United States Environmental Protection Agency

2014 GREEN INFRASTRUCTURE TECHNICAL ASSISTANCE PROGRAM
Iowa City, IA

Towards a Resilient Future: Restoration of Ralston Creek within Riverfront Crossings Park

JUNE 2016
EPA 832-R-16-003

About the Green Infrastructure Technical Assistance Program

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, soil and plants absorb and filter the water. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby water bodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, *green infrastructure* refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, *green infrastructure* refers to stormwater management systems that mimic nature by soaking up and storing water. Green infrastructure can be a cost-effective approach to improving water quality and helping communities stretch their infrastructure investments further by providing multiple environmental, economic, and community benefits. This multibenefit approach creates sustainable and resilient water infrastructure that supports and revitalizes urban communities.

The U.S. Environmental Protection Agency (EPA) encourages communities to use green infrastructure to help manage stormwater runoff, reduce sewer overflows, and improve water quality. EPA recognizes the value of working collaboratively with communities to support broader adoption of green infrastructure approaches. Technical assistance is a key component to accelerating the implementation of green infrastructure across the nation and aligns with EPA's commitment to provide community-focused outreach and support in response to the President's *Priority Agenda for Enhancing the Climate Resilience of America's Natural Resources*. Creating more resilient systems will become increasingly important in the face of a changing climate. As more intense weather events or dwindling water supplies stress the performance of the nation's water infrastructure, green infrastructure offers an approach to increase resiliency and adaptability.

For more information, visit http://www.epa.gov/greeninfrastructure.

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This report was developed under U.S. Environmental Protection Agency (EPA) Contract No. EP-C-11-009 as part of the 2014 EPA Green Infrastructure Technical Assistance Program.

Cover photo: Southern equalization basin at the decommissioned North Wastewater Treatment Facility.

Contents

Figures

Tables

1 Executive Summary

Like many communities across the country that have established themselves along rivers, Iowa City has a rich history intricately linked to its water resources. Development has encroached upon the Iowa River and Ralston Creek to the point at which some areas of their channels have been hardened, straightened, or even buried. “Sunny-day development” of Iowa City’s floodplains has left critical infrastructure vulnerable to large floods and heavy storm events, which can occur more and more frequently with climate change affecting weather patterns.

The North Wastewater Treatment Plant, inundated during the flood of 2008, is one example of critical public infrastructure susceptible to flooding from the Iowa River. Located at the confluence of Ralston Creek and the Iowa River and immediately upstream of Highway 6, the site of the treatment plant becomes completely isolated during a 100-year flood event. Rather than continually protecting the treatment plant from future floods or repairing it after flood damage, Iowa City has decommissioned the plant and is removing all of the built components from the floodplain. As part of that project, the city plans to soften the edge along the Iowa River by creating a public park with 5 acres of restored floodplain and wetland area along Ralston Creek.

Restoring the floodplain and wetland areas on the treatment plant site can benefit water quality, flood resiliency, urban habitat, recreation, and education, and can serve as a catalyst to encourage additional economic development in adjacent areas. Creating a viable and sustainable ecosystem that can support the necessary flora requires a reliable water supply to reestablish wetland conditions. This component of the project consists of three main objectives:

- *To excavate the previously elevated floodplain to connect the restored wetland area to the ground water table*. Since this area is located at the confluence of the Iowa River and Ralston Creek, connecting it to ground water will provide reliable hydrology for the wetland and mimic the natural conditions found in stream confluences.
- *To restore Ralston Creek’s banks*. To maximize the potential of the wetland area to improve water quality, restoration of the creek banks is proposed to allow storm flows from the Ralston Creek watershed to flow into the wetland area during smaller, more frequent storm events, enabling physical and chemical processes to reduce sediment and nutrients.
- *To stabilize Ralston Creek*. Stream restoration structures and emergent plant species will be incorporated to support long-term stability, habitat creation, and the aesthetics of the project site. By incorporating natural stream structures, restoration activities along the banks and floodplain area will be protected until native vegetation can stabilize the site.

The stream and floodplain restoration is one component of a larger proposed park plan, which in turn is part of a larger redevelopment master plan for downtown Iowa City. Trails and pathways will connect the restoration site with the remainder of the park and the adjacent proposed mixed-use development area. City residents and visitors will be able to access the restored area at a variety of points and interact with ecosystems, plants, and habitats, which will help to instill a strong environmental ethic in frequent users of the park. The green infrastructure concepts implemented on a large scale in the restored wetland are easily transferable beyond the site. Smaller stormwater gravel wetlands are proposed as part of the master redevelopment plan to treat stormwater from impervious areas. The smaller wetlands, which will treat stormwater instead of storm flows, will perform similar water quality functions and incorporate similar plants, creating a seamless connection from the restoration project to the upland mixed-use area.

2 Introduction

Iowa City's history as the former state capital and home to the University of Iowa is richly intertwined with the Iowa River. Residential and commercial zones are located on both sides of the river, and the university's world-renowned hydraulics laboratory is built on the river to enable scientists to draw water for experiments directly from it. The city's history includes several large floods that have caused extensive damage to many city and university properties, even with the Coralville Dam controlling much of the watershed upstream. As the city continues to grow, much of its growth is focused on moving critical infrastructure out of the floodplain and providing effective management and safe access to the Iowa River corridor.

One such project is the decommissioning and demolition of the North Wastewater Treatment Plant, which is located at the confluence of the Iowa River and Ralston Creek and just north of Highway 6 (see Figure 1). The site is approximately 1 mile south of the University of Iowa campus and downtown Iowa City and is easily accessible from nearby residential areas. While the majority of the plant's components have been elevated out of the floodplain, some areas are still inundated during extreme flood events. One such event occurred in the summer of 2008 and left the facility nearly inoperable. Because of the increased risk, the plant was decommissioned and Iowa City received funding to demolish its components in preparation for converting the area into a public park. In addition to removing critical infrastructure from the floodplain, the proposed park will serve as a focal point and provide river access for planned redevelopment. Riverfront Crossings, the name of the redevelopment, will convert light industrial areas to the north and east of the project site into mixed-use residential and commercial areas, with a connection to the newly created park through the restored riparian wetland and floodplain areas of Ralston Creek.

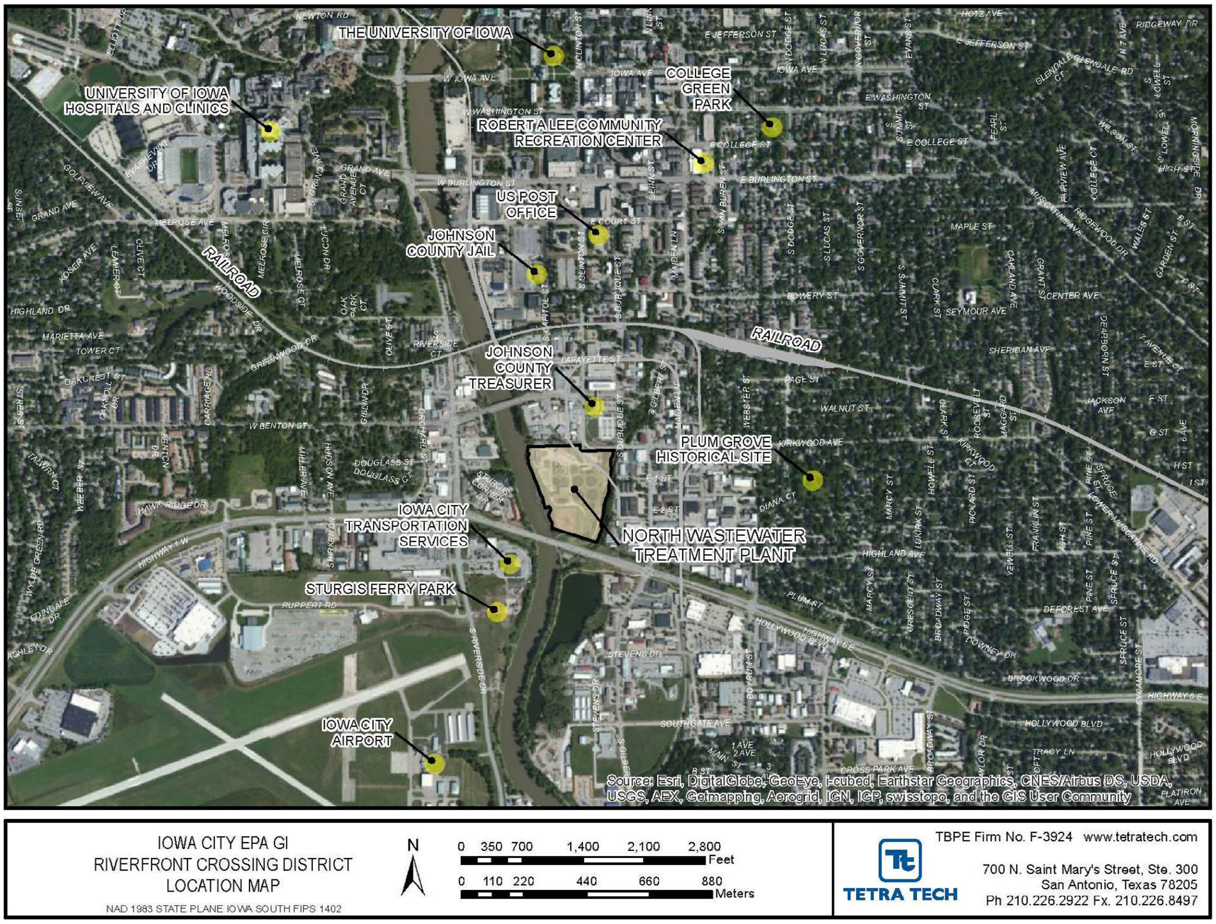


Figure 1. Location of the North Wastewater Treatment Plant within Iowa City.

2.1 Historical Conditions

The Iowa River has served as a major resource for Iowa City commercial and residential areas and the University of Iowa campus dating back to the 19th century. Several railroad and vehicular bridges have provided easy access to both sides of the river. A low-head dam located at the Burlington Street Bridge originally was constructed to provide river water for early experiments at the University of Iowa's C. Maxwell Stanley Hydraulics Laboratory, one of the nation's oldest hydraulics labs.

Iowa River flows are partially managed by the Coralville Dam located approximately 5 miles upstream of the city. During the historic Iowa Flood of 2008, the Iowa River crested at 31.53 feet (ft) at Iowa City, 3 ft above the previous peak set during the disastrous flood of 1993 (Buchmiller and Eash 2010). The flooding caused significant damage to sections of the city and the university and inundated the North Wastewater Treatment Plant (Figure 2).

Following the extreme flood event in 2008, Iowa City developed plans to decommission the treatment facility and direct wastewater to the upgraded South Wastewater Treatment Plant, located approximately 4 miles downstream. The North Wastewater Treatment Plant is no longer operating and Iowa City is currently developing plans to demolish the existing buildings on the site.

Source: Iowa Homeland Security.
Figure 2. 2008 Flood Overview—North Wastewater Treatment Facility.

The floodplain at the confluence of Ralston Creek and the river was modified to accommodate the construction of the North Wastewater Treatment Plant. Since its construction in the mid-1930s, the facility has undergone modifications and expansions that have further altered the local landscape. The treatment plant and construction of Highway 6 along the southern border of the plant have divided and greatly impacted the natural floodplain.

The historic condition of the floodplain area is unknown, but a review of the *Soil Survey of Johnson County Iowa* indicates that the site consists of Sparta loamy fine sand, typical of stream benches and uplands (Schermerhorn 1983). That soil type is excessively drained and normally found on shallow slopes, common with the loess and glacial drift that makes up much of the soil parent material in the region.

2.2 Project Overview and Goals

The construction of the North Wastewater Treatment Plant and Highway 6, along with the need to protect critical infrastructure from flood events, resulted in the modification of Ralston Creek and loss of its ecosystem diversity. It also disconnected the Ralston Creek and Iowa River floodplains. With the removal of the buildings and equipment, Iowa City has the opportunity to transition the site back to its historic, natural condition.

The city intends to convert the treatment facility site into a multiuse public park to increase access to the Iowa River and provide open, natural space for the benefit of the community. Conversion plans include designs for a 5-acre portion of the site to reestablish natural floodplain connections and to promote additional flood mitigation benefits via off-channel constructed wetlands. The purpose of this project is to produce a concept plan for the restoration of Ralston Creek that improves flow and habitat conditions and maximizes the treatment of stormwater overflows in constructed wetlands within the reclaimed floodplain.

2.3 Project Benefits

To protect critical infrastructure near the treatment facility, Ralston Creek was straightened, hardened, and essentially forgotten. Riprap lines both banks in some areas and the channel cross-section remains uniform through much of the study reach. Without restoration of the floodplain, which is significantly higher than the bed of the creek and disconnected from bankfull flows, adjustments to the channel pattern or cross-section will have little impact on the health of the ecosystem. Creating a floodplain that is accessible under frequent flow conditions will help to establish the hydrologic regimes necessary for healthy stream conditions, to promote aquatic life, and to reconnect nearby residents to a water resource that has been significantly minimized throughout Iowa City.

2.3.1 Water Quality Benefits

A constructed wetland system located within the Ralston Creek floodplain will accept storm flows from the creek and provide water quality benefits through longer residence time, resulting in additional settling, filtering, and plant uptake processes. By primarily treating creek flows that occur during short, intense storm events, the off-channel wetland can provide water quality benefits and complement the water quality improvements from site-scale green infrastructure distributed throughout the watershed. Restoration from a channelized stream reach to a naturalized section can increase travel time, and a study by Bukaveckas (2007) has shown that slowing water velocities can result in significantly higher nutrient uptake rates. Cadenasso et al. (2008) offered many options for reducing nitrate yield from urban areas, noting that the "key ability of new functional interfaces to serve as hot spots for denitrification in urban watershed[s] is for them to capture nitrate-laden water and hold it long enough under the anaerobic, high-carbon conditions suitable for denitrification to occur" (Cadenasso et al. 2008, p. 223). Directing smaller storm flows from Ralston Creek into a constructed wetland area to provide the necessary conditions and residence time for denitrification could result in a significant reduction in nutrients reaching the Iowa River.

2.3.2 Flood Resiliency Benefits

In an attempt to floodproof the North Wastewater Treatment Plant, the wastewater treatment facilities were elevated to remain outside of the floodplain, creating an island between Ralston Creek and the Iowa River during flood events. By lowering the elevated area and introducing a tiered approach to the landscape and plant material, the restored floodplain area will be able to handle larger and longer flood events that impact the Iowa River.

2.3.3 Habitat Benefits

The riparian areas and channel banks along the river and the creek upstream of the treatment plant are heavily developed. Little shelter or food supply is available to encourage aquatic animal diversity within the Iowa River or Ralston Creek corridors throughout Iowa City. Restoring Ralston Creek and the surrounding floodplain into a riparian wetland area would provide much-needed habitat to sustain a rich aquatic ecosystem. In a survey of why landowners restore wetlands conducted by Pease et al. (1996), more than 80 percent of respondents listed providing habitat for wildlife as “extremely important.”

2.3.4 Recreational and Educational Benefits

The restoration of Ralston Creek and the associated floodplain at this location creates an opportunity for area residents and visitors to access the stream. In its current condition, the stream is largely unavailable due to encroachment of the riparian area by commercial and industrial land uses along with an incised stream channel. A tiered, or *benched*, approach to channel restoration that results in a range of elevations will inspire a variety of habitats as well as multiple vantage and access points to use to interact with the habitat areas.

2.3.5 Local Redevelopment Benefits

The conversion of the North Wastewater Treatment Plant site to a park and restored floodplain serves as a critical focal point of a planned Riverfront Crossings redevelopment project (HDR 2013). The park district, shown conceptually in Figure 3, is central to the walkable, mixed-use redevelopment anticipated along the Iowa River and Ralston Creek. The proposed park will serve as a public amenity for the neighboring community and the entire city, but also will inspire green infrastructure and sustainability themes that can be carried out on a smaller scale in the surrounding residential and commercial areas.

Source: HDR 2013.

