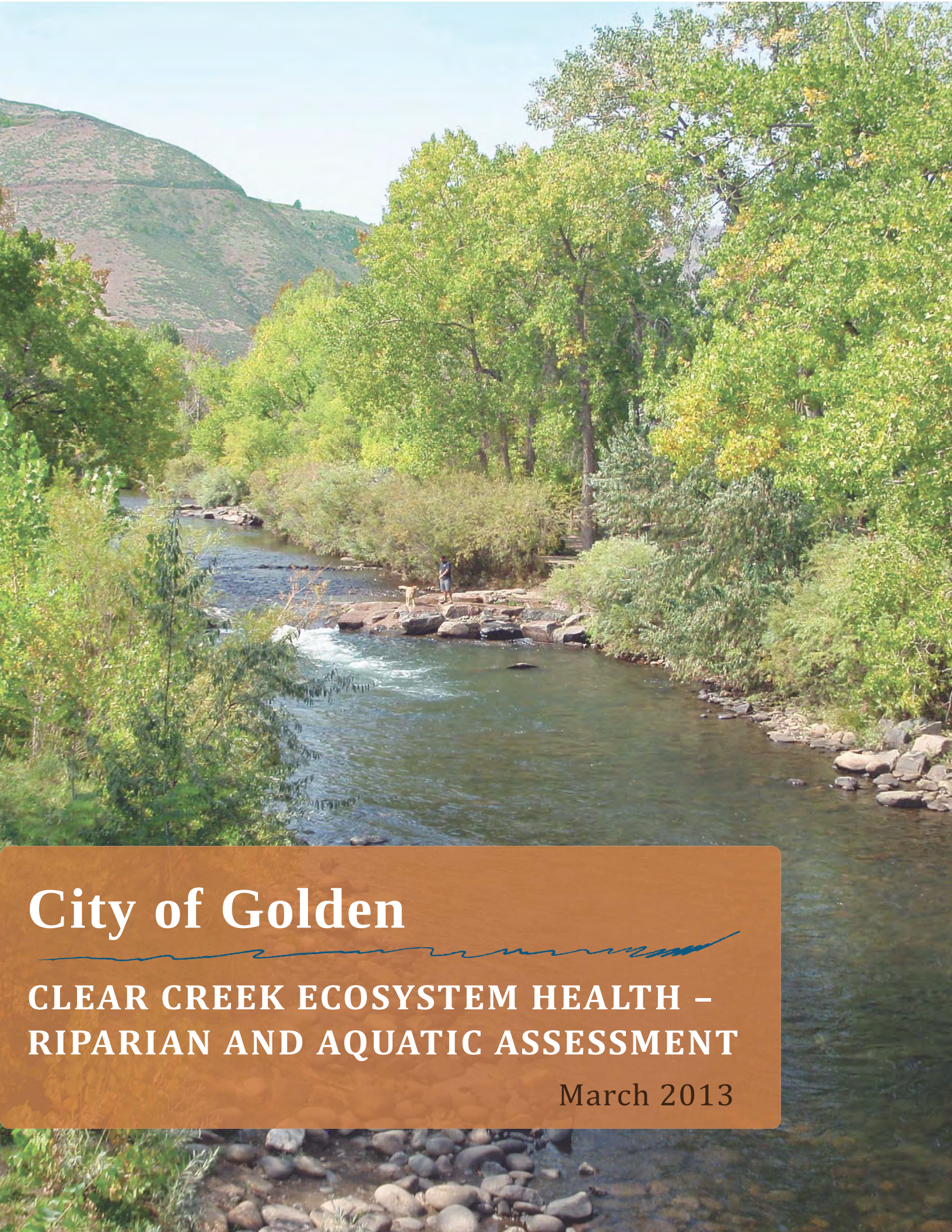

# City of Golden

## CLEAR CREEK ECOSYSTEM HEALTH – RIPARIAN AND AQUATIC ASSESSMENT

March 2013

# CITY OF GOLDEN

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# I. INTRODUCTION

## A. Project Purpose

Clear Creek serves as an integral component of the City of Golden (City). The City in recent years has undertaken significant efforts in developing the Clear Creek corridor as a recreational and natural focal point for the City.

The recently completed Clear Creek Corridor Master Plan (Master Plan) (Wenk Associates 2011) summarizes that the Clear Creek corridor serves not only the citizens of Golden but also has a regional and national draw primarily due to the popularity of water sports along the stream. The Master Plan is shaped by six key goals; 1) create a continuous linear park; 2) improve pedestrian connectivity, access and reduce user conflicts; 3) identify the optimal vehicular circulation and parking; 4) improve the functioning of community gatherings in the corridor; 5) identify the long term uses strategies within the corridor and 6) improve parkland and recreation facilities; maintain a local focus.

Through improvements and planning the corridor has developed into an extremely successful public amenity as observed by high year-round recreational and visitor use. This high recreational use and great demand periodically exceeds the corridor's capacity. A growing concern has developed that when high recreational use exceeds capacity, not only does user conflict increase and experience quality decrease, but the riparian and aquatic ecosystem health may also be significantly at risk.

While the Master Plan presents key concepts and uses of the corridor, it was not intended to provide a detailed assessment of the ecological condition or integrity of the corridor. Ecological Resources Consultants, Inc. (ERC) was contracted by the City to conduct an overview assessment of the corridor in the context of riparian and aquatic ecosystem health as well as provide potential ecosystem protection and management strategies. The following report provides a scientific assessment of the corridor based on existing conditions and offers recommendations which can be used by the City in future planning decisions regarding management, maintenance and enhancement of the Clear Creek corridor.

**View of Clear Creek and riparian corridor from Billy Drew Bridge (October 2012).**

## B. General Project Area

The Project Area is located in the City of Golden, which is situated approximately 15 miles to the west of Denver along the foothills of the Rocky Mountains. Clear Creek flows from the Rocky Mountains to the northeast through the center of the City (**Figure 1**). The Project Area, considered as part of this assessment, encompasses the Clear Creek corridor from the Washington Street bridge extending upstream approximately 4,100 feet (0.78 miles) to the west side of the Highway 6 bridge (**Figure 2**). Within the Project Area, Clear Creek flows through a variety of land use types including parks and open space, residential neighborhoods, the Colorado School of Mines (CSM) property and the central business district. The level of use within the Project Area is largely based on the predominant activity types within each land use area. The lowest use within the Project Area occurs along the south side of the stream, east of Hwy 6. This area consists largely of undeveloped land on the CSM property, a steep hillside with no adjacent structures, Clear Creek History Park and a new, multiuse, paved recreational trail. The new City trail will bring increased public use to this area and intensify pressures not experienced previously. Both the north and south sides of the stream, to the west of Hwy 6, are low to moderate use areas encompassed by parks and open space (north) or light residential development (south). The Grant Terry Trail, a 15 foot wide, compacted dirt trail runs along the north side of the corridor through this area. The highest use areas occur on the north side of the stream, east of Hwy 6 and include a variety of active recreational activity areas (i.e., Clear Creek White Water Park, Lions Park/ball fields, etc.), civic uses (Golden Library, Golden History Museum, City Hall), and other specialized use areas (i.e., Clear Creek RV Park, water treatment area). The Clear Creek Trail, which runs along the north side of the stream is heavily used and provides the primary public access along the corridor.

**Figure 1. Project Area Vicinity Map.**

**Figure 2. Project Area Location Map.**

# II. ISSUE OF CONCERN

The primary issue of concern forming the basis of this assessment is that high recreational use, during extended periods of low stream flows, as observed in late summer months, may exceed ecosystem capacity therefore resulting in potential degradation to the riparian and aquatic environment.

Recreational use occurs year-round within the Project Area, and includes a wide variety of activities such as kayaking, tubing, fishing, walking/biking/trail use, gold panning, and other general passive water related activities (i.e., wading, swimming, dog swimming, lounging and picnicking). While detailed recreational/visitor use data is not available, City staff has identified the following use trends: (1) kayak use of the white water park generally tends to coincide with higher flow periods beginning in early spring months as snowpack melts and runoff increases extending into early summer, as flows decrease, kayak use also decreases, (2) tubing generally tends to occur during safer low flow periods and warmer air temperatures of late summer (after kayak use), (3) more passive water related activities also tend to peak during low flow and warm air periods in late summer.

**Kayaking Clear Creek White Water Park (photo source City of Golden).**

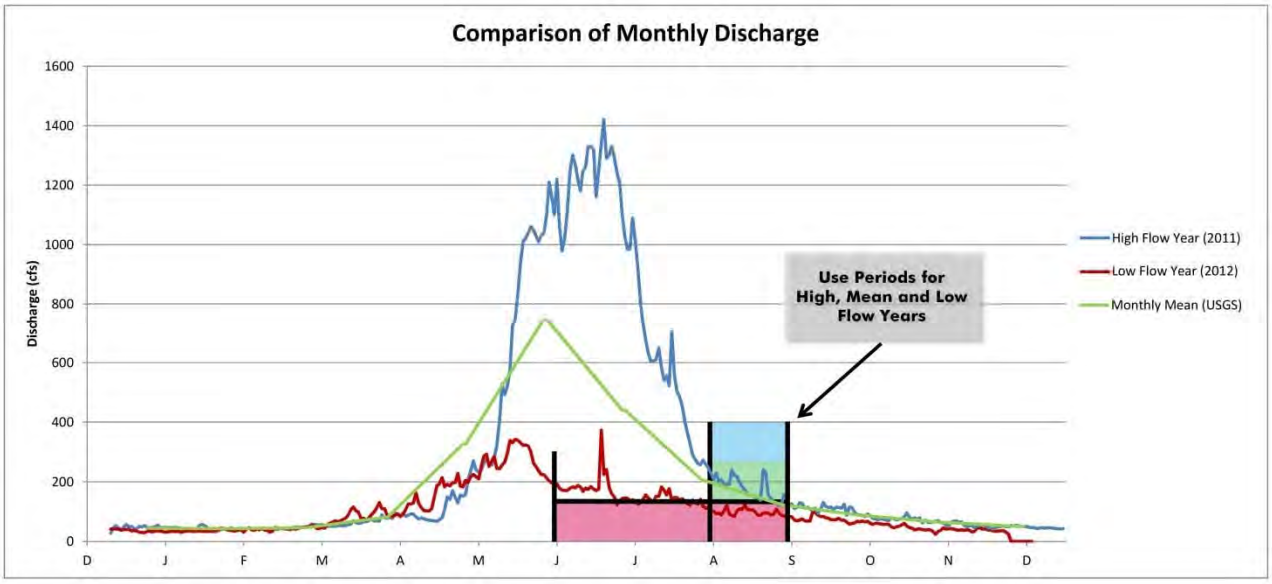
In an ideal situation, natural seasonal distribution of recreational uses can help to reduce conflicts and ecosystem capacity issues. During most of the year, the Clear Creek corridor adequately supports high recreational use periods with little concern. However, because late summer months typically provide the most suitable weather for the greatest number of recreational activities, a growing concern has developed over pressures from user conflicts and observable direct damage to the riparian and aquatic environment. During high recreational use periods, City staff has noted excessive public use resulting in trampled riparian vegetation, creation of informal trails, streambank erosion, damage to existing infrastructure, increased trash as well as a decline in user experience.

Ecosystem capacity concerns can occur during peak recreational use periods when many overlapping activities occur and stream flows are at their lowest. In comparing flow records (US Geological Survey (USGS) Station 06719505 Clear Creek at Golden, CO) the highest recreational use periods have been observed by the City during periods of low flow and high temperatures, typically during late summer months.

In taking a more detailed look at stream flow data specific to the Project Area, lower flows generally occur during the warmest summer months, which also tends to correspond to high recreational use periods. During years of average to high flow, such as in 2011, the period of high recreational use is much less, generally extending only from August to September. However during years with flows below average, such as in 2012, the high recreational use period can extend much longer, generally from June

through September. The figure below shows recorded average and minimum mean daily flow values through the Project Area (**Figure 3**).

**Figure 3. Recreational Use Periods and Flow Hydrograph.**




Source: USGS Station #06719505 Clear Creek at Golden, CO

This situation of an extended period of low flow combined with high recreational use has been noted as the primary issue of concern and the period when the most extensive directly observable damage occurs in the corridor. As a result of these concerns, this assessment was developed to evaluate the health of the riparian and aquatic environment, and determine the extent that excessive public recreational use has and might continue to further degrade the Clear Creek corridor ecosystem. This assessment has been structured to first evaluate the existing conditions within the corridor, identify site specific issues of concern, determine the extent or severity of issues and then provide recommendations for potential corrective actions.

