City of Boulder
Open Space and Mountain Parks
Visitor Master Plan Monitoring
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System-wide Undesignated Trail Mapping on Open Space and Mountain Parks Lands
2011/2012 Protocol

1.0 Background

1.1. Rationale for monitoring

The informal paths that visitors leave on the City of Boulder's Open Space and Mountain Parks (OSMP) lands are signs of the recreational desires of visitors. In 2006, over 170 miles of these informal and often physically unsustainable "undesignated trails" were mapped on OSMP lands (O'Malia 2011). From 2004 to 2005, OSMP received an estimated 4.7 million visits (Vaske et al. 2009) to the 45,000 acre land system. As visitation increases, the extent of social trail development is also likely to increase in the absence of a plan for managing undesignated trails and visitor-use of these trails. OSMP's Visitor Master Plan (VMP) mandates periodic assessment of the extent of undesignated trails across the system (City of Boulder 2005, p.61). Undesignated trail mapping is a crucial step in developing management strategies for undesignated trails and in evaluating activities that occur off designated trails (i.e., off-trail activities) on OSMP lands. A comprehensive and consistent method for mapping and documenting OSMP's undesignated trails provides the needed tool to facilitate an informed approach to recreational planning and decision-making on undesignated trails. This 2011 protocol documents the most recent revisions to methods for mapping undesignated trails and roads across the OSMP system.

1.2. Background and history

Undesignated trails (i.e., "informal", "visitor-created" or "social" trails) are those trails formed by erosion or compaction from repeated, informal visitor travel in parks, natural areas, and other undeveloped landscapes. Undesignated visitor trails arise because trail systems developed by land managers typically do not lead to all the destinations or create the travel experiences (e.g., opportunities for solitude, exploration, nature observation) that visitors seek (Byers et al. 2000; Park et al. 2008; Hockett et al. 2010; Wimpey & Marion 2011). Undesignated trails may evolve when visitors lose the formal trail and/or inadvertently travel along wildlife or cattle trails. They may also develop when visitors choose to follow alternative routes to short cut switchbacks, avoid muddy, rutted or crowded conditions, or bypass obstacles or degraded patches on the formal designated trails (Turner & LaPage 2002; Park et al. 2008; Hockett et al. 2010).

Undesignated trails are of concern to managers because their development impacts the landscape through vegetation loss, soil erosion, weed proliferation, disturbance to wildlife and fragmentation of habitat. Undesignated trails also have unplanned alignments that make them particularly unstable and susceptible to degradation. These conditions create confusing and often unsafe conditions for visitors and maintenance expenses for land managers. Such concerns have

prompted national park managers to choose undesignated trail development as one of several key indicators of the contiguity and ecological health of an ecosystem and the quality of visitor experiences (Leung et al. 2002; Marion et al. 2006; Monz & Leung 2006; National Park Service 2008a).

In 2006, OSMP staff conducted an intensive survey of undesignated trails on OSMP lands that assessed the location, extent, and condition (e.g., trail width, trail incision, function) of undesignated trails using a fixed-point monitoring technique (O'Malia 2011). Review of the literature and extensive testing of the 2006 methods and alternative monitoring techniques highlighted the need to clarify criteria used for identifying and mapping pathways as undesignated trails. Field testing also revealed the difficulty of consistently determining trail edges, trail width, and categorical assessments of tread condition under the wide range of trail conditions that exist on OSMP lands. Consultation with OSMP staff suggested that the 2006 measurements made to characterize conditions of undesignated trails could be simplified greatly without compromising customer needs. OSMP staff also voiced a desire for mapping of other road-like pathways in our system (i.e., pathways that were potentially drivable but were not otherwise designated as trails or roads). The resulting 2011 mapping methods for undesignated trails retain only a small subset of attributes measured and recorded during the 2006 undesignated trail survey (Table 1), focusing effort instead on identification and mapping of undesignated pathways (i.e., trails and roads). Additional data was collected to satisfy staff interest in the location of constructed features and signs that were found along the corridors of undesignated trails or road-like pathways.

Table 1. Comparison of data collected during 2006 and 2011 undesignated trail mapping

Collected Data type	2006	2011
Location of undesignated trails	Yes	Yes
Undesignated trail width, incision and tread cover	Yes	No
Undesignated trail alignment and slope	Yes	No
Undesignated trail purpose and function	Yes	No
Areas of concentrated use locations and purpose	Yes	No
Location of road-like pathways	No[1]	Yes
Sign structure and messages along undesignated trails	No	Yes
Constructed features along undesignated trails	No	Yes

2.0 Goals and objectives

The goal of undesignated trail mapping is to depict the extant location of undesignated trails in relation to OSMP's cultural and natural resources and developed infrastructure. Mapping is also intended to provide a snapshot depicting the extent of informal trail development. Undesignated trail mapping aims to collect data needed to make informed decisions regarding management of undesignated trails in OSMP's trail study areas (Lenth 2006). When repeated using consistent methods over time, undesignated trail monitoring can provide long-term documentation of

[1] Some road-like pathways were mapped in 2006 if they were also considered undesignated trails.

changes in the location and extent of undesignated trails as well as the success of management efforts to close selected trails.

Specific objectives of this project are to:
1. Map the linear extent and spatial distribution of undesignated trails and road-like pathways on OSMP managed lands and identify those used by cattle;
2. Map the location of constructed trail features in the vicinity of undesignated trails and road-like pathways[2]; and
3. Map the location of trail signs in the vicinity of undesignated trails and road-like pathways

All objectives will be met concurrently by using GPS technology to map and attribute point features.

3.0 Guidance from OSMP planning documents

The 2005 Visitor Master Plan (VMP) outlines strategies to assess, plan for, and manage undesignated trails (City of Boulder, 2005, p 41-42). The VMP identifies varying management strategies for existing undesignated trails that differ by management area designations (i.e., Passive Recreation, Natural Area, Agricultural Area, Habitat Conservation Area). The VMP also proposes two overall monitoring measurements or standards for success of undesignated trail management across the system based on length of mapped undesignated trails (Table 2).

Table 2. System-wide measures and standards proposed for undesignated trails on OSMP land (City of Boulder, 2005, p. 61)

Monitoring Measure	Proposed Standard
Miles of undesignated trails	Less than 50 miles
Miles of new undesignated trails	0 miles

Recent evaluations of surveyor consistency in applying criteria for mapping undesignated trail segments and determining when an undesignated trail begins and ends suggest that length may be unreliable as a system-wide indicator. Staff should be cautious in characterizing the total length of undesignated trails on OSMP's land system given the many decisions surveyors make when determining whether to include or exclude a segment from mapping Instead, locations of mapped undesignated trails could be used as a spatial footprint of OSMPs unplanned trails during any given time period.

4.0 Field methods

4.1 Study area

OSMP's system-wide undesignated trail mapping will occur on all OSMP-managed fee lands, conservation easements in which OSMP has management responsibilities (IBM Conservation easement, Boulder County Hospital, and N.I.S.T. properties) and U.S. Government Land (NCAR) or miscellaneous easements (Sawhill Ponds, Gunbarrel Tech Center, Southern Hills United Church, and Syntex Chemicals) managed by OSMP. The 2011/2012 mapping area included all new properties acquired by December 2011. Of the total 35,650 acres surveyed,

[2] In the vicinity of undesignated trails and road-like pathways means that, in the opinion of the mapper, the sign or constructed feature is meant to facilitate, confine, or prevent travel along the specific undesignated pathway

approximately 1.7 acres comprised of small properties less than 0.7 acres in size were overlooked during the 2011/2012 undesignated trail survey[3].

The mapping area is a topographically diverse setting that includes mountain slopes, summits, mesas, bottomlands, canyons and plains. The approximately 35,219 acres included in the survey occur in riparian, grassland, foothill scrub, ponderosa pine and Douglas-fir forest vegetation falling within the Central Shortgrass Prairie and Southern Rocky Mountains ecoregions as defined by the Nature Conservancy (Bunin 1985; Cooper 1984; Nied et al., 2009). Elevations in the mapping area range from 5,060 feet to 8,440 feet. The undesignated trail study area falls into four different OSMP management categories that vary in their degree of habitat protection and visitor travel requirements (Appendix A). The study area includes 144 miles of OSMP-managed designated[4] trails and provides recreational opportunities for approximately 4.7 million visits per year (Vaske et al. 2009).

4.2 Mapping schedule

Undesignated trails and roads will be mapped at five-year intervals. OSMP's most recent inventory of undesignated trails was conducted from June 2006 through December 2006[5] using an earlier and more data intensive version of the methods outlined here (O'Malia 2006; Lenth 2006). When feasible, undesignated trail mapping in specific management subareas of the OSMP system will be carried out at nearly the same time of year during each repeat mapping period[6]. However, mapping staff may need to postpone mapping in certain areas where wildlife closures are in effect until closures are lifted. Within a given area, field staff may map undesignated trails and road-like pathways in any order, allowing for choices in mapping that increase efficiency and minimize walking. For consistency, mapping will be conducted on dry weather days when tread surfaces are snow-free, hard, and dry or only slightly moist. Mapping month and approximate order in which management subareas were mapped in 2006/2007 and 2011/2012 are given in Appendix B1 and B2. General locations and times for field mapping should be shared with rangers and other OSMP staff to insure their awareness of these activities.

[3] Parcels included in the project area but not surveyed for undesignated trails in 2011/2012 were two miscellaneous easements owned by Southern Hills United Church (0.024 and 0.643 acres), and four fee properties: Rocky Mountain Outdoor Advertising (0.061 acres), Odendahl (0.147 acres), Pospahala (0.343 acres), and Short and Milne- frey (0.451 acres).

[4] Designated trails are those trails marked with signs that include a trail name and are indicated on OSMP trail maps.

[5] A small proportion of trails were mapped in March 2007

[6] A number of factors influenced differences in mapping periods between 2006 and 2011 including: 1) later start date due to time spent resolving methods; 2) in 2011/2012 two full time mappers and one part-time mapper were employed and dispersed to different areas whereas in 2006 one full time mapper worked alone for the first 3 months when a second full time mapper joined on; 3)in 2011/2012, some areas that were part of the W. TSA were prioritized for mapping;; 4) in 2011/2012, a number of heavy snow events obscured trails in the fall and winter; 4) In 2011/2012, less data was collected at each point but more effort/time was taken to assess if a trails met definitions.

4.3 Equipment and materials

Equipment and materials needed for undesignated trail mapping:

- □ Trimble GeoXH, Trimble Nomad with ProXH receiver (2011 only) or the Trimble XT 6000[7] and associated GPS instructions. Units should be uploaded with prepared data dictionary and relevant background maps
- □ As needed: elevating range pole or external magnetic patch antenna when mapping under heavy tree cover or near canyon walls
- □ OSMP cell phone loaded with updated phone numbers for emergency response, OSMP rangers, front desk and environmental planning staff. Carry printed contact list in case cell phone fails and a personal cell phone must be used.
- □ The weekly ranger work schedule
- □ OSMP labeled shirt, hat or name tag
- □ Distance measuring wheel (needed only to estimate individual surveyor stride)
- □ Pin flags to temporarily mark intersecting side trails or end points of "recovered" trail alignments
- □ Pencils, clipboard, and tracking sheets for photographs, undesignated trails, and roads
- □ Copy of protocol and cheat sheets for constructed features and sign types
- □ Printed map tile pages for area being mapped
- □ Sharpies, colored felt tip markers, or grease pencils for sketching in segment alignments on maps
- □ Digital camera and batteries
- □ OSMP gate keys, building key card, and after hours gas entry card

4.4 Preparation for mapping

Compile GIS data and prepare map tiles of undesignated trails

Before each field season begins, monitoring and Resource Information System (RIS) staff will compile undesignated trail GIS data into an ArcMap map document (UDT_[*YEAR]*_TILES.mxd) for use in identifying potential undesignated trails and roads in the office and the field. Historically mapped undesignated trails, other relevant map layers and aerial photographs, and an index layer delineating gridded sections to be mapped within the survey area will be added to this map document.

During each survey period, the two most recent undesignated trail map layers will be exhibited in the ArcMap map document described above, forming a basis for searching for current undesignated trails. For example, in 2011, system-wide data from the 2006 survey will be displayed on this undesignated trail map document. Undesignated trail layers derived from the 2001-2002 survey may also be reviewed and displayed. New properties acquired since the last

[7] The Trimble XT6000 replaced the Trimble Nomad with ProXH receiver in January 2012. The Trimble XT6000 should be the unit of choice in the mountain backdrop because of enhanced satellite availability. While both units give submeter accuracy in ideal situations, the surveyor should be aware that poor accuracy with the XT6000 can be improved by using this unit with the ProXH antennae. Addition of the ProXH antennae, however, will decrease the ability to capture satellites under canopy and in canyons.

undesignated trails survey likely are not covered by historic undesignated trail layers. For these properties, monitoring staff will first create a New Properties shape file from the OSMP property layer by selecting all properties having "year closed" dates after the last undesignated trail survey. Monitoring staff will then identify potential undesignated trails and roads by examining recent aerial photographs of the properties for evidence of linear pathways, access gates and residences. When necessary, OSMP staff involved in property purchase or management planning may be queried about the status of undesignated trails and roads on new properties.

To enhance the utility of the map for finding and accessing undesignated trails in the field, monitoring staff will superimpose map layers showing OSMP property boundaries, designated trails, recent aerial photographs and the undesignated Trail_ID labels onto the undesignated trail maps. In addition, monitoring staff may add official roads, areas closed to the public, seasonal wildlife closures, fences and gates, ditches and creeks to maps for visual inspection or printing. To allow surveyors to differentiate among previously mapped undesignated trails where they merge or cross paths, undesignated trail IDs will be symbolized using an incrementing color spectrum. The "grazed fields" from the agriculture GIS layer will also be superimposed on map tiles to identify the portions of the tiles where cattle trails may exist.

To subdivide the undesignated trail survey area into smaller gridded sections for field mapping, RIS staff will develop and add an index or tile layer to the map document. The tile layer is comprised of data driven pages, used to produce a series of output pages formatted with a single layout (See Appendix C). Each output page shows one of 240 different spatial extents (each 1.0 x 0.6 mile), as defined by the polygon features (gridded rectangles) in the tile layer.

Print map tiles

Each data driven page has a number of identical map layout elements including north arrow, scale bar, legend, map extent, and prompt lines for recording surveyor name and survey date. Each data driven page also displays a number of dynamic elements (e.g., Tile #, specific tile printed) that change with location. Each tile covers approximately 1 mile by 0.6 mile and will be printed on ledger paper for use in the field. An index map will be created and printed to track progress on mapping the entire survey area (Appendix D).

Obtain permissions

Surveyors will scrutinize map tiles for areas with restricted or no public access (e.g., wildlife closures, burn closures, restoration closures, easements managed by OSMP but closed to the public). Surveyors will also use maps to locate potential vehicle parking spots and to determine if they will need permission to park on private roads. As necessary, and except for wildlife closures, staff will obtain permission before mapping in areas with restricted or no public access and on properties currently occupied by on-site residents. Staff will also obtain permission before parking on private roads as necessary. Surveyors will abide by all wildlife closures, delaying access until the closure is lifted. Finally, surveyors will alert the real estate compliance monitoring specialist via voice mail or email prior to mapping on conservation and miscellaneous easements.

Update and transfer data dictionary and background maps to GPS unit
Before field surveys begin, monitoring staff will prepare and update the data dictionary, a digital field form on the Trimble GPS receiver that prompts the user to enter attributes describing undesignated trails. The data dictionary prepared for the 2011 survey can be edited for future surveys. GIS maps showing designated and undesignated trails, roads, fences and other features can also be downloaded to the GPS as "background maps" to aid in locating trails to be surveyed. Mapped points from prior undesignated trail surveys can be downloaded as waypoints to Trimble GPS receivers to facilitate relocating of the historic undesignated trail alignment. Detailed instructions for preparing data dictionaries and transferring files to the GPS for undesignated trail mapping can be found within the project folders.

Prepare and print hard copy documents
Before going out in the field, monitoring staff will prepare and print the following forms and documentation:

- Protocol for undesignated trail mapping
- Cheat sheet for constructed features identification
- Cheat sheet for sign types
- Checklist of available ID numbers for new undesignated trails
- UDT and road field data tracking and photo documentation forms
- GPS instructions

Check satellite configuration
Monitoring staff may use the Trimble Office software utility (Trimble Office/Utilities/Planning) on the GIS walk-up computer to determine times and days when satellite configuration will be unacceptable (PDOP >6) for long blocks of time. This may be particularly useful when working in the mountain backdrop, under heavy tree canopy, and/or in canyon areas.

Organize equipment and materials
Monitoring staff will gather equipment and materials listed in section 4.3. Monitoring staff will sign out and use OSMP-marked cars and wear clothing or name tags identifying them as OSMP staff while surveying undesignated trails.

4.5 Training, testing, and coming to consensus on field methods
Undesignated trail mapping staff will be trained in field survey methods, use of GPS equipment, and field data entry via the data dictionary. Survey staff will review the definitions and methods described in the protocol and will be introduced to real-life situations described in the protocol through photographs and field visits. Survey staff will practice differentiating pathways that do or do not meet the definition of undesignated trail or road outlined in this protocol. Prior to independent mapping, surveyors will be tested on their ability to correctly and consistently identify undesignated trails. Any discrepancies in interpretation and coding among field staff will be resolved and field staff will be retested until agreement is reached. Staff will also discuss and test their ability to consistently differentiate undesignated trails used, created, or maintained by cattle from those recreational trails lacking cattle use. During training and testing, photographs and descriptive information will be taken to document examples of undesignated trails that do and do not meet the criteria for mapping and these photos will be shared with all surveying staff.

4.6 Criteria for mapping undesignated trails and roads

A. Determining which trail segments to map as ***undesignated trails***

Staff will need to make prompt decisions in the field to determine which of the many miles of trampled pathways should be mapped as undesignated trails.

Definition of an undesignated trail

For this mapping project, an undesignated trail is defined as[8] a linear or curvilinear pathway on the landscape that:

1) Is greater than 20 feet long;
2) Has a continuous trail boundary on the surface of the earth (i.e., width of disturbance stays relatively constant rather than appearing to be a series of foot, paw, or hoof prints);
3) Has evidence of repeated use. Potential evidence of repeated use includes but is not limited to:
   a) Specific tracks (human, horse, dog, bicycles, cattle) on the ground along the trail;
   b) Flattened or cupped condition of the trail tread;
   c) Soil compaction within the trail tread;
   d) Pulverized or crushed litter in the middle of the tread;
   e) Noticeably impeded (stunted) vegetation development (National Park Service 2008) within the tread as compared to the adjacent landscape (note: the presence of merely flattened or matted vegetation is not considered ample evidence of repeated use);
   f) Rock alignments along the trail that appear to have been placed/stacked or have settled into "flattened" corridors;
   g) Presence of cairns along the trail corridor in rocky areas and on tallus slopes;
   h) Distinctly greater abundance of pulverized rock or rock shards along a curvilinear pathway as compared to surrounding rocky landscape;
   i) Rock surfaces along the trail tread lacking lichen cover as compared to the surrounding corridor of lichen-covered rock
   j) Greater exposed soil cover along the trail as compared to the adjacent landscape;
   k) Soil erosion associated with evidence of trampling as indicated by exposed roots and rocks, incision, and or undercutting along the trail tread (note: This criteria excludes linear drainage features subjected to water, wind, or ice erosion but lacking erosion caused by trampling.); and
4) Is not formally designated[9]

A given pathway must meet all three criteria to be mapped as an undesignated trail for the purposes of this project. The only exception to this rule is where pathways intersect or form junctions with other trails or roads. At these locations, a short segment of the pathway may not meet all three criteria listed above given the potential for concentrated traffic to disperse at intersections. However, when these segments are continuous with trail segments that have all of the above characteristics, they will be mapped as undesignated trails.

[8] This definition was added in 2011 and was not in place when surveyors made decisions about undesignated trails in 2006 or 2002.

[9] For the purpose of this project, any closed but formerly designated trail or section of trail will be mapped as an undesignated trail if it otherwise meets the definition. These segments will be identified as former designated trails to acknowledge that they were not created or maintained by informal visitor use.

The following are some situation-specific clarifications of the criteria described above:

1) Areas of disturbed vegetation that have been pushed to the side or are lying down, but lack a linear or curvilinear alignment and/or discernible edges will not be considered undesignated trails and will not be mapped.
2) Pathways where tread disturbance is limited to a series of foot, paw, or hoof prints, uneven pocking, or multiple bare patches evidently created by wildlife where disturbance is limited to the width of the print interspersed with non-disturbed areas and lacking a continuous edge on the surface of the ground will not be considered undesignated trails and will not be mapped.
3) <u>In erosion prone areas characterized by steep slopes and erodible soils</u>, pathways consisting of a series of foot, paw, or hoof prints where the disturbed soil may extend beyond the width of the print will not be considered undesignated trails and will not be mapped unless there is additional evidence of repeated use.
4) Pathways comprised of multiple faint and/or discontinuous tracks in which the surveyor needs to use their imagination to detect a linear or curvilinear path (e.g., paths through bunch grass; paths on rocky substrate) will not considered undesignated trails and will not be mapped.
5) Pathways where the disturbance is limited to bike tire tracks but which lack a continuous edge on the surface of the ground outside of the bike tracks will not be considered undesignated trails and will not be mapped.

