

Reiter Foothills Summary

Technical Trail System



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Table of Contents

Reiter Foothills Motorized Trail System



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1. Introduction	1
2. Planning Area	2
3. Site Evaluation	3
4. Conceptual Motorized Trail System	5
5. Technical Trail Concepts	6
6. Technical 4x4 Trails	11
7. Next Steps	14
8. Bibliography	15
9. Appendix – Technical Trail Specifications and Details	18

Introduction

Reiter Foothills Motorized Trail System

1

January 18, 2011

The Reiter Foothills area, located in Washington between Gold Bar and Index, has been used by the local and regional community for non-motorized and motorized recreation over the last twenty years or more. This is an unplanned use, without any formal trail system, parking, or other support facilities. The natural environment in the Reiter Foothills has been adversely affected by this use and the Department of Natural Resources, who owns and manages the Foothills area, closed down all recreational use of the area so that restoration efforts could begin and a more formal trail system could be developed.

The process to develop a trail system at Reiter began with an overall Recreation Plan to evaluate the suitability of the Reiter Foothills for recreational use, engage the recreation community in a planning process, and determine the best location for a motorized and non-motorized trail system within the Reiter Foothills area. GIS and mapping tools, along with field verification methods, were used to evaluate and identify critical areas, slope stability, habitat features, and topography, to determine potential areas suitable for recreational use. Based on this analysis and

input from the community, the non-motorized recreation area was located adjacent to Wallace Falls State Park, generally extending south and east towards the existing gravel mine off Reiter Road. The motorized recreation area was located off Reiter Road and Deer Flats Road, generally extending from the Reiter Pond and the “rock garden” area by the power lines to the top of Deer Flats Road.

This summary outlines the existing conditions and general suitability of the motorized trail system, as well as a more detailed evaluation of the proposed 4x4 trail system. Through the planning process, it was determined that the 4x4 trail system would provide a technical trail experience, measuring the quality of the experience in terms of how many feet per hour a user travels, rather than the more typical miles per hour.

The existing condition of the motorized recreation area at Reiter Foothills offers a diverse and challenging environment for single track, double track, 4x4 and trials users. To facilitate the planning process, the motorized section of Reiter Foothills was divided into seven planning areas (Figure 1). Area 1 generally includes the lowland around the intersection of Deer Flats Road and Reiter Road through to the area around Reiter Pond. Area 2 is located off Reiter Road where the proposed trailhead is located, and extends north of the transmission lines,

through the “rock garden”. Area 3 encompasses the steep slope above the “rock garden”. Area 4 extends from the top of Area 3 east to the edge of the Aquifer Recharge Area. Area 5 goes through the Aquifer Recharge Area. Area 6 continues from the Aquifer Recharge Area to the first tributary of Deer Creek. Area 7 encompasses the remainder of the planning area to the top of Deer Flats Road and the cell tower site.

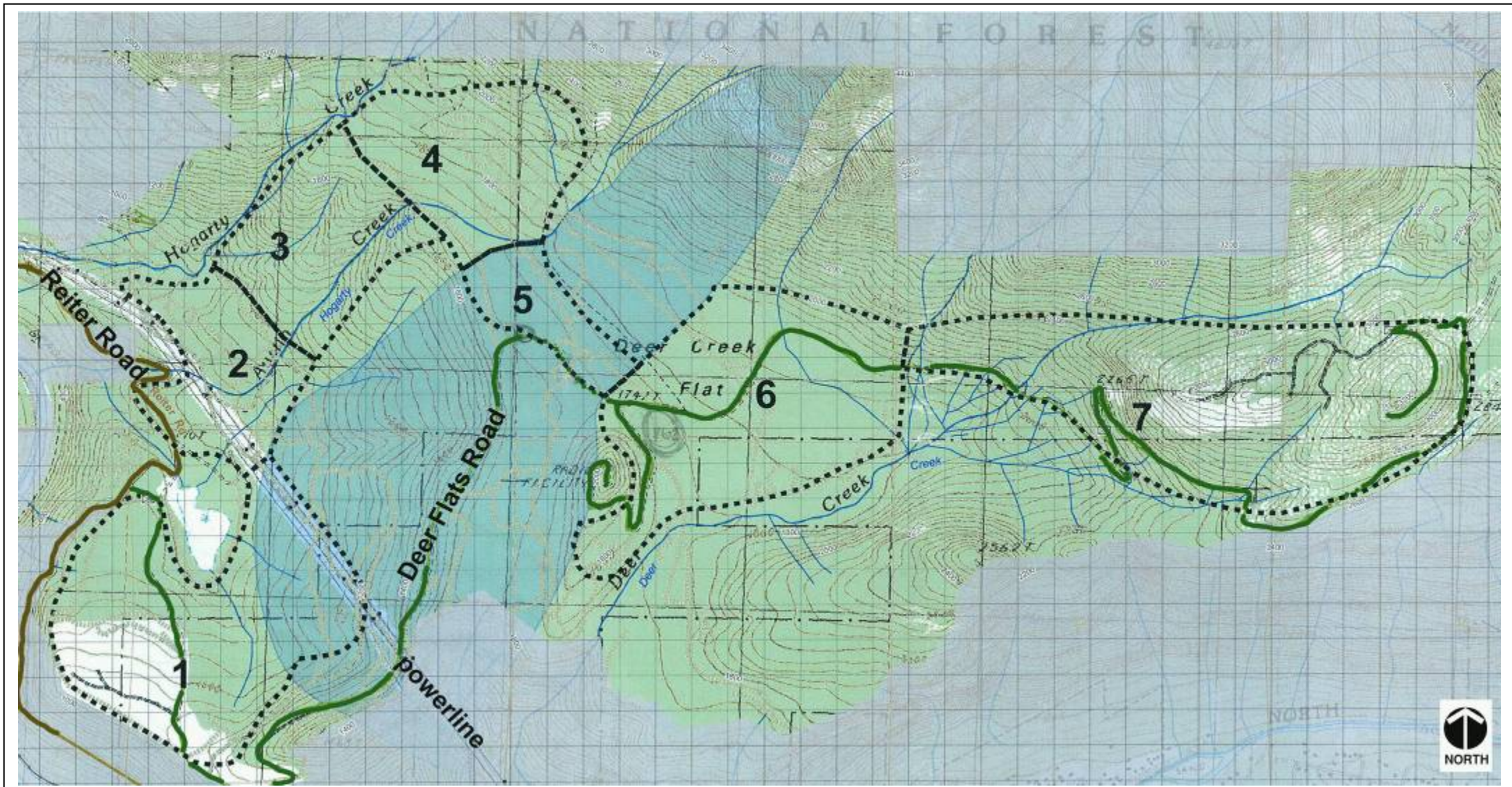


Figure 1. Planning Area Boundaries

The overall site was evaluated by the HBB team. In addition to research and documentation of 4x4 trail and vehicle conditions, HBB also visited the site over a three day period, from February 19 – 21, 2010. The initial evaluation included the area around Deer Flats Road, from the intersection at Reiter Road to the cell tower site at the end of the road in Area 7. Areas 2 and 3 were walked and evaluated more thoroughly. Areas 4, 5 and 6 were partially walked for a general overview. Areas 1 and 7 were reviewed from Deer Flats Road. A motorized recreation workshop was also conducted at the site on February 20, 2010 with DNR staff and representatives from each of the potential motorized user groups. The workshop took participants to one location in each planning area to discuss general trail possibilities and preferences. Below is a brief summary of each area from these visits.

