US Army Corps of Engineers
Fort Worth District

Detailed Project Report and Integrated Environmental Assessment

San Marcos River Section 206 Aquatic Ecosystem Restoration Project

February 2014

U.S. Army Corps of Engineers
Fort Worth District

DETAILED PROJECT REPORT AND INTEGRATED ENVIRONMENTAL ASSESSMENT

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

February 2014

DRAFT

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.

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Charles H. Klinge, Jr. Colonel, US 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.

Study Area and San Marcos River Ecosystem

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. The upper boundary of the study area is Spring Lake Dam, and the lower boundary is the confluence with the Blanco River, approximately 4 river miles from Spring Lake Dam. Above Interstate Highway (IH) 35, the level of surrounding urbanization, cover of submerged vegetation, and level of recreational use are significantly higher when compared to the section downstream of IH 35. The upstream section runs through City Park, Bicentennial Park, Children’s Park-Playscape Park, Rio Vista Park, and Lucio Park. In the downstream segment, the river is much less urbanized and runs primarily through forest and agricultural lands, passing a water treatment plant, a fish hatchery, and a park.

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.

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. 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

Partnerships with regional organizations and agencies provide an opportunity to implement restoration measures with a reasonable assumption of effectiveness. Regional partners have developed successful methods to control elephant ear (*Colocasia esculenta*) and remove channel bottom sediments, and have established facilities to propagate large numbers of native plants from local stock. Texas State University currently controls elephant ear and other exotic plants on Spring Lake, which is the primary upstream source of propagules. Furthermore, anecdotal data suggest that education has resulted in control of elephant ear on private land in the study area. A large portion of the riparian corridor is owned by the City of San Marcos, which provides the opportunity to reduce the impacts of urbanization by expanding the riparian corridor, providing connectivity with previous upstream restoration efforts, and improving discharge locations.

Development of Restoration Measures

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.

National Ecosystem Restoration (NER) Plan Selection

The suitability of riparian and aquatic habitats were quantified using Habitat Evaluation Procedures (HEP). Habitat suitability was evaluated for all existing and future habitats potentially included in the project, including riparian forest, riverine, and wetland habitats. Seven Habitat Suitability Index models were used in HEP (downy woodpecker [*Picoides pubescens*], belted kingfisher [*Megaceryle alcyon*], channel catfish [*Ictalurus punctatus*], bluegill [*Lepomis macrochirus*], smallmouth bass [*Micropterus dolomieu*], American coot [*Fulica americana*], and slider turtle [*Pseudemys scripta*]). Baseline data were collected in the field or gleaned from previous studies. As evaluated, the aquatic ecosystem would provide approximately 15 average annual habitat units (AAHUs) of riparian forest habitats and approximately 15 AAHUs of aquatic habitats over the 50-year planning period under the future without project (FWOP) conditions.

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.

Best-buy Plan 8, which consists of measures to control aquatic and riparian exotic plants, measures to restore riparian habitats on managed lands and at discharge locations, measures to restore wetlands, and measures to remove accumulations of sediments, is justified as the NER plan based upon consideration of HEP and non-quantifiable ecosystem benefits. Non-quantifiable ecosystem benefits would include benefits to listed species including Texas wild-rice (*Zizania* *texana*), San Marcos gambusia (*Gambusia georgei*), fountain darter (*Etheostoma fonticola*), San Marcos salamander (*Eurycea nana),* and their designated critical habitat, as well as the candidate species golden orb (Quadrula aura) and Texas pimpleback (Quadrula petrina), as well as quantitatively small benefits to water quality that would benefit native species but are not captured by the HEP models. Best-buy Plan 8 also 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 study area. Best-buy Plan 8 has been selected as the Proposed NER Plan.

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.

Environmental Effects

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 best management practices (BMPs) during the project construction. Consistency of all Proposed NER Plan activities with a Texas Pollutant Discharge Elimination System General Permit will be certified by 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 area and quality of wetlands in the study area.

The flora and fauna of the San Marcos River, including listed species, would be temporarily affected by restoration activities that disturb soils and river substrates. Adverse effects on these species would be minimized through standard BMPs, as well as conservation measures and reasonably prudent measures, through formal consultation with the USFWS. These measures include planting of disturbed areas with native macrophytes and sweeping of fountain darters prior to disturbance of stream bed or aquatic vegetation.

Recreational, scenic, and aesthetic resources would benefit from implementation of the Proposed NER Plan. Although no recreational features are included with the project, restoration of the ecosystem would provide a sustainable environment for recreation into the foreseeable future. Scenic and aesthetic resources would benefit from expansion of the riparian corridor.

There are numerous previously identified cultural resources in the study area; however, none would be directly or indirectly affected by the Proposed NER Plan. Section 106 consultation is complete for the feasibility phase of the study, but additional coordination and consultation with the Texas State Historic Preservation Officer will be completed prior to completion of project design to ensure that no significant historic or cultural resources would be directly or indirectly impacted by the project implementation.

Air and noise emissions resulting from the Proposed NER Plan would be temporary and minimal and would be minimized through use of BMPs. No known hazardous materials concerns were identified in the study area. All hazardous materials (e.g., fuels) used during implementation of the Proposed NER Plan would be handled following BMPs to avoid and remediate any spills.

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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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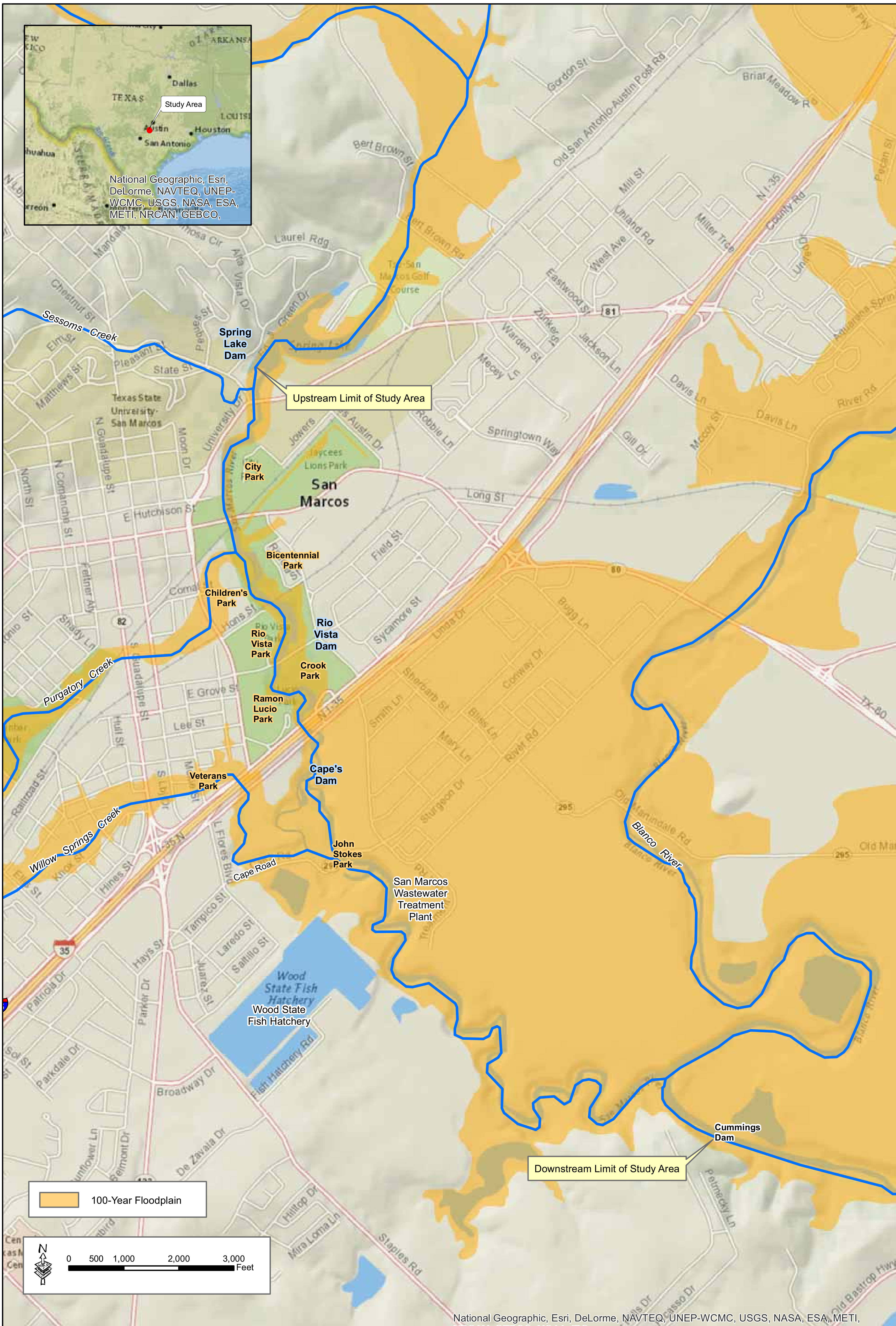

Figure 1-1. San Marcos River Study Area

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.

