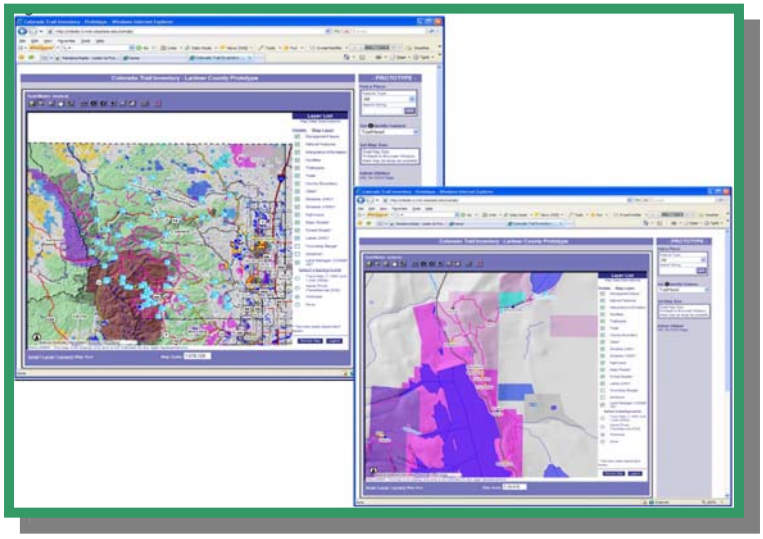
Colorado Trails Mapping Project

Phase II: Data Inventory System, Web Prototype and Pilot Mapping Project

Colorado State Parks

Fall, 2008



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This project was made possible by a grant from Great Outdoors Colorado.

CHAPTER 1

INTRODUCTION AND OVERVIEW

Colorado State Parks

INTRODUCTION AND OVERVIEW

Mission Statement

This report marks the completion of the second phase of a statewide trails mapping project. The Overall Mission is to create a sustainable statewide universal trail system mapping, information, way-finding program and inventory. The goal is to create a system that will be usable by, and accessible to: the general public; local trail planning and advocacy officials; local trails management agencies; public safety agencies; GOCO; State Trails; tourism promotion organizations; the tourism industry; and others with an interest in using, managing and promoting trails in Colorado.

When completed, the system will address publicly accessible in local, county, state, and federal jurisdictions, open to the public. The system will address all types of trail uses.

The project is exploring practical, cost effective media for disseminating and routinely updating the trails information including: digital information available on disk; digital information available by downloading from the Internet; digital information available by downloading to personal digital assistant devices (PDA's) including conventional PDA's and web-enabled cell phones; Global Positioning System (GPS) devices; digital kiosks at airports and activity centers and possible digital trailhead displays. The system will also be designed for cost-effective information contribution and updating by local entities and agencies with an accessible user-friendly and uniform platform that allows each participant to routinely enter their latest trail system information into the statewide system using a uniform digital template.

Tasks Completed

Phase I of this effort, published in a separate report, addressed exploration of the state-of-the-art in digital trails mapping including a survey of comparable systems nationwide, exploring optimal Web access and information management systems, drafting concepts for Web site layout and art and suggesting optimal definitions and trail component descriptions (attributes such as types of trails and trail amenities such as trailheads). It also included recommendations for proto-type software and digital system "architecture", an interactive spreadsheet for collecting existing trails mileage information from local jurisdictions and recommendations for developing a rudimentary working system and pilot project.

Phase II (presented in this report) completed the development of a prototype inventory and trails attribute database and basic Web concepts for a pilot study area in Larimer County. Specific objectives included designing a spatial database using GIS to contain the trail inventory; the compilation of data to generate the inventory for Larimer County investigating alternative methods to disseminate

the inventory via the Internet; and provide estimated costs and overall recommendations for extending the trails database to construct a full, statewide Colorado Trails mapping system. Phase II also refined the approach to the users and manager interface with the technology—that is the basic elements of how the system should appear to the users including the general public and agency personnel who own and operate trails. Finally, Phase II addressed recommendations for the next steps toward completing, in a timely manner, an affordable, working, sustainable statewide trails mapping system.

Work Products Delivered

- A report prepared by CSU presenting the challenges, process and proposed solutions to creating a workable database management system and interactive Web presentation approach.

- Interactive digital mapping of trails in the Larimer County pilot study area (over 4000 miles of trails).

- A geodatabase using ArcGIS v9.2 software that represents three feature types including: trail segments (lines); trailheads (points); and miscellaneous points.

- A "data dictionary" that describes the database design, attributes, standards, features to be collected, and quality.

- A meta-data technical description of the advantages/disadvantages and costs to generate a spatial trails database (piloted in Larimer County).

- An investigation into Website prototype products to display the trails database with examples and pros and cons of each format or Web product.

- Forms for land manager feedback/updates with formats for data collection and entry for agencies and volunteers (including volunteer guidelines) to enter trails data in an uniform and consistent manner for incorporation into the mapping system.

- A technical document for data management and importing new data.

- A GPS waypoint "shell" for managing data entered.

- A User-Technology Interface Monograph providing recommended guidelines for creating an easy to use public "face" to the mapping system including an optimal list of trail and trail amenity attributes.

- Recommendations for next steps in completing the mapping system and trails inventory.

- Recommendations for how to submit new data to the trails inventory.

Study Financial Support

This effort has been funded by a grant from Great Outdoors Colorado Funds through the Colorado State Trails Program. These fund were matched by in-kind staff, consultant services and volunteers dedicated to trails in Colorado.

CHAPTER 2

COLORADO STATE UNIVERSITY
DATA MANANAGEMENT, WEB PROTO TYPE AND PILOT AREA REPORT
(With Appendices)

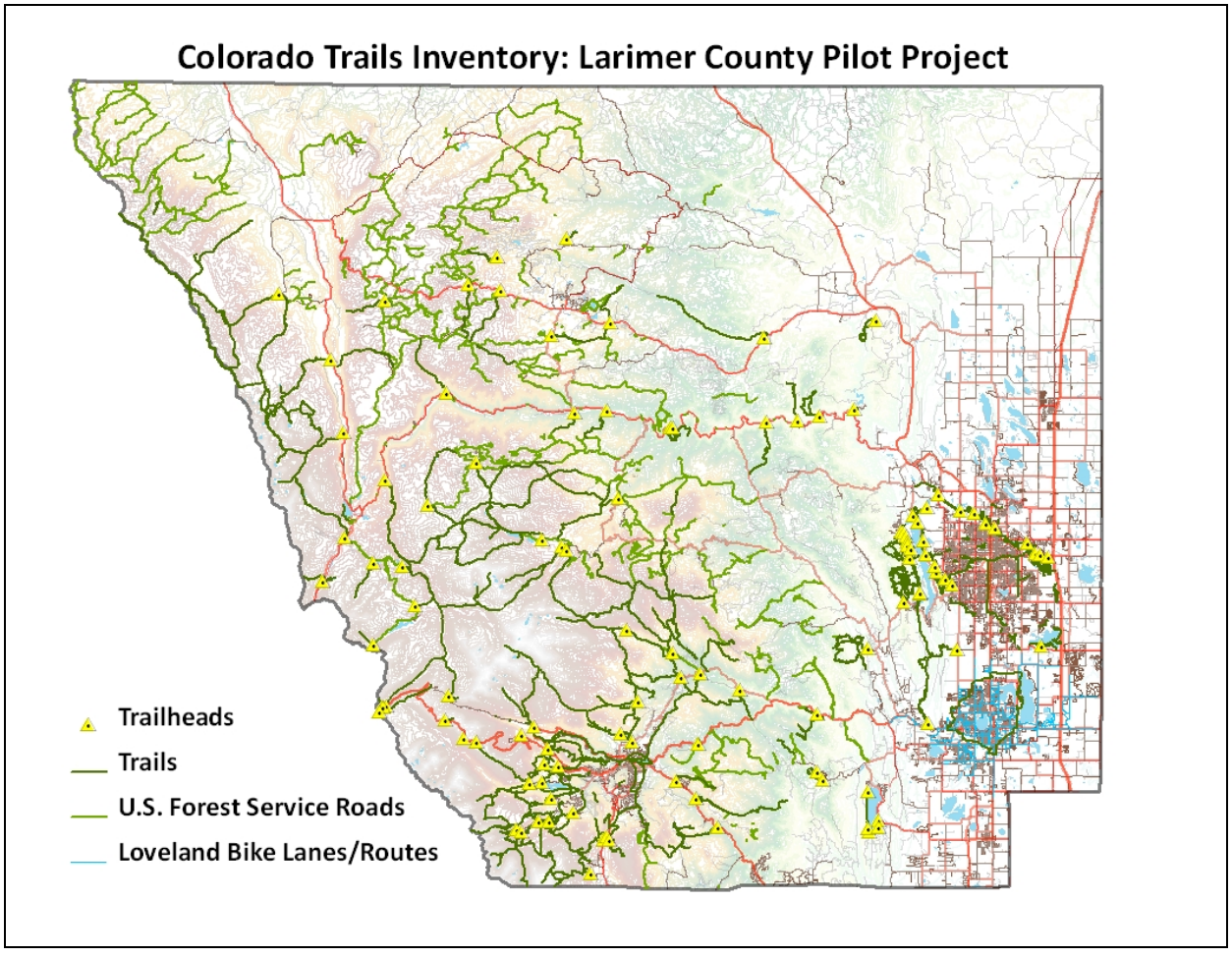
Colorado State Parks

Final Report for Phase II of Colorado Trails Inventory

Larimer County Pilot Project

Sophia E. Linn, David M. Theobald, Robert Flynn

July 21, 2008



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Executive Summary

The main goal of the Colorado Trails Inventory project is to provide a consistent, standardized, and comprehensive inventory of all motorized and non-motorized trails on public lands in Colorado and to make this information widely available in a variety of map forms to the public and land managers. This report documents the Phase II findings in which Colorado State University was contracted to develop a prototype of the inventory database and basic web products for a pilot study area of Larimer County. Our specific objectives were to design a spatial database using GIS to contain the trail inventory; compile data to generate the inventory for Larimer County; investigate alternative methods to disseminate the inventory via the Internet; and provide estimated costs and overall recommendations for extending the inventory to construct a full, statewide Colorado Trails Inventory. For the purposes of this project, we defined a trail as: *a path used primarily for recreational travel, typically separated or distinct from routes such as streets, urban sidewalks or other transportation corridors.*

After reviewing existing efforts to inventory trails elsewhere, we developed a database design (or "data dictionary") and vetted our approach to both general and technical advisory teams. The requirements of such a complex endeavor demanded the use of a database that employed geographic information system (GIS) technology. As such, we developed a geodatabase using ArcGIS v9.2 software that represents three feature types including: trail segments (lines); trail heads (points); and miscellaneous points. An important characteristic of the trail segments is that each trail segment begins and ends at a trailhead, a trail intersection, or along a trail where there is a major change in attribute type, such as a change in surface type or allowed uses. The reason segments need to be created this way – which is called "planar topology enforcement" in GIS terms – is that it provides a robust and flexible manner in which to encode the data. It also ensures that this inventory is compatible and can be used with other natural resource information such as ownership (e.g., from the Colorado Management Ownership and Protection (COMaP) database), vegetation types, and wildlife areas.

The primary attributes and coding scheme developed for the Colorado Trails Inventory include:

- Trail name
- Length
- Elevation (min, max, change, slope)
- Surface type (natural, gravel, paved, wood, bridge, other)
- URL (to link to online resources managed by land agency)
- Motorized uses (all, ATV/ORV, single-track, none)
- Non-motorized uses (all, pedestrian, bike, ped/bike, horse, ped/horse)
- ADA accessibility (yes, no, unknown)
- Pet access (yes, leashed, voice controlled, no pets)
- Park name
- Manager (agency responsible for trail)
- Owner (property owner)

We collected and compared data using four primary collection methodologies: directly from agencies; from printed maps and atlases; from "heads-up" digitizing from aerial-photography; and field-based collection using GPS. We mapped over 1,400 miles of trails in Larimer County (including 830 miles of trails and 616 miles of Forest Service roads), with the cooperation of the trail managing agencies in the county. We estimate that the Larimer County Trails Inventory currently (June 2008) contains a complete

(~95%) set of publicly accessible trails. The pilot inventory is available at the website below, to demonstrate a number of ways the inventory can be disseminated, including through PDF maps, Google Maps, Google Earth KML files, and interactively via a web-browser.

http://cotrails.library.colostate.edu

Our findings suggest that a reasonable estimate of the per mile cost of data collection and editing into the inventory is roughly $15 per mile (but could range from $10-30 per mile). An extremely rough estimate of the costs to develop a statewide trails inventory would be $350-500k, over a two-year period, assuming full cooperation and assistance from land management agencies across the state and assuming that a knowledgeable and experienced GIS team would construct the inventory.

Introduction

The overall goal of the Colorado Trails Inventory is to provide a consistent, standardized, and comprehensive inventory and mapping of all motorized and non-motorized trails (federal, state, and local) on public lands in Colorado and to make this information widely available in a variety of map forms to the public and land managers. Phase I of the project was completed in Fall 2006 by Robert Searns and the Greenway Team, Inc., and included an overview of mapping options, layout and user-interface concepts, content and information requirements, and recommendations for moving forward. The Phase I report from Fall 2006 entitled *Colorado Trails Mapping Project, Phase I: Concept and Feasibility Investigation* provides an extensive overview of options and conceptual ideas for the statewide trails mapping project. From that document:

> *The recommended approach is a logically phased effort that includes the development of a prototype software application (using existing software mapping products) and the broad acceptance of a common language and mapping protocols system. This might best be accomplished with the development of a* ***prototype pilot project*** *[in a] test community [with] a variety of trail types, terrain types, open space types and a working Web home page.* (pp. 4.1 – 4.3)

Of the four management and partnership options presented in that document for moving to the next phase (p. 4.3), the one that was selected was to partner with a university. Consequently, CSU was contracted to move forward with specific tasks in developing the database and pilot project.

Building on the Phase I goals, the present document reports on Phase II of the effort in which Colorado State University was charged with developing a prototype of the database and basic web products for a pilot study area that encompasses Larimer County.

The specific objectives for Phase II were to:

- **design a spatial database** to contain Colorado trails inventory data, and to ensure that is compatible with other natural resource data including open space (COMaP);
- **develop a trails inventory database** for the pilot study area of Larimer County;
- **investigate and recommend alternative web-based dissemination methods** such as maps and databases (i.e. PDFs, online, and Google Earth/Google Map), including **dissemination of the pilot database through a website** that is query-able (both through maps and the database) and allows feedback by land managers.
- **provide recommendations for Phase III**—development of statewide data collection, management and dissemination system by providing workable strategies and methods and estimating rough costs for different data collection methods (e.g., digitize, acquire & edit, GPS in the field, etc.).

From February 2007 contract, filename: IAA-DNR 2006 20070219

<u>Personnel</u>

To help guide and provide feedback on the design of the trails inventory, we formed two teams: an overall project team and a technical advisory team. The overall project team provided initial guidance and recommendations regarding the general scope of the project, especially related to the kind of trail information that should be included. The overall project team consisted of:

Project Leadership Team	
Rick Storm	State Parks
Larry Kramer	State Parks
Project Team	
Lori Malcolm	State Parks
Kim Frederick	Jefferson County Open Space
Kevin Johnston	Larimer County Open Space
Matt Robins	Colorado Lottery
Tom Mesta	State Parks
Jeff Boring	Larimer County Parks
Gary Buffington	State Parks
Melanie Gose	State Parks
Brenda Bennett	GOCO
Michael Regan	GOCO/State Parks Liaison
Jack Placchi	BLM
Randy Engle	State Parks
Chris Johnson	Division of Wildlife
Jeff Engleman	Stay the Trail/ COHVCO
Sara Bell	State Tourism

The technical advisory team provided guidance and feedback on technical aspects of the project including database development and web-delivery options. Members of this team met three times (August 12, 2007; November 1, 2007; and May 23, 2008) during Phase II to evaluate the technical progress of the project and to provide comments. The technical advisory team consisted of:

Technical Advisory Team	
Rob Billerbeck	State Parks GIS
Deb Duke	State Parks Graphics
Heather Hicks	DNR IT
Curt Harvey	GIS Consultant
Bob Searns	Greenway Team
Kris Wahlers	State Trails Program
Brad Eckert	Summit County
Chris Johnson	Division of Wildlife
Grant Wilcox	CSU/Division of Wildlife

The researchers at CSU who had primary responsibility for project development included:

CSU Development Team	
Dave Theobald	Principal Investigator
Sophia Linn	GIS analyst
Bob Flynn	GIS & web development
Jaime Whitlock	Project scoping

In addition to these, we spoke on a number of occasions with a variety of partners to seek feedback and input into the Colorado Trails inventory. This included:

- Director of the Fort Collins Museum, regarding their "Preserve America Grant" for a trails project in Larimer County;
- Director of Communications from the Estes Park Visitors Center, regarding the type of system that would be most useful to the millions of visitors they encounter each year;
- Members of Larimer County Search and Rescue, to discuss the ease of access, ability to post current or temporary information, and the sharing of resources.

Organization of Report

Closely aligned with the list of objectives above, the remainder of this report discusses the processes followed and the resulting products of the project. Note that we provide much more detailed technical discussions regarding specific methodologies in the Appendices, which are intended for a technical GIS audience. The main sections of this report are as follows:

I. Design Spatial Database
II. Develop Trails Inventory
III. Investigate Web-based Dissemination Options
IV. Launch Dissemination of Pilot Project
V. Estimate Rough Costs
VI. Recommendations for Next Steps

I. Design Spatial Database

A spatial database is a database that contains information about geographic features on Earth's surface—represented by points, lines or polygons—and that stores attributes associated with those features. Using a Geographic Information System (GIS) allows for the creation of a spatial database, in this case a "geodatabase," to store the abundance of information associated with trails. As such, it forms the most comprehensive, consistent, and robust format in which to construct and maintain a trails inventory.

It is important to emphasize that creating a robust, viable, and easily maintainable trails inventory requires the use of a GIS. Because trails data come in a variety of electronic formats, sources, and quality, any long-term trails inventory will require the input, editing, and management of these ever-changing spatial data. Simple graphics of trails can be generated using a variety of graphic software (e.g., Adobe Illustrator), but these are difficult to maintain and extend over time, and offer very limited means of answering questions of the inventory, such as the length of trails, what type of ecosystems they occur in, and who manages them. Also, because potential users of the inventory require a variety of products from the inventory, such as printed hard-copy (PDFs), display with other software (GIFs, TIFFs, PDFs, KML), GIS compatible datasets, GPS waypoints, etc., there need to be multiple and flexible ways to generate output products (maps and databases) from the inventory. Creating the GIS-based database (a geodatabase) provides these necessary capabilities.

In designing a spatial database, decisions are made regarding both the spatial data as well as the attribute data. **Spatial data** refers to the digital elements that define the shape and location of

geographic features, e.g., a *line* that represents the shape and location of a trail, or a *point* that shows the location of some feature of interest. **Attribute data** refers to the information about the spatial data, e.g., details about that trail "line" such as its surface type or allowed uses, or what the "point" represents, such as an emergency call box or an interpretive sign. The spatial and attribute data are explicitly joined in the GIS through a unique identifier.

Part of the challenge involves selecting the appropriate spatial data to collect (the geometry type—points, lines or polygons), attributes (or fields) and also the values that are allowed within those fields. The first task completed by CSU, building on the research in Phase I, was an extended and updated review of existing trail inventories and relevant trail websites from around the state and country to compile commonly used attributes for trails. These included: the federal Interagency Trail Data Standards (ITDS) document; Colorado Front Range Trail; trails.com; mapDetroit; Florida trails; outrageGIS.com; allsportGPS; MapXChange; singletrack.com and MapMyHike.com, among others. (See **Appendix I** for a list of resources reviewed.) From this review, a preliminary list of feature types and attributes was compiled and presented to members of the overall project and technical advisory teams. Through discussion and final consensus, a series of feature types, attributes and values were agreed upon. These are discussed below.

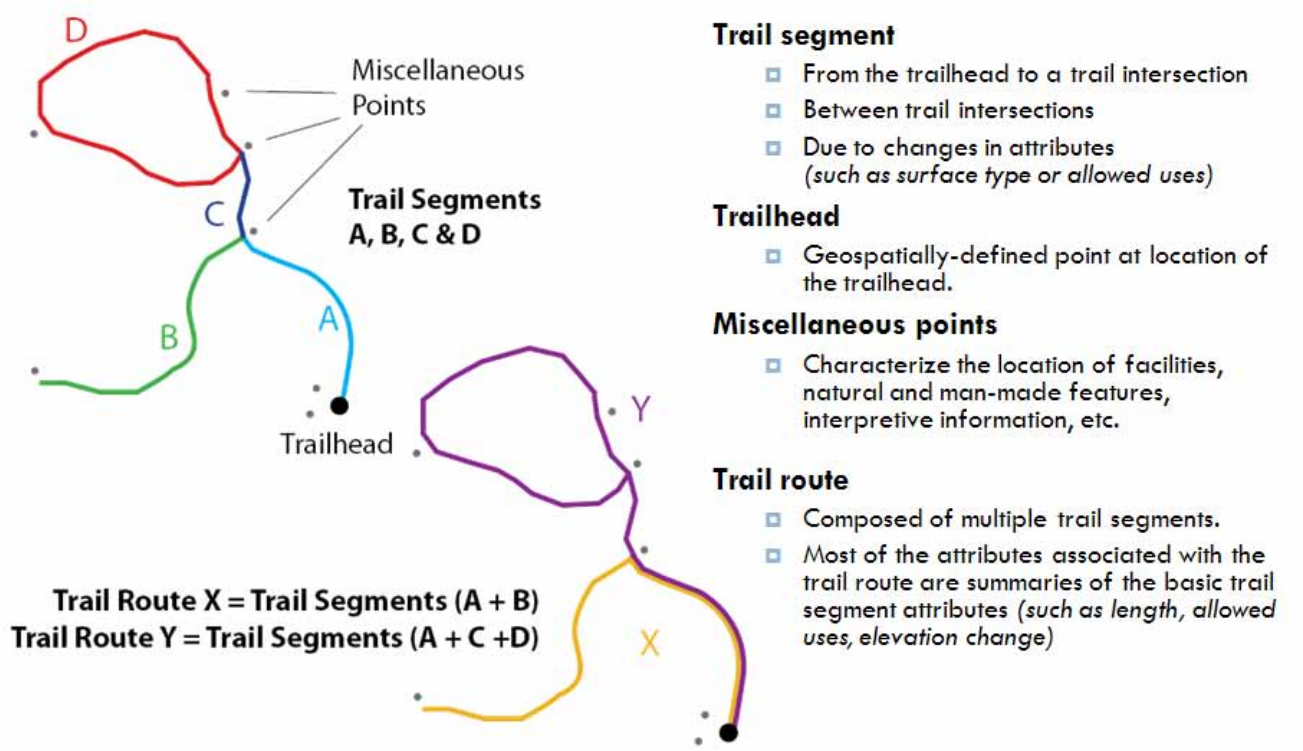
We settled on representing trails, and trail elements, using four different types of geographic features (or classes). These are defined as follows:

a) trail segment: a length of trail between intersections, a trailhead or an endpoint. This can also be defined by a significant change in attribute (such as surface type or allowed use);
b) trailhead: point location at the beginning of a trail; usually accompanied by parking spaces (though a "trailhead" may also be a point where a trail intersects a road with no amenities present);
c) miscellaneous points: significant points along a trail including facilities, natural or man-made features, interpretive information or management issues;
d) trail route: trail composed of multiple trail segments; can be generated on-the-fly to create a variety of route options; alternatively, can be defined as multiple trail segments with the same name.

For the purposes of this project, we defined a trail as: *a path used primarily for recreational travel, typically separated or distinct from routes such as streets, urban sidewalks or other transportation corridors.*

An important characteristic of a 'trail segment' is that each trail segment begins and ends at a trailhead, a trail intersection, or along a trail where a major change in attribute type, such as a change in surface type or allowed uses. The reason segments need to be created in this way – which in GIS terms is called "planar topology enforcement" – is that it provides a robust and flexible manner in which to encode the data. It specifically allows distances between trail intersections to be computed directly from the geometry of the line. This allows maximum flexibility and rigor. Note that many approaches to mapping trails use simple representation of points and lines (e.g., drawing lines on topographic maps, points in Google Earth represented in KML format) and consequently do not allow for this type of flexibility.

Figure 1: Feature Classes and Definitions



A list of attributes for each of the feature classes was developed, discussed at a couple of the technical advisory team meetings, and agreed upon by consensus. For example, for any given trail segment, there are attributes associated with that segment for: surface type, allowed motorized or non-motorized uses, length, elevation (minimum/maximum), manager of the trail, among others. For the trailhead feature class, attributes include: number of parking places, number of ADA accessible spaces and long vehicle spaces, etc.

During one of the technical advisory team meetings, there was concern that populating the database in its entirety would be a monumental task; consequently, the committee prioritized the attributes into primary (1), secondary (2), and tertiary (3) rankings. These priorities were based both on the importance of the attribute for the user, and also on the relative practicality of obtaining the data. These rankings are listed in Appendix II. In general, trail segment attributes were primary (top) priority, while miscellaneous point features were third (low) priority.

Once the feature classes, attributes and list of values were agreed upon, a geodatabase was constructed in ArcGIS v9.2 to "house" all of these elements. The geodatabase begins empty—essentially creating placeholders for any incoming data that correspond to the database design. The next task then "populates" the empty geodatabase. A complete, technical description of the geodatabase can be found in **Appendix II** (a.k.a. the "data dictionary"), which provides a complete listing of feature classes, their attributes and list of values (LOV). A generalized list of key features and attributes of the database design, including all of first priority attributes, is included below.

