2015 Inventory and Condition Assessment of Trail Systems on Missoula Conservation Lands

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Table of Contents

Executive Summary:

In 2015, Missoula Conservation Lands Management (CLM) staff conducted an inventory and condition assessment of the trails located on Missoula parklands which are managed as Conservation Lands. Periodic inventories of trails are recommended by the Missoula Conservation Lands Management Plan, with the last inventory in 2008. CLM staff used GPS units to map all System and Non-System trails, recording information about trail condition, grade and erosion, in addition to mapping infrastructure such as water bars, trail signs, and culverts.

In total, 53.63 miles of designated System trails and roads, and nearly 20 miles of Non-System trails were inventoried on lands managed by the Conservation Lands Management Program. An additional 30 miles of paved and unpaved trails are managed by other divisions of Missoula Parks and Recreation, but are not described in this report. Since 2008, the CLM trail system has added 8 miles (18% growth) of designated System trails through the construction of new trails, trail re-routes, and the acquisition of new properties. Non-System trails have also proliferated. Crews documented 100% (10 miles) more Non-System trails in 2015 than in 2008. The 2015 survey is more comprehensive, partially explaining the large increase in Non-System mileage. However, the survey also shows that some Non-System trails mapped in 2008 are still in use, despite repeated efforts to close and reclaim them. The growth and persistence of Non-System trails across City Conservation Lands is a serious challenge to reaching management goals established by the 2008 CLM Plan (see also Appendix 4).

Conditions on System trails are also a concern. Inappropriate slope, trail widening, formation of multiple tracks, and inadequate drainage are all issues faced on our well-used trail system. Although CLM crews have adequate tools to correct most infrastructural issues, affecting the behavior of the 150,000+ recreationists that use CLM trails yearly will require better public communication and outreach.

In order effectively manage public safety and balance habitat protection with recreational use, we need more tools to encourage a culture of respect for trail etiquette, and rules on Conservation Lands. Currently, the Missoula CLM system is deficient in providing accurate trail maps, adequate way finding, and trail etiquette signage that set clear expectations for trail use. These improvements are seen by the majority of recreation managers and researchers as fundamental tools for influencing recreationists.

CLM will use information gathered in this inventory and condition assessment to: produce new trail maps, plan trail maintenance, manage a Special-Use permit process, and to develop strategies that improve trail etiquette. This inventory is being shared with other local public land management agencies and map providers. An updated layer of publicly accessible hiking and biking trails in the Missoula Valley resulting from this effort will be available online in 2016.

This report:

1. Presents findings from a 2015 inventory, including a condition assessment of trails managed by Conservation Lands;
2. Recommends management strategies;
3. Recommends adoption of several Non-System trails into the CLM trail system;
4. Highlights areas of the trail system where future attention is needed to stem the proliferation of social trails, take advantage of potential connections, and formalize existing connections to the greater area trail systems.

1. 2015 Conservation Lands Trail Inventory

Background

In 2006, when the CLM program was created the City of Missoula Parks and Recreation Department estimated 25 miles of trails on City Conservation Lands. In 2008, the Conservation Lands manager conducted a trail inventory using data from public and private entities with GPS tracks, existing City trail maps, site-specific knowledge, and input from citizen advisory committees. Results from the 2008 inventory were presented to the public through multiple public meetings and open houses during the development of the Conservation Lands Management plan. In 2009, the Conservation Lands Technical Working Group, Conservation Lands Management Plan Working Group, Mt. Jumbo Advisory Committee, Greenough Park Advisory Committee, Missoula Parks and Recreation Board, and Missoula City Council used this public input to memorialize the designated trail system on City Conservation Lands in the Conservation Lands Management Plan (CLMP, 2010). In total, the 2010 CLMP recognized 45.6 miles of System trails that would be managed by the CLM program.

The 2015 trails inventory is the first complete inventory and condition assessment of all trails located on Missoula Conservation Lands. See Appendix 1 for a map of all System and Non-System trails discussed in this report.

Methods

The 2015 inventory was conducted March through September 2015. CLM staff used handheld Trimble GPS units to map all System and Non-System trails, record trail width, trail grade, trail cross-slope, vegetation clearance and trail related infrastructure (*see appendix 3 and 4* for: a glossary, mapping protocols, and CLM trail design standards). Crews also documented specific problems on the trails they walked, noting drainage issues, trail widening, trail braiding, inappropriate slopes and erosion. If trail problems were localized, crews recorded the information with a 'point' rather than as part of a trail segment. Information was then loaded from GPS units into an ArcGIS database, where CLM staff added information about trail designation, ownership, management, dog restrictions, types of allowed trail use and seasonal closures.

Results: System Trail Mileage

The 2015 inventory found a total of 53.63 miles of System trails, compared to 45.6 miles in 2008 (see *table 1*). Multiple factors resulted in the 18% (8.07 miles) expansion of System trails

between 2008 and 2015. The acquisition of the Marshall Canyon parcel and the Yawle property on the eastern flanks of Mt. Jumbo added 2.5 miles and .7 miles of System trails, respectively. New trail construction on the North Hills Sunlight property (Sunlight loop, Black Fox access), Waterworks hill (Cherry gulch re-route), Hemayagan park, South Jumbo (Hidden trail) and at the Tower St. Conservation Area added an additional 4.3 miles. Re-routes of unsustainable fall-line trail on the "L" trail, North Jumbo's Elk Ridge access, and the Sound of Music trail north of Jumbo Saddle added an additional .5mi. of trail via the additions of switchbacks. The CLM program also successfully closed and re-vegetated 0.6 miles of trail on Mt. Jumbo, and 0.5 miles of trail on the North Hills.

As of 2015, the CLM trail system includes about 25 miles of trail designated as single-track, 21 miles of non-motorized roads, 6.9 miles of double-track, and a 0.5 miles of neighborhood connector paths / walkways (see *table 2*).

2015 CLM Trail mileage (2008 mileage)	**System**	**Non-System**	**Area Total**
Hellgate / Rattlesnake	7.33 (8.19)	2.82 (0.65)	10.15 (8.84)
Mt Jumbo / Marshall	22.25 (17.79)	8.43 (4.94)	30.68 (22.73)
Mt Sentinel	6.72 (6.55)	2.42 (0.82)	9.15 (7.37)
North Hills	11.46 (9.72)	3.86 (1.75)	15.33 (11.47)
South Hills	4.35 (2.52)	0.76 (0.30)	5.11 (2.82)
Tower Street	1.52 (0.79)	1.60 (1.48)	3.12 (2.27)
Total 2015 Trail Miles (2008 miles)	**53.63 (45.56)**	**19.89 (9.94)**	**73.53 (55.50)**

Table 1*. Summary of miles of trails managed by CLM, in the 2015 and 2008 trail inventories (2008 values in parentheses). The 2008 survey focused on documenting System trail mileage, so estimates of Non-System mileage from 2008 may be low. In 2015, we found a total of 53.63 miles of System trails, 19.89 miles of Non-System trails, for a total of 73.53 miles of trails inventoried on lands in the Missoula Conservation Lands System.*

	Singletrack	**Doubletrack**	**non-motorized road**	**Other**	**Area Total**
Hellgate / Rattlesnake	2.24	1.68	3.34	0.07	7.33
Mt Jumbo / Marshall	9.97	2.57	9.57	0.14	22.25
Mt Sentinel	2.66	0.86	3.21		6.72
North Hills	6.32	0.69	4.46		11.46
South Hills	2.88	0.87	0.30	0.29	4.35
Tower St.	0.93	0.21	0.38		1.52
Total 2015 Trail Miles	**24.99**	**6.88**	**21.26**	**0.50**	**53.63**

Table 2*. Summary of CLM System trail mileage by trail type and area, as mapped in 2015 trail inventory.*

The inventory documented 351 problem-points, measured trail width at 851 locations, measured the grade of 524 trail segments, and document the location and type of 251 signs, trashcans, water bars, culverts and bridges. Only some of this information is presented in this report, however all of this information will be used by the CLM program to enhance management strategies, such as special-use permit requests, trail use impact assessments, trail network planning, and maintenance work plans.

Results: Non-System Trails Mileage

A surprising discovery from the 2015 inventory was a 100% (9.95 mi.) increase in the mileage of documented Non-System trails since 2008 (*table 2*). Not all of this increase is due to the creation of new trails: the 2015 inventory was more comprehensive than the 2008 trail inventory and field crews simply found more trails, and CLM acquired some property that had existing Non-System trails.

The presence of nearly 20 miles of Non-System trails represents a significant issue for land management. The persistence and expansion of Non-System trails on Missoula Conservation Lands is contrary to management goals which seek to balance recreation and habitat preservation. The fact that few Non-System trails have been successfully closed between 2008 and 2015, and more have appeared, identifies an area where management goals outlined by the 2010 are not being met. This deficit will require the use of new approaches, and new tools in order to meet management goals for the trail system.

Results: Condition Class Assessment

The 2015 inventory was the first time trail conditions have been assessed. By measuring trail conditions and documenting trails which do not meet CLM construction guidelines (*Appendix 4)*; we provide critical information for development of comprehensive work plans to improve the recreation experience, increase the life of our trails, mitigate public safety issues, and to protect natural resources.

The inventory shows that about 20% of System trails (approximately 10 miles) have some level of maintenance need. The causes and solutions to maintenance issues vary from trail to trail. We will try to broadly describe the scope of the problem here, and discuss potential solutions in section 2 of this report. *Appendix 2* shows maps of trail slopes and where problems exist across the majority of System trails.