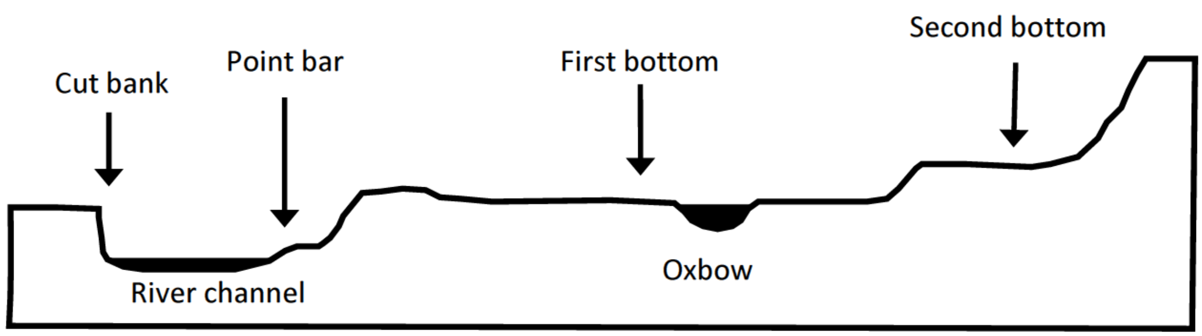
Figure 3. Riverfront Crossings Conceptual Rendering of the Park District (labels added).

3 Design Approach

The floodplain restoration of the 5-acre portion of the site focuses on reconnecting more frequent storm flows within Ralston Creek to a larger floodplain area. Plans include a constructed wetland to maximize the water quality benefits associated with storm flows inundating the larger floodplain area.

The designs for the restored portion of Ralston Creek, the reclaimed floodplain area at the confluence of the creek and the Iowa River, and the constructed wetland mimic historical conditions at the site or natural features commonly found in similar environments. The design is intended to improve ecosystem health at all flow levels by establishing multiple inundation zones, each defined by different flood events. The different zones allow the design to incorporate a wide variety of plant species, contributing to the diverse environment necessary for resilience under varying water surface elevations.

Multiple zones located at different elevations are typical of forested floodplains in Iowa. Randall and Herring (2012) note that “flooding can both enhance and stress a riparian ecosystem” (Randall and Herring 2012, p. 1). They identify three main floodplain site types as “point bar,” “first bottom,” and “second bottom” (see Figure 4). The design of the restored Ralston Creek and reclaimed floodplain follows these types, with the added curvature of the Ralston Creek pattern establishing the point bar, the constructed wetland simulating an oxbow feature within the first bottom, and the remnant treatment facility site elevation serving as the high terrace, or second bottom.



Source: Randall and Herring 2012.
Figure 4. Floodplain Site Types.

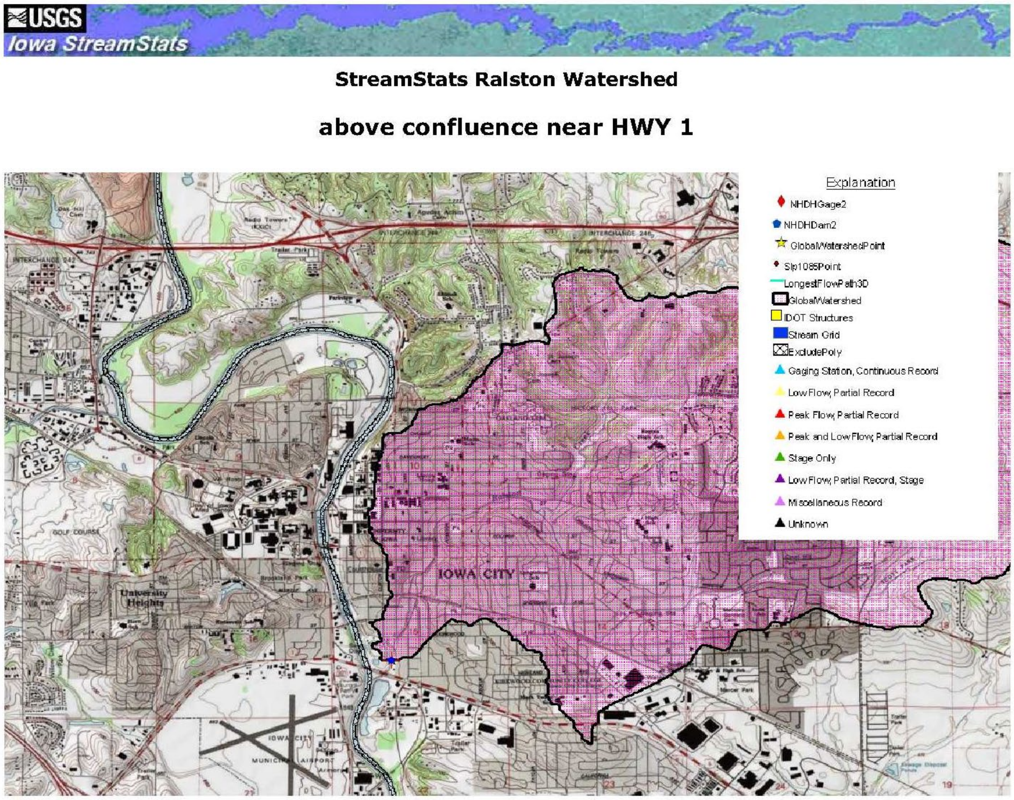
The hydrology of Ralston Creek serves as the basis for establishing elevations of the floodplain zones. The creek’s watershed (about 9 square miles) is much smaller and more urbanized than the Iowa River watershed (more than 3,200 square miles at Iowa City), making the creek much more responsive to smaller but more intense storm events. Targeting the more frequent fluctuations is consistent with typical design guidance for other green infrastructure, such as the EPA’s criteria of retaining the 95th percentile storm intended to provide significant water quality treatment (USEPA 2009). In this instance, the smaller storm events are not used to size retention areas but to set the elevation at which storm flows will access the overbank area, treating nutrients and sediment through physical and chemical processes that occur in floodplain areas.

3.1 Hydrology

The restoration site is influenced by flows from Ralston Creek and the Iowa River, both of which have defined Federal Emergency Management Agency floodplains. The Johnson County Flood Insurance Study (FIS) indicates that the 100-year flood (the highest elevation that has a 1 percent chance of occurring annually) for the Iowa River varies from an elevation of 644.6 ft at Highway 6 and increases to an elevation of 645.5 ft at the railroad crossing located near the northern portion of the treatment facility site (FEMA 2002). This represents approximately a 1-foot drop in head as the river flows along the site from north to south, passing under the structures at the railroad, Benton Street, and Highway 6. Flood elevations of all of the expected storm events vary from about 18 ft to about 26 ft above the stream bed of the Iowa River. As most of the existing treatment plant site is situated at elevations above 640 ft, most of the site is currently subjected only to the 10-percent chance flood (or 10-year return frequency) and higher. This is typical of a higher terrace feature. Access to a floodplain between the 1- and 10-year return intervals is not consistently available throughout the site. Setting the water surface elevations for lower flood events is important for establishing the correct elevation for the first bottom zone. During higher flood events, the floodplain in the area is dominated by the Iowa River; however, during lower flood events, the water surface elevations most likely will differ between the Iowa River and Ralston Creek.

Randall and Herring (2012) indicate that first bottoms flood every 1–3 years, which is consistent with the bankfull frequencies commonly used in stream restoration design (Woodyer 1968). Established flood elevations are not available within the FIS for events below the 10-year return interval. Therefore, to develop water levels for lower storm events, USGS StreamStats was used to determine flows at the ungaged Ralston Creek (Eash et al. 2013).[1] Figure 5 shows the delineated watershed for Ralston Creek displayed in the StreamStats program.

[1] A USGS stream gage is located along the south branch of Ralston Creek but is not appropriate to use to determine flows at the treatment facility site.

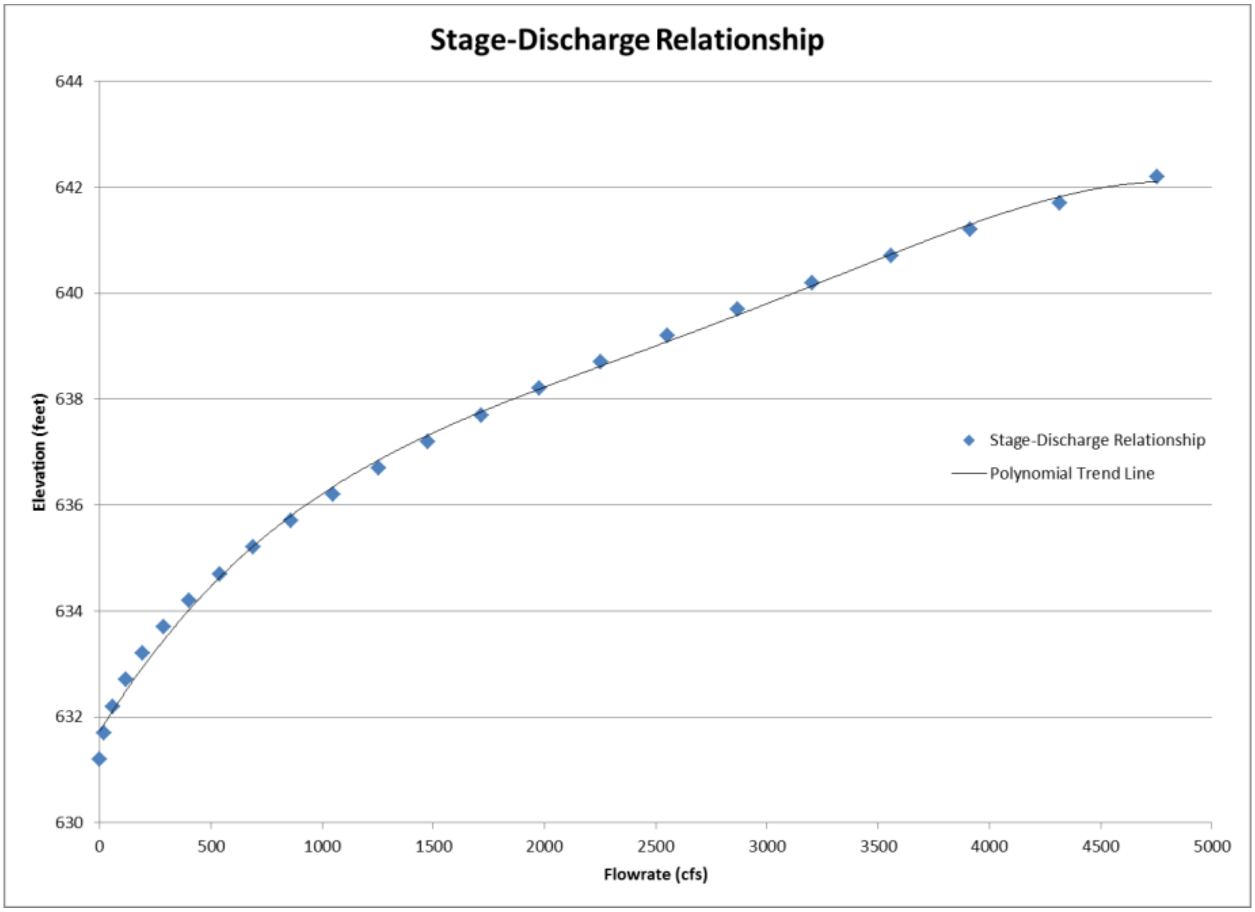


Source: USGS StreamStats.

Figure 5. Screen Capture Showing the Ralston Creek Watershed.

While StreamStats can be an effective way to quickly establish flows over a broad range of return intervals, they still need to be converted to flood elevations. To determine elevations, the city provided a cross-section of Ralston Creek created from site topography. Manning's equation was used along with conservative assumptions for energy slope (0.004) and roughness (0.05) to develop a stage-discharge relationship for Ralston Creek in the area of the treatment facility site, as shown in Figure 6. Flows for the 2-, 5-, 10-, 25-, and 50-year return intervals were converted to elevations using this relationship, as shown in Table 1.

Table 2 compares the elevations calculated using the StreamStats flows and the stage-discharge relationship to the established elevations presented in the FIS (FEMA 2002). While the difference for the 10-year flood is less than one-half of a foot, this difference doubles at the 50-year return interval. The reliability of this analysis is limited at higher flow events, but it can be used for lower flow events to establish the first bottom level. For this conceptual design, the top of the bank for the restored Ralston Creek will be set at 634 ft to fit within the 1–3-year flood frequency typical of Iowa floodplains.



Source: USGS StreamStats.

Figure 6. Stage-Discharge Relationship for Ralston Creek Determined Using Flows.

Table 1. Ralston Creek Water Surface Elevations

Frequency (Years)	Flow (cfs)	Elevation (ft)
2	558	634.7
5	1,210	636.7
10	1,850	638.0
25	2,830	639.5
50	3,500	640.6

Source: USGS StreamStats.
Note: cfs = cubic feet per second.

Table 2. Difference in Elevation between FIS and StreamStats Flows

Frequency (Years)	Elevation from FIS (ft)	Elevation from StreamStats (ft)	Difference (ft)
10	638.4	638.0	0.4
50	641.4	640.6	0.8

Sources: FEMA 2002; USGS StreamStats.

Performing a regression analysis on gage data over a period of 111 years enables a comparison with the Iowa River water surface elevations. The USGS National Water Information System provided the stage and discharge data for the Iowa River stream gage at Iowa City. That gage is located eight-tenths of a mile upstream from the mouth of Ralston Creek. A Log Pearson Type III flood frequency analysis was performed to determine flowrates for the 2- and 5-year return intervals and a stage-discharge relationship was developed for the Iowa River gage and used to convert the selected flows to water surface elevations. To relate the water surface elevations determined at the stream gage to water surface elevations at the treatment facility site, a consistent conversion factor was applied to the data. Table 3 shows a comparison between the Iowa River elevations—calculated with the regression analysis as well as with the 10-year water surface elevation included in the FIS—and the Ralston Creek elevations. Although the data show minimal difference at the 2-year frequency, the difference varies significantly at higher flood events.

Table 3. Comparison of Iowa River and Ralston Creek Flood Elevations

Frequency (Years)	Iowa River		Ralston Creek		Difference (ft)
	Elevation from FIS (ft)	Elevation from Regression (ft)	Elevation from FIS (ft)	Elevation from StreamStats (ft)	
2		634.9		634.7	0.2
5		638.9		636.7	2.2
10	639.8		638.4		1.4

Sources: FEMA 2002; USGS StreamStats.

Establishing an oxbow feature or, in this case, an off-channel constructed wetland, requires tapping into ground water sources to obtain the hydrologic conditions necessary to support emergent wetland plant species. Since this project is at a conceptual level, no soil borings or ground water investigations were conducted. Instead, past soil investigations were used to determine potential ground water levels. A subsurface investigation was conducted in July 1994 as part of proposed improvements to the wastewater treatment and collection facilities (Terracon Consultants 1994). Four borings were conducted within and adjacent to the treatment facility; appendix A provides a map of the boring locations and the boring logs. Table 4 shows ground water levels for the boring locations.

Table 4. Ground Water Elevations

Boring No.	Description of Location	Surface Elevation (ft)	Ground Water Elevation (ft)
NP-1	Northeast corner of site, near east bank of the Iowa River	645.1	630.1
B-5	East side of site, along west bank of Ralston Creek	641.5	631.5
B-7	Southeast corner of site, along west bank of Ralston Creek	641.5	633.0
B-7A	Southeast corner of site, along east bank of Ralston Creek	646.4	626.4
Range of Elevations		641.5–646.4	626.4–633.0

Source: Terracon Consultants 1994.

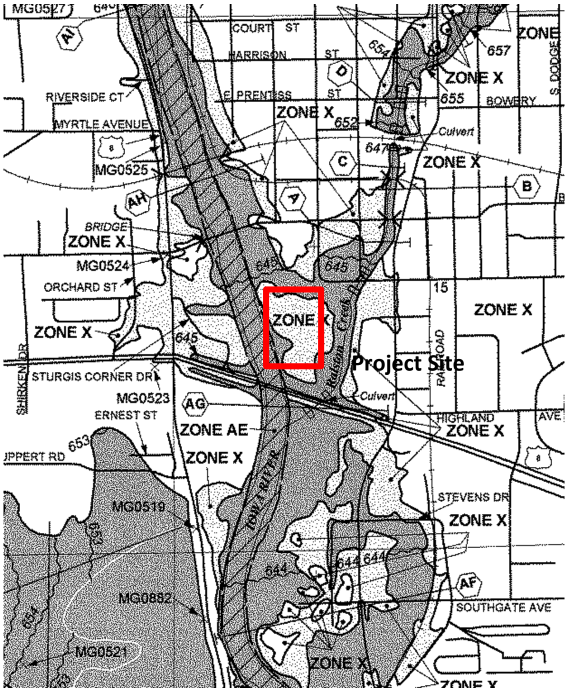
The borings conducted in 1994 show a range of ground water levels across the site. Excluding boring 7A, which is located on the east side of Ralston Creek and not within the treatment facility site, the values range from approximately 630 ft at the northeast corner of the site near the Iowa River to 633 ft at the southeast corner of the site near Ralston Creek. For the purposes of this concept design, a summer ground water range of 630–633 ft will be used to establish elevations for the constructed wetland.

