

**Renaissance Park
Methodology for Landscape Performance Benefits
Case Study Investigation 2014**

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Landscape Performance Benefits & Methodologies

- 1. Removed 34,000 cu yd of contaminated soil from the 100-year floodplain and sealed it safely within the park's iconic landforms. This includes 12,000 cu yd of soil commingled with enamel frit, which was leaching contaminants into groundwater.**

Methodology:

This performance indicator is based on the thorough review of information provided and cut/fill calculations performed by the project's consulting team.

The site's industrial past as a manufacturing/finishing facility for consumer-grade stoves contaminated soil throughout the site to varying degrees and with a range of toxic contaminants, including PCBs, heavy metals, cyanide, SVOCs and VOCs. The most threatening was 12,000 cubic yards of soil comingled with enamel frit. Capped waste cells where the manufacturer had disposed of this material were leaching contaminants into groundwater resources, creating a contaminated groundwater bloom down gradient from the capped cells.

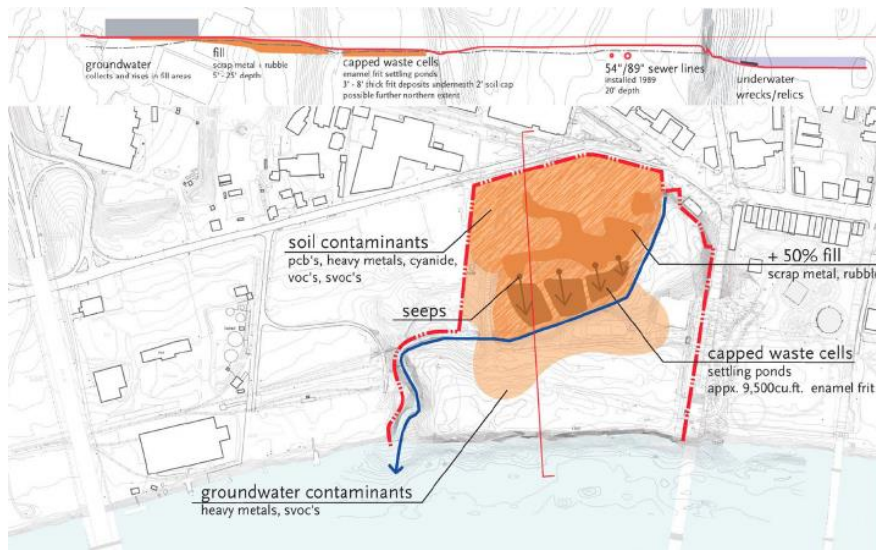


Figure 1. Site Contamination Study. Source: Hargreaves Associates

A digital topographic analysis of the site was conducted using historical maps of the site's undeveloped and post-industrial conditions, soil borings, and groundwater analysis to generate three-dimensional models of the likely extent of contaminated soil. This analysis allowed the team to design the site and properly size the site's iconic landforms under which contaminated soils were to be encapsulated.

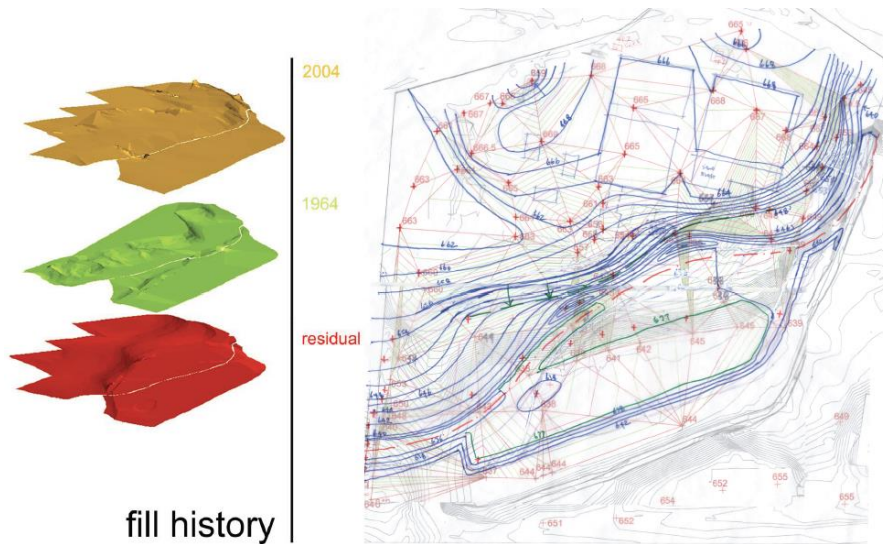


Figure 2. Study of site's historic topography. Source: Hargreaves Associates

34,000 cubic yards of contaminated soils were excavated and redistributed to areas of the site that required fill. These areas were designed by the project team to be outside of the 100-year floodplain and safe from groundwater intrusion. Redistributed soils were graded according to plans and safely capped with a complex stabilization and safety assembly that included geogrids, warning tape, and not less than two feet of clay subsoil and planting soil. An underdrain system is installed within the cells to move any leachate from these soils to the sanitary sewer system.

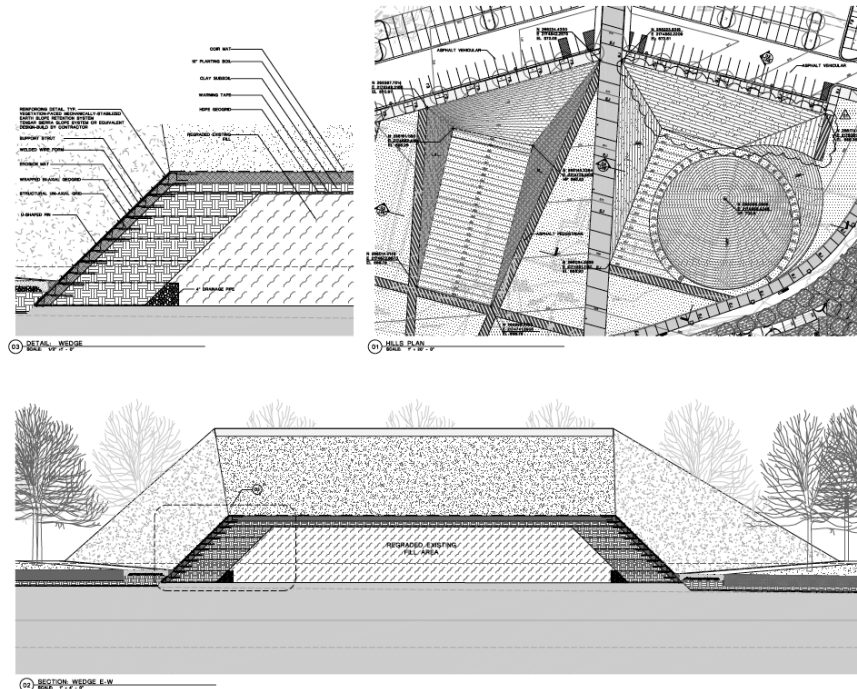


Figure 3. Iconic landforms safely encapsulate regraded contaminated soils. Source: Hargreaves Associates

Limitations:

Sufficient information was not provided to verify the accuracy of the consulting team's calculations.