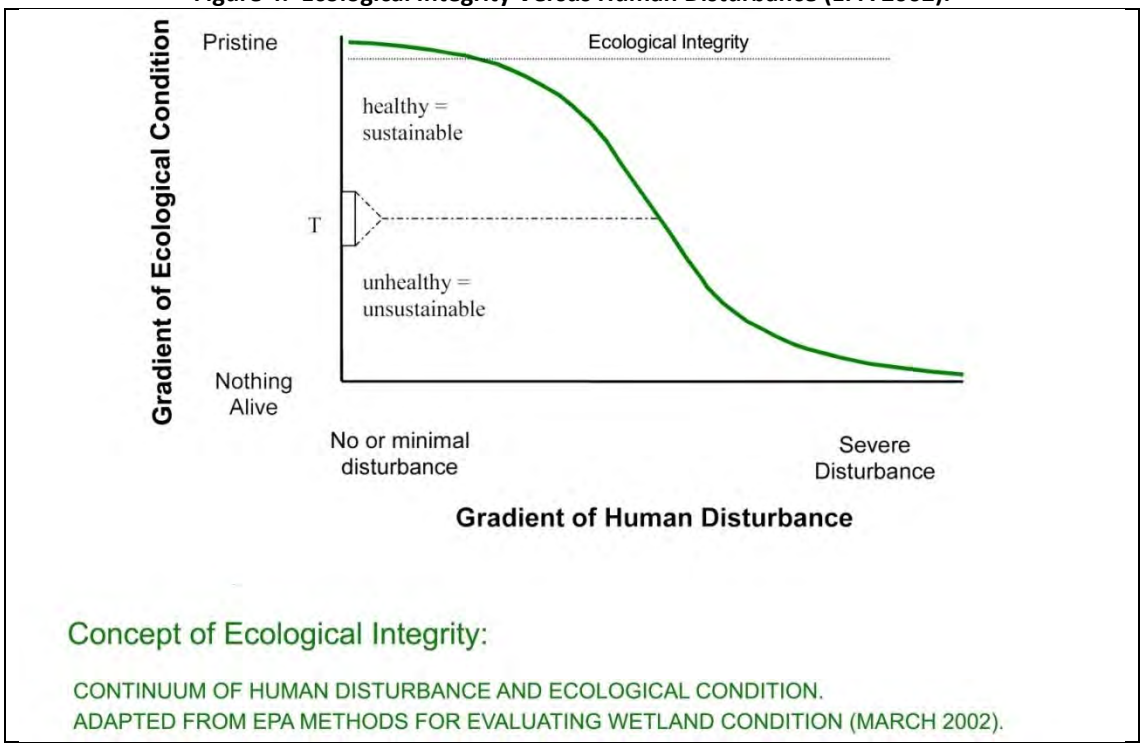
- **Photo examples of Project Area capacity concerns during peak recreational use period (Summer 2012).**
- **Photos show many overlapping activities such as swimming, tubing and wading when stream flows are lowest.**
- **Observable damage to riparian and aquatic environment from trampled vegetation, creation of informal trails and streambank erosion.**

# III. CONCEPT OF ECOLOGICAL INTEGRITY

The concern over periods of high recreational use exceeding ecosystem capacity directly resulting in degradation, specifically, to the riparian and aquatic environments, has been well studied and documented in the scientific literature (Parrish, Braun et al. 2003, EPA 2002). The concern of over-use or "loving it to death" has become a growing problem in many communities throughout the country and in particular Colorado. In more recent years, communities have begun to promote or focus activities towards natural areas as active lifestyle populations increase. This recreation trend, combined with increasing populations results in added pressures on the natural ecosystems. Many local communities are finding that a balance needs to be maintained between riparian and aquatic health and recreational use.

To evaluate the health of the riparian and aquatic environment, this assessment used the Environmental Protection Agency (EPA) concept of ecological integrity (EPA 2002). Ecological integrity is the concept that when all ecological characteristics (i.e., elements of composition, structure, function, and ecological processes) are in a natural state, the system will support and sustain a community of organisms (Parrish, Braun et al. 2003). The ecological integrity of an area can be measured against the level of human disturbance that is occurring (refer to **Figure 4**). Areas of "high" ecological integrity would be in a pristine, healthy and stable state and would be considered a reference condition. In comparison areas with "low" ecological integrity would be severely disturbed, unhealthy and unsustainable, no longer functioning in their original state. In all ecosystems there is a threshold limit (indicated in **Figure 4** by the "T") at which time human disturbance or stressors influence an ecosystem from a healthy sustainable condition towards an unhealthy and unsustainable condition.

**Figure 4. Ecological Integrity Versus Human Disturbance (EPA 2002).**



Stressors can influence the ecological integrity of an area and the premise that the aquatic and riparian environments will respond to stressors and that human disturbance will remove a riparian environment from a healthy sustainable condition has been supported through both scientific articles and publications from regulatory agencies (Darnell 1976, EPA 2001). Stressors can have widespread impacts on an ecosystem but may also occur in discreet areas leaving a mosaic of habitats with low or high ecological integrity.

Ecological integrity is typically measured with respect to undisturbed reference condition. However, the ecological integrity of reference sites in urban landscapes differs from those in undisturbed conditions. Within the context of an urban landscape, the reference condition would represent the best possible condition that the urban landscape might achieve in the region. Urban corridors may include incised stream channels, steep banks, toe erosion, impervious surfaces, or infrastructure such as installed riprap (Patti Banks Associates and Applied Ecological Services, Inc. 2006).

Within the Project Area are distinct areas subject of intense human disturbance and other areas which appear relatively undisturbed. Stressors most relevant to the Project Area include recreational use, a bisecting major highway (Hwy 6), designated trails and pedestrian bridges, urban development, informal social trails, failing or damaged infrastructure, streambank erosion, artificial banks, instream white water park structures, channelization, water diversions, and point source pollution. While intact portions of the riparian corridor still exist, the habitat fragmentation that has occurred represents a degradation of the corridor as a whole. As the loss of ecological integrity is proportional to the level of human disturbance (stressors), ecological integrity will continue to decline in the face of persistent stressors. This concept of stressors influencing ecological integrity is the underlying principle of this assessment and has been utilized for the existing conditions assessment presented in **Section V.**

# IV. EVALUATING THE RIPARIAN AND AQUATIC ENVIRONMENT

The following section provides the context in which the Project Area riparian and aquatic environment was assessed. Because so much variation exists with semantics in riparian terminology (Fischer et al. 2001), this section summarizes the definitions used for riparian and aquatic environments, outlines the significance of these habitats and describes the primary issues of concern within the Project Area.

This assessment has focused primarily on the physical condition of the riparian environment and secondarily on the potential influences to the aquatic environment. The following provides the basic concepts considered as part of this assessment for each natural resource.

## A. Riparian Environment

The riparian environment or a riparian corridor is defined as the transitional area between upland terrestrial and aquatic habitats. A riparian corridor encompasses the stream channel and that portion of the landscape from the ordinary high water mark towards the adjoining uplands, that affect or are affected by the presence of water. Riparian corridors typically comprise a small percentage of the landscape, often less than one percent, yet they frequently support a disproportionately high number of wildlife species and perform a disparate number of ecological functions when compared to most upland habitats (Fischer and Fischenich 2000).

**The riparian environment serves many purposes including:**

- Restoring and maintaining the chemical, physical and biological integrity of the stream;
- Removing pollutants from stormwater runoff;
- Reducing erosion and sediment entering the stream;
- Reducing future flood hazards;
- Stabilizing stream banks;
- Providing infiltration of stormwater runoff;
- Maintaining the base flow of streams;
- Contributing the organic matter that is a source of food and energy for the aquatic ecosystem;
- Providing tree canopy to shade streams and promote desirable aquatic organisms;
- Providing riparian wildlife habitat; and
- Creating community and neighborhood amenities by furnishing scenic value and recreational opportunity (Patti Banks Associates and Applied Ecological Services, Inc. 2006).

Properly functioning riparian corridors of high ecological integrity contain an unfragmented, structurally diverse vegetation community, typically composed of trees, shrubs and grasses (**Figure 5**) that are native to the region and that are adapted to the climatic, soil, and hydrologic conditions (USACE 2000). Dense vegetation overhanging the stream provides aquatic habitat benefits through shading the water, decreasing overall water temperatures and providing overhead cover. In an ideal situation, natural stream flows are able to access a broad floodplain. These well vegetated riparian environments provide important terrestrial wildlife habitat within an otherwise urban landscape setting, provide aquatic habitat benefits, soil stabilization, and reduced problems from erosion, flooding and nutrients. A properly functioning riparian corridor protects the physical integrity of the aquatic environment.

Unfortunately, many riparian corridors of the Front Range no longer function properly (i.e., they are degraded to the point that they no longer protect the physical integrity of the stream ecosystem). This degradation also negatively affects many of the other important functions and values these landscape features provide, in particular the aquatic environment.

- Vegetation is one of the key ingredients to a healthy and properly functioning riparian corridor.
- Within the Front Range, the typical high ecological integrity community would consist of patches of cottonwoods in the canopy layer, with sandbar willow along the stream edge and grasses, such as switchgrass and prairie cordgrass, between cottonwood clumps.

Specific to the Project Area, the condition of the riparian corridor has been dramatically altered from its natural state. Historic channelization, water diversions, urban encroachment, instream white water park features, riprap streambanks and bridge crossings have altered the natural hydrological regime and the historic floodplain that maintain the riparian environments. Within such urban settings, the functions of the riparian environment can become impaired from modified vegetation, altered channel morphology, and increased pollutants which in turn may lead to flooding concerns, accelerated bank erosion, decreased water quality, decreased aquatic habitat function and overall reduced biodiversity (Walsh et al. 2005). Scientific research has demonstrated that the benefits of riparian corridors are maximized when they extend at least 75 feet from the streambank. (Montgomery County Planning Commission 2006). Within the Project Area the width of the riparian corridor ranges from approximately 10 feet to 200 feet wide.

Therefore, the primary issue of concern considered as part of this assessment is the integrity of the existing riparian corridor.

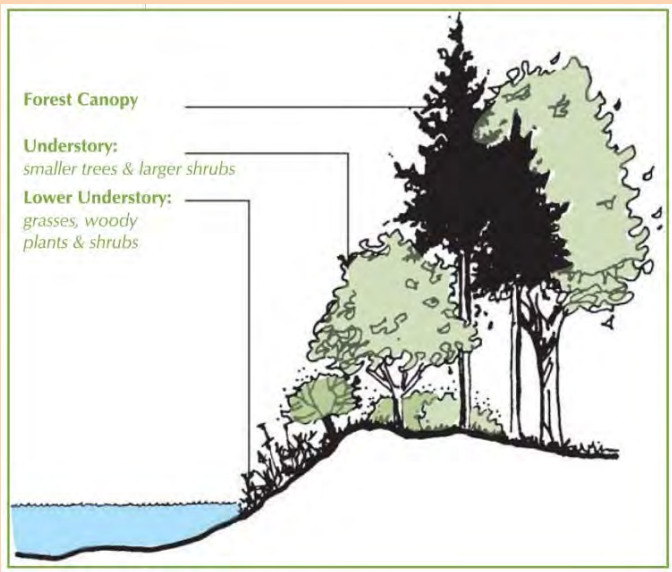



**Figure 5. Natural riparian corridors of high ecological integrity typically contain three distinct layers of vegetation – forest canopy of trees, understory of shrubs and a lower understory of grasses. (Montgomery County Planning Commission 2006)**

**Example of high ecological integrity, riparian forest habitat within the Project Area - dominated by cottonwood overstory with willow and grass understory.**

## B. Aquatic Environment

The aquatic environment is defined as the natural ecosystem which is either permanently or periodically under water (i.e., within the ordinary high water mark of the stream channel). Healthy aquatic habitats provide a variety of ecologic, social and economic benefits. The State of Colorado classifies water bodies for beneficial uses that, along with chemical and physical standards, assures their protection. Clear Creek (Segment 11) through the Project Area is designated as Aquatic Life Cold 1 by the Colorado Department of Public Health and Environment (CDPHE). These are waters that (1) are currently capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters should be considered capable of sustaining such biota where physical habitat, water slows or levels, and water quality conditions result in no substantial impairment of the abundance of diversity of species.

As discussed above, impairments to the aquatic environment are typically a result of human induced stressors. As stressors increase the ecological integrity of the aquatic environment generally tends to decrease. One indicator of ecological integrity within the aquatic environment can be inferred from the type and abundance of aquatic life present.

Studies of fish populations within the Project Area have been conducted by the Colorado Division of Parks and Wildlife (CPW) since 1979 (CPW 2012). During the earliest studies (1979), the fish species present were primarily native suckers, minnows, and chubs. The Argo Treatment plant in Idaho Springs began treating metals-laden water from the Argo Tunnel in 1998. Since the initiation of water treatment, trout populations downstream of Idaho Springs and within the Project Area have generally improved (CPW Fish Survey and Management Data). By 2002 the fish species present within the Project Area were brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), white sucker (*Catostomus commersonii*), and longnose sucker (*Catostomus catostomus*). While rainbow and cutthroat trout have been stocked in Clear Creek since at least 2005, the latest survey, conducted in 2011 above Ford Street, found only one species, brown trout (CDOW 2011).

One common method for assessing the general quality of the aquatic environment is to identify a representative species of interest and then assess specific life requirements present within a study area. Based on CPW fish data, brown trout can be considered a representative species and an important component of recreational activities as a game species within the Project Area. Using brown trout as a representative species, information from the US Fish and Wildlife Service (USFWS) Habitat Suitability Index (Raleigh et al. 1986) can be applied to determine the condition and quality of the aquatic environment for the species within the Project Area. The most critical brown trout habitat variables applicable to the Project Area are related to low stream flows which can affect water quality (temperature and dissolved oxygen) and riparian cover. Optimal brown trout riverine habitat is characterized by clear, cool to cold water; a relatively silt-free rocky substrate in riffle-run areas; a 50% to 70% pool to 30% to 50% riffle-run habitat combination with areas of slow, deep water; well vegetated, stable streambanks; abundance instream cover; and relatively stable annual water flow and temperate regimes (Raleigh et al. 1986). While a detailed Habitat Suitability Index was not conducted, the general principles and associated data can be referenced as they apply to conditions within the Project Area and are discussed as follows.

Trout serve as good "indicators" of aquatic health because they have very specific water chemistry requirements and are extremely sensitive to water quality and water temperature (Trout Unlimited 2012).

