Conceptual Design Memorandum

Zandale Park Stream Bank Protection Project

Prepared for
Lansdowne Neighborhood Association
June, 2012

Sustainable Streams LLC
Science · Service · Solutions

1.0 Executive Summary:

The Zandale Park Stream Bank Protection Project is meant to provide stability to a portion of the unnamed tributary to West Hickman Creek that flows through Zandale Park. This stream is currently experiencing extensive bank failure, channel incision, and widening. The Lansdowne Neighborhood Association (LNA) contracted Sustainable Streams, LLC to evaluate the stream and develop conceptual design alternatives and relative opinions of cost for bank stabilization. Sustainable Streams conducted a site reconnaissance of the entire reach and completed more detailed hydrogeomorphic data collection on the portion of the creek that flows through the park property. Our observations and hydrogeomorphic data confirm that without mitigation, continued bank failure is likely to occur due to the geotechnically-unstable condition of the banks throughout much of the park. Additional bank failure is both a water quality concern (i.e. excess loads of fine sediment) and a risk to adjacent infrastructure such as the pedestrian bridge and the sanitary sewer crossing at Zandale Park.

This Conceptual Design Memorandum presents three potential alternatives for the Zandale Park Stream Bank Protection Project. Each alternative ranges in varying levels of cost, degree of disturbance to the park, and risk for additional bank failure. The conceptual design alternatives, which are illustrated in the attached appendix, include the following:

Alternative No. 1 - Log Vane Armoring
Alternative No. 2 - Major Rock Armoring
Alternative No. 3 - Re-grade Banks

Each alternative includes additional protection to the pedestrian bridge and sanitary sewer crossing, as well as options for riparian vegetation and type of rock specified.

The *Log Cross Vane* alternative is the most economical and least disruptive to Zandale Park, but comes with the highest risk of additional bank failure. The *Major Rock Armoring* alternative costs more than the *Log Cross Vane* alternative, and may create slightly more disturbance to the existing conditions in Zandale Park due to the large amount of rock that would be delivered and installed. This alternative has a moderate risk of additional bank failure. Lastly, the third alternative, *Re-grade Banks*, is the most expensive and creates the highest amount of disturbance to the park, but provides the lowest risk of future bank failure. The following sections of this Conceptual Design Memorandum include results of our watershed assessment, hydrogeomorphic field data collection, and processed metrics, details of each alternative, input from Lexington Parks and Recreation as well as Lexington Fayette Urban County Government (LFUCG) Water Quality, guidance relating to potential permitting requirements, and conceptual opinions of probable construction cost.

2.0 Introduction:

Sustainable Streams conducted a site reconnaissance over a 1,600-foot reach of the unnamed tributary to West Hickman Creek to obtain a more complete understanding of the stream bank protection project. This field reconnaissance allowed us to evaluate the upstream watershed conditions, understand the overall stability of the reach, and identify target locations for detailed hydrogeomorphic data collection, where channel cross sections, profiles, and pebble counts were collected. Following this site reconnaissance, we completed the more detailed hydrogeomorphic data collection at two cross section locations as well as profile data collection along approximately 700-feet of the reach within Zandale Park. Based on observing a range of unstable conditions throughout the reach, the status of the Zandale Park Creek can be generalized as follows:

1. Extensive bank failure impairs the aesthetic character of Zandale Park.
2. Excess sediment loads from channel instability exacerbate water quality impairments.
3. Active channel incision and widening poses a risk to adjacent infrastructure.

Regarding the first point, bank instability throughout the park is an unsightly blemish in an otherwise well-kept park. The bank erosion is also resulting in active loss of notable riparian trees (Figure 1).

(1a) Active Bank Failure Downstream of the Pedestrian Bridge adjacent to Zandale Park Entrance Sign

(1b) Stump of 18-inch Tree Recently Lost to Bank Erosion

Figure 1 – Extensive Bank Failure Impairs the Aesthetic Character of Zandale Park

In regards to the second point, the active bank erosion is a problem for the LFUCG stormwater compliance program because it causes excess sediment loads to the Zandale Park Creek and downstream reaches including West Hickman Creek. Sediment and siltation is the number one pollutant of Kentucky rivers and streams (KDOW, 2008); therefore, stormwater utilities have every incentive to minimize the sources of such sediment wherever possible.

The third point may provide the most compelling case for both the LNA and LFUCG to pursue a solution to this problem. The instability throughout the unnamed tributary to West Hickman Creek is actively undermining public infrastructure. Bridges, sewer/waterline crossings, manholes, and a section of

Zandale Drive are all at risk of being impacted by channel instability (Figure 2). The cost of replacing a single sewer crossing can range up to $100,000; bridges and culvert crossings can be more. Some of the at-risk infrastructure along the 1,600 feet of our site reconnaissance includes the following:

1. Approximately 200-feet of Zandale Drive are within 10- to 25-feet of the top of bank
2. Pedestrian bridge with pier scour and bank failure
3. Road crossing (at Landsdowne Estates) with abutment scour at wingwalls
4. Approximately 5 sewer/waterline crossings, many with concrete pier supports undergoing scour
5. At least one manhole at risk of being impacted by bank failure
6. Several stormwater outfalls undermined by channel downcutting

(2a) Stormwater Outfall Undermined by Channel Downcutting

(2b) Sanitary Sewer Crossing – Concrete Pier Support Undergoing Scour

(2c) Pier Scour and Flanking of Pedestrian Bridge

Figure 2 - Active Channel Incision and Widening Poses a Risk to Adjacent Infrastructure