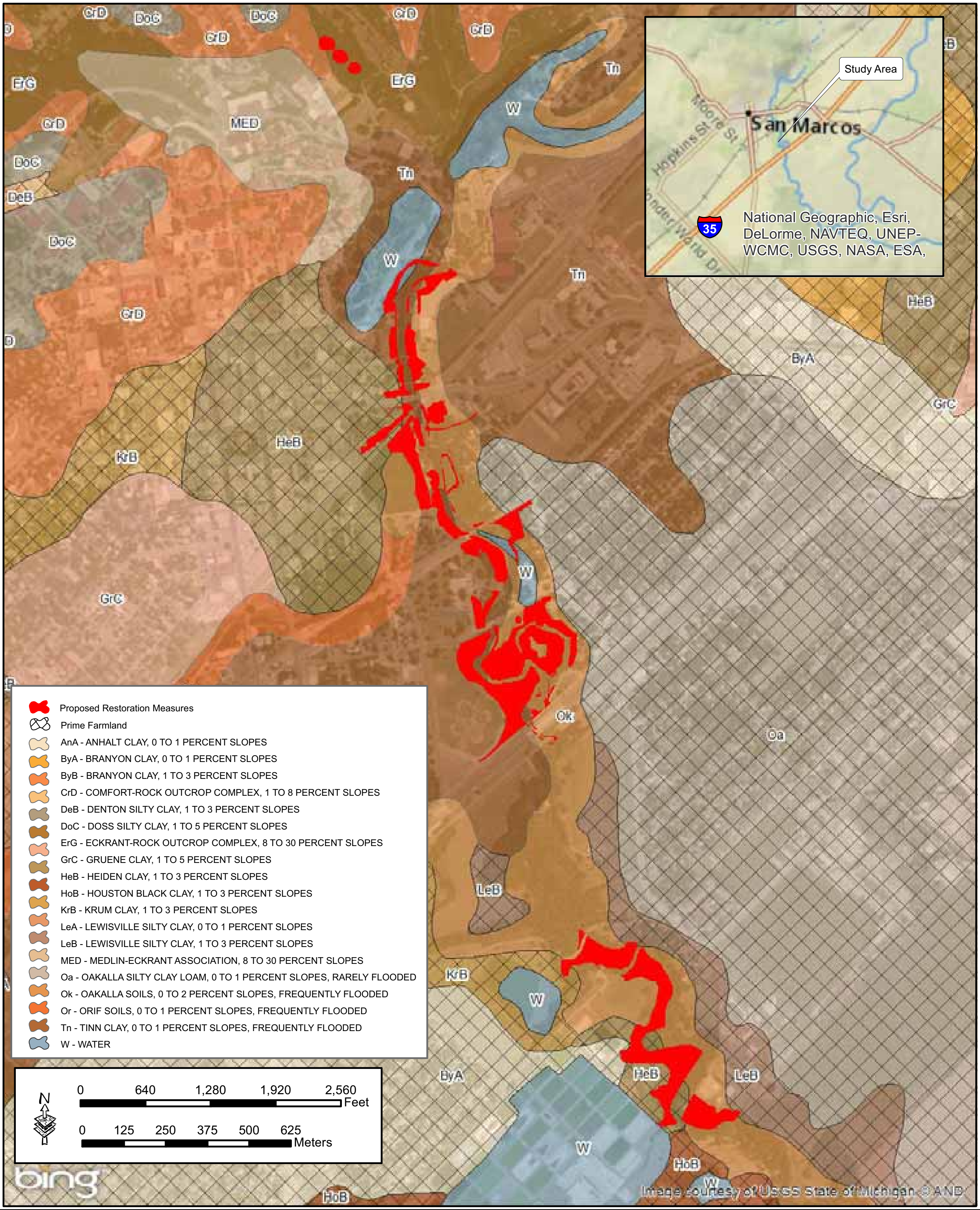

Figure 2-1. Soils in the San Marcos River Study Area

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

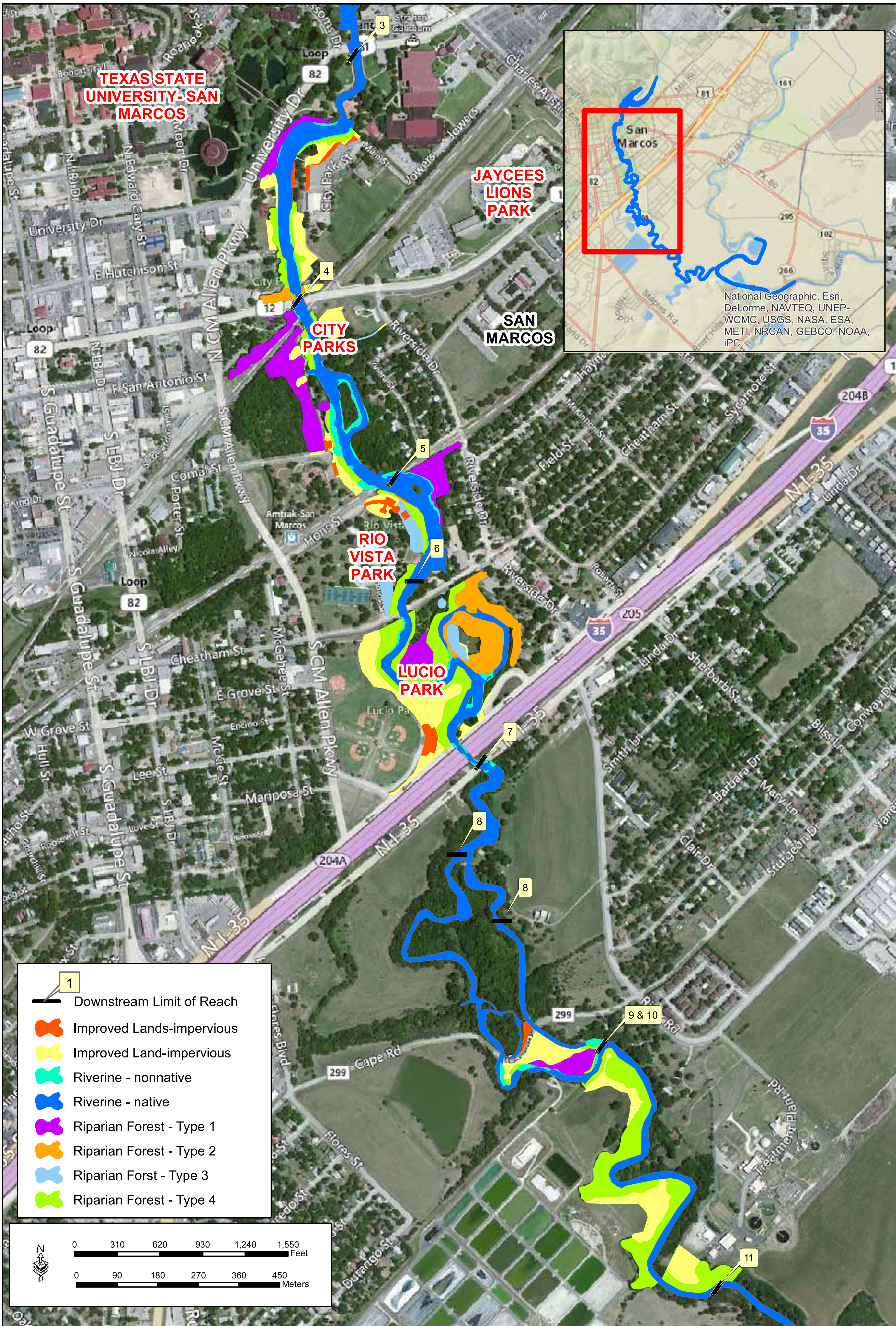

Figure 2-2. Existing Habitats in the San Marcos River Study Area

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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

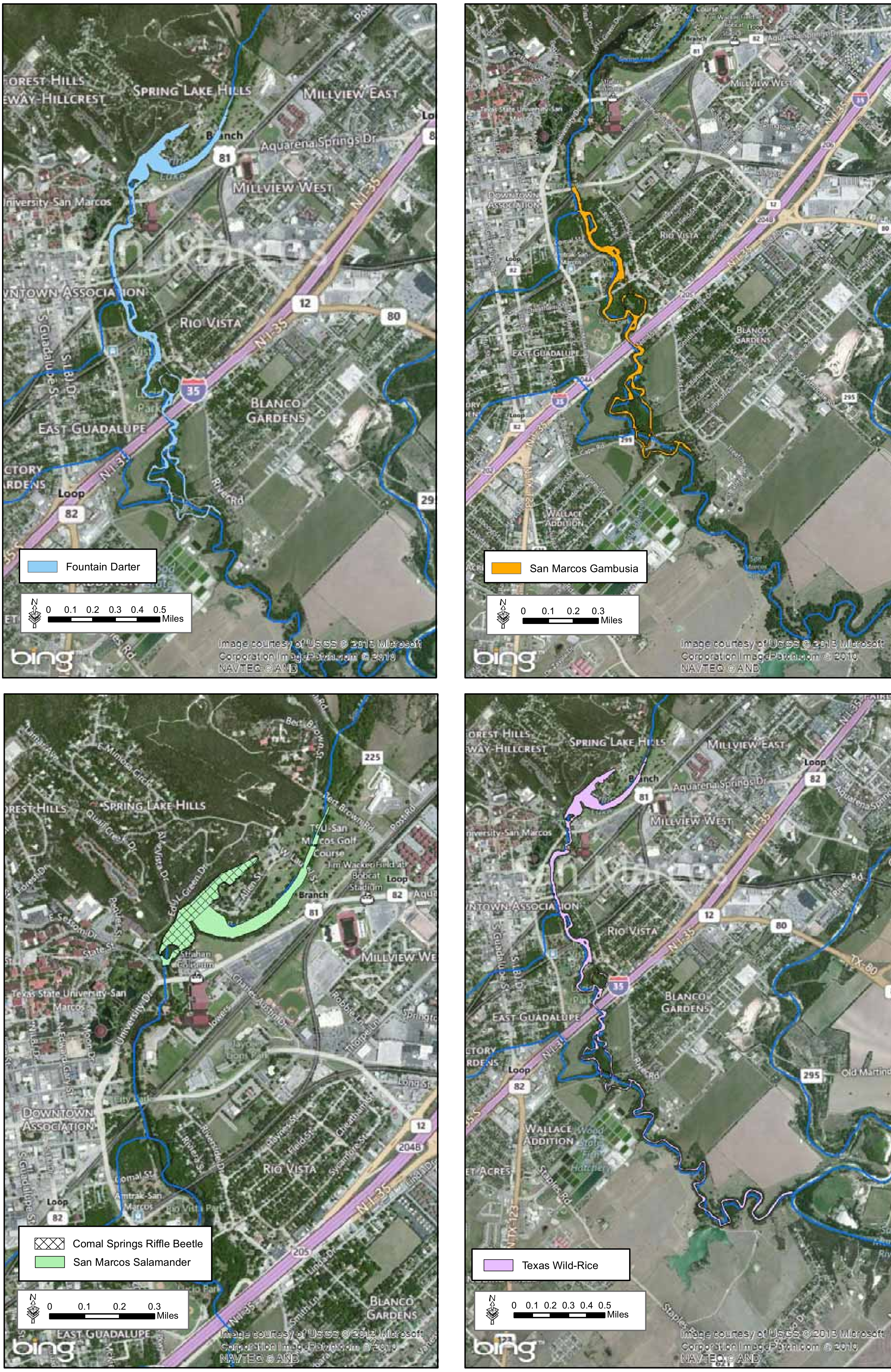

Figure 2-3. Critical Habitat for Species in San Marcos River Study Area

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May 2013

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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.

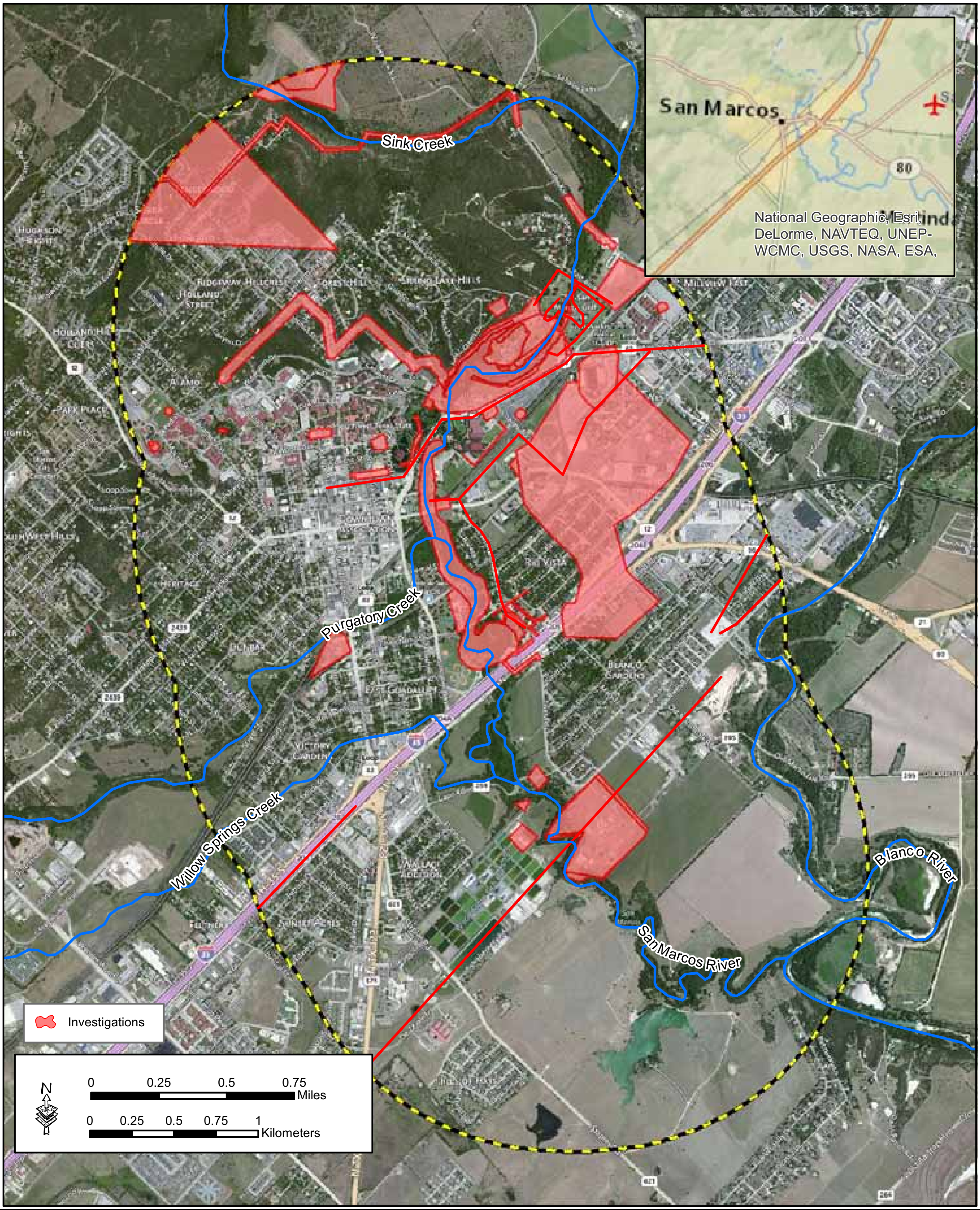

Figure 2-4. Previously Conducted Archaeological Investigations within a 1.6-kilometer (1.0-mile) Radius of the San Marcos River Study Area

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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 ≤ 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.