Sources:

Hargreaves Associates, Renaissance Park Construction Documents, 08/13/04
Hargreaves Associates, presentation titled "11.07.05_remediation.pdf"

2. Increases floodplain storage by 9.33 acre feet (15,047 cu yd.) due to excavation of contaminated soil below 100 year floodplain elevation and creation of a constructed wetland.

Methodology:

This performance indicator is based on the thorough review of information provided and cut/fill calculations performed by the project's consulting team as well as calculations performed by the research team.



Figure 4. 100 Year Floodplain

The portion of the site where contaminated soils were excavated from capped waste cells of enamel frit was excavated as much as 10' below finished grade. This +/- one acre area is creatively redesigned as a one-acre constructed wetland that receives, retains, and treats runoff from the site while increasing the storage capacity of the 100-year flood by 9.32 acre feet. Though the surface area of the floodplain appears reduced in the above pre development and post development diagrams (Figure 4), the depth of the wetland excavation yields a net increase in floodplain volume.

Per project construction documents, the net total volume of contaminated soils excavated below the 100 year flood elevation is 18,000 cu yd. This figure takes into account the volume of clean fill replaced in the flood plain as part of site improvements and the normal pool level (EL 640) of the constructed wetland that is within the void that once contained contaminated soils.

Runoff from within the park is directed to and retained within the constructed wetland, the volume of which decreases the park's floodplain storage capacity for off-site runoff during the course of a storm event.

There are two feet of freeboard between the normal pool and the elevation of the bottom-most orifice on the wetland's outfall structure (EL 642), meaning that the increase in the floodplain's storage capacity is equivalent to 18,000 cu yd. less incremental water volume held by the wetland between EL 640 and EL 642.

This volume was calculated by the research team by first calculating the average surface area within consecutive contours (640-641, 641-642) and then multiplying average areas (sq ft) by one foot of elevation to determine the volume (cu ft.). Calculations are shown below in Figure 5.



Figure 6

Figure 7 shows the area of each landscape type for each park. A baseline case “transfers” the percentage of each landscape type of Coolidge Park to the total landscaped area of Renaissance Park.

	Landscape Type	Irrigated	Area (sf)	% of total landscape
Renaissance Park				
	floodplain forest	n	314,665	53%
	meadow	n	135,926	23%
	turfgrass	y	79,322	13%
	turfgrass: cone landform	y	39,633	7%
	grassy areas	y	28,208	5%
	total landscaped area		597,754	
	total irrigated area		147,163	
Coolidge Park				
	turfgrass	y	205,189	65%
	mixed trees, shrubs & groundcover	y	22,061	7%
	mixed turf, trees, shrubs & groundcover			
	50% turfgrass	y	43,883	14%
	50% mixed trees, shrubs & groundcover	y	43,883	14%
	total landscaped area		315,016	
Baseline - Renaissance Park landscape types similar to Coolidge Park				
	turfgrass	y	472,623	79%
	mixed trees, shrubs & groundcover	y	125,131	21%
	total landscaped area		597,754	

Figure 7. Landscape Types

Total water applied (TWA) was calculated for Renaissance Park, Coolidge Park and the baseline case using the LEED Water Efficient Landscaping Calculator from LEED for new construction v2009. Figure 8 shows the calculations.

Design Case-Renaissance Park										
Landscape Type	Area (sf)	Species Factor (ks)	Density Factor (kd)	Microclimate Factor (kmc)	KL	ETL	Irrigation Type	IE	CE	Design TWA (Total Water Applied)
turfgrass: Bermuda on "cone"	39,633	0.7	1	1.2	0.84	5.07	Sprinkler	0.625		140,142
turfgrass: Bermuda other areas	79,322	0.7	1	1	0.7	4.22	Sprinkler	0.625	0.7	233,735
turfgrass: fescue mix	28,208	0.6	1	0.8	0.48	2.89	Sprinkler	0.625		56,996
Total:	147,163									TOTAL: 430,874
Design Case - Coolidge Park										
Landscape Type	Area (sf)	Species Factor (ks)	Density Factor (kd)	Microclimate Factor (kmc)	KL	ETL	Irrigation Type	IE	CE	Design TWA (Total Water Applied)
turfgrass	205,189	0.7	1	1	0.70	4.22	Sprinkler	0.625		604,623
mixed trees, shrubs & groundcover	22,061	0.5	1	1	0.5	3.02	Sprinkler	0.625	0.7	46,433
mixed turfgrass, trees, shrubs & groundcover	87,766									
turfgrass(50%)	43,883	0.7	1	1	0.7	4.22	Sprinkler	0.625		129,308
trees, shrubs & groundcover(50%)	43,883	0.5	1	1	0.5	3.02	Sprinkler	0.625		92,363
Total:	315,016									TOTAL: 872,728
Baseline Case - Renaissance Park areas based on landscape types of Coolidge Park										
Landscape Type	Area (sf)	Species Factor (ks)	Density Factor (kd)	Microclimate Factor (kmc)	KL	ETL	Irrigation Type	IE	CE	Baseline TWA (Total Water Applied)
turfgrass	472,623	0.7	1	1	0.70	4.22	Sprinkler	0.625		1,392,661
mixed trees, shrubs & groundcover	125,131	0.5	1	1	0.50	3.02	Sprinkler	0.625	0.7	263,371
Total:	597,754									TOTAL: 1,656,031
ETo Coefficient										TOTAL Water Savings: 74%
6.03										

Figure 8. LEED Water Efficient Landscaping Calculator

Figure 9 shows the different species, density, microclimate and irrigation efficiency coefficients used in the Figure 8.

Vegetation Type	Species Factor (k _s)			Density Factor (k _d)			Microclimate Factor (k _{mc})		
	Low	Avg	High	Low	Avg	High	Low	Avg	High
1	2	3	4	5	6	7	8	9	1
Trees	0.2	0.5	0.9	0.5	1.0	1.3	0.5	1.0	1.4
Shrubs	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.3
Groundcovers	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.2
Mixed	0.2	0.5	0.9	0.6	1.1	1.3	0.5	1.0	1.4
Turfgrass	0.6	0.7	0.8	0.6	1.0	1.0	0.8	1.0	1.2
Irrigation Type	IE								
1	2								
Sprinkler	0.625								
Drip	0.900								
Other									

Figure 9

The following formula was used to calculate Total Water Applied (TWA):

$$TWA(\text{gal}) = [\text{Area}(\text{sf}) \times (\text{ETL}(\text{in})/\text{IE})] \times \text{CE} \times 0.6233 \text{ gal/sf/in}$$

Where:

$$\text{ETL}(\text{in}) = \text{ETo} \times \text{KL}$$

Evapotranspiration Rate: ETo = 6.03 for peak month of June. The EPA Water Budget Data Finder was used to determine the appropriate evapotranspiration value for the 37402 zip code (Chattanooga).

Landscape Coefficient: KL = k_s x k_d x k_{mc}

Controller Efficiency: CE – percent reduction from weather-based or moisture sensor-based systems.

