3.0 BASELINE ASSESSMENT RESULTS

Watershed Conditions

Size and Land Use

City Creek is the northernmost significant mountain stream drainage in Salt Lake City (Figure 3.1). The upper subwatershed, which includes the RCS study area above Bonneville Boulevard, drains 11,189 acres of wooded mountainous terrain ranging in elevation from 9,400 to 4,300 feet. Upper City Creek flows for a total length of 10.3 miles (SLCO 2009). The majority of the upper subwatershed is forested and undeveloped, with an estimated overall impervious cover of 9.2% (SLCO 2009). Much of this impervious cover is associated with the paved City Creek Canyon Road which extends 5.75 miles up the canyon to Rotary Park. More than 99% of the upper subwatershed is public land owned by Salt Lake City and managed for drinking water

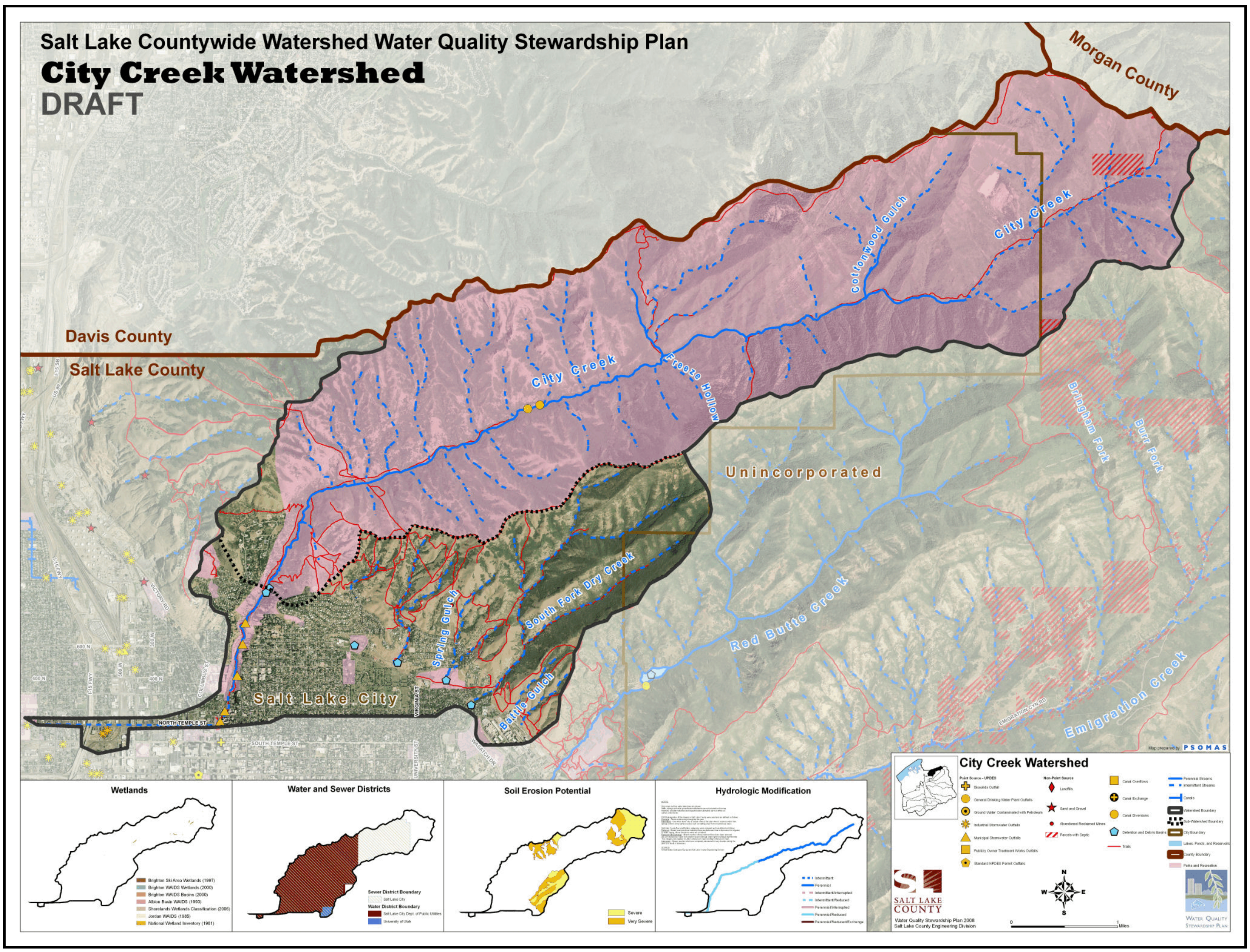


Figure 3.1. City Creek watershed (map from SLCO 2009).

source protection and open space/recreation. The City Creek Water Treatment Plant (CCWTP) is located about 3 miles up the canyon; access to the area above the CCWTP is subject to restrictions designed to limit potential water supply contamination. Recreational opportunities in the upper subwatershed include biking, jogging, hiking, fishing, picnicking at designated picnic sites, skiing, and snowshoeing.

The lower City Creek sub-watershed is much smaller, draining 4,621 acres of mixed use land below Bonneville Boulevard. Lower City Creek flows approximately 1.5 miles through Memory Grove, an area owned and managed by the City's Parks Division. The corridor is bordered by the Avenues residential area on the east and the State Capitol complex on the west. An additional 2.3 miles of lower City Creek south and west of the RCS study area is conveyed in engineered conduits to the Jordan River (Figure 1.1). Estimated existing impervious cover is 19.7% within the lower subwatershed (SLCO 2009).

Hydrology

The hydrology of City Creek is altered by flow diversions at the CCWTP, which commonly removes all available flows from the creek. Typical withdrawal rates average about 4.6 cfs, but rates as great as 23 cfs are sometimes diverted during the spring runoff period (F. Reynolds 2010, pers. comm.). In the vicinity of the CCWTP, the stream is a "gaining reach" where surface flows are supported by groundwater inputs, and flows in the channel recover rapidly below the CCWTP diversion point.

Below: City Creek debris basin above Bonneville Boulevard shortly after dredging.

Average annual precipitation ranges from 32–42 inches in the highest portion of the upper subwatershed, from 22–32 inches in the mid-elevation portions of the upper subwatershed, and from 11 to 22 inches in the valley/lower subwatershed (SLCO 2009). Above the CCWTP City Creek is classified as having perennial flow; below the CCWTP the creek is classified as "perennial-reduced," indicating that flows are artificially reduced by the stream diversions for municipal water supply (SLCO 2009).

No significant water storage reservoirs are currently present on City Creek, although historically reservoirs were constructed in the canyon to store water for municipal supply. Two debris basins located immediately above and below the Bonneville Boulevard crossing provide some degree of flow regulation and capture a significant portion of the creek's coarse sediment loads. These debris basins are maintained by Salt Lake County and require dredging approximately every two to three years. Additionally, the formal portion of Memory Grove Park adjacent to study reach LCC_R02B is designed to function as a flow regulation basin that would control flood flows entering the downstream engineered conduits. This current system for flow and sediment regulation was constructed to prevent damages similar to those sustained during the major flood event in 1983.

City Creek's hydrology is characterized by a distinct springtime peak typical of snowmelt-driven systems. Based on analysis of flow data recorded at the County gage in Memory Grove from 1980–2005, mean annual flow is 8.3 cfs, average monthly flow is highest in May (Figure 3.2), and base flows average about 3 cfs. Peak daily flow occurs on May 21st on average (SLCO 2009), and average annual high flow is 67 cfs based on analysis of the 1980–2005 time period.

Urbanization and development in the lower subwatershed have affected surface water-groundwater patterns. These influences affect the study reaches from LCC_R01B downstream, which receive water from urbanized areas via storm drain outfalls. As contributing watershed areas become converted to impervious surfaces, a greater proportion of storm water runs off as surface flow rather than infiltrating into the ground, leaving less groundwater available to supply baseflow to the creek during the summer dry period (Figure 3.3). The relatively high proportion of

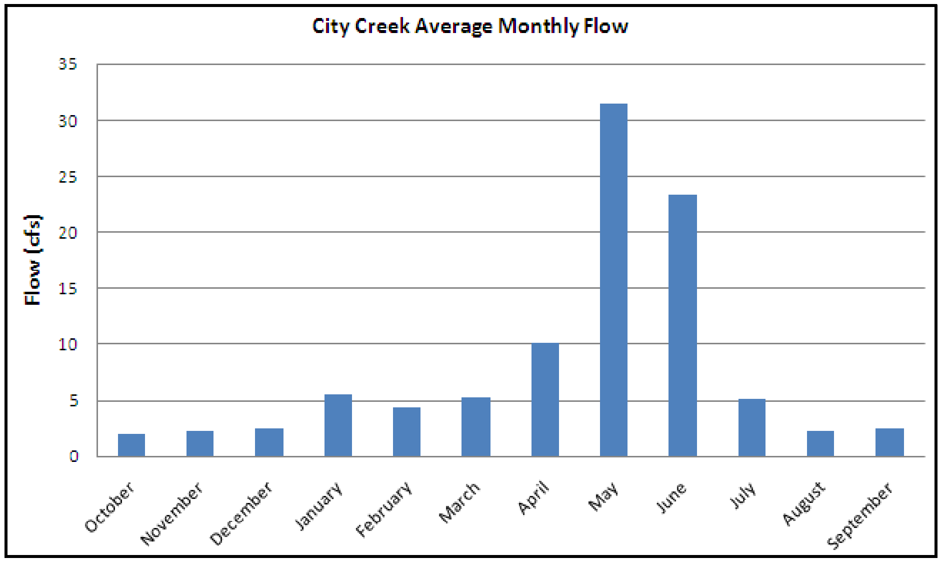


Figure 3.2. Monthly flows at Salt Lake County's gage at Memory Grove.

