

Cherry Creek Trail at Arapahoe Road Feasibility Study



Prepared by:

Arapahoe County
City of Aurora
City of Centennial
Parker Jordan Metro District
Vision Land Consultants, Inc.

In cooperation with:

Arapahoe County Water and Wastewater Authority
Cherry Creek Basin Water Quality Authority
Colorado Department of Transportation
Southeast Metro Stormwater Authority
Urban Drainage and Flood Control District
Valley Country Club

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1. INTRODUCTION

Greenways and trails have long been popular in the Denver metropolitan area and are recognized as assets to the region and the state. These resources are recognized as vital components that contribute to making a place more livable by:

- preserving and protecting natural resources;
- connecting open space and parks;
- enabling outdoor education opportunities;
- providing opportunities for public recreation, health and fitness;
- supporting alternative modes of transportation; and
- enhancing economic growth and prosperity.



A greenway and trail network is similar to a roadway network, which connects all kinds of destinations through a linear system, but the focus of the latter is primarily motorized transportation while the former is on linear corridors for non-motorized travel, recreation and conservation. In order to enhance the public benefits of conserved lands as well as access to destinations linked by a greenway, trails for pedestrians and bicyclists are typically incorporated by design.

Because regional trails often transcend political boundaries, they must be planned, established and managed through partnerships between municipalities, counties and other cooperating entities. The **Cherry Creek Trail at Arapahoe Road Feasibility Study** was prepared to promote and support the regional and multi-jurisdictional trail effort along the Cherry Creek. The study is the result of a collaborative process to make decisions about the future of the Cherry Creek Trail near Arapahoe Road, where there is a missing gap in the regional trail.

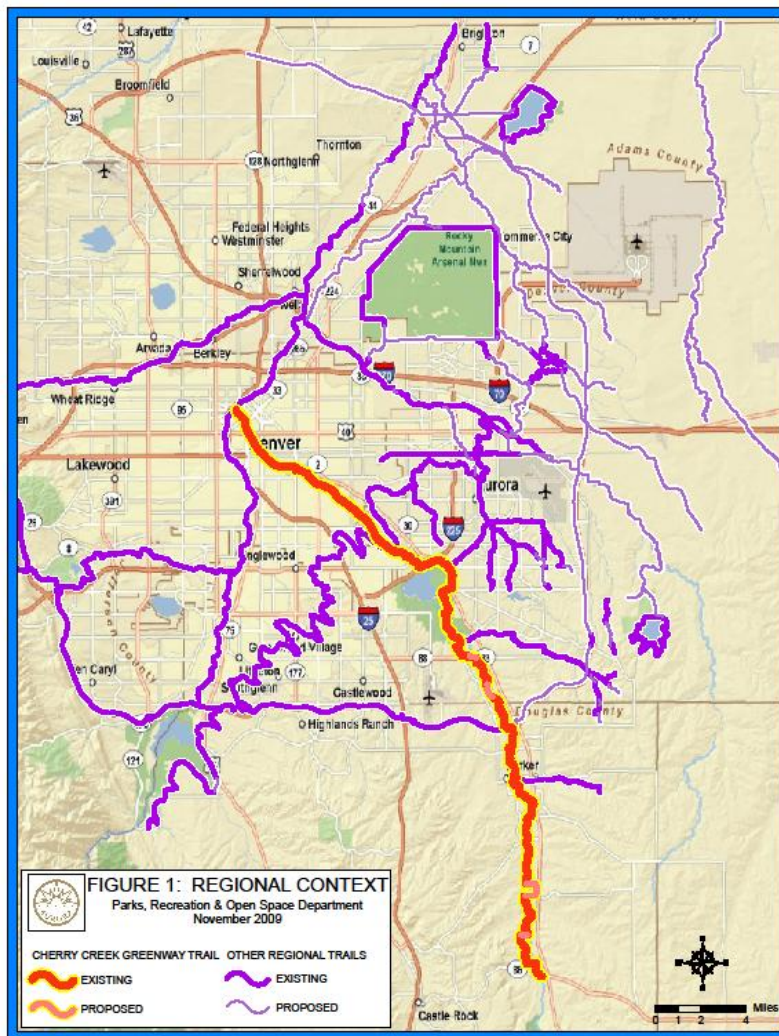
A. Background

As the Cherry Creek flows from its headwaters in El Paso County through Denver, Arapahoe, Douglas and Denver counties, its watershed encompasses nearly 400 square miles. The watershed and the creek itself serve as a major physiographic feature in the southeast quadrant of metro Denver and beyond.

Counties, local municipalities and others have taken measures to protect the natural resources and processes of the watershed in the face of growth and development pressures. As a result, much of the land flanking the main stem of the creek is protected as open space. Efforts to capitalize on the inherent recreation potential afforded by this long swath of open space have also resulted in the provision of the Cherry Creek Trail.

The Cherry Creek Trail, originally envisioned as a connector trail between Cherry Creek and Castlewood Canyon state parks, has evolved into a corridor that extends downstream all the way to the Cherry Creek's confluence with the South Platte River. The trail is the centerpiece of the watershed, providing people throughout the region with recreation and transportation opportunities for nearly a continuous distance of 39 miles (refer to **Figure 1**). The corridor has become one of the most popular trails in the metro area. It serves pedestrians, bicyclists and equestrians.

Figure 1: Regional Context



The user base for the Cherry Creek Trail actually includes more than the local and regional populations, as this long-distance trail attracts people on day trips from beyond the metro area as well as vacation-oriented visitors. In this regard, the trail supports tourism and economic growth by generating revenue from tourists' expenditures. The trail's function as a tourist destination is compatible with the Colorado Front Range Trail (CFRT) Initiative, which is a project lead by Colorado State Parks to establish a

continuous statewide trail a distance of more than 875 miles between the New Mexico and Wyoming borders, in part, to attract visitors to explore the Front Range. The Cherry Creek Trail is a designated segment of the CFRT, as shown in **Figure 2**.

Figure 2: Colorado Front Range Trail in Aurora



Being a 39-mile trail corridor passing through a multitude of jurisdictions, construction of the trail has occurred in phases, implemented by different entities at different times. This has resulted in discontinuity in the trail over time. Even today breaks in the trail still exist, though strides are being made to close those gaps.

Due in part to governmental fragmentation throughout the length of the regional trail corridor, a master plan was never prepared to guide its development. Instead, the trail was planned and designed on a piecemeal basis, and different design criteria were applied in various segments. Some stretches of the trail were integrated into the design of larger, private development projects and then developed accordingly, too.

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The Cherry Creek Trail is managed locally by the jurisdictions through which it passes. Responsibility for completion of the missing links also rests with local agencies.

B. History

Completing the connectivity gap in the Cherry Creek Trail near Arapahoe Road has been discussed and debated for many years. As far back as the early 1990s stakeholders were actively engaged in pursuing development of this segment. Construction drawings were prepared, but implementation was deferred at that time due to maintenance issues. In the years since that deferral, the trail has been further extended north and south with endpoints that now terminate closer to this location, thereby reducing the size of the gap. The popularity of the trail continued to grow during the same time period, despite the discontinuity that trail users encountered. Today, there remains a lot of user and stakeholder interest in finishing this segment of the Cherry Creek Trail. The volume of trail users continues to increase.

In mid-2006, Arapahoe County approached the City of Aurora with the idea of partnering to undertake a feasibility study to decide how the trail might be completed. The City agreed to collaborate on the study, but the project was put on hold when it was learned that a large retail shopping center being proposed upstream of Arapahoe Road was expected to modify the Cherry Creek floodplain and floodway, which could impact the feasibility of a trail underpass at the road. Both parties agreed to wait for development approval to be received and until the changes to the floodwaters of the creek were known before proceeding with the study.

In late 2007, the County and City collaborated on an application to the State Trails Grant Program for funding reserved especially for eligible projects related to the CFRT. In the spring of 2008, a trail planning grant was approved with the objective of strategizing on a trail route and a grade-separated crossing that minimizes conflicts between trail users and motor vehicle traffic along Arapahoe Road.

The engineering firm Vision Land Consultants, Inc. was selected in July 2008 to conduct the feasibility study. The consultant prepared a draft study dated January 2009. The draft was then modified by a team that continued to closely explore the opportunities and design constraints associated with construction of a potential trail connection. This **Cherry Creek Trail at Arapahoe Road Feasibility Study** is the culmination of that process, which involved the parties and stakeholders noted in the next section.

Toward the middle of 2009, the County applied to the Funding Advancements for Surface Transportation and Economic Recovery (FASTER) program, which was created by the State legislature as a way to help generate jobs through transportation improvement projects. FASTER allocates funding with a focus on improving the safety of bridges and roads.

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The County was successful in getting \$1.5 million for completing the gap in the regional trail, which was awarded, in part, due to the project's association with the Arapahoe Road bridge replacement. CDOT expects to initiate the design by the end of 2010.

In January 2010, the Parker Jordan Metropolitan District decided to take the lead by applying for a grant from the County to extend the Cherry Creek Trail in accordance with the preliminary recommendations of this feasibility study. Funding in the amount of \$250,000 was subsequently awarded in June 2010 to design and construct a low-water crossing across Cherry Creek and a trail connection south of Arapahoe Road generally following the route of the creek. Engineering for the project has begun.

C. Study Area

This feasibility study focuses on a missing link in the regional trail corridor in the vicinity of Arapahoe Road as shown in **Figure 3**.

1) Area Stakeholders

The study area falls within several governmental jurisdictions, including the City of Aurora, unincorporated Arapahoe County and the City of Centennial. The service area of the Parker Jordan Metropolitan District extends into this area as well. These partners collaborated to jointly plan how to go about closing the trail gap for this reason.

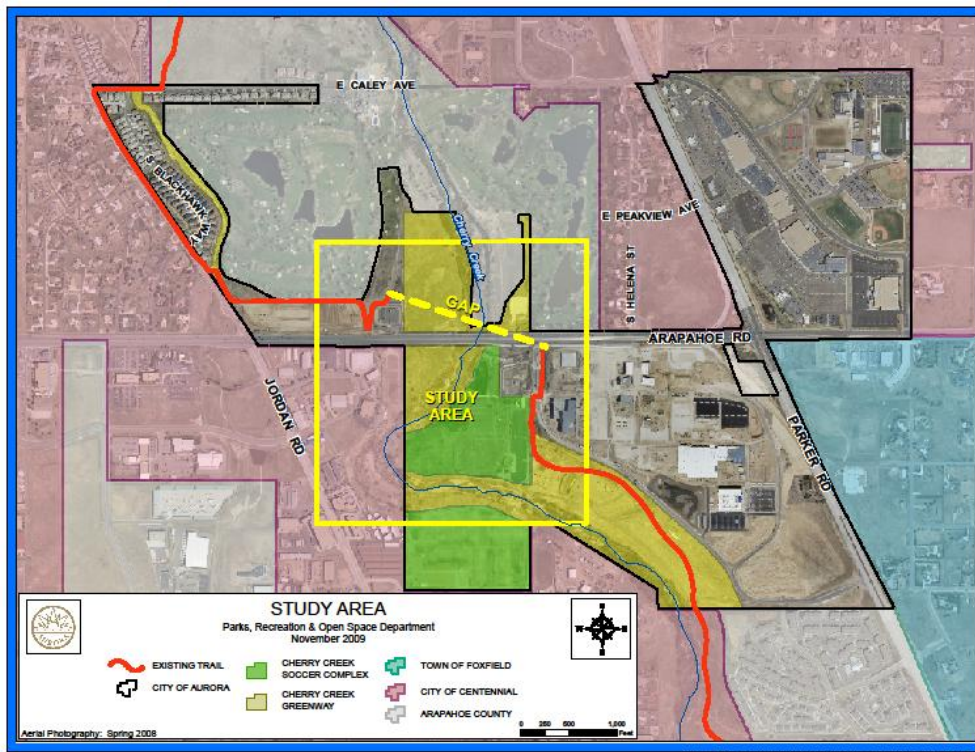
2) Agency Coordination

A number of agencies may have jurisdictional authority over certain aspects of the project through review of plans and documents as well as issuance of permits or approvals for trail construction. As needed, coordination was undertaken with the below list of entities as part of the decision-making process, which helped select a preferred trail connection alternative:

Local/Regional Entities

- *City of Aurora* – In addition to being a major landowner through which the regional trail connection will pass, the project could impact the facilities and operations of many aspects of Aurora's municipal services, including those under the auspices of the Parks, Recreation & Open Space, Public Works and Aurora Water departments. The provision of a community-wide trail network and enhancing the connectivity of regional trails for recreation and transportation purposes is a strategic goal of the City, which has approved capital funding for the segment of the Cherry Creek Trail at Arapahoe Road.
- *Arapahoe County* – The Open Space Division of the Arapahoe County Public Works and Development Department strives to advance park and open space initiatives throughout the county. Regional trail development and management is part of its mission. The Division and the Board of County Commissioners have also recently committed to focus efforts within the Cherry Creek basin.

