148848	769.15	769.04	0.11	767.73	767.66	0.07	766.03	765.93	0.1
	u/s Huebner Creek	148048	768.76	768.66	0.1	767.36	767.3	0.06	765.69	765.58	0.11
	d/s Huebner Creek	147620	767.93	767.83	0.1	766.57	766.5	0.07	764.95	764.85	0.1
	u/s Culebra Rd	145073	761.08	760.97	0.11	759.56	759.49	0.07	757.94	757.84	0.1
	d/s Culebra Rd	144862	761.03	760.92	0.11	759.47	759.4	0.07	757.84	757.75	0.09
	u/s SW Loop 410	142963	758.76	758.64	0.12	757.15	757.08	0.07	755.65	755.56	0.09
	d/s SW Loop 410	142391	748.71	748.59	0.12	747.01	746.93	0.08	745.17	745.07	0.1
	u/s Leon Trib G	139942	743.79	743.65	0.14	741.99	741.89	0.1	739.95	739.83	0.12
	d/s Leon Trib G	139336	743.75	743.61	0.14	741.95	741.85	0.1	739.91	739.79	0.12
	u/s TX HWY 151	136389	736.91	736.75	0.16	735.03	734.93	0.1	732.95	732.84	0.11
	d/s TX HWY 151	135790	733.28	733.14	0.14	731.83	731.76	0.07	730.28	730.19	0.09
	u/s Leon Trib F	127612	714.31	714.25	0.06	713.27	713.22	0.05	712.05	711.98	0.07
	d/s Leon Trib F	126859	714.06	714	0.06	713.04	713	0.04	711.85	711.78	0.07
	u/s Slick Rach	124054	706.1	706.06	0.04	705.53	705.49	0.04	704.83	704.81	0.02
	d/s Slick Rach	123319	705.36	705.3	0.06	703.99	703.93	0.06	702.41	702.32	0.09
	u/s Westwood Village Creek	117896	697.65	697.61	0.04	696.75	696.72	0.03	695.75	695.67	0.08
	d/s Westwood Village Creek	117405	697.2	697.14	0.06	696.13	696.08	0.05	694.94	694.85	0.09
	u/s US Hwy 90 W	117144	696.37	696.32	0.05	695.28	695.24	0.04	694.26	694.17	0.09
	d/s US Hwy 90 W	116690	690.11	690.06	0.05	689.06	689.01	0.05	687.82	687.75	0.07
	u/s Leon Trib E	102466	670.25	670.18	0.07	668.8	668.74	0.06	667.23	667.16	0.07
	d/s Leon Trib E	102236	670.29	670.22	0.07	668.84	668.78	0.06	667.27	667.2	0.07
	u/s Leon Trib D	97465	663.85	663.73	0.12	662.32	662.27	0.05	660.53	660.45	0.08
	d/s Leon Trib D	96588	661.77	661.6	0.17	660.18	660.14	0.04	658.27	658.2	0.07
	u/s Elmore Hall Blvd	95755	660.3	660.08	0.22	658.5	658.46	0.04	656.5	656.42	0.08
	d/s Elmore Hall Blvd	95690	660.71	660.55	0.16	659.01	658.94	0.07	657.02	656.91	0.11
	u/s Military Dr SW	88636	650.44	650.4	0.04	649.49	649.45	0.04	648.32	648.1	0.22
	u/s Military Dr SW	87864	646.92	646.86	0.06	645.66	645.6	0.06	644.13	644.06	0.07
	AOI 2	87627	646.6	646.55	0.05	645.29	645.24	0.05	643.8	643.73	0.07
	AOI 2	86207	639.47	639.41	0.06	638.04	637.98	0.06	636.62	636.59	0.03
	AOI 2	84973	639.03	638.97	0.06	637.63	637.57	0.06	636.05	635.94	0.11
	u/s Leon Trib C	82969	638.47	638.41	0.06	636.93	636.87	0.06	635.07	634.92	0.15
	d/s Leon Trib C	82554	638.4	638.34	0.06	636.86	636.79	0.07	634.98	634.82	0.16
	u/s Quintana Rd	71561	622.93	622.9	0.03	622.32	622.29	0.03	621.77	621.68	0.09
	d/s Quintans Rd	71115	619.74	619.72	0.02	619.12	619.09	0.03	618.66	618.62	0.04
	u/s New Laredo Hwy / AOI 1	69321	618.16	618.15	0.01	617.74	617.72	0.02	617.06	617.01	0.05
	d/s New Laredo Hwy / AOI 1	68856	614.8	614.75	0.05	614.08	614.07	0.01	613.65	613.65	0
	u/s IH 35 S	63024	609.12	609.09	0.03	608.19	608.13	0.06	607.11	607.08	0.03
	d/s IH 35 S	62672	607.67	607.63	0.04	606.81	606.78	0.03	605.81	605.76	0.05
	u/s Leon Trib B	57417	597.39	597.37	0.02	596.93	596.91	0.02	596.21	596.18	0.03
	d/s Leon Trib B	56444	596.97	596.95	0.02	596.57	596.56	0.01	595.92	595.89	0.03
	u/s SE Loop 410	55095	596.3	596.28	0.02	596.02	596.02	0	595.46	595.43	0.03
	d/s SE Loop 410	54631	594.64	594.6	0.04	593.78	593.75	0.03	591.87	591.85	0.02
	u/s Leon Trib A	51940	590.49	590.46	0.03	589.1	589.06	0.04	587.31	587.25	0.06
	d/s Leon Trib A	51046	587.1	587.06	0.04	586.16	586.12	0.04	585.04	585	0.04
	u/s Indian Creek	36743	572.86	572.82	0.04	571.64	571.62	0.02	570.37	569.71	0.66
	d/s Indian Creek	35989	572.56	572.52	0.04	571.35	571.34	0.01	570.1	569.4	0.7
	u/s Palo Alto Rd	32858	567.79	567.78	0.01	567.33	567.39	-0.06	566.85	563.68	3.17
	d/s Palo Alto Rd	32681	562.49	562.45	0.04	561.4	561.31	0.09	559.91	559.84	0.07
	u/s Applewhite Rd	25143	553.37	553.3	0.07	553.51	548.38	5.13	545.03	545.54	-0.51
	d/s Applewhite Rd	25092	550.86	550.76	0.1	547.05	546.97	0.08	543.29	543.16	0.13
	u/s Comanche Creek	9432	522.15	521.96	0.19	517.92	517.78	0.14	513.41	513.27	0.14
	d/s Comanche Creek	8907	522.44	522.25	0.19	518.09	517.95	0.14	513.46	513.32	0.14
	most d/s Leon Creek	426	511.55	511.36	0.19	507.07	506.92	0.15	502.18	502.05	0.13

Table G.1-29

Alternative 15: Leon AOI-7 100 Year Levee

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	d/s French Creek	168201	826.86	826.94	-0.08	824.28	824.28	0	822.44	822.44	0
		167725	826.82	826.92	-0.1	823.67	823.67	0	821.22	821.21	0.01
		166687	821.75	822.53	-0.78	818.92	818.89	0.03	816.36	816.35	0.01
		166195	820.25	821.48	-1.23	817.03	816.93	0.1	813.34	813.28	0.06
	u/s Levee	165459	819.71	821.07	-1.36	816.44	816.32	0.12	812.42	812.33	0.09
	Within Levee / AOI 7	164568	817.45	818.46	-1.01	814.09	813.84	0.25	810.3	810.15	0.15
	Within Levee / AOI 7	163183	815.85	816.55	-0.7	812.23	811.58	0.65	807.97	807.64	0.33
	u/s Lower French Crk / AOI 7	161668	806.93	810.3	-3.37	803.28	804.57	-1.29	800.74	801.4	-0.66
	d/s Lower French Crk / AOI 7	161047	802.49	803.32	-0.83	800.52	800.45	0.07	796.32	796.19	0.13
	d/s Levee	159661	799.42	799.33	0.09	795.24	795.21	0.03	791.45	791.42	0.03
		158897	794.16	794.16	0	791.01	791.01	0	787.65	787.65	0
	u/s Grissom Rd	158683	794.04	794.04	0	790.69	790.69	0	787.3	787.3	0
	d/s Grissom Rd	158571	794.47	794.47	0	790.61	790.61	0	786.71	786.71	0

Table G.1-30

Alternative 16: Leon AOI-7 500 Year Levee

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	d/s Bandera Rd	171219	842.47	842.47	0	840.91	840.91	0	838.63	838.63	0
		169928	833.02	833.04	-0.02	829.52	829.52	0	826.99	826.99	0
	u/s French Creek	168730	830.44	830.47	-0.03	827.38	827.38	0	824.97	824.97	0
	d/s French Creek	168201	826.86	826.97	-0.11	824.29	824.29	0	822.44	822.44	0
		167725	826.82	826.95	-0.13	823.67	823.68	-0.01	821.22	821.22	0
		166687	821.75	822.69	-0.94	818.92	818.97	-0.05	816.36	816.36	0
		166195	820.25	821.69	-1.44	817.03	817.16	-0.13	813.34	813.35	-0.01
	u/s Levee	165459	819.71	821.31	-1.6	816.44	816.60	-0.16	812.42	812.43	-0.01
	Within Levee / AOI 7	164568	817.45	818.81	-1.36	814.09	814.28	-0.19	810.3	810.32	-0.02
	Within Levee / AOI 7	163183	815.85	817.06	-1.21	812.23	812.33	-0.1	807.97	807.95	0.02
	u/s Lower French Crk / AOI 7	161668	806.93	806.39	0.54	803.28	803.21	0.07	800.74	800.74	0
	d/s Lower French Crk / AOI 7	161047	802.49	802.46	0.03	800.52	800.52	0	796.32	796.32	0
	d/s Levee	159661	799.42	799.35	0.07	795.24	795.24	0	791.45	791.45	0
		158897	794.16	794.16	0	791.01	791.01	0	787.65	787.65	0
	u/s Grissom Rd	158683	794.04	794.04	0	790.69	790.69	0	787.3	787.3	0
	d/s Grissom Rd	158571	794.47	794.47	0	790.61	790.61	0	786.71	786.71	0

Table G.1-31

Alternative 17: AECOM Quarry at the Rim RSWF

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
	d/s Quarry @ Rim RSWF	224100	1039.35	1039.35	0	1037.88	1037.88	0	1036.3	1036.3	0
	u/s IH 10 W/US Hwy 87	222596	1030.93	1030.93	0	1028.29	1028.28	0.01	1026.46	1026.47	-0.01
	d/s IH 10 W/US Hwy 87	222405	1030.69	1030.7	-0.01	1027.94	1027.94	0	1026.13	1026.14	-0.01
	u/s NW Loop 1604	214215	1003.24	996.59	6.65	1002.48	994.77	7.71	997.79	992	5.79
	d/s NW Loop 1604	213669	988.75	986.23	2.52	987.95	985.48	2.47	987.14	984.09	3.05
	u/s UTSA Blvd	208037	970.7	965.85	4.85	970.15	965.21	4.94	966.76	963.17	3.59
	d/s UTSA Blvd	207961	969.69	962.79	6.9	964.96	963.23	1.73	963.47	961.55	1.92
	u/s Hausman Rd	199411	945.66	942.22	3.44	944.71	941.13	3.58	942.84	939.52	3.32
	d/s Hausman Rd	199287	944.42	941.06	3.36	943.12	940.1	3.02	941.6	938.5	3.1
	u/s Huesta Creek	193432	919.8	917.53	2.27	918.9	916.58	2.32	917.65	914.95	2.7
	d/s Huesta Creek	193141	916.41	913.28	3.13	914.93	912.57	2.36	913.36	911.13	2.23
	u/s Prue Rd	185918	891.26	890.04	1.22	889.69	888.64	1.05	887.96	887.05	0.91
	d/s Prue Rd	185801	889.59	888.2	1.39	887.86	886.87	0.99	886.21	885.3	0.91
	u/s Bandera Rd	171483	847.24	846.95	0.29	846.56	846.37	0.19	845.82	845.64	0.18
	d/s Bandera Rd	171219	840.91	840.6	0.31	840.08	839.51	0.57	838.63	836.56	2.07
	u/s French Creek	168730	827.38	827.34	0.04	826.22	826.18	0.04	824.97	824.82	0.15
	d/s French Creek	168201	824.28	824.28	0	823.37	823.37	0	822.44	822.34	0.1
	AOI 7	164568	814.09	814.09	0	812.26	812.26	0	810.3	810.02	0.28
	u/s Lower French Creek / AOI 7	161668	803.28	803.28	0	801.88	801.87	0.01	800.74	800.71	0.03
	d/s Lower French Creek / AOI 7	161047	800.52	800.52	0	797.94	797.93	0.01	796.32	796.08	0.24
	u/s Grissom Rd	158683	790.69	790.68	0.01	789.11	789.09	0.02	787.3	786.59	0.71
	d/s Grissom Rd	158571	790.61	790.61	0	788.61	788.59	0.02	786.71	785.99	0.72
	u/s confluence Culebra Creek	152400	779.54	779.48	0.06	777.53	777.49	0.04	775.42	774.91	0.51
	d/s confluence Culebra Creek	151954	778.44	778.38	0.06	776.5	776.47	0.03	774.5	774.02	0.48
	u/s SW Loop 410	142821	758.54	758.5	0.04	756.78	756.76	0.02	755.06	754.82	0.24
	d/s SW Loop 410	142600	758.5	758.47	0.03	756.79	756.77	0.02	754.7	754.35	0.35
	u/s Leon Trib G	139942	743.79	743.75	0.04	741.99	741.96	0.03	739.95	739.52	0.43
	d/s Leon Trib G	139336	743.75	743.71	0.04	741.95	741.92	0.03	739.91	739.47	0.44
	u/s TX Hwy 151/Stotzer Frwy	136282	735.82	735.78	0.04	734.07	734.05	0.02	732.15	731.73	0.42
	d/s TX Hwy 151/Stotzer Frwy	136045	735.47	735.43	0.04	733.77	733.75	0.02	731.9	731.5	0.4
	u/s Leon Trib F	127612	714.31	714.29	0.02	713.27	713.25	0.02	712.05	711.78	0.27
	d/s Leon Trib F	126859	714.06	714.04	0.02	713.04	713.03	0.01	711.85	711.59	0.26
	u/s US Hwy 90 W	116958	693.29	693.29	0	693.01	693.01	0	692.45	692.35	0.1
	d/s US Hwy 90 W	116825	688.52	688.51	0.01	688	687.99	0.01	687.28	687.06	0.22
		110862	680.72	680.69	0.03	679.22	679.2	0.02	677.2	676.79	0.41
	u/s Leon Trib E	102466	670.25	670.23	0.02	668.8	668.78	0.02	667.23	666.94	0.29
	d/s Leon Trib E	102236	670.29	670.27	0.02	668.84	668.82	0.02	667.27	666.97	0.3
	u/s Leon Trib D	97465	663.85	663.78	0.07	662.32	662.29	0.03	660.53	660.15	0.38
	d/s Leon Trib D	96588	661.77	661.67	0.1	660.18	660.14	0.04	658.27	657.86	0.41
	u/s Military Dr SW	88636	650.44	650.43	0.01	649.49	649.48	0.01	648.32	647.81	0.51
	d/s Military Dr SW / AOI 2	87864	646.92	646.9	0.02	645.66	645.64	0.02	644.13	643.84	0.29
	AOI 2	86207	639.47	639.45	0.02	638.04	638.01	0.03	636.62	636.5	0.12
	AOI 2	84973	639.03	639.01	0.02	637.63	637.6	0.03	636.05	635.7	0.35
	u/s New Laredo Hwy	69321	618.16	618.16	0	617.74	617.73	0.01	617.06	616.91	0.15
	d/s New Laredo Hwy	68856	614.8	614.79	0.01	614.08	614.08	0	613.65	613.59	0.06
	u/s IH 35 S	62942	608.67	608.66	0.01	607.8	607.78	0.02	606.77	606.58	0.19
	d/s IH 35 S	62806	608.11	608.1	0.01	607.23	607.22	0.01	606.23	606.05	0.18
	u/s Leon Trib B	57417	597.39	597.38	0.01	596.93	596.92	0.01	596.21	596.07	0.14
	d/s Leon Trib B	56444	596.97	596.96	0.01	596.57	596.57	0	595.92	595.78	0.14
	u/s SE Loop 410	55095	596.3	596.29	0.01	596.02	596.03	-0.01	595.46	595.33	0.13
	d/s SE Loop 410	54631	594.64	594.62	0.02	593.78	593.77	0.01	591.87	591.78	0.09
	u/s Leon Trib A	51940	590.49	590.47	0.02	589.1	589.07	0.03	587.31	587	0.31
	d/s Leon Trib A	51046	587.1	587.09	0.01	586.16	586.14	0.02	585.04	584.81	0.23
	d/s Indian Creek	36743	572.86	572.85	0.01	571.64	571.62	0.02	570.37	570.09	0.28
	u/s Indian Creek	35989	572.56	572.55	0.01	571.35	571.34	0.01	570.1	569.83	0.27
	u/s Palo Alto Rd	32858	567.79	567.79	0	567.33	567.32	0.01	566.85	566.69	0.16
	d/s Palo Alto Rd	32681	562.49	562.48	0.01	561.4	561.38	0.02	559.91	559.58	0.33
	u/s Comanche Creek	9432	522.15	522.05	0.1	517.92	517.81	0.11	513.41	512.48	0.93
	d/s Comanche Creek	8907	522.44	522.33	0.11	518.09	517.98	0.11	513.46	512.5	0.96
		1770	511.32	511.2	0.12	506.79	506.66	0.13	501.91	500.9	1.01
		426	511.55	511.43	0.12	507.07	506.94	0.13	502.18	501.16	1.02

Table G.1-32

Alternative 18: Target AOI-11 Ponds

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Trib M	d/s of Proposed Pond	10630	1261.8	1261.8	0	1261.18	1261.18	0	1260.47	1260.47	0
	u/s Boerne Stage Rd	6614	1234.38	1233.50	0.88	1234.11	1233.23	0.88	1233.82	1233.07	0.75
	d/s Boerne Stage Rd	6558	1231.69	1230.51	1.18	1231.31	1230.07	1.24	1230.87	1229.21	1.66
	u/s Boerne Stage Rd	2488	1209.89	1208.96	0.93	1209.34	1208.63	0.71	1208.83	1208.27	0.56
	d/s Boerne Stage Rd	2438	1209.38	1208.66	0.72	1209.01	1208.34	0.67	1208.53	1207.99	0.54
		2130	1208.48	1207.81	0.67	1208.12	1207.47	0.65	1207.68	1207.12	0.56
	u/s confluence w/Leon Crk	653	1201.53	1200.69	0.84	1201.07	1200.22	0.85	1200.52	1199.73	0.79
Leon Creek	u/s confluence w/Leon Trib M	269552	1205.52	1204	1.52	1204.47	1203.35	1.12	1203.65	1202.59	1.06
	d/s confluence w/Leon Trib M	268942	1202.36	1201.48	0.88	1201.83	1201.01	0.82	1201.23	1200.47	0.76
	u/s Boerne Stage Rd	268623	1201.58	1200.79	0.79	1201.12	1200.32	0.8	1200.53	1199.72	0.81
	d/s Boerne Stage Rd	268551	1201.23	1200.42	0.81	1200.76	1199.93	0.83	1200.14	1199.32	0.82
	AOI 11	262508	1172.82	1171.59	1.23	1171.96	1170.88	1.08	1171.04	1170.23	0.81
	u/s confluence w/Leon Trib L / AOI 11	258191	1154.33	1153.05	1.28	1153.36	1152.35	1.01	1152.46	1151.57	0.89
	d/s confluence w/Leon Trib L / AOI 11	257761	1153.43	1152.13	1.3	1152.44	1151.44	1	1151.54	1150.67	0.87
	u/s IH 10 W/US HWY 87 / AOI 11	255034	1143.61	1141.82	1.79	1142.16	1140.52	1.64	1140.63	1139.08	1.55
	d/s IH 10 W/US HWY 87 / AOI 11	254878	1136.24	1134.8	1.44	1135.08	1133.74	1.34	1133.82	1132.56	1.26
	AOI 11	254011	1133.36	1132.67	0.69	1132.62	1132.02	0.6	1131.72	1131.05	0.67
	u/s confluence of Leon Trib J	246605	1109.91	1109.14	0.77	1108.97	1108.13	0.84	1107.83	1107.29	0.54
	d/s confluence of Leon Trib J & Dominion Dr	246348	1109.08	1108.32	0.76	1108.17	1107.24	0.93	1106.92	1106.45	0.47
	d/s Dominion Dr	246249	1106.49	1106.04	0.45	1105.96	1105.17	0.79	1104.3	1103.56	0.74
		244099	1098.5	1097.85	0.65	1097.72	1097.1	0.62	1096.84	1096.22	0.62
		241630	1089.17	1087.83	1.34	1087.7	1087.28	0.42	1087.02	1086.15	0.87
	AOI 10	239820	1085.74	1084.96	0.78	1084.8	1084.09	0.71	1083.62	1082.85	0.77
	u/s PVT Rd / AOI 10	239039	1082.86	1081.97	0.89	1081.81	1080.9	0.91	1080.52	1079.67	0.85
	d/s PVT Rd / AOI 10	239000	1082.32	1081.4	0.92	1081.24	1080.31	0.93	1079.92	1079.03	0.89
	u/s PVT St / AOI 10	237824	1076.27	1075.53	0.74	1075.06	1074.5	0.56	1074.2	1073.53	0.67
	d/s PVT St / AOI 10	237673	1076.61	1075.93	0.68	1075.65	1074.81	0.84	1074.44	1074.2	0.24
	u/s Camp Bullis Rd / AOI 10	235659	1070.69	1070.27	0.42	1069.91	1070.32	-0.41	1068.67	1064.4	4.27
	d/s Camp Bullis Rd / AOI 10	235598	1069.4	1068.91	0.49	1068.73	1065.62	3.11	1065.7	1064.75	0.95
	u/s Old Camp Bullis Rd / AOI 10	232257	1063.19	1062.21	0.98	1061.82	1060.8	1.02	1060.29	1059.48	0.81
	d/s Old Camp Bullis Rd / AOI 10	232168	1063.11	1062.12	0.99	1061.71	1060.67	1.04	1060.14	1059.28	0.86
	AOI 10	231730	1062.85	1061.82	1.03	1061.41	1060.31	1.1	1059.74	1058.81	0.93
	u/s HI 10/US Hwy 87	222596	1030.93	1030.83	0.1	1028.29	1026.97	1.32	1026.46	1025.72	0.74
	d/s HI 10/US Hwy 87	222405	1030.69	1030.67	0.02	1027.94	1026.61	1.33	1026.13	1025.44	0.69
	u/s HI 10/US Hwy 87	217004	1012.53	1012.18	0.35	1012.36	1011.35	1.01	1010.41	1008.32	2.09
	d/s HI 10/US Hwy 87	216540	1003.15	1002.58	0.57	1002.12	1000.18	1.94	999.12	998.14	0.98
	u/s NW Loop 1604	214215	1003.24	1003.11	0.13	1002.48	999.28	3.2	997.79	996.35	1.44
	d/s NW Loop 1604	213669	988.75	988.48	0.27	987.95	987.57	0.38	987.14	986.14	1
	u/s UTSA Blvd	208037	970.7	971.18	-0.48	970.15	967.32	2.83	966.76	965.67	1.09
	d/s UTSA Blvd	207961	969.69	965.71	3.98	964.96	964.24	0.72	963.47	962.66	0.81
	u/s Hausman Rd	199411	945.66	944.79	0.87	944.71	944.29	0.42	942.84	942.01	0.83
	d/s Hausman Rd	199287	944.42	943.75	0.67	943.12	942.47	0.65	941.6	940.88	0.72
	u/s Huesta Creek	193432	919.8	919.33	0.47	918.9	918.39	0.51	917.65	917.14	0.51
	d/s Huesta Creek	193141	916.41	915.65	0.76	914.93	914.21	0.72	913.36	912.97	0.39
	u/s Babcock Rd	192804	914.4	913.75	0.65	913.12	912.52	0.6	911.75	911.25	0.5
	d/s Babcock Rd	192681	912.89	912.25	0.64	911.62	911.04	0.58	910.3	909.82	0.48
	u/s Prue Rd	185918	891.26	890.59	0.67	889.69	889	0.69	887.96	887.41	0.55
	d/s Prue Rd	185801	889.59	888.83	0.76	887.86	887.22	0.64	886.21	885.67	0.54
		183725	880.91	880.42	0.49	879.82	879.34	0.48	878.52	878.05	0.47
		178929	863.47	862.7	0.77	861.74	861	0.74	859.82	859.17	0.65
		173346	849.73	849.29	0.44	848.67	848.37	0.3	847.5	847.36	0.14
	u/s Bandera Rd	171483	847.24	846.95	0.29	846.56	846.37	0.19	845.82	845.73	0.09
	d/s Bandera Rd	171219	840.91	840.6	0.31	840.08	839.51	0.57	838.63	836.76	1.87
	u/s BVT Rd at 7581 Bandera	169364	828.29	828.13	0.16	827.05	826.94	0.11	825.71	825.66	0.05
	d/s BVT Rd at 7581 Bandera	169047	827.96	827.84	0.12	826.74	826.65	0.09	825.42	825.38	0.04
	u/s French Creek	168730	827.38	827.34	0.04	826.22	826.18	0.04	824.97	824.95	0.02
	d/s French Creek	168201	824.28	824.28	0	823.37	823.37	0	822.44	822.44	0
		167417	822.51	822.51	0	821.37	821.37	0	820.2	820.2	0
		165459	816.44	816.44	0	814.44	814.44	0	812.42	812.42	0

Table G.1-33

Alternative 19 - Boerne Stage Rd. Improvements

261496 and 255196 along Boerne Stage Road in order to run a more thorough analysis in this area.

The only XS in this area which remain as in the May 2009 geometry file are 261496, 256824, 256760, & 255196.

All others within this extent are new or modified. A levee has been placed in this geometry file to represent the proposed improvements to Boerne Stage Road.

Stream		100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	278308	1249.87	1248.05	1.82	1248.74	1246.81	1.93	1247.33	1245.22	2.11
	277963	1248.33	1247.78	0.55	1247.02	1246.40	0.62	1245.23	1244.41	0.82
	277543	1247.58	1246.92	0.66	1246.18	1245.51	0.67	1244.07	1243.26	0.81
	276997	1245.85	1244.27	1.58	1244.34	1242.7	1.64	1242.11	1240.87	1.24
	276612	1244.25	1243.55	0.7	1242.54	1241.69	0.85	1240.5	1239.59	0.91
	276101	1240.92	1237.54	3.38	1239.36	1236.82	2.54	1237.61	1235.66	1.95
	275725	1237.13	1235.81	1.32	1236.22	1234.85	1.37	1234.99	1233.67	1.32
	275259	1235.49	1234.41	1.08	1234.5	1233.38	1.12	1233.22	1232.09	1.13
	274898	1233.45	1231.46	1.99	1232.43	1230.45	1.98	1231.14	1229.31	1.83
	274323	1229.72	1228.44	1.28	1228.76	1227.57	1.19	1227.65	1226.59	1.06
	273809	1228.43	1227.5	0.93	1227.54	1226.66	0.88	1226.46	1225.61	0.85
	273629	1227.88	1226.23	1.65	1226.98	1225.36	1.62	1225.9	1224.32	1.58
	273245	1225.19	1223.24	1.95	1224.2	1222.24	1.96	1223.05	1221.09	1.96
	272917	1221.95	1219.78	2.17	1220.9	1218.88	2.02	1219.66	1217.82	1.84
	272600	1219.95	1219.43	0.52	1218.81	1218.2	0.61	1217.64	1216.67	0.97
	272528	1218.95	1217.37	1.58	1218.02	1216.7	1.32	1217.06	1215.93	1.13
	272324	1217.39	1217.02	0.37	1216.64	1216.29	0.35	1215.8	1215.46	0.34
	271773	1215.72	1214.84	0.88	1214.91	1214	0.91	1213.89	1212.82	1.07
	271440	1214.78	1214.19	0.59	1213.93	1213.41	0.52	1212.71	1212.17	0.54
	270699	1213.05	1212.21	0.84	1212.19	1211.31	0.88	1210.97	1210.19	0.78
	270228	1211.75	1211.5	0.25	1210.79	1210.54	0.25	1209.55	1209.27	0.28
	269552	1208.2	1205.52	2.68	1207.12	1204.47	2.65	1205.9	1203.65	2.25
	268942	1203.15	1202.36	0.79	1202.55	1201.83	0.72	1201.92	1201.23	0.69
	268623	1201.8	1201.58	0.22	1201.33	1201.12	0.21	1200.73	1200.53	0.2
	268551	1201.46	1201.23	0.23	1200.98	1200.76	0.22	1200.36	1200.14	0.22
	267230	1198.85	1197.84	1.01	1198.32	1197.32	1	1197.66	1196.73	0.93
	266258	1195.17	1194.45	0.72	1194.45	1193.57	0.88	1193.65	1192.51	1.14
	265064	1189.75	1187.28	2.47	1188.62	1186.27	2.35	1187.37	1185.19	2.18
	263946	1183.06	1182.23	0.83	1182.03	1181.22	0.81	1180.96	1180.14	0.82
	262508	1174.03	1172.81	1.22	1173.11	1171.95	1.16	1172.12	1171.04	1.08
	261496	1170.22	1169.78	0.44	1169.51	1169.1	0.41	1168.49	1168.06	0.43
	260996	1168.7	1167.08	1.62	1167.81	1165.51	2.3	1166.84	1164.8	2.04
	260796	1167.46	1164.66	2.8	1166.57	1164.18	2.39	1165.82	1164.09	1.73
	260617	1166.26	1164.48	1.78	1165.54	1164.02	1.52	1165.11	1163.14	1.97
	260396	1165.16	1163.46	1.7	1164.61	1163.25	1.36	1164.5	1162.87	1.63
	260196	1164.08	1161.95	2.13	1164.73	1160.81	3.92	1163.3	1159.59	3.71
	259996	1162.65	1161.4	1.25	1161.98	1160.79	1.19	1161.6	1159.67	1.93
	259796	1161.7	1161.08	0.62	1161.1	1160.49	0.61	1160.29	1159.67	0.62
	259634	1161.27	1160.29	0.98	1160.7	1159.78	0.92	1159.83	1158.62	1.21
	259396	1160.65	1159.69	0.96	1159.96	1158.49	1.47	1159.1	1157.73	1.37
	259196	1160.15	1158.92	1.23	1159.35	1158.16	1.19	1158.54	1157.4	1.14
	258996	1159.37	1158.65	0.72	1158.58	1157.88	0.7	1157.81	1157.11	0.7
	258808	1158.66	1157.67	0.99	1157.85	1156.85	1	1157.01	1155.93	1.08
	258596	1157.23	1154.86	2.37	1156.5	1154.3	2.2	1155.73	1153.68	2.05
	258396	1155.2	1154.29	0.91	1154.26	1153.38	0.88	1153.33	1152.49	0.84
	258191	1154.44	1153.95	0.49	1153.51	1153.05	0.46	1152.6	1152.18	0.42
	257946	1153.66	1152.98	0.68	1152.71	1152.02	0.69	1151.82	1151.14	0.68
	257761	1152.79	1151.73	1.06	1151.85	1150.83	1.02	1150.98	1149.99	0.99
	257596	1152.1	1150.69	1.41	1151.15	1149.66	1.49	1150.31	1148.89	1.42
	257396	1151.33	1149.99	1.34	1150.34	1148.98	1.36	1149.54	1148.36	1.18
	257182	1150.54	1149.57	0.97	1149.53	1148.56	0.97	1148.83	1148	0.83
	256996	1149.92	1149.39	0.53	1148.9	1148.36	0.54	1148.29	1147.83	0.46
	256824	1149.46	1148.73	0.73	1148.42	1147.65	0.77	1147.88	1147.27	0.61
	256760	1148.78	1148.01	0.77	1147.7	1146.89	0.81	1146.41	1145.82	0.59
	256596	1147.76	1147.42	0.34	1146.58	1146.21	0.37	1145.47	1145.06	0.41
	256421	1147.46	1147.19	0.27	1146.22	1145.92	0.3	1145.04	1144.71	0.33
	256263	1147.13	1146.91	0.22	1145.82	1145.57	0.25	1144.57	1144.27	0.3
	256044	1146.9	1146.6	0.3	1145.53	1145.15	0.38	1144.22	1143.76	0.46
	255925	1146.75	1146.43	0.32	1145.34	1144.93	0.41	1143.98	1143.45	0.53
	255796	1146.51	1146.23	0.28	1145.03	1144.63	0.4	1143.57	1142.97	0.6
	255595	1146.33	1146.14	0.19	1144.79	1144.49	0.3	1143.24	1142.71	0.53
	255404	1146.18	1146.09	0.09	1144.58	1144.45	0.13	1142.88	1142.68	0.2
	255196	1146.15	1146.09	0.06	1144.53	1144.46	0.07	1142.82	1142.72	0.1
	255132	1146.13	1146.12	0.01	1144.5	1144.49	0.01	1142.77	1142.76	0.01
	255034	1145.55	1143.61	1.94	1143.96	1142.16	1.8	1142.28	1140.63	1.65
	254878	1140.96	1136.23	4.73	1139.48	1135.08	4.4	1137.91	1133.82	4.09
	254753	1136.26	1134.97	1.29	1135.82	1134.38	1.44	1135.32	1133.94	1.38
	254474	1134.76	1134	0.76	1134.32	1133.68	0.64	1133.84	1133.25	0.59
	254380	1134.41	1134.13	0.28	1133.71	1133.4	0.31	1132.96	1132.54	0.42
	254011	1133.83	1133.36	0.47	1133.1	1132.62	0.48	1132.26	1131.72	0.54
	253380	1131.71	1130.45	1.26	1130.89	1129.53	1.36	1129.9	1128.51	1.39

Table G.1-34

Alt 20- AOI7 Channel Modifications - 300' bottom width

Stream			100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	179995		863.85	863.85	0	860.23	860.23	0	857.62	857.62	0
	175163		854.01	854.01	0	850.69	850.69	0	848.19	848.19	0
	171483		847.24	847.24	0	845.82	845.82	0	844.13	844.13	0
	171219		840.91	840.91	0	838.63	838.63	0	835.24	835.24	0
	169364		828.29	828.29	0	825.72	825.72	0	824.06	824.07	-0.01
	168201		824.31	824.3	0.01	822.45	822.46	-0.01	821.23	821.24	-0.01
	167417		822.57	822.55	0.02	820.21	820.28	-0.07	818.75	818.78	-0.03
	165801		817.39	811.79	5.6	814.16	809.81	4.35	811.67	808.48	3.19
	165279		816.65	808.78	7.87	813.36	806.49	6.87	810.61	805.11	5.5
	164568		813.44	803.12	10.32	810.91	800.45	10.46	808	798.72	9.28
	164045		812.13	801.12	11.01	810.02	798.3	11.72	807.02	796.47	10.55
	163492		810.73	799.1	11.63	808.94	796	12.94	805.86	793.96	11.9
	163052		810.07	797.78	12.29	808.16	794.43	13.73	805.14	792.08	13.06
	162450		809.58	796.44	13.14	807.72	792.78	14.94	804.46	789.8	14.66
	161878		806.43	795.52	10.91	803.1	791.72	11.38	800.54	788.16	12.38
	161249		801.58	794.84	6.74	799.32	791.01	8.31	797.73	787.05	10.68
	160629		798.63	794.43	4.2	795.2	790.62	4.58	791.31	786.49	4.82
	159661		795.38	794.06	1.32	791.6	790.28	1.32	787.63	786.07	1.56
	158683		790.69	790.69	0	787.3	787.3	0	783.63	783.63	0
	158571		790.61	790.61	0	786.71	786.71	0	783.2	783.2	0

Table G.1-35

Alt AOI7 - 21B - 200' channel imp

Stream			100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	179995		863.85	863.85	0	860.23	860.23	0	857.62	857.62	0
	175163		854.01	854.01	0	850.69	850.69	0	848.19	848.19	0
	171483		847.24	847.24	0	845.82	845.82	0	844.13	844.13	0
	171219		840.91	840.91	0	838.63	838.63	0	835.24	835.24	0
	169364		828.29	828.29	0	825.72	825.71	0.01	824.06	824.06	0
	168201		824.31	824.28	0.03	822.45	822.44	0.01	821.23	821.23	0
	167417		822.57	822.51	0.06	820.21	820.21	0	818.75	818.75	0
	165801		817.39	816.73	0.66	814.16	813.46	0.7	811.67	811.39	0.28
	165279		816.65	815.88	0.77	813.36	812.43	0.93	810.61	810.16	0.45
	164568		813.44	811.78	1.66	810.91	808.81	2.1	808	806.74	1.26
	164045		812.13	809.74	2.39	810.02	807.02	3	807.02	805.1	1.92
	163492		810.73	804.79	5.94	808.94	801.64	7.3	805.86	799.68	6.18
	163052		810.07	801.8	8.27	808.16	798.72	9.44	805.14	796.7	8.44
	162450		809.58	798.69	10.89	807.72	795.21	12.51	804.46	792.69	11.77
	161878		806.43	797.14	9.29	803.1	793.41	9.69	800.54	790.28	10.26
	161249		801.58	795.62	5.96	799.32	791.88	7.44	797.73	788.24	9.49
	160629		798.63	794.77	3.86	795.2	790.98	4.22	791.31	787.02	4.29
	159661		795.38	794.21	1.17	791.6	790.45	1.15	787.63	786.29	1.34
	158683		790.69	790.69	0	787.3	787.3	0	783.63	783.63	0
	158571		790.61	790.61	0	786.71	786.71	0	783.2	783.2	0

Table G.1-36

Alt AOI 7 - 21B - 100' channel imp

			100 WSEL (ft)	100 WSEL (ft)	Difference	25 WSEL (ft)	25 WSEL (ft)	Difference	10 WSEL (ft)	10 WSEL (ft)	Difference
Stream			FC w/o Project	FC wtih Project	w/o - w/Proj	FC w/o Project	FC wtih Project	w/o - w/Proj	FC w/o Project	FC wtih Project	w/o - w/Proj
Leon Cree	179995		863.85	863.85	0	860.23	860.23	0	857.62	857.62	0
	175163		854.01	854.01	0	850.69	850.69	0	848.19	848.19	0
	171483		847.24	847.24	0	845.82	845.82	0	844.13	844.13	0
	171219		840.91	840.91	0	838.63	838.63	0	835.24	835.24	0
	169364		828.29	828.29	0	825.72	825.71	0.01	824.06	824.06	0
	168201		824.31	824.29	0.02	822.45	822.44	0.01	821.23	821.23	0
	167417		822.57	822.52	0.05	820.21	820.21	0	818.75	818.75	0
	165801		817.39	816.88	0.51	814.16	813.49	0.67	811.67	811.4	0.27
	165279		816.65	816.03	0.62	813.36	812.48	0.88	810.61	810.17	0.44
	164568		813.44	812.17	1.27	810.91	808.95	1.96	808	806.78	1.22
	164045		812.13	810.39	1.74	810.02	807.26	2.76	807.02	805.17	1.85
	163492		810.73	807.52	3.21	808.94	803.96	4.98	805.86	801.59	4.27
	163052		810.07	805.56	4.51	808.16	801.8	6.36	805.14	799.28	5.86
	162450		809.58	803.76	5.82	807.72	799.73	7.99	804.46	796.93	7.53
	161878		806.43	798.77	7.66	803.1	795.6	7.5	800.54	792.97	7.57
	161249		801.58	796.83	4.75	799.32	793.26	6.06	797.73	790.08	7.65
	160629		798.63	795.24	3.39	795.2	791.49	3.71	791.31	787.79	3.52
	159661		795.38	794.55	0.83	791.6	790.74	0.86	787.63	786.62	1.01
	158683		790.69	790.69	0	787.3	787.3	0	783.63	783.63	0
	158571		790.61	790.61	0	786.71	786.71	0	783.2	783.2	0

Table G.1-37

Alternative 22 - LC-15 HB@Prue & Huebner Trib A Pond

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Huebner Creek	u/s Prue Rd	37467	918.24	918.24	0	918.24	918.01	0.23	917.77	917.77	0
	d/s Prue Rd	37408	916.6	916.60	0	916.6	916.26	0.34	915.9	915.90	0
	u/s Lockhill Rd	36146	910.46	910.39	0.07	910.46	909.99	0.47	909.6	909.56	0.04
	d/s Lockhill Rd	36089	910.33	910.25	0.08	910.33	909.85	0.48	909.47	909.43	0.04
		35768	909.41	909.19	0.22	909.41	908.65	0.76	908.24	907.97	0.27
		35696	909.43	909.2	0.23	909.43	908.68	0.75	908.28	908.12	0.16
		34939	906.33	905.75	0.58	906.33	905.25	1.08	905.21	904.77	0.44
		34290	903.03	902.45	0.58	903.03	902.05	0.98	902.02	901.59	0.43
		33578	899.49	898.86	0.63	899.49	898.44	1.05	898.41	897.99	0.42
	u/s Babcock Rd / AOI 9	32884	896.42	895.75	0.67	896.42	895.29	1.13	895.26	894.77	0.49
	d/s Babcock Rd / AOI 9	32782	895.67	895.12	0.55	895.67	894.74	0.93	894.72	894.31	0.41
	u/s Hollyhock Rd	32032	891.04	889.39	1.65	891.04	888.94	2.1	890.16	888.4	1.76
	d/s Hollyhock Rd	31954	890.92	889.41	1.51	890.92	888.96	1.96	890.06	888.44	1.62
	AOI 9	31068	885.79	881.6	4.19	885.79	881.18	4.61	884.71	880.7	4.01
	AOI 9	30379	882.21	877.85	4.36	882.21	877.48	4.73	881.36	877.06	4.3
		30096	879.96	876.23	3.73	879.96	875.82	4.14	879	875.35	3.65
	AOI 9	29469	875.55	874.12	1.43	875.55	873.65	1.9	874.59	873.07	1.52
	AOI 9	28870	872.47	870.65	1.82	872.47	870.22	2.25	871.64	869.73	1.91
		28627	870.77	869.37	1.4	870.77	868.97	1.8	869.98	868.47	1.51
		28369	869.14	867.35	1.79	869.14	867.03	2.11	868.26	866.91	1.35
	u/s Whitby Rd	28230	868.23	867.72	0.51	868.23	867.34	0.89	867.32	866.88	0.44

Results below Cross-Section 28230 are Identical to the Results for the Huebner RSWF by itself.

Table G.1-38

Alternative 23 - Leon DC-3A Channel Modifications

CROSS SECTIONS MODIFIED INCLUDE: 151954, 151394, 150827, 149929, 149460. MODIFICATIONS INCLUDE BOTTOM WIDTHS WHICH VARY FROM 340 TO 485.

Stream			100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	164568		815.53	814.09	1.44	813.61	812.26	1.35	811.49	810.3	1.19
	164045		814.13	812.77	1.36	812.34	811.23	1.11	810.23	809.23	1
	163492		813.08	812.58	0.5	811.38	810.82	0.56	809.21	808.54	0.67
	163183		812.75	812.23	0.52	810.97	810.31	0.66	808.72	807.97	0.75
	162879		812.34	811.44	0.9	810.53	809.71	0.82	808.25	807.45	0.8
	162298		810.37	807.3	3.07	808.67	805.92	2.75	806.45	804.11	2.34
	161668		806.9	803.28	3.62	805.3	801.88	3.42	803.5	800.76	2.74
	161047		802.46	800.52	1.94	800.66	797.94	2.72	799.27	796.29	2.98
	160629		799.87	797.02	2.85	797.86	795.44	2.42	795.94	793.13	2.81
	159661		796.2	795.24	0.96	794.45	793.52	0.93	792.09	791.27	0.82
	158897		793.52	791.01	2.51	791.79	789.41	2.38	789.43	787.12	2.31
	158683		792.05	790.68	1.37	790.34	789.13	1.21	787.93	786.7	1.23
	158571		791.66	790.61	1.05	789.94	788.63	1.31	786.94	786.09	0.85
	158247		790.6	790.02	0.58	788.74	788.31	0.43	786.05	785.52	0.53
	157859		790.14	789.96	0.18	788.35	788.15	0.2	785.61	785.44	0.17
	157565		789.96	789.62	0.34	788.13	787.74	0.39	785.42	785.04	0.38
	157257		789.33	787.6	1.73	787.34	785.16	2.18	784.69	782.88	1.81
	156851		787.98	785.18	2.8	785.91	783.31	2.6	783.75	781.48	2.27
	156147		784.88	782.4	2.48	783.02	780.74	2.28	781.09	779.08	2.01
	155223		778.71	774.25	4.46	777.23	773.25	3.98	775.73	772.19	3.54
	154568		774.81	774.5	0.31	773.19	772.89	0.3	771.44	771.16	0.28
	153709		773.66	773.47	0.19	771.93	771.75	0.18	770.06	769.89	0.17
	152400		773.08	773.02	0.06	771.34	771.29	0.05	769.44	769.39	0.05
	151954		772.72	771.41	1.31	771.01	769.91	1.1	769.13	768.2	0.93
	151394		772.27	771.19	1.08	770.61	769.7	0.91	768.76	767.98	0.78
	150827		771.83	770.34	1.49	770.2	768.9	1.3	768.38	767.23	1.15
	149929		771.08	769.65	1.43	769.5	768.3	1.2	767.71	766.71	1
	149460		770.66	769.58	1.08	769.13	768.22	0.91	767.38	766.62	0.76
	148983		770.04	769.61	0.43	768.58	768.19	0.39	766.89	766.55	0.34
	148848		769.78	769.15	0.63	768.32	767.73	0.59	766.63	766.03	0.6
	148048		768.88	768.76	0.12	767.47	767.36	0.11	765.78	765.69	0.09

Table G.1-39
Alternative 23b - Leon DC-3A Channel Modifications
CROSS SECTIONS MODIFIED INCLUDE: 151394, 150827, 149929, 149460. MODIFICATIONS INCLUDE BOTTOM WIDTHS WHICH VARY FROM 340 TO 485.

