PRESERVE TRAIL GUIDELINES

Resource Management Guidelines for Trails in Preserves

County of San Diego
Department of Parks and Recreation
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CHAPTER 1: INTRODUCTION

The Preserve Trail Guidelines provide direction on developing and implementing ecologically sustainable trails within County preserves. These guidelines support the Department of Parks and Recreation's (DPR) mission to enhance the quality of life in San Diego County by providing exceptional parks and recreation experiences and preserving significant resources. The Preserve Trail Guidelines (PTG) demonstrates how to achieve a functional trail system while minimizing impacts to the environment. These guidelines ensure connectivity to existing or proposed trails while providing high quality trail experiences for all users.

Preserve trails provide trail users an opportunity to connect to the natural environment. The PTG are formulated with the intent to create opportunities for the public to responsibly access biologically and culturally sensitive preserve lands and enjoy the many benefits of nature trails. DPR is committed to providing programs that interpret natural and cultural resources and encourage environmental stewardship. Sustainable trails enhance quality of life by inspiring active, healthy lifestyle choices and connecting people to nature.

A prime objective for the Preserve Trail Guidelines is to incorporate appropriate methods that minimize or avoid impacts to biological and cultural resources within a preserve. Each preserve presents its own unique challenges when pursuing sustainable trail alignments depending on the resources, habitat and topography present.
The trail siting and design recommendations outlined in this document are intended to allow for low impact public access in County-owned preserves while preserving natural and cultural resources. Sustainably designed narrow trails reduce long term impacts by reducing erosion and maintenance requirements. Building new trails with ecology and sustainability in mind is more successful than converting an existing road into a multi-use trail. The siting, design and construction guidelines outlined in this document create non-motorized, primarily multi-use, narrow recreational trails within preserve lands.

Most preserve lands in San Diego County have been acquired through the Multiple Species Conservation Program (MSCP) to preserve lands for special-status species and provide trail opportunities for the public. DPR's preserves contain a wide variety of special-status biological resources, sensitive cultural resources, and important historical structures. Public access in preserves is provided for a variety of user types including mountain bikers, equestrians, and pedestrians.

While continuing to provide opportunities for public access to preserve lands, trail alignments will avoid or be rerouted away from the most sensitive areas within a preserve. Allowing controlled access to sensitive ecological areas is an integral part of educating the public about the value of resource protection. Most often, this takes the form of routing a trail on the periphery of a sensitive area with adequate buffers and allowing direct access to only in very select locations. This approach provides reasonable access while limiting the potential for environmental impact. This approach is particularly effective when used in conjunction with an environmental education program. All trail development must be consistent with the preserve's Resource Management Plan.

Preserve Trail Guidelines Mission Statement

The PTG Mission Statement focuses on balancing DPR's two primary functions of preserving significant resources and providing exceptional recreational opportunities. The DPR Preserve Trail Guidelines mission statement is:

To provide guidance for the design and development of sustainable preserve trail systems that ensure an environmentally diverse, high-quality trail user experience while protecting the natural and cultural value of preserve lands.

Trail Philosophy

DPR has an obligation to provide public access to County-owned and managed lands while protecting and preserving biological and cultural (including historical) resources. The use of trails fosters a greater appreciation for the environment, encourages continued public support of preserve lands, and improves physical and mental health.

The primary mission of County open space preserves is conservation of natural and cultural resources. Narrow trails devoted to a nature-based user experience are promoted in the PTG with the following goals:

1. Minimal environmental impacts
2. Ensuring sustainability to minimize maintenance
3. Providing high quality user experiences

DPR follows this philosophy during the planning, development, implementation, and operation phases of creating a preserve trail system. DPR recognizes the need to preserve valuable habitat, special-status species, archaeological resources, and historical resources while satisfying the public's needs for passive outdoor recreation.

Community Trails Master Plan

The County of San Diego's (COSD) Trails Program *Community Trails Master Plan* (CTMP), provides design guidance for all types of trails. The CTMP *Type C – Primitive Trail* is the foundation for this document. These Preserve Trail Guidelines ensure sensitive resources and community needs are considered in preserve trail design. Biological resource baseline studies and cultural resource inventories will precede trail siting, design, and construction. Trail user type will be appropriately analyzed for each area and trail restrictions, if any, will be determined accordingly. All opportunities and constraints will be considered when designing and constructing nature-based trails.

Figure 1. This narrow multi-use trail follows the contour, has an appropriate cross-slope, has a sustainable grade, uses a large rock as a control point, and boasts good line of sight for trail users.

CHAPTER 2: DESIGNING AND PLANNING PRESERVE TRAILS

Design Principles

Proper trail design is crucial for ensuring an alignment is sustainable, safe, minimizes conflict, reduces environmental impact, and minimizes future maintenance. Establishing specific siting criteria for a new trail must consider direct and indirect impacts to the environment. Not all criteria can be met on every segment of every trail; however, DPR will make every attempt to provide flexibility in a preserve trail to balance resources and public access. Trail design criteria must ensure safe trails for all users and levels of ability.

It is important to determine anticipated user types before starting to design a trail. Research shows that determining allowable trail user types prior to allowing public access is more successful in gaining public support than making changes over time.

User Groups

The user groups on the County's preserve trails include mountain bikers, equestrians, the differently abled, and pedestrians (hikers, dog walkers, trail runners, wildlife viewers).

Mountain Biking: Mountain biking is bicycling off-road or on unpaved surfaces such as mountain trails and dirt road—often over rough terrain.

Mountain biking started in the 1970s in Marin County, California. In the 1980s and 1990's mountain biking started to gain popularity. Over the years, mountain biking has evolved. Technology has transformed the mountain bike and mountain biking sport into many disciplines and styles of riding like cross country riding, downhill riding, dirt jumping, and endurance riding. Some of these styles of riding require additional design or technical elements that may not be suitable for a preserve trail system or provide for the safety and enjoyment of other user groups. The type of mountain biking styles appropriate for preserves should be identified and included in the Resource Management Plan for the preserve prior to establishing the trails plan.

Differently Abled: Differently abled trail users are permitted to use mobility devices to access COSD DPR parks and preserves. In some facilities, there are specific ADA compliant and easily accessible portions of the trail system available.

Hikers and Pedestrians: While there are many uses for trails that may be pursued by hikers (such as hiking, dog walking, trail running, and cross country running), hikers do not necessarily need specially designed trails. Narrow trails that have good flow and sinuosity are acceptable for faster pedestrians such as trail runners and hikers and dog walkers alike. However, these uses are not always appropriate on preserve trails or compatible with other trail user experiences.