Seasonal low flows are a naturally occurring cycle of western streams. However due to induced alterations these flow conditions can become highly exacerbated. Extreme low stream flows can have a detrimental effect on the quantity and quality of both the riparian and aquatic environment. In regards to the riparian environment, prolonged low flow condition can result in changes to native riparian vegetation species composition, loss of required soil moisture and lack of species regeneration. From an aquatic environment perspective, low flows can increase levels of sediment, nutrients and concentrate pollution in streams creating a toxic environment for aquatic life as concentrations rise (USDA 2012, Trout Unlimited 2012).

As water warms, the amount of dissolved oxygen (DO) within the water decreases proportionally. This decrease in DO can adversely affect aquatic organisms including game species like brown trout and other non-game native fish species. As a general rule, brown trout for example, have an optimal temperature requirement range for good growth and survival between 53.6 degrees Fahrenheit (˚F) to 66.2˚F (Raleigh et al. 1986). The upper limiting, near lethal water temperature for brown trout is 80.96˚F and typically cannot tolerate sustained water temperatures above 77˚F (Raleigh et al. 1986).

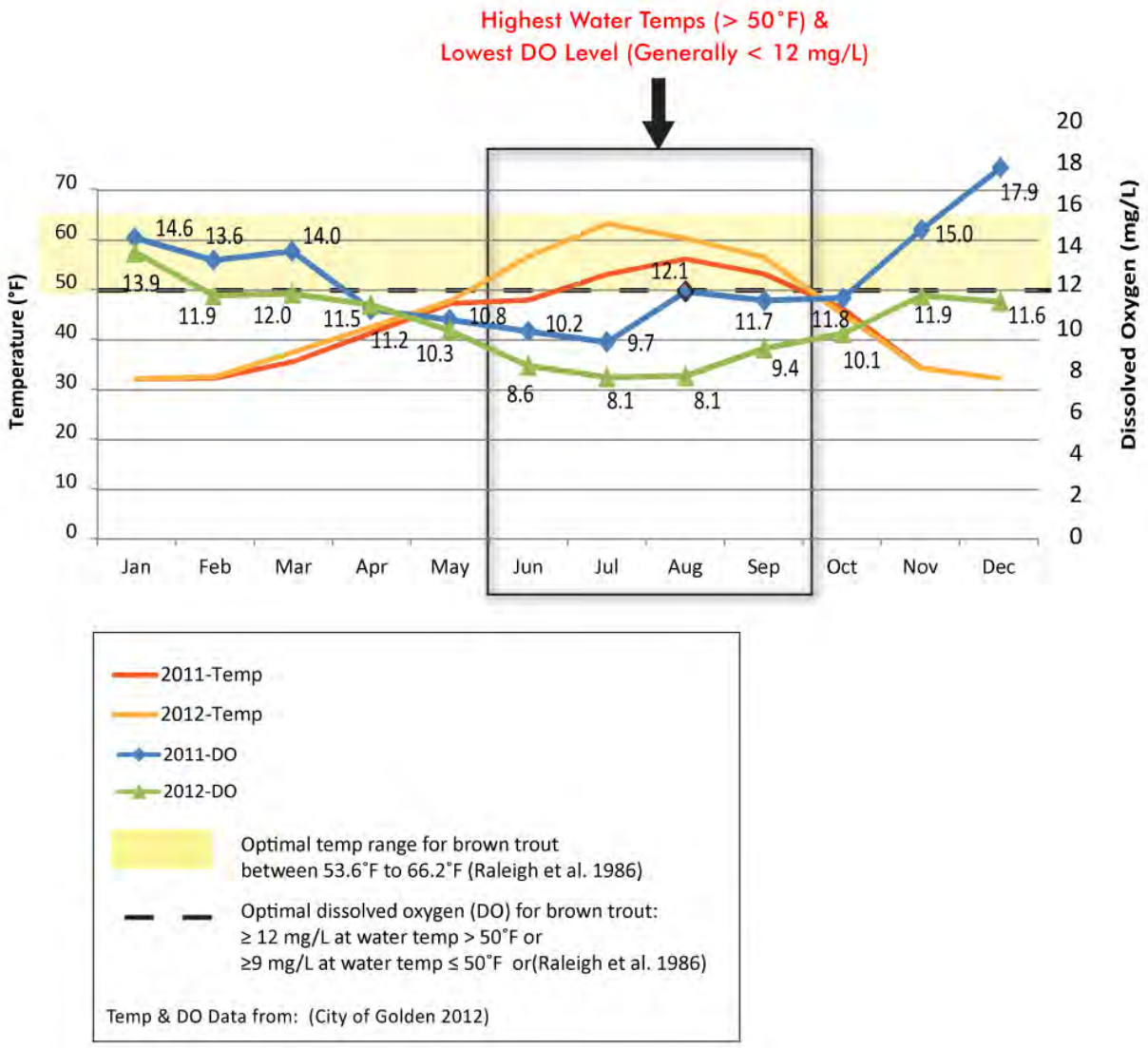
Optimum DO levels for brown trout are not well documented, but appear to be optimal at greater than or equal to 9 milligrams per liter (mg/L) at water temperatures less than or equal to 50˚F and greater than or equal to 12 mg/L at temperatures greater than 50˚F (Raleigh et al. 1986).

Specific to the Project Area lower flows generally occur during the warmest time of the summer. **Figure 6** below summaries stream monitoring data for the Project Area from 2011 and 2012 (City of Golden 2012) and illustrates that from approximately July through September in 2011 and June through September in 2012, stream temperatures were their highest at greater than 50˚F and correspondingly contained the lowest level of DO at less than 12 milligrams per liter. The data also indicates that while stream temperatures are generally within tolerable ranges for brown trout, DO is often below optimal. When stream temperatures exceed 50˚F, DO levels in the stream, during low flow years, generally range from 8.1 mg/L to a high of 9.1 mg/L, well below optimal ranges. The kayak white water park has created an artificial situation where deeper pools are maintained and fish can seek refuge during low flow situations. While these refuge pools provide increased habitat to the aquatic environment, fish populations are still affected by the condition of the water. Therefore, these higher temperatures and low DO concentrations can be considered a significant stressor and potential limiting factor to the aquatic environment. This low flow condition combined with excessive recreational use can severely stress and potentially kill already weakened fish.

The implication of low flows, increased water temperatures and low DO on fish populations have been of concern to the public as well as the CPW over recent years in several Colorado streams. For example, as recently as July 2012, the CPW called for voluntary closure of waters in Bear Creek in Jefferson County and the Yampa River in Routt County, due to the situation of extreme low flow, higher water temperatures, low dissolved oxygen levels and increased recreational pressures on the aquatic environment. These voluntary closures have been generally established by the CPW based on a low flow discharge thresholds at which aquatic life of concern is considered highly at risk. The thresholds for the voluntary closures were generally established by CPW aquatic biologists based upon local site-specific knowledge and vary from stream to stream. In situations where the CPW has imposed a closure, public notice was provided and the site posted. According to the CPW, emergency closure of waters may be authorized for up to nine months when environmental conditions combined with recreational pressures can result in unacceptable levels of fish mortality (CPW 2013).

Although the habitat variables discussed above are not directly evaluated as part of this assessment, they are highly indicative of the ecological integrity of the aquatic environment.

**Figure 6. Comparison of Water Temperature and Dissolved Oxygen in Clear Creek (2011 and 2012).**



# V. EXISTING CONDITIONS ASSESSMENT

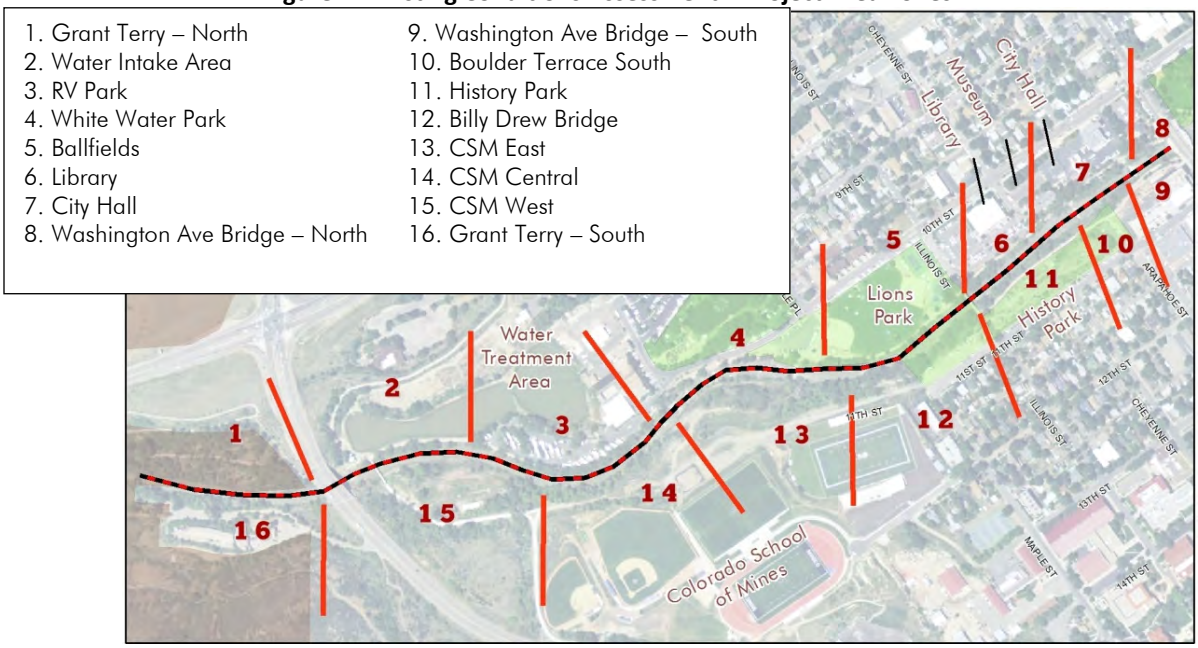
The concept of ecological integrity was integrated as part of the foundation of the existing conditions assessment within the Project Area. The assessment was intended to identify the gradient of ecological condition by identifying areas of high, moderate and low ecological integrity. Within the Project Area, areas of high ecological integrity (reference condition) were considered those riparian environments that resemble natural communities with comparatively less direct stressors. As human disturbance or stressors increase, the continuum of ecological integrity moves farther from a reference condition riparian environment. Conversely, areas of low ecological integrity were considered those areas where stressors exhibit a severity, frequency, or duration that is significant enough to potentially cause profound changes to the fundamental character of the riparian or aquatic environment. Such areas are highly altered, impaired or degraded (i.e., fundamental change in vegetation community, excessive erosion, exposed bare soils, failing infrastructure). The rating of ecological integrity used as part of this assessment is presented in **Table 1**.

ERC conducted an assessment of existing conditions within the Project Area during late summer and fall of 2012. The assessment was completed first in the field through visual observations and collection of feature-specific data using Global Positioning Systems (GPS) equipment, and later incorporated into project base mapping using Geographic Information Systems (GIS) for spatial analysis and mapping. The entire Project Area was walked and the condition of the channel, streambanks and vegetation were evaluated. Observations of general use and potential concerns were documented within the Project Area.

The following outlines the principles used to complete the Existing Conditions Assessment:

1. **Zones** - The Project Area was divided into sixteen (16) zones based on general use and physical characteristics (**Figure 7**).

**Figure 7. Existing Conditions Assessment – Project Area Zones.**



2. **Areas of Interest** - Within the Project Area, discrete Areas of Interest (AOI) were identified within each of the 16 zones. An AOI was considered any identifiable natural feature, manmade structure or potential stressor to ecological integrity. A total of 60 AOIs were identified within the Project Area.

3. **Feature Categories** - AOIs were grouped into one of five feature categories; Riparian Habitat, Streambank Erosion, Infrastructure, Informal Access Areas and Informal Trails. Because Informal Trails were located within Riparian Habitats, they were considered a sub-feature category within Riparian Habitat.

**Within the Project Area:**
30 AOIs comprised Riparian Habitat
66 Informal Trail Features were identified within Riparian Habitat
13 AOIs comprised Informal Access Areas
12 AOIs comprised Infrastructure
5 AOIs comprised Bank Stabilization
**60 AOIs TOTAL**

4. **AOI Rating** - Each AOI was provided a rating of; High, Moderate or Low based on its relative observed ecological integrity. The AOI rating criteria is provided in **Table 1**. **Table 2** below provides a summary of AOI rating for the Project Area.

**Table 2. Summary of AOI Rating for the Project Area.**

| Feature Category Rating | # of AOIs |
|---|---|
| **RIPARIAN HABITAT** | |
| Low | 6 |
| Moderate | 15 |
| High | 9 |
| ***Subtotal*** | ***30*** |
| **INFORMAL ACCESS AREAS** | |
| Low | 10 |
| Moderate | 3 |
| ***Subtotal*** | ***13*** |
| **INFRASTRUCTURE** | |
| Low | 2 |
| Moderate | 8 |
| High | 2 |
| ***Subtotal*** | ***12*** |
| **BANK STABILIZATION** | |
| Low | 3 |
| Moderate | 2 |
| ***Subtotal*** | ***5*** |
| **GRAND TOTAL** | **60** |

| Feature Category Rating | # of Trails |
|---|---|
| **TRAILS** | |
| Low | 15 |
| Moderate | 36 |
| High | 15 |
| **GRAND TOTAL** | **66** |

5. All AOIs identified within the Project Area are graphically depicted on **Existing Conditions Sheets 1 and 2 (Figure 8 and 9)**.