			100 WSEL (ft)	100 WSEL (ft)	Difference	50 WSEL (ft)	50 WSEL (ft)	Difference	25 WSEL (ft)	25 WSEL (ft)	Difference
Stream			FC w/o Project	FC wtih Project	w/o - w/Proj	FC w/o Project	FC wtih Project	w/o - w/Proj	FC w/o Project	FC wtih Project	w/o - w/Proj
Leon Creek		157565	789.96	789.62	0.34	788.13	787.74	0.39	785.42	785.04	0.38
		157257	789.33	787.6	1.73	787.34	785.16	2.18	784.69	782.88	1.81
		156851	787.98	785.18	2.8	785.91	783.31	2.6	783.75	781.48	2.27
		156147	784.88	782.4	2.48	783.02	780.74	2.28	781.09	779.08	2.01
		155223	778.71	774.25	4.46	777.23	773.25	3.98	775.73	772.19	3.54
		154568	775.27	774.99	0.28	773.6	773.33	0.27	771.78	771.52	0.26
		153709	774.27	774.11	0.16	772.5	772.34	0.16	770.58	770.43	0.15
		152400	773.77	773.71	0.06	771.98	771.93	0.05	770.06	770.01	0.05
		151954	773.19	771.53	1.66	771.44	770.02	1.42	769.52	768.28	1.24
		151394	772.4	771.27	1.13	770.72	769.76	0.96	768.84	768.03	0.81
		150827	771.88	770.06	1.82	770.24	768.62	1.62	768.39	766.96	1.43
		149929	770.98	769.45	1.53	769.39	768.11	1.28	767.58	766.53	1.05
		149460	770.55	769.46	1.09	769.01	768.1	0.91	767.25	766.5	0.75
		148983	769.96	769.57	0.39	768.49	768.15	0.34	766.8	766.5	0.3
		148848	769.72	769.16	0.56	768.26	767.74	0.52	766.56	766.05	0.51
		148048	768.88	768.76	0.12	767.47	767.36	0.11	765.78	765.69	0.09

Table G.1-40

Alternative 2: Leon AOI-2 100 Year Levee w CH MODS

Stream	Location / AOI #	Cross-section	500 WSEL (ft FC w/o Project	500 WSEL (ft FC wtih Project	Difference (w/o - w/Proj)	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		95755	665.12	665.09	0.03	660.33	660.13	0.2	656.53	656.3	0.23
		95690	665.46	665.42	0.04	660.71	660.57	0.14	657.02	656.86	0.16
		94824	665.12	665.09	0.03	660.35	660.19	0.16	656.63	656.45	0.18
		94802	665.09	665.06	0.03	660.32	660.17	0.15	656.61	656.43	0.18
		94293	664.92	664.88	0.04	660.15	659.99	0.16	656.42	656.24	0.18
		94274	664.89	664.85	0.04	660.12	659.97	0.15	656.4	656.22	0.18
		93810	664.72	664.69	0.03	659.95	659.79	0.16	656.21	656.01	0.2
		93798	664.7	664.67	0.03	659.94	659.78	0.16	656.18	655.99	0.19
		93047	664.08	664.04	0.04	659.32	659.13	0.19	655.5	655.27	0.23
		93032	663.83	663.78	0.05	659.07	658.87	0.2	655.25	655.01	0.24
		92368	660.84	660.77	0.07	656.66	656.54	0.12	653.38	653.02	0.36
		92350	659.64	659.55	0.09	655.87	655.71	0.16	652.69	652.24	0.45
		90894	656.97	656.81	0.16	653.84	653.57	0.27	650.98	650.19	0.79
		90875	656.87	656.71	0.16	653.83	653.55	0.28	650.96	650.18	0.78
		90266	656.43	656.26	0.17	653.32	652.97	0.35	650.65	649.82	0.83
		90248	655.79	655.57	0.22	652.82	652.44	0.38	650.52	649.66	0.86
		90179	655.72	655.49	0.23	652.7	652.29	0.41	650.3	649.44	0.86
		90158	655.61	655.37	0.24	652.64	652.22	0.42	650.25	649.34	0.91
		89670	654.41	654.01	0.4	651.66	651.01	0.65	649.2	648	1.2
		89593	653.92	653.49	0.43	651.29	650.56	0.73	648.85	647.46	1.39
		88636	652.7	652.24	0.46	650.44	649.83	0.61	648.32	647.02	1.3
		87864	648.96	648.79	0.17	646.92	645.76	1.16	644.13	641.91	2.22
		87627	648.51	648.48	0.03	646.6	645.06	1.54	643.8	641.84	1.96
		87518	648.18	648.49	-0.31	646.37	640.93	5.44	643.52	640.23	3.29
		87210	645.43	640.97	4.46	642.05	641.82	0.23	640.4	640.17	0.23
		86710	644.28	643.39	0.89	640.87	641.13	-0.26	639.42	639.64	-0.22
		86207	643.5	643.31	0.19	639.47	638.92	0.55	636.62	637.19	-0.57
		85866	643.41	643.36	0.05	639.45	639.34	0.11	636.64	636.55	0.09
		85691	643.38	643.36	0.02	639.41	639.37	0.04	636.59	636.58	0.01
		85024	643.16	643.14	0.02	639.12	639.08	0.04	636.19	636.13	0.06
		84973	643.09	643.09	0	639.03	639.03	0	636.05	636.05	0
		83663	642.8	642.8	0	638.63	638.63	0	635.33	635.33	0
		82554	642.63	642.63	0	638.4	638.4	0	634.98	634.98	0
		80352	642.08	642.08	0	637.81	637.81	0	634.21	634.21	0

Table G.1-41

Alternative 4: 100' BP Channel

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		95755	660.33		660.33	656.53		656.53	653.23		653.23
		95690	660.71		660.71	657.02		657.02	653.85		653.85
		94824	660.35		660.35	656.63		656.63	653.42		653.42
		94802	660.32		660.32	656.61		656.61	653.39		653.39
		94293	660.15		660.15	656.42		656.42	653.2		653.2
		94274	660.12		660.12	656.4		656.4	653.18		653.18
		93810	659.95		659.95	656.21		656.21	652.98		652.98
		93798	659.94		659.94	656.18		656.18	652.95		652.95
		93047	659.32		659.32	655.5		655.5	652.28		652.28
		93032	659.07		659.07	655.25		655.25	652		652
		92368	656.66		656.66	653.38		653.38	650.45		650.45
		92350	655.87		655.87	652.69		652.69	649.8		649.8
		90894	653.84		653.84	650.98		650.98	648.29		648.29
		90875	653.83		653.83	650.96		650.96	648.27		648.27
		90266	653.32		653.32	650.65		650.65	648.03		648.03
		90248	652.82		652.82	650.52		650.52	647.93		647.93
		90179	652.7		652.7	650.3		650.3	647.82		647.82
		90158	652.64		652.64	650.25		650.25	647.72		647.72
		89670	651.66		651.66	649.2		649.2	646.88		646.88
		89593	651.29		651.29	648.85		648.85	646.65		646.65
		88636	650.44		650.44	648.32		648.32	646.24		646.24
		87864	646.92		646.92	644.13		644.13	641.71		641.71
		87627	646.6		646.6	643.8		643.8	641.24		641.24
		87518	646.37		646.37	643.52		643.52	641.05		641.05
		87210	642.05		642.05	640.4		640.4	638.78		638.78
		86710	640.87		640.87	639.42		639.42	638.15		638.15
		86207	639.47		639.47	636.62		636.62	635.35		635.35
		85866	639.45		639.45	636.64		636.64	633.99		633.99
		85691	639.41		639.41	636.59		636.59	633.96		633.96
		85024	639.12		639.12	636.19		636.19	633.53		633.53
		84973	639.03		639.03	636.05		636.05	633.31		633.31
		83663	638.63		638.63	635.33		635.33	631.95		631.95
		82554	638.4		638.4	634.98		634.98	631.33		631.33
		80352	637.81		637.81	634.21		634.21	630.49		630.49
		78641	635.69		635.69	631.59		631.59	628.24		628.24
		77693	635.21		635.21	631.17		631.17	627.87		627.87
		76884	634.85		634.85	630.86		630.86	627.63		627.63
		75186	631.35		631.35	627.98		627.98	625.11		625.11

Table G.1-42

Alternative 4: 40' BP Channel

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		95755	660.33		660.33	656.53		656.53	653.23		653.23
		95690	660.71		660.71	657.02		657.02	653.85		653.85
		94824	660.35		660.35	656.63		656.63	653.42		653.42
		94802	660.32		660.32	656.61		656.61	653.39		653.39
		94293	660.15		660.15	656.42		656.42	653.2		653.2
		94274	660.12		660.12	656.4		656.4	653.18		653.18
		93810	659.95		659.95	656.21		656.21	652.98		652.98
		93798	659.94		659.94	656.18		656.18	652.95		652.95
		93047	659.32		659.32	655.5		655.5	652.28		652.28
		93032	659.07		659.07	655.25		655.25	652		652
		92368	656.66		656.66	653.38		653.38	650.45		650.45
		92350	655.87		655.87	652.69		652.69	649.8		649.8
		90894	653.84		653.84	650.98		650.98	648.29		648.29
		90875	653.83		653.83	650.96		650.96	648.27		648.27
		90266	653.32		653.32	650.65		650.65	648.03		648.03
		90248	652.82		652.82	650.52		650.52	647.93		647.93
		90179	652.7		652.7	650.3		650.3	647.82		647.82
		90158	652.64		652.64	650.25		650.25	647.72		647.72
		89670	651.66		651.66	649.2		649.2	646.88		646.88
		89593	651.29		651.29	648.85		648.85	646.65		646.65
		88636	650.44		650.44	648.32		648.32	646.24		646.24
		87864	646.92		646.92	644.13		644.13	641.71		641.71
		87627	646.6		646.6	643.8		643.8	641.24		641.24
		87518	646.37		646.37	643.52		643.52	641.05		641.05
		87210	642.05		642.05	640.4		640.4	638.78		638.78
		86710	640.87		640.87	639.42		639.42	638.15		638.15
		86207	639.47		639.47	636.62		636.62	635.35		635.35
		85866	639.45		639.45	636.64		636.64	633.99		633.99
		85691	639.41		639.41	636.59		636.59	633.96		633.96
		85024	639.12		639.12	636.19		636.19	633.53		633.53
		84973	639.03		639.03	636.05		636.05	633.31		633.31
		83663	638.63		638.63	635.33		635.33	631.95		631.95
		82554	638.4		638.4	634.98		634.98	631.33		631.33
		80352	637.81		637.81	634.21		634.21	630.49		630.49
		78641	635.69		635.69	631.59		631.59	628.24		628.24
		77693	635.21		635.21	631.17		631.17	627.87		627.87
		76884	634.85		634.85	630.86		630.86	627.63		627.63
		75186	631.35		631.35	627.98		627.98	625.11		625.11

Table G.1-43

Alternative 4: 25' BP Channel

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		95755	660.33		660.33	656.53		656.53	653.23		653.23
		95690	660.71		660.71	657.02		657.02	653.85		653.85
		94824	660.35		660.35	656.63		656.63	653.42		653.42
		94802	660.32		660.32	656.61		656.61	653.39		653.39
		94293	660.15		660.15	656.42		656.42	653.2		653.2
		94274	660.12		660.12	656.4		656.4	653.18		653.18
		93810	659.95		659.95	656.21		656.21	652.98		652.98
		93798	659.94		659.94	656.18		656.18	652.95		652.95
		93047	659.32		659.32	655.5		655.5	652.28		652.28
		93032	659.07		659.07	655.25		655.25	652		652
		92368	656.66		656.66	653.38		653.38	650.45		650.45
		92350	655.87		655.87	652.69		652.69	649.8		649.8
		90894	653.84		653.84	650.98		650.98	648.29		648.29
		90875	653.83		653.83	650.96		650.96	648.27		648.27
		90266	653.32		653.32	650.65		650.65	648.03		648.03
		90248	652.82		652.82	650.52		650.52	647.93		647.93
		90179	652.7		652.7	650.3		650.3	647.82		647.82
		90158	652.64		652.64	650.25		650.25	647.72		647.72
		89670	651.66		651.66	649.2		649.2	646.88		646.88
		89593	651.29		651.29	648.85		648.85	646.65		646.65
		88636	650.44		650.44	648.32		648.32	646.24		646.24
		87864	646.92		646.92	644.13		644.13	641.71		641.71
		87627	646.6		646.6	643.8		643.8	641.24		641.24
		87518	646.37		646.37	643.52		643.52	641.05		641.05
		87210	642.05		642.05	640.4		640.4	638.78		638.78
		86710	640.87		640.87	639.42		639.42	638.15		638.15
		86207	639.47		639.47	636.62		636.62	635.35		635.35
		85866	639.45		639.45	636.64		636.64	633.99		633.99
		85691	639.41		639.41	636.59		636.59	633.96		633.96
		85024	639.12		639.12	636.19		636.19	633.53		633.53
		84973	639.03		639.03	636.05		636.05	633.31		633.31
		83663	638.63		638.63	635.33		635.33	631.95		631.95
		82554	638.4		638.4	634.98		634.98	631.33		631.33
		80352	637.81		637.81	634.21		634.21	630.49		630.49
		78641	635.69		635.69	631.59		631.59	628.24		628.24
		77693	635.21		635.21	631.17		631.17	627.87		627.87
		76884	634.85		634.85	630.86		630.86	627.63		627.63
		75186	631.35		631.35	627.98		627.98	625.11		625.11

Table G.1-44

Alternative 2 and 4 Combo: Leon AOI-2 100 Year Levee w 100' BP Channel

Stream	Location / AOI #	Cross-section	500 WSEL (ft) FC w/o Project	500 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Leon Creek		95755	665.12	665.34	-0.22	660.33	660.44	-0.11	656.53	656.55	-0.02
		95690	665.46	665.61	-0.15	660.71	660.86	-0.15	657.02	657.19	-0.17
		94824	665.12	665.28	-0.16	660.35	660.51	-0.16	656.63	656.82	-0.19
		94802	665.09	665.25	-0.16	660.32	660.49	-0.17	656.61	656.8	-0.19
		94293	664.92	665.08	-0.16	660.15	660.32	-0.17	656.42	656.63	-0.21
		94274	664.89	665.05	-0.16	660.12	660.3	-0.18	656.4	656.61	-0.21
		93810	664.72	664.89	-0.17	659.95	660.13	-0.18	656.21	656.42	-0.21
		93798	664.7	664.87	-0.17	659.94	660.12	-0.18	656.18	656.4	-0.22
		93047	664.08	664.26	-0.18	659.32	659.53	-0.21	655.5	655.75	-0.25
		93032	663.83	664.02	-0.19	659.07	659.24	-0.17	655.25	655.51	-0.26
		92368	660.84	661.16	-0.32	656.66	656.98	-0.32	653.38	653.76	-0.38
		92350	659.64	660.08	-0.44	655.87	656.09	-0.22	652.69	653.16	-0.47
		90894	656.97	657.73	-0.76	653.84	654.27	-0.43	650.98	651.55	-0.57
		90875	656.87	657.61	-0.74	653.83	654.25	-0.42	650.96	651.54	-0.58
		90266	656.43	657.26	-0.83	653.32	653.84	-0.52	650.65	651.18	-0.53
		90248	655.79	656.78	-0.99	652.82	653.4	-0.58	650.52	651.08	-0.56
		90179	655.72	656.72	-1	652.7	653.32	-0.62	650.3	650.92	-0.62
		90158	655.61	656.63	-1.02	652.64	653.26	-0.62	650.25	650.87	-0.62
		89670	654.41	655.83	-1.42	651.66	652.51	-0.85	649.2	650.13	-0.93
		89593	653.92	655.47	-1.55	651.29	652.21	-0.92	648.85	649.84	-0.99
		88636	652.7	654.78	-2.08	650.44	651.59	-1.15	648.32	649.41	-1.09
		87864	648.96	653.67	-4.71	646.92	650.19	-3.27	644.13	647.74	-3.61
		87627	648.51	653.47	-4.96	646.6	649.65	-3.05	643.8	647.29	-3.49
		87518	648.18	652.07	-3.89	646.37	648.37	-2	643.52	646.05	-2.53
		87210	645.43	646.62	-1.19	642.05	643.96	-1.91	640.4	641.53	-1.13
		86710	644.28	644.13	0.15	640.87	640.76	0.11	639.42	641.47	-2.05
		86207	643.5	642.74	0.76	639.47	638.43	1.04	636.62	637.64	-1.02
		85866	643.41	642.85	0.56	639.45	638.76	0.69	636.64	635.08	1.56
		85691	643.38	642.83	0.55	639.41	638.74	0.67	636.59	635.06	1.53
		85024	643.16	642.63	0.53	639.12	638.47	0.65	636.19	634.72	1.47
		84973	643.09	642.59	0.5	639.03	638.42	0.61	636.05	634.6	1.45
		83663	642.8	642.34	0.46	638.63	638.05	0.58	635.33	633.89	1.44
		82554	642.63	642.17	0.46	638.4	637.83	0.57	634.98	633.58	1.4
		80352	642.08	641.66	0.42	637.81	637.29	0.52	634.21	633.1	1.11
		78641	640.36	640.04	0.32	635.69	635.6	0.09	631.59	631.69	-0.1
		77693	639.76	639.76	0	635.21	635.21	0	631.17	631.17	0
		76884	639.31	639.31	0	634.85	634.85	0	630.86	630.86	0
		75186	635.67	635.67	0	631.35	631.35	0	627.98	627.98	0

Table G.1-45

Alternative 22: Huebner RSWF & Trib A Pond(optimized)

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference (w/o - w/Proj)
Huebner Creek	d/s Huebner Trib A	23532	839.44	838.06	1.38	838.76	837.25	1.51	837.92	836.58	1.34
	u/s Apple Green Rd	22929	839.23	837.82	1.41	838.54	836.15	2.39	837.67	835.52	2.15
	d/s Apple Green Rd	22778	833.42	832.14	1.28	832.76	831.61	1.15	832.03	831.06	0.97
	AOI 8	21610	831.44	830.18	1.26	830.82	829.61	1.21	830.06	828.99	1.07
	u/s Evers Rd / AOI 8	18498	824.22	823.48	0.74	823.79	823.17	0.62	823.38	822.83	0.55
	d/s Evers Rd / AOI 8	18390	823.92	823.12	0.8	823.45	822.74	0.71	822.95	822.32	0.63
	AOI 8	15969	814.79	814.26	0.53	814.39	813.91	0.48	813.93	813.52	0.41
	u/s Bandera Rd / AOI 6	14267	811.45	810.87	0.58	811.02	810.35	0.67	810.4	809.6	0.8
	d/s Bandera Rd / AOI 6	14017	808.34	807.42	0.92	807.62	806.83	0.79	806.87	806.13	0.74
	AOI 6	12264	799.97	799.19	0.78	799.38	798.59	0.79	798.61	798.16	0.45
	AOI 6	10195	794.96	794.36	0.6	794.46	793.99	0.47	794	793.62	0.38
	AOI 6	7282	792.34	791.4	0.94	791.34	790.53	0.81	790.32	789.58	0.74
	u/s Timberhill Dr	5000	789.73	788.86	0.87	788.52	787.77	0.75	787.29	786.56	0.73
	d/s Timberhill Dr	4877	789.67	788.79	0.88	788.5	787.69	0.81	787.2	786.51	0.69
	u/s Ingram Rd	1724	766.3	765.57	0.73	765.33	764.63	0.7	765.19	764.7	0.49
	d/s Ingram Rd	1636	760.72	760.13	0.59	759.94	759.4	0.54	759.06	758.54	0.52
Leon Creek	u/s Huebner Creek	148048	768.76	768.79	-0.03	767.36	767.38	-0.02	765.69	765.7	-0.01
	d/s Huebner Creek	147620	767.93	767.96	-0.03	766.57	766.59	-0.02	764.95	764.96	-0.01
	u/s Culebra Rd	145073	761.08	761.12	-0.04	759.56	759.6	-0.04	757.94	757.95	-0.01
	d/s Culebra Rd	144862	761.03	761.08	-0.05	759.47	759.5	-0.03	757.84	757.85	-0.01
	u/s SW Loop 410	142963	758.76	758.81	-0.05	757.15	757.2	-0.05	755.65	755.66	-0.01
	d/s SW Loop 410	142391	748.71	748.75	-0.04	747.01	747.03	-0.02	745.17	745.19	-0.02
		141639	745.85	745.9	-0.05	743.88	743.9	-0.02	741.82	741.83	-0.01
	u/s Leon Trib G	139942	743.79	743.84	-0.05	741.99	742	-0.01	739.95	739.96	-0.01
	d/s Leon Trib G	139336	743.75	743.79	-0.04	741.95	741.96	-0.01	739.91	739.92	-0.01
	u/s TX Hwy 151	136389	736.91	736.95	-0.04	735.03	735.04	-0.01	732.95	732.97	-0.02
	d/s TX Hwy 151	135790	733.28	733.31	-0.03	731.83	731.84	-0.01	730.28	730.29	-0.01
	u/s Pinn Rd	134897	732.54	732.57	-0.03	731.01	731.03	-0.02	729.33	729.34	-0.01
	d/s Pinn Rd	134762	732.26	732.29	-0.03	730.77	730.78	-0.01	729.14	729.15	-0.01
	u/s Old Hwy 90 W	118873	703.14	703.18	-0.04	701.7	701.71	-0.01	700	700	0
	d/s Old Hwy 90 W	118757	702.39	702.44	-0.05	700.62	700.64	-0.02	698.65	698.66	-0.01
	u/s US Hwy 90 W	117144	696.37	696.41	-0.04	695.28	695.29	-0.01	694.26	694.26	0

Table G.1-46

Alt AOI 7 - 21B - 85' channel imp

Stream			100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	179995		863.85	863.85	0	860.23	860.23	0	857.62	857.62	0
	175163		854.01	854.01	0	850.69	850.69	0	848.19	848.19	0
	171483		847.24	847.24	0	845.82	845.82	0	844.13	844.13	0
	171219		840.91	840.91	0	838.63	838.63	0	835.24	835.24	0
	169364		828.29	828.29	0	825.72	825.71	0.01	824.06	824.06	0
	168201		824.31	824.29	0.02	822.45	822.44	0.01	821.23	821.23	0
	167417		822.57	822.52	0.05	820.21	820.21	0	818.75	818.75	0
	165801		817.39	816.94	0.45	814.16	813.53	0.63	811.67	811.41	0.26
	165279		816.65	816.1	0.55	813.36	812.52	0.84	810.61	810.19	0.42
	164568		813.44	812.34	1.1	810.91	809.08	1.83	808	806.85	1.15
	164045		812.13	810.63	1.5	810.02	807.47	2.55	807.02	805.3	1.72
	163492		810.73	808.26	2.47	808.94	804.61	4.33	805.86	802.08	3.78
	163052		810.07	806.77	3.3	808.16	802.76	5.4	805.14	800.06	5.08
	162450		809.58	805.13	4.45	807.72	800.84	6.88	804.46	797.97	6.49
	161878		806.43	799.36	7.07	803.1	796.19	6.91	800.54	793.62	6.92
	161249		801.58	797.25	4.33	799.32	793.72	5.6	797.73	790.65	7.08
	160629		798.63	795.26	3.37	795.2	791.6	3.6	791.31	788.03	3.28
	159661		795.38	794.58	0.8	791.6	790.81	0.79	787.63	786.72	0.91
	158683		790.69	790.69	0	787.3	787.3	0	783.63	783.63	0
	158571		790.61	790.61	0	786.71	786.71	0	783.2	783.2	0

Table G.1-47

Alt AOI 7 - 21B - 150' channel imp

Stream			100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	10 WSEL (ft) FC w/o Project	10 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Leon Creek	179995		863.85	863.85	0	860.23	860.23	0	857.62	857.62	0
	175163		854.01	854.01	0	850.69	850.69	0	848.19	848.19	0
	171483		847.24	847.24	0	845.82	845.82	0	844.13	844.13	0
	171219		840.91	840.91	0	838.63	838.63	0	835.24	835.24	0
	169364		828.29	828.29	0	825.72	825.71	0.01	824.06	824.06	0
	168201		824.31	824.28	0.03	822.45	822.44	0.01	821.23	821.23	0
	167417		822.57	822.51	0.06	820.21	820.2	0.01	818.75	818.75	0
	165801		817.39	816.75	0.64	814.16	813.45	0.71	811.67	811.39	0.28
	165279		816.65	815.9	0.75	813.36	812.42	0.94	810.61	810.15	0.46
	164568		813.44	811.83	1.61	810.91	808.79	2.12	808	806.69	1.31
	164045		812.13	809.83	2.3	810.02	806.97	3.05	807.02	805.01	2.01
	163492		810.73	805.93	4.8	808.94	802.65	6.29	805.86	800.54	5.32
	163052		810.07	803.2	6.87	808.16	799.94	8.22	805.14	797.76	7.38
	162450		809.58	799.53	10.05	807.72	796.22	11.5	804.46	793.79	10.67
	161878		806.43	797.5	8.93	803.1	794.02	9.08	800.54	791.13	9.41
	161249		801.58	796.12	5.46	799.32	792.38	6.94	797.73	788.9	8.83
	160629		798.63	794.66	3.97	795.2	790.92	4.28	791.31	787.04	4.27
	159661		795.38	794.35	1.03	791.6	790.55	1.05	787.63	786.4	1.23
	158683		790.69	790.69	0	787.3	787.3	0	783.63	783.63	0
	158571		790.61	790.61	0	786.71	786.71	0	783.2	783.2	0

Table G.1-48

Helotes Quarry with Alternative 2 w/ Mitigation

Stream	Location / AOI #	Cross-section	100 WSEL (ft) FC w/o Project	100 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	50 WSEL (ft) FC w/o Project	50 WSEL (ft) FC wtih Project	Difference w/o - w/Proj	25 WSEL (ft) FC w/o Project	25 WSEL (ft) FC wtih Project	Difference w/o - w/Proj
Helotes Creek	d/s Helotes RSWF	26428	962.09	957.72	4.37	961.64	957.39	4.25	960.28	956.75	3.53
	u/s Braun Rd	21806	955.51	949.11	6.4	954.94	948.08	6.86	953.86	946.38	7.48
	d/s Braun Rd	21577	955.37	948.92	6.45	954.75	947.88	6.87	953.64	946.18	7.46
	u/s SW Loop 1604	14111	918.85	911.68	7.17	918.59	910.91	7.68	917.88	909.51	8.37
	d/s SW Loop 1604	13795	909.72	905.95	3.77	909.28	905.64	3.64	908.14	905.06	3.08
	AOI 12	9407	898.47	892.88	5.59	897.82	892.26	5.56	896.2	891.27	4.93
	AOI 12	7731	890.51	884.72	5.79	889.66	884.06	5.6	887.84	883.26	4.58
	AOI 12	6267	886.44	880.1	6.34	885.36	879.28	6.08	883.44	878.27	5.17
	u/s confluence Culebra Crk / AOI 5	702	849.22	846.6	2.62	848.65	846.19	2.46	847.84	845.73	2.11
					0			0			0
Culebra Creek	d/s confluence Helotes Creek / AOI 5	24901	854.75	852.18	2.57	852.88	850.66	2.22	850.73	849.25	1.48
	u/s Culebra Rd / AOI 5	24033	853	850.35	2.65	851.09	848.64	2.45	848.71	847.1	1.61
	d/s Culebra Rd / AOI 5	23896	852.46	849.83	2.63	850.57	848.26	2.31	848.33	846.76	1.57
	AOI 5	15208	824.77	823.11	1.66	823.38	822.39	0.99	822.4	819.76	2.64
	AOI 5	9168	808.15	806.28	1.87	806.57	805.36	1.21	805.35	804.1	1.25
	u/s Culebra Trib A / AOI 5	5742	793.62	792.36	1.26	792.51	791.68	0.83	791.64	790.47	1.17
	d/s Culebra Trib A / AOI 5	5310	790.02	788.66	1.36	788.88	787.71	1.17	787.66	786.1	1.56
	u/s confluence Leon Creek / AOI 5	1927	775.77	773.97	1.8	774.16	772.99	1.17	772.94	771.58	1.36
					0			0			0
Leon Creek	d/s confluence Culebra Creek	151954	778.44	777.45	0.99	776.5	775.83	0.67	774.5	773.43	1.07
	u/s SW Loop 410	142821	758.54	757.99	0.55	756.78	756.03	0.75	755.06	754.56	0.5
	d/s SW Loop 410	142600	758.5	757.98	0.52	756.79	756	0.79	754.7	754.03	0.67
	u/s Leon Trib G	139942	743.79	743.25	0.54	741.99	741.36	0.63	739.95	739.08	0.87
	d/s Leon Trib G	139336	743.75	743.21	0.54	741.95	741.32	0.63	739.91	739.03	0.88
	u/s TX Hwy 151/Stotzer Frwy	136282	735.82	735.29	0.53	734.07	733.47	0.6	732.15	731.32	0.83
	d/s TX Hwy 151/Stotzer Frwy	136045	735.47	734.96	0.51	733.77	733.19	0.58	731.9	731.1	0.8
	u/s Leon Trib F	127612	714.31	714.01	0.3	713.27	712.89	0.38	712.05	711.5	0.55
	d/s Leon Trib F	126859	714.06	713.77	0.29	713.04	712.67	0.37	711.85	711.31	0.54
	u/s US Hwy 90 W	116958	693.29	693.28	0.01	693.01	692.71	0.3	692.45	692.26	0.19
	d/s US Hwy 90 W	116825	688.52	688.4	0.12	688	687.81	0.19	687.28	686.88	0.4
		110862	680.72	680.33	0.39	679.22	678.7	0.52	677.2	676.44	0.76
	u/s Leon Trib E	102466	670.25	669.85	0.4	668.8	668.34	0.46	667.23	666.67	0.56
	d/s Leon Trib E	102236	670.29	669.9	0.39	668.84	668.38	0.46	667.27	666.71	0.56
	u/s Leon Trib D	97465	663.85	663.41	0.44	662.32	661.78	0.54	660.53	659.81	0.72
	d/s Leon Trib D	96588	661.77	661.28	0.49	660.18	659.59	0.59	658.27	657.46	0.81
	u/s Military Dr SW	88636	650.44	649.63	0.81	649.49	647.74	1.75	648.32	645.99	2.33
	d/s Military Dr SW / AOI 2	87864	646.92	646.17	0.75	645.66	643.78	1.88	644.13	641.38	2.75
	AOI 2	86207	639.47	638.73	0.74	638.04	637.89	0.15	636.62	636.79	-0.17
	AOI 2	84973	639.03	638.7	0.33	637.63	637.21	0.42	636.05	635.4	0.65
	u/s New Laredo Hwy	69321	618.16	618.09	0.07	617.74	617.52	0.22	617.06	616.8	0.26
	d/s New Laredo Hwy	68856	614.8	614.5	0.3	614.08	613.97	0.11	613.65	613.55	0.1
	u/s IH 35 S	62942	608.67	608.47	0.2	607.8	607.51	0.29	606.77	606.43	0.34
	d/s IH 35 S	62806	608.11	607.9	0.21	607.23	606.94	0.29	606.23	605.9	0.33
	u/s Leon Trib B	57417	597.39	597.27	0.12	596.93	596.73	0.2	596.21	595.95	0.26
	d/s Leon Trib B	56444	596.97	596.87	0.1	596.57	596.39	0.18	595.92	595.68	0.24
	u/s SE Loop 410	55095	596.3	596.23	0.07	596.02	595.87	0.15	595.46	595.23	0.23
	d/s SE Loop 410	54631	594.64	594.45	0.19	593.78	593.53	0.25	591.87	591.72	0.15
	u/s Leon Trib A	51940	590.49	590.32	0.17	589.1	588.79	0.31	587.31	586.78	0.53
	d/s Leon Trib A	51046	587.1	586.88	0.22	586.16	585.85	0.31	585.04	584.64	0.4
	d/s Indian Creek	36743	572.86	572.6	0.26	571.64	571.29	0.35	570.37	570.23	0.14
	u/s Indian Creek	35989	572.56	572.3	0.26	571.35	571.01	0.34	570.1	570	0.1
	u/s Palo Alto Rd	32858	567.79	567.71	0.08	567.33	567.23	0.1	566.85	567.36	-0.51
	d/s Palo Alto Rd	32681	562.49	562.26	0.23	561.4	561	0.4	559.91	559.19	0.72
	u/s Comanche Creek	9432	522.15	520.97	1.18	517.92	516.67	1.25	513.41	511.97	1.44
	d/s Comanche Creek	8907	522.44	521.22	1.22	518.09	516.8	1.29	513.46	511.97	1.49
		1770	511.32	510.05	1.27	506.79	505.43	1.36	501.91	500.36	1.55
		426	511.55	510.29	1.26	507.07	505.72	1.35	502.18	500.62	1.56

Table G.1-49 – Depth of Flooding by Event by Reach

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	2-Year	780	1,017.97	1,020.60	2.63
Chimenea Creek	16,224.00	2-Year	610	1,202.98	1,206.96	3.98
Culebra Creek 1	13,961.00	2-Year	1,770	798.56	805.03	6.47
Culebra Creek 2	44,257.00	2-Year	650	913.79	915.93	2.14
Culebra Trib A	9,112.00	2-Year	1,390	826.44	829.96	3.52
Culebra Trib C	10,833.00	2-Year	480	917.42	919.23	1.81
Culebra Trib E	5,149.00	2-Year	260	966.45	968.61	2.16
French Creek	15,966.00	2-Year	1,920	878.44	885.76	7.32
French Trib A	4,255.00	2-Year	1,210	872.40	874.28	1.88
Helotes Creek	34,369.00	2-Year	1,590	978.25	982.63	4.38
Helotes Trib A	4,042.00	2-Year	250	990.45	992.36	1.91
Helotes Trib B	6,273.00	2-Year	420	1,145.43	1,149.65	4.22
Huebner Creek	22,330.00	2-Year	2,960	823.61	827.16	3.55
Huebner Trib A	6,300.00	2-Year	1,230	866.85	871.60	4.75
Huesta Creek	11,206.00	2-Year	590	983.60	987.13	3.53
Indian Creek	24,551.00	2-Year	1,820	597.83	604.10	6.27
Leon Creek 1	16,302.00	2-Year	6,520	489.36	503.86	14.50
Leon Creek 2	58,342.00	2-Year	6,350	570.85	580.96	10.11
Leon Creek 3	86,710.00	2-Year	6,350	616.09	627.83	11.74
Leon Creek 4	118,221.00	2-Year	6,190	668.28	680.14	11.86
Leon Creek 5	163,183.00	2-Year	3,310	789.34	794.31	4.97
Leon Creek 6	224,604.00	2-Year	2,120	1,018.49	1,025.36	6.87
Leon Creek 7	276,101.00	2-Year	880	1,213.61	1,221.77	8.16
Leon Trib B	4,565.00	2-Year	1,460	610.60	615.41	4.81
Leon Trib F	4,097.00	2-Year	540	704.99	708.99	4.00
Leon Trib H	4,009.00	2-Year	600	894.46	896.99	2.53
Leon Trib J	3,775.00	2-Year	350	1,126.76	1,130.24	3.48
Leon Trib K	8,446.00	2-Year	800	1,157.66	1,161.83	4.17
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	2-Year	540	1,242.14	1,245.70	3.56
Los Reyes Creek	14,816.00	2-Year	920	1,119.87	1,124.28	4.41
Ranch Creek	2,115.00	2-Year	540	1,095.51	1,099.83	4.32
Slick Ranch	18,540.00	2-Year	1,300	756.71	761.58	4.87
Slick Ranch Trib B	2,145.00	2-Year	1,280	757.08	761.76	4.68
WW Village	4,570.00	2-Year	930	689.49	697.29	7.80

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	5-Year	3,650	1,017.97	1,023.79	5.82
Chimenea Creek	16,224.00	5-Year	4,180	1,202.98	1,212.24	9.26
Culebra Creek 1	13,961.00	5-Year	20,700	798.56	812.10	13.54
Culebra Creek 2	44,257.00	5-Year	4,640	913.79	922.57	8.78
Culebra Trib A	9,112.00	5-Year	2,840	826.44	831.24	4.80
Culebra Trib C	10,833.00	5-Year	1,980	917.42	920.63	3.21
Culebra Trib E	5,149.00	5-Year	1,210	966.45	969.80	3.35
French Creek	15,966.00	5-Year	6,080	878.44	888.49	10.05
French Trib A	4,255.00	5-Year	2,440	872.40	875.12	2.72
Helotes Creek	34,369.00	5-Year	11,900	978.25	989.31	11.06
Helotes Trib A	4,042.00	5-Year	1,180	990.45	994.53	4.08
Helotes Trib B	6,273.00	5-Year	1,750	1,145.43	1,153.82	8.39
Huebner Creek	22,330.00	5-Year	6,410	823.61	829.16	5.55
Huebner Trib A	6,300.00	5-Year	2,740	866.85	873.28	6.43
Huesta Creek	11,206.00	5-Year	3,360	983.60	991.48	7.88
Indian Creek	24,551.00	5-Year	4,350	597.83	607.22	9.39
Leon Creek 1	16,302.00	5-Year	25,900	489.36	514.30	24.94
Leon Creek 2	58,342.00	5-Year	26,100	570.85	589.68	18.83
Leon Creek 3	86,710.00	5-Year	26,600	616.09	635.19	19.10
Leon Creek 4	118,221.00	5-Year	26,900	668.28	688.81	20.53
Leon Creek 5	163,183.00	5-Year	12,500	789.34	799.51	10.17
Leon Creek 6	224,604.00	5-Year	10,700	1,018.49	1,030.12	11.63
Leon Creek 7	276,101.00	5-Year	7,010	1,213.61	1,229.94	16.33
Leon Trib B	4,565.00	5-Year	2,800	610.60	617.59	6.99
Leon Trib F	4,097.00	5-Year	1,470	704.99	711.64	6.65
Leon Trib H	4,009.00	5-Year	1,500	894.46	898.10	3.64
Leon Trib J	3,775.00	5-Year	1,750	1,126.76	1,132.92	6.16
Leon Trib K	8,446.00	5-Year	3,000	1,157.66	1,164.67	7.01
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	5-Year	2,520	1,242.14	1,247.91	5.77
Los Reyes Creek	14,816.00	5-Year	4,430	1,119.87	1,129.22	9.35
Ranch Creek	2,115.00	5-Year	2,480	1,095.51	1,103.82	8.31
Slick Ranch	18,540.00	5-Year	3,940	756.71	764.79	8.08
Slick Ranch Trib B	2,145.00	5-Year	2,890	757.08	764.08	7.00
WW Village	4,570.00	5-Year	1,890	689.49	700.43	10.94

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	10-Year	5,570	1,017.97	1,025.10	7.13
Chimenea Creek	16,224.00	10-Year	6,590	1,202.98	1,214.63	11.65
Culebra Creek 1	13,961.00	10-Year	36,000	798.56	815.55	16.99
Culebra Creek 2	44,257.00	10-Year	7,700	913.79	924.38	10.59
Culebra Trib A	9,112.00	10-Year	3,760	826.44	832.01	5.57
Culebra Trib C	10,833.00	10-Year	2,900	917.42	921.23	3.81
Culebra Trib E	5,149.00	10-Year	1,800	966.45	970.21	3.76
French Creek	15,966.00	10-Year	9,010	878.44	889.60	11.16
French Trib A	4,255.00	10-Year	3,210	872.40	875.57	3.17
Helotes Creek	34,369.00	10-Year	19,400	978.25	992.31	14.06
Helotes Trib A	4,042.00	10-Year	1,720	990.45	995.37	4.92
Helotes Trib B	6,273.00	10-Year	2,510	1,145.43	1,155.85	10.42
Huebner Creek	22,330.00	10-Year	8,660	823.61	830.31	6.70
Huebner Trib A	6,300.00	10-Year	3,800	866.85	874.13	7.28
Huesta Creek	11,206.00	10-Year	5,340	983.60	992.95	9.35
Indian Creek	24,551.00	10-Year	5,860	597.83	608.79	10.96
Leon Creek 1	16,302.00	10-Year	46,300	489.36	520.15	30.79
Leon Creek 2	58,342.00	10-Year	47,900	570.85	594.17	23.32
Leon Creek 3	86,710.00	10-Year	48,900	616.09	637.48	21.39
Leon Creek 4	118,221.00	10-Year	49,600	668.28	692.86	24.58
Leon Creek 5	163,183.00	10-Year	20,400	789.34	802.95	13.61
Leon Creek 6	224,604.00	10-Year	17,300	1,018.49	1,033.16	14.67
Leon Creek 7	276,101.00	10-Year	11,500	1,213.61	1,232.93	19.32
Leon Trib B	4,565.00	10-Year	3,400	610.60	618.44	7.84
Leon Trib F	4,097.00	10-Year	2,040	704.99	712.87	7.88
Leon Trib H	4,009.00	10-Year	2,120	894.46	898.71	4.25
Leon Trib J	3,775.00	10-Year	2,630	1,126.76	1,133.92	7.16
Leon Trib K	8,446.00	10-Year	4,440	1,157.66	1,165.98	8.32
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	10-Year	3,790	1,242.14	1,248.83	6.69
Los Reyes Creek	14,816.00	10-Year	6,350	1,119.87	1,131.48	11.61
Ranch Creek	2,115.00	10-Year	3,650	1,095.51	1,105.38	9.87
Slick Ranch	18,540.00	10-Year	5,900	756.71	766.51	9.80
Slick Ranch Trib B	2,145.00	10-Year	3,830	757.08	765.14	8.06
WW Village	4,570.00	10-Year	2,480	689.49	702.41	12.92

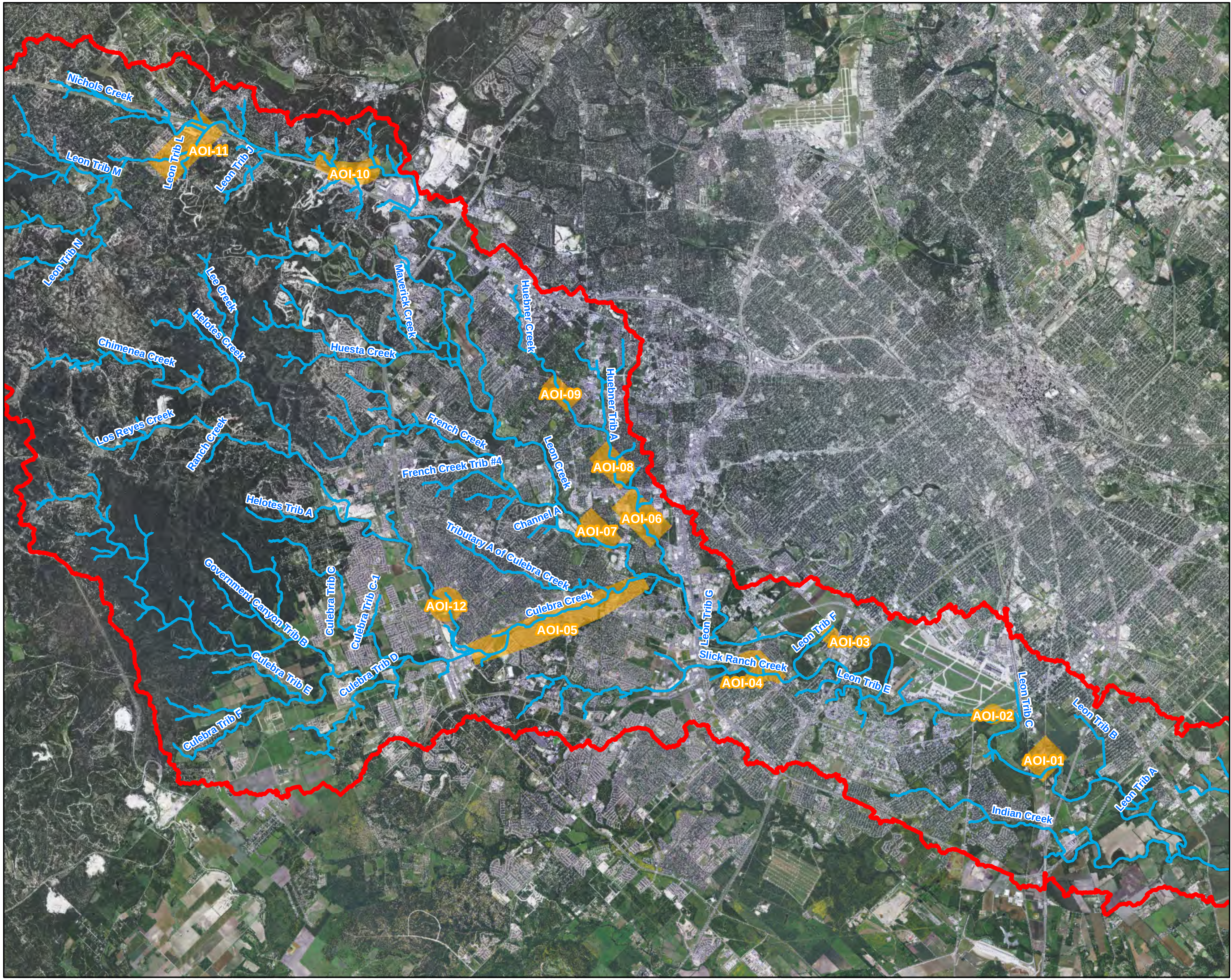
Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	25-Year	7,270	1,017.97	1,025.91	7.94
Chimenea Creek	16,224.00	25-Year	8,450	1,202.98	1,216.19	13.21
Culebra Creek 1	13,961.00	25-Year	53,800	798.56	820.71	22.15
Culebra Creek 2	44,257.00	25-Year	10,800	913.79	925.73	11.94
Culebra Trib A	9,112.00	25-Year	4,540	826.44	832.55	6.11
Culebra Trib C	10,833.00	25-Year	3,970	917.42	921.75	4.33
Culebra Trib E	5,149.00	25-Year	2,260	966.45	970.49	4.04
French Creek	15,966.00	25-Year	11,700	878.44	890.42	11.98
French Trib A	4,255.00	25-Year	3,850	872.40	875.92	3.52
Helotes Creek	34,369.00	25-Year	28,200	978.25	995.20	16.95
Helotes Trib A	4,042.00	25-Year	2,170	990.45	995.91	5.46
Helotes Trib B	6,273.00	25-Year	3,120	1,145.43	1,157.30	11.87
Huebner Creek	22,330.00	25-Year	10,900	823.61	831.32	7.71
Huebner Trib A	6,300.00	25-Year	4,780	866.85	874.74	7.89
Huesta Creek	11,206.00	25-Year	6,900	983.60	993.78	10.18
Indian Creek	24,551.00	25-Year	7,470	597.83	610.13	12.30
Leon Creek 1	16,302.00	25-Year	72,300	489.36	526.25	36.89
Leon Creek 2	58,342.00	25-Year	74,200	570.85	596.23	25.38
Leon Creek 3	86,710.00	25-Year	75,000	616.09	639.08	22.99
Leon Creek 4	118,221.00	25-Year	75,400	668.28	696.79	28.51
Leon Creek 5	163,183.00	25-Year	30,400	789.34	806.47	17.13
Leon Creek 6	224,604.00	25-Year	28,700	1,018.49	1,037.47	18.98
Leon Creek 7	276,101.00	25-Year	15,600	1,213.61	1,234.76	21.15
Leon Trib B	4,565.00	25-Year	3,910	610.60	619.06	8.46
Leon Trib F	4,097.00	25-Year	2,530	704.99	713.78	8.79
Leon Trib H	4,009.00	25-Year	2,720	894.46	899.22	4.76
Leon Trib J	3,775.00	25-Year	3,320	1,126.76	1,134.50	7.74
Leon Trib K	8,446.00	25-Year	5,640	1,157.66	1,166.94	9.28
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	25-Year	4,910	1,242.14	1,249.53	7.39
Los Reyes Creek	14,816.00	25-Year	8,260	1,119.87	1,137.83	17.96
Ranch Creek	2,115.00	25-Year	4,540	1,095.51	1,106.25	10.74
Slick Ranch	18,540.00	25-Year	7,710	756.71	767.88	11.17
Slick Ranch Trib B	2,145.00	25-Year	4,700	757.08	765.93	8.85
WW Village	4,570.00	25-Year	3,040	689.49	703.82	14.33

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	50-Year	8,620	1,017.97	1,026.46	8.49
Chimenea Creek	16,224.00	50-Year	9,950	1,202.98	1,217.31	14.33
Culebra Creek 1	13,961.00	50-Year	67,200	798.56	822.05	23.49
Culebra Creek 2	44,257.00	50-Year	13,000	913.79	926.36	12.57
Culebra Trib A	9,112.00	50-Year	5,210	826.44	832.98	6.54
Culebra Trib C	10,833.00	50-Year	4,910	917.42	922.10	4.68
Culebra Trib E	5,149.00	50-Year	2,660	966.45	970.70	4.25
French Creek	15,966.00	50-Year	13,500	878.44	890.89	12.45
French Trib A	4,255.00	50-Year	4,510	872.40	876.30	3.90
Helotes Creek	34,369.00	50-Year	34,500	978.25	997.03	18.78
Helotes Trib A	4,042.00	50-Year	2,560	990.45	996.30	5.85
Helotes Trib B	6,273.00	50-Year	3,660	1,145.43	1,158.42	12.99
Huebner Creek	22,330.00	50-Year	13,000	823.61	832.15	8.54
Huebner Trib A	6,300.00	50-Year	5,630	866.85	875.27	8.42
Huesta Creek	11,206.00	50-Year	8,140	983.60	994.32	10.72
Indian Creek	24,551.00	50-Year	8,660	597.83	610.94	13.11
Leon Creek 1	16,302.00	50-Year	93,800	489.36	530.65	41.29
Leon Creek 2	58,342.00	50-Year	95,200	570.85	597.20	26.35
Leon Creek 3	86,710.00	50-Year	96,000	616.09	639.86	23.77
Leon Creek 4	118,221.00	50-Year	96,000	668.28	698.76	30.48
Leon Creek 5	163,183.00	50-Year	38,300	789.34	808.87	19.53
Leon Creek 6	224,604.00	50-Year	36,200	1,018.49	1,039.39	20.90
Leon Creek 7	276,101.00	50-Year	18,600	1,213.61	1,236.05	22.44
Leon Trib B	4,565.00	50-Year	4,360	610.60	619.55	8.95
Leon Trib F	4,097.00	50-Year	2,970	704.99	714.56	9.57
Leon Trib H	4,009.00	50-Year	3,210	894.46	899.61	5.15
Leon Trib J	3,775.00	50-Year	3,910	1,126.76	1,134.94	8.18
Leon Trib K	8,446.00	50-Year	6,730	1,157.66	1,167.64	9.98
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	50-Year	5,810	1,242.14	1,250.07	7.93
Los Reyes Creek	14,816.00	50-Year	10,400	1,119.87	1,138.80	18.93
Ranch Creek	2,115.00	50-Year	5,340	1,095.51	1,106.91	11.40
Slick Ranch	18,540.00	50-Year	9,110	756.71	769.71	13.00
Slick Ranch Trib B	2,145.00	50-Year	5,500	757.08	766.58	9.50
WW Village	4,570.00	50-Year	3,550	689.49	704.63	15.14

Reach	**Index Point**	**Event**	**Flow**	**Channel Elevation**	**Water Surface Elevation**	**Depth**
Babcock Trib	16,508.00	100-Year	10,000	1,017.97	1,026.97	9.00
Chimenea Creek	16,224.00	100-Year	11,400	1,202.98	1,218.31	15.33
Culebra Creek 1	13,961.00	100-Year	82,100	798.56	823.48	24.92
Culebra Creek 2	44,257.00	100-Year	15,100	913.79	926.88	13.09
Culebra Trib A	9,112.00	100-Year	5,900	826.44	833.33	6.89
Culebra Trib C	10,833.00	100-Year	5,800	917.42	922.39	4.97
Culebra Trib E	5,149.00	100-Year	3,080	966.45	970.88	4.43
French Creek	15,966.00	100-Year	15,000	878.44	891.31	12.87
French Trib A	4,255.00	100-Year	5,220	872.40	876.68	4.28
Helotes Creek	34,369.00	100-Year	40,800	978.25	998.78	20.53
Helotes Trib A	4,042.00	100-Year	2,950	990.45	996.63	6.18
Helotes Trib B	6,273.00	100-Year	4,230	1,145.43	1,159.43	14.00
Huebner Creek	22,330.00	100-Year	15,100	823.61	832.86	9.25
Huebner Trib A	6,300.00	100-Year	6,500	866.85	875.76	8.91
Huesta Creek	11,206.00	100-Year	9,230	983.60	994.75	11.15
Indian Creek	24,551.00	100-Year	10,200	597.83	611.73	13.90
Leon Creek 1	16,302.00	100-Year	116,300	489.36	534.71	45.35
Leon Creek 2	58,342.00	100-Year	116,100	570.85	598.42	27.57
Leon Creek 3	86,710.00	100-Year	116,000	616.09	640.82	24.73
Leon Creek 4	118,221.00	100-Year	115,300	668.28	700.26	31.98
Leon Creek 5	163,183.00	100-Year	46,200	789.34	811.18	21.84
Leon Creek 6	224,604.00	100-Year	44,000	1,018.49	1,040.66	22.17
Leon Creek 7	276,101.00	100-Year	21,600	1,213.61	1,237.04	23.43
Leon Trib B	4,565.00	100-Year	4,780	610.60	619.97	9.37
Leon Trib F	4,097.00	100-Year	3,430	704.99	715.51	10.52
Leon Trib H	4,009.00	100-Year	3,690	894.46	899.96	5.50
Leon Trib J	3,775.00	100-Year	4,500	1,126.76	1,135.36	8.60
Leon Trib K	8,446.00	100-Year	7,860	1,157.66	1,168.24	10.58
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	100-Year	6,720	1,242.14	1,250.57	8.43
Los Reyes Creek	14,816.00	100-Year	12,400	1,119.87	1,139.51	19.64
Ranch Creek	2,115.00	100-Year	6,170	1,095.51	1,107.54	12.03
Slick Ranch	18,540.00	100-Year	10,500	756.71	770.10	13.39
Slick Ranch Trib B	2,145.00	100-Year	6,310	757.08	767.14	10.06
WW Village	4,570.00	100-Year	4,090	689.49	705.39	15.90

