Title
Post-Project Appraisal of Baxter Creek at Booker T. Anderson Park : Shopping Carts - The New Boulders

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Table of Contents

Abstract:

In 2000, an 850-ft reach of Baxter Creek in Booker T. Anderson Jr. Park, Richmond, CA was regarded and the banks planted with riparian vegetation to improve water quality and wildlife habitat, and to provide an attractive amenity for the neighborhood and educational opportunity for nearby schools. Baseline studies of the restoration project were completed in 2000. In November 2005 we conducted a post-project appraisal, by surveying three cross sections and a long profile, mapping site characteristics, measuring water flow and temperature, and assessing growth of riparian vegetation by comparing current conditions with those documented on photographs taken pre-project and after construction. Our results showed that channel geometry has remained stable and riparian vegetation has increased. However, the channel has accumulated a great deal of trash, including shopping carts, mattresses, plastic bottles, and oil residues on the water surface. Improvement in certain wildlife habitat parameters is offset by the large volume of trash and its negative effect on water quality and aesthetics.

1.0 Introduction:

1.1 Background

Baxter Creek originates in the Richmond and El Cerrito Hills and flows southwesterly through the flatlands to the San Francisco Bay (Figure 1). A large percentage of the creek is culverted; only two open reaches exist in the flat lands. One of these reaches flows through Booker T. Anderson Jr. Park in southwest Richmond, California (Figure 2). This section of the park has experienced numerous disturbances including: cattle grazing, frog ponds, and failed "restoration" attempts in 1970 and 1988 (Owens-Viani, 2000). The end result was a widening creek with abundant weeds and algae but lacking woody riparian vegetation and dissolved oxygen levels needed to support a diverse wildlife. In addition, erosion undermined bridges across the creek and exposed subsurface drainage pipes; cement and boulders from the 1970 and 1988 restoration projects had also fallen into the creek.

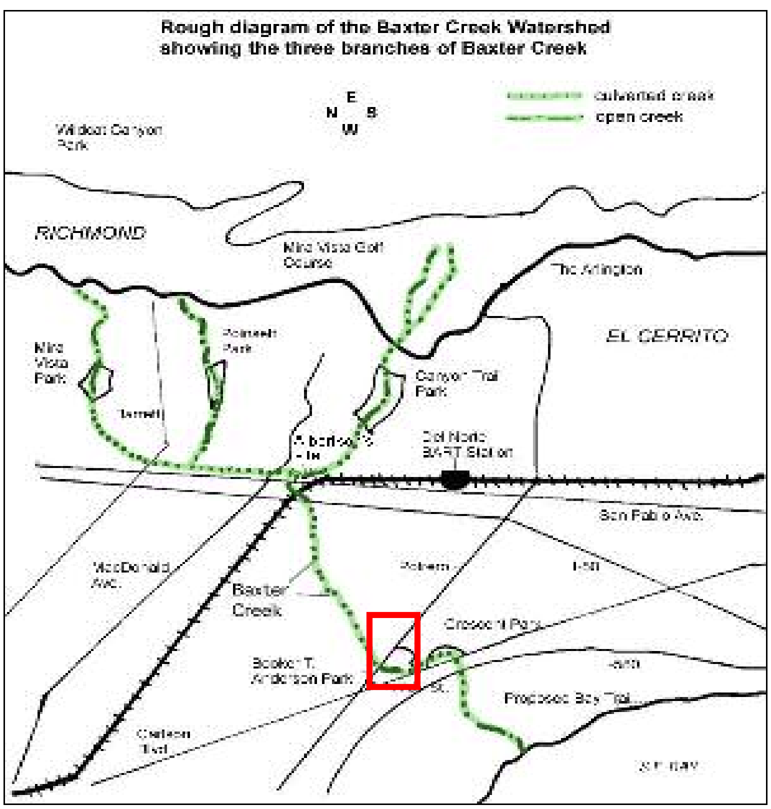

Figure 1: Baxter Creek (Source: Friends of Baxter Creek Website)

Figure 2: Booker T Anderson Jr. Park

In 2000, the Urban Creeks Council (UCC) restored an 850-ft reach of Baxter Creek in Booker T. Anderson Jr. Park. The stated goals of the project were: 1) to improve water quality and provide wildlife habitat, by revegetating banks and shading the water; 2) to provide a more functional hydraulic geometry, creating pools and riffles in the stream; 3) to provide an attractive amenity to the neighborhood; 4) to provide an educational opportunity for the community and nearby schools; 5) to offer a demonstration of the benefits of urban stream restoration in a flatlands area; and 6) to create 800 feet of riparian corridor and in doing so, restore a sense of regional identity (Owens-Viani, 2000).The restoration project consisted of re-grading sections of the creek and planting woody riparian vegetation. In addition, there was also an emphasis placed on community involvement for this project; schools and the Friends of Baxter Creek were encouraged to take an active role in maintaining and monitoring the restored creek. The construction of the project occurred in August and September 2000 and the vegetation was planted in December. Alison Purcell and Lisa Owens-Viani both studied the initial post-project restoration reach in 2000. In November 2000, Purcell conducted a baseline study that acts as an as-built biological study for the 2000 project (Purcell, 2000). She conducted a biological assessment of the benthic macroinvertebrates at four sites and a habitat assessment using the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol for the entire reach of Baxter Creek in Booker T. Anderson Jr. Park. She also conducted water quality tests including temperature, conductivity, dissolved oxygen, pH, salinity, nitrates, and discharge. Owens-Viani wrote a case study in December 2000, which included design considerations and baseline information (Owens-Viani, 2000). She collected one longitudinal and nine cross-sectional surveys, and habitat data for the project reach.

