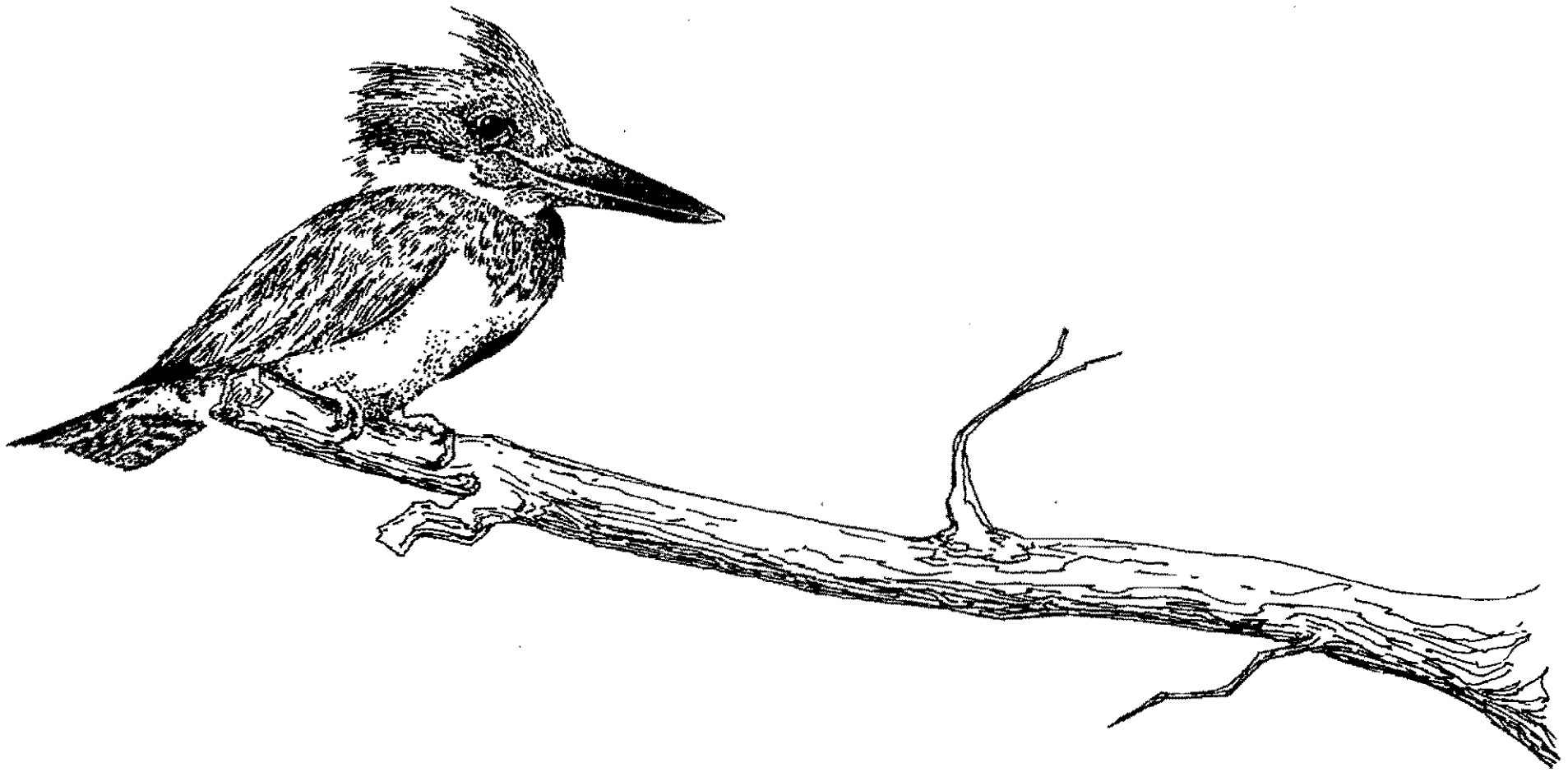
THE FRIENDS OF BIG COTTONWOOD CREEK



BIG COTTONWOOD CREEK GUIDE

A Handbook for Riparian and Aquatic Enhancement

SALT LAKE COUNTY PUBLIC WORKS ENGINEERING

SALT LAKE COUNTY

Big Cottonwood Creek Guide
A Handbook for Riparian and Aquatic Enhancement

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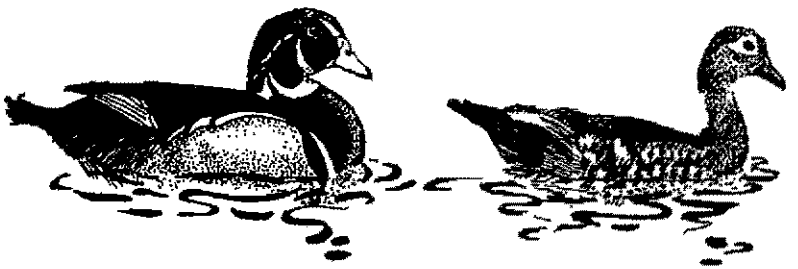
The Purpose of This Guide

The purpose of this guide is to provide information and education to private property owners and other stakeholders living adjacent to or in close proximity to Big Cottonwood Creek. Over the last 20 years, there has been increasing interest and concern by local Salt Lake County residents over the health and well being of the Creek, including how the Creek can impact them, mostly by flooding. But there are many other concerns, including year-round instream flows, trash and litter, trespass problems, water quality, irrigation water quality and odor, fishery habitat improvement, reporting and preventing toxic spills to the Creek, enhancement of streamside vegetation and bird habitat. Those living near the Creek have an intimate relationship with it, and consider its beauty and magic as something much more than a channel that threatens to flood every spring.

This guide provides a wealth of background information on how the Creek was formed and why it acts the way it does. Any land owner that desires to improve or restore Creek conditions in their backyard will find the guide insightful and useful. Organizations such as Boy Scout groups, Church groups, environmental interests, fish enthusiasts, or bird watchers will find important information to help identify and plan potential projects, no matter how small or large. Salt Lake County believes that by empowering its citizens with such information, they can play an important role in the long term stewardship of the Creek's resources, and not rely on the government to solve all the problems the Creek faces as the valley continues to grow.



Wood Duck

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Special Thanks to Dee Holladay, Maunsel Pearce, Gordon Yates Alan Matheson and Friends of Big Cottonwood Creek
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Special thanks to Mr. Gene Reetz (EPA) and Ms. Nancy Keate (Utah DNR)
Cover : Belted Kingfisher

I. INTRODUCTION TO STREAMS

A. Taking Care of the Public Trust

Streams are resources of the Public Trust, because no single person or entity can own or operate them. Public trust responsibilities include:

1. Prevent Erosion of Banks and Creek Bed

Many areas of the Creek continue to erode, due mainly to high spring flood flows, stream-side development constraints, and channel incisement. Reducing or preventing bed and bank erosion helps to maintain a stable, sustainable stream environment.

2. Enhance Fishery and Wildlife Habitat

Big Cottonwood Creek is one of very few Wasatch Front tributaries that supports a year-round instream flow (from Cottonwood Lane to the Jordan River) and a reproducing Brown Trout fishery. This quality is unique and deserves increased protection as an urban fishery. The wildlife habitat of the Creek corridor is also unique, with extensive Cottonwood forests dominating the upper half of the valley segment. The bird population in this area is diverse and dense, and the exclusive residential development has preserved much of the resource over time.

3. Maintain Flood Conveyance

The floods of 1983 reminded us that this Creek can and will flood. Although damage from the Big Cottonwood flooding was minimized, it is apparent that further constriction of limitation of the channel can produce disastrous results during flood events. It is important that the Creek channel be cleared of debris and that new development be set back to alleviate future flooding conditions.

4. Enhance Function and Value of Riparian Vegetation

A riparian zone is the green vegetation that dominates the natural stream-side landscape. It provides many functions and values important to a stable stream environment, including flood storage, groundwater recharge and discharge, shoreline/bank anchoring, sediment trapping, biological food chain support, nutrient or pollutant uptake, as well as wildlife habitat and recreation. Degrading riparian vegetation reduces the capacity of the environment to perform these functions, which directly impacts local residents and users of the Creek.

5. Maintain Water Quality Standards

Big Cottonwood Creek is protected for "non-contact" recreational uses, such as floating, boating or kayaking. It is protected for coldwater fishery values and aquatic food chain support (aquatic insects that provide food for fish and birds). By reducing sediment and nutrient loads (nitrate and phosphorus), the aquatic environment will flourish. Reducing the amount or organic litter (leaves, grass clippings, limbs and garden trimmings) dumped into or along side the Creek by residents will help keep the aquatic habitat healthy. Eliminating pesticide and herbicide applications, runoff, or discharges to the Creek is mandatory, since these inpacts can immediately destroy both aquatic insects and fish. It can take two to three years for the Creek to recover from such impacts.

Robin

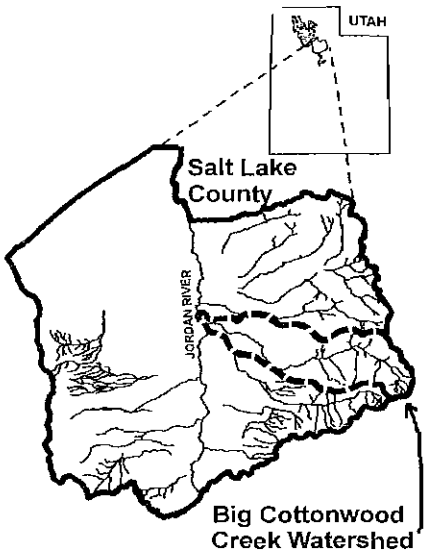
B. Taking Care of the Landowners Needs

Many portions of Big Cottonwood Creek falls within private ownership boundaries, and private ownership needs beeome an issue. Protection from flood events is a primary concern of Creek-side residents. Stability of the bed and banks of the Creek will directly impact private property during a flood event, resulting in failure of the channel to convey the flood and consequential property loss.

While property owners need this protection, most prefer stabilization measures which are aesthetically pleasing to them and their neighbors. Such measures enhance and preserve property values, as well as providing natural wildlife values sought by homeowners and prospective buyers.

C. Stream 101: The Dynamics of Big Cottonwood Creek

1. Big Cottonwood Creek Watershed and Hydrology



The Canyon The Big Cottonwood Canyon watershed drainage basin includes approximately 50 square miles with elevations ranging from 5,000 to 10,500 feet. The drainage headwater is a broad, glaciated basin with numerous meadows and "tarn" lakes, vegetated mainly by subalpine fir, Engelmann spruce, and aspen. The mid-montane zone (5,000-7,000 ft.) is a steeply meandering down-cut canyon dominated by riparian species such as narrowleaf cottonwood, Rocky Mountain maple, boxelder, water birch, and willows.

With the largest flow of any adjacent Wasatch canyon streams, Big Cottonwood provides the largest source of culinary water to Salt Lake City, which owns 99% of the water rights. Although most of the canyon is owned and managed by the United States Forest Service, significant private land-holdings exist near the headwaters. In addition to the Brighton and Solitude Ski areas, there are approximately 530-600 private residences in the Silverfork area.

Flows from the Big Cottonwood drainage basin average an annual water yield of 51,238 acre-feet. Seasonal high flows occur in June, with the melting of the winter snowpack. The maximum bankfull discharge, measured near the mouth of the canyon, is 570 cubic feet per second (c.f.s.) with bankfull elevation at about 3.4 feet. The Flood stage of the Creek is 700 c.f.s. at an elevation of 3.9 feet. The average seasonal peak flow for June ranges from 61-350 c.f.s. The average seasonal low flow in December ranges from 13-31 c.f.s. The high quality canyon creek is an "anti-degradation" segment with special protection under Utah Water Quality Standards, and meets or exceeds its beneficial uses.

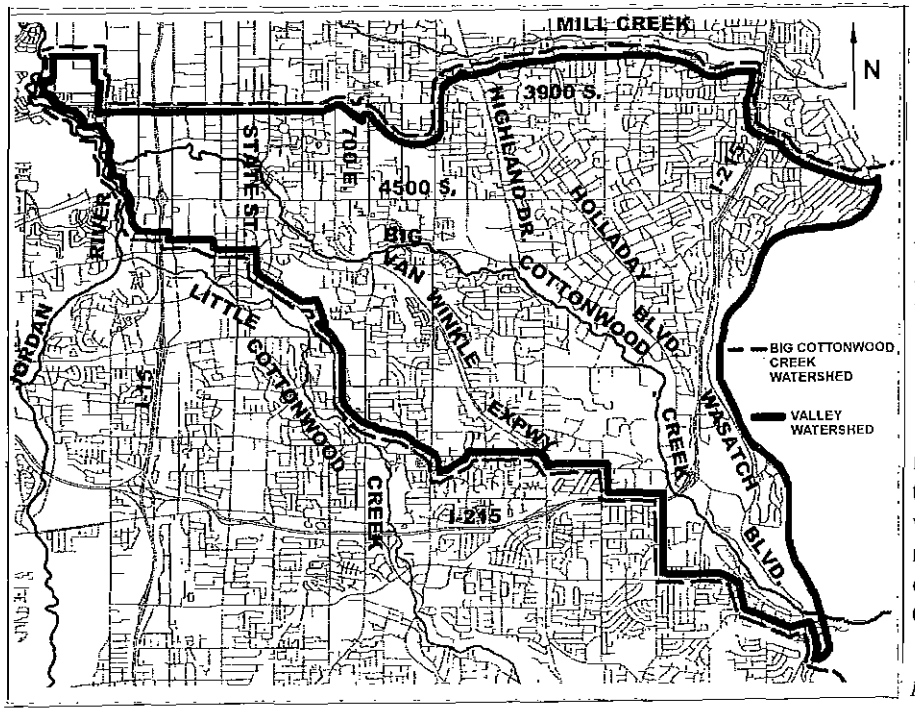


Figure 1. Big Cottonwood Creek Valley Watershed

The Valley The Big Cottonwood Valley watershed drainage basin includes approximately 28 square miles with elevations ranging from 4,200 to 5,000 feet. The Creek meanders through glacial alluvium near the canyon and across Cottonwood-laced deposits of Lake Bonneville and post-glacial floodplains prior to its confluence with the Jordan River near 4200 South.

Four miles of the valley segment of Big Cottonwood Creek is seasonally de-watered between the Canyon mouth downstream to Cottonwood Lane by Salt Lake City water treatment diversions. The City makes up the diverted flow with exchanges from the Jordan and Salt Lake Canal between April and October, but from November through March, 50% of the Valley creek segment is dry. From Cottonwood Lane downstream, late Autumn-Winter instream flow originates, supporting a reproducing brown trout fishery. The source of this 1-3 c.f.s. flow is probably groundwater discharge from the shallow unconfined aquifer.

In this urban environment, the fishery uses of the creek have been degraded by runoff from urban land uses, illegal discharges, and hydrologic modification. About 62% of the valley watershed area is paved and residentially developed, while 10% is commercial, with 1% industrial. Approximately 21% remains open. Significantly high volumes of urban runoff impact Big Cottonwood Creek during storms and snow melt. Even though water quality continues to be high enough to support the trout fishery, over the last eight years the Creek has experienced four significant fish kills from industrial or illegal discharges.

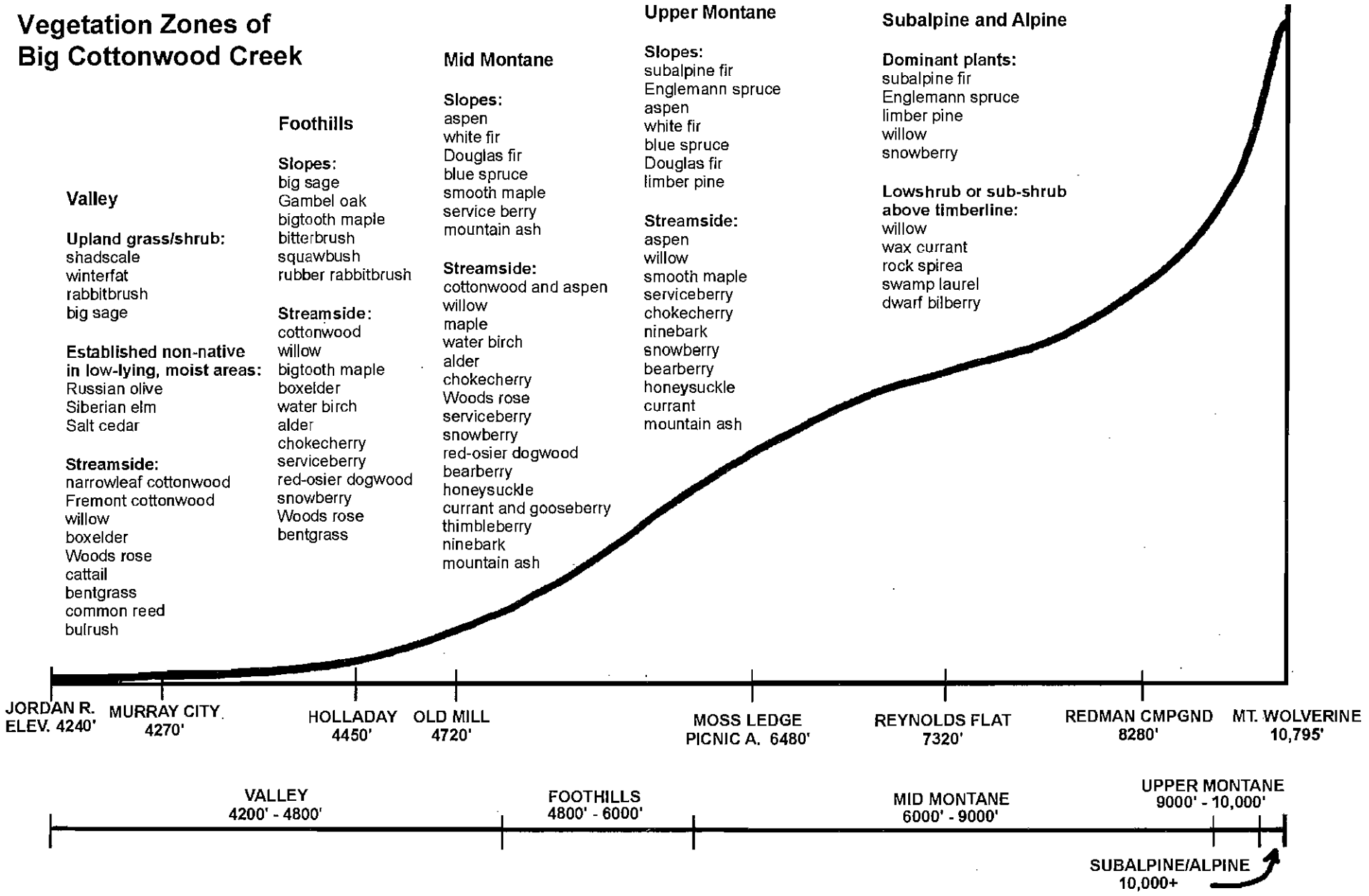


Figure 2. Vegetation zones of Big Cottonwood Creek vary with elevation ranging from desert scrub near the Jordan River to above timberline on Mt. Wolverine. Almost 6000' difference in elevation.

2. Stream Values

What is the Value of Big Cottonwood Creek?

Streams and creeks provide many values to both the natural world and man-made world. They provided early Native Americans with food and water, shelter and tools. Many of the values have been lost or taken for granted by settlers, but those living near Big Cottonwood Creek recognize many others. In the first organizing meeting of the Friends of Big Cottonwood Creek in March 2001, participants were asked to identify the positive values, or things people like about living in a creekside environment (2001, Friends). In order of priority, these positive values are:

1. *Wildlife Habitat:*
   The enjoyment of the fish, mammals and numerous birds of the area.
2. *Serenity and Quiet:*
   Urban noises are replaced by the sounds of the Creek rushing past.
3. *Natural Boundaries:*
   The urban landscape is blocked out by the natural landscape.
4. *Coolness During Summer Months:*
   Shade and evaporation make the hottest times bearable.
5. *Quality of Life:*
   These attributes provide qualities most treasured by urban dwellers.
6. *Protection from Floods:*
   Folks can enjoy the Creek with some piece of mind during floods.
7. *Restricted Access:*
   The riparian zone affords a level of privacy which is rare in the city.
8. *A Sense of Community:*
   A natural community can exist within an urban setting.

What are the Issues of Concern Along the Creek?

Participants were asked to identify those values they want to see conserved or improved in the Big Cottonwood Creek Environment:

1. Year Round Instream Flows
2. Riparian Zone Conservation
3. Water Quality improvement
4. Wildlife Habitat improvement
5. Trash & Litter Removal
6. Trespass Enforcement
7. Improved Aesthetics
8. Limit Dredging
9. Limit Development
10. Increase Pest Control
11. Channel Maintenance
12. Bank Stabilization
13. More Education & Information
14. Irrigation Water Quality
15. Changed Property Boundaries

Opportunities for Improvement

Participants then provided input on what they were willing to do:

1. Help to establish year round instream flows through water rights donation or acquisition through water resource agencies.
2. Support a Friends of Big Cottonwood Creek organization.
3. Help perform habitat assessments and evaluations.
4. Help get support from local government.
5. Gather information.
6. Help implement education or enhancement projects.

Sharpshin Hawk

3. Riparian and Wetland Habitat

Riparian habitat refers areas dominated by plants and trees found along stream banks, lakes or ponds. These areas are usually comprised of "hydrophytic" plants that flourish on or near the water, and are often saturated for part of the growing season. Examples of riparian tree species include cottonwood, willow, and water birch. Important riparian shrubs include dogwood, golden currant, and Wood's rose.

Wetland habitat may include riparian-type trees and shrubs, but is most often associated with cattails, bulrushes, and various types of sedges. Wetlands may be part of a streamside riparian system, and in such cases is classified as a "riverine" or "scrub-shrub" type wetland. Most wetlands that occur near streams, or in close proximity, are classified as "palustrine emergent" wetlands often dominated by grass-sedge plant communities. These areas are also referred to as "marshes" or "swamps."

Wetlands and riparian habitat are not just important for fish and wildlife. They perform many functions and possess values important to society:

Flood Storage

Since these areas are located in depressions near streams, spring snowmelt and stormwater runoff is stored for long periods, diminishing the high velocity flows, and preventing flood damage. Numerous studies over the last 30 years have

shown direct correlation between extensive flood damage and loss of wetlands. In areas that have lost wetlands, local agencies often must resort to the construction of very large and expensive detention ponds to provide the lost flood storage functions of wetlands.

Streambank Anchoring

Riparian and wetland plants have extensive "rhizomatus" root systems that create thick mats within erodible soils. Removal of these plants will often de-stabilize a stream and induce extensive erosion and resulting sedimentation that impairs or modifies stream stability. Big Cottonwood Creek owes much of its stability to large and extensive tree root systems that extend creek-side to hundreds of feet behind the banks, creating unique floodplain forests dominated by cottonwood trees.

Sediment Trapping

Hundreds and thousands of taxpayer dollars are spent on the removal of sediment from streams, mainly to conserve channel capacity for potential future floods. Although sediment plays a critical role in stream habitat & fishery values, excessive sediment can produce wide shifts in channel sinuosity. Sediment also provides an adsorptive media for phosphorus, nitrates, heavy metals, pesticides and herbicides. Root masses of wetland and riparian plants provide zones for sediment trapping, and often use the entrained nutrients for growth.

Pollutant Trapping and Attenuation

Willows, cottonwood trees, cattails, bulrushes and other wetland plants possess unique qualities of uptake and storage of pollutants, including nitrate, phosphorus, and various heavy metals. The rhizomatus root mass of baltic rush (*Juncus balticus*) effectively traps pollutants in the sub-surface zone, while the stems and leaves of water sedge (*Carex aquatilis*) uptake pollutants in the surface zone. The plants utilize phosphorus and nitrates in their growth cycle, then slowly release excess concentrations during autumn decay.

Food Chain Support

Aquatic plants and insects form the principal food web for both aquatic and terrestrial animals. Impairment of the algae and sediment regime in a stream directly impacts fish and water birds, which impacts predators on up the food chain. Wetlands, riparian plant communities, and the water column are the critical base of support for entire families of aquatic and terrestrial animals.

Fishery and Wildlife Habitat

Shade and bank cover are two of the most important functions of riparian trees and shrubs. Water temperature is regulated by shade, and for coldwater trout fisheries, this becomes a critical factor during late summer. Fish also require cover within the stream for resting, feeding, and avoidance of predators. Trees and shrubs harbor insects that ultimately provide feed for fish and birds. "Snags" (standing dead trees, see p. 41) are an absolute necessity in any stream habitat zone, since they provide nesting for important bird species such as woodpeckers and flickers, which help reduce or manage insect infestations. There are a variety of terrestrial animals which are water dependant, including racoons, skunks, otters, mink, weasels, and rodents. Large terrestrial animals such as a moose are famous wetland feeders and dwellers.

Recreation

Finally, riparian and wetland areas provide many forms of recreation, including passive activities such as bird watching and picnicking, to active recreation such as fishing, canoeing, kayaking, biking, and hiking. Shade and cooler temperatures are attributes of the streamside environment, which attracts people and their dwellings.

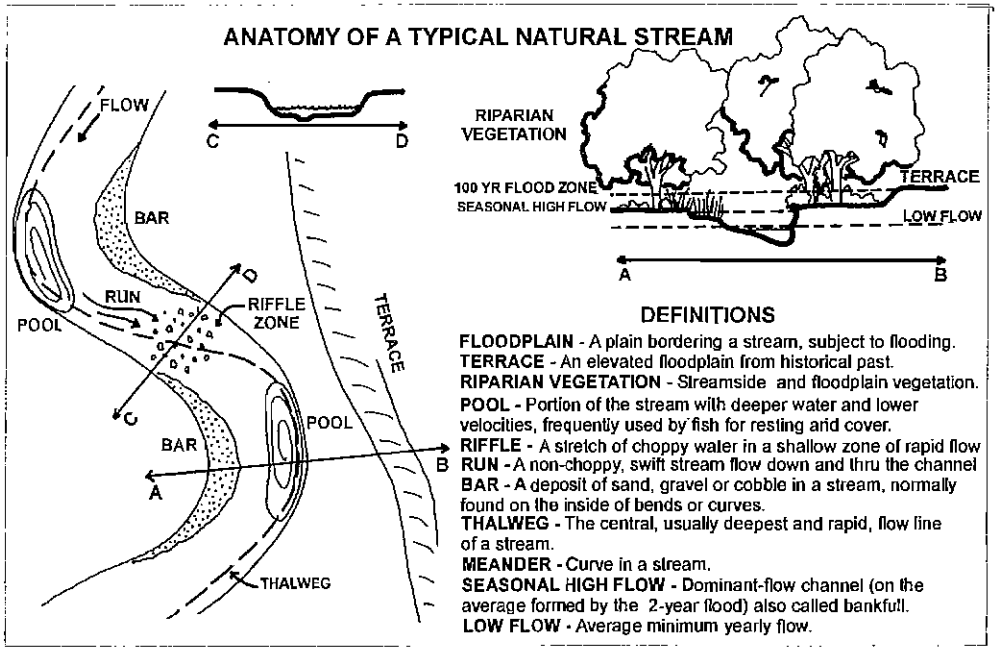


Figure 3. Stream anatomy. *(1998, Riley)*

4. Aquatic Habitat

Fish, aquatic insects and plants are the resident beneficiaries of healthy aquatic habitat. All three organism groups exist in a symbiotic, or interdependent, relationship, where changes in one group will produce changes in one or the other.