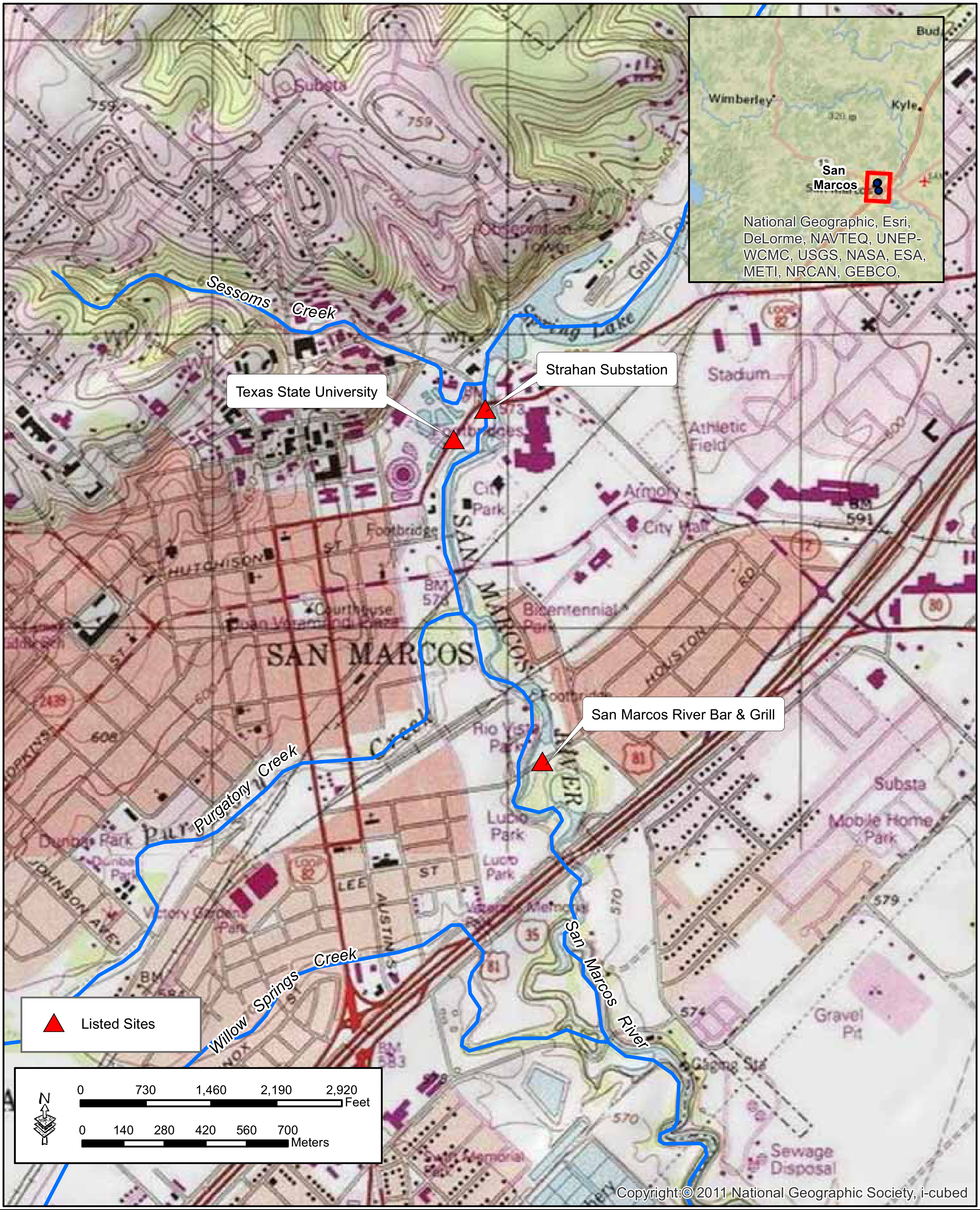

Figure 2-5. Hazardous, Toxic, Radioactive Waste Handlers near San Marcos River Study Area

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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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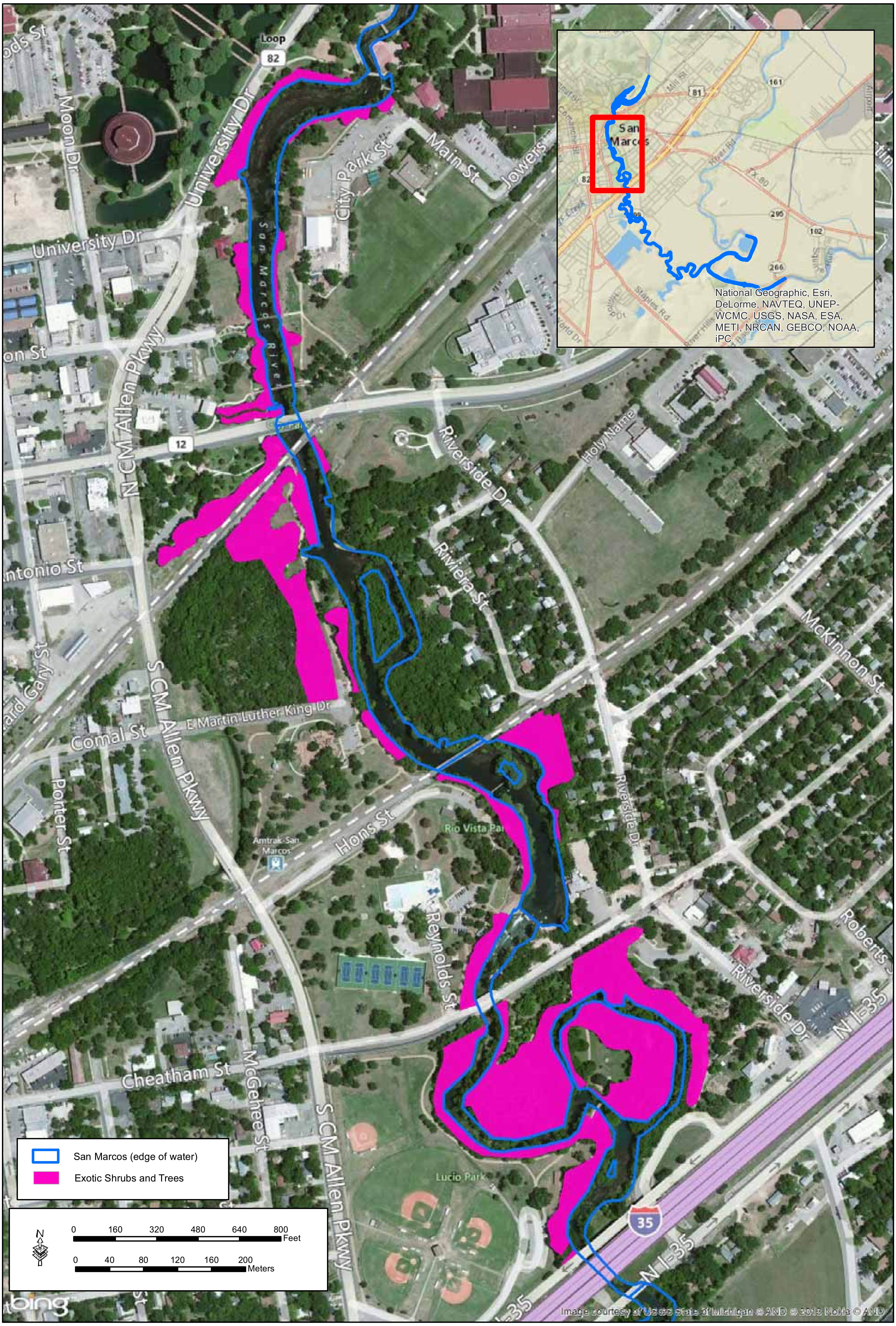

Figure 4-1a. Control of Exotic Shrubs and Trees (EXOT)

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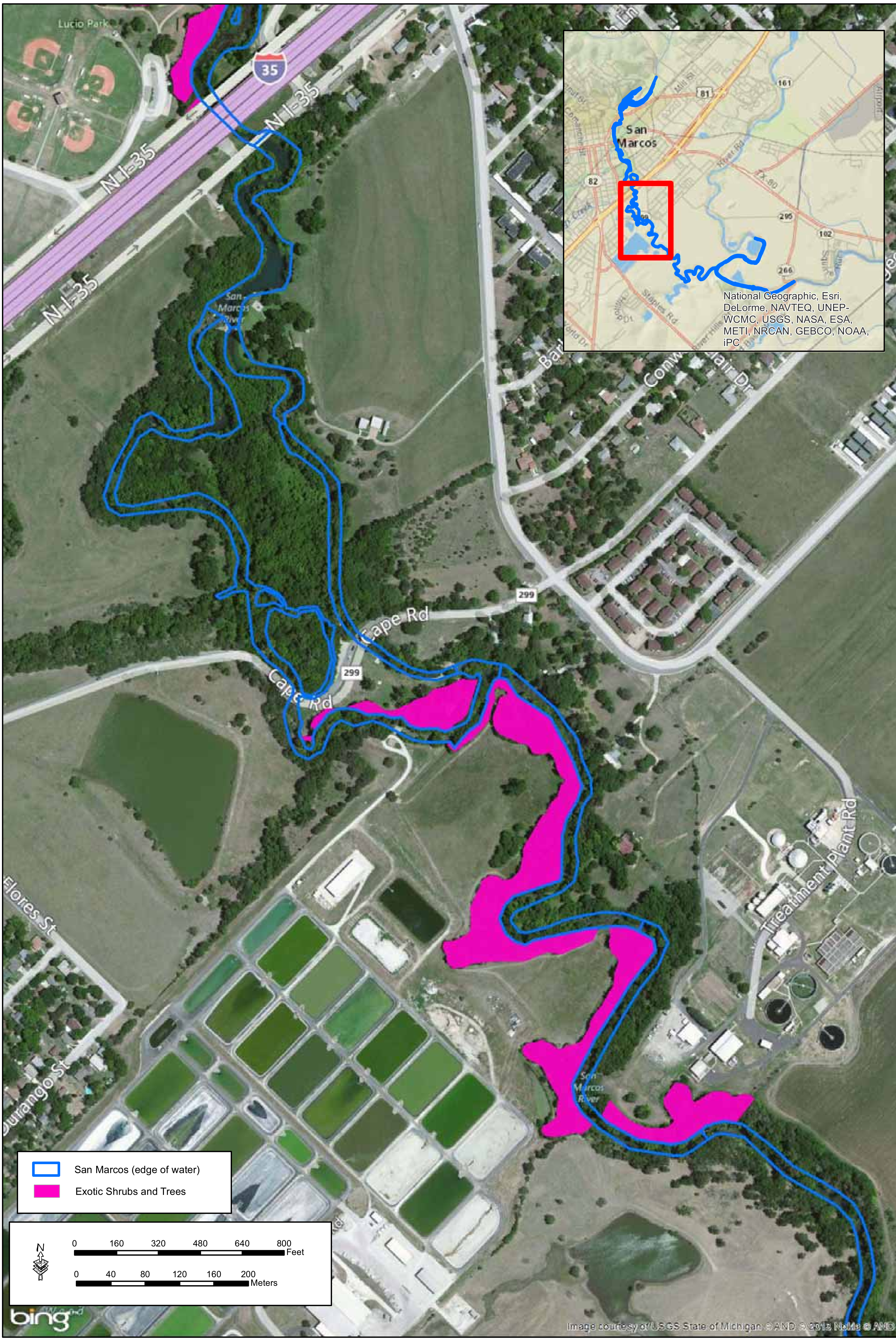

Figure 4-1b. Control of Exotic Shrubs and Trees (EXOT)

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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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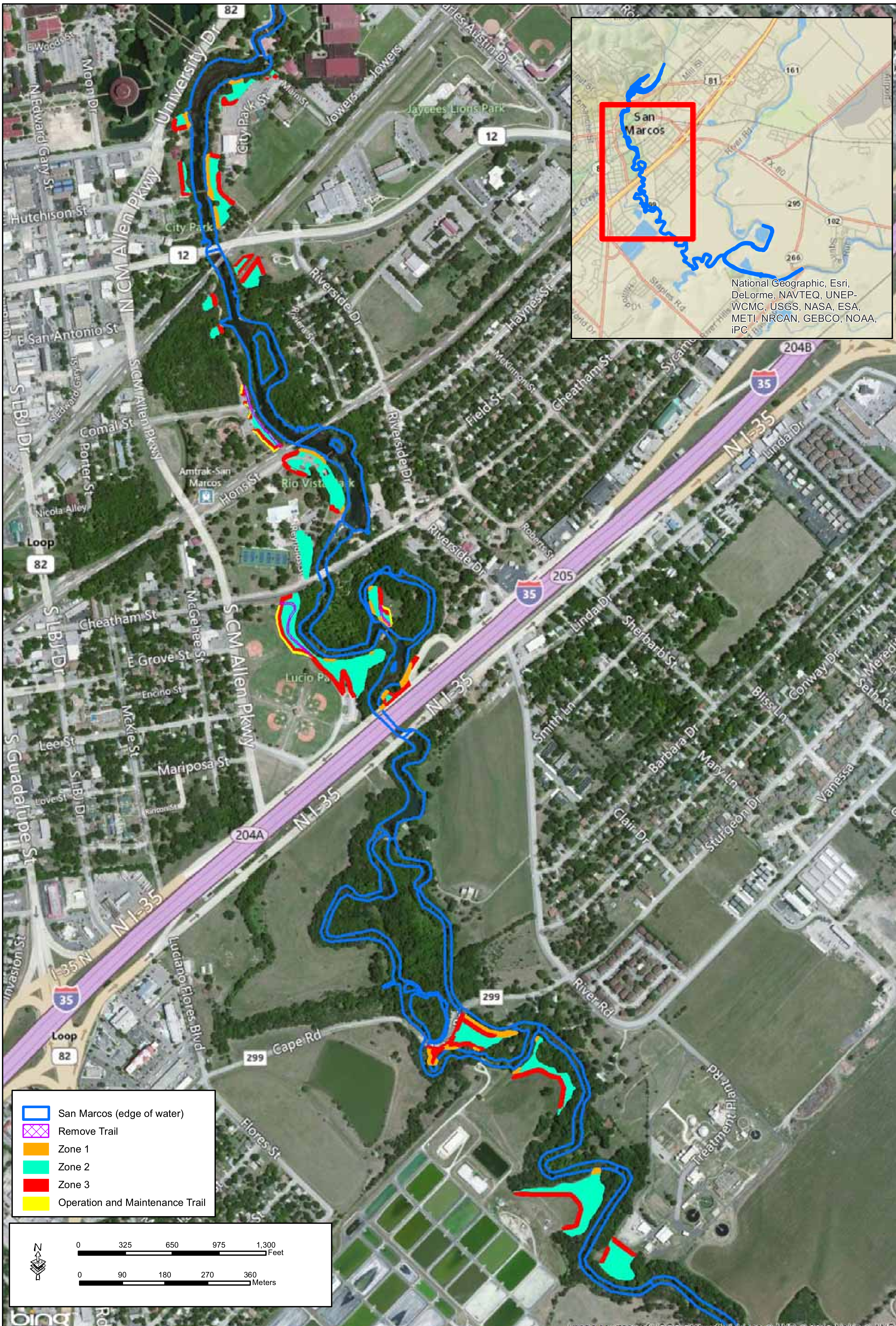