1.2 Problem Statement:

Post-project appraisals attempt to compare the current and as-built conditions of a restoration site and judge the success of the project by the degree to which it met its goals/objectives. Often the ability to determine the success is limited by vague objectives or limited/nonexistent as-built data. For the Booker T. Anderson Jr. Park restoration project, the studies by Purcell and Owens-Viani provide some of the necessary data for a post-project appraisal. Although the goals could have been more specific, they were sufficient to support a post-project appraisal.

2.0 Methods:

2.1 Overall Approach

In November 2005, we designed a post-project appraisal to compare the current condition of the creek with 2000 reports by Purcell and Owens-Viani. The major goal of our appraisal was to determine the success of the 2000 restoration project.

2.1 Sampling Site Selection

We selected our sampling sites based Purcell's 2000 study (Purcell, 2000). She chose four sites, Sites 1- 4 respectively. We were unable to locate Site 1 accurately and therefore we did not include it in our post-project appraisal, only including Sites 2 - 4.

We located the three sampling sites with as much accuracy as possible to replicate Purcell's original assessment. We relied heavily on the photographs included in her work, the given distance downstream from the inlet, and the visual descriptions given.

Site 2 is located approximately 430 feet downstream from the inlet and approximately four feet downstream from a bridge that crosses the creek (Figure 3). We conducted tests at the point immediately downstream of the concrete structure that juts out over the creek. Site 3 is located approximately 205 feet downstream from the inlet and is adjacent to the wooden structure that surrounds the Baxter Creek information sign, next to the playground (Figure 4 and 5). Site 4 is approximately 30 feet downstream from the inlet (Figures 6-8).

Figure 3: Site 2

Figure 4: Site 3

Figure 5: Site 3

Figure 6: Site 4

Figure 7: Site 4 – Overview of Site

Figure 8: Site 4 – Trash Bar

2.3 Water Characteristics

Based on time and equipment constraints, we decided only to measure temperature and flow from the list of water parameters studied by Purcell. We recorded air and water temperatures at each site using a thermometer. We were not interested in the actual temperatures but the difference between the water and air temperature at each site. Also, we measured surface velocity by recording the time it took for a floating object (a twig) to travel four feet. To achieve accurate measurements, we averaged three time trials at each site and divided the four-foot distance by the averaged time. Then we calculated flow by multiplying the average surface velocity by the water depth and width.

2.4 Habitat Assessments

We conducted a visual survey at each sampling site to assess the wildlife and flora populations. We visually surveyed the sites instead of the macroinvertebrate assessment Purcell conducted because of lack of lab equipment. We noted any visible insects, the shading of the sampling site, vegetation in the creek, and any visible trash at the site.

We attempted to perform a habitat assessment for Baxter Creek at Booker T. Anderson Park using the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol. However, due to our limited flora knowledge and the subjective nature of the test, we decided the assessment would not be beneficial for our post-project appraisal.

2.5 Surveying

Although we initially planned to resurvey the longitudinal profile that the Urban Creeks Council surveyed in 2000 and nine cross sections that they surveyed in 2001, we were unable to locate any of the markers where the data had been collected. We used a site map from the Owens-Viani document (Figure 9) that included the locations of the cross sections to get as close to the original sites as possible. We resurveyed the only three cross sections we were able to roughly identify based on landmarks on the site map; we surveyed cross sections V, VI, and VII highlighted in Figure 9). We determined that Cross-section V began where the concrete path diverged. Using the map in Figure 9, we estimated the location of cross section VI and VII. We are only able to compare cross sections V and VI to previous data since the Urban Creeks Council was unable to find the 2001 data for cross section VII.

The longitudinal profile was similarly unmarked although the field notes from the 2000 survey indicate that it began at the culvert invert. We surveyed from the upstream culvert to downstream culvert while the 2000 survey covered only the reach upstream of the bridge, the reach that had been significantly altered by the restoration project.

We received all previous data on cross sections and longitudinal survey from the Urban Creeks Council.