**Table 1. Feature Category Ecological Integrity Rating Criteria.**

| Feature Category | ECOLOGICAL INTEGRITY AREA OF INTEREST RATING | | |
|---|---|---|---|
| | **Low** | **Moderate** | **High** |
| **1 - Riparian Habitat** | • Non-native or weedy species dominant;<br>• 1 strata;<br>• Fragmented in isolated pockets;<br> | • Native vegetation dominant;<br>• 2 strata;<br>• Small, narrow intact community;<br> | • Native vegetation dominant;<br>• 3 vegetation strata;<br>• Long, wide intact community;<br> |

**Table 1. Feature Category Ecological Integrity Rating Criteria (cont'd).**

| Feature Category | ECOLOGICAL INTEGRITY AREA OF INTEREST RATING | | |
|---|---|---|---|
| | **Low** | **Moderate** | **High** |
| **2 - Streambank Erosion** | • Unstable;<br>• High erosion (i.e., undercutting, mass wasting, and/or vertical banks);<br>• Vegetation lacking or limited;<br> | • Unstable;<br>• Moderate erosion (i.e., partial bank collapse, localized erosion and/or gullies);<br>• Vegetation lacking or limited;<br> | • Stable;<br>• Minor erosion (i.e., sloping bank with eroded interface, roots exposed but stable no gullies;<br>• Vegetation present;<br> |

**Table 1. Feature Category Ecological Integrity Rating Criteria (cont'd).**

| Feature Category | ECOLOGICAL INTEGRITY AREA OF INTEREST RATING | | |
|---|---|---|---|
| | **Low** | **Moderate** | **High** |
| **3 - Infrastructure** | • Non-functional (i.e., failure, unstable, significant erosion present);<br>• No or limited Riparian Habitat;<br> | • Functional (i.e., working as intended, stable; only localized erosion;<br>• Riparian Habitat present but limited and/or disturbed;<br> | • Functional (i.e., working as intended, stable no erosion/failure;<br>• Riparian Habitat present;<br> |

**Table 1. Feature Category Ecological Integrity Rating Criteria (cont'd).**

| Feature Category | ECOLOGICAL INTEGRITY AREA OF INTEREST RATING | | |
|---|---|---|---|
| | **Low** | **Moderate** | **High** |
| **4 -Informal Access** | • High intensity use;<br>• Nearly complete or total loss of vegetation cover and organic litter, bare soil widespread. Soil erosion obvious, as indicated by exposed roots and rocks and/or gullying. Generally unsafe or hazardous.<br> | • Moderate intensity use;<br>• Vegetation cover lost and/or organic litter pulverized. Some bare soil exposed but relatively stable. Generally safe.<br> | • Low intensity use;<br>• Distinguishable loss of vegetation cover and/or minimal disturbance of organic litter.<br><br>*Condition does not occur within Project Area.* |

**Table 1. Feature Category Ecological Integrity Rating Criteria (cont'd).**

| Feature Category | ECOLOGICAL INTEGRITY AREA OF INTEREST RATING | | |
|---|---|---|---|
| | **Low** | **Moderate** | **High** |
| **5 - Informal Trail** | • Nearly complete or total loss of vegetation cover and organic litter within the trail;<br>• Bare soil widespread;<br>• Soil erosion obvious, as indicated by exposed roots and rocks and/or gullying;<br> | • Trail obvious; vegetation cover lost and/or organic litter pulverized in primary use areas;<br>• Some bare soil exposed but relatively stable;<br> | • Trail distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter.<br> |

**Figure 8. Existing Conditions Sheet 1.**

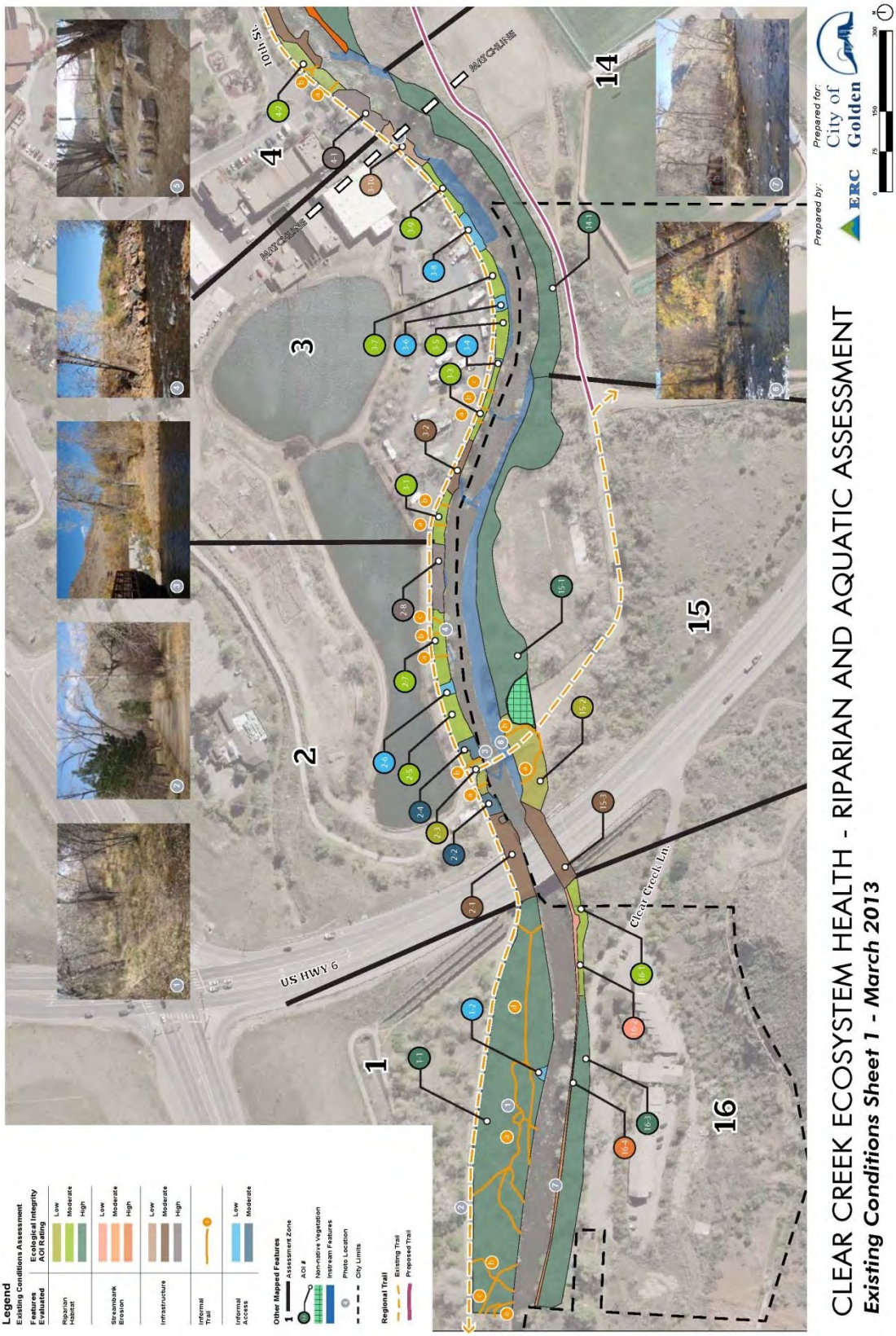
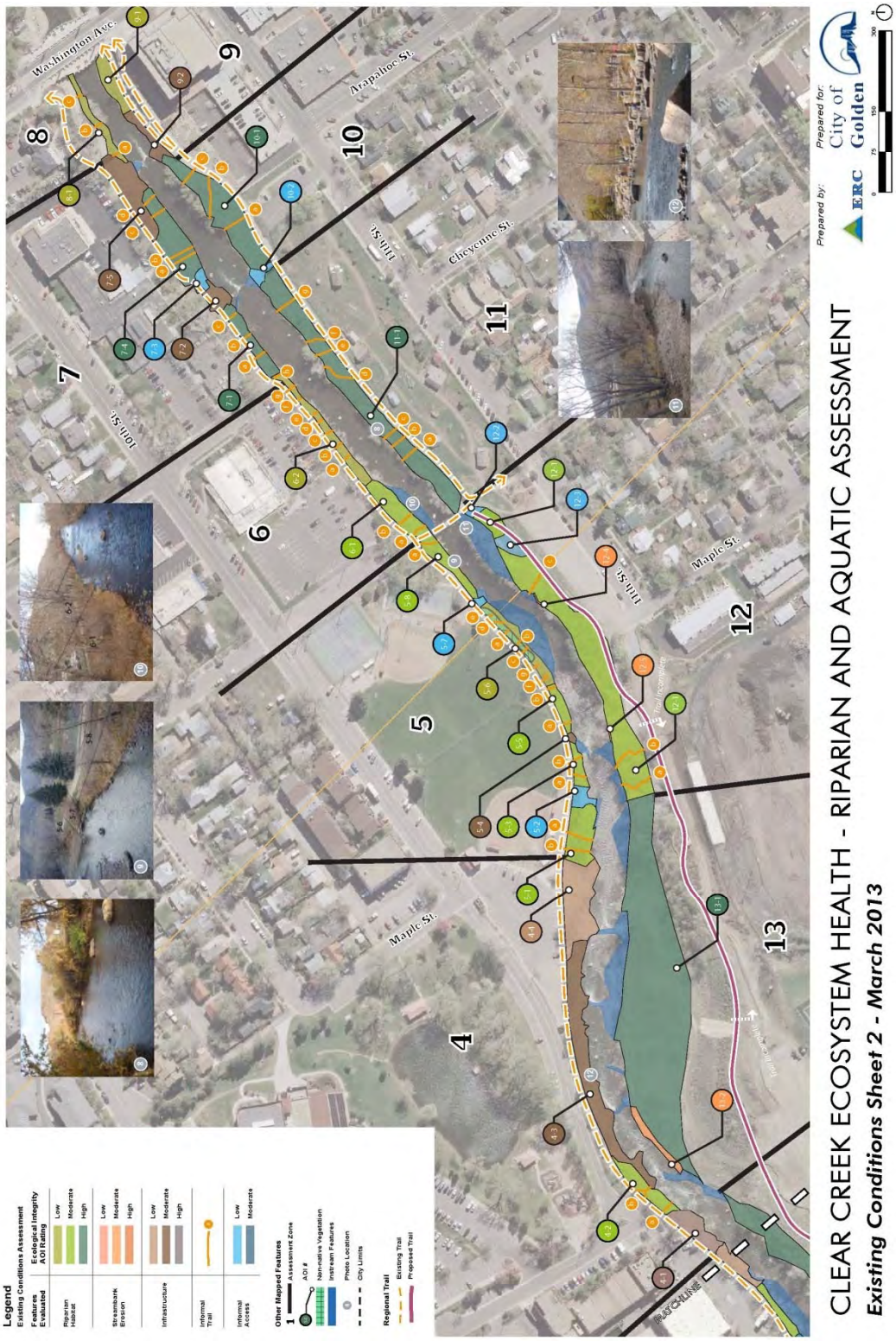


**Figure 9. Existing Conditions Sheet 2.**



# VI. ECOSYSTEM PROTECTION AND MANAGEMENT STRATEGIES

## A. Summary of Physical and Policy Protection and Management Strategies

Based on the existing conditions assessment, a series of ecosystem protection and management strategies were developed. These strategies are intended to assist the City in future decision making. The guiding principles of the strategies are to maintain and provide enjoyable and safe recreational use of the corridor while preserving and enhancing the ecological integrity of natural environment. When combining the strategies along the entire corridor, a balance can be achieved that provides adequate access to all instream water features and infrastructure while maintaining ecological integrity.

The first and most basic management strategy is to preserve the existing riparian corridor, especially where it is intact and consists of relatively high to moderate quality habitat that requires minimal restoration effort. Preservation would include eliminating or restricting access to an area. The second strategy is to concentrate or direct recreational use to harden stabilized areas that can withstand intensive use. This generally includes establishing access points to areas that are known high use areas. While not all inclusive, these basic protection and management strategies can be applied throughout the Project Area.

The physical protection and management strategies encompass each of the five feature categories - Riparian Habitat, Streambank Erosion, Infrastructure, Informal Access Areas and Informal Trails. The range of recommendations include a spectrum from preservation to creation of formalized infrastructure and are provided in **Table 3**.

**Table 3. Summary of Physical Protection and Management Strategies.**

| Feature Category | Physical Protection and Management Strategies |
|---|---|
| **1 Riparian Habitat** | • Preservation-use elimination and rehabilitation-complete fencing both stream and upland side<br>• Infrastructure-convert to formalized infrastructure (boulder terraces/access areas) |
| **2 Streambank Erosion** | • Streambank stabilization-boulder toes, cobble toes, buried riprap |
| **3 Infrastructure** | • Redesign and rebuild existing infrastructure<br>• Feature specific-minor repairs and improvements |
| **4 Informal Access** | • Use elimination-rehabilitation to riparian habitat with preservation-complete fencing both on stream and upland side<br>• Create formalized access-hardscape access/infrastructure |
| **5 Informal Trail** | • Use elimination-rehabilitation to riparian habitat with preservation-complete fencing both on stream and upland side<br>• Create formalized access-hardscape access/infrastructure |

As physical protection and management strategies are established within the Project Area, policy protection and management strategies may also be necessitated to encourage safe recreational use and to prevent degradation to the preserved/restored aquatic and riparian environments. Potential policy protection and management strategies are outlined below in **Table 4.** These generally include use limitations based on stream flow, education or enforcement options and should be employed in tandem with the physical protection and management strategies. Policy-specific guidance developed by the City may be effective for future protection and management of the Project Area.