The Zandale Park Creek is undergoing a very unstable period of channel evolution that ranges between Stage 3 and Stage 4 in the schematic shown in Figure 3 below. There are portions of the channel that are actively widening from the current width of ~23 feet. Banks are near vertical and range 4- to 6-feet high. Other portions have already undergone widening (~26-feet wide) and are beginning to develop vegetated point bars and benches. The goal of the project would be to artificially accelerate the evolution process, such that the stream re-attains a stable, equilibrium form and minimizes additional periods of bank erosion and failure. Figure 3 presents the channel evolution process and two examples of different stages on the unnamed tributary to West Hickman Creek. Figure 4 illustrates how stream instability can migrate up and downstream in relation to a hardpoint such bedrock. This explains the reason for the headcutting and increased slope on the upstream portion of the stream within Zandale Park and is further explained in Section 4 *Field Data Collection and Processed Metrics*.

(3a) Reach Immediately Downstream of Pedestrian Bridge (~23' Wide) Undergoing Downcutting and Widening (Stage 3 of Channel Evolution) Evident by Coarse Bed Material and Active Bank Failure. This is the location of hydrogeomorphic site B (discussed later in this memo).

(3b) Reach Farther Downstream of Pedestrian Bridge (~26' Wide) Undergoing Deposition and Floodplain Reconstruction (Stage 4 of Channel Evolution) Evident by Fine Bed Material and Vegetated Point Bars, Benches, and Banks. This is close to the location of hydrogeomorphic site A (discussed later in this memo).

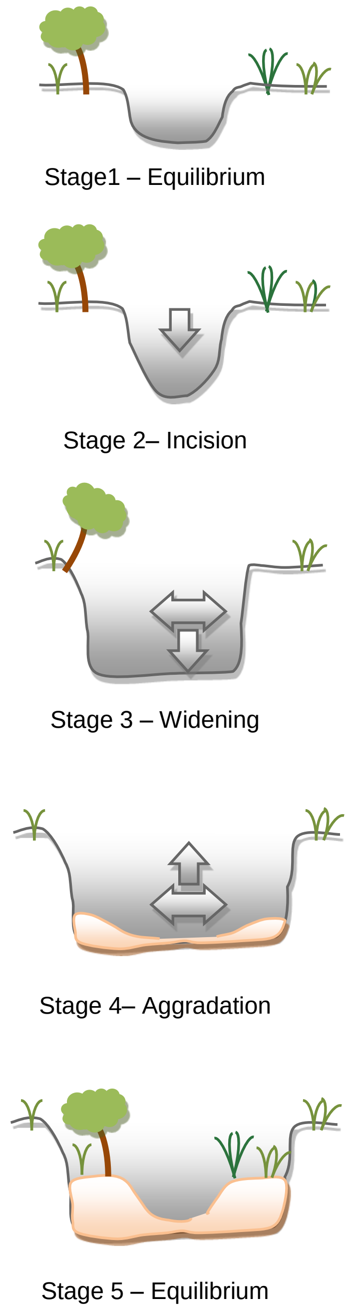


Figure 3 –The Channel Evolution Sequence in Response to Increased Flows from Urbanization, Adapted from Schumm et al. (1984) and Hawley et al. (In Press) with Examples from the Zandale Park Project

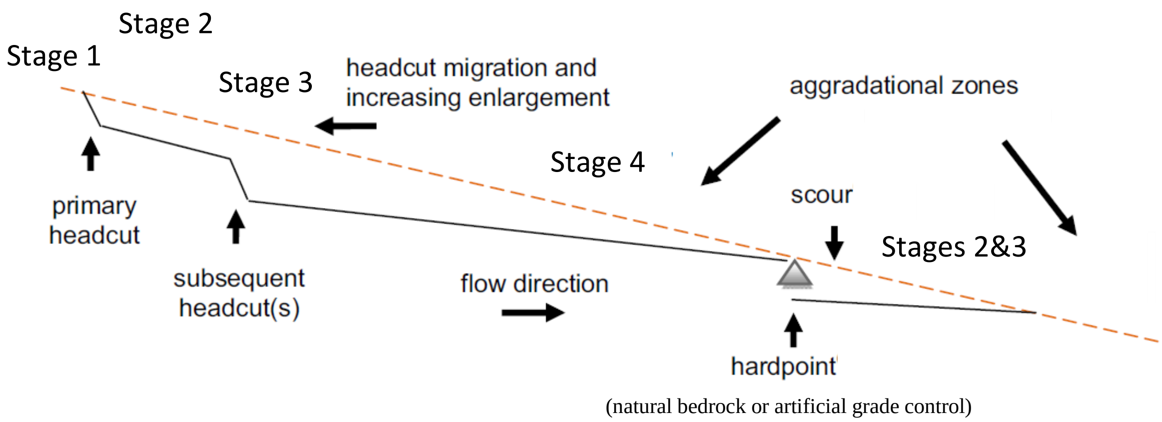


Figure 4 –Stream Instability Can Migrate Up and Downstream,
Adapted from Hawley et al. (In Press)