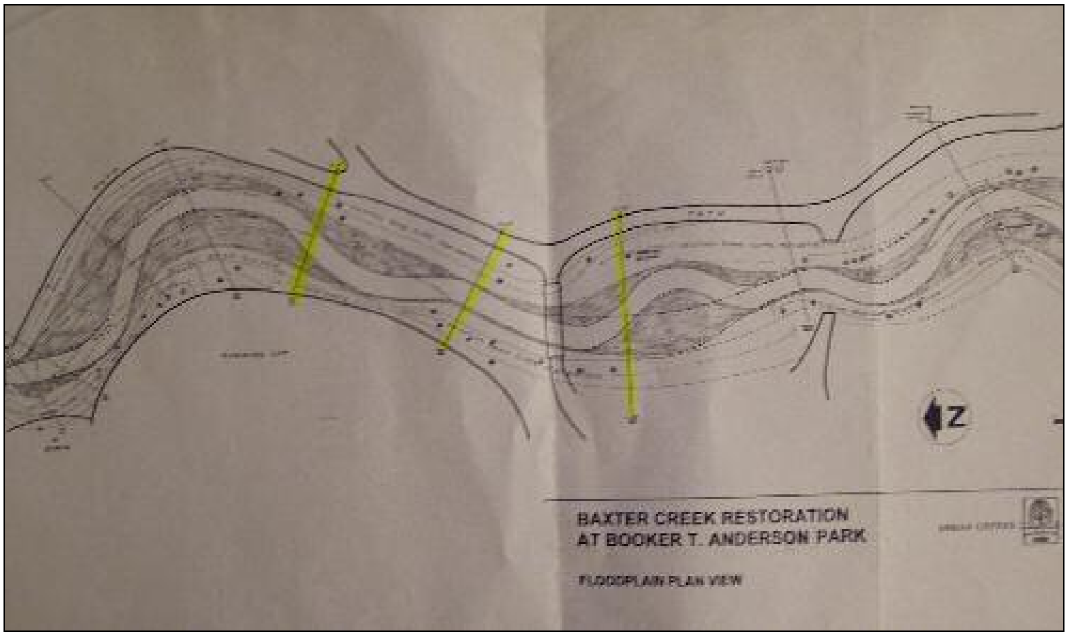

Figure 9: 2001 Cross-Sections (highlighted 2005 Cross-Sections)

2.6 Site Map

We performed site mapping at the same time as the longitudinal survey. Using an additional measuring tape, a ruler and engineering paper, we mapped the entire reach at a scale of 0.2 inches: 1 foot. We did not perform pebble counts because most of the bars were covered with trash. During the site mapping, we also noted visual observations of the creek.

3.0 Results:

3.1 Water Characteristics

We took all water characteristic tests on November 10, 2005 starting at 12 pm. It was partly cloudy with calm winds and the air temperature was 19.5 °C. The results of the water temperature and flow tests, as well as the 2000 results, are found in Table 1.

We found the temperature to be similar at each site, only varying 0.5 °C, and the average temperature being 15.8 °C. We observed flow at Site 2 and Site 3 to be fairly similar, with the average flow being 0.31 ft³/sec. We were unable to test the discharge at Site 4 due to the large amount of trash.

Table 1: Water Characteristic Assessment of Baxter Creek at Booker T. Anderson Park

	November 2000 (Alison Purcell)				**November 2005**			
	Site 2	**Site 3**	**Site 4**	**Average**	**Site 2**	**Site 3**	**Site 4**	**Average**
Water Temperature	17.4 °C	17.4 °C	16.3 °C	17.0 °C	16 °C	16 °C	15.5 °C	15.8 °C
Air Temp. - Water Temp. 2000: Air Temp = 16.1 °C 2005: Air Temp = 19.5 °C	- 1.3 °C	- 1.3 °C	- 0.2 °C	- 0.9 °C	3.5 °C	3.5 °C	4.0 °C	3.7 °C
Flow (w x d x velocity)	0.60 ft³/sec	0.57 ft³/sec	0.46 ft³/sec	0.54 ft³/sec	0.29 ft³/sec	0.33 ft³/sec	Unable to perform test	0.31 ft³/sec

3.2 Habitat Assessments

The results of the visual survey for each site are found in Table 2. All of the sites had at least some shading from vegetation and few visible insects. We noticed trash to be a problem at all sites and throughout this reach of Baxter Creek. Some of the more notable trash we observed in the creek at sites other than the three specific sampling sites was a car fender, a lawn mower, a goal post from the park, multiple shopping carts, hubcaps, various metal objects, and a tricycle. In addition, along some sections of the creek the water surface had an oily residue.

Table 2: Visual Survey Results of Baxter Creek at Booker T. Anderson Park

	Site 2	Site 3	Site 4
Visible Insects & other wildlife	Ants. Small, green hopping insects. Files. Heard frogs croaking and some birds.	Ants. Small, green hopping insects.	Ants. Small, green hopping insects. Black millipedes approximately 2-4 inches long burrowing into soil and trash.
Shading	Some shading from trees. Shading immediately upstream from concrete.	Partial shading from tree on right bank.	Well shaded by trees/shrubs on both banks.
Vegetation	Not much in wetted channel. Large amount of vegetation in non-wetted channel.	Vegetation in wetted channel. Large amount of vegetation in non-wetted channel.	Not much vegetation in wetted channel. Vegetation covering banks.
Visible Pollution	Trash all around the area. Pile of trash the width of the stream and approximately 8 inches long is creating a small "dam" effect, with a pool immediately after the trash pile.	Multiple cans and plastic wrappers in surrounding area (in wetted channel and non-wetted channel). Golf ball in wetted channel.	Site is overrun by trash. Shopping cart immediately downstream of sampling site. Bicycle gears and vacuum cleaner in creek immediately upstream of sampling site. Plastic bag of trash and piles of loose trash at sampling site. Bank eroded near trash pile.

