City of Austin
WATERSHED PROTECTION

Willowbrook Reach Riparian Restoration: A Case Study

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Abstract

The Willowbrook Reach of Boggy Creek received riparian restoration as a means of improving water quality and slowing the bank erosion. With an approach developed by the Watershed Protection Department, a trail and stream crossing were installed and 1.6 acres of riparian land was planted with native trees, shrubs and groundcover. A cost comparison shows that riparian restoration, at about $50 per linear foot, has the potential to cost far less than traditional bank and channel stabilization with typical costs of approximately $850 per linear foot.

Introduction

The plight of the urban stream is apparent in many parts of Austin. Urban streams suffer hydrologic, chemical, morphologic, ecologic and biologic changes that are so pervasive that full recovery and/or complete restoration are inappropriate terms (Walsh et al. 2005). Many urban streams have been relegated solely to the function of stormwater conveyance with little to no ecological function left or expected. The resulting aesthetics offer no indication of past ecological value and inspire little in the imagination for what improvements are possible. Creek conditions conducive to riparian restoration versus other City of Austin Watershed Protection Department (WPD) capital improvement project solutions include low Environmental Integrity Index (EII) scores (Clamann 2009), lack of critical flooding and stormwater conveyance issues,

lack of infrastructure threatened by erosion, and positive community interest in the project. The WPD riparian restoration project in the Willowbrook reach of Boggy Creek was driven primarily by opportunity. A systematic method for prioritizing City-owned properties for riparian restoration has since been compiled and implemented using EII scores, GIS analysis, site evaluations and stakeholder support (Duncan et al. 2012).

Upper Boggy Creek has been heavily affected by increasing human use of the land. The headwaters include Interstate Highway 35 and the former site of the Mueller International Airport. The upper part of this watershed is located on the eastern edge of the Blackland Prairie ecoregion, at the transition from the Central Texas Plateau to the west. This gives the stream relatively deep soils that have been incised and eroded down to bedrock in many places. Residential development along the stretch of Boggy Creek known as the Willowbrook Reach began in the late 1940s. Based on historic aerial photo analysis the previous land use was most likely dominated by domestic animal grazing (Figure 1). This type of land use leads to the loss of aquatic and terrestrial biodiversity, reduced ecological function, and a change in community organization (Fleischner 1994). This earlier depletion of native vegetation followed by residential development and associated urban influences led to the relatively poor condition of this stream today.

Figure 1. Aerial photos depicting land use around Willowbrook Reach (yellow) in the 1940s (left) and later in 2009 (right).

Hydrologic changes in urban watersheds generally lead to incision which, in combination with reduced infiltration, can reduce near-stream groundwater levels (Groffman 2002). This reduction in the water table impacts the riparian plant community, and the ability for denitrification in the soil. Besides draining wetlands, incised streams eliminate stream-floodplain interaction and reduce ecosystem services (Shields et al. 2009).

In 2010, WPD staff determined that the rate of erosion in the reach was decreasing and thus a structural restoration capital project was unnecessary. Instead, an effort was undertaken to improve riparian zone structure and function in this reach by adding groundcover, understory and

canopy vegetation to the existing riparian community with the input and involvement of local stakeholders. This paper chronicles the development of this restoration design and its initial implementation.

Methods

The first step was to evaluate the target reach and assess potential restoration activities which included moving the existing trail away from the edge of the stream, reducing mowing throughout the greenbelt, and increasing the density and diversity of native vegetation. It was agreed by WPD staff and local stakeholder group Friends and Lovers of Willowbrook Reach (FLWR) that the existing trail, which was within 2 ft of the top of the stream bank, was too close. Having a trail at the top edge of the bank had created an erosion problem and was preventing vegetation from establishing. The solution was to move the primary trail approximately 10 ft away from the top of the bank.