**Table 4. Summary of Potential Policy Protection and Management Strategies.**

| Feature Category | Policy Protection and Management Strategies |
|---|---|
| **Recreational Use** | ▪ Use Limitations (based on cfs)<br>– limit number of users of a particular type of activity<br>– limit season of use for a particular group of users<br>– limit all use during critical low flow periods<br>▪ Use Dispersion<br>– construct stream diversions<br>– encourage use in other stream sections<br>▪ Emergency Closure<br>– temporary closure due to extreme aquatic conditions (i.e., daily temperature/oxygen/ flow) resulting in fish mortality<br>▪ Education<br>– signage, brochure, website, focus groups, newsletter updates<br>▪ Enforcement<br>– restrictions, patrol, fines, fees, parking/use<br>▪ Gold Panning/Exploration Restrictions |

## B. Detailed Ecosystem Protection and Management Strategies

Following the existing conditions assessment within the Project Area, ecosystem protection and management recommendations were provided for each AOI (refer to **Table 5, Section VIII Results**). Graphical depiction of each AOI and corresponding ecosystem protection and management summary is provided on the **Recommendations Sheet 1 and 2 (Figures 10 and 11, Section VIII Results)**.

Within the framework of ecological integrity, prioritization of ecosystem protection and management strategies can be viewed as a parallel pathway between preservation or protection of high quality, potentially threatened habitats and rehabilitating failed or low quality habitats which contribute to aquatic and riparian impairment. Whether one is more valuable than the other to the riparian corridor becomes a highly subjective matter.

Within the Project Area, riparian habitats identified with a high ecological integrity rating were considered important to protect and maintain thus are recommended as preservation-use elimination areas. On the other end of the spectrum, critically damaged areas (low ecological integrity rating) were identified for direct physical improvements. Damaged areas include streambank erosion, failing infrastructure or informal access areas which require formalization or rehabilitation. The existing conditions assessment clearly identified primary access points to and from the stream. In many cases multiple informal trails have formed to access a single point within the stream. The basic strategy employed in this situation was to concentrate access to a single formalized access and eliminate multiple trails thereby restoring riparian ecological integrity.

Prioritization and sequencing of individual projects should be based on the City's goals and objectives and as funding becomes available for specific improvement projects therefore is not discussed in detail in this report. A balance should be obtained between the health of the aquatic and riparian ecosystem and the recreational amenity which provides an enjoyable and safe feature for the City.

# VII. EXAMPLE ECOSYSTEM PROTECTION AND MANAGEMENT STRATEGIES

## A. Preservation - Use Elimination and Rehabilitation

Preservation-use elimination includes complete enclosure of moderate to high ecological integrity riparian habitat using a combination of signage (restricted or educational) and fencing. Riparian habitat should be enclosed on both the trail/upland and stream sides as public access has been observed from the trail down to the stream as well as access out of the stream. Preservation is intended to eliminate all use and access to an area. Rehabilitation will take many forms based on site specific conditions ranging from simple elimination of access and natural vegetation regeneration to extensive stabilization and revegetation.

Considerations for design and development of preservation measures should include the following items.

- The type of fencing requires analysis of the topography, type of riparian vegetation, wildlife and human use, size of area, ease of installation and future management and maintenance.
- Fencing is intended to restrict access however public safety should be priority.
- Fencing products should be comprised of a variety of materials which are durable, visible and which complement the natural character of the corridor.
- Signage should be incorporated with fencing to promote education of riparian habitat preservation and discourage fence crossing in rehabilitation areas.
- Existing post and rail fencing appears to be relatively new and located on the trail-side only, along the north side of the stream. This fencing is generally effective (in areas where the fencing is complete and continuous) and therefore would provide a suitable option for fencing style within the Project Area.
- Existing buck and pole fencing is currently located in the History Park area. This fencing is generally effective and appears to preserve the historic quality in the area of the History Park; however this fencing style occupies more space. This fence style is a suitable option within Project Area but may have limited use due to space.
- Plastic construction safety fence and caution tape has been used within the Project Area for short-term temporary closures. This fencing appears to have been effective for very short time periods and quickly becomes in disrepair. This type of temporary fencing style is not recommended for any long term preservation strategies.
- Bollard and chain fencing may provide an effective fencing option. This type of fencing can be cost effective, easy to install and maintain, provide sufficient use elimination and can specifically be designed to visually integrate with the natural appearance of the Project Area. Bollard and chain fencing is also highly flexible with easily removable chains, therefore could likely be more effective for stream side enclosure. Fencing along the stream must be carefully planned and must consider high water flow conditions and safety of kayaks and floaters. Bollard and chain

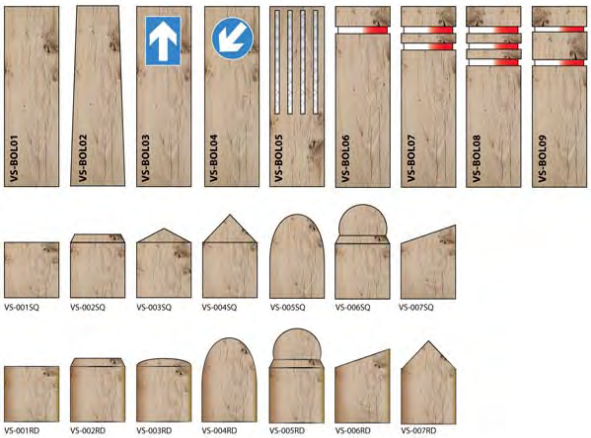
type fencing may be most appropriate in that it could be removed during high flow periods and easily reinstalled during low flow periods.

- All fencing should be tied in to existing physical features as to prevent public use end-running.
- Localized impacts on soils, vegetation, and water quality from informal access areas and informal trails may require some degree of rehabilitation, including decompaction, revegetation and temporary erosion control measures.
- Native plant species selected for riparian habitat rehabilitation should be selected to match the estimated hydrologic regime within each specific area. In addition vegetation can be selected which has dense growth form that would assist in access elimination.
- Rehabilitation areas should consider a long-term monitoring and maintenance schedules, including temporary irrigation, weed management and herbivory prevention.

Following are examples of fencing and signage that may be considered appropriate within the Project Area:

Example 1 – Existing Fences within the Project Area
Post And Rail (left); Buck And Pole (right).

Example 2 – Bollard and Chain Fence Types.



Example 3 – Bollard and Chain Fence Types.

Example 4 – Proposed Project Area Fencing – Upland/Trail Side.

a. Existing – No Fence

b. Graphical Depicton Example – Post & Rail

c. Graphical Depicton Example – Bollard & Chain

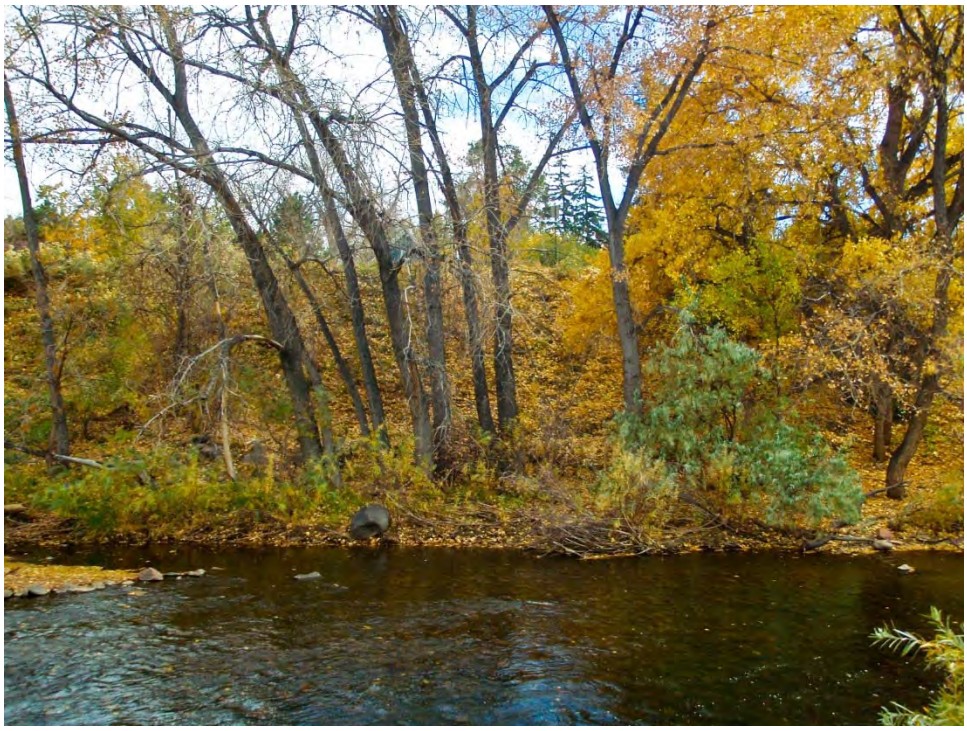
Example 5 – Proposed Project Area Fencing – Stream Side.

a. Existing –
No Fence

b. Graphical
Depicton Example –
Bollard & Chain

Example 7 – Proposed Project Area Fencing – Stream Side.

a. Existing –
No Fence



b. Graphical Depicton
Example – Bollard &
Chain

## B. Streambank Stabilization

Streambank stabilization has been recommended in areas where bank failure along the water interface is evident. Streambank stabilization will require mechanical repair of the stream and riparian interface with structural materials and native vegetation. All proposed streambank stabilization will require import and placement of structural materials and upper bank revegetation.

Considerations for design and development of streambank stabilization should include the following items:

- Each specific area of streambank erosion needs to be independently evaluated and will require unique stabilization techniques. Cause of erosion and bank failure will need to be identified to ensure stabilization efforts are appropriate and do not adversely affect upstream and downstream banks.

- Structural material forming the toe of slope along the water interface must be properly sized for stability and scour.

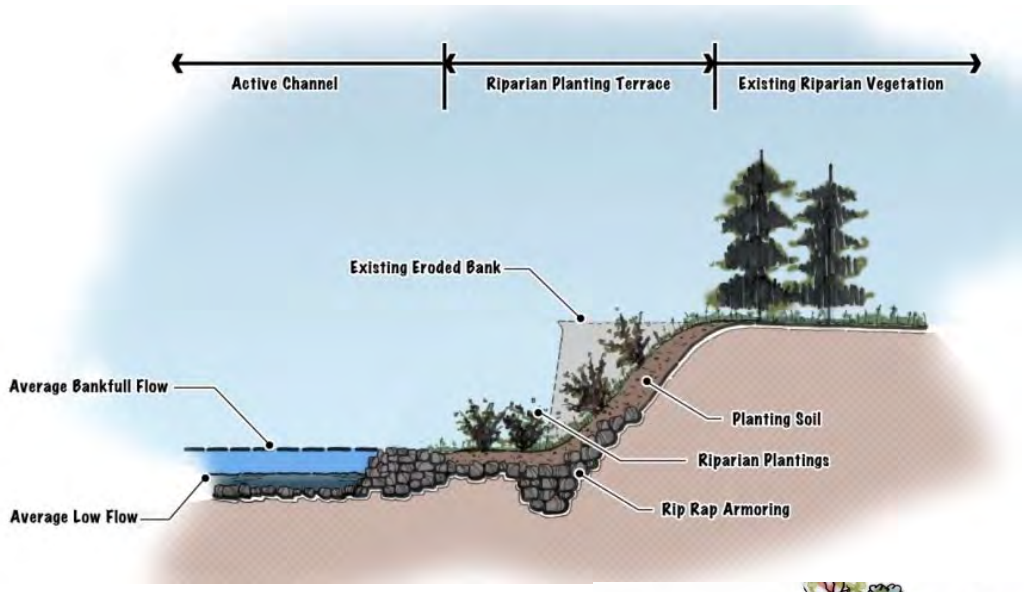
- Native vegetation should be incorporated into the stabilization design to promote riparian habitat development. Native vegetation species should be selected based on site specific characteristics and moisture regimes.

- Rehabilitation areas should consider a long-term monitoring and maintenance schedules, including temporary irrigation, weed management and herbivory prevention.

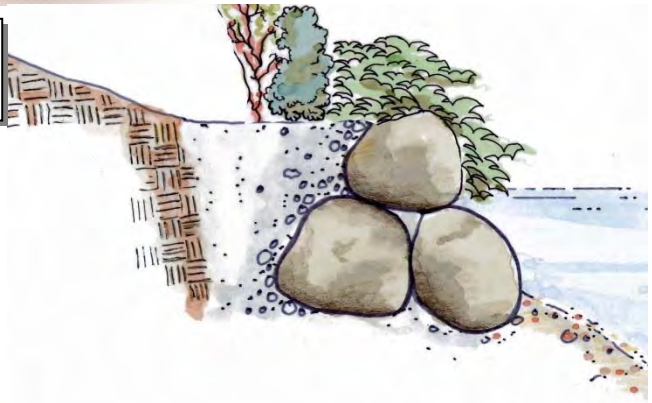
Example 1 – Existing Streambank Erosion in Project Area.

