November
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Yampa River Structural Master Plan

Ecological Resource Consultants, Inc.

City of Steamboat Springs
Parks, Open Space and Recreational Services

Executive Summary

The Yampa River Structural Master Plan was created in a combined effort between Ecological Resource Consultants, Inc. (ERC), the City of Steamboat Springs (City) and the general public. It provides a framework for instream and riparian area improvements that will optimize the recreational benefits of the river while protecting its ecological integrity. The area that was used includes approximately 34,000 linear feet (6.4 miles) of the Yampa River located on City property from the Chuck Lewis Wildlife Management Area to the Fournier Open Space. The plan prioritizes the recommended improvements and provides budgetary cost estimates for City implementation. The study area consists of approximately 6.4 miles of river and riparian corridor located along City owned property.

Resident interest and comment was encouraged throughout the study process and was primarily received during three public meetings. This input, combined with river reconnaissance performed by ERC and the results of past studies, allowed "areas of interest" (AOIs) to be identified and recommended improvements to be given for each. These areas were grouped into three categories based on the nature of their issue(s): river rehabilitation, recreational use and water rights. River rehabilitation AOIs were defined as areas where the stream channel and adjacent riparian corridor have been degraded and natural aquatic habitat is limited. This category was further broken down into smaller categories including bank stabilization, vegetation and riparian buffer, channel form and aquatic habitat. Recreational use included AOIs were active and passive recreational opportunities exist and require improvement or areas where they are desired. The water rights category addressed the need for the construction of a gage that will ensure that Steamboat Springs receives flows required for its recreational demands. These flows were decreed by the Recreational in Channel Diversion Steamboat Springs received in March of 2006. Community input and reconnaissance also facilitated the ranking of each AOI based on its severity.

The culmination of the study was an easily understood and usable master plan, including detailed costs and mapping, which will help the City in planning future river improvements.

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I. INTRODUCTION

A. Project Description

The City of Steamboat Springs (the City) is developing a structural master plan that will provide a framework for instream and riparian area improvements on City owned lengths of the Yampa River. These improvements will optimize the recreational benefits of the Yampa River (the River) while protecting its ecological integrity. The Yampa River Structural Master Plan (the Plan) is intended to prioritize these improvements and to provide budgetary cost estimates for City implementation.

The Plan is the result of a collaboration between the City, Ecological Resource Consultants, Inc. (ERC), and the general public..

B. Project Area

Within the project area the Yampa River flows through both urban and natural settings including parks and downtown Steamboat Springs. The project area includes approximately 34,000 linear feet (6.4 miles) of the Yampa River from the Chuck Lewis Wildlife Management Area to the Fournier Open Space. Throughout a significant portion of the project area, the river generally flows from south to north with a railroad on its western bank and the City on its eastern bank. There are 6 main tributaries to the Yampa within the study area and include: Walton Creek, Fish Creek, Spring Creek, Soda Creek, Butcher Knife Creek and Burgess Creek. The land adjacent to the River is held in both public and private ownership and there is development, existing or planned, on many of the river's borders within the study area. City owned properties were analyzed as part of this Plan. Some other adjacent areas that were identified as areas of interest by the City that are not on City property were also evaluated.

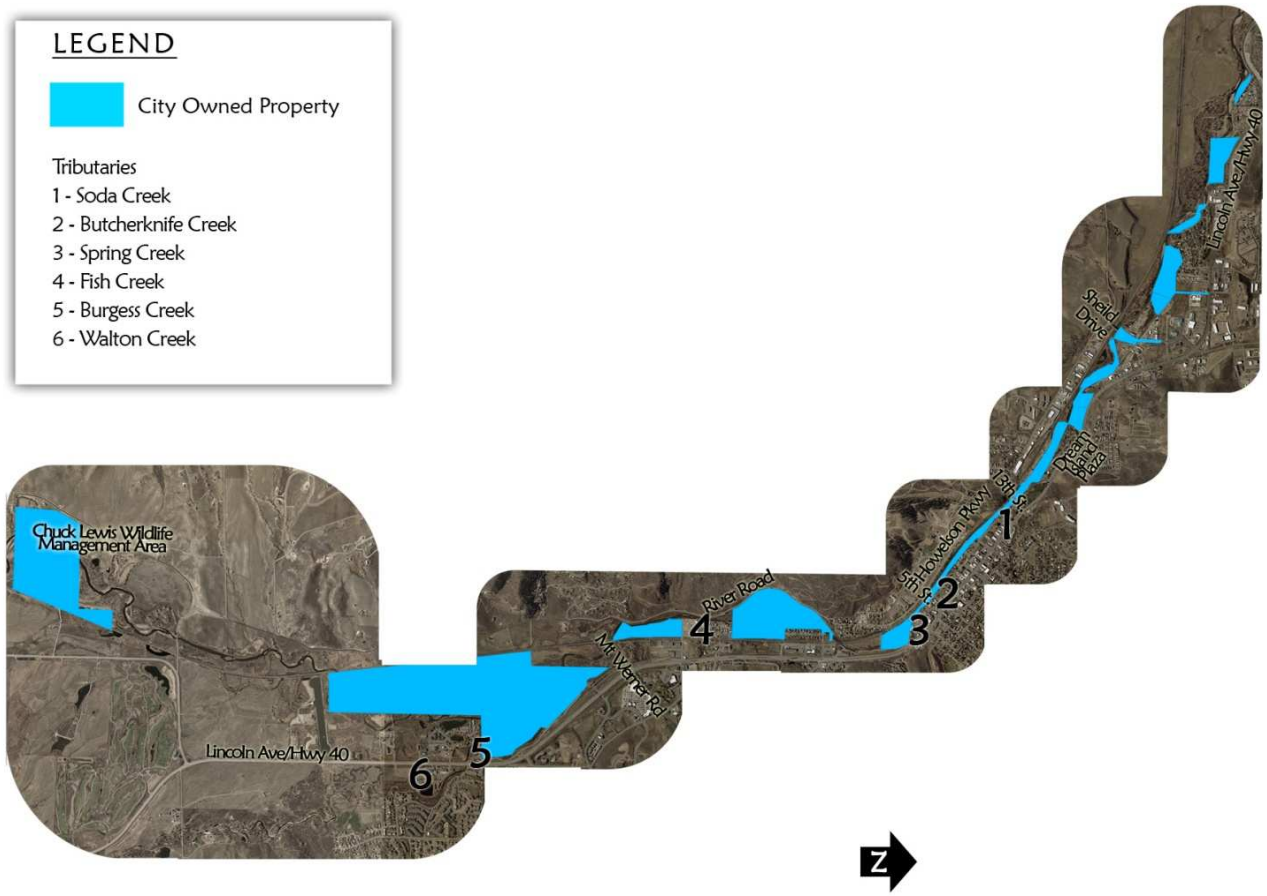

Figure 1 - City Owned Parcels

C. Project Approach

Residents of the City are very interested in protecting and improving the Yampa River. Because of this, citizens' input was solicited in public meetings that took place during each of the three phases of the project and used throughout the creation of the Plan. Phase 1 consisted of gathering existing information, including mapping and past studies of the River, as well as a river reconnaissance by ERC. Public meeting #1 introduced the project and ERC to the community and provided a forum where stakeholders raised the main issues they see affecting the River. In Phase 2 ERC performed additional river reconnaissance and more closely observed those areas that had received comments in Phase 1. During this phase ERC identified areas of interest based on the River assessments and community comments. This phase also included public meeting #2 where ERC presented its areas of interest and asked the community to identify additional areas they perceived as areas of interest. Phase 3 included the completion of a draft Plan and public meeting #3 where ERC showed the community its draft recommendations for the River. It also allowed the community to provide input on the Plan before it was finalized.

Please note that all report figures can be found in a larger size in Appendix A. A figure showing photo locations can also be found in Appendix A.

D. Data Collection, Mapping and Surveys

Project sponsors provided information and records during the course of the study. The information included copies of previous related studies, aerial topographic data and aerial photographs. The City provided all mapping. M.J. Harden Associates, Inc. processed and prepared the aerial topography with a 2' contour interval in August of 2007 based on 1994 contour data. Aerial photographs were created by Pixxures, Inc. in July of 2007.

E. Previous Studies

In 2001, the City collaborated with Aquatic and Wetland Company (AWC) of Boulder, Colorado and completed the Yampa River Studies. It provided a river management plan for approximately 4 miles of the Yampa River from the Walton Creek-Yampa River confluence to the James Brown Bridge. Phase 1 and phase 2 of a planned 5 phase study, including a water quality and macroinvertebrate analysis and a river user survey, were completed. Phases 3-5 which included baseline map development, policy development and a river management plan were not completed.

In 2003, the City collaborated with EDAW of Denver, Colorado to produce the Yampa River Management Plan (YRMP). This plan divided the Yampa River Corridor into 5 River Management Areas (RMAs) based on their land and aquatic habitats, land uses and recreational amenities. It also defined recreational uses, access points and seasons of use along the corridor. Recreational uses included tubing, paddling (kayaking and rafting) and fishing. It also provided a river management and monitoring plan. The recreational uses, seasonal use and access point information from this plan were used to define specific improvements in the Plan that will enhance the recreational use of the river.

II. BACKGROUND

A. Community Amenity

The Yampa River corridor is one of the most important amenities to the City of Steamboat Springs. From its value as an ecological resource to its economic impact on the community from activities associated with stream related recreation to the beauty and character it provides, the Yampa corridor is vital to the City. The community appreciates how important a resource it is and has worked hard to protect and improve the area.

Use of the corridor by the public is encouraged by the multitude of parks and trails that the City has developed. Parks located along the River include: Dr. Rich Weiss Park, River Creek Park, Rotary Park, Fetcher Park, Emerald Park, Little Toots Park, West Lincoln Park, Howelsen Park and the Stockbridge Multi-Modal Center. Wildlife Management Areas (WMAs) like the Chuck Lewis WMA and public open space also exist along the River. Connecting the parks and neighborhood trails is the Yampa River Core Trail. This trail follows the river from Walton Creek Road and Highway 40 to the James Brown Bridge on Shield Drive and provides access to the river. The trail is highly used and there are plans to extend the trail South and West along the river corridor.

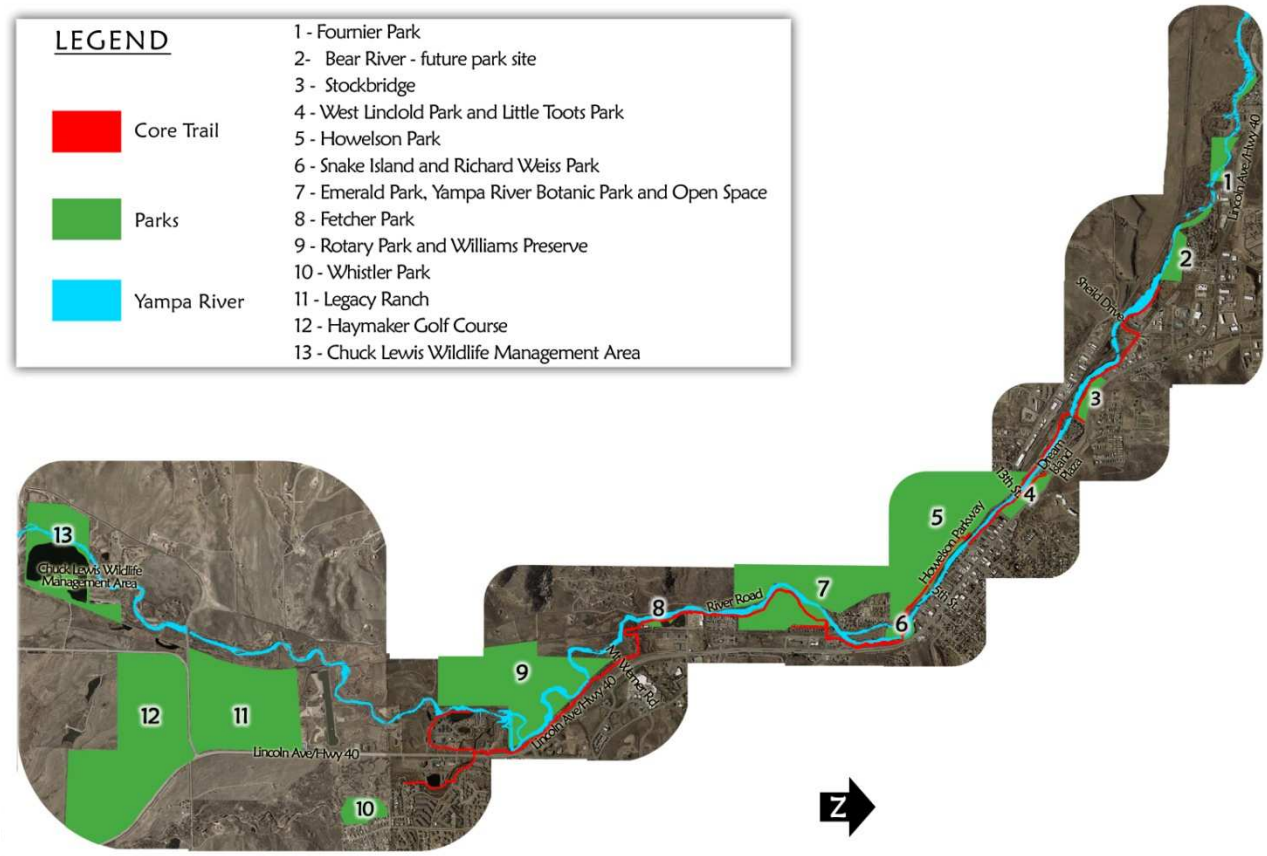

Figure 2 - Parks, WMA's and the Core Trail provide easy access to the River

The parks, WMAs, open space and trail offer easy river access which has led to an increase in recreational demands on the river. This increase has occurred with some impacts to the resource. Creation of informal access points along the banks of the river, loss of vegetation and bank erosion, user conflicts and increased trash are all results of the high level of use this area receives. ERC anticipates that as the City implements improvements presented in this Plan, more use will follow. We recommend that the necessary level of regulation, monitoring and maintenance is implemented to ensure the resource retains its character and value.

B. Yampa River Hydrology

Daily flow data from the United States Geologic Survey (USGS) database for the Yampa River at Steamboat was retrieved from October 1, 1904 to July 1, 2007 (USGS Station No. 09239500). The data was analyzed and statistics of observed daily flows were determined.

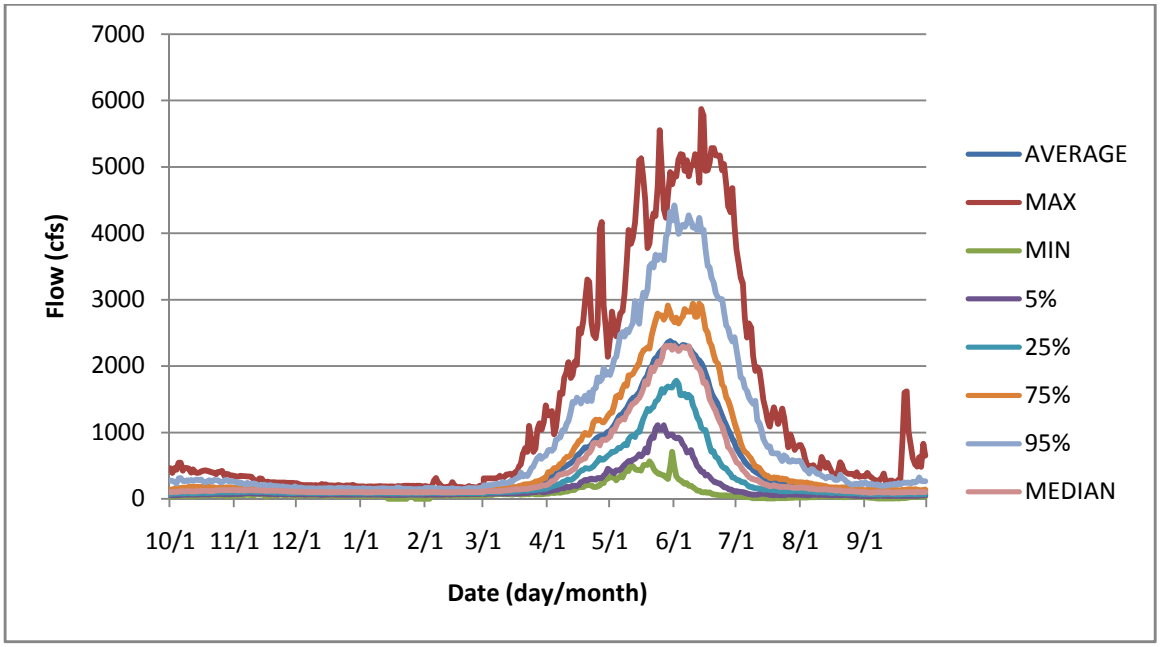

Figure 3 - Flows on the Yampa River

This graph shows the average, minimum, maximum, median and varying percentile daily flows on the Yampa River. Percentile flows describe how one flow relates to other observed flows. For example, the 95% daily flow value is the value below which 95% of the observed flows for that day during the years that measurements were taken have occurred.

Historically, lower flows occur during the months of October through March with the lowest flows occurring during January or February. Flows begin to increase in March from snowmelt and reach their peaks during May and June. The flows decrease during July through October. These flows coincide with the recreational use seasons on the river specified in the YRMP; with recreational use occurring from April to November and peaking in July and August.

In an average year, flows peak in early June at a flow rate of approximately 2940 cfs. Average flows through the critical late summer months of August and September when air and water temperatures peak are approximately 256 cfs and 189 cfs, respectively. Average flows through the lowest flow month of January are approximately 114 cfs.

The bankfull, or channel maintenance discharge, is the flow that generally controls the channel shape. Regionally the bankfull flow can be defined as the flood flow that occurs on an average of once every 1.5- to 2- years. Bankfull flow is an important parameter in stream improvement projects as any proposed channel modifications need to take this parameter into account so as to not adversely impact major sediment transport requirements. Based on review of the available flow data the bankfull flow for the Yampa River at Station No. 09239500 is approximately 2,700 cfs.

C. Existing Channel Character

The character of the River changes along the project reach. The upstream and downstream most portions have been impacted the least by encroachment and development and are slightly entrenched, have natural meander patterns and relatively low slopes. The riparian buffer in these sections of the River is typically wider than through the downtown area. The downtown area, through the more developed reaches along the river, is more entrenched, has less sinuosity and steeper slopes. The riparian buffer in this portion is narrow or non-existent due to development on its eastern bank and the location of the railroad on its western bank. In some areas, development has occurred adjacent to the river bank and little to no buffer is present.

The channel within the project reach was classified by ERC according to the Rosgen Classification System, level 1 (Rosgen, 1996). Using this system, stream channels are given a classification based on the general geometry of the channel and floodplain. The Rosgen classification system was used as a tool to describe the existing state of the River in the study area. The channel classification system was not used to determine rehabilitation methods; rather, each area of interest was viewed as unique and received improvements tailored to its issue(s).

A majority of the stream was classified as a Type C stream. Type C streams are riffle/pool streams with well developed meanders, pointbars and a broad well defined floodplain. They are wide streams with a width to depth ratio (W/D) greater than 12, are slightly entrenched and usually have slopes less than 2%. Prior to human impacts we believe the Yampa River, through the entire project area, would have classified as a Type C stream.

In areas where the stream has been straightened and encroachment into the natural floodplain has occurred with development of the City and railroad, the channel is no longer in a natural state. The straightening of the channel reduced sinuosity and increased channel gradients. The channel banks have been built up to minimize flooding and have resulted in increased entrenchment. Using the Rosgen method, the decreased sinuosity and increased entrenchment result in a Type F classification. Type F streams are riffle/pool streams that are deeply entrenched with a W/D ratio greater than 12. They are often meandering, have little to no floodplain and low slopes.

Other isolated sections of the project area have braided flows most likely resulting from an increase in deposition. These areas classify as D stream types. Type D streams are braided streams characterized by moderate to high bank erosion rates, depositional features such as longitudinal and transverse bars and a frequent shift in bed forms. They are very wide channels, are slightly entrenched and have slopes of less than 4%. The results of ERC's level 1 classification are shown below.

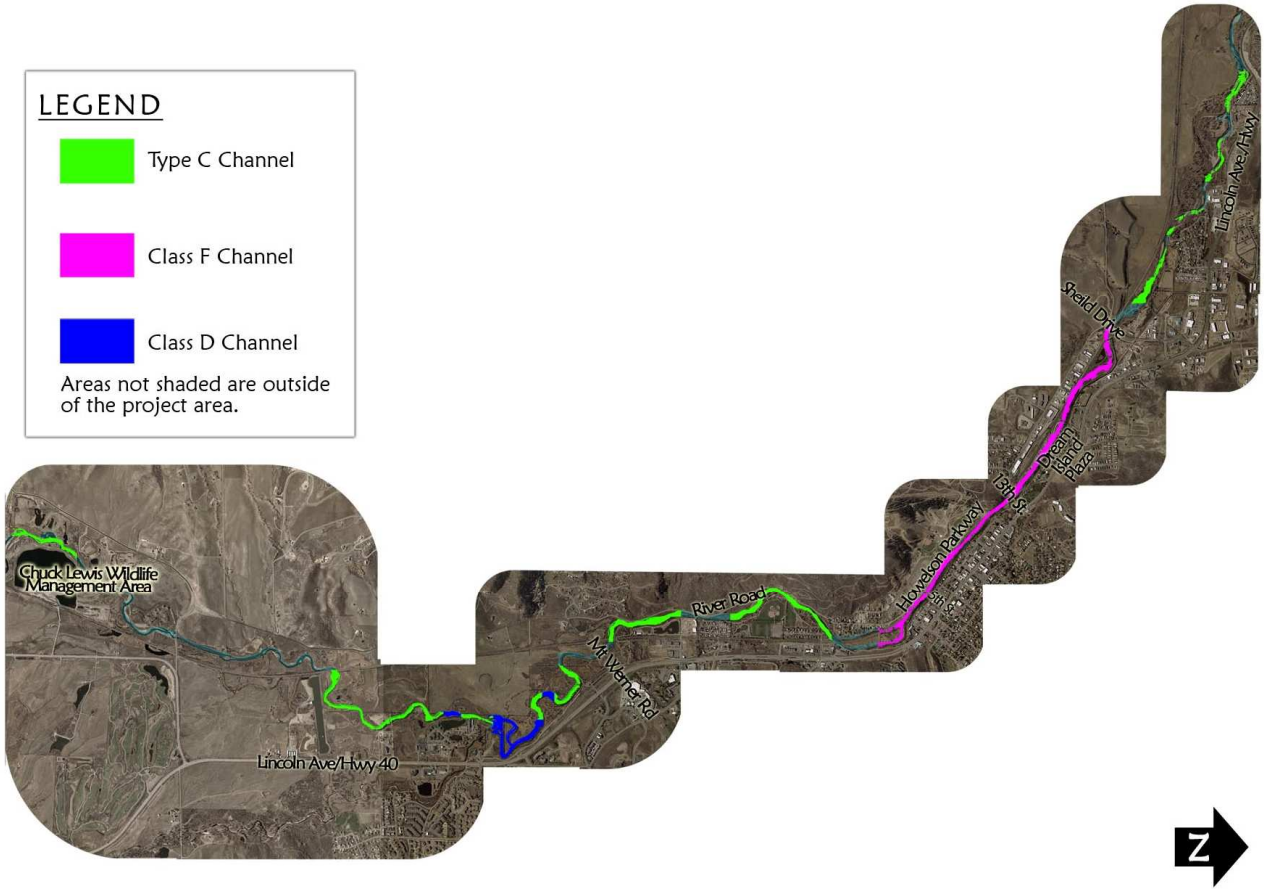

Figure 4 – Level I Rosgen Channel Classification

This classification system was established for natural rivers. Many portions of the River through the project reach have been modified from their natural state through straightening and encroachment. Classifications therefore may not be completely accurate.

D. Defined River Use

Due to the quality of the resource there are many competing interests for its use. The Yampa River Management Plan (EDAW, 2003) identified river users and the times of years they used the river.

***Private Tubing **Commercial Tubing**

Figure 5 - Optimal Use Periods by Recreation Activity (EDAW, 2003)

In addition to the time of year the river is used, the Yampa River Management Plan established the locations along the river where different uses are allowed/recommended. The River was divided into five distinct River Management Areas (RMAs) and major uses within each RMA were defined.

River Management Area	Main Recreational Uses
RMA - 1	Wildlife viewing, fishing and kayaking
RMA - 2	Fishing, kayaking and private tubing
RMA - 3	Fishing, kayaking, swimming and private tubing
RMA - 4	Fishing, kayaking and tubing
RMA - 5	Kayaking and commercial tubing
*RMA – 6	Wildlife viewing and fishing
*RMA – 7	Wildlife viewing and fishing

*RMA created by ERC for this report. It was not part of the EDAW report. Recommended uses for these areas were provided by the City.

Table 1 - RMA's and Their Main Recreational Use

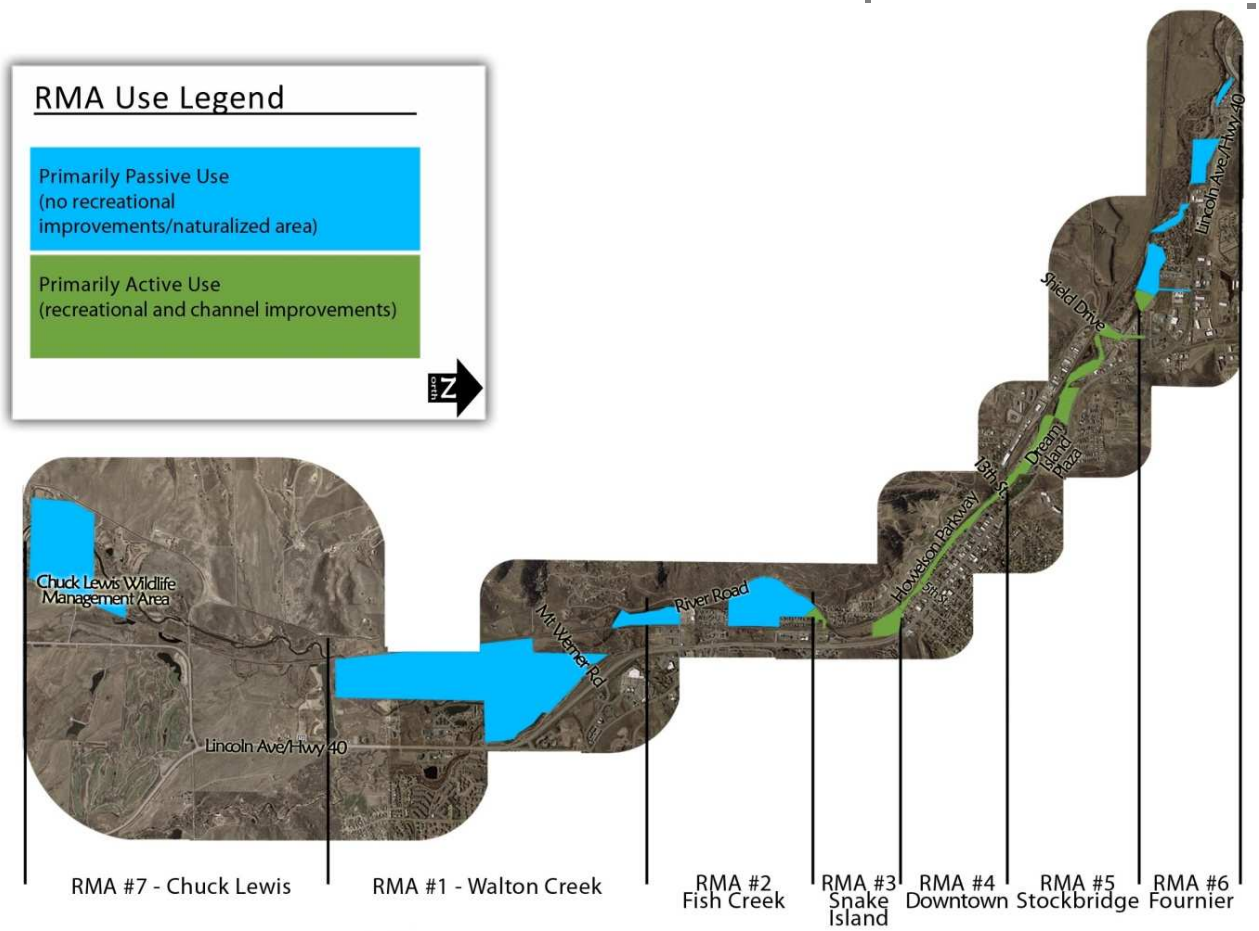

Figure 6 –RMAs and Their Recreational Use

The Plan includes Fournier Park, an area recently acquired by the City, and the Chuck Lewis WMA. These areas were not included in the 2003 YRMP. Per direction from the City, uses in Fournier Open Space and the Chuck Lewis WMA will emphasize wildlife viewing and fishing.

The recommended improvements presented in this Plan will reflect these use patterns. Heaviest "park and play" boating kayak uses occur from downstream of the Fifth Street Bridge to the "D Hole" downstream of the 13th Street Bridge. The approach in this reach will be to recommend improvements that improve/optimize its recreational utility while a more natural, less structural approach is recommended in other areas to protect and promote the natural character of the stream.