Revisiting the cross-section showing the typical zones of Iowa floodplains in Figure 4, Table 5 lists the defining elevations for each level. These elevations will determine the grading within the proposed 5-acre restoration area.

Table 5. Design Elevations for Floodplain Zones

Floodplain Feature	Elevation (ft)
Point Bar	632–634
First Bottom	634
Constructed Wetland	631
Second Bottom (Higher Terrace)	638–640

Existing flood studies and gage analyses were used to establish the design elevations of the floodplain zones to allow frequent storms to access the overbank areas. Proposed grading changes within the site make the area more accessible to flood flows and could have an effect on the floodplain surface elevations. A section of the flood insurance rate map shows that a large portion of the treatment facility site is located in zone X, surrounded by zone AE (Figure 7). The floodplain model might need to be altered and resimulated to provide the final floodplain elevations needed for design. The current floodplain delineation also includes both a floodplain (flood hazard) and a floodway. The proposed project should not alter the floodway, but rather create a larger floodplain area by removing some of the fill material at the treatment plant construction site. A more detailed hydraulic modeling analysis of the Iowa River than was performed as part of the conceptual design should be included in future design efforts, especially if the park redevelopment results in significant alteration of the berm along the east bank of the Iowa River.



Source: FEMA 2002.

Figure 7. Project Site shown in Zone X on the Johnson County FIRM, Panel 195

3.2 Soils

The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) provides soil surveys for Johnson County from 1922 and 1983 (Tharp and Artis 1922; Schermerhorn 1983). Evaluating both surveys often provides separate information, as older soil surveys often provide a better context for replicating the historic floodplain conditions and more recent surveys provide data on current disturbed conditions. In this case, the two soil surveys represent conditions before and after the construction of the North Wastewater Treatment Plant. According to the 1922 survey, the prevailing soil types were silt loams of loessial origin. Rolling hills found within the region were forested and the soils were not high in organic matter. Flatter areas typically consisted of prairies generally well supplied with humus. Floodplains along rivers often made very fertile agricultural lands, and farmers historically stripped them of timber and converted them to farmland.

According to the 1922 NRCS soil survey, there was little alluvial land along the course of the Iowa River. Below Iowa City, however, was approximately 30 square miles of floodplain and terrace. Only occasional expansions of the narrow floodplain existed above Iowa City, but below the city the valley widened to 2–3 miles and produced tillable bottom land suitable for agriculture (Tharp and Artis 1922).

The 1983 NRCS maps show the site soils as 7, 11B, 41, 163F, and 793. The Iowa River is listed as "W" for water. The portion of the property where the treatment plant is currently located is completely in the designation 41, which refers to soil type Sparta—fine sand mixed with loamy fine sand. That soil type maintains a depth to the high water table of at least 6 ft or more below the surface. Sparta is an extremely well-drained soil type and is designated as hydrologic soil group A (Schermerhorn 1983).

The 11B area contains soil type Colo—frequently flooded soil and is found at the location of Ralston Creek. This soil type consists primarily of silty clay loam with a high water table typically found between 1 –3 ft below the surface. Colo is subjected to occasional flooding and is poorly drained, designated as hydrologic soil group B/D. Appendix B provides a map of the soil types found in that area.

Soils with hydrologic groups of A and B and high water tables are not hydric or conducive to wetland formation without connecting to the reliable hydrologic conditions needed to create a saturated or inundated condition that promotes anaerobic conditions during the wet season. However, these soils can support vibrant forested areas that accept overbank riverine flooding. Creating off-channel wetland systems in this area requires a connection to the ground water level to establish the necessary hydrologic conditions. This process is similar to the forming of oxbow lakes from remnant channel sections that are closely tied to the ground water level. In natural environments, oxbow lakes often transition to wetland areas through the accumulation of sediment and wetland seed banks during overbank flood flows.

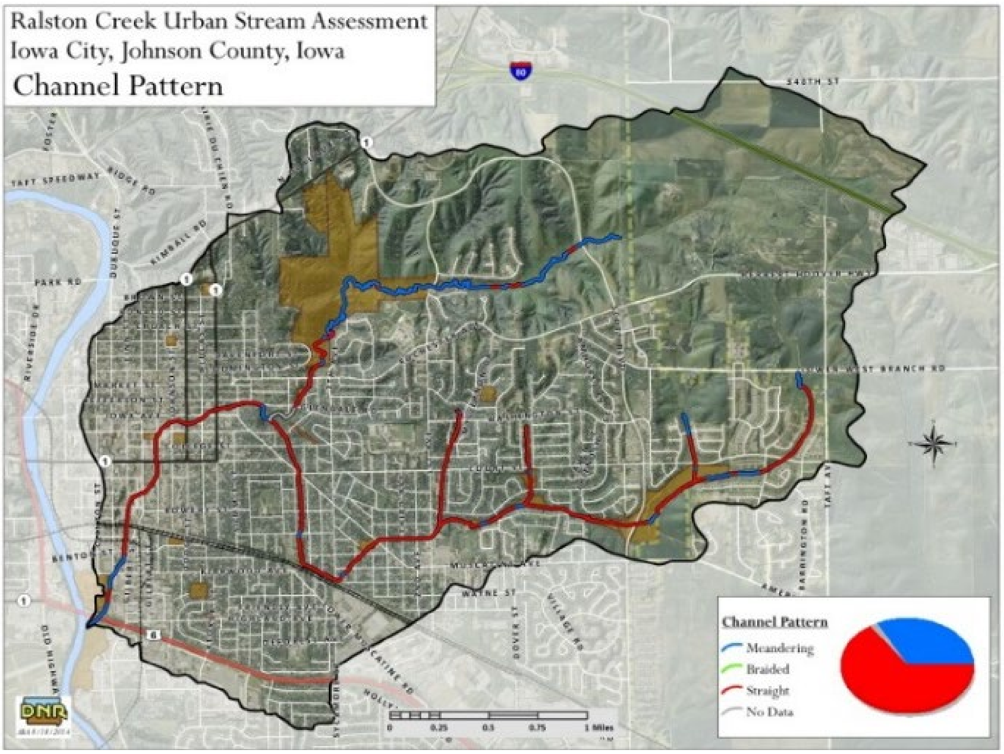
3.3 Topography

The confluence of the Iowa River and Ralston Creek is near the portion of the state where the riverine system transitions from riparian conditions to the north, characterized by steeper bluffs cut by the river and little adjacent floodplain, to conditions further south, characterized by broader expanses of floodplain as large as 2–3 miles wide. The restoration system proposed in this conceptual design would transition to overbank systems that follow the concept of providing for multiple hydrological conditions and habitats to match the overall transition to wider floodplains typical of southern Iowa.

3.4 Geomorphology

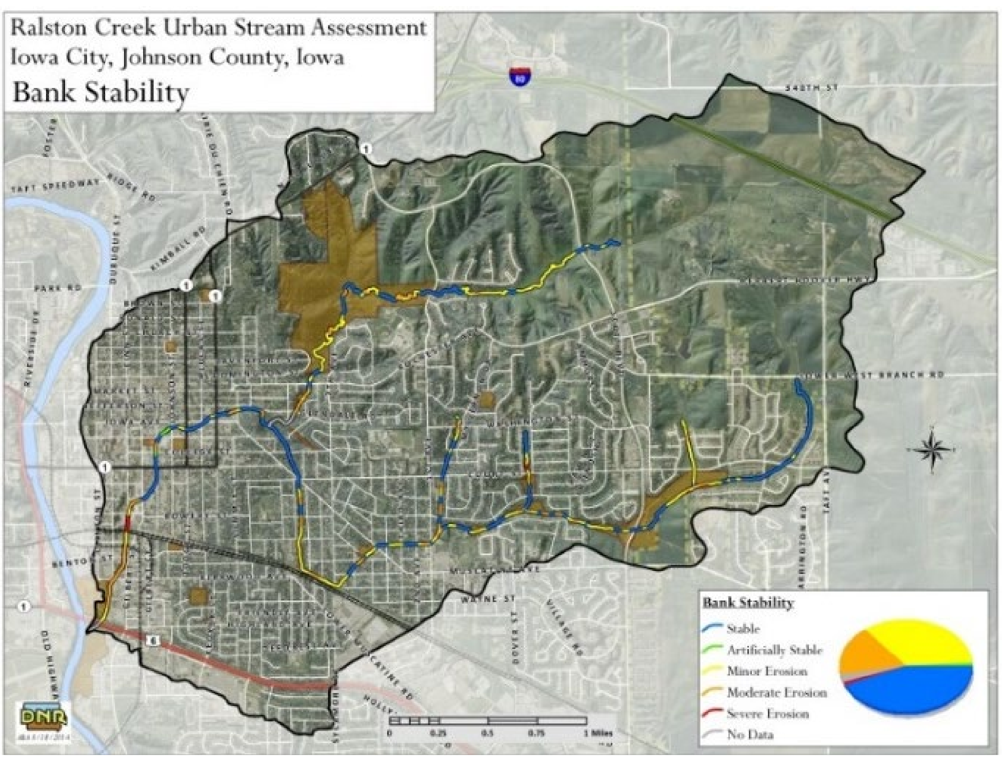
Geomorphological field assessments were not conducted as part of this conceptual-level design. To develop an understanding of geomorphologic conditions, historic maps and an external stream assessment were examined.

The Iowa Department of Natural Resources recently conducted a watershedwide assessment of Ralston Creek, producing several informative maps that document current stream conditions (IDNR 2014). Figure 8 through Figure 11 show some of the stream parameters IDNR evaluated: channel pattern, bank stability, channel condition, and bank height. Table 6 includes a comparison of the parameters between the section of Ralston Creek along the treatment facility site and the dominating condition of the Ralston Creek watershed.



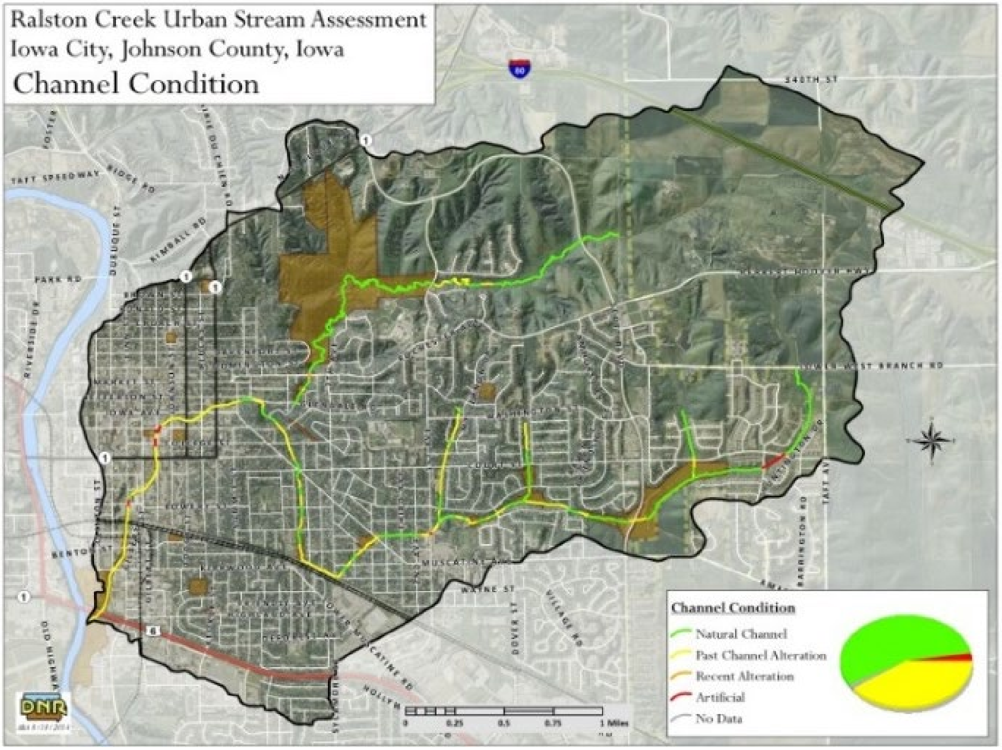
Source: IDNR 2014.

Figure 8. Channel Pattern of Ralston Creek.



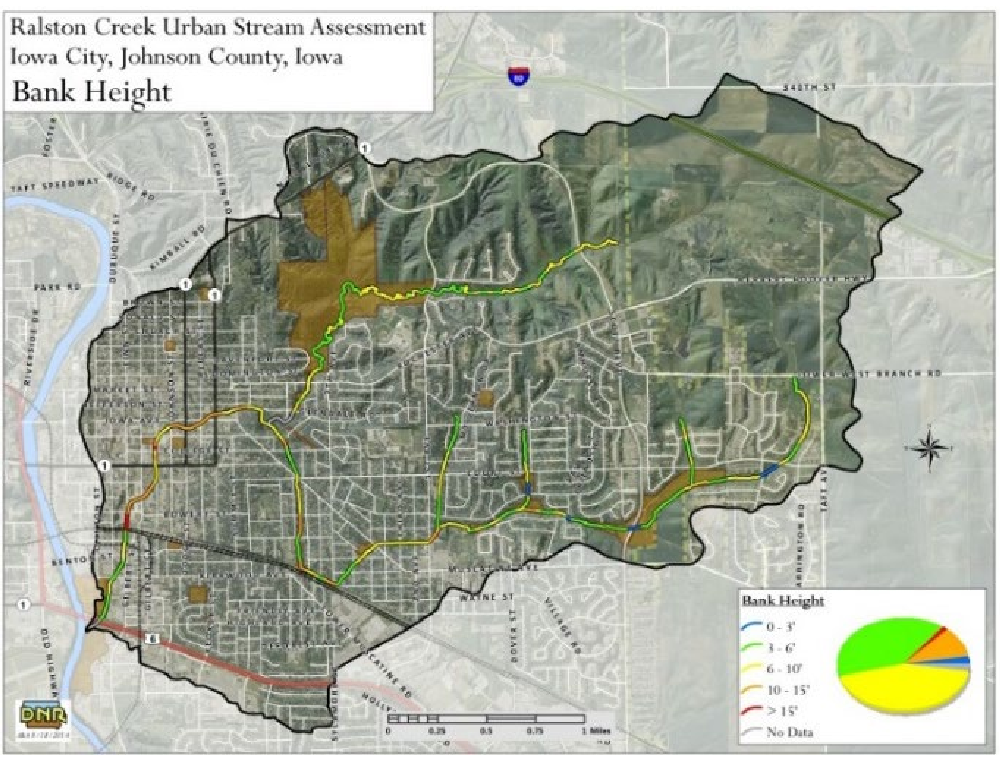
Source: IDNR 2014.

Figure 9. Bank Stability of Ralston Creek.



Source: IDNR 2014.

Figure 10. Channel Condition of Ralston Creek.



Source: IDNR 2014.

Figure 11. Bank Height of Ralston Creek.