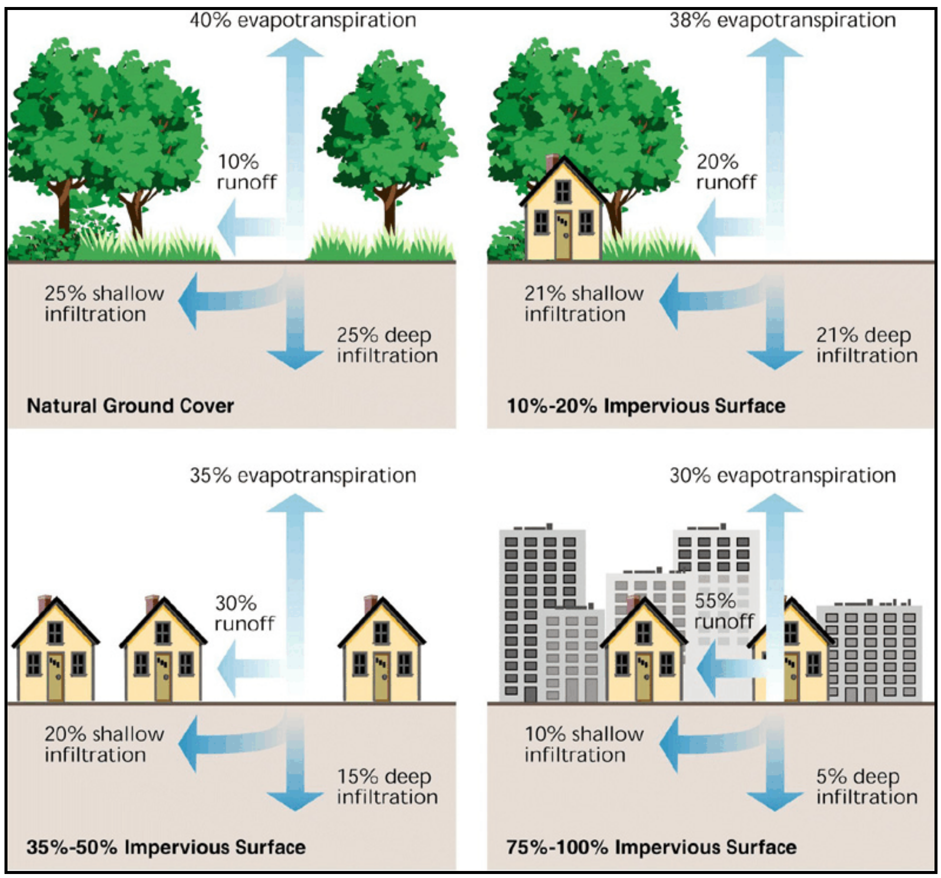


Figure 3.3. Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. Diagram and caption text from FISRWG 1998.

surface flow during storm events can also lead to a "flashy" hydrologic pattern with rapid, brief rises in flow during storms (Figure 3.4). On City Creek, however, these influences are limited only to the downstream-most study reaches because the majority of the contributing watershed area has been protected as undeveloped open space.

Water Quality

Above the CCWTP, City Creek's beneficial use classifications as designated by the Utah Division of Water Quality (DWQ) include 1C (high quality drinking water), 2B (secondary contact recreation), and 3A (cold water fishery). Below the CCWTP, the designated beneficial uses include 2B and 3A. City Creek's water quality is considered good and fully supports all of its beneficial uses (DWQ 2006).

Potential nonpoint sources of contamination in the City Creek watershed include fertilizers and herbicides from managed parks, runoff from roads/urbanized areas (e.g., automotive fluids), and waste from wildlife (e.g., deer, ducks) and pets. Bacteriological contamination is of particular concern because the Jordan River, the receiving body for City Creek water, is currently listed as impaired for E. coli (DWQ 2006). To help inform ongoing TMDL studies on the Jordan River, several new E.coli monitoring stations have been recently established on City Creek by DWQ and Salt Lake County. Samples are being collected monthly at these sites, but data have not yet gone through quality assurance/control procedures and have not been released to the public or comprehensively analyzed. As additional data are collected and analyzed and as DWQ's new E. coli work group becomes more established, it is anticipated that a better understanding of bacteriological contamination sources within City Creek will develop.

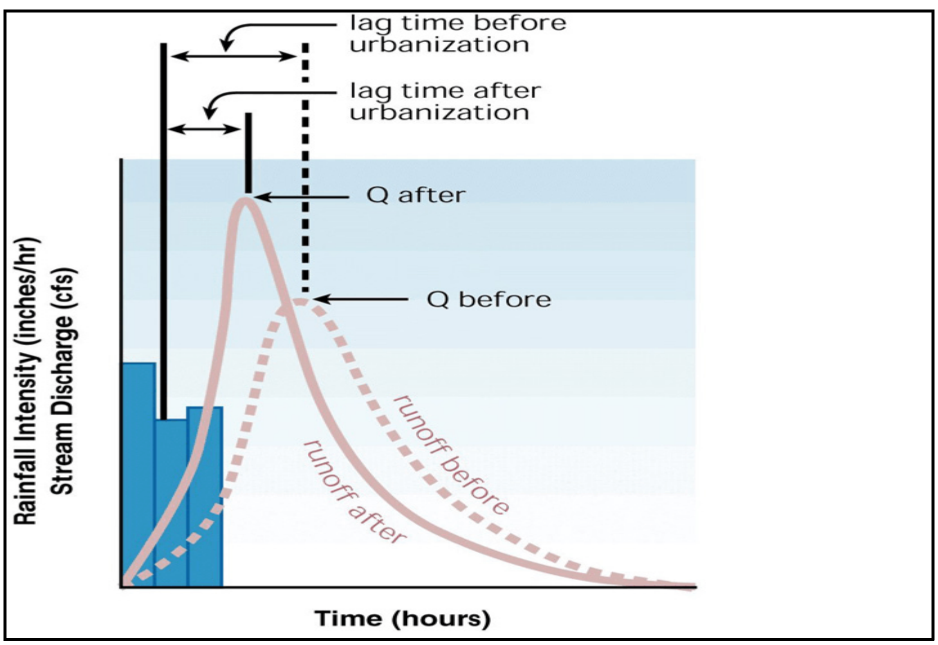


Figure 3.4. A comparison of hydrographs before and after urbanization. The discharge curve is higher and steeper for urban streams than for natural streams. Diagram and caption text from FISRWG 1998.

Geology and Soils

Within the upper subwatershed, City Creek flows primarily through Pennsylvanian and Mississippian age sandstones and limestones. Within the RCS study area, the channel flows through Miocene conglomerates, Oligocene and Eocene tuffs and other volcanics, and quaternary landslide deposits. Below reach UCC_R10C, these formations are surrounded by Pleistocene Lake Bonneville deposits ranging from finer-grained silt and clay deposits to coarser sand and gravel deposits. Within reach LCC_R01C and downstream, the channel flows directly through these Lake Bonneville deposits and other quaternary alluvial deposits (Bryant 1990).

In the upper City Creek subwatershed, approximately 20–35 % of the soils have severe to very severe soil erosion potential. In the lower subwatershed, 35–50% of the soils have severe to very severe erosion potential (SLCO 2009). Several significant hillslope slumps are evident adjacent to the south/east side of the channel within the study area. Slumps have also occurred recently on the steep hillside west of the channel within areas adjacent to reach LCC_R01B and downstream. In some areas these instabilities appear to be influenced by steepened cut slopes and runoff associated with the Bonneville Boulevard roadway; other areas are part of larger natural landslide features.

After Lake Bonneville receded approximately 16,000 years ago, it left a series of old shoreline deposits that now form prominent "benches" along the edges of Salt Lake Valley. To reach its modern base level at the Jordan River, City Creek had to carve through these deposits. In part because of this natural geologic history, stream gradient is steep, and the channel is entrenched between tall slopes that extend up to the Bonneville bench levels on the east and west sides of the corridor within the lower subwatershed. The degree of channel confinement has also been artificially increased by placement of fill material for roadways.

Fish, Birds, and Wildlife

Above the CCWTP City Creek supports a confirmed conservation population of native Bonneville cutthroat trout, the state fish of Utah and a state-designated special status species that evolved as the top predator within ancient Lake Bonneville (Lentsch et al. 2000). City Creek also supports rainbow trout, brown trout, and rainbow-cutthroat hybrid crosses (SLCO 2009). During the RCS field assessments, trout (species unknown) were observed throughout the upper portion of the study area between reaches UCC_R09 to UCC_R11B. The Utah Division of Wildlife Resources (DWR) conducted fisheries sampling in a 200-foot-long portion of the stream in this area in 2007 and observed 19 brown trout and one cutthroat trout (D. Wiley 2010, pers. comm.).

Quantitative data on fish populations within the lower reaches of City Creek below Bonneville Boulevard are limited. Fish were not observed during RCS assessments in the lower study reaches, suggesting that population numbers may be lower. However, fishery information was not a specific focus of the RCS assessment and observations were merely noted when staff happened to see fish while collecting stream channel condition information. The DWR has not conducted fisheries surveys in this portion of the creek (D. Wiley 2010, pers. comm.).

During the Audubon Society's 2005 Christmas bird count, which included City Creek Canyon and Memory Grove, 19 different bird species were observed (Carr 2009). Scientific data describing detailed information about mammal populations are limited. However, general observations suggest that wildlife populations in the canyon include deer, bobcats, moose, mountain lions, coyotes, raccoons, rattlesnakes, rabbits, mice, and large numbers of elk (Hooton 2000). Evidence of beaver was noted within several of the upper RCS study reaches.