The water savings was calculated as such:

$$\text{Total Water Savings} = (\text{Baseline TWA} - \text{Renaissance Design TWA})/\text{Baseline TWA} \times 100$$

$$74\% = (1,656,031 - 430,874)/1,656,031 \times 100$$

From the areas listed in figure 7, a direct comparison of gallons per acre of water used for irrigation for the two parks yields the following results:

Renaissance Park: 597,754 sq ft / 43,560 sq ft per acre = 13.7 acres
430,874 gal / 13.7 acres = 31,451 gal/acre

Coolidge Park: 315,016 sq ft / 43,560 sq ft per acre = 7.2 acres
872,728 gal / 7.2 acres = 121, 212 gal/acre

Sources:

Google Earth, accessed July 1, 2014.

http://www.epa.gov/watersense/new_homes/wb_data_finder.html

LEED Building Design and Construction v2009 Reference Guide

<http://caddinstituteofmiami.com/leed/BD/PDFs/WE.pdf>

4. Improved habitat value of the North Market Branch stream from “marginal” to “suboptimal”. USEPA Rapid Bioassessment habitat scores rose from 60 in 2002 to 122 in 2014 as a result of bank stabilization and native riparian plantings.

A habitat assessment was conducted on North Market Branch stream prior to park construction by the City Water Quality Department on June 20, 2002 using the EPA’s Rapid Bioassessment Protocol (Barbour et al, 1999). Parameters evaluated include epifaunal substrate/available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protective and riparian vegetative zone width. Habitat scores are ranked on a 0-200 point scale and divided into four categories: 0-50 (Poor), 51-100 (Marginal), 101-150 (Suboptimal), 151-200 (Optimal). Results of the assessment yielded a score of 60 (Figure 10). On June 16, 2014, another habitat assessment was conducted by the City Water Quality Department. Results of this assessment yielded an improved score of 122 (Figure 11). Although this score shows an improvement, it is still below the Tennessee Department of Environment and Conservation’s (TDEC) Ecoregion guideline of ≥ 144 .

An extensive stream restoration was not a design intent, but measures taken to stabilize the stream bank were implemented, which contributed to the improvement in the habitat score. Planted coir logs, seeded erosion control mat and live stakes were installed. Native riparian species such as Switchcane (*Arundinaria gigantea*), Indian Woodoats (*Chasmanthium latifolium*), Winterberry Holly (*Ilex verticillata*), Virginia Sweetspire (*Itea virginica*) and Smooth Solomon’s Seal (*Polygonatum biflorum*) were planted along the stream bank help to improve stream ecology.

Figure

Division of Water Pollution Control
SOP for Macroinvertebrate Stream Surveys
Revision 2
Effective Date: March 2002
Appendix B: Page 5 of 12

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present	Channelization may be extensive; embankments or shoring structures, present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement, over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5-7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >35.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded area; “raw” areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
Note: determine left or right side by facing downstream.				
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protective (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height
Note: determine left or right side by facing downstream.				
SCORE 4 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 6 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
TOTAL SCORE	60			

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME <i>MSTRE</i>		LOCATION <i>Market St. Branch</i>		
STATION # <i>0001CC</i> RIVER MILE		STREAM CLASS		
LAT <i>35° 0. 03. 479N</i> LONG <i>85° 18. 918W</i>		RIVER BASIN		
STORE#		AGENCY		
INVESTIGATORS		DATE <i>6/20</i> TIME <i>8:35</i>		
FORM COMPLETED BY <i>CWB</i>		REASON FOR SURVEY		
Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable habitat; availability less than desirable; substrate frequently disturbed or removed	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE <i>6</i>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 <i>6</i>	5 4 3 2 1
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 76% surrounded by fine sediment.
SCORE <i>7</i>	20 19 18 17 16	15 14 13 12 11	10 9 8 <i>7</i> 6	5 4 3 2 1
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) (slow is <0.3m/s deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower than regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime (usually slow-deep)
SCORE <i>5</i>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	<i>5</i> 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased far development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE <i>6</i>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 <i>6</i>	5 4 3 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills > 75% of the available channel; or 25 % of channel substrate is exposed.	Waters fills 25-75 % of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE <i>5</i>	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	<i>5</i> 4 3 2 1

Figure 10. Habitat Assessment Data Sheet – 2002.
 Source: City of Chattanooga Water Quality Department

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
 (See Protocol E for detailed descriptions and rank information)

STATION ID:		HABITAT ASSESSED BY: <i>Tristan Johnson</i>							
STREAM NAME: <i>North Market street</i>		DATE: <i>6/16/14</i>				TIME: <i>10:10 AM</i>			
STATION LOCATION: <i>Renaissance Park</i>		ECOREGION: <i>QC: Consensus Duplicate</i>							
WBID/HUC:		GROUP:				ASSOCIATED LOG #:			
1. Epifaunal Substrate/ Available Cover	Optimal	Suboptimal	Marginal	Poor					
	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.)	Natural stable habitat covers 20-40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.					
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1					
Comments									
2. Embeddedness of Riffles	Optimal	Suboptimal	Marginal	Poor					
	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.	Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.	Gravel, cobble, and boulders are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.					
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1					
Comments									
3. Velocity/ Depth Regime	Optimal	Suboptimal	Marginal	Poor					
	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime. Others regimes too small or infrequent to support aquatic populations.					
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1					
Comments									
4. Sediment Deposition	Optimal	Suboptimal	Marginal	Poor					
	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Slight sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.					
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1					
Comments									
5. Channel Flow Status	Optimal	Suboptimal	Marginal	Poor					
	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.	Water covers > 75% of streambed or 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or productive habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.					
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1					
Comments		<i>Low Flow Conditions</i>							

Figure 11. Habitat Assessment Data Sheet – 2014. Source: City of Chattanooga Water Quality Department

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

Station ID	Date										Initials														
6. Channel Alteration	Optimal	Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.					Suboptimal	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.					Marginal	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.					Poor	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.					
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1				
Comments																									
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.					Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.					Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.					Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.									
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1				
Comments																									
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.					Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.					Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods. If approaching 60% score poor if banks steep.					Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.									
	SCORE (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0	SCORE (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1
Comments																									
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.					70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)					50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).					Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)									
	SCORE (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0	SCORE (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1
Comments																									
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.					Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.					Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.					Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.									
	SCORE (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0	SCORE (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1
Comments																									

Total Score 122 Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score is below guidelines, result of (circle): Natural Conditions or Human Disturbance

Describe

Figure 11 (cont'd). Habitat Assessment Data Sheet – 2014

Figure 12 shows the stream in 2002. Notable is the excessive sediment deposition, eroding and incised streambank and lack of riffles. Figure 13 shows the stream in 2014. The streambank shows improved stability and vegetative cover, as well as an improved frequency of riffles and reduction in sediment.



Figure 12. 2004



Figure 13. 2014

Image Credit: City of Chattanooga Water Quality Department

Limitations:

Upstream variables beyond the scope of the project contribute to the stream conditions on site, making a significant habitat score improvement unlikely. An extensive stream restoration would probably result in a habitat score within TDEC Ecoregion Guidelines. *E. coli* continues to be a problem in the stream due to aging septic systems still in use within the watershed. Signs posted along the stream inform park users not to come in contact with the water.

The EPA's Rapid Bioassessment Protocol (Barbour et al, 1999) is designed to be a quick and inexpensive tool for agencies to use in determining whether a stream is or is not supporting a designated aquatic life use. Additional tools can be used, such as benthic macroinvertebrate, periphyton and fish assessments, which would give a more complete assessment. A macroinvertebrate sampling was conducted in 2002, which yielded a score of 4 (severely impaired). A macroinvertebrate sampling was not conducted for this report due to time and budget constraints.

