
Welcome. . .

City of Austin
Stream Restoration Program

Mid-Atlantic Stream Restoration Conference, Rocky Gap, MD
November 2011

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City of Austin
Watershed Protection Department
Environmental Resource Management Division
Stormwater Treatment and Stream Restoration Section

Stream Restoration Program

STREAM STABILIZATION RIPARIAN RESTORATION HABITAT ENHANCEMENT

For over a decade, the City of Austin has been a leading agency in developing and implementing bioengineering and stream restoration practices resulting in creeks that: remain stable, provide habitat, and retain the natural and traditional character of Austin's waterways.

City of Austin Watershed Protection Department

Three primary service missions:

- Water Quality → Green Infrastructure/LID
- Creek Erosion → Stream restoration
- Flood Control

A **<u>mission integration process</u>** (MIP) was developed to :

- **Maximize the opportunities** and **Minimize negative impacts** to Other missions (flooding, erosion and water quality) when planning capital improvement projects.

The team is composed of experts representing each of missions who evaluate opportunities and impacts at the project planning level.

stream stabilization

City of Austin
WATERSHED PROTECTION

water quality treatment

PROGRAM HISTORY

1992: The first bond passed to address erosion in Little Walnut Creek.

1994: Erosion Control Services Program was established in response to citizen complaints. Service began with drainage utility funding for operating expenses.

1997: WPD initiated the citywide erosion assessments to identify and prioritize erosion problems as part of the Watershed Protection Master plan.

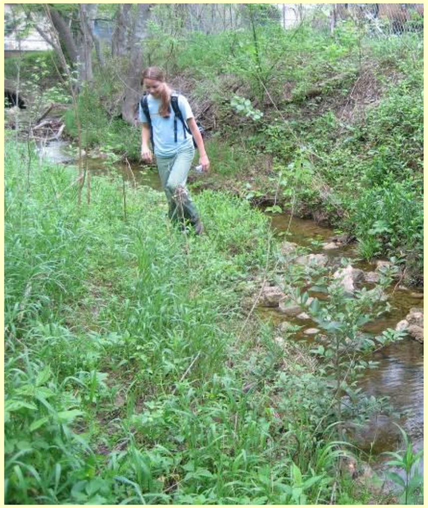
2001: Watershed Protection Master Plan adopted by City Council to guide future solution implementation.

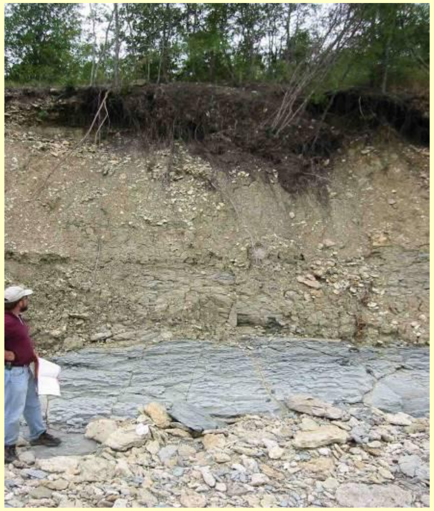
SINCE : Completed more than 5 miles of stream projects, but the demand for stream restoration services has continued to increase.

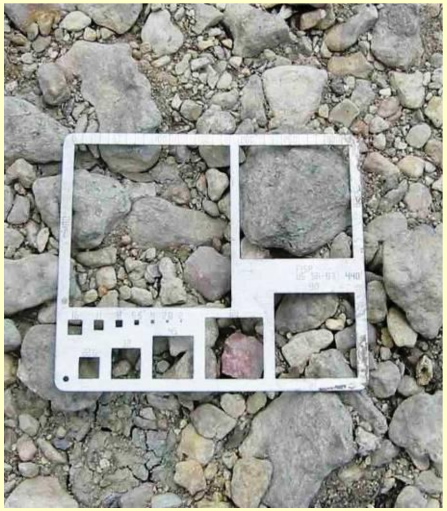
PROGRAM SERVICES

- WATERSHED EROSION ASSESSMENTS
- PROJECT PLANNING AND PRIORITIZATION
- SURVEY, DESIGN, CONSTRUCTION ADMINISTRATION
- SPECIAL STUDIES AND ANALYSES
- TECHNICAL ASSISTANCE
- PRESENTATIONS AND TRAINING

Watershed Erosion Assessments







- Stream Inventory: document and photograph stream features
- Hydraulic change as a result of urbanization
- Determination of channel enlargement
- Delineate erosion hazard areas
- Knick point identification and management strategy
- Identify meander migration problems
- Identify and classify stream reaches and erosion sites
- Watershed Mapping (GIS)

Geomorphic Reach Assessment

Rapid Geomorphic Assessment For Stream Reaches

Assessment by: ________________ **Date:** ________
Stream: ________________ **Tributary:** ________
Reach: ________________ **STA:** ________
Bank Material Composition* ________________
Bed Material Composition* ________________

*AL = Alluvial (sand/gravel/clay), RH = Hard Rock (Buda/Edwards), RS = Soft rock (Austin/Taylor)
COMP = Composite (alluvium over rock), STRUCT = Structural (concrete/gabions)

FORM/ PROCESS	GEOMORPHIC INDICATOR	PRESENT		INDEX
		NO	YES	
EVIDENCE OF AGGRADATION (AI)	1. lobate bars			
	2. coarse material in riffles embedded			
	3 siltation of pools			
	4. medial bars			
	5. accretion on point bar			
	6. poor longitudinal sorting of bed materials			
	7. deposition of sediment in the overbank zone			
	8. buried structures or tree base			
EVIDENCE OF DEGRADATION (DI)	1. exposed bridge footing(s)			
	2. exposed sanitary sewer/gas pipelines/etc			
	3. elevated storm sewer outfall(s)			
	4. undermined gabion baskets/concrete aprons etc.			
	5. scour pools downstream of culverts/stormsewer outlets			
	6. avalanche faces on bar forms			
	7. head cutting due to knick point migration			
	8.terrace cut through older bar material			
	9. suspended armor layer visible in bank			
	10. channel worn into undisturbed overburden			
EVIDENCE OF WIDENING (WI)	1. fallen/leaning trees fence posts			
	2. occurrence of Large Organic Debris			
	3. exposed roots on trees			
	4. basal scour on inside meander bends			
	5. basal scour on both sides of the channel in riffle sections			
	6. gabion baskets/concrete walls/etc. out flanked			
	7. length of channel with basal scour > 50%			
EVIDENCE OF PLANIMETRIC ADJUSTMENT (PI)	1. formation of chutes			
	2. evolution of single thread channel to multiple			
	3. evolution of pool-riffle to braided form			
	4. cutoff channels			
	5. formation of islands			
	6. thawleg alignment out of phase with meander geometry			
	7. bar forms poorly formed/re-worked/removed			
	STABILITY INDEX	SI		

The stability index (SI) is defined as:

SI = (AI + DI +WI +PI)/m

where m=4, AI, DI, WI, and PI are the normalized values of the aggradation, degradation, width enlargement and planimetric indices, respectively. The normalized value for each of the four FORM/PROCESS categories is computed as the sum the GEOMORPHIC INDICATOR for which a Yes determination is reported in the PRESENT column divided by n = the number of GEOMORPHIC INDICATORS used for each index. If a GEOMORPHIC INDICATOR is not applicable note N/A opposite this INDICATOR in the PRESENT column and reduce n by 1. For example, if there are no bridges in the reach then GEOMORPHIC INDICATOR No. 1 "exposed bridge footing(s)" under "EVIDENCE OF DEGRADATION (DI)" is not applicable and the observer should record an N/A opposite this INDICATOR, reduce n to 9 and move to the next INDICATOR.