Table 1. Key Attributes and Values for Features in the Geodatabase

TRAIL SEGMENTS		
Priority	Attribute Name	Possible values
1	Name	Trail name
1	Number	Trail number, if available
1	Length - meters and miles	Meters and miles
1	Elevation (minimum) - meters and feet	Meters and feet
1	Elevation (maximum) - meters and feet	Meters and feet
1	Change in elevation	Meters and feet
1	Net slope	Net elevation divided by segment length
2	Difficulty	Objective rating using elevation, surface type, and net relief*
1	Surface type	Natural surface Crushed gravel Paved Wood Bridge Other
1	URL	Link to most detailed and current trail info.
1	Motorized uses	All ATV/ORV Single track (motorcycle) None
1	Non-motorized uses	All Ped Bike Ped, bike Horse Ped, horse
2	ADA accessibility	Accessible Not accessible Unknown
2	Pet access	Yes Yes, leashed Yes, voice controlled No pets
2	Name of park (or general area)	Park name or general location of trail
2	Manager	Agency responsible for trail
1	Owner	Property owner
3	Status of trail	Official Planned Decomissioned Temporarily closed Social
	TRAILHEADS	
	Attribute Name	Possible values
1	Name	Name of trailhead
2	ADA accessibility	Yes
		No
3	Number of parking spaces	(number)
3	Number of ADA parking spaces	(number)
3	Number of long vehicle spaces	(number)

	MISCELLANEOUS POINTS		
	Attribute Name	Possible values	
3	Intersection	With official trail With road With social trail With parallel trail	
3	Facilities	Bench Bike rack Boat ramps Cabin/yurt Campground Covered shelter Equine facilities Fort Grills Memorial	Mine/quarry Monument Other Picnic table Potable water Public transit stop Ranger station Refreshments Rentals Toilet
3	Interpretive Information	Interpretive sign Map Other info Photograph Regulations Scheduled info Trail marker	
3	Management Issues	Accident Animal encounter Attack/assault Caution area Citation Search/rescue incident Sensitive area Temporary closure/restriction Other	
3	Natural points of interest	Glacier Mountain pass Mountain peak Other (natural) Overlook Rapids River crossing Spring Waterfall	
3	ADA points	Blind walk Elevated tent pads Fishing ramp Obstacle Other	

* We sought to develop an objective trail rating or difficulty score that is general purpose and objective, to accommodate a range of abilities, users (hiking, roller blading, bicycle riding, etc.), and trail surface condition. To that end, our rating scheme is a numerical value that rates the difficulty between 0 and 1. It is computed by:

$$D = \text{sqrt}(R/100) \times S$$

where *R* is the relief computed as the percent slope (net elevation gain divided by length of trail segment); and *S* is a modifier for trail surface conditions (paved=1.0; crushed gravel=1.1; natural surface 1.3; wood=1.2).

Note that a modified difficulty score *D** can also be computed to account for the effects of elevation on oxygen intake. As a result, the difficulty can be computed as follows:

$$D^* = R \times S \times E$$

where *E* is a 10% increase (*E*=1.1) for every 1,000 m above the "normal" elevation where a person is accustomed to (e.g., sea level for a visitor fresh from Los Angeles) compared to the average trail elevation.

II. Develop Trails Inventory

Once the database design was complete and a geodatabase was constructed using ArcGIS, we began to populate the database with as much data as possible. A variety of methods were used to gather both spatial and attribute data to create the inventory of trails for Larimer County. Pre-existing GIS datasets from agencies, paper maps, websites, and GPS field observations were all used to compile the most accurate and current data.

Our original goal was to compare the quality and amount of time required to process trail data from a variety of sources:

- from agency databases;
- from gazetteers, books, and trail maps (e.g., Delorme, Trails Illustrated, etc.);
- from aerial photography;
- from field-based data collection (GPS and field observations; points only);
  - from our staff; and
  - from volunteers.

Each of these methods was utilized and further discussion of their benefits and challenges are described below. However, it became clear that none of these methods was adequate on its own, nor could they provide enough information to be considered complete without relying on other sources of data. In fact, utilizing websites (not included in the original list above, but discussed below) became an invaluable source for gathering additional attribute information. Also, we relied on other datasets to populate fields accordingly —such as digital elevation models (DEMs) to provide elevation information, and the Colorado Ownership, Management, and Protection (COMaP) dataset for accurate and complete information about property ownership and management. Aerial photography was used to visibly see where trails were in relation to other features on the ground.

<u>From agencies:</u>

In August 2007, emails were sent to all land management agencies in Larimer County that are responsible for the management of public trails (see **Appendix III** for the email solicitation and list of contacts). Whenever possible, requests for data were directed to GIS departments, as they are the managers of any spatial and attribute data for the trails. The contact list included the following seven agencies: Larimer County, the City of Fort Collins, Colorado State Parks, Rocky Mountain National Park, U.S. Forest Service (Arapaho/Roosevelt National Forest—Canyon Lakes Ranger District), the Town of

Estes Park and the City of Loveland. We requested datasets on trails in the format of ArcGIS compatible datasets (shapefiles, coverages, geodatabases).

Datasets were received from each of these agencies. Most provided GIS-ready data, but some—such as Estes Park—provided PDF maps that required on-screen digitizing. Not unexpectedly, the data varied in both quality and quantity because each agency has its own purpose, focus, and standards for the trail data they keep. Therefore, our task was to create consistency among the datasets, especially among the given attributes, and to complement and complete missing data. Using the database design and data dictionary described above, the data we received were cross walked into our geodatabase, incorporating the relevant attributes into the corresponding fields. This meant, for instance, that one agency's data might have a field called "SURF_TYPE" and our corresponding field is "TS_SURFACE." They may have a value of "CONCRETE," whereas ours is "Paved." By sorting on each field by value, we could populate our database (using a function in ArcGIS called the Field Calculator) with the values that are defined in our data dictionary. This allowed for some degree of consistency among datasets as they were brought in to one. Metadata fields were added to each dataset so that a record of the source and other reference information could be included.

The spatial data also varied in quality. It should be noted that nearly all of the data gathered from the agencies were *line* data corresponding to trails; very little *point* data were gathered from this source. To create consistency within our geodatabase, onscreen or "heads-up" editing and digitizing was done using aerial photography in the background, roughly at a 1:10,000 scale. Also, in order to correspond to the database design, many of the trail lines had to be either joined or broken to meet the criteria of a "trail segment." To ensure geographic integrity of the trail lines, a topology was created that specified that "no lines cross" (thus ensuring that each segment was truly between intersections) and also that there could be "no multi-part features" (meaning that each trail segment, even if it had the same name as another, was unique). Requiring a "topologically-correct" dataset ensures correct computation of trail distances, eliminates potential double-counting of trails, and helps to generate a robust dataset.

As trails from agencies were added to the database, the map of trails in Larimer County began to fill in. However, it was clear once all of the "trail" datasets were incorporated that there was still something obviously missing. Forest Service roads were not there -- which led to the question of: What constitutes a "trail"? We had asked agencies for *trail* data, but because agencies and the public may think about trails (and roads) slightly differently, we felt that it was important to include the Forest Service roads (which are to be considered temporary because they are in draft status) —but we maintained these roads as distinct from our more specific "trails" dataset. Indeed, the types of attributes associated with this road dataset were different from the attributes assigned to trails, so instead of incorporating these roads into our trail segments feature class, we decided to include U.S. Forest Service Roads (as "usfs_roads") in the geodatabase as a separate feature class. That is, the Forest Service roads are included within the geodatabase "container", but are stored explicitly as a separate layer from the trail segments. Whether or not these roads should be incorporated explicitly as "trails" is a decision that requires further discussion.

Another situation where the definition of a trail is fuzzy concerns "bike lanes" and "bike routes." These are designated paths where biking is explicitly allowed, but they lie along roads in the traffic lanes designated by striping, signage or other graphic means. The City of Loveland provided data for these in a GIS format; the City of Fort Collins did not (because they do not have these in GIS format, although bike lanes and routes do exist). For this pilot, the Loveland bike lanes and routes were incorporated into the

geodatabase, as a separate feature class, as an example of how they could be included. A field entitled "PARALLEL" is included to signify that this "trail" is along a road but separated from automobile traffic lanes. This type of trail is also called a "sidepath" in the bicycle and trail-planning profession.

Data collection for trails is ultimately a multi-step, iterative process. Initial spatial data received from agencies was an excellent starting point, but there was still an abundance of data that were missing from our database. Essentially, we needed to enrich the trail segments feature class with more detailed attributes and we also needed to populate the trailhead and miscellaneous point feature classes.

Print maps:

Another source of data was printed, publicly-available maps such as selected *Trails Illustrated* maps and *Delorme's Colorado Atlas*. Within the past year, two new maps were produced in Fort Collins that proved particularly useful with this project: the *Fort Collins Bike Map* (City of Fort Collins, FC Bikes, by Xplore Interpretive Design, Inc. 2008) and the *Fort Collins Natural Areas Map* (City of Fort Collins, Natural Areas Department, 2008). These were used to confirm the data that had been provided, in some cases revealing new trails that were not in the original dataset from the city. These maps, as well as *Trails Illustrated* maps of Rocky Mountain National Park and Cache La Poudre/Big Thompson (2003), were also used to locate and mark trailheads. Once trailheads were located and marked as points in the geodatabase, they were overlaid onto the aerial imagery and, when visible, the number of parking spaces was estimated. We also made use of USGS Topographic 7.5' series (DRGs) and U.S. Forest Service national forest visitor maps.

Aerial photography:

The National Agriculture Imagery Program (NAIP) acquires imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to enable availability of digital orthophotography within a year of acquisition (from http://165.221.201.14/NAIP.html). Using NAIP imagery for all of Larimer County allowed us to overlay any of the other data we received and to "see" it on the landscape. In many cases, this provided a visual of trails and trailheads that could verify (or dispute) data received from other sources. However, NAIP cannot be used in isolation: there are many "lines" in the images that cannot be distinguished *(trails or roads?),* not all trails are visible due to vegetation cover, the location of a trail could have changed since the aerial photo was taken, and NAIP does not provide any attribute information for the features it shows.

In addition to NAIP, Google Earth was also used to visualize and/or corroborate trail data. In one case, we obtained GPS waypoints along a trail from a volunteer (see below) but there were no trails in either our geodatabase or on NAIP. A look at Google Earth revealed that the area where the observations were made was actually a park under construction in 2008 (Spring Canyon Park in Fort Collins). The combination of resources is essential to obtaining the most up to date information.

Field-based data collection using GPS:

As GPS receivers become more widely used, there is an opportunity to build upon the increasing recreational use of these devices to help populate the database with current, "real world" observations. Because of the variety of GPS units available and the quality of data they are capable of receiving, we decided to utilize GPS only to gather points. Although it is possible to record "tracks" as well, these data tend to be quite messy and cumbersome to generate a line to represent a trail. This can be due to poor reception in some areas causing points to "jump around" causing large errors and "knots" in the linework, or because the user stops to rest or have lunch. It should be noted, however, that the use of

high- or resource-grade units by agencies, managers, and/or other trained personnel could feasibly provide adequate track (trail or line) data and attributes as well. These can easily be incorporated into the trail segments feature class.

Our task in this case was to develop a method whereby individuals of varying skills and technical abilities could take waypoints with a GPS receiver, record what they saw, download the GPS points, and send in their observations. We had to ensure that the types of points gathered were consistent and that the attributes were uniform. Also, because the system would be used both by our own staff as well as volunteers, we had to develop a standard that was simple and did not rely on either high-level skills or high-quality GPS devices. Ease of use was fundamental, but also it had to be created in a system that could be transferred into the geodatabase in ArcGIS.

We considered creating an online method for inputting data, but opted not to for a number of reasons. Recommendations from members of the technical advisory team who had worked with volunteers collecting GPS data suggested that a spreadsheet would be the easiest, most straight-forward method. As Microsoft Excel is probably the most widely used spreadsheet program, we opted to create a "shell" in Excel that volunteers could use to input their GPS points, record their observations in pre-existing fields, and e-mail the file to us.

We initially produced a list of "Things to Look For" along trails and a rather complicated chart to use for recording observations. After field testing the chart both ourselves and with CSU students, it became clear that it was too unwieldy and ultimately unnecessary. Instead, we streamlined the method by simply asking volunteers to refer to the list of "Things to Look For" as they took a waypoint reading, record the waypoint number (automatically generated by the GPS), and take note of what they saw there. They could use a notepad or a voice recorder to state the waypoint number and their observation. This method proved much easier for all. When they returned from their outing, they downloaded their GPS points (either using their GPS software, or a free program such as DNR Garmin), copied and pasted the waypoint numbers, latitude and longitude into the Excel "shell" then used the (already created) drop-down menus to record their observations. See **Appendix IV** for the volunteer information packet and Excel "shell" that was distributed to volunteers. Figure 2 shows both the "Things to Look For" list and an excerpt of the spreadsheet "shell."

Figure 2. "Things to Look For" and Excerpt from GPS Spreadsheet "Shell"

Colorado Trails Inventory: *Version: Feb. 25, 2008*

Things to Look For

TRAIL SEGMENTS *(mark the point where trail changes)*

Surface Type
(TP_SURFACE)
1. Natural surface
2. Crushed gravel
3. Paved
4. Wood
5. Bridge
6. Other

Motorized
(TP_MOTOR)
1. All
2. ATV/OHV
3. Motorcycle
4. None

Non-motorized
(TP_NONMOTOR)
1. All
2. Ped only
3. Ped, bike only
4. Bike only
5. Bike, horse only
6. Horse only
7. Ped, horse only
8. None

Additional Snow Uses
(TP_SNOW_USE)
1. All
2. Snowmobile
3. X-country ski
4. None

ADA Accessible
(TP_ADA)
1. Accessible
2. Not accessible
3. Not evaluated

Pet Access
(TP_PET_ACCESS)
1. Yes, pets allowed
2. Yes, on leash
3. Yes, voice control
4. No pets allowed

Trail status
(TP_STATUS)
1. Official
2. Planned
3. Decommissioned
4. Temporarily closed
5. Social trail

Intersection
(PT_INTERSECT)
1. With official trail
2. With road
3. With social trail
4. With parallel trail

POINTS OF INTEREST

Facilities
(PT_FACILITY)
1. Bench
2. Bike rack
3. Boat ramps
4. Cabin/yurt
5. Campground
6. Covered shelter
7. Equine facilities
8. Fort
9. Grills
10. Memorial
11. Mine/quarry
12. Monument
13. Other (built/non-natural)
14. Picnic tables
15. Potable water
16. Public transit stop
17. Ranger station
18. Refreshments
19. Rentals
20. Telephone
21. Toilet

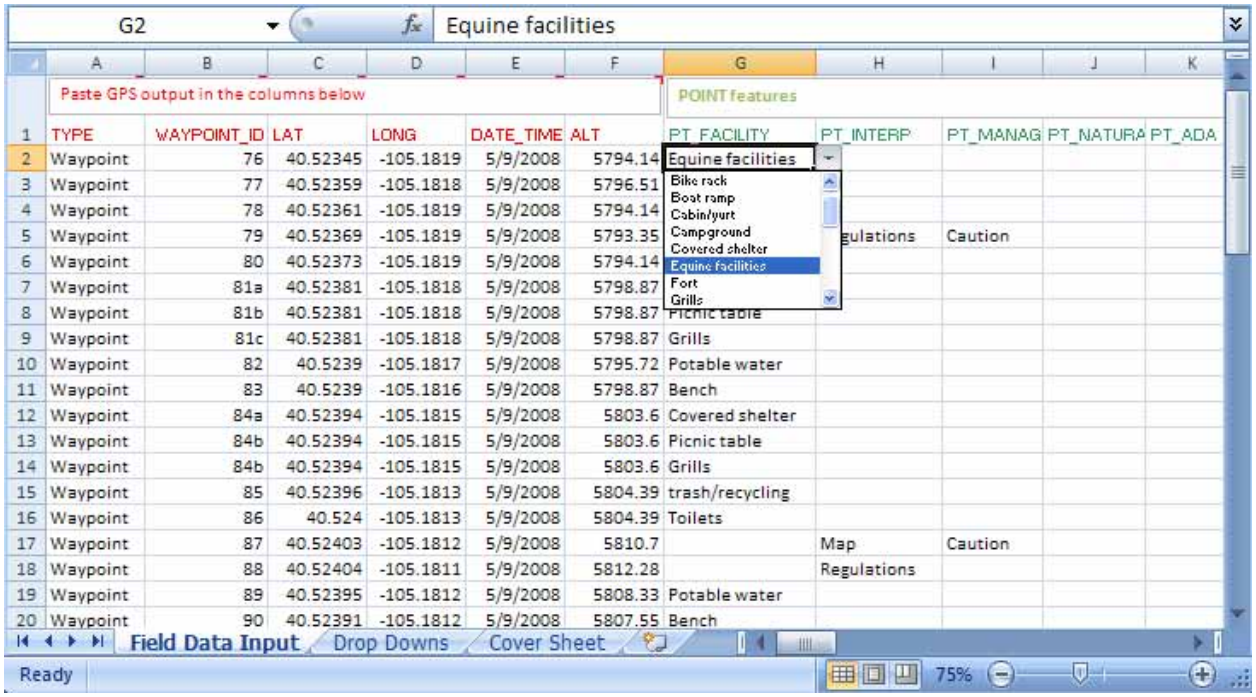
Interpretive information
(PT_INTERP)
1. Interpretive sign
2. Map
3. Other info
4. Photograph
5. Regulations
6. Scheduled info
7. Trail marker

Management issues
(PT_MANAGE)
1. Accident
2. Animal encounter
3. Attack/assault
4. Caution area
5. Citation
6. Search and rescue
7. Sensitive area
8. Temp closure/ restriction
9. Other

Natural features
(PT_NATURAL)
1. Glacier
2. Mountain pass
3. Mountain peak
4. Other point of interest (natural)
5. Overlook
6. Rapids
7. River crossing
8. Spring
9. Waterfall

ADA (disability access)
(PT_ADA)
1. Blind walk
2. Elevated tent pads
3. Fishing ramp
4. Obstacle
5. Other

User Feedback
(PT_USERFEED)
1. Experience
2. Facilities
3. Trail quality
4. Opinions
5. Problems
6. Suggestions
7. Other



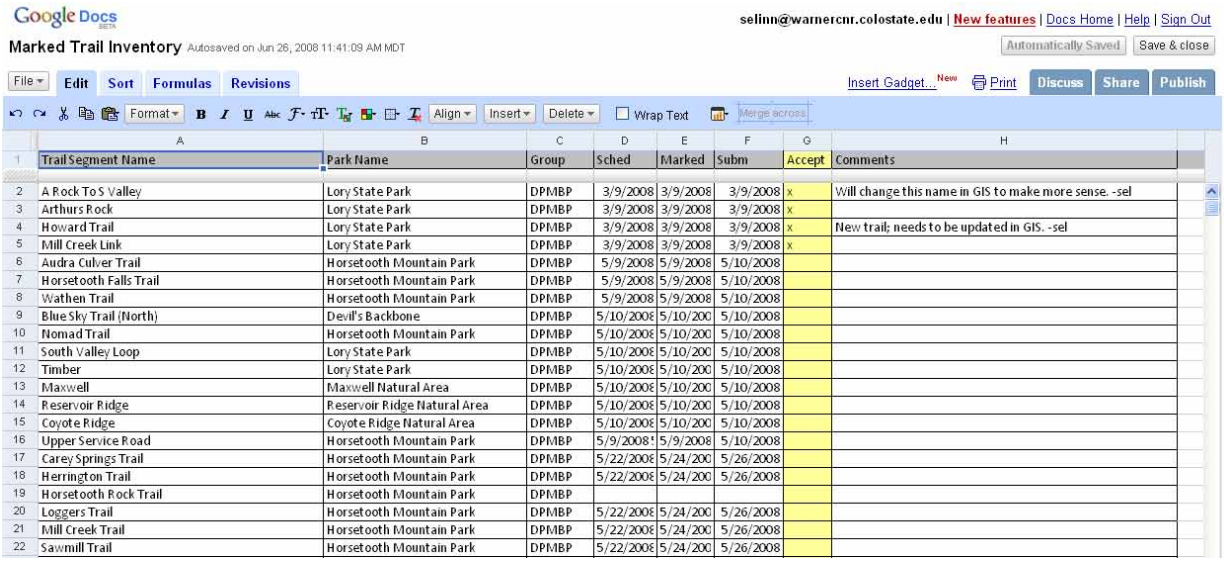
	A	B	C	D	E	F	G	H	I	J	K
1	TYPE	WAYPOINT_ID	LAT	LONG	DATE_TIME	ALT	PT_FACILITY	PT_INTERP	PT_MANAG	PT_NATURA	PT_ADA
2	Waypoint	76	40.52345	-105.1819	5/9/2008	5794.14	Equine facilities				
3	Waypoint	77	40.52359	-105.1818	5/9/2008	5796.51					
4	Waypoint	78	40.52361	-105.1819	5/9/2008	5794.14					
5	Waypoint	79	40.52369	-105.1819	5/9/2008	5793.35		gulations	Caution		
6	Waypoint	80	40.52373	-105.1819	5/9/2008	5794.14					
7	Waypoint	81a	40.52381	-105.1818	5/9/2008	5798.87					
8	Waypoint	81b	40.52381	-105.1818	5/9/2008	5798.87	Picnic table				
9	Waypoint	81c	40.52381	-105.1818	5/9/2008	5798.87	Grills				
10	Waypoint	82	40.5239	-105.1817	5/9/2008	5795.72	Potable water				
11	Waypoint	83	40.5239	-105.1816	5/9/2008	5798.87	Bench				
12	Waypoint	84a	40.52394	-105.1815	5/9/2008	5803.6	Covered shelter				
13	Waypoint	84b	40.52394	-105.1815	5/9/2008	5803.6	Picnic table				
14	Waypoint	84b	40.52394	-105.1815	5/9/2008	5803.6	Grills				
15	Waypoint	85	40.52396	-105.1813	5/9/2008	5804.39	trash/recycling				
16	Waypoint	86	40.524	-105.1813	5/9/2008	5804.39	Toilets				
17	Waypoint	87	40.52403	-105.1812	5/9/2008	5810.7		Map	Caution		
18	Waypoint	88	40.52404	-105.1811	5/9/2008	5812.28		Regulations			
19	Waypoint	89	40.52395	-105.1812	5/9/2008	5808.33	Potable water				
20	Waypoint	90	40.52391	-105.1812	5/9/2008	5807.55	Bench				

In order to enlist volunteers, a list of potential groups was compiled and contacted. Ron Winston, a local volunteer with contacts in both the Poudre Wilderness Volunteers and the Fort Collins biking community, rose to the top as a volunteer leader who could serve as a liaison of sorts with the other volunteer groups. A meeting was held in early March including representatives from Poudre Wilderness Volunteers, Fort Collins Cycling Club (FCCC), Diamond Peaks Mountain Bike Patrol (DPMBP), COHVCO/Stay the Trail and the Larimer County Youth Conservation Corps. A subsequent meeting was held with members of Loveland PEDAL, a bicycling club in that area. The groups had differing levels of commitment for contributing to the project; usually dependent on logistical issues or availability and interest of members. Nonetheless, all agreed that the project was worthwhile and would be a great asset to the community. In some cases, one individual took the lead; in other cases, a whole group participated. In fact, one individual (Doug Cutter) from DPMBP alone marked over 250 waypoints of miscellaneous features. FCCC planned one day in May on which a group of eight riders marked all of the bike trails within the City of Fort Collins. (They gathered at the end for a barbeque and "download" party.) Two of the members compiled all of the waypoints and notes and worked together to input everyone's observations into the "shell." Overall, this method was quite efficient and effective.

The data gathered from volunteers was in general quite good and the process that was established was functional. We had asked volunteers to use the "Things to Look For" sheet to guide their observations, but we also allowed them to mark any other feature that they thought was worth marking, even if it wasn't on the list. This was so we could see whether we had omitted any obvious features on our list and include those on subsequent versions. In general, the volunteers were able to follow the instructions and transmit the data accordingly. One minor complaint was that the Excel spreadsheet was a bit cumbersome for data entry (perhaps Access would have been better), but it did work!

To track which trails needed to be "marked" and which were already completed, Ron Winston set up a Google Docs spreadsheet that listed all of the known trails in Larimer County. Columns indicated whether the trail was "scheduled," was "marked," or was "submitted" to CSU. All volunteers had read and write access to this site. While the site was not used to its maximum potential, it is a recommended method for managing volunteers and GPS trail submissions, as it provides controlled access to a variety of users.