Sources:

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Correspondence with Rebecca Robinson, Water Quality Supervisor, City of Chattanooga on 6/6/2014 & 6/16/2014.

5. Promotes a healthy lifestyle, according to 85% of 85 park users surveyed. 81% agree that the park increases their outdoor activity.

A survey was developed and distributed by the UTK research team to gather information on user perception and experiences in and around the park. The following topics were included: motivation for visiting park, frequency and length of use, activities partaken, user understanding of the educational, environmental and cultural features, park type preference, knowledge of the past use of the site, proximity of user's residence, whether the park influenced choice of housing

location and patronage of nearby businesses before or after visiting the park. User profile questions were also included in to understand the population of respondents.

Two survey types were implemented. One survey was distributed to park users on-site on Sunday, June 8, 2014. The other survey was created in Survey Monkey and distributed through a list-serve by the adjacent condominiums property managers, as well as through a link shared on Outdoor Chattanooga and the Northshore Merchants Collective's Facebook Pages. 27 surveys were completed on site by park users. On-line surveys were accessible from June 10- July 16, 2014, with 67 completed.

The survey was voluntary and anonymous. An introduction to the research project was provided, as well as a statement that completion of the survey is consent to participate. The format was check box with appropriate answer and short fill in answers. University of Tennessee Knoxville- Institutional Review Board approval was applied for in order to conduct the research. The research team completed the UTK-IRB application, completed the online training requirement to conduct the study, and received approval on June 6, 2014.

Notable results of the survey regarding ways in which the park contributes to the health and well-being of its users are as follows:

- 69% of 89 respondents visit the park once a week or more, 21% of which visit the park every day.
- 58% of 89 respondents arrive at the park on foot
- 80% of 89 respondents visit the park to enjoy nature and be outdoors
- 69% of 89 respondents visit the park for exercise and fitness
- 86% of 85 respondents use the park for walking
- 58% of 85 respondents use the park for relaxation
- 85% of 85 respondents agree that the park promotes a healthy lifestyle
- 81% of 85 respondents agree that the park increases their outdoor activity
- 79% of 85 respondents agree that the park improves their quality of life

Figure 14 shows the questions asked and results from Survey Monkey.

Survey Question	Answer Choice	Responses	
On average, how often do you visit Renaissance Park?	Every day	22%	20
	Several times a week	26%	23
	About once a week	21%	19
	About once a month	18%	16
	Once every six months	4%	4
	Once a year or less	4%	4
	Don't know	0%	0
	This is my first visit (on site respondents only)	3%	3
Total Survey Responses			89
How do you usually arrive at the park?	on foot	58%	52
	by bicycle	7%	6
	by car	35%	31
	by public transportation	0%	0
Total Survey Responses			89

What is your motivation for visiting Renaissance Park (check all that apply)?	exercise/fitness activities	69%	61
	enjoying nature & being outdoors	80%	71
	socializing with friends and family	43%	38
	stress reduction	44%	39
	Other (please specify)	20%	18
Total Survey Responses			89
What are the primary activities in which you participate while in Renaissance Park (check all that apply)?	walking	86%	73
	jogging/running	32%	27
	walking dog	42%	36
	plant/wildlife viewing	35%	30
	picnicking/eating	19%	16
	'sledding' down hills	16%	14
	cycling	36%	31
	relaxation	58%	49
	outdoor education	7%	6
	environmental stewardship activity/volunteering	5%	4
	public art viewing	36%	31
	community events	35%	30
Other (please specify)	9%	8	
Total Survey Responses			85
Renaissance Park _____ (check all with which you agree based on your experience/use at the park).	improves my quality of life	79%	67
	promotes a healthy lifestyle	85%	72
	provides a safe and secure environment	74%	63
	increases my outdoor activity	81%	69
	enhances my understanding of the site's cultural history	42%	36
	contributes to my understanding of alternative stormwater management practices	36%	31
	contributes to my understanding of floodplain forest ecology	27%	23
	creates habitat for wildlife	54%	46
	promotes art	49%	42
	promotes educational opportunities	22%	19
	promotes scheduled outdoor events	42%	36
Total Survey Responses			85

Figure 14

The use of the park by personal trainers is another way in which the park promotes healthy lifestyles. During the project kick-off site tour on March 19, 2014, Don Lewis, Parks Supervisor for the City of Chattanooga revealed that personal trainers use the steep hills in the park as part of their training regimen. The research team identified four fitness centers offering personal training programs within a half-mile radius of the park.

An online survey was developed in Survey Monkey and distributed to the personal trainers at three of the four studios in the Northshore neighborhood. The survey questions were aimed at

quantifying the number of clients that participate in training at the park, frequency of use, determining which park features are used for training (hills, amphitheater steps, etc.) and whether the park has had a positive impact on the trainer's business and provides unique training opportunities not found elsewhere. Findings include:

- 100% of the trainers use the grassy landforms, 83% use the amphitheater steps and 67% use the benches
- 100% of the trainers say that the park impacts their business by providing a venue to use new or unique training exercises
- trainers work with 2-15 clients in the park and one trainer works with more than 15 clients in the park.

One trainer provided the following response in describing the unique opportunities provided by the park: "The hills and flat grass areas are the best that the park had to offer. There really is no other place to perform hill exercise."

Limitations:

The day chosen for the on-site survey (Sunday, June 8, 2014) happened to be a day of low park visitation. A conversation with a resident of the adjacent condominiums revealed that a festival held across the river was a draw to many people, and that many residents leave town to escape the crowds associated with this event. She noted that the park is heavily used on weekends and that on this particular day the park was unusually "empty".

On-site surveys took more time than anticipated and more results would have been obtained if conducted over multiple days. In comparison, the on-line survey resulted in 67 responses in 10 days (responses began on June 11 and ended on June 21, 2014) without the research team having to be on site.

Despite the research team's efforts to engage with the personal trainers in the Northshore neighborhood, only 6 responded to the survey. It is estimated that there are approximately 15 personal trainers in the area. Additional completed surveys would give a more accurate idea of the ways in which Renaissance Park has had a positive impact on the personal training business and on exercise opportunities for park users.

Sources:

https://www.gocolumbiamo.com/ParksandRec/About_Us/documents/mktstudy.pdf
<https://www.portlandoregon.gov/PARKS/article/317545>

6. *Attracts an estimated 145,220 visitors annually, many of whom also patronize local businesses. 89% of 85 surveyed park users shop or dine within ½ mile of the park before or after visiting the park.*

The research team contacted the city and two event-coordinating organizations to obtain information on events and attendance in the park. The City of Chattanooga Events Coordinator, Kim McNamara provided the following information on June 11, 2014:

- An estimated 114,000 people used the park on a daily basis from June 2013 – May 2014.
- Twelve individual rentals of the pavilion had approximately 420 attendees total and generated \$2400 in revenue.