Trail Slope

Well-designed trails develop fewer problems and in general require much less maintenance than poorly designed trails. Trails should be built with slopes and tread cross-slopes appropriate for the soil type, terrain, and type of recreational use they will receive (eg. max. 20% grade for hikers, 15% for bikers, *Appendix 4*). Trails with inappropriate slopes or cross-slopes quickly develop drainage and erosion issues which can lead to trail braiding and social trail creation as recreationists seek alternative routes. Many of the trail problems documented in this section are either due to unsustainable trail slopes or are exacerbated by trail slope.

Across all System trails 2.44 mi. of trail segments were recorded that exceed a 20% slope (*Table 3*), the maximum allowable slope for trail construction as defined in the CLM Plan (2010). A loss of GPS slope data on many trails during the survey season has created a deficit in this survey. Hence, 26.86 mi. of trail (*Table 3*) are shown as having either 0% or unrecorded trail slopes. The balance of information will be collected in the future. A map of all recorded trail slopes on System Trails is provided in *Appendix 2.*

% Slope of Trails:	0% or unrecorded	1-5%	6-10%	11-15%	16-18%	20-25%	26-30%	31%+	Grand Total
Hellgate / Rattlesnake	6.84	0.47	0.03						7.33
Mt Jumbo / Marshall	8.69	6.00	4.26	1.91	0.82	0.35	0.16	0.05	22.25
Mt. Sentinel	1.97	1.86	0.60	0.63	0.12	1.18	0.23	0.13	6.72
North Hills	7.46	1.67	1.29	0.79	0.02	0.16	0.07		11.46
South Hills	0.93	2.08	0.76	0.43	0.04	0.09			4.35
Tower St.	0.97	0.55							1.52
Total System	**26.86**	**12.62**	**6.94**	**3.77**	**1.00**	**1.79**	**0.46**	**0.19**	**53.63**
Total Non-System	**14.29**	**2.14**	**0.71**	**0.65**	**0.37**	**0.60**	**0.64**	**0.50**	**19.89**

Table 3. *System, and Non-System trail miles summarized by percent slope and trail area. The Conservation Lands Management sets the maximum specified grade for hikers (10-20%) and bikers (10-15%). Of the data collected (approx. half of System trails, 2.44 miles of trail had slopes exceeding 20%, and 1.7 miles of Non-System trails had slopes exceeding 20%.A loss of GPS data resulted in a high proportion trail with 0% or unrecorded slopes.*

Trail Erosion

Trail erosion issues were documented on 68% of System trails. Of the ~36 miles of System trails where crews recorded erosion class, 6.3 miles of trail have "light" erosion, 2.6 miles have moderate, and 0.1 miles have high erosion (*Table 4*). Of the 14.8 mi. of Non-System trails where erosion class was recorded, 1.2 miles showed light erosion, 0.6 miles moderate, and 0.2 miles of high erosion. Most Non-System trails had either a "lightly trodden" erosion class (5.9 mi.) or showed normal wear (6.85 mi.).

	Not recorded	Lightly trodden	Normal Wear	Light Erosion	Moderate Erosion	High Erosion
Hellgate / Rattlesnake	5.21	0	2.10	0	0.02	0
Mt Jumbo / Marshall	4.66	0.16	12.73	3.20	1.40	0.11
Mt. Sentinel	2.03	0	3.16	1.31	0.22	0

North Hills	3.88	0.49	4.64	1.53	0.92	0	
South Hills	1.20	0.37	2.45	0.27	0.06	0	
Tower St.	0.11	0.20	1.20	0	0	0	**Total**
Total System	**17.10**	**1.22**	**26.27**	**6.32**	**2.61**	**0.11**	**53.63**
Total Non-System	**5.11**	**5.94**	**6.85**	**1.18**	**0.61**	**0.21**	**19.89**

***Table 4**. Miles of CLM System and Non-System trails, summarized by trail erosion class and area, as mapped in 2015 trail inventory.*

Additional Trail Issues

Like trail slopes and erosion, trail drainage and trail widening are two other important characteristics that significantly influence maintenance. Inadequate trail drainage can lead to a variety of outcomes such as increased erosion, exposure of surface obstacles, and seasonal creation of muddy and icy trails. Icy and muddy trails often lead to trail widening, as recreationists avoid mud and ice. Trail widening also commonly occurs when recreationists walk abreast (vs. single file) on a singletrack trail; perhaps signifying a trail poorly designed to handle the current level of use.

In 2015, CLM crews identified at least 6.8 miles of trail where widening has occurred, 1.44 miles where drainage is an issue (often due to trail tread cupping, where water can't leave), and 0.4 miles of switchbacks that do not meet basic CLM trail construction guidelines (*Table 5*, below).

	drainage	**switchback**	**widening**
Hellgate / Rattlesnake	0	0	0
Mt Jumbo / Marshall	0.58	0.19	1.12
Mt. Sentinel	0.10	0.03	1.59
North Hills	0.38	0.18	3.64
South Hills	0.38	0	0.44
Tower St.	0	0	0
Grand Total	**1.44**	**0.41**	**6.79**

***Table 5**. Miles of trail where drainage, switchback, and widening issues were identified as issues.*

2. Management Recommendations

"Trails connect users to virtually all recreation opportunities; they are a very important component of the Missoula Conservation Lands system. Well-designed trails, located away from protected and sensitive habitats are critical to preserving natural resources on MCL. By locating trails appropriately, providing a sufficient number, and maintaining the quality of trails, recreation use can be maximized while the negative impacts of human use can be minimized" (Conservation Lands Management Plan, 2010)

Maintaining a trail system that meets the needs of users and minimizes impacts on natural resources is a challenge. This inventory supplies land managers with basic information on physical trail conditions and highlights easy to identify problems. Problems with trails are often caused by a combination of factors; identification of the causative factors of trail problems will require further analysis of this data and subsequent site visits by land managers. Developing and maintaining trail systems that comply with widely-recognized trail-construction standards is essential. However simply building "good" trails will not be enough to reduce the development of social trails into areas where trails are not wanted. Success in providing balanced recreational use and habitat protection on our Conservation Lands will also require provision of infrastructure that meets usage patterns, such as directional & educational information, and clear communication of the rules and expectations of trail users.

Trailheads and Signage

Missoula Conservation Lands Program manages 8 Primary trail heads, 25 Secondary trailheads, and 30 local access points. It is well documented in recreation management texts and verified through countless field examples that informational signage, accurate trail maps, and wayfinding on public lands are fundamental improvements necessary for decreasing damage from recreational use. In the 2010 CLM Plan, upgrading trailheads was recognized as a major need. Currently, all but 1 Primary trailhead, none of our Secondary trailheads and only ½ of our Local access points meet the City's adopted trailhead specifications. In general, Missoula Conservation Lands currently lack accurate trail maps at our trailheads and many areas lack directional signage (namely Mt. Jumbo). Investing in updates to City trail maps, trailhead improvements, seasonal sign packages to encourage responsible recreation, and the addition of more wayfinding signage will be essential for improving compliance with trails closures and preventing proliferation of future user-made trails. Developing strategies for funding the design and development of these improvements are beyond the scope of this report, but will be essential to management success.

System trails

Trail conditions documented by the 2015 inventory identify a significant level of deferred maintenance on our designated trail system. Overall, newly constructed and/or rerouted trails have held up well and few problems were identified on those trails. The majorities of trail problems are located on trails constructed before the creation of the CLM Program in 2006; where many trail segments do not meet the basic trail construction guidelines adopted in the 2010 CLM Plan (see *Appendix 4* for guidelines).

Addressing minor issues, for example repairing minor drainage issues, clearing vegetation, fixing cross-slope, and replacing missing signs can be remedied in a short period of time and will prevent these issues from degrading into more serious issues. Developing and implementing fixes for System trails with moderate or high erosion, unsustainable slopes, cupped tread, significant widening/braiding, and poorly constructed switchbacks will require more labor

intensive solutions. To solve these issues installation of new drainage features, trail reroutes, trail tread reconstruction, and possibly the importation of trail tread material is often required.

Over the past few years, CLM has invested in information and equipment that will help address the backlog of trail maintenance. New equipment in 2015 (power wheelbarrow, mini-excavator), staff training in trail construction, and the completion of this inventory all improve our ability to plan and respond to deficiencies in the system in an efficient fashion. However, CLM staff is limited in the number of trail miles it can construct and maintain in a year. Making all the needed improvements to System Trails in a timely fashion will require a combination of resources including direct funding from the City of Missoula, the support of local organizations, grants and volunteer labor.

Specific management recommendations in order of priority for System Trails include:

1. Continue to seek additional funding for trail and trailhead improvements from the City general fund, grants, and donations.
2. In 2016, resurvey all trails where trail slope was not recorded in 2015. Compare trail slope data with the problem points described in Section 2 of this document to distinguish the root causes of trail issues and prioritize repairs.
3. Through 2016 & 2017 systematically implement improvements on slightly degraded trails, where the majority of trail problems were documented before conditions worsen.
4. Use inventory data to prioritize larger repairs and begin developing plans for repairs. Where major repairs/reroutes are required appropriate restoration, and rehabilitation plans must accompany maintenance plans.

Non-System trails

User-created Non-System trails are one of the most challenging trail management issues that CLM faces. Recreationists create Non-System trails when they are unfamiliar with the designated trail system, to short-cut existing routes, or to access areas where trails do not currently travel. Because these trails are created without regard for sensitive plant and animal species, special resource areas, or future maintenance they often conflict with the City's conservation goals. Non-System trails generally do not meet construction guidelines (*Appendix 4)* as many have unsustainable grades and are prone to erosion making them difficult to restore. This inventory provides a foundation for the CLM Program to develop holistic strategies for reducing the amount of Non-System trails.