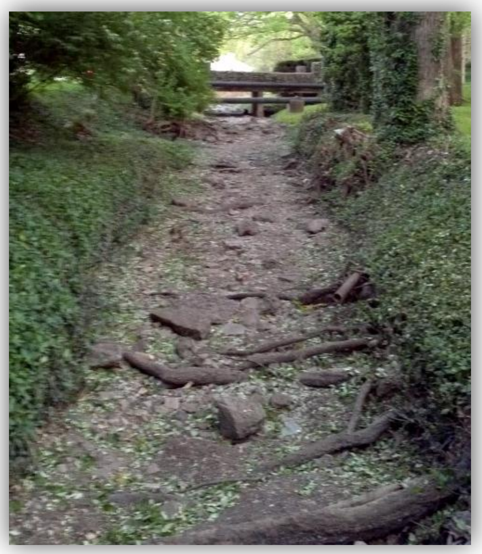
3.0 Watershed Assessment:

Beyond the reach of concern, Sustainable Streams performed a synoptic assessment of the watershed (Figure 5) to better understand the source of the problems in Zandale Park. The erosion occurring throughout the Zandale Park Creek can be largely attributed to two factors. First, urban/suburban development dominates the watershed. With little evidence of stormwater detention, it is clear that the increase in impervious cover has caused much greater volumes of rainfall to runoff relative to pre-development conditions. Secondly, the runoff is routed much more efficiently to Zandale Park via a network of stormwater pipes and approximately 2,000 feet of concrete-lined channel immediately upstream of the park (Figure 5a). This results in increased magnitudes and durations of erosive flows in Zandale Park (Hawley and Bledsoe, 2011; Hawley et al., 2012).

Flows that cause damage to the Zandale Park Creek and the adjacent trees and infrastructure occur much more frequently and last for much longer periods of time than the stream had evolved to convey under pre-development land cover conditions. The increased erosive flows are causing the creek to respond in a predictable pattern in which the stream evolves into a larger channel to more adequately accommodate the urban flow regime.

Select reaches of the creek that are relatively stable provide examples of what the reconstructed channel within Zandale Park might resemble. The reach immediately upstream of the culvert crossing at Lansdowne Estates has low banks with a well-connected floodplain terrace that dissipates flow energy over a wider area (Figure 5b). Doing so keeps the flow depths in the main channel shallower, resulting in less erosion. Augmenting channel stability in that section are frequent tree roots and woody debris that serve as grade control check dams. These natural features, that provide vertical stability to the channel, can be cost-effectively duplicated by using engineered log vanes. Conceptual alternatives for stabilization are presented in Section 5 of this memo.

(5a) View of Concrete-lined Channel Immediately Upstream of Zandale Park



(5b) View of Relatively Stable Reach Immediately Upstream of the Culvert Crossing with Lansdowne Estates (Stage 5 of Channel Evolution) Evident by Low, Vegetated Banks and A Channel Bed Reinforced with Large Tree Roots and Woody Debris

(5c) Looking Downstream from the Culvert Crossing at Lansdowne Estates—Note the Limestone Bedrock on the Channel Bed and Protruding from the Left Bank

Figure 5 – Watershed Assessment Photos

4.0 Field Data Collection and Processed Metrics:

Following the site reconnaissance and watershed assessment, Sustainable Streams completed a more detailed stream assessment of the project area. This involved hydrogeomorphic data collection (including cross sections, profiles, and pebble counts) along approximately 700 linear feet of the Zandale Park Creek according to industry standard techniques. We collected geometric data at two representative locations, named Site A (downstream near the sanitary sewer crossing) and Site B (upstream near the pedestrian bridge crossing) after Harrelson et al. (1994). Table 1 presents the GPS coordinates of each site and Figure 6 depicts the site locations in relation to adjacent infrastructure. This geometric data collection included cross sectional data utilizing monumented (rebar) cross sections, a 20x level, and tape. For the pebble counts, which were taken at both the upstream and downstream sites, we used an evenly-spaced sampling frame along complete transects to measure particle diameter via a phi template (gravelometer). 100 particles were counted at each cross section site (Bunte and Abt. 2001a and 2001b).

Figure 6 – Geometric Data Collection Locations

Table 1 – GPS Coordinates of Site Rebar Locations[(a)]

	Left Rebar		Right Rebar	
Site	**Northing**	**Easting**	**Northing**	**Easting**
A	38.00155	-84.50317	38.00145	-84.50325
B	38.00200	-84.50398	38.00178	-84.50408

[(a)] coordinate accuracy ±10 – 30 feet, rebar locations 'left' and 'right' looking downstream

Superimposed cross sections, pebble counts, and the profile are provided in Figures 7 – 9, respectively. Profile slopes over the reaches ranged from 0.2% on the downstream portion of the stream segment to 1.1% on the upstream portion of the segment, while d50 and d84 was around 46 mm and 120 mm (respectively) for Site B and 11 mm and 26 mm (respectively) for Site A. As evident in Figure 7, the bed material gradation at Site A is much finer than Site B because this site is experienceing aggradation and the finer particles have migrated downstream to this site. As previously illustrated in Figure 3(b), this portion of the stream is in Stage 4 of the Channel Evolution Process and is experienceing deposition and floodplain reconstruction. The terrace shown in the Cross Section Summary (Figure 7) around station 35-45 illustrates the floodplain reconstruction. Key metrics are summarized in Table 2. It should be noted that drainage area delineations and area estimates are approximate and were determined with the Kentucky USGS Stream Stats software.