Figure 3. GoogleDocs "Marked Trail Inventory" Example


Google Docs

selinn@warnercnr.colostate.edu | New features | Docs Home | Help | Sign Out

Marked Trail Inventory Autosaved on Jun 26, 2008 11:41:09 AM MDT

Automatically Saved | Save & close

File | Edit | Sort | Formulas | Revisions | Insert Gadget... New | Print | Discuss | Share | Publish

Format | B | I | U | Align | Insert | Delete | Wrap Text | Merge across

	A	B	C	D	E	F	G	H
1	Trail Segment Name	Park Name	Group	Sched	Marked	Subm	Accept	Comments
2	A Rock To S Valley	Lory State Park	DPMBP	3/9/2008	3/9/2008	3/9/2008	x	Will change this name in GIS to make more sense. -sel
3	Arthurs Rock	Lory State Park	DPMBP	3/9/2008	3/9/2008	3/9/2008	x	
4	Howard Trail	Lory State Park	DPMBP	3/9/2008	3/9/2008	3/9/2008	x	New trail; needs to be updated in GIS. -sel
5	Mill Creek Link	Lory State Park	DPMBP	3/9/2008	3/9/2008	3/9/2008	x	
6	Audra Culver Trail	Horsetooth Mountain Park	DPMBP	5/9/2008	5/9/2008	5/10/2008		
7	Horsetooth Falls Trail	Horsetooth Mountain Park	DPMBP	5/9/2008	5/9/2008	5/10/2008		
8	Wathen Trail	Horsetooth Mountain Park	DPMBP	5/9/2008	5/9/2008	5/10/2008		
9	Blue Sky Trail (North)	Devil's Backbone	DPMBP	5/10/2008	5/10/200	5/10/2008		
10	Nomad Trail	Horsetooth Mountain Park	DPMBP	5/10/2008	5/10/200	5/10/2008		
11	South Valley Loop	Lory State Park	DPMBP	5/10/2008	5/10/200	5/10/2008		
12	Timber	Lory State Park	DPMBP	5/10/2008	5/10/200	5/10/2008		
13	Maxwell	Maxwell Natural Area	DPMBP	5/10/2008	5/10/200	5/10/2008		
14	Reservoir Ridge	Reservoir Ridge Natural Area	DPMBP	5/10/2008	5/10/200	5/10/2008		
15	Coyote Ridge	Coyote Ridge Natural Area	DPMBP	5/10/2008	5/10/200	5/10/2008		
16	Upper Service Road	Horsetooth Mountain Park	DPMBP	5/9/2008	5/9/2008	5/10/2008		
17	Carey Springs Trail	Horsetooth Mountain Park	DPMBP	5/22/2008	5/24/200	5/26/2008		
18	Herrington Trail	Horsetooth Mountain Park	DPMBP	5/22/2008	5/24/200	5/26/2008		
19	Horsetooth Rock Trail	Horsetooth Mountain Park	DPMBP					
20	Loggers Trail	Horsetooth Mountain Park	DPMBP	5/22/2008	5/24/200	5/26/2008		
21	Mill Creek Trail	Horsetooth Mountain Park	DPMBP	5/22/2008	5/24/200	5/26/2008		
22	Sawmill Trail	Horsetooth Mountain Park	DPMBP	5/22/2008	5/24/200	5/26/2008		

Overall, based on our experiences, enlisting volunteers is a viable option, provided they have some introduction and explanation of the procedures.

Websites:

Accessing websites of the managing agencies proved useful in gathering general attributes about trails within a particular park or jurisdiction. For instance, pets are not allowed on *any* trail within Rocky Mountain National Park; pets are allowed on leash on all trails in the City of Fort Collins. This information was systematically added into the database by universally attributing those values to all of the relevant trails accordingly. Also, instead of populating our database with text descriptions of trails, whenever possible we simply provide a URL link to the managing agencies *trail specific* web page where users can find descriptions and additional data. The technical advisory group was especially supportive of simply recording a URL in the attribute table which "points to" the best online source of data that is managed and maintained by the land manager. This allows easy and rapid updates that are in control of the managing agency for a given trail.

Table 2 provides a summary and comparison of the data sources discussed above.

Table 2. Comparison of Data Sources

	Agency GIS Data	Print Maps	Aerial Imagery	Field Observation/ GPS
Advantages	A lot of data received at once; directly from agencies that manage trails; excellent place to start	Tangible; easy to see a lot at once	Allows control over line quality and segment start/end; works well to have agency data and then compare it to NAIP and adjust lines accordingly	Excellent for ground truthing; beneficial in locating or confirming intersections, trail-heads, and miscellaneous points; provides most current information
Disadvantages	Accuracy varies; scale and resolution vary; some agencies more cooperative and interested in the project than others	Not updated often; currency varies	Tedious; can't always see the trails (through the trees); sometimes "trails" are visible on NAIP, but not in agency line work; uncertain which are roads vs. trails	Challenge to create a simple yet comprehensive system; attributes relate to points, not segments; precision of GPS varies; limitations on when/where they can go, based on weather
Spatial quality	Generally fairly good; editing required to meet criteria for CO Trails geodatabase	Varies, depending on scale and purpose	Excellent, when visible	Excellent in open areas; restricted in valleys or in heavily wooded areas
Attribute quality	Generally up to date; some agencies record more than others; in most cases, cross-walking data is required; names, coding and completeness vary	Helpful for general features (trailheads), uses (bike map); minimal details for others	Helpful for some attributes (parking lots, for instance).	Volunteers choose to include different features, although there is some general consistency that makes it worthwhile.

Revising the Data Dictionary:

In response to the actual data that were collected, we made some minor modifications to the database design. During the roughly six months of data acquisition, attention was paid to the priorities as set forth in the original database design. However, in some cases data were added simply because they were readily available (even though they may have had a priority ranking of 3); conversely, some of the priority fields didn't actually have any values. For example, one field called "TS_ACC_COMMENTS" was never used; it was meant for any further comments on accessibility. Any such comments could be incorporated into the general comments field. Another case was that originally we had a separate attribute to record the spatial scale of the source data called "SCALE". We absorbed this attribute into the attribute "spatial source" which provides more flexibility in describing the data source, rather than a strict map scale (e.g., 1:24,000). This reflects the wide variety of sources and quality of data that a statewide inventory will likely need to contend with. Incorporating these changes, the database design was modified accordingly. **Appendix V** provides the modified data dictionary. Based on our experience in the pilot project, we make this a recommendation for a final database design, trying to balance comprehensiveness with flexibility and retaining a relatively manageable format

Status of Larimer County Pilot Project:

With over 1,400 miles of trails mapped (including 830 miles of trails and 616 miles of Forest Service roads), and cooperation from all of the trail managing agencies in the county, the Larimer County trails inventory as it currently stands (June 2008) contains a complete set of publicly accessible trails. (We estimate 95% complete. We know that the database does not have trails for state wildlife areas because they have not been mapped by DOW.) In reality, we cannot know how many miles of trail we are missing; we relied primarily on the managing agencies to provide the most current dataset, and then modified those with the other resources as discussed above. Figure 4 includes a general reference map of the trails in Larimer County. Note that there are a variety of attributes that could also be displayed in such a map to depict, for example, the different surface types, motorized vs. non-motorized trails, where pets are allowed off-leash, where trails are handicap accessible, etc. As an example of this, Figure 5 illustrates trail surface types in the Fort Collins/Loveland area.

Figure 4. Map of Larimer County Pilot Project

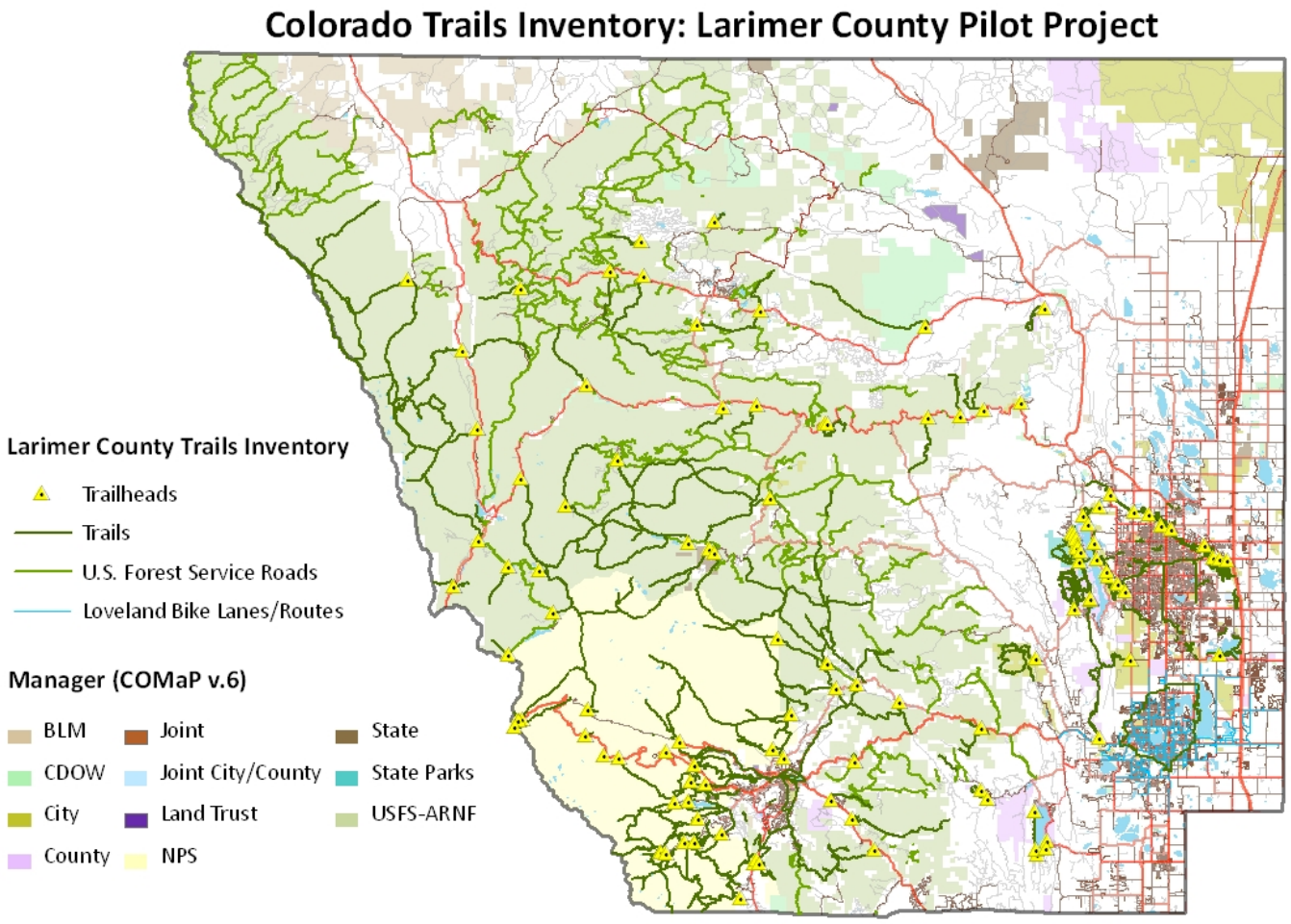


Figure 5: Trail Surface Types in Fort Collins/Loveland Area

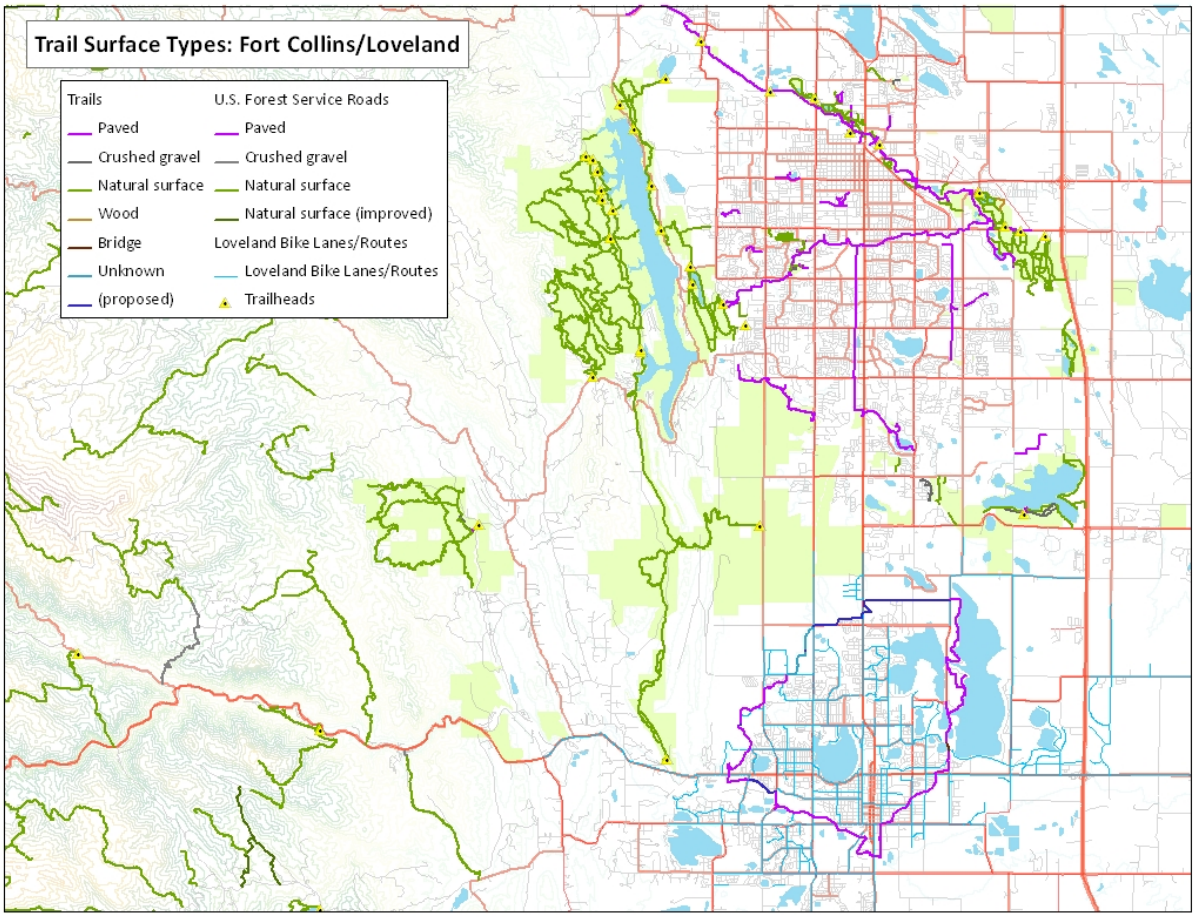


Table 3: Summary of Trail Features in Larimer County Pilot Project

Trail Segments	**1467**
• Miles of trails	830 miles
Forest Service Roads (segments)	**710**
• Miles of Forest Service Roads	616 miles
Trailheads	**96**
Miscellaneous points	**948**

Table 4: Results of Sample Queries

Trail Segments:	
Paved trails	67 miles
ADA accessible	56 miles
Pets allowed on trails	542 miles
Forest Service Roads:	
High-clearance vehicles (USFS roads)	468 miles
Miscellaneous Points (limited area):	
Benches	136
Emergency call boxes	4
Toilets	25

Table 5 provides a summary of the degree to which the major attributes for trail features are complete, with the following caveats:

- We estimate that the trailheads features are under-populated because these are in practice difficult to identify if not formally marked by a designated sign. All designated trailheads with parking lots are mapped.
- While it may be stated that the attributes are 100% complete, some values are still listed as "Unknown." This implies that the information was sought, but not readily available.
- The miscellaneous points feature class is designed as a third priority. Also, it is designed to be open and flexible allowing ongoing input; consequently it is difficult to evaluate "completeness" for it.
- Volunteers contributed most of the miscellaneous points and were not able to provide data on high-elevation trails because of snow cover during the winter/spring months. Nonetheless, the process is established such that data can continue to be received and incorporated.

Table 5: Percent Complete of 1st and 2nd Priority Attributes (June 2008)

TRAIL SEGMENT

Priority	Number complete	% complete	Attribute Name	Comments
1-D	**1467**	**100%**	**TS_ID**	Unique identifier for use in GIS
1	**1449**	**99%**	**TS_NAME**	Common name of trail
1	**265**	**18%**	**TS_NUMBER**	Note: most trails do not have an associated number
1-D	**1467**	**100%**	**TS_LENGTH_MI**	Length of segment
1-D	**1467**	**100%**	**TS_MIN_ELEV**	Derived, in meters and feet
1-D	**1467**	**100%**	**TS_MAX_ELEV**	Derived, in meters and feet
1-D	**1467**	**100%**	**TS_NET_ELEV**	Derived, in meters and feet
1-D	**1467**	**100%**	**TS_NET_SLOPE**	Derived
2	**1450**	**99%**	**TS_DIFFICULTY**	Derived
1	**1467**	**100%**	**TS_SURFACE**	Surface type
1	**1461**	**100%**	**TS_URL**	For park, agency, or specific trail
1	**1467**	**100%**	**TS_MOTOR**	Allowed motorized use
1	**1467**	**100%**	**TS_NONMOTOR**	Allowed non-motorized uses
2	**1467**	**100%**	**TS_ADA**	Many are "Unknown"
2	**1467**	**100%**	**TS_PET_ACCESS**	Pets allowed
2	**1467**	**100%**	**TS_MANAGER**	Derived from COMaP
1-D	**1467**	**100%**	**TS_OWNER**	Derived from COMaP

TRAILHEAD

Priority			Attribute Name	Comments
1	**111**	**100%**	**TH_NAME**	More trailheads may well exist; these were estimated from existing maps and NAIP imagery.
2	**18**	**19%**	**TH_ADA**	Most trailhead data were gathered from NAIP imagery; there is no way to distinguish among types of parking spaces.

MISC. POINT FEATURES

Note: All miscellaneous points are 3rd priority. For reference, there are currently 948 points included in the geodatabase.

The *trail routes* feature class, as it was originally designed, is not included in the final geodatabase. This is because trail routes are best calculated "on the fly" as a combination of one or more connecting trail segments. An alternative way to calculate trail routes is simply by combining trail segments that have the same name such as "Greyrock Trail" which is composed of three segments (but Greyrock Meadows, which is a trail that forms a loop with the others, would not be included, by this method).

Limitations of the Colorado Trails Inventory design

The following comments pertain to specific feature classes and include limitations or known inconsistencies with the data for the Larimer County pilot project.

- Trailheads can be defined as a point at which a trail begins. However, in the current inventory database, trailheads are only marked where there are parking spaces. This should be expanded to include any point where a trail begins. Database design would allow for that; simply mark the location and input "0" in Number of Spaces.
- Bike routes and lanes along roads are not included in the City of Fort Collins. They were not part of the trails dataset we received from the city. (The Bike Map used Adobe Illustrator files, which are digital but not spatially referenced and therefore could not be readily used.) Bike routes and lanes *are* included separately in the City of Loveland, as an example.
- Sidewalks within parks are not included, though clearly they are paths that can be walked/"hiked" on. Perhaps other paths, sidewalks, roads can be included, but *not* in the trails geodatabase per se; it would be too unwieldy to include all sidewalks. Also, by using other databases (like Google Earth/Google Maps) much of that base data may already exist or be visible. We just provide attributes on the "dedicated" trails.
- Using the COMaP dataset: Some trails cross over multiple "properties" with different owners and different managers. In some cases this may alter allowed uses (e.g., between Forest Service property and a national park); in others it may not. Because we defined a trail segment as a path between intersections (or start/end), breaking the segments along property boundaries would have further fragmented the dataset. If this information is essential, it is recommended that trail segments be broken at property boundaries only if it indicates a use change. Another option is for all owners along that segment to be listed in the "TS_OWNER" or "TS_ MANAGER" fields.
- The map "scale" field was removed because of the variety of sources utilized. In general, the overall scale of the data is approximately 1:10,000.
- Miscellaneous points from volunteer sources are limited to areas that were accessible by May 2008. A deep snow pack in the spring made it difficult for volunteers to mark waypoints along trails at higher elevations. Timing and logistics influenced the involvement of some groups; some were more participatory than others.
- Miscellaneous points acquired from volunteers can be very numerous. At this point, most waypoints are included in the inventory; about 150 were "removed" (i.e., put into another temporary feature class) because they were observations that did not fall neatly into our categories, or they did not seem worthy of inclusion at this point.
- Waterways/paddling "trails" are not presently included in the dataset, but could be added at a later time using a similar approach.

Submitting New Data:

As our experience with our work on the Colorado open space inventory (COMaP) has demonstrated, a dataset like this is never finished; ongoing maintenance is required. Trails change, new information becomes available, and more points can always be added. Adding new data can be accomplished in a number of ways, depending on who is adding it and what kind of data it is.

New data can be added to the database through submittals by contractors, agency personnel and/or volunteers in one of three ways:

- In a ArcGIS format (shapefile, ArcGIS geodatabase, coverage)
- As GPS data (for points)
- As comments or minor changes in Google Earth (sent in as a .kml/.kmz file)

Appendix VI explains each method in detail. It is important to note that the best way to collect, enter, and manage the inventory is highly dependent on how the project will continue (i.e., who will manage it) and where the database will ultimately reside.

Processing New Data: Technical Documentation

Appendix VII provides an explanation of all major steps required to process and import the data into the CO Trails database format, as well as additional comments on database development and data management. This appendix is intended to provide the technical guidance needed for experienced GIS personnel to be able construct and manage the trails inventory.

III. Investigate Web-based Dissemination of Trails Inventory

The creation of the spatial database and trails inventory, as described above, provides an abundance of "content" about trails that can be delivered in a number of ways. We identified three broad likely user groups: the general public, land managers, and emergency service personnel. As it is inherently in a GIS format, it can be used by anyone who has access to GIS software, thus enabling the user to see the full breadth and depth of the data as it was intended. However, making the database, in its entirety, accessible to the public via the web is the ultimate goal. Any online mapping application is only as good as the data that is provided for it. Thus the data quality and the format of the data has been a major emphasis of this project. Keeping this in mind, a variety of delivery methods for the data are feasible and many products can provide a variety of options for viewing the data.

Obviously, there are *many* trail websites on the Internet right now, and more seem to come online weekly. Many of these systems allow users to search for a trail with certain characteristics and then link to a *static* trail map with a text box containing additional trail information (such as the hiking trails of the Minnesota Department of Natural Resources: http://www.dnr.state.mn.us/hiking/index.html). Static maps include those in image formats such as PDF, JPG, and GIF are intended for viewing and printing only.

Our efforts focused on creating the geodatabase and then trying to discover (or create) methods to serve up the data such that the trails attributes could be searched, but also so that the trails (lines) and points could be "smart"; that is, one could click on them and have all of the attributes available. Interactive maps can have GIS tools that include some or all of the following features: zoom, pan,

select/highlight, query, symbolize, select visible layers, add notes. Another benefit of having GIS-based data is that it enables us to overlay our data with other spatially-referenced data sets (such as COMaP) so that we can capitalize on what is already available and conduct more sophisticated analyses such as what types of ecosystems can be reached by different trails; how long the trails are; how many lakes with native fish might be easily reached, etc.

There is a balance, but we believe that working on the "engine" or "content" side of the inventory needs to come first. This reasoning is not only because having the content is a necessary condition to disseminate the information, but that the technology to disseminate information through the internet, using web browsers, "mash-ups", and the like, change so rapidly that a major investment in web technology would be required.

Several web-based products were evaluated using the following criteria:

- Ability to read ESRI (shapefile, geodatabase) and/or .kml data formats
- Customizable or have these tools available in base version:
    - Queries – search any combination of fields
    - Comments—allow comments to be submitted
    - Display—ability to turn layers on and off
- Performance – Speed of drawing features
- Ease of use for everyday users
- Amount of software installation required
- 3D viewing capabilities
- Accuracy of features drawn
- Accuracy of base street and aerial layers
- Printing capabilities
- Download trails to .kml files or other format for GPS.
- Developer issues
    - How much data massaging required from ArcMap data?
    - Ease of programming/good documentation
    - Customization
        - How much required vs. already exists?
        - How easy and fast to customize?
    - Access to tools
    - Software setup

The following software was evaluated:

- ArcGIS Explorer
- ArcExplorer Java Edition
- MS Virtual Earth (3D version of Live Maps)
- Google Earth
- Google Maps
- ArcIMS (HTML and Java versions)

The steps for researching and evaluating capabilities of the different products were:

1. Research products on company's websites by reading their features and reviewing comments from developer websites.
2. Try all products that meet minimum criteria of reading and displaying either .kml files or other ESRI formats so that data created in ArcGIS could be exported and used by the application.
3. Customize as needed to develop a subset of the trails application; then load/import a standard set of .kml or shapefiles into the application.
4. Evaluate each of the above criteria for each and rate it as either pro (strong in this area) or con (weak in this area).
5. Customize the higher-rated ones to further evaluate.
6. Evaluate these finalists and provide overall rating for each.

Querying/Searching the Spatial Database

Querying of features is important for this trails application. We analyzed each product's query-ability based on its built-in tools and whether or not it can be customized to perform queries.

The following products have built in query tools plus the ability to customize:

- ArcIMS

The following products have no built in query tools but can be customized:

- ArcGIS Explorer
- MS Virtual Earth
- Google Maps

The following products have built in query tools but cannot be customized.

- ArcExplorer Java Edition

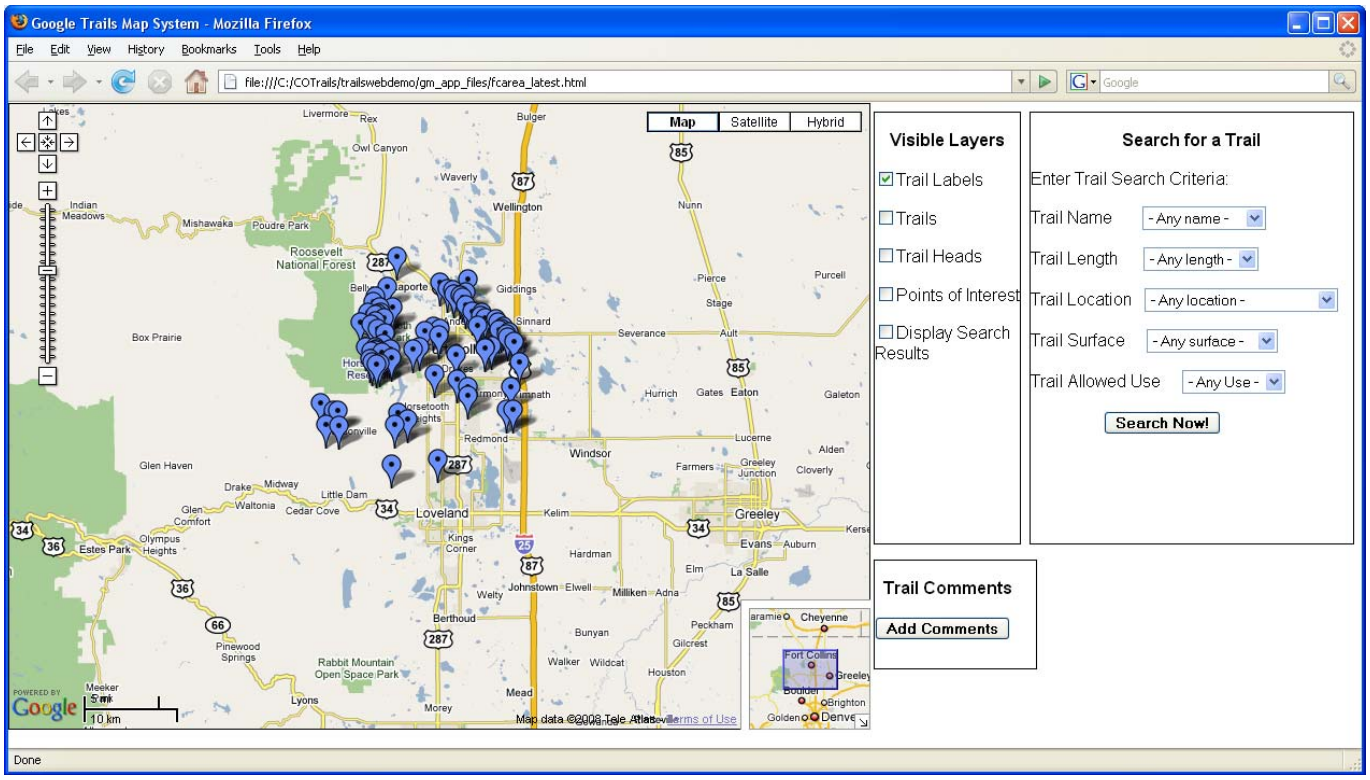
The following products have no built in query tools and cannot be customized, at this point.