3.3 Surveying

Results of the cross section profiles V, VI and VII are shown in Figures 10, 11 and 12, respectively. Figure 13 shows the longitudinal profile. The 2000 longitudinal profile indicates a slope of 0.80±0.05 %. We used a regression analysis of the thalweg elevation to calculate the slopes; our 2005 survey shows a slope of 0.78±0.06 % in the reach surveyed in 2000 and an overall slope of 0.56±0.03 %.

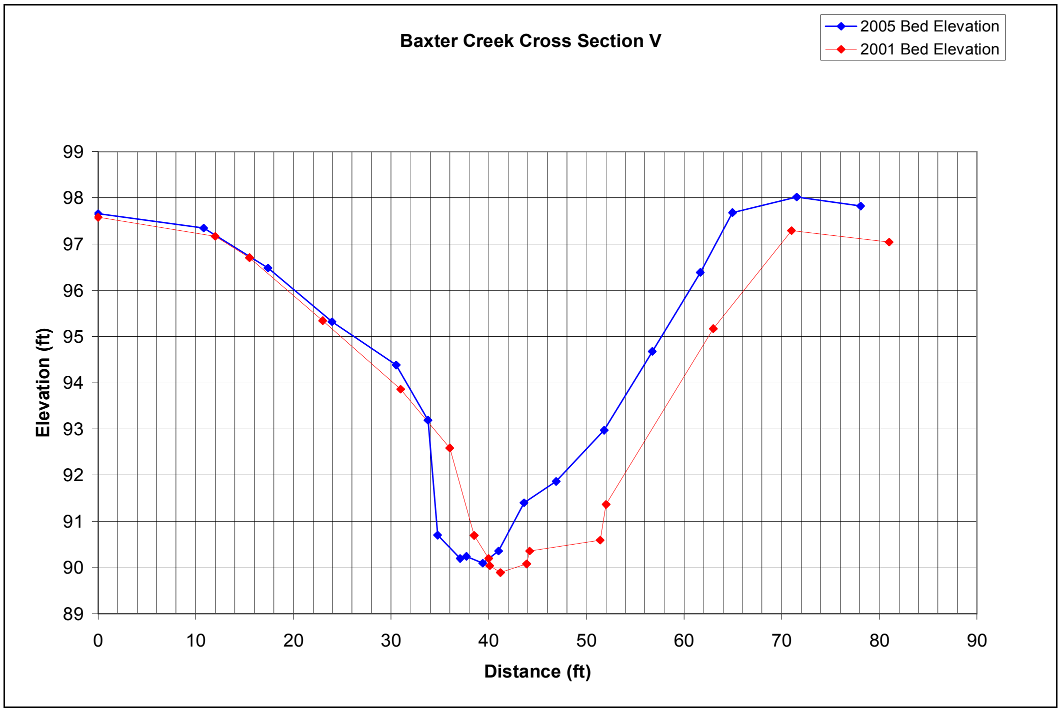

Figure 10: Cross Section V

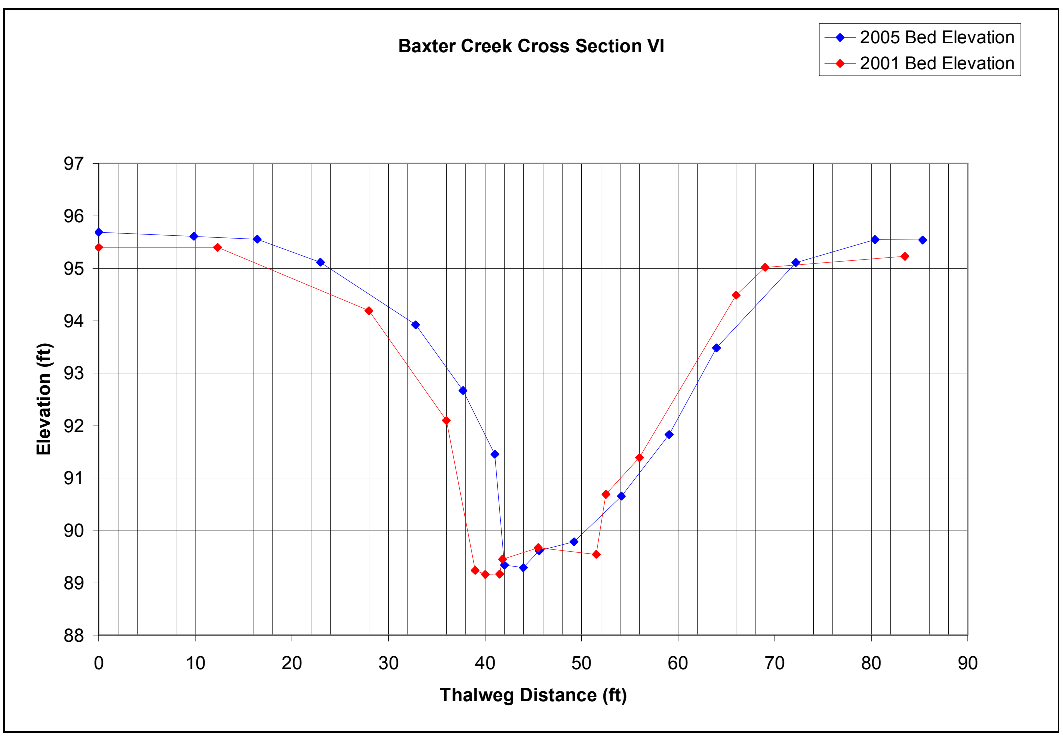

Figure 11: Cross Section VI

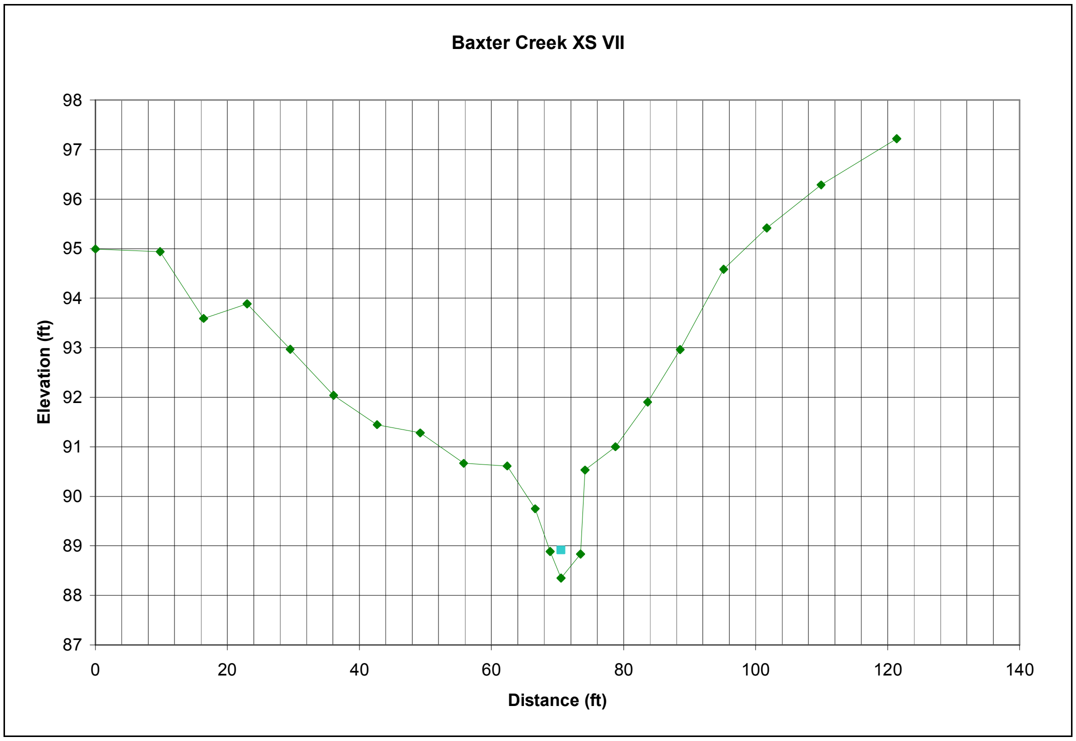

Figure 12: Cross Section VII

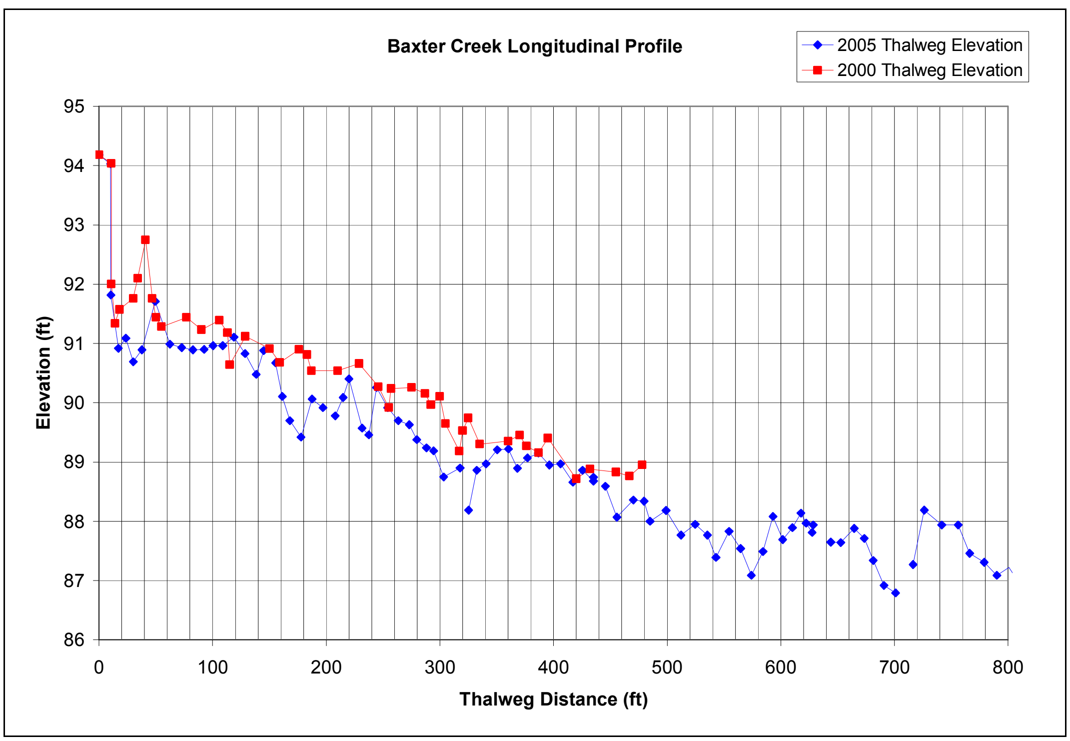

Figure 13: Longitudinal Profile

3.4 Site Map

The complete site map is located in Appendix A. We noted important features throughout the site mapping process including: steep banks in the upstream half of the reach, significant amounts of trash collected on bars or floating in pools, grassy vegetation/weeds dominating bars and growing in the creek. Although we did not complete any pebble counts, we estimated the bars to be dominantly silt/sand as noted on the site map. Riffles and pools were observed throughout the reach. Figures 14 – 20 show significant sites of the site mapping.

Figure 14: Beginning of project reach

Figure 15: 50 ft from upstream culvert (looking downstream)

Figure 16: Approximately 300 ft from upstream culvert

Figure 17: Approximately 320 ft from upstream culvert

Figure 18: Approximately 400ft from upstream culvert (looking downstream)

Figure 19: Approximately 510 ft from upstream culvert

Figure 20: Downstream end of project reach

4.0 Discussion:

4.1 Water Characteristics

Our study found the average water temperature to be 15.8 °C, which was lower than the air temperature. A comparison of the air-water temperature difference from our study to the results in 2000 gives a better assessment of any changes rather than the actual temperatures. The air-water temperature difference can imply an increase or decrease in shading, whereas the actual water temperatures fluctuate daily with the air temperature. The average water temperature in 2000 was 0.9 °C higher than the air temperature. In 2005, the water temperature was 3.7 °C below the air temperature. This change is most likely due to the increased shading from vegetation.