Dog Walkers: Dogs, when leashed, are permitted on trails within most preserves. According to some studies (e.g., Sime, 1999), the level of disturbance from dogs diminishes with distance, therefore any deleterious effect of dogs in large areas of DPR Preserves in which no trail use is permitted would be minimal.

Equestrians: Narrow preserve trails that have good flow and sinuosity are acceptable for horseback riders; however, horseback riding is not always appropriate on preserve trails or compatible with other trail user experiences.

Wildlife disturbance from horseback riding is not well documented, but some studies suggest that many wildlife species are habituated to livestock and that equestrians can approach wildlife at closer distances than others. Burger (1986) found that people on horseback did not seem to threaten birds or other wildlife even when moving quickly. Burger surmised that the birds perceived only the horse and not the person riding the horse.

Determining the best trail design is site-specific and depends on many factors, including: the types of trail users, user and community needs, the capacity of the setting, land availability, and specific jurisdictional requirements. The design should provide the most flexibility for trail siting and the preserve's natural environment. Control points are defined as specific locations or components that influence the path of the prospective trail. To reduce erosion and improve sustainability, trails should follow land contours and avoid using existing fall line and flat ground trails. (*See Chapter 4: Construction of Sustainable Preserve Trails*).

Figure 2. Rocks placed close to the trail are good control points to slow down users

Often unsustainable, fall line, and flat ground trails once used as ranch or utility access roads are incorporated into preserve or park trails plans with the misconception that they would not create new impacts. Unfortunately, this is not true. Unsustainable trail alignments are difficult to maintain, create on-going, sometimes extensive damage to the surrounding environment, and have a propensity to promote braided and user created trails that are very costly to maintain.

Sustainable, narrow trail design tends to slow users down and can improve public safety. Generally, the narrower the trail and the more features such as turns, rises and falls, and control points, the slower the user. Narrow trails have a concentrated impact area at the trail's centerline and will need more frequent trail tread maintenance. Brush trimming will also be required more frequently unless trail shoulders can be widened to assist with maintaining good sight lines. Identifying positive control points such as rock outcroppings, a stand of trees or scenic overlooks will influence and guide trail placement. Trails should be planned to incorporate such features to avoid user created non-sustainable trails.

Figure 3. Preserve Trails

Sustainability *is the ability of the travel surface to support current and anticipated appropriate uses with minimal impact to the adjoining natural systems and cultural resources. Sustainable trails have negligible soil loss or movement and allow the naturally occurring plant systems to inhabit the area while allowing for the occasional pruning and removal of plants as necessary to build and maintain the trail. If well-designed, built, and maintained, a sustainable trail minimizes braiding, seasonal muddiness, and erosion*

-National Park Service

Well-designed trails follow the natural topography (curvilinear trails) while avoiding sensitive habitat areas to the greatest extent feasible. Curvilinear trails have the ability to shed water, blend with the surrounding terrain, and provide enjoyable trail user experiences. To ensure sustainability, drainage facilities such as grade dips/grade reversals should be integrated into the trail. Trails that meet "sustainability criteria" have lower maintenance requirements.

Basic elements that should be considered while designing sustainable trails consistent with the conservation goals of a preserve include:

- Narrow tread width
- out-sloped tread
- Sustainable grades
- Frequent grade reversals
- Natural land contours
- Positive user experience
- Water runoff capabilities
- Keeps users on designated trail
- Connection to identified control points
- Low maintenance

Figure 4. Picture of a sustainable multi-use trail including some characteristics listed above such as: less than 10% grade, good sightline, narrow tread.

Figure 5. Example of a trail that was not designed with sustainability in mind: no out-slope, an unsustainable grade, shows evidence of trail creep/trail widening, trenching of centerline, lack of water diversions.

CHAPTER 3: TRAIL SITING

Overview

Trail location criteria are intended to guide the siting of narrow trails in preserves to provide a safe and manageable trail system. Appropriate trail siting has minimum impact on the land and seeks to avoid conflicts with natural resources to the maximum extent feasible.

Siting trails within preserves and open space can be challenging because a balance between trail needs and biological and cultural resource protection and management is necessary. It is crucial to understand the existing conditions of the land, including biological and cultural resources, within and adjacent to a preserve in order identify opportunities and constraints for developing a trail. It is imperative to take biological, cultural, and historic resources, as well as vegetation, species movement, geology, topography and hydrology into account while devising a trail. Trail planning is site specific as no two preserves will have the same biological, cultural or topographical conditions.

Desktop GIS Analysis

The first step of the planning process to evaluate existing site-specific conditions for determining trail alignments is to apply a Geographic Information System (GIS) analysis. This "desktop" GIS review can identify some of the opportunities and constraints for a trail system. Data from baseline technical (e.g., biological, cultural) surveys (part of the Resource Management Plan for each DPR Preserve) are added into the GIS database, then a constraints map is generated to identify the areas that will have the least impact on resources and support trail sustainability. The constraints map is used with field reconnaissance to verify ground conditions. The constraints map depicts the following:

- Slope
- Soil type/erodibility
- Vegetation
- Sensitive species (and associated buffers)
- Known wildlife movement corridors
- Drainages/streams
- Cultural Resources of Historic and Archaeological types
- Adjacent land uses
- Disturbed areas
- Proximity to property boundaries
- Off-site attractions

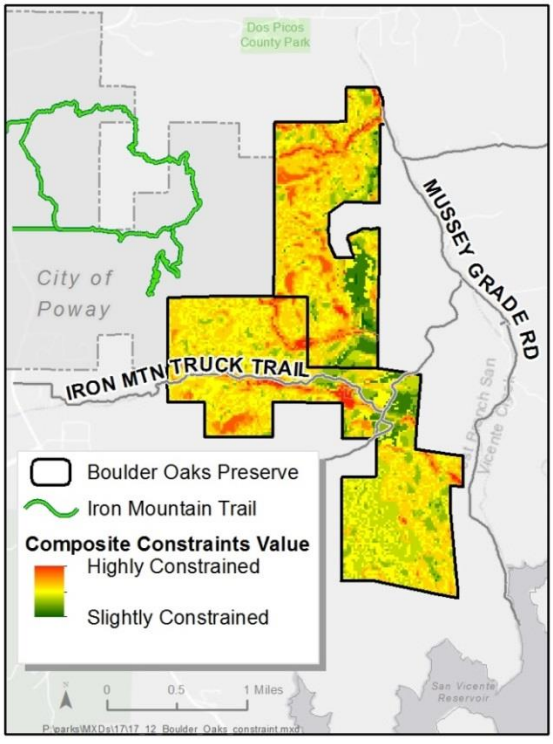

Figure 6. Constraints Map

The constraints map will not be the only information used to identify favorable trail location but may be a significant factor in guiding the alignment. Other factors that will be evaluated include: user experience, user groups, trail sustainability, existing and proposed trail connections, constructability, and adjacent land uses. An example of a constraints map is seen on the following page.