- Google Earth

Online mapping sites and companies such as Google, Microsoft, and ESRI are adding significant new features with each release. Google Earth, for example, is likely in the near future to have full-fledged Application Program Interface (API) that will provide some, if not all of the features it is lacking for this trail application. The shortcomings in Microsoft and ESRI may also be addressed in future releases.

The online options reviewed each have strengths and weaknesses, summarized below. At this point, the two products that warrant further exploration are ArcIMS (Internet Map Server) and Google Earth. These are substantially different in that ArcIMS requires a much greater investment, both in purchasing software, technical skill and system management, and has a considerably less friendly user interface. Google Earth is essentially free, has become a standard of sorts for displaying digital spatial data online, and is fast and user friendly. The primary drawback is that it does not easily allow a user to search the trails dataset by attribute. The importance of querying by attribute *may* in fact be overestimated, as users may simply browse the data and click on features of interest to access additional information about them. Also, as suggested above, it is quite likely that such queries will soon be easily available within Google Earth. Figure 6 shows screen shots of the trail dataset in Google Maps and Google Earth.

Figure 6: Portion of Trails from the Larimer County Pilot Project: Google Maps and Google Earth



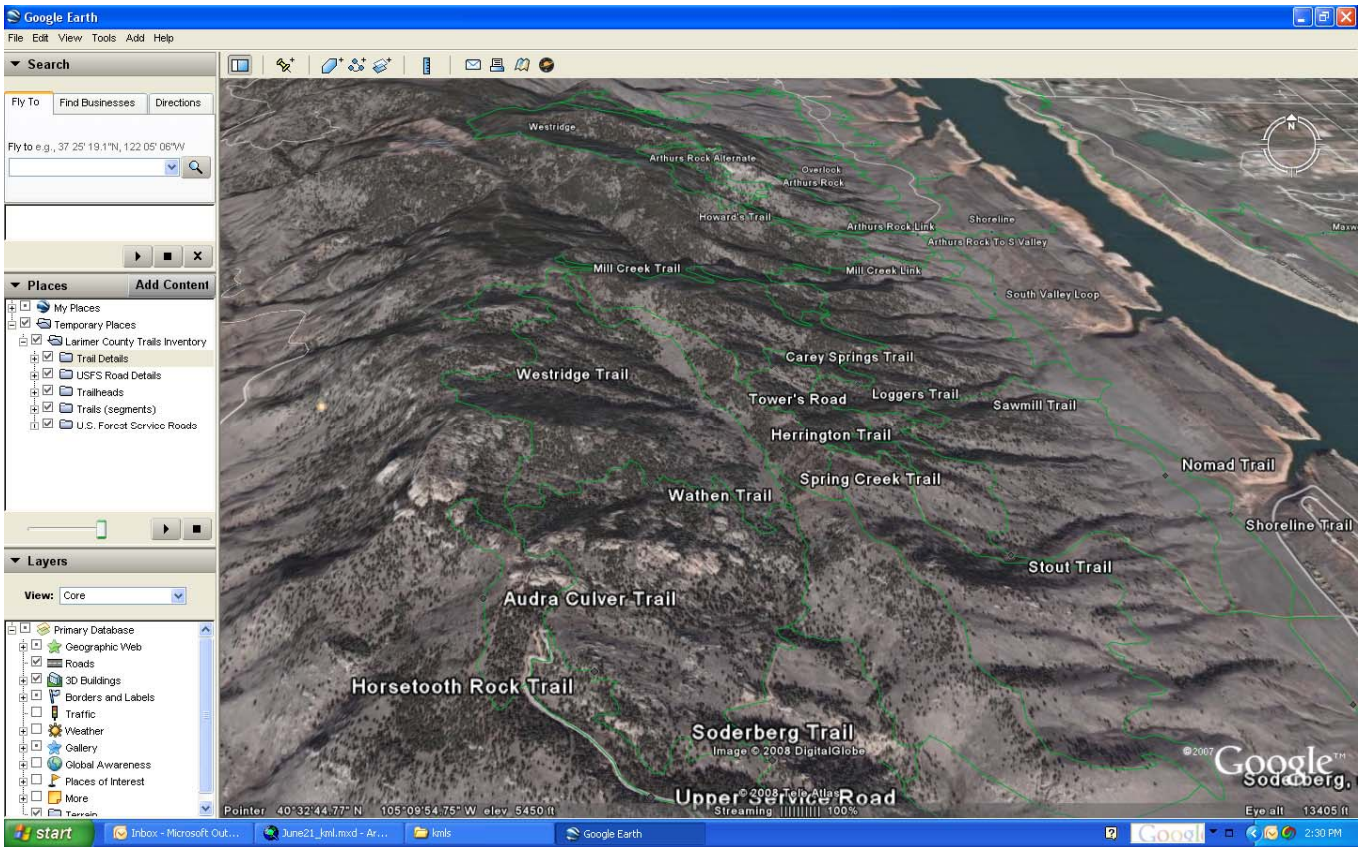


Table 6: Strengths and Weaknesses of Web-based Dissemination Options

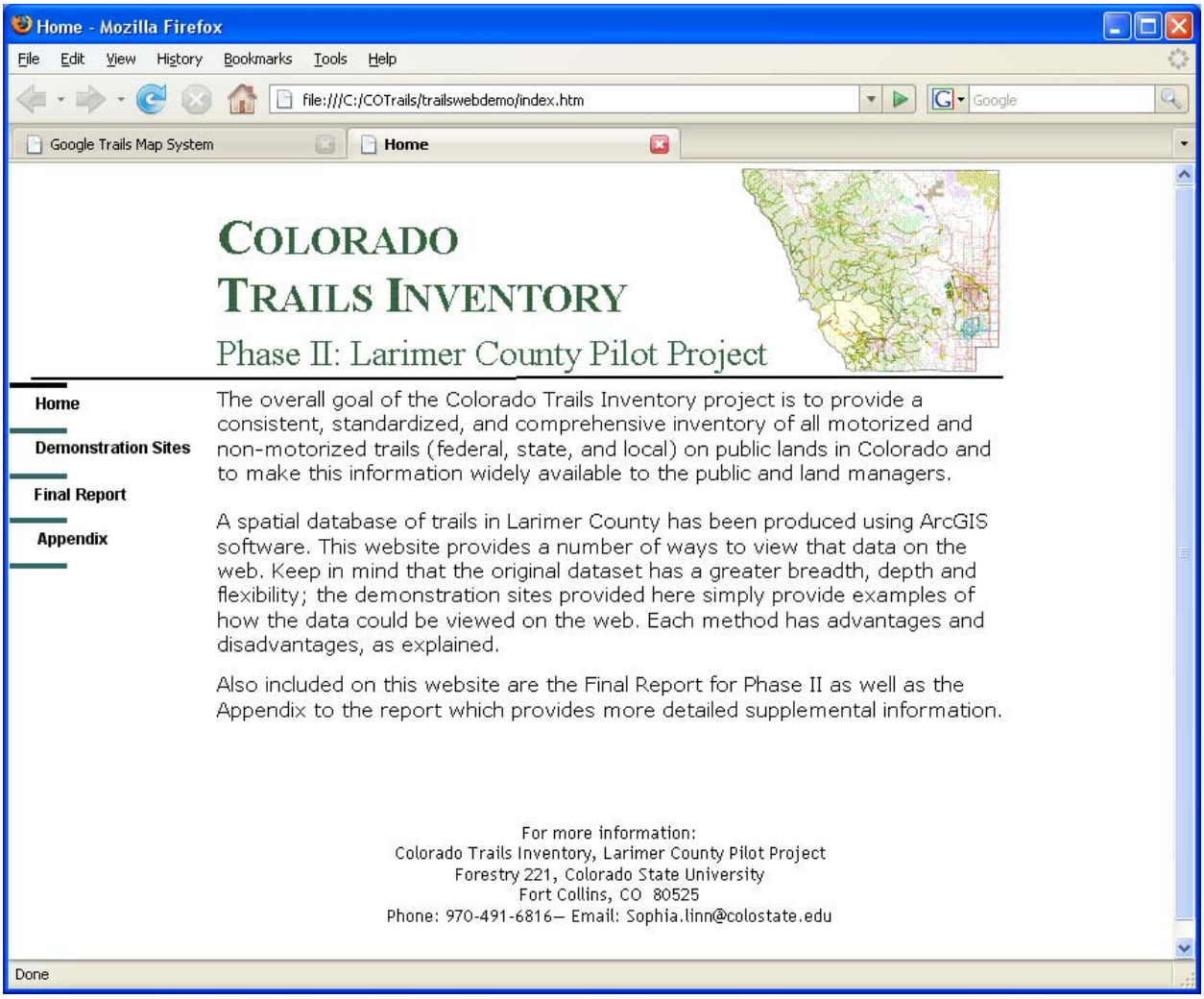
	Pros	Cons	Overall Rating
1. ESRI ArcExplorer	• Relatively fast drawing and navigation. • No customization coding required for queries or layer display/symbolization – they are built in.	• Doesn't support KML files – must provide downloadable shapefiles to users. • Adding comments or other customization not possible. • Some tools are not intuitive for non-GIS users. • Requires user to download/install software.	• Low. Inability to customize is big limitation.
2. ESRI ArcGIS Explorer	• Supports KML files • 3D viewing – Can see trails overlaid on 3D image.	• Often very slow response. • Lines don't always draw completely and leave gaps. • Requires user to download/install software. • Can customize with SDK, but unable to test this for querying tools or adding trail comments since SDK requires very specific version of Visual Studio.	• Low. Similar to Google Earth, but more clumsy.
3. Virtual Earth (Microsoft Maps Live with 3D download)	• Customizable – can create queries (with PHP / SQL database) and can create comment entries. • 3D tools are interfaced with Browser (thus can view customizable apps in 3D). • Relatively fast drawing and navigation with all trail lines displayed.	• Doesn't properly handle complex trail lines (would need to simplify these) or more than 200 lines per KML file. • 3D tools don't work on Mac. • Customization of queries requires extensive PHP scripts and SQL database setup (import of KML files). • Customization coding required for layer on/off. • 3D tools require users to download/install software.	• Overall Rating: Medium. Fast, clean viewing, but inability to draw complex lines is big limitation.

4. Google Earth	• 3D viewing – Can see trails overlaid on 3D image. • Very fast drawing and navigation even with large KML files. • No customization coding required for layer display/symbolization – they are built in. • Relatively simple to design and export from ArcMap.	• Not customizable as far as queries, entering comments. • Requires users to download/install software.	• Overall Rating – Medium. Fast, clean viewing, but lack of customization is big limitation. Could use it in conjunction with Google Maps where user requests view of selected files in Google Earth. Excellent to view data; working on searching capabilities.
5. Google Maps	• Customizable – can create queries (with PHP / SQL database) and can create comment entries.	• Relatively slow drawing and navigation with all trail lines displayed (somewhat faster in Firefox). • Customization of queries requires extensive PHP scripts and SQL database setup (import of KML files). • Customization coding required for layer on/off and comments. • No 3D viewing. • Users/developers can get locked out of all Google map applications for several hours if you hit their site with too much data too often.	• Overall Rating – Med-High. Can properly customize to meet most requirements, but requires a lot of coding and database development. Lock out is a problem.
6. ESRI ArcIMS	• No customization coding required for queries or layer display/symbolization – they are built in. • A "Comments" features is built in. • Relatively fast drawing and navigation with all trail lines displayed. • Relatively simple updates – just move geodatabase files to server.	• You must purchase, setup and maintain server software along with other software components. • ESRI's base layers (roads/imagery) may not be as detail or up-to-date as Google's and Microsoft's. • Some tools are not intuitive for non-GIS users. • No 3D viewing. • For advanced Java version, requires user to download/install software.	• Overall rating: High. Does most of what you need with very little coding. Recommended if ArcIMS licensing is inexpensive.

IV. Launch Dissemination of Pilot Project

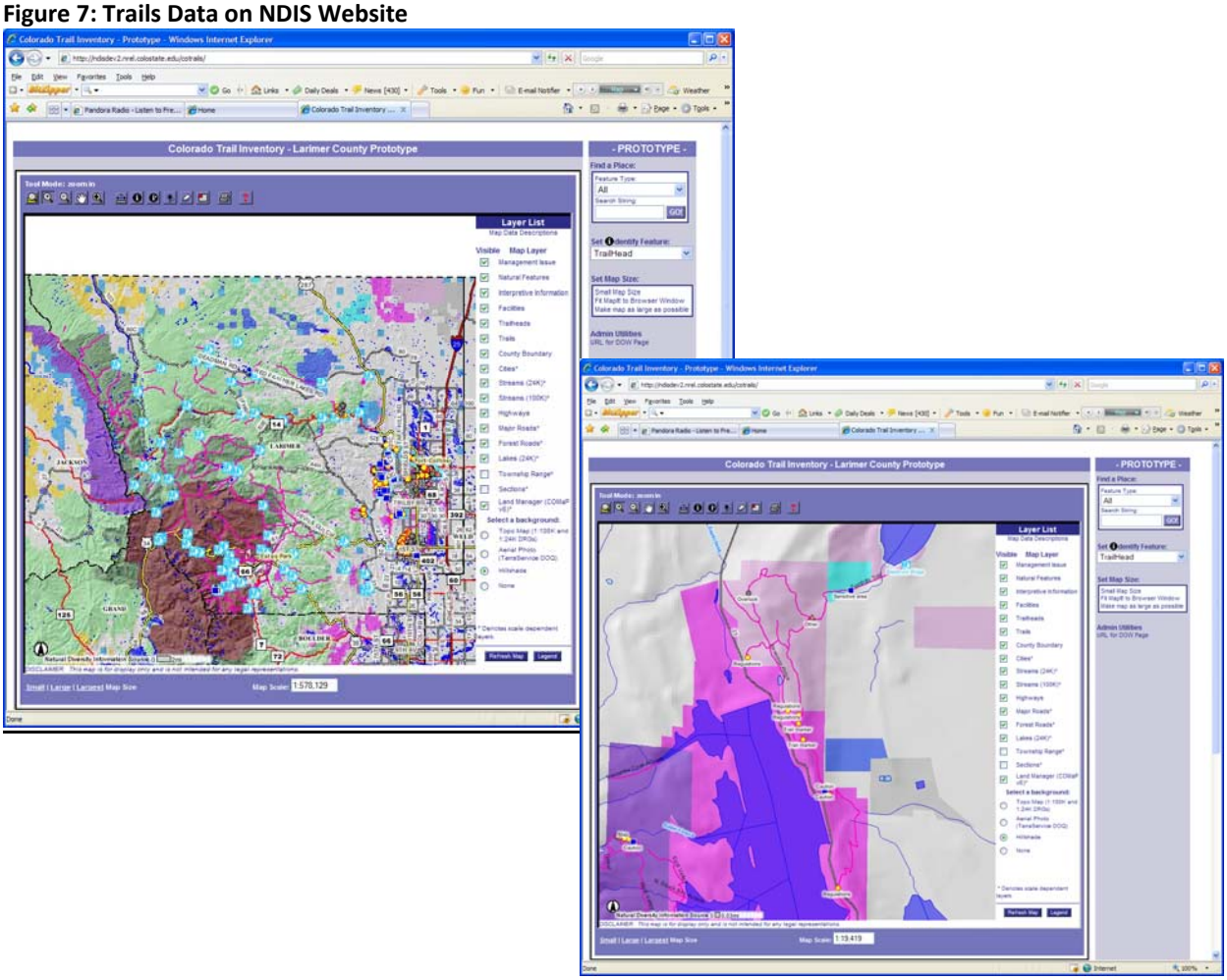
We developed a website to disseminate the results of the Larimer County pilot project. The intent of the website is to provide some basic information about the technical design of the trails inventory, as well as to provide interim linkages to some of the various dissemination methods that we explored. The website is located at:

http://cotrails.library.colostate.edu



Note that we also explored the utility of embedding the trails inventory within the Division of Wildlife's Natural Diversity Information Source website. The advantage of disseminating the trails inventory this way is leveraging existing complementary datasets on roads, ownership (COMaP), topographic quads, aerial photos, etc. Also, it leverages the considerable expertise and "web presence" of the NDIS website. The direct link to the trails dataset on NDIS can be found at: http://ndisdev2.nrel.colostate.edu/cotrails/ (see graphic below).

Figure 7: Trails Data on NDIS Website



V. Estimate Rough Costs

Looking forward to Phase III, we were asked to make recommendations about how best to develop a full, statewide inventory, and to generate estimates for the likely cost per mile of trail, and the possible technological impediments. We note that although the Larimer County pilot is fairly representative of other counties in Colorado in that it has a variety of land types, management agencies, and volunteer groups, etc., one must be careful to extrapolate directly from our findings to the state level.

In the Larimer County trails inventory database, there are approximately 830 miles (1335 km) of trails, and approximately 616 miles (992 km) of U.S. Forest Service roads, for a total of 1446 miles (2314 km). Listed below are our estimates of the time spent on:

- Acquiring and processing data from agencies
- Developing a method for processing field/GPS data and working with volunteers
- Using aerial imagery for verification and 'heads-up' digitizing
- Conducting additional research using websites, books and paper maps

Truly, it is a combination of all of these that enabled the Larimer County data to be completed and an approach that combines and exploits the variety of sources of data certainly would be necessary to compile a statewide trails inventory. (Note: The estimates below **do not** incorporate planning time, learning time, setting up the database, or equipment costs. Those are additional and substantial costs, approximately $20-40K.)

Acquiring and processing data from agencies:
The starting point for populating the Larimer County trails inventory was acquiring, importing, and editing the trail datasets from the managing agencies and placing them within the geodatabase. This included editing line segments, cross-walking attributes, and adding the new data into the trail segments feature class. Estimated times for processing trail data from each agency is listed below:

- City of Fort Collins	~16 hours
- Larimer County	~20 hours
- Rocky Mountain National Park	~20 hours
- Canyon Lakes Ranger District, USFS (trails)	~18 hours
- Canyon Lakes Ranger District, USFS (roads)	~14 hours
- Loveland:	
Recreation Trail only	~11 hours
Bike lanes and routes (along roads)	~26 hours
TOTAL:	~125 hours

- This equates to approximately five minutes per mile, or about 12 miles per hour. (125 hours = 7,500 minutes. 7,500 minutes / 1,446 miles = 5.2 minutes)
- Based on a typical GIS analyst's hourly rate of $35 per hour, that would be approximately **$3.00 per mile.**

Field data/GPS:
A considerable amount of time was spent developing a method to receive GPS data and observations (point data) from volunteers. Approximate times are listed below:

- Developing original "Field Form" (that was later discarded), "Things to Look for" and GPS spreadsheet "shell"	~25 hours
- Meeting with volunteers	~ 8 hours
- Trying out different methods; modifying procedures	~20 hours
TOTAL:	~53 hours

- 48 hours x $35/hour = $1,855
- Because most of this has been done now, these costs would not be incurred again, except for modifications to the documents and procedures as needed, and meeting with volunteers.

Once a system was set up and volunteers had instructions and knew what to do, receiving volunteer data and transferring to ArcGIS became relatively easy. For each Excel spreadsheet that was submitted, it takes one to two hours to check the points in Excel, export as .csv, import into ArcMap, add metadata fields, populate fields (based on information on their submitted cover sheet), and append the data to the miscellaneous points feature class. An estimated total for a selection of areas are listed below. Note that multiple spreadsheets were submitted for some of these areas.

- Horsetooth Mountain Park	1.5 hours
- Lory State Park	1.5 hours
- City of Fort Collins trails	~3 hours
- Loveland Recreation Trail	~4 hours
TOTAL STAFF TIME:	~10 hours

- 10 hours x $35/hour = $350

The estimates above do not include volunteer time, both marking points along the trails and downloading and submitting their data. An estimate for volunteers marking points follows:

Greyrock: (CSU staff; original trial run)

Hiking and marking trail	~6 hours
Downloading, inputting, completing "shell," submitting	~2 hours
TOTAL "VOLUNTEER" TIME:	~8 hours

- The Greyrock/Greyrock Meadows loop trail is about 6 miles long.
- 8 hours of "volunteer" work at $18.77/volunteer hour = $150.16 / 6 miles = **$25/mile**

Arthur's Rock: (Diamond Peaks Mountain Bike Patrol)

Riding and marking trail	2.5 hours
Downloading, inputting, completing "shell," submitting	½ hour
TOTAL VOLUNTEER TIME:	3 hours

- The Arthur's Rock loop is about 4.2 miles
- 3 hours at $18.77/volunteer hour = $56.30 / 4.2 miles = **$13.40/mile**

City of Fort Collins Trails: (Fort Collins Cycling Club)

Riding and marking trail (4 teams of 2 x 2.5 hours)	20 hours
Downloading, inputting, completing "shell," submitting (2 people)	2.5 hours
	22.5 hours

- Approximately 115 miles of trail were marked by FCCC volunteers in one day.
- 22.5 hours at $18.77/volunteer hour = $422.33 / 115 miles = **$3.68/mile**

The wide discrepancy in the calculated costs per mile can be attributed to a number of factors: hiking time vs. biking; working alone or with a partner; a group effort vs. a single outing; and also, increasing familiarity with the methods for processing the data. For an estimate of volunteer cost per hour, we take an average of the two actual volunteer outings, which equates to approximately **$8.50 per mile**; but we note that it could range from $3.68 per mile to as much as $25 per mile.

Paper Maps and Websites:
Additional attributes were gathered from paper maps, trail books, and websites.

- Approximately 40 hours were spent researching these documents for information about trails, trailheads and miscellaneous points.
- 40 hours at $35/hour = $1,400 / 1,467 = **$.95/mile**
- Note that this also includes trailheads and miscellaneous points, not just trail segments
- In general, this was supplemental information and not a primary source of spatial or attribute data

Aerial Imagery (heads-up digitizing)
Approximately 80 hours were spent on-screen digitizing or editing over the course of the project.

- 80 hours x $35/hour = $2,800
- This was the amount of time spent on all of the trails in the database, or 1,446 miles.
- $2,800 / 1,446 miles = **$1.94 per mile**

Table 7 summarizes the costs for each method of gathering and processing data.

Table 7: Estimated Costs for Data Acquisition and Processing

Data Source	Rate (per hour)	Approximate "cost" per mile
Acquiring and processing data from agencies:	**$35**	**$3.00**
Paper Maps and Websites:	**$35**	**$.95**
Field data/GPS: (volunteer time)	**$18.77**	**$8.50**
Aerial Imagery (heads-up digitizing)	**$35**	**$1.94**

Note that none of these methods alone can provide a complete set of data, and therefore a conservative estimate assumes the need to collect information using a variety of approaches.

Rounding up these estimates and adding them all together brings the total cost to approximately $15 per mile of trail, but again this could range roughly from $10 – 30 per mile.

We also identified a number of technical "short-cuts" or procedures that would likely ease the creation of the statewide inventory. These include:

- assisting individual government agencies to "cross-walk" their standard database (if available) to convert it easily into the CO Trails format. Note that in our experience, few agencies have an existing standard. In fact, many agency folks mentioned that having a de facto standard database design would be useful for them and would likely be used by their agency.
- Be clear to describe the most important (top priority) types of features to volunteer groups/personnel.
- A centralized datasheet to coordinate volunteer help, to prioritize what trails and what attributes are highest priority.
- Possible recommendation for GOCO trail grantees to submit their data in CO Trails database design

<u>Development of web-based dissemination</u>
Exploring the various web-based dissemination possibilities and further developing the more promising options required approximately 80 hours of time. This is a very labor intensive process that requires skills in both GIS and web development. The technology is still evolving, so keeping abreast of latest developments is essential.

<u>Estimated cost for statewide trails inventory development</u>
Larimer County provides a reasonable case study area to develop recommendations on the possible costs and impediments to developing a full statewide trails inventory. Based on our experience with gathering and processing trail data from a variety of sources, and an initial web dissemination effort, it is estimated that developing a statewide trails inventory database and dissemination website would cost approximately $350 - $500K, over a two year period. Note that this is roughly close to, perhaps a bit lower than, the estimate from Phase I (Conceptual Design from Elroi Consulting, Inc.; August 2005) – but note that they estimated a completion rate of only 5,000 miles per year.

<u>Long term maintenance for both database and web-based dissemination</u>
Once the system is established and functioning, to provide an ongoing publicly accessible website with technical support we estimate roughly ½ person to maintain the website, roughly $40-$50k per year, plus computer and internet support costs of $10k per year.