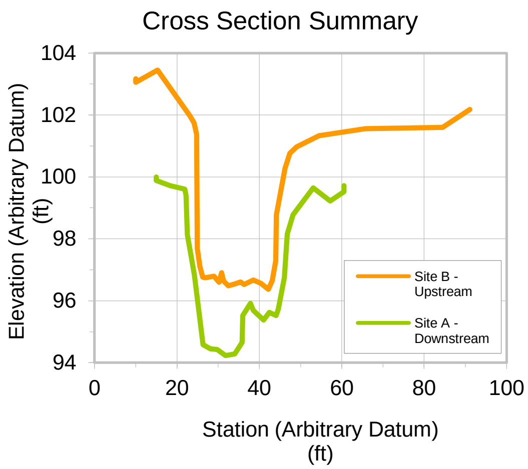


Figure 7 – Superimposed Cross Sections

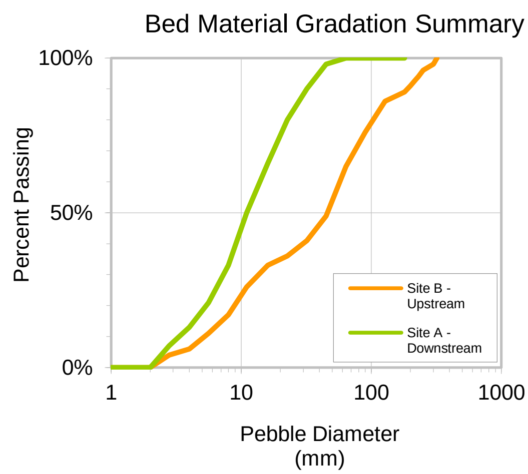


Figure 8 – Superimposed Pebble Counts

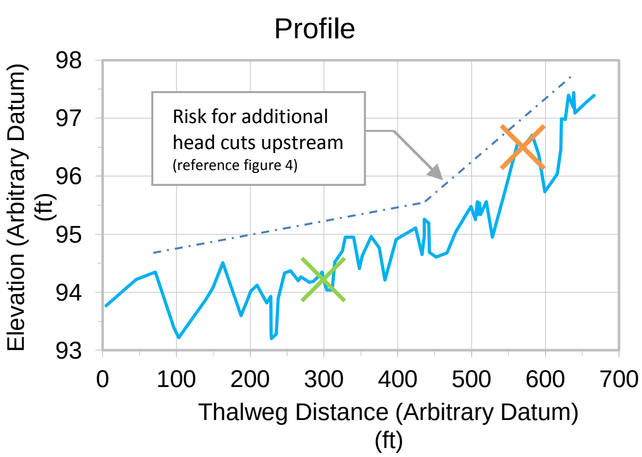


Figure 9 – Profile

Note: Cross section locations of sites A and B are indicated by the green and orange 'X', respectively.

Table 2 – Hydrogeomorphic Metrics

	Site	B	A
Metric	*unit*		
Drainage area	mi^2	0.72	0.74
Q_2	cfs	146	149
Reach slope	ft/ft	0.011	0.002
d_{50}	mm	46	11
d_{84}	mm	120	26
BF depth	ft	4.4	4.6
BF top width	ft	22.6	25.8
BF area	ft^2	81.5	83.5

*Note: Drainage areas estimated with USGS KY StreamStats. "BF" (i.e. Bankfull) dimensions reference the channel-filling stage of the entrenched channel. "Benchfull" dimensions at reaches with a defined bench would be much smaller (e.g. depth ~ 1.7 ft, top width ~ 13 ft, and area ~16 ft^2 at Site A).

5.0 Conceptual Alternatives:

As previously illustrated in Figure 5(b), the reach immediately upstream of the culvert crossing at Lansdowne Estates is an appropriate example of a relatively stable channel with low banks and a well-connected floodplain terrace. At this location, the natural grade control check dams (tree roots and woody debris) provide vertical stability to the channel and can be duplicated by using engineered log cross vanes. Rock reinforcement can also provide vertical stability and is available in riprap (lower cost, lower aesthetic value) and creek rock (higher cost, higher aesthetic value) forms.

A variety of restoration approaches and techniques were considered to ensure that the final solution is tailored the unique nature of the stream segment as well as the interests of LNA and vested stakeholders/agencies. Our recommended alternatives typically involve a two tiered approach for both toe/bank armoring and energy dissipation throughout the entirety of the unstable reach. We have presented three alternatives, each ranging in degree of cost, level of disturbance, and overall lasting stability. The alternatives include the following, but ultimately, the final project design may include various aspects of each alternative presented.

1. Log Vane Armoring
2. Major Rock Armoring
3. Re-grade Banks

Alternative No. 1 - Log Vane Armoring:

The first alternative, *Log Vane Armoring*, is the least invasive and most economical alternative but results in a higher risk of additional bank erosion. The conceptual plan is presented as Figure 2 in the attached appendix. This alternative, which seems to support the existing character of Zandale Park, involves installation of nine log vanes to provide grade control on the creek bed and promote stabilization along the banks. Each log vane will be angled upstream and tied into the banks to disrupt flow and direct the erosive energy towards the center of the stream, away from the banks. In addition to the log vanes, some rock armoring will be necessary to support the logging and promote bed stability. Figure 10 presents as example of typical log vane details. If this alternative is advanced to detailed design, the locations of the log vanes will need to be strategically determined to minimize disruption/removal of existing trees along the banks. The log vanes should help to accelerate ultimate stabilization (Stage 5 of the Channel Evolution Sequence – Figure 3) through two primary mechanisms. First, they should reduce the risk of additional channel downcutting by providing grade control. Second, they act to promote deposition of sediment along the toe of the banks, which serves to gradually improve bank stability.