Developing solutions to close and restore Non-System trails is a complicated process. The closure and rehabilitation of well-established trails is labor-intensive, trail tread must be chopped, replanted, reseeded, slashed-in with sticks & rocks, and signed as closed. Successfully persuading trail users who are accustomed to hiking a Non-System trail to stop using that trail is often more difficult than the physical act of rehabilitating the trail. Efforts to close and rehabilitate a trail are usually repeated multiple times over a 2-3 year period to be successful.

In general, more user trails are created in areas where there aren't clear signage directing users to designated trails, and where trails access City lands from adjacent private property (where the City is unable to manage access). The fact that ~35% of Non-System trails are classified as "lightly trodden" may represent a ripe opportunity for preventative measures. Utilizing signage and temporary fencing to restrict use of lightly trodden trails then allowing them to re-vegetate naturally, versus waiting until the trail is well-established and requires labor-intensive restoration would save money and time. Moderately and highly eroded Non-system trails represent a more costly problem, and should be addressed through appropriate closures and restoration. Current resources within the CLM Program allow for the closure up to 1 mi. of Non-System trails a year.

Specific management recommendations in order of priority for Non-System Trails include:

1. Continue to seek additional funding for trail rehabilitation, wayfinding and educational signage from the City general fund, grants, and donations.
2. Develop and purchase new metal trail closure signage to post when trails are closed and rehabilitated.
3. Prioritize closure and repair of social trails which are only lightly established, before the tread has reached mineral soil.
4. Use trail inventory and natural resource data to determine which Non-System trails are the most impactful and prioritize their closure and rehabilitation.
5. Develop accurate trail maps for trailheads and major access points and post wayfinding signage throughout the system.
6. Work with adjacent landowners to maintain better oversight of access to City lands from across adjacent public and private lands.
7. Begin formulation of program to help educate recreationists about trail etiquette, responsible recreation and the importance of Missoula Conservation Lands System.

The remainder of this document: presents recommendations for re-designation of certain Non-System trails as System trails (section 3), and describes areas of our trail system with the most significant management challenges or opportunities (section 4).

3. Proposed Additions to the CLM Trail System

Many of the Non-System trails inventoried have existed for years. Not all Non-System trails have an unsustainable design and/or negatively impact resources. Several of them meet the City's trail construction guidelines (*Appendix 4*); or could meet guidelines with minimal improvements. In this section, we propose adoption of five Non-System trails, totaling 1.66 miles, as System trails. Each proposed trail currently acts as a de-facto System trail, due to relatively consistent level of use in the absence of directional signage. By adding these trails, CLM hopes to respond to the increased demand for recreation by adopting existing suitable trails, rather than closing these relatively popular hiking spots. Adoption of these trails as System trails would require minor trail tread repairs, installation of drainage features,

construction of 0.1 miles of new trail, but would facilitate the closure and restoration of 1.01 miles of adjacent Non-System trails (not including miles transferred to the system).

The process for adopting (or building) a new System trail on Missoula Conservation Lands has several parts. CLM staff review appropriate legal documents (eg. easements, deeds, management plans) for conflicts; review existing inventories of natural, cultural and recreational resources; and finally make a formal proposal to the Conservation Lands Advisory Committee (CLAC). CLAC reviews all pertinent information during one of their regularly scheduled public meetings and makes a recommendation to the Missoula Parks Board (MPB). MPB reviews the recommendations of CLM staff and CLAC during one of their regularly scheduled public meeting and votes to approve or deny the request.

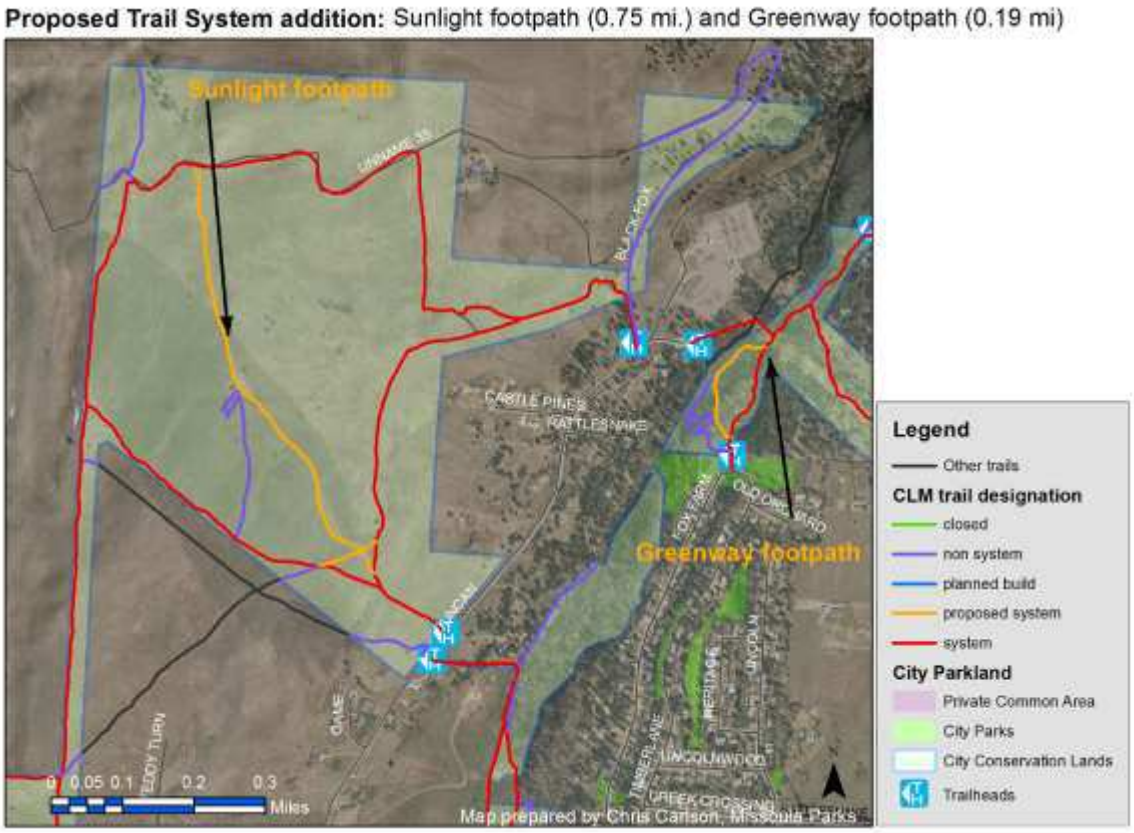
After a thorough review, CLM proposes that these trails be added as CLM System trails, with use restrictions as described.

A. Sunlight Property Footpath (*Map A*)

This property is accessed via two trailheads near the end of Duncan Drive. The main trailhead has been re-configured since 2008, to direct foot traffic away from the original trail which crossed private land. The Sunlight footpath is a 0.75mi. long footpath that was previously used as a road and has been a well-travelled route since the property was purchased by the City in the late 1990's. It has a gentle grade, generally meets the CLM Plan's trail guidelines (*Appendix 4)*and is well used by local recreationists. Impacts on natural resources appear low, although some drainage issues exist. The path does intersect a small wet seep which is utilized by local wildlife. This seep was excavated by previous landowners to increase water depth for livestock. CLM staff recommends this trail for inclusion as a designated System trail, with only pedestrian and equestrian traffic allowed (all connecting trails are pedestrian & equestrian only). Additional, measures to increase the available cover and amount of water in the seep, and to explore ways to limit human and dog use of the seep may help improve habitat values on site.