Surveyors should use the four criteria defining an undesignated trail <u>(is at least 20 feet in length, has a continuous boundary or edge, has evidence of repeated use, and is not formally designated)</u> to evaluate all pathways they encounter in the project area. While this document attempts to clarify when a pathway meets the project's definition of an undesignated trail, surveyors will undoubtedly encounter situations where the decision to map the pathway as an undesignated trail is not clear and the surveyor must use their best professional judgment to determine whether to map the pathway as an undesignated trail. In these situations, as a last resort, surveyors may also consider the pathway's destination and degree to which the pathway would need active treatment to facilitate its restoration. Pathways for which the surveyor cannot determine whether the pathway meets all three criteria of an undesignated trail AND are unlikely, in the surveyor's opinion, to draw visitors off the formal trail network because they do not go to a feature visitors are likely to want to go (e.g., the pathways ends at a fence rather than at a scenic view) or that pass through a landscape through which visitors are unlikely to want to travel (e.g., under low hanging shrub branches) do not need to be mapped as undesignated trails. Similarly, pathways for which the surveyor cannot determine whether the pathway meets all three criteria AND do not appear to warrant closure or restoration because they are too faint and are unlikely to lead to repeated visitor use do not need to be mapped as undesignated trails.

Pathways that meet the criteria defining undesignated trails: Special situations

If a pathway meets the three criteria outlined above defining an undesignated trail for this

project, surveyors should next consider if the pathway fits into the following specific situations when determining if a feature should be mapped:

1) Braids and parallel trails:
   a) Braids defined
      i) Braids will be recognized when a secondary trail emerges from the primary trail and then merges back to the primary trail within the surveyor's view while standing at a single spot AND when there is some indication that visitors are using the secondary trail to move around an obstacle (e.g., fallen tree) or undesirable condition (e.g., muddy spot, banked tread, loose gravel) on the primary trail and then returning to the primary trail. A braid suggests the intention on the part of the visitor of returning to the primary trail rather than traveling elsewhere
      ii) A braid is distinguished from widening of the primary trail by the presence of intervening ground cover between the trail and the braid that is more like the substrate of the matrix outside the primary trail than the trail tread cover. In contrast, if the intervening ground cover is more like the primary trail cover than the matrix, or if the intervening ground cover is a relatively small patch relative to the width of the primary trail then this branched pathway is considered part of the primary trail.

   b) Parallel trails defined
      i) A parallel trail is a secondary trail that is parallel to a primary trail for nearly all of its length. A parallel trail differs from a braid in that there is evidence that visitors made an extra effort to leave the primary trail and stay off this primary trail beyond any effort required to move around an obstacle, poor trail conditions, or to walk on a less worn portion of the tread.
      ii) As with braids, a parallel trail is distinguished from widening of the primary trail by the presence of intervening ground cover between the primary trail and the parallel pathway that is more like the substrate of the matrix outside the primary trail than the trail tread cover. In contrast, if the intervening ground cover is more like the primary trail cover than the matrix, or if the intervening ground cover is a relatively small patch relative to the width of the primary trail then this parallel pathway is considered part of the primary trail.

   c) When to map braids and/or parallel trails as undesignated trails
      i) Braids and parallel trails associated with undesignated trails or roads will be mapped when all the characteristics of the undesignated trail definition are met, when the braid or parallel trail is >20 feet long, AND when the pathway meets the definitions above.
      ii) Parallel tracks (i.e., two-tracks) created by vehicle tires embedded in a roadbed are not mapped as two parallel and separate trails
      iii) Braids of designated trails that leave the main trail to avoid an obstacle or poor conditions in the trail and return to the main designated trail are not mapped as undesignated trails. The braided condition will be recorded during System-wide Trail Condition monitoring.

iv) Parallel trails that are parallel to designated trails will be mapped as undesignated trails if they otherwise meet the definition of an undesignated trail, are separated from the designated trail by a strip of intervening "matrix" vegetation or substrate of consistent width, and consistently run parallel to the designated trail (> 20 ft). The one exception to this rule is if there is clear evidence (e.g. tire track) suggesting that the trail running parallel to the designated trail was created by vehicle traffic. In this case, the parallel trail is not mapped as an undesignated trail.

v) Parallel pathways that lie within a designated trail will be considered problems associated with the designated trail and they will not be mapped as undesignated trails; these typically occur when the designated trail widens and strips of vegetation remain between parallel paths within the trail bed.

vi) Any other pathway branching from or within the corridor of a designated trail that is not a braid (e.g., a shortcut) but otherwise meets the definition of an undesignated trail will be mapped as an undesignated trail.

2) Undesignated trails with interspersed segments of NAT

a) Definition of NAT. Any pathway or segment of a pathway that has recovered, revegetated, or been minimally disturbed so that it does not meet the undesignated trail mapping criteria above is described as "Not A Trail" or a "NAT" for the purpose of this mapping project. Additionally, a pathway traversing a resistant surface (e.g., bedrock), for which trail edges are not discernible and no other clues of visitor travel are evident will be considered a NAT.

b) What to do when encountering NATs of greater than 20 ft. Due to restoration efforts, changes in visitor travel patterns, and/or natural processes, some of the undesignated trails that were mapped during previous surveys may still be evident and meet the criteria for mapping as an undesignated trail, but have one or more "recovered" or "revegetated" sections or NATs greater than 20 feet in length that no longer meet our criteria for mapping as an undesignated trail. If a surveyor encounters the beginning of such a section when mapping an undesignated trail, the surveyor will map an endpoint to the undesignated trail. The surveyor will then explore the alignment mapped during the previous survey using the background file on the GPS to determine if at least 20 feet of the undesignated trail (according to the project definition) becomes evident again. If the undesignated trail starts up again, the surveyor will map a new start point and assign the same Trail_ID as used on the trail prior to encountering the "recovered" segment. The surveyor will document the occurrence of NATs as outlined in section 4.7.6 using the same Trail_ID used for the associated undesignated trail.

c) Search strategies when encountering NATs. In evaluating how far to search along a former undesignated trail alignment for evidence that the undesignated trail begins again after encountering a segment of NAT, the surveyor will check their map tiles to see if the pathway connects to another access point [10], road,

[10] Defined in glossary

designated or undesignated trail, or other point of interest. If so, the surveyor will search the previously mapped alignment. If the map tile suggests that the undesignated trail segment does not connect to another access point (including access points from non-OSMP trails), OSMP designated or undesignated trail, road, or other point of interest, or if the surveyor is unable to tell from their map tiles, then the surveyor will use their judgment to determine how far along a recovered section they will search for evidence that the trail begins again. A common strategy is to search the next 200 feet of the alignment. During the digitizing process, the surveyor should eliminate any segments later determined to be "floaters" as described in e) below while field mapping is still fresh in their minds.

d) Mapping NATs of less than 20 ft. When a surveyor encounters segments of NAT ≤ 20 feet in length embedded within a longer pathway that clearly meets the definition of an undesignated trail, the surveyor will map this embedded segment as part of the undesignated trail if it is continuous with the longer undesignated trail and particularly if there is a clear line of sight to the continuation of the trail.

e) Definition of floaters. When mapping undesignated trails with intervening segments of NAT, surveyors will keep in mind the goal of ensuring the final undesignated trail map produced from their field work does not contain "floaters". "Floaters" are sections of undesignated trail that are: 1) not connected to designated or undesignated trails, roads, access points or other pathways as illustrated in Figure 1; and 2) in the opinion of the surveyor, "floaters" represent a section of a pathway on which visitors no longer travel but which has revegetated at a slower pace than intervening sections of the pathway that were characterized as NATs. These floating sections may satisfy all three criteria for an undesignated trail but, like the surrounding segments that were characterized as NATs, are not believed to be in current use as a travel corridor. **These floating segments will not be mapped or will be deleted from the final map.**

f) Isolated undesignated trail segments that are not "floaters". Some mapped undesignated trail segments that are discontinuous from other mapped segments may appear to be floaters, but in the surveyor's best professional judgment, continue to be part of a current travel route by visitors. The surveyor must believe that visitors and/or their dogs, their horses, or cattle travel both on the segment of interest and along a route that connects at least one end of the segment to another designated or undesignated trail, road, access point, other pathway. In these situations, the connection contains one or more segments of intervening NAT that fails to meet the definition of undesignated trail, often because a continuous trail boundary on the surface of the earth is obscured by the immediate landscape and land uses that surround them (as illustrated in Appendix E). **When isolated segments meet the characteristics described in this section, they will be field mapped and retained in the final map projects.**

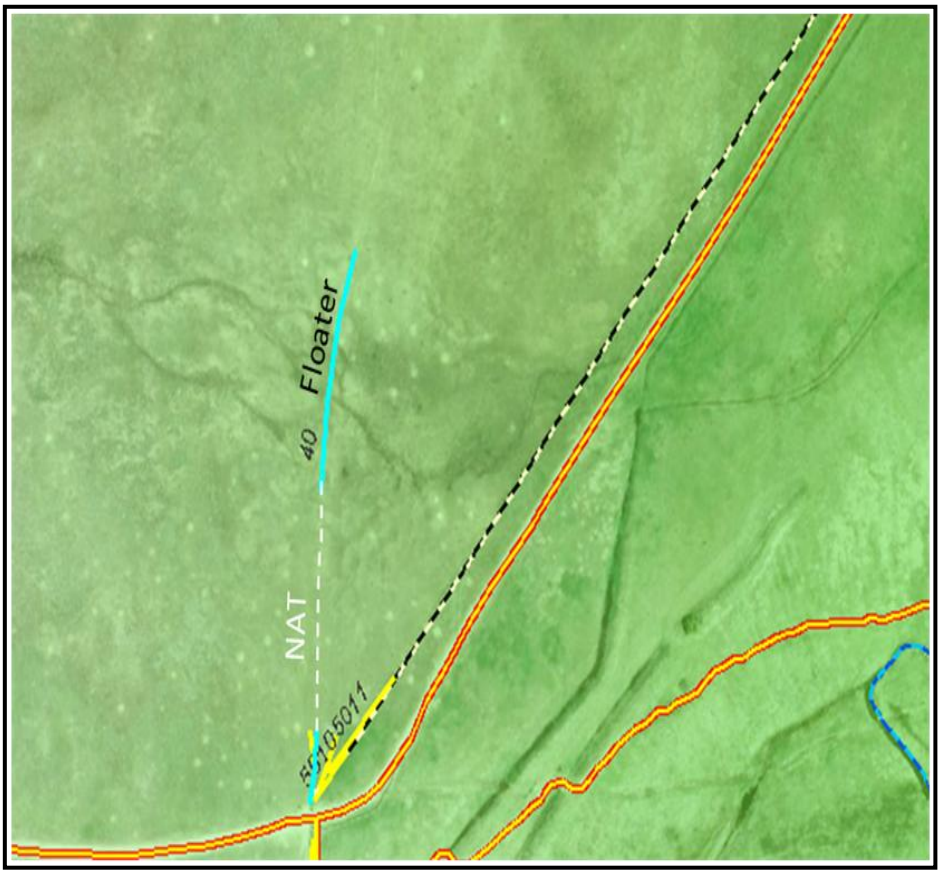

Figure 1. Example of a floater to be deleted from the final map. A revegetated segment or NAT (white dashed line) was encountered midway along the 2006 alignment of undesignated trail 40. A second segment was mapped at the northern end because undesignated trail criteria were again met. The surveyor identified the northern-most segment as a floater, believing that visitors no longer used this segment or the intervening NAT and finding no other connection with another undesignated trail, designated trail, or road to the north.

3) Closed and restored undesignated trails
   a) Undesignated trails that have been closed or received restoration treatments will be mapped if they meet the undesignated trail definition above. In these situations, the presence of persisting indirect evidence such as the jute netting is enough to meet the repeated use criterion in the definition.

4) Pathways created and used exclusively by cattle[11]

[11] Prior to March 2012, cattle trails were mapped if they otherwise met our definition of undesignated trail. Item 4 was added to the protocol in March 2012 as surveyors began to map properties used exclusively by cattle during a season when newly created trails were also evident. Surveyors will retroactively identify those previously mapped

a) Rational for mapping decisions. Some pathways that clearly meet the criteria defined above may be trails created and used seasonally only by cattle. Such pathways may vary in location on the land and extent of development with time since grazing. Thus if surveyed prior to grazing, no pathway may be visible, where as a well-defined path may be evident only months later. Knowing the location of these cattle trails on OSMP lands used exclusively for agriculture may be of little value for trail planning purposes. Furthermore, mapping these networks of cattle trails would be expensive in terms of staff time. In other OSMP locations, cattle trails may be visible to visitors traveling on other routes, or they may be historically used for recreation as well (e.g.,Steinbach property). In these situations, mapping the location of such trails may be of value for future planning.

b) When to map pathways with evidence of cattle use: Trails with evidence of cattle use otherwise meeting our definition of undesignated trail will be mapped when any of the following criteria are also met:
   i) There is direct evidence that the undesignated trail has been used by people on foot, bikes, dogs, or horses (e.g., footprints, bike tracks, dog tracks, horse manure); or
   ii) The pathway can be reached from a designated trail, another undesignated trail, a trailhead, a pedestrian gate, or another visitor access point (including adjacent private residences); or
   iii) There is indirect evidence that the undesignated trail is used for recreational travel such as signs (e.g., cattle grazing in area, please close gate), pedestrian bridges, or historic knowledge of visitor travel.
   iv) When in doubt as to whether the undesignated trail receives recreational use, the surveyor will map it.

c) When to NOT map pathways with evidence of cattle use: Trails with evidence of cattle use that meet our definition of undesignated trail will not be mapped when any of the following criteria are met:
   i) The property is used exclusively for agriculture (grazing or grazing and crops) and cannot be accessed without going around a fence, through a gate typically locked to the public, or entering via an on-site residence or facility
   ii) The property is officially recognized as "no public use"

5) Pathways dissected by stonewalls
   a) Pathways running on one or both sides of a stone wall, that in a surveyor's best professional judgement,is functioning as an "undesignated trail edge" are independently evaluated to determine if one or both meet the definition of an undesignated trail.

B. Determining which path segments to map as ***road-like paths***

Staff will also need to decide which pathways they should map as a "road". Some pathways will be mapped as both a road and an undesignated trail if they meet both definitions.

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trails that would have been excluded based on this protocol update. When in doubt as to whether the trails are used exclusively by cattle, the mapped trails will be retained.

Definition of an undesignated road

1) For this mapping project, a road is defined as a continuous linear or curvilinear pathway on the landscape that:
   a) Is not a designated trail or designated road[12]
   b) Is greater than 20 feet long
   c) Is wide enough to accommodate an OSMP vehicle
   d) Is connected to an access point that accommodates vehicles or to another drivable pathway (includes those off OSMP property); some access points or connecting pathways may have barriers blocking vehicle access, but these barriers could be removed to accommodate vehicle access. Barriers include, but are not limited to boulders, fences, slash piles, dirt piles, and/or single trees or shrubs at access point.
   e) Is drivable or drivable with "some" maintenance
   f) Has evidence of repeated vehicle use when compared to the surrounding landscape. Evidence does not need to be direct (i.e., tire tracks). Evidence of repeated use (see illustrations in Appendix F1) includes but is not limited to:
      i) A corridor of intentionally cleared vegetation or vegetation loss created by travel (i.e., crushed, stunted, trampled). Note: flattened vegetation believed by the surveyor to be associated with a single pass of a vehicle is not adequate criteria of repeated vehicle use (see Figure 2).
      ii) A convex, cupped, compacted, level or incised linear feature (i.e., roadbed)
      iii) Continuous and distinct tire tracks that suggest multiple passes along the same pathway
      iv) Widespread pulverized litter
      v) Widespread crushed rock or gravel
      vi) Greater bare soil cover within pathway than in surrounding landscape
      vii) Erosion within the corridor greater than that observed in the surrounding landscape.
      viii) Posted signs related to vehicle travel
      ix) Functional vehicle access gate

Surveyors should use the criteria defining a road to evaluate all pathways they encounter in the project area. While this document attempts to clarify when a pathway meets the project's definition of a road, surveyors will undoubtedly encounter situations where the decision to map the pathway as a road is not clear and the surveyor must use their best professional judgment to determine whether to map the pathway as a road. Of particular concern is trying to discern whether a pathway in grassland habitat satisfies the criterion of having evidence of repeated use. Grassland habitat, with or without a pathway through it, is often drivable and can accommodate a vehicle. Surveyors will use their best professional judgment in determining whether a pathway visible in grassland habitat receives repeated use, keeping in mind that they are not to map pathways that are believed to be created by a single pass of a vehicle.

[12] For the purpose of the project, a designated road is one that is already included in the current GIS roads layer.

Figure 2. A vaguely apparent 2-track through a grassland is not mapped if the surveyor believes it lacks evidence of repeated use and is likely due to one or two passes of a vehicle.

Pathways that meet the criteria defining roads: Special situations

If a pathway meets the criteria outlined above defining a road for this project, surveyors should next consider if the pathway fits into the following specific situations when determining if a feature should be mapped:

1) Floaters:
   a) "Floater" roads meet all the criteria of a road except 1) d) above because they are not connected to another public or private road, a drivable road as defined above, a drivable designated trail, or other access points that accommodate vehicles (e.g., parking area). Like one type of "floating" undesignated trail, "floater" roads are likely segments of former roads that have not sufficiently recovered from past use and are not believed to be in current use as a travel corridor. **Floater road segments will not be mapped or will be deleted from the final map.**

   b) Isolated road segments that are not "floaters". Some mapped roads that are discontinuous from other mapped segments may appear to be floaters, but in the surveyor's best professional judgment, continue to be part of an active vehicle route. The surveyor must belief that vehicles travel repeatedly both on the road segment of interest and along a route that connects at least one end of the segment to another drivable road, drivable designated trail, or access point that accommodates vehicles. In these rare situations, the connection contains one or more segments of intervening pathway that is also drivable but fails to meet the definition of road because evidence of repeated vehicle use was not identified on that segment of road. Examples where isolated road segments may be

mapped are illustrated in Appendix F2. **When isolated segments meet the characteristics described in this section, they will be field mapped and retained in the final map projects.**

2) Co-occurrence of roads and undesignated trails
   a) If a road segment that meets the criteria in the road definition above also contains or is contiguous to a pathway that meets our definition of undesignated trail the combined feature (road and undesignated trail) is mapped once, but attributed as both a road and an undesignated trail. Not all roads are also undesignated trails as some may lack a continuous trail boundary on the surface of the earth. A pathway may be identified as a both a road and an undesignated trail even if there is no direct evidence that human visitors are using the pathway, as long as other criteria for roads and undesignated trails are met, including that for repeated use.

   b) If a road that meets the criteria in the road definition above and undesignated trail are parallel but not connected, each will be mapped as distinct features (i.e., a road and a trail).

3) Links to public roads
   a) Roads that meet the above criteria only along the short segment linking a Colorado Department of Transportation roadway (local road, major road, or highway) and a vehicle gate will not be mapped, even if the part of the pathway lies on OSMP land.

   b) Roads that directly or indirectly link a residence, ranch, business, or other facility (i.e., serving as a driveway) to a public road via a motorized vehicle pathway on OSMP managed land will be mapped if they otherwise meet the criteria for roads[13]. Surveyors will note the specific destination or purpose of the driveway to the best of their ability. For example the surveyor may note that the driveway goes solely to a private residence, or they may note that the driveway provides access to a ranch and addition pasture gates.

GPS Settings

From the "TerraSync™" main menu, select the "Setup" window from the drop down menu to insure the settings are as follows:

- GPS Receiver Port: Com2 or Com3 or Com8 when using the ProXH antenna
- Slide bar: not checked
- DOP type: PDOP
- Max PDOP: 6.0
- Min SNR: 33.0
- Min Elevation: 15°
- Velocity Filter: Off

4.7. Steps for field data collection and documentation

4.7.1 Starting and setting up the GPS

Immediately upon arrival to the study area, field technicians will turn on the Trimble GPS Receiver, start TerraSync™, and begin to acquire satellites. The receiver should be set up to record points in NAD

[13] Some driveways were not mapped in the field prior to February, 2012 because an earlier version of this protocol (01/03/2012) specified that surveyors would not map driveways believed to serve primarily as parking areas or access to parking areas at residences, ranches, businesses and other facilities. These driveways were later digitized based on aerial photographs and the surveyor's previous observations of the area.

1983 State Plane Colorado North FIPS 0501 Feet.[14] The Setup/GPS Setting window on the GPS receiver should be checked to make sure that the slider bar check mark is off and the Maximum Positional Dilution of Precision (PDOP) is set to 6. This will insure good satellite configuration and an acceptable accuracy threshold for collecting field data. When this PDOP is exceeded, the Trimble software will stop computing GPS points until satellite geometry improves or until the surveyor increases productivity settings on the slider bar.

If there is poor GPS coverage (satellite geometry) the surveyor will:

1. Wait a minute or two to see if coverage improves;
2. On occasion, field surveyors will use their best professional judgment to determine whether to increase the maximum PDOP (increase productivity or decrease precision on the slider bar) to allow the GPS to collect less accurate location data. The surveyor will stay at the point long enough to record at least 30 positions at this lower accuracy. Notes should be recorded to indicate that the PDOP was temporarily changed. Surveyors should remember to change PDOP back to 6 after satellite configuration improves. When collecting points at a higher PDOP, surveyors may observe their Predicted Post-processed Accuracy (PPA) when using the Trimble XH/ProXH or the Estimated Accuracy after Post Processing on the Trimble XT6000 and consider taking additional points to bring horizontal accuracies down (ideally within 1 m horizontal accuracy)[15].
3. Alternatively, the surveyor may choose to draw and label the point on their map tile and digitize the point in the office. Attribute data should still be entered on the GPS using the data dictionary, noting in the comment field that the point should be manually digitized.
4. When satellite coverage is not available for the majority of points even when increasing the maximum PDOP, or when predicted post-process horizontal accuracy is consistently higher than 2 m, consider returning at another time to map this trail.