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	250-Year	12,000	1,017.97	1,027.67	9.70
Chimenea Creek	16,224.00	250-Year	13,900	1,202.98	1,219.89	16.91
Culebra Creek 1	13,961.00	250-Year	103,300	798.56	825.70	27.14
Culebra Creek 2	44,257.00	250-Year	17,900	913.79	927.57	13.78
Culebra Trib A	9,112.00	250-Year	6,930	826.44	833.86	7.42
Culebra Trib C	10,833.00	250-Year	7,320	917.42	922.83	5.41
Culebra Trib E	5,149.00	250-Year	3,680	966.45	971.11	4.66
French Creek	15,966.00	250-Year	18,600	878.44	892.11	13.67
French Trib A	4,255.00	250-Year	6,180	872.40	877.06	4.66
Helotes Creek	34,369.00	250-Year	50,800	978.25	1,001.41	23.16
Helotes Trib A	4,042.00	250-Year	3,530	990.45	997.05	6.60
Helotes Trib B	6,273.00	250-Year	5,040	1,145.43	1,160.80	15.37
Huebner Creek	22,330.00	250-Year	18,300	823.61	833.77	10.16
Huebner Trib A	6,300.00	250-Year	7,810	866.85	876.43	9.58
Huesta Creek	11,206.00	250-Year	11,000	983.60	995.45	11.85
Indian Creek	24,551.00	250-Year	13,400	597.83	613.05	15.22
Leon Creek 1	16,302.00	250-Year	147,500	489.36	539.56	50.20
Leon Creek 2	58,342.00	250-Year	147,000	570.85	599.43	28.58
Leon Creek 3	86,710.00	250-Year	147,000	616.09	642.63	26.54
Leon Creek 4	118,221.00	250-Year	146,600	668.28	702.46	34.18
Leon Creek 5	163,183.00	250-Year	58,900	789.34	813.70	24.36
Leon Creek 6	224,604.00	250-Year	55,700	1,018.49	1,042.59	24.10
Leon Creek 7	276,101.00	250-Year	25,800	1,213.61	1,237.94	24.33
Leon Trib B	4,565.00	250-Year	5,380	610.60	620.57	9.97
Leon Trib F	4,097.00	250-Year	4,090	704.99	716.43	11.44
Leon Trib H	4,009.00	250-Year	4,460	894.46	900.49	6.03
Leon Trib J	3,775.00	250-Year	5,360	1,126.76	1,135.89	9.13
Leon Trib K	8,446.00	250-Year	9,510	1,157.66	1,169.22	11.56
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	250-Year	8,080	1,242.14	1,251.22	9.08
Los Reyes Creek	14,816.00	250-Year	15,400	1,119.87	1,140.45	20.58
Ranch Creek	2,115.00	250-Year	7,380	1,095.51	1,108.32	12.81
Slick Ranch	18,540.00	250-Year	12,700	756.71	770.93	14.22
Slick Ranch Trib B	2,145.00	250-Year	7,520	757.08	767.90	10.82
WW Village	4,570.00	250-Year	4,860	689.49	706.37	16.88

Reach	Index Point	Event	Flow	Channel Elevation	Water Surface Elevation	Depth
Babcock Trib	16,508.00	500-Year	13,800	1,017.97	1,028.25	10.28
Chimenea Creek	16,224.00	500-Year	16,000	1,202.98	1,221.10	18.12
Culebra Creek 1	13,961.00	500-Year	118,200	798.56	826.95	28.39
Culebra Creek 2	44,257.00	500-Year	20,700	913.79	928.14	14.35
Culebra Trib A	9,112.00	500-Year	7,760	826.44	834.18	7.74
Culebra Trib C	10,833.00	500-Year	8,560	917.42	923.16	5.74
Culebra Trib E	5,149.00	500-Year	4,180	966.45	971.30	4.85
French Creek	15,966.00	500-Year	21,500	878.44	892.69	14.25
French Trib A	4,255.00	500-Year	6,970	872.40	877.36	4.96
Helotes Creek	34,369.00	500-Year	59,800	978.25	1,003.54	25.29
Helotes Trib A	4,042.00	500-Year	4,020	990.45	997.36	6.91
Helotes Trib B	6,273.00	500-Year	5,720	1,145.43	1,161.86	16.43
Huebner Creek	22,330.00	500-Year	21,100	823.61	834.46	10.85
Huebner Trib A	6,300.00	500-Year	8,890	866.85	876.92	10.07
Huesta Creek	11,206.00	500-Year	12,600	983.60	996.05	12.45
Indian Creek	24,551.00	500-Year	16,400	597.83	613.78	15.95
Leon Creek 1	16,302.00	500-Year	181,500	489.36	543.12	53.76
Leon Creek 2	58,342.00	500-Year	180,100	570.85	600.50	29.65
Leon Creek 3	86,710.00	500-Year	179,900	616.09	644.44	28.35
Leon Creek 4	118,221.00	500-Year	179,100	668.28	704.45	36.17
Leon Creek 5	163,183.00	500-Year	71,100	789.34	815.13	25.79
Leon Creek 6	224,604.00	500-Year	67,000	1,018.49	1,043.97	25.48
Leon Creek 7	276,101.00	500-Year	29,400	1,213.61	1,238.71	25.10
Leon Trib B	4,565.00	500-Year	5,840	610.60	621.04	10.44
Leon Trib F	4,097.00	500-Year	4,640	704.99	717.12	12.13
Leon Trib H	4,009.00	500-Year	5,050	894.46	901.00	6.54
Leon Trib J	3,775.00	500-Year	6,110	1,126.76	1,136.32	9.56
Leon Trib K	8,446.00	500-Year	10,700	1,157.66	1,169.77	12.11
Leon Trib L	-	-	-	-	-	-
Leon Trib M	9,081.00	500-Year	9,200	1,242.14	1,251.67	9.53
Los Reyes Creek	14,816.00	500-Year	18,000	1,119.87	1,141.14	21.27
Ranch Creek	2,115.00	500-Year	8,410	1,095.51	1,108.91	13.40
Slick Ranch	18,540.00	500-Year	14,600	756.71	771.81	15.10
Slick Ranch Trib B	2,145.00	500-Year	8,500	757.08	768.57	11.49
WW Village	4,570.00	500-Year	5,520	689.49	707.12	17.63



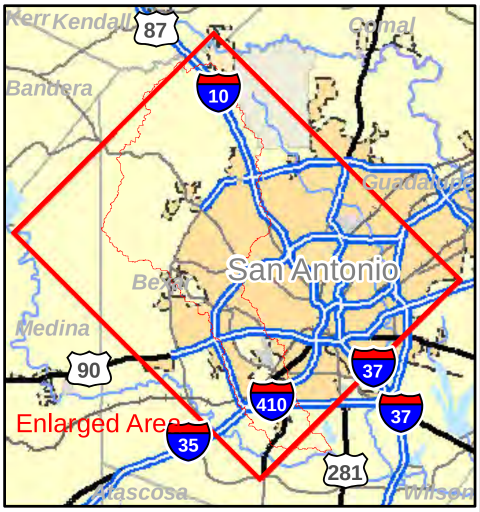
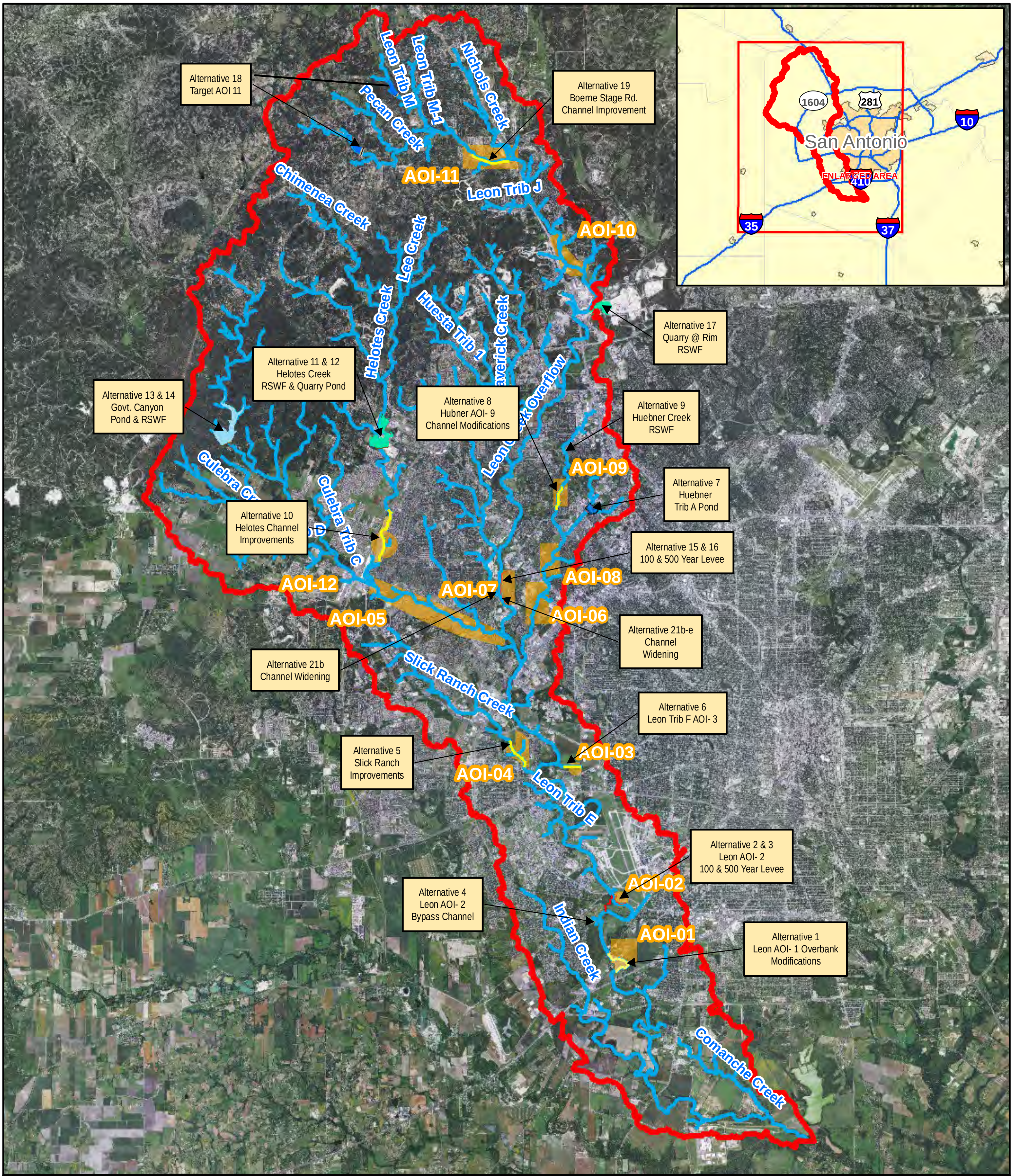


Plate 4 Areas of Interest (Structural)

US Army Corps of Engineers ®
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 5, 2012
Author: Lucas Daniels
Location: \\swf-netapp1\Civil\San_Antonio_Rvr_Bsn\Leon_Creek\Geospatial\Documents\mxd\20110408_AFB\LeonCreek_Alternative15.mxd



US Army Corps of Engineers®
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: \\swf-fs1fbgis\projects\cvljobs\LeonCreek\Documents\

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PLATE 5
INITIAL SUITE OF MEASURES

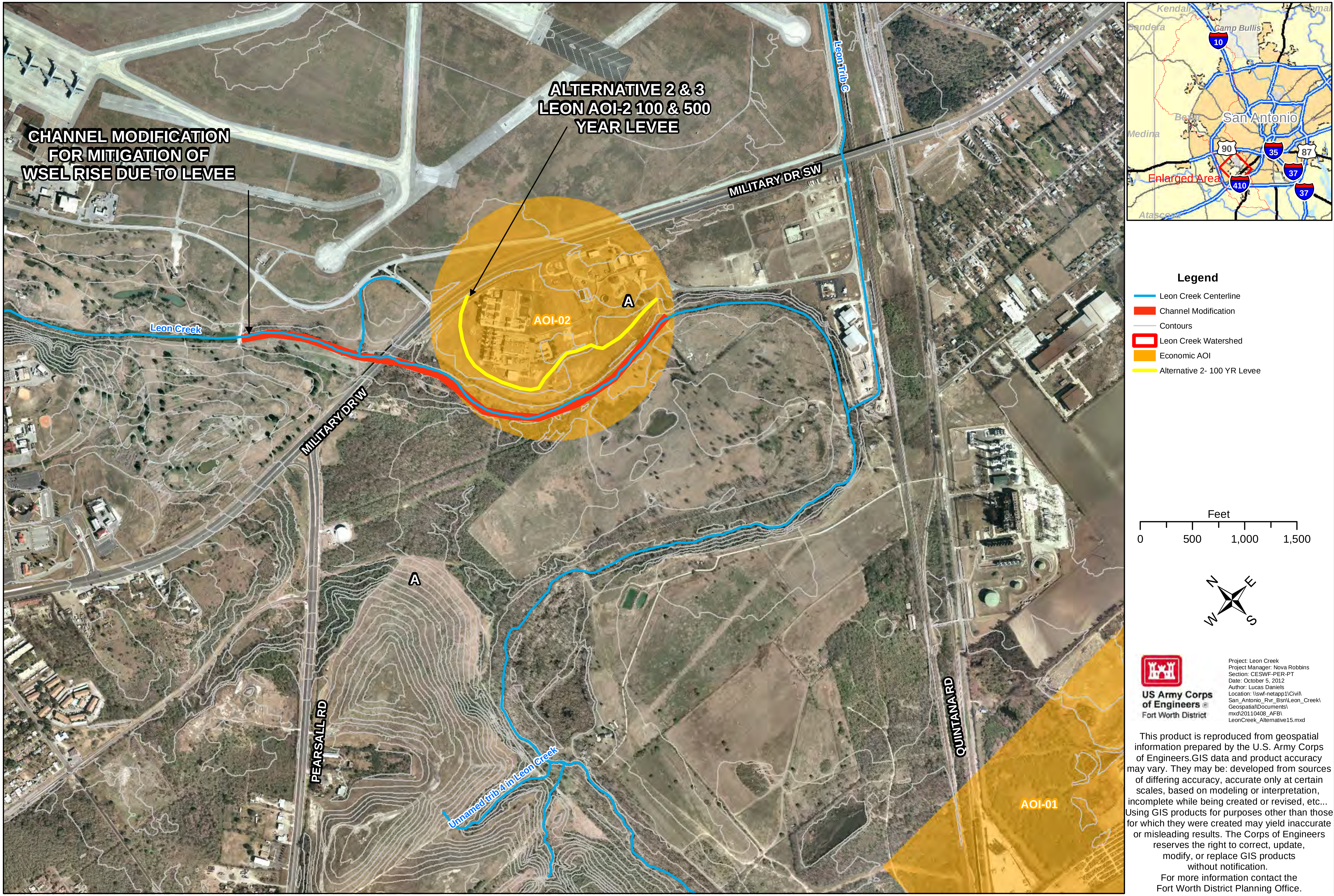
N

1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Plate 6 Alternative 2 with Channel Modification



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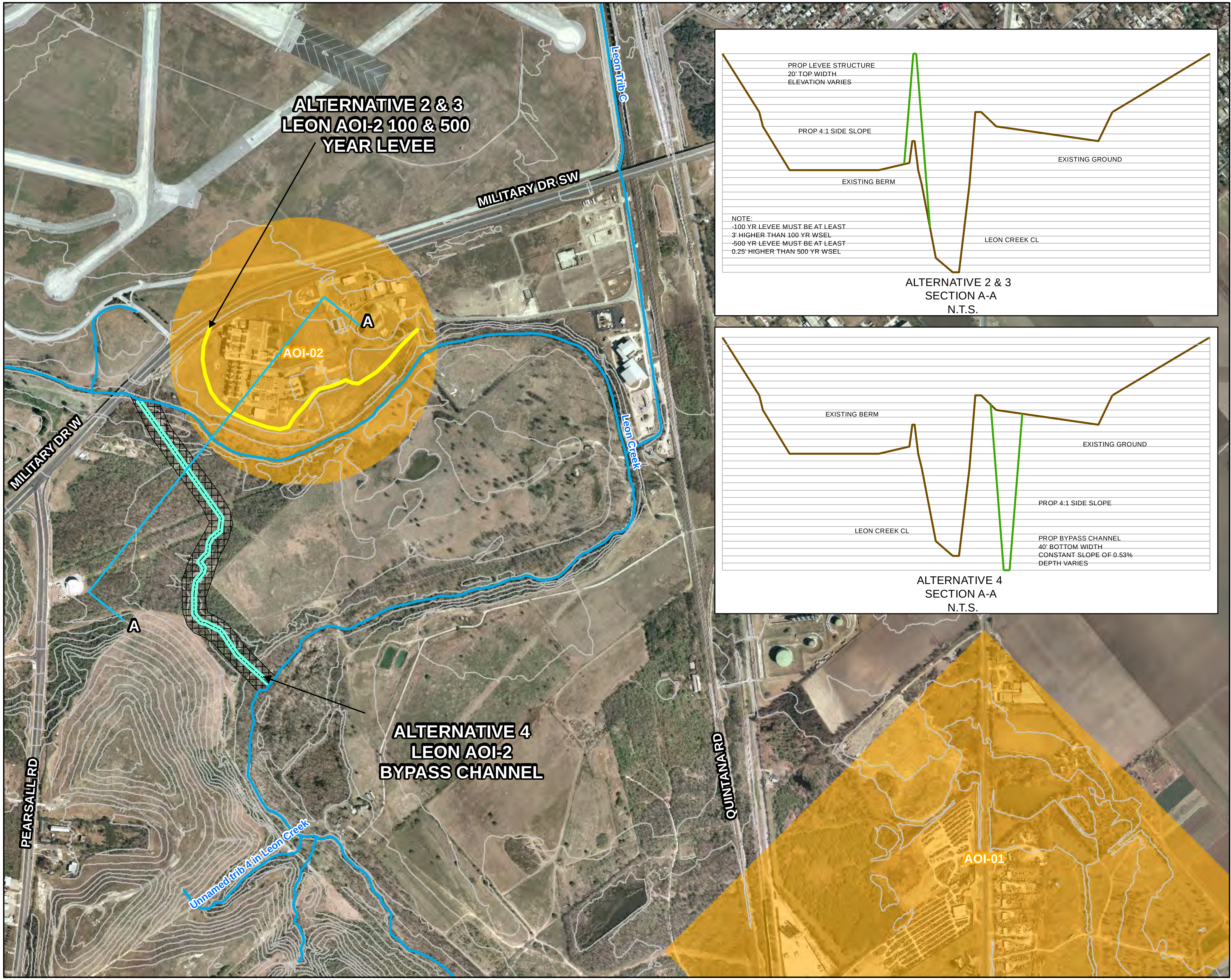
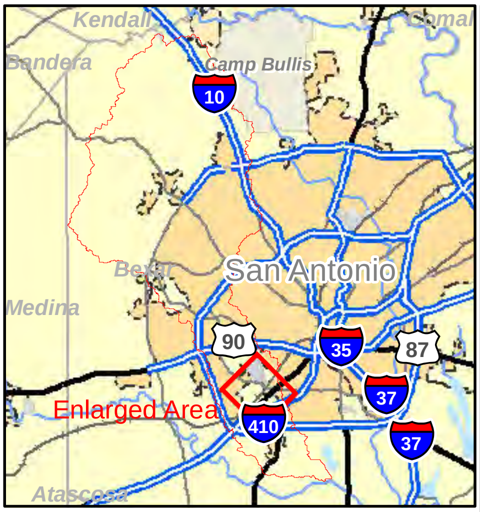
Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 5, 2012
Author: Lucas Daniels
Location: \\swf-netapp1\Civil\San_Antonio_Rvr_Bsn\Leon_Creek\Geospatial\Documents\mxd\20110408_AFB\LeonCreek_Alternative15.mxd

Plate 7 Measures Evaluated- AOI- 2





Legend

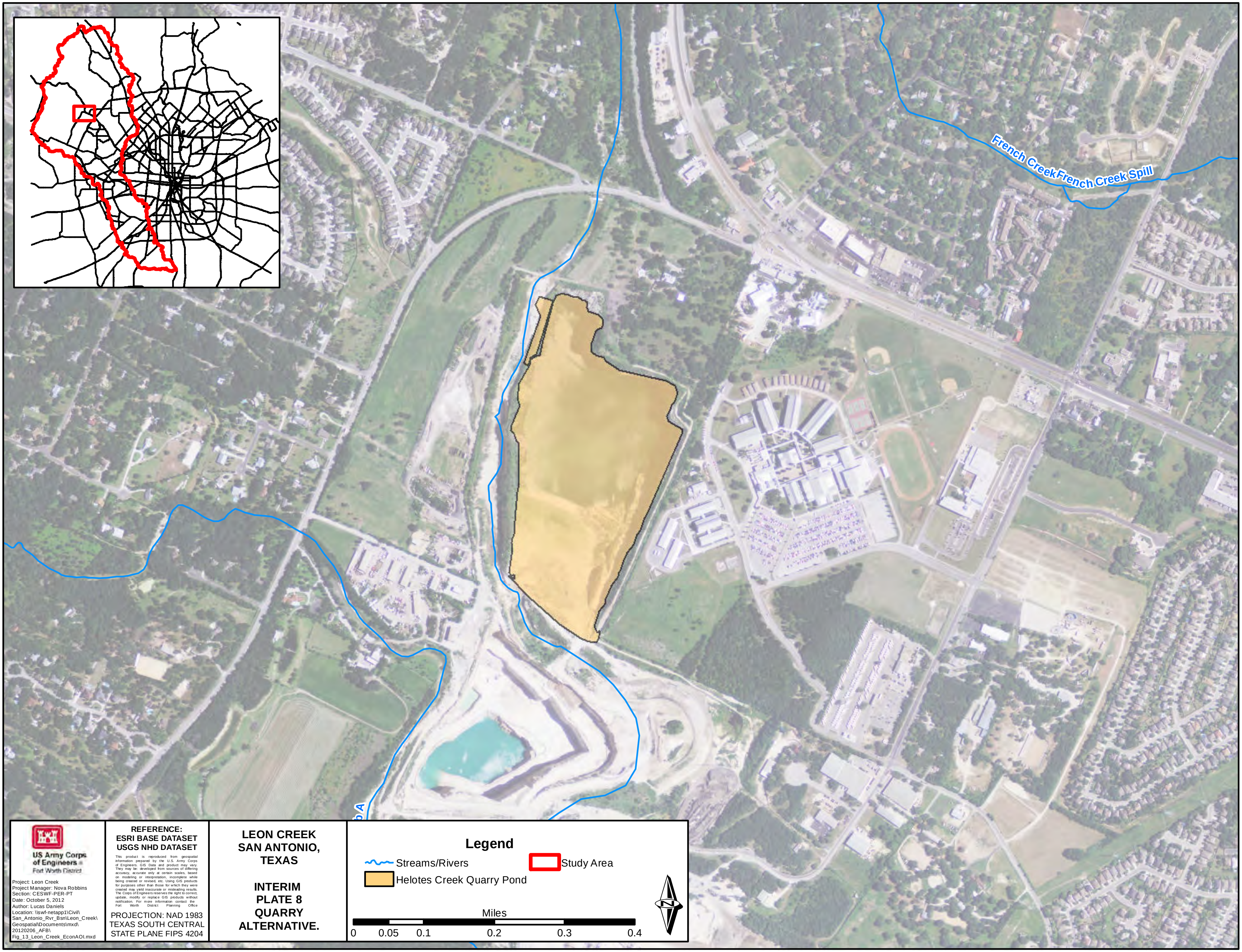
━	Leon Creek Centerline
━	Contours
▭	Leon Creek Watershed
■	Economic AOI
━	Alternative 2- 100 YR Levee
╍	Alternative 4- Bypass Channel
▨	Alternative 4- Bypass Channel Excavation Area

Feet
0 500 1,000 1,500

N E S W

US Army Corps of Engineers®
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 5, 2012
Author: Lucas Daniels
Location: \\swf-netapp1\Civil\San_Antonio_Rvr_Bsn\Leon_Creek\Geospatial\Documents\mxd\20110408_AFB\LeonCreek_Alternative15.mxd



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 5, 2012
Author: Lucas Daniels
Location: \\swf-netapp1\Civil\San_Antonio_Rvr_Bsn\Leon_Creek\Geospatial\Documents\mxd\20120206_AFB\Fig_13_Leon_Creek_EconAOI.mxd

REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET

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PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

LEON CREEK
SAN ANTONIO,
TEXAS

INTERIM
PLATE 8
QUARRY
ALTERNATIVE.

CIVIL DESIGN AND GEOTECH ANALYSES

CIVIL DESIGN

PURPOSE

The Leon Creek feasibility study is being conducted under the Guadalupe-San Antonio River Basin Watershed authority. This study addresses opportunities relating to flood damage reduction within the Leon Creek watershed, investigation of environmental restoration features to include protection of aquifer recharge and sensitive karst components, and investigating appropriate linear open space areas for recreation to supplement the City of San Antonio Creek-Based Greenways.

EXISTING CONDITIONS – GENERAL DESCRIPTION

The Leon Creek watershed is located entirely within Bexar County along the western section of the county, stretching from the county's northwestern limits to the confluence of Leon Creek, with the Medina River southwest of the city of San Antonio. The lower portion of the watershed is located inside the city limits of San Antonio and is highly urbanized. This portion of the watershed has experienced significant ecosystem degradation and flooding as a result of the urbanization. The upper and western portions of the watershed are still in relatively undeveloped areas. Elevations within the watershed range from 1600 feet to 455 feet North American Vertical Datum of 1988 (NAVD88).

The Leon Creek watershed includes several major tributaries including: Culebra Creek, Huebner Creek, French Creek, Slick Ranch Creek, Indian Creek, Helotes Creek, Babcock Tributary, Huesta Creek, plus numerous smaller tributaries.

The shape of the Leon Creek watershed is unique in that the portion upstream of Huebner Creek is relatively wide, with an average width of approximately 10 miles and a length of about 18 miles. The portion of the watershed downstream of Huebner Creek is relatively narrow, with an average width of approximately 4 miles and a length of about 16 miles.

A variety of types and intensity of development exist within the Leon Creek watershed. The portion of the watershed upstream of the upper Interstate Highway 10 crossing is relatively undeveloped with scattered residential and agricultural structures. Downstream of the upper Interstate Highway 10 crossing the watershed is comprised of extensive residential and commercial development. The area south of State Loop 1604 and north of Loop 410 is primarily residential, and the existing creek banks have been improved due to the development of the area.

The area within Loop 410 is a mixture of residential and commercial development. Lackland Air Force Base and Port of San Antonio (PSA) (formally Kelly Air Force Base) are situated within this part of the watershed. One of the tenants at the PSA is Lockheed Martin Engine Test Cell Division, which is located adjacent to Leon Creek. An existing levee surrounds this facility; however, the levee has deteriorated and now overtops during more frequent storm events. Storm drainage that drains the area from the Lackland AFB runways uses concrete open ditches that run on the east side of the facility and drain into Leon Creek. It should be noted that the Test Cell Facility has sustained flooding on several occasions.

Across Leon Creek there are 41 total bridge crossings, which consist of both vehicle and railroad bridge crossings. There are three railroad bridges that cross Leon Creek at two locations. There are two areas where the crossings are actually low-water crossings with a flood gauge marker. During flood events the city will close these street crossings. The remaining bridge crossings vary in width and length, but all are pier-supported bridge structures. No evidence was found that indicates flows under the bridges are constricted; however, there was some scouring around the pier supports. Coarse grain sediment deposits were also found under the bridges. Typically, the channel cross-section for Leon Creek is defined with a limestone channel bottom and side slopes consisting of sands, silts, or clays. In some areas the limestone bottom is fractured or broken-up, while in others it is evident along the sloped bank to a height of no more than 5 feet above the channel bottom. In areas along residential development, the natural channel has been improved with uniform side slopes, which has native grasses growing on the slopes. In the areas where the creek has remained natural or undeveloped, there are heavy growths of vegetation and natural pool areas.

Since the creek runs through urban and developed areas, major utility lines for sanitary sewer, water, and gas traverse the creek bottom or are elevated and supported by a bridge superstructure. In some areas, major power lines cross and run adjacent to the creek. It should be noted that once the exact locations and the various types of flood damage reduction projects are defined, further research will be performed to identify major utility infrastructure, bridge crossings, or structural buildings that may require relocation or modifications.

Flood damage reduction features that will be evaluated in the plan formulation phase will be channel improvements, levee construction, and/or structural buyouts. Leon Creek, within the potential detention dam sites, is perennial in nature and is characterized by intermittent flows, large lagoons, pools, and riffle areas. Leon Creek receives water from rainfall, storm water discharge, and various tributaries along the creek’s reach.

SAMPLE PHOTOS OF EXISTING CONDITIONS

Leon Creek - Culebra St Bridge Piers Looking Downstream

Culebra Creek - DS of Old Grissom Rd Culvert at Low Water Crossing

Culebra Creek - Culebra St Bridge Looking Upstream

Culebra Creek - Culebra St Bridge Piers Scouring

Leon Creek - Levee Around PSA Test Cell Area

Leon Creek - PSA Test Cell Area SW Drainage Ditch

Leon Creek - Ingram Road Low Water Crossing

Leon Creek - Grissom Rd Bridge Looking Downstream from Upstream side

Leon Creek - Prude Rd From Under Bridge Looking Downstream

FORMULATED ALTERNATIVES

Multiple flood mitigation alternatives (both structural and non-structural) within the Leon Creek watershed were analyzed as part of the Leon Creek Interim Feasibility Study (IFS) and Alternatives Formulation Briefing (AFB) document. Based on the measures detailed in the Leon Creek IFS and AFB, three distinct plans were recommended for further development either as standalone plans or a combination of measures. The following alternative plans were reviewed further to develop a final recommended plan:

1. Helotes Creek Quarry Pond – This alternative consists of a pond being located at an existing quarry along Helotes Creek northwest of Loop 1604 and south of FM 1560. This alternative involves the diversion of a portion of Helotes Creek flood flows into the quarry site.
2. Floodplain Evacuation Plan along Babcock Trib – This alternative involves the buyout of structures along Old Cedar Road and Babcock Road that are flooded up to the 4% ACE event.
3. Test Cell Facility Levee and Floodwall – This alternative involves the construction of a levee along Leon Creek to protect the PSA property and Lockheed Martin Test Cell Facility. Channelization along a portion of Leon Creek would also be required to mitigate the increases in water surface elevations associated with the levee.

Helotes Creek Quarry Pond

The Helotes Creek Quarry Pond consists of utilizing an existing quarry along Helotes Creek northwest of Loop 1604 and south of FM 1650 for flood detention storage. The approximately 50-acre quarry is excavated to 100 feet below natural grade to provide approximately 5,000 acre-feet of storage. A weir structure would need to be constructed to divert flood flows into the quarry, and a pump station would be required to evacuate the flood storage following an event.

Since the quarry is located in an active mining area, Helotes Creek has been diverted and is naturally spilling into some of the quarry areas today. A site visit by USACE SWF staff in August 2013 indicated that flood flows along Helotes Creek are already spilling into the quarry, so benefits are already in place today. As a result, further analysis associated with the Helotes Creek Quarry Pond was not recommended at the present time.

Floodplain Evacuation Plan Along Babcock Trib

Area of Interest-4 is located south of Loop 1604 and west of Babcock Road. It is subject to flooding from Babcock Creek. The proposed buy-out alternatives include four single-family residential structures (two subject to damages from the 10% AEP event and two subject to damages from the 4% AEP event) and 32 townhouses, all subject to damages from the 20% AEP event. The structures are located on five tracts totaling 3.85 acres.

Preliminary coordination with resource agencies indicates that the buyout of townhomes and residential structures included in this alternative result in only minimal temporary adverse impacts to the natural environment. Trees adjacent to the structures would be preserved to the extent possible, and following demolition and removal of debris, the disturbed areas would be replanted with grasses to stabilize the soil against erosion. Approximately 3.85 acres of floodplain lands would be available for use by the sponsor for open space uses. This alternative is not expected to require environmental mitigation other than compliance with best management practices during demolition to control dust emissions and surface erosion into the aquatic environment.

Test Cell Facility Levee and Floodwall

Purpose

One of the alternatives investigated is a combination of levee, floodwall, and Leon Creek channelization in the vicinity of the Jet Engine Test Cell Facility (Test Cell) located along Leon Creek near S.W. Military Drive in San Antonio, Texas. Alternative levee and floodwall alternatives were analyzed for PSA by HDR Engineering, Inc. in 2007. This site has experienced flooding from Leon Creek on multiple occasions in the past. An existing levee is in place, but is in a state of deterioration and does not provide protection from less frequent flood events. The Test Cell was impacted by a flood along Leon Creek as recently as May 2013.

A conceptual design was completed to develop construction quantities for the USACE so a cost estimate could be prepared and the risk and uncertainty with that estimate established. The conceptual design did not include any additional geotechnical, hydraulic, or field survey analyses. The design was based upon information in the IFS, aerial photographs, LiDAR topographic data, utility locator maps, and previous geotechnical/engineering reports prepared by others.

In August 2013, the Project Delivery Team (PDT) held a meeting to begin to establish the Risk Register associated with the Test Cell project. The following sections summarize the conceptual design, assumptions, limitations, and risk/uncertainty associated with the various project elements. This document is prepared to assist with determining the overall risk/uncertainty associated with the anticipated construction costs. Plan sheets developed as part of this process are to aid in the development of construction quantities. These plan sheets are PRELIMINARY and are not intended for construction purposes.

Test Cell Facility Background

Lockheed-Martin operates the Kelly Aviation Center Test Cell Facility (Building P652) on the site. The Test Cell Facility is located on PSA property. A groundwater contamination treatment plant (GWTP) is operated by the United States Air Force CEC restoration section on the east side of the property.

PSA has contracted with Pape-Dawson to investigate the feasibility of an interim flood protection project for Building P652. The project is just underway, but PSA and Pape-Dawson are investigating Flood Break Walls and concrete walls to provide additional flood protection for Building P652. These interim measures would not provide 1% ACE protection.

The U.S. Air Force (through CBI Federal Services) operates the GWTP to the east of the Lockheed-Martin facility. The GWTP treats 0.2 to 0.6 MGD of contaminated groundwater. The system consists of 1-3” and 1-4” HDPE pipes that bring contaminated groundwater in from Lackland Air Force Base (AFB) to the GWTP. The GWTP also receives flow from multiple groundwater wells on the southeast corner of the site near Leon Creek. The groundwater from these wells is lifted via the Zone 2 Lift Station to the GWTP. The treated effluent is discharged via a 12” or 14” pipe directly into Leon Creek. Lackland AFB also has a lift station (Zone 1 Irrigation) to take a portion of this treated effluent directly from the pipe before it reaches Leon Creek to an open storage tank on site where it can be pumped to Lackland for irrigation purposes. The existing known utilities are shown on the “Utility Relocation and Demolition Plan” sheet.

Data Collection

As noted, this preliminary effort did not involve additional detailed analyses to support the design beyond information that was readily available. The following is a list of data sources utilized in developing this preliminary design and construction cost estimate.

- Leon Creek Interim Feasibility Study
- Test Cell Levee Feasibility Analysis – Port San Antonio (HDR, 2007)
- Geotechnical Study – Test Cell Levee Feasibility Analysis (HVJ, 2006)
- Flood Control Structures Alternatives Assessment – Test Cell Levee Feasibility Study (HVJ, 2006)
- Aerial Photographs
- SAWS water and sewer locator maps
- CPS electric and gas locator maps

- S.W. Military Drive Bridge at Leon Creek Construction Plans (TxDOT, 1942 and 1962)
- Topographic Data – 2005 LiDAR

In addition to these data sources, Halff Associates, Inc. had phone conversations with Lockheed-Martin, PSA, Pape-Dawson Engineers, and CBI Federal Services personnel to aid in the development of the preliminary design. A brief summary of those discussions is provided below.

- *Lockheed-Martin (Ed VanderPooten)* – Lockheed-Martin is not associated with the groundwater monitoring wells and water treatment plant activities in the vicinity of the Test Cell. The Lockheed-Martin main facility is Building P652 located on the northwest side of the area. The underground fuel tanks have been abandoned and removed from the north side of Building P652. A Fuel Farm is now located above ground on the northwest corner of Building P652. The proposed project layout was provided to Mr. VanderPooten.
- *Port San Antonio (John Farrow)* – The U.S. Air Force operates and maintains groundwater monitoring wells and the water treatment plant. Pape-Dawson Engineers is working on general drainage projects for PSA including Interim Flood Protection Measures for the Test Cell. The proposed project layout was provided to Mr. Farrow.
- *Pape-Dawson (Stephen Dean)* – Pape-Dawson is working on a feasibility study and a preliminary design of Interim Flood Protection Measures for Building P652. These measures include Flood Break Walls and concrete floodwalls. Pape-Dawson is also working on the design of an emergency egress road from Building P652 in the event of high water. The proposed project layout was provided to Mr. Dean.
- *CBI Federal Services (David Poole)* – CBI Federal Services operates the Groundwater Treatment Facility on the site for the U.S. Air Force. Details related to the existing GWTP infrastructure were provided by Mr. Poole and are summarized in the “Test Cell Facility Background” section. The proposed project layout was provided to Mr. Poole.

Floodwall Alternative

Initially, a 1,260 linear foot floodwall was proposed to tie into the proposed earthen levee and extend along S.W. Military Drive. The top of proposed floodwall was at elevation 649.0. Based on the limited geotechnical information available, two floodwall options were analyzed. The first option involved the use of drilled shaft piers to support a concrete floodwall and footing. The total width of this proposed structure would be approximately 20 feet.

The second floodwall alternative involved the use of PZC 37 sheet piles driven into the hard dark bluish-grey clay stratum at approximate elevation 608.0. A concrete facing could be included on the exposed sheet pile surfaces to improve the aesthetic look. The USACE geotechnical representative noted that typically sheet piles cannot be driven through material with blow counts greater than 50. Based on the geotechnical boring B-10 (the one closest to the floodwall), a blow count of 50 will be reached near elevation 615.0. An auger could be used to initially loosen the soil and enable the sheet piles to be driven through the harder material. Due to the hydrostatic loading on the exposed sheet pile floodwall, the section modulus controls the design. The thickness of the sheet pile cannot be reduced, even with the use of an auger to loosen the soil.

The proposed floodwall is within seventy feet of Test Cell Building P652 at the closest point. The potential impacts of the sheet pile driving on Building P652 cannot be analyzed without further geotechnical analysis and a determination of the sensitivity of equipment housed within Building P652.

Further guidance from the SWF geotechnical ITR indicated concerns with the assumption that the sheet piles (Alternative 2) could be driven through the anticipated material. Therefore, for this preliminary investigation with limited geotechnical information, the drilled shaft option was quantified. This alternative will have a larger footprint than the sheet pile alternative. The existing driveway around Building P652 may also have to be removed and shifted slightly to allow space for the floodwall since it has a wider footprint than Alternative 2. Given the existing ground elevations and short duration of hydraulic loading, seepage may not be a major concern for the floodwall section. Elimination or a reduction of the sheet pile cutoff or soil-bentonite slurry wall may be practical following a more detailed geotechnical analysis during design.

Based on the preliminary cost estimates associated with the floodwall, the feasibility of eliminating the floodwall and extending the proposed earthen levee along Military Drive was investigated. Ultimately it was decided to eliminate the floodwall and move forward with only an earthen levee as detailed in the following sections.

Earthen Levee

Based on existing pipelines, lift stations, and groundwater wells, the proposed earthen levee was not extended as far to the southeast as shown in the IFS document. Instead, the levee is turned and tied to high ground approximately 280 feet to the west of the location shown in the IFS. This change will eliminate conflicts with multiple existing groundwater wells, pipelines, a lift station, and GWTP effluent discharge pipeline just to the east of this new tie-in.

The proposed earthen levee will extend approximately 3,700 linear feet from high ground on the southeast side of the PSA area and wrap around Building P652 along Military Drive to high ground as shown in the “Concept Plan” sheet. The levee was aligned in an attempt to provide adequate benching between the riverside toe and the Leon Creek channelization for stability reasons, as well as to avoid existing buildings on the Test Cell site. The top of levee was set to provide adequate freeboard above the 1% annual chance exceedance (ACE) event in accordance with FEMA regulations (44 CFR 65.10). A 12’ top width was assumed and will provide a maintenance/patrol access route along the top of the levee. Side slopes of 3.5:1 (H:V) were also assumed for this preliminary design.   The proposed levee will be over 21 feet high near the existing low point at Station 21+50. Landside toe ditches will be graded to convey interior runoff to the proposed sump area. The proposed levee toe will be within thirteen feet of Building P652 at the closest point. Access to the Test Cell Fuel Farm will also be impacted with the proposed levee alignment.

Access to the levee will be provided at the southeast terminus via an existing concrete driveway and on the north side terminus via an existing driveway. The levee patrol road will be constructed of base course material.

Additional geotechnical analyses are required to determine the global stability of the levee, suitability of excavated on-site materials to be used for levee construction, and seepage potential. Preliminary geotechnical analyses and limited borings indicate the existing soils that the levee will be founded on are alluvial soils (10-20 feet deep) consisting of clay, silt, sand and gravel. There are high plasticity (fat) clays below the alluvial soils. Due to the poor condition of the existing on-site levee/berm, it was assumed that this structure and fill would be completely removed prior to construction of the proposed levee.

Soft materials just below the existing levee fill were identified in the B-7 Boring (HVJ Associates Report). However, no other borings indicated soft materials. The extent of soft material appears to be localized and is not anticipated to be found beneath a significant portion of the proposed levee footprint. Removal of soft materials beneath the proposed levee embankment will be required to ensure embankment stability. Limits and depth of soft material excavation beneath the proposed levee embankment will be identified during PED and shall be displayed on Plan and Profile Sheets. Sufficient contingencies are in the current cost estimate that should cover any potential cost increase due to excavation of soft material beneath the proposed levee embankment.

The HVJ Associate’s Report indicates the water table is near the existing ground elevation in some locations of the proposed levee footprint. However, the actual water table could vary greatly due to the seasonal variations within the regional area. If during PED a determination is made that excavation depths are at or below the ground water table, a dewatering plan shall be developed. Sufficient contingencies are in the current cost estimate that should cover any potential cost increase due to dewatering efforts.

Initially, as part of the Risk Register exercise completed with the PDT, it was decided to assume that the levee could be constructed of 50% on-site soils (sump/channel excavation) and 50% would need to be imported. It was also assumed that 100% of the levee core/cutoff would need to be imported material. The levee core/cutoff was assumed to include an eight-foot wide core beginning 3 feet below the top of the levee with 1:1 side slopes to natural ground and the top of the proposed soil bentonite slurry wall.

Permeability tests of the on-site soils are not available. The Leon Creek watershed at the Test Cell is over 200 square miles. The watershed is relatively steep and is heavily developed. Therefore, it has a quick (flashy) response to rainfall. A USGS streamflow gauge (USGS 08181480) is located at IH-35 along Leon Creek downstream of the Test Cell. Streamflow records for a few historic high flow events along Leon Creek were analyzed and are shown in Figure 1. Based on the preliminary HEC-RAS hydraulic model, a flow rate of approximately 6,100 cfs will begin to impact the toe of the proposed levee. As shown in Figure 1, Leon Creek does not remain at high stages for long periods of time. The May 2013 and August 2007 events were only above the levee toe flow threshold for 10-17 hours. The July 2002 event represented a wet cycle with successive high flow events. The longest sustained period with Leon Creek flows greater than 6,100 cfs during this 2002 wet cycle was less than 1.5 days.

Although the anticipated duration of hydraulic loading on the levee is relatively short, with the limited geotechnical information showing considerable sand and gravel soils, the SWF geotechnical ITR recommends the inclusion of a soil-bentonite slurry wall to provide additional seepage control along the full length of the levee for this preliminary analysis. The soil-bentonite slurry wall was assumed to be 48 inches thick and would extend from the top of the levee to approximately elevation 604.0 based on guidance provided by SWF. With the inclusion of the soil-bentonite slurry wall, an inspection trench was not included as part of the levee construction. By extending the slurry wall to the top of the levee, import of select material for the levee construction is not anticipated. Additional geotechnical analyses, in combination with anticipated hydraulic loading of the levee and the construction of a clay core, may result in the elimination or reduction of the soil-bentonite slurry wall for a detailed design.

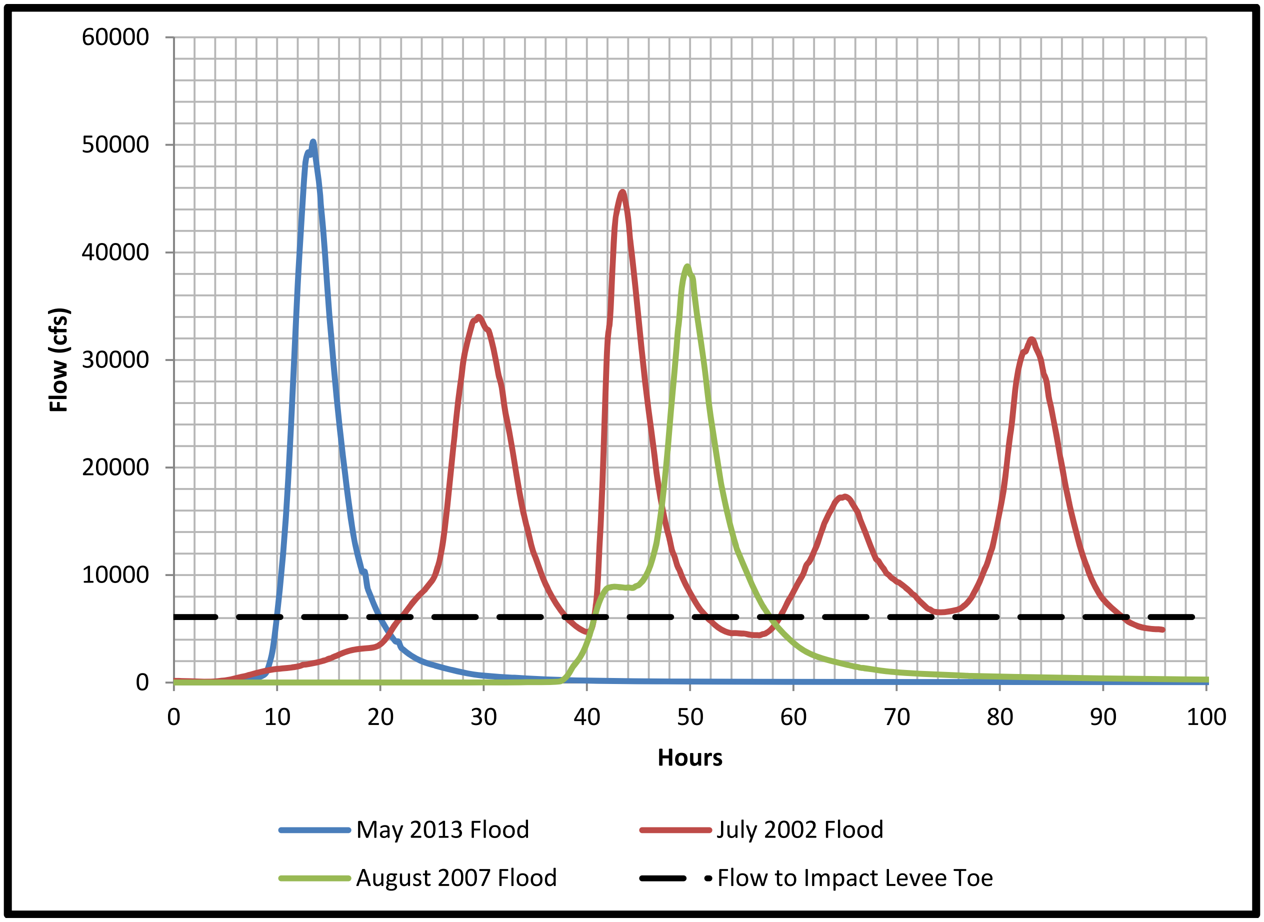


Figure 1. Historic Flows at the Leon Creek at IH-35 Streamflow Gauge (USGS 08181480)

The levee side slopes will be vegetated following construction of the levee. Preliminary hydraulic model results indicate that velocities along the riverside levee will be 8.5 to 9.5 feet per second between proposed levee Stations 23+00 to 39+00 with shear stresses between 3 and 5 pounds/square foot between the levee and Leon Creek channel. Based on these velocity and shear stress values, it is recommended that a permanent turf reinforcement mat (Landlok Woven TRM or equivalent) be installed along the riverside of the levee in these areas to provide additional erosion protection. The Texas Department of Transportation guidelines indicate that an established stand of mowed Bermuda grass can withstand shear stresses of 1 pound/square foot.

