DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS
1100 COMMERCE STREET
DALLAS, TEXAS 75242-0216

Reply to
Attention of:

December 28, 2006

CESWD-PDS-P

MEMORANDUM FOR Commander, Fort Worth District

SUBJECT: Report Approvals

1. References:

a. Memorandum, CESWF-PM-C, 15 December 2006, subject: Submittal of Final Detailed Project Report and Integrated Environmental Assessment, Section 206 Aquatic Ecosystem Restoration Project, Olmos Creek, San Antonio, Bexar County, Texas (PWI# 171463).

b. Memorandum, CESWF-PM-C, 5 December 2006, subject: Response to SWD Review of the Final Detailed Project Report and Integrated Environmental Assessment, Lewisville Lake Section 1135 Ecosystem Restoration Project, Frisco, Texas (PWI# 167355)

c. Memorandum, CESWF-PM-C, 8 August 2006, subject: Submittal of Final Detailed Project Report and Integrated Environmental Assessment, Section 206 Aquatic Ecosystem Restoration Project, Spring Lake, San Marcos, Texas (PWI# 167351).

2. The Final Reports submitted with the referenced memoranda are approved. The District may continue plans and specifications within available funds.

3. The draft project cooperation agreement (PCA) for each project is anticipated to conform to the model based on preliminary review. Final review and approval of each PCA is pending HQUSACE ongoing revision of these models.

4. The District Commander may not execute the PCA until the project conforms to all of the requirements (as yet undetermined) that may be associated with expiry of the current PCA moratorium, budgetary guidance and other requirements.

5. The District will separately submit a request for project approval to us, including updated cost estimates and real estate information, at an appropriate time during the plans and specifications phase. No work may be performed unless funds are available.

5. Questions on these projects should be directed to Sam Arrowood, 469-487-7069.

Jo Ann M. Duman

JO ANN M. DUMAN
Chief, Planning and Policy

CF:
CESWD-PDF
CESWF-PM-C

US Army Corps of Engineers
Fort Worth District

Detailed Project Report and Integrated Environmental Assessment

San Marcos River Section 206 Aquatic Ecosystem Restoration Project

April 2014

U.S. Army Corps of Engineers
Fort Worth District

DETAILED PROJECT REPORT AND INTEGRATED ENVIRONMENTAL ASSESSMENT

San Marcos River Section 206 Aquatic Ecosystem Restoration Project

U.S. Army Corps of Engineers
Fort Worth District
Fort Worth, Texas

April 2014

FINDING OF NO SIGNIFICANT IMPACT

SAN MARCOS RIVER SECTION 206
AQUATIC ECOSYSTEM RESTORATION PROJECT
SAN MARCOS, TEXAS

A Detailed Project Report and integrated Environmental Assessment (DPR/EA) have been prepared to evaluate environmental restoration alternatives in the San Marcos River and its tributaries, from Spring Lake Dam to the confluence with the Blanco River, in San Marcos, Texas. The proposed project would restore valuable aquatic and riparian habitats along the San Marcos River, which have been degraded by recreational use, invasive exotic plant and animal species, and sedimentation. Aquatic and riparian exotic plants would be controlled, riparian habitats on managed lands and at discharge points would be restored, and sediment accumulated in the San Marcos River channel would be removed. The proposed project would provide benefits to the federally listed species Texas wild-rice (*Zizania texana*), San Marcos gambusia (*Gambusia georgei*), fountain darter (*Etheostoma fonticola*), and San Marcos salamander (*Eurycea nana*), and their designated critical habitat, as well as the federal candidate species golden orb (Quadrula aura) and Texas pimpleback (Quadrula petrina). Further, the proposed project expands upon the habitat restoration for federally listed endemic species through its connectivity with the Spring Lake Section 206 Aquatic Ecosystem Restoration project that was recently implemented upstream of the proposed project area.

Nine restoration measures were developed and carried forward for cost-benefit analysis. Each of these measures was independent of the others, meaning each could serve as a stand-alone plan. The nine measures were controlling discharge, increasing the width of the riparian forest, improving wetlands in the watershed, controlling riparian exotic plants, controlling aquatic exotic plants, removing sediments from the channel, creating recreational access structures, controlling nuisance waterfowl, and educating the public. Alternatives evaluated included a No Action Plan, and all combinations of the nine measures. All restoration plans were evaluated using an incremental cost analysis to ensure that the most cost-effective plan was selected. The Proposed National Environmental Restoration (NER or recommended) plan included measures to control aquatic and riparian exotic plants, measures to restore wetlands, and measures to remove accumulations of sediments from the San Marcos River channel.

The Proposed NER Plan would have short-term and minimal adverse effects on soils and surface water quality as a result of soil and substrate disturbance and consequent erosion and turbidity. Soil erosion would be minimized through development of a Stormwater Pollution Prevention Plan and implementation of appropriate best management practices during the project construction. Consistency of all Proposed NER Plan activities with a Texas Pollutant Discharge Elimination System General Permit would be certified by the Texas Commission on Environmental Quality prior to construction. Measures to restore the riparian zone, redirect recreation from sensitive areas, and control surface discharges would all have long-term beneficial effects on soils and water quality. The Proposed NER Plan would have a negligible effect on floodplains and would result in a net increase in the acreage and quality of wetlands in the study area. Removal of sediments, restoration of wetlands, and removal of exotic aquatic vegetation would occur within jurisdictional waters of the U.S. The Proposed NER Plan would meet the conditions of Nationwide Permit (NWP) 27 for Stream and Wetland Restoration Activities. The Texas Commission on Environmental Quality has issued a water quality

certification for NWP 27; thus, no further coordination for Section 401 water quality certification is required.

The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service (USFWS) completed Section 7 Endangered Species Act (ESA) consultation for the proposed project on October 18, 2013. The proposed project would likely adversely affect three species listed under the ESA: Texas wild-rice, fountain darters, and San Marcos gambusia. The proposed project would likely adversely affect critical habitat of the fountain darter. However, it is the USFWS's Biological Opinion that the effects of the proposed action and cumulative effects would not jeopardize the continued existence of these species or destroy or adversely modify critical habitat. The USACE and the City of San Marcos would be responsible for implementing the conservation measures identified in the Biological Opinion, as well as complying with all of the terms and conditions required to implement reasonable and prudent measures for conservation of the species. These measures include, but are not limited to, planting of dredged areas with native macrophytes and sweeping for darters prior to disturbance of the stream bed or aquatic vegetation.

The removal of exotic riparian and aquatic species and replanting of native vegetation would have the potential to adversely impact known and unknown cultural resources that may be located under the existing structure and pavement. Potential adverse impacts on cultural resources would be avoided and mitigated, as necessary, through coordination and consultation with the State Historic Preservation Officer, where additional archaeological testing, monitoring, and demarcation of areas to be avoided will occur. Any hazardous materials found in the project area would be removed in accordance with all applicable federal and state regulations.

Based on a review of the information contained in this EA, it is concluded that the implementation of the San Marcos River Section 206 Aquatic Ecosystem Restoration Project is not a major federal action that 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.

22 APRIL 2014

Charles H. Klinge
Colonel, U.S. Army Corps of Engineers
District Engineer

Date

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EXECUTIVE SUMMARY

This Detailed Project Report and integrated Environmental Assessment (DPR/EA) is submitted under the authority of Section 206 of the Water Resources Development Act of 1996, as amended (33 U.S. Code 2201). This DPR/EA includes a detailed description of and supporting information for the decisions made during the planning process and the assessment of environmental effects necessary to fulfill National Environmental Policy Act requirements.

The purpose of this study is to identify potential aquatic ecosystem restoration alternatives for the San Marcos River. The goal of the DPR/EA is to evaluate each proposed alternative, and, through coordination among the federal sponsor, the U.S. Army Corps of Engineers (USACE), Fort Worth District (CESWF); the non-federal Local Sponsors, the City of San Marcos and Texas General Land Office; and participating agencies, U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD), develop a National Ecosystem Restoration (NER) plan. Both the TPWD and USFWS are supportive of this Section 206 project.

The City of San Marcos is located approximately 30 miles south-southwest of Austin, Texas. The study area lies along and within the San Marcos River and its tributaries, from Spring Lake Dam to the confluence with the Blanco River, approximately 4 river miles from Spring Lake Dam. The San Marcos River flows through a relatively arid region and is fed by a constant, high output of high-quality groundwater from the Edwards Aquifer. The San Marcos River supports a diverse assemblage of plants and animals, including six species listed under the Endangered Species Act (ESA), five of which are supported by designated Critical Habitat within the study area. The San Marcos River ecosystem has been affected by an altered hydrology, urbanization of the watershed, establishment and spread of exotic plants and animals, and recreational use. Impoundments and diversions within the study area, urbanization, and recreation have resulted in reduced flow velocity, degradation of river shoreline and riparian vegetation, and an increased rate of sediment accumulation and erosion. The mild climate and consistent flow of spring water create conditions that are suitable for multiple exotic plants and animals, which have also negatively affected the ecosystem. Restoration of the San Marcos River aquatic ecosystem could improve conditions for a unique and diverse assemblage of plants and wildlife, including species federally listed as threatened, endangered, or candidate and their Critical Habitats.

Through coordination with the USFWS and TPWD, nine restoration measures were developed to solve ecosystem problems and address the goals of the project: controlling discharge, increasing the width of the riparian forest, improving wetlands in the watershed, controlling riparian exotic plants, controlling aquatic exotic plants, removing sediments from the channel, creating recreational access structures, controlling nuisance waterfowl, and educating the public. Alternatives evaluated included a No Action Plan, and all possible combinations of the nine measures. All restoration plans were evaluated using an incremental cost analysis (ICA) to ensure that the most cost-effective plan was selected. Through ICA, nine best-buy plans, including the No Action Plan, were identified. The Proposed National Environmental Restoration (NER or Recommended) Plan, which includes six measures, would restore 43.93 acres of riparian habitats, 1.19 acres of wetland habitats, and 28.03 acres of aquatic habitats. Restoration of riparian habitat includes planting of approximately 14.56 acres of riparian forest in areas currently supporting low quality riparian habitat, parkland, sidewalks, parking lots, or other impervious surfaces; planting of approximately 2.10 acres of riparian forest along currently degraded discharge locations, and control of exotic shrubs and trees in approximately 27.28 acres of existing riparian forest. Restoration of aquatic habitat includes removal of approximately 2.61 acres of exotic vegetation along the river banks and removal of sediments over approximately 25.42 acres of the river bed (4.75 acres during the establishment phase). The NER Plan would improve the riparian corridors' ability to function as a filter of stormwater runoff and substantially reduce the input of sediments in the river. Concurrently, the removal of sediments and elephant ear from approximately 3.5 miles of river channel would restore native substrates and local hydraulics. The long-term reduction of sediment input, combined with continuous efforts to remove accumulated sediments and control elephant ear, would restore native substrates in the channel. Restoration of native substrates was evaluated as beneficial through Habitat Evaluation Procedures and would also benefit federally listed species. The NER Plan would provide a total of 47.19 Average Annual Habitat Units (AAHU) over the life of the project, while the No Action Plan would provide 30.56 AAHUs.

The total investment cost, which includes lands, easements, right of ways, relocation and disposal areas, and construction costs is $3.64 million. The City of San Marcos and Texas General Land Office, as the non-federal, Local Sponsors, would provide the lands required for the recommended plan. The City of San Marcos would be responsible for all operation, maintenance, repair, replacement, and rehabilitation costs. The Proposed NER Plan provides

relatively high ecosystem benefits relative to costs. Furthermore, the Proposed NER Plan would accomplish the objectives of this study, including improved conditions for listed species.

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SECTION 1.0
INTRODUCTION

1.0 INTRODUCTION

This Detailed Project Report and integrated Environmental Assessment (DPR/EA) provides the findings of an Aquatic Ecosystem Restoration Study of the San Marcos River ecosystem. The Aquatic Ecosystem Restoration Study included identification of goals and objectives, as well as opportunities and constraints, evaluation of baseline habitat suitability, development of restoration measures, and use of estimated costs and benefits to evaluate and compare alternatives. Through this planning process, the most cost-effective alternative that met the study goals was selected as the Proposed National Ecosystem Restoration (NER) Plan. This DPR/EA also includes documentation of the assessment of the potential adverse and beneficial effects of the Proposed NER Plan (i.e., proposed action) on the human and natural environment necessary for compliance with the National Environmental Policy Act (NEPA) (Public Law [P.L.] 91-190, 42 U.S. Code [U.S.C.] 4321 et seq.) and all other applicable federal laws.

1.1 LOCATION AND DESCRIPTION OF STUDY AREA

San Marcos is located in south-central Texas in Hays County, approximately 30 miles south-southwest of Austin, Texas (Figure 1-1). The study area includes the San Marcos River and lands within its 100-year floodplain from Spring Lake Dam to Cummings Dam. The study area of the San Marcos River is bisected by Interstate Highway 35 (IH 35). The portion of the study area upstream of IH 35 is urbanized, surrounded by commercial and residential areas, and located within the City of San Marcos. The portion of the study area downstream of IH 35 is less developed and is primarily rural residential. However, the San Marcos Wastewater Treatment Plant and A.E. Wood State Fish Hatchery are both located within the study area downstream of IH 35. Other lands considered in the study include tributaries of the San Marcos River (i.e., Sessoms Creek, Purgatory Creek, and Willow Springs Creek), as well as lands adjacent to the river that provide opportunities for aquatic or riparian habitat restoration but that are not within the 100-year floodplain.

1.2 STUDY AUTHORITY

This Aquatic Ecosystem Restoration Study was undertaken under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996 (P.L. 104-303). Under the authority provided by Section 206, U.S. Army Corps of Engineers (USACE) may participate in planning,

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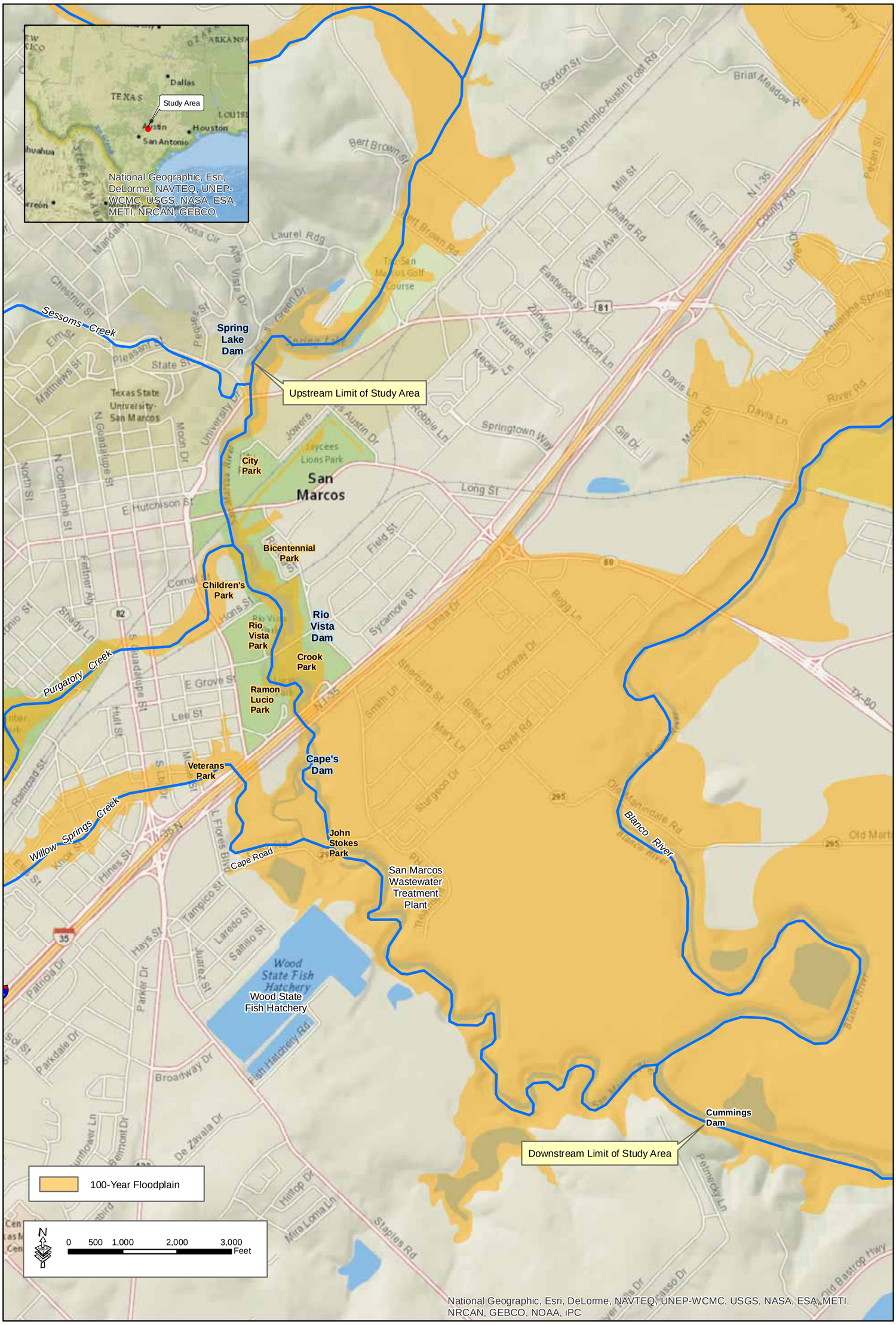

Figure 1-1. San Marcos River Study Area

GSRC

May 2013

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engineering and design, and construction of projects to restore degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition when the restoration would improve the environment, is in the public interest, and is cost-effective, as described in *USACE Planning Guidance Book* (Engineering Regulation [ER] 1105-2-100). USACE, Fort Worth District (CESWF), is the lead federal agency on this project, and U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) are participating agencies. The non-federal Local Sponsors are the City of San Marcos and Texas General Land Office

1.3 STUDY PURPOSE AND SCOPE

The San Marcos River is a primarily spring-fed stream with flows originating from the Edwards Aquifer above the Spring Lake Dam. This unique environment directly provides habitat for six species federally listed as threatened, endangered, or candidate species. However, the San Marcos River ecosystem has been affected by altered hydrology, urbanization of the watershed, establishment and spread of exotic plants and animals, and intensive recreational use. The purpose of this study is to identify areas of aquatic ecosystem degradation, evaluate measures to restore important ecological resources, and recommend a plan for implementation, if one can be found, that is technically feasible, environmentally acceptable, and supported by the non-federal sponsors. The result of the study would restore the riparian corridor and aquatic communities of the San Marcos River to benefit a variety of resident and migratory wildlife, including endemic populations and threatened and endangered species that utilize the study area.

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SECTION 2.0
EXISTING CONDITIONS AND REGULATORY BACKGROUND

2.0 EXISTING CONDITIONS AND REGULATORY BACKGROUND

This section of the DPR/EA provides a description of the existing conditions of the study area and of the regulatory background as it pertains to the status of resources.

2.1 SOILS

Soils in the study area are generally deep, well-drained, and clayey or loamy (U.S. Department of Agriculture [USDA] 1984). The dominant soil types are Oakalla Soils, 0 to 2 percent slopes, frequently flooded; and Tinn Clay, 0 to 1 percent slopes, frequently flooded. Five soil associations in the study area are listed as Prime or Unique Farmland Soils under the Farmland Protection Policy Act (FPPA) (7 U.S.C. 4201 et seq., 7 Code of Federal Register [CFR] 658) (Figure 2-1). The FPPA was authorized to minimize the unnecessary and irreversible conversion of farmland to nonagriclutlural use. Under the FPPA, conversion of these soils from agricultural to nonagricultural is quantified using Land Evaluation Site Assessment (LESA), which is used by the Natural Resources Conservation Service (NRCS) to compare alternatives and to track farmland conversion. If the LESA score exceeds NRCS established thresholds, mitigation would be required.

2.2 AQUATIC RESOURCES

2.2.1 Surface Water

Flows in the San Marcos River are supported by springs in the Balcones Fault Zone, a geologic feature that divides the Edwards Plateau to the west and the lower Blacklands Prairie to the east (Correll and Johnston 1996). The springs supporting flows in the San Marcos River are fed by the Edwards Aquifer, which underlies the southeastern portion of the Edwards Plateau (Edwards Aquifer Authority [EAA] 2013, Figure 2-1). Of the 281 major freshwater springs recorded in Texas, only four are known to have had flows greater than 100 cubic feet per second (cfs). Just two of these largest springs remain today, the San Marcos and Comal Springs, both supported by the Edwards Aquifer (Brune 1975). San Marcos Springs includes six major and several minor orifices at the bottom of the man-made Spring Lake.

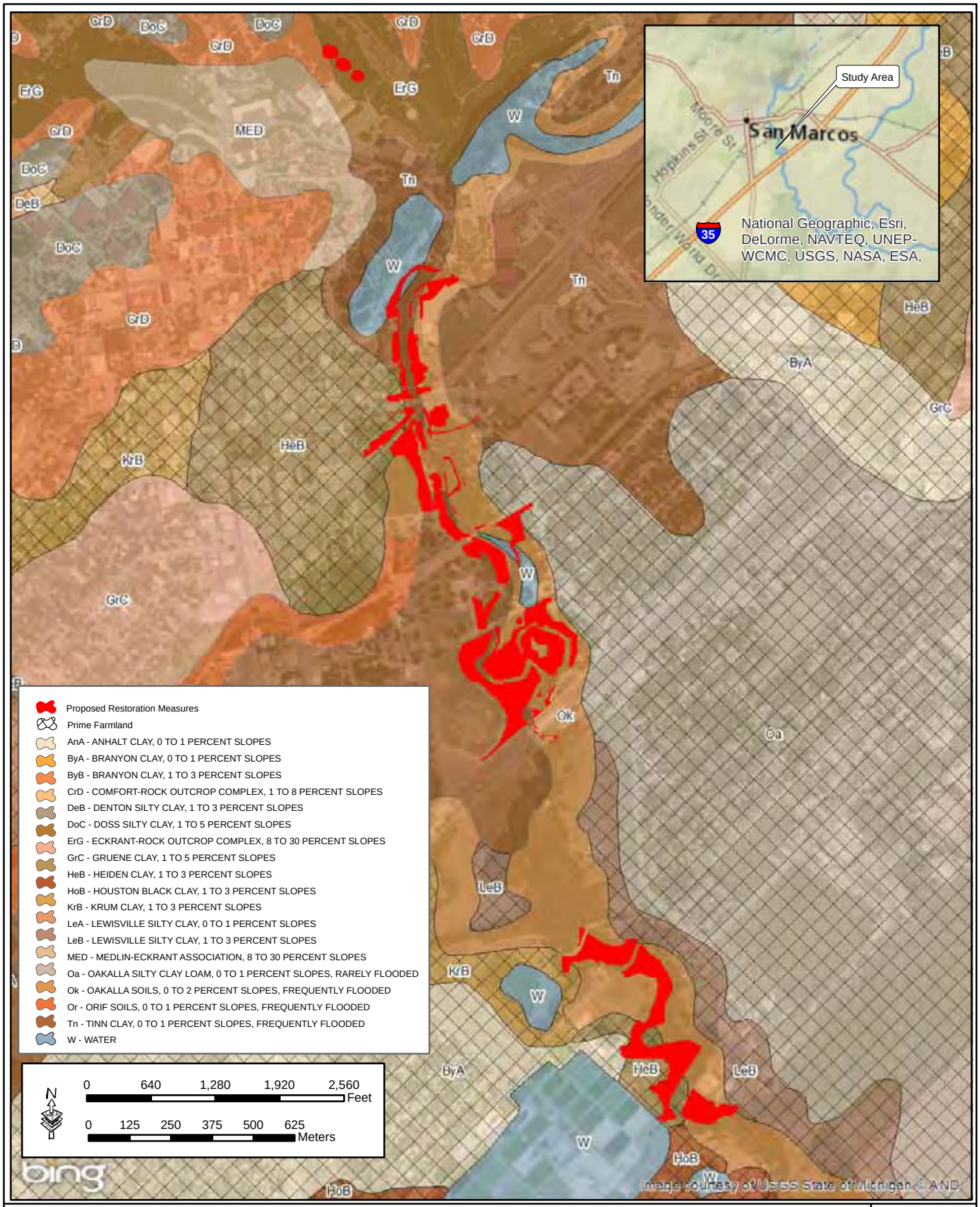

Figure 2-1. Soils in the San Marcos River Study Area

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October 2013

Watersheds contributing to the San Marcos River in the study area include Sessoms Creek, Purgatory Creek, Willow Springs Creek, and the Blanco River (see Figure 1-1). Sink Creek discharges into Spring Lake above the study area. Sessoms Creek, which is predominantly channelized near its confluence with the San Marcos River, enters a stormwater detention pond prior to discharging into the San Marcos River, and the remaining tributaries discharge directly into the river. The Blanco River joins the San Marcos River approximately 5 miles downstream of Spring Lake, and they collectively discharge into the Guadalupe River (Smyrl 2001).

Due to the relatively high and constant flow rate of the San Marcos River, the river was historically dominated by riffle/run habitats with a firm gravel substrate (Vaughn 1986; Terrell et al. 1978). Damming of the river and associated diversions for municipal, industrial, and irrigation uses have altered natural hydraulic conditions, resulting in a loss of run/riffle habitat and an increase in pool and backwater habitats (Earl and Wood 2002). Pool and backwater habitats are characterized by low current velocity, greater depths, and a tendency to accumulate silts. The five flood control/recharge dams in the upper San Marcos watershed (i.e., Purgatory and Sink creeks) have reduced both the intensity and frequency of bank-full events (USFWS 1996a). Without bank-full events, flow velocities are insufficient to carry sediment loads, and sediments accumulate in the channel. Sediment accumulation is apparent throughout much of the study area, especially near the confluence of Sessoms Creek. Cummings Dam contributes to substantial backwater effects, including increased turbidity and temperature and reduced velocity in the lower portion of the study area.

The average flow from San Marcos Springs for the period of record (1957 to 2009) is 175 cfs (EAA 2010). High spring flows occur in March and April, and the highest spring flow on record, 451 cfs, occurred in March 1992; the previous record was 316 cfs in 1975 (Brune 1981). San Marcos Springs have never ceased flowing in recorded history, and the lowest recorded discharge of 46 cfs occurred during the drought of record (DOR) in 1956. Low flows occur in the summer months as a result of climatological factors and increased seasonal pumping from the Edwards Aquifer. Based on an analysis of historic flows from 1956 to 1998, monthly median flows exhibit a narrow range (147 to 182 cfs) (Saunders et al. 2001).

2.2.2 Groundwater

The Edwards Aquifer was the first aquifer designated as a sole-source aquifer in 1975 and is the main source of water for the City of San Antonio, and much of central Texas, supplying

approximately 1.7 million people (EAA 2013). The Edwards Aquifer is approximately 180 miles long, varies in width between 5 and 40 miles, and underlies 10 counties in central Texas.

The Edwards Aquifer recharge zone is a fault zone aquifer, and the annual average recharge from 1934 to 2010 was approximately 718,000 acre-feet (EAA 2013). Since 1980, as a result of increased pumping, there has been greater fluctuation of springflow with increased time required for recovery, even during a period that recorded the two highest levels of aquifer recharge (1992 and 1987). The majority of the recharge occurs when surface water intersects the permeable formation and goes underground; the remaining recharge occurs when precipitation falls directly on the outcrop. However, rainfall is highly variable, so recharge amounts vary widely from year to year.

The EAA was created by the EAA Act, landmark legislation adopted by Texas lawmakers in 1993 and put into effect in 1996, as a special groundwater district with the purpose of managing and regulating the San Antonio segment of the Edwards Aquifer (Eckhardt 2002). The EAA Act has the mission of groundwater stewardship that can be simply stated as follows: manage, enhance, and protect the Edwards Aquifer system. In late 1999, the EAA formed a Technical Advisory Group to study aquifer relationships during critical periods when aquifer discharge from springflow and pumping is considerably higher than aquifer recharge. In 2013, a Final Environmental Impact Statement (EIS) for the Edwards Aquifer Recovery Implementation Plan Habitat Conservation Plan (EARIP HCP) was published by the USFWS (2013). The anticipated effects of the EARIP HCP as discussed in the 2013 EIS are incorporated herein by reference. This action has just begun to be implemented and data supporting these effects are not yet available. Thus, conditions of the study area in the reasonably foreseeable future and as affected by the EARIP HCP are described in the cumulative effects in Section 7.11 of this DPR/EA.

2.2.3 Floodplains

Under *Executive Order (EO) 11988: Floodplain Management,* adverse long-term and short-term impacts on floodplains, to the extent possible, should be avoided whenever there is a practicable alternative. This includes impacts associated with the occupancy, development, and modification of floodplains. According to the Federal Emergency Management Agency (FEMA), the 100-year floodplain exists as a narrow corridor along the reach of the study area above IH 35 and broadens substantially along the reach below IH 35 (FEMA 2012; see Figure 1-1).

2.2.4 Waters of the U.S. including Wetlands

The Clean Water Act (CWA) (33 U.S.C. 1251 et seq., 40 CFR 112) defines waters of the U.S. (Section 328.3[2] of the CWA) as those waters used in interstate or foreign commerce, subject to ebb and flow of tide, and all interstate waters including interstate wetlands, intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds, or impoundments of waters, tributaries of waters, and territorial seas. Jurisdictional boundaries for waters of the U.S. are defined in the field as the ordinary high water mark, which is that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural lines impressed on the bank, shelving, changes in the character of soil, destruction of riparian vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. Wetlands are those areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987). Areas of wetland vegetation within the boundaries of the river (i.e., the ordinary high water mark (OHWM) as defined at 33 CFR 328.39(e)) are regulated under Section 404 of the CWA and are considered special aquatic sites.

The San Marcos River is classified as a waters of the U.S. Hydric plants are common in the study area; however, typical soils lack the characteristics that would classify them as hydric. There are no hydric soils mapped in the study area (USDA 2002) and there are no data available from the National Wetland Inventory (USFWS 2013c); however, jurisdictional wetlands are known to occur above the OHWM and within the study area. Although the San Marcos River is navigable by boat for recreational purposes, the San Marcos River is not considered a navigable waterway under Section 10 of the Rivers and Harbors Act and is, therefore, not regulated as a navigable water.

Section 404 of the CWA regulates the discharge of dredged or fill material into jurisdictional wetlands or waters of the U.S. The USACE and the U.S. Environmental Protection Agency (USEPA) both have responsibilities in administering this program and typically issue permits for these regulated activities after notice and opportunity for public hearings. The General Permit program, which includes Nationwide Permits, is for activities that are similar in nature or that would likely cause minimal environmental effects. Ecosystem restoration activities in or adjacent to waters of the U.S. are typically covered under Nationwide Permit 27. Construction

of recreational access/step-down structures is typically covered under Nationwide Permit 42 for Recreational Facilities. Although CESWF does not issue itself permits for its own Civil Works projects, USACE regulations state that the USACE does have to comply with the intent of the regulatory permitting process and must apply the guidelines and substantive requirements of Section 404(b)1 to its activities. Section 401 of the CWA requires certification of the USACE's 404(b)1 water quality assessment by the Texas Commission on Environmental Quality (TCEQ).

EO 11990: Wetlands directs the USACE to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands when implementing Civil Works projects.

2.2.5 Water Quality

As identified by the U.S. Environmental Protection Agency (USEPA), the study area lies within the San Marcos Watershed - 12100203 (USEPA 2013a). The TCEQ identifies the portion of the San Marcos River in the study area as stream segment 1814 - Upper San Marcos River 2304. The CWA, Sections 301-320, establishes standards and enforcement guidelines for the protection of water quality. As required by the CWA, the TCEQ regulates activities related to water quality. The CWA requires that states categorize waters by the uses they provide and establish maximum pollutant levels acceptable for their identified use. If a water body should become polluted to the extent that it is not suitable for its designated use, the TCEQ is required to list this water as impaired under Section 303(d) of the CWA. All projects that disturb soils in or adjacent to a water of the state of Texas must be approved under a Texas Pollutant Discharge Elimination System (TPDES) General Permit No. TXG830000.

Stream segment 1814 – Upper San Marcos River is not listed as impaired. The only conventional parameter that has exceeded TCEQ water quality standards in this segment is nitrate, which occasionally exceeds the screening level. Waters of the Edwards Aquifer are naturally high in nitrate. Water temperature, pH, dissolved oxygen (DO) and carbon dioxide (CO_2) are perhaps the most biologically important parameters. Water temperature and pH are relatively constant. Concentrations of DO typically fluctuate between 6 and 11.5 milligrams per liter and have never been a cause for concern in the San Marcos River (Bio-West 2009). CO_2 concentrations, which are especially important to aquatic plants, are high in spring areas, and tend to decrease in downstream reaches due to uptake by plants and interaction of the water column with the atmosphere. As a result of a decrease in CO_2 concentrations, pH increases in

downstream areas, but rarely exceeds 7.7. In addition, the downstream reach tends to have slightly higher turbidity.

Water from San Marcos Springs is characterized by relatively constant temperatures, pH, and dissolved ion concentrations, and large flow volumes result in relatively constant water quality conditions throughout the upper (i.e., above the confluence with the Blanco River) San Marcos River (Slattery and Fahlquist 1997, Saunders et al. 2001, Bio-West 2010, EAA 2007). Water quality parameters measured over the course of multiple studies and multiple years vary only slightly and appear to be influenced primarily by groundwater inputs from the Edwards Aquifer. Monitored water quality parameters have included conductivity, pH, DO, CO_2, alkalinity, total suspended solids (TSS), nitrate, ammonium, total nitrogen, soluble reactive phosphorus (SRP), and total phosphorus (EAA 2007). Water temperatures in the study area typically range from 20 to 25 degrees Celsius (°C) (Bio-West 2010). Water temperature remains nearly constant near spring inputs and is closely associated with atmospheric conditions further from spring influences.

2.3 BIOLOGICAL RESOURCES

The Texas Water Development Board has classified the San Marcos River as an “Ecologically Significant Stream Segment” under Texas Administrative Code Section 357 and Texas Water Code Section 16.051 (TPWD 2012a). An ecologically significant stream segment has unique ecological value in one or more of the following categories: biological function, hydrologic function, riparian conservation areas, high water quality, exceptional aquatic life, high aesthetic value, or threatened or endangered species/unique communities. The stretch of San Marcos River from 0.7 mile downstream of IH 35 to a point 0.4 mile upstream of Loop 82 (which comprises most of the study area downstream of IH 35) is classified as stream segment 1814 and meets all of the significant stream segment criteria. Designation of a stream segment as “ecologically unique” can afford the segment and its natural resources a certain degree of protection from activities that may distract from its uniqueness.

2.3.1 Flora

Aquatic

The long growing season and historically stable thermal characteristics and flow rates of the upper San Marcos River have contributed to a highly diverse assemblage of aquatic plants,

including rare and threatened plants, as well as many introduced species (Lemke 1989; Whiteside et al. 1992; Lemke 1999; Bowles and Bowles 2001; Owens et al. 2009). Introduced species, particularly hydrilla (*Hydrilla verticillata*), elephant ear (*Colocasia esculenta*), and East Indian hygrophila (*Hygrophila polysperma*), have formed large stands in Spring Lake and in the study area above IH 35 (USFWS 2001).

Vegetation surveys in the San Marcos River have shown great variation in coverage depending on critical periods and low- and high-flow events. Comprehensive vegetation surveys of the San Marcos River were conducted in 2001 and 2009 (Owens et al. 2009). Species recorded in both surveys were similar. However, in 2009, emergent alligatorweed (*Alternanthera philoxerodies*) was observed, indicating that the species may have been newly introduced since 2001. In 2001, Glover's Island supported a dense monoculture of elephant ear. However, in 2009, no elephant ear was recorded. The 2001 survey showed greater expanses of mixed native communities, while the 2009 survey recorded greater coverage by Texas wild-rice (*Zizania texana*).

In general, introduced aquatic plant species (all growth forms) occupy approximately three times as much area as native plant species in the San Marcos River (Owens et al. 2009). Hydrilla, East Indian hygrophila, and elephant ear are the exotic species of greatest threat to native plant populations in the San Marcos River. Monospecific colonies of these invasive aquatic plants have been recorded in most areas of the river above IH 35 and are often intermixed in areas dominated by native species (Owens et al. 2009). During field surveys, large monoculture stands of exotics were observed to be especially prominent in the area south of Hopkins Street and the Union Pacific Railroad bridge, as described in Owens et al. (2009). Overall, less exotic vegetation is present south of IH 35 (Owens et al. 2009). Other exotic plants established in the river include Eurasian watermilfoil (*Myriophyllus spicatum*), water hyacinth (*Eichhornia crassipes*), and water lettuce (*Pistia stratiotes)* (Owens et al. 2009).

Riparian

The most common trees observed in the riparian corridor of the study area were boxelder (*Acer negundo*), cedar elm (*Ulmus crassifolia*), spiny hackberry (*Celtis ehrenbergiana*), pecan (*Carya illinoensis*), and other hickories (*Carya* spp.). Other common trees included black willow (*Salix nigra*), Texas sugarberry (*Celtis laevigata* var. *texana*), American sycamore (*Platanus occidentalis*), bald cypress (*Taxodium distichum*), eastern cottonwood (*Populus deltoides*),

green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), several oaks (*Quercus* spp.), and Ashe juniper (*Juniperus ashei*). Shrubs, as well as trees primarily observed in the shrub layer, included glossy privet (*Ligustrum lucidum*), deciduous holly (*Ilex decidua*), chinaberry (*Melia azedarach*), Chinese tallow (*Triadica sebifera*), algerita (*Mahonia trifoliolata*), knockaway (*Ehretia anacua*), roughleaf dogwood (*Cornus drummondii*), honey mesquite (*Prosopis glandulosa*), and sweet acacia (*Acacia farnesiana*) (Best 2010). The understory layer contained such vines as poison ivy (*Toxicodendron radicans*), saw greenbrier (*Smilax bona-nox*), peppervine (*Ampelopsis arboria*), and mustang grape (*Vitis mustangensis*). Some portions of the riparian zone, especially in the upper (i.e., above IH 35) segment of the study area, have been paved or covered with exotic turf grasses and are maintained as parklands.

2.3.2 Fish and Wildlife

Aquatic

The unique aquatic habitat and nearly continuous riparian corridor in the study area provide suitable habitats for a diverse assemblage of wildlife and fish, including several endemic species (USFWS 1996a). A 1992 survey of fishes on the upper San Marcos River identified 49 species of fish in the San Marcos River from its headwaters at Spring Lake to the confluence with the Guadalupe River (Whiteside et al. 1992). Common fish and other native aquatic species known to occur in the study area include largemouth bass (*Micropterus salmoides*), redear sunfish (*Lepomis microlophus*), snapping turtle (*Chelydra serpentina*), and giant river prawn (*Macrobranchium* sp.). Wading birds that commonly use this ecosystem include green heron (*Butorides virescens*), great blue heron (*Ardea herodias*), American coot (*Fulica americana*), and great egret (*Casmerodius albus*). Waterfowl such as pied-billed grebe (*Podilymbus podiceps*), mallard (*Anas platyrhynchos*), northern shoveler (*Anas clypeata*), wood duck (*Aix sponsa*), and gadwall (*Anas strepera*) are also common visitors. Other resident birds in the area include mourning dove (*Zenaida macroura*), barn swallow (*Hirundo rustica*), belted kingfisher (*Ceryle alcyon*), and eastern kingbird (*Tyrannus tyrannus*).

A 2001 review of exotic species in the San Marcos River identified four species of invertebrates and 28 species of vertebrates (Bowles and Bowles 2001). These species were introduced through a variety of means, but released aquaria specimens and stocking for the purpose of supplementing the sport fishery of the river are the primary sources. All four exotic invertebrate species are mollusks that are considered highly detrimental to the ecological function of the river. Of particular concern is the giant ramshorn snail (*Marisa conuarietis*), which is capable of

consuming large volumes of aquatic vegetation, and the red-rimmed melania (*Melanoides tuberculatus*), which serves as an intermediate host in the life-cycle of a fluke that parasitizes the gills of fishes, including the fountain darter, a federally protected species. A trematode parasite (*Centrocestus formansus*) has also been documented in reaches of the San Marcos River near IH 35. This trematode infects the gills of minnows and sunfish, including the fountain darter, and also infects birds, which can carry the parasite over large distances. Of the 28 exotic vertebrates identified, many occur in small numbers or have limited or unknown effects on the ecological function of the river. The Rio Grande cichlid (*Cichlasoma cyanoguttatum*) is a predatory species and likely competes with or preys upon other species, including the fountain darter. The common carp (*Cyprinus carpio*) is also present within the San Marcos River. In aquatic environments, the common carp consumes large amounts of aquatic vegetation and stirs up substrates, and can have substantial effects on native vegetation (USFWS 1996a). In addition, introduced fish species may compete with the federally listed, endemic fountain darter and San Marcos gambusia (*Gambusia georgei*) for needed resources or prey upon listed fish species (USFWS 1996a). Nutria (*Myocastor coypus*), a large exotic rodent, has become abundant in the San Marcos River and is known to destabilize banks and feed on native vegetation, including Texas wild-rice. Suckermouth catfish (*Hypostomus plecostomus*) may also destabilize the shoreline by burrowing into the river banks.

High densities of resident waterfowl can degrade water quality by causing excessive nutrient loading and by denuding shorelines of vegetation. Areas with high concentration of waterfowl droppings may have an increased health risk to humans and can affect nutrient balances in aquatic habitats. Continuous grazing on Texas wild-rice by introduced and non-migratory waterfowl can reduce its reproductive success. Evidence of these adverse effects was observed in City Park and in Rio Vista Park, where resident waterfowl congregate to feed from recreationists. Although some waterfowl present on the river are likely to be native, migratory birds, other waterfowl have been hand-reared and released into the river, and have become resident birds.

Riparian

The riparian forests associated with the river also support a diverse assemblage of wildlife including common species such as raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), armadillo (*Dasypus novemcinctus*), cottontail (*Sylvilagus floridanus*), and fox squirrel (*Sciurus niger*). White-tailed deer (*Odocoileus virginianus*) were observed near

Bicentennial Park during baseline surveys. A survey of Freeman Ranch (Baccus et al. 2000), located north of the study area on Sink Creek, identified several other mammal species, such as mice, rats, and bats, that are also likely to occur in the study area. The riparian forests also provide habitat for a variety of songbirds and raptors, as well as reptiles and amphibians.

2.3.3 Existing Habitats

In order to evaluate potential restoration opportunities, it was necessary to establish baseline habitat conditions for the study area. Existing habitats can be classified into three types: riparian forest, riverine, and herbaceous wetland. An overall evaluation of the quality of existing habitats within the study area was conducted using Habitat Evaluation Procedures (HEP). HEP allows assessment of the current and potential habitat value to wildlife species based on a Habitat Suitability Index (HSI), which assigns a comparative value based on a single species, multiple species, or an ecosystem. An HSI value of 0.0 reports the lowest habitat value and a 1.0 represents the optimum value of habitat.

HSI models are used to describe habitat quality for selected fish and wildlife species. The USFWS, in conjunction with other federal agencies, developed numerous HSI models, which are available to evaluate habitat quality. Existing HSI models were reviewed to determine 1) species applicable to the study area and 2) applicability of species to cover types affected by ecosystem restoration (Appendix A). Applicable species were selected by HEP team members and ranked using criteria relevant to the project to determine the likely effect of measures listed in the preliminary restoration plan on model output. Those models that are likely to reflect changes in the environment occurring both with and without the implementation of measures identified in the preliminary restoration plan were selected for further consideration. A total of seven HSI models were chosen for application of HEP for this project: downy woodpecker (*Picoides pubescens*), belted kingfisher, channel catfish (*Ictalurus punctatus*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieu*), American coot, and slider turtle (*Pseudemys* [*Trachemys*] *scripta*). However, the proposed measures had no effect on the bluegill model and this model was later removed. Models representing federally endangered, endemic species (Texas wild-rice and fountain darter) were also considered, but these models were still under development and not certified, thus, they were not utilized.

Habitat Delineation

Existing habitats within the study area were delineated by hand-digitizing boundaries in a Geographic Information System (GIS) with reference to aerial photography, delineations created in the field with Global Positioning System (GPS), and various GIS layers provided by resource agencies (Figure 2-2). GIS was used to measure the area of each of the three habitat types as classified for use of selected HSI models: riparian forest, riverine, and herbaceous wetland (Table 2-1). Riparian forest habitats were evaluated by forest type and riverine habitats were evaluated by reach.

Table 2-1. Baseline Area of Existing Habitats and Improved Lands

Habitat	Area by Type/Reach (acres)								Total Area
Riparian Forest	Type 1		Type 2		Type 3		Type 4		
	7.98		5.78		1.95		15.49		30.43
Riverine – native habitat[+]	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Reach 11	
	4.50	3.19	2.61	4.32	2.63	1.12	3.83	3.22	25.42
Riverine – nonnative habitat	0.336	1.114	0.173	0.483	0.039	0.003	0.434	0.031	2.61
Herbaceous Wetland*									0.00
Improved Lands – pervious									12.95
Improved Lands – impervious**									1.41
Total									**73.59**

[+]see Figure 2-2 for location of reaches
*Although the suitability of the Sessoms Creek wetland complex was assessed, it is not included in any measures and, thus, is not included in the project baseline.
** parking lots, headwalls, and all hard structures

Riparian forest habitat quality varied dependent on location, density, and age of stands in the watershed; thus, the following four general forest types were delineated (Figure 2-2).

- Type 1: Riparian forest with a mature and closed or nearly closed upper canopy of elms, oaks, and hackberry and a relatively open understory
- Type 2: Dense scrubby forest with closed or nearly closed upper canopy and understory
- Type 3: Parkland with scattered, large trees and a maintained understory
- Type 4: Riparian forest nearest the channel and composed of a mature upper canopy and a dense understory of exotic shrubs

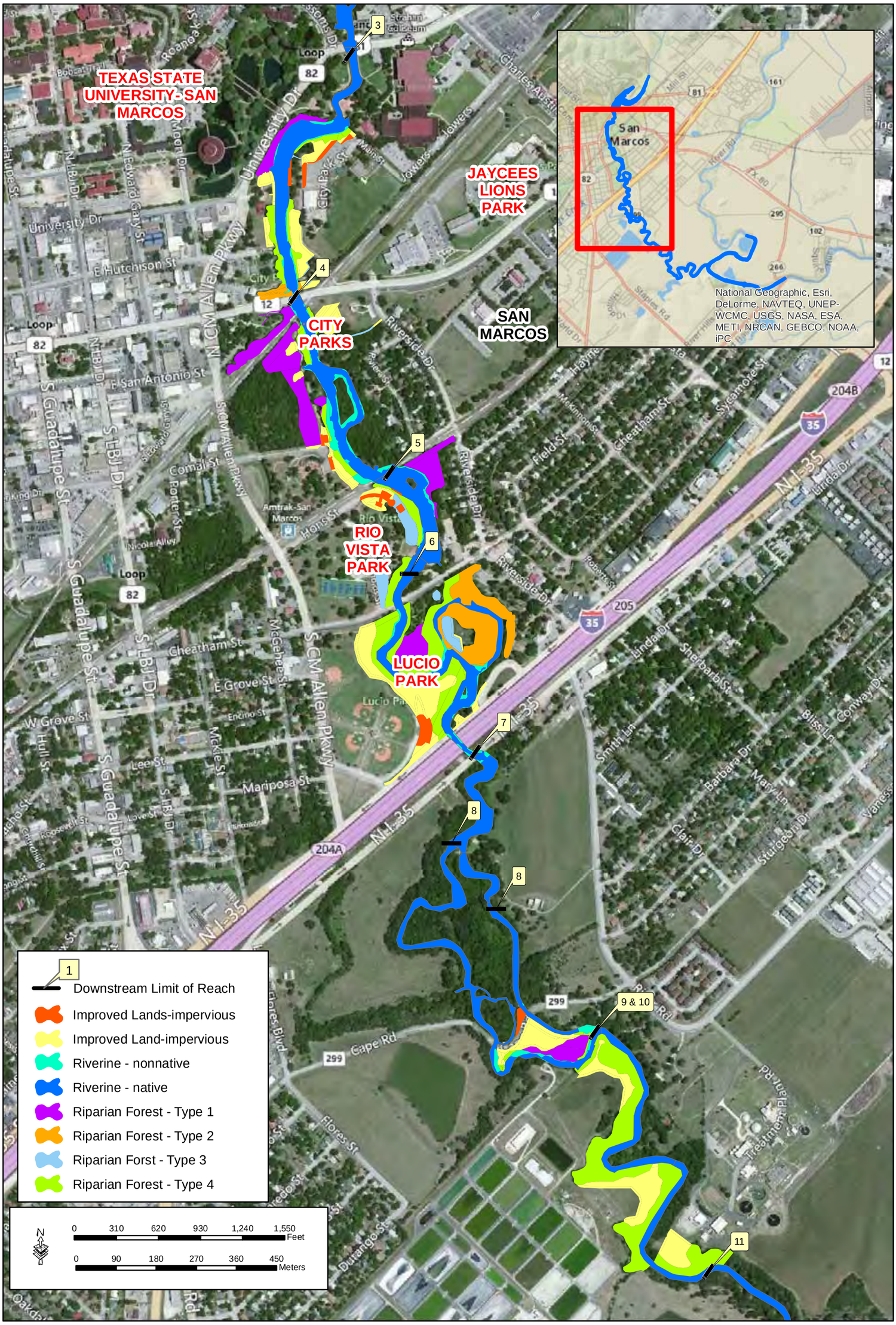

Figure 2-2. Existing Habitats in the San Marcos River Study Area

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Riverine habitats were assessed by reach using a GIS file provided by the USFWS (see Figure 2-2). The USFWS delineation defines reaches in the San Marcos River by hydrological and geomorphic features in the channel that are largely dependent on the location of dams and diversions. Riverine habitats were then classified as either native or nonnative based on the absence or presence, respectively, of elephant ear in the channel.

The remaining areas within the extent of proposed measures are improved lands. Improved lands were assessed as either pervious, which consisted of maintained grasslands and gravel trails, or impervious, which included parking lots, sidewalks, headwalls, and other concrete structures.

Evaluation of Baseline Quality

The existing or baseline quality of each habitat type was evaluated as the HSI produced by selected models. For this study, a total of 55 variables were evaluated using published data and data gathered in the field (Appendix B, Tables B-1a through B1d). Biologists from CESWF, the City of San Marcos, USFWS, TPWD, and Gulf South Research Corporation (GSRC) conducted sampling efforts during the week of November 7, 2011, to collect baseline data.

The baseline quality of riparian forest habitats was evaluated using the downy woodpecker model. The two riparian variables, basal area and snag density, were measured at sample plots within each of four forest types. Basal area, the area of a given section of land that is occupied by the cross-section of tree trunks and stems at their base, was measured at least once at representative locations within each forest type patch using a forester's prism. Density of snags was estimated using the point-quarter method. The distance to the nearest snag was recorded in each quadrant and was then measured and averaged to determine the snag density.

The baseline quality of riverine habitats was evaluated using the smallmouth bass, channel catfish, and belted kingfisher models. Water quality variables were estimated using mean conditions over the period of record based on existing studies completed by resource agencies and other professionals (Hardy et al. 2011, Bio-West 2010, Owens et al. 2009, and Saunders et al. 2001). Data that were not available from these studies were collected by measurement in the field and application of GIS, including two separate measures of instream cover (one for pools and one for all mesohabitats) and a measure of surface water obstruction. Instream cover included large woody debris, exposed roots, overhanging banks, boulders, pylons, and other man-made

structures. Surface water obstruction included large woody debris, branches overhanging the stream, and patches of elephant ear.

The baseline quality of the Sessoms Creek wetlands was evaluated using the American coot and slider turtle models. Restoration or enhancement of these wetlands was later excluded from proposed measures due to land ownership. However, it was assumed that constructed wetlands would be similar in construction, function, and habitat quality to the existing Sessoms Creek wetlands; therefore, data on existing conditions were collected and presented here for comparison. Of the five variables required for the wetland models, four were measured in the field, including percent cover of vegetation, an edge index of vegetation, water regime, and water depth. Percent cover of vegetation and the edge index were measured using ocular estimation, and water regime was determined by assessing indicators in the field. Water temperature was estimated using published data.

Results

Under the downy woodpecker model, optimum riparian forest habitat is characterized as having a relatively open understory with large trees for foraging and a high density of snags for nesting. With an HSI of 0.62, Type 1 forests currently provide the highest quality habitats due to a relatively open understory and high number of snags. With an HSI of 0.50, Type 2 and Type 4 forests each provide near optimum nesting conditions (i.e., number of snags), but the high density of small trees in the understory limits foraging opportunities. With an HSI of 0.20, Type 3 forests are the least suitable. Although Type 3 forests provide near-optimum foraging conditions, they lack the nesting opportunities provided by snags.

Optimal riverine habitat for the channel catfish model is characterized by warm, stable water temperatures, an approximately 40 to 60 percent of deep pools, and abundant cover in the form of logs, boulders, cavities, and debris. For the smallmouth bass model, optimal riverine habitat is described as clear water, a second order stream with a gradient between 0.75 and 4.7 meters/kilometer, at least 25 percent pools, at least 25 percent cover, warm summer temperatures, and gravel, rubble, or boulder substrate. Optimal conditions characterized by the belted kingfisher model are clear, shallow water with little wave action and 25 to 75 percent riffles in streams, open perches over the water, and vertical to overhanging soil banks devoid of excessive vegetation, root masses, and rocks on the faces.

The suitability of riverine habitats was evaluated as the guild-weighted average HSI of the channel catfish, smallmouth bass, and belted kingfisher models so that each guild is given equal importance, regardless of the number of models representing that guild (Table 2-2). The guild-weighted HSI was calculated for each reach by multiplying the HSI calculated for the channel catfish and smallmouth bass by 0.25, multiplying the HSI calculated for the belted kingfisher by 0.5, and summing the products of these calculations (i.e., guild-weighted HSI = [0.25 x channel catfish HSI] + [0.25 x smallmouth bass HSI]) + [0.5 x belted kingfisher HSI]). This guild-weighted average gives equal consideration to the two separate guilds, fish and bird, in the evaluation of overall habitat suitability.

Table 2-2. Baseline Habitat Suitability Index (HSI) by Reach for Each Riverine Model

Model	Baseline HSI by Reach**							
	4	5	6	7	8	9	10	11
Channel Catfish	0.49	0.50	0.53	0.59	0.61	0.33	0.33	0.51
Smallmouth Bass	0.55	0.57	0.66	0.77	0.68	0.00	0.70	0.48
Belted Kingfisher	0.73	0.50	0.71	0.66	0.67	0.62	0.68	0.52
Total*	**0.63**	**0.52**	**0.65**	**0.67**	**0.66**	**0.39**	**0.60**	**0.51**

* (0.25 x Channel Catfish) + (0.25 x Smallmouth Bass) + (0.5 x Belted Kingfisher)
**see Figure 2-2 for location of reaches

The existing area of elephant ear was assessed as nonnative habitat that is not suitable for these models and was evaluated as having an HSI of 0.00. In general, the water quality variables (e.g., DO, turbidity, salinity, velocity, pH, and water transparency) for all riverine models were evaluated at optimum or near-optimum conditions. However, the food and cover requirements were evaluated at suboptimal conditions for all riverine models due to factors such as a low percentage of pools within a reach, low percent cover, and suboptimal substrate type. The least suitable reaches for channel catfish are Reaches 9 and 10 due to decreased water quality requirements as a result of suboptimal midsummer water temperature within pools and backwaters. The low habitat suitability for smallmouth bass in Reaches 9 and 13 is due to low food life requisites that are dependent on percent pools and percent cover within pools. For belted kingfisher, the cover and reproduction variables were evaluated at optimum conditions, but the water requirements changed from reach to reach and were predominantly impacted by low/no percent riffles within each representative reach. The water habitat variables, specifically percent of water less than or equal to 60 centimeters in depth, were the limiting factor for the belted kingfisher model. Percent surface water obstructions resulting from extensive cover of elephant ear also reduced suitability for the belted kingfisher model.

Under the slider turtle model, optimum conditions include at least 90 percent cover of emergent and submerged vegetation, low water velocity, water depths between 1 and 2 meters that remain permanently flooded, with warm water temperatures. Optimal conditions of the American coot model are described by semi-permanently flooded wetlands that support emergent vegetation and contain highly dispersed stands of emergent vegetation and open water. The suitability of wetland habitats was calculated as the average HSI of the slider turtle and American coot models. The Sessoms Creek wetlands were evaluated as having a suitability of 0.15. Suitability of these wetlands is limited by depth and percent cover of vegetation. However, cost constraints associated with property ownership excluded this area from the project measures. No other wetland habitats are currently present in the project area.

Baseline suitability of available habitat was quantified as Habitat Units (HUs), and was calculated as the product of the area in acres and suitability of a given habitat, or 31.17 HUs (Table 2-3).

Table 2-3. Baseline Habitat Suitability Index (HSI) and Habitat Units (HU) of Existing Habitats

Habitat	Type/Reach	Area (acres)	HSI	HU
Riparian Forest	Type 1	7.98	0.62	4.95
	Type 2	5.78	0.50	2.89
	Type 3	1.95	0.20	0.39
	Type 4	15.49	0.50	7.75
Riverine – native habitat	Reach 4	4.50	0.63	2.84
	Reach 5	3.19	0.52	1.66
	Reach 6	2.61	0.65	1.70
	Reach 7	4.32	0.67	2.89
	Reach 8	2.63	0.66	1.74
	Reach 9	1.12	0.39	0.44
	Reach 10	3.83	0.60	2.30
	Reach 11	3.22	0.51	1.64
Riverine – nonnative habitat	All Reaches	2.61	0.00	0.00
Wetland*	All Reaches	0.00	0.00	0.00
Improved Lands - pervious	All Reaches	12.95	0.00	0.00
Improved Lands - impervious	All Reaches	1.41	0.00	0.00
Total		**73.59**		**31.17**

* The suitability of the Sessoms Creek wetland complex was assessed; it is not included in any measures and, thus, is not included in the evaluation of baseline conditions.

2.4 THREATENED AND ENDANGERED SPECIES

2.4.1 Federally Protected Species

The Endangered Species Act (ESA) [16 U.S.C. 1532 et. seq.] of 1973 was enacted to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All federal agencies are required to implement protection programs for designated species and to use their authorities to further the purposes of the ESA. In addition, the USFWS has identified species that are candidates for listing as a result of identified threats to their continued existence. The ESA provides for the conservation of designated Critical Habitat - the areas of land, water, and air that an endangered species needs for survival. Critical habitat also includes such things as food, breeding sites, cover or shelter, and sufficient habitat area to provide for normal population growth and behavior.

As identified by the USFWS, there are 11 federally endangered, one federally threatened, and five candidate species for listing under the ESA that could potentially be affected by projects that occur in Hays County (USFWS 2012a; Table 2-4 and Appendix C). The status of listed species in the study area and coordination with the USFWS was considered throughout this study, including the development of restoration measures (Appendix D).

Table 2-4. Federally Listed Species Potentially Affected by Projects Occurring in Hays County, Texas

Common Name	Scientific Name	Federal Status	Potential to Occur in Study Area?
Birds			
Golden-cheeked warbler	*Dendroica chrysoparia*	Endangered	No
Whooping crane	*Grus americana*	Endangered	No
Black-capped vireo	*Vireo atricapillus*	Endangered	No
Fish			
Fountain darter	*Etheostoma fonticola*	Endangered, Critical Habitat	Yes
San Marcos gambusia	*Gambusia georgei*	Endangered, Critical Habitat	Yes
Amphibians			
Austin blind salamander	*Eurycea waterlooensis*	Candidate	No
San Marcos salamander	*Eurycea nana*	Threatened, Critical Habitat	Yes
Texas blind salamander	*Eurycea rathbuni*	Endangered	No
Barton Springs salamander	*Eurycea sosorum*	Endangered	No

Table 2-4, continued

Common Name	Scientific Name	Federal Status	Potential to Occur in Study Area?
Invertebrates			
Comal Springs riffle beetle	*Heterelmis comalensis*	Endangered, Critical Habitat	Yes
Comal Springs dryopid beetle	*Stygoparnus comalensis*	Endangered	No
Peck's cave amphipod	*Stygobromus pecki*	Endangered	No
Mollusks			
Golden orb	*Quadrula aura*	Candidate	Yes
Texas fatmucket	*Lampsilis bracteata*	Candidate	No
Texas pimpleback	*Quadrula petrina*	Candidate	Yes
Plants			
Bracted twistflower	*Streptanthus bracteatus*	Candidate	No
Texas wild-rice	*Zizania texana*	Endangered, Critical Habitat	Yes

Source: USFWS 2012a

A review of habitat requirements and occurrence records identified seven of these listed species that have some potential to occur in the study area: fountain darter, San Marcos gambusia, San Marcos salamander (*Eurycea nana*), Comal Springs riffle beetle (*Heterelmis comalensis*), golden orb (*Quadrula aura*), Texas pimpleback (*Quadrula petrina*), and Texas wild-rice. Critical Habitat has been designated for five of the listed species with potential to occur in the study area: fountain darter, San Marcos gambusia, San Marcos salamander, Comal Springs riffle beetle, and Texas wild-rice (Figure 2-3). However, of these, only four species (fountain darter, San Marcos gambusia, San Marcos salamander, and Texas wild-rice) have the potential to be affected by the proposed restoration measures.

Fountain Darter

The fountain darter is known to have been present in the San Marcos River from the headwaters (including Spring Lake) downstream to the vicinity of Martindale in Caldwell County (USFWS 1996a). Researchers have estimated the San Marcos River population of the fountain darter to total 45,900 individuals (downstream of and excluding Spring Lake) (Linam et al. 1993), to as many as 103,000 (Schenck and Whiteside 1976). Fountain darter densities appear to be highest in the upper segments of the San Marcos River and decrease markedly in an area below Cape's Dam (Linam et al. 1993, Whiteside et al. 1994).

Fountain darters require undisturbed stream floor habitats, including runs, riffles, and pools; a mix of submerged vegetation, including nonnative species, for cover; clear and clean water; a

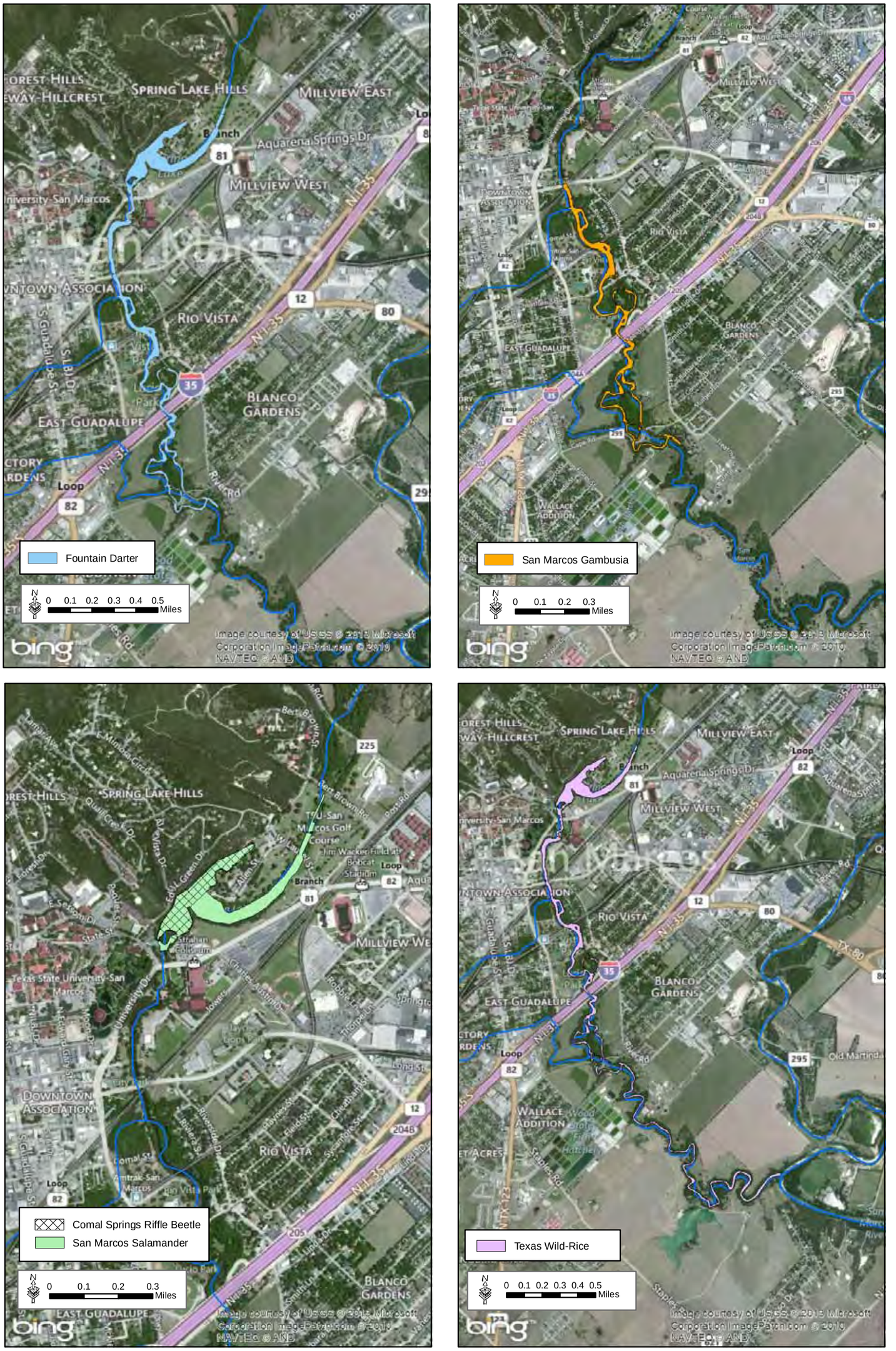

Figure 2-3. Critical Habitat for Species in San Marcos River Study Area

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food supply; constant water temperatures; and adequate spring flows. In 1976, the population of fountain darters on the San Marcos River was estimated to be 103,000 individuals (Schenck and Whiteside 1976). In 1990, Linam et al. (1993) estimated the total abundance of fountain darters in the San Marcos River, excluding Spring Lake, to be 45,900 individuals, with a 90 percent confidence interval of 15,900 to 107,700 individuals. Surveys for the fountain darter conducted from 2000 to 2009 did not report a population size estimate, but indicated that population levels were relatively stable (Bio-West 2010). Critical Habitat has been designated for the fountain darter as Spring Lake and its outflow, as well as the San Marcos River, downstream to approximately 0.5 mile below IH 35 (45 Federal Register [FR] 47355).

San Marcos Gambusia

The San Marcos gambusia is represented in collections taken in 1884 by Jordan and Gilbert during their surveys of Texas stream fishes and in later collections (as a hybrid) taken in 1925 (Hubbs and Peden 1969). Unfortunately, records of exact sampling localities are not available for these earliest collections, as localities were merely listed as “San Marcos Springs.” These collections likely were taken at or near the headsprings area. If true, then San Marcos gambusia appears to have significantly altered its distribution over time. For the area of the San Marcos River downstream of the headwaters area, there are few records of sampling efforts prior to 1950. However, even in the samples that were taken, there are few collections of San Marcos gambusia. A single individual was taken in 1953 below the low dam at Rio Vista Park.

Almost every specimen of San Marcos gambusia collected since that time, however, has been taken in the vicinity of the IH 35 Bridge crossing or shortly downstream. The single exception to this was a male taken incidentally with an Ekman dredge (sediment sampler) about 0.62 mile below the outfall of the San Marcos wastewater treatment plant in 1974 (Longley 1975).

Historically, San Marcos gambusia populations have been extremely sparse. Intensive collections during 1978 and 1979 yielded 18 San Marcos gambusia from 20,199 gambusia total (0.09 percent) (USFWS 2013a). Collections made in 1981 and 1982 within the range of San Marcos gambusia indicated a slight decrease in relative abundance of this species (0.06 percent of all gambusia) and none have been collected in subsequent sampling from 1982 to the present. Intensive searches for San Marcos gambusia were conducted in May, July, and September of 1990 but were unsuccessful in locating any pure San Marcos gambusia.

The San Marcos gambusia requires thermally constant water; quiet, shallow, open water adjacent to moving water; muddy substrates without appreciable quantities of silt; partial shading; clean and clear water; and a food supply of living organisms.

San Marcos Salamander

The San Marcos salamander occurs in Spring Lake and in rocky areas up to 500 feet downstream of the dam at Spring Lake (USFWS 1996a). Moss and algae provide hiding places for the salamanders and habitat for small animals that serve as their food. Clean, clear, flowing water of constant temperature is required for suitable habitat. The San Marcos salamander eats tiny aquatic crustaceans, aquatic insects, and snails. The total population size was estimated to be 53,200 individuals, with at least 5,200 individuals occurring downstream of the dam (USFWS 1996a).

Habitat consists of algal mats (Tupa and Davis 1976), where rocks are associated with spring openings (Nelson 1993). Sandy substrates devoid of vegetation and muddy silt or detritus-laden substrates with or without vegetation are apparently unsuitable habitats for this species. Specimens are occasionally collected from beneath stones in predominantly sand and gravel areas. In view of the abundance of predators (primarily larger fish, but also crayfish, turtles, and aquatic birds) in the immediate vicinity of spring orifices, protective cover such as that afforded by algal mats and rocks is essential to the survival of the salamander. The flowing spring waters in the principal habitat are near neutral (pH 6.7 to 7.2), range from 69.8 to 73.4 degrees Fahrenheit (°F), and are clear with low DO levels (Tupa and Davis 1976, Najvar 2001, Guyton and Associates 1979, Groeger et al. 1997).

Prey items for the San Marcos salamander include amphipods, tendipedid (midge fly) larvae and pupae, other small insect pupae and naiads (an aquatic life stage of mayflies, dragonflies, damselflies, and stone flies), and small aquatic snails (USFWS 1996a).

Reduced flow of water from the springs is the greatest threat to the survival of the San Marcos salamander. The growth of cities has led to higher water use by people and increased problems with water pollution and silt accumulation. Introduction of exotic species is also a threat because they may destroy aquatic vegetation, prey on endangered animals, or compete with them for food. Critical Habitat for the San Marcos salamander has been designated as Spring Lake and its outflow, as well as the San Marcos River, downstream to approximately 170

feet from the Spring Lake Dam (45 FR 47355). San Marcos salamanders have been recorded and are likely to still occur in and around the sediment plume at the mouth of Sessoms Creek.

Comal Springs Riffle Beetle

The Comal Springs riffle beetle is an aquatic insect that is primarily surface-dwelling (77 FR 64272). The Comal Springs riffle beetle has been found in various spring outlets of Comal Springs and in spring outlets of San Marcos Springs in the upstream portion of Spring Lake. The species is also likely to occur at other spring outlets of San Marcos Springs, including spring outlets associated with Spring Lake Dam, but sampling has been done on a limited basis. Comal Springs riffle beetles occur in conjunction with a variety of bottom substrates that mainly occur in areas with gravel and cobble ranging between 0.3 to 5.0 inches and do not occur in areas dominated by silt, sand, and small gravel. The Comal Springs riffle beetle is likely a detritivore that consumes dead organic materials and is typically found on roots where it presumably feed on fungus and bacteria associated with detritus.

Portions of Spring Lake have been designated as critical habitat for the Comal Springs riffle beetle (72 FR 39248), and proposed revisions to critical habitat include the San Marcos River 50 feet downstream of Spring Lake Dam (77 FR 64272). The primary constituent elements of the physical or biological features essential to the Comal Springs riffle beetle consist of the following three components: (1) springs, associated streams, and underground spaces immediately inside of or adjacent to springs, seeps, and upwellings that include high-quality water with no harmful levels of pollutants such as soaps, detergents, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, and semivolatile compounds such as industrial cleaning agents; and hydrologic regimes similar to the historical pattern of the specific sites, with continuous surface flow from the spring sites and in the subterranean aquifer; (2) spring system water temperatures that range from approximately 68 to 75 °F; and (3) food supply that includes, but is not limited to, detritus (decomposed materials), leaf litter, living plant material, algae, fungi, bacteria, other microorganisms, and decaying roots.

Golden Orb

The golden orb is known to have occurred in the Guadalupe, San Antonio, and Nueces River basins (Howells 2010a). Data indicate that the golden orb has declined significantly throughout its former range and is now known from nine disjunct locations in four streams. Since 1995, the golden orb has only been found in the Guadalupe, lower San Marcos, and lower San Antonio

Rivers and Lake Corpus Christi (an impoundment of the lower Nueces River). Of the nine known populations, four appear to be relatively stable and recruiting, while the remaining populations are represented by only a few individuals.

The golden orb is a small round-shaped freshwater mussel that is endemic to central Texas and restricted to the following populations: two populations in the lower Guadalupe River, a single population in the upper Guadalupe River, rare distribution in the Nueces River, and locations in the San Marcos River. Golden orb populations have been found downstream of the study area at and adjacent to Goliad and Palmetto State Parks in the San Marcos River. The golden orb is currently listed as a candidate species under the ESA.

The species is restricted to flowing waters with sand, gravel, and cobble bottoms at depths of a less than an inch to over 9 feet. It is intolerant of scouring floods that produce swept bedrock and boulder bottoms or excess sand/mud deposition. The golden orb is primarily threatened by habitat destruction and modification from impoundments that scour river beds and consequently remove mussel habitat, decrease water quality, modify stream flows, and prevent fish host migration (USFWS 2012b). Other threats include sedimentation, dewatering, sand/gravel mining, chemical contaminates, and the current and projected effects of climate change, population fragmentation, and nonnative species (USFWS 2012b).

Texas Pimpleback

The Texas pimpleback is a large freshwater mussel with a moderately thick and inflated shell that generally reaches 2.4 to 3.5 inches in length (Howells 2002). With the exception of growth lines, the shell of the Texas pimpleback is generally smooth (Howells 2002). The Texas pimpleback typically occurs in moderately sized rivers, usually in mud, sand, gravel, and cobble, and occasionally in gravel-filled cracks in bedrock slab bottoms (Horne and McIntosh 1979; Howells 2002). The species has not been found in water depths greater than 6.6 feet. Texas pimplebacks have not been found in reservoirs, which indicates that this species is intolerant of deep, low-velocity waters created by artificial impoundments (Howells 2002). Texas pimplebacks appear to tolerate faster water more than many other mussel species (Horne and McIntosh 1979).

The Texas pimpleback is endemic to the Colorado and Guadalupe-San Antonio River basins of central Texas (Howells 2002). In the Colorado River basin, the Texas pimpleback occurred

throughout most of the mainstem, as well as numerous tributaries, including the Concho, North Concho, San Saba, Llano, and Pedernales Rivers; and Elm and Onion Creeks (Howells 2010b, Randklev et al. 2010, OSUM 2011). The species occurred throughout most of the Guadalupe River, as well as in the San Antonio, San Marcos, Blanco, and Medina Rivers (Horne and McIntosh 1979, Howells 2010b, OSUM 2011). The Texas pimpleback has declined significantly rangewide, and only four streams, San Saba, Concho, Guadalupe, and San Marcos rivers, are known to harbor persisting populations of the species. These populations are disjunct, small, and isolated. The species has been extirpated from the remainder of its historical range (76 FR 62166).

Only two populations appear large enough to be stable, and evidence of recruitment in the Concho River population is limited. The San Saba River population may be the only remaining recruiting population of Texas pimpleback. The remaining populations in the San Marcos and Guadalupe Rivers are represented by very few individuals (76 FR 62166). In the San Marcos River near the confluence with the Blanco River in Hays County, repeated surveys between 1992 and 2000 yielded no evidence of Texas pimpleback (76 FR 62165). However, in 2003, two shells were collected (76 FR 62165), and in 2004 a single live individual was found. The Texas pimpleback likely persists in the action area in very low numbers.

Texas Wild-rice

When Texas wild-rice (Photograph 2-1) was first described in 1933, it was found in abundance in the San Marcos River and Spring Lake, as well as in contiguous irrigation ditches (Terrell et al. 1978; Silveus 1933). Following its discovery, abundance of Texas wild-rice declined substantially, and the species was listed as endangered in 1978.

Photograph 2-1. Texas Wild-rice Stand in San Marcos River

Spring flow is critical for growth and survival of Texas wild-rice (Saunders et al. 2001). Texas wild-rice relies on CO_2 as its inorganic carbon source for photosynthesis rather than the more commonly available bicarbonate used by most other aquatic plants (Seal and Ellis 1997). Water from the Edwards Aquifer contains relatively high levels of dissolved CO_2 due to the calcium

carbonate makeup of the region's karstic geology, and springflows transport the dissolved gas-enriched water downstream.

The current distribution of Texas wild-rice extends from the upper reaches of the San Marcos River, including several plants in Spring Lake just upstream of the dam and numerous stands just below the dam, throughout the river to an area just below the wastewater treatment plant. Multiple researchers employed different methods and reported varying total coverage of the species from 1975 through 1986, ranging from a low of 2,580 square feet to a high of 12,161 square feet (USFWS 2013b, Emery 1977, Vaughan 1986). TPWD began a regular monitoring and reporting effort in June 1989, and has reported coverage ranging from a low of 10,806 square feet in 1989 to a maximum of 52,248 square feet in 2010 (Poole and Bowles 1999, USFWS 2012b). The most recent rangewide estimate of Texas wild-rice coverage is 39,417 square feet from September 2011 (Bio-West 2012, USFWS 2013b). Data indicate that while the total areal coverage of Texas wild-rice has generally increased in recent years, the distribution of the species has contracted (Poole 2002). Texas wild-rice is now only found in the upper 3.5 miles of the upper San Marcos River, including Spring Lake. All examples of Texas wild-rice now found in Spring Lake are the result of reintroduction efforts (USFWS 1996b).

Increased sedimentation, water depth and turbidity, and a decrease in current velocities have contributed to a loss of habitat for Texas wild-rice throughout the lower portions of its historic range (Poole and Bowles 1999). While water depth and current velocity are primarily dependent on the rate of springflow into the San Marcos River, dams and other modifications have substantially altered local conditions of depth and current velocity. The impacts of increased sedimentation and turbidity on Texas wild-rice are largely a result of urbanization within the contributing watershed. Other threats to Texas wild-rice include direct damage to plants and substrates as a result of recreation and herbivory by waterfowl. Critical Habitat has been designated for the Texas wild-rice as Spring Lake and its outflow and the San Marcos River downstream to its confluence with the Blanco River (45 FR 47355).

2.4.2 State-Listed Species

The TPWD maintains a list of rare species potentially affected by projects in Hays County (Appendix C). This list includes flora and fauna whose occurrence in Texas is or may be in jeopardy or that have or have had known or perceived threats or population declines. These species are not necessarily the same as those protected by the federal government under the

ESA. In addition to federally listed species, Chapter 68 of the Texas Parks and Wildlife Code protects species considered to be threatened with extinction within Texas. Any take of a state-listed species is prohibited. ''Take'' is defined in Section 1.101(5) of the Texas Parks and Wildlife Code as to "collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take." The fountain darter and San Marcos gambusia are each state-listed as endangered, with the San Marcos gambusia recognized as extinct. The golden orb and Texas pimpleback are state-listed as threatened, and Texas wild-rice is state-listed as endangered. There are no other state-listed species.

2.4.3 State Scientific Area

The TPWD is authorized to establish State Scientific Areas for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value. To promote conservation of listed species and minimize the impacts of recreational activities on such species and their habitats, TPWD designated a State Scientific Area encompassing a 2-mile segment of the San Marcos River effective May 1, 2012. The segment begins at Spring Lake Dam and extends downstream to the wastewater treatment plant.

This designation authorizes TPWD to limit recreation within this reach when San Marcos River flows fall below 120 cfs. The designation provides for continued recreational use of the waterway by maintaining open channels outside of protection zones that run the length of the river. These areas allow for continued use of the river even during low flow periods for activities such as tubing, canoeing, kayaking, and swimming. The regulation makes it unlawful to move, deface, or alter any signage, buoys, booms, or markers delineating the boundaries of the State Scientific Area; to uproot Texas wild-rice within the area; or to enter any such marked areas.