The flows in 2000 were almost twice the flows in 2005. However, there is little we can decipher from this information because the flow is so dependent on the amount of precipitation in the area at the time of sampling. Comparing flows of the same year at each site is more informative. The flows at Sites 2 and 3 were very similar, both in 2000 and 2005.

4.2 Habitat Assessments

The only insects we saw at all three sites were ants and small, green hopping insects. We did not see any other water insects throughout this reach of Baxter Creek. We saw one frog (Figure 21) while surveying a cross-section of the creek and neighborhood children reported catching frogs in the creek. The large amount of trash and the oily residue on parts of the water surface could be contributing to the small amount of insects and other wildlife living in the water.

Shading and overall vegetation did increase from 2000. Vegetation covered the banks and non-wetted channel at all three sampling sites. The amount of trash at the sites did not seem to affect the amount of vegetation.

Figure 21: Frog in Booker T. Anderson Jr. Park Reach

4.3 Channel geometry

Due to the uncertainty in our cross section locations, the longitudinal profile is a better indication of changes since 2000. The profile shows that the slope in the upper reach has not appreciably changed. A visual comparison suggests that there has been some channel incision, but the difference in average thalweg elevation is only 0.6 ft, indicating that the channel as designed has been relatively stable since its implementation in 2000. Although there is more uncertainty associated with a comparison of the cross sections V and VI (Figure 10 and 11), they also roughly indicate channel stability—certainly no drastic changes have taken place.