4.7.2 Searching for undesignated trails and road-like pathways

All roads, designated trails, and previously documented undesignated trails within the project area will be systematically visited by surveyors as they search for undesignated trails and roads within the surveyor's view. The surveyor will not always need to walk the entire alignment of a previously mapped undesignated trail if all junctions with other designated trails, roads, and undesignated trails no longer meet our criteria for mapping and the surveyor follows guidelines for determining how far along a recovered segment to search as outlined in the Special Situations section of 4.6 *A* above. A background map on the GPS showing the 2006 undesignated trails (or undesignated trails mapped during the previous survey) can be used to navigate to the historically mapped undesignated trail junctions or alignments. Surveyors may also display OSMP property boundaries and designated trails as background layers to insure that they can differentiate undesignated from designated trails and limit mapping to OSMP managed properties.

[14] Prior to December 31, 2011; all GPS units recorded field data in latitude/longitude (WGS84) and were later converted to NAD 1983 State Plane Colorado North FIPS 0501 Feet when exporting data to GIS files.

[15] Setting standards for keeping estimated horizontal accuracy within 2 m. was added to the protocol in Feb., 2012. Prior to that, surveyors were setting PDOP masks and using best judgment to determine if mapping should continue. Surveyors need to consider all factors (e.g., time constraints, difficulty of returning to a particular location) when making decisions about mapping accuracy, however documentation of trails mapped with poorer accuracy should be kept with the data.

Surveyors will also look for newly developed undesignated trails within the project area using the search strategy described above. Any potentially new undesignated trails identified in aerial photographs and having connections to mapped pathways will be visited. Any pedestrian, vehicle, and external ranch gates depicted on the OSMP fence layers will be searched for evidence of new undesignated trails and road-like pathways, being alert to any isolated segments emerging from internal ranch gates that may be floaters. Surveyors will also check for undesignated trails or road-like pathways in the vicinity of areas known to attract visitors in the past (e.g., staging areas for bouldering or climbing, popular fishing access locations) if there is evidence of visitor travel connecting such visitor attractions to a pathway searched during the survey or if the attraction is within view of a visitor travel corridor.

4.7.3 Collecting GPS coordinates for features

To collect GPS coordinates for undesignated trails, roads, road barriers, constructed features and signs, the surveyor will "Create" a new data file in the Data/New window using the Undesignated Trails data dictionary updated for each mapping year. From the "Collect Features" screen, the surveyor will choose the appropriate Features type (Figure 3)

- Undesignated Trail: to map points along both roads and undesignated trails
- Constructed features: to record point locations for human-made trail features
- Signs: to map the point locations of sign structures and associated sign messages
- Barriers: to map the point locations of road barriers

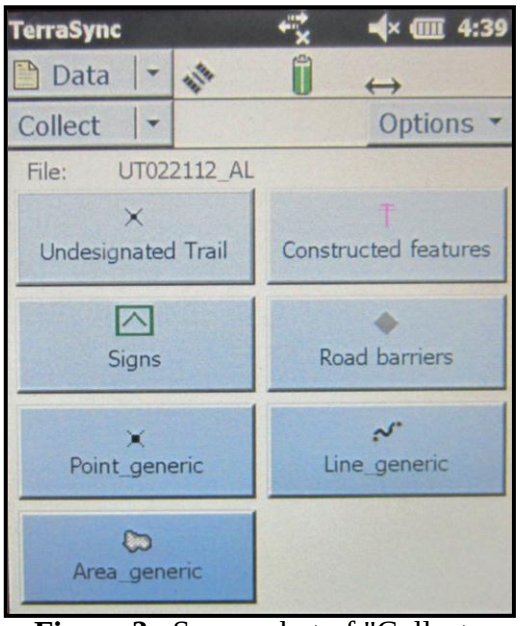


Figure 3. Screen shot of "Collect Features" screen in the undesignated trail data dictionary

As soon as that feature is opened the GPS will begin to try to log points, so the surveyor should stand still, holding the GPS receiver above the point. The receiver should be held at a height equivalent to the "antennae height" recorded on the GPS at the start of the mapping session. At least 30 measurements should be logged at each mapped point. Surveyors working under heavy tree canopy or near canyon walls should consider collecting additional measurements per feature (60 measurements recommended), particularly if estimated post-processed accuracies are low. Instructions for collecting GPS points using TerraSync on the GeoXT/GeoXH are found within online instruction folders.

4.7.4 Mapping points along undesignated trails or roads

When an undesignated trail or road is located, GPS coordinates for a point feature will be mapped at the beginning (i.e., Start) and end point of the pathway (i.e., End) and at multiple midway points (Mid or Change points) along the length of the entire pathway (Figure 4). Start points are defined as the point of intersection with the edge of a designated or undesignated trail or road, or at the boundary of OSMP-managed properties, as inferred by landmarks on the ground (a posted gate, a posted fence, a sign). In the absence of landmarks at property

boundaries, surveyors will use the GPS background maps and hard copy maps to estimate where OSMP property boundaries are located. There is no rule for differentiating an undesignated trail start from its end; either terminus can be mapped first. Mid trail points are mapped at intervals of 200 feet from the previous mapped point, with additional points mapped as needed to adequately capture curves or turns in the trail alignment, or to provide additional control points when GPS coverage is poor. A measuring wheel will initially be used to allow the surveyor to determine the number of strides per 200 foot interval. Once a stride length is established, the surveyor may approximate 200 foot intervals without using the measuring wheel.

Change points will be GPS-mapped when any of the three attributes described below changes (e.g., at the point a road ends and becomes a trail). Change points can occur at any distance interval along the trail. Change points may also be GPS-mapped to represent the start and end of additional parallel or braided trails along a pathway. If a surveyor is mapping an undesignated trail and a braided or parallel trail emerges from the trail and later merges back to the main undesignated trail or ends, the surveyor may map the beginning and end points of the braid along the pathway, sketch the specific alignment of the secondary trail on the map tile, and note in the data dictionary comments field that the points represent the beginning or end of a secondary trail. This enables the surveyor to digitize the braid without actually walking it separately. Alternatively, braids and parallel trails can be sketched and annotated on the map tile and/or described in more detail on the tracking sheet (e.g., braid ~ 60 feet long and 4 feet to the north of undesignated trail).

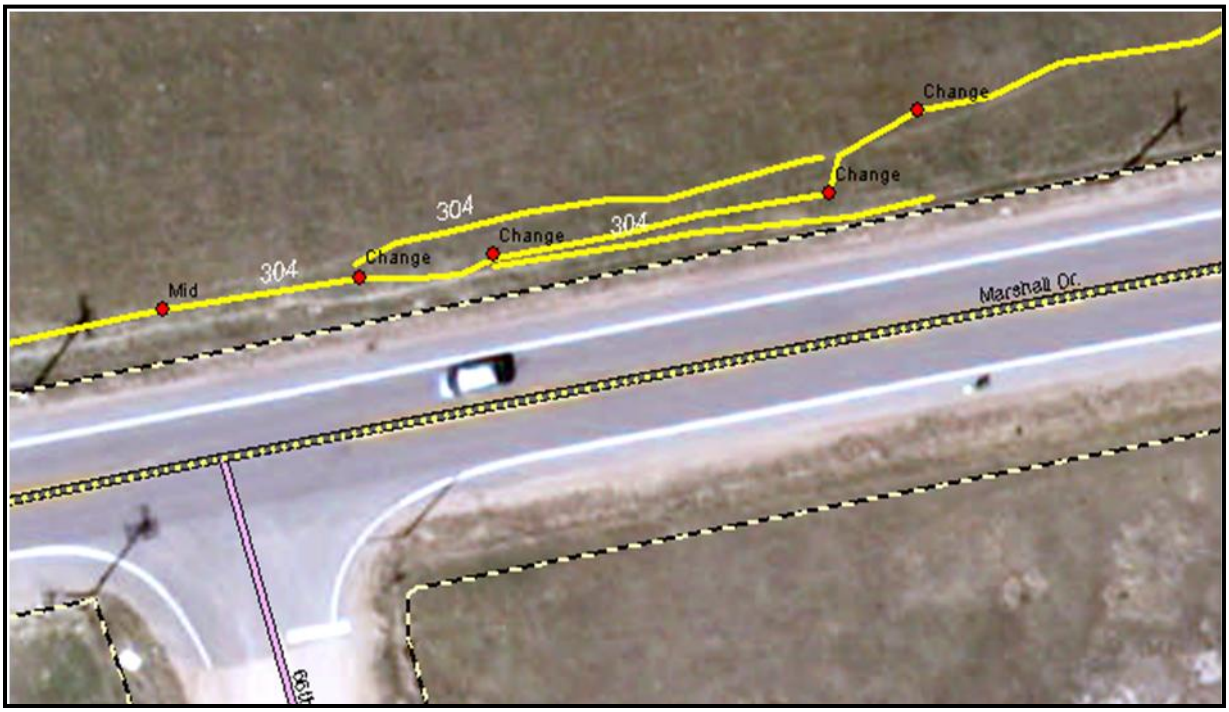


Figure 4. Digitized undesignated trails (yellow lines with italic Trail_ID labels) and corresponding GPS mapped points (red dots). Mapped points are attributed with a Point_type, where "Change" is used to indicate a change in the road or cattle status of the pathway, or a change in the number of parallel trails as illustrated above.

4.7.5 Mapping branches and extensions

When undesignated trails branch or form junctions with other undesignated trails, the surveyor should continue along the undesignated trail that was formerly labeled with the same Trail_ID number as the trail the surveyor was mapping before she/he reached the junction. When mapping a new undesignated trail that does not have a Trail_ID number from a previous survey and arriving at a junction, the surveyor continues along the segment that appears, in the surveyor's best professional judgment, to be the most similar to the segment already mapped. When an undesignated trail extends beyond the original length mapped in 2006 or the most recent survey, the extended portion will continue to be assigned the same Trail_ID number as that assigned during the most recent survey.

4.7.6 Mapping recovered or revegetated sections of undesignated trails

When a surveyor encounters a revegetated or recovered section of an undesignated trail that no longer meets the undesignated trail definition within an undesignated trail that otherwise meets the definition, the surveyor will map an "end" point on that trail. The surveyor will then explore the former alignment using the background file on the GPS and determine if the undesignated trail becomes evident and meets our definition for a length of 20 feet or more. If the undesignated trail starts up again, the surveyor maps a new start point and assigns the same Trail_ID as used before encountering the recovered section (Figure 5). If the surveyor encounters a segment of NAT of less than 20 feet in length and they see clear evidence that trail continues ahead, she/he will include the short segment within a mapped segment.

When surveyors map only discontinuous portions of a former trail because some portions have recovered or revegetated, mapped points will be numbered starting with one and continuing sequentially even when unmapped gaps are encountered between the mapped points. This method will help surveyors recognize that these segments are part of the same undesignated trail but need to be digitized as separate lines.

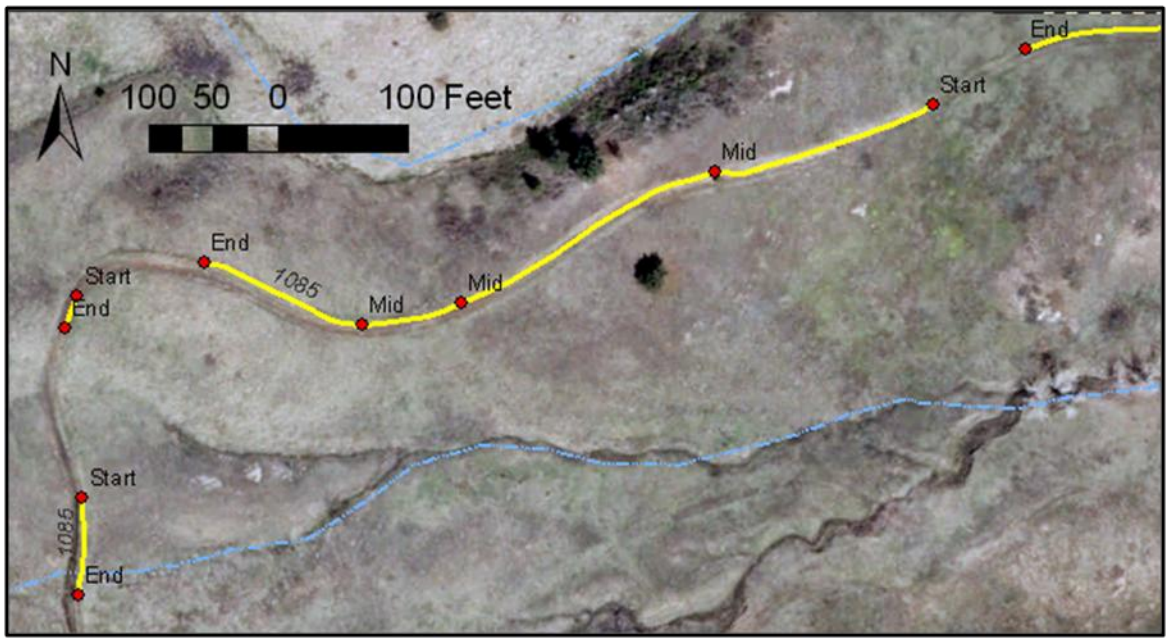


Figure 5. Digitized undesignated trails (yellow lines with italic Trail_ID labels) and corresponding GPS mapped points (red dots) illustrate gaps where recovered segments or NATs were encountered. End points are mapped where the undesignated trails segment ends and the NAT segment begins. Start points are mapped at the point the undesignated trail is evident again. The isolated undesignated trail segments are not considered "floaters" because the surveyor believed that visitors were still using the entire pathway.

In evaluating how far to search along a previous undesignated trail alignment, the surveyor will consult their map tiles to determine if the far end of the trail historically connected to another access point, road, undesignated or designated trail or point of interest. If so, they will search the previously mapped alignments. If the map tile suggests that the undesignated trail segment <u>does not connect</u> to another access point (including access points from non-OSMP trails,OSMP designated or undesignated trail, road, or other point of interest,) or if the surveyor discovers that the distant connection no longer exists, then the surveyor will use their judgment to determine how far along a recovered section they will search for evidence that the trail begins again. Surveyors will use the guidelines for "floaters" outlined earlier [*Pathways that meet the criteria defining undesignated trails: Special situations, 2) e) and 2) f)]* to determine if they should map undesignated trail segments that are essentially islands (i.e., floaters), with no connection to another access point, road, undesignated or designated trail or point of interest. If such a isolated segment is mapped because it is believed to be part of a current visitor travel route then the surveyor should document their reasoning for retaining the isolated segment in the map

4.7.7 Entering undesignated trail attributes

Attributes described below and shown in Figure 6 are entered electronically using the project's data dictionary. The attributes Trail_ID, Point_ID, Point Type, and Surveyor characterize the mapped point and are entered for each GPS-mapped start, mid, end, or change point. Additional attributes Cattle, Pathway and Comments apply more broadly to conditions on the preceding segment. Cheat sheets in Appendix G can be used in the field to clarify attribute menu choices.

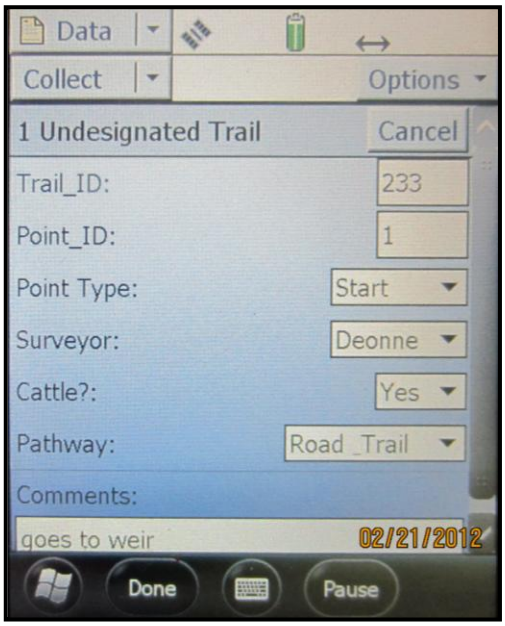


Figure 6. Screen shot of attributes to be recorded within the Undesignated Trail feature window.

Numbering system - undesignated trails/roads

During undesignated trail and road mapping, each mapped point will be assigned a Trail_ID that corresponds with the "grouped sections" trail number assigned by GIS staff during the previous survey. Any undesignated trail segment that is an extension of a previously mapped undesignated trail will be given the previously mapped undesignated trail number. New trail segments parallel to a previously numbered trail or appearing to be a new braided segment of that trail will generally be assigned the same Trail_ID as the primary trail since these clustered trail segments provide similar visitor routes to or from the same locations and are likely to be managed or restored together. However, surveyors may assign such segments unique numbers as needed to minimize confusion and increase efficiency in the field. For other new undesignated trails or roads, surveyors will assign a unique Trail_ID number from the list of available numbers[16]. Any previously mapped undesignated trail with a Trail_ID number of 9999 will be assigned a new Trail_ID number between 3000 and 4999. These 9999 Trail_ID numbers generally occur in the NIST and NCAR areas, with a few scattered around elsewhere.

Point ID will be used to consecutively number each mapped point along the undesignated trail alignment. Numbers start at 1. Surveyors will assign the next consecutive number to points in the order mapped along each numbered pathway, even if there is a change in pathway status, cattle status, or intervening gaps of NAT.

If the surveyor maps a previously mapped undesignated trail as a road but not as an undesignated trail in 2011, the surveyor will reuse the 2006 Trail_ID to identify the road. However, if both a road and an undesignated trail occupy separate but parallel pathways in 2011, the 2006 Trail_ID will be assigned to the undesignated trail and the road will be given a new number.

Point type

Each point will also be assigned a Point Type from the data dictionary menu that described its location or status along the undesignated trail or road-like pathway as either a start, end, mid trail or change point. (See *Mapping points along undesignated trails or roads* for descriptions of each point type.)

[16] In 2011, new Trail_IDs will start at 5000.

Surveyor name
Surveyor name will be entered from a menu listing names.

Cattle presence
The surveyor will determine if the preceding trail segment receives cattle use, choosing from menu options "Yes" or "No". If the trail lies in an areas on the map tiles identified as a "grazed area" and if the surveyor observes cattle directly or encounters indirect evidence of cattle presence (e.g., cow pies, cattle hoof prints, salt licks, trail goes to a water tank or feeding area) along or in the vicinity of the trail, the surveyor will consider the trail to be used by cattle and check the appropriate box in the data dictionary. Noting the trail is used by cattle does not mean the trail is used exclusively by cattle. It will be helpful for the surveyor to note on their field tracking sheet if they believe that the trail is created or used exclusively by cattle.

Pathway status
The surveyor will also determine if the preceding mapped segment meets the definition of an undesignated trail, a road, or both, choosing from menu options "Trail", "Road and Trail", or "Road". Multiple pathways within a road otherwise meeting the definition of undesignated trail will be mapped as a single pathway in the field and assigned the attribute "road and trail". For example, a two-track in which both tracks meet the definition of undesignated trail will still be mapped as a single pathway. A comment can be entered to describe the number of parallel pathways encountered within a road. In the office, a single line will be digitized to represent both the road and trail(s). Starting in fall 2012, surveyors will also try to determine if part or all of a mapped pathway is a former designated trail. For future mapping projects, this pathway status will be added to the data dictionary and assigned either in the field or during the editing process based on GIS data. Surveyors will need to use their best judgment in assigning pathway status for unusual situations. Decisions made on how to categorize an unusual or unclear pathway status will be communicated to other surveyors.

Comments
Comments will be entered as necessary to describe mapping problems, unusual feature conditions, evidence observed of specific visitor or cattle use, destination for roads, adjustments made to maximum PDOP, or the presence of adjacent trails not directly mapped but sketched in the field. Comments apply to the point or to preceding segment and serve as important reminders of notes to be included in tracking sheets.

4.7.8 Mapping road barriers
When a road barrier is encountered at either end or along the road being mapped, GPS points will be collected at that location. Location and attributes (Trail_ID, barrier type, comments) will be entered using the Road barriers feature class in the project's data dictionary (Figure 7). When multiple barrier types occur at one location,

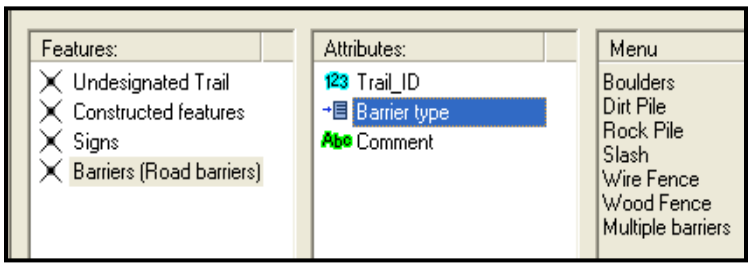


Figure 7. Screen shot of barrier types recorded for the road barrier feature

surveyors will choose “multiple barriers” for type and list the types in the comments field, separating each type by a comma.

Mapping constructed features along undesignated trails
When a constructed feature is encountered in the corridor of an undesignated trail, GPS points will be collected at the location of the feature or in the middle of any linear feature running along the trail. Location data and attributes (Trail_ID, constructed feature type, comments) will be entered using the Constructed features class within the project’s data dictionary (Figure 8).