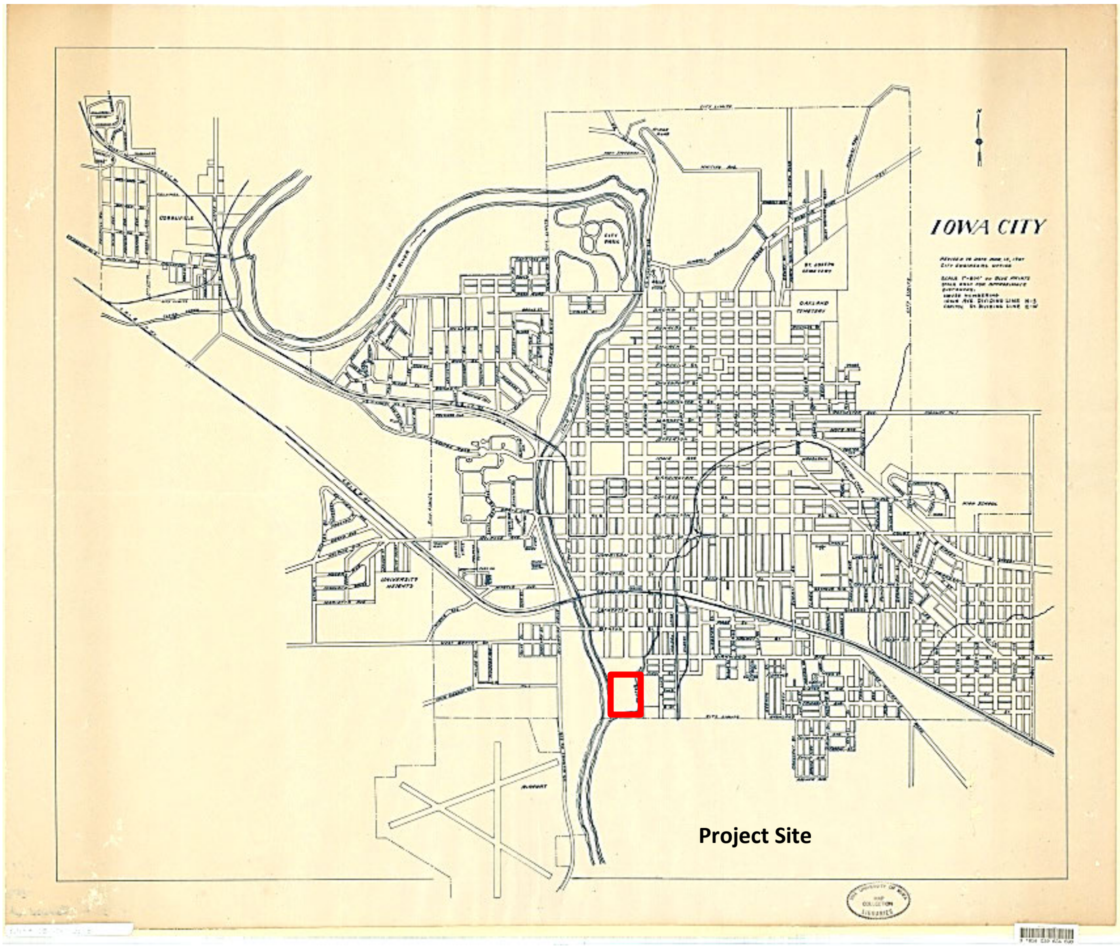
Table 6. Ralston Creek Watershed Stream Assessment

Stream Parameter	Condition at Treatment Facility Site	Dominating Condition in Watershed
Channel Pattern	Meandering, straight	Straight
Bank Stability	Moderate erosion, minor erosion	Stable
Channel Condition	Past channel alteration	Natural channel
Bank Height	6–10 ft	3–6 ft, 6–10 ft

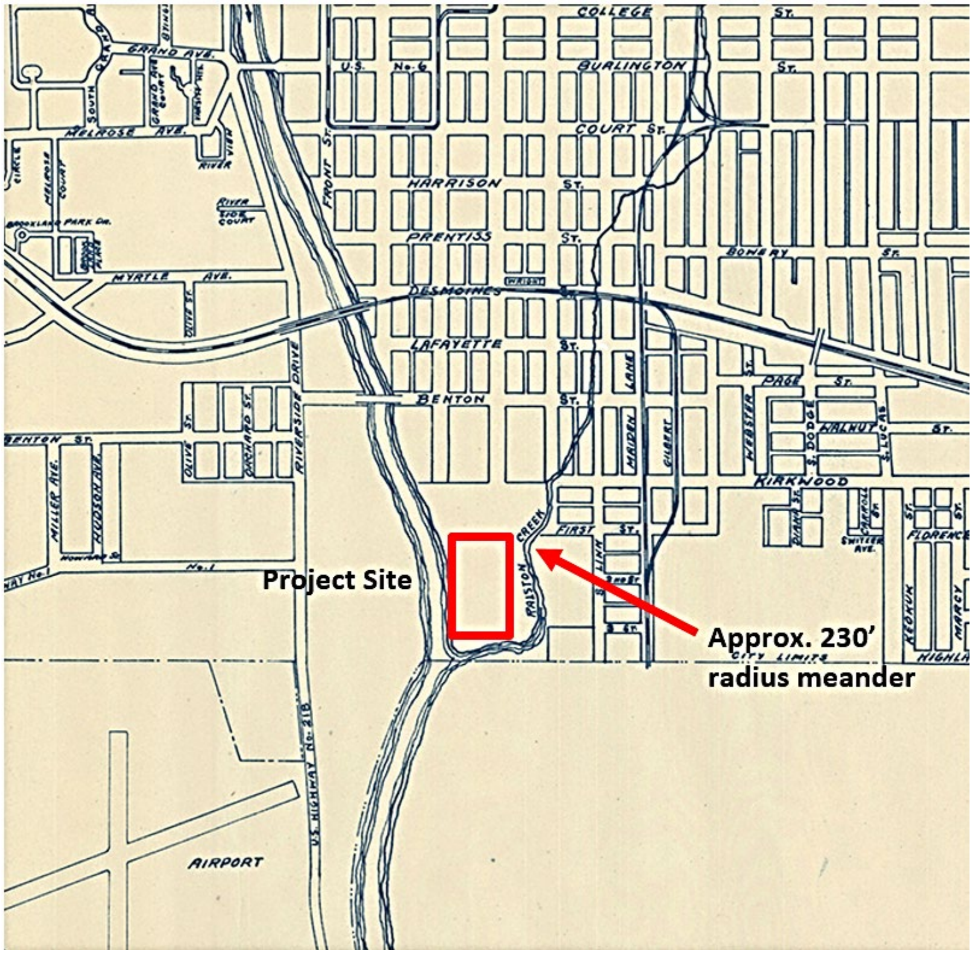
Source: IDNR 2014.

Stable and natural channels dominate the overall condition of Ralston Creek. In contrast, the section of Ralston Creek bordering the treatment facility site is disconnected from the floodplain, altered, and showing erosion. The figures from the IDNR assessment show a more comprehensive view of Ralston Creek. Even though much of Ralston Creek is considered to be a natural channel condition, high banks and erosion are still present in these sections. The assessment indicates that Ralston Creek could be evolving as a result of changes in hydrology within the watershed. Restoration of this section of Ralston Creek to preexisting natural conditions found upstream could serve as a guide for future restoration upstream if instabilities continue.

The IDNR assessment validates the opportunity for channel restoration along the selected reach of Ralston Creek. As discussed in section 3.1, Hydrology, Iowa floodplains typically include a point bar that extends towards a first bottom. Establishing the appropriate connection to the first bottom is critical to restoring a natural channel condition. Even with that connection, however, creating a point bar feature is not possible in a straightened stream channel. An investigation into previous conditions can help to establish the appropriate curvature required to initiate the creation of point bar features. Figure 12 shows a map of Iowa City that the City Engineer's Office prepared in 1947. A close-up of the treatment facility site shows the historic pattern of Ralston Creek (Figure 13). Mimicking those conditions leads to the establishment of a meandering channel with a radius of curvature in the bends of approximately 230 ft (Iowa City Engineer's Office 1947).



Source: Iowa City Engineer's Office 1947.
Figure 12. Map of Iowa City (1947).



Source: Iowa City Engineer’s Office 1947.

Figure 13. Close-up of Treatment Facility Site (1947).

3.5 Habitat and Water Quality

Wetlands can be used to treat stormwater flows and as a green infrastructure approach to improve water quality (Miller 2007; USEPA 1999). Stormwater runoff is a major source of pollutants to our waterways and has been shown to transport pesticides, oils, heavy metals, nutrients, and other pollutants (Lenhart and Hunt 2011). Constructed wetlands provide many environmental benefits. They enhance water quality by mitigating peaks in flow, replenishing ground water, reducing channel erosion, using vegetation to reduce pollution, and providing wildlife habitat (SMRC 2014; USEPA 1995; USEPA 1999).

The effectiveness of stormwater wetlands in pollutant removal is dependent on establishing proper hydrology, appropriate flow paths, wetland system type, and loading rates. Stormwater wetlands achieve pollutant removal through physical (e.g., sedimentation, filtration), chemical (e.g., precipitation, adsorption to sediments), and biological (e.g., plant and bacterial uptake) mechanisms (USEPA 1996). In *Storm Water Technology Fact Sheet: Storm Water Wetlands*, EPA indicates significant long-term removal rates for many key pollutants found in urban environments (Table 7) (USEPA 1999).

Table 7. Performance of Stormwater Wetlands

Pollutant	Removal Rate
Total Suspended Solids	67%
Total Phosphorus	49%
Total Nitrogen	28%
Organic Carbon	34%
Petroleum Hydrocarbons	87%
Cadmium	36%
Copper	41%
Lead	62%
Zinc	45%
Bacteria	77%

Source: Modified from USEPA 1999.

A recent study of stormwater wetlands in North Carolina found significant reductions in peak flows and runoff volumes by 80 percent and 54 percent, respectively. In addition, pollutant load reductions were significant—total Kjeldahl nitrogen: 35 percent; nitrate/nitrite (NO_{2+3}): 41 percent; ammonium (NH_4-N): 42 percent; total nitrogen (TN): 36 percent; total phosphorus (TP): 47 percent; organophosphate OP: 61 percent; and total suspended solids (TSS): 49 percent (Lenhart and Hunt 2011). The International Stormwater BMP Database is a compilation of BMP effectiveness measures from various designs throughout the world. According to the July 2012 update, when looking at wetland basins and channels, median removal of pollutants comparing inflow to outflow included TSS: 20.0–20.4 milligrams per liter (mg/L) inflow and 9.06–14.3 mg/L outflow; TP: 0.13–0.15 mg/L inflow and 0.08–0.14 mg/L outflow; and TN: 1.14–1.59 mg/L inflow and 1.19–1.33 mg/L outflow (Leisenberg 2012).

Although the types and effectiveness of constructed wetland systems vary, a common factor in the success of all wetland systems is the presence of proper hydrology. The dominant soils in the treatment facility site are well draining and not conducive to establishing the anaerobic conditions necessary to support wetland vegetation. In many constructed wetlands, a natural or synthetic liner is installed to prevent water from draining through the soil media and ultimately establishing a hydric soil community. The success of constructed wetlands with liners is dependent on a reliable water supply that can provide the proper hydrology. In the case of constructed wetlands for wastewater treatment, effluent discharges can reliably provide that supply. In the case of stormwater treatment, the wetland system rely on the dynamic nature of storm events. In both cases, proper sizing of the wetland to match the incoming load is critical to the success of the system.

Alternatively, a constructed wetland also can tie into the ground water supply to provide the necessary hydrology. Ground water can provide a reliable source of water for wetland systems, even in well-drained soils, and is not dependent on loading variations. Ground water levels do fluctuate, which can lead to large-scale changes in plant communities, but effects can be mitigated by providing a diversity of plants at a variety of elevations throughout the wetland area. A thorough understanding of the local ground water table is needed to successfully establish wetland plant communities, ensuring that they can access the ground water supply at the correct times throughout the year. The fluctuation of the ground water table will ultimately define the final grading plan, and the correct ground elevations will support establishment of a strong wetland plant community.

The diversity of plants and elevations also supports a range of habitats and promotes use by a variety of wildlife. Wetlands can provide food sources, access to water, and refuge from predators and environmental conditions. They are among the most biologically productive ecosystems in the world. Up to one-half of North American bird species nest or feed in wetlands and, although wetlands make up only about 5 percent of the land surface in the continental United States, about 31 percent of the plant species found in wetlands (USEPA 2001a). Research has shown that constructed wetlands support high levels of biodiversity among phytoplankton, zooplankton, benthic macroinvertebrates, fish, and birds (Shaharuddin et al. 2011). Additionally, a national survey conducted by Pease et al. (1996) found that 85 percent of landowners believe that providing habitat for wildlife is an extremely important reason for restoring wetlands. Bordered by the Iowa River on the west, Highway 6 on the south, and existing and proposed development areas on the north and east, the treatment facility site can become an important urban oasis for wildlife.

4 Conceptual Design

The approach to the conceptual design of the Iowa City restoration site was to re-create the historic floodplain conditions and establish an off-channel wetland to maximize water quality treatment during frequent storm events. This approach requires the establishment of multiple elevations that replicate the functionality of typical floodplain systems in the region, while stabilizing entry and exit points for flows from both Ralston Creek and the Iowa River. Ultimately, the functionality of the flood flow and water quality components of the site should seamlessly integrate with the other proposed modifications and amenities of the park site to encourage public interaction and environmental education in all portions of the reclaimed treatment facility site. Figure 14 shows a cross section of the proposed restoration design for Ralston Creek and the off-channel wetland area.

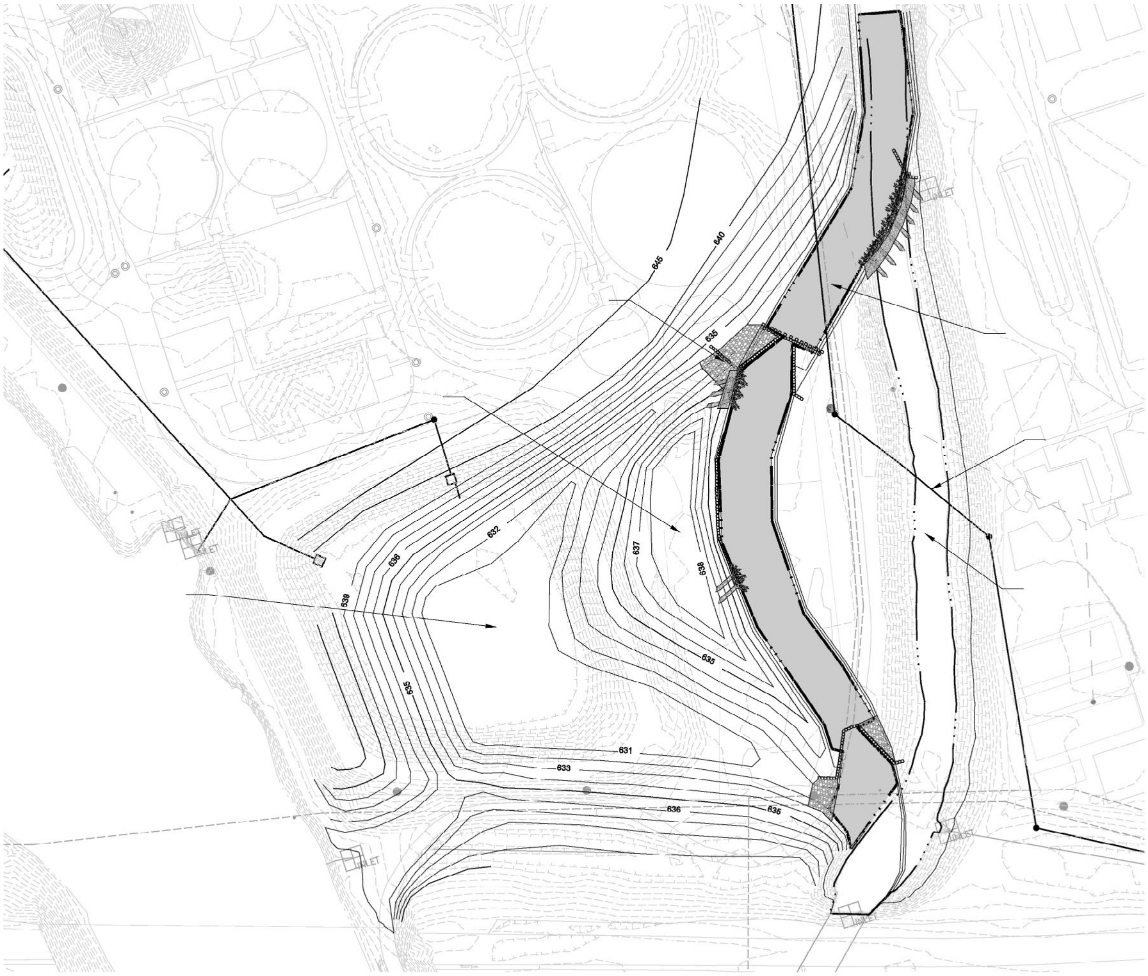
Source: Tetra Tech.

Figure 14. Conceptual Rendering of Restoration Cross Section.

4.1 Stream/Wetland Complex

To develop a restored stream/wetland complex that returns natural functionality to this site, a 5-acre parcel was selected that begins near the abandoned railroad crossing of Ralston Creek and gradually expands to include the area between the Iowa River and Ralston Creek on the south side of the site, ending near the Highway 6 embankment. Appendix C provides an outline of the proposed restoration area. The primary floodplain and wetland restoration components of the project will be located within this area, although grading could extend beyond the boundary to tie into existing grades or other park features. Appendix D provides conceptual grading plans of the site (including cross sections); Figure 15 also provides a view of the grading in this area.