Figure 4-2a. Restore Riparian Corridor on Type 3 Forest and Pervious Improved Land (RIP1)

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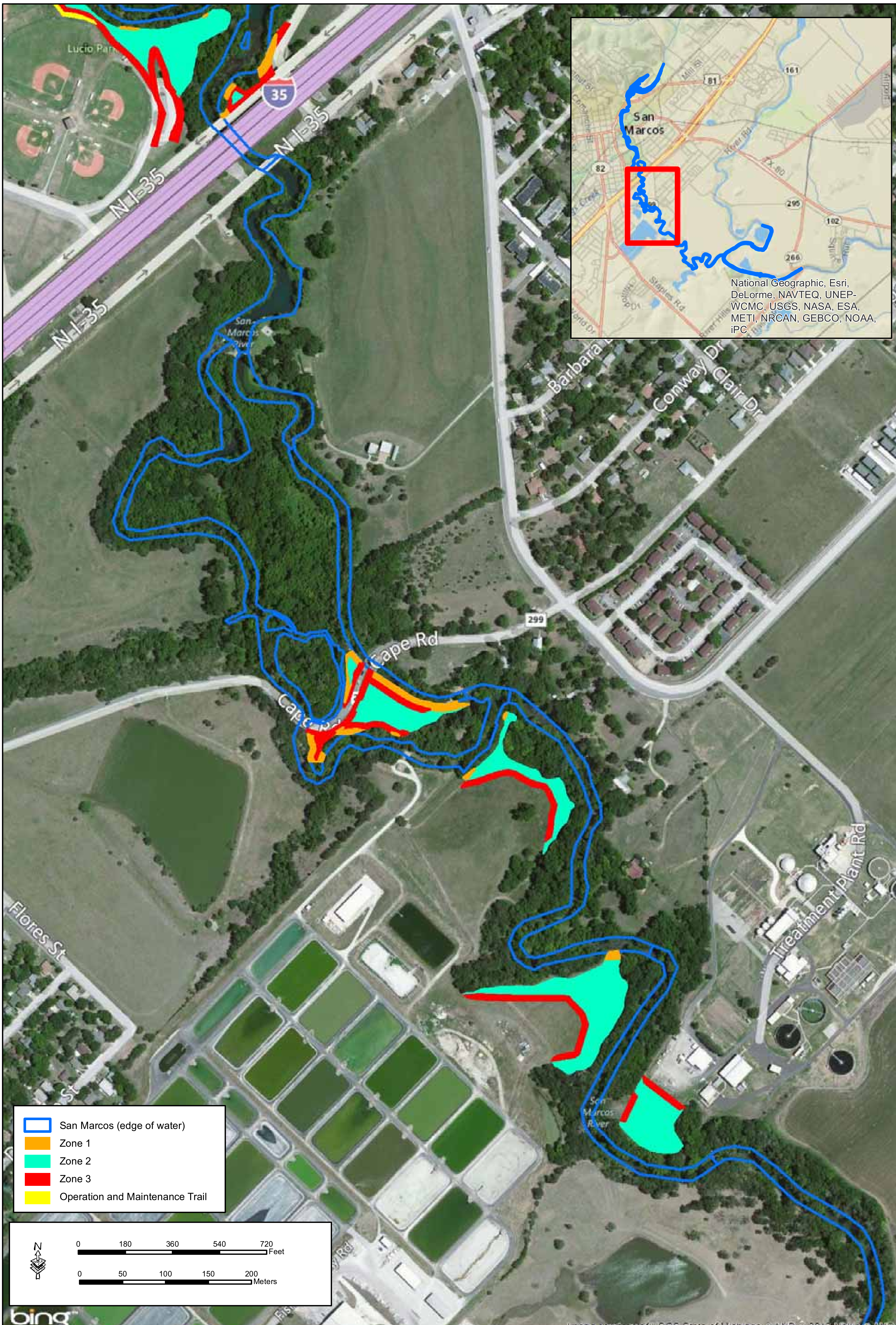

Figure 4-2b. Restore Riparian Corridor on Type 3 Forest and Pervious Improved Land (RIP1)

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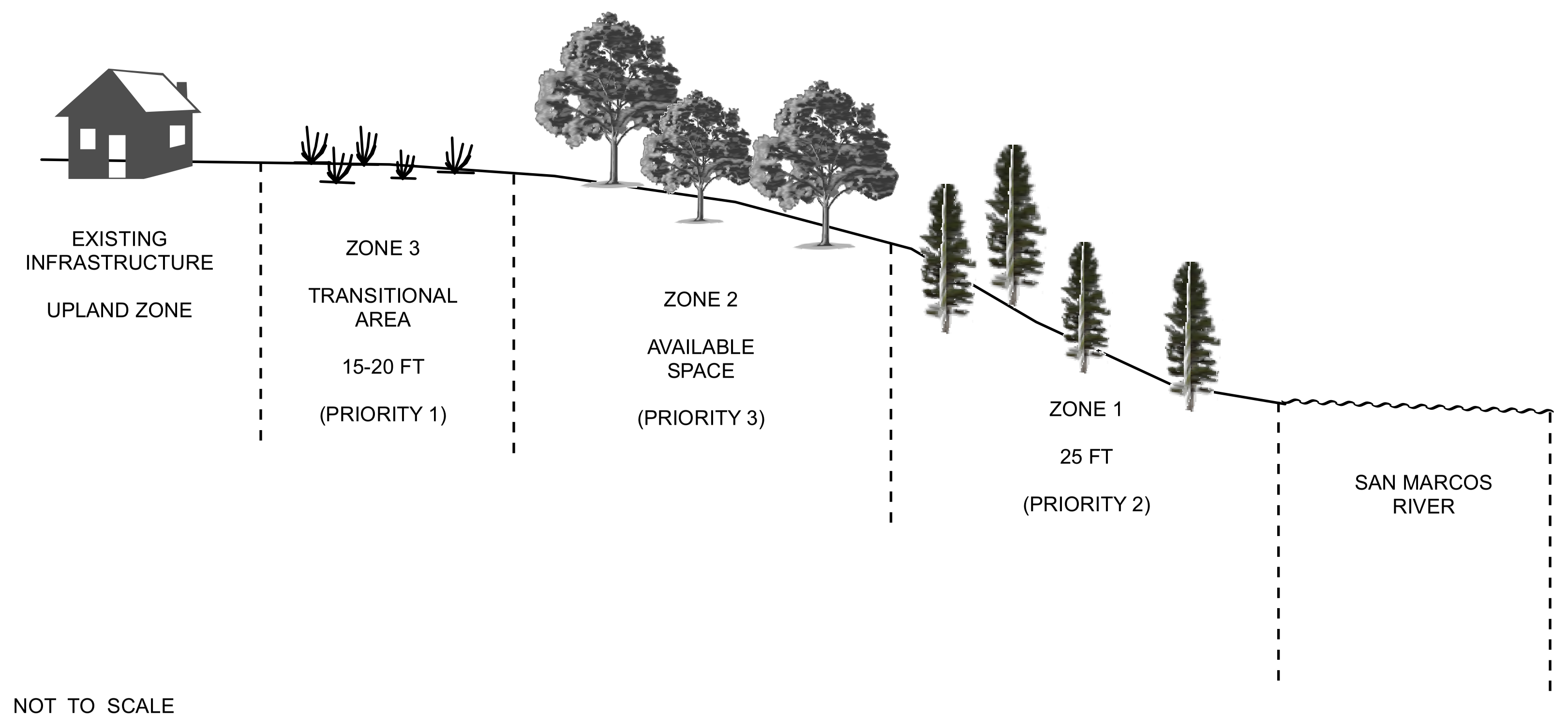

Figure 4-3. Conceptual Illustration of Native Planting Zone (RIP) Profile

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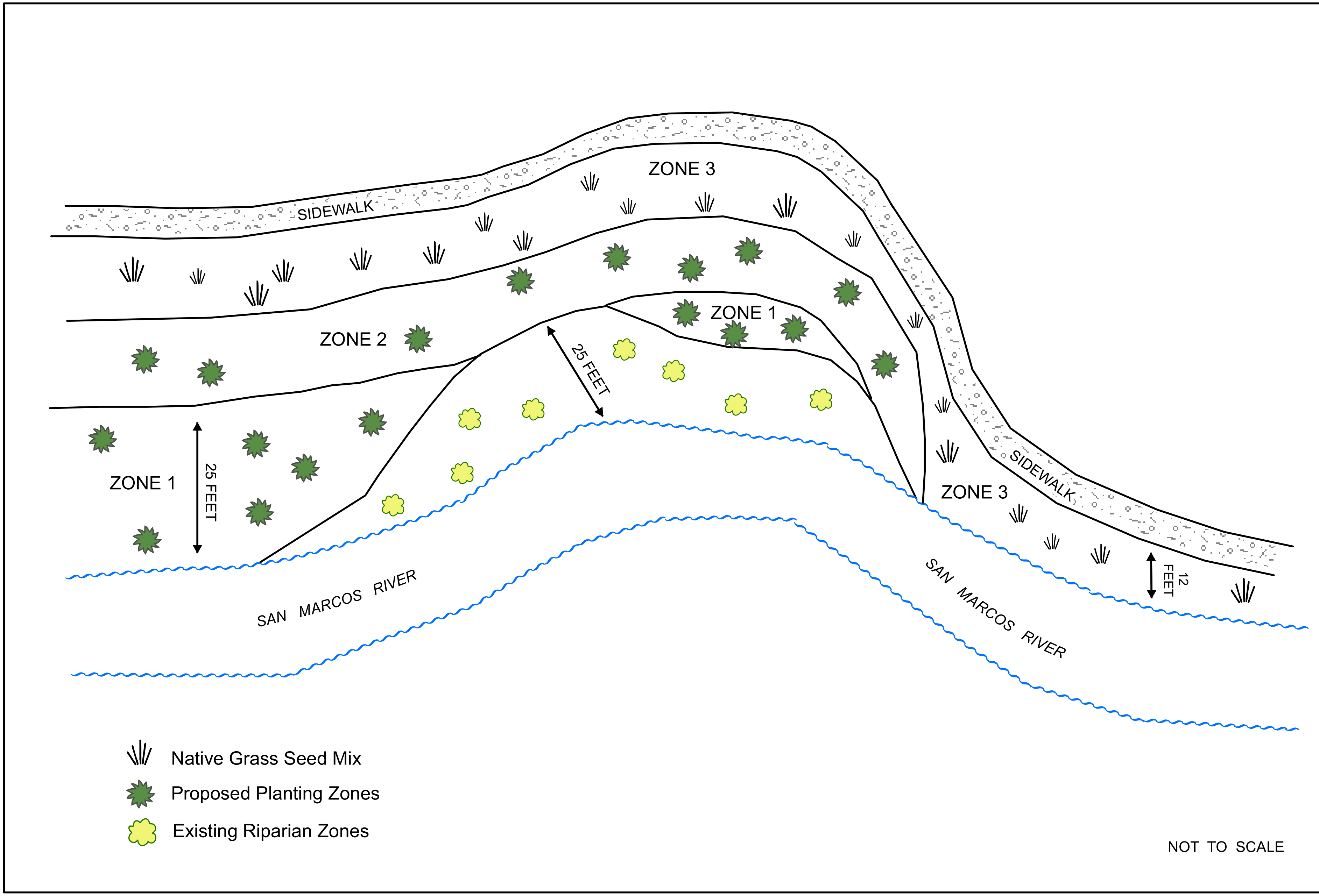