Historical Conditions and Current Trends

City Creek History

City Creek holds a prominent place in Utah's history, as it became an important municipal and irrigation water source shortly after Mormon pioneers entered Salt Lake Valley in 1847 (Figure 3.5). At that time the creek was described as being covered with willows and shrubs; specific types of vegetation mentioned include box elder, cottonwood, rose briar, and squawbush. City Creek originally exhibited a braided (multi-channel) plan form where it exited the canyon. The main

1847

Mormon Pioneers Describe City Creek as "a beautiful stream of water covered on both sides with willows and shrubs," and also mention the presence of box elder, cottonwood, rose briars, and squawbush.[6] The stream is described as splitting into two main branches at the canyon mouth: one branch flowed west along what is now North Temple Street; the other branch flowed south and joined Red Butte, Emigration, and Parleys Creeks before flowing into the Jordan River.[5]

1847 - 1880s

Various early water diversions and ditch systems harness City Creek for drinking water, agriculture, and industrial mills.[1 & 3]

1850

Brigham Young obtains control of City Creek Canyon and encourages citizens to *"clear the Kanyon of the dead wood, and the creek of every combustible…leaving the small timber and shrubbery on its banks to shade it."* Every third load of wood is collected as a toll at Eagle Gate.[7]

Footnotes

1. Bowthorpe 1961
2. Deseret News 1867
3. http://www.slcgov.com/story.pdf
4. http://www.utahheritagefoundation.org/memorialhouse/history
5. LDS CHO 1990
6. LDS CHO 1997
7. Prince and Shea 1995

CITY CREE

1870 - 1924

Through a series of projects, City Creek below Memory Grove is enclosed in underground pipes and becomes the North Temple Conduit. A 1921 newspaper editorial laments the decision: *"To hide completely the flowing water within a conduit and to make of the street a stretch of ordinary pavement would be to throw away an opportunity for which many cities would gladly pay a Million dollars."*[6]

1884 - 1947

Through a series of purchases, the City acquires the lands of the City Creek watershed for the purpose of protecting the water supply.[3]

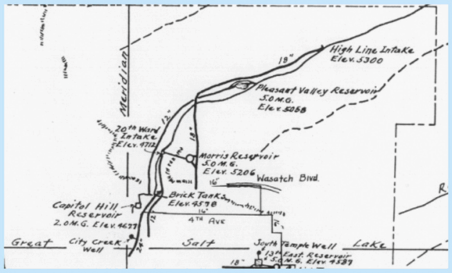
1952 - 1955

City Creek canyon is closed to the public after high coliform bacteria counts associated with high levels of human recreational use are found in the water. The lower canyon is reopened in 1955 after completion of the modern-day City Creek Water Treatment Plant, which provides a greater level of treatment than previous techniques involving only chlorination. The upper canyon was not reopened to the public until 1966.[7]

Figure 3.5. City Creek historical timeline.

K HISTORY

1856



To help prevent continued flood damages and facilitate irrigation, the Two branches of City Creek are combined into a 12-foot-wide cribbed ditch in the middle of North Temple Street.[7] Reflecting on the new ditch, an 1867 newspaper article observes, *"It is pleasant to stand at the east end of the street, and looking west watch the now bridled and curbed stream dashing on to the Jordan."* [2] Over subsequent years the North Temple ditch poses problems as a drowning hazard, proves difficult to protect from contamination, and continues to flood during high water years.

1876

Salt Lake City Waterworks is formed, providing piped City Creek water directly to residents' homes.[3]

1902

Memory Grove is set aside as a city park.[4]

1983

Major flooding clogs the intake to the North Temple conduit; City Creek's waters are diverted down the sandbag-lined State Street. City Creek Canyon Road suffers significant damage.

1986

The City Creek Master Plan designates preservation of the upper canyon and establishes current recreation and access policies. The closure of Bonneville Boulevard to two-way motor vehicle traffic enhances recreational use and appeal of the lower portion of the canyon.[3]

1999

A tornado strikes Memory Grove Park, destroying nearly 500 mature trees.[4]

Historical activities that have altered riparian corridor conditions:

- mining for iron and other metals
- logging and timber harvest
- beaver trapping and removal
- channel clearing and debris removal
- construction of water supply storage reservoirs
- flow diversion for irrigation and drinking water
- road and stream crossing construction
- residential and commercial development
- introduction of invasive, nonnative plants
- piping of the creek in underground conduits
- channel straightening and ditch construction
- bank armoring
- placement of fill within floodplain areas
- debris basin construction

branch of the channel is described as following a sinuous path to marshy swamp lands near the Jordan River (LDS CHO 1997) and flowing through a grove of cottonwoods west of the Temple Block (LDS CHO 1990). Pioneer accounts also remark on the abundant, cold, clear water in the creek.

Alterations to the Riparian Corridor

Over the last 160 years, the various activities associated with development and population growth in Salt Lake Valley have resulted in significant alterations to the stream channel and riparian conditions of City Creek. Among other factors, systematic programs to clear debris from channels likely contributed to reduced riparian vegetation density relative to pre-settlement conditions. Early citizens of Salt Lake were encouraged to gather wood in City Creek canyon by clearing the stream of deadfall (Prince and Shea 1995). Such "cleaning" programs involved removing debris dams and beaver dams that increased inundated streamside habitat area, elevated the water table, reduced flood velocities and erosion, and trapped sediment and nutrients (Gardner et al. 1999). The removal of such structures decreased the natural "checks" on sediment and water, resulting in greater flow velocities and streambed down-cutting (Wohl 2000). Today City Creek

is maintained in a relatively natural condition, and beaver populations are present in the upper subwatershed. The presence of beaver is unique relative to the other streams assessed during the RCS; however, current population levels in City Creek are most likely significantly smaller than during the pre-settlement era.

Many of the direct alterations to City Creek occurred to resolve flooding problems and accommodate water supply for municipal and agricultural purposes. Within the lower subwatershed, the most significant direct changes to the creek involved combining the multiple branches of City Creek into an artificial channel that ran down North Temple Street (Figure 3.5). By the mid-1920s this channel had been enclosed in underground pipes, resulting in the loss of most of the original streamside and riparian areas within the valley portion of the watershed. Within both the lower and upper subwatersheds, placement of fill material for road construction has directly affected the corridor by reducing the width of the active floodplain. Channel realignments have also historically occurred in conjunction with construction of mills, water supply canals, and storage reservoirs (Figure 3.5). Following the 1983 floods, extensive channel armoring (primarily with gabion baskets) was installed to protect City Creek Canyon Road. In most cases the present-day streambed remains flush with the lowest tier of these gabions, suggesting that bed elevations have remained stable since the 1980s.

The longitudinal connectivity of the City Creek riparian corridor remains relatively intact compared to the other streams assessed as part of the RCS. Bonneville Boulevard is the only major road crossing within the study area. However, various in-channel structures have been installed to protect utility crossings including water, sewer, and petroleum pipelines. Some of these structures influence transport of sediment and debris and may impede fish passage. Channel dewatering and facilities associated with the CCWTP also interrupt the corridor's longitudinal connectivity. In sum, existing channel conditions within the City Creek corridor reflect a complex response to a variety of historical and ongoing

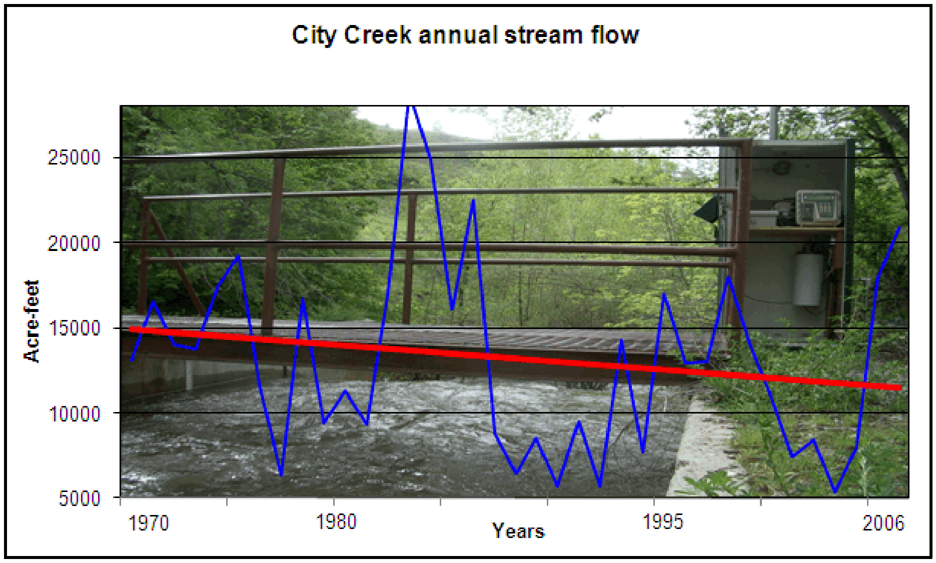


Figure 3.6. Plot of temporal trends in annual stream flow at City Creek gage. Plot provided by the Salt Lake City Department of Public Utilities.

alterations throughout the watershed.

Recent and Anticipated Future Trends

Within both the upper and lower City Creek subwatersheds, land use predictions for 2030 do not indicate significant changes in impervious cover (SLCO 2009). This is a unique situation relative to the other lower subwatersheds within Salt Lake City, where increases in imperviousness of 12% or more are anticipated over this time period.

Climate change can be anticipated to affect the City Creek riparian corridor. Climate projections for the southwest region of the United States show increased temperatures, reduced mountain snowpack, a 10–20% decrease in annual runoff volume, reduced springtime precipitation amounts, and anticipated water supply shortages (Karl et al. 2009). The risk of drought, as well as the risk of flooding, are expected to increase. The changes in temperature will likely result in a shift in vegetation communities, and altered precipitation patterns will influence stream hydrology and channel conditions. The timing of snowmelt runoff is expected to occur earlier in the spring, with an anticipated reduction in summertime base flows (Karl et al. 2009). It is difficult to predict specific changes to City Creek with certainty, but recorded annual stream flow volumes on City Creek already show a declining trend between 1970 and 2006 (L. Alserda 2009, pers. comm., Figure 3.6). This trend is anticipated to continue into the future (Karl et al. 2009).