4.4 Complexity of the Stream

No information from any of the 2000 studies indicated if pools and riffles were present in the creek. Therefore, we can not determine if the complexity has increased. However, pools and riffles were observed in both the upstream and downstream reaches of the creek.

4.5 Effect of trash

Trash added to the Booker T. Anderson Park reach appears to be adding some complexity to the system. We observed pools after many of the large trash piles, indicating that the trash piles are acting as large woody debris placed in streams. However, the trash debris takes away from the attractiveness of the creek, which was one of the goals of the restoration project. In addition, it can limit the habitat available for wildlife species and can even endanger animals who accidentally try to consume the trash. Therefore the trash also keeps the project from meeting its goal of improving water quality and wildlife habitat.

4.6 Monitoring/maintenance

As stated in the report published by Owens-Viani, a monitoring/maintenance program was established for the creek (Owens-Viani, 2000). However, after witnessing the amount of debris in the creek, we doubt that any maintenance activities have taken place in a long time. Local schools and community groups, such as Friends of Baxter Creek (FOBC), were listed as groups to help in this effort. According to the FOBC website, they originally had community clean-up days; however they apparently have not occurred in a while.

4.7 Community Opinion

Although no formal community assessment occurred as part of our survey, we gained insight on some of the neighborhood's view of the creek from conversations while we were surveying. Of the local residents we talked to, many enjoyed having the creek to walk along.

However, we also heard the creek referred to as “the dirty, old creek” and a “ditch.” These comments show some of the negative attitudes toward the creek that may improve through education and regular maintenance.