Based on GIS analysis and the identification of opportunities and constraints, potential alignments or trail corridors can be identified.

These Desktop-level trail alignments should take into account specific site factors, but follow these general guidelines:

- Existing paths and roads will be evaluated for sustainability to determine if they can be incorporated into the trail system or revegetated;
- Trails should minimize direct and indirect impacts to sensitive species and habitats, including minimizing edge effects;
- Buffers should be incorporated to protect sensitive resources (biological, cultural, historic);
- Wetland and riparian areas should be avoided;
- Trail tread widths should be minimized to ~2 feet to protect habitat;
- Trails should avoid impacts to root zones of sensitive trees and sensitive woodlands, oaks (*Quercus*) in particular;
- Trails should be consistent with the MSCP and Biological Mitigation Ordinance (if applicable);
- Sufficient sight distance should be provided to promote safety and minimize trail user conflicts;
- Trails should follow topographic contours, where feasible, to ensure a sustainable alignment;
- Trail grade should not be steeper than 10 percent where feasible;
- Alignments that require trail structures should be avoided to minimize impacts to surrounding habitat; if an alternative route is not available, such structures should be the minimum necessary to accommodate passage;
- Trails should be located on stable soils when possible; structural containment of unstable soils should be limited to short sections and only when soil relocation would create more environmental damage;
- Trails should not be routed over extended areas of exposed rock and should avoid areas with a high potential for erosion, talus slopes, and rock slides;
- Alignments that are suitable for year-round use should be a priority;
- Fencing and signs should be employed strategically to exclude users from sensitive areas;
- For trail locations adjacent to known cultural resources, Archaeologists and Native American representatives should be consulted to minimize or avoid impacts to resources;

- For preserve lands on or adjacent to agricultural operations, refer to the COSD *Community Trails Master Plan*, Section 6 Trail Planning Considerations, Agricultural Operations.

Reconnaissance and Trail Siting Evaluation

After the preliminary GIS analysis has identified opportunities and constraints, an approximate trail alignment can be proposed. This trail alignment represents a corridor of where the trail can be located. The width of the corridor will vary based on the GIS analysis. A general alignment is especially useful in planning so adjustments can be made to accommodate topographical, biological resources, cultural resources, or other site-specific constraints before selecting the final trail location.

Along with the desktop GIS analysis, one of the most important factors in preserve trail planning is field reconnaissance to evaluate site conditions and trail alignment. Maps and desktop analyses are tools to assist in focusing an on-site visit to general trail locations. Exploring potential trail routes is very important and may need to be repeated before settling on the best alignment. There is no substitute to walking the proposed area to locate field constraints that cannot be determined through GIS review. Conducting field reconnaissance ensures the final trail alignment will:

- Minimize or avoid impacts to sensitive biological and cultural areas—thus ensuring environmental compliance with local, state, and federal regulations;
- Survey multiple potential trail alignments and select the alignment that has the least potential for disturbing sensitive species;
- Avoid highly erosive soils and areas with standing water;
- Ensure the trail alignment follows the existing contours in accordance with accepted sustainable trail design standards;
- Provide buffers to protect sensitive ecological and hydrologic systems;
- Develop trails in areas already influenced/disturbed by human activity wherever possible;
- Identify areas with unavoidable impacts to resources or habitat for determination of mitigation requirements.

Reconnaissance will include a systematic study of the area to identify and evaluate proposed and alternative trail routes for both existing trails and new trails. Existing dirt roads (typically 8-feet wide) can be made more sustainable by reducing their width. A narrower tread will reduce environmental impacts, improve habitat quality, and provide a more enjoyable trail experience. If any existing trail alignments, including dirt roads, are not sustainable, they should be identified and then decommissioned, revegetated, and possibly used as mitigation for other impacts.

It is imperative that appropriate staff and specialists in trail planning, environmental review, design, construction, and operations are included when conducting the field

assessment. The proposed alignment can be walked, flagged and recorded using Global Positioning System (GPS) and GIS technology. Several field reconnaissance or site assessments may be necessary to determine the final alignment. Once the alignment is identified, specific trail design details (width of trail, control points, fencing, etc.) can be determined to provide the highest protection of natural and cultural resources while ensuring the trail is sustainable, safe for all users, and provides an enjoyable experience in the preserve. Refer to Section 6 and Section 7 of the COSD *Community Trails Master Plan* for additional information on trail planning and design.

The final proposed preserve trail alignments will best meet the established trail objective while taking into account environmental and cultural resources. The application of trail design guidelines will avoid or minimize potential environmental impacts and future trail maintenance requirements.

Trail Layout

Often, sections of trails that cause the most problems can be rerouted to become sustainable in less time and cost than repairing them on an annual basis.

Trail layout starts with identifying and understanding the opportunities and constraints of a trail through a preserve. Staff responsible for determining the appropriate trail layout and protection of biological and cultural resources within a preserve should identify areas to be avoided prior to field reconnaissance (Figure 6).

Figure 7. Clinometer

When in the field plotting the alignment, a clinometer is essential to find a sustainable grade. A clinometer is an instrument for measuring slope (the grade in percent). As the sustainable grade is determined, flagging tape is used to identify the alignment. Once the preliminary route has been marked, one or two additional trips should be made to finalize the route. Flagging the "high-side" of the trail corridor ensures the flagging is always visible through construction. The final alignment should be mapped with a GPS and added to the DPR GIS database to ensure environmentally sensitive areas are avoided.

Areas to be avoided, including environmentally sensitive areas (negative control points) should be marked out first after having been identified by a specialist in the field as the trail layout begins. It will take several trips before a final alignment is determined.

When evaluating trail layouts, road crossings and all aquatic resources (e.g., waterways, wetlands, vernal pools, etc.) should be identified as potential negative control points. If they cannot be avoided, a bridge will most likely be considered and thus appropriate resource permits will be needed for jurisdictional waterways.

Inherent aesthetics, such as the proximity and access to water or other points of interest, should be incorporated into the alignment. If access is not provided, the trail users will find their own way, which results in unwanted and often unsustainable user-created trails. These points of interest are also called positive control points and should be used to guide trail design and layout. Flat terrain with long straight sections of trail should be avoided where possible because it can be difficult to maintain. Therefore, the alignment should meander, creating sinuosity and interest around trees and rock outcroppings. The trails plan should incorporate interesting loops rather than a single out and back trail that could lead to user conflict and user-created trails. Well planned loop trails offer a variety of trail options. Occasionally, destination trails to a point of interest will require an out-and-back trail, but only if they cannot be reasonably incorporated into a loop.