2.5 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

2.5.1 Recreation

Common recreation activities on the upper (i.e., above the Blanco River) San Marcos River include swimming, tubing, canoeing, kayaking, fishing, and nature watching (Saunders et al. 2001). These activities have been enhanced through access to the river provided by city-owned parklands, including the San Marcos River Walkway that unites three parks along the river. Canoe outfitters, tube rentals, and shuttle services have grown substantially over the last 2 decades. In 1985, an estimated 25,000 people rented equipment for use on the river, and by

1992 a single equipment provider recorded 26,874 rentals for the summer (Saunders et al. 2001).

The former Aquarena Center at Spring Lake was purchased by Southwest Texas University (now Texas State University [TSU]) in 1994. At that time, the focus of the area was shifted from theme park-style entertainment to preservation and environmental education. In 2002, TSU created the River Systems Institute for research, study, and environmental advocacy. An endangered species exhibit and glass bottom boat tours are currently available to the public. Glass bottom boat tours account for the majority of the park's revenues.

Recreation primarily occurs between City Park and Cape Road (see Figure 1-1). TSU restricts recreational access to Spring Lake; however, the San Marcos River can be easily accessed from Sewell Park, just below the Spring Lake Dam, to IH 35. On most of the TSU property, the river is channelized, and concrete headwalls are several feet above the normal water elevation. However, ladders and a step-down provide easy access on campus. Parking is available at City Park and Rio Vista Park, which each provide hardened access points. Tubing is popular, and tubes can be rented from the Lions Club in City Park. Most tubers exit the river above the Cheatham Street Bridge and nearly all tubers exit before Cape Road, where flows begin to slow substantially and opportunities to exit the river are sparse. Kayaks can be rented from several local and regional outfitters, which also provide shuttle services. When Rio Vista Dam was reconstructed, a kayak training course was built, and this area is popular for kayaking; however, many boats continue downstream to Cummings Dam and beyond. Since Rio Vista Dam was refashioned, there has been an increase in kayak recreation between Rio Vista Dam and the IH 35 bridge. Swimming, fishing, and nature watching are popular on the west side of the river from City Park to IH 35, where city-owned parklands provide direct access to the river. Although some portions of the bank have been improved to provide easy access for swimming and fishing, there are many well-established foot trails and trampled banks at popular swimming and fishing holes.

2.5.2 Scenic and Aesthetic Resources

Above IH 35, the study area is more urbanized and developed than the area below IH 35. However, the City of San Marcos has taken advantage of the aesthetic value of the river, and the majority of the river's corridor is parkland containing landscaped views of the river and areas to enjoy the parks (i.e., benches, picnic areas). Areas along the river, including TSU-owned land and privately owned lands, are generally intensively maintained. A waterfall is visible to the

public near TSU as Spring Lake flows over the Spring Lake Dam. South of IH 35, the project corridor is either privately owned or owned by TPWD. Longer stretches of the river are more natural due to less development along the riparian corridor and include natural forested areas, pastureland, and some residential areas. The San Marcos River is considered an aesthetically pleasing river due to its clear water and abundant wildlife. Recreational users, private landowners, and the public appreciate the river's beauty and natural setting.

2.6 CULTURAL RESOURCES

Several federal laws govern the treatment of archaeological resources on federal lands or affected by federal undertakings, undertakings involving federal funding, and/or permitting. Most relevant is the National Historic Preservation Act (NHPA) of 1966 as amended (16 United States Code [U.S.C.] 470), and in particular Section 106 (36 CFR part 800), which details the NHPA's implementing regulations, and Section 110 (16 U.S.C. 470*h-2*), which details a federal agency's responsibilities under the NHPA. The manner in which the NHPA is coordinated with the NEPA is spelled out in 36 CFR 800.8, including how actions that are categorically excluded under NEPA are dealt with under Section 106 (36 CFR 800.8[a][2][b]), and when the NEPA process can be used for Section 106 purposes (36 CFR 800.8[a][2][b]).

Under the NHPA (16 U.S.C. 470 et seq, 36 CFR 800), a federal agency with jurisdiction over a federal undertaking, or one that is federally assisted or federally licensed, must take into account the effect that the undertaking will have on properties included in or eligible for listing on the National Register of Historic Places (NRHP). Section 106 of the NHPA governs the process in which agencies assess those impacts. The Section 106 process requires that the federal agency identify and evaluate the significance of historic properties that may be affected by the proposed undertaking in consultation with the State Historic Preservation Officer (SHPO) and consistent with the Secretary of the Interior's Guidelines and Standards for NRHP evaluation. If the Agency Head and the SHPO agree that a property potentially affected by the undertaking is eligible for listing on the NRHP, then they shall apply the Criteria of Adverse Effect found in 36 CFR 800.5 to such a property. If an adverse effect is determined, then the federal agency, in consultation with the SHPO, shall seek ways to either avoid or minimize those effects to the fullest possible extent.

This study also falls under the purview of the Antiquities Code of Texas (ACT) (Texas Natural Resource Code, Title 9, Chapter 191) because it may involve archaeological sites located "on land owned or controlled by the State of Texas or any city, county, or local municipality thereof." The ACT considers all such properties potential State Antiquities Landmarks and requires that each be examined for potential significance. Chapter 26 of the Texas Historical Commission's (THC) Rules of Practice and Procedure for the ACT outlines the standards for determining significance.

Other applicable cultural resources laws include the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001-3013), the Archaeological Resources Protection Act (ARPA) of 1979 (Public Law 96-95; 16 U.S.C. 470 *aa-mm)* as amended, and Executive Order 13007.

Cultural Background

The situation of the San Marcos River as a high output, spring-fed stream in a relatively arid area that provides conditions supporting a diverse assemblage of plants and animals otherwise sparse or nonexistent outside the floodplain has been a favorable location for humans to visit and inhabit since the earliest arrivals to the area. Archaeological evidence in the vicinity of the study area indicates that people were present along the San Marcos River as early as the Paleo-Indian period through the present (Shiner 1983). Many archaeologists believe the area around the springs, which feed the river 2 miles to the north of the present-day City of San Marcos, is one of the oldest continually inhabited locations in North America (Shiner 1983).

Prehistoric occupation in the study area is generally divided into five periods: the Paleo-Indian period, the Early Archaic period, the Middle Archaic period, the Late Archaic period, and the Late Prehistoric period. These periods are commonly subdivided into smaller temporal phases based on particular characteristics of the associated artifact assemblages encountered. The prehistoric occupation and corresponding periods are defined by the presence of particular diagnostic artifacts such as projectile points, certain types of pottery, and occasionally particular site locations. The Tonkawas living in the area at the time of European contact had farmed the area as early as 800 years ago; their name for the springs, Canocanayesatetlo, means warm water (Brune 2013).

The first Europeans to the area were probably members of the Espinosa - Olivares - Aguirre expedition in 1709, and decades later San Marcos was the site of the short-lived San Xavier mission. Another attempt to establish a settlement, San Marcos de Neve, in 1808 was hindered by attacks from Indians and flooding and abandoned by 1812 (Brune 2013, Folsom 2013). Under Spanish and later Mexican claim to the area, the river and springs became an important stop along the San Antonio Road from northern Mexico to Nacgodoches.

Americans began settling the area in the 1830s and 1840s using the reliable water flow to power gins and mills and later to water cattle along the Chisholm Trail. When Hays County was established in 1848, the small community of San Marcos was named the county seat. Cotton production and cattle raising, along with the mill industry, provided economic growth for the community through the mid to late 1800s. The link to stagecoach lines and later the International-Great Northern Railroad in 1881 provided further commercial growth for San Marcos through connection with external markets. The establishment of the Southwest Texas State Normal School in 1903 and the San Marcos Baptist Academy in 1907 added education to the local industry (Greene 2013).

Previous Investigations and Recorded Cultural Resources

Previous investigations recorded in the *Texas Archeological Sites Atlas* have identified numerous cultural resources within 1 mile of the study area (Figure 2-4). A total of 29 NRHP-listed properties, three NRHP-listed districts, and 18 state historic landmarks are located within 1 mile of the study area (Table 2-5). A total of 34 archaeological sites have been recorded within 1.6 kilometers (1.0 mile) of the proposed undertaking with 13 recorded within the Area of Potential Effects (APE) of proposed restoration measures, including 41HY161, 41HY319, 41HY432, 41HY489, 41HY135, 41HY133, 41HY393, 41HY425, 41HY134, 41HY261, 41HY164, 41HY166, and 41HY167. Three sites 41HY319, 41HY432, and 41HY393, are recommended not eligible for the NRHP. Sites 41HY135, 41HY133, 41HY425, 41HY134, 41HY166, 41HY489, and 41HY167, are of undetermined eligibility. Site 41HY161 is listed as a State Archaeological Landmark, Site 41HY261 is recommended eligible for the NRHP, and Site 41HY164 is listed on the NRHP and its numerous components comprise a historic district.

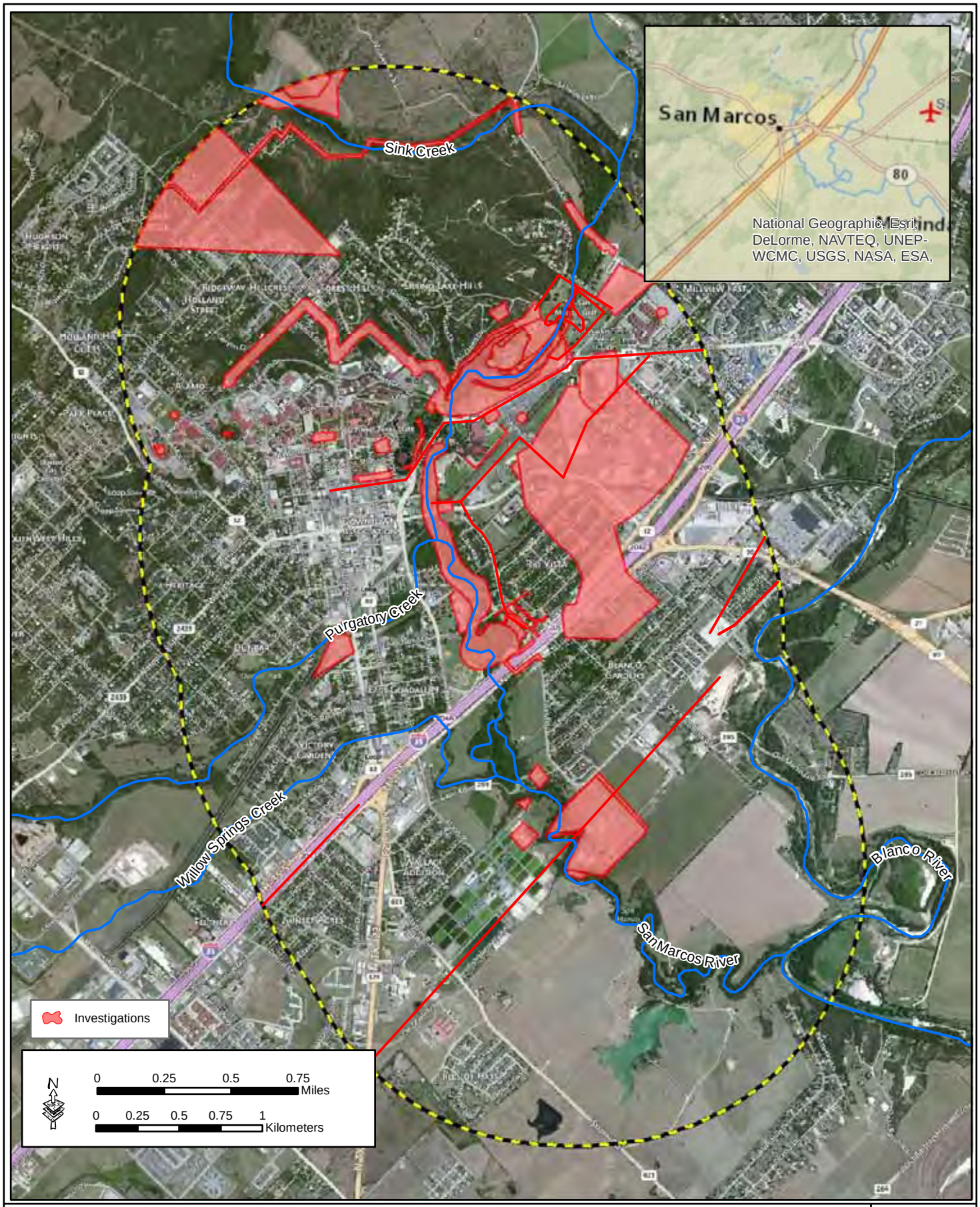

Figure 2-4. Previously Conducted Archaeological Investigations within a 1.6-kilometer (1.0-mile) Radius of the San Marcos River Study Area

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Table 2-5. National Register of Historic Places-Listed Properties and Districts and Recorded Texas Historic Landmarks within 1.0 mile of the San Marcos River Study Area

NRHP-Listed Properties and Districts		Recorded Texas Historic Landmarks
Main Building, Southwest Texas Normal School	Thompson-Cape Dam and Ditch Engineering Structure (districted)	Beverly Hutchison House
Hays County Courthouse Historic District	Commercial Structure at 131 Guadalupe Street	H. C. Keese Home
Goforth-Harris House	Hofheinz, Walter, House	Robert Early McKie
Cock House	BelvinStree1 Historic District	John Matthew Cape House
Moore Grocery Company	Kone-Cliett House	Charles Cock Home
Hardy-Williams Building	Smith House	The Calaboose
Hutchison House	Williams-Tarbutton House	Basil Dailey House
Hays County Courthouse	Caldwell House	Heard-Baker House
Green and Faris Building	Farmers Union Gin Company	Ragsdale-Jackman-Yarbough House
McKie-Bass Building	San Marcos Milling Company	Ike Wood House
First United Methodist Church	Belger-Cahill Lime Kiln	Rober Hixon Belvin Home
Fire station and City Hall	Ragsdale-Jackman-Yarbough House	Gerge Thomas McGeehee House
Simon Building	Rylander-Kyle House	John F. McGeehee Home
San Marcos Telephone Company		George Henry Talmadge Home
Hays County Jail		O. T. Brown Home
Episcopalian Rectory		Kone-Cliett House
Cape House		Old Storey Home
Fort Street Presbyterian Church		Farmers Union Gin Company
Heard House		

These cultural resources include prehistoric lithic scatters and campsites, historic middens and structures, and sites containing multiple temporal components spanning a long period of human occupation. Given the topography, as well as the large number of previously recorded and deeply buried archaeological sites within the surveyed portions of the study area, there is a high potential for unrecorded archaeological sites to occur within areas that have not yet been surveyed.

2.7 AIR QUALITY, GREENHOUSE GASES (GHG), AND CLIMATE CHANGE

Air Quality Standards and Attainment Status

The USEPA established National Ambient Air Quality Standards (NAAQS) for specific pollutants determined to be of concern with respect to the health and welfare of the general public (USEPA 2013b, Table 2-6). Ambient air quality standards are classified as either "primary" or "secondary." The major pollutants of concern, or criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, particulate matter less than 10 microns (PM-10), particulate matter less than 2.5 microns (PM-2.5), and lead. NAAQS represent the maximum levels of background pollution that are considered safe, with an adequate margin of safety, to protect the public health and welfare.

Areas that do not meet these NAAQS standards are called non-attainment areas; areas that meet both primary and secondary standards are known as attainment areas. The federal Conformity Final Rule (40 CFR Parts 51 and 93) specifies criteria and requirements for conformity determinations of federal projects. The federal Conformity Final Rule was first promulgated in 1993 by the USEPA, following the passage of Amendments to the Clean Air Act in 1990. The rule mandates that a conformity analysis be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS.

A conformity analysis is the process used to determine whether a federal action meets the requirements of the General Conformity Rule. It requires the responsible federal agency to evaluate the nature of a proposed action and associated air pollutant emissions and calculate emissions that may result from the implementation of the proposed action plan. If the emissions exceed established limits, known as *de minimis* thresholds, the proponent is required to perform a conformity determination and implement appropriate mitigation measures to reduce air emissions. The USEPA has designated Hays County as in attainment for all NAAQS (USEPA 2013c).

Table 2-6. National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Times
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour [1]	None	
	35 ppm (40 mg/m^3)	1-hour [1]		
Lead	0.15 µg/m^3 [2]	Rolling 3-Month Average	Same as Primary	
	1.5 µg/m^3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	53 ppb [3]	Annual (Arithmetic Average)	Same as Primary	
	100 ppb	1-hour [4]	None	
Particulate Matter (PM-10)	150 µg/m^3	24-hour [5]	Same as Primary	
Particulate Matter (PM-2.5)	15.0 µg/m^3	Annual [6] (Arithmetic Average)	Same as Primary	
	35 µg/m^3	24-hour [7]	Same as Primary	
Ozone	0.075 ppm	8-hour [8]	Same as Primary	
	0.08 ppm	8-hour [9]	Same as Primary	
	0.12 ppm	1-hour [10]	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour [1]
	0.14 ppm	24-hour [1]		
	75 ppb [11]	1-hour	None	

Source: USEPA 2013b at http://www.epa.gov/air/criteria.html
Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb - 1 part in 1,000,000,000) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air (µg/m^3).
[1] Not to be exceeded more than once per year.
[2] Final rule signed October 15, 2008.
[3] The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard
[4] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
[5] Not to be exceeded more than once per year on average over 3 years.
[6] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.
[7] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).
[8] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)
[9] (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c)USEPA is in the process of reconsidering these standards (set in March 2008).
[10] (a)USEPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.
[11] (a) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

GHG and Climate Change

Global climate change refers to a change in the average weather on the earth. GHG are gases that trap heat in the atmosphere. They include water vapor, carbon dioxide, methane (CH_4), nitrous oxide (N_2O), fluorinated gases including chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HFC), and halons, as well as ground-level O_3 (California Energy Commission 2007).

The Council on Environmental Quality (CEQ) drafted guidelines for determining meaningful GHG decision-making analysis. The CEQ guidance states that if the Project would be reasonably anticipated to cause direct emissions of 25,000 metric tons (27,557 U.S. tons) or more of CO_2 GHG emissions on an annual basis, agencies should consider this a threshold for decision-makers and the public. CEQ does not propose this as an indicator of a threshold of significant effects, but rather as an indicator of a minimum level of GHG emissions that may warrant some description in the appropriate NEPA analysis for agency actions involving direct emissions of GHG (CEQ 2010).

The GHG covered by *EO 13514 Federal Leadership in Environmental, Energy, and Economic Performance* are CO_2, CH_4, N_2O, HFC, perfluorocarbons, and sulfur hexafluoride. These GHG have varying heat-trapping abilities and atmospheric lifetimes. CO_2 equivalency (CO_2e) is a measuring methodology used to compare the heat-trapping impact from variousGHG relative to CO_2. Some gases have a greater global warming potential than others. Nitrous oxides (NO_x), for instance, have a global warming potential that is 310 times greater than an equivalent amount of CO_2, and CH_4 is 21 times greater than an equivalent amount of CO_2.

2.8 NOISE

Measuring Noise

Noise is generally described as unwanted sound, which can be based either on objective effects (i.e., hearing loss, damage to structures, *etc*.) or subjective judgments (e.g., community annoyance). Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. The A-weighted decibel (dBA) is a measurement of sound pressure adjusted to conform to the

frequency response of the human ear. The dBA metric is most commonly used for the measurement of environmental and industrial noise.

Noise levels occurring at night generally produce a greater annoyance than do the same levels occurring during the day. It is generally agreed that people perceive intrusive noise at night as being 10 dBA louder than the same level of intrusive noise during the day, at least in terms of its potential for causing community annoyance. This perception is largely because background environmental sound levels at night in most areas are also about 10 dBA lower than those during the day. Long-term noise levels are computed over a 24-hour period and adjusted for nighttime annoyances to produce the day-night average sound level (DNL). DNL is the community noise metric recommended by the USEPA and has been adopted by most federal agencies (USEPA 1974). A DNL of 65 dBA is the level most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like construction. As a general rule, noise generated by a stationary noise source, or "point source," will decrease by approximately 6 dBA over hard surfaces and 9 dBA over soft surfaces for each doubling of the distance. For example, if a noise source produces a noise level of 85 dBA at a reference distance of 50 feet over a hard surface, then the noise level would be 79 dBA at a distance of 100 feet from the noise source, 73 dBA at a distance of 200 feet, and so on.

Noise Thresholds

Acceptable noise levels have been established by the U.S. Department of Housing and Urban Development (HUD) for construction activities in residential areas (HUD 1984). Noise not exceeding 65 dBA is categorized as acceptable. Acceptable noise exposure may be of some concern, but common building construction will make the indoor environment acceptable, and the outdoor environment will be reasonably pleasant for recreation and play. Noise above 65 but not greater than 75 dBA is categorized as normally unacceptable. Normally unacceptable noise exposure is significantly more severe; barriers may be necessary between the site and prominent noise sources to make the outdoor environment acceptable; special building construction may be necessary to ensure that people indoors are sufficiently protected from outdoor noise. Noise greater than 75 dBA is categorized as unacceptable. Unacceptable noise exposure at the site is so severe that the construction costs to make the indoor noise environment acceptable may be prohibitive, and the outdoor environment would still be unacceptable.

Noise emission abatement criteria for construction activities have been adopted by the Federal Highway Administration (FHWA). The FHWA noise abatement criteria specify outdoor noise levels (dBA) for various land use activity categories (Table 2-7). The criteria thresholds are used to assess the impacts from short-term noise emissions associated with construction.

Table 2-7. Outdoor Construction Noise Abatement Criteria

Activity Category	Hourly dBA	Description of Activity Category	Type of Land Uses
A	57	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose	National Wilderness Areas, National Parks, State and Federal Wildlife Refuges
B	67	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals	National Forest, public beaches, city parks, community commons areas
C	72	Developed lands, properties, or activities not included in Categories A or B above	Industrial parks, commercial areas

Source: 23 CFR 772 Table 1.

Noise Generators in the Study Area

Noise in the upper segment (i.e., above IH 35) of the study area is generated by surface streets, IH 35, and other common low-level noise sources in urban and parkland environments. TSU and its programs, including athletics, generate noise. The east side of the study area above IH 35 is primarily residential, and noise from surface streets is likely to be less in this area. Below IH 35, the surrounding area is primarily agricultural; however, equipment at the state fish hatchery and the wastewater treatment plant can likely be heard when receptors are near these properties.

2.9 HAZARDOUS WASTE, SOLID WASTE, AND POLLUTION

The use, storage, disposal, or release of hazardous materials and wastes and pollutants is regulated under the Resource Conservation and Recovery Act (RCRA) (40 CFR 260). Solid and hazardous wastes are regulated in Texas by a combination of mandated laws of the USEPA, TCEQ, and regional governments. Standard environmental record sources were searched to identify records within the 0.5-mile buffer around the lands proposed for use in restoration measures (Environmental Data Resources, Inc. 2012). These records included one Comprehensive Environmental Response, Compensation, and Liability Information System site, one RCRA-Large Quantity Generators site at TSU, 29 leaking petroleum storage tank incident

reports, 38 underground storage tanks, one aboveground storage tank, and seven TCEQ spill sites.

There are no known records of hazardous materials being generated, stored, or disposed of on lands proposed for use in any of the restoration measures. The majority of the sites identified through review of records are located at distances that would not pose a risk to the proposed restoration measures. The Strahan Substation, TSU facilities, and the San Marcos River Pub and Grill are sites located nearest to lands proposed for use in restoration measures (Figure 2-5). The Strahan Substation stores electrical insulating oil in electrical equipment and sulfuric acid in sealed lead acid batteries. The records review identified 14 sites or violations associated with TSU. TSU has several reports associated with the physical plant (e.g., failure to comply with emissions laws). The San Marcos River Pub and Grill is included on a registry system and no reports of violations were available through standard records search.

Historic uses of the river, such as ranchland, pastureland, crops, and milling, likely did not use persistent hazardous materials, and it is unlikely that previous use of chemicals resulted in constraints to use of the landscape for other purposes. More recent and current uses of lands in the study area, such as restaurants and residential areas, could also store or handle hazardous materials; however, these materials are likely to occur in very small quantities or to be handled in a safe manner. Additionally, while conducting habitat reconnaissance surveys of the project corridor, no evidence of hazardous, toxic, or radioactive waste (HTRW) was observed. Based upon available information indicating no constraints on use, no additional HTRW investigations would be conducted prior to any construction.

2.10 SOCIOECONOMICS

2.10.1 Demographics

EO 12898, Environmental Justice, was issued by President Clinton on February 11, 1994. Objectives of the EO include development of federal agency implementation strategies, identification of minority and low-income populations where proposed federal actions have disproportionately high and adverse human health and environmental effects, and participation of minority and low-income populations.

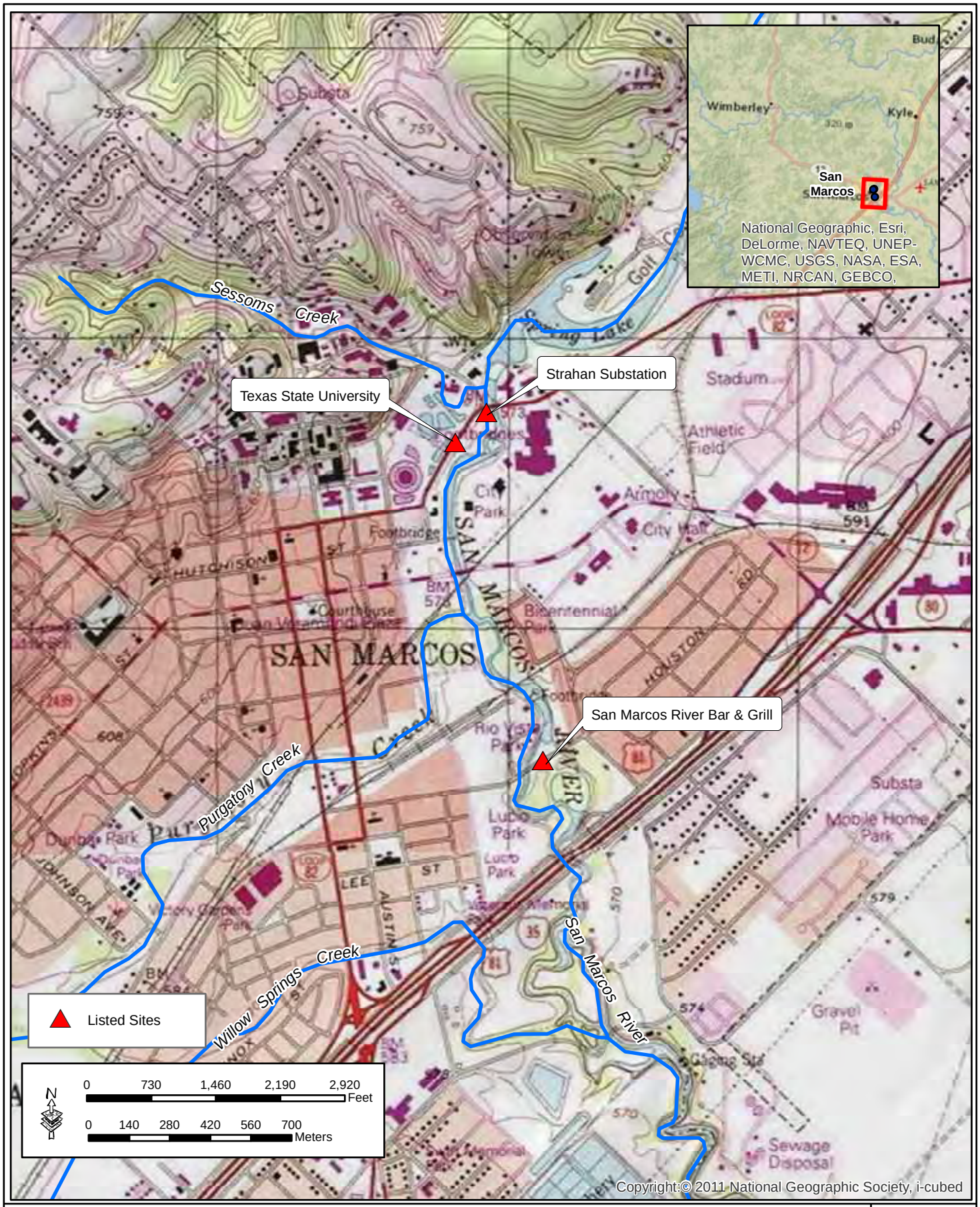

Figure 2-5. Hazardous, Toxic, Radioactive Waste Handlers near San Marcos River Study Area

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Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, or Pacific Islander. A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population. Low-income populations are those whose income is $22,050 or less for a family of four as identified using the U.S. Census Bureau's (USCB) statistical poverty threshold. USCB defines a "poverty area" as a census tract with 20 percent or more of its residents below the poverty threshold and an "extreme poverty area" as one with 40 percent or more below the poverty level. A potential disproportionate impact may occur when the percent minority in the study area exceeds 50 percent or the percent low-income exceeds 20 percent of the population. Additionally, a disproportionate impact may occur when the percent minority or low-income in the study area is meaningfully greater than that in the reference community.

Hays County had a 2012 estimated resident population of 168,990, which ranked 24th in the state (USCB 2013). This is a 58 percent increase over the 2000 estimation, when the Hays County population of 97,589 ranked 35th in the state (USCB 2005). In 2010, 44,894 people or 26.5 percent of Hays County population lived in the City of San Marcos. The racial mix of the City of San Marcos is predominantly White (71 percent), followed by people claiming to be some race other than African American, Native American or Alaskan Native, Asian, native Hawaiian or other Pacific Islander (20 percent), African American (5 percent), Asian (2 percent), American Indian and Alaska Native (less than 1 percent), and Native Hawaiian and other Pacific Islander (less than 1 percent) (USCB 2012). People claiming two or more races composed nearly 2 percent of the population, and people of any race claiming to be of Hispanic or Latino origin composed 40 percent of the population. The census tracts surrounding the study area (101, 103.2, 103.3, and 105) include minority populations (USCB 2010a).

2.10.2 The San Marcos Economy

Dean Runyan Associates (2013) estimated impacts of tourism on the State of Texas and its regions, counties, and major cities. Their estimates show more than $251 million in direct travel spending in Hays County in 2011, an almost 9 percent increase over 2010. For the City of San Marcos, estimates show almost $134 million in direct travel spending, a 4.4 percent increase over 2010 (Dean Runyan Associates 2013). The USCB American Community Survey estimates that "arts, entertainment, recreation, accommodation, and food services" provided approximately 19 percent of employment within the City of San Marcos compared to about 9

percent in Hays County and 8 percent in the State of Texas (USCB 2010a). County Business Patterns data show that employment in Hays County is concentrated in the retail and accommodation and food services sectors. Together they account for approximately 42 percent of employment in Hays County, compared to 23 percent for Texas and the Nation. According to the San Marcos Chamber of Commerce, TSU - San Marcos is the largest employer in the county (2,780 employees), with two large outlet malls, Prime and Tanger, listed as the second and third largest employers, with 2,100 and 1,540 employees, respectively.

Over the period from 2007 to 2011, the median household income of San Marcos was $27,597 and the mean household income was $38,491 (USCB 2013). Of the population 16 years of age and older, 59 percent are in the labor force, with 10 percent of the current labor force claiming unemployment. The percentage of all people living below the poverty level was 35.6 percent, which includes 15.8 percent of all families. The census tracts surrounding the study area (101, 103.2, 103.3, and 105) include low-income populations (USCB 2010b).

SECTION 3.0
PLAN FORMULATION

3.0 PLAN FORMULATION

According to USACE *Policy and Planning Guidance for Conducting Civil Works Planning Studies* (Engineering Regulation 1105-2-100), aquatic ecosystem restoration projects should be formulated in a systems context to improve the potential for long-term survival of aquatic, wetland, and terrestrial complexes as self-regulating, functioning systems. This section details the steps that were taken to formulate a plan that meets the guidance; considers the problems, opportunities, and constraints; and meets the study's planning objectives. Alternative measures were identified, and the beneficial and adverse contributions of each alternative measure were then evaluated against future without project (FWOP) conditions. Finally, the remaining alternative measures were combined into plans and compared against each other using cost-effectiveness and incremental analyses. Comments and recommendations from the resource specialists were incorporated into a number of possible restoration measures appropriate to the habitat type, site location, and existing conditions.

3.1 ENVIRONMENTAL PROBLEMS AND OPPORTUNITIES

The first step in the planning process is the identification of problems (i.e., undesirable conditions to be resolved) and opportunities (i.e., positive conditions to be improved) that the planning team seeks to address. Problems and opportunities statements are framed in terms of the federal objective and the specific study planning objectives.

3.1.1 Problems

- **Hydrology** - The natural hydrology of the San Marcos River has been altered by groundwater withdrawals from the Edwards Aquifer, and by five flood control projects on tributaries above Spring Lake (i.e., Sink Creek) and tributaries of the upper San Marcos River (i.e., Purgatory Creek) (Saunders et al. 2001).
- **Urbanization** - Urbanization has increased the volume of sediments and other pollutants carried in stormwater runoff and reduced the filtering effect of the riparian zone (USFWS 1996a).
- **Exotic Plants** - It is estimated that nearly 80 percent of the native plants along the banks of the San Marcos River have been replaced by the spread of exotic plant species since the 1930s (Young et al. 1973), which can be attributed to harvesting by commercial aquarium plant suppliers, aggressive competition with exotic species, and habitat destruction resulting from erosion, dredging, and pollution (Young et al. 1973, Bradsby 1994), and recreation (Mumma et al. 1996).

- **Recreation** - At common access points and narrow reaches of the channel, swimming, snorkeling, diving, boating, tubing, wading, and fishing can each cause degradation of stream banks, trampling and destruction of vegetation, and suspension of river sediments, which affects both common and listed species.
- **Impacts on Listed Species** - The four listed species occurring in the study area are threatened by each of the above-listed problems, which have directly and indirectly degraded native habitats.

3.1.2 Opportunities

Opportunities for meeting the objectives of this study include availability of restoration methods that have been tested for feasibility and effectiveness, existence of ongoing and planned restoration efforts affecting the San Marcos River, and availability of a large portion of lands within the study area for implementation of restoration measures.

- **Expansion on Adjacent Restoration Efforts** - Riparian and aquatic habitats associated with Spring Lake were recently restored though Section 206 funding and included measures, such as the removal of nonnative plants, that would have cumulative benefits on these habitats through restoration measures proposed for this study; other restoration efforts that have or would benefit the study area include the EARIP HCP, community efforts to control elephant ear on private lands adjacent to the river, and others. There is an opportunity to expand on previous upstream restoration efforts by increasing the habitat corridor and providing connectivity with existing restored areas.
- **Availability of Restoration Methods and Materials** - Efforts by USFWS, TPWD, and the TSU, River Systems Institute to conserve and restore the San Marcos River ecosystem provide the knowledge and experience necessary to develop feasibility and cost-effective restoration measures; furthermore, the current availability of plant stock propagated from local specimens increases the success probability of restoration efforts.
- **Availability of Lands for Restoration** - A large portion of the floodplain corridor is publicly owned, primarily by the City of San Marcos, which provides the opportunity to reduce the impacts of urbanization by expanding the riparian corridor and improving discharge locations to restore the function of riparian forests.

3.2 STUDY GOALS

The primary goal of this study is to develop an aquatic ecosystem restoration plan that restores degraded sensitive aquatic habitats and provides the greatest ecosystem benefits relative to implementation costs.

3.3 MOST PROBABLE FUTURE WITHOUT PROJECT CONDITIONS

The most probable FWOP conditions represent a baseline for evaluation of benefits resulting from proposed measures. In order to quantify changes in habitat suitability occurring throughout the 50-year planning period for the project, target years (TY) were established at TY1, TY3, TY15, TY25, and TY50. Target years were selected at points in time when the rate of loss or gain in the HSI or habitat area was predicted to change; changes are predicted linearly between years. Baseline conditions would exist during TY1. TY3 was selected as the first year that land and water use conditions would be expected to deviate from baseline conditions for restoration measures to remove elephant ear and accumulated sediment. These measures are constrained by the extent to which they can be implemented each year, and it was assumed that these measures would not begin to provide benefits until the end of TY3. Although conditions would begin to vary at multiple locations during the first 3 years, the rate of change in conditions during this time would be linear. TY15 was selected as the year when the canopy of planted trees begins to reach closure, and TY25 was selected as the year when the canopy is nearly closed and self-thinning would begin to occur. The last year of the project life is TY50. AAHUs were then calculated following HEP methods (USFWS 1980).

It was necessary to make assumptions about the future conditions of the habitats in the study area during each target year. Assumptions regarding FWOP conditions, as they relate to HEP models, are quantified in Appendix B, Tables B-2 through B-8.

The following assumptions were necessary to evaluate FWOP suitability of riparian forest:

- The extent of riparian forest would remain constant over time. A predominance of the riparian forests within the study area is owned by the City of San Marcos and would not be developed. Remaining forested areas are on public or state-owned lands, where development has already occurred and remaining riparian forests are also not likely to be developed.
- The basal area of Type 1 forests would increase over time. Increased basal area would negatively affect foraging opportunities for downy woodpecker by increasing the density of shrubs in the mid-canopy.
- The basal area of Type 2, 3, and 4 forests would remain constant throughout the life of the project. In Type 2 and 4 forests, nonnative shrubs and trees already compose a significant portion of the canopy, and an increase in nonnatives would not result in further reduction of habitat quality. In Type 3 forests, the understory is controlled by mowing; thus, basal area is assumed to remain relatively constant throughout the life of the project.

- The snag density would remain constant in all forest types throughout the life of the project.
- The area of degraded shoreline would remain constant throughout the life of the project. Currently degraded areas would continue to provide no habitat value.

The following assumptions were necessary to evaluate FWOP suitability of riverine habitats:

- The area of riverine habitats would remain constant over the life of the project. Although the distribution of elephant ear, which provides unsuitable riverine habitat, is assumed to change over the life of the project, the proportion of each reach occupied by elephant ear is assumed to remain constant.
- Existing improved lands within the channel (i.e., headwalls and debris) would remain in place during the life of the project.
- Spring flows would continue at the historic mean of approximately 175 cfs. Water quality and hydrology and hydraulic conditions are primarily influenced by existing flood control structures, spring output, and atmospheric conditions. The future of the in-channel dams on the San Marcos River is uncertain; however, it was assumed that any repairs or replacements would result in hydrology and hydraulic conditions similar to the baseline. Thus, all future water quality parameters are estimated by reach using published estimates of mean values during normal conditions.
- The existing balance of sediment transport and deposition would be maintained over the life of the project. Although additional development within the study area is likely, measures to reduce sediment transport associated with new development would likely result in maintenance of current conditions. Furthermore, the baseline substrate conditions (i.e., predominance of fine sediments) are evaluated as the least suitable condition; thus, assuming an increase in fine sediment accumulation over time would not affect the evaluation of AAHUs.
- Cover and water obstruction would remain relatively constant over the life of the project.

It is assumed that under FWOP conditions, no wetlands would be restored within the area of proposed restoration measures; thus, the wetland HUs would remain constant throughout the life of the project.

Based upon these assumptions, the same physical area of proposed restoration measures would provide 30.56 AAHUs under the FWOP conditions (Table 3-1 and Appendix B, Table B-8).

Table 3-1. FWOP AAHUs by Habitat Type

Habitat	AAHUs by Type/Reach								Total
Riparian Forest	Type 1		Type 2		Type 3		Type 4		
	4.38		2.89		0.39		7.74		15.40
Riverine – (native habitat)	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Reach 11	
	2.81	1.66	1.70	2.89	1.73	0.44	2.30	1.64	15.16
Total									**30.56**

3.4 OBJECTIVES AND CONSTRAINTS

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. The planning objectives are directly related to the problems and opportunities identified for the study and are used for the formulation of measures. Constraints are restrictions that limit the planning process. Resource constraints are those associated with limits on knowledge, expertise, experience, ability, data, information, money, and time. Legal and policy constraints are those defined by law and USACE policy and guidance.

The following objectives would achieve the federal goal of ecosystem restoration by addressing the specific problems and opportunities identified above:

- Increase habitat suitability of the riparian corridor
- Improve the function of the riparian corridor as a buffer against sediment and pollutant inputs
- Increase aquatic habitat suitability
- Reduce recreational impacts on habitat suitability and on endemic species
- Improve habitats for endemic species

The following constraints identify resource and legal constraints that limit the scope of measures developed to achieve the study objectives:

- All activities within aquatic habitats should avoid or minimize potential impacts on Texas wild-rice, fountain darters, San Marcos gambusia, and San Marcos salamanders.
- No measures can be proposed that would promote spread of nonnative invasive species.

- The project sponsors have no control over groundwater withdrawal and associated spring flow or tributary flood control reservoirs and associated discharge into the tributaries.
- Legal and policy constraints include the provisions of *EO 11988 – Floodplain Management*, the WRDA, the CWA, the ESA, and NHPA.

SECTION 4.0
ENVIRONMENTAL RESTORATION MEASURES

4.0 ENVIRONMENTAL RESTORATION MEASURES

Project measures were developed through coordination with the City of San Marcos, USFWS, and TPWD to address the stated problems within the constraints identified and represent stand-alone actions that would improve the aquatic ecosystem. Guidelines provided in the following documents would be adhered to during design and implementation of proposed measures, where applicable:

- Engineering Manual (EM) 1110-2-1205, Environmental Engineering for Local Flood Control Channels, 15 November 1989
- EM 1110-2-1902, Slope Stability, 31 October 2003
- EM 1110-2-410, Design of Recreation Areas and Facilities – Access and Circulation, 31 December 1982
- Engineer Research and Development Center (ERDC)/Coastal Hydraulics Laboratory (CHL) Technical Report (TR)-01-28, Hydraulic Design of Stream Restoration Projects, September 2001

Initially, an array of 15 measures was considered (Table 4-1).

Table 4-1. Initial Restoration Measures for Consideration

Measure	Name	Carried Forward?	New Name
Control of Exotic Shrubs and Trees	EXOT	Yes	EXOT
Planting of Native Vegetation in Riparian Zone	RIP	Combined with DHR	RIP1
Removal of Debris/Hardpan	DHR	Combined with RIP	RIP2
Control of Exotic Aquatic Vegetation – Emergent	EXOA	Yes	EXOA
Control of Exotic Aquatic Vegetation – Submerged	EXOS	No	N/A
Removal of Instream Hard Structures	IHS	Combined with SHORE	SHORE2
Stabilization of Stream Bank and Control of Recreational Access	SHORE	Combined with IHS	SHORE1
Control of Discharge	DISC	Yes	DISC
Removal of Accumulated Sediments	SED	Yes	SED
Removal/Modification of Dams	DAMR	No	N/A
Modification of Dams	DAMM	No	N/A
Improvement of Wetlands	WETE	Combined with WETC	WET
Develop Wetlands	WETC	Combined with WETE	WET
Improve Habitat for Endemic Species	ENDS	No	N/A
Education	EDU	Yes	EDU

During consideration of the initial 15 measures, it was determined that several could not be implemented and these were eliminated from further consideration. Control of Exotic Aquatic Vegetation-Submerged (EXOS) was removed from consideration because removal of submerged exotic species would require replacement of nonnative with native species; thus, the measure would not affect suitability within the selected HSI models. Due to cost, liability, and private ownership issues associated with the dams, the measures DAMM and DAMR were excluded from further consideration. Improve Habitat for Endemic Species (ENDS) was removed because the HEP analysis would not show habitat benefits for endemic species using the selected HSI models, and the other proposed measures would provide similar improvements to endemic species habitat. Of the remaining measures, those measures that addressed the same problem and resulted in similar ecosystem benefits were combined as one measure or as one measure with multiple scales. Removal of Instream Hard Structures (IHS) provides benefits similar to Stabilization of Stream Bank and Control of Recreational Access (SHORE), and these two measures were combined into SHORE. Because the two measures differ in cost to implement, this measure includes two scales, with SHORE1 addressing restoration on natural substrates and SHORE2 addressing removal of hard structures and subsequent restoration. Removal of Debris/Hardpan (DHR) and Planting of Native Vegetation in Riparian Zone (RIP) were similarly combined into RIP1 and RIP2. Improvement and creation of wetlands were also combined, but would require similar costs per benefit; thus, WET is a measure with only one scale. Later in the planning process, USFWS recommended adding a measure that involved the management of nuisance waterfowl within the project area (DUCK). With these revisions, nine measures were carried forward (Table 4-2). A detailed description of the monitoring and adaptive management of restoration measures included in the Proposed NER Plan can be found in Appendix I. Measures to avoid and minimize adverse effects are described in Section 8.0 for each restoration measure included in the Proposed NER Plan.

Table 4-2. Restoration Measures Carried Forward

Restoration Measure	Name
Control of Exotic Shrubs and Trees	EXOT
Restore Riparian Corridor	RIP
Control of Exotic Aquatic Vegetation – Emergent	EXOA
Stabilization of Stream Bank and Control of Recreational Access	SHORE
Control of Discharge	DISC
Removal of Accumulated Sediments	SED
Management of Waterfowl	DUCK
Restoration of Wetlands	WET
Education	EDU

4.1 CONTROL OF EXOTIC SHRUBS AND TREES (EXOT)

4.1.1 Initial Construction

Exotic invasive trees and shrubs in the study area include chinaberry tree, Japanese privet (*Ligustrum sinense*), glossy privet, Chinese tallow, loquat (*Eriobotrya japonica*), and paper mulberry (*Broussonetia papyrifera*). Under EXOT, these trees would be controlled using herbicide over 27.28 acres of the study area within Type 1 (7.74 acres), Type 2 (4.59 acres), and Type 4 (14.96 acres) forests (Figures 4-1a and 4-1b). Initial herbicide application would occur in the fall following the end of the migratory bird breeding season (Appendix F, Table F-2a). Areas to be treated would be surveyed, and target trees would be flagged or otherwise marked. Herbicide would then be applied using backpack sprayers equipped with sponges to avoid overspray and damage to desirable species. The herbicide manufacturer's recommended rate of application for each targeted species would be followed. A pest control business license for the State of Texas and a qualified applicator certification would be obtained. Exotic invasive trees greater than 6 inches diameter at breast height (dbh) would be treated by using herbicide spikes or by applying herbicide to girdling of the trees and left in place to provide snags, which increase suitability of habitat for cavity-nesting birds.

4.1.2 3-year Establishment Period

During the 3-year establishment period (Appendix F, Table F-2b), or until successful control of exotics is achieved, treated areas would be surveyed annually to spray resprouts and germinated seeds. During each follow-up treatment, the abundance and distribution of live exotic trees and shrubs would be recorded and reported to ensure successful control.

4.1.3 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

It is assumed that following the 3-year establishment period, the areas would be self-sustaining and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) would be minimal (Appendix F, Table F-2c). OMRR&R would include surveys at TY15 and TY25, application of herbicide if necessary, and reporting of any new establishment.

4.1.4 Assumed Benefits

EXOT would improve the structure of the riparian forests by reducing the cover of exotic invasive shrubs and increasing the density of snags. These shrubs occupy the middle canopy of the riparian forest, resulting in a dense cover of smaller stems. By removing these high-

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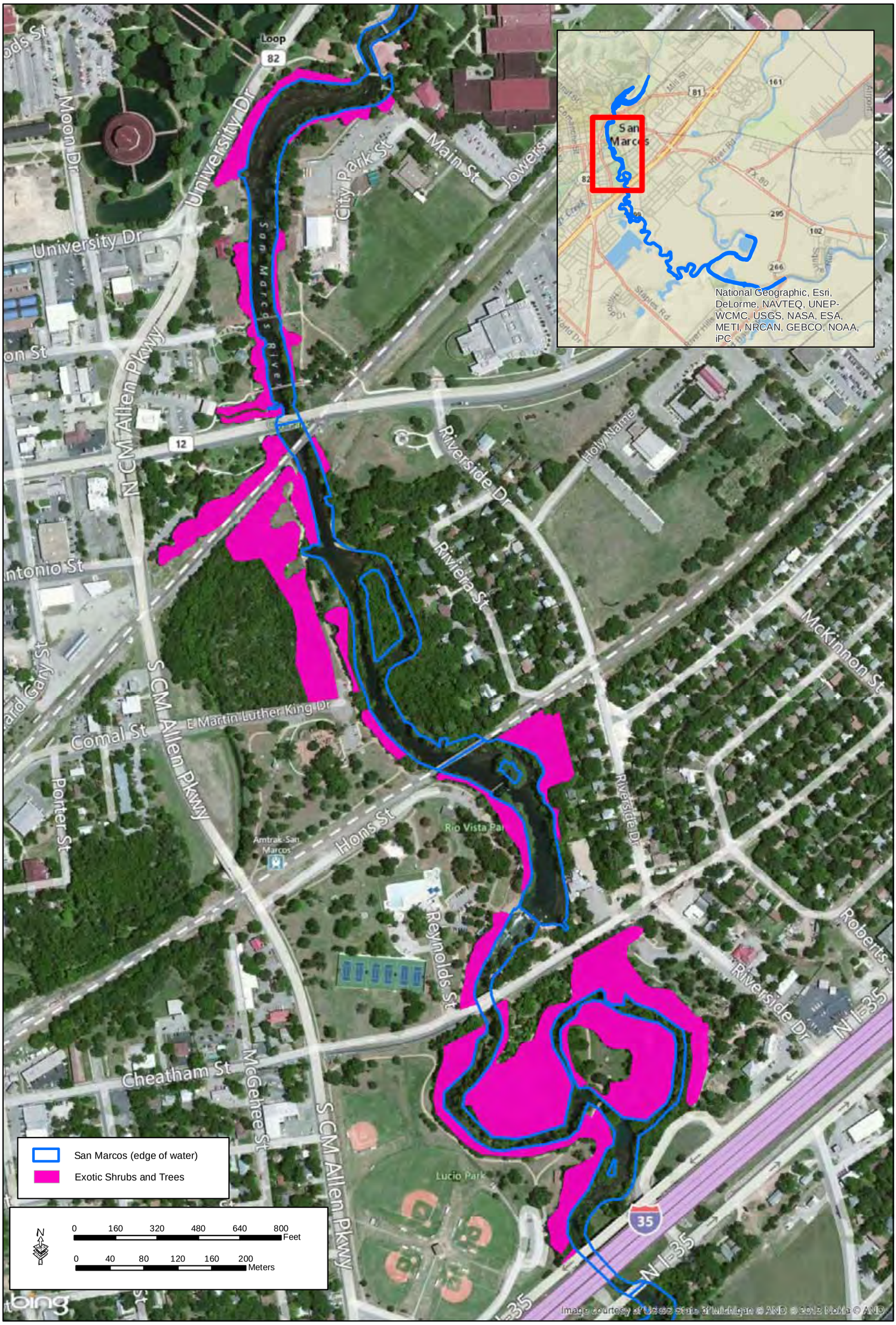

Figure 4-1a. Control of Exotic Shrubs and Trees (EXOT)

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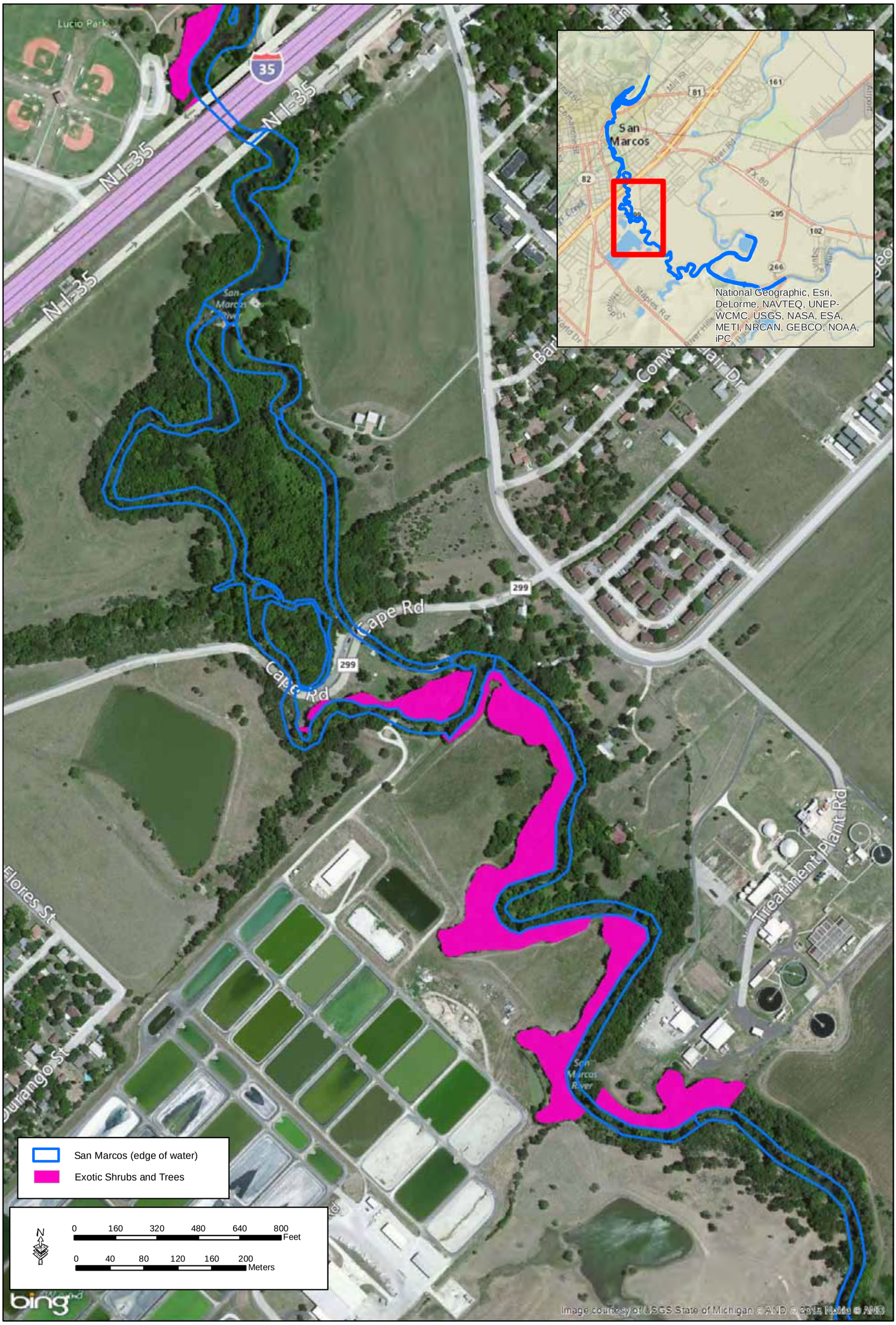

Figure 4-1b. Control of Exotic Shrubs and Trees (EXOT)

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frequency, small stems, EXOT would result in a reduction of basal area to optimum or near-optimum conditions in Type 1, Type 2, and Type 4 forests at TY1 (Appendix B, Table B-2). Because no exotics occur within Type 3 forest, this forest type would not benefit from EXOT.

4.2 RESTORE RIPARIAN CORRIDOR (RIP1 AND RIP2)

4.2.1 Scales of Implementation

Two scales were considered for the development of the RIP (Appendix F, Table F-3). One scale, RIP1, would result in restoration of the riparian corridor by vegetative management within existing, low-quality forest types and improved lands to obtain increased habitat quality. A second scale, RIP2, would restore the riparian corridor by first removing impervious surfaces, such as parking lots and other hardpan or concrete structures, then planting native vegetation. Parking lots would not be replaced. Both scales would require relocation of trails. These trails are necessary for operation and maintenance of other recreational features within an existing, continuous trail system that connects the various public lands in the study area. Trails proposed for relocation are located near the river and allow easy access for recreationists at unauthorized locations, which unnecessarily damages existing riparian and aquatic habitats. The cost of removing trails would be considered part of the initial construction cost, and the cost to construct replacement trails would be considered operation and maintenance.

4.2.2 Initial Construction (RIP1)

Under RIP1, the existing riparian corridor would be widened by planting native vegetation on 1.67 acres of existing Type 3 forest (i.e., parklands, pasture, residential property with mature trees and maintained understory) and on 11.84 acres of existing pervious improved lands (Figures 4-2a and 4-2b; Appendix F, Table F-3a). RIP1 would replace Type 3 forest and pervious improved lands with 11.84 acres of Type 5 forest (i.e., planted riparian forest). Trails would be removed at two locations.

Planting would occur in three zones defined primarily by distance from the river and suitable vegetation species (Table 4-3; Figures 4-3 and 4-4). The specific planting pallet was based upon in-field observations and through consultation with the City of San Marcos, USFWS, and TPWD. The extent of planting zones was established using a GIS, with Zones 1, 2, and 3 totaling 0.65, 10.30, and 2.27 acres, respectively. A total of 0.28 acre of new, pervious

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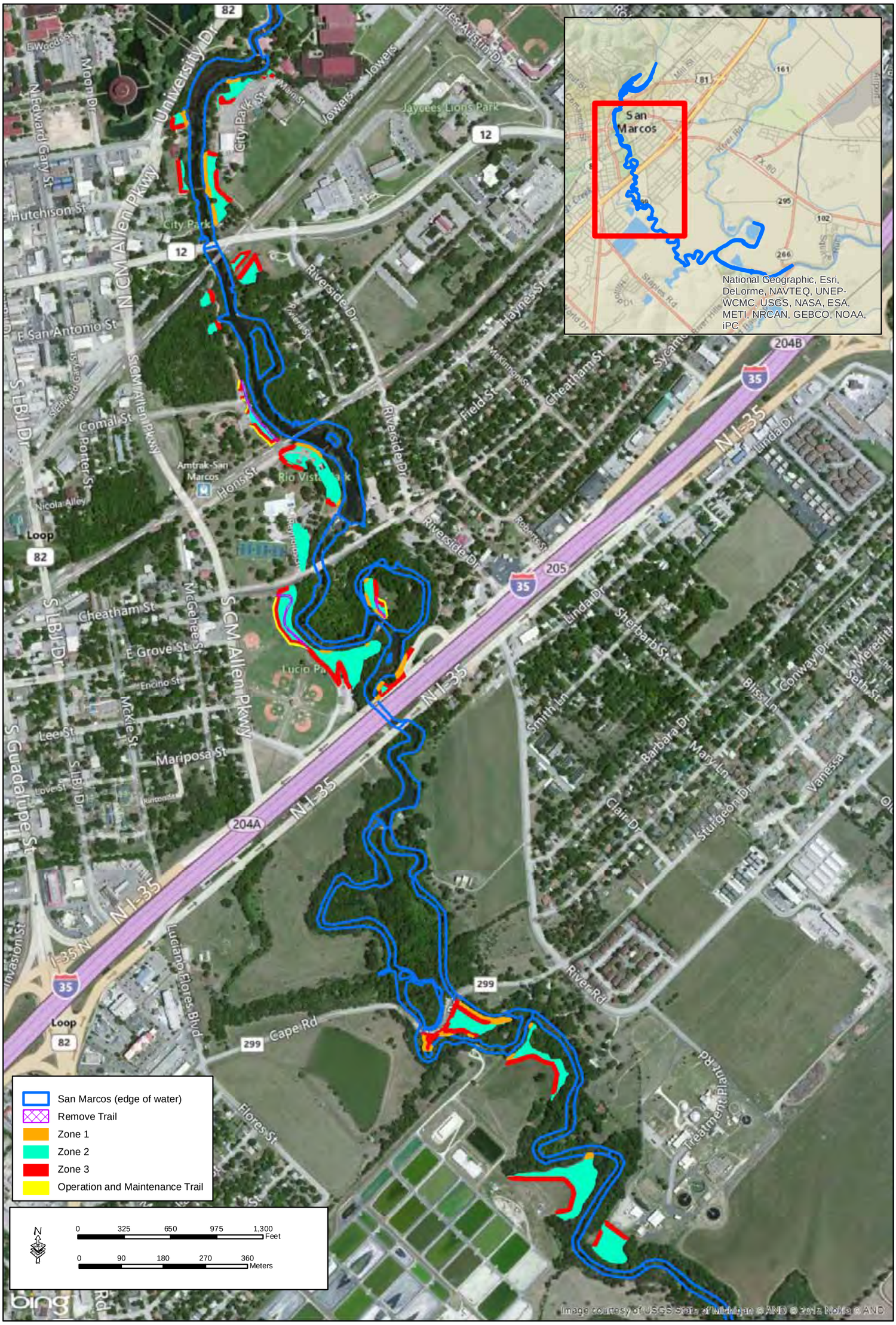

Figure 4-2a. Restore Riparian Corridor on Type 3 Forest and Pervious Improved Land (RIP1)

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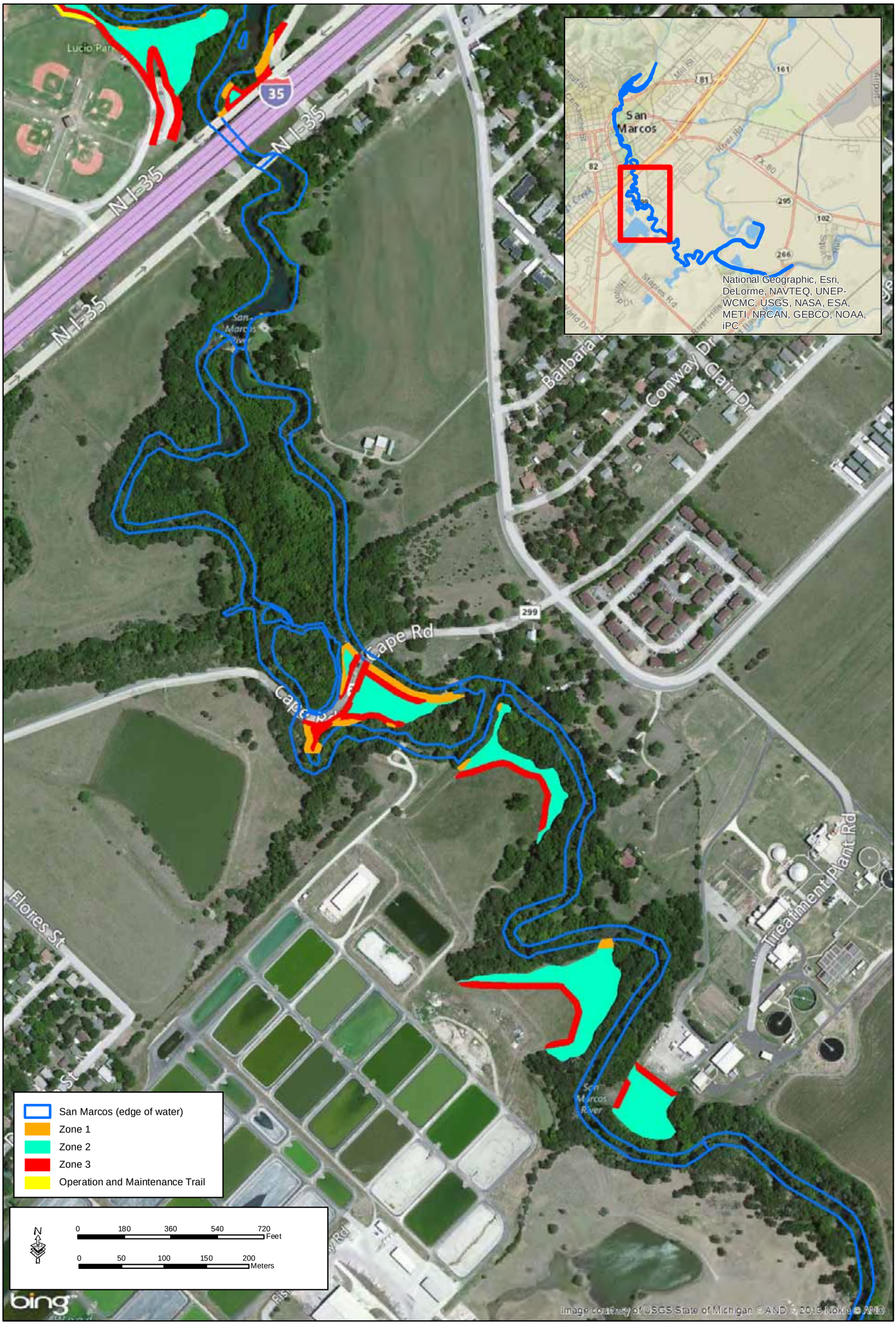

Figure 4-2b. Restore Riparian Corridor on Type 3 Forest and Pervious Improved Land (RIP1)

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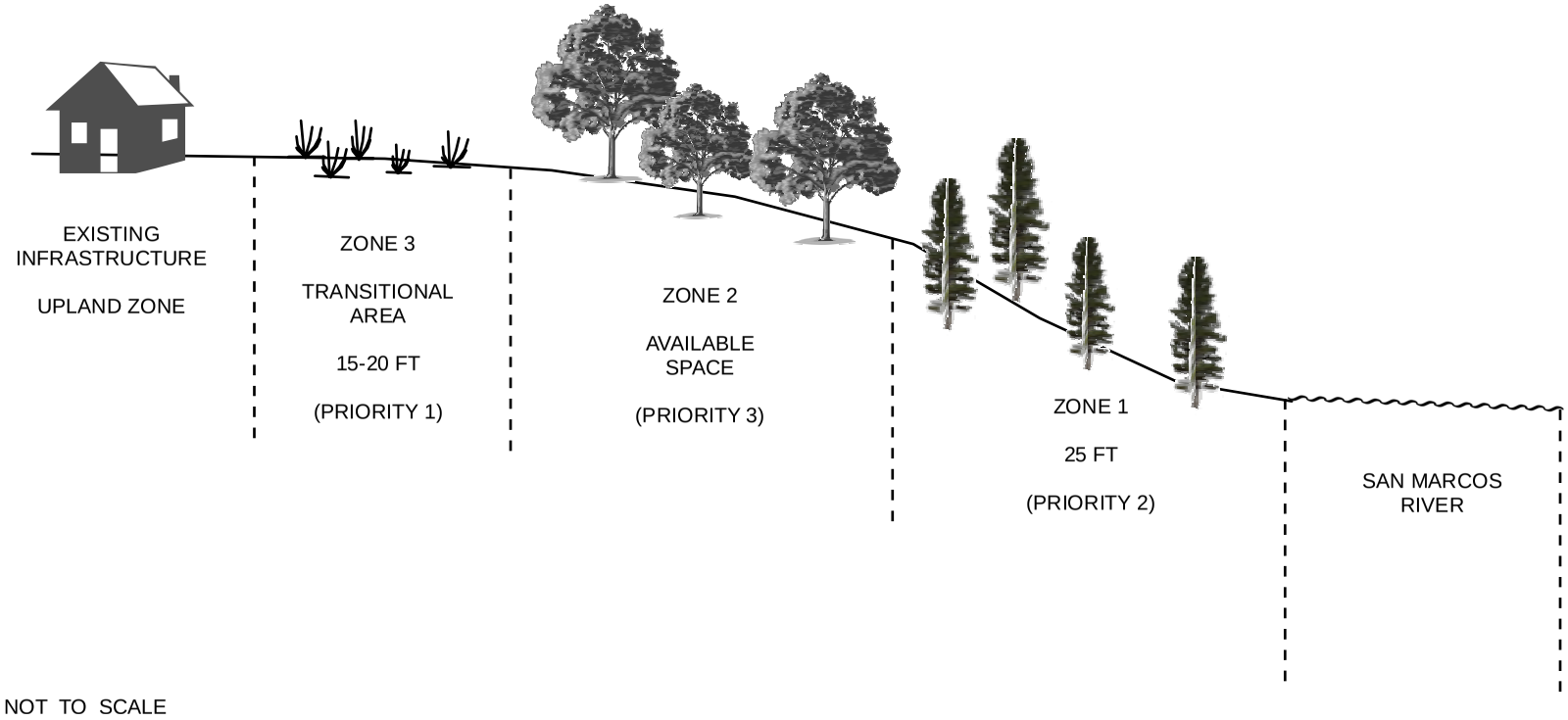

Figure 4-3. Conceptual Illustration of Native Planting Zone (RIP) Profile

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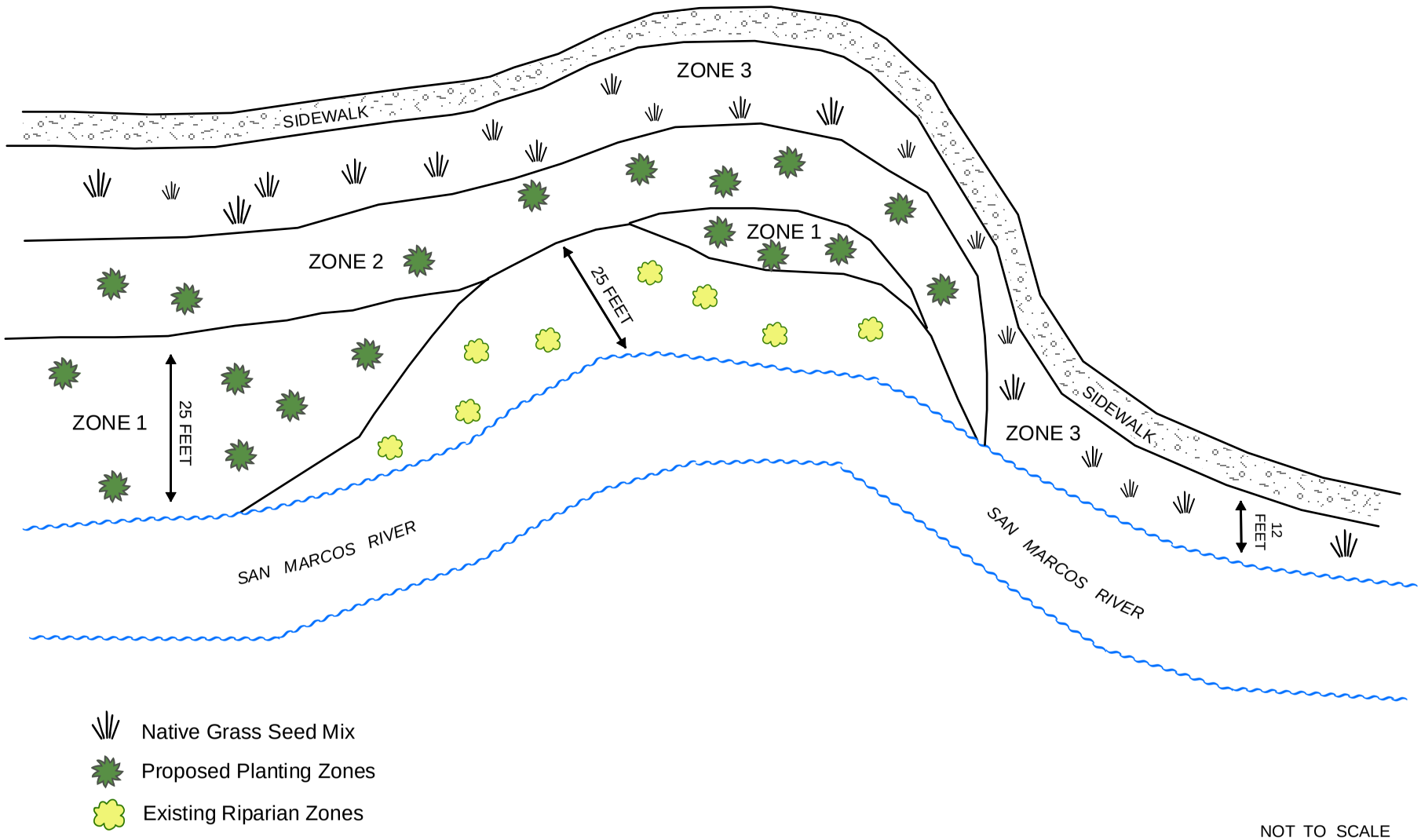

Figure 4-4. Conceptual Illustration of Native Planting Zones (RIP) Overview

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maintenance trails would be constructed at locations further from the river than existing trails, which would be removed.

Table 4-3. Riparian Corridor Planting Zones

Zone	Distance from river (feet)	Species Requirements	Suitable species
1	0 to 25	Tolerant of frequent disturbance and provide bank stabilization, shade, and food for aquatic organisms	bald cypress (*Taxodium distichum* var. *distichum*), black willow (*Salix nigra),* sycamore (*Platanus occidentalis*), box elder (*Acer negundo*)
2	25 plus	Large, fruit- or mast-producing	Texas sugarberry (*Celtis laevigata* var. *texana*), red mulberry (*Morus rubra*), bur oak (*Quercus macrocarpa*), chinkapin oak (*Q. muehlenbergii*), Texas live oak (*Q. fusiformis*), pecan (*Carya illinoinensis*)
3	Transition zone	Warm season grasses, large root systems, high aboveground productivity, value to wildlife, and low maintenance	switchgrass (*Panicum virgatum*), big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), Virginia wildrye (*Elymus virginicus*), inland seaoats (*Chasmanthium latifolium*), eastern mock grama (*Tripsacum dactyloides*), Indian grass (*Sorgahstrum nutans*)

Not all zones would be planted in all proposed locations due to restrictions from existing infrastructure or land use. Priority would be placed on establishing Zone 3 in areas where the width of the riparian corridor is limited by existing structures or land use. In areas that are less than 15 feet wide from the edge of the river to the nearest improved lands (i.e., trail, roadway, maintained grassland), only Zone 3 would be established (see Figure 4-4). Because Zone 3 has the greatest capacity for filtration of pollutants from surface flows, Zone 3 is essential for providing the transition between improved, managed, and unimproved, natural lands. In areas where the width of the unimproved riparian corridor is greater than 15 feet wide, Zone 1 tree species would be planted up to 25 feet from the river. The maximum width of Zone 1 and Zone 3 would be 50 feet. If the width of the unimproved portion of the riparian corridor is greater than 50 feet, Zone 2 species would be planted in the available space between Zone 1 and Zone 3.

Trees, shrubs, and seed mixes would be derived from local stock and acquired from local nurseries. A cover crop during construction/earthwork activities should include the use of a multi-species native lawn seed mix available from commercial sources that requires less mowing, less watering, and less invasive species removal than other commercial seed mixes.

All trees necessary for Zones 1 and 2 would be grown in tree cells (2 by 2 by 8 inches) because tree cells are inexpensive, are easily handled and planted, and have an acceptable success rate

relative to their cost. Tree cells would be planted in the fall and would be hand-watered immediately following planting. Tree cells would be planted at a density of 250 trees per acre.

Existing low-growing turf grasses would not be removed in proposed planting areas because these grasses are not likely to compete with planted trees and would hold soils in place until the planted trees become established.

Zone 3 would be sprayed with herbicide and disced in late winter using a small tractor in order to remove existing vegetation and ready the soil for native seed mix. Application of herbicide within 30 feet of surface waters would be conducted with a sponge applicator to avoid overspray. Herbicide would not be applied within 10 feet of surface waters, and all exotic species in these areas would be removed by hand. The area would then be planted with a native seed mix using a broadcast spreader and covered with coconut fiber mats to reduce erosion and loss of seed to foraging animals. Precautions to avoid damaging existing riparian habitat and mature trees during site preparation would be taken.

All planting zones would include temporary irrigation systems and temporary exclusion fencing. Irrigation would be installed using a system of pipes, drip lines, and spray emitters. Water would be taken from city lines because potential impacts on fountain darters would preclude the use of portable pumps set up in the river. Meters would be installed to track water use, and the City of San Marcos would be given credit for water used at the same rates that residents are charged. This would be considered a sponsor credit because irrigation would occur as part of the initial construction. Irrigation lines would be run from city water meters to planting areas, and progressively smaller pipes would be extended to plants. Spray emitters would be used where space allows (generally within areas planted with native seed mix), and narrow corridors of plantings would be irrigated using drip emitters (generally in areas where native trees or shrubs would be planted). Post-and-cable fencing and signage would be installed around all planted areas to prevent pedestrian traffic and vandalism.

4.2.3 Initial Construction (RIP2)

Under RIP2, riparian forest would be restored as identified in RIP1 (see Figures 4-2a and 4-2b) with the inclusion of approximately 1.05 acres of impervious, improved lands in the riparian corridor (Figures 4-5a and 4-5b) (Appendix F, Table F-3d). Impervious surfaces include a pavilion, a basketball court, sidewalks, and parking areas. Impervious surfaces would be

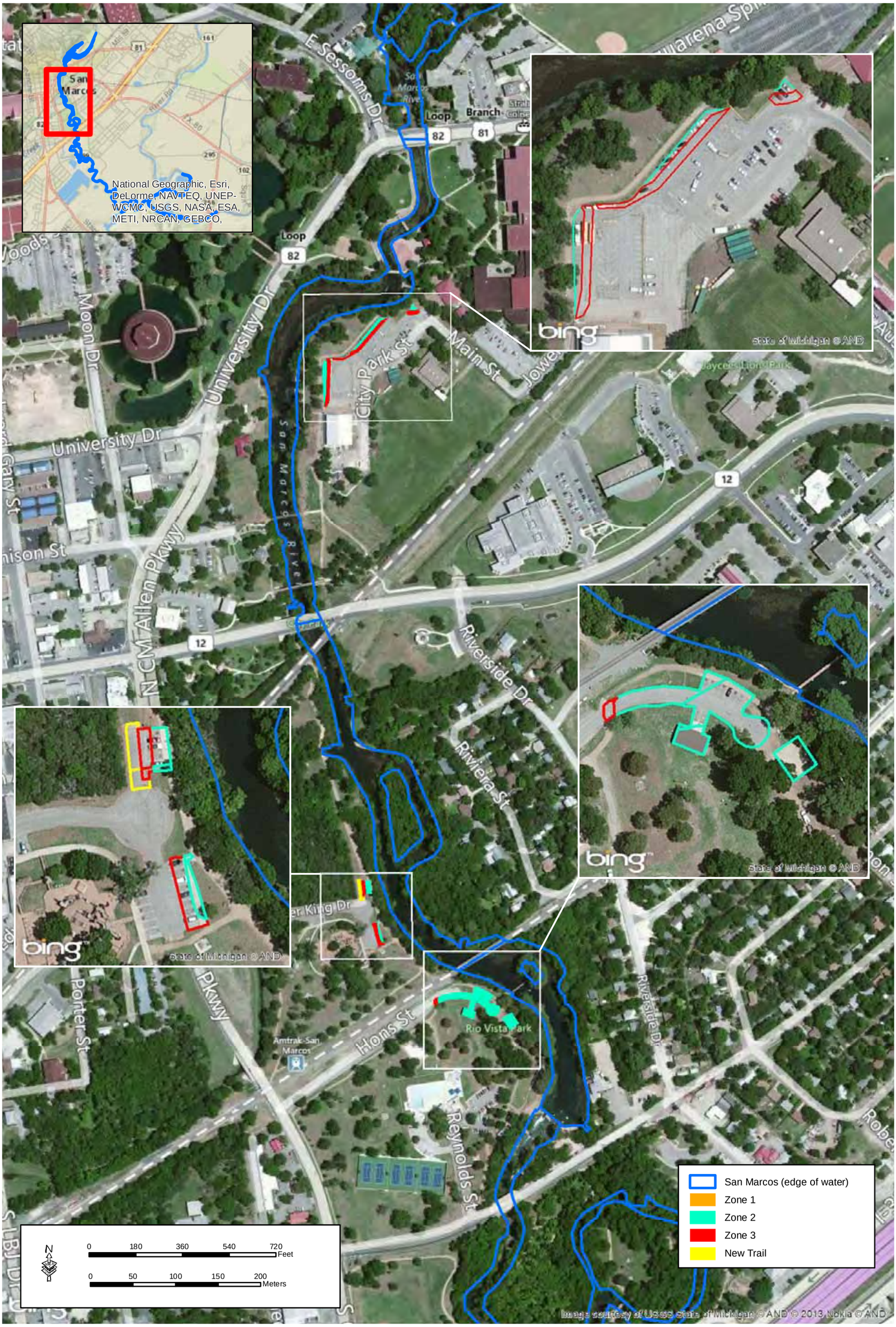

Figure 4-5a. Restore Riparian Corridor on Impervious Improved Lands (RIP2)

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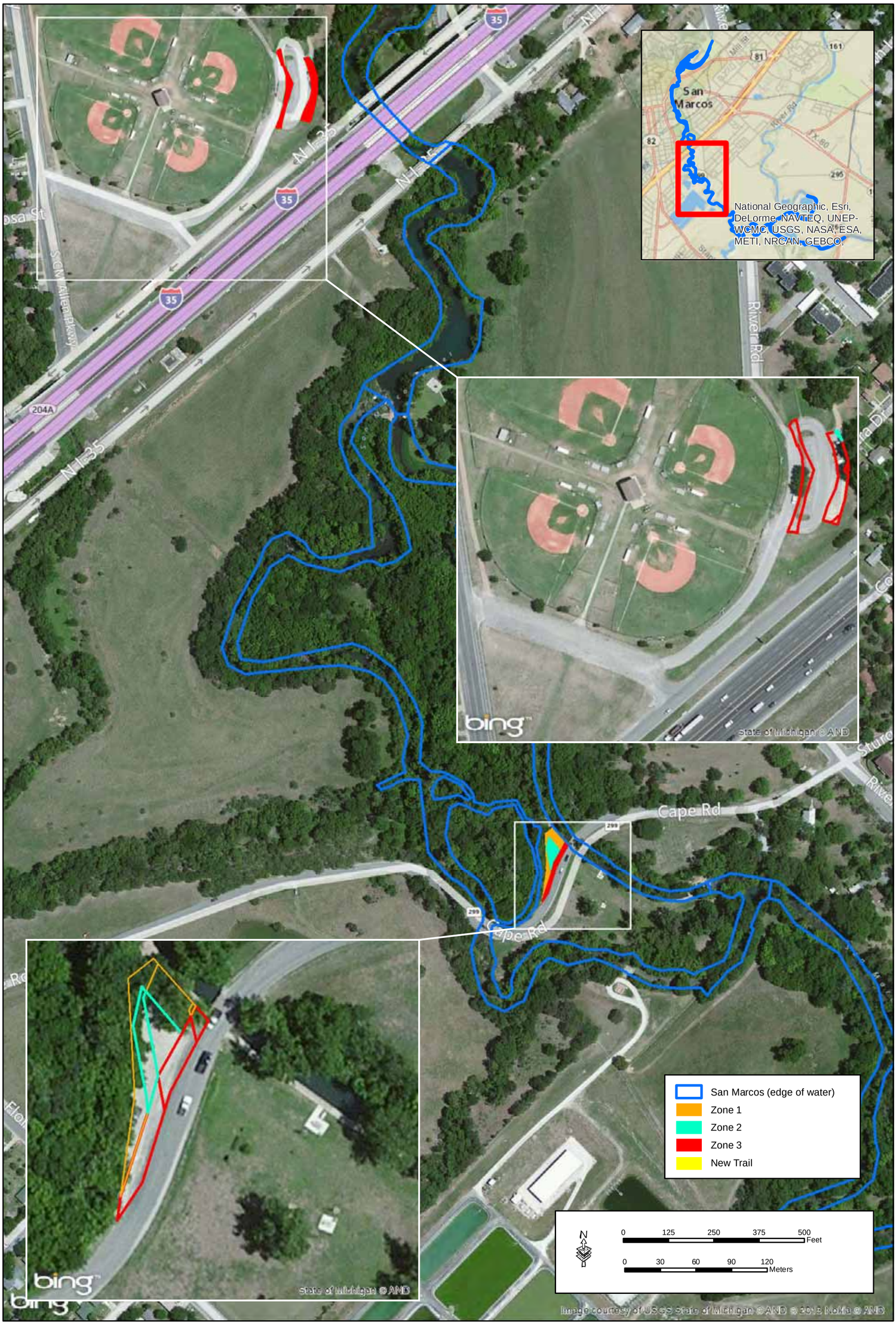

Figure 4-5b. Restore Riparian Corridor on Impervious Improved Lands (RIP2)

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removed and disposed of at a local landfill or stored by the City of San Marcos to be used as future non-aquatic fill material. Existing parking areas (i.e., approximately 80 spaces) would be removed from City Park, Lucio Park, and a popular access point along Cape Road. Best Management Practices (BMP), irrigation, and exclusion-fencing would be implemented similar to RIP1. The extent of planting zones was established using a GIS, with Zones 1, 2, and 3 totaling 0.06, 0.51, and 0.45 acres, respectively. A total of 0.03 acre of new, pervious maintenance trails would be constructed at locations further from the river than existing trails, which would be removed.