Plant Communities

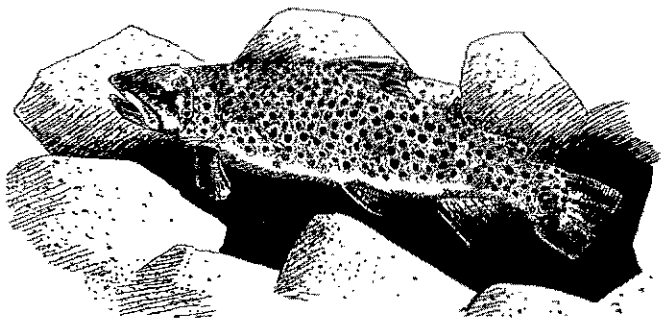
Plant communities change in density and diversity with changes in water quality. For example, increases in nitrogen or phosphorus in the water act as aquatic "fertilizer" and often produces excessive growth creating "eutrophic" conditions that increases plant growth over and above animal growth. If the water is deficient in these nutrients, plant growth is drastically reduced, producing "oligotrophic" conditions. Where nutrients and plant density & diversity are balanced, "mesotrophic" conditions exist.

Aquatic Insect Communities

Aquatic insect communities are dependent on the same physical, chemical, and biological conditions as plants. They thrive on nutrients and fiber contained in aquatic plants. They require a variety of physical substrate (rock, sand and silt) conditions for habitat. They require water chemistry free of toxins, heavy metals and excessive nutrient load.

You Can Help

Residents can directly influence the good health of habitat by properly disposing of organic yard debris (leaves, grass clippings, limbs and garden trimmings) rather than illegally dumping them alongside or in the creek. Natural organic litter is necessary for a healthy stream. However, excess organic material fills in fish habitat and smothers food sources. It also breaks down and depletes oxygen supply. Several other options for debris disposal are available. See page 45 for more information and resources available.



Brown Trout

Fish Communities

Fish rely on aquatic insects and plants as their only source of food. Changes in physical conditions favoring plants or insects directly changes food availability and feeding habits for fish. Changes in water chemistry directly impacts fish health, causing chronic diseases, acute contamination, or reproduction failure. Excessive sedimentation can make spawning success impossible. Modification of habitat for resting, feeding, breeding and cover elimninates the fishery altogether until the stream can naturally re-establish that habitat.

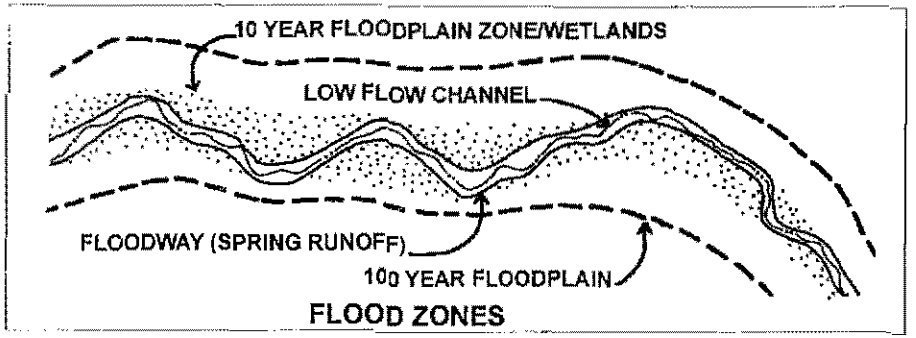


Figure 4. Flood zone definitions.

5. Flood Plain

Streams are created by natural cycles of snowmelt and storm runoff, and provide conveyance of water throughout the watershed area to lakes or oceans. A floodway is created by constant spring floods which raise the water surface enough to scour and create a channel, which normally contains and conveys flood water safely. Sometimes this channel capacity is exceeded by abnormally high spring or storm runoff, and the water spills into adjacent lands called floodplains. The Federal Emergency Management Agency (FEMA) and local jurisdictions develop maps for the public to determine location of the floodplain relative to private lands. In many instances, wetlands adjacent to the stream provide the floodplain function, and effectively store flood water until the floods recede.

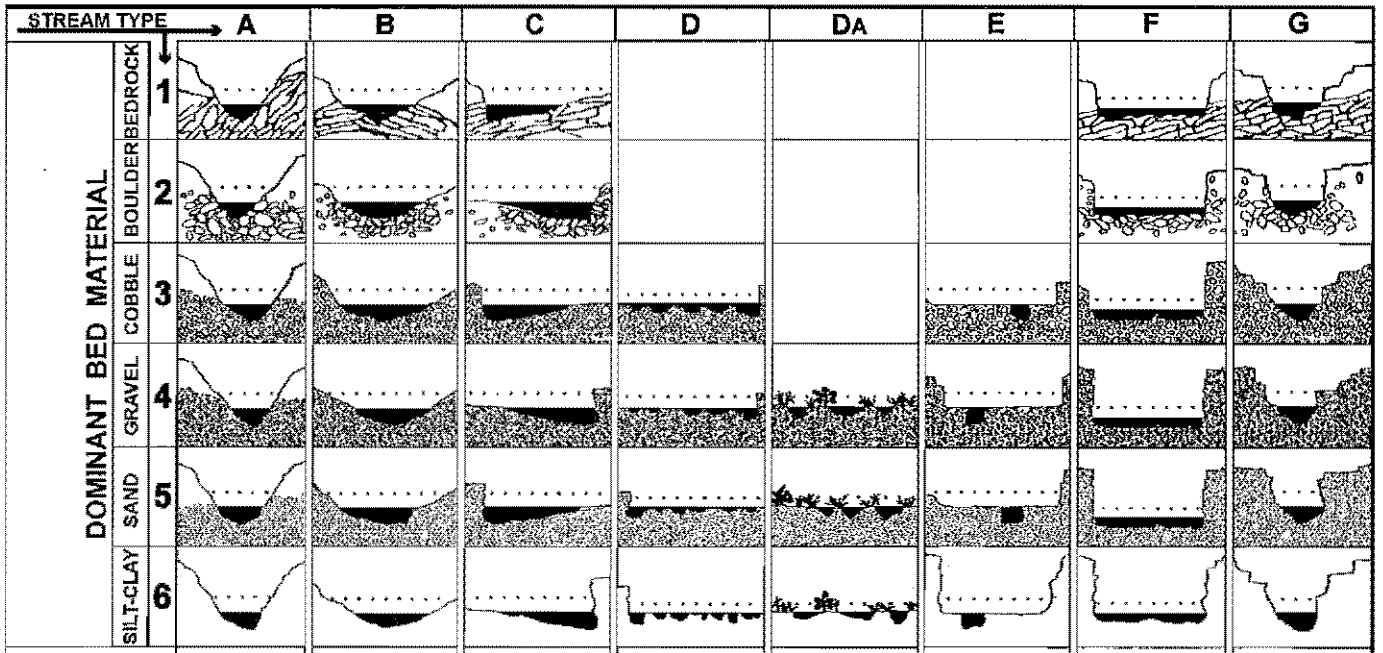
Flood storage provided by wetlands or floodplains is an important facet of the stream system. Without flood storage, damage to downstream homes, businesses or other facilities will be more severe. The devastating flood damage along the Missouri River in the late 90's was determined to be directly related to the loss of wetlands and floodplain areas to development. Failure to recognize and conserve floodplain zones will ultimately result in higher flood damages and tax dollars to compensate and maintain conflicting land uses in flood-prone areas.

6. Hydrogeomorphology

This rather big word simply means the geological study of the configuration and evolution of land forms by water. In the past, the function and dynamics of streams were studied independent of the interface between water and geology, with upstream watershed conditions largely ignored. Recent developments in water resource planning require that stream problems and solutions be identified on a watershed scale, taking into consideration historic conditions and the upstream/downstream effects of proposed actions. This approach emphasizes how sediment is entrained into a stream and how scouring and deposition interact with various flow regimes. Modification of historic stream channels will undoubtedly change the way a stream reacts to increased flows, sediment deposition, and scouring. Flood protection, flood control maintenance, and bank stabilization are rapidly drawn into focus when these factors are considered, because such public policies will be directly affected.

The beneficial uses of the stream will be affected as well, since Big Cottonwood Creek is protected for fishery and passive recreational uses. In order to restore the beneficial uses which may have been impaired from past land use or other policies, the limitations of the stream based on watershed conditions and geomorphology must be understood. To help evaluate these conditions, a stream classification system was developed (Rosgen, 1996):

PRIMARY CRITERIA FOR MAJOR STREAM TYPES

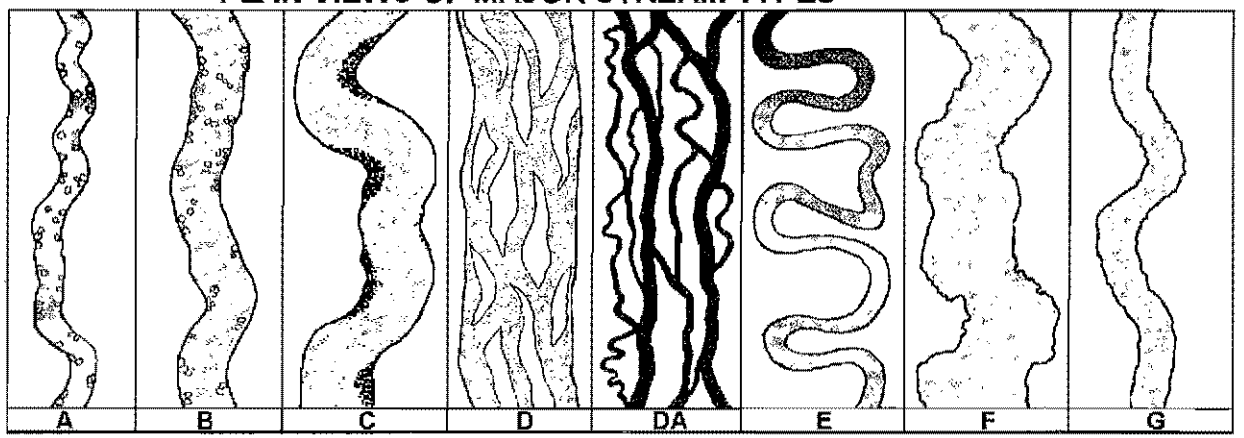


STREAM TYPE	A	B	C	D	DA	E	F	G
Entrenchment	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
Width/Depth Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	>1.5	> 1.2	>1.2
Slope	.04-.099	.02-.039	< .02	< .04	< .005	< .02	< .02	.02-.039

NOTE: < = less than

(1996, Rosgen 5-5)

PLAN VIEWS OF MAJOR STREAM TYPES



(1994, ROSGEN)

Figure 5 Hydrogeomorphology criteria for Major Stream types.

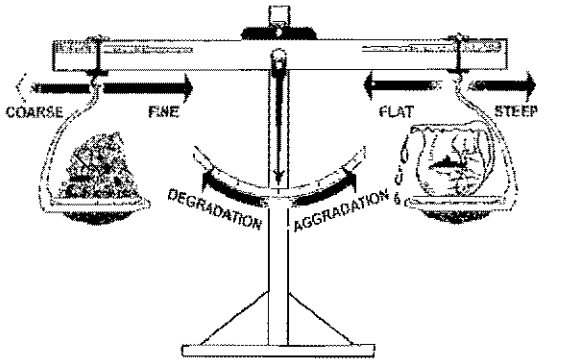
The Geomorphic History of Big Cottonwood Creek

Big Cottonwood Canyon was heavily glaciated 10,000 years ago. The canyon is still relatively steep except in the upper basin where the glaciers were deeper and scoured it wider. The upper basin would be classified as a "B-2" or "B-3" stream type according to the chart on the previous page. The steeper lower canyon basin displays more "A-2" or "A-3" traits.

However, as the Creek entered Salt Lake Valley, the gradient was lower and had a wide flood plain. Now, developing urban land use constricts the channel with resulting down-cutting or "incisement" creating "G" type channels. Because of these factors, it is difficult–if not impossible–to restore the historic channel width and depth, and limits the choice of techniques for bank stabilization.

Entrenchment: At the end of the glacial period, Big Cottonwood Creek cut down through 80-100 feet of glacial outwash or alluvium as it entered Salt Lake Valley. The Creek deposited these huge volumes of sediment downstream, creating a meandering network of braided channels prone to frequent flooding. As urban land use replaced these floodplains, the channel became constricted, or entrenched, as the force of the water scoured the remaining sediment deposition.

Width and Depth: The width of the channel, constricted from its historic condition, has gradually responded by scouring, or down-cutting the creek bottom. This increased bank erosion to the extent that deposition in the stream increased flood hazard (by reducing channel capacity) and decreased fishery habitat (by reducing reproduction). Without the wider floodplain available to store sediment, the storage of sediment in the narrow channel has been limited to the extent that it must now be removed to prevent flooding. The removal of sediment limits the pools and riffle development necessary for high quality fish habitat.



(SEDIMENT LOAD) X (SEDIMENT SIZE) ∝ (STREAM SLOPE) X (STREAM DISCHARGE)

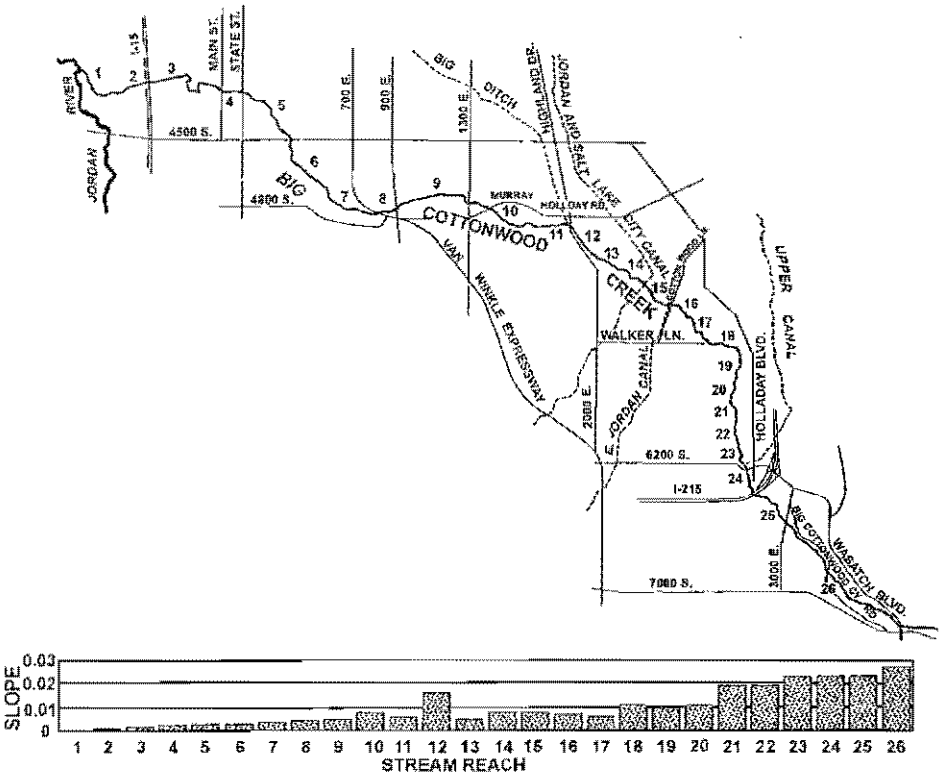


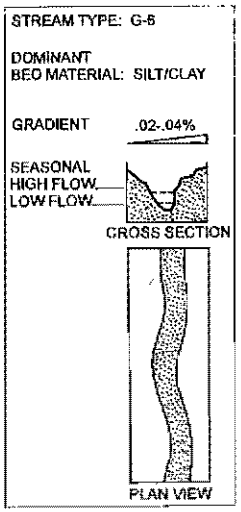
Figure 6. Streambed gradient by Valley stream reach (1994 Revised, FEMA).

Sinuosity: The historic meandering nature of the Big Cottonwood Creek channel has been straightened to facilitate more rapid water passage and reduce potential flooding. Meanders and their attendant wetlands and flood benches served to store flood water at one time, but storage is now limited to the channel. Meanders were also considered to be undesirable or negative features because of their tendency to erode and be a nuisance to the property owner.

Gradient: As the channel became modified by land use incursion and flood prevention, gradients were often artificially increased in one reach, and decreased in another, through the removal or rapid flushing of sediment. Meanwhile, the channel attempts to regain its natural grade through Salt Lake Valley. Changes in available sediment will increase bottom scour in one reach, while depositing in another downstream, ultimately creating more "step-pool" conditions.

The following pages show typical classifications in reaches of Big Cottonwood Creek through the urban landscape of Salt Lake Valley.

Jordan River to State Street



This moderately to steeply incised creek channel is characterized by perennial flow and relatively heavy but narrow riparian vegetation consisting of trees and shrubs, both native and ornamental. This portion of the creek supports both cold and warm water fish species, which readily travel up the channel from the Jordan River to spawn in upstream sand and gravel bottoms. The creek here is slow moving and lacks consistent pools and riffles, and the quality of the water is heavily influenced by backwater conditions from the Jordan River. During widespread flooding events when the Jordan and Big Cottonwood have high flows, this reach is very susceptible to flooding at bridges or other control points where the channel is not as deep.

The adjacent land uses are predominantly commercial and industrial. Illegal discharges and nonpoint pollution source potential is concentrated in this area. Because of the relatively steep banks, flood control maintenance access in this reach is limited. Some deposition of sediment is known to occur, although the slower stream velocities are still high enough to move sediment downstream and into the Jordan River.

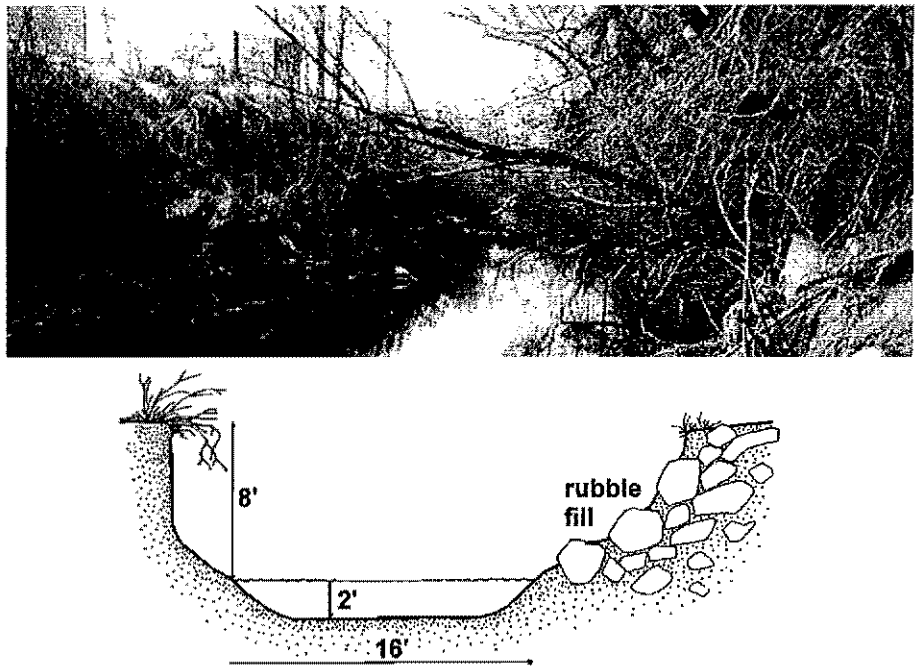


Figure 7. Cross section of Big Cottonwood Creek at 500 West.

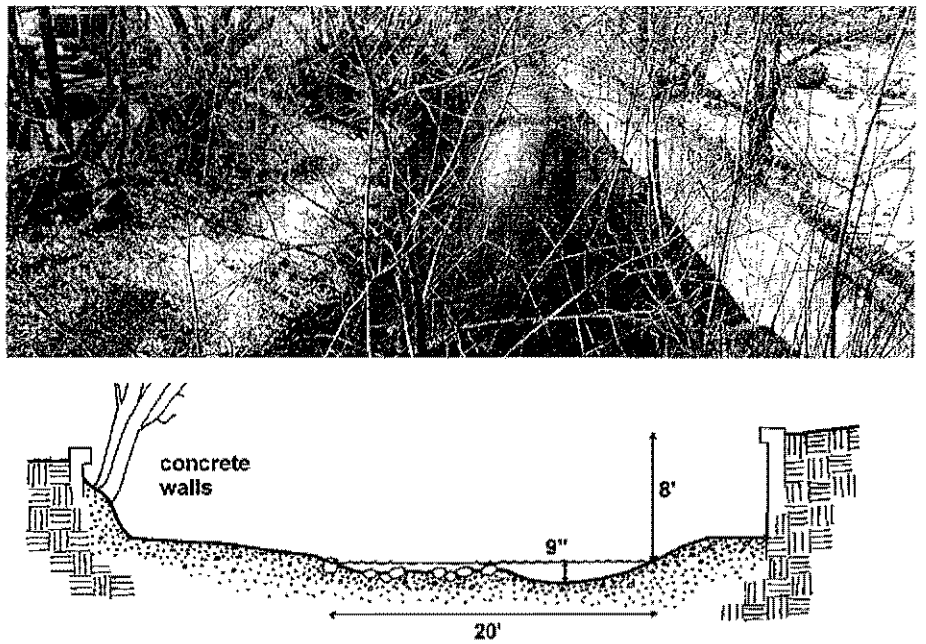
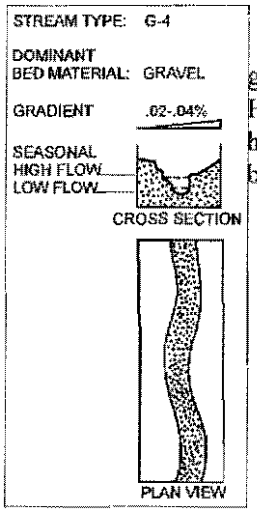


Figure 8. Cross section of Big Cottonwood Creek at State Street.

State Street to 900 East



From 4500 South downstream, the creek has been greatly channelized from past flood control activities. However, large rock toe protection has salvaged much of the habitat providing limited pools, riffles, and resting areas for both fish and ducks.

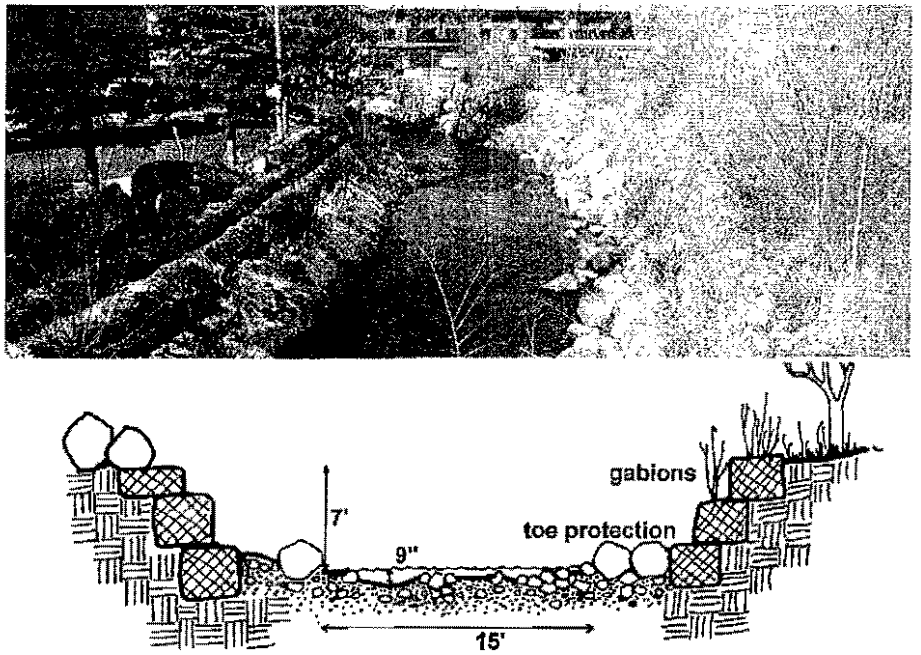
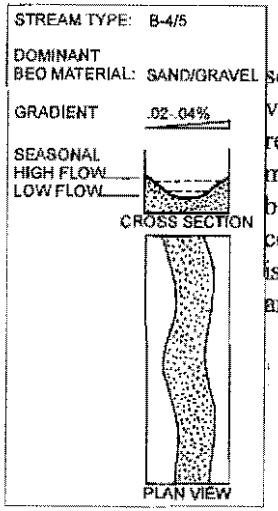


Figure 9. Cross section of Big Cottonwood Creek at 4500 S. and 400 E.



From 4500 South upstream, the creek has been somewhat preserved, and displays broad riparian vegetation buffers next to the single and multi-family residential uses. The wider channel supports low flow meanders and high pool and riffle ratios. Little bank or bed erosion occurs within this reach, and stable bottom conditions are common. Subsequently, fishing in this reach is extraordinarily good, and brown trout between 16-18" are not uncommon.

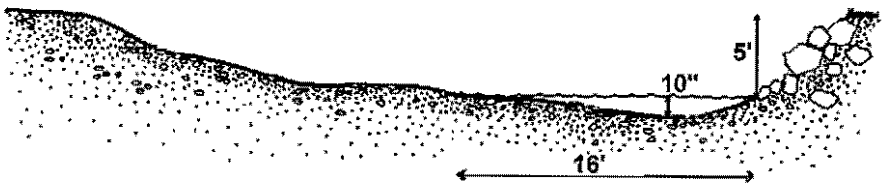
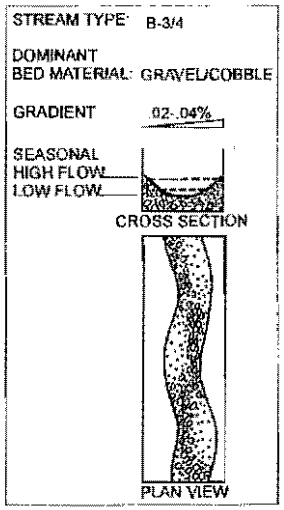


Figure 10. Cross section of Big Cottonwood Creek at 600 East.