Figure 3: Study Area



These projects translate into an ongoing interest in the completion of the Cherry Creek Trail.

- *City of Centennial* – Coordination with Centennial for planning and long-term improvement of the Cherry Creek Trail is needed because the study area includes land within its corporate limits. The City's strategic plans identify the regional trail as an important community asset and further target the missing link at Arapahoe Road as a high priority.
- *Parker Jordan Metro District* – PJMD, a special district established to undertake and finance public infrastructure and facility projects to benefit the property owners within its district boundaries, elected to participate in this feasibility study in an effort to lend assistance to expedite completion of the Cherry Creek Trail. The District supports this regional facility for the recreation and transportation opportunities it will provide as a complete, cohesive trail. PJMD has in the past successfully partnered to construct parts of the trail south of the study area.
- *Urban Drainage and Flood Control District* – The UDFCD is an agency established by the Colorado legislature to work with local governments to coordinate planning, design, construction and floodplain management efforts in the Denver metro area. The District helps administer the National Flood Insurance Program at the local level through flood hazard delineation, mapping and

development review. It also conducts master planning studies that propose capital improvements to address regional drainage, flood control and stormwater management needs.

- *Southeast Metro Stormwater Authority* – SEMSWA is a political subdivision and a public corporation of the state that manages stormwater runoff and implements remedial and capital projects to maintain and upgrade stormwater infrastructure within its service area. The Authority undertakes capital improvement projects along drainage channels and waterways to control pollutants and enhance water quality. Although technically outside of the study area for this feasibility study, SEMSWA's activities influence the Cherry Creek and consequently have implications on the regional trail.
- *Cherry Creek Basin Water Quality Authority* – CCBWQA, formed by the State legislature, is an agency responsible for achieving and maintaining water quality standards for the watershed of the Cherry Creek Reservoir. The Authority manages water quality by developing and implementing plans for stormwater regulation, erosion and sediment control, and pollutant reduction facilities.
- *Arapahoe County Water and Wastewater Authority* – The service area for ACWWA, a political subdivision responsible for developing water resources, systems and facilities as well as wastewater collection and treatment facilities, extends into the study area. Certain trail alignments may need to be coordinated with ACWWA's subsurface "wet" utilities, such as sanitary sewer and water lines.
- *Affected Landowners* – The Valley Country Club, a private 18-hole golf course with associated recreation facilities, is a major landowner north of Arapahoe Road. The country club property lies adjacent to one of the existing endpoints of the Cherry Creek Trail, which is aligned such that the southern extension of the trail could potentially necessitate the acquisition of right-of-way across the property. Given the size and configuration of the golf club, various trail alignment alternatives might cross and impact other parts of this property.

State Entities

- *Colorado Department of Transportation* – Arapahoe Road is a State highway administered by CDOT. Any passage over or under the road requires coordination with and approval from this agency.
- *Colorado Division of Wildlife* – Since Cherry Creek is a significant riparian area serving as habitat and a corridor for wildlife, DOW review of trail improvements may be required.

Federal Entities

- *U.S. Army Corps of Engineers* – Potential impact to Waters of the U.S. may warrant coordination with USACE staff.
- *U.S. Fish and Wildlife Service* – Potential impact to threatened and endangered species may warrant coordination with the USFWS staff.

General Note

- Local governments manage and regulate land use and development activities within and adjacent to the 100-year floodplain to prevent, to a maximum extent possible, future flood damages from the 100-year flood and to minimize the damages from larger floods. Any improvements and modifications affecting the floodplain, including trail construction if applicable, must be reviewed and approved by such local jurisdictions.

2. STUDY GOAL AND OBJECTIVES

A. Study Goal

The following goal summarizes the purpose of the feasibility study:

- To inventory and examine potential solutions to close the Cherry Creek Trail gap at Arapahoe Road and to recommend a specific alignment for development.

B. Objectives

Objectives were formulated to help guide the decision making process for attaining the Study Goal. The intent of the objectives was to keep them as simple as possible so they are easily understood and clearly describe the task at hand. The result was the following list of factors and an explanation of how they should generally be taken into account when considering the alignment alternatives for the trail. The list is not organized in any order of priority.

- Safety – Ensure the safety of trail users relative to the general layout and configuration/design of the trail. Minimize liability concerns.
- Accessibility – Access has two perspectives to be addressed: 1) Provide linkage to nearby destinations for trail users; and 2) Consider the need to accommodate as many types of trail users as possible, inclusive of equestrians and universally accessible modes.
- Trail Experience – Maximize the trail user's experience and meet transportation needs for alternative modes of transportation.
- Vehicular Interface – To the extent possible, limit potential conflict with motorists, particularly with regard to at-grade trail crossings involving heavily traveled roads.
- Maintenance – Consider operational challenges and needs as well as the frequency of maintenance work required. Minimize major maintenance challenges associated with key project features.
- Environmental Impact – Although it may be possible for the trail to pass through environmentally sensitive land, identify trail alignments that avoid, minimize or mitigate impacts to such areas as much as practicable.
- Cost – Include cost factors as an important consideration when identifying potential design components and in selecting the preferred trail route. Balance proposed costs with benefits.
- Timing – The alignment should, to the greatest degree possible, be able to be constructed and opened for use in the near term.
- Land Use Impact – Minimize adverse impacts to adjacent land uses. If an impact is unavoidable, the route should be situated so as to mitigate the impact as much as possible.
- Stakeholder Input – Gather local information and opinions about alternative alignments and use this input as a basis for selecting a preferred trail alignment.

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3. LAND USE AND ENVIRONMENTAL ISSUES

An inventory of land uses and existing conditions can reveal positive and negative implications for future trail development opportunities.

A. Land Uses

1) Cornerstar

Cornerstar, a commercial retail shopping center and mixed use development located at the southwest corner of Parker and Arapahoe roads, built an extension of the Cherry Creek Trail in 2008. The trail is located along the creek east overbank through open space dedicated to Aurora by the developer. Instead of following the creek the entire distance to Arapahoe Road, the trail route veers toward the shopping center and shares the sidewalks along South Chambers Way to Arapahoe Road. The current terminus of Cherry Creek Trail from the south is the Arapahoe Road/South Chambers Way intersection stoplight where an at-grade crosswalk is provided. This trail endpoint is a logical point of connection for the missing link, either as the alignment of the main stem regional trail or as a secondary access to Cornerstar. Cornerstar is a major destination and employment center that could benefit from being directly linked by one or more routes leading from/to the regional trail.

2) The Shoppes at Arapahoe Commons & Xcel Energy

In 2008, the Shoppes at Arapahoe Commons, a retail shopping center at the northeast corner of Arapahoe and Jordan roads, extended the Cherry Creek Trail through its property to connect to a trail segment previously constructed by Xcel Energy. As a result, the current terminus of the regional trail from the north is at the northeastern corner of the electrical substation. This trail endpoint is a logical point of connection for planning the missing link. Although the trail through the substation has already navigated challenging slopes via a switchback design, other options, if any, should not be discounted as a possible way to feasibly extend the trail southward.

3) Cherry Creek Well Field

Alluvial wells are located on land owned by Aurora on both sides of Arapahoe Road. These wells pump groundwater from the Cherry Creek alluvial aquifer and distribute it via subsurface pipelines to either the Griswold Water Treatment Plant or Quincy Reservoir. These water resources are managed by the Aurora Water department and must be protected or otherwise not adversely impacted by any regional trail improvements.

4) Cherry Creek Greenway

Much of the Cherry Creek corridor through the study area is currently protected by municipal ownership. The City of Aurora purchased as

well as accepted dedication of land in order to manage the floodplain within its corporate boundaries. The floodplain in unincorporated



Arapahoe County is owned by the Valley Country Club. North of Arapahoe Road, the creek cuts directly through the golf course where it serves as an integral feature and amenity for golf play. A de-facto greenway is provided along this stretch by way of the Club's protection of the resources that add value to its property and land use.

5) Cherry Creek Soccer Complex

South of Arapahoe Road is approximately 50 acres dedicated to a youth soccer field complex. The complex is operated and maintained by the Storm Soccer Association under a lease agreement with the City of Aurora, the landowner. The soccer complex is laid out to maximize field space for the Association's athletic programming needs, which leaves very little room around the perimeter for players and spectators as well as for potential trail routes. The lease was recently renewed with the understanding that future regional trail development may impact the soccer facilities.

6) Lift Station No. 15

The Aurora Water department recently constructed a lift station on the north side of Arapahoe Road and east of Cherry Creek. The project included a ten-foot (10') wide crusher fine path parallel to the road along the frontage of this facility. Although this improvement does not provide direct connectivity to either the Arapahoe Road bridge sidewalk to the west or the crosswalk at South Chambers Way to the east, it is a first phase of establishing enhanced pedestrian and bicycle connectivity along Arapahoe Road.

7) Valley Country Club

The Valley Country Club owns more land than just what is occupied by its 18-hole golf course. The Club's ownership extends southward to include frontage along Arapahoe Road that straddles Cherry Creek. Approved conceptual land uses for portions of the property that are yet undeveloped include residential. Land that is environmentally sensitive, such as areas impacted by the creek, are likely to remain in a natural state, absent any regional stream improvements that might be undertaken within the floodplain.

B. Street and Trail Crossings

There are a few roads where the existing and potentially permanent trail

alignment poses various degrees of difficulty for trail crossings. The current trail alignment through the Cornerstar shopping center involves the following at-grade street crossings:

- South Chambers Way – There is no traffic control at this intersection to require motorists to stop at the trail crossing. Motorists must yield the right-of-way to trail users.
- East Briarwood Circle – Motorists entering South Chambers Way from East Briarwood Circle must stop, but there are no stops required for motorists turning from South Chambers Way as they interface with the crosswalk. Instead, motorists must yield to trail users in the crosswalk.
- Arapahoe Road – The first point of interface between trail users and motorists at Arapahoe Road is at the “continuous right” vehicular movement from South Chambers Way. This is an unmarked crossing point, except for signage instructing vehicles to yield the right-of-way to trail users. At the “pork chop refuge island,” a trail user push button activates the crosswalk signal that provides time for users to cross to the north side of Arapahoe Road. Because there is not a sidewalk or trail on the north side of the road, a “Trail Ends” sign is located near the Arapahoe Road intersection to warn trail users the facility does not continue beyond that point.

Proper signs and striping are provided at all crossings in accordance with City, CDOT, and *Manual on Uniform Traffic Control Devices (MUTCD)* requirements. The MUTCD governs the appropriate regulatory, guidance and warning signs as well as pavement markings. Compliance with these regulations ensures that at-grade crossings serving pedestrians and bicyclists meet minimum standards for safety and functionality.

C. Bridges

There are two bridges that cross over Cherry Creek in the study area.

1) Soccer Complex Connector

An existing wooden bridge connects two halves of the Cherry Creek Soccer Complex which is divided by the creek. The bridge is not suited for regional trail purposes due to its design and construction. The greatest drawback to incorporating the bridge into a route as a way for the trail to cross the creek is the lack of passable route on the western side of the creek further downstream. Where the creek makes a sweeping bend on its course toward the north, urban land uses have encroached close to the creek’s edge. Fill was used at this point to construct a parking and storage lot resulting in a narrow space with a very steep slope that precludes trail construction.

2) Arapahoe Road

Arapahoe Road, a six lane road that bisects the study area, is a major accessibility barrier and obstacle to the trail. To achieve a grade-separated trail crossing of the road, there are two basic options: an

overpass or an underpass. The roadway bridge at Cherry Creek offers little opportunity for an underpass without significant modifications to the creek bed.