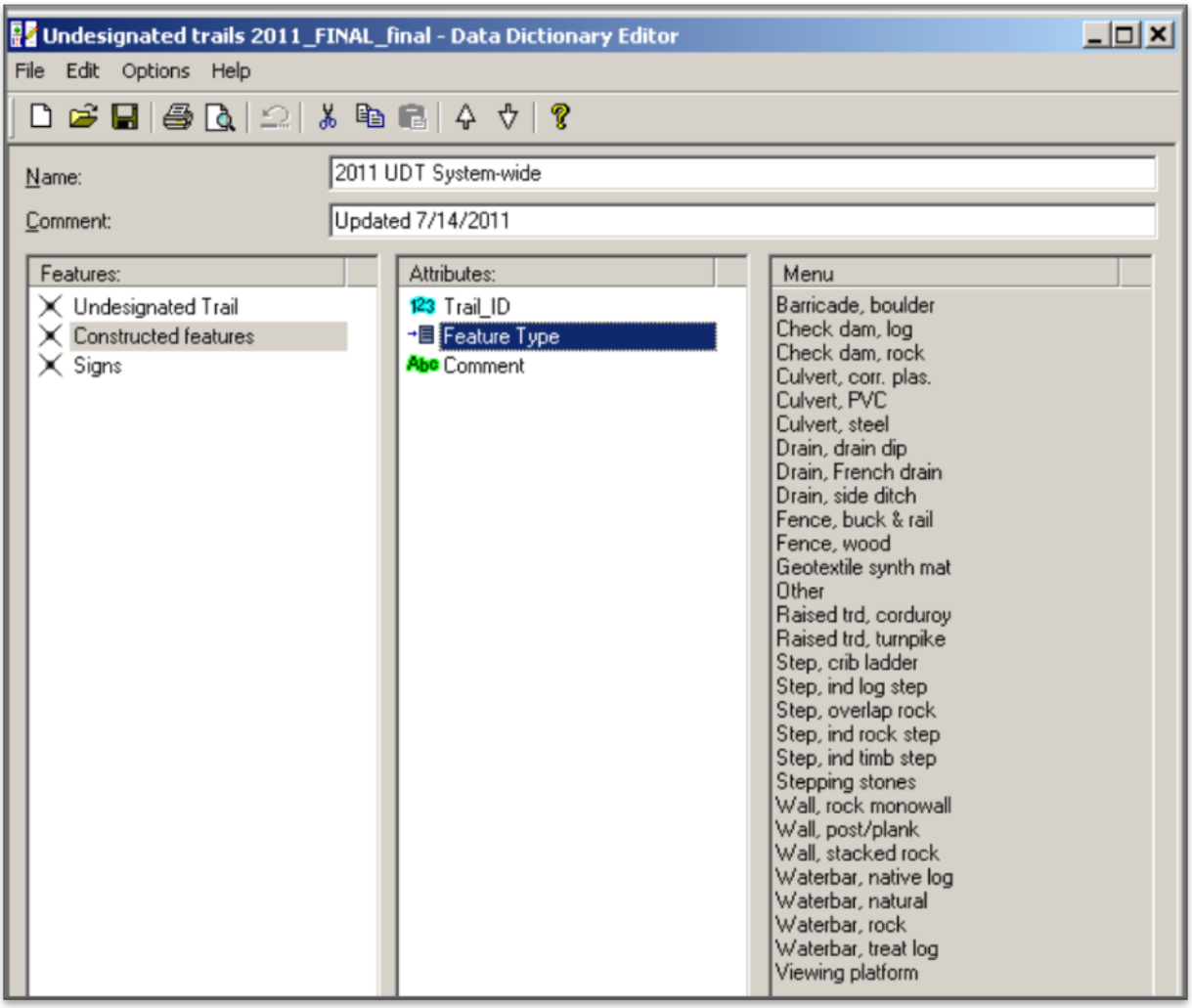


Figure 8 Screen shot of attributes to be recorded within the Constructed features window.

Constructed features observed near the junctions of previously mapped undesignated trails that have recovered to the extent that they no longer meet our definition of undesignated trail should also be mapped and assigned the previously mapped undesignated trail’s Trail_ID number. Any additional constructed features encountered as the surveyor investigates unmapped visitor travel routes (e.g., on a faint pathway not meeting our undesignated trail definition or just outside the edge of OSMP-managed lands) should also be mapped and assigned the number 9999. Constructed features will be mapped regardless of who constructed them (e.g.,OSMP staff, a

helpful visitor to OSMP) or whether the surveyor believes they are functional. OSMPs constructed feature layer for designated trails may be reviewed or printed on the map tile prior to mapping to differentiate any features already mapped. A "cheat sheet" will be carried in the field to insure that surveyors correctly identify constructed features (Appendix H). Surveyors will photograph any constructed features they are unable to identify, record the constructed feature type as "Other", describe the feature type in the comments, and ask for staff assistance in correct labeling of that feature. The surveyor should share the photograph and feature identification with other surveyors.

Constructed feature types given in the data dictionary (see Figure 8, right panel) correspond to those tracked during designated trail condition monitoring. To save time, multiple steps will be considered as a linear feature and location data will be collected at the middle step. The surveyor will note the number of steps in a comment field. Surveyors will map those constructed features expected to have a lifespan measured in decades and over multiple successive surveys. Constructed features installed during trail closure and restoration such as wattles and biodegradable geotextiles meant to degrade beyond identification within several years will not be mapped as constructed features. Fences used as cattle barriers (barbed wire, wire fences) paralleling or crossing the trail with an opening for travel will not be mapped as constructed features. However fences blocking the trail and used to limit human visitor access (e.g., wood fence, buck rail fence) will be included as constructed features. On the rare occasion where a barbed wire or wire fence lies perpendicular to the undesignated trail and is signed or otherwise determined to restrict visitor access, the feature will be mapped, attributed as "other" and described in the comments field.

4.7.9 Mapping signs and sign structures along undesignated trails

When a sign is posted on or in the corridor of an undesignated trail, GPS points will be collected at the location of the sign structure and the type of sign structure (Figure 9) and message type (Figure 10) will be entered using the Signs feature class. When multiple messages are posted on a single structure, the surveyor will need to map multiple points to enter each of the sign messages separately. A "cheat sheet" showing sign structure and message types will be carried in the field to insure that surveyors correctly identify sign structures (Appendix H1) and messages (Appendix H2). Surveyors will photograph any sign message or structure types they are unable to identify, record the sign structure or message as "Other", give a description of the sign structure or message in the comments, and ask for staff assistance in correct labeling of that feature. The surveyor should share the photograph and feature identification with other surveyors.

Signs observed near the junctions of recovered undesignated trails should also be mapped using the former Trail_ID. Any additional signage encountered during the undesignated trail survey that is not on a numbered undesignated trail (e.g., on a faint pathway not meeting our undesignated trail definition or just outside the edge of OSMP-managed lands) or a designated trail will be mapped and assigned the number 9999. The purpose of mapping signs on undesignated trails is to augment and complete the sign inventory conducted during designated trail monitoring. Signs previously mapped during trail condition monitoring can be added to and printed on map tiles to insure these can be differentiated from any undocumented signs, particularly near the intersections with designated trails. However, when in doubt, the surveyor should map a sign and delete any duplicates in the office.

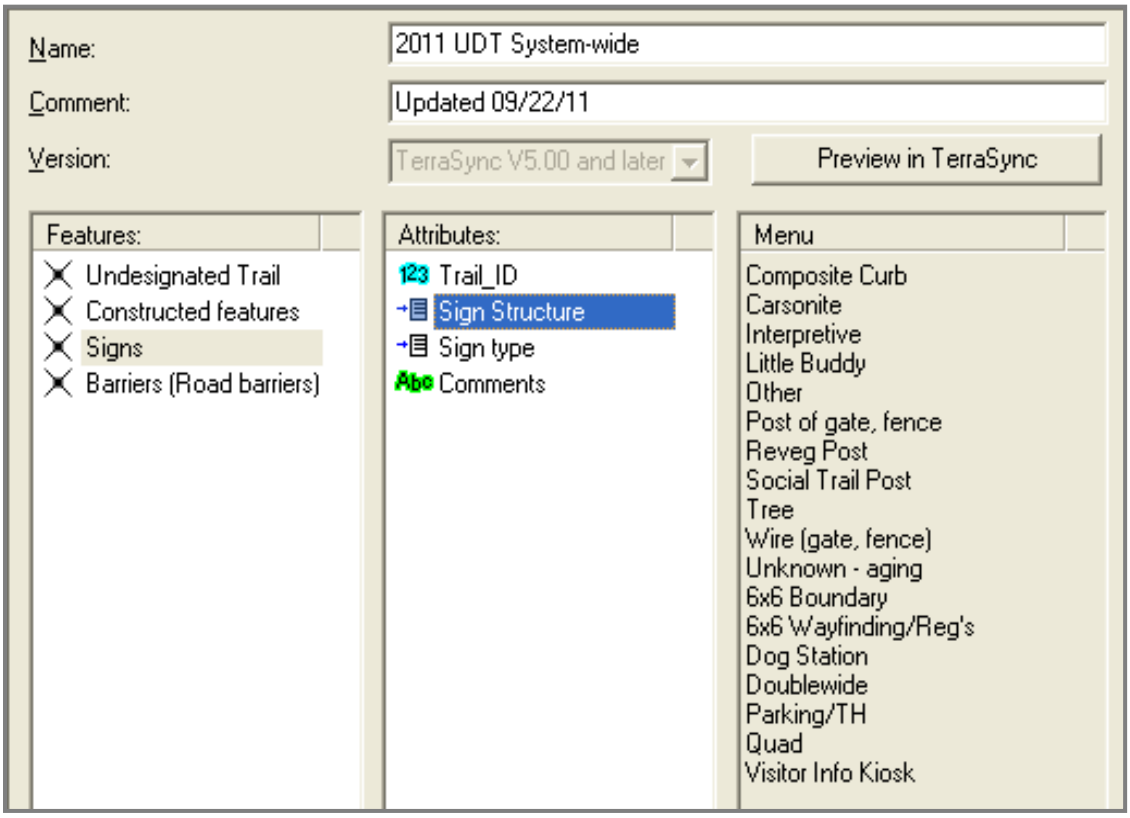


Figure 9. Screen shot of attributes recorded within the Signs feature window showing menu choices for sign structure type.

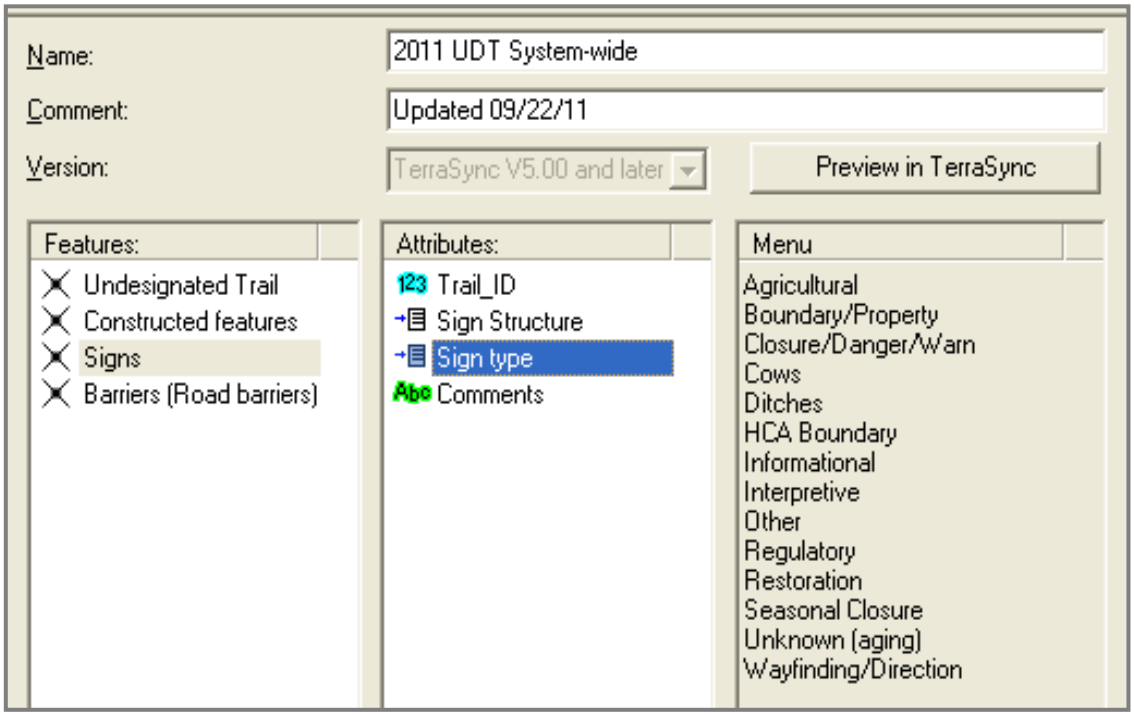


Figure 10. Screen shot of attributes recorded within the Signs feature window showing menu choices for sign message types.

4.7.10 Completion of GPS point mapping.
When the surveyor has logged at least 30 points at the location for which data is being collected and finished recording notes and attributes, he/she will hit "OK" on the feature data collection window to store the feature.

4.7.11 Tracking mapping progress and additional mapping information in the field
While in the field, monitoring staff will document their mapping progress and challenges encountered by filling in field tracking sheets, annotating map tiles, and taking photographs where pictorial records would be helpful.

Filling in tracking sheets
Surveyors will document all new and historically mapped undesignated trails and roads visited during the current survey on a field tracking sheet (Appendix J). Each visited road or undesignated trail should be listed by date visited in the field, trail_ID, and primary mapping tile. The pathway status should be recorded as either an undesignated trail (UT), NAT, road (RD), road and undesignated trail (RD&UT), former designated trail (FDT), new designated trail (NDT), or new climbing access trail (NCAT). A separate line should be recorded for each unique combination of a trail_ID and path status. The surveyor should indicator whether cattle use the trail and provide notes that will be helpful when digitizing the trail and describing the trail status to others. The surveyor should add comments to the tracking sheet indicating if part of the undesignated trail was a NAT (i.e., the trail is shorter than during the previous survey), if braids or parallel trails were also mapped, destinations or functions served by the pathway, and notes further explaining pathway status as a road, NAT, "floater", or undesignated trail. If the status of a numbered road switches between road, road and trail, or undesignated trail it should be noted in the comments. If an undesignated trail was not GPSed in the field but was sketched onto the map tile for later digitizing, the surveyor should also indicate this on the tracking form.

Annotating map tiles
Monitoring staff will also annotate map tiles or enlargements of map tiles to keep track of their progress in the field. Staff will fill in the header information on the printed map tiles to show the mapping dates and name of the surveyor mapping in that location. Map tiles will be annotated as needed by each surveyor to show which historic undesignated trails have already been visited and to indicate any new or previously documented undesignated trail segments to which the surveyor must return. New undesignated trail segments will be sketched on the map and labeled with a new Trail_ID. When of use to surveyors, printed maps will also be annotated to indicate the approximate locations of any recovered segments and any parallel, braided, or adjacent undesignated trails not GPSed in the field.

Photographic documentation
During mapping, photographs will be taken by surveyors opportunistically to document novel situations, to clarify elements of the protocol for future use, or to provide examples to share with other surveyors to help insure inter-observer consistency.

Situations that should be photographed by surveyors in 2011/2012 include:
- Linear features that the surveyor considers borderline between satisfying and not satisfying the criteria for an undesignated trail

- Constructed features not listed in the data dictionary
- Sign structures not listed in the data dictionary
- Range of feature types identified as roads
- Range of feature types identified as undesignated trails
- Undesignated trail segments on resistant surfaces
- Examples of features mapped during a previous system-wide mapping project but identified as not satisfying the criteria for an undesignated trail and not mapped during the current system-wide survey
- Barrier types observed at road access points
- Situations encountered to be shared with rangers, trail staff, visitor access staff, VMP implementation coordinator or managing staff (e.g., illegal situations, situations where visitors/staff could be in danger/at risk, etc.)

Photographs should be shared among other surveyors in a timely manner to provide a basis for discussion and to insure that all surveyors are consistent in their field methods and mapping definitions.

Any photographs taken will be documented on the bottom of the field tracking sheets (Appendix J) listing photographer, photograph number, date, type of pathway, tile number, Trail_ID number, and any notes describing the content of the photograph. This information will be used to name the digital photograph and to place it in the appropriate subdirectory. Photograph file names should include the type of pathway, the Trail_ID, the Tile number, the date (mmddyy), and the initial of the photographer (e.g., Road_5538_T60_100311_AL.jpg).

4.7.12 Completion of field mapping session
When surveyors complete a field session, they will review the GPS data while still in the field to make sure no data was lost. They will check that the data dictionary, tracking field sheets, and map tile annotation were filled out completely and correctly. Notes should be recorded to indicate any trails left to be mapped as well as deviations from the protocol or problems with the mapping session while still fresh in the surveyors' mind.

4.7.13. Sharing and resolving mapping problems
Undesignated trail mapping staff will likely encounter situations that have not been documented in this protocol and questions about which pathways to map. Ad-hoc office meetings should occur every time an unresolved or new situation arises in the field. Mapping staff should share photographs, verbal or written descriptions and maps to explain the unresolved situation. The goal of these meetings will be to develop guidelines for handling these situations, insuring that every mapper has unambiguous tools for making decisions in the field in a consistent way. Mapping staff should be sure to follow up on these meetings by changing the data dictionary as needed, editing previously-collected GIS data and Excel tracking files to be consistent with decisions made, and revising this protocol, In addition to these office meetings, mapping staff should meet in the field whenever live observation will facilitate resolutions.

4.7.14. Maintaining mapping consistency through regular check-ins. A crucial element of consistency in mapping will be regular meetings and/or communication among mapping personnel during the mapping process. Periodic group mapping sessions in the field will allow

mappers to recalibrate their mapping decisions, facilitating better uniformity among mappers and consistency with the protocol. This proactive approach will replace the post-hoc quality check implemented in 2006 to evaluate completeness of undesignated trail mapping.

5.0 Data management

5.1 Data transfer, differential corrections, and file export to GIS files

GPS data will be downloaded, corrected, and exported to GIS files at the end of each field day or early the following day before the GPS is taken back out in the field. Trimble® GPS Pathfinder® Office software will be used to download, correct and export GPS data. Detailed instructions for using the GPS and GIS for download, differential correction, export, and digitization are found in a separate document.

5.1.2 Reviewing differential corrections

If differential corrections of GPS positions are not successful, give poor levels of accuracy or correct only a portion of the positions (see standards below), the correction should be repeated with another base station or at a later time. Surveyors should follow the steps summarized below to assess the effectiveness of the differential correction.

Percent positions corrected: Surveyors should check the differential correction output text file (see Correct_*yyyy-mm-dd_number*.txt) to see that at least 80% of all positions were corrected before proceeding to the "data export" step[17]. If less than 80% of positions were corrected, surveyors should try correcting data with a different base station or at a different time. If repeating the differential correction does not improve matters, the surveyor should try to trouble shoot why much of the data is not correcting. Surveyors should then attempt to export data, examining the text file given during export (expMMDDd.txt) to see if any features were lost. If no features were lost, then most of the uncorrected positions are "not in feature positions (i.e., paths)" and surveyors should be careful in using this data to guide digitizing of undesignated trail segments. However, if the export text file reports that some features have no positions and were therefore discarded, the surveyor should attempt to recover the uncorrected data associated with the missing features. The surveyor should use their best judgment to decide if they will 1) redo the differential correction and data export with both corrected and uncorrected positions included; 2) redo the field survey; or 3) manually digitize the missing features and enter attribute data from the *.SSF file as outlined in this protocol. Surveyors should add a comment and warning for those undesignated trails that were influenced by uncorrected positions in the excel tracking sheet. They should also provide an explanation for high proportions of uncorrected positions in the accuracy assessment spreadsheet.

Percent of positions within accuracy standards

Estimated accuracies for each mapping session listed in the differential correction output text file (see Correct_*yyyy-mm-dd_number*.txt) should be within the following guidelines[17]:

- At least 90% of all positions should have estimated accuracies less than 2 meters
- At least 80% of all positions should have estimated accuracies less than 1 meter.

[17] Setting differential correction standards was not formally implemented prior to 02/15/2012. However, prior to this date surveyors used their best judgment to identify problems with differential correction and to determine when to redo the correction. For those differential corrections outside of these standards, explanations will be included in the files noted.

If the differential correction output text file indicates that these guidelines have not been met, the surveyor should explore and note explanations for poor GPS accuracies and consider correcting data with a different base station or revisiting the site when satellite configurations are improved. Surveyors should add an explanation and warning in the Excel tracking spreadsheet for those undesignated trails influenced by poor positional accuracies. The shape file attribute table can be checked during trouble-shooting to identify features with high PDOP and low horizontal precision. The surveyor should also provide an explanation for poor estimated accuracy in the accuracy assessment file named above.

5.1.3. *Exporting corrected data*

Corrected GPS data will be exported and converted to ArcMap GIS shape files (point data) using the export setup file. "Sample ESRI Shapefile Setup". This setup should specify the correct coordinate system (i.e., NAD 1983 State Plane Colorado North FIPS 0501 Feet), request inclusion of additional data with the export (time and date stamp, the GPS receiver type, horizontal precision, maximum PDOP, the number of measurements per point), and specify that "paths" (i.e.,"not-in-feature" measurements between GPS feature points) be downloaded to provide guidance on the trail alignment between sample points. During export to GIS files, Pathfinder software automatically names resulting GIS shape files according to the first eight characters of the feature name in the data dictionary (e.g., undesign.shp). Surveyors should rename these files **immediately** to avoid overwriting older files with newer files with the same name.

Although Pathfinder is set up to automatically place exported shape files into the directory, surveyors should use ArcCatalog to move files to the appropriate directory (\GISdata\UTs\, \GISdata\Signs\,\GISdata\Constructed_Features\, or GISdata\Paths\,) and rename the files to indicate their feature type, date, tiles included and initials of the surveyor. Surveyors should also reproject files in ArcCatalog by right clicking and choosing the correct coordinate system (NAD 1983 HARN State Plane Colorado North FIPS 0501 Feet) in the Properties/XY Coordinate System windows. Below are examples of the naming convention used for each feature type:

Table 3. Naming convention templates for GIS shape files associated with each GPS feature type. An asterisk (*) indicates all file extensions associated with a shape file (e.g., .shp, .sbn, .dbf, .prj).