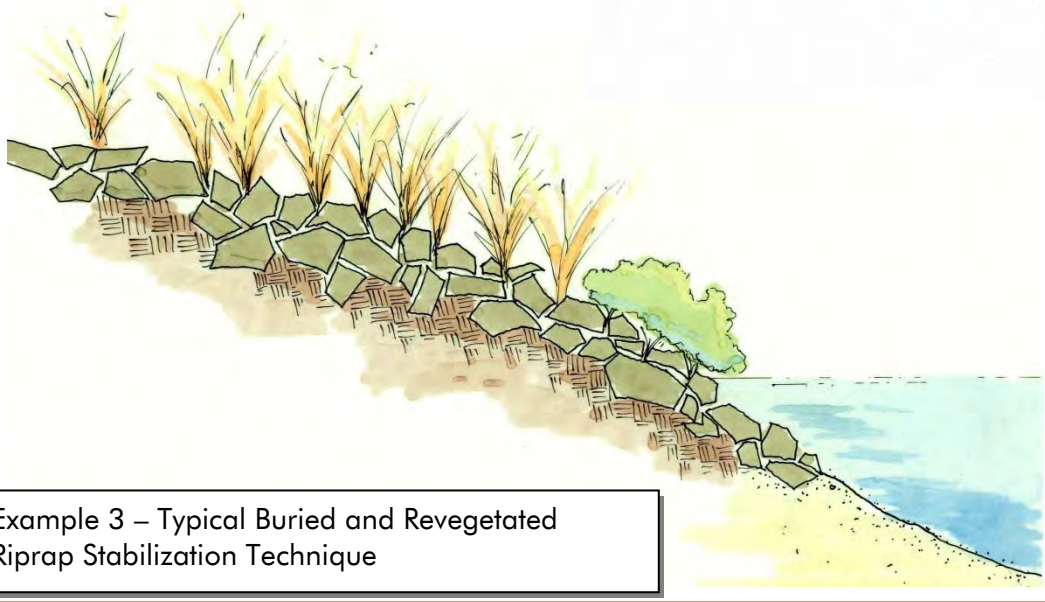
Example 2 – Appropriately Stabilized Streambank in Project Area.

Example 3 - Schematic of Typical Streambank Stabilization Components and Concepts.




Example 2 – Typical Boulder Toe Stabilization Technique.





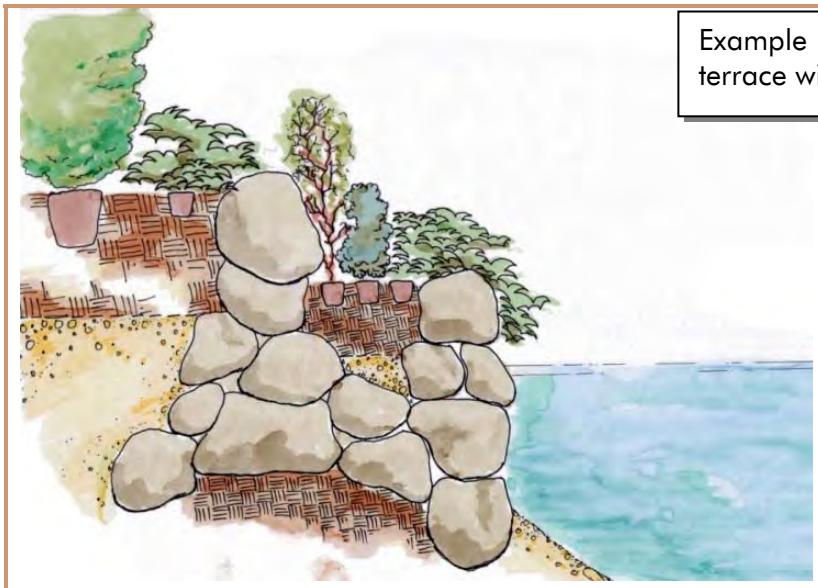
Example 3 – Typical Buried and Revegetated Riprap Stabilization Technique

## C. Infrastructure-Boulder Terrace

Creation of formalized infrastructure or boulder terraces, typically formed from large boulders should include a stable streambank and water interface, provide for public access for a wide variety of user ability and incorporate natural vegetation pockets.

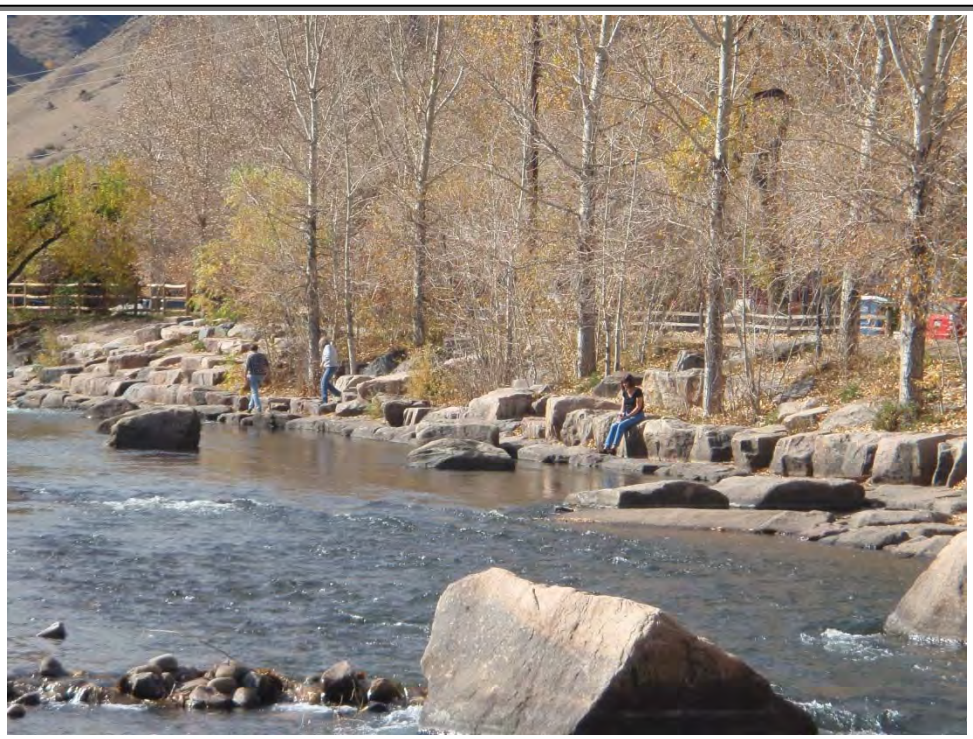
Considerations for design and development of boulder terraces should include the following items.

- Boulder terraces must be designed to withstand and function under all stream flow conditions and serve as streambank stabilization. Additionally boulder terrace should be intended as a public access and a recreation amenity.
- Large smooth surface boulders should be considered.
- Stabile foundation and interlocking is imperative for safety. Grouting may be required.
- Native vegetation planting pockets should be incorporated into boulder terraces to promote riparian corridor development and maintain a more natural setting. Planting pockets should be protected with preservation fencing techniques to limit disturbance and promote long term growth.
- Rehabilitation areas and planting pockets should consider a long-term monitoring and maintenance schedules, including temporary irrigation, weed management and herbivory prevention.
- Elevations differences between levels of boulder terrace should not sloping nor constructed of sloping soil or fine grained material to prevent erosion.

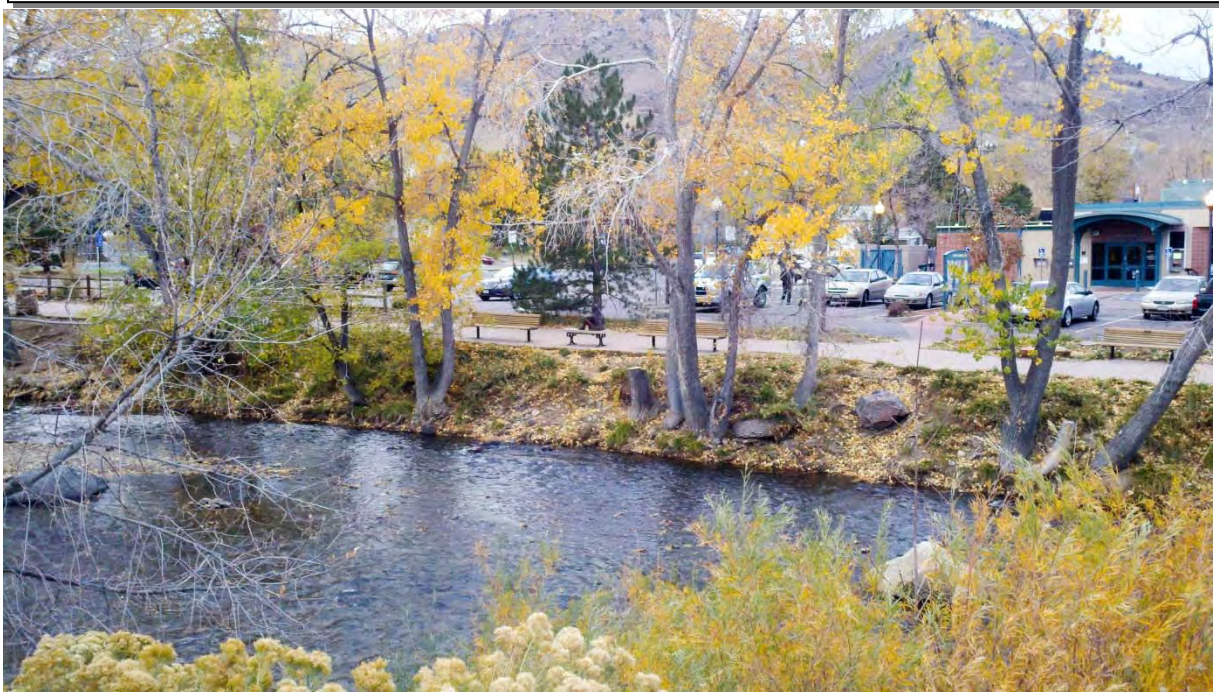


Example 1 – Schematic of typical boulder terrace with native vegetation pockets.

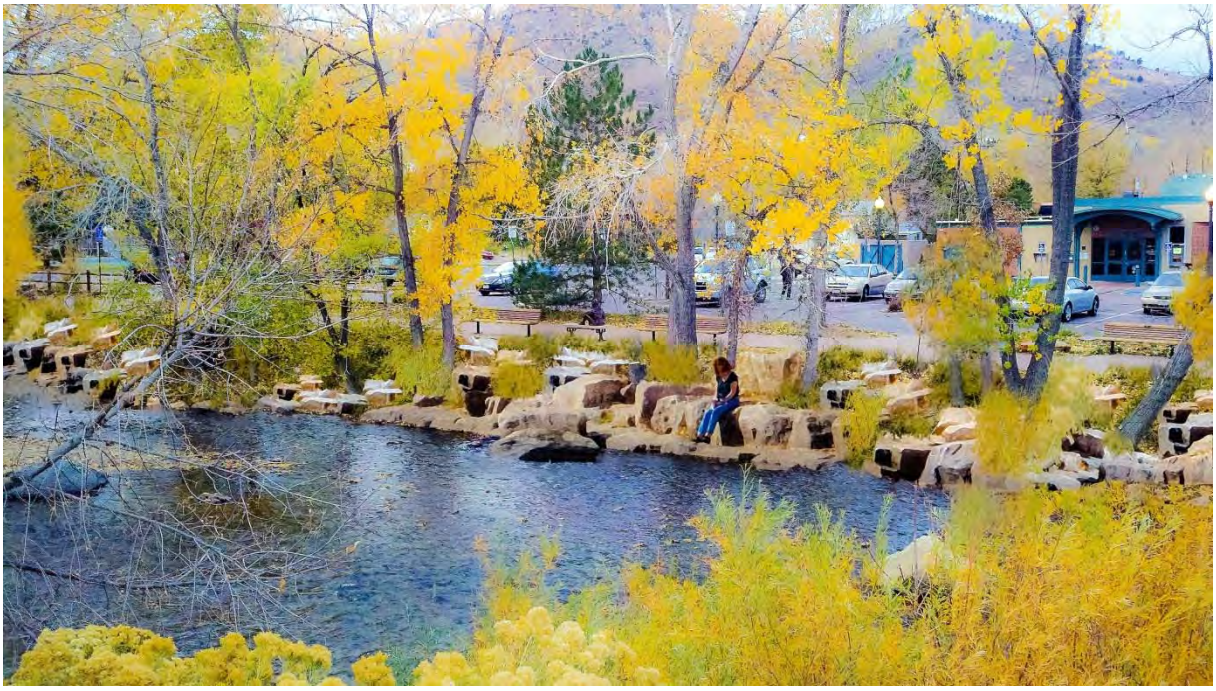
Example 2 – Existing Properly Functioning Boulder Terrace
With Native Vegetation Pockets and Adequate Public Access.



Example 3 – Existing Low Ecological Integrity Riparian Habitat.



Example 4 – Graphical Depiction Example – Infrastructure With Native Vegetation Pockets and Adequate Public Access.



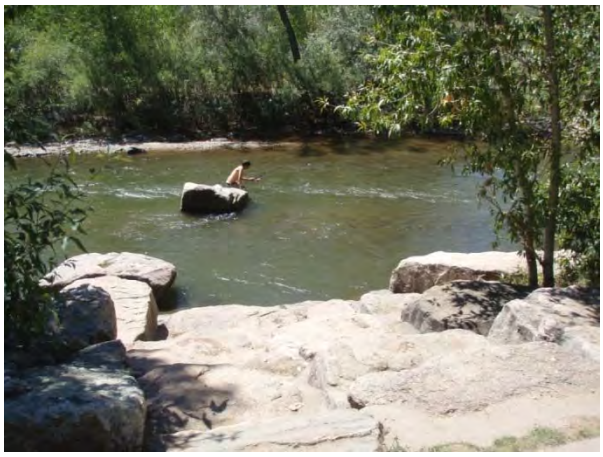
## D. Formalized Access

Formalized accesses points have been identified throughout the Project Area to provide ingress and egress between the formal trail and the stream. Formalized accesses have been located at key locations of in high use area providing access to specific instream features.

Considerations for design and development of formalized access should include the following items.