VI. Recommendations for Next Steps

A number of options exist for moving forward with the next phase of the Colorado Trails Inventory Project. Some possible scenarios are introduced below:

- State GIS Trails Coordinator: One individual would be hired to manage entire project with support from additional technical staff (up to two FTE). Staff would follow procedures outlined in this document—gathering agency data, utilizing pre-existing datasets, editing, enlisting volunteers. Staff would also design, create and manage website for disseminating the inventory. Requires skill in both GIS and web development.
- County Participation: Invite individual counties to apply to State Trails for funds for them to develop their trails based on this model. Prioritize which counties you want for which year. Staff would be managed at county level. Training could be provided for successful applicants.
- Partner with Other Trail Mapping Organizations: Cooperate with for-profit organizations such as Trails Illustrated (National Geographic maps) or other online trail groups such as TrailPeak – Canada (www.trailpeak.com) who already have a presence and have done similar projects in other areas. They could provide the technical expertise, infrastructure and potentially house the inventory. Creating the database could be hired out to consultants.
- A combination of the above with incentives and a user-friendly mechanism for local entities to join and feed their data into the system.

The pilot project allowed for the development of a trail dataset for all of Larimer County. A number of web options were explored and a pilot website was created. Looking towards the future, it is possible that we can further develop the website—specifically for Larimer County—such that it is a functional presence on the web. Agencies in the area, including Larimer County Search and Rescue and the Estes Park Visitors Center, expressed a high-level of enthusiasm for accessing and using a map and dataset like this. Through cooperation with multiple agencies, we may be able to continue working to share the work we have complete and potentially to make it viable in the long term.

Appendix 1: Resources Reviewed

Appendix I: Resources Reviewed for Trail Attributes

Reference Name
GOVERNMENT SPONSORED PROGRAMS
Interagency National Trails Data Standards
Adams County Trails Inventory
Alaska Trails
City of Boulder
Utah Trails
Colorado Front Range Trail
Map Detroit
Florida Greenways and Trails
PRIVATE / COMMERCIAL
Colorado Outdoor Training Initiative
ProTrails
Latitude 40 Maps
Rails-to-Trails Conservancy
Trails.com
Outrage GPS
All Sport GPS
MapXChange, Trails Illustrated/National Geographic
Single Track.com
Map My Hike
ACCESSIBILITY
Beneficial Designs
AASHO - Guide to the Development of Bicycle Facilities
Designing Sidewalks and Trails for Access, Part II of II: Best Practices Design Guide, 2001
Universal Access to Outdoor Recreation, 1993
Street Design Guidelines for Healthy Neighborhoods
Boulder Area Accessible Trails & Natural Sites

Appendix I: Resources Reviewed for Trail Attributes

Reference
http://www.nps.gov/gis/trails/
Adams County.xls
http://www.dnr.state.ak.us/parks/aktrails/index.htm
http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=3058&Itemid=411
http://www.utah-trails.com/
http://parks.state.co.us/Trails/ColoradoFrontRangeTrail/
http://www.mapdetroit.com
http://www.dep.state.fl.us/gwt/guide/
Trail Terminology 202005.pdf
http://www.protrails.com/
http://latitude40maps.com/
http://www.traillink.com/
http://www.trails.com
http://www.outrageGIS.com
http://www.allsportGPS.com
http://www.trailsillustrated.com/topo/search.cfm
http://www.singletrack.com
http://www.mapmyhike.com
http://www.beneficialdesigns.com/trails/trailware.html
http://www.bouldercolorado.gov/files/openspace/pdf_involved/tap-guide.pdf

Appendix 2: Data Dictionary

CO TRAILS DATABASE ATTRIBUTES AND LISTS OF VALUES

TRAIL SEGMENT

Trail Segment Classification

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1-D	TS_ID	Unique segment identification number generated by the GIS	(GIS generated)	
1	TS_NAME	Name that the trail segment is officially known by	(hand-entry)	
3	TS_NAMEALIAS	Alternate name(s) that the trail segment is known by	(hand-entry)	
1	TS_NUMBER	Official numeric or alphanumeric identifier for the trail segment	(hand-entry)	
1-D	TS_LENGTH	Recorded length (meters)	(GIS generated)	
1-D	TS_MIN_ELEV	Lowest elevation on the trail segment	(GIS generated)	
1-D	TS_MAX_ELEV	Highest elevation on the trail segment	(GIS generated)	
1-D	TS_NET_ELEV	Net elevation change over the trail segment (meters)	(database calculation - difference)	
1-D	TS_NET_SLOPE	Net slope of the trail segment	(database calculation - net elevation relief/length)	
2	TS_DIFFICULTY			Create algorithm to calculate this objectively
1	TS_SURFACE	Predominant surface types	NATURAL SURFACE	Natural surface -- native materials/not imported
			CRUSHED GRAVEL	Crushed gravel/Aggregate
			PAVED	Asphalt/Concrete
			WOOD	Wood planking/Boardwalk
			BRIDGE	Bridge
			OTHER	Other
3	TS_DESCRIPTION	Paragraph description of the trail segment	(hand-entry)	Most often refers to URL link to website
1	TS_URL	URL link to additional information	(hand-entry)	
1-D	TS_LENGTH_MI	Recorded length (miles)	(GIS generated)	
1-D	MIN_ELEV_FT	Lowest elevation on the trail segment (feet)	(GIS calculated)	
1-D	MAX_ELEV_FT	Highest elevation on the trail segment (feet)	(GIS calculated)	
1-D	NET_ELEV_FT	Net elevation change over the trail segment (feet)	(database calculation - difference)	
1	TS_MOTOR	Motorized uses	ALL	All motorized uses
			ATV/ORV	4WD all terrain vehicles - double-track
			MOTORCYCLE	Motorcycle only - single-track
			NONE	No motorized uses allowed
1	TS_NONMOTOR	Non motorized uses	ALL	All non-motorized uses, no restrictions
			PED	Any pedestrian activity (walking, running, hiking)
			PED, BIKE	Pedestrian and bike, no horse
			BIKE	Bicycling only
			BIKE, HORSE	Bike and horse, no pedestrian
			HORSE	Horseback riding only
			PED, HORSE	Pedestrian and horse, no bike
			NONE	No non-motorized uses allowed
1	TS_SNOW_USE	Additional uses with snow cover	ALL	All motorized uses
			SNOWMOBILE	Snowmobile
			X-COUNTRY SKI	Cross country ski
			NONE	No motorized uses allowed
2	TS_ADA	Accessibility guideline compliance status for trail segments that are actively managed for pedestrian use.	ACCESSIBLE	Trail segment meets current agency accessibility guidelines.
			NOT ACCESSIBLE	Trail segment determined ineligible to meet current agency accessibility guidelines.
			NOT EVALUATED	Trail segment not evaluated for accessibility.
2	TS_PET_ACCESS	Conditions/constraints on bringing pets (esp. dogs) to the trail segment. Horses are not defined in this context as pets. Horse access is defined in the "TS_NONM_USE" field.	YES	Pets can be brought on the trail segment - check location URL for details on specific restrictions
			YES, LEASHED	Pets are allowed with a leash.
			YES, VOICE CONTROLLED	Pets are allowed, if voice controlled.
			NO PETS	No animals can be brought on the trail segment
3	TS_ACC_COMMENTS	Additional comments on access to the trail segment	(hand entry)	Place for managers to add additional information about access to the trail segment and any additional specific conditions/restrictions that must be met

Trail Segment Administration/Management

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
2	TS_PARKNAME	Name of park where segment is	(COMaP)	
2	TS_MANAGER	Agency that has long-term responsibility for management of the trail segment	BIA	Bureau of Indian Affairs
			BLM	Bureau of Land Management
			BOR	Bureau of Reclamation
			CITY	City
			COE	Corps of Engineers
			COUNTY	County, Parish, Borough
			DOD	Department of Defense
			DOE	Department of Energy
			DOW	Division of Wildlife
			FAA	Federal Aviation

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
			FS	Forest Service
			FWS	Fish and Wildlife Service
			HOA	Home Owners Association
			JOINT	Joint City/County management
			METRO	Metro Disctrict
			NPS	National Park Service
			OTHER FED	Federal agencies other than USFS, NPS, BLM
			PRIVATE	Private - Non-government agency or entity
			REC	Recreation districts
			STATE	State
			TRIBAL	Tribal
			UTILITY	Utilities
			OTHER	Other
1-D	**TS_OWNER**	COMaP owner field - incidates who owns the land	(GIS generated from COMaP)	
3	**TS_STATUS**	Current physical state of being of the trail segment	**OFFICIAL**	Offical & currently existing
			PLANNED	Planned
			DECOMISSIONED	Decommisioned
			TEMPORARILY CLOSED	Temporarily closed
			SOCIAL	Non-offical social trail (intended for manager use/view only)
3	**TS_ROW**	Right of ways, permits, easements that exist or are needed along the trail segment.	**AUTHORIZATION NEEDED**	Authorization needed
			EASEMENT	Exisiting easement
			FEE	Fee simple
			LEASE	Existing lease
			LICENSE	License
			OTHER	Other
			PERMIT	Existing permit
			TEMP EASEMENT	Existing temporary easement
3	**TS_ROW_END**	End date of Right of ways, permits, easements that exist or are needed along the trail segment.	(hand entry)	
3	**TS_URL_MGR**	A URL link to appropriate web page of segment manager	(hand entry)	

TRAIL ROUTE

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Trail Route Classification

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1-D	**TR_ID**	Unique route identification number generated by the GIS. Implementation by 1) a list of the TS_IDs that compose the trail route or 2) a "multi-part" polyline that can represent the multiple segments as a single polyline inside the GIS shape	(GIS generated)	
3	**TR_NAME**	Name that the trail route is known by	(hand-entry)	
1-D	**TR_MIN_ELEV**	Lowest elevation on the trail route	(database calculation)	
1-D	**TR_MAX_ELEV**	Highest elevation on the trail route	(database calculation)	
1-D	**TR_NET_ELEV**	Recorded elevation change of the trail route (meters)	(database calculation - difference)	
	TR_NET_SLOPE			
	TR_DIFFICULTY			
1-D	**TR_SURFACE**	Compile all the segments' different surface types	(database calculation - sum)	
3	**TR_DESCRIPTION**	Paragraph description of the trail segment	(hand-entry)	

TRAILHEAD

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Trailhead Classification

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1	**TH_NAME**	Name that the trailhead is officially or legally known by	(hand-entry)	
1-D	**TH_TR_LENGTH_MI**	Sum of length of associated trails	(GIS generated - sum)	
2	**TH_ADA**	Is the trailhead ADA accessible	**YES**	Yes, the trailhead is fully ADA accessible
			NO	No, the trailhead is not fully ADA accessible
3	**TH_PARK_SPACES**	Total number of parking spots	(hand-entry)	
3	**TH_ADA_SPACES**	Total number of handicapped-accessible parking spots	(hand-entry)	
3	**TH_LONG_SPACES**	Number of parking spots capable of handling trailers, buses, or other larger vehicles	(hand-entry)	
3	**TH_DESCRIPTION**	Paragraph description of the trailhead area	(hand-entry)	

Each item will represent a single geospatial point, with a comment field attached for additional information.

MISC. POINT FEATURES

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Points

Priority	Group Name	Group Definition	Point Names	Point Definition
3	**PT_INTERSECT**	Intersection with another trail	**With official trail**	
			With road	
			With social trail	
			With parallel trail	

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
3	**PT_FACILITY**	Trailhead and site facilities	**BENCH**	Bench
			BIKE RACK	Bike rack
			BOAT RAMPS	Boat ramp
			CABIN/YURT	Cabin/Yurt
			CAMPGROUND	Campground
			COVERED SHELTER	Covered pavilion / Shelter
			EQUINE FACILITIES	Equine facilities -- tie ups
			FORT	Fort
			GRILLS	Grills
			MEMORIAL	Memorial
			MINE/QUARRY	Mine / quarry
			MONUMENT	Monument
			OTHER	Other facility
			OTHER POI (CONSTRUCTED)	Other constructed point of interest
			PICNIC TABLE	Picnic tables
			POTABLE WATER	Potable water
			PUBLIC TRANSIT STOP	Public Transit stop - Bus or commuter rail
			RANGER STATION	Ranger station
			REFRESHMENTS	Refreshments
			RENTALS	Rentals
			TOILET	Toilet
3	**PT_INTERP**	Interpretive Information	**INTERPRETIVE SIGN**	Interpretive sign
			MAP	Map of area or trails
			OTHER INFO	Other information
			PHOTOGRAPH	Photograph
			REGULATIONS	Rules, regulations for use
			SCHEDULED INFO	Description of scheduled information or events
			TRAIL MARKER	Trail marker
3	**PT_MANAGE**	Features related to management of the trail and facilities	**ACCIDENT**	Accident incident
			ANIMAL ENCOUNTER	Area with frequent animal encounters
			ATTACK/ASSAULT	Personal attack/assault
			CAUTION AREA	Area that managers want to warn visitors about
			CITATION	Citation description
			SEARCH/RESCUE INCIDENT	Search-and-rescue incident
			SENSITIVE AREA	Ecological, historic or other sensitive areas
			TEMPORARY CLOSURE/RESTRICTION	Temporary trail closures/restriction
			OTHER	Description of other incidents (break-in, burglary, vandalism, trespass, etc.)
3	**PT_NATURAL**	Natural features	**GLACIER**	Glacier
			MOUNTAIN PASS	Mountain pass
			MOUNTAIN PEAK	Mountain peak
			OTHER POI (NATURAL)	Other natural point of interest
			OVERLOOK	Overlook
			RAPIDS	Rapids
			RIVER CROSSING	River crossing
			SPRING	Spring
			WATERFALL	Waterfall
3	**PT_ADA**	ADA accessibility features	**BLIND WALK**	Trail designed to allow a blind person to follow a rope along the trail
			ELEVATED TENTPADS	Elevated Tent Pads
			FISHING RAMP	Fishing ramp that allows a wheelchair easy access into a river/creek
			OBSTACLE	Obstacle (narrow bridge, stream crossing, natural logs across trail, steep steps, broken concrete)
			OTHER	Other ADA feature
3	**PT_USERFEED**	User provided / Prompted questions	**EXPERIENCE**	User shared experiences at the trail / park
			FACILITIES COMMENTS	User shared comments on the facilities
			PEER DIFFICULTY	User-evaluation of the trail difficulty rating
			PEER OPINIONS	User advice, opinions about the trail / park
			PROBLEMS	User shared problems
			SUGGESTIONS	User shared suggestions for improvements
			OTHER	Other comments

METADATA

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These attributes will be appended to each of the Trail Segment, Trailhead, and Miscellaneous Point features listed above

Data Collection

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1	**MD_SOURCE_TYPE**	Type of source used for **spatial** data	**GIS**	GIS
			GPS	GPS tracks
			CAD	CAD
			PDF	PDF
			ART	Art
			DIGITIZE	Digitize "heads up"
			PAPER	Paper
			MAP	Map traces
			DRG	Digital raster graphics (DRGs)
			SAT IMAGE	Satellite images
			DEM	DEMs
			XSECTION	Cross-sections
1	**MD_SPATIAL_SOURCE**	Type of source used for spatial trail data	**type and source, spatial data**	
1	**MD_ATTRIBUTE_SOURCE**	Type of source used for attributes	**type and source, attribute data**	

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1	**MD_SOURCE_SCALE**	Appropriate/associated scale	**5K**	1:5,000
			10K	1:10,000
			25K	1:25,000
			100K	1:100,000
1	**MD_SOURCE_GROUP**	Contributing group	**CTI Personnel**	CO Trails Inventory project team
			Children	Children
			Citizen science	Citizen science
			General public	General Public
			Land manager	Land manager
			Search/Rescue	Search and rescue team
			Volunteer	Volunteer group
3	**MD_SOURCE_NOTES**	Miscellaneous notes about the field	(hand-entry)	
1	**MD_AUTHOR**	Contact information for author	(hand-entry)	
1	**MD_SOURCE_DATE**	Date the field was created	yyyy/mm/dd	(8 character numeric: year/month/day)
1	**MD_UPDATE_AUTHOR**	Contact information for update author	(hand-entry)	
1	**MD_UPDATE_DATE**	Date the field was last updated	yyyy/mm/dd	(8 character numeric: year/month/day)

Appendix 3: E-Mail Solicitation and Contacts

Appendix III: Email Solicitation and Contact List

Hi (Name),

My name is Jaime Whitlock, project coordinator for the Colorado Trails Inventory project, a collaboration between Colorado State University and Colorado State Parks. The purpose of this email is to introduce you to the project and ask for your assistance. A GIS colleague at CSU referred me to you.

PROJECT INFORMATION
The overall goal is to 1) create a standardized, comprehensive inventory of all motorized and non-motorized trails in Colorado (Federal, State, County and City) and 2) make this information widely available to the public and land managers via a web-based site. Thus far we have completed a full feasibility study and have designed a robust spatial database to contain the trails inventory.

We are in year two of the three-year project. In this next phase of the project, we are charged with fully developing/populating the spatial database for all trails in Larimer County, the chosen pilot study area.

ASSISTANCE NEEDED
We are requesting geospatial trail and/or other ArcGIS geodatabase or shapefiles for your management areas within Larimer Country. Once we have the geospatial information in our system, we will get back in touch and you will have the option of adding additional information about your trails (i.e. trail surface type, access restrictions, interpretive info, descriptions, facility, management and interpretive information).

The primary types of information we are collecting are: 1) the trails themselves (polylines), and 2) miscellaneous point data (facilities, interpretive information, visitor safety information, etc).

Regardless of whether you have spatial information, ANY additional trail / park / area / facility information related to trails under your management in Larimer County would be very helpful. This might include spreadsheets with your trail inventory information, trail maps, lists of trails with official names, park or area guides, links to websites with management plans, helpful information, etc.

MORE INFORMATION
Attached are two reference documents:
1. Overview document explaining terminology for this project
2. The database dictionary – a comprehensive list of the attributes we are collecting in the database, along with descriptions and lists of values.

We understand we are asking for your time and effort and we very much appreciate it. We want to make this process as easy as possible. Please drop me an email or call and we can determine the best way to transfer the information. My contact information is below.

I will be following up with you in the next week or so. I look forward to working together and nice (virtually) meeting you!

All the best,

Jaime

_____

Jaime Whitlock – CSU project coordinator
jaime@dynamictrails.com 970.412.3653

Dave Theobald – CSU project leader
davet@warnercnr.colostate.edu 970.491.5122

Mailing -- Department of Human Dimensions of Natural Resources
c/o Jaime Whitlock or Dave Theobald
College of Natural Resources – Colorado State University
233 Forestry Building
Fort Collins, CO 80523-1480

CONTACT LIST: Agency Trail Data Sources for Larimer County

	Contact	E-mail	Phone
Federal			
Rocky Mountain National Park	Ron Thomas	ron_thomas@nps.gov	970-586-1292
National Park Service Intermountain Region Coordinator	Theresa Ely	theresa_ely@nps.gov	303-969-2653
USFS - Arapaho/Roosevelt National Forest - GIS Coordinator	Mary Hattis	mhattis@fs.fed.us	970-295-6616
USFS - Arapaho/Roosevelt National Forest - Canyon Lakes GIS	Janice Naylor	jnaylor@fs.fed.us	970-295-6769
State			
State Parks - Program Manager	Rob Billerbeck	rob.billerbeck@state.co.us	303-866-3203 x 341
State Parks - GIS Tech	Matt Schulz	matt.schulz@state.co.us	303-866-3203 x 345
CDOW	Chris Johnson	Chris.Johnson@state.co.us	970-472-4330
County			
Larimer - GIS Group Manager	Jeff Rulli	jrulli@larimer.org	970-498-5000
Larimer - GIS Specialist	Art Shumaker	aschumaker@larimer.org	
City			
Fort Collins - GIS Programmer/Analyst	Katy Carpenter	kcarpenter@fcgov.com	970-416-2048
Loveland - GIS Senior Specialist	Terry Giles	gilest@ci.loveland.co.us	970-962-2646
Loveland - Parks Planner	Chad Giron	gironc@ci.loveland.co.us	970-962-2455
Estes Park - Utilities Director	Bob Goehring	bgoehring@estes.org	970-577-3580
Estes Park - Tourist Office	Suzy Blackhurst		970-577-9900
Estes Park - Director, Estes Valley Recreation and Park District	Stan Gengler	sgengler@evrpd.com	970-586-8191
Estes Park - Town of Estes Park	Greg Sievers	gsievers@estes.org	970-577-3586
Berthoud - Parks & Rec Director	Jeremy Olinger	berthoudrecreation@hotmail.com	970-532-1600

Appendix 4 (a & b): Volunteer Packet and GPS Data Shell

Colorado Trails Inventory (CTI):

Larimer County Pilot Project

March 3, 2008

The purpose of the Colorado Trails Inventory (CTI) Project is to create a substantive and consistent spatial database of trails within the state of Colorado. Colorado State University is charged with carrying out the initial pilot phase of the project, by establishing such a spatial database of trails within Larimer County. Trail data include the "lines" of the trails themselves, attributes associated with each trail (including surface type, uses, accessibility, etc.), and points of interest—both natural and built—along the trails.

To date, much of the spatial and attribute data have been gathered from various agencies that manage trails within the county. These have been compiled into a consistent format, as much as possible. However, because the various agencies gather and manage their data differently, there are significant gaps in the data for our purposes. This is where volunteers can help.

We would like volunteers to hike (or bike or ride) along the trail, gather information (using a GPS receiver as well as written or 'spoken' field notes), and submit their observations back to us. A process has been developed to assist volunteers in this task. Essentially, individuals or groups will:

- select a trail or trails to visit,
- complete the Volunteer Cover Sheet which includes information about the TRAILHEAD where you begin,
- use a GPS receiver to record (mark) waypoints of significant features,
- take note of what is found at each waypoint marked (either on paper or with a voice recorder),
- return home and download the waypoints onto a computer,
- paste these points into an Excel spreadsheet ("GPSdatashell.xls," provided),
- fill in the spreadsheet by inputting what was observed at each location,
- save the spreadsheet, and
- email it to us along with the Volunteer Cover Sheet.

As this is a pilot project, we most certainly welcome any feedback about the process described here. Please send any comments to Sophia Linn, CTI Project Coordinator, at: Sophia.linn@colostate.edu (Phone: 970-491-6816/ office or 970-443-7893/cell)

Colorado Trails Inventory:

How to Gather and Submit Field Data

GPS Requirement:

To gather data for the Colorado Trails Inventory, you should be comfortable using a GPS receiver, marking waypoints, and downloading the recorded waypoints onto a computer. Although GPS receivers vary greatly, the collection methods described here should be suitable for any GPS receiver.

GPS Setup:

Set your GPS receiver to record data in:

- Decimal degrees (hddd.ddddd)
- WGS 84 datum

Optional: Reset TRACKS so you can record your track from the beginning of your hike.

Data to Collect:

There are two general types of data that should be collected, recorded, downloaded and submitted: POINT data and TRAIL data.

1. POINT data refers to any point of interest observed along the trail. These include: significant natural or man-made features, interpretive signs, or facilities such as water, bathrooms, phones, etc.

2. TRAIL data include qualities of the trail itself; that is, its surface type, permitted uses, accessibility, and intersections with other trails.

Refer to the page entitled "Things to Look For" for a more thorough list of the kinds of features to record.

Marking Waypoints:

To simplify data collection, you will mark all data observations (either POINT or TRAIL) with a waypoint on your GPS receiver. Each observation you make needs to have its own unique waypoint number which is automatically generated by the GPS receiver. Write down (or speak into your voice recorder) the following information:

1. the waypoint ID number (as generated by your GPS),
2. whether the waypoint identifies a POINT of interest, or a TRAIL segment change,
3. what the waypoint is marking (a brief description, referring to the "Things to Look For" sheet, as needed)
4. Any additional comments or observations you have regarding that point.

NOTE: Each trail change or point of interest needs to have its own unique waypoint ID number. For instance, if you come to a trail *intersection* that has an interpretive *sign* and a *bench*, you would need to mark THREE unique waypoints: 1) intersection, 2) interpretive sign, and 3) bench.

Using a Trail Map:

In addition to using a GPS receiver to record waypoints, you may also choose to bring along a printed copy of a topographic map (or aerial photo) of the trail area to write on.

Getting Started:

<u>Trailhead:</u> When you arrive at the trailhead, complete the Trailhead section on the "Volunteer Cover Sheet", including:

- Trailhead name
- Date and time of visit
- Waypoint ID
- Parking lot information
- Note that this information pertains to the trailhead itself, not the actual trail.

Trail START point:
At the beginning of an actual trail, take a waypoint reading and record that waypoint ID as the first TRAIL waypoint. Be sure to gather as much information as you can about the qualities of the trail, as all subsequent changes you observe will be related back to those original trail conditions. Refer to the **Trail Segments** list on "Things to Look For." Continue to mark waypoints, as described above. If you back track along the same trail, you do not need to mark the same features again.