Feature Type	Shape file name and location
Undesignated trails and roads	\GISdata\UTs\UT_060811_T24_25_DV.*
Signs	\GISdata\Signs\Signs_060811_T24_T25_DV.*
Constructed features	\GISdata\Constructed_Features\Construc_ 060811_T24_T25_DV.*
Not in feature points (paths)	\GISdata\Paths\PosnPnt_060811_T24_T25_DV.*

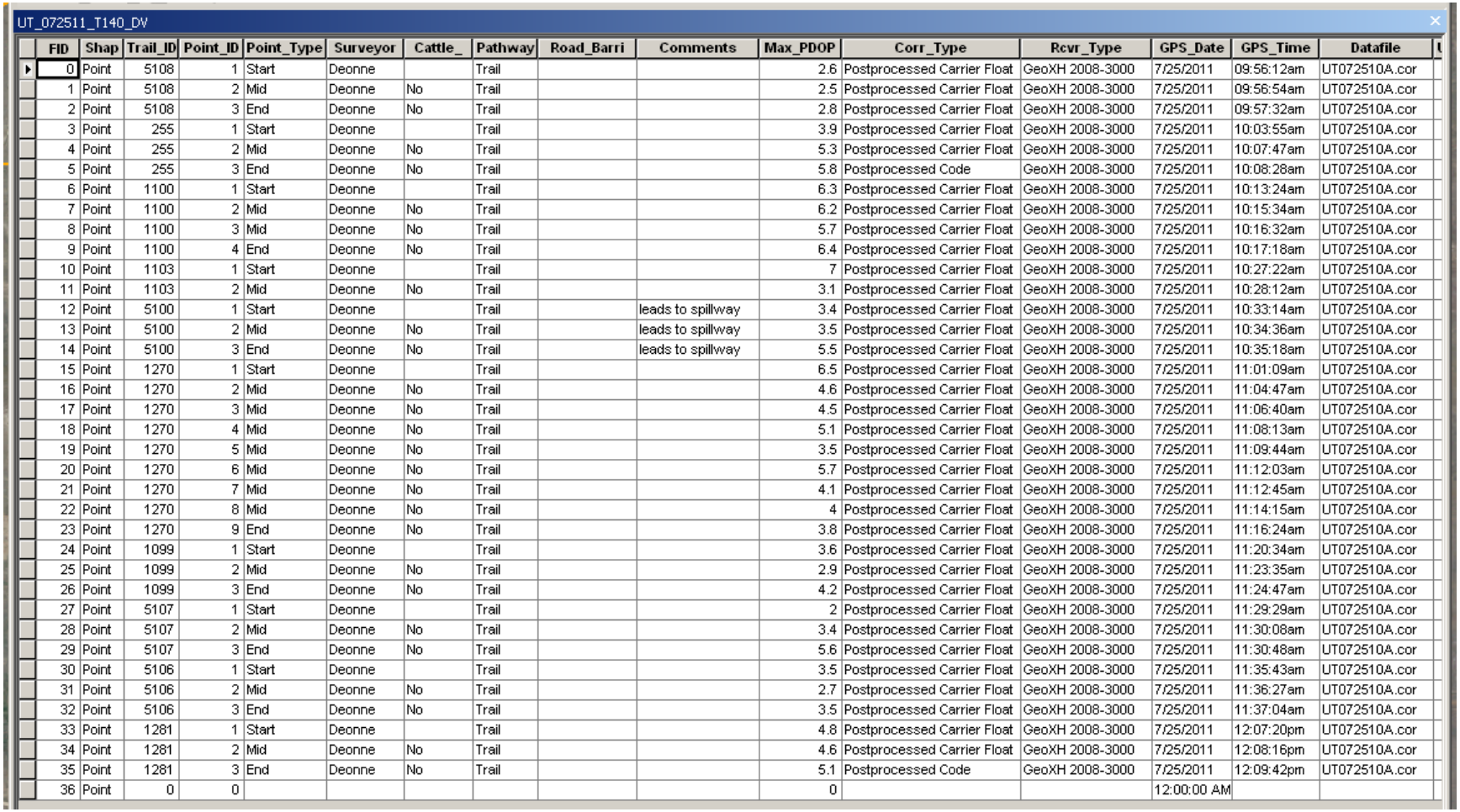
5.2. Assessment and edits to original GIS shape files (point data)

Before digitizing undesignated trail or road segments, each surveyor will review point locations and attribute values in the associated attribute table (Figure 11) using their customized map document (UDT_working_[*NAME*].mxd) in ArcMap GIS software. All feature types (including signs, constructed features, and road barriers) should be added to the map and reviewed. Review of point data will evaluate the following:

- Do point locations match features visible in aerial photographs (e.g., intersections with roads; clearly visible trails)?
- Do point locations make sense with respect to previously mapped features (e.g., fences, designated trail intersections, undesignated trails from last undesignated trail survey)?
- Do point locations fall outside of OSMP managed land?
- Are there missing or misnumbered Point_ID numbers?
- Was attribute data correctly and completely recorded (check for blank attribute data or data mistakenly copied from a previous record; check for correct Trail_ID, especially if a new number was assigned)?
- Does horizontal precision or Max. PDOP suggest imprecise or inaccurate location of any features?
- Are there comments noted that are useful to include in the excel tracking file or that help explain the status of the mapped pathway?
- Do points identified as having cattle use fall within a known OSMP grazed property. If not, please note this and check if grazing status has changed with appropriate OSMP staff.

For undesignated trail and road segments, results from this review will be used to guide needed changes in the alignment or attributes of the associated lines digitized as outlined in the next section. Although the location of these original points may be more accurate than the location of fence lines or OSMP property borders in OSMP's GIS layers, staff will use existing GIS layers to guide final placement of the undesignated trail segments. This will prevent unintentional data loss that could occur during GIS processing of the final undesignated trail and road map created from the point data. Comments noted in the point file and GPS accuracy indicators should be reviewed and recorded, when useful, in the excel data tracking spreadsheet discussed in the next section. Problems found and corrections made should also be noted in the excel data tracking spreadsheet file.

For signs, constructed features, and road barriers, attribute edits should be made directly into the point file. On rare occasions, the point location may also be manually edited (i.e., moved) to locate the point accurately with reference to other GIS layers and features observed in the aerial photo layers.



UT_072511_T140_DV

FID	Shap	Trail_ID	Point_ID	Point_Type	Surveyor	Cattle_	Pathway	Road_Barri	Comments	Max_PDOP	Corr_Type	Rcvr_Type	GPS_Date	GPS_Time	Datafile
0	Point	5108	1	Start	Deonne		Trail			2.6	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	09:56:12am	UT072510A.cor
1	Point	5108	2	Mid	Deonne	No	Trail			2.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	09:56:54am	UT072510A.cor
2	Point	5108	3	End	Deonne	No	Trail			2.8	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	09:57:32am	UT072510A.cor
3	Point	255	1	Start	Deonne		Trail			3.9	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:03:55am	UT072510A.cor
4	Point	255	2	Mid	Deonne	No	Trail			5.3	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:07:47am	UT072510A.cor
5	Point	255	3	End	Deonne	No	Trail			5.8	Postprocessed Code	GeoXH 2008-3000	7/25/2011	10:08:28am	UT072510A.cor
6	Point	1100	1	Start	Deonne		Trail			6.3	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:13:24am	UT072510A.cor
7	Point	1100	2	Mid	Deonne	No	Trail			6.2	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:15:34am	UT072510A.cor
8	Point	1100	3	Mid	Deonne	No	Trail			5.7	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:16:32am	UT072510A.cor
9	Point	1100	4	End	Deonne	No	Trail			6.4	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:17:18am	UT072510A.cor
10	Point	1103	1	Start	Deonne		Trail			7	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:27:22am	UT072510A.cor
11	Point	1103	2	Mid	Deonne	No	Trail			3.1	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:28:12am	UT072510A.cor
12	Point	5100	1	Start	Deonne		Trail		leads to spillway	3.4	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:33:14am	UT072510A.cor
13	Point	5100	2	Mid	Deonne	No	Trail		leads to spillway	3.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:34:36am	UT072510A.cor
14	Point	5100	3	End	Deonne	No	Trail		leads to spillway	5.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	10:35:18am	UT072510A.cor
15	Point	1270	1	Start	Deonne		Trail			6.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:01:09am	UT072510A.cor
16	Point	1270	2	Mid	Deonne	No	Trail			4.6	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:04:47am	UT072510A.cor
17	Point	1270	3	Mid	Deonne	No	Trail			4.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:06:40am	UT072510A.cor
18	Point	1270	4	Mid	Deonne	No	Trail			5.1	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:08:13am	UT072510A.cor
19	Point	1270	5	Mid	Deonne	No	Trail			3.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:09:44am	UT072510A.cor
20	Point	1270	6	Mid	Deonne	No	Trail			5.7	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:12:03am	UT072510A.cor
21	Point	1270	7	Mid	Deonne	No	Trail			4.1	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:12:45am	UT072510A.cor
22	Point	1270	8	Mid	Deonne	No	Trail			4	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:14:15am	UT072510A.cor
23	Point	1270	9	End	Deonne	No	Trail			3.8	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:16:24am	UT072510A.cor
24	Point	1099	1	Start	Deonne		Trail			3.6	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:20:34am	UT072510A.cor
25	Point	1099	2	Mid	Deonne	No	Trail			2.9	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:23:35am	UT072510A.cor
26	Point	1099	3	End	Deonne	No	Trail			4.2	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:24:47am	UT072510A.cor
27	Point	5107	1	Start	Deonne		Trail			2	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:29:29am	UT072510A.cor
28	Point	5107	2	Mid	Deonne	No	Trail			3.4	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:30:08am	UT072510A.cor
29	Point	5107	3	End	Deonne	No	Trail			5.6	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:30:48am	UT072510A.cor
30	Point	5106	1	Start	Deonne		Trail			3.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:35:43am	UT072510A.cor
31	Point	5106	2	Mid	Deonne	No	Trail			2.7	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:36:27am	UT072510A.cor
32	Point	5106	3	End	Deonne	No	Trail			3.5	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	11:37:04am	UT072510A.cor
33	Point	1281	1	Start	Deonne		Trail			4.8	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	12:07:20pm	UT072510A.cor
34	Point	1281	2	Mid	Deonne	No	Trail			4.6	Postprocessed Carrier Float	GeoXH 2008-3000	7/25/2011	12:08:16pm	UT072510A.cor
35	Point	1281	3	End	Deonne	No	Trail			5.1	Postprocessed Code	GeoXH 2008-3000	7/25/2011	12:09:42pm	UT072510A.cor
36	Point	0	0							0			12:00:00 AM		

Figure 11. Attribute data associated with GPS point data along undesignated trails and roads

5.3 Digitizing and documenting undesignated trail and road segments

For each undesignated trail survey, segment data will be stored in a polyline feature class. An empty working SDE Feature Class will be created by RIS staff and stored on the osmpgis server to allow multiple users to simultaneously edit this feature class. Surveyors will edit and add to this working file within their personalized map document (UDT_working_[*MAPPER_NAME*].mxd). Undesignated trail and road segments will be "heads up" digitized in edit mode[18] within this feature class. Using the "not in feature" path data and the aerial photograph as a guide for digitizing between points, staff will digitize segments from point to point along each numbered undesignated trail, creating a new line each time a "change" point or an "end" point is encountered or a new Trail_ID is assigned. A new line is digitized for each segment with a unique cattle status or pathway status (road, trail, road and trail). Additional lines will also be digitized to represent multiple parallel or braided trails sketched on the map tile but for which no GPS data was collected.

During segment digitizing, the snapping environment will be modified so that segment vertices and ends snap to GPS-mapped points (vertices) of the undesignated trail shape file and to ends of other 2012 segments. This snapping environment ensures that there are no gaps between segments or segments and points and that the segment accurately follows the original mapped points. However, in rare cases, individual mapped points may appear to be mislocated given the context of other GIS layers (e.g., fencelines; aerial photos, 2006 undesignated trail layer). In these cases, the mapper will turn off snapping and use their best judgment to digitize the associated segments along the most likely alignment (e.g., on the OSMP-managed side of a fence line). The mapper should summarize any such deviations from the point data in the excel tracking file described below

The attribute table (Figure 12) associated with the undesignated trail polyline feature class is edited in ArcMap so that each segment is assigned the same Trail_ID, cattle status, and pathway status recorded for the underlying points. Any missing or erroneous attributes identified during the review of the point file should be correctly entered in the polyline file Each attribute must be carefully and manually entered into the table during the editing session. Typographical errors, including adding extra "spaces" to the attribute values, will make analysis of the data difficult.

5.4 Digitizing and attributing "missing" points when GPS coverage was unavailable.

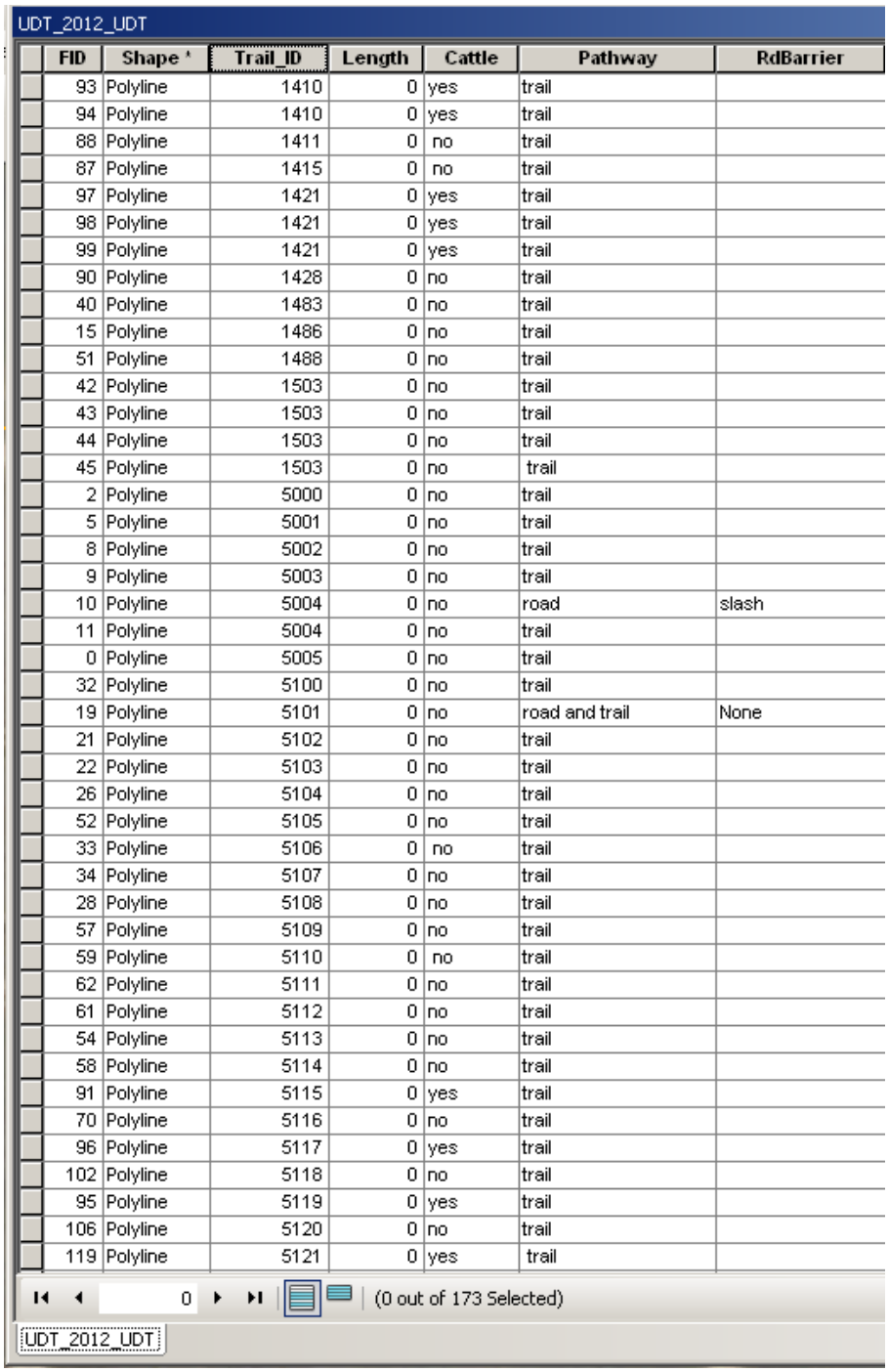
If attribute data were collected in the field without logging positions, the surveyor can view the attributes for that point in Pathfinder software using the View menu (feature class). In Pathfinder, surveyors can scroll through each data record, listed in order of time stamp, to locate the relevant attribute data. The surveyor will digitize the point in the point data GIS shape file based on the point location sketched on the hard copy map tile. The surveyor then locates the record for the newly digitized point in the point data GIS shape file and manually enters the attribute values associated with this point. The field tracking sheet should note that one or more points were manually digitized from field sketches.

5.5 Final review of tile completeness by surveyor before check –off.

[18] See Methods for Digitizing Line Segments in Systemwide UT Monitoring *Instruction Sheet* -Guidelines for using GPS and GIS to collect and manage undesignated trail data.

Before checking off that a tile map has been completed, surveyors should double-check that all field and office steps have been completed according to the protocol (see Tile Review Checklist in Appendix K). All undesignated trails shown on a map tile should have been visited and documented. Field tracking sheets should be entered digitally into the excel spread sheet. Surveyors will make sure that every road, undesignated trail, constructed feature and sign structure has been digitally mapped and the attribute table associated with these features has been checked and edited for accuracy and completeness. When surveyors have completed digitizing undesignated trails, they will check the "Digitized" column in the excel data tracking spreadsheet.

When all steps have been completed, the surveyor should: 1) delete data files from the GPS; and 2) check that all associated GIS shape files have been moved to the appropriate subdirectories. When the surveyor surveys an entire tile, she/he should mark the tile as complete on the hard copy index map.



UDT_2012_UDT

FID	Shape *	Trail_ID	Length	Cattle	Pathway	RdBarrier
93	Polyline	1410	0	yes	trail	
94	Polyline	1410	0	yes	trail	
88	Polyline	1411	0	no	trail	
87	Polyline	1415	0	no	trail	
97	Polyline	1421	0	yes	trail	
98	Polyline	1421	0	yes	trail	
99	Polyline	1421	0	yes	trail	
90	Polyline	1428	0	no	trail	
40	Polyline	1483	0	no	trail	
15	Polyline	1486	0	no	trail	
51	Polyline	1488	0	no	trail	
42	Polyline	1503	0	no	trail	
43	Polyline	1503	0	no	trail	
44	Polyline	1503	0	no	trail	
45	Polyline	1503	0	no	trail	
2	Polyline	5000	0	no	trail	
5	Polyline	5001	0	no	trail	
8	Polyline	5002	0	no	trail	
9	Polyline	5003	0	no	trail	
10	Polyline	5004	0	no	road	slash
11	Polyline	5004	0	no	trail	
0	Polyline	5005	0	no	trail	
32	Polyline	5100	0	no	trail	
19	Polyline	5101	0	no	road and trail	None
21	Polyline	5102	0	no	trail	
22	Polyline	5103	0	no	trail	
26	Polyline	5104	0	no	trail	
52	Polyline	5105	0	no	trail	
33	Polyline	5106	0	no	trail	
34	Polyline	5107	0	no	trail	
28	Polyline	5108	0	no	trail	
57	Polyline	5109	0	no	trail	
59	Polyline	5110	0	no	trail	
62	Polyline	5111	0	no	trail	
61	Polyline	5112	0	no	trail	
54	Polyline	5113	0	no	trail	
58	Polyline	5114	0	no	trail	
91	Polyline	5115	0	yes	trail	
70	Polyline	5116	0	no	trail	
96	Polyline	5117	0	yes	trail	
102	Polyline	5118	0	no	trail	
95	Polyline	5119	0	yes	trail	
106	Polyline	5120	0	no	trail	
119	Polyline	5121	0	yes	trail	

0 (0 out of 173 Selected)

UDT_2012_UDT

Figure 12. Attribute table for undesignated trail and road segments.

5.5 Staff review of system-wide undesignated trail map.

Periodically during the mapping process, and after completion of all field mapping, staff will take a number of steps to check the mapping results across the entire OSMP land area.

5.5.1. Universal checks on merged point files

To facilitate review of GIS point data that resides in hundreds of separate files, staff will periodically merge files produced on a daily basis into cumulative files for constructed features, signs, and road barriers[19]. The Arc Toolbox tool found under **Data Management Tools, General, Merge** will combine multiple input datasets of the same data type (e.g., point) into a single new output database.