SI		
<0.2 Stable	0.2 - 0.4 In Transition	>0.4 In Adjustment

Geomorphic Reach Data

aggradation

degradation

channel widening

planimetric adjustment

Stability Index (0 < SI < 1)

Erosion Site Inspection

Stream Restoration Program - Erosion Site Inspection Form

Date ____________________

Inspector ____________________

Address ____________________

Property Type (Commercial/single-family/multi-family/COA/AISD/Texas) ____________________

Watershed ____________________

Geomorphic Reach ____________________

Resource Threatened ____________________

(**See Resource Code Sheet** i.e. House, Building, Major Road, Minor Road, Low Water Crossing, Mobile Home, Fixed Storage Building, Garage, Dam, Deck, Driveway, Sidewalk, Fence, Yard, Grade Control, Retaining Wall, Parking Lot, Public Recreational Amenity, Swimming Pool, Tennis Court, Playscape, Hike and Bike Trail, Protected Tree, Manhole, Utility , Line, Storm Drain, Wastewater Pipe, Gas Line, Power Pole, Concrete Riprap Slope Protection, , Concrete Flume, Bridge, Railroad Bridge, Railroad, Pedestrian Bridge)

Erosion Type Rating ____________________ **(1, 2 or 3)**
Type 1: Imminent threat to a habitable/primary structure or public roadway.
Type 2: Threat to secondary structure/ private property or public infrastructure (Doffset < .5 ft)
Type 3: Property or structure that may be threatened by future stream channel erosion (DOffset >= 0.5 ft)

Horizontal Offset from Top of Bank to Threatened Resource (ft) ____________________ **D_{offset}**

Bank Height (ft) ____________________ **Y**

Horizontal Distance from Top of Bank to Toe (ft) ____________________ **$D_{Top2Toe}$**

Existing Bank Slope, Horizontal:Vertical ____________________ **SS = ($D_{Top2Toe}$ / Y) : 1**

Erosion Damage Length along Creek Flowpath (ft) ____________________ **Le**

Bank Material Composition* ____________________

Bed Material Composition* ____________________
*AL = Alluvial (sand/gravel/clay), RH = Hard Rock (Buda/Edwards), RS = Soft rock (Austin/Taylor)
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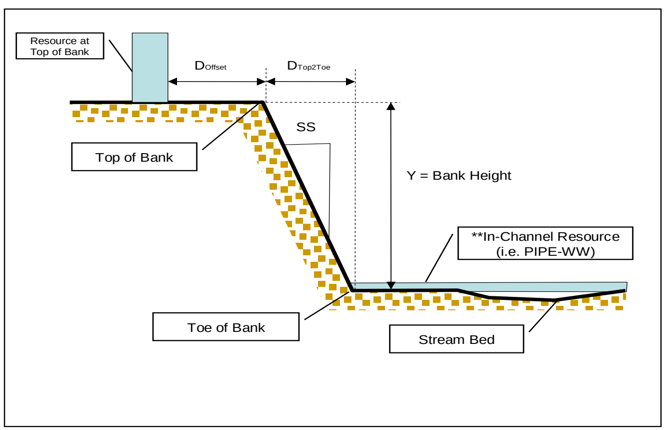

** for in-channel resources such as pipelines use N/A for D_{offset} and indicate the exposed length, height and depth of undermining.

Notes: ____________________

Erosion Site Data

PROPERTY TYPE

EASEMENT

RESOURCE VALUE

DISTANCE TO RESOURCE

BANK HEIGHT

BANK SLOPE

BANK MATERIAL

BED MATERIAL

Erosion Problems in Austin


HOUSE


UTILITY POLE - HOUSE


WASTE WATER LINE


PEDESTRIAN BRIDGE


HOUSE


BRIDGE - TRAIL


HOUSE


PEDESTRIAN BRIDGE


STORM DRAIN PIPE

Prioritization and Planning

Erosion problems are identified through…

Watershed Erosion Assessments

Citizen Service Requests

Staff Reconnaissance

↓

SRP DATABASE

↓

PRIORITIZATION

↓ ↓

CAPITAL PROJECT

IN-HOUSE DESIGN CONSTRUCTION

Stream Restoration Program

City-Wide Erosion Problem Prioritization

"Problem Score" Approach

Stream Restoration Program

Erosion Problem Prioritization

Problem Score Approach

- ❖ *Problem Score = f(# resources in the reach, resource value, Erosion Site severity)*
- ❖ *Individual Erosion Site Score*
- ❖ *Geomorphic Reach Score*

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Erosion Problem Prioritization