CHAPTER 4: CONSTRUCTION OF SUSTAINABLE PRESERVE TRAILS

At certain times of the year, in areas of high sensitivity or challenging topography, trail construction may involve only hand tools rather than more environmentally impactful mechanical tools. For some preserve trail projects, all that is needed are hand tools and a group of volunteers. For other more complicated trail projects, the use of mechanized equipment, skilled operators, and experienced trail builders may be required.

Figure 8. Curvilinear trail with good cross slope and rolling grade dips. Using the trees as control points creates a sustainable trail with minimal maintenance requirements. Photo used with permission from Arrowhead Trails, Inc.

During the construction phase of building trails in preserves, the following DPR protocols are in place to protect the natural environment:

- Vegetation removal is conducted outside of the avian breeding season and in the presence of a biological monitor if warranted.
- Trail construction activities are conducted outside of avian breeding season when possible.
- If there is a gap in time between vegetation removal and trail construction due to breeding season avoidances, construction best management practices (e.g., gravel bags, straw waddles, etc.) are installed and maintained to prevent erosion until trail construction begins.
- Use archaeological and Native American monitors in areas of archaeological sensitivity. Use archaeological monitors in areas of historical sensitivity.
- Clear delineation of the construction corridor to avoid impacts to surrounding areas.

At the commencement of the construction phase, user-created (aka social, volunteer, or unauthorized) trails not incorporated into the preserve's trails plan should be decommissioned and allowed to either passively or actively restore.

Trail Corridor

There can be many factors that influence the trail project beyond the travel surface or clearing limits. The corridor attributes are variable to provide ecological protection, a better user experience, and a higher level of comfort and safety.

A trail corridor contains the following elements: a trail tread, horizontal and vertical clearing, trail shoulders, and functional control points. Vegetation should be trimmed back and obstacles, such as boulders and fallen trees, should be removed. The corridor width will ensure adequate flexibility in the final trail alignment design and construction. Trail corridors with adjacent natural and cultural resources should be delimited with significantly narrower trail tread width than

trails in less sensitive settings. Diligent field work will ensure the preserve trail corridors are the minimum width necessary to support construction of a sustainable approximately 2–4-foot trail in these circumstances. More detailed field work may be required in complex areas to ensure trail sustainability and avoidance of sensitive resources.

Of the various types of trails depicted in the CTMP, the "Preserve Trail Corridor" is most appropriate for trails constructed in preserves or other sensitive areas (see Figure 9).

1. **Natural Surface Material:** In most circumstances, native soil is the preferred substrate, when it provides good draining capabilities. Natural surfaces increase a trail's sustainability. If natural surfaces are unable to be retained, tread surface may consist of at least 4-inches of decomposed granite (DG) compacted to 90%. When DG is added to the trail tread, it also adds higher maintenance and environmental impact considerations.

2. **Out-Slope 3% - 8%:** Some out-slope or "cross slope" on a trail alignment is necessary to allow water to sheet flow off the trail naturally and not cause erosion. On a 24-inch trail, the cross slope should not exceed 5%. An out-sloped tread is lower on the outside or downhill side of the trail than on the inside or bankside.

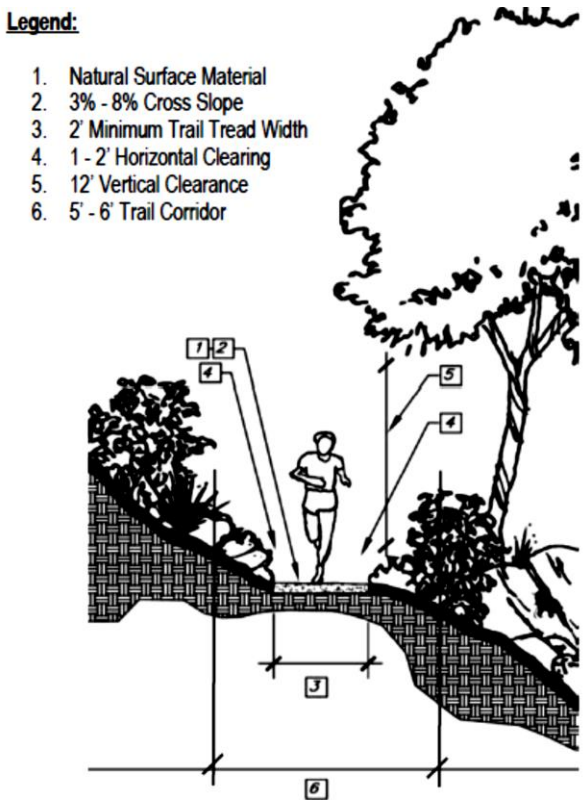

Figure 9. Preserve Trail Corridor. Used with permission from the US Forest Service.

Figure 10. A multi-use trail with rocks left in trail tread to challenge mountain biking skills.

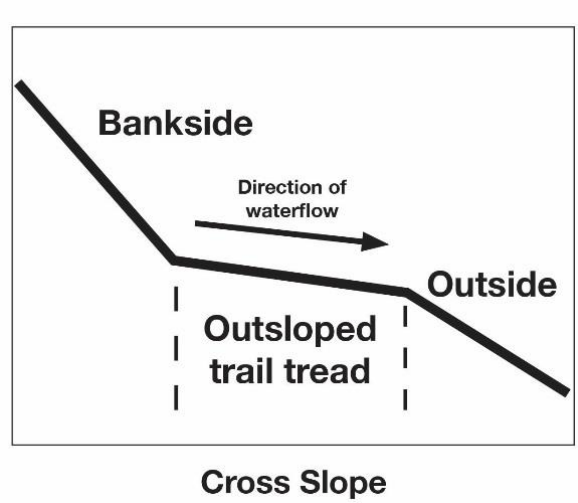

Figure 11. Cross Slope. Used with permission from US Forest Service.

3. **Horizontal Clearance (Trail Shoulders):** Trail shoulders are the areas on both sides of the trail tread within the corridor. They should be clear of obstructions that may affect trail users. Horizontal clearing could extend through the shoulders to the edge of the trail corridor if necessary.

4. **Tread Width Minimum 24 - 48 inches:** The tread on preserve trails will be the minimum necessary to create a safe and sustainable trail. Tread width will range between 24 - 48 inches, based on site conditions. On steep slopes where it may be difficult for users to step off the trail, passing areas should be incorporated into the trail. For high use trails, a wider tread width or the addition of turnouts may be necessary to increase trail sustainability.