According to field survey information obtained in the fall of 2008, the maximum clearance under the Arapahoe Road Bridge was approximately six feet - eight inches (6'8"). The bridge does not have capacity to convey the base flood event under the bridge. Therefore, during the 100-year flood event, water is conveyed over the bridge and road. Due to the inadequate hydraulic capacity during a base flood (100-year) event as well as the deteriorating condition of the structure, CDOT has placed it on the State's list of bridges to be replaced. CDOT will soon begin design engineering for the replacement bridge to position the project as a priority for construction funding. At this time, money is only allocated for design expenses. Other funding will have to be secured to cover the costs of construction, but by completing the design phase and having construction drawings in-hand it is hoped the bridge will be in better standing to compete for future dollars.

According to CDOT, preliminary designs indicate that the replacement bridge would be placed approximately five (5) to seven (7) feet higher than the current bridge to obtain additional hydraulic capacity. This would also provide additional height clearance for a trail to pass underneath.

As mentioned in the Introduction, FASTER funding from the State has been approved to design and construct completion of the regional trail at Arapahoe Road, including the provision of a grade-separation for the trail. The County was successful in getting \$1.2 million for closing the gap in the trail, which was awarded, in part, due to the project's association with the Arapahoe Road bridge replacement. FASTER projects focus on structurally deficient and functionally obsolete transportation infrastructure. The improvement to the regional trail will enhance bicycle and pedestrian mobility and safety where currently there is a deficiency for through travel, and the improvements will be integrated into the overall design for the new bridge to be engineered by CDOT.

D. Utilities

The Arapahoe Road corridor serves as a primary east-west route for many underground utilities. Known major utilities within the corridor include:

- Gas pipeline paralleling the north side of the road.
- 21-inch sanitary sewer line (ACWWA) paralleling the south side of the road.
- 12-inch water line (ACWWA) paralleling the south side of the road.
- 12' X 6' box culvert (CDOT) paralleling the south side of Arapahoe Road from the west side of South Chambers Way eastward. This culvert, which carries stormwater, outfalls into a constructed wetland channel that flows into the Cherry Creek.

Other known utility lines in the study area include various underground pipes used to convey the raw alluvial water from the Cherry Creek Well Field wells.

Utility conflicts represent a constraint where potential trail alignments require grading, but a utility can sometimes be relocated to overcome such an obstacle, though at an additional expense to trail construction. Occasionally a utility company will share in the costs of relocation.

E. Drainage and Hydrology

1) Creek Characteristics

The gradient of the creek is fairly uniform. There are no natural vertical controls or manmade drop structures in the study area. Since the floodplain is broad, much of the area is inundated during a flood event. The channel of the Cherry Creek is a sand bed with fine gravels. Surface water generally flows continuously, which also infiltrates into the sand bed and replenishes the underlying alluvial aquifer. The creek and the aquifer are hydraulically connected.

The stretch of creek through the study area is characteristic of a drainage that is experiencing aggradation. It is receiving increased sediment supply from degradation and bank instability occurring upstream. The depositional nature of the creek in this area helps support wetlands adjacent to the channel due to low flow banks and frequent channel flows into the overbanks during storm events. However, the deposition and sediment is also reducing the vertical clearance under the Arapahoe Road bridge and its hydraulic capacity. This adversely affects options for a trail underpass at this location.

The Cherry Creek has been extensively studied to determine the extent of problems related to flooding, bank erosion and sediment deposition. In 2004, UDFCD prepared a planning study and preliminary and conceptual engineering for the drainageway. The report recommends the following general features or improvements for the creek:

- Floodplain stabilization, habitat enhancement and creation of wetland areas by constructing structural grade controls and providing floodplain corridors;
- Enhancement of braided stream characteristics;
- Lateral bank stabilization using buried rip-rap with soil and vegetation;
- Sediment and phosphorus load reductions utilizing a strategically located sediment trap facility; and
- Channel restoration and corridor management efforts to reduce erosion.

There are three recommended structural grade controls that fall within the study area. One drop structure is proposed immediately downstream from the Arapahoe Road bridge while two are located upstream of the wide bend in the creek. If constructed, a drop structure

might present an opportunity to design and co-locate a low water crossing for the trail. This concept was recommended in the UDFCD report.

A drainageway stabilization project immediately upstream from the project area is currently being engineered by UDFCD, PJMD, SEMSWA, the City of Centennial and Arapahoe County. This project involves the preparation of engineering plans to address longitudinal grade control, erosion control, channel stability and floodplain rehabilitation for Cherry Creek between East Broncos Parkway and the City of Aurora.

The CCBWQA has studied measures to reduce sediment transport and the phosphorus load in Cherry Creek. These pollutant reduction facilities include constructed wetlands downstream of Arapahoe Road beyond the study area as well as a sediment basin closer to the road.

2) Wetlands

Cherry Creek is classified as a Water of the U.S. with the presence of wetlands in the floodplain. The low flow channel and water table have provided favorable conditions for riparian vegetation and wetlands to become established.

The Clean Water Act is the primary federal law that governs water pollution in the United States. Section 404 of the act regulates the placement of fill material in Waters of the U.S. Activities such as moving (discharging) or placing materials such as dirt, rock, concrete, geotextiles, culverts, etc. (also referred to as discharge of dredged or fill material) into or within USACE jurisdictional areas will trigger the need for a 404 Permit. There are two types of permits:

- Individual permits – These are required for activities that have extensive impacts to jurisdictional areas and do not fall within categories outlined under nationwide permits. Due to the requirement of public review and the complexity of the permitting process, individual permits can take six (6) to twelve (12) months or longer to process.
- Nationwide permits – These may be issued on a nationwide, regional or statewide basis. These permits are issued when activities are considered to cause minimal adverse impacts to the environment. Nationwide permits are general permits that have already been written for a specified category or activity, and there are currently approximately forty (40) types. These take approximately three (3) to four (4) months to process.

Based on the scope of probable trail improvements to be located within the Cherry Creek channel, a Nationwide Permit would likely be required for construction activity. Conversations with the local USACE office indicate that a Nationwide Permit 14 (Linear Transportation Projects) generally applies to trail projects. This permit authorizes placement of fill for minor road (trail) crossings or upgrades to existing crossings within

jurisdictional areas. Normal circulation and flow of water must be maintained and discharges into wetlands are limited to one hundred feet (100') on either side of the crossed body.

If the entire project disturbs more than 0.10 acre of delineated wetlands, wetland mitigation is required. Mitigation can be performed in two ways: generated wetlands onsite or purchasing wetlands from a wetland bank.

F. Habitat – Plants and Animals

The creek serves as habitat for a variety of plant and animal species. It is not expected that trail development would adversely affect threatened and endangered species in the project vicinity. However, the 404 Permit application process by the USACE would assess the effects of the action under the Endangered Species Act. Species that may require investigation to determine their presence or lack thereof include:

1) Preble's Meadow Jumping Mouse

The Preble's Meadow Jumping Mouse (PMJM) is a small mammal approximately 9-inches in length with large hind feet adapted for jumping, a long bi-colored tail (which accounts for 60% of its length), a distinct dark stripe down the middle of its back and is bordered on either side by gray to orange-brown fur. PMJM is a shy, largely nocturnal mouse lives primarily in heavily vegetated, shrub-dominated riparian (streamside) habitats and immediately adjacent upland habitats along the foothills of southeastern Wyoming south to Colorado Springs along the eastern edge of the Front Range of Colorado. The PMJM recently documented distribution includes Arapahoe County. According to the USFWS, the Cherry Creek corridor is an area of concern for PMJM habitat. As part of the 404 Permitting process, the USFWS will require that a biological assessment be performed on the proposed project disturbance areas along Cherry Creek.

Should proposed trail improvements be located within PMJM habitat there are two options. First, the alignment could be revised to an area that is not considered PMJM habitat, or secondly, habitat mitigation could be performed at a 2:1 ratio. There is no minimum disturbance that would trigger mitigation. Should PMJM habitat mitigation be required, providing additional plantings/landscaping of non-habitat areas as determined by the USFWS might be acceptable actions.

2) Ute Ladies'-Tresses Orchid

The Ute Ladies'-Tresses Orchid is typically found in old stream channels, alluvial terraces, sub-irrigated meadows and other locations with soils saturated to within eighteen (18) inches of the surface during the spring or summer growing seasons. The Cherry Creek corridor meets the minimum requirements that warrant a site survey to verify or discount the presence of this orchid. After the survey is conducted, the report will be

sent to the USFWS for review. If the orchid is not found, USFWS concurrence with that finding is valid for one year.

3) Migratory Birds

Given that Cherry Creek is a riparian corridor supporting aquatic and terrestrial resources providing habitat for wild birds, field reconnaissance of the project area might be needed to protect species in accordance with the Migratory Bird Treaty Act.

4. PLANNING AND DESIGN CONSIDERATIONS

A. Standards and Criteria

The City of Aurora has adopted standards specific to trails, which should be applied to any improvements located within the city boundaries. Since much of the trail connection is likely to be in the Aurora, excerpts from the Parks, Recreation & Open Space Department's *2008 Dedication and Development Criteria Manual* are provided below to highlight important requirements.

- 1) **General Requirements** – All parks and open spaces, including trails shall comply with all Americans with Disabilities Act Accessibility Guidelines (ADAAG), American Society for Testing and Materials (ASTM), Manual on Uniform Traffic Control Devices (MUTCD), and American Association of State Highway and Transportation Officials (AASHTO) requirements.
- 2) **Regional Trails** – These trails shall be no less than ten feet (10') in width and shall be concrete.
- 3) **ADA** – All trails shall meet ADA regulations. The longitudinal grade shall not exceed five percent (5%). The cross slope shall not exceed two percent (2%). In areas not conducive to accommodating these longitudinal grade and cross slope requirements, the Department will make a determination if departure from these criteria is warranted based on the most current version of the *Accessibility Guidelines for Outdoor Developed Areas* prepared by the Architectural and Transportation Barriers Compliance Board (Access Board). These guidelines acknowledge that under certain circumstances exceptions to the ADA regulations should be granted, thereby allowing steeper trails and deviations from other trail design standards. Generally, the guidelines allow the following running slopes: 8.33% maximum for 200 feet maximum; 10% maximum for 30 feet maximum; and 12.5% maximum for 10 feet maximum. If a departure from the maximum 5% and 2% standards is proposed, Department staff should be consulted early in the design of the trail to determine whether an exception is warranted.
- 4) **Hard Surface** – Hard surface trails shall be a minimum five-inch (5") depth concrete with fiber mesh reinforcement. Where the trail also serves as a maintenance access road for another City department, the trail shall be a minimum of six-inch (6") depth concrete with fiber mesh reinforcement.
- 5) **Return Radius** – If the trail is hard surface, a twelve-foot (12') radius shall be at all trail intersections. If the trail is used as an access drive for utilities or drainage maintenance, the radius shall increase to twenty

feet (20'). If the trail serves as a Fire Lane access, it needs to meet the Fire Department's minimum radius standards.

- 6) **Floodplain** – Trails shall be above the 10-year floodplain. They may be within the 10-year floodplain in limited cases, as approved by Department staff, requiring additional protection through the use of buried rip-rap, walls, or other means of stabilization.
- 7) **Clear Zone** – All trails shall have a two-foot (2') wide shoulder or clear zone on both sides of the trail to allow for recovery from accidents or passing. The clear zone shall be at the same grade as the trail (with maximum 2% cross slope) and be free of obstructions.
- 8) **Street Crossings/Grade Separation** – While trails generally provide for physical separation between trail users and motor vehicle traffic, they inevitably must intersect with streets, resulting in the need to provide connectivity between these two types of transportation facilities coupled with a need to also design their junctions so that operations and safety are maximized and the number of conflicts are minimized. Considering the complexity of design variables, including diverse trail user characteristics and varied traffic operational conditions, the best approach for determining the design requirements of a trail-street crossing is to fully examine site-specific information and to apply sound planning and engineering judgment on a case-by-case basis.
- 9) **Street Crossing Criteria Summary** – The Department objective is to protect the safety of the public by minimizing trail user opportunities for exposure to the risks associated with vehicular conflicts. The following principles shall not be interpreted as precise requirements but are instead meant to serve as general guidelines for the planning and design of trail-street crossings:
 - Where a regional trail intersects with an arterial street, a grade-separated crossing shall be required (requiring a bridge or underpass structure). Clearance for pedestrians and bicyclists shall be ten feet (10') in height and fourteen feet (14') in width. If horses are permitted, clearance shall be twelve feet (12') in height and fourteen feet (14') in width. The bottom of a box culvert underpass and trails affected by drainage flows under bridges shall have a 2% cross slope, and the trail surface should be above the 5-year developed flow depth at a minimum (above the 10-year developed flow depth is preferred).
 - If a grade-separated crossing for a regional trail and arterial intersection is not feasible, a signal-controlled at-grade crossing shall be preferred, either designed as a midblock crossing or co-located with the crosswalk of a T-intersection or 4-legged intersection for streets.
 - Site-specific improvements and crossing treatments recommended by Department staff, City Public Works Department, and/or the Colorado Department of Transportation

shall be incorporated, as appropriate, into all trail-street crossing designs.