AREA 1

This area is generally characterized by gradual topography through an evergreen forest, with an open, hummocky understory and forest floor. From DNR's initial suitability mapping, soils appear to be adequate to support the intended use. However, evidence of erosion is visible along some previously used trails. Stabilization and additional trail support measures may be needed where an increase in slopes could cause additional erosion or where evidence of previously eroded soils exists.

There are several large rock outcroppings that could be used as challenges by a variety of users along the trail system. Each rock outcropping should be reviewed by DNR staff to confirm if any of the outcroppings function as a protected habitat that would preclude trail development in that area.

Motorized use should remain outside of the required buffer around Reiter Pond wherever possible, and areas within the buffer should be restored with natural vegetation. Signage, fencing and other measures should be utilized to educate users about the ecological functions of the pond and reinforce the sensitive nature of that environment. There are also a few potential stream crossings in the area around Reiter Pond.

AREA 2

Area 2 is located along a slope, north of the proposed trailhead and power line up to a bench where an old forest road was located. This area includes the existing "rock garden" with large exposed boulders that was used heavily by the motorized recreation community. The "rock garden" is located between an active river and a dry river bed, limiting access into and out of the area without crossing either natural feature. The area outside of the "rock garden" remains more forested, with a few exposed boulders.

Drainage within the "rock garden" area will need to be enhanced to control future erosion, and the edges of the "rock garden" should be delineated to control future access within the area. Any new trails in Area 2 should be carefully planned to control access, limit conflicts within the "rock garden", plan for long term vegetation management, and direct any potential erosion in order to protect the remaining natural areas.

AREA 3

Area 3 is one of the steeper areas in the motorized trail system, generally consisting of a ridgeline between two stream corridors. The topography is steep enough to generally preclude most 4x4 vehicles, leaving this area more suitable to single track and double track use. Double track use may even be a challenge, and will likely need more detailed planning and site specific design to ensure slope stability and reinforcing of the trail surface on the steepest sections of the area.

AREA 4

Area 4 has more gradual slopes and a wider flat area through the middle. The topography is hummocky with a dense forest canopy and fairly open forest floor. There is little evidence of eroded soils from existing trails in this area. An old road bisects this area, providing an existing, direct route from Area 4 to Area 6. This route, and others in this area, should be evaluated further to determine the best locations for future trails based on site specific suitability and future trail alignments. There were few stream corridors or other natural features visible in this area, though the area was only generally reviewed during initial visits. There are a variety of opportunities for motorized use through this area, generally for single or double track given the limited access through Area 3 without the use of Deer Flats Road.

AREA 5

Area 5 runs across the Aquifer Recharge Area, connecting Area 4 and Area 6. Because of its location through the Aquifer Recharge Area, trails through this area should be minimal, providing a cross connection only.

AREA 6

Area 6 includes dense canopy forest and more open forested areas. The topography is generally level, but with lots of micro-topographic features and an overall hummocky character. There are also large boulder outcroppings that could be used as individual trail features or obstacles. This area was used for trials bike events because of the wide variety of terrain in a small geographic area with lots of down logs, boulders and other features that lend itself to that type of use. There were no visible streams or other drainage features during the initial walk through, though the area evaluated during this time was not comprehensive and the entire area should be evaluated further before final trail alignment and use is determined. This area is also generally split in half by Deer Flats Road, so potential crossings of the DNR road with the trail system seem likely in this area. Additional safety features, speed control, signage or other measures should be considered to reduce any potential conflicts between trail users and vehicles along Deer Flats Road. Generally, crossings should be minimized wherever possible.

AREA 7

Area 7 extends from Area 6 through to the end of Deer Flats Road. The area at the end of Deer Flats Road adjacent to the cell tower should be avoided due to vandalism concerns, but views may be possible from a similar highpoint in the area west of the cell tower, providing a natural destination for recreational users. Steeper topography and a network of streams and natural drainage courses weave in and around this area, making it one of the more challenging areas to plan in. 4x4 use in this area is generally less suitable because of these features. Double-track use may also be difficult to accommodate without direct use of Deer Flats Road for at least some of the trail system. While there was less evidence of erodible soils, the steeper terrain and natural drainage features may require more site specific design considerations, additional trail stabilization and more limited access to this area. This area is also near the boundary of the Reiter Foothills and a protected habitat area, so additional measures may be needed to direct recreational users within the system and avoid trails at the edges of the area.

Based on the site evaluation above, a series of workshops with the motorized recreation community, and further site evaluation and suitability studies by DNR, the following conceptual trail plan was developed (Figure 2). This was a general concept only. Actual trail layout has been adjusted based on field verifications and site context.

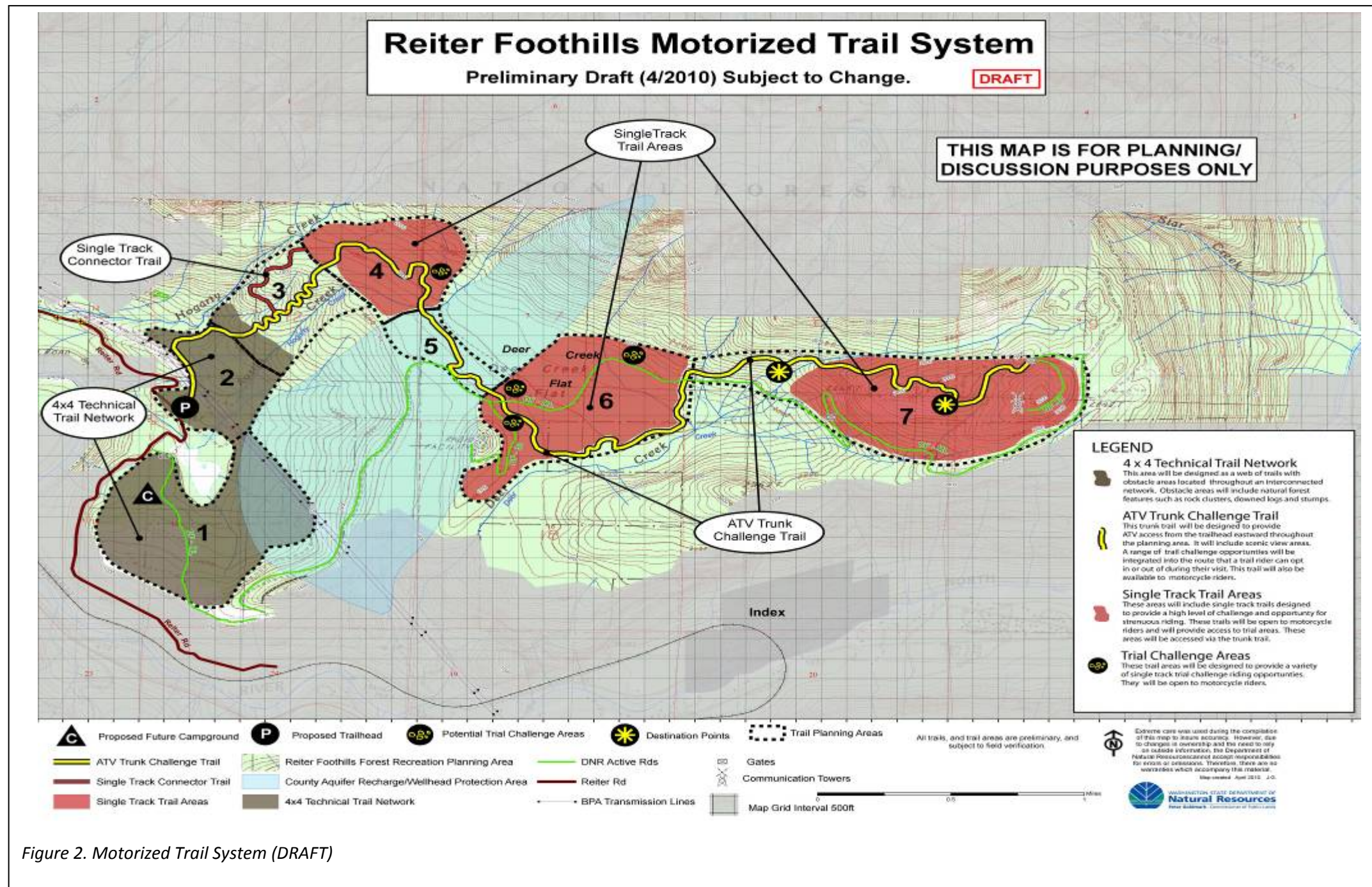


Figure 2. Motorized Trail System (DRAFT)