900 East to Cottonwood Lane



The channel of Big Cottonwood Creek flowing through the western portions of Holladay has a slightly greater width and is not so deeply incised as its downstream neighbor. The trees and shrubs occupy a wider portion of the upper and lower bank zones, and are dominated mostly by native species. Bottom habitat tends to represent more small cobble-gravel conditions, with more pools and riffles preferred by cold water fish species. A resident, reproducing brown trout fishery was documented in this portion of the Creek in the early 1980's. Spawning takes place just below the Cottonwood Lane bridge crossing, where discharge from the shallow unconfined aquifer sustains a year-round flow of approximately 6-10 cfs.

Land uses are mixed but predominantly residential. Illegal discharges and spills over the last 10 years have resulted in at least three (3) documented fish kills. Some flood control access is used, but more infrequently since construction of the upstream Old Mill Debris Basin.

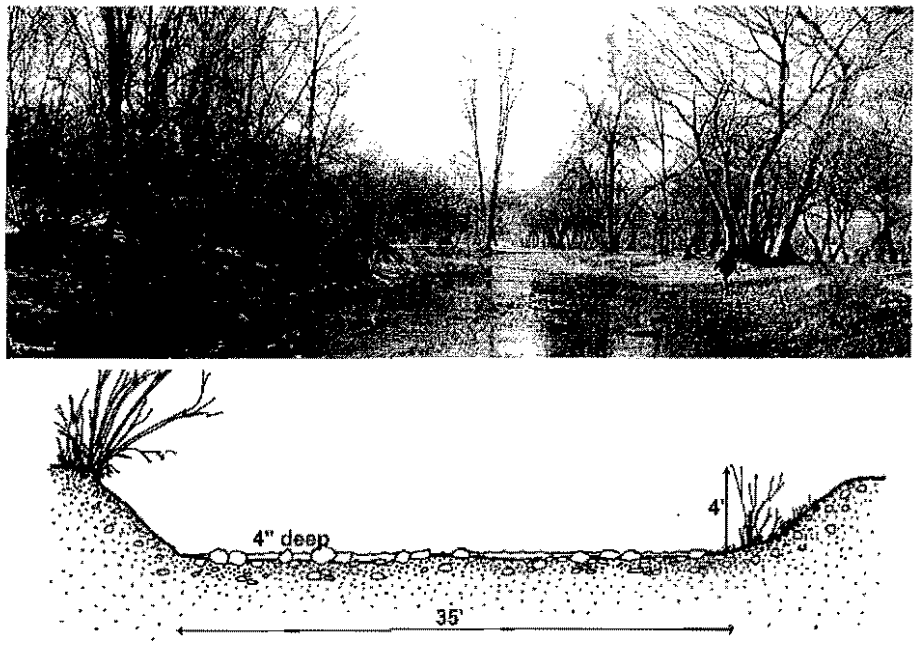


Figure 11. Cross section of Big Cottonwood Creek at Creekside Park (1500 East)

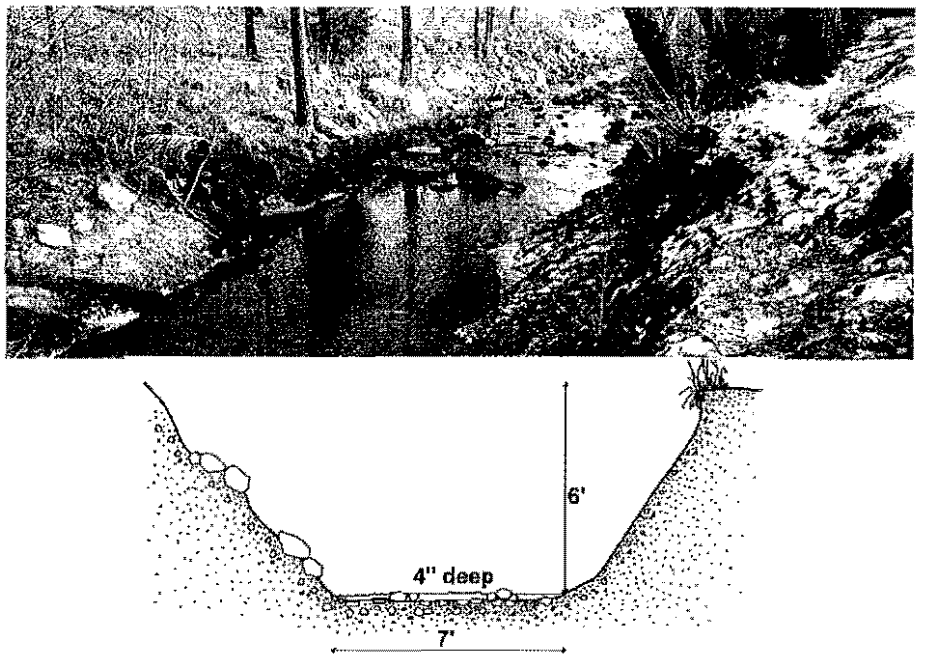
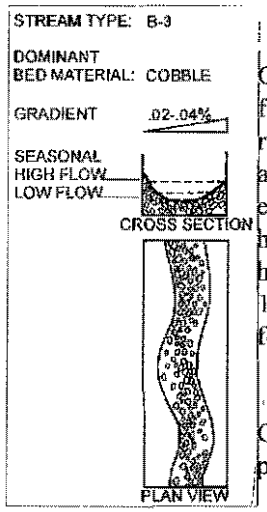


Figure 12. Cross section of Big Cottonwood Creek at Highland Drive (1900 East)

Cottonwood Lane to 6200 South



Groundwater and spring inflow ends at Cottonwood Lane, and upstream is devoid of flow for about 8 months of the year. Spring snowmelt runoff sustains some instream activity for fish and aquatic organisms, but after the spring floods the entire reach is dry. This segment is dominated by high priced single family residential homes, and has been highly channelized and structurally stabilized over the last 17 years. Flood events of 1982-83 were most responsible for the channel stabilization efforts.

Water Rights must be purchased from Salt Lake City or another water purveyor in order to remedy the problem of seasonal de-watering.

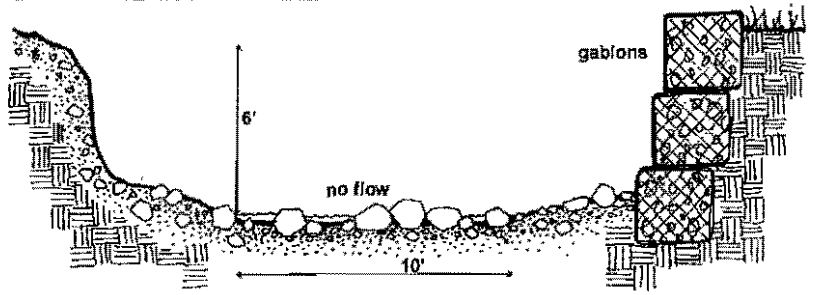
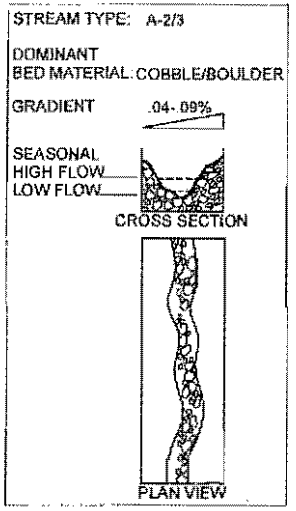


Figure 13. Cross section of Big Cottonwood Creek at Cottonwood Lane

6200 South to Mouth of the Canyon



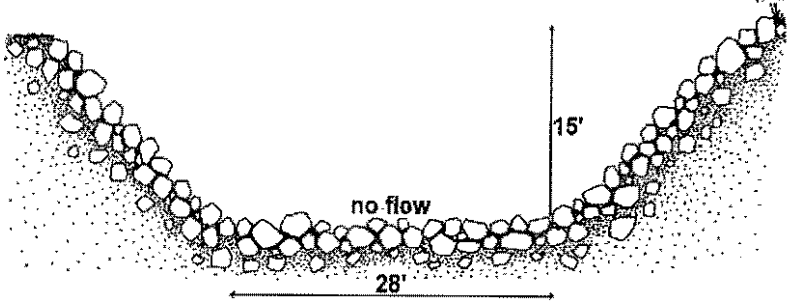


Figure 14. Cross section of Big Cottonwood Creek at Big Cottonwood Canyon Road.

7. Urban Impacts on Streams

Historic De-watering

There are numerous changes to streams in urban settings over a long period of time. The first usually comes in the form of irrigation diversions, where "first in time, first in right" water law philosophy has dewatered many a stream in the American West. Streams are typically called "creeks" where they are first or second order contributors to local rivers, but their role in total river management and function is critical. The Jordan River, for example, doubles in size past its confluence with Little Cottonwood, Big Cottonwood, and Mill Creeks.

Invasive Land Use

The second major change from urbanization comes from land use invasion of the floodplain, floodway, primary, and secondary channels. The width of the creek is usually compromised at first, with supporting calculations that certain spring flood or storm volumes can be "safely" transported within the "new" channel. But the most dramatic compromise is to streamside, or riparian, vegetation. The entire ecology of the stream environment zone is modified with the removal of native shrub and tree canopy, and with it goes the wildlife.

Channelization and Urban Hydrology

The final dramatic change occurs years after these initial invasive actions. The creek begins to down cut, causing bank and bed erosion, which displaces flood carrying capacity from resulting sedimentation. The water flows faster, the volumes grow larger with increased runoff from impermeable urban surfaces, and flooding increases at virtually every constriction, whether natural or man-made. Now, much of the creek has become nothing more than a flood conveyance--cemented, rip-rapped, gabioned, straightened, leveed, and dredged.

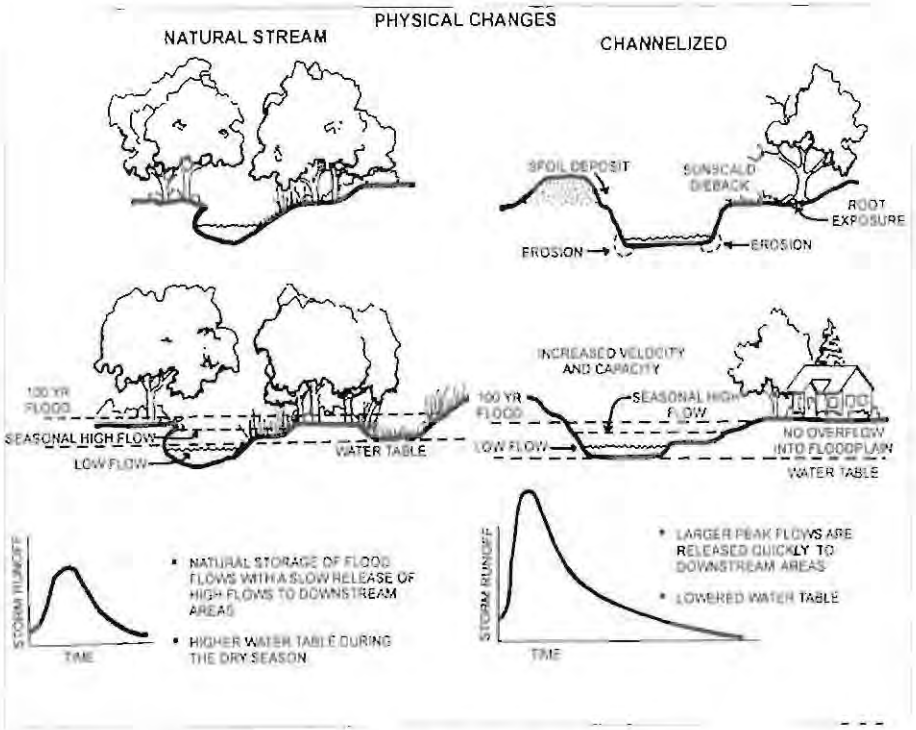


Figure 15. Urban Impacts on streams: Physical Changes. (1998, Riley)

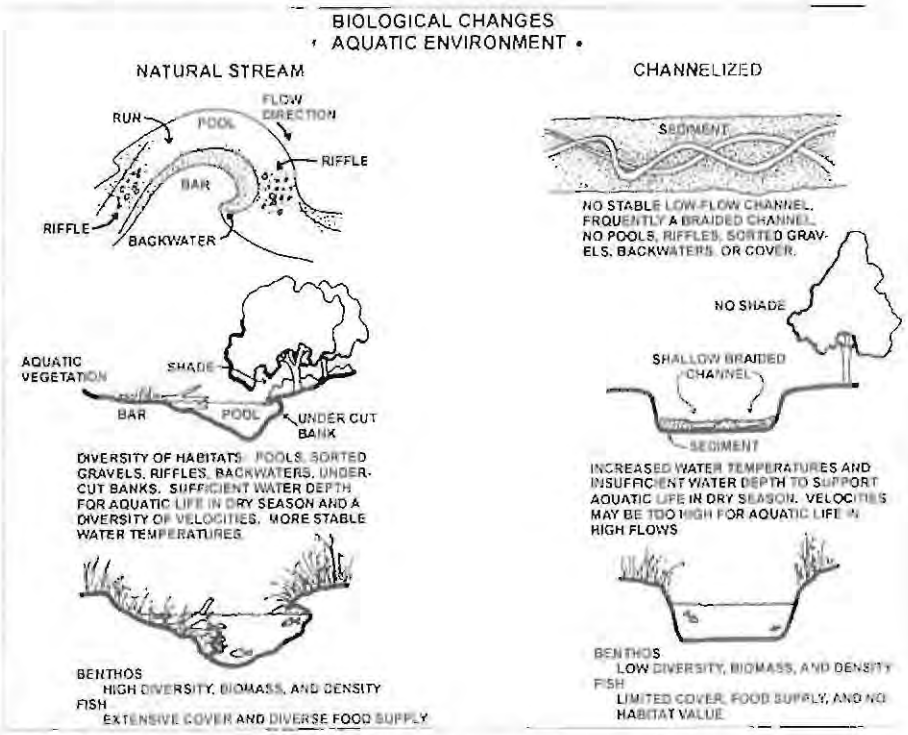


Figure 16. Urban impacts on streams: Biological Changes in the Aquatic Environment. (1998, Riley)

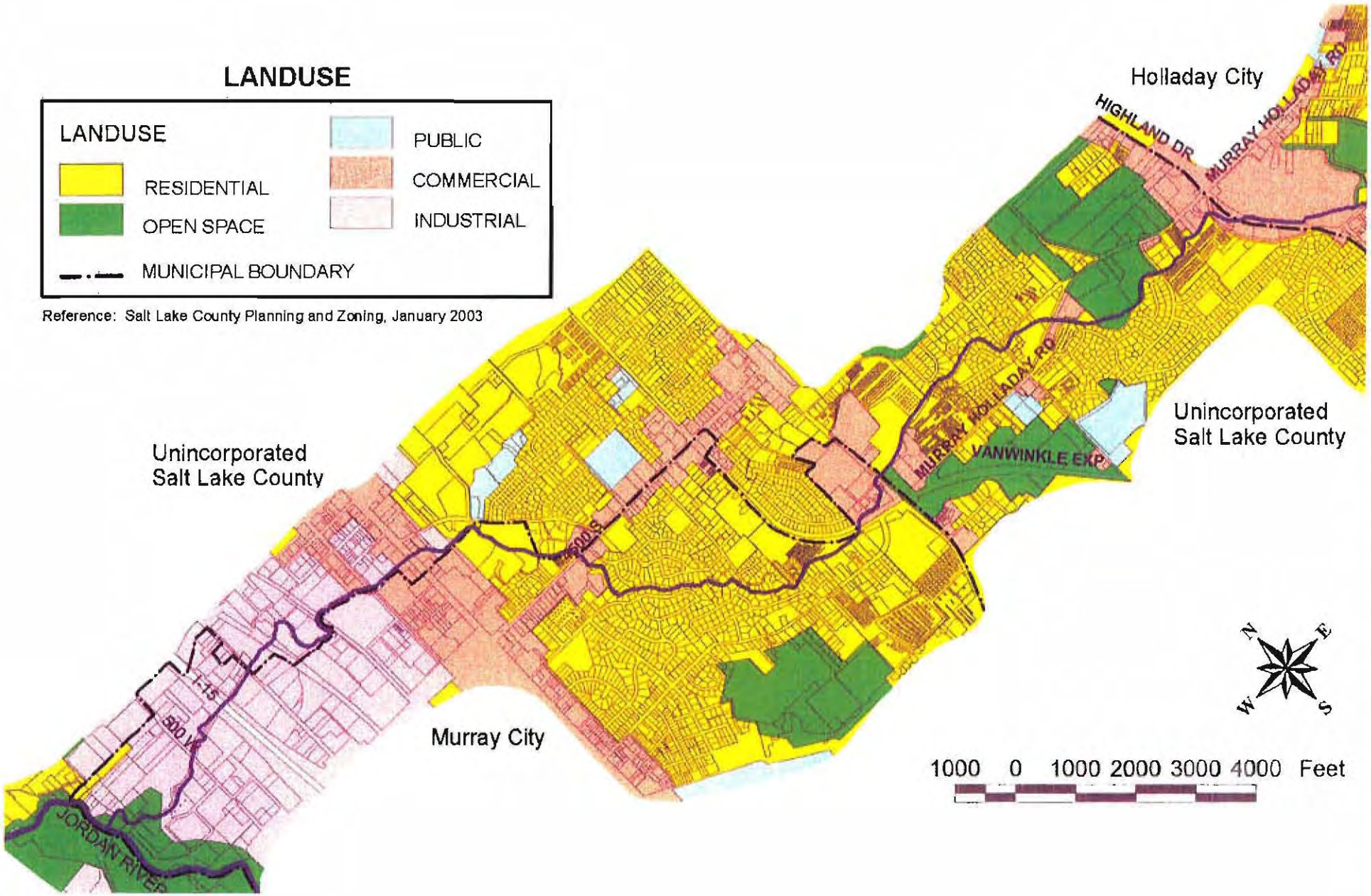
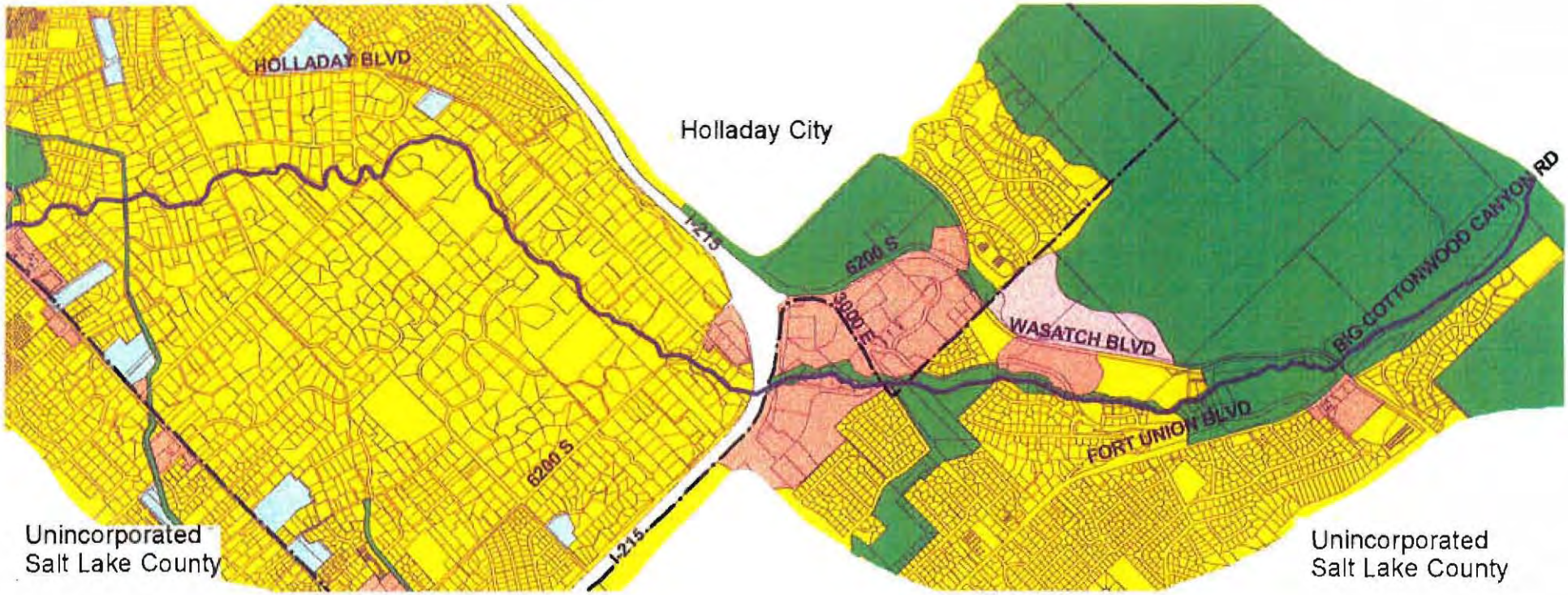


Figure 17. Land Use



Individual Choice and People Pollution

Even though Big Cottonwood Creek is historically incised and impacted by invasive development, it does not pollute itself. The valley segment of the Creek passes through mixed land uses ranging from very intense commercial zones to very serene, isolated residential estates. Near the confluence with the Jordan River, light industrial uses predominate with spotty remains of historic riparian Cottonwood groves. As one travels upstream, public parks are encountered with all of the residual picnic and canine rubbish. Commercial shopping centers and malls can easily be identified by the ever-present shopping cart—if not already sunk and embedded--waiting precipitously on the banks for its ultimate doom.

Storm events bring about even more surprises in the Creek, for all the rubble and debris that has racked up near the catch-basins has finally washed into the pipe and downstream. The morass of floating plastic bottles, aluminum cans, plastic papers, plastic bags, sticks, logs, dolls, stuffed animals, and omni-present cigarette butts gush and rush to the Jordan River in the first flush of the storm.

If this weren't enough, consider the site of dozens of floating trout, doused by a careless dump of plant herbicide or pesticide from the nearest restaurant parking lot by some non-thinking, underpaid employee. Or how about a nice dose of copper cleaning solvent from a newly built copper roof on some upstream million dollar home? And we must not forget the herbicide dumps from canal cleaning operations, which have been responsible for at least two fish kills on Big Cottonwood Creek in the last 10 years.

This is the reality of an urban stream. All of the enhancement or restoration measures combined cannot rid Big Cottonwood Creek of these events. These are people-caused events. People have a choice about what they do and how they do it. Often, people do not think before they act. The ease of tossing yard waste over the fence, dumping oil into a stream-side pit, or disposing of toxic fluids into storm drains is learned behavior that must be un-learned. Streams, creeks, and waterways are special places. They are home to many other animals and organisms that are connected by a web of life which is also connected to ours through perceptions and illuminations of stream-ways. Ultimately, the health and future of the Creek belongs to greater perception and understanding of these values.

As Chief Seattle once said, "The Earth does not belong to us. We belong to the Earth."