- The Department staff shall, in its sole discretion, decide whether an at-grade crossing is acceptable based on a review that takes into account the cumulative impact of all variables, positive and negative, influencing the safety and functionality of a proposed crossing solution.

B. Applying the Criteria

If all the criteria were literally applied to the trail planning exercise within the study area, several factors could conceivably complicate and potentially limit the ability to build a trail connection. Consideration should be given to deviating from the criteria, as appropriate. For example:

1) Grade Separation & Height Clearance

Although criteria encourage grade-separated crossings where regional trails intersect with an arterial street, they also recognize that circumstances sometimes are not conducive for this to happen. Grade-separated crossings should have a minimum clearance of ten feet (10') for pedestrians and bicyclists and twelve feet (12') for equestrians. The elevation of Cherry Creek and the height of the Arapahoe Road bridge pose challenges for compliance with these standards. The *Guide for the Development of Bicycle Facilities* (AASHTO 1999) states that the minimum clearance to obstructions should be eight feet (8'), with ten feet (10') being desirable in undercrossings and tunnels. To achieve a ten-foot (10') clearance would require approximately eight feet (8') of excavation within the channel (to install stabilization and footings) during construction and would place the trail approximately two feet (2') below the thalweg (low flow channel) elevation of Cherry Creek.

2) Trail Slope

According to established criteria, the longitudinal grade should not exceed five percent (5%) and the cross slope should not exceed two percent (2%). At Arapahoe Road, a maximum longitudinal slope of five percent (5%) may not be feasible for a trail underpass due to the impacts to the Cherry Creek wetlands and mitigation requirements. In this case, a ramp with a grade of 8.33% and landings provided at intervals no more than 200 feet might be an alternative.

3) Trail Flooding

Criteria specify that trails shall be located above the 10-year floodplain. However, due to the channel characteristics at Arapahoe Road, this is not feasible. A proposed trail bridge and trail construction will be inundated by the 10-year flood event of Cherry Creek. A proposed Arapahoe Road underpass would be impacted by anything greater than the minor flood event.

C. Physical Challenges

There are two main design considerations that need to be addressed in this study. Each represents a major, physical feature that must be crossed by the trail. The first is crossing Cherry Creek and the second is crossing Arapahoe Road.

1) Cherry Creek Crossing Options

There are two basic ways to approach crossing Cherry Creek, and **Figure 4** maps these strategies:

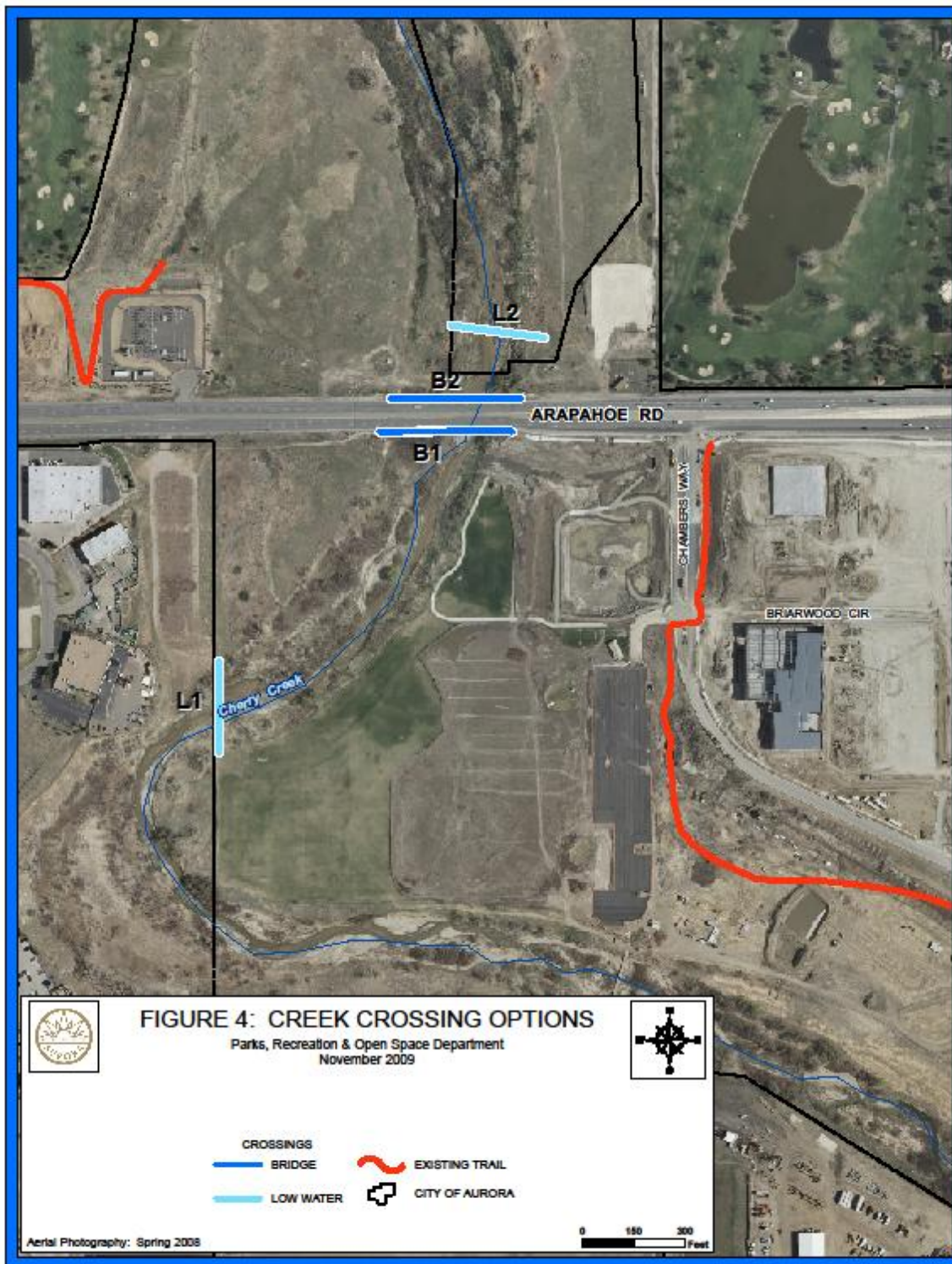
- One approach is to take advantage of existing infrastructure to achieve the crossing. The existing Arapahoe Road bridge offers two options as described below.
 - **Option B1** – This is the existing sidewalk on the south side of the Arapahoe Road bridge.
 - **Option B2** – This is the existing sidewalk on the north side of the bridge.

Commentary: Either of the above sidewalks could serve as a segment of the overall trail alignment. Use of the north or south side would be dependent on other decisions regarding the chosen trail alignment. In any case, these sidewalks would provide connectivity for the regional trail until such time as the bridge is removed and replaced by CDOT. Wider walkways to better accommodate trail users could be integrated into the bridge during its design. In the meantime, another option for the sidewalks could be to widen the bridge by adding a cantilevered attachment, for example, so trail users would have a total width of ten (10) to twelve (12) feet as opposed to the existing six-foot (6') space.

- The second approach for crossing Cherry Creek is to construct a new structure, budget permitting.
 - **Option L1** – This low water crossing is strategically located to cross Cherry Creek where it is thought to have the least hydraulic impact to the base flow and flood events.
 - **Option L2** – This low water crossing is co-located with a drop structure proposed in an UDFCD drainageway study.

Commentary: A low water crossing is generally a 3-sided concrete culvert on footings that is located within the floodplain and which allows floodwaters to overtop the trail surface during heavy storm flows. These crossings are used successfully to accommodate trails and yet minimize impacts to the floodplain and wildlife habitat. They generally blend well into the surrounding landscape due to their low profile. Low water crossings can also be integrated into vertical grade control structures as a stream improvement measure that doubles as a means to provide trail connectivity. This type of combined design is supported by the UDFCD study.

Figure 4: Creek Crossing Options



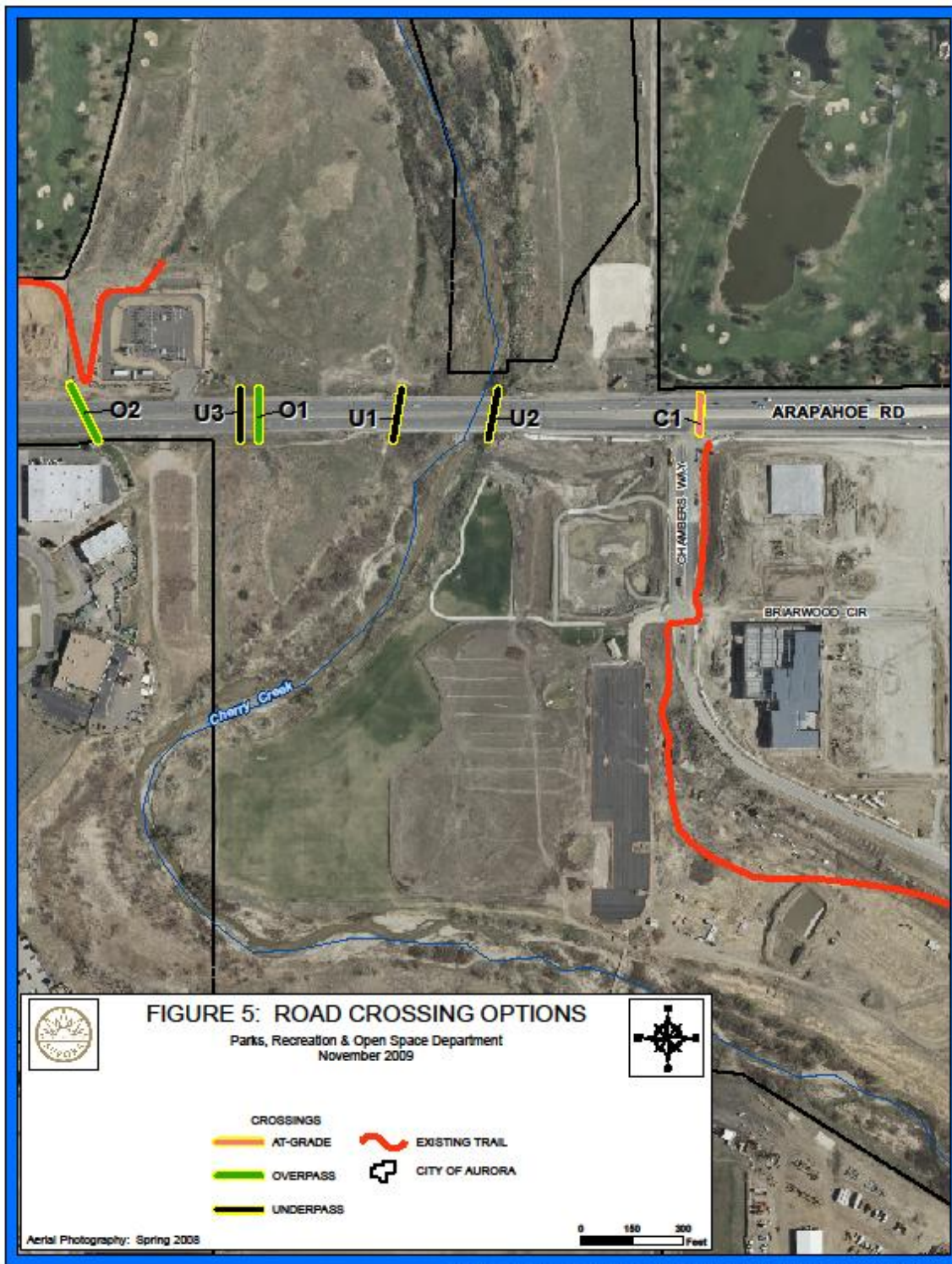
2) Arapahoe Road Crossing Options (refer to Figure 5)

Crossing Arapahoe Road can be achieved in one of three ways:

- The first is to cross at-grade.
 - Option C1 – Utilize the existing, signalized at-grade crossing at Arapahoe Road and South Chambers Way.
- The second is to take advantage of the existing opening for the creek under the Arapahoe Road bridge.
 - Option U1 – This location is at the western abutment of the bridge. This side is not where the low flow channel of Cherry Creek is currently positioned, but this area is often underwater during time of high flow. The undercrossing in this “cell” of the bridge is sandy from deposition when the creek rises through this broad, braided section of the drainage.
 - Option U2 – This eastern side of the existing creek underpass at Arapahoe Road is where the thalweg currently flows. The consistent surface flow and the periodic fluctuations from minor storm events make this location for a trail crossing more problematic than Option U1.