Localized “point-repairs,” such as log/cross vanes, can fail if part of the vane becomes dislodged or if other portions of the system are unstable. Inspection and maintenance, particularly during the first year while the systems become established, is critical to the success of the log vanes. Additionally, because of the erosive nature of the urban flow regime, vegetative colonization of the depositional surfaces near the toe of the bank at each log vane may not occur quickly enough to establish permanent vegetation. Establishing permanent vegetation is important for promoting long-term stability as the log vanes naturally decay over future decades.

As previously mentioned, this is the most economical alternative of the three. A relative opinion of probable construction cost at this conceptual stage in the project would be approximately $14,500. Reference *Section 7.0 Opinion of Probable Construction Cost* for additional detail relating to costs.

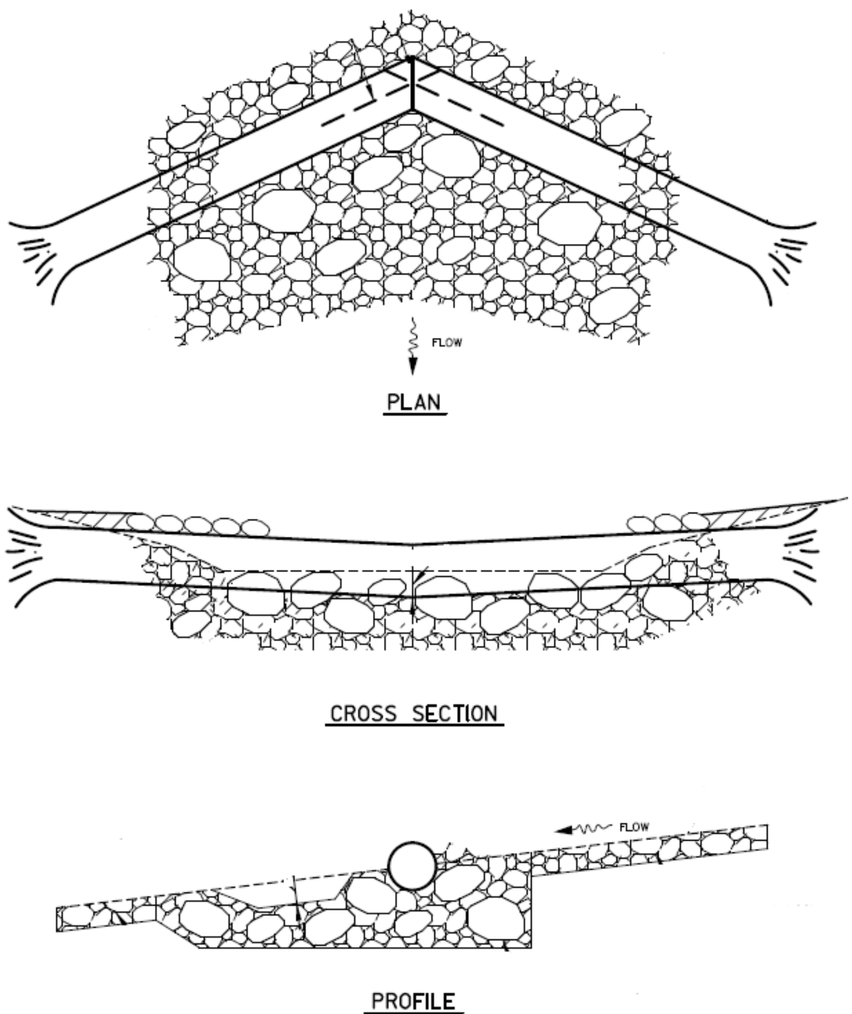


Figure 10 – Log Vane "V" Log Drop Structure
(Sustainable Streams – Strand Associates Glenway Woods Project)

Alternative No. 2 - Major Rock Armoring:

Quantifying the size and gradation of the bed material of the stream is important for understanding how much energy the channel uses to erode the bed. Understanding the stability of the channel bed is imperative for design, because bed stability is a pre-requisite for bank stability. No matter how large of rock (or log) is used in protecting the bank, the entire bank reinforcement can fail if the bed downcuts and undermines the toe of the bank.

This alternative involves installation of large diameter rock along the creek bed, bringing the finished elevation of the bed approximately 1 to 2-feet higher than the existing grade. It would stabilize the bed, but there may be some additional risk of bank failure (although not as much risk as the log vane alternative). The conceptual plan for this alternative is presented as Figure 3 in the attached appendix.

Using industry standard equations for particle mobility, we sized the rock for the 100-year flow at both the upstream and downstream sites with a 50% factor of safety. Because of the large differences in channel slope (0.2% downstream vs. 1.1% upstream), approximately a 6-inch diameter rock would be appropriate for the flatter downstream reach (Site A) and a 12-inch diameter rock would be necessary for the steeper upstream reach (Site B). Both of these sizes are within a reasonable cost range and avoid the need of extremely expensive boulders.

A relative opinion of probable construction cost at this conceptual stage in the project would be approximately $88,000. Reference *Section 7.0 Opinion of Probable Construction Cost* for additional detail relating to the project costs.