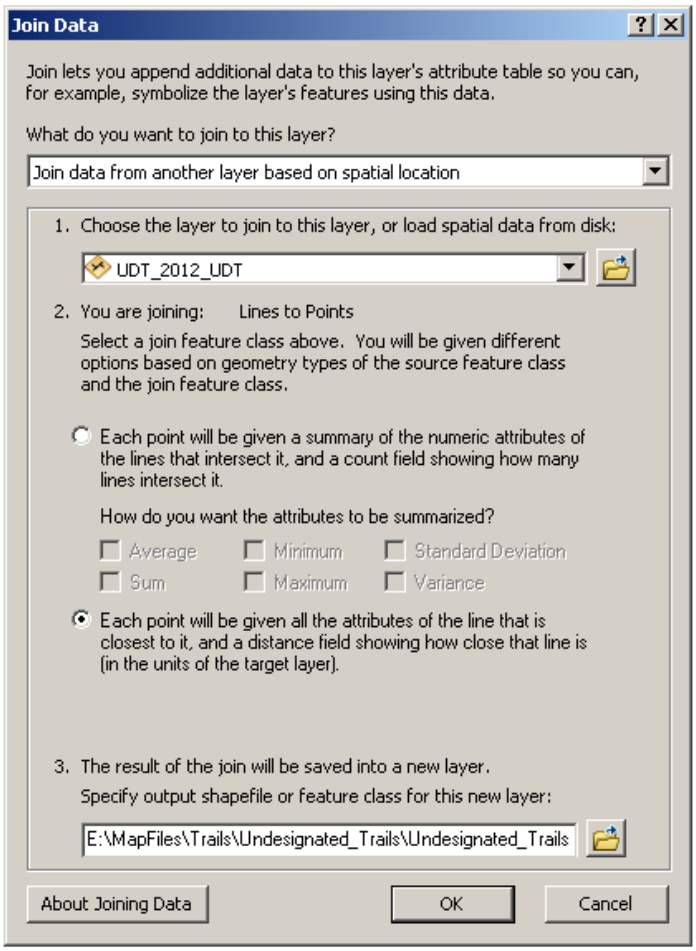
Data checks on merged point files are similar to those done daily by individual surveyors, but provide a final check by another staff member focused on consistency. The reviewer checks that:

- Only standard sign structure, sign type, and constructed feature attributes listed in the data dictionary are recorded. Search for extra spaces and misspellings.
- Comments are always filled in describing a feature in more detail when the "other" category is chosen for sign structure, sign type, or constructed feature type.
- Comments are reviewed for spelling and clarity; check that comments are transferred to the excel tracking file if they seem of relevance to clients in understanding the status of the nearby undesignated trail.
- Maximum PDOP and horizontal precisions showing poor levels of accuracy or precision are noted and/or explored.
- Signs and constructed features mapped do not duplicate those mapped during trail condition monitoring of designated trails.

[19] Earlier in the 2011 mapping season, staff also merged the UT point files and conducted a similar review but subsequently decided this was counter-productive because the mapper was making edits directly into the associated line segment file rather than into the merged point file.

Checking Trail_ID assignments and attribute matching

Reviewers will check that the Trail_ID assigned to points matches that assigned to the associated and nearest undesignated trail segment. After merging point files, the reviewer will join the merged point file to the 2012 line file using a spatial join. This should be done for all feature types except undesignated trail points as outlined below:



- In the Table of Contents in ArcMap, Right click on the merged point file you want to join
- Choose "Joins and Relates"
- Choose "Joins"
- At the top of the Join Data screen, choose "Join data from another layer based on spatial locations"
- At the number 1 prompt, browse through files to choose the undesignated trail line file (i.e., 2012_UDT_2012) to join to.
- At the number 2 prompt, choose "Each point will be given all the attributes of the line that is closest to it, and a distance field showing how close that line is)
- At the number 3 prompt, assign a new name for the new layer.

The resulting file will contain attributes from both files, organized so that for each record (each feature), the attributes of the closest undesignated trail or road is also listed. To search for Trail_IDs that do not match, the file is exported to a comma separated value (*.csv) text file and opened in MS Excel. In Excel, subtract the point Trail_ID from the line Trail_ID. Any non-zero number indicates a Trail_ID that doesn't match. Investigate each unmatched pair of points and lines to determine the source of the mismatch. Misnumbered Trail_IDs should be corrected in the line or point file, as needed and in the Excel tracking file.

When mapping is complete, monitoring staff will create final merged files for constructed features, signs, and road barriers by appending any additional point shape files to the previously merged file. These files will be archived. The undesignated trail point files will not be merged into a single file. These point files, as well as all "path" files will be discarded once the Undesignated Trail polyline shape file is finalized.

5.5.2. Universal checks for undocumented or unmapped trails

The Join Data tools in ArcGIS will also be used to check that all 2006 and 2011/2012 undesignated trails have been documented in the Excel file and all 2011/2012 documented undesignated trails have been digitized. To conduct the following checks, an up-to-date version of the Excel tracking file will be saved as a comma separated value (*.csv) file and added to the ArcGIS map document. The *csv file will need to be edited to remove spaces and symbols in column headings and to create a new field concatenating Trail_ID and path status. The 2012 UDT line file will also need to be edited to create a new text field concatenating Trail_ID and path status.

1. To check that all 2006 grouped trails have been visited and documented, the 2006 grouped trail layer is joined to the field tracking file with TrailID joined to the Final_Trail_ID in the tracking file. The resulting temporary join file is examined, looking for any NULL values in the Final_Trail_ID field. NULL values represent 2006 grouped trails that have not yet been accounted for as a NAT, a UT or a Road, either because the surveyor forgot to enter the data in the excel file, or because that area has not yet been surveyed. Because the join is a one to many relationship, only the first occurrence in the *.csv file will be linked in the temporary join file.

2. To check that all undesignated trails digitized in 2012 have also been documented, the 2012_UDT_2012 line file (or the most recent undesignated trail line file) will be joined to the field tracking file with the concatenated Trail_ID and pathway field joined to the concatenated Final_Trail_ID and pathway field in the tracking file. The resulting temporary join file is examined, looking for any NULL values in the concatenated field in the *.csv file. NULL values represent 2012 digitized segments that were not entered into the Excel spreadsheet, either because the surveyor did not enter documentation or because there is a Trail_ID or pathway status entry error in either of the joined files. Because the mapper may have digitized multiple segments associated with each unique Trail_ID and path status combination, the matching record from the *.csv file will be repeated for each of those segments in this many to one relationship.

3. To check that we have digitized all undesignated trails and roads documented in the Excel tracking sheet, the *csv file will be temporarily joined to the 2012 line file by the concatenated Trail_Id and path status fields described above. NULL values in the concatenated field of the 2012 line file should correspond to former undesignated trails that are now NAT or to undesignated trails that are not digitized, either because they were overlooked during digitizing or because the trail was incorrectly numbered. This is a one to many relationship so only the first occurrence of a matching digitized segment will be joined.

5.5.3. Review of undesignated trail line attributes file

Staff should check that attributes are entered consistently (e.g., no leading spaces on entries). Errors can be identified by sorting the attribute field and identifying inconsistent entries.

5.5.4. Review of Excel field tracking file

The Excel field tracking file should be reviewed periodically for inconsistent entries in the Date, Surveyor, and Path_status fields. The file can be filtered or sorted to facilitate this review. The

notes should be reviewed and edited for clarity, spelling and accuracy. When mapping is completed, a new field is created by concatenating Trail_ID and path status. Reviewers can then check for duplicate entries using the conditional formatting feature in MS Excel

5.5.5. System-wide tile-by-tile checks

To check for consistency with the protocol across the entire mapped system, the map will be reviewed tile by tile, searching for following potential problems*:*

- Are there any isolated segments that look like floaters? Has a surveyor documented a reason to retain these segments in the Excel tracking file?
- Are there any obvious roads and driveways that have not been mapped? Has the surveyor confirmed that these were visited and did not meet our criteria as a road?
- Have braids been mapped off of Designated Trails? Has the surveyor confirmed that they had reason to map these as undesignated trails (e.g., they considered it a parallel trail)
- Are there any mapped trails used by cattle that do not meet our criteria for mapping as described (see section 4)) that should be deleted?

5.5.6. Opportunity for data review by other OSMP staff

OSMP field staff (rangers, lease managers, etc.) will be given the opportunity to review the undesignated trail and road map layer to identify any additional undesignated trails or known roads that they believe were missed. They will also be able to identify any pathways misidentified as undesignated trails or roads that should be excluded from the final map. RIS staff will also review the undesignated trail map to determine if any segments should be excluded from the data because they fall outside OSMP-managed fee lands. Care should be taken during GIS procedures to insure that no mapped segments are eliminated from the data due to mapping errors in our property or fence-line maps.

5.6. Preparing undesignated trail layers for staff use – adding attributes and metadata

When the undesignated trail and road map are finalized, segment length will be calculated using XTools Pro© for ArcGIS and presented in miles (field name=Mileage) and feet (field name=Shape.len). By linking to the final Excel tracking file through a Join in ArcMap or via a Geodatabase, mapping date and comments will be added as additional fields in this GIS file. This file will be saved as both an SDE and layer file. RIS staff will then group segments with the same trail ID into single polyline features so that each trail ID is associated with a single group of lines. Mileage in miles and feet will be recalculated. The TSA in which the most of the linear trail distance falls will be given. This layer will be named Undesignated Trails [*Year*] (Original Grouped). Metadata for the final map will be created by monitoring staff with input from RIS staff.

5.7. Data quality of undesignated trail map products

Staff using any map products produced by this project should be aware of the following:

- Poor GPS accuracy at different times may lead to inconsistency in the location and length of undesignated trails. Standards for GPS accuracy (e.g., requiring a maximum PDOP, requiring use of either the GeoXH, the GeoXT6000, or the ProXH antennae) will be used to lessen this problem.
- Hand-drawn segment alignments between points may lead to some error in line location. However, these segments are grounded at points of at least 200 ft intervals and their accuracy

can be improved by using aerial photos and GPS paths walked during mapping to guide digitization.

While calculations of total undesignated trail length and/or new undesignated trail length may be of interest and were identified as a measure for monitoring the effectiveness of OSMP management in the VMP, any such calculations should be interpreted with caution for the following reasons:

- Despite repeated training, inter-observer testing, written definitions, use of photographic examples, and frequent discussions during the mapping project, surveyors likely exhibit differences in determining which pathway segments:
  - meet the criteria for undesignated trails or roads and are therefore mapped
  - are braids of designated trails and therefore not mapped as opposed to parallel trails that are mapped

  These differences can lead to inconsistencies in measurements of total length among observers.
- Similarly, despite efforts to understand and repeat the methods used during the 2006 mapping of undesignated trails, no criteria is available defining which undesignated trails or road-like pathways were mapped in 2006.. Given the subjectivity associated with determining which pathways to map, it is unlikely that the decisions made by the 2011 field surveyors were always consistent with the decisions made by the 2006 field surveyors. This inhibits OSMP's ability to compare total length of undesignated trails between these years.
- Additionally, it is known that during the 2006 mapping of undesignated trails, field staff mapped braids of designated trails, while staff did NOT map braids of designated trails in 2012. This inhibits OSMP's ability to compare total length of undesignated trails between years.
- Further differences in weather and rainfall from year to year can lead to differences in the severity and persistence of undesignated trails. This inhibits OSMP's ability to compare total length of undesignated trails between years.

6.0 Data analyses

6.1 Data analyses overview

Given the diverse data being collected as part of this project, a number of analyses are possible. These include, but are not limited to:

- Maps depicting the location of undesignated trails and road-like pathways and signs and constructed features associated with undesignated trails and road-like pathways.
- Map overlays comparing the results of the 2011 survey effort with historical mapping surveys in specific OSMP-managed areas (e.g., the Eldorado Mountain/Doudy Draw Trail Study Area) coupled with information from surveyors' data tracking sheets to qualitatively evaluate undesignated trail restoration success.
- Calculations of various measures such as number of signs or constructed features per unit length of undesignated trail
- Calculations of how undesignated trail length is distributed among trail study areas and management areas
- Spatial analyses of how undesignated trail density and unfragmented habitat blocks vary across the system.

6.2 Data analyses files

For the purpose of analyses, copies of source files and derived files will be stored together in the project folder or in the geodatabase created for this purpose.

The GIS files listed and described below will be used as source data when conducting data analyses.

Surveyed properties:
This polygon geodatabase feature class represents the 2012 OSMP undesignated trails study area surveyed. Properties managed by OSMP and acquired before December 2011 include 451 OSMP fee properties, 8 miscellaneous easements, 3 conservation easements and NCAR). This feature class was copied from the sdeProperty.OSMP.Properties on 06/11/2013 and manipulated to remove newer properties and lands not managed by OSMP.

Undesignated trails and roads:
Original dataset showing undesignated trails mapped up to November 2012 on OSMP managed lands. These data were not dissolved by Trail ID column so multiple segments may exist for a given Trail ID.

Grouped segments contains polyline features describing the location and status of undesignated trails (i.e., social trails) and undesignated roads on Open Space and Mountain Park managed lands. Segments with the same Trail ID have been dissolved and grouped by Trail ID in this version.

Constructed features:
This point feature class describes the location and type of constructed features along undesignated trails and roads on Open Space and Mountain Park managed lands. Points were GPS-mapped in the field between July 2011 and November 2012 as part of the system-wide undesignated trail mapping project.

Signs:
This feature class contains point features that describe the location and type of sign structures and their messages along undesignated trails and roads on Open Space and Mountain Park managed lands. Points were GPS-mapped in the field between July 2011 and November 2012 as part of the system-wide undesignated trail mapping project.

For analyses needs, source files will be manipulated using GIS tools. For example, undesignated trail segments may need to be split at the boundary of the project area, TSAs, or grid cells. Segments may also need to be dissolved, buffered, or clipped prior to analyses.

Other map data used in analyses will include:

- OSMP designated trails
- Non-OSMP trails
- OSMP property polygons
- Roads

RIS staff will periodically archive snapshots of other OSMP layers that are likely to change over time to facilitate requests for repeat analyses that require data from a specific time frame.

The steps and tools used to create derived and intermediate analyses files from source files and the dates the processes occurred will be automatically documented in the metadata for each file under the Geoprocessing history. Metadata can be accessed by highlighting the file name in ArcCatalog and choosing the Description tab after choosing the FGDC CSDGM Metadata style from the Metadata tab in the ArcCatalog Options.

6.3 Data analyses methods

Mileage of undesignated trails and roads by project area, TSAs and management areas
To determine the distribution of undesignated trails within the entire project area, and among TSAs and management area designations, undesignated trails or roads crossing a boundary will be split into multiple segments using the identity or intersect tool (Analyses tools\Overlay\Identity or Intersect) in the ArcGIS Arctoolbox. Segment lengths contained within the project area and in each TSA and management area designation can then be summed using queries in an Access database. These steps will be repeated to derive summed segments lengths for each pathway category (undesignated trail, road, undesignated trail/road), and with and without cattle.

Density of undesignated trails and roads using grid cell analysis
To evaluate the spatial variability in density of undesignated trails and roads (feet/acre) across the project area, a GIS shapefile of grid cells (300 meters on a side or 22.24 acres/grid cell) will be overlaid on the project area and undesignated trails and roads GIS feature class. The grid will be created using the ArcTool Create Fishnet clipped to the project area. Using the Identity tool, undesignated trail and road segments extending across multiple grid cells will be split at the cell boundaries. Access database queries will be used to sum the lengths of the split undesignated trail and road segments within grid cells. Density for each grid cell can be calculated as the summed undesignated trail and road length (feet) for each grid cell divided by the acreage of each grid cell. Grid cell densities will be depicted in maps and summarized to give frequency of cells by density classes. During analyses, staff will make decisions about including or excluding partial grid cells (<22.24 acres) clipped along study area boundaries. In particular, cells clipped to less than 1 acre portions can artificially inflate density values.

Spatial variability in density of undesignated trails and roads using kernel density analysis
The Kernel Density GIS tool in the Spatial Analysis Tools toolbox a will also be used to evaluate the relative spatial variability in density of undesignated trails and roads across OSMP lands. The Kernel Density tool can calculate the density of linear features (e.g., undesignated trails and roads) in a neighborhood around each output raster cell using a kernel function to fit a smoothed surface. A search radius of 750 feet emanating from any undesignated trail or road segment was chosen for this analysis after evaluating a range of distances. The results of this analysis will display the density in a raster map with 50 foot grid cells.

Size of remaining un-fragmented polygons on OSMP lands
To determine how the project area (dissolved across internal boundaries) is fragmented by roads, designated trails, and undesignated trails and roads (i.e., access routes), these linear access routes

will be merged, buffered by 40 feet on each side, and erased from the project area. Buffering of access routes will reduce the prevalence of lines that fall just short of completely bisecting a project area polygon. Size in acres of the remaining polygons left when the buffered lines are removed will be calculated. The spatial distribution of un-fragmented polygons will be depicted in maps and summarized to give frequency of polygons by size classes.

Proximity of OSMP land in the project area to nearest designated or undesignated trail or road
To determine the proportion of the landscape that is relatively near and far from designated and undesignated roads and trails (linear access routes), a proximity analyses will be conducted that uses the Euclidian distance tool to calculate the straight line distance from 100 x 100 ft grid cells comprising the project area to the nearest linear access route. These distances will be compared with and without the undesignated trails and undesignated roads. For this analysis, designated trails will include trails owned or managed by OSMP, the City of Boulder, Boulder County and other municipalities or counties in the project area. Roads will include routes depicted in the transportation layer and within the project area. The value of each cell will depict how far it is from a trail or road and will be used to visually represent proximity in maps.

Distribution data for constructed features, signs, and road barriers.
To better characterize the distribution of mapped constructed features, signs and road barriers on undesignated trails, a spatial join will be performed to derive a new database table joining each feature point type with the management area type or TSA polygon they fall within. Using an Access database and the imported feature attribute table, the total number of each feature class will be summed for the entire study area, by management area designation and by TSA.

7.0 Roles, Responsibilities and Resources

Roles and Responsibilities
Monitoring staff will conduct the undesignated trail field surveys. Monitoring staff will coordinate the project and oversee data dictionary design, field data collection, data management and data review. RIS staff will work with monitoring staff in preparing map tiles, producing final GIS products, and conducting data analyses. Monitoring staff will produce a final report with assistance of other appropriate staff (RIS and trails staff).

Resources Required
The major resource needed to complete this project will be staff time from the monitoring group and the RIS group. Staff expects the project to require approximately one year for one to two full-time technicians (or the equivalent in part-time work), with three months for preparation, seven months of field data collection, and two months of data management, analyses and report preparation.

Use of OSMP vehicles and two GPS receivers will be required from June through December or as long as undesignated trail mapping continues.

8.0 Adaptive Management Responses

The purpose of the undesignated trail and road mapping is to help managers make informed decisions regarding undesignated trails and unmapped roads. Additional data collected regarding constructed features and signs will help complete OSMP's inventory of these structures. All of

the information collected will be used to better understand where and possibly why visitors travel off-trail. The maps and database will provide managers with information needed to inform decisions about closing or designating undesignated trails and unfulfilled needs for designated trails in each of OSMP's Trail Study Areas.

9.0 Revising the Protocol

Despite advanced planning and testing during protocol development, some changes and improvements in field methods, data management, and reporting requirements are likely to occur after implementation of a monitoring project (Oakley et al., 2003). Metadata should clearly state which version (or date) of a protocol guided data collection. Revisions should be noted within the protocol, with dates of change implementation clearly stated.

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11.0 Glossary

Definitions used in this mapping protocol are modified specifically for the purpose of the undesignated trail mapping project and should not be construed as being universal.

Access point: For the purpose of this project, a location on or off OSMP lands (including a designated trailhead, facility, parking area, business, residence, vehicle or pedestrian gate, junction with a designated trail, undesignated trail, or road) from which a visitor or vehicle can reach an undesignated trail or road, typically without going off trail.

Closure: Intentional OSMP effort to eliminate the use of a trail by humans and their non-human companions such as dogs or horses. Closure methods may include fencing, slash or rock placement, signage and revegetation.

Constructed feature: A human-made structure designed to help maintain a trail's sustainability, such as to divert water, or retain sediment, or raise the level of the tread (e.g., retaining walls, turnpikes, waterbars, steps, culverts).

Data dictionary: For the purpose of this protocol, the data dictionary is an automated tool for describing, recording, and organizing spatial and attribute information on objects of interest (e.g., sample points along undesignated trails). The data dictionary for this project is an electronic file accessed in the field on a Global Positioning System (GPS) device and created using Trimble® GPS Pathfinder® Office software (Pathfinder).

Data driven pages: In ArcGIS 10.0, data driven pages allow you to quickly and easily create a series of layout pages from a single map document. An index layer, divides the map into sections based on each index feature in the layer and generates one page per index feature. Data Driven Pages can be based on a regular grid of polygons. A single layout defines the map composition for each data-driven page. Only dynamic parts of the layout (e.g., map scale, north arrow, scale bar, page name and number, geographic extent of map) change with each page. Static elements (size and orientation of layout page, size and position of data frame, static text, neat lines) stay the same. Any changes made to static elements of the layout will be reflected on each page of the map series (Adapted from ArcGIS on-line help).

Designated trail: A trail that is approved and maintained by an agency included other agencies managing land adjacent to OSMP.

Differential correction: The process of correcting GPS data collected on a mobile GPS data collector with data collected simultaneously at a base station. Because the base station is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the mobile GPS data collector. Differential correction can be done in real time, or after the data has been collected by post-processing (adapted from TerraSync™ Software Reference Manual, March 2007 Release [Revision A]).

Discernable visitor use: Observable evidence of visitation by humans and/or their non-human companions such as dogs or horses (e.g., human foot print, horse manure, bike track, dog paw print).

Dilution of Precision (DOP): A measure of the quality of GPS positions, based on the geometry of the satellites used to compute the positions, where a lower DOP value indicates greater accuracy (less error) of the position when satellites are widely spaced relative to each other. PDOP is a DOP value that indicates the accuracy of three-dimensional measurements whereas HDOP gives the horizontal position accuracy (adapted from TerraSync™ Software Reference Manual, March 2007 Release [Revision A]).

Flattened vegetation: An undesignated trail tread condition in which there is a distinct trail feature present and light repeated human use evidenced by trampled, matted or flattened vegetation lacking both a clear trail boundary and noticeably impeded vegetation growth.

Global Positioning System (GPS): A world-wide radio-navigation system formed from a constellation of 24 satellites and their ground stations that can be used as reference points with a GPS receiver to calculate accurate positions of locations on earth (Trimble Navigation Limited 2010).

Mid-trail point: A sample point mapped along the undesignated trail that falls between the start and end points of the trail where GPS locations and attributes are recorded. Mid-trail points are taken every 200 foot along the trail or more often as needed to map curves and turns along the trail.