B. Rattlesnake Greenbelt Footpath (*Map A*)

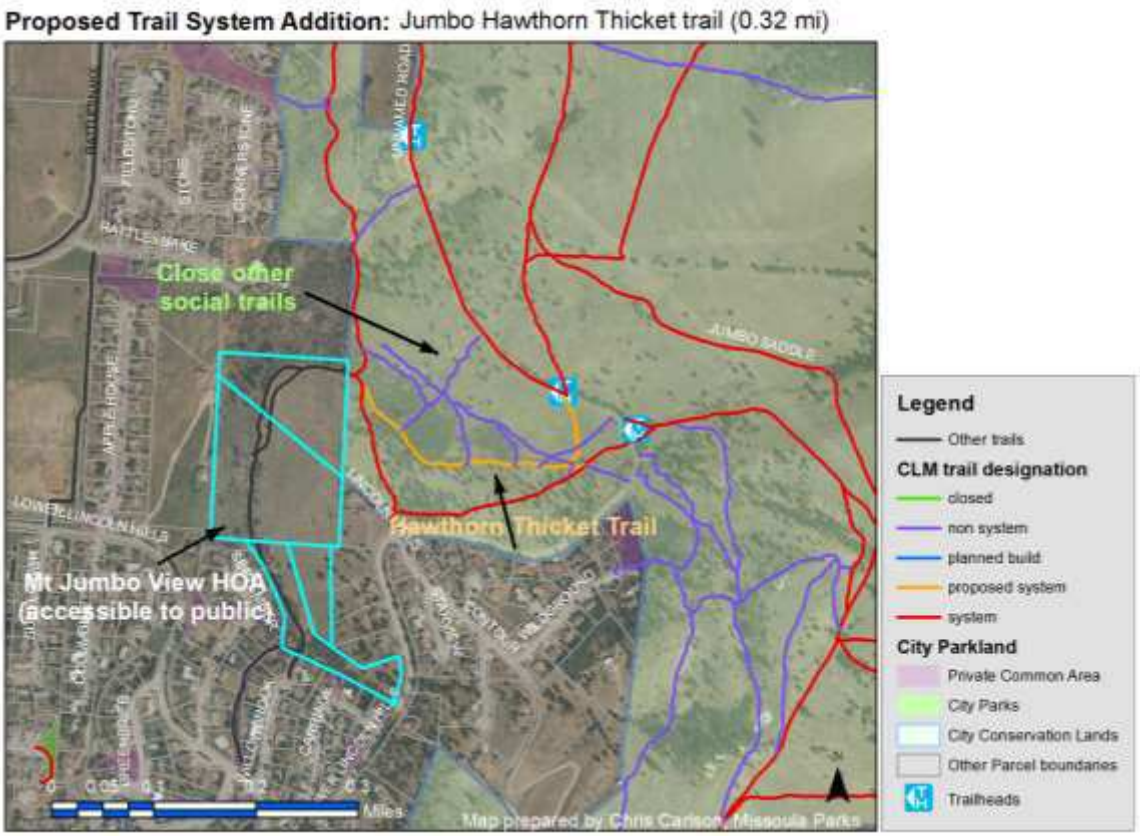
This trail is along Rattlesnake Creek, just downstream from the footbridge connecting Duncan drive with the Rattlesnake Greenway trail. The trail is 0.19mi. long, passes a large pine who's bark was peeled by Native Americans for cambium harvest and runs through picnic grounds that Montana Power Company (previous landowner) used to use for company retreats. This trail is approximately 4 ft. wide and has likely been used by the public for decades. This area (and many others along Rattlesnake Ck.) was not surveyed in the 2008 trails inventory. Had this area been surveyed in 2008 it is highly likely that this trail would have been included as a System trail in the 2010 CLM Plan. CLM staff recommends designation of this trail as a public non-motorized System trail. We also recommend taking steps to close adjacent Non-System trails, to better protect the park's value as wildlife habitat.



***Map A**: Showing locations of proposed additions to CLM trail system: Sunlight footpath and Greenbelt footpath. Current System trails shown in red, Proposed System trails shown in Orange.*

C. Lincoln Hills "Hawthorn Thicket" Trail (*Map B*)

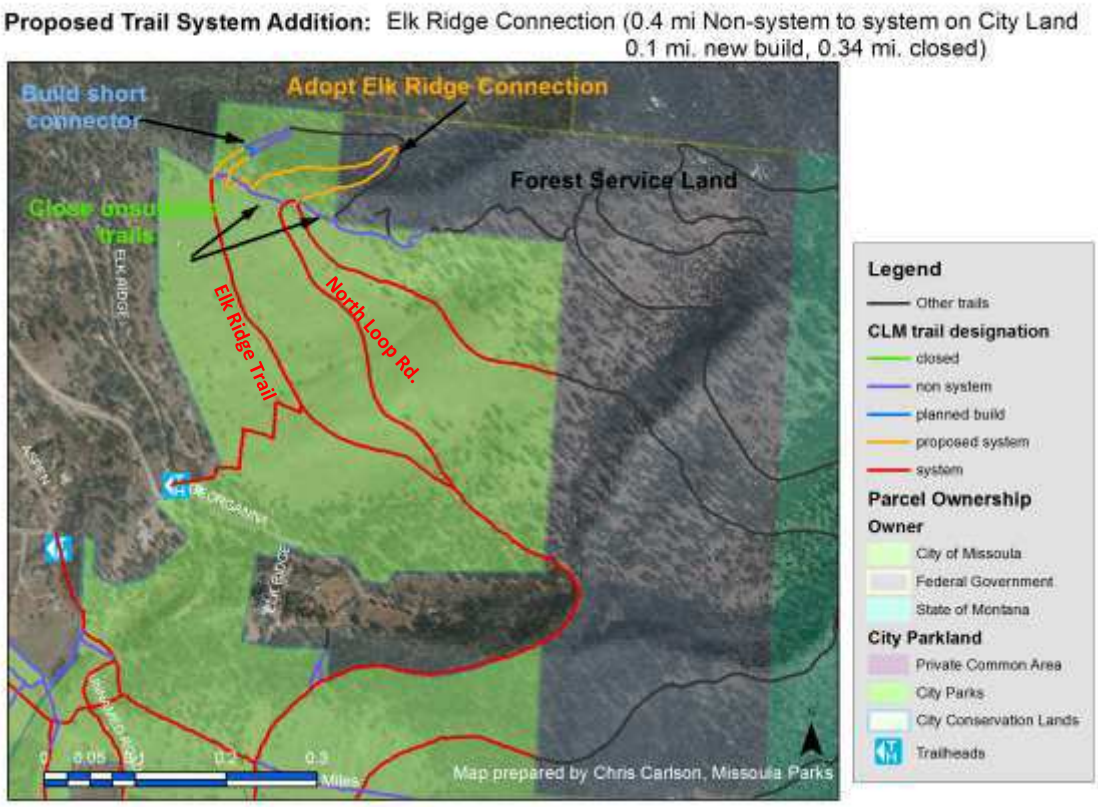
This property sits downhill of the main Jumbo Saddle trailhead on Lincoln Hills Drive. There are currently many other Non-System trails in the area that bisect a hawthorn thicket, with a perennial spring, which are important to local wildlife. The Hawthorn thicket trail has been in use since the City purchased the property in the late 1990's. It connects the Mt. Jumbo Views Homeowner Association Common Area to the East and provides a critical link for neighbors to access the Mt. Jumbo Saddle. As it serves as the direct route between these two locations stopping public use of this trail would be very difficult. The 0.32 mile trail is at a sustainable grade and with minor improvements can comply with CLM Plan guidelines (*Appendix 4)*. CLM recommends adoption of the highlighted segment (Map B) as a public non-motorized System trail. Closure and restoration of all other Non-System trails (0.67mi.) through the hawthorn thicket is a priority of the CLM program.



Map B. *Showing locations of proposed additions to CLM trail system: Hawthorn Thicket trail. Current System trails shown in red, Proposed System trails shown in Orange.*

D. Elk Ridge x North Loop Connector (*Map C*)

The Elk Ridge parcel is situated north of Mt Jumbo's Saddle, adjoining Forest Service land. There are currently several trails which connect the northern terminus of the Elk ridge trail to the North Loop road. The .40 mile Elk Ridge x N. Loop connector purposed for adoption is already in existence and mostly meets trail specifications outlined in the CLM plan. CLM staff recommends adopting this connection as a shared use trail with the intent to adopt much of the existing trail; close inappropriate sections; construct appropriate connections (.10 mi.) to encourage pedestrians to stay on the trail; and to close all other Non-System trails (.34mi.) in the area. The additional existing trail (a.k.a. son-of-sidewinder) which connects the North Loop Road to Forest Service logging roads, uphill and to the east of the Elk ridge x N. Loop connecter, may make a good trail connection if the Forest Service is in favor of allowing the connection. CLM staff recommend that the City adopt sections of this trail if the Forest Service supports this connection.



Map C *Showing locations of proposed changes to CLM trail system: Elk Ridge Bike Descent, "Sound of Music" overlook. Current System trails in Red, Proposed System trails in Orange, Proposed new construction in Blue, Non-System trails in purple.*

4. Areas Requiring Additional Consideration

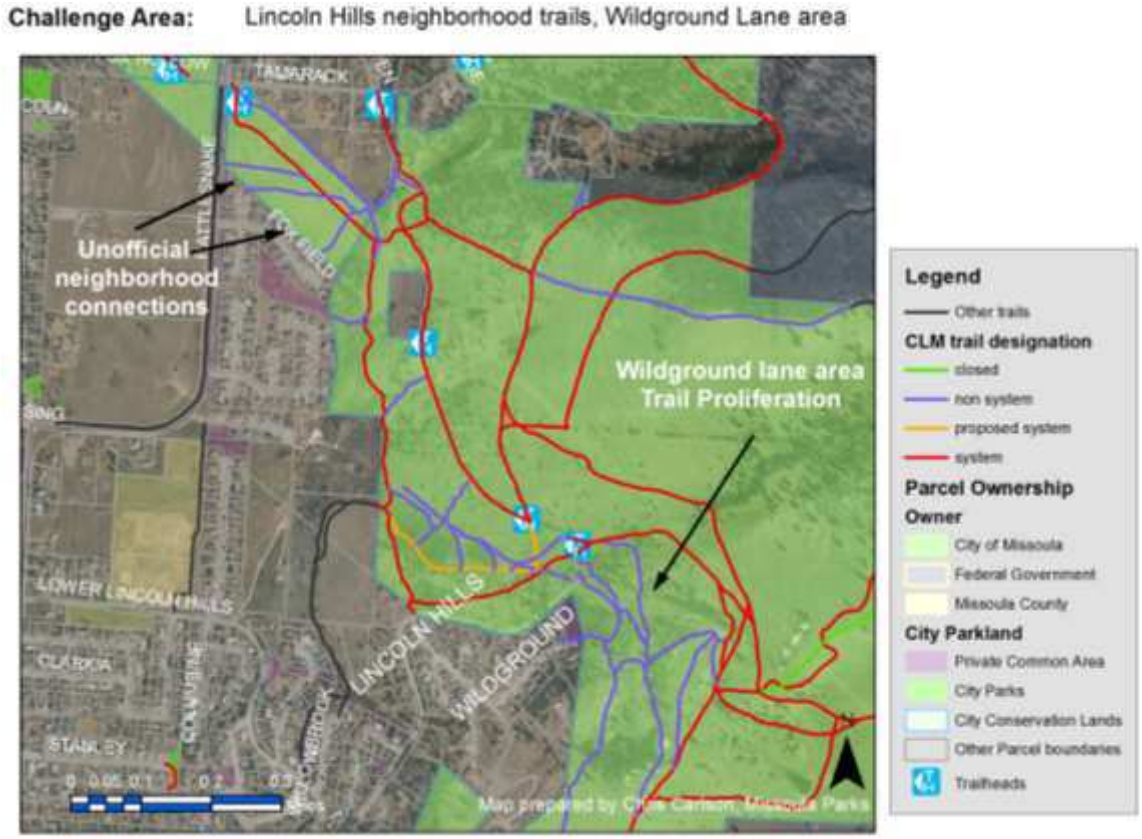
During the course of this inventory it became evident that several areas across the Conservation Lands System present significant management issues. The locations described below may require more immediate actions for one or multiple reasons. These include: protection of natural resources, improving recreational access, taking advantage of potential connections with nearby trails, better management of existing recreational use, and increased coordination between neighboring land management agencies.