5.0 Conclusions/Recommendations:

5.1 Conclusions

Table 3 lists each of the goals of the project, whether the goal was achieved and supporting evidence for this decision. According to our results, the channel geometry has remained stable and riparian vegetation has increased. However, the channel has accumulated a great deal of trash, including shopping carts, mattresses, plastic bottles, and oil residues on the water surface. We observed an evident lack of consistent maintenance of the creek, which is probably contributing to the accumulation of trash.

Table 3: Determining Success of Project Goals

Goal	Was Goal achieved?	Why or Why not?
To improve water quality and provide wildlife habitat, by revegetating banks and shading the water	Partially	• Increased shading • Increased bank vegetation • Significant amounts of pollution
To provide a more functional hydraulic geometry, creating pools and riffles in the stream	Yes	• Pools and riffles evident in stream • No significant slope changes in past 4 years • No significant elevation changes in past 4 years
To provide an attractive amenity to the neighborhood	No	• Trash evident on entire stretch of creek • Oil residue on creek water • Noticeably less attractive than other parts of the park • Unfavorable opinion by some of neighborhood residents
To provide an educational opportunity for the community and nearby schools	Uncertain	• Limited information available
To offer a demonstration of the benefits of urban stream restoration in a flatlands area	No	• Creek heavily polluted • No indication of recent monitoring or maintenance
To create 800 feet of riparian corridor and in doing so, restore a sense of regional identity	Partially	• Riparian vegetation increased • Polluted creek does not restore positive sense of regional identity

5.2 Recommendations:

If it occurs soon, increased maintenance of the Booker T. Anderson Park reach of Baxter Creek could revive the creek at minimal cost. The trash/pollution appears not to have damaged the channel geometry. Therefore, a community effort led by UCC to clean up the creek could result in an improved creek for the benefit of the neighborhood community and local wildlife. In addition, there would need to be consistent monthly maintenance of the creek, possibly by the park or Friends of Baxter Creek.

A trash and pollution awareness program should be put in place. Signs should be placed near both ends of the creek and the bridge informing residents who to call if they witness someone dumping trash into the creek. In addition, a new "Welcome to Baxter Creek" sign should be put in place to foster community awareness and stewardship, the old sign is badly faded.

6.0 References:

1) Lisa Owens-Viani. *Restoring an Urban Stream: Baxter Creek Case Study*; December 2000

2) Purcell, Alison. *Baseline Assessment of Baxter Creek at Booker T. Anderson Park;* November 2000

Appendix A: Site Map

Appendix B: Surveying Profiles

Cross Section V

BAXTER CREEK X-SECTION V, JANUARY 2001		
Distance (ft)	**Elevation(ft)**	**Notes**
0.00	97.58	front of light post
12.00	97.17	rt edge path
15.50	96.71	
23.00	95.34	
31.00	93.86	
36.00	92.59	
38.50	90.69	
40.00	90.19	edge of deposition
40.10	90.04	rt edge water
41.20	89.89	TW
43.90	90.08	left edge water
44.20	90.36	deposition
51.40	90.59	
52.00	91.36	
63.00	95.17	
71.00	97.29	
81.00	97.04	

BAXTER CREEK X-SECTION V, NOVEMBER 2005		
Distance (ft)	**Elevation(ft)**	**Water Surface Elevation(ft)**
0.0	97.66	
10.8	97.35	
17.4	96.48	
24.0	95.32	
30.5	94.38	
33.8	93.19	
34.8	90.7	
37.1	90.19	
37.7	90.24	90.29
39.4	90.09	90.34
41.0	90.36	
43.6	91.4	
46.9	91.86	
51.8	92.97	
56.8	94.68	
61.7	96.39	
65.0	97.68	
71.5	98.02	
78.1	97.82	

Cross Section VI:

BAXTER CREEK X-SECTION VI, JANUARY 2001

Distance (ft)	Elevation(ft)	Notes
0.00	95.40	Rebar
12.30	95.40	rt edge path
28.00	94.19	
36.00	92.10	
39.00	89.24	left edge water
40.00	89.16	
41.50	89.17	rt edge water
41.80	89.45	deposition
45.50	89.67	
51.50	89.54	
52.50	90.69	
56.00	91.39	
66.00	94.49	
69.00	95.02	
83.50	95.23	

BAXTER CREEK X-SECTION VI, NOVEMBER 2005

Distance (ft)	Elevation(ft)	Water Surface Elevation(ft)
0.0	95.69	
9.8	95.61	
16.4	95.56	
23.0	95.12	
32.8	93.92	
37.7	92.67	
41.0	91.45	
42.0	89.34	89.59
44.0	89.29	89.59
45.6	89.61	
49.2	89.78	
54.1	90.65	
59.1	91.83	
64.0	93.48	
72.2	95.11	
80.4	95.55	
85.3	95.54	

Cross Section VII

BAXTER CREEK X-SECTION VI, NOVEMBER 2005

Distance (ft)	Elevation (ft)	Water Surface Elevation (ft)
0.0	94.99	
9.8	94.94	
16.4	93.59	
23.0	93.89	
29.5	92.97	
36.1	92.04	
42.7	91.45	
49.2	91.28	
55.8	90.67	
62.3	90.61	
66.6	89.75	
68.9	88.89	
70.5	88.35	88.92
73.5	88.83	
74.2	90.53	
78.7	91.00	
83.7	91.90	
88.6	92.96	
95.1	94.58	
101.7	95.42	
109.9	96.29	
121.4	97.22	