The restoration of Ralston Creek into a natural channel with a stable stream-floodplain connection requires adjustment of the channel cross section and pattern further to the west. The top elevation of the banks is generally set at 634 ft to provide overbank flows under the 1–2-year flood frequency. A bench will be graded into the east bank of the creek at that elevation until it matches the existing left bank. The grading will reduce stresses along the existing left bank, which the city does not currently control. A radius of curvature of approximately 230 ft—estimated from historical maps of the area to match preexisting conditions—is used to pull the channel away from the existing left bank and push it back to reconnect with the existing channel location slightly upstream of the culvert under Highway 6.



Source: Tetra Tech
Figure 15. Proposed Grading for the Restoration Area.

Reestablishing sinuosity within this section of the complex will help to naturally create point bars in the meander bends connecting the stream bed to the first bottom, or *primary bench*. Creating the point bars is important to manage sediment within this reach and to encourage habitat diversity in the channel. Point bars and channel sinuosity also can have an effect on local variations in water surface elevation for various flood events, adjusting specific locations of overbank flows.

The ground water-supplied wetland area is established by using the existing topography to simulate an oxbow lake configuration. Significant excavation is necessary to establish the approximately 631-ft elevation required to access the ground water table. Locating the wetland area at the site of the existing equalization pond (elevation of approximately 638 ft) minimizes this excavation. Typically, oxbow lakes form from remnant channel sections of large meanders that are cut off from the main channel; to simulate this formation, a high terrace will be left between Ralston Creek and the created wetland. The high terrace is the second bottom and is located at an elevation of approximately 638 ft to adhere to the secondary level found in Iowa floodplains. The terrace is a typical feature of stream corridors throughout this region.

The high terrace serves multiple functions. Primarily, it helps to ensure that park users access the newly established floodplain and wetland area only at specific locations. Intentional access points along the high terrace help protect the sensitive wetland ecosystem, promote safety, and provide multiple viewpoints for park users. From a geomorphic perspective, the significant modifications to the channel pattern and overbank floodplain proposed in this concept design can alter the creek's capacity to transport sediment. Loads from upstream could dynamically adjust water surface elevations and overbank flow locations. Maintaining the high terrace helps to ensure that overbank flows primarily follow designed entrance and exit points into and out of the wetland area. The entry and exit points can be reinforced to provide long-term stability of the system. The high terrace also creates a higher established bank on the outside bend of the restored stream channel, helping to maintain natural flow conditions within Ralston Creek. Finally, the high terrace allows a wider variation of plant material within the area such as less flood-resistant plants.

To promote more access to the wetland and floodplain areas during lower storm events, the conceptual design includes lower portions of the west bank of Ralston Creek in areas where there is a remnant channel. The lower areas, located at approximately 633 ft, would be accessed during the 1-year flood event or perhaps even more frequently. These areas should be graded appropriately to maintain a positive drainage from the entrance to the exit to facilitate a natural flow-through system following the direction of the riparian corridor.

Water surface elevations of the 2-year flood frequency for the Iowa River are similar to those established for Ralston Creek. Currently, a berm along the east bank of the Iowa River prevents the flows from accessing this area, and it is not until nearly the 10-year flood event that the Iowa River directly inundates portions of this site. The concept plan proposes lowering the elevations only slightly, to an elevation of approximately 636 ft, which is more closely tied to the 5-year flood event. No other major changes to the berm are proposed in this project as a way to reduce grading and cut on the site and to minimize any impacts to the Iowa River floodway. Coordinating with other proposed park uses could adjust the ultimate grading and elevations within the area.

This proposed design requires a significant amount of cut and, ultimately, removal of material from the site to match the multiple design elevations. Initial estimates indicate a net cut of more than 64,000 cubic yards of material.

4.2 Water Quality Treatment

By not connecting the Iowa River and Ralston Creek at lower flow events, the full wetland and floodplain area is available to treat smaller storm events from the Ralston Creek watershed. With an overbank connection to Ralston Creek near the mouth, this area can assist in removing sediment, nutrients, and other pollutants before they enter the Iowa River. Stormwater flows up to the 2-year event will enter only from Ralston Creek,[2] and the proposed high terrace and additional site grading will result in longer flow paths and residence times within the system.

[2] Flood events higher than the 2-year event will begin to experience backwater effects from the Iowa River.

While the ultimate size of the wetland portion depends on available ground water hydrology, a minimum of one-half acre of permanent wetland area located at an elevation of 631 ft is proposed. This permanent wetland area could expand to 1 acre depending on ground water and overbank flow availability. Significant water quality improvements are not limited to the permanent wetland area. As the water surface elevation increases, flows access larger portions of the site, which causes filtering and uptake processes to occur. Figure 16 shows the inundation of the site under flood conditions. The permanent wetland area under normal flow conditions (631 ft, shown in blue) is approximately one-half acre. As the water surface elevation increases to 634 ft (between the 1- and 2-year events), flows inundate more than 1 acre of the site. At 634 ft, flood flows access nearly 4 acres of the restored site. Under current conditions, the banks of Ralston Creek at that elevation would still confine the flows; however, under restored conditions, there is the possibility for greater water quality benefits through physical, biological, and chemical processes.

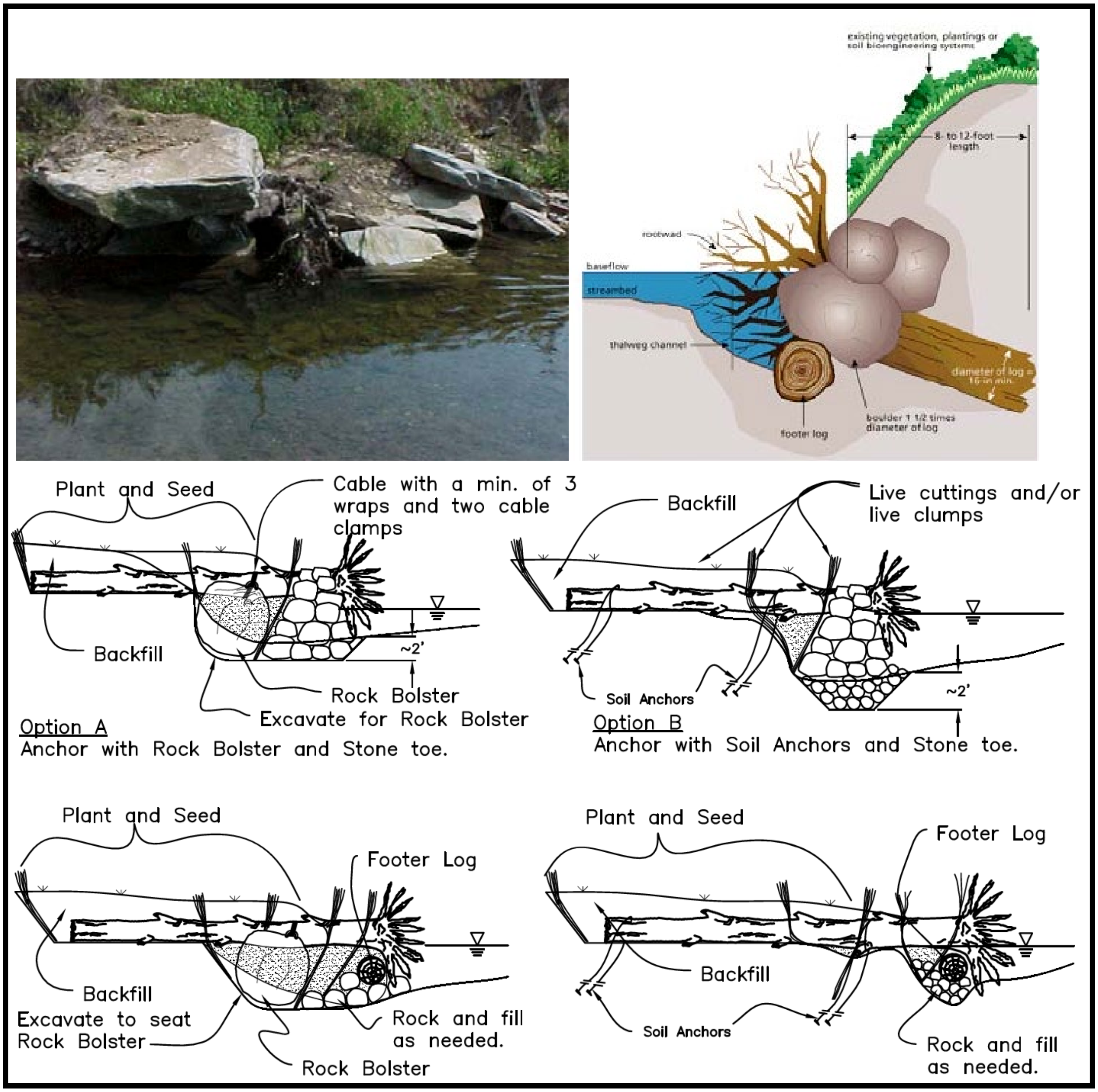
Source: Tetra Tech

Figure 16. Site Inundation under Flood Conditions.

4.3 Typical Restoration Components

Typical restoration features that would be beneficial in the design of a stormwater wetland and for improving the bank and meander pattern of Ralston Creek include root wads, cross vanes, vegetated soil lifts, and imbricated streambed material.

Root wad structures can help to stabilize banks and provide in-stream habitat among the root branches for fish and invertebrates. Figure 17 shows typical examples of how a root wad can help stabilize the edge of a streambank.



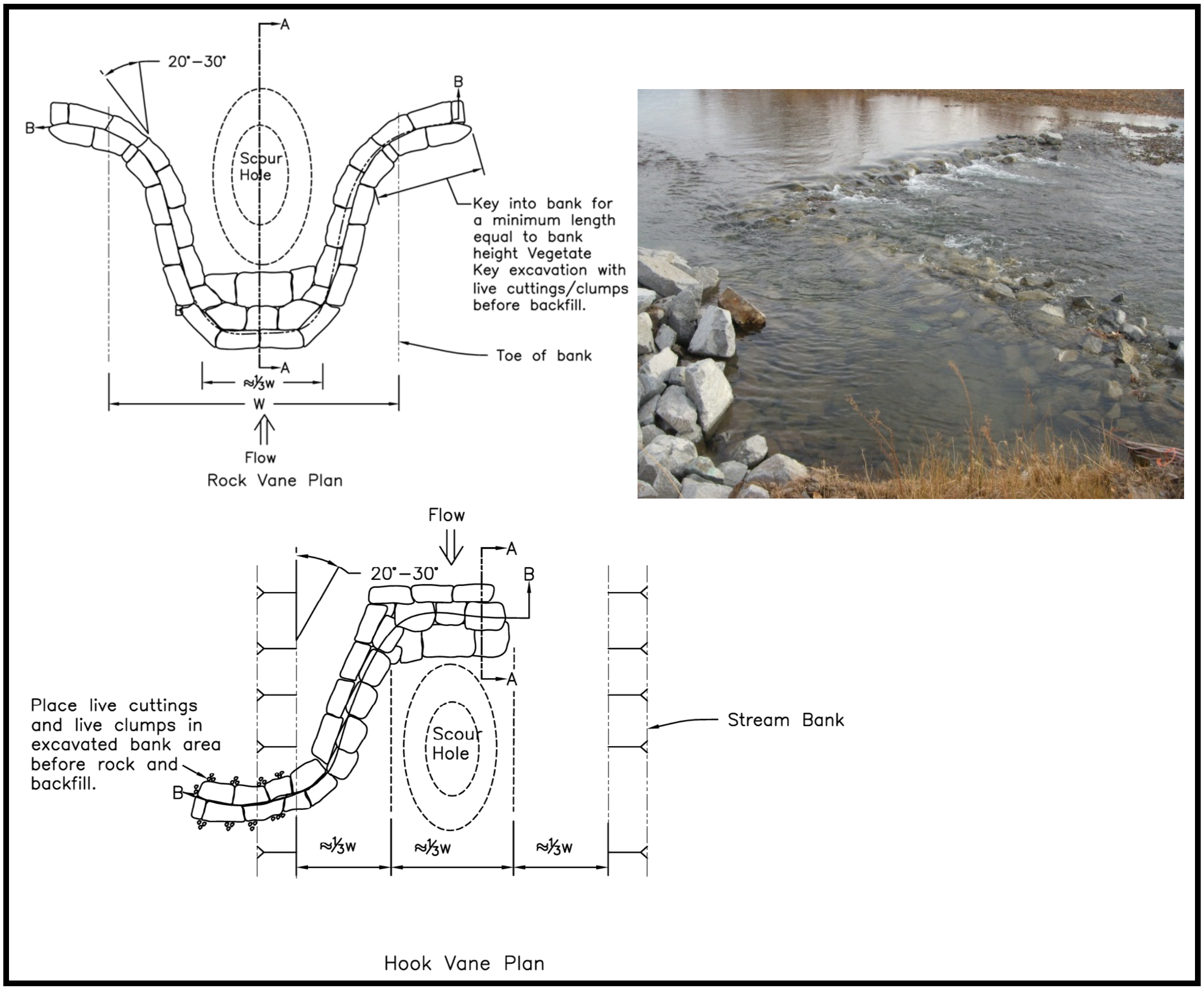
Sources: USEPA 2001b; NRCS 2008.

Figure 17. Examples of Design Details and Field Photos of Root Wads Used in Restoration.

Cross vanes or *J-hook vanes* can help to stabilize a channel and to channel flow away from banks to prevent erosion. Figure 18 shows a typical detail of cross vanes and J-hook vanes, as well as a photo of a cross vane in practice.

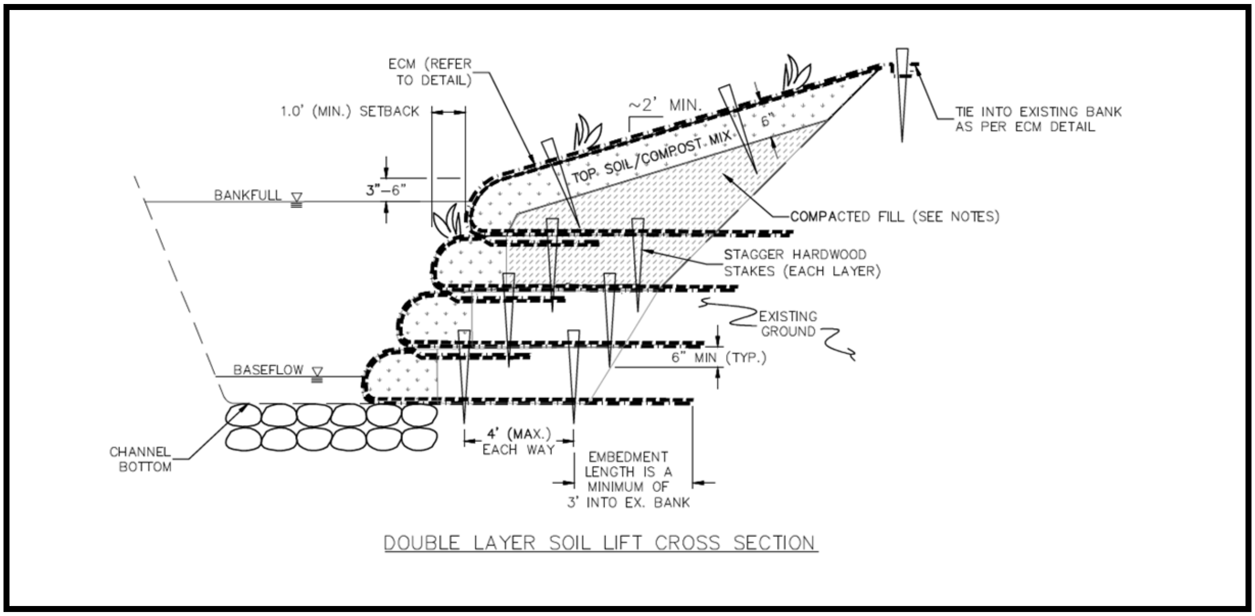
Soil lifts can help to stabilize a bank and to tie it in to a more gradual slope. Figure 19 shows a typical detail of a soil lift.

Imbricated rip-rap can help to stabilize a bank and prevent erosion. Figure 20 shows a typical detail of imbricated rip-rap.