Technical Trail Concepts were developed based on discussions at the on-site workshop, a review of background information on general motorized recreation, the previous planning efforts in the Reiter Foothills Recreation Plan, a review of existing trails at Walker Valley, and the site evaluation described in Section 3 above. Precedents from other technical motorized recreation areas around the country were also reviewed. The concepts considered permanent erosion control features that would meet DNR and Forest Service standards, as well as other environmental considerations to ensure long-term sustainability of the natural environment.

The concepts developed primarily focus on the types of trail features needed to provide a technical user experience, photo examples of each feature, and general design parameters to guide further design development of technical motorized trails.

Specific design details and specifications for 4x4 Trails were further developed and are included in the Appendix to this document.

The Technical Trail Concepts include:

- 4X4 Trails (Figure 3)
- ATV Trails (Figure 4)
- Motorcycle Trails (Figure 5)
- Mountain Bike Trails (Figure 6)

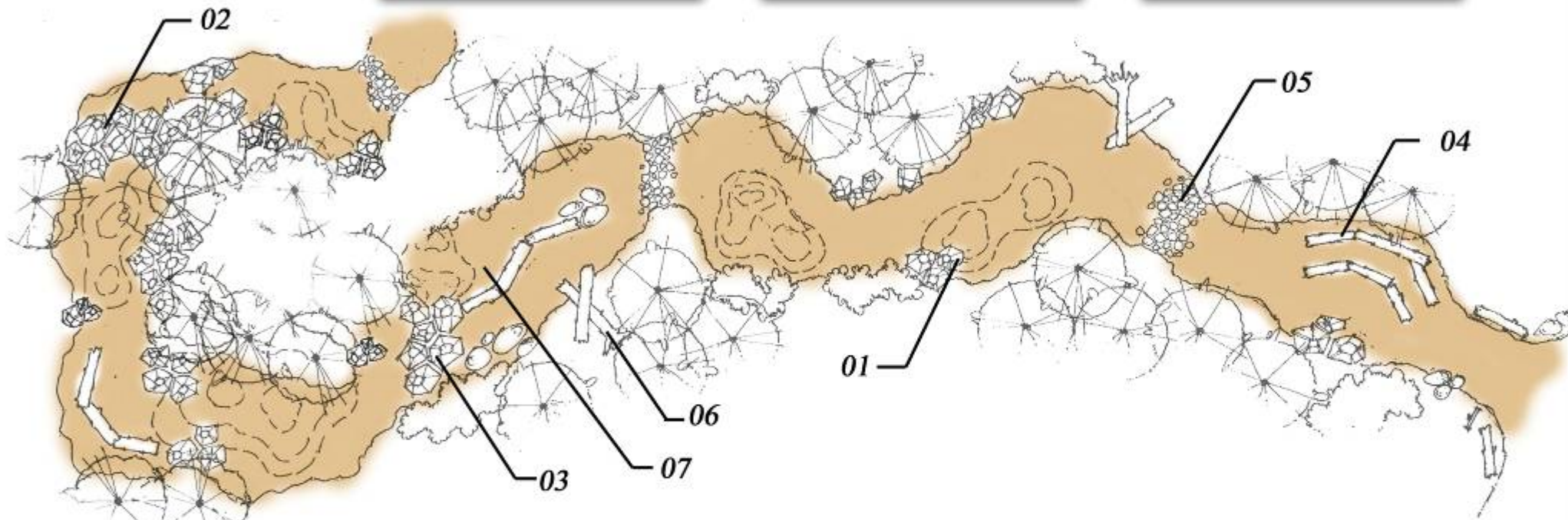
01 Dips and Bumps



02 Constructed Rock Course



03 Boulders



04 Log Rails



05 Alternating Surfaces



06 Protrusions



07 Thru-Lane



TECHNICAL TRAIL CONCEPT 4x4 VEHICLES

MITIGATION & DESIGN FEATURES

Surfacing
Armoring
Swales

Reinforced Base
Drainage Dips or Water Basins
Plant Material

TRAIL SPECIFICATIONS

See 4x4 Trail Specifications & Details

TECHNICAL FEATURES

Dips and Bumps (01)
Constructed Rock Course (02)
Boulders (03)
Log Rails (04)
Alternating Surfaces (05)
Protrusions (06)
Thru-Lane (07)

OTHER FEATURES

Trail Entrance Restriction (Gate
Keeper
Curves & Switchbacks
Trail Contouring



REITER FOOTHILLS Technical Trail Design Concept

Draft: for discussion purposes only and subject to changes without notice

Figure 3. 4x4 Technical Trail Concepts (DRAFT)