A. Lincoln Hills to Aspen Drive area (*Map D*)
The powerline corridor allows both wildlife and recreationalists to pass between the Rattlesnake greenway and the Jumbo Saddle / Elk Ridge area. In this area, bike recreation, neighborhood use, and power line maintenance have resulted in a growing number of Non-System trails. In this area alone there are 5 neighborhood access points where homeowners can access City land through neighborhood common areas. None of these access points were included in the 2008 inventory and none contain any of the basic

information pertaining to rules, regulations or wayfinding on City lands. Addressing this lack of signage and working to reduce the number of Non-System trails is recommended.

B. Wildground Lane Trail and Area (*Map D*)
At the end of Wildground Ln. is an unofficial trail connection that serves as a neighborhood access to Mt. Jumbo's Saddle area. This trail currently crosses private property upon leaving the street, then crosses a neighborhood common area, then continues onto City Land. The trail leads to many nearby Non-System trails, in an area already containing sufficient System trails. This area is also along the boundary of the Mt. Jumbo Winter Wildlife Closure area. The majority of the trail is well established (an old road cut), provides an easy connection for neighborhood residents, and complies with CLM trail specifications.

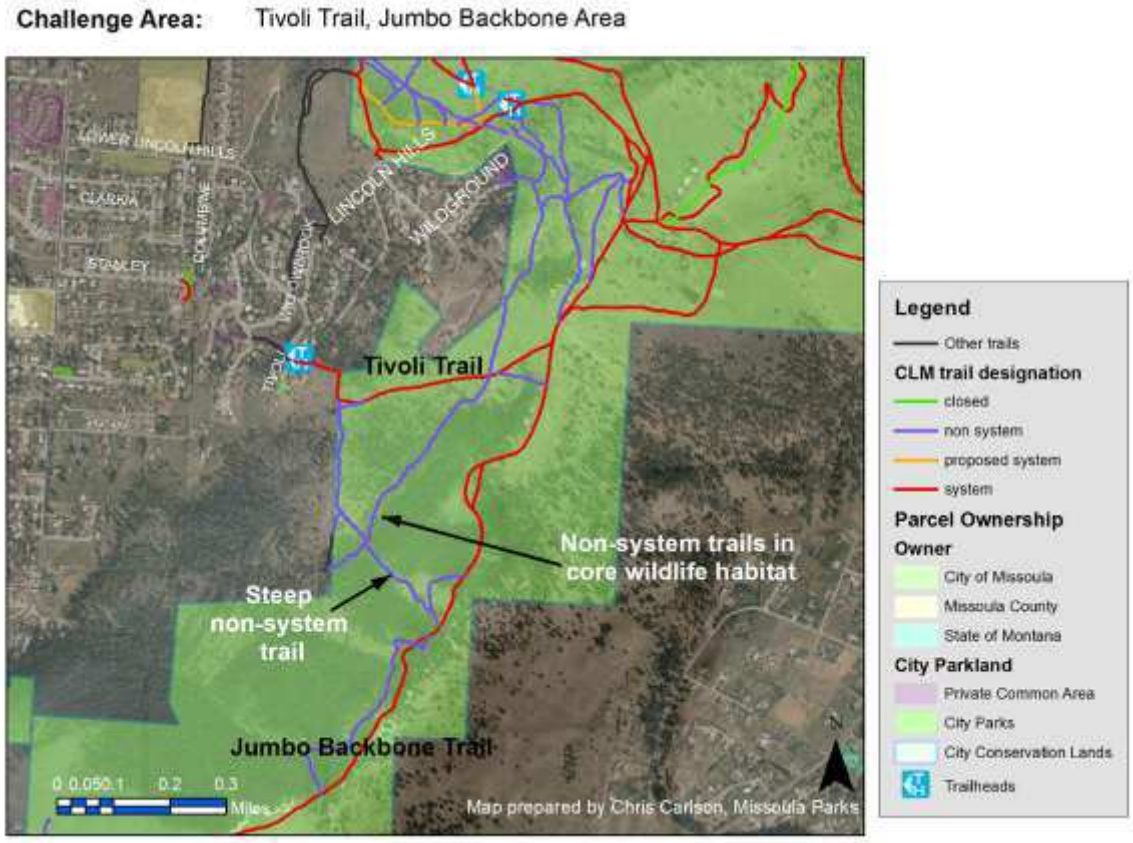
Pending negotiation of a public access agreement with the private landowner, where the trail leaves Wildground Lane, *we recommend the City should consider formalizing the trail connection.* If no access easement is possible the City should close and rehabilitate the trail when the private property is developed. In the short term, CLM crews should work to decrease the number of Non-System spur trails in this area and continue to post closure-signage at this location during the Mt. Jumbo Winter Closure.



Map D. *Showing the Lincoln Hills / Wildground Lane challenge areas.*

C. Tivoli Trail Area (*Map E*)

Tivoli trail begins at a minor but well-designed neighborhood access trailhead managed (via a public trails easement) by the CLM program. It connects to a well-established Non-System trail to the south, which cuts up a very steep face and connects with Mt. Jumbo's Backbone (Map E). This steep fall-line trail is highly erosive. Anecdotal reports from field staff concur that this trail is experiencing increased usage. Since it was first mapped in 2008 several adjacent spur trails have developed which bisect core wildlife habitat. Closure and restoration of these trails before more Non-System trails appear in the area should be a priority.

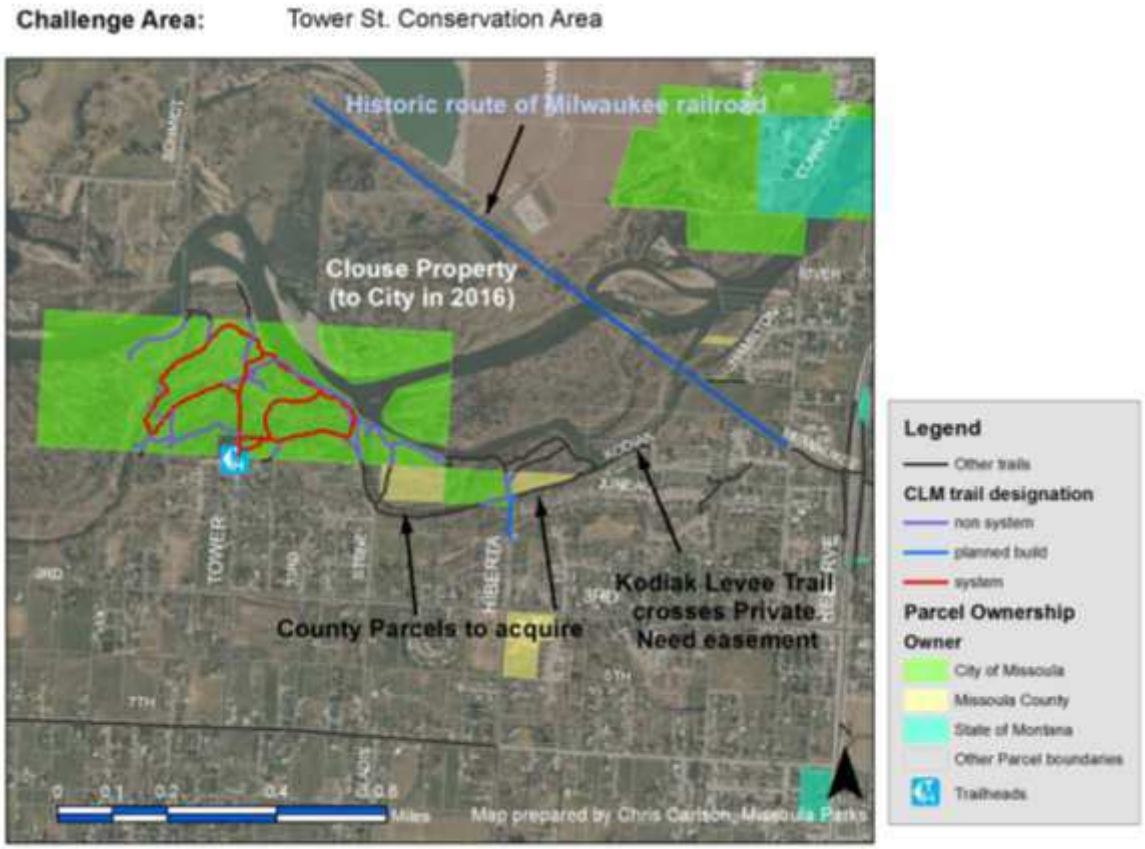


Map E. *Showing the Tivoli trail, Jumbo Backbone challenge area. Non-System trails which spur off the Tivoli Trail in this area infringe on core wildlife habitat zones. The "Steep Non-System trail" shown on this map has a grade of over 45% in places, and is eroding.*