5. **Vertical Clearance 10-12 feet:** Vertical clearance is the space over the trail tread that is clear of obstructions. For multi-use trails, a vertical clearance of 12 feet is preferred.

6. **Trail Corridor 5-6 feet:** The trail corridor in a preserve is significantly reduced to 5 to 6 feet to provide the optimum environmental protection with a minimum constructed trail tread width.

Positive Design Elements

In addition to the typical trail design details, there are other design and trail construction fundamentals that can promote sustainability and quality user experiences while reducing impacts on the surrounding environment, including the incorporation of "positive control points."

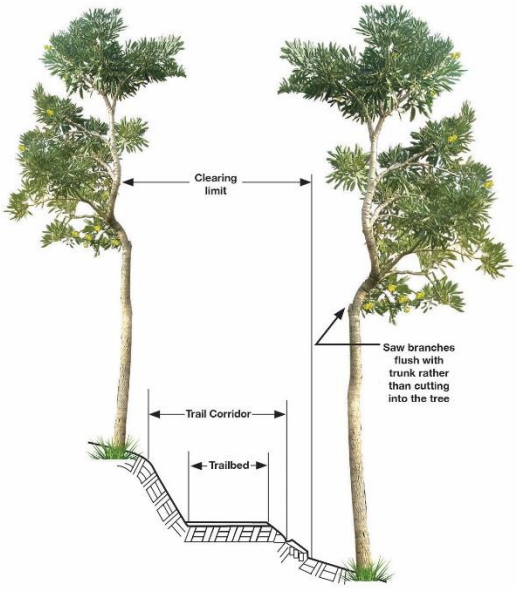

Figure 12. Trail Clearance

Positive control points are places resource managers want users to visit, including scenic overlooks, historic sites, waterfalls, rock outcroppings, lakes, rivers, and other natural features or points of interest. If the trail does not incorporate these features, users will likely create unsustainable social trails to get to them.

Figure 13. Positive Control Point: Interpretive Panel and Historical Structure

The Half Rule *The International Mountain Biking Association's "Trail Solutions" Manual states: "A trail's grade shouldn't exceed half the grade of the hillside or side-slope (cross-slope) that the trail traverses. If the grade does exceed half the side-slope, it's considered a fall-line trail. Water will flow down a fall-line trail rather than run across it. For example, if you're building across a hillside with a (cross slope) of 20 percent, the trail tread grade should not exceed 10 percent" (2004).*

Figure 14. This user created trail has minimal grade deferential, follows the land contour, has a good sight line and cross slope, and has a narrow tread.

Grade:

For greatest sustainability, the *average* trail grade over the length of the trail should be 10 percent or less, although sections may exceed this threshold in areas for short distances or where the topography and environmental constraints together preclude re-alignment. The goal is to minimize the erosional forces that may occur, even at the ideally sustainable gradient of 0-8%. The incorporation of positive design elements (such as grade dips, nicks, and cross slope) is meant to help combat erosion and increase sustainability.

When site conditions cannot tolerate the preferred 0-8 percent grade, it would be necessary for COSD to address the increased maintenance time, maintenance costs, and impacts to resources. Therefore, it is imperative to align the trail in the most environmentally sustainable location and position.

Grade Criteria:

0 - 8% ideal
10% or less for distances over 200 feet
15% or less for distances under 200 feet
20% or less for distances under 100 feet
>20% for short distances under 50-feet

Full Bench Cut: Full bench construction consists of cutting the entire trail tread into a hillside. It is an important construction technique to ensure sustainability. The cut is made through the native soil and out-sloped

3-5 percent. The cut or excavated material is either disbursed onto the tread or downslope or is removed from the site. Once completed, the trail can be used immediately.

Full bench cut construction usually requires little maintenance. Two examples of trails incorporating this design element include COSD DPR's Historic Flume Trail in the Community of Lakeside and parts of the California Riding and Hiking Trail, a regional trail which traverses parts of the state of California.

Figure 15. California Riding and Hiking Trail (c. 1890)

Grade Reversals/Rolling Dip (Rolling Grade Dip; Grade Dip): Grade reversals work best when they are designed and built into new trails. A trail with grade reversals and out-sloped tread encourages water to continue sheeting across the trail—not down it—creating a more sustainable trail.

Figure 16. Rolling Contour Trail with a Grade Reversal. Used with Permission from the US Forest Service

A trail alignment should take advantage of natural dips or drainages in the terrain. A reversal can be placed every 20 to 50 feet. The grade of the trail is reversed for about 10 to 15 feet, then "rolled" back over to resume the descent. Grade reversals enhance the user experience and require little maintenance.

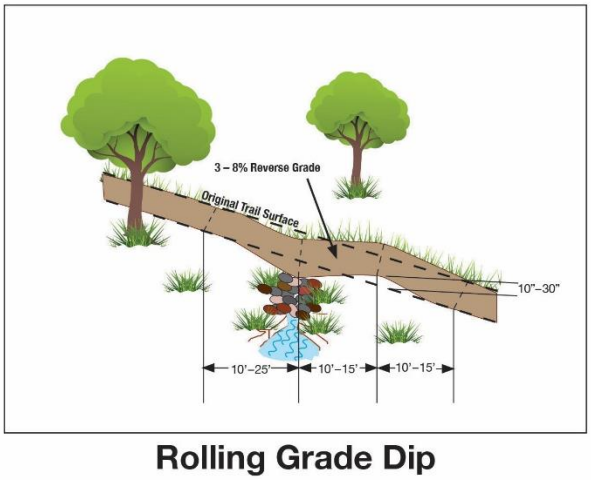

Figure 17. Rolling Dip with a grade reversal, taking advantage of a natural drainage.

Turnouts: Given the narrow nature of many preserve trails, passing sections known as turnouts may be needed to allow for trail users to pass and minimize user conflict. The

typical passing width is twice the tread width and approximately 16-feet long. However, in constrained areas, a minimum of 48 inches wide and 60 inches long is acceptable.

Because the trail tread can be reduced for trails that are in remote locations or are located near sensitive environments, specific site conditions will regulate the turn-out design and placement including sight distances, grade, stability of the soils, and other characteristics of the topography. Generally, on narrow trails 5-10 % grade, turnouts should be provided at +/- 500 ft. At 10-15% grade, they are needed more often at +/-100 foot intervals.