The neighborhood had a concern with the obstruction of view from the road while walking on the trail. The solution was to break up the landscape plan into different zones (Figure 2). The zone between the street and the trail would be planted with only an upper canopy tree layer, enabling a more open view below the canopy, between about 3 ft and 8 ft. The zone between the trail and the stream would be planted with three tiers of vegetation, upper canopy, understory, and groundcover. Other requests from stakeholders were to have wildflower prairies and view corridors crossing the stream. To accommodate both requests, prairie plantings were placed immediately opposite each other along the stream using that as a view corridor. There was a request from the neighborhood association to put in a pedestrian bridge across the stream. This would have been prohibitively expensive and outside of the scope of this restoration project. A location was identified along the stream that was already a natural crossing and improvements were made in lieu of construction of a pedestrian bridge.

Figure 2. Planting zones delineating the different plant communities used to create the landscape design. The trail indicated is the new trail located further from the top of the stream bank than the previous trail.

The funds to implement this project were provided by the Field Operations Division of WPD. American Youth Works (AYW) was hired to do most of the labor on this project because they were cost-effective and had the skill set needed to perform the required minor earthwork, hardscaping, trail cutting, invasive plant removal, planting, and follow up maintenance. However, in addition to AYW, extensive volunteer labor from local stakeholders and neighbors was utilized throughout installation and maintenance phases of this project.

Prior to groundwork and planting, the entire reach was mowed excluding the stream channel. The first tasks for AYW were to remove invasive species and begin a phased cut and grade of the new trail. The focus species for removal were Ligustrum (*Ligustrum japonicum and L. sinense*), Chinaberry (*Melia azedarach*), Chinese Tallow (*Sabium sebiferum*), and Johnsongrass (*Sorghum halepense*). Removing invasive plants took multiple sessions in the first year and will continue to be part of the maintenance plan for four years after project completion. The new trail was made by first delineating the path with flags then clearing the vegetation with a string trimmer and hand tools. Prior to the major planting efforts, FLWR was given 20 lbs of a native grass and wildflower seed mix (Appendix B) to spread. Getting the seed out ahead of the other work increased the chance of the seed being pushed into the topsoil and germinating.

After the first round of invasive removal and trail cutting the site was ready for the irrigation to be installed. Due to budget constraints, the irrigation supplies were purchased directly from the supplier and the City of Austin Parks and Recreation Department (PARD) was hired to install the irrigation system and connect it to a temporary meter attached to a fire hydrant. With the irrigation system installed and running the site was ready for planting. Seven hundred trees, shrubs, and forbs (Appendix A) were delivered by Native Texas Nursery on September 27, 2010. On that same day AYW began digging holes and planting. A second crew from AYW showed up halfway through the week and began work on the hardscape. The hardscaping included cedar log terraces where street runoff was causing erosion and juniper log steps located at both ends of the trail and stream crossing (Figure 3). The new trail location needed upgrading, which involved leveling and cutting benches into the side slope of hills and digging drainage runs where necessary. AYW completed the groundwork and planting in 5 work days, with a crew of approximately 12 people per day.

Figure 3. Examples of hardscaping installed by AYW include juniper log access steps and terraces to prevent street from street runoff.

Results/Discussion

The irrigation system proved to be a major component in the success of the revegetation effort. The winter following the planting efforts was dry and cold followed by the 2011 spring and summer that set records for high heat and low precipitation. Originally the irrigation system was set up with timers and overhead sprinklers that were spaced to allow for near 100% coverage. There were some areas that the sprinklers did not reach and the newly planted vegetation in those

areas suffered severely. Use of the sprinklers enabled invasive non-native grasses to thrive, leading to a productive season for King Ranch bluestem and Bermuda grass in the irrigated areas.

To alleviate these problems many of the sprinklers were replaced with bubblers set at the base of the targeted woody trees and shrubs. While increasing the water reaching the roots of the larger plants, removing spray irrigation also gave the native grass community a better chance at out-competing the non-native grasses that are less acclimated to the hot, dry climate.