Two event coordinating organizations, Friends of the Festival and Chattanooga Presents!, were contacted to provide additional information on events and attendance. Figure 15 shows past and projected events for 2014, in addition to the pavilion rental and daily users figure provided by the city. Estimated attendance for all events except UnCorked was provided to Friends of the

Festival by the Chattanooga Police Department. UnCorked was a ticketed event and sold 900 tickets for their 2014 fundraiser.

Event	Organization	Date	Estimated Attendance
Strides of March	Chattanooga Cares	3/24	2,000
Beer Over Dirt	North Chickamauga Conservancy	5/18	700
UnCorked	Chattanooga Presents for the Chattanooga Symphony & Opera	5/31	900
Pops on the River*	Chattanooga Presents!	7/3	25,000
River Rocks*	Chattanooga Presents!	10/4	500
Seven Bridges Marathon	Scenic City Multi Sport	10/19	1,200
Purple Stride	Pancreatic Cancer	11/16	500
pavilion rentals			420
daily users			114,000
TOTAL			145,220

*These events take place in both Renaissance Park and adjacent Coolidge Park.

Figure 15

The park is also a popular venue for wedding & engagement photographers, as well as weddings and Meetup events:

- <http://www.annaandspencer.com>
- <http://lorilinephotography.com/blog/lynsey-and-justin-engaged-renaissance-park/>
- <http://www.leifandlucky.com/ceremony/>
- Second Sunday Free Spin Hoop Jam Chattanooga Hoop Group (118 hoopers) Meetup event on the second Sunday of each month
<http://www.meetup.com/ChattanoogaHoopGroup>

The survey noted in Performance Benefit 5 above also inquired whether users usually shop or dine at a business within ½ mile before or after visiting the park. 89% of respondents replied “yes”. 97% of the 34 of the respondents that live more than 5 miles from the park shop or dine at a business within ½ mile. Coupled with yearly park attendance estimates, this information indicates the park has a positive effect on nearby businesses.

Limitations:

The number of daily park users is an estimate by city personnel. Needed information would include the city’s methodology for calculating park visitors. Because three separate entities coordinate events in the park, quantifying attendees of all events may not be accurate. The 4th of July event with an estimated 25,000 attendees takes place in both Renaissance and Coolidge Parks and makes it difficult to determine those attendees only using Renaissance Park.

Sources:

Correspondence with Kim McNamara, Administrative Support Specialist, City of Chattanooga, Department of Public Works, Parks & Facilities Management Division on June 11 & July 9, 2014
Correspondence with Carla Pritchard, owner of Chattanooga Presents!, a public events company, on July 24, 2014

Correspondence with Barbara Agee, Communications Manager, Friends of the Festival, a non-profit event management company for the City of Chattanooga, on July 30, 2014

7. Stimulates economic development and neighborhood reinvestment. Since 2005, \$55 million has been invested in two redevelopment projects on properties immediately adjacent to Renaissance Park. Five additional properties within a quarter mile of the park were redeveloped between 2005 and 2013.

Total investment value of the two redeveloped properties immediately adjacent to Renaissance Park was sourced and confirmed through each projects' developers, contractors, and/or property management representatives. Figure 16 shows the location of these projects relative to the park.

One North Shore, located at 200 Manufactures Drive, was also an industrial site before being redeveloped as a mixed-use project with 203 condominiums and 22,196 sf of retail space. Completed in 2008 as a single phase, the total value of construction permits approved for the project suggests a total construction investment of \$41.5 million.

4 Cherokee Blvd was previously a branch of a regional bank before it was redeveloped as Bridgeview on Northshore, also a mixed-use project with 37 condominiums and an estimated 23,000 sf of retail space. The total value of construction permits approved for this project suggests a total construction investment of \$13.5 million.

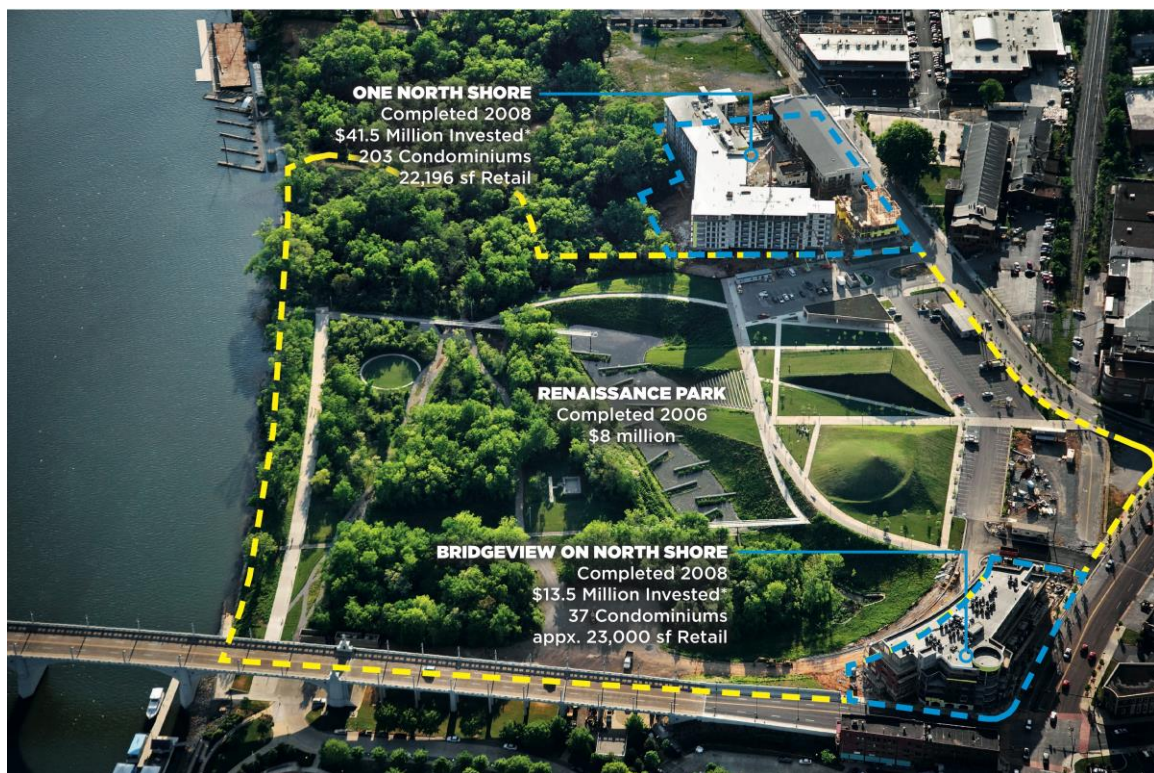


Figure 16: Base image credit: John Gollings

Both projects boast proximity, views, and access to Renaissance Park through their websites, featuring it as an amenity to their prospective buyers. Bridgeview on Northshore claims two front doors, one on the street and one on the park, while One North Shore features its adjacency to the park and views available to residents of the park through imagery on its website (Figure 17). A web camera was installed facing the park by One North Shore during their pre-construction sales phase so that prospective buyers could observe Renaissance Park's construction progress in real time.



Figure 17. Image Credit: onenorthshore.com

Inspecting aerial photography dated 2003 and 2013, five additional redevelopment projects were identified within the identified study area (Figure 18). These redevelopment projects were confirmed by the City Land Development Office to include two retail projects and three mixed-use developments.