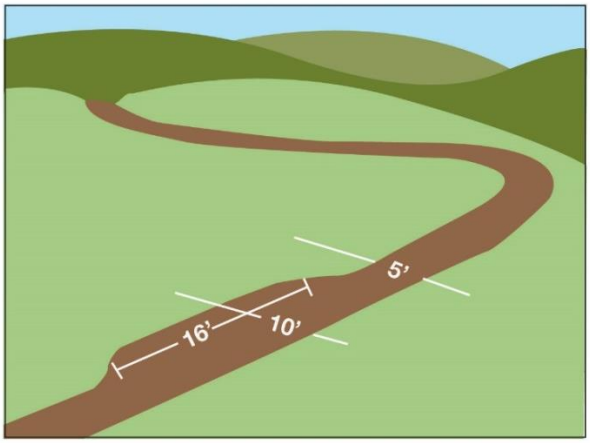

Figure 18. Turnout example

Negative Design Elements

The design elements discussed below should be avoided as much as possible to reduce maintenance costs and promote sustainability, but there may be circumstances where so called “negative” design elements must be incorporated. Topographic complications, the presence of sensitive resources, or other difficult trail layout conditions are some examples that may require a negative design element to remediate the situation. It should be noted that when this situation occurs, maintenance resources, funding, and staffing will need to be increased to keep the trail safe and functioning at an acceptable level.

Negative Control Points: Negative control points are places resource managers want users to avoid. These areas include low-lying wet areas, flat ground, extremely steep cross slopes or cliffs, unstable soils, environmentally sensitive areas, sensitive archaeological sites, safety hazards, and private property.

Fall Line Trail: A fall line trail alignment follows the shortest route down a hill and focuses water down the length of the alignment. The speeding water strips the trail of soil, exposing roots, creating gullies, and scarring the environment. These trails are very difficult to sustain, create on-going, sometimes extensive damage to the surrounding environment, and have a propensity to promote braided and/or user created alternative trails resulting in costly maintenance requirements.

Figure 19. Typical Erosion of a fall-line trail alignment.

Flat Terrain Trail: Flat topography appeals to many trail builders with the initial ease of trail construction. However, if a trail is not located on a slope, there is the potential for it to become a collection basin for water. The trail tread must always be slightly higher than the ground on one side so water can drain properly.

Figure 20. Deeply entrenched trail located on flat terrain

In-Sloped Trails: An in-sloped trail tilts towards the uphill side of the trail allowing water to run down the inside of the trail (the inside edge of the trail is lower than the outside edge). If a drainage system is not in place to capture runoff, the trail erodes. An in-sloped trail is rarely recommended due to its high maintenance (but may be a component of a properly constructed switchback).

In-Sloped Turns: In-sloped turns are popular with mountain bikers because it allows them to keep their speed through the turn. In-sloped turns would be appropriate on single use mountain bike trails; however, they are not recommended on multi-use trails. In-sloped turns typically require more construction expertise and more frequent maintenance.

Figure 21. In-sloped turn on a multi-use trail showing erosion and breakdown of the berm; silt build-up on the downhill side does not allow the water to drain off.

Partial Bench Cut: Partial bench trail construction—cutting half of the trail tread into a hillside and using the cut material to fill the downhill slope—results in trails that are typically unsustainable due to the unstable out-slope fill material. Partial bench often requires support such as crib walls on the downhill edge of the trail to hold the fill. The fill soil is soft and less compacted than the cut slope forming a berm, which will cause water to flow down the trail rather than across it. This method often requires time (6 months or more) for the fill slope to settle before the trail can be used. Partial bench cuts require constant maintenance.

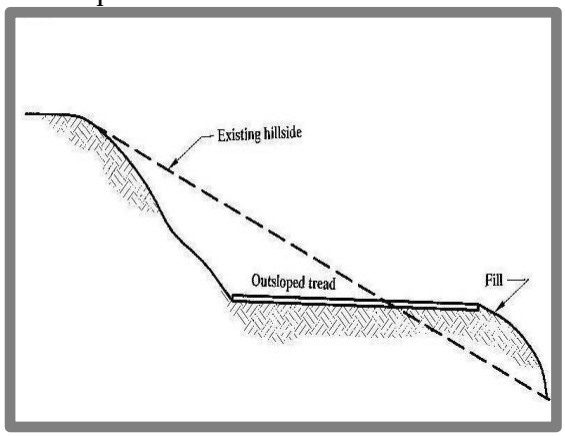

Figure 22. Partial Bench Cut Illustration. Used with permission from the US Forest Service.

Trail Structures

In general, trail structures should be avoided or minimized. Every structure constructed will become an on-going maintenance expense, and there is often a more sustainable solution to the trail issue.

Switchbacks: Switchbacks are a trail structure that should be avoided as they are difficult, time-consuming, expensive to construct correctly, and require regular maintenance. Trail users often cut across them causing greater impacts that could result in habitat and trail damage—or even trail closure. Using curvilinear design principles eliminates the need for most switchbacks. Climbing turns or topographic turns are easier to construct and maintain and utilize natural terrain features (benches, knolls, rock outcrops) to change the direction of a trail. They are less obvious and less prone to cutting and erosion.

Water Bars: Water bars are one of the more common drainage structures used in trail construction. They should be avoided unless absolutely necessary due to the high maintenance needs. Water bars are used to divert water off the trail by redirecting flow towards the lower edge of the trail. If water bars are not properly maintained, sediment will accumulate behind them, resulting in water flowing over the bar. Instead, incorporate grade dips and reversals to facilitate proper drainage across the trail and minimize erosion. Additionally, users tend to go around water bars rather than over them, contributing to a phenomenon called "trail creep."

Figure 23. Avoidance of water bar results in "trail creep."

User Experience

Trail User Conflict

Preserve trails should provide an enjoyable experience for all users. Conflicts among trail users can result in an unfavorable or even dangerous trail experience.

According to a study by Jacob and Schreyer, (1980), conflict on trails is often defined as "goal interference" which is attributed to another trail user's behavior. Trail conflicts occur among both different user groups, and among different users within the same user group. In fact, no actual contact among users need occur for conflict to be perceived. Trail conflict can be related to activity style (e.g., mode of travel, level of technology), the focus of the trip, user expectations, attitudes toward and perceptions of the environment, level of tolerance for others, and different norms held by different users.

Recognizing conflict as goal interference and not as an inherent incompatibility among different trail user groups can go a long way toward remedying conflict. Conflict can be

addressed by providing adequate trail mileage, loop systems, and opportunities for a variety of trail experiences. This will also help reduce congestion and impacts on the trails and surrounding environment. However, extensive trails systems on preserves may be incompatible with the goals of the preserve. During the planning and design phase, potential conflicts should be addressed with prospective trail users. Planning ahead to address users' needs and expectations will help avoid user conflicts.