Stream and Vegetation Conditions

Stream Channel Characteristics

Salt Lake County has classified City Creek within the RCS study area as entrenched, meaning the channel is vertically confined. Composite stream stability ratings for the area were good during County stream assessments completed in 2007. Also during these assessments, the County classified City Creek as Rosgen (1996) stream type B4 in reach UCC_R9, and as stream type B3 in the remaining RCS study reaches (K. Collins 2009, pers. comm.). County bankfull width estimates for the stream reaches in the RCS study area ranged from 10 feet to 23 feet, with an average value of 18 feet (K. Collins 2009, pers. comm.).

Results of RCS field surveys and GIS analyses further illustrate the fact that the City Creek channel is commonly entrenched and inset between tall, steep slopes (Figure 3.7). However, the extent of vertical confinement varies, and in some locations the channel shape is wider and includes broader, flatter bank and floodplain surfaces (Figure 3.7). These areas are important because they allow water to spread out horizontally during flood events, dissipating velocity and reducing erosion potential.

Surveyed channel width values are quite variable, ranging from about 4 to 20 feet at low flow, with an average value of 12 feet (Table 3.1). During the spring runoff period, field surveys were conducted at a streamflow of 78 cfs, which is close to the 1980–2005 average annual high flow value of 67 cfs. Width at this high flow value varies from about 12 to 35 feet, with an average of 19 feet. Within LCC_R02B, channel width has been directly affected by installed bank hardening measures.

Channel slope, as determined for each stream reach from digital elevation data, varies from 2.9% to 4.5% within the RCS study area, with an average value of 3% (Figure 3.8, Table 3.1). City Creek does not show any obvious consistent spatial trends in gradient through the study area. Historically, channel gradient would have shifted to a flatter, less confined, more sinuous channel type in the flatter valley area west of State Street; however, this portion of the creek is now piped underground in the North Temple conduit.

Median (D50) streambed particle size at the measured cross sections ranges from 26 to 74 millimeters (mm), indicating that medium- and large-sized gravel are the dominant substrate sizes in riffle areas of City Creek (Table 3.1). Medium gravel comprises the D16 particle size at all cross sections, and cobble-sized material typically comprises the D84 particle size (Table 3.1). Embeddedness values are highly variable. In flatter-gradient portions of the channel such as run and pool areas, particle sizes are smaller, with fine gravel and sand often dominant. No consistent upstream-to-downstream trends are evident in the pebble count results; rather, bed material size and embeddedness appear to be largely a function of local factors such as sediment inputs from erosion areas, composition of bank material, and the presence or proximity of bedrock.

Vegetation Characteristics

Table 3.2 lists all plant species noted on the data forms during the study area mapping effort. Species are identified by their common and scientific names, mapping code, wetland indicator status (USFWS 1988), and whether the species is native to Utah or introduced (NRCS 2009). A total of 82 different species were noted during the City Creek mapping work, with 50 of these species being native to Utah. As seen in Table 3.3, most of the nonnative species within the corridor occur in the canopy and understory vegetation layers, while the shrub layer is dominated almost entirely by native species.

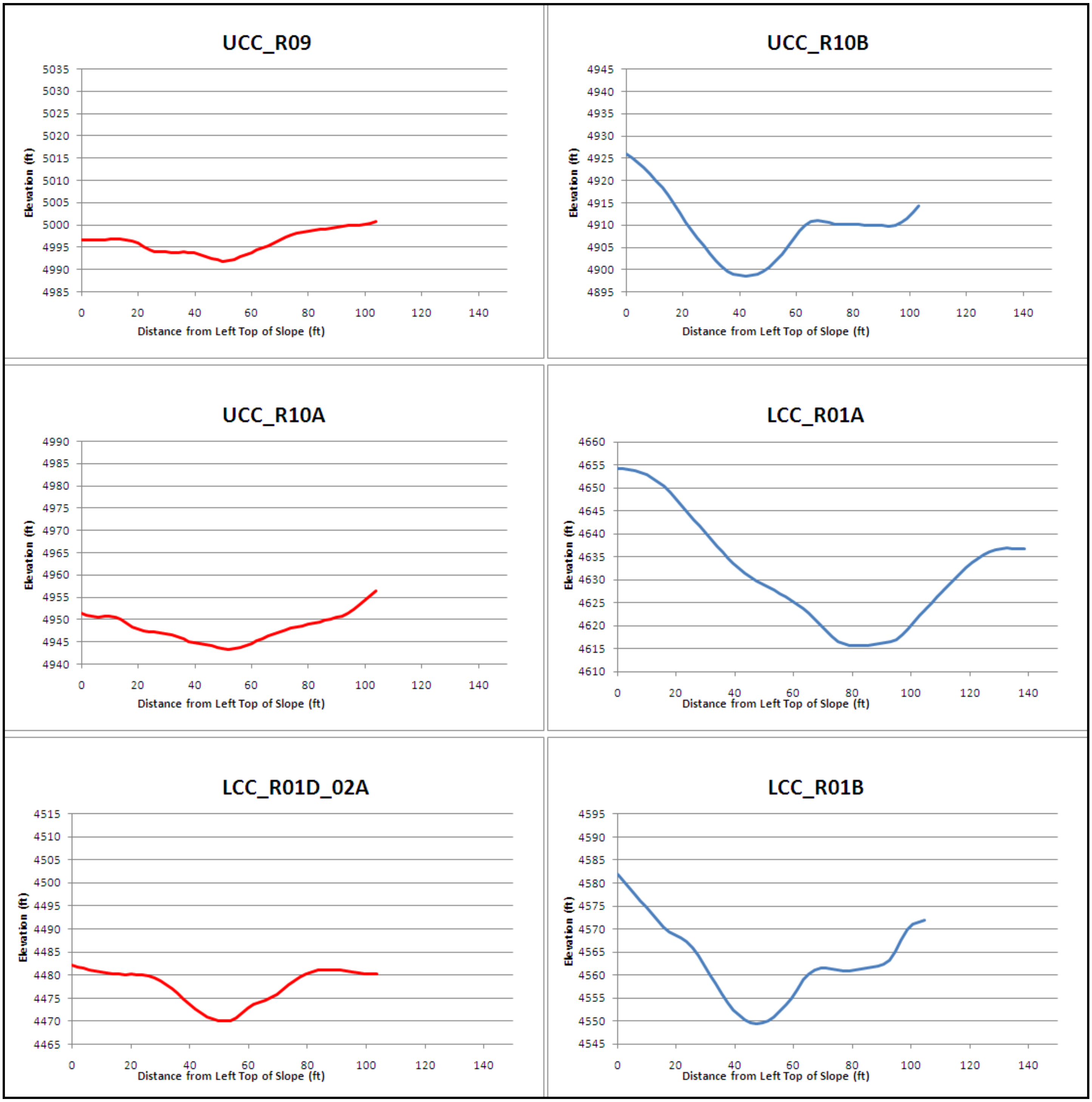


Figure 3.7. **Cross-section plots extrapolated from digital elevation data. Plots on left (in red) exhibit less vertical confinement and include relatively well-developed active floodplain surfaces. Plots on right (in blue) exhibit a greater degree of vertical confinement between tall, steep side slopes.**

Table 3.1. Summary of streambed material, channel geometry, and slope data.

REACH NUMBER	MEASURED VALUES AT RIFFLE CROSS SECTION							REACH DATA	
	STREAMBED MATERIAL SIZE DATA				CHANNEL GEOMETRY				
	D16 (mm) [a]	D50 (mm) [a]	D84 (mm) [a]	Percent Embedded	Low Flow Wetted Width (ft) [b]	Wetted Width (ft) [b] at 78 cfs [c]	Local Slope (ft/ft) [d]	Reach Slope (ft/ft) [d]	Reach Length (ft) [b]
UCC_R09	8	26	99	12	7.0	21.0	0.008	0.029	1565
UCC_R10A	8	29	56	3	4.9	35.6	0.020	0.031	1427
UCC_R10B	17	39	102	22	4.4	13.4	0.014	0.036	1905
UCC_R10C	15	46	121	20	14.8	16.9	0.033	0.032	1612
UCC_R11A	17	43	148	29	13.6	16.6	0.024	0.033	1836
UCC_R11B	16	58	171	0	7.6	14.1	0.034	0.032	1207
UCC_R11C	14	40	79	9	13.4	19.7	0.015	0.038	1357
LCC_R01A	14	34	108	8	19.9	21.0	0.041	0.036	1686
LCC_R01B	32	74	187	7	10.9	13.7	0.031	0.045	836
LCC_R01C	15	38	128	13	19.0	23.2	0.028	0.035	1303
LCC_R01D02A	13	37	89	11	13.4	19.0	0.019	0.032	681
LCC_R02B	-	-	-	-	10.0	12.0	0.016	0.034	748
averages	15	42	117	12	11.7	19.5	0.024	0.034	1401

[a] The 16th, 50th, and 84th percentile values of the particle size distribution, in millimeters.
[b] Feet.
[c] Cubic feet per second.
[d] Feet per feet.

Bigtooth maple (*Acer grandidentatum*), box elder (*Acer negundo*), cottonwood (*Populus* sp.), and water birch (*Betula occidentalis*) are the most common trees along the stream-side areas of City Creek, with Gambel oak (*Quercus gambelii*) common on upper slope areas. Siberian elm (*Ulmus pumila*), an introduced invasive tree, is also common in the lower reaches of the study area and comprises the dominant canopy species in some reaches (Table 3.3). Common shrub species include chokecherry (*Prunus virginiana*) and redosier dogwood (*Cornus sericea*), with Wood's rose (*Rosa woodsii*) and skunkbush sumac (*Rhus trilobata*) common on upper portions of slopes. The understory vegetation layer shows the greatest species variety. Creeping barberry (*Mahonia repens*) and field horsetail (*Equisetum arvense*) are the most common native understory species in stream-side areas, with bluebunch wheatgrass and ragweed (*Ambrosia* sp.) common on upper slopes. Nonnative turf grass dominates the understory cover within the formal Memory Grove lawn area in reach LCC_R02B. Common invasive understory species include lesser burdock (*Arctium minus*), cheatgrass (*Bromus tectorum*), and Dalmatian toadflax (*Linaria dalmatica*) (Table 3.3).