E. Public Input

Community input was received throughout the Plan development process with specific input obtained during the first two public meetings. At the first public meeting recreational use improvements requested included increased and more user-friendly River access, new kayak holes and play areas and the reconstruction of existing play structures. The installation of a gage for RICD rights and agricultural diversion repair were other requests. The need for strict regulation and enforcement to protect the resource was also a main concern raised at the first public meeting. During the second public meeting,

when ERC's initial assessment of areas of interest was presented, river health concerns were more prominent with channel stabilization and minimizing and controlling River access being more vocal concerns. Community comments from public meeting #1 and #2 can be found in Appendix B.

F. Past Improvements

The Yampa River has historically been a popular place for fishing, rafting, swimming, tubing and kayaking and, because of this, the community has been committed to improving the health and recreational use of the river. Improvements have included the addition of boating play structures, rock vanes and boulder clusters, revegetation and bank stabilization measures. Many of these improvements still exist today. Dates and scope of prior stream projects known to ERC are provided in Appendix C.

III. EXISTING CONDITIONS ASSESSMENT

As part of ERC's assessment of existing conditions, the entire project area was walked and the condition of the channel, banks and vegetation were evaluated. Input was also received from the City and public on problems along the project reach. Based on our observations and input from others, areas of interest (AOIs) were defined. These AOIs were the basis for ERC's recommended improvements.

Areas of interest were grouped into two major categories: river rehabilitation and recreational use. River rehabilitation AOIs were defined by ERC as areas where the stream channel and adjacent riparian corridor have been degraded to a point where they are functioning well below their potential, considering current conditions and constraints. Included in this category are areas where the channel form is degraded (poor width/depth ratio, low sinuosity, etc) and natural aquatic habitat is limited. It also includes areas lacking a healthy riparian corridor (stable, vegetated banks with riparian terraces and connected floodplains where possible). Recreational use AOIs included areas where active and passive recreational opportunities exist and are desired.

A third category was included in ERC's assessment for water rights. Ensuring that maximum flows continue through this reach is of importance to the health of the river system and recreational uses alike.

To understand the basis for ERC's assessment, the sections below describe types of problems that were noted and why these issues are concerns to the overall integrity of the system. Specific areas along the project reach where each type of problem was identified are presented in Appendix D.

A. River Rehabilitation

1. Bank Stabilization

Bank stability affects channel shape, aquatic habitat and water quality. Eroding banks can cause the river to widen, migrate laterally or create a new bend. The sediment from an eroding bank can fill in pools and other areas that fish use for refuge and, by increasing the amount of suspended solids, it can decrease water quality. Bank instability results from a lack of sufficient natural armoring.

Bank stability problems can be found in many locations along the River and vary from minor surface erosion to mass wasting and undercutting. In some locations the undercutting is stabilized by existing vegetation and provides aquatic habitat. In others, vegetation is not well established or does not sufficiently stabilize the bank. Existing revetments, i.e. forms of structural bank stabilization, include large placed boulders and logs and riprap. Many of these structures are locally effective and have been placed on an as needed basis.

Steep bank angles and sparse surface protection, both vegetative and structural, are closely correlated with bank instability in severely eroded sections of the River. These steep banks may have formed as either a result of channel incision or of the River adjusting to past channel modifications and encroachment. In areas that have been straightened and confined the River has tried to reestablish its equilibrium by becoming erosive. These changes, combined with the River's inability to access its historic floodplain, have increased shear stresses and caused bank erosion to be more prevalent.

New areas of bank instability may develop over time in sections that are not identified in this report and areas that received a low ranking in this report may develop into more immediate problems if corrective measures are not taken, particularly as existing revetments degrade with age.

Photo 1- Existing Bank Stabilization AOI example

Photo 2 - Existing revetment

Areas where bank stabilization was observed are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

2. Vegetation and Riparian Buffer

Healthy and viable vegetation in the riparian corridor is very important. It has many functions including: stabilizing riverbanks and resisting erosion, filtering suspended solids, nutrients and other pollutants, supporting riverine and riparian fish and wildlife species and helping to moderate the climate of the riparian system. It also protects and buffers the river from adverse impacts such as stormwater runoff.

Vegetative quality is a subjective indicator of observed vegetation characteristics. These characteristics include the presence and density of overstory, midstory and understory vegetation, amount of hardscape present, complexity of the vegetation structure, amount of non-native species present and the presence and width of the riparian buffer. A table of recommended native plant species and non-native species is located in Appendix F.

Higher vegetative quality is found in the upstream and downstream reaches where less development is present. In many of these areas the amount of vegetation could be increased but is sufficient and, since there is very little development on the banks of the river, buffer width is adequate. This is primarily true along the eastern bank of the river.

In many locations in the middle reaches, the railroad track or road lies along the top of the western bank and little to no buffer is present. The middle portion, through downtown, has lower vegetative quality with little to no buffer and less vegetation along the banks. In areas where bank instability has necessitated the installation of bank armoring little to no vegetation is present. The lack of riparian vegetation in these areas affects the overall health and function of the channel.

Photo 3- Lack of Riparian buffer and Vegetation Example

Photo 4 - Lack of Riparian buffer and Vegetation Example

Areas where concerns with the vegetation and riparian buffer were observed are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

3. Channel Form

In its natural state the Yampa River through the project area was an alluvial or unconstrained river. This means that its beds, banks and floodplain were composed of materials deposited by the river and, since these materials were constantly being moved, the bed and banks were moveable boundaries. Thus, the floodplain was constantly being reworked as the river removed sediment from one bank and deposited

the material in a sandbar on the opposite bank. Channel stability occurred when the removal and deposition of this material was equal.

As previously described, the River channel was naturally a Rosgen Type C channel through the project reach prior to human impacts. Areas less affected by development and where braiding has not occurred are typical of this type of alluvial rivers. During flood events they are able to access their floodplains and they have meanders and point bars.

Areas where past human activities have straightened the channel, built up its banks to prevent flood flows from leaving the main channel and encroached within the natural floodplain, the natural stream balance has been upset and the River is no longer in a natural state. In these areas natural meanders have been lost as the river has been straightened, the channel has become incised due to the heightened banks and the natural floodplain has been lost to railroads, roads and development. These activities have combined to result in a channel that is no longer functioning as a natural system.

It is natural for a river to change its morphology in response to a disturbance. Following a channel altering disturbance the river typically undergoes a period of recovery in which the equilibrium of the channel is reestablished. For example, a channel that widens and straightens in response to a flood will narrow and regain sinuosity through revegetation and sediment transport. In the case of the River through much of the project reach, the degree of human impact is so great that the system is not capable of adapting to the forced changes. This is indicative of areas on the River where the channel is wide, straight and shallow with little or no pronounced thalweg.

Photo 5 - Overly wide and shallow channel

Photo 6 - Slackwater and braiding

Given the development that has occurred in these areas, true channel restoration is not possible. ERC believes the goals for these areas should be to provide a level of channel equilibrium that is obtainable given current land constraints. Minor improvements can regain some of the natural function of the stream system which will lead to improved aquatic and riparian function and recreational opportunities.

The main, fixable problem observed within the River is the absence of a defined low flow channel. This impacts both the ecological and recreational function of the channel. Ecologically, a low flow channel is important because during times of low flow it provides deeper water and higher quality habitats, less evaporation losses by decreasing the water surface area and lower water temperatures. Recreationally, a low flow channel extends the time during the year when boating can occur as a result of the confined, deeper water.

In the past the City has constructed vanes from the bank into the channel in an attempt to remedy this problem. In some locations vanes have been constructed along both the right and left bank. In other locations vanes have been constructed in an alternating fashion with one on the left bank followed by a downstream vane on the right bank followed by a downstream vane on the left bank, etc.

Photo 7 – Vanes have been used previously in an effort to create meanders and low flow water depths

ERC believes that the installation of vanes has benefited the stream by creating deeper water in some areas. However, in most cases the vanes as constructed have further aggravated the unnatural form of the channel.

Natural channels have a thread of the deepest water, called the thalweg, on the outside bend and shallower areas and bars on the inside of bends. This follows the natural stream process where channel material is eroded from an outside bend and deposited on an inside bend. In locations where vanes have been constructed along both banks the vanes are fighting this natural process and instead trying to structurally force flows down the center of the channel. This is generally not an optimal solution as the vanes further force the channel into a straight alignment and they are susceptible to failure as the natural forces of the channel are working against them.

Installing vanes on alternating banks, as has been done in other locations, is a more natural approach as it allows the stream to meander from one bank to the other. The problem ERC has observed with these installations, however, is the meandering pattern they force the stream to take.

A degree of variability exists in the shape of meanders that form but the meander wavelength in rivers is generally between 10 and 14 times the width of the channel (Leopold, 1992). One meander wavelength includes a left and a right meander; therefore a single meander should occur approximately once every five to seven channel widths. The width of the river through a majority of the straightened sections is typically between 70 and 90 feet, meaning that each meander should be between 350 and 630 feet apart and that total meander wavelengths should be between approximately 700 and 1260 feet. Alternating meanders that have been installed on the River through the project reach have much shorter wavelengths and distances between meanders. Single meanders spaced as close as 50 feet apart

(100 foot meander wavelength) have resulted based on the vane spacing. These extremely short constructed meanders are fighting the natural tendency of the river and creating an unnatural, structural control that is impacting the health and function of the stream.

Areas where the form of the channel could be modified to improve the overall health and function of the stream are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

4. Aquatic Habitat

Aquatic habitat is affected by hydraulic variability, bed material, flow velocity, nutrient availability, water quality and water temperature. Hydraulic variability ensures the presence of an array of microhabitats for various riverine species. Given that this reach of river is of such importance as a trout fishery, the aquatic habitat was judged based on requirements for a healthy trout population and managed as a cold water fishery.

Quality habitat requires that varying flow velocity, depth and flow patterns exist in the channel through a range of flows. Hydraulic variability is a result of varying gradients (channel slopes), thalwegs and instream features. A natural river of this type with hydraulic variability will have riffles (shallow fast moving water) and pools (deep, slower moving water). High flow channels can improve aquatic habitat by providing added diversity. Many factors contribute to the quality of the aquatic environment. During times of the year, water quality (temperature, pH, dissolved oxygen and suspended solids) can be the most influential component. Physical habitat conditions also limit the aquatic habitat of a significant amount of the project reach with average water depth and overwintering pool habitat the two primary limiting physical habitat factors.

An optimal trout fishery requires a variety of specific habitat features. In general, optimal trout riverine habitat can be characterized by clear, cold water; a silt-free rocky substrate in riffle-run areas; an approximately 1:1 pool-to-riffle ratio, with areas of slow, deep water; well-vegetated stream banks; abundant instream cover; and relatively stable water flow, temperature regimes, and stream banks (Raleigh and Duff 1980).

Photo 8 - Lack of aquatic habitat

Photo 9 - Lack of aquatic habitat

There are many areas along the River where aquatic habitat is well below optimal. Overall a majority of the channel is dominated by low gradient riffles with limited deeper pools. Habitat variety is minimal through most of the project reach. In other areas little or no instream habitat exists.

Areas where aquatic habitat was limited were identified as part of the site assessment and are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

B. Recreational Use

Recreational values gained by the river system are of high importance to the City, its citizens and visitors to the community. Recreation takes many forms along and adjacent to the river including wildlife viewing, walking/running/biking the trail, boating (tubing, rafting and kayaking) and angling. These varying uses require different types of amenities and direct access to the river.

As part of ERC's assessment of existing conditions, a specific assessment was completed to evaluate river access and boating. Wildlife viewing was incorporated indirectly as part of the evaluation of vegetation and riparian buffer presented above. Quality angling is related to channel form and aquatic habitat and is therefore addressed indirectly through those categories. Access, which is a requirement of many uses and boating are addressed as part of this section.

1. Access

Access to the river is required to support a number of different active and passive recreational activities. Quality access allows the specific users to enter the river setting in a safe and secure manner. Good access points should direct users to a specific location thereby limiting impacts on adjacent slopes and vegetation.

Photo 10 - Eroding access point at "The Beach" in Dr. Rich Weiss Park

Photo 11 – Eroding Informal Access Point

As part of our investigation, existing access points to the stream were evaluated. Areas where the access was either difficult to use, unsafe, in a state of disrepair, poorly defined and/or where access was clearly impacting surrounding areas were identified and are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

2. Boating

Boating is a major use of the Yampa River. Boating takes on many forms including rafting, tubing and kayaking. Boating uses are further split into those who put in the water at one location and float downstream (top to bottom users) and those whose recreation is focused on one specific location (park and play). Use by top to bottom boaters is dominated by tubing (EDAW, 2003) however, kayaking and rafting are still important uses of the area. Park and play use is typically limited to kayaks.

The section of the River flowing through the downtown corridor provides a world class resource to experienced and amateur kayakers alike. The many instream boating structures offer both park and play and top to bottom boating opportunities. The community has been heavily involved with the creation and maintenance of these structures.

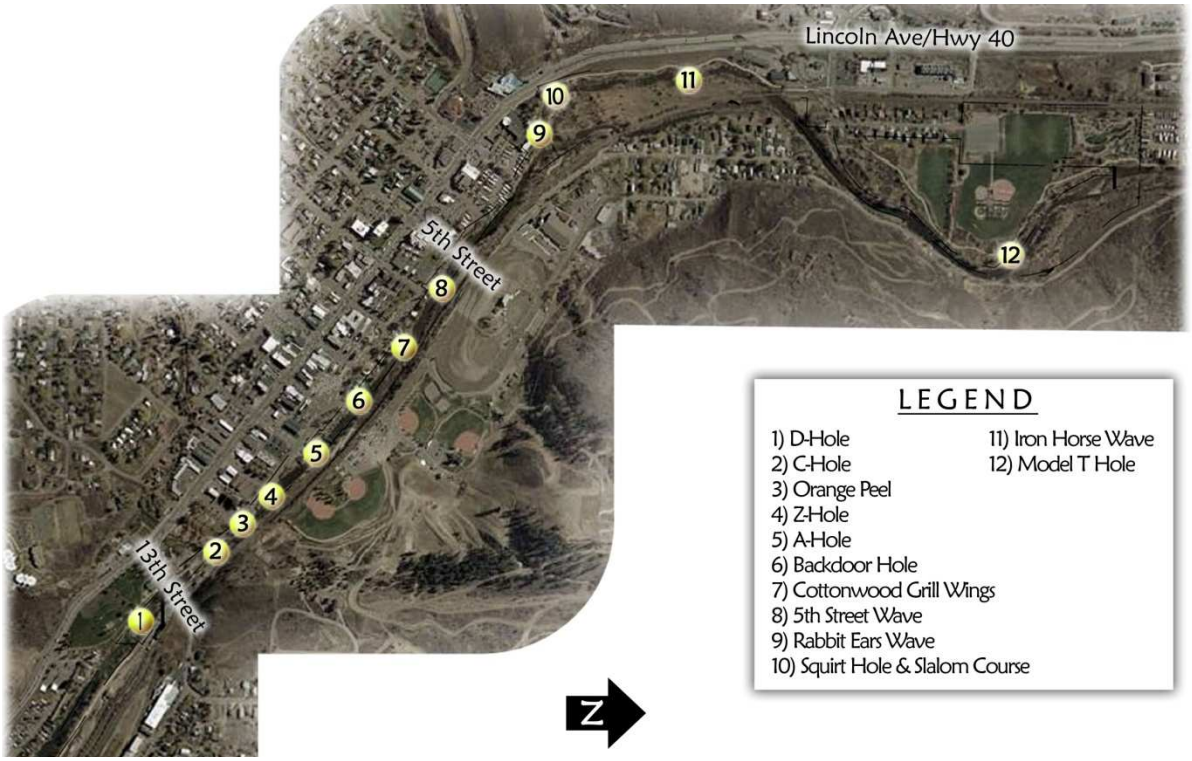

Figure 7 - Play Structures in the Project Area

In order to function as a quality amenity, boating features should function over a range of time and flow conditions and they should provide a variety of opportunities for enjoyment for differing ability levels. Any boating feature should provide safe passage for novice users.

ERC's evaluation of existing boating features found that a significant number of structures have been built for this purpose. Despite the high number of features available, discussions with the boating community indicated that two specific features, Charlie's Hole and the D-Hole receive far more use than any of the other structures. Other features typically only function well under a small range of flows or do not function as intended altogether. This results in underutilization of most of the boating features and crowding at the most popular locations. Concerns with channel form discussed above are generally areas where the overall channel shape limits the top to bottom boater.

ERC's assessment of the river, which included significant input from the public, identified improvements that could be made to better the area for recreational boating. Areas where boating features are poorly designed or are in a state of disrepair were identified and are depicted on Drawings 1 – 11 in Appendix D. A description of the specific issues noted at the individual AOIs is presented in Appendix E.

C. Water Rights

To ensure that the River within City limits receives flows required for its recreational demands, the City obtained a Boating Park Recreational in Channel Diversion (RICD) in March of 2006. Before this right can be administered the City must install gages required to calculate average daily flow in 1 of 2 locations:

on Butcher Knife Creek near its confluence with the River and on Soda Creek near its confluence with the River; or at or near the 13th Street Bridge. As part of ERC's assessment of existing conditions, the need to perfect this water right by installation of the required gage(s) was identified. The City installed a gage at the 13th Street Bridge in the summer of 2008.

IV. MASTER PLAN IMPROVEMENTS

The City's stated objectives for this project were to define master plan improvements:

- To enhance/preserve the natural character of the River through river rehabilitation improvements
- To enhance the value of the River as a community amenity through access points and recreational use opportunities

After ERC completed its evaluation of the stream system through site assessment, review of background data and public input, recommended improvements were defined. Improvements presented herein are intended to address problems identified in a consistent manner establishing a roadmap for future implementation. Improvements presented include all items identified as part of this Plan evaluation. It is envisioned that recommended improvements could be phased in and it is likely that some improvements may never be implemented. It is also likely that as areas which are outside the scope of this study are evaluated, other related improvements may be undertaken and incorporated into this Plan.

Recommended improvements presented in this Plan are described at a conceptual level of detail. Prior to implementation, a more detailed site specific investigation and design will need to be conducted to verify the appropriateness and suitability of a technique for a given area and refine the improvements made in this report.

The sections below describe the typical improvement techniques that were considered as part of the Plan improvements. Possible treatments are broken out below to correspond to the categories of problems observed and discussed above. For each treatment method, means of implementing the treatment along with pros and cons are discussed. Where appropriate, a graphical example of the typical treatment is presented. Locations within the project reach where specific Plan improvements are recommended are shown on Drawings 1 – 11 in Appendix G.

A. River Rehabilitation Improvements

1. Bank Stabilization

Bank stabilization is recommended in locations throughout the project reach where instabilities were noted.

- Improvement techniques
  a) Vegetate

Figure 8 - Improvement Example, Vegetate

- Description
  - Remove non-native species
  - Revegetate with native species
  - Vegetation may either be along the slope, the top of bank or both
- Where appropriate
  - Where banks are stable and erosion is not a serious problem
  - Widely recommended where structural reinforcement is unnecessary
- Implementation
  - Area is vegetated with a variety of native species.
  - Revegetation should include under-, mid- and overstory.
- Advantages
  - Relatively inexpensive
  - Uses natural materials ensuring a long-lasting effectiveness with generalized habitat benefits.
  - Attractive
  - Improves water quality by decreasing turbidity
  - Improves aquatic habitat through overhead cover
  - Decreases water temperature due to shading
- Disadvantages
  - Only feasible in areas with stable slopes and easy access
  - Maintenance and irrigation may be necessary

b) Vegetate existing stabilization feature

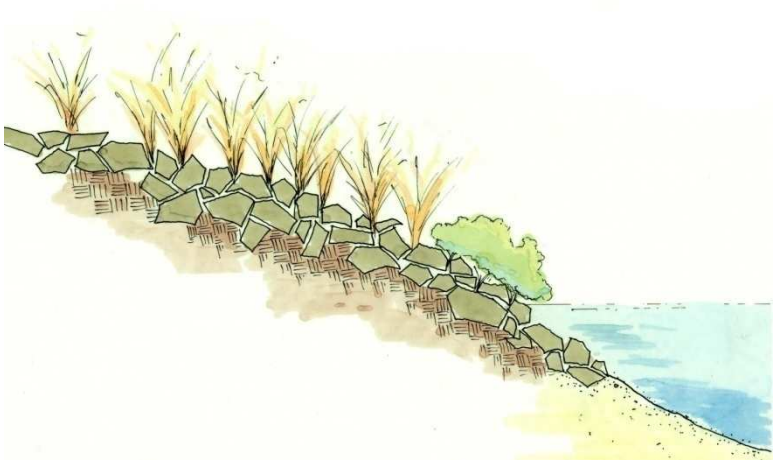

Figure 9 - Improvement Example, Vegetate Existing Stabilization Feature

- Description
  - Existing bank structure remains and is revegetated with native and varied species
- Where Appropriate
  - In areas where the existing feature is effective and in good condition and revegetation is possible
- Implementation
  - Create planting zones with required planting soils
  - Plant appropriate native vegetation
- Advantages
  - Makes structural bank stabilization more natural looking
  - Improves water quality by decreasing turbidity
  - Improves aquatic habitat through overhead cover
  - Decreases water temperature due to shading
- Disadvantages
  - May be difficult to establish planting zones through some existing structural revetment
  - Maintenance and irrigation may be required

c) Regrade and replant

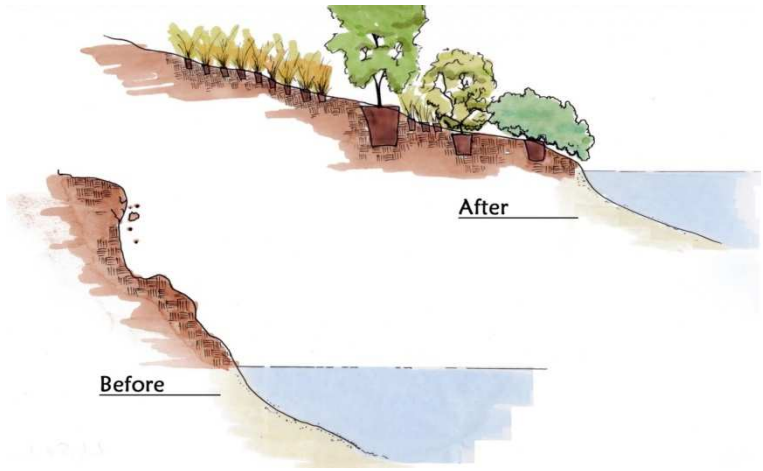

Figure 10 - Improvement Example, Regrade and Replant

- Description
  - Existing steep banks are regarded to a maximum 3:1 bank slope
  - Area is replanted with native and varied plant species
- Where Appropriate
  - Where the room exists to regrade and the access is good
  - Along lower banks where water velocities are sufficiently low
  - Where regrading is necessary for vegetation establishment and vegetation is desired
- Implementation
  - Regrade banks without altering the toe of the existing slope
  - Vegetate with native and varied plant species
- Advantages
  - Plant growth will maintain bank stability
  - Aesthetically pleasing
  - Improves water quality by decreasing turbidity
  - Improves aquatic habitat through overhead cover
  - Decreases water temperature due to shading
- Disadvantages
  - Can have a significant lag time between implementation and improved bank stability
  - Disturbs soil and existing plants
  - Maintenance and irrigation may be required

d) Boulder Terrace

Figure 11 - Improvement Example, Boulder Terrace

- Description
  - Bank is stabilized by the creation of one or more vegetated terraces (wide benches cut into the river bank)
- Where Appropriate
  - Where space is limited so that a stable soil slope is not feasible
  - Where riprap is not required
- Implementation
  - Grade terraces
  - Install boulders for vertical face of terrace
  - Provide planting areas in flat sections behind boulders
  - Seed and plant flat sections with native and varied species
- Advantages
  - More aesthetically pleasing than riprapped slopes
  - Long lasting, solid armoring
  - Improves water quality by decreasing turbidity
  - Improves aquatic habitat through overhead cover
  - Decreases water temperature due to shading
- Disadvantages
  - May be more costly than riprap
  - Maintenance and irrigation may be necessary

e) Boulder Wall

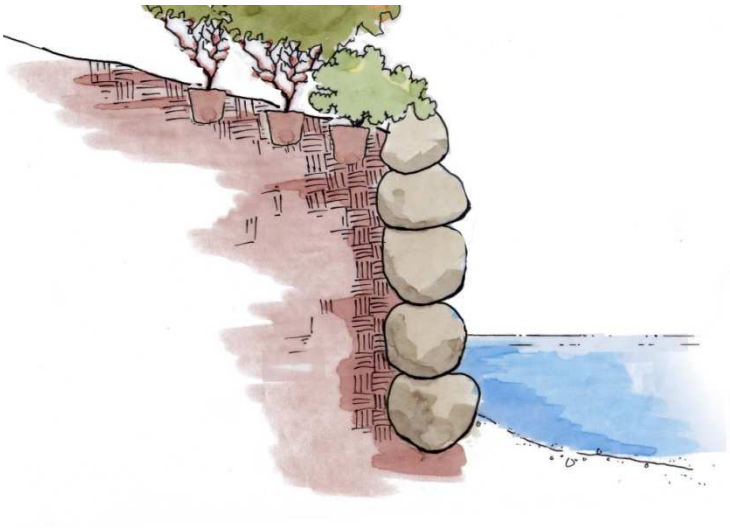

Figure 12 - Improvement Example, Boulder Wall

- Description
  - Bank is stabilized by construction of near vertical wall
- Where Appropriate
  - Where a distinct buffer is required between the river and adjacent areas and sufficient room does not exist for other treatment methods
- Implementation
  - Regrade bank to facilitate construction of wall
  - Wall typically constructed of boulders or similar materials
  - May use wall to move existing toe of slope
  - Top of wall can be vegetated, if room exists
- Advantages
  - Distinct break between riverine and urban environments
  - Structures are stable under high shear stresses
- Disadvantages
  - Costly to construct
  - Unnatural in appearance

f) Boulder Toe

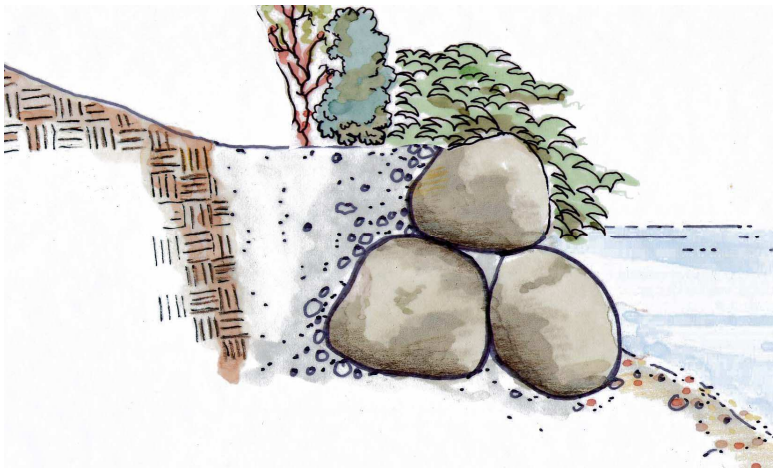

Figure 13 - Improvement Example, Boulder Toe

- Description
  - Protect toe with sufficiently large rocks
  - Include revegetation above the rocks
- Where Appropriate
  - Where erosion is pronounced at the toe
- Implementation
  - Bank graded for stability
  - Boulders placed at toe of bank
- Advantages
  - Prevents further erosion at toe of bank
- Disadvantages
  - Can be costly and labor intensive
  - Does not allow for naturally occurring bank undercutting or other natural bank variation

2. Vegetation and Riparian Buffer

Vegetation and riparian buffer improvements were recommended at locations throughout the project reach as determined necessary.

- Improvement techniques
  a) Supplement existing vegetation
    - Description
      - Remove non native vegetation
      - Add plantings to vegetated areas
    - Where appropriate

        - Areas where vegetative quality is good but could improve with the placement of additional vegetation and removal of non native species
    - Advantages
        - Increases vegetative quality
        - Plant growth will maintain bank stability
        - Aesthetically pleasing
        - Improves water quality by decreasing turbidity
        - Improves aquatic habitat through overhead cover
        - Decreases water temperature due to shading
    - Disadvantages
        - Some cost and labor
        - Maintenance and irrigation may be necessary

b) Revegetation
    - Description
        - A currently non-vegetated or sparsely vegetated area is planted with native species. Non native species are removed.
    - Where appropriate
        - Areas where minimal or no vegetation exists
    - Advantages
        - Increases vegetative quality
        - Plant growth will maintain bank stability
        - Aesthetically pleasing
        - Improves water quality by decreasing turbidity
        - Improves aquatic habitat through overhead cover
        - Decreases water temperature due to shading
    - Disadvantages
        - Some cost and labor
        - Maintenance and irrigation may be necessary

3. Channel Form

Channel form improvements were recommended at many locations along the project reach. In general channel form improvements were not recommended in areas through the heart of downtown where existing boating structures are prevalent as reshaping the channel in this manner would likely be detrimental to some boating recreation.