4.2.4 3-year Establishment Period (RIP1 and RIP2)

Each area would be monitored annually during the 3-year establishment period (Appendix F, Table F-3b and F-3e) for function of irrigation systems and fencing, survival of plantings, establishment of nonnative invasive plants, and any damage caused by humans or wildlife. Any damage to irrigation, fencing, or signage would be repaired, dead planted trees would be replaced, and invasive exotic plants would be controlled using herbicide and hand removal. Maintenance of native vegetation would be achieved through a site-specific, adaptive process of replacing lost plants with species proving successful at that location. Irrigation would be maintained and operated primarily during the summer months, and repairs would occur as needed.

4.2.5 OMRR&R (RIP1 and RIP2)

Long-term OMRR&R is assumed to be minimal (Appendix F, Table F-3c and F-3f). Each area would be monitored twice during this period, once at TY15 and again at TY25. It is assumed that herbicide applications would be required to ensure maintenance of assumed benefits, but no additional plantings would be necessary. In order to provide access for OMRR&R, sidewalks removed under this measure would be replaced with trails to be located further from the river.

Replacement trails would be constructed along the westward edge of the expanded riparian zone according to USACE guidelines presented in EM 1110-2-1902. Trail construction would include limited grading to remove existing, maintained turf grass, placement of a weed barrier over the soil, and placement of a trail suitable aggregate mix.

4.2.6 Assumed Benefits (RIP1 and RIP2)

It was assumed that the basal area of Type 5 forest would be 5 square meters per hectare (m^2/ha) at TY15, 10 m^2/ha at TY25, and 20 m^2/ha at TY50 (Appendix B, Table B-2). It was assumed that the number of snags per acre in Type 5 forests would be 0 at TY1 and TY15, 2 at TY25, and 5 at TY50. The plants established in Zone 3 would not be trees and would not be utilized directly by downy woodpecker. However, this zone and the associated species pallet is an important part of maintaining the structure of the interior portions of the mature riparian forest. If Zone 3 were excluded from the restoration design and maintained grasslands or trails were located immediately adjacent to the restored forest, then it is expected that an edge habitat composed of species similar to those planted in Zone 3 would become established and replace the planted trees. The edge habitat would not be used directly by the downy woodpecker. Therefore, it was assumed that Zone 3 is necessary to achieve the assumed benefits of the restored forest and it was evaluated as part of that forest.

The aquatic habitats of the San Marcos River and listed species would also benefit from this measure; however, these benefits were not captured by the HSI models. Relocating trails and increasing the buffer between recreation and the river would reduce access and result in a reduction of localized disturbances and erosion. The increased width of the riparian buffer would also reduce both windblown detritus and pollutants carried in surface runoff from entering the river.

4.3 CONTROL OF EXOTIC AQUATIC VEGETATION-EMERGENT (EXOA)

4.3.1 Initial Construction

Of the approximately 16 exotic aquatic plant species known to occur on the San Marcos River, elephant ear has relatively substantial adverse effects on the ecosystem (Photograph 4-1). Elephant ear also occurs in relatively monotypic stands, allowing its removal without disturbance to existing native vegetation. Elephant ear located adjacent to City of San Marcos-owned land would be systematically

Photograph 4-1. Exotic Elephant Ear and Water Hyacinth in the San Marcos River

removed one patch at a time starting at the upstream end of the project corridor (Figures 4-6a and 4-6b). In order to reduce the total area of disturbance at any given time, annual removal efforts would be limited to an area equal to 33 percent the current extent of established elephant ear. Thus, at the end of the first year of implementation, 67 percent of the current extent of elephant ear would remain untreated.

Removal would occur between March 1 and June 30 to allow for successful establishment of native plants. Elephant ear would be removed by hand using a shovel or spade, and an effort would be made to remove the whole plant, including rhizomes. Excess sediment and plant materials would be disposed of on City of San Marcos property and recycled by the City for future use as upland fill. The area would immediately be replanted with locally acquired native species suited to the local conditions and could include Texas wild-rice, creeping primrose willow (*Ludwigia repens*), delta arrowhead (*Sagittaria platyphyla*), lizard's tail (*Saururus cernuus*), Illinois pondweed (*Potamogeton illinoensis*), grassleaf mudplantain (*Heteranthera dubia*), and soft stem bulrush (*Schoenoplectus tabernaemontani*). Plants would be grown in cells (2 by 2 by 8 inches) and planted at a density of 1,000 plants per acre. The plantings must have a sufficient root depth to ensure establishment without irrigation. Holes would be dug with a dibble, granular fertilizer would be placed near each hole at recommended rates, and each planting would be hand-watered to ensure sufficient contact between the roots and soils.

BMPs to reduce erosion and sedimentation into the river would include a silt fence or comparable barrier erected around each area during removal of elephant ear and establishment of native vegetation. Conservation measures identified through formal consultation with the USFWS would be implemented and would include (1) avoiding and minimizing erosion through use of erosion mats and properly installed silt fences, (2) selection of herbicides that are unlikely to affect (a) Texas wild-rice, (b) other non-target aquatic vegetation, (c) fountain darters, or (d) fountain darter prey, (3) diligent and careful hand application of herbicides, (4) using elephant ear control methods that will have the least impact on the river and its biota, and (5) ongoing communication with TPWD and USFWS to help ensure minimal adverse effects from restoration measures. In addition, biologists permitted by the USFWS and TPWD would clear fountain darters from the work area and carefully move fountain darters to nearby areas with plant cover.

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Figure 4-6a. Control of Exotic Aquatic Vegetation - Emergent (EXOA)

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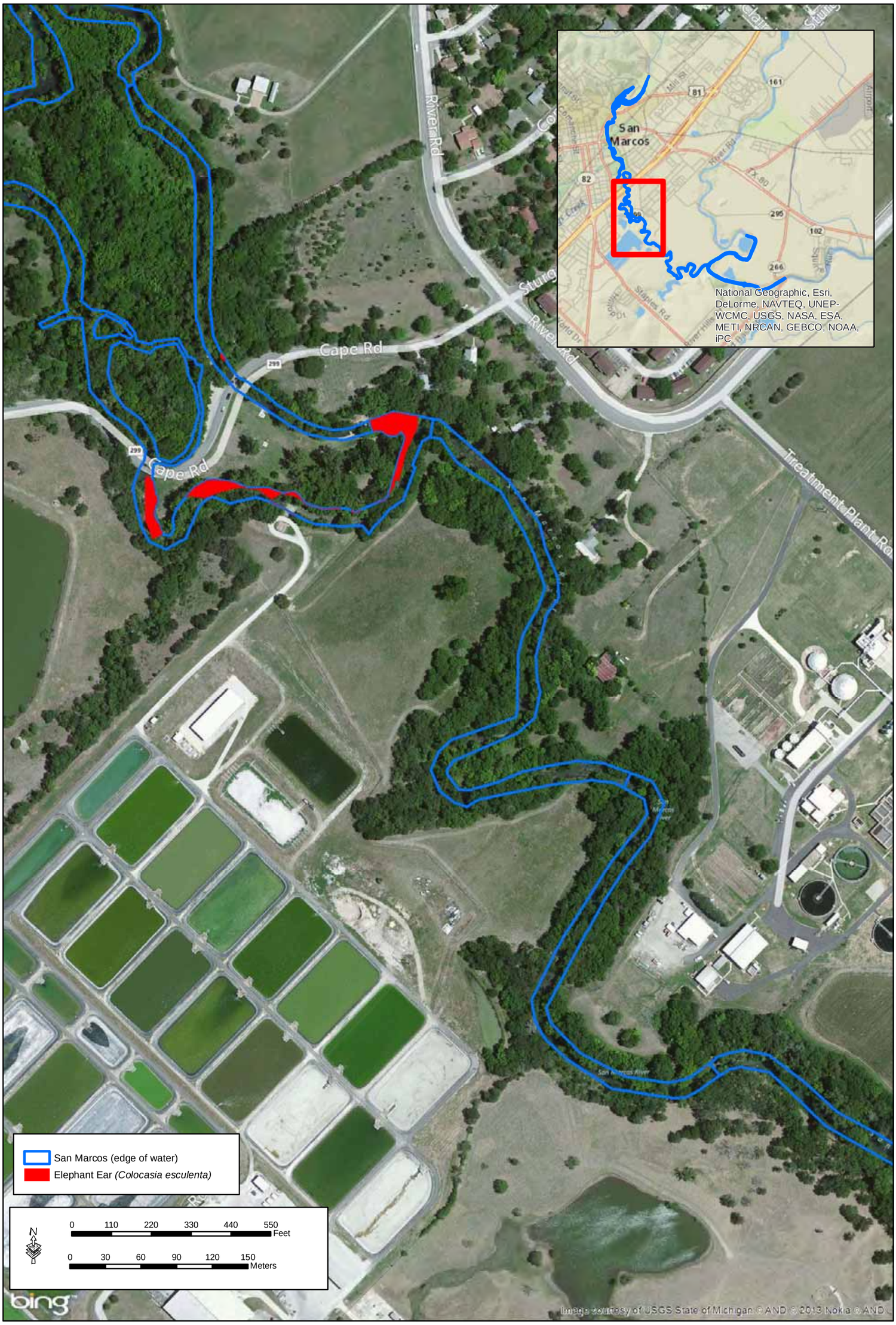

Figure 4-6b. Control of Exotic Aquatic Vegetation - Emergent (EXOA)

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Three additional reasonable and prudent measures (RPM) were identified through consultation and would be implemented: avoidance (RPM1), monitoring (RPM2), and maintenance of the coverage of submergent aquatic plants (RPM3). Where avoidance of Texas wild-rice and fountain darters is not practical, the USACE and the City will minimize the disturbance in space and time. BMPs to improve the water quality of stormwater shall be employed. All monitoring will include reporting of appropriate and relevant information to the USFWS and TPWD in a timely manner. The USACE and the City of San Marcos would ensure that the coverage of submergent aquatic plants is not permanently reduced by the restoration activities. The USACE would plant a commensurate coverage of native submergent plants within 1 year of removing or destroying any rooted macrophytes.

4.3.2 3-year Establishment Period

Measures used to control elephant ear during the initial construction effort would be repeated during TY2 and TY3 (Appendix F, Table F-4b), with half the remaining elephant ear controlled in TY2 and the last remaining stands of elephant ear treated in TY3 (Appendix F, Table F-4b).

4.3.3 Long-term Operation and Maintenance

Long-term OMRR&R would include monitoring every 5 years to document survival of plantings, establishment of nonnative invasive plants, and any damage caused by humans or wildlife. Any damage to fencing or signage would subsequently be repaired, dead plants would be replaced, and invasive exotic plants would be controlled using hand removal. Maintenance of native vegetation would be achieved through a site-specific, adaptive process of replacing lost plants with species proving successful at that location. All BMPs would be implemented where necessary.

4.3.4 Assumed Benefits

It is assumed that EXOA would result in restoration of native riverine habitats at TY1 and continue throughout the life of the project (Appendix B, Tables B-3 through B-5). These habitats are assumed to have the same suitability as existing adjacent riverine habitats. Removal of elephant ear would not only result in an increased area of suitable riverine habitats, but would increase suitability of native riverine habitats by improving foraging conditions for both smallmouth bass and belted kingfisher (Appendix B, Tables B-4 and B-5). This measure would also benefit listed species by restoring portions of the channel invaded by elephant ear to native habitats. There is evidence to suggest that fountain darters prefer native vegetation over some

nonnative plant species, and that Texas wild-rice once occurred in portions of the channel now occupied by elephant ear.

4.4 RESTORE SHORELINE (SHORE1 AND SHORE2)

4.4.1 Scales of Implementation

Two scales were considered for the development of the SHORE. SHORE1 would result in restoration of the shoreline by stabilizing areas of erosion. SHORE2 would include all of the restoration features of SHORE1 and would remove recreational headwalls at two locations and concrete debris from an area of the river channel near the shore.

4.4.2 Initial Construction (SHORE1)

SHORE1 includes recontouring or stabilizing areas of shoreline degraded by repeated recreational use (Photograph 4-2), planting native plants and emergent wetland vegetation, and constructing recreational access structures at preferred locations (Figures 4-7 through 4-9).

Photograph 4-2. Area of Degraded Shoreline Where SHORE1 Is Proposed

Approximately 0.34 acre (Appendix F, Table F-5a) of degraded shoreline would be contoured, where necessary, using USACE guidelines and standards (EM 1110-2-1902) and planted with locally acquired native vegetation as described above for EXOA (see Figures 4-7 and 4-8). Contouring and stabilizing the degraded areas would likely involve the deposition of riprap or other fill material. Native seed mix would be scattered and covered with coconut fiber mats to control erosion. Containerized plants would be planted through the coconut fiber mat. The wetland vegetation as described in EXOA would be planted near the river's edge while other more prohibitive species would be planted along the upper portion of the contoured shoreline. The prohibitive species could include saw greenbrier, Turk's cap (*Malva viscusdrummondii*), American beautyberry (*Callicarpa americana*), switchgrass (*Panicum virgatum)*, eastern mock grama (*Tripsacum dactyloides),* native prickly pear (*Opuntia* spp.), and native yucca (*Yucca* spp.). These plants would be established in apparently natural arrangements and provided with temporary irrigation, as described in Section 4.2.2.

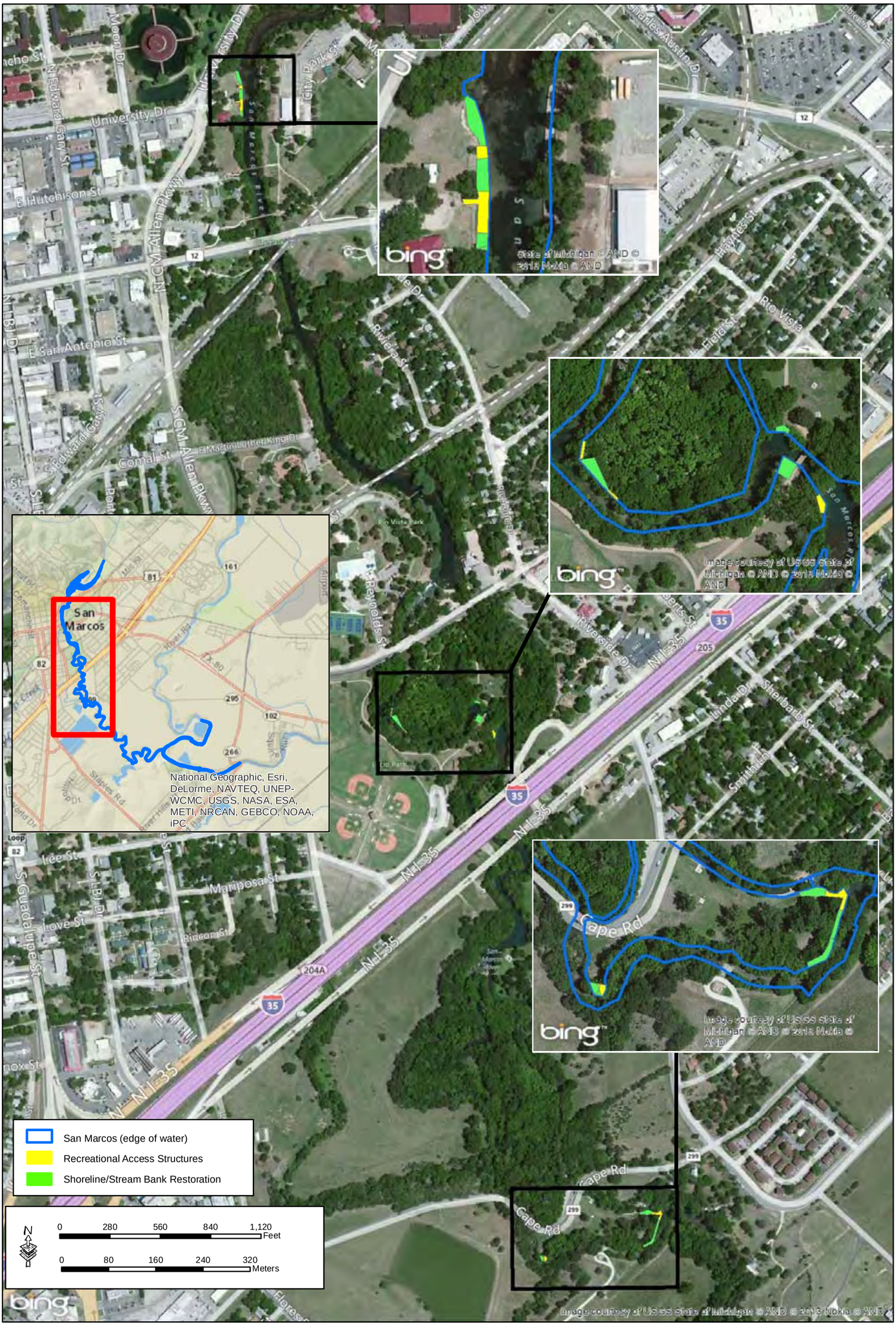

Figure 4-7. Shoreline Restoration (SHORE1)

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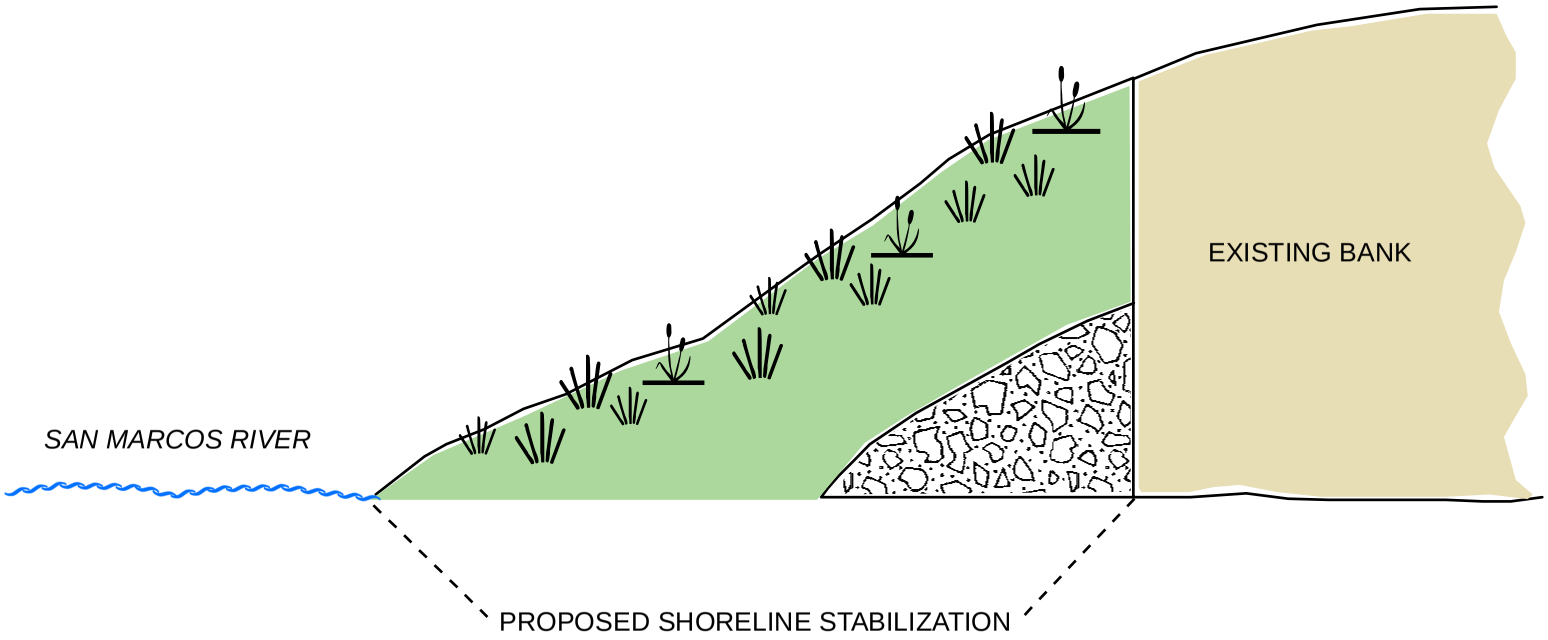

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Figure 4-8. Conceptual Illustration of Shoreline Stabilization (SHORE)

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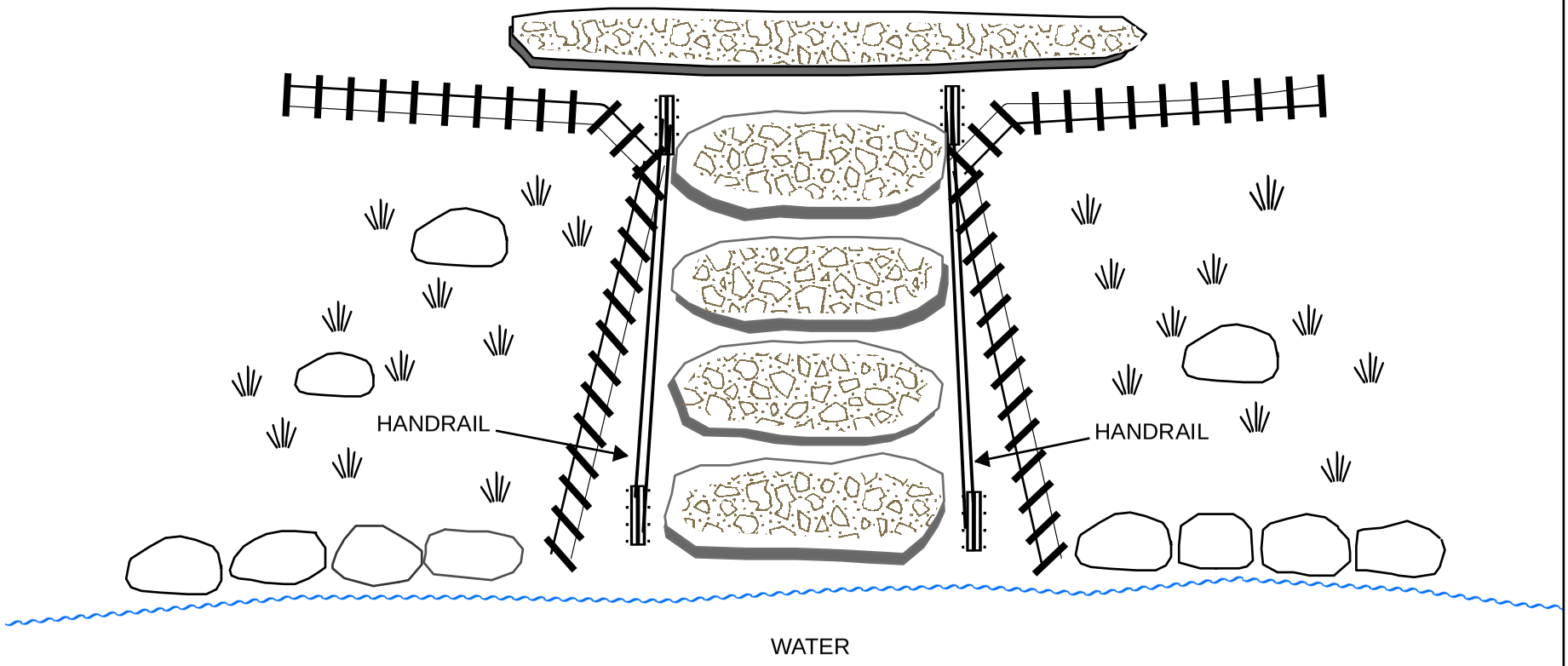

Fencing

Natural Stone Steps

Proposed Planting of Eroded / Denuded Areas

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Figure 4-9. Conceptual Illustration of Recreational Access / Step-down (SHORE)

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A total of seven locations of existing degraded San Marcos River shoreline totaling 0.012 acre have been identified for construction of access structures (see Figure 4-7). Recreational access would be controlled through deterrence and redirection. Several locations within the study area have been identified as areas that are frequently used by recreationists and where recreation would not impact existing stands of Texas wild-rice. These locations were selected using a GIS to compare the location of heavy recreational use recorded in the field with the distribution of Texas wild-rice analyzed by Kristina Towers (Towers 2009). At these locations, step-downs consisting of large natural stones set into the bank would be constructed to allow access without damage to the shoreline or endemic species (see Figure 4-9). Recreational access structures would be designed according to USACE standards presented in EM-1110-2-410, including the use of appropriate safety features (i.e., guards and handrails). Signage would be erected near parking lots and along trails to direct recreational users to areas where step-downs would be installed.

4.4.3 Initial Construction (SHORE2)

Under SHORE2, approximately 0.087 acre of hard structures identified as impervious improved lands occurring along the banks (0.044 acre) or within the river channel (0.023 acre) would be removed and replaced with native habitats along Reaches 4, 5, 6, 7, and 10 (Figure 4-10) (Appendix F, Table F-5d). Two concrete headwalls, one in City Park and one immediately north of the bridge leading to Cypress Island (Photographs 4-3 and 4-4), would be removed using a backhoe. The two headwalls are assumed to be hardened access structures and occur in association with recreational features such as parking lots, parks, the Lion's Club tube rental, and Cypress Island. They each occur on relatively straight portions of the channel with relatively level surrounding floodplains, and there are no outlets or large bridges directly associated with these headwalls. The headwalls appear to have been designed for fishing and not for any hydrologic measure.

Photograph 4-3. Concrete Headwall Proposed for Removal

Photograph 4-4. Concrete Headwall Proposed for Removal

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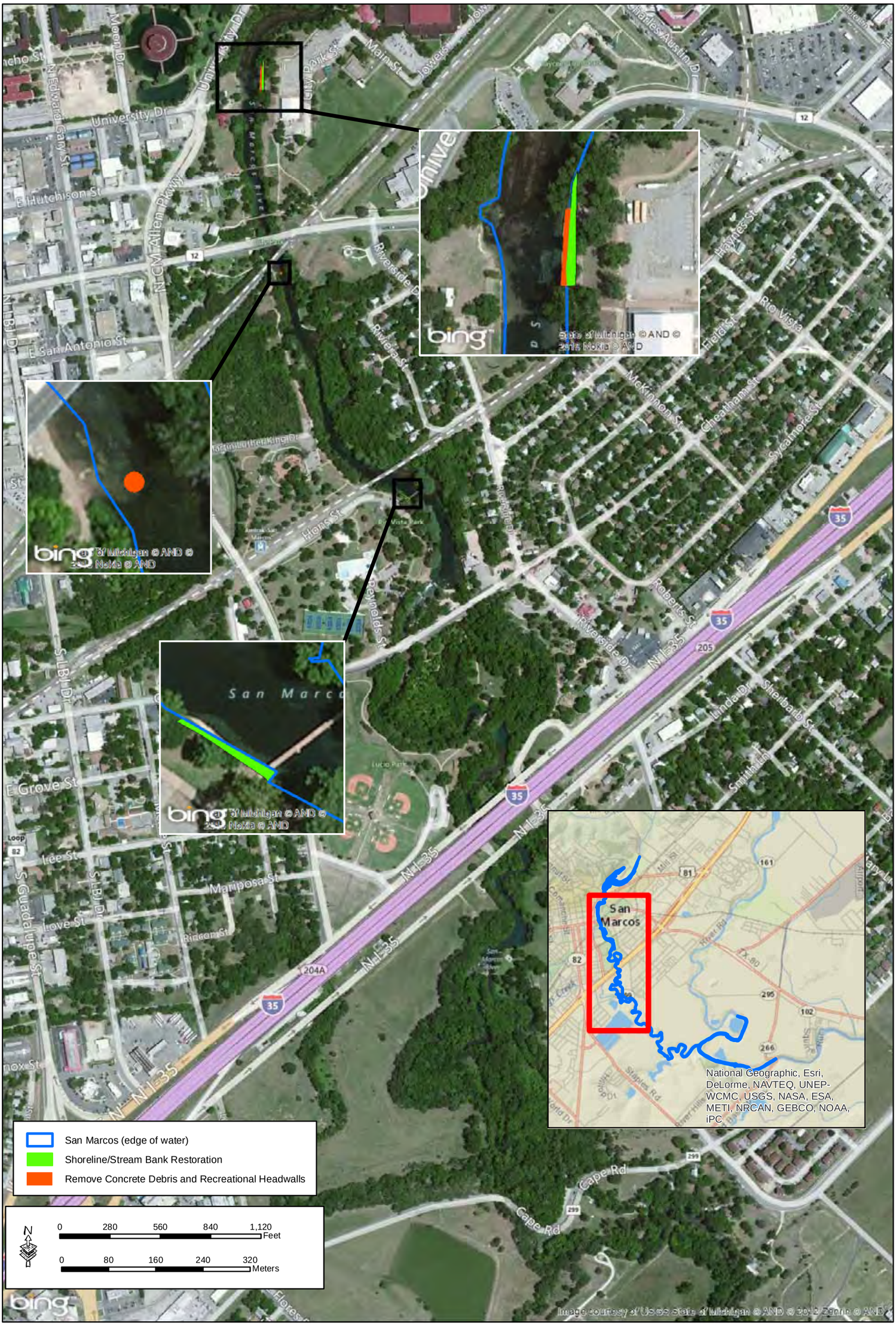

Figure 4-10. Shoreline Restoration on Impervious Improved Lands with Natural Shoreline (SHORE2)

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Following removal of the headwalls, the area would be stabilized using methods similar to those described above in Section 4.4.2 (see Figure 4-8). Concrete would be recycled and any excess cut material would be used for other project features or disposed of on city property to be recycled by the city for future use as non-aquatic fill. A silt fence or comparable barrier would be erected around each area prior to removal of hard structures to prevent erosion and sedimentation. Removal of instream hard structures would occur between March 1 and June 30 to allow for success of subsequent plantings. Monitoring and maintenance of planted areas would occur using the same materials and methods described for EXOA.

4.4.4 3-Year Establishment Period (SHORE1 and SHORE2)

Each area would be monitored annually during the 3-year establishment period (Appendix F, Tables F-5b and F-5e) for function of stabilized shorelines, survival of plantings, establishment of nonnative invasive plants, and any damage caused by humans or wildlife. Any damage to shorelines, fencing, or signage would be repaired, dead planted trees would be replaced, and invasive exotic plants would be controlled using herbicide and hand removal. Maintenance of native vegetation would be achieved through a site-specific, adaptive process of replacing lost plants with species proving successful at that location.

4.4.5 Long-term Operation and Maintenance (SHORE1 and SHORE2)

Due to the high frequency of recreational use in these areas, long-term OMRR&R would include monitoring every 5 years, starting at TY5, to identify any damage to steps or plantings. It is assumed that each access step would be entirely repaired or replaced once over the life of the project, and that every 5 years, 10 percent of each area of planting would be treated for exotic invasive plants and 10 percent of plants would be replaced (Appendix F, Tables F-5c and F-5f). All BMPs would be implemented as necessary during OMRR&R.

4.4.6 Assumed Benefits (SHORE1 and SHORE2)

The benefits of SHORE1 were assumed to be similar to those occurring under RIP, and restored riparian forest evaluated as Type 5 forest habitats with benefits accruing over the life of the project as described for RIP (Appendix B, Table B-2). It was assumed that the headwalls and the debris would be replaced with riverine habitat providing the same habitat value as the surrounding reach (Appendix B, Tables B-3 through B-5).

The implementation of SHORE1 and SHORE2 would also provide substantial local benefits to listed species as a result of redirecting and minimizing recreational impacts. Stabilizing these small areas of shoreline and reducing overall recreational disturbance would also reduce the volume of pollutants entering the river following storm events. Although these short-term pulses have a small local effect that would not be evaluated by HSI models, these conditions could adversely affect listed species.

4.5 CONTROL OF DISCHARGE (DISC)

4.5.1 Initial Construction

This measure would include improving stormwater discharge at 12 locations on 2.10 acres along the San Marcos River according to USACE standards presented in ERDC/CHL TR-01-28 and EM 1110-2-1902 (Figure 4-11). The contour and path of existing drains (Photograph 4-5) would be modified to reduce the velocity of flows and allow for capture of sediments and pollutants prior to discharge into the river. Modified drainages would mimic natural, self-sustaining systems to the extent practicable within existing site-specific constraints (Hoag and Fripp 2002). Improvements would include terracing, creation of vegetated swales, use of wattles, riffle dams, and other soil bioengineering techniques to stabilize drainages and remove sediments and pollutants carried in runoff prior to discharge into the San Marcos River (see Figure 4-11). Long-term erosion control designs include placement of rock or boulders to reduce flow velocity. Planting of native vegetation would occur using the same methods and materials used for shoreline improvements and Zone 2 riparian improvements, and would also include willow poles and wattles. Temporary erosion control (i.e., matting, bales, and silt fence) would be erected during contouring to prevent additional erosion and sedimentation into the San Marcos River, and post-and-cable fencing would be used to deter human disturbance.

Photograph 4-5. Example of Existing Drain Requiring Improvement

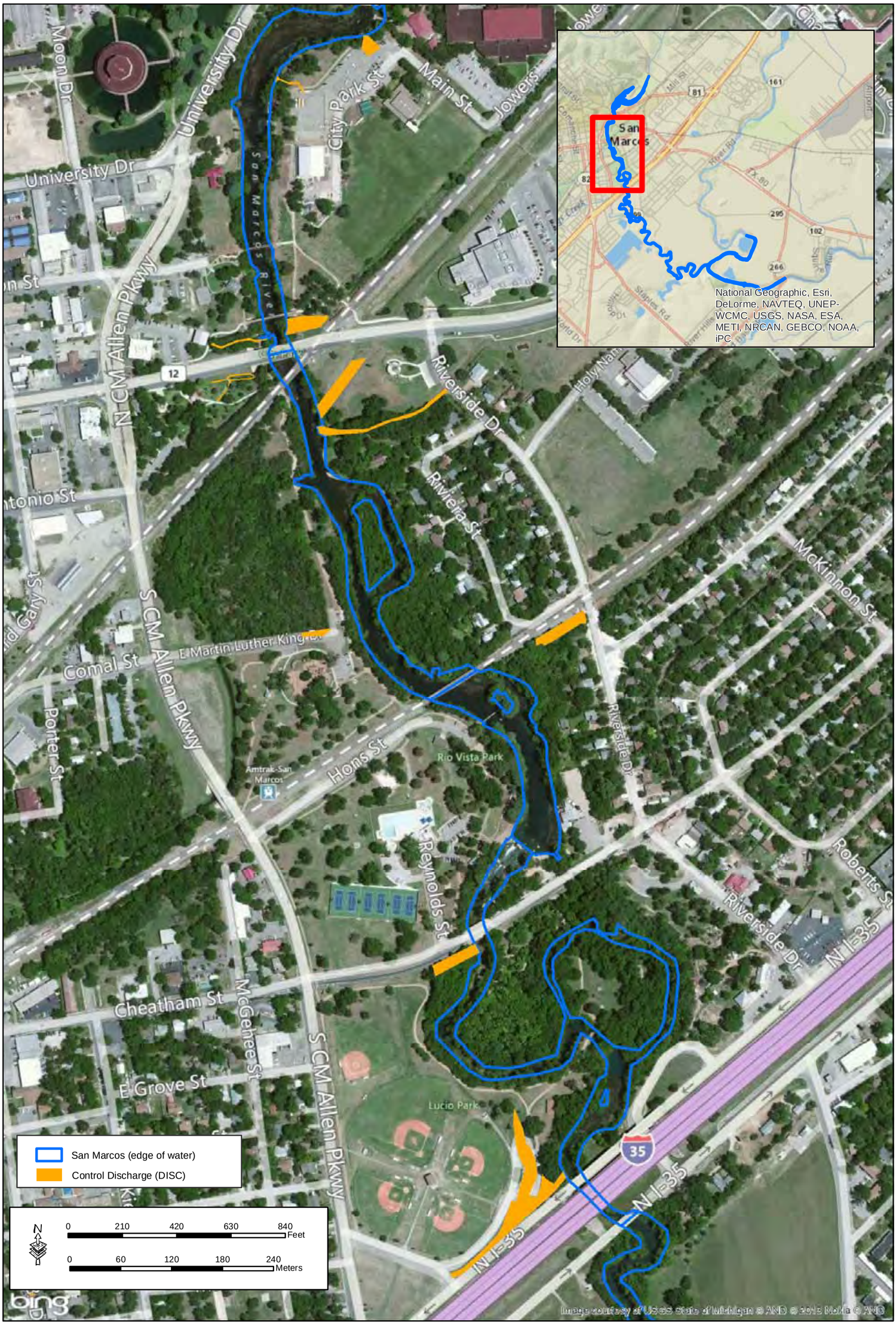

Figure 4-11. Restoration of Riparian Zone at Discharge Locations (DISC)

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4.5.2 3-year Establishment Period

Each area would be monitored annually during the 3-year establishment period (Appendix F, Table F-6b) for function of restored drainages, survival of plantings, establishment of nonnative invasive plants, and any damage caused by humans or wildlife. Any damage to shorelines, fencing, or signage would be repaired, dead planted trees would be replaced, and invasive exotic plants would be controlled using herbicide and hand removal. Maintenance of native vegetation would be achieved through a site-specific, adaptive process of replacing lost plants with species proving successful at that location.

4.5.3 Long-term Maintenance

Due to the highly dynamic nature of these areas, long-term OMRR&R would include monitoring every 5 years, starting at TY5, to identify any damage to or reduced function of the improved drains (Appendix F, Table F-6c). It is assumed that some debris removal would occur every 5 years and that each drain would be entirely replaced over the life of the project. It was assumed that natural vegetation would become established and only herbicide application would be necessary to maintain assumed benefits. All BMPs would be implemented as necessary during OMRR&R.

4.5.4 Assumed Benefits

Similar to SHORE and RIP, it is assumed that habitats providing the same benefits as Type 5 forests would be restored where DISC is implemented and that HUs would accrue at the same rate described for Type 5 forest under implementation of RIP (Appendix B, Table B-2). It is also assumed that DISC would reduce future input of suspended sediments to the San Marcos River (Appendix B, Tables B-3 and B-4). It is assumed that the DISC improvements proposed at locations throughout the study area would be sufficient to affect the relative composition of substrates (coarse vs. fine) within the channel. DISC would also reduce the magnitude of pollutant concentrations following storm events, which would benefit listed species similar to SHORE.

4.6 REMOVAL OF ACCUMULATED SEDIMENTS (SED)

4.6.1 Initial Construction

Fine sediment would be removed from the river channel through use of hydrosuction. Sediment would be suctioned through a polyvinyl chloride (PVC) pipe approximately 4 inches in diameter

using a 5-horsepower pump, and the PVC pipe would be covered by a mesh screen of the minimum practical size that work, starting with a 0.5-inch mesh, to minimize suctioning biota. If a 0.5-inch mesh screen is not practical, a mesh screen as large as 1.0 inch may be used on the end of the PVC pipe. The sediment would then flow through a hose and would be released into a tank. Water would be drained from the removed sediment, clarified in a stilling basin, and returned to the river. The drained sediment will be removed from the restoration area and handled and stored at the City of San Marcos Animal Shelter, where the City routinely stores and handles excess fill and compostable materials, for future non-aquatic fill material. Sediment removal would occur throughout the river where endemic species would not be affected. There are currently 25.42 acres of riverine habitat affected by accumulated sediment (Appendix B, Tables B-3 through B-5); however, sediment accumulation currently occurs on approximately 20 percent of the river channel. Priority areas for dredging were identified through coordination with the USFWS and these areas total 4.75 acres in area (Figure 4-12). It was assumed that 1.58 acres, or one third of the priority areas, would be dredged during each year of the establishment phase. Following the establishment phase, up to 1.58 acres would be dredged every 5 years, but could occur anywhere in the river that sediment accumulation occurs (Appendix F, Table F-7a). Sediment removed from the channel would be disposed of on city property and recycled by the City of San Marcos for future non-aquatic fill material.

Conservation measures identified through formal consultation with the USFWS would be implemented and include: (1) avoiding and minimizing erosion through use of erosion mats and properly installed silt fences, (2) selection of herbicides that are unlikely to affect (a) Texas wild-rice, (b) other non-target aquatic vegetation, (c) fountain darters, or (d) fountain darter prey, (3) diligent and careful hand application of herbicides, (4) using elephant ear control methods that will have the least impact on the river and its biota, and (5) ongoing communication with TPWD and USFWS to help ensure minimal adverse effects from restoration measures. In addition, biologists permitted by the USFWS and TPWD would clear fountain darters from the work area and carefully move fountain darters to nearby areas with plant cover.

Three additional reasonable and prudent measures (RPM) were identified through consultation and would be implemented: avoidance (RPM1), monitoring (RPM2), and maintenance of the coverage of submergent aquatic plants (RPM3). Where avoidance of Texas wild-rice and fountain darters is not practical, USACE and the City will minimize the disturbance in space and time. BMPs to improve the water quality of stormwater shall be employed. All monitoring will

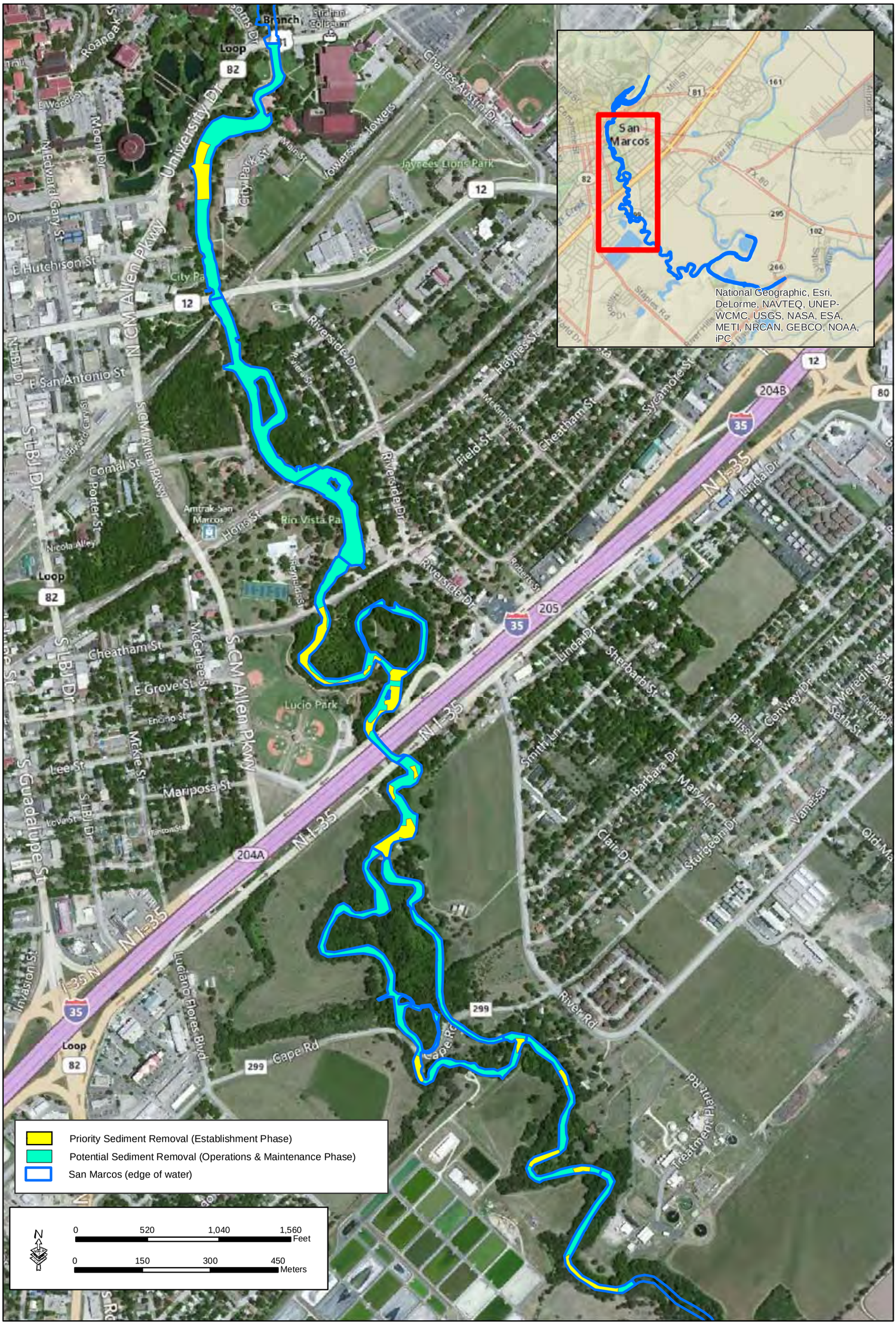

Figure 4-12. Sediment Removal (SED)

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include reporting of appropriate and relevant information to the USFWS and TPWD in a timely manner. The USACE and the City of San Marcos would ensure that the coverage of submergent aquatic plants is not permanently reduced by the restoration activities.

4.6.2 3-year Establishment Period

It was assumed that 20 percent of the river channel would be dredged each year as described for initial construction and that BMPs would be implemented (Appendix F, Table F-7b).

4.6.3 Long-term Maintenance

Due to the highly dynamic nature of sediment accumulations, long-term maintenance would require monitoring every 5 years beginning at TY5 to identify areas of accumulating sediment (especially those areas impacting endemic species). It is assumed that the initial sediment removal efforts would be repeated following each survey (Appendix F, Table F-7c).

4.6.4 Assumed Benefits

It is assumed that SED would affect the relative composition of substrates (coarse vs. fine) throughout the entire study area over the life of the project (Appendix B, Tables B-3 and B-4), thus improving the quality of substrates for foraging conditions of the selected HSI model species. It was assumed that implementation of DISC and SED would have a cumulative effect on substrates, resulting in a greater improvement than implementation of either measure by itself. It is assumed that Texas wild-rice prefers the coarse substrates, which were historically predominant in the study area, for establishment; thus, SED would provide a substantial benefit to Texas wild-rice.

4.7 RESTORATION OF WETLANDS (WET)

4.7.1 Initial Construction

WET would involve restoration of approximately 0.08 acre of wetland habitats on a backwater channel of the San Marcos River (currently not functioning as wetland habitat) and approximately 1.11 acres of wetland habitats in the form of a series of in-line wetponds on Sessoms Creek (Figure 4-13) (Appendix B, Tables B-6 and B-7). All wetland measures would be designed according to USACE guidelines presented in EM 1110-2-1205, EM 1110-2-1902, and ERDC/CHL TR-01-28.

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Figure 4-13. Restoration of Wetlands (WET)

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An area south of Cheatham Street was identified that could be restored to wetland habitat in Reach 7 (Photograph 4-6). This area was previously excavated to develop a wetland for the purpose of filtering stormwater runoff. It does not currently provide suitable habitat because it does not support emergent vegetation. This area is hydrologically connected to the San Marcos River via a small channel that runs alongside Rio Vista Dam. This backwater area fills with water as elevation of the San Marcos River rises and only reconnects downstream during heavy rain events. Habitat suitability could be improved by excavating the area to a depth approximately 1 foot below normal surface water elevation with 4:1 side slopes, removing nonfunctional concrete structures, and constructing a flap-gate to capture backflows as water levels recede. Excess cut material not used on-site would be disposed of at a local landfill and utilized in the future by the City of San Marcos for non-aquatic fill. There is a limited area available for restoration of wetland habitats at this location; thus, only one scale of implementation was considered.

Photograph 4-6. Proposed Wetland Restoration South of Cheatham Street

A series of three in-line wetponds would be constructed to capture stormwater runoff in the Sessoms Creek drainage approximately 2,000 feet upstream of the San Marcos River (see Figure 4-12). This would require clearing of trees and excavation to a depth of approximately 2 feet with 4:1 side slopes. Trees would be disposed of at a suitable location and soils would be used on-site to construct containment berms and earthen dams to a height of approximately 1 foot. An armored spillway with flow dampening features would be constructed at the downstream end of each wetpond. The shoreline of these wetponds would be planted with native vegetation using the same methods described for EXOA. Access to this site would require construction of a temporary road, which would require minimal grading and tree removal. Erosion control features (i.e., fencing, bales, and mats) would be used during construction to prevent sedimentation and erosion into the San Marcos River. Native vegetation would be established along the perimeter of each wetland habitat using the same methods and materials described for SHORE. Protective fencing would not be required, as the wetlands would be constructed in areas that are not frequented by the public.

4.7.2 3-year Establishment Period

Each area would be monitored annually during the 3-year establishment period (Appendix F, Table F-8b) for function of the flap-gate and spillway, erosion, survival of plantings, establishment of nonnative invasive plants, and any damage caused by humans or wildlife. Any damage to structures and erosion would be repaired, dead plants would be replaced, and invasive exotic plants would be controlled using herbicide and hand removal. Maintenance of native vegetation would be achieved through a site-specific, adaptive process of replacing lost plants with species proving successful at that location.

4.7.3 Long-term Operation and Maintenance

The wetlands are assumed to be relatively stable over the life of the project; however, wetlands would be monitored every 5 years beginning at TY5. It is assumed that repairs and replacements would require the equivalent of replacing all three spillways and the entire flap-gate structure over the life of the project. It is also assumed that sediment clearing equivalent to dredging to a depth of 6 inches over the entire wetland would occur once over the life of the project.

4.7.4 Assumed Benefits

It is assumed that construction, function, and habitat quality of wetlands restored under WET would be similar to the existing Sessoms Creek wetlands (Appendix B, Tables B-6 and B-7). It is assumed that habitat would be available at TY1 and would remain relatively constant through the life of the project. The removal of trees would be required for restoration of wetlands at the Sessoms Creek location; however, the surrounding forest at this location is an upland forest and the loss of these habitats is assumed to have no effect on the suitability of the surrounding forest.

4.8 EDUCATION (EDU)

4.8.1 Initial Construction and Long-term Operation and Maintenance

Signs would be erected near restoration and improvement projects to educate the public on the processes and explain the need for such projects in the study area (Appendix F, Table F-9a and F-9b). Permanent kiosks would be constructed near popular points of access, including City Park, Rio Vista Park, and John Stokes Park. These kiosks would provide information about the

endemic species of the San Marcos River and their habitats, as well as ways to avoid impacting these resources.

4.8.2 Assumed Benefits

There are no quantifiable benefits, as evaluated using selected models, that are assumed to occur as a result of education. However, it is assumed that EDU would result in reduced adverse impacts at a more localized scale and specifically to endemic species.

4.9 MANAGEMENT OF WATERFOWL (DUCK)

4.9.1 Initial Construction and Long-term Operation and Maintenance

Management of waterfowl would include removing and relocating or euthanizing resident waterfowl (Appendix F, Table F-10a). Target species would include feral domesticated species or wild nuisance species that have become acclimated to urban environments and are resident throughout the year (e.g., Canada geese [*Branta canadensis*], Muscovy [*Cairina moschata*], mallards [*Anas platyrhynchos*], and mallard hybrids). Individuals would be captured using live traps outside of the migratory season to avoid take of non-resident individuals. If possible, individuals would be relocated to agricultural ponds outside the study area. Otherwise, captured individuals would be euthanized by a veterinarian. All applicable permits and licenses would be obtained to ensure that laws regarding waterfowl are being followed. Annually during the life of the project, a single trapper would be employed for 1 week to set 30 traps per day at three locations and to relocate or deliver individuals for euthanizing (Appendix F, Table F-10b). It is assumed that up to 15 individuals would be captured each year (Appendix F, Table F-10c).

4.9.2 Assumed Benefits

There are no quantifiable benefits, as evaluated using selected models, that are assumed to occur as a result of the management of waterfowl. While nonnative waterfowl likely have resulted in some level of degradation of shoreline habitats in the riparian zone, this effect would be difficult to quantify. However, it is assumed that DUCK would result in reduced adverse impacts at a more localized scale and specifically to endemic species.

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SECTION 5.0
INCREMENTAL COST ANALYSIS

5.0 INCREMENTAL COST ANALYSIS

5.1 EVALUATION OF BENEFITS

Benefits were evaluated in AAHUs for each HEP model in each habitat type under each possible combination of measures (Appendix B, Table B-8). Benefits of project measures were evaluated as the difference between baseline AAHUs and AAHUs produced by each plan, or FWOP and future with project (FWP) AAHUs, respectively. A GIS was used to track the geographic extent of changes resulting from proposed measures, and an Excel™ database was used to calculate the effect of each possible combination of measures on HUs provided during each year of the project.

5.2 COST EVALUATION

Costs were evaluated for each of the nine possible restoration measures as Average Annual Cost Units (AACU). AACUs included costs related to lands, easements, rights of way, relocation, and disposal areas (LERRDS) (Appendix F, Table F-1); general construction; planning, engineering, and design (PED); construction management; interest during construction and profit; and OMRR&R (Appendix F, Tables F-2 through F-10). LERRDS costs are based on the June 2012 Real Estate Reconnaissance Estimate prepared in compliance with Engineering Circular 405-1-04, Section III (4-19). General construction costs include all labor with an overhead burden of 2.7 applied, materials, and equipment costs incurred during the first 3 years of the project, and OMRR&R costs include all costs incurred during the last 47 years of the project life. Quantities for general construction and OMRR&R features were measured using a GIS database, and prices are based on vendor quotes, internet-based estimates, and professional experience. An abbreviated cost risk analysis was conducted to calculate contingencies for each measure, for PED, and for construction management. First Cost was then calculated as LERRDS, general construction and contingency, PED and contingency, construction management and contingency, and 10 percent profit. Interest during construction was applied to the First Cost at an annual rate of 3.75 percent during the 3-year general construction period. Costs were assumed to be additive; thus, the cost of each plan is the sum of included restoration measures' costs.

5.3 INCREMENTAL COST/BENEFIT ANALYSIS

Incremental Cost Analysis (ICA) was performed using the USACE Institute for Water Resources Planning Suite Version 1.0.11.0, following guidelines presented in the *Evaluation of Environmental Investments Procedures Manual* (Robinson et al. 1995). Each unique measure combination is referred to as a plan. All possible combinations of measures were formulated using the "assemble all possible combinations of management measures" approach. The resulting 1,152 combinations of measures were then carried forward as alternative plans. To identify the cost-effective and non-cost-effective plans, all plans were sorted by Total AAHU production. Cost-effective plans are defined as those where greater benefit can be produced at a cost lesser or equal to that of previous plans. The ICA procedure identified 40 cost-effective plans from the 1,152 plan alternatives (Appendix G, pages 1 and 2 and Figure G-1).

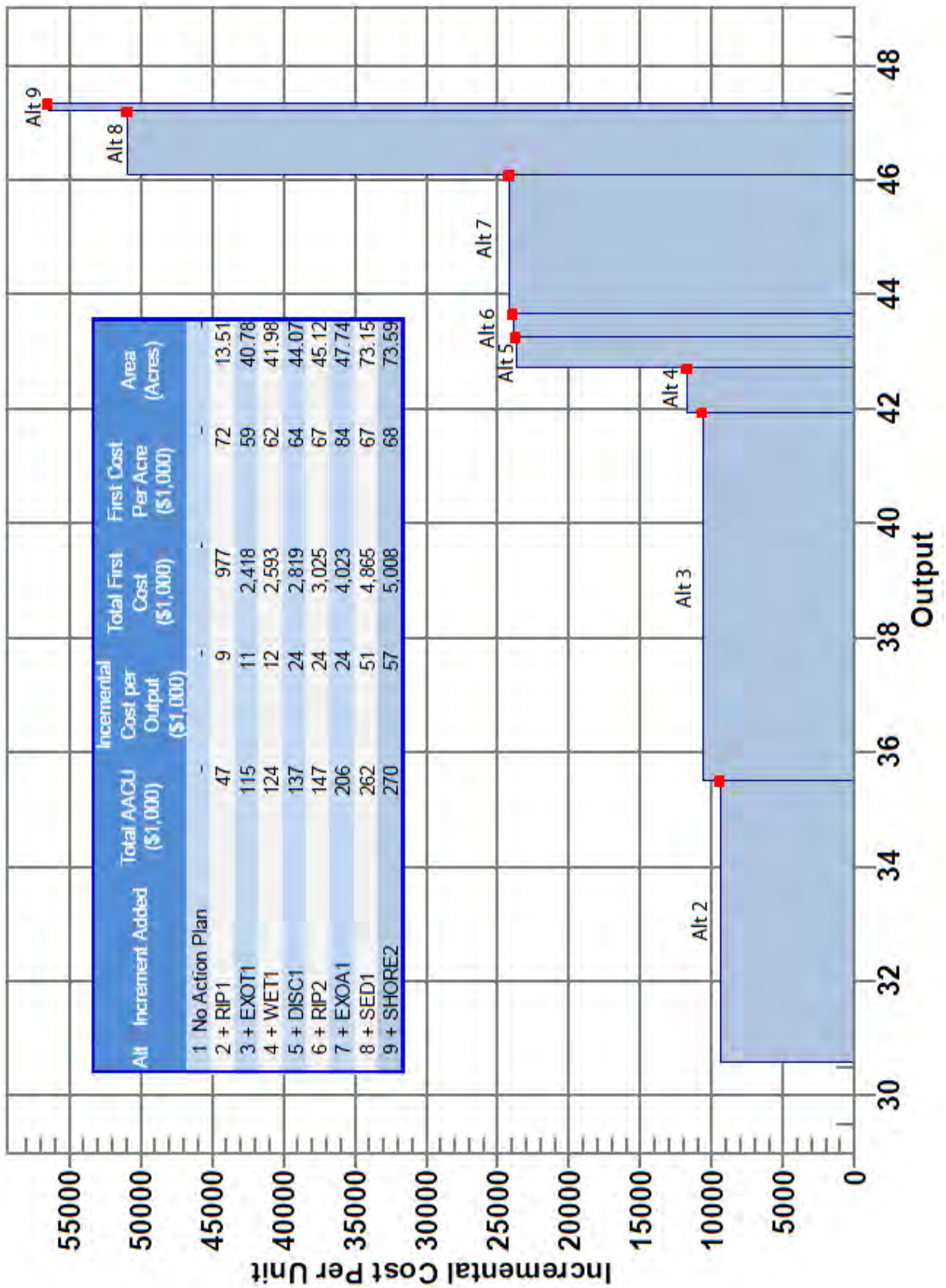
The cost-effective plans were then evaluated based on incremental cost per unit output (i.e., incremental AACU divided by incremental AAHU) to identify the best-buy plans. Best-buy plans are those that have the lowest incremental cost per output at a given level of cost. Because the No Action Plan does not have an associated cost, it is identified as the first best-buy plan. Each successive plan is then compared to the No Action Plan until the next best-buy plan producing greater output per cost than previous plans is selected. Plans producing less output than the best-buy plan are removed from the analysis, and the last identified best-buy plan becomes the baseline for comparison of successive plans. ICA identified nine best-buy plans, including the No Action Plan, which can be assessed using tabular and graphical summaries (Table 5-1; Figure 5-1; and Appendix G, page 4 and Figure G-2).

Table 5-1. Cost (AACU) and Benefit (AAHU) of Best-buy Plans*

Best-buy Plan	Measure									Benefit (AAHU)	Cost (AACU)	Average Cost (AACU/AAHU)	Incremental Cost (AACU)	Incremental Benefit (AAHU)	Incremental Cost per Output (AACU/AAHU)
	EXOT	RIP	EXOA	SHORE	DISC	SED	DUCK	WET	EDU						
1	0	0	0	0	0	0	0	0	0	30.56	0	0			
2	0	1	0	0	0	0	0	0	0	35.50	46,782	1,318	46,782	4.94	9,470
3	1	1	0	0	0	0	0	0	0	41.93	115,384	2,752	68,602	6.43	10,669
4	1	1	0	0	0	0	0	1	0	42.70	124,433	2,914	9,049	0.77	11,752
5	1	1	0	0	1	0	0	1	0	43.25	137,496	3,179	13,063	0.55	23,751
6	1	2	0	0	1	0	0	1	0	43.66	147,311	3.374	9,815	0.41	23,939
7	1	2	1	0	1	0	0	1	0	46.08	205,907	4,468	58,596	2.42	24,213
8	1	2	1	0	1	1	0	1	0	47.19	262,474	5,562	56,567	1.11	50,961
9	1	2	1	2	1	1	0	1	0	47.33	271,389	5,713	7,915	0.14	56,536

*Rounding errors are present in this table; see Appendix G, page 3, for precise numbers

Figure 5-1. Incremental Cost per Incremental Output (AACU/AAHU) and Output (AAHU) of Best-buy Plans



Alt	Increment Added	Total AACU ($1,000)	Incremental Cost per Output ($1,000)	Total First Cost ($1,000)	First Cost Per Acre ($1,000)	Area (Acres)
1	No Action Plan	-	-	-	-	-
2	+ RIP1	47	9	977	72	13.51
3	+ EXOT1	115	11	2,418	59	40.78
4	+ WET1	124	12	2,593	62	41.98
5	+ DISC1	137	24	2,819	64	44.07
6	+ RIP2	147	24	3,025	67	45.12
7	+ EXOA1	206	24	4,023	84	47.74
8	+ SED1	262	51	4,865	67	73.15
9	+ SHORE2	270	57	5,008	68	73.59

SECTION 6.0
PROPOSED NATIONAL ECOSYSTEM RESTORATION (NER) PLAN

6.0 PROPOSED NATIONAL ECOSYSTEM RESTORATION (NER) PLAN

6.1 PROPOSED NER PLAN SELECTION

The NER Plan is selected by asking "Is it worth it?" of each successively more expensive best-buy plan and then considering potential benefits not captured by the HEP analysis. ICA generated nine best-buy plans, including Best-buy Plan 1, which is the No Action Plan (see Table 5-1; Figure 5-1).

6.1.1 Best-buy Plan 1

Beginning with Best-buy Plan 1 (the No Action Plan), each successive plan costs more than the previous plan. Best-buy Plan 1 represents the FWOP alternative. If implemented, the study area habitat would remain in its degraded state and no restoration activities would occur. This plan would provide 30.56 AAHUs over the life of the project and all of the identified problems would continue.

6.1.2 Best-buy Plan 2

Best-buy Plan 2 provides an additional 4.94 AAHUs over the No Action Plan. The additional gain in AAHUs results from restoration of riparian habitats. The increase in riparian habitats would occur primarily where the riparian corridor is narrow and would improve the function of the riparian zone as a filter of stormwater runoff. This measure would also relocate trails further from the river, thus potentially reducing impacts associated with recreation. At an incremental cost per incremental output of $9,470, the substantial gain in riparian habitats results in a minimal increase in cost per unit gained; therefore, Best-buy Plan 2 is "worth it." Best-buy Plan 2 does not address altered hydrology, aquatic exotic plants, or improvements in habitat for listed species. Best-buy Plan 2 does not fully meet the study objectives.

6.1.3 Best-buy Plan 3

As compared to Best-buy Plan 2, Best-buy Plan 3 provides an additional 6.43 AAHUs, a 31.0 percent gain, at an incremental cost per incremental output of $10,669, a 12.7 percent gain. The additional gains in AAHUs come from the control of exotic shrubs and trees, which would result in a more open canopy and increased snag density and, thus, improves suitability of riparian habitats. The improvements to existing riparian forest habitats is "worth it". Best-buy Plan 3 begins to remove nonnative species and address their effects on native habitats, but

does not address problems related to altered hydrology, urbanization, aquatic exotic plants, or recreation. Thus, Best-buy Plan 3 does not fully meet the study objectives.

6.1.4 Best-buy Plan 4

When compared to Best-buy Plan 3, Best-buy Plan 4 provides an additional 0.77 AAHU, a 6.8 percent gain, at an incremental cost per incremental output of $11,752, a 10.1 percent increase. Although the additional benefits are relatively small, this is the first plan to include restoration of wetlands. Restoration of wetland habitats would provide benefits to water quality not captured by the HEP models and would meet the planning objective to restore wetland habitats. Thus, Best-buy Plan 5 is "worth it." However, Best-buy Plan 4 would not address problems associated with altered hydrology and does not fully meet the study objectives.

6.1.5 Best-buy Plan 5

As compared to Best-buy Plan 4, Best-buy Plan 5 provides an additional 0.55 AAHU, a 4.5 percent gain, at an incremental cost per incremental output of $23,751, a 102 percent increase. The additional gain in AAHUs results from the restoration of riparian habitats at discharge locations, which would also benefit aquatic habitats by addressing sediment inputs. Best-buy Plan 5 begins to address water quality and sedimentation associated with urbanization that are not provided by less expensive best-buy plans. Best-buy plan 5 would benefit common riparian and aquatic species, and would provide substantial benefits to threatened and endangered species that are not captured by the HSI models. Thus, Best-buy Plan 5 is "worth it". However, Best-buy Plan 5 does not fully address the accumulated sediments associated with altered hydrology and urbanization, which also substantially affect the quality of habitat for federally listed species. Best-buy Plan 5 does not fully meet the study objectives.

6.1.6 Best-buy Plan 6

As compared to Best-buy Plan 5, Best-buy Plan 6 provides an additional 0.41 AAHU, a 3.2 percent gain, at an incremental cost per incremental output of $23,939, a 0.8 percent increase. The additional gain in AAHUs results from the restoration of riparian habitats on lands that are currently impervious (a ball court, parking lots, and sidewalks near the river). Best-buy Plan 6 further improves the function of the riparian zone as a buffer for pollutants, and the increase in incremental cost per output is minimal; thus, Best-buy Plan 6 is "worth it." Best-buy Plan 6 improves upon the benefits to water quality and sedimentation associated with urbanization, recreation, and altered hydrology that are provided by less expensive best-buy plans. However,

Best-buy Plan 6 does not addresses all of the problems associated with nonnative species and does not remove accumulated sediments from the river, which reduces the quality of the aquatic habitats for Texas wild rice and fountain darter. Therefore, Best-buy Plan 6 does not fully meet the study objectives.

6.1.7 Best-buy Plan 7

When compared to Best-buy Plan 6, Best-buy Plan 7 provides an additional 2.42 AAHUs, an 18.5 percent gain, at an incremental cost per incremental output of $24,213, a 1.14 percent increase. This plan would include removal of elephant ear from the river. Compared to Best-buy Plan 5, the increase in incremental cost per output is minimal, and Best-buy Plan 7 addresses nonnative aquatic species; thus, Best-buy Plan 7 is "worth it." Best-buy Plan 7 addresses problems associated with both terrestrial and aquatic nonnative species; however, Best-buy Plan 7 does not address existing hardpan near the river or the accumulated sediments already present in the river. Best-buy Plan 7 does not fully meet the study objectives.

6.1.8 Best-buy Plan 8

When compared to Best-buy Plan 7, Best-buy Plan 8 provides an additional 1.11 AAHUs, a 7.2 percent gain, at an incremental cost per incremental output of $50,961, a 110 percent increase. Best-buy Plan 8 includes efforts to address the accumulated sediments in the river channel that may prevent establishment of Texas wild-rice and reduce habitat suitability for common fishes. The combination of measures to restore riparian habitats on managed lands and at discharge locations, in combination with long-term measures to remove existing accumulations of sediments, would fully address the problem of altered hydrology. Although the incremental cost per incremental output of Best-buy Plan 8 increases substantially compared to Best-buy Plan 7, Best-buy Plan 8 would result in restoration of native substrates that would benefit federally listed species in the study area, especially Texas wild-rice. Because Best-buy Plan 8 is the least expensive Best-buy Plan that fully addresses each of the identified problems, this plan is "worth it." Best-buy Plan 8 is incrementally justified and would address recreation and impacts on listed species throughout the study area.

6.1.9 Best-buy Plan 9

When compared to Best-buy Plan 8, Best-buy Plan 9 provides an additional 0.14 AAHU, a less than 1 percent gain, at an incremental cost per incremental output of $56,536, an 11.0 percent increase. Best-buy Plan 9 includes measures to restore the shoreline by restoring areas of

degraded shoreline and removing impervious surfaces. However, Best-buy Plan 9 would address localized recreational impacts not addressed by less expensive plans. Although this plan would provide localized benefits to listed species, the benefits have been determined to be minor. Additionally, Best-buy Plan 8 addresses all of the study objectives and restores habitat for federally protected species with approximately 21 percent less incremental cost per incremental output; thus, Best-buy Plan 9 is not "worth it."

6.1.10 Proposed NER Plan

Based on the results of the ICA, consideration of HEP limitations and non-quantifiable ecosystem benefits (e.g., benefits to federally listed species), and agency technical review by the USACE, Rock Island District, Best-buy Plan 8 is justified as the Proposed NER Plan. The following measures would be implemented under the Proposed NER Plan: EXOA, RIP2, EXOT, WET, DISC, and SED (Figures 6-1a and 6-1b). A summary of activities included Proposed NER Plan by restoration measure and TY is provided in Table 6-1. Additional considerations are discussed below in Sections 6.1 through 6.7.

6.2 PROPOSED NER PLAN BENEFITS AND ACCOMPLISHMENTS

The NER Plan would include improvements to or restoration of 43.93 acres of riparian habitats, 1.19 acres of wetland habitats, and 28.03 acres of aquatic habitats. Improvements to riparian habitats include planting of approximately 14.56 acres of riparian forest in areas currently serving as parkland, sidewalks, parking lots, or other impervious surfaces; planting of approximately 2.10 acres of riparian forest along currently degraded discharge locations, and control of exotic shrubs and trees in approximately 27.28 acres of existing riparian forest. Improvements to aquatic habitats include removal of approximately 2.61 acres of exotic vegetation along the river banks and removal of sediments over approximately 25.42 acres of the river bed (4.75 acres during the establishment phase). The NER Plan would improve the riparian corridors' ability to function as a filter of stormwater runoff and substantially reduce the input of sediments in the river. Concurrently, the removal of sediments and elephant ear from approximately 3.5 miles of river channel would restore native substrates and local hydraulics. The long-term reduction of sediment input, combined with continuous efforts to remove accumulated sediments and control elephant ear, would restore native substrates in the channel. Restoration of native substrates was evaluated as beneficial through HEP and would also benefit federally listed species.

Table 6-1. Overview of Restoration Measures and Implementation Phases of the Proposed NER Plan

Restoration Measure	General Construction			47-year Maintenance
	Initial Construction	Initial Construction Duration*	3-year Establishment	
Control of exotic trees and shrubs (EXOT)	Herbicide treatment of exotic invasive trees and shrubs	24 days (2-person crew)	Annual monitoring, treatment of resprouts, and new establishment of invasive species	Monitoring and treatment of resprouts and new establishment at TY15 and TY25
Control of elephant ear (*Colocasia esculenta*) (EXOA)	Hand removal of elephant ear from the river channel and establishment of native wetland plants	7 days (2-person crew)	Annual monitoring, hand removal of invasive plants, and additional native plantings, as needed	Repeat every 10 years
Restoration of riparian zone (RIP2)	Removal of impervious surfaces, removal of parking areas, relocation of trails, signage, and establishment of native riparian plants	10 days (2-person crew)	Annual monitoring, herbicide and hand removal of invasive species, and additional native plantings, as needed	Monitoring and treatment of resprouts and new establishment of invasive species at TY15 and TY25
Restoration of discharge locations (DISC)	Contouring and placement of natural materials to reduce flow velocity and capture pollutants	12 days (2-person crew)	Annual monitoring, repair and clearing, and additional native plantings	Monitoring, repair and debris removal, and herbicide control of invasive species (as needed) every 5 years starting at TY5
Removal of accumulated sediment (SED)	Use of hydrosuction to remove accumulated sediment over 20 percent of the river channel	16 days (2-person crew)	Annual monitoring and use of hydrosuction to remove accumulated sediment over 20 percent of the river channel	Monitoring and use of hydrosuction to remove accumulated sediment over 20 percent of the river channel every 5 years beginning at TY5
Restoration of wetland habitats (WET)	Restoration of the wetland habitats on backwater channel of San Marcos River and wetponds on Sessoms Creek	19 days (2-person crew)	Annual monitoring, herbicide and hand removal of invasive species, and additional native plantings, as needed	Monitoring, repair of structures, and sediment clearing in wetponds every 5 years beginning at TY5

*construction duration days are not necessarily consecutive

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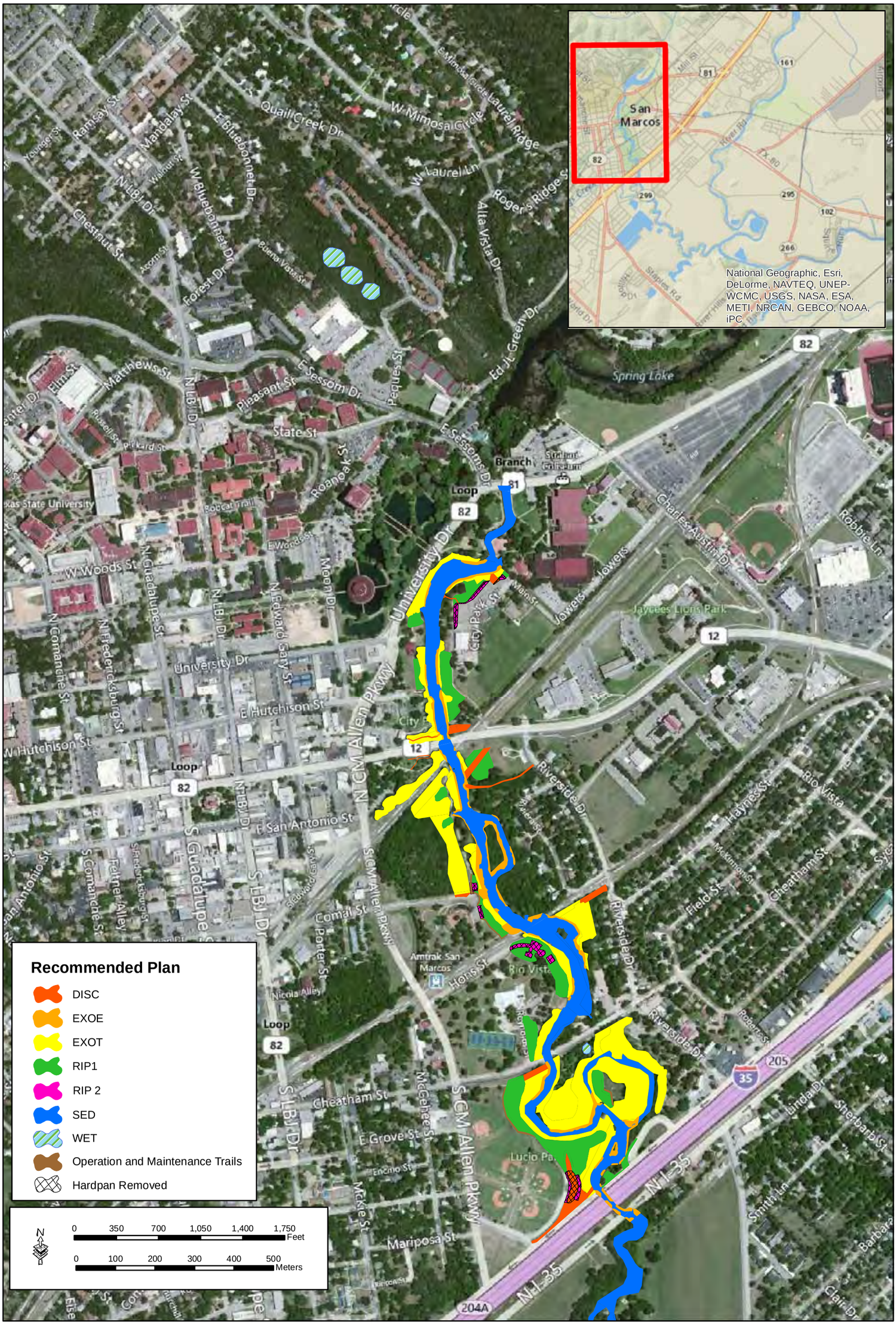

Figure 6-1a. Recommended Restoration Plan

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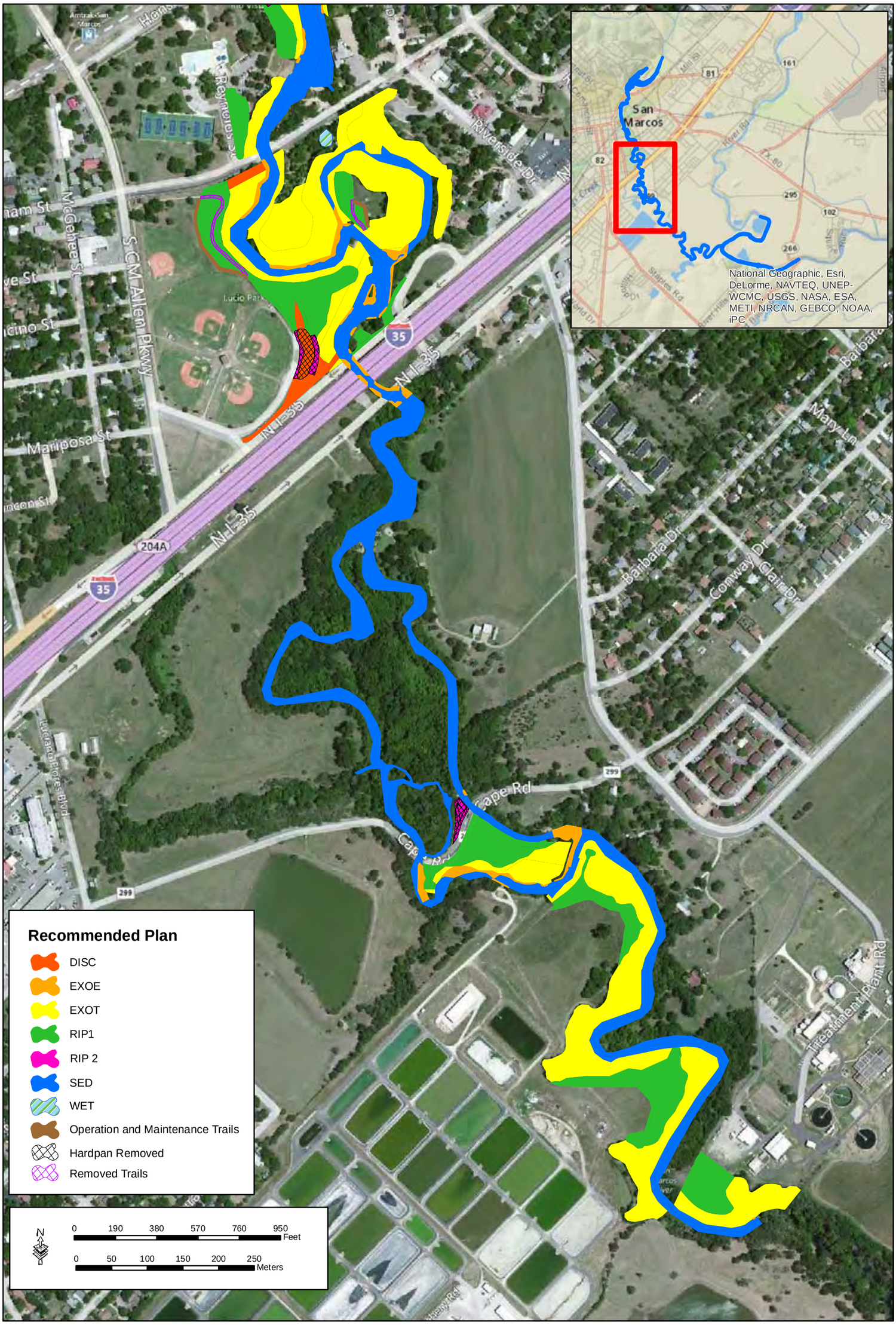

Figure 6-1b. Recommended Restoration Plan

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Non-quantifiable ecosystem benefits would include benefits to listed species including Texas wild-rice, fountain darter, San Marcos gambusia, San Marcos salamander, Texas pimpleback, and golden orb, as well as quantitatively small benefits to water quality that would benefit native species but are not captured by the HEP models. The NER Plan also expands upon the habitat restoration for federally listed endemic species through its connectivity with the Spring Lake Section 206 Aquatic Ecosystem project, which was recently implemented upstream of the study area, and the EARIP HCP, which includes the study area. The removal of trails occurring nearly adjacent to the river bank, would reduce the number of unauthorized river access points and redirect recreational users to improved access areas. This reduction of recreational access would benefit both listed and non-listed aquatic plants and animals by reducing disturbance of bank and channel substrates.