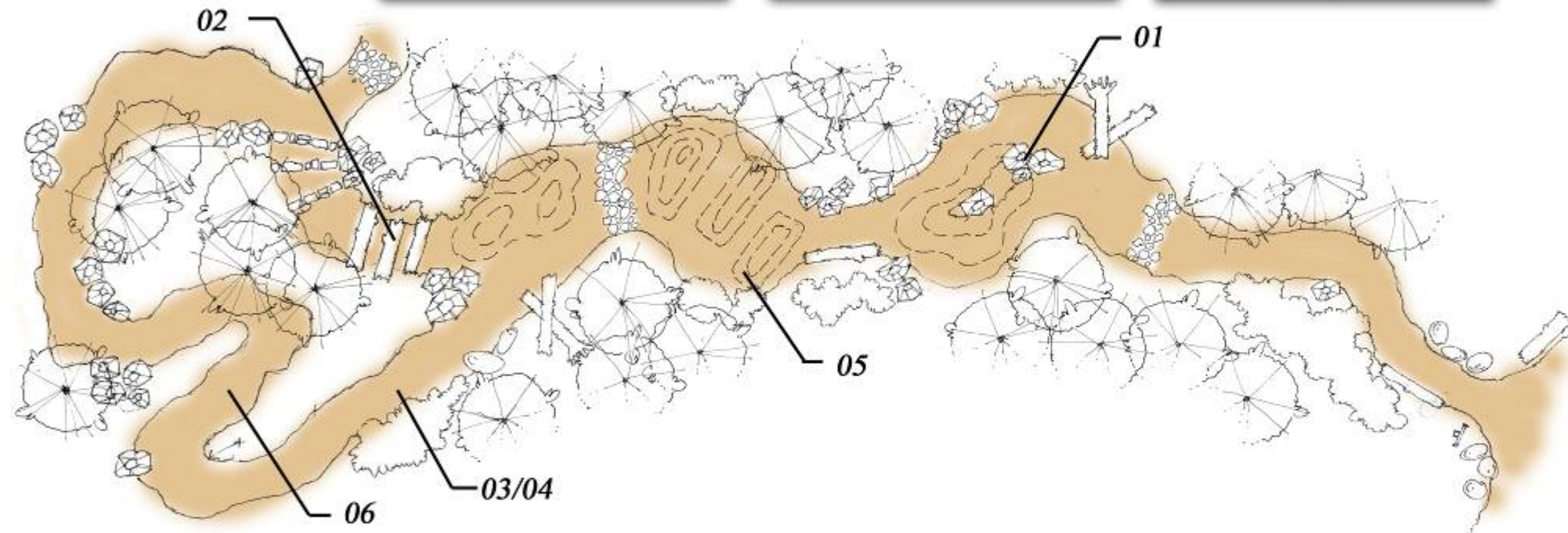
01 Boulder Obstacles



02 Log Obstacles



03 Climbing in Trail Alignment



04 Descents in Trail Alignment



05 Dips, Bumps and Whoops



06 Curves and Switchbacks



**TECHNICAL TRAIL
CONCEPT
ALL TERRAIN VEHICLES**

MITIGATION & DESIGN FEATURES

- Surfacing
- Armoring
- Swales
- Reinforced Base
- Drainage Dips (preferred)
- Plant Material

TRAIL SPECIFICATIONS




To be determined for any trails outside of DNR or Forest Service standards

TECHNICAL FEATURES

- Boulders (01)
- Log Obstacles (02)
- Trail Alignment (03/04)
- Dips, Bumps and Whoops (05)
- Curves and Switchbacks (06)

OTHER FEATURES

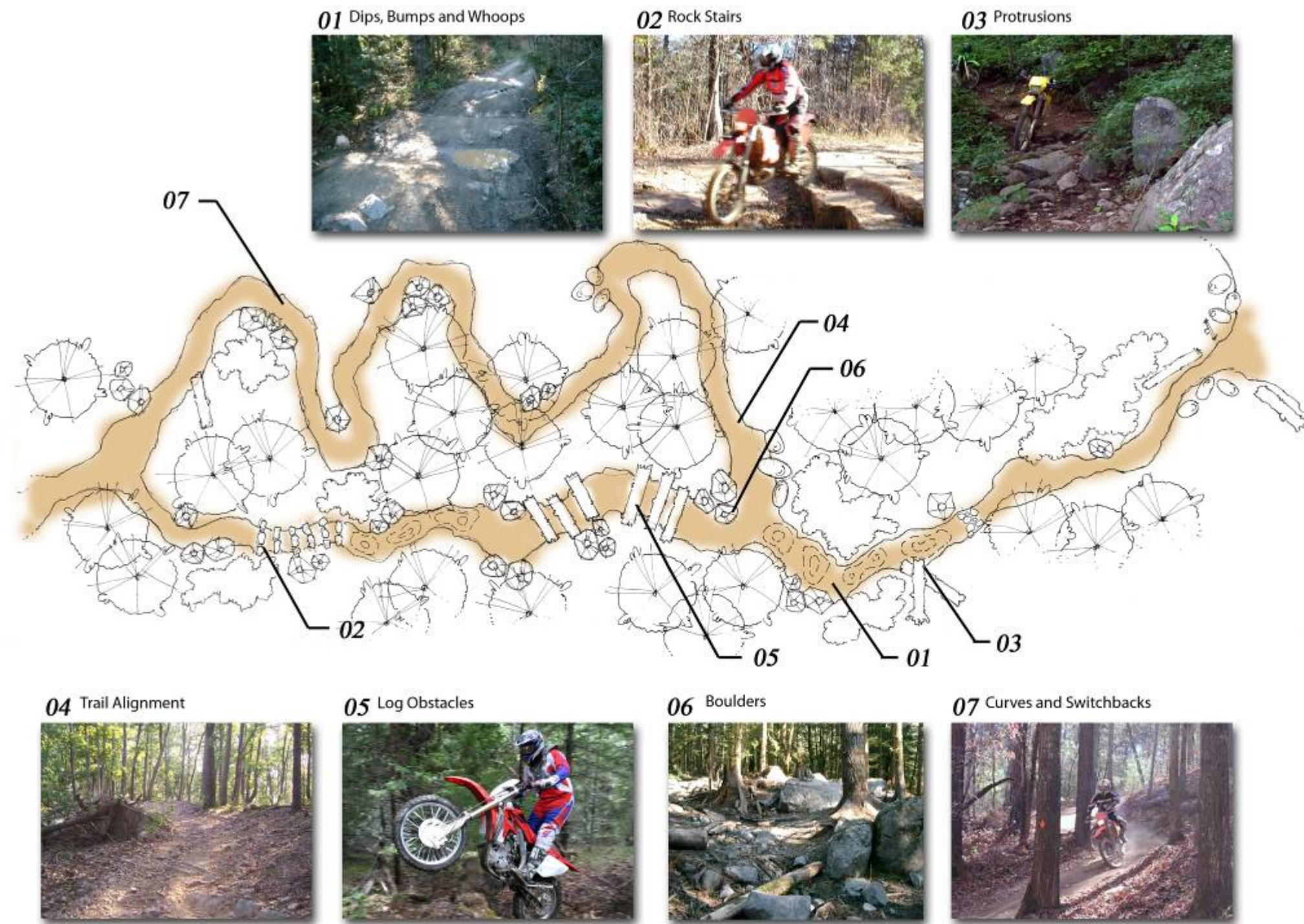
- Protrusions
- Rock Stairs
- Alternating Surfaces
- Trail Entrance Restrictions
- Technical Areas

REITER FOOTHILLS Technical Trail Design Concept

Draft: for discussion purposes only and subject to changes without notice

Figure 4. ATV Technical Trail Concepts (DRAFT)



**TECHNICAL TRAIL
CONCEPT
MOTORCYCLES**

- MITIGATION & DESIGN FEATURES**
- Surfacing
 - Armoring
 - Swales
 - Reinforced Base
 - Drainage Dips (preferred)
 - Plant Material

TRAIL SPECIFICATIONS
To be determined for any trails outside of DNR or Forest Service standards

- TECHNICAL FEATURES**
- Dips, Bumps and Whoops (01)
 - Rock Stairs (02)
 - Protrusions (03)
 - Trail Alignment (04)
 - Log Obstacles (05)
 - Boulders (06)
 - Craves and Switchbacks (07)

- OTHER FEATURES**
- Alternating Surfaces
 - Thru-Lane
 - Trail Entrance Restrictions
 - Technical Areas



REITER FOOTHILLS Technical Trail Design Concept

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Figure 5. Motorcycle Technical Trail Concepts (DRAFT)