Near-stream canopy (tree) cover is generally high throughout the study area, averaging 67% (Table 3.4.). Tree cover is limited by the proximity of the

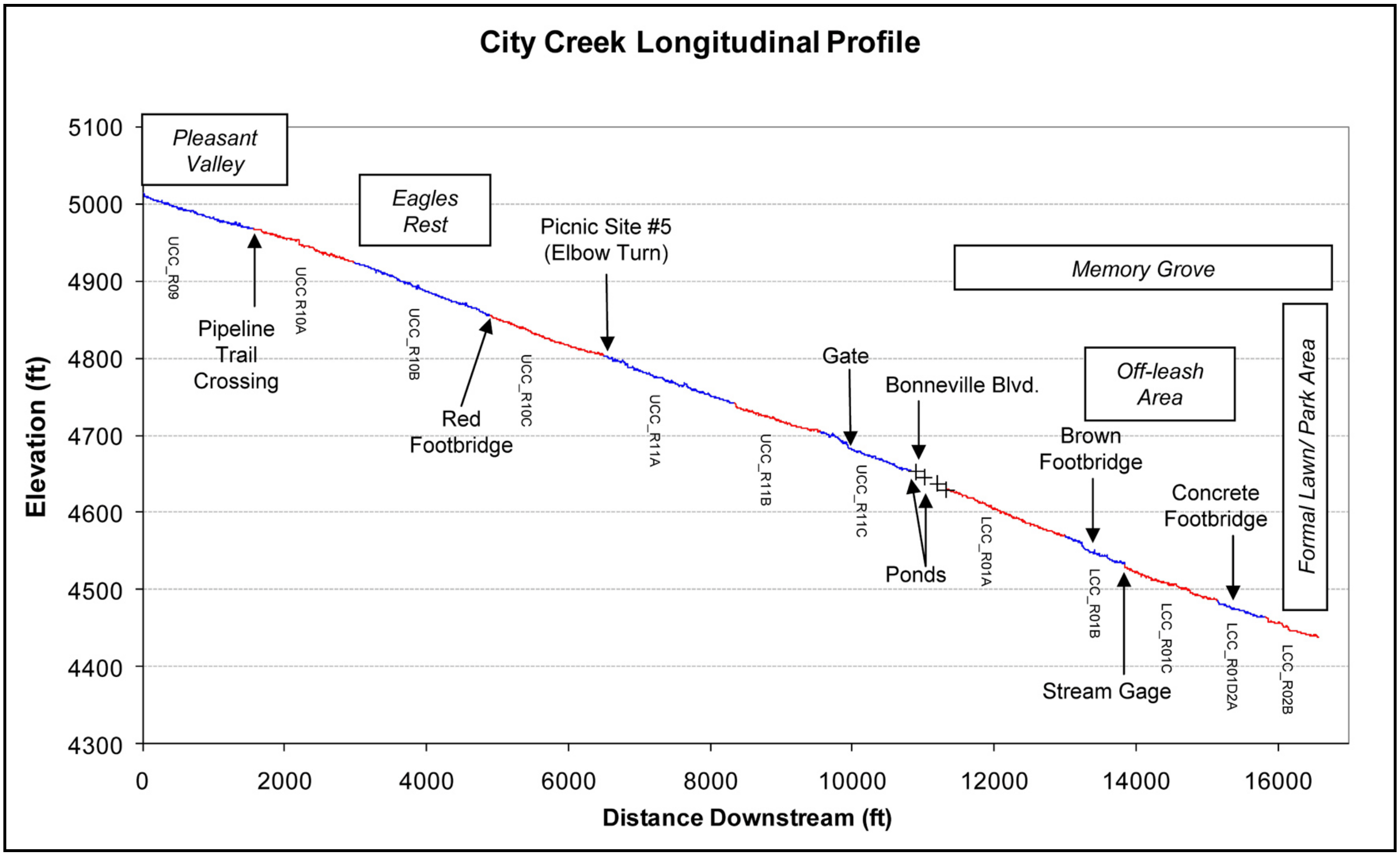


Figure 3.8. Longitudinal profile plot of City Creek streambed based on 2006 digital elevation data. Black cross marks indicate culvert inlets and outlets; red and blue lines indicate open channel stream sections.

canyon road in some areas, and is lacking in the formal Memory Grove lawn area (reach LCC_R02B). Because of the generally high-quality tree cover within the City Creek riparian corridor, the riparian functions of shading and water-temperature control are met to a high degree. Thirty-seven percent of the overall mapped area has greater than 25% cover in all three vegetation layers (canopy, shrub, understory); these areas are particularly effective at providing the riparian functions of nutrient filtration and sediment trapping.

Invasive weeds are a problem in all study reaches, and 52% of the overall mapped area has a weed classification of moderate, high, or majority (Table 3.4). Understory cover is minimal in the reaches downstream from reach LCC_R01A.

Issues Affecting Riparian Functions

During the baseline assessment work, several common issues were observed to be affecting and limiting riparian functions in the City Creek corridor. These issues are discussed by function below.

Aesthetics

Although many visually appealing portions of City Creek exist, the presence of trash and debris degrades corridor aesthetics in a number of locations. Common types of trash include miscellaneous small items such as bottles, cans, food wrappers, ropes, tarps, etc. These items are common in the more accessible stream reaches that are used for recreation.

Table 3.2. Plant species noted during City Creek mapping work.

SCIENTIFIC NAME	COMMON NAME	WETLAND INDICATOR STATUS	NATIVE TO UTAH OR INTRODUCED
Aibes concolor	white fir	not listed	native
Acer glabrum	Rocky Mountain maple	facultative	native
Acer grandidentatum	bigtooth maple	not listed	native
Acer negundo	box elder	facultative wetland	native
Aegilops cylindrica	jointed goatgrass	not listed	introduced
Aesculus hippocastanum	horse chestnut	not listed	introduced
Agrostis gigantea	redtop	no indicator	introduced
Ailanthus altissima	tree of heaven	no indicator	introduced
Alnus incana	gray alder	facultative wetland	native
Ambrosia artemisiifolia	annual ragweed	facultative upland	native
Artemisia cana	silver sagebrush	facultative	native
Arctium minus	lesser burdock	not listed	introduced
Artemisia tridentata	big sagebrush	not listed	native
Betula occidentalis	water birch	facultative wetland	native
Bromus tectorum	cheatgrass	not listed	introduced
Catabrosa aquatica	water whorlgrass	obligate wetland	native
Cardaria draba	whitetop	no indicator	introduced
Centaurea maculosa	spotted knapweed	not listed	introduced
Centaurea solstitialis	yellow star-thistle	not listed	introduced
Ceanothus velutinus	snowbrush ceanothus	not listed	native
Chenopodium album	lambsquarters	facultative upland	native
Chrysothamnus viscidiflorus	yellow rabbitbrush	not listed	native
Cirsium arvense	Canada thistle	facultative upland	introduced
Cichorium intybus	chicory	not listed	introduced
Cirsium vulgare	bull thistle	facultative	introduced
Cornus sericea	redosier dogwood	facultative wetland	native
Crataegus rivularis	river hawthorn	not listed	native
Cynoglossum officinale	gypsyflower (houndstongue)	not designated	introduced
Dactylis glomerata	orchardgrass	facultative upland	introduced
Elaeagnus angustifolia	Russian olive	facultative	introduced
Equisetum arvense	field horsetail	facultative	native
Euphorbia myrsinites	myrtle spurge	not listed	introduced
Fraxinus pennsylvanica	green ash	facultative wetland	native
Grindelia squarrosa	curlycup gumweed	facultative upland	native
Gutierrezia sarothrae	broom snakeweed	not listed	native
Helianthus annuus	common sunflower	facultative upland	native
Hedera helix	English ivy	not listed	introduced
Hordeum jubatum	foxtail barley	facultative	native
Isatis tinctoria	Dyer's woad	not listed	introduced
Juniperus osteosperma	Utah juniper	not listed	native
Lactuca serriola	prickly lettuce	facultative upland	introduced

Table 3.2. Plant species noted during City Creek mapping work (cont.).