- Improvement Techniques
    a) Create meander and thalweg

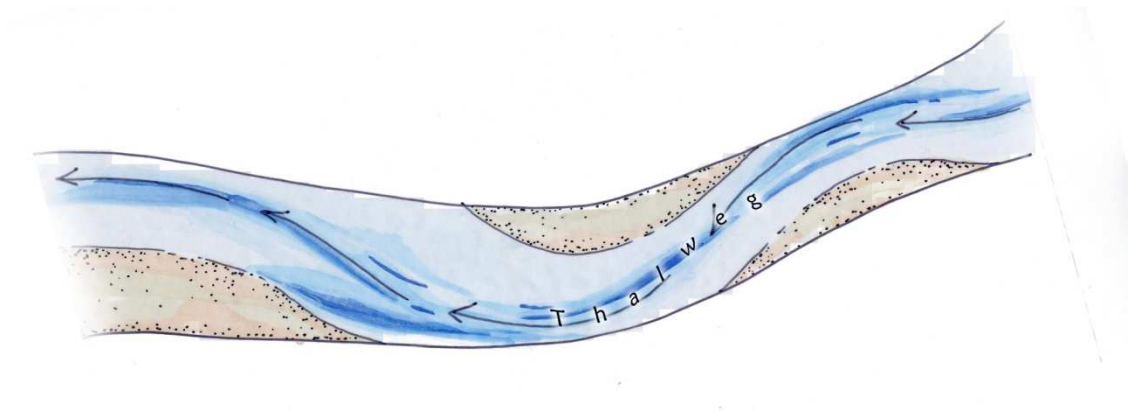

Figure 14 - Improvement Example, Create Meander and Thalweg

- Description
    - A meander is created at the appropriate spacing
- Where Appropriate
    - Areas where no low flow channel exists
    - Straight channel sections
    - Areas where a meander exists, but is spaced improperly
- Implementation
    - Excavate a meandering low flow channel
    - Move excavated material to opposite side of channel to create bars
    - Typically done in combination with longitudinal channel modification.
- Advantages
    - Increases depth of water at low flows which results in better aquatic habitat and more boatable water
    - Decreases water temperature
    - Reduces evaporative losses
    - Reestablishes meander pattern of natural channel – if spaced correctly
    - Eliminates improperly spaced meanders that fight natural forces of the stream
- Disadvantages
    - Temporarily disrupts streambed

b) Create High Flow Channel

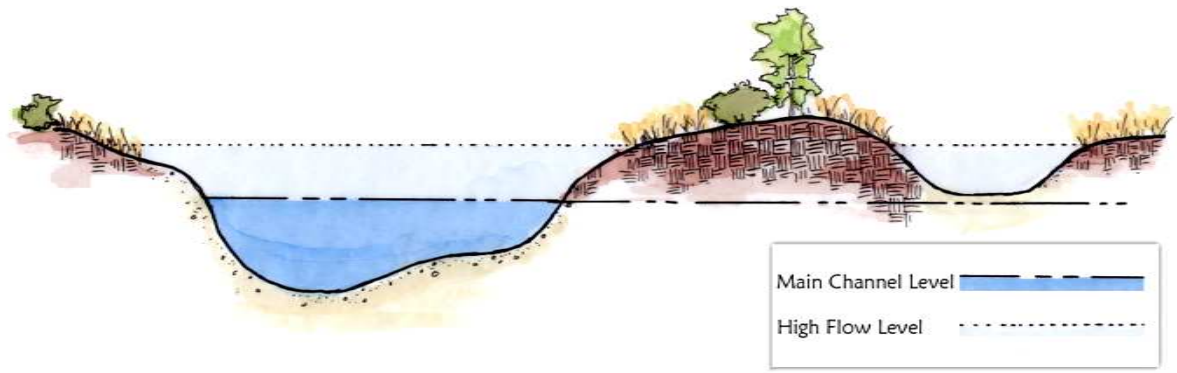

Figure 15 - Improvement Example, Create High Flow Channel

- Description
  - A high flow channel is created within the channel
- Where Appropriate
  - Areas that require a high flow channel to avoid flooding
- Implementation
  - A high flow channel is graded into the stream channel
- Advantages
  - Contains high flows in channel banks
- Disadvantages
  - Disrupts channel banks and streambed

c) Remove boulder vanes

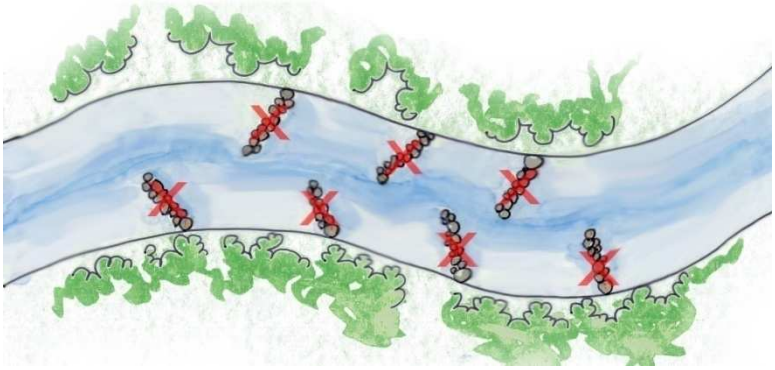

Figure 16 - Improvement Example, Remove Boulder Vanes

- Description
  - Existing boulder vanes are removed from the channel
- Where Appropriate
  - Areas where boulder vanes are fighting the natural form of the channel or are causing bank erosion
- Implementation
  - Boulder vanes are removed from the channel
- Advantages
  - Allows the channel to follow a natural erosion and deposition process
  - Reduces bank erosion caused by the vane structure
- Disadvantages
  - Disrupts channel banks and streambed

4. Aquatic Habitat

Aquatic habitat improvements were recommended in locations where existing habitat is limited. Locations for these improvements were generally not recommended in locations where use by boaters is highest.

- Improvement Techniques

a) Create riffle/pool/glide sequences

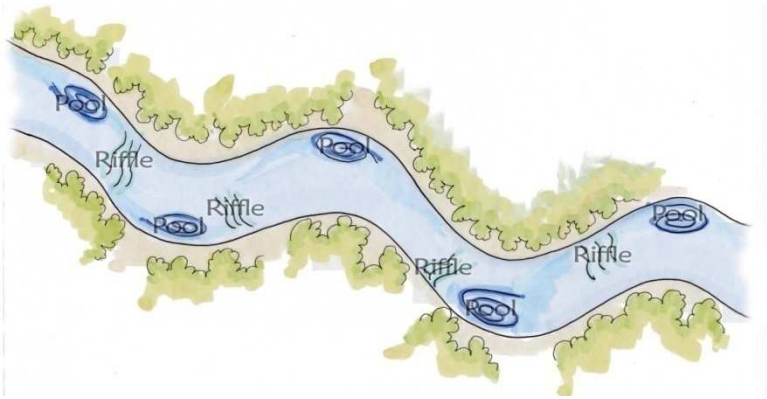

Figure 17 - Improvement Example, Create Riffle/pool/glide Sequences

- Description
  - Riffle/pool/glide sequences are created within the channel
- Where Appropriate
  - Areas that lack aquatic habitat diversity and have sufficient longitudinal gradient for riffles.
- Implementation
  - The streambed is graded to have steep and shallow sections (riffles), depressions (pools) and transition areas (glides)
  - Done in combination with longitudinal grading discussed above.
- Advantages
  - Provides habitat variety needed for various flow conditions and trout life cycles.
  - Establishes deep overwintering pool habitat.
  - Improves experience for angling
  - Creates instant habitat improvements.
- Disadvantages
  - Temporarily disrupts stream bed

b) Install boulder habitat clusters

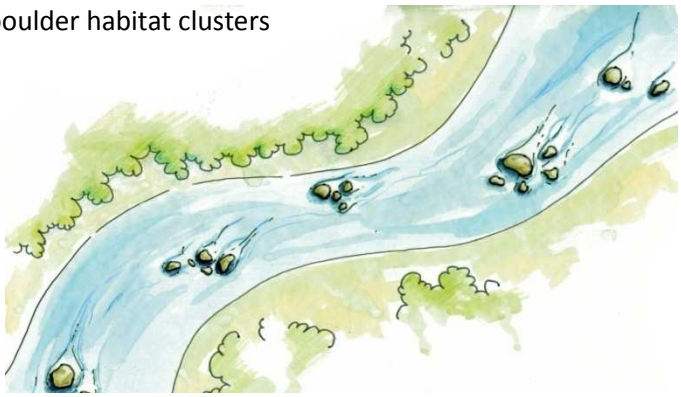

Figure 18 - Improvement Example, Install Boulder Habitat Clusters

- Description
  - Boulders are placed within the stream to create micro aquatic habitat
- Where Appropriate
  - Areas with insufficient instream aquatic habitat
  - Areas with inadequate hydraulic diversity
- Implementation
  - Boulders are placed within the stream in clusters to provide hiding/resting areas for trout. Instream habitat creates quality feeding lanes and increase holding capacity.
- Advantages
  - Improved habitat
  - Can generally be completed using material that is already in the stream.
- Disadvantages
  - If placed in pool locations may increase erosion downstream or create a backwater issue upstream

c) Install natural habitat feature

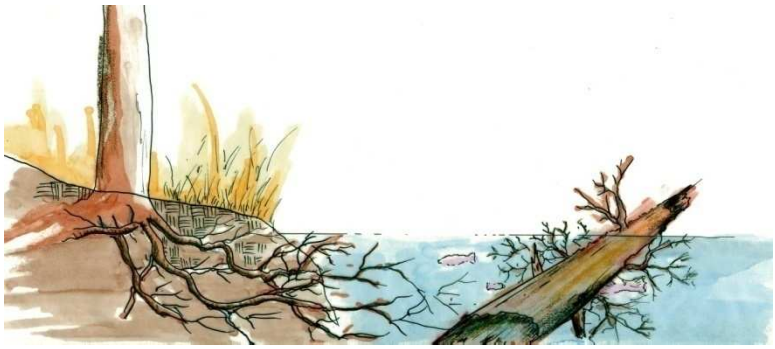

Figure 19 - Improvement Example, Install Natural Habitat Feature

- Description
  - Instream cover features such as rootwads, submerged vegetation and logs are installed
- Where Appropriate
  - Areas with inadequate instream cover
  - Particularly successful in areas with low flow velocities and shear stresses
- Implementation
  - Add logs, rootwads or similar natural material to the stream bed and banks
- Advantages
  - In-stream cover gives fish and macro-invertebrates shelter from predators, competitors and river current and offers areas for feeding and reproduction
- Disadvantages
  - Often susceptible to being dislodged
  - Can result in sediment accumulation if placed incorrectly

d) Remove debris
- Description
  - Debris and other items are removed and disposed of
- Where Appropriate
  - Areas with a large amount of debris or debris that presents a safety concern
- Implementation
  - Debris is removed and disposed of
- Advantages
  - Improves aquatic habitat health
  - Improves user safety

- Disadvantages
  - May be labor intensive

e) Convert open water to wetland

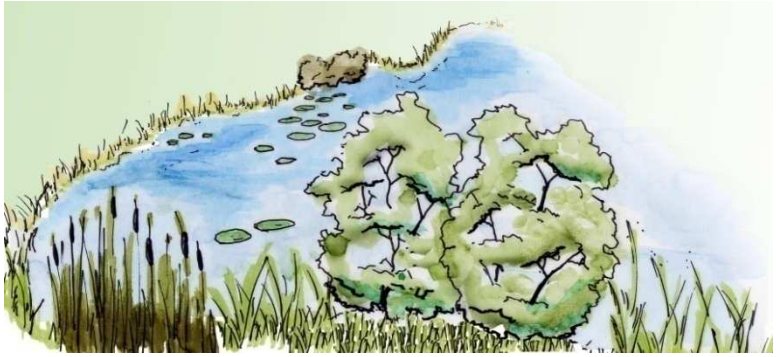

Figure 20 - Improvement Example, Convert Open Water to Wetland

- Description
  - Converts a section of land that is currently open water to wetland habitat
- Where Appropriate
  - In locations where stagnant, open water exists and the riparian area would be improved by the creation of wetlands
- Implementation
  - Import channel material to establish proper ground elevation.
  - Add suitable planting matrix, if necessary
  - Vegetate with wetland species
- Advantages
  - Wetlands filter runoff prior to it reaching the river, increasing water quality
  - Wetlands add variety and high quality habitat to the stream system
  - Possible to use material from other portions of the channel improvements to create wetlands thereby eliminating or reducing costs associated with hauling and disposing excavated material.
- Disadvantages
  - Costly if fill material must be purchased and imported.
  - Chance for failure if not set at correct elevations related to river.

B. Recreational Use Improvements

1. Access

Access improvements were recommended in locations throughout the project.

- Improvement Techniques
  a) Formalize access point

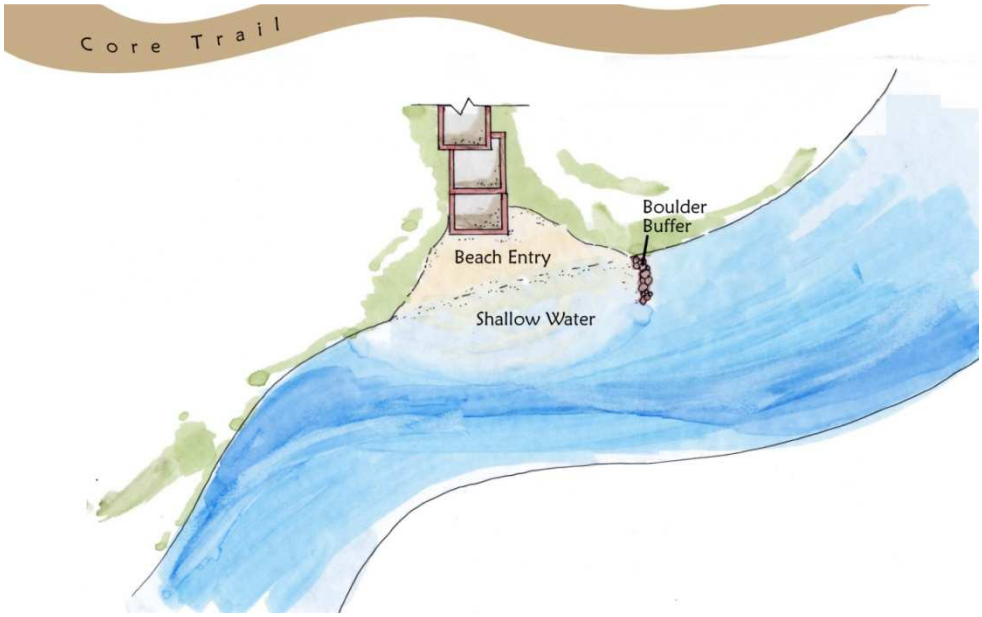

Figure 21 - Improvement Example, Formalize Access Point

- Description
  - User created access point is formalized
- Where Appropriate
  - Areas where additional access is desired and a user created access point exists
- Implementation
  - Boulder terrace similar is installed
  - Slope is graded and stabilized
- Advantages
  - Increases river access
  - Lessens need to user created access point
  - Improves bank stability/reduces erosion and vegetation impacts at access point
- Disadvantages
  - Increases river access
  - Places unnatural structure along river bank

b) Create formalized access point
- Description
  - A formalized access point is installed
- Where Appropriate
  - Areas where additional access is desired and a user created access point does not exist

- Implementation
  - Boulder terrace is installed
  - Slope is graded and stabilized with concrete
- Advantages
  - Increases river access
  - Lessens need to user created access point
  - Ensures bank stability at access point
- Disadvantages
  - Increases river access
  - Places unnatural structure along river bank

2. Boating

Boating improvements were generally recommended for portions of the project reach that are already heavily used for boating. Additional boating features were not recommended in areas that are currently more natural to reduce impacts on these areas that come with heavy boating use.

- Improvement Techniques
  a) Repair/enhance existing boating structure
    - Description
      - Repairs or enhancements are made to an existing boating structure to increase its recreational usability and/or safety
    - Where Appropriate
      - In areas where a boating feature exists, but is functioning in a sub-optimal manor or a safety concern exists
    - Implementation
      - Feature(s) is repaired by moving boulders, grading, extending hole, adding or removing boulders.
    - Advantages
      - Less costly than replacing boating feature
      - Extends lifetime of existing boating features
      - Decreases user pressure at existing high quality boating features
    - Disadvantages
      - Inherent uncertainty as to how feature will function

  b) Remove and/or replace boating structure
    - Description
      - Existing boating structure is removed and replaced, if appropriate
    - Where Appropriate
      - In areas where the boating structure has become unsafe and/or ineffective and cannot be improved through repair or enhancement

        - Areas where the existing structure requires more than minor modifications to function properly
    - Implementation
        - Existing boating structure is removed
        - If appropriate, a new boating structure is constructed in its general location
    - Advantages
        - Ineffective and/or unsafe boating structures are removed
        - Higher quality feature can be implemented
        - Increases the recreational usability of the river
        - Decreases user pressure at existing high quality boating features
    - Disadvantages
        - May be costly
        - Possible floodplain and/or 404 permit issues
        - Inherent uncertainty as to how feature will function

c) Install new boating structure
    - Description
        - A boating structure such as a hole or wave is installed where currently no feature exists
    - Where Appropriate
        - In areas where a boating structure is desired, channel grade is sufficient and it will not have a negative impact on the river
    - Implementation
        - Desired boating structure is designed and installed
    - Advantages
        - The recreational usability of the river is increased
        - Decreases user pressure at existing high quality boating features
    - Disadvantages
        - Adds boating use pressure to new section of the river
        - May be costly
        - Possible floodplain and/or 404 permit issues
        - Inherent uncertainty as to how feature will function

C. Water Rights Improvements

a) Install gage for RICD rights
    - Description
        - A streamflow gage(s) is installed to allow the City to exercise its RICD water rights
    - Where Appropriate

    - At the 13th Street bridge
- Implementation
    - Install streamflow gage(s) with recording device to continually measure stream flows
- Advantages
    - The City will be able to make a call on the River for the RICD
- Disadvantages
    - Costly
    - Must be operated and maintained by the City or by a contractor
    - Water right may be so junior that it does not result in any "wet water"

V. PRIORITIZATION OF AREAS OF INTEREST

Areas of interest were categorized based on their need for improvements. Their characteristic rating was based on a matrix developed by ERC in conjunction with input from the community. Each individual proposed treatment was ranked on a scale of 1 (least critical) to 3 (most critical). Criteria used to rank the individual components are shown below.

Criterion/Rank	3	2	1
Aquatic Habitat	Existing aquatic habitat is poor. Little to no diversity exists in channel and instream cover is lacking. During low flow periods problems are extreme.	Existing aquatic habitat is limited. Some diversity and instream cover exists, but area is well below optimal conditions.	Overall aquatic habitat is moderate; however minor improvements would increase carrying capacity of the channel.
Channel Form	Channel is out of balance with natural equilibrium. Width, lack of low flow channel and sinuosity are disturbed and affecting health of the stream. Longitudinal profile and plan form require modification.	Channel is in transition between impacted and natural state. Work is required to achieve a natural state, but less work needed than areas ranking as a 3	Channel has characteristics of a natural stream form, but could be improved with minor grading and/or shaping.
Vegetation/ Riparian Buffer	No or limited vegetation on banks and/or in the riparian buffer, non-native species are in high numbers and should be removed. Vegetation will provide habitat, and water quality benefits.	Existing vegetation is sparse and/or non-native vegetation is present and should be removed. Minor habitat and water quality benefits exist, but could be greatly improved with more plantings and/or increased diversity.	Existing vegetation looks good, non-native species are not significant. Additional vegetation would help but is not required.

Criterion/Rank	3	2	1
Bank Stabilization	Visible, extensive bank erosion, bank undercutting, and/or mass wasting. Erosion appears to be on-going in this location and likely to become a greater problem if not addressed. Stabilization is an immediate concern.	Visible erosion and bank undercutting occurring but is localized problem. These areas may develop into larger problems in the future.	Minor localized erosion.
Recreational Use Boating*	Boating structure does not exist or no longer functions as intended, enhancement or improvement is needed for feature to function near optimal condition.	Existing boating structure function is moderate. It provides quality use for a limited amount of time but duration of time it functions well is limited. Modifications or enhancements are expected to significantly improve recreational opportunities.	Existing boating structure functions reasonably well. Improvements could be obtained with minor modifications, but feature currently provides quality recreational experience.
Recreational Use Passive	No formal access points, trails, picnic areas or opportunities for wildlife observation or existing amenities are unusable	Few formal access points, trails, picnic areas and/or opportunities for wildlife observation - none currently needed but may be needed in the future, or existing features in decent condition but need work	Sufficient access points, trails, picnic areas and opportunities for wildlife observation and all in good condition
Water Rights Improvements	Installation of stream gages will allow the City to make calls on the river that result in a significant increase in streamflows through the town. Recreational uses and ecological benefits of resulting from additional water will be significant.	Installation of stream gages will allow the City to make calls on the river that result in an increase in streamflows through the town. Recreational uses and ecological benefits resulting from additional water will be notable.	Installation of stream gages will allow the City to make calls on the river that result in a minor increase in streamflows through the town. Amount or timing of additional water results in minor recreational and ecological benefits.

*Boating includes kayaking, rafting and tubing

Table 2 - Area of Interest Categories and Ranking Criteria

VI. IMPROVEMENT COSTS

Cost estimates were developed for the individual Plan improvements. As the improvements presented herein are conceptual in nature, all costs should be considered budgetary level costs. More detailed costs can be developed as part of the final design for improvements as they occur.

Costs contained in this Plan are based on 2008 prices. Estimates were generated from known material costs, cost data provided by the City, costs for completed river improvement projects and engineering judgment.

Unit construction costs (per linear foot, per square foot, per each, etc) were prepared for each specific Plan improvement. Estimated costs to implement any specific improvement can be determined by scaling the unit cost to the number or size of a particular problem area. A table summarizing unit costs for each improvement type is shown below. An itemized breakout that includes all individual items and costs used to generate unit costs is presented in Appendix H.

ERC took the approach that any improvements to be made would be done in the highest quality manner. As an example, areas requiring revegetation were assumed to planted at very high densities and include seeding, grass plugs, shrubs and trees. As a result, the unit costs for improvements are high. If desired the City could scale back many of the treatments and obtain cost savings over the values derived by ERC.

Category	Improvement	Unit	Unit Cost
Bank Stabilization			
	Vegetate	SF	6.67
	Vegetate existing feature	SF	6.67
	Regrade and replant	SF	7.09
	Boulder Terrace	SF	57.89
	Boulder Wall	LF	350.40
	Boulder Toe	LF	55.85
	Pipe Repair and Bank stabilization	*LS	4,500.00
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	SF	1.62
	Revegetation	SF	6.40
	Remove vehicle	EA	1,000.00
Channel Form			
	Create meander and thalweg	LF	73.80
	Create high flow channel	LF	16.40
	Remove boulder vane structures	EA	1,000.00

Category	Improvement	Unit	Unit Cost
Aquatic Habitat			
	Create riffle/pool/glide sequences	EA	3,000.00
	Install boulder habitat clusters	EA	670.00
	Install natural habitat feature	EA	1,250.00
	Remove debris	*LS	2,000.00
	Convert open water to wetland	SF	6.78
Recreational Use			
Boating			
	Repair/enhance boating structure	EA	10,000.00
	Remove boating structure	EA	8,000.00
	Install boating structure	EA	40,000.00
	Diversion structure at James Brown Bridge	LS	5,000.00
Access			
	Formalize access point	EA	2,000.00
	Create formalized access point	EA	5,000.00
	Create formalized access point with ADA access and trail connection	EA	15,000.00
Water Rights			
	Install gage for RICD rights	EA	30,000.00
Other			
	Temporary Fencing	LF	3.00
Per Cost Total			
	Construction Management	LS	8% of total cost
	Contingency	LS	10% of total cost
	Design & Permitting	LS	10% total cost
	Mobilization/Demobilization	LS	5% of total cost
	Sediment Control	LS	2% of total cost

***LS = Lump Sum**

Table 3 - Improvement Unit Cost

Total costs were then defined for each AOI and can be found in Appendix H. A detailed cost breakdown is provided in Appendix H. For the total cost estimate, final design and permitting was assumed to cost 10% of the total, construction management was assumed to cost 8% of the total, mobilization/demobilization was assumed to cost 5% of the total, sediment control was assumed to cost 2% of the total and contingency was added at a cost of 10% of the total.

The overall cost for all improvements presented in the plan, including design and permitting, construction management, mobilization/demobilization and contingencies is $5,116,440.61

Costs were evaluated based on AOI rankings. It is anticipated that AOIs ranking most critical will require a majority of the total cost. The ranking of the installation of the RICD gages was ranked uncertain because the effect of the streamflow increase gained by the instream flow right is unknown to ERC.

Ranking	Cost	Percent of total
3 (most critical)	$2,917,227.47	76%
2 (medium)	$669,215.12	18%
1 (least critical)	$260,505.23	7%
Total	$3,846,947.82	100%

Table 4 - Cost per Ranking

Costs were also evaluated based on the type of improvement recommended. Due to the amount of overlap, aquatic and channel form improvements were combined. Vegetation and riparian buffer, which often are recommended in conjunction with bank stabilization, are similarly grouped together.

Improvement Category	Cost	Percent of Total
Aquatic Habitat and Channel Form	$1,530,946.10	40%
Vegetation/Riparian Buffer and Bank Stabilization	$2,059,001.72	54%
Recreational Use - Boating	$179,000.00	5%
Recreational Use - Access	$48,000.00	1%
Water Rights (RICD)	$30,000.00	1%
Total	$3,846,847.82	100%

Table 5 - Cost per Category

VII. PRIORITIZATION OF IMPROVEMENTS

Given the high cost to implement the recommended improvements, the recommendations within this Plan will need to be prioritized. Final prioritization should factor in the relative need for the improvement (ranking presented above), desires of the community and available financial resources.

VIII. REFERENCES

Aquatic and Wetland Company. (2002). Preliminary Report – Yamp River Studies. AWC.

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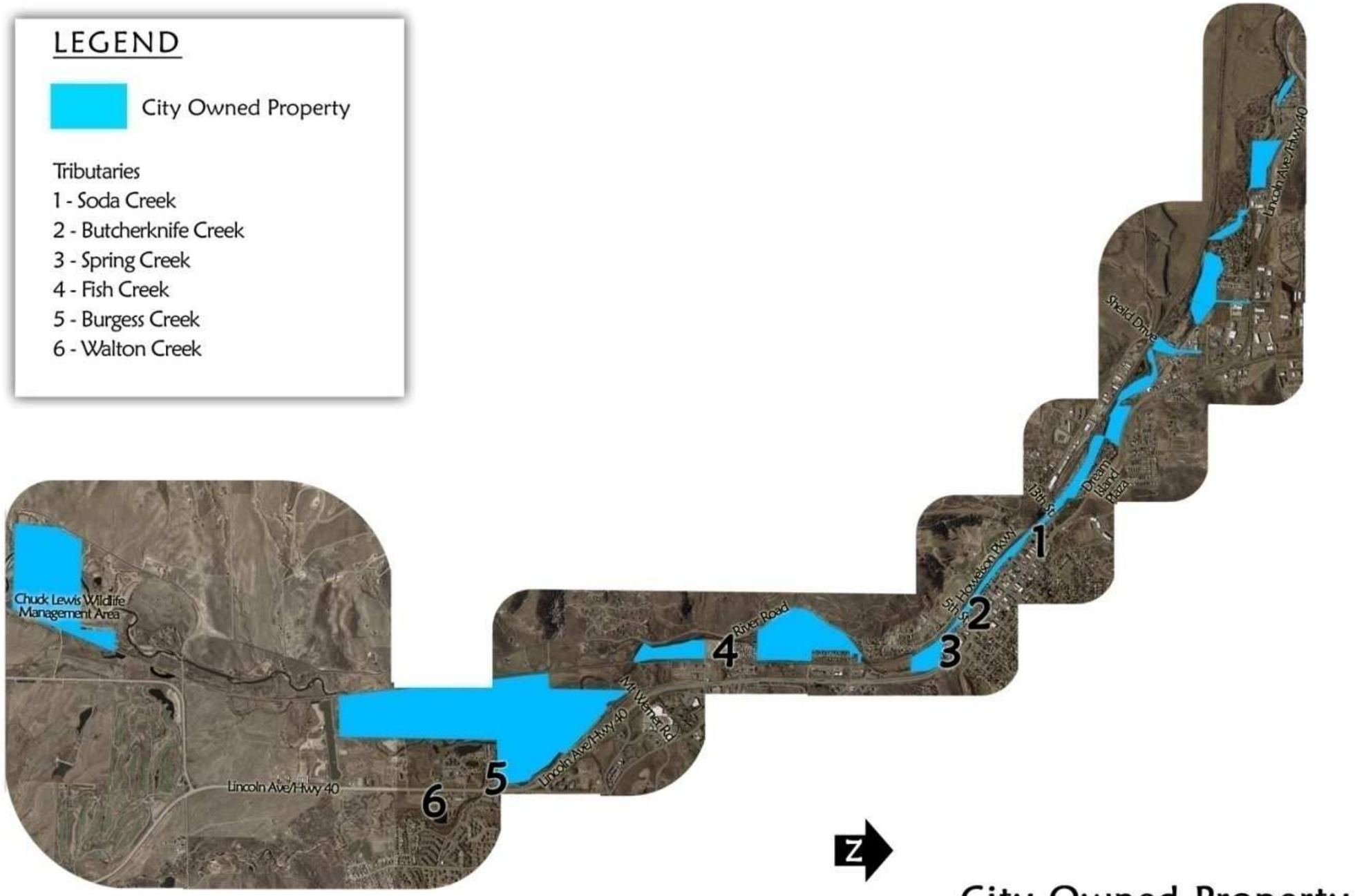
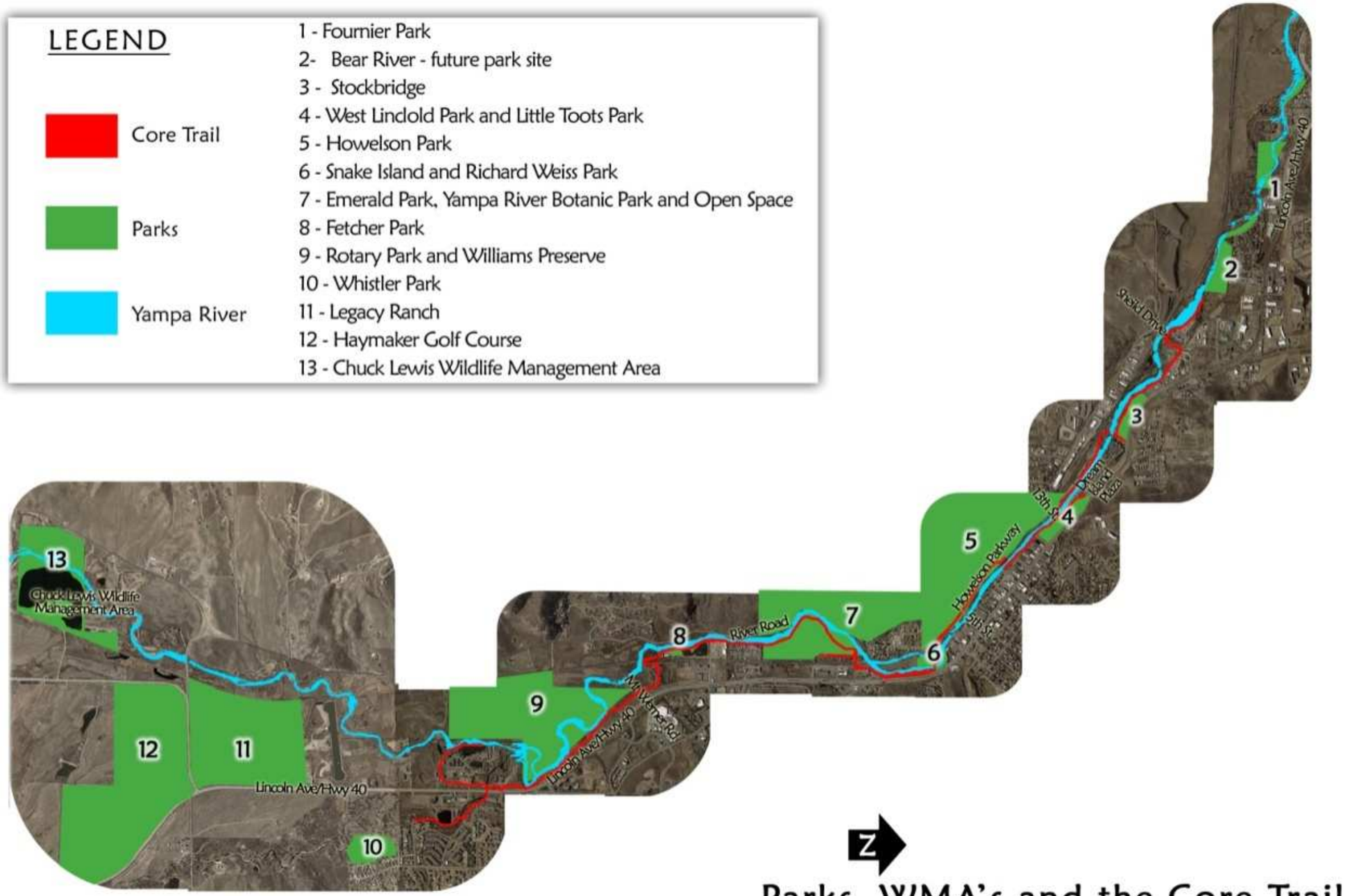
Leopold, L, et al., (1992). Fluvial Processes in Geomorphology. Dover Publications, Inc.