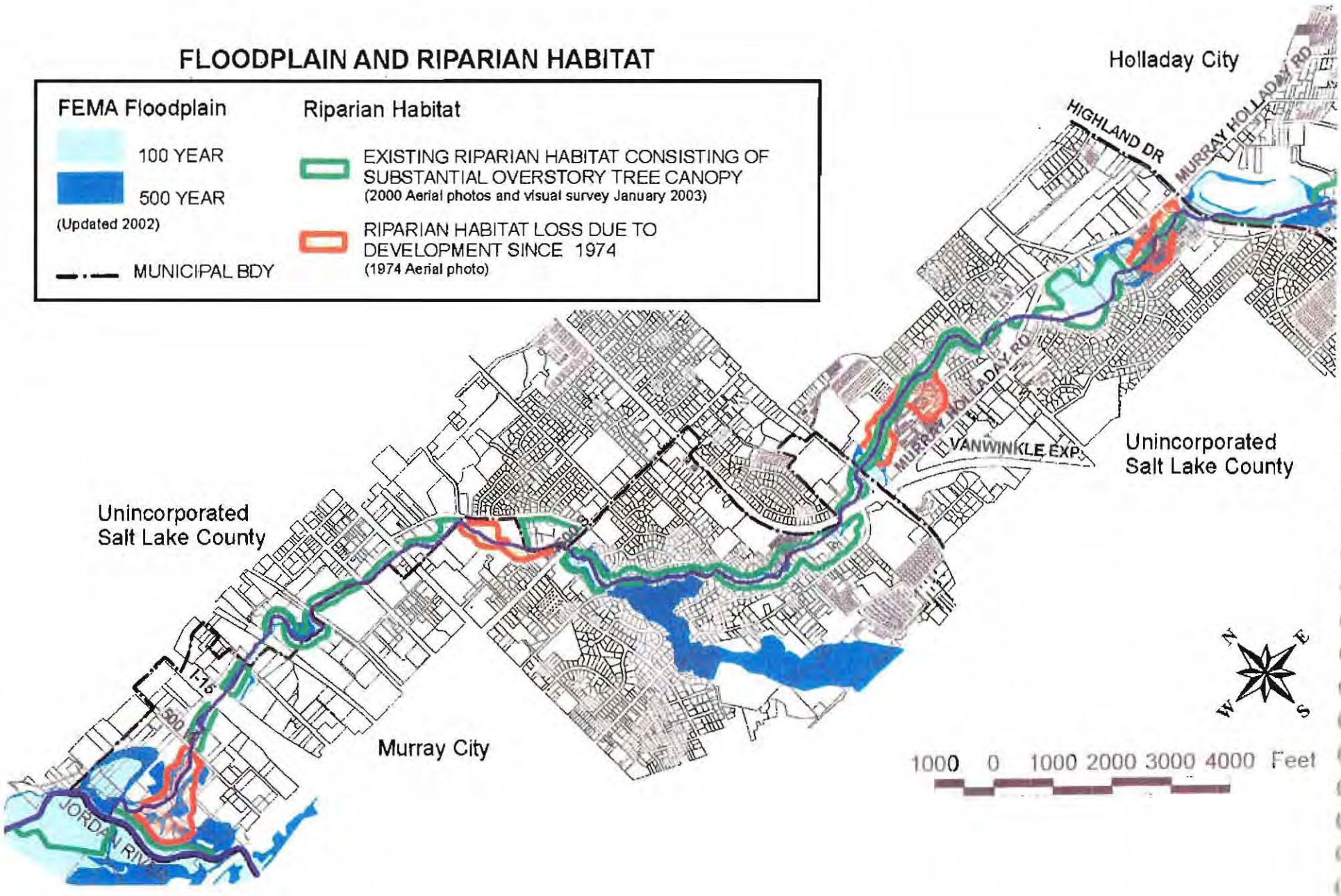
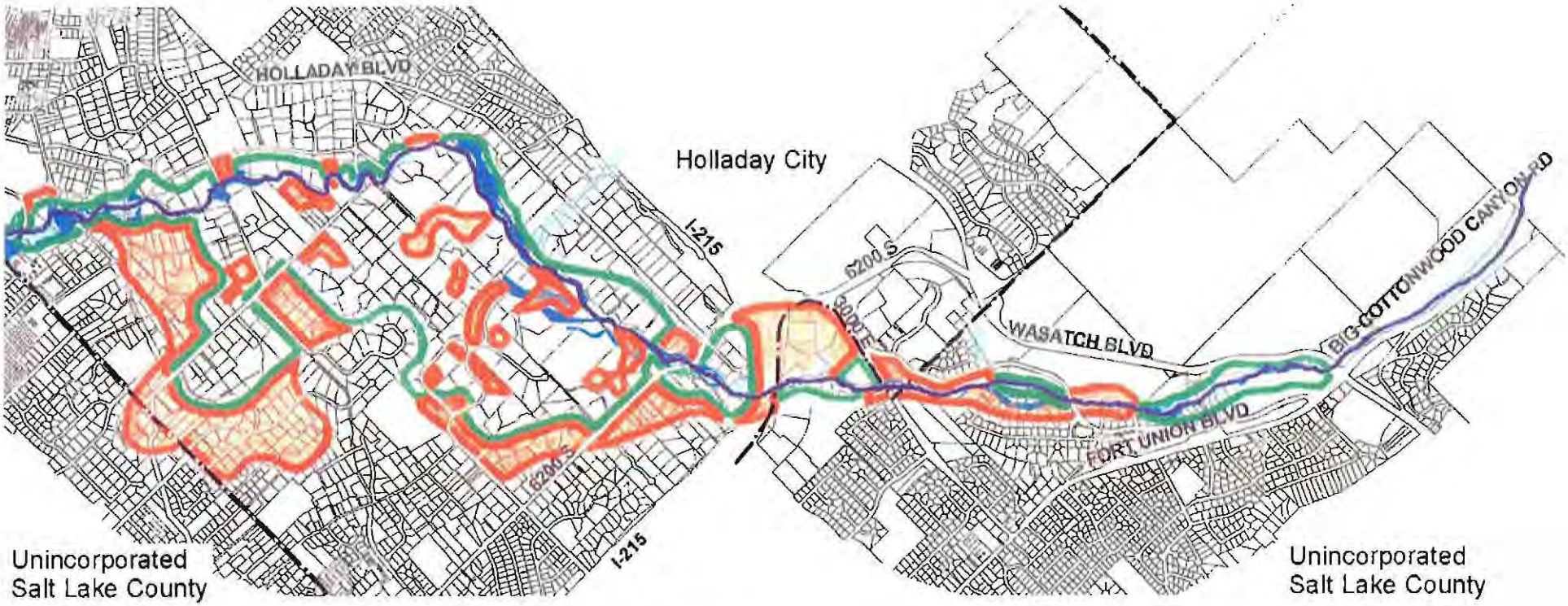


Figure 18. Floodplain and Habitat



Historic Changes of Big Cottonwood Creek Riparian Habitat

Over the last 100 + years, creek channel, groundwater, land use and tree canopy along Big Cottonwood Creek have changed from a dominant cottonwood floodplain ecosystem to a more "refined" urban type ecosystem. The channel of Big Cottonwood Creek has been confined by invasive land use, lot filling, and flood control activities, resulting in creek "down-cutting" or incisement. Groundwater volume and flow has been more or less diverted into sumps and pumped around developed areas, and the incisement of the creek channel has served to further drain high water table conditions. A shift from cottonwood and native riparian species has given way to a mix of invasive non-natives, ornamental trees and shrubs including conifers such as spruce, pine and juniper.

Geologic studies (1992, Personius and Scott) show the area in Holladay City bounded by the Creek on the east and north, 2000 East on the west and 6200 South on the south to be the Big Cottonwood Creek delta dating from the end of the last ice age when melt water washed large amounts of glacier alluvial material from the canyon. As the creek deposited its burden of gravel, cobble and boulders, the creekbed shifted, seeking the lowest course. Each time the Creek shifted, water became available for riparian vegetation to take hold such as cottonwood and willow. The area of the delta shows on the map as roughly the boundary of the riparian habitat in 1974. The location of Big Cottonwood Creek in Holladay is its final resting place in our lifetime. Now, any sediment found in the stream comes from scouring of the banks and downcutting the streambed, not from the canyon (1984, Christenson).

To look at recent changes of riparian habitat, aerial photos from the year 2000 were viewed and visual surveys conducted in early 2003 to determine the approximate extent of current riparian habitat (green). Very little riparian habitat is left below Highland Drive at Cottonwood Mall. In the Holladay area, far from being pristine after 150 years of clearing, diverting water, cultivating and building homes, many valuable characteristics of riparian habitat remain. One characteristic is the connected nature of the large canopy cottonwood, willow and boxelder trees over developed and undeveloped lots. Areas of native shrubs increase habitat value on undeveloped lots. Natural openings and old pastures are part of the habitat mosaic.

Viewing aerial photographs from 1974 shows an approximation of lost habitat along the Creek (orange). In almost thirty years, the riparian habitat has substantially been reduced in the Holladay area, not only the perimeter but the interior as well. Some of the most devastating habitat losses that can be seen are along the creek where the loss of native trees and shrubs along the banks are being replaced with buildings, hard surfaces or groomed lawn. In addition, much of the bank hardening with gabions and floodwalls occurred during the early to mid- 80's high water years.

As development pressure continues and the remaining riparian habitat is at risk, a greater understanding and appreciation of the value of the native vegetation and working with the natural of the Creek can lead to creative solutions for homeowners, developers and landscapers.

Impacts to Fishery and Recreation Values

The long term results of these changes is depletion of both active and passive recreational opportunities normally afforded by the open space, flow regime, and riparian vegetation communities, and impairment of fish reproduction and habitat values. Fisheries, in particular, take the brunt of the urban impact. Physical, chemical and biological changes to the stream channel and its aquatic ecology are drastic, except for those few streams with sustained year round instream flows. Big Cottonwood is a rarity in this regard, since throughout all its urbanization history, it continues to support a reproducing brown trout fishery.

8. Enhancing the Value of the Urban Creek

Although Big Cottonwood Creek has undergone dramatic and severe changes in the last 150 years since settlement, some values can be enhanced and even restored. Total restoration is impossible unless the historic channel can be re-constructed and re-vegetated, which would be cost prohibitive. However, some modifications to the creekside landscape and the creek channel itself can improve riparian habitat, recreation values and replace fishery habitat.

Wilson's Warbler

Native Versus Ornamental Plants

For example, native riparian vegetation can provide more bird and wildlife habitat than typical ornamental species sold at the nursery. Native plants are used successfully in urban landscapes, are adapted to local soils and climates, and typically require less maintenance than ornamentals. As with any plant, research of its requirements is essential. For instance, if you have a high water table or in a potential flood zone, a native plant that likes their "feet wet" is a good selection. Once established, many natives require less watering than non-natives. These are good for the drier areas in your yard but equally important to the overall habitat enhancement. If the use of ornamentals are desired, make sure they are not invasive, and smother or replace healthy riparian species.

Floodway Buffer Zones

Restoring an "emergent bench" stream buffer zone where seasonal inundation can occur will enable the establishment of both wetland and riparian species that possess "rhizomatus" root systems that protect the banks from erosion, mass wasting, and sedimentation. Replacing ornamental trees with wildlife-compatible native trees will help support bird populations on the wane from depletion of global habitat, by providing food and nesting places. And don't forget that birds are predators of insects. Stream zones typically have greater nuisance insect populations that are kept under control by birds.

The Goal: Increase Density and Diversity

Bank stabilization can be done to increase the cover factors important to fishery habitat. Large boulder placement affords cover, temperature control, resting and feeding zones for coldwater fisbes, where gabions provide little or no opportunities for such habitat. Maintenance of pools and riffles sustains large populations of aquatic insects–or "benthic macroinvertebrates"-- which are the principal source of food for most fish. Density and diversity of biological organisms is the goal: the greater the density and diversity of the pool-riffle-run sequence in a stream, the greater the density and diversity of the aquatic organisms which inhabit them, and the greater the density and diversity of fishes supported.

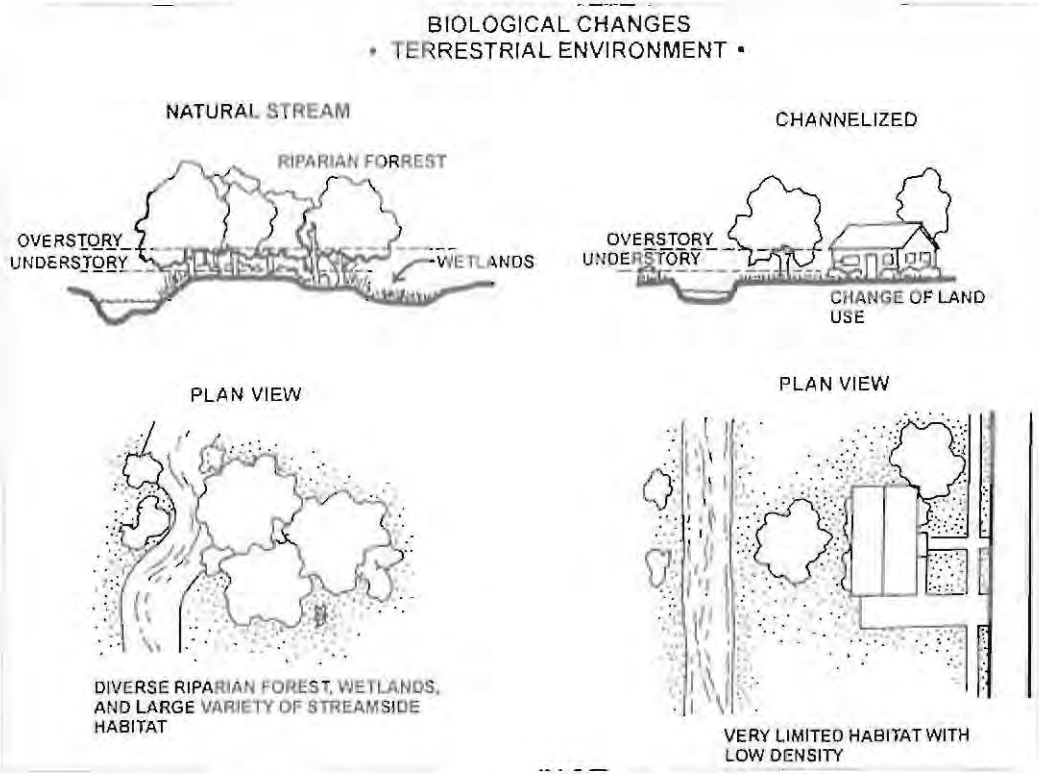


Fig. 19 Urban impacts on streams, Biological Changes in the Terrestrial Environment. (1998, Riley)

C. Water Quality and Quantity

Aside from the classic navigation functions streams performed for commerce, early in the history of developing America, they were used for waste disposal. Pollution was documented from the turn of the century as just another competing use for streams, until early Clean Water Act policy recognized that pollution rendered other stream values useless.

High quality water supply gained more status with passage of the federal Water Quality Policy act in 1972, which set forth a planning process to identify waters of the United States whose beneficial uses had been impaired. Beneficial uses, including **clean water supply, fishery & aquatic habitat, recreation & aesthetics, and irrigation** took the forefront. These uses are now protected under state water quality regulations across the country, consistent with the goals of the federal Clean Water Act provisions, and are enforced by state or local environmental health agencies.

Instream flow for fishery production had not been an issue until large scale western water development began impacting blue ribbon trout streams. Utah recognized the need to provide instream flow for productive streams and rivers with the passage of Instream Flow legislation that allows the Utah Division of Wildlife Resources to purchase water rights for that purpose. Other conservation groups in the western United States, such as The Nature Conservancy or Henry's Fork Foundation, purchase water rights to insure success of aquatic habitat restoration. However, water rights purchase or exchange for instream flow is rare, due mainly to the cost of water for competing municipal supplies.

1. Water Quality Standards

The water quality in Big Cottonwood Creek varies greatly with the seasons.

Late Autumn/Winter/Early Spring is the low flow period, where the Creek is de-watered from Cottonwood Lane upstream to Wasatch Boulevard. The remaining spring flow

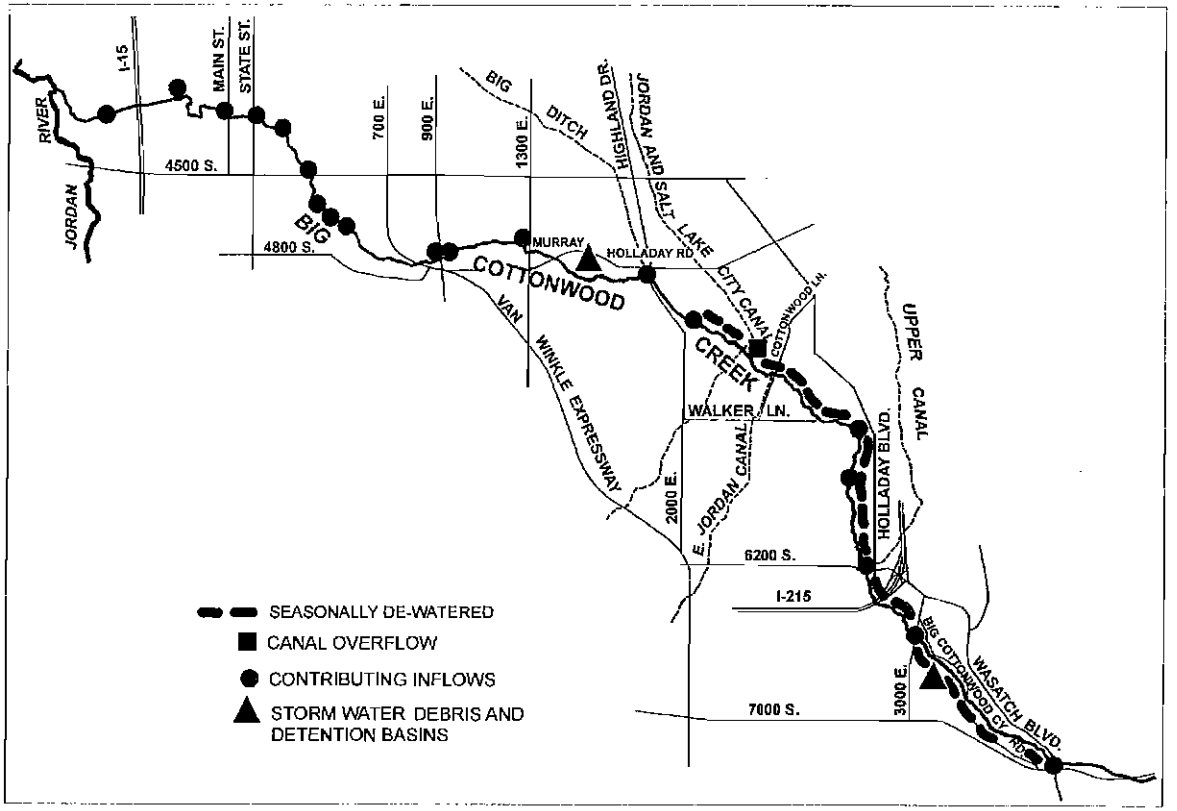


Figure 20. Hydrologic impacts to Valley segment of Big Cottonwood Creek.

during winter is, however, fairly clear high quality-- enough to sustain kingfishers that rely on the sustained, reproducing brown trout fishery.

In April and May, irrigation exchange flows from the Jordan & Salt Lake Canal begin to inflow at Cottonwood Lane, just prior to beginning of spring snow melt runoff. Snow melt flows begin in late April-May and usually peaks in early June. Because of dilution with snow melt, water quality remains high.

By mid-June, spring runoff is concluded, leaving the stream occupied mainly by Utah Lake exchange water, with a smaller proportion of groundwater and canyon inflow. At this time until October, water quality is marginal, but adequate to sustain the fishery. During this period the Creek has been plagued with illegal discharges of herbicide, pesticide, and other careless toxic events. In the last ten years, the Creek has been poisoned and hundreds of fish killed four (4) times. Two of those events were from improper canal herbicide applications; one was from pesticide disposal into a storm drain; one from copper plating disposal directly into the Creek.

TABLE 1. BIG COTTONWOOD CREEK WATER QUALITY STANDARDS* (1996)

Beneficial Use Parameter	Secondary Recreation 2B	Coldwater Fishery 3A	Irrigation 4
Total Coliform Bacteria	1,000 per100 ML	NA	NA
Fecal Coliform Bacteria	200 per 100 ML	NA	NA
pH	6.5- 9.0	6.5-9.0	
Total Dissolved Solids	NA	NA	1,200 MG/L
Total Suspended Solids	90 MG/L	35 MG/L	NA
Biochemical Oxygen Demand	5 MG/L	5 MG/L	NA
Nitrate (N)	4 MG/L	4 MG/L	NA
Phosphorus (P)	.05 MG/L	.05 MG/L	NA
14 Heavy Metals		See Numeric Criteria	
4 Inorganic Parameters		See Numeric Criteria	
11 Organic Parameters		See Numeric Criteria	
Oil & Grease	Visible Sheen	Visible Sheen	

* Standards are met if amounts are at or below the numbers listed in the chart.

2. Illegal Discharges and Spills

Careless dumping and spills in the Creek are not commonplace, but infrequent events are severe and damaging. It is likely that more spills and illegal discharges occur than are reported, because smaller spills usually kill less fish and tend to go unreported. The larger dumps can and have destroyed the entire fishery all the way downstream to the confluence with the Jordan River, and it takes 3-5 years for the fishery to recover. The recovery time is long because downstream recruitment faces blockages and obstacles at some road crossings and at Big Cottonwood's Creekside Park. Upstream recruitment is complicated by the outlet obstacle of the Old Mill Debris Basin, but over time, smaller fish will migrate downstream from Big Cottonwood Canyon.

Despite decades of irrigation & municipal water diversions, seasonal de-watering of about half of the valley stream reach, extensive hydrologic modifications from flood control activities, land use invasion of the habitat, and toxic spills, the brown trout fishery in the Creek still struggles to survive. Education of the public alone is not enough to prevent the trend toward illegal discharges. Enforcement against guilty parties is essential, and the best way to catch perpetrators is through observation and collection of water and fish samples.

Illegal spills and discharges can occur during any season, but the pattern of past events is clearly during summer season low flow. Herbicide applications to canals and landscaping occur between June and August, and have no benefit of dilution by higher spring runoff flows. During this period when the Creek water is green with Utah Lake algae (exchange flows from the Jordan & Salt Lake Canal), pay particular attention to the Creek in both early morning and evenings.

WHAT TO DO IF YOU SEE DEAD FISH OR DETECT PECULIAR ODORS OR COLORS IN THE CREEK:

1. Call the Salt Lake Valley Health Department emergency number: **580-6681** and report conditions.

2. Call the Utah Division of Wildlife Resources Hotline number: **1-800-662-3337** and report conditions.

3. Take a water sample, using a clean quart-sized glass jar with a lid. Dip the jar into the water near the fish, odor, or color, and fill it to the top. Replace the lid tightly and place it in the refrigerator. Tell the Health Department that you have collected a sample and give it to them when they arrive to investigate your complaint. Label the sample with tape, showing date, time and place.

4. Division of Wildlife Resources personnel will collect fish samples for laboratory analysis, but in the case of many toxic pollutants, they dissipate over time. A water sample is crucial to help determine what killed the fish.

5. Report any observations you had of equipment, machinery, or individuals near the Creek or dumping into a storm drain inlet in proximity to the Creek. Get a license number.

SUCH POLLUTION ACTIONS ARE PUNISHABLE UNDER COUNTY, STATE AND FEDERAL LAW, WITH FINES UP TO $ 10,000 PER DAY.

Hi! My name's Droplet and I'm asking you to help me reduce stormwater pollution in Salt Lake County

Please read this information to learn what to do to help! And, visit our website at www.stormwatercoalition.org.

Why is Stormwater Quality Important?

In the Salt Lake Valley, stormwater flows through stormdrains directly to local creeks and rivers with NO TREATMENT.

Stormwater quality can be affected by a number of natural elements including dirt, leaves and grass clippings. Fertilizer over-application, herbicide and pesticide runoff, soap from washing your car, paint, household cleaners, used oil, antifreeze and even the slow oil leak from your car all degrade stormwater quality.

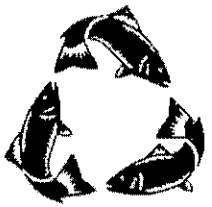
What harm can just one person cause?

One homeowner alone washing one paintbrush in the gutter might not cause significant harm, but if even 5% of the homeowners of the County did, that's about 12,500 paintbrushes!

One pint of oil can produce a one acre slick on a water surface and can contaminate 250,000 gallons of water!

Salt Lake County has developed a Storm Water Management Program to educate local residents and businesses and to improve the quality of storm water runoff. The following are recommended methods of keeping the environment and Big Cottonwood Creek clean.

Fresh concrete and cement-related mortars that wash into streams or lakes is toxic to fish and the aquatic environment. Disposing of these materials to storm drains or streams causes serious problems - and is prohibited by law.



What Can You Do?

❑ **NEVER USE THE GUTTER, STORM DRAIN SYSTEM OR CREEK FOR DISPOSAL OF HOUSEHOLD OR GARDEN WASTE.** Liquid residue from paints, thinners, solvents, glues and cleaning fluids are HAZARDOUS WASTE.

❑ Take unwanted hazardous materials and containers to the household hazardous waste disposal facility. SEE RESOURCE LIST ON PAGE 49.

❑ Take used motor oil and antifreeze to a recycling center or household hazardous waste facility. SEE RESOURCE LIST ON PAGE 49. Do not mix with other materials.

❑ Collect lawn and garden clippings, pruning waste and tree trimmings. Chip if necessary and compost or dispose of properly. Do not use gutter or the Creek for disposal of organic waste. SEE RESOURCE LIST ON PAGE 49 FOR GREEN WASTE DISPOSAL AND RECYCLING.

❑ Apply fertilizers and pesticides according to manufacturers instructions. Do not over apply. Sweep up and apply any excess back onto the area intended.

❑ Remove all pet waste from yard, curb and creekside and dispose of in trash to prevent the spread of bacteria. Flush pet waste down the toilet or bag and put in the trash.

❑ **DO NOT WASH INTO THE STREET!** Do not wash tools and equipment in driveways, gutters, drainageways or creeks. Wash over grassed or soil areas where wash water won't reach street or creek.

❑ Vehicles should be washed at a commercial car wash. Vehicles can be washed on the lawn with biodegradable soap to reduce wash water flows to the storm drain system.

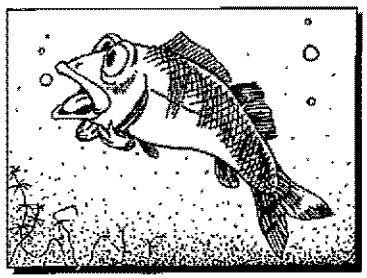
❑ Sweep up dust and paint chips from sanding or stripping and dispose of in trash. Select water based or latex paints whenever possible.

❑ Store toxic products and chemicals indoors or in a shed or storage cabinet.

❑ Do not discharge pool or spa water to a street or storm drain.

❑ Control erosion on your property by planting groundcover and stabilizing erosion prone areas.

3. Strategies for Protecting Flows in Big Cottonwood Creek



Water quality is directly related to water quantity. Therefore, efforts to improve Big Cottonwood Creek's flows should accompany efforts to reduce pollution of the stream. Currently, opportunities to protect or enhance flows in Big Cottonwood Creek are limited. Under Utah water law, only the Division of Wildlife Resources (DWR) and the Division of Parks and Recreation (DPR) can hold a right to keep water flowing in a stream. These agencies can receive water rights by donation and convert them to instream rights or they may purchase water rights for instream purposes, but only with funds specifically appropriated for that purpose by the Legislature. Few instream flow rights have been created under this statute. Nevertheless, those interested in improving Big Cottonwood Creek flows have some options:

- Acquire a consumptive water right in Big Cottonwood Creek and then donate that right to DWR or DPR for conversion to an instream flow right.

- Contact water right holders on Big Cottonwood Creek and encourage them to donate all or a portion of their rights to DWR or DPR for flow enhancement. These water right holders could achieve significant tax advantages from such donations.

- Acquire a water right in Big Cottonwood Creek with a diversion point high on the stream and then file a change application with the State Engineer to move the point of diversion further down the stream. If approved, this change in point of diversion would have the effect of restoring flows, in the amount consumed by the diversion, between the points of the old and new diversions. This approach would require that water still be diverted from the creek and put to a beneficial use.

- Explore opportunities for water right exchanges that would retain natural flows in longer reaches of the stream.

An active effort is underway to broaden Utah's instream flow law to allow political subdivisions of the state and qualified nonprofit organizations to hold instream flow rights. Concerns among water users must be resolved before a bill is formally introduced. If successful, this legislation would open the door for municipalities along Big Cottonwood Creek, or individuals who form a nonprofit organization, to acquire and hold water rights for use in the natural stream channel. If this broader bill does not pass, advocates could seek legislation focused specifically on Big Cottonwood Creek restoration.

II. Big Cottonwood Creek in Your Back Yard

A. Fitting Your Yard into the Picture: Perform a Program and Site Assessment

In order to develop a plan, it's important to "fit" your conditions into the total stream environment. This involves mainly two steps: 1) Determine your overall objectives, and 2) Determine existing conditions on your property.

Step 1. Determine Overall Objectives - Conditions you desire to improve or enhance may include:

Wildlife Habitat What kinds of animals frequent the area or are desirable? If you have an interest in birds, different species require different types of food, cover, habitat, and nesting arrangements. Find out from your local wild bird center about species that frequent the area, or those that can be attracted with certain types of food and cover. Mammals are a different story, because many mammals are considered "nuisances" in an urban setting, such as skunks, racoons, weasels, squirrels and rodents (i.e. rats & mice). Be aware that providing food and habitat for birds can attract potentially undesirable animals, or create conditions that increase the numbers of "pest" mammals or birds. A "pest" is like a "weed," in that both gain the notoriety through increased numbers. Natural selection and predation normally maintain stable animal populations supported by habitat types.