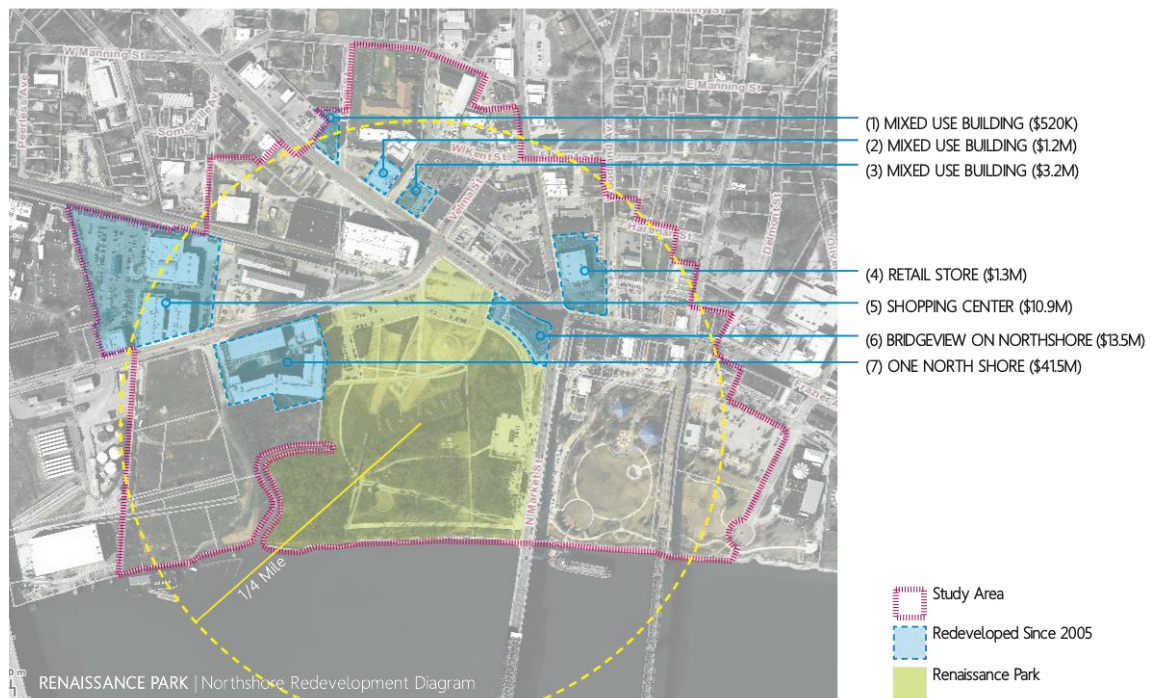


Figure 18: Renaissance Park Study Area

Limitations:

- The economic development activity on properties proximate to Renaissance Park cannot exclusively be attributed to the introduction of the park. Other forces across local, national, and global scales were at play during the study period that affects the reported data. Locally these include strategic public private partnerships/investments, rezoning initiatives, and other strategic infrastructure projects such as renovations to the Market Street Bridge and Coolidge Park (completed 1999) in the Northshore neighborhood that have made it one of the most desirable places to live and do business in Chattanooga. In some respects, Renaissance Park is as much a product of Northshore's reinvigoration as it is a catalyst for it.

- Total investment dollars, including property acquisition costs and third party investments for tenant build-outs in One North Shore and Bridgeview on North Shore were not available and are not included in the reported value of these projects in Figure 18.

Sources:

City of Chattanooga Land Development Office Data

Onenorthshore.com

<http://www.bridgeviewonnorthshore.com/bridgeview/>

City of Chattanooga GIS

8. Catalyzes the increase of property values. The aggregate land value within a quarter mile of Renaissance Park increased by 821% between 2005 and 2013 compared to a 319% increase within the North Shore Neighborhood but outside the study area over the same period.

An analysis of historic data from the Hamilton County assessor’s office (Figure 19) revealed stable land values within the study area (Figure 18) leading up to when Renaissance Park’s construction commenced in 2004-2005. Land values were then observed to begin increasing between 2005 and 2006 when construction at the park was complete. Figure 20 shows the results of the analysis of this data, representing value change between 2000 and 2013. Figures shown are aggregated appraised values. A 821% increase in the aggregate land value of 338 properties within the study area was observed between 2005 and 2013. This growth was benchmarked against the 319% increase in the aggregate land value of the 973 parcels within the North Shore Neighborhood that are outside of the study area during the same period.

YEAR	LAND VALUE	
	Study Area (338 Parcels)	North Shore Outside Study Area (973 Parcels)
2000	\$4,096,100.00	\$11,060,400.00
2001	N/A	N/A
2002	\$4,627,300.00	\$17,736,300.00
2003	\$4,706,500.00	\$18,093,900.00
2004	\$4,728,700.00	\$18,962,100.00
2005	\$4,833,300.00	\$19,467,300.00
2006	\$11,408,100.00	\$31,078,200.00
2007	\$12,556,400.00	\$31,237,000.00
2008	\$14,646,300.00	\$31,319,800.00
2009	\$16,437,400.00	\$36,587,000.00
2010	\$43,235,200.00	\$51,458,900.00
2011	\$43,333,400.00	\$52,591,900.00
2012	\$41,775,000.00	\$53,246,500.00
2013	\$39,679,200.00	\$60,715,600.00

Figure 19.

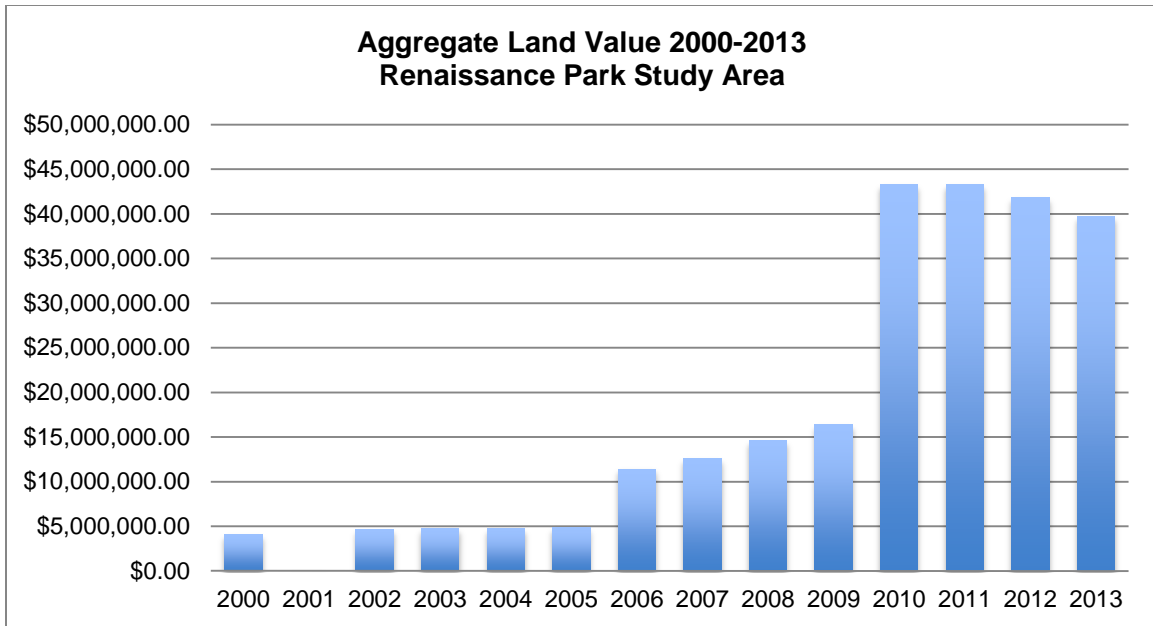


Figure 20

A significant spike is noticed in the study area aggregate land value between 2009 and 2010. 2010 is the first year in the county tax records that the 245 retail and residential condominiums in the One North Shore and Bridgeview On North Shore properties are reflected in tax records. Each condominium then carries a pro-rated value of the property's total value, and the land value for the parent property is reduced accordingly.