01 Rock Drops



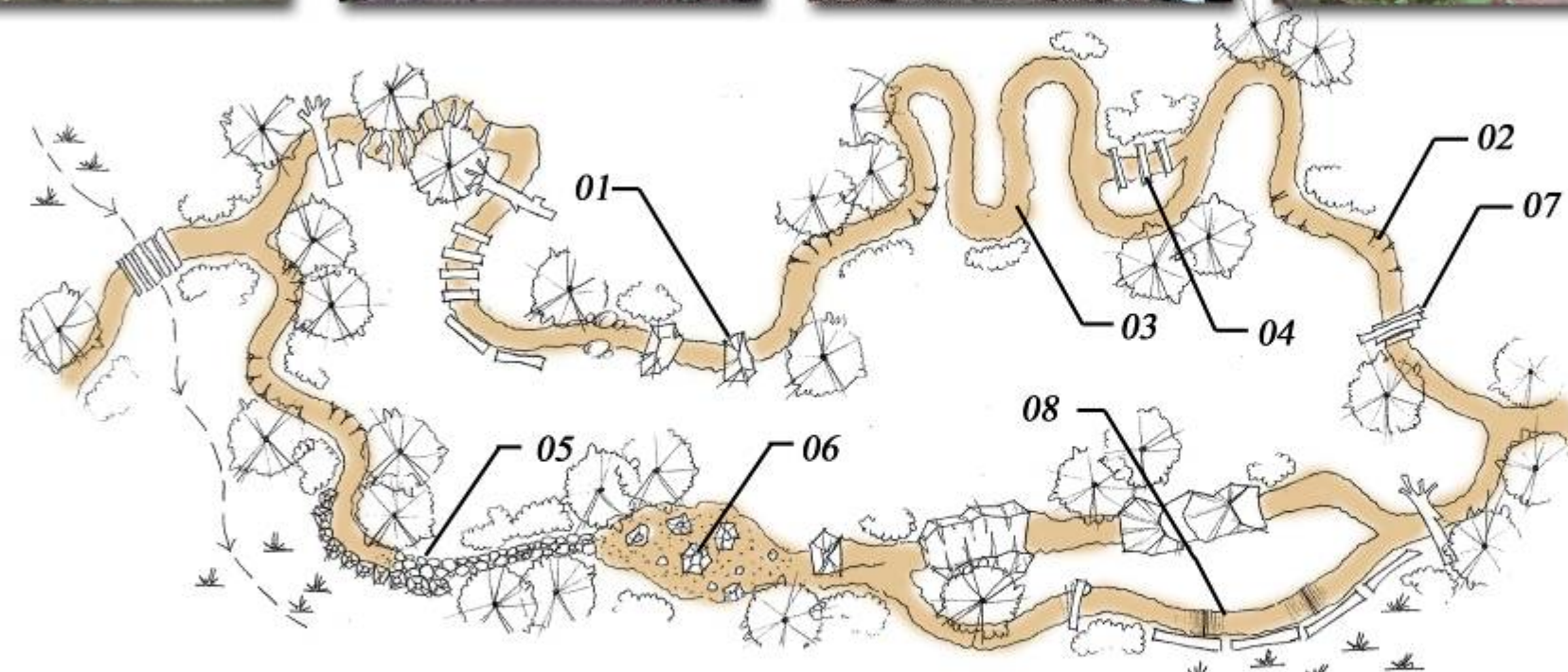
02 Banked Corners for Speed



03 Tight Switchbacks



04 Log Piles



05 Cobbled Path (rough ride)



06 Rock Garden/Boulder Causeway



07 Log Drops



08 Bump and Jump



TECHNICAL TRAIL CONCEPT MOUNTAIN BIKES

MITIGATION & DESIGN FEATURES

- Surfacing and Armoring
- Swales and Gutter Lines
- Drainage Rim Out with Disbursements
- Log Boardwalk Crossing (minor drainages)

TRAIL SPECIFICATIONS

To be determined for any trails outside of DNR or Forest Service standards

TECHNICAL FEATURES

- Rock Drops (01)
- Banked Corners for Speed (02)
- Tight Switchbacks (03)
- Log Piles (04)
- Cobbled Path (rough ride) (05)
- Rock Garden/Boulder Causeway (06)
- Log Drops (07)
- Bump and Jump (08)

OTHER FEATURES

- Trail Entrance Restrictions
- Fallen Trees and Roots
- Armored Side Slopes
- Rock Drop
- Parallel Log (not on downward slopes)
- Twist and Turns
- Rolling Trail and Choke Points
- Tree/Rock Deflection Points
- Log Challenge
- Steep/Rock Down Hill Chute



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REITER FOOTHILLS Technical Trail Design Concept

Draft: for discussion purposes only and subject to changes without notice

Figure 6. Mountain Bike Technical Trail Concepts (DRAFT)

Technical 4x4 Trails

DNR staff worked with volunteers from the 4x4 motorized recreation communities to develop an initial trail alignment in Area 1. The proposed alignment (Figure 7) includes a network of trails around several trail “nodes”. It will be recommended that a vehicle have a minimum of one winch and two tow-hooks (front and back), or other mechanism to facilitate vehicle extraction without damage to the surrounding natural resource, in order to use the trail system. Full roll-over protection will be recommended on each vehicle. The type of trail would be identified in the field through signage and by a constructed “gate keeper” designed to limit the size and modification of vehicles needed to pass through each trail’s entrance. This will also provide an example of the types and scale of obstacles that will be encountered on each trail. The trails are categorized and defined as follows:

- BLACK** Old DNR roads used for access to nodes, for maintenance, and as a link between Areas 1 and 2; minor obstacles included to control speed.
- PURPLE** Special use trails are designed for a wheelbase of 86” or less, narrow “jeep type” vehicles; trails would be “tight and twisty” as its primary challenge. Only vehicles less than or equal to 86” wheelbase will be allowed on purple trails.
- GREEN** Trails for lightly modified vehicles, obstacles are designed to be a challenge to stock 4x4 vehicles locked in 4WD. It is recommended that vehicles typically have a 2” lift with a sufficient tire size to be able to maneuver over a 12” high vertical obstacle. It is recommended that vehicles have rear axle lockers.
- YELLOW** Trails for moderately modified vehicles, design has large obstacles designed to be a challenge to 4x4 vehicles locked in 4WD. It is recommended that vehicles typically have a greater than 2” lift and a sufficient tire size to be able maneuver over a 24” high vertical obstacle. It is recommended that vehicles have lockers on both front and rear axles.
- RED** Trails for highly modified, built vehicles, mostly large boulders that are a challenge for “rock crawler” type vehicles. It is recommended that vehicles be capable of maneuvering on and over a 36” high vertical obstacle and equipped with lockers on both front and rear axles. It is recommended that vehicles have the ability to adjust the center of gravity and height of ground suspension stiffness.