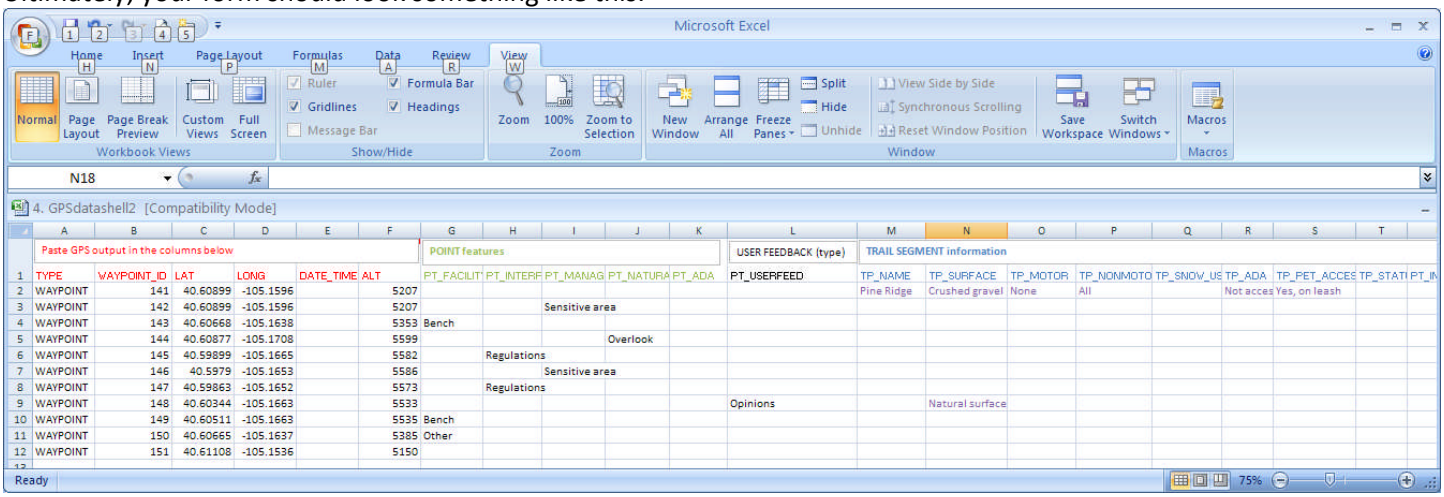
Downloading Waypoints and Tracks:

To download waypoints from your GPS receiver onto a computer, you will need a download cable and software that will enable your computer to connect to the GPS receiver. You may have software that is specific to your GPS (such as MapSource for Garmin), but also note that there are a variety of free software programs that will also download GPS data (e.g., *DNR Garmin* is a freeware package that is simple and generally effective.) Basically, you will connect the GPS to your computer via the cable, launch the software program, and "download waypoints." The waypoints, including their ID number and latitude/longitude (plus some other info) should be transferred and displayed in a series of columns. These columns can then be copied and pasted into an Excel spreadsheet. *Optional: you may also download your TRACKS of the relevant trails and send those to us separately.*

Open the Excel spreadsheet provided, called **GPSdatashell**. This is where you will paste the waypoint data that you just downloaded from your GPS and where you will input your field observations.

Copy and paste the downloaded waypoints and their relevant columns from the GPS data into the "matching" columns. (These include: TYPE, ID, LAT (Y), LONG (X), TIME/COMMENTS, ALTITUDE). Disregard the other columns from the waypoint download. Once you have the waypoint information in the spreadsheet, refer to your field notes (or recorder) to input the observations you made—referring to the WAYPOINT ID. Simply type in (or use the drop-down lists) to complete the cells for each waypoint. Refer to the "Things to Look For" sheet to see the available options. NOTE: You do NOT need to fill in all of the cells! Just fill in the relevant columns for each of the waypoints taken.

Ultimately, your form should look something like this:



When you have finished, save the file and give it a new name--something like: GPSdata _trailname.xls

Volunteer Cover Sheet: Complete the Volunteer Cover Sheet, and submit it along with your field data.

Send it in! Send your files as email attachments to: sophia.linn@colostate.edu
Phone: 970-491-6816 or (cell) 970-443-7893. Thanks very much for participating!

Colorado Trails Inventory:

Volunteer Cover Sheet

VOLUNTEER INFO

Your name:

Phone:

Email:

Group:

Date:

Start time:

End time:

GPS receiver used (model):

TRAILHEAD INFORMATION: **Waypoint ID#?**

Trailhead name:

ADA/Handicap accessible?

Number of handicap spaces:

Number of long vehicle spaces:

Total number of parking spaces:

Facilities/Information:

Trail(s) followed:

Description of trail(s):
(256 character max.)

Things to Look For

TRAIL SEGMENTS *(mark the point where trail changes)*

Surface Type
(TP_SURFACE)
1. Natural surface
2. Crushed gravel
3. Paved
4. Wood
5. Bridge
6. Other

Motorized
(TP_MOTOR)
1. All
2. ATV/OHV
3. Motorcycle
4. None

Non-motorized
(TP_NONMOTOR)
1. All
2. Ped only
3. Ped, bike only
4. Bike only
5. Bike, horse only
6. Horse only
7. Ped, horse only
8. None

Additional Snow Uses
(TP_SNOW_USE)
1. All
2. Snowmobile
3. X-country ski
4. None

ADA Accessible
(TP_ADA)
1. Accessible
2. Not accessible
3. Not evaluated

Pet Access
(TP_PET_ACCESS)
1. Yes, pets allowed
2. Yes, on leash
3. Yes, voice control
4. No pets allowed

Trail status
(TP_STATUS)
1. Official
2. Planned
3. Decommissioned
4. Temporarily closed
5. Social trail

Intersection
(PT_INTERSECT)
1. With official trail
2. With road
3. With social trail
4. With parallel trail

POINTS OF INTEREST

Facilities
(PT_FACILITY)
1. Bench
2. Bike rack
3. Boat ramps
4. Cabin/yurt
5. Campground
6. Covered shelter
7. Equine facilities
8. Fort
9. Grills
10. Memorial
11. Mine/quarry
12. Monument
13. Other (built/non-natural)
14. Picnic tables
15. Potable water
16. Public transit stop
17. Ranger station
18. Refreshments
19. Rentals
20. Telephone
21. Toilet

Interpretive information
(PT_INTERP)
1. Interpretive sign
2. Map
3. Other info
4. Photograph
5. Regulations
6. Scheduled info
7. Trail marker

Management issues
(PT_MANAGE)
1. Accident
2. Animal encounter
3. Attack/assault
4. Caution area
5. Citation
6. Search and rescue
7. Sensitive area
8. Temp closure/ restriction
9. Other

Natural features
(PT_NATURAL)
1. Glacier
2. Mountain pass
3. Mountain peak
4. Other point of interest (natural)
5. Overlook
6. Rapids
7. River crossing
8. Spring
9. Waterfall

ADA (disability access)
(PT_ADA)
1. Blind walk
2. Elevated tent pads
3. Fishing ramp
4. Obstacle
5. Other

User Feedback
(PT_USERFEED)
1. Experience
2. Facilities
3. Trail quality
4. Opinions
5. Problems
6. Suggestions
7. Other

Field Data Input											
Paste GPS output in the columns below						POINT features					
TYPE	WAYPOINT_ID	LAT	LONG	DATE_TIME	ALT	PT_FACILITY	PT_INTERP	PT_MANAGE	PT_NATURAL	PT_ADA	PT_USERFEED
Drop Downs											
TS_SURFACE	**TS_MOTOR**	**TS_NONMOTOR**	**TS_SNOW_USE**	**TS_ADA**	**TS_PET_ACCESS**	**TS_STATUS**	**PT_INTERSECT**	**PT_FACILITY**	**PT_INTERP**	**PT_MANAGE**	**PT_NATURAL**
Natural	**All**	**All**	**All**	**Accessible**	**Yes, pets allowed**	**Official**	**With official trail**	**Bench**	**Interpretive**	**Accident**	**Glacier**
Crushed	**ATV/OHV**	**Ped only**	**Snowmobile**	**Not**	**Yes, on leash**	**Planned**	**With road**	**Bike rack**	**Map**	**Animal**	**Mountain pass**
Paved	**Motorcycle**	**Ped, bike**	**X-country**	**Not**	**Yes, voice controlled**	**Decommissione**	**With social trail**	**Boat ramp**	**Other info**	**Attack/assault**	**Mountain peak**
Wood	**None**	**Bike only**	**None**		**No pets allowed**	**Temporarily**	**With parallel trail**	**Cabin/yurt**	**Photograph**	**Caution**	**Other**
Bridge		**Bike, horse**				**Social trail**		**Campground**	**Regulations**	**Citation**	**Overlook**
Stairs		**Horse only**						**Covered**	**Scheduled**	**Entrance fee**	**Rapids**
Other		**Ped, horse only**						**Emergency call box**	**Trail marker**	**Search/rescue incident**	**River crossing**
		None						**Equine facilities**		**Sensitive area**	**Spring**

TRAIL SEGMENT information									COMMENTS	Name of photo
TP_NAME	TP_SURFACE	TP_MOTOR	TP_NONMOTOR	TP_SNOW_USE	TP_ADA	TP_PET_ACCESS	TP_STATUS	PT_INTERSECT		
PT_ADA	**PT_USERFEED**									
Blind	Experience									
Elevated	Facilities									
Fishing	Trail quality									
Obstacle	Opinions									
Other	Problems									
	Suggestions									
	Other									
Volunteer Cover Sheet										
VOLUNTEER INFO										
Your name:										
Phone:										
Email:										
Group:										
Date:										
Start time:										
End time:										
GPS receiver used (model):										
TRAILHEAD INFORMATION:										
Waypoint ID#										
Trailhead name:										
ADA/Handicap accessible?										
Number of handicap spaces:										
Number of long vehicle spaces:										
Total number of parking spaces:										
Facilities/Information:										
Trail(s) followed:										
Description of trail(s):										
(256 character max.)										

Appendix 5: Data Dictionary Modified

CO TRAILS DATABASE ATTRIBUTES AND LISTS OF VALUES

TRAIL SEGMENT

Trail Segment Classification				
Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1-D	**TS_ID**	Unique segment identification number generated by the GIS	(GIS generated)	
1	**TS_NAME**	Name that the trail segment is officially known by	(hand-entry)	
3	**TS_NAMEALIAS**	Alternate name(s) that the trail segment is known by	(hand-entry)	
1	**TS_NUMBER**	Official numeric or alphanumeric identifier for the trail segment	(hand-entry)	
1-D	**TS_LENGTH**	Recorded length (meters)	(GIS generated)	
1-D	**TS_MIN_ELEV**	Lowest elevation on the trail segment	(GIS generated)	
1-D	**TS_MAX_ELEV**	Highest elevation on the trail segment	(GIS generated)	
1-D	**TS_NET_ELEV**	Net elevation change over the trail segment (meters)	(database calculation - difference)	
1-D	**TS_NET_SLOPE**	Net slope of the trail segment	(database calculation - net elevation relief/length)	
2	**TS_DIFFICULTY**		Difficulty (D) = sqrt(relief or R)/100) x (segment length or S)	Values between 0 and 1, where 0 = easiest; 1 = most difficult
1	**TS_SURFACE**	Predominant surface types	**Natural surface**	Natural surface -- native materials/not imported
			Crushed gravel	Crushed gravel/Aggregate
			Paved	Asphalt/Concrete
			Wood	Wood planking/Boardwalk
			Bridge	Bridge
			Other	Other
			Unknown	Surface not known
			(proposed)	Trail not yet constructed; proposed
3	**TS_DESCRIPTION**	Paragraph description of the trail segment	(hand-entry)	Most often refers to URL link to website
1	**TS_URL**	URL link to additional information	(hand-entry)	
1-D	**TS_LENGTH_MI**	Recorded length (miles)	(converted from meters)	
1-D	**MIN_ELEV_FT**	Lowest elevation on the trail segment (feet)	(converted from meters)	
1-D	**MAX_ELEV_FT**	Highest elevation on the trail segment (feet)	(converted from meters)	
1-D	**NET_ELEV_FT**	Net elevation change over the trail segment (feet)	(database calculation - difference)	
1	**TS_MOTOR**	Motorized uses	**All**	All motorized uses
			ATV/ORV	4WD all terrain vehicles - double-track
			Single Track OHV	Motorcycle, single-track
			None	No motorized uses allowed
1	**TS_NONMOTOR**	Non motorized uses	**Ped, bike, horse**	All non-motorized uses, no restrictions
			Ped	Any pedestrian activity (walking, running, hiking)
			Ped, bike	Pedestrian and bike, no horse
			Bike	Bicycling only
			Horse	Horseback riding only
			Ped, horse	Pedestrian and horse, no bike
			None	No non-motorized uses allowed
1	**TS_SNOW_USE**	Additional uses with snow cover	**No additional uses**	No additional snow uses
			Snowmobile	Snowmobile
			X-Country Ski	Cross country ski

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
2	**TS_ADA**	Accessibility guideline compliance status for trail segments that are actively managed for pedestrian use.	**Accessible**	Trail segment meets current agency accessibility guidelines.
			Not accessible	Trail segment determined ineligible to meet current agency accessibility guidelines.
			Unknown	Trail segment not evaluated for accessibility.
			(Proposed)	Trail not yet built; proposed
2	**TS_PET_ACCESS**	Conditions/constraints on bringing pets (esp. dogs) to the trail segment. Horses are not defined in this context as pets.	**Yes**	Pets can be brought on the trail segment - check location URL for details on specific restrictions
			Yes, leashed	Pets are allowed with a leash.
			Yes, voice controlled	Pets are allowed, if voice controlled.
			No pets	No animals can be brought on the trail segment
2	**TS_PARALLEL**	Denotes whether trail is along road	**Bike lane along road**	
			Bike route on road	

Trail Segment Administration/Management

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
2	**TS_PARKNAME**	Name of park where segment is	(Hand entry)	Park name or name of city; general locator
3	**TS_MANAGER**	Agency that has long-term responsibility for management of the trail segment.	(COMaP)	Derived from COMaP, "MANAGER_DETAIL" field
1-D	**TS_OWNER**	COMaP owner-DETAILED field - incidates who owns the land	(GIS generated from COMaP)	Derived from COMaP, "OWNER_DETAIL" field
3	**TS_STATUS**	Current physical state of being of the trail segment	**Official**	Offical & currently existing
			Planned	Planned
			Decomissioned	Decommisioned
			Temporarily Closed	Temporarily closed
			Social	Non-offical social trail (intended for manager use/view only)
			(Other values allowed)	Under construction; Proposed; Closed until 2010

TRAILHEAD

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Trailhead Classification

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1	**TH_NAME**	Name that the trailhead is officially or legally known by	(hand-entry)	
2	**TH_ADA**	Is the trailhead ADA accessible	**Yes**	Yes, the trailhead is fully ADA accessible
			No	No, the trailhead is not fully ADA accessible
3	**TH_PARK_SPACES**	Total number of parking spots	(hand-entry)	
3	**TH_ADA_SPACES**	Total number of handicapped-accessible parking spots	(hand-entry)	
3	**TH_LONG_SPACES**	Number of parking spots capable of handling trailers, buses, or other larger vehicles	(hand-entry)	

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
3	**TH_DESCRIPTION**	Paragraph description of the trailhead area	(hand-entry)	

Each item will represent a single geospatial point, with a comment field attached for additional information.

MISC. POINT FEATURES

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Points

Priority	Group Name	Group Definition	Point Names	Point Definition
2	**PT_INTERSECT**	Intersection with another trail	**With official trail**	
			With road	
			With social trail	
			With parallel trail	
3	**PT_FACILITY**	Trailhead and site facilities	**Bench**	Bench
			Bike rack	Bike rack
			Boat ramps	Boat ramp
			Cabin/Yurt	Cabin/Yurt
			Campground	Campground
			Covered shelter	Covered pavilion / Shelter
			Equine facilities	Equine facilities -- tie ups
			Fort	Fort
			Grills	Grills
			Helicopter LZ	Helicopter landing zone
			Memorial	Memorial
			Mine/Quarry	Mine / quarry
			Monument	Monument
			Other	Other facility or constructed point of interest
			Picnic table	Picnic tables
			Potable water	Potable water
			Public transit stop	Public Transit stop - Bus or commuter rail
			Ranger station	Ranger station
			Refreshments	Refreshments
			Rentals	Rentals
			Toilet	Toilet
			Trash/recycling	Trash disposal or recycling bin
			Historic building	Historic building
3	**PT_INTERP**	Interpretive Information	**Interpretive sign**	Interpretive sign
			Map	Map of area or trails
			Other Info	Other information
			Photograph	Photograph
			Regulations	Rules, regulations for use
			Scheduled Info	Description of scheduled information or events
			Trail marker	Trail marker
3	**PT_MANAGE**	Features related to management of the trail and facilities	**Accident**	Accident incident
			Animal Encounter	Area with frequent animal encounters
			Attack/Assault	Personal attack/assault
			Caution Area	Area that managers want to warn visitors about
			Citation	Citation description
			Search/Rescue Incident	Search-and-rescue incident
			Sensitive Area	Ecological, historic or other sensitive areas
			Temporary Closure/Restriction	Temporary trail closures/restriction

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
			Other	Description of other incidents (break-in, burglary, vandalism, trespass, etc.)
3	**PT_NATURAL**	Natural features	**Glacier**	Glacier
			Mountain Pass	Mountain pass
			Mountain Peak	Mountain peak
			Other (Natural)	Other natural point of interest
			Overlook	Overlook
			Rapids	Rapids
			River Crossing	River crossing
			Seasonal creek crossing	Creek that may or may not have running water
			Spring	Spring
			Waterfall	Waterfall
3	**PT_ADA**	ADA accessibility features	**Blind Walk**	Trail designed to allow a blind person to follow a rope along the trail
			Elevated Tentpads	Elevated Tent Pads
			Fishing Ramp	Fishing ramp that allows a wheelchair easy access into a river/creek
			Obstacle	Obstacle (narrow bridge, stream crossing, natural logs across trail, steep steps, broken concrete)
			Other	Other ADA feature
3	**PT_USERFEED**	User provided / Prompted questions	**Experience**	User shared experiences at the trail / park
			Facilities Comments	User shared comments on the facilities
			Peer Difficulty	User-evaluation of the trail difficulty rating
			Peer Opinions	User advice, opinions about the trail / park
			Problems	User shared problems
			Suggestions	User shared suggestions for improvements
			Other	Other comments

METADATA

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These attributes will be appended to each of the Trail Segment, Trailhead, and Miscellaneous Point features listed above

Data Collection				
Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
1	**MD_SOURCE_TYPE**	Type of source used for **spatial** data	**GIS**	GIS
			GPS	GPS tracks
			CAD	CAD
			PDF	PDF
			ART	Art
			DIGITIZE	Digitize "heads up"
			PAPER	Paper
			MAP	Map traces
			DRG	Digital raster graphics (DRGs)
			SAT IMAGE	Satellite images
			DEM	DEMs
			XSECTION	Cross-sections
1	**MD_SPATIAL_SOURCE**	Type of source used for spatial trail data	(hand entry)	type and source, spatial data
1	**MD_ATTRIBUTE_SOURCE**	Type of source used for attributes	(hand entry)	type and source, attribute data
1	**MD_SOURCE_GROUP**	Contributing group	**Agency GIS department**	GIS department of managing agency

Priority	Attribute Name	Attribute Definition	List of Values (LOV) Names	LOV Definition
			CTI Personnel	CO Trails Inventory project team
			Children	Children
			Citizen science	Citizen science
			General public	General Public
			Land manager	Land manager
			Search/Rescue	Search and rescue team
			Volunteer	Volunteer group
3	**MD_SOURCE_NOTES**	Miscellaneous notes about the field	(hand-entry)	
1	**MD_AUTHOR**	Contact information for author	(hand-entry)	
1	**MD_SOURCE_DATE**	Date the field was created	yyyy/mm/dd	(8 character numeric: year/month/day)
1	**MD_UPDATE_AUTHOR**	Contact information for update author	(hand-entry)	
1	**MD_UPDATE_DATE**	Date the field was last updated	yyyy/mm/dd	(8 character numeric: year/month/day)

Appendix 6: Submitting New Data

Appendix VI: How to Submit New Data into the Trails Inventory

There are a number of ways to submit additions or edits to the trails inventory, depending on the purpose and the agency or individual who is submitting the data.

From agencies or managers, data may be submitted as:

- Periodic/annual updates from agencies, trail managers, in GIS format, or
- Real-time or temporary issues: emergency, trail conditions, etc.

From the public or volunteers, data may be submitted as:

- Observations and input to online maps via Google Earth (send in .kmls)
- Comments in Google Maps ("comments" balloon)
- As GPS waypoints using the GPS spreadsheet "shell."

AGENCIES AND MANAGERS:

- Periodic/annual updates:

Agencies submit GIS data periodically. (Similar process as COMaP). CO Trails personnel send out periodic requests to trail managers and/or agencies for their most up-to-date GIS data. The data dictionary is provided so they know what attributes are included in the inventory. Also, definitions of trail segments, trail heads, and miscellaneous points are included.

Data will be submitted to a GIS technician who will follow the processes for editing and appending the new data to the trails inventory.

- Real-time or temporary issues:

Use Google Earth to mark points and submit .kmls to the inventory or to private "viewing" for your specific agency (such as search and rescue).

PUBLIC OR VOLUNTEERS:

- Submit GPS Data

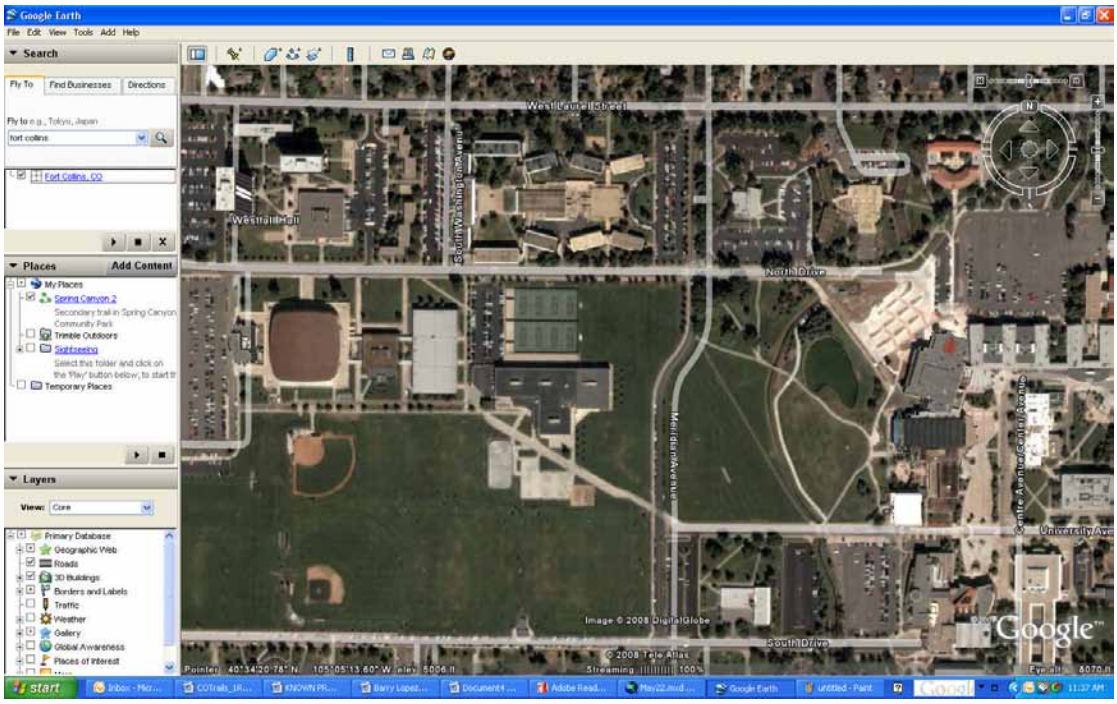
Full details are provided in Appendix V: Volunteer Guidelines

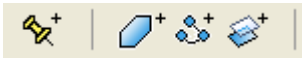
- Submit New Trails or Comments via Google Earth

This method could be used by any user who may have comments or corrections to suggest. This requires coordination and management (personnel!) who can manage any inputs. Some of these comments can be made available in a User Comments area; other comments can be reviewed and incorporated into the inventory database.

How to Submit New Trails, Points or Comments to the Trail Inventory via Google Earth

Launch the Google Earth application and zoom in to the area where you want to create a new trail segment. In this example, we will draw in a bike trail on the campus of Colorado State University.



Notice the tool bar above the image: 

Each of these tools allows you to add or create a different type of feature in Google Earth:

-  a point (or placemark),
-  a polygon,
-  a line (or path)
-  or an image overlay.

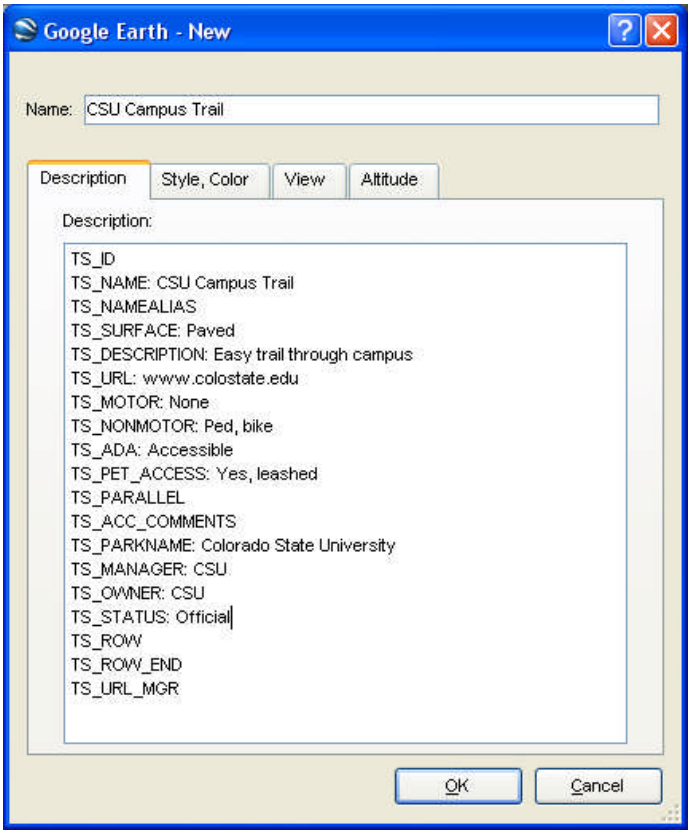
In this example, we will create a new trail segment which is a line (or path).

Select the tool by clicking once on the button.  A new window will open. Where it says **Name: Untitled Path,** type in a name for the new segment you will create. In this example, we'll use "CSU Campus Trail."