Figure 4-4. Conceptual Illustration of Native Planting Zones (RIP) Overview

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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

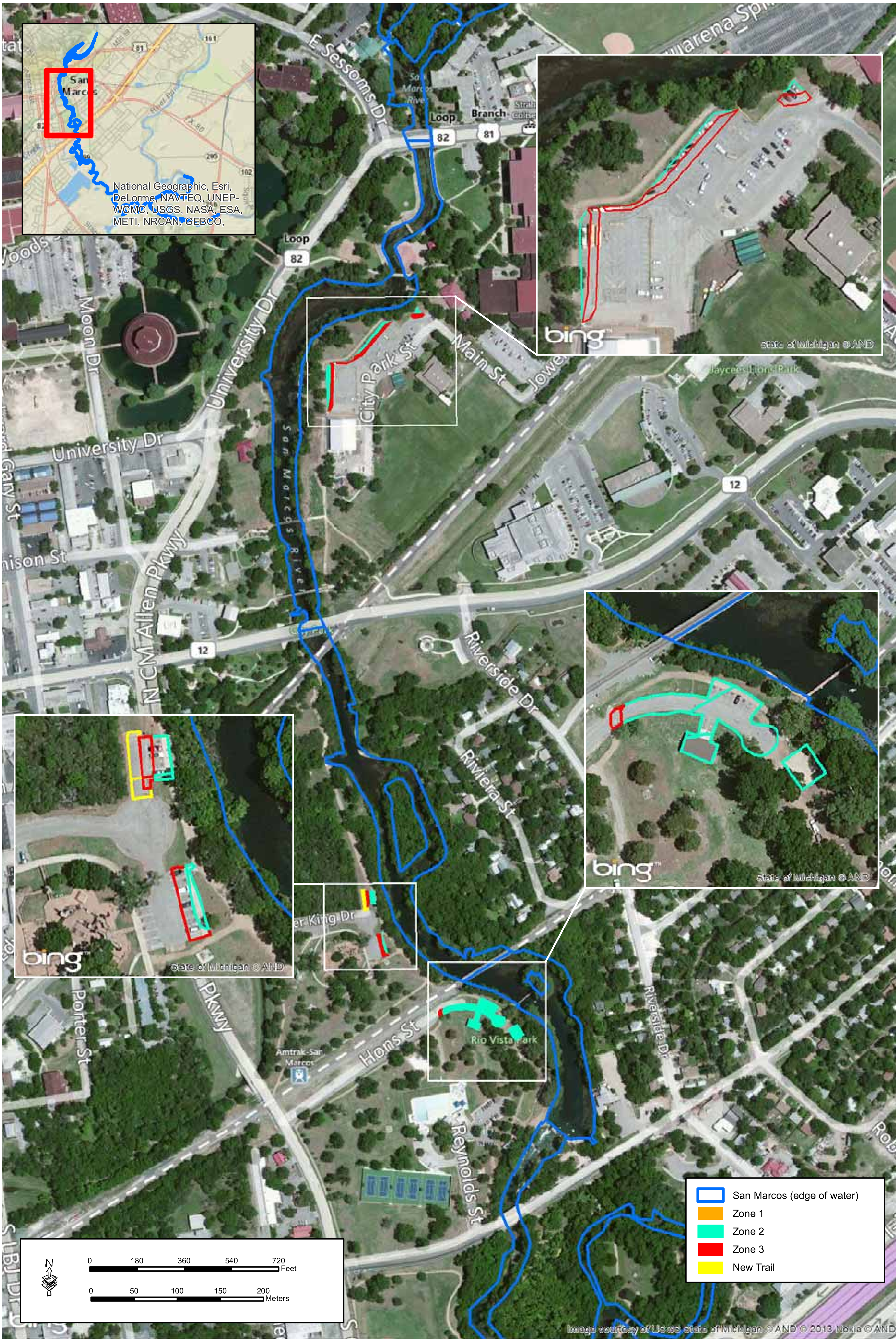

Figure 4-5a. Restore Riparian Corridor on Impervious Improved Lands (RIP2)

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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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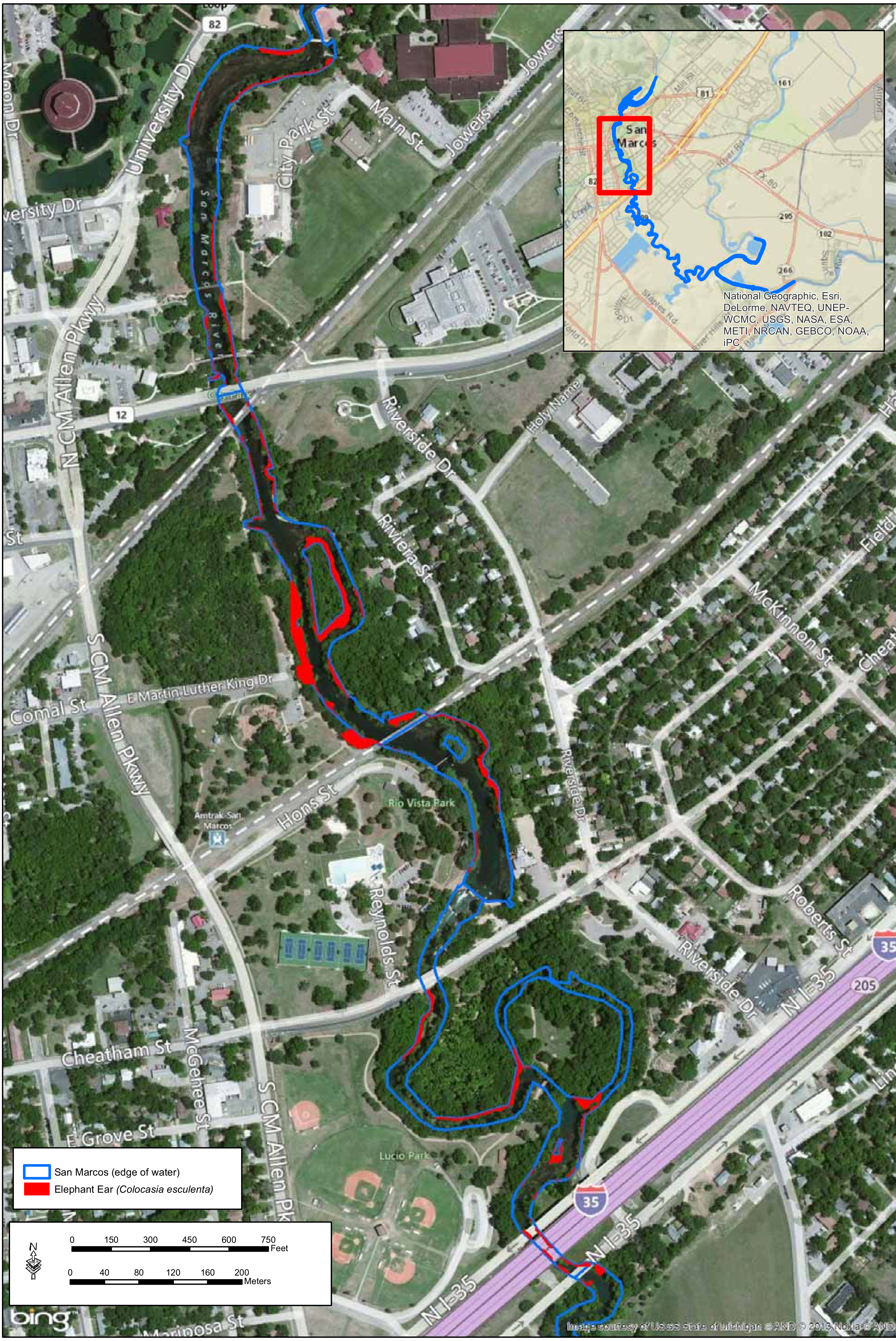

Figure 4-6a. Control of Exotic Aquatic Vegetation - Emergent (EXOA)

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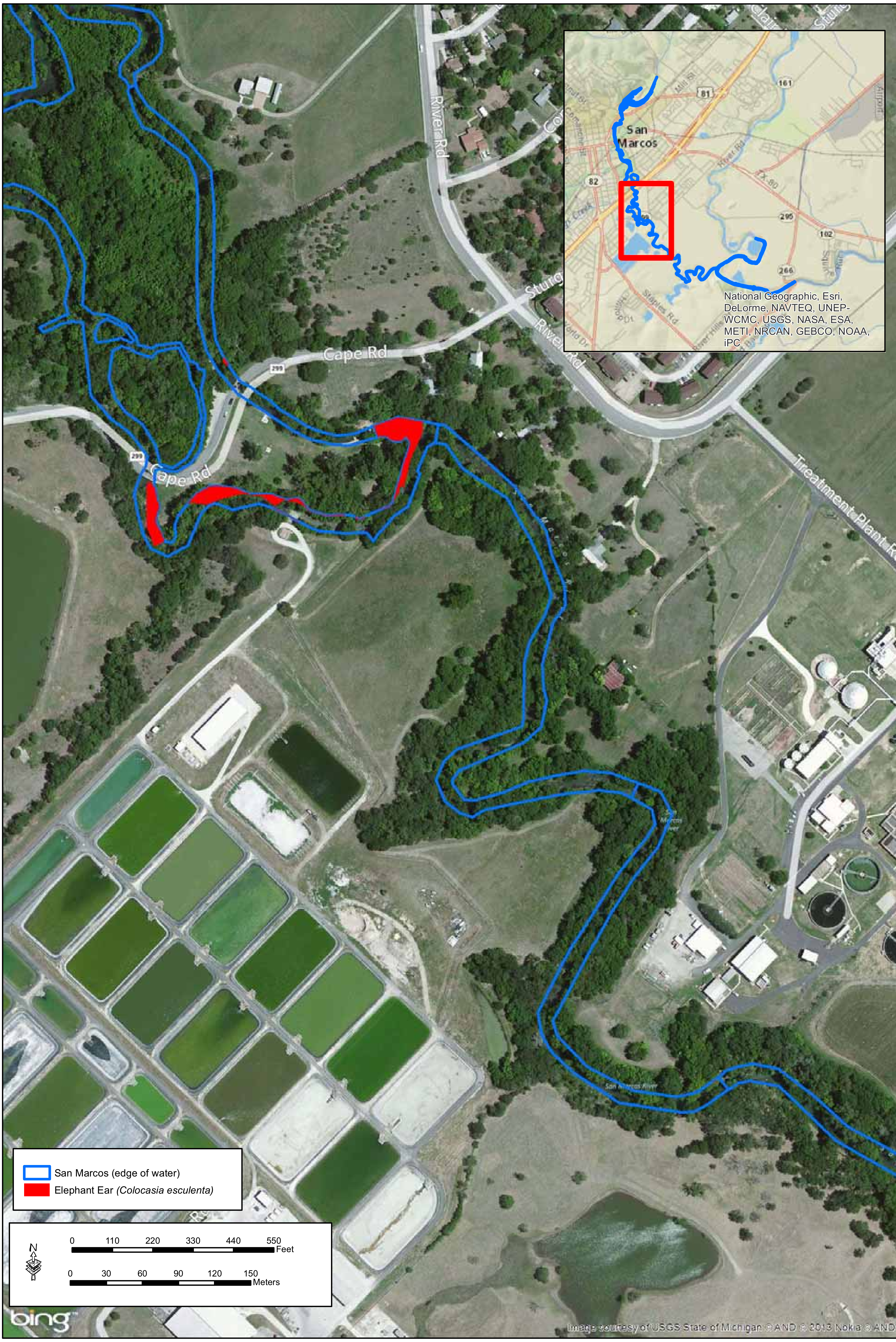

Figure 4-6b. Control of Exotic Aquatic Vegetation - Emergent (EXOA)

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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.