SCIENTIFIC NAME	COMMON NAME	WETLAND INDICATOR STATUS	NATIVE TO UTAH OR INTRODUCED
Linaria dalmatica	dalmatian toadflax	not listed	introduced
Lonicera involucrata	twinberry honeysuckle	facultative	native
Mahonia repens	creeping barberry	not listed	native
Maianthemum stellatum	starry false lily of the valley	facultative	native
Melilotus officinalis	yellow sweetclover	facultative upland	introduced
Medicago sativa	alfalfa	not listed	introduced
Onopordum acanthium	scotch cottonthistle	not listed	introduced
Parthenocissus quinquefolia	Virginia creeper	no occurrence	native
Phalaris arundinacea	reed canarygrass	obligate wetland	native
Phragmites australis	common reed	facultative wetland	native
Picea engelmannii	Engelmann spruce	facultative upland	native
Pinus nigra	Austrian pine	not listed	introduced
Pinus ponderosa	ponderosa pine	facultative upland	native
Picea pungens	blue spruce	facultative	native
Populus angustifolia	narrowleaf cottonwood	facultative	native
Populus deltoides	eastern cottonwood	facultative wetland	native
Poa pratensis	Kentucky bluegrass	facultative upland	introduced
Prunus virginiana	chokecherry	facultative upland	native
Pseudoroegneria spicata	bluebunch wheatgrass	obligate upland	native
Quercus gambelii	Gambel oak	not listed	native
Rhus glabra	smooth sumac	not listed	native
Rhus trilobata	skunkbush sumac	no indicator	native
Ribes montigenum	gooseberry currant	not listed	native
Robinia pseudoacacia	black locust	facultative upland	native
Rosa woodsii	Woods' rose	facultative	native
Rumex crispis	curly dock	facultative wetland	introduced
Salix bebbiana	bebb willow	facultative wetland	native
Salix exigua	narrowleaf willow	obligate wetland	native
Salix fragilis	crack willow	facultative	introduced
Schoenoplectus acutus	hardstem bulrush	obligate wetland	native
Scirpus microcarpus	panicled bulrush	obligate wetland	native
Secale cereale	cereal rye	not listed	introduced
Solanum dulcamara	climbing nightshade	facultative	introduced
Solidago missouriensis	Missouri goldenrod	not listed	native
Sorbus scopulina	greene's mountain ash	no indicator	native
Symphoricarpos albus	common snowberry	facultative upland	native
Symphyotrichum eatonii	Eaton's aster	facultative	native
Thinopyrum intermedium	intermediate wheatgrass	not listed	introduced
Toxicodendron rydbergii	western poison ivy	facultative upland	native
Tragopogon dubius	yellow salsify	not listed	introduced
Ulmus pumila	Siberian elm	not listed	introduced

Table 3.3. List of mapped canopy, shrub, and understory plant species found in each assessed stream reach.

PLANT SPECIES			UCC_R09	UCC_R10A	UCC_R10B	UCC_R10C	UCC_R11A	UCC_R11B	UCC_R11C	LCC_R01A	LCC_R01B	LCC_R01C	LCC_R01D_R02A	LCC_R02B
	Common Name	Scientific Name												
CANOPY	White fir	*Aibes concolor*	X	X										
CANOPY	Rocky mountain maple	*Acer glabrum*	X											
CANOPY	Bigtooth maple	*Acer grandidentatum*	X	X	X	X	X	X	X	X	X	X	X	X
CANOPY	Box elder	*Acer negundo*	X	X	X	X	X	X	X	X	X	X	X	X
CANOPY	Water birch	*Betula occidentalis*	X	X	X	X	X	X	X	X	X			
CANOPY	Green ash	*Fraxinus pennsylvanica*				X	X	X	X	X	X			
CANOPY	Utah juniper	*Juniperus osteosperma*											X	X
CANOPY	Engelmann spruce	*Picea engelmannii*							X				X	
CANOPY	Ponderosa pine	*Pinus ponderosa*							X					
CANOPY	Blue spruce	*Picea pungens*											X	X
CANOPY	Narrowleaf cottonwood	*Populus angustifolia*	X	X	X	X	X	X	X	X	X	X	X	X
CANOPY	Eastern cottonwood	*Populus deltoides*							X	X	X	X	X	
CANOPY	Gambel oak	*Quercus gambelii*	X	X	X	X	X	X	X	X	X	X	X	X
CANOPY	Smooth sumac	*Rhus glabra*												X
CANOPY	Austrian pine [a]	*Pinus nigra* [a]												X
CANOPY	Horse chestnut [a]	*Aesculus hippocastanum* [a]						X	X	X	X			
CANOPY	Russian olive [b]	*Elaeagnus angustifolia* [b]							X	X		X	X	
CANOPY	Black locust [c]	*Robinia pseudoacacia* [c]										X		
CANOPY	Tree of heaven [c]	*Ailanthus altissima* [c]								X			X	
CANOPY	Siberian elm [b]	*Ulmus pumila* [b]							X	X	X	X	X	X
SHRUB	Chokecherry	*Prunus virgniana*	X	X	X	X	X	X	X			X	X	X
SHRUB	Gray alder	*Alnus incana*										X		
SHRUB	Common snowberry	*Symphoricarpos albus*	X											
SHRUB	Snowbrush ceanothus	*Ceanothus velutinus*						X	X					
SHRUB	Greene's mountain ash	*Sorbus scopulina*										X		
SHRUB	Redosier dogwood	*Cornus sericea*	X	X	X	X	X	X	X	X	X	X		
SHRUB	River hawthorn	*Crataegus rivularis*							X	X				
SHRUB	Twinberry honeysuckle	*Lonicera involucrata*												X
SHRUB	Skunkbush sumac	*Rhus trilobata*		X	X	X			X	X	X	X	X	X
SHRUB	Gooseberry currant	*Ribes montigenum*	X	X										
SHRUB	Woods' rose	*Rosa woodsii*		X	X	X	X	X	X	X	X	X	X	X
SHRUB	Bebb willow	*Salix bebbiana*										X		
SHRUB	Narrowleaf willow	*Salix exigua*	X						X	X	X	X	X	

Table 3.3. List of mapped canopy, shrub, and understory plant species found in each assessed stream reach (cont.).

PLANT SPECIES			UCC_R09	UCC_R10A	UCC_R10B	UCC_R10C	UCC_R11A	UCC_R11B	UCC_R11C	LCC_R01A	LCC_R01B	LCC_R01C	LCC_R01D_R02A	LCC_R02B
	Common Name	Scientific Name												
SHRUB	Yellow rabbitbrush	*Chrysothamnus viscidiflorus*							X	X			X	
SHRUB	Common reed	*Phragmites australis*							X					
SHRUB	Silver sagebrush	*Artemisia cana*									X	X	X	
SHRUB	Big sagebrush	*Artemisia tridentata*										X		
SHRUB	Crack willow [a]	*Salix fragilis* [a]							X	X		X	X	X
UNDERSTORY	Annual ragweed	*Ambrosia artemisiifolia*	X	X	X	X	X	X	X	X	X	X	X	
UNDERSTORY	Bluebunch wheatgrass	*Pseudoroegneria spicata*	X	X		X	X	X	X	X	X	X	X	
UNDERSTORY	Broom snakeweed	*Gutierrezia sarothrae*							X		X	X		
UNDERSTORY	Common reed	*Phragmites australis*	X						X	X				
UNDERSTORY	Common sunflower	*Helianthus annuus*	X	X	X	X	X		X			X	X	
UNDERSTORY	Creeping barberry	*Mahonia repens*	X	X	X	X	X	X	X	X	X	X	X	X
UNDERSTORY	Curlycup gumweed	*Grindelia squarrosa*				X	X		X	X	X	X	X	X
UNDERSTORY	Eaton's aster	*Symphyotrichum eatonii*	X	X	X	X	X	X	X					X
UNDERSTORY	Field horsetail	*Equisetum arvense*	X	X	X	X	X	X	X	X		X	X	
UNDERSTORY	Foxtail barley	*Hordeum jubatum*							X	X	X	X		
UNDERSTORY	Hardstem bulrush	*Schoenoplectus acutus*								X				
UNDERSTORY	Missouri goldenrod	*Solidago missouriensis*	X	X			X		X	X		X	X	
UNDERSTORY	Panicled bulrush	*Scirpus microcarpus*	X											
UNDERSTORY	Reed canarygrass	*Phalaris arundinacea*	X	X										
UNDERSTORY	Starry false lily of the valley	*Maianthemum stellatum*	X	X	X	X	X	X	X	X				
UNDERSTORY	Virginia creeper	*Parthenocissus quinquefolia*					X						X	X
UNDERSTORY	Water whorlgrass	*Catabrosa aquatica*						X	X	X		X	X	
UNDERSTORY	Western poison ivy	*Toxicodendron rydbergii*					X	X	X	X	X	X		
UNDERSTORY	Redtop [a]	*Agrostis gigantea* [a]	X	X		X	X	X	X	X			X	
UNDERSTORY	Yellow sweetclover [a]	*Melilotus officinalis* [a]		X	X	X	X		X	X	X	X	X	
UNDERSTORY	Alfalfa [a]	*Medicago sativa* [a]								X	X	X		
UNDERSTORY	Lambsquarters [a]	*Chenopodium album* [a]							X					
UNDERSTORY	Orchardgrass [a]	*Dactylis glomerata* [a]	X	X	X	X	X	X		X	X	X		X
UNDERSTORY	Kentucky bluegrass [a]	*Poa pratensis* [a]	X	X					X				X	X
UNDERSTORY	Intermediate wheatgrass [a]	*Thinopyrum intermedium* [a]	X	X									X	
UNDERSTORY	Yellow salsify [a]	*Tragopogon dubius* [a]							X					
UNDERSTORY	Chicory [a]	*Cichorium intybus* [a]	X									X	X	

Table 3.3. List of mapped canopy, shrub, and understory plant species found in each assessed stream reach (cont.).

PLANT SPECIES			UCC_R09	UCC_R10A	UCC_R10B	UCC_R10C	UCC_R11A	UCC_R11B	UCC_R11C	LCC_R01A	LCC_R01B	LCC_R01C	LCC_R01D_R02A	LCC_R02B
	Common Name	Scientific Name												
UNDERSTORY	Climbing nightshade [a]	*Solanum dulcamara* [a]				X	X	X	X	X	X	X	X	
	Prickly lettuce [a]	*Lactuca serriola* [a]			X	X	X	X	X	X		X	X	X
	Curly dock [a]	*Rumex crispis* [a]							X					
	Cereal rye [a]	*Secale cereale* [a]										X	X	
	Lesser burdock [b]	*Arctium minus* [b]	X	X	X	X	X	X	X	X			X	X
	Cheatgrass [c]	*Bromus tectorum* [c]	X	X			X		X	X		X	X	X
	Spotted knapweed [b]	*Centaurea maculosa* [b]									X	X		
	Yellow star-thistle [b]	*Centaurea solstitialis* [b]	X	X										
	Myrtle spurge [b]	*Euphorbia myrsinites* [b]									X	X	X	
	English ivy [c]	*Hedera helix* [c]							X			X	X	
	Dyer's woad [b]	*Isatis tinctoria* [b]	X				X		X			X	X	
	Dalmatian toadflax [b]	*Linaria dalmatica* [b]	X			X	X	X	X	X	X	X	X	
	Scotch cottonthistle [b]	*Onopordum acanthium* [b]							X	X		X	X	X
	Whitetop [b]	*Cardaria draba* [b]											X	
	Gypsyflower (houndstongue) [b]	*Cynoglossum officinale* [b]	X				X		X	X				
	Jointed goatgrass [b]	*Aegylops cylindrica* [b]	X	X										
	Bull thistle [b]	*Cirsium vulgare* [b]	X	X										
	Canada thistle [b]	*Cirsium arvense* [b]					X			X				

[a] Species not native to Utah.
[b] State- or City-listed, nonnative, noxious weed species.
[c] Nonnative, invasive species.