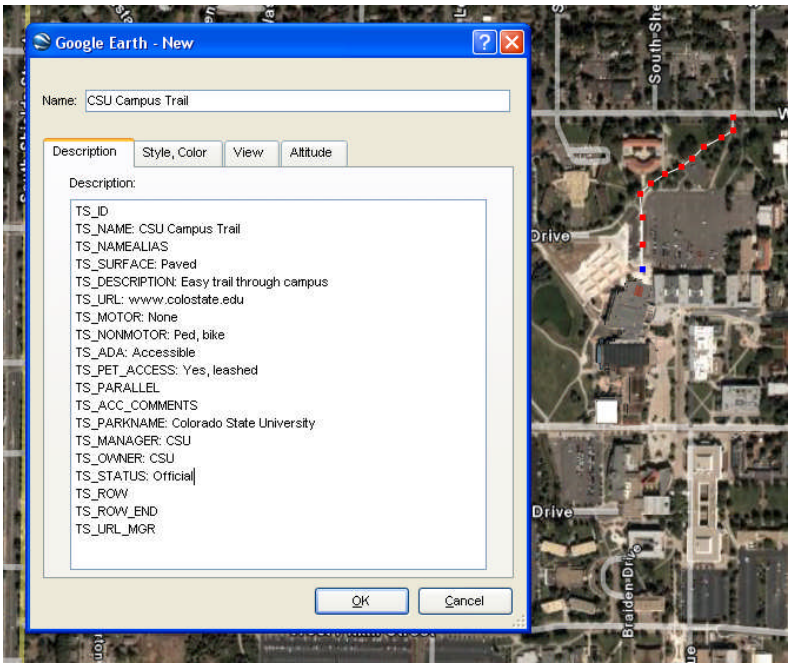
Paste the following list into the Description box and then fill in as many attributes as you can. (Don't worry if you can't fill in all of the attributes.)

TS_NAME
TS_NAMEALIAS
TS_SURFACE
TS_DESCRIPTION
TS_URL
TS_MOTOR
TS_NONMOTOR
TS_ADA
TS_PET_ACCESS
TS_PARKNAME
TS_MANAGER
TS_OWNER
TS_STATUS
TS_URL_MGR

MD_SOURCE_TYPE
MD_SPATIAL_SOURCE
MD_ATTRIBUTE_SOURCE
MD_SOURCE_SCALE
MD_SOURCE_GROUP
MD_SOURCE_NOTES
MD_AUTHOR
MD_SOURCE_DATE
MD_UPDATE_AUTHOR
MD_UPDATE_DATE
(or simply Your Name, Affiliation, Phone, Email)



With that box still open, move your cursor back onto the map and begin digitizing along the path where your new trail segment should be.



When you are finished with your first segment, click OK. You will now see your new feature called “CSU Campus Trail” in the contents of the Places box. If you click on its name, you will “fly” to your new trail and the balloon window will open with your descriptions inside.

To send this new trail line and the accompanying details to the Colorado Trails Inventory, simply right click on the new trail name and select “Email.” This will launch your email program and attach the newly created .kml file to the email. Send the email to: <comap@nrel.colostate.edu>. That’s it!

Once we receive it, the .kml will be brought in to ArcGIS using an XTools Pro conversion. This will enable us to view the new data, evaluate it, and include it in the inventory.

Appendix 7: Data Management

Appendix VII: Technical Document: Data Management and Importing New Data

The original Data Dictionary (Appendix II) guided the development of the geodatabase. All of the trail data is contained in one geodatabase, in one feature dataset, with four feature classes. The feature classes represent **trail segments, trail routes, trailheads, and miscellaneous points**. (Note that "trail routes" is a place holder at this point. In theory, it could be something generated "on the fly" by combining connecting trail segments. Alternatively, it could simply combine trail segments with the same name, or other attribute.) The Data Dictionary provides details about each of the feature classes, their attributes and list of values (LOV).

Below are specific comments on each of the feature classes (except for trail routes).

TRAIL SEGMENTS

Field name:

tr_segments

Geometry:

polyline

Number of Attributes:

40

Attribute types:

Attributes are either numbers (integers, short, float or date) or text.

Comments:

At first we tried to associate DOMAINS with each attribute field so that there would always be consistency with the values in that field. For example, domains for the feature class of **tr_segments** and the FIELD of **TS_SURFACE** would be:

1 = Natural surface
2 = Crushed gravel
3 = Paved
4 = Wood
5 = Bridge
6 = Other

The reason behind this was to enable easy data input. That is, if a trail segment was paved, the input in that cell would simply be "3."

The original geodatabase was set up like this. However, because the domain value was a SHORT INTEGER, an integer is the only type of value that could be put into that cell. That is great for consistency sake. However, when trying to cross-walk data from different agencies, it is easier to use the Field Calculator to equate the values from the existing dataset into our pre-defined fields. This usually required that the field's data type be able to accept text values.

In discarding the use of domains, it became essential that our typing be very good! We relied on summarizing the values in each field (at the end) to see what values actually were typed in. This allowed us to go back and make typo/editing changes to ensure consistency of values. Examples: Picnic Tables vs. Picnic table. This would not have been a problem if domains were used. Domains may indeed be a viable option in the future, and may be worth exploring further.

TRAILHEADS

Field name:

trailheads

Geometry:

point

Number of Attributes:

19

Attribute Types:

Numbers (short or date) and text.

Comments:

Most of the points in this feature class were derived from consulting paper maps, digitizing the points, and overlaying them on NAIP imagery to verify the location and, in some cases, to count visible parking spaces. This did not allow for additional attribute information, such as ADA or long vehicle spaces, or trailhead description. Additional field observations would provide additional attribute information. Volunteers could provide these data.

MISCELLANEOUS POINTS:

Field name:

misc_points

Geometry:

point

Number of Attributes:

22

Attribute Types:

Numbers (short or date) and text

Comments:

Most of the miscellaneous points were gathered by our staff and by volunteers. Waypoints were recorded by GPS receivers, downloaded and copied into an Excel spreadsheet "shell," (see Appendix V: Volunteer Guidelines) where attributes were selected from drop-down menus. The file was saved in a .csv format and then imported into ArcMap ("Display x,y data"), where the data was then exported as a "temporary" feature class in the CO Trails geodatabase. Metadata fields were then added so that details about the data and contributor could be included. Once checked and edited as needed, this "temporary" feature class was "appended" to the feature class called "misc_points," thereby incorporating it into the trails inventory.

Similar to the trail segments, we had tried setting up the miscellaneous points feature class with 'domains' such that each possible value was given a short integer identifier (e.g., 1 = Bench; 2 = Bike rack, etc.) However, for similar reasons as explained above, it was easier overall to have text fields (instead of short integers) to attribute the fields. To ensure some consistency, though, we created a shell in Excel that had "drop-down" menus for every possible option in a field. When the GPS waypoints were copied in to the WAYPOINT ID, and LAT/LONG fields in the shell, the user could simply tab to the relevant FIELD and use the drop-down menus to record their observation. The values came across cleanly and consistently, and were easily incorporated into the miscellaneous points feature class. One note: We allowed, and even welcomed, volunteers to mark additional point features during this pilot because it enabled us to see what observations they thought were "important" on a trail. We could then decide whether or not to include those observations and, consequently, to add any new values to the LOV.

Some volunteers found inputting data into the spreadsheet to be tedious, and suggested Access as another option. This could be explored.

Importing New Data into ArcGIS:

Processing data from an agency GIS department

- Open the dataset (shapefile, coverage, geodatabase) in ArcMap and explore the data to see what you have. Check out the quality of the line work; open the attribute table to see what fields and values are included. Assess the level of compatibility with the CO Trails geodatabase.
- Ensure the projection is the same as the one you desire (NAD 83, UTM zone 13—for Northern Colorado). Look at the line segments first and determine whether or not it would be better to re-digitize or to edit the existing. Determine this before filling in all of the attributes for each trail segment.
- Modify line work and points (geometry)
    - If provided with line segments, make sure they are not "multipart." Break apart each line segment as needed by using the "Explode Multipart Feature" in the Advanced Editing Toolbar. (Data Management Tools > Features>Multipart to singlepart.)
    - If you get segments with too many vertices and you want to simplify the lines, you can use the "generalize" tool in the advanced editing toolbar. This CAN be done "globally." Also, by using the "properties" of the line segments, you can see how many vertices there are and how many "parts." This is interactive so you can see where the parts are.
    - Editing lines: Utilize the Advanced Editing Toolbar to get rid of unnecessary nodes and to smooth lines. Fiddle around the maximum tolerance numbers such that the line looks the way you want it to. If you want to retain attributes, you can merge line segments to get those attributes, then split the lines where it needs to be split (i.e., at official intersections)
    - Use NAIP imagery and/or Google Earth to better align trails, where you can see them.
- Modifying attributes (the information about the features)
    - Models were created (using Model Builder) to add the appropriate fields to each feature class. Run the appropriate model (either for trail segments, trailheads or miscellaneous points) so that your new dataset has the necessary fields in the correct format. Then use the Field Calculator to populate the new fields with the data from the original dataset. In addition, there is a model to add metadata fields. This model should be applied to all feature classes, as the metadata information is the same for all.
    - Save this feature class in an "Agency Original" folder so that you can reference back to it if necessary. Then, use the "Append" tool to add this new data into your inventory feature class. This will add the new data to the inventory.

Processing GPS points:

- Open GPS "shell" in Excel and read through entries. Make adjustments as needed to ensure that the cells are filled in as well as possible with the drop-downs.
- Save the document as a .csv file.
- From ArcMap, add data. Select the .csv file you just created. It will come in in the "Source" tab (because it still doesn't know where it is). Right-click on its name and select "Display x,y data." Make sure that x = Longitude and y = Latitude. Set the projection to: **Geographic, World, WGS84** It will then appear in the Display window as an Event. Take this Event and export it as a feature class into your geodatabase. (Create a feature dataset called "GPS_originals"). Your field names should be OK, but you should ADD IN THE METADATA FIELDS ASAP and fill in the cells with information from the volunteer cover sheet.

- Once this is done, use the Append tool (Data Management →General→Append), and append your new feature class to the feature class entitled "misc_points." By using "Append… NO TEST" you can perform "Field Mapping" to align field names that may not be exactly the same.
- Also, from the Cover Sheet, you can also get information about the TRAIL HEADS. Essentially, you can find the trailhead point from the GPS data (usually). Copy and paste that point into the trailhead feature class, and then input the attributes from the cover sheet. (Also, look at the trailhead in NAIP or GE.)

Working with other Datasets:

COMaP data:

- To determine which properties a trail crosses, use the COMaP dataset (Colorado Ownership, Management and Protection).
- Perform a spatial join on the trail segments with a clipped version of COMaP (on Larimer County). "Give line all attributes of the polygon" that is "closest to it." Then used the Field Calculator to populate the "TS_OWNER" and "TS_MANAGER" fields in the tr_segments feature class with the "OWNER_DETAIL" and "MANAGER_DETAIL" fields from COMaP.

Using DEMs to calculate elevation:

- First, convert the trail segments (ts_segments) to a raster, keeping the TS_ID as the field.
- Then used Zonal Statistics to Table (in Spatial Analyst), with input zone being the new raster of the trail segments, the field being "value" and then the "value raster" as the DEM (in this case, Larimer_10m). This generates a table of those statistics.
- Join this back to tr_segments by TS_ID. Then, use the Field Calculator to move the cell values into the appropriate columns.
- These elevation values will come in as meters (from the DEM). There are fields in the ts_segments feature class for both meters and miles. Simply calculate across as needed.

NOTE: Be cautious of tiny segments that do not get any elevation readings. This is because of the cell size/resolution and the size of the trail segments (that is, the segments are smaller than the cell size, i.e., less than 10 meters.)

One way to manage this is to calculate segment lengths (with many decimal points) then sort to find those that are miniscule and check to see if they are legitimate. If not, delete them. Then redo the convert to raster using a cell size of 10 meters. Then do zonal stats again and see if you "catch" all of the line segments this time.

CHAPTER 3

CONCLUSION AND NEXT STEPS

Colorado State Parks

CONCLUSIONS AND NEXT STEPS

Overview of Challenges and Solutions

With the completion of the Phase II work items there now exists a rudimentary structure for digitizing and posting a comprehensive recreational trails compendium on the Web. The next step is to refining this initial working system developed by CSU into a consumer-friendly format that is accessible, highly appealing and easy to use by both the general public and local trail managers.

The second and more daunting challenge is to build the content. To be meaningful and useful to the public and to managers the trails information must be comprehensive, complete, accurate and sustainable including being kept up to date over time. In addition and vital to this process is completing the statewide inventory of trails—both non-motorized and motorized—that was begun in Phase I of this effort. Successful completion of these key tasks will require refinements, staff and technical expertise and, of course, financial resources. Lastly cooperation and compliance by local, state and national agencies that operate trails in providing inventory information and sharing their trails databases is essential.

Building Content and Inventory Strategies

There are a number of potential ways to move forward from this phase to build content and complete the statewide trails inventory. Content building strategies include:

1. Initiate a Single Massive Endeavor to Build Content

Description— A single agency, institution or private consultant takes on the task of gathering, entering and converting content to fit the data management and access system. This could be a prioritized approach where key population centers and destinations are mapped and released first followed by the remaining areas. This would involve professional on-site data gathering, use of volunteers, and conversion of data provided by cooperating jurisdictional entities. This effort could be initiated by a "Request for Information" from outside consultants who might bid to develop the system.

Priority mapping areas— As an example, the metro Front Range, and major resort counties. Estimate 5000 miles of trails to start working with 30-50 jurisdictions.

Cost— $0 to 1.5 M - $2 M at $10-$30 per mile (with volunteer support to collect data) plus $100,000 in hardware and up to $200,000 in Web set-up costs.

Timeframe— 1-3+ years.

Financing— GOCO, Colorado Lottery, local in-kind by partnering entities or possible retention of an outside consultant or Web developer/operator who might recoup costs by revenues through marketing and advertising.

Pros

- Single professional entity takes on task of building the content
- Coordinated effort
- Uniformity of product and data.
- Relative speed of building content for metro areas, etc.

Cons

- Upfront costs and may divert funds from trail building and other GOCO priorities.
- Issue of agency compliance in providing data.

Examples--A number of states are pursuing statewide trails mapping system that are in various states of completion, detail, interactive function and comprehensiveness including:

- Michigan Trails Finder http://www.michigantrails.org/map/
- Alaska Trails http://www.dnr.state.ak.us/parks/aktrails/ats/ken-ats.htm
- Florida office of Greenways and Trails: http://www.dep.state.fl.us/gwt/guide/index.htm
- New Jersey http://yoda.rutgers.edu/ims/njcf/viewer.htm

2. Pursue Incremental Content Building Starting with Feature Trails

Description— A single entity—private, public or institutional--builds the system incrementally starting with the largest most popular individual trails and building the system over time. In the interim, the system may include two levels of content—1) Searchable, interactive GIS-based digital mapping accessible and usable through the State Trails Web site and compatible with the State Trails data management system. 2) In the interim, linking to existing Web links that offer "static" mapping (such as pdf's) and local trails mapping resources such as city and county trails Web sites that offer completed pdf-type maps.

Priority mapping areas—Based on selection criteria such as trail popularity, size, diversity of locations throughout the state, connectivity and range of uses a priority list "top 100" trails are identified to be mapped. These are digitally mapped as well as a list of links established for available local on-line mapping and pdf's. Once a "critical mass" (for example 100 trails) is reached the data is put on line.

Also, local entities with digital mapping are offered the opportunity to convert their files to fit our format in return for posting them at our site or other incentives. System is expanded year-by-year with 100 to 500 miles added per year. Need to work with 30-50 jurisdictions.

Cost Estimate— $10-$30 per mile (assuming volunteer assistance) with annual cost of $ 20,000 to $50,000 (plus $100,000 in hardware and up to $200,000 in Web set-up costs).

Timeframe--1 year to implement first 1000 miles and 2-10 years+ to build remainder.

Financing—GOCO, Colorado Lottery, local in-kind by partnering entities, possible Web revenue (such as advertising) to recoup costs.

Pros
- Affordable incremental way to build, test and refine the system over time.
- Track record with this approach in Wisconsin, Michigan, and others.

Cons
- Challenge to select the priority trails
- May take many years to flesh out.
- Limited usability in the early years.

Examples—
- Michigan Trails On-Line Maps http://www.michigantrails.org
- Adams County, CO http://www.co.adams.co.us/documents/page/parks/parks_trails_os_map.pdf

3. "Mc Trail Map" Multiple Entities Feed Data in Correct Format

Description—Promote local incremental development of content by creating a popular model and data entry format that multiple entities use and feed into the statewide data system. This model involves coordination and incentives at the State level but relies heavily on voluntary participation by myriad entities including: cities, counties, agencies, commercial entities, tourism entities and

others who want to join a "franchise-type" model for mutual benefits. This might begin with Larimer County as CSU has already gathered significant data there.

First prepare a high quality working proto-type (Larimer County) that could initiate this model. Then recruit three to four additional major local partners who agree to join the system. An on-line digital data entry model could be developed that allows local GIS staff to enter their data.

Initially, the State could provide a technical assistant, support person to assist in both mapping and entering data. Alternatively or in addition commercial mapping companies could be granted the right to use the system to map individual jurisdictions or convert existing mapping from local jurisdictions to the State format. Grants ($10k to $20k) could be offered either in full or match to finance local mapping.

Priority Mapping Areas—Initially recruit one or two smaller jurisdictions with a variety of trail types that already have digital mapping to cooperatively produce a "showcase", working proto-type. Examples include Larimer County, Jefferson County Opens Space or Highlands Ranch. Each community's mapping can work as a stand alone for that community's needs and once a "critical mass" (for example 10 communities) is reached the data is put on line at the state level.

Similarly to the previous scenario, local entities with digital mapping are offered the opportunity to convert their files to fit our format in return for posting them at our site or other incentives.

System is expanded year by year.

Cost--Estimate 10 jurisdictions at $ 25,000 to $50,000 each to build the start-up with a goal of adding 10 to 20 communities per year. Annual cost $ 25,000 to $50,000. ($100,000 in hardware and up to $200,000 in Web set-up costs).

If successful the franchise can be self-replicating thereby accelerating the pace of mapping. Success will depend on the quality and promotion of the statewide system and incentives to local communities such as matching funding, technical assistance, long term data maintenance, tourism promotion, and incentives tie to State Trails funding.

Timeframe-- 1 to 10+ years

Financing—GOCO, Colorado Lottery, local in-kind by partnering entities, possible re-sale of content to recoup costs.

Pros

- Affordable incremental way to build, test and refine the system over time.

- May be the lowest cost approach by spreading the cost amongst cooperating jurisdictions.
- If franchise model takes, this may accelerate the process of broad-based mapping.

Cons
- Challenge to recruit partners—need compelling incentives.
- High likelihood of inconsistencies and quality control issues.
- Limited usability in the early years.

Example—
- Vermont (by *Locomotion*) http://www.localmotion.org/trails/welcome.php

Resource Options to Gather Data

There are several different approaches to engaging the resources to gather data and build content. These include:

1. Hire a firm to gather mapping data statewide
2. State agency gathers data
3. State/Consultant Partnership
4. Encourage local entities to adopt the Statewide product—Mc Trail Map concept

Completing the Statewide Trails Inventory

Completing the statewide inventory has proven to be a challenge. In 2006, an interactive spreadsheet was distributed literally thousands of individual jurisdictions and agencies throughout Colorado. It is estimated there are tens of thousands of miles of trails. There has been an ongoing attempt to get agencies to complete the trails inventory spreadsheet including e–mail contacts and telephone calls. Compliance has been limited over the past two years. To help improve this process several alternative strategies are put forward:

Alternative Strategies
- Focus on entities known to have ten or more miles (not including federal lands within theses jurisdictions—that would be collected directly from federal agencies) of trails in their jurisdiction and entities that have received State Trails funding since its inception.

- Prioritize the largest entities first with both Front Range and mountain jurisdictions pursued.

- Provide incentives or penalties to promote compliance such as extra points on state trail grant applications for compliance or hard requirement that an inventory be submitted bi-annually to be eligible to apply for grants. May need to offer some assistance in completing forms to entities with limited resources.

- Commit a support person or seasonal employee at State Parks to continuously contact entities by both e-mail and telephone. In many cases a phone call is necessary to follow up e-mailing an inventory form. It is important also to make sure the form went to the right individual in the jurisdiction.

Next Steps

Listed below are the next logical steps toward successfully building on what has been accomplished and expeditiously achieving the vision of the mapping effort. Four key efforts are recommended:

1. **Deploy a Working Web Site**--Moving forward with the CSU pilot study and recommendations (Chapter 2 of this report), create a proto-type working, user-friendly Web site—an attractive "storefront" for trail users and managers that is easy to use and can be deployed for actual public use and refinement. Ideally, this could be accomplished beginning with the data that CSU gathered in Larimer County though other venues could be used as well.

   This process could be initiated by regrouping with key agency officials in Larimer County including representatives from Larimer County Open Space, Cities of Berthoud, Fort Collins, Loveland, Estes Park, Arapahoe Roosevelt/National Forest, Rocky Mountain National Park and other jurisdictions in the County that own and operate trails.

   Working with these entities protocols should be established for transferring data, identifying gaps and refining the system. Working with the partnering agencies and a review "focus group", the Web site would then be refined for optimal appeal and performance and posted on line as a "beta site" for use and feedback by the public and the trail managing agencies. Web site refinement might be realized through a contract with a professional Web site developer with both graphic and computer skills. Part of this effort would include a public awareness program that could include posting links at the partnering agency sites, media stories, advertising and other means to get the word out. Once perfected the Larimer County proto-type could be used as a demonstration model to promote the creation of similar mapping efforts in other jurisdictions with the software made available to "clone" the model around the State.

2. **Refine a Content-Building System**—Based on the experience in Larimer County in Phase II and other knowledge gleaned; identify and develop an optimal and cost-effective mechanism for building content (see list of content-building strategies above). This includes a digital Web-based "input manual" where managers can upload local trails data in a mode

that fits our system. Similarly, refine an "import" mechanism that facilitates incorporating existing GIS mapping from local agencies. This component could be included in the proposed "Request for Information" that seeks outside consulting and development services.

3. **Sustainable System**—Determine and pursue an optimal strategy for implementing and maintaining a long-term, sustainable mapping program including the organizational and financial structure with the goal of a comprehensive statewide system in place and available to the public within four years.

4. **Complete the Statewide Trails Inventory**—Complete the statewide tally of existing trails using the Excel spreadsheet developed under Phase I.

To accomplish the above tasks a number of specific next steps are recommended:

1. Identify appropriate funding to implement the next step.

2. Identify potential on-going/sustainable revenue sources to maintain the program.

3. Identify a State representative to oversee the project.

4. Identify State or consulting staff to implement the project including set-up, marketing and on-going management.

5. Identify and retain the expertise to build a marketable working model in a local jurisdiction to demonstrate the product.

6. Identify and retain graphic capability to create/refine a graphically impressive, user-friendly working proto-type—with a user-friendly data input manual of interactive Web-accessible system that can easily be adopted by other local jurisdictions that wish to participate.

7. As the working proto-type is refined and perfected, secure participating jurisdictions on a priority basis (priority criteria including: large trail network, significant digital mapping already exists; willingness to comply and integrate local digital data into the Statewide system.)

8. Create a participation package including: easy-to-load software; user-friendly access to the master State Parks-run Web site (i.e. Coloradotrailsinfo.com); a data conversion package of instructions and software to covert local digital information to the statewide format.

9. Format; a local user input—on-line system—that allows local users to input data and update/correct their data.

10. Create an entity, retain an institution such as CSU or hire a consultant to create and manage a central server that holds the data and manages usage. This entity would also manage quality control, mediate issues such as content and proprietary mapping and serve as a "traffic cop" to manage data fields and complexity.

11. Using the Inventory Compliance List 07 Excel spreadsheet, continue to work down the list and fill in the spaces as well as secure the inventory forms. Identify a "top 100" list of jurisdictions and work on those first.

12. Determine if an incentive for inventory compliance can be worked into the State Trails Grant program. Consider other incentives such as eligibility for an automatic cash incentive grant to the jurisdiction for compliance.

APPENDIX 1:

USER-TECHNOLOGY INTERFACE MONOGRAPH

Colorado Trails Mapping Project

Phase II

User/Technology Interface

Final August 2008

Robert Searns, The Greenway Team, Inc. with Lori Malcolm, Colorado State Trails

Mission:

Create an attractive and user-friendly "storefront" for the statewide digital mapping system. This is basically the body and interior of the "hot car" that everyone will want to drive. This addresses the graphics, level of detail, commonality of definitions, hierarchy of information, and ease of a lay person "driving the vehicle".

Trail Mapping Criteria (From the 2006 "White Paper")

1. **Address public trails funded by the State Trails Program & trails on local, county and federal jurisdictions--all types of trail uses including both motorized & non-motorized.**
2. **Sustainable statewide universal trail system mapping, information, way-finding program & inventory.**
3. **Accessible by website to the general public, local trail planning & advocacy officials; local trail management agencies; public safety agencies; GOCO; State Trails; tourism organizations;& others with an interest in using, managing & promoting trails in Colorado.**
4. **Simple and convenient to use by non-technical consumers & agency staff.**
5. **Layered system similar to "*Map Quest*™" site where users will be able to "drill down" by trail activity or location of the trail.**
6. **Designed for ease of updating by local entities and agencies. It will allow participants to routinely enter their latest trail system information into the statewide system by using GPS coordinates and minimal attributes.**
7. **Explore practical, cost effective media for disseminating and routinely updating the trail information. This will include downloading information to a PDA, web-enabled cell phones, digital kiosks, GPS devices, etc. and printable maps.**
8. **Offer a "feedback" site to provide comments to the trail Manager on the trail conditions, map information, safety issues, users concerns, etc.**
9. **Financially sustainable & access free to users.**
10. **"Architecture" will be developed by CSU that will overlap with other GIS products.**

Key Design Objectives to Guide Phase II

(Derived from the 2006 "White Paper")

1. Attractive and appealing/Easy to access, to follow and use
2. Consistent, usable definitions and attributes user friendly to general public
3. Multiple methods of finding a trail (by zip, from a map, by activity, etc.) using same access point/gateway for both trail users and managers
4. Efficient to enter and maintain accurate data including importing existing GIS mapping from local sources
5. Develop a "gold standard" format to accept data from participants
6. Functions on most home computers/and pda's. Interfaces with other existing resources like Google Earthtm™/Map Quest™
7. Initial level of acceptable functionality with potential to upgrade and refine over time.