Rosgen, D. (1996). *Applied River Morphology.* Pagosa Springs: Hilton Lee Silvey.

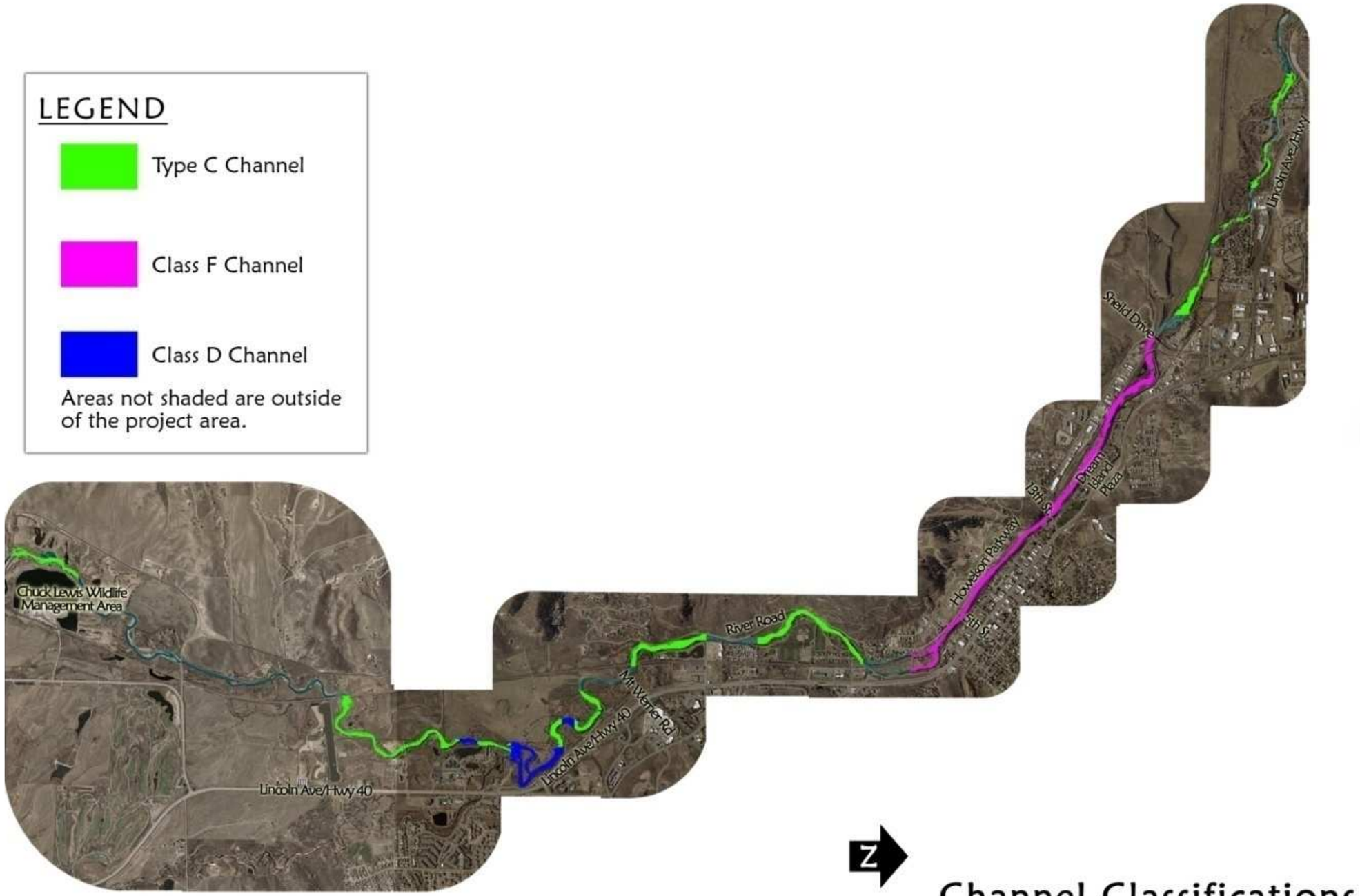
Appendix A - Report figures 11x17



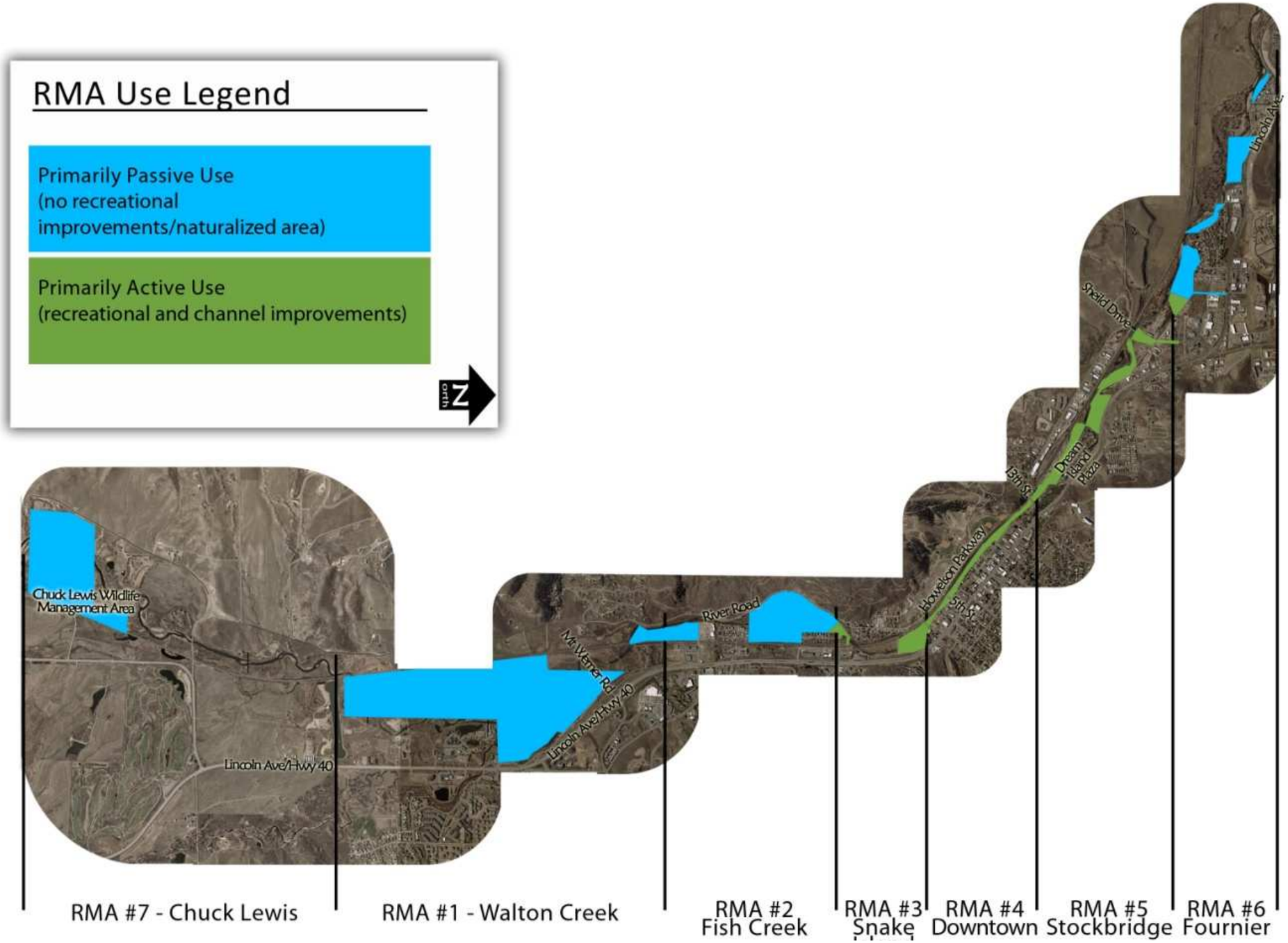
City Owned Property

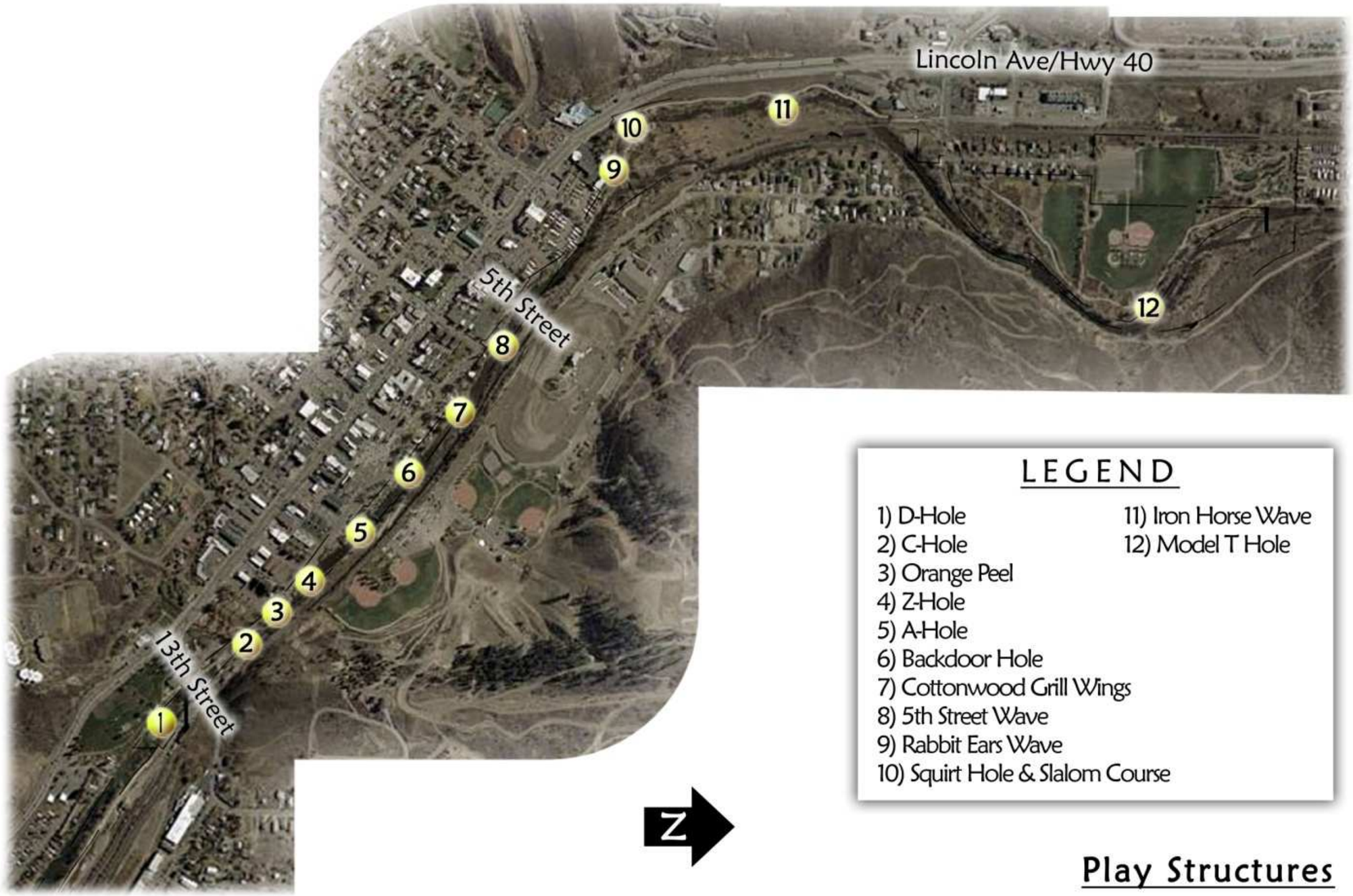


Parks, WMA's and the Core Trail



Channel Classifications


RMA Use Legend
Primarily Passive Use
(no recreational
improvements/naturalized area)
Primarily Active Use
(recreational and channel improvements)
N
Chuck Lewis Wildlife
Management Area
Lincoln Ave/Hwy 40
Mc Werner Rd
Lincoln Ave/Hwy 40
River Road
Howelson Parkway
Sheid Drive
Lincoln Ave
Dream
Island
Plaza
RMA #7 - Chuck Lewis
RMA #1 - Walton Creek
RMA #2
Fish Creek
RMA #3
Snake
RMA #4
Downtown
RMA #5
Stockbridge
RMA #6
Fournier



LEGEND

1) D-Hole
2) C-Hole
3) Orange Peel
4) Z-Hole
5) A-Hole
6) Backdoor Hole
7) Cottonwood Grill Wings
8) 5th Street Wave
9) Rabbit Ears Wave
10) Squirt Hole & Slalom Course
11) Iron Horse Wave
12) Model T Hole

Play Structures

Report Photos Locator Map

Appendix B: Community Comments from Public Meetings

Comments from Yampa River Structural Master Plan

August 2, 2007 Public Workshop

From notepads

- Need to preserve wetlands and streambanks for wild habitat. Ospreys have recently been seen around Steamboat. Need to preserve habitat and water quality for birds and small river animals.
- Consider erecting nest platforms for Osprey.
- This fishing is a great resource for this community. Overall use impacts needs to be better monitored. Tools need to be available to city departments.
- Canoe and Kayak Access
    - Most access is by unimproved, narrow footpaths
        - Wider, more solid footpaths would make access easier and could reduce erosion.
        - Clear sections along the banks at access points are needed to get into and out of boats.
            - Need to be non-muddy.
- RMA maps
    - For the next meeting, please note a couple of landmarks (e.g. street names) to help orient people.
- River Health should be our first priority. Let's help Mother Nature do what needs to be done.
    - Bank stabilization where needed.
    - Meander to slow the river down.
    - Protection for riparian areas.
- But we need to help private landowners with trespass issues.
- Keep trash out of river.
- Educate users (maybe through signage or enforcement).
- Seems like the river is getting overused by private tubers in the upper section. Would like to see additional enforcement of the alcohol rules for tubers.

- Improve access for kayakers at Fetcher Park.
- I enjoy running down a river and stopping to play briefly at many spots along the way. Many of the good play ledges do not have good eddies alongside to feed into the hole from. Strategically placed eddies would help.
- More individual park 'n' play holes AND some design overall that encourages boating runs from upper to lower.
- Put a kayak/canoe rack on a shuttle bus to encourage top to bottom boating.
- More shelves and beaches.
- More public access.
- City Parks and Recreation should have authority to close river and enforce.
- River education kiosk and live programs.
- In depth signage of rules and regulations at put-in along the river (i.e., signs now on highways and interstate giving info per weather, closures (the new highlighted signs)).
- Maybe: fines doubled for alcohol on river.
- To protect the river environment, restrict future development to only (2) two "water features", the Library and the Depot. If the City wants another water feature, require the removal of one of the two existing features. It is now time to concentrate on water quality and the health of the river. – John Armiger
- All kayak features should be below rabbit ears. Everything should begin at 5th St. More flow = more fun.
- D-hole should be pinched to create a low flow hole and a wave when it's high.
- Z-hole and 5th St. need to be pinched/rebuilt riverwide.
- All features need a maintenance plan. Fixing concrete, trimming bushes.
- Lights at C-hole, permanent.
- Webcam on C-hole for promotion.
- New feature in Milner below Elk. – crossed out
- More holes like C and D at 5th St. /Double Z.
- A low-water feature, 300-cfs, channeled to 6 feet wide
- Concrete slabs in upper Yampa near the soccer fields should be cleaned up.

- Wave could be put in above Soda below ZZ. Water is channelized and would be a great spot. Gradient/naturally pinched.
- Raise the elevation of the pinch at C-hole.
- Remove sediment below Soda Creek confluence.
- New play spot adjacent to the new "River Walk" project. – Jim Cook, old trailer park

RMA#1- Walton Creek

- Enforce parking/alcohol restrictions.
- Not much swimming occurs here.
- Use needs to be controlled.
- City departments need more tools to implement/enforce regulations and use.
- Pike habitat exists at head of rich – could this be reduced?
- Excellent fishing habitat, could there be more fishing habitat?
- Not much paddling features, but great for beginners/int paddlers.
- Works good for rafting put-in and great for float through.
- Take out/put-in at Rotary Park needs work for ability to put in rafts, some rocks in water need to be moved just at the water surface.
- Some erosion occurring in select areas.
- How is cottonwood recruitment doing…i.e. riparian habitat

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- Some erosion occurring in select areas.
- How is cottonwood recruitment doing…i.e. riparian habitat

RMA#2 – Fish Creek

- Enforce access – parking/alcohol.
- Pool at Fish Creek is very important as area for fish at low water.
- Area on east bank of river adjacent and downstream from trailer park is circled. Old construction cleanup. Barbed wire and metal in the water. Trash build up area.
- Kayak launch eroding bank – rocks not placed well. Lots of kayaking and access. Consolidate access and rouge tracks, many trails spurring off into riparian.

RMA#3 – Snake Island

- Second most swimming beyond C-hole at hot spring.
- Could more fish habitat be placed?
- Iron Horse Hole – need to be fixed. This hole fell over and is not functioning.
- Not many high play waves.
- Problem with erosion above Iron Horse Hole at bird statue on river right – take out bench or rebuild.
- Some minor bank erosion below features along reach.
- Rich Weiss Park is very, very important as lots of use, great access, as head of boating park. Will see increased use in the future. Currently needs lot of work. Needs bathroom.
- Rocks have moved at Iron Horse Hole and it is dangerous.
- Rocks just about 5th Street need to be reconfigured.

RMA#4 – Downtown

- Water quality #1 issue
    - Water temperature – no porous surface
    - Non source point pollution
    - DO
    - Flows

        - RICD – need to implement

- If we address water quality and volume many issued are resolved.
- Rebuild A-hole. Lots of erosion on river. Great access…bad for tubing @ low water.
- Reexamine all river features for effectiveness in this area for all recreation.
- Excellent location for feature above and below 5th Street (possible surf wave at higher water). Work with new developers to maximize efficiencies.
- Major work at Rabbit Ears/Rich Weiss – needs help with erosion issues.
- This is most important reach of the entire river from recreational standpoint – most use – great fishery, most important kayak/tubing area.
- Great fish habitat. Riffles. Pools. Access.
- Need to help educate developers about the rivers needs. More native/riparian habitat.
- Access is all over. Need to fence/limit some trails.
- Access at Lions Park needs help – major erosion.
- Work with landowners to rebuild certain banks if possible.
- Fix diversion to Wolf Ranch for tubing/kayaking/fishing. Build solid structure.
- Need erosion control upstream of Z-hole.
- Area upstream of 13th Street Bridge circled – pinch to make deeper pocket at water levels of 300 – 700 cfs.

RMA#5 – Stockbridge

- Around the bus barn (Multimodal center) there is a nice area for kids to wade.
- Area on left bank upstream and adjacent to James Brown Bridge circled– Dangerous objects from railroad in water and on the banks.
- Area on left bank downstream and adjacent to James Brown Bridge circled– Need permanent (not giant boulders) diversion structure at current tube take out to protect agricultural senior water rights.

Project Area: Fournier Open Space

- Help stop trespassing onto private property.
- Old meander that should probably be restored.
- Do not puncture another neighborhood.

Existing assets of the Yampa River

- Education – Produce DVD education/infomercial for cable channel 6, 10 minutes.

Channel Shape

- Rock vanes seem to work well for 1. maintaining a deep center channel and 2. creating fish habitat.
    - They do not work well as play features for kayaks and canoes because the flow on the downstream side flushed the boater back into the center channel.
    - Would a J-shaped feature work for 1 and 2 above?
    - It could create a nice play feature at the end of a rock vane.

Comments from Yampa River Structural Master Plan

November 7, 2007 Public Workshop

Sheet	Reference #	Category	Description	Comments				
Sheet 1	1a	VEG/RB	lacking vegetation			Riverside Park - fix damage done by sewer line repair		
	1b	AH	lacking aquatic habitat diversity					
	1c	VEG/RB	lacking vegetation	allow for water inundation				
	1d	BS	eroding bank		future tube take out			
	1e	RU	formalized access needed					
	1f	VEG/RB	lacking vegetation					
	1g	BS	eroding bank					
Sheet 2	2a	OTHER	existing diversion structure	very dangerous diversion structure, needs mitigation				
	2b	RU	tubing take out					
	2c	BS	unstable slope					
	2d	VEG/RB	lacking riparian buffer		eroding bank of right bank			
Sheet 3	3a	VEG/RB	lacking riparian buffer		move channel to left bank through new newly deposited cobble, involve planners with the Bear River Parcel options			
	3b	AH	poor aquatic habitat			improve habitat		
	3c	RU	need to formalize access					
	3d	VEG/RB	lacking vegetation					
	3e	VEG/RB	encroachment/buffer management					
	3f	BS	eroding bank					
	3g	RU	D Hole - limited pool and drop	requires dredging				
Sheet 4	4a	OTHER	need for flow gage	artificial buffer, more meandering	Very important, needed to implement water rights			
	4b	RU	eroding access point					
	4c	RU	C Hole - functioning well		needs riparian habitat/focus human impact			
	4d	VEG/RB	lacking riparian buffer					
	4e	RU	non utilized gradient in boating reach					
	4f	VEG/RB	existing rubble - safety concern					
	4g	RU	Orange Peel Hole - ineffective		could go away	very ineffective		
	4h	RU	Z Hole - sub optimal function		too wide	build with 2 outlets (large boulders in the middle, very wide channel right now)		
	4i	BS	eroding bank	add fencing				
	4j	RU	improve access point					
	4k	RU	A Hole - sub optimal function	high priority restructuring, somewhat dangerous	Take pressure off of riparian buffer (N.) access needed on south side of river + by foot bridge near tunnel	Rebuild		

Sheet	Reference #	Category	Description	Comments				
Sheet 5	5a	BS	eroding bank					
	5b	RU	Backdoor Hole - sub optimal function			built to divert water to city snowmaking inlet		
	5c	BS	eroding bank	add fencing				
	5d	RU	Boating wave - sub optimal function			could go away		
	5e	RU	Cottonwood Hole - sub optimal function			could go away		
	5f	AH	lacking aquatic habitat diversity					
	5g	VEG/RB	encroachment/buffer management					
	5h	OTHER	degraded Butcherknife Creek confluence					
	5i	BS	eroding bank					
	5j	RU	eroding access point					
	5k	RU	5th Street Wave - sub optimal function			potential for Charlie's Hole quality structure		
	5l	BS	eroding bank	good fishing area, reorient structures US				
	5m	BS	eroding bank	DO NOT TOUCH!				
	5n	RU	ineffective boating area	don't change this	great trout habitat, deep, cool, shelters	great fish habitat - don't change!		
	5o	OTHER	future daylight of Spring Creek		rebuild			
	5p	RU	Rabbit Ears Wave - sub optimal function					
	5q	BS	eroding bank					
	5r	RU	Squirt Hole - functioning well					
	5s	RU	existing slalom kayak course					
	5t	RU	Iron Horse Wave - functioning well					
	5u	RU	eroding access point					
Sheet 6	6a	VEG/RB	river against toe of slope and unvegetated					
	6b	AH	lacking aquatic habitat diversity	riparian buffer				
	6c	RU	Model T Hole - sub optimal function		rebuild for optimum function			
Sheet 7	7a	VEG/RB	river against toe of slope and unvegetated	vegetative diversity				
	7b	BS	eroding bank		not necessary DS of drain	DS limit of 7b - river eroding bankside of structure		
	7c	OTHER	Pond outfall					
	7d	BS	eroding pipe outfall and bank		fix before road slumps!			
	7e	BS	eroding bank					
	7f	AH	lacking aquatic habitat diversity					
	7g	VEG/RB	lacking riparian buffer					

Sheet	Reference #	Category	Description	Comments				
Sheet 8	8a	BS	eroding bank	allow for river meandering				
	8b	VEG/RB	lacking riparian buffer					
	8c	AH	lacking aquatic habitat diversity		good invertebrate habitat			
	8d	AH	lacking aquatic habitat diversity			not necessary to improve	is stream too wide? River left	
	8e	VEG/RB	lacking riparian buffer			good trout habitat		
	8f	BS	eroding bank		important spawning area	yes, but good gravel bottom for natural reproduction		
Sheet 9	9a	AH	lacking aquatic habitat diversity	close off backwater + wetland creation	point source pollution, vegetative diversity, interactive areas	great habitat for frogs, ducks, pike, snakes	block slough first, then examine effect on 9A + 9B and design accordingly	better aquatic habitat
	9b	BS	lacking riparian buffer					
	9c	BS	lacking riparian buffer					
	9d	BS	eroding bank					
	9e	BS	lacking riparian buffer					
	9f	BS	lacking riparian buffer					
	9g	BS	eroding bank					
	9h	BS	eroding bank					
	9i	BS	eroding bank					
	9j	BS	eroding bank					
	9k	BS	eroding bank					
	9l	BS	eroding bank					
Sheet 10	10a	VEG/RB	debris - vehicles		US wetland areas, vegetative diversity	included phase III of Chuck Lewis Project that is currently being worked on	pulling vehicles - replace with vegetation	
	10b	BS	eroding bank	not that bad, point bar is revegging				
	10c	BS	eroding bank					
	10d	BS	eroding bank					
Sheet 11	11a	AH	lacking aquatic habitat diversity	shoud be another reference between 11a + 11b	diversity of flow, multiple uses	add boulders, deepen channel	large slack water area between 11A + 11B is the biggest problem area	
	11b	AH	lacking aquatic habitat diversity	to address large backwater (gravel pit) on river left		add boulders - not necessary though		

Appendix C: Past Yampa Corridor Improvements known to ERC

1980

- Slalom Course construction

1981

- Downtown improvements – Rabbit Ears to Backdoor Sports

1982

- Continued downtown improvements – Rabbit Ears to Backdoor Sports

1985

- Yampa River Kayak Course Improvements
- Yampa River Fish Habitat Improvements

1986

- Dr Rich Weiss Park (formerly known as Yampa River Park)