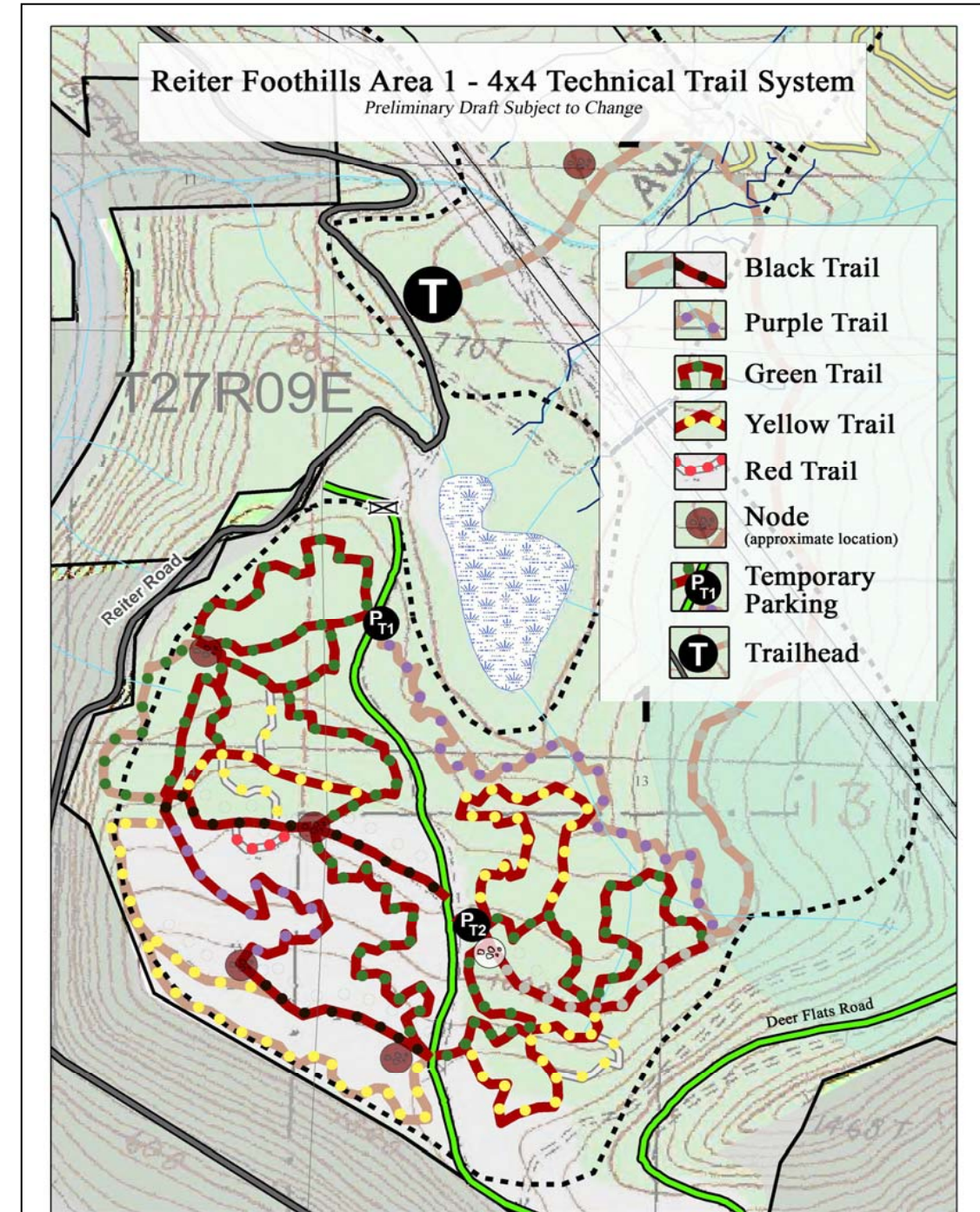


Figure 7. Proposed 4x4 Trail Alignment (Area 1; DRAFT)

Nodes are areas, approximately ¼ acre to 2 acres in size, within the trail system that allow for multiple 4x4 vehicles and spectators to gather around a technical challenge feature (Figure 8). The larger space provided at each node allows the challenge features to be approached from multiple directions, expanding the recreational value of each feature. Node challenge features should accommodate a variety of trail categories, but are primarily intended for Green, Yellow and Red categories. They should also be located in an area that would allow for extraction of damaged vehicles, as well as access for larger construction equipment needed to construct a node area. In general, it is anticipated that the node areas will offer technical challenge opportunities not found elsewhere in the 4x4 trail system. Each node should offer a challenge for each trail category that the node is accessible to. The types of node considered include:

- A boulder pile and earthwork, or series of boulder piles and earthwork;
- A constructed mud area with underlying reinforcement to contain the feature and eliminate any downstream effect to hydrology, sedimentation or other environmental considerations; and
- A large individual boulder or a series of individual boulders.

Gate keepers are obstacles at the entrance to a trail that define the type of experience, complexity and technical challenge that will be encountered on that trail. They are designed to limit the type of vehicle using a trail to those that are capable of overcoming the types of obstacles that will be encountered. Every trail will have a gate keeper at the beginning of the trail. Gate keepers will be constructed to provide the maximum challenge level encountered on a given trail and will be constructed intentionally to cover the full width of the trail without any “opt out” area or bypass allowed. Signage will also be used at the beginning of each trail to identify the category of trail (green, yellow, etc.), the level of challenge to be encountered along the trail, and any other information needed.

The proposed 4x4 trail alignment was reviewed over a four day period, on July 20 – 21, 2010 and on July 28 – 29, 2010. The area was evaluated based on the overall circulation within the trail system, potential crossings with Deer Flats Road, location of natural features (boulders, down logs, tree density, etc.), topography, drainage patterns, trail intersections, and trail node locations. Based on this review, the following features or modifications to the trail system were identified:

1. One area was identified that could contain an underground drainage course and seasonal surface ponding (Figure 9). Any crossings in this area would need to bridge the underground drainage course to allow for natural flows to continue through the area.
2. Large boulder areas along one yellow trail (Figure 10) were reviewed with a DNR biologist and determined that the boulders reviewed did not provide any significant habitat and could be included in the trail system. Additional large boulder areas along this trail, or other trails, should be evaluated by a biologist as well prior to trail construction. It was also determined that the trail around these large boulders could pose additional liability and safety concerns and should be developed based on detailed survey information and site-specific design input, rather than by volunteers based on standard details or specifications.
3. An area of significant steep topography along a yellow trail (Figure 11) was reviewed and the trail alignment adjusted to allow for added vehicle recovery areas between steeper trail climbs. It was also adjusted to provide greater separation from an adjacent trail.

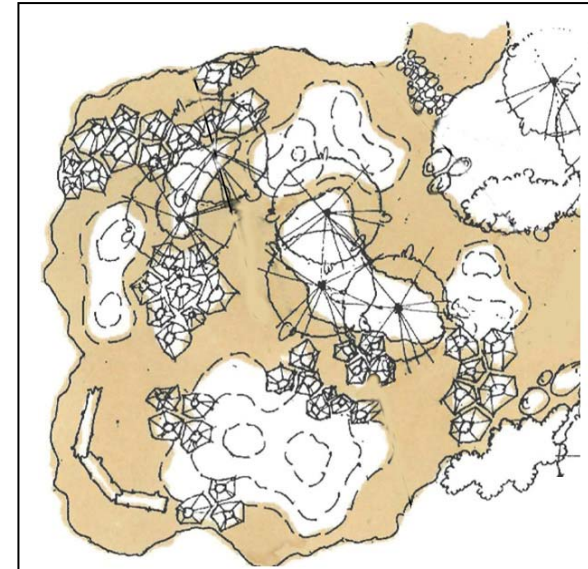


Figure 8. Typical Example of Node



Figure 9. Drainage Area



Figure 10. Boulder Yellow Trail



Figure 11. Steep Yellow Trail

4. One node area (Figure 12) was eliminated due to its location adjacent to a steeper slope and the difficulty of accessing the node area for construction, extraction of damaged vehicles or emergency vehicles.
5. One trail alignment along a yellow trail (Figure 13) was adjusted to provide greater separation between the trail and a steep adjacent slope.
6. The red trail (Figure 14) was adjusted to allow for two “opt out” locations, approximately 1/3 of the way through the trail, for extraction of damaged vehicles, emergency vehicle access, or a way for vehicles to leave the trail after they have started. Red trail are not . . . designed at this time . . .
7. Trails should widen where obstacles encompass the total width of the trail to accommodate different levels of difficulty within the obstacle, but a separated “opt out” would not be allowed. “Opt out” features would only be included on the red trail (item 6 above) or within node areas.
8. Trail crossings with Deer Flats Road were reviewed. Trail design nearing these crossings should be constructed to reduce speeds, with sight distances increased at the intersection and additional signage to notify both recreational users and those along Deer Flats Road of the crossing.
9. Trail entry features were discussed (“gate keepers”) and should be included at the beginning of each trail, and at each transition between different trail types. They should be constructed to provide the maximum challenge level encountered on a given trail and signed as such.
10. It was determined that all trail surfaces would be “constructed” with some type of specified material forming the base of the trail, the surface, and the edge conditions. The type of surface specified will reflect each trail category to provide a technical challenge along the entire length of the trail, in between specific obstacles. Surfacing and edges would be constructed with natural materials, such as different sizes and gradation of rock. Small areas of more gradual and smaller size surfacing should follow major trail obstacles or challenge features to allow users to inspect and/or fix their vehicles as needed.