Not in feature data: GPS data points collected along the pathway walked by the surveyor between logged features while carrying the GPS receiver. Mapped points are collected at intervals of distance or time and are exported as the **PosnPnt.shp file.**

Off-trail: Off of a designated trail or road

Pulverized litter: Organic litter (e.g., pine needles, pine cones) within the trail tread with discernable crushing.

Recovered trail segment: A portion of an undesignated trail that was visible during the 2006 baseline survey but no longer meets our definition of undesignated trail due to vegetation regrowth on the trail tread

Roadbed: The earth or rock foundation supporting a road or the surface acting as a road upon which vehicles travel

Road-like path: A continuous linear or curvilinear pathway that is wide enough for a vehicle, driveable with some maintenance, and exhibits evidence of repeat vehicle use

Standard: The standard defines the minimum acceptable condition of each indicator variable. A standard does not define an intolerable condition (National Park Service 2008, p. 96).

Stunted vegetation: (as defined by National Park Service 2008): An undesignated trail tread condition in which there is a distinct trail feature present, moderate repeated use evident, and

noticeably impeded vegetation growth as evidenced by stunted, short, or poorly developed vegetation

Trampled vegetation: Vegetation observed within the trail tread with discernable crushing.

Trail braiding: A specific type of secondary trail tread branching from the designated trail or the main stem of an undesignated trail near an apparent obstacle and looping back to the main trail; typically within sight distance

Trail corridor: The full dimensions of a route including the tread and a zone on either side (usually three feet) and above the tread from which brush will be removed

Trail edge: The most pronounced outer boundary of visually obvious human disturbance created by trail construction or travel (not trail maintenance like vegetation clearing) used to delineate the trail tread that receives the majority (>95%) of traffic. These boundaries are defined by pronounced changes in ground vegetation height (trampled vs. untrampled), cover, or composition; or, when vegetation cover is reduced or absent, as pronounced changes in organic litter (intact vs. pulverized) (Marion & Hockett 2008) (See Attachment 3).

Tread width: Tread width is the distance between trail edges measured perpendicular to the trail alignment. For the purpose of this system-wide undesignated trail mapping, trail width includes the tread width where 95% of visitor use is estimated to occur plus any disturbed areas immediately adjacent to the tread area.

Undesignated trail: Unofficial, but discernable and continuous linear trail (Leung et al. 2002) created by repeated visitor activity and typically not authorized or maintained by OSMP. For the purpose of this mapping protocol, undesignated trails include shortcutting of climbing turns, parallel trails, and trails to new destinations but will not include trail braiding within the designated trail corridor.

Waypoint: A geographic point of interest, captured and stored on a GPS as latitude-longitude coordinates but not associated with any attribute information beyond a name and location. For this project, waypoints are used to navigate back to points surveyed in previous years along undesignated trails (adapted from TerraSync™ Software Reference Manual, March 2007 Release [Revision A] and ESRI GIS dictionary).

Appendices

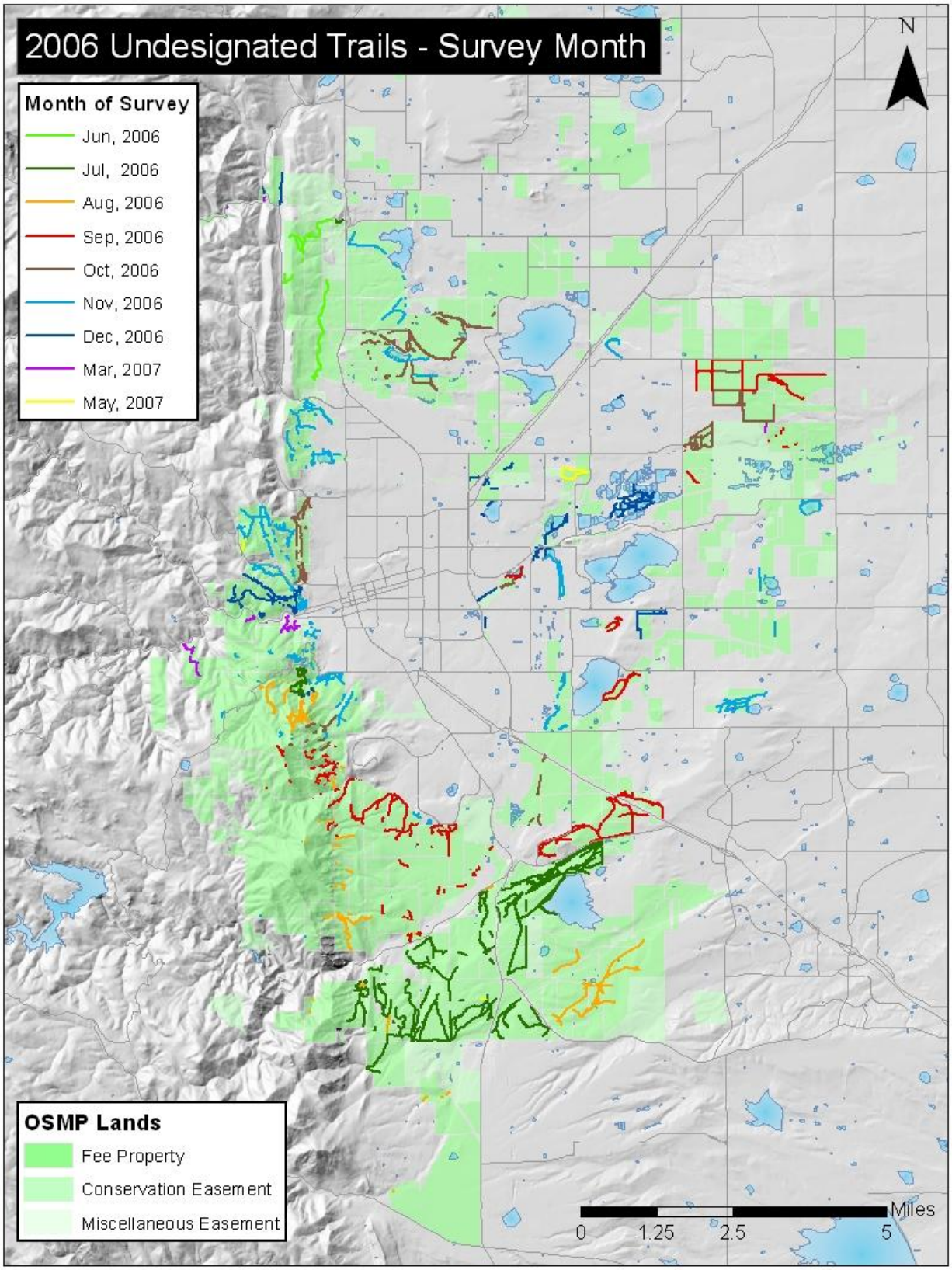
Appendix A.. Management strategies and actions for undesignated trails by management area designation (City of Boulder, 2005, p. 50, Table 4.1).

Passive Recreation Area Strategies	Natural Area Strategies	Agricultural Area Strategies	Habitat Conservation Area Strategies
Lower priority for management of undesignated trails. Minimize new undesignated trails. .Management actions for existing undesignated trails include: • Evaluate best management actions • Designate • Re-route • Close and reclaim • Retain undesignated trails • Monitor newly established or developing undesignated trails	Variable priority for management of undesignated trails. Minimize new undesignated trails. management actions for existing undesignated trails include: • Evaluate best management actions • Designate • Re-route • Close and reclaim • Retain undesignated trails • Monitor newly established or developing undesignated trails	Variable priority for management of undesignated trails. Minimize new undesignated trails. Management actions for existing undesignated trails include: • Evaluate best management actions • Designate • Re-route • Close and reclaim • Retain undesignated trails	High priority for management of undesignated trails. Minimize new undesignated trails. Management actions for existing undesignated trails include: • Evaluate best management actions • Designate • Re-route • Close and reclaim

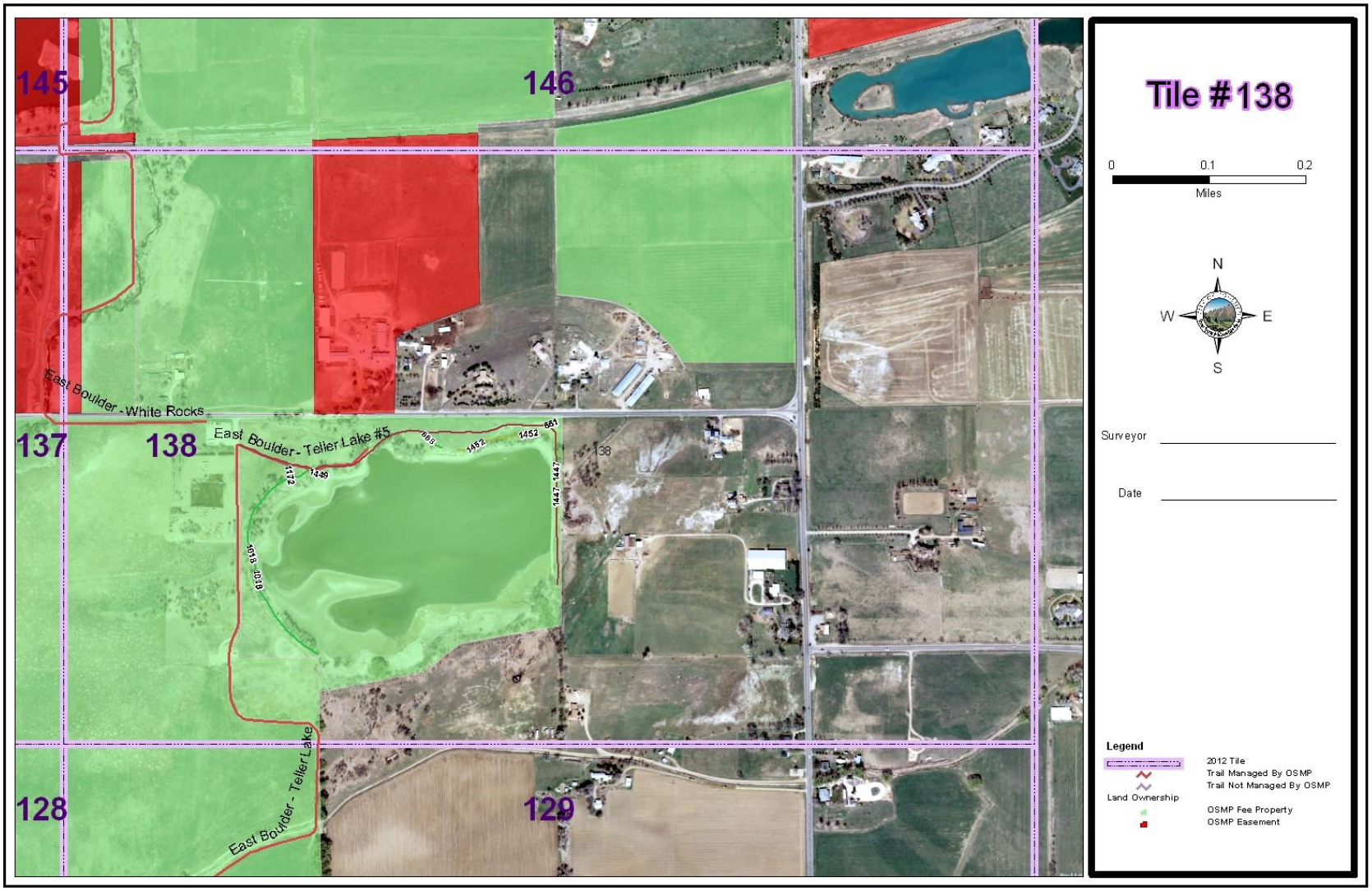
Appendix B1. Mapping periods and initial month of mapping for 2006 and 2011 undesignated trail surveys (based on the OSMP map layer Management Zone Designations). .

Management Zone	2006/2007		2011/2012	
	All months	Start month	All months	Start month
Anemone Hill	Nov, Dec	Nov	Sep, Oct	Sep
Boulder Valley Ranch	Oct	Oct	Aug, Sep, Oct	Aug
Creek Confluence	Nov, Dec, Mar	Nov	Jan, Mar	Jan
Diagonal	Nov	Nov	Mar, Apr, Nov	Mar
Doudy Draw	Jul	Jul	Jul, Aug, Oct, Jan, Feb, Mar,	Jul
Dry Creek	Sep	Sep	Oct	Oct
East Beech	Nov	Nov	Jul, Aug, Sep, Oct	Jul
East Boulder	Aug	Aug	Sep, Nov, Mar	Sep
East Boulder Valley	Nov	Nov	Oct, Jan, Mar, Apr	Oct
East Marshall Mesa	Jul	Jul	Jan	Jan
Eldorado Mountain	Jul	Jul	Jul, Aug, Oct	Jul
Elephant Buttress	Jul, Aug, Sep, Oct	Jul	Sep	Sep
Flagstaff / Chautauqua	Nov	Nov	Jan, Apr	Jan
Flatirons / Mountain Backdrop	Dec	Dec	Aug,. Oct, Nov, Jan, Apr	Aug
Gunbarrel / Heatherwood - NA	Nov	Nov	Jan, Feb, Mar, Jul	Jan
Gunbarrel / Heatherwood - PRA	Oct	Oct	Sep, Jan	Sep
Jewel Mountain	Aug	Aug	Feb	Feb
Lefthand Canyon	Mar	Mar	Jul, Aug, Sep	Jul
Lower Boulder Creek	Mar, Oct, Sep, Oct	Mar	Sep, Oct, Jan	Sep
NCAR	Mar	Mar	Nov, Jan	Nov
NIST (*OSMP managed*)	Mar	Mar	Jan	Jan
North Boulder Valley	Oct, Nov	Oct	Aug, Jan, Mar	Aug
North Foothills	Mar, Jun, Jul	Jun	Jul, Aug, Sep	Jul
Northern Tier	*No trails mapped*		Mar	Mar
Outlots	Dec	Dec	Nov, Jan, Mar, Apr	Nov
Sanitas Valley / Red Rocks	Oct, Nov, Dec	Oct	Sep, Oct, Nov	Sep
Sawhill Ponds (*OSMP managed*)	Dec	Dec	Mar	Mar
Shanahan	Jul, Sep, Nov	Jul	Aug, Sep, Oct, Nov, Feb	Aug
Sombrero Marsh	Sep	Sep	Nov	Nov
South Boulder Creek	Oct, Nov	Oct	Sep, Oct	Sep
South Mesa	Aug, Sep	Aug	Aug, Sep	Aug
Southern Grasslands	Jul, Aug	Jul	Sep, Oct, Jan, Mar,	Sep
Tallgrass Prairie East	Sep, Oct	Sep	Sep, Oct, Nov, Jan	Sep
Valmont Reservoir	*No trails mapped*		Mar	Mar
West Marshall Mesa	Jul	Jul	Jan, Mar	Jan
West Sanitas	Oct, Nov, Dec, May	Oct	Oct, Nov	Oct
Western Mountain Parks	Aug, Sep, Oct, Nov, Dec,	Aug	Aug, Oct, Feb, Apr, May	Aug
Wonderland	Nov, Mar	Nov	Jul, Sep, Oct	Jul

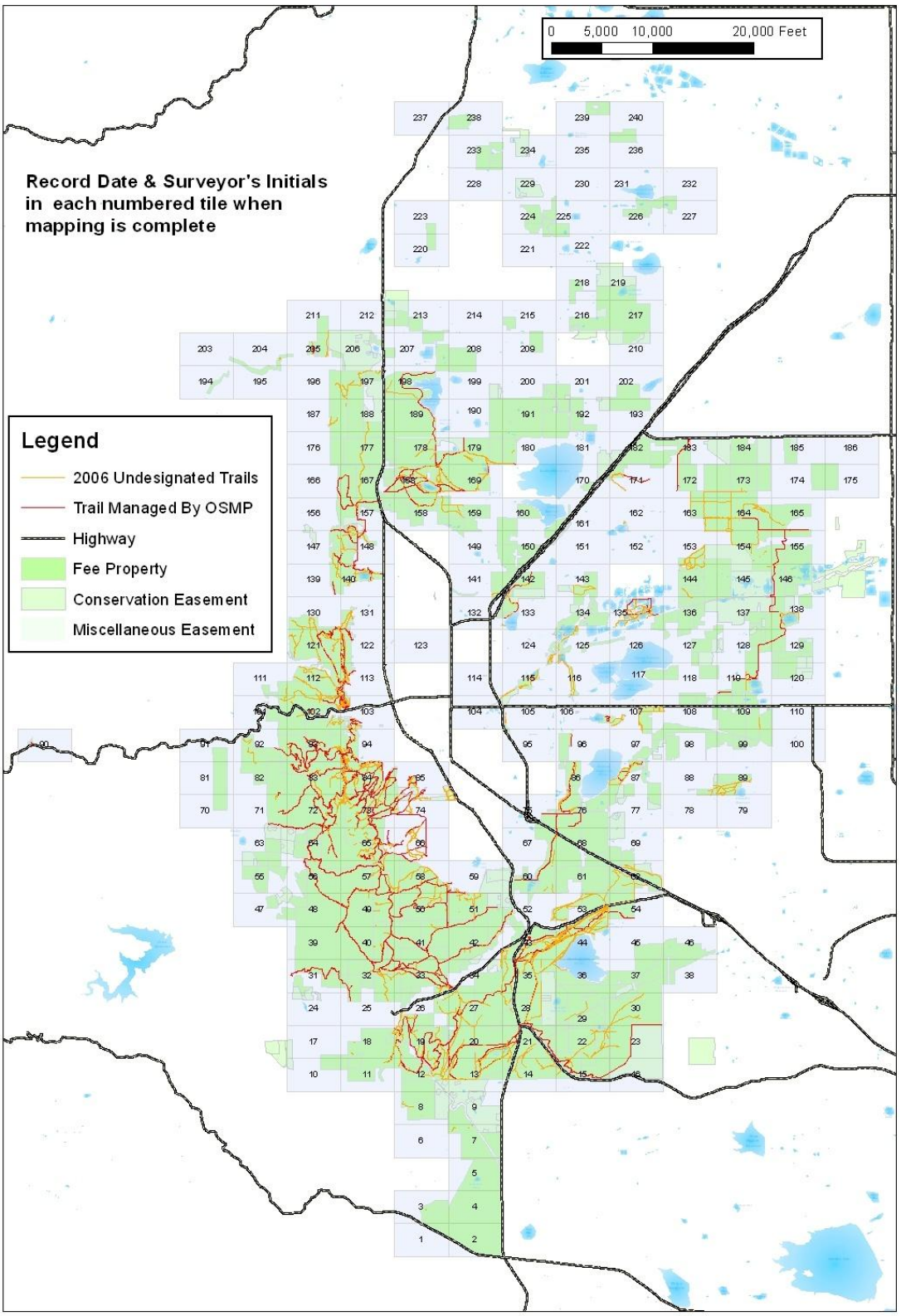
Appendix B2. Month of undesignated trail survey in 2006 to 2007



Appendix C. Example of a map tile used in the field to find existing undesignated trails and to annotate new trail locations

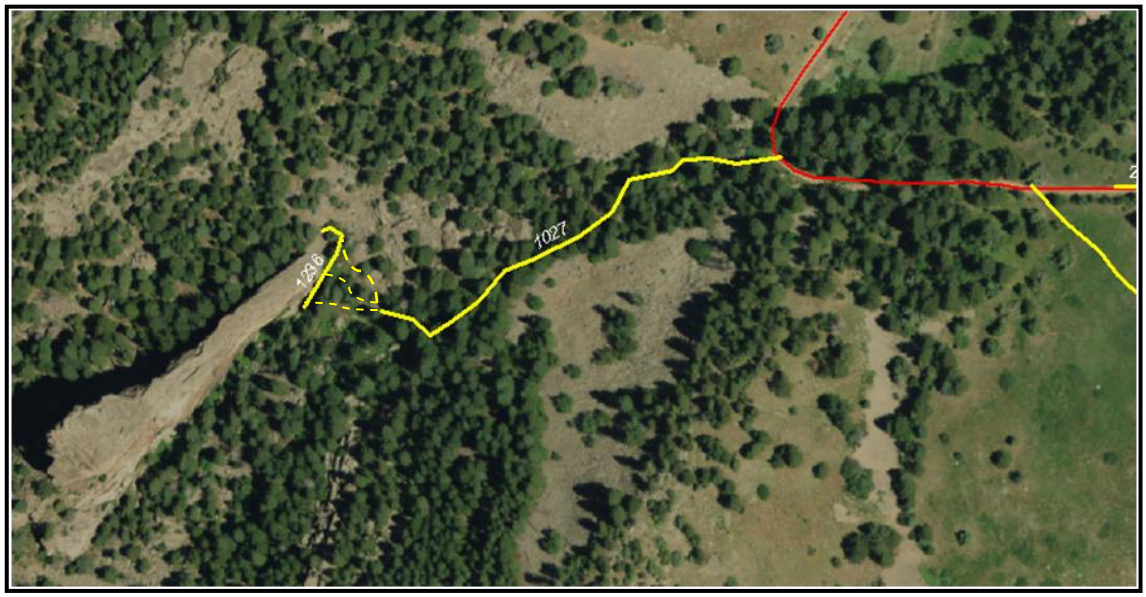


Appendix D. Index to map tiles used in undesignated trail mapping

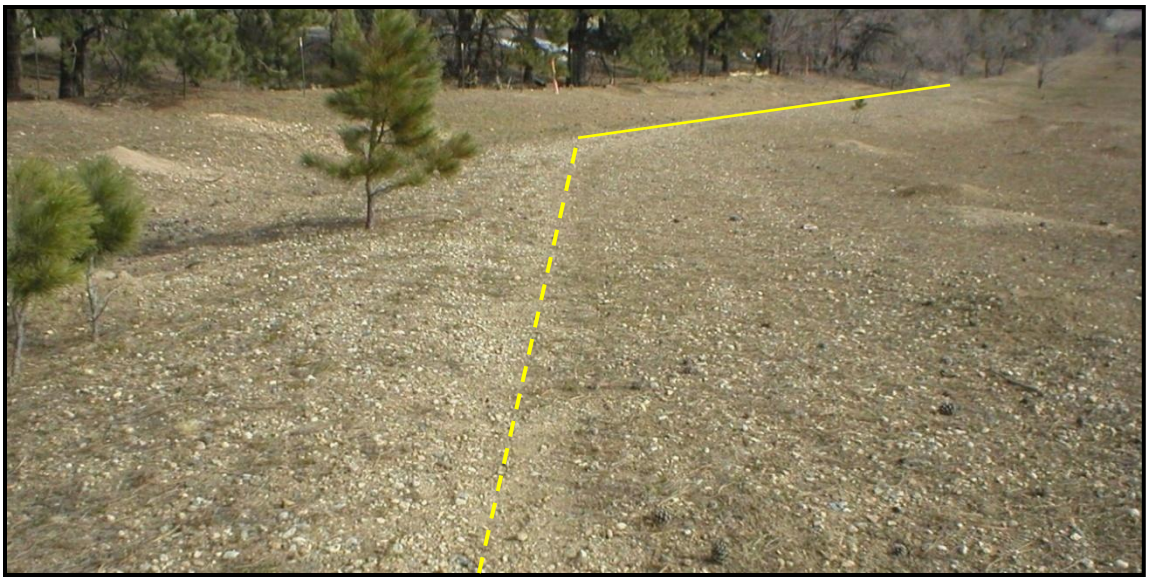


Appendix E. Examples of situations leading to isolated segments that look like "floaters" but that are still part of a current visitor travel. In these examples, NAT segments that are part of a current visitor travel route are represented by dashed yellow lines while the isolated undesignated trail segments are solid yellow lines.