1987

- Stockbridge Road (Depot) Riverbank Landscaping

1988

- Yampa River Park

1989

- 5th Street to 13th Street, 1989
    - Created fish habitat in slow moving water
    - River wide kayaking structure below 5th Street
    - Installed wing structures at Bear River Center
    - A-hole wings by library
- Stockbridge Riverbank
- Yampa River Improvements

1990

- 5th Street to 13th Street, 1990
    - Moved 5th Street hole to put in at Lions Club Park
    - Made a channel on river left of A-hole
    - Moved rocks at library to create more of a kayaking feature

1991

- Phases 4 & 5 of Yampa River Channel Improvements,

1992

- Phase 6 of Yampa River Channel Improvements

1993

- River Improvements
- Xeriscape Corridor/River Road/Trail

1994

- Yampa River Kayak Course
- Yampa River Stream Improvements

1996

- Yampa River Cottonwood Grove/River Improvements

1997

- Yampa Stream improvement Vermeer Tree Spade
- Yampa River Habitat Improvement

1998

- The "Yampa River Improvement Project," 1998
    - Changed all DS wings built in 1989 to US wings
    - Built Z-hole
    - Habitat work above Z-hole, random rock placement
- Friends of the Yampa – Kayak Course

1999

- YV Stream Improvement – River Management Plan

2001

- Rivers and Trails Committee

2002

- D-hole
- Rivers and Trails Committee

2003

- Charlie's Hole (C-hole)
- Additional work to D-hole
- Yampa Valley Stream Improvement – Tree Planting
- Friends of the Yampa River – Hydraulic Feature

2004

- Repaired C-hole
- Friends of the Yampa – River Improvements

2005

- Friends of the Yampa – Yampa River and Fetcher Pond ADA Access

2006

- Chuck Lewis State Wildlife Park, 2006
    - Installed vane structures
    - Removed Detroit rip rap
- YVSICT – Yampa River Channel Stabilization

Appendix D: Areas of Interest Drawings

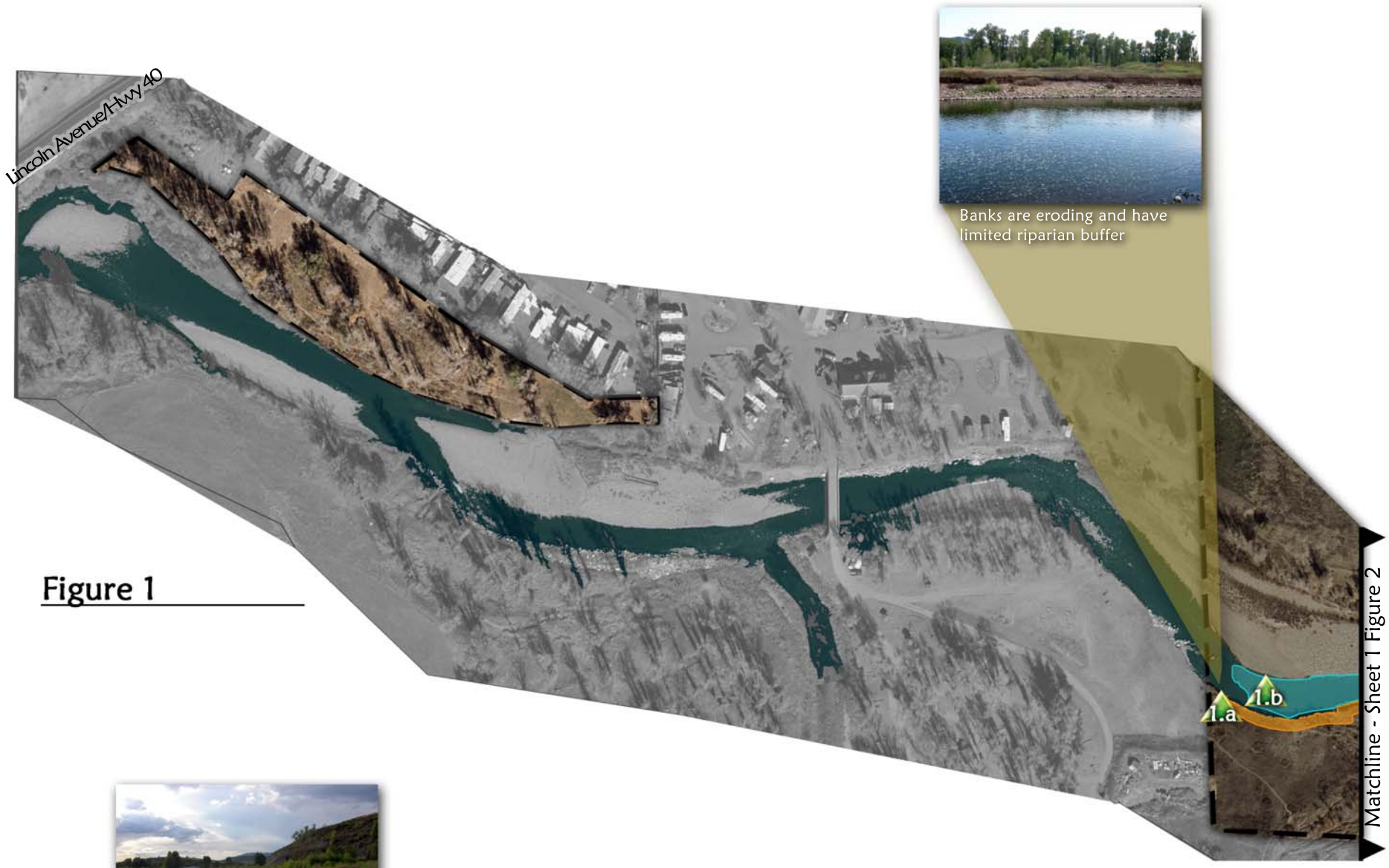


Figure 1

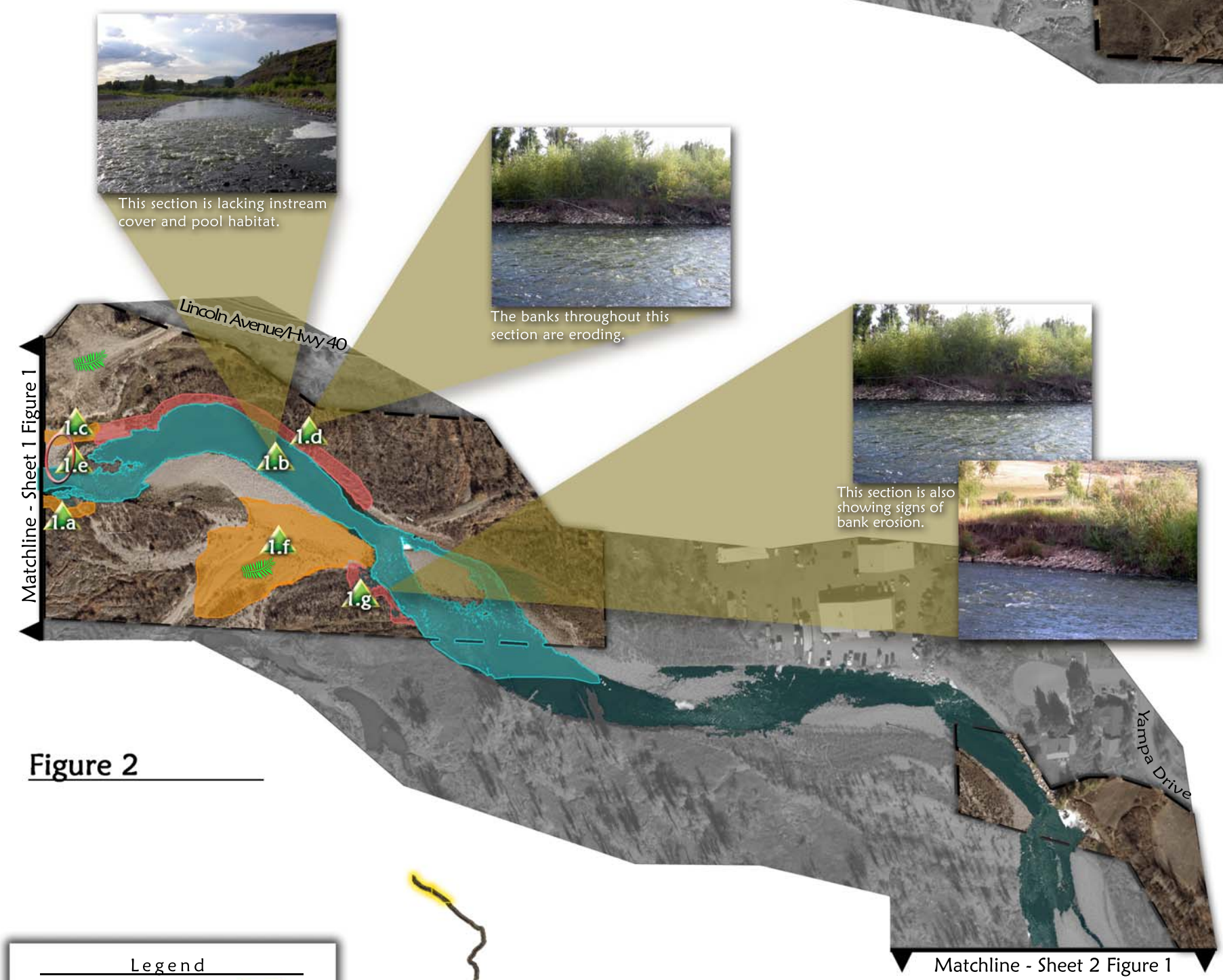
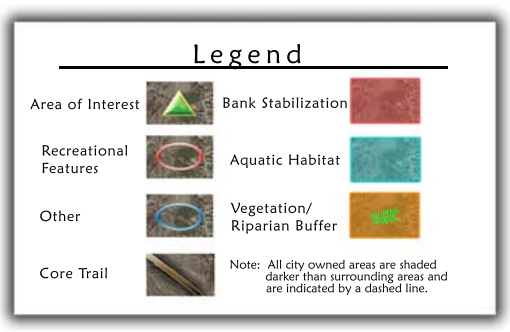


Figure 2



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Yampa River Master Plan Site Assessment

Steamboat Springs, Colorado

November 2008

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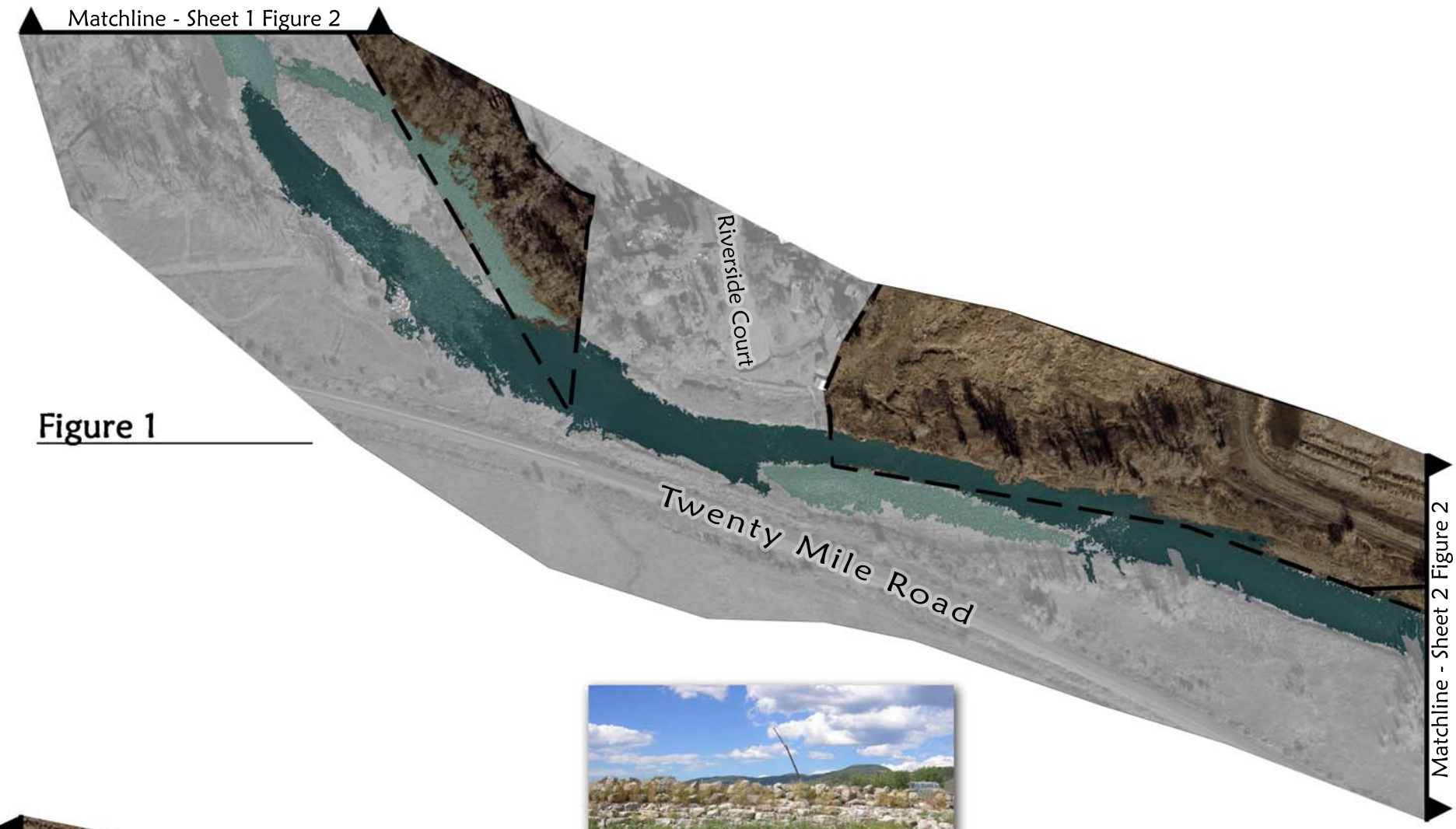

Figure 1

The bank is stable but is lacking in riparian vegetation

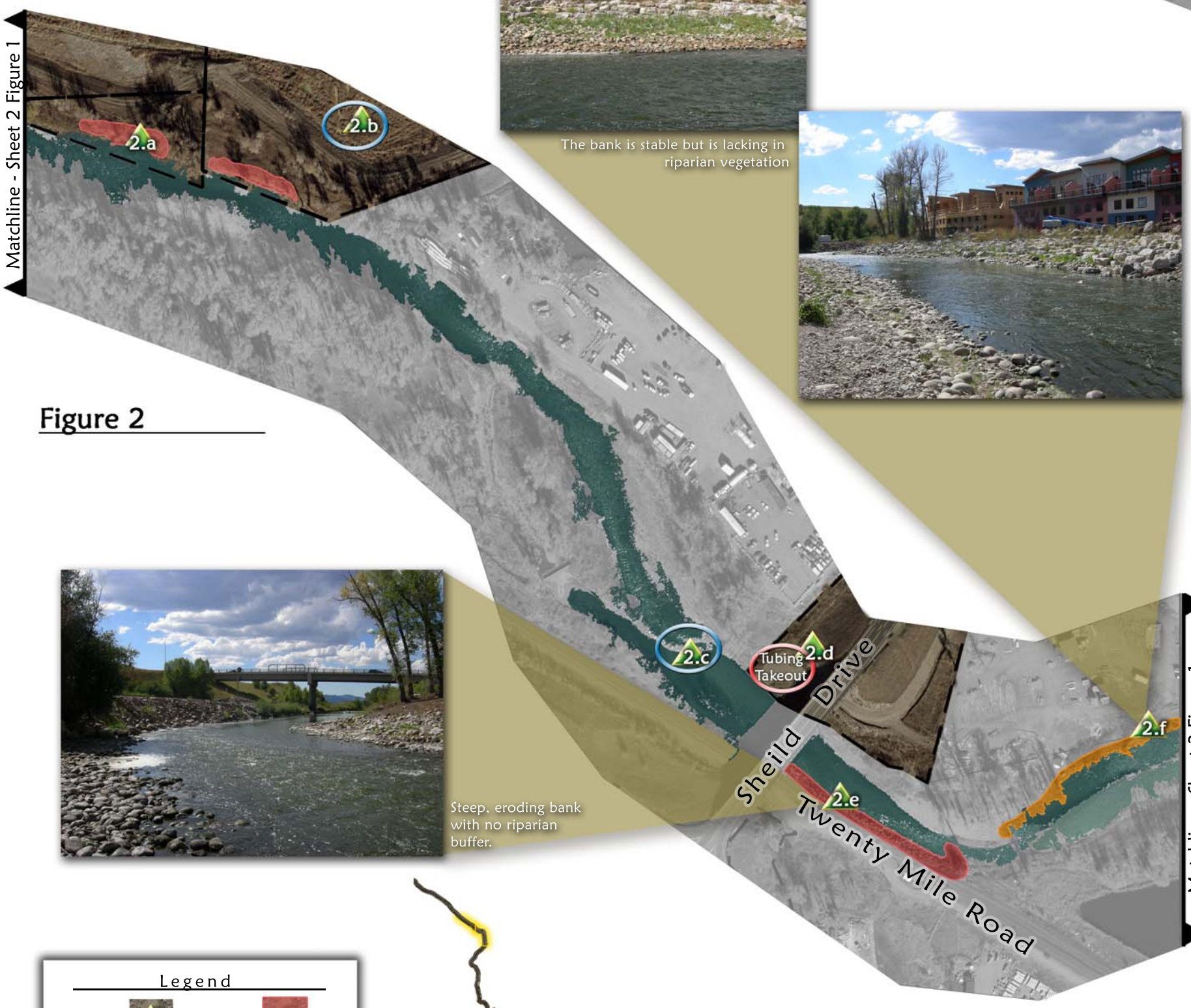

Figure 2

Steep, eroding bank with no riparian buffer.

Legend

Area of Interest		Bank Stabilization	
Recreational Features		Aquatic Habitat	
Other		Vegetation/ Riparian Buffer	
Core Trail			

Note: All city owned areas are shaded darker than surrounding areas and are indicated by a dashed line.

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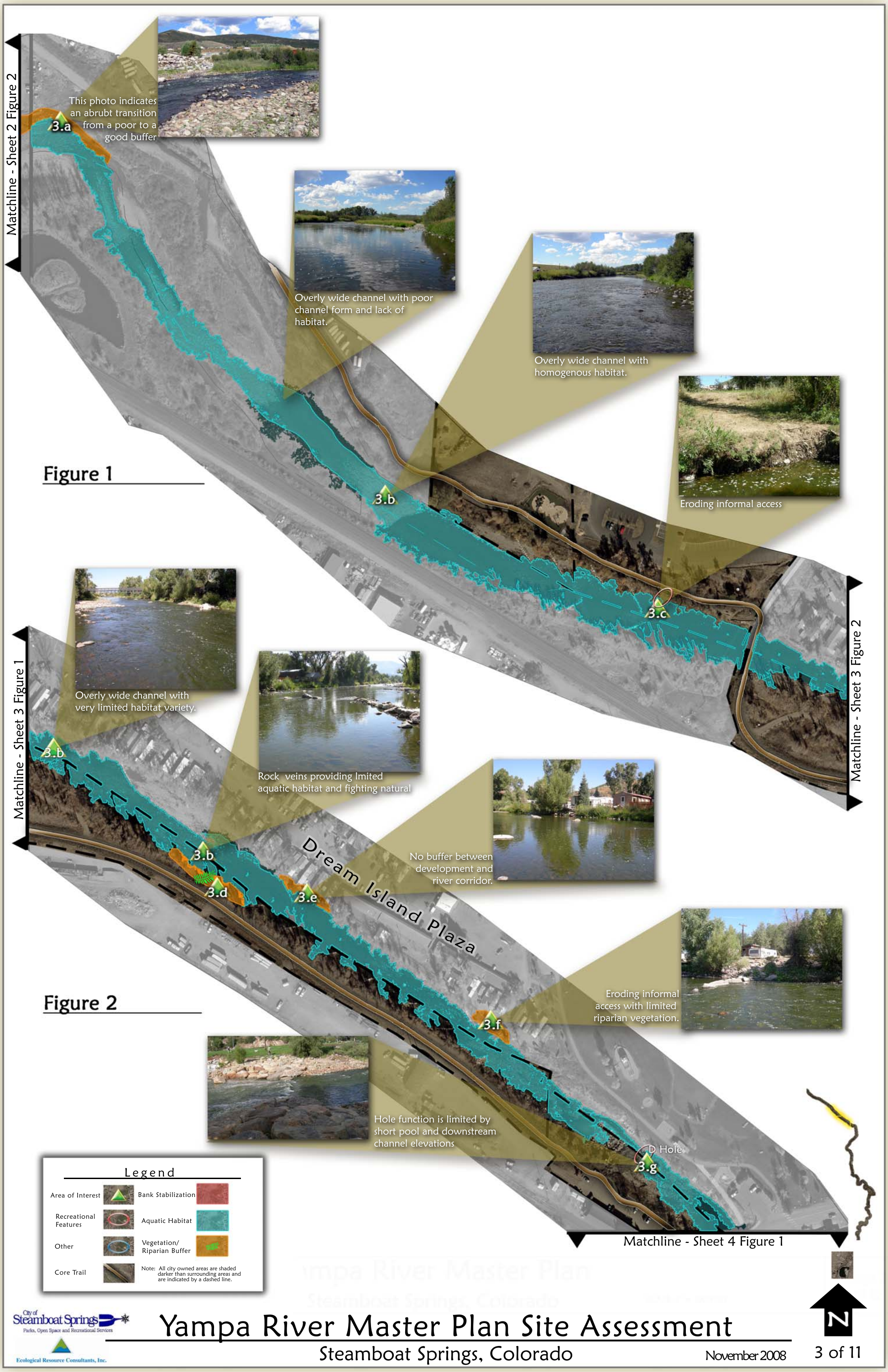

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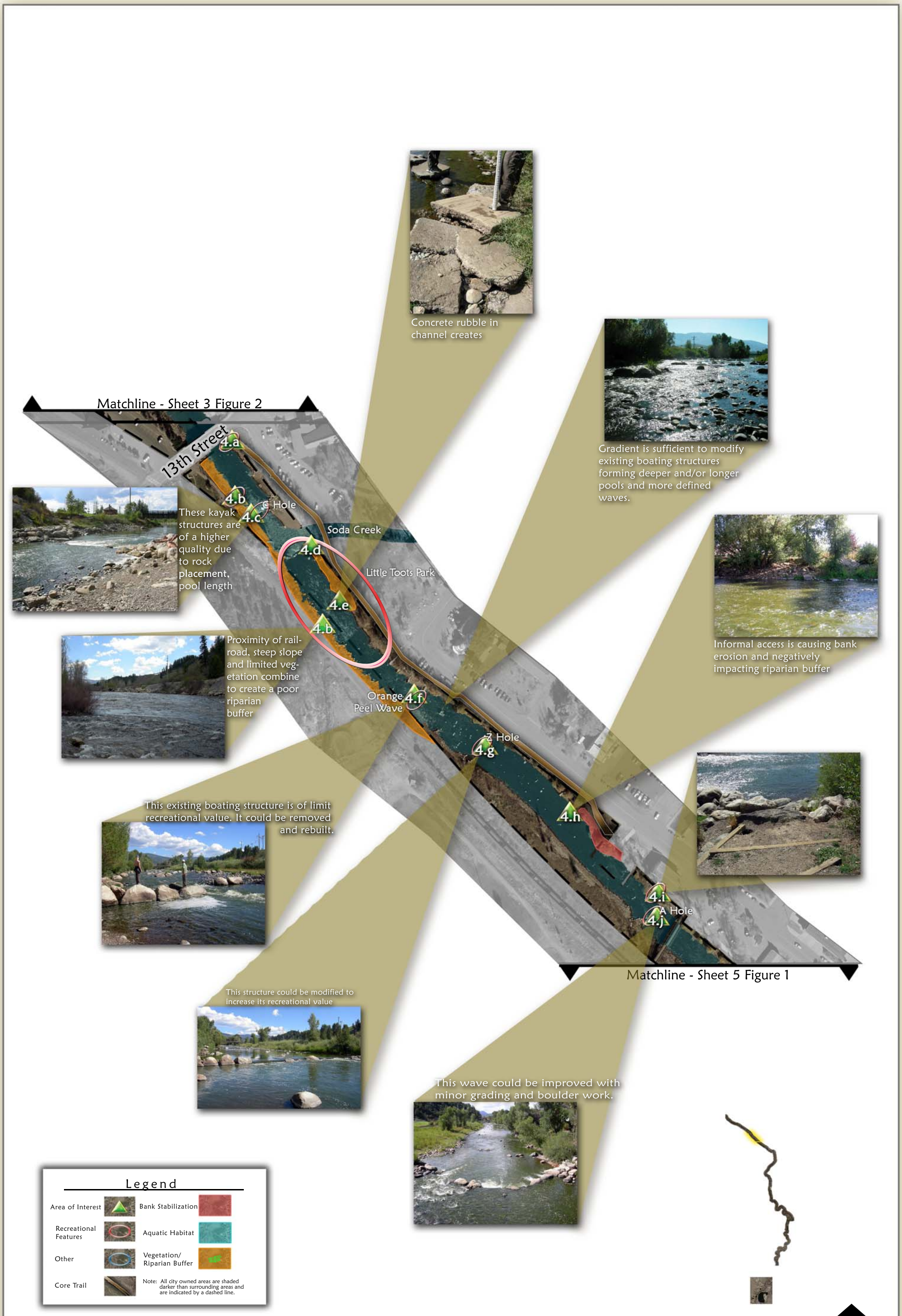

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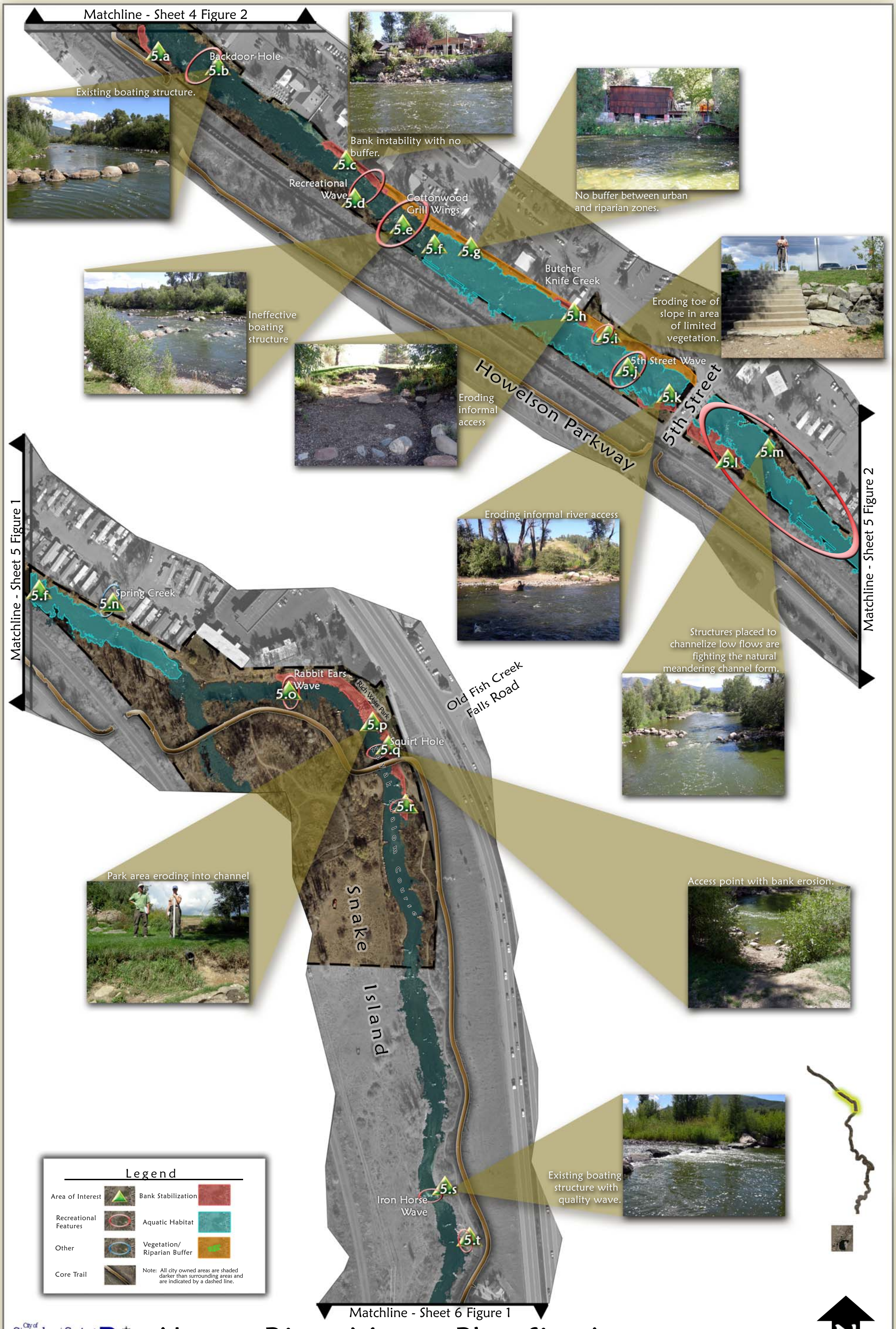