Additional field work may be needed within Area 1 to support permit applications for final trail development, including soil depth information, grading requirements (cut/fill quantities), and estimated tree removal. A biologist should also evaluate the final trail alignment to ensure no critical areas or special habitat features would be impacted by the final trail alignment proposed.

Final trail design of the “typical” trails within Area 1 may be completed utilizing user volunteers under the direction of DNR staff and implementation of the technical 4x4 trail details and specifications included in the Appendix to this document.

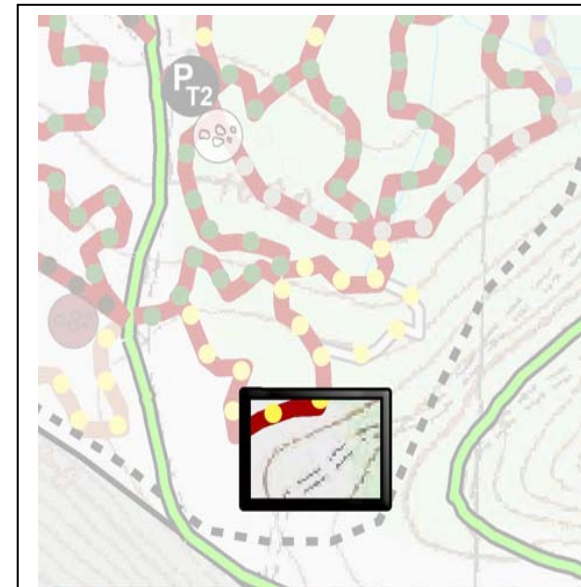


Figure 12. Node Area Eliminated



Figure 13. Separation at Yellow Trail



Figure 14. Red Trail

Next Steps

7

Reiter Foothills Technical Trail System

The technical 4x4 specifications and details, included in the Appendix to this document, will be used by DNR staff in conjunction with volunteers to develop the majority of 4x4 trails in Area 1, after any applicable permits have been approved. The following trails will need a more detailed survey and site-specific design to develop further, and are not included in the initial phase of trails constructed through volunteer user groups (Figure 15):

1. Red Trail
2. Existing Boulder Trail (Yellow Trail)
3. Steep Yellow Trail
4. Surface Drainage Crossing

A detailed site survey and site-specific design process is also recommended for development of any of the node areas.

It is recommended that DNR work with the recreation user groups to develop strategies for on-going maintenance and long-term sustainability of the trail system, ensuring the protection of the natural environment and the user experience for future generations.

It is also recommended that DNR develop a signage system to promote user and spectator safety within the 4x4 trail system. The signage system could explain the different trail categories, provide sufficient information for the type of obstacles that will be encountered along a trail, and the suggested vehicle type recommended for each trail category (see trail categories on page 10). A signage system should also educate users of the environment within which the trail system is developed, along with the measures needed to ensure the protection of that environment. A good signage system along with enforcement is a key feature to the long-term success of the motorized trail system at the Reiter Foothills area.

January 18, 2011

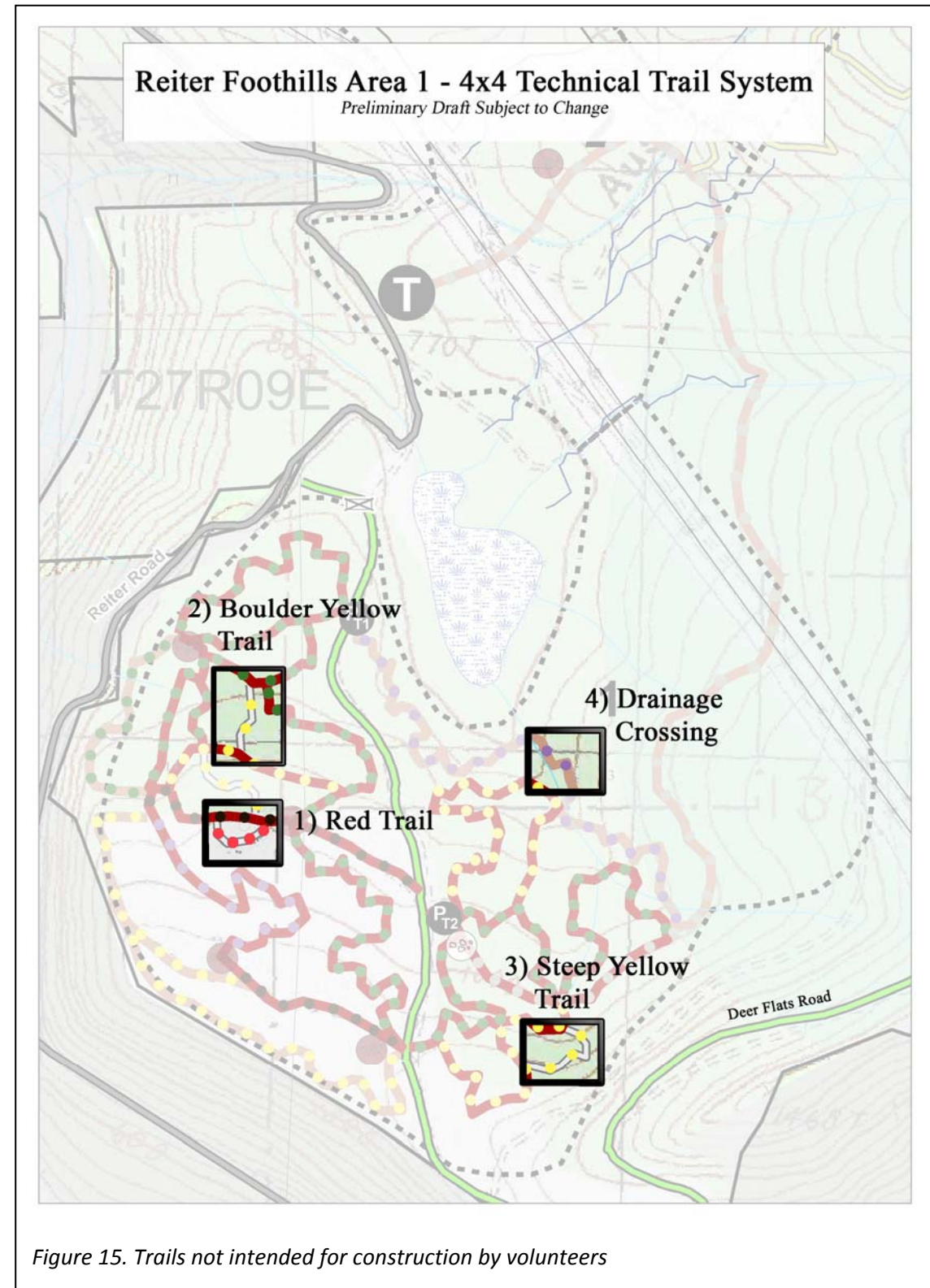


Figure 15. Trails not intended for construction by volunteers

1. Trail Construction Specifications

A. Maximum Rollover Angle

- a. Crimmins, Tom M., 2006. "Management Guidelines for Off Highway Vehicle Recreation." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 51 pages.
- b. Brumbelow, M.L. and Teoh, E.R. 2009. Roof strength and injury risk in rollover crashes of passengers cars and SUVs. *Proceedings of the 21st International Technical Conference on the Enhanced Safety of Vehicles* (CD-ROM). Washington, DC: National Highway Traffic Safety Administration
- c. Wolpert, J. and Belanger, R. 1980. Vehicle handling tests of the American Motors CJ-5 Jeep. Phoenix, AZ: Dynamic Science, Inc
- d. Various vehicle manufacturer's websites for vehicle specifications: http://en.wikipedia.org/wiki/Jeep_CJ, <http://www.dimensionsguide.com/hummer-dimensions>,
- e. Various United States federal government websites for vehicle standards and testing: <http://www.safercar.gov/rollover/pages/faqs.htm>,
- f. Various private websites: <http://4wheeldrive.about.com/cs/crasttestresults/a/aa03101a.htm>, <http://mb-soft.com/public/rollover.html>