Erosion Site Severity Score

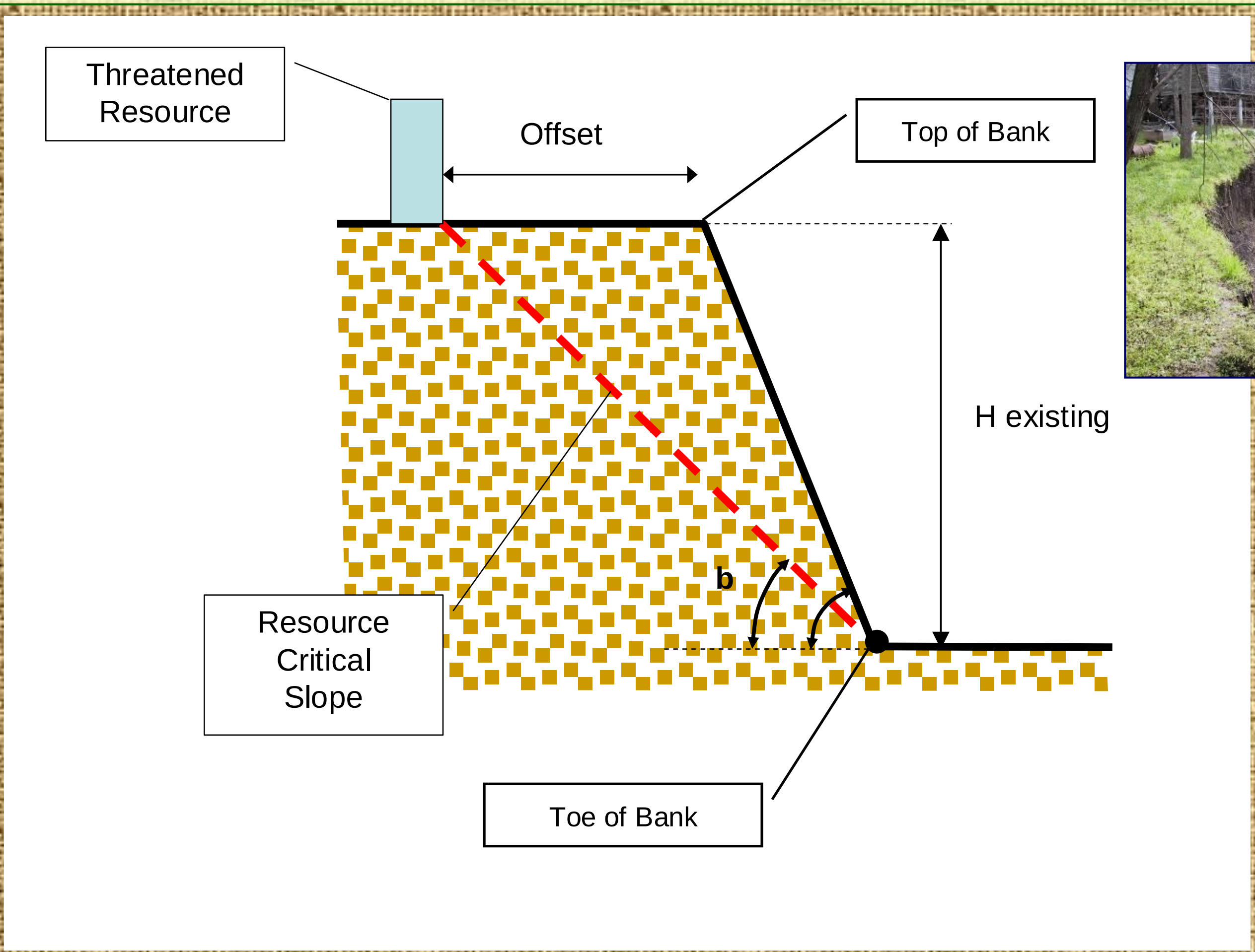
- *ES = f(Geotechnical, Vegetative, Planform)*
- *Geotechnical Consideration*
  - *Stability of Stream Bank based on Geometry and Slope Stability*
    - *Proximity of Resource to Stream Bank*
    - *Height of Stream Bank*
    - *Slope of Stream Bank (Critical Resource Slope)*
    - *Stream Soil Types*

- *Vegetative Consideration*
  - *Protection Provided by Bank Surface Cover*
- *Planform Consideration*
  - *Effects of Stream Meander Migration Potential*
    - *Inside, Straight, Outside of Stream Bend*

Stream Restoration Program

Erosion Problem Prioritization

Geotechnical Score =
f(bank height, bank angle, resource distance, soils)



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Erosion Problem Prioritization

*Geotechnical Score = (H/Hc) * Normalization Factor*

- *H = Existing Bank Height*
- *Hc = Critical Bank Height*
- *Normalization Factor such that values range 0 - 100*

$$Hc = 4*c/gamma*[\sin(B)*\cos(phi)/(1 - \cos(B - phi))]$$

where:

Hc = critical bank height (ft) {Cullman's Limit Equilibrium Method}
c = bank material cohesion (lb/ft^2)
gamma = unit weight of bank material (lb/ft^3)
phi = bank material internal friction angle (degrees)
B = critical resource slope angle