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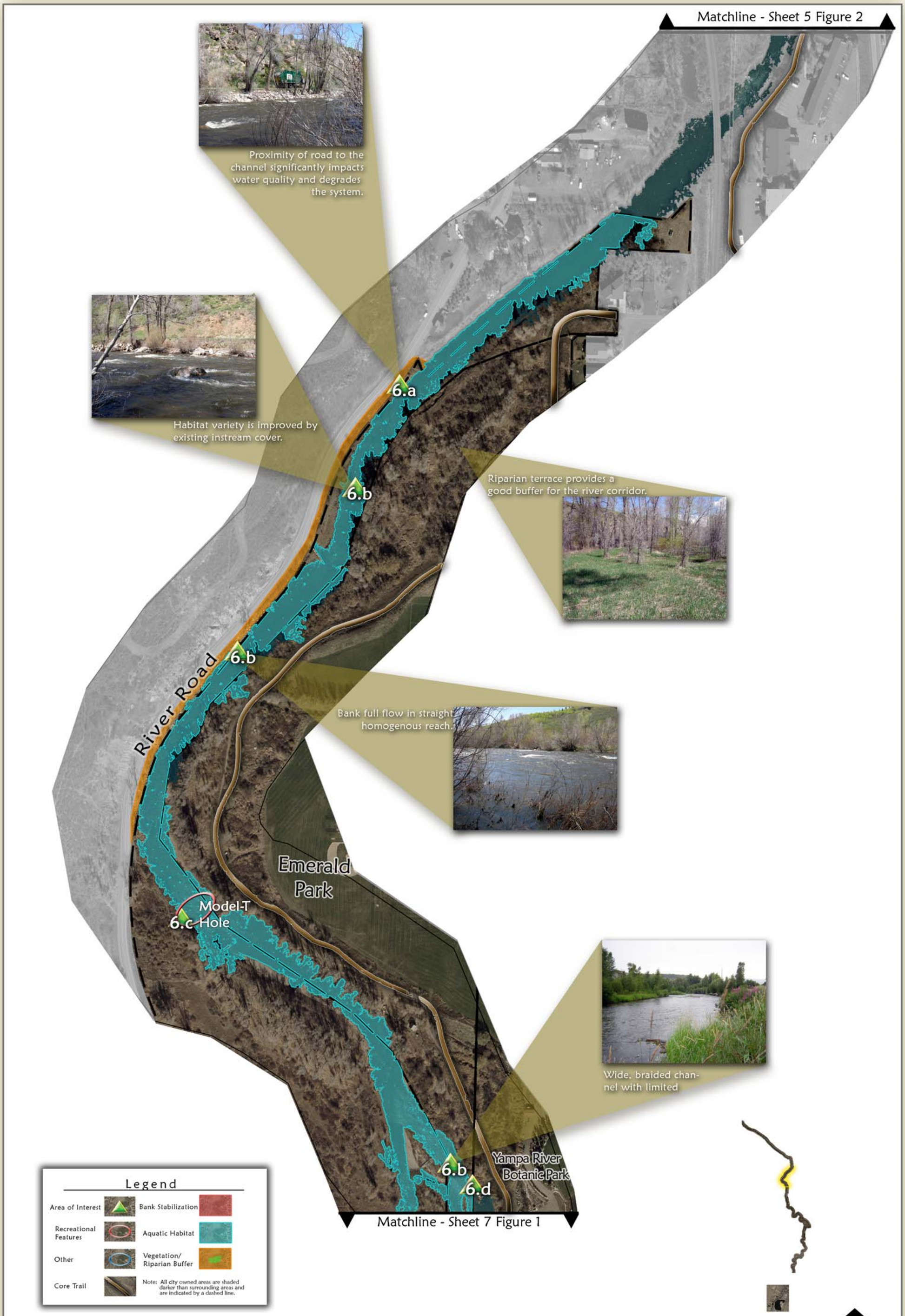

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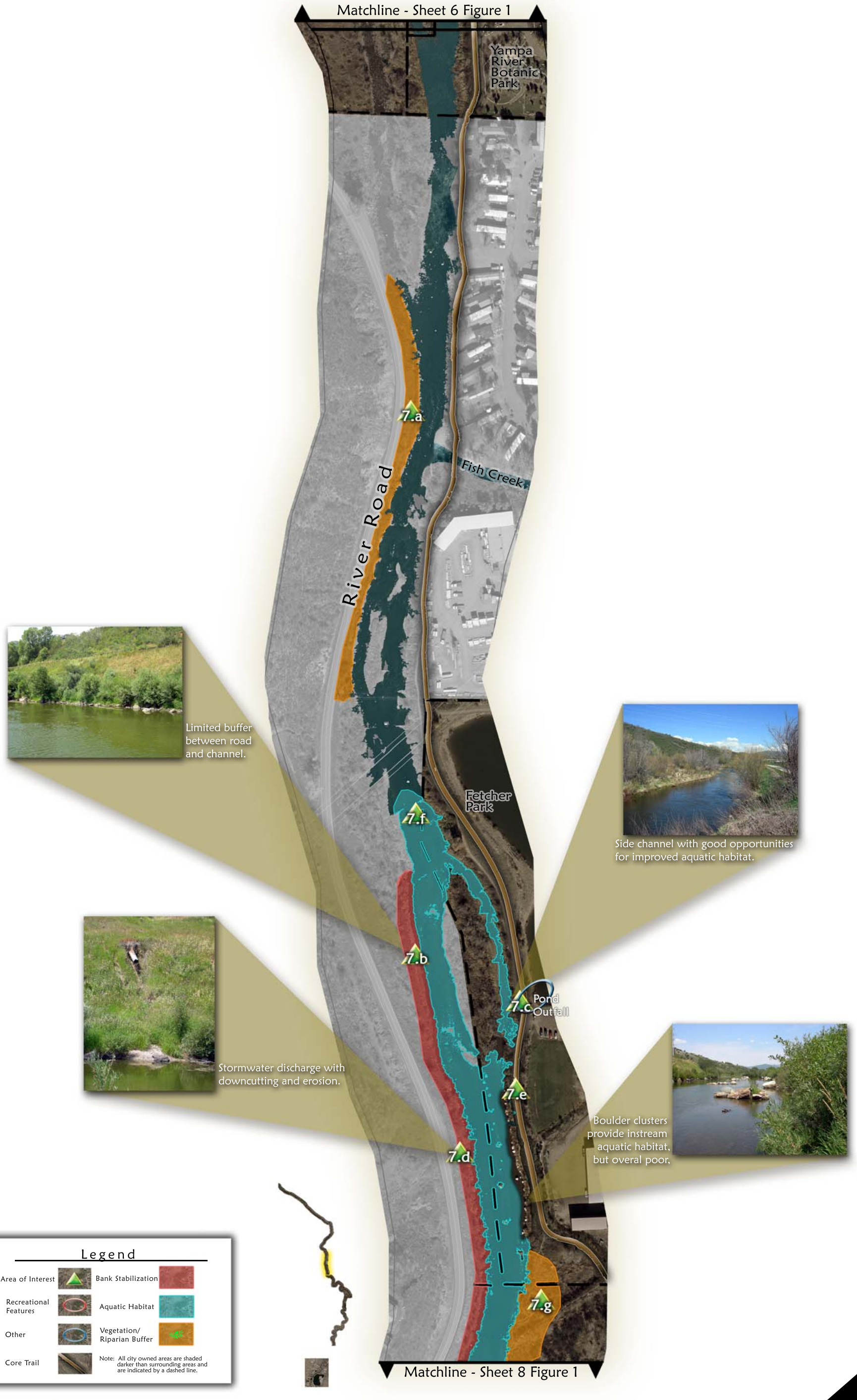

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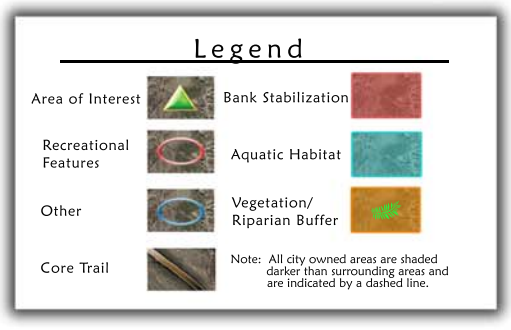

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Yampa River Master Plan Site Assessment

Steamboat Springs, Colorado

November 2008

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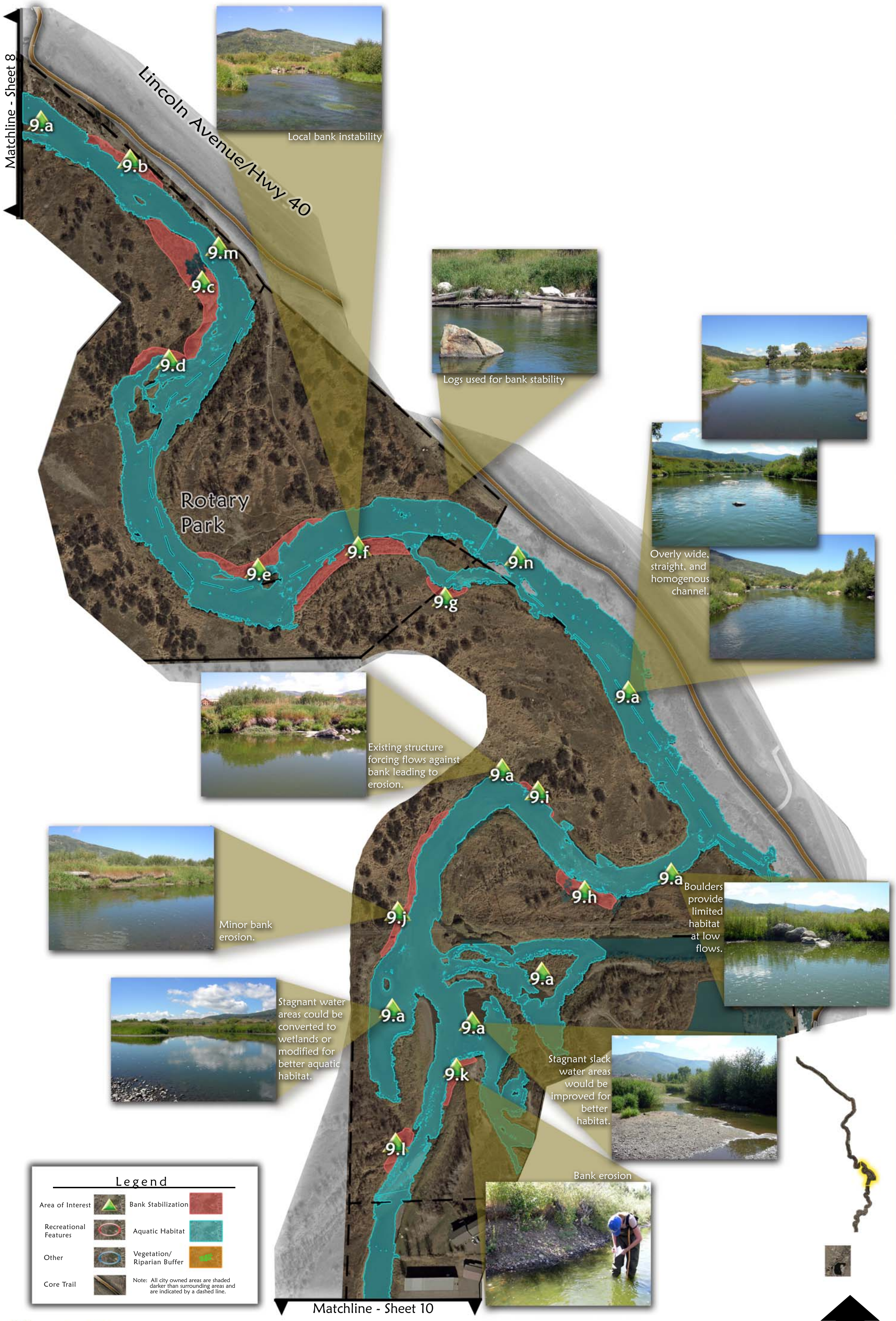

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Matchline - Sheet 9

Bank erosion and debris

10.a

10.b

10.c

10.d

Lateral channel migration.

Bank erosion and lmited riparian vegetation ersulting in channel migration.

Stable banks near infiltration gallery.

Legend

Area of Interest		Bank Stabilization	
Recreational Features		Aquatic Habitat	
Other		Vegetation/ Riparian Buffer	
Core Trail			

Note: All city owned areas are shaded darker than surrounding areas and are indicated by a dashed line.

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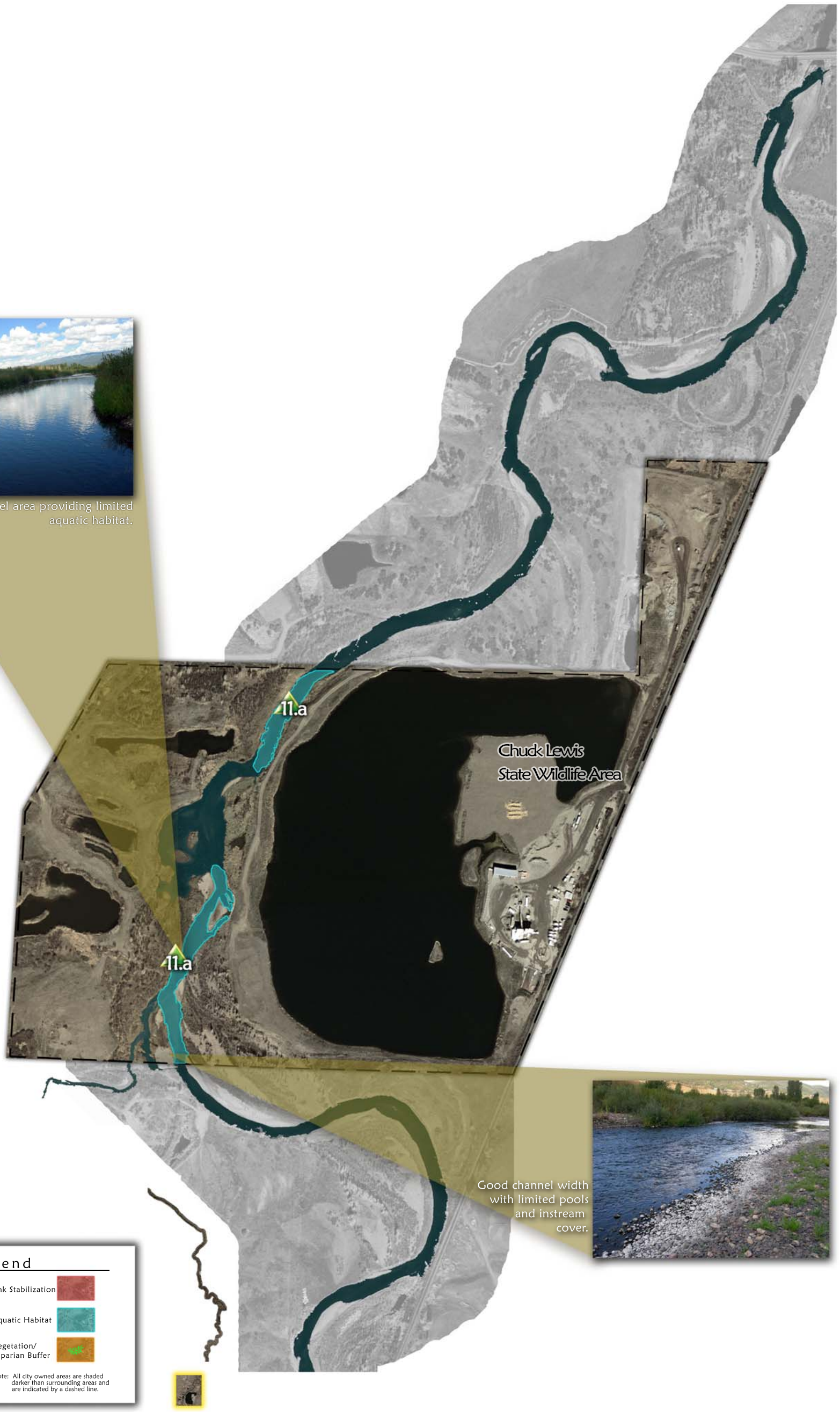
Stagnant channel area providing limited aquatic habitat.



Good channel width with limited pools and instream cover.

Legend

Area of Interest		Bank Stabilization	
Recreational Features		Aquatic Habitat	
Other		Vegetation/ Riparian Buffer	
Core Trail			

Note: All city owned areas are shaded darker than surrounding areas and are indicated by a dashed line.

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Appendix E: Area of Interest Descriptions, Rankings and Cost

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
1a	VEG/RB, BS	Active bank erosion is occurring and there is limited existing vegetation. Bank should be regraded to a stable slope, the toe of the slope stabilized and vegetation should be added.	3	Regrade and replant	31,561.58
1b	AH, CF	Some riffles and point bars present. Limited instream cover and instream aquatic habitat features exist. The channel has good meander shape, but low flow should be better defined.	2	Create high flow channel Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters	44,953.90
1c	VEG/RB, BS	Little to no vegetation is present. Area expected to be used as parking lot area, but vegetation buffer should be implemented to restore other areas.	3	Regrade and replant	10,711.92
1d	VEG/RB, BS	Active bank erosion is occurring and there is limited existing vegetation. Bank should be regraded to a stable slope, the toe of the slope stabilized and vegetation should be added.	3	Regrade and replant	63,081.78
1e	RU - Access	This area is used as an informal access point. There is sparse vegetation present which may lead to bank erosion. A formal access point needs to be placed here if the vehicle access remains and is used.	3	Create formalized access point	5,000.00
1f	VEG/RB, BS	Limited vegetation exists in this area. Creation of riparian area will provide quality habitat, reduce future erosion and water quality impacts and improve the stream system.	2	Supplement existing vegetation/riparian buffer	40,265.25
1g	VEG/RB, BS	Active bank erosion is occurring and there is limited existing vegetation. Bank should be regraded to a stable slope, the toe of the slope stabilized and vegetation should be added.	3	Regrade and replant	2,700.00
2a	VEG/RB, BS	The bank is actively eroding and bank undercutting is present. There are no space constraints so regrading is possible.	3	Regrade and replant	42,516.55
2b	RU - Access	A formalized river access point is being constructed in this area. It will be ADA accessible and connect to the Yampa Core Trail.	1	Create formalized access point with ADA access and trail connection	15,000.00

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
2c	RU - Boating	A way for the tubers to safely pass the structure is needed. It also needs to function well as a diversion structure for agricultural water rights.	3	Diversion structure at James Brown Bridge	$5,000.00
2d	RU - Access	Area is heavily used as a tube take-out. Area is not in a bad state but its condition will deteriorate as it is used if nothing is done.	2	Formalize access point	$2,000.00
2e	VEG/RB, BS	Slope has been recently built up by dumping riprap. Due to the steep slope, rock is sliding into the River. The bank will continue to degrade if nothing is done, however solutions in this area are limited due to space constraints. Addition of vegetation would be helpful, but it is likely that bank erosion will continue and more riprap will be added by the railroad. Area is severely degraded, but options are limited. Not on City property.	1	Vegetate existing feature	$45,369.59
2f	VEG/RB, BS	The bank has been stabilized with a boulder wall and rock. It appears effective in terms of stabilization and has allowed some vegetative growth. Aesthetics and riparian function could be improved with additional of native vegetation. Not on City property.	1	Supplement existing vegetation/riparian buffer	$10,950.29
3a	VEG/RB, BS	The bank has been stabilized with a boulder wall and rock. It appears effective in terms of stabilization and has allowed some vegetative growth. Aesthetics of riparian function could be improved with the addition of native vegetation. Abrupt transition from wall to vegetation.	1	Supplement existing vegetation/riparian buffer	$9,003.08
3b	AH, CF	The channel is very wide and shallow. Rock vanes have been constructed in many places but are spaced in a manner that is against natural stream tendency. Rock clusters have been placed within the channel, but appear to be minimally effective at low flow conditions. There is limited instream cover and more instream aquatic habitat diversity is recommended. No meanders or point bars are present.	3	Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters Remove boulder vane structures	$312,080.00

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
3c	RU - Access	Informal access is eroding and falling into the channel. Vegetation along travel path is gone. Undercutting of the bank has occurred.	3	Formalize access point	$2,000.00
3d	VEG/RB, BS	Area is lacking in vegetation.	1	Supplement existing vegetation/riparian buffer	$8,570.63
3e	VEG/RB, BS	There is little to no buffer between the Dream Island development and the River. In some locations decks and/or houses are placed on the banks. Informal access points exist throughout the area. Area is on private property, so land owner input needed.	3	Boulder Terrace	$129,395.62
3f	VEG/RB, BS	There is little to no buffer between the Dream Island development and the River. In some locations decks and/or houses are placed on the banks. Informal access points exist throughout the area. Area is on private property, so land owner input needed.	3	Boulder Terrace	$145,426.06
3g	RU - Boating	The structure has a limited pool which appears to be limiting its function. The structure itself is in good condition, so work would focus on grading downstream. It is expected that the D Hole could function as well as the C Hole with these improvements.	2	Repair/enhance boating structure	$10,000.00
4a	WATER RIGHTS	A gage needs to be installed for the RICD implementation. The gage on the Yampa near 13th Street bridge will be installed. Actual amount of water that would be received by perfecting this water right is unknown therefore ranking is uncertain.	1	Install gage for RICD rights	$30,000.00
4b	VEG/RB, BS	Rock has been placed along the bank for stabilization. There is sparse vegetation present. The access point is heavily used by swimmers and boaters. Success of any treatment at this location is dependent on O&M activities of the railroad.	3	Vegetate existing feature	$92,125.80
4c	RU - Boating	C-Hole. Boating structure functions well. No modifications recommended.	1	Repair/enhance boating structure	$10,000.00

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
4d	RU - Boating	An additional boating structure could be placed here as there is sufficient space and channel gradient to accommodate it. This would reduce high level of use at other play features. Improvement is not needed, but would improve overall recreational benefits.	2	Install boating structure	$40,000.00
4e	VEG/RB, BS	There concrete debris scattered in the channel and along the right bank in this location. It is a safety concern and aesthetic detriment.	3	Remove debris	$2,000.00
4f	RU - Boating	This boating structure is not effective. Although it does provide some good rapids and drop, it has limited recreational value.	3	Repair/enhance boating structure	$10,000.00
4g	RU - Boating	Also called the Double Z wave and Rock 'n' Roll wave. It is minimally effective and traps sediment. It could be improved by continuing the hold downstream and could reshape the structure.	3	Repair/enhance boating structure	$10,000.00
4h	RU - Access	Bank is eroding and is being used for River access. Rocks have been placed along the bank for stabilization and are effective at the toe. There is some vegetation including shrubs.	2	Create formalized access point Regrade and replant	$24,323.84
4i	RU - Access	Boulders have been placed along the bank for stabilization and railroad ties have been used to provide steps to the channel. The informal access is bare earth with no vegetation.	2	Create formalized access point	$5,000.00
4j	RU - Boating	A-hole. Boating feature is functioning sub-optimally. It would function better if rebuilt with curve in opposite direction.	3	Repair/enhance boating structure	$10,000.00
5a	VEG/RB, BS	Bank is eroding and there is little vegetation. It may be being used as an informal access point.	1	Regrade and replant	$9,931.92
5b	RU - Boating	Backdoor Hole. Boating feature is effective but could use some enhancement.	1	Repair/enhance boating structure	$10,000.00
5c	VEG/RB, BS	A rock wall was constructed to stabilize the bank and has fallen into the channel. Some vegetation exists along the bank but it could be increased.	3	Boulder Wall Revegetation	$65,498.26

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
5d	RU - Boating	Boating feature is functioning sub-optimally. It could be removed.	1	Repair/enhance boating structure	$10,000.00
5e	RU - Boating	Boating feature is function sub-optimally. River right works well but River left does not.	3	Remove boating structure	$8,000.00
5f	VEG/RB, BS	The channel is very wide and shallow. Rock vanes have been constructed in many places but are spaced in a manner that is against natural stream tendency. Rock clusters have been placed within the channel, but appear to be minimally effective at low flow conditions. There is limited instream cover and more instream aquatic habitat diversity is recommended. No meanders or point bars are present.	3	Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters Remove boulder vane structures	$138,120.00
5g	VEG/RB, BS	There is little no buffer between development and the River. In some locations decks and/or houses are placed on the banks. Informal access points exist throughout the area.	3	Boulder Wall Revegetation	$321,461.71
5h	RU - Access	Bank is eroding due to the creation of an informal access. Some rocks are present along the access path but are not effectively stabilizing the banks. The access path is primarily gravel and sand. It is eroding almost up to the Core Trail.	3	Create formalized access point Regrade and replant	$14,163.31
5i	RU - Access	Access point consists of concrete steps and boulders. Beyond the concrete steps no armoring exists and erosion can be seen. Upstream stabilization consists of a boulder wall.	2	Boulder Wall Regrade and replant	$49,022.99
5j	RU - Boating	5th Street Wave. This area receives less use as a park and play structure and this portion of the channel could be converted to a more natural state.	3	Remove boating structure	$8,000.00
5k	VEG/RB, BS	During high flows there is no bank armoring. During low flows there are cobbles along the banks. It may be being used as an informal access.	2	Create formalized access point Regrade and replant	$15,610.53
5l	VEG/RB, BS	Bank stabilization consists of vegetation and some rocks. The bank is steep. It appears to be stable but will need work in the future.	1	Regrade and replant	$13,353.11

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
5m	RU - Boating	This area receives less use as a park and play structure and this portion of the channel could be converted to a more natural state. Existing boating structure and vanes should be removed.	3	Remove boating structure	$8,000.00
5n	OTHER	This area will likely need to be addressed in the future, however until plans for realignment of Spring Creek are completed the appropriate improvements for this area are unknown.	1	No action	$0.00
5o	RU - Boating	Rabbit Ears Wave. Boating feature is functioning sub-optimally. It is located at the downstream end of a kayak course.	1	Repair/enhance boating structure	$10,000.00
5p	VEG/RB, BS	This area is heavily used and is known as "the Beach." Mass wasting is present and outfall pipes have been exposed. Banks are in need of immediate repair as ongoing erosion is evident and due to high use is only expected to worsen.	3	Boulder Terrace Revegetation	$83,009.33
5q	RU - Access	Informal access is eroding and falling into the channel. Vegetation along travel path is gone and the access path is steep. This access is heavily used.	3	Formalize access point	$2,000.00
5r	RU - Boating	Squirt Hole and Slalom Course. Existing features are functioning well. Minor improvements or resetting of rocks could be made, however are receives limited use	1	Repair/enhance boating structure	$10,000.00
5s	RU - Boating	Iron Horse Wave. The boating feature functions well. It is not located on City property.	1	Repair/enhance boating structure	$10,000.00
5t	RU - Access	This access point is eroding and appears to be unsafe. It is not located on City property.	2	Formalize access point	$2,000.00
6a	VEG/RB, BS	In this area there is very little space between the road and the river. Area would be greatly improved by moving toe of the slope further away from road, stabilizing with boulder toe and vegetating area between toe and road.	3	Boulder Toe	$65,340.90
6b	AH, CF	The channel is somewhat wide and shallow, however some natural characteristics exist. Rock clusters have been placed within the channel, providing some habitat. There is limited instream diversity and majority of area is low gradient riffle.	2	Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters	$232,320.00

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
6c	RU - Boating	Model T Hole. The feature is performing sub-optimally.	2	Repair/enhance boating structure	$10,000.00
6d	AH	There is approximately 90 LF of concrete debris scattered along the channel in this location. It is a safety concern and aesthetic detriment.	3	Remove debris	$2,000.00
7a	VEG/RB, BS	In this area there is very little space between the road and the river. Area would be greatly improved by moving toe of the slope further away from road, stabilizing with boulder toe and vegetating area between toe and road.	3	Boulder Toe	$46,352.95
7b	VEG/RB, BS	Minimal buffer is present due to the proximity of River road. In some areas the roadway is on the River bank. Vegetation is present but could be improved.	2	Regrade and replant	$73,936.48
7c	OTHER	Pond outfall from Fetcher Park.	1	No action	$0.00
7d	VEG/RB, BS	Area surrounding a stormwater outfall is eroding. Undercutting is occurring beneath the pipe and may compromise its integrity.	3	Pipe Repair and Bank stabilization	$4,812.00
7e	VEG/RB, BS	Bank is eroding and mass wasting and undercutting is present.	3	Regrade and replant	$42,190.72
7f	AH, CF	Boulder clusters exist in the main channel and some vanes have been placed in the side channel. Both provide poor low flow aquatic habitat. The channel is straight and no point bars or thalweg are presents	3	Create high flow channel Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters	$103,754.00
7g	VEG/RB, BS	Vegetation is sparse. Many informal pathways and access points exist in this area.	2	Supplement existing vegetation/riparian buffer	$23,840.79
8a	VEG/RB, BS	See 7b	2	Regrade and replant	$12,736.36
8b	VEG/RB, BS	See 7g	3	Supplement existing vegetation/riparian buffer	$22,244.83
8c	AH, CF	See 7f	3	Create meander and thalweg Create riffle/pool/glide sequences	$38,350.20