Another common category of trash is remnant/obsolete pieces of infrastructure such as pieces of concrete and asphalt or old pipes and barrels. In some instances the concrete and asphalt pieces are associated with poorly designed bank stabilization efforts. A total of 43 individual litter areas were mapped in the study area during the RCS baseline assessment work. Other items impacting aesthetics include utility pipe crossings and gabion basket bank protection.

Wildlife Habitat and Connectivity

A wide range of native bird and mammal species rely on native insects as a key food source (Tallamy 2009). These insects must share an evolutionary history with plants in order to recognize them and use them as a food source. Therefore, healthy native plant communities are necessary for a riparian corridor to function to its maximum potential in terms of wildlife habitat. As discussed above, invasive nonnative plant species are a concern in all of the study reaches within the City Creek corridor, and significantly affect the composition of the understory and canopy vegetation layers. In some areas

Table 3.4. Percent cover and invasive species class for mapped vegetation polygons.

REACH	POLYGON NUMBER	PERCENT CANOPY COVER	PERCENT SHRUB COVER	PERCENT UNDERSTORY COVER	INVASIVE SPECIES CLASS
UCC_R09	1	0	0	51–75	high
UCC_R09	2	51–75	26–50	1–5	none
UCC_R09	3	51–75	51–75	76–100+	low
UCC_R09	4	0	6–25	76–100+	none
UCC_R09	5	25–50	6–25	76–100+	none
UCC_R09/10A	6	51–75	6–25	51–75	none
UCC_R09	7	51–75	26–50	76–100+	high
UCC_R09	8	76–100+	6–25	76–100+	none
UCC_R09	9	51–75	26–50	76–100+	moderate
UCC_R09	10	76–100+	26–50	26–50	low
UCC_R09	11	51–75	26–50	51–75	moderate
UCC_R09	12	6–25	1–5	51–75	majority
UCC_R09	13	51–75	6–25	51–75	moderate
UCC_R09	14	6–25	0	26–50	none
UCC_R10A	15	51–75	6–25	51–75	moderate
UCC_R10A	16	76–100+	6–25	76–100+	low
UCC_R10A	17	76–100+	51–75	26–50	none
UCC_R10A	18	51–75	6–25	26–50	low
UCC_R10A	19	76–100+	76–100+	26–50	moderate
LCC_R02B	20	26–50	6–25	51–75	majority
LCC_R02B	21	26–50	26–50	76–100+	majority
LCC_R01D/02A/02B	22	51–75	26–50	6–25	moderate
LCC_R01D/02A/02B	23	26–50	26–50	51–75	moderate
LCC_R02B	24	26–50	0	76–100+	moderate
LCC_R01D/02A/02B	25	0–25	0–5	51–100+	low
UCC_R10A	26	76–100+	26–50	51–75	low
UCC_R10A	27	76–100+	51–75	26–50	low
UCC_R10B	28	76–100+	76–100+	76–100+	none
UCC_R10A/10B	29	76–100+	51–75	51–75	moderate
UCC_R10A/10B	30	51–75	76–100+	6–25	none
UCC_R10B	31	76–100+	6–25	76–100+	low
UCC_R10B	32	76–100+	51–75	76–100+	none
UCC_R10B	33	76–100+	51–75	51–75	low
UCC_R10B	34	76–100+	26–50	76–100+	none
UCC_R10B	35	76–100+	26–50	76–100+	low
UCC_R10B/10C	36	76–100+	26–50	51–75	low
UCC_R10B	37	76–100+	26–50	76–100+	none
UCC_R10C	38	76–100+	26–50	26–50	low
UCC_R10C	39	76–100+	6–25	51–75	low
UCC_R10C	40	76–100+	26–50	76–100+	none

Table 3.4. Percent cover and invasive species class for mapped vegetation polygons (cont.).

REACH	POLYGON NUMBER	PERCENT CANOPY COVER	PERCENT SHRUB COVER	PERCENT UNDERSTORY COVER	INVASIVE SPECIES CLASS
UCC_R10C	41	76–100+	6–25	51–75	low
UCC_R10C	42	6–25	0	26–50	moderate
UCC_R10C	43	51–75	26–50	51–75	low
UCC_R10C	44	76–100+	6–25	51–75	none
UCC_R10C	45	76–100+	26–50	51–75	none
UCC_R10C	46	76–100+	26–50	76–100+	none
UCC_R10C	47	76–100+	6–25	51–75	none
UCC_R10C/11A	48	76–100+	6–25	51–75	none
UCC_R10C	49	76–100+	51–75	51–75	low
UCC_R10C	50	76–100+	51–75	51–75	none
LCC_R01B	51	51–75	26–50	6–25	none
LCC_R01B	52	51–75	26–50	26–50	moderate
LCC_R01B	53	6–25	0	76–100+	moderate
LCC_R01B	54	51–75	6–25	26–50	low
LCC_R01B/01C	55	51–75	6–25	26–50	low
LCC_R01B/01C	56	76–100+	6–25	6–25	moderate
LCC_R01B	57	76–100+	6–25	6–25	none
LCC_R01B	58	6–25	1–5	51–75	high
LCC_R01B	59	76–100+	6–25	26–50	none
UCC_R11A	60	51–75	51–75	76–100+	low
UCC_R11A	61	51–75	26–50	76–100+	high
UCC_R11A	62	51–75	26–50	26–50	moderate
UCC_R11A	63	51–75	76–100+	51–75	high
UCC_R11A	64	51–75	26–50	26–50	high
UCC_R11A	65	26–50	26–50	26–50	moderate
UCC_R11A	66	76–100+	51–75	51–75	low
UCC_R11A	67	76–100+	51–75	26–50	high
UCC_R11A	68	51–75	26–50	51–75	low
UCC_R11A	69	26–50	6–25	6–25	moderate
UCC_R11A	70	51–75	51–75	51–75	low
UCC_R11B	71	26–50	26–50	26–50	none
UCC_R11B	72	76–100+	26–50	26–50	none
UCC_R11B	73	76–100+	51–75	51–75	moderate
UCC_R11B/11C	74	51–75	26–50	51–75	none
UCC_R11B	75	51–75	51–75	51–75	moderate
UCC_R11B	76	76–100+	51–75	76–100+	none
UCC_R11B	77	26–50	6–25	26–50	moderate
UCC_R11B	78	26–50	51–75	26–50	moderate
UCC_R11A/11B	79	51–75	6–25	26–50	moderate
UCC_R11C	80	6–25	6–25	26–50	none

Table 3.4. Percent cover and invasive species class for mapped vegetation polygons (cont.).

REACH	POLYGON NUMBER	PERCENT CANOPY COVER	PERCENT SHRUB COVER	PERCENT UNDERSTORY COVER	INVASIVE SPECIES CLASS
UCC_R11C	81	51–75	26–50	6–25	none
UCC_R11C	82	51–75	26–50	6–25	moderate
UCC_R11C	83	26–50	6–25	26–50	moderate
UCC_R11C	84	26–50	26–50	26–50	moderate
UCC_R11C	85	51–75	26–50	26–50	moderate
UCC_R11C	86	51–75	26–50	26–50	none
UCC_R11C	87	26–50	6–25	26–50	high
UCC_R11C	88	51–75	51–75	26–50	moderate
UCC_R11C	89	51–75	26–50	51–75	high
UCC_R11C	90	6–25	26–50	26–50	high
UCC_R11C	91	76–100+	51–75	6–25	moderate
Lower Debris Basin	92	76–100+	51–75	26–50	majority
LCC_R01A	93	26–50	6–25	26–50	moderate
LCC_R01A	94	51–75	6–25	26–50	high
LCC_R01A	95	51–75	26–50	26–50	high
LCC_R01A	96	26–50	6–25	6–25	moderate
LCC_R01A	97	51–75	26–50	26–50	moderate
LCC_R01A	98	51–75	26–50	26–50	high
LCC_R01A	99	26–50	6–25	26–50	moderate
LCC_R01A	100	76–100+	26–50	26–50	moderate
LCC_R01A	101	76–100+	6–25	6–25	none
LCC_R01A	102	51–75	26–50	6–25	moderate
LCC_R01A/01B	103	51–75	26–50	26–50	none
LCC_R01A	104	51–75	26–50	26–50	moderate
LCC_R01B	105	26–50	6–25	26–50	moderate
LCC_R01A	106	26–50	26–50	51–75	high
LCC_R01A	107	6–25	6–25	26–50	moderate
LCC_R01C	108	6–25	1–5	26–50	high
LCC_R01C	109	6–25	1–5	51–75	high
LCC_R01C	110	51–75	6–25	6–25	moderate
LCC_R01C	111	6–25	6–25	51–75	high
LCC_R01C	112	26–50	6–25	51–75	high
LCC_R01C/01D/02A	113	6–25	6–25	76–100+	moderate
LCC_R01C	114	76–100+	6–25	0	high
LCC_R01C/01D/02A	115	76–100+	6–25	51–75	high
LCC_R01C	116	26–50	6–25	51–75	moderate
LCC_R01C	117	76–100+	26–50	6–25	high
LCC_R01D/02A	118	26–50	0	51–75	high
LCC_R01D/02A	119	51–75	51–75	51–75	high
LCC_R01D/02A	120	76–100+	51–75	6–25	moderate
LCC_R01D/02A	121	51–75	26–50	51–75	high
LCC_R01D/02A	122	51–75	6–25	51–75	majority

Dominant canopy species/ vegetation types in the study area:

- bigtooth maple
- bigtooth maple-Gambel oak
- box elder
- Gambel oak
- introduced/native tree mix
- ornamental mix
- other native trees or shrubs
- Siberian elm
- understory
- water birch

invasive species comprise the majority plant cover within a vegetative layer, limiting the ability of native plants to thrive and support native insects, birds, and wildlife. A lack of understory and shrub cover in some reaches also limits habitat quality in terms of structural diversity, which is particularly important for bird populations.