- Maintain existing stream flow patterns and not create erosional forces upstream or down (i.e. eddies or concentrated flow paths).
- Withstand and function under all flow conditions and high use. Creation of formal accesses should be intended as a recreation amenity.
- Provide access for a wide range of user abilities safely
- Each specific formal access needs to be independently evaluated and will vary based on access needs (i.e. ramp or steps) and bank heights
- Structural material forming the toe of slope along the water interface must be properly sized for stability and scour.
- Stabile foundation and interlocking of the structure is imperative for safety. Grouting may be required.
- Fencing installed to promote use of formalized access and to discourage informal access within riparian habitats.
- Signage incorporated with fencing to 1) promote education of riparian habitat preservation, 2) discourage fence crossing in rehabilitation areas

Example 1 – Existing Formalized Access within Project Area. Formed Concrete Steps with Boulder Edge and Native Vegetation (left); Grouted Boulder Steps with Native Vegetation (right).



Example 2 – Existing Informal Access.

Example 3 – Graphical Depiction Example – Proposed Formalized Access with Fencing.

# VIII. ECOSYSTEM PROTECTION AND MANAGEMENT RECOMMENDATIONS

The following section provides the ecosystem protection and management recommendations for each AOI within the Project Area (**Table 5**). Graphical depiction of each AOI and corresponding ecosystem protection and management summary is provided on the **Recommendations Sheet 1 and 2 (Figures 8 and 9)**.

**Table 5. Existing Conditions Assessment Results and Proposed Ecosystem Protection and Management Strategies**

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| Zone 1 - Grant Terry - North | | | | | | |
| 1-1 | Riparian Habitat | | High | Tree dominated with shrub and grass understory; many trails; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Long, non-directional meandering trail; general stream access in several locations and connection to other crisscrossing trails* | *813* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *General stream access and connection to other crisscrossing trails* | *120* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *Moderate* | *General stream access and connection to other crisscrossing trails* | *107* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *d* | *Moderate* | *General stream access and connection to other crisscrossing trails* | *292* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *e* | *Moderate* | *Trail to instream V-weir and connection to other crisscrossing trails* | *85* | Create formalized access |
| 1-2 | Informal Access | | Low | General stream access; potentially used as upper floating launch | | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| Zone 2 - Water Intake Area | | | | | | |
| 2-1 | Infrastructure | | Moderate | Riprap streambank - highway overpass; non-vegetated | | Feature specific improvements-vegetation establishment |
| 2-2 | Informal Access | | Moderate | Equipment access to water intake structure and instream V-weir | | Create formalized access |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| 2-3 | Riparian Habitat | | Low | Pockets of trees, bordering bridge; moderate slope with areas of riprap | | Infrastructure-convert to formalized infrastructure (boulder terraces/access areas) |
| | *Informal Trail* | *a* | *Moderate* | *Access from top of bridge to below bridge, downstream from instream V-weir* | *28* | Eliminate-incorporate into 2-3 infrastructure |
| | | *b* | *Moderate* | *Access from top of bridge to below bridge, upstream from instream V-weir* | *19* | Eliminate-incorporate into 2-3 infrastructure |
| 2-4 | Informal Access | | Moderate | Access to non-vegetated streambank - existing fence incomplete | | Create formalized access |
| 2-5 | Riparian Habitat | | Moderate | Tree dominated with dense shrub/sapping and herbaceous understory; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| 2-6 | Informal Access | | Low | Access to non-vegetated streambank from bench | | Create formalized access |
| 2-7 | Riparian Habitat | | Moderate | Tree-dominated streambank with dense shrub/sapping and herbaceous understory; steep slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access to instream J-hook feature* | *23* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access to streambank J-hook boulders* | *20* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *Moderate* | *Access to streambank J-hook boulders* | *14* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 2-8 | Infrastructure | | High | Riprap streambank interspersed with shrubs and grass; access to instream J-hook feature | | Feature specific-minor repairs and improvements |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| Zone 3 - RV Park | | | | | | |
| 3-1 | Riparian Habitat | | Moderate | Tree dominated with shrub and herbaceous understory; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *General stream access* | *22* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Low* | *Access upstream from kayak drop structure; general stream use area* | *21* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 3-2 | Infrastructure | | Moderate | Steam overlook at bench; access to instream kayak drop structure | | Feature specific-minor repairs and improvements |
| 3-3 | Riparian Habitat | | Moderate | Tree dominated with dense shrub and herbaceous understory; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *High* | *General stream access upstream from kayak drop structure* | *10* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access to instream kayak drop structure* | *12* | Create formalized access |
| | | *c* | *Moderate* | *Access downstream from kayak drop structure* | *11* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 3-4 | Informal Access | | Low | General stream access | | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 3-5 | Riparian Habitat | | Moderate | Tree dominated with dense shrub and herbaceous understory; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| 3-6 | Informal Access | | Low | Access to instream point bar | | Create formalized access |
| 3-7 | Riparian Habitat | | Moderate | Trees present with shrubs and herbaceous understory; level, low slope; vegetation limited near trail | | Preservation-use elimination and rehabilitation-complete fencing |
| 3-8 | Informal Access | | Low | Access to instream point bar | | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 3-9 | Riparian Habitat | | Moderate | Tree dominated with sparse shrub and dense herbaceous understory; level, low slope; confined by trail to the north | | Preservation-use elimination and rehabilitation-complete fencing |
| 3-10 | Infrastructure | | Low | Eroded boulder terrace; general stream access | | Redesign and rebuild infrastructure |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| **Zone 4 - White Water Park** | | | | | | |
| 4-1 | Infrastructure | | High | Primary launch-concrete path | | Feature specific-minor repairs and improvements |
| 4-2 | Riparian Habitat | | Moderate | Patchy vegetation, trees present with dense shrub and herbaceous understory; fence incomplete; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access to instream kayak drop structure* | *45* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access to instream kayak drop structure* | *24* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 4-3 | Infrastructure | | Moderate | Boulder terrace; kayak viewing and overlook area | | Feature specific-minor repairs and improvements |
| 4-4 | Infrastructure | | Low | White Water Park - kayak staging and beach with significant streambank erosion | | Redesign and rebuild infrastructure |
| **Zone 5 - Ballfields** | | | | | | |
| 5-1 | Riparian Habitat | | Moderate | Trees present with shrubs and herbaceous understory overhanging streambank; limited vegetation adjacent to recreational trail; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *General stream access* | *43* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access upstream from kayak drop structure* | *41* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 5-2 | Informal Access | | Low | Access to instream kayak drop structure | | Create formalized access |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| 5-3 | Riparian Habitat | | Moderate | Trees present with limited herbaceous understory; steep slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Low* | *General stream access* | *18* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Low* | *Access upstream from kayak drop structure* | *15* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 5-4 | Infrastructure | | Moderate | Riprap streambank; access to instream kayak drop structure | | Feature specific-minor repairs and improvements |
| 5-5 | Riparian Habitat | | Moderate | Dense shrubs with herbaceous understory; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Low* | *General stream access downstream from kayak drop structure* | *15* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | *Informal Trail* | *b* | *Low* | *General stream access* | *16* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 5-6 | Riparian Habitat | | Low | Trees present with sparse understory or bare soil; Russian olive dominant; located on streambank above point bar | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *General stream access* | *11* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *General stream access* | *14* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *Moderate* | *General stream access* | *14* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *d* | *Low* | *General stream access* | *24* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *e* | *Moderate* | *General stream access* | *7* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *f* | *High* | *General stream access* | *15* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *g* | *Moderate* | *General stream access* | *8* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| 5-7 | Informal Access | | Low | Access to boulder current deflector and point bar from bench | | Create formalized access |
| 5-8 | Riparian Habitat | | Moderate | Patchy vegetation-western portion dominated by dense shrubs with herbaceous understory-level, low slope; eastern portion dominated by trees with limited shrub/herbaceous understory-steep high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access from top of bridge to below bridge* | *31* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| Zone 6 - Library | | | | | | |
| 6-1 | Riparian Habitat | | Moderate | Tree dominated with limited herbaceous understory or bare soil near trail, shrubs with herbaceous understory along streambank; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access to non-vegetated streambank* | *29* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access to non-vegetated streambank* | *29* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| 6-2 | Riparian Habitat | | Low | Tree dominated with bare soil; moderate slope | | Infrastructure-convert to formal boulder terrace/access areas |
| | *Informal Trail* | *a* | *Low* | *General stream access* | *16* | Eliminate-Incorporate into 6-2 infrastructure |
| | | *b* | *Low* | *General stream access* | *16* | Eliminate-incorporate into 6-2 infrastructure |
| | | *c* | *Low* | *General stream access* | *16* | Eliminate-incorporate into 6-2 infrastructure |
| | | *d* | *Low* | *General stream access* | *12* | Eliminate-incorporate into 6-2 infrastructure |
| | | *e* | *High* | *General stream access* | *12* | Eliminate-incorporate into 6-2 infrastructure |
| | | *f* | *Low* | *General stream access* | *9* | Eliminate-Incorporate into 6-2 infrastructure |
| | | *g* | *Moderate* | *General stream access* | *13* | Eliminate-incorporate into 6-2 infrastructure |
| | | *h* | *Moderate* | *General stream access* | *15* | Eliminate-incorporate into 6-2 infrastructure |

| Zone 7 - City Hall | | | | | | |
|---|---|---|---|---|---|---|
| 7-1 | Riparian Habitat | | High | Shrub dominated with herbaceous understory; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access to instream kayak drop structure* | *22* | Create formalized access |
| | | *b* | *High* | *General stream access upstream from kayak drop structure* | *16* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *High* | *General stream access upstream from kayak drop structure* | *22* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 7-2 | Infrastructure | | Moderate | Mesa overlook, access to instream kayak drop structure | | Feature specific-minor repairs and improvements |
| 7-3 | Informal Access | | Moderate | Access to mesa overlook and instream kayak drop structure | | Create formalized access- |

| AOI # | Feature | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|
| 7-4 | Riparian Habitat | High | Tree dominated with dense shrub and herbaceous understory; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a High* | *General stream access* | *44* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b High* | *General stream access* | *43* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c High* | *General stream access* | *28* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *d High* | *General stream access* | *27* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 7-5 | Infrastructure | Moderate | Amphitheater and access to instream kayak drop structure | | Feature specific-minor repairs and improvements |

| Zone 8 - Washington Ave Bridge - North | | | | | |
|---|---|---|---|---|---|
| 8-1 | Riparian Habitat | Low | Patchy vegetation - tree dominated areas contain limited herbaceous understory or bare ground; shrub dominated areas contain dense herbaceous understory; level, low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a Low* | *General stream access* | *12* | Create formalized access |
| | | *b Moderate* | *General stream access* | *15* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c Low* | *General stream access upstream from Washington Avenue bridge* | *10* | Create formalized access |

| Zone 9 - Washington Ave Bridge - South | | | | | |
|---|---|---|---|---|---|
| 9-1 | Riparian Habitat | Low | Planted vegetation - patchy trees, shrub dominated with herbaceous understory; level low slope; non-native trees | | Preservation-use elimination and rehabilitation-complete fencing |
| 9-2 | Infrastructure | Moderate | Access to instream kayak drop structure and boulder terrace | | Feature specific-minor repairs and improvements |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| Zone 10 - Boulder Terrace South | | | | | | |
| 10-1 | Riparian Habitat | | High | Tree dominated with shrub and grass understory; steep, high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *High* | *General stream access* | *38* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *General stream access* | *22* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *Moderate* | *General stream access* | *67* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 10-2 | Informal Access | | Low | Access to instream kayak drop structure | | Create formalized access |

| | | | | | | |
|---|---|---|---|---|---|---|
| Zone 11 - History Park | | | | | | |
| 11-1 | Riparian Habitat | | High | Tree dominated with shrub and grass understory; steep, high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *General stream access* | *33* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *General stream access* | *19* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *c* | *Moderate* | *General stream access* | *18* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *d* | *Moderate* | *General stream access* | *48* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *e* | *Moderate* | *General stream access* | *17* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *f* | *Moderate* | *General stream access* | *23* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *g* | *High* | *General stream access upstream from kayak drop structure* | *26* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |

| AOI # | Feature | | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|---|
| Zone 12-Billy Drew Bridge | | | | | | |
| 12-1 | Riparian Habitat | | Moderate | Tree dominated with limited understory or riprap; steep, high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a* | *Moderate* | *Access to instream kayak drop structure* | *64* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b* | *Moderate* | *Access to instream kayak drop structure* | *71* | Create formalized access |
| | | *c* | *Moderate* | *Access to instream boulder current deflector* | *53* | Create formalized access |
| 12-2 | Informal Access | | *Low* | *Access to point bar, upstream from Billy Drew Bridge* | | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 12-3 | Informal Access | | *Low* | *Access to point bar* | | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 12-4 | Streambank Erosion | | Moderate | Undercutting instream boulder current deflector | 32 | Streambank stabilization |
| 12-5 | Streambank Erosion | | Moderate | Undercutting streambank | 18 | Streambank stabilization |
| Zone 13-CSM East | | | | | | |
| 13-1 | Riparian Habitat | | High | Tree dominated with dense shrub and grass understory; level, low slope; fenced area - former tailing pond | | Preservation-use elimination and rehabilitation-complete fencing |
| 13-2 | Streambank Erosion | | Moderate | Streambank erosion between instream kayak drop structures | 161 | Streambank stabilization |
| Zone 14-CSM Central | | | | | | |
| 14-1 | Riparian Habitat | | High | Tree dominated with dense shrub and grass understory; invasive vine present; steep, high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| Zone 15 - CSM West | | | | | | |
| 15-1 | Riparian Habitat | | High | Tree dominated with shrub and grass understory; level slope - adjacent to point bar | | Preservation-use elimination and rehabilitation-complete fencing |

| AOI # | Feature | Ecological Integrity Rating | Description | Length (Feet) | Proposed Ecosystem Protection & Management Strategies |
|---|---|---|---|---|---|
| 15-2 | Riparian Habitat | Low | Patchy vegetation - pockets dominated by trees with shrub and herbaceous understory; generally shrub dominated with herbaceous understory; invasives colonizing; low slope | | Preservation-use elimination and rehabilitation-complete fencing |
| | *Informal Trail* | *a Moderate* | *Access to point bar and instream V-weir from bridge/trail* | *87* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| | | *b Moderate* | *Access to point bar from bridge/trail* | *59* | Use elimination-rehabilitation-complete fencing-restore to riparian habitat |
| 15-3 | Infrastructure | Moderate | Non vegetated highway riprap | | Feature specific improvements-vegetation establishment |
| Zone 16 - Grant Terry - South | | | | | |
| 16-1 | Riparian Habitat | Moderate | Tree dominated with shrub and grass understory confined by road and residential development; steep, high slope | | Preservation-use elimination and rehabilitation-complete fencing |
| 16-2 | Streambank Erosion | Low | Undercutting streambank | 203 | Streambank stabilization |
| 16-3 | Riparian Habitat | High | Tree dominated with shrub and herbaceous understory; patches of limited vegetation (herbaceous) in residential areas; moderate slope | | Preservation-use elimination and rehabilitation-complete fencing |
| 16-4 | Streambank Erosion | High | Undercutting streambank | 583 | Streambank stabilization |