Mammals that call stream corridors home can become dependent on food and habitat that is created for them, so be aware that you may create your own nuisance condition. Squirrels, for example, are generally considered delightful and interesting creatures to have around, unless of course, you are feeding birds. Squirrels are great bird feeder robbers, as are rats and racoons. All are great climbers, and can reach even the most remotely placed feeder. So-called "squirrel-proof" feeders are very simply detached and knocked to the ground by squirrels, creating a ground feast. Another consideration is the interaction between house pets and wild animal neighbors. Rodents, including rats and squirrels, are vectors for diseases like bubonic plague, which is carried by fleas.

It is very important that well-meaning food and habitat improvements not create nuisance conditions requiring attention by wildlife, health or animal control officers. Such attention usually results in sad endings for the animal.

Fish Habitat There is a variety of fish inhabiting Big Cottonwood Creek, both cold and warm water species. Cold water species are dominated by naturally reproducing brown trout, along with rainbow, brook, and cutthroat trout. Brown trout are voracious predators on other trout and warm water fishes. Warm water species include mainly omnivore bottom feeders like carp, sucker, and dace. However, white bass have become more prevalent in the warmer, slower moving sections near the confluence with the Jordan River.

The main consideration for enhancement of instream habitat is year-round flow, which occurs on Big Cottonwood Creek below Cottonwood Lane. Any efforts to enhance habitat above this reach would be wasted. Small scale instream modifications can be made without sacrificing flood capacity or harming fish, and most usually produce a net increase in both population and diversity of fishes.

Flood Protection If you have experienced past flooding, this objective may be paramount. Fortunately, landscape modifications can do a lot to decrease flooding potential and increase protection, such as the use of set-backs or buffers of various types, structural or non-structural. For buildings that invade the flood zone or are directly adjacent to the Creek, there are far fewer options for protection. Erosion control through the use of rocks or gabions will not guarantee the prevention of inundation during overbank flood conditions.

Flood insurance should be considered, and is available at relatively low cost. Federal flood insurance can be acquired for most structures, but the level of coverage is limited in sub-grade improvements. If older structures or improvements are next to the Creek, consideration should be given to removal and replacement elsewhere on the site, away from potential water damage.

Visual Screening Vegetation is the most appropriate visual screen along the Creek, since it will not require replacement after flood events and is most durable during flood events.

Yard Enhancement and Beautification It is important to be aware of what kinds of shrubs and trees are predominant in the area. Cottonwood trees, for

example, are considered "weedy, noxious, nuisance" species by some. The fact is that they are native, dominant plants naturally selected for the local environment and ecology they inhabit. They are essential to the dozens of bird and animals that rely on them in riparian corridors. High water table, flooding frequency, wet soil, and other conditions of riparian wetland areas favor these plant types that are not tolerated by others.

Certain backyard uses may be restricted by the natural environment. The Creek environment and ecology is unique and generally not well suited to high maintenance features like swimming pools, over-stream decks, or in-fill. Use common sense about the type of backyard environment you desire, and keep in mind the natural impacts and limitations you will encounter living next to a stream that can swell to 900-1,000 cubic feet per second!

Step 2. Identify Existing Conditions - Photograph, observe, and collect information on:

The Type of Channel: Use the geomorphic cross sections and plan views to determine stream type.

County Maintenance and Frequency: Where and how often does the County perform flood control maintenance in the Creek? What operations or activities do they conduct? How can this affect your plans or improvements? Will your improvements impede or harm flood channel capacity?

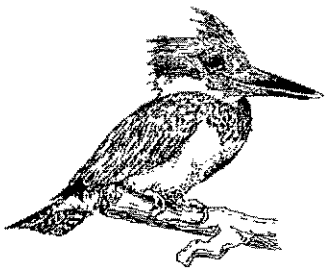
Upstream and Downstream Features That Affect You: Any structures, such as bridges, can increase flow velocity downstream, or decrease it upstream. Is the channel constricted by trees, boulders, concrete slabs, gabions, flood walls? Does the channel fill up with sediment, or is the sediment carried through? Is there a stormwater outfall or drainage outlet? Are there stairs or ramps? What does your neighbor do or not do?

Historical Flood Events: If you have lived near Big Cottonwood for many years, you likely experienced the flood events of 1982-83. Smaller events occurred in 1992. Some damage to property was sustained in certain parts of the Creek, while other properties were affected little or none. Are there changes you want to make for future protection? How can changes in your landscape help protect the property and reduce potential damage?

Natural Features of Your Stream Segment: Be sure to identify the following conditions:

1. Are you located on a bend or straight reach?
2. Are you located on the inside or outside of the bend?
3. What is the flow rate of the Creek? Fast moving or slow?
4. What is the elevation at your location?
5. What is the gradient of the stream at your location?
6. What is the size and composition of the stream bed materials?
7. Is the bank stable, or eroding to some degree? Is the erosion washing away your property?
8. Are there springs or seeps in the bank or discharging from your property?
9. What are the favorable/nuisance seasonal wildlife inhabitants or visitors?

In the sample creekside property in figure 21, several objectives have been set and existing conditions recorded by the three homeowners. Homeowner A simply wants to improve the aesthetics of a gabion, a wire and rock structure, previously installed for bank stabilization. Homeowner B and C need to stabilize their portion of the creek bank. Homeowner B also has a filled in floodplain that could potentially erode if not removed or stabilized in some way. Homeowner B wants to remove as much lawn as possible to reduce maintenance, create a 'wildlife sanctuary' with native riparian plants and block the view of the neighbor across the creek to create a more private space. Homeowner C wants to include a more formal look to their entrance but still have the benefit of low maintenance and wildlife habitat. The objectives of bank stabilization, increasing wildlife habitat, screening views, and reducing yard maintenance are all compatible and versatile.



The Belted Kingfisher
(Megaceriye alcyon)

The resident Kingfisher epitomizes dependence on the Creek for survival. These unique birds rely on catching small trout for their livlihood, not just for recreation. The Kingfisher nests in burrows 3-7 ft. in length, excavated into upper stream banks (using its bill and feet,it may take 3 weeks to excavate). They sometimes nest in tops of hollow stumps or cavities of trees. Protected by Federal Law, they are often found near water, perched above pools, awaiting a fish to dive for and devour, before flying off down the channel (only a few feet above the water) with a loud, boisterous rattling call.

Known in Greek antiquity as the "Halcyon", a fabled bird supposed to have the power to calm the wind and waves of the of the winter solstice while it nested on the sea. Thus, Halcyon Days, are those days of fine weather 7 days before and 7 days after the winter solstice, attributed by legend to the magical powers of the Halcyon. Denotes Peace and Tranquility.

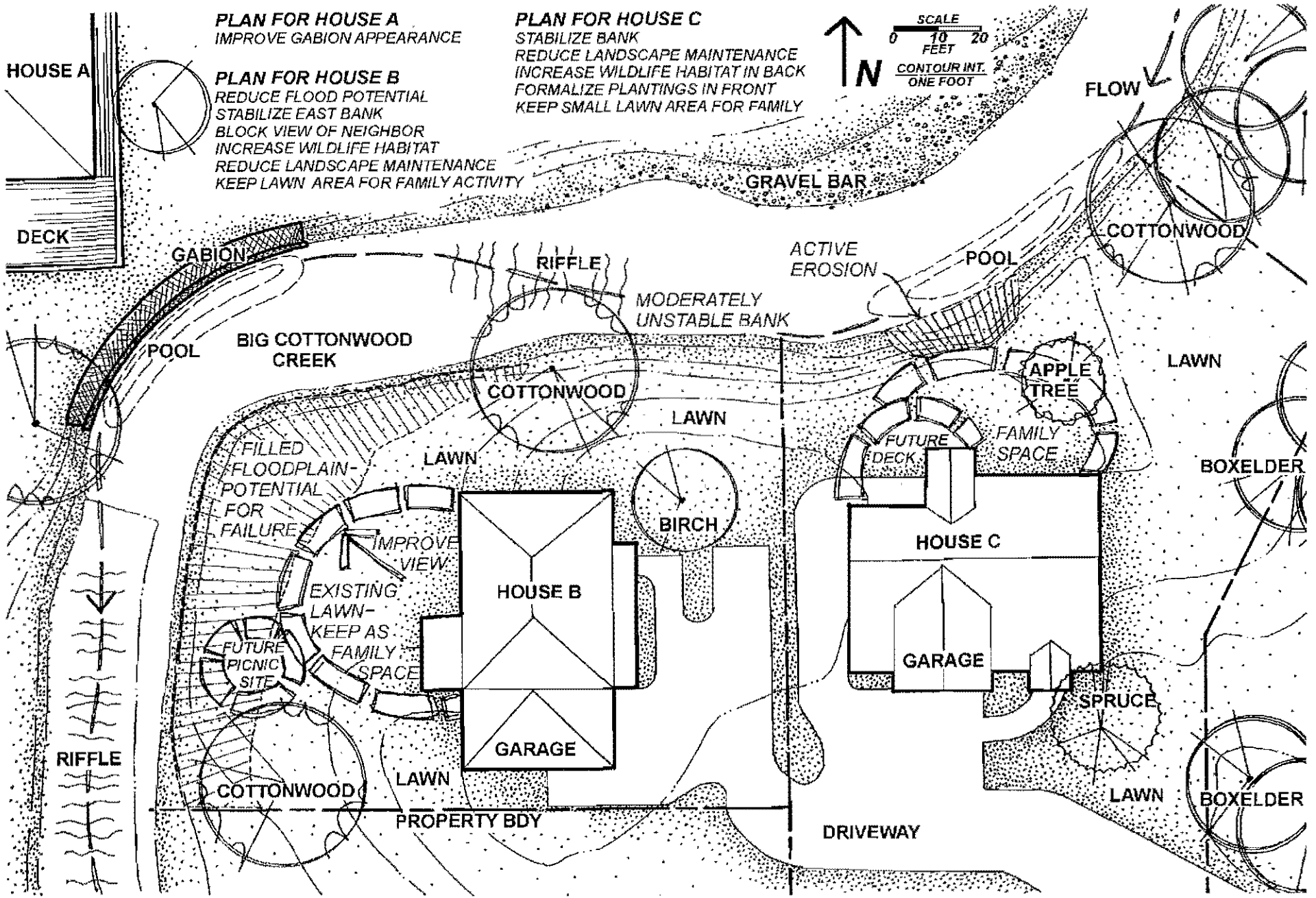


Figure 21. Sample creekside property: Site Assessment

B. Developing Your Plan

Once your overall objectives are clear and you've collected as much information as possible on conditions that affect your plan, you can begin formulating a site plan with specific applications and locations. Ideas about types of instream modifications, bank stabilization methods, flood protection, and wildlife habitat are included in this section. Resources available for more information are listed in the last section of this book.

1. General Planning Guidelines

The following are key considerations in this example of planning. The page numbers are where you can find more information in this book.

Bank Protection and Stabilization (p. 29 and 34-38)
-Solution compatible with up and downstream conditions
-Cost effective/not under or overbuilt
-All plans approved and all necessary permits acquired
Instream Structures/Aquatic Habitat Enhancement (p 29-33)
-Improvements only in reaches with year-round flows.
-Same considerations as bank protection listed above.
Stream Access (p. 44)
-Place rock steps where high traffic volume and erodibility are a concern.
Floodplain (p.39)
-Place flood protection walls or sandbags away from the creek.
-Do not build any structure in the floodplain or over the creek.
-Create or restore a floodplain bench to reduce flood velocities and damage
Enhancing the Appearance of Gabions (p. 43)
Riparian Wildlife Habitat (p. 40-42)
-Include a structure of under-, middle-, and overstory plantings.
-Use native riparian plants whenever possible.
-Use diverse plants to provide habitat for a variety of wildlife species and uses
Reduce Maintenance and Water Use
-Reduce the amount of lawn to what is necessary for your family.
-Select a turf grass with low water and mowing requirements.
-Once established, wild meadows with perennial grasses and flowers need minimal maintenance.
-Where regular watering of plants is necessary, use water-wise drip systems.

For our example creekside property, a master plan is shown on p. 28. Homeowner A chose two types of low growing evergreens to cover the gabion.

Homeowners B and C decided to work on a common solution to stabilize the creek bank. They understand that separate and incompatible solutions may create more problems in the future. They decided on creating narrow terraces, placing rock toe protection and heavy planting to stabilize the soil. To reduce the impact of stream flows on the newly stabilized bank, an instream j-hook vane structure was designed and installed. Homeowner B also designed and installed a w-weir to create and maintain a riffle and pool condition downstream for fish habitat.

Homeowner B removed the floodplain fill down to the native soil and planted with native riparian species. Both homeowners chose to include trees, shrubs, and groundcovers good for wildlife and compatible with soils and the high water table, particularly along the creek banks. Both homeowners have reduced turf lawn and are using a drip watering system to establish new plantings. Homeowner C landscaped the front area of the house with ornamentals with low water requirements and installed a drip watering system.

Section A showing re-established floodplain and habitat plantings

Section B showing stabilized bank and habitat plantings.

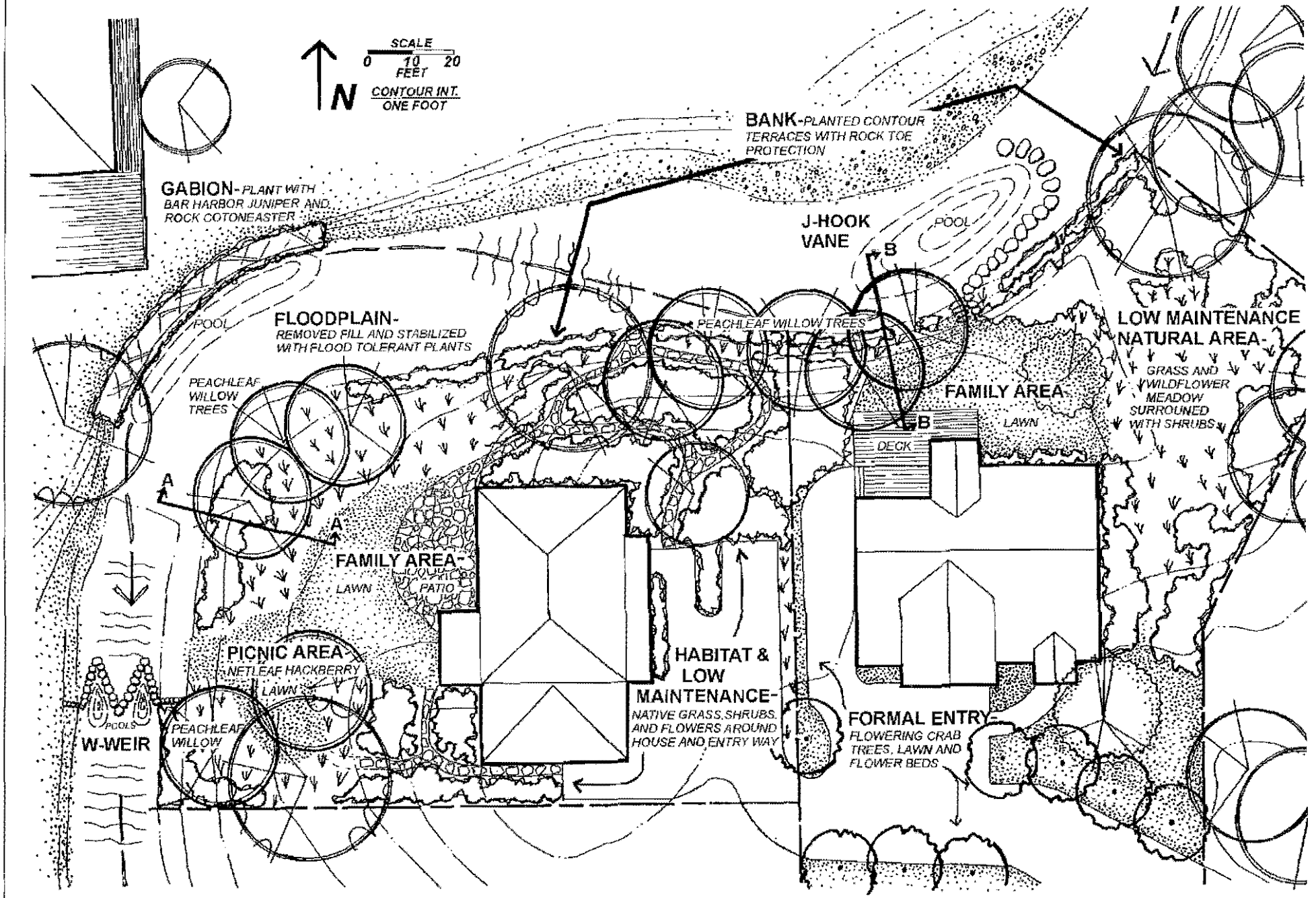


Figure 22. Sample creekside property: Master Plan

2. Stream Applications

Performing landscape-type work on your property normally does not require much technical or regulatory attention, but when working on or adjacent to natural streams, be aware that your work may require a level of technical planning, review, and even permitting, for which you are not prepared.

All instream applications, and most bank applications, will likely require permits from Salt Lake County and the State of Utah Division of Water Rights (Stream Alteration Permit). Larger projects may even require a permit from the U.S. Army Corps of Engineers (usually in excess of 500 linear feet). Permits aside, it is important to insure that your work is designed properly and conforms to basic hydraulic standards. Salt Lake County Engineering Division can provide you with this technical information and expertise. A private consulting landscape architect, planner, or engineer can also be employed, but the plans must still be reviewed and approved by the County. Contact the County Engineering office if you have questions. Likewise, contact the Utah Division of Water Rights for any conditions imposed by the State.

Instream Applications: Flow Deflection and Concentration

It is common for spring runoff flows in Big Cottonwood Creek to exceed 500 cubic feet per second. Flows in the 200-300 c.f.s. range will wash away rock structures not properly sized, or produce unintended/undesirable changes.

Flow deflection or concentration is intended to change flow within the stream channel. These applications are used to deflect flow away from an eroding stream bank, concentrate flow in the center of the channel, re-direct water in an out of meanders, or enhance pool and riffle habitats. Recommended applications include:

1. J-Hook Vanes (p. 30)
2. Vortex Rock and Log Weirs (p. 31)
3. Rock Cross Vanes (p. 32)
4. W-Weirs (p. 33)

General Guidelines

For all instream improvements, there are at least four general guidelines to keep in mind:

1. *Use measures that are consistent with the stream type.* A grade control or check structure may not work in a wide, shallow channel. Conversely, a grade control may require much larger sized rock to work in a deeply down-cut channel. Excessively steep channels (higher gradient) may have velocities that wash away your improvements in one spring flood, or damage improvements not properly sized.

2. *Instream flow is the limiting criteria for fishery habitat.* If you live above Cottonwood Lane, forget about fish habitat improvements until future year-round flows are restored. Focus on bank applications for erosion control or flood protection, and consider riparian landscaping species adapted to flood conditions. The area above Cottonwood Lane is a thick native riparian floodplain forest, where you may consider a host of potential avian or mammal wildlife enhancements.

3. *Stream maintenance measures and frequency.* If you have concerns or problems about the type of stream maintenance, impacts and frequency, you have two options: Live with it, or discuss changes with Salt Lake County. The County's role in Flood Control is to protect you. However, if you feel County operations have gone beyond what is necessary to protect you and your neighbors, discuss the issues with your County Engineer to see if it's possible to modify the measures and frequency in your reach.

4. *Pools and riffles are important to preserve.* A good "pool to riffle ratio" is a sign of a healthy physical and biological stream habitat. Without significant amounts of pools and riffles, oxygenation of the water cannot occur, habitat for aquatic insects is reduced–thereby reducing food for fish and birds; Places for nesting, resting, feeding and breeding of fish and birds is reduced; Eliminating pools and riffles significantly impairs the physical, chemical and biological benefits of the Creek. Be sure your efforts improve, rather than degrade these features.

Bank Applications: Protection and Stabilization

Bank applications are divided into bank protection and bank stabilization.

Bank protection applications are structural in nature and are designed to protect the stream from erosion or potential failure. These include mainly Rock Toe Protection and Boulder Revetment (p. 34).

Bank stabilization applications are a non-structural way to stabilize stream banks from further erosion and are frequently used with bank protection techniques. Bank stabilization applications generally involve re-grading the stream bank to a stable angle and geometry followed by the use of vegetative plantings and biodegradable materials to stabilize the streambank and prevent future erosion. Such practices are most often utilized where there is sufficient area to re-grade the streambank and sufficient sunlight to promote the growth of stabilizing vegetation. Most common applications include:

1. Coconut Fiber Matting (p. 34)
2. Live Stakes (p. 35)
3. Live Fascines (p. 35)
4. Joint Planting (p. 36)
5. Brush Mattress (p. 36)
6. Dormant Tree Pole Plantings (p. 37)
7. Branch Packing (p. 37)
8. Bank Terracing and Planting (p. 38)

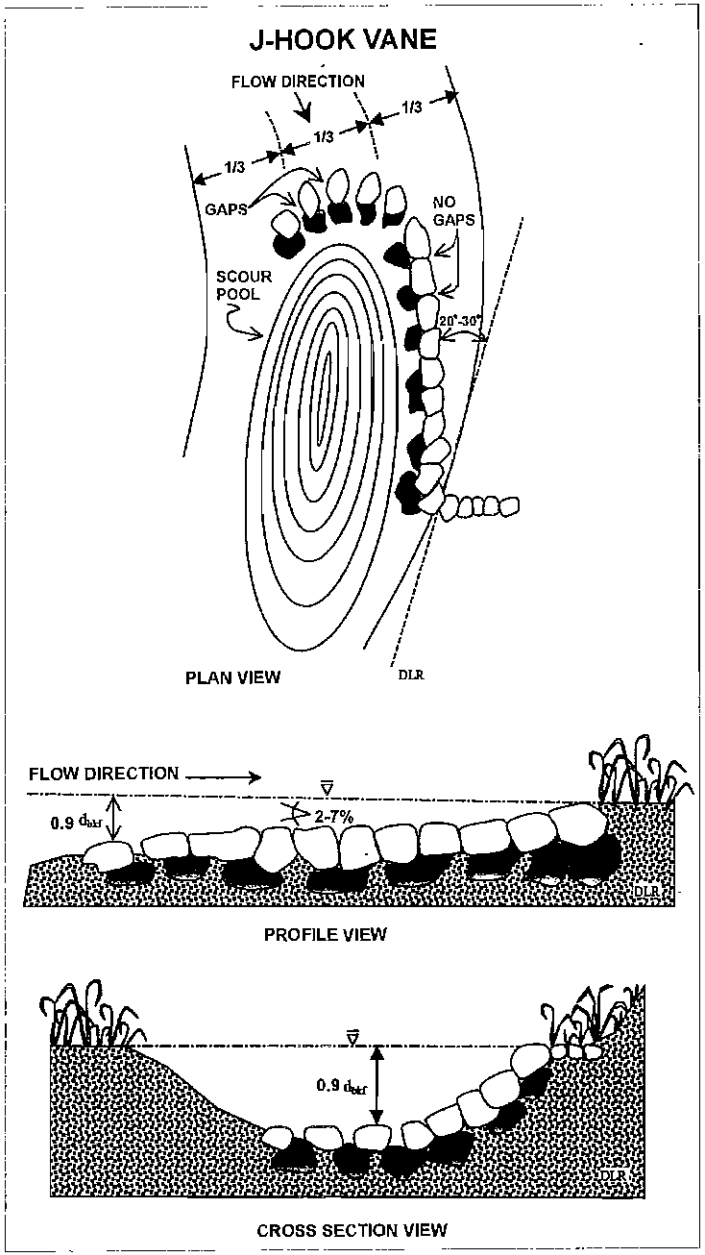


Figure 23. Instream Application: J-Hook Vane Flow Deflector (2001, Rosgen)

J-Hook Vane Flow Deflector

(D.L. Rosgen, P.H., Wildland Hydrology, Inc., 2001)

General Description

The J-Hook Vane is an upstream directed, gently sloping structure usually composed of boulders. It is located on the outside of stream bends where strong currents and high velocity gradients generate high stress in the near bank area. This structure is designed to reduce bank erosion by reducing near-bank slope, velocity, gradient, stream power and shear stress. The vane portion of the structure occupies 1/3 of the bankfull width of the channel, while the "hook" occupies the center 1/3. The J-Hook Vane is designed to reduce accelerated streambank erosion of the outside bend of meanders. At a minimum, the amount of bank protected is 2 times the vane length, while maximum spacing provides 3 times the bank protection to vane length. If both banks are eroding due to confinement (lateral containment) and entrenchment (vertical containment), then using the Cross-Vane decreases the stream power and shear stress concurrently on both banks. This avoids lining or hardening both banks through a reach to provide protection.

Applications and Effectiveness

- The J-Hook Vane is designed to reduce accelerated streambank erosion of the outside bend of meanders.
- Re-direction of flow from the near bank area will not cause erosion due to back-eddy circulation.
- Maximum velocity, stress, stream power and gradients are decreased in the near-bank area, and increased in the center of the channel.
- Sediment transport capacity can be maintained as a result of the increased stress and power in the center 1/3 of the channel.
- Backwater is created only in the near bank area, and the small departure angle gently redirects the velocity from the near bank.
- The scour pool in the center 1/3 of the channel provides energy dissipation and holding cover for fish.
- The "hook" portion of the vane produces longer, wider, deeper pools than those of vane-only structures.
- The 1/4-1/3 rock diameter gaps between the rocks associated with the hook creates vortex or corkscrew flow that increases center channel stress.
- The center of the channel associated with the hook is efficient at transporting sediment and debris.
- The "shooting flow" associated with the hook provides for recreation boating in moderate to larger sized streams.