SOLUTIONS

REGULATORY SOLUTIONS

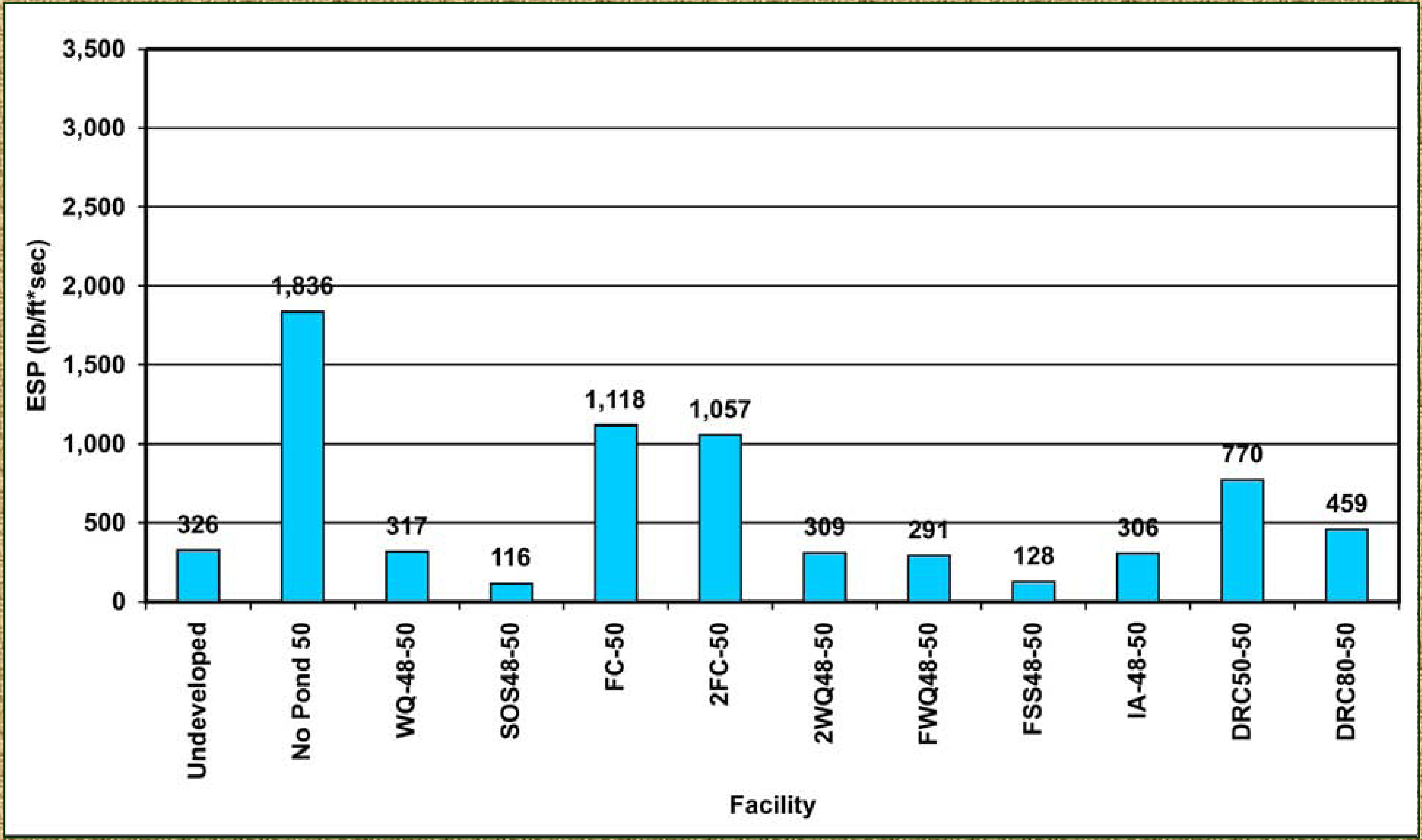
EROSION HAZARD BUYOUTS

DESIGN SOLUTIONS

Regulatory solutions

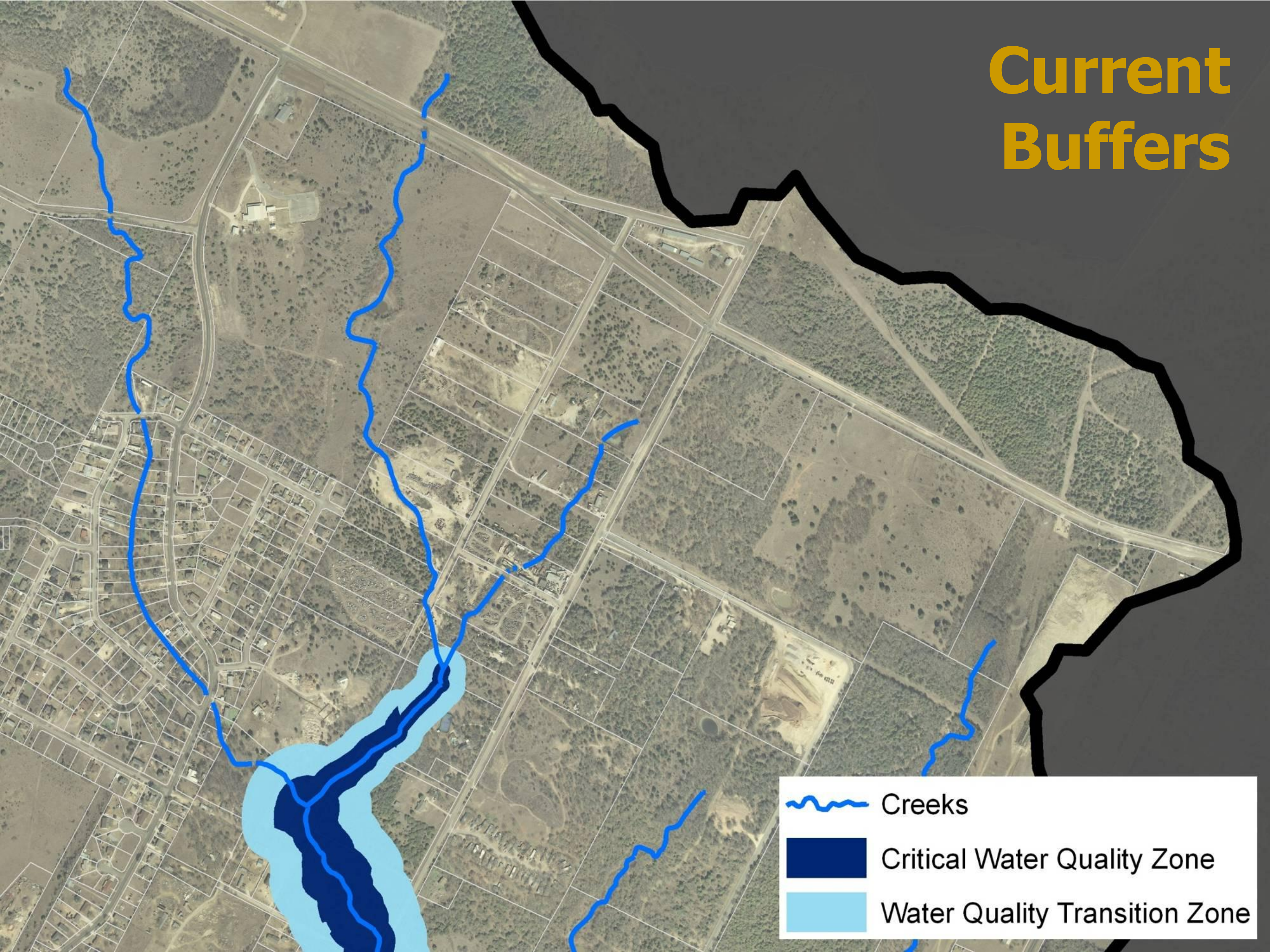
- Floodplain regulations
- Stormwater management Controls
- Critical water quality zones
- Erosion hazard zone
- Headwater protection