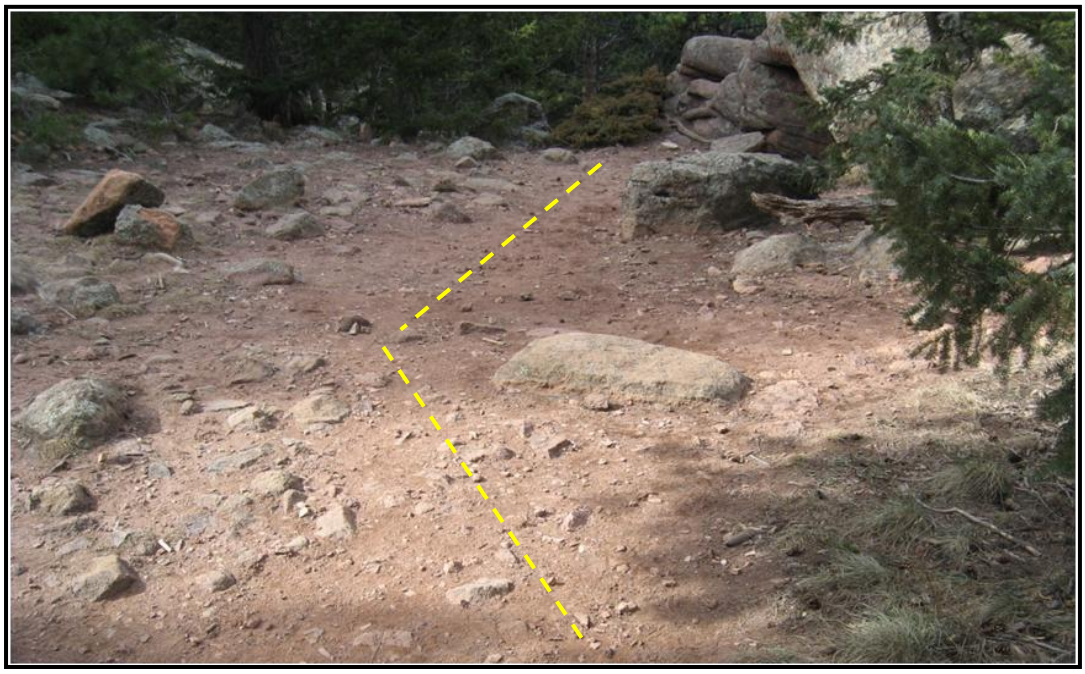
1. Access/egress routes in climbing areas: The isolated segment(s) are descent routes from rock formations in the steepest portions of the terrain or circling routes around climbing areas and the surveyor believes the segments are part of a current travel route in which visitors (primarily climbers) access or egress the isolated segment via more dispersed routes or other less impacted routes (such as routes over resistant surfaces). An initial descent from a rock formation on steeper slopes is more likely to create tread impacts. When the terrain flattens, climbers may disperse their travel or there may not be sufficient visitor travel on the flatter terrain to create a pathway that satisfies all three criteria of an undesignated trail.



2. Routes through prairie dog colonies: The isolated segment(s) is part of an undesignated trail route passing through prairie dog colonies and portions of the connecting routes lack obvious trail edges because the matrix also lacks vegetation and is heavily disturbed by prairie dogs.



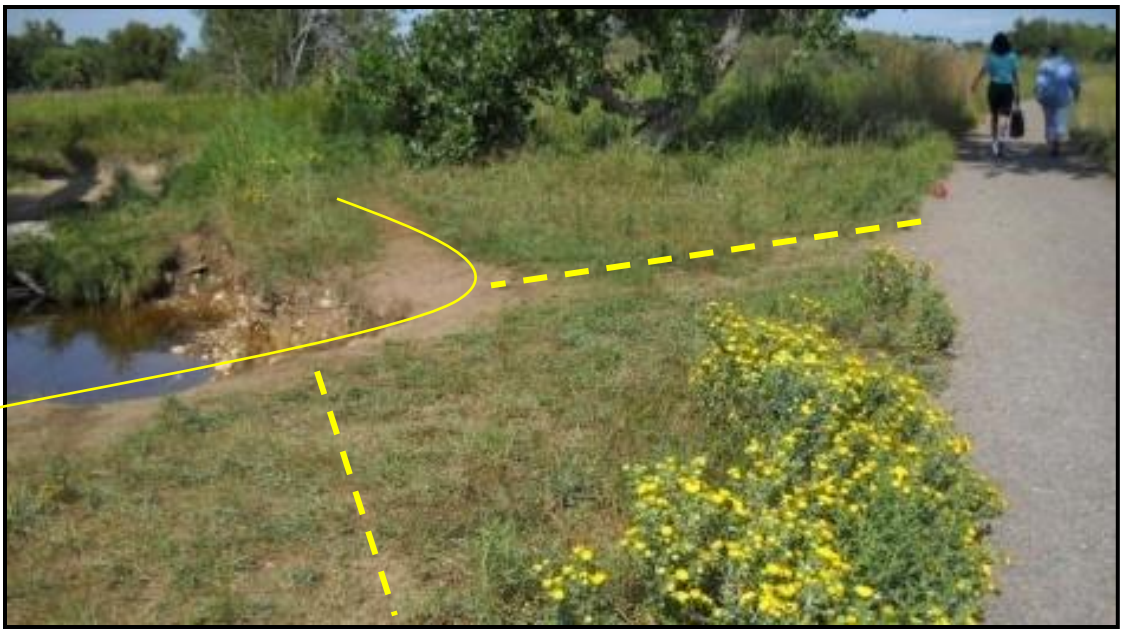
3. Routes through heavily disturbed areas: The isolated segment(s) are part of an undesignated trail route that passes through an area heavily disturbed by people, dogs, vehicles, horses or cattle and portions of the connecting routes lack obvious trail edges because the matrix lacks vegetation or litter due to trampling or vehicle travel. This may occur where undesignated trails pass through cattle feeding areas or areas of shifting vehicle traffic, enter areas of concentrated use, or receive heavy dispersed travel at trail junctions.



4. Routes impacted by erosion: Active travel routes in which erosion and/or visitors shifting travel to contiguous, less-eroded areas has obscured the trail boundary leading to a highly disturbed area of NAT along an otherwise active travel route.

5. Routes crossing impervious surfaces: The isolated segment(s) are part of a travel route in which the visitor is believed to cross an impervious surface (e.g., bed rock, paved road, gravel substrate) to get to the isolated segment.

6. Routes initiated from multiple dispersed pathways. Isolated segments close to and within view of other designated trails, undesignated trails, gates or roads may be part of an active travel route where visitors travel via multiple, less trampled short pathways to access a destination of interest. These isolated segments may occur where dispersed pathways merge into an undesignated trail along a creek or at the border of a scenic vista.



7. <u>Routes in which topography minimizes or exaggerates trampling impacts</u>: Active travel-routes where the isolated segment is more vulnerable to impacts because of topographic setting (e.g., sloped) but the intervening NATs are more resistant to development of treads and boundaries.

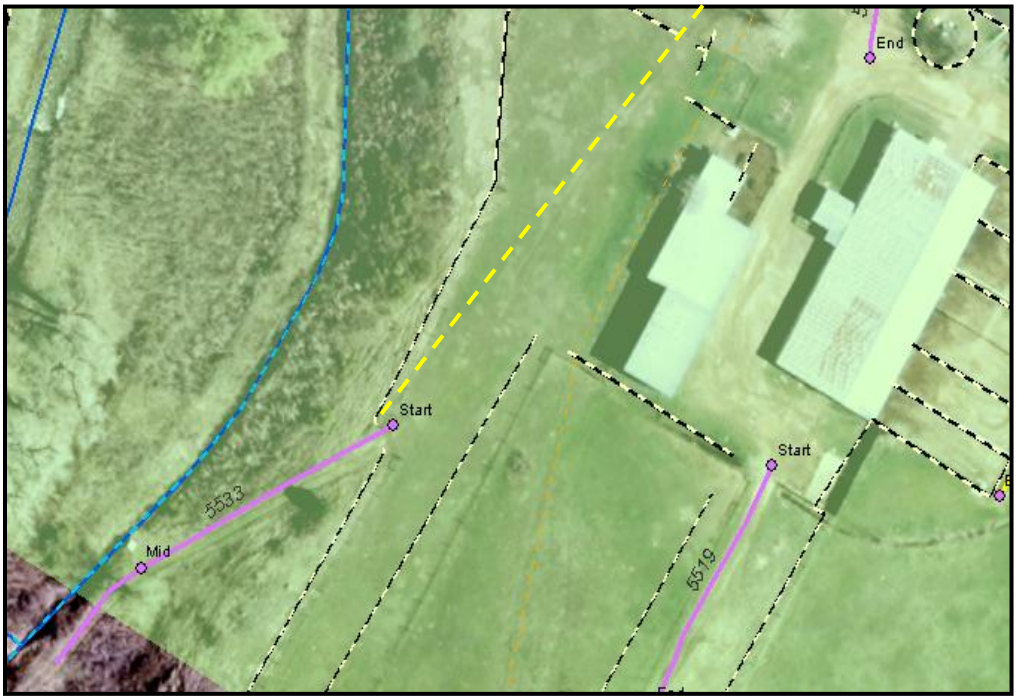
Appendix F1. Examples of roads showing" evidence of repeat use"

1. A corridor of intentionally cleared vegetation or vegetation loss created by travel (i.e., crushed, stunted, trampled). Note: flattened vegetation believed by the surveyor to be associated with a single pass of a vehicle is not adequate criteria of repeated vehicle use.
2. A convex, cupped, compacted, level or incised linear feature (i.e., roadbed)
3. Continuous and distinct tire tracks that suggest multiple passes along the same pathway
4. Widespread pulverized litter
5. Widespread crushed rock or gravel
6. Greater bare soil cover within pathway than in surrounding landscape
7. Erosion within the corridor greater than that observed in the surrounding landscape.
8. Posted signs related to vehicle travel
9. Functional vehicle access gate

Appendix F2. Examples of isolated road segments that look like “floaters” but that are still part of a current vehicle travel route and therefore would be mapped

1) Short stretches of drivable road that follow berms bordering ditches or ponds. Evidence of repeat vehicle use is obscured by the nature of the berm substrate but is observed on either side of the berm

2) Vehicle routes that can be driven to from an access point but that include segments that fail to meet the definition of road because evidence of repeated vehicle use is obscured by widespread disturbance as the route passed through a horse or cow pasture.



Appendix G. Cheat sheet to attribute choices in the undesignated trail data dictionary.

Attribute	Definition	Procedure
Trail_ID	Integer assigned to an undesignated trail/pathway or trail cluster, typically emerging or ending at an access point such as a road or designated trail	For trails previously mapped in 2006, use 2006 Trail_ID in the "grouped sections" undesignated trail layer. For new extensions, braids, parallel trails or short branches of 2006 undesignated trails, use the Trail_ID assigned to the 2006 primary trail. For new trails/pathways, assign a unique number from the new Trail_ID list
Point_ID	Integer assigned to the mapped points at the GPS-mapped start, end, change, and mid-trail locations along an undesignated trail or pathway	Numbers start at 1. Assign the next consecutive number to each point in order mapped along each numbered pathway, even if there is a change in pathway status, cattle status, or intervening gaps of revegetated trail.
Point Type	Point type with respect to location on the undesignated trail segment or pathway	Attribute type assigned in field from data dictionary menu: a. Start: one end of an undesignated trail or pathway arbitrarily assigned as the start point for mapping convenience b. Mid: points mapped along the undesignated trail or pathway, other than end, start, or change points c. Change: point along an undesignated trail or pathway where the status of an attribute or number of adjacent, parallel or braided pathways changes d. End: final mapped point associated with a Trail_ID
Surveyor	Name of surveyor mapping and measuring undesignated trail points	Chosen from data dictionary menu: a. Deonne: D. VanderWoude b. Donna: D. Middleton c. Ann: A. Lezberg
Cattle?	Indication of whether pathway was developed or used by cattle	Assign attribute to describe preceding segment from menu to describe if segment receives cattle use, choosing from menu options "Yes" or "No". If the trail lies in an areas on the map tiles identified as a "grazed area" and if the surveyor observes cattle directly or encounters indirect evidence of cattle presence (e.g., cow pies, cattle hoof prints, salt licks, trail goes to a water tank or feeding area), the surveyor will

Attribute	Definition	Procedure
		consider the trail to be used by cattle The surveyor does not need to see cattle or specific evidence of cattle such as cattle excrement. Noting the trail is used by cattle does not mean the trail is used exclusively by cattle.
Pathway	Type of pathway mapped	Assign attribute to describe preceding segment, choosing from data dictionary menu as either undesignated trail (only), road (only) or road and trail. Multiple pathways within a roadbed or road corridor otherwise meeting the definition of undesignated trail will be mapped as a single pathway in the field and assigned the attribute "road and trail". Enter a comment noting the number of pathways embedded in the road corridor. After 2012, additional pathway types will include FDT (former designated trail), NDT (new designated trial), and NCAT (new climbing access trail).
Comments		Describe problem mapping situations, unusual feature conditions, adjustments to PDOP Max, or presence of parallel trails not directly mapped but sketched in the field. Include other notes to be added to tracking sheets

Appendix H. Cheat sheet for identifying constructed features mapped along undesignated trails

Attribute type	Feature name	Code	Definition
check dam, log	check dam - log	LD	A treated/untreated round log half-buried in tread perpendicular to trail within the trail edges. 
check dam, rock	check dam - rock	RD	A rock half-buried in tread perpendicular to trail within the trail edges. 
culvert, corrug pl	culvert - corrugated plastic	CP	Small or large diameter black plastic tube with ridges (not smooth).  
culvert, PVC	culvert - PVC	PP	Small or large diameter white or black plastic smooth tube with no ridges. 
culvert, steel	culvert - steel	SC	Large or small diameter steel tube with ridges (not smooth). 
drain, drain dip	drainage - drain dip	DD	Natural dip in trail to create a grade reversal. 
drain, french drain	drainage - french drain	FD	Excavated ditch alongside and across trail filled with rocks. 
drain, side ditch	drainage - side ditch	SD	Excavated channel running parallel to trail. 
fence, buck & rail	fence - buck and rail	BF	Untreated logs fastened together to form a fence in an upside down V-shape. 

Attribute type	Feature name	Code	Definition
fence, wood	fence - wood	WF	Treated/untreated logs forming a fence with or without a high-tensile wire used to keep logs together. 
footbridge	footbridge		Structure built over a watercourse, ditch, chasm, etc. that accomodates people on foot or bikes. 
Geotextile synth mat	geotextile material	GM	Black fabric buried in the tread.  
steps, crib ladder	steps - crib ladder stairway	CL	Treated/untreated logs/timber steps that are connected to form stairway. 
steps, ind log	steps - individual log	LS	A treated/untreated round log half-buried in tread perpendicular to trail, extending beyond trail edges. 
steps, ind rock	steps - individual rock	RS	Rocks half-buried in tread perpendicular to trail, extending beyond trail edges.  
steps, ind timber	steps - individual timber	TS	A treated and sawn piece of timber half-buried in tread perpendicular to trail, extending beyond both trail edges.
steps, overlap rock	steps - overlap rock	OL	Rocks half-buried in tread perpendicular to trail placed on top of each other, extending beyond trail edges. 
stepping stones	steps, stepping stones	SS	Individual rocks placed in a low-lying area or stream for+027 stepping across. 

Attribute type	Feature name	Code	Definition
wall, post/plank	retaining wall - post/plank	PW	Treated timber planks buried alongside trail to reinforce hillside. 
wall, rock monowall	retaining wall - monowall	MW	Single layer of rock half-buried alongside trail to reinforce trail. 
wall, stacked rock	retaining wall - stacked rock	SR	Rocks stacked on top of each other to reinforce hillside.  
waterbar, native log	waterbar - native log	NL	An untreated log half-buried in the tread at a 45 degree angle to the trail.
waterbar, natural	waterbar - natural	NW	An excavated triangular area in the tread at a 45 degree angle to the trail. 
waterbar, rock	waterbar - rock	RW	A row of rocks half-buried in the tread at a 45 degree angle to the trail. 
waterbar, treat log	waterbar - treated log	TL	A treated log half-buried in the tread at a 45 degree angle to the trail. 

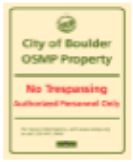
Appendix I1. Cheat sheet for identifying sign structures mapped along undesignated

Sign Structure	Definition
6 x 6 Boundary	6x6 wooden post 36" height, top is angled on one side; also used for restorati  
6 x 6 Wayfinding/Reg's	6x6 wooden post 52" height, top is angled on 4 sides 
Carsonite	Flexible, thin fiberglass material 
Embedded Curb	Low to the ground made of composite or other (e.g., wood) material, 'No Bikes" sign in the middl 
Dog Station	Four wooden 4x4 posts together, 64" height with round plastic cylinde 
Doublewide	Two wooden 6x6 posts together, 54" height 

Sign Structure	Definition
Interpretive	Short thin metal post 
Little Buddy	2x2" wooden post secured to a flat metal bottom plate 
Parking/TH	Located at Trailhead parking area 
Post of gate, fence	Wooden post of a gate or fence 
Quad	Four wooden 6x6 posts together, 64" height 
Reg. board/kiosk	Visitor information sign structure with posts and sometimes a roof  

Sign Structure	Definition
Tree	Standing tree bole  
Tree, hanging wire	Wire secured around or on a tree
Wire (gate, fence)	Wire on a gate or fence  

Appendix I2. Cheat sheet for identifying sign messages mapped along undesignated trails.

Sign Type	Definition
Agricultural	Pertaining to farm equipment/operations 
Boundary/Property	OSMP property or boundary marker/sign 
Closure/Danger/Warning	Closed area (w/out restoration),dangerous area, warning of wildlife    
Cows	Pertaining to livestock, grazing operations 
Ditches	Pertaining to ditch maintenance
HCA Boundary	HCA boundary marker/sign  

Sign Type	Definition
Informational	Information regarding land stewardship, LNT, pick up poop  
Interpretive	Cultural and/or historical. 
Regulatory	Pertaining to rules/regulations, "Do Not" signs  
Restoration	Pertaining to revegetation/restoration projects 
Seasonal Closure	Seasonal wildlife/raptor closure areas (maybe year-round) 
Wayfinding/Directional	Signs with arrows/trail name to direct visitors 

Appendix J. Field tracking sheet for undesignated trails, roads, and photographs

Surveyor	Date	Trail ID	Tile(s)	Path_status	Cattle	Renamed	Digitized	Notes
Surveyor	Date	Photo #	Photo description					

Appendix K. Checklist for reviewing completeness of mapped tiles

Tile Review Checklist	Data Review Stage	√
Tiles initialed and dated	Office	
Date of completion for all data management documented	Office	
All 2006 UTs visited and checked	Field	
Potential roads and driveways checked, mapped, and destination described	Field	
Excel hard copy tracking sheet filled in for each UT, Road, and NAT	Field	
Gates checked for potential UTs	Field	
Constructed features mapped	Field	
Sign structures and messages mapped	Field	
Road barriers mapped	Field	
Potential new UTs seen in aerial photo checked	Field	
Known visitor attractions checked for UTs	Field	
UT point file reviewed	Office	
Unmapped UT field points (due to poor GPS coverage) digitized manually as needed	Office	
Signs data reviewed/edited	Office	
Constructed features data reviewed/edited	Office	
Road barriers data reviewed/edited	Office	
Unmapped braids and parallel trails digitized manually as needed	Office	
UTs digitized and labeled	Office	
Excel tracking sheet filled out electronically	Office	
Photos downloaded, labeled and organized into appropriate directories	Office	
Floaters deleted and explained in tracking sheets	Office	
Remaining questions documented	Office	
GPS and GIS computer files organized	Office	
GPS files deleted from GPS	Office	