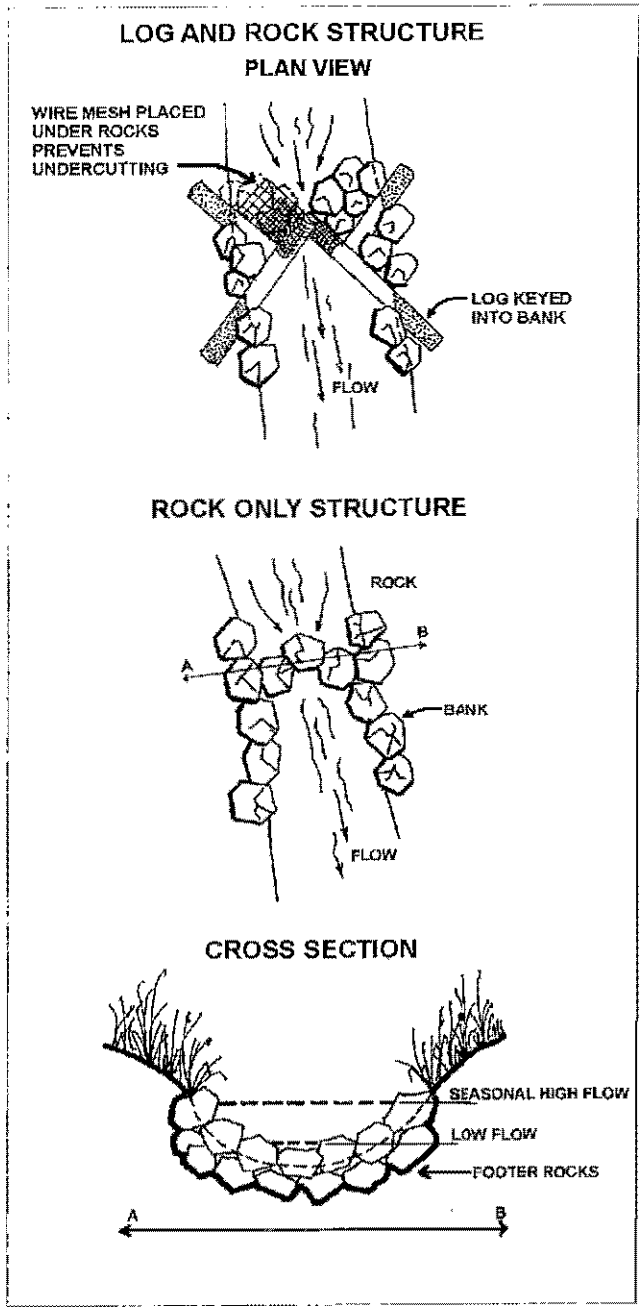


Figure 24. Instream Application: Vortex Weir (2001, Rosgen)

Vortex Weirs

(D.L. Rosgen, Applied River Morphology, 1996)

General Description

Vortex weirs are considered an improvement over broad crested straight weirs or check dams, which tend to create backwater and flat slopes. They are also intended to avoid problems of downstream pointing weirs which create twin parallel bars and a scour hole which de-stabilizes the structure.

Applications & Effectiveness

- The objectives of these structures is to create instream cover/holding water.
- Take excess shear stress away from the "near bank" area and direct it to the center of the stream to maintain lateral stability.
- Increase stream depth by decreasing the width/depth ratio.
- Increase sediment transport capacity.
- Provide natural sorting of gravel on the up-welling portion on the downstream side of the structure for spawning beds.
- Create grade control to prevent further down-cutting.
- The design can be modified (as shown) utilizing anchored logs.

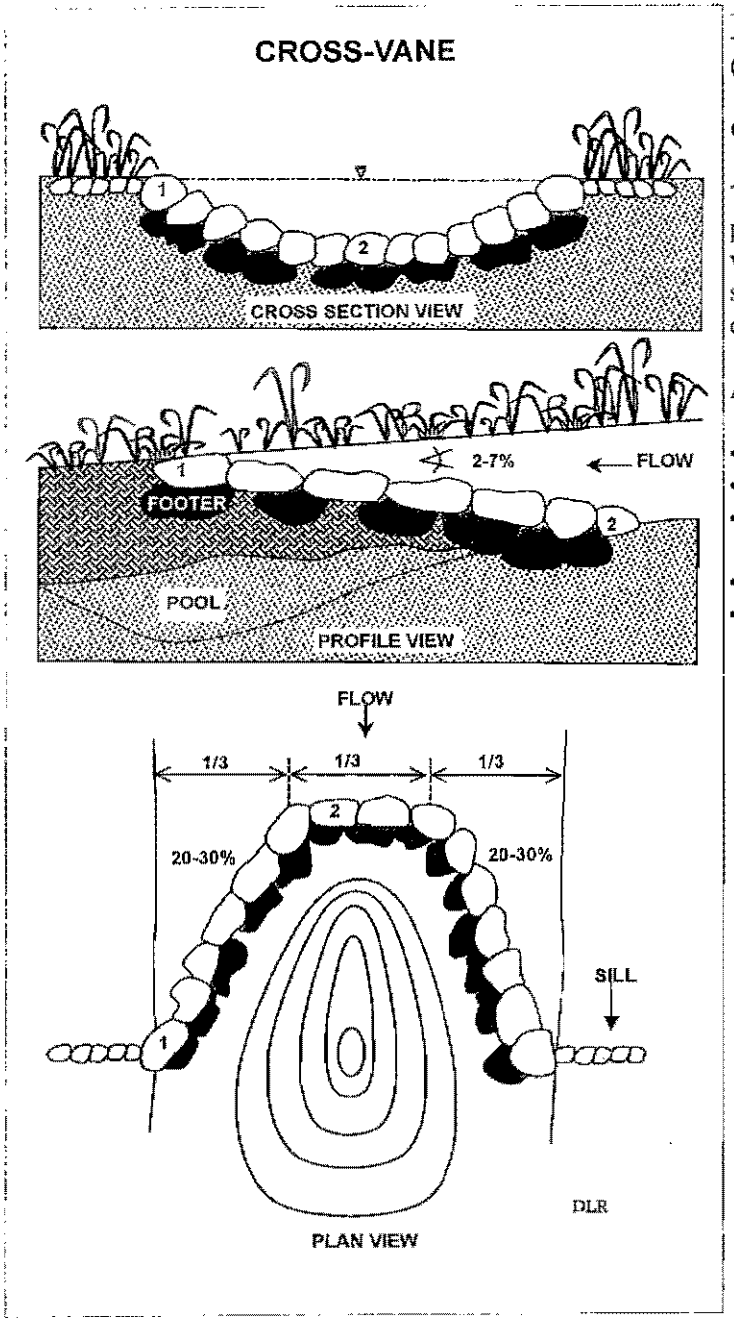


Figure 25. Instream Application: Rock Cross Vane (2001, Rosgen)

Rock Cross Vane

(D.L. Rosgen, P.H., Wildland Hydrology Inc., 2001)

General Description

The Cross Vane is a grade control structure designed to decrease near-bank stress, velocity, and stream power, while increasing the energy in the center of the channel (much like the Vortex Weir). This structure will establish grade control while reducing bank erosion and creating a stable width-depth ratio, and maintain sediment transport capacity. The Cross Vane also provides for the proper natural conditions of secondary circulation patterns, but with higher velocity gradients shifted away from the near bank.

Applications & Effectiveness

- The Cross Vane is an effective stream habitat improvement structure.
- It will increase bank cover due to a differential raise of the water surface in the bank area.
- Results in the creation of holding and refuge cover during both high and low flow periods in the deep pool.
- Develops feeding lanes in the flow separation zones (the interface between fast and slow water).
- Creates sustained fish spawning habitat in the tail-out or glide portion of the pool, even after major floods.

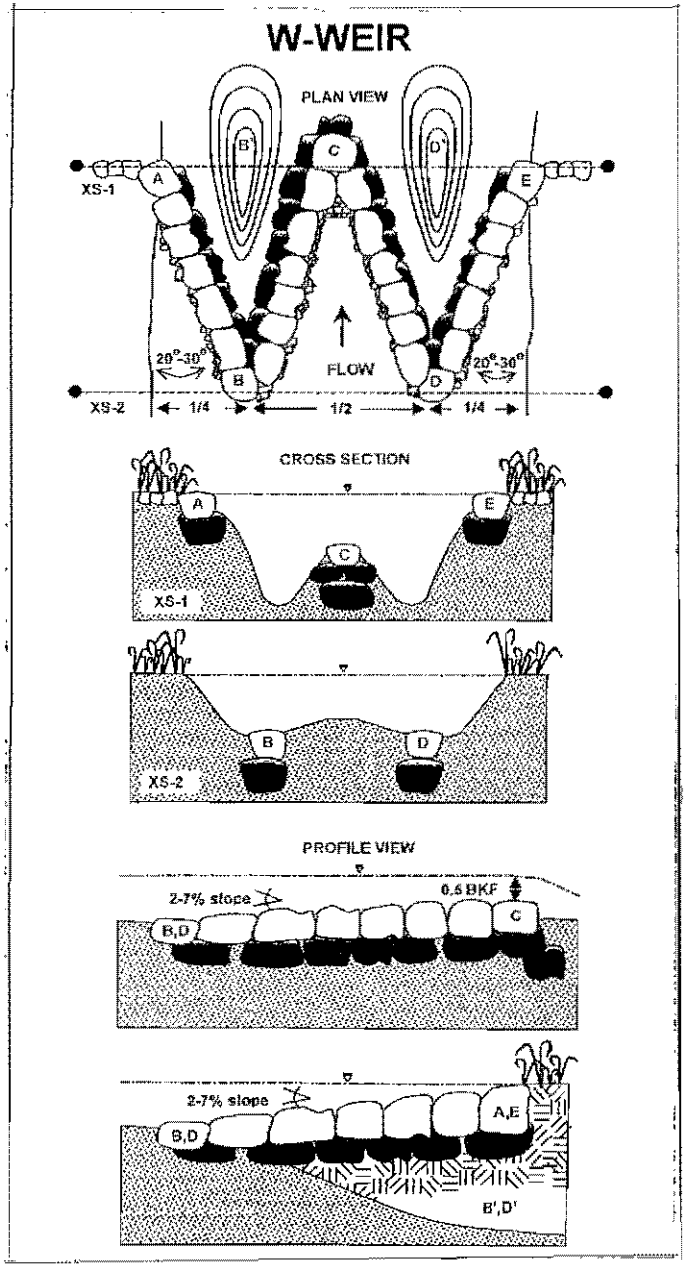


Figure 26. Instream Application: W-Weir (2001, Rosgen)

W-Weir

(D.L. Rosgen, P.H., Wildland Hydrology, 2001).

General Description

The design of the W-Weir was initially developed to resemble bedrock control channels on larger streams. Various rock weirs installed across streams for fish habitat, grade control or bank protection often create an unnatural and uniform "line of rocks" that detracts from visual values. The W-Weir is similar to a Cross Vane Weir in that both sides are vanes directed from the bankfull bank upstream toward the bed with similar departure angles, creating two thalwegs, instead of one. Smaller versions of the W-Weir can be adapted for smaller streams, such as Big Cottonwood Creek.

Applications & Effectiveness

- W-Weirs are normally used for stream segments with a higher width-depth ratio, to enhance fish habitat, provide recreational boating and streambank stabilization, facilitate irrigation diversions, reduce bridge center pier and foundation scour, and increase sediment transport at bridge locations.
- Habitat for trout is enhanced by maximizing usable holding, feeding and spawning areas.
- Fish hold in the multiple feeding lanes created by the two thalweg locations and pools.
- Various age classes of trout also hold in the deep glide created upstream of the structure and against both banks due to the increased depth and reduced velocity of flows in the near-bank area.
- Spawning habitat is created in the tail-out of the pools due to upwelling currents and a sorting of gravel bed material sizes preferred by trout.

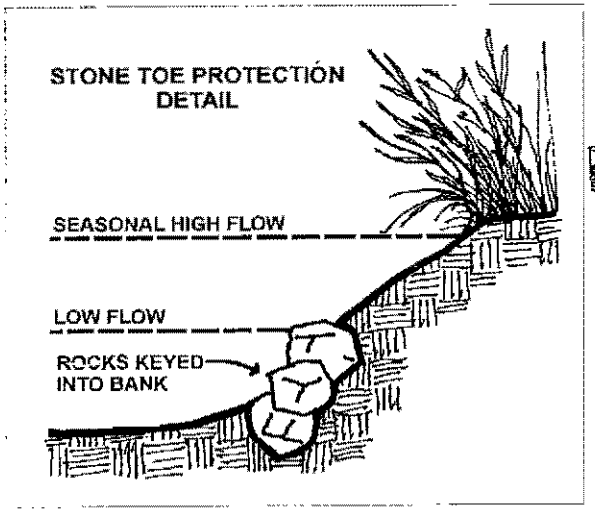
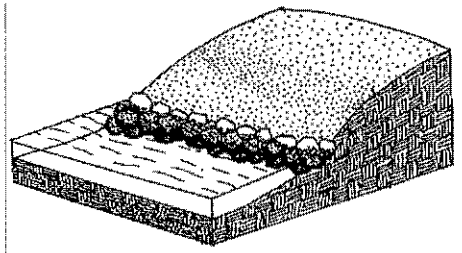


Figure 27. Bank Application: Stone Toe Protection Detail



Stone Toe Protection

Description

A ridge of quarried rock or stream cobble placed at the tow of the streambank as an armor to deflect flow from the bank, stabilize the slope and promote sediment deposition.

Applications and Effectiveness

- Should be used on streams where banks are being undermined by toe scour, and where vegetation cannot be used.
- Stone prevents removal of the failed streambank material that collects at the toe, allows revegetation and stabilizes the streambank.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerated source of streamside vegetation.
- Can be placed with minimal disturbance to existing slope, habitat, and vegetation.

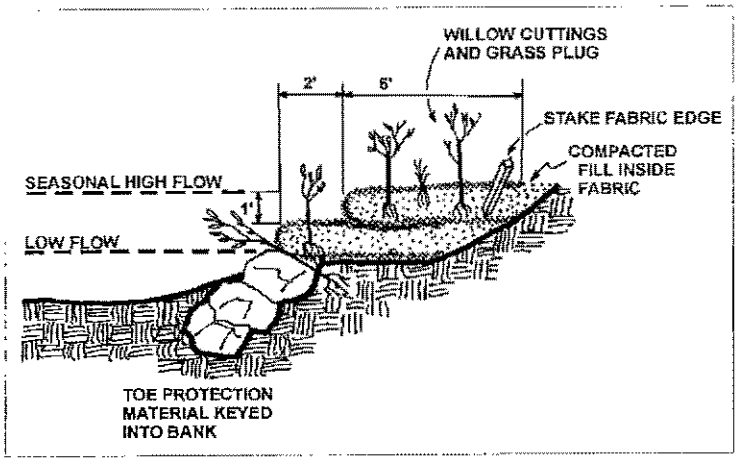
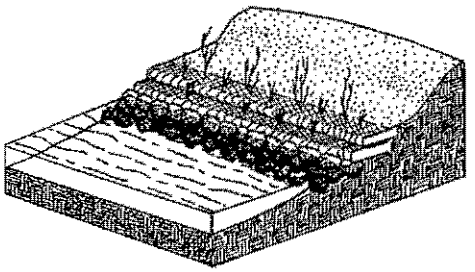


Figure 28. Bank Application: Coconut Fiber Lift Detail



Coconut Fiber

Description

Coconut fiber products, such as COIR Fabric manufactured by Bon Terra Corp., are relatively thick, high tensil strength mats used to contain or reinforce bank fill or re-graded bank zones. They are part of a new line of products designed to work as components of "bio-engineered" erosion control solutions. COIR fabric normally comes in three different thicknesses which are rated to corresponding stream velocities, and also comes in various widths for different applications (6' width minimum, 13'width maximum). COIR fabric is expensive. One roll of 13 ft. width X 200 ft. length costs about $ 600.

Applications and Effectiveness

- COIR fabric is typically used in the construction of earthen terraces, or lifts, which are revegetated with grass, shrub, and even tree pole plantings. The fabric is un-rolled and laid out flat along a re-graded bank reach and secured at the back side with 10"-12" ground staples. Wooden forms are put up adjacent to the stream on the outside lift exposure and secured with wooden stakes. The lifts are filled and compacted with soil, and the fabric is pulled back over the compacted soil terrace and secured with ground staples. COIR lifts overlap each other to create an interlocking system of terraces.
- Although COIR fabric is rated to withstand flows between 7-16 feet per second, the material bio-degrades within 5 years, making the fabric less than desirable for bank toe protection applications.
- Where rock toe protection is used, COIR lifts can be constructed behind the rock in progressive terraces for effective grass, shrub and tree revegetation.
- COIR fabric can also be used for temporary shoreline anchoring or upper bank stabilization to help reduce wave action or "rill" erosion during revegetation. This application requires the use of longer earth staples or pins normally secured below the bank water surface and within the bank itself.

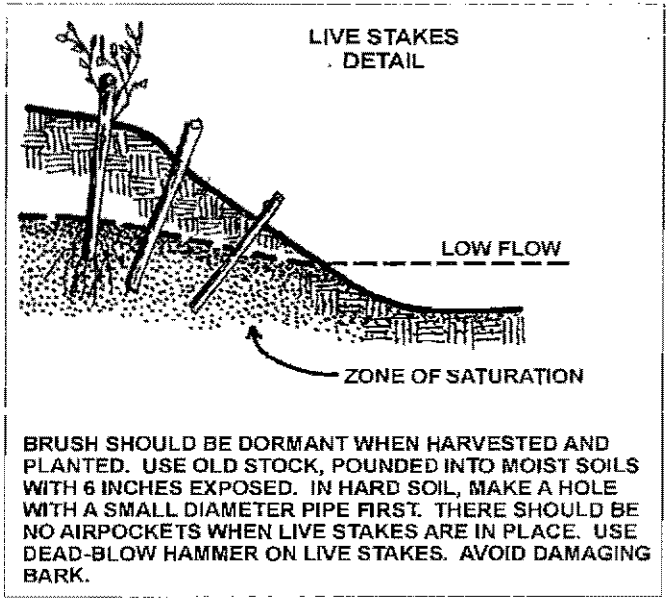


Figure 29. Bank Application: Live Stakes Detail

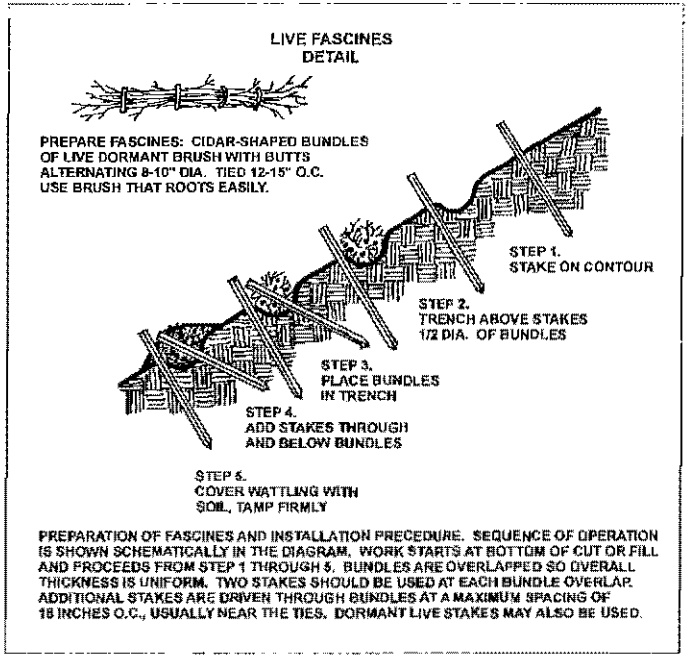
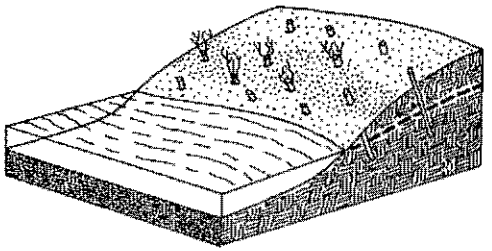


Figure 30. Bank Application: Live Fascines Detail



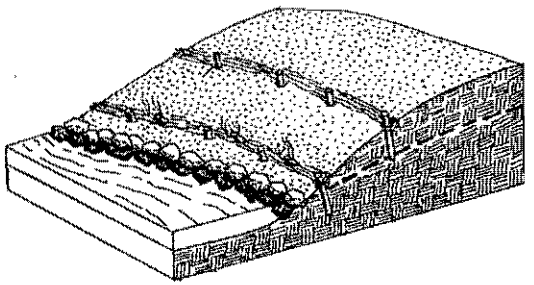
Live Stakes

Description

Live, woody cuttings which are tamped into the soil to root, grow and create a living root mat that stabilizes the soil by reinforcing and binding soil particles together, and by extracting excess soil moisture.

Applications and Effectiveness

- Effective where site conditions are uncomplicated, construction time is limited, and an inexpensive method is needed.
- Appropriate for repair of small earth slips and slumps that are frequently wet.
- Can be used to stake down surface erosion control materials.
- Stabilize intervening areas between other soil bioengineering techniques.
- Rapidly restores riparian vegetation and streamline habitat.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plants.
- Enhance conditions for colonization of vegetation from the surrounding plant community.
- Requires toe protection where toe scour is anticipated.



Live Fascines

Description

Dormant branch cuttings bound together into long sausage-like, cylindrical bundles and placed in shallow trenches on slopes to reduce erosion and shallow sliding.

Applications and Effectiveness

- Can trap and hold soil on streambanks by creating small dam-like structures and reducing the slope length into a series of shorter slopes.
- Facilitate drainage when installed at an angle on the slope.
- Enhance conditions for colonization of native vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plants.
- Requires toe protection where toe scour is anticipated.
- Effective stabilization technique for streambanks, requiring a minimum amount of site disturbance.
- Not appropriate for treatment of slopes undergoing mass movement.

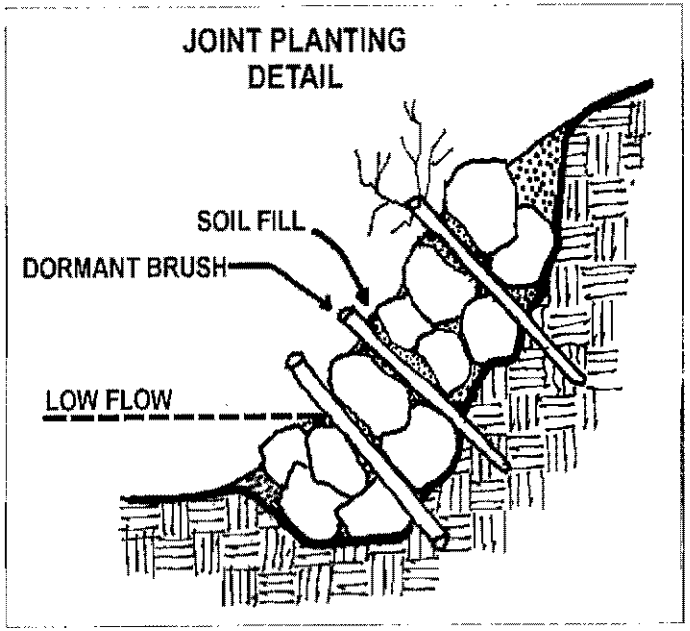
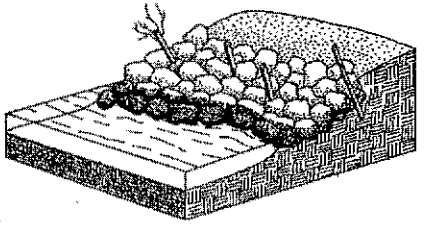


Figure 31. Bank Application: Joint Planting Detail



Joint Plantings

Description

Live stakes tamped into joints or openings between rock which have previously been installed on a slope or while rock is being placed on the slope face.

Applications and Effectiveness

- Appropriate where there is a lack of desired vegetative cover on the face of existing or required rock riprap.
- Root systems provide a mat upon which the rock riprap rests and prevents loss of fines from the underlying soil base.
- Root systems also improve drainage in the soil base.
- Will quickly establish riparian vegetation.
- Should, where appropriate, be used with other soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streambank vegetation.
- Have few limitations and can be installed from base flow levels to top of slope, if live stakes are installed to reach ground water.
- Survival rates can be low due to damage to the cambium or lack of soil/stake interface.
- Thick rock riprap layers may require special tools for establishing pilot.

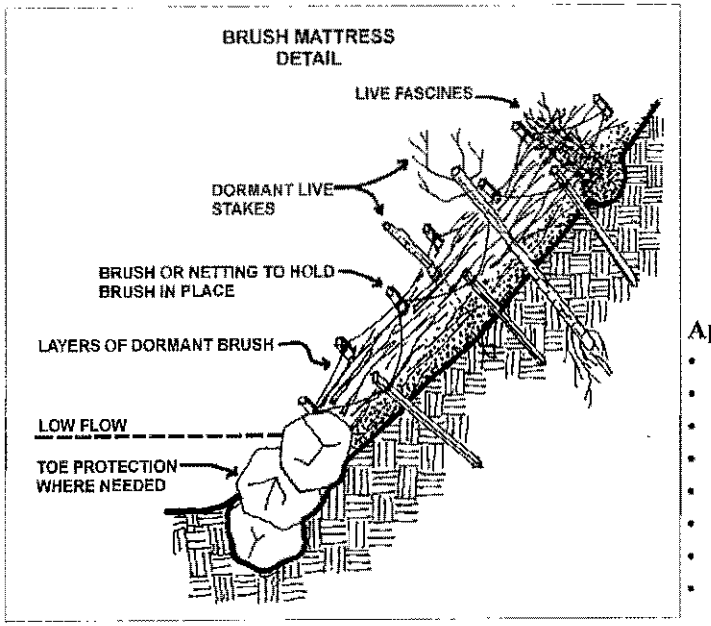
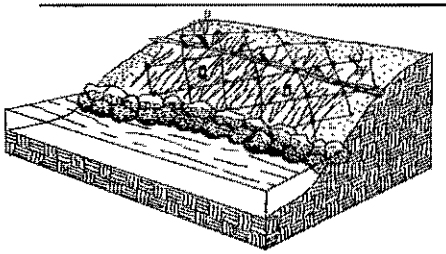


Figure 32. Bank Application: Brush Mattress Detail



Brush Mattresses

Description

Combination of live stakes, live fascines, and branch cuttings installed to cover and physically protect streambanks; eventually to sprout and establish numerous individual plants.