Alternative No. 3 - Re-grade Banks:

Full scale restoration of the stream is the most expensive and disruptive alternative, but the risk of additional bank erosion would be minimal. This alternative involves re-grading the stream geometry to convey the 100 year flow. It could be as simple as relaying the banks at a 4 to 1 slope or creating a dual staged main channel/terrace option. A dual staged main channel/terrace option is presented in this alternative's conceptual plan, which is included as Figure 4 in the attached appendix. As this alternative is the most disruptive of the three, many trees would need to be removed and the stream floodplain would occupy a larger portion of the park property. Additionally, the existing pedestrian bridge would be disturbed. With the installation of double wing deflectors to protect the bridge, the re-graded banks could taper in and out around the existing location. Otherwise, the LNA would need to replace the bridge with a new crossing. The new crossing could be a simple earthen berm with culverts or a more complex, aesthetically pleasing bridge. Other infrastructure, such as the sanitary sewer crossing and the stormwater outfalls will also need to be modified to accommodate the new channel geometry.

For this alternative, a relative opinion of probable construction cost at this conceptual stage in the project would be approximately $211,000. Reference *Section 7.0 Opinion of Probable Construction Cost* for additional detail relating to the project costs.

Protect Adjacent Infrastructure:

Additional protection will be necessary for the piers supporting the pedestrian bridge, several stormwater outfalls, and the piers supporting the sanitary sewer crossing. A double wing deflector installed beneath the pedestrian bridge around the pier supports should prevent additional scour and flanking in this location. The two wing deflectors, which are constructed from large rocks, will each extend into the channel about a fourth to a third of the way and reduce the baseflow channel width by at least one-half. During the first year after construction the deflectors should be inspected and maintained after every large storm event, and then they should be inspected annually following the first year. If the inspector observes any changes (movement or loss of rock) the wing deflector should be repaired immediately (Center for Watershed Protection, 2004).

The wing deflectors for the pedestrian bridge in Zandale Park would require approximately 26 cubic yards of rock. Figure 11 presents an example (plan view and cross section) of a double wing deflector and Figure 12 presents several photos of double wing deflectors.

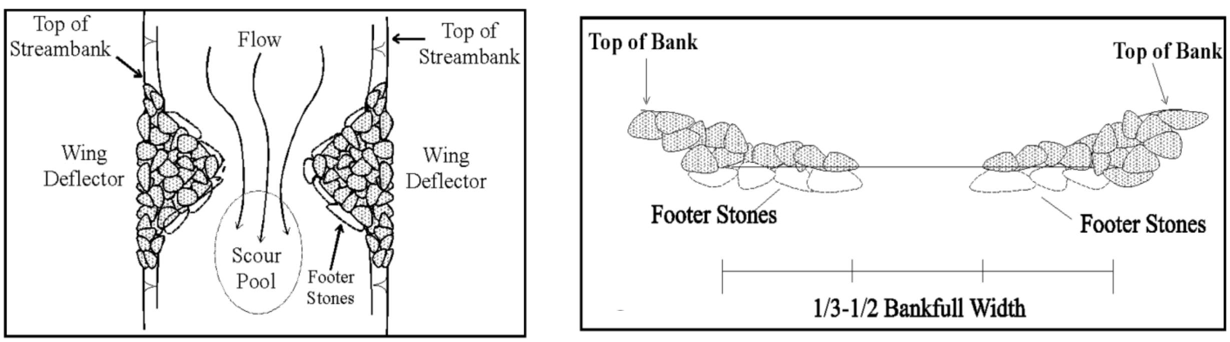


Figure 11 – Plan View and Cross Section of Double Wing Deflector (Center for Watershed Protection (2004) Urban Stream Repair Manual page 126)

River Structures from Denver and Streamboat, Colorado
Figure 12 – Example of Double Wing Wall Deflectors

Bank Re-grading (Alternative No. 3) may result in removal/replacement of the pedestrian bridge; and therefore the double wing deflector may not be needed with this alternative.

In addition to the pedestrian bridge, the pier supporting the sanitary sewer crossing (near Site A) and several stormwater outfalls should also be reinforced to minimize additional scour and undermining by the channel. This can be achieved with a single wing deflector at the sanitary sewer crossing. Approximately 3 cubic yards of rock reinforcement should be added at the sanitary sewer crossing.

Riparian Buffer Zone

Riparian buffer zones are important aspects of healthy streams. Dense root systems from native trees, shrubs, and ground cover reinforce bank strength and can reduce the risk of additional bank erosion. Permanent vegetation adjacent to the stream banks can also trap sediment and enhance filtration of pollutants from overland runoff. Additionally, riparian buffer zones help to promote biodiversity by providing enhanced habitat conditions for wildlife.

Since the aesthetic character of Zandale Park is important to LNA, input on the channel appearance and materials, as well as the selection of plant species for riparian zone beautification and stabilization will be necessary as the project progresses into the design phase. In terms of vegetation options, hardy, native grasses/flowers or shrubs is a more sustainable approach because they require minimal maintenance and can be maintained by Lexington Parks and Recreation. However, LNA may prefer to become responsible for the maintenance of the riparian buffer zone and create more of a mulched, flower-bed appearance to augment the aesthetic character of the park. Figure 13 presents several of the possible native plant alternatives.