Commentary: Placing the Cherry Creek Trail under the bridge seems to be an economical alternative to an at-grade crossing of Arapahoe Road. However, this approach places the trail where it will be subject to recurring floods that will require cleanup and maintenance as well as pose a potential public risk from floodwater hazards. With approximately six feet - eight inches (6’8”) from the bottom of the bridge girders to the creek bed, excavation below the elevation of the creek bed will be required to achieve sufficient height clearance for the trail. Rather than adhere to the preferred standard of ten feet (10’), allowing a minimum 8-foot (8’) clearance would be acceptable to minimize impacts to the creek and groundwater conditions. Such a design would include a floodwall along the creek side of the trail to prevent minor flood events from impacting the trail. A pumping system would be needed to remove water remaining after a larger flood event overtops the flood wall and to remove any groundwater from the alluvial aquifer that seeps into this below-grade space.

Figure 5: Road Crossing Options



- The third is to construct a new crossing of the road, and there are three options:
 - **Option U3** – This underpass would carry the trail under the road and be located as far west from Cherry Creek as possible so as to minimize impacts from flood events.
Commentary: Separating the underpass from the creek near the edge of the 100-year floodplain limit would reduce the amount of maintenance required after minor and even higher magnitude flood discharges. Cleanup of debris and sediment might still be required at this location, but only as a result of extreme flood conditions, such as the 100-year storm.
 - **Option O1** – This overpass would be a bridge and its associated approaches that carry the trail over the road.
Commentary: According to CDOT, the minimum vertical clearance required for an overpass is sixteen feet - six inches (16'6"). Any overpass design must take this into consideration. When CDOT replaces the Arapahoe Road bridge, the roadway approaches will be raised to compensate for the increased (five to seven feet) bridge elevation. To hopefully avoid impacts from the future elevation of the road, the proposed overpass was kept as far west as possible where the crossing point is already somewhat higher than to the east due to the longitudinal grade of the road. The type of overpass assumed in this study is a covered, truss style bridge with concrete decking. One benefit the overpass offers over the underpass is that it is not impacted by the water flow of Cherry Creek.
 - **Option O2** – This overpass is located farther west and uphill from Option O1. The bridge would be similar to O1, but the difference with this concept is that the approaches to the bridge could perhaps be earthen ramps with retaining walls instead of raised, structural ramps.
Commentary: This crossing location takes advantage of embankments on both sides of Arapahoe Road that slope upward onto surrounding property. This is an advantage because the adjoining lands are already higher than the grade of the road. Therefore, construction of the bridge abutments and at least one approach to the bridge may be less complicated. A drawback to this option is the trail south of the road must navigate the large hill, which would likely require extensive retaining wall work and also right-of-way acquisition.

5. ALTERNATIVE TRAIL ALIGNMENTS

The inventory of existing conditions has revealed positive and negative implications for future trail development. Based on the opportunities and constraints, it is possible to define a host of various routes that the Cherry Creek Trail could take through the study area. **Figure 6** illustrates these alignment alternatives. The physical descriptions below refer to this map.

The alignments presented are not mutually exclusive of each other. Any one or a combination of alignments as well as segments of alignments may be chosen or recommended for the future trail connector route. Furthermore, the descriptions are not presented in any order of priority.

A. Alternative A1

Aurora's long-standing strategy for the Cherry Creek Trail has been to accomplish its construction in stages as development occurs to take advantage of developer-built obligations. This is how the segments of trail have been constructed through the Xcel Energy electric substation, The Shoppes at Arapahoe Commons and Cornerstar. The latest segment to come on line was a crusher fines trail built by Aurora Water as part of the Lift Station No. 15, although this stretch is only meant to be a temporary solution to accommodate bicyclists and pedestrians at that location.

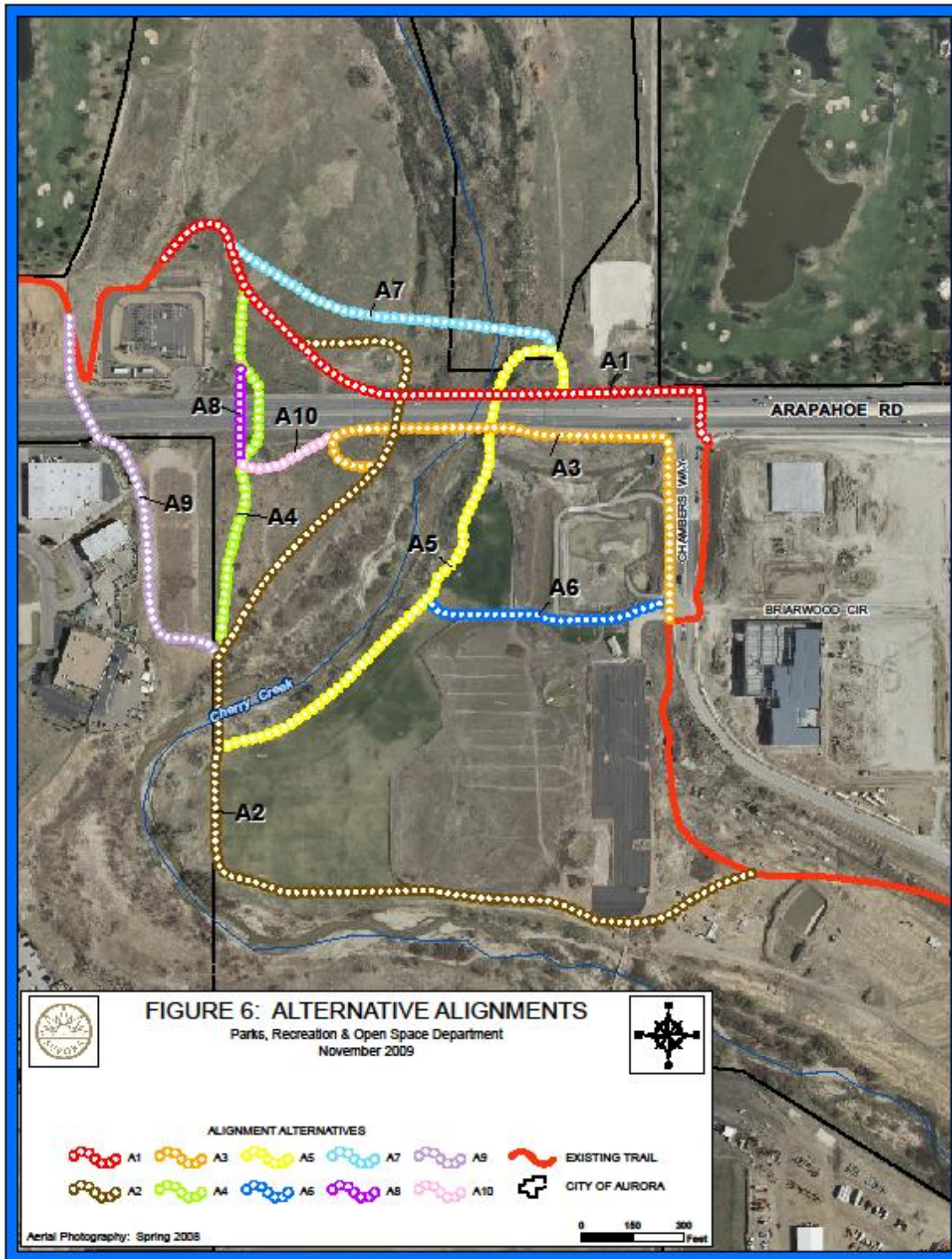
When Aurora reviewed the Cornerstar project, the City approved routing the trail to its existing endpoint at the Arapahoe Road-South Chambers Way intersection. The decision to use this route was based on the physical and environmental constraints posed by Cherry Creek and the Arapahoe Road bridge. In order to expedite connecting the trail, the City opted to allocate monies in its capital budget to construct the trail following the A1 alignment. The vision of this approach was to establish a connection that would be in place for the regional trail until such time as a better connection could be constructed and the trail could be officially rerouted using a grade-separation at Arapahoe Road.

Because Aurora has capital funding and design staff available to devote to this project in 2010, Alternative A1 is believed to be a viable link that could be accomplished in the near term future. The alignment is comprised of the following components:

- Road Crossing Option **C1** – This is an existing, signalized at-grade crosswalk with refuge island.
- Frontage along the north side of Arapahoe Road, including the section past Lift Station No. 15.
- Creek Crossing Option **B2** – This is the sidewalk on the north side of the Arapahoe Road bridge.

After reaching the western end of the bridge sidewalk, the alignment then veers away from the road and passes through Aurora Water land before it bends through Valley Country Club property to join the existing terminus of the trail at the Xcel substation.

Figure 6: Alignment Alternatives



B. Alternative A2

This alignment connects to the existing Cherry Creek Trail south of South Chambers Way and east of the Soccer Complex parking lot. It meanders westward between the north side of Cherry Creek and the soccer fields. At the southwestern corner of the soccer complex, the trail turns to the north to Cherry Creek. Once the trail reaches Cherry Creek, a proposed low water crossing (Creek Crossing Option **L1**) would be constructed across the creek channel.

After crossing Cherry Creek, the trail follows the west bank of the creek northeast to Arapahoe Road. Once at the road, the trail crosses under it on the west side of the opening (Road Crossing Option **U1**) and then turns west to join Alternative A1 before reaching the electric substation.

C. Alternative A3

This alignment reroutes the main stem of the trail so as to eliminate the at-grade crossings with South Chambers Way and East Briarwood Circle. The trail veers away from the current alignment before crossing South Chambers Way at its intersection with East Briarwood Circle. At this point, rather than crossing over to the east side of South Chambers Way, the trail continues north to Arapahoe Road. At Arapahoe Road, the trail turns west and utilizes the existing sidewalk to the Arapahoe Road Bridge. The trail crosses the bridge using Creek Crossing Option **B1** and then circles down to join Alternative A2.

D. Alternative A4

This alignment deviates from Alternative A2 after the trail reaches the west side of Cherry Creek. Beginning at that point, the trail would continue north generally paralleling the Aurora-Centennial jurisdictional boundary to Arapahoe Road. At Arapahoe Road, a 10-foot wide cloverleaf ramp leading to an overpass provides a grade-separated crossing (Road Crossing Option **O1**). Once on the north side of the road, the trail continues north to join Alternative A1, which connects to the existing Cherry Creek Trail switchback northwest of the Xcel Energy substation.

E. Alternative A5

Like Alternative A4, this alignment deviates from Alternative A2, but before, not after, the trail crosses Cherry Creek. This alignment begins at the northwestern-most corner of the soccer complex where the trail then travels in a northeasterly direction along the perimeter of the soccer fields. The alignment uses an existing concrete trail along the way before it ends at a constructed wetlands channel that was constructed by Cornerstar. Some sort of crossing of this channel would be needed for the trail to extend to and pass under Arapahoe Road (Road Crossing Option **U2**). After passing through to the northern side of the underpass, the trail loops up to join the sidewalk along the road as part of Alternative A1.

F. Alternative A6

This alignment simply offers a different route for the trail to pass through or along the soccer complex. This alignment departs from Alternative A3 north of East Briarwood Circle and heads west following an existing concrete path. The segment ends once the trail intersects Alternative A5. At this point, the trail can go either left or right depending on the chosen methods for crossing Cherry Creek and Arapahoe Road.

G. Alternative A7

This alignment breaks away from Alternative A1 east of Cherry Creek and drops down to cross the creek using a low water crossing (Creek Crossing Option **L2**). After crossing over to the western bank of the creek, the trail continues west and rejoins Alternative A1 just before its connection to the existing terminus of the Cherry Creek Trail.