The NER Plan meets the objectives defined in Section 3.2 as follows:

- Habitat suitability of the riparian corridor would increase as a result of improved structure and composition and an increase in area.
- The function of the riparian zone as a buffer against sediment and pollutant inputs would improve as a result of increased width, improved control of discharge, and restoration of wetlands.
- Aquatic habitat suitability would increase as a result of restored substrates, reduced input of sediments and pollutants, and an increase in area of native habitats.
- Recreational impacts would be reduced by placing some trails further from the river to minimize the creation of unauthorized trails and access points.
- Habitats for endemic species would be improved through reduced sediment and pollutant input, restoration of native sediments, and replacement stands of elephant ear with native habitats.

6.3 ALTERNATIVE NER PLAN COSTS

The total investment cost for the NER alternative, which includes LERRDS, general construction costs over the 3-year construction period with risk-based contingencies, PED with allowances for contingencies, construction management with contingency, interest during construction, and 10 percent profit is $5,359,626 (Table 6-2).

Table 6-2. Design and Implementation Costs (For Alternatives Comparison) of the NER Plan

Cost Item	Restoration Measure Cost (dollars)*						Total
	EXOA	RIP2	EXOT	WET	DISC	SED	
Lands, Easements, Right of Way, Relocation, and Disposal Areas	**981,112**	**659,711**	**1,243,530**	**52,725**	**110,632**	**438,100**	**3,485,810**
General Construction							
Initial Construction	28,899	*240,918*	31,897	75,286	58,233	79,172	514,405
3-year Establishment Period	53,448	*73,833*	19,622	6,274	9,819	158,344	321,340
Subtotal	82,347	314,751	51,519	81,559	68,052	237,516	835,744
Contingency (%)	14.97%	9.36%	5.82%	7.54%	16.12%	14.97%	n/a
Contingency Value	12,325	29,460	2,999	6,149	10,967	35,548	97,448
Subtotal	**94,672**	344,211	54,518	**87,708**	**79,019**	**273,064**	**933,192**
Planning, Engineering, and Design (PED)							
PED (10%)	8,235	**31,475**	5,152	8,156	6,805	23,752	83,575
PED Contingency (9.22%)	759	**2,901**	475	752	627	2,189	7,703
Subtotal	**8,994**	**34,376**	**5,627**	**8,908**	**7,432**	**25,941**	**91,278**
Construction Management							
Construction Management (10%)	8,235	31,475	5,152	8,156	6,805	23,752	83,575
Construction Management Contingency (20.08%)	1,654	6,322	1,035	1,638	1,367	4,770	16,786
Subtotal	**9,889**	**37,797**	**6,187**	**9,794**	**8,172**	**28,522**	**100,361**
Subtotal First Cost	**1,094,666**	**1,076,096**	**1,309,861**	**159,134**	**205,256**	**765,627**	**4,610,640**
profit (10%)	109,467	107,610	130,986	15,913	20,526	76,563	461,065
TOTAL FIRST CONSTRUCTION COSTS	**1,204,133**	**1,183,705**	**1,440,847**	**175,048**	**225,781**	**842,189**	**5,071,703**
Interest During Construction	68,359	67,199	81,797	9,938	12,818	47,811	287,922
INVESTMENT COST	**1,272,492**	**1,250,905**	**1,522,644**	**184,985**	**238,599**	**890,001**	**5,359,626**
Interest	47,718	46,909	57,099	6,937	8,947	47,811	215,421
Amortization	9,002	8,849	10,772	1,309	1,688	6,296	37,916
Annual Operations, Maintenance, Repair, Rehabilitation, and Replacements	1,876	838	731	803	2,428	16,896	23,572
AVERAGE ANNUAL COST UNIT (AACU)	**58,597**	**56,596**	**68,602**	**9,049**	**13,064**	**56,567**	**262,475**

*EXOA – Control of exotic aquatic vegetation – emergent
RIP2 – Restore riparian corridor
EXOT – Control of exotic shrubs and trees
WET – Restoration of wetlands
DISC – Control of discharge
SED – Removal of accumulated sediments

6.4 ALTERNATIVE NER PLAN SUSTAINABILITY

Part of the USACE Mission Campaign is to develop sustainable water resource solutions. The maintenance of most restoration measures following the 3-year establishment period is expected to be minimal; thus, the relatively low cost of annual OMRR&R. Aquatic Ecosystem restoration measures were developed to be self-sustaining to the greatest extent practicable, and long-term maintenance is primarily limited to the control of newly established exotic species and potential accumulation of sediments at discharge locations. There are several complementary actions that have occurred or are anticipated to occur in the study area including the Spring Lake Section 206 Aquatic Ecosystem Restoration Project, the EARIP HCP, and designation of the San Marcos River within the study area as a State Scientific Area, and the San Marcos Comprehensive Master Plan. These complimentary actions will help control upstream sources of invasive species, sediments, and pollutants; educate the public regarding potential recreational impacts on sensitive resources, restrict recreational access during low flow conditions, and direct recreational access to permanent access points on the river. The Proposed NER Plan was developed with consideration of these actions and is designed to contribute to the overall sustainability of the San Marcos River Ecosystem.

6.5 REAL ESTATE CONSIDERATIONS

A market value of properties within the study area was prepared by CESWF, including public property located outside of 100-year floodplain, private property located outside of 100-year floodplain, all property within 100-year floodplain, property located below the mean high water mark of the San Marcos River, mineral, damages/severance (20 percent) and contingency (20 percent). A Real Estate Plan was developed and is included in Appendix H.

The Local Sponsors (City of San Marcos and the Texas General Land Office) own the majority of the land that would be utilized under the proposed project. Land within the river below the mean high water mark is owned by the State of Texas. This would include lands associated with removal of elephant ear, sediment, and instream hard-structures.

6.6 CONSTRUCTION CONSIDERATIONS

Design plans, additional testing, preparation of a construction schedule, and contracting would occur during the PED phase. The timing of some measures is likely to be contingent on conservation measures; however, this is not anticipated to affect cost of PED or of implementing those measures. The cost of PED was estimated and an appropriate contingency was applied through cost risk analysis. Additional tasks to be completed during the PED phase are identified in Section 7 and include activities necessary to comply with NEPA.

It is not anticipated that any adverse effects would occur such that the feasibility, costs, or benefits of the proposed measures would be substantially altered. An abbreviated cost risk analysis was conducted to identify areas where efforts to comply with, or obtain, a decision document could result in increased costs, and an appropriate contingency was applied. All NEPA requirements, including the requirements of all permits and plans that must be completed prior to initiation of construction, are presented in Section 7.0.

6.7 MONITORING AND ADAPTIVE MANAGEMENT CONSIDERATIONS

Adaptive management would include surveys to collect data on the function of each measure, the success of plantings, establishment of exotic invasive plants, and damage by wildlife and humans (Appendix I). The costs of monitoring (i.e., surveys and data reporting) have been estimated for each measure during both the 3-year establishment phase and the long-term OMRR&R phase of the project. Monitoring considerations were included in the ICA.

6.8 RECREATION COMPONENTS

Because recreational infrastructure is abundant in the study area, there are no measures proposed for the improvement of recreational opportunities. Although recreation is associated with some measures, none of the proposed measures would increase or enhance recreational opportunities. Relocating trails at a greater distance from the river and replacing them with native habitats would improve conditions in the river due to reduced recreational access, and maintenance of a continuous trail system is assumed to reduce the creation of unauthorized trails. Decreasing the accessibility of the river, which is the main recreational feature in the

study area, is not considered a recreational component. These costs are included in the operation and maintenance of the existing, continuous trail system.

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SECTION 7.0
ENVIRONMENTAL EFFECTS

7.0 ENVIRONMENTAL EFFECTS

This section of the DPR/EA describes and, where practicable, quantifies the potential effects of each viable alternative on the resources within or near the study area. These discussions are presented in the same sequential order as the existing conditions for resources were described in Section 2. The assessment of the No Action Plan includes proposed, planned, and ongoing actions that are or are reasonably certain to affect resources in the study area in the foreseeable future.

Although not part of the NER Plan, the City of San Marcos is constructing additional parking areas outside of the study area regardless of the implementation of implementation of the NER Plan. Therefore, the construction of additional parking by the City of San Marcos would replace any parking spaces lost as a result of implementing the NER Plan.

An effect is defined as either a beneficial or adverse modification to the human or natural environment that would result from the implementation of an action. The effects or impacts can be direct, indirect, or cumulative. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action later in time or farther removed in distance, but are still reasonably foreseeable. Cumulative impacts result when the effects of an action are added to or interact with other effects. The concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time.

The effects can be short-term, long-term, or permanent. For purposes of this DPR/EA, short-term effects are defined as those that would occur while restoration measures are being implemented and possibly a few days thereafter. Long-term effects are defined as those that would result in a change that lasts for many years following implementation of restoration measures. Permanent impacts would result in a change that cannot be undone and, thus, require an irretrievable commitment of resources.

Impacts can vary in degree or magnitude from a slightly noticeable change to a total change in the environment. The significance of the impacts presented in this DPR/EA is based upon existing regulatory standards, scientific and environmental knowledge, and best professional opinions of the authors. The significance of the impacts on each resource would be described

as significant, moderate, negligible, or no impact. Significant impacts are those effects that would result in substantial changes to the environment (as defined by 40 CFR 1500-1508) and should receive the greatest attention in the decision-making process. Negligible impacts are discountable (near the limits of detection) or reasonably unlikely to occur. All effects described in the following sections are considered to be adverse, unless stated otherwise. Where practical, all potential adverse effects would be avoided or minimized through use of BMPs.

7.1 SOILS

7.1.1 No Action Plan

Under the No Action Plan, future development within the study area would have minimal long-term effects on soils. Development can remove soils from productivity, and the resulting increase in soil disturbance and impervious surfaces can increase soil loss through erosional processes. Because the study area primarily consists of state and public lands, future changes in land use within the study area, such as development, are not likely to occur under the No Action Plan. However, it is anticipated that development of urban land uses within the San Marcos River basin will continue. Development surrounding the study area can contribute to increased stormwater runoff that causes soil erosion in the study area.

7.1.2 Proposed NER Plan

Up to 46 acres of soils (18 acres in the riparian zone and 28 acres of instream substrates) would be directly affected by the Proposed NER Plan. Soil disturbance can result in short- and long-term soil loss through uncontrolled erosion. Adherence to BMPs and local and state water quality protection measures (such as TCEQ regulations) would minimize potential short-term adverse effects. Further, the proposed restoration measures would reduce long-term soil erosion in the study area.

Approximately 6.0 acres of soils classified as Prime Farmland Soils would be directly affected by the NER Plan. The FPPA was authorized to minimize the unnecessary and irreversible conversion of farmland to nonagricultural use. Although Prime Farmland Soils would be disturbed, none would be removed from productivity or irreversibly converted to nonagricultural use. Effects on Prime Farmland Soils would be negligible, and the Proposed NER Plan is in compliance with the FPPA.

7.2 SURFACE WATERS AND OTHER AQUATIC RESOURCES

7.2.1 No Action Plan

Under the No Action Plan, surface water quality would continue to be affected by development of lands within the San Marcos River watershed. Increased areas of impervious surfaces can contribute to the input of sediments to surface waters during storm events, which can increase turbidity. Increased areas of impervious surfaces and increased vehicle use within the basin can increase the potential for spills of pollutants to enter the river and adversely affect water quality.

7.2.2 Proposed NER Plan

The Proposed NER Plan would have moderate short-term adverse effects on water quality as a result of soil and stream substrate disturbance. Up to 18 acres of soils disturbance in the riparian zone, including measures to plant riparian forest and restore wetlands, and remove elephant ear, would occur during the first year of construction. Elephant ear removal would disturb up to 0.87 acre of soils per year for the first 3 years and substantially less during subsequent years. Additionally, up to 20 percent of river substrates could be disturbed as a result of sediment removal in any given year during the project life. Soil disturbance can result in increased erosion, suspension of sediments, and accumulation of fine sediments over naturally coarse stream substrates. The adverse effects of soil disturbance would be short-term and would only affect those resources within the immediate vicinity of the measure as sediment plumes would dissipate over a short distance. Potential short-term adverse effects of soil disturbance on water quality would be minimized by adhering to the conditions of Texas Pollutant Discharge Elimination System (TPDES) General Permit No. TXG830000, including preparation of a site-specific Stormwater Pollution Prevention Plan (SWPPP).

Restoration of the riparian zone and restoration of wetlands would have long-term beneficial effects on water quality by reducing the volume of sediments discharged into the San Marcos River and by filtering other pollutants from stormwater runoff. Restoration of discharge locations would also reduce the potential of small spills of pollutants on roadways from affecting aquatic habitats in the San Marcos River. The long-term commitment to removal of accumulated fine sediments under the Proposed NER Plan would contribute to sustainability of the proposed measures to improve water quality, as these fine sediments can be resuspended during storm events and recreational activities.

Maintenance of high flow volumes is necessary to maintain the high water quality characteristic of the San Marcos River. Up to 1,562,985 gallons of City of San Marcos water would be used to irrigate native plantings under the Proposed NER Plan during the 3-year establishment period. Irrigation would be limited to the volumes necessary to ensure survival of plantings, and a portion of the irrigation water would be discharged to the San Marcos River as surface flows and groundwater recharge. The City of San Marcos obtains raw surface water via a pipeline from Canyon Lake on the Guadalupe River. The City of San Marcos obtains approximately 75 percent of its potable water from the San Marcos Water Treatment Plant and augments the remaining 25 percent from groundwater sources located at five separate wells. In 2008, the City of San Marcos treated 2,374 million gallons of surface water. Because the City of San Marcos obtains surface waters from downstream sources and groundwater from aquifers not contributing to the Edwards Aquifer, the use of water for irrigation would have a negligible effect on surface flows in the San Marcos River.

The restoration of wetlands on Sessoms Creek would alter the hydrology of the San Marcos River by reducing the peak and total volume and velocity of flows discharged from Sessoms Creek to the San Marcos River. Changes in the hydrology on other tributaries of the San Marcos River as a result of restoration projects and the construction of detention basins have contributed to a reduction of peak flows in the San Marcos River and a loss of scour during flood events, which has resulted in an accumulation of sediments in the San Marcos River channel. Restoration measures to reduce the input of sediments and to remove accumulated sediments over the life of the project would reduce the adverse effects of proposed and existing wetland restoration on tributaries of the San Marcos River. The restoration of wetlands in the backwater near Cheatham Street would have minimal effect on hydrology of the San Marcos River.

Implementation of the Proposed NER Plan would have impacts on waters of the U.S., including wetlands within the restoration area. However, there would be no net loss of wetlands or waters of the U.S. resulting from construction of any of the restoration measures. The waters of the U.S. are subject to Sections 401 and 404 of the CWA. Although the USACE does not issue itself Section 404 permits for construction activities that would affect waters of the U.S., the USACE must meet the legal requirements of the CWA. Although a USACE permit would not be issued for the Proposed NER Plan, the restoration measures would be covered by Nationwide Permit 27, Aquatic Habitat Restoration, Establishment, and Enhancement Activities. As part of the Nationwide Permit 27 evaluation, a qualitative description of baseline conditions and

description of the post-project condition would be prepared to demonstrate that the project components would be ecologically beneficial. Nationwide Permit 27 authorizes activities in waters of the U.S. associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas, provided the activities result in a net increase in aquatic functions and services. The proposed restoration measures would improve hydrologic connectivity amongst the existing and created wetlands, reduce turbidity and sedimentation within the restoration area, and remove nonnative vegetation while replacing it with native hydrophytic herbaceous and shrub stratum vegetation, thereby improving aquatic functions and services of the waters of the U.S. within the restoration area.

In Texas, all activities carried out in compliance with the terms and conditions of Nationwide Permit 27 are also considered to be in compliance with Section 401 of the CWA and do not require separate permitting in the form of a Water Quality Certification from TCEQ.

7.3 BIOLOGICAL RESOURCES

7.3.1 No Action Plan

Under the No Action Plan, biological resources would continue to be threatened or affected by surrounding development and by recreation within the study area. Continuing urbanization of land surrounding the study area but within the San Marcos River watershed threatens to increase the input of sediments and increase the potential for input of other pollutants (i.e., spills of harmful substances). Existing recreation in the study area has a more direct effect on biological resources. Recreational use results in the creation of unauthorized trials where users leave the approved trail system to gain access to the river. Continuous use of popular access points along the river has resulted in the loss of riparian vegetation and destabilization of river banks at multiple locations. Soil erosion occurring along unauthorized trails and at denuded/destabilized access points can affect local water quality and stream substrates that support the native flora and fauna. Many of the parking areas located near the river drain directly into the river and contribute to the input of sediments and to the potential for other pollutants to enter the river.

7.3.2 Proposed NER Plan

The Proposed NER Plan would have short-term and minor adverse effects on biological resources in the study area. Implementation of restoration measures would disturb soils and

vegetation in up to 1.32 acres of impervious improved lands, 12.83 acres of pervious improved lands (i.e., maintained grasslands), 0.24 acre of Type 1 forest, 1.19 acres of Type 2 forest, 1.95 acres of Type 3 forest, 0.31 acres of Type 4 forest, and approximately 28 acres of aquatic habitats in the San Marcos River. Temporary adverse effects on wildlife utilizing riparian habitats would include increased noise and human presence, loss of cover and forage or prey, and potentially take of relatively sedentary animals. Temporary adverse effects on aquatic wildlife would include increased turbidity, disturbance of substrates, loss of cover, forage, and prey, and potentially take of more sedentary animals. All adverse effects would be avoided where possible and minimized through use of BMPs.

The Proposed NER Plan would have long-term beneficial effect on biological resources. The proposed restoration measures would restore (30.16 acres) and improve the suitability of (27.28 acres) up to 48 acres of riparian forest, 1.2 acres of wetlands, and 28 acres of aquatic habitats in the San Marcos River. The restoration of riparian forest includes the removal of 1.33 acres of impervious surfaces that do not currently provide any habitat value. Control of exotic trees and shrubs in the 27.28 acres of existing riparian forest zone would improve habitat suitability. Long-term riparian forest habitat benefits would include improved vegetation structure and diversity and increased nesting opportunities for cavity nesters. Long-term aquatic habitat benefits would include improved water quality, reduced potential for spills to adversely affect water quality, and restoration of native substrates. Control of elephant ear would further benefit aquatic habitats by increasing the area of native vegetation, reducing water loss through evapotranspiration, and by removing obstructions to flow in the channel.

The NER Plan would reduce the effects of recreational trails and parking on biological resources. Up to 1,400 linear feet of trails would be removed at locations where the trails are relatively close to the river (i.e., typically where the river is readily visible from the trail). These trails would be relocated further from the river with the intent of deterring the creation of unauthorized trails. Approximately 80 parking spaces located near the river, most of which drain directly into the river, would be removed and replaced with native riparian forest. The City of San Marcos is constructing comparable parking spaces on improved lands outside of the study area that do not drain directly into the river as a separate action. New parking would be constructed by the City of San Marcos using impervious surfaces or other means by which surface run-off from the parking area would be filtered prior to being discharged to surface waters.

7.4 LISTED SPECIES

7.4.1 No Action Plan

Among many other factors, listed species in the study area are dependent upon a source of high water quality and coarse substrates and are affected by trampling and disturbance of substrates or vegetation where they occur. Under the No Action Plan, listed species would continue to be threatened by surrounding land development where it contributes to increased erosion and discharge of pollutants. Recreation would continue to adversely affect listed species where recreation occurs in proximity to individuals or their potential habitats.

7.4.2 Proposed NER Plan

The Proposed NER Plan would have short-term and minimal effects on listed species, while the long-term effects of the Proposed NER Plan would benefit these species. Soil disturbance in the riparian zone, including planting of riparian forest, improvements to discharges, and restoration of wetlands, would expose soils to erosion. Implementation of BMPs to reduce soil erosion, as described above in Section 7.1.2, would avoid and minimize the potential discharge of sediments and other pollutants into surface waters during construction. The removal of trails and parking near the river would reduce the discharge of sediments and other pollutants into the river. The proposed restoration measures would reduce long-term soil erosion and the potential for other pollutants to be discharged into the San Marcos River.

The restoration of wetlands on Sessoms Creek would alter the natural hydrology of the San Marcos River and thereby reduce the frequency of scouring events, which are important for the maintenance of more course substrates for listed species. However, measures to reduce sediment input and the long-term removal of accumulated sediments would minimize the effects of altered hydrology on the composition of stream substrates.

The removal of elephant ear would have direct effects on listed species. Elephant ear removal would result in suspension of sediments and disturbance of vegetation and substrates that could be occupied by listed species. Individuals in the path of sediment plumes could be affected by increased turbidity and individuals dependent on the disturbed vegetation or substrates could be displaced or harmed. These effects are not anticipated to put any listed species in jeopardy and would result in substantial long-term benefits as native substrates and vegetation is restored in the study area.

Several BMPs would be implemented to avoid the adverse effects of herbicide use on native vegetation and aquatic environments. For example, a Texas-licensed herbicide applicator would be present during herbicide application to ensure that proper techniques and avoidance buffers are implemented. Exotics, such as elephant ear, located adjacent to channel banks where herbicide could affect listed species, would be controlled by hand.

Through coordination with the USFWS, it was determined that the Proposed NER Plan is likely to adversely affect the fountain darter, San Marcos gambusia, San Marcos salamander, golden orb, Texas pimpleback, Comal Springs riffle beetle, and Texas wild-rice. The Proposed NER Plan would not result in destruction or adverse modification of designated critical habitats for the fountain darter, San Marcos gambusia, San Marcos salamander, or Texas wild rice or proposed critical habitats for Comal Springs riffle beetle. A detailed description of the effects of the Proposed NER Plan can be found in the Biological Opinion prepared by the USFWS (Appendix D).

7.5 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

7.5.1 No Action Plan

The existing trail and park system would continue to be managed in its current condition. The scenic and aesthetic environment would continue to be influenced by the predominance of open spaces and parkland settings.

7.5.2 Proposed NER Plan

The Proposed NER Plan would have minimal long-term effects on recreational uses, facilities, and amenities. Restoration of riparian forests would reduce the influence of open spaces and parkland settings on the scenic and aesthetic environment and increase the more natural and wild land settings associated with the native habitats of the San Marcos River ecosystem. The relocation of trails would reduce access to the river at some locations; however, access would continue to be available at multiple places throughout the trail and park system. Although some parking would be removed, the City of San Marcos is constructing additional parking outside the study area that provides comparable accessibility to the trail and park system without adversely affecting native habitats. The removal of a basketball court and a small pavilion would have a minimal impact on recreational opportunities in the study area, as similar facilities and alternatives for recreation occur throughout the trail and park system.

7.6 CULTURAL RESOURCES

7.6.1 No Action Plan

Cultural resources in the study area would continue to be affected by human, mechanical, biochemical, and other miscellaneous threats. The location of cultural resources in public areas within the study area makes them susceptible to human-caused effects such as recreational use. The primary anticipated threat to cultural resources is indiscriminate collecting or looting, which results in loss of artifacts, associated information, and disturbance of the stratigraphic and archaeological record. Mechanical effects usually occur near the surface as a result of natural weathering processes and erosion from flood events. Biochemical effects result when water inundates a terrestrial site. The San Marcos River system is prone to flooding events that may result in mechanical and biochemical effects.

7.6.2 Proposed NER Plan

Implementation of the Proposed NER Plan has the potential to result in adverse effects on previously recorded cultural resources located within the APE of proposed restoration measures. Additionally, portions of the Proposed NER Plan APE have not previously been investigated for the presence of cultural resources. Section 106 consultation with the Texas SHPO will be completed for the feasibility phase of the study. Coordination and consultation with the SHPO will be conducted during the design phase, and additional archaeological testing, monitoring, and demarcation of areas to be avoided will occur. Thus, any adverse effects that may occur on cultural resources as a result of implementing the Proposed NER Plan would be avoided or mitigated according to the requirements determined through Section 106 consultation.

7.7 AIR QUALITY

7.7.1 No Action Plan

Air pollution resulting from vehicle traffic, construction, agriculture, and other air pollutant sources, is expected to continue or increase in the foreseeable future. However, these individual actions would occur over an extended period of time and are not expected to result in a non-attainment of NAAQS in the study area.

7.7.2 Proposed NER Plan

The effects of the Proposed NER Plan on air quality would be short-term and minimal. Temporary and minor increases in air pollution would occur from the use of construction equipment (combustion emissions) and the disturbance of soils (fugitive dust) during construction. The following paragraphs describe the methods used to estimate air emissions produced by implementation of the proposed restoration measures.

Fugitive dust emissions were calculated using the USEPA's preferred emission factor of 0.19 ton per acre per month (Midwest Research Institute 1996), which is a more current standard than the 1985 PM-10 emission factor of 1.2 tons per acre-month presented in AP-42 Section 13 Miscellaneous Sources 13.2.3.3 (USEPA 2001).

NONROAD2008a model was used to estimate air emissions from construction equipment. It is the USPEA's preferred model for estimating emissions from non-road sources (USEPA 2009a). Combustion emission calculations were made for standard construction equipment, such as a backhoe, bulldozer, dump truck, crane, and cement truck. Assumptions were made regarding the total number of days and hours each piece of equipment would be used.

Construction workers would temporarily increase the combustion emissions in the airshed during their commute to and from the project area. Emissions from trucks delivering materials such as cement, fill, and supplies would also contribute to the overall air emission budget. Emissions from delivery trucks and construction worker commuters traveling to the job site were calculated using the USEPA's preferred on-road vehicle emission model MOVES2010a (USEPA 2009b).

The total air quality emissions from the construction activities were calculated to compare to the *de minimis* thresholds of the General Conformity Rule (Table 7-1, Appendix J).

Several sources of air pollutants would contribute to the overall air impacts of the construction project. The air results in Table 7-1 included emissions from the following:

1. Combustion engines of construction equipment
2. Construction workers commuting to and from work
3. Supply trucks delivering materials to construction site
4. Fugitive dust from job site ground disturbances

Table 7-1. Air Emissions (tons/year) from Proposed NER Plan Construction Activities versus the *de minimis* Threshold Levels[1]

Pollutant	Total	*de minimis* Thresholds
Carbon Monoxide	5.95	100
Volatile Organic Compounds	2.36	100
Nitrous Oxides	8.23	100
Particulate Matter (PM-10)	35.36	100
Particulate Matter (PM-2.5)	4.39	100
Sulfur Dioxide	0.89	100
Carbon Dioxide and equivalents	3,053	27,557

Source: 40 CFR 51.853 and GSRC model projections (Appendix J).
[1] Note that Hays County is in attainment for all NAAQS (USEPA 2013c).

As can be seen in Table 7-1, air emissions from the Proposed NER Plan do not exceed federal *de minimis* thresholds. As there are no violations of air quality standards and no conflicts with the state implementation plans, the impacts on air quality in Hays County from the implementation of the Proposed NER Plan would be less than significant. During the construction of the Proposed NER Plan, proper and routine maintenance of all vehicles and other construction equipment would be implemented to ensure that emissions are within the design standards of all construction equipment. Dust suppression methods should be implemented to minimize fugitive dust, including wetting solutions applied to construction areas.

7.8 NOISE

7.8.1 No Action Plan

Under the No Action Plan, noise levels in the study area are not anticipated to change substantially. Construction activities in areas surrounding the study area could result in short-term and localized spike in noise levels during the day. Typical construction noise would have a negligible effect on noise levels in the study area.

7.8.2 Proposed NER Plan

The proposed construction activities would require the use of common construction equipment such as a backhoe, dump truck, or front-end loader. Table 7-2 presents noise emission levels for construction equipment expected to be used during the proposed construction activities. Anticipated sound levels at 50 feet from various types of construction equipment range from 76 dBA to 82 dBA, based on data from the FHWA (2007).

Table 7-2. Sound Levels (dBA) of Construction Equipment and Modeled Attenuation at Various Distances[1]

Noise Source	50 feet	100 feet	200 feet	500 feet	1000 feet
Backhoe	78	72	66	58	51
Dump Truck	76	70	64	56	49
Front-end loader	82	76	70	62	55

Source: FHWA 2007
1. The dBA at 50 feet is a measured noise emission. The 100- to 1,000-foot results are GSRC modeled estimates.

The use of a front-end loader would produce a noise emission level of 82 dBA at 50 feet from the source. Assuming the worst case scenario, the noise model (Caltrans 1998) estimates that noise emissions of 82 dBA would have to travel 344 feet before they would attenuate to an acceptable level of 65 dBA. Depending upon the number of construction hours, and the number, type, and distribution of construction equipment being used, the noise levels near the project area could temporarily exceed 65 dBA up to 344 feet from the project area. A GIS was used to determine the number of sensitive noise receptors within 344 feet from the edge of the project corridor. Table 7-3 presents the number of sensitive noise receptors located within the 75 dBA and 65 dBA noise contour created by the construction equipment.

Table 7-3. Number of Sensitive Noise Receptors Exposed to the 65 dBA and 75 dBA Levels

Noise Receptor	Greater than 75 dBA	65 dBA to 74 dBA
Residences	4	15
Schools	0	2
Parks	3	5

Source: Google Earth 2013 and GSRC 2013

Approximately 29 sensitive noise receptors may experience temporary noise intrusion equal to or greater than 65 dBA from construction equipment. Of these 29, approximately four residential receptors and three parks may experience temporary noise intrusion equal to or greater than 75 dBA from construction equipment.

Noise generated by the construction activities would be intermittent and last sporadically for approximately 2 years, after which noise levels would return to ambient levels. To minimize this potential effect, construction activities should be limited to daylight hours during the workweek, between 7:00 a.m. to 5:00 p.m. on Monday through Friday. Noise impacts would be minor if these timing restrictions are implemented during construction.

7.9 HAZARDOUS MATERIALS

7.9.1 No Action Plan

The handling of hazardous materials and pollutants within and surrounding the study area could have short-term and potentially moderate effects on biological resources, including listed species. Existing handlers of hazardous materials within and surrounding the study area are regulated under RCRA. However, spills do occur. Spills occurring near the study area could be discharged into the San Marcos River where they could affect recreational uses and biological resources, including listed species. Spills are most likely to occur along transportation corridors. Although the transport of hazardous materials is also regulated under RCRA, transportation increases the risk of spills and exposure of biological resources to hazardous materials. The use of oil, fuels, and other hazardous materials and pollutants found in most vehicles is not regulated under RCRA and could also be a source of spills along roadways.

7.9.2 Proposed NER Plan

The use of heavy equipment under the Proposed NER Plan would result in potential contamination of soils and water with hazardous materials and pollutants. However, proper maintenance of heavy equipment and implementation of a SWPPP would minimize this potential. Any spill of pollutants would have a minimal and short-term effect on soils and water and is not likely to result in exposure of listed species to increased pollutant levels. Measures to reduce potential exposure to pollutants would benefit water quality and listed species over the long term.

7.10 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

7.10.1 No Action Plan

Under the No Action Plan, socioeconomic indicators are not expected to change substantially.

7.10.2 Proposed NER Plan

The Proposed NER Plan is not expected to affect socioeconomic indicators in the study area in the long term. Some short-term spending during construction would have localized and temporary economic benefits. Although low-income and minority populations could be affected by noise, these effects would be temporary, would not be disproportionate, and there are no environmental justice concerns.

7.11 CUMULATIVE EFFECTS

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that is the focus of the cumulative impacts analysis. While impacts can be differentiated as direct, indirect, and cumulative, the concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus, the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource regardless of what entity (federal, non-federal, or private) is taking the actions.

Cumulative effects include the effects of the EARIP HCP (USFWS 2012c), the declaration of the San Marcos River as a State Scientific Area, and the pertinent planning goals and objectives found in the San Marcos Comprehensive Master Plan (City of San Marcos 2013). All of these proposed projects support water resources sustainability in the San Marcos River. The effects of these activities on the condition of the human and natural environment are described below for each resource.

The Final EARIP HCP EIS (USFWS 2012c) assessed the cumulative effects of the EARIP HCP and is incorporated herein by reference. The EIS describes multiple actions that would have direct and indirect effects in the study area and are reasonably foreseeable through 2030. These include transportation projects, water supply infrastructure projects, water supply management strategies, natural resource management programs and HCPs, and land development projects. The primary activities of concern in the study area are those related to development and urban conditions, and those related to recreation. Adverse conditions associated with these activities include increased water demand on the Edward's Aquifer, increased hard pan surfaces in the San Marcos River watershed, increased use or handling of pollutants in the San Marcos River watershed, or increased damage of vegetation and habitats due to recreational use. Many of the activities proposed or ongoing under the EARIP HCP, the State Scientific Area designation, and the City of San Marcos Comprehensive Plan would minimize the adverse conditions associated with development and recreation.

EARIP HCP

The EARIP HCP was prepared under the direction of the Texas Legislature and was required to include recommendations regarding aquifer withdrawal adjustments during critical periods that ensure that federally listed species associated with the Edwards Aquifer will be protected. The EARIP HCP includes many measures that would complement the Proposed NER Plan. Under the EARIP HCP, permanent access structures would be constructed on the San Marcos River. Relocation of trails under the Proposed NER Plan would contribute to efforts to control recreational impacts, especially at locations where sensitive species are present.

San Marcos River State Scientific Area

Designation of the San Marcos River as a State Scientific Area would place controls on recreation during periods of low flow. Efforts to educate the public and restrict access to sensitive areas during low-flow periods would have a minimal effect on recreation. All recreation activities would be allowed to continue. Efforts to reduce impacts of recreation during critical periods would contribute to the sustainability of the Proposed NER Plan by protecting the habitat benefits gained during more favorable climate conditions.

City of San Marcos Comprehensive Master Plan

The goals of the City of San Marcos' Comprehensive Master Plan (City of San Marcos 2013) include measures to protect natural resources and are incorporated herein by reference. The natural resource goals of the City's plan that would minimize potential long-term adverse effects of development include incorporation of low-impact development practices, adoption of watershed specific regulations, incentives for high density development, and proactively building the infrastructure and regional detention facilities to support growth.

7.11.1 No Action Plan

Under the No Action Plan, improvements to habitats in the San Marcos River and adjacent riparian habitats from the Proposed NER Plan would not be made. However, components of the EARIP HCP and Comprehensive Master Plan would likely be implemented, subject to local funding. Therefore, the No Action Plan would provide some cumulative benefits to the water quality and biological resources of the San Marcos River.

7.11.2 Proposed NER Plan

Soils

The EARIP HCP and Proposed NER Plan include measures to reestablish healthy functioning riparian zones, such as removing exotic vegetation and planting native vegetation. Although short-term soil disturbance and erosion could result during implementation of these measures, adherence to BMPs and local and state water quality protection measures (such as TCEQ regulations) would minimize potential adverse effects. Properly functioning riparian zones provide natural sediment and bank stabilization benefits that would reduce erosion of soils in the study area.

Sediment management and control, restoration of a functioning riparian zone, and control of recreation under the EARIP HCP in combination with the Proposed NER Plan would have minimal short-term cumulative adverse effects on sedimentation and erosion; however, these short term effects would be minimized by adhering to BMPs and local and state water quality protection measures. Although these measures could have short-term cumulative effects, sedimentation in the San Marcos River would be reduced over the long-term as soil erosion in the study area is reduced.

Aquatic Resources

Various measures in the EARIP HCP, Proposed NER Plan, and Comprehensive Master Plan would have indirect long-term beneficial cumulative effects on water quality in the study area including efforts to prohibit transport of hazardous materials through the San Marcos River and its tributaries, management of household hazardous wastes, a septic system registration and permitting program, impervious cover and water quality protection measures, and efforts to reduce contaminated runoff. The EARIP HCP also includes measures to ensure minimum flows are sustained in the San Marcos River and would result in increased surface water volumes in the study area. Many water quality parameters are related to the volume of spring flows; thus, measures that protect spring flows would have beneficial cumulative effects on water quality.

Biological Resources

A number of measures proposed under the EARIP HCP in combination with the Proposed NER Plan would have long-term beneficial cumulative effects on habitat conditions for biological resources in the study area. Measures such as riparian restoration, exotic plant and animal control, and sediment removal would be beneficial to aquatic and riparian wildlife habitats in the

study area. Although increased noise, human presence, and soil/substrate disturbance associated with implementation of these measures could affect wildlife habitats in the study area, these cumulative effects would be short-term and minimal. The EARIP HCP includes adaptive management measures to improve understanding of and management responses to issues such as the effects of low flow on wildlife and their habitats and the effectiveness of various exotic plant and animal control methods. Because many of the native inhabitants of the study area have adapted to a constant flow of high-quality water from the San Marcos Springs, measures to ensure long-term enhancement of spring-flows and maintenance of water quality would also benefit wildlife and their habitats in the study area.

Recreation, including boating, swimming, and fishing, all contribute to the degradation of vegetation on both improved and unimproved lands. Multiple unauthorized trails have been created, the banks of the river are denuded in multiple locations, and aquatic vegetation and substrates are frequently disturbed. These effects are intensified during periods of low flow and drought, when stress and decreased water depths increase the susceptibility of riparian and aquatic vegetation.

Listed Species

The Proposed NER Plan and the EARIP HCP both include measures that directly benefit listed species in the San Marcos River. Although there would be some short term cumulative impacts associated with soil disturbance, removal of sediments and vegetation, and turbidity in the San Marcos River, all listed species would realize long-term cumulative benefits through increased habitat area and improved habitat conditions.

Recreational, Scenic and Aesthetic Resources

The Proposed NER Plan in combination with the Comprehensive Master Plan, EARIP HCP, and the State Scientific Area designation, along with the completed Spring Lake Section 206 Aquatic Ecosystem Restoration project would cumulatively benefit the aesthetic resources of the San Marcos River. Although there would be short-term construction impacts on the visual environment, the benefits from ecosystem restoration and habitat protection would be long-term.

Recreational users would benefit from specific improved access points to the San Marcos River and restored banks with a reduction of generalized access to the River. Recreation is maintained on the San Marcos River due to consistent stream flows, consistent water

temperatures, and a scenic environment. Although recreation is not a component of the Proposed NER Plan, these conditions would be improved by all the proposed projects in the region.

Cultural Resources

Naturally occurring effects are expected to have a greater adverse impact on cultural resources than any activities proposed under the EARIP HCP, Proposed NER Plan, and the Comprehensive Management Plan. As described in the EARIP HCP EIS, any discovery of new sites or if newly discovered effects are identified, an assessment would be made to effectively mitigate any adverse effect in compliance with Chapter 26 of the THC's Rules of Practice and Procedure for the Act.

Air Quality

Short-term cumulative impacts on air quality would occur during construction activities from the various measures proposed by the EARIP HCP, Comprehensive Management Plan, and Proposed NER Plan. However, these impacts would return to ambient conditions following construction activities and no long-term cumulative impacts on air quality would occur.

Noise

Only short-term construction-related cumulative noise impacts would occur from the measures in the Proposed NER Plan, EARIP HCP, and Comprehensive Management Plan. No long-term cumulative impacts on the noise environment would occur.

Hazardous Materials

Other projects in the area, such as the EARIP HCP and those described by the Comprehensive Management Plan, are not likely to increase hazardous materials in the area. BMPs will be implemented during all construction activities to ensure that hazardous materials are properly stored and contained. Therefore, no adverse cumulative impacts from hazardous materials would occur as a result of the Proposed NER Plan.

Socioeconomic and Environmental Justice

The Proposed NER Plan, EARIP HCP, and Comprehensive Management Plan would have no long-term cumulative impacts on housing, employment, or regional spending. During construction activities, cumulative economic benefits would occur due to expenditures on

materials and supplies, but these beneficial impacts would only occur for the life of the construction projects. In the long-term, ecosystem restoration, maintenance of river flows, improvements in water quality, and specifically designated recreational access points will maintain the public interest in visiting and recreating in the San Marcos River, and existing businesses providing assistance in recreational uses will continue to be economically supported.

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SECTION 8.0
BEST MANAGEMENT PRACTICES

8.0 BEST MANAGEMENT PRACTICES

This section describes the BMPs that would be implemented as part of the Proposed NER Plan. Due to the limited nature of disturbance, the proposed restoration measures are not expected to cause any long-term adverse effects. The measures discussed below would decrease the severity of any short-term or temporary project-related effects on resources such as soils and listed species.

8.1 GENERAL BMPs

General BMPs provided in USACE guidance documents (EM 1110-2-1205, Environmental Engineering for Local Flood Control Channels; EM 1110-2-1902, Slope Stability; ERDC/CHL, TR 01-28, Hydraulic Design of Stream Restoration Projects) and applicable BMPs identified through review of species' listings, recovery plans, recent biological opinions, or consultation with USFWS are included in the Proposed NER Plan. BMPs are discussed below for each restoration measure. General construction BMPs to be implemented for all restoration measures include the following:

- All staging of equipment, materials, and vehicles will occur in paved parking areas.
- Any area to be disturbed would be minimized through limiting materials deliveries and equipment on-site to only those needed for effective project implementation.
- Construction and maintenance activities will be conducted only during daylight hours to avoid noise and lighting issues at night; noise levels for construction and maintenance should be minimized; all generators should be in baffle boxes (a sound-resistant box that is placed over or around a generator), have an attached muffler, or use other noise-abatement methods in accordance with industry standards.
- Vehicle traffic associated with restoration efforts will remain on established roads and speeds will be reduced to the maximum extent practical.
- All access routes into and out of the project disturbance area will be flagged to limit the disturbance in construction ingress and egress, and no disturbance outside of those access route boundaries will be authorized.
- All herbicides will be applied in the presence of an herbicide applicator licensed in the State of Texas.
- Application of herbicide within 30 feet of surface waters would be conducted with a sponge applicator to avoid overspray.
- Herbicide would not be applied within 10 feet of surface water, and all exotic species in these areas would be removed by hand.

- Waste materials and other discarded materials should be removed from the site as quickly as practicable; this should assist in keeping the restoration area and surroundings free of litter and reduce the amount of disturbed area needed for waste storage.
- Waste water (i.e., water used for project purposes that is contaminated with construction materials or water used for cleaning equipment, thus carrying oils or other toxic materials or other contaminants in accordance with state regulations) should also be stored in closed containers on-site until removed for disposal.
- The Monitoring and Adaptive Management Plan (Appendix I) would provide for a report describing the implementation of the BMPs and their effectiveness.
- All personnel involved with the on-the-ground construction or maintenance for the Proposed NER Plan will receive training in the affected listed species, the agreed upon BMPs, and the role of the construction monitor.

The following are BMPs to be implemented for specific restoration measures, subject to refinement during design.

EXOT

Areas to be treated will be surveyed, and target trees will be flagged or otherwise marked. Herbicide will then be applied at the manufacturer's recommended rate using backpack sprayers equipped with sponges to avoid overspray and damage to desirable species. Application will be conducted under the direction of a herbicide applicator licensed by the State of Texas.

In order to avoid disturbance of the river banks, channel, and associated habitats, exotic trees overhanging the river channel will be sprayed and left in place. Where foliage cannot be reached without trampling of river bank, channel, or associated habitats, an herbicide spike will be driven into the main trunk of the tree.

EXOA

Measures to reduce erosion and input of sediments into the river will include a silt fence or comparable barrier erected around each area during removal of elephant ear and establishment of native vegetation.

These measures could include surveys to determine the presence or absence of endemics, avoidance of areas where Texas wild-rice is present, and removal and exclusion of fountain

darters during control of elephant ear. Qualified permitted biologists will perform all removal efforts.

SED

The size and design of the hydrosuction equipment will minimize the suction of biota (except plankton) from within the San Marcos River. No hydrosuction will occur near or within areas identified as having endemic species, such as Texas wild-rice. All sediment will be captured within an enclosed system, transported to the Animal Shelter, and recycled by the City of San Marcos for future non-aquatic fill material. Additionally, erosion and sedimentation controls (i.e., wattles or straw bales) will be installed around the land-based hydrosuction equipment in the event of spillage or overtopping.

RIP and DISC and WET

All mechanical site preparation activities will include measures to minimize erosion and sedimentation into the San Marcos River, including silt fences, erosion mats, etc. All site preparation activities will follow guidelines presented in EM 1110-2-1902 and EM 1110-2-1205.

8.2 MIGRATORY BIRDS

The Migratory Bird Treaty Act requires that federal agencies coordinate with the USFWS if construction activity would result in the “take” of a migratory bird. If construction or clearing activities were scheduled during the breeding season (March 1-September 1), surveys would be performed to identify active nests. If construction activities would result in the “take” of a migratory bird, coordination with the USFWS and the TPWD would be conducted, and applicable permits would be obtained prior to construction or clearing activities. Another mitigation measure that would be considered is to schedule all construction activities outside the nesting season, thus, negating the requirement for nesting bird surveys.

8.3 LISTED SPECIES

Formal consultation with the USFWS to determine the effects of the Proposed NER Plan on listed species was completed on October 18, 2013. A Biological Assessment was submitted to the USFWS that included the general BMPs identified above. The Biological Opinion issued by the USFWS includes BMPs and Conservation Recommendations (Appendix D). Conservation

measures identified through formal consultation with the USFWS would be implemented and include (1) avoiding and minimizing erosion through use of erosion mats and properly installed silt fences; (2) selection of herbicides that are unlikely to affect (a) Texas wild-rice, (b) other non-target aquatic vegetation, (c) fountain darters, or (d) fountain darter prey; (3) diligent and careful hand application of herbicides; (4) using elephant ear control methods that will have the least impact on the river and its biota; and (5) ongoing communication with TPWD and USFWS to help ensure minimal adverse effects from restoration measures. In addition, biologists permitted by the USFWS and TPWD would clear fountain darters from the work area and carefully move fountain darters to nearby areas with plant cover.

Three additional reasonable and prudent measures (RPM) were identified through consultation and would be implemented: avoidance (RPM1), monitoring (RPM2), and maintenance of the coverage of submergent aquatic plants (RPM3). Where avoidance of Texas wild-rice and fountain darters is not practical, the USACE and the City of San Marcos will minimize the disturbance in space and time. BMPs to improve the water quality of stormwater shall be employed. All monitoring will include reporting of appropriate and relevant information to the USFWS and TPWD in a timely manner. The USACE and the City of San Marcos would ensure that the coverage of submergent aquatic plants is not permanently reduced by the restoration activities.

8.4 CULTURAL RESOURCES

Section 106 consultation with the Texas SHPO has been completed for the feasibility phase of the study. Prior to completion of design, additional coordination and consultation will be completed with the Texas SHPO. Numerous cultural resources are known to occur throughout the project area and occur very near the surface. Through consultation with the Texas SHPO, surveys, avoidance, and the appropriate measures would be developed and implemented during the design phase of the project to minimize the adverse effects on those resources.

SECTION 9.0
PROJECT IMPLEMENTATION

9.0 PROJECT IMPLEMENTATION

9.1 PROJECT DESCRIPTION

The Project includes all aquatic ecosystem restoration features described in this DPR/EA. The NER Plan would include improvements to or restoration of 43.93 acres of riparian habitats, 1.19 acres of wetland habitats, and 28.03 acres of aquatic habitats. Restoration of riparian habitat includes planting of approximately 14.56 acres of riparian forest in areas currently supporting low quality riparian habitat, parkland, sidewalks, parking lots, or other impervious surfaces; planting of approximately 2.10 acres of riparian forest along currently degraded discharge locations, and control of exotic shrubs and trees in approximately 27.28 acres of existing riparian forest. Restoration of aquatic habitat includes removal of approximately 2.61 acres of exotic vegetation along the river banks and removal of sediments over approximately 25.42 acres of the river bed (4.75 acres during the establishment phase). The NER Plan would improve the riparian corridors' ability to function as a filter of stormwater runoff and substantially reduce the input of sediments in the river. Concurrently, the removal of sediments and elephant ear from approximately 3.5 miles of river channel would restore native substrates and local hydraulics. The long-term reduction of sediment input, combined with continuous efforts to remove accumulated sediments and control elephant ear, would restore native substrates in the channel. Restoration of native substrates was evaluated as beneficial through HEP and would also benefit federally listed species.

9.1.1 Recreation Features

There are no recreation features proposed as part of the project.

9.1.2 Cost-Shared Monitoring

During the initial establishment period of 3 years, the USACE would perform monitoring of the project to determine whether the expected output is being achieved. The total cost of the cost-shared monitoring is estimated at $9,200.00. Monitoring after the 3-year period would be a Local Sponsor operations and maintenance responsibility.

9.2 PROJECT SCHEDULE

The project schedule for the aquatic ecosystem restoration project is presented in Table 9-1.

Table 9-1. Project Milestone Schedule

Milestone	Date Complete
USFWS Planning Aid Letter	January 2010
Habitat Analysis	April 2011
Complete ICA	April 2013
Complete Alternative Formulation Briefing	May 2013
Sponsor National Environmental Restoration Meeting	June 2013
DPR/EA	February 2014
Start Public Review	March 2014
Finish Public Review	April 2014
Execute Finding of No Significant Impact, if appropriate	April 2014
Initiate Plans and Specifications	May 2014
Initiate Construction	2015
Complete Construction	2018
Project Complete	2021

The detailed schedule for the Plans and Specifications Phase, Construction Phase, and Close-out Phase are presented in Table 9-2.

Table 9-2. Schedule for Preconstruction Engineering and Design (PED) Phase, Construction Phase, and Close-Out Phase

Phase and Task Description	Projected Start Date	Projected Completion Date
Preconstruction Engineering and Design (PED) Phase		
Initiate Plans and Specifications	N/A	May 2014
95% Plans and Specifications	May 2014	September 2014
Execute PCA	N/A	March 2014
Request Construction Funds	N/A	October 2014
Construction Phase		
Initiate construction	March 2015	N/A
EXOT	August 2015	December 2016
EXOA	April 2015	May 2018
RIP2	August 2015	March 2017
DISC	November 2015	December 2015
SED	August 2015	October 2015
WET	August 2016	March 2017
Construction Complete	N/A	May 2018
Establishment, Monitoring, and Adaptive Management	May 2018	May 2021
Close-Out Phase		
Initiate Project Close-out	N/A	May 2021
Final Transition to Operations and Maintenance	N/A	May 2021
Completion Report	June 2021	August 2021

N/A – not applicable

The PED would last approximately 3 to 6 months, construction would last approximately 3 years, and monitoring of implemented project features for approximately 3 years. Following the 3-year establishment period and successful establishment of all restoration measures, the project would be closed out and the sponsor would then assume all operation and maintenance requirements associated with the project.

9.3 PROJECT COSTS

9.3.1 Cost Apportionment

Project costs (Table 9-3) would be shared between the Federal Government and the Local Sponsors, the City of San Marcos and Texas General Land Office. Under Section 206 guidance, the non-federal, Local Sponsor interest shall provide 35 percent of the cost of construction of any project carried out under Section 206, including provision of all lands, easements, rights-of-way, and necessary relocations. No more than $5 million in federal funds may be allotted under a Section 206 project. Based on certified cost estimates (Appendix F), the Federal Government would be responsible for $2,367,000, and the Local Sponsors would be responsible for $1,275,000 (Table 9-4).

Table 9-3. Cost Allocation

Project Item	Project Costs ($1,000)
Construction	$1,680
LERRDS	$1,477
Planning, Engineering, and Design	$234
Construction Management	$251
Total	**$3,642**

Table 9-4. Summary of Project Cost Apportionment

Project Item	Total Investment Cost ($1,000)
Total Project Cost*	**$3,642**
Federal Share (65 percent)	$2,367
Sponsor Share (35 percent)	$1,275
Sponsor LERRD Credit	$1,275
Cash Contribution	$0

*does not include cost of Feasibility Study

9.3.2 Project Partnership Agreement

The Project Partnership Agreement (PPA) is a contract between the Federal Government and the non-federal, Local Sponsor describing the rights and responsibilities of each party during project implementation, including cost sharing. The PPA would be executed after the receipt of federal project approval.

9.4 SPECIAL ITEMS OF LOCAL COOPERATION

9.4.1 Local Sponsors

The Local Sponsors for the project will be the City of San Marcos and the Texas General Land Office as signatories to the PPA. Exhibits 9-1 and 9-2 are current Letters of Intent in support of the project. Exhibit 9-3 is a self-certification of financial capability from the City of San Marcos.

9.4.2 Local Cooperation Requirements

The PPA is anticipated to refer to the sponsors as the "Non-federal sponsors" throughout the Agreement, collectively. The City of San Marcos would assume full financial responsibility for the project, including operations and maintenance, and the Texas General Land Office would make its lands available for the project. The PPA could reflect these items with the following proposed language for items of local cooperation (or an equivalent) in the PPA:

"Notwithstanding any other provision of this Agreement, the Non-Federal sponsor Texas General Land Office shall make the lands, easements, and rights-of-way under its jurisdiction available as specifically required to the Project including for operation, maintenance, repair, rehabilitation and replacement under Article VIII of this Agreement; and the Non-Federal sponsor City of San Marcos shall assume sole responsibility for any and all Non-Federal sponsor financial obligations towards the Project and shall assume sole responsibility to operate, maintain, repair, rehabilitate, and replace the entire Project in accordance with Article VIII of this Agreement".

The PPA may require further coordination with SWD/HQUSACE to address these items early during the design phase for the project.

Exhibit 9-1. Letter of Support from the Texas General Land Office

TEXAS GENERAL LAND OFFICE

JERRY PATTERSON, COMMISSIONER

November 20, 2013

Colonel Charles H. Klinge, Jr.
District Engineer
ATTN: CESWF-PM-C
U.S. Army Corps of Engineers
819 Taylor Street
Fort Worth, Texas 76102

Re: Provision of Adequate Real Estate Interest for the Corps' Aquatic Ecosystem Restoration Project in San Marcos, Texas

Dear Sir,

This letter is in response to inquiries made by the U.S. Army Corps of Engineers (Corps) to clarify the proposed participation by the Texas General Land Office (GLO) in the referenced project (Project). The GLO is interested in participating in the Project to the fullest extent of the GLO's authority related to the use of state-owned river beds. The GLO's authority as it relates to state-owned river beds can be found at TEX. NAT. RES. CODE Section 51.291, *et seq.*, and 31 TEX. ADMIN. CODE §13.12, *et seq.*

Based on a review of a sample Project Partnership Agreement (PPA) provided to the GLO by the Corps, we are confident that we will be able to be a signatory to the PPA as a co-sponsor with the City of San Marcos (City). We further understand that the specific language to be included in the PPA to detail the respective division of the responsibilities and obligations of the signatory parties is subject to further negotiation and approvals, and we are confident that it is within our statutory authority to sign the resulting PPA as a co-sponsor with the City.

The GLO fully supports the Corps' proposal to eliminate exotic flora and fauna and to restore native vegetation to the San Marcos River. It is our opinion that the following proposed maintenance activities under the PPA by the City may be performed following notification/coordination with the GLO:

1. Ongoing removal, chemical control and planting of vegetation
2. Ongoing monitoring, maintenance and repair of plantings or other Project measures
3. As-needed mitigation measures such as fish exclusion fencing and signage

Additionally, as a signatory to the PPA, including appropriate language therein, the GLO is able to agree and coordinate on any activity or easement necessary to accomplish Project construction within the GLO's authority to do so, including one time sediment removal during construction and site access, among other things. However, please note that removal of sediment from the river bottom is regulated by the Texas Parks and Wildlife Department (TPWD). The GLO will be in concomitant coordination with TPWD and the City throughout construction and ongoing maintenance of the Project.

As a PPA signatory, we will extend our full commitment and support to the Project and are fully willing and able to take the steps necessary within GLO's authority to work with the Corps, the City, and the

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TPWD to ensure that the construction and ongoing maintenance of the Project will be achievable in accordance with the PPA.

If you have any questions concerning this letter, please contact Tony Williams at 512-463-5055, or by e-mail at tony.williams@glo.state.tx.us.

Sincerely

Ned Polk

Ned Polk, Director Uplands Leasing

Exhibit 9-2. Letter of Support from the City of San Marcos

CITY MANAGER'S OFFICE

February 10, 2014

Colonel Charles Klinge, Jr.
District Commander
PO Box 17300
819 Taylor Street
Fort Worth, Texas 76102

Re: Section 206 Aquatic Restoration Project-San Marcos River, Texas

Dear Colonel Klinge,

The City of San Marcos, Texas extends its full support for the Section 206 Aquatic Ecosystem Restoration Project - San Marcos River, Texas. We understand that the study was conducted under the authorities given to the Corps of Engineers by Congress under the Corp's Continuing Authorities Program for approval of the report to move into the implementation phase of this project.

The restoration plan, contained in the feasibility report is an appropriate action to address the ecosystem concerns in the area, is consistent with our goals, and is supported by the public.

We understand that the total current estimated cost is about $3.65 million for the ecosystem restoration project. We further understand that the non-federal minimum cost share requirement for this project is 35% resulting in a total sponsor share of the project of approximately $1.28 million. The currently estimated valuation for our provision of all lands, easements, rights-of-way, relocations, and disposals (LERRDs) is about $1.48 million, which is to be credited against our total sponsor cost sharing requirement, resulting in no required sponsor cash contribution, as currently estimated. We further understand that no credit will be afforded and no cash reimbursement made for the valuation of our LERRDs that exceeds our required cost share for the project.

We are committed to this project and are willing, able, and fully prepared to enter into the next phase of this project in order to proceed to completion. We look forward to executing a Project Partnership Agreement (PPA) at the earliest opportunity. We understand that the Texas General Land Office will be co-signatory to the PPA. We understand the provisions of the PPA including the requirements for annual operation and maintenance (OMRRR) of the project.

The City of San Marcos assumes full financial responsibility toward the project and for the subsequent OMRRR. Our Self-Certification of Financial Capability is attached.

Thank you for your assistance with this much needed restoration project. Please contact me if you need any additional information.

Sincerely,

Jared Miller
City Manager

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Exhibit 9-3. Self-Certification of Financial Capability from the City of San Marcos

NON-FEDERAL SPONSOR'S
SELF-CERTIFICATION OF FINANCIAL CAPABILITY
FOR DECISION DOCUMENTS

I, Heather Hurlbert, do hereby certify that I am the Director of Finance for the City of San Marcos (the "Non-Federal Sponsor"); that I am aware of the financial obligations of the Non-Federal Sponsor for the Section 206 Aquatic Ecosystem Restoration Project – San Marcos River, Texas; and that the Non-Federal Sponsor will have the financial capability to satisfy the Non-Federal Sponsor's obligations for that project. I understand that the Government's acceptance of this self-certification shall not be construed as obligating either the Government or the Non-Federal Sponsor to implement a project.

IN WITNESS WHEREOF, I have made and executed this certification this 31 day of January, 204.

BY: [illegible]
TITLE: Director of Finance
DATE: 1-31-14

9.4.3 Other Implementation Items

The TPWD owns approximately 12 acres which are part of the project. They have indicated the willingness and ability to provide a permanent easement for the project. The specific language of the easement to be recorded will be coordinated for approval through USACE Real Estate during design. Exhibit 9-4 is the letter of support for the project from TPWD.

Exhibit 9-4. Letter of Support from TPWD

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Lee M. Bass
Chairman-Emeritus
Fort Worth

Carter P. Smith
Executive Director

December 9, 2013

Colonel Charles H. Klinge, Jr.
District Engineer
ATTN: CESWF-PM-C
U.S. Army Corps of Engineers
819 Taylor Street
Fort Worth, Texas 76102

Re: Provision of Adequate Real Estate Interest for the Corps' Aquatic Ecosystem Restoration Project in San Marcos, Texas

Dear Sir,

This letter is to clarify the participation in the referenced project of the Texas Parks and Wildlife Department (TPWD) in accordance with our associated rules, regulations, policy, and procedures.

The TPWD has reviewed the standard Articles of the Corps Project Partnership Agreement (PPA) and it is our preference not to be a signatory to the Agreement as a co-sponsor with the City of San Marcos. We have also reviewed the preliminary real estate plan for the project dated 17 July 2013 including the proposed language for a non-standard estate. We understand that the specific language for a non-standard estate is subject to further negotiation and approvals, and we are confident that it can be made consistent with our statutory authority to grant an interest in real property owned by TPWD.

The TPWD fully supports the proposal to eliminate exotic vegetation and restore native vegetation to the San Marcos River. Permanent easements can be created in accordance with the Texas Natural Resources Code, Title 8, Chapter 183 (Enclosure 1). Specifically, section 183.002(c) provides that "a conservation easement is unlimited in duration unless the instrument creating it makes some other provision". It is TPWD general policy that these easements are to be in perpetuity. One of our standard conservation easement templates is provided (Enclosure 2) as a sample, which includes our standard language "WHEREAS, Grantors further intend, as owners of Property, to convey to Grantee the right to preserve and protect the conservation values of the Property in perpetuity;" and "1. **Grant of Conservation Easement.** Grantor hereby grants and conveys to Grantee, and Grantee hereby voluntarily accepts, a perpetual Conservation Easement, an immediately vested interest in real property defined by Chapter 183 of the Texas Natural Resources Code, of the nature and character described herein."

Any grant of a real estate interest in property owned by TPWD is subject to approval of the Texas Parks and Wildlife Commission (the Commission). The next scheduled Commission meeting is January 23, 2014. TPWD staff intends to recommend at that time that the Commission approve the grant of a non-standard estate or conservation easement on approximately 12.0 acres adjacent to the San Marcos River, subject to agreement on the terms of such a conveyance, in consideration for the financial commitment of USACE and the City of San Marcos to eliminate exotic vegetation and

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restore native vegetation on this tract. The conveyance will reserve the right of TPWD to make necessary changes to its operations at the A.E. Wood Fish Hatchery, such as relocation of the water intake structure, provided that TPWD would be responsible for restoring any native vegetation affected by such operational changes. The conveyance will include provisions for any activity or easement necessary to accomplish project construction and site access. It is understood that in making this conveyance, TPWD assumes no responsibility for the permitting, regulatory compliance, funding or success of the project.

TPWD will be in concomitant coordination with the General Land Office (GLO) and the City of San Marcos throughout construction and ongoing maintenance of the project. We extend our full commitment and support to the project and are fully willing and able to take the steps necessary and work with the Corps, the City, and the GLO to ensure that the construction and ongoing maintenance of the project will be achievable in accordance with the PPA.

If you have any questions concerning this letter, please contact Ryan McGillicuddy, 512-389-8622, Ryan.McGillicuddy@tpwd.texas.gov.

Sincerely

Todd Engeling
512-389-4826
todd.engeling@tpwd.teaxs.gov

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SECTION 10.0
PUBLIC INVOLVEMENT

10.0 PUBLIC INVOLVEMENT

10.1 AGENCY COORDINATION

Coordination with USFWS and TPWD has been ongoing since the inception of this study. Other agencies and interested parties that have participated in the review of this plan include the following (Appendix E):

- USEPA
- FEMA
- Texas SHPO
- TCEQ
- TSU, San Marcos
- EAA
- Guadalupe Blanco River Authority
- Federal Aviation Administration
- TxDOT Aviation Division

The San Marcos Municipal Airport is located approximately 3 miles from the study area. Because habitat restoration components have the potential to create a hazardous wildlife attractant, coordination with the Federal Aviation Administration and Texas Department of Transportation, Aviation Division, according to the Advisory Circular Number 150/5200-33B, has occurred as part of the agency coordination.

10.2 PUBLIC REVIEW

The USACE and the City of San Marcos held a public meeting in an open house format during the public scoping period. The public scoping meeting was held on June 12, 2013, at the Dunbar Recreation Center, San Marcos, Texas. A copy of the public scoping meeting announcement is provided in Appendix E.

The DPR/EA was made available for public review for a period of 30 days beginning February 20, 2014. The Notice of Availability and agency coordination letters are included in Appendix E.

The USACE received an email from the Texas Department of Transportation on February 24, 2014 stating their lack of objection to the project and a letter of concurrence with the USACE's determination of no effect on cultural resources was received from Texas SHPO on February 21, 2014 (Appendix E). No other comments were received during the public review period. Hard copies of the DPR/EA were mailed to agencies identified in the mailing list and the San Marcos Public Library. A digital copy was made available through the USACE Fort Worth website and the City of San Marcos website.

SECTION 11.0
RECOMMENDATIONS

11.0 RECOMMENDATIONS

I recommend that the restoration plan as generally described in the Detailed Project Report and Integrated Environmental Assessment be implemented under the authority of Section 206 of the WRDA of 1996, Public Law 104-303, with such modifications as in the discretion of the appropriate authority may be deemed advisable. The total project cost is currently estimated to be $3,642,000.

Prior to the commencement of construction, local interests must agree to meet the requirements for Local Sponsor responsibilities as outlined in this report and future legal documents. The City of San Marcos, Texas, and the Texas General Land Office have demonstrated that they have the authority and financial capability to provide all Local Sponsor requirements for the implementation, operation, and maintenance of the project. The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation, evaluation, and development of individual projects under the U.S. Army Corps of Engineers Continuing Authorities Program.

Charles H. Klinge
Colonel, U.S. Army Corps of Engineers
District Engineer

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SECTION 12.0
LIST OF ACRONYMS/ABBREVIATIONS

12.0 LIST OF ACRONYMS/ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic meter
AACU	Average Annual Cost Unit
AAHUs	Average Annual Habitat Units
ACT	Antiquities Code of Texas
APE	Area of Potential Effects
BMP	best management practice
C	degrees Celsius
CEQ	Council on Environmental Quality
CESWF	USACE, Fort Worth District
CFC	chloroflourocarbon
CFR	Code of Federal Register
cfs	cubic feet per second
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CWA	Clean Water Act
dB	decibel
dBA	A-weighted decibel
dbh	diameter breast height
DISC	Control of Discharge
DO	dissolved oxygen
DOR	drought of record
DPR/EA	Detailed Project Report/Environmental Assessment
DUCK	Management of Waterfowl
EAA	Edwards Aquifer Authority
EARIP HCP	Edwards Aquifer Recovery Implementation Plan Habitat Conservation Plan
EDU	Education
EIS	Environmental Impact Statement
EM	Engineering Manual
EO	Executive Order
ER	Engineering Report
ESA	Endangered Species Act
EXOA	Control of Exotic Aquatic Vegetation – Emergent
EXOT	Control of Exotic Shrubs and Trees
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FPPA	Farmland Protection Policy Act
FR	Federal Register
FWOP	future without project
FWP	future with project
GHG	greenhouse gases
GIS	Geographic Information System
GPS	Geographic Positioning System
GSRC	Gulf South Research Corporation
HEP	Habitat Evaluation Procedures
HFC	hydrochlorofluorocarbon

HSI	Habitat Suitability Index Model
HTRW	hazardous, toxic, or radioactive waste
HU	Habitat Units
HUD	U.S. Department of Housing and Urban Development
ICA	Incremental Cost Analysis
IH	Interstate Highway
LERRDS	lands, easements, rights of way, relocation, and disposal areas
LESA	Land Evaluation Site Assessment
m^2/ha	square meters per hectare
mg/m^3	milligrams per cubic meter
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NER	National Ecosystem Restoration
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
O_3	ozone
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
P.L.	Public Law
PED	planning, engineering, and design
PM-10	particulate matter less than 10 microns
PM-2.5	particulate matter less than 2.5 microns
ppm	parts per million
PVC	polyvinyl chloride
RIP	Restore Riparian Corridor
SED	Removal of Accumulated Sediments
SHORE	Stabilization of Stream Bank and Control of Recreational Access
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SRP	soluble reactive phosphorus
TCEQ	Texas Commission on Environmental Quality
THC	Texas Historical Commission
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TR	Technical Report
TSS	total suspended solids
TSU	Texas State University
TWC	Texas Water Code
TY	Target Year
U.S.C	U.S. Code
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WET	Restoration of Wetlands
WRDA	Water Resources Development Act

SECTION 13.0
LIST OF PREPARERS

13.0 LIST OF PREPARERS

The following people were involved in the preparation of this DPR/EA.

Name	Agency/ Organization	Discipline/Expertise	Experience	Role in Preparing DPR/EA
Amanda McGuire	USACE CESWF	Environmental Planning	11 years of environmental planning experience	Project Manager
Sam Arrowood	CESWD-PDP/CESWF-PM-C	Planning	23 years of USACE experience	CAP PgM/Expert Reviewer
Thurman Schweitzer	USACE CESWF	Real Estate	10 years of real estate experience	Development of Real Estate Plan
Nancy Parrish	CESWF-PEC-PF	Plan Formulation/Cultural Resources	21 years of experience	Cultural Resources Reviewer
Ninfa Taggart	USACE CESWF	Economics	2.5 years of cost estimating experience	Cost analysis
Patrick Conner	USFWS		27 years of USFWS experience	Development of restoration measures and baseline surveys
Ryan McGillicuddy	TPWD		8 years of TPWD experience	Development of restoration measures and baseline surveys
Melanie Howard	City of San Marcos			Development of restoration measures and baseline surveys
Chris Ingram	GSRC	Biology/Ecology	35 years of EA/EIS studies	Quality Control
Eric Webb, PhD	GSRC	Forestry/Wildlife	20 years of NEPA and related studies	Project Manager
Josh McEnany	GSRC	Biology	12 years of NEPA and natural resources	Aquatic and biological resources
Bretton Somers	GSRC	Anthropology/Project Archaeologist	8 years of archaeological studies	Cultural resources
Sharon Newman	GSRC	GIS/Graphics	13 years GIS experience	Graphics
Michael Hodson	GSRC	Biology/Plan Communities	10 years in NEPA and related studies	HEP analysis and baseline surveys
Ann Guissinger	GSRC	Socioeconomics	30 years of economic analysis	Socioeconomic resources
Steve Ovianki	GSRC	Geology	22 years of NEPA and remediation	HTRW
Steve Kolian	GSRC	Forestry	13 years of environmental studies	Air and noise

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SECTION 14.0
REFERENCES

14.0 REFERENCES

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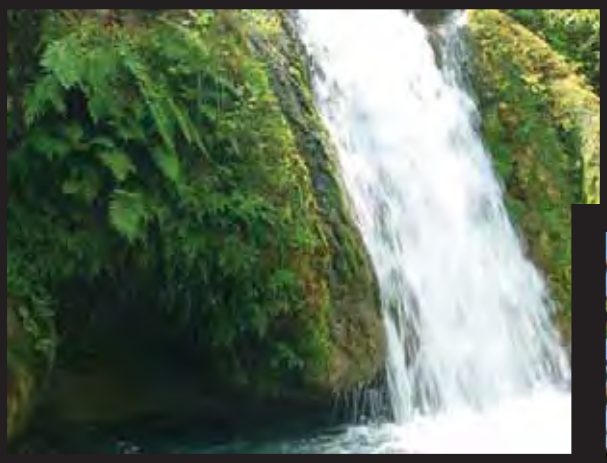
APPENDIX A
HABITAT SUITABILITY INDEX MODEL SELECTION

US Army Corps of Engineers
Fort Worth District

San Marcos Aquatic Ecosystem Restoration Project
Habitat Suitability Index Model Selection for use in Habitat Evaluation Procedures

April 2011

U.S. Army Corps of Engineers
Fort Worth District



SAN MARCOS AQUATIC EOCOSYSTEM RESTORATION PROJECT
HABITAT SUITABILITY INDEX MODEL SELECTION
FOR USE IN HABITAT EVALUATION PROCEDURES

Contract No. W9126G-09-D-0067-0029
Delivery Order No. 0012

Lead Agency:
U.S. Army Corps of Engineers
Fort Worth District

US Army Corps
of Engineers
Fort Worth District

Local Sponsor:
City of San Marcos, Texas

Prepared by:
Gulf South Research Corporation
Baton Rouge, Louisiana

April 2011

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1.0 INTRODUCTION

The Continuing Authorities Program (CAP) and Section 206 of the Water Resources Development Act of 1996 authorizes the U.S. Army Corps of Engineers (USACE), Fort Worth District (CESFW) to participate in the development and implementation of projects to restore terrestrial and aquatic habitats that have been significantly disturbed, degraded, or altered. CESFW and the local sponsor, the City of San Marcos, have prepared a Preliminary Restoration Plan (PRP) proposing measures for the restoration of the aquatic and riparian habitats along the San Marcos River between Rio Vista Dam and Cumming's Dam (Figure 1). Measures proposed for the restoration of aquatic habitats include the control of non-native plants, planting of native plants, creation of wetlands or wet-ponds to treat stormwater, and modification of one or more of the check dams within the project area. Measures proposed for the restoration of riparian habitats include controlling recreational access to reduce trampling of vegetation and degradation of stream banks, removing hard surfaces, and converting maintained grasslands into forested habitats.

The existing and future suitability of the aquatic and riparian habitats will be assessed using Habitat Evaluation Procedures (HEP). HEP provide standards and guidelines to be used for documenting and projecting the quality and quantity of available habitat for selected wildlife species. HEP are based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This Model Selection Report documents the criteria and assumptions used to select HSI models for application of HEP to the San Marcos aquatic ecosystem restoration project.

2.0 SELECTION OF POTENTIALLY APPLICABLE MODELS

All certified Habitat Suitability Index (HSI) models were reviewed to determine which models assess habitats for species whose distribution overlaps with the project area. The selected models included 17 fishes, one amphibian, two reptiles, four waterfowl, two upland game birds, one raptor, four song birds, and five mammals. The scientific names, general habitat preferences, and applicable cover types for each model are presented in Appendix 1. To be selected for assessment of existing and future habitat conditions, a model must be applicable to the existing and future cover types in the project area. Grassland cover types are not, and have

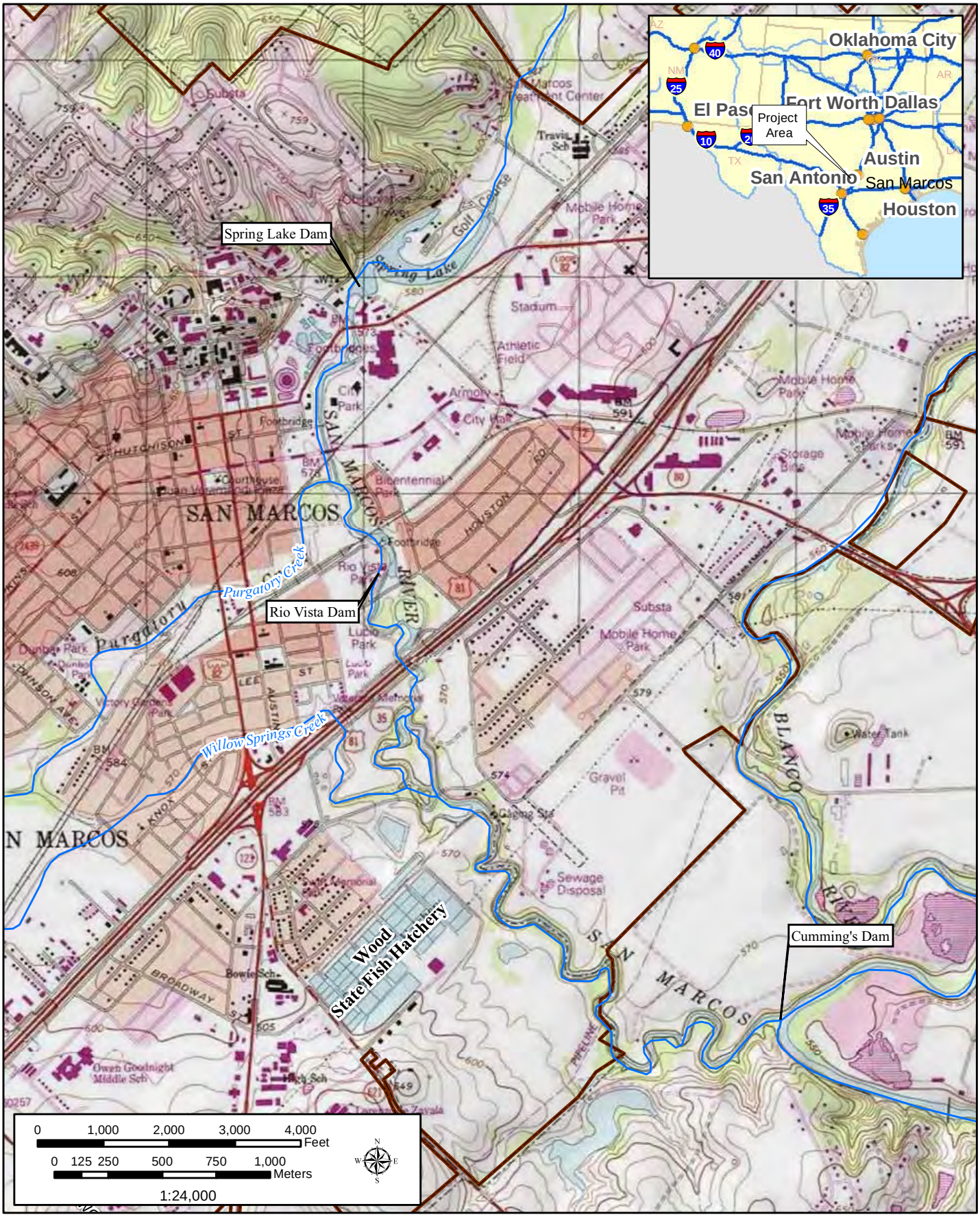

Figure 1: Vicinity Map

GSRC

March 2011

not historically been, a substantial part of the San Marcos River ecosystem. Therefore, models that require the presence of grassland cover types for optimal suitability were eliminated from further consideration.