There are ways to mitigate the potential for trail user conflict during siting and design of trails (i.e., sight distance, speed regulation, etc.). There are also operational measures, such as bike bells that reduce the potential for trail user conflict. Bike bells easily attach to bikes and alert hikers, equestrians, and other bikers to oncoming bike traffic. The bells can be effective on heavily used multi-use trails where there is a high probability of user interaction. Boxes containing loaner bike bells can be installed at trailheads. Some mountain bike organizations work with trail managers to voluntarily install and refill bike bell boxes.

Figure 24. Bike Bell Box

CHAPTER 5: MANAGEMENT AND MAINTENANCE

The major challenge to managing a successful trail system is providing quality recreational opportunities while protecting resources. Trails must be designed and constructed to produce minimum disturbance to the natural environment and ensure the safety and enjoyment of the users.

Trails within a preserve must be managed to ensure that biological and cultural resources will be protected. Good trail management starts with good trail system planning, design, construction, maintenance, and operations. It is easier to manage a well-planned trail system constructed and designed for appropriate user groups and the anticipated levels of use that offers diversity of the trails both in challenge and length.

Management Tools

There are many technology tools (web mapping applications, phone applications, GIS and GPS) that record resource information to establish the foundation for management of preserve trails. Community participation is also an integral part of land management. Collaboration with other agencies, neighbors, nonprofit organizations, special interest groups, and volunteers can assist land managers in protecting natural resources and preserving trail opportunities for future generations.

Signs: One of the easiest and more effective ways to manage trails within preserves is the careful use of signs: both regulatory and interpretive. Preserve and trail rules should be posted at a kiosk near the trail head. These rules and regulations should outline accepted trail uses and trail etiquette. A map of the trails system should be available at the kiosk and on-line at DPR's website. Signs on trails should be limited to trail markers and trail maps.

Figure 25. Habitat Restoration Sign.

Figure 26. Preserve Sign that gives information on approved activities and hours of operation.

Signs along trails stating "Sensitive Environmental Resource" or "Habitat Restoration Area" present an opportunity for environmental education or interpretation of sensitive species/environment. Educational opportunities allow trail users to understand the significance of protecting an area and provide insight on restricted areas. Additionally, it will allow trail users to enhance their understanding of how important it is for human activities to responsibly coincide with nature.

The public should be educated regarding the importance of staying on designated trails and keeping dogs on leash. Dogs are allowed in most County Parks and Preserves; however, there are rules associated with this privilege. According to County Ordinance SEC.62.669, a dog brought into a public area in which dogs are allowed shall be restrained by a handheld leash no longer than 6 feet.

Leash requirements in preserves are implemented to ensure the safety of others and protect wildlife. Because dogs instinctively want to hunt or seek out wildlife and their scents, some agencies do not allow dogs—even on leash in their preserves. Dogs must be on leash at all times when on County parklands and trails, unless they are within a designated off-leash area. Even if the dog is leashed, the owner must have the ability to control it at all times.

Figure 27. Dog on Leash Sign

Seasonal Closures: Closing a trail seasonally is a management practice meant to keep the user experience safe and mitigate impacts to the natural environment. When a trail is closed seasonally, DPR alerts the public through the website, notes that the trail is seasonal on any trail brochures, and also posts signs up in the preserve. Signs can be used to identify trail closures when trails are closed due to weather, trail conditions, or even the temporary presence of biological resources such as nesting birds

Figure 28. Trail Closure sign

Fences and Barriers: Keeping the public on designated trails and reducing opportunities for off trail activities that impact sensitive resources are challenges for land managers. Good trail design that avoids sensitive or protected areas and provides opportunities for the public to meet their outdoor recreational goals are essential to keeping users on designated trails.

Fences and barriers can keep the public on designated trails and can play an important role towards the protection of natural and cultural resources. Trail structures including fences, gates, and other forms of constructed barriers become an annual, on-going maintenance expense for COSD; therefore, installation in key locations is more practical than fencing an entire trail system. Large rocks, boulders, or fallen trees purposefully placed along the trail can be as effective as fencing. Keeping the vegetation dense beyond trail shoulders will also deter the public from going off trail. Before erecting fences, the first consideration should be education and interpretation to ensure that the public understands the importance of staying on trails. This can be conveyed through signs at trail heads and kiosks, interpretative panels strategically placed along the trail, brochures, and information on websites.

Fences and Wildlife: When fences are the only solution for protecting resources near or adjacent to a trail, the fence material must be wildlife friendly. Fences can create hazards for the wildlife it was intended to protect. Wildlife must be able to pass through the fence either by jumping over or crawling under. It is important that the fence also be highly visible, so animals do not become entangled or run into the fence. Careful consideration must be given when locating fences. An area with too many fences can actually hinder wildlife movements and they may avoid the area.

When designing fences for wildlife it is best to consider the following:

- Purpose
- Topography—hills, gullies, streams and wetlands
- Species/movement of wildlife present
- Presence of water, food and cover for wildlife
- Use of appropriate fence design

The ideal wildlife friendly fence will have top wires/rails low enough for large animals to jump over and bottom wires/rails high enough for small wildlife to crawl under. The location of the fence is very important, as a

fence of any height is more difficult for animals to traverse when placed across a steep slope or next to a deep ditch.

Post and Rail Fence Design:

- Use only two rails
- Use pressure treated 6–8-foot posts
- Locate the top rail no more than 40” above the ground
- Locate the bottom rail approximately 18” from the ground.

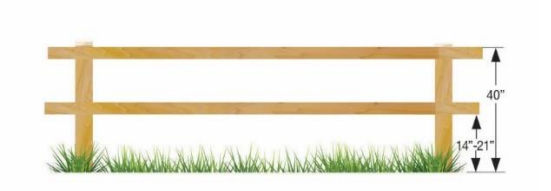

Figure 29. Posts should not extend beyond the rails making it easier and safer for wildlife to jump over.

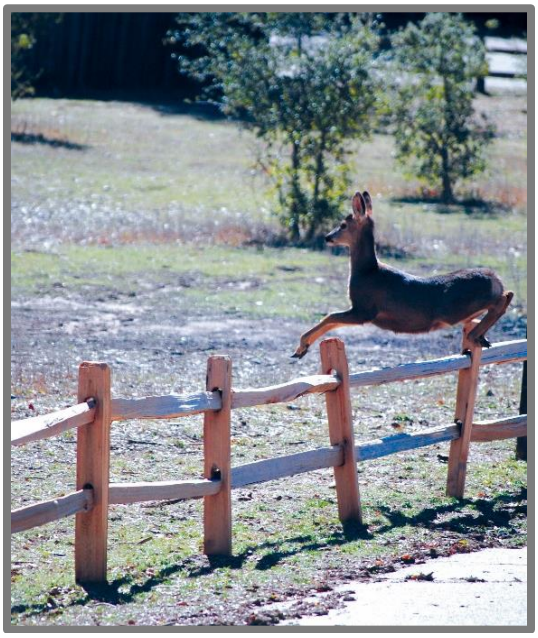

Figure 30. Mule deer jumps over split rail fence.