Stormwater Management Erosion Detention Study

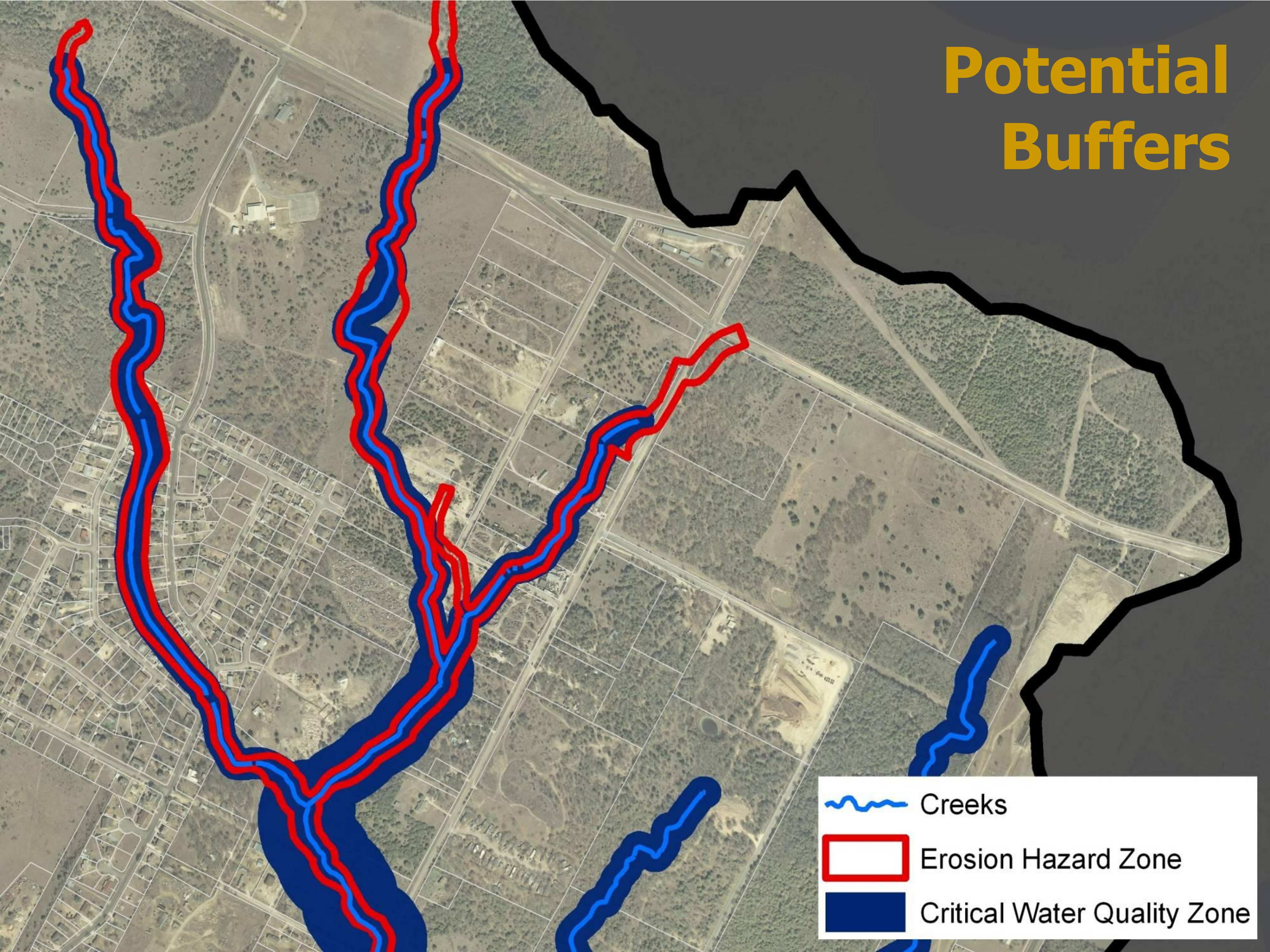



EROSION
HAZARD
ZONE
new
construction

Current Buffers



Potential Buffers

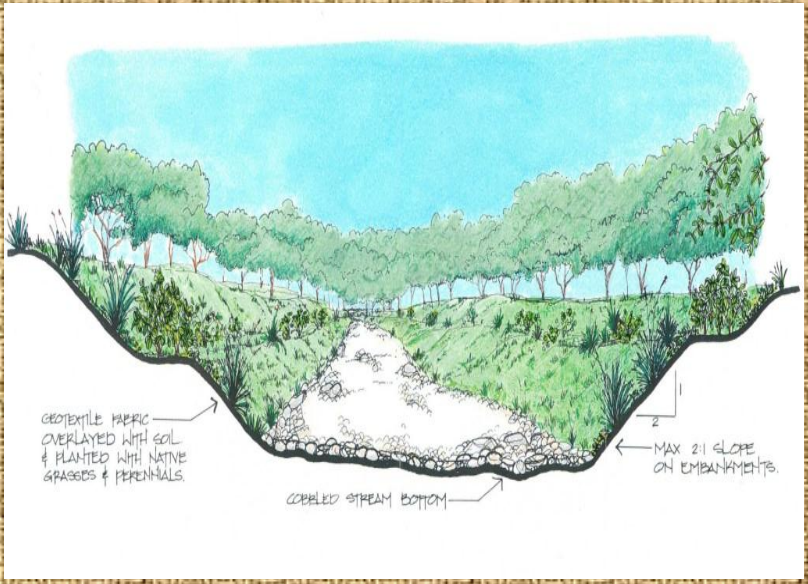


Voluntary Erosion Hazard Buyouts

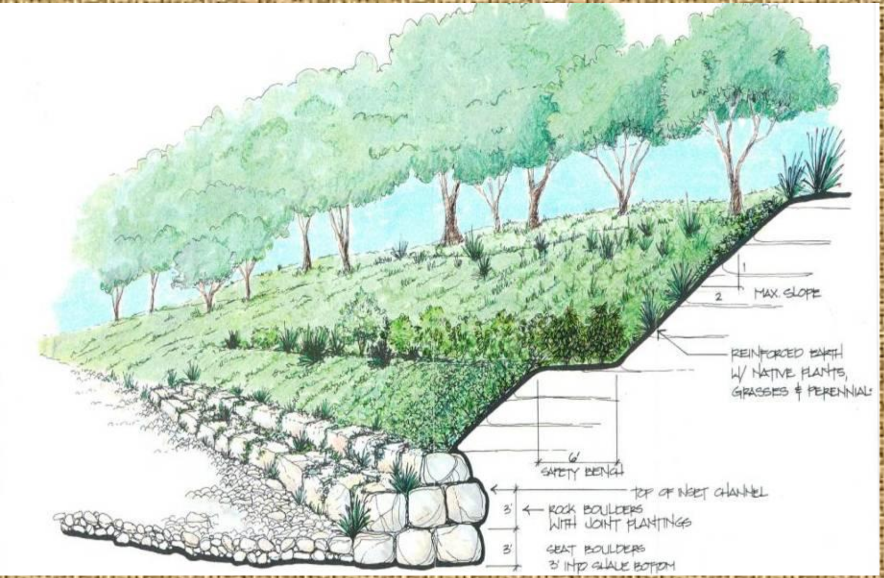
- PURCHASING PROPERTY AND REMOVING THE STRUCTURE MAY BE THE BEST LONG TERM SOLUTION.
- COST BENEFIT ANALYSIS COMPARES STREAM STABILIZATION COST TO PROPERTY ACQUISITION COST.
- VOLUNTARY ACQUISITION
- NO THREAT OF CONDEMNATION
- APPRAISED MARKET VALUE AND RELOCATION COSTS OFFERED

Construction Projects

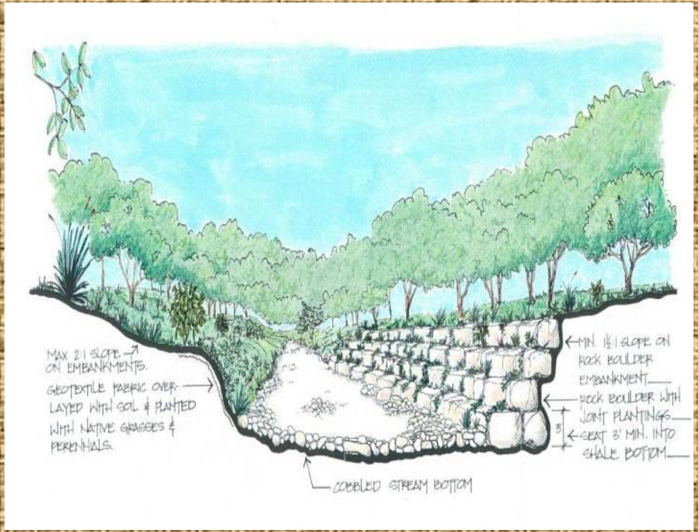
Active Restoration Techniques



Vegetated Graded Slopes



Natural Limestone Boulder Toe with Vegetated Upper Slopes



Natural Limstone Boulder Wall

Stream Team Projects

IN-HOUSE DESIGN AND CONSTRUCTION MANAGEMENT

Stream restoration program staff prepare erosion repair and stream stabilization designs and plans for two field operations construction crews.