The above ground irrigation system was easily susceptible to damage from park users and cold weather. Repair to the system was occurring at a weekly rate which also meant that damaged areas were not being effectively irrigated. Weekly evaluations of the irrigation system were necessary to keep plants properly watered. During several periods, weeks to a month went by with infrequent or interrupted watering, causing severe stress to the plants. Changing many of the sprinklers to bubblers and better attaching the sprinkler risers to the support rebar greatly reduced the frequency of damage to the system as a whole.

Though a comprehensive count has not been conducted due to seasonal and drought variability, it is estimated that more than 80% of the trees and shrubs survived. Those that did perish have already been replaced by neighborhood volunteers. The meadow areas were full of wildflowers during the 2011 growing season. The prominent species were Mexican Hat (*Ratibida columnifera*), Indian Blanket (*Gaillardia pulchella*), Purple Horsemint (*Monarda citriodora*) and Greenthread (*Thelesperma filifolium*). The aquatic plant *Sagittaria platyphylla* was provided by the WPD rescue nursery to FLWR volunteers for in-stream habitat restoration efforts. As a result FLWR has planted more than 20 *Sagittaria* starts in Boggy Creek along the Willowbrook reach. Many of these have been washed away in heavy stormflow but in some locations they are proliferating.

Success of the grass seeding effort has been hard to measure because an inventory of pre-restoration grasses was not completed. Once the mowing was removed from the greenbelt the presence of non-native invasive grasses became more apparent. Far more resources could have been spent trying to control the invasive grasses but the decision was made to focus solely on Johnson grass (*Sorghum halepense*). Through the combined efforts of spraying and hand applying Round-Up (glyphosate) and Eraser AQ (glyphosate without surfactant) several times in the summer and fall, an estimated 90% of the mature Johnson grass stands have been eradicated . Continued efforts will be necessary to keep the Johnson grass under control. As the understory and overstory woody plants become more established, the increasing shade they provide is expected to have a detrimental effect on the non-native grasses and forbs, allowing for greater success from more shade tolerant native riparian plants.

Other non-native plants removed were Chinaberry (*Melia azedarach*), Chinese Tallow (*Triadica sebifera*), and Ligustrum (*Ligustrum japonicum* and *Ligustrum sinense*). All visible seedlings and saplings were removed, but some mature Chinaberry and Chinese Tallow were left in place as they provide critical shade. It is assumed they can be removed when the added native canopy trees become mature. Some of the poison ivy (*Toxicodendron radicans*) along the trail was also treated with herbicide. This was only done where the chance for accidental contact by park users

was very high. These efforts will be continued on a yearly basis until the new vegetation is better established.

Response of the neighborhood to the restoration project has been mostly positive. Being on site to make regular checks and repairs to the irrigation system provided WPD staff with the opportunity to speak to the daytime users of the greenbelt. WPD staff remained in contact with FLWR. There are people who do not like the trail being moved away from the edge of the creek and they refuse stop using it, resulting in the old trail not revegetating as was hoped. However, approximately 70% of the old trail has become overgrown.

The estimated cost for materials used in this revegetation effort was approximately $15,000 and covered an area of about 1.6 acres. Many parts of this project including the landscape and irrigation plan were performed by City of Austin staff. The cost estimate also does not include monthly water bills and irrigation supplies, which can exceed $300 per month. A more accurate itemized price estimate (Appendix C) was created and includes five years of maintenance. A comprehensive estimate works out to be approximately $39,000 per acre of restoration. Of this cost, less than $5,000 is for plants and seeds.

The Willowbrook restoration effort provides a good example of basic costs and effort for riparian revegetation in urban Austin. Riparian vegetative restoration appears to be relatively affordable when compared to more structural stream restoration efforts for which typical costs may be $850/linear foot. There are times when property and safety are at risk and the engineered approach is necessary, but in many situations riparian restoration such as the restoration project in the Willowbrook reach is an efficient model to utilize.

Recommendations

A full range of riparian measures were not taken prior to the initiation of this work. An inventory of non-native invasive plants and estimated coverage should be compiled along with types of historic disturbance. This information can then be used to better identify and customize further restoration efforts. When intensive mowing has occurred for a long time and the location is depleted of native species there will be a greater need for seed dispersal to compensate for lack of seed source. If an area that has been allowed to revegetate is replete with both native and non-native plants, managing just the non-native species may be a more effective approach.