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
8d	AH, CF	Overall channel form and aquatic habitat are poor. Meander pattern exists, but no low flow thalweg is present. Aquatic habitat diversity is limited and boulders that have been placed in the channel are generally not providing quality habitat, particularly at low flows.	3	Create high flow channel Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters	$57,580.00
8e	VEG/RB, BS	There is sparse vegetation along the point bar and along the banks.	1	Supplement existing vegetation/riparian buffer	$18,768.13
8f	VEG/RB, BS	The bank is actively eroding and bank undercutting is present. There are no space constraints so regrading is possible.	3	Regrade and replant	$12,417.75
9a	AH, CF	Overall channel form and aquatic habitat are poor. Meander pattern exists, but no low flow thalweg is present. Aquatic habitat diversity is limited and boulders that have been placed in the channel are generally not providing quality habitat, particularly at low flows.	3	Convert open water to wetland Create high flow channel Create meander and thalweg Create riffle/pool/glide sequences Install boulder habitat clusters Install natural habitat feature	$556,146.40
9b	VEG/RB, BS	Vegetation is sparse.	1	Vegetate	$29,834.19
9c	VEG/RB, BS	Vegetation is sparse.	1	Supplement existing vegetation/riparian buffer	$21,667.00
9d	VEG/RB, BS	Bank is eroding and vegetation is sparse.	2	Supplement existing vegetation/riparian buffer	$5,256.38
9e	VEG/RB, BS	Vegetation is sparse.	1	Supplement existing vegetation/riparian buffer	$10,722.75
9f	VEG/RB, BS	Vegetation is sparse.	1	Supplement existing vegetation/riparian buffer	$13,334.54
9g	VEG/RB, BS	Bank is eroding along this side channel. Formalize channel into a high flow channel.	2	Supplement existing vegetation/riparian buffer	$3,036.88
9h	VEG/RB, BS	Existing feature is forcing flows towards the bank and causing local erosion. Bank is eroding and needs to be stabilized.	2	Boulder Toe	$10,610.92

AOI	AOI Category	AOI Description	AOI Rating	Improvement	Improvement Cost
9i	VEG/RB, BS	Existing feature is forcing flows towards the bank and causing erosion.	2	Boulder Toe	$12,286.32
9j	VEG/RB, BS	Bank has eroded and become destabilized. Undercutting has occurred with vegetation holding the bank together above the high flow line. This could provide aquatic habitat during high flows but it may cause the bank to fall into the River if the erosion keeps occurring.	3	Regrade and replant	$33,278.80
9k	VEG/RB, BS	Bank is eroding and no vegetation exists below the high flow line. Undercutting is not occurring.	2	Regrade and replant	$18,585.23
9l	VEG/RB, BS	Bank is eroding at the toe and vegetation is sparse.	2	Regrade and replant	$16,988.01
9m	VEG/RB, BS	Area is eroding due to flows hitting bank.	2	Boulder Toe	$2,039.27
9n	VEG/RB, BS	Area is eroding due to flows hitting bank.	2	Boulder Toe	$1,402.00
10a	VEG/RB, BS	Two vehicles were left here and are rusting.	1	Remove vehicle	$2,000.00
10b	VEG/RB, BS	Bank has eroded and become destabilized. Undercutting has occurred with vegetation holding the bank together above the high flow line. This could provide aquatic habitat during high flows but it may cause the bank to fall into the River if the erosion keeps occurring.	3	Regrade and replant	$18,056.62
10c	VEG/RB, BS	Mass wasting has occurred and the bank is vertical. There is no vegetation along the bank helping to stabilize it.	3	Boulder Terrace	$69,473.31
10d	VEG/RB, BS	Mass wasting has occurred and the bank is vertical. There is no vegetation along the bank helping to stabilize it. Bank erosion has caused the exposure of a PVC outfall pipe.	3	Boulder Terrace	$254,735.47
11a	AH, CF	The channel leading into and out of the pond area has limited aquatic habitat and would benefit from additional instream variety and features. The pond area is stagnant water that could be partially converted to wetlands with the remainder improved by habitat features.	3	Convert open water to wetland Create riffle/pool/glide sequences Install boulder habitat clusters Install natural habitat feature	$43,641.60

Appendix F: Steamboat Springs, Routt County, Yampa River Riparian Corridor Commercially Available Native Plants Appropriate for Ecological Restoration

Trees & Shrubs	
Scientific Name	**Common Name**
Acer glabrum	Rocky Mountain Maple
Alnus incana	thinleaf alder
Amelanchier alnifolia	Saskatoon serviceberry
Betula glandulosa	bog birch
Lonicera involucrata	twinberry
Picea pungens	Colorado blue spruce
Populus angustifolia	narrowleaf cottonwood
Prunus americana	American plum
Prunus virginiana	choke cherry
Ribes spp.	currants
Rose woodii	woods rose
Salix spp.	willows

Grasses & Grasslike Species	
Scientific Name	**Common Name**
Beckmannia syzigachne	American sloughgrass
Bromus marginatus	mountain brome
Calamagrostis canadensis	bluejoint reedgrass
Carex spp.	sedges
Deschampsia cespitosa	tufted hairgrass
Eleocharis spp.	spikerush
Elymus lanceolatus	streambank wheatgrass
Elymus trachycaulus	slender wheatgrass
Festuca arizonica	Arizona fescue

Grasses & Grasslike Species	
Scientific Name	**Common Name**
Glyceria grandis	American mannagrass
Glyceria striata	fowl mannagrass
Juncus spp	rushes
Pascopyron smithii	western wheatgrass
Poa palustris	fowl bluegrass

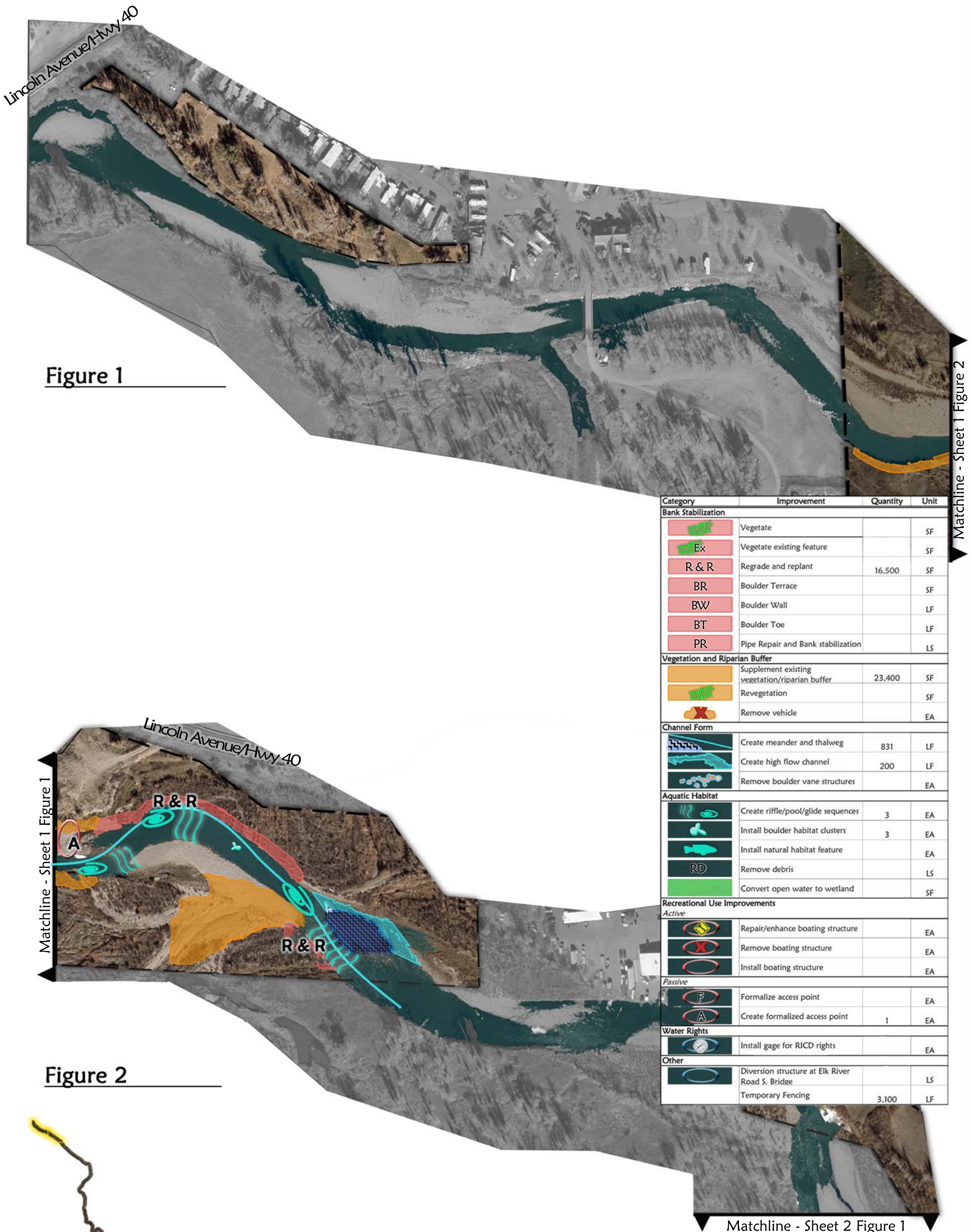
Noxious/ do not plant species	
Scientific Name	**Common Name**
Abutilon theophrasti	velvetleaf
Acroptilon repens	Russian knapweed
Aegilops cylindrica	jointed goatgrass
Agropyron cristatum	crested wheatgrass
Alhagi pseudalhagi	camelthorn
Anoda cristata	spurred anoda
Anthemis arvensis	corn chamomile
Anthemis cotula	mayweed chamomile
Arctium minus	common burdock
Artemisia absinthium	absinth wormwood
Bromus inermis	smooth brome
Bromus tectorum	downy brome/cheatgrass
Cardaria draba	whitetop/ hoary cress
Carduus acanthoides	plumeless thistle
Carduus nutans	musk thistle

Noxious/ do not plant species	
Scientific Name	**Common Name**
Carum carvi	wild caraway
Centaurea diffusa	diffuse knapweed
Centaurea maculosa	spotted knapweed
Centaurea pratensis	meadow knapweed
Centaurea solstitialis	yellow starthistle
Centaurea virgata	squarrose knapweed
Chondrilla juncea	rush skeletonweed
Chrysanthemum leucanthemum	oxeye daisy
Cichorium intybus	chicory
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Clematis orientalis	Chinese clematis
Conium maculatum	poison hemlock
Convolvulus arvensis	field bindweed
Crupina vulgaris	common crupina
Cynoglossum officinal	houndstongue
Cyperus esculentus	yellow nutsedge
Dipsacus fullonum	common teasel
Dipsacus laciniatus	cutleaf teasel
Elaeagnus angustifolia	Russian olive
Elytrigia repens	quackgrass
Erodium cicutarium	redstem filaree
Euphorbia cyparissias	cypress spurge
Euphorbia esula	leafy spurge

Noxious/ do not plant species	
Scientific Name	**Common Name**
Euphorbia myrsinites	myrtle spurge
Halogeton glomeratus	halogeton
Hesperis matronalis	Dame's rocket
Hibiscus trionum	Venice mallow
Hieracium aurantiacum	orange hawkweed
Hydrilla verticillata	hydrilla
Hyoscyamus niger	black henbane
Hypericum perforatum	common St. Johnswort
Isatis tinctoria	Dyer's woad
Lepidium latifolium	perennial pepperweed
Lespedeza cuneata	sericea lespedeza
Linaria dalmatica	Dalmatian toadflax
Linaria vulgaris	yellow toadflax
Lythrum salicaria	purple loosestrife
Matricaria perforata	scentless chamomile
Myriophyllum spicatum	Eurasian watermilfoil
Onopordum acanthium	scotch thistle
Panicum miliaceum	wild proso millet
Peganum harmala	African rue
Phalaris arundinacea	reed canary grass
Potentilla recta	Sulfur cinquefoil
Salvia aethiopis	Mediterranean sage
Salvinia molesta	giant salvinia
Saponaria officinalis	bouncingbet

Noxious/ do not plant species	
Scientific Name	**Common Name**
Senecio jacobaea	tansy ragwort
Sonchus arvensis	perennial sowthistle
Sorghum halepense	johnsongrass
Taeniatherum caput-medusae	medusahead
Tamarix sp.	tamarisk
Tanacetum vulgare	common tansy
Tribulus terrestris	puncturevine
Typha sp.	cattails
Verbascum blattaria	moth mullein
Verbascum Thapsus	common mullein

Appendix G: Recommended Improvements Drawings



Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	16,500	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	23,400	SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	831	LF
	Create high flow channel	200	LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	3	EA
	Install boulder habitat clusters	3	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point	1	EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	3,100	LF

City of Steamboat Springs
Parks, Open Space and Recreational Services
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Yampa River Master Plan Recommended Improvements

Steamboat Springs, Colorado

November 2008

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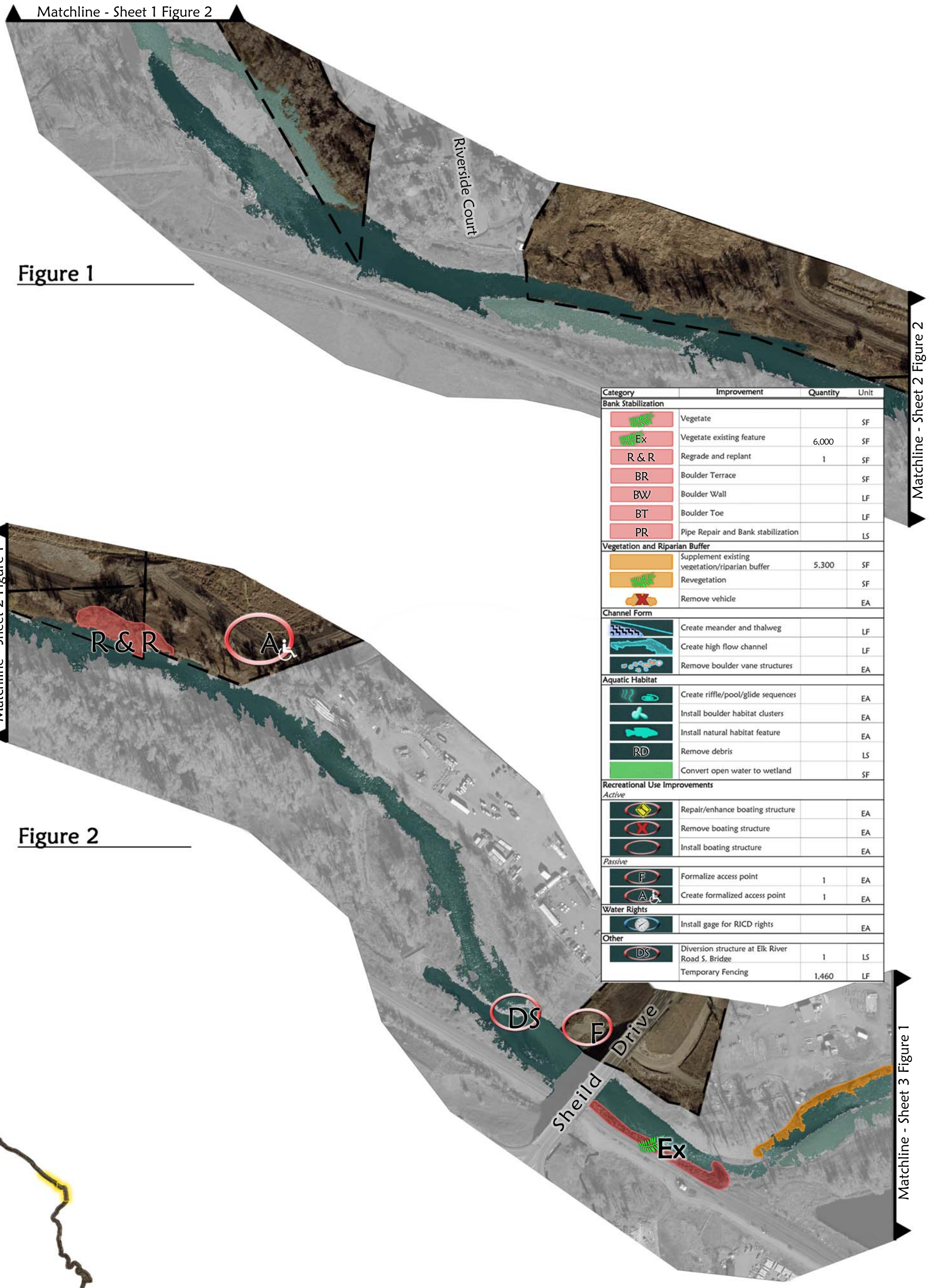

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature	6,000	SF
R & R	Regrade and replant	1	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	5,300	SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg		LF
	Create high flow channel		LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences		EA
	Install boulder habitat clusters		EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point	1	EA
A	Create formalized access point	1	EA
Water Rights			
	Install gage for RICD rights		EA
Other			
DS	Diversion structure at Elk River Road S. Bridge	1	LS
	Temporary Fencing	1,460	LF

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Matchline - Sheet 2 Figure 2

Figure 1

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant		SF
BR	Boulder Terrace	4,720	SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	9,100	SF
	Revegetation		SF
X	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	3,300	LF
	Create high flow channel		LF
	Remove boulder vane structures	6	EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	9	EA
	Install boulder habitat clusters	20	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure	1	EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point	1	EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
DS	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	1,450	LF

F

Matchline - Sheet 3 Figure 2

Matchline - Sheet 3 Figure 1

Figure 2

Dream Island Plaza

BR

BR

D Hole

Matchline - Sheet 4 Figure 1

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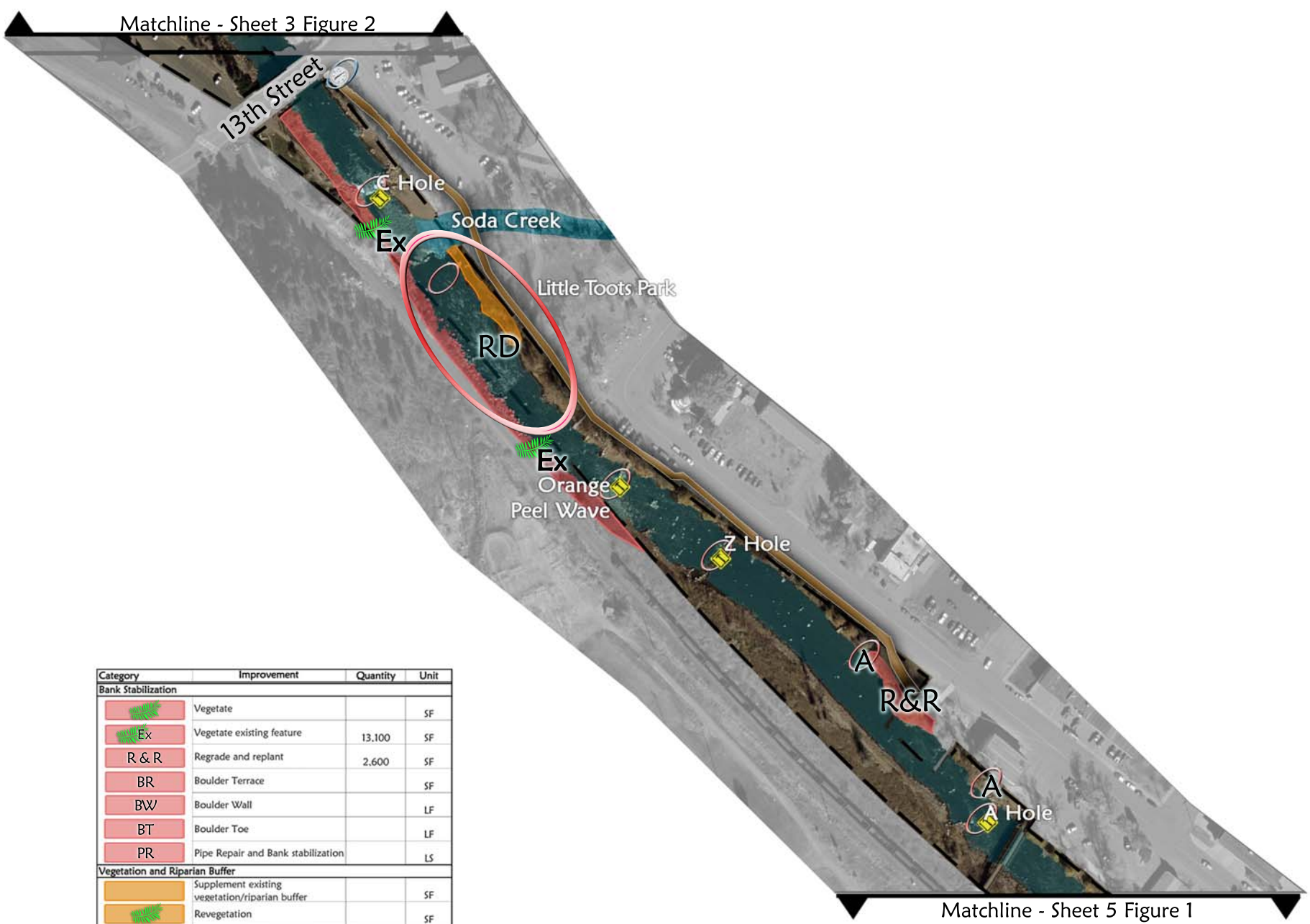

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature	13,100	SF
R & R	Regrade and replant	2,600	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer		SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg		LF
	Create high flow channel		LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences		EA
	Install boulder habitat clusters		EA
	Install natural habitat feature		EA
RD	Remove debris	1	LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure	3	EA
	Remove boating structure		EA
	Install boating structure	1	EA
Passive			
F	Formalize access point		EA
A	Create formalized access point	3	EA
Water Rights			
	Install gage for RICD rights	1	EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	1,900	LF

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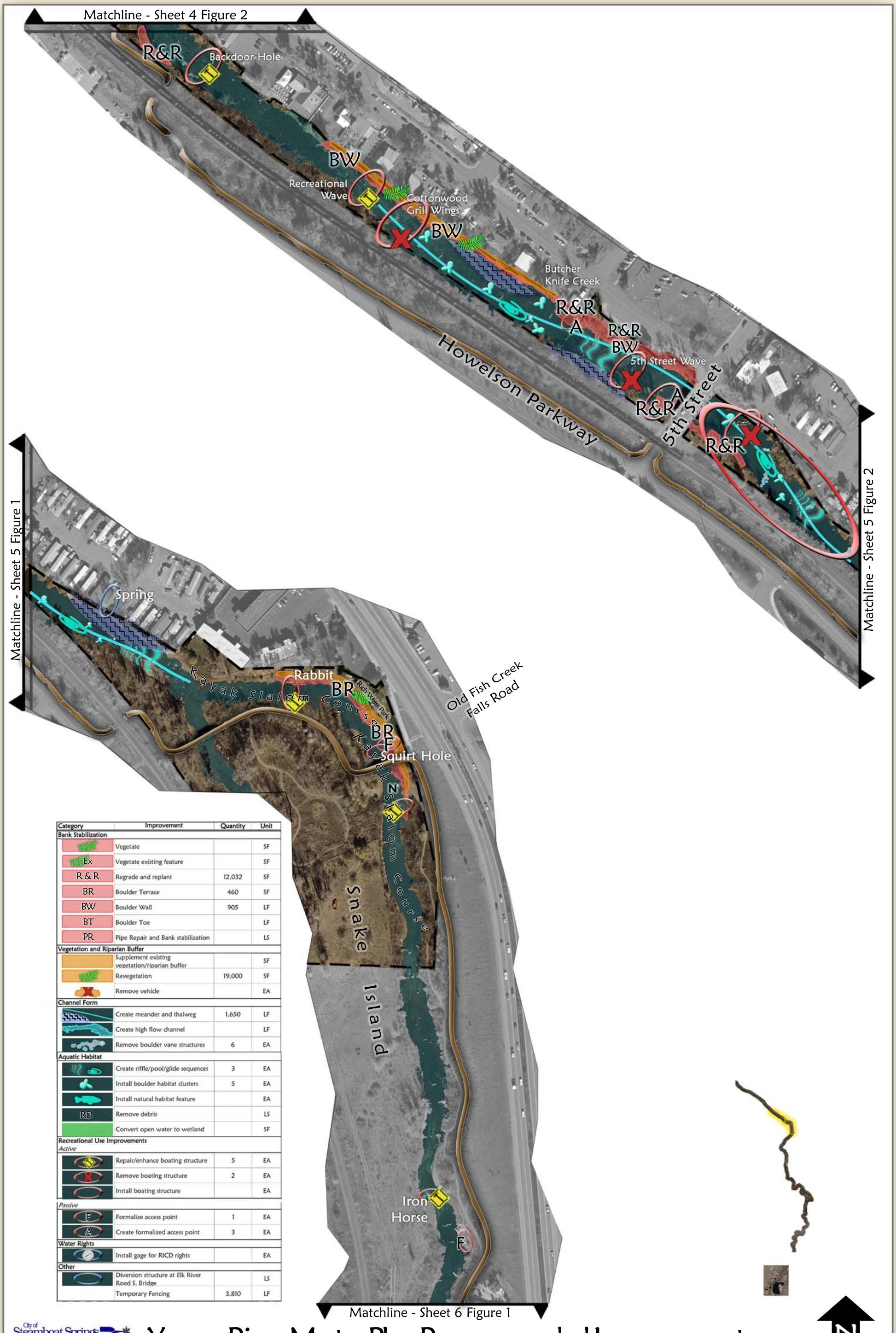

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	12,032	SF
BR	Boulder Terrace	460	SF
BW	Boulder Wall	905	LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer		SF
	Revegetation	19,000	SF
X	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	1,650	LF
	Create high flow channel		LF
	Remove boulder vane structures	6	EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	3	EA
	Install boulder habitat clusters	5	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure	5	EA
	Remove boating structure	2	EA
	Install boating structure		EA
Passive			
F	Formalize access point	1	EA
A	Create formalized access point	3	EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	3,810	LF

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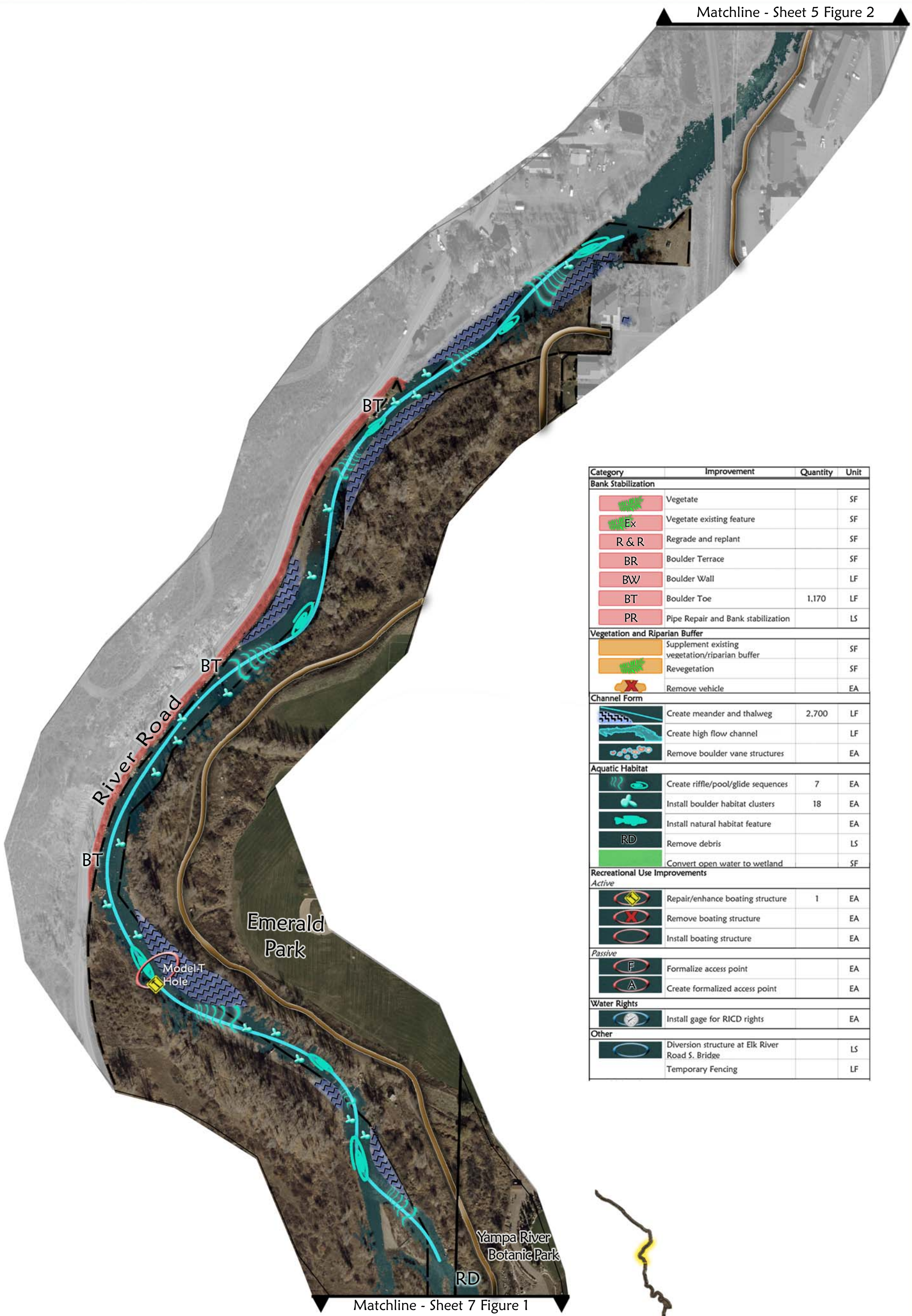