Stream restoration staff specialize in natural stream design that stabilize channels while enhancing the natural character of Austin's waterways.

Stream Restoration Program

In-house Projects

BLUNN STACY PARK - BEFORE


DEERE

BLUNN STACY PARK - AFTER

BLUNN STACY PARK - AFTER


BLUNN STACY PARK - BEFORE


DEERE

BLUNN STACY PARK - AFTER

Capital Projects

Larger Projects (>1000 ft) are generally implemented with private contractors

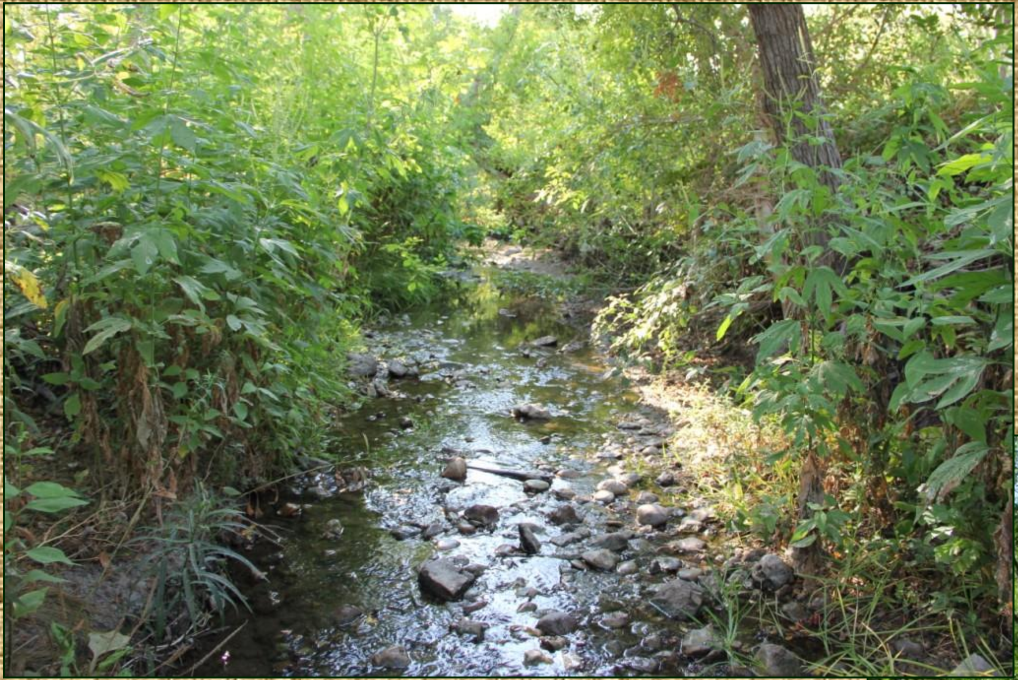
Passive Restoration Example

Willow Brook Reach (Before)

1997

Passive Restoration Example

Willow Brook Reach (After)



2011

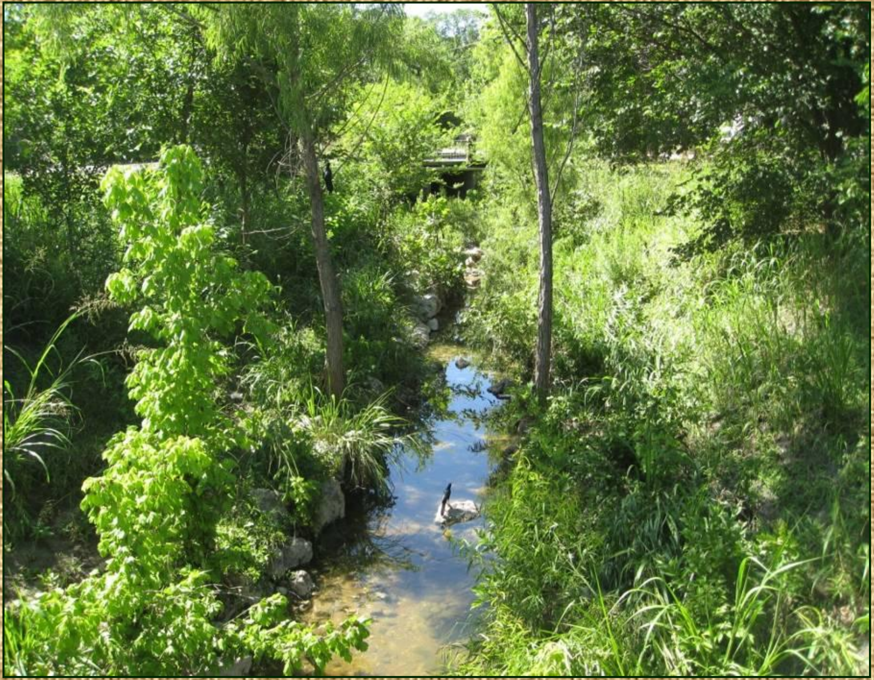
Active Restoration Example

Shipe Park (Before)

1997

Active Restoration Example

Shipe Park (After)