Each of the remaining models is applicable to at least one aquatic, wetland, or upland cover type, and at least one model must be selected to assess habitat suitability for each of these cover type groupings. For each cover type grouping, the list of applicable models was reviewed to determine the likely effect of measures listed in the PRP on model output. Those models which are likely to result in a net gain of habitat suitability as a result of implementing measures identified in the PRP were selected for further consideration. During this review, models which provide opportunities to create habitat output through possible restoration measures not included in the PRP were also carried forward for further consideration.

Non-certified models representing Federally endangered, endemic species, Texas wild-rice (*Zizania texana*) and fountain darter (*Etheostoma fonticola*), were also considered. Because these species are endangered, there distribution is limited, which limits the ability to identify preferred habitat conditions. As with most rare species, habitats considered potentially suitable are often not occupied by these species for unknown reasons. For a model to be certified, all of the conditions which affect abundance must be identified and included in the model. Although the models for these species represent the best available approach to predicting the species abundance and for identifying opportunities to improve conditions for these species, the models do not meet the requirements for certification. Two of the variables considered in the models, velocity and depth, are dependent primarily on the rate of discharge from the Edwards Aquifer and would not be substantially affected by measures identified in the PRP. Furthermore, because the models would only be applicable to the San Marcos River and would be used just once, they would be assigned the lowest priority for review and certification. For these reasons, the Texas wild-rice and fountain darter models were excluded from further consideration as models for use in HEP.

It was noted in a coordination meeting held on March 8, 2011 that the HEP analysis need not be exclusive of habitat preferences of these endemic species. The U.S. Fish and Wildlife Service (USFWS) HEP: 102 Ecological Services Manual and USACE Engineering Regulation 1105-2-104 require that other factors, including endangered species and cultural resources, be considered in the development and evaluation of restoration measures and plans. Thus, a

measure which is not shown to be cost-effective through the HEP and Incremental Cost Analysis (ICA) processes can be included in the final plan selection if benefits to these endangered, endemic species can be shown.

2.1 Aquatic Habitats

Of the applicable fish models, 10 represent species known to occur in the reach of the San Marcos River between Rio Vista Dam and the confluence with the Blanco River: black bullhead, bluegill, channel catfish, common carp, gizzard shad, green sunfish, largemouth bass, redbreast sunfish, redear sunfish, and warmouth. All of these models, except the redbreast sunfish, represent species with a preference for slower, deeper mesohabitats such as pools and backwater areas. The redbreast sunfish is adapted to swifter waters associated with riffles and runs. Applicable models of fish species not documented within the project area include the black crappie, creek chub, flathead catfish, slough darter, smallmouth bass, smallmouth buffalo, and white crappie. Of these models, the creek chub, flathead catfish and smallmouth bass, represent species more adapted to swift water habitats. The group of selected models should include at least one model that represents a species preferring pools and one species preferring riffles and runs.

Although existing water quality conditions are near optimum for most of the applicable fish models, some models are tolerant of, or prefer, slightly turbid or warmer waters when compared to other models. These include channel catfish, common carp, flathead catfish, gizzard shad, slough darter, smallmouth buffalo, and white crappie. Clear water and cool temperatures are the historical condition for the San Marcos River ecosystem, are the preferred conditions of endemic species, and should be the goal of ecosystem restoration. Measures to reduce the input of sediment from storm water or tributaries would not result in net benefits as evaluated using these fish models. Therefore, models which assume that relatively higher water temperatures or turbidity are tolerable or preferred were eliminated from further consideration.

The fish models' habitat conditions generally include measures of hydrology (such as velocity, gradient, percent pool area, etc.), water quality (such as temperature, dissolved oxygen, turbidity, etc.), substrate, vegetative cover, and hard cover (e.g., boulders and in-stream woody material). The primary difference between fish models is found in the range of conditions considered optimal for a given species. With the exception of slightly cooler water temperatures and faster velocities, the existing conditions of the San Marcos River in the project area would

be evaluated as optimal to near optimal using the available, certified HSI models. Models representing species that are known to occur in the project area and are not tolerant of warm or turbid waters were carried forward for more detailed assessment (Table 1). Models representing species that are not known to occur in the project area, but are not tolerant of warm or turbid waters and prefer riffle/run mesohabitats were also carried forward for more detailed assessment.

Table 1. Presence and General Habitat Preference of Applicable Fish Models

Model	Present in Project Area	Tolerant of turbidity or warm water	Preferred Mesohabitat	Carried Forward
black bullhead	yes	no	pools	yes
black crappie	no	no	pools	no
bluegill	yes	no	pools	yes
channel catfish	yes	yes	pools	no
common carp	yes	yes	pools	no
creek chub	no	no	riffle/run	yes
flathead catfish	no	yes	riffle/run	no
gizzard shad	yes	yes	pools	no
green sunfish	yes	no	pools	yes
largemouth bass	yes	no	pools	yes
redbreast sunfish	yes	no	riffle/run	yes
redear sunfish	yes	no	pools	yes
slough darter	no	yes	pools	no
smallmouth bass	no	no	riffle/run	yes
smallmouth buffalo	no	yes	pools	no
warmouth	yes	yes	pools	no
white crappie	no	yes	pools	no

Several models are suitable for evaluating aquatic cover types and wetland cover types. Although these models include an aquatic component, riverine habitats are not necessary to provide suitable conditions. These models are considered below in Section 2.2. The belted kingfisher model is the only non-fish model that is only applicable to aquatic cover types. The model assumes that clear, shallow, relatively open streams provide optimal habitat. Measures which remove canopy cover over the river would result in increased habitat suitability for this species; thus, the model is carried forward.

2.2 Wetland Habitats

Wetland cover types include forested, scrub-shrub, and herbaceous wetlands. Forested and scrub-shrub wetlands are limited within the project area, but could be created by improving connection of the river to the floodplain. The creation of wetlands or shallow ponds within the project area would increase the area of herbaceous wetland habitats. Most of the models

applicable to herbaceous wetland cover types are also applicable to aquatic cover types, and these models are assessed here. Models that are applicable to wetland and upland cover types are discussed below under upland habitats. One fish model, the white crappie, is applicable to wetland cover types, but was eliminated from further consideration due to a tolerance of turbid waters. One waterfowl model, the great blue heron, assumes that human disturbance results in unsuitable habitat conditions, and this model is eliminated from further consideration. One mammal model, the beaver, was eliminated because of the species' tendency to alter stream hydrology and consequent incompatibility within an urban setting. A second mammal model, the swamp rabbit, requires wetlands greater than 250 acres in size with suitable upland refuge. It is unlikely that 250 acres of suitable wetland habitat would be created as a result of the project; thus, the swamp rabbit model is excluded from further consideration.

The amphibian model (bullfrog) and both reptile models (slider turtle and snapping turtle) assume that optimum conditions are provided by slow, warm waters with abundant vegetative cover. Creation of wetlands or shallow ponds within the floodplain or along tributaries would likely result in a net gain of habitat suitability as evaluated by these three models. The American coot, red-winged blackbird, and muskrat each consider herbaceous wetlands with moderate vegetative cover and normally inundated to be optimal. Of these three models, the American coot is most tolerant of dry periods while the muskrat is least tolerant of dry periods. The American coot model assumes that suitability increases with increasing length of the vegetation/open water edge, where linear ditches lined with vegetation provide the least suitable habitats. The red-winged blackbird and muskrat models are indifferent to spatial heterogeneity, but require that at least 80 percent of emergent vegetation be persistent broad-leaved monocots such as bulrush or cattails. The red-winged blackbird model is very similar to the muskrat model, but also considers the presence or absence of Odonata species (i.e., damselflies and dragonflies). Because the model suggests that the presence of Odonata species must be based on empirical evidence, projecting future conditions would be spurious. For these reasons, the red-winged blackbird model is excluded from further analysis.

2.3 Terrestrial Habitats

Each of the four terrestrial models that have not been eliminated (i.e, barred owl, downy woodpecker, hairy woodpecker, and fox squirrel) assumes that mature forest communities provide optimum habitat suitability. Each model includes a measure of mean (average) tree size. The downy woodpecker, hairy woodpecker, and fox squirrel models assume that a mean

tree size greater than 14 inches in diameter at breast height (dbh) provides optimum conditions. While the barred owl assumes that a mean tree size greater than 20 inches dbh and more than 2 trees per acre with a 20 inch or greater dbh are required to provide optimum conditions. Both woodpecker models assume that snags are necessary to provide optimum conditions, with the downy woodpecker model favoring a larger number of small snags compared to the hairy woodpecker model.

The barred owl model states that data used to develop suitability index curves for tree size are based on studies conducted in northwestern and eastern coastal areas, and that calibration of the model for regional variation is appropriate. Without suitable data for calibration of the model to regional conditions, the barred owl model would likely underestimate habitat suitability. Other terrestrial models would not require calibration; therefore, the barred owl model is eliminated from further consideration. The fox squirrel model assumes that a canopy cover greater than 60 percent will result in declining habitat suitability, and that at least 40 percent of canopy cover is provided by mast-producing species. Factors limiting tree canopy cover such as fire or frequent inundation are absent from the San Marcos riparian zone. Creating optimal conditions, as assessed by the fox squirrel model, would require thinning of the existing canopy, replacement with mast-producing species, and long-term canopy maintenance to ensure that suitable conditions are maintained. For these reasons, the fox squirrel model is also eliminated from further consideration.

3.0 COMPARISONS OF POTENTIALLY SELECTED MODELS

Of the 36 HSI models considered applicable based on the species' range and preferred habitat types, 20 were removed from further consideration based on the criteria described above. The remaining 16 potentially selected models (Table 2) were discussed with USACE, USFWS, and Texas Parks and Wildlife Department (TPWD) at a meeting held on March 8, 2011.

Table 2. Potentially Selected Models

<table>
<tr><th colspan="2">Aquatic</th><th colspan="2">Wetland</th><th rowspan="2">Terrestrial</th></tr>
<tr><th>riffle/run</th><th>pool</th><th>shallower</th><th>deeper</th></tr>
<tr><td>creek chub</td><td>black bullhead</td><td>snapper turtle</td><td>bullfrog</td><td>downy woodpecker</td></tr>
<tr><td>redbreast sunfish</td><td>bluegill</td><td>American coot</td><td rowspan="4">slider turtle</td><td rowspan="4">hairy woodpecker</td></tr>
<tr><td rowspan="3">smallmouth bass</td><td>green sunfish</td><td rowspan="4">muskrat</td></tr>
<tr><td>largemouth bass</td></tr>
<tr><td>redear sunfish</td></tr>
<tr><td colspan="2">belted kingfisher</td></tr>
</table>

Because ecosystem degradation in the project area is primarily limited to the increasing abundance of non-native aquatic plants, controlling these plants is one of the primary objectives of ecosystem restoration. Measures to remove non-native plants and plant native species are included in the PRP; therefore, at least one model should be sensitive to the cover of submerged and emergent species.

The list of species included in Table 2 was reviewed by USFWS and TPWD, and the following models were recommended based primarily on the sensitivity of the models to the cover of submerged and emergent plants: black bullhead, green sunfish, bullfrog, and slider turtle. However, because the black bullhead is considered to be a species more tolerant of poor water quality conditions, the channel catfish was recommended as an alternative. It was also recommended that the longear sunfish (*Lepomis megalotis*) replace the green sunfish; however, there is not an approved model for the longear sunfish. A comparison of the optimum conditions for the black bullhead and channel catfish (Attachment B) shows that the channel catfish is more sensitive to changes in the cover of aquatic vegetation; therefore, the channel catfish is suggested as a selected model. The channel catfish is more dependent on pools and backwater areas than riffle/run mesohabitats. Because the San Marcos River was historically a riffle/run dominated system, a model which considers conditions related to these mesohabitats should be included. A similar comparison of the bluegill and green sunfish model identified the bluegill model as being more sensitive to vegetative cover, and the bluegill is recommended for selection. From the list provided in Table 2, the smallmouth bass is also suggested for inclusion. Although this species is not native to the Guadalupe Basin, it is similar to the Guadalupe bass (*Micropterus treculii*) and prefers swift, clear, cool rivers similar to the San Marcos.

Although the bullfrog and slider turtle HSI models would apply to the riverine habitats of the San Marcos River, they would primarily be used to evaluate herbaceous wetland habitats created along tributaries. The bullfrog requires permanent water at a depth of greater than 5 feet, and optimum conditions are not likely to be created by these wetlands. The slider turtle is more tolerant of fluctuations in water levels, and optimum conditions are met at a minimum depth of 3.3 feet. Conversely, the American coot model does not have a minimum depth requirement, and optimum conditions are met by semi-permanently flooded wetlands. It is suggested that both the slider turtle and American coot models be included for evaluation of herbaceous wetlands. These two models will also be used to evaluate potential changes in the cover of emergent vegetation within the San Marcos riparian zone as a result of measures included in the PRP.

Other than creating additional habitat in the riparian zone, there are few measures which would result in improved conditions of terrestrial habitats as evaluated by certified HSI models. Of the two terrestrial models listed in Table 2, future conditions are likely to be most suitable for the downy woodpecker, and this model is suggested for selection. One other bird, the belted kingfisher, is also recommended for selection. The belted kingfisher is known to occur in the project area and prefers open waterways. The PRP includes a measure to remove overhanging trees from the river to reduce impacts on submerged aquatic vegetation resulting from recreational activities. The belted kingfisher model would evaluate this measure as a beneficial impact.

4.0 SUGGESTED HSI MODEL SELECTION

A total of seven HSI models are suggested for application of HEP to the San Marcos aquatic ecosystem restoration feasibility study (Table 3). The slider turtle and American coot are selected for their tolerance of shallow wetlands and occasional exposure of wetland substrates. These two models will provide a means of evaluating the proposed creation of wetlands along tributaries of the San Marcos River. Three fish models are suggested: channel catfish, bluegill, and smallmouth bass. Combined, these three fish models will be sensitive to any change in vegetative cover regardless of existing conditions. Each of the models is sensitive to substrate types in pools, and two of the three models are sensitive to changes in current velocity. The channel catfish and bluegill are more dependent on conditions found in pool mesohabitats.

Table 3. Recommended HSI Model Selection based on PRP Habitat Restoration Measures

HSI Model	Riverine/Herbaceous Wetland	Herbaceous Wetland	Deciduous Forested Wetland
Channel Catfish	X		
Smallmouth Bass	X		
Bluegill	X		
Slider Turtle	X	X	
American Coot	X	X	
Belted Kingfisher	X		
Downy Woodpecker			X

At least one species which is more dependent on conditions found in riffle/run habitats should be included in the selected models. Although the smallmouth bass is not native to the Guadalupe Basin, it prefers small, clear, cool, swift streams, is more dependent on riffle/run habitats, and is similar to the Guadalupe bass, which is a native fish.

Two avian models are suggested for evaluation of riparian habitats. The belted kingfisher prefers open water courses and would benefit from proposed measures to reduce overhanging vegetation, while the downy woodpecker would benefit from proposed measures to increase the area of forested riparian areas.

ATTACHMENT A
Potentially Applicable Models

Model	General Habitat Preference	Aquatic		Wetland			Upland					
		Lacustrine	Riverine	Forested	Scrub-Shrub	Herbaceous	Forest	Savanna	Shrubland	Grassland	Pasture	Cropland
FISHES												
Black bullhead *Ameiurus melas*	mixture of low-velocity pools with moderate cover and riffle/run areas	x	x									
Black crappie *Pomoxis nigromaculatus*	slower waters of pools, backwaters, and cut-offs	x	x									
Bluegill *Lepomis macrochirus*	slower waters of pools, backwaters, and cut-offs	x	x									
Channel catfish *Ictalurus punctatus*	warmer (> 21 °C) waters and tolerant of turbidity up to 100 ppm	x	x									
Common carp *Cyprinus carpio*	shallow, warm, sluggish waters with mud or silt substrate	x	x									
Creek chub *Semotilus atromaculatus*	small, clear, cool streams with moderate to high gradients		x									
Flathead catfish *Pylodictis olivaris*	large, slow, turbid rivers	x	x									
Gizzard shad *Dorosoma cepedianum*	warm, shallow waters with soft mud bottoms and high turbidity	x	x									
Green sunfish *Lepomis cyanellus*	pools in small to medium streams	x	x									
Largemouth bass *Micropterus salmoides*	prefers lakes or large, slow moving rivers	x	x									
Redbreast sunfish *Lepomis auritus*	low gradient, moderate-sized streams providing areas of hard cover	x	x									
Redear sunfish *Lepomis microlophus*	large, clear, low gradient streams with sluggish current and some vegetative cover	x	x									
Slough darter *Etheostoma gracile*	warm, turbid waters with little or no flow, mud or silt bottoms, and some cover	x	x									
Smallmouth bass *Micropterus dolomieu*	cool, clear, mid-order streams with abundant shade and cover, deep pools, moderate current, and gravel or rubble substrate.	x	x									
Smallmouth buffalo *Ictiobus bubalus*	deep, clear, warm waters of larger streams	x	x									
Warmouth *Lepomis gulosus*	slow moving waters with soft substrate and dense aquatic vegetation or other cover	x	x									
White crappie *Pomoxis annularis*	low gradient rivers, tolerant of turbidity	x	x	x	x	x						
AMPHIBIANS												
Bullfrog *Lithobates* (*Rana*) *catesbeiana*	slower waters with abundant emergent and shoreline cover	x	x	x	x	x						
REPTILES												
Slider turtle *Trachemys scripta elegans*	quiet water, 3 to 6 feet deep, with soft bottom and abundant vegetation	x	x	x	x	x						
Snapping turtle *Chelydra serpentina*	slow, shallow, turbid waters flowing over soft substrates	x	x	x	x	x						
WATERFOWL/SHOREBIRDS												
American coot *Fulica americana*	moderate cover of emergent vegetation, semi-permanently flooded	x	x			x						
Belted kingfisher *Megaceryle alcyon*	clear, shallow, relatively open streams	x	x									
Great blue heron *Ardea herodias*	general habitat requirements, but intolerant of disturbance	x	x	x	x	x						
Great egret *Ardea alba*	forages in shallow (< 9 inches) water with abundant cover; nests in trees over water	x	x	x	x							

Model	General Habitat Preference	Aquatic		Wetland			Upland					
		Lacustrine	Riverine	Forested	Scrub-Shrub	Herbaceous	Forest	Savanna	Shrubland	Grassland	Pasture	Cropland
GAME BIRDS												
Eastern wild turkey *Meleagris gallopavo silvestris*	mix of wooded and grassland upland habitats greater than 2,200 acres in area			x			x	x	x	x	x	x
Northern bobwhite *Colinus virginianus*	mix of wooded and grassland upland habitats greater than 12 acres in area						x	x	x	x	x	x
RAPTORS												
Barred owl *Strix varia*	expansive forest area with mature and decadent trees			x			x					
SONGBIRDS												
Downy woodpecker *Picoides pubescens*	mature woods greater than 10 acres			x			x					
Eastern meadowlark *Sturnella magna*	grasslands with perch opportunities									x	x	
Hairy woodpecker *Picoides villosus*	mature woods greater than 10 acres			x			x					
Red-winged blackbird *Agelaius phoeniceus*	wetlands dominated by broad-leafed monocots	x	x			x				x	x	
MAMMALS												
Beaver *Castor canadensis*	streams with less than 15 percent gradient and moderate canopy cover of shrubs and small trees	x	x	x	x	x						
Eastern cottontail *Sylvilagus floridanus*	mix of forest, shrub, and grassland habitats						x	x	x	x	x	x
Fox squirrel *Sciurus niger*	open forest habitats with a variety of mast trees			x			x	x				
Muskrat *Ondatra zibethicus*	herbaceous wetlands and low gradient streams with bulrush and cattail		x			x						
Swamp rabbit *Sylvilagus aquaticus*	large wetlands (> 250 acres) with adequate refuge during flood events			x	x	x						
SAN MARCOS ENDEMICS												
Texas wild rice *Zizania texana*	shallow (1 to 3 feet) slow (0.25 to 2 feet/second) streams		x									
Fountain darter *Etheostoma fonticola*	deeper (> 2.25 feet), slower (< 0.6 feet/second) streams with abundant cover of prefered substrates		x									

ATTACHMENT B
Comparison of Channel Catfish and Black Bullhead

HSI Variable	Optimum Conditions		Best Match to PRP*	Assumptions
	Channel Catfish	Black Bullhead		None
% pools during summer flow	40 to 60	50 to 75	CC	Measures to restore riffle/run dominance would have greater benefit for CC
% cover (vegetation, logs boulders, cavities, brush, debris, or standing timber)	> 40	> 25	CC	CC is most sensitive to reduction in cover below 40%
% cover during spawning	Not Provided	> 20	CC	None
Average current velocity at 0.6 m during average summer flow	Not Provided	< 4 cm/sec	?	The optimum current velocity (with respect to protected species) at this depth is known, but has not been identified
Average current velocity in cover areas during summer flow	< 12 cm/sec	Not Provided	?	The optimum current velocity (with respect to protected species) in areas of cover is known, but has not been identified
Food production potential by substrate type	fines not common in riffle/runs; aquatic vegetation abundant (>30%) in pools	Not Provided	CC	Assumes that removal of fines from riffle/runs would be cost-effective
Dominant substrate type in spawning areas	Not Provided	fines dominant	CC	Assumes that removal of fines from pools would be cost-effective
Maximum midsummer water temperature in pools	Not Provided	18 to 29 °C	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Average midsummer water temperature in pools	26 to 29 °C	29 to 30 °C	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Average midsummer water temperature in pools (Juvenile)	28 to 30 °C	Not Provided	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
DO range in pools	Not Provided	Seldom < 6 mg/l	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Average minimum DO in pools	> 7 mg/l	Not Provided	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
pH range during the year	Not Provided	usually 6.5 to 8.5	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Maximum salinity during summer	< 1.5	< 2 ppt	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Maximum salinity during summer (fry, juvenile)	< 5 ppt	Not Provided	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Maximum salinity during spawning	Not Provided	< 3 ppt	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Maximum monthly average turbidity during growing season	< 110 ppm	25 to 100 ppm	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure
Average spawning water temperature in pools	26 to 27.5° C	20 to 22° C	N	Assumes that existing conditions are optimum and/or would not be substantially affected by any measure

PRP = Preliminary Restoration Plan
CC = Channel catfish
N = neither
BB = Black bullhead
? = best match to PRP not documented

APPENDIX B
HABITAT EVALUATION PROCEDURES DATA AND ANALYSIS

Table B-1a. HSI Model Hydrology and Hydraulics Variables for Riverine Habitats Baseline Conditions

Hydrology and Hydraulics (Riverine)								
Habitat Condition	**Model***	**Variable**	**Variable Description**	**Optimum Range**	**Units**	**San Marcos Range**	**Baseline Source**	**Potentially Affected?**
Mesohabitat	CC	V1	Percent pools during average summer flow	40-60	%	From 0 to 100 percent depending on reach, average of Reach 4 through 12 is 26 percent	Saunders et al. 2001	Yes
	SB	V2	Percent pools	50 - 75	%			Yes
	BG	V1	Percent pool area during average summer flow	> 60	%			Yes
	BK	V5	Percent riffles	30 - 70	%			Yes
Hydraulics - Velocity	SB	V15	Stream gradient within representative reach	0.9 - 4.8	m/km	From 2 to 5 in reaches 4,5,7,10,11,and12; and from 10 to 12 in reaches 6,8,and 9	Hardy 2011	Yes
	BG	V18	Stream gradient within representative reach	< 0.5	m/km			Yes
	BG	V15	Average current velocity in spawning areas (embryo)	< 9	cm/sec	From 2 to 11 depending on reach, average of Reach 4 through 12 is 6.09	Hardy 2011	Yes
	BG	V16	Average current velocity in pools and backwater areas during early summer (fry)	< 4.5	cm/sec	From 0 to 10 depending on reach, average of Reach 4 through 12 is 5.01	Hardy 2011	Yes
	BG	V17	Average current velocity in pools and backwater areas during the growing season (juvenile)	< 4	cm/sec			Yes
Hydraulics - Depth	SB	V4	Average depth of pools during midsummer	1.6 - 4.6	meter	Average of 0.32 from Reach 4 through 12	Hardy 2011	Yes
	BK	V4	Percent of water area that is ≤ 60 cm in depth	100	%	Average of 23 from Reach 4 through 12	Hardy 2011	Yes
Hydrology	SB	V14	Water level fluctuations during spawning and for 45 days after spawning	Slow rise previous to spawning with stable levels during and afterward	index	Slow rise previous to spawning with stable levels during and afterward	Hardy 2011	No

*CC = Channel Catfish; SB = Smallmouth Bass; BG = Bluegill; BK = Belted Kingfisher

Table B-1b. HSI Model Water Quality Variables for Riverine Habitat Baseline Conditions

Water Quality (Riverine)								
Habitat Condition	**Model***	**Variable**	**Variable Description**	**Optimum Range**	**Units**	**San Marcos Range**	**Baseline Source**	**Potentially Affected?**
Turbidity	CC	V7	Maximum monthly average turbidity during summer	< 100	ppm	Assume Optimum	Assume Optimum	Yes
	SB	V9	Maximum monthly average turbidity level during the summer	< 25	JTU			Yes
	BG	V6	Maximum monthly average turbidity during average summer flow	< 50	ppm			Yes
Transparency	BK	V2	Average water transparency (Secchi depth)	> 60	cm	Assume Optimum	Assume Optimum	Yes
Dissolved Oxygen	CC	V8	Average minimum dissolved oxygen levels within pools, backwaters, or littoral areas during midsummer	>7	mg/l	6 - 11.5	Bio-West 2010	Yes
	BG	V8	Minimum dissolved oxygen range during summer	Seldom below 5 mg/l	index			Yes
Temperature	CC	V5	Average midsummer water temperature within pools, backwaters, or littoral areas (adult)	26 - 29	°C	23 - 25	Bio-West 2010	Yes
	CC	V10	Average water temperature within pools, backwaters, and littoral areas during spawning and embryo development (embryo)	26 - 27.5	°C	19.9 - 22.9	Bio-West 2010	Yes
	CC	V12	Average midsummer water temperature within pools or backwaters	28 - 30	°C			Yes

Table B-1b, continued

Water Quality (Riverine)								
Habitat Condition	**Model***	**Variable**	**Variable Description**	**Optimum Range**	**Units**	**San Marcos Range**	**Baseline Source**	**Potentially Affected?**
Temperature	CC	V14	Average midsummer water temperature within pools or backwaters (juvenile)	28 - 30	°C	19.9 - 22.9	Bio-West 2010	Yes
	SB	V10	Water temperature in selected habitat during the growing season (May to October) (adults)	25 - 29	°C			Yes
	SB	V11	Water temperature in selected habitat during spawning and for 45 days afterwards (embryo)	15 - 25	°C			Yes
	SB	V12	Water temperature in selected habitat during the growing season (May to October) (fry)	22 - 29	°C			Yes
	SB	V13	Water temperature in selected habitat during the growing season (May to October) (juvenile)	22 - 29	°C			Yes
	BG	V10	Maximum midsummer temperature within pools	26 - 27	°C			Yes
	BG	V11	Average of mean weekly water temperature within pools or littoral areas during spawning (embryo)	22 - 27	°C			Yes
	BG	V12	Maximum early summer temperature within pools or littoral areas	24.5 - 32	°C			Yes
	BG	V13	Maximum midsummer temperature within pools or littoral areas (juvenile)	30	°C			Yes
pH	SB	V6	Average pH level during the year	7.9 - 8.1	pH	7.4 - 7.7	Bio-West 2010	No
	BG	V7	pH range during growing season	6.5 - 8.5	pH index	7.4 - 7.7		No
Salinity	CC	V9	Maximum salinity during summer (adult)	< 1	ppt	<1	Bio-West 2010	No
	CC	V11	Maximum salinity during spawning and embryo development	< 2	ppt	<1		No
	CC	V13	Maximum salinity during summer (fry, juvenile)	< 5	ppt	<1		No
	BG	V9	Maximum monthly average salinity during growing season	< 2	ppt	<1		No

*CC = Channel Catfish; SB = Smallmouth Bass; BG = Bluegill; BK = Belted Kingfisher

Table B-1c. HSI Model Cover and Substrate Variables for Riverine Habitat Baseline Conditions

Cover and Substrate (Riverine)								
Habitat Condition	**Model***	**Variable**	**Variable Description**	**Optimum Range**	**Units**	**San Marcos Range**	**Baseline Source**	**Potentially Affected?**
Instream Cover	CC	V2	Percent cover of logs, boulders, cavities, brush, debris, or standing timber during summer within pools, backwater areas, and littoral areas	> 40	%	0 - 11	Field Survey	Yes
	SB	V5	Percent cover in the form of boulders, stumps, dead trees, and crevices (adults) or vegetation and rocks (fry)	25 - 50	%			Yes
	BG	V2	Percent cover (e.g., logs, brush, and debris) within pools during summer	20 - 60	%			Yes
Instream Cover	BG	V3	Percent cover (aquatic vegetation, submersed, dense stands, or finely divided leaves)	15 - 30	%	6.4 – 90.7	Owens 2010	Yes
Hydraulics - Velocity	CC	V4	Food production potential by substrate type present during average summer flow	rubble dominant runs, >30% vegetation in pools	index	Dominated by sands and silts	Owens 2010	Yes
	SB	V1	Dominant substrate type within pool or backwater	1.6 - 2.0 cm, and boulder	Index			Yes
	BG	V20	Substrate composition within pools during spawning (embryo)	fines and gravel present	index			Yes
Riparian Vegetation	BK	V7	Distance from nearest suitable soil bank to 1-km sections of stream	0	km		Assume Optimum	Yes
	BK	V3	Percent water surface obstruction	< 0	%	0 – 2	Field Survey	Yes
Riparian Vegetation	BK	V6	Average number of stream subsections that contain one or more perches	> 40	count/km	> 40	Assume Optimum	Yes

*CC = Channel Catfish; SB = Smallmouth Bass; BG = Bluegill; BK = Belted Kingfisher

Table B-1d. HSI Model Variables for Palustrine and Terrestrial Habitat Baseline Conditions

Palustrine and Terrestrial								
Habitat Condition	**Model***	**Variable**	**Variable Description**	**Optimum Range**	**Units**	**San Marcos Range**	**Baseline Source**	**Potentially Affected?**
Vegetative Cover	AC	V1	Percent of wetland basin dominated by persistent emergent herbaceous vegetation	40 - 60	%	55	Field Survey	Yes
	AC	V2	Edge index between emergent vegetation and open water	> 4	index	1		Yes
	ST	V1	Percent cover of emergent and submerged vegetation	> 90	%	55		Yes
Hydrology and Water Quality	ST	V4	Water Temperature (average of daily minimum and maximum during growing season)	25 - 30	°C	20	Estimation by Team	Yes
	ST	V3	Water regime	Permanently Flooded	index	Permanently flooded	Field Survey	Yes
	AC	V3	Water regime	Semipermanently Flooded	index	Permanently flooded		Yes
	ST	V2	Water depth	1 - 2	meters	0.7		Yes
Riparian Vegetation	DW	V1	Basal area	10 - 20	m^2/ha	4 – 99.8	Field Survey	Yes
	DW	V2	Number of snags > 15 cm diameter breast height	> 5	count/0.4 ha	0 - 4		Yes

*AC = American Coot; ST = Slider Turtle; DW = Downy Woodpecker

Table B-2. Downy Woodpecker (DW) Future Without and With Project (FWOP/FWP) Conditions

Variable		Optimum	FWOP/FWP	Forest Type				
				1	2	3	4	5
Area	**Riparian Forest**		**FWOP**	7.98	5.78	1.95	15.49	0.00
(acres)			**RIP1 (TY1 and TY50)**	7.98	5.78	0.28	15.49	13.51
			RIP2 (TY1 and TY50)	7.98	5.78	0.28	15.49	14.55
			DISC (TY1 and TY50)	7.74	5.71	1.75	15.18	2.10
			SHORE1 (TY1 and TY50)	7.98	5.77	1.95	15.26	0.24
			SHORE2 (TY1 and TY50)	7.98	5.78	1.95	15.49	0.31
			WET (TY1 and TY50)	7.98	4.67	1.87	15.49	0.00
V1	**Basal Area**	**10 - 20**	**FWOP (TY1 and TY15)**	27.55	39.03	22.96	45.46	0.00
(m^2/ha)			**FWOP (TY25)**	33.06	39.03	22.96	45.46	0.00
			FWOP (TY50)	39.67	39.03	22.96	45.46	0.00
			EXOT (TY1)	20.00	20.00	22.96	30.00	0.00
			EXOT (TY50)	20.00	20.00	22.96	30.00	0.00
			RIP (TY1)	27.55	39.03	22.96	45.46	0.00
			RIP (TY15)	27.55	39.03	22.96	45.46	5.00
			RIP (TY25)	33.06	39.03	22.96	45.46	10.00
			RIP (TY50)	39.67	39.03	22.96	45.46	20.00
V2	**Snag Density**	**> 5**	**FWOP**	4	4	1	3	0
(no. > 6 dbh/acre)			**EXOT (TY1)**	5	5	1	5	0
			EXOT (TY50)	5	5	1	5	0
			RIP (TY1)	4	4	1	3	0
			RIP (TY15)	4	4	1	3	0
			RIP (TY25)	4	4	1	3	2
			RIP (TY50)	4	4	1	3	5

Table B-3. Channel Catfish (CC) Future Without and With Project (FWOP/FWP) Conditions

	Variable	Optimum	FWOP/FWP	Reach 4	5	6	7	8	9	10	11
Area	**Riverine**		**FWOP**	4.50	3.19	2.61	4.32	2.63	1.12	3.83	3.22
(acres)			**EXOE (TY3)**	4.83	4.30	2.78	4.80	2.67	1.12	4.27	3.26
			EXOE (TY50)	4.83	4.30	2.78	4.80	2.67	1.12	4.27	3.26
			SHORE2 (TY1 and TY50)	4.52	3.19	2.61	4.32	2.63	1.12	3.83	3.22
V1	**Percent pools during average summer flow**	**40-60**	**FWOP/FWP**	6.80	12.59	57.55	39.58	49.81	0.00	22.38	12.15
(%)											
V2	**Percent cover (logs, boulders, cavities, brush, debris, or standing timber during summer within pools, backwater areas, and littoral areas**	**> 40**	**FWOP/FWP**	0.04	0.57	0.96	5.24	7.62	7.00	6.76	2.92
(%)											
V4	**Food production potential by substrate type present during average summer flow**	**A**	**FWOP**	C	E	C	C	C	C	C	C
(index)			**DISC (TY1)**	B	B	B	B	B	B	B	B
			DISC (TY50)	B	B	B	B	B	B	B	B
			SED (TY3)	B	B	B	B	B	B	B	B
			SED (TY50)	B	B	B	B	B	B	B	B
			DISC/SED (TY3)	A	A	A	A	A	A	A	A
			DISC/SED (TY50)	A	A	A	A	A	A	A	A
V5	**Average midsummer water temp within pools, backwaters, or littoral areas (Adult)**	**26 - 29**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
	Maximum monthly average turbidity during summer	**< 100**	**FWOP/FWP**	50	50	50	50	50	50	50	50
V8	**Average minimum dissolved oxygen levels within pools, backwaters, or littoral areas during midsummer**	**>7**	**FWOP/FWP**	7	7	6	6	6	6	7	6
(mg/l)											
V9	**Maximum salinity during summer (Adult)**	**< 1**	**FWOP/FWP**	0	0	0	0	0	0	0	0
(ppt)											
V10	**Average water temperatures within pools, backwaters, and littoral areas during spawning and embryo development (Embryo)**	**26 - 27.5**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V11	**Maximum salinity during spawning and embryo development**	**< 2**	**FWOP/FWP**	0	0	0	0	0	0	0	0
(ppt)											
V12	**Average midsummer water temperature within pools or backwaters**	**28 - 30**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V13	**Maximum salinity during summer (Fry, Juvenile)**	**< 5**	**FWOP/FWP**	0	0	0	0	0	0	0	0
(ppt)											
V14	**Average midsummer water temperature within pools or backwaters (Juvenile)**	**28 - 30**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V18	**Average current velocity in cover areas during average summer flow.**	**<20**	**FWOP/FWP**	4.27	3.35	2.13	8.23	3.05	6.10	11.28	10.36
(cm/sec)											

Table B-4. Smallmouth Bass (SB) Future Without and With Project (FWOP/FWP) Conditions

Variable		Optimum	FWOP/FWP	Reach							
				4	5	6	7	8	9	10	11
Area	**Riverine**		**FWOP**	4.50	3.19	2.61	4.32	2.63	1.12	3.83	3.22
(acres)			**EXOE (TY3)**	4.83	4.30	2.78	4.80	2.67	1.12	4.27	3.26
			EXOE (TY50)	4.83	4.30	2.78	4.80	2.67	1.12	4.27	3.26
			SHORE2 (TY1 and TY50)	4.52	3.19	2.61	4.32	2.63	1.12	3.83	3.22
V1	**Dominant substrate type within pool or backwater**	**C**	**FWOP**	A	A	A	A	A	A	A	A
(Index)			**DISC (TY1)**	B	B	B	B	B	B	B	B
			DISC (TY50)	B	B	B	B	B	B	B	B
			SED (TY3)	B	B	B	B	B	B	B	B
			SED (TY50)	B	B	B	B	B	B	B	B
			DISC/SED (TY3)	C	C	C	C	C	C	C	C
			DISC/SED (TY50)	C	C	C	C	C	C	C	C
V2	**Percent pools**	**50 - 75**	**FWOP/FWP**	7.34	15.67	61.38	44.00	50.53	0.00	25.05	12.10
(%)											
V4	**Average depth of pools during midsummer**	**1.6 - 4.6**	**FWOP/FWP**	0.24	0.31	0.35	0.38	0.41	0.00	0.33	0.31
(meter)											
V5	**Percent cover in the form of boulders, stumps, dead trees, and crevices (adults) or vegetation and rocks (fry)**	**25 - 50**	**FWOP/FWP**	70.35	91.25	71.82	30.66	53.69	94.50	28.44	5.84
(%)			**EXOE (TY3)**	62.87	56.34	65.17	19.47	52.21	94.21	17.12	4.89
			EXOE (TY50)	62.87	56.34	65.17	19.47	52.21	94.21	17.12	4.89
V6	**Average pH level during the year**	**7.9 - 8.1**	**FWOP/FWP**	7.7	7.8	7.7	7.6	7.6	7.5	7.5	7.6
(pH)											
V8	**Minimum dissolved oxygen (DO) level throughout the year**	**6-8**	**FWOP/FWP**	7	7	6	6	6	6	7	6
(ppt)											
V9	**Maximum monthly average turbidity level during the summer**	**< 25**	**FWOP/FWP**	15	15	15	15	15	15	15	15
(JTU)											
V10	**Water temperature in selected habitat during the growing season (May to October) (adults)**	**25 - 29**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V11	**Water temperature in selected habitat during spawning and for 45 days afterwards (embryo)**	**15 - 25**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V12	**Water temperature in selected habitat during the growing season (May to October) (fry)**	**22 - 29**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V13	**Water temperature in selected habitat during the growing season (May to October) (juvenile)**	**22 - 29**	**FWOP/FWP**	22	21	21	21	21	20	20	21
(°C)											
V14	**Water level fluctuations during spawning and for 45 days after spawning**	**C**	**FWOP/FWP**	c	c	c	c	c	c	c	c
(index)											
V15	**Stream gradient**	**0.9 - 4.8**	**FWOP/FWP**	2.72	5.03	12.12	3.33	9.96	10.09	2.26	4.63
(m/km)											

Table B-5. Belted Kingfisher (BK) Future Without and With Project (FWOP/FWP) Conditions

Variable		Optimum	FWP/FWOP	Reach 4	5	6	7	8	9	10	11
Area	**Riverine**		**FWOP**	4.50	3.19	2.61	4.32	2.63	1.12	3.83	3.22
(acres)			**EXOE**	4.83	4.30	2.78	4.80	2.67	1.12	4.27	3.26
			SHORE2	4.52	3.19	2.61	4.32	2.63	1.12	3.83	3.22
V2	**Average water transparency (Secchi depth)**	**> 60**	**FWOP/FWP**	75	75	75	75	75	75	75	75
(cm)											
V3	**Percent water surface obstruction**	**< 0**	**FWOP**	6.98	26.52	6.30	11.95	3.38	1.11	10.42	1.34
(%)			**EXOE (TY3)**	0.02	0.65	0.06	1.89	1.93	0.82	0.25	0.39
			EXOE (TY50)	0.02	0.65	0.06	1.89	1.93	0.82	0.25	0.39
V4	**Percent of water area that is <= 60 cm in depth**	**> 100**	**FWOP/FWP**	30.36	32.42	26.02	22.99	11.8	21.65	28.16	21.43
(%)											
V5	**Percent riffles**	**30 - 70**	**FWOP/FWP**	70.35	91.25	71.82	30.7	53.7	94.5	28.4	5.8
(%)											
V6	**Average number of stream subsections that contain one or more perches**	**> 40**	**FWOP/FWP**	50	50	50	50	50	50	50	50
(count/km)											
V7	**Distance from nearest suitable soil bank from 1-km sections of stream**	**0**	**FWOP/FWP**	0	0	0	0	0	0	0	0
(km)											

Elephant Ears								
Acres	0.34	1.11	0.17	0.48	0.04	0.00	0.43	0.03
%	6.96	25.87	6.24	10.06	1.45	0.29	10.17	0.95

Table B-6. Slider Turtle (ST) Future Without and With Project (FWOP/FWP) Conditions

Variable	Assumptions	Optimum	FWP/FWOP	
Area	**Wetland**		**FWOP**	0.00
(acres)			**WET**	1.19
V1	**Percent cover of emergent and submerged vegetation**	**> 90%**	**FWOP**	55
(%)			**WET**	55
V2	**Water Depth**	**1 to 2**	**FWOP**	0.3
(m)			**WET**	0.3
V3	**Water Regime**	**A - permanently flooded**	**FWOP**	A
(index)			**WET**	A
V4	**Water Temperature**	**C - 25 to 30℃**	**FWOP**	C
(index)			**WET**	C

Table B-7. American Coot (AC) Future Without and With Project (FWOP/FWP) Conditions

Variable		Optimum	FWP/FWOP	
Area	**Lacustrine/Riverine/Herbaceous Wetland**		**FWOP**	0.00
(acres)			**WET**	1.19
V1	**Percent of wetland basin dominated by persistent emergent herbaceous vegetation**	**40 - 60**	**FWOP**	55
(%)			**WET**	55
V2	**Edge index between emergent vegetation and open water**	**> 4**	**FWOP**	1
(index)			**WET**	1
V3	**Water regime**	**3**	**FWOP**	1
(index)			**WET**	1

Table B-8. AAHUs by Habitat Type for Example Alternative Plans*

Alternative Plan #	Description	Measure									AAHUs			
		EXOT	RIP	EXOA	SHORE	DISC	SED	DUCK	WET	EDU	Riverine	Wetland	Riparian	Total
No Action Plan	no measures	0	0	0	0	0	0	0	0	0	15.16	0.00	15.40	30.56
2	EXOT1 only	1	0	0	0	0	0	0	0	0	15.16	0.00	21.83	36.99
3	RIP1 only	0	1	0	0	0	0	0	0	0	15.16	0.00	20.34	35.50
4	RIP2 only	0	2	0	0	0	0	0	0	0	15.16	0.00	20.75	35.91
7	EXOA1 only	0	0	1	0	0	0	0	0	0	17.57	0.00	15.40	32.98
13	SHORE1 only	0	0	0	1	0	0	0	0	0	15.16	0.00	15.50	30.66
14	SHORE2 only	0	0	0	2	0	0	0	0	0	15.18	0.00	15.52	30.70
37	DISC1 only	0	0	0	0	1	0	0	0	0	15.40	0.00	15.86	31.26
73	SED1 only	0	0	0	0	0	1	0	0	0	15.38	0.00	15.40	30.79
343	DUCK1 only	0	0	0	0	1	1	1	1	0	16.40	0.76	15.86	33.03
388	WET1 only	0	0	1	0	1	0	0	0	1	17.82	0.00	15.86	33.69
544	EDU1 only	0	0	0	1	0	0	1	1	0	15.16	0.76	15.50	31.42
1149	All measures at scale1	1	2	1	2	0	1	1	1	1	17.83	0.76	27.30	45.89
1150	RIP2 all other mesaures scale1	0	0	0	0	1	1	1	1	1	16.40	0.76	15.86	33.03
1151	SHORE2 all other mesaures scale1	1	0	0	0	1	1	1	1	1	16.40	0.76	22.15	39.31
1152	Maximum scale of all measures	1	2	1	2	1	1	1	1	1	18.95	0.76	27.61	47.33

*measures were coded by scale to track plan combinations; a 0 means no implementation, a 1 means implementation at scale 1, and a 2 means implementation at scale 2; all 1,152 plan combinations were evaluated

APPENDIX C
TEXAS PARKS AND WILDLIFE DEPARTMENT ANNOTATED COUNTY LIST OF RARE SPECIES

HAYS COUNTY

AMPHIBIANS

		Federal Status	State Status
Barton Springs salamander	*Eurycea sosorum*	LE	E

dependent upon water flow/quality from the Barton Springs pool of the Edwards Aquifer; known from the outlets of Barton Springs and subterranean water-filled caverns; found under rocks, in gravel, or among aquatic vascular plants and algae, as available; feeds primarily on amphipods

Blanco blind salamander	*Eurycea robusta*		T

troglobitic; water-filled subterranean caverns; may inhabit deep levels of the Balcones aquifer to the north and east of the Blanco River

Blanco River springs salamander	*Eurycea pterophila*		

subaquatic; springs and caves in the Blanco River drainage

San Marcos salamander	*Eurycea nana*	LT	T

headwaters of the San Marcos River downstream to ca. ½ mile past IH-35; water over gravelly substrate characterized by dense mats of algae (Lyng bya) and aquatic moss (Leptodictym riparium), and water temperatures of 21-22 O C; diet includes amphipods, midge larve, and aquatic snails

Texas blind salamander	*Eurycea rathbuni*	LE	E

troglobitic; water-filled subterranean caverns along a six mile stretch of the San Marcos Spring Fault, in the vicinity of San Marcos; eats small invertebrates, including snails, copepods, amphipods, and shrimp

ARACHNIDS

		Federal Status	State Status
Bandit Cave spider	*Cicurina bandida*		

very small, subterrestrial, subterranean obligate

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Bald Eagle	*Haliaeetus leucocephalus*	DL	T

found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

HAYS COUNTY

BIRDS

		Federal Status	State Status
Black-capped Vireo	*Vireo atricapilla*	LE	E

oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer

Golden-cheeked Warbler	*Setophaga chrysoparia*	LE	E

juniper-oak woodlands; dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer

Mountain Plover *Charadrius montanus*

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Sprague's Pipit	*Anthus spragueii*	C	

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Western Burrowing Owl *Athene cunicularia hypugaea*

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Whooping Crane	*Grus americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

Zone-tailed Hawk	*Buteo albonotatus*		T

arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions

HAYS COUNTY

CRUSTACEANS

		Federal Status	State Status
A cave obligate crustaean	*Monodella texana*		

subaquatic, subterranean obligate; underground freshwater aquifers

Balcones Cave amphipod	*Stygobromus balconis*		

subaquatic, subterranean obligate amphipod

Ezell's cave amphipod	*Stygobromus flagellatus*		

known only from artesian wells

Texas cave shrimp	*Palaemonetes antrorum*		

subterranean sluggish streams and pools

Texas troglobitic water slater	*Lirceolus smithii*		

subaquatic, subterranean obligate, aquifer

FISHES

		Federal Status	State Status
Fountain darter	*Etheostoma fonticola*	LE	E

known only from the San Marcos and Comal rivers; springs and spring-fed streams in dense beds of aquatic plants growing close to bottom, which is normally mucky; feeding mostly diurnal; spawns year-round with August and late winter to early spring peaks

Guadalupe bass	*Micropterus treculii*		

endemic to perennial streams of the Edward's Plateau region; introduced in Nueces River system

Guadalupe darter	*Percina sciera apristis*		

Guadalupe River basin; most common over gravel or gravel and sand raceways of large streams and rivers

Ironcolor shiner	*Notropis chalybaeus*		

Big Cypress Bayou and Sabine River basins; spawns April-September, eggs sink to bottom of pool; pools and slow runs of low gradient small acidic streams with sandy substrate and clear well vegetated water; feeds mainly on small insects, ingested plant material not digested

San Marcos gambusia	*Gambusia georgei*	LE	E

extinct; endemic; formerly known from upper San Marcos River; restricted to shallow, quiet, mud-bottomed shoreline areas without dense vegetation in thermally constant main channel

INSECTS

		Federal Status	State Status
A mayfly	*Procloeon distinctum*		

mayflies distinguished by aquatic larval stage; adult stage generally found in shoreline vegetation

Comal Springs dryopid beetle	*Stygoparnus comalensis*	LE	E

dryopids usually cling to objects in a stream; dryopids are sometimes found crawling on stream bottoms or along shores; adults may leave the stream and fly about, especially at night; most dryopid larvae are vermiform and live in soil or decaying wood

HAYS COUNTY

INSECTS

		Federal Status	State Status
Comal Springs riffle beetle	*Heterelmis comalensis*	LE	E

Comal and San Marcos Springs

Edwards Aquifer diving beetle *Haideoporus texanus*

habitat poorly known; known from an artesian well in Hays County

Flint's net-spinning caddisfly *Cheumatopsyche flinti*

very poorly known species with habitat description limited to 'a spring'

Leonora's dancer damselfly *Argia leonorae*

south central and western Texas; small streams and seepages

Rawson's metalmark *Calephelis rawsoni*

moist areas in shaded limestone outcrops in central Texas, desert scrub or oak woodland in foothills, or along rivers elsehwere; larval hosts are Eupatorium havanense, E. greggii.

San Marcos saddle-case caddisfly *Protoptila arca*

known from an artesian well in Hays County; locally very abundant; swift, well-oxygenated warm water about 1-2 m deep; larvae and pupal cases abundant on rocks

Texas austrotinodes caddisfly *Austrotinodes texensis*

appears endemic to the karst springs and spring runs of the Edwards Plateau region; flow in type locality swift but may drop significantly during periods of little drought; substrate coarse and ranges from cobble and gravel to limestone bedrock; many limestone outcroppings also found along the streams

MAMMALS

		Federal Status	State Status
Cave myotis bat	*Myotis velifer*		

colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore

Plains spotted skunk *Spilogale putorius interrupta*

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf	*Canis rufus*	LE	E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

HAYS COUNTY

MOLLUSKS

		Federal Status	State Status
Creeper (squawfoot)	*Strophitus undulatus*		

small to large streams, prefers gravel or gravel and mud in flowing water; Colorado, Guadalupe, San Antonio, Neches (historic), and Trinity (historic) River basins

False spike mussel	*Quadrula mitchelli*		T

possibly extirpated in Texas; probably medium to large rivers; substrates varying from mud through mixtures of sand, gravel and cobble; one study indicated water lilies were present at the site; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins

Golden orb	*Quadrula aurea*	C	T

sand and gravel in some locations and mud at others; found in lentic and lotic; Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins

Texas fatmucket	*Lampsilis bracteata*	C	T

streams and rivers on sand, mud, and gravel substrates; intolerant of impoundment; broken bedrock and course gravel or sand in moderately flowing water; Colorado and Guadalupe River basins

Texas pimpleback	*Quadrula petrina*	C	T

mud, gravel and sand substrates, generally in areas with slow flow rates; Colorado and Guadalupe river basins

REPTILES

		Federal Status	State Status
Cagle's map turtle	*Graptemys caglei*		T

endemic; Guadalupe River System; shallow water with swift to moderate flow and gravel or cobble bottom, connected by deeper pools with a slower flow rate and a silt or mud bottom; gravel bar riffles and transition areas between riffles and pools especially important in providing insect prey items; nests on gently sloping sand banks within ca. 30 feet of water's edge

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas garter snake	*Thamnophis sirtalis annectens*		

wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

HAYS COUNTY

PLANTS

		Federal Status	State Status
Bracted twistflower	*Streptanthus bracteatus*	C	

Texas endemic; shallow, well-drained gravelly clays and clay loams over limestone in oak juniper woodlands and associated openings, on steep to moderate slopes and in canyon bottoms; several known soils include Tarrant, Brackett, or Speck over Edwards, Glen Rose, and Walnut geologic formations; populations fluctuate widely from year to year, depending on winter rainfall; flowering mid April-late May, fruit matures and foliage withers by early summer

Hill Country wild-mercury *Argythamnia aphoroides*

Texas endemic; mostly in bluestem-grama grasslands associated with plateau live oak woodlands on shallow to moderately deep clays and clay loams over limestone on rolling uplands, also in partial shade of oak-juniper woodlands in gravelly soils on rocky limestone slopes; flowering April-May with fruit persisting until midsummer

Texas wild-rice	*Zizania texana*	LE	E

Texas endemic; spring-fed river, in clear, cool, swift water mostly less than 1 m deep, with coarse sandy soils rather than finer clays; flowering year-round, peaking March-June

Warnock's coral-root *Hexalectris warnockii*

in leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rocky creekbeds in canyons; in the Trans Pecos in oak-pinyon-juniper woodlands in higher mesic canyons (to 2000 m [6550 ft]), primarily on igneous substrates; in Terrell County under Quercus fusiformis mottes on terrraces of spring-fed perennial streams, draining an otherwise rather xeric limestone landscape; on the Callahan Divide (Taylor County), the White Rock Escarpment (Dallas County), and the Edwards Plateau in oak-juniper woodlands on limestone slopes; in Gillespie County on igneous substrates of the Llano Uplift; flowering June-September; individual plants do not usually bloom in successive years

APPENDIX D
U.S. FISH AND WILDLIFE SERVICE BIOLOGICAL OPINION

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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OCT 18 2013

Colonel Charles H. Klinge, Jr.
U.S. Army Corps of Engineers
(Attn: CESWF-PER-EE)
P.O. Box 17300
Fort Worth, Texas 76102-0300

Consultation No. 02ETAU00-2013-F-0214

Dear Colonel Klinge

This transmits the U.S. Fish and Wildlife Service's (Service) final biological opinion for the U.S. Army Corps of Engineers (USACE) proposed restoration project under section 206 of the Water Resources Development Act (WRDA) of 1996 as amended (33 U.S.C. 2201 and 2330) for the upper San Marcos River. The USACE proposes to partner with the City of San Marcos (City) and implement ecosystem restoration measures on the upper San Marcos River and its riparian corridor.

In accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act), the USACE has determined this project may affect four federally listed threatened or endangered species: Texas wild-rice (*Zizania texana*), San Marcos gambusia (*Gambusia georgei*), fountain darter (*Etheostoma fonticola*), and San Marcos salamander (*Eurycea nana*). The USACE has also determined the project may affect the critical habitat of Texas wild-rice, San Marcos gambusia, and fountain darter. Based on our review of the proposed project and restoration measures, we concur that the project may affect Texas wild-rice and its critical habitat, San Marcos gambusia critical habitat, and the fountain darter and its critical habitat (collectively, consultation species and critical habitat). This biological opinion is based on information from: (1) the BA, (2) conversations with the USACE, Texas Parks and Wildlife Department (TPWD), the City, and Gulf South Research Corporation (GSRC), (3) field investigations by the Service, TPWD, Texas State University – San Marcos, Baylor University, and BIO-WEST, Inc., and (4) other sources of information. A complete administrative record of this consultation is on file at our office.

Consultation History

September 2003	USACE prepares Preliminary Restoration Plan.
May 20, 2009	Meeting with USACE, TPWD, City, and Texas State University.
August 18, 2009	Meeting with USACE, TPWD, and City.

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February 16, 2011	Meeting with USACE, TPWD, City, and GSRC.
July 26, 2012	USACE provides Draft Alternatives Formulation Briefing Report.
January 30, 2013	USACE provides updated Alternative Formulation Briefing Report.
May 21, 2013	USACE provides Draft Biological Assessment (BA).
June 3, 2013	USACE provides Integrated Detailed Project Report and Environmental Assessment (DPR/EA).
June 4, 2013	Service receives the USACE Final BA, formal consultation begins.
September 16, 2013	USACE provides clarification on sediment removal measure
October 1, 2013	Service provides draft biological opinion. Federal government offices close due to a lapse in appropriations through October 16.
October 3, 2013	USACE provides review of draft biological opinion.

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification of critical habitat" at 50 CFR 402.02. Instead, we have relied on the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

BIOLOGICAL OPINION

1. Description of the Proposed Action

Action Area

By regulation, the action area is defined as all areas to be affected directly or indirectly by the federal action, and not merely the immediate area involved in the action (50 CFR 402.02). The action for the USACE proposed action includes area, which includes the San Marcos River and its riparian area from Spring Lake Dam downstream to a point just below Cummings Dam and is buffered 400 meters (m) from the centerline of the San Marcos River (Figure 1). The Service with Utah State University subdivided the upper San Marcos River into study sections, which have been used by the USACE and GSRC in their project planning and habitat evaluations (Figure 1). The action area includes all of the proposed restoration measures and nearby roads. The lowest part of the action area herein is extended from the action area presented in the BA to include the lowest reach where project activities may affect fountain darters, for example through increased temporary turbidity.

Proposed Action

The USACE proposes to partner with the City to implement measures that enhance and restore parts of the upper San Marcos River ecosystem. The proposed measures are actions that would be conducted in the river and riparian corridor to enhance: (1) native woodlands, (2) native aquatic plants and animals, and (3) natural riverine conditions. The original suite of restoration measures under consideration were:

(a) Control of exotic shrubs and trees, e.g., chinaberry trees and ligustrum (EXOT)
(b) Restoration of the riparian corridor by enhancing existing woodlands (RIP)
(c) Control of exotic emergent aquatic vegetation, including elephant ears (EXOE)
(d) Stabilization of stream bank and control of recreational access (SHORE)

(e) Control of stormwater with bioengineering improvements to improve water quality (DISC)
(f) Removal of accumulated sediment in river channel (SED)
(g) Waterfowl management (DUCK)
(h) Wetland restoration (WET)
(i) Education (EDU)

Following cost-benefit analyses and implementation considerations, only the following six restoration measures remain as part of the proposed action: EXOT, EXOE, RIP, DISC, SED, and WET. The BA and particularly the DPR/EA describe in detail each restoration measure. Some of the proposed measures are not expected to have adverse effects on listed species because: (1) they will be done above the water surface of the river, (2) riparian treatments, such as controlling exotic woody species, will affect only the immediate area treated and will have no effect on the river or its biota, and (3) the riparian treatments will use best management practices (BMPs) to minimize erosion and sedimentation. Four restoration measures, EXOT, RIP, DISC, and WET, are considered not likely to cause harm to Texas wild-rice, take of fountain darters, or have any adverse effect critical habitat of these two species.

The remaining two restoration measures, namely EXOE and SED, may affect listed species and we consider the effects of these measures on the consultation species in this biological opinion. The description of the proposed action will focus on the proposed removal of exotic vegetation and sediment removal measures, which may affect the consultation species and their critical habitats.

Elephant Ear and Other Exotic Plants Control

The BA states that elephant ear will be removed from the channel and banks of the San Marcos River downstream of Sewell Park, and that disturbed areas will be planted with native vegetation (Figure 2). About 15,141 m^2 will be disturbed (See Table 1 for area disturbed in each river section). During each year of the three establishment years proposed for this measure, elephant ears will be removed from about 33 percent, or 5,047 m^2 of the river channel and banks.

Elephant ear removal will be conducted in patches such that each patch is treated and stabilized before creating additional disturbance. Removal will occur annually between March 1 and June 30 to allow for successful establishment of native plants during the growing season. Elephant ears may be removed by hand using a shovel or spade. In some instances, plants may be removed by pulling out the whole plant along with its rhizomes. The proposed action also includes the careful use of approved herbicides by trained applicators.

The disturbed patch will be immediately replanted with locally acquired native species suited to the local conditions and could include Texas wild-rice (*Zizania texana*), creeping primrose willow (*Ludwigia repens*), delta arrowhead (*Sagittaria platyphyla*), lizard's tail (*Saururus cernuus*), Illinois pondweed (*Potamogeton illinoensis*), grassleaf mudplantain (*Heteranthera dubia*), and soft stem bulrush (*Schoenoplectus tabernaemontani*). Excess sediment and plant material will be disposed of on city property to be recycled by the city for future use as upland fill.

Sediment Removal from Upper San Marcos River

The proposed restoration project will remove sediment from the river channel at specific locations using suction dredging (Figure 3). Using a screened intake pipe, water and sediment pumped from the river and separated. While the BA indicated the mesh openings would be about 1 mm, larger mesh openings may be used to more effectively dredge. The screen mesh openings will be the minimum practicable that works for dredging starting with 0.5 inch mesh. If the 0.5 inch mesh is not practical in certain areas, mesh as large as 1.0 inch may be used.

The water-sediment mixture will flow to a portable tank. Water will be drained from the removed sediment, clarified in a stilling basin, and returned to the river. The drained sediment will be removed from the restoration area and stored for future non-aquatic fill material near the City of San Marcos Animal Shelter, where the City routinely stores and handles excess fill and compostable materials. Alternative means of dewatering the dredged sediment, such as Geotubes®, are allowable under this biological opinion provided it produces return water of equal or superior water quality than the settling tank method. The main water quality parameter of concern is turbidity.

The USACE and City will replant the dredged area with locally acquired native species suited to the local conditions and could include Texas wild-rice (*Zizania texana*), creeping primrose willow (*Ludwigia repens*), delta arrowhead (*Sagittaria platyphyla*), lizard's tail (*Saururus cernuus*), Illinois pondweed (*Potamogeton illinoensis*), grassleaf mudplantain (*Heteranthera dubia*), and soft stem bulrush (*Schoenoplectus tabernaemontani*).

The USACE and City have developed a list of priority areas that will be targeted for sediment removal. Table 1 lists areas targeted for sediment removal by section. The total area is 19,252 m^2. 20 percent of the sediment removal will be done annually during each of the first five establishment years that funding is available.

Conservation Measures

The DPR/EA provides a detailed description of the BMPs for the restoration efforts. The BMPs include but are not limited to: (1) avoiding and minimizing erosion through use or erosion mats and properly installed silt fences, (2) selection of herbicides (for elephant ear control) that are unlikely to affect (a)Texas wild-rice, (b) other non-target aquatic vegetation, (c) fountain darters, or (d) fountain darter prey, (3) diligent and careful hand application of herbicides, (4) using elephant ear control methods that will have the least impact on the river and its biota, and (5) ongoing coordination and communication with TPWD and USFWS to help ensure minimal adverse effects from restoration measures.

In addition to the BMPs for the two restoration measures that affect the fountain darter (elephant ear and sediment removal), the project biologists (permitted by the Service and TPWD) will clear fountain darters from the work area and will carefully move fountain darters to nearby areas with plant cover.

2. Status of Species and Critical Habitat

2.a Texas Wild-Rice

Texas wild-rice was listed as endangered on April 26, 1978, and its critical habitat was designated on July 14, 1980. Critical habitat includes Spring Lake and its outflow, and the San Marcos River, downstream to the confluence with the Blanco River.

Species Description and Life History

Texas wild-rice is a typically submergent aquatic perennial grass. Its leaves are 3 to 6.5 feet long. When flowering, the inflorescence and the upper culms and leaves emerge above the water surface. In slow moving waters, Texas wild-rice functions as an annual, exhibiting less robust vegetative growth, then flowering, setting seed, and dying within a single season. Texas wild-rice forms stands in the San Marcos River at depths from 0.7 to 7.0 feet. The species requires clear, relatively cool, thermally constant (about 72°F) flowing water. Texas wild-rice prefers gravel and sand substrates overlaying Crawford black silt and clay soils (Poole and Bowles 1999, Saunders et al. 2001).

Reproduction of Texas wild-rice occurs either asexually (clonally) through stolons or sexually via seeds. Asexual reproduction occurs where shoots arise as clones at the ends of rooting stolons (Emery and Guy 1979). Clonal reproduction appears to be the primary mechanism for expansion of established stands, but does not appear to be an efficient mechanism for dispersal and colonization of new areas. Texas wild-rice tillers have, however, been observed floating downstream and some of these tillers may become established plants; but only if lodged in suitable substrate and physical habitat. Seed production is therefore believed to be essential for dispersal and establishment of new stands of Texas wild-rice (Service 1996a).

Sexual reproduction occurs when wind pollinated florets produce seed. This typically takes place in late spring through fall, though flowering and seed set may occur at other times in warm years (Service 1996a). Triggers for flowering are not well understood. Texas wild-rice seed is not long-lived, and seed viability begins to drop markedly within one year of production. No appreciable seed bank is therefore expected to exist in the substrate.

Historic and Current Distribution

Texas wild-rice was first collected in the San Marcos River in 1892 (Service 1996a). When the species was originally described in 1933, it was reported to be abundant in the San Marcos River, including Spring Lake and its irrigation waterways (Silveus 1933, Terrell et al. 1978). In 1976, Emery surveyed Texas wild-rice and estimated areal coverage at 1,131 m^2 in the San Marcos River (Emery 1977). Vaughan (1986) estimated overall Texas wild-rice coverage in 1986 at 454 m^2.

The Texas Parks and Wildlife Department has monitored Texas wild-rice coverage since June 1989, and TPWD estimates of its areal extent have ranged from 1,004 m^2 in 1989 to 4,995 m^2 in 2012. Texas wild-rice only occurs today in the upper San Marcos River from the vicinity of Spring Lake Dam downstream 5.0 river-kilometers. The most recent provisional rangewide

estimate of Texas wild-rice coverage (July 2013) is 5,529 m^2, which is an increase of about 11 percent from the previous year (pers. comm. Jeff Hutchinson, Service, San Marcos Aquatic Resource Center). Table 2 shows the two most recent available surveys for Texas wild-rice. BIO-WEST surveyed between April 10 and May 15, 2013 and Jeff Hutchinson and volunteers surveyed in latter half of July 2013.

Reasons for Decline and Threats to Survival

Reduced springflow is the greatest threat to the survival of Texas wild-rice. Other threats include water quality degradation, physical alteration of Spring Lake or the San Marcos River, and physical disturbance of the species (Service 1996a). Non-native species have also been implicated as a threat to the species.

Texas wild-rice is adapted to clear water, uniform flow rate, and constant year-round temperature (Beaty 1975). Low springflows and reduced San Marcos River flows can cause adverse effects to Texas wild-rice and designated critical habitat (Service 1996a). Drought conditions can adversely affect Texas wild-rice by reducing flows or eliminating water in portions of the river. Low flow conditions allow floating mats of vegetation (which normally move slowly downriver) to become lodged in wild-rice leaves near the surface. Vegetation mats shade plants, may mechanically damage Texas wild-rice, and may interfere with culm emergence thereby interfering with sexual reproduction (Power 1996, Power 1997). Decreased flows expose Texas wild-rice to herbivory by waterfowl, nutria, and giant rams-horn snails (Rose and Power 1992). Altered flow conditions may also result in competitive advantages for non-native plants when conditions are sub-optimal for Texas wild-rice.

An additional threat is recreational use of the river, which has been shown to have measurable adverse effects on Texas wild-rice (Breslin 1997). Breslin (1997) detailed the relative impacts of various activities (tubing, swimming, boating, and dog activities) to Texas wild-rice, and Bradsby (1994) discussed the relative quantity of use of the river during different levels of flow. These studies did not, however, quantify effects to the species at various discharge levels. As discharge decreases and the river becomes shallower, a greater percentage of Texas wild-rice plants are exposed to trampling. With decreased water depths, more Texas wild-rice leaves are on or near the river surface and therefore more exposed to physical disturbance. Recreational use of the river has also been postulated to interfere with flowering and seed set (Service 1996a). In September 2006, a significant loss of Texas wild-rice between Spring Lake Dam and University Drive bridge was reported and attributed to vandalism (BIO-WEST 2007).

Range-wide Survival and Recovery Needs

There are specific recovery actions listed in the 1996 San Marcos and Comal Springs and Associated Aquatic Ecosystems (Revised) Recovery Plan (Service 1996a). These include: (1) ensuring adequate flows and water quality in Spring Lake and the San Marcos River; (2) maintenance of genetically diverse reproductive populations in captivity; (3) creation of reintroduction techniques for use in the event of a catastrophic event; (4) removal or reduction of threats due to: (a) non-native species, (b) recreational use of the river, and (c) habitat alteration;

and (5) maintenance of healthy, self-sustaining, reproductive populations in the wild. Please refer to the Recovery Plan for additional details and priority actions prescribed for recovery.

Adequate springflows and river flows are needed throughout the year for existing Texas wild-rice to survive, grow, and recruit new individuals (stands). The San Marcos River flow regime is characterized by generally stable flows punctuated by small and large floods. However, during droughts, springflow and river flow may decrease 100 cfs in less than one year. Survival and recovery of Texas wild-rice will depend on aquifer management to avoid critically low flows.

Status of Texas wild-rice Critical Habitat

Texas wild-rice critical habitat includes Spring Lake and extends downstream to the confluence of the Blanco River. Critical habitat for Texas wild-rice (45 FR 47355) was designated July 14, 1980, prior to our October 1, 1984, regulation (49 FR 38900) directing the Service to identify primary constituent elements (PCEs) in when designating critical habitat. Nonetheless, important biological and physico-chemical factors (effectively PCEs) were described in the final rule for critical habitat of Texas wild-rice, and fountain darter.

Texas wild-rice critical habitat's primary constituent elements could generally be defined as: (1) clear high quality water, (2) unaltered San Marcos River flow, (3) constant year-round temperature, and (4) maintenance of the natural substrate. Texas wild-rice critical habitat encompasses about 253,000 m^2 (62 acres) of the upper San Marcos River.

2.b San Marcos Gambusia

The entire range of the San Marcos gambusia (*Gambusia georgei)* falls within the action area and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The San Marcos gambusia (SMG) was described from the upper San Marcos River system in 1969, and was subsequently listed as endangered on July 14, 1980 (45 FR 47355). Of the three species of *Gambusia* native to the San Marcos River, SMG has apparently always been much less abundant than either the largespring gambusia (*G. geiseri*) or the western mosquitofish (*G. affinis*) (Hubbs and Peden 1969).

The SMG is a member of the family Poeciliidae and belongs to a genus of Central American origin having more than 30 species of livebearing freshwater fishes. The genus *Gambusia* is well defined and mature males may be distinguished from related genera by their thickened upper pectoral fin rays (Rosen and Bailey 1963). Only a limited number of species of *Gambusia* are native to the United States, and of these the SMG has one of the most restricted ranges.

The food habits of SMG are unknown. Presumably, as in other poeciliids, insect larvae and other invertebrates account for most of the diet of this species.

There is little information on the reproductive capabilities of SMG. Two individuals kept in laboratory aquaria produced 12, 30, and 60 young, although the largest clutch appeared to have been aborted and did not survive (Edwards et al. 1980).

Hybridization between SMG and *G. affinis* was first noted by Hubbs and Peden (1969) and the production of hybrid individuals between them has continued for many years without obvious introgression of genetic material into either of the parental species. Given the history of hybridization between these two species, this factor was not thought to be of primary importance in considerations of the status of SMG. It was thought that so long as the proportion of hybrids remained relatively low compared to the abundance of pure SMG, few problems associated with genetic swamping or introgression would occur (Hubbs and Peden 1969, Edwards et al. 1980). However, the series of collections (R.J. Edwards, pers. comm.) taken during 1981 - 1983 indicate that hybrid individuals may have become many times more abundant than the pure SMG. It may have been possible that hybrid individuals at that time were competing with SMG, placing an additional stress on the small native population of SMG.

The SMG apparently prefers quiet waters adjacent to moving water, but seemingly of greatest importance, thermally constant waters. SMG is found mostly over muddy substrates but generally not silted habitats, and shade from over-hanging vegetation or bridge structures is a factor common to all sites along the upper San Marcos River where apparently suitable habitats for this species occur (Hubbs and Peden 1969, Edwards et al. 1980).

Historic and Current Distribution

The SMG is represented in collections taken in 1884 by Jordan and Gilbert during their surveys of Texas stream fishes and in later collections (as a hybrid) taken in 1925 (Hubbs and Peden 1969). Unfortunately, records of exact sampling localities are not available for these earliest collections, as localities were merely listed as "San Marcos Springs." These collections likely were taken at or near the headsprings area. If true, then SMG appears to have significantly altered its distribution over time. For the area of the San Marcos River downstream of the headwaters area, there are few records of sampling efforts prior to 1950. However, even in the samples that were taken there are few collections of SMG.

A single individual was taken in 1953 below the low dam at Rio Vista Park. Almost every specimen of SMG collected since that time, however, has been taken in the vicinity of the Interstate Highway 35 Bridge crossing or shortly downstream. The single exception was a male captured accidentally with an Ekman dredge (sediment sampler) about 0.62 miles below the outfall of the San Marcos wastewater treatment plant in 1974 (Longley 1975).

Historically, SMG populations have been extremely sparse. Intensive collections during 1978 and 1979 yielded only 18 SMG from 20,199 *Gambusia* total (0.09 percent) (Edwards et al. 1980). Collections made in 1981 and 1982 within the range of SMG indicated a slight decrease in relative abundance of this species (0.06 percent of all *Gambusia*) and none have been collected in subsequent sampling from 1982 to the present. Intensive searches for SMG were conducted in May, July, and September of 1990 but were unsuccessful in locating any pure SMG. The searches consisted of a total of 18 hours of effort (more than 180 people-hours) over

three separate days and covered the area from the headwaters at Spring Lake to the San Marcos wastewater treatment plant outfall. Over 15,450 *Gambusia* were identified during the searches. One individual collected during the search was visually identified as a possible backcross of *G. affinis* and SMG (Service 1990 permit report). This individual was an immature fish with plain coloration. Additional sampling near the Interstate Highway 35 type locality has occurred at approximately yearly intervals since 1990 and no SMG have been found.

The Service and cooperators conducted five fish collections in the upper San Marcos River during the period 1994 and 1996. Edwards (1999) identified 32,811 *Gambusia* in collection jars from that effort. No SMG were found and Edwards concluded this species appears to be extinct.

The pattern of SMG abundance strongly suggests a decrease beginning prior to the mid-1970s. The increase in hybrid abundance between SMG and *G. affinis* and the decrease in the proportion of genetically pure SMG is considered evidence of its rarity. As fewer pure individuals encountered each other, the chances of hybridization with the much more common *G. affinis* substantially increased. The subsequent decrease in SMG abundance along with their hybrids suggests the extinction of this species.

The SMG has not been collected since 1982 despite annual survey efforts, and may no longer exist in the wild. The species has not, however, been declared extinct or removed from the list of endangered species and must therefore be addressed in this biological opinion.

Reasons for Decline and Threats to Survival

At the time the species was listed, small and declining populations, lowered water tables, pollution, bottom plowing, and cutting of vegetation were cited as threats to the species (Service 1980).

Groundwater depletion, reduced springflows, contamination, habitat impacts resulting from severe drought conditions, and cumulative effects of human activities are all identified as threats to the species throughout all or a significant portion of its range (Service 1980).

Water quality is believed to be important to the SMG. Groundwater contamination or pollution resulting from a catastrophic event such as a hazardous material spill into the San Marcos River constitutes another threat to the species. The upper San Marcos River and its immediate tributaries are crossed by a total of 30 bridges including four railroad bridges and six associated with Interstate Highway 35. Any of these river crossings could be the source of a spill or release that could affect the species or its designated critical habitat in the San Marcos River. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

Recreational use of the San Marcos River can also result in adverse impacts to the SMG or its habitat. Recreational uses that physically alter habitats may affect the species ability to feed and shelter.

Non-native species may threaten the SMG though habitat disturbance, or alteration. The SMG inhabits open areas with little vegetation. Suckermouth catfishes (Loricaridae) introduced into the San Marcos River disrupt substrates and may burrow into and destabilize riverbanks, thereby introducing additional sediment loads and turbidity into the river systems. Some researchers have hypothesized that the non-native plant elephant ears (*Colocasia esculenta*) may have adversely affected SMG habitat suitability (Service 1996*a*).

Sediment and sand bar accumulations that modify the river channel and associated habitats may also impact the species or its designated critical habitat. These sediment loads may be associated with the increasing urbanization of the lands surrounding the upper San Marcos River.

The apparent demise of the SMG may be attributed in part to the Allee effect, which becomes important in small populations. The few SMG present in the early 1980s were unlikely to find mates and reproduction rates likely went from rare to zero.

Survival Needs and Recovery Criteria

The SMG apparently requires thermally constant water; quiet, shallow, open water adjacent to moving water; muddy substrates without appreciable quantities of silt; partial shading; clean and clear water; and a food supply of living organisms.

Elephant ears (*Colocasia esculenta*) are a non-native emergent macrophyte believed to have been introduced into the San Marcos area in the early 1900s (Akridge and Fonteyn 1981). This species has displaced native vegetation and now form extensive stands at the water's edge in the San Marcos system. Although the exact nature of the relationship between the occurrence and abundance of elephant ears and the disappearance of SMG is unknown, some investigators believe these nonnative plants may have decreased habitat suitability and contributed to its decline (Service 1996*a*).

The San Marcos gambusia has been presumed extinct for over ten years. The uppermost reach of the action area (Rio Vista Park downstream to Thompson Island) has less suitable San Marcos gambusia habitat compared to 50 years ago due to spread of elephant ears on the San Marcos River banks. There are small areas of suitable habitat for the San Marcos gambusia present in the reach between Hopkins Road and Capes Dam. All of the action area is San Marcos gambusia critical habitat.

Status of San Marcos Gambusia Critical Habitat

Critical habitat of the San Marcos gambusia includes the San Marcos River from Hopkins Street Bridge downstream to approximately 0.5 miles below IH-35 Bridge (45 FR 47355). Important elements of San Marcos gambusia habitat are: (1) open areas with minimal aquatic vegetation, (2) mud substrate, (3) reduced water velocities, and (4) stenothermal (fairly constant) water temperature regime of the spring-fed San Marcos River. The San Marcos River currently provides these elements.

2.c Fountain Darter

The fountain darter was listed as endangered on October 13, 1970, and critical habitat was designated on July 14, 1980. The designated critical habitat is described as "Texas, Hays County; Spring Lake and its outflow, the San Marcos River, downstream approximately 0.5 miles below Interstate Highway 35 Bridge." Fountain darter critical habitat encompasses about 199,772 m^2 (49 acres) of the upper San Marcos River.

Species Description and Life History

The fountain darter is a small benthic, reddish-brown fish. Adult fountain darters range in length from 0.75 to 1.5 inches. Fountain darter habitat requirements as described in the Recovery Plan (Service 1996a) include: undisturbed stream floor habitats; a mix of submergent plants (algae, mosses, and vascular plants), in part for cover; clear and clean water; invertebrate food supply of living organisms; constant water temperatures within the natural and normal river gradients; and adequate springflows. Fountain darters have reduced densities, or are absent, in areas lacking submergent vegetation (Service 1996b, BIO-WEST 2011).

Historic and Current Distribution

The historic range of the fountain darter includes the San Marcos and Comal rivers in central Texas (Service 1996a). In 1884, Jordan and Gilbert (1886) collected the type specimens of *E. fonticola* in the San Marcos River from immediately below the confluence of the Blanco River.

In the San Marcos River system, the fountain darter is found in Spring Lake and the San Marcos River downstream to an area just below the emergency spillway to the Smith Ranch impoundment. The fountain darter population in the San Marcos River downstream of Spring Lake Dam was estimated annually over a 9 year period from 2002 to 2010, and ranged from a minimum of 58,562 to a maximum of 471,315 (EARIP 2012). Fountain darter densities appear to be highest in the upper segments of the San Marcos River and decrease markedly below Cape's Dam (Linam 1993).