If the land values associated with these 245 condominiums are removed from the analysis of the study area's aggregate land value, an increase of 477% remains, still outpacing that of the North Shore Neighborhood outside of the study area.

Limitations:

- The increase in land values cannot exclusively be attributed to the introduction of Renaissance Park. Other forces across local, national, and global scales were at play during the study period that affects the reported data. Locally these include strategic public private partnerships/investments, rezoning initiatives, and other strategic infrastructure projects such as renovations to the Market Street Bridge and Coolidge Park (completed 1999) in the Northshore neighborhood that have made it one of the most desirable places to live and do business in Chattanooga. In some respects, Renaissance Park is as much a product of Northshore's reinvigoration as it is a catalyst for it.
- Total investment dollars, including property acquisition costs and third party investments for tenant build-outs in One North Shore and Bridgeview on North Shore were not available and are not included in the reported value of these projects in Figure 9.
- Information for 2001 was not available, but does not affect the outcome of this analysis.

Sources:

Hamilton County Property Assessor's Office Data
 City of Chattanooga Land Development Office Data
 City of Chattanooga GIS

9. Influenced the housing choice of 76% of 51 survey respondents who live within one mile of the park. 41% said they are willing to pay a premium to live close to the park.

The research team wanted to understand how the existence of the park influences the surrounding housing market and businesses. Determining an accurate dollar amount generated from park users is beyond the scope of this project. However, information obtained by the survey indicates that the park has a positive effect on both.

Of the 51 respondents that live within one mile of the park, 76% say that the park played a role in their choice of housing location. One can infer that the park has had a positive influence on the sale of condominiums in adjacent properties, and may also impact on the attractiveness of the broader Northshore neighborhood. Figure 21 shows the questions asked and results in Survey Monkey.

Survey Question	Answer Choice	Responses	
How far do you live from Renaissance Park?	Less than 1/4 mile	47%	44
	1/4 - 1/2 mile	1%	1
	1/2-1 mile	6%	6
	1-5 miles	10%	9
	More than 5 miles	36%	34
Total Survey Responses			94
Was proximity to Renaissance Park a factor in the selection of your current place of residence?	yes	75%	38
	no	25%	13
	Total Survey Responses		
Were you willing to to pay a premium price for your apartment's rent or condominium price due to its proximity to Renaissance Park?	yes	41%	21
	no	18%	9
	I do not feel as though I am paying a premium for my condominium/apartment	41%	21
	Total Survey Responses		

Figure 21

10. Saved \$1,080,000 in construction cost by salvaging 18,000 cu yd of concrete factory floor from the site.

Calculations:

cost to haul concrete off-site: 18,000 CY x \$60/CY = \$1,080,00
 cost to replace fill with other soil: 18,000 CY x \$5/CY = \$90,000
 cost to reuse concrete on-site: 18,000 CY x \$5/CY = \$90,000

total cost savings = cost to haul concrete to landfill + cost to import fill – cost to re-use concrete as fill

$$\$1,080,00 = \$1,080,00 + \$90,000 - \$90,000$$

Source:

Cost for hauling and fill replacement provided during correspondence with Gavin McMillan, Hargreaves Associates, 6/10/14 and 2005 Opinion of Probable Construction Costs Worksheet

11. Reduces actual per acre maintenance labor cost by \$4,500 or 73% per year compared to an adjacent park with large expanses of lawn and ornamental plantings.

Labor hours incurred in 2012 for Renaissance Park and neighboring Coolidge Park were obtained from Don Lewis, City of Chattanooga Parks Supervisor. Lewis provided a figure of \$15 per hour as an average labor cost. Figure 22 shows a breakdown of labor types and total man-hours per park. The labor cost per acre was calculated as such:

$$\begin{aligned} \text{total man-hours} \times \text{labor cost (\$/hr)} &= \text{total labor cost} \\ \text{total labor cost} / \text{acres of park} &= \text{labor cost per acre} \end{aligned}$$

Park Labor Maintenance Cost Comparison for 2012			
	Coolidge Park	Renaissance Park	% decrease
labor for 2012 (hrs)			
turf maintenance	1337	769	42%
landscape maintenance (plants)	3598	1441	60%
irrigation maintenance	238	115	52%
hardscape maintenance (pavers, signage, picnic tables, grills)	180	120	33%
Total man hours	5353	2445	54%
labor cost (\$/hr)	\$15	\$15	
Total labor cost	\$80,295	\$36,675	54%
area (acres)	13	22	
Labor cost per acre	\$6,177	\$1,667	73%

Figure 22

Aerial photographs of the two parks illustrate the difference in park style (Figures 23 & 24):

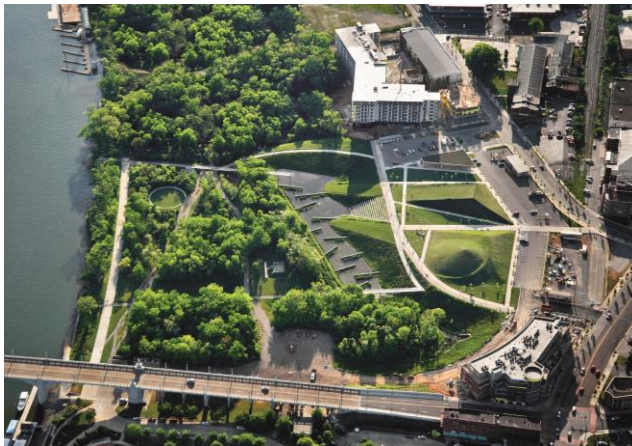


Figure 23. Renaissance Park
credit: John Gollings, Hargreaves Associates



Figure 24. Coolidge Park
Staff Photo by Doug Strickland/Chattanooga Times Free Press, April 20, 2012.

Limitations:

The data provided was for 2012 only. Data from additional years would provide an average number over time. Additional line items such as amounts of fertilizer, pesticides and water could not be obtained. This information would be useful to compare chemical and water use between the two parks.

Source:

Don Lewis, City Of Chattanooga Parks Supervisor, personal correspondence May 9 & 11, 2014 and site tour March 19,2014.

Cost Comparison

- 1. Alternative "hard engineering solutions" to managing contaminated soils and preventing further groundwater contamination that included proposed subterranean groundwater diversion walls and an asphalt cap were also explored by the client. The implemented "soft" approach was 25% less expensive than these alternatives while also converting the site to a public park.**

Calculation:

Further details regarding this cost comparison other than that which is included in the statement above and elsewhere in this case study are protected by a confidentiality agreement between the consulting team and the client.