Swamp Milkweed with Butterfly

Grey Goldenrod

Purple Coneflower

Grey Headed Coneflower

Joe Pye Weed with Butterfly

Great Blue Lobelia

New England Aster

Cardinal Flower

Figure 13 - Range of Native Plant Alternatives for Riparian Zone Beautification to Be Selected Based on LNA Stakeholder Input

6.0 Agency/Stakeholder Input:

Lexington Parks and Recreation:

The Lexington Parks and Recreation (Parks) Planning and Design Department (Michelle Koseniak) favored Alternative 1 – Log Vane Armoring along with wing deflector stabilization at the pedestrian bridge and additional rock reinforcement at compromised infrastructure within the project area. Ms. Koseniak felt that full scale restoration (Alternative 3 – Re-grade the Banks) required too much disturbance to the existing park. Ms. Koseniak also had reservations about Alternative 2, which involves heavy rock armoring, because of the potential for increased flow stage during high flow events and potential loss of park access during flood conditions. Should Alternative 3 – Regrade the Banks be advanced to design and construction, which could include replacement of the pedestrian bridge, Parks would need a crossing wide and strong enough for its mowers in order to retain access to the southern side of Zandale Park. Additionally, she saw the value in a 'no mow zone' and buffer strip to help stabilize the stream and promote natural habitats. It must be emphasized that Parks will only maintain native grasses/flowers in the buffer zone by infrequent (e.g. annual) bush-hogging. Parks cannot be expected to provide hand weeding of a mulched zone with more of a flower-bed type aesthetic. If the LNA prefers a mulched/landscaped aesthetic instead of native grass/flower seed mix, the LNA must commit to weeding and maintaining this area of the Zandale Park. The Maintenance Department (Tim Clark) strongly encouraged use of native grasses/flowers within the buffer zone for ease of long-term maintenance.

In conclusion, with respect to the Parks and Recreation Department, Ms. Koseniak noted that Parks may be able to provide additional assistance through the donation of logs and/or creek rock if available through stockpiling from their regular maintenance activities. Depending on the quality and quantity of the donated material, such assistance could substantially reduce overall construction costs of some of the concept alternatives. Reference Section 7.0 *Opinion of Probable Construction Cost* for additional detail relating to the project costs.

LFUCG Division of Water Quality:

LFUCG Division of Water Quality (Susan Plueger, P.E.) was open to all three concept alternatives. Ms. Plueger expressed an interest in long-term sustainability through full scale restoration, such as Alternative 3 – *Re-grade the Banks*, but noted that this alternative may not be desired by all stakeholders because it would likely convert a large portion of the park into a floodplain environment. She requested that this conceptual design memorandum present several alternatives – some illustrating more cost-effective solutions with higher risk for additional bank failure and also an alternative for full scale restoration such as Alternative 3.

Ms. Plueger also expressed openness to expanding the project to reaches beyond the park property. With regard to this point, the concept alternatives and unit costs presented herein would be applicable to reaches downstream from Zandale Park, but would need to be prorated according to the relevant quantities. It should be noted, however, that any potential impacts/adjustments to the large double box culvert crossing at Lansdowne Estates would need to be cost estimated separately from this task. There are also several additional sewer/waterline crossings downstream from Zandale Park—any potential impacts to those crossings other than rock reinforcement of pier supports would also need to be cost estimated separately from this task. Reference *Section 7.0 Opinion of Probable Construction Cost* for additional detail relating to the project costs.

6.0 Permits:

The following table (Table 3) presents a summary of potential permits that may be required as the project progresses through design to construction. It also includes agency contact information.

Table 3 – Stream Restoration Permitting Requirements

Agency	Permit Required	Contact	Comments
USACE	Section 404 Individual Permit --OR— Section 404 Nationwide Permit (NWP)	Louisville Permits: Leanne Devine 502-315-6692	NWP 13 Bank Stabilization NWP 27 Aquatic Habitat As the project progresses into design, coordination with USACE will be necessary to determine which permit (or combination thereof) will be required.
Kentucky Division of Water (KDOW)	Section 401 Water Quality Individual Permit Certification (To be obtained concurrently with or before Section 404) Floodplain construction permit NOI - NPDES Site General Permit (ie: Erosion Control)	Water Quality Certification: Barbara Scott / Joyce Fry 502-564-3410 Floodplain: Todd Powers 502-564-3410 NOI: Alan Ingram 502-564-3410	Floodplain construction permit and water quality certification permit is included in the same application, but once submitted the applicant works with each department separately. There is an application fee associated with the water quality certification permit if the project is greater than 500 linear feet and both the floodplain and water quality certification permits require public notice. The stormwater construction permit (NOI) is simpler than other KDOW permits.
Kentucky Historical Preservation Office	Request confirmation of no historical impact relative to project	Mark Dennen Kentucky Heritage Council 502-564-7005	Project data to be submitted for their review and response for compliance with the NWP requirements.
Kentucky Fish and Wildlife	Request confirmation of no effect relative to project	Jim Gruhala U.S. Fish & Wildlife 502-695-0468	Project data to be submitted for their review and response for compliance with the NWP requirements.
Lexington-Fayette Urban County Government	Land Disturbance Permit	Hillard Newman LFUCG 859-258-3410	Construction drawings are submitted for proposed improvements and supporting copies of state and federal permits.

7.0 Opinion of Probable Construction Costs:

The following tables present a conceptual level opinion of probable construction cost for each alternative. It is important to note that these opinions of probable cost are in fact conceptual and as the project advances into detailed design a more accurate opinion of probable cost can be determined. These costs are only intended to help the LNA understand relative costs for each alternative. As previously mentioned, each alternative presents varying levels of cost, disturbance, and risk for additional bank failure. In terms of cost, Alternative No. 1 – *Log Vane Armoring* provides the most economical option and Alternative No. 3 – *Re-grade Banks* is the most expensive option. The following project costs do not include additional costs for design or permitting.