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant		SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe	1,170	LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer		SF
	Revegetation		SF
X	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	2,700	LF
	Create high flow channel		LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	7	EA
	Install boulder habitat clusters	18	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure	1	EA
X	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing		LF

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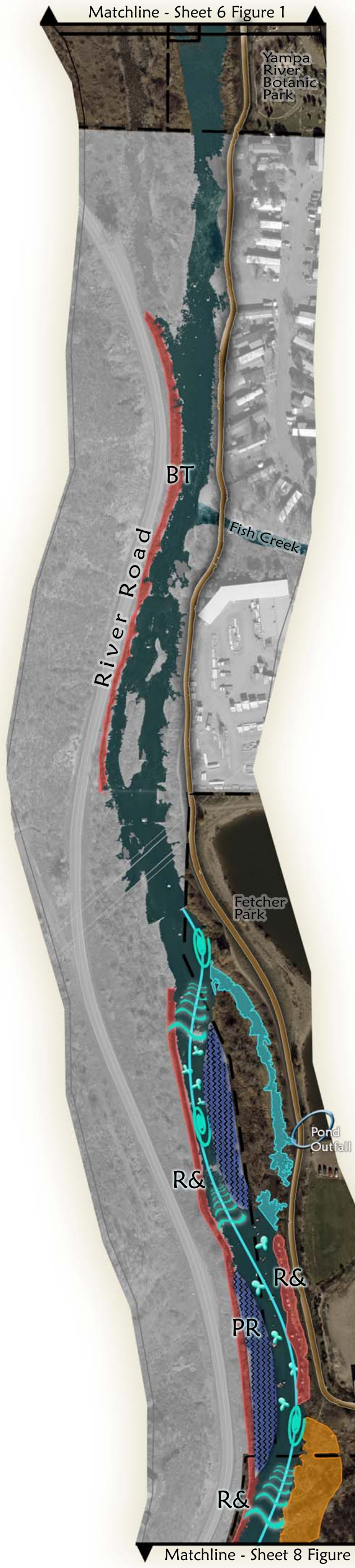

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	15,300	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe	830	LF
PR	Pipe Repair and Bank stabilization	1	LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	13,700	SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	1,100	LF
	Create high flow channel	460	LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	3	EA
	Install boulder habitat clusters	9	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	3,202	LF

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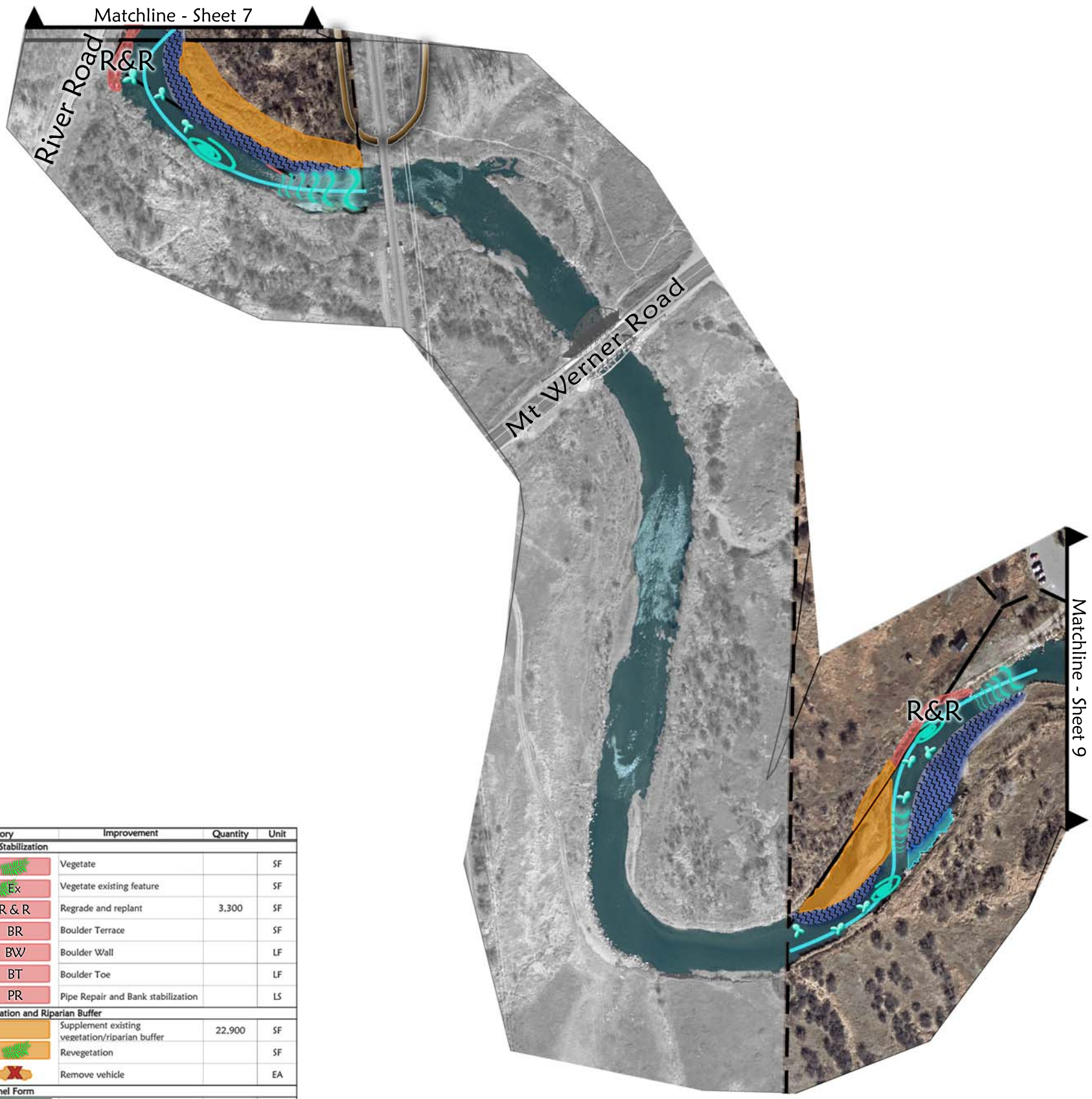

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	3,300	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	22,900	SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	1,079	LF
	Create high flow channel	200	LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	3	EA
	Install boulder habitat clusters	6	EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	1,860	LF

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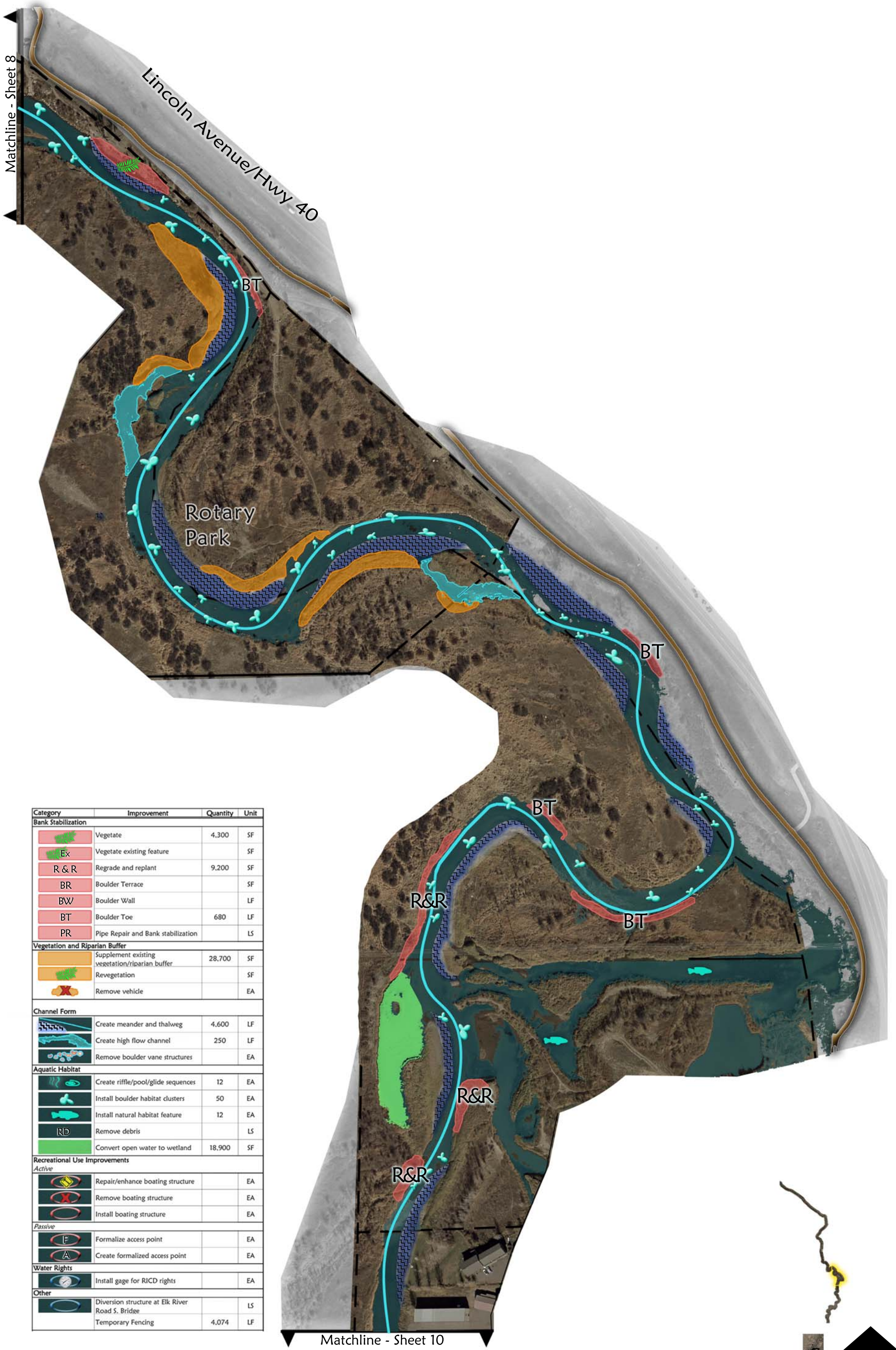

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate	4,300	SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	9,200	SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe	680	LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer	28,700	SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg	4,600	LF
	Create high flow channel	250	LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	12	EA
	Install boulder habitat clusters	50	EA
	Install natural habitat feature	12	EA
RD	Remove debris		LS
	Convert open water to wetland	18,900	SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	4,074	LF

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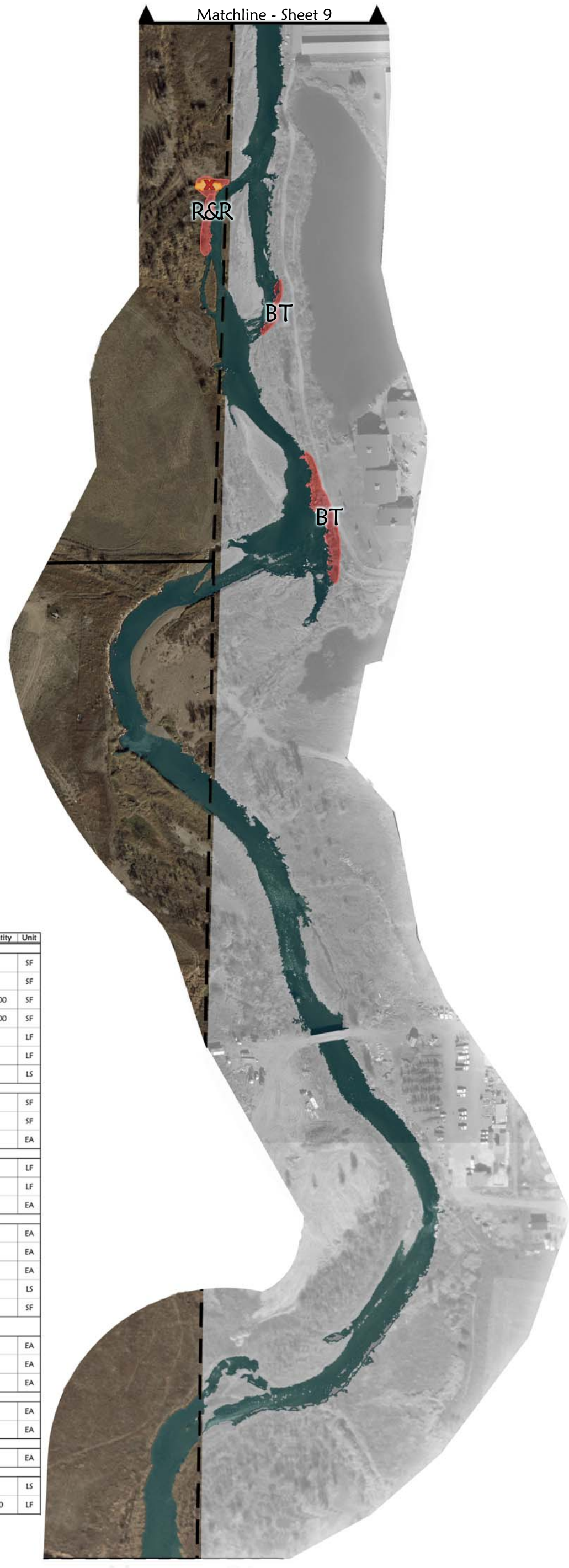

Category	Improvement	Quantity	Unit
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant	2,400	SF
BR	Boulder Terrace	5,600	SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer		SF
	Revegetation		SF
	Remove vehicle	2	EA
Channel Form			
	Create meander and thalweg		LF
	Create high flow channel		LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences		EA
	Install boulder habitat clusters		EA
	Install natural habitat feature		EA
RD	Remove debris		LS
	Convert open water to wetland		SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing	350	LF

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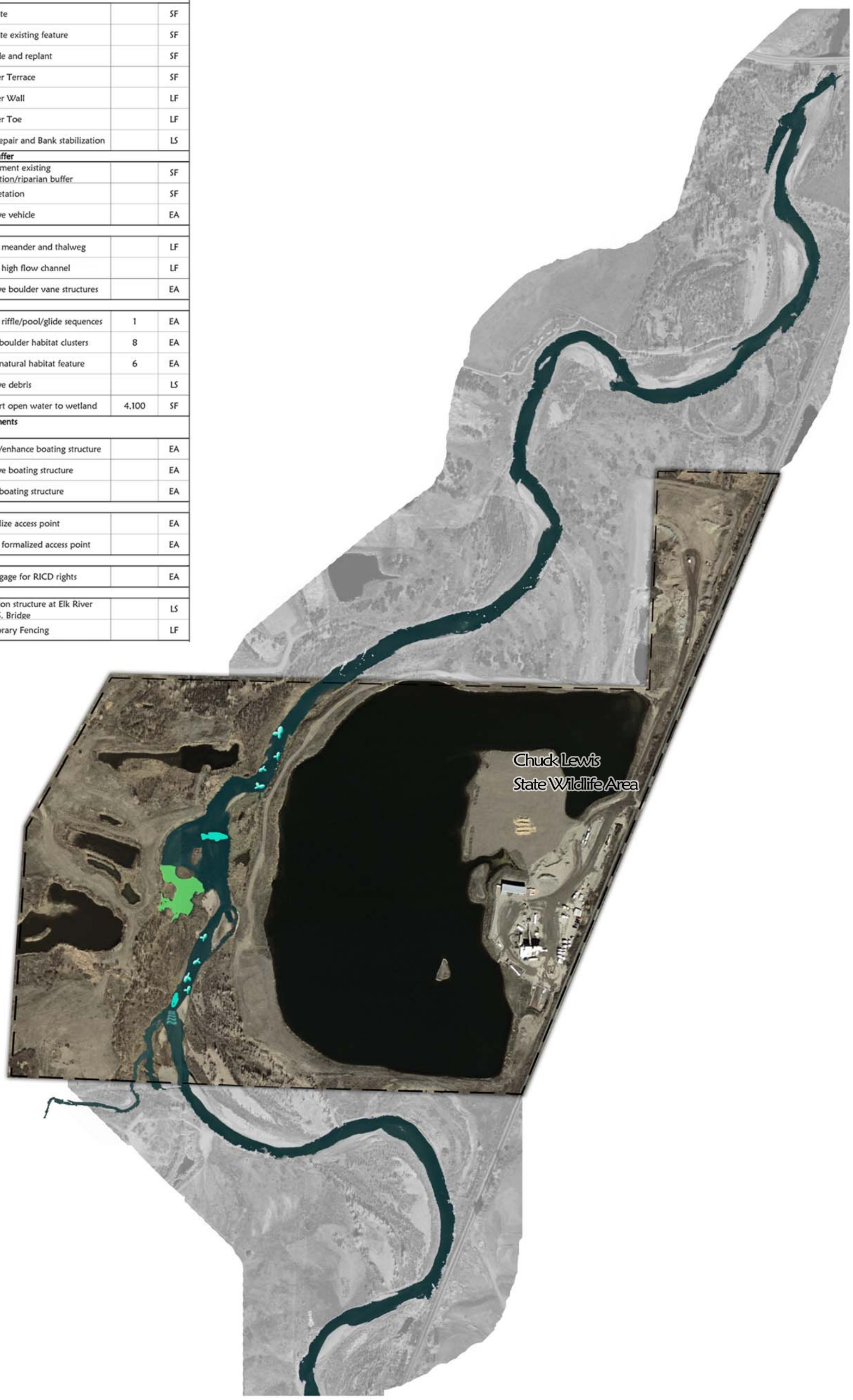
Bank Stabilization			
	Vegetate		SF
Ex	Vegetate existing feature		SF
R & R	Regrade and replant		SF
BR	Boulder Terrace		SF
BW	Boulder Wall		LF
BT	Boulder Toe		LF
PR	Pipe Repair and Bank stabilization		LS
Vegetation and Riparian Buffer			
	Supplement existing vegetation/riparian buffer		SF
	Revegetation		SF
	Remove vehicle		EA
Channel Form			
	Create meander and thalweg		LF
	Create high flow channel		LF
	Remove boulder vane structures		EA
Aquatic Habitat			
	Create riffle/pool/glide sequences	1	EA
	Install boulder habitat clusters	8	EA
	Install natural habitat feature	6	EA
RD	Remove debris		LS
	Convert open water to wetland	4,100	SF
Recreational Use Improvements			
Active			
	Repair/enhance boating structure		EA
	Remove boating structure		EA
	Install boating structure		EA
Passive			
F	Formalize access point		EA
A	Create formalized access point		EA
Water Rights			
	Install gage for RICD rights		EA
Other			
	Diversion structure at Elk River Road S. Bridge		LS
	Temporary Fencing		LF



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Appendix H: Cost Background Information

Improvement Breakdown by Category

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
	No action					
		No action	-	0.00	-	0.00
Bank Stabilization	**Vegetate**		SF		1	6.67
		Non-native species removal	SF	0.25	1.0000	0.25
		Planting Soil	CY	24.00	0.0370	0.89
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees	EA	750.00	0.0025	1.88
		Fence protection (trees)	EA	30.00	0.0025	0.08
		Shrubs (5 gallon) area treatment	EA	34.00	0.0278	0.94
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.000023	0.04
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.32
Bank Stabilization	**Vegetate existing feature**		SF			6.67
		Non-native species removal	SF	0.25	1.0000	0.25
		Planting Soil	CY	24.00	0.0370	0.89
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees	EA	750.00	0.0025	1.88
		Fence protection (trees)	EA	30.00	0.0025	0.08
		Shrubs (5 gallon) area treatment	EA	34.00	0.0278	0.94
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.000023	0.04
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.32

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
Bank Stabilization	**Regrade and replant**		SF			7.09
		Bank grading	CY	10.00	0.0400	0.40
		Non-native species removal	SF	0.25	1.0000	0.25
		Planting Soil	CY	24.00	0.0370	0.89
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees	EA	750.00	0.0025	1.88
		Fence protection (trees)	EA	30.00	0.0025	0.08
		Shrubs (5 gallon) area treatment	EA	34.00	0.0278	0.94
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.000023	0.04
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.34
Bank Stabilization	**Pipe Repair and Bank stabilization**		LS			4,500.00
		Pipe repair	LS	4,500.00	1.0000	4500.00
Bank Stabilization	**Boulder Terrace**		SF			57.89
		Boulder import	TON	70.00	0.5000	35.00
		Non-native species removal	SF	0.25	1.0000	0.25
		Planting Soil	CY	24.00	0.0370	0.89
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Filter Fabric	SF	3.00	1.0000	3.00
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees	EA	750.00	0.0025	1.88
		Fence protection (trees)	EA	30.00	0.0025	0.08
		Shrubs (5 gallon) linear treatment	EA	34.00	0.3333	11.33
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.000023	0.04
		Bank grading	CY	10.00	0.0400	0.40
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	2.76

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
Bank Stabilization	**Boulder Wall**		LF	AVG. HEIGHT	6	350.40
		Boulder import	TON	70.00	0.5000	35.00
		Wall construction	LF	20.00	1.0000	20.00
		Filter Fabric	SF	3.00	1.0000	3.00
		Bank grading	CY	10.00	0.0400	0.40
Bank Stabilization	**Boulder Toe**		LF			55.85
		Boulder import	TON	70.00	0.5000	35.00
		Bank grading	CY	10.00	0.0400	0.40
		Non-native species removal	SF	0.25	1.0000	0.25
		Planting Soil	CY	24.00	0.0370	0.89
		Filter Fabric	SF	3.00	1.0000	3.00
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Shrubs (5 gallon) linear treatment	EA	34.00	0.3333	11.33
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.0000	0.04
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	2.66
Vegetation and Riparian Buffer	**Supplement existing vegetation/riparian buffer**		SF			1.62
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees area supplement	EA	750.00	0.0013	0.94
		Fence protection (trees area supplement)	EA	30.00	0.0013	0.04
		Shrubs (5 gallon) area supplement	EA	34.00	0.0139	0.47
		Wetland/Riparian plugs supplement	EA	2.00	0.0000	0.00
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.08

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
Vegetation and Riparian Buffer	**Revegetation**		SF			6.40
		Planting Soil	CY	24.00	0.0370	0.89
		Upland Seed Mix	SF	0.05	1.0000	0.05
		Riparian Seed Mix	SF	0.05	1.0000	0.05
		Trees	EA	750.00	0.0025	1.88
		Fence protection (trees)	EA	30.00	0.0025	0.08
		Shrubs (5 gallon) area treatment	EA	34.00	0.0278	0.94
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Hay mulch	AC	1,600.00	0.000023	0.04
		Stabilization blanket	SY	3.20	0.0550	0.18
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.30
Vegetation and Riparian Buffer	**Remove vehicle**		EA			1,000.00
		Remove vehicle	EA	1,000.00	1.0000	1,000.00
Channel Form	**Create meander and thalweg**		LF	AVERAGE WIDTH	90	73.80
		Channel excavation - meander	CY	25.00	0.0200	0.50
		Channel grading - meander	CY	16.00	0.0200	0.32
Channel Form	**Create high flow channel**		LF	AVERAGE WIDTH	20	16.40
		Channel excavation and grading	CY	25.00	0.0200	0.50
		Channel grading	CY	16.00	0.0200	0.32
Channel Form	**Remove boulder vane structures**		EA			1,000.00
		Remove boulder vane	EA	1,000.00	1.0000	1,000.00
Aquatic Habitat	**Create riffle/pool/glide sequences**		EA			3,000.00
		Riffle/Pool/Glide Sequences	EA	3,000.00	1.0000	3,000.00
Aquatic Habitat	**Install boulder habitat clusters**		EA			670.00
		Boulder import	TON	70.00	6.0000	420.00
		Boulder placement	LS	250.00	1.0000	250.00
Aquatic Habitat	**Install natural habitat feature**		EA			1,250.00
		Import natural feature	EA	500.00	1.0000	500.00
		Install Instream natural habitat feature	EA	750.00	1.0000	750.00
Aquatic Habitat	**Remove debris**		LS			2,000.00
		Remove debris	LS	2,000.00	1.0000	2,000.00

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
Aquatic Habitat	**Convert open water to wetland**		SF			6.78
		Wetland Seed Mix	SF	0.10	1.0000	0.10
		Planting Soil	CY	24.00	0.0370	0.89
		Shrubs (5 gallon) area treatment	EA	34.00	0.0278	0.94
		Wetland/Riparian plugs	EA	2.00	1.0000	2.00
		Channel grading	CY	16.00	0.0200	0.32
		Import fill from on-site supply	CY	20.00	0.1100	2.20
		Monitoring & Irrigation	LS	5% of total cost	1.0000	0.32
Recreational Use - Active	**Repair/enhance boating structure**		EA			10,000.00
		Repair/Enhance boating structure	EA	10,000.00	1.0000	10,000.00
Recreational Use - Active	**Remove boating structure**		EA			8,000.00
		Remove boating structure	EA	8,000.00	1.0000	8,000.00
Recreational Use - Active	**Install boating structure**		EA			40,000.00
		Install boating structure	EA	40,000.00	1.0000	40,000.00
Recreational Use - Passive	**Formalize access point**		EA			2,000.00
		Formalize Access	EA	2,000.00	1.0000	2,000.00
Recreational Use - Passive	**Create formalized access point**		EA			5,000.00
		Install formalized access	EA	5,000.00	1.0000	5,000.00
Recreational Use - Passive	**Create formalized access point with ADA access and trail connection**		EA			15,000.00
		Install formalized access with ADA access and trail connection	EA	15,000.00	1.0000	15,000.00
Water Rights	**Install gage for RICD rights**		EA			30,000.00
		Install streamflow gage	EA	30,000.00	1.0000	30,000.00
Other	**Diversion structure at James Brown Bridge**		LS			5,000.00
		Diversion Structure	EA	5,000.00	1.0000	5,000.00
Other	**Construction Management**		LS			8% of total cost
		Construction Management	LS	8% of total cost	1.0000	

Category	Improvement	Improvement break down	Unit	Cost/Unit	Quantity	Cost/Improvement Unit
Other	**Contingency**		LS			10% of total cost
		Contingency	LS	10% of total cost	1.0000	
Other	**Design & Permitting**		LS			10% total cost
		Design & Permitting	LS	10% total cost	1.0000	
Other	**Mobilization/Demobilization**		LS			5% of total cost
		Mobilization/Demobilization	LS	5% of total cost	1.0000	
Other	**Temporary Fencing**		LF			3.00
		Temporary fencing	LF	3.00	1.0000	3.00
Other	**Sediment Control**		LS			2% of total cost
		Sediment Control	LS	2% of total cost	1.0000	

Unit Cost

Item	Unit	Unit Cost	Cost/Improvement Unit
Bank excavation	CY	15.00	0.04
Bank grading	CY	10.00	0.04
Boulder import	TON	70.00	0.50
Boulder placement	LS	250.00	1.00
Boulder removal	TON	10.00	0.30
Channel excavation - meander	CY	25.00	0.02
Channel grading - meander	CY	16.00	0.02
Channel excavation and grading	CY	25.00	0.02
Channel grading	CY	16.00	0.02
Construction Management	LS	8% of total cost	1
Contingency	LS	10% of total cost	1
Design & Permitting	LS	10% total cost	1
Diversion Structure	EA	5,000.00	1.0000
Fence protection (trees area supplement)	EA	30.00	0.0013
Fence protection (trees)	EA	30.00	0.0025
Filter Fabric	SF	3.00	1.0000
Formalize Access	EA	2,000.00	1.00
Hay mulch	AC	1,600.00	0.000023
Import fill from on-site supply	CY	20.00	0.11
Import natural feature	EA	500.00	1.00
Install streamflow gage	EA	30,000.00	1.00
Install boating structure	EA	40,000.00	1.00
Install formalized access	EA	5,000.00	1.00
Install formalized access with ADA access and trail connection	EA	15,000.00	1.00
Install Instream natural habitat feature	EA	750.00	1.00
Mobilization/Demobilization	LS	5% of total cost	1.00
Monitoring & Irrigation	LS	5% of total cost	1.00
No action	-	0.00	1.00
Non-native species removal	SF	0.25	1.00
Pipe repair	LS	4,500.00	1.00
Planting Soil	CY	24.00	0.04
Planting soil placement and grading	CY	15.00	0.04
Quarried rock	TON	50.00	0.30
Remove boating structure	EA	8,000.00	1.00

Item	Unit	Unit Cost	Cost/Improvement Unit
Remove boulder vane	EA	1,000.00	1.00
Remove debris	LS	2,000.00	1
Remove informal access	EA	2,000.00	1.00
Remove vehicle	EA	1000	1
Repair/Enhance boating structure	EA	10,000.00	1.00
Reset rock	SF	10.00	1.00
Revetment removal	EA	5,000.00	1.00
Riffle/Pool/Glide Sequences	EA	3,000.00	1.00
Rip Rap	SF	7.22	1.00
Riparian Seed Mix	SF	0.05	1.00
Sediment Control	LS	2% of total cost	1
Shrubs (5 gallon) area supplement	EA	34.00	0.0139
Shrubs (5 gallon) area treatment	EA	34.00	0.02778
Shrubs (5 gallon) linear treatment	EA	34.00	0.3333
Stabilization blanket	SY	3.20	0.06
Temporary fencing	LF	3.00	1.00
Trees	EA	750.00	0.0025
Trees area supplement	EA	750.00	0.0013
Upland Seed Mix	SF	0.05	1.00
Wall construction	LF	20.00	1.00
Wetland Seed Mix	SF	0.10	1.00
Wetland/Riparian plugs	EA	2.00	1.00
Wetland/Riparian plugs supplement	EA	2.00	0.00