1. Attractive and Appealing/Easy to Use

Attractive and appealing/Easy to access, to follow and use….

1. Use simple but informative graphics with optimal information—no more no less. (see definitions and query fields below.)
2. Use graphics and symbols people are universally familiar with from road maps, ski area maps, *Mapping International Symbols*, etc.
3. Stylize the graphics to add eye appeal with staying consistent with universality—easy to pan and zoom.
4. Organize information in a drill down hierarchy with basics at the top level such at the trail, key amenities, topography, and overlying road/street system.

Example from Clear Creek County

2. Consistent Usable Definitions & Queries

Following are the recommended initial mapping elements. These are basic with expansion of *drill-down* capability in the future.* There are six categories of fields including:

1. **Context Factors**—Base mapping information to facilitate user orientation and relevant environmental factors such as terrain. **(4-fields)**
2. **Trail Activities**—List of common trail activities, non-motorized and motorized, that users are likely to engage in. **(12 fields)**
3. **Trail Facilities**—Types of trails and trail surfaces that will accommodate the above activities such as paved multi-use path or hiking path. **(13 fields)**
4. **Trail Amenities**—Important support facilities related to trails such as parking lots and toilets. **(12 Fields)**
5. **Trail Accessibility & Difficulty**—Factors affecting trail accessibility, difficulty & certain permitted activities such as grade, surface, animals permitted and leash policy. **(8 Fields)**
6. **Trail Manager's Elements**—Items of vital interest to trail managers such as gaps, planned projects, deferred maintenance. **(8 Fields)**

**** The above can/should be derived, distilled, integrated and adapted from the CSU attributes list (See June 2008 CSU Report and Appendices).***

Recommended initial definitions/query fields continued by category:

Category 1: Context Factors

Name	Definition/Queries	Symbol Concept
1. Jurisdiction	State, county, city, Fed., populated areas	boundary/light shade 
2. Roads	Interstate, state, county, local, rural	by line width/symbol 
3. Terrain/Water	Relief map with colors, topo lines by drill down with context-appropriate contours	shading with USGS style show profile 
4. Parks	National, state, regional local parks	

9

Category 2: Trail Activities

Name	Definition/Queries	Symbol Concept
1. Bike	Bike on prepared surface—road/hybrid	
2. Walk/jog	Local walking or running	
3. Mountain Bike	Single-track “fat tire” biking	
4. Paddle	Canoe, kayak, raft, tube	
5. Horseback	Western saddle riding	
6. Skate	In-line skating/rollerblade	
7. Backpack	Overnight hiking/primitive camping	
8. X-Country Ski	Nordic ski/snowshoe--trail or set track	
9. ATV	ATV trail vehicles (50” wide or less)	
10. 4 x 4	Jeep or similar automobile	
11. Dirt Bike	Motorized 2-wheel trail bike	
12. Snowmobile	Snowmobile	

10

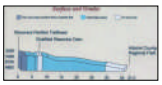
Category 3: Trail Types

Name	Definition	Symbol Concept
1. Paved/Concrete Shared-Use	Hard surface shared multi-use trail	
2. Crushed Gravel Trail	Crusher fine shared multi-use trail	
3. Hiking Path	Single-track natural surface path	
4. On-Road Bike Route	Striped bike lane or on-street routes	
5. Back Country Trail	Dirt trail in more remote areas	
6. Mountain Bike Trail	Single-track mountain bike trail	
7. Paddleway	River or stream corridor for paddling	
8. Sidewalk Tour	Demarcated sidewalk interp. safewalk..,	
9. X-County Ski Trail	Accommodates Nordic and snowshoe	
10. 4 x 4 Trail	Full-width jeep road	
11. ATV Trail	Suitable for ATV's and dirt bikes	
12. Dirt Bike Trail	Suitable for 2-wheel dirt bikes	
13. Snowmobile Trail	Suitable for snowmobile	

Category 4: Trail Amenities (See Pages 2.3-4 of Phase I Report)

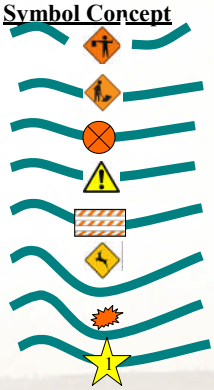
Name	Definition	Symbol Concept
1. Trailhead	Marked access point or boat put-in	
2. Parking	Parking for trail users	
3. Rest Area	An identified place to sit and rest	
4. Drinking Water	Potable water (humans and stock)	
5. Toilet	Public toilet facility	
6. Shelter	Protection from sun or storms	
7. Convenience Store	Shop with food and snacks	
8. Picnic Facility	Table(s) possible grill(s), fire ring (s)	
9. Camping	May be public of private camp facility	
10. Lodging	Hotel, motel or hostel	
11. Interpretive	Display, exhibit, artwork along trail	
12. Transit	Bus or commuter rail stop	

Category 5: Trail Accessibility

Name	Definition/Attribute	Symbol Concept
1. **Accessible**	Accessible per ADA	
2. **Stock Animals**	Horses and pack animals permitted	
3. **Off-Leash Area**	Dogs okay off leash or voice command	
4. **Surface/Terrain Profile**	Shows surface & topo in cross-section	

These advisories should include a disclaimer that user judgment is foremost.

Category 6: Trail Manager's Elements (Non-publicly accessible layer.)

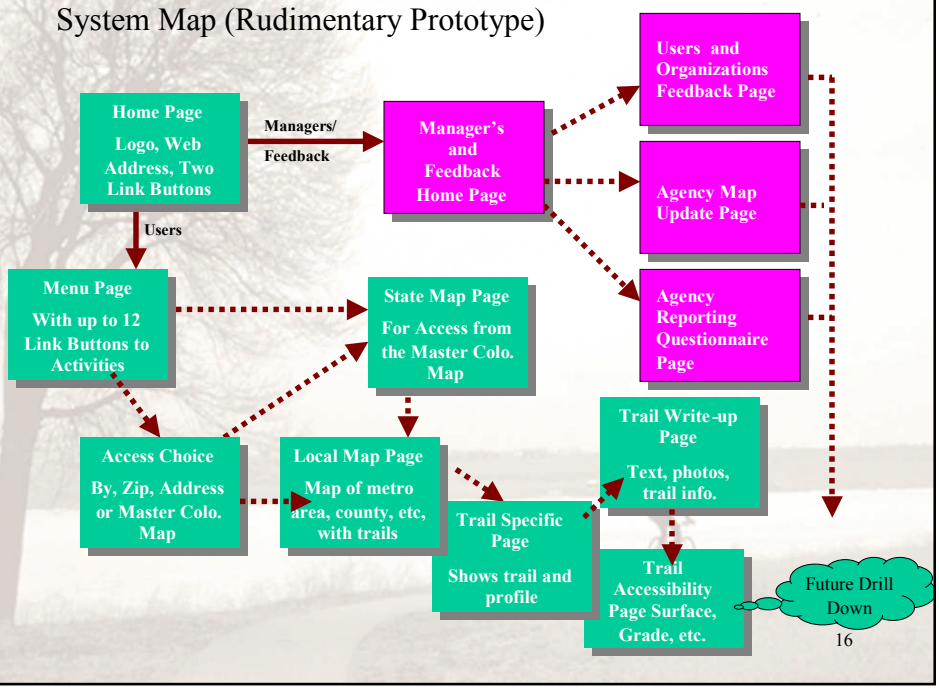
Name	Definition	Symbol Concept
1. **Gaps**	Missing or substandard segments	
2. **Maintenance Needed**	Significant remedial maint. issues	
3. **Crime Sites**	Reported crimes or police activity	
4. **Accident/Incident Sites**	Accidents or other problem events	
5. **Barriers**	Obstructions of difficult passages	
6. **Sensitive Sites**	Such as wetlands, wildlife areas	
7. **Land Owner Conflicts**	Problems/complaints—adjacent owners	
8. **Priority Projects**	Hope to accomplish in next 2 years	

Also consider animal encounters, user feedback tabulation, and segment status.

In future integrate more detailed queries consistent with current agency attributes as a drill-down layer.

3. Multiple Methods of Finding a Trail

System Map (Rudimentary Prototype)



4. Mock-Up of Web Page "Sketch Concept"

Your Trails Information Source

Find just the trail you want, when you want it!

www.trailsinfo.com

Colorado State Parks

By Activity

By Location

Feedback

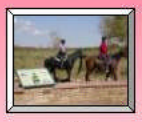
Pick a Trail Activity


Bike


Walk/Jog


Mountain Bike


Paddle


Horse


Skate

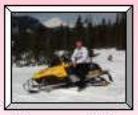

Back Pack


X-Country Ski


ATV


4 x 4


Dirt Bike


Snowmobile


Accessibility Info

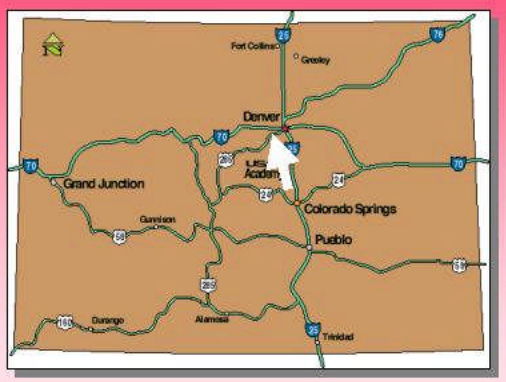
Pick a Location

Zip: *80127*

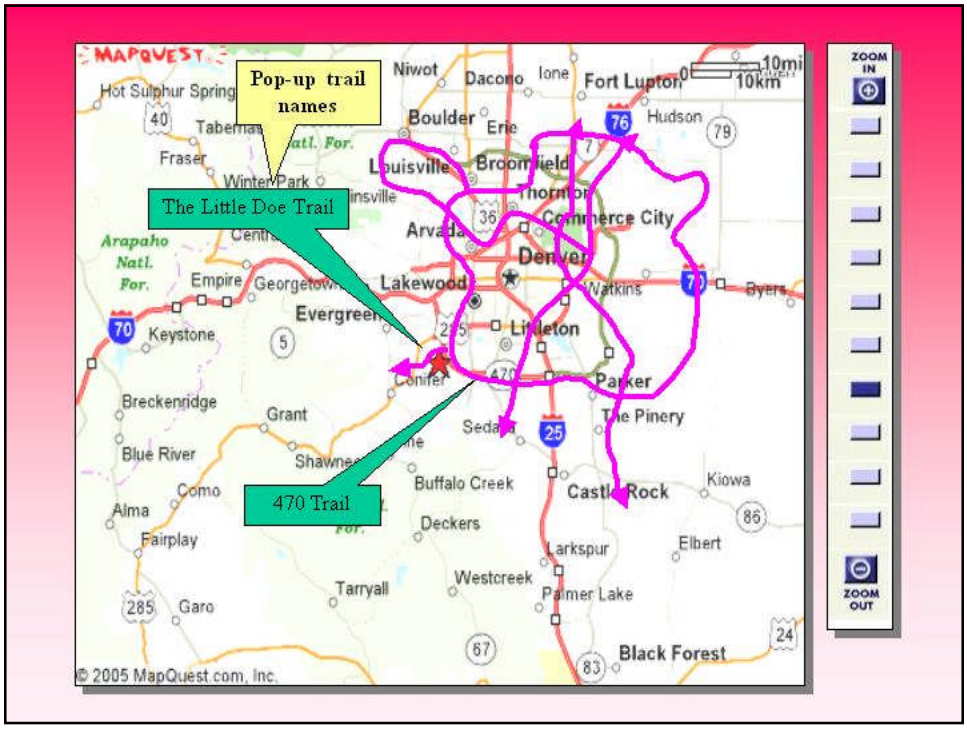
Or:

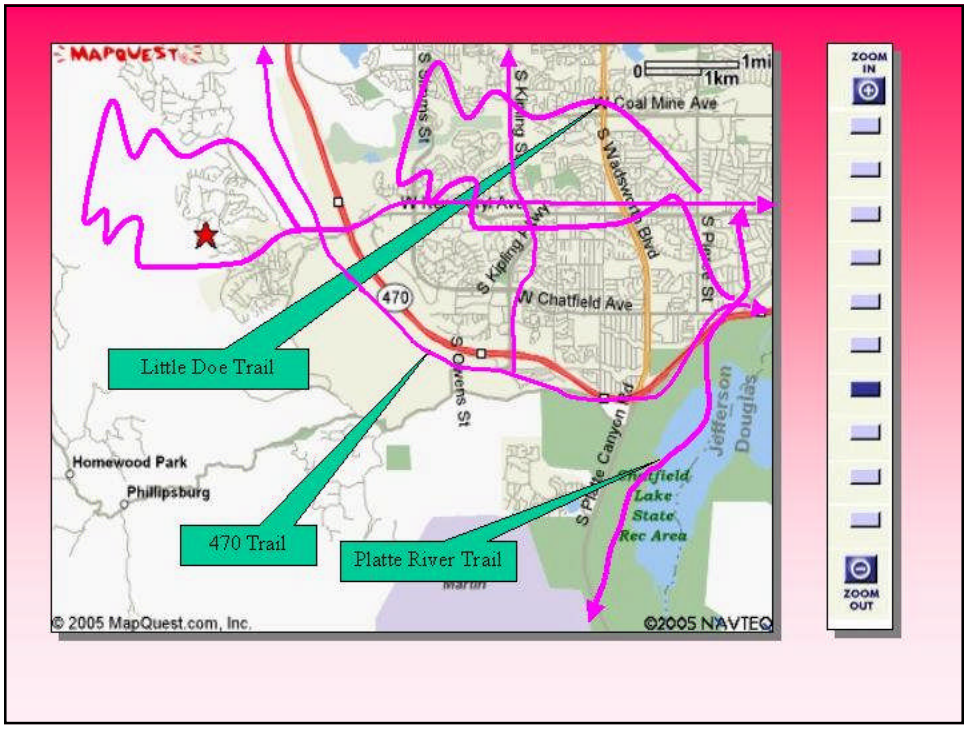
Address: 8 White Fir

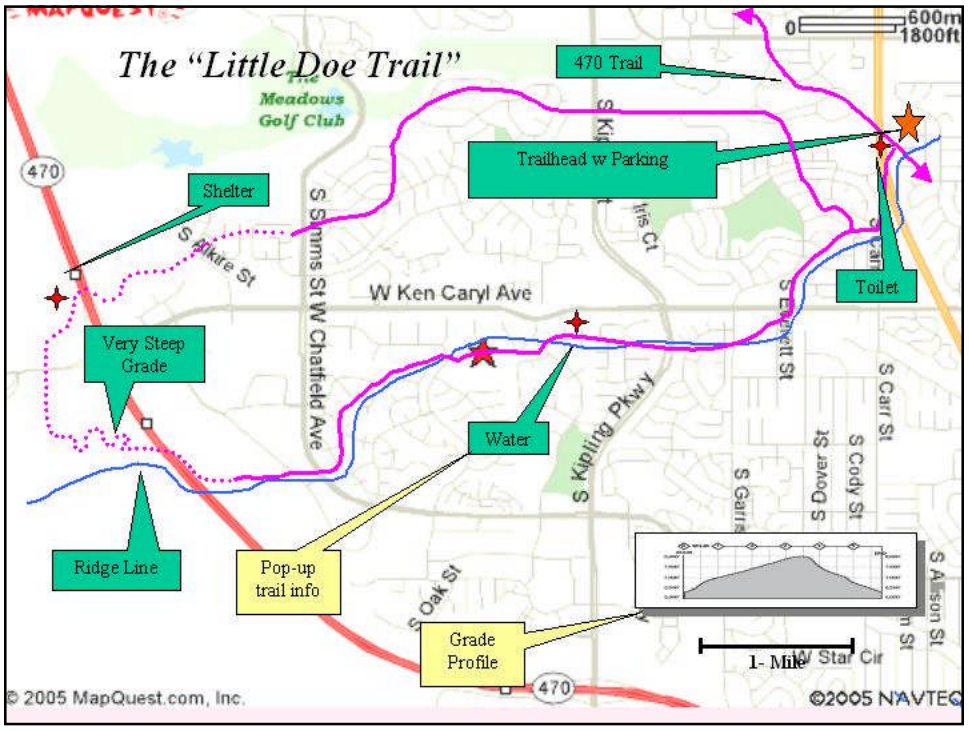
City: Littleton

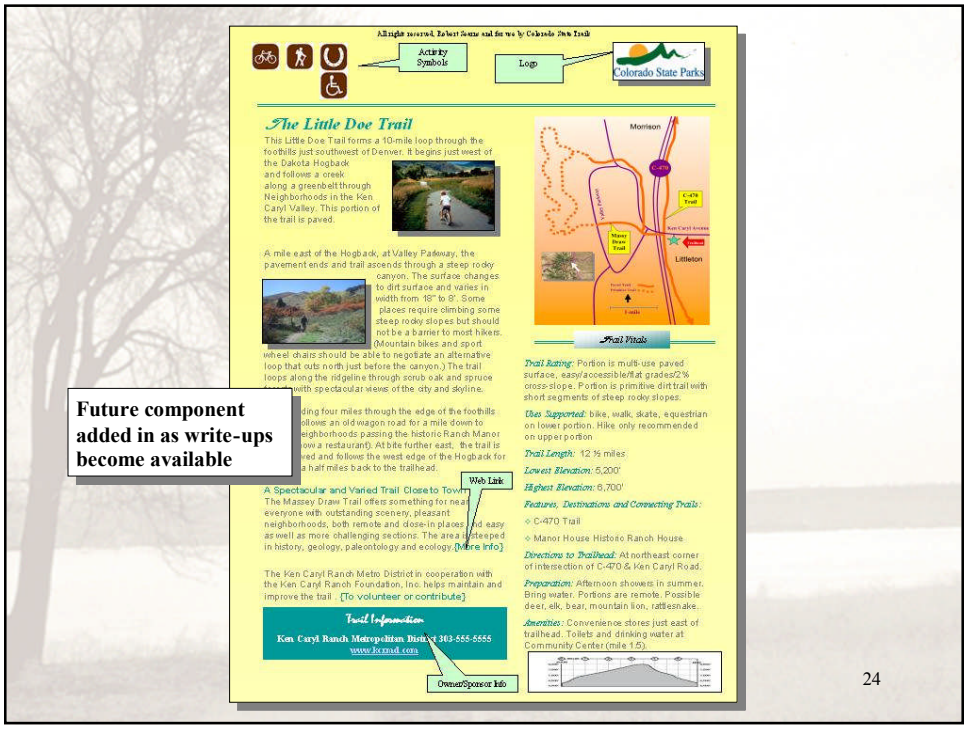


Enter A Location *Or* *Click On The Map and Zoom In*


MAPQUEST
Pop-up trail names
The Little Doe Trail
470 Trail
Niwot
Dacono
Ione
Fort Lupton
Hot Sulphur Spring
Boulder
Erie
Hudson
Fraser
Louisville
Broomfield
Thornton
Commerce City
Arvada
Denver
Arapaho Natl. For.
Empire
Georgetown
Lakewood
Watkins
Byers
Evergreen
Keystone
Littleton
Parker
Breckenridge
Grant
The Pinery
Blue River
Shawnee
Buffalo Creek
Castle Rock
Kiowa
Como
Alma
Deckers
Fairplay
Larkspur
Elbert
Tarryall
Westcreek
Palmer Lake
Garo
Black Forest
10mi
10km
ZOOM IN
ZOOM OUT
© 2005 MapQuest.com, Inc.


MAPQUEST
Little Doe Trail
470 Trail
Platte River Trail
Coal Mine Ave
S Wadsworth Blvd
S Kipling St
S Pierce St
W Chatfield Ave
S Owens St
Homewood Park
Phillipsburg
Jefferson
Douglas
Chatfield Lake State Rec Area
1mi
1km
ZOOM IN
ZOOM OUT
© 2005 MapQuest.com, Inc.
©2005 NAVTEQ





Future component added in as write-ups become available

Trail Information

Massey Draw Trail

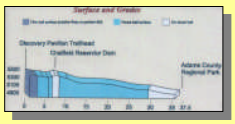
Ownership: i.e. Larimer County (970-555-5555)

Trail Type: Multi-Use (Loop) first 2 miles plus 4 miles single track primitive.

Uses Accommodated: Foot, Mountain Bike, Horse, Wheel Chair (first 2 miles).

Length: 6 Miles

Degree of Difficulty: Easy (2 miles) Difficult (4 miles)



Surface: Asphalt (2 miles, Dirt (4 miles)

Cross Slope: 2%

Amenities: Trailhead with park, storm shelter, drinking water.

Emergency Services: Ranger patrol. Pay phone at Community Center.

www.trailsfeedback.com

Please share your comments:

Trail Name: Massey Draw Trail **Location:** Littleton **Date:** April 4, 2007

There is no public trailhead on the Little Doe Trail—Please correct your map.

This trail is pretty good except, I fell in the mud where the trail washed out near the barn.

May we contact you?

Name: Joe Trail Blazer

Address: 8 Smith Street, Las Vegas, NV 20223

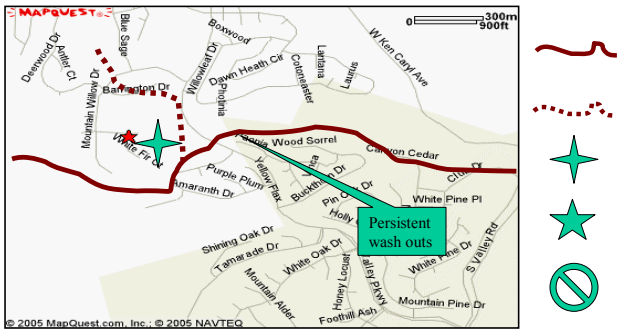
E-Mail: Joetrl@aol.com

Phone: 702-444-4444

Click here to send us your comments:

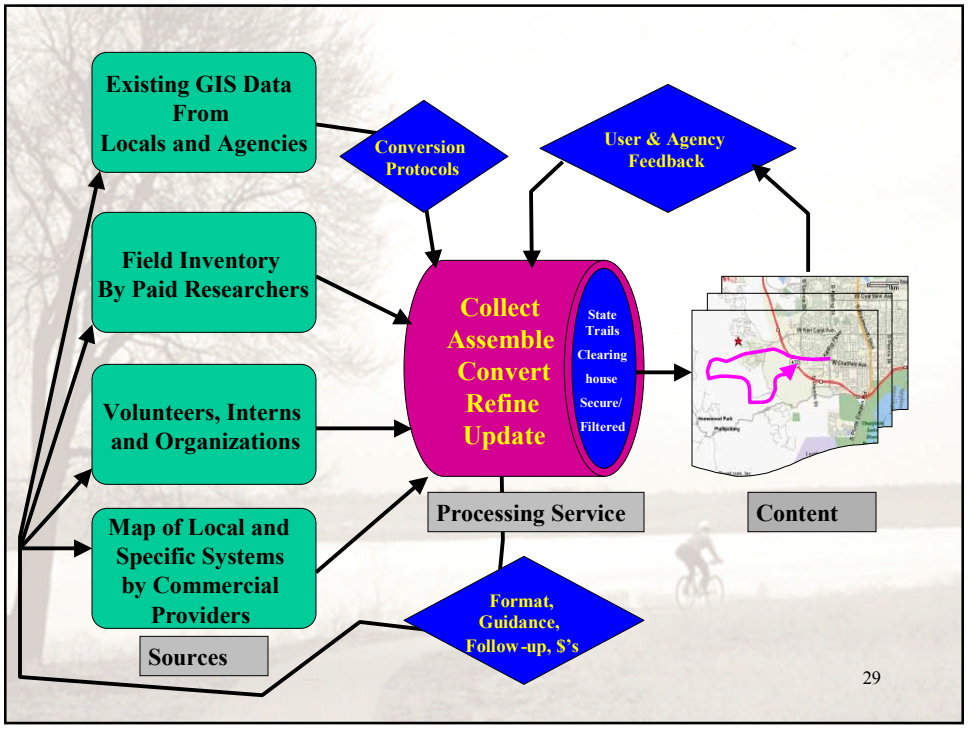
www.trailsfeedback.com

Please draw the following information on the map below:



5. Efficient to Enter & Maintain Accurate Data

Incl. Importing Exiting Local GIS Data



29

6. Becomes the "Gold Standard" Format

30

Become the "Gold Standard"

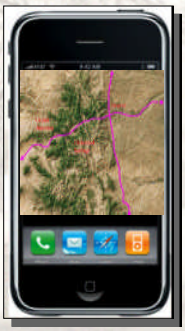
1. Attractive simple to use by lay people—both users and agency managers. Does not require "IT" or "GIS" skills to update and manage by locals
2. Symbols and definitions are compellingly logical
3. Non-threatening to or conflicting with other agencies standards, definitions and protocols to the extent achievable
4. Make the case to other entities that this is an optimal system integrating a reasonable level of technical accuracy with ease of use by the general public and lay agency participants.
5. Affordable to build and maintain
6. Uses broadly available software and applications.

Example from Clear Creek County

7. Functions on Most Computers/pda's. Interfaces with Common Applications

Functions on common platforms

1. Usable on any home computer with broadband service
2. Easy to print out maps or load into portable device like a phone of GPS
3. Accessible to download and read to pda's
4. Usable on digital kiosks at interface sites such as as airport, hotels, etc.
5. Link icon found at common Web sites



8. Initial Level of Acceptable Functionality

Potential to Upgrade

Initial Functionality

1. Design to minimal but workable and appealing standard
2. Keep it simple and basic but comprehensive enough to be meaningful
3. Graphically attractive to build broad appeal
4. Run past focus groups to refine to minimal acceptable level if information detail, accuracy, etc.
5. Must achieve the appropriate level for user safety