Supplementing the planting of container plants with seeds for trees and shrubs could be beneficial during drought prone times or for when irrigation is not available. Seeds have the ability to sprout at the appropriate time and they have a higher below to above ground biomass ratio, enabling them to better tolerate periods of low precipitation. In addition to tree and shrub seeds, more aquatic plants and bare root grasses should be planted. Future restoration sites should receive more rooted plants in and at the water's edge, where water quality and erosion benefits are direct and possibly more effective.

Despite the reduction in rate of erosion, the banks along this reach are still heavily incised. These steep banks prevent frequent inundation of the stream side banks with water. Easy establishment of obligate or facultative plants is therefore impeded. In time the banks will erode

to form a more natural stream channel but this process could be hastened through mechanical means, though costs of the project would increase as would the impact from disturbance.

This method differs from the more common engineering practices performed in most stream rehabilitation projects. From an ecological perspective, the benefits should be greater than hardening the toe of the bank with concrete or large boulders and adding rip-rap to the channel walls. The time involved in the this type of restoration process is longer than those more active engineering methods. Recovery via revegetation will take more time as there are many levels of disturbance to overcome before a healthy functioning riparian system is recreated. Having an educated and dedicated group of local stakeholders makes the process of transitioning a highly maintained area into a natural state much easier and more likely to be successful, from both a water quality perspective and from a public perception perspective.

References

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Appendix A. Willowbrook Plant List

These plants were purchase from Native Texas Nursery in Austin Texas.

Item No.	Description	Quantitiy		
		4"	1 gallon	5 gallon
1.0	Mexican Sycamore			4
2.0	Pecan			7
3.0	Cedar Elm			7
4.0	Live Oak			7
5.0	Chinquapin Oak			8
6.0	Bur Oak			7
7.0	Huisache			5
8.0	Bald Cypress			4
9.0	Carolina Buckthorn			5
10.0	Possumhaw Holly			8
11.0	Yaupon Holly			7
12.0	Hop Tree			3
13.0	Mexican Plum			8
14.0	Rusty Blackhaw Viburnum			5
15.0	Redbud			8
16.0	Texas Persimon			3
17.0	Texas Mountain Laurel			3
18.0	American Beautyberry		18	
19.0	Coralberry		18	
20.0	Fragrant Mimosa		18	
21.0	Flameleaf Sumac		5	
22.0	Fragrant Sumac		25	
23.0	Spineless Prickley Pear		12	
24.0	Lindheimer's Nolina		25	
25.0	Chile Petin	2	20	
26.0	Texas Gold Columbine	6	20	
27.0	Fall Obedient Plant		10	
28.0	Frog Fruit	2	20	
29.0	Texas Lantana	2	20	
30.0	Gregg's Mist Flower	2	20	
31.0	Pigeonberry	2	20	
32.0	Turks Cap	2	20	
33.0	Orange Zexmenia	2	20	
34.0	Gulf Coast Muhly		10	
35.0	Webberville Sedge	4		
36.0	Horseherb	2		

Appendix B. Willowbrook Seed List

Seed purchased from Native American Seed in Junction Texas

7 lbs Midway Mix	
1 lb Shade friendly Grass	
1 lb Prairie Starter Mix	
2 lb Butterfly Retreat	
2 lb Hummers and Singers	
5 lb Shade Friendly Wildflower Mix	
Upland Switchgrass	For terraces under swing tree
Texas Wintergrass	For terraces under swing tree

Appendix C. Per Acre Cost

	Base Cost
Irrigation design	$300
Irrigation supplies	$2,500
Hydrant hookup	$485
Irrigation Installation	$2,500
Water	$3,600
Landscape design	$500
Plants	$2,200
Plant installation	$5,000
Soil retention blanket?	$1,500
Misc. materials	$500
Maintenance (5 years, 4k per year?)	$20,000
sum	$39,085