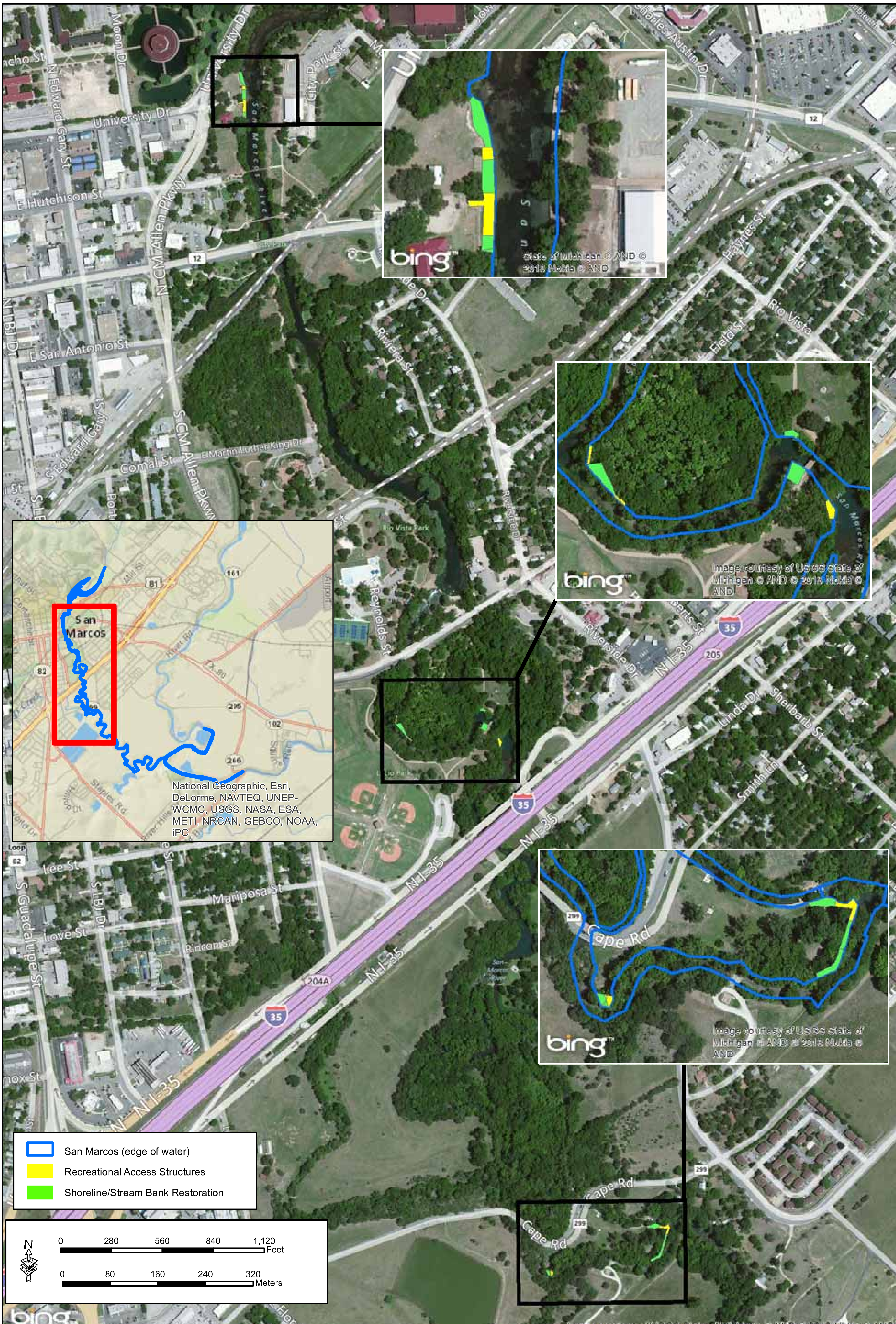

Figure 4-7. Shoreline Restoration (SHORE1)

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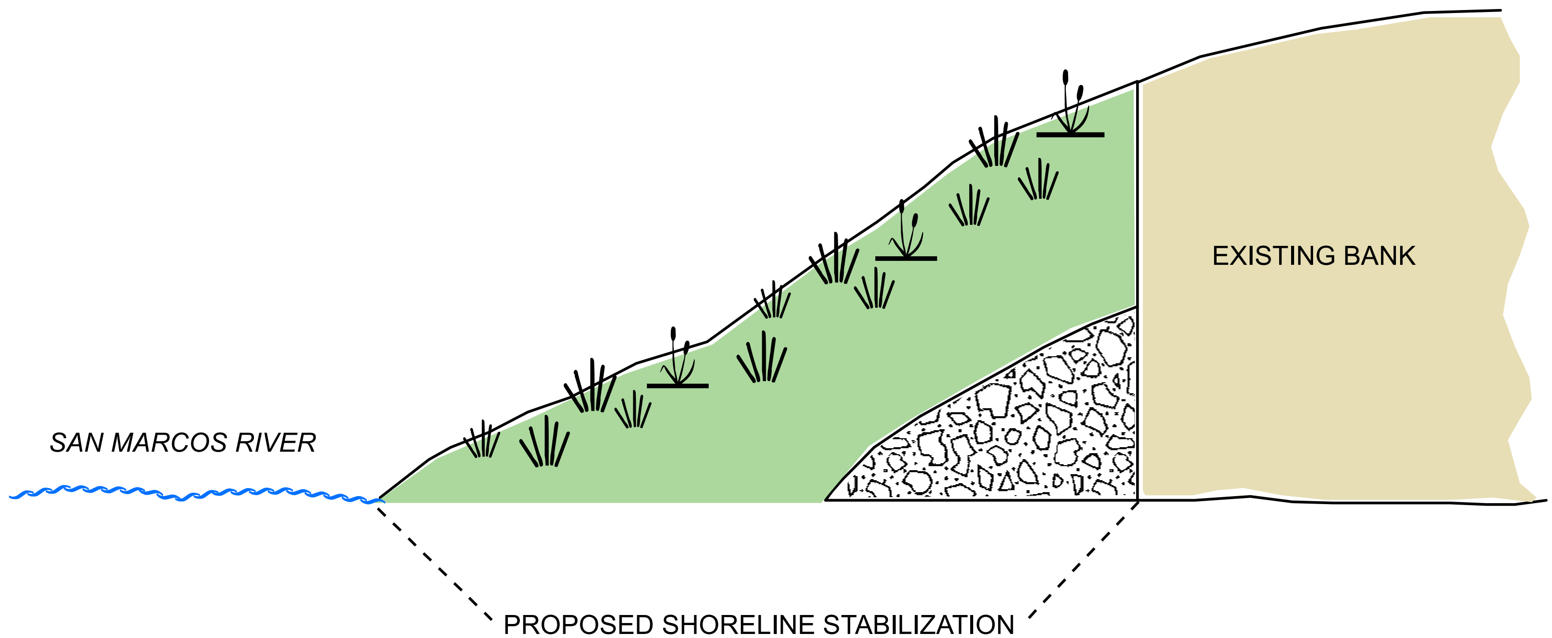

Figure 4-8. Conceptual Illustration of Shoreline Stabilization (SHORE)

May 2013

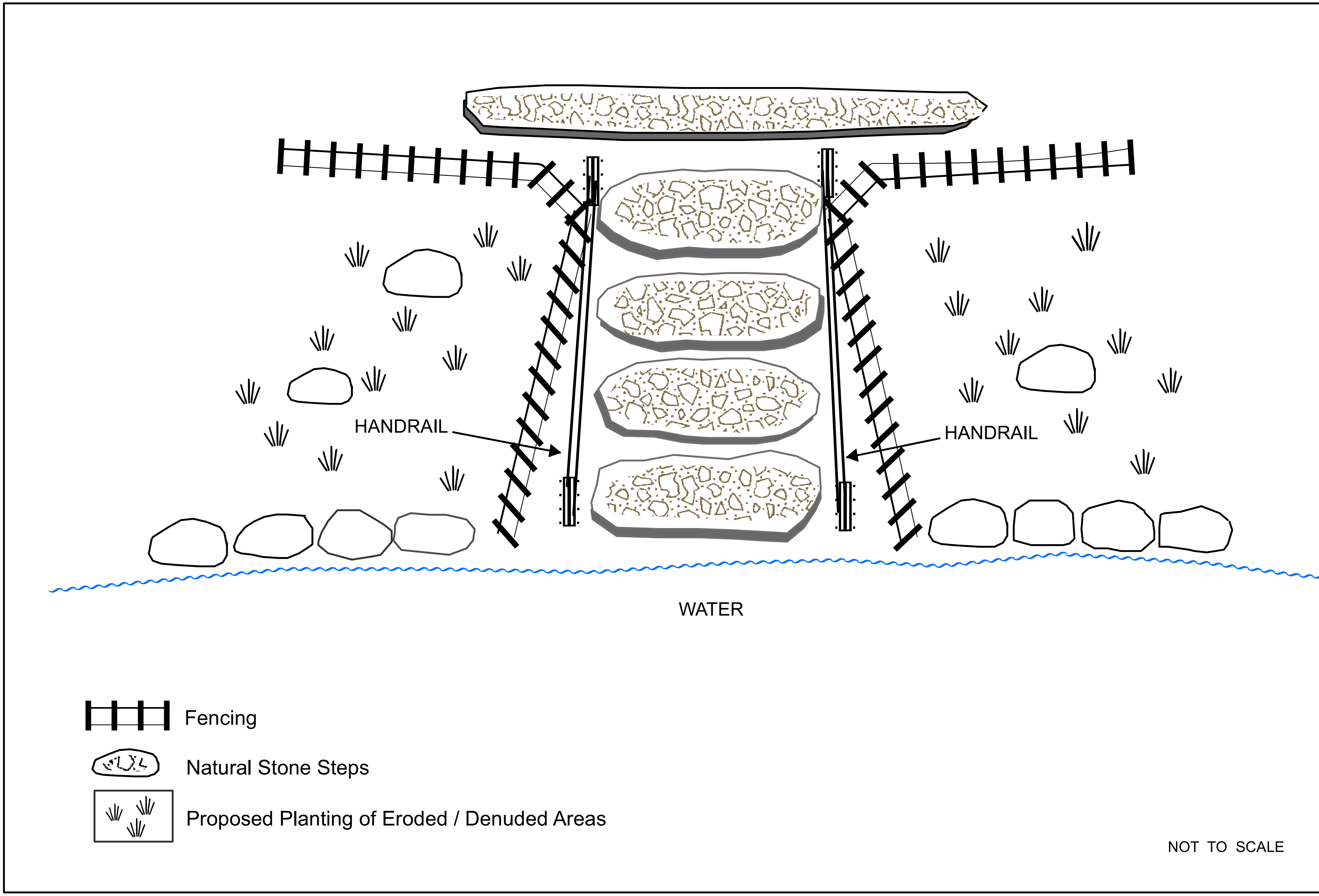

Figure 4-9. Conceptual Illustration of Recreational Access / Step-down (SHORE)

May 2013

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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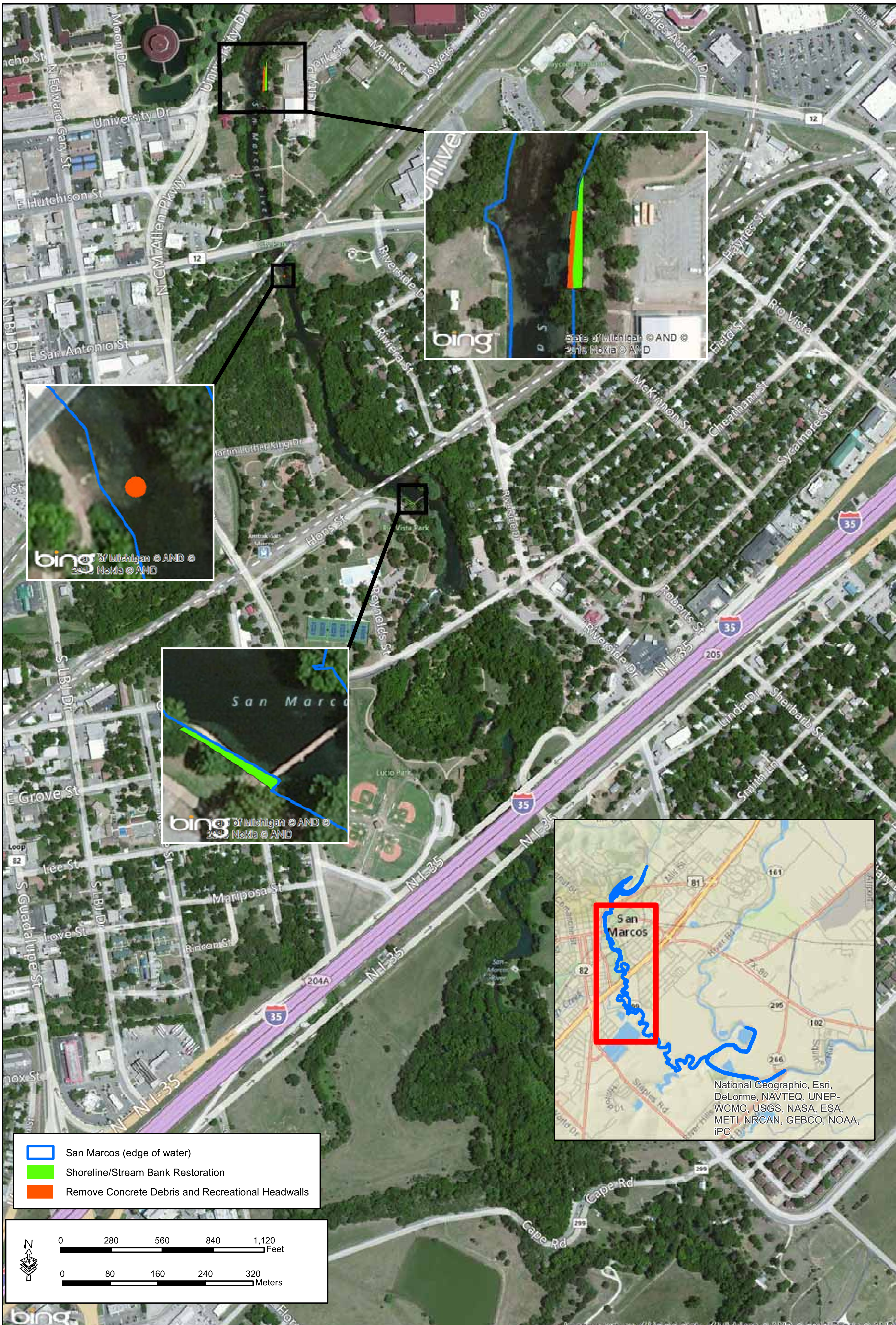