Applications and Effectiveness

- Form an immediate protective cover over the streambank.
- Capture sediment during flood flows.
- Provide opportunities for rooting of the cuttings over the streambank.
- Rapidly restores riparian vegetation and streamside habitat.
- Enhance conditions for colonization of native vegetation.
- Limited to the slope above base flow levels
- Toe protection is required where toe scour is anticipated.
- Appropriate where exposed streambanks are threatened by high flows prior to vegetation establishment.
- Should not be used on slopes which are experiencing mass movement or other slope instability

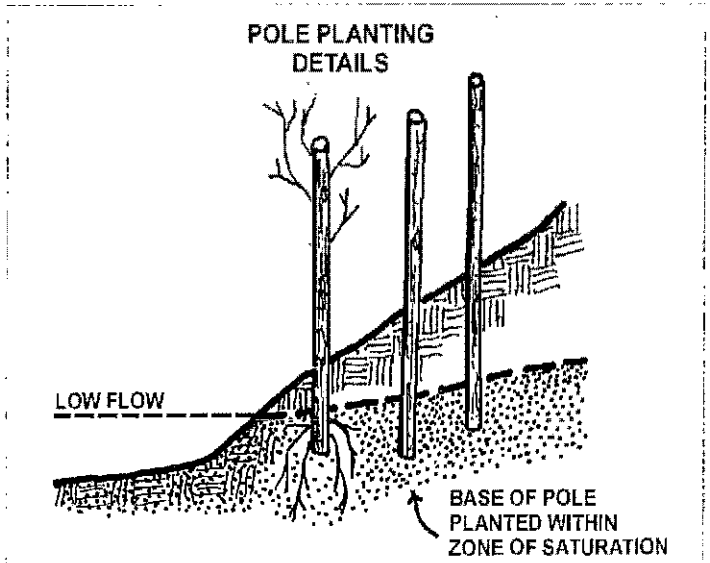


Figure 33. Bank Application: Pole Planting Details

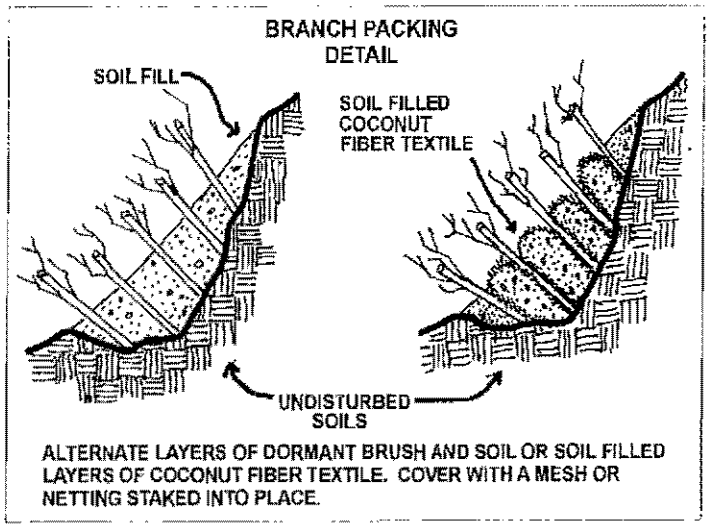
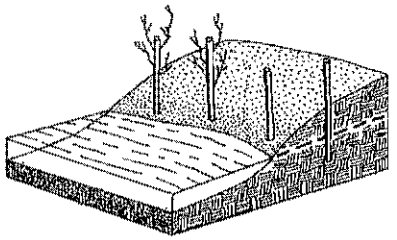


Figure 34. Bank Application: Branch Packing Detail



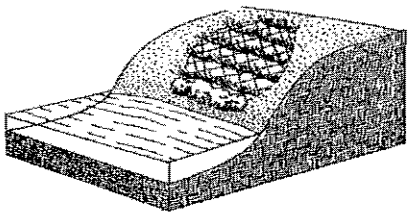
Dormant Pole Plantings

Description

Plantings of cottonwood, willow, poplar, or other species embedded vertically into streambanks to increase channel roughness, reduce flow velocities near the slope face, and trap sediment.

Applications and Effectiveness

- Can be used as live piling to stabilize rotational failures on streambanks where minor bank sloughing is occurring.
- Useful for quickly establishing riparian vegetation, especially in arid regions where water tables are deep.
- Will reduce near bank stream velocities and cause sediment deposition in treated areas.
- Reduce streambank erosion by decreasing the near-flow velocities.
- Generally self-repairing and will restem if attacked by beaver or livestock; however, provisions should be made to exclude such herbivores where possible.
- Best suited to non-gravely streams where ice damage is not a problem.
- Will enhance conditions for colonization of native species.
- Are less likely to be removed by erosion than live stakes or smaller cuttings.
- Should, where appropriate, be used with soil bioengineering systems and vegetative plantings to stabilize the upper bank and ensure a regenerative source of streamside vegetation.
- Unlike smaller cuttings, post harvesting can be very destructive to the donor stand, therefore, they should be gathered as 'salvage' from sites designated for clearing, or thinned from dense stands.



Branch Packing

Description

Alternate layers of live branches and compacted backfill which stabilize and revegetate slumps and holes in streambanks.

Applications and Effectiveness

- Commonly used where patches of streambank have been scoured out or have slumped leaving a void.
- Appropriate after stresses causing the slump have been removed.
- Less commonly used on eroded slopes where excavation is required to install the branches.
- Produces a filter barrier that prevents erosion and scouring from streambank or overbank flows.
- Rapidly establishes a vegetated streambank.
- Enhances conditions for colonization of native species.
- Provides immediate soil reinforcement.
- Live branches serve as tensile inclusions for reinforcement once installed.
- Typically not effective in slump areas greater than four feet deep or four feet wide.

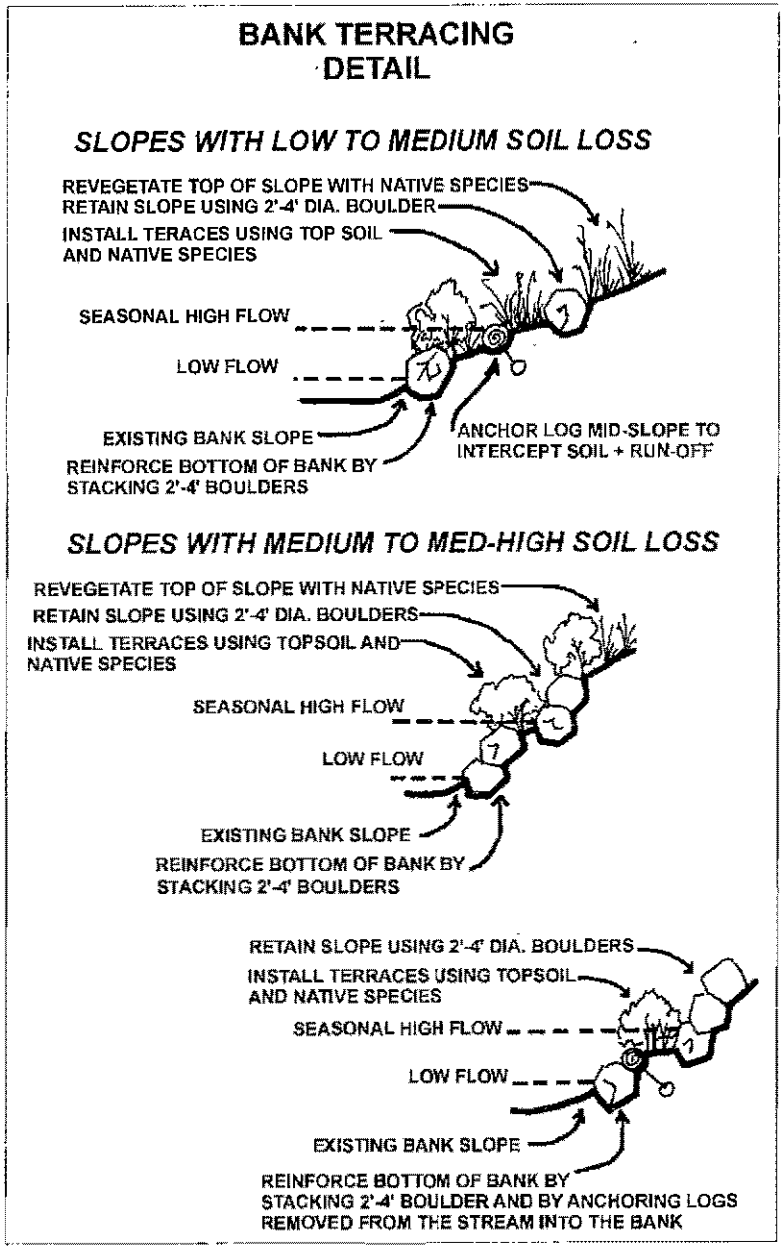
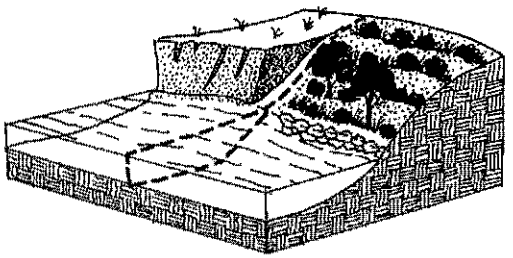


Figure 35. Bank Application: Terracing and Planting (1996, Landureth and Jensen).



Terracing and Planting

Description

Regrading streambanks to a stable slope, placing topsoil and other materials needed for sustaining plant growth, and selecting, installing and establishing appropriate plant species.

Applications and Effectiveness

- Most successful on streambanks where moderate erosion and channel migration are anticipated.
- Reinforcement at the toe of the embankment is often needed.
- Enhances conditions for colonization of native species.
- Used in conjunction with other protective practices where flow velocities exceed the tolerance range for available plants, and where erosion occurs below base flows.
- Streambank soil materials, probable groundwater fluctuation, and bank loading conditions are factors for determining appropriate slope conditions.
- Slope stability analyses are recommended.
- Unless severely restricted by setback area, this process requires minimum bank re-grading usually at less than 2:1 slopes. 3:1 or 4:1 slopes are considered optimum where area allows. Otherwise, boulder terracing should be incorporated for increased structural stability.
- Contour terracing is typically used to help establish plant materials. Depending on slope length and width, contour terraces vary between 8"-24" in width and depth.

The Big Cottonwood Creek Flood Plain

The most recent floods in 1982-83 produced peak flows in Big Cottonwood Creek exceeding 800 cubic feet per second (c.f.s.). These floods produced relatively minor damage to homes and property in the Holladay area, because the channel was able to contain the majority of the flow. Many areas where flows escaped the channel were protected by extensive community sand bagging efforts.

In general, areas most often impacted by less than 100-year flood flows are considered in the "Floodway." The area inundated when the floodway loses its capacity is defined as the "Floodplain," and usually occurs with 100-year up to 500-year flood frequencies (Federal Emergency Management Agency). Along the valley segment of Big Cottonwood Creek, the majority of the channel can carry the 100-year frequency flood. There are areas where the channel is constricted (mainly road crossings), where water will leave the channel and inundate limited areas with depths of one foot or deeper. These areas occur near 900 East, Big Cottonwood Creekside Park (1700 East), and limited areas upstream of the I-215 Creek crossing.

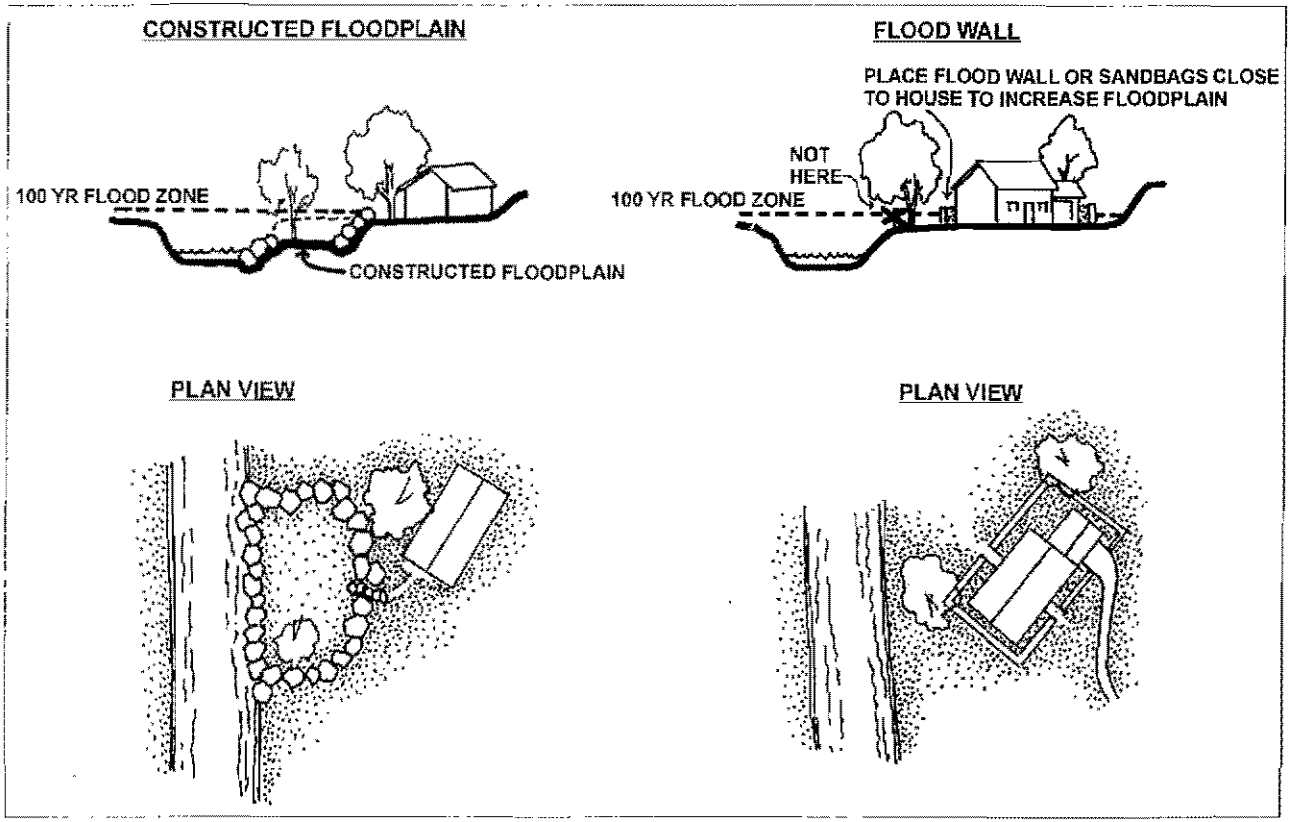


Figure 36. Flood protection techniques for creekside property. (1998, Riley)

Residents living in close proximity to Big Cottonwood Creek can obtain flood insurance through FEMA or its subscriber agencies at reasonable rates. The FEMA maps are available at the Salt Lake County Engineering Division, Murray City and Holladay City. During flood events, creek-side residents should take care not to place sand bags so as to constrict the channel (i.e. placing them directly on the bank). Sand bag walls should be placed as far AWAY from the channel as possible, to allow for flood storage and reduction of extremely erosional high flow velocities. The more upstream storage that can be provided in this way will reduce downstream damages significantly.

5. Riparian Habitat Improvements

Using the principles of riparian habitat structure (see p. 19) combined with native plants, will provide a sanctuary for native birds as well as wildlife watching enjoyment for the homeowner. The greater the number of homesites that include habitat related landscapes, the better the chance of remaining native wildlife populations to survive in an urban environment. Here are some suggestions.

-If building on a lot with existing habitat, evaluate what vegetation can be left undisturbed. Save the largest cluster of plants where possible rather than fragments in different locations. Mature and partially mature native trees benefit wildlife as well as the homeowner for aesthetics and modifying on-site weather impacts. Soil compaction, cutting roots, and breaking limbs could be fatal for the tree identified to be saved. The rule of thumb is to leave undisturbed an area as wide as the perimeter of the canopy. Consult an arborist about saving trees during construction.

-In a floodplain or riparian area, use native plants suitable to elevation, soils and water table or flooding.

-Include plantings that vary in height to create an under-, middle-, and overstory effect.

-Include a variety of plants that provide year-round food, cover and nesting resources for wildlife

-Design with clusters of plants and use groups of the same species together.

-Predators such as racoons, skunks, feral and domestic cats are efficient hunters and are devastating to songbird populations. Providing clusters of dense vegetation connected by corridors of vegetation reduce the exposure and the risk wildlife needs to take in order to move about their home.

Table 2. Native Riparian Forb Species Characteristics

FORBS	FORM	HEIGHT inches	FLOWER color	FLOWER season	COMMENTS
Achillea millefolium common yarrow	Perennial	12-24	white	spring-fall	Sun to partial shade; drought tolerant; light helps germination; occurs on dry and moist sites
Geranium viscosissimum wild geranium	Perennial	12-48	pink	summer	Diffused sunlight; moderate water requirements; occurs foothills to subalpine; under oak, maple, aspen in mesic to moist meadows, and streamside.
Hedysarum boreale northern (Utah) sweetvetch	Perennial	10-24	pink/ purple	spring	Full sun to partial shade; drought tolerant; foothills on open grassy or rocky slopes; performs well on steep disturbed sites
Lupinus caudatus tailcup lupine	Perennial	12-24	blue	spring-summer	Full sunlight; low to moderate water requirements; valleys to upper montane; on dry open slopes with sagebrush, on mesic grassy meadows, woodland clearings, and occasionally streamsides.
Oenothera hookeri Hooker's evening primrose	Biannual	36-48	yellow	spring	Full sun to partial shade; moderate water requirements; valleys to midmontane; in moist lowlands, and along ditches, fencerows, streams and shaded roadside
Penstemon cyanathus Wasatch penstemon	Perennial	18	blue	summer	Full sun to partial shade; low to moderate water requirements; from foothills to subalpine; in dry to moist sites, on open slopes, under aspens and in meadows; semi-evergreen
Sphaeralcea coccinea scarlet globemallow	Perennial	6-12	red/ orange	spring	Full sun; drought tolerant; valleys to foothills; in dry open prairie grasslands, sometimes alkaline sites.
Viguiera hirta multiflora showy goldeneye	Perennial	12-40	yellow	summer	Full sun to partial shade; moderate moisture requirements; from foothills to upper montane, on open slopes and under trees; competitive with annuals and perennials; establishes quickly on disturbed sites and with rapid seeding growth.

(1990, Collins)

Table 3. Native Riparian Shrub Species Characteristics

SHRUBS	HEIGHT	WIDTH	DROUGHT TOLERANCE	COMMENTS
Artemisia tridentata big sage	2-6'	5-8'	high	Evergreen; occurs in foothills to alpine; on well-drained soils.
Atriplex gardneri gardner saltbush	.5-2'	3'	high	Warm season, small suffrutescent half-shrub; occurs in valleys; in alkaline to saline soil; tolerant to sand to dense clays; slow growing; tolerates seasonal flooding and alternating wet/dry periods.
Berberis repens oregon grape	1-3'	4-6'	low	Low, evergreen trailing undershrub; well drained loams, protected on north-facing slopes; intolerant of high water table; tolerant of weakly acidic, basic and saline soils.
Chrysothamnus nauseosus rubber rabbit brush	2-4'	2-3'	good	Brilliant show of fall flowers; in dry, open, often disturbed, sometimes alkaline sites of open plant communities; well drained soils, tolerates occasional flooding.
Cornus stolonifera red-osier dogwood	3-10'	to 10'	poor	Fast growth, thicket forming; sun or shade; streamside or marshy areas with water for short periods; good red twig winter color.
Rhus trilobata oak leaf sumac	to 6'		high	Deciduous, thicket forming warm season shrub; occurs in foothills; in dry to mesic sites on open slope and streamside; intolerant of flooding and high water tables; tolerant of partial shade; fast growing densely branched; good nurse plant; very versatile
Ribes aureum golden currant	3-5'	4'	poor	Deciduous, small to medium sized, irregular-shaped shrub; occurs in valleys and foothills; in moist to mesic sites, along streams and north slopes; attractive, fragrant yellow flowers and late summer dark blue fruit; widely adapted; excellent for site stability
Rosa woodsii woods rose	2-6'	6-9'	moderate	Deciduous, prickly, briar patch-forming shrub; occurs in valleys to midmontane; in mesic or moist sites, streamside, under oak-maple; intolerant of poor drainage, high water table and prolonged flooding; aggressive pioneer on disturbed soils; moderately competitive and fairly compatible with herbs; widely adapted; excellent for site stability
Salix exigua coyote willow	6-10'	3-5'	poor	Dense thicket forming shrub;valleys to midmontane; streamside, near springs, in marshes, and in wet, low lying areas; salt tolerant; occurs along the Jordan River.

(1990, Collins)

-Use mulch to retain soil moisture, reduce weeds and provide the birds who are ground feeders foraging opportunities.

-Plant in stages, for example, for an understory, plant shade loving plants once trees or shrubs have been established and that can provide the necessary shade.

-Consider the mature size and invasiveness of plants when designing the plan.

-Include water for wildlife particularly if you do not border on the Creek, or the Creek is dry part of the year.

-Do not plant large trees under overhead wires or too close to the house foundation or roof line

-Do not use treated railroad ties or landscape timbers in contact with water.

-Supplement your landscape plan with nest boxes and birdfeeders until plants grow and can supply those needs. Along Big Cottonwood Creek, include mandarin or wood duck nest boxes in potential sites. The local library is excellent source of information on bird structures. The Division of Wildlife has a Utah bird list available at the Map and Book Store for free. See Resource List on p. 45.

-Where regular watering of plants is necessary, use water-wise drip systems.

-To learn more about the needs of wildlife and integrating them into your landscape, see Creating Landscapes for Wildlife: A Guide for Backyards in Utah. See Resource List p.49.

Table 4. Native Riparian Tree Species Characteristics

TREES	HEIGHT	WIDTH	DROUGHT TOLERANCE	COMMENTS
Acer grandidentatum bigtooth maple	5-15' to 40'	20-25'	fair/good	Deciduous, bushy shrub or medium sized tree; foothills and midmontane; along streams and on mesic slopes in the lower reaches of the canyons; often in assoc with A. negundo; in moderately acidic to slightly basic, well drained soils.
Acer negundo boxelder	50'	25-30'	good	Fast growing shade tree; subject to bugs and breaking; occurs in foothills to upper montane; usually streamside; often in association with Acer grandentatum; drought tolerant good when established.
Alnus incana thinleaf/mountain alder	30'	15-20'	poor	Small tree similar in appearance to water birch; occurs in foothills to upper montane; usually streamside; often in association with Betula occidentalis and Acer grandentatum; well drained but tolerates periods of standing water.
Betula occidentalis river birch	30'	10-20'	good	Fast growing medium sized tree; foothills and midmontane; streamside, often in association with A. grandentatum and Alnus incana; much less susceptible to bores and winter dieback than other birches; use var. fontinalis
Celtis reticulata (douglasii) netleaf hackberry	30'	15-20'	good	Small shade tree large shrub for dry sites; occurs in valleys and foothills; in shallow canyons or in moderately moist sites on open hillsides; recommend training for tree shape where needed
Crataegus douglasii douglas hawthorne	10-12'	10'	good	Small tree or large shrub; occurs in valleys and foothills; streamsides or in marshy areas; well drained but can stand some periods of wet soil; drought tolerance good if established
Populus angustifolis narrowleaf cottonwood	30-50'	30-40'	poor	Fast growing, upright columnar, yellow fall color; occurs in valleys to midmontane; along waterways, occasionally on drier sites; fairly strong.
Populus fremontii Fremont cottonwood	30-50'	30-80'	poor	Wide spreading crown often wider than tree is tall; wood is soft.
Prunus virginiana chokecherry	to 20'	10-15'	poor	Deciduous, loose thicket-forming shrubs or small trees; occurs in foothills to upper montane; streamside on moderately moist slopes and in opening; intolerant of poor drainage and prolonged spring flooding and high water tables; moderate shade tolerance.
Quercus gambelii gambel oak	to 20'	12-15'	moderate	Slow growing small tree though quite variable; occurs in foothills as scattered dense clones on hillsides and dense woods in canyon bottoms; associated with Acer grandentatum in mesic sites; recommend 2 gal containers spaced 5-6'
Salix amygdaloides peachleaf willow	to 30'	_	poor	Tree or large shrub with a high crown and ascending branches; occurs in valleys and foothills along waterways; is the only large native willow in the region; wood is light and soft susceptible to decay

(1990, Collins)

Forb referenees:
Granite Seed, Lehi, UT
Plants of the Southwest, Santa Fe, NM
Flora of the Central Wasateh Front, Utah, by L. Arnow, B. Albee and A. Wyckoff

Shrub referenees:
Ecology and Culture of Seleeted Speeies useful in Revegetating Disturbed Lands in the West by C. Wasser
Flora of the Central Wasateh Front, Utah by L. Arnow, B. Albee and A. Wyckoff
Interagency Forage and Conservation Planting Guide for Utah, edited by Howard Horton
Landseape Plants from Utah's Mountains by R. Sutton and C. Johnson
Steve Pendleton, Progressive Plants Nursery, Sandy, Utah

Tree referenee:
Flora of the Central Wasatch Front, Utah by L. Arnow, B. Albee and A. Wyckoff
Landscape Plants from Utah's Mountains by R. Johnson
Steve Pendleton of Progressive Plants Nursery, Sandy, Utah

6. Treatment of Special Existing Situations

There are a few conditions that require a slightly different approach to gain enhancement of a less-than-desirable condition. Most often, these involve pre-existing features or situations which can only be "retro-fitted," or covered up. Typically, these features involve "historic" applications that have broken down or weathered over time. Gabion baskets and concrete wall structures are most notable. How to approach "snags" or dead trees, and dealing with stream access are examples of other special problems.

Gabion Basket Walls

Rock-filled wire baskets were considered to be one of the most cost-effective structural applications during the flooding of Big Cottonwood Creek in 1983. Salt Lake County even had the "50/50" program in place, where property owners would pay for materials and the County would install them, and the measures usually involved the gabion basket.

Table 5. Non-native Plant Species for Covering Gabions and Flood Walls

Scientific Name	Common Name	Deciduous /Evergreen	Watering	Sun/Shade	Form and Size	Application
Mahonia repens	creeping mahonia	evergreen	needs little water	sun or partial shade	shrub; creeps by underground stems; to 3 feet all with spreading habit; divided leaflets with spiny teeth on edges	ground cover, easy to grow, good wildlife plant
Juniperus horizontalis	Bar Harbor Juniper	evergreen	needs little water	sun or partial shade	coniferous shrub; to 1 foot by 10 ft., hugs the ground; fast growing; feathery blue gray foliage	ground cover that will trail over wall or gabion; many varieties to chose from
Lonicera spp.	Honeysuckle	evergreen to deciduous	needs moderate summer watering	sun to light shade	vine or small shrub	ground cover; several species, good wildlife plant, NOTE: L. japonica not suitable due to invasive rampant growth, smothering other plants.
Hedera helix	English Ivy	evergreen	best with regular water	shade	woody vine; to 1 foot tall; holds soil; roots grow deep and fill soil densely; branches root as they grow; climbs with aerial rootlets	ground cover and roots to walls or gabions; several varieties; tolerant of aridity; dependable, uniform, neat
Parthenocissus quinquefolia	Virginia Creeper	deciduous	regular watering	shade to sun	vine; clings by sucker discs at ends of tendrils; big vigorous leaves	ground cover and clings to walls or gabions; superb and dependable fall leaf color orange to scarlet; may climb nearby tree
Vinca spp.	Periwinkle, myrtle	evergreen	needs moderate watering	best in shade	perennial; long trailing stems root as they spread; oval dark green leaves; mounds typically 6-12 inches;	ground cover; can be invasive in areas sheltered and forested; V. major can tolerate some sun if watered generously. V. minor can only be grown in shade, and may need more water
Cotoneaster horizontalis	Rock Cotoneaster	deciduous	little or no water once established	full sun	shrub; 2-3 feet tall and 15 feet wide; small leaves on stiff branches, showy red fruit; vigorous growth with little or no maintenance; grow well in poor soils	ground cover and trails over walls and gabions; give enough room to grow
Euonymus fortunei	Euonymous	evergreen	moderate watering	best in full sun or light shade	vine; trails or climbs by aerial rootlets; can be spreading mass of 20 feet or more; dark rich green 1- 2 ½ in.	Ground cover and roots to walls and gabions; several varieties, favorite deer food.