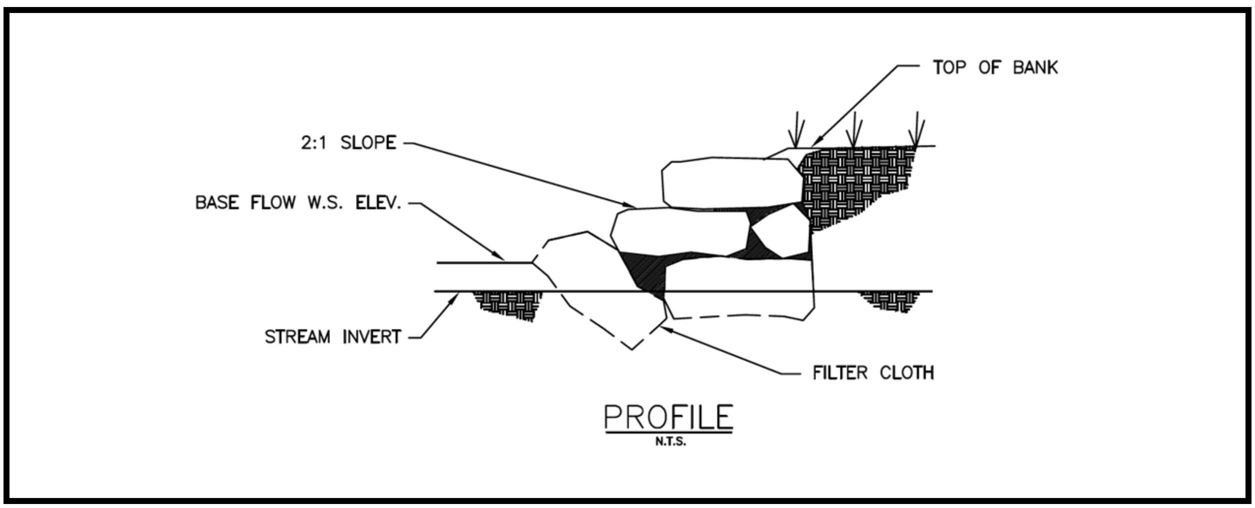
Sources: NRCS 2006, 2007.

Figure 18. Design Details and Field Photo of Cross Vanes Used in Restoration.



Source: WSSC 2013.

Figure 19. Design Detail of Double Soil Lift Used in Restoration.



Source: M-NCPPC 2014.

Figure 20. Design Detail of Imbricated Rip-Rap Used in Restoration.

4.4 Plant Palette

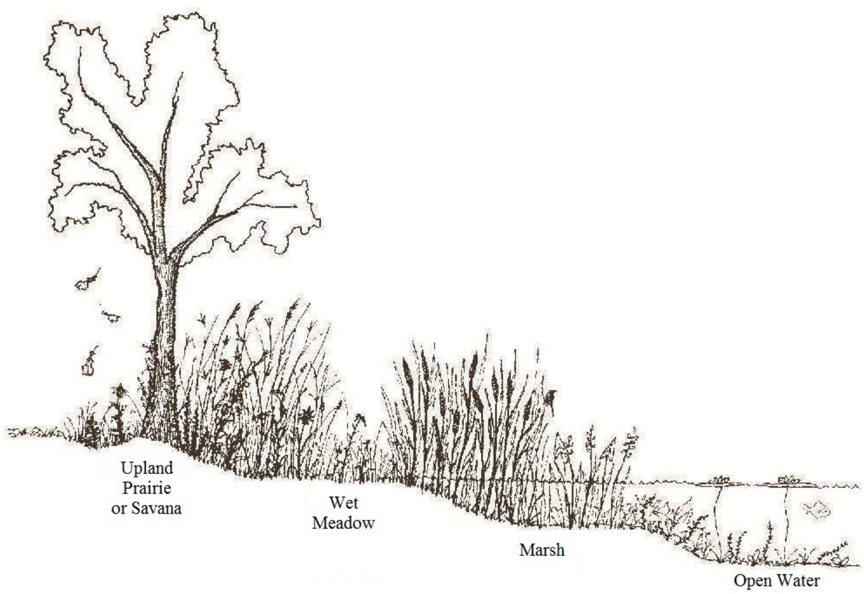
In this region of Iowa, native stream/wetland systems contain a variety of species with a significant adapted variation to perennial or periodic inundation. The tolerance of those species would sort out along the hydrologic gradient based on the frequency and duration with which the areas become inundated or saturated. Wetlands often are categorized based on the typical water depth during the growing season and the vegetative community, as described in Table 8 (Shaw and Fredine 1956). The proposed restoration of the wetland involves connection to the ground water table to maintain wetland hydrology; no open water wetland areas are proposed. Instead, the proposed wetland area will be planted with a marsh vegetative community and transition gradually to wet meadow and upland plants.

(see Figure 21). The delineation between these vegetative communities will depend on hydrology and other environmental factors, and will likely adjust as the proposed restoration stabilizes. Similar plantings will be established along the restored Ralston Creek, with an emphasis on wet meadow plants.

Table 8. Wetland Types by Water Depth

Wetland Type	Water Depth	Vegetative Community
Wet Meadow	No standing water, soils saturated	Grasses, sedges, rushes, various broad-leaved plants
Marsh	Up to 3 ft	Grasses, bulrushes, spikerushes, cattails, reeds, pondweeds, waterlilies
Open Water	3–10 ft	Pondweeds, coontail, watermilfoils, waterlilies

Source: Shaw and Fredine 1956.



Source: Arbuckle and Pease 1999.

Figure 21. Typical Cross Section of Wetland Types.

The following criteria were assessed in selecting the palette of plant species:

- Mimic a typical floodplain wetland with vegetation native to Iowa.
- Require as little maintenance as possible during the species establishment period.
- Contain advantageous seed dispersal and germination traits so that natural regeneration occurs and the system is sustained.
- Resist varied hydrologic conditions to enable adaptive management and to increase survivability under natural stabilization processes.
- Be readily available at nurseries and in stock in sizes that make sense for initial planting.
- Create an environment for diverse wildlife.
- Result in an environmental restoration project that is aesthetically pleasing to the public.

The palette of plant species includes grasses and grass-like plants (Table 9), flowering plants (Table 10), and trees and shrubs (Table 11) and was created to meet the desired criteria and is based on each species' suitability for each of the wetland types proposed for the project. The conceptual grading plans will create a tiered approach with opportunities for differing hydrologic flood regimes so that the system will stabilize and adjust its native composition, as any natural system does with time.

Table 9. Grasses and Grass-Like Plants

Grasses and Grass-Like Plants				
Species			Wetland Type	
Common Name	Scientific Name	Upland Prairie	Wet Meadow	Marsh
Big Bluestem	*Andropogon gerardii*	X	X	
Bluejoint	*Calamagrostis canadensis*		X	
Sedges	*Carex spp.*		X	X
Spike Rushes	*Eleocharis spp.*		X	X
Virginia Wild Rye	*Elymus virginicus*		X	
Mana Grass	*Glyceria spp.*		X	X
Rushes	*Juncus spp.*	X	X	X
Cutgrasses	*Leersia spp.*		X	
Common Reed	*Phragmites australis*			X
Fowl Blue Grass	*Poa palustris*	X	X	
Bulrushes	*Schoenoplectus spp.*			X
Dark Green Bulrush	*Scirpus atrovirens*		X	X
Wool Grass	*Scirpus cyperinus*		X	X
Prairie Cordgrass	*Spartina pectinata*		X	
Broadleaf Cattail	*Typha latifolia*			X

Table 10. Flowering Plants

Flowering Plants				
Species			Wetland Type	
Common Name	Scientific Name	Upland Prairie	Wet Meadow	Marsh
Nodding Onion	*Allium cernuum*	X	X	
Canada Anemone	*Anemone canadensis*	X	X	
Milkweeds	*Asclepias spp.*	X	X	
Sticktight	*Bidens spp.*		X	
False Aster	*Boltonia asteroides*	X	X	
Buttonbush	*Cephalanthus occidentalis*		X	
Flat Topped Aster	*Doellingeria umbellata*	X	X	
Rattlesnake Master	*Eryngium yuccifolium*	X	X	
Bonset	*Eupatorium perfoliatum*		X	

Flowering Plants				
Species			Wetland Type	
Common Name	Scientific Name	Upland Prairie	Wet Meadow	Marsh
Joe Pye Weed	*Eutrochium spp.*		X	
Sneezeweed	*Helenium autumnale*	X	X	
Sawtooth Sunflower	*Helianthus grosseserratus*	X	X	
Cow Parsnip	*Heracleum maximum*	X	X	
Rose Mallow	*Hibiscus laevis*		X	
Great St. John's Wort	*Hypericum ascyron*	X	X	
Blue Flag Iris	*Iris virginica*		X	
Prairie Blazingstar	*Liatris pycnostachya*	X	X	
Great Blue Lobelia	*Lobelia siphilitica*		X	
Monkey Flower	*Mimulus spp.*		X	
White Water Lily	*Nymphaea odorata*			X
Smartweed	*Persicaria spp.*		X	X
Pondweed	*Potamogeton spp.*			X
Mountain Mint	*Pycnanthemum spp.*	X	X	
Sweet Blackeyed Susan	*Rudbeckia subtomentosa*	X	X	
Water Dock	*Rumex britannica*		X	X
Arrowhead	*Sagittaria spp.*			X
Cup Plant	*Silphium perfoliatum*	X	X	
Goldenrod	*Solidago spp.*	X	X	
Aster	*Symphyotrichum spp.*		X	
Blue Vervain	*Verbena hastata*	X	X	
Ironweed	*Vernonia gigantea*	X	X	
Golden Alexander	*Zizia aurea*	X	X	

Table 11. Tree and Shrubs

Trees and Shrubs				
Species			Wetland Type	
Common Name	Scientific Name	Upland Prairie	Wet Meadow	Marsh
Red Maple	*Acer rubrum*	X	X	
Silver Maple	*Acer saccharinum*	X	X	
Speckled Alder	*Alnus incana*	X	X	
Ohio Buckeye	*Aesculus glabra*	X	X	
Birch	*Betula spp.*	X	X	
Pecan	*Carya illinoinensis*	X	X	
Shell-Bark Hickory	*Carya laciniosa*	X	X	
Dogwood	*Cornus spp.*	X	X	
Black Walnut	*Juglans nigra*	X	X	
Eastern Red Cedar	*Juniperus virginiana*	X	X	
American Sycamore	*Platanus occidentalis*	X	X	
Quaking Aspen	*Populus tremuloides*	X	X	
Black Cherry	*Prunus serotina*	X	X	
Swamp White Oak	*Quercus bicolor*	X	X	
Burr Oak	*Quercus macrocarpa*	X	X	
Pin Oak	*Quercus palustris*	X	X	
Black Elder	*Sambucus nigra*	X	X	

A combination of grading, planting, and natural regeneration will be used to establish the vegetation, which will require proper site preparation, installation, and maintenance. With the goal of establishing the wetland vegetation as soon as possible, it is recommended that primarily rapidly growing species such as grasses, sedges, cattails, and maples be used, with a smaller proportion of slower growing plants. This combination provides diversity and promotes important wildlife habitat value. Quickly establishing desirable vegetation also reduces the opportunity for nuisance and invasive plants to take over the freshly disturbed and planted wetland and floodplain areas.

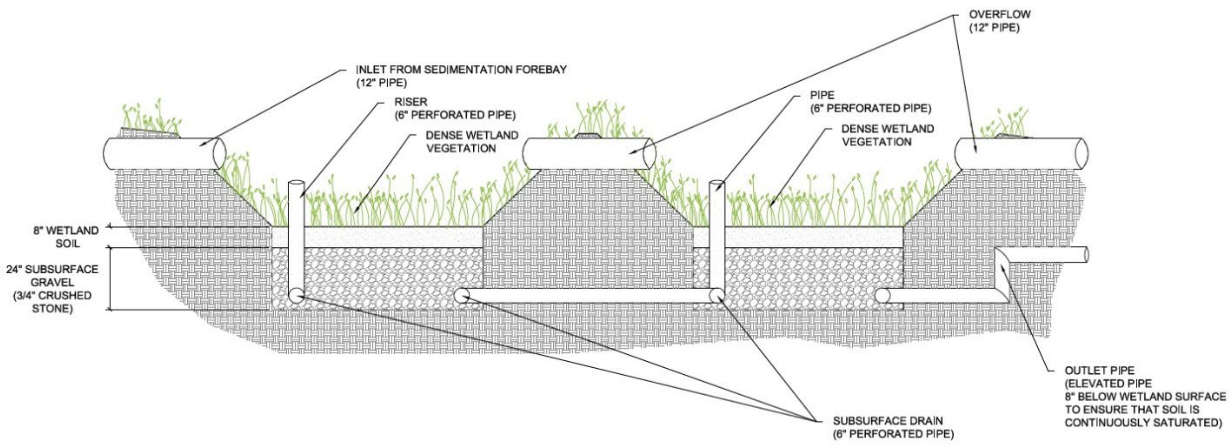
4.5 Park Configuration and Connection to Surrounding Redevelopment

Restoration of Ralston Creek and the adjacent floodplain is part of a larger effort to establish a multiuse public park at the site of the former North Wastewater Treatment Plant. The park, currently in the conceptual design phase, will consist of many different design elements and will encourage a wide range of residential users. Figure 22 shows a section of the proposed park that features the connection between the restoration area and the surrounding area.

Source: RDG 2015.
Figure 22. Proposed Concept for Riverfront Crossings Park.

A frequent comment at public outreach events for the park project is the desire to obtain better public access to the water. Accordingly, a trail system is proposed that takes advantage of multiple viewpoints over the Iowa River, Ralston Creek, and the restored wetland area. The trail system will bridge high points and include lower sections that will allow users to explore the wetland. Although the main entrances to the proposed park will be located at the north end, away from the restoration area, low-water crossings of Ralston Creek using natural rock boulders are included in the conceptual stream restoration design to allow more informal access points from the anticipated mixed-use area to the east of the creek. Residents and visitors will be able to access the proposed park from the planned redevelopment area through a path that will travel through the restored floodplain area and across the low-water crossing, providing a direct connection to the restored area.

The water quality components of the wetland also could extend to the surrounding redevelopment areas, expanding Iowa City's connection to this restoration. The Downtown and Riverfront Crossings Master Plan proposes wide promenades leading towards the park and ending at Ralston Creek (HDR 2013). Constructed stormwater gravel wetlands, as shown in Figure 23 , can be very effective at reducing nutrients and sediment (Ballestero et al. 2012). While the water quality treatment processes associated with the restored wetland require a larger area and reliable ground water supply, constructed stormwater gravel wetlands can be installed in much smaller areas with only stormwater runoff as a water source. It will be easy to integrate these facilities into the redeveloped promenade areas to treat stormwater from neighboring buildings and impervious surfaces before discharging it to Ralston Creek. The selection of plant species for the stormwater gravel wetlands can match the plantings planned for the restored wetland to provide an additional visual connection between the two areas.



Source: CRWA 2009.
Figure 23. Gravel Wetland Schematic.

5 Future Steps

Iowa City is preparing for the demolition of the North Wastewater Treatment Plan facilities and has developed concepts for the development of the Riverfront Crossings Park. The city has performed park planning in conjunction with this stream and wetland restoration conceptual design to integrate the restoration components and necessary grading into the overall park plan. Both the park plan and the restoration plan will need to advance through more detailed design phases to develop construction plans. Since the restoration plan affects a regulated waterway, environmental permitting also will be required before construction can begin.

The redevelopment planning should include the extension of the green infrastructure concepts implemented in the wetland to the surrounding planned mixed-use development early on in the planning process. Designing the stormwater gravel wetlands along with the promenade and other necessary infrastructure will maximize the effectiveness and ease-of-implementation of these green infrastructure approaches.