H. Alternative A8

This alignment is an alternative to crossing Arapahoe Road using a bridge as required in Alternative A4. To pursue an underpass (Road Crossing Option **U3**) instead, the trail breaks away from A4 at a distance appropriate to ramp down and pass beneath the road. After the underpass, the alignment ramps back up to grade and rejoins Alternative A4.

I. Alternative A9

This alignment starts at the same location as Alternative 4, which is after Alternative A2 crosses Cherry Creek. Here the trail turns west and then curves to the north as it climbs the embankment at the edge of some light industrial uses. As the trail nears Arapahoe Road, it continues to hug the hillside and yet climb higher as it approaches the bridge over the road (Road Crossing Option **O2**). The bridge would likely be positioned at a skew so the abutments could be placed at high points on either side of the road. On the north side of the road, the trail would ramp down to connect to the existing Cherry Creek Trail. Reconfiguration of the "Xcel switchback" at its upper reach might be necessary to achieve proper grades and a landing for the overpass ramp.

J. Alternative A10

This alignment is a short connection between Alternatives A3 and A4 or A8. The trail splits from Alternative A3 when it starts the downward loop to the creek underpass. The alignment then continues west, allowing the trail to tie into either the new construction overpass or underpass for crossing Arapahoe Road (Road Crossing Option **O1** or **U3**, respectively).

6. RECOMMENDED TRAIL CONNECTION

This chapter provides an overview of various trail connections determined to be the most feasible and practical. The prioritized routes were selected based on input obtained during Study Team meetings and discussions with affected stakeholders. It should be noted that the recommendations reflect the most appropriate alignments relative to the goals and objectives of this study, but they are also subjective. Therefore, this study should be used as an advisory trail feasibility guide and not as a basis for construction.

A. Priority Issues

As the planning process evolved and the multitude of trail alignment options were analyzed, it became obvious that a select subset of the study objectives were of higher priority than others. Below are four objectives valued for being of highest importance when selecting a preferred alignment.

1) Timing: *“The alignment should, to the greatest degree possible, be able to be constructed and opened for use in the near term.”* Fulfilling this objective requires that certain questions be asked:

- How long will it take to assemble and establish a connection?
- Is the construction timeframe reasonable and acceptable, and are there other alternatives for accomplishing the task faster?
- Will the connection remain available for public use indefinitely?
- What circumstances could affect the usability of the connection?

2) Safety: *“Ensure the safety of trail users relative to the general layout and configuration/design of the trail. Minimize liability concerns.”* The following questions apply to this issue:

- Are there any risks, and if so to what degree, due to the trail's interface with streets, such as motorized traffic?
- Are there any risks, and if so to what degree, due to the trail's interface with environmental hazards, such as flooding?
- Can design elements adhere to accepted criteria and standards?
- Can all types of expected trail users be safely accommodated?

3) Maintenance: *“Consider operational challenges and needs as well as the frequency of maintenance work required. Minimize operation and maintenance associated with key project features.”* Questions helpful for gauging maintenance impacts are as follows:

- Does the trail have special design elements that will result in maintenance challenges?
- Is there an entity available to assume maintenance responsibilities?
- How often will major maintenance activities be required?

4) Cost: *“Include cost factors as an important consideration when prioritizing various components of each alternative alignment and in selecting the preferred trail route. Balance proposed costs with benefits.”* Applicable questions dealing with cost include:

- Consider the benefits of improvements relative to public investment costs and the length of time the improvements will be available for use.
- What is the life cycle of the trail improvement relative to its cost?
- What is the longevity of the trail improvement relative to the costs incurred and the public benefits received?
- Will the improvements be available only for short-term use?

B. Crossing Priorities

By evaluating the potential creek and road crossings against the above principles, the options that best match those values were identified. Primarily due to a probable year long period for construction of a new Arapahoe Road bridge that could likely require the closure of any trail facility located on or below the bridge, concerns about timing resulted in the decision to recommend both primary and secondary connections to address short term and long range strategies to close the trail gap. A basic intent behind employing two strategies is to ensure continuity in the regional trail during bridge replacement.

The matrix in **Table 1** provides an overview of the various options on a very simplified basis. In the matrix, an option that has more darkened circles is revealed as being more feasible than one with lighter circles, and the scores reflect this – a higher score is more feasible than a lower score. The last column of the matrix includes an overall ranking or priority based on the score of each option.

Using the evaluation scores as a general basis for assembling feasible trail alignments, the following crossing locations were chosen:

1) Preferred Cherry Creek Crossing

- Primary Option – B1 or B2
- Secondary Option – L1

Commentary: Cherry Creek is not in equilibrium. Some stretches are degrading and other sections are aggrading. Efforts to improve the creek elsewhere can have “spillover” effects where the creek flows through the study area. For example, reductions in upstream sediment supply may reverse the aggradational tendency and result in channel incision in this reach. Changes in the depositional nature of the creek from upstream bank stabilization and vertical control improvements could also affect the low flow’s hydrologic connectivity with adjoining lands, thereby changing other characteristics of the channel over time.

Table 1: Crossing Options Evaluation Matrix

	TIMING		SAFETY	MAINT.	COST	Score	Rank
	Short Term	Long Range					
Cherry Creek Crossing Options							
B1 - South sidewalk of Arapahoe Road bridge	●	●	●	●	●	3	1st
B2 - North sidewalk of Arapahoe Road bridge	●	●	●	●	●	3	1st
L1 - Low water crossing south of Arapahoe Road	○	●	●	●	●	1.8	2nd
L2 - Low water crossing north of Arapahoe Road	○	○	●	●	●	1.6	3rd
Arapahoe Road Crossing Options							
C1 - At-grade crossing at South Chambers Way	●	●	●	●	●	2.8	1st
U1 - Western side of Arapahoe Road bridge undercrossing	○	○	●	●	○	1.4	5th
U2 - Eastern side of Arapahoe Road bridge undercrossing	○	○	●	○	○	1.2	6th
U3 - Underpass	○	●	●	●	●	2	2nd
O1 - Overpass east of Xcel substation	○	●	●	●	○	1.8	3rd
O2 - Overpass west of Xcel substation	○	○	●	●	○	1.6	4th

= 3 points **High**
 = 2 points **Medium**
 = 1 point **Low**

Not knowing what the creek will do, except for accepting the fact that the creek is dynamic and changes will occur, makes it difficult to decide where a trail should cross the drainage. Use of the Arapahoe Road bridge sidewalks as a permanent route across Cherry Creek was eliminated because of CDOT's plan to replace the bridge, which would likely close the trail for a short interval during the construction phase or at worst for the duration of construction lasting as long as one year.

Since it is unknown when and to what extent future drainageway improvements will take place downstream of Arapahoe Road as well as the degree of impact such work might have on being able to provide a stand-alone trail crossing, it is believed the best plan is to locate the crossing somewhere that is unlikely to be jeopardized. For this reason, Option L2 was eliminated as a possibility. When more information is available about future drainage facilities, this crossing point can be re-evaluated if the regional trail connection has yet to be completed at that time.

Placement of a low water crossing, across Cherry Creek at the Option L1 location is thought to have the least hydraulic impact if it is placed parallel to the base flow. If, through final design analysis, it is determined that such a structure creates adverse impact to the floodplain or the dynamics of the creek, an alternative crossing may need to be considered. Based on a very simple and conceptual analysis, it is assumed the base flood elevation would not be impacted by the structure, particularly if the design engineering for the project is undertaken to achieve that standard. If the base flood elevation is raised, a LOMR may be required.

2) Preferred Arapahoe Road Crossing

- Primary Option – C1
- Secondary Option – U3 or O2

Commentary: Due to the concerns for the safety of the trail users, alternatives to an at-grade crossing at Arapahoe Road were explored. Utilization of the existing crosswalk alignment at Arapahoe Road and South Chambers Way would expose trail users to risks associated with crossing this State roadway. However, adherence to state and federal design standards for at-grade crossings ensures an appropriate degree of safety for this crosswalk to serve the regional trail. It should be noted that trail users as well as motorists must obey traffic signs, signals and laws to maintain operational safety at this intersection.

Although the crosswalk can be a safe crossing for the trail, it is not convenient when trail users must wait for traffic signals and corresponding crosswalk lights to change. Consistent use of the crosswalk timing delays can also lead to disruption of traffic

progression, which is not ideal for a high volume roadway such as Arapahoe Road. For these reasons, the provision of a grade-separated trail crossing would ultimately be best for the long term.

Again, because of the nature of Cherry Creek, locating a trail undercrossing where it would pass under a roadway bridge that is hydraulically constrained and be subject to recurring floods is not a best practice. Based on existing bridge conditions, the trail underpass would be below the thalweg of Cherry Creek and flood walls would be required to hold back water during a minor flood event. When water exceeds the minor flood elevation the trail would flood. A pump station would pump the water out of the trail after the floodwaters recede below the minor water surface elevation. There would be ongoing maintenance costs associated with the pump station and cleaning dirt and debris from the underpass after flooding, although the trail could be redesigned and reconstructed by CDOT at a higher elevation less influenced by the floodwaters when the bridge is replaced.

If the creek opening under the Arapahoe Road bridge were to be used for the trail, the continuity of the trail will likely be interrupted when CDOT replaces the bridge; whereas an alternative overpass or underpass could remain open and functional. A stand-alone grade-separated crossing would provide trail users with a higher level of safety.

The responsibilities, liabilities and associated costs for ongoing operation and maintenance of the trail are major considerations for determining feasibility and future planning. Environmental impacts, ongoing maintenance costs, public safety hazards, and other concerns prompted interest to define other crossing points with fewer negative implications. A significant benefit offered by constructing a different underpass or overpass as opposed to using the existing bridge undercrossing is that it could be located to eliminate or minimize impacts from the water flow of Cherry Creek.

C. Trail Connection Priorities

Based on a purely academic exercise that weighed the pros and cons of alignments the Cherry Creek Trail could take through the study area, the numerous potential routes were narrowed down to four for further consideration by trail partners and affected local jurisdictions. The routes were chosen for their consistency with the crossing priorities that were established in the above section. Consequently, there are three routes mapped as possible primary connections, each having a different priority for implementation – #1, #2 and #3. The primary connection that is ultimately selected should be regarded as the preferred long term, main stem of the trail corridor. The fourth route, the secondary connection, should be thought of as an immediate trail connection solution.

1) Primary Connection Priority #1

The top choice for construction of the regional trail connection is mapped in **Figure 7**. Described in a direction from the south to the north, the route for this connection is a combination of Alternative Alignments A2, A4, A8 and A1. The route includes Crossings L1 and U3, which are a Cherry Creek low water crossing and an Arapahoe Road underpass/tunnel, respectively.

2) Primary Connection Priority #2

The second choice for the regional trail connection is mapped in **Figure 8**. It is a combination of Alternative Alignments A2 and A9 and includes Crossings L1 and O2, which are a Cherry Creek low water crossing and an Arapahoe Road overpass/bridge, respectively.

3) Primary Connection Priority #3

Figure 9 shows the route ranked third for priority as the regional trail connector. This route includes segments of Alternative Alignments A2 and A1 as well as Crossings L1 and U1, which are a Cherry Creek low water crossing and the undercrossing for the creek at the Arapahoe Road bridge, respectively.

4) Secondary Connection

Figure 10 maps an auxiliary route that offers a way to quickly close the regional trail gap with fewer implementation issues than any of the primary connections. Priority connections #1, #2 and #3 will be more challenging and take longer to complete, thereby leaving trail users to contend with the missing link in the corridor for a longer period of time.

The secondary connection is considered an auxiliary route because it provides trail users an alternative and supplemental means to travel through the study area after the primary connection is in place. It becomes important to offer trail users choices, especially in the event that the primary connection is impassable due to flooding or for other trail closure purposes.

The secondary connection can and should function as a stand-alone project even though a primary connection is constructed. The benefit of this route is that it extends access to the regional trail and enhances connectivity to the surrounding area, including nearby retail shopping and neighborhoods. Because the route will essentially serve as a continuous sidewalk that is now missing along Arapahoe Road, it has functionality beyond acting as a section of the trail. For reasons of expanding pedestrian and bicycle mobility in this area, this project should proceed as programmed and budgeted by the City of Aurora.