Figure 4-10. Shoreline Restoration on Impervious Improved Lands with Natural Shoreline (SHORE2)

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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

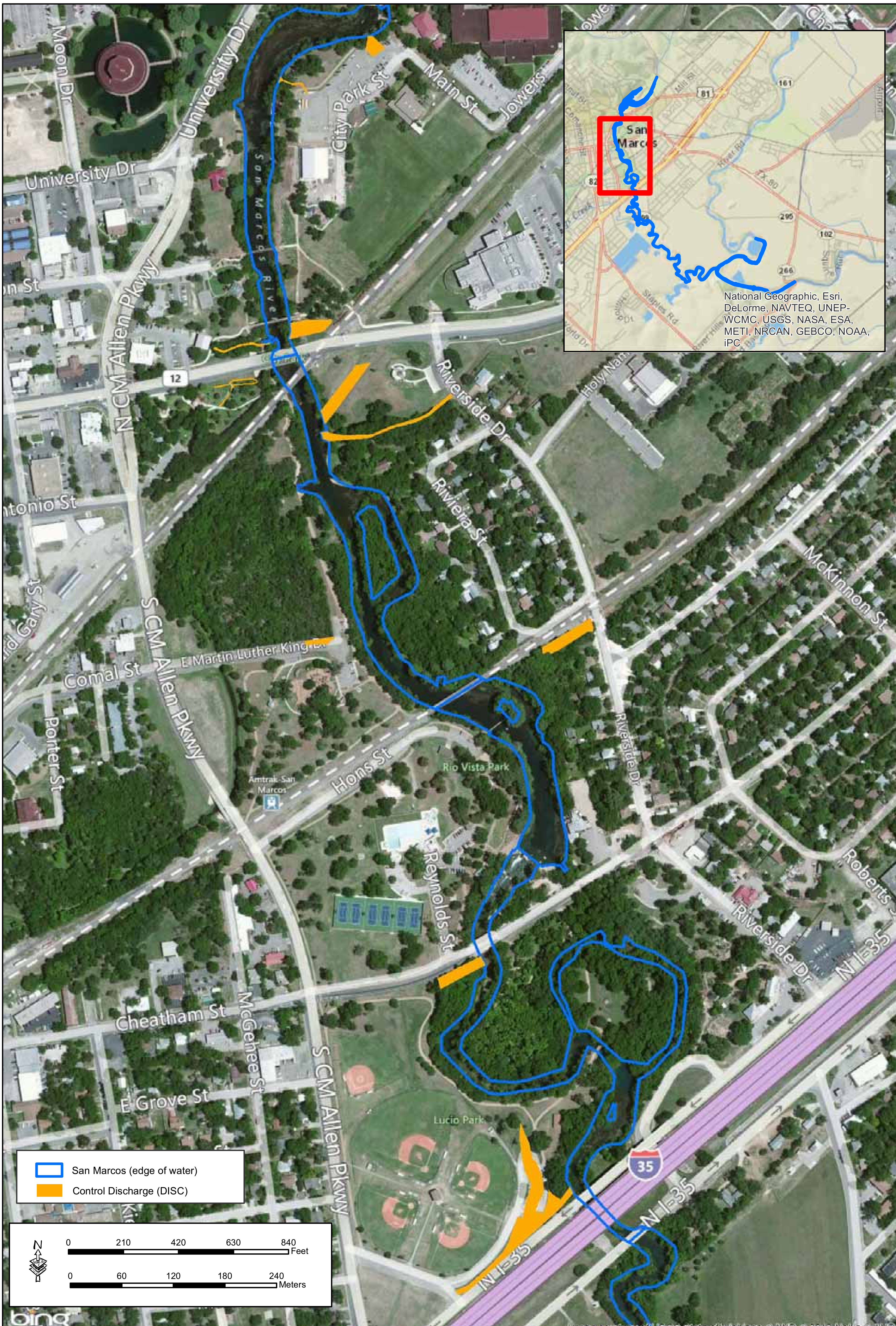

Figure 4-11. Restoration of Riparian Zone at Discharge Locations (DISC)

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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

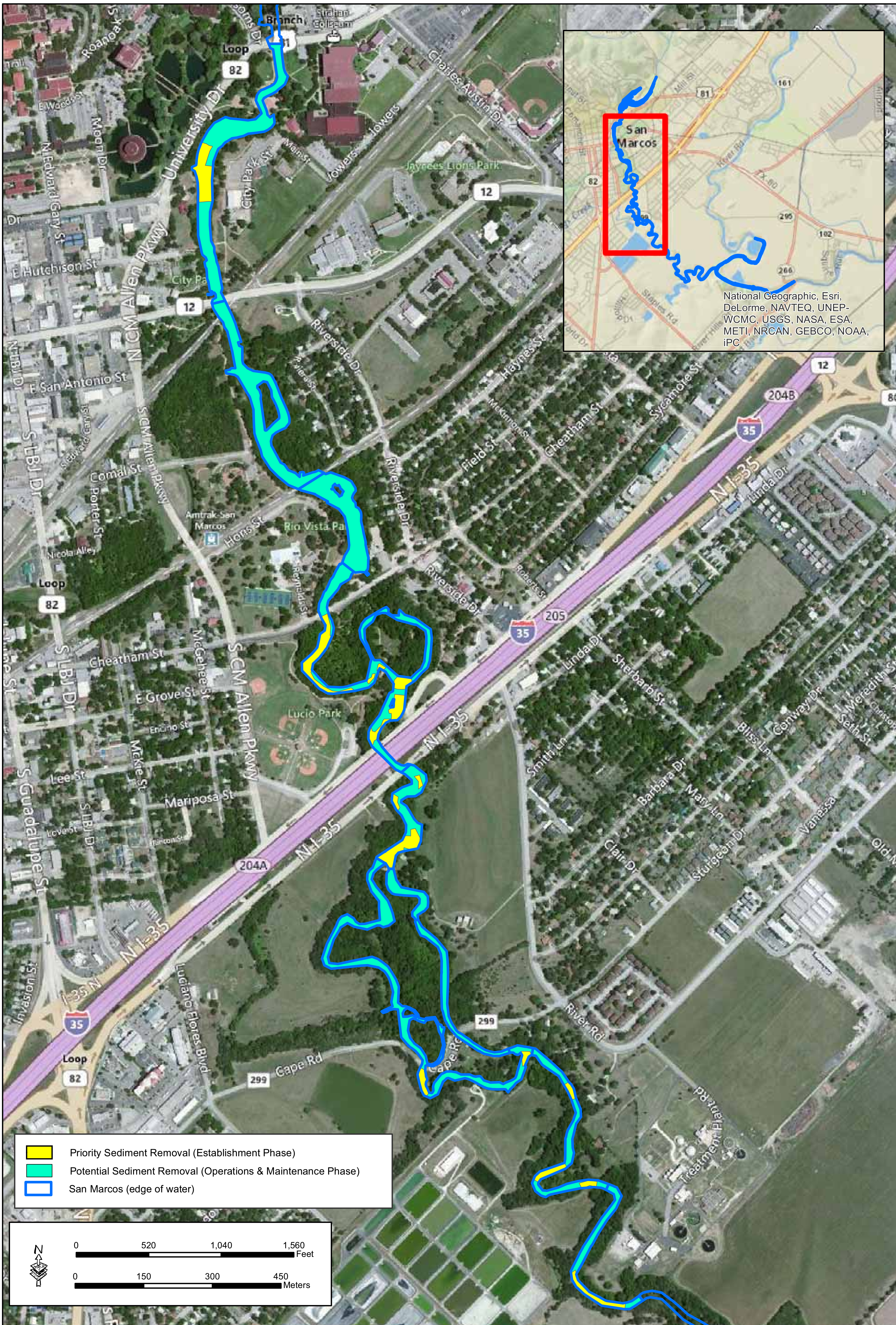

Figure 4-12. Sediment Removal (SED)

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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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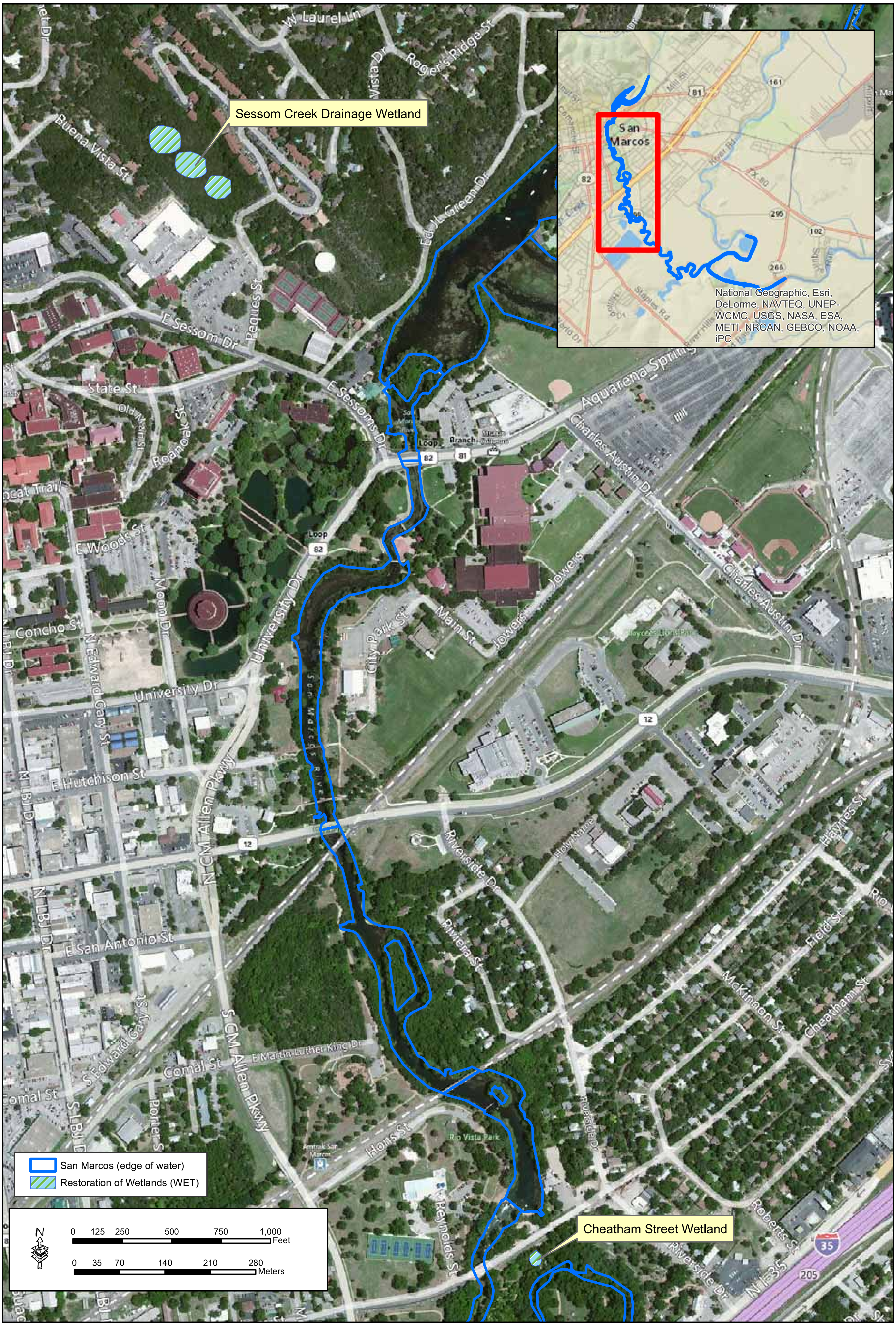

Figure 4-13. Restoration of Wetlands (WET)

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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).