References: Mill Creek Garden Nursery, Salt Lake City and Sunset Western Garden Book, 1995

Gabions were constructed in long, terraced placements over 200 linear feet in some places. In others places, they were limited to courses of 20-50 linear feet. They are now typically reserved for bridge crossings or culvert protection. In 1983, the efficiency of gabion protection had little debate, although its aesthetic appeal left much to be desired. People wanted immediate protection from flood erosion and aesthetics were second.

Many gabion basket systems which remain in Big Cottonwood Creek are in various stages of sag, disrepair, breakage, and collapse, the thin metal baskets giving way to 20 years of bed-level erosion and abrasion by moving bed material. Those which remain are generally in full view up and down stream, and many property owners now want to know "how to cover them up."

Table 5 summarizes planting options for gabions, which are generally limited to ornamental shade plants. Planting "climbing" materials such as ground cover or trailing vines is the most convenient method, but another measure such a topsoiling and planting directly on the structures is possible. Most of these approaches requires regular irrigation.

Concrete Walls

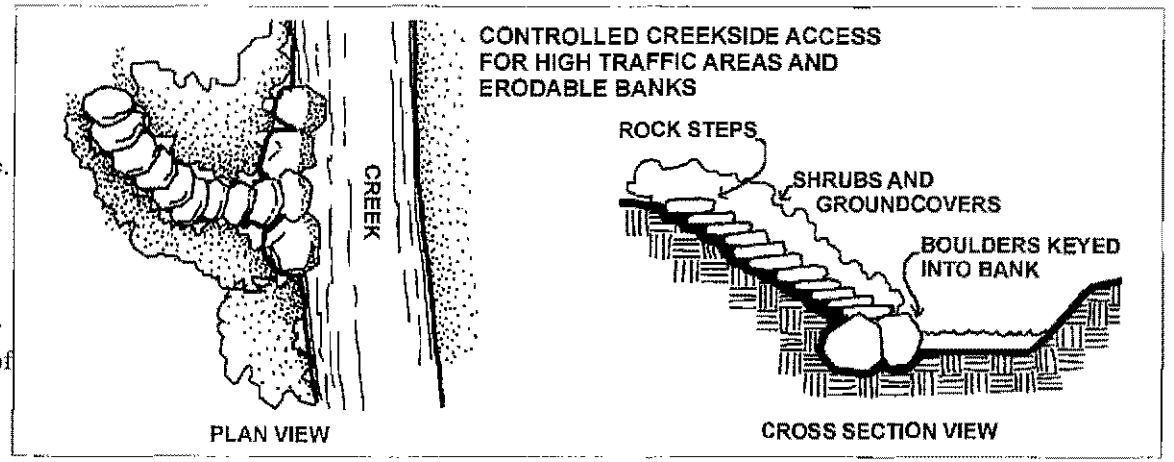
Another relic of historic erosion control technology is the concrete wall. While these structures were long considered the most effective way of solving a single site problem, the negative instream and downstream effects have actually multiplied from their existence. There is little space to really adequately address the effects (or disaffects) of concrete walls in this publication. The bottom line is, concrete walls will ultimately fall into the creek from undercutting and cause huge flood hazards, and they will cost thousands of taxpayer dollars to remove. For those of you willing simply to cover up the wall, use the same approach as that with gabions. For those of you that desire a better long term, aesthetic, and effective solution, tear it down and start over.

Controlled Stream Access

Excessive access by stream recreationists can induce severe bank erosion and mass wasting, causing stream instability and water quality impairment. On 2:1 (or greater) bank slopes in excess of four feet in slope length, repeated walking, sliding, or climbing will strip grass and shrub vegetation to bare ground conditions, with sheet/rill erosion to follow. This condition will evolve into significant bank failure over time, and induce flow back-eddies that undercut banks, trees, and ultimately the property.

The Creek has many unique attractions that draw people to its shorelines. There may be 2-3 deep pool and riffle zones with overhanging shade–an excellent fishing spot. Or there may be huge, old stands of Cottonwoods casting a golden autumn glow through the Creek corridor. There may be a favorite spot to watch kingfishers charging up and down the stream, or a great place to wade on a hot summer day. Whatever the attraction, it may be best to recognize and accommodate access rather than block it off.

Roek stairways are an example of a structural controlled access application, which have been installed by Salt Lake County and the Forest Service near the Terraces Campground in Millcreek Canyon. Such measures were necessary because the Creek reach is located adjacent to a heavily used picnic area. The Creek stairways are constructed of large overlapping granite slabs which traverse the 20-foot banks down to the Creek shoreline. The bottom slab sits atop a keyed-in boulder which serves as toe protection for the high veloeity flows. Such stairways are expensive and require the use of heavy equipment for installation, and are thus limited by cost.



Smaller versions of controlled stream access should employ rock or brick as opposed to wooden stairs, since wooden structures will not survive high spring runoff flow. Keyed-in boulders (>12"), terraced so as to incorporate intermediate planting between the stairs, is also a recommended option. Because these are structural improvements, permits will likely be required.

IN NO CASE SHOULD BRIDGES OR DECKS BE CONSTRUCTED ACROSS THE CHANNEL. Such structures inhibit flood control access, routinely catch and lodge large debris, and subsequently fail during flood events, causing significant downstream flood hazard.

Snags

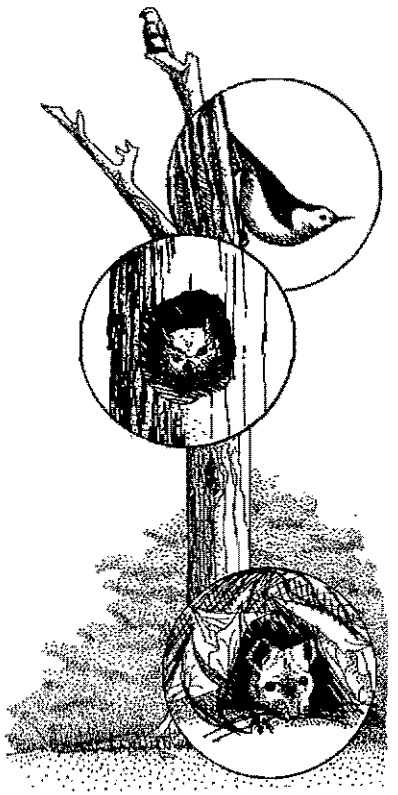
"Snag" is perhaps one of the most disrespectful terms for one of the most unique and valuable natural features. Dead or partially dead trees play a crucial role in ecological maintenance, and should be preserved whenever the opportunity is presented. Safety is always a concern around large trees, and snags are no exception. The human safety and welfare risks of snag preservation need to be carefully weighed against the natural benefits. Streamside or bank snags should be given consideration, like live trees, for structural revetment or stabilization if possible, to keep them from becoming future flood debris and hazards. Fallen snags can always be incorporated into bank stabilization measures as log headers, footers, or benches.

7. Maintenance, Monitoring and Stewardship of Your Improvements

Like all landscape features, stream or bank applications need to be watched. Pre-flood conditions should be assessed in March and April, and with advent of the spring flooding in May and June, modifications to weakened members of an application need attention before May. During the flood, which will last well into June, make frequent observations to assess how the measure is working, or what changes are taking place.

Post flood conditions in July and August may also afford opportunities to assess damage and make modifications. A properly designed feature should require little or no intensive maintenance.

More Valuable with Age...



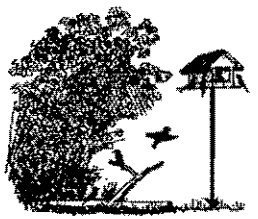
A youthful tree may provide a lush canopy of leaves that shelters a variety of songbirds. As the tree ages and the production of leaves wanes, the tree assumes a different, but important habitat role.

Dead and decaying trees are especially important for wildlife. Without them, some birds and other animals could not exist. In the aging process, the woody portion of a tree begins to soften and develop holes that are used by owls, woodpeckers, or squirrels as nesting or resting cover. As wood become softer with age and decay, woodpeckers excavate their nest sites. Woodpeckers, bluebirds, chickadees, house wrens, nuthatches, tree swallows, American kestrels, flying squirrels, and many other animals are all cavity-nesters that depend on the availability of holes in trees.

The composition of a snag changes during the decaying process, and different mosses, lichens, and insects are attracted. These in turn provide a source of food and nesting materials for wildlife species that reside in and near older trees.

Snags, dead or partially dead trees, are treasured by wildlife and they are the focal point of life and support for many plants, insects, birds, and mammals. Many people who have retained or incorporated snags or branches in their yards report that these are the most often-used elements of their wildlife garden.

If you have a dead or partially-dead tree in your yard, consider it to be a blessing. Remove any branches that might pose a safety threat, and then watch the snag become a center of wildlife activity over the years. If a snag just isn't a possibility for your yard, there are other ways that you can include older tree parts in your wildlife garden.



Rescue dead logs and branches that are set out at the curb or that have blown down in a windstorm, and place them in your yard near food, cover, or water. A branch for perching is especially useful near bird feeders, and logs can be placed among the thicker plantings of shrubs and groundcovers.

In some areas of your wildlife plantings, let the fallen leaves accumulate and decay naturally. These not only help to enrich the soil and conserve moisture, but they also provide nesting, feeding, and hiding opportunities for wildlife species not commonly seen in a back yard.

Look for ways to include all ages of trees and other plants in your yard!

Reprinted from "Creating Landscapes for Wildlife...a guide for back yards in Utah" by Sue Nordstrom,

Salt Lake County Stream Maintenance

For instream improvements, take the time to notify Salt Lake County Flood Control Operations in February or March to evaluate your measures in the process of performing routine stream maintenance activities. This helps the County and it helps you. There is no better deterrent to having a desirable tree removed by Salt Lake County than clear indications of stabilization, support, or revetment on your part. If it's not perceived as a stream flood or debris hazard, the chances are no mistakes will be made. Using bed stakes and bank pins to determine relative rates of erosion on your site will also help the County to determine risk of excessive sedimentation of bank failure.

Stewardship

Although Big Cottonwood Creek is considered a public water conveyance, take a little time to do some routine policing of trash and litter accumulations. It all winds up in larger quantities downstream, so a little upstream preventive maintenance is invaluable. Be aware of how you use pesticides, herbicides, and your on-site disposal practices.

- Big Cottonwood Creek is not the best place to dump your yard waste and grass clippings.
- Chemical lawn "treatment" could also treat your local bird population to an early grave (Ever notice the dead robins after such treatments? It comes from eating poison worms!) The little alert flags to keep your pets off the lawn should also alert you to keep your shoes on!
- Spraying pesticides all over hard surfaces are a quick and free ride for polluting the Creek during the next rain storm.
- Pay attention to how these things can influence the food chain in the riparian environment, and make conscious choices to avoid unnecessary damage to your ecological niche .

The more time and enhancement you contribute to your section of the Creek, the more productive and beautiful the local Creek environment will be. The trees, plants, and wildlife will become more numerous and diverse.

C. Big Cottonwood Project Checklist

The following items should be checked off to help you determine the path and needs for a possible enhancement project on your property or within the Creek channel next to your property. Check the box if "Yes" applies:

Stream Conditions:

- ❑ Has any part of the property experienced recent flooding or flood damage (1982-83)?
- ❑ Does erosion of the bank or any bank failure exist along the Creek next to your property?
- ❑ Is there year-round in-stream flow in the Creek?
- ❑ Has Flood Control Maintenance occurred on your part of the Creek in the last 2 years?
- ❑ Is the Creek channel deeply down-cut with scouring apparent?
- ❑ Is there a partial flood bench, floodplain, or stream setback on your property or in the vicinity?
- ❑ Are there existing flood control structures on the property such as rock, gabions or a flood wall?
- ❑ Is the condition of these structures stable?
- ❑ Are the structures unstable, breaking down, cracked, or moved?
- ❑ Is a repeated pool & riffle pattern apparent along the stream course?
- ❑ Is the stream course dominated only by riffles?
- ❑ Does an opportunity exist to enhance the fishery habitat using in-stream applications? (If so, see Stream Applications)

Bank Conditions:

- ❑ Is there overhanging vegetation that provides cover and shade for pools or fish resting areas?
- ❑ Is there a preponderance of native riparian (streamside) vegetation providing bank stability and wildlife habitat?
- ❑ Is the landscape dominated by introduced ornamental grasses, shrubs, and trees?
- ❑ Is there adequate space between the Creek and the nearest structure to allow grading or flattening of the upper bank zone?
- ❑ Does an opportunity exist to enhance the landscape with bank modifications and introduction of native vegetation? (If so, see Bank Applications.
- ❑ Does your backyard require visual screening or additional yard enhancements or beautification? (If so, see Section on Your Back Yard)
- ❑ Will any of these measures require permits from Holladay City, Salt Lake County, State of Utah, or Army Corps of Engineers?

SECTION III. USEFUL INFORMATION

A. Glossary

Adsorption Assimilation of gas, vapor, or dissolved matter by the surface of a solid or liquid.

Aggradation The raising of a stream-channel bed with time due to the deposition of sediment that was eroded and transported from the upstream watershed or the channel.

Armoring Formation of a layer of rocks on the surface of a streambed that resists erosion by water flows. The rocks can be naturally occurring, caused by the scour of smaller particles from high discharges, or placed by humans to stop channel erosion.

Bankfull See "Seasonal high flow."

Bar A deposit of sand or gravel deposit found on the bed of a stream, normally found on the inside of bends or curves, that is often exposed during low-water periods.

Bed The bottom of the channel.

Bedload Sediment particles up to rock, which slide and roll along the bottom of the streambed.

Bed slope The inclination of the channel bottom.

Butt end The bottom end of a cutting taken from a riparian plant that will root if planted in soil (it is opposite the budding tip's end of the cutting).

Bio-uptake p6

Cut bank The outside bank of a bend, often eroding opposite a point bar.

Degradation The lowering of a stream-channel bed with time due to the erosion and transport of bed materials or the blockage of sediment sources.

Discharge The volume of water passing through a channel during a given time, usually measured in cubic feet per second (cfs).

Drainageways Small depressions, natural or humanmade, that carry water only after a rainfall. Also called a swale.

Emergent bench Low lying stream bank terrace within the seasonal high flow channel that is inundated or saturated during spring runoff.

Emergent vegetation Wetland plants that are the most characteristic of marshes - cattail (*Typha* sp.), bulrush (*Scirpus* sp.), rush (*Juncus* sp.), sedges (*Carex* sp.) - typically occurring in shallow water and most having long, erect linear leaves.

Entrenchment See "Incised channel."

Eutrophic Relatively high concentration of nutrients that produce an algae bloom, reducing water clarity and depleting oxygen.

Failure Collapse or slippage of a large mass of bank material into a stream.

Fill material Soil that is placed at a specified location to bring the ground surface up to the desired elevation or angle of slope. Same as infill.

FIRM map Flood insurance rate map used to establish the insurance rates for structures under the National Flood Insurance Program.

FEMA The Federal Emergency Management Agency is an executive branch federal agency in charge of emergency preparedness and disaster relief. They provide a flood insurance program based on the Flood Insurance Rate Maps (FIRM).

Floodplain A plain bordering a stream, subject to flooding. The land adjacent to a channel at the elevation of the bankfull discharge, which is inundated on the average of about 2 out of 3 years. The floor of stream valleys, which can be inundated by small to very large floods. The one-in-100-year floodplain has a probability of .01 chance per year of being covered with water.

Floodway A regulatory floodplain under the National Flood Insurance Program that includes the channel and that portion of the adjacent floodplain that is required to pass flood flows (normally the one-in-100-year flood) without increasing the water surface elevation more than a designated height (1 foot in most areas).

Flow regime The amount and frequency of water in a stream and its affects over time.

Gabion Wire mesh box filled with rock used to armor stream banks.

Geomorphic Pertaining to the study of the earth, its shape, or surface configuration.

Gradient Steepness of streambed. Ratio of elevation and distance

Hydrogeomorphology The geological study of the configuration and evolution of land forms by water.

Hydrophyte A plant growing in and adapted to aquatic or very wet environment

Incised channel A stream that has degraded and cut its bed into the valley bottom. Indicates accelerated and often destructive erosion.

Lifts Layers of loose soil. Used to specify how much loose soil should be laid down at a time before it must be compacted or wrapped in geotextile fabrics.

Low flow The flow that a perennially flowing stream reduces to during the dry season. It is supported by ground water seepage into the channel.

Meanders A sinuous channel form in flatter river grades formed by the erosionon one side of the channel (pools) and deposition on the other (point bars).

Mulch A substance placed over the soil surface to inhibit weed growth and conserve moisture. Examples include straw, wood chips, and leaves.

Mesotrophic Balance of plant nutrients in aquatic habitat.

Nonpoint source pollution Pollutants that are released into ground water, streams, rivers or lakes from a wide area rather than a single discharge point such as a pipe.

Oligotrophic Water deficient in plant nutrients.

Omnivore An animal that eats both plant and animal substances.

Palustrine Emergent wetlands often dominated by grass-sedge plant communities. These areas are also referred to as marshes or swamps

Perennial flow A stream that has water flowing all year, every year.

Pool and riffle ratios A sequence of pools and riffles. A stream in balance with its rate and depth of flow will have pools and riffles occurring in a certain number and distance of each other within a stream reach.

Pool A deep place in a stream typically on the inside of a bend or behind instream debris where fish gather.

Reach A section of a stream's length.

Revetment A facing of stone, bags, blocks, pavement, etc., used to protect a bank against erosion.

Rhizomatous plants Plants with rootlike horizontal stems growing under or along the ground that sends out roots from its lower surface and leaves or shoots from its upper surface. Rhizomatous plants help bind soil and protect it from active erosional forces such as floods.

Riffle A stretch of choppy water caused by rocks, gravel or sandbars, just below the surface of a stream. A shallow rapid, usually located at the crossover in a meander of the active channel.

Riparian Of, on or pertaining to the bank of a stream, river, pond or lake. Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation

Riprap Heavy stones used to protect soil from the action of fast-moving water.

Riverine wetland See "Riparian"

Run A non-choppy, swift stream flow down and through the channel.

Scour The erosive action of the flowing water in streams that removes and carries away material from the bed and banks.

Seasonal high flows The channel-forming discharge, which is equivalent to the bankfull discharge, responsible for the active channel that erodes and deposits, creates pools, riffles, and meanders. The discharge , in terms of flood frequency, usually has a return period or recurrence interval of 2 years in natural channels. This represents a flow condition where the stream flow completely fills the stream channel up to the top of the bank before overflowing onto the floodplain.

Sediment Soil particles that have been transported from their natural location by wind or water action.

Sediment deposition The accumulation of soil particles on the channel bed and bank.

Sediment load The soil particles transported through a channel by stream flow.

Seepage Ground water emerging on the face of a stream bank.

Sinuosity The shape and amount of curves, meanders, within a stream reach.

Soil bioengineering Also referred to as biotechnical slope protection. Involves the use of live and dead woody cuttings and poles or posts collected from native plants to revegetate watershed slopes and stream banks. The cuttings, posts, and vegetative systems composed of bundles, layers, and mats of the cuttings and posts provide the structure, drains, and vegetative cover to repair eroding and slumping slopes.

Snag Standing dead trees.

Terrace A flat, narrow stretch of ground, often having gentle or steep slopes, facing a stream. An abandoned floodplain that is located at a higher elevation than the current active floodplain.

Toe The break in slope at the foot of a stream bank where the bank meets the bed.

Top of bank The break in slope between the bank and surrounding terrain.

Thalweg The central, usually deepest and rapid, flow-line of a stream.

Vortex rocks Rocks placed in a streambed to help direct flows for the formation of meanders and creation of riffles and pools. The rocks are so named for their ability to contribute to sediment transport through the channel.

Watershed An area confined by topographic divides that drains a given stream or river.

Water table The depth below the surface of the ground where the soil is saturated (the open spaces between the individual soil particles are filled with water).

Wetland Wetlands are a transition between terrestrial and aquatic systems, where water is the dominant factor determining development of soils and associated biological communities and where, at least periodically, the water table is at or near the surface, or the land is covered by shallow water.

Wetland plants Plants capable of growing in an environment that is periodically but continuously inundated for more than 5 days during the growing season. Plants that grow in water or saturated soils at least part of the year.

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C. Resource List and Permits

1. Facilities and Programs

Recycling Hotline 974-6902
Hours 8:00 am - 4:30 pm M-F
www.slvswmf.net

Household Hazardous Waste Facilities
Salt Lake County residents can bring their household hazardous waste to the facility and it will be taken off their hands for **free!**

1) Salt Lake Valley Solid Waste Facility at 6030 W. 1300 S.

2) Trans Jordan Landfill at 10873 S. 7200 W.

Both are open Monday through Saturday from 8:00 am to 4:00 pm.

3) Murray Public Works A.B.O.P.
Only Antifreeze, Batteries, Oil and Paint (A.B.O.P)
Open Monday thru Friday 7:00 am to 3:00 pm.

Green Waste Disposal
Salt Lake County residents can bring their yard debris *(tree branches, leaves, grass clippings)* to recycle in the Salt Lake Valley Landfill Composting Program. Both are open Monday through Saturday; hours change *seasonally; minimal charge required, call for information.*

1) Salt Lake Valley Solid Waste Facility at 6030 W. 1300 S., **974-6922**

2) Trans Jordan Landfill at 10873 S. 7200 W., **569-8994**

Salt Lake County Sanitation Division provides **leaf bags and drop off locations** in the fall for residents of unincorporated County and the city of Holladay. The collected leaves are used in the Salt Lake Valley Landfill Composting Program . For more information call **562-6435**.

Murray City provides **dumpsters for yard debris**. For more information call **270-2440.**

Prevent Pollution–Recycle Oil
To find out where you can properly dispose of used oil for free recycling call **1-800-458-0145**
Utah Department of Environmental Quality
Division of Solid and Hazardous Waste

Put Used Oil In It's Place!

Used oil recyclers
Pep Boys Stores — AutoZone Stores
Jiffy Lube — NAPA Auto Parts
Checker Auto Parts Stores
The preceding list is not all encompassing nor does it constitute an endorsement by Salt Lake County of any particular company

Salt Lake County Stormwater Coalition
Salt Lake County has developed a Storm Water Management Program to educate local residents and businesses and to improve the quality of storm water runoff.

Pamphlets available describing storm water protection measures for specific types of activities:
-Landscaping, Gardening and Yard Maintenance
-Fresh Concrete and Mortar Application
-Erosion Control
-Paint and Household Hazardous Waste
-Pet Waste and Water Quality
-Household and Vehicle Maintenance

Markers like this one are being applied to the curbs in your neighborhood to remind us that stormdrains connect directly to nearby streams and other waterways with no treatment.
What goes down the drain ends up in a creek! If you are interested in helping to install markers in your neighborhood, *or for more information about the Salt Lake County storm water quality management program and pamphlets, contact:*

Salt Lake County Engineering Division
(801) 468-2711

Visit the Salt Lake County Stormwater Coalition webpage:
www.stormwatercoalition.org
or email: pwengineering@co.slc.ut.us

2. Plan Approval and Permits

Floodplain Information
Salt Lake County Engineering **468-2779**

Engineering Design Review and Approval
Salt Lake County Engineering **468-2779**

Plan Approval and Permits
Utah Division of Water Rights
Stream Alteration Permit **538-7404**

U.S. Army Corps of Engineers Regulatory Division
295-8380

Salt Lake County Plan Approval and Permit **468-2779**

3. Printed Information About Trees, Landscaping and Wildlife

Department of Natural Resources Map and Book Store
1594 W. North Temple, Salt Lake City
537-3320
www.mapstore.utah.gov

Landscaping for Wildlife...A Guide for Back Yards in Utah
Available for **free** at the Div. of Wildlife Info. Desk
Department of Natural Resources Building
1594 W. North Temple, Salt Lake City
538-4700

International Society of Arboriculture
(217) 355-9411
www.isa-arbor.com

USU Extension Service
2001 S. State St., Suite S1200, Salt Lake City
468-3170
www.extension.usu.edu

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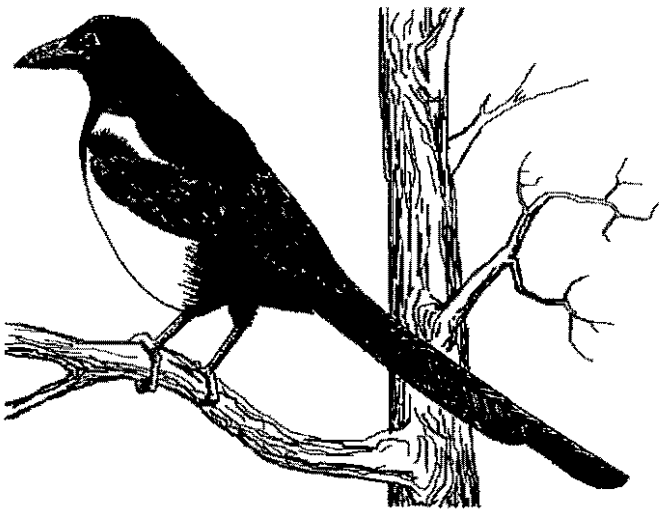

Salt Lake County Engineering Division
2001 South State Street, Suite N3100
Salt Lake City, UT 84190-4600
(801) 468-2711

SALT LAKE COUNTY

Visit the Salt Lake County Stormwater Coalition webpage:
www.stormwatercoalition.org
or email: pwengineering@co.slc.ut.us

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WE ALL LIVE DOWNSTREAM

Spill Response

Dial 911
-or-
State of Utah
Environmental Response
(801) 536-4123

Report Fish Kills

Division of Wildlife Resources
(801) 662-3337

Local Pollution Control Agencies

Utah Division of Water Quality
(801) 538-6146

Salt Lake Valley
Health Department
(801) 313-6700
Emergency Response
(801) 580-6681

Salt Lake County
Engineering Division
(801) 468-2711

Recycling Hotline
(801) 974-6902

Put Used Oil In Its Place!

1-800-458-0145