Wildlife Fence Design Criteria:

- A top wire or top rail should be no more than 40” off the ground
- Provide at least 12" between the top two wires
- A bottom wire or rail 18" above the ground
- Smooth wire or wooden rail for the top, and bottom
- Preferably, no vertical stays; if used, consider stiff plastic or composite stays, or wire stays that are easily bent
- Posts at 16.5-foot intervals

Increasing visibility using a top rail with high-visibility poly-wire, flagging, or other markers can help wildlife and birds better avoid or navigate fences. Using smooth wire, such as barbless twisted wire, for the top and bottom strands will help prevent snagging and injuries.

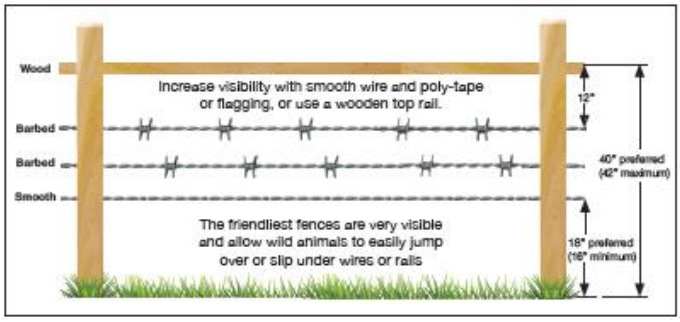

Figure 31.Wildlife friendly fence (top and bottom) with cattle control barbs in middle.

Volunteers

DPR enlists the assistance of volunteers from diverse backgrounds and age groups to serve as on-site camp hosts and volunteers for basic trail maintenance and park clean-ups.

DPR has a very active and successful volunteer trail patrol. Patrol groups include members from all user groups and are a valuable resource for managing preserve trails. Volunteer patrol members assist staff in protecting sensitive areas of the preserve, deterring vandalism, providing information and assistance to trail users, and ensuring that

visitors are able to enjoy the natural beauty of our preserves and trails. Each preserve manager determines the number of volunteers needed.

Trail Patrol responsibilities include:

- Members reporting to a ranger to sign in. The ranger may designate the patrol area.
- While on patrol, members will be responsible for providing trail and facility information, informing visitors of rules and regulations, and obtaining assistance for accidents and injuries.
- Within 24 hours after each patrol, a Patrol Report will be completed and submitted to the appropriate ranger. Patrol Reports provide information regarding contact and visitor activity, rule infractions, trail conditions, wildlife sightings, etc. This important report provides timely and valuable information to assist park staff with the overall preserve management.

Maintenance

Maintenance begins immediately following trail construction and is a continuous process. Well designed and constructed trail systems require minimum routine maintenance. The objective of routine maintenance is to keep a trail at or near its original constructed or intended standards.

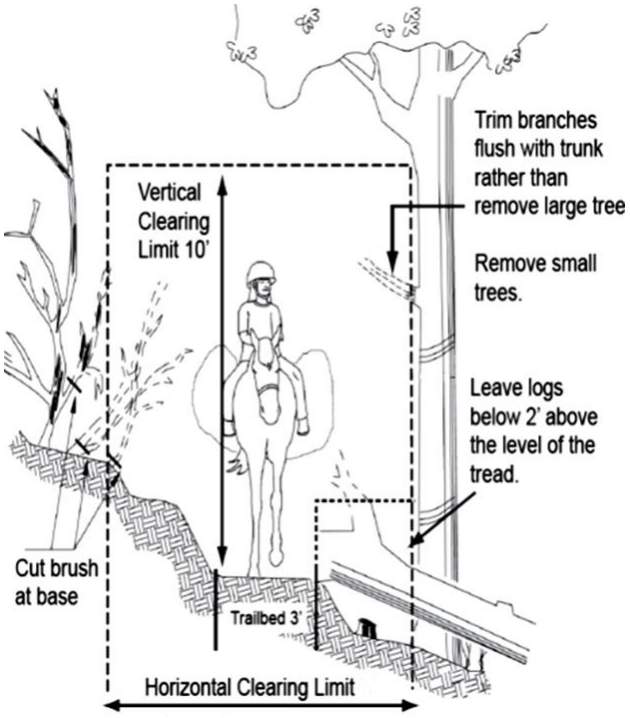

Figure 32. Clearing limits. Used with permission from the US Forest Service.

The first priority for trail maintenance is the assessment or "Trail Triage". Truly unsafe conditions will be corrected first, followed by areas that may cause environmental or significant trail damage. Routine trail maintenance that returns the trail to its original design includes:

1. Tread surface repair:
    - Pulling the outside berm back removing the berm and scattering the berm material back on to the trail to allow water to sheet flow off the trail

- Cleaning up trail tread slough and redistributing it back on to the tread
- Reshaping the tread and restoring the out-slope of the trail
- Restoring the tread to the designed width
- Drainage facility repair or clearing
- Must be maintained or cleared on a regular basis
- Brush work and tree trimming: Clear brush to trail corridor
- Remove tree branches to the edge of the trail corridor

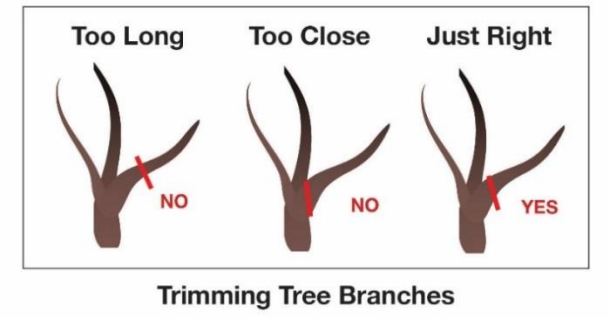

Figure 33. Trimming Trees for Trails

This is “basic” trail maintenance and can easily be taught to volunteers to assist staff with on-going maintenance. Following the design guidelines for sustainable trails will ensure trails have reduced maintenance requirements. However, there will be circumstances where the trail may not meet these guidelines to accommodate a preferred siting location or extreme topographical conditions. Any trail maintenance beyond routine maintenance should be supervised by DPR staff. When maintenance is beyond the skill level of volunteers or more technical or sensitive in nature, maintenance should be performed by experienced DPR staff. Poor maintenance efforts can be as damaging as no maintenance.

CHAPTER 6: RESOURCES

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