As discussed previously, the longitudinal connectivity of City Creek within the RCS study area is relatively intact compared to other streams within Salt Lake City. However, the debris basins and associated culverts near Bonneville Boulevard create an interruption in the corridor that impedes fish passage (Figure 3.12, Table 3.5). The other crossings within the study area are generally footbridges that do not significantly impede connectivity with regards to fish or wildlife (Table 3.5). However, several concrete in-channel apron/sill structures that protect pipe crossings create significant vertical drops that may hinder fish passage (Table 3.6).

Nutrient Filtration and Sediment Trapping

Several areas within the City Creek corridor lack the dense near-stream understory and shrub cover that is needed to maximize the ability of the riparian corridor to filter sediment, nutrients, and pollutants from storm runoff. Another factor limiting the filtration function in portions of City Creek is the design of storm drain outfalls. Some pipes discharge directly into the main flow of the stream, eliminating the opportunity for runoff to be filtered by riparian vegetation.

Invasive plants of concern in the study area:

- spotted knapweed
- yellow starthistle
- dalmation toadflax
- dyer's woad
- whitetop
- Canada thistle
- gypsyflower (houndstongue)
- myrtle spurge
- Scotch thistle
- bull thistle
- common burdock
- Russian olive
- Siberian elm
- tree of heaven
- jointed goatgrass
- English ivy
- black locust
- cheatgrass

Table 3.5. Bridges and culvert crossings in the study area.

CROSSING LOCATION/ DESCRIPTION	REACH NUMBER(S)	APPROXIMATE CULVERT LENGTH (feet)	CROSSING TYPE	SIZE/ DESCRIPTION	CONDITION	RECOMMENDATIONS
Red Footbridge	between UCC_R10B and UCC_10C	N/A [a]	pre-fabricated metal footbridge	full span, high clearance	good	none
Wood Plank Footbridge	between UCC_11B and UCC_11C	N/A [a]	wood plank on metal I-beam supports	low clearance; does not span entire floodplain	planks missing; in disrepair	remove or repair to eliminate safety concern
Bonneville Boulevard	between UCC_R11C and lower debris basin	96	concrete culvert pipe	6-foot diameter	good	none
Canyon Road	between lower debris basin and LCC_R01A	72	concrete culvert pipe	6-foot diameter	good	none
Brown Footbridge	middle of LCC_R01B	N/A [a]	pre-fabricated metal footbridge	full span, high clearance	good	none
Stream Gage	between LCC_R01B and LCC_R01C	N/A [a]	footbridge across concrete flume	high clearance, spans width between concrete flume walls	good	improve bed protection below concrete flume
Concrete utility crossing	LCC_R01C	6	concrete/stone arch culvert	6-foot-wide arch; 3.5-foot clearance	evidence of sediment deposition on upstream side	monitor condition; if feasible replace with full-span structure
Concrete utility crossing	LCC_R01D_02A	6	concrete/ stone arch culvert	7-foot-wide arch; 3.5-foot clearance	fair; crack in cement	monitor condition; if feasible replace with full-span structure
Concrete Footbridge	LCC_R01D_02A	N/A [a]	concrete bridge and wingwalls	3-foot clearance; spans width between concrete wingwalls	fair; some scour at wingwalls	remove bridge/wingwalls and replace with bridge that spans entire floodplain
Rockwork Bridge	middle of LCC_R02B	N/A [a]	arched rockwork footbridge	full span, high clearance	good	none
Concrete Bridge in Memory Grove Park	LCC_R02B	N/A [a]	flat concrete footbridge with metal railing	high clearance; spans width between grouted rock walls	good	none

[a] Not applicable.

Table 3.6. Existing significant streambed protection structures in the study area.

REACH [a]	DESCRIPTION	POTENTIAL FISH BARRIER	ESTIMATED VERTICAL DROP IN WATER SURFACE AT STRUCTURE [b]	LATERAL CHANNEL CONFINEMENT
UCC_R11C	concrete sill/old gage	yes	3 feet	yes (concrete wall)
UCC_R11C	concrete and rubble	yes	two drops, each 2 feet	yes (concrete walls)
UCC_R11C	narrow concrete sill	no	0.5 foot	yes (concrete piers)
LCC_R01B	narrow concrete sill	no	0.8 foot	yes (concrete wing walls; gabions)
LCC_R01B	cemented bed	yes	2.5 to 3 feet	no
LCC_R01B	boulder weir	unlikely	2 feet total	no
LCC_R01B	concrete block, boulders, rubble	unlikely	several drops, each 2 feet	not confined at structure, but confined just upstream by stone block wall
LCC_R01B	two long concrete pieces	no	0.5 foot	no
LCC_R01B	concrete flume (stream gage)	yes	two drops; 3.5 and 2.5 feet	yes (concrete walls)
LCC_R01C	grouted rock drop structure	yes	4 feet	yes (grouted rock wing walls)
LCC_R01D_02A	grouted rock drop structure	yes	10 feet	yes (narrow grouted rock wing walls)
LCC_R01D_02A	grouted rock drop structure	yes	3.5 feet	yes (grouted rock wing walls)
LCC_R02B	grouted rock drop structure	yes	5 feet	yes (grouted rock channel)
LCC_R02B	grouted rock drop structure	yes	5 feet	yes (grouted rock channel)
LCC_R02B	grouted rock drop structure	yes	5 feet	yes (grouted rock channel)

[a] Structures listed in upstream to downstream order.
[b] Assessed at low flow.

Factors limiting shrub and understory cover:

- oversteepened slopes
- inadequate revegetation efforts following maintenance or construction work
- soil compaction from heavy foot traffic
- poorly controlled runoff from upland areas

Stream Stability

A number of different issues were noted as affecting stream stability within the City Creek riparian corridor. Specific issues are discussed in the subsections below.

Fill Encroachment

Steep, poorly vegetated fill slopes associated with roads affect stability in portions of the lower reaches of City Creek and are particularly prevalent in reach LCC_R01A. Because these slopes lack vegetation and the associated resistive strength it provides, they are vulnerable to erosion during flood events. Fill slopes also restrict floodplain width and laterally confine high flows, causing increased flow velocities and shear stress on streambanks. Fill encroachment also limits the ability of floodplain surfaces to act as sponges to absorb flood water.

Top left: Steep bare slope adjacent to Bonneville Boulevard in reach LCC_R01A. Note trees, grass, and large rocks at base of slope indicating toe stability. Top right: Rill erosion below pipe outfalls. Bottom left: Rill erosion where road runoff concentrates at gabion/ natural bank interface. Bottom right: Bare bank and compacted soil associated with heavy recreational foot traffic.

Road Runoff and Storm Drain/Pipe Outfalls

Erosion associated with poorly controlled road runoff was observed in several study reaches. In a number of instances, road runoff concentrates at the edges of installed gabion basket bank armoring, causing rill development at the gabion/ natural bank interface. Rills were also observed at several unprotected pipe outfalls that convey tributary and storm flows under roads and into City Creek. The outfalls lack adequate outlet protection to dissipate runoff velocities and lack stabilized conveyance channels between the outlet and the main City Creek channel. Clogged roadside storm drain inlet grates were also observed in several locations, and could lead to further rill creation when flows bypass the designed storm drain pipe system.

Above: Steep vertical bank where stream has migrated laterally into a fine-grained geologic formation.

Compaction from Foot Traffic

Within the downstream reaches of the study area that receive the greatest recreational use, trampled bank and floodplain areas were commonly observed. Steep, poorly stabilized access trails also occur locally throughout the study area and are commonly associated with established picnic sites. These areas lack vegetation and are susceptible to erosion during storm and flood events.

Bank Erosion

Lateral erosion of streambanks is a natural process in stream channels, which are dynamic systems. Erosion and sediment transport are necessary for the creation and maintenance of important habitat features such as scour pools, undercut banks, and spawning gravels. Deposition of sediment on floodplain areas is also important, as it provides fresh substrate for the growth of willow and cottonwood seedlings that are needed to maintain native riparian forests. However, excessive amounts of erosion or deposition can degrade habitat and water quality and threaten infrastructure and homes.

In some reaches of City Creek tall, vertical, bare banks are present where the creek has migrated laterally into steep, fine-grained alluvial or tuff formations. This is a natural erosion process that is relatively common within confined canyon settings where less-resistant geologic formations are present. Low bank/root zone erosion is another type of bank erosion that is common in urbanized channels where hydrology is dominated by flashy, frequent, erosive runoff events during storms. Because the City Creek watershed remains relatively natural, evidence of this type of erosion is minimal in the study area. The fact that nearly 1 mile of bank length in the study area has been artificially hardened with gabion baskets and other structures also limits the potential for this type of bank erosion. As discussed previously, in the areas where gabions were installed after the 1983 flood, the present-day streambed generally remains flush with the lowest tier of gabions, suggesting that bed elevations have remained stable since the 1980s. On other streams assessed as part of the RCS, bed lowering and associated bank erosion caused by the toe of the slope being undermined was a commonly observed process. This does not appear to be occurring to a significant degree within City Creek.