D. Tower St. Conservation Area (*Map F*)

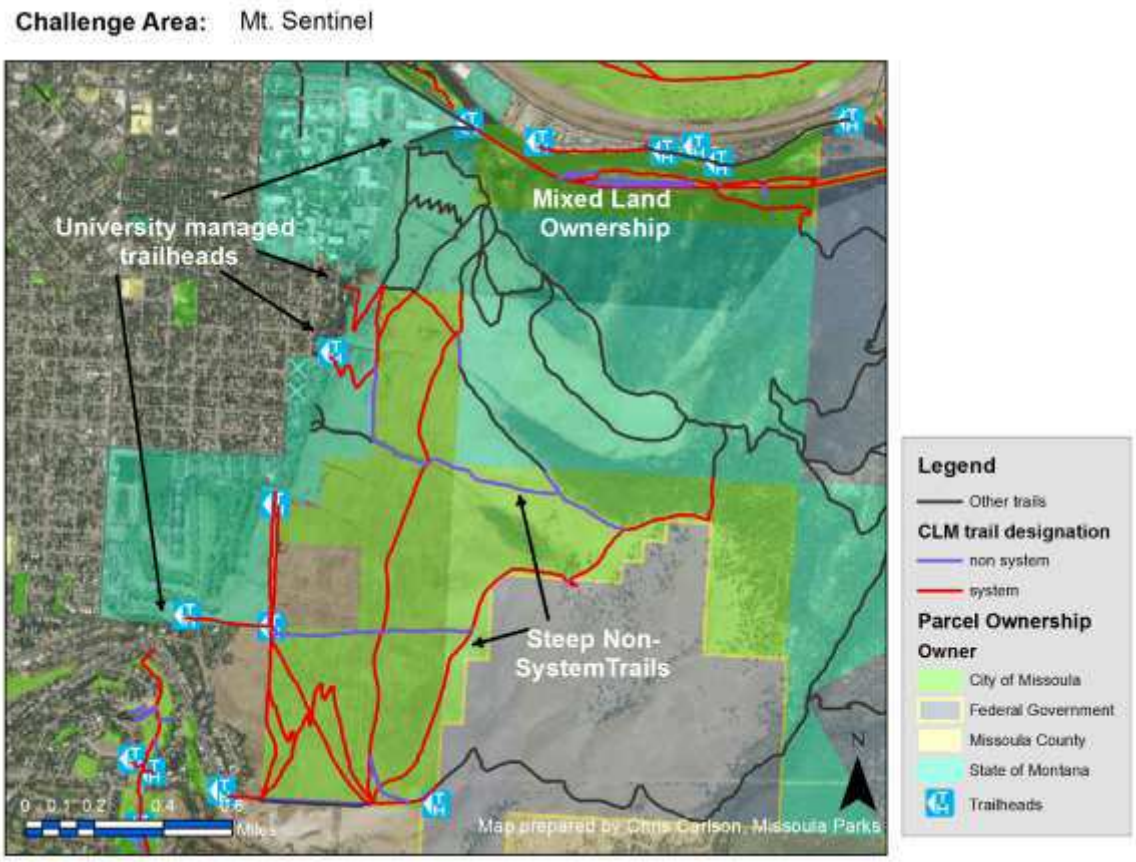
The Tower Street Conservation Area has only one formal trailhead, but multiple other access points are situated on County, City and Private Property. Only the formal trailhead has rules and regulations signage; none of the access points have trail maps. The Tower Street C.A. has roughly equal amount of System and Non-System trails. Perennial flooding and the mixed ownership make it difficult to effectively manage trails and access points.

CLM staff recommends developing a formal trailhead at the end of Hiberta St., adding trail maps to trailheads, adding way-finding throughout the area and closing the most deleterious Non-System trails. The ultimate goal is to connect the Tower St C.A with the Milwaukee trail System. The pending transfer of the Clouse property and a small portion of the Water Wheel subdivision to the City will go a long way to achieving this goal. However, this connection will also require obtaining public access easements across the Kodiak levee, and from some private landowners. To establish continuity in ownership and improve recreation management in this area it is further recommended that the City pursue transfer of adjacent Missoula County-owned parcels to the City.



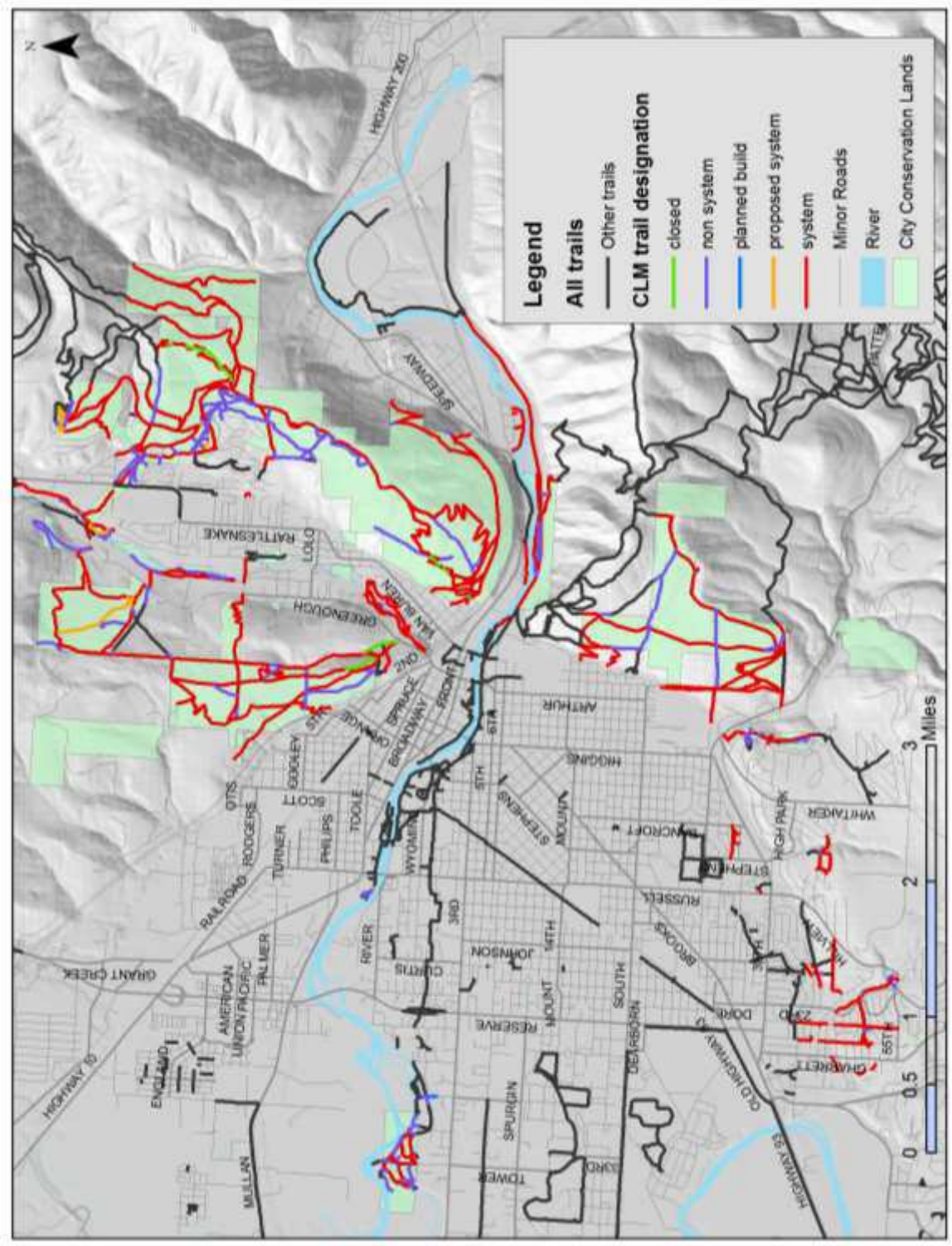
Map F. *Showing Tower St. Conservation area trail related challenges.*

D. Mt Sentinel Challenge area (*Map G*)
Mt Sentinel receives a high level of use and contains a mix of University / City / Federal / State land ownership. The Northernmost portion of City Open Space is surrounded on three sides by land owned and managed by the University of Montana. The University of Montana has no formal program or resources to maintain trails, trailheads and signage on the lands they own. Many of the more problematic Non-System trails on City land are difficult to close without also addressing access points and trails on University Land. City and University Land managers should work to develop a plan to manage recreational use across these properties.