Limitations:

Sufficient information was not provided to verify the accuracy of the consulting team's calculations.

Source:

Correspondence with Gavin McMillan, Hargreaves Associates, 5/6/14

- 2. Remediating 12,000 cubic yards of leaching soil containing commingled frit on site costs \$180,000, 75% less than the \$720,000 estimated cost to haul the same volume of soil to a proper landfill.**

Cost to excavate, handle on-site, haul, and dispose of contaminated soil off-site: \$60/cu yd
 12,000 cu yd x \$60/ cu yd = \$720,000 to manage off site
 Cost to excavate, handle on-site, and install protective clay cap assembly over regraded contaminated soil on site: \$15/cu yd
 12,000 cu yd x \$15/ cu yd = \$180,000 to manage on site
 \$720,000 - \$180,000 = \$540,000
 \$540,000 / \$720,000 = 75%

Sources:

Correspondence with Gavin McMillan, Hargreaves Associates, 6/2014
2005 Opinion of Probable Construction Costs Worksheet

Limitations:

Sufficient information was not provided to verify the accuracy or completeness of the consulting team's calculations.

Sustainable Features Calculations

76% of landscaped area is planted as non-irrigated, adapted and native plants (23%) and preserved riparian landscape (53%). Planting palette consists of 39 native riparian and wetland plant species, including 4 aquatic plants, 7 forbs and grasses and 28 trees and shrubs.

See Performance Benefit 3 for methodology in calculating the area of landscape types.

Area of floodplain forest:	314,665 sq ft
Area of meadow:	135,926 sq ft
Total area of non-irrigated landscape:	450,591 sq ft
Total landscaped area:	597,754 sq ft
% of landscaped area non-irrigated:	450,591 sq ft / 597,754 sq ft = 75%

Source:

Hargreaves Associates, Renaissance Park Construction Documents, 08/13/04
Google Earth, accessed 7/1/14

Impervious area of the site is reduced by 21%. The pre-development site had 382,207 sq ft of impervious area compared to the park's 301,849 sq ft. While most of the forest was retained, former factory rooftop, asphalt parking areas and concrete are now meadows, grassy open space and wetland.

Methodology:

PDFs of construction documents of existing site conditions and proposed redevelopment were brought into AutoCAD. Impervious areas of the pre-development conditions were identified and outlined with the polyline tool. These areas were calculated with the area tool and added together. Pervious areas of the new park site were delineated and quantified using the polyline tool, then subtracted from the overall impervious area, also delineated and quantified with the polyline tool. The percent difference in impervious area was calculated as shown below:

Industrial site impervious area:	382,207 sq ft
Park overall impervious area:	301,849 sq ft
Difference:	80,358 sq ft
% difference = 80,358 sq ft/382,207 sq ft = 0.21 or 21%	

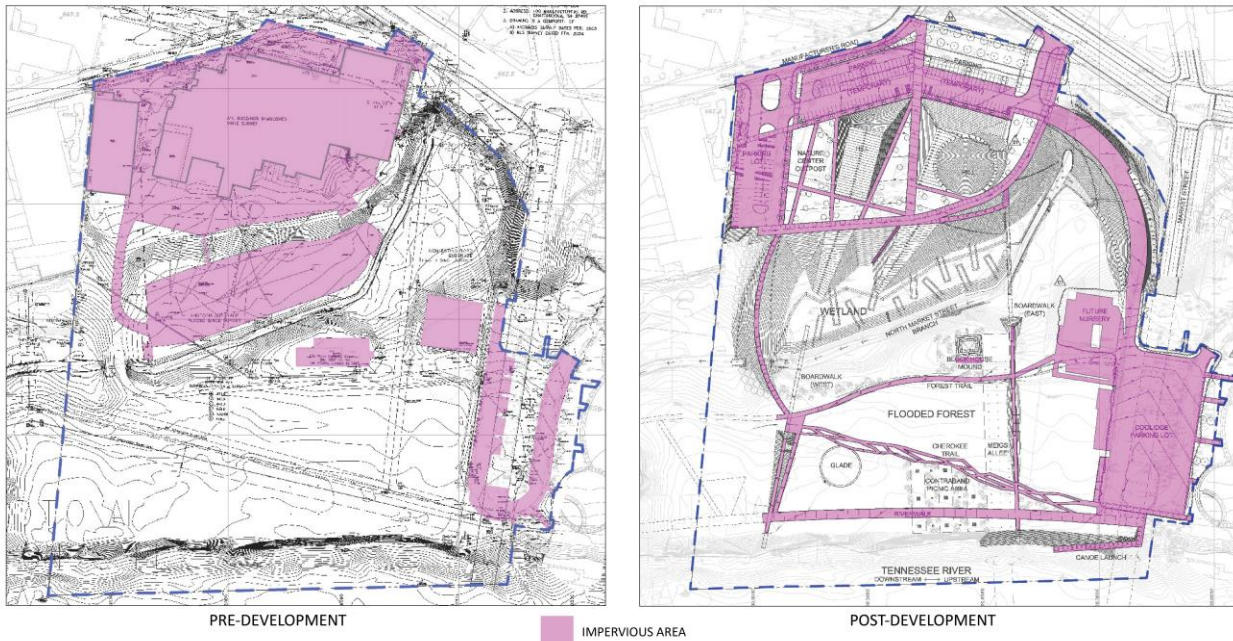


Figure 25

Figure 25 shows the pre and post development impervious areas. Adjustments were made to account for the difference in as-built conditions compared to construction drawings by viewing aerial photographs in Google Earth.

Source:

Hargreaves Associates, Renaissance Park Construction Documents, 08/13/04
 Google Earth, accessed 6/11/14

Groundwater Contamination

Test wells indicated a bloom of contaminated groundwater down-gradient from the known location of previously capped industrial waste settling ponds and fill areas near the old main building. Shallow groundwater of the site is hydraulically connected to North Market Street Branch. Groundwater samples from a 1991 environmental study indicated contaminants (fluoride, barium, cadmium, chromium and nickel) to exceed the then applicable USEPA Primary Drinking Water Standards. Additional monitoring wells were installed in 2002. Samples from several of these wells indicated contaminant levels above USEPA Drinking Water Standard Maximum Contaminant Levels (MCLs) and Tennessee Department of Environment and Conservation (TDEC) Domestic Supply Criteria. The encapsulation of the contaminated soils rectified the groundwater contamination problem and eliminated the need for further monitoring after the park was constructed. Permission to close the wells was granted by TDEC in April 2005. Furthermore, the site is encumbered with a deed restriction prohibiting extraction of groundwater for human use.

Sources:

“Phase II Site Assessment” Roper Corporation, Chattanooga, TN, by Parsons, May, 2002
 Letter regarding “Well Abandonment at Former Roper Manufacturing Facility” to Ashley Holt, Tennessee Department of Environment and Conservation, Nashville, TN from Doye B. Cox, Barge, Waggoner, Sumner & Cannon, Inc., April 20, 2005
 Correspondence with Ashley Holt, Tennessee Department of Environment and Conservation, Nashville, TN, July 11 & 15, 2014