B. Maximum Obstacle Tilt

- a. Crimmins, Tom M., 2006. "Management Guidelines for Off Highway Vehicle Recreation." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 51 pages.
- b. Brumbelow, M.L. and Teoh, E.R. 2009. Roof strength and injury risk in rollover crashes of passengers cars and SUVs. *Proceedings of the 21st International Technical Conference on the Enhanced Safety of Vehicles* (CD-ROM). Washington, DC: National Highway Traffic Safety Administration
- c. Wolpert, J. and Belanger, R. 1980. Vehicle handling tests of the American Motors CJ-5 Jeep. Phoenix, AZ: Dynamic Science, Inc

- d. Various vehicle manufacturer's websites for vehicle specifications: http://en.wikipedia.org/wiki/Jeep_CJ, <http://www.dimensionsguide.com/hummer-dimensions>,

- e. Various United States federal government websites for vehicle standards and testing:

<http://www.safercar.gov/rollover/pages/faqs.htm>,

- f. Various private websites: <http://4wheeldrive.about.com/cs/crasttestresults/a/aa03101a.htm>, <http://mb-soft.com/public/rollover.html>

C. Vehicle Clearance:

- a. Various vehicle manufacturer's websites for vehicle specifications: http://en.wikipedia.org/wiki/Jeep_CJ, <http://www.dimensionsguide.com/hummer-dimensions>, <http://allpar.com/model/jeep/wrangler.html>

D. Vehicle Minimum Angles:

- a. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.
- b. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages
- c. Various vehicle manufacturer's websites for vehicle specifications: http://en.wikipedia.org/wiki/Jeep_CJ, <http://www.dimensionsguide.com/hummer-dimensions>, <http://allpar.com/model/jeep/wrangler.html>
- d. Various private websites: <http://www.truckdigest.com/TTDfeatures/TTDfeature2009hummer.com>

E. Obstacle Run Length

- a. Wernex, Joe, 1994, "Off-Highway Motorcycle and ATV Trails: Guidelines for Design, Maintenance and User Satisfaction, Second Edition." American Motorcyclist Association, P.O. Box 6114, Westerville, OH 43081-6114. 56 pages
- b. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages

- c. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.

F. Trail Types

- a. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages

G. Trail Width

- a. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages

2. Trail Construction Details

A. Trail Surface and Edge Trail Detail

- a. United States Department of Agriculture, Forest Service, 1991, Trails Management Handbook, USFS Handbook 2309.18.
- b. Wernex, Joe, 1994, "Off-Highway Motorcycle and ATV Trails: Guidelines for Design, Maintenance and User Satisfaction, Second Edition." American Motorcyclist Association, P.O. Box 6114, Westerville, OH 43081-6114. 56 pages
- c. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages
- d. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.
- e. California Department of Parks and Recreation, 1991. "Soil Conservation Guidelines/Standards for Off-Highway Vehicle Recreation Management" 78 pages
- f. State of Pennsylvania, Department of Conservation and Natural Resources, 2004 "Pennsylvania Trail Design Manual for Off-Highway Recreational Vehicles", Bureau of Facility Design and Construction and Recreation and Conservation, 400 Market Street, Harrisburg, PA 17105-8767, 123 pages

B. Boulder and Tree Trail Feature

- a. United States Department of Agriculture, Forest Service, 1991, Trails Management Handbook, USFS Handbook 2309.18.

- b. Wernex, Joe, 1994, "Off-Highway Motorcycle and ATV Trails: Guidelines for Design, Maintenance and User Satisfaction, Second Edition." American Motorcyclist Association, P.O. Box 6114, Westerville, OH 43081-6114. 56 pages

- c. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages

- d. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.

- e. California Department of Parks and Recreation, 1991. "Soil Conservation Guidelines/Standards for Off-Highway Vehicle Recreation Management" 78 pages

- f. State of Pennsylvania, Department of Conservation and Natural Resources, 2004 "Pennsylvania Trail Design Manual for Off-Highway Recreational Vehicles", Bureau of Facility Design and Construction and Recreation and Conservation, 400 Market Street, Harrisburg, PA 17105-8767, 123 pages

C. Boulder Pile Gate Keeper Trail Feature

- a. United States Department of Agriculture, Forest Service, 1991, Trails Management Handbook, USFS Handbook 2309.18.
- b. Wernex, Joe, 1994, "Off-Highway Motorcycle and ATV Trails: Guidelines for Design, Maintenance and User Satisfaction, Second Edition." American Motorcyclist Association, P.O. Box 6114, Westerville, OH 43081-6114. 56 pages
- c. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages
- d. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.
- e. California Department of Parks and Recreation, 1991. "Soil Conservation Guidelines/Standards for Off-Highway Vehicle Recreation Management" 78 pages
- f. State of Pennsylvania, Department of Conservation and Natural Resources, 2004 "Pennsylvania Trail Design Manual for Off-Highway Recreational Vehicles", Bureau of Facility Design and Construction and Recreation and Conservation, 400 Market Street, Harrisburg, PA 17105-8767, 123 pages

D. Boulder Climb and Trail Dip Trail Detail

- a. United States Department of Agriculture, Forest Service, 1991, Trails Management Handbook, USFS Handbook 2309.18.
- b. Wernex, Joe, 1994, "Off-Highway Motorcycle and ATV Trails: Guidelines for Design, Maintenance and User Satisfaction, Second Edition." American Motorcyclist Association, P.O. Box 6114, Westerville, OH 43081-6114. 56 pages
- c. State of Minnesota, Department of Natural Resources, 2007. "Trail Planning, Design, and Development Guidelines." Trails & Waterways Division, 500 Lafayette Road, St. Paul, MN 55155-4052. 306 pages
- d. Fogg, George E., 2002. "Park Guidelines for Off Highway Vehicles." National Off-Highway Vehicle Conservation Council, 4718 South Taylor Drive, Sheboygan, WI 53081. 196 pages.
- e. California Department of Parks and Recreation, 1991. "Soil Conservation Guidelines/Standards for Off-Highway Vehicle Recreation Management" 78 pages
- f. State of Pennsylvania, Department of Conservation and Natural Resources, 2004 "Pennsylvania Trail Design Manual for Off-Highway Recreational Vehicles", Bureau of Facility Design and Construction and Recreation and Conservation, 400 Market Street, Harrisburg, PA 17105-8767, 123 pages

Technical Tail Specifications and Details are attached as a separate stand-alone document.