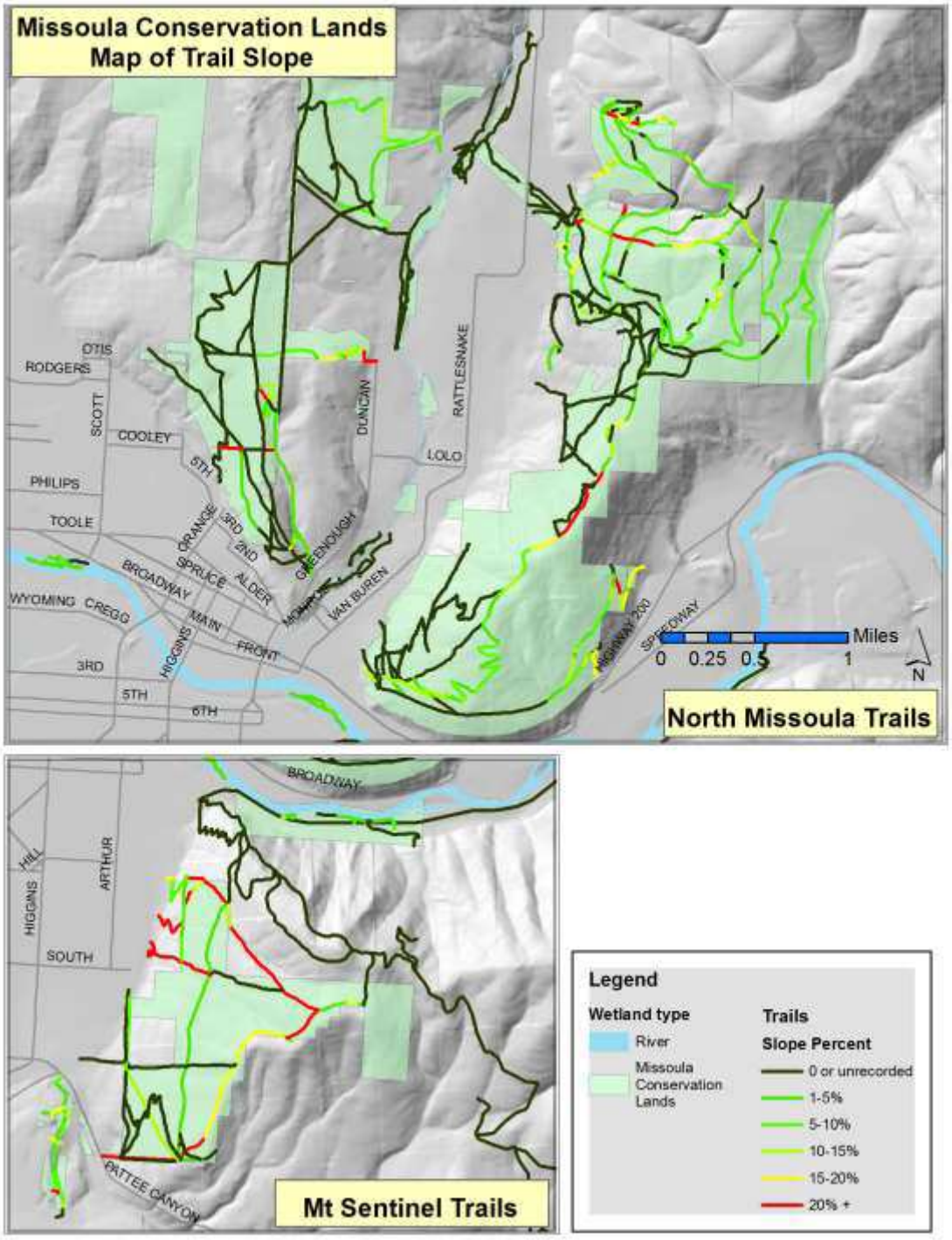


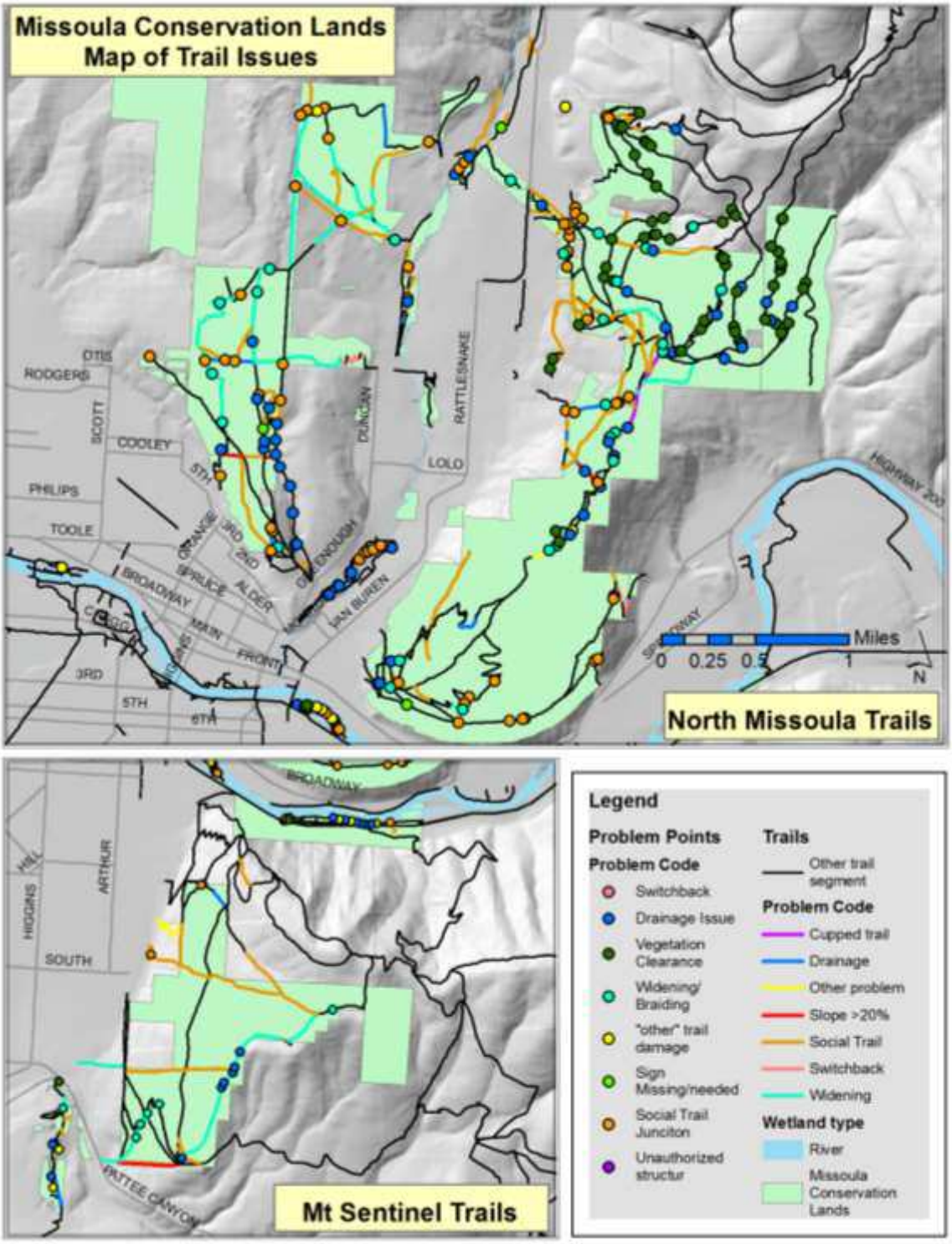
Map G. *Showing trail related management challenges on Mt. Sentinel. Trail management in this area is complicated by mixed ownership between the City, University, State, and US Forest Service. Most trailheads on Mt. Sentinel are managed by the University, rather than the City. This area is also challenging because of high rates of recreational use. We recommend working more closely with the University to ensure consistent posting of signs and rules, and working to close steep Non-System trails using signage, fencing, and re-vegetation where appropriate.*

Appendix 1. Missoula Conservation Lands Trails



Appendix 2. Maps of Trail Conditions on Missoula Conservation Lands




Missoula Conservation Lands
Map of Trail Issues
North Missoula Trails
Mt Sentinel Trails
Miles
0 0.25 0.5 1
N
Legend
Problem Points
Problem Code
Switchback
Drainage Issue
Vegetation Clearance
Widening/ Braiding
"other" trail damage
Sign Missing/needed
Social Trail Junciton
Unauthorized structur
Trails
Other trail segment
Problem Code
Cupped trail
Drainage
Other problem
Slope >20%
Social Trail
Switchback
Widening
Wetland type
River
Missoula Conservation Lands

Appendix 3: Glossary and Trail Mapping protocol

MPB: Missoula Parks Board. An public board appointed by the Mayor, which creates policies and rules pertaining to City Parks, Recreation, and Open Space.
CLAC: Conservation Lands Advisory Committee. A sub-committee of the Missoula Parks Board that provides advice on the implementation of the Conservation Lands Management plan.
CLM: Conservation Lands Management, a division of Missoula Parks and Recreation
CLMP: Conservation Lands Management Plan, adopted in 2010.

Trail Grade (trail slope): Steepness of hiking trail between two points, measured as a percent
Trail Cross-slope: Steepness of a cross-section of trail at one location in percent slope. In-sloped trails have a negative value, flat trails are 0, out-sloped trails have a positive value.

System trail: A trail that is located on City Property or managed via an easement or agreement, and has been approved as a System trail via the 2010 Conservation Lands Management Plan, or subsequent action from the MPB. These are the trails the CLM program actively maintains for recreation.
Non System trail: A trail that has not gone through any of the above processes to become a System trail. Non System Trails include trails that existed on a given parcel prior to city acquisition as well as Social Trails which were created or improved by recreationists without department approval following acquisition. May also occasionally include stock trails formed by sheep or the sheep herder's horse.

Instructions used by CLM crews in 2015 for Inventorying Trails.