2009

Active Restoration Example

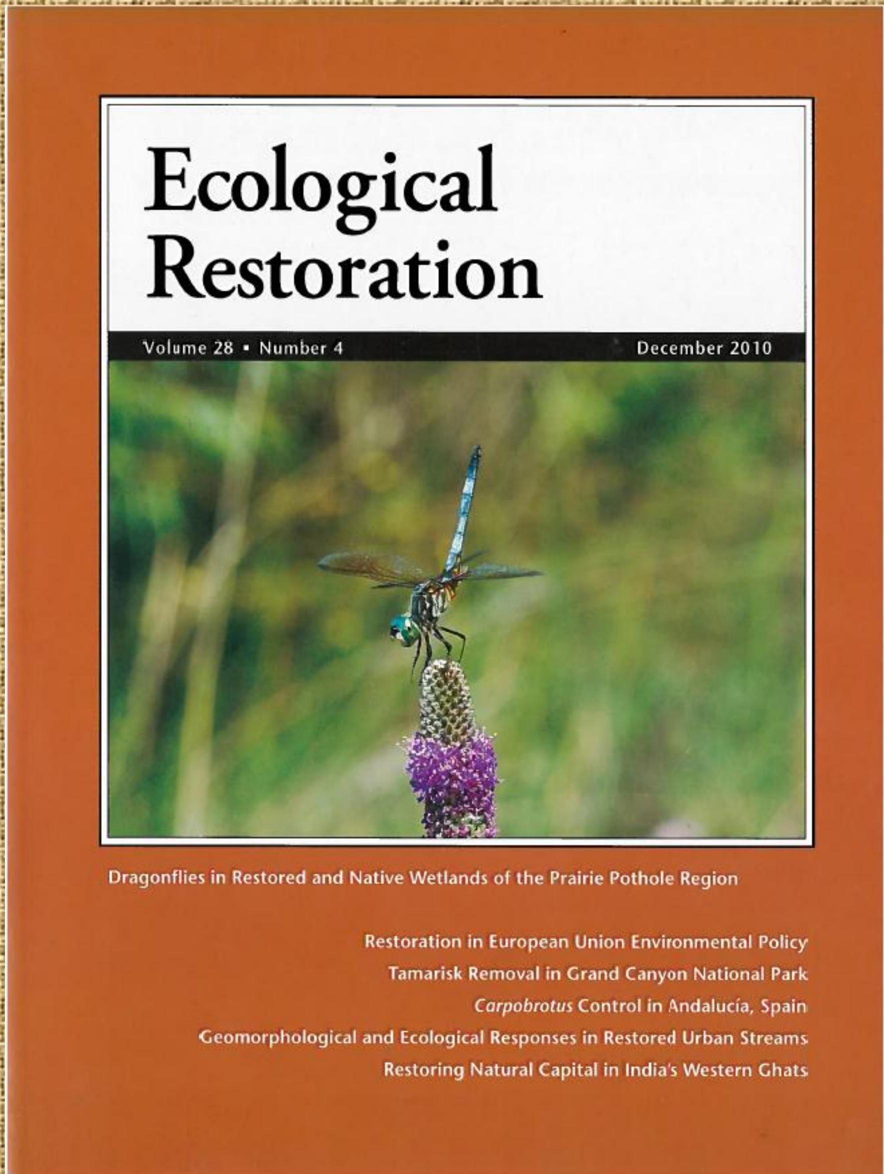
Fort Branch Project (before)

Active Restoration Example

Fort Branch Project (After)

2011

Ecological Benefits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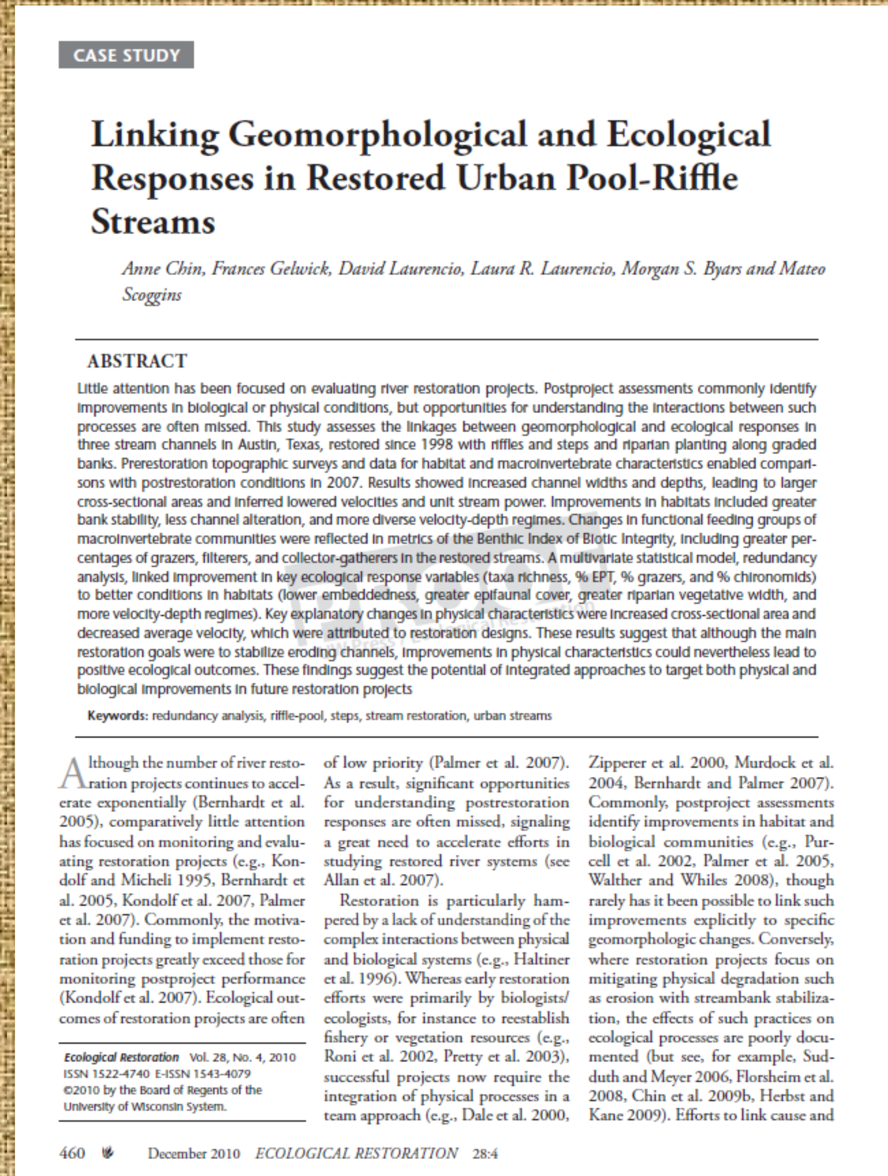
Dragonflies in Restored and Native Wetlands of the Prairie Pothole Region

Restoration in European Union Environmental Policy
Tamarisk Removal in Grand Canyon National Park
Carpobrotus Control in Andalucía, Spain
Geomorphological and Ecological Responses in Restored Urban Streams
Restoring Natural Capital in India's Western Ghats


CASE STUDY

Linking Geomorphological and Ecological Responses in Restored Urban Pool-Riffle Streams

Anne Chin, Frances Gelwick, David Laurencio, Laura R. Laurencio, Morgan S. Byars and Mateo Scoggins