Figure 7: Primary Connection Priority #1

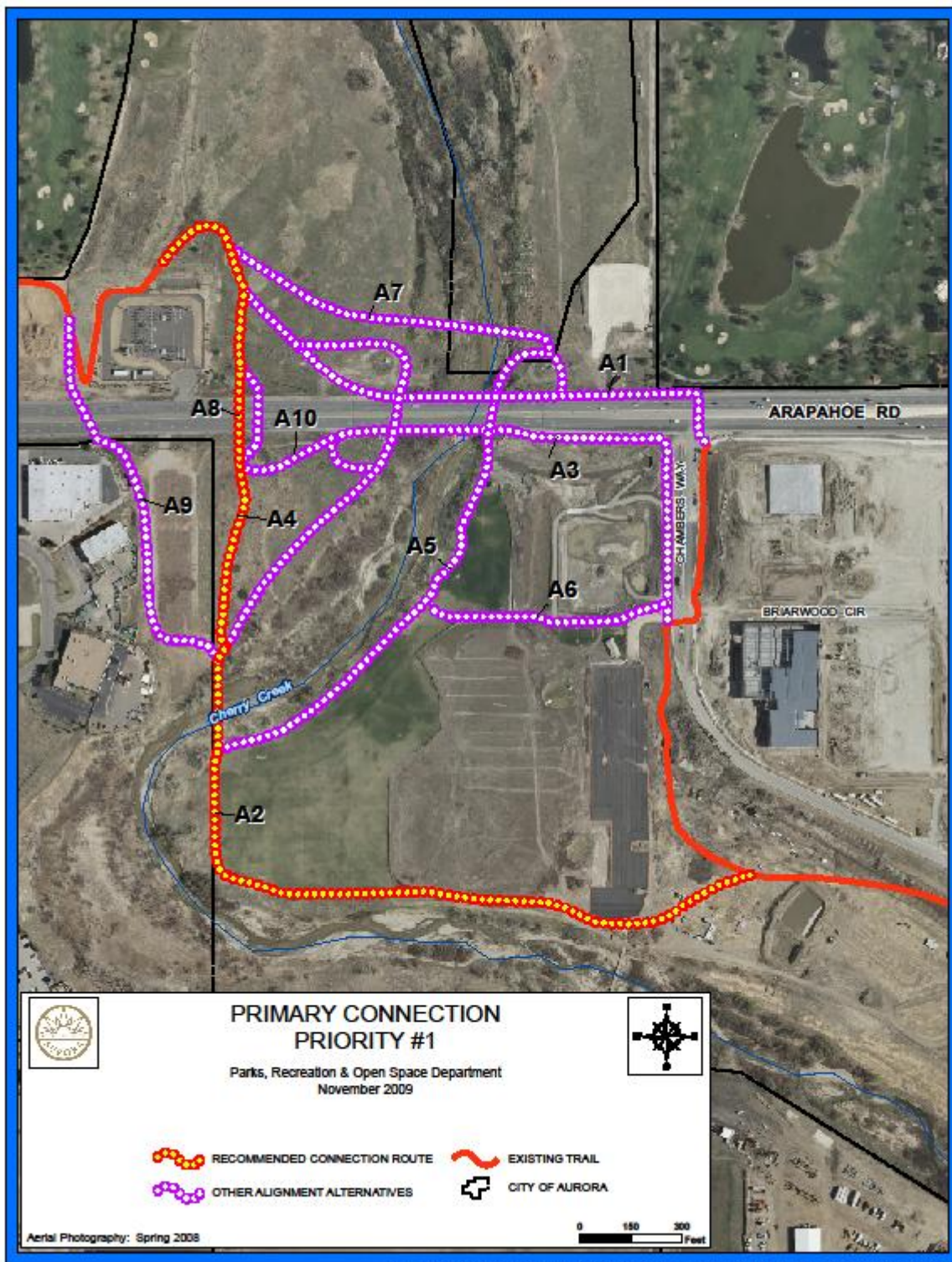


Figure 8: Primary Connection Priority #2

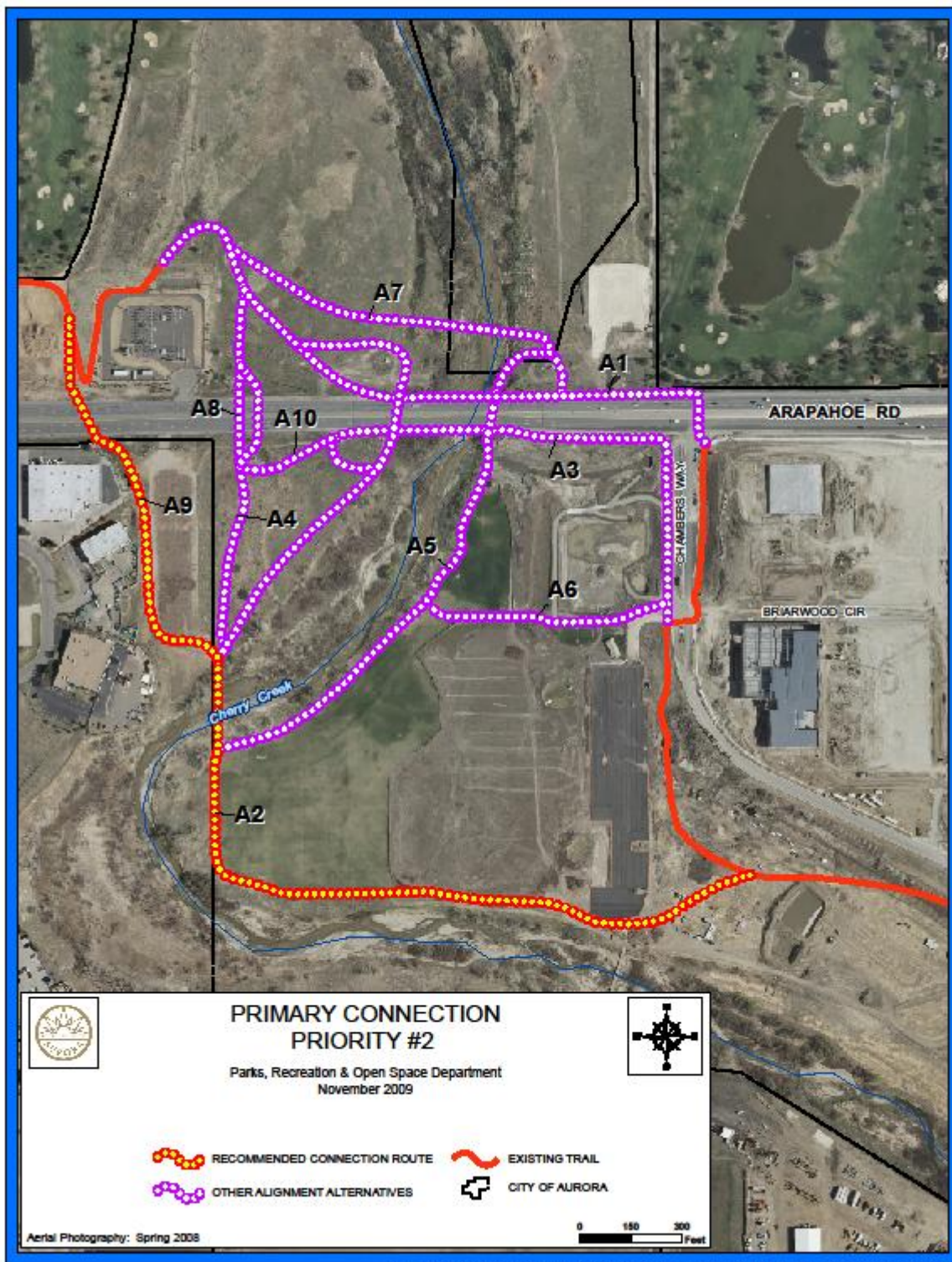


Figure 9: Primary Connection Priority #3

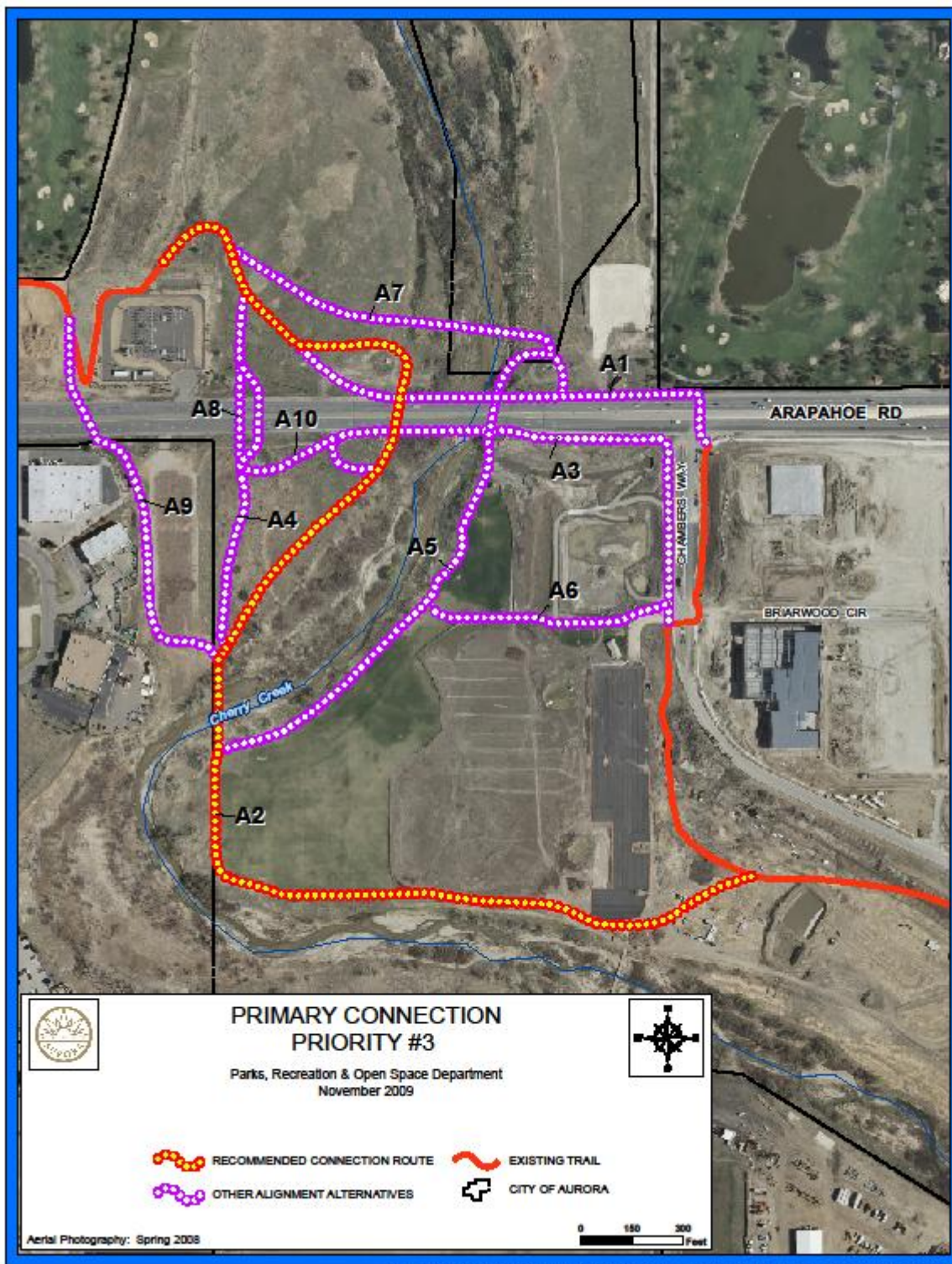
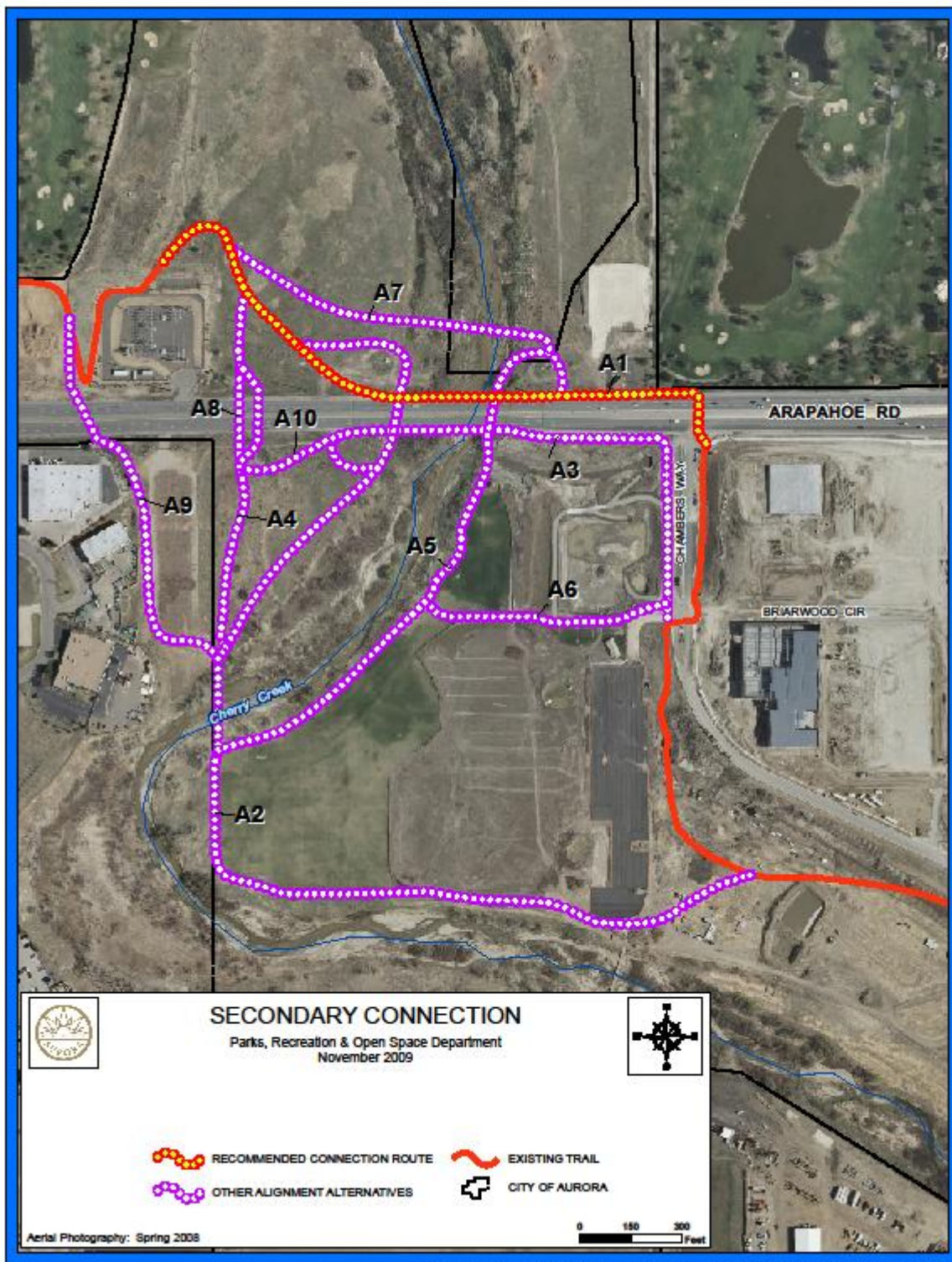