In the Comal River system, the fountain darter is found in Landa Lake and throughout the Comal River system downstream to the confluence with the Guadalupe River (Service, unpublished data, 1996b). The fountain darter population in the Comal River system, including Landa Lake, was estimated annually over the same 9 year period as in the San Marcos River, and ranged from a minimum of 172,783 to a maximum of 775,567 (EARIP 2012). Similar to the San Marcos River, Comal River fountain darter densities are lowest in the downstream reaches, due in part to a limited coverage of rooted aquatic plants.

Reasons for Decline and Threats to Survival

The Recovery Plan (Service 1996a) identifies several threats to the fountain darter. The primary threats are related to the quality and quantity of aquifer and spring water. Drought conditions or increased groundwater utilization resulting in reductions to or loss of springflows threaten the species recovery. Activities that may pollute the Edwards aquifer and its springs and

streamflows may also threaten or harm the species (Service 1996a). Additional threats include effects from increased urbanization near the rivers, recreational activities, alteration of the rivers, habitat modification (e.g., dams, bank stabilization, and flood control measures), predation, competition, habitat alteration by non-native species, and introduced parasites (Service 1996a).

Fountain darters are being affected by an introduced parasitic trematode that attaches the gills. Multiple researchers have documented the presence of a trematode parasite that threatens fountain darters (Mitchell et al. 2000 and McDonald et al. 2006). This trematode is more widespread in the Comal than the San Marcos system. The effect of these parasites on darters is likely to increase during stressful periods of low spring discharge (Cantu 2003), and the parasite's adverse effects may be greater to younger fountain darter life-stages (McDonald et al. 2006). Currently, the trematode in the San Marcos system is found in the river near IH-35. The trematode may spread in the San Marcos system through movement of host species such as other fish species, snails, and black-crowned night-herons, and adversely impact the health of the San Marcos fountain darter population.

Range-wide Survival and Recovery Needs

There are numerous actions listed in the Recovery Plan regarding specific recovery efforts. The Recovery Plan recommends recovery efforts aimed at maintaining adequate springflows, protecting water quality, and reducing local threats to fountain darter habitat.

The Recovery Plan specifies the need to develop and implement management plans for both the San Marcos and Comal systems. One recovery need is to protect species and their habitats by management of river recreation entry and exit points to help avoid aquatic plant losses (Service 1996a, EARIP 2012). Recreational use of the river adversely impacts aquatic vegetation. Rooted submergent plants are an important component of fountain darter habitat. Aquatic plants provide: (1) surface area for egg attachment (breeding); (2) nursery habitats; (3) habitat for prey species such as amphipods; and (4) cover from predators. The recovery plan calls for enhancement of fountain darter habitat by protecting and restoring rooted aquatic plants, including Texas wild-rice.

Status of Fountain Darter Critical Habitat

The rulemaking for the fountain darter predates the October 1, 1984, regulation (49 CFR 38900) stipulating that primary constituent elements essential for the conservation of the species be identified at the time critical habitat is designated. However, the rule designating fountain darter critical habitat (45 CFR 47362) does describe actions that would adversely modify designated critical habitat, including any actions that would significantly reduce aquatic vegetation in the San Marcos River, impound water, excessively withdraw water, reduce flow, and pollute the water.

Fountain darter critical habitat includes the San Marcos River, including Spring Lake downstream to approximately 0.5 miles below the Interstate Highway 35 Bridge.

The important elements of fountain darter critical habitat are generally be defined as:
(1) undisturbed stream floor habitats (including runs, riffles, and pools), (2) a mix of submergent vegetation (algae, mosses, and vascular plants), (3) clear and clean water, (4) a food supply of small, living invertebrates, (5) constant water temperatures within the natural and normal river gradients, and (6) adequate spring flows to maintain the conditions above.

The springflow element of fountain darter critical habitat is dependent on the Edwards aquifer water level which can be reduced by drought and by groundwater pumping from the Edwards aquifer.

The water quality in the upper San Marcos River is generally recognized as good. However, a gradient of increasing turbidity from upstream to downstream is notable, particularly during daylight hours in the months of May through September.

Aquatic plants have been mapped and highest densities are found in the uppermost reaches. Below IH-35 and particularly below Capes Dam, aquatic plants in the San Marcos River become less dense. Thus, overall, as one moves downstream from Spring Lake to the Cape Dam and continuing to the downstream end of the critical habitat, the water quality and the density of aquatic vegetation decreases.

3. Environmental Baseline

The environmental baseline section focuses on factors affecting the species and critical habitat in the action area and the status of the species in the action area. As described in the BA, there are ongoing efforts that will benefit the listed species, namely, the conservation and restoration measures resulting from implementation of the EARIP HCP, and the establishment of the San Marcos River State Scientific Area. Also, the City is making improvements to its sewer and stormwater systems to reduce river pollution. The City is also working on reducing the impacts of river recreation on Texas wild-rice in concert with the EARIP HCP.

Texas wild-rice

The factors affecting Texas wild-rice in the action area are similar to those outside the action area. The action area is occupied by about 3,837 m^2 of Texas wild-rice, which is 69 percent of the July 2013 estimate of 5,530 m^2 (pers. comm. Jeff Hutchinson, SMARC). All of the current stands of Texas wild-rice occur within the critical habitat. The action area includes about 15.858 ha (63 percent) of all Texas wild-rice critical habitat. The most recent survey results (July 2013) indicate that the total coverage increased about 11 percent from July 2012. For comparison, the average annual increase since 1990 has been about 8 percent. Texas wild-rice's status is currently stable but a prolonged drought and lack of Edwards Aquifer recharge, may result in instream flows that expose Texas wild-rice to damage.

The Service has issued 10 biological opinions on Federal actions that affected Texas wild-rice in the action area. The 10 formal consultations including a sewage pipeline crossing, a wastewater discharge permit, stormwater outfalls, a railroad bridge replacement, two road bridge repairs, National Fish Hatchery use of Edwards Aquifer water, Joint Base San Antonio use of Edwards

Aquifer water, and the EARIP HCP. All biological opinions were non-jeopardy and non-adverse modification or destruction of critical habitat.

San Marcos Gambusia

The San Marcos gambusia is likely extinct and has not been found in the wild since 1982. All historical collections and all San Marcos gambusia critical habitat are within the action area. Thus the status provided above in Section 2 addresses the environmental baseline.

Fountain Darter

The factors affecting the fountain darter in the action area are similar to those affecting the species rangewide. The highest densities of fountain darters in San Marcos are found in the heavily vegetated headwaters in Spring Lake and in nearby sections of the San Marcos River. The density of native submergent aquatic vegetation (NSAV) decreases downstream of the headwaters. Similarly, fountain darters abundance decreases going downstream. The upper part of the action area has a relatively large fountain darter population and the downstream reaches of the action area have few aquatic plants and low densities of fountain darters (see Table 1). BIO-WEST (2011) estimated 480,000 individual fountain darters within the San Marcos River downstream of Spring Lake and we infer that the action area supports more than half of that population.

Rangewide, the fountain darter has been the subject of 18 formal consultations. The Service has issued 10 biological opinions on actions affecting fountain darters in the action area, including a sewage pipeline crossing, a wastewater discharge permit, two stormwater outfalls, a railroad bridge replacement, two road bridge repairs, San Marcos Aquatic Resources Center and National Fish Hatchery use of Edwards Aquifer groundwater, Joint Base San Antonio use of Edwards Aquifer groundwater, and the EARIP HCP. All biological opinions were non-jeopardy and non-adverse modification and destruction of critical habitat.

4. Effects of the Action

Analysis for Effects

This BO analyzes the effects of the two restoration measures contained in the San Marcos Section 206 Aquatic Ecosystem Restoration Project, and the BMPs and conservation measures associated with those two restoration measures that may affect listed species. There have been prior efforts to control elephant ears above the river level and available information indicates that work has not affected biota in the river. However, the non-native plant removal taking place along the edge of the river or sediment removal in the river may affect listed species in several ways: (1) temporarily increasing turbidity, (2) unavoidably impacting submergent native aquatic vegetation, and (3) causing lethal or sub-lethal effects to fountain darters from hydraulic dredging. The specific measures that are considered to have an effect on Texas wild-rice, fountain darters, and San Marcos gambusia are: (1) the removal of elephant ears, and (2) sediment removal. Table 3 summarizes the areas involved for elephant ear removal and

sediment removal. Table 4 shows the area of current stands of Texas wild-rice in proposed sediment removal target areas.

Texas wild-rice

The restoration measures in the river are planned in such a manner as to avoid and minimize impacts to Texas wild-rice. However, the distribution of Texas wild-rice plants is dynamic and new plants can show up in previously unoccupied areas wherever habitat is suitable. The proposed action will either avoid Texas wild-rice or translocate a limited number of plants to nearby suitable habitat. Some loss of plants is expected even if carefully transplanted. The number of Texas wild-rice plants to be moved is unknown at this time but conservation measures will direct efforts to limit translocations to a small fraction (e.g., less than 5 percent of a TPWD Texas wild-rice segment total coverage).

The effects of the USACE's proposed San Marcos Section 206 Aquatic Ecosystem Restoration Project would be similar to some ongoing restoration efforts conducted under the EARIP HCP. The proposed elephant ear removal is not expected to impact any current stand of Texas wild-rice. However, sediment removal target areas include a small number of Texas wild-rice plants and the breakdown by TPWD segment is shown in Table 4. While efforts to avoid Texas wild-rice whenever possible will be made, some small stands that cannot be avoided will be transplanted to suitable habitat in the same general area, based on the expertise of botanists working to recover Texas wild-rice.

Critical habitat of Texas wild-rice

Texas wild-rice critical habitat's primary constituent elements could generally be defined as:

i. Clear high quality water,
ii. Unaltered San Marcos River flow,
iii. Constant year-round temperature, and
iv. Maintenance of natural substrate

The restoration project is not expected that permanently alter or affect any of these PCEs. There will be some temporary turbidity for the measures in the river. However, best management practices are planned to minimize the turbidity in work areas from affecting the river at large (e.g., through use of silt curtains or similar means).

San Marcos Gambusia

No effects to San Marcos gambusia are expected since this species is likely extinct.

Critical Habitat of San Marcos Gambusia

San Marcos gambusia critical habitat's primary constituent elements could generally be defined as:

i. Open areas with little current or vegetation away from stream banks;

ii. Maintenance of natural substrates;
iii. A natural temperature regime in occupied areas of the San Marcos River, and
iv. Reduced water velocities.

The restoration project is not expected to alter any of these PCEs. Sediment removal (primarily silt) will be removed during the project and the disturbance created by dredging and plant removal will be temporary. The restoration activities will reduce elephant ear coverage, which will improve habitat for the San Marcos gambusia.

Fountain Darter

The restoration project is expected to affect the fountain darter wherever the river substrate and vegetation are affected. The removal of elephant ears and sediment removal are the measures that are expected to result in fountain darter take. Fountain darter density varies by section and generally decreases in the downstream direction. The work area for elephant ear removal is estimated at 15,141 m^2 and the area for sediment removal is estimated at 19,252 m^2. Table 3 shows the estimated number of darters affected by elephant ear removal per river section by multiplying the expected density by the area affected.

About 22,651 fountain darters would be harassed or killed in the areas affected by elephant ear removal throughout the life of project. Elephant ear removal is slated to work on 33 percent each year for three years. The number of fountain darters affected annually by elephant ear removal is expected to be less than 7,550 (33 percent of 22,651) because fountain darter density in elephant ears is lower than the average for other aquatic plants.

To estimate the effects of sediment removal on the fountain darter, we divided the work area into the Service's study sections (4 through 13). In the 1990s, the Service estimated that fountain darter densities in sections 4 through 8 averaged 2.24 darters per m^2. The density for sections 9 through 11 averaged lower at 0.22 darters per m^2. Section specific fountain darter densities were used to estimate the number of fountain darters occupying the areas affected by elephant ear and sediment removal. The specific areas to be treated for sediment removal may change over time due to flooding and other geomorphic processes. The restoration project proposes to limit sediment removal to 20 percent of the total area for a given year. If sediment removal is done as proposed, the number of fountain darters affected on an annual basis is 6,634 individuals. The actual number of darters affected will be strongly dependent on the coverage of submergent plants in sediment removal work area. Plants like hydrilla and hygrophila are adapted to colonize disturbed areas and it is likely both native and non-native submergent plants will occur in areas targeted for sediment removal. If not captured during efforts to clear the area of fauna, a few fountain darters may be killed if they take cover in a work area and are then entrained or impinged during suction dredging.

Critical Habitat of Fountain Darter

The important elements of fountain darter critical habitat are generally be defined as:

i. Undisturbed stream floor habitats (including runs, riffles, and pools),

ii. A mix of submergent vegetation (algae, mosses, and vascular plants),
iii. Clear and clean water,
iv. A food supply of small, living invertebrates,
v. Constant water temperatures within the natural and normal river gradients, and
vi. Adequate spring flows to maintain the conditions above.

The restoration project is expected to affect two of these habitat elements. First, suction dredging will disturb the streambed. Second, the activity will increase turbidity during dredging. Some slight disturbance of the stream floor will result from elephant ear removal when areas are treated. The careful use of herbicides is one means of killing and controlling elephant ears. Physical removal by restoration may also be used although the removal of the elephant ear corm would result in sediment suspension and turbidity.

5. Cumulative Effects

Cumulative effects include the effects of future State, local or private (i.e., non-Federal) actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The USACE, Department of Defense (U.S. Air Force and U.S. Army), Federal Highway Administration, FEMA, U.S. Department of Agriculture – Rural Development, USEPA, and Service are the most likely Federal agencies to authorize or fund projects warranting section 7 review in the vicinity of San Marcos, Texas.

Ongoing impacts from water recreationists remain a serious local threat to Texas wild-rice and fountain darter habitat. The most intense use of the river by recreationists is from late spring to late summer. An invasive non-native species, Beckett's water trumpet (*Cryptocoryne beckettii*), has almost been eliminated in the action area. However, future unintentional introductions (and establishment) of other non-native plants seem likely to occur. These introduced plants may out compete with Texas wild-rice for habitat. Mild to severe flooding is expected in the action area during the life of the project. Flood control projects in the San Marcos area have reduced the severity of flooding in the action area. However, as the immediate watershed becomes more developed, the stormwater hydrograph and water quality are expected to be altered. One effect of greater impervious cover in the watershed will be flashier runoff events. Another effect of increased urbanization on Texas wild-rice, fountain darters, and other biota of the upper San Marcos River is the potential increase risk of contaminants draining into the upper San Marcos River.

6. Biological Opinion Conclusion

After reviewing the current status, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed USACE's Section 206 San Marcos Aquatic Ecosystem Restoration Project will not jeopardize the continued existence of Texas wild-rice, fountain darter, or the San Marcos gambusia. This conclusion is based on: (1) the limited areal extent of the project effects relative to the areas currently occupied by these species; (2) the limits of work done in the San Marcos River during any given year of the project; (3) the likely continued occupation of the San Marcos

River by Texas wild-rice and fountain darters above, in, and below the work area; and (4) the likelihood of that fountain darters will recolonize available aquatic habitats after elephant ears and sediment have been removed and turbidity has subsided. The recolonization of disturbed areas by fountain darters will depend in part on the availability of plant cover. The proposed action includes the timely restoration of submergent plants including Texas wild-rice. The proposed restoration project will not destroy or adversely modify designated critical habitat of Texas wild-rice, fountain darter, or San Marcos gambusia. This conclusion is based on the limited amount of critical habitat affected by the proposed action and the temporary nature of project-related effects.

7. Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

Sections 7(b)(4) and 7(o)(2) of the Act do not generally apply to listed plant species. However, limited protection of listed plants from damage is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in know violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

The measures described below are non-discretionary, and must be undertaken by the USACE so that they become binding conditions of any authorization issued to the City or its contractors, as appropriate, for the exemption in section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE: (1) fails to assume and implement the terms and conditions or (2) fails to require the local sponsor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the effect of incidental take, the USACE must report the progress of the action and its effect on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take Anticipated

Fountain Darter Incidental Take

We estimate the incidental take associated with the early phases of the restoration project where the aquatic habitat is temporarily disturbed by treatments.

The incidental take for the project is considered to be all fountain darters within the riverine habitat areas disturbed by the specific measures – treatments discussed above. The total number of fountain darters taken for is estimated at: (1) 22,651 fountain darters resulting from elephant ear removal and (2) 33,169 fountain darters resulting from sediment removal. The areas to be treated for sediment removal were identified as complimentary and do not overlap with the sediment removal efforts of the EARIP HCP. Capturing and moving fountain darters also constitutes take and we anticipate the temporary silt curtains and general presence of people standing and working in the river will harm some darters. The total number of fountain darters taken is 55,820 from all restoration measures for the life of the project.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effects of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The USACE must directly provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Effect of the take

In the accompanying biological opinion, we have determined that this level of anticipated take is not likely to jeopardize the continued existence of the fountain darter and San Marcos gambusia for the reasons stated in Section VI above.

REASONABLE AND PRUDENT MEASURES

Pursuant to section 7(b)(4) of the Act, we believe the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize effects of incidental take on fountain darters:

RPM 1 Restoration activities affecting (a) substrate, (b) water quality, (c) aquatic plants, and (d) listed animals of the San Marcos River will avoid disturbances of Texas wild-rice and fountain darters to the maximum extent practicable. Where avoidance is not practical, USACE will minimize the disturbance in space and time. Best management practices to improve the water quality of stormwater shall be employed.

RPM 2 The USACE shall monitor the project and ensure appropriate and relevant information on the project is provided in a timely manner to the Service.

RPM 3 The USACE shall ensure that the coverage of submergent aquatic plants is not permanently reduced by the restoration activities particularly sediment removal. The USACE shall plant a commensurate coverage of native submergent plants within one year of removing or destroying any rooted macrophytes.

Terms and conditions

To be exempt from the prohibitions of section 9 of the Act, the USACE must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. The applicant shall be responsible for complying with these terms and conditions, which are non-discretionary.
Terms and conditions that implement RPM 1:

1. The USACE and City will ensure: (a) equipment will be readied and mobilized in a manner to minimize the duration for disturbance, and (b) equipment will be demobilized if a precipitation event and runoff is likely to flood the area.

2. Work by the USACE, City, and/or contractors shall be done with careful staging of heavy equipment by the river and inspections for leakage of fuels, hydraulic fluids, coolants, and any other fluids are required. If fluid leakage is detected, equipment must be repaired and cleaned prior to working in or along the river. Care must be taken to prevent material falling into the river.

3. The biologists working to clear fountain darters species from the area will carefully move any algal or moss mats, to nearby areas with macrophytes.

4. Captured fountain darters will be removed and released in a manner that avoids predation by larger fishes, by releasing individuals with aquarium nets near plant cover on the river bed. Persons involved in these efforts should have proper equipment and authorizations/permits from the Service (section 10(a)(1)(A)) and Texas Parks and Wildlife Department (Scientific Permits pursuant to Texas Parks and Wildlife Code Chapter 43, subchapter C). Habitat will be swept with small (D-frame type or similar) dipnets or small seine to salvage fountain darters immediately prior to sediment removal. The amount of time that netted fountain darters are out of water must be kept to a minimum.

5. Turbidity will be visually monitored daily during elephant ear and sediment removal. If project-related turbidity in the San Marcos River averages more than 20 ntu (nephelometric turbidity units) in a 24-hour period, the applicant will contact the Service to discuss the source of turbidity. If indicated, additional measures to reduce turbidity may be recommended.

6. If Texas wild-rice plants or stands occur in an area to be disturbed, the trans-location of Texas wild-rice may be done after written coordination and approval by the Service and TPWD's lead for Texas wild-rice.

Terms and Conditions that implement RPM 2

7. USACE will ensure project-related work will be actively monitored by the City, who will help ensure that actions taken on-site are consistent with approved plans and this biological opinion.

Terms and Conditions that implement RPM 3

8. USACE will monitor the areal coverage of submergent macrophytes removed or destroyed by restoration activities and USACE and the City will restore native submergent plants in dredged areas within two years. Native macrophytes will be planted and maintained such that the coverage at year five equals or exceeds the coverage at the beginning of the project. USACE and the City will, in coordination with the Service and TPWD, plan for plantings of native submergent aquatic plants in areas not expected to be affected by future restoration activities or other factors. The species composition and planting strategies will be discussed during further coordination on the restoration project.

8. Conservation Recommendations

1. Increase the coverage of native submergent aquatic vegetation (NSAV) throughout the upper San Marcos River. The most effective enhancement will be in areas currently lacking or deficient in NSAV, such as below Capes Dam. It is not clear that the measures in the Nationally Recommend Plan or the Locally Preferred Plan specifically address or support this need explicitly. If sediment removal occurs, the area treated will generally lack rooted macrophytes. We recommend that the project limit the reduction in fountain darter habitat by establishing a commensurate extent of NSAV in appropriate areas prior to sediment removal. Desirable native rooted macrophytes include Texas wild-rice and creeping primrose-willow (*Ludwigia repens*). Texas State University is investigating factors that may affect NSAV including incidence of sunlight and diurnal turbidity. Prof. Thomas Hardy (pers. comm, 2013) indicated Texas wild-rice and other macrophytes are more successful establishing stands and growing in areas where sunlight is not obstructed by tree canopy.

2. Assist with restoration and protection of native macrophytes in the upper San Marcos River, including Texas wild-rice.

3 Assist with efforts to improve the water quality of runoff from San Marcos to the San Marcos River including but not limited to stormwater associated with neighborhoods, railroads, and roads.

4 Assist with additional efforts to avoid and minimize disturbance of the San Marcos River by people.

5 Assist with the implementation of recovery tasks for the fountain darter and Texas wild-rice in the revised Recovery Plan.

We request notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats.

9. Reinitiation Notice

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. If the final action to be carried out differs from the proposed action that our opinion is based on, USACE needs to communicate with the Service to make sure the effects to species and the amount of take are not changed. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Reinitiation would be indicated if final plans differ from the proposed action in a manner that additional aquatic habitats or species numbers are affected.

Thank you for your efforts to protect the ecologically unique fish and wildlife resources of the upper San Marcos River. If you have any questions about our letter, please contact Tanya Sommer at (512) 490-0057 extension 222.

Sincerely,

Adam Zerrenner
Field Supervisor

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Tables and Figures

Table 1. Work areas proposed for elephant ear and sediment removal by section

Table 2. Texas wild-rice surveys from 2013.

Table 3. Estimated effects to fountain darters from section 206 activities in the San Marcos River (elephant ear removal and sediment removal)

Table 4. Estimated areal extent of Texas wild-rice in areas targeted for sediment removal

Figure 1. Action area with sections.

Figure 2. Areas proposed for elephant ear removal under the section 206 project

Figure 3. Areas proposed for sediment removal under the section 206 project

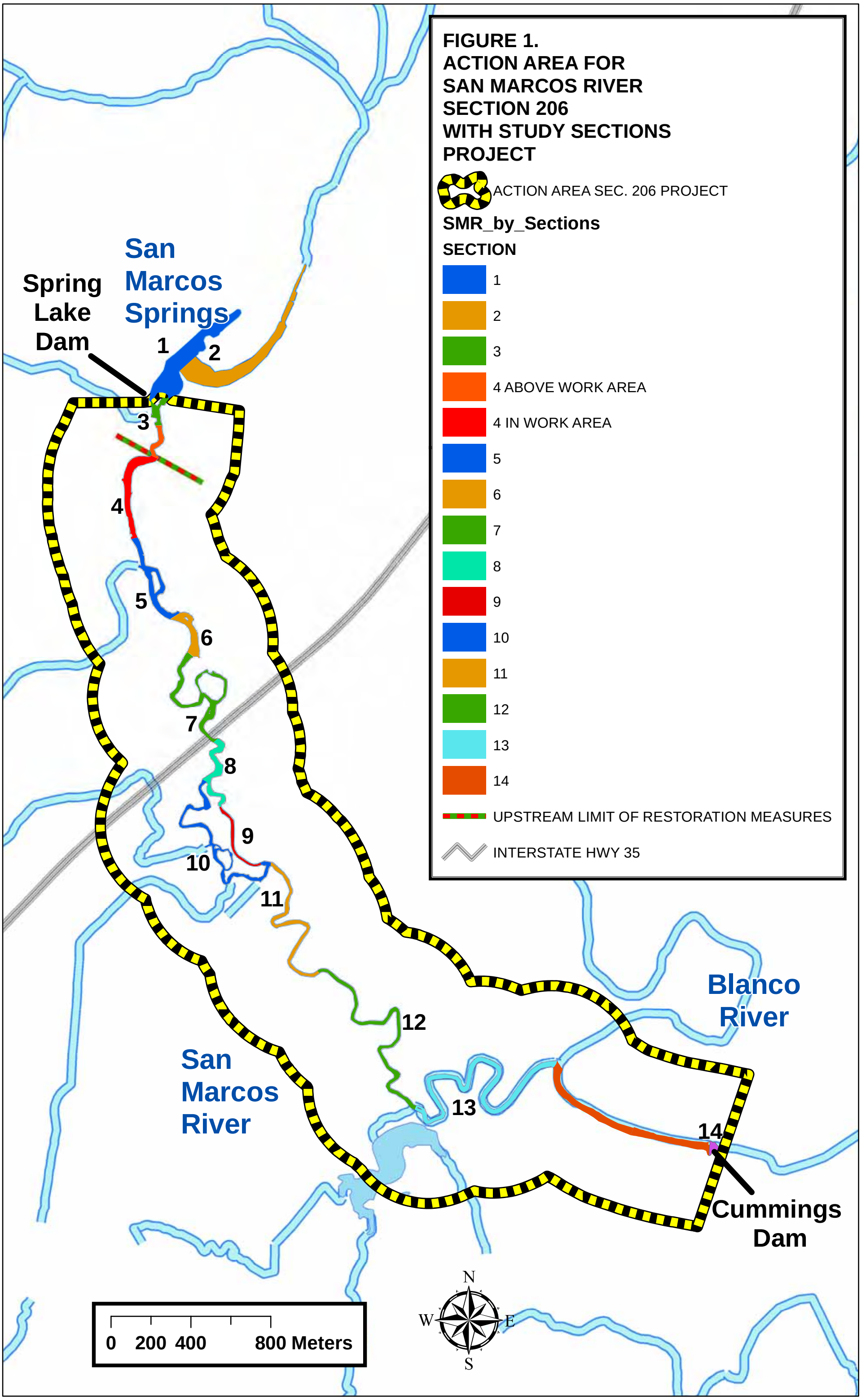
FIGURE 1.
ACTION AREA FOR
SAN MARCOS RIVER
SECTION 206
WITH STUDY SECTIONS
PROJECT
ACTION AREA SEC. 206 PROJECT
SMR_by_Sections
SECTION
1
2
3
4 ABOVE WORK AREA
4 IN WORK AREA
5
6
7
8
9
10
11
12
13
14
UPSTREAM LIMIT OF RESTORATION MEASURES
INTERSTATE HWY 35
San Marcos Springs
Spring Lake Dam
Blanco River
San Marcos River
Cummings Dam
0 200 400 800 Meters
N
W
E
S

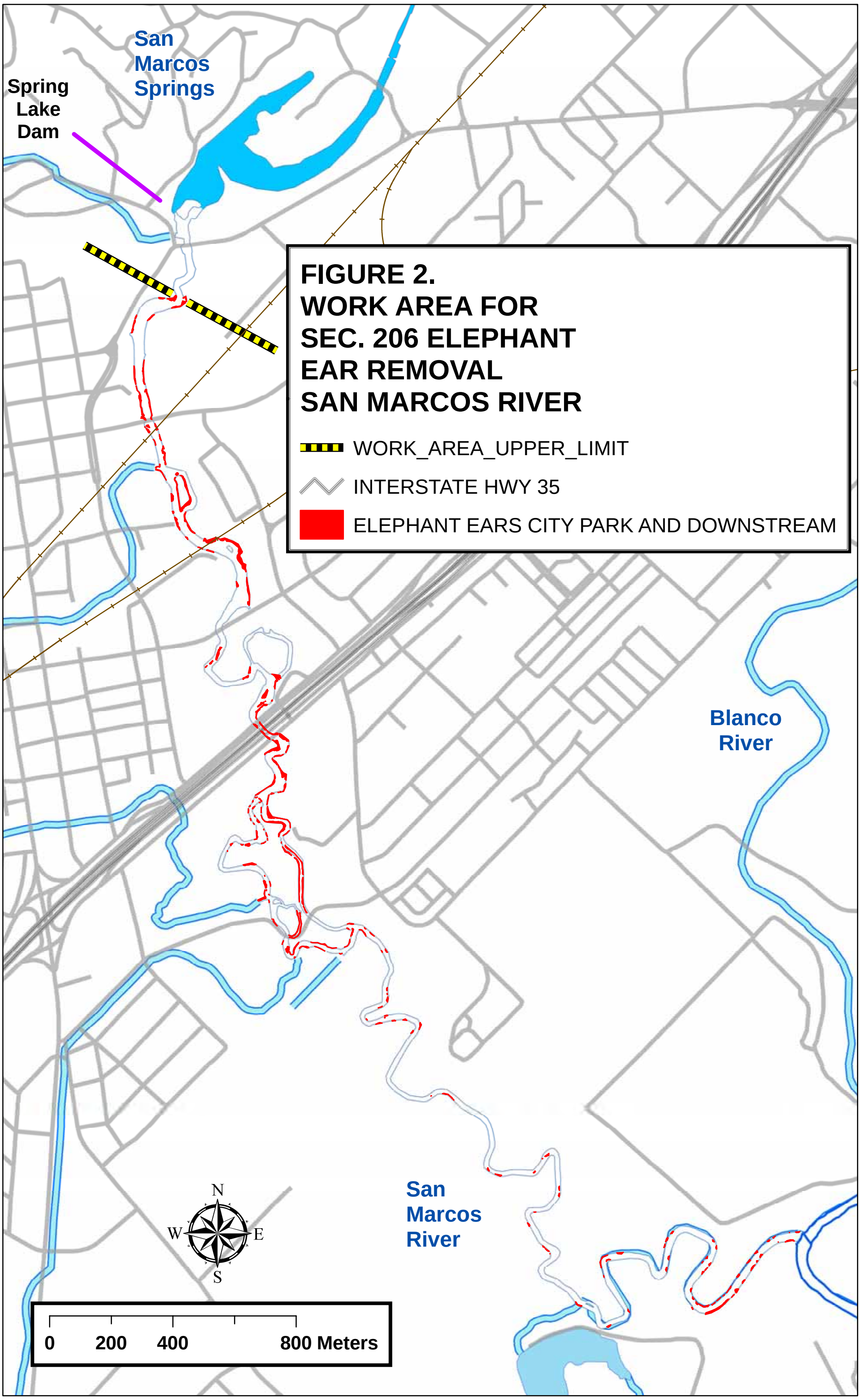
San Marcos Springs
Spring Lake Dam
FIGURE 2.
WORK AREA FOR
SEC. 206 ELEPHANT
EAR REMOVAL
SAN MARCOS RIVER
WORK_AREA_UPPER_LIMIT
INTERSTATE HWY 35
ELEPHANT EARS CITY PARK AND DOWNSTREAM
Blanco River
San Marcos River
N
W
E
S
0
200
400
800 Meters

FIGURE 3. SEDIMENT REMOVAL TARGET AREAS

Priority Areas for Sediment Removal
TY1 to TY5

GSRC

September 2013

TABLE 1. WORK AREAS SAN MARCOS RIVER BY SECTION	Area of Section in M SQ *	SUM OF ELEPHANT EARS AREA M SQ	SUM OF SEDIMENT REMOVAL TARGET AREA M SQ
4 City Park Only	15,789	1,606	3,877.1
5	14,860	2,526	
6	9,697	1,585	
7	19,193	1,548	6,808.6
8	10,817	2,502	3,472.4
9	4,520	913	
10	17,377	1,863	1,324.3
11	13,091	413	3,769.1
12	19,538	419	
13	29,733	1,766	
Total	154,616	15,141	19,252

* PARTIAL FOR SECTION 4

FIGURE 2. TEXAS WILD-RICE (ZIZANIA TEXANA) SURVEYS

ZIZANIA TPWD SEGMENT	10 APR - 15 MAY 2013 AREA BIO-WEST	JULY 2013 AREA SMARC PROVISIONAL
Spring Lake	34.22	t.b.d.
A	645.74	535.35
B	3,373.92	3,503.39
C	782.78	813.16
D		
E	2.49	0.24
F	493.69	503.22
G	57.65	56.45
H	20.36	19.59
I		
X		
J	1.79	0.87
K	56.66	55.59
L	10.77	8.76
M	0.67	0.52
UNASSIGNED		31.59
Grand Total	5,480.74	5,528.73

t.b.d. = to be determined

TABLE 3. ESTIMATED EFFECTS SAN MARCOS RIVER SECTION	Area of Section in M SQ	FOUNTAIN DARTER DENSITY INDIVIDUALS PER M SQ	ESTIMATED FOUNTAIN DARTER POPULATION IN SECTION *	SUM OF ELEPHANT EARS AREA M SQ	ESTIMATED NUMBER OF INDIVIDUALS IN ELEPHANT EARS REMOVAL TARGET AREA	SUM OF SEDIMENT REMOVAL TARGET AREA M SQ	ESTIMATED NUMBER OF INDIVIDUALS IN SEDIMENT REMOVAL TARGET AREA	TOTAL NUMBER OF FOUNTAIN DARTERS IN BOTH WORK AREAS (ELEPHANT EAR AND SEDIMENT REMOVAL)
4 City Park Only	15,789	3.20	50,524	1,606	5,139	3,877.1	12,407	17,545
5	14,860	2.20	32,692	2,526	5,556			5,556
6	9,697	2.00	19,395	1,585	3,171			3,171
7	19,193	1.89	36,275	1,548	2,925	6,808.6	12,868	15,793
8	10,817	1.92	20,768	2,502	4,803	3,472.4	6,667	11,470
9	4,520	0.30	1,356	913	274			274
10	17,377	0.30	5,213	1,863	559	1,324.3	397	956
11	13,091	0.22	2,880	413	91	3,769.1	829	920
12	19,538	0.15	2,931	419	63			63
13	29,733	0.04	1,189	1,766	71			71
Total	154,616		173,224	15,141	22,651	19,252	33,169	55,820

* PARTIAL FOR SECTION 4

TABLE 4. TEXAS WILD-RICE TO BE POTENTIALLY TRANSPLANTED

BASED ON BIO-WEST SPRING 2013 SURVEY

TEXAS WILD-RICE CURRENTLY IN SEDIMENT REMOVAL TARGET AREAS

TPWD SEGMENT	AREA IN M SQ
B	25.3
E	2.0
F	7.6
G	3.1
J	1.8
K	10.1
Grand Total	49.9

APPENDIX E
CORRESPONDENCE AND COMMENTS

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

NOTICE OF AVAILABILITY

DRAFT FINDING OF NO SIGNIFICANT IMPACT AND DETAILED PROJECT REPORT/ENVIRONMENTAL ASSESSMENT FOR THE SAN MARCOS RIVER CONTINUING AUTHORITIES PROGRAM SECTION 206 AQUATIC RESTORATION PROJECT, SAN MARCOS, TEXAS

The public is hereby notified of the availability of the Draft Finding of No Significant Impact (FONSI) and Detailed Project Report and Integrated Environmental Assessment (DPR/EA) evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem restoration measures along the San Marcos River in San Marcos, Texas. The U.S. Army Corps of Engineers, Fort Worth District, and the City of San Marcos, the non-federal sponsor, have prepared the Draft FONSI and DPR/EA to address the proposed restoration measures by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

The Draft FONSI and DPR/EA will be available for review at the following locations:

San Marcos Public Library
625 E. Hopkins Street
San Marcos, Texas 78666

Albert B. Alkek Library
Texas State University
601 University Drive
San Marcos, Texas 78666

The Draft FONSI and DPR/EA can also be viewed via the Internet on the Fort Worth District's website at the following address: www.swf.usace.army.mil

A 30-day-long public comment period begins with publication of this Notice of Availability. Please address any comments to Ms. Amanda McGuire, Environmental Resources Planner, ATTN: CESWF-PEC-TN, P.O. Box 17300, Fort Worth, Texas 76102-0300, or Amanda.Mcguire@usace.army.mil.

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Draft EA Distribution List

Mr. Adam Zerrenner
U.S. Fish and Wildlife Service
10711 Burnet Rd., Suite 200
Austin, Texas, 78758

Mr. Michael Jansky
Office of Planning and Coordination
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Mail Stop 6ENXP
Dallas, Texas 75202

Mr. Tom Heger
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Ms. Julie Wicker
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Gregg Easley, Team 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

Mr. Mark Wolfe
State Historic Preservation Office
P.O. Box 12276
Capital Station
Austin, Texas 78711

Honorable Mark Chino, President
Mescalero Apache Tribe
124 Chiricahua Plaza
Mescalero, New Mexico 88340

Honorable Wallace Coffey, Chairman
ATTN: Mr. James Arterberry
Comanche Nation
584 NW Bingo Rd
HC 32 Box 908
Lawton, Oklahoma 73502

Honorable Ron Twohatchet, Chairman
Kiowa Tribe of Oklahoma
Hwy 9 West
Carnegie, Oklahoma 73015
Ms. Kate Johnson
Chair, Hays County Historical Commission
P.O. Box 1230
Buda, Texas 78610

Honorable Don Paterson, President
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonkawa, Oklahoma 74653

Mr. Mark Denton
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711-2276

Ms. Kim Barker
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711-2276

Sandra Bailey, Librarian
San Marcos Public Library
625 E. Hopkins Street
San Marcos, Texas 78666

Joan Heath, University Librarian
Albert B. Alkek Library
Texas State University
601 University Drive
San Marcos, Texas 78666

Mr. Tony Williams
General Land Office
Stephen F. Austin Building
1700 North Congress Avenue
Austin, Texas 78711-2873

Mr. Todd Engeling
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Mr. Dean McMath
ASW-613
Federal Aviation Agency
2601 Meacham Blvd.
Fort Worth, Texas 76137

Stephen Alexander
Texas Aviation Partners
1807 Airport Drive, Suite 200
San Marcos, Texas 78666

Robert W. Jackson, AICP
Environmental Specialist
Texas Department of Transportation
Aviation Division
125 E. 11th Street
Austin, TX 78701-2483

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Mr. Adam Zerrenner
U.S. Fish and Wildlife Service
10711 Burnet Rd, Suite 200,
Austin, Texas 78758

Dear Mr. Zerrenner:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Mr. Michael Jansky
U.S. Environmental Protection Agency, Region 6
Office of Planning and Coordination
1445 Ross Avenue, Mail Stop 6ENXP
Dallas, Texas 75202

Dear Mr. Jansky:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2014

Regional Planning and Environmental Center

Mr. Tom Heger
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Dear Mr. Heger:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Ms. Julie Wicker
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744

Dear Ms. Wicker:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Mr. Gregg Easley, Team Leader
Texas Commission on Environmental Quality
Water Quality Division, Standards Implementation Team
12100 Park Circle 35, Bldg F
P.O. Box 13087, Capital Station
Austin, Texas 78711

Dear Mr. Easley:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2004

Regional Planning and Environmental Center

Mr. Mark Wolfe
State Historic Preservation Office
Capital Station
P.O. Box 12276
Austin, Texas 78711

Dear Mr. Wolfe:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Honorable Mark Chino, President
Mescalero Apache Tribe
124 Chiricahua Plaza
Mescalero, New Mexico 88340

Dear President Chino:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 1 FEB 2014

Regional Planning and Environmental Center

Honorable Wallace Coffey, Chairman
Comanche Nation
ATTN: Mr. James Arterberry
584 NW Bingo Rd
HC 32, Box 908
Lawton, Oklahoma 73502

Dear Chairman Coffey:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

21 FEB 2014

Regional Planning and Environmental Center

Honorable Ron Twohatchet, Chairman
Kiowa Tribe of Oklahoma
Highway 9 West
Carnegie Oklahoma 73015

Dear Chairman Twohatchet:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2016

Regional Planning and Environmental Center

Ms. Kate Johnson, Chairman
Hays County Historical Commission
P.O. Box 1230
Buda, Texas 78610

Dear Chairman Johnson:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 4 FEB 2014

Regional Planning and Environmental Center

Honorable Don Paterson, President
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonikawa, Oklahoma 74653

Dear President Paterson:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 1 FEB 2014

Regional Planning and Environmental Center

Mr. Mark Denton
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711-2276

Dear Mr. Denton:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

Ms. Kim Barker
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711-2276

Dear Ms. Barker:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

Ms. Sandra Bailey, Librarian
San Marcos Public Library
625 Hopkins Street
San Marcos, Texas 78666

Dear Ms. Bailey:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2004

Regional Planning and Environmental Center

Ms. Joan Heath, University Librarian
Texas State University
Albert B. Alkek Library
601 University Drive
San Marcos, Texas 78666

Dear Ms. Heath:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

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Director, Regional Planning and
Environmental Center

Enclosures

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. Tony Williams
General Land Office
Stephen F. Austin Building
1700 North Congress Avenue
Austin, Texas 78744

Dear Mr. Williams:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

A Public Notice has been prepared to notify the public of this action and to solicit comments. The Public Notice, Draft FONSI, and DPR/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
Director, Regional Planning and
Environmental Center

Enclosures

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. Todd Engeling
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Dear Mr. Engeling:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2014

Regional Planning and Environmental Center

Mr. Dean McMath
Federal Aviation Agency
ASW-613
2601 Meacham Blvd
Fort Worth, Texas 76137

Dear Mr. McMath:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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

REPLY TO
ATTENTION OF:

2 FEB 2014

Regional Planning and Environmental Center

Mr. Stephen Alexander
Texas Aviation Partners
1807 Airport Drive, Suite 200
San Marcos, Texas 78666

Dear Mr. Alexander:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

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Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

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. Robert W. Jackson, AICP
Texas Department of Transportation
Aviation Division
125 E. 11th Street
Austin, Texas 78701

Dear Mr. Jackson:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

A Public Notice has been prepared to notify the public of this action and to solicit comments. The Public Notice, Draft FONSI, and DPR/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
Director, Regional Planning and
Environmental Center

Enclosures

-----Original Message----

From: Robert Jackson [mailto:Robert.W.Jackson@txdot.gov]
Sent: Wednesday, February 26, 2014 2:14 PM
To: Mcguire, Amanda SWF
Subject: [EXTERNAL] San Marcos restoration project

Ms. Mcquire,

I have reviewed the Detailed Project Report and Integrated Environmental Assessment for San Marcos River Section 206 Aquatic Ecosystem Restoration Project (February 2014). TxDOT Aviation Division (AVN) has no objection to the FONSI. Thank you for allowing AVN to review this document.

Regards,

Robert W. Jackson, AICP

Environmental Specialist

TxDOT Aviation Division

Drink. Drive. Go to Jail. Drink.

Drive. Go to Jail. <http://www.txdot.gov/driver/sober-safe/nascar-drink-drive-go-to-jail.html>

Texas Department of Transportation
125 EAST 11TH STREET | AUSTIN, TEXAS 78701-2483 | (512) 463-8700 | WWW.TXDOT.GOV

February 13, 2014

Ms. Mandy McGuire
Environmental Resources Planner
Department of the Army
Fort Worth District, Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

Dear Ms. McGuire:

The Texas Department of Transportation, Aviation Division (AVN), has reviewed the aquatic ecosystem restoration project within Section 206 of the San Marcos River in San Marcos, Texas, as that project is described in a letter to AVN from Eric W. Verwers, director, Regional Planning and Environmental Center, dated February 10, 2014. This project would involve, among other actions, restoration of approximately 0.08 acre of existing wetland habitats on a backwater channel of the San Marcos River near Cheatham Street and approximately 1.11 acres of wetland habitats in the form of a series of in-line wetponds on Sessoms Creek near Spring Lake. This project has been reviewed for compliance with the recommendations of Federal Aviation Administration Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants On or Near Airports.

AVN has no objection to the project as described. AVN welcomes the opportunity to review the Detailed Project Report and Integrated Environmental Assessment when that document is ready for agency review and comment.

Thank you for allowing AVN to review this project.

Regards,

Robert W. Jackson

Robert W. Jackson, AICP
Environmental Specialist
Texas Department of Transportation,
Aviation Division
125 E. 11th Street
Austin, TX 78701-2483

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

REPLY TO
ATTENTION OF

February 10, 2014

Regional Planning and Environmental Center

Robert W. Jackson, AICP
Environmental Specialist
Texas Department of Transportation
Aviation Division
125 East 11th Street
Austin, Texas 78701-2483

Dear Mr. Jackson:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, in partnership with the City of San Marcos and the Texas General Land Office, are conducting a feasibility study for aquatic ecosystem restoration within the San Marcos River, San Marcos, Texas (Figure 1). The study area includes the San Marcos River and adjacent land from Spring Lake Dam to Cummings Dam on the Blanco River. Other lands within the study area include the headwaters of the San Marcos River (i.e., Sessoms Creek, Purgatory Creek, and Willow Springs Creek). The aquatic ecosystem restoration study is being conducted under the authority of the Continuing Authorities Program Section 206 of the Water Resources Development Act of 1996 (Public Law 104-33).

During the development of restoration measures, the USACE has taken into consideration the potential for aquatic ecosystem restoration features to be hazardous wildlife attractants to any nearby airports. The nearest public-use airport to the San Marcos River Section 206 study area is the San Marcos Municipal Airport (HYI). HYI does serve turbine-powered aircraft and sells Jet-A fuel. As such, the USACE mapped a 10,000-foot perimeter around HYI per the Federal Aviation Administration (FAA) Advisory Circular No. 150/5200-33b to ensure that the restoration measures proposed in the study area that could be considered a hazardous wildlife attractant were located greater than 10,000 feet from the HYI air operations area (AOA) (Figure 2). In accordance with the FAA Advisory Circular, a 5-mile perimeter around HYI is included on Figure 2 as well. The nearest proposed restoration measure in the project study area is located greater than 3 miles from the HYI AOA.

The restoration measures that are proposed as part of the Tentatively Selected Plan (Figure 3) for the San Marcos River Section 206 project are:

a. Control of Exotic Aquatic Emergent Vegetation in the San Marcos River (EXOE) - This measure includes the removal of approximately 2.61 acres of exotic vegetation (Elephant ear) along the river banks. Areas where exotic vegetation is removed will be replanted with native species.

b. Restoration of the San Marcos River Riparian Corridor (RIP1 and RIP2) - This measure includes improvements to riparian habitats by planting native vegetation on approximately 14.56 acres of riparian forest in areas currently serving as parkland, sidewalks, parking lots, or other impervious surfaces.

c. Control of Exotic Trees and Shrubs in the San Marcos River Riparian Corridor (EXOT) - This measure includes the removal and control of exotic shrubs and trees in approximately 19.92 acres of existing riparian forest.

d. Restoration of Wetlands (WET) – This measure includes restoration of 1.19 acres of wetland habitats (Figure 4). WET would involve restoration of approximately 0.08 acre of existing wetland habitats on a backwater channel of the San Marcos River near Cheatham Street and approximately 1.11 acres of wetland habitats in the form of a series of in-line wetponds on Sessoms Creek near Spring Lake.

e. Control of Sediment Discharge into the San Marcos River (DISC) - This measure would include improving currently degraded discharges at 12 locations on 2.10 acres along the San Marcos River. The contour and path of existing discharges would be modified to reduce the velocity of flows and allow for capture of sediments and potentially pollutants prior to discharge into the river.

f. Removal of Accumulated Sediments from the San Marcos River (SED) – This measure includes removal of sediments within the San Marcos River over approximately 4.75 acres during the initial Federally cost shared construction and up to 25.42 acres over the 50-year life of the project during normal Operation and Maintenance (O&M) activities.

The USACE is preparing a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing these proposed restoration measures along the San Marcos River and identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area. During coordination with FAA, USACE was informed that HYI is part of the FAA State Block Grant Program and under the jurisdiction of the Texas Department of Transportation Aviation Division (TxDOT) as well. While the Draft DPR/EA and FONSI are being prepared, we invite TxDOT to review the restoration measures associated with the Recommended Plan for the San Marcos River Section 206 Aquatic Ecosystem Restoration Project and provide us with any comments.

Please address any comments you may have to Ms. Mandy McGuire, Environmental Resources Planner, ATTN: CESWF-PEC-TN, P.O. Box 17300, Fort Worth, Texas 76102-0300 or email at amanda.mcguire@usace.army.mil. Thank you for your cooperation in this matter.

Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

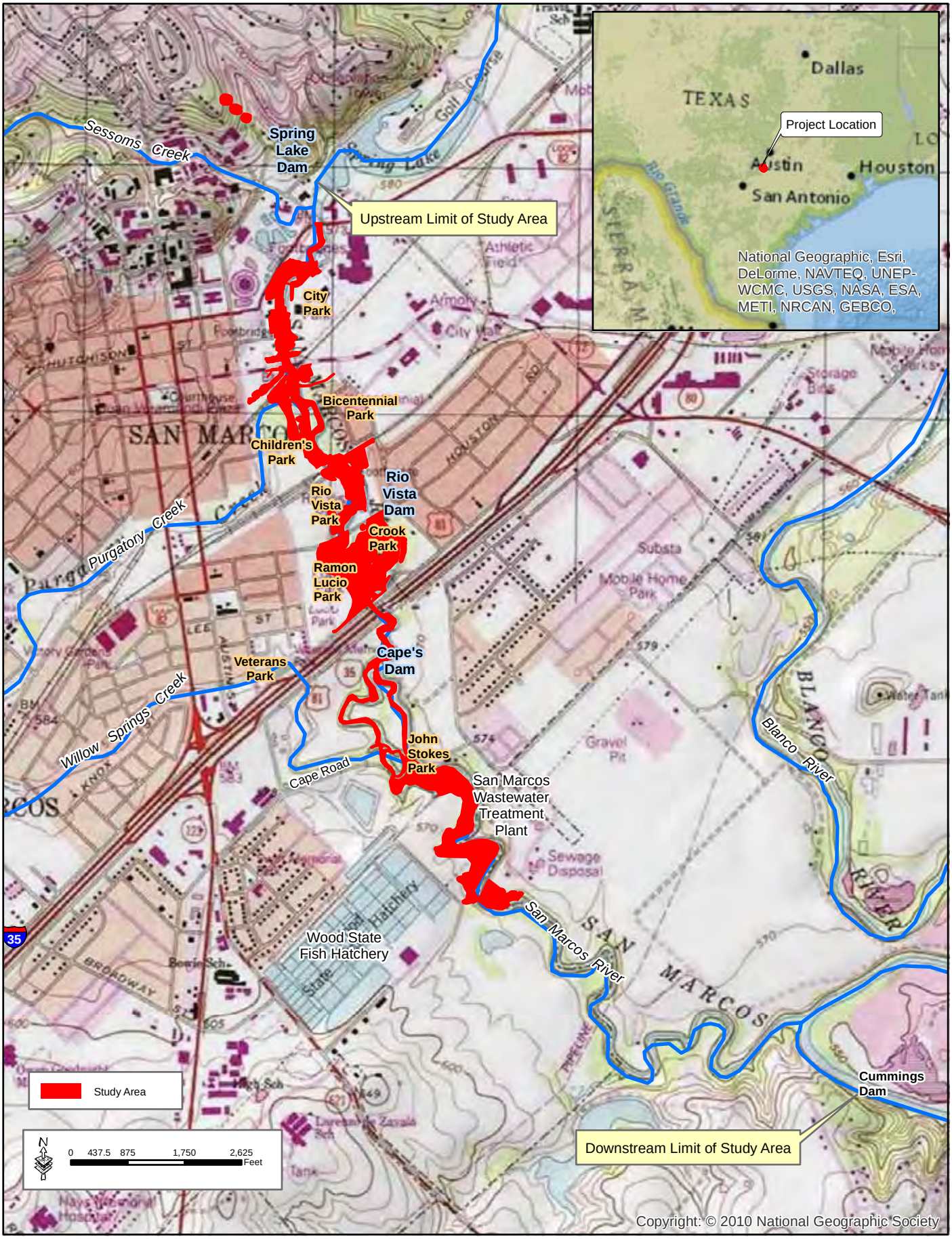

Figure 1. Vicinity Map

GSRC

January 2014

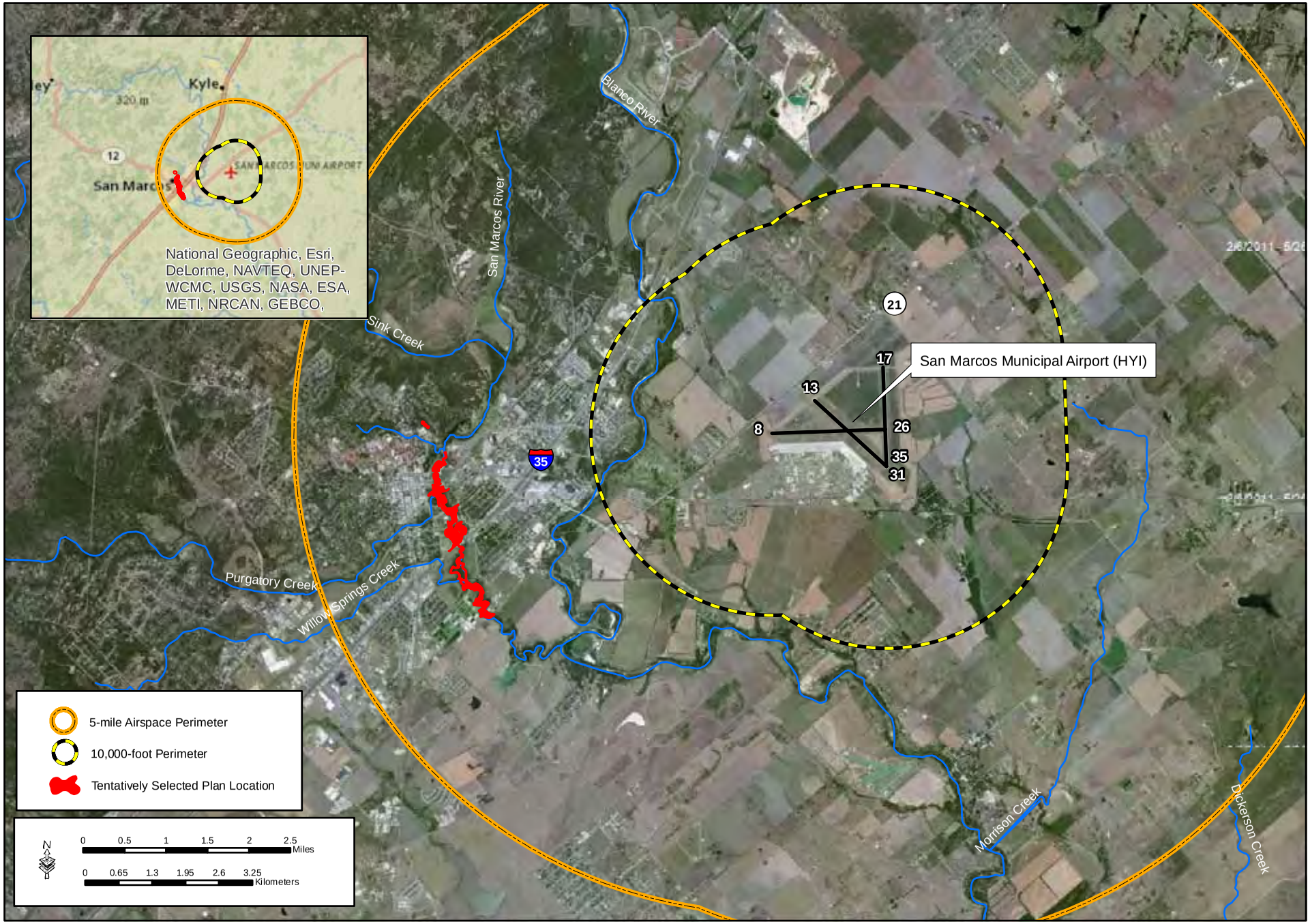

Figure 2. Tentatively Selected Plan in Relation to San Marcos Municipal Airport (HYI)

GSRC

January 2014

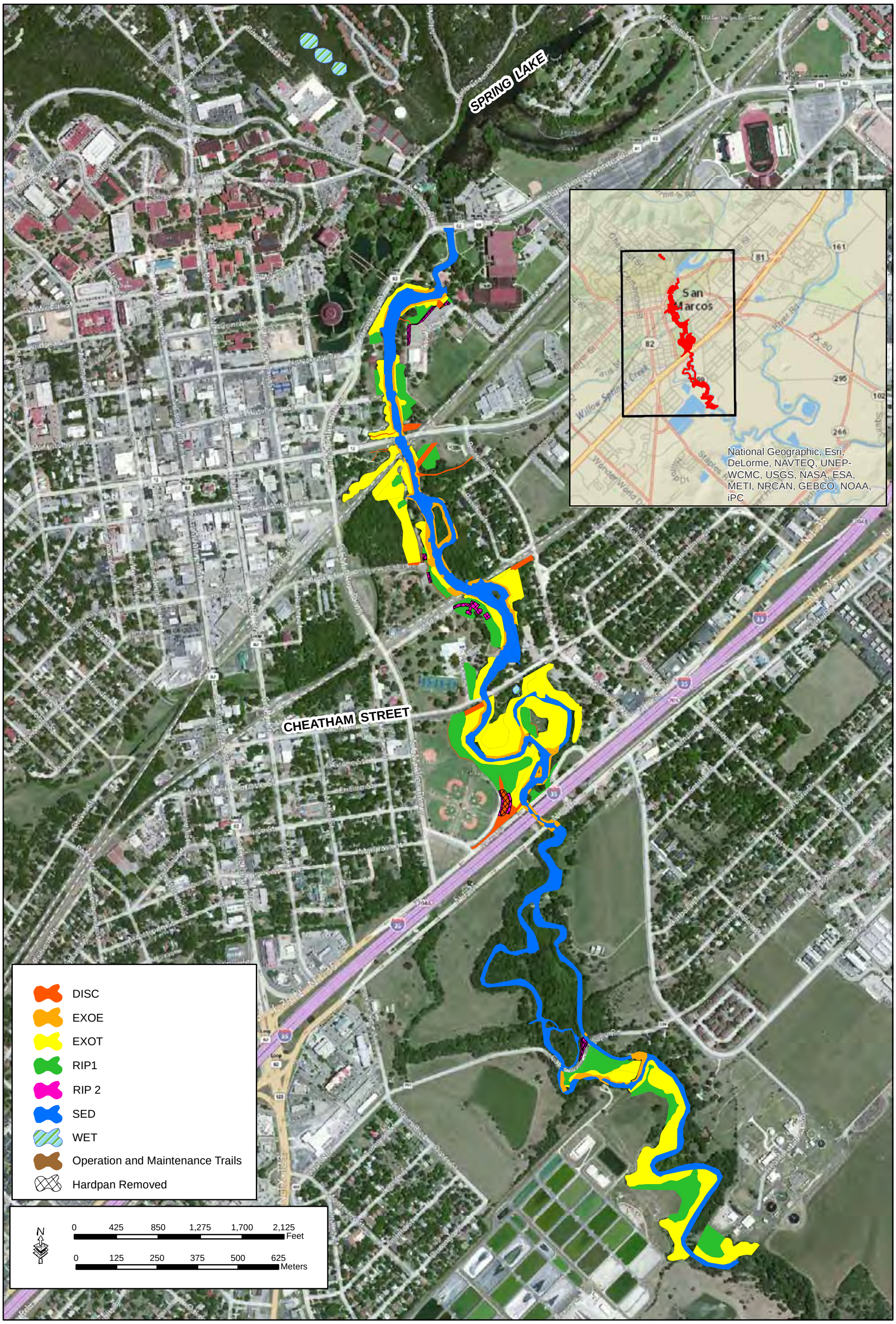

Figure 3. Tentatively Selected Restoration Plan

GSRC

January 2014

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

REPLY TO
ATTENTION OF:

January 21, 2014

Regional Planning and Environmental Center

Mr. Dean McMath
ASW-613
Federal Aviation Agency
2601 Meacham Blvd.
Fort Worth, Texas 76137

Dear Mr. McMath:

The U.S. Army Corps of Engineers, Fort Worth District (USACE), in partnership with the City of San Marcos and the Texas General Land Office, are conducting a feasibility study for aquatic ecosystem restoration within the San Marcos River, San Marcos, Texas (Figure 1). The study area includes the San Marcos River and adjacent land from Spring Lake Dam to Cummings Dam on the Blanco River. Other lands within the study area include the headwaters of the San Marcos River (i.e. Sessoms Creek, Purgatory Creek, and Willow Springs Creek). The aquatic ecosystem restoration study is being conducted under the authority of the Continuing Authorities Program Section 206 of the Water Resources Development Act of 1996 (Public Law 104-33).

During the development of restoration measures, the USACE has taken into consideration the potential for aquatic ecosystem restoration features to be hazardous wildlife attractants to any nearby airports. The nearest public-use airport to the San Marcos River Section 206 study area is the San Marcos Municipal Airport (HYI). HYI does serve turbine-powered aircraft and sells Jet-A fuel. As such, the USACE mapped a 10,000-foot perimeter around HYI per the Federal Aviation Administration (FAA) Advisory Circular No. 150/5200-33b to ensure that the restoration measures proposed in the study area that could be considered a hazardous wildlife attractant were located greater than 10,000 feet from the HYI air operations area (AOA) (Figure 2). In accordance with the FAA Advisory Circular, a 5-mile perimeter around HYI is included on Figure 2 as well. The nearest proposed restoration measure in the project study area is located greater than 3 miles from the HYI AOA.

The restoration measures that are proposed as part of the Tentatively Selected Plan (Figure 3.) for the San Marcos River Section 206 project are:

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None of these restoration measures would create a hazardous wildlife attractant because each measure restores existing aquatic habitats. Wetland restoration, which, of the proposed restoration measures has the greatest probability of creating a new hazardous wildlife attractant, is limited to 1.19 acres of habitat, and is over 3 miles away from the western end of Runway 8/26.

The USACE is preparing a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing these proposed restoration measures along the San Marcos River and identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area. If requested, the USACE will provide the FAA with a copy of the Draft DPR/EA and FONSI when it is distributed for public review and comment. While the Draft DPR/EA and FONSI are being prepared, we invite the FAA to review the restoration measures associated with the Tentatively Selected Plan for the San Marcos River Section 206 Aquatic Ecosystem Restoration Project and provide us with any comments or concerns. We look forward to receiving your comments and concerns as we move forward.

Please address any comments you may have to Ms. Amanda McGuire, Environmental Resources Planner, CESWF-PEC-TN, P.O. Box 17300, Fort Worth, Texas 76102-0300 or email amanda.mcguire@usace.army.mil. Thank you for your cooperation in this matter.

Sincerely,

Eric W. Verwers
Director, Regional Planning and Environmental Center

3 Enclosures
1. Vicinity Map (Figure 1)
2. Tentatively Selected Plan (Figure 2)
3. Selected Plan (Figure 3)

CC: Texas Aviation Partners, Attn: Stephen Alexander, 1807 Airport Drive, Suite 200, San Marcos, Texas 78666

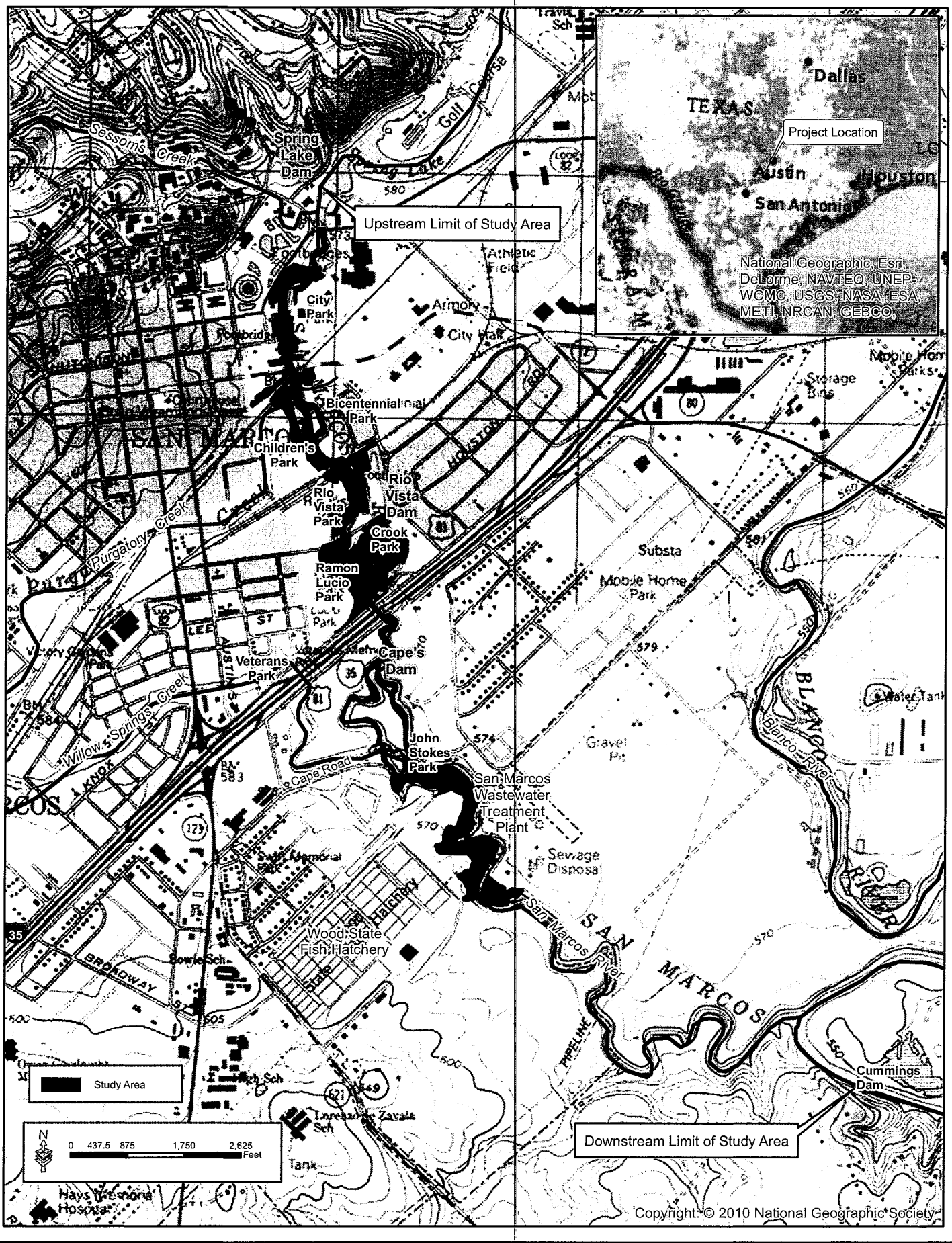


Figure 1. Vicinity Map

GSRC

January 2014

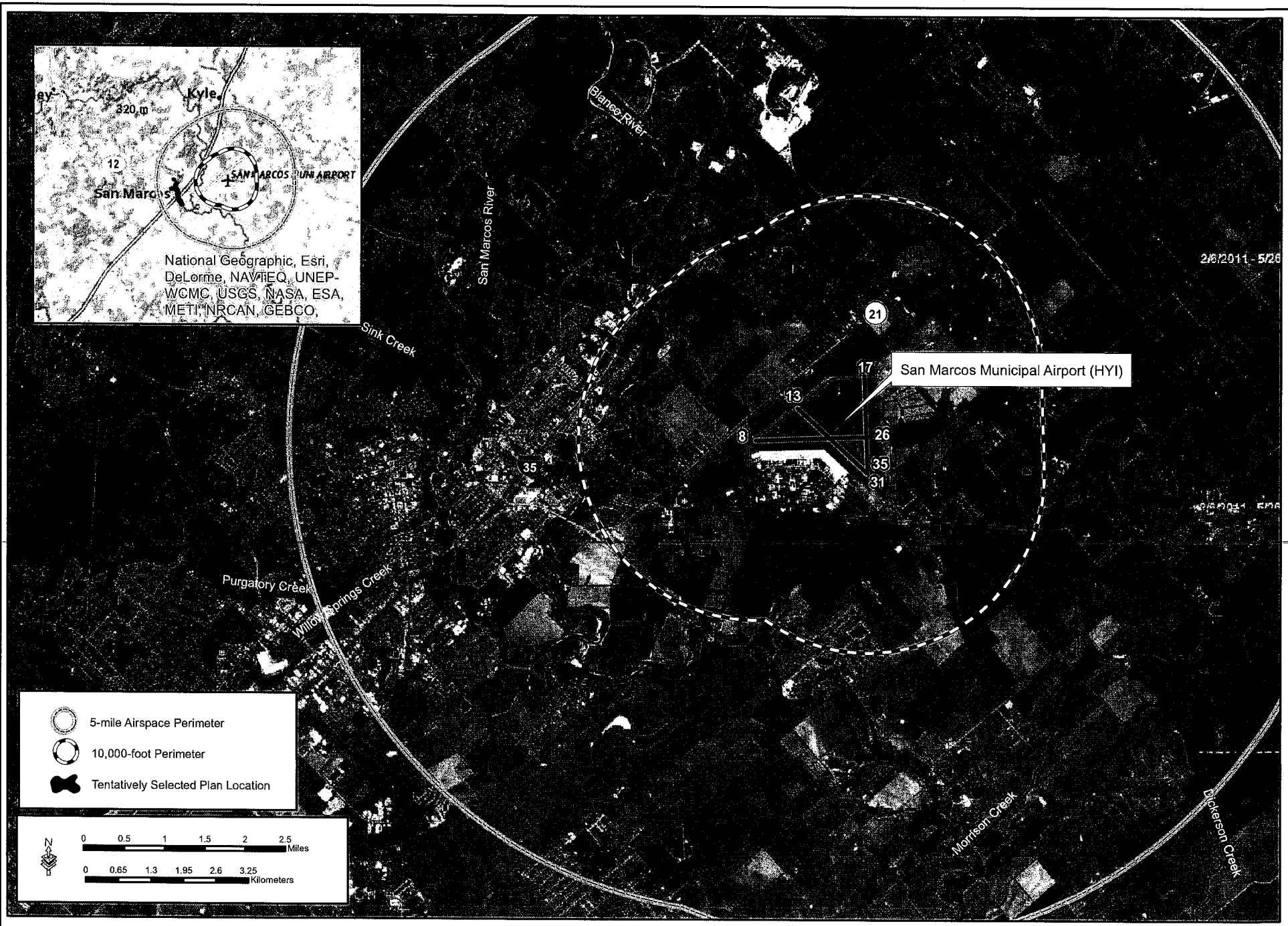


Figure 2. Tentatively Selected Plan in Relation to San Marcos Municipal Airport (HYI)

GSRC

January 2014

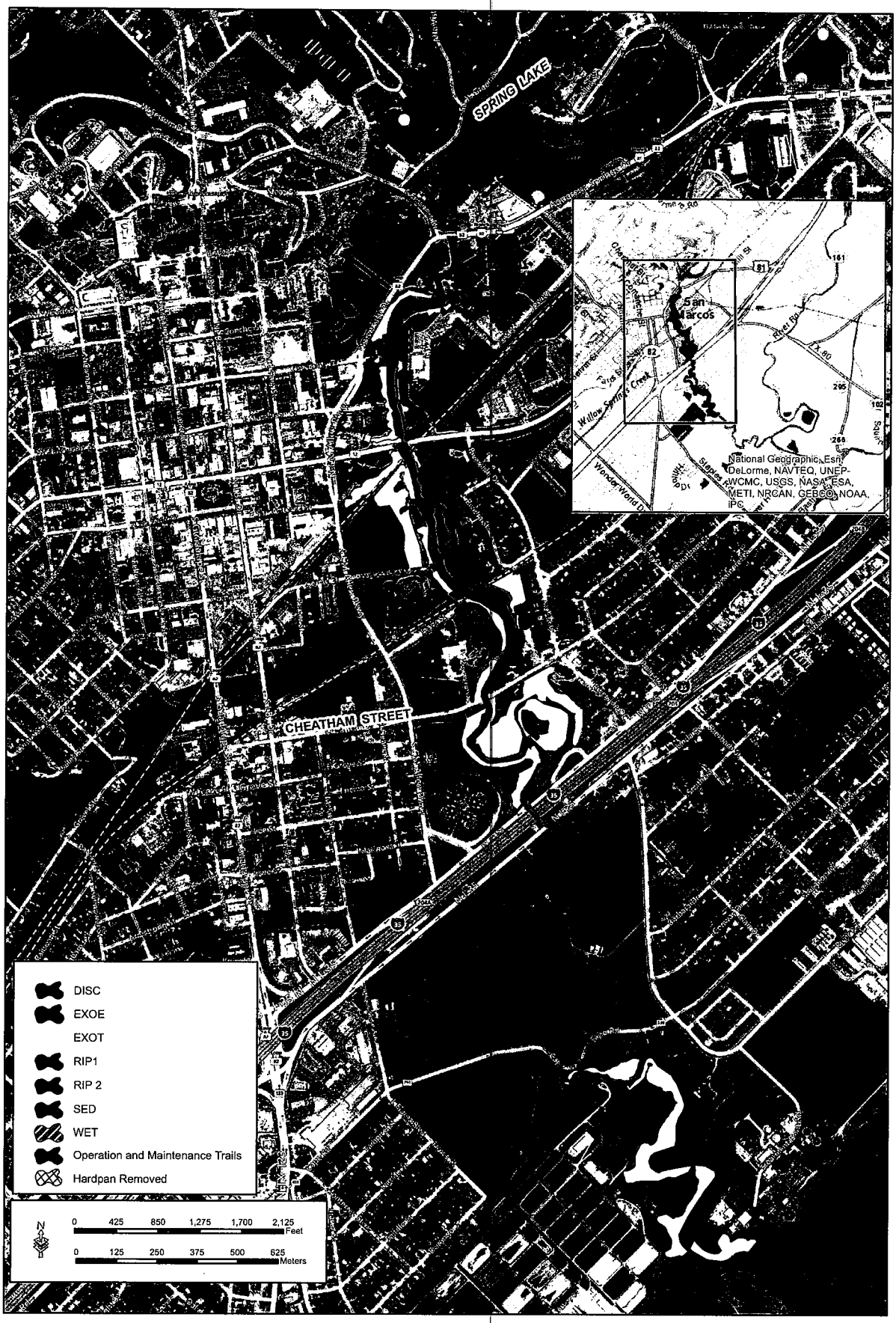


Figure 3. Tentatively Selected Restoration Plan

GSRC

January 2014

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

REPLY TO
ATTENTION OF:

2 FEB 2014

RECEIVED
FEB 21 2014

Regional Planning and Environmental Center

Mr. Mark Wolfe
State Historic Preservation Office
Capital Station
P.O. Box 12276
Austin, Texas 78711

Dear Mr. Wolfe:

The U.S. Army Corps of Engineers (USACE), Fort Worth District, and the City of San Marcos, Texas, the non-federal sponsor, are evaluating the potential environmental consequences resulting from implementing proposed aquatic ecosystem measures along the San Marcos River in San Marcos, Texas. The proposed aquatic ecosystem restoration plan was analyzed as part of the San Marcos River Continuing Authorities Program, Section 206 Aquatic Restoration Feasibility Study.

The USACE has prepared a Detailed Project Report and Integrated Environmental Assessment (DPR/EA) and Draft Finding of No Significant Impact (FONSI) addressing proposed restoration measures along the San Marcos River by identifying and evaluating impacts that would result from proposed restoration measures to the human and natural resources found within the San Marcos River area.

A Public Notice has been prepared to notify the public of this action and to solicit comments. The Public Notice, Draft FONSI, and DPR/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.

CONCUR
by Mark H Wolfe
for Mark Wolfe
State Historic Preservation Officer
Date 3-14-14
Track#

Sincerely,

E. W. Verwers

Eric W. Verwers
Director, Regional Planning and
Environmental Center

NO HISTORIC
PROPERTIES AFFECTED
PROJECT MAY PROCEED
by Mark H Wolfe
for Mark Wolfe
State Historic Preservation Officer
Date 3-14-14
Track#

Enclosures

From: Mark Denton <Mark.Denton@thc.state.tx.us>
Sent: Wednesday, January 29, 2014 4:58 PM
To: Parrish, Nancy A SWF
Cc: Sarah Birtchet; Bill Martin
Subject: [EXTERNAL] RE: San Marcos River Aquatic Ecosystem Restoration (UNCLASSIFIED)

I don't think, so. But, if they find a significant deposit and can't avoid it then I guess we'll have to write an MOA. Right Bill?

-----Original Message-----
From: Parrish, Nancy A SWF [mailto:Nancy.A.Parrish@usace.army.mil]
Sent: Wednesday, January 29, 2014 12:01 PM
To: Mark Denton
Cc: Sarah Birtchet
Subject: RE: San Marcos River Aquatic Ecosystem Restoration (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Mark-

We found the reports and have done some quick checking against out project area. We think there is maybe 25% of our proposed ecosystem restoration area that has not yet been surveyed. We plan to do the survey while the engineers do their more detailed design. The idea is that we can help influence the design to avoid impacts as best we can. Anything we can't avoid, we'd mitigate before anything goes to construction. Do we really need a PA for that in your opinion, or do we just consider consultation on-going throughout the design phase?

Nancy

****
Nancy Parrish, RPA
Plan Formulation CESWF-PEC-PF
819 Taylor St
Fort Worth, TX 76102
ph.817-886-1725

-----Original Message-----
From: Mark Denton [mailto:Mark.Denton@thc.state.tx.us]
Sent: Wednesday, January 15, 2014 12:23 PM
To: Parrish, Nancy A SWF
Cc: Sarah Birtchet
Subject: [EXTERNAL] RE: San Marcos River Aquatic Ecosystem Restoration (UNCLASSIFIED)

The cities of San Marcos and New Braunfels hired (possibly with some funding from the Edwards Aquifer District) their own archeologists to separately perform investigations on the Comal and San Marcos Rivers for their respective ecosystem restoration projects. New Braunfels was never going to do any bank modifications and there 106 needs were therefore pretty limited. San Marcos on the other hand had some fairly aggressive bank modification in mind to seriously cut back (literally) the erosion problems they are experiencing, particularly along public access swimming areas. Among other things, the publicly owned "Lions Club" swimming area modification along the San Marcos River

were going to involve removal of 1930's vintage concrete bank stabilization walls and water level sidewalks that sit on top of a significant (Sate Archeological Landmark) prehistoric deposits, but once I explained the potential adverse effects and expense of modifying this area they immediately abandoned that concept and all other major bank modifications plans, besides adding fill to a small section of the bank down close to the I-35 frontage road. There's also an SAL down there, but we worked out a no adverse effect way for them to accomplish what they need to do.

Most of the rest of the work for both rivers involved silt removal of strictly modern silt deposits in the main canals, hand removal of invasive vegetation, and hand planting of new anti-erosion plants along the banks.

The City of San Marcos also excavated a pit close to the river as a holding pond for dredge material and water. The excavation of this pit was monitored by CAS archeologists, artifacts were found and an interim report is pending.

Mark H. Denton, Coordinator
State & Federal Review Section
Archeology Division
Texas Historical Commission
P.O. Box 12276
Austin, Texas 78711-2276
(512) 463-5711
www.thc.state.tx.us

-----Original Message-----
From: Parrish, Nancy A SWF [mailto:Nancy.A.Parrish@usace.army.mil]
Sent: Wednesday, January 15, 2014 10:47 AM
To: Mark Denton
Cc: Sarah Birtchet
Subject: RE: San Marcos River Aquatic Ecosystem Restoration (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Wow. Um.... I had no idea work had been done by USFWS or anyone else. Frankly, I was brought in late and told no one had done anything for Section 106! Let me get with the PM and the contractor and figure out what might be left to actually do. What's the point of resubmitting reports? I would rather submit a letter that says someone else did the survey and we will have no adverse effect (or we will, if that's the case) and move from there.

Lately I feel like you know way more about my projects than I do! No one ever talks to me!