IDENTIFIED RISKS: Detailed geotechnical analysis may indicate the need for additional global stability measures (shelves, stability berms, etc…) and/or changes to seepage control (cut-off walls, toe drain collection system, etc…). Proximity of the levee to Building P652 and loss of access around the northwest corner of Building P652 may not be acceptable.

Sump Area

The total interior drainage area inside the proposed levee and floodwall is approximately 43 acres. It was assumed that interior runoff would be drained through the levee via a gravity sluice structure dependent on Leon Creek tailwater. No pumps are assumed for evacuating floodwaters from the interior of the proposed levee and floodwall.

If the ultimate intent of the proposed flood control project is to remove the Test Cell Facility buildings from the 1% ACE floodplain, the interior drainage facilities must be sized accordingly. For detailed design, USACE EM 1110-2-1413 would be utilized to analyze the interior drainage considering coincident flows along Leon Creek. Given the preliminary nature of the current design and limited time, a complete interior drainage analysis was not feasible. Based on the USGS Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas, the 24-hour, 100-year rainfall depth for Bexar County is approximately 10 inches. Based on existing land uses and impervious areas within the interior drainage area, it was assumed that 80% of the rainfall volume would runoff (20% would infiltrate). If this entire runoff volume needed to be stored (i.e., unable to discharge to Leon Creek due to high tailwater elevations), the total required sump storage volume is 28.7 acre-feet. As shown in Figure 1, Leon Creek typically rises and falls relatively quickly, which should enable stored interior runoff to be evacuated from the sump via the gravity sluice.

The proposed sump is shown in the Concept Plan Sheet. A “shelf” (50-feet wide) is provided between the landside toe of the levee and the sump area for stability/seepage purposes. A detailed geotechnical investigation would be required to further refine this distance. The existing on-site 48” storm drain line will be outfalled into the proposed sump area. Rock riprap and concrete riprap protection will be needed at locations where inflows to the sump are concentrated (toe ditches and the 48” storm drain outfall) to provide erosion protection. Details related to the gravity sluice are provided in the “Sluice Structure” section of this document. Access ramps will ultimately need to be provided to allow for maintenance and mowing in the sump area.

The currently proposed sump area provides approximately 27 acre-feet of storage below elevation 626.0. The proposed sump bottom as currently designed is at elevation 617.0. The limited geotechnical analysis that is available indicates that this elevation is close to the "normal" groundwater level in this area, although the groundwater level typically fluctuates with Leon Creek water surface elevations. If the bottom elevation of the sump has to be raised, this will further restrict the storage capacity of the proposed sump.

Although there are no known groundwater wells (as identified by CBI Federal Services) in the vicinity of the proposed sump, the locations of any groundwater contamination plumes are not known by the A/E at this time. The proposed sump excavation could disturb these plumes if they are in the area. More details on location and depths of the plumes will be required for the detailed design.

IDENTIFIED RISKS: Insufficient sump storage provided due to higher groundwater levels or longer periods of storage without evacuation. Unable to excavate to this depth or in this area due to groundwater contamination plume disturbance.

Sluice Structure

The sump storage area will be drained via a gravity sluice to Leon Creek. A 5'x5' reinforced concrete box (RCB) is assumed for the sluice structure. This size box will allow for periodic maintenance access. The box structure will outfall into Leon Creek and rock riprap will be placed to provide erosion protection. A flap gate will be installed at the outfall and serve as the primary means of preventing Leon Creek backflow through the box culvert and into the sump area. A manually operated sluice gate structure will be installed with access from the top of the levee. The sluice gate provides back-up protection in the event that the flap gate is compromised during an event. Structural concrete quantities are based on a similar size sluice structure designed by Halff Associates, Inc. for the USACE Wharton Colorado River Flood Control project.

A detailed analysis of the sluice structure and sump evacuation times considering historic Leon Creek events was beyond the scope of the current project, but would need to be evaluated during detailed design. For sump headwater elevations over 621.0 (top of box is 622.0), the sluice can discharge over 100 cfs with a 1-foot head differential between the headwater and the tailwater. This would equal over 8.2 acre-feet/hour of storage evacuation when the headwaters and tailwaters are in this range.

IDENTIFIED RISKS: Sluice structure would need to be larger to provide quicker evacuation times of the sump based on a more detailed analysis.

Leon Creek Channelization

The proposed levee and floodwall at the Test Cell Facility will result in increases in the water surface elevation along Leon Creek. In order to mitigate this rise, channelization is proposed for Leon Creek from downstream of S.W. Military Drive to near the existing low water crossing/dam near the southeast terminus of the proposed levee (approximately 2,900 river feet). The proposed channel has a 60-foot bottom width with variable side slopes. Environmental impacts and mitigation associated with the channelization are being addressed by others at the USACE. The focus of Halff Associates, Inc. is the preliminary civil design and hydraulic analysis of the channelization.

The hydraulic analysis is based on an existing HEC-RAS hydraulic model developed from LiDAR topography (no survey other than at structures). For a detailed design of the channelization, field survey would be needed and additional cross-sections would be added to the hydraulic model. The transitions at the upper and lower limits of the channelization would also need to be analyzed and designed in greater detail.

The proposed channel grading and incorporation with the proposed levee grading is shown on the "Concept Plan" sheet. A "shelf" is included between the riverside levee toe and top of the Leon Creek channelization bank for stability of the levee. A detailed geotechnical and stability analysis would be required to further refine the size and limits of this "shelf".

The proposed channelization was based on a 0.04 Manning's n-value following construction. This would indicate a grass-lined and maintained channel through the limits of the channelization. A maintained grass-lined channel was selected to limit the extents of channelization and disturbance along Leon Creek. The USACE is working on the mitigation associated with the project which includes re-establishment of native vegetation, trees, and riffle structures. Since a detailed design and iteration between the USACE and Halff Associates was not possible for this preliminary effort, the USACE recommended utilizing a 0.085 Manning's n-value for the proposed channel to account for the environmental mitigation work. When the roughness value was increased to 0.085, significant water surface elevation increases resulted along Leon Creek compared to the originally designed channel with a 0.04 Manning's n-value. After discussions with the USACE, it was decided to not increase the Manning's n-value for this preliminary design. Instead, the computed earthwork quantities were increased by 20% to account for additional channelization that may be required for hydraulic considerations as a result of more detailed mitigation design. In addition to the potential for increased earthwork, moving the channelization extents downstream will require improvements to the existing low water crossing/dam and moving upstream may require work under the S.W. Military Drive Bridge.

Velocities in the proposed channel are shown in Table 1, as well as without project conditions (no levee and no channelization) for the 1% ACE event. Under without project conditions, the 1% ACE velocities through this reach of Leon Creek are high. The proposed channelization project will further increase these velocities, so erosion protection is recommended. The velocity increases related to the channelization propagate upstream of S.W. Military Drive approximately 4,100 river feet. A more detailed model and further design of transitions may enable these upstream velocity increases to be mitigated or eliminated. A permanent turf reinforcement mat is included in the preliminary design throughout the channelization limits to provide additional erosion/scour protection.

No trees/shrubs should be planted or allowed to grow within 15 feet of the proposed levee toes as this is the Vegetation Free Zone.

Table 1. Channel Velocities (Preliminary)

Hydraulic Model Station	Proposed Channel Velocity (fps)	Without Project Channel Velocity (fps)
87864	13.5	13.0
87627	14.1	11.7
87518	17.8	12.3
87210	14.6	24.3
86710	15.0	16.5
86207	16.1	13.9
85866	7.6	5.7
85691	6.2	4.5

IDENTIFIED RISKS: Channelization extents may be extended with more detailed survey, hydraulics, and environmental mitigation details. This has the potential to significantly increase the costs if the environmental mitigation results in increased channelization for hydraulic purposes.

Utilities

Existing utility locator maps for the Test Cell were obtained from the San Antonio Water System (SAWS) for water and sewer service and CPS for gas and electric service. Aerial photographs were also used to locate above ground utilities. Given the preliminary nature of this project, the existing utilities shown and to be re-located are approximate and should not be considered a comprehensive list. There are over 2,800 linear feet of overhead electric distribution lines and associated power poles/transformers that will need to be relocated for the levee, channel, and sump construction. No power poles will be allowed within the levee footprint or within 15 feet of the toes. Any crossings of OH electric lines over the levee will need to be raised a sufficient height to provide clearance for levee patrol and maintenance vehicles to pass along the top of the levee.

Based on the sanitary sewer plans, there is a large 54” diameter main along the southside of Leon Creek. The proposed Leon Creek channel improvements should not impact this sewer line. There is a 4” sanitary sewer force main line that crosses under S.W. Military Drive just beyond the limits of the proposed floodwall based on the locator maps. It is not anticipated that this force main will need to be re-located for the floodwall construction. There is also a 4” plastic supply gas and a 8” cast iron water service line that passes under S.W. Military Drive and the proposed levee near Station 44+00. These utility lines will need to be re-located around the levee. Existing water lines and service along the northwest corner of Building P652 will need to be removed for the proposed levee construction. There is a 6” cast-iron water line identified in a corner of the proposed sump grading where the ground will be cut approximately seven feet below existing grade, so this water line will need to be re-located as well. A fire hydrant in this area will also need to be re-located.

Based on conversations with Lockheed Martin personnel, there is an existing Fuel Farm facility located near the northwest corner of Building P652. The proposed levee will limit access to this facility and may result in the need for re-location or adjustments to the existing infrastructure.

The 3” and 4” HDPE pipes that convey contaminated groundwater from Lackland AFB to the on-site GWTP will need to be relocated. The existing lines are just a few feet deep and are located within the footprint of a large portion of the proposed levee and directly through the proposed sump area. The pipes will be routed along the riverside toe of the levee to near Station 27+00 where they will be enclosed in casing pipe under the future levee. Control valves need to be installed fifteen feet from each toe of the levee. The re-located lines will then pass through the side slope of the proposed sump before connecting back to the existing pipes near the GWTP.

The utilities identified for this project are preliminary in nature. A more comprehensive investigation including survey/SUE would be required to identify additional utilities that may be in conflict with the proposed project. Given the long history of this site (military operations) and the current industrial use, there is a fairly high probability that additional utility conflicts are present.

IDENTIFIED RISKS: Unknown utility locations and elevations. Unknown impacts to the Fuel Farm.

Demolition

Demolition associated with the proposed project is based on a review of aerial photos. The demolition quantities do not include any field site verification or detailed field survey. The demolition will include removal and disposal of 380 linear feet of existing 48” RCP storm drain. An existing 7,600 square foot metal building near levee Station 28+50 will also most likely need to be removed to allow for construction of the levee toe ditch. Miscellaneous fence and concrete pavement sections will also be removed as part of the project.

In conversations with CBI Federal Services, the remnants of an abandoned water treatment plant facility are located near the levee and sump footprints at Stations 15+00 to 19+00. An old sludge dewatering basin and concrete basin were noted and are shown on the “Utility Relocation and Demolition Plan” sheet, but there may be additional features and debris buried in this location. The depths of these features are not known.

IDENTIFIED RISKS: Features not readily identifiable from aerial photos.

Military Drive Drainage

There is an existing concrete-lined channel parallel to Military Drive that conveys runoff from a 5’x5’ RCB to Leon Creek. With the proposed levee in this area, this concrete-lined channel will need to be removed and re-graded. The existing 5’x5’ RCB will need to be extended approximately 600 linear feet to outfall back into the existing ditch away from the proposed levee as shown in the “Concept Plan”.

Given the close proximity of the proposed levee to Military Drive, it is also recommended that a metal beam guard fence be installed along the edge of the pavement.

Summary of Earthwork Quantities

Table 2 provides a summary of estimated earthwork quantities for the project assuming a 10% compaction factor for fill soils. The Leon Creek channelization quantities also include the 20% contingency for the environmental mitigation. It is assumed that a 48” thick slurry wall will be constructed from the top of levee to elevation 604.0 so no import of material will be required.

Table 2. Summary of Earthwork Quantities

Component	**Cut**	**Fill**
Levee	2,645 (BCY)	151,150 (LCY)
Sump	71,815 (BCY)	3,475 (LCY)
Leon Creek Channelization	123,690 (BCY)	16,450 (LCY)
TOTAL	**198,150 (BCY)**	**171,075 (LCY)**

In summary, all but approximately 27,100 CY of soil will be balanced on-site. The excess material will need to be spoiled at on off-site location. A portion of this excess material may be disposed of by overbuilding the levee section towards the channel side between stations of 34+00 to 38+00. This overbuilt template design along with any impacts to Leon Creek hydraulics shall be analyzed during the Preconstruction, Engineering, and Design (PED) phase of the project.

Conclusions

Several assumptions had to be made for this preliminary design based on limited detailed data and information. For each component of the proposed project, major factors affecting the uncertainty and risks associated with the quantities/costs have been identified and summarized in this document. Major issues affecting the risk and uncertainty related to the construction costs will be the extents of the channelization effort, seepage control requirements for the proposed levee, and unknown utility conflicts.

GEOTECHNICAL DESIGN

Site visit

On 10 May 2007 a preliminary evaluation for potential storm water retention structure sites including foundation problems, proximity of possible borrow material sources, and environmental concerns was conducted along Leon Creek in Bexar County, Texas. The retention structures are to be sited at locations in the watershed that are potentially within the Edwards Aquifer recharge zone to allow storm waters to infiltrate the aquifer. Ten locations were observed in the Leon Creek watershed.

Leon Creek

Typically, the Leon Creek channel consists of a wide, shallow, jointed and fractured limestone bed with low banks. Significant coarse grained material deposits ranging from fine sand to cobble and boulder size exist. Stream banks are generally about 5 to 15 foot high and consist of very gravelly dark gray to black medium to high plasticity clay or poorly graded clayey gravel. Stream flow in the area observed is intermittent with occasional pools of standing water due to the karstic nature of the area. A significant flow was observed at the lower portion of the area which is attributed to the sewer plant discharge from former Kelly Air Force base.

Overburden materials are typically comprised of Quarternary terrace deposits consisting of sand, silt, clay, and gravel in various proportions, with gravel more predominant in older, higher terrace deposits. The material is locally indurated with calcium carbonate (caliche) in terraces along streams. The USDA classifies the overburden soils along the portion of Leon Creek examined in the study as Trinity or Frio clays. These soils are characterized as calcareous clay or gravelly clay that is dark gray to grayish brown and has increasing gravel with depth.

Primary materials encountered over the extent of the alignment visited for this study consisted typically of fractured, thinly to massively bedded limestone or clay shale. The Edwards Formation is exposed in the northern portion of the Leon Creek Channel. The Edwards Formation consists of gray to white, dense, hard, semi-crystalline limestone of both calcium limestone and magnesium limestone. Surface water dissolves the Limestone at a relatively rapid rate, forming cavities in the stone. The lower portion of the Leon Creek Channel is underlain by the Navarro Group and Marlbrook Marl, undivided, overlain with Quaternary (recent) stream deposits. This formation is composed of marl, clay, sandstone, and siltstone, with concretions of siderite and siliceous limestone.
At potential retention structure locations along the upper reaches of the watershed the fractured and jointed limestone primary materials encountered will require considerable effort to construct an appropriate foundation. Large amounts of the gravelly overburden will require removal and disposal as the existing material may not be appropriate for

reuse as retention structure fill material and require the location of an offsite source for fill materials. The fractured, jointed limestone encountered in the upper reaches of the study area may also require grouting of the foundation to control seepage.

General Geology

San Antonio and Bexar County are on the boundary between the Gulf Coastal and Great Plains physiographical provinces. Dividing these two provinces in this region of Texas is the Balcones Escarpment, part of the Balcones Fault Zone. The escarpment extends from near Del Rio, Texas northwest through Bexar County to Austin. Remnants of the escarpment extend as far north as Waco. The Balcones Escarpment rises approximately 1,000 feet above the coastal prairie to the south and east, creating a marked influence on the area's environment. Northwest of the escarpment lies the Edwards Plateau area of the Great Plains Province. Since the plateau's formation, it has eroded, becoming a rugged hilly region dissected by numerous small streams with elevations ranging from 1,100 to 1,900 feet. Southeast of the escarpment and running along at the base lies the Blackland Prairie area of the Gulf Coastal Province, with its gently rolling hills. The San Antonio and Bexar county area are comprised of eight minor physiographic Divisions. These are: the Glen Rose Hills, the Edwards Flint Hills, the Del Rio Hills, the Austin Hills, the Taylor-Navarro Plain, the Stream Terrace Plain, the Midway-Wilcox Hills, and the Sand Hills. Most of San Antonio lies on the Taylor-Navarro Plain that forms a wide belt passing through the center of Bexar County. The relatively nonresistant strata of the late Cretaceous and early Tertiary formations formed the plain. Overlaying the Taylor-Navarro Plain is the Stream Terrace Plain, an alluvial gravel terrace deposited by streams eroding the Edwards Plateau and Balcones Escarpment. The Austin Hills form a belt passing north of the Taylor-Navarro Plain and through the northern portion of the city of San Antonio. North of the Austin Hills lie the Del Rio Plain, the Edwards Flint Hills, and the Glen Rose Hills. The Del Rio Plain is located north of and adjacent to the Austin Hills division. The Edwards Flint Hills are located north of, and adjacent to the Del Rio Plain division and along the northern extremity of San Antonio. The Edwards Flint Hills is a belt of hilly country in which the flint rock is extremely abundant in the soils and surface debris. The prevailing rock is the Edwards limestone from which the flints have been derived by weathering. The Glen Rose Hills are located north of, and adjacent to, the Edwards Flint Hills division, and north of San Antonio. The Glen Rose Hills division, being northwest of the Balcones Escarpment, forms the eastern margin of the Edwards Plateau. This area is of the maximum elevation for the county, approximately 1,900 feet above sea level. South of Taylor-Navarro Plain of San Antonio are the Midway-Wilcox Hills and the Carrizo Sand Hills. The Midway-Wilcox division forms a belt across the country which includes low hills together with level lands. The Carrizo Sand Hills division is located south of and adjacent to the Midway-Wilcox Hills division. The surface exposures of the Carrizo formation are characterized by low hills and very sandy soil.

Leon Creek is located on the western edge of San Antonio in Bexar County. The area is within the Balcones Fault Zone, an area characterized by numerous parallel and en echelon faults, downthrown to the south. The topography is characterized by a gently rolling land surface that slopes southeastward toward the Gulf of Mexico. Primary material underlying the Leon Creek area examined for this study consists of strata belonging to three geologic formations. The Edwards Limestone underlying the northern portion of the area. The Taylor Marl, underlying the middle portion consists of soft to moderately hard, calcareous shale. The southern portion of the area is underlain by the Navarro Group consisting of sandy, silty clay shale.

Subsurface Hydrology

The Comanche Peak, Edwards, and Georgetown Limestone formations comprise a hydrologic unit known as the Edwards Underground Reservoir, or Edwards Aquifer. This aquifer extends along the Balcones Fault Zone from Kinney County through Uvalde, Medina, Bexar, and Comal counties, terminating in Hays County. Seventeen cities and communities are dependent on the Edwards Aquifer for their domestic water supply, with San Antonio being the largest city in the United States that obtains its entire water supply from underground sources. Where these formations exist on the Edwards Plateau, they form an extensive, percolated water table from which the residents derive their water. In places where the Edwards Aquifer outcrops to the south, numerous springs and seeps issue forth forming the base flow for several of the perennial steams in the area. In the area below the escarpment where the Edwards outcrops, water reenters the formation through solution cavities that have developed along fractures in the limestone. At various places down slope from the recharge zones, water reaches the surface under hydraulic pressure through faults that reach the surfaces. The water sources have formed some of the more famous of Texas springs and artesian wells. Recharge to the aquifer is primarily from streams that flow across its outcrop in the Fault Zone although some recharge is from direct precipitation on the outcrop.

Surface Hydrology

Bexar County and the San Antonio area are located in the San Antonio River Basin. Major streams of the basin, all of which flow through Bexar County include the Medina River, Leon Creek, Salado Creek, Cibolo Creek, and the San Antonio River. Drainage is southward and southeastward off the Balcones Escarpment. Some of the flow of Leon Creek within the upper reaches is lost to the Edwards Aquifer as it passes over the recharge zone. This is due to the porous nature of the underlying limestone.

Soil Conditions

The San Antonio area and Bexar County are comprised of several general soil associations. Two major soil associations classified by the USDA occur along the extent of the Leon Creek alignment examined for this study. They are the Trinity Unit found above the Commerce Street bridge and the Frio unit below.

Trinity Series

The Trinity series consists of alluvial soils that are deep, dark colored, and nearly level. These soils are on the bottom land in the eastern and southwestern parts of the county. The surface layer is dark-gray, calcareous clay and is about 50 inches thick. It has medium, subangular blocky structure and is firm when moist. The subsurface layer is gray, calcareous clay and is about 15 inches thick. This layer has weak, subangular blocky structure. The underlying material is recent clayey alluvium washed from the clayey, upland soils. The surface layer ranges from black to grayish brown in color and from 40 to 70 inches in thickness. It is generally clay in texture. The subsurface layer ranges from 4 to 20 inches in thickness and from gray to light grayish brown in color. The depth to strata of water-worn gravel ranges from 4 to 12 feet.

Frio series

The Frio series consists of limy alluvial soils that are moderately deep, grayish brown or dark grayish brown, and nearly level. The surface layer is grayish-brown or dark grayish-brown clay loam and is about 20 inches thick. It has weak, granular structure, is friable, and is easily worked. This limy layer contains few to many worm casts and snail fragments. The subsurface layer is light brownish gray. It is more loamy and more compacted than the surface layer; the texture is light clay loam or loam. This layer has weak, fine, granular structure. It is limy, firm but crumbly when moist, and about 5 inches thick. The parent material is limy, friable, loamy alluvium. In places it contains thin layers of more sandy or more clayey material. There are a few beds of water-rounded limestone gravel at a depth of 3 to 6 feet. The surface layer of Frio soils ranges from 8 to 25 inches in thickness and from loam to clay loam and silty clay loam in texture. The finer textured soils are the darker colored. The subsurface layer is 5 to 20 inches thick. It has moderate, fine, granular and subangular blocky structure and is friable when moist. The underlying material ranges from sandy loam through light loam and stratified loam to clay loam in texture.

Test Cell Facility Site

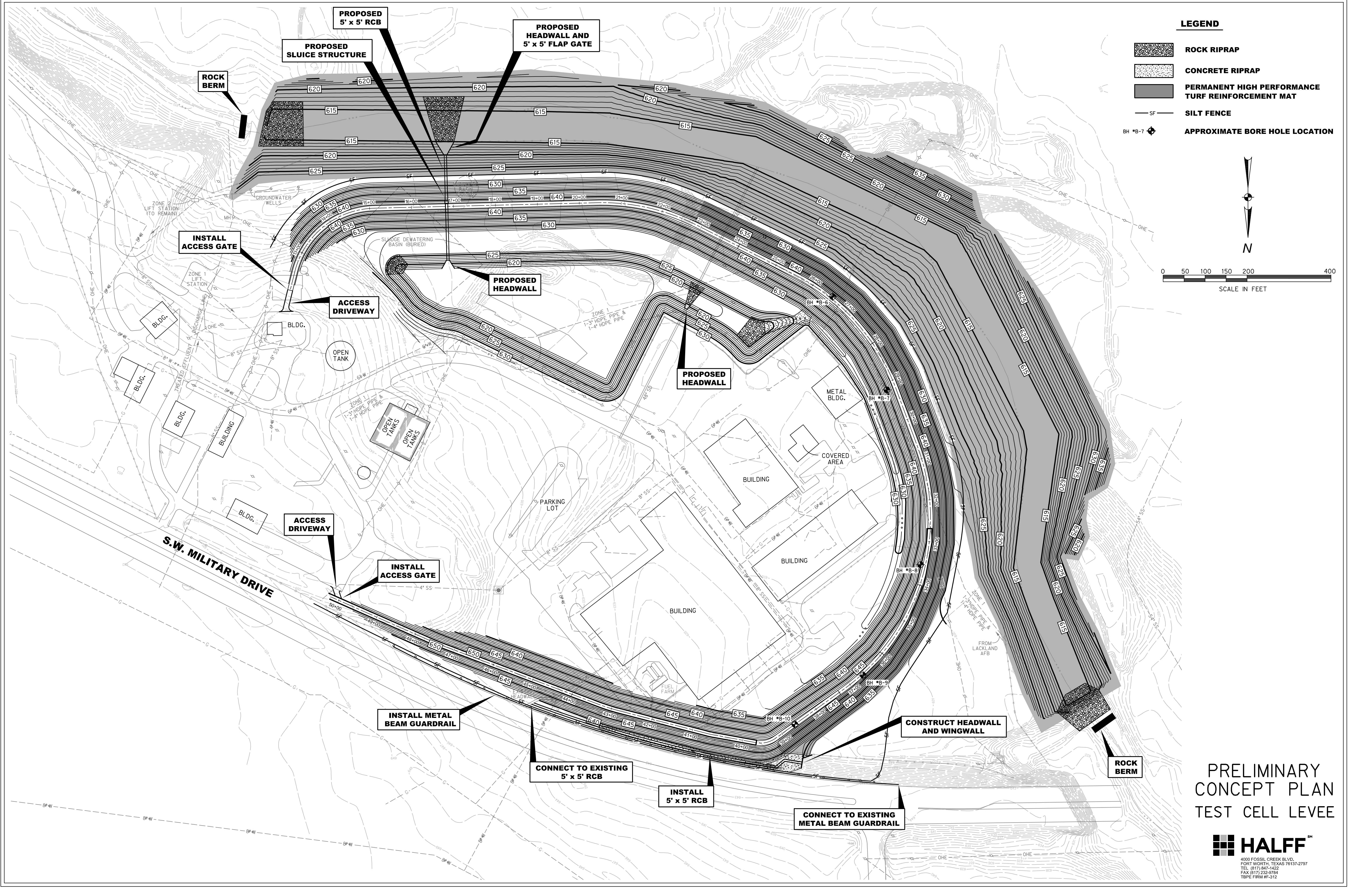
The final recommended plan from the Leon Creek IFS and AFB includes the construction of a levee, floodwall, sump, and Leon Creek channelization in the vicinity of the Port San Antonio (PSA) property which includes the Lockheed Martin Jet Engine Test Cell Facility (Test Cell). There is limited geotechnical information available from a previous feasibility study authorized by the PSA for the Test Cell. HVJ Associates, Inc. was the geotechnical consultant to HDR Engineering, Inc. as part of a 2006-2007 feasibility study. An existing levee (in poor condition) is located along Leon Creek on the proposed PSA property, but it is breached and overtopped for less frequent events. A summary of the HVJ Associates, Inc. analysis and findings is presented below. These excerpts are taken directly from the HVJ Associates, Inc. April 2006 report, *"Geotechnical Study – Test Cell Levee Feasibility Analysis, San Antonio, Texas"*.

1. A preliminary geotechnical investigation was performed that included drilling and sampling 10 borings along the crest of the existing levee structure. Laboratory testing was performed on select samples to characterize the engineering properties of the subsurface strata.
2. The subsurface stratigraphy consists of approximately 25 to 30 ft of alluvial soils comprised of soft to hard/dense clay, silt, sand and gravel over highly overconsolidated, high plasticity clay.
3. Groundwater was encountered at all boring locations. It is anticipated that the groundwater level is consistent with the level in Leon Creek.
4. The layers of soil at the level of the groundwater table (approximately 15 ft below grade) are very compressible and have essentially no undrained shear strength.
5. The alluvial strata are very permeable, i.e., have a high hydraulic conductivity; the underlying clay stratum has a very low permeability and essentially acts as a hydraulic barrier resulting in perched groundwater conditions.
6. The condition of the existing levee is poor. The soils are non-uniform and uncharacterized containing layers of sand and construction debris. Localized slope failures and areas of subsidence were observed. Most important, multiple penetrations parallel to, on top of, and longitudinally along the levee were observed and are causing detrimental impacts to the structure.
7. The levee should not be used in whole or in part for the long-term flood-control solution.

Geotechnical Investigations, Testing, and Analyses to be Completed during PED

A geotechnical investigation will be conducted during the PED phase to supplement the information obtained during planning. This information is necessary to substantiate site-specific conditions by drilling borings along and within the alignments of project features. Soil and rock samples collected will be tested to obtain engineering properties in order for design parameters to be developed, in addition to obtaining information on potential borrow sources within the project boundaries, and construction limitations associated with the use of these materials. Groundwater conditions will also be monitored to determine the impact on the flood control features associated with this project.

All analyses performed during the PED phase shall be in accordance with current USACE criteria using site-specific information. The analyses shall address foundation design conditions, slope stability requirements, and seepage mitigation measures for the flood control features. Seepage and stability models developed shall reflect design project cross-sections, actual soil types, with associated geotechnical engineering properties, and groundwater conditions. The geotechnical investigation will also document construction techniques, limitations, and problems associated with the in situ conditions of the project site.



PRELIMINARY CONCEPT PLAN
TEST CELL LEVEE

HALFF℠
4000 FOSSIL CREEK BLVD.
FORT WORTH, TEXAS 76137-2797
TEL (817) 847-1422
FAX (817) 232-9784
TBPE FIRM #F-312

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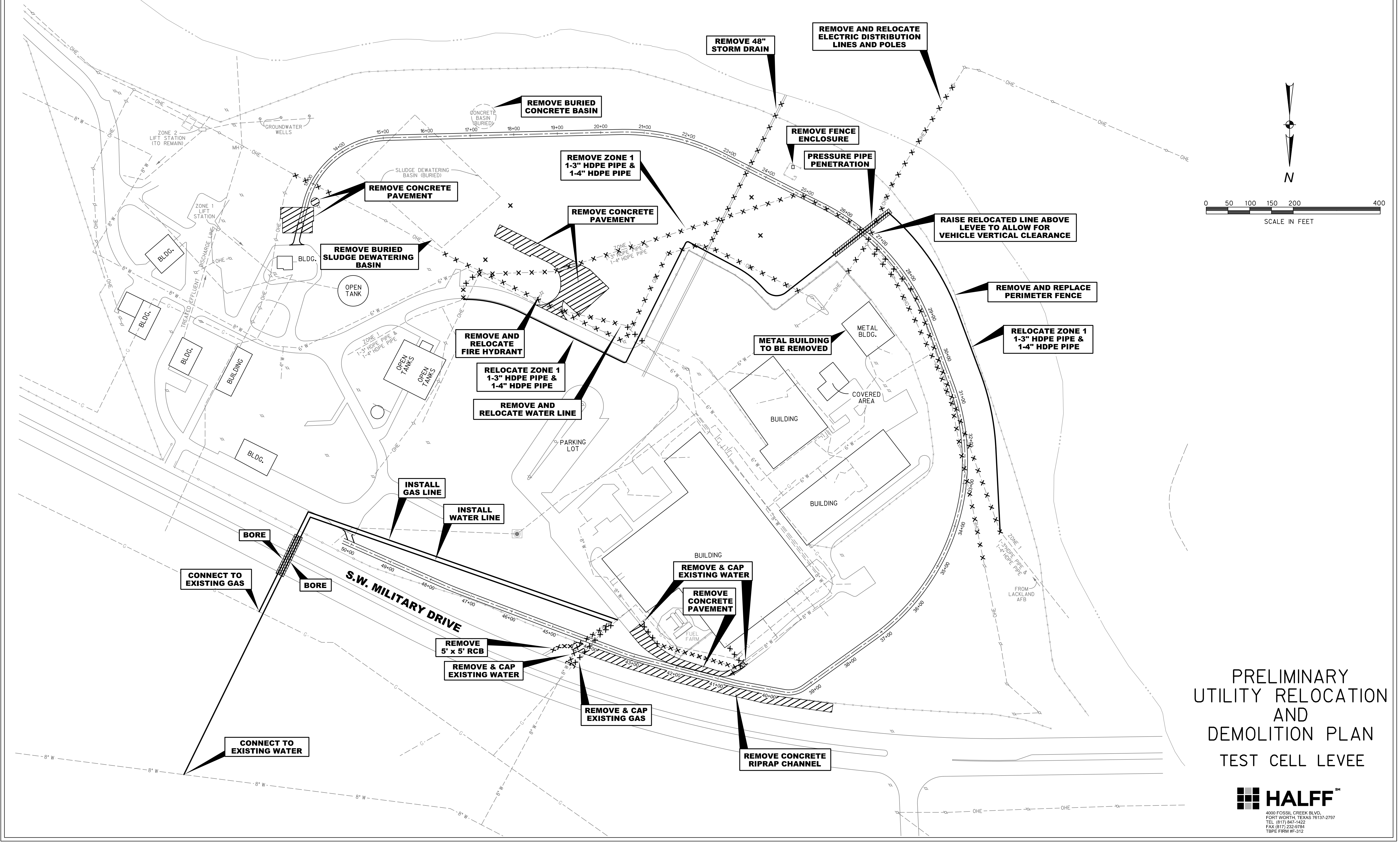
NOTE:

NO POWER POLES OR OTHER FEATURES MAY BE RELOCATED ON THE LEVEE OR WITHIN 15' OF THE LEVEE TOES.



PRELIMINARY UTILITY RELOCATION AND DEMOLITION PLAN

TEST CELL LEVEE

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4000 FOSSIL CREEK BLVD.
FORT WORTH, TEXAS 76137-2797
TEL (817) 847-1422
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TBPE FIRM #F-312

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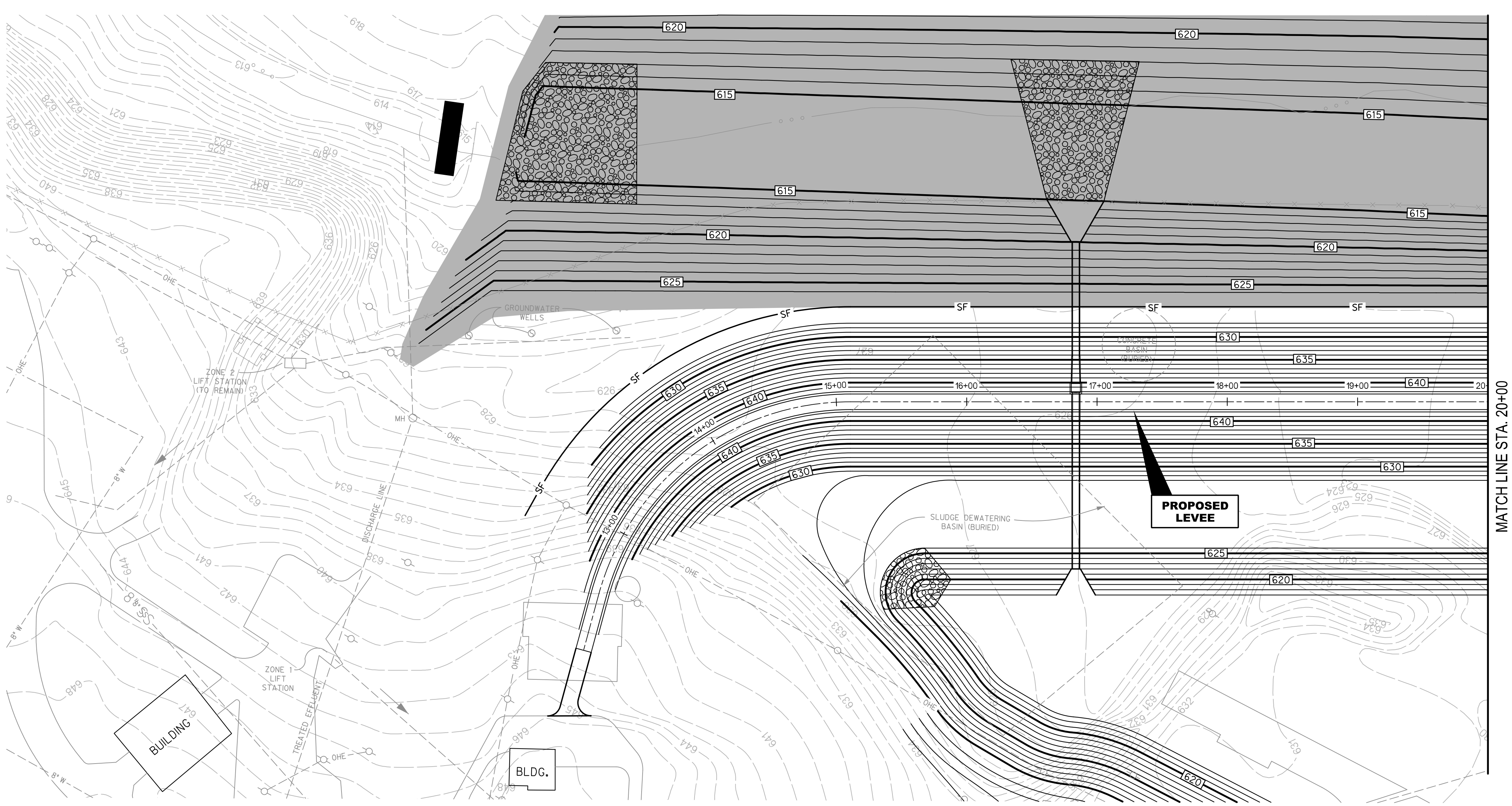
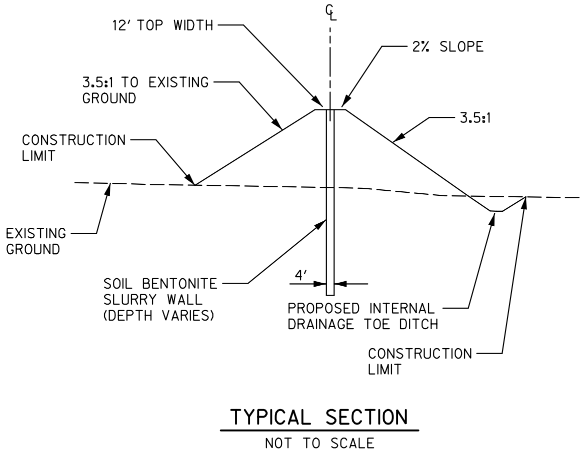


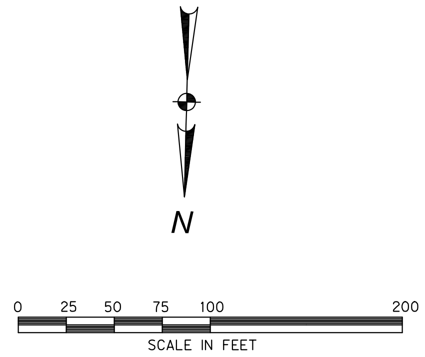


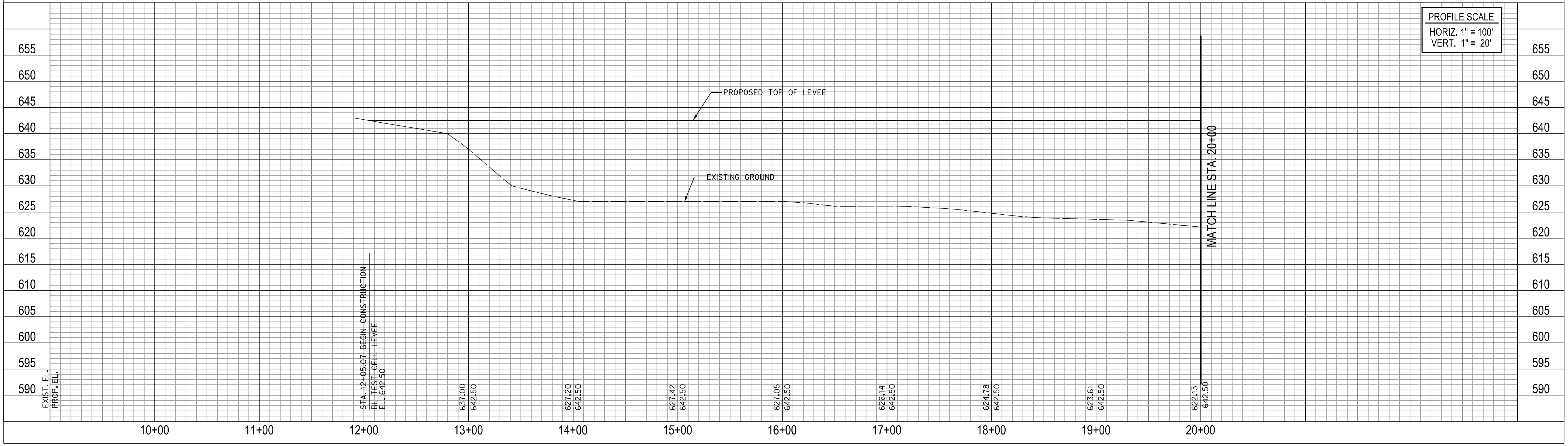
TYPICAL SECTION

NOT TO SCALE

NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ALL UTILITIES, WHETHER PUBLIC OR PRIVATE, PRIOR TO CONSTRUCTION.
2. EXISTING UTILITIES TO REMAIN, UNLESS OTHERWISE NOTED.





LEON CREEK
INTERIM FEASIBILITY STUDY
U.S. ARMY CORPS
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Revision No.	Date	Description
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PRELIMINARY

FOR INTERIM REVIEW ONLY

THESE DOCUMENTS ARE FOR INTERIM REVIEW AND NOT INTENDED FOR REGULATORY APPROVAL, PERMIT, BIDDING OR CONSTRUCTION PURPOSES. THEY WERE PREPARED BY OR UNDER THE SUPERVISION OF:

ANDREW D. ICKERT 94698
NAME P.E. NO.
DATE 10/23/2013
TBPE FIRM #F-312

Project No.: 26322
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Checked By: ADI
Sheet Title
TEST CELL LEVEE ALT
PLAN & PROFILE

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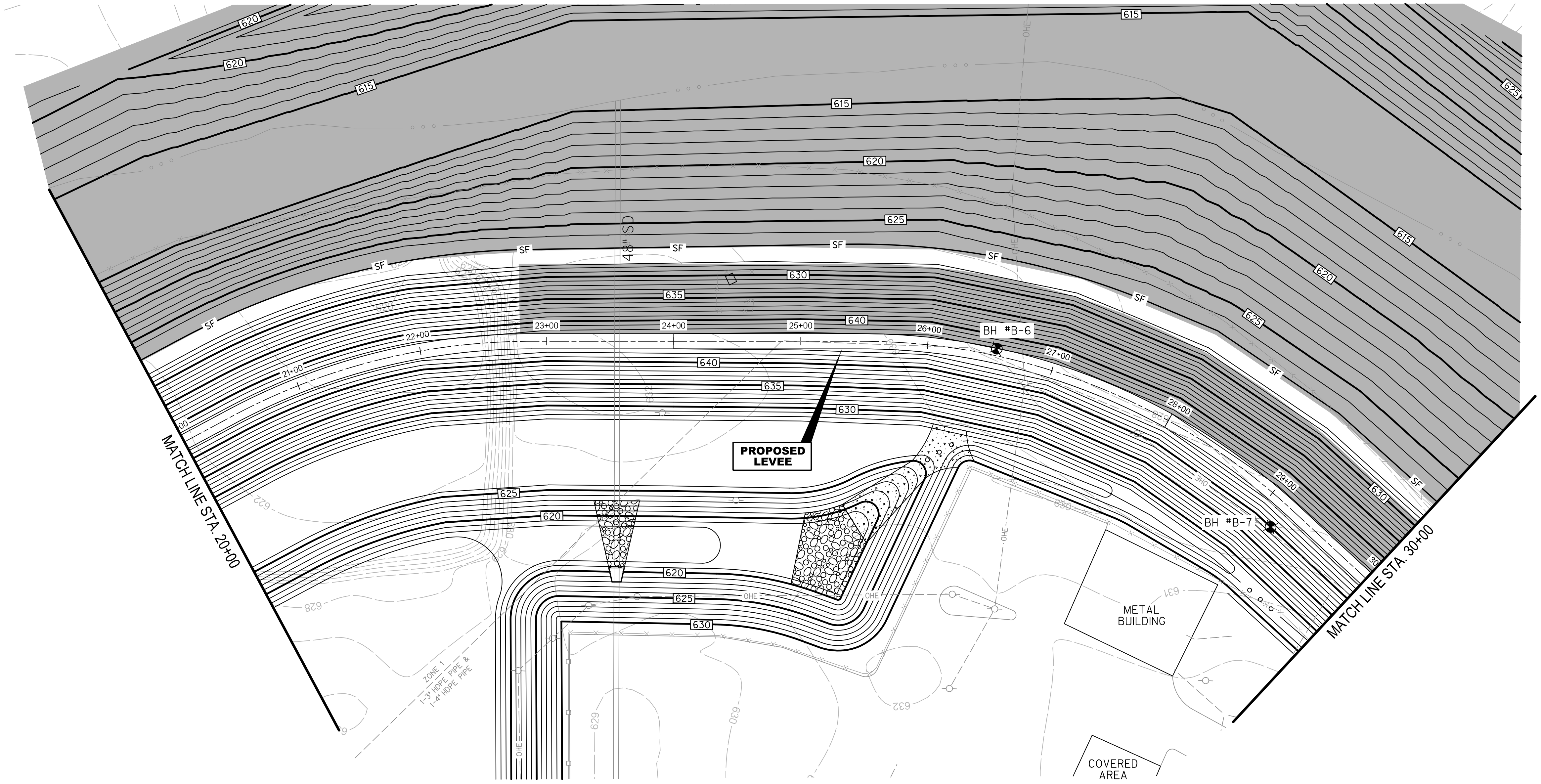

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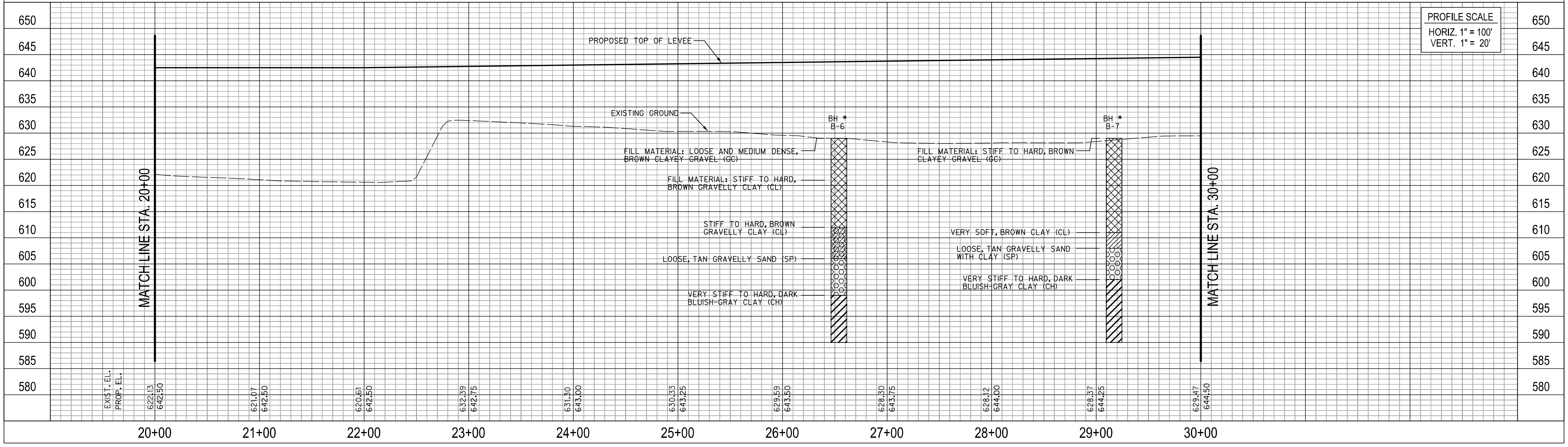

LEON CREEK
INTERIM FEASIBILITY STUDY

U.S. ARMY CORPS
OF ENGINEERS

HALFF℠
4000 FOSSIL CREEK BLVD
FORT WORTH, TEXAS 76137-2797
TEL (817) 847-1422
FAX (817) 232-9784
TBPE FIRM #F-312

Revision No.	Date	Description
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ANDREW D. ICKERT	94698
NAME	P.E. NO.
DATE	10/23/2013
TBPE FIRM #F-312	

Project No.:	26322
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Sheet Title