ABSTRACT

Little attention has been focused on evaluating river restoration projects. Postproject assessments commonly identify improvements in biological or physical conditions, but opportunities for understanding the interactions between such processes are often missed. This study assesses the linkages between geomorphological and ecological responses in three stream channels in Austin, Texas, restored since 1998 with riffles and steps and riparian planting along graded banks. Prerestoration topographic surveys and data for habitat and macroinvertebrate characteristics enabled comparisons with postrestoration conditions in 2007. Results showed increased channel widths and depths, leading to larger cross-sectional areas and inferred lowered velocities and unit stream power. Improvements in habitats included greater bank stability, less channel alteration, and more diverse velocity-depth regimes. Changes in functional feeding groups of macroinvertebrate communities were reflected in metrics of the Benthic Index of Biotic Integrity, including greater percentages of grazers, filterers, and collector-gatherers in the restored streams. A multivariate statistical model, redundancy analysis, linked improvement in key ecological response variables (taxa richness, % EPT, % grazers, and % chironomids) to better conditions in habitats (lower embeddedness, greater epifaunal cover, greater riparian vegetative width, and more velocity-depth regimes). Key explanatory changes in physical characteristics were increased cross-sectional area and decreased average velocity, which were attributed to restoration designs. These results suggest that although the main restoration goals were to stabilize eroding channels, improvements in physical characteristics could nevertheless lead to positive ecological outcomes. These findings suggest the potential of integrated approaches to target both physical and biological improvements in future restoration projects

Keywords: redundancy analysis, riffle-pool, steps, stream restoration, urban streams

Although the number of river restoration projects continues to accelerate exponentially (Bernhardt et al. 2005), comparatively little attention has focused on monitoring and evaluating restoration projects (e.g., Kondolf and Micheli 1995, Bernhardt et al. 2005, Kondolf et al. 2007, Palmer et al. 2007). Commonly, the motivation and funding to implement restoration projects greatly exceed those for monitoring postproject performance (Kondolf et al. 2007). Ecological outcomes of restoration projects are often of low priority (Palmer et al. 2007). As a result, significant opportunities for understanding postrestoration responses are often missed, signaling a great need to accelerate efforts in studying restored river systems (see Allan et al. 2007).

Restoration is particularly hampered by a lack of understanding of the complex interactions between physical and biological systems (e.g., Haltiner et al. 1996). Whereas early restoration efforts were primarily by biologists/ecologists, for instance to reestablish fishery or vegetation resources (e.g., Roni et al. 2002, Pretty et al. 2003), successful projects now require the integration of physical processes in a team approach (e.g., Dale et al. 2000, Zipperer et al. 2000, Murdock et al. 2004, Bernhardt and Palmer 2007). Commonly, postproject assessments identify improvements in habitat and biological communities (e.g., Purcell et al. 2002, Palmer et al. 2005, Walther and Whiles 2008), though rarely has it been possible to link such improvements explicitly to specific geomorphologic changes. Conversely, where restoration projects focus on mitigating physical degradation such as erosion with streambank stabilization, the effects of such practices on ecological processes are poorly documented (but see, for example, Sudduth and Meyer 2006, Florsheim et al. 2008, Chin et al. 2009b, Herbst and Kane 2009). Efforts to link cause and

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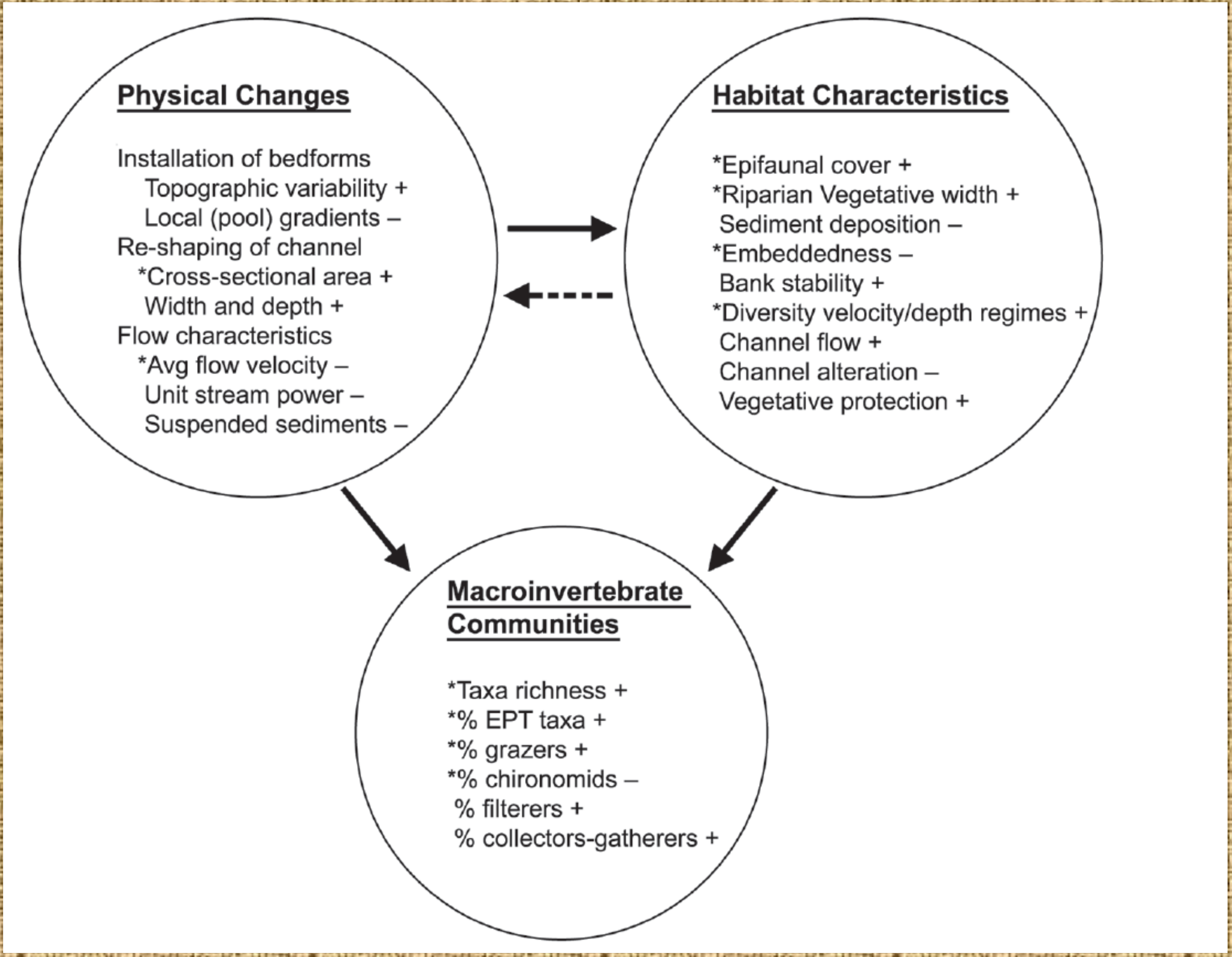
Austin Ecological Benefits Change in Metrics




I like it natural …

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HTTP://WWW.CI.AUSTIN.TX.US/WATERSHED/EROSION.HTM


Thank You