****
Nancy Parrish, RPA
Plan Formulation CESWF-PEC-PF
819 Taylor St
Fort Worth, TX 76102
ph.817-886-1725

-----Original Message-----
From: Mark Denton [mailto:Mark.Denton@thc.state.tx.us]
Sent: Wednesday, January 15, 2014 9:59 AM
To: Parrish, Nancy A SWF
Cc: Sarah Birtchet

Subject: [EXTERNAL] San Marcos River Aquatic Ecosystem Restoration

Hey Nancy hope you had a good holiday season.

Just before the holiday season began we got a draft PA from you folks for this "restoration" project and yet all of this has already been coordinated with the THC through US Fish & Wildlife, the Edwards Aquifer District, and the City of San Marcos. I know there is a little bit of archeology left to do, but almost all of the archeological investigations have already been taken care of under State Antiquities Permits. So, I'm wondering is the USACE just going to resubmit all of the reports to us that we have already reviewed, or how is this going to work. I guess as a formality I don't mind have our ED sign a PA since the ecosystem project isn't done yet, but otherwise this is all sort of after-the-fact. The parties have supposedly abandoned any plans to affect historic structures (i.e., historic walls along the banks and swimming areas), so we are hoping that will hold true.

What's your read on things?

PS. US Fish & Wildlife did not to write a PA with us, because their permit process was a no adverse effect.

Mark H. Denton, Coordinator

State & Federal Review Section

Archeology Division

Texas Historical Commission

P.O. Box 12276

Austin, Texas 78711-2276

(512) 463-5711

www.thc.state.tx.us <http://www.thc.state.tx.us/>

LOGO MAIL

Classification: UNCLASSIFIED
Caveats: NONE

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300, 819 TAYLOR STREET
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

December 13, 2013

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 has formulated an Aquatic Ecosystem Restoration project on the San Marcos River with our non- Federal sponsor, the City of San Marcos, Texas. This effort began in the late 1990s and has progressed slowly dependent upon availability of funding. Recently, USACE identified a Tentatively Selected Plan which is described in the *Draft Integrated Detailed Project Report and Environmental Assessment, San Marcos River, 206 Aquatic Ecosystem Restoration Project* which is enclosed for your office's review and comment. Proposed ground disturbing activities include excavation of four wetland cells, sediment removal from river channel, and invasive species removal primarily from riparian areas.

The prolonged project formulation delayed the start of the Section 106 process. As a result, USACE plans to conduct a cultural resources inventory of all properties included within the restoration effort, including access roads, staging areas, and other ancillary areas related to the undertaking when the project moves into the Pre-Construction Engineering and Design (PED) phase of the study. Subsequent site evaluations, if needed, will also be conducted during PED. Through consultation with your office, USACE will consider potential impacts to significant historic properties if they are found within the Area of Potential Effects and the best way to mitigate for impacts or monitoring in order to prevent impacts during construction. All consultation and treatment measures will be executed prior to project construction. The USACE plan to accomplish Section 106 during PED is outlined in the enclosed Programmatic Agreement.

Please send your comments on the draft report and Programmatic Agreement to Mr. Douglas Sims, Chief, NEPA and Cultural Resources Section, 817-886-1853 or douglas.c.sims@usace.army.mil. We look forward to your participation in the Section 106 consultation process on this study.

Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosures

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT, THE TEXAS STATE HISTORIC PRESERVATION OFFICER, REGARDING THE SAN MARCOS SECTION 206 AQUATIC ECOSYSTEM RESTORATION PROJECT

WHEREAS, Section 106 of the National Historic Preservation Act (NHPA), 16 United States Code (U.S.C.) 470f, and its implementing regulations at 36 Code of Federal Regulations (CFR) Part 800 (Section 106), require Federal agencies to take into account the effects of their undertakings on historic properties and to provide the Advisory Council on Historic Preservation (ACHP) with a reasonable opportunity to comment on those undertakings; and

WHEREAS, the U.S. Army Corps of Engineers (USACE) and the City of San Marcos will implement ecosystem restoration measures on 4 river miles adjacent to the San Marcos River under the authority of Section 206 of the Water Resources Development Act of 1996 (hereinafter, "Undertaking") (Attachment A); and

WHEREAS, the Area of Potential Effects (APE) for the ecosystem restoration consists of measures to remove non native and invasive tree species, plant native grass and woody vegetation, improve storm water discharge through terracing, creation of vegetated swales, use of wattles, riffle dams, and other soil bioengineering techniques, and remove accumulated sediment. All measures will be implemented within the 100-year floodplain along the San Marcos River between Spring Lake Dam and Cummings Dam (Attachments B1 and B2); and

WHEREAS, the result of the feasibility study has identified an ecosystem restoration tentatively selected plan which is detailed in the entitled Draft *Integrated Detailed Project Report and Environmental Assessment; San Marcos River Section 206 Aquatic Ecosystem Restoration Project* (August 2013); and

WHEREAS, the USACE has consulted with the Comanche Nation, Kiowa Tribe of Oklahoma, and Mescalero Apache Tribe of the Mescalero Reservation regarding the Undertaking in accordance with 36 CFR 800.2(c)(2)(ii), and has invited them as concurring parties on this Programmatic Agreement (PA); and

WHEREAS, this agreement has addressed all phases of the Undertaking; and

WHEREAS, the definitions set forth in 36 CFR 800.16 are incorporated herein by reference and apply throughout this PA; and

WHEREAS, the USACE has determined that the Undertaking has the potential to adversely affect properties listed or eligible for listing in the National Register of Historic

Places (NRHP), either individually or as part of a district, and has consulted with the Texas SHPO, in accordance with Section 106 and implementing regulations; and

NOW, THEREFORE, the USACE and the Texas State Historic Preservation Officer (SHPO), henceforth known as the Signatories, agree that the implementation of the following stipulations evidence that USACE has taken into account the effects of the Undertaking upon historic properties, and that execution of this agreement evidences compliance with Section 106 of the NHPA in accordance with 36 CFR 800.6(c) and 36 CFR 800.14.

STIPULATIONS

The USACE shall ensure that the following measures are carried out:

1. Cultural Resources Inventory

a. Survey: USACE shall complete and report the results of all required intensive surveys of the Undertaking's APE, prior to the implementation of the restoration measures, in a manner consistent with the "Secretary of the Interior's Standards and Guidelines for Identification" (48 FR 4472—23) and the Texas Historical Commission's (THC) "Archeological Survey Standards for Texas" and taking into account the National Park Service (NPS) publication, "The Archeological Survey: Methods and Uses" (1978 GPO stock #024-016-00091). This will include areas not previously surveyed and areas where previous surveys are deemed by the USACE, in consultation with the Texas SHPO, to be inadequate. This will also include any additional areas that may be affected by changes in project design, access roads, staging areas, and other ancillary areas related to the Undertaking. All surveys shall be conducted and reports prepared by or under the direct supervision of persons that meet the "Secretary of the Interior's Qualifications Standards" (48 FR 44738-9), as well as the requirements for Principal Investigator defined in Title 13, part II of the Texas Administrative Code, Chapter 26 (hereafter, "Qualification Standards").

b. Reporting: USACE will document the results of any and all inventories are documented in reports that follow the "Secretary of the Interior's Standards for Archeological Documentation" and the "Council of Texas Archeologists Guidelines for Cultural Resource Management Reports."

c. Review: USACE will submit all reports for review to the Texas SHPO, and appropriate Native American tribes. Reviewers shall have thirty (30) calendar days to complete their review and provide comments. USACE will incorporate comments as appropriate and distribute a final report to all reviewers. Failure by any reviewer to comment within the thirty (30) calendar day review period shall not preclude the USACE from allowing draft reports to be finalized. The USACE

shall ensure that all reviewers named in this Stipulation expeditiously receive copies of all final survey and evaluation reports.

2. Resource Evaluation

a. Site Testing: If resources are located during the inventories, they will be evaluated to determine whether they are eligible for the National Register of Historic Places (NRHP). All evaluations will be consistent with the "Secretary of the Interior's Standards and Guidelines for Evaluation" (48 FR 44723-26). A testing plan will be developed in consultation with the Texas SHPO prior to excavation. USACE shall make all determinations of eligibility in accordance with the criteria set forth in 36 CFR 60.4 for all properties within the APE.

b. Reporting: USACE will document the results of site testing in reports that follow the "Secretary of the Interior's Standards for Archeological Documentation" and the "Council of Texas Archeologists Guidelines for Cultural Resource Management Reports".

c. Review: The USACE shall distribute the draft testing and evaluation report to the Texas SHPO and appropriate Native American Tribes for review and comment. Reviewers shall have thirty (30) calendar days to complete their review and provide comments to USACE. USACE will incorporate comments as appropriate and distribute a final report. Failure by any reviewer to comment within the thirty (30) calendar day review period shall not preclude the USACE from allowing draft reports to be finalized. The USACE shall ensure that all reviewers named in this Stipulation expeditiously receive copies of all final survey and evaluation reports

d. Disputes: If the USACE and the Texas SHPO cannot agree on the National Register eligibility of a property, or on the effects of the undertaking on a Historic Property, the USACE shall obtain a determination from the Keeper of the National Register in accordance with 36 CFR 63. The determination of the Keeper shall be final for purposes of this PA.

3. Determination of Effects

a. Determination of Efffects: USACE will make a determinate of effects of the undertaking on any cultural resources determined eligible for the NRHP and submit that determination to the SHPO for concurrence. This may be done concurrently with the submission of determination of eligibility at the discretion of USACE.

b. Review: SHPO will be afforded 30 days to concur with the USACE determination of effects. If no response is forthcoming, USACE will assume concurrence and proceed under the stipulations of this document.

4. **Adverse Effects:**

a. Avoidance: Wherever practicable, USACE will act to avoid adverse effects to a Historic Property within the APE.
   i) Avoidance of a Historic Property may require monitoring during construction to ensure the property is not inadvertently impacted. Monitoring of historic properties that have been preserved in-place through avoidance of impacts shall follow the ongoing monitoring schedule of the restoration measures beyond the construction phase.

b. Mitigation: When avoidance is not possible, USACE will consult with SHPO on the most appropriate means of mitigation for an identified resource. At a minimum, a research design plan will be developed and mitigation carried out in accordance with Secretary of the Interior's Standards and the THC Guidelines. Mitigation may include construction monitoring by a professional archaeologist who meets the Secretary of the Interior Standards.

c. Reporting: USACE will document the results of any and all inventories are documented in reports that follow the "Secretary of the Interior's Standards for Archeological Documentation" and the "Council of Texas Archeologists Guidelines for Cultural Resource Management Reports."

d. Review: USACE will submit all reports for review to the Texas SHPO and appropriate Native American tribes. Reviewers shall have thirty (30) calendar days to complete their review and provide comments. USACE will incorporate comments as appropriate and distribute a final report to all reviewers. Failure by any reviewer to comment within the thirty (30) calendar day review period shall not preclude the USACE from allowing draft reports to be finalized. The USACE shall ensure that all reviewers named in this Stipulation expeditiously receive copies of all final survey and evaluation reports.

5. **Modifications of Restoration Measures and Ancillary Areas**
If modifications of the restoration measures result in construction outside of previously surveyed areas or if activities are planned in an ancillary area that has not been previously surveyed for historic properties, the USACE will notify the SHPO and ensure that the APEs of the proposed areas are inventoried, evaluated, and if Historic Properties are identified, effects will be evaluated and adverse effects mitigated. USACE will follow Stipulations 1 through 4 of this PA for modified restoration areas and ancillary areas.

6. **Exempt Activities**
Activities that do not have the potential to affect historic properties are exempt from further Texas SHPO review and consultation. USACE has consulted with the Texas SHPO and determined that the following activities associated with the Undertaking

do not have the potential to affect historic properties and require no further consultation under Section 106 of the NHPA:

a. Herbicide treatment and hand cutting of nonnative vegetation where there would be no root or rhizome removal

b. Placement of obstructions for the removal of impervious surfaces (e.g., parking lot) that does not include any excavation

7. Implementation of Construction

a. The USACE may authorize the implementation of any of the restoration measures after the USACE and the Texas SHPO have consulted and concurred that (1) such measures will not affect historic properties, or (2) the area does not contain historic properties, or (3) historic properties have been satisfactorily mitigated, and (4) that any provisions for monitoring of construction as described in Stipulation 4(b) above is agreed upon by USACE and Texas SHPO as an appropriate mitigation measure.

b. In accordance with this PA, the USACE shall ensure that historic properties are protected against damage until the applicable treatment measures are implemented.

8. Post Review Discoveries

a. If Native American human remains and/or objects subject to the provisions of the Native American Graves Protection and Repatriation Act (NAGPRA), including human burials, associated and unassociated funerary objects, sacred objects and objects of cultural patrimony, are encountered before the transfer of LSAAP and RRAD, the USACE shall notify and consult with the identified culturally affiliated Tribe(s) and lineal descendants to determine appropriate treatment measures for these human remains in agreement with NAGPRA (25 USC Section 3001 et seq) and 43 CFR Part 10.

b. In the event of post-review discovery of historic properties not subject to NAGPRA, work shall immediately stop in the area of discovery and the USACE shall comply with 36 CFR 800.13(b) to notify and consult with the Texas SHPO and appropriate Native American Tribes.

9. Monitoring and Reporting Requirements

a. When monitoring of construction or post construction activities is undertaken as a measure to avoid adverse effects to a Historic Property in accordance with Stipulation 4(a), USACE shall ensure that the results of that monitoring will be documented in reports that follow the "Secretary of the Interior's Standards for Archeological Documentation" and the "Council of Texas Archeologists

Guidelines for Cultural Resource Management Reports." The technical reports shall include the current state of the historic properties, the effectiveness of the mechanisms used to protect the historic properties from adverse effects, and any recommendations for mitigating or minimizing any future or unforeseen adverse effects on the historic properties.

b. USACE will submit all reports for review to the Texas SHPO and appropriate Native American tribes. Reviewers shall have thirty (30) calendar days to complete their review and provide comments. USACE will incorporate comments as appropriate and distribute a final report to all reviewers. Failure by any reviewer to comment within the thirty (30) calendar day review period shall not preclude the USACE from allowing draft reports to be finalized. The USACE shall ensure that all reviewers named in this Stipulation expeditiously receive copies of all final survey and evaluation reports

c. If adverse effects on historic properties are noted or foreseen to occur in the future, the USACE shall consult with the Texas SHPO on a modification to the monitoring plan or to seek alternative mitigation when necessary. Consultation shall take into account the recommendations from the monitoring reports, as well as comments from the reviewers.

10. Dispute Resolution

a. Should any party to this Agreement object at any time to any actions proposed or the manner in which the terms of this PA are implemented, the USACE shall consult with the objecting party(ies) to resolve the objection. If the USACE determines, within thirty (30) days, that such objection(s) cannot be resolved, the following process will be implemented:

i) USACE shall Forward all documentation relevant to the dispute to the ACHP in accordance with 36 CFR Section 800.2(b)(2). Upon receipt of adequate documentation, the ACHP shall review and advise the USACE on the resolution of the objection within thirty (30) days of receipt of the documentation. Any comment provided by the ACHP, and all comments from the parties to the PA, will be taken into account by the USACE in reaching a final decision regarding the dispute.

ii) If the ACHP does not provide comments regarding the dispute within thirty (30) days after receipt of adequate documentation, the USACE may render a decision regarding the dispute. In reaching its decision, the USACE will take into account all comments regarding the dispute from the parties to the PA.

iii) USACE shall notify all parties of its decision in writing before implementing that portion of the undertaking subject to dispute under this stipulation. The USACE's decision will be final.

iv) USACE shall continue to carry out all other actions subject to the terms of this PA that are not the subject of the dispute.

11. Provision for Biannual Review of Agreement

The USACE and Texas SHPO shall consult biannually to review implementation of the terms of this PA and determine whether revisions or amendments are needed. If revisions are needed, the parties to this agreement shall consult in accordance with 36 CFR 800 to make such revisions.

12. Amendment, Noncompliance, and Termination of Agreement

a. If a change occurs in the Undertaking that creates new circumstances or if the Signatories are unable to carry out the terms of this PA, any Signatory to this PA may request an amendment by letter or via email in accordance with 36 CFR part 800.6(c)(7), but the Amendment shall not be effective unless agreed upon and signed by all Signatories.

b. Any Signatory that signs this PA may terminate the agreement by providing thirty (30) days' written notice by letter or via email to the other parties, provided that the parties have consulted during this period to seek amendment in accordance with Stipulation 11 or other actions that would prevent termination.

c. If this PA is terminated and the USACE determines that the Undertaking authorizing the Project will proceed, the USACE shall comply with 36 CFR part 800.14(b)(2)(v).

d. The USACE, in consultation with the Signatories, may determine that the terms of this agreement have been satisfactorily fulfilled. Upon such determination, the PA shall terminate and the USACE shall provide all Signatories with written notice by letter or via email of the determination and terminate.

13. Effective Date, End Date, Applicability

a. This PA shall take effect on the date that it has been fully executed by the USACE and the Texas SHPO.

b. If the Project has not been implemented within five (5) years of the date of execution of the PA, and the PA had not been terminated, the Signatories shall consult on a date not less than ninety (90) days prior to the fifth anniversary of this PA to reconsider its terms. Reconsideration may include continuation of the PA as originally executed, amendment, or termination. If the PA is terminated because the Undertaking no longer meets the definition of an "Undertaking" set forth in 36CFR Part 800.16(y), the Agreement shall be terminated in accordance with Stipulation 12(d).

c. Execution of this PA and implementation of its terms evidence that the USACE has afforded the Texas SHPO an opportunity to comment on the Undertaking and that the USACE has taken into account the effect of the Undertaking on the Historic Properties.

d. This PA is intended for the benefit and protection of the Signatories, and no party is a third-party beneficiary hereof.

EXECUTION AND IMPLEMENTATION of the PA pursuant to 36 CFR 800.14(b) evidences that the USACE has afforded ACHP a reasonable opportunity to comment on the Undertaking and its effects on historic properties, that USACE has taken into account the effects of the Undertaking on historic properties, and that USACE has satisfied its responsibilities under Section 106 of the NHPA and applicable regulations.

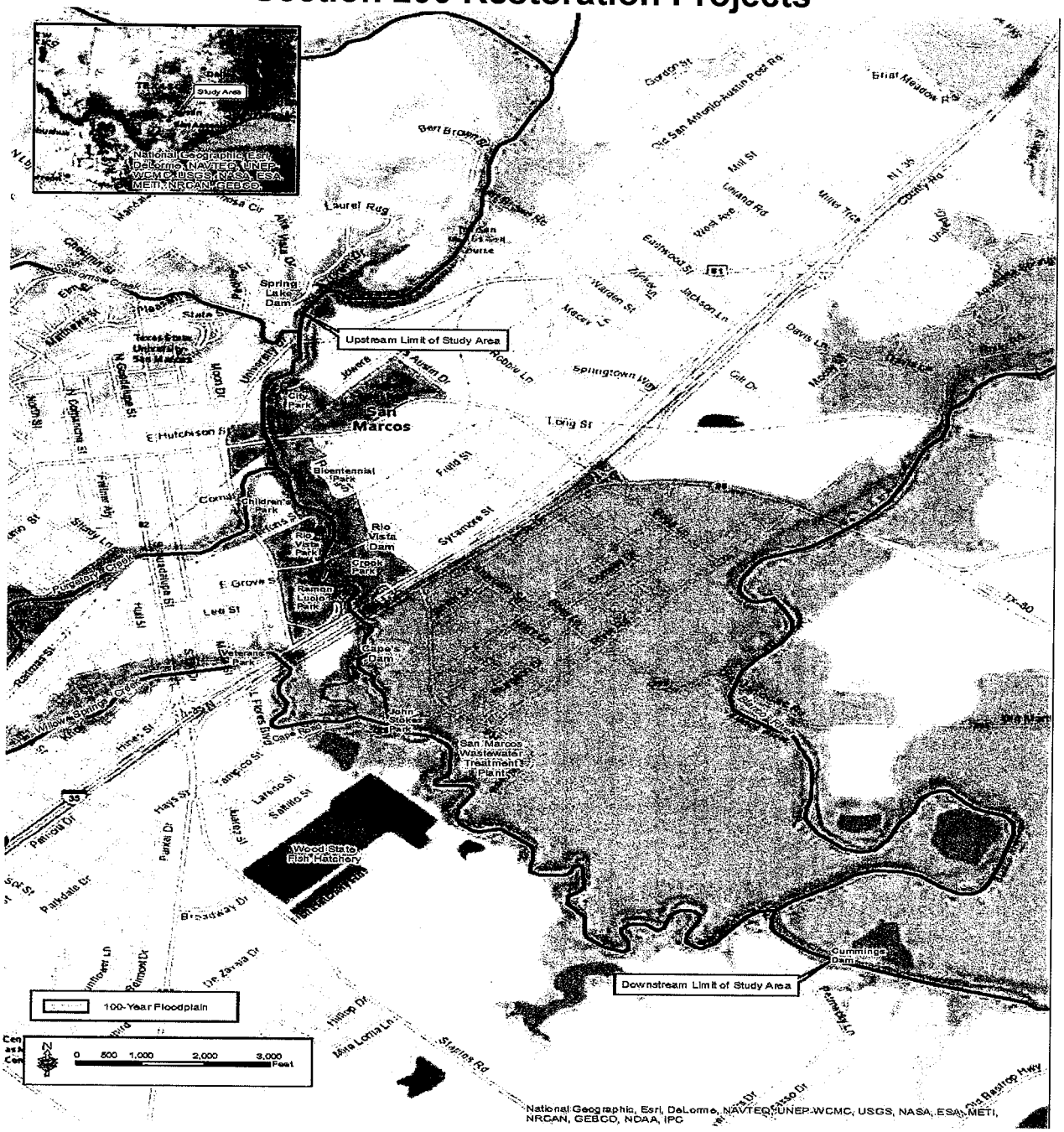
U.S. ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT

By: _____ Date _____
Charles H. Klinge, Colonel, U.S. Army, Commanding

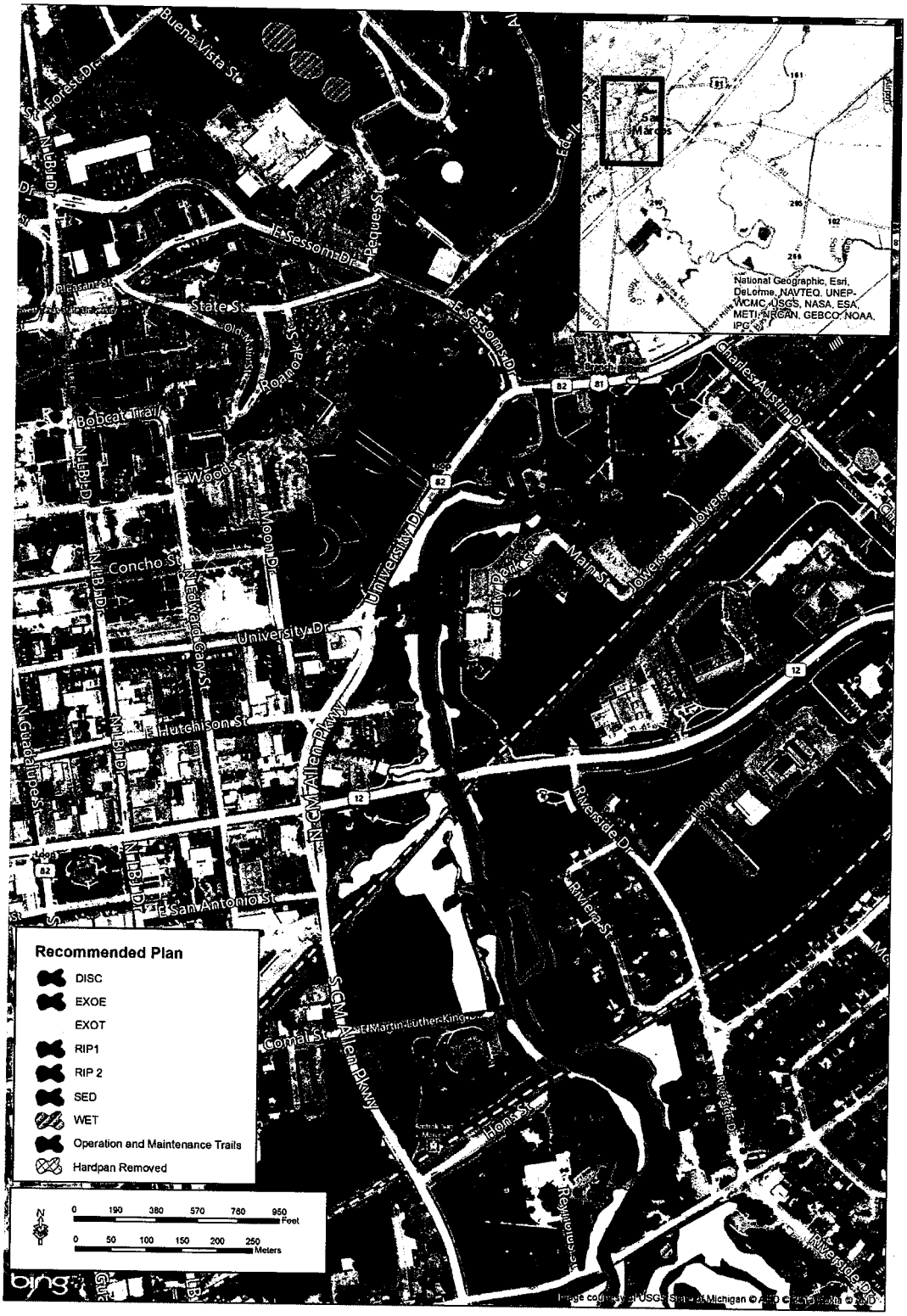
TEXAS HISTORICAL COMMISSION

By: _____ Date _____
Mr. Mark Wolfe, State Historic Preservation Officer

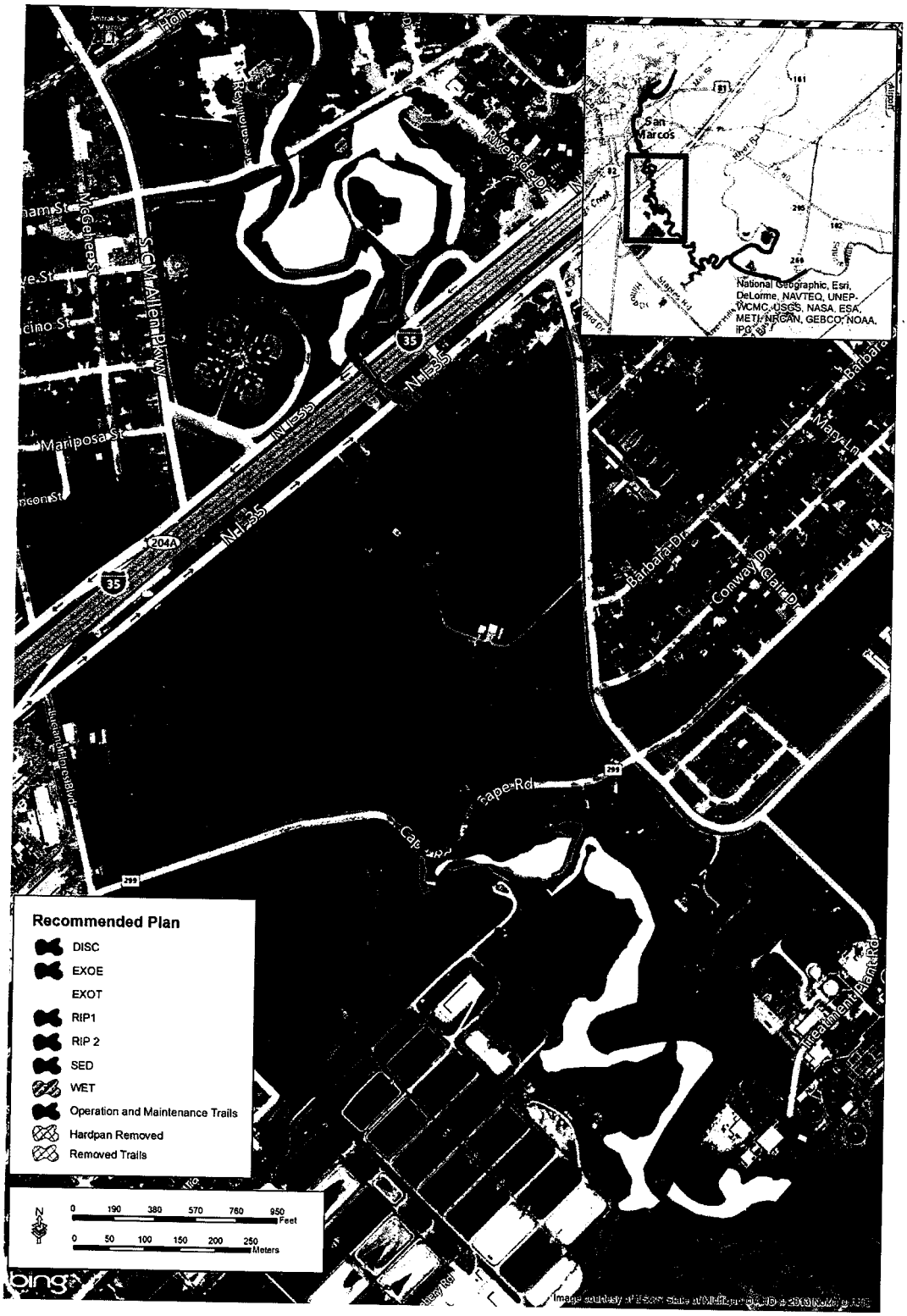
Attachment A
The Area of Potential Effect for the Proposed San Marcos Section 206 Restoration Projects



Attachment B1
Tentatively Selected Plan for Aquatic Ecosystem Restoration



Attachment B2
Tentatively Selected Plan for Aquatic Ecosystem Restoration



DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300, 819 TAYLOR STREET
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

December 16, 2013

Regional Planning and Environmental Center

Ms. Holly Houghten, THPO
Mescalero Apache Tribe
P. O. Box 227
Mescalero, New Mexico 88340

Dear Ms. Houghten:

The U.S. Army Corps of Engineers (USACE), Fort Worth District has formulated an Aquatic Ecosystem Restoration project on the San Marcos River with our non- Federal sponsor, the City of San Marcos, Texas. This effort began in the late 1990s and has progressed slowly dependent upon availability of funding. Recently, USACE identified a Tentatively Selected Plan which will be described in a Draft *Integrated Detailed Project Report and Environmental Assessment, San Marcos River, 206 Aquatic Ecosystem Restoration Project* available for your review and comment in January 2014. Proposed ground disturbing activities include excavation of four wetland cells, sediment removal from river channel, and invasive species removal primarily from riparian areas.

The prolonged project formulation delayed the start of the Section 106 process and we wish to initiate consultation with the Mescalero Apache Tribe at this time. USACE plans to conduct a cultural resources inventory of all property included in the restoration effort, including access roads, staging areas, and other ancillary areas related to the undertaking when the project moves into the Pre-Construction Engineering and Design (PED) phase of the study. Subsequent site evaluations, if needed, will also be conducted during PED. USACE will consider potential impacts to significant historic properties if they are found within the Area of Potential Effects and the best way to mitigate for impacts or monitor to prevent impacts during construction. USACE will consult with the Mescalero Apache Tribe throughout this process. All consultation and treatment measures will be executed prior to project construction. The USACE plan to accomplish Section 106 during PED is outlined in a Programmatic Agreement (PA) to be executed with the Texas State Historic Preservation Officer (SHPO) enclosed for your review.

Please send your comments on the draft PA to Mr. Douglas Sims, Chief, NEPA and Cultural Resources Section, 817-886-1853 or douglas.c.sims@usace.army.mil. We look forward to your participation in the Section 106 consultation process on this study.

Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosure

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300, 819 TAYLOR STREET
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

December 16, 2013

Regional Planning and Environmental Center

Mr. Jimmy W. Arterberry, THPO
Comanche Indian Tribe of Oklahoma
584 NW Bingo Road
Lawton, Oklahoma 73502

Dear Mr. Arterberry:

The U.S. Army Corps of Engineers (USACE), Fort Worth District has formulated an Aquatic Ecosystem Restoration project on the San Marcos River with our non- Federal sponsor, the City of San Marcos, Texas. This effort began in the late 1990s and has progressed slowly dependent upon availability of funding. Recently, USACE identified a Tentatively Selected Plan which will be described in a Draft *Integrated Detailed Project Report and Environmental Assessment, San Marcos River, 206 Aquatic Ecosystem Restoration Project* available for your review and comment in January 2014. Proposed ground disturbing activities include excavation of four wetland cells, sediment removal from river channel, and invasive species removal primarily from riparian areas.

The prolonged project formulation delayed the start of the Section 106 process and we wish to initiate consultation with the Comanche Indian Tribe of Oklahoma at this time. USACE plans to conduct a cultural resources inventory of all property included in the restoration effort, including access roads, staging areas, and other ancillary areas related to the undertaking when the project moves into the Pre-Construction Engineering and Design (PED) phase of the study. Subsequent site evaluations, if needed, will also be conducted during PED. USACE will consider potential impacts to significant historic properties if they are found within the Area of Potential Effects and the best way to mitigate for impacts or monitor to prevent impacts during construction. USACE will consult with the Comanche Indian Tribe of Oklahoma throughout this process. All consultation and treatment measures will be executed prior to project construction. The USACE plan to accomplish Section 106 during PED is outlined in a Programmatic Agreement (PA) to be executed with the Texas State Historic Preservation Officer (SHPO) enclosed for your review.

Please send your comments on the draft PA to Mr. Douglas Sims, Chief, NEPA and Cultural Resources Section, 817-886-1853 or douglas.c.sims@usace.army.mil. We look forward to your participation in the Section 106 consultation process on this study.

Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosure

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300, 819 TAYLOR STREET
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

December 16, 2013

Regional Planning and Environmental Center

Mr. Ronald Twohatchet, Chairperson
Kiowa Indian Tribe of Oklahoma
Kiowa Way Hwy 9 West
Carnegie, Oklahoma 73015

Dear Mr. Twohatchet:

The U.S. Army Corps of Engineers (USACE), Fort Worth District has formulated an Aquatic Ecosystem Restoration project on the San Marcos River with our non- Federal sponsor, the City of San Marcos, Texas. This effort began in the late 1990s and has progressed slowly dependent upon availability of funding. Recently, USACE identified a Tentatively Selected Plan which will be described in a Draft *Integrated Detailed Project Report and Environmental Assessment, San Marcos River, 206 Aquatic Ecosystem Restoration Project* available for your review and comment in January 2014. Proposed ground disturbing activities include excavation of four wetland cells, sediment removal from river channel, and invasive species removal primarily from riparian areas.

The prolonged project formulation delayed the start of the Section 106 process and we wish to initiate consultation with the Kiowa Indian Tribe of Oklahoma at this time. USACE plans to conduct a cultural resources inventory of all property included in the restoration effort, including access roads, staging areas, and other ancillary areas related to the undertaking when the project moves into the Pre-Construction Engineering and Design (PED) phase of the study. Subsequent site evaluations, if needed, will also be conducted during PED. USACE will consider potential impacts to significant historic properties if they are found within the Area of Potential Effects and the best way to mitigate for impacts or monitor to prevent impacts during construction. USACE will consult with the Kiowa Indian Tribe of Oklahoma throughout this process. All consultation and treatment measures will be executed prior to project construction. The USACE plan to accomplish Section 106 during PED is outlined in a Programmatic Agreement (PA) to be executed with the Texas State Historic Preservation Officer (SHPO) enclosed for your review.

Please send your comments on the draft PA to Mr. Douglas Sims, Chief, NEPA and Cultural Resources Section, 817-886-1853 or douglas.c.sims@usace.army.mil. We look forward to your participation in the Section 106 consultation process on this study.

Sincerely,

Eric W. Verwers
Director, Regional Planning and
Environmental Center

Enclosure

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

REPLY TO
ATTENTION OF:

May 30, 2013

PUBLIC MEETING NOTICE
SAN MARCOS RIVER CONTINUING AUTHORITIES PROGRAM SECTION 206 AQUATIC ECOSYSTEM RESTORATION FEASIBILITY STUDY

The U.S. Army Corps of Engineers (USACE), Fort Worth District, in partnership with the City of San Marcos, is currently conducting a feasibility study for aquatic ecosystem restoration within the San Marcos River, San Marcos, Texas. The study area includes the San Marcos River and adjacent land from Spring Lake Dam to Cummings Dam located on the Blanco River. Other lands considered within the study area include the headwaters of the San Marcos River (i.e. Sessoms Creek, Purgatory Creek, and Willow Springs Creek). This aquatic ecosystem restoration study was conducted under the authority of the Continuing Authorities Program Section 206 of the Water Resources Development Act of 1996 (Public Law 104-33).

During the formulation process of the feasibility study, problems and opportunities for aquatic ecosystem restoration were identified based upon the ongoing degradation of the ecosystem within and adjacent to the study area. The following study objectives were established to improve the aquatic ecosystem: a) increase habitat suitability of the riparian corridor, b) improve the function of the riparian corridor as a buffer against sediment and pollutant inputs, c) increase aquatic habitat suitability, d) reduce recreational impacts on habitat suitability and on Federally-listed endemic species, and e) improve habitats for Federally-listed endemic species. Numerous aquatic restoration measures were identified based upon their ability to restore the aquatic ecosystem and to meet the study objectives. Through the formulation process, a tentatively selected plan consisting of multiple aquatic restoration measures was identified. These measures include riparian forest improvements, removal and control of invasive vegetation species, stormwater discharge channel improvements, fine sediment removal, and restoration of wetland habitats at various locations within and adjacent to the study area.

We would like to invite you to a public meeting addressing the tentatively selected plan. The public meeting, which will be conducted in an open house format, will occur from 5:30 p.m. to 7:00 p.m. on June 12, 2013, and will be held at the following location:

Dunbar Recreation Center
801 W. Martin Luther King Drive
San Marcos, Texas 78666

We look forward to receiving your comments as we move forward. Please address any comments to Mrs. Mandy McGuire, CESWF-PER-EE, P.O. Box 17300, Fort Worth, Texas 76102-0300 or by email at amanda.mcguire@usace.army.mil. Thank you for your interest and cooperation.

Eric W. Verwers
Chief, Planning, Environmental, and
Regulatory Division

THE STATE OF TEXAS }
County of Hays: }

Before me, the undersigned, holding the office of **Notary Public** in and for Hays County, Texas, personally appeared Don Moore, who states under oath that he is the publisher of the San Marcos Daily Record, a newspaper which has been regularly and continuously published in San Marcos, Hays County, Texas, for a period of more than one year immediately preceding the date of publication of this notice and that the Notice by Publication hereto attached was published in the regular edition of said newspaper for a period of 1 day on the following dates June 2, 2013, _____, 20___, _____, 20___, _____, 20___, _____, 20___, _____, 20___, _____, 20___, a printed clipping of said notice being hereto attached.

The said publisher further states that the rate charged for this publication is the lowest rate charged commercial advertisers for the same class of advertising for a like amount of space.

(Signed) Don Moore
Publisher

Subscribed and sworn to before me this 11 day of June 2013

RONDA YOUNG
Notary Public, State of Texas
My Commission Expires
May 24, 2016

Ronda Young

Ronda Young

San Marcos Daily Record Classifieds

Your 5 line ad runs 5 days for FREE in the San Marcos Record Call for details!

Place a classified

Call **512-392-2458**, Fax **512-392-1514**
or email to:
ryoung@sanmarcosrecord.com or
pgravis@sanmarcosrecord.com
Hours are 8:00 am - 5:00 pm Monday - Friday

View the Classifieds Online at: **www.sanmarcosrecord.com**

WE ACCEPT

For any questions contact Karie Beach, Purchasing Specialist Senior at 512/393-8181 or at cosmpurchasing@sanmarcostx.gov.

Public Notices

PUBLIC NOTICE

The City Council of the City of San Marcos, Texas, will hold a public hearing in the Council Chambers at City Hall, 630 E. Hopkins, at **7:00 p.m.** on **Tuesday, June 18, 2013**, to consider the following:

A request to abandon streets and alleys in the Park Addition, First and Second Division, as follows: a 16 foot alley between lots 43 and 50 to the north and lots 41, 42, 51 and 52 to the south from Sessom Drive to Peachtree Street; a 16 foot alley between lots 39, 53, 56 and 61 to the north and lots 38, 54, 57 and 60 to the south from Sessom Drive to the northwest boundary of said Park Addition; Locust Street from Loquat Street (a/k/a Pecan Street) to the northeast corner of lot 50; Loquat (a/k/a Pecan) Street from Sessom Drive to Peachtree Street; and Peachtree Street from the southeast corner of lot 63 to the northwest corner of lot 50.

The City of San Marcos does not discriminate on the basis of disability in the admission or access to its services, programs, or activities. Individuals who require auxiliary aids and services for this

Public Notices

PUBLIC MEETING NOTICE SAN MARCOS RIVER CONTINUING AUTHORITIES PROGRAM SECTION 206 AQUATIC ECOSYSTEM RESTORATION FEASIBILITY STUDY

The U.S. Army Corps of Engineers, Fort Worth District, in partnership with the City of San Marcos, is currently conducting a feasibility study for aquatic ecosystem restoration within the San Marcos River, San Marcos, Texas. The study area includes the San Marcos River and adjacent land from Spring Lake Dam to Cummings Dam located on the Blanco River. Other lands considered within the study area include the headwaters of the San Marcos River (i.e. Sessoms Creek, Purgatory Creek, and Willow Springs Creek). A public meeting addressing the tentatively selected plan will be conducted in an open house format, from 5:30 p.m. to 7:00 p.m. on June 12, 2013, and will be held at the following location:

Dunbar Recreation Center
801 W. Martin Luther King Drive
San Marcos, Texas 78666

PART TIME GRAPHIC

Lot 1, Block 1, J.B. Wilson's First Addition to Mixed Use (MU) for an-

The Edwards Aquifer Authority invites qualified firms to submit sealed bids for Hot Wells large diameter caisson installation.

Bid specifications will be available at 900 E. Quincy Street, San Antonio, TX 78215, on Monday, May 20, 2013.

A mandatory on-site pre-bid meeting is scheduled for Wednesday, June 12, 2013, at 9:00 a.m.

The deadline for bids is 3:00 p.m., Tuesday, June 18, 2013.

For more information contact Ms. Cyndi Holman, Procurement Specialist, at (210) 222-2204 or visit www.edwardsaquifer.org

Child Care

HIRING CHILD care givers. M-F, AM/PM positions. Apply 2411 Hunter Rd., 392-3150

Drivers

DRIVER, CLASS CDL-A Belly Dump. Local Driving. 210-392-2973

CDL DRIVERS. End/belly dump, pd. hrly. Avg. 60 hrs/wk, local, home every night. Must be 22 w/driving exp. Call Geoff @ 830-743-1345 830-743-0228

DRIVERS: COMPANY & Owner

Premium Pay Available

396-2271.
APPLY BY 6/7/13

GuadalupeValleyElectricCooperative, Inc.

GVEC is seeking an experienced graphic designer to develop marketing collateral and corporate communications. The successful candidate will be skilled in corporate branding, layout design principles for multiple mediums including print and online, and the ability to do basic copywriting for diverse audiences. Basic HTML knowledge, photography, and video editing experience a plus.

Must be proficient with Microsoft Office Suite, Adobe Creative Suite, and producing work on a MAC. A Bachelor's degree in communications/marketing or related field and/or a minimum of 2 years related experience in graphic design and placement including working with external vendors, printers, and publications is preferred. Must have good organizational skills, excellent written and verbal communication skills and be able to handle multiple projects in a fast-paced, deadline-driven environment. Portfolio required at time of interview including design and writing samples. In addition to application and interviews, assessment tools may also be used in the candidate evaluation process.

HOW TO APPLY

GVEC offers advancement potential, competitive compensation and excellent benefits. To apply, visit gvec.org and click on "GVEC Careers" under the "Your GVEC" menu. Find the position you are interested in and apply online. Applications must be submitted online by the deadline in order to be considered. Equal Opportunity Employer.

800.223.GVEC (4832)

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APPENDIX F
CERTIFIED COSTS, PLANNING COSTS, AND ABBREVIATED COST RISK ANALYSIS

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 101394

SWF San Marcos Section 206
Aquatic Ecosystem Restoration Project

The San Marcos Aquatic Ecosystem Restoration – Section 206 as presented by Fort Worth District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of January 8, 2014, the Cost MCX certifies the estimated total project cost:

FY 2014 Project First Cost:	$3,576,000
Total Project Cost:	$3,642,000
Estimated Federal Cost:	$2,417,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **San Marcos Section 206**
PROJECT NO: **P2 No 101394**
LOCATION: **San Marcos, TX**

DISTRICT: **SWF Fort Worth**
PREPARED: **12/16/2013**
POC: **CHIEF, COST ENGINEERING, Milton Schmidt**

This Estimate reflects the scope and schedule in report: CAP Feasibility STUDY - San Marcos

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru 10/1/2012 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
06	FISH & WILDLIFE FACILITIES	$1,204	$261	22%	$1,466	1.3%	$1,219	$265	$1,484			$1,260	$273	$1,533
16	BANK STABILIZATION	$115	$26	23%	$141	1.9%	$117	$27	$144			$120	$27	$147
	CONSTRUCTION ESTIMATE TOTALS:	$1,319	$287		$1,607	1.3%	$1,337	$291	$1,628			$1,379	$300	$1,680
01	LANDS AND DAMAGES	$1,197	$261	22%	$1,458	1.3%	$1,213	$264	$1,477			$1,213	$264	$1,477
30	PLANNING, ENGINEERING & DESIGN	$190	$35	18%	$225	1.8%	$193	$36	$229			$197	$36	$234
31	CONSTRUCTION MANAGEMENT	$190	$47	25%	$237	1.9%	$194	$48	$242			$201	$50	$251
	PROJECT COST TOTALS:	$2,897	$631	22%	$3,527		$2,937	$639	$3,576			$2,990	$651	$3,642

CHIEF, COST ENGINEERING, Milton Schmidt

Amanda McGuire — PROJECT MANAGER, Amanda McGuire

Rocky L. Lee — CHIEF, REAL ESTATE, Rocky Lee

CHIEF, PLANNING, xxx

CHIEF, ENGINEERING, Brian Giacomozzi

CHIEF, OPERATIONS, Charlie Burger

CHIEF, CONSTRUCTION, xxx

CHIEF, CONTRACTING, Kathrine Freeman

CHIEF, PM-PB, xxxx

CHIEF, OPM, xxx

ESTIMATED TOTAL PROJECT COST:		**$3,642**
ESTIMATED FEDERAL COST:	65%	$2,367
ESTIMATED NON-FEDERAL COST:	35%	$1,275
22 - FEASABILITY STUDY (CAP studies):		**$50**
ESTIMATED FEDERAL COST:		$50
ESTIMATED NON-FEDERAL COST:		
ESTIMATED FEDERAL COST OF PROJECT		**$2,417**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: San Marcos Section 206
LOCATION: San Marcos, TX
This Estimate reflects the scope and schedule in report, CAP Feasibility STUDY - San Marcos

DISTRICT: SWF Fort Worth
POC: CHIEF, COST ENGINEERING, Milton Schmidt
PREPARED: 12/16/2013

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 3/8/2013; Effective Price Level: 10/1/2012				Program Year (Budget EC): 2014; Effective Price Level Date: 1 OCT 13								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	PHASE 1 or CONTRACT 1													
06	EXOT1	$52	$11	21.8%	$64	1.3%	$53	$12	$64	2014Q4	1.7%	$54	$12	$65
06	RIP2	$440	$78	17.8%	$518	1.3%	$445	$79	$525	2015Q4	3.4%	$461	$82	$543
06	EXOA	$136	$35	26.1%	$171	1.3%	$137	$36	$173	2015Q3	2.9%	$141	$37	$178
06	SED	$447	$108	24.3%	$555	1.3%	$452	$110	$562	2015Q4	3.4%	$468	$114	$581
06	WET	$130	$28	21.3%	$158	1.3%	$132	$28	$160	2015Q4	3.4%	$136	$29	$165
16	DISC	$115	$26	22.7%	$141	1.9%	$117	$27	$144	2015Q1	1.9%	$120	$27	$147
	CONSTRUCTION ESTIMATE TOTALS:	$1,319	$287	21.8%	$1,607		$1,337	$291	$1,628			$1,370	$300	$1,680
01	LANDS AND DAMAGES	$1,107	$261	21.8%	$1,458	1.3%	$1,213	$264	$1,477	2014Q1		$1,213	$264	$1,477
30	PLANNING, ENGINEERING & DESIGN													
1.00%	Project Management	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2014Q2	0.5%	$13	$2	$16
1.00%	Planning & Environmental Compliance	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2014Q2	0.5%	$13	$2	$16
6.50%	Engineering & Design	$86	$16	16.4%	$102	1.8%	$88	$16	$104	2014Q2	0.5%	$86	$16	$104
1.00%	Engineering Tech Review ITR & VE	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2014Q2	0.5%	$13	$2	$16
1.00%	Contracting & Reprographics	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2014Q2	0.5%	$13	$2	$16
2.00%	Engineering During Construction	$26	$5	16.4%	$31	1.8%	$26	$5	$31	2016Q1	8.0%	$29	$5	$34
1.00%	Planning During Construction	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2016Q1	8.0%	$14	$3	$17
1.00%	Project Operations	$13	$2	16.4%	$15	1.8%	$13	$2	$16	2014Q2	0.5%	$13	$2	$16
31	CONSTRUCTION MANAGEMENT													
10.00%	Construction Management	$132	$33	24.9%	$165	1.9%	$135	$33	$168	2016Q1	3.8%	$140	$35	$174
2.00%	Project Operation	$26	$6	24.9%	$32	1.9%	$26	$7	$33	2016Q1	3.8%	$28	$7	$34
2.45%	Project Management	$32	$8	24.9%	$40	1.9%	$33	$8	$41	2016Q1	3.8%	$34	$8	$42
	CONTRACT COST TOTALS:	$2,897	$631		$3,527		$2,937	$639	$3,576			$2,990	$651	$3,642

Detailed Cost Estimate and Cost Analysis

Project Goals and Objectives

The primary goal of this study is to develop an aquatic ecosystem restoration plan that provides the greatest ecosystem benefits relative to implementation costs for the San Marcos 206 Project. The following objectives were developed to address specific problems and opportunities identified during the planning process.

- Increase habitat quality of the riparian corridor
- Improve the function of the riparian corridor as a buffer against sediment and pollutant inputs
- Increase aquatic habitat quality
- Reduce recreational impacts on habitat quality and on listed species
- Improve habitats for federally listed species

Opportunities for meeting the objectives of this study include availability of restoration methods that have been tested for feasibility and effectiveness, existence of ongoing and planned restoration efforts affecting the San Marcos River, and availability of a large portion of lands within the study area for implementation of restoration measures.

Expansion on Adjacent Restoration Efforts - Riparian and aquatic habitats associated with Spring Lake were recently restored though Section 206 funding and included measures, such as the removal of nonnative plants, that would have cumulative benefits on these habitats through restoration measures proposed for this study; other restoration efforts that have or would benefit the study area include the Edwards Aquifer Habitat Conservation Plan, community efforts to control elephant ear on private lands adjacent to the river, and others.

Availability of Restoration Methods and Materials - Efforts by USFWS, TPWD, and the TSU, River Systems Institute to conserve and restore the San Marcos River ecosystem provide the knowledge and experience necessary to develop feasibility and cost-effective restoration measures; furthermore, the current availability of plant stock propagated from local specimens increases the success probability of restoration efforts.

Availability of Lands for Restoration - A large portion of the floodplain corridor is publicly owned, primarily by the City of San Marcos, which provides the opportunity to reduce the impacts of urbanization by expanding the riparian corridor and improving discharge locations to restore the function of riparian forests.

Methodology

Through coordination with the USFWS and TPWD, nine restoration measures were developed to solve ecosystem problems and address the goals of the project: controlling discharge, increasing

the width of the riparian forest, improving wetlands in the watershed, controlling riparian exotic plants, controlling aquatic exotic plants, removing sediments from the channel, creating recreational access structures, controlling nuisance waterfowl, and educating the public. These measures were developed in sufficient detail to project their benefits across target years throughout the life of the project, to estimate costs, and to assess feasibility. These measures were developed in sufficient detail to project their benefits, estimate costs, and assess engineering feasibility. Incremental Cost Analysis (ICA) was used to determine the most cost-effective plan from all possible combinations of measures. The cost of each measure evaluated as average annual cost units (AACUs) was compared to the benefit of each measure evaluated as AAHUs. Through ICA, nine best-buy plans, including the No Action Plan, were identified, and seven of these best-buy plans were incrementally justified. Best-buy Plan 8, the most expensive and incrementally justified plan, includes six measures. Once the recommended plan was chosen, a detailed cost estimate was prepared in MII 4.2 as well as a detailed OMRR&R cost estimate, that was no included as part of the fully funded cost estimate. The Planning, Engineering and Design (PED) and Construction Management (CM) costs are reflected as 10 percent of the total cost for each alternative. PED and CM are assumed at the same percentage since it is a small project with minimal structural development. This is an ecosystem project with no items of work that are unusual or specialized with a design that has been used in the area previously.

Assumptions and Constraints

All work will be done within the current limits. The estimate is based on the assumption that this project will be awarded to a small business that will completed the majority of the work, with minimal specialty items being subbed out. It is assumed that there will be no need to capture sales tax since the project is located within Texas and contractors should fill out the proper request for tax exemption before beginning wok. Material being excavated from the wetland restorations will hauled to the San Marcos Animal Shelter for future use as needed. Plants and seeds being used for this project are assumed to be available from the same nurseries that were used for a previous project. The estimate is based on the assumption that the trees being chipped will be spread on site over the areas invasive species are being removed so no costs are associated with hauling that material off site or disposing of material.

Risks

Contingencies were developed and applied where areas of uncertainty exist. Risks for each alternative were based on available information and difficulty of the task. The computation of the contingency for each alternative was influenced by the known variables and their associated risk and was incorporated in the estimate.

Contingencies were based on an abbreviated cost risk analysis broken out for each of the features incorporated in the CE-ICA. The contingencies run from 17.82% to 24.88% with an overall

construction contingency of 21.79%. The risks were determined by a collaboration of the PDT members and possible issues that may arise before and during construction.

The costs associated with LLERDS include a 21.8% contingency.

Alternatives

Project measures were developed through coordination with the City of San Marcos, USFWS, and TPWD to address the stated problems within the constraints identified and represent stand alone actions that would improve the aquatic ecosystem. Guidelines provided in the following documents would be adhered to during design and implementation of proposed measures, where applicable. The following measures were considered:

CONTROL OF EXOTIC SHRUBS AND TREES (EXOT) - EXOT would improve the structure of the riparian forests by reducing the cover of exotic invasive shrubs and increasing the density of snags. These shrubs occupy the middle canopy of the riparian forest resulting in a dense cover of smaller stems. By removing these high frequency, small stems, EXOT would result in a reduction of basal area to optimum or near- optimum conditions in Type 1, Type 2, and Type 4 forests at TY1 (Appendix B, Table B-2). Because no exotics occur within Type 3 forest, this forest type would not benefit from EXOT.

RESTORE RIPARIAN CORRIDOR (RIP1 AND RIP2) - Two scales were considered for the development of the RIP (Appendix F, Table F-3). One scale, RIP1, would result in restoration of the riparian corridor by vegetative management within existing, low-quality forest types and improved lands to obtain increased habitat quality. A second scale, RIP2, would restore the riparian corridor by first removing impervious surfaces, such as parking lots and other hardpan or concrete structures, then planting native vegetation. Both scales would require relocation of trails. These trails are necessary for operation and maintenance of other recreational features within an existing, continuous trail system that connects the various public lands in the study area. Trails proposed for relocation travel near the river and allow easy access for recreationists at unauthorized locations. The cost of removing trails would be considered part of the initial construction cost and the cost to construct replacement trails would be considered operation and maintenance.

CONTROL OF EXOTIC AQUATIC VEGETATION-EMERGENT (EXOA) - It is assumed that the removal of elephant ear would result in restoration of native riverine habitats at TY1 and continue throughout the life of the project (Appendix B, Tables B-3 through B-5). These habitats are assumed to have the same suitability as existing adjacent riverine habitats. Removal of elephant ear would not only result in an increased area of suitable riverine habitats, but would increase suitability of native riverine habitats by improving foraging conditions for both smallmouth bass and belted kingfisher (Appendix B, Tables B-4 and B-5). This measure would also benefit listed species by restoring portions of the channel invaded by elephant ear to native habitats. There is evidence to suggest that fountain darters prefer native vegetation over some nonnative plant species, and that Texas wild-rice once occurred in portions of the channel now occupied by elephant ear.

RESTORE SHORELINE (SHORE1 AND SHORE2) - Two scales were considered for the development of the SHORE. SHORE1 would result in restoration of the shoreline by stabilizing areas of erosion. SHORE2 would include all of the restoration features of SHORE1 and would remove recreational headwalls at two locations and concrete debris from an area of the river channel near the shore.

CONTROL OF DISCHARGE (DISC) - Similar to SHORE and RIP, it is assumed that habitats providing the same benefits as Type 5 forests would be restored where DISC is implemented and that HUs would accrue at the same rate described for Type 5 forest under implementation of RIP (Appendix B, Table B-2). It is also assumed that DISC would reduce future input of suspended sediments to the San Marcos River (Appendix B, Tables B-3 and B-4). It is assumed that the DISC improvements proposed at locations throughout the study area would be sufficient to affect the relative composition of substrates (coarse vs. fine) within the channel. DISC would also reduce the magnitude of pollutant concentrations following storm events, which would benefit listed species similar to SHORE.

REMOVAL OF ACCUMULATED SEDIMENTS (SED) - It is assumed that SED would affect the relative composition of substrates (coarse vs. fine) throughout the entire study area over the life of the project (Appendix B, Tables B-3 and B-4), thus improving the quality of substrates for foraging conditions of the selected HSI model species. It was assumed that implementation of DISC and SED would have a cumulative effect on substrates, resulting in a greater improvement than implementation of either measure by itself. It is assumed that Texas wild-rice prefers the coarse substrates, which were historically predominant in the study area, for establishment; thus, SED would provide a substantial benefit to Texas wild-rice. It is assumed that there would be 10% sediment removal initially and 20% would be removed during the 3 year establishment period.

RESTORATION OF WETLANDS (WET) - It is assumed that construction, function, and habitat quality of wetlands restored under WET would be similar to the existing Sessoms Creek wetlands (Appendix B, Tables B-6 and B-7). It is assumed that habitat would be available at TY1 and would remain relatively constant through the life of the project. The removal of trees would be required for restoration of wetlands at the Sessoms Creek location; however, the surrounding forest at this location is an upland forest and the loss of these habitats is assumed to have no effect on the suitability of the surrounding forest.

EDUCATION (EDU) - There are no quantifiable benefits, as evaluated using selected models, that are assumed to occur as a result of education. However, it is assumed that EDU would result in reduced adverse impacts at a more localized scale and specifically to endemic species.

MANAGEMENT OF WATERFOWL (DUCK) - There are no quantifiable benefits, as evaluated using selected models, that are assumed to occur as a result of the management of waterfowl. While nonnative waterfowl likely have resulted in some level of degradation of shoreline habitats in the riparian zone, this effect would be difficult to quantify. However, it is assumed that DUCK would result in reduced adverse impacts at a more localized scale and specifically to endemic species.

Recommended Plan

The recommended plan was chosen to be the one that had the most benefit for the cost based on the Cost Estimated –Incremental Cost Analysis. The measures that were carried forward are: EXOT, RIP2, EXOA, DISC, SED, and WET.

SanMarcos_Section206_TSP_Dec2013
The MII file was revised on 16 Dec 2013 to reflect addtitional notes and changes made based on Dr. Checks comments. THe TPCS and ARA have also been adjusted to reflect updated cost infromation.

The TSP is based on the combined best buy measures determined by the implementation of the Cost Estimating-Incremental Cost Analysis (CE-ICA). The quantities and costs were developed by the AE and are based on best judgement and historical knowledge frm previous projects in the area. The current estiamte assumes all work is done by the Prime Contractor.

Estimate assumes a Small Business contractor will be the Prime Contractor

Hourly wages include a burden of 2.7, or a 100 percent markup for overhead and a 170 percent markup for benefits.

The Markups for the Prime Contractor are as follows:

For work completed by the Prime:
JOOH - 10%
HOOH - 10%
Profit - 10%
Bond - 1.5%

Work Completed by the Subcontractor:
JOOH - 8%
HOOH - 10%
Profit - 6%
Bond - 1.5%

Markups for the Subcontractor are as follows:
JOOH - 8%
HOOH - 5%
Profit - 10%

Estimated by	Michael Hodson
Designed by	
Prepared by	Ninfa Taggart
Preparation Date	3/8/2013
Effective Date of Pricing	10/1/2012
Estimated Construction Time	Days

Description	Quantity	UOM	ProjectCost
PROJECT SUMMARY - Scope			2,897,317
1 TSP	1.00	LS	2,897,317
1.1 01 Lands and Damages	1.00	LS	1,197,162
1.1.1 Real Estate	1.00	LS	1,197,162
1.2 EXOT1 - CONTROL OF EXOTIC SHRUBS AND TREES (EXOT)	1.00	LS	66,255
1.2.2 Fish and Wildlife	1.00	LS	52,161
1.2.3 Planning, Enginnering and Design	1.00	LS	7,047
1.2.4 Construction Management	1.00	LS	7,047
1.3 RIP2 - RESTORE RIPARIAN CORRIDOR (RIP1 AND RIP2)	1.00	LS	574,687
1.3.2 Fish and Wildlife	1.00	LS	439,791
1.3.3 Planning, Enginnering and Design	1.00	LS	67,448
1.3.4 Construction Management	1.00	LS	67,448
1.4 EXOA1 - CONTROL OF EXOTIC AQUATIC VEGETATION-EMERGENT (EXOA)	1.00	LS	180,464
1.4.2 Fish and Wildlife	1.00	LS	135,653
1.4.3 Planning, Enginnering and Design	1.00	LS	22,406
1.4.4 Construction Management	1.00	LS	22,406
1.5 DISC - CONTROL OF DISCHARGE	1.00	LS	146,210
1.5.2 Bank Stabilization	1.00	LS	115,109
1.5.3 Planning, Enginnering and Design	1.00	LS	15,551
1.5.4 Construction Management	1.00	LS	15,551
1.6 SED - REMOVAL OF ACCUMULATED SEDIMENTS	1.00	LS	567,181
1.6.2 Fish and Wildlife	1.00	LS	446,531
1.6.3 Planning, Enginnering and Design	1.00	LS	60,325
1.6.4 Construction Management	1.00	LS	60,325
1.7 WET - RESTORATION OF WETLANDS	1.00	LS	165,357
1.7.2 Fish and Wildlife	1.00	LS	130,183
1.7.3 Planning, Enginnering and Design	1.00	LS	17,587
1.7.4 Construction Management	1.00	LS	17,587

Abbreviated Risk Analysis

Project (less than $40M): **San Marcos Section 206 Ecosystem Restoration**
Project Development Stage: **Feasibility (Recommended Plan)**
Risk Category: **Low Risk: Simple Project-No Life Safety**

Total Construction Contract Cost = $ 1,319,428

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ 1,197,162		21.80%	$ 260,992	$ 1,458,153.97
1	06 FISH AND WILDLIFE FACILITIES	RIP2	$ 439,791		17.82%	$ 78,384	$ 518,175.66
2	06 FISH AND WILDLIFE FACILITIES	EXOT	$ 52,161		21.78%	$ 11,360	$ 63,521.14
3	06 FISH AND WILDLIFE FACILITIES	EXOA	$ 135,653		26.11%	$ 35,423	$ 171,076.26
4	06 FISH AND WILDLIFE FACILITIES	DISC	$ 115,109		22.68%	$ 26,102	$ 141,210.48
5	06 FISH AND WILDLIFE FACILITIES	SED	$ 446,531		24.29%	$ 108,475	$ 555,005.98
6	06 FISH AND WILDLIFE FACILITIES	WET	$ 130,183		21.28%	$ 27,699	$ 157,882.02
12		Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 190,364		18.39%	$ 35,001	$ 225,365.22
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 190,364		24.88%	$ 47,361	$ 237,725.36

Totals					
Real Estate	$ 1,197,162	21.80%	$ 260,992	$ 1,458,153.97
Total Construction Estimate	$ 1,319,428	21.79%	$ 287,443	$ 1,606,872
Total Planning, Engineering & Design	$ 190,364	18.39%	$ 35,001	$ 225,365
Total Construction Management	$ 190,364	24.88%	$ 47,361	$ 237,725
Total	$ 2,897,318		$ 630,798	$ 3,528,116

ALTERNATIVE COMPARISON COSTS

Table F-1. LERRDS Cost per acre (For Alternatives Comparison)

Property Type	Cost	Acres*	Cost Per Acre**
Property Outside of 100-year floodplain (Public)	$ 852,800.00	17.055	$ 50,002.93
Property Outside of 100-year floodplain (Private)	$ 7,500.00	0.15	$ 50,000.00
Property Within 100-year floodplain	$ 1,040,900.00	34.695	$ 30,001.44
Property within San Marcos River	$ 7,100.00	2.35	$ 3,021.28
		54.25	
Minerals	$ 5,500.00	54.25	$ 101.38
Damages/Severance @20%	$ 382,800.00		$ 7,056.22
Contingency @20%	$ 382,800.00		$ 7,056.22
TOTAL	**$ 2,679,400.00**		$ 14,213.82

*These costs are based on an initial real estate evaluation of lands within the study area, including all of those lands within the current distribution of proposed measures

** It was assumed that public lands would be acquired through easement at 60 percent of market value

RIP1			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	9.273		
< 100-year	*8.492*	$ 44,215.27	$ 375,461.11
> 100-year	*0.781*	$ 64,216.76	$ 50,157.99
State-owned (100% of value)	4.234		
< 100-year	*4.234*	$ 44,215.27	$ 187,194.98
> 100-year	*0.000*	$ 64,216.76	$ -
Private	0.000		
< 100-year	*0.000*	$ 44,215.27	$ -
> 100-year	*0.000*	$ 64,213.82	$ -
Total	**13.506**		**$ 612,814.08**

Table F-1. LERRDS Cost per acre (For Alternatives Comparison) (continued)

RIP2			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	0.896		
< 100-year	*0.866*	$ 44,215.27	$ 38,276.71
> 100-year	*0.030*	$ 64,216.76	$ 1,933.49
State-owned (100% of value)	0.000		
< 100-year	*0.000*	$ 44,215.27	$ -
> 100-year	*0.000*	$ 64,216.76	$ -
Private	0.151		
< 100-year	*0.151*	$ 44,215.27	$ 6,687.02
> 100-year	*0.000*	$ 64,213.82	$ -
Total	**1.047**		**$ 46,897.21**

EXOT			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	19.915		
< 100-year	*18.044*	$ 44,215.27	$ 797,816.19
> 100-year	*1.871*	$ 64,216.76	$ 120,149.76
State-owned	7.363		
< 100-year	*7.363*	$ 44,215.27	$ 325,563.93
> 100-year	*0.000*	$ 64,216.76	$ -
Total	**27.278**		**$ 1,243,529.89**

EXOA			
LERRDS	**Acres**	**$/Acre**	**$**
Total	**2.613**	$ 375,461.11	**$ 981,111.99**

Table F-1. LERRDS Cost per acre (For Alternatives Comparison) (continued)

SHORE1			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	0.217		
< 100-year	*0.174*	$ 44,215.27	$ 7,673.64
> 100-year	*0.044*	$ 64,216.76	$ 2,811.38
State-owned	0.129		
< 100-year	*0.129*	$ 44,215.27	$ 5,693.72
> 100-year	*0.000*	$ 64,216.76	$ -
Total	**0.346**		**$ 16,178.74**

SHORE2			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned - Riparian	0.093		
< 100-year	*0.090*	$ 44,215.27	$ 3,993.59
> 100-year	*0.003*	$ 64,216.76	$ 180.49
Riverine	*0.000*	$ 17,235.10	$ -
Total	**0.093**		**$ 4,174.08**

DISC			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	2.098		
< 100-year	*1.204*	$ 44,215.27	$ 53,253.59
> 100-year	*0.894*	$ 64,216.76	$ 57,378.75
State-owned	0.000		
< 100-year	*0.000*	$ 44,215.27	$ -
> 100-year	*0.000*	$ 64,216.76	$ -
Total	**2.098**		**$ 110,632.34**

Table F-1. LERRDS Cost per acre (For Alternatives Comparison) (continued)

SED			
LERRDS	**Acres**	**$/Acre**	**$**
Riverine	25.419	$ 17,235.10	$ 438,099.93

WET			
LERRDS	**Acres**	**$/Acre**	**$**
City-owned	1.192		
< 100-year	*0.084*	$ 44,215.27	$ 3,692.65
> 100-year	*1.109*	$ 44,215.27	$ 49,031.85
Total	**1.192**		**$ 52,724.50**

*** All quantities are accounted using Excel, which calculates to a high precision. Some calculations may appear incorrect due to rounding errors. ***

Table F-2a. Initial Construction Costs for EXOT (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (4hr/ac)	27.28	AC	109	60	6,546.74					6,546.74
2) Herbicide Application (10hr/ac)	27.28	AC	273	60	16,366.84					16,366.84
initial herbicide (2gal/ac)	54.56	GAL						150	8,183.42	8,183.42
3) Monitoring (data reporting)	1	#	10	80	800.00					800.00
TOTAL THIS SHEET					**23,713.58**				**8,183.42**	**31,897.00**

Table F-2b. 3-year Establishment Period Costs for EXOT (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (4hr/ac)	27.28	AC	109	60	6,546.74					6,546.74
2) Herbicide Application (5hr/ac)	27.28	AC	136	60	8,183.42					8,183.42
herbicide (1gal/ac)	27.28	GAL						150	4,091.71	4,091.71
3) Monitoring (data reporting)	1	#	10	80	800.00					800.00
TOTAL THIS SHEET					**15,530.16**				**4,091.71**	**19,621.87**

Table F-2c. Operations and Maintenance Costs for EXOT (For Alternatives Comparison) (TY3-50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (4hr/ac) x 2	27.28	AC	218	60	13,093.47					13,093.47
2) Herbicide Application (5hr/ac) x 2	27.28	AC	273	60	16,366.84					16,366.84
herbicide (1gal/ac)	27.28	GAL						150	4,091.71	4,091.71
2) Monitoring (data reporting)	1	#	10	80	800.00					800.00
TOTAL THIS SHEET					**30,260.31**				**4,091.71**	**34,352.02**

Table F-3a. Initial Construction Costs for RIP1 (For Alternatives Comparison) (TY-0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Planting Zone 1 (20hr/ac)	0.65	AC	13	60	781.27					781.27
containerized tree (250/ac)	163	cell						6	976.58	976.58
2) Planting Zone 2 (20hr/ac)	10.30	AC	206	60	12,365.20					12,365.20
containerized tree (250/ac)	2,576	cell						6	15,456.50	15,456.50
3) Planting Zone 3 (30hr/ac)	2.28	AC	68	60	4,096.10					4,096.10
tractor with disc or box-blade (5hr/ac)	2.28	AC	11	80	910.25	50	568.90			1,479.15
initial herbicide (2gal/ac)	5	GAL						150	682.68	682.68
native seed mix (20lb/ac)	46	lb						65	2,958.30	2,958.30
fiber mat (100% area)	99,126	SF						0.50	49,562.86	49,562.86
4) Irrigation Installation (20hr/ac)	13.23	AC	265	80	21,169.61					21,169.61
lines, sprinklers, etc	13.23	AC						350	4,630.85	4,630.85
water (2,000 gal/ac/yr)	26,462	GAL						0.1	2,646.20	2,646.20
5) Relocate Trail (10hr/ac)	0.28	AC	3	60	165.27					165.27
bobcat or tractor with box-blade (10hr/ac)	0.28	AC	3	80	220.36	50	13.77			234.13
48" weed cloth	11,999	SF				0.15	1,799.78			1,799.78
3/8" crushed rock, trail suitable mix (4" depth)	148	CY						15	2,221.95	2,221.95
6) Best Management Practices (1hr/100LF)	13,453	LF	135	60	8,071.54					8,071.54
signs (1/300' fencing)	22	#						100	2,242.09	2,242.09
post-and-cable (50% perimeter)	6,726	LF						1	6,726.28	6,726.28
bales, wattles, silt fence, etc (15% perimeter)	2,018	LF						3	6,053.66	6,053.66
7) Monitoring (data reporting)	1	#	40	80	3,200.00					3,200.00
TOTAL THIS SHEET			**743**		**50,979.60**		**2,382.46**		**94,157.97**	**147,520.02**

Table F-3b. 3-year Establishment Period Costs for RIP1 (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	13.23	AC	212	60	12,701.77					12,701.77
2) Herbicide Application (5hr/ac) x 2	13.23	AC	132	60	7,938.60					7,938.60
follow-up herbicide (1gal/ac) x 2	26	GAL						150	3,969.30	3,969.30
3) Tree Replacement (5hr/ac) x 2	13.23	AC	132	60	7,938.60					7,938.60
containerized tree (20% installation) x 2	1,096	GAL						6	6,573.24	6,573.24
4) Irrigation and Fencing Maintenance (5hr/ac) x 2	13.23	AC	132	60	7,938.60					7,938.60
signs (10% installation) x 2	4	#						100	448.42	448.42
post-and-cable fencing (10% installation) x 2	1,345	LF						1	1,345.26	1,345.26
pipe, sprinklers, valves, etc (10% installation) x 2	2.65	AC						15	39.69	39.69
water (2,000gal/ac/yr) x 2	52,924	GAL						0.1	5,292.40	5,292.40
5) Monitoring (data reporting) x 2	2	#	80	80	6,400.00					6,400.00
TOTAL THIS SHEET			**689**		**42,917.57**				**17,668.31**	**60,585.88**

Table F-3c. Operation and Maintenance Costs for RIP1 (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	13.23	AC	212	60	12,701.77					12,701.77
2) Herbicide Application (5hr/ac) x 2	13.23	AC	132	60	7,938.60					7,938.60
follow-up herbicide (1gal/ac) x 2	26	GAL						150	3,969.30	3,969.30
3) Trail Maintenance (5hr/ac) x 2	0.28	AC								-
bobcat or tractor with box-blade (10hr/ac) x 2	0.28	AC	6	80	440.72	50	13.77			454.49
3/8" crushed rock, trail suitable mix (4" depth) x 2	296	CY						15	4,443.90	4,443.90
4) Monitoring (data reporting) x 2	2	#	80	80	6,400.00					6,400.00
TOTAL THIS SHEET			**430**		**27,481.09**		**13.77**		**8,413.20**	**35,908.06**

Table F-3d. Initial Construction Costs for RIP2 (For Alternatives Comparison) (TY0-TY1)

.	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Removal of Hardpan (60hr/ac)	1.05	AC	63	80	5,025.77					5,025.77
bobcat or tractor with bucket	63	HR				50	3,141.11			3,141.11
asphalt and concrete recycling (2' depth)	3,378	CY						12.5	42,230.47	42,230.47
2) Planting Zone 1 (20hr/ac)	0.06	AC	1	60	67.89					67.89
containerized tree (250/ac)	14	cell						6	84.86	84.86
3) Planting Zone 2 (20hr/ac)	0.51	AC	10	60	616.06					616.06
containerized tree (250/ac)	3,536	cell						6	21,214.71	21,214.71
4) Planting Zone 3 (30hr/ac)	0.45	AC	13	60	804.55					804.55
tractor with disc or box-blade (5hr/ac)	0.45	AC	2	80	178.79	50	111.74			290.53
initial herbicide (2gal/ac)	1	GAL						150	134.09	134.09
native seed mix (20lb/ac)	9	lb						65	581.07	581.07
fiber mat (100% area)	19,470	SF						0.50	9,735.07	9,735.07
5) Irrigation Installation (20hr/ac)	1.02	AC	20	80	1,627.08					1,627.08
lines, sprinklers, etc	1.02	AC						350	355.92	355.92
water (2,000 gal/ac/yr)	2,034	GAL						0.1	203.39	203.39
6) Relocate Trails (10hr/ac)	0.03	AC	0.30	60	18.07					18.07
bobcat or tractor with box-blade (10hr/ac)	0.03	AC	0.30	80	24.09	50	1.51			25.59
48" weed cloth	1,312	SF				0.15	196.73			196.73
3/8" crushed rock, trail suitable mix (4" depth)	16	CY						15	242.88	242.88
7) Relocate Parking	0.00	AC								-
bobcat or tractor with box-blade (10hr/ac)	0.00	AC	-	80	-	50	-			-
1" to 3/4" crushed rock, parking suitable mix (6" depth)	0	CY						15	-	-
8) Best Management Practices (1hr/100LF)	3,730	LF	37	60	2,237.72					2,237.72
signs (1/300' fencing)	6	#						100	621.59	621.59
post-and-cable (50% perimeter)	1,865	LF						1	1,864.76	1,864.76
bales, wattles, silt fence, etc (15% perimeter)	559	LF						3	1,678.29	1,678.29
9) Monitoring (data reporting)	1	#	5	80	400.00					400.00
TOTAL THIS SHEET			**153**		**11,000.01**		**3,451.09**		**78,947.09**	**93,398.19**

Table F-3e. 3-year Establishment Period Costs for RIP2 (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	1.05	AC	17	60	1,005.15					1,005.15
2) Herbicide Application (5hr/ac) x 2	1.05	AC	10	80	837.63					837.63
follow-up herbicide (1gal/ac) x 2	2	GAL						150	314.11	314.11
3) Tree Replacement (5hr/ac) x 2	1.05	AC	10	60	628.22					628.22
containerized tree (20% installation) X 2	1,420	GAL						6	8,519.83	8,519.83
4) Irrigation and Fencing Maintenance (5hr/ac) *2	1.05	AC	10	60	628.22					628.22
signs (10% installation) x 2	1.24	#						100	124.32	124.32
post-and-cable fencing (10% installation) x 2	373	LF						1	372.95	372.95
pipe, sprinklers, valves, etc (10% installation) x 2	1.02	AC						15	15.25	15.25
water (2,000gal/ac/yr) x 2	4,188	GAL						0.1	1.00	1.00
5) Monitoring (data reporting) x 2	2	#	10	80	800.00					800.00
TOTAL THIS SHEET			**58**		**3,899.23**				**9,347.46**	**13,246.69**

Table F-3f. Operation and Maintenance Costs for RIP2 (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	1.05	AC	17	60	1,005.15					1,005.15
2) Herbicide Application (5hr/ac) x 2	1.05	AC	10	80	837.63					837.63
follow-up herbicide (1 gal/ac) x 2	2.09	GAL						150	314.11	314.11
3) Trail Maintenance x 2	0.03	AC								-
bobcat or tractor with box-blade (10hr/ac) x 2	0.03	AC	1	80	48.17	50	1.51			49.68
3/8" crushed rock, trail suitable mix (4" depth) x 2	32	CY						15	485.75	485.75
4) Parking Maintenance x 2	0.00	AC								-
bobcat or tractor with box-blade (10hr/ac) x 2	0.00	AC	-	80	-	50	-			-
1" to 3/4" crushed rock, parking suitable mix (6" depth) x 2	0	CY						15	-	-
5) Monitoring (data reporting) x 2	2	#	10	80	800.00					800.00
TOTAL THIS SHEET			**38**		**2,690.96**				**799.87**	**3,490.82**

Table F-4a. Initial Construction Costs for EXOA (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Hand Removal (33% total area) (80hr/ac)	0.87	AC	70	60	4,180.94					4,180.94
sediment disposal (100% removal area) (2" depth)	234	CY						7	1,639.47	1,639.47
2) Best Management Practices (1hr/100LF)	2071	LF	21	60	1,242.59					1,242.59
bails, wattles, silt fence, etc (50% fencing)	1035	LF						3	3,106.47	3,106.47
fish exclusion (1/3 number of polygons)	22	#						500	10,833.33	10,833.33
signs (1/3 number of polygons)	22	#						100	2,166.67	2,166.67
post-on-cable (1/3 polygon perimeter)	2071	LF						1	2,070.98	2,070.98
3) Plant Natives (20hr/ac)	0.87	AC	17	60	1,045.23					1,045.23
containerized herbaceous plants (1,000/ac)	871	cell						3	2,613.09	2,613.09
TOTAL THIS SHEET			**108**		**6,468.76**				**22,430.01**	**28,898.77**