TEST CELL LEVEE ALT
PLAN & PROFILE

C1.02

Sheet Number

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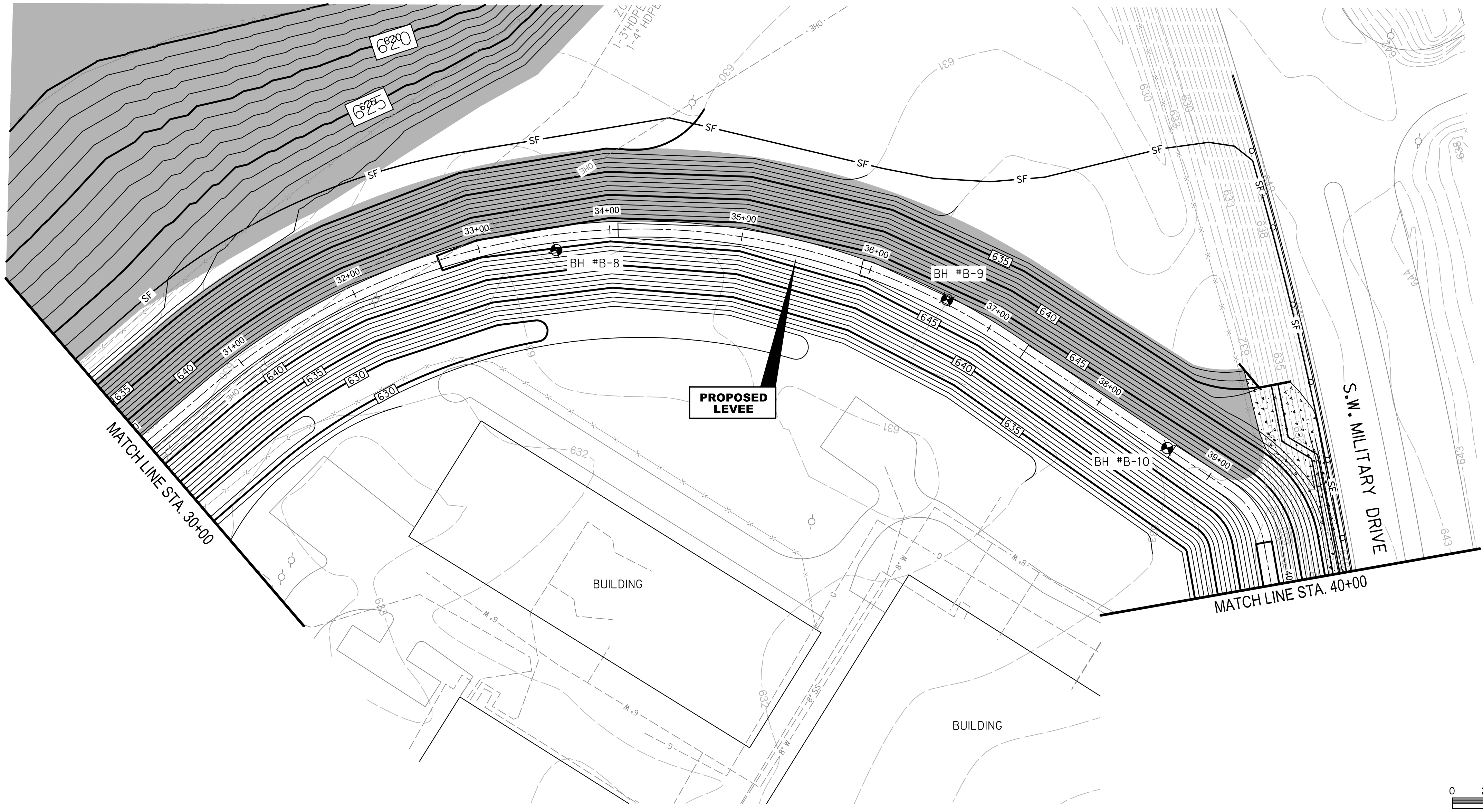

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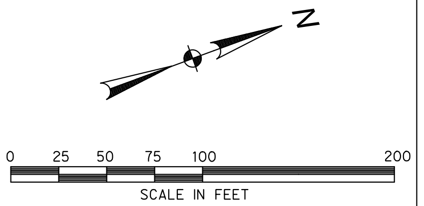

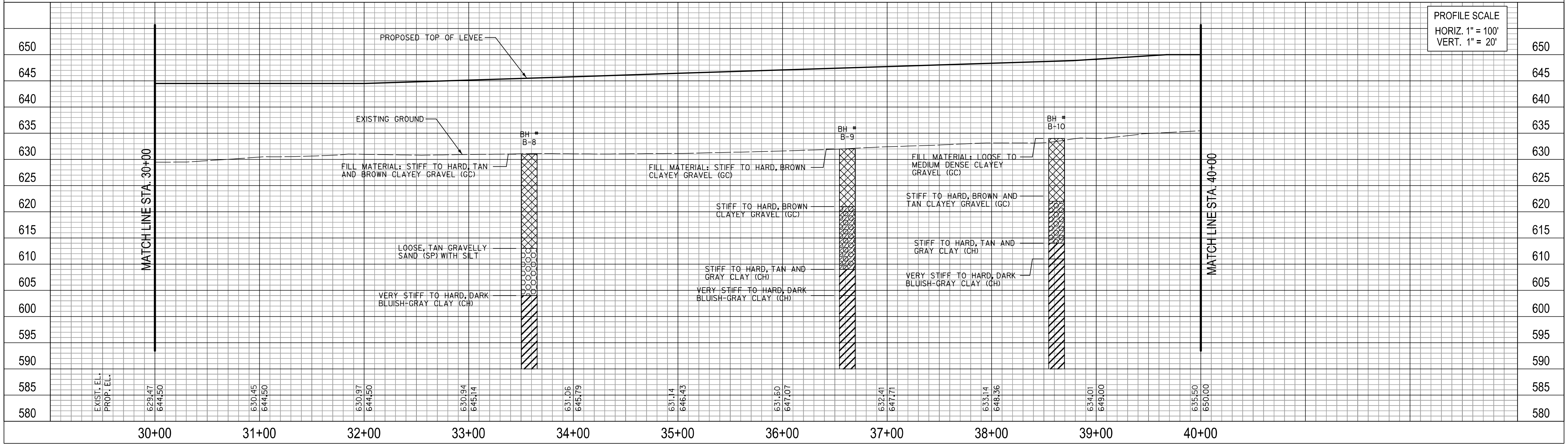

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INTERIM FEASIBILITY STUDY

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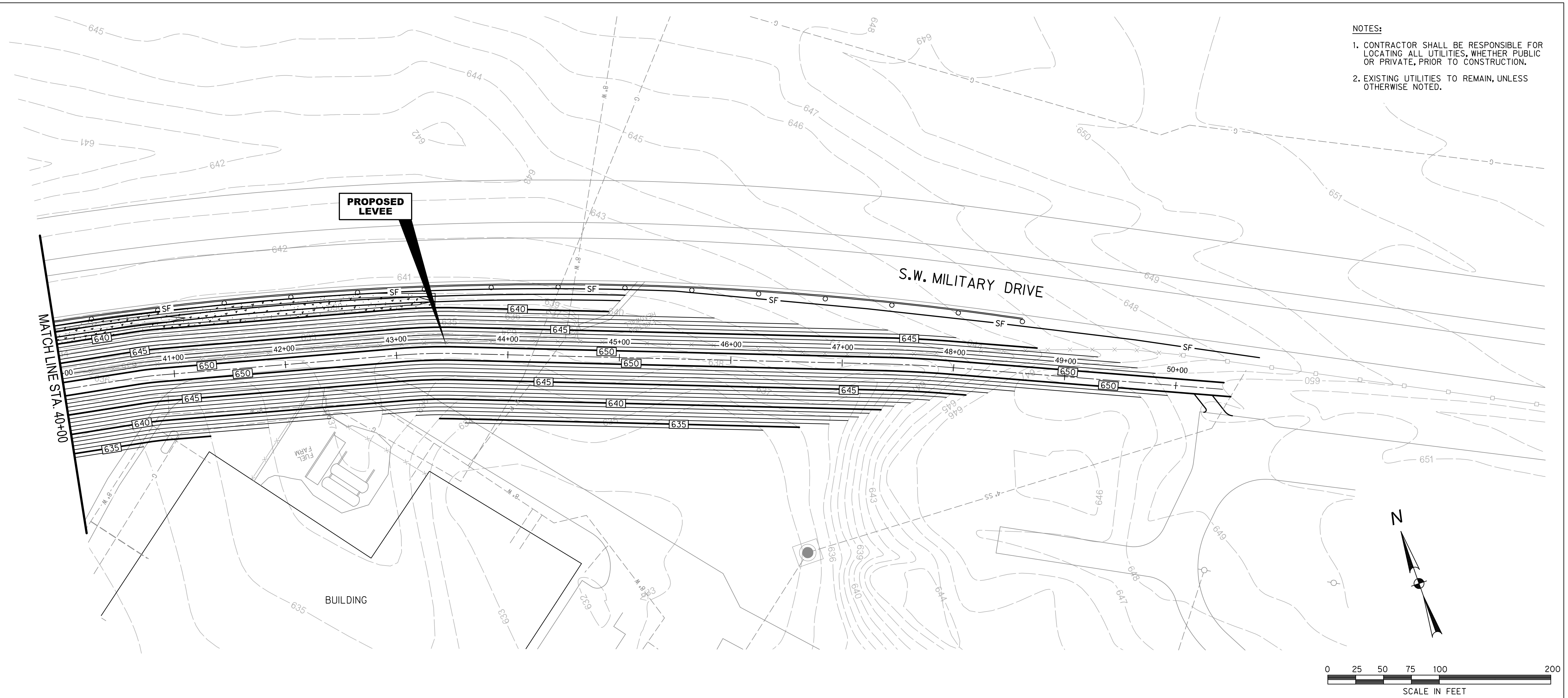

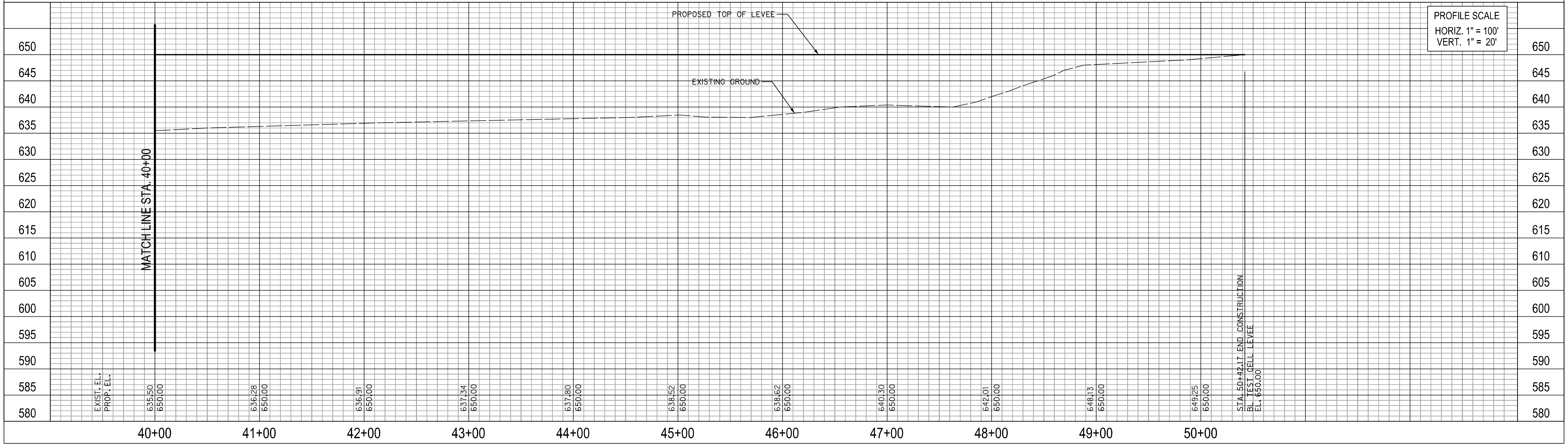

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NAME P.E. NO.
DATE 10/23/2013
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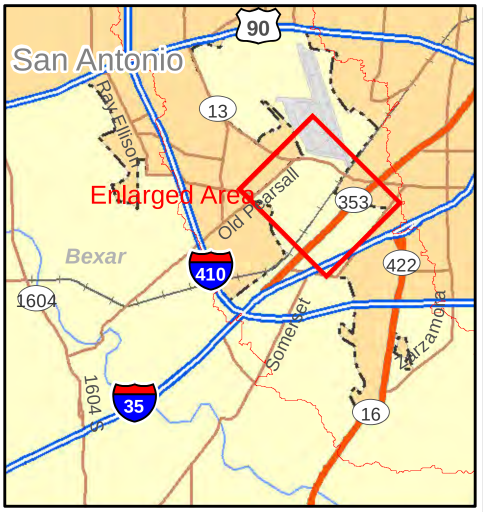
Leon Creek- Regional Faulting NearTest Cell Levee



Legend

▬ ▬	Regional Faults
▦	Ecological Mitigation Area
▦	Sump - Inside
▦	Sump - Outside
▨	1% AEP Levee
▨	Excavation Area
▨	Channel Area

0 250 500 1,000 1,500 Feet

N E W S

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 22, 2013
Author: Jennifer Holland
Location: \\swf-netapp1\Civil\
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HVJ
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March 21, 2006

Mr. John Marler, P.E.
HDR Engineering, Inc.
4401 Westgate Blvd., Suite 400
Austin, Texas 78745

Re: Flood-Control Structure Alternatives Assessment
Test Cell Levee Feasibility Analysis
San Antonio, Texas
Owner: Port Authority of San Antonio
HVJ Report No. 02-155GA-0

Dear Mr. Marler:

Submitted herein is our letter report summarizing alternatives for a flood-control structure at the project site and a preliminary outline of the potential failure modes for the alternatives identified. The discussions presented herein were developed from a brief review of the available information, a site visit and preliminary results from a field investigation. In addition, Dr. Roy E. Olson, professor at the University of Texas at Austin was consulted and provided input. This report is intended as preliminary and should be used as the basis for future investigations and more detailed study.

Flood-Control Structure Alternatives

The selection of a suitable flood-control structure for the project site depends primarily on three variables, 1) the purpose of the structure, 2) the permeability of the in-situ alluvial soils underlying the project site, and 3) the available space for construction. After review of the available data, these three factors were determined to be the driving factors in the selection of the alternatives presented in the table below. After the engineering, the cost is the next significant factor. The inclusion of a variety of different types of structures was aimed at addressing this issue. It is anticipated that other factors affecting the design and not considered in this assessment will be considered in later phases.

Purpose of Flood-Control Structure

The purpose of the flood-control structure at this project site is to maintain dry conditions within the structure with sufficient reliability. The design level of reliability is undetermined at this time. However, the selection of the alternatives was focused on typical geotechnical structures for which their reliability could be estimated from available data from similar projects.

Permeability of In-situ Soils

The permeability of the in-situ soils will determine whether a sufficient pathway exists for groundwater flow between Leon Creek and the project site. Specifically, the duration of time that elapses between a given rise in Leon Creek and a response directly under the project site is significant to the design. In addition, the depth of water that can be sustained outside a given structure will also be limited by the permeability, i.e. the gradient across the structure. At the project site specifically, it is important to note that the subsurface conditions consist of approximately 25 ft of alluvial deposits over very low permeability clays. This discussion is, therefore, aimed at the upper 25 ft of deposits.

Space Availability

The type of structure that can be constructed and used is dictated by the space available. Along the length of the proposed levee, it appears as if there are areas where sufficient space exists and other areas where only designs that cover a limited area can be used. An additional factor in determining available space is the property limits and coordination with adjacent owners. The actual space restrictions are unknown at this time.

Alternatives

The various conditions for each variable and the associated flood-control alternative are presented in the following table. These alternatives were considered suitable for construction at the project site with typical construction effort.

Site Specific Variables		**Flood-Control Structure**	
Available Space	**Subsurface Permeability**	**Surface Structure**	**Cut-off Structure**
sufficient	high	engineered earthen levee	grout curtain
limited	high	earth covered sheet-piling	sheet piling
sufficient	low	engineered earthen levee	none
limited	low	cantilever retaining wall	none

It should be noted that a combination of the two alternatives due to the varying space conditions is likely. One additional alternative component that was considered was the use of pumps or a drain system on the land side of the flood-control structure to maintain dry conditions. However, a thorough seepage analysis given the specific site and design flood conditions is required to even determine whether it is a feasible option. The feasibility of this alternative is undetermined at this time but should be considered after additional data are available.

Failure Modes

The modes of failure identified in this letter report for the flood-control structures presented in the table above are limited to failures resulting from the in-situ soil conditions provided a sufficient design and quality construction of the structure itself. Specifically, the permeability of the soils and the loading that will result from the design flood event are the focus of this failure mode assessment. It should be noted, however, that neither of these variables are known at this time. In addition, the existing flood levels estimated by FEMA are currently being updated and are anticipated to increase in response to recent flood events. Therefore, the failure modes identified at this time are speculative and should be used to identify areas where additional data are needed.

The primary mode of failure for all the structures is excessive seepage. Again, it is assumed that the structures themselves are engineered for the site-specific conditions. For the alternatives that do not include a below-grade cut-off, the gradient that will be produced across the structure could result in significant loss of strength of the subsurface soils leading to a piping failure and 'boiling' of the land-side soils resulting in a bearing failure of the foundation. However, construction of a cut-off in the alluvial soils that sufficiently seals all pathways down to the low permeability clays will be difficult. A more complete analysis of each structure will be possible when estimated loadings and characterization of the in-situ soils is complete.

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.

LIZAN N. GILBERT
91796
3/21/06

Lizan N.Gilbert, P.E.
Project Engineer

Copies submitted: 1 electronic (Marler)

The seal appearing on this document was authorized by Lizan N. Gilbert, P.E. 91796 on March 21, 2006. Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act.

GEOTECHNICAL STUDY
TEST CELL LEVEE FEASIBILITY ANALYSIS
SAN ANTONIO, TEXAS

SUBMITTED TO
HDR ENGINEERING, INC.
4401 WESTGATE BOULEVARD
SUITE 400
AUSTIN, TX 78745

BY
HVJ ASSOCIATES, INC.
APRIL 4, 2006

REPORT NO. 02-155GA-0

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April 5, 2006

Mr. John Marler, P.E.
HDR Engineering, Inc.
4400 Westgate Boulevard
Suite 400
Austin, Texas 78745

Re: Test Cell Levee Feasibility Analysis
San Antonio, Texas
Owner: Port Authority of San Antonio
HVJ Report No. 02-155GA-0

Dear Mr. Marler:

Submitted herein is the Geotechnical Study for the above referenced project. In general, this report presents the boring logs, a boring location plan, laboratory test results and a description of the existing levee condition. The investigation was performed in accordance with our proposal number 02-155GA-0.

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.

LIZAN N. GILBERT
91736

Lizan N.Gilbert, P.E.
Project Engineer

4/5/06

Copies submitted: 4 hard copies HDR (Marler)
1 electronic copy HDR (Marler)

TABLE OF CONTENTS

PLATES

APPENDICES

I. EXECUTIVE SUMMARY

HVJ Associates, Inc. was retained by HDR Engineering, Inc. to perform a geotechnical study of the existing levee at the Test Cell Facility in San Antonio, Texas. The project site is comprised of the structures for a jet engine test facility surrounded by an earthen levee. The study consisted of three primary objectives, 1) determine the in-place condition of the existing levee structure, 2) perform a preliminary geotechnical investigation, and 3) identify alternatives for a flood-control structure at the project site. The first two objectives are outlined in this report. The third objective, the list of alternatives is presented in a separate letter report, "Flood-Control Structure Alternatives Assessment," written by HVJ and dated March 21, 2006. The results of the first two are summarized briefly below.

1. A preliminary geotechnical investigation was performed that included drilling and sampling 10 borings along the crest of the existing levee structure. Laboratory testing was performed on select samples to characterize the engineering properties of the subsurface strata.
2. The subsurface stratigraphy consists of approximately 25 to 30 ft of alluvial soils comprised of soft to hard/dense clay, silt, sand and gravel over highly overconsolidated, high plasticity clay.
3. Groundwater was encountered at all boring locations. It is anticipated that the groundwater level is consistent with the level in Leon Creek.
4. The layers of soil at the level of the groundwater table (approximately 15 ft below grade) are very compressible and have essentially no undrained shear strength.
5. The alluvial strata are very permeable, i.e., have a high hydraulic conductivity; the underlying clay stratum has a very low permeability and essentially acts as a hydraulic barrier resulting in perched groundwater conditions.
6. The condition of the existing levee is poor. The soils are non-uniform and uncharacterized containing layers of sand and construction debris. Localized slope failures and areas of subsidence were observed. Most important, multiple penetrations parallel to, on top of and longitudinally along the levee were observed and are causing detrimental impacts to the structure.
7. The levee should not be used in whole or in part for the long-term flood-control solution.

A thorough review of this report and all data presented herein is required for a complete understanding of this data summary.

1 INTRODUCTION

1.1 Project Description

HVJ Associates, Inc. was retained by HDR Engineering, Inc. to perform a geotechnical study of the existing levee at the Test Cell Facility in San Antonio, Texas. The study consisted of three primary objectives, 1) determine the in-place condition of the existing levee structure, 2) perform a preliminary geotechnical investigation, and 3) identify alternatives for a flood-control structure at the project site. The first two objectives are outlined in this report. The third objective, the list of alternatives is presented in a separate letter report, "Flood-Control Structure Alternatives Assessment," written by HVJ and dated March 21, 2006.

1.2 Purpose and Scope of Work

The purpose of this portion of the study was to gather sufficient information on the in-place soils of the existing levee structure at the project site and perform a preliminary geotechnical investigation at the site to facilitate the selection of flood-control alternatives, including an evaluation of the existing levee structure. Our scope of work included:

1. Drilling and sampling ten (10) soil borings at various locations along the levee structure to depths of 40 ft.

2. Performing field and laboratory tests to determine physical properties and engineering characteristics of the soils.

3. Observing and measuring in-situ groundwater levels during drilling.

Subsequent sections of this report contain descriptions of the field investigation, laboratory-testing program, and general subsurface conditions.

2 FIELD INVESTIGATION

2.1 General

The field investigation was initiated on December 13, 2005. In total ten (10) borings were drilled to depths of 40.0 ft along the alignment of the existing levee. The boring logs are presented on Plates 4 through 13. The keys to terms and symbols shown on the borings logs are presented on Plates 14A and 14B. The locations of the soil borings are presented on Plate 3, Plan of Borings.

2.2 Sampling Method

During dry advancement of the boring, 3-inch diameter thin-walled tube samplers were pushed into the soil to obtain samples of cohesive soil strata in accordance with ASTM D1587. The samples were extruded in the field and visually classified. An estimate of the undrained shear strength was obtained by means of the pocket penetrometer. Upon refusal of the thin-walled samplers or when cohesionless soils were encountered, split-spoon samplers, with an outside diameter of 2 in., an inside diameter of 1.375 in. and a barrel length of 21 inches, were driven into the soil strata to obtain disturbed samples. Standard Penetration blow counts were recorded as the number of blows to drive the sampler three (3), 6-inch increments using a 140-lb hammer for a maximum of 50 blows for 6 inches of penetration (ASTM D1586). The Standard Penetration N-value is the sum of the number of blows for the last two, 6-inch intervals. Samples were subsequently wrapped and sealed for transport to our laboratory. Detailed descriptions of the soils encountered in the borings are given on the boring logs.

2.3 Borehole Completion

Upon completion of drilling, all project borings were backfilled with bentonite chips.

3 LABORATORY TESTING

The laboratory testing program was aimed at determining the physical properties and engineering characteristics of the selected soil samples. The soil strata were tested to determine their Atterberg limits, sieve analyses, unconfined compressive strength, water contents and moisture-density relationships. All tests were performed in accordance with the relevant ASTM Standards. The sieve analyses were run on samples obtained from the fill material that comprises the earthen levee. The laboratory test results are presented on the boring logs at their respective depths and in the Appendix, Laboratory Test Results Summary. The results of the sieve analyses and moisture-density relationships are presented in the Appendix, Sieve Analysis Results and Moisture-Density Relationships.

4 SITE CHARACTERIZATION

4.1 Site Characterization

The project site is located directly adjacent to Leon Creek and south of SW Military Drive on the old Kelly USA in south west San Antonio, Texas. A site vicinity map is presented on Plate 1, Vicinity Map. The site currently contains the jet engine test facility structures surrounded by an earthen levee on roughly three sides. The site slopes in the direction of flow in Leon Creek, south-southeast, from approximately 641 ft to 639 ft. The site is within the 100 year floodplain, although the exact elevation is currently being determined. Survey data for the site and the borings was not available at the time of this report. The site has minimal vegetation.

4.2 General Geology

According to the Geologic Atlas of Texas[1], the project area is underlain by alluvial deposits of Leon Creek over clay of the Taylor Group. The alluvial soils are comprised of a mixture of normally consolidated clay, silt sand and gravel. The grain size of the soils generally increase with depth with gravel and sand layers located directly above the Taylor clay. Water is generally encountered within these sand and gravel layers. The Taylor clay is comprised of highly plastic and blocky clay and shale. The clay has a very low hydraulic conductivity and, therefore, acts as a hydraulic boundary to groundwater. A generalized map of the surface geology is included as Plate 2, Geology Map.

---

[1] W. L. Fisher, 'Geologic Atlas of Texas, San Antonio Sheet' Bureau of Economic Geology, The University of Texas at Austin, 1983.

4.3 Subsurface Stratigraphy and Engineering Properties

The subsurface stratigraphy is comprised of fill material, i.e., the levee, over alluvial soils comprised of lean clay, silt, sand and gravel over highly overconsolidated fat clay and shale. A thorough review of the boring logs is required to develop a sufficient understanding of the subsurface conditions. A brief description of the subsurface strata is presented below.

The fill for the earthen levee is comprised of uncharacterized material including clay, sand and gravel as well as debris, e.g., asphalt and concrete. The thickness of fill varies from 11.0 ft to 18.0 ft as the levee height is inconsistent along its length. The standard penetration values are inconsistent with depth, although a slight trend towards a decrease with depth, i.e., material becoming more loose with depth, occurs at a few boring locations. Classification tests indicate percentages of material passing the No. 200 sieve ranging from 2 to 69 (average 29). The material is generally non-cohesive and samples within this material were recovered exclusively using split-spoon samplers. In addition, the results of the eight (8) sieve analyses indicate a well graded material with a maximum particle size of approximately 7/8 inches. Sand layers were also encountered at various boring locations within the fill material. Last, moisture-density relationships were developed for material sampled from the levee. The results indicate a maximum dry density varying between 108 pcf to 120 pcf with associated optimum water contents of 15 percent and 10 percent, respectively. These results also indicate a non-uniform material placement.

Below the fill, clay, silt, sand and gravel layers were encountered to depths ranging from 20.0 to 30.0 ft below grade. As discussed above, it should be noted that the actual thickness of alluvial soils is undetermined as the elevations of the borings are undetermined. It is anticipated that the contact between the alluvial soils and the underlying clay and shale is generally consistent, although the presence of an eroded channel within the clay is possible. The results of the classification tests indicate a liquid limit (LL) ranging from 31 to 47 percent (average 41 percent), the plasticity index (PI) ranging from 16 to 31 percent (average 22 percent) and the percentage of material passing the No. 200 sieve ranging from 7 to 81 (average 43). Groundwater was encountered within this layer at depth of approximately 15 to 18 ft below grade. The SPT values in the immediate vicinity of the water table were very low at all boring locations. At the B-7 boring location specifically, a penetration of 18 inches was observed for 1 blow. The soils in this layer are characterized as very soft and very compressible, i.e. essentially no undrained shear strength. They are, however, highly permeable.

Highly plastic, fat clay was encountered below the alluvial soils. These soils are highly overconsolidated with SPT values indicating a hardness of very stiff to hard throughout. At the boring B-3 location, the SPT values were greater than 50 blows for a penetration of 6 inches. These results are indicative of shale, or the intact formation. The results of the classification tests indicate a liquid limit (LL) ranging from 36 to 76 percent (average 61 percent), the plasticity index (PI) ranging from 20 to 60 percent (average 42 percent) and the percentage of material passing the No. 200 sieve ranging from 78 to 100 (average 94).

4.4 Groundwater

Groundwater was encountered at all boring locations between 15 and 23 ft below the ground surface. The variation in groundwater level is not indicative of the true condition but a function of not having survey elevations for the borings. It is anticipated that the true groundwater level is consistent across the site and with the water levels in Leon Creek. In addition, a pump and treat system with monitoring wells is currently set up at the project site. This indicates a relatively high permeability of the alluvial soils, the actual value undetermined during this investigation. Groundwater levels will fluctuate with rainfall conditions and flood events.

5 EXISTING LEVEE EVALUATION

The condition of the existing levee was evaluated for the purpose of answering two questions, 1. What is the condition of the material in its current configuration, and 2. Can the existing structure be used in any manner for the long-term flood control of the Test Cell area? Historical data and the results of this geotechnical investigation were reviewed and the site was visited to answer these questions. In addition, the alternatives for constructing a long-term flood-control structure were identified, as discussed in the Introduction section of this report, to determine the possibilities for how the existing earthen levee could be utilized in future solutions.

First, the condition of the existing levee is poor. The south/south east portion of the levee has been eroded and multiple areas of localized slope failures were observed. The remaining material is inconsistent, very soft and contains construction debris. It is clear that the levee was comprised of unprocessed material such as an uncontrolled on-site stockpile and placed without construction oversight typical for this type of structure.

Perhaps more important than the in-place condition of the material is the number of penetrations into and through the levee. Multiple telephone poles were founded at various points along the crest of the levee, a flexible pipeline was buried longitudinally along the alignment, and at least two penetrations perpendicular to the levee, including a water line and a small concrete box culvert type structure, were constructed at the base of the levee. These by far have the most impact on the integrity of the existing levee. In fact, multiple areas of erosion directly around these structures were observed including a large, approximately 10 ft diameter and 8 ft deep sink hole was observed in the immediate vicinity of one of the buried pipes. It is anticipated that these penetrations could result in loss of material by piping and ultimate failure of any structure founded on top of or using this existing structure.

It is recommended that the existing levee should not be used in whole or in part of the long-term flood control solution. It is possible that the material could be processed and used in an alternative that included an earthen portion. However, the penetrations in the levee should be eliminated or carefully engineered for any long-term flood-control structure to operate properly.

6 LIMITATIONS

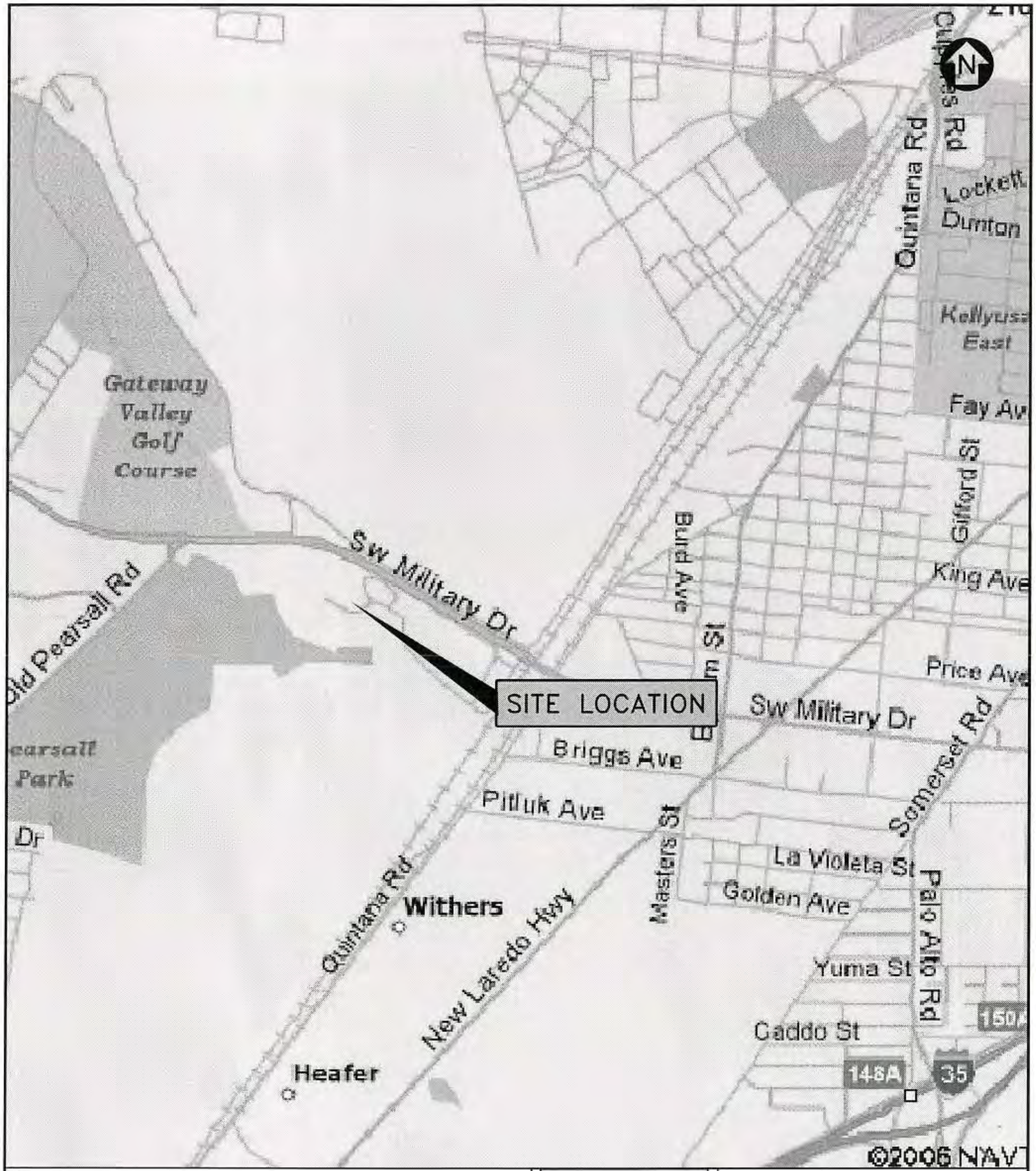
This study was performed for the exclusive use of HDR Engineering, Inc. for specific application to the proposed Test Cell Levee Feasibility Analysis in San Antonio, Texas. HVJ Associates, Inc. has endeavored to comply with generally accepted geotechnical engineering practices common in the local area. HVJ Associates, Inc. makes no warranty, express or implied.

The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations.

Should any subsurface conditions other than those described in our boring logs be encountered, HVJ Associates should be immediately notified so that further investigation and supplemental recommendations can be provided.

Subsurface conditions at the site can differ significantly from those encountered in the borings due to the natural variation of geologic conditions, which may not have been detected by the field boring program. In the event that any changes in the nature, design, or location of the improvements are made, the conclusions and recommendations in this report should not be considered valid until the changes are reviewed and the conclusions and recommendations modified or verified in writing by HVJ Associates.

PLATES



HVJ ASSOCIATES

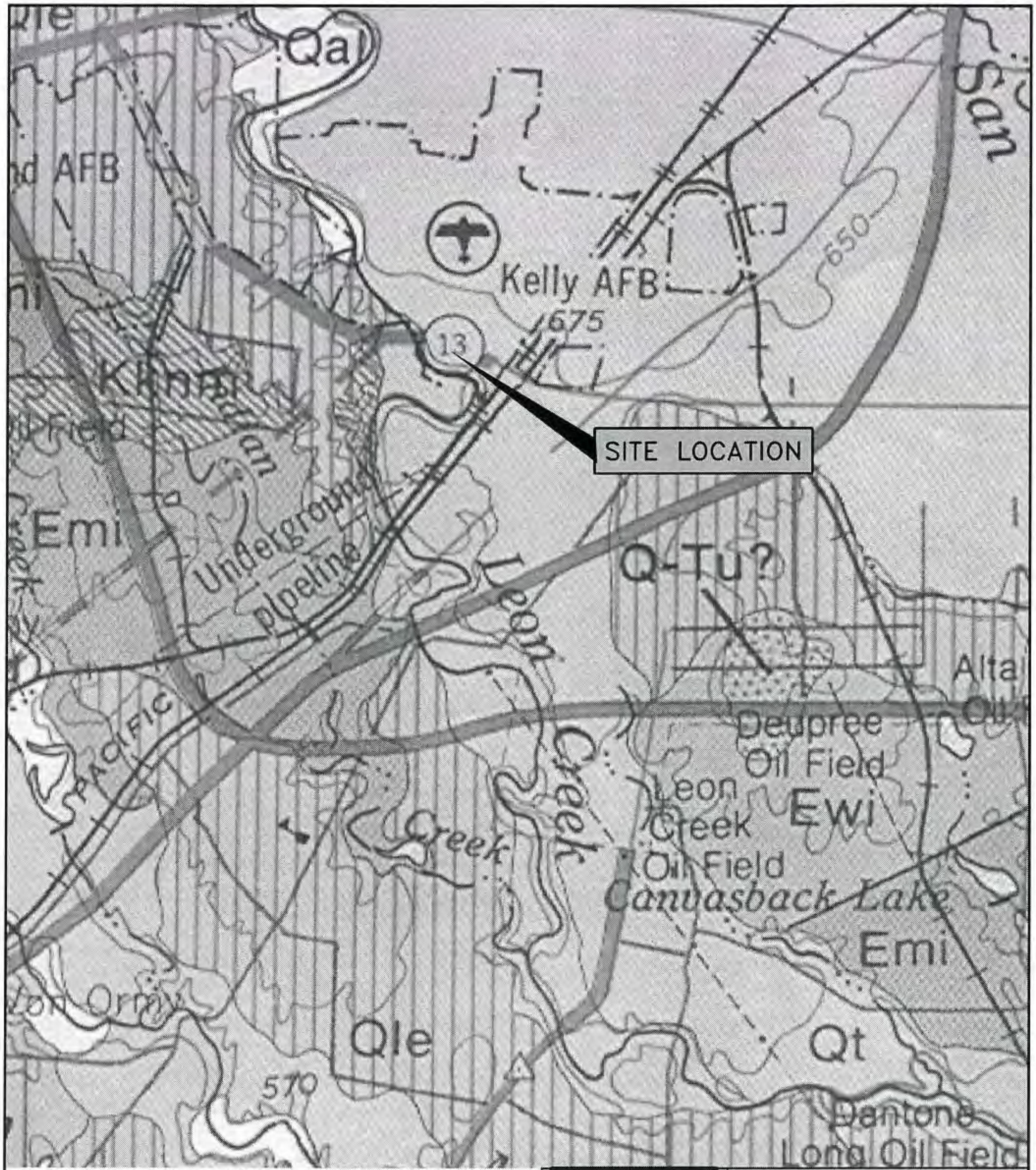
SCALE: N.T.S.

DATE: 4/5/2006

DRAWN BY:	PROJ. CHK:	APPRV. BY:
JS	JS	LG

VICINITY MAP
TEST CELL LEVEE
FEASIBILITY ANALYSIS
SAN ANTONIO, TEXAS

PROJECT NO.:	DRAWING NO.:	PLATE 1
02–155GA–0	VICINITY	



Base Map Source: Bureau of Economic Geology, GEOLOGIC MAP OF THE SAN ANTONIO AREA, TEXAS 1982

LEGEND

Qal	ALLUVIUM
Qlcr	LOWER COLORADO RIVER TERRACE DEPOSITS
Qt	FLUVATILE TERRACE DEPOSITS
Kgt	GEORGETOWN FORMATION
Kta	TAYLOR GROUP
Kau	AUSTIN GROUP
Kpt	PILOT KNOB BASALT
Kef	EAGLE FORD FORMATION
Kbu	BUDA FORMATION
Kcp	COMMANCHE PEAK FORMATION
Ked	EDWARDS FORMATION

NOT TO SCALE

MAP LOCATION

HVJ ASSOCIATES

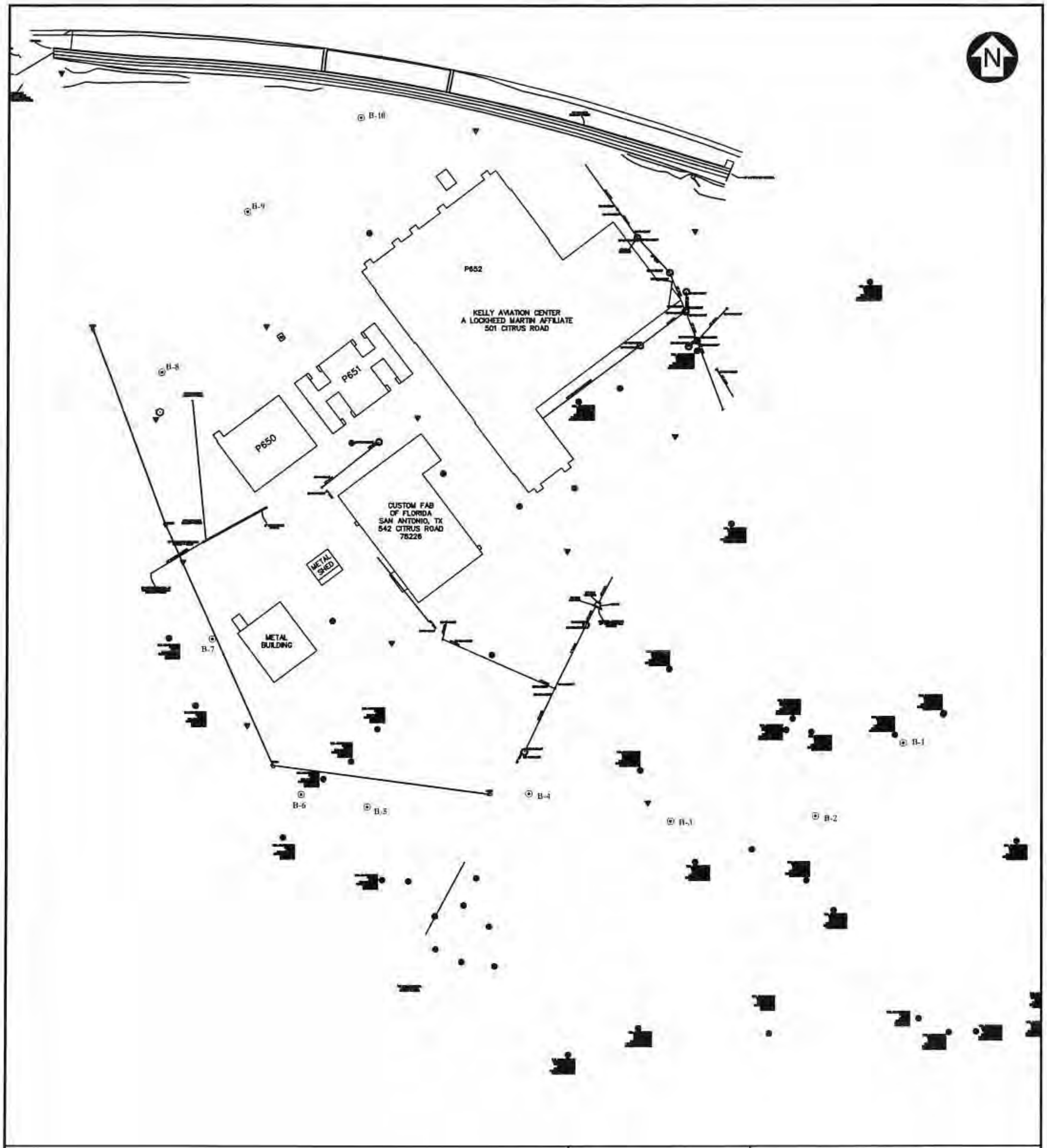
SCALE: N.T.S.

DATE: 04/3/06

DRAWN BY:	PROJ. CHK:	APPRV. BY:
JS	JS	LB

GEOLOGY MAP
TEST CELL LEVEE
FEASIBILITY ANALYSIS
SAN ANTONIO, TEXAS

PROJECT NO.:	DRAWING NO.:	
02-155GA-0	GEOLOGY	PLATE 2



HVJ ASSOCIATES

SCALE: NTS

DATE: 4/4/2006

DRAWN BY:	PROJ. CHK:	APPRV. BY:
LNG		G

PLAN OF BORINGS
TEST CELL LEVEE FEASIBILITY ANALYSIS
SAN ANTONIO, TEXAS

PROJECT NO.:	FILENAME:	
02-155GA-0	POB	PLATE 3

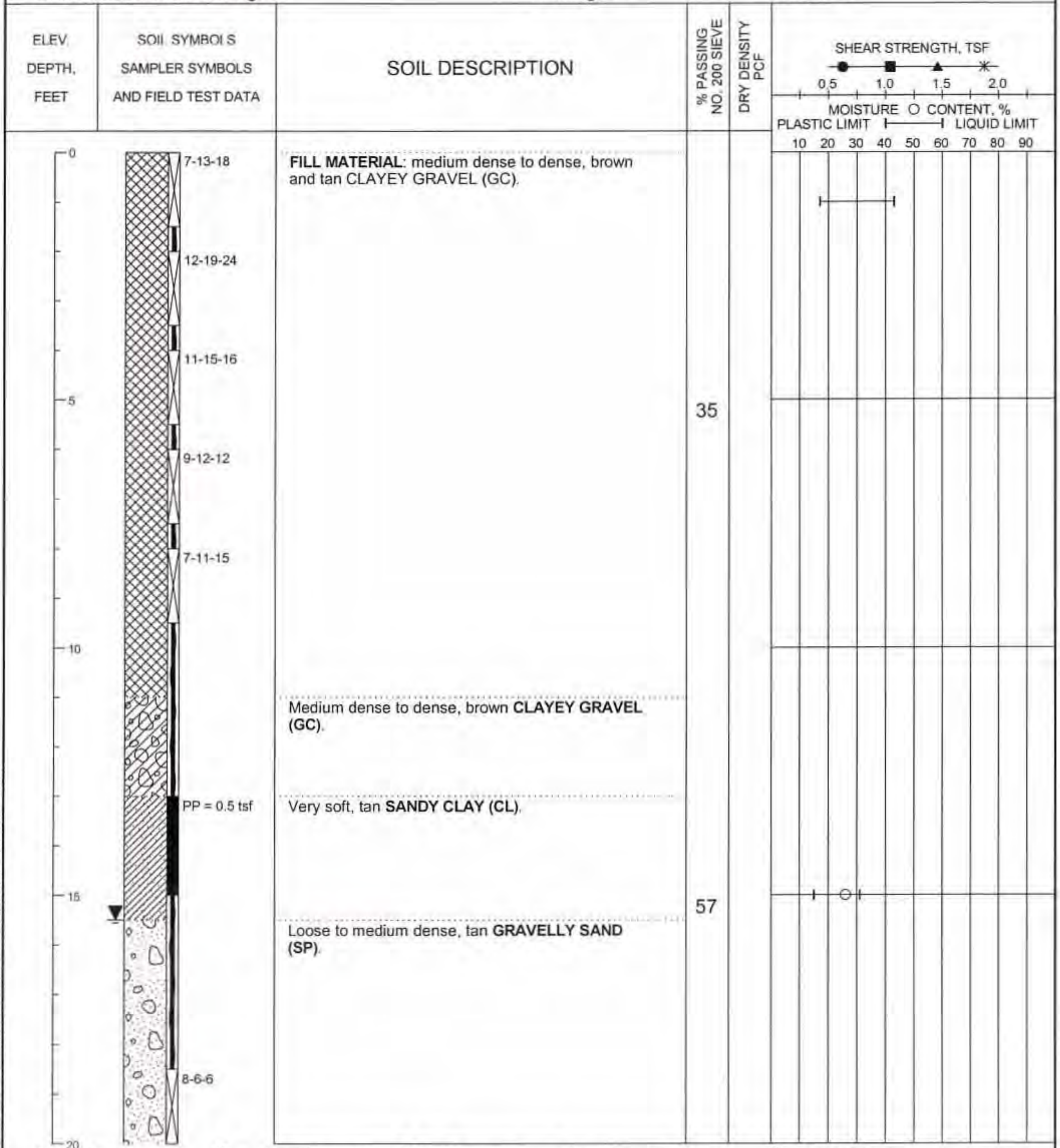
DATE: LA
FILE: Drawing1.dwg

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-1
Groundwater during drilling: 15.5 feet
Groundwater after drilling: ---

Date: 12-13-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: medium dense to dense, brown and tan CLAYEY GRAVEL (GC).

Medium dense to dense, brown **CLAYEY GRAVEL (GC)**.

Very soft, tan **SANDY CLAY (CL)**.

Loose to medium dense, tan **GRAVELLY SAND (SP)**.

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 4a

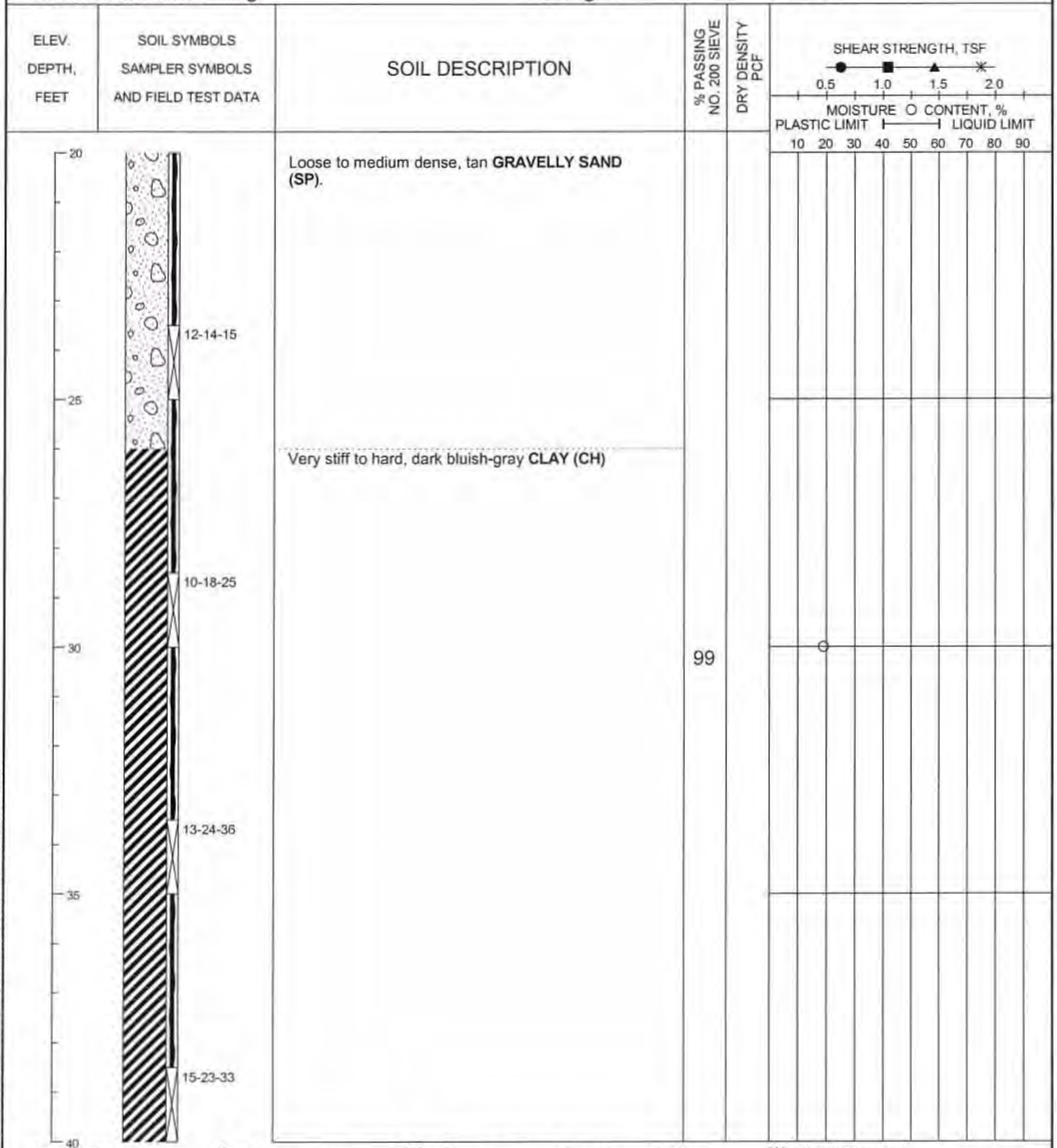
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-1
Groundwater during drilling: 15.5 feet
Groundwater after drilling: ---

Date: 12-13-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



Loose to medium dense, tan **GRAVELLY SAND (SP)**.