Figure 10: Secondary Connection



D. Connection Recommendations

Over the course of preparing this feasibility study, circumstances changed and opportunities arose which influenced its recommendations. It is not uncommon for factors beyond those imagined in the beginning of a feasibility study to come into play and change the strategic path and outcome of a project. This is particularly true for complex planning projects involving a multitude of governmental entities and stakeholders that embrace a shared goal and each try to find ways to collectively achieve that goal. Such is the story of this multi-partner project for the Cherry Creek Trail.

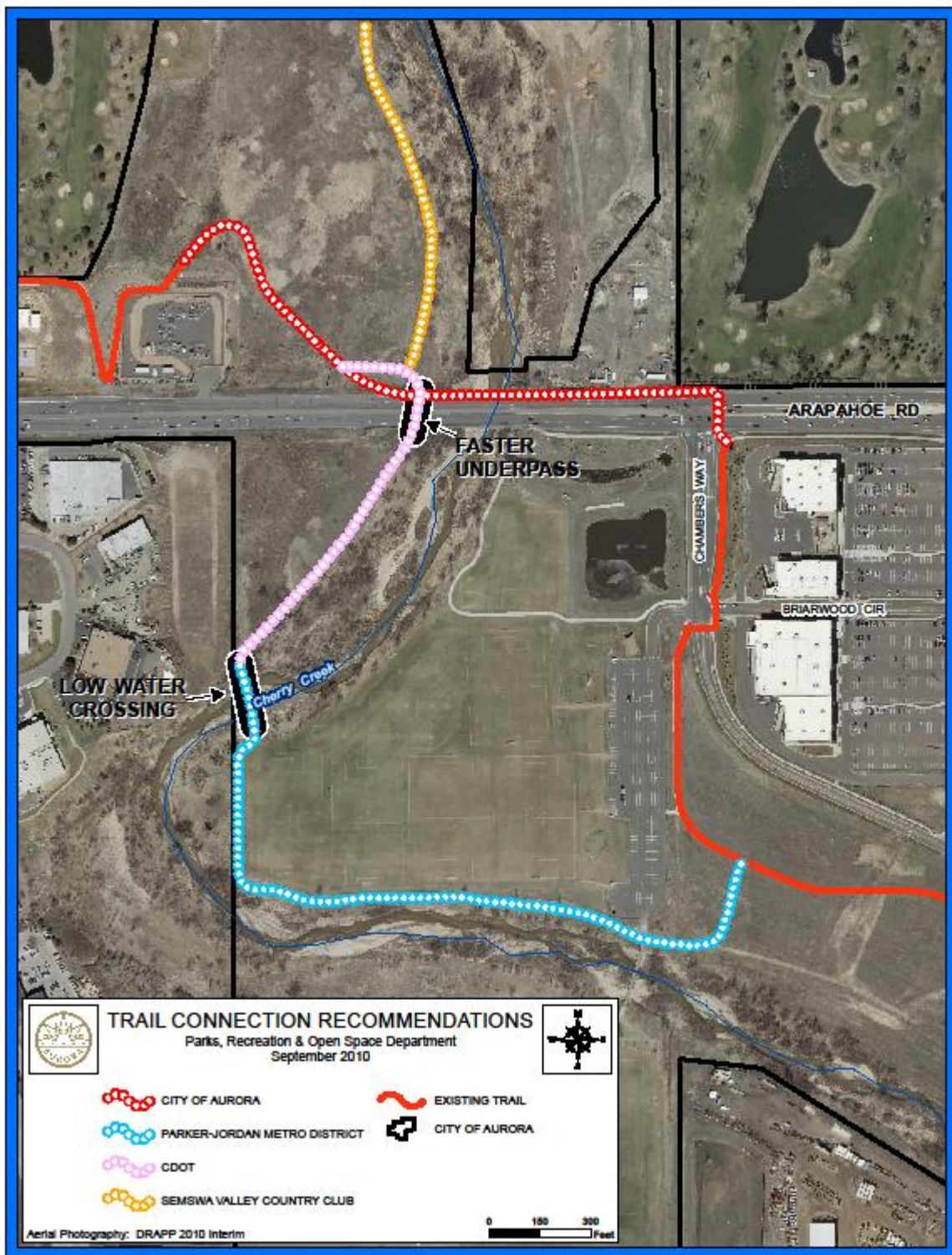
In the end, certain steps and otherwise integral components of a trail feasibility study, such as compiling and comparing cost estimates as well as outlining implementation actions, roles and responsibilities, were not conducted and are therefore not incorporated into this document. These were deemed unnecessary for purposes of concluding how the partners should proceed to close the missing gap in the regional trail corridor. It ultimately was the cooperative actions of the involved partners and the pursuit of trail construction funding that has guided the selection of the following Cherry Creek Trail connection recommendations.

1) Recommended Primary Connection

Primary Connection Priority #3 was elevated to the preferred trail connection option, surpassing #1 and #2, due to funding that has been secured to construct two separate segments as depicted in **Figure 11**.

- Parker-Jordan Metropolitan District (dotted blue) segment – The metro district, in part using grant funding awarded from Arapahoe County, will design and construct a trail segment that meanders between the soccer complex and Cherry Creek and then finishes with a low-water crossing that takes the trail to the western side of the creek.
- CDOT (dotted pink) segment – Using FASTER Safety Program funding, CDOT will design and build the trail from the low-water crossing to the north side of Arapahoe Road, including a trail underpass at the road. The underpass is regarded to be a “temporary” improvement because it will eventually be relocated and reconstructed as a “permanent” underpass likely further westward when the Arapahoe Road bridge is replaced. Depending on the timing of CDOT construction relative to the construction schedule for the Secondary Connection described below, the northern end of the trail will tie into either the Secondary Connection trail to be built by the City of Aurora or the current trail terminus at the Xcel substation. It is likely the point of connection will be the former rather than the latter.

Figure 11: Trail Connection Recommendations



Since the start of this feasibility study partners have also begun to explore whether the Cherry Creek Trail route can be further enhanced by a major realignment north of Arapahoe Road. The Valley Country Club has initiated a dialogue to pursue improvements to Cherry Creek that could enhance their golf course operations as well as open the possibility of constructing the trail along the creek through the golf course. Such realignment (refer to the dotted orange line) would eliminate the need for trail users to take the circuitous Caley Ave and Jordan Rd route and allow them to follow the creek instead. The Southeast Metro Stormwater Authority is spearheading this effort since it will involve engineering for changes to the creek channel. Planning for the project is expected to get underway in 2011.

2) Recommended Secondary Connection

Using its own capital construction funding, the City of Aurora is pursuing an immediate connection in the Cherry Creek Trail. This alignment (shown as the dotted red segment) uses the existing at-grade, signalized crossing of Arapahoe Road and a proposed sidewalk along the north side of the road west of the S. Chambers Way intersection, including linkage to the existing trail at the Xcel substation. This will provide closure of the regional trail gap in the short-term. It will also serve as an auxiliary long-term route, functioning as a possible detour route in the event the main stem of the trail must be closed. The project is expected to be constructed in 2011.

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7. SUMMARY OF FINDINGS AND FOLLOW-UP

This **Cherry Creek Trail at Arapahoe Road Feasibility Study** was intended only to address potential solutions to close the regional trail gap at Arapahoe Road. Future planning and funding efforts for the trail will be made based on these recommendations.

Implementation will be a multi-step process. Partnerships will remain key to the success of implementation efforts. Portions of the trail will be completed by a partnership of several entities, such as the City of Aurora, the County, Parker Jordan Metro District, SEMSWA, UDFCD and CDOT with help from possibly others.

A. Recommendations for Additional Analysis

1) Continuation of Partner Support & Commitment

Additional research should be carried out by partners to avoid potential fatal flaws in the conceptual alignments that could preclude trail development. For example, more information pertaining to subsurface utilities and design data for future infrastructure in the vicinity of the recommended trail alignments must be gathered and assessed to verify compatibility with the trail vision. Continued collaboration with stakeholders is necessary to account for the future trail within their projects. Once the gap in the Cherry Creek Trail is closed and users get accustomed to its use, trail closures and detours should be avoided. Therefore, all plans and work associated with the replacement of the Arapahoe Road bridge should be coordinated to minimize disruption to the continuity of the regional trail to the greatest degree possible.

2) Drainageway Planning & Design Involvement

As plans and projects for drainageway improvements within Cherry Creek advance, all stakeholders for the trail should be involved. Opportunities may come up to expand the scope of projects to address regional trail interests.

3) Geomorphology Study

A geomorphologist should review sediment transport, hydraulic and hydrology information to assess probable changes to the channel and its impacts on the feasibility of any underpass and other improvements to be placed within the floodplain and floodway of the creek.

4) Geotechnical Study

During the initial phases of the design process, a geotechnical report should be obtained for the proposed trail improvements. The geotechnical report should analyze any anticipated low water crossing

areas. The report should also analyze any possible underpass alignments that are proposed.

5) Hydraulic Study

When designing the proposed improvements, a hydraulic study will be required to verify that the proposed improvements do not increase the base flood water surface elevation (100-year) of Cherry Creek. During initial conversations with UDFCD, it was thought that a Letter of Map Revision (LOMR) would not be required if the hydraulic study for the proposed improvements shows zero rise in water surface.