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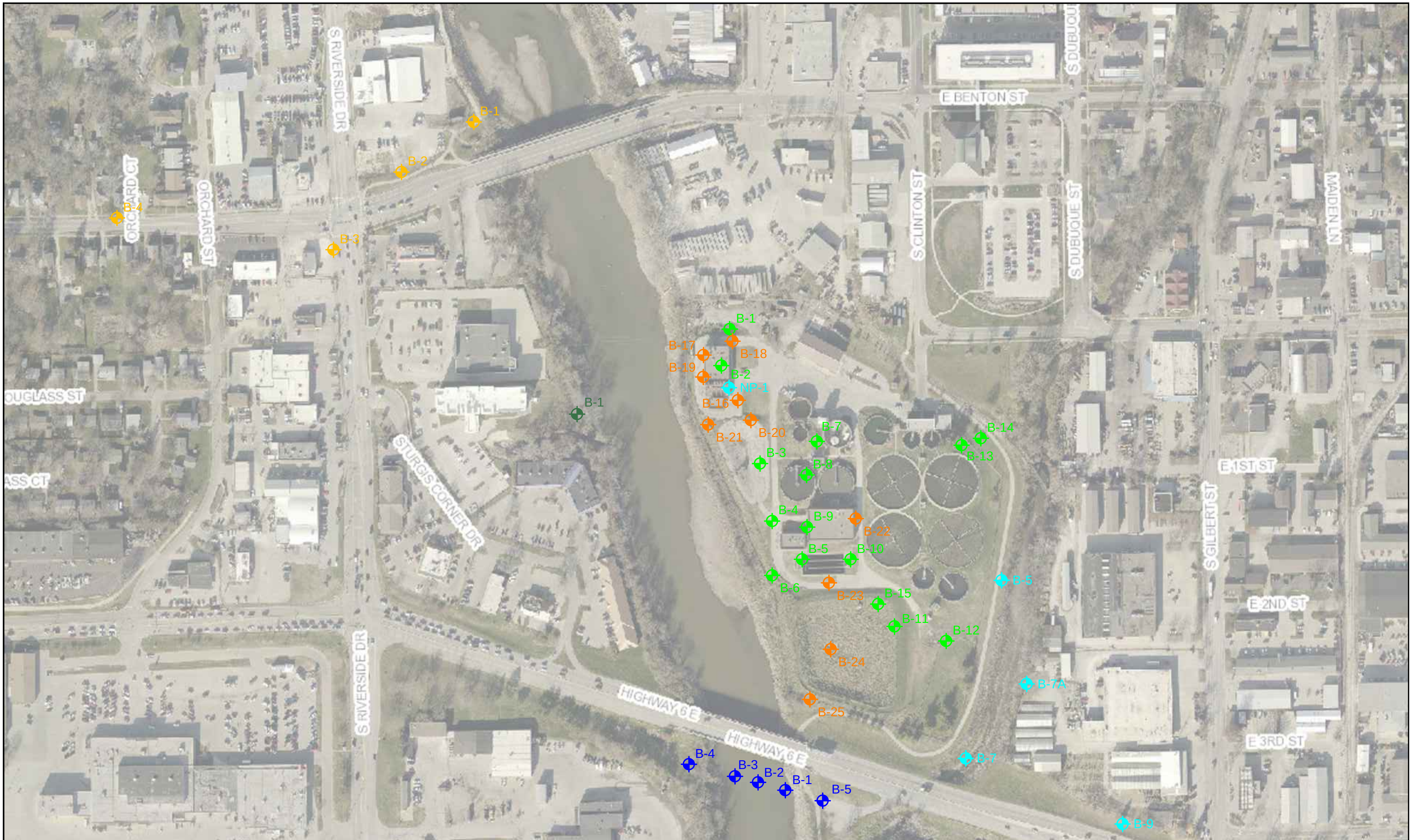
Appendix A: Soil Boring Map and Logs



LEGEND

- APPROXIMATE BORING LOCATION
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06095646
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06865076
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06875041
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06945060
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06885023
- APPROXIMATE BORING LOCATION TERRACON PROJ. NO. 06955103

BASE DRAWING A 2012 AERIAL FROM JOHNSON COUNTY, IOWA GIS
THIS DRAWING IS INTENDED FOR GENERAL LOCATION PURPOSES ONLY

0 350'
APPROXIMATE DRAWING SCALE

Project No.: P06140170	Date: MARCH 2014
Project Mngr: TWS	Drawn By: PC
File Name: P06140170-01.dwg	
Layout Name: PROPOSED BORING	

Terracon
Consulting Engineers and Scientists
2640 12TH STREET SW CEDAR RAPIDS, IOWA 52404
PH. (319) 366-8321 FAX. (319) 366-0032

PROPOSED BORING LOCATION PLAN

IOWA RIVER IMPROVEMENTS PROJECT
McLAUGHLIN WHITEWATER DESIGN GROUP
IOWA RIVER BETWEEN BENTON ST AND HIGHWAY 6
IOWA CITY, IOWA

EXHIBIT #
A-X.1

LOG OF BORING NO. NP-1

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT, IOWA CITY, IOWA	PROJECT: PHASE II - FACILITY IMPROVEMENTS

GRAPHIC LOG	DESCRIPTION Approx. Surface Elev.: 645.1ft.	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY	SPT - N BLOW / FT.	TESTS MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	0.5 ~~LEAN CLAY, TRACE ORGANICS, Dark Brown~~ 644.6				PA					
	FILL, SANDY LEAN CLAY AND CLAYEY FINE SAND, Brown		SC	1	SS	13	6	14.4		
	6.5 — 638.6	5			PA					
	VERY SANDY LEAN CLAY, Brown, Stiff		CL	2	SS	15	8	16.3		
		10			PA					
	14.5 — 630.6		CL	3	SS	18	13	20.0		
	FINE TO MEDIUM SAND, TRACE GRAVEL, Brown, Medium Dense	15	SP		PA			14.9		
	20 — 625.1		SP/SW	4	SS	18	15	15.1		
	BOTTOM OF BORING	20								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS			BORING STARTED	6-27-94
WL	∇ 15'	WS	BORING COMPLETED	6-27-94
WL			RIG #14	FOREMAN GAE
WL	WCI @ 15' (6/29/94)		APPROVED TTW	JOB # 06945060

Terracon

LOG OF BORING NO. 5

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT, IOWA CITY, IOWA	PROJECT: PROPOSED FACILITY IMPROVEMENTS

DESCRIPTION (Approx. Surface Elev.: 641.5ft.)	Elev.	DEPTH (FT.)	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY	**SPT - N BLOWS / FT.	TESTS: MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
1.5 SILTY CLAY, Dark Brown	640				HS					
VERY SANDY SILTY CLAY, Brown Gray, Soft		5	CL/ML	1	SS	14	3	19.7		*1000
					HS					
9	632.5									
FINE TO MEDIUM SAND, TRACE SILT, Brown, Loose		10	SP	2	SS	10	4	13.8		
					HS					
12	629.5									
FINE TO COARSE SAND, WITH GRAVEL, TRACE SILT & CLAY, Brown, Very Loose to Medium Dense			SW	3	SS	4	3	11.7		
		15			HS					
			SW	4	SS	12	11	18.8		
		20			HS					
			SW	5	SS	6	11	11.7		
		25			HS					
			SW	6	SS	10	15	15.9		
		30			HS					
32	609.5									

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS			
WL	∇ 10'	WS ▼ 7.5'	AB
WL			
WL	WCI @ 11' 48 HR AB		

Terracon

BORING STARTED	12-15-93		
BORING COMPLETED	12-15-93		
RIG	NO. 37	FOREMAN	REF
APPROVED	DEW	JOB #	06935119

LOG OF BORING NO. 5

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT IOWA CITY, IOWA	PROJECT: PROPOSED FACILITY IMPROVEMENTS

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY	**SPT - N BLOWS / FT.	TESTS: MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	FINE TO MEDIUM SAND, TRACE SILT & GRAVEL, Gray, Medium Dense		SP	7	SS	13	25	16.3		
		35			HS					
	37 — 604.5									
	COARSE SAND & GRAVEL, Gray, Very Dense		SP	8	SS	12	55	8.0		
	40 — 601.5	40								
	BOTTOM OF BORING N. END OF PLANT; W. SIDE OF RALSTON CREEK									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS			
WL	∇ 10'	WS ▼ 7.5'	AB
WL			
WL	WCI @ 11' 48 HR AB		

Terracon

BORING STARTED			12-15-93
BORING COMPLETED			12-15-93
RIG	NO. 37	FOREMAN	REF
APPROVED	DEW	JOB #	06935119

LOG OF BORING NO. 7

OWNER/CLIENT: CITY OF IOWA CITY	ARCHITECT/ENGINEER: STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT, IOWA CITY, IOWA	PROJECT: PROPOSED FACILITY IMPROVEMENTS

Approx. Surface Elev.: 641.5ft.

Depth (ft.)	Description	Elev.
1.5	SILTY CLAY, TRACE SAND, Dark Brown	640
2.5	SANDY LEAN CLAY, Brown	639
9	FINE TO MEDIUM SAND, TRACE SILT, Brown, Very Loose	⊽ 632.5
11.5	SILTY CLAY, TRACE SAND & ORGANICS, Gray, Very Soft	630
15.5	FINE TO MEDIUM SAND, TRACE SILT, Brown, Loose	626
19.5	SILTY CLAY, TRACE SAND, WITH SAND LAYERS, Gray, Soft	622
21.5	FINE TO MEDIUM SAND, TRACE SILT, Gray	620
	MEDIUM TO COARSE SAND, TRACE SILT, GRAVEL & COBBLES, Brown, Medium Dense	

Continued Next Page

Depth (ft.)	USCS Symbol	Samples: Number	Type	Recovery	**SPT - N Blows / Ft.	Tests: Moisture, %	Dry Density PCF	Unconfined Strength PSF
			HS					
5	SP	1	SS	16	3	3.2		
			HS					
10	CL/ML	2	SS	17	1	30.4		*500
			HS					
	SP	3	SS	14	9	20.0		
15			HS					
	CL/ML	4	SS	8	10	24.4		
20	SP					15.4		
			HS					
	SP	5	SS	16	13	20.0		
25			HS					
	SP	6	SS	8	11	13.5		
30			HS					

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS		
WL	⊽ 8.5'	WD ⊻
WL		
WL	WCI @ 8' 48 HR AB	

Terracon

BORING STARTED	12-15-93		
BORING COMPLETED	12-15-93		
RIG	NO. 37	FOREMAN	REF
APPROVED	DEW	JOB #	06935119

LOG OF BORING NO. 7

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE WASTE WATER TREATMENT PLANT IOWA CITY, IOWA	PROJECT PROPOSED FACILITY IMPROVEMENTS

GRAPHIC LOG	DESCRIPTION		DEPTH (FT.)	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY	SAMPLES: **SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: DRY DENSITY PCF	TESTS: UNCONFINED STRENGTH PSF
	FINE TO COARSE SAND, TRACE SILT, GRAVEL & COBBLES, Brown, Medium Dense			SP	7	SS	8	10	17.3		
			35			HS					
	37.5	604									
	38.5 LIMESTONE COBBLES	603									
	40 FINE TO COARSE SAND, TRACE SILT & GRAVEL, WITH LIMESTONE FRAGMENTS, Brown, Very Dense	601.5	40	SP	8	SS	12	63	8.5		
	BOTTOM OF BORING										
	S. END OF PLANT; W. SIDE OF RALSTON CREEK										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS				
WL ▽ 8.5'	WD ▼	Terracon	BORING STARTED	12-15-93
WL			BORING COMPLETED	12-15-93
WL			RIG NO. 37	FOREMAN REF
WL WCI @ 8' 48 HR AB			APPROVED DEW	JOB # 06935119

LOG OF BORING NO. 7A

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT IOWA CITY, IOWA	PROJECT: PHASE II - FACILITY IMPROVEMENTS

GRAPHIC LOG	DESCRIPTION Approx. Surface Elev.: 646.4ft.	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY	SPT - N BLOW / FT.	TESTS MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	FILL, SANDY LEAN CLAY, Dark Brown and Brown				HS					
		5		1	SS	14	5	19.8		
					HS					
	7.5 — 638.9									
	SANDY LEAN CLAY, Brown, Medium to Soft	10	CL	2	SS	14	6	26.9		
					HS					
		15	CL	3	SS	16	3	29.4		
					HS					
	19.5 — 626.9 ▽									
	FINE TO COARSE SAND, TRACE GRAVEL AND SILT, Gray, Brown, Loose to Dense	20	SP	4	SS	16	9	19.0		
					WB					
		25	SP	5	SS	12	9	22.5		
					WB					
		30	SP	6	SS	18	47	18.0		
					WB					

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS			
WL	▽ 20'	WD	▼
WL			
WL			

Terracon

BORING STARTED	7-6-94		
BORING COMPLETED	7-6-94		
RIG	#14	FOREMAN	GAE
APPROVED	TTW	JOB #	06945060

LOG OF BORING NO. 7A

OWNER/CLIENT	ARCHITECT/ENGINEER
CITY OF IOWA CITY	STANLEY CONSULTANTS, INC.
SITE: WASTE WATER TREATMENT PLANT, IOWA CITY, IOWA	PROJECT: PHASE II - FACILITY IMPROVEMENTS

Depth	DESCRIPTION	Elev.	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY	SPT - N BLOW / FT.	TESTS MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	FINE TO COARSE SAND, TRACE GRAVEL AND SILT, Gray, Brown, Medium Dense		35	SP	7	SS	18	19	21.4		
						WB					
			40	SP	8	SS	16	20	21.4		
						WB					
45		601.4	45	SP	9	SS		36	16.8		
46.5	FINE TO COARSE SAND WITH LIMESTONE FRAGMENTS, Gray, Dense	599.9				RB					
48	***HIGHLY WEATHERED LIMESTONE, Brown	598.4									

Refusal @ 48'.
BOTTOM OF BORING

*** Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

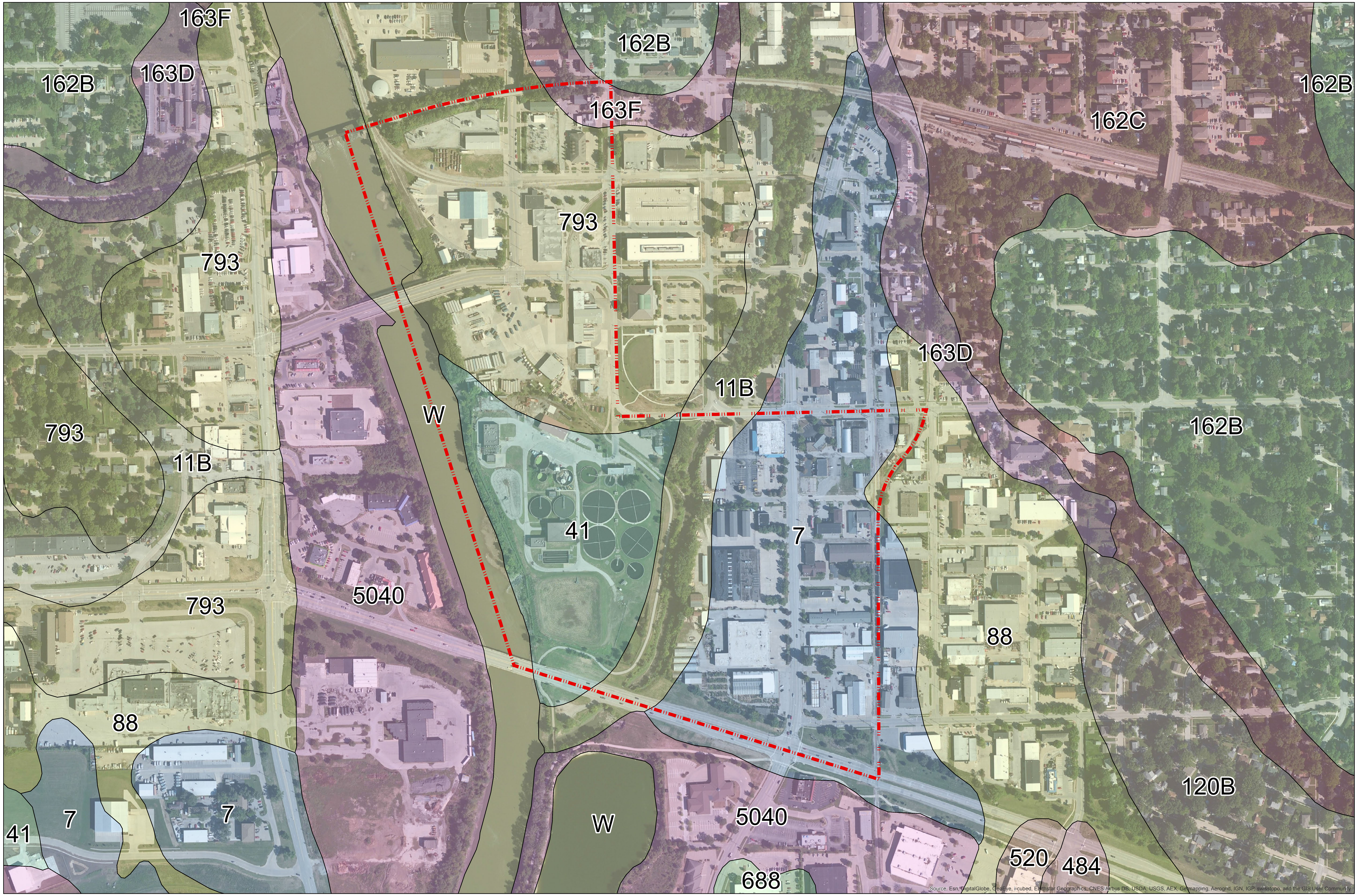
Calibrated Hand Penetrometer*
CME 140 Lb. Auto. SPT Hammer**