Table 4 – Conceptual Opinion of Probable Construction Cost
Alternative No. 1 - Log Vane Armoring

Item	Quantity	Unit	Labor	Material[1]	Unit Cost	Total Cost
Log Vanes	9	ea	$400	$300	$700	$6,300
Bridge - Double Wing Deflector (creek rock[2])	26	cy	$50	$80	$130	$3,410
Sewer Crossing Pier - Wing Deflector (creek rock[2])	3	cy	$50	$80	$130	$390
Riparian Zone Vegetation (native grass/flower seed[3])	1,600	sy	$0.30	$0.30	$0.60	$960
					Subtotal	$11,100
					30% Contingency	$3,300
					Total	**$14,400**

Notes for various cost scenarios with Alternative No. 1:

[1]If Parks donates the logs and rock material, this alternative could cost approximately $8,000.

[2]If rip rap is installed instead of creek rock (material cost of $40/CY instead of $80/CY), this alternative could cost approximately $13,000.

[3] If the LNA prefers to install manicured flower beds instead of native grasses/flowers, this alternative could cost anywhere from $35,000 to $55,000 depending on the amount of flower beds. This does not include the additional costs associated with annual maintenance.

Table 5 – Conceptual Opinion of Probable Construction Cost
No. 2 - Major Rock Armoring

Item	Quantity	Unit	Labor	Material[1]	Unit Cost	Total Cost
Creek Rock	523	cy	$40	$80	$120	$62,760
Bridge - Double Wing Deflector (creek rock[2])	26	cy	$50	$80	$130	$3,410
Sewer Crossing Pier - Wing Deflector (creek rock[2])	3	cy	$50	$80	$130	$390
Riparian Zone Vegetation (native grass/flower seed[3])	1,600	sy	$0.30	$0.30	$0.60	$960
					Subtotal	$67,500
					30% Contingency	$20,300
					Total	**$87,800**

Notes for various cost scenarios with Alternative No. 2:

[1]If Parks donates the rock material, this alternative could cost approximately $30,000

[2]If rip rap is installed instead of creek rock (material cost of $40/CY instead of $80/CY), this alternative could cost approximately $59,000

[3] If the LNA prefers to install manicured flower beds instead of native grasses/flowers, this alternative could cost anywhere from $100,000 to $120,000 depending on the amount of flower beds. This does not include the additional costs associated with annual maintenance.

Table 6 – Conceptual Opinion of Probable Construction Cost
Alternative No. 3 - Re-grade Banks

Item	Quantity	Unit	Labor	Material[1]	Unit Cost	Total Cost
Excavation	3,600	cy	$40		$40	$144,000
Riparian Zone Vegetation (native grass/flower seed[3])	1,600	sy	$0.30	$0.30	$0.60	$960
Grass Restoration	900	sy	$0.20	$0.10	$0.30	$270
Trees (30 ft spacing)	25	ea	$100	$100	$200	$5,100
Bridge[2] - Double Wing Deflector (creek rock[1])	26	cy	$50	$80	$130	$3,400
Sanitary Sewer Crossing	1	each	$1,500	$1,000	$2,500	$2,500
Relocation of at risk storm sewer infrastructure	3	each	$1,000	$1,000	$2,000	$6,000
					Subtotal	$162,200
					30% Contingency	$48,700
					Total	**$210,900**

Notes for various cost scenarios with Alternative No. 3:

[1]If Parks donates the rock material, this alternative could cost approximately $205,000

[2]The current alternative allows the existing bridge to remain and the banks will taper in and out to accommodate the existing location. However, should the LNA prefer to replace the bridge the project costs would increase significantly. This could include installation of a new bridge (approximately $15,000-$30,000 increase) or it could include installation of an earthen berm crossing with culvert (approximately $7,000).

[3] If the LNA prefers to install manicured flower beds instead of native grasses/flowers, this alternative could cost anywhere from $235,000 to $260,000 depending on the amount of flower beds. This does not include the additional costs associated with annual maintenance.

8.0 Conclusion - Summary of Alternatives:

Results of our stream evaluation indicate that the Zandale Park Creek will continue to experience bank failure and head cutting unless the channel evolution sequence, as presented in Figure 3, is artificially accelerated such that the stream re-attains a stable, equilibrium form and avoids additional periods of bank erosion and failure.

Three conceptual design alternatives for the Zandale Park Stream Bank Protection Project, each ranging in varying levels of cost, degree of disturbance, and risk for additional bank failure, were presented. The *Log Vane Armoring* alternative is the most economical and least disruptive to the existing park, but it comes with a high risk of additional bank failure. The *Major Rock Armoring* alternative costs more than the *Log Vane Armoring* alternative, and may be more disruptive due to the quantity of rock that would need to be hauled to the site. This alternative has a moderate risk of additional bank failure. Lastly, the third alternative, *Re-grade Banks*, is very expensive and disruptive, but provides the lowest risk of future bank failure. Table 7 below presents a summary of the advantages and disadvantages of each alternative.

Table 7 – Summary of Zandale Park Stream Bank Protection Conceptual Alternatives

Alternative	Risk of Additional Bank Erosion	Relative Cost	Level of Disturbance
Alternative No. 1 Log Vane Armoring	High	Low $14,500	Low
Alternative No. 2 Rock Armoring	Medium	Medium $88,000	Medium
Alternative No. 3 Re-grade Banks	Low	High $211,000	High

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