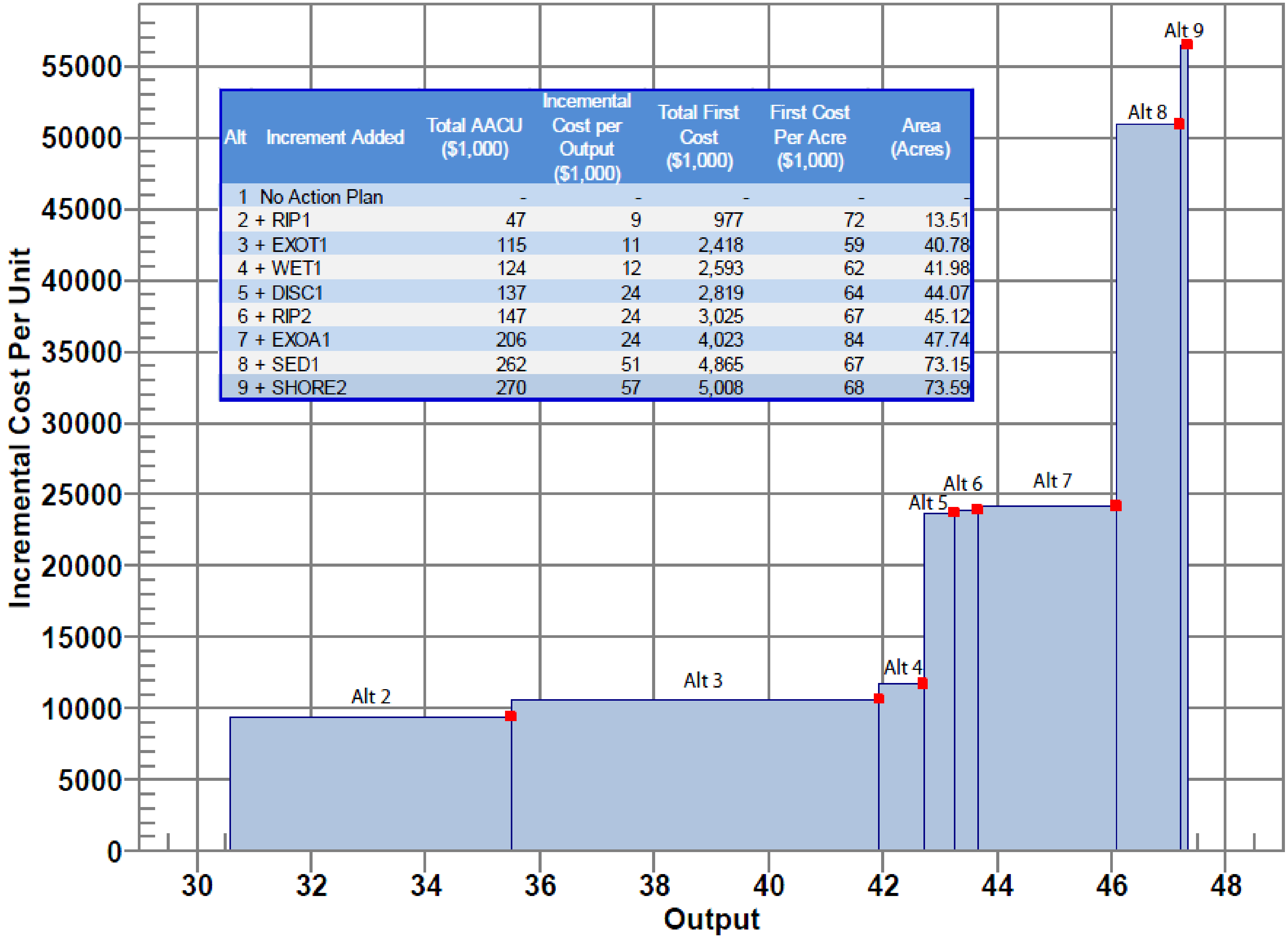
The cost-effective plans were then evaluated based on incremental cost per unit output (i.e., incremental AACU divided by incremental AAHU) to identify the best-buy plans. Best-buy plans are those that have the lowest incremental cost per output at a given level of cost. Because the No Action Plan does 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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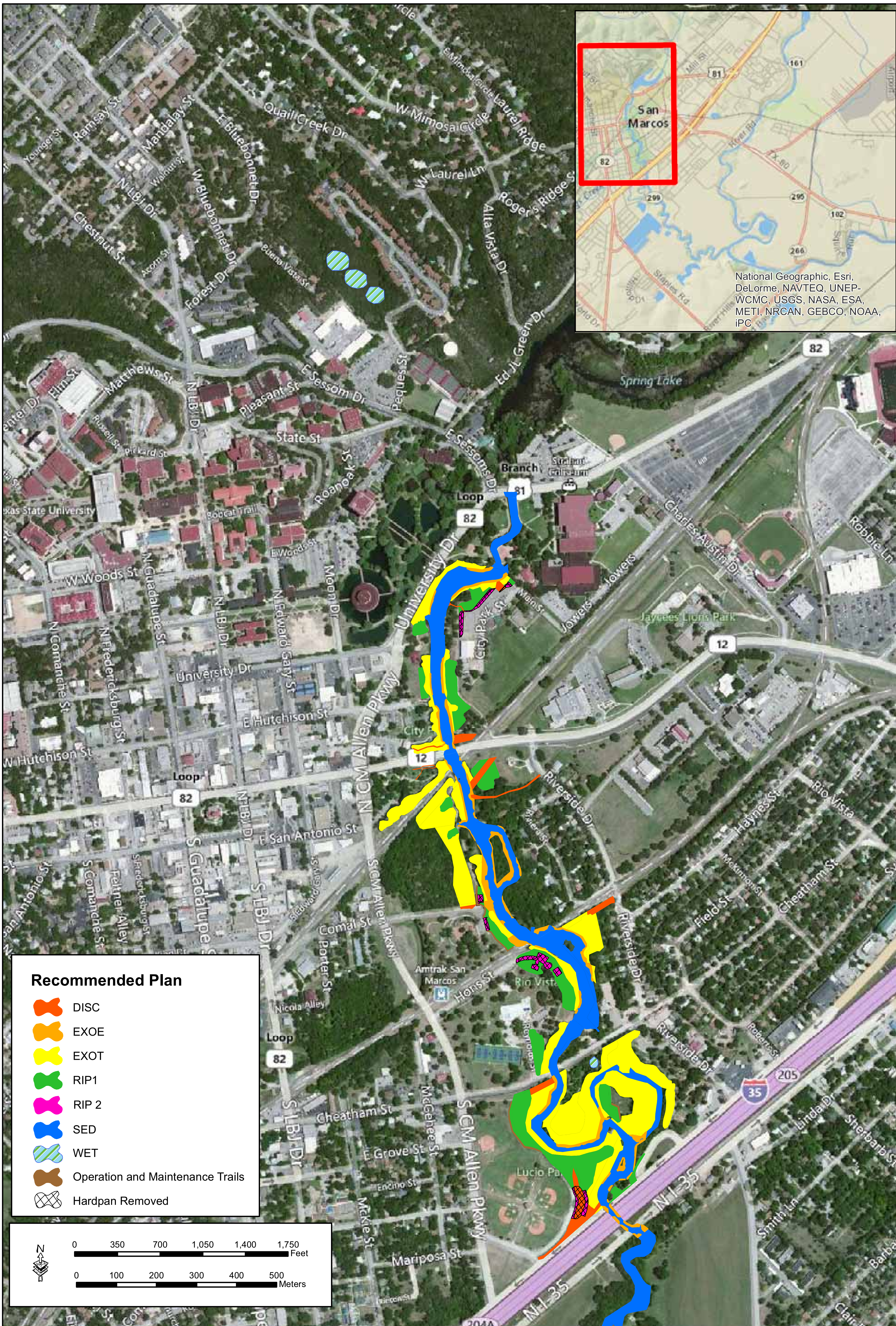

Figure 6-1a. Recommended Restoration Plan

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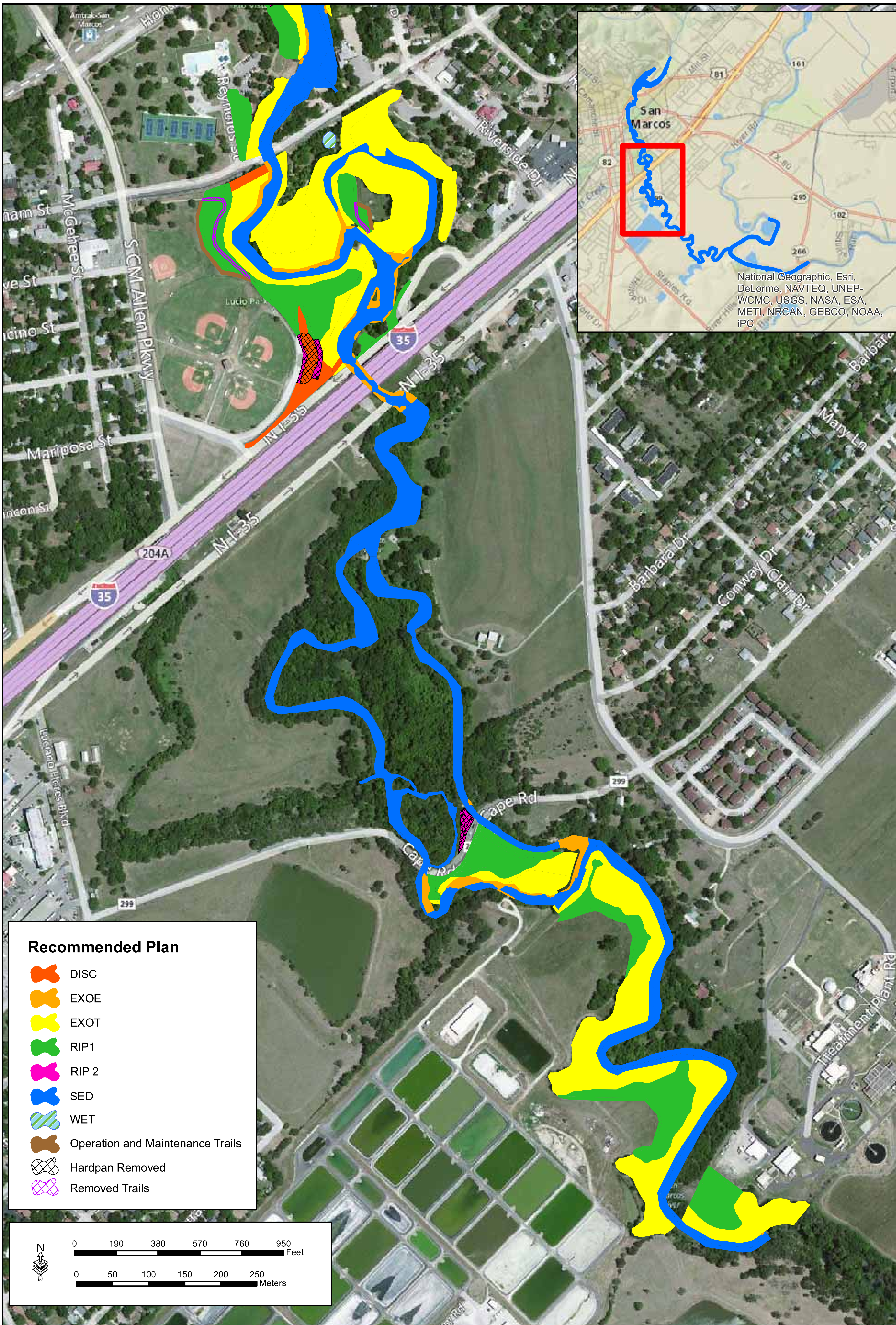

Figure 6-1b. Recommended Restoration Plan

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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.

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".

After the Feasibility Report is approved, 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

Stephen F. Austin Building • 1700 North Congress Avenue • Austin, Texas 78701-1495
Post Office Box 12873 • Austin, Texas 78711-2873
512-463-5001 • 800-998-4GLO
www.glo.state.tx.us

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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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 9-3 is the letter of support for the project from TPWD.

Exhibit 9-3. Letter of Support from TPWD

TEXAS PARKS & WILDLIFE

Life's better outside.®

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

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.state.tx.us

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.

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

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

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 or will participate 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 will be made available for public review for a period of 30 days, and the Notice of Availability will be published in the local newspaper. The proof of publication, Notice of

Availability, agency coordination letters, and comments received from the public review period will be included in Appendix E. Any necessary changes will be incorporated into the DPR/EA prior to execution of the FONSI, if applicable.

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, Jr.
Colonel, US 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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