GPS layers we will be editing

1. *Trails_mapping_segments* (a line type shapefile) ; **2.** *Trail_problem_points* (a point type shapefile)
1. *Trail_control_points* (a point type shapefile) ; **4.** *Trail_infrastructure* (a point type shapefile)

Trail Segments For each segment, the lead Mapper will collect the following information about the segment she just walked in the Layer: (see "cheatsheet" on page 3 for full definitions of classes of erosion, etc.):

1. Segment Slope from end to start of segment (measure in **percent** slope)
2. Erosion Condition Class (*scale of 0-6*, 3 is a trail in normal, good condition. Only use class 0-2 for social trails)
3. Surface obstacle class (*scale of 1-3*, how many obstacles for feet/strollers, etc.)
4. Number of tracks (count average number of parallel footpaths, optional)
5. Surface type (*native, paved or imported*)

6. Problems with segment (drop down list of problems: ***widening, cupped, braiding, slope, Social trail***)

Trail control points: measure trail width, crossslope, and indicate cupped trails, about 50' after the start of a segment, and every 300' or so within a segment. Aim for at least 2 points per segment

2. Trail width (distance between outside edges of beaten track, *measure in centimeters, 1 meter = 100 cm*)

3. Cross-slope: Measure in degrees. Use a compass, or inclinometer to measure cross slope. If trail is outsloped, it record a positive value, if the trail is insloped, record a negative value, Record 0 for a cupped trail.

4. if the trail is cupped, record in the "cupped" field with a Yes value.

Problem points layer: use to document **any** problems with trail system.

1. Record the type of problem (*drainage, widening/braiding, sign missing/needed, other trail damage, veg width clearance, veg height clearance, social trail junction, switchback problem, vandalism, graffiti, trash, illegal camp, other problem (note)*
2. Record the length of trail impacted (in feet), if any.
3. Indicate if the problem is *high, medium, or low priority*. High priority fixes include anything that might cause a public safety hazard. Medium priority includes missing signs, trash cleanup, or trail damage that will worsen if not ignored. Low priority points are any that will not worsen if we wait a season to fix.
4. Record any notes that will help work crews know what the problem is before going to fix it

Trail infrastructure: While walking the trail system, keep an eye out for infrastructure or assets that are managed by the City. Mark a point where you find any. Mark >1 point if there are two different kinds of signs, benches, etc.

1. Types of infrastructure
    a. Signs: *Trailhead sign cluster, Map, Interpretive, Milage, Direction, Public Property Sign, Private Easement Sign, Private Property Sign, Leash/Voice control post, Trail Closed, No Bikes, Foot Only, Seasonal Closure,*
    b. Infrastructure: *waterbar, gate, bench, picnic table, steps, rail fence, wire fence, gate, picnic table, trash can.*
2. Indicate infrastructure condition (*excellent, good, fair, poor, missing/broken*), and any notes

Segment rules: Mappers should end a **segment** and begin a new one when they encounter:

1. A junction in System trails (or end of a trail)
2. Loss of line of sight between the mappers
3. A dramatic change in slope (especially if sustained >20%)
4. A major switchback
5. A change in dog leash laws
6. If none of the above rules come into play, try not to make segments not longer than ~1/4 mile.
7. ***Note:*** If the trail Non-System "social trail", map it in its entirety, and document any problems with the trail that could lead to trail closure (slopes >20%, erosion, widening, etc. as normal)).

Trail Erosion Condition Classes (a class of 3 is a typical, non-eroding trail, while class 0-2 can apply to Non-System trails)
Class 0 Trail barely distinguishable; no or minimal disturbance of vegetation / litter
Class 1 Trail distinguishable, slight loss of veg cover and minimal disturbance of litter
Class 2 Trail Obvious; veg cover lost in center of trail, some bare ground
Class 3 *TYPICAL* Complete loss of vegetation in trail center but no erosion
Class 4 Light erosion, surface coarsening less than 1" lost
Class 5 Moderate erosion, rocks and roots exposed less than 2" lost
Class 6 Heavy erosion, rocks and roots exposed, rilling and gullying obvious

Surface Obstacle Classes
1: Smooth with few obstacles
2: Occasional obstacles or protrusions >2" high
3: Frequent obstacles or protrusions >2" high

Potential problems with trails (details about what to look for and note**)**
***Note*: Pay especially close attention to problems on high-use trails, and give problems on high-use trails a higher priority ranking. Look for signs of trail widening, and the variety of drainage issues.**

- **Drainage (**Look for signs of water running on trail, berms on outslope, an out-slope that drains onto the trail, or a filled in water bar. Look for people avoiding pools of water. Make notes about what exactly the drainage issue is)
- **Sign Missing / Needed (**Use if there is a confusing intersection, or missing sign)
- **Social trails (**that lead somewhere off System trails, cut switchbacks, or run parallel to the main trail.)
- **Unauthorized structures** (bike jumps, forts)
- **Widening (**are people stepping off the trail to avoid water? Could indicate a drainage issue)
- **Switchback issue (**is there a radius of at least 12 feet for hiking, 20' for biking?)
- **Slope too large** (>20% for more than ~50 feet**)**
- **Other trail damage (**Requiring trail maintenance, Not covered by above, note the issue)
- **Other problem (**Not requiring trail maintenance, note the issue. eg. damage to vegetation, .)

Appendix 4. System trail specifications and guidelines (from the Conservation Lands Management Plan)

These guidelines are taken verbatim from the guiding management document for Conservation Lands Management, the Conservation Lands Management Plan (2010), Chapter 5 (Recreation), Pages 74-79. See also Chapter 6 (implementation strategies), especially section 6.5 (Recreation, pp 88-89) and Section 6.9 (needed trailhead upgrades, pp. 91-92)

Designated Use	**Hiker**	**Biker**	**Equestrian**
Tread Width	18" – 48"	24" – 48"	48" – 96"
Target Grade (% slope)	Desirable 1 – 10% **Max 20%**	Max 15%	5% Max 10%
Target Cross-slope Range	3 – 7% **Max 10%**	3 – 7% Max 10%	5% Max 10%
Vegetation Clearing Width	12" – 18" outside of tread edge	36" – 72" outside of tread edge	36" – 76" Outside of tread edge
Clearing Height	8'	8'	10 – 12'
Minimum switchback Radius	4'	8' – 12'	10' – 12'
Surface type	Native or imported materials		
Surface obstacles	Smooth with few obstacles. Occasional protrusions 2-3" above trailbed		

Table 1. Specifications for trail characteristics, by use type on Missoula Conservation Lands. This table is taken from Chapter 5 of the 2010 Conservation Lands Management Plan.

Trails:
"Trails connect users to virtually all recreation opportunities; they are a very important component of the Missoula Conservation Lands system. Well-designed trails, located away from protected and sensitive habitats are critical to preserving natural resources on MCL. By locating trails appropriately, providing a sufficient number, and maintaining the quality of trails, recreation use can be maximized while the negative impacts of human use can be minimized.

Trails throughout the system should:
Be designed, built, and maintained per standards developed to provide desirable surfaces, widths, access for intended trail users, and erosion control. These standards are listed in Table 5-1 (*table 1 above).

- Be designed, built and located to minimize disturbance to native flora and fauna.
- Be repaired, rebuilt or closed if they do not meet aforementioned guidelines.
- Be completely rehabilitated to natural conditions if closed.

- Be designated by use (e.g., Pedestrian, Public non-motorized, Dogs on- or off-leash) based on objective criteria including but not limited to historic use, trail condition, grade, width, user conflict, impacts to native flora and fauna, impacts to adjacent trails/lands, enforcement capability, and priority goals for any given parcel. All trails should be signed accordingly in-the-field.
- Avoid areas with threatened or sensitive habitat. If current trails negatively impact such areas they should be closed, rerouted or use should be restricted.
- Be signed by name with distances to provide direction for users and reduce "cutting" of trails.
- Be multi-modal when practical. If multi-modal, post appropriate signage on-site.
- Connect with other trails within the City Parks and Open Space System and to those managed by adjacent land owners. When possible, management, as it pertains to use, closures and maintenance, of any trail that crosses property boundaries should be cooperative between landowners."

***Maps**:*
"Accurate, easy to use maps of MCL and trails are essential to developing knowledgeable users. Maps are communication tools that assist users in choosing routes and understanding rules and regulations. Additionally, quality maps enhance the user's experience and their ability to recreate responsibly. Successful land management requires quality, accurate, user-friendly maps be available to the public around town, at primary and secondary trailheads, and on the Web. While several locally available paper maps of MCL exist, few up-to-date maps exist at trailheads and little is available on the Web."

***Signage**:*
"Accurate, universal, easy to understand signage on trails and at trailheads communicate important messages to users. All MCL should have a level of signage including, but not limited to, parcel name, trailhead names, trail names, rules and regulations for the area, interpretive information, seasonal and temporary closures, directions, and emergency contact information. Over-signage should be avoided whenever possible to maintain viewshed. The Conservation Lands Program should inventory all signs across the system, and work to standardize all signage. A prototype for signage at trails and trailheads, as well as other important MCL areas, should be developed. Information on new signs should be concise and to the point."

Mitigation Goals and Tools:
As with most behaviors, prevention, education, and enforcement are the best tools. However, mitigation is sometimes required. Following is a list of tools that might be used to effectively mitigate past or future issues on MCL.

- Close and restore unauthorized trails immediately.
- Aggressively manage for weeds at trailheads and along trails to reduce spread.
- Immediately remove unauthorized structures such as camps, bike ramps, and hunting stands to name a few.