Longitudinal

BAXTER CREEK LONGITUDINAL PROFILE SURVEY, NOVEMBER 2000

Distance (ft)	Thalweg Elevation (ft)	Water Surface Elevation (ft)
0.0	94.18	
10.7	94.04	
10.8	92.00	92.25
14.0	91.34	92.26
18.0	91.57	92.27
30.0	91.76	92.27
34.0	92.10	92.24
41.0	92.75	92.16
47.0	91.76	91.86
50.0	91.44	91.64

55.0	91.28	91.63
77.0	91.44	91.60
90.0	91.23	91.60
106.0	91.39	91.56
113.0	91.18	91.37
115.0	90.64	31.42
129.0	91.12	91.42
150.0	90.91	91.10
159.0	90.68	91.08
176.0	90.90	91.09
183.0	90.81	90.94
187.0	90.54	90.95
210.0	90.54	90.93
229.0	90.66	90.85
246.0	90.27	90.58
255.0	89.92	90.58
257.0	90.24	90.60
275.0	90.26	90.58
287.0	90.16	90.32
292.0	89.97	90.30
300.0	90.11	90.27
305.0	89.65	89.88
317.0	89.18	89.89
320.0	89.53	89.91
325.0	89.74	89.87
335.0	89.30	89.67
360.0	89.35	89.70
370.0	89.45	49.56
376.0	89.27	89.50
387.0	89.16	89.50
395.0	89.40	89.50
420.0	88.72	89.39
432.0	88.88	89.37
455.0	88.83	89.31
467.0	88.76	89.26
478.0	88.95	89.14

BAXTER CREEK LONGITUDINAL PROFILE SURVEY, NOVEMBER 2005

Distance(ft)	**Thalweg Elevation(ft)**	**Water Surface Elevation(ft)**
0.0	94.18	94.19
10.2	94.03	94.11
10.4	91.82	92.68
17.1	90.92	92.67
23.6	91.09	92.54
30.2	90.69	92.58
37.7	90.89	92.49
49.5	91.71	92.12

62.2	90.99	91.72
72.8	90.93	91.69
82.7	90.89	91.69
92.5	90.90	91.65
100.2	90.96	91.65
108.9	90.96	91.61
118.8	91.11	91.55
128.6	90.83	91.14
138.5	90.48	91.20
145.0	90.88	91.18
155.5	90.67	90.98
161.4	90.11	90.76
168.0	89.70	90.73
177.8	89.42	90.73
187.7	90.06	90.72
197.2	89.92	90.67
208.0	89.78	90.70
214.9	90.09	90.73
220.2	90.40	90.69
231.6	89.57	90.48
237.2	89.46	90.44
244.3	90.26	90.49
253.9	89.92	90.24
263.1	89.70	90.05
273.0	89.63	89.87
279.5	89.38	89.63
288.1	89.24	89.55
294.3	89.19	89.58
303.2	88.75	89.52
317.6	88.90	89.48
325.1	88.19	89.51
332.5	88.86	89.52
340.6	88.97	89.55
350.4	89.21	89.34
360.3	89.22	89.34
368.1	88.89	89.34
377.0	89.07	89.36
386.5	89.15	89.35
396.3	88.95	89.32
406.2	88.97	89.25
417.2	88.66	89.20
425.5	88.86	89.15
435.1	88.68	89.13
435.2	88.74	89.12
445.6	88.59	88.88
455.7	88.07	88.67
470.2	88.36	88.67
479.7	88.34	88.64

484.9	88.00	88.65
499.0	88.18	88.66
512.2	87.77	88.56
524.7	87.95	88.73
535.5	87.77	88.52
543.0	87.39	88.53
554.5	87.83	88.50
564.7	87.54	88.43
574.2	87.09	88.49
584.3	87.49	88.45
593.2	88.08	88.44
601.7	87.69	88.41
610.3	87.89	88.38
617.8	88.14	88.36
622.4	87.97	88.37
627.7	87.81	88.37
628.6	87.94	88.42
644.1	87.65	88.47
652.9	87.64	88.46
664.7	87.88	88.43
673.6	87.71	88.45
681.5	87.34	88.37
691.0	86.92	88.44
700.8	86.79	88.36
716.2	87.27	88.44
726.1	88.19	88.45
741.5	87.94	88.25
755.9	87.94	88.20
766.1	87.46	88.14
778.9	87.31	88.12
790.1	87.09	87.91
800.6	87.22	88.07
809.4	86.97	87.89
818.0	87.52	88.03
826.5	87.53	88.02
835.7	87.39	87.95
842.2	87.34	87.99

Appendix C:

Flow Calculation Formula

$$Q = V * W * D \quad \text{(Equation 1)}$$

Where:

Q = flow (cubic feet per second)
V = velocity (feet per second)
W = width of stream (feet)
D = depth of stream (feet)