Very stiff to hard, dark bluish-gray **CLAY (CH)**

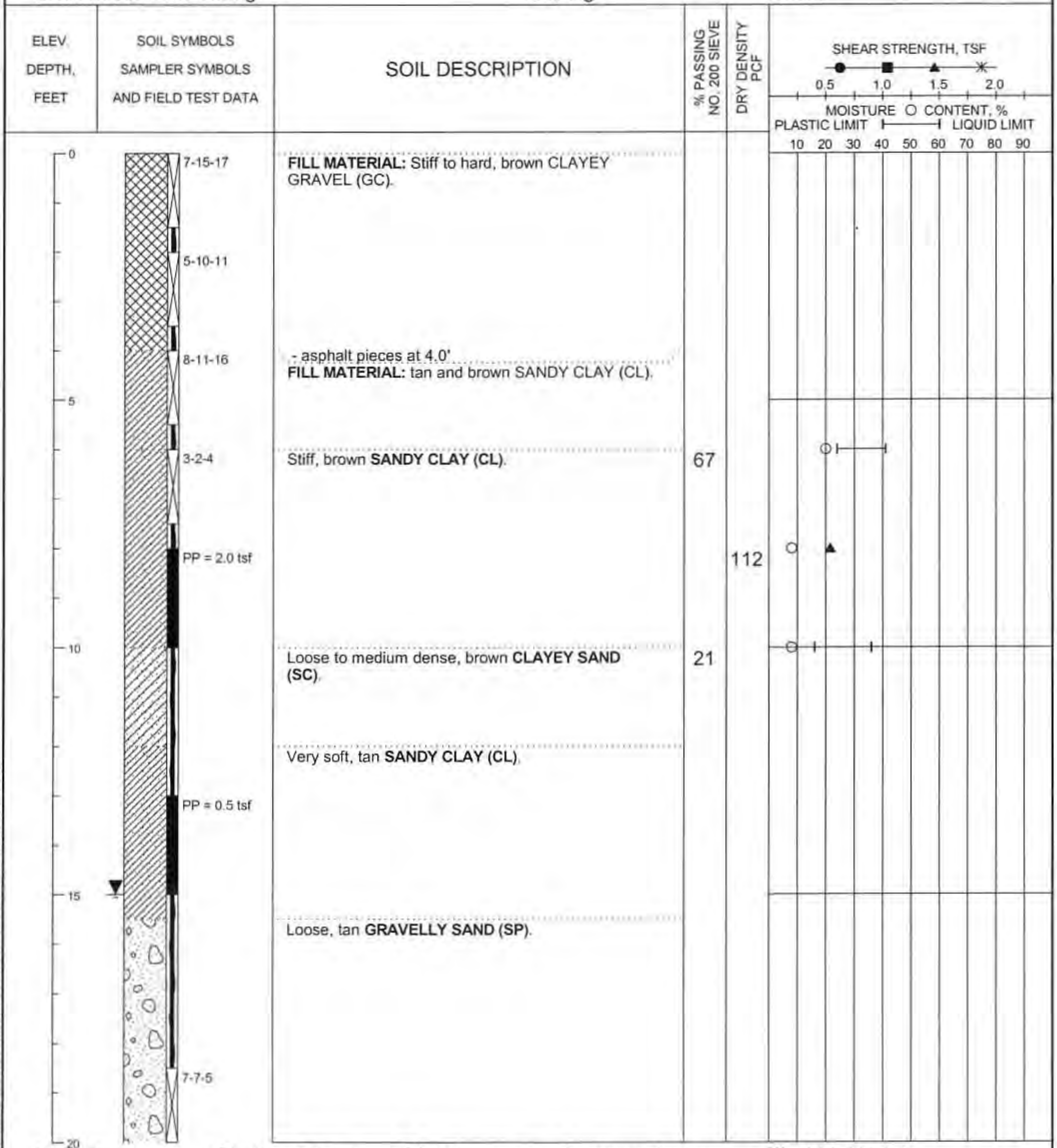
Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 4b

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Project No.: 02-155GA-0
Boring No.: B-2
Date: 12-13-05
Elevation:
Groundwater during drilling: 15.0 feet
Northing: --
Station: --
Groundwater after drilling: ---
Easting: --
Offset: --



Field Test Data	Soil Description	% Passing No. 200 Sieve	Dry Density PCF
7-15-17	**FILL MATERIAL:** Stiff to hard, brown CLAYEY GRAVEL (GC).		
5-10-11			
8-11-16	- asphalt pieces at 4.0' **FILL MATERIAL:** tan and brown SANDY CLAY (CL).		
3-2-4	Stiff, brown **SANDY CLAY (CL)**.	67	
PP = 2.0 tsf			112
	Loose to medium dense, brown **CLAYEY SAND (SC)**.	21	
	Very soft, tan **SANDY CLAY (CL)**.		
PP = 0.5 tsf			
	Loose, tan **GRAVELLY SAND (SP)**.		
7-7-5			

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 5a

HVJ ASSOCIATES

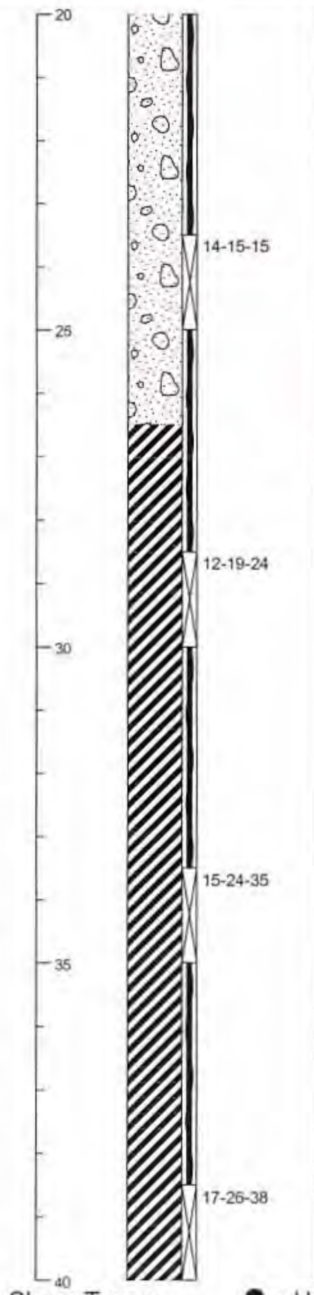
LOG OF SOIL BORING

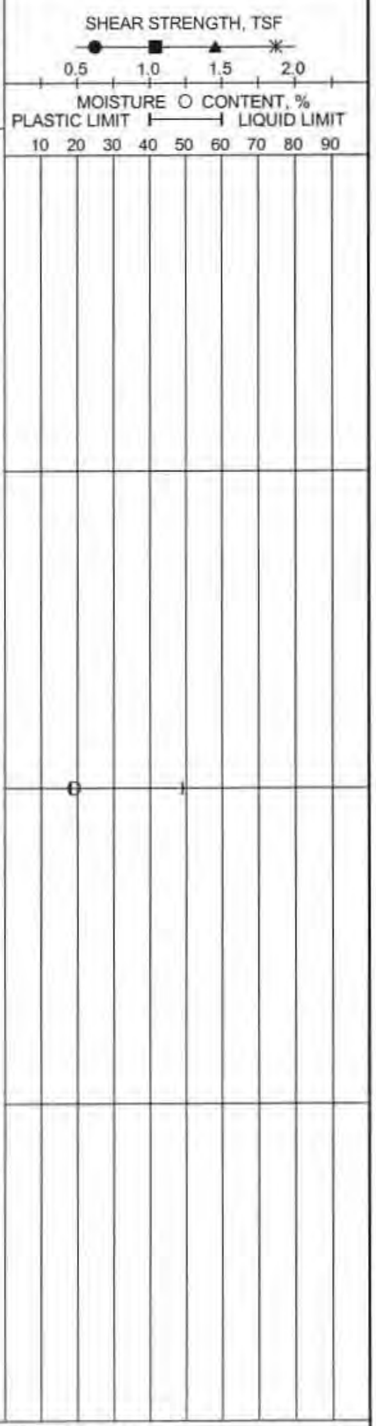
Project: Test Cell Levee Feasibility Analysis
Boring No.: B-2
Groundwater during drilling: 15.0 feet
Groundwater after drilling: ---

Date: 12-13-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
20		Loose, tan **GRAVELLY SAND (SP)**.		
	14-15-15			
		Very stiff to hard, dark bluish-gray **CLAY WITH SAND (CH)**.		
	12-19-24			
30			84	
	15-24-35			
	17-26-38			
40				





Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 5b

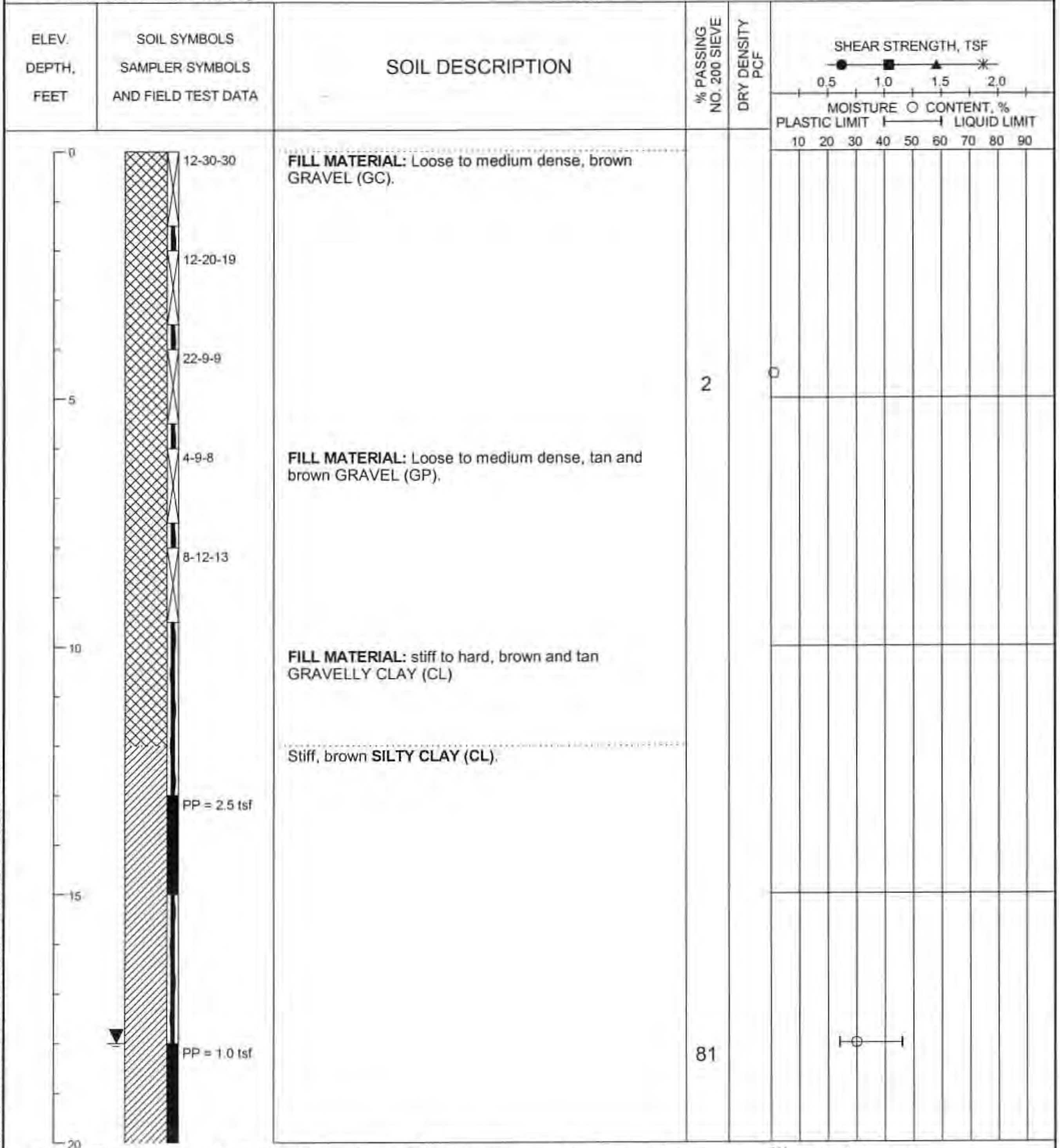
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-3
Groundwater during drilling: 18.0 feet
Groundwater after drilling: ---

Date: 12-12-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: Loose to medium dense, brown GRAVEL (GC).

FILL MATERIAL: Loose to medium dense, tan and brown GRAVEL (GP).

FILL MATERIAL: stiff to hard, brown and tan GRAVELLY CLAY (CL)

Stiff, brown **SILTY CLAY (CL)**.

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

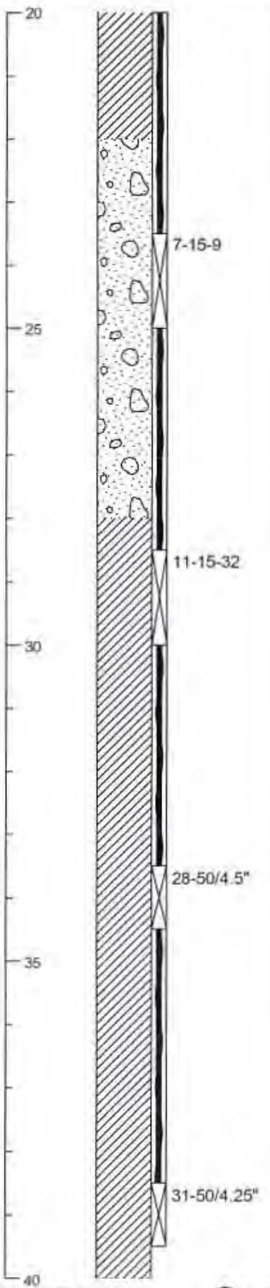
Plate 6a

LOG OF SOIL BORING

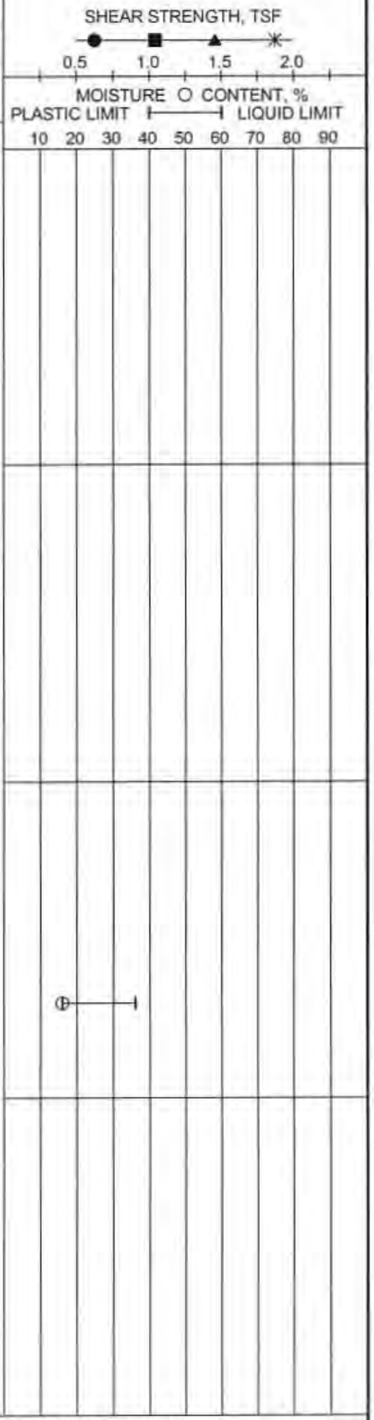
Project: Test Cell Levee Feasibility Analysis
Boring No.: B-3
Groundwater during drilling: 18.0 feet
Groundwater after drilling: ---

Date: 12-12-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
20		Stiff, brown **SILTY CLAY (CL)**.		
		Loose to medium dense, tan **GRAVELLY SAND (SP)**.		
	7-15-9			
25				
		Very stiff to hard, dark bluish-gray **CLAY (CL)**.		
	11-15-32			
30				
	28-50/4.5"		86	
35				
	31-50/4.25"			
40				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

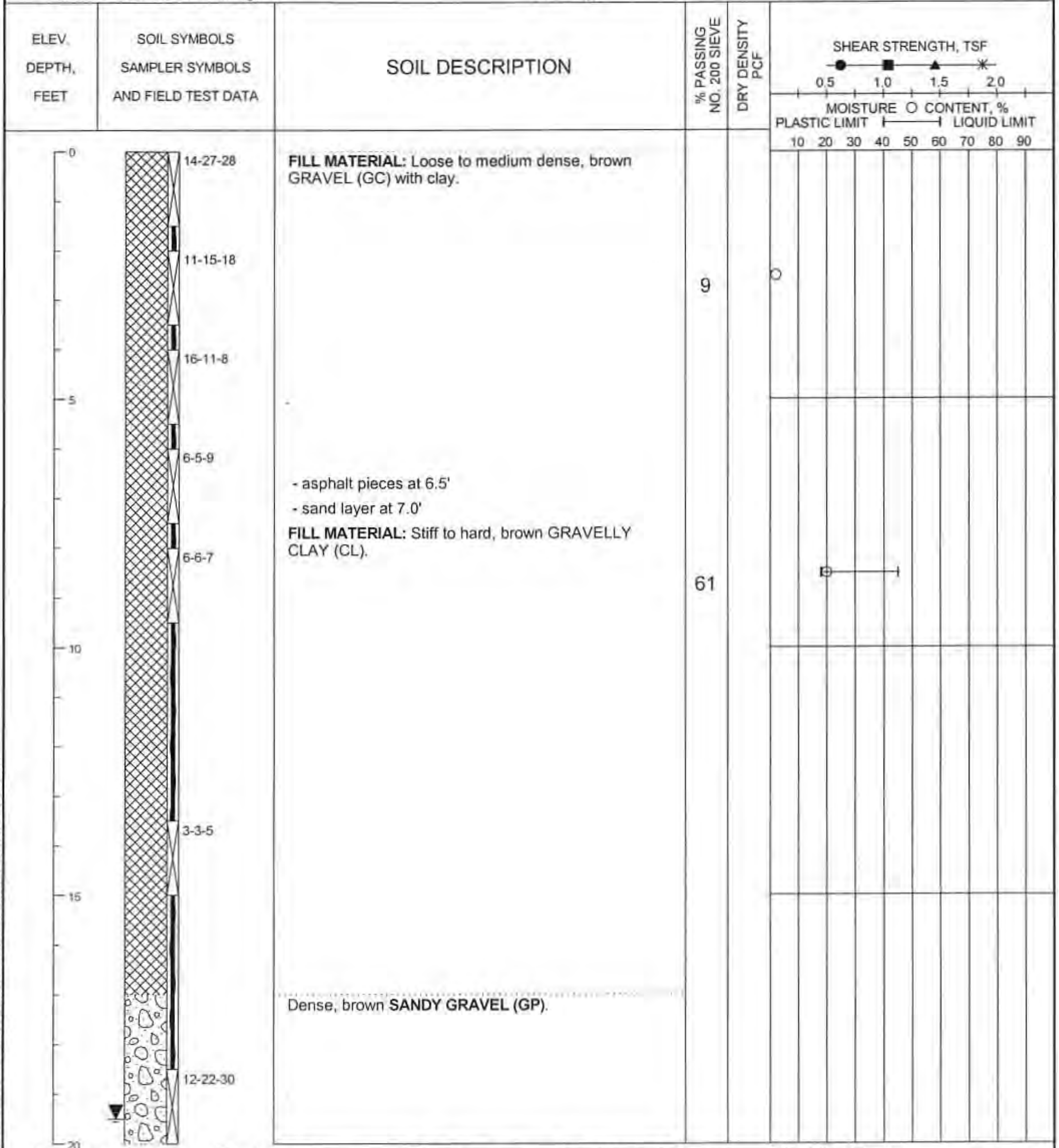
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-4
Groundwater during drilling: 19.5 feet
Groundwater after drilling: ---

Date: 12-13-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: Loose to medium dense, brown GRAVEL (GC) with clay.

- asphalt pieces at 6.5'
- sand layer at 7.0'

FILL MATERIAL: Stiff to hard, brown GRAVELLY CLAY (CL).

Dense, brown **SANDY GRAVEL (GP)**.

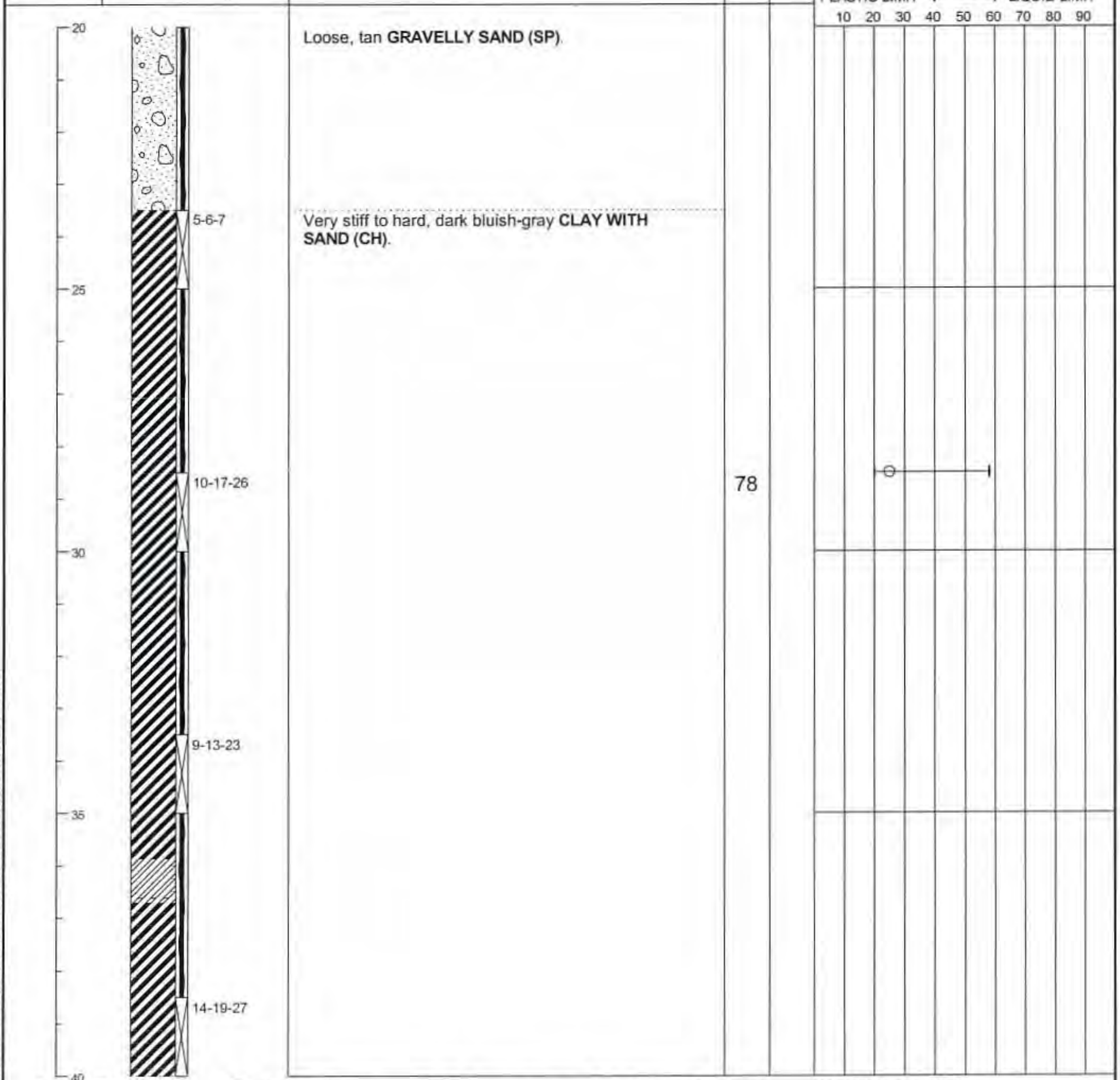
Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis		Project No.: 02-155GA-0
Boring No.: B-4	Date: 12-13-05	Elevation:
Groundwater during drilling: 19.5 feet	Northing: --	Station: --
Groundwater after drilling: ---	Easting: --	Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF / MOISTURE ○ CONTENT, % PLASTIC LIMIT ⊢—⊣ LIQUID LIMIT
20		Loose, tan **GRAVELLY SAND (SP)**.			
	5-6-7	Very stiff to hard, dark bluish-gray **CLAY WITH SAND (CH)**.			
	10-17-26		78		
	9-13-23				
	14-19-27				
40					



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 7b

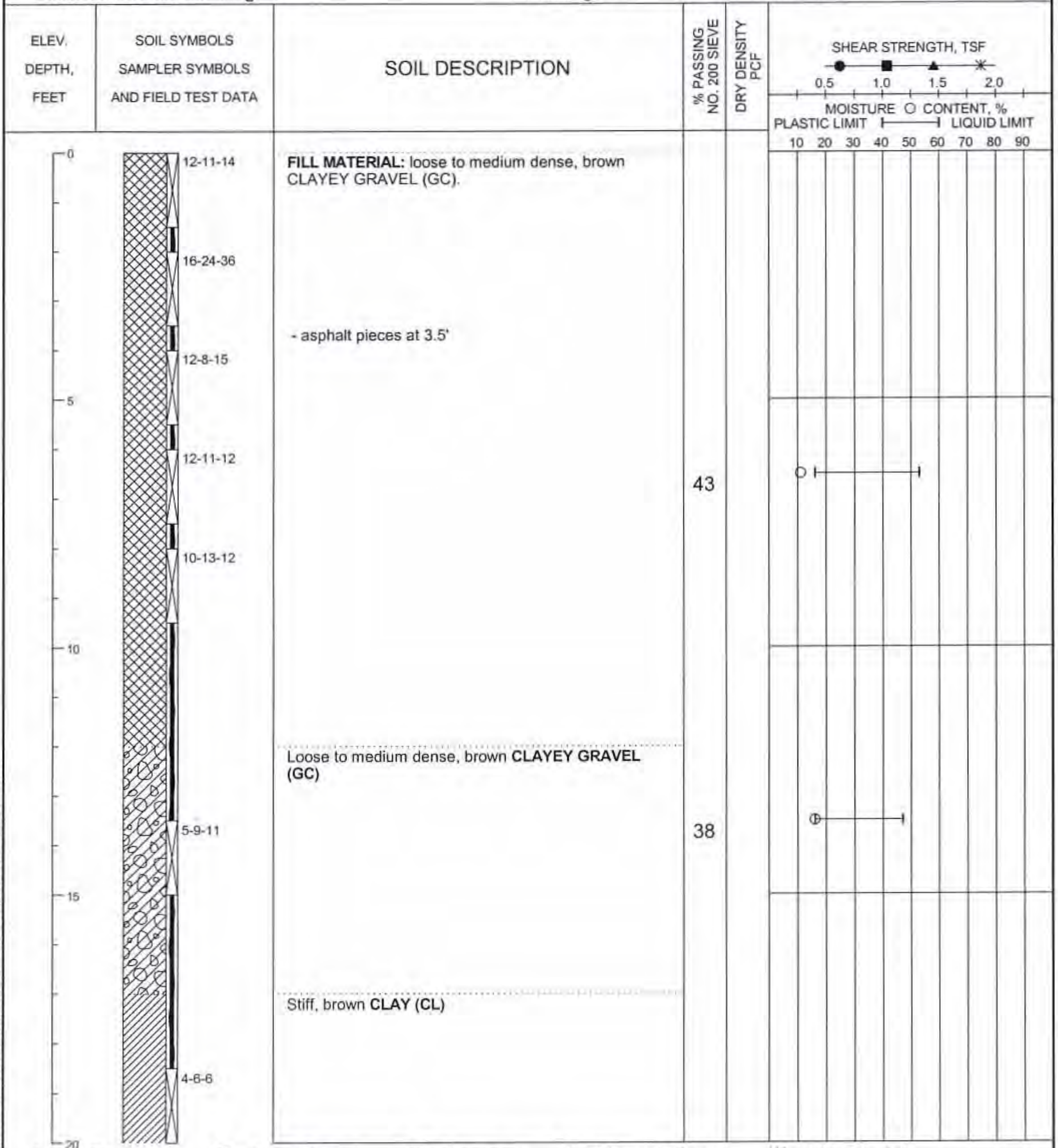
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-5
Groundwater during drilling: 22.0 feet
Groundwater after drilling: ---

Date: 12-14-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: loose to medium dense, brown CLAYEY GRAVEL (GC).

- asphalt pieces at 3.5'

Loose to medium dense, brown **CLAYEY GRAVEL (GC)**

Stiff, brown **CLAY (CL)**

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

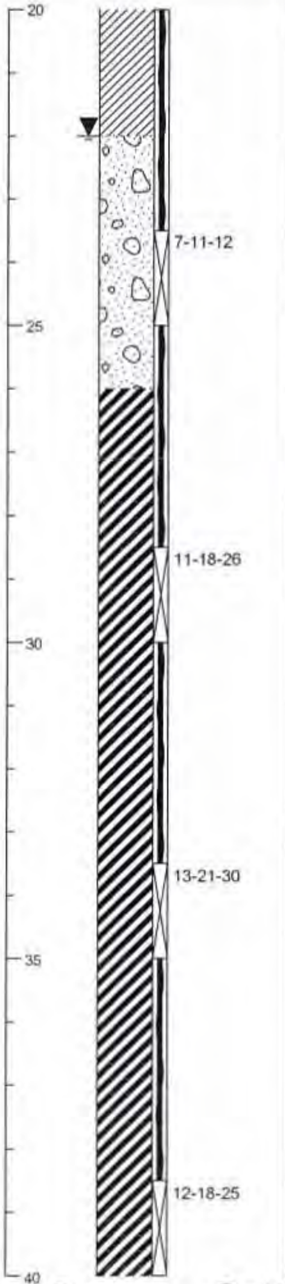
Plate 8a

HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis		Project No.: 02-155GA-0
Boring No.: B-5	Date: 12-14-05	Elevation:
Groundwater during drilling: 22.0 feet	Northing: --	Station: --
Groundwater after drilling: ---	Easting: --	Offset: --

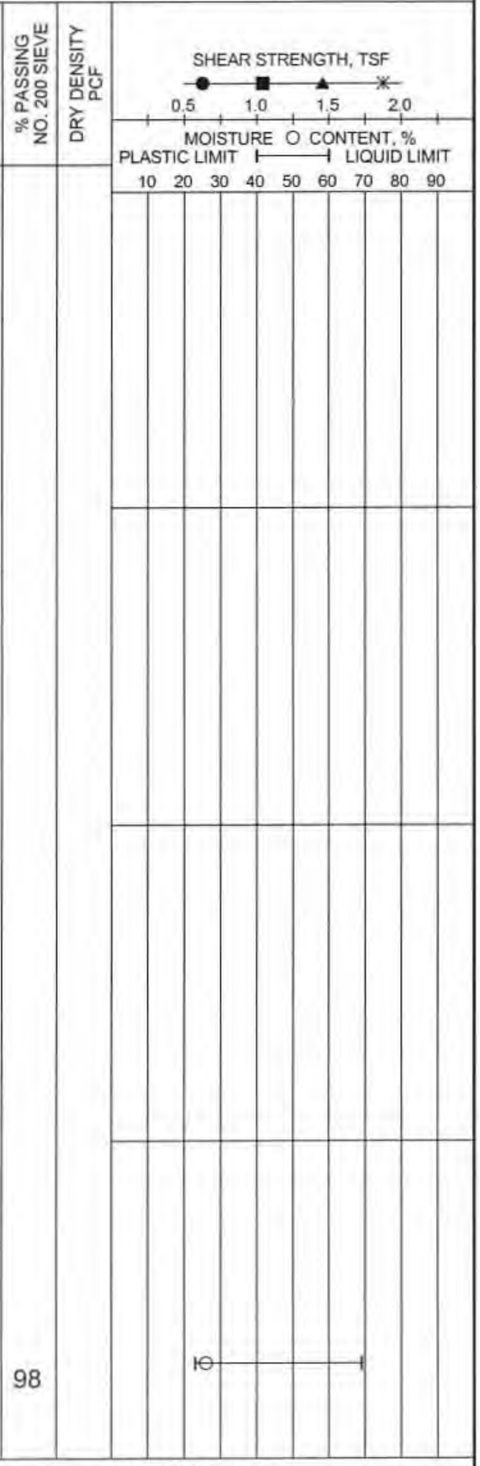
ELEV. DEPTH, FEET | SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA | SOIL DESCRIPTION | % PASSING NO. 200 SIEVE | DRY DENSITY PCF | SHEAR STRENGTH, TSF / MOISTURE CONTENT, %



Stiff, brown **CLAY (CL)**

Loose, tan **GRAVELLY SAND (SP)**.

Very stiff to hard, dark bluish-gray **CLAY (CH)**



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 8b

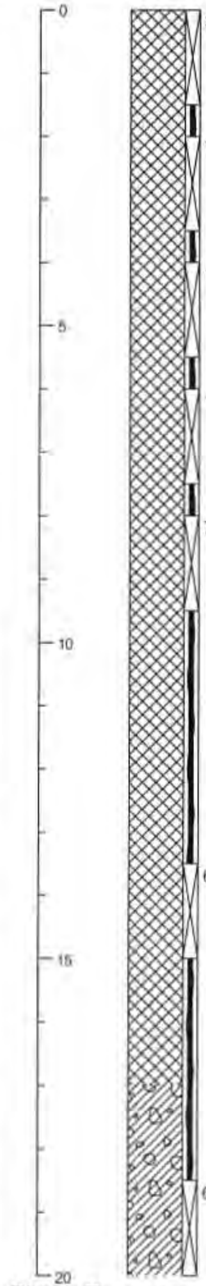
LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-6
Groundwater during drilling: 23.0 feet
Groundwater after drilling: ---

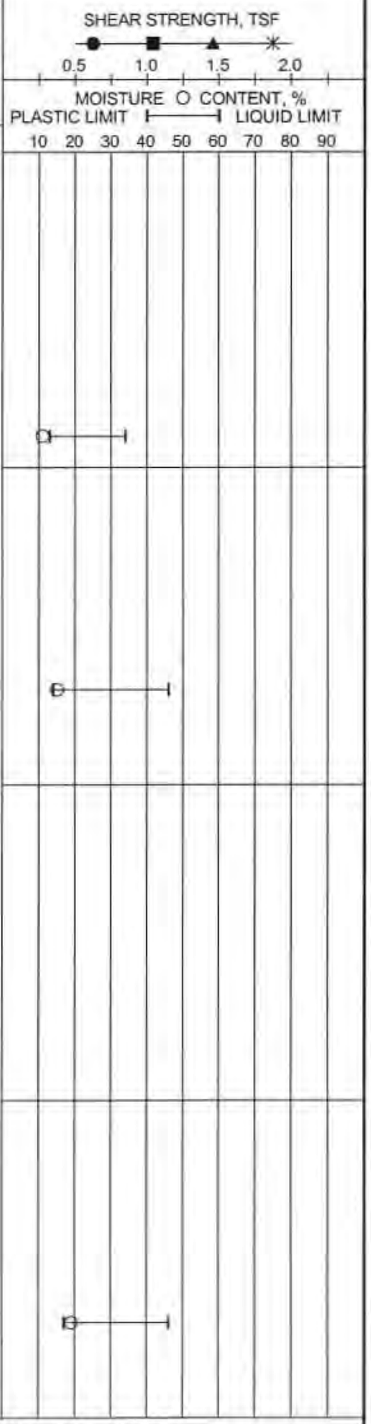
Date: 12-14-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --

ELEV. DEPTH, FEET



SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
32-24-11	**FILL MATERIAL:** loose and medium dense, brown CLAYEY GRAVEL (GC).		
7-12-18			
14-18-20		39	
12-10-14			
7-9-8	- sand seam at 7.5' **FILL MATERIAL:** stiff to hard, brown GRAVELLY CLAY (CL)	51	
6-17-11	- concrete pieces at 14.5'		
6-7-8	Stiff to hard, brown **GRAVELLY CLAY (CL)**	60	



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

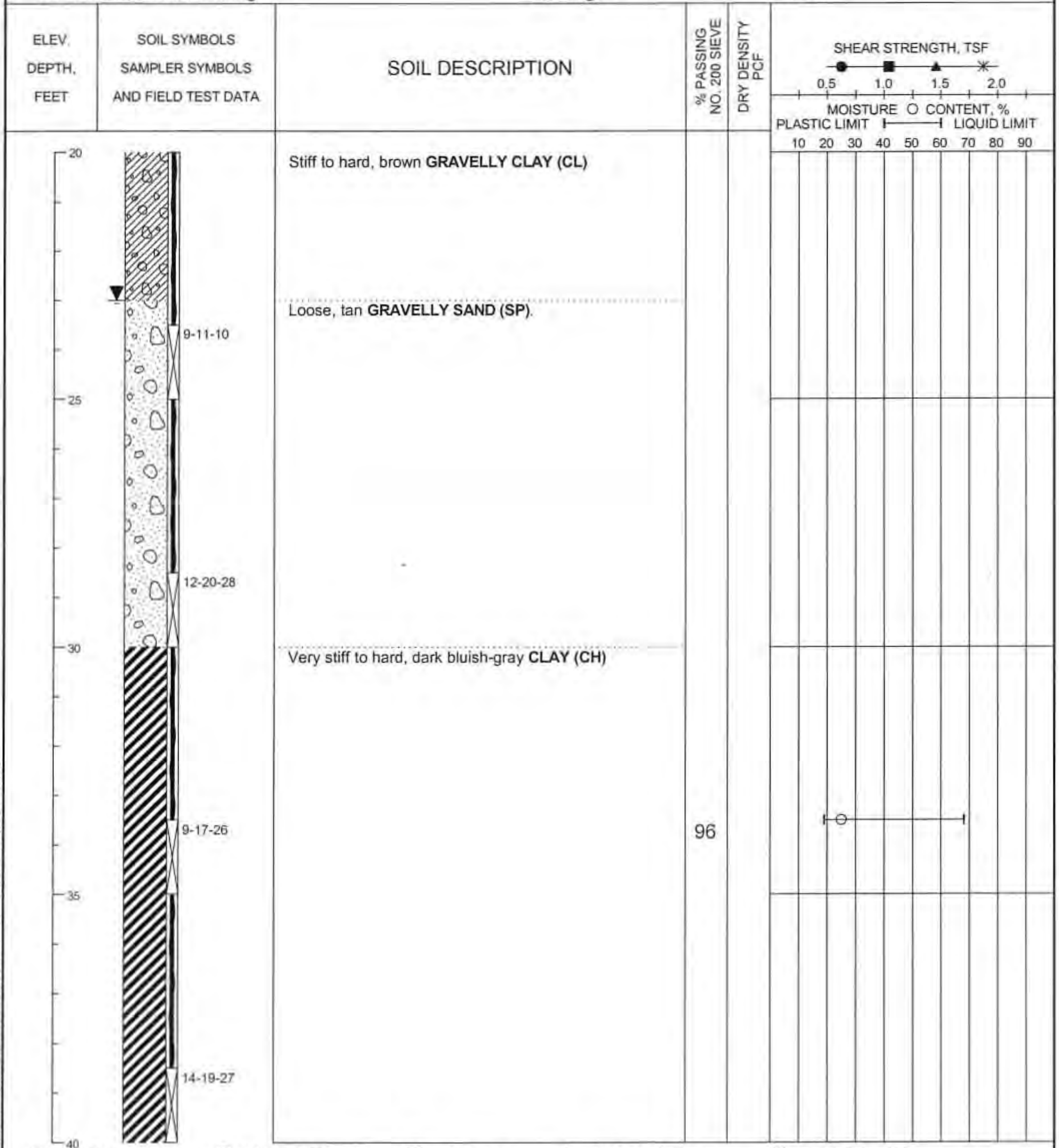
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-6
Groundwater during drilling: 23.0 feet
Groundwater after drilling: ---

Date: 12-14-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



Stiff to hard, brown **GRAVELLY CLAY (CL)**

Loose, tan **GRAVELLY SAND (SP)**.

Very stiff to hard, dark bluish-gray **CLAY (CH)**

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

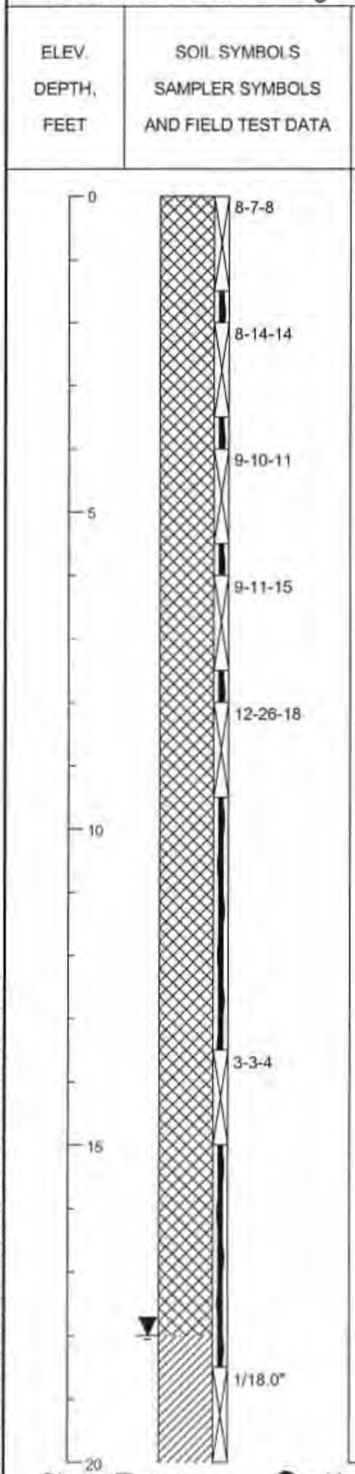
Plate 9b

LOG OF SOIL BORING

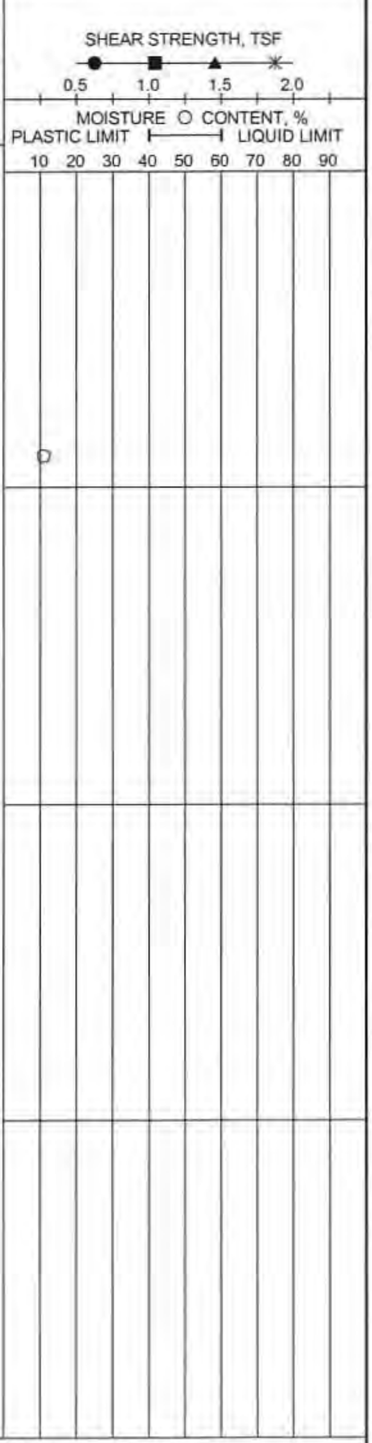
Project: Test Cell Levee Feasibility Analysis
Boring No.: B-7
Groundwater during drilling: 18.0 feet
Groundwater after drilling: ---

Date: 12-14-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
FILL MATERIAL: Stiff to hard, brown **CLAYEY GRAVEL (GC)**.		
- asphalt pieces at 4.0'	19	
- concrete pieces at 9.0'		
Very soft, brown **CLAY (CL)**.		



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 10a

HVJ ASSOCIATES

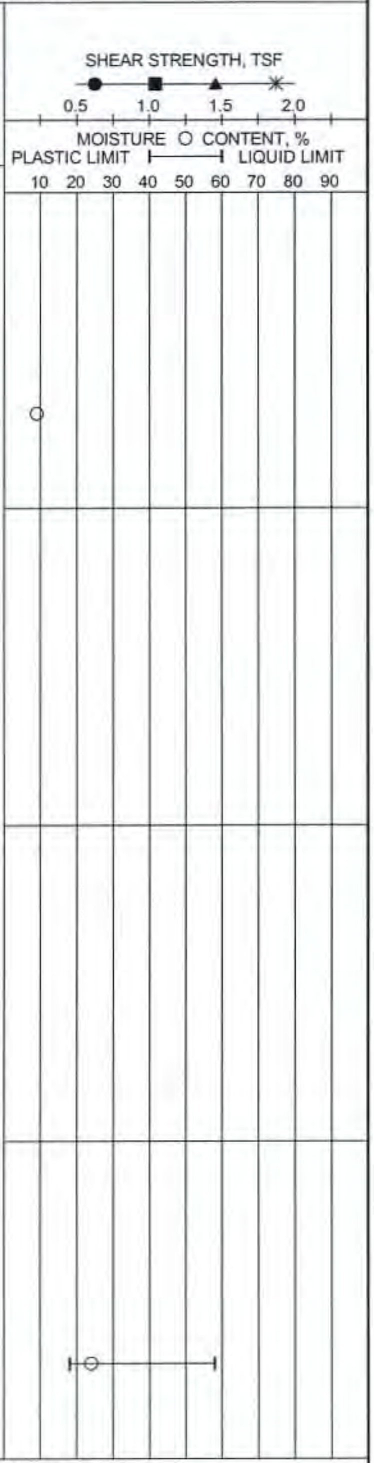
LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-7
Groundwater during drilling: 18.0 feet
Groundwater after drilling: ---

Date: 12-14-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
20		Very soft, gray **CLAY (CL)**.		
		Loose, tan **GRAVELLY SAND WITH CLAY (SP)**.		
	7-12-12		7	
25				
		Very stiff to hard, dark bluish-gray **CLAY (CH)**		
	9-15-20			
30				
	11-16-24			
35				
	13-19-27		95	
40				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

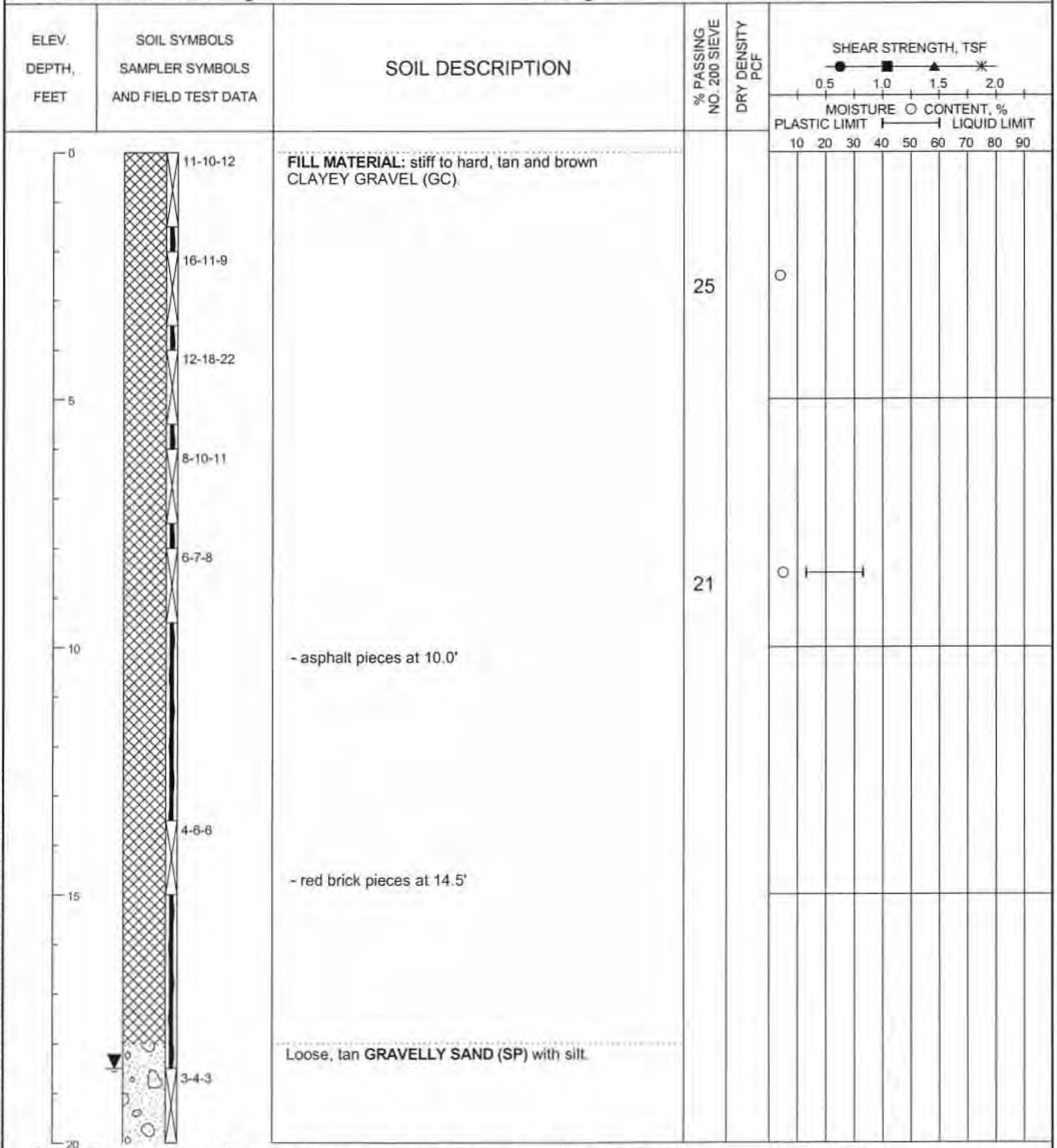
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-8
Groundwater during drilling: 18.5 feet
Groundwater after drilling: ---

Date: 12-15-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: stiff to hard, tan and brown CLAYEY GRAVEL (GC).