**Figure 8. Recommendations Sheet 1.**

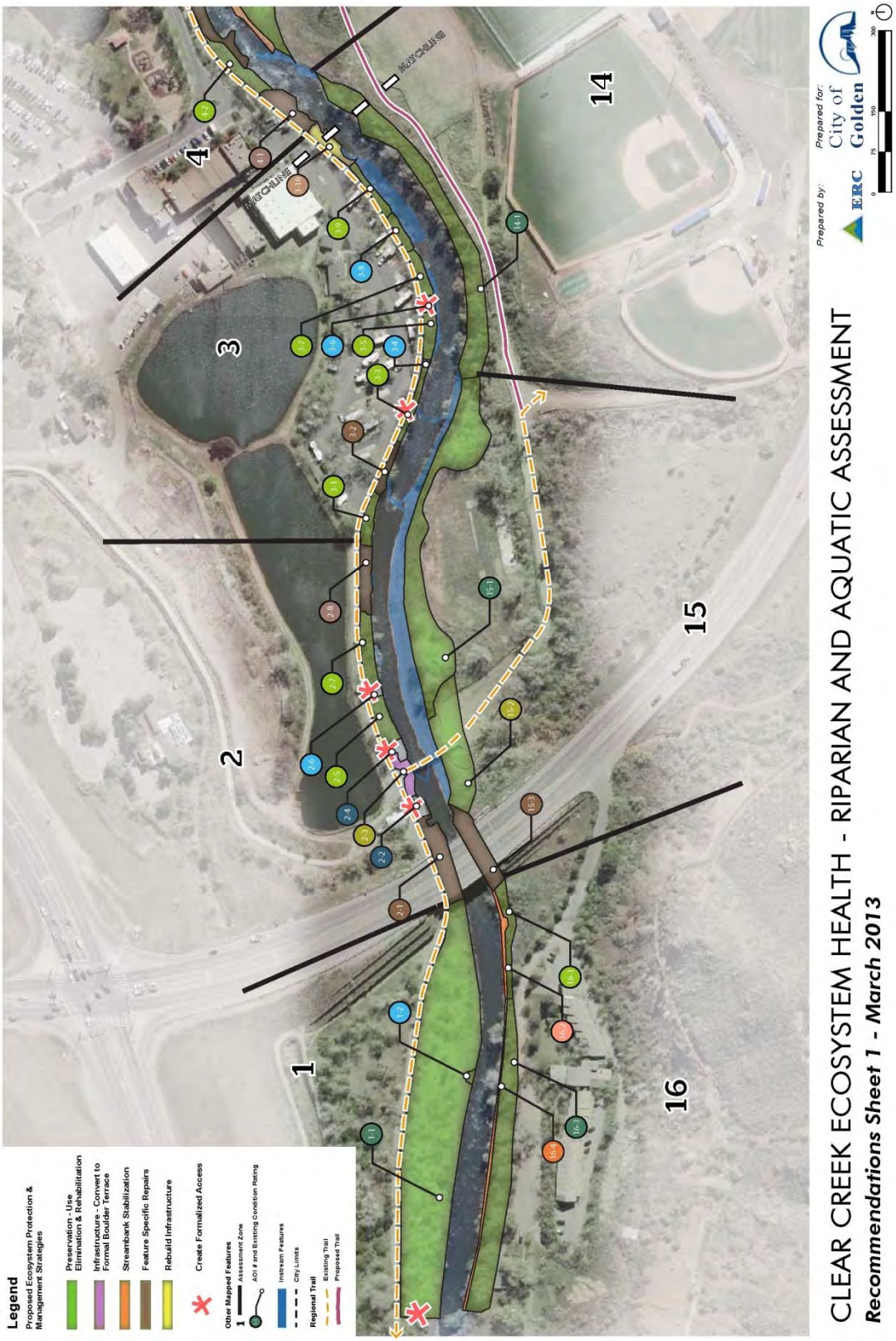


**Figure 9. Recommendations Sheet 2.**

# IX. PERMITTING

In accordance with Section 404 of the Clean Water Act (CWA), a Department of the Army (DA) permit would be required from the USACE for structures or work including excavation, dredging, disposal activities, and/or discharges of dredged or fill material into waters of the United States (US). Within the Project Area, waters of the US likely include potential fringe wetlands along Clear Creek and the active channel (non-vegetated), below the ordinary high water mark (OHWM). Five types of proposed improvements have been identified within the Project Area and include the creation of formalized infrastructure, minor infrastructure repairs and improvements, creation of formalized access and streambank stabilization. The proposed improvements are intended for recreational enhancement, riparian and aquatic habitat enhancement and bank stabilization improvement. Completion of the proposed improvements will likely require that work be performed in, and materials placed below the Clear Creek OHWM, therefore a DA permit would be required for those activities. A formal wetland and waters of the US delineation has not been completed to date but would be recommended to determine the exact extents of jurisdictional waters of the US.

According to personal communication with the USACE Denver Regulatory Office, the preferred permitting direction recommended for the proposed improvements would be authorization under a combination of Nationwide Permits (NWPs). NWPs that may be most appropriate for anticipated improvements include:

- NWP 3 – Maintenance (for existing infrastructure improvements)
- NWP 13 – Bank Stabilization (for bank stabilization repairs)
- NWP 18 – Minor Discharges (for minor riparian habitat rehabilitation or minor trail repair)
- NWP 27 – Aquatic Habitat Restoration, Establishment, and Enhancement Activities (for more extensive riparian habitat rehabilitation or enhancement)
- NWP 42 – Recreational Facilities (for creation of formalized infrastructure or access)

The USACE has stated that under the preferred permitting process, all foreseeable activities should be permitted at once. Although prioritization and sequencing of individual projects is not known at this time, all potential proposed improvements should be evaluated simultaneously, to the extent practical, as one single and complete project. NWPs should be selected for all potential proposed improvements identified herein up to the NWP threshold limit of 0.5-acre of cumulative waters of the US impact. Conceptual level or typical designs could be adequate from permit review and authorization.

Authorization would require submittal of a pre-construction notification (PCN) to the USACE. Typical turn-around time for USACE authorization under NWPs is 30-60 calendar days upon submittal. The PCN will require at a minimum concept designs and typical details of proposed improvements. Most NWPs are valid for a period of two years however can be re-authorized and/or re-verified to potentially extend the permit. If changes are required to specific proposed improvement areas after the NWPs are issued, permit modifications can be obtained as long as the modification is authorized under the terms and conditions of the permit. If additional improvement impacts are identified for the Project Area in the long term which exceed the threshold limit of 0.5-acre or that do not meet the terms and conditions of the authorized NWPs, a more comprehensive Individual Permit review process would be likely. The Individual Permit review process can typically take upwards of 120 to 150 days to receive authorization.

This preferred permitting method identified by the USACE is highly dependent on the design of the proposed improvements and extent of disturbances therefore is subject to change as a result of final design and further agency review.

# X. PUBLIC PROCESS

The approach, concepts, results and preliminary recommendations of this assessment were presented in draft form as part of a scheduled Open House meeting held at the City of Golden Community Center on February 12, 2013 (5:30 p.m. - 7:30 p.m.). As part of the Open House, ERC staff assisted City staff in an informal question and answer presentation accompanied by graphical wall displays. The public was encouraged to review the information, ask questions and provide comment verbally as well as through the formal Management Plan Survey. Based on ERC's interactions, the majority of the public expressed support for preservation of the riparian corridor character, promoting local recreational use and management during high use periods.

Results of the Clear Creek Management Plan Survey and Comments were posted on the City's web page at: http://www.cityofgolden.net/hot-topics/your-input-needed-clear-creek-management-plan/.

# XI. SUMMARY

Ecological Resource Consultants, Inc. (ERC) was contracted by the City of Golden to conduct an overview assessment of the Project Area in the context of riparian and aquatic ecosystem health as well as provide potential ecosystem protection and management strategies. This report provides a scientific assessment of the corridor based on existing conditions and offers recommendations which can be used by the City in future planning decisions regarding management, maintenance and enhancement of the Clear Creek corridor.

The primary issue of concern forming the basis of this assessment was that high recreational use, during extended periods of low stream flows, may exceed ecosystem capacity therefore resulting in potential degradation to the riparian and aquatic environment. This assessment focused primarily on the physical condition of the riparian environment and secondarily on the potential influences to the aquatic environment.

The Project Area was divided into 16 zones based on general use and physical characteristics. Areas of Interest (AOIs) were grouped into one of five feature categories; Riparian Habitat, Streambank Erosion, Infrastructure, Informal Access Areas and Informal Trails. A total of 60 AOIs were identified within the Project Area. A total of 66 Informal Trails were identified within the feature category of Riparian Habitat.

Following are key results for the assessment:

**Riparian Habitat**

- Approximately 80% of Riparian Habitat within the Project Area is considered moderate (50%) to high (30%) ecological integrity, while 20% is considered low ecological integrity.

- Riparian Habitats are important to protect and maintain thus are recommended as preservation-use elimination areas. Such areas are potentially subject to increased degradation and ultimately loss. Complete fencing is recommended both on stream and upland sides of Riparian Habitat to ensure long-term ecological integrity of the Riparian Habitat. Of the 30 Riparian Habitat AOIs identified within the Project Area, 28 are recommended for preservation-use elimination.

- 2 of the 30 Riparian Habitats identified are critically damaged and recommended for direct physical improvements, which may include hardening or stabilizing areas that can withstand intensive use. These low ecological integrity areas are too extensive damaged to repair as Riparian Habitat and continue to contribute to aquatic and riparian impairment.

**Informal Access Areas**

- The majority (77%) of Informal Access Areas are identified as low ecological integrity. Approximately 23% are identified as moderate ecological integrity. No high rated Informal Access Areas are identified.

- Of the 13 Informal Access Areas identified within the Project Area, 8 are recommended for direct physical improvements, which includes formalized access-hardscape access/infrastructure. These areas are critically damaged or failing, contributing to aquatic and riparian impairment. The formalization of access areas involves establishing specific access points to areas that are known high use areas.

- The remaining 5 Informal Access areas are recommended for use elimination-rehabilitation to Riparian Habitat with preservation-complete fencing both on stream and upland side. These 5 areas will likely require more intensive rehabilitation efforts.

**Infrastructure**

- The majority (67%) of existing Infrastructure is considered moderate ecological integrity while 17% is considered low and 17% is considered high ecological integrity.

- Of the 12 existing Infrastructure areas identified within the Project Area, 9 are considered to be functioning correctly and are not considered an immediate threat to the aquatic and riparian environment. These areas are only recommended for feature specific-minor repairs and improvements as needed.

- 3 Infrastructure areas are identified as critically damaged or failing, contributing to aquatic and riparian impairment through erosion. These areas are recommended for redesign or rebuild.

**Streambank Erosion**

- All Streambank Erosion areas are identified as moderate (40%) or low (40%) ecological integrity.

- A total of 5 Streambank Erosion areas are identified within the Project Area. All Streambank Erosion areas are recommended for improvement (boulder toes, cobble toes, buried riprap).

**Informal Trails**

- Of the 66 total Informal Trails identified within Riparian Habitat, 55% are considered moderate ecological integrity, 23% are considered low ecological integrity and 22% are considered high ecological integrity.

- Informal Trails were identified through Riparian Habitat as access for specific points or features within the stream. Recommendations include concentrating access to a single formalized access and eliminating 62 of the 66 identified Informal Trails within the Project Area thereby restoring riparian ecological integrity.

- 4 of the 66 Informal Trails identified within the Project Area are too extensive to repair or were identified as specific access points to known high use areas therefore are recommended as formalized access areas.

Prioritization and sequencing of individual projects should be based on the City's goals and objectives and as funding becomes available for specific improvement projects therefore is not discussed in detail in this report. A balance should be obtained between the health of the aquatic and riparian ecosystem and the recreational amenity which provides an enjoyable and safe feature for the City. This assessment has provided a baseline evaluation of riparian and aquatic ecosystem health within the Project Area. The recommendations included as part of this assessment are intended to provide the framework for guiding the City in developing management strategies and future planning options for the Clear Creek corridor, and are not intended to be all inclusive.

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