Table F-4b. 3-year Establishment Period Costs for EXOA (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Hand Removal (33% total area) (80hr/ac) x 2	0.87	AC	139	60	8,361.87					8,361.87
sediment disposal (100% removal area) (2" depth) x 2	468	CY						7	3,278.94	3,278.94
2) Best Management Practices (1hr/100LF) x 2	2071	LF	21	60	1,242.59					1,242.59
bails, wattles, silt fence, etc (50% fencing) x 2	1035	LF						3	3,106.47	3,106.47
fish exclusion (1/3 number of polygons) x 2	43	#						500	21,666.67	21,666.67
signs (1/3 number of polygons) x 2	43	#						100	4,333.33	4,333.33
post-on-cable (1/3 polygon perimeter) x 2	4142	LF						1	4,141.96	4,141.96
3) Plant Natives (20hr/ac) x 2	0.87	AC	35	60	2,090.47					2,090.47
containerized herbaceous plants (1,000/ac) x 2	1742	cell						3	5,226.17	5,226.17
TOTAL THIS SHEET			**195**		**11,694.93**		**0**		**41,753.54**	**53,448.48**

Table F-4c. Operation and Maintenance Costs for EXOA (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 10	0.87	AC	70	60	4,180.94					4,180.94
2) Hand Removal (10% reestablishment) (10hr/ac) x 10	0.87	AC	87	60	5,226.17					5,226.17
sediment disposal (2" depth) x 10	234	CY						2	468.42	468.42
3) Best Management Practices (1hr/100LF) x 10	2071	LF	207	60	12,425.89					12,425.89
bails, wattles, silt fence, etc (10% installation) x 10	1035	LF						3	3,106.47	3,106.47
fish exclusion (10% installation) x 10	22	#						500	10,833.33	10,833.33
sign (10% installation) x 10	22	#						100	2,166.67	2,166.67
post-on-cable (10% installation) x 10	20710	LF						1	20,709.81	20,709.81
4) Plant Replacement (20hr/ac) x 10	0.87	AC	174	60	10,452.34					10,452.34
containerized herbaceous plants (10% installation) (1,000/ac) x 10	871	cell						3	2,613.09	2,613.09
5) Monitoring (data reporting) x 10	10	#	200	80	16,000.00					16,000.00
TOTAL THIS SHEET			**738**		**48,285.34**		**0**		**39,897.79**	**88,183.13**

Table F-5a. Initial Construction Costs for SHORE1 (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Contouring Shore (80hr/ac)	0.35	AC	28	80	2,215.07					2,215.07
bobcat or tractor with box blade	28	HR				50	1,384.42			1,384.42
coarse, 2" by 4" aggregate (10% of area) 1' depth	56	CY						10	558.38	558.38
2) Install Access Steps (8hr/site)	9	#	72	80	5,760.00					5,760.00
bobcat or tractor with box blade	72	HR				50	3,600.00			3,600.00
limestone or granite slab (> 3 foot diameter @ 4/site)	36	#						600	21,600.00	21,600.00
3/4" bent metal tubing hand rail and concrete	9	#						200	1,800.00	1,800.00
3) Plant Native Vegetation (60hr/ac)	0.31	AC	18	60	1,104.69					1,104.69
containerized herbaceous plants (50% of area @ 500/ac)	77	cell						8	613.72	613.72
containerized woody plants (50% of area @ 125/ac)	19	cell						15	287.68	287.68
native seed mix (20lb/ac)	6.14	LB						65	398.92	398.92
fiber mat (75% of area)	10,025	SF						0.50	5,012.53	5,012.53
4) Best Management Practices (1hr/100LF)	870	LF	9	60	522.18					522.18
fish exclusion (Number of polygons)	21	#						500	10,500.00	10,500.00
bales, wattles, silt fence, etc (50% fencing)	435	LF						3	1,305.46	1,305.46
signs (2/access step)	18	#						100	1,800.00	1,800.00
post-and-cable (100% polygon perimeter)	870	LF						1	870.31	870.31
			127		**9,601.94**		**4,984.42**		**44,747.00**	**59,333.35**

Table F-5b. 3-year Establishment Period Costs for SHORE1 (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	0.31	AC	5	60	294.58					294.58
2) Herbicide Application (5hr/ac) x 2	0.31	AC	3	60	184.12					184.12
herbicide (1gal/ac)	0.61	GAL						150	92.06	92.06
3) Plant Replacement (5hr/acre) x 2	0.31	AC	3	60	184.12					184.12
containerized herbaceous plants (20% installation)	31	cell						8	245.49	245.49
containerized woody plants (20% installation)	8	cell						15	115.07	115.07
4) Monitoring (data reporting) x 2	2	#	40	80	3,200.00					3,200.00
TOTAL THIS SHEET			**51**		**3,862.81**		**0**		**452.62**	**4,315.43**

Table F-5c. Operation and Maintenance Costs for SHORE1 (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 10	0.31	AC	2	60	147.29					147.29
2) Repairs to Damaged Steps (8hr/site)	9	#	72	60	4,320.00					4,320.00
bobcat or tractor with box-blade	72	HR				50	3,600.00			3,600.00
3/4" bent metal tubing hand rail and concrete	9	#						200	1,800.00	1,800.00
3) Herbicide Application (10% installation) (5hr/ac) x 10	0.31	AC	3	60	184.12					184.12
herbicide (1gal/ac)	0.31	GAL						150	46.03	46.03
4) Plant Native Vegetation (10% installation) (60hr/ac) x 10	0.31	AC	18	60	1,104.69					1,104.69
containerized herbaceous plants (10% installation) x 10	77	cell						8	613.72	613.72
containerized woody plants (10% instllation) x 10	19	cell						15	287.68	287.68
5) Best Management Practices (1hr/100LF)	870	LF	9	60	522.18					522.18
fish exclusion (Number of polygons)	21	#						500	10,500.00	10,500.00
bales, wattles, silt fence, etc (50% fencing)	435	LF						3	1,305.46	1,305.46
signs (2/access step)	18	#						100	1,800.00	1,800.00
post-and-cable (100% polygon perimeter)	870	LF						1	870.31	870.31
6) Monitoring (data reporting) X 10	10	#	200	60	12,000.00					12,000.00
TOTAL THIS SHEET			**305**		**18,278.28**		**3,600.00**		**17,223.19**	**39,101.47**

Table F-5d. Initial Construction Costs for SHORE2 (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Removal of Hardpan and Contouring (160hrs/ac)	0.09	AC	14	80	1,156.12					1,156.12
bobcat or tractor with box-blade	14	HR				50	722.57			722.57
2" by 4" coarse aggregate (10% area above mhwm) (1' depth)	0	CY						10	-	-
concrete recycling 2' depth	291	CY						12.5	3,642.97	3,642.97
2) Plant Native Vegetation (60hr/ac)	0.09	AC	5	60	325.16					325.16
containerized herbaceous plants (50% of area @ 500/ac)	23	cell						8	180.64	180.64
containerized woody plants (50% of area @ 125/ac)	6	cell						15	84.68	84.68
native seed mix (20lb/ac)	2	LB						65	117.42	117.42
fiber mat (25% of area)	984	SF						0.50	491.80	491.80
3) Best Management Practices (1hr/100LF)	222	LF	2	60	133.38					133.38
fish exclusion (number of polygons)	4	#						500	2,000.00	2,000.00
bales, wattles, silt fence, etc (50% fencing)	111	LF						3	333.45	333.45
signs (2/access step)	29	#						100	2,890.29	2,890.29
post-and-cable (100% polygon perimeter)	222	LF						1	222.30	222.30
TOTAL THIS SHEET			**22**		**1,614.65**		**722.57**		**9,963.54**	**12,300.76**

Table F-5e. 3-year Establishment Period Costs for SHORE2 (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2	0.09	AC	1.4	60	86.71					86.71
2) Herbicide Application (5hr/ac) x 2	0.09	AC	0.9	60	54.19					54.19
follow-up herbicide (1gal/ac) x 2	0.2	GAL						150	27.10	27.10
3) Plant Replacement (5hr/ac) x 2	0.09	AC	0.9	60	54.19					54.19
containerized herbaceous plants (20% installation)	9	cell						8	72.26	72.26
containerized woody plants (20% installation)	2	cell						15	33.87	33.87
4) Monitoring (data reporting) x 2	2	#	40	60	2,400.00					2,400.00
TOTAL THIS SHEET			**43**		**2,595.09**		**0**		**133.22**	**2,728.32**

Table F-5f. Operation and Maintenance Costs for SHORE2 (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 10	0.09	AC	7	60	433.54					433.54
2) Herbicide Application (10% installation) (5hr/ac) x 10	0.09	AC	5	60	270.96					270.96
herbicide (1gal/ac)	0.09	GAL						150	13.55	13.55
3) Plant Native Vegetation (10% installation) (60hr/ac) x 10	0.09	AC	54	60	3,251.57					3,251.57
containerized herbaceous plants (10% installation) x 10	23	cell						8	180.64	180.64
containerized woody plants (10% installation) x 10	6	cell						15	84.68	84.68
4) Monitoring (data reporting) X 10	10	#	200	60	12,000.00					12,000.00
TOTAL THIS SHEET			**266**		**15,956.08**				**278.87**	**16,234.95**

Table F-6a. Initial Construction Costs for DISC (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Remove Hardpan (60hr/ac)	0.28	AC	20	80	1,600.00					1,600.00
bobcat or tractor with bucket	20	HR				50	1,000.00			1,000.00
concrete recycling 1' depth	446	CY						12.5	5,575.42	5,575.42
2) Contouring/Drain Improvement (20hr/ac)	2.10	AC	42	80	3,356.69	50	2,097.93			5,454.63
rip rap, < 24" (10% of area) 1' depth	338	CY						17	5,753.93	5,753.93
boulder (1/0.01ac)	28	#						250	6,911.68	6,911.68
2) Plant Native Vegetation (60hr/ac)	2.10	AC	126	60	7,552.56					7,552.56
containerized herbaceous plants (50% of area @ 500/ac)	524	cell						8	4,195.87	4,195.87
containerized woody plants (50% of area @ 125/ac)	131	cell						15	1,966.81	1,966.81
native seed mix (20lb/ac)	41.96	LB						65	2,727.31	2,727.31
fiber mat (25% of area)	22,846	SF						0.50	11,423.25	11,423.25
3) Best Management Practices (1hr/100LF)	1071	LF	11	60	642.81					642.81
bales, wattles, silt fence, etc (100% perimeter)	1071	LF						3	3,214.07	3,214.07
post-and-cable (20% polygon perimeter)	214	LF						1	214.27	214.27
TOTAL THIS SHEET			**199**		**13,152.07**		**3,097.93**		**41,982.62**	**58,232.62**

Table F-6b. 3-year Establishment Period Costs for DISC (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (4hr/ac) x 2	2.10	AC	17	60	1,007.01					1,007.01
2) Herbicide Application (5hr/ac) x 2	2.10	AC	21	60	1,258.76					1,258.76
follow-up herbicide (1gal/ac) x 2	4	GAL						150	629.38	629.38
3) Plant Replacement (5hr/ac) x 2	2.10	AC	21	60	1,258.76					1,258.76
containerized herbaceous plants (20% installation) x 2	210	cell						8	1,678.35	1,678.35
containerized woody plants (20% installation) x 2	52	cell						15	786.72	786.72
4) Monitoring (data reporting) x 2	2	#	40	80	3,200.00					3,200.00
TOTAL THIS SHEET			**99**		**6,724.53**		**0**		**3,094.45**	**9,818.98**

Table F-6c. Operations and Maintenance Costs for DISC (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Debris Removal (40hr/ac) x 10	2.10	AC	839	60	50,350.40					50,350.40
2) Repair (80hr/ac)	2.10	AC	168	80	13,426.77					13,426.77
bobcat or tractor with bucket	168	HR				50	8,391.73			8,391.73
rip rap (< 24") 10% of area 1'deep	338	CY						17	5,753.93	5,753.93
boulder (1/0.1ac)	28	#						250	6,911.68	6,911.68
3) Best Management Practices (1hr/100LF)	1071	LF	11	60	642.81					642.81
bales, wattles, silt fence, etc	1071	LF						3	3,214.07	3,214.07
4) Herbicide Application (5hr/ac) x 10	2.10	AC	105	60	6,293.80					6,293.80
herbicide (1gal/ac) x 10	20.98	GAL						150	3,146.90	3,146.90
5) Monitoring x 10	10	#	200	80	16,000.00					16,000.00
TOTAL THIS SHEET			**1323**		**86,713.78**		**8,391.73**		**19,026.59**	**114,132.10**

Table F-7a. Initial Construction Costs for SED (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Sediment Removal (1/3 priority area) (100hr/ac)	1.58	AC	158	60	9,500.00					9,500.00
hydro-suction machine	158	HR				125	19,791.67			19,791.67
sediment disposal (6" depth)	1277	CY						7	8,940.56	8,940.56
2) Best Management Practices	1.58	AC								-
sediment fence (1hr/100LF)	1583	LF	16	60	950.00			1	1,583.33	2,533.33
fish exclusion (0.1ac site)	16	#	10	60	600.00					600.00
plant natives	1.58	AC	120	60	7,200.00			20000	31,666.67	38,866.67
TOTAL THIS SHEET					**11,050.00**		**19,791.67**		**10,523.89**	**80,232.22**

Table F-7b. 3-year Establishment Period Costs for SED (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Sediment Removal (1/3 priority area) (100hr/ac) x 2	3.17	AC	633	60	38,000.00					38,000.00
hydro-suction machine	633	HR				125	79,166.67			79,166.67
sediment disposal (6" depth) x 2	5109	CY						7	35,762.22	35,762.22
2) Best Management Practices x 2	3.17	AC								-
sediment fence (1hr/100LF)	3167	LF	32	60	1,900.00			1	3,166.67	5,066.67
fish exclusion (0.1ac site)	32	#	20	60	1,200.00					1,200.00
plant natives	3.17	AC	240	60	14,400.00			20000	63,333.33	77,733.33
TOTAL THIS SHEET					**55,500.00**		**79,166.67**		**102,262.22**	**236,928.89**

Table F-7c. Operations and Maintenance Costs for SED (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Sediment Removal (1/3 priority area) (100hr/ac) x 10	15.83	AC	1583	60	95,000.00					95,000.00
hydro-suction machine	1,583	hr				125	197,916.67			197,916.67
sediment disposal (6" depth) x 10	12772	CY						7	89,405.56	89,405.56
3) Best Management Practices (1hr/100lf) x 10	15.83	AC								-
sediment fence (1hr/100LF)	15833	LF	158	60	9,500.00			1	15,833.33	25,333.33
fish exclusion (0.1ac site)	158	#	100	60	6,000.00					6,000.00
fish exclusion (0.1ac site) x 10	15.83	AC	1200	60	72,000.00			20000	316,666.67	388,666.67
TOTAL THIS SHEET					**182,500.00**		**197,916.67**		**421,905.56**	**802,322.22**

Table F-8a. Initial Construction Costs for WET (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Excavation/Contouring (80hr/ac)	1.19	AC	95	80	7,631.68					7,631.68
bobcat or tractor with bucket (80hr/ac)	95	HR				50	4,769.80			4,769.80
sediment disposal (2' depth)	3848	CY						7	26,933.47	26,933.47
chipper (4hr/yd)	191	HR	191	60	11,447.52	50	9,539.60			20,987.12
tree disposal (40cy/ac)	48	CY						7	333.89	333.89
2) Flap-gate Structure	1.00	#								-
concrete or engineered earthen structure (1.5'h x 15'l x .75'w)	1.00	#						10,000	10,000.00	10,000.00
flap-gate (6" diameter steel)	4.00	#						200	800.00	800.00
3) Armor Spillway (5% polygon area)	0.06	AC								-
bobcat or tractor with bucket (60hr/ac)	3.58	#	4	80	286.19	50	178.87			465.06
rip rap, < 24" (1' depth)	96	CY						17	1,635.25	1,635.25
4) Best Managment Practices (1hr/100lf)	40	LF	0	60	24.23					24.23
bales, wattles, silt fence, etc (10% polygon perimeter)	40	LF						3	121.16	121.16
5) Plant Vegetation (10% polygon area) (60hr/ac)	0.12	AC	7	60	429.28					429.28
containerized herbaceous plants (50% of area @ 500/ac)	30	cell						8	238.49	238.49
containerized woody plants (50% of area @ 125/ac)	7	cell						15	111.79	111.79
native seed mix (20lb/ac)	2	LB						65	155.02	155.02
fiber mat (25% of planting area)	1,299	SF						0.50	649.29	649.29
TOTAL THIS SHEET			**297**		**19,818.90**		**14,488.27**		**40,978.35**	**75,285.53**

Table F-8b. 3-year Establishment Costs for WET (For Alternatives Comparison) (TY1-TY3)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 2yr	1.19	AC	19	60	1,144.75					1,144.75
2) Herbice Application (5hr/ac) x 2	1.19	AC	12	60	715.47					715.47
follow-up herbicide (1gal/ac) x 2	2.38	GAL						150	357.74	357.74
3) Plant Replacement (5hr/ac) x 2	1.19	AC	12	60	715.47					715.47
containerized herbaceous plants (20% installation) x 2	12	cell						8	95.40	95.40
containerized woody plants (20% installation) x 2	3	cell						15	44.72	44.72
4) Monitoring x 2	1.19	AC	40	80	3,200.00					3,200.00
TOTAL THIS SHEET			**83**		**5,775.69**				**497.85**	**6,273.54**

Table F-8c. Operations and Maintenance Costs for WET (For Alternatives Comparison) (TY3-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Surveys (8hr/ac) x 10	1.19	AC	95	60	5,723.76					5,723.76
2) Repair and Replacement										-
spillway repair	1	#						2,100	2,100	2,100.30
flapgate and structure repair	1	#						10,800	10,800.00	10,800.00
3) Sediment Clearing (80hr/ac) x 1	1.19	AC	95	80	7,631.68					7,631.68
bobcat or tractor with bucket	1	#				50	4,769.80			4,769.80
sediment disposal (0.5' depth)	962	CY						7	6,733.37	6,733.37
TOTAL THIS SHEET			**191**		**13,355.44**		**4,769.80**		**19,633.67**	**37,758.91**

Table F-9a. Initial Construction Costs for EDU (For Alternatives Comparison) (TY0-TY1)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Signage	20	#	40	60	2,400.00			200	4,000.00	6,400.00
2) Kiosk	3	#						10,000	30,000.00	30,000.00
TOTAL THIS SHEET					**2,400.00**		**-**		**34,000.00**	**36,400.00**

Table F-9b. Operation and Maintenance Costs for EDU (For Alternatives Comparison) (TY1-TY50)

TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Sign Repair/Replacement	20	#	40	60	2,400.00			100	2,000.00	4,400.00
2) Kiosk Maintenance	3	#						1,000	3,000.00	3,000.00
TOTAL THIS SHEET					**2,400.00**				**5,000.00**	**7,400.00**

Table F-10a. Initial Costs for DUCK (For Alternatives Comparison) (TY0-TY1)

MAP # AND TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Traping (5day/week) x 3 weeks	15	Days	120	80	9,600.00					9,600.00
traps	60	#				80	4,800.00			4,800.00
2) Animal Disposal (1/day)	15	#				40	600.00			600.00
TOTAL THIS SHEET			**120**		**9,600.00**		**5,400.00**		**0**	**15,000.00**

Table F-10b. Initial Costs for DUCK (For Alternatives Comparison) (TY1-TY3)

MAP # AND TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Traping (5day/week) x 3 weeks x 2yr	15	Days	240	80	19,200.00					19,200.00
2) Animal Disposal x 2 yr	30	#				40	1,200.00			1,200.00
TOTAL THIS SHEET			**240**		**19,200.00**		**1,200.00**		**0**	**20,400.00**

Table F-10c. Operation and Maintenance Costs for DUCK (For Alternatives Comparison) (TY1-TY50)

MAP # AND TASK DESCRIPTION	QUANTITY		LABOR			EQUIPMENT		MATERIAL		TOTAL
	NO. OF UNITS	UNIT MEAS	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST	TOTAL
1) Traping (5day/week) x 3 weeks x 10yr	15	Days	1,200	50	60,000.00					60,000.00
trap repair and replacement	60	#				80	4,800.00			4,800.00
2) Animal Disposal (1/day) x 10yr	150	#				40	6,000.00			6,000.00
TOTAL THIS SHEET			**1,200**		**60,000.00**		**10,800.00**		**-**	**70,800.00**

Table F-11a. Average Annual Cost Unit (AACU) by Measure (For Alternatives Comparison)

	EXOT	RIP1	RIP2	EXOA	SHORE1
LERRDS					
	$ 1,243,530	**$ 612,814**	**$ 659,711**	**$ 981,112**	**$ 16,179**
General Construction					
Initial Construction	$ 31,897	$ 147,520	$ 240,918	$ 28,899	$ 59,333
3-year Establishment Period	$ 19,622	$ 60,586	$ 73,833	$ 53,448	$ 4,315
subtotal	$ 51,519	$ 208,106	$ 314,751	$ 82,347	$ 63,649
contingency (%)	5.82%	9.36%	9.36%	14.97%	16.46%
Contingency Value	$ 2,999	$ 19,479	$ 29,460	$ 12,325	$ 10,477
Subtotal	**$ 54,518**	**$ 227,584**	**$ 344,211**	**$ 94,672**	**$ 74,126**
Planning, Engineering, and Design (PED)					
PED (10%)	$ 5,152	$ 20,811	$ 31,475	$ 8,235	$ 6,365
PED contingency (9.22%)	$ 475	$ 1,918	$ 2,901	$ 759	$ 587
Subtotal	**$ 5,627**	**$ 22,729**	**$ 34,376**	**$ 8,994**	**$ 6,952**
Construction Management					
Construction Management (10%)	$ 5,152	$ 20,811	$ 31,475	$ 8,235	$ 6,365
Construction Management Contingency (20.08%)	$ 1,035	$ 4,180	$ 6,322	$ 1,654	$ 1,278
Subtotal	**$ 6,187**	**$ 24,990**	**$ 37,797**	**$ 9,889**	**$ 7,643**
Subtotal First Cost	**$ 1,309,861**	**$ 888,118**	**$ 1,076,096**	**$ 1,094,666**	**$ 104,899**
profit (10%)	$ 130,986	$ 88,812	$ 107,610	$ 109,467	$ 10,490
TOTAL FIRST COST	**$ 1,440,847**	**$ 976,929**	**$ 1,183,705**	**$ 1,204,133**	**$ 115,389**
Interest During Construction	$ 81,797	$ 55,461	$ 67,199	$ 68,359	$ 6,551
INVESTMENT COST	**$ 1,522,644**	**$ 1,032,390**	**$ 1,250,905**	**$ 1,272,492**	**$ 121,940**
Interest	$ 57,099	$ 38,715	$ 46,909	$ 47,718	$ 4,573
Amortization	$ 10,772	$ 7,303	$ 8,849	$ 9,002	$ 863
Annual Operations, Maintenance, Repair, Rehabilitation, and Replacements (OMRR&R)	$ 731	$ 764	$ 838	$ 1,876	$ 832
Average Annual Cost Unit (AACU)	**$ 68,602**	**$ 46,782**	**$ 56,596**	**$ 58,597**	**$ 6,267**

ANNUAL INTEREST RATE (decimal)	**0.03750**
PROJECT LIFE (years)	**50**
CONSTRUCTION PERIOD (months)	**36**

Table F-11b. Average Annual Cost Unit (AACU) by Measure (For Alternatives Comparison)

	SHORE2	DISC	SED	DUCK	WET	EDU
LERRDS						
	$ 20,353	**$ 110,632**	**$ 438,100**	**$ -**	**$ 52,725**	**$ -**
General Construction						
Initial Construction	$ 71,634	$ 58,233	$ 80,232	$ 15,000	$ 75,286	$ 36,400
3-year Establishment Period	$ 7,044	$ 9,819	$ 236,929	$ -	$ 6,274	$ -
subtotal	$ 78,678	$ 68,052	$ 317,161	$ 15,000	$ 81,559	$ 36,400
contingency (%)	16.46%	16.12%	7.54%	9.41%	7.54%	5.82%
Contingency (risk-based)	$ 12,951	$ 10,967	$ 23,914	$ 1,411	$ 6,149	$ 2,119
Subtotal	**$ 91,629**	**$ 79,019**	**$ 341,075**	**$ 16,411**	**$ 87,708**	**$ 38,519**
Planning, Engineering, and Design (PED)						
PED (10%)	$ 7,868	$ 6,805	$ 31,716	$ 1,500	$ 8,156	$ 3,640
PED contingency (9.22%)	$ 725	$ 627	$ 2,924	$ 138	$ 752	$ 336
Subtotal	**$ 8,593**	**$ 7,432**	**$ 34,640**	**$ 1,638**	**$ 8,908**	**$ 3,976**
Construction Management						
Construction Management (10%)	$ 7,868	$ 6,805	$ 31,716	$ 1,500	$ 8,156	$ 3,640
Construction Management Contingency (20.08%)	$ 1,580	$ 1,367	$ 6,370	$ 301	$ 1,638	$ 731
Subtotal	**$ 9,448**	**$ 8,172**	**$ 38,086**	**$ 1,801**	**$ 9,794**	**$ 4,371**
Subtotal First Cost	**$ 130,023**	**$ 205,256**	**$ 851,901**	**$ 19,850**	**$ 159,134**	**$ 46,865**
profit (10%)	$ 13,002	$ 20,526	$ 85,190	$ 1,985	$ 15,913	$ 4,687
TOTAL FIRST COST	**$ 143,025**	**$ 225,781**	**$ 937,091**	**$ 21,835**	**$ 175,048**	**$ 51,552**
Interest During Construction	$ 8,120	$ 12,818	$ 53,199	$ 1,240	$ 9,938	$ 2,927
INVESTMENT COST	**$ 151,144**	**$ 238,599**	**$ 990,290**	**$ 23,075**	**$ 184,985**	**$ 54,478**
Interest	$ 5,668	$ 8,947	$ 37,136	$ 865	$ 6,937	$ 2,043
Amortization	$ 1,069	$ 1,688	$ 7,006	$ 163	$ 1,309	$ 385
Annual Operations, Maintenance, Repair, Rehabilitation, and Replacements (OMRR&R)	$ 1,177	$ 2,428	$ 17,071	$ 1,506	$ 803	$ -
Average Annual Cost Unit (AACU)	**$ 7,915**	**$ 13,064**	**$ 61,212**	**$ 2,535**	**$ 9,049**	**$ 2,428**

ANNUAL INTEREST RATE (decimal)	**0.03750**
PROJECT LIFE (years)	**50**
CONSTRUCTION PERIOD (months)	**36**

APPENDIX G
INCREMENTAL COST ANALYSIS

Total and Average Cost

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Cost Effective Plan Alternatives

Planning Set: CEICA Analysis 39

Counter	Name	Output HU	Cost $1000	Average Cost
1	No Action Plan	30.56	0.00	0.00
2	EXOT0RIP0EXOA0SHORE1DISC0SED0 DUCK0WET0EDU0	30.66	6,267.00	204.40
3	EXOT0RIP0EXOA0SHORE2DISC0SED0 DUCK0WET0EDU0	30.70	7,915.00	257.82
4	EXOT0RIP0EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	31.33	9,049.00	288.83
5	EXOT0RIP0EXOA0SHORE1DISC0SED0 DUCK0WET1EDU0	31.42	15,316.00	487.46
6	EXOT0RIP0EXOA0SHORE2DISC0SED0 DUCK0WET1EDU0	31.46	16,963.00	539.19
7	EXOT0RIP0EXOA0SHORE0DISC1SED0 DUCK0WET1EDU0	32.03	22,113.00	690.38
8	EXOT0RIP0EXOA0SHORE1DISC1SED0 DUCK0WET1EDU0	32.12	28,380.00	883.56
9	EXOT0RIP0EXOA0SHORE2DISC1SED0 DUCK0WET1EDU0	32.16	30,027.00	933.68
10	EXOT0RIP1EXOA0SHORE0DISC0SED0 DUCK0WET0EDU0	35.50	46,782.00	1,317.80
11	EXOT0RIP1EXOA0SHORE1DISC0SED0 DUCK0WET0EDU0	35.60	53,049.00	1,490.14
12	EXOT0RIP1EXOA0SHORE2DISC0SED0 DUCK0WET0EDU0	35.64	54,696.00	1,534.68
13	EXOT0RIP1EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	36.27	55,831.00	1,539.32
14	EXOT0RIP1EXOA0SHORE1DISC0SED0 DUCK0WET1EDU0	36.36	62,098.00	1,707.87
15	EXOT0RIP1EXOA0SHORE2DISC0SED0 DUCK0WET1EDU0	36.40	63,745.00	1,751.24
16	EXOT0RIP2EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	36.68	65,645.00	1,789.67
17	EXOT1RIP0EXOA0SHORE0DISC0SED0 DUCK0WET0EDU0	36.99	68,602.00	1,854.61
18	EXOT1RIP0EXOA0SHORE1DISC0SED0 DUCK0WET0EDU0	37.09	74,869.00	2,018.58
19	EXOT1RIP0EXOA0SHORE2DISC0SED0 DUCK0WET0EDU0	37.13	76,516.00	2,060.76
20	EXOT1RIP0EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	37.76	77,651.00	2,056.44
21	EXOT1RIP0EXOA0SHORE1DISC0SED0 DUCK0WET1EDU0	37.85	83,918.00	2,217.12
22	EXOT1RIP0EXOA0SHORE2DISC0SED0 DUCK0WET1EDU0	37.89	85,565.00	2,258.25
23	EXOT1RIP0EXOA0SHORE0DISC1SED0 DUCK0WET1EDU0	38.31	90,714.00	2,367.89
24	EXOT1RIP0EXOA0SHORE1DISC1SED0 DUCK0WET1EDU0	38.40	96,982.00	2,525.57
25	EXOT1RIP0EXOA0SHORE2DISC1SED0 DUCK0WET1EDU0	38.45	98,629.00	2,565.12
26	EXOT0RIP1EXOA1SHORE0DISC0SED0 DUCK0WET1EDU0	38.68	114,428.00	2,958.32
27	EXOT1RIP1EXOA0SHORE0DISC0SED0 DUCK0WET0EDU0	41.93	115,384.00	2,751.82
28	EXOT1RIP1EXOA0SHORE1DISC0SED0 DUCK0WET0EDU0	42.03	121,651.00	2,894.38
29	EXOT1RIP1EXOA0SHORE2DISC0SED0 DUCK0WET0EDU0	42.07	123,298.00	2,930.78
30	EXOT1RIP1EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	42.70	124,433.00	2,914.12

Cost Effective Plan Alternatives

Planning Set: CEICA Analysis 39

Counter	Name	Output HU	Cost $1000	Average Cost
31	EXOT1RIP1EXOA0SHORE1DISC0SED0 DUCK0WET1EDU0	42.79	130,700.00	3,054.45
32	EXOT1RIP1EXOA0SHORE2DISC0SED0 DUCK0WET1EDU0	42.83	132,347.00	3,090.05
33	EXOT1RIP2EXOA0SHORE0DISC0SED0 DUCK0WET1EDU0	43.10	134,247.00	3,114.78
34	EXOT1RIP1EXOA0SHORE0DISC1SED0 DUCK0WET1EDU0	43.25	137,496.00	3,179.10
35	EXOT1RIP1EXOA0SHORE1DISC1SED0 DUCK0WET1EDU0	43.34	143,764.00	3,317.12
36	EXOT1RIP1EXOA0SHORE2DISC1SED0 DUCK0WET1EDU0	43.38	145,411.00	3,352.03
37	EXOT1RIP2EXOA0SHORE0DISC1SED0 DUCK0WET1EDU0	43.66	147,311.00	3,374.05
38	EXOT1RIP2EXOA0SHORE1DISC1SED0 DUCK0WET1EDU0	43.75	153,578.00	3,510.35
39	EXOT1RIP2EXOA0SHORE2DISC1SED0 DUCK0WET1EDU0	43.79	155,225.00	3,544.76
40	EXOT1RIP1EXOA1SHORE0DISC0SED0 DUCK0WET0EDU0	44.34	173,980.00	3,923.77
41	EXOT1RIP1EXOA1SHORE1DISC0SED0 DUCK0WET0EDU0	44.44	180,247.00	4,055.96
42	EXOT1RIP1EXOA1SHORE2DISC0SED0 DUCK0WET0EDU0	44.48	181,895.00	4,089.37
43	EXOT1RIP1EXOA1SHORE0DISC0SED0 DUCK0WET1EDU0	45.11	183,029.00	4,057.39
44	EXOT1RIP1EXOA1SHORE1DISC0SED0 DUCK0WET1EDU0	45.20	189,296.00	4,187.96
45	EXOT1RIP1EXOA1SHORE2DISC0SED0 DUCK0WET1EDU0	45.25	190,944.00	4,219.76
46	EXOT1RIP2EXOA1SHORE0DISC0SED0 DUCK0WET1EDU0	45.52	192,843.00	4,236.45
47	EXOT1RIP1EXOA1SHORE0DISC1SED0 DUCK0WET1EDU0	45.67	196,093.00	4,293.69
48	EXOT1RIP1EXOA1SHORE1DISC1SED0 DUCK0WET1EDU0	45.77	202,360.00	4,421.24
49	EXOT1RIP1EXOA1SHORE2DISC1SED0 DUCK0WET1EDU0	45.81	204,007.00	4,453.33
50	EXOT1RIP2EXOA1SHORE0DISC1SED0 DUCK0WET1EDU0	46.08	205,907.00	4,468.47
51	EXOT1RIP2EXOA1SHORE1DISC1SED0 DUCK0WET1EDU0	46.17	212,174.00	4,595.49
52	EXOT1RIP2EXOA1SHORE2DISC1SED0 DUCK0WET1EDU0	46.22	213,822.00	4,626.18
53	EXOT1RIP1EXOA1SHORE0DISC1SED1 DUCK0WET1EDU0	46.78	252,660.00	5,401.03
54	EXOT1RIP1EXOA1SHORE1DISC1SED1 DUCK0WET1EDU0	46.88	258,927.00	5,523.19
55	EXOT1RIP1EXOA1SHORE2DISC1SED1 DUCK0WET1EDU0	46.92	260,575.00	5,553.60
56	EXOT1RIP2EXOA1SHORE0DISC1SED1 DUCK0WET1EDU0	47.19	262,474.00	5,562.07
57	EXOT1RIP2EXOA1SHORE1DISC1SED1 DUCK0WET1EDU0	47.29	268,742.00	5,682.85
58	EXOT1RIP2EXOA1SHORE2DISC1SED1 DUCK0WET1EDU0	47.33	270,389.00	5,712.85

Incremental Cost of Best Buy Plan Combinations (Ordered By Output)

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Planning Set: CEICA Analysis 39

Counter	Plan Alternative	Output (HU)	Cost ($1000)	Average Cost ($1000 / HU)	Incremental Cost ($1000)	Inc. Output (HU)	Inc. Cost Per Output
1	No Action Plan	30.56	0.00	0.0000			
2	EXOT0RIP1EXOA0SHORE 0DISC0SED0DUCK0WET0 EDU0	35.50	46,782.00	1,317.8028	46,782.0000	4.9400	9,470.0405
3	EXOT1RIP1EXOA0SHORE 0DISC0SED0DUCK0WET0 EDU0	41.93	115,384.00	2,751.8245	68,602.0000	6.4300	10,669.0513
4	EXOT1RIP1EXOA0SHORE 0DISC0SED0DUCK0WET1 EDU0	42.70	124,433.00	2,914.1218	9,049.0000	0.7700	11,751.9481
5	EXOT1RIP1EXOA0SHORE 0DISC1SED0DUCK0WET1 EDU0	43.25	137,496.00	3,179.0983	13,063.0000	0.5500	23,750.9091
6	EXOT1RIP2EXOA0SHORE 0DISC1SED0DUCK0WET1 EDU0	43.66	147,311.00	3,374.0495	9,815.0000	0.4100	23,939.0244
7	EXOT1RIP2EXOA1SHORE 0DISC1SED0DUCK0WET1 EDU0	46.08	205,907.00	4,468.4679	58,596.0000	2.4200	24,213.2231
8	EXOT1RIP2EXOA1SHORE 0DISC1SED1DUCK0WET1 EDU0	47.19	262,474.00	5,562.0682	56,567.0000	1.1100	50,961.2613
9	EXOT1RIP2EXOA1SHORE 2DISC1SED1DUCK0WET1 EDU0	47.33	270,389.00	5,712.8460	7,915.0000	0.1400	56,535.7143

Figure G-1. Cost (AACU) and Output (AAHU)

All Plans Differentiated by Cost Effectiveness

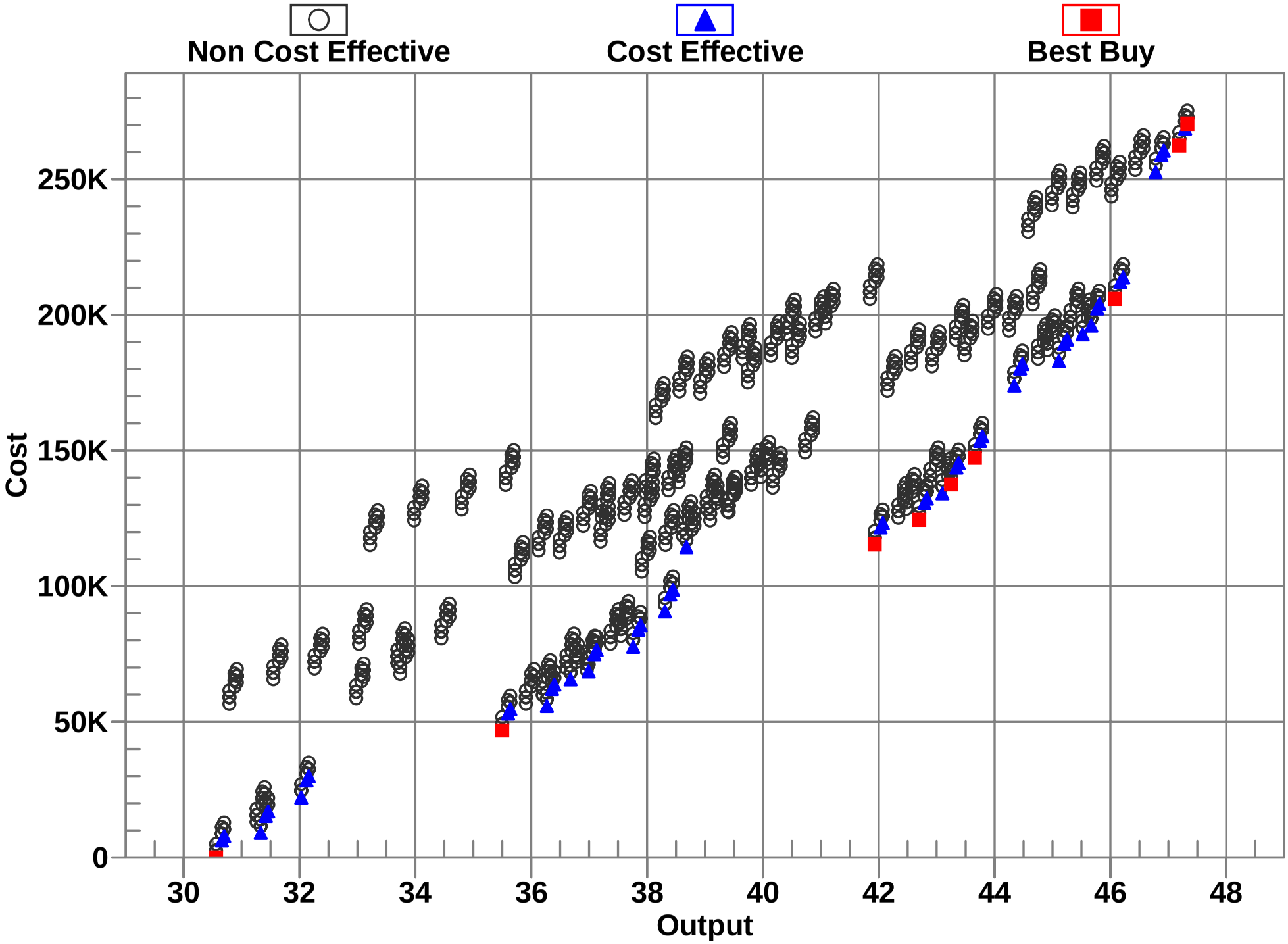
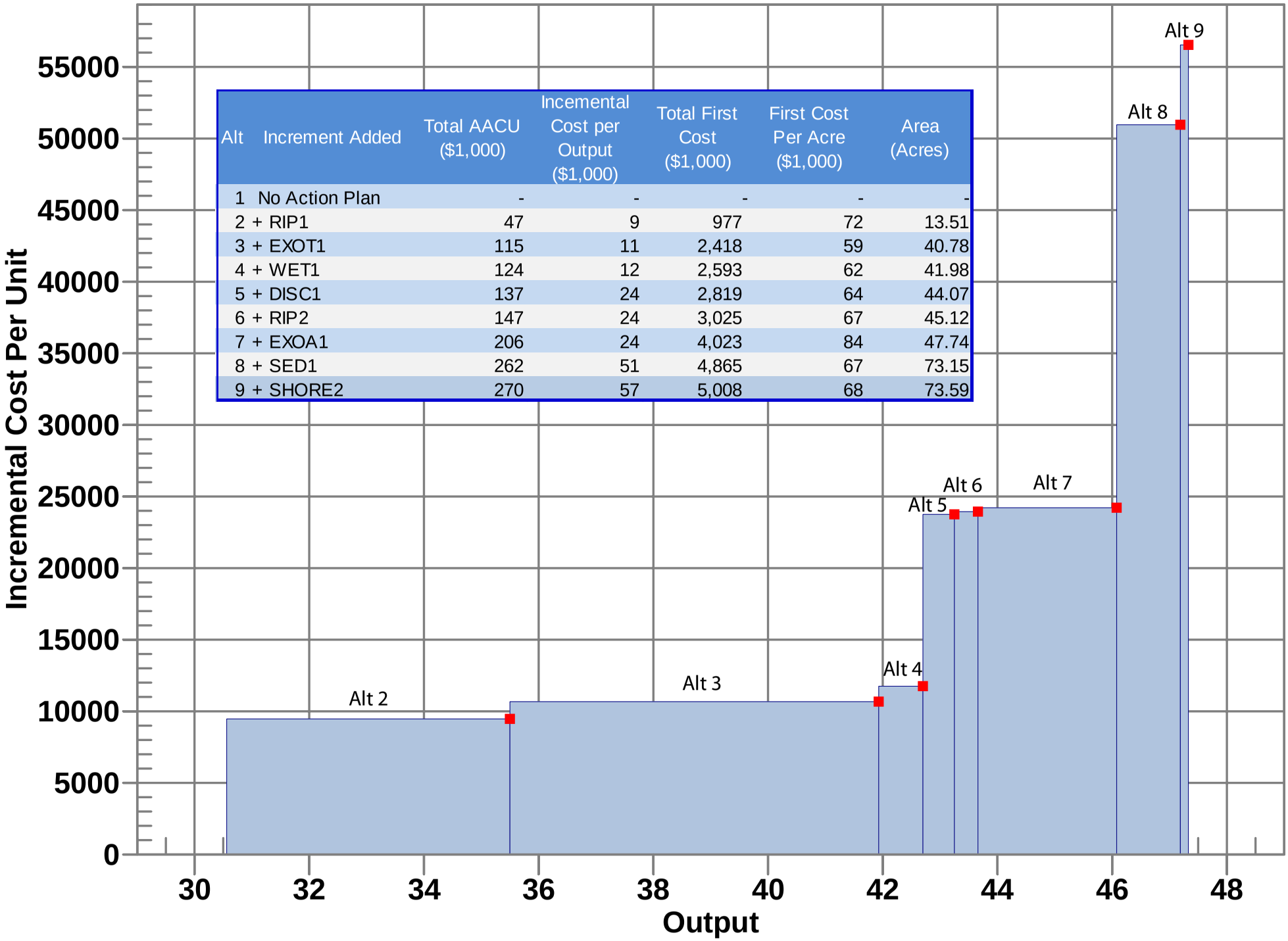


Figure G-2. Incremental Cost per Output (AACU/AAHU) and Output (AAHU)

Best Buy Plan Alternatives



Alt	Increment Added	Total AACU ($1,000)	Incemental Cost per Output ($1,000)	Total First Cost ($1,000)	First Cost Per Acre ($1,000)	Area (Acres)
1	No Action Plan	-	-	-	-	-
2	+ RIP1	47	9	977	72	13.51
3	+ EXOT1	115	11	2,418	59	40.78
4	+ WET1	124	12	2,593	62	41.98
5	+ DISC1	137	24	2,819	64	44.07
6	+ RIP2	147	24	3,025	67	45.12
7	+ EXOA1	206	24	4,023	84	47.74
8	+ SED1	262	51	4,865	67	73.15
9	+ SHORE2	270	57	5,008	68	73.59

APPENDIX H
REAL ESTATE PLAN

APPENDIX E
REAL ESTATE PLAN

SAN MARCOS RIVER SECTION 206 AQUATIC ECOSTSTEM RESTORATION PROJECT

CITY OF SAN MARCOS, TEXAS

DATE OF REPORT

APRIL 7, 2014

PREPARED BY

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

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 San Marcos River Section 206 Aquatic Ecosystem Restoration Project in the City of San Marcos (Hays County) Texas and is based on the gross appraisal that was prepared on July 12, 2013. Both the City of San Marcos and the State of Texas, General Land Office are the non-Federal sponsors. As part of a cooperative agreement between the two NFS, the City of San Marcos and GLO will provide the LERRD (already owned – 60.871 acres) and the City will acquire the necessary additional land from Texas Parks & Wildlife (12.007 acres).

The Continuing Authorities Program (CAP) and Section 206 of the Water Resources Development Act of 1996 authorizes the U.S. Army corps of Engineers to participated in the development and implementation of projects to restore aquatic habitats that have been significantly disturbed, degraded, or altered.

The project would restore valuable aquatic and riparian habitats along the San Marcos River, which have been degraded by recreational use, invasive exotic plant and animal species, and sedimentation. The Proposed National Environmental Restoration (NER or recommended plan) includes measures to control aquatic and riparian exotic plants, measures to restore riparian zones, measures to restore wetlands, and measures to remove and control accumulations of sediments from the San Marcos River channel. The project would have benefits to several federally listed species.

LAND, EASEMENTS, AND RIGHTS-OF-WAY FOR THE RECOMMENDED PLAN

In accordance with ER 405-1-12, dated May 1, 1998, the estate to be acquired for "fish and wildlife mitigation lands, **ecosystem restoration**, and other environmental purposes" is Fee. Based on this guidance, the estate valued is defined by the U.S. Army Corps of Engineers as:

> *The fee simple title to the land described, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.*

The subject property is located within the City of San Marcos in Hays County, Texas. The recommended plan is a combination of in-stream ecosystem restoration and that entails the removal of invasive species and the replacement with native species and the restoration of riparian habitats along the river bank. A total of 72.878 publically owned acres are involved.

- Public Owned Land
  - City of San Marcos – 35.003 acres
  - State of Texas, General Land Office (GLO) – 25.868 acres
  - State of Texas, Parks & Wildlife (TxP&W) – 12.007 acres

The NFS (City of San Marcos and GLO) currently own 60.871 acres which includes an area for sediment disposal and a work area. Both the City and GLO own the land in fee simple which includes minerals. The remaining 12.007 acres owned by the TxP&W will be acquired as a perpetual easement which is a non-standard estate (NSE). The NSE will be developed during the design phase and submitted for approval. Through the approval of this document, MSC approval is being sought to submit the NSE. TxP&W has stated publically that they are willing to work with the NFS and the Corps on the project. In support, a letter dated November 26, 2013 states that staff will recommend their Commission grant a non-standard estate for the land needed.

ER1105-2-100 allows exceptions to the general policy requiring fee. "Notwithstanding that fee title is generally the interest that must be provided to support CAP ecosystem restoration projects,

there are circumstances where it may be appropriate to utilize permanent easements instead of fee. Such circumstances include:

- where project lands consist of the bed and immediate bank of a watercourse for the installation of features that improve habitat for aquatic resources (for example, root wads, shallow excavations, riffles, etc.)
- where project lands are owned in fee by public agencies other than the non-Federal sponsor and the owning agency cannot convey fee title and will not serve as a co-sponsor of the project; foreseeable future uses of the land by the public agency fee owner are compatible with project purposes; and public access is provided otherwise or is not compatible with project purposes.

Where one or more of the circumstances described exists, the MSC may approve use of a permanent easement instead of fee for the implementation of the CAP ecosystem restoration project where use of such easement will satisfy project requirements and protect the project benefits. Given that none of the standard estates contained in EC 405 are applicable, language for a permanent easement (non-standard estate) will be developed during the design phase and submitted to Headquarters for approval.

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 title. Table 1 - identifies the estate and estimated value of the land that will be acquired by the City of San Marcos.

TABLE 1
LAND, EASEMENTS, and RIGHTS OF WAY
San Marcos River Aquatic Ecosystem Restoration
San Marcos, Texas

ESTATE	ACRES	ESTIMATED VALUE
PROJECT PURPOSE: Aquatic Ecosystem Restoration		
PROJECT FEATURE: Aquatic Ecosystem Restoration		
Fee Simple Non-Standard Perpetual Easement	60.871 12.007	$412,342 $108,238

NON-STANDARD ESTATE

A total of 60.871 acres is owned in fee simple (includes minerals) by the NFS. An additional 12.007 owned by TxP&W will be acquired through a permanent easement that is allowed under ER1105-2-100. This permanent easement will be a NSE and will be developed and submitted for approval during the design phase. Approval to submit the NSE is being sought from the MSC through this document.

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

Navigational Servitude is not applicable to this project because the San Marcos River is not navigable.

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, San Marcos River Aquatic Ecosystem Restoration Project, dated July 8, 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
- 01.23.03.15 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 72.878 acres needed for the project are presented in Table 2. The estimates are presented in the standard Code of Accounts from M-CACES Model Database, October 1994.

REAL ESTATE COST ESTIMATES - PROJECT IMPLEMENTATION
TABLE 2
SAN MARCOS RIVER AQUATIC ECOSYSTEM RESTORATION
SAN MARCOS, TEXAS

ACCOUNT	DESCRIPTION	ESTIMATE	CONTINGENCIES
01	Land & Damages		
01.23	Construction Contract Documents		
01.23.03	Real Estate Analysis Documents		
01.23.03.01	Real Estate Planning Documents		
	Planning by Non Federal Sponsor	$44,000	$11,000
	Review of Non Federal Sponsor	$17,600	$4,400
01.23.03.02	Real Estate Acquisition Documents		
	Acquisitions by Sponsor	$352,000	$88,000
	Review of Sponsor	$17,600	$4,400
01.23.03.03	Real Estate Condemnation Documents		
	Condemnations by Sponsor (estimate 10%)	$0	$0
	Review of Sponsor	$0	$0
01.23.03.05	Real Estate Appraisal Documents		
	Appraisals by Sponsor	$220,000	$44,000
	Review of Sponsor	$17,600	$3,520
01.23.03.06	Real Estate PL 91-646 Asst. Documents		
	PL 91-646 Asst. by Sponsor	$0	$0
	Review of Sponsor	$0	$0
01.23.03.15	Real Estate Payment Documents		
	Payments by Local Sponsor (Fee)	$520,580	$104,116
	Payments by Sponsor (PL 91-646)	$0	$0
	Review of Sponsor	$0	$0
01.23.03.17	Real Estate LERRD Credit Documents	$17,600	$3,520
	Total Admin & Payments	$1,206,980	
	Total Contingencies		$262,956
	GRAND TOTAL	$1,469,936	

Notes:

1. During DQC, the value was revised and does not match what was previously sent to the PCX. The Delta of an additional $11,782 is considered inconsequential and included in the contingencies.
2. LERRD estimated costs total $1,328,696
3. Estimated costs are based on the gross appraisal prepared in July 2013

RELOCATION ASSISTANCE PROGRAM PL 91-646

No residential or business relocation will occur.

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. If minerals are found to be of significance or the surface owner does not own, a waiver for acquiring the minerals will be sought at the time of discovery. There is no merchantable timber on the property.

NON-FEDERAL SPONSOR'S CAPABILITY TO ACQUIRE LERRD

Even though both the City of San Marcos and GLO are co-sponsors, the City will be responsible for acquiring the additional LERRD from TxP&W. A checklist has been prepared in accordance with Chapter 12 of ER 405-1-12 and is attached. The City is aware of the requirements of PL 91-646, as amended, and the requirements for documenting expenses for credit purposes.

The City will also be advised of the risks associated with acquiring LERRD before execution of the PPA. 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 & estate(s)	30 days after PPA signed
Obtain Surveys	60 days after transmittal of ROW drawings & estate(s)
Obtain Title Evidence	60 days after obtaining surveys
Obtain Appraisals & Reviews	60 days after obtaining titles
Authorization to Proceed with Offer	10 days after obtaining appraisals & reviews
Conclude Negotiations	90 days after start of negotiations
Conclude Closings	45 days after concluding closings
Conclude Condemnations	240 days after condemnation process starts
Attorney Certify Availability of LERRD	15 days after condemnations concluded
Corps Certifies Availability of LERRD	5 days after NFS Attorney Certifies LERRD
Review LERRD Credit Request	45 days after receiving LERRD documentation
Approve or Deny LERRD Credit Requests	5 days after concluding review of LERRD documentation

FACILITY OR UTILITY RELOCATIONS

Current plans indicate that no facility or utility relocations will occur.

CONTAMINANTS ON REAL ESTATE ACQUISITIONS

A literature review and site assessment for the area has been completed. Based on this evaluation, there are 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 to the project has been raised during public hearings.

OTHER REAL ESTATE ISSUES

No other Real Estate issues are known to exist.

CHECKLIST TO ACQUIRE LERRD (City of San Marcos)

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 - However, the City does not have the power of eminent domain over the State of Texas (i.e. TxP&W). Such action, if necessary would occur through an agreement with the Corps.**
   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? **Not Applicable**
   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 Ms. Melani Howard (City of San Marcos).

Prepared by

Thurman Schweitzer
Chief, Realty Services Section

Reviewed and approved by:

Roger Jennings
Chief, Planning & Appraisal Branch

CHECKLIST TO ACQUIRE LERRD (State of Texas, General Land Office)

I. Legal Authority

f. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes**

g. Does the sponsor have the power of eminent domain for this project? **Yes**

h. Does the sponsor have "quick-take" authority for this project? **Yes**

i. Are any of the lands/interested in land required for the project, located outside the sponsor's political boundary? **No**

j. 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

g. 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**

h. If the answer to II(a) is yes, has a reasonable plan been developed to provide such training? **Not applicable**

i. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes**

j. Is the sponsor's projected in-house staffing level sufficient considering other work load, if any, and the project schedule? **Yes**

k. Can the sponsor obtain contractor support, if required, in a timely fashion? **Yes**

l. Will the sponsor likely request USACE assistance in acquiring real estate? **No**

III. Other Project Variables

c. Will the sponsor's staff be located within reasonable proximity to the project site? **Yes**

d. Has the sponsor approved the project/real estate schedule/milestones? **Pending**

IV. Overall Assessment

c. Has the sponsor performed satisfactorily on other USACE projects? **Not Applicable**

d. With regard to this project, the sponsor is anticipated to be: **Fully Capable**

V. Coordination

c. Has this assessment been coordinated with the sponsor? **Yes**

d. Does the sponsor concur with this assessment? **Pending**

Information provided to Mr. Tony Williams (GLO).

Prepared by

Thurman Schweitzer
Chief, Realty Services Section

Reviewed and approved by:

Roger Jennings
Chief, Planning & Appraisal Branch

Central Portion of Project

Southern Portion of Project

APPENDIX I
MONITORING AND ADAPTIVE MANAGEMENT PLAN

Monitoring and Adaptive Management Plan
San Marcos River
Section 206 Aquatic Ecosystem Restoration Project

A National Ecosystem Restoration (NER) Plan has been selected for the San Marcos River Section 206 Aquatic Ecosystem Restoration Project. This Adaptive Management Plan provides a schedule and description of monitoring and maintenance activities, as well as success criteria and potential adaptive management strategies.

Monitoring is included for each measure included in the NER Plan (Table 1), and reporting would occur by December 31 of each Target Year (TY) during which monitoring occurs. All monitoring reports would be submitted to U.S. Army Corps of Engineers, Fort Worth District (CESWF). It is assumed that all restoration measures would be sustainable with minimal maintenance following the 3-year establishment period. Monitoring would occur during each year of the establishment period to quantify and report the status of success criteria. The control of exotic emergent vegetation (EXOE), restoration of wetland (WET), restoration of discharge locations (DISC), and removal of accumulated sediment (SED) would all be monitored at 5-year intervals following successful establishment. The restoration of the riparian zone (RIP2) and control of exotic shrubs and trees (EXOT) would be monitored at TY15 (when the canopy is anticipated to begin forming) and at TY25 (when the canopy is anticipated to become closed).

Table 1. Monitoring Schedule for Restoration Measures Included in the NER Plan

Measure	Monitoring Year*										
	TY1 to TY3	TY5	TY10	TY15	TY20	TY25	TY30	TY35	TY40	TY45	TY50
EXOE	Annual	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
RIP2	Annual			yes		yes					
EXOT	Annual			yes		yes					
WET	Annual	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
DISC	Annual	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
SED	Annual	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

*Additional monitoring years may be required where success criteria are not met.

The findings of the monitoring reports would be used to determine the sustainability of restoration measures. Annual monitoring would continue until all success criteria are met or coordination with resource agencies determines that the measures are self-sustaining. If

success criteria are not met, adaptive management measures would be implemented as described below.

EXOE

EXOE would be implemented such that one-third of the existing area of elephant ear (*Colacasia esculenta*) at TY0 is removed during each year of the 3-year establishment period, and maintenance would include control of any reestablishment at 5-year intervals. Control would be implemented at discrete locations no larger than 500 square feet to be delineated and identified as a restoration site. A restoration site can include more than one patch of elephant ear, but the total area cannot exceed 500 square feet. Any patch of elephant ear larger than 500 square feet would be identified and reported as two independent restoration sites. The following information would be reported for each restoration site in any TY during which control of elephant ear occurs:

- qualitative description of restoration site with photographs
- location, area, and number of patches removed, as recorded using a GPS
- area, number, list and qualitative description of native species impacted (trampling, incidental removal, etc.)
- number and list of native species planted
- qualitative and quantitative description of any temporary best management practices (BMPs) installed

Monitoring of sites where elephant ear was removed in TY1 would occur prior to the initiation of removal at sites scheduled for TY2. Elephant ear removed at sties initiated in TY1 and TY2 would be monitored prior to initiation of the removal at sites scheduled for TY3. If success criteria are met at a site at the beginning of TY3, no further monitoring of that site would be required until TY5. The following information would be reported for each restoration site during the TY following initial control efforts:

- qualitative description of restoration site with photographs
- percent cover of plants by species, as quantified using three randomly located 1-square-meter quadrats

- qualitative description of any damage to site including damage to BMPs resulting from wildlife, recreation, or weather events
- quantitative and qualitative description of any evidence of erosion

Monitoring and reporting would occur at each restoration site where removal was implemented during the previous TY or where success criteria were not met in the previous TY. The following success criteria are required for EXOE:

- no elephant ear present
- at least 50 percent relative cover of native plants
- no evidence of uncontrolled erosion occurring within or downstream of the restoration site

Any elephant ear remaining would be removed. If elephant ear are observed at the same restoration site over 2 subsequent years, additional efforts would be implemented to remove rhizomes to a greater depth. Any exotic plants present would be removed by hand. If the relative cover of native plants is less than 50 percent, additional plantings would be installed. Plantings would be selected from those native species with the greatest percent cover at the site. Any uncontrolled erosion would be addressed by implementing additional temporary BMPs. If uncontrolled erosion continues for more than 1 year, additional long-term measures would be considered, such as contouring and bank stabilization through placement of aggregate, wattles, or other native plants, or implementing other measures appropriate for the situation.

It is assumed that all elephant ear would be removed from the study area by the end of the TY3 and that control of upstream sources (i.e., Spring Lake) would prevent future establishment in the study area. However, monitoring of the study area for newly established patches of elephant ear would continue at 5-year intervals throughout the life of the project. The same monitoring, reporting, and management measures implemented during the establishment period would be implemented during subsequent monitoring and maintenance.

RIP2

RIP2 would be implemented such that all initial soil preparation, planting, and BMPs would be completed during TY1. Restoration would be conducted at discrete sites supported by an

independent irrigation system. The following information would be reported for each restoration site at the end of TY1:

- qualitative description of restoration site with photographs
- location and area of planting zones, as recorded using a GPS
- location, total length, and estimated use of installed irrigation, as recorded using a GPS
- area, number, and list of native species planted by zone, as recorded using a GPS
- qualitative and quantitative description of any temporary BMPs installed

Monitoring would occur at each restoration site during the late spring of TY2 and TY3, and the following information would be reported:

- percent cover of woody plants by species, as quantified using one line-intercept transect situated perpendicular to the river and passing through the widest part of the restoration site; at least one transect would be surveyed for every 100 yards (or part thereof) of restoration site (as measured parallel to the river)
- percent mortality of planted trees and shrubs, as quantified by enumerating live and dead specimens following a wandering transect within the restoration site
- percent cover of herbaceous plants by species within Zone 3, as quantified using three randomly located 1-square-meter quadrats within every 0.5 acre of restoration site or any part thereof
- qualitative and quantitative description of any evidence of erosion occurring within or downstream of the restoration site

The success of RIP2 would be evaluated at the end of TY3 and again at the end of TY5. The following success criteria are required for RIP2 at TY3:

- percent cover of native woody plants greater than 20 percent
- percent cover of exotic woody plants less than 5 percent
- percent mortality of planted shrubs and trees less than 20 percent
- percent cover of native herbaceous plants in Zone 3 greater than 70 percent
- percent cover of exotic herbaceous plants in Zone 3 less than 5 percent
- no evidence of uncontrolled erosion occurring within or downstream of the restoration site

If percent cover of native woody plants is less than 20 percent at TY3, irrigation would be left in place for 2 more years. Additional plantings would be made to replace dead shrubs and trees and to fill gaps in Zone 3. Plantings would be selected from those species with the greatest percent cover at the site. All exotic plants would be removed by hand where feasible, and an herbicide would be applied to exotic plants where establishment is pervasive. Any uncontrolled erosion would be addressed by implementing additional temporary BMPs. If uncontrolled erosion continues for more than 1 year, additional long-term measures would be considered, such as contouring and bank stabilization through placement of aggregate, wattles, or other native plants, or other measures appropriate for the situation.

If RIP2 success criteria are not met at the end of TY3, the following success criteria are required for RIP2 at TY5:

- percent cover of native woody plants exceeds 60 percent
- percent cover of exotic woody plants is less than 1 percent
- percent mortality of planted shrubs and trees is less than 20 percent
- percent cover of native herbaceous plants in Zone 3 exceeds 90 percent
- percent cover of exotic herbaceous plants in Zone 3 is less than 5 percent
- no evidence of uncontrolled erosion occurring within or downstream of the restoration site

If RIP2 success criteria are not met at the end of TY5, irrigation would remain in place, additional plantings would be made, invasive species would be controlled, and any evidence of erosion would be remediated using long-term measures. These measures would be repeated each year until TY5 success criteria are met.

Following successful establishment, restoration sites would be monitored at TY15 and TY25, and the following information would be reported:

- percent cover of plants by species as quantified using one line-intercept transect situated perpendicular to the river and passing through the widest part of the restoration site; at least one transect would be surveyed for every 100 yards (or part thereof) of restoration site (as measured parallel to the river)
- qualitative and quantitative description of any evidence of erosion occurring within or downstream of the restoration site

There are no success criteria for TY15 and TY25. The restoration site would be established at this time, and only maintenance of exotic plants or erosion would be required.

EXOT

EXOT would be implemented such that the application of herbicide would be completed at the end of TY1. EXOT would be conducted at discrete sites defined by contiguous patches of forest not separated by trails, roads, or surface waters. The following information would be reported at the end of TY1 for each restoration site:

- qualitative description of restoration site with photographs
- approximate location and area of herbicide application, as recorded using a GPS
- list and estimated relative abundance of species controlled
- type, concentration (rate), and volume of herbicide applied and number of herbicide spikes used

It is assumed that some resprouts and germination of exotic plant seeds in the seed bank would continue through TY3. Thus, control of exotic plants and monitoring of each restoration site would be repeated in TY2 and TY3. The following success criterion is required for EXOT at TY3:

- less than 5 percent cover of exotic shrubs or trees, as quantified using a GPS; each individual or patch of exotic trees would be quantified or delineated, respectively, and total area of exotics would be divided by total area of the restoration site to determine percent cover

If greater than 5 percent cover of exotic shrubs or trees is reported, an additional year of exotic control, monitoring, and reporting would be required. Herbicide application would continue until the success criterion is met.

It is assumed that all exotic shrubs and trees, including any shrubs or trees below the 5 percent success threshold, would be controlled at the end of TY3; however, each restoration site would be monitored at TY15 and TY25 to ensure that any new establishment of exotic species is controlled. The same monitoring, reporting, and management measures implemented during

the establishment period would be implemented during subsequent monitoring and maintenance.

WET

WET would be implemented such that construction activities and planting of native vegetation is completed by the end of TY1. The following information would be reported at the end of TY1 for each wetland restoration site (Sessoms Creek and Cheatham Street):

- qualitative description of restoration site with photographs
- number and list of native species planted
- qualitative and quantitative description of any temporary BMPs installed

Each wetland restoration site would be monitored at the end of TY2 and TY3, and the following information would be reported:

- qualitative description of restoration site with photographs
- percent cover of aquatic plants by species, as quantified using five 1-square-meter quadrats located randomly along the edge of each separate wetland area (i.e., one area at Cheatham Street site and three separate areas/wetponds on Sessoms Creek site)
- water depth, as measured at the deepest point using a graduated rod
- qualitative and quantitative description of any evidence of erosion occurring within or downstream of the restoration site

It is assumed that the wetlands would be established at the end of TY3, and the following success criteria are required:

- at least 55 percent cover of aquatic plants
- water present at a depth of at least 1 foot
- percent cover of exotic plants is less than 5 percent
- percent cover of native invasive plants (e.g., cattails) is less than 5 percent
- no evidence of uncontrolled erosion occurring within or downstream of the restoration site

If these criteria are not met at TY3, an assessment of the wetlands functionality would be conducted. If beneficial, additional plantings would be made selecting those species that are successful at the site. It may be determined either that climatic conditions have prevented success criteria from being met, or that some aspect of the wetland design is not functioning as intended. If climatic conditions are determined to be the issue, then the wetlands will continue to be monitored until conditions are observed during a normal climate year. If wetland design is determined to be the issue, potential solutions would be developed to remediate suspected design deficiencies. Coordination with resource agencies would be required prior to any modification of wetlands.

DISC

DISC would be implemented such that all improvements to topography, addition of natural, flow dampening materials, and plantings are completed by the end of TY1. The following information would be reported at the end of TY1 for each discharge restoration site:

- qualitative description of discharge restoration site with photographs
- location and total area of soil disturbance, as recorded using a GPS
- number and list of native species planted
- qualitative and quantitative description of any temporary BMPs implemented

Each discharge restoration site would be monitored at the end of TY2 and TY3, and the following information would be reported:

- qualitative description of restoration site with photographs
- percent cover of plants by species, as quantified using one randomly located line-intercept transect situated along one side of the drainage; each transect would cover the entire length of the discharge restoration site
- percent mortality of planted trees and shrubs, as quantified by enumerating live and dead specimens following a wandering transect within the restoration site
- no unintended accumulation of sediments or obstruction to flow
- qualitative and quantitative description of any evidence of erosion occurring within or downstream of the restoration site

It is assumed that all discharge locations would be established and self-sustaining at the end of TY3; however, the following success criteria are required:

- percent cover of plants greater than 80 percent
- percent mortality of planted shrubs and trees less than 20 percent
- percent cover of exotic woody plants is less than 1 percent
- percent cover of exotic herbaceous plants is less than 5 percent
- no evidence of unintended obstructions or uncontrolled erosion occurring within or downstream of the restoration site

If these success criteria are not met, an assessment of the drainage's functionality would be assessed. If beneficial, additional plantings or seeding would be implemented. If mortality of planted shrubs and trees is less than 20 percent, the plants would be replaced with species selected from those providing the greatest cover at the site. If there is evidence of unintended obstructions or uncontrolled erosion, the design of the drainage would be reviewed and any steps necessary to remediate the problems would be implemented. Potential remediation could include installation of additional temporary BMPs or more permanent measures such as the re-contouring or installing of additional plantings or natural materials to reduce flow velocity. Coordination with resource agencies would be required prior to any modification of discharges.

SED

SED would be implemented such that no more than 10 percent of the river channel would be affected in any year. At TY0, a survey of the river channel would be conducted to identify areas of accumulation. Areas of accumulation would be identified as patches of fine sediment greater than 50 square feet in area and greater than 2 inches in depth. Accumulated sediments would be removed from discrete locations to be identified as substrate restoration sites. The results of the initial survey would be reported to CESWF and resource agencies, and the list of restoration sites would be prioritized. This survey for accumulation and the consultation with resource agencies would be repeated for each monitoring year. The following information would be reported for each substrate restoration site for any TY during which sediment removal occurs:

- qualitative description of each restoration site with photographs
- location, area, depth, and volume of sediments removed, as quantified using a GPS

- area, number, list, and qualitative description of native species impacted (trampling, incidental removal, etc.)
- qualitative and quantitative description of any BMPs implemented

It is assumed that measures to control the input of sediments (RIP2, DISC, and WET) would reduce sediment accumulation after TY3. There are no success criteria for SED. Monitoring, reporting, and sediment removal would occur at 5-year intervals. If there is not sufficient accumulation of sediments to warrant removal, no removal would occur.

APPENDIX J
AIR QUALITY ANALYSIS

CALCULATION SHEET-COMBUSTION EMISSIONS-CONSTRUCTION

Assumptions for Combustion Emissions					
Type of Construction Equipment	Num. of Units	HP Rated	Hrs/day	Days/yr	Total hp-hrs
Water Truck	1	300	8	130	312,000
Diesel Road Compactors	0	100	8	15	-
Diesel Dump Truck	1	300	8	15	36,000
Diesel Excavator	0	300	8	15	-
Diesel Hole Trenchers	0	175	8	60	-
Diesel Bore/Drill Rigs	0	300	8	60	-
Diesel Cement & Mortar Mixers	0	300	8	60	-
Diesel Cranes	0	175	8	130	-
Diesel Graders	0	300	8	15	-
Diesel Tractors/Loaders/Backhoes	3	100	8	90	216,000
Diesel Bulldozers	1	300	8	15	36,000
Diesel Front-End Loaders	1	300	8	30	72,000
Diesel Forklifts	2	100	8	130	208,000
Diesel Generator Set	2	40	8	130	83,200

Emission Factors[1]							
Type of Construction Equipment	VOC g/hp-hr	CO g/hp-hr	NOx g/hp-hr	PM-10 g/hp-hr	PM-2.5 g/hp-hr	SO2 g/hp-hr	CO2 g/hp-hr
Water Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Road Compactors	0.370	1.480	4.900	0.340	0.330	0.740	536.200
Diesel Dump Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Excavator	0.340	1.300	4.600	0.320	0.310	0.740	536.300
Diesel Trenchers	0.510	2.440	5.810	0.460	0.440	0.740	535.800
Diesel Bore/Drill Rigs	0.600	2.290	7.150	0.500	0.490	0.730	529.700
Diesel Cement & Mortar Mixers	0.610	2.320	7.280	0.480	0.470	0.730	529.700
Diesel Cranes	0.440	1.300	5.720	0.340	0.330	0.730	530.200
Diesel Graders	0.350	1.360	4.730	0.330	0.320	0.740	536.300
Diesel Tractors/Loaders/Backhoes	1.850	8.210	7.220	1.370	1.330	0.950	691.100
Diesel Bulldozers	0.360	1.380	4.760	0.330	0.320	0.740	536.300
Diesel Front-end Loaders	0.380	1.550	5.000	0.350	0.340	0.740	536.200
Diesel Forklifts	1.980	7.760	8.560	1.390	1.350	0.950	690.800
Diesel Generator Set	1.210	3.760	5.970	0.730	0.710	0.810	587.300

CALCULATION SHEET-COMBUSTION EMISSIONS-CONSTRUCTION

1. Emission factors (EF) were generated using USEPA's preferred model for nonroad sources, the NONROAD2008 model. Emmisions were modeled for the 2007 calendar year. The VOC EFs include exhaust and evaporative emissions. The VOC evaporative components included in the NONROAD2008 model are diurnal, hotsoak, running loss, tank permeation, hose permeation, displacement, and spillage. The construction equipment age distribution in the NONROAD2008 model is based on the population in U.S. for the 2007 calendar year.

Emission Calculations							
Type of Construction Equipment	VOC tons/yr	CO tons/yr	NOx tons/yr	PM-10 tons/yr	PM-2.5 tons/yr	SO_2 tons/yr	CO_2 tons/yr
Water Truck	0.151	0.712	1.888	0.141	0.138	0.254	184.290
Diesel Road Paver	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Dump Truck	0.017	0.082	0.218	0.016	0.016	0.029	21.264
Diesel Excavator	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Hole Cleaners\Trenchers	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Bore/Drill Rigs	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Cement & Mortar Mixers	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Cranes	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Graders	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Tractors/Loaders/Backhoes	0.440	1.954	1.719	0.326	0.317	0.226	164.504
Diesel Bulldozers	0.014	0.055	0.189	0.013	0.013	0.029	21.276
Diesel Front-end Loaders	0.030	0.123	0.397	0.028	0.027	0.059	42.544
Diesel Forklift	0.454	1.779	1.962	0.319	0.309	0.218	158.342
Diesel Generator Set	0.111	0.345	0.547	0.067	0.065	0.074	53.847
Total Emissions	**1.218**	**5.049**	**6.919**	**0.910**	**0.884**	**0.890**	**646.068**

Conversion factors	
Grams to tons	1.102E-06

MOVES2010a MODEL ON-ROAD TRANSPORTATION AIR EMISSIONS-
DELIVERY MATERIALS AND COMMUTING DURING CONSTRUCTION ACTIVITIES

MOVES 2010a					
Source	**Fuel type**	**Number of vehicles**	**Miles traveled per day**	**Days of travel per year**	**Miles traveled per year**
Passenger cars	Gasoline	10	20	260	52,000
Passenger truck	Gasoline	10	20	260	52,000
Light commercial truck	Diesel	2	20	260	10,400
Short-haul truck	Diesel	4	120	260	124,800
Long-haul truck	Diesel	1	80	260	20,800

Emission Factors (MOVES 2010a Emission Rates)[1]							
Source	**VOC (g/mile)**	**CO (g/mile)**	**NOx (g/mile)**	**PM-10 (g/mile)**	**PM-2.5 (g/mile)**	**SO_2 (g/mile)**	**CO_2 and CO_2 Equivalents (g/mile)**
Passenger cars	8.497	2.892	0.576	0.019	0.018	0.005	320
Passenger truck	3.645	5.449	1.168	0.027	0.025	0.007	439
Light commercial truck	4.460	2.158	2.986	0.164	0.190	0.005	609
Short-haul truck	2.438	2.273	6.095	0.270	0.313	0.007	929
Long-haul truck	2.519	3.610	14.776	0.625	0.726	0.016	2,020

Total Emission for On-Road Construction Activities (tons/year)							
Source	**VOC**	**CO**	**NOx**	**PM-10**	**PM-2.5**	**SO_2**	**CO_2 and CO_2 Equivalents**
Passenger cars	0.487	0.166	0.033	0.001	0.001	0.000	18
Passenger truck	0.209	0.312	0.067	0.002	0.001	0.000	25
Light commercial truck	0.051	0.025	0.034	0.002	0.002	0.000	7
Short-haul truck	0.335	0.313	0.838	0.037	0.043	0.001	128
Long-haul truck	0.058	0.083	0.339	0.014	0.017	0.000	46
Total	**1.140**	**0.898**	**1.311**	**0.056**	**0.064**	**0.002**	**225**

Key:

Short-haul trucks category includes trucks such as dump trucks and cement trucks.
Long-haul trucks category includes trucks such as semi-trailers (18-wheelers).

1. Emission factors were generated by the USEPA preferred model MOVES2010a. MOVES simulates daily motor vehicle operations and produces emission rates. MOVES emission rates include sources from engine combustion, tire wear, brake wear, evaporative fuel permiation, vapor venting and leaking (running and parking), and crankcase loss. Emission rates are daily averages for each of the criteria pollutants. The averages are from a combination of vehicle operations such as stop and go, highway travel, acceleration at on-ramps, parking, start-up, extended idle, etc.

CALCULATION SHEET-FUGITIVE DUST-CONSTRUCTION

Assumptions for Combustion Emissions

Construction Fugitive Dust Emission Factors

	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM-10/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM-10/acre-month	MRI 1996; EPA 2001; EPA 2006

PM-2.5 Emissions

PM-2.5 Multiplier	0.10	(10% of PM-10 emissions assumed to be PM-2.5)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM-10 and PM-2.5 emissions)	EPA 2001; EPA 2006

Project Assumptions

Construction Area (0.19 ton PM-10/acre-month)

Duration of Soil Disturbance in Projec	12	months
Length	0	miles
Length (converted)	0	feet
Width	0	feet
Area	30.00	acres

Conversion Factors

0.000022957	acres per feet
5280	feet per mile

Staging Areas

Duration of Construction Project	12	months
Length		miles
Length (converted)		feet
Width		feet
Area	2.00	acres

Project Emissions (tons/year)

	PM-10 uncontrolled	PM-10 controlled	PM-2.5 uncontrolled	PM-2.5 controlled
Construction Area (0.19 ton PM-10/a	68.40	34.20	6.84	3.42
Staging Areas	0.38	0.19	0.04	0.02
Total	**68.78**	**34.39**	**6.88**	**3.44**

References:

USEPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

USEPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Assumptions for Fugitive Emissions

General Construction Activities Emission Factor

0.19 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM-10/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM-10/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions from Construction Operations, calculated the 0.19 ton PM-10/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM-10/acre-month) and 75% of the average emission factor (0.11 ton PM-10/acre-month).

The 0.19 ton PM-10/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM-10/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particle (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District and the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM-10 and PM-2.5 in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM-10/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM-10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

PM-2.5 Multiplier **0.10**

PM-2.5 emissions are estimated by applying a particle size multiplier of 0.10 to PM-10 emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM-10 and PM-2.5 **0.50**

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM-10 and PM-2.5 in PM nonattainment areas. Wetting controls will be applied during project construction (EPA 2006).

References:

EPA 2001. *Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999.* EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. *Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants.* Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. *Improvement of Specific Emission Factors (BACM Project No. 1).* Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

CALCULATION SHEET-SUMMARY OF EMISSIONS

Summary of Emissions (tons/year)									
Emission Source	VOC	CO	NOx	PM-10	PM-2.5	SO_2	CO_2	CO_2 Equivalents	Total CO_2
Combustion Emissions	1.22	5.05	6.92	0.91	0.88	0.89	646.07	2,182	2,828
Construction Site-Fugitive PM-10	NA	NA	NA	34.39	3.44	NA	NA	NA	NA
Construction Workers Commuter & Trucking	1.14	0.90	1.31	0.06	0.06	0.00	NA	225	225
Total Emissions-CONSTRUCTION	**2.36**	**5.95**	**8.23**	**35.36**	**4.39**	**0.89**	**646**	**2,407**	**3,053**
De minimis Threshold (1)	100	100	100	100	100	100	NA	NA	25,000

1. Note that San Marcos county is in attainment for all NAAQs (USEPA 2013b).

Carbon Equivalents	Conversion Factor
N_2O or NOx	311
Methane or VOCs	25

Source: EPA 2010 Reference, Tables and Conversions, Inventory of U.S. Greenhouse Gas Emissions and Sinks; http://www.epa.gov/climatechange/emissions/usinventoryreport.html