- asphalt pieces at 10.0'

- red brick pieces at 14.5'

Loose, tan **GRAVELLY SAND (SP)** with silt.

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 11a

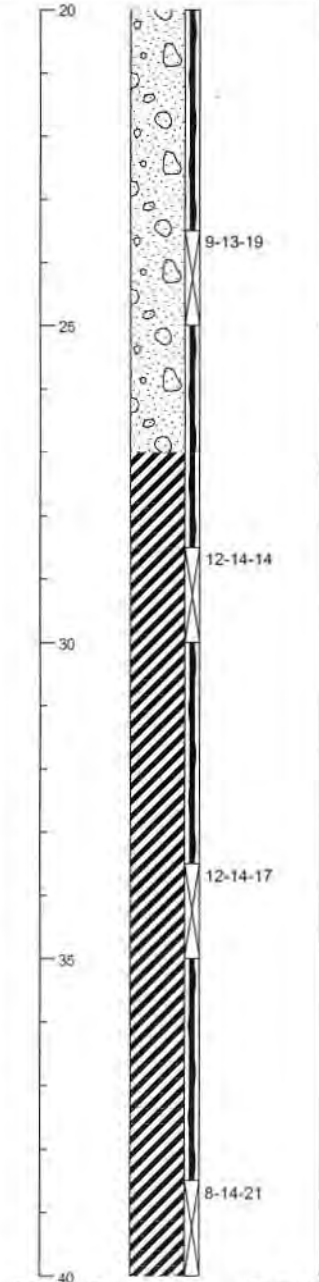
LOG OF SOIL BORING

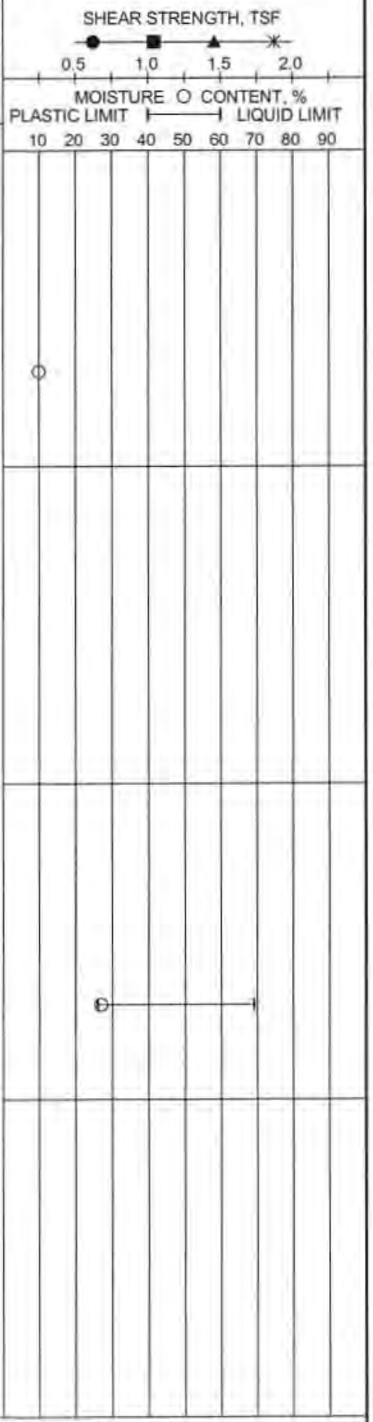
Project: Test Cell Levee Feasibility Analysis
Boring No.: B-8
Groundwater during drilling: 18.5 feet
Groundwater after drilling: ---

Date: 12-15-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
20		Loose, tan **GRAVELLY SAND (SP)** with silt.		
	9-13-19		12	
		Very stiff to hard, dark bluish-gray **CLAY (CH)**		
	12-14-14			
	12-14-17		98	
	8-14-21			





Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

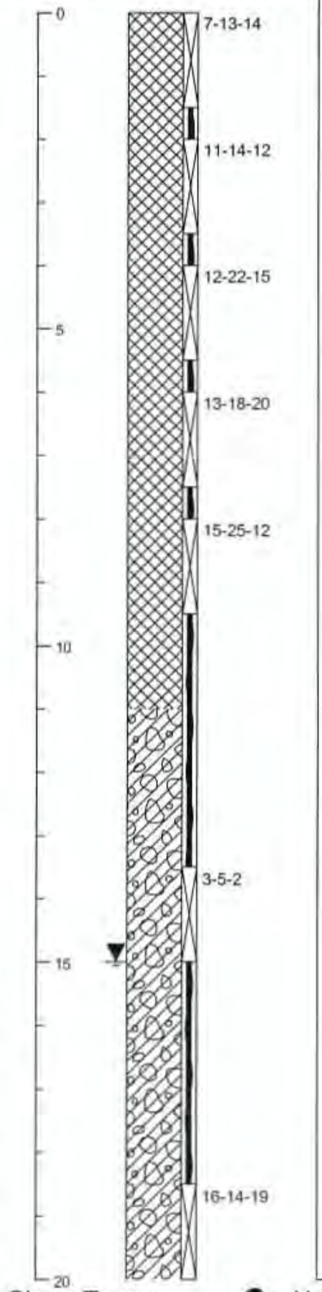
LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-9
Groundwater during drilling: 15.0 feet
Groundwater after drilling: ---

Date: 12-15-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF / MOISTURE CONTENT, %

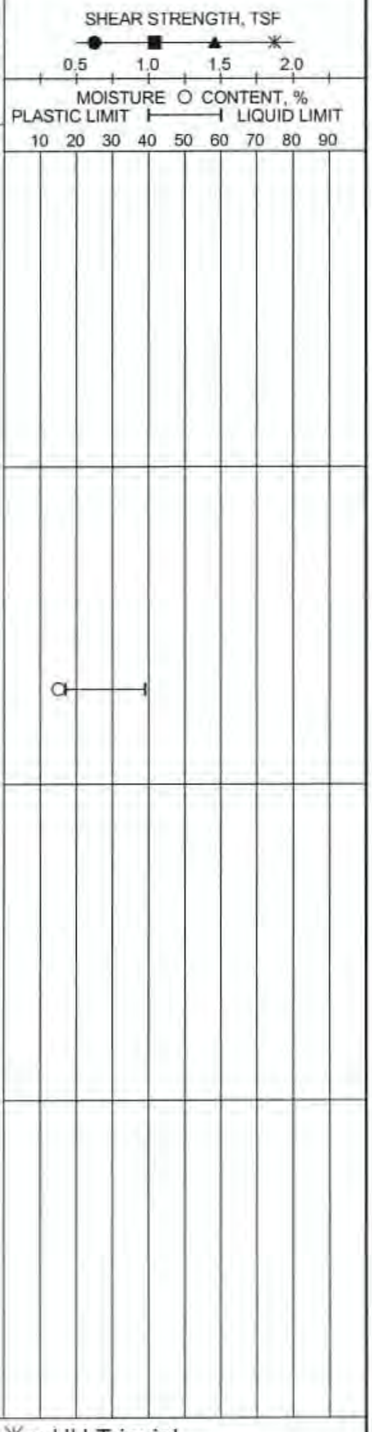


FILL MATERIAL: stiff to hard, brown CLAYEY GRAVEL (GC).

16

Stiff to hard, brown **CLAYEY GRAVEL (GC)**.

- moist at 12.0'



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 12a

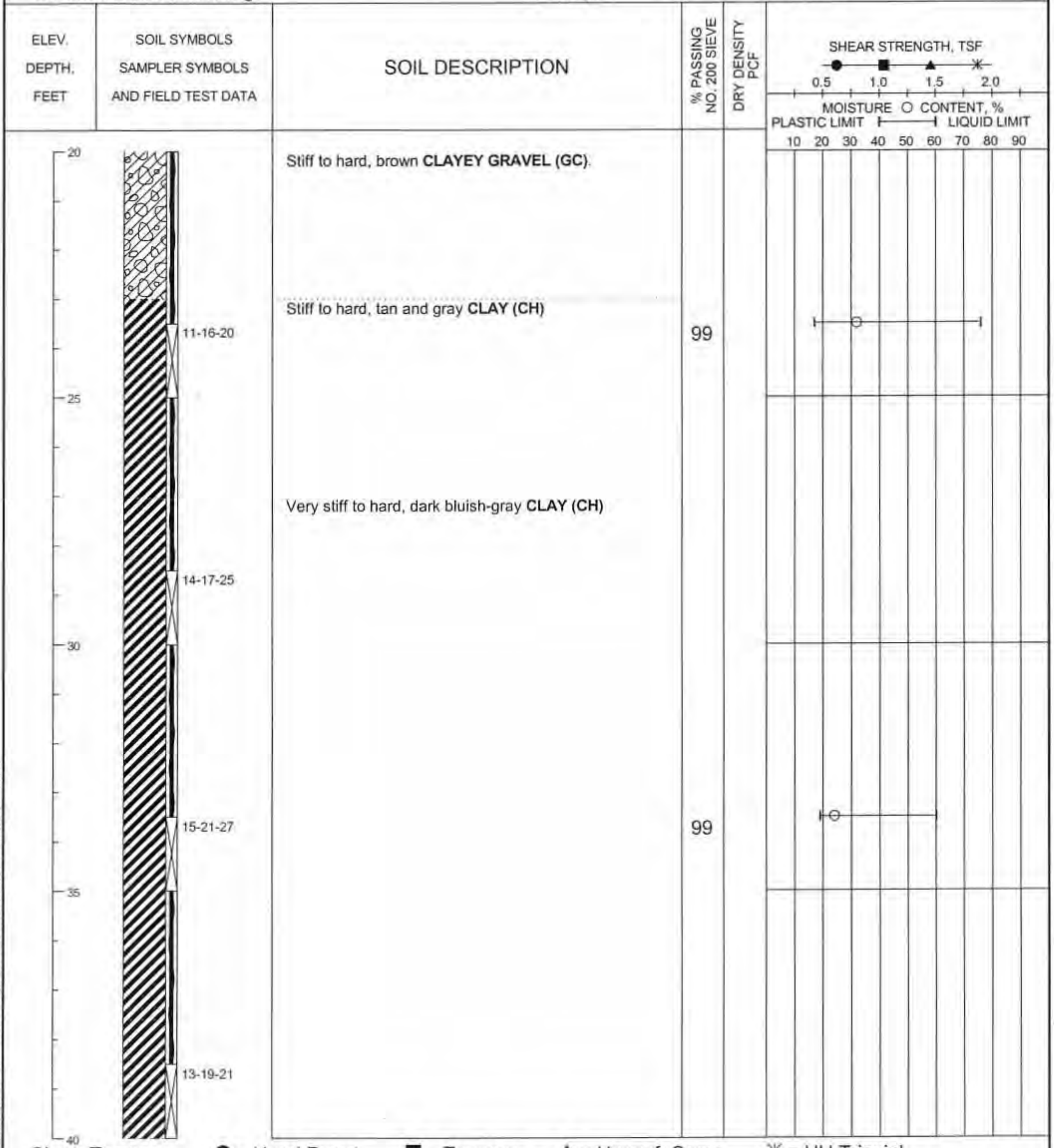
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-9
Groundwater during drilling: 15.0 feet
Groundwater after drilling: ---

Date: 12-15-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
20		Stiff to hard, brown **CLAYEY GRAVEL (GC)**.		
	11-16-20	Stiff to hard, tan and gray **CLAY (CH)**	99	
25				
		Very stiff to hard, dark bluish-gray **CLAY (CH)**		
	14-17-25			
30				
	15-21-27		99	
35				
	13-19-21			
40				

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 12b

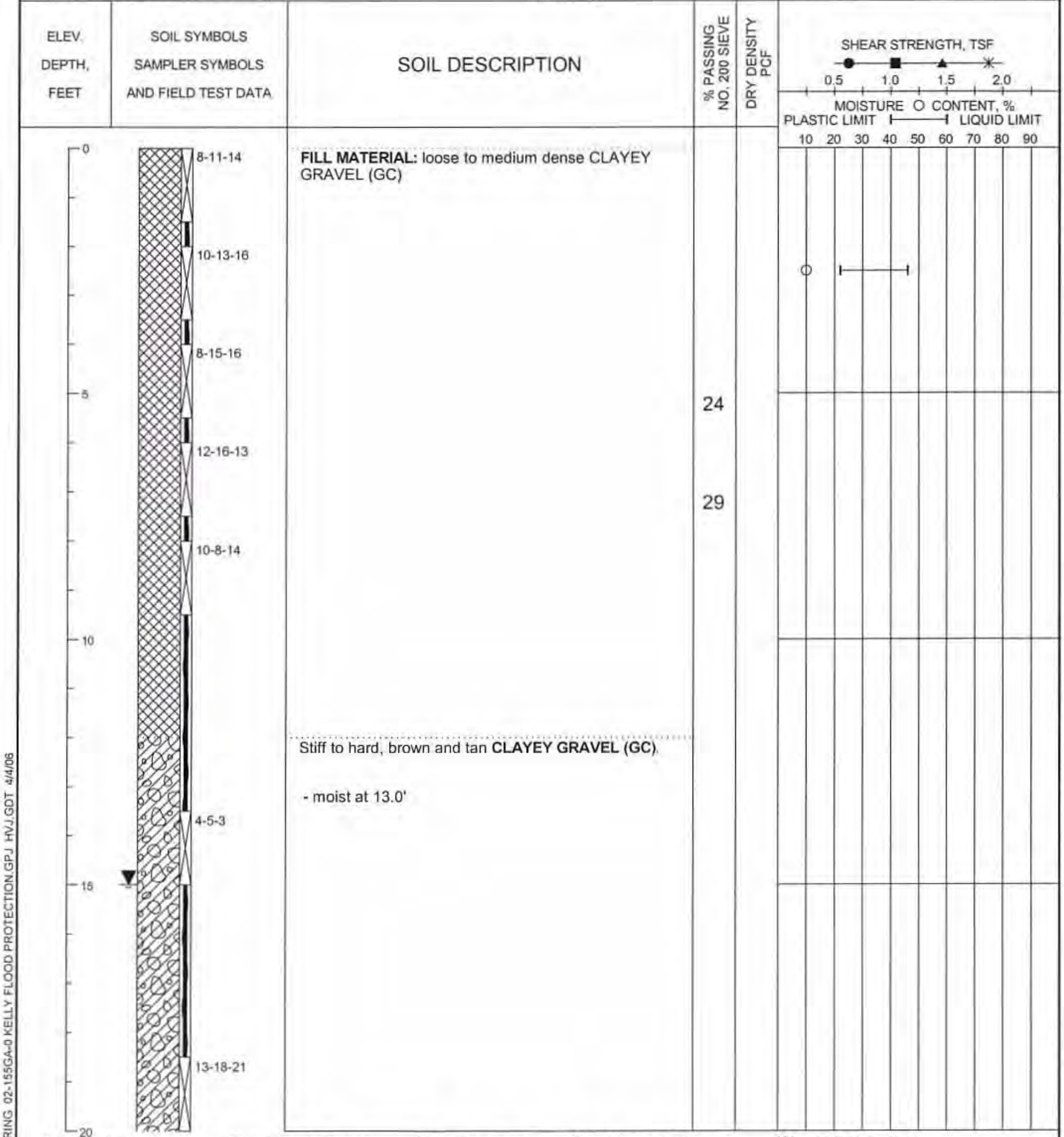
HVJ ASSOCIATES

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-10
Groundwater during drilling: 15.0 feet
Groundwater after drilling: ---

Date: 12-16-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



FILL MATERIAL: loose to medium dense CLAYEY GRAVEL (GC)

Stiff to hard, brown and tan **CLAYEY GRAVEL (GC)**.

- moist at 13.0'

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

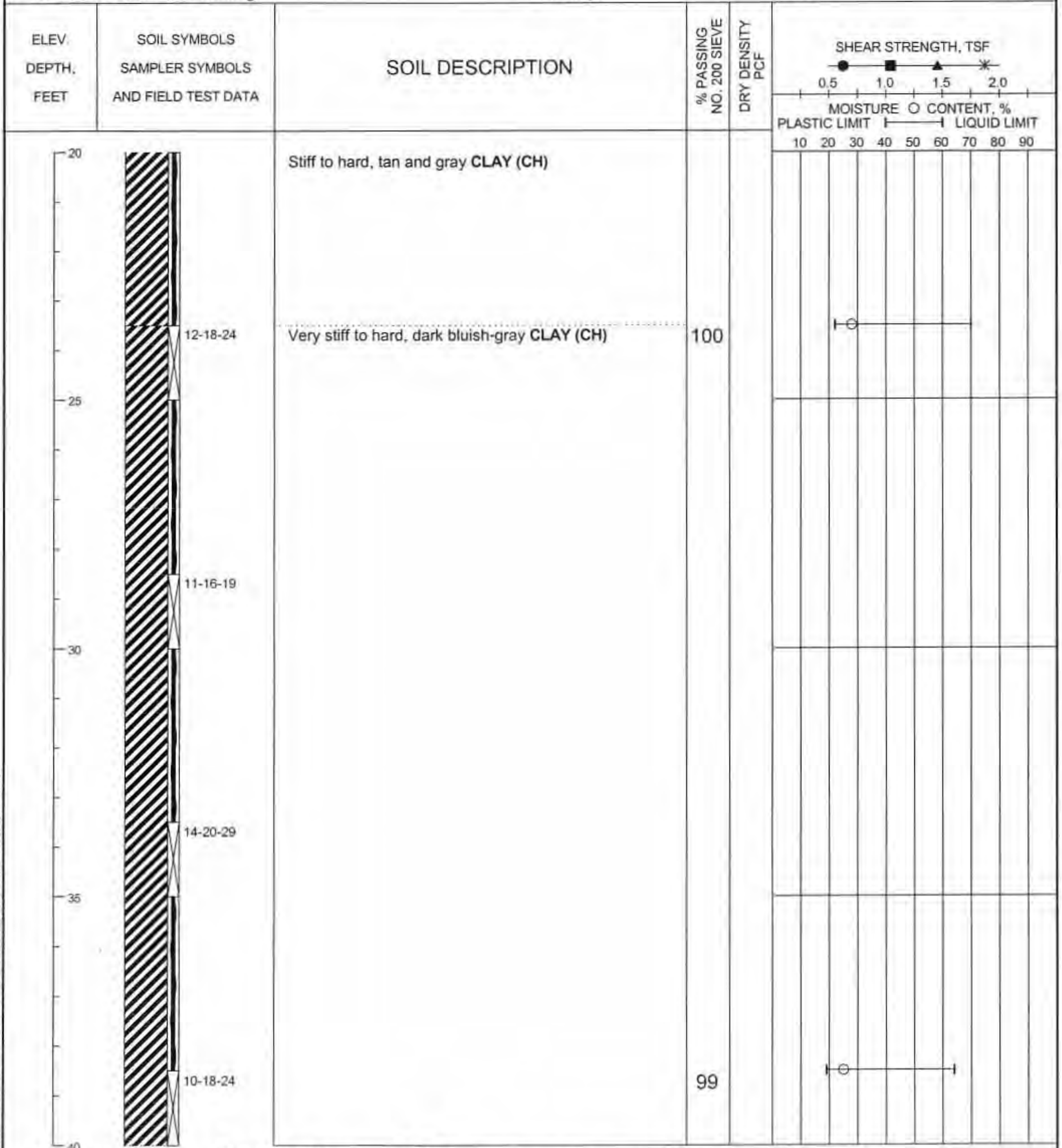
Plate 13a

LOG OF SOIL BORING

Project: Test Cell Levee Feasibility Analysis
Boring No.: B-10
Groundwater during drilling: 15.0 feet
Groundwater after drilling: ---

Date: 12-16-05
Northing: --
Easting: --

Project No.: 02-155GA-0
Elevation:
Station: --
Offset: --



ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE
20		Stiff to hard, tan and gray **CLAY (CH)**	
	12-18-24	Very stiff to hard, dark bluish-gray **CLAY (CH)**	100
	11-16-19		
	14-20-29		
	10-18-24		99

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 3 for boring location.

Plate 13b

ROCK TYPES

- ▦ Limestone
- ▨ Highly Weathered Limestone
- ▦ Weathered Limestone
- ▤ Shale
- ▨ Weathered Shale
- ▦ Dolomite
- ⬚ Sandstone
- ■ Boulders
- ▩ Granite

SAMPLER TYPES

- ■ Thin-Walled Tube
- ☒ Standard Penetration Test
- ▤ THD Cone Penetration Test
- ▯ Rock Core
- ⌇ Auger
- ◧ Bag Sample

SOLUTION AND VOID CONDITIONS

Void	Interstice; a general term for pore space or other openings in rock.
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pores, interstices, or other openings which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

HARDNESS

Friable	Crumbles under hand pressure
Low Hardness	Can be carved with a knife
Moderately Hard	Can be scratched easily with a knife
Very Hard	Cannot be scratched with a knife

WEATHERING GRADES OF ROCKMASS (1)

Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces.
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil.
Highly	More than half of the rock material is decomposed or disintegrated to a soil.
Completely	All rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed.

JOINT DESCRIPTION

SPACING

Very Close	<2"
Close	2"-12"
Medium Close	12"-3'
Wide	>3'

INCLINATION

Horizontal	0-5
Shallow	5-35
Moderate	35-65
Steep	65-85
Vertical	85-90

SURFACES

Slickensided	Polished, grooved
Smooth	Planar
Irregular	Undulating or granular
Rough	Jagged or pitted

REFERENCES:

(1) British Standard (1981) Code of Practice for Site Investigation, BS 5930.

(2) The Bridge Div., Tx. Highway Dept. Foundation Exploration & Design Manual, 2nd Division, revised June, 1974.

BEDDING THICKNESS (2)

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	1/2"-2"
Laminated	0.08"-1/2"
Thinly Laminated	<0.08"

Information on each boring log is a compilation of subsurface conditions and soil and rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

HVJ ASSOCIATES

PROJECT NO.: 02-155GA-0

DRAWING NO.: PLATE 14B

KEY TO TERMS AND SYMBOLS
USED ON BORING LOGS FOR ROCK

SOIL SYMBOLS

Soil Types

- ▨ Clay (CH)
- ▨ Clay (CI)
- □ Sand
- ▩ Gravel

Modifiers

- ▨ Clayey
- ▥ Silty
- ▨ Sandy Clay
- ▩ Sandy Gravel

Construction Materials

- ▦ Asphaltic Concrete
- ▩ Concrete
- ▦ Fill or Debris
- ⬡ Base

SAMPLER TYPES

- ■ Thin Walled Shelby Tube
- ▨ No Recovery
- ☒ Split Barrel
- ⌇ Auger
- ◧ Liner Tube
- ⧗ Jar Sample

WATER LEVEL SYMBOLS

- ▽ Groundwater level determined during drilling operations
- ▼ Groundwater level after drilling in open borehole or piezometer

SOIL GRAIN SIZE

Classification	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	< 0.002 mm	< 0.002 mm
Silt	0.002 - 0.075 mm	0.002 mm - #200 sieve
Sand	0.075 - 4.75 mm	#200 sieve - #4 sieve
Gravel	4.75 - 75 mm	#4 sieve - 3 in.
Cobble	75 - 200 mm	3 in. - 8 in.
Boulder	> 200 mm	> 8 in.

DENSITY OF COHESIONLESS SOILS

Descriptive Term	Penetration Resistance "N" * Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF COHESIVE SOILS

Consistency	Undrained Shear Strength (tsf)
Very Soft	0 - 0.125
Soft	0.125 - 0.25
Firm	0.25 - 0.5
Stiff	0.5 - 1.0
Very Stiff	1.0 - 2.0
Hard	> 2.0

PENETRATION RESISTANCE

3/6	Blows required to penetrate each of three consecutive 6-inch increments per ASTM D-1586 *
50/4"	If more than 50 blows are required, driving is discontinued and penetration at 50 blows is noted
0/18"	Sampler penetrated full depth under weight of drill rods and hammer

* The N value is taken as the blows required to penetrate the final 12 inches

TERMS DESCRIBING SOIL STRUCTURE

Slickensided	Fracture planes appear polished or glossy, sometimes striated
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Inclusion	Small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Parting	Inclusion less than 1/4 inch thick extending through the sample
Seam	Inclusion 1/4 inch to 3 inches thick extending through the sample
Layer	Inclusion greater than 3 inches thick extending through the sample
Laminated	Soil sample composed of alternating partings of different soil type
Stratified	Soil sample composed of alternating seams or layers of different soil type
Intermixed	Soil sample composed of pockets of different soil type and laminated or stratified structure is not evident
Calcareous	Having appreciable quantities of calcium carbonate
Ferrous	Having appreciable quantities of iron
Nodule	A small mass of irregular shape

HVJ ASSOCIATES

PROJECT NO.: 02-155GA-0

DRAWING NO.: PLATE 14A

KEY TO TERMS AND SYMBOLS
USED ON BORING LOGS FOR SOIL

LABORATORY TEST RESULTS SUMMARY

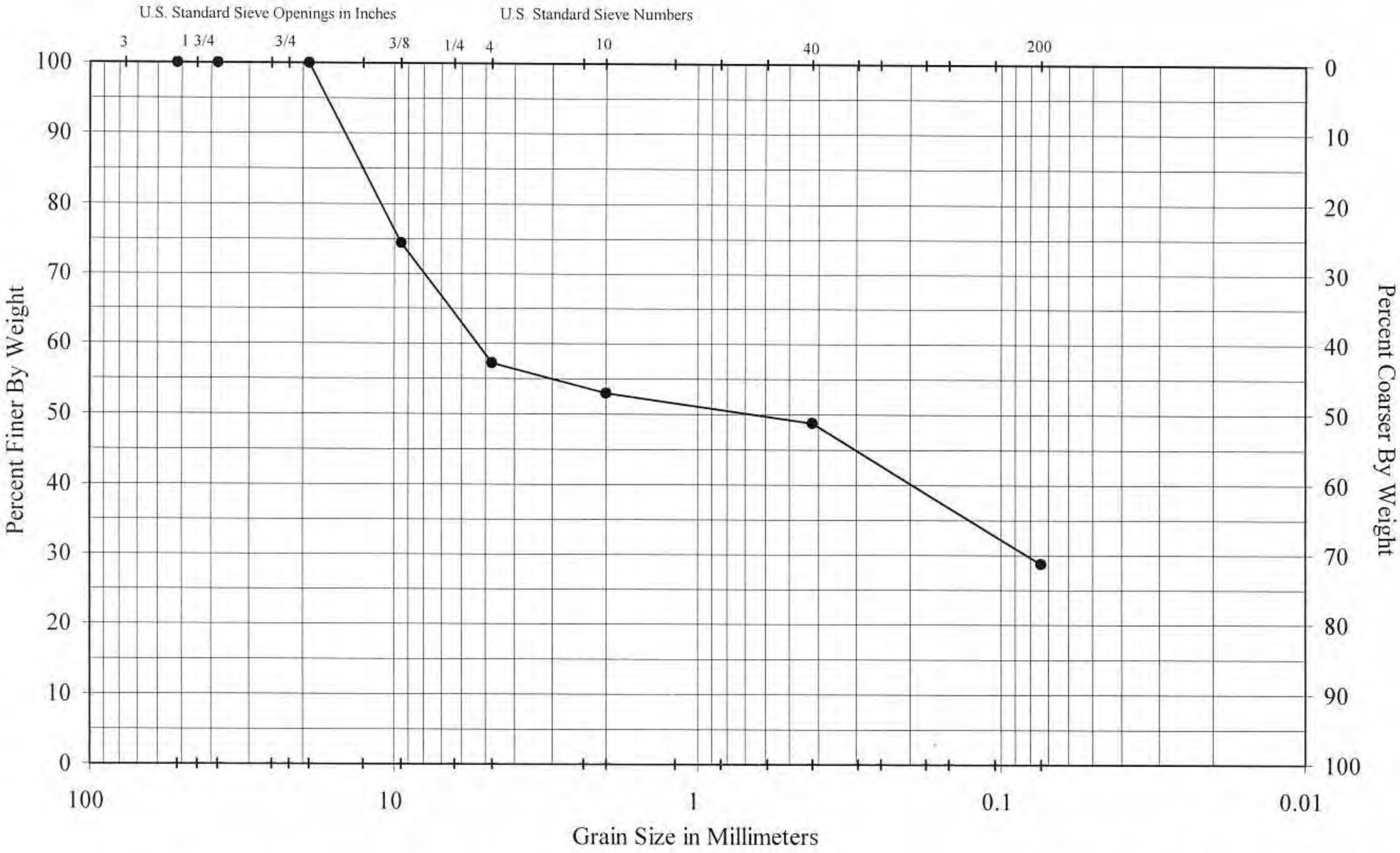
LABORATORY TEST RESULTS SUMMARY
Test Cell Levee Feasibility Analysis
02-155GA-0

Boring No.	Depth (ft)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Wet Unit Wt. (pcf)	Dry Unit Wt. (pcf)	Strength Test	Compressive Strength (tsf)	Hand Penetrometer Reading (tsf)
B-1										
	1.0		43	26						
	4.5	35.0								
	15.0	57.1	31	16	25.0					
	30.0	98.9			19.1					
B-2										
	6.0	67.0	41	17	22.1					
	8.0				8.2	121.5	112.3	UC	1.0	
	10.0	21.0	36	20	8.2					
	30.0	84.1	49	31	1.6					
B-3										
	4.5	1.6			1.3					
	18.0	80.6	45	21	30.5					
	33.5	86.2	36	20	16.3					
B-4										
	2.5	8.6			1.8					
	8.5	61.2	45	27	19.6					
	28.5	77.9	58	38	24.8					
B-5										
	6.5	43.3	53	37	11.2					
	13.5	38.4	47	31	16.5					
	38.5	98.3	69	46	25.6					
B-6										
	4.5	39.4	34	21	10.9					
	8.5	50.9	46	27	15.0					
	18.5	59.8	46	29	18.6					
	33.5	96.4	68	49	29.8					
B-7										
	4.5	19.4			10.5					
	23.5	7.0			8.6					
	38.5	94.6	58	40	24.1					
B-8										
	2.5	25.2			4.3					
	8.5	21.1	33	20	4.8					
	23.5	11.7			10.0					
	33.5	98.4	69	43	27.1					

LABORATORY TEST RESULTS SUMMARY
Test Cell Levee Feasibility Analysis
02-155GA-0

Boring No.	Depth (ft)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Wet Unit Wt. (pcf)	Dry Unit Wt. (pcf)	Strength Test	Compressive Strength (tsf)	Hand Penetrometer Reading (tsf)
B-9										
	8.5	16.0	39	22	19.8					
	23.5	99.4	76	60	32.0					
	33.5	98.5	60	41	23.5					
B-10										
	2.5		46	24	9.9					
	4.5	24.0								
	6.5	29.0								
	23.5	99.6	69	47	27.7					
	38.5	99.0	64	45	25.0					