WATER LEVEL OBSERVATIONS		
WL	▽ 20'	WD ▼
WL		
WL		

Terracon

BORING STARTED	7-6-94		
BORING COMPLETED	7-6-94		
RIG	#14	FOREMAN	GAE
APPROVED	TTW	JOB #	06945060

Appendix B: Soil Classification Map



Date: 9/24/2014 User Name: Ruben.Martinez Document Path: C:\Users\ruben.martinez\Documents\Projects\Iowa City\Tetra Tech MXD Files\Project_Soil_Types.mxd

TETRA TECH

www.tetratech.com
700 N. Saint Mary's Street, Ste. 300
San Antonio, TX 78205
Ph. (210) 226-2922 Fx. (210) 226-8497
TBPE Firm No. F-3924

N
W E
S

IOWA CITY EPA GI

RIVERFRONT CROSSING DISTRICT

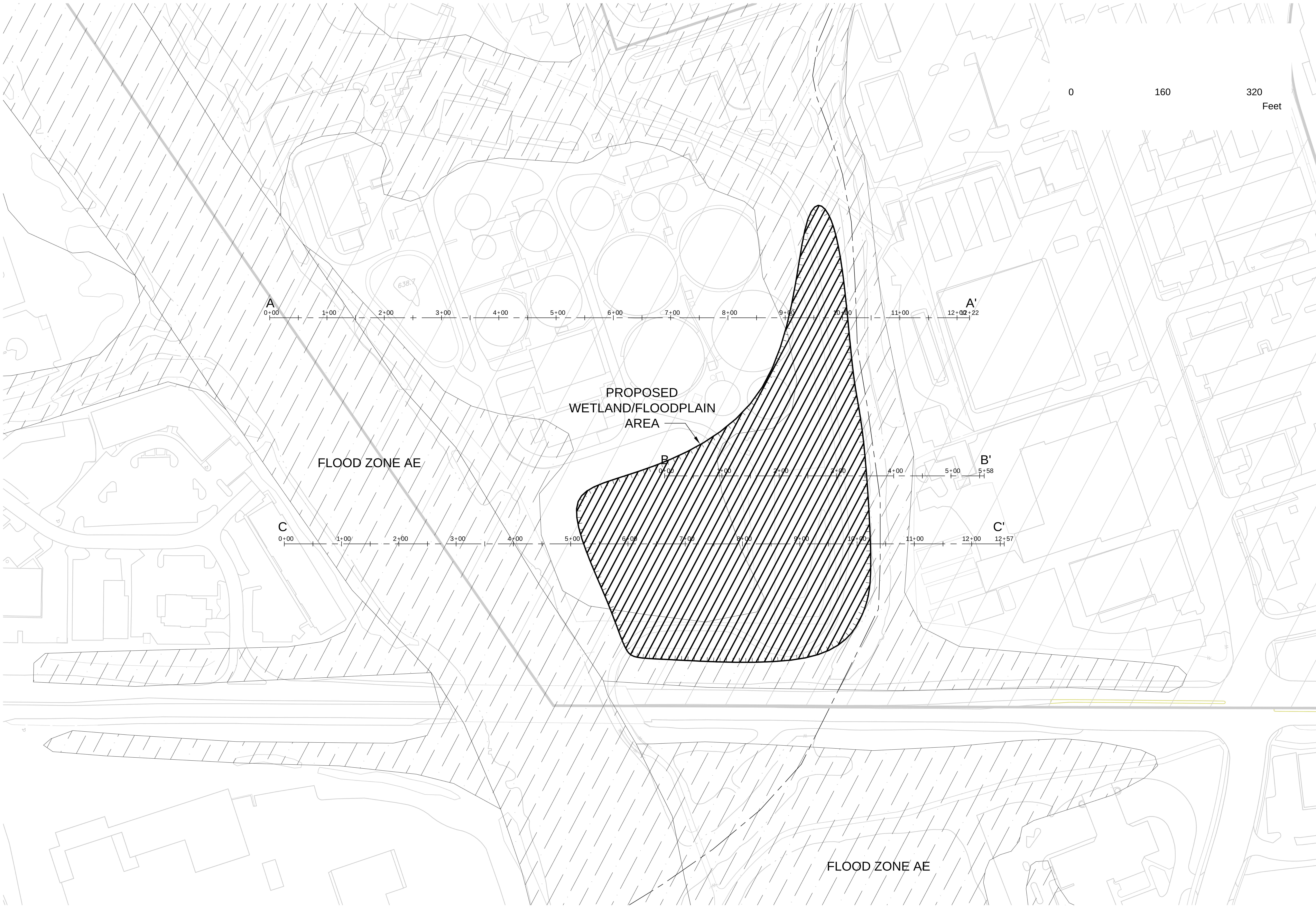
SOIL TYPES MAP

Project No.:	100-FFX-P140150
Designed By:	TD
Cartography By:	RM
Checked By:	TD

1

Bar Measures 1 inch
0 200 Ft.

Appendix C: Proposed Restoration Area



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700 N. Saint Mary's Street, Ste. 300
San Antonio, TX 78205
Ph. 210.226.2922 Fx. 210.226.8497
TBPE Firm No. F-3924

MARK	DATE	DESCRIPTION	BY

IOWA CITY EPA GI
RIVERFRONT CROSSING DISTRICT

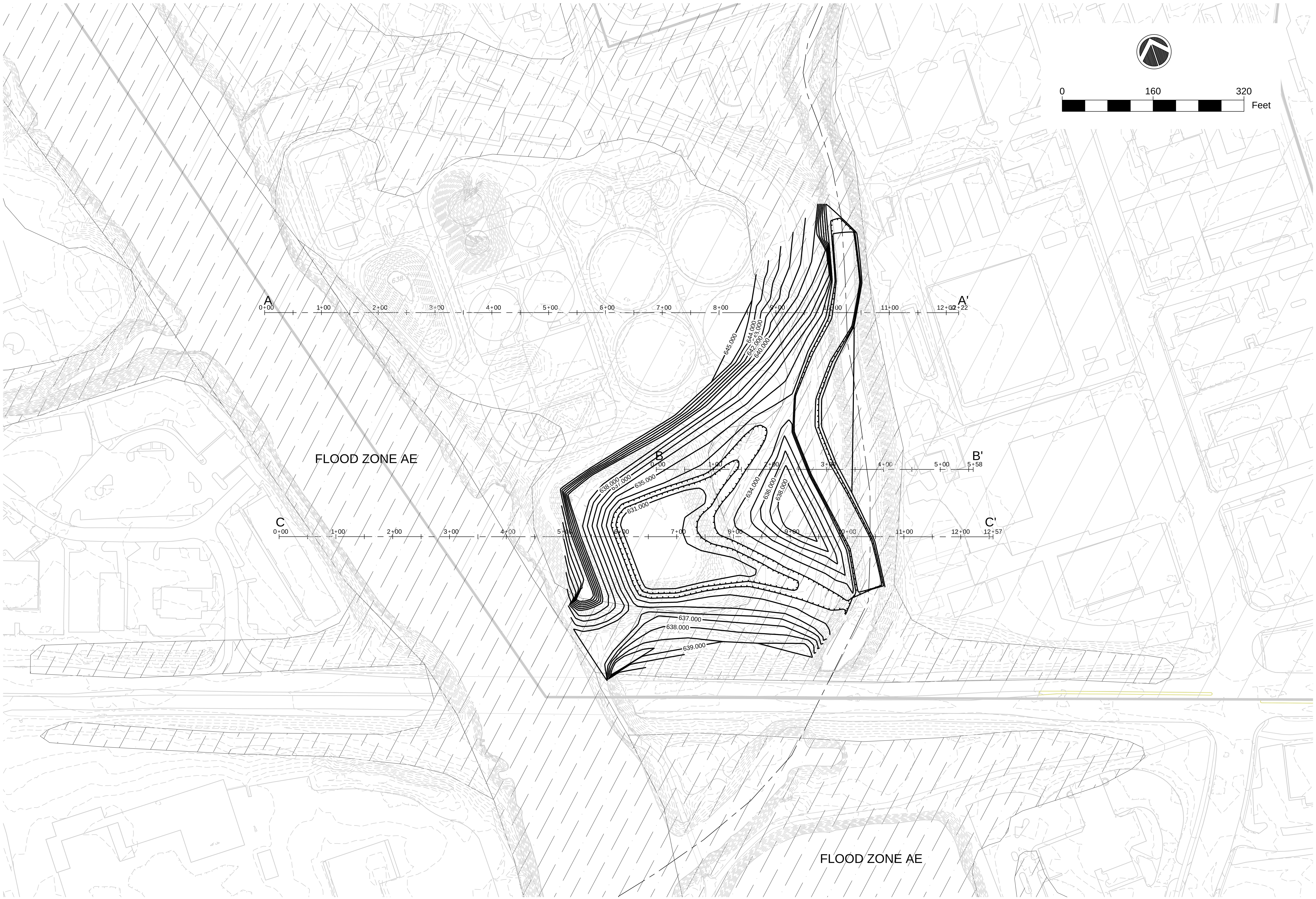
PROPOSED WETLAND AREA

Project No.: 100-FFX-T32047
Designed By:
Drawn By:
Checked By:

1

Bar Measures 1 inch

Appendix D: Draft Grading Plan and Cross Sections



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San Antonio, TX 78205
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TBPE Firm No. F-3924

MARK	DATE	DESCRIPTION	BY

IOWA CITY EPA GI
RIVERFRONT CROSSING DISTRICT

PROPOSED GRADING PLAN

Project No.: 100-FFX-T32047
Designed By:
Drawn By:
Checked By:

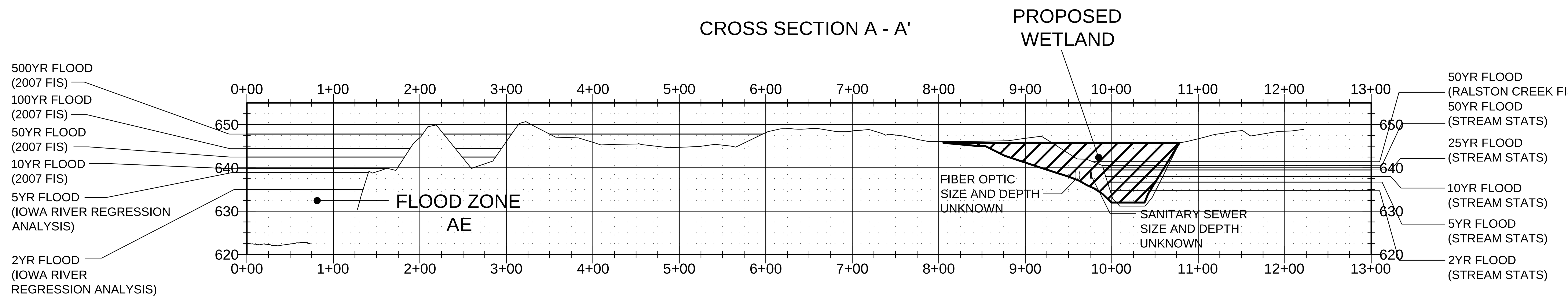
3

3 OF 4

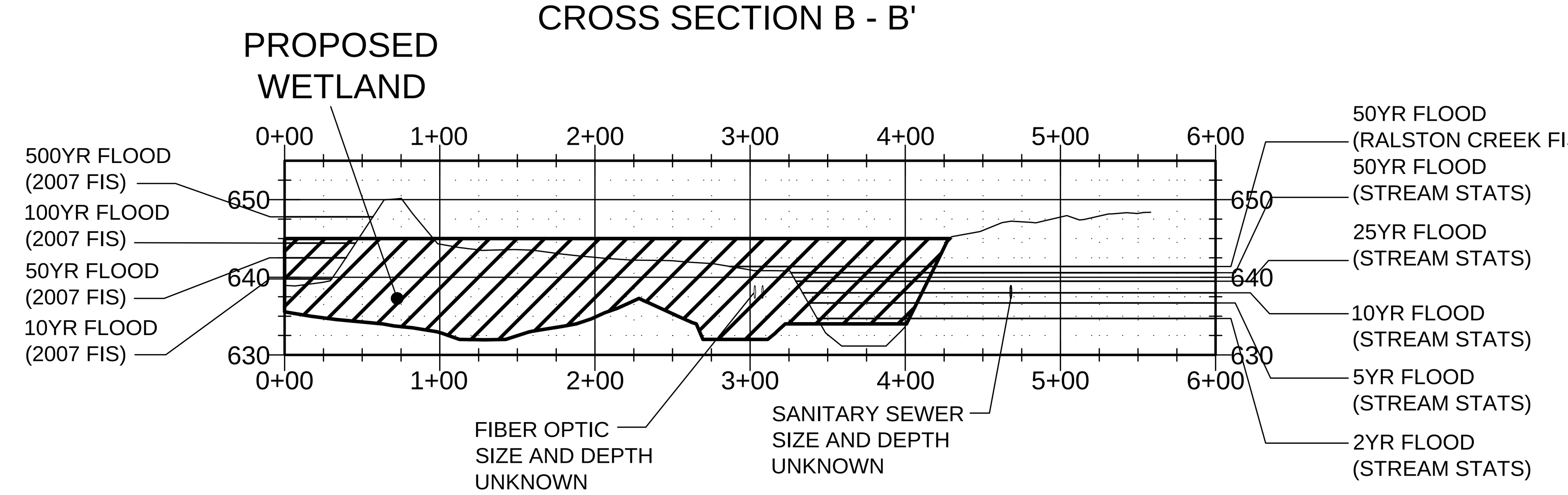
Bar Measures 1 inch

10/16/2014 2:58:02 PM - C:\USERS\RUBEN.MARTINEZ\DOCUMENTS\PROJECTS\IOWA CITY\TETRA TECH CAD FILES\SHEETFILES\PROP_WETLANDAREA-10-16-2014.DWG - MARTINEZ, RUBEN

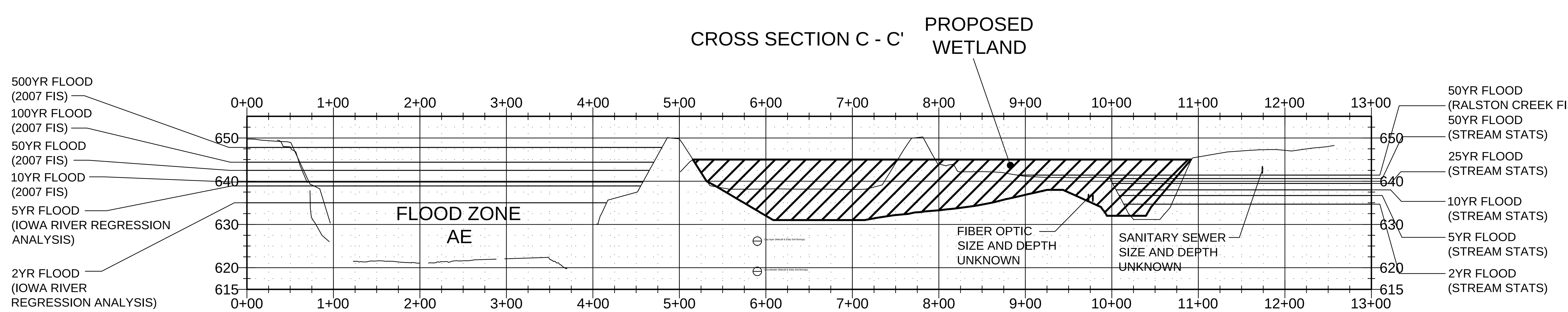
CROSS SECTION A - A'



CROSS SECTION B - B'



CROSS SECTION C - C'



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Ph. 210.226.2922 Fx. 210.226.8497

MARK	DATE	DESCRIPTION	BY

IOWA CITY EPA GI
RIVERFRONT CROSSING DISTRICT

CROSS SECTIONS

Project No.: 100-FFX-T32047
Designed By:
Drawn By:
Checked By:

4

4 OF 4

Bar Measures 1 inch