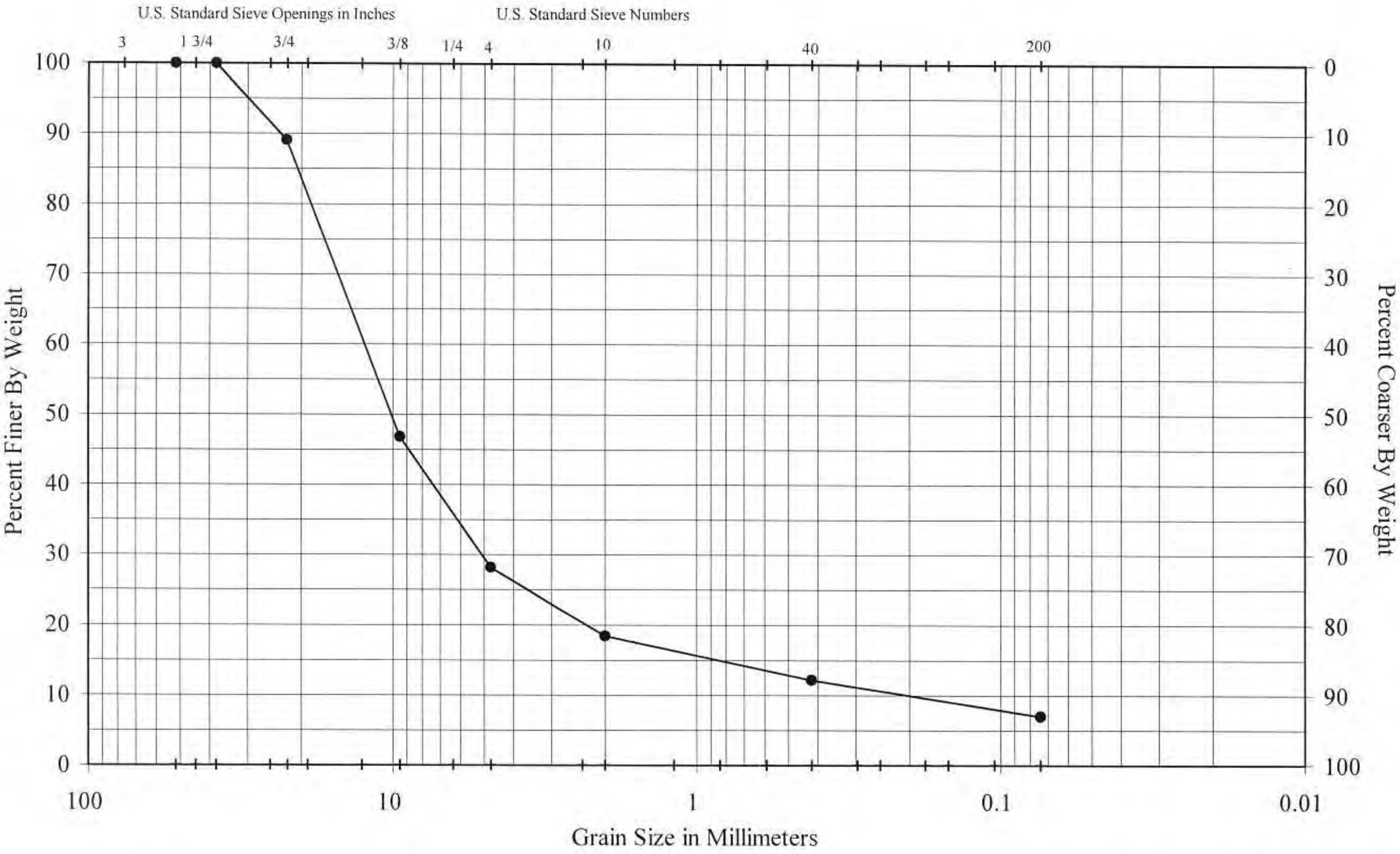
GRAIN SIZE ANALYSES



<u>Sample No.</u>
B-10
6.5'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

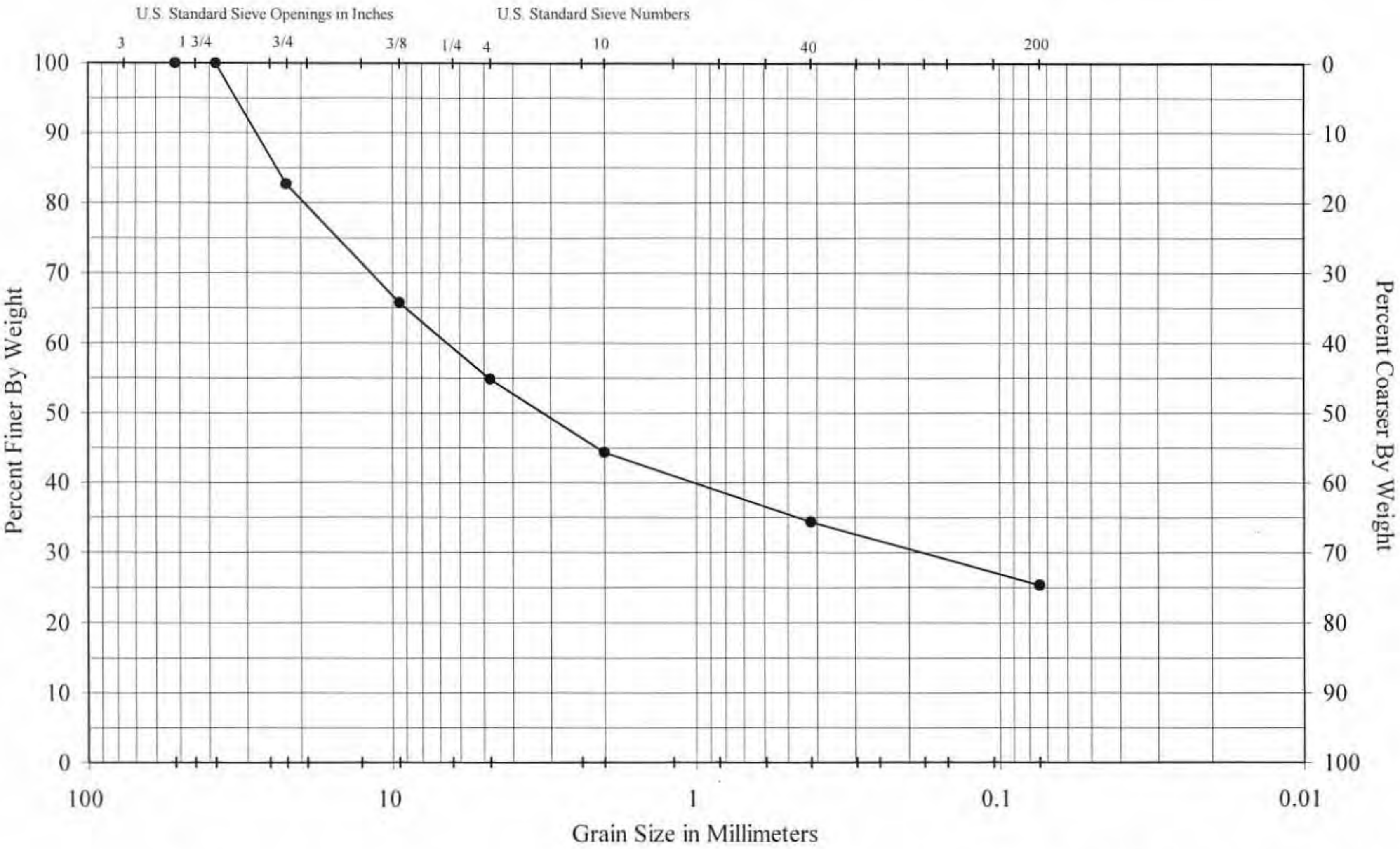
HVJ Project No. 02-155GA-0



Sample No.
B-7
23.5' - 25.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

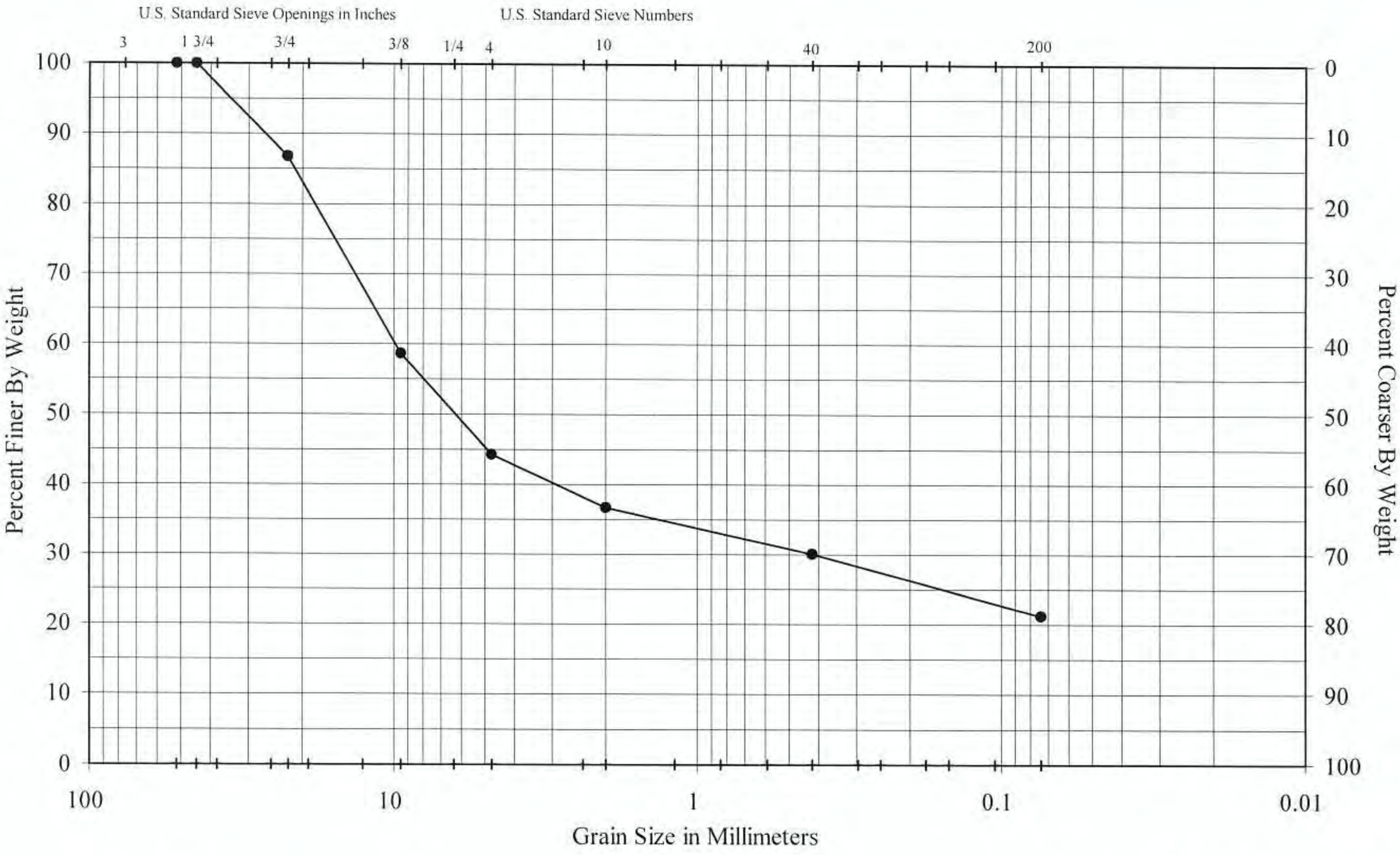
HVJ Project No. 02-155GA-0



Sample No.
B-8
2.5' - 4.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

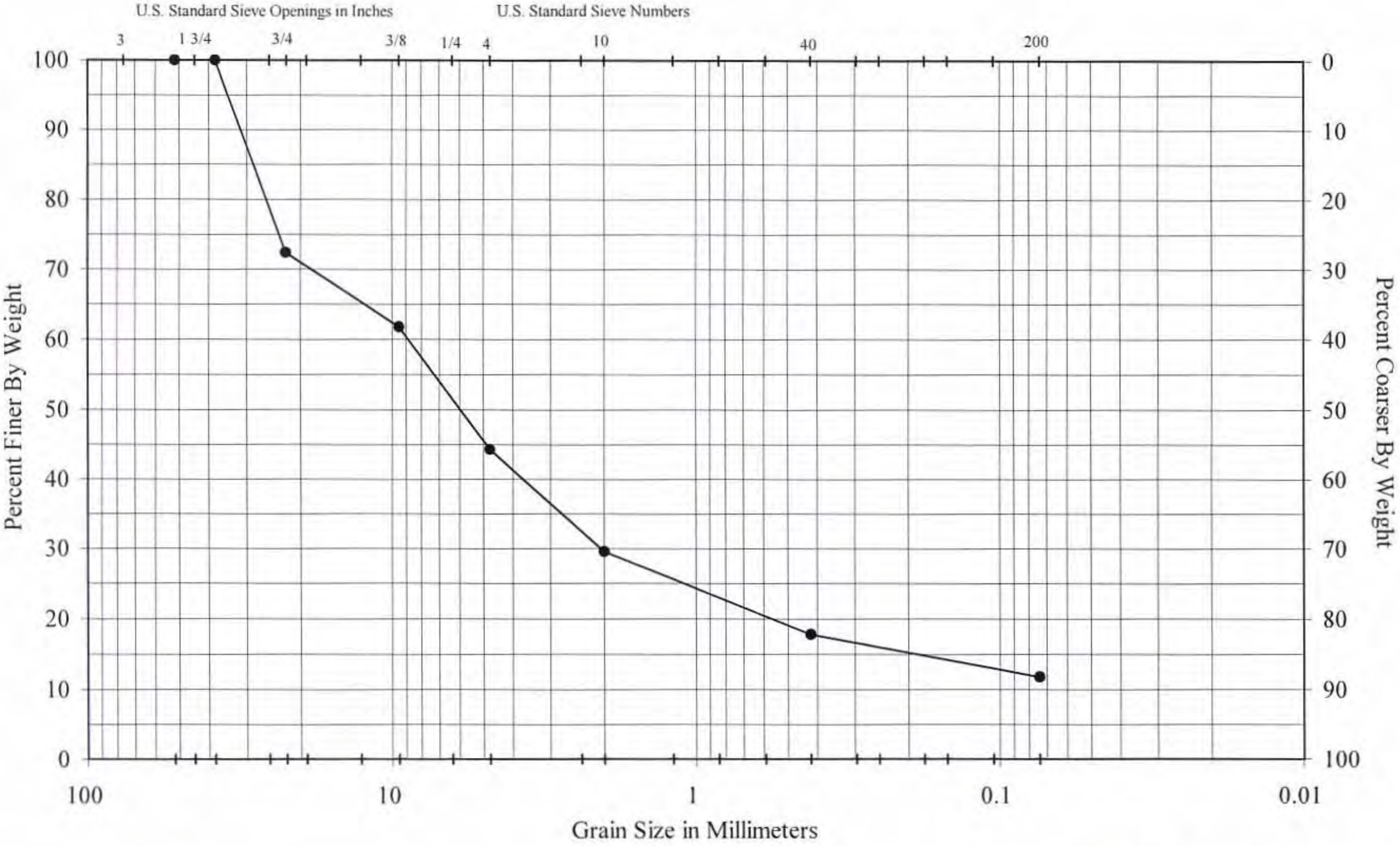
HVJ Project No. 02-155GA-0



Sample No.
B-8
8.5' - 10.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

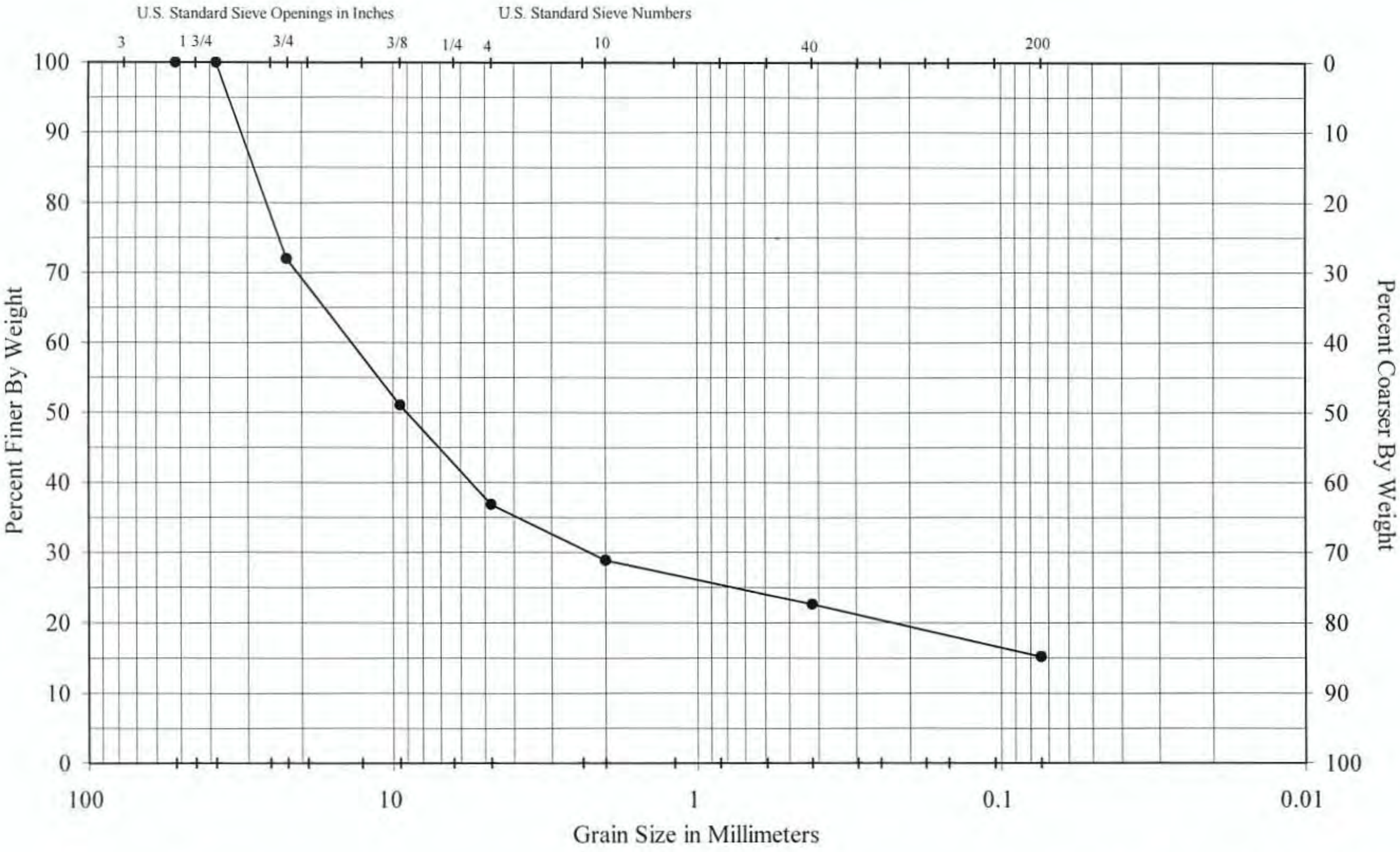
HVJ Project No. 02-155GA-0



Sample No.
B-8
23.5' - 25.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

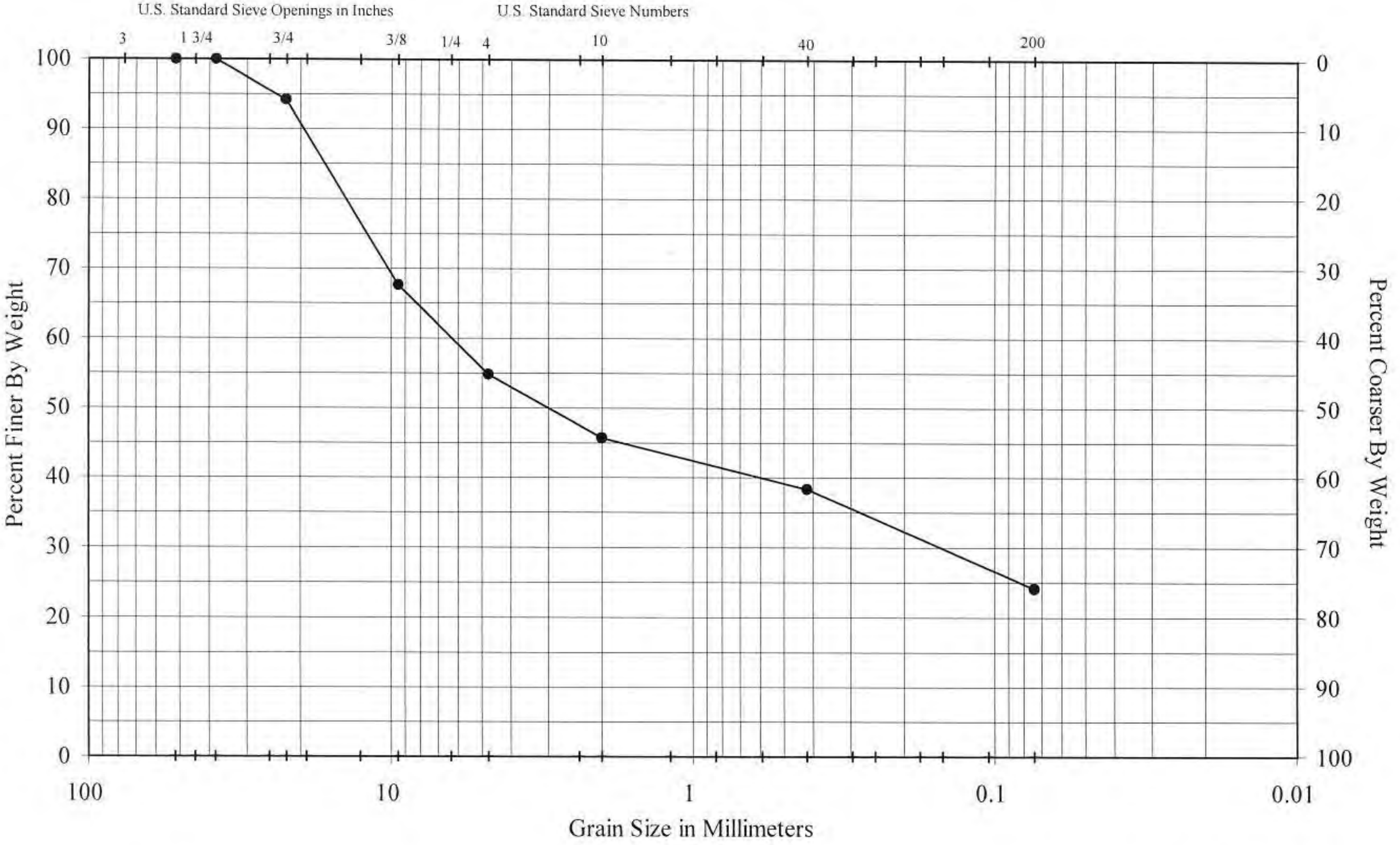
HVJ Project No. 02-155GA-0



Sample No.
B-9
6.5' - 8.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

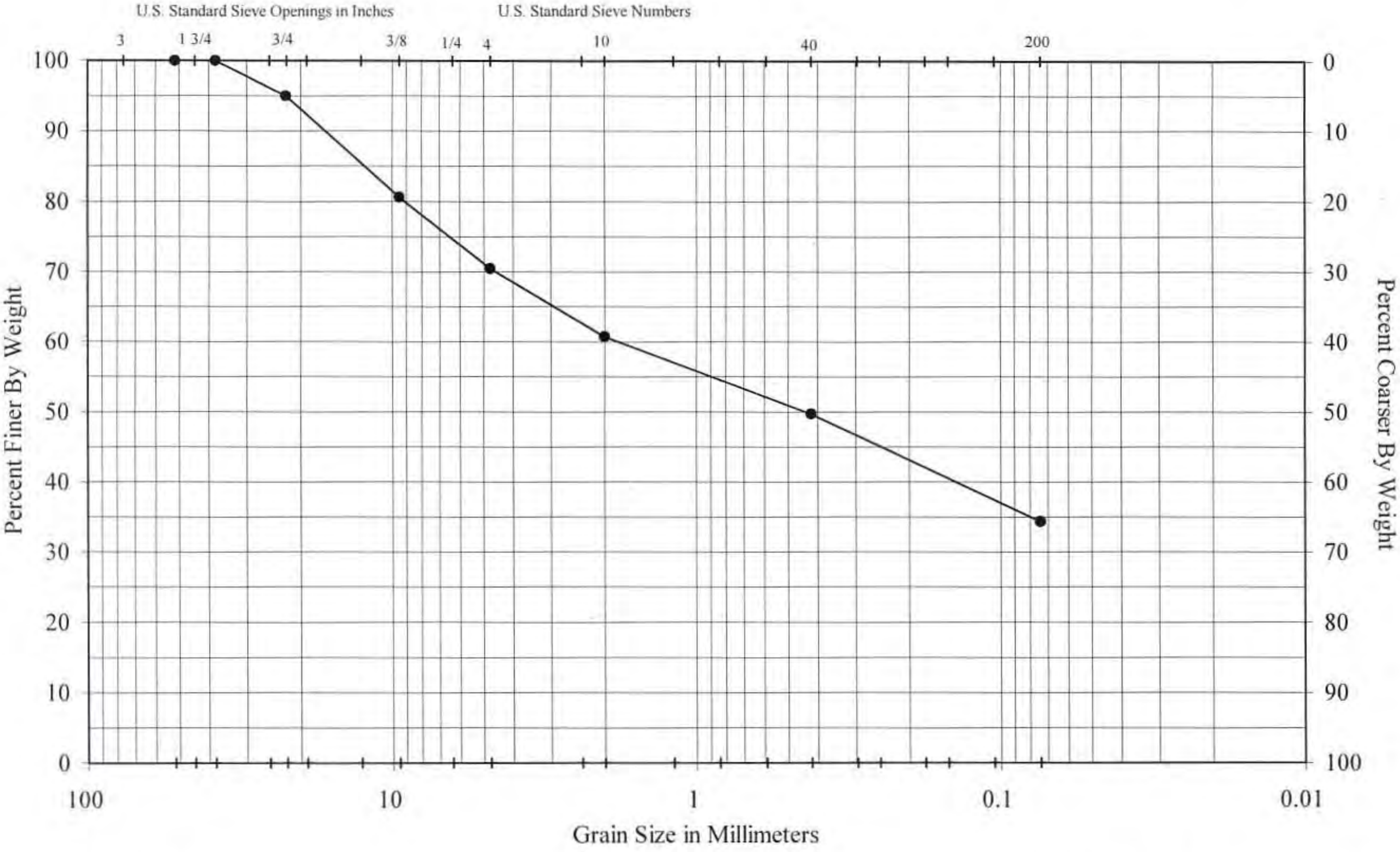
HVJ Project No. 02-155GA-0



Sample No.
B-10
4.5' - 6.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

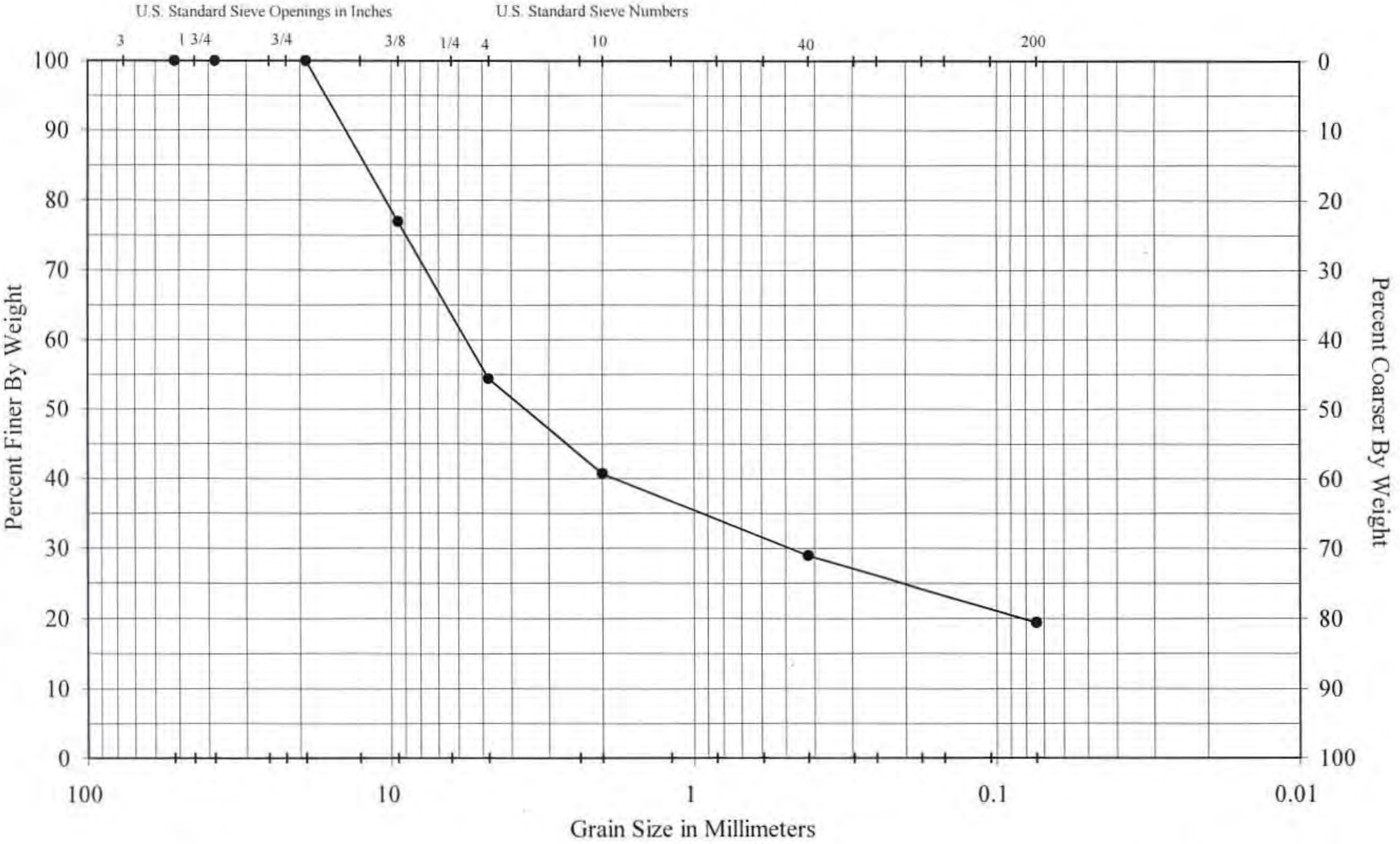
HVJ Project No. 02-155GA-0



<u>Sample No.</u>
B-1
4.0'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

HVJ Project No. 02-155GA-0



Sample No.
B-7
4.5'

Test Cell Levee Feasibility Analysis
Gradation Analysis
San Antonio, Texas

HVJ Project No. 02-155GA-0

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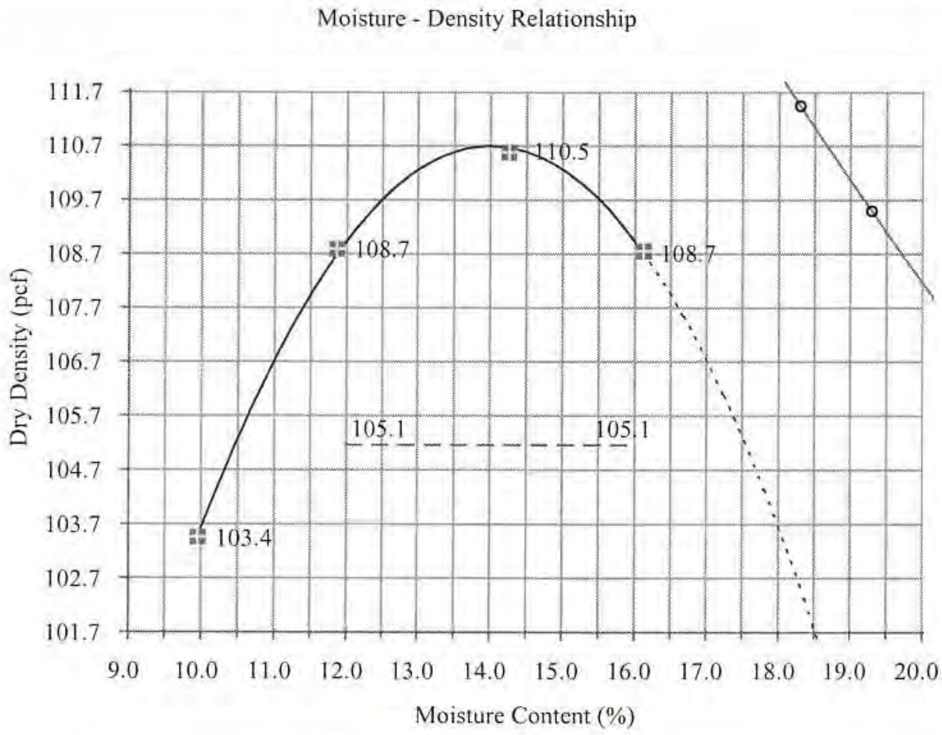
Report No	**B-1**	Date Sampled	12/20/05
Project Name	**Test Cell Levee Feasibility Analysis**	Project Number	**02-155GA-0**
Contractor Name		Work Order or CIP No.	
Lab. Technician	Jason Schwarz	Certification Type & No	NICET II 111079
City Inspector		Report of	Moisture/Demsity
Material Description	Tannish Brown Clayey SAND with gravel	Material use Type	Site Backfill
Material Source	Site Excavation	Date Tested	01/21/06



Sieve Analysis		
Size	% Passing	FAA adjusted
3"		
2"		
1 3/4"		
1 1/2"		
1"		
7/8"	100.0	
3/8"	86.8	
No. 4	73.8	
No. 10	64.0	100.0
No. 40	54.1	84.5
No. 200	38.5	60.1

Atterberg Limits		
LL	PL	PI
40	**14**	**26**

Soil Classification		
Unified:	SC	Group Index
AASHTO	A-6	4
FAA	E-7	

Test Method Used:	
Soil Sampling	TEX-100E
Soil Preparation	TEX-101E
Liquid Limit	TEX-104E
Plastic Limit	TEX-105E
Plasticity Index	TEX-106E
Sieve Analysis	TEX-110E
Compaction M/D Relatio	TEX-114E-II
Standard Classification	ASTM D2487

Estimated Specific Gravity	2.65	Points on Graph: 4

Moisture Content in %	9.9	11.8	14.2	16.1
Dry Density (pcf)	103.4	108.7	110.5	108.7
Max Density (kg/m3)	1,772.6			
Maximum Density (pcf)	110.7		Std Error	
Optimum Moisture(%)	14.0		0.07070	

Estimated Moisture 12.9

* FAA classification with a * suffix indicates that it is possible to raise the classification if the coarse material is reasonably sound & fairly well graded.

STATE OF TEXAS
LIZAN N. GILBERT
91796
LICENSED PROFESSIONAL ENGINEER

P.E. Signature

P.E. Seal

Report Review by: Lizan N. Gilbert, P.E.
Company Name HVJ Associates, Inc.

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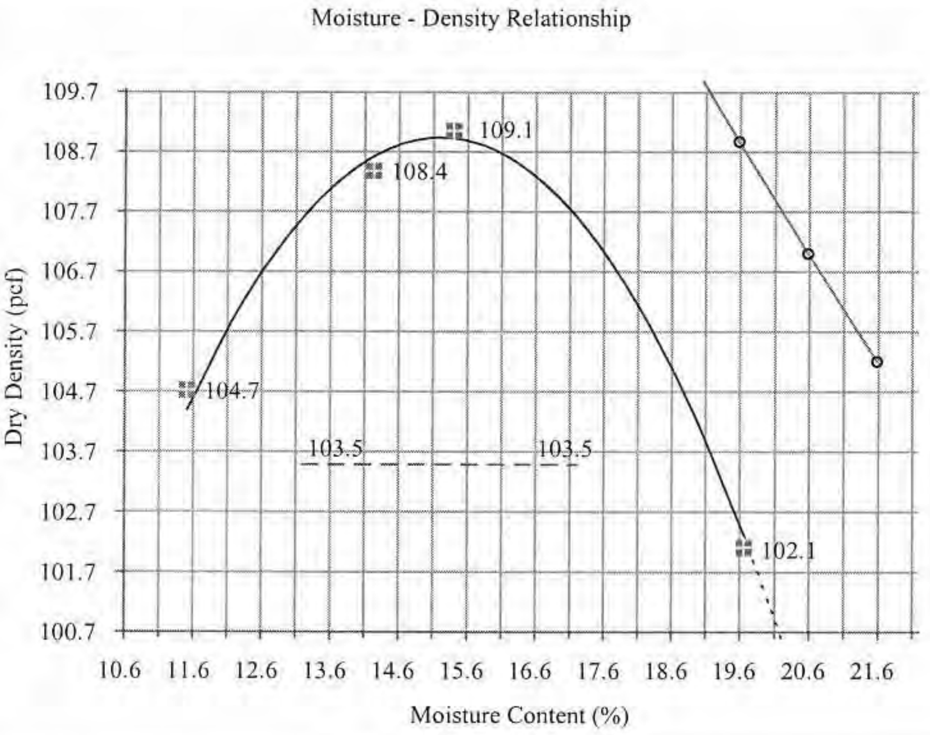
Report No	**B-6**	Date Sampled	12/20/05
Project Name	**Test Cell Levee Feasibility Analysis**	Project Number	**02-155GA-0**
Contractor Name		Work Order or CIP No.	
Lab. Technician	Jason Schwarz	Certification Type & No	NICET II 111079
City Inspector		Report of	Moisture/Demsity
Material Description	Brown Gravely Clay	Material use Type	Site Backfill
Material Source	Site Excavation	Date Tested	01/10/06


Moisture - Density Relationship

Sieve Analysis		
Size	% Passing	FAA adjusted
3"		
2"		
1 3/4"		
1 1/2"		
1"		
7/8"	#DIV/0!	
3/8"	#DIV/0!	
No. 4	#DIV/0!	
No. 10	#DIV/0!	100.0
No. 40	#DIV/0!	#DIV/0!
No. 200	#DIV/0!	#DIV/0!

Atterberg Limits		
LL	PL	PI
		#VALUE!

Soil Classification		
Unified:	**#DIV/0!**	Group Index
AASHTO	**#DIV/0!**	**#DIV/0!**
FAA	**#DIV/0!**	

Test Method Used:	
Soil Sampling	TEX-100E
Soil Preparation	TEX-101E
Liquid Limit	TEX-104E
Plastic Limit	TEX-105E
Plasticity Index	TEX-106E
Sieve Analysis	TEX-110E
Compaction M/D Relatio	TEX-114E-II
Standard Classification	ASTM D2487

Estimated Specific Gravity	2.65
Points on Graph: 4	

Moisture Content in %	11.5	14.2	15.4	19.7
Dry Density (pcf)	104.7	108.4	109.1	102.1
Max Density (kg/m3)	1,745.0			
Maximum Density (pcf)	108.9			
Optimum Moisture(%)	15.2			

Std Error
0.23584

Estimated Moisture
15.1

* FAA classification with a * suffix indicates that it is possible to raise the classification if the coarse material is reasonably sound & fairly well graded.

LIZAN N. GILBERT
91796

P.E. Signature

P.E. Seal

Report Review by: Lizan N. Gilbert, P.E.
Company Name HVJ Associates, Inc.

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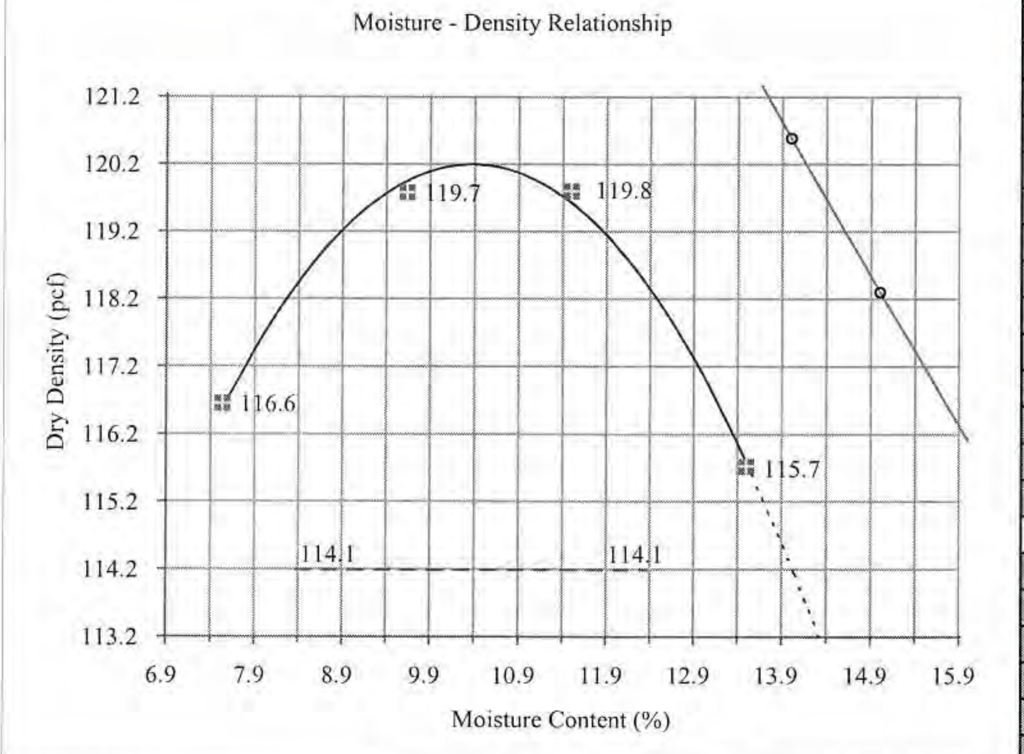
Report No	**B-8**	Date Sampled	12/20/05
Project Name	**Test Cell Levee Feasibility Analysis**	Project Number	**02-155GA-0**
Contractor Name		Work Order or CIP No.	
Lab. Technician	Jason Schwarz	Certification Type & No	NICET II 111079
City Inspector		Report of	Moisture/Density
Material Description	Brown Clayey Sand with Gravel	Material use Type	Site Backfill
Material Source	Site Excavation	Date Tested	01/10/06



Sieve Analysis		
Size	% Passing	FAA adjusted
3"		
2"		
1 3/4"		
1 1/2"		
1"	75.1	
7/8"	75.1	
3/8"	73.4	
No. 4	59.1	
No. 10	49.8	100.0
No. 40	41.8	83.9
No. 200	32.1	64.4

Atterberg Limits		
LL	PL	PI
39	**12**	27

Soil Classification		
Unified:	GC	Group Index
AASHTO	A-2-6	2
FAA	E-7	

Test Method Used:	
Soil Sampling	TEX-100E
Soil Preparation	TEX-101E
Liquid Limit	TEX-104E
Plastic Limit	TEX-105E
Plasticity Index	TEX-106E
Sieve Analysis	TEX-110E
Compaction M/D Relatio	TEX-114E-II
Standard Classification	ASTM D2487

Estimated Specific Gravity: 2.65

Points on Graph: 4

Moisture Content in %	7.6	9.7	11.5	13.5
Dry Density (pcf)	116.6	119.7	119.8	115.7

Max Density (kg/m3)	1,924.6
Maximum Density (pcf)	120.1
Optimum Moisture(%)	10.4

Std Error: 0.12929

Estimated Moisture: 10.7

* FAA classification with a * suffix indicates that it is possible to raise the classification if the coarse material is reasonably sound & fairly well graded.

Lizan N. Gilbert

P.E. Signature

STATE OF TEXAS
LIZAN N. GILBERT
91736
LICENSED PROFESSIONAL ENGINEER

P.E. Seal

Report Review by: Lizan Gilbert, P.E.
Company Name: HVJ Associates, Inc.

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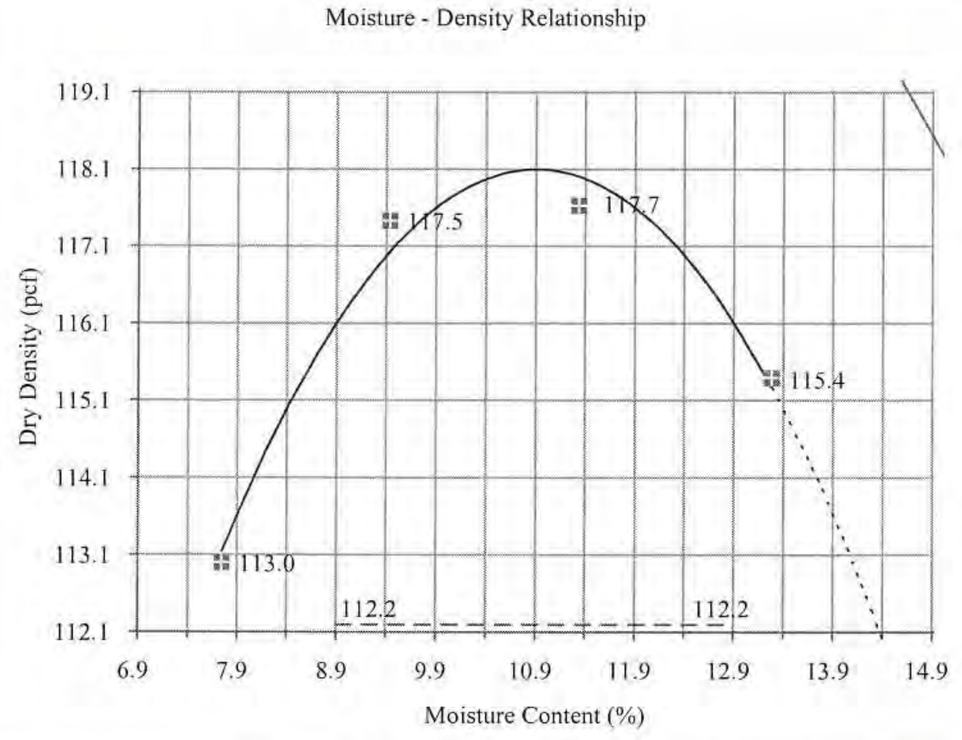
Report No	**B-3**	Date Sampled	12/20/05
Project Name	**Test Cell Levee Feasibility Analysis**	Project Number	**02-155GA-0**
Contractor Name		Work Order or CIP No.	
Lab. Technician	Jason Schwarz	Certification Type & No	NICET II 111079
City Inspector		Report of	Moisture/Demsity
Material Description	Tannish Brown Clayey SAND with gravel	Material use Type	Site Backfill
Material Source	Site Excavation	Date Tested	01/21/06


Moisture - Density Relationship

Sieve Analysis		
Size	% Passing	FAA adjusted
3"		
2"		
1 3/4"		
1 1/2"		
1"		
7/8"	100.0	
3/8"	86.8	
No. 4	73.8	
No. 10	64.0	100.0
No. 40	54.1	84.5
No. 200	38.5	60.1

Atterberg Limits		
LL	PL	PI
32	**12**	**20**

Soil Classification		
Unified:	SC	Group Index
AASHTO	A-6	2
FAA	E-7	

Test Method Used:	
Soil Sampling	TEX-100E
Soil Preparation	TEX-101E
Liquid Limit	TEX-104E
Plastic Limit	TEX-105E
Plasticity Index	TEX-106E
Sieve Analysis	TEX-110E
Compaction M/D Relatio	TEX-114E-II
Standard Classification	ASTM D2487

Estimated Specific Gravity: 2.65

Points on Graph: 4

Moisture Content in %	7.7	9.4	11.3	13.3
Dry Density (pcf)	113.0	117.5	117.7	115.4
Max Density (kg/m3)	1,892.1			
Maximum Density (pcf)	118.1			
Optimum Moisture(%)	10.9			

Std Error: 0.29154

Estimated Moisture: 10.1

* FAA classification with a * suffix indicates that it is possible to raise the classification if the coarse material is reasonably sound & fairly well graded.

LIZAN N. GILBERT
91796

P.E. Signature

P.E. Seal

Report Review by: Lizan N. Gilbert, P.E.
Company Name: HVJ Associates, Inc.

APPENDIX J

404(b)(1) ANALYSIS

Section 404 (b)(1) Analysis
Leon Creek, San Antonio Texas

I. Project Description

a. Location

The proposed flood damage reduction project is located on Leon Creek, a tributary to the San Antonio River, within the city of San Antonio, Bexar County, Texas.

b. General Description

A complete description of the proposed project including maps and figures that augment the description are included in the main text of the report to which this analysis is appended. A summary of project features is provided below.

Specific construction activities associated with the NED plan alternative include the construction of a levee along Leon Creek to protect against damages attributed to a 1% annual exceedance probability (AEP) and the modification of 2,738 linear feet of the Leon Creek channel to accommodate the hydraulic impacts of the construction of the levee. Channel modifications to Leon Creek would be designed utilizing natural channel design principles to mitigate for aquatic impacts and the channel capacity would be increased to accommodate the planting of native aquatic and riparian vegetation along the Leon Creek 'self-mitigation' of impacts to area natural resources.

c. Authority and Purpose

The Leon Creek Feasibility Study is authorized by the Guadalupe and San Antoinio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution Docket 2547, 11 March 1998. The objective of the study is to examine flood damage reduction alternatives along Leon Creek in San Antonio, Texas, and recommend a flood damage reduction project for implementation if one could be found that is technically and economically feasible, environmentally acceptable, and supported by the San Antonio River Authority (SARA).

d. General Description of Dredged or Fill Material

(1) General Characteristics of Material

The material would be derived primarily from the channel banks along Leon Creek. The fill material is comprised primarily of clayey gravel, loose gravelly sand, and hard clay.

(2) Quantity of Material

Approximately 96,600 cubic yards of soil derived from cutting the channel would be reutilized as backfill on side slopes of the channel and construction of the adjacent levee structure, if the material suitable. Approximately 27,100 cubic yards of excavated material would be removed from the project area and placed in a licensed disposal site. Two scales of natural channel design features are proposed for the channel. Eight small in-stream structures each comprised of 56 cubic yards of riprap and 30 cubic yards of boulders would be interspersed throughout the channel. At the downstream extent, a larger in-stream structure comprised of approximately 195 cubic yards of riprap and 174 cubic yards of boulders would be constructed. Altogether, the in-stream structures would result in 1,057 cubic yards of material placed within the channel.

(3) Source of Material

The riprap and boulders would be brought in from local commercial sources.

e. Description of the Proposed Discharge Site(s)

(1) Location

Discharge into waters of the United States would occur along the banks and bottom of Leon Creek. Bottom channel widths for Leon Creek vary from 15 to 50 feet. Surplus material would be removed from the project area and deposited into a disposal site that would not impact waters of the United States.

(2) Size

The surface area of the channel at top of the bank would be approximately 20 acres in size.

(3) Type of Site

The disposal site would be confined (not placed in open water).   Disposal will be conducted in the dry, compacted and followed by stabilization with vegetation.

(4) Type(s) of Habitat

The EPA Rapid Bioassessment Method was used to characterize the aquatic habitat of Leon Creek. The existing habitat condition scores indicate that Lower Leon Creek is of moderately high quality receiving a habitat score of 148 out of a possible 200, with 200 representing a pristine habitat. A low water crossing backs the creek up to form a pool habitat at the lower extent of the project reach. In addition to the aquatic habitat, excavation to form the channel would also impact approximately 20 acres of low to moderate quality upland forest that transitions to a grassland savannah towards the lower end of the reach.

(5) Timing and Duration of Discharge

Discharges would occur over the entire construction period which is estimated to be 6 to 9 months. It is anticipated that once the project begins, there would continual construction until completion.

f. Description of Disposal Method

Equipment used to excavate and to backfill the channel would be done by front end loaders, possibly with rippers, other heavy excavation equipment including bulldozers and dump trucks.

II. Factual Determinations

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope

The existing profile slope of Leon Creek is variable, but averages 0.07%. The proposed would result in a relatively constant average slope of 0.01%.

(2) Sediment Type

The sediment in the Lower Leon Creek reach is silty clay. Because of the natural channel design proposed for the channel modifications incorporates sediment transport balance as a key design factor, excessive sedimentation and erosion is not expected.

(3) Dredged/Fill Material Movement

After the material is placed in the channel bottom and side slopes, it would be compacted and stabilized by native vegetative plantings. Only minor movement of fill material would occur after stabilization.

(4) Physical Effects on Benthos

The existing benthos would be temporarily impacted within the proposed 2,703 linear feet of channelization; however, the natural channel design of the proposed channel improvements would restore the aquatic function and benthic habitats to the system. The proposed in-stream structures would create pool, riffle, run, and glide habitats that would sustain a diverse and abundant benthic community. During construction, erosion and sedimentation Best Management Practices (BMPs) would be utilized to minimize impacts to benthos downstream of the proposed project area.

(5) Other Effects

No other effects are anticipated.

(6) Actions Taken to Minimize Impacts

Alternatives were investigated during the study as displayed in the main report, including the creation of a bypass channel and several channel configurations. The channel configuration incorporating the in-stream structures associated with the natural channel concept was selected as it would mitigate the ecological impacts in contrast with channelizing and armoring the stream with hardened structures. In addition, additional excavation was incorporated into the channel to accommodate the planting of native, woody, riparian vegetation within the proposed flood channel. The riparian vegetation would provide vital organic input into the stream channel and provide valuable shading that maintain water temperatures and dissolved oxygen levels at ecologically beneficial levels. BMPs would also be implemented to minimize erosion and sedimentation during construction and establishment of the riparian vegetation.

b. Water Circulation. Fluctuation and Salinity Determinations

(1) Water, Consider effects on:

(a) Salinity
The project would not impact salinity in Leon Creek.

(b) Water Chemistry (pH.etc.)
No current water quality data is available for this stream in the project area, however, no long term impacts to water chemistry are anticipated from project implementation as the stream structure and function will be similar after project completion.

(c) Clarity
Temporary disruption to water clarity is expected during construction. After the channel is completed and stabilized, water clarity would be similar to that found in the stream now.

(d) Color
No changes in color are anticipated following construction.

(e) Odor
No changes in odor should occur following construction

(f) Taste
The stream is not used as a potable water source within any portion of the area that would be impacted by the project.

(g) Dissolved Gas Levels
Minor changes may result in the concentration of dissolved gasses of Leon Creek due to the potential aeration resulting from the in-stream structures. The upper section of the proposed channel improvements consists of riparian woodlands while the lower section is bordered by grassland/savannah habitats. Although the proposed woody vegetation proposed along the riparian corridor would provide shading to regulate water temperatures and dissolved oxygen concentrations in the lower section of the proposed project area, these benefits may be neutralized by the opening of wooded habitats in the upper section. However, any changes in dissolved gas levels are expected to be minimal.

(h) Nutrients
The project as proposed would not increase nutrient loading to the stream.

(i) Eutrophication
Eutrophication is not evident in the project reach and there would be no factors changed that would impact eutrophication of the aquatic system of Leon Creek.

(2) Current Patterns and Circulation

Flow and Water Circulation

(a) Current Patterns and Flow

Much of Leon Creek flows through urban and suburban environments and is heavily influenced by stormwater runoff magnified by the relatively high impervious cover in the watershed. Patterns of flow are dependent on the distribution and intensity of rainfall over this area. The normal patterns of precipitation result in minor fluctuations of flow intensity through the system. Heavy thunderstorms can induce large flows and higher water surface elevations. Circulation basically does not change as the system has no braids or large in-stream detention. The project as proposed would not alter flows or circulation patterns, but would decrease the water surface elevations, causing less out of bank flows that cause damages to existing structures in the urban area.

(b) Velocity

There would be a minor increase in velocity for most flow events due to channelization of the stream. Overall, any areas where velocities that would might induce scour would be controlled by the placement of the in-stream structures designed to dissipate energy while creating pool and riffle habitats. Where required, the channel and banks would be protected with suitable erosion control techniques.

(c) Stratification

Stratification in the project reach does not occur now in the stream nor would it occur following project implementation.

(d) Hydrologic Regime

Two-year flood flows with the proposed project completed would be approximately 12,200 cubic feet per second and 116,900 cubic feet per second for the 100 year event. Although existing flows were not measured, more frequent events were not computed but vary from essentially no flows during and following dry summer conditions to a few cubic feet per second for several days following local rainfall.

(3) Normal Water Level Fluctuations

Existing water level fluctuations have not been measured. Upon completion of the proposed channel, water surface elevation would fluctuate 5 to 6 feet between the 2 year and 100 year flood events.

(4) Salinity Gradients

No changes to salinity gradient would occur

(5) Actions That Will Be Taken to Minimize Impacts

The natural channel design of the proposed action avoids and minimizes impacts to the flow and circulation of waters in the project reach. Although the in-stream structures result in the pooling of the stream, they mirror the pool and riffle sequences found in natural streams. Impacts were further reduced minimizing the aereal extent of the channel modifications and minimizing the channel width as much as feasible.

e. Suspended Particulate/Turbidity Determinations

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

Only temporary increases in suspended particulates and turbidity levels would occur during construction. Most fill would occur in the dry. There would be some movement of these materials downstream of the construction zone should high flow events occur prior to stabilization.

(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column

(a) Light Penetration

Changes to light penetration would occur during construction associated with minor turbidity increases. Appropriate erosion and sedimentation controls would be implemented to mitigate impacts to downstream waters. After project completion and stabilization, the clarity of the stream would return to preconstruction levels.

(b) Dissolved Oxygen

Temporary lowering of dissolved oxygen could occur during construction. Dissolved oxygen may increase as a result of aeration over the in-stream structures placed within the channel as part of the natural channel design. Woody riparian vegetation planted along the stream channel would shade the stream further benefitting the dissolved oxygen levels of the stream. Effects of the project to dissolved oxygen would not extend significantly downstream of the construction zone.

(c) Toxic Metals and Organics

No water testing was conducted in the immediate proposed project area and no data was identified to provide information on water quality measures. The proposed project would not result in the introduction of toxicants into Leon Creek. The watershed is primarily urban with most of the run-off coming from industrial, commercial, and residential areas. Several ground water wells are located in the watershed above the project area to remove and treat contaminated ground water before entering Leon Creek. Although the ground water wells and treatment facilities would not be impacted by the proposed project, there is a remote possibility that the soils in and around the creek could contain residual contamination from prior exposure. Therefore, soil excavated from the channel would be tested for contaminants before being used in the levee or bank reconstruction. If site soils exceed toxicity standards, the project sponsor would be responsible for site reclamation prior to construction of the project.

(d) Pathogens

No pathogens would be added to the water column as a result of this project.

(e) Aesthetics

The proposed natural channel design of the Leon Creek channel would create pool, riffle, run, and glide habitats providing a naturalized aesthetic to the modified Leon Creek channel. In addition, the restoration of native riparian vegetation after channel construction would also restore the natural aesthetics of the area.

(f) Others as Appropriate

No other effects to water column are anticipated

(3) Effects on Biota

Displacement of local biota would occur during construction as mobile species would emigrate to adjacent habitats. Although sessile species would be impacted during construction activities, the natural channel design and restoration of the woody vegetation would restore the aquatic and riparian habitats of Leon Creek.

(a) Primary Production, Photosynthesis

Aquatic and riparian vegetation would be removed from the project site during the modification of the Leon Creek channel. Once the channel is constructed, primary producers would be restored to the aquatic and riparian ecosystem. No net loss of primary production is anticipated as the result of the proposed action.

(b) Suspension/Filter Feeders

Suspension and filter feeders would be temporarily displaced during construction activities. BMPs would be established to control erosion and sedimentation downstream that may otherwise impact filter feeders. Once the proposed channel is constructed, suspension and filter feeders would repopulate the riffle and pool habitats created through the natural channel design. No net loss of suspension or filter feeders is anticipated as the result of the proposed action.

(c) Sight Feeders

Sight feeders would be temporarily displaced during construction activities. BMPs would be established to control erosion and sedimentation downstream that may otherwise impact sight feeders. Once the proposed channel is constructed, sight feeders would repopulate the riffle and pool habitats created through the natural channel design. No net loss of sight feeders is anticipated as the result of the proposed action.

(4) Actions taken to Minimize Impacts

The length of the channelized reach of Leon Creek was minimized to reduce impacts to aquatic biota. BMPs will be established to control erosion and sedimentation to minimize impacts to biota downstream. By utilizing a natural channel design for the modified channel and restoring native riparian vegetation, long term impacts to the aquatic biota would be minimized and inconsequential.

d. Contaminant Determinations

The proposed project would not result in the exposure of toxicants to the biota of Leon Creek. As previously stated, if site soils exceed toxicity standards due to potential contamination of adjacent properties, the project sponsor would be responsible for site reclamation and providing an uncontaminated site prior to construction of the project.

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton and Nekton

Temporary impacts to plankton and nekton would occur during construction of the modified channel. However, the in-stream structures included in the natural channel design would result in a series of riffle/pool complexes throughout the project reach. The habitat diversity provided by the created pools and riffles would provide habitat to a diverse community of plankton and nekton once the channel and vegetation is restored. Therefore, no net loss of plankton and nekton is anticipated.

(2) Effects on Benthos. No additional effects other than those previously discussed were identified.

(3) Effects on Aquatic Food Web

Temporary disruptions to the food web would occur during construction. However, the in-stream structures of the proposed natural channel design would result in a series of riffle/pool complexes throughout the project reach. This habitat diversity would provide habitat to a diverse community of organisms at all trophic levels. Therefore, no net loss of species or negative impacts to trophic levels are anticipated as the result of the proposed action.

(4) Effects on Special Aquatic Sites.

(a) Sanctuaries and Refuges

No fish and wildlife sanctuaries or refuges occur within the project area.

(b) Wetlands

No wetlands were identified within the area to be impacted by the project.

(c) Mud Flats

No mud flats were observed within the study area to be impacted by the project

(d) Vegetated Shallows

No vegetated shallows were observed in the area to be impacted by the project.

(e) Coral Reefs

No coral reefs occur within the project area.

(f) Riffle and Pool Complexes.

The in-stream structures of the proposed natural channel design would result in a series of riffle/pool complexes throughout the project reach. Therefore, riffle and pool complexes may increase as a result of the proposed action.

(5) Threatened and Endangered Species

The project would not affect any federally listed threatened or endangered species.

(6) Other Wildlife

Wildlife inhabiting the aquatic and riparian habitats within the project reach would be temporarily displaced during construction of the proposed channel. Mobile species would emigrate to adjacent habitats placing. Although sessile species would be impacted during construction activities, the natural channel design and restoration of the woody vegetation would restore the aquatic and riparian habitats of Leon Creek.

(7) Actions to Minimize Impacts

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination

Most fill would occur within areas of the channel while in a dry state and only minimal mixing would occur, primarily due to churning of shallow waters by equipment traversing the channel bottom. Best Management Practices will be implemented such as silt curtains to lower impacts. Disposal of surplus material would occur at an offsite location that is not within waters of the United States.

(2) Determination of Compliance with Applicable Water Quality Standards

The 2012 Section 303(d) list published by the Texas Commission on Environmental Quality classifies Segment 1906_04 (Lower Leon Creek from Highway 353 to two miles upstream) as impaired for aquatic life uses based on depressed dissolved oxygen and for fish consumption use based on PCBs in edible tissue. As discussed in previous sections, the non-federal project sponsor would be responsible for providing an uncontaminated project site before the proposed action would commence; therefore, the proposed project would not contribute to the fish consumption use limitations within the lower sections of Leon Creek. In addition, the natural channel design and native vegetation restoration associated with the modified channel may actually provide some aeration of water as it flows over the riffle structures. Although this aeration would not substantially address the aquatic life limitations of Lower Leon Creek, the proposed action would not contributed to a decline in dissolved oxygen concentrations.

(3) Potential Effects on Human Use Characteristic

(a) Municipal and Private Water Supply

Municipal and private water supplies in the action area rely on groundwater associated with the Edwards Aquifer. The project area is not located in the recharge or contributing zone of the Edwards Aquifer and Leon Creek is not utilized as a local water supply; therefore, the propsed action would not impact the local water supply.

(b) Recreational and Commercial Fisheries

No signs of recreational fisheries activities were identified. No significant impact to recreational fisheries is anticipated. No commercial fisheries were identified within the project area

(c) Water Related Recreation

No additional effects to water related recreation are anticipated

(d) Aesthetics

The proposed natural channel design of the Leon Creek channel would create pool, riffle, run, and glide habitats providing a naturalized aesthetic to the modified Leon Creek channel. In addition, the restoration of native riparian vegetation after channel construction would also restore the natural aesthetics of the area.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

No parks, monuments, seashores, wilderness areas, research sites, or preserves occur in the project area.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

Because the proposed action would utilize natural channel design principles and would entail the restoration of native riparian habitat, the direct impacts were mitigated. The temporary effects of construction activities that may the result at the project site and areas downstream would be relatively minor. However, with proper BMPs in place, these minor impacts would not substantially contribute to cumulative impacts on water quality for are waterbodies.

h. Determination of Secondary Effects on the Aquatic Ecosystem

No secondary effects on the aquatic ecosystem were identified

FINDING OF COMPLIANCE
FOR
LEON CREEK, SAN ANTONIO, TEXAS

1. No significant adaptations of the guidelines were made relative to this evaluation.

2. Several channel configurations were initially considered including an extension of the proposed channel length upstream of Military Drive and a bypass channel that would convey floodwaters across the bend of Leon Creek. In addition, two different channel designs were considered: an engineered trapezoidal channel and a natural channel design channel. In order to avoid and minimize impacts to aquatic and riparian habitats, a shorter section of channelization was proposed with the channel capacity designed to accommodate the replacement of native aquatic and riparian vegetation. This alternative would enable the proposed project to “self-mitigate” impacts to aquatic habitats onsite.

3. The planned disposal of dredged material within the construction area would not violate established State water quality standards for Leon Creek. The disposal operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4. Use of the selected disposal sites will not harm any endangered species or their critical habitat.

5. The proposed disposal of dredged material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values will not occur. Impacts to riparian forest impacts were identified and will be mitigated onsite by replacing native riparian vegetation at a density of 30 trees per acre.

6. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include use of suitable erosion control technologies including the implementation of procedures to protect against erosion and sedimentation during and after construction.

7. On the basis of the guidelines the proposed disposal site for the discharge of dredged material is specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem.