Click here to take online survey.

Trails Management Manual

Standards and Guidelines for Planning, Design, Construction, and Maintenance of the Trails and Track Systems for Maricopa County Parks Department

Maricopa County Parks and Recreation Department

October 2017

Table of Contents

Quick Reference Tables

San Tan Mountains Regional Park

1.0 INTRODUCTION

Trails serve multiple purposes including exercising, walking, jogging, hiking, bicycling, bird-watching, equestrian, and Off Highway Vehicle (OHV) use. They can also provide safe alternative transportation routes as well as create connectivity from one facility or municipality to another. Connecting people and places enhances the user experience and promotes long term stewardship of the trail systems, parks, and the Sonoran Desert as a whole.

The purpose of this handbook is to serve as a point of reference for best practices in trail planning, construction, and maintenance standards within the Maricopa County Parks trail system. Best practices were referenced in whole or in part from both federal and regional agencies identified at the end of this manual. While this handbook is meant to be as thorough as possible, it is difficult to cover every situation; therefore flexibility will be necessary in constructing trails within the system. Best practices shall be implemented when possible, however, specific site conditions must be evaluated and proper design guidelines applied to those conditions in order to maintain a safe, cohesive, and sustainable trail system for the region.

The Trails Management Manual outlines the standards and construction components that provide trail and track-related recreation opportunities that meet Department management objectives and are within the directions of applicable federal, state, and local laws.

The Trails Management Objectives identified below are the building blocks and principle elements for creating an efficient, effective, and sustainable trail management plan for both motorized and non-

motorized trails. These objectives are meant to document and make transparent Maricopa County Parks and Recreation Department's management intentions for its trail system, while also providing reference for trail planning, construction, and management. The trail management objectives outline the vision and the desired conditions for the entire trail system as a whole, providing consistency and stability for the long term management of the system.

1.1 Trail Manual Objectives

Objective #1 - Trail Quality

Provide high quality trails that energize visitors and create life-long users and advocates of the trail system, parks, and the Sonoran desert.

Objective #2 – Connectivity

Create a trail system that promotes various modes of travel to insure greater connectivity and experiences with the natural environment by all users.

Objective #3 – Visitor Experience

Provide a diverse array of visitor experiences which support mental, emotional, and physical wellbeing while creating life-long positive memories.

Objective #4 – Resource Protection

Provide trail-related recreation corridors and opportunities that are consistent with land and social carrying capacity, which support, promote, and protect the natural and cultural resources for the surrounding areas, i.e. Limits of Acceptable Change (LAC).

Objective #5 – Agency Cooperation

Coordinate trail management between county departments (and other agencies where applicable), to ensure compliance with policies, regulations, and specifications within the Maricopa County Parks System.

Objective #6 – Trail Sustainability

Design and construct safe quality trails to ensure long-term cost effectiveness and sustainability.

Objective #7 – Community Engagement

Utilize a wide range of interactive participation tools (including innovative multi-media applications) to engage residents, park users and stakeholders.

1.2 Standard Definitions

Whenever the following terms or associated pronouns are used in this manual, project specifications, or a contract document, the intent and meaning should be as follows:

Barrier-free Trail – A trail with all obstacles removed from the tread for people with mobility, sight, and/or hearing limitations.

Backcountry Trail – A trail that extends into an isolated and remote area that is difficult to access via motor vehicle.

Carrying Capacity – The maximum level of use that an area or resource can sustain before deterioration occurs.

Classification – A category of management objectives and standards directing the design, construction, and maintenance of designated trails aimed at providing an optimal visitor experience.

Connectivity – Connecting both people and places through various modes of travel and transportation.

Competitive Track – A recreation facility designed, constructed, and maintained for non-motorized, competitive-type activities that allows for high speeds, technical and sport use (also referred to as Track).

Conservation – The management of natural resources to prevent waste, loss, destruction, or neglect.

Construction – Building a trail or competitive track on a new alignment. Construction also refers to building a trail with a different classification over an existing trail.

County – Maricopa County, Arizona.

Cultural Resource – Any archaeological, prehistoric, or historical structure, artifact, or other remains which are of interest and are at least 50 years of age, and the physical site, locations, or context in which they are found.

Department – Maricopa County Parks and Recreation Department.

Designated Trail or Track – An authorized trail or track established through the public planning process, and designed, constructed, and maintained according to standards within this manual. The trail or track is within County Park boundaries, has been included in a Park Trail System Plan, and is

identified on County Park maps. If a Park Trail System Plan is not in effect, a trail or track is considered designated if it appears on a Park Visitor's Map or if it is posted with authorized signs. Park Visitor's Maps are those developed for each specific County Park and distribution to the public.

Facilities – Buildings and the associated supporting infrastructure such as roads, trails, and utilities.

Hard Surface – A ground surface with a base composite of asphalt, stabilized material, or concrete.

Limits of Acceptable Change (LAC) – The process which focuses on human-induced impacts to the environment. It requires land managers to define desired resource conditions and take actions to maintain or achieve those conditions.

Livestock – Domestic animals used for riding, packing, recreation or work. This includes livestocks, mules, burros, and llamas.

Maintenance – Repair work on the existing alignment of a designated trail or track, including erosion control, vegetation clearance, cleaning drainage structures, tread reconstruction, and trail revegetation.

Management Team – This team consists of the Parks and Open Space Planner, Operations Manager, Planning and Development Manager, Park Superintendent, Trails Supervisor, and the Department Director.

Multiple-use – Multiple uses/modes of travel allowed on trails and tracks. For trails, these modes are pedestrian/hiking, equestrian, bicycling, and OHV use. For tracks, these modes are running, equestrian riding, and bicycle racing. May be expressed as "multi-use" or as "shared-use."

Off Highway Vehicle (OHV) – An off highway vehicle is any motor vehicle operated on unimproved roads, trails, and approved use areas not suitable for conventional two-wheel drive vehicular travel. Examples include All Terrain Vehicles (ATVs), Utility Task Vehicles (UTVs), motorcycles, and dirt bikes.

OHV Trail – Off Highway Vehicle trails are usually longer trails extending over further distances and range in difficulty level from easiest to most difficult, with an increase of barriers to overcome within those range levels.

Park – Any Maricopa County Park, Recreation Area, or other land under control of the Maricopa County Board of Supervisors.

Project Leader – The authorized person responsible for onsite execution of work associated with a

project on behalf of the County.

Realignment – Construction of a new segment of trail or track and revegetation of the old segment.

Reconstruction or Renovation – Heavy maintenance that brings a severely degraded (or improperly constructed) trail into compliance with the standards according to its classification. This includes but is not limited to restoration of gradient, restoration of tread width, and/or constructing tread stabilizing structures (walls, rip-rap, block and fill).

Regional Parks – An area of land preserved for recreational use which services multiple cities across political jurisdictions.

Revegetate (-tion) – The process of restoring an area of land to its natural state.

Road – A travel facility designed, constructed, and maintained to accommodate motor vehicles according to Maricopa County Department of Transportation Road Standards.

Service Road – A road within the Park System which is solely utilized for administrative, maintenance or emergency purposes.

Social Setting – The surroundings or environment in which social activities occur.

Spur Trail – A trail that branches off the main tail and stops. It does not reconnect or loop back around to the main trail.

Trail – A recreational path designed, constructed, and maintained to serve non-motorized modes of transportation. Acceptable motor travel may include suitable wheelchairs and administrative or emergency vehicles.

Trailhead – The transfer point between a trail and a road, mooring, or other transportation facility, i.e. a parking lot with public facilities available.

Unauthorized Path – A short cut, an abandoned road, track, or trail, a path through a cut fence, etc., which does not appear on Park Visitor's Maps, is not officially posted, and/or does not appear in a Trail System Plan (or as specified in Chapter 2.). Also may be referred to as "vandal route", "spider", "wildcat", or "illegal route".

Visual Resources – The composite of basic terrain, geological features, water features, vegetative patterns, and land-use effects that characterize and influence the visual appeal of the surrounding area.

Volunteer – An individual who contributes time and services to the Department without monetary compensation.

Wash Trail – A designated trail established primarily in a wash bottom.

1.3 Trail Component Terms

Whenever the following terms or associated pronouns are used in this manual, project specifications, or a contract document, the intent and meaning should be as follows:

Arroyo – Also called a wash, is a dry creek, stream bed or gulch that temporarily or seasonally fills and flows after sufficient rain fall.

Backslope – The excavated slope "in back" or uphill of the trail, rising from the uphill (inside) edge of the tread, and eventually transitioning into native hillside by varying degrees, depending on bank composition and slope stability (cut-bank, back-cut, cut-slope).

Bench – A level or slightly sloped trail tread constructed on a hillside. A bench may consist of compacted fill (half or quarter bench) and/or original earth (full bench).

Berm - A ridge of compacted earthen material usually formed on the outer edge of the tread.

Boardwalks – A fixed planked structure, used to provide access to an area via a dry crossing.

Borrow Material – Soil, gravel, or rock materials taken from sources approved by the project leader, to be used for fill.

Checkdam – A small, sometimes temporary, dam constructed across a swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity.

Compacted – Consolidation that is obtained by tamping or rolling mineral soil, small aggregate, cement, etc. in successive layers.

Cut Slope – The upslope edge of a tread bench cut from a hill slope.

Duff – Partly decomposed plant material, such as brush, twigs, leaves, that covers rock or mineral soil.

Drain – A constructed watercourse which moves water away from the tread surface.

Fall Line – The direction that water flows down a hill; the path of least resistance.

Fill – Earthen material used to fill voids in tread, behind walls, around waterbars. Also, large quantities of earth used to build tread bench (may also be expressed as "backfill", "fill slope").

French Drain – A trench filled with gravel or rock or contains a perforated pipe which redirects surface water and groundwater away from an area.

Ghost Fence – A fence construct primarily of wire and metal posts which has an open end or is a section piece. This section piece blocks the main access point to a closed area when a full length fence is not established.

Grade – The grade (also called slope, incline, or gradient) of a physical feature is the vertical distance of ascent or decent of the trail expressed as a percentage of the horizontal distance commonly measured as a ratio of rise to length or as a percent.

Grade dip – A grade dip is a reverse in the gradient of the trail tread.

Gradient – The incline of the tread along the length of the trail centerline, usually expressed in percent.

In slope – Tread tilted towards the uphill side of the slope.

Mineral Soil – Soil consisting primarily of mineral (sand, silt and clay) material rather than organic matter.

Outslope –Tread tilted downward towards the downhill side of the slope.

Post – metal, fiberglass, wood, or tee-post.

Slope – The natural slope of a hillside measured at a right angle to the topographic contour, usually expressed in percent. Slope may also be expressed as "side slope", "upslope", "downslope".

Slough – Soil that has moved downhill onto the tread, associated with the process of downhill soil movement.

Terrace – A leveled surface area cut into the landscape.

Talus Slope – The pile of rocks that accumulates at the base of a cliff, chute, or slope

Trail Braiding – The process of numerous routes being created from a single starting point to a single end point in order to avoid obstacle or create an easier path.

Tread – The surface portion of a trail upon which users travel.

Turnpike – A trail constructed with a combination of soil and gavel to make the tread higher than the surrounding water table.

Waterbar – A waterbar is a log or a row of rocks covered with soil which interrupt and deflect water off the trail.

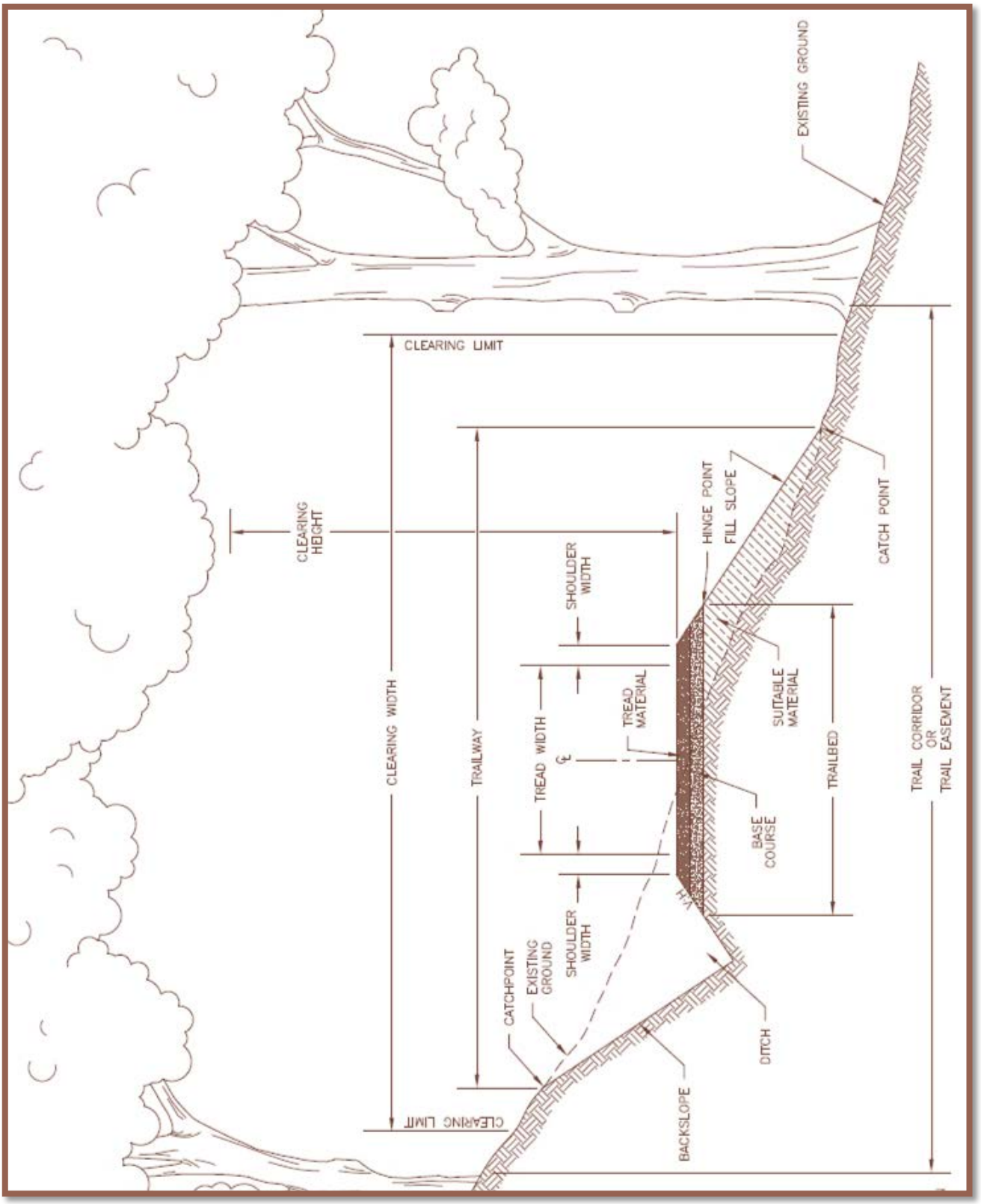


Illustration 1 - Trail Component Terms

*Illustrations #1 - #17 were retrieved from USDA Forest Service Standard Trail Plans and Specifications (9).

White Tank Mountains Regional Park

2.0 PLANNING

2.1 Guidelines

Maricopa County Parks and Recreation Department (MCPRD) will create and maintain Trail System Plans for each park and future development plan including the Maricopa Trail. Trail Plans consist of corresponding maps and designating trails and tracks. Plans involve cooperation with the interested public, department staff, the Parks and Recreation Commission, affected neighboring communities, and government agencies.

All Trail System Plans will be approved by the Department Director. Additionally any fundamental changes to the Trail System Plan will require an amendment to the Plan. Trails in the Trail System Plans should be considered as "Designated" and are subject to County Park rules and State statutes.

Trails (or segments of each) established prior to promulgation of this manual that do not conform to standards may be considered designated and included in a Trail System Plan (including trails designated on service roads). These trails may remain in non-conformance with standards so long as they are judged to be reasonably safe and do not cause significant impact to the landscape. When a segment of tread is realigned or renovated for any reason, it should be designed and constructed according to standards within this manual.

The majority of the trails within the County Parks Trail System should be developed, designated, and maintained for non-motorized and leisurely travel. Modes of travel allowed on trails include pedestrian/hiking, equestrian, bicycling, and OHV use on specified trails only. One or more modes of

travel may be restricted on certain trails; such restrictions should be posted on site and on Park Visitor Maps. OHV trails are specifically designated as such. Travel by motor vehicles on trails and competitive tracks may be allowed for maintenance, administrative purposes, or for emergency response. Such vehicle use is subject to Department policy concerning safety, and protection of facilities and resources.

Equestrian and bicycle use is prohibited on barrier-free trails. Junctions are never permitted between a barrier-free trail to any multiple-use trail or a competitive track.

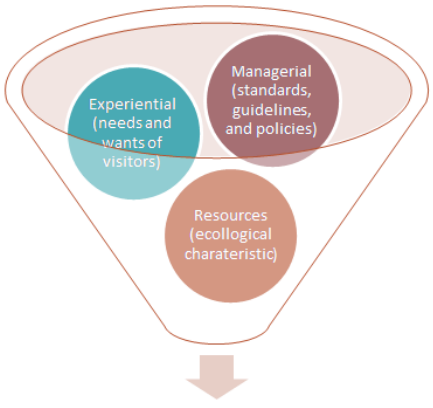
Competitive tracks should be developed, designated, and maintained for non-motorized travel, travel featuring competition, challenges, high speeds, and to conduct organized, competitive event(s). Modes of travel allowed on competitive tracks are running, equestrian riding, and bicycle riding. Travel may be restricted during organized events; prior notice should be posted. Connection of any segment of a competitive track to any segment of trail is prohibited (regardless of trail classification). A buffer must always be maintained between both types.

Access to trails and tracks should be provided via trailhead(s), parking lot(s), and entry gate(s) which have been authorized and developed by the Department as described in section 2.6. Unauthorized entry points should be closed, obstructed, posted, and/or revegetated.

Prior to the construction of a proposed alignment, planning should include an evaluation of biological and cultural resources including; field observation, review of documents on file, and a survey/ assessment performed by a certified professional. Planning and design of such an area should take in to consideration all appropriate levels of supporting facilities for the type of trail/trailhead needed.

2.2 Resource Protection, Carrying Capacity, and Limits of Acceptable Change (LAC)

The quality of trail construction and the frequency of trail maintenance play a significant role in the longevity and sustainability of a trail system. The integration of resource management as well as carefully conceived trail location and design, help prevent or minimize trail use conflicts and stay within the designed carrying capacity for the trail. Protecting both the natural and man-made infrastructure within the park system is imperative. Maintaining a park and its trail system to the highest quality possible is the key to bringing visitors back time and again creating life-long users and advocates.



Natural resources shall be managed to preserve the fundamental physical, ecological and biological processes native to the park ecosystem. Equally as important as protecting the components of this system, is protecting the natural process that creates those components. By protecting both the components and the processes we can prevent resource degradation and avoid any subsequent need for resource restoration.

In order to determine the type of visitor experience to be provided, this manual will utilize the Limits of Acceptable Change (LAC) framework in assessing the park trail system as a whole. LAC is the reformulation of the recreational Carrying Capacity concept with an emphasis on the desired conditions rather than how much use an area can tolerate.

The framework follows 9 steps in assessing the use of an area in order to provide the best possible strategy to manage it.

- Identify Issues and Concerns
- Define and Describe Opportunity Zones
- Select Indicators of Resource and Social Conditions
- Inventory Existing Resources and Social Conditions
- Specify Measurable Standards for the Resource and Social Indicators Selected for Each Opportunity Zone
- Indentify Alternative Opportunity Zone Allocations
- Identify Management Actions for Each Alternative
- Evaluation and Selection of a Preferred Alternative
- Implement Actions and Monitor Conditions

Additional information on how to assess and apply the LAC framework can be referenced in the General Technical Report on *The Limits of Acceptable Change (LAC) System for Wilderness Planning (8).*

2.3 Visitor Experience

Visitor Experience is what a user will take away from their time spent in a park. The visitor experience includes the perceptions, feelings, and reactions a park visitor has in relationship with the surrounding environment. Maricopa County Parks and Recreation Departments Vision and Mission statement best exemplifies what park patrons can expect from their time and experience(s) in any of the Regional Parks.

> *"Our vision is to connect people with nature through regional parks, trails and programs, inspire an appreciation for the Sonoran Desert and natural open spaces, and create life-long positive memories."*

> *"Our mission, through responsible stewardship, is to provide the highest quality parks, trails, programs, services and experiences that energize visitors and create life-long users and advocates."*

2.4 Trail Classifications

Trail Classifications are determined through the planning process, and provide categories of trail objectives, standards, and guidelines. Information within each classification directs design, construction, maintenance, and the use of trails and tracks.

The following five (5) trail classifications should be used for designated trails and competitive tracks*: Barrier-free Trail, Primary Trail, Secondary Trail, OHV Trail and Competitive Track.*

2.5 Planning Objectives for Each Trail Classification

Barrier-free Trail

When planning a barrier-free trail, it is important to consider that the purpose of a barrier-free trail is to provide leisurely outdoor recreation. Leisurely travel requires that all obstacles be removed from the tread for people with mobility, sight, and/or hearing limitations. A barrier-free trail provides users with sitting benches and a hardened surface for easy navigation. The width of this type of trail allows for side-by-side travel and easy passing. Barrier-free trail users experience socializing, and a feeling of being surrounded by nature while enjoying a relaxing stroll. Interpretive signs and displays may also be incorporated into the design and construction of a barrier-free trail. Interpretive elements provide trail users with a sense of discovery, and environmental awareness wh connecting with and being surrounded by nature. Motorized vehicles, livestock, and bicycles are prohibited from using a barrier-free trail. Motorized vehicles may be used for administrative, maintenance, or emergency purposes;

caution must be exercised when using vehicles to avoid damage to hard-surface material.

Primary Trail

A primary trail provides leisurely outdoor recreation and allows for side-by-side travel and easy passing. The function or purpose of a primary trail is to provide users with the ability to exercise and socialize while simultaneously being surrounded by nature. User type is non-motorized multi-use (hikers, equestrians, bicyclists). Interpretive signs and displays may also be incorporated into the design and construction of a Primary trail. All motorized vehicle use on a primary trail is prohibited with the exception of administrative, maintenance, and emergency response purposes.

Secondary Trail

A secondary trail provides both leisurely and challenging outdoor recreation in areas that may be distant from a trailhead and/or have rugged topography. The function or purpose of a secondary trail is to provide users with the experience of an adventure, a sense of discovery, remoteness, and a feeling of connecting with nature. The user type on a secondary trail is limited to non-motorized multi-use (hikers, equestrians, bicyclists). The width of a secondary trial restricts use of all motor vehicles for any purpose.

OHV Trail

The purpose of an OHV trail is to provide leisurely and exciting motorized outdoor recreation. OHV trail classifications are divided into two different rating types. The first type is the Trial Difficulty Level which rates from easiest to most difficult. This rating relates to the riders level of skill necessary to maneuver an OHV on a trail segment. The second rating is called a Trail Exposure Rating and indicates the degree of risk the rider will encounter on a particular trail segment (12). These classifications provided various levels of challenges for the user, as well as offer an adventurous experience over vast distances. When planning an OHV route, it is important to first determine who the trail will be designed for and developed the trail based on the rating level that best supports that user group. Federal and State law apply.

Competitive Track

Competitive Tracks are designed for non-motorized, challenging, strenuous, and high-speed outdoor recreation. Difficulty levels will vary in the track sections to cater to persons with different skill levels (beginner to expert). The direction of travel on a competitive track is restricted to one-way travel. A competitive track offers users a challenge, risk-taking, and vigorous exercise in a natural setting. A competitive track is utilized by non-motorized, multiple-use (runners, equestrian racers, and bicyclists). Use of a competitive track may be restricted during approved organized event(s). Motorized vehicles may be used for administrative, maintenance or emergency purposes on track segments not restricted by width or other obstacles.

SUMMARY OF PLANNING OBJECTIVES FOR EACH TRAIL CLASSIFICATION			
	Trail Objectives	**Experience Objectives**	**User Types**
Barrier-free Trail	Provides outdoor recreation and removes barriers for visitors with mobility, sight, and hearing limitations. Provides sitting benches and a hard-ended surface. Low speed. Non-motorized.	To socialize and have safe unhindered access to an area surrounded by nature.	Pedestrians, including the physically disabled and toddlers.
Primary Trail	Provides leisurely outdoor recreation which allows for side-by-side travel and easy passing. Medium speed. Non-motorized. Administrative access restrictions.	To exercise, socialize, and be surrounded by nature.	Hikers, Equestrians, and Bicyclists.
Secondary Trail	Provides leisurely outdoor recreation in areas that may be distant from an access point and/or have rugged topography. Medium speed. Non-motorized.	To be adventurous, obtain solitude and connect with nature.	Hikers, Equestrians, and Bicyclists.
OHV Trail	Provides motorized outdoor recreation over large areas of land. Motorized.	To be adventurous, competitive, surrounded by nature and travel long distances	Licensed motor-vehicles.
Competitive Track	Provides challenging, strenuous, and high-speed outdoor recreation for individuals, groups, and organized events. Direction of travel is one-way. High speed. Non-motorized.	To be challenged, take risks, be competitive, exercise, and be active in a natural setting.	Hikers, Equestrians, and Bicyclists.

2.6 Park Trail System Plans

Each Regional Park Master Plan includes a separate component called a Trail System Plan. This Plan is an officially-approved planning document that includes trails, tracks, and access points associated with the individual park. It identifies the desired condition of the trail system and lays out a strategy for how it should be managed in the future.

The Trails System Plan is written as an action plan in lieu of a series of recommendations. It includes specific action statements directing the development of designated trails, tracks, and access points. Action statements also direct classification, restrictions (if any), and other management direction as appropriate.

Planning Team

The planning team is identified as a group of people who conduct all aspects of the planning process for each regional parks trail system plan. The team includes the Parks and Open Space Planner, Trails Supervisor, Park Supervisor, and other staff designated by those individuals. The Parks and Open Space Planner is the team leader and is responsible for organizing the planning process and writing/submitting for official approval of the plan.

2.7 Planning Process

When planning a park trail system, the twelve (12) primary planning steps listed below should be followed.

1. Internal Analysis and Review

The Parks and Open Space Planner coordinates and facilitates the planning process, collects background data, and conducts meetings with the management team.

2. Invitations

Develop a mailing list through press releases and invitation letters sent to key members of the public such as special interest organizations, stakeholders, special use permittees, other agency officials, and citizens known to have interest in the park. Persons on the mailing list should be invited to be involved throughout the planning process regardless of whether or not they provide comments (unless they specifically request to be removed from the list). A person may request to be added to the mailing list at any phase of the planning process; their participation will begin at that stage.

The scoping phase should begin within four (4) weeks of the press release and mailing notification. Invitation letters should always be reviewed by the planning team. Additionally, the Department Director should also review and sign the letter prior to dispersal.

3. Scoping

The scoping process can be initiated via email or other social media invitations. A scoping letter is sent to all persons, organizations, and/or agencies requesting to be involved in the planning process. During this phase of the process, the Plan is treated as a clean slate; that is, no assumptions are made that any existing paths are part of a designated trail or track system. The

scoping letter asks for comments and suggestions from participants. Scoping phase outreach must include Department staff. The planning participants including appropriate superintendent if applicable and Division Manager should be given six (6) weeks to return their comments.

Early on in the scoping phase, a public meeting or online forum should be conducted to explain the planning process and give additional details of the project. During this phase, the planning team gathers resource and user data such as ecological, educational, scenic, cultural, and geologic and geographic resources, social and economic factors, and use characteristics. Data may be gathered through sources such as field inventory, study of file documents, interviews with resource specialists, and/or scientific research documents.

4. Analysis

The planning team compiles public comments and resource data. The information is analyzed and the decisions made by the planning team are the basis of the written draft Plan, which may include alternative plans, corridors, based on the public scoping outcomes. Refer to Section 2.5 for Analysis Guidelines.

5. Draft Plan

Write a draft plan which includes proposed designated trails, classifications, access points, service roads, and other action items.

6. Reviewing the Plan

The draft plan is sent to participants on the public and agency mailing list. Participants will be encouraged to return comments supporting and/or disagreeing with proposed actions. Participants should offer reasoning and justification behind their comments. The draft must be reviewed by Management Team as appropriate for coordination with other management programs. A second public meeting or online forum may be conducted if there is no clear alternative or consensus among the stakeholders and/or the public.

7. Analysis and Final Draft

The Parks and Open Space Planner collects and compiles the public comments and revises the proposed actions if appropriate into the Final Draft Plan.

8. Approval steps

The Final Draft is presented to the Management Team and the Director for final review. Next, it is presented for review by the Parks and Recreation Commission. Once approved by the Commission, the Plan is approved by the Parks Director and indicated by a signature on the title page.

9. Notice to the public

Once approved and printed, copies of the Plan should be sent to the planning participants. Additionally, electronic versions should also be made available for download by the public.

10. Appeal

The public will have forty-five (45) days to file a written appeal to a Plan. If an appeal is received, it is reviewed by the Management Team who in turn make a recommendation to the Director who is responsible for deciding to uphold or deny the appeal. If an appeal is denied, the appellant should be notified by mail and no other action will be taken. If the appeal is upheld, revised pages of the Plan will be sent to planning participants. No additional appeal phases should be conducted.

11. Distribution of the Plan

At the conclusion of the appeal period, copies of the Final Plan will be distributed to pertinent Department staff including recording as record. The Final Plan will be made available to the public through the Maricopa County Parks and Recreation webpage.

12. Maintenance of the mailing list

The mailing list should be held by each park supervisor. The list is used for future planning actions such as amendments to the Plan. Any interested person, party, or agency will be added to the mailing list upon request. Planning participants are responsible for notifying the Parks and Open Space Planner of updated addresses.

Amendments to the Plan

As per section 2.1, new trails and track proposals require approval through the amendment process. The amendment process should consist of the planning team gathering and analyzing data concerning the proposed action. The proposal is sent to participants on the mailing list as per step 3. The planning team then follows the remaining steps 4, 5, 6, and 7. Minor modifications to a plan can be authorized by the Director after a 30-day notification on the Department's website.

2.8 Analysis Process

As proposals for trails at specific locations are received, the following set of questions must be answered by the planning team. This analysis process is typically initiated during the public planning process, or when an individual at any time requests the establishment of a new or a realignment of trails, tracks, access points, or a trail segment.

1. Managerial Aspects

- Does the project proposal conform to objectives (Section 2.5) for trails and other resources?
- What is the land ownership status (and associated regulations and specifications)?
- What management actions will be necessary to administer trail use, including the use of formal regulations, signs, and physical barriers?
- Does the project align with the Master Plan for the park?
- Is the proposal compatible with natural and cultural resources management activities and existing facilities?
- How does the proposed trail fit in to the Master Plan for the park in question?
- How does the proposal fit in with future park needs, demands, community changes and departmental plans?
- Does the plan improve connectivity among major destinations within the Park?

Is the proposal cost-effective?

- Are resources (such as funds, personnel, and equipment) available for construction and long-term maintenance?
- Are resources available for management of user behavior?
- Are resources available for providing associated facilities, such as trailhead parking, corrals, water and sanitation facilities, and signs?
- Are long-term maintenance costs expected to be reasonable (stable soils to reduce repair of erosion, locations with reduced expectation of vandalism, etc.)?

2. Land Resource Aspects

- What is the location and placement of the proposed or existing trail and appending structures, including trailhead facilities?
- What is the visual resource provided by the characteristic landscape through which the trail passes?
- What visual impact will the trail have on the surrounding terrain as it is viewed by others from other locations?
- What is the nature of the local geography and climatic effects?
- What is the location and distribution of wildlife, vegetation, watershed, threatened or endangered plant and animal species and cultural resources as surveyed?

3. Potential Impacts

- Will there be significant impacts to cultural and biological resources, other management activities, other Park facilities, or Park visitors?

4. Social Setting

- What is the expected type of use, specifically the mode of travel, and mix of user groups?
- What is the expected volume of use, i.e. the number and frequency of encounters between user groups and the impact of the amount of use on the adjacent physical setting?
- What are the past and projected trends in use (increased or decreased use, changes in use, introduction of new technologies)?
- What are the expected conflicts among user groups?
- Does the project enhance the visitor experience in a significant way?

5. Study Public Issues

- What is the relationship of the trail system to nearby private lands?
- What public issues have been expressed in the past, such as concerns about trespassing, littering, parking, and user conflicts?
- Does a new trail proposal have the support of a significant portion of the public or just a single special interest?
- Does the plan or specific trail in the plan assist in creating greater regional connectivity with other trail systems and communities?

2.9 Access

There are three types of access points within park boundaries that need to be considered as part of the planning process for each park trails plan: Trailheads, Competitive Track Parking Lots, Gates and Access Points.

Trailheads

The Location of trailheads requires coordination with other aspects of the facility including public roads, picnic areas, campgrounds, utilities, etc. Remote location trailhead considerations must include entry gates that limit motor-vehicle access, collection of entry fees, additional security or warnings of the lack of security, etc. Additional information regarding the trailheads can be found in each Park's master plan.

Competitive Track Parking Lots

The location of parking lots requires coordination with other aspects of the facility including public roads, utilities, picnic areas, campgrounds, etc. Ensure parking facilities can accommodate the

potential for large organized events. Locate track parking lots within a manageable distance from other facilities.

Gates and Access Points

In remote areas of the parks, access gates are occasionally necessary to protect both the hikers and the trails from roaming cattle and unauthorized motor-vehicle use. The following five (5) gate styles are typically used when a non-motorized gate entry into a park is necessary: step-over, roll-over, chicanes, rock barrier, and metal swing gates.

Equestrian Access Gate

Gate selection for each access point will depend on the most suitable gate for the trail use and terrain. Most of the trails within the County Park system are non-motorized multi-use trails, which creates the need for multiple types of access gates at any single access point.

When it is necessary to construct a gate entrance into a park or trailhead, the Trails Supervisor and the Park Supervisor will determine the most suitable type of gate for the trail.

Construction consideration for access points utilized by equestrians include: a hardened natural surface at the “control point” where trail users pass through the barriers, a safety zone of 2m (6.5ft) in width to allow for clear access and egress, and a clear trail corridor through the barrier allowing for extended sightlines for both the approach and departure.

Barriers requiring a livestock to step over an obstacle should not exceed 35cm (14in) in height and should be clear of all protruding edges. Step over access gates should be designed with a minimum width of 1.5m (5ft).

Service road gates should be at least 3m (10ft) wide and may double as an equestrian or pedestrian swinging gate.

A rock barrier access point (below) utilizes locally collected rocks which are large enough to prevent an OHV from entering the trail. The rocks should be space approximatly 31cm (12in) apart in order to leave room for other users to safely navigate the barrier.


Service Road and Equestrian Gate

A multipe system gate can serve as a single access point for all trail users on a multi-purpose trail. An example of a muliple system gate (below right) includes a 10ft wide access road gate, an equestrian walk over and a bicyle roll over gate.

Rock Barrier Access

Multiple System Gate

Chicane Access "U" or "V" Design

This type of access entry allows for unhindered pedestrian travel while prohibiting cattle and OHV entry. A "V" shape Chicane has four post points creating a 90° angel at the vertex. The center post should have a width distance of 91cm (36in) from the wire fencing to the vertex post.

A "U" shapped Chincane has five post points. Both the entry and exit width should be a minimum of 107cm (42in) from the outer posts to center post. The Chicane should be 122cm (48in) deep from center post to wire fence. See Illustration 2 below.

Chicane and Equestrian Gate

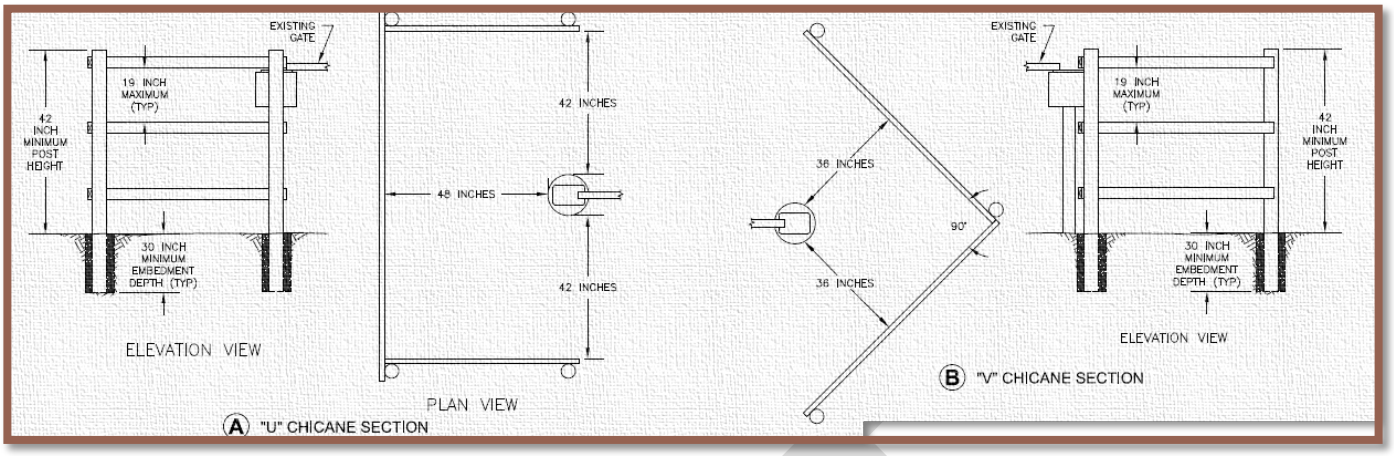


Illustration 2 – Chicane Construction Standards

Fencing

Fencing types and materials utilized within the Parks boundaries may vary. A few examples of material include but are not limited to; post wire, post rail, woven wire, pipe rail, wood, and rock.

Barbed or smooth wire fencing should be zinc coated galvanized steel. Barbed wire should be 12 1/2 gage with two-points. In a flat range type environment with moderate use, posts are typically spaced 7.6m (25ft) apart, with a 1.9m (6ft 3in) stay spacing. Regardless of the type of material utilized, verticle brace posts should be a diameter of 12cm – 15cm (5in – 6in).

A barbed wire fence system should be constructed with three (3) wires. The bottom wire should be placed 61cm (24in) off the ground, followed by a 23cm (9in) space between the remaining two wires.

Pipe rail fencing can range from a single rail to muiltipe rails depending on the fence use and need. Space between each rail should be 23cm (9in) in height.

Service Roads

Service roads should meet standards found in "Standards for Maricopa County Parks' Roadway System". Class V standards are appropriate for roads supporting trails and tracks (7).

Across Park Boundaries

Remote access points may be developed if the following criteria are met:

- There exists a demonstrated public need and demand.
- The access is guaranteed, long-term for the general public.
- In most parks, access is designated for non-motorized, multiple-use.
- Adjacent landowners concur with the establishment of the access.

Access for adjacent residential neighborhoods may be granted if access via the main entrance is demonstrated to be excessively inconvenient. Access should not be granted to serve a selective group of individuals (i.e. one or two homeowners). Parking along residential streets or other roads in close proximity to the access point is prohibited. The road managing agency will be requested to post "No Parking" signs along the roadway. If complaints are received from residents concerning problems associated with the access point, the situation will be studied and appropriate action taken with closure of the access being one of the alternatives.

Access may be granted for connecting trails between adjacent agency trail systems. This includes government and private land trusts holding land for recreational use by the general public. An appropriate agreement is required (intergovernmental agreement, cooperative agreement, or memorandum of understanding). Locations of the access points and trail segments within the park will be at the complete discretion of the Department.

Access may be granted to adjacent private landowners operating a commercial guiding service if it is in the best interest of the public, serves the general public, and the operator is under contract or permit with the County.

When evaluating proposed access locations for a park, refer to the Access Matrix worksheet:
S:\Trails Division\AccessMatrix\Access Matrix_BLANK.docx

White Tank Mountains Regional Park

3.0 DESIGN AND LAYOUT

3.1 Guidelines

Design and layout of trails and tracks is ultimately the responsibility of the Trails Supervisor.

Most Park trails are designed for non-motorized, leisurely, recreational travel. Some modes of travel may be restricted. Design specifications are directed by standards and guidelines for each classification found in Chapter 4. Classification is determined using the planning process in Chapter 2.

3.2 Considerations

After completing the planning process and the construction of a new trail or segment has been authorized, the following considerations will be reviewed during the design phase of trail development.

- **Recreation Opportunities**

  The design of a trail must reflect the intended recreation experience for that area. The type of experience to be provided is based on managerial decision, land resource, connectivity, and social settings.

- **Environment**

  Trail design must involve a study of the following natural resource components:

Soil

Compaction, erosion potential, moisture, texture, structure, and depth of soil can influence tread stability.

Topography

The Sonoran Desert terrain is as diverse as the ecosystem. Trails that complement and flow with the surrounding landscapes are more sustainable and easier to maintain.

Vegetation

The Sonoran Desert ecosystem is more biodiverse than any other desert in North America and is highly influenced by environmental factors. Vegetation density is a critical factor in trail planning.

Climate

Consideration of seasonal weather patterns, especially precipitation resulting in flash flooding should be taken into consideration when planning trail locations.

Wet Areas

Springs, seeps, streams, and riparian habitat are challenging locations in which to construct and maintain trails. Additionally, biological factors have to be given more consideration in these sensitive areas.

Hydrologic Regimen

Trail construction can disturb surface and sub-surface water flow. Various erosion control techniques and features such as outslope, dips, and waterbars can help mitigate damage to the new and existing trails.

❖ Human Factors

Trail design must provide for a pleasurable experience and reflect on management issues such as:

Special Features

Utilizing the natural features of an area such as vistas, geologic features, and water sources can be a major destination factor and provide interpretive/educational opportunities.

Visual Quality

Design the trail to be pleasing to the eye and in harmony with the natural landscape.

Social Behavior

Implement design features that best support the anticipated use of the area while also considering how best to reduce use conflicts, encourage sharing of the trail and traveling in a leisurely manner, etc.

Access for Administrative Activities

It may be deemed necessary to allow vehicle access for trail work, law enforcement, or search and rescue missions. A trail may be located in proximity to service road access.

❖ Landscape Management

A basic consideration in reducing visual impacts of a trail is by minimizing landform disturbances and contrasts.

1. Harmonize with the landscape by minimizing landform modifications. Reduce the size of cut slopes and fill slopes; round the edges and retain large rocks in cut slopes.

2. Utilize a flowing line instead of abrupt changes of gradient and alignment. A trail which is complimentary to the area's topography requires a minimum of earthwork and vegetation clearance.

3. Utilize excavated material whenever possible. Excavated soil and rock can be utilized in filling the tread bench, stabilizing side slope, constructing walls, creating barriers to shortcuts, and covering scarred areas.

4. Retain a maximum amount of vegetation. The trail should undulate among the vegetation appropriately to avoid removal of vegetation. This will preserve the scenery, reduce future vegetation clearance, improve visual quality, function as screening from developments, and/or act as a barrier to shortcuts.

5. Properly dispose of debris. Excess rock, soil, and vegetation must be scattered out of sight or removed from the area to retain visual quality and reduce hazards.

6. Utilize transplanted vegetation and native seed to cover scarred areas and prevent shortcuts.

7. Resolve possible conflicts of landscape management by making common sense decisions on a case-by-case basis. Conflict may arise between methods of management of visual quality. For example, slope rounding is contrary to minimizing size of cut-slopes.

❖ Trailheads

The design of trailheads requires similar environmental and social considerations as trail planning. Plan the size of the trailhead facility in accordance with the carrying capacity of the area to be served while considering growth potential.

Other trailhead considerations include pull-through parking for vehicles with trailers, space for unloading livestock, security of unattended vehicles, water availability, kiosk or information boards, picnic tables, restrooms, roads, utilities, and barrier-free facilities where necessary.

❖ Track Parking Lots

Design of track parking lots requires similar environmental and social considerations as trailhead planning. The size of the parking facility must accommodate large organized events.

Other parking lot considerations include pull-through parking for vehicles with trailers, space for unloading livestock, the security of unattended vehicles, roads, utilities, water availability, and barrier-free facilities where necessary. Where possible the lot should have the ability to be divided into sections to allow for multiple groups or activities. Ideally large lots for major events would have water, electric, sewer and phone (for vending and credit cards) connections in the lot or nearby.

❖ Road Crossings

Road crossings should be avoided, but may occasionally be necessary for the continuation of a trail. Road crossings should be designed with the user's safety as the main concern. The right-of-way should be to the road traffic.

The crossing must be located so that the line of sight is unobstructed in both directions from the trail crossing. See Maricopa County Department of Transportation (MCDOT) standards for required clearance distances (6). Road crossings require warning signs placed on the road and the trail in each direction to warn travelers of the intersection (see Chapter 5 for road crossing sign specifications). It may be necessary to place barriers in the trail to prevent access to unauthorized vehicles.

❖ Purpose of Trails

Multiple-use

Multiple-use trails accommodate hikers, equestrians, and bicyclists and are designed for leisurely

travel. Signing is necessary to educate all user groups, and encouraging cooperation and safe use of the trail. Interpretive signs and displays may also be added to educate or inform the user about various facts of the trail and surrounding area.

During the designing process consider providing access to vistas, activity areas, communities, cultural sites, or other points of interest.

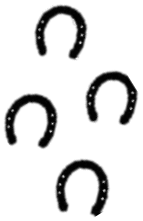
To make all trails conform to barrier-free specifications is neither feasible nor desirable. Trail users vary in ability and experience, therefore offering varied trail conditions and lengths to challenge different levels of ability is highly recommended.

Hiking

Trails for hiking generally require less development than other travel modes and offer maximum opportunity to bring users close to nature. Tread width, vegetation clearance, alignment, and structures are normally on a smaller scale.

Horseback riding

When designing a trail give special consideration to the care and safety of livestock and their riders. Inform visitors when water is not available. Avoid locations where other activities could startle the animals. Vegetation clearance is similar to that for hikers with the exception of increased height.



Livestock can cause severe wear and tear on the trail tread when the soil is wet, soft, or otherwise unstable. Locate trails on stable soil types and on side-slopes where water can be drained away. When crossing a small arroyo, attempt to locate a natural ford instead of constructing a new one. For large arroyos, seek a location with natural undulations that allow for a logical crossing point.

Bicycle riding

Good visibility is necessary to avoid hazards, prevent sudden braking, and avoid minimized site line confrontations with other users. Where possible, provide broad, sweeping turns and minimize the length and gradient of uphill and downhill sections.

Barrier-Free

Barrier-free trails are designed to accommodate users with disabilities; this includes mobility, vision, and hearing impairment. Barrier-free trails feature gentle gradients, short to moderate lengths, frequent resting places, safety rails and curbs, and other features that remove obstacles

along the path. Livestock and bicycles are prohibited from utilizing this type of trail. Do not construct junctions with multiple-use trails.

Consider locating barrier-free trails in an area with existing gentle topography. Side slopes should be less than 40% in grade. Steep side slopes may cause apprehension and may endanger travelers. All supporting facilities (parking lots, restroom, etc.) must be designed in compliance with Americans with Disabilities Act (ADA) Accessibility Guidelines (13).

The addition of interpretive signs and displays to a barrier-free trail can provide an educational experience that enriches the visitors understanding of the environment and achieves selective park management objectives through interpretation. When adding interpretive signs and displays to any multiuse trail considerations the following:

Develop a sound interpretive plan

- ☑ Determine the **specific objectives** of the message
- ☑ Determine the **audience** to be reached
- ☑ Determine the **appropriate media** (i.e., displays, listening systems, brochures) best suited to the message and the audience.

Evaluate

- ☑ If the sites provide the **intended message** and **theme**
- ☑ The sites **expected use**
- ☑ Adjacent **facilities** and **services**
- ☑ General **desirability** of the area

When adding interpretive signs and displays to a barrier-free trail, make reference to ADA Accessibility Guidelines (13), including character proportions, Braille characters, and listening systems if feasible.

Design Considerations for Interpretive Aspects on Barrier-Free Trails

- Inventory the selected site to identify limitations, opportunities, and fragile areas.
- The length of interpretive trails should be less than 1.6km (1mi). Attempt to locate the trail away from distracting activities. A screen of vegetation can correct some distracting conditions.
- Design the message or theme of a trail to achieve management objectives, develop user awareness, and promote enjoyment of the area.
- Space stations to allow the user to absorb ideas. Plan for up to 15 displays or stops per trail, with stations no less than 60m (200 ft) apart. If more than 15 stations are planned, consider using numbered stations with a corresponding brochure.
- Write the text of the message to be easily understood by all users. Indicate in the message why the item is important. Test stations and text with individual representatives of the intended audience before final development.
- Call attention to items to observe between stations, such as birds and animals, by noting them in signs or brochures.
- Do not interpret all items on the trail. Avoid an overload of information.
- Take special care in designing entry signs, brochure distribution boxes, and other signs to present a positive image and a pleasant entrance experience.

❖ Purpose of Competitive Tracks

Competitive tracks are designed for high-speed travel, technical challenge, risk, competitive sport, and organized competitive events. Tracks are designed to strike a balance between allowing some adverse impact to the tread, but not so severe as to become dangerous to users or unreasonably damaging to the land. Unlike trails, tracks may include steep gradients, sharp turns, and other technical features. Tracks should be designated and posted for one-way direction of travel.

Given that competitive tracks are designed and designated for competitive type purposes, education of users is critical to avoid conflicts and hazards. Design and post informational signs to alert users of the challenging nature of travel on the tracks and that those seeking a leisurely travel experience must utilize the trails. (Conversely at trailheads, signs should be posted encouraging users to high speed activities on the tracks and that such activity on the trails is considered reckless).

Utilize the following design considerations for Competitive Tracks:

Design Consideration for Competitive tracks:

- Include "expert" sections with sharp curves, steep up or down gradients, narrow corridors between obstacles, and rugged "hike-a-bike" segments.
- Include sandy, wash bottom segments for testing the endurance of bicyclists, equestrian or runners.
- Include "novice" sections with gentle curves, moderate gradients, clearance from obstacles, and wide tread width.
- Include a mix of wide and narrow tread widths. Wide tread for passing is especially desirable on tracks routinely utilized for organized race events.
- Design stacked loops where feasible to accomodate varing skill levels and to provide adequate distance for endurance.

Service roads for administrative access and medical assistance (especially during organized events) must be located in close proximity and with occasional connection points. Do not locate tracks on long segments of service road. Traffic on a competitive track that doubles as a service road will interfere with emergency assistance.

❖ Purpose of OHV Trails

An OHV Trail is a multi-purpose corridor which has been designated for the purposes of off-highway vehicle use and recreation. OHV use on designated trails can offer a fun and exciting way to access remote and scenic areas which can require greater distances to be traveled. OHV routes may include steep gradients, sharp turns, and other technical features.

Design Considerations for OHV Trails

- OHVers are extremely diverse in their riding skills; be mindful of the trail length and trail type each user group prefers when planning a trail.
- Trail sections with sharp curves, steep gradients, narrow corridors, and rough terrain make for a more technically difficult trail requiring the user to be more advance in order to navigate the trail safely. The majority of OHVers prefer "more difficult" trail ratings.
- Trail loops are highly desirable and offer the rider a consistent difficulty rating level.
- Twists and turns are desirable trail features and help to create a more enjoyable and interesting ride.
- Part of the appeal of OHV recreation is the isolation provided by traveling greater distances. Keep the trail as natural as possible.
- Provide access to areas of scenic interest; destination along the trail will provide a high quality riding experience.

3.3 Layout

Layout work must begin early and be completed prior to construction. The level of detail for location work depends upon the type of facility being designed. A simple, hiker-only trail may require less pre-construction work than a higher-standard barrier-free trail. Regardless of detail, the series of steps remains the same and begins with reconnaissance.

Reconnaissance

The reconnaissance process includes the identification and evaluation of alternative routes which leads to the selection of the best possible alignment and meets the established objectives. Application of sound principles of trail location, alignment, and gradient will minimize future operation and maintenance problems.

Examine good topographic maps, Google Earth and/or aerial photographs of the area to assist identifying significant land forms, drainage patterns, and vegetation. Even with maps, photos, and personal contacts, there is no substitute for on-the-ground examinations of the potential alignment. Determine the location of control points such as ridge saddles, rock outcrops, and clearings, as well as important construction considerations such as heavy vegetation areas, unstable soils, and arroyo crossings. Conduct a systematic study of the area by walking a range of alternate routes and viewing the area from different vantage points. The best location of a trail is identified with thorough and careful reconnaissance.

Control Points

The proper location of a trail is dependent on finding features which facilitate trail construction, reduce costs, minimize labor, and diminish future maintenance. There are also features which make trail construction challenging and difficult. These features are known as control points.

Avoid the following control points as much as possible:

- Wet and flat areas with limited drainage
- Arroyo bottoms
- Rock slides
- Steep slopes and abrupt elevation changes
- Bluffs, ledges, and cliffs except where featured as a scenic resource
- Frequent arroyo crossings
- Heavy vegetation requiring frequent maintenance
- Switchbacks
- Long straight segments
- Locations requiring bridges or culvers
- Fragile vegetation
- Cultural resource sites
- Lightning-prone areas
- Road crossings
- Known habitats of threatened or endangered species of plants or animals
- Fences, cables, or guy wires

Favor areas with the following control points:

- Natural arroyo crossings
- Ridge lines
- Hillside benches
- Natural openings
- Sparse stands of vegitation
- Scenic vistas
- Natural drainages in sloped locations
- Well-drained soils
- Safe and quick crossing of roads
- Good trailhead crossings

Staking/Flagging

Stakes or flags act as a guide to construction so that alignment, gradient, and distances can be easily followed. Locators should utilize proper tools for this activity: clinometer, abney level, topographic map, compass, measuring tape, Google Earth, notebook, etc.

Location is easily accomplished with three individuals acting as surveyor, rod holder, and recorder.

Locate stakes or flags on the trail centerline. The location of dips, walls, retention of selected vegetation, and other special features should be indicated with color-coded flags. Pin flags which mark the exact location of the trail tread should be placed every 3m (10ft) or so.

Place the line where it will avoid trees, rock outcrops, sites prone to erosion, and other features that will increase construction and future maintenance costs. Following the curvature of the land and considering the flow of the trail will produce a more sustainable trail.

Alignment

Trail alignment should follow the contours of the land and consist of a series of gently sweeping curves. Long, straight segments and sharp, angular turns should be avoided.

Alignment should take advantage of natural drainage of the land to minimize the need for major drainage modifications. Locating the trail directly up or down a slope (fall line) will result in water flowing directly down the trail. This can cause severe erosion to the trail and damage to the landscape. Proper drainage is a long-term investment that pays off in reduced future maintenance and reconstruction.

Gradient

The location of the line of the tread is the most important element of trail development; the gradient influences the length of trail, level of difficulty, and drainage and maintenance requirements. Construct the gradient to undulate with natural topography to take advantage of drainage and to avoid continuously climbing gradients which are tiring to the user.

Computing the distance between control points at given gradients can be done in advance of field work. Plot the grade line between control points to determine if switchbacks or other features will be necessary to sustain a certain gradient.

On moderate to steep side slopes, periodically reverse the gradient to create dips for drainage at regular intervals. Drain dips have proven to be superior design features to water bars and are highly recommended for inclusion in new trail construction or reconstruction wherever possible.
Specified gradients for each trail classification are found in Section 4.4.

Drainage

Proper drainage is the most important factor in producing a lasting, low-maintenance facility. Remove water from the trail surface as quickly as possible. Outslope, dips, waterbars, and in slope with ditch and drain, are all features utilized to protect the trail surface from erosion.
Trail surface erosion results from three factors: soil or surface type; velocity of water along the trail;

and distance that running water is allowed on the trail. The most common modification is to reduce the running water distance by increasing the number of structures designed to remove water.

There are two types of drainage structures which should be considered as part of any trail design, renovation and/or construction work. A waterbar is a log or a row of rocks covered with soil which interrupt and deflect water off the trail. A grade dip is a reverse in the gradient of the trail tread. The primary limiting factor for grade dip installation is too short of a run for a given rise. If topography, tread length, or other factors allow installation, grade dips are superior to waterbars. See Chapter 4 for full descriptions of these structures.

Spacing of these structures is dependent on gradient, soil type, location of natural drains, volume and type of traffic, and weather. There are multitudes of waterbar spacing guides available, however landscape conditions tend to be vary; in Maricopa County one dip or waterbar every 15m (50ft) is reasonable. Use common sense to determine proper drainage location for specific trail segments. Tie in waterbars and dips to natural features as much as possible.

All drain outlets must be armored to prevent erosion. Install a rock apron (a layer of larger rocks) at the outlets of waterbars, dips, culverts, fords, etc. See Chapter 4 for full descriptions of these structures.

Arroyo Crossings

Arroyo crossings are important control points. Natural fords are preferred, as arroyo crossing structures may be costly to construct and maintain and, if located poorly, are susceptible to being damaged by high water flows.

Locate arroyo crossings in an area with the following features

- A well-defined arroyo channel.
- Minimal channel width.
- A flat arroyo channel gradient.
- Stable slopes on trail segments leading up from both sides of the center crossing point.

McDowell Mountain Regional Park

4.0 CONSTRUCTION AND MAINTENANCE

4.1 Guidelines and Procedures

1. Construction of a new trail or track requires following the planning process as described in Section 2.7.

2. Realignment of an existing designated trail or track involving a segment greater than 1.0km (0.6mi) in length requires approval of the Management Team.

3. Execution and direction of all trail and track construction and maintenance activities are the responsibility of the Trails Supervisor.

4. Conduct preconstruction analysis and design procedures as described in Chapter 3 in this manual prior to any construction work.

5. All shortcuts, braiding, illegal and vandal routes should be closed and naturalized. Immediately remove all unauthorized markers.

6. All major trail work requires onsite supervision of an authorized project leader. Qualifications include knowledge of the policies, specifications, and guidelines within this manual. Project leaders are authorized by the Trails Supervisor.

7. All trail workers will wear appropriate clothing and utilize proper safety equipment. This includes

long sleeved shirts, long pants, work boots, gloves, eye wear, etc. Do not allow work to proceed if an unsafe situation.

8. Trail edges should never be lined with rocks, unless the Trails Supervisor determines it to be essential for controlling shortcuts and other impacts to off-trail areas.

9. Do not allow adverse impacts to cultural resources and/or plants and animals listed as threatened or endangered species.

10. Remove all project markers (flagging, stakes, etc.) immediately upon the completion of any project.

11. All construction and maintenance should be finished in a manner which preserves the visual quality of the landscape.

Individual Park Trail System Plans			
Park	**Folder Location**	**Total number of trails**	**Competitive Track Loops**
Cave Creek	S:\Trails Division\PLANS\S	8	n/a
McDowell	S:\Trails Division\PLANS\MCDOWELL\final\TEXT.DOC	27	3
Estrella	S:\Trails Division\PLANS\estrella\final\FINAL.DOC	15	4
White Tank	S:\Trails Division\PLANS\white tanks\final\trail system plan.doc	14	3
Usery	S:\Trails Division\PLANS\USERY\FINPLN.DOC	20	n/a
San Tan	S:\Trails Division\San Tan\Plan\final\SanTanTrail_plan_2005.pdf	9	n/a
Spur Cross	S:\Trails Division\PLANS\spur cross\Spur Cross trail plan draft.doc	8	n/a
Lake Pleasant	S:\Trails Division\PLANS\LAKE\FINAL\LPTP_Final_Signed.pdf	10	n/a
Hassayampa	S:\Trails Division\PLANS\HassayampaRiverPreserve\4 HRP_Trails_Plan_FINAL_101016.pdf	6	n/a

4.2 Safety Guidelines

The most important thing in trail maintenance is personal well–being and safety. Worker Assessments: Is the worker capable, what are their physical limitations, do they have the skills and tools they need in order to complete the task safely?

Proper personal gear, clothing, and safety equipment are critical. Leather boots, at least 200mm (8in) high, offer the best support and ankle protection especially when using cutting or digging tools. Ankle–high hiking boots are acceptable for some trail work. Sneakers or tennis shoes do not provide enough support and protection.

Pants rather than shorts give greater protection from scrapes, insects, and sunburn. Long–sleeve shirts are best for the same reasons.

Items to bring when working on a trail:

- gloves
- drinking water
- lip balm
- sunscreen
- sunglasses
- insect repellent
- personal medications
- wide brimmed hat

Remember:
Your most important tool is your brain—use it. Always use proper personal protective equipment (PPE), such as hardhats, gloves, and safety glasses. Make sure a job hazard analysis has been approved and a safety plan is being followed.

Other safety gear that may be need includes: **hardhats, eye protection, ear protection** near most motorized equipment, and **dust masks** for some types of rock work and in extremely dusty conditions. No task should be started without the proper equipment.

The crew should **always have a first aid kit** on hand as well as the training to know how to use it, and a realistic emergency and communication plan.

Tools

Specialized trail tools can help make your trail work more enjoyable.

Pace yourself. Take rest breaks, drink plenty of water, and keep your mind on your work. Crew members should trade off on work tasks occasionally for relief from repetitive stresses.

Keep cutting tools sharp. A dull tool makes your work harder and more dangerous. Before you start, clear away any brush or limbs that might catch a swinging tool.

Posture is important. Stand comfortably in balance. Adjust your stance and tool grip continually to prevent slipping and to avoid glancing blows. Be especially careful when working in wet, slippery conditions.

Be thinking about the consequences of every move. If you are working with a rock or log, think ahead so you are not standing in the wrong place when it moves. Be ready to toss your tool aside and jump free. Avoid cutting toward any part of your body, and watch out for your coworkers. Use skill, not brute force. Maintain at least 3m (10ft) between workers as a safe operating distance when using individual chopping and cutting tools.

When carrying, loading, or storing a cutting tool, cover the blade with a sheath to protect both the sharp edge and yourself. In vehicles, make sure tools are fastened down.

Carry sharp tools at your downhill side. Grasp the handle at about the balance point with the sharpened blade forward and down. If you fall, throw the tool clear.

At the work site, lay tools on the uphill side of the trail with the tool head furthest uphill. Make sure the handles are far enough off the edge of the trail so they are not a tripping hazard. Never sink double-bit axes, McLeods, Pulaskis, mattocks, or similar tools into tree trunks, stumps, or the ground where the exposed portion of the tool will present a hazard.

Tool Safety

Safety is the single most important thing when conducting trail work. Knowing how to use tools properly and safely plays a critical role in the efficiency of the trail construction process. Knowing what to use for each task and when to use it, in addition to practicing the safest techniques can save time and money. ***However, Safety is always the number one priority and should never take a back seat to time or money.*** If you feel something is unsafe, don't do it. Always analyze the project and be sure to list the safety concerns during the pre-job strategy meeting for the project or that day. Some of the key factors in tool safety include, but are not limited to:

- Choose the right tool for the job
- Make sure the tool is sharp or in proper working condition
- Carry the tool properly
- Always have a good grip and good footing
- Watch for people around you
- Have the right PPE

Desert Safety

The Sonoran desert is a beautiful landscape with harsh and rugged conditions. In its beauty there lies an enormous potential for dangerous hazards, whether it be the hot conditions, sharp rocks, plant material with thorns or wildlife that might bite or sting. Workers must always be prepared. A few key tips to remain safe while working in the desert:

- Wear proper clothing for the working conditions, temperature and terrain
- Be aware of the plants and wildlife in the area that could be a potential hazard
- Drink plenty of water
- Always wear gloves - cactus, critters, and sharp rocks are everywhere
- Know your limits

Metric Comparisons

- A millimeter, one-thousandth of a meter, is about the thickness of a dime.
- One inch is just 1⁄64 inch longer than 25 millimeters (1 inch = 25.4 millimeters).
- 150 millimeters is the length of a dollar bill.
- One foot is about 3⁄16 inch longer than 300 millimeters (12 inches = 304.8 millimeters).
- A meter is a little longer than a yard, about a yard plus the width of this notebook.
- A kilometer is about five-eighths of a mile.

To convert from this unit	To this unit	Multiply by
inch	millimeter	25.4*
inch	centimeter	2.54*
foot	meter	0.3048*
yard	meter	0.9144*
mile	kilometer	1.6
millimeter	inch	0.039
centimeter	inch	0.394
centimeter	foot	0.0328
meter	foot	3.28
meter	yard	1.09
kilometer	mile	0.62
acre	hectare (square hectometer)	0.405
square kilometer	square mile	0.386*
hectare (square hectometer)	acre	2.47
degrees Fahrenheit	degrees Celsius	(°F – 32) ÷ 1.8
degrees Celsius	degrees Fahrenheit	(°C x 1.8) + 32
***The conversion factors with asterisks are exact (the others give approximate conversions).**		

1 kilometer
|<----------->|

1 mile
|<----------->|

Trials Crew Hard At Work

Crew performing finishing work on Beardsley Trail, Lake Pleasant

Dozer operator pushing out a large rock on Wild Burrow Trail, Lake Pleasant

Crew splitting a large boulder on Wild Burrow Trail, Lake Pleasant

Crew leader supervising finishing work on Beardsley Trail, Lake Pleasant

4.3 Construction Guidelines for Classification

Trail Priorities

High–quality and timely maintenance will greatly extend the useful life of a trail. The job of the trail's crew is to direct water and debris off the tread, and keep the users on it.

Every trail crew faces challenges with not having enough staff to conduct all the trail maintenance that a busy park system incurs. To meet the proper maintenance specifications under these conditions, how does a crew decide how to prioritize work?

Since it's a given that there will always be more work to do than workers to do it, it's important to:

The best trail maintainers are those with "trail eye," the ability to anticipate physical and social threats to trail integrity and to head off problems.

Monitor trail conditions closely.

- Decide what can be accomplished as basic maintenance.
- Identify what area will need major work.
- Determine what can be deferred.
- Seek an expert's assistance when in doubt.

This prioritization is critically important if maintenance dollars are going to be spent keeping most of the tread in the best possible condition.

1st Priority

Correct unsafe situations - This could mean repairing impassable washouts along a cliff, or removing blowdown from a steep section of a trail.

2nd Priority

Correct issues causing significant trail damage - Such as erosion, sedimentation, and heavy use.

3rd Priority

Restore the trail to the planned design standard - This means that the ease of finding and traveling the trail matches the design specifications for the recreational setting and target user. Actions range from

simply adding "reassurance markers" to complete reconstruction of eroded tread or failed structures. Whatever the priority, doing maintenance when the need is first noticed will help prevent more severe and costly damage later.

Barrier-Free

The objective for a barrier-free trail is to provide an all-inclusive, obstacle free pathway for persons with disabilities, including mobility, visual, and hearing impairment. Interpretative aspects can be added to a Barrier-free trail thus creating a more educational recreation experience for the user. Barrier-free trails are of short to moderate length with frequent pull-outs for resting.

The surface can be hardened with concrete, asphalt, or soil cement. Protection from drop-offs should be provided commensurate with safety concerns and site conditions. Curbs, handrails, or other types of barricades must be installed to keep trail users on the path.

Utilize culverts or bridges for drainage crossings. Do not construct steps, dips or waterbars.

Bridges may be constructed to maintain proper gradient across broken topography. Bridges should have non-skid material. Wooden bridges must have board's perpendicular to the direction of travel and close together to prevent wheels, crutches, or other devices from lodging in cracks.

Barrier-free trails should be located in areas with gentle topography. Avoid constructing barrier-free trails on side-slopes greater than 40%. Switchbacks should be avoided as this requires an immense amount of excavation.

Design and construct all new facilities in compliance with ADA Accessibility Guidelines.

Barrier-free trails are closed to livestock and bicycles. Wheelchairs, Mobility Aids, and other Power-Driven Mobility Devices are allowed. Motor-vehicles may be allowed for administrative purposes and emergency situations only.

Primary

The management objective for primary trails is leisurely, non-motorized, multiple-use. They usually occur within areas of gentle topography. The tread is wide, allowing for side-by-side travel by hikers, easier passing by livestock and bicycles, and travel by certain all-terrain motor vehicles for essential administrative purposes and emergency situations. Grades of primary trails are generally easy with short, steeper segments allowed and sustained grades of 10% or less. Due to the large tread width, minimal vegetation clearance beyond the tread edge is necessary. Steps are not installed on primary trails. Block and fill may be used to stabilize severely eroded tread.

Secondary

The management objective for secondary trails is leisurely, non-motorized, multiple-use. Secondary trails generally occur in areas with rugged topography. The tread is narrow for minimal disturbance to the landscape and requires single file travel by all users. Travel by motor vehicles for any purpose is not recommended since vehicles exceed the tread width causing damage to the landscape. Grades of secondary trails may be steeper with sustained grades of up to 15% and short segments of up to 20% allowed where essential. Vegetation clearance is the same as for primary trails. Steps may be used on secondary trails where determined to be essential. See section 4.5 for details.

OHV Trail

The management objective for an OHV trail is to provide motorized recreation on a designated route which allows for long distance scenic travel over rural and rugged terrain. The tread grades vary depending on the desired rating level of the trail. The more vegetation, tight curves, and obstacles within the trail corridor, the higher the difficulty rating the trail will have. OHV trails should extend over long distances and offer both technically challenging trail sections as well as smooth trail sections for a more leisurely experience. OHV trails should be kept as rugged and natural as possible, with minimally developed facilities along the route.

Competitive Track

The management objective for a competitive track is sport, competition, high speeds, technical challenge, and organized events. The principle user type will be bicycle riders, but competitive tracks are designated for non-motorized, multiple-use. Signs will include messages to inform users of the competitive nature of travel intended for the tracks. Users seeking a more leisurely experience will be directed to utilize the trail system. Likewise, signs at the trail access points will direct users seeking a competitive experience to utilize the competitive tracks and that universally accepted etiquette is required on the trails.

Competitive tracks should be multiple loops of varied distances, located in varied topography to accommodate varied skill levels. Tracks are designated and signed for one-way travel only.

Competitive tracks may have sharp corners with berms, bumps, steep grades, and other features that are not found on trails. Serious hazards are removed.

The tread may be wide and grades may be extremely steep. Sustained steep grades (>10%) should be constructed with grade dips. Switchbacks should be avoided. Minor trampling of vegetation along the tread edge is acceptable, however short-cutting at corners or between loops is not allowed.

Travel by motor-vehicles may be allowed for administrative purposes and emergency situations.

Tracks are not located in sensitive areas where other park users, wildlife, cultural resources, or threatened or endangered species will be negatively impacted.

Organized events on competitive tracks are allowed according to Maricopa County policy covering special use administration. Upon completion of a competitive event, tracks should be maintained to ensure compliance with specifications established in the manual.

4.4 Specifications for Trail Classification

The following specifications should be utilized for all new tread construction and maintenance of existing tread (except as exempted under section 2.1):

Barrier-Free Trail

Outslope - 2% - Provide 10cm (4in) high curbs at drop-offs judged to be hazardous. Construct drainage scuppers in curbs at minimum intervals of 3m (10ft). Provide railings 86cm - 96cm (34in - 38in) in height (or other feasible safety guards) at drop-offs greater than 80cm (31in).

Vegetation width - Remove all vegetation and those parts of extending into the clearance limit. Dead vegetation will remain in place unless considered a hazard or obstruction. Cuts must be flush with the trunk, branch, or ground level. Remove all downed logs and branches (including saguaro cactus) which have fallen across the trail. The clearance limit should be equal to the tread width. Provide rest stops every 60m - 90m (200ft - 300ft). Each rest stop should consist of a level pad with a sitting bench and space for a wheelchair. Pad dimensions should be a minimum of 0.6m x 1.5m (2ft x 6ft). The trail may be a hardened surface.

Primary, Secondary, and Competitive Trails

Outslope - The start and finish segments should be a minimum width of 2.5m (8ft) for a distance of 50m (165ft) in length. Do not exceed 3m (10ft) width on side slopes greater than 10%.

Vegetation - Remove all woody vegetation and those parts of woody plants extending into the clearance limit which exceed 5cm (2in) basal diameter and 1m (3ft) in height. Dead vegetation will remain in place unless considered a hazard or obstruction. Cuts must be flush with the trunk, branch, or ground level. Remove all downed logs and branches (including saguaro cactus) which have fallen across the trail. The clearance limit should be equal to the tread width.

**See Non-Motorized Trail Construction and Maintenance Standards Table on the page 49.*

The following diagram, illustrates how MCPRD rates trails within the park system.

Trail Rating Guide

During the hotter months when the temperature and or humidity is high, trails will be rated at least one level higher

Rating Symbol	Brief Definition	Surface	Grade	Obstacles /Steps
easiest	Paved Accessible Trail	Paved or hard and smooth		None
easy	Mostly smooth and wide	Dirt with occasional unevenness		2" or less, rocks and ruts
moderate	Mostly smooth, variable width	Dirt with occasional unevenness		<8" rocks and ruts, loose material
mod. difficult	Mostly uneven surfaces	Dirt and rock		<12" rocks and ruts, loose material
difficult	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness		12" or taller, loose rocks, exposure to drops
extremely difficult	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness		12" or taller, loose rocks, exposure to drops and excessive heat >90F

OHV Trails

For OHV trials, trail difficulty is typically rated with the following three (3) labels: easiest, more difficult, and most difficult (14).

In addition to trail difficulty ratings referenced above, the following five trail class ratings will also be considered when constructing and maintaining an OHV Trail:

- **Trail Class 1 –** Minimally developed
- **Trail Class 2 –** Moderately developed
- **Trail Class 3 –** Developed
- **Trail Class 4 –** Highly developed
- **Trail Class 5 –** Fully developed

Typically the trail rating, trail class, and the desired trail experience will define the trail, as well as the standard construction practices and maintenance required for the tread and trail corridor. However, Trail class 2 through 4 are typically designed and constructed as follows:

Motorized Trail Construction and Maintenance Standards

Designed Use: All-terrain vehicle		Trail Class 2 Simple/minor developed	Trail Class 3 Developed/improved	Trail Class 4 Highly developed
Design tread width (If sideslopes are more than 50 percent, increase widths by 6 to 18 inches)	**One lane**	48 to 60 inches	60 inches	60 to 72 inches
	Two lane	Typically not designed for two-lane travel Passing areas (uncommon) 108 inches	Typically not designed for two-lane travel Passing areas (common) 108 inches	Two-lane travel (common) 108 to 120 inches
	Structures (minimum width)	60 inches	72 inches	78 inches
Design surface	**Type**	Native, with limited onsite borrow or imported materials Few loose or soft trail segments, commonly rough	Native, with some onsite borrow or imported materials No loose or soft trail segments, occasionally rough	Native, with extensive gravel, pavers, or other imported materials Firm and stable
	Obstacles	Rough, with embedded rock, holes, and protrusions up to 6 inches	Generally smooth, with few protrusions exceeding 4 inches	Smooth, with few obstacles exceeding 1 to 3 inches
Design grade[1] (also referred to as target grade in Alaska)	**Target range** (more than 90 percent of trail)	Less than 15 percent More than 3 percent	Less than 12 percent More than 3 percent	Less than 10 percent More than 3 percent
	Short pitch maximum (up to 100-foot lengths—with appropriate water control above and within pitch)	25 percent on rock or bedrock 20 percent on soil	20 percent on rock or bedrock 15 percent on soil	15 percent
	Maximum pitch density[2]	Less than 15 percent of trail	Less than 10 percent of trail	Less than 5 percent of trail
Design tread cross slope (outslope)	**Target range**	5 to 10 percent	3 to 8 percent	3 to 5 percent
	Maximum	15 percent	10 percent	8 percent
Design clearing	**Width** (on steep sidehills, increase clearing on uphill side by 6 to 12 inches)	12 inches outside of tread edge Some light vegetation may encroach into clearing area	12 to 18 inches outside of tread edge	More than 18 to 24 inches outside of tread edge
	Height	7 to 8 feet	8 feet	10 feet
Design turns	**Radius**	15 feet minimum	15 to 20 feet minimum	20 feet minimum
	Type	Climbing turns (switchbacks only when absolutely necessary)	Climbing turns	Climbing turns
Water control[3]	**Type**	Grade reversals Dip drains Rolling grade dips No water bars	Grade reversals Dip drains Rolling grade dips No water bars	Grade reversals Dip drains Rolling grade dips No water bars
Sustainable trail design	**Elements**	Contour alignment Controlled grade Integrated drainage Full bench Durable tread	Contour alignment Controlled grade Integrated drainage Full bench Durable tread	Contour alignment Controlled grade Integrated drainage Full bench Durable tread

Table Referenced from USDA Designing Sustainable Off-Highway Vehicle Trails - An Alaska Trail Managers' perspective. (2013). (10).

For additional information on OHV trail construction and maintenance see references (4), (9), (10) and (12).

Non-motorized Trail Construction and Maintenance Standards

		BARRIER-FREE TRAIL	PRIMARY TRAIL	SECONDARY TRAIL	COMPETITIVE TRACK
Max Sustained Grade		5%	10%	15%	20%
Tread Width		2.1m (7ft) (two-way), or 1.5m (5ft) (one-way)	1.2m (4ft) wide	0.6m (2ft) wide	Up to 3m (10ft) wide
Max Grade		8% (for 1/10th or less of total length) max. grade	15% max. grade Distance for max. grade should not exceed 30m (100ft) in length	20% max. grade Distance for max. grade should not exceed 7m (25ft) in length	(No limit) max. grade Distance for max. grade should not exceed 30m (100ft) in length
Outslope		2%	5-10%	10%	3m (10ft) max.
Vegetation Clearance	**Width**	30cm (12in) from tread edge	2m (6ft) clearance width 30cm (12in) from tread edge	2m (6ft) clearance width 30cm (12in) from tread edge	30cm (12in) from tread edge
	Height	2.4 (8ft) from tread surface	3m (10ft) from tread surface	3m (10ft) from tread surface	3m (10ft) from tread surface
Switchback Grade Through Turn		3%	5%	5%	5%
Grade on Approach		3% for 3m (10ft) 5% for 15m (50ft)	5% for 2m (6ft) 10% min. for 15m (50ft)	5% for 2m (6ft) 15% for 15m (50ft)	5% for 2m (6ft) 15% for 15m (50ft)
Turning Radius At Centerline		5m (16ft)	3m (10ft) min.	1.2m (4ft) min. 1.8m (6ft) max.	1.2m (4ft) min. 1.8m (6ft) max.
Junctions Corners Recessed		1.5m (5ft)	1m (3ft)	50cm (1.5ft)	As necessary to facilitate one-way travel.

For specified short distances where essential.* may be utilized for dips, arroyo crossings, and certain trail segments where essential to avoid rock outcrops and vegetation for a distance

4.5 Construction Elements

Vegetation Clearance

This work consists of clearing, grubbing, trimming, removing, and disposing of live and/or dead vegetation, construction slash, and debris within the vegetation clearance limits for all classifications of trails. See Illustrations 3 and 3.1

Cut vegetation within the clearance limits listed in Section 4.3 according to each trail's classification. Cut vegetation as close as possible, flush to the ground (or slightly below the duff layer) or flush to a main stem. Do not leave stubs or "hat racks". Trim prickly-pear and Cholla cactus at the joint between segments.

Remove all vegetation growing directly on the trail tread, except low grasses and forbs. Grub out all stubs and stumps from the trail tread.

Try to retain a natural appearance by carefully choosing the points to cut. Avoid an appearance of a "hair cut" or manicured hedge.

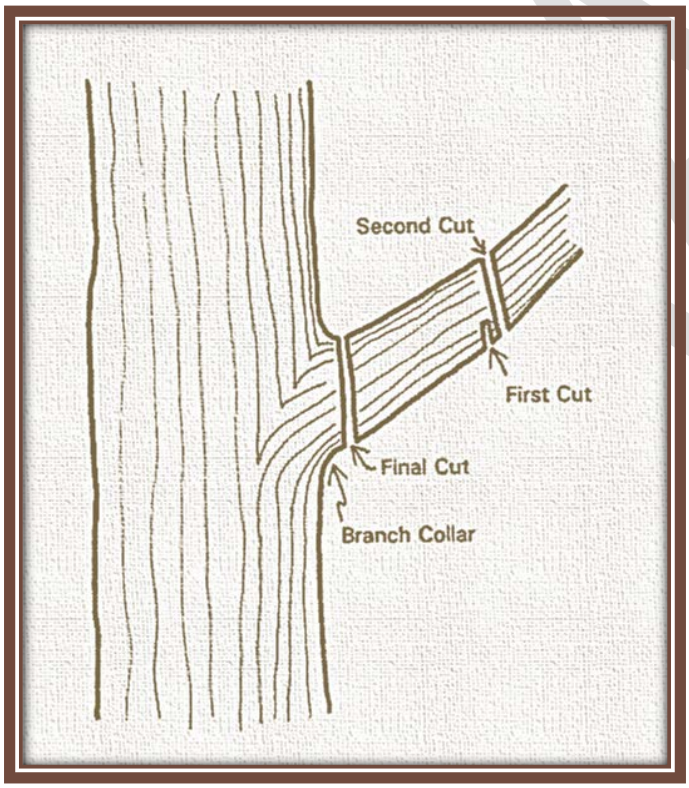


Illustration 3 - Vegetation Clearance

Where large trees are near or within the clearance limit, study the possibility of slightly realigning the trail to reduce maintenance needs and to retain the maximum amount of vegetation in the natural environment.

Felling, cutting, and trimming should be done so as to cause no tearing of the bark or other damage to remaining vegetation. Use saws or shears for this work; do not use axes.

The best way, generally, to prune tree branches is to make three cuts with a handsaw: one partial cut from underneath away from the trunk; a second cut from the top of the branch above the first cut - which snaps off the weighty branch; and the third, final cut to remove the remaining stub.

The final cut should not be precisely flush with the trunk, but slightly in front of the branch collar to reduce the size of the wound and assist healing.

All cut vegetation should be scattered out of sight of the trail. When located on a side slope steeper than 20%, debris should be scattered on the downhill side. Flatten debris on the ground; avoid large piles. Whenever possible, cut vegetation should be utilized for obliterating shortcuts or as mulch for revegetation. See Section 4.6 for discussion of revegetation. Standing dead vegetation may remain within the clearance limits. Remove if determined to be a hazard or obstruction.

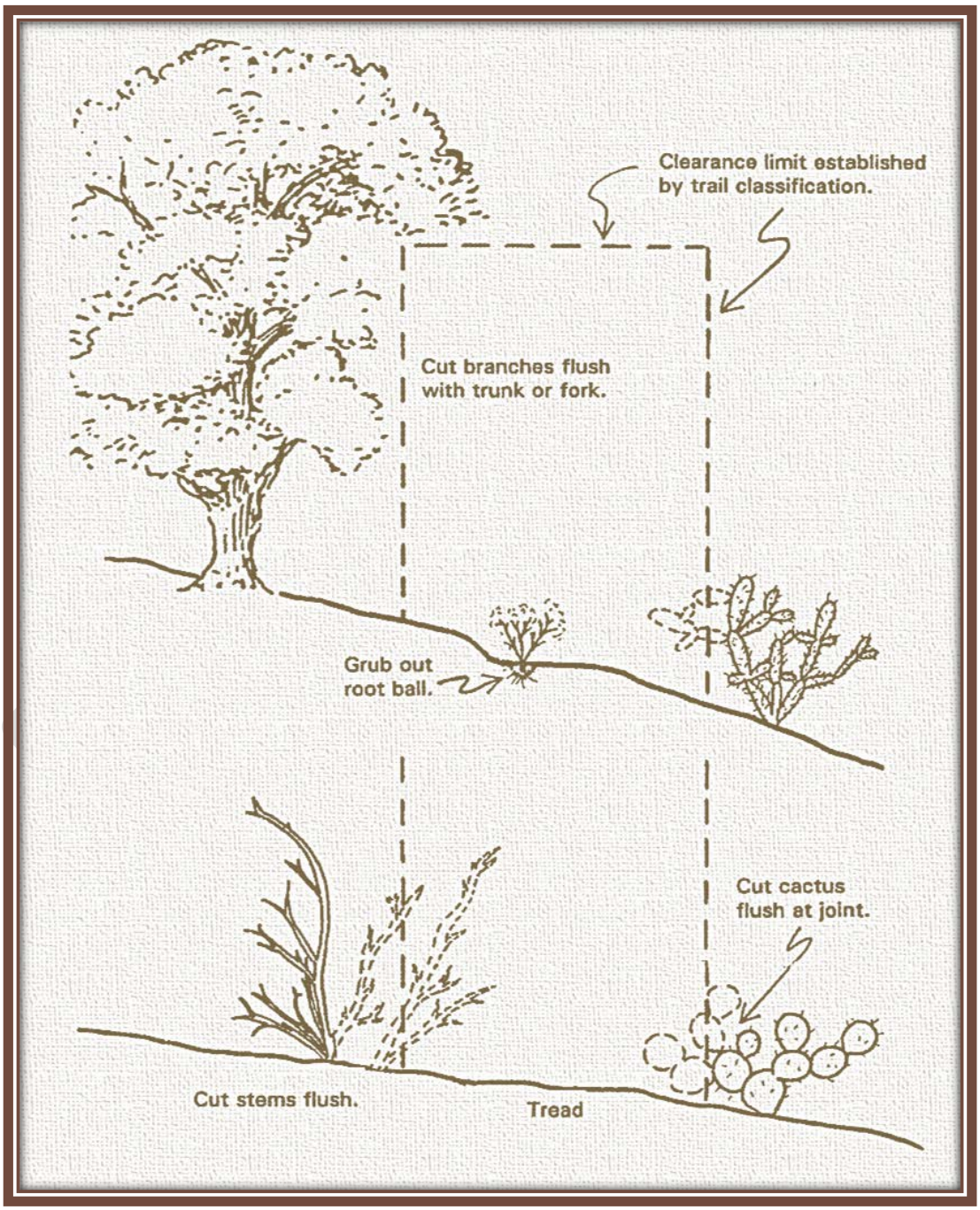


Illustration 3.1 - Vegetation Clearance

Proper Pruning Techniques

Always trim trees flush with the trunk or at the nodes of branches

Improper Pruning Techniques

Leaving stubs is not in the best interest of the tree's health but it also looks bad

Unnecessary Tree Removal

Necessary Saguaro Removal

Tread Construction

This work consists of excavation and embankment construction required to shape and finishes the trail tread, backslope, and fills lope. Associated work includes the construction of dips, fords, arroyo crossings, talus sections, and retaining walls; these items are covered in separate sections.

Construct the tread as shown in Illustration 4. A full bench should be constructed on side slopes greater than 40%; up to ¼ of the tread width may be fill material on side slopes of 30% - 40%; and up to half of the tread width may be fill material on sideslopes of 10% - 30%.

Excavation is not necessary on side slopes less than 10%. Simple clearing of vegetation followed by the imprint of boots is often sufficient to create a tread on near-level ground. Embedded rock may be allowed to remain in the tread if it is not a significant obstacle. The tread should have outslope as noted in the specifications for that trail classification.

The only section of a trail where in slope may be constructed is the upper approach of a switchback and other locations utilizing a lead-off ditch and crossover drain. All suitable excavated material should be conserved and utilized in the tread, fill bench, rip-rap, walls, etc. If necessary, fill material may be imported from a borrowed source, either an on-site location approved by the Park Supervisor or a material pile in the maintenance yard. For trails with a surface of native material, such fill material must be similar in composition to the native soil.

Excess and unsuitable material should be scattered on the downslope side or utilized as loose rip-rap to protect the fill slope. Place debris in a manner which ensures no blockage of drainage or impacts to the visual quality of the landscape.

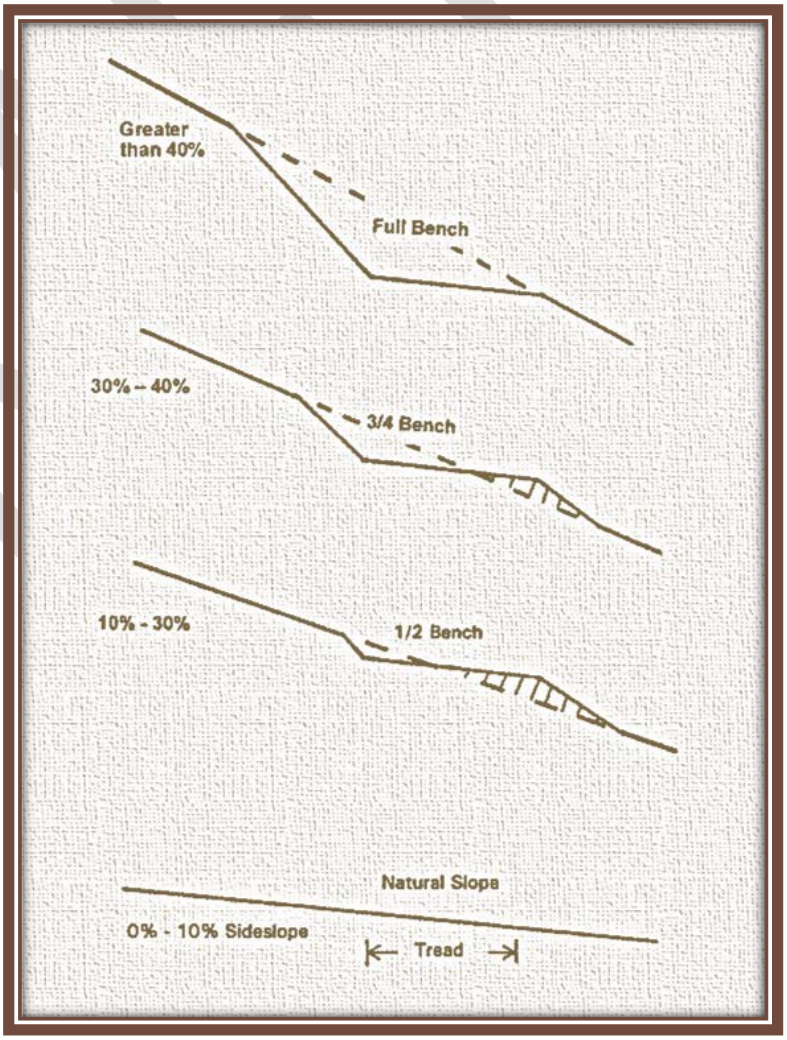


Illustration 4 - Tread Construction

Construct tread on talus slopes as shown in Illustration 5. Tread should be constructed by building up a bench on the slope instead of removing rocks down to mineral soil; this would result in creation of a trench. Firmly place rocks on the outside slope to stabilize the bench. Place rocks according to specifications for retaining wall or rip-rap construction as necessary. Fill material can be imported to form the tread. All voids within 30cm (12in) of the tread surface should be filled with rock and mineral soil, and a cap of fine mineral soil of at least 10cm (4in) depth.

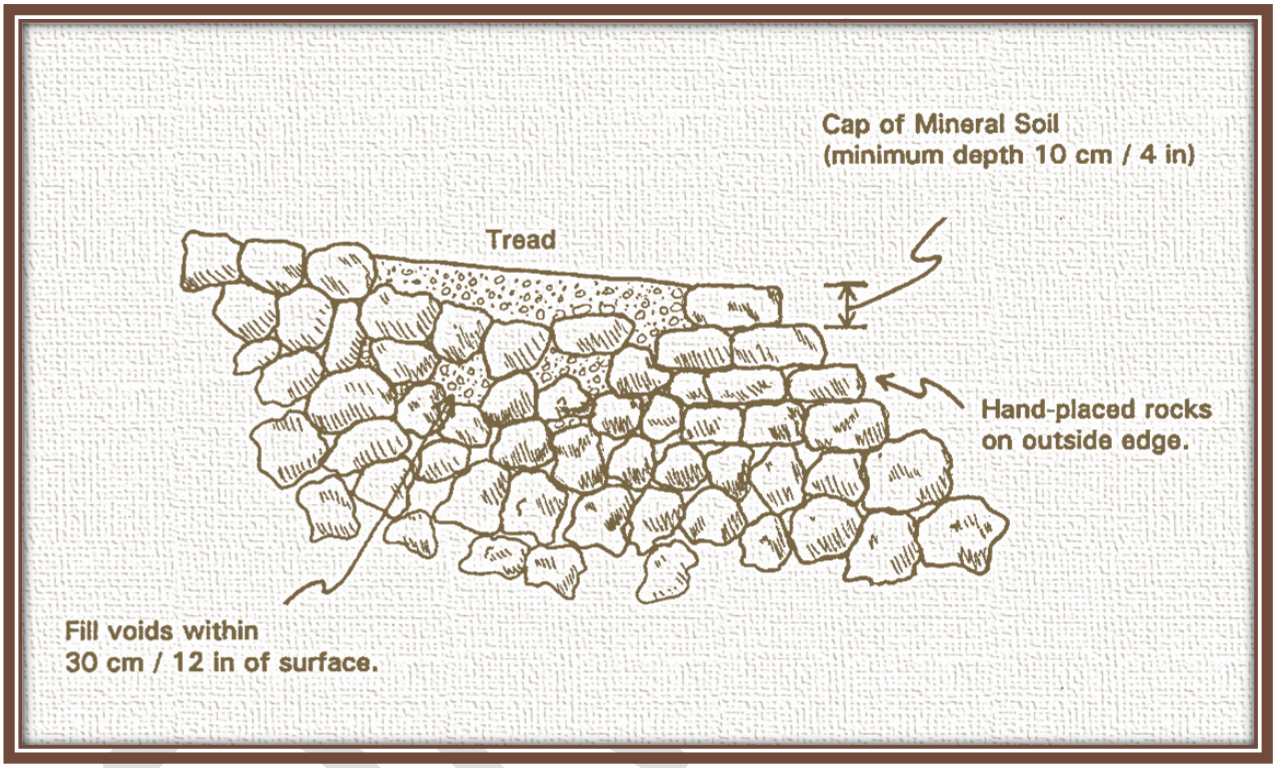


Illustration 5 - Tread Construction on a Talus Slope

Tread Reconstruction

Tread reconstruction consists of restoring the tread to meet construction specifications including but not limited to; filling ruts, scraping slough and berms, shaping backslopes and fill slopes, and otherwise reconstructing a finished tread.

Restore the tread bench to specifications shown in Illustration 4. The tread should have outslope as noted in the specifications for each trail classification.

Scrape slough and berms to level the tread as shown in Illustration 6. All suitable material should be conserved and utilized in the tread, fill bench, rip-rap, walls, etc. If necessary, fill material may be imported from a borrowed source, either an on-site location or from a material pile in the

maintenance yard supervisor approval. For trails with a surface of native material, the fill material must be similar in composition to the native soil.

Unsuitable material should be scattered on the downslope side or utilized as loose rip-rap to protect the fill slope. Place debris in a manner which ensures no blockage of drainage, creation of a windrow effect, or impacts to the visual quality of the landscape.

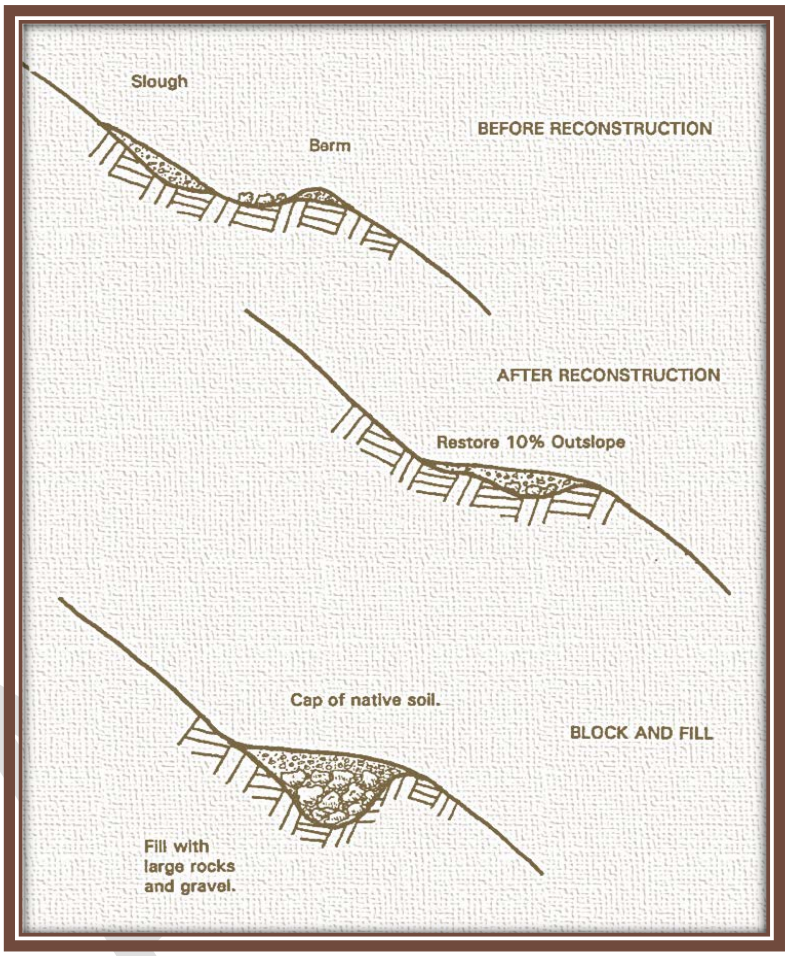


Illustration 6 - Tread Reconstruction

Large ruts in severely eroded tread may be repaired with a "block and fill" technique. The intent is to restore the tread to the original surface level. This should be accomplished in stages; beginning with filling in the rut with large rocks to a point below the finished surface level. Then adding gravel and dirt until the rocks are covered. Finish with a cap of native soil up to the desired level. If the existing tread exceeds the standard gradient for its classification and there is excessive erosion damage or hazardous conditions, a new alignment should be constructed to meet specifications as per Section 2.1.

Drainage Structures

Grade Dips

This work consists of constructing tread with a grade reverse to that of the prevailing grade and installing a rock apron. Grade dips are most effective when installed in new tread construction or realignment.

On existing tread, a dip may be installed to enhance a small natural cross drain. For large natural cross drains, see Illustration 13 for construction methods for watercourse crossings.

Illustration 7 demonstrates grade dip construction at a logical point along the prevailing downgrade,

reverse the grade for a short distance and then continue the downgrade direction. The reverse grade segment should be a minimum of 3m (10ft) in length and a minimum gradient of 5%.

On a sustained downgrade, a regular spacing of grade dips is required. As noted in section 3.3, a frequency of one dip per 15m (50ft) is appropriate. As much as possible, tie in the spacing to natural cross drains and the natural arrangement of vegetation, large rocks, and other features.

At the low point of the dip, maintain a proper outslope to facilitate complete drainage and eliminate formation of a mud puddle. Install a rock apron to reduce erosion potential.

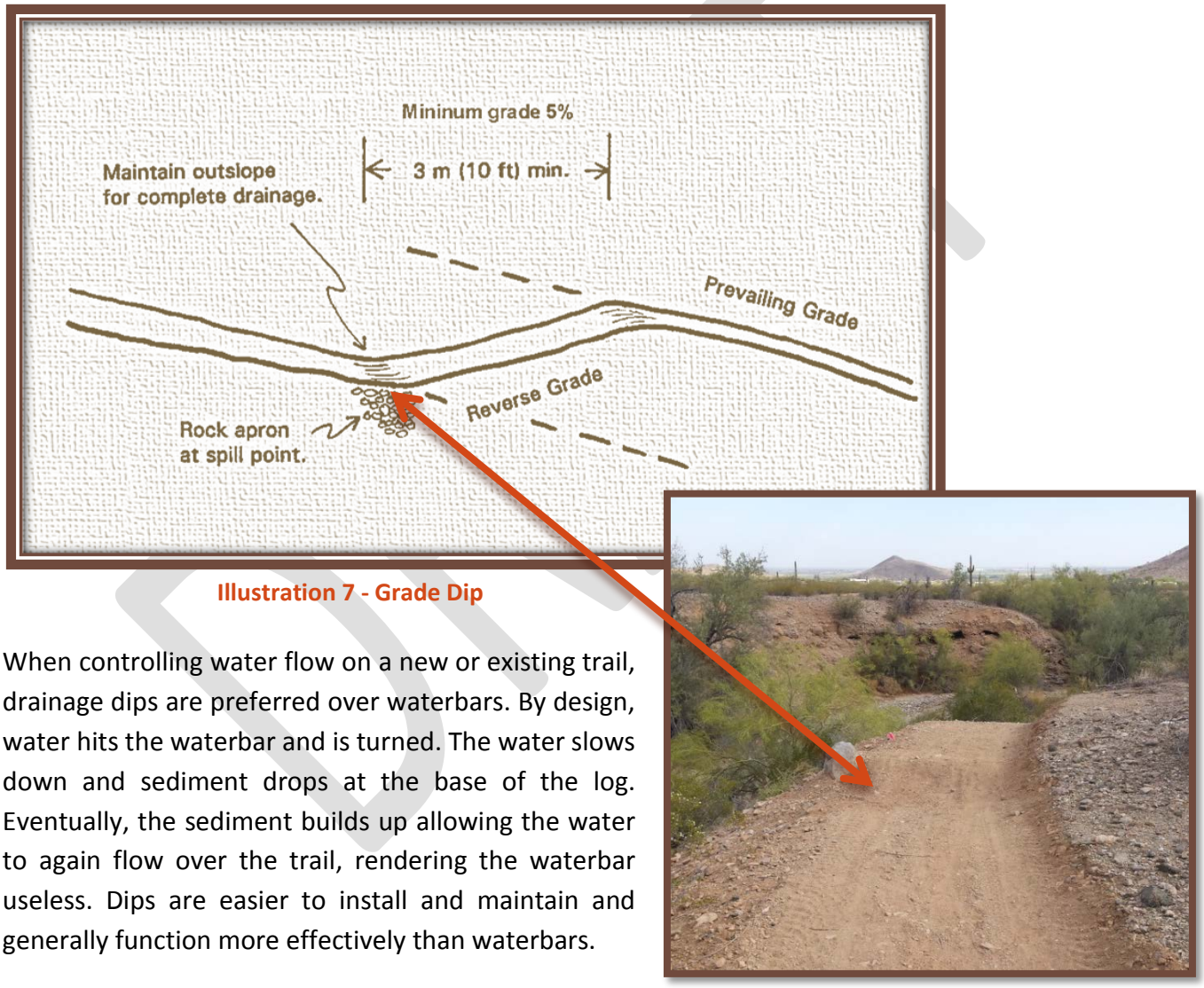


Illustration 7 - Grade Dip

When controlling water flow on a new or existing trail, drainage dips are preferred over waterbars. By design, water hits the waterbar and is turned. The water slows down and sediment drops at the base of the log. Eventually, the sediment builds up allowing the water to again flow over the trail, rendering the waterbar useless. Dips are easier to install and maintain and generally function more effectively than waterbars.

Waterbars

This work consists of excavation, installation of rocks or logs, backfill, and rock-lined spillways. Rock is the preferred material for waterbars; wood will rot eventually, and additional material for anchoring is required.

Waterbars should be installed at an angle of 30% to 60% from the direction of travel. All waterbars should extend a minimum of 30cm (1ft) beyond each outer edge of the tread or farther as needed to ensure complete diversion of water from the trail on a steep sideslope. On steep sideslopes, the upper end of the waterbar is buried at least 30cm (1ft) into the cut bank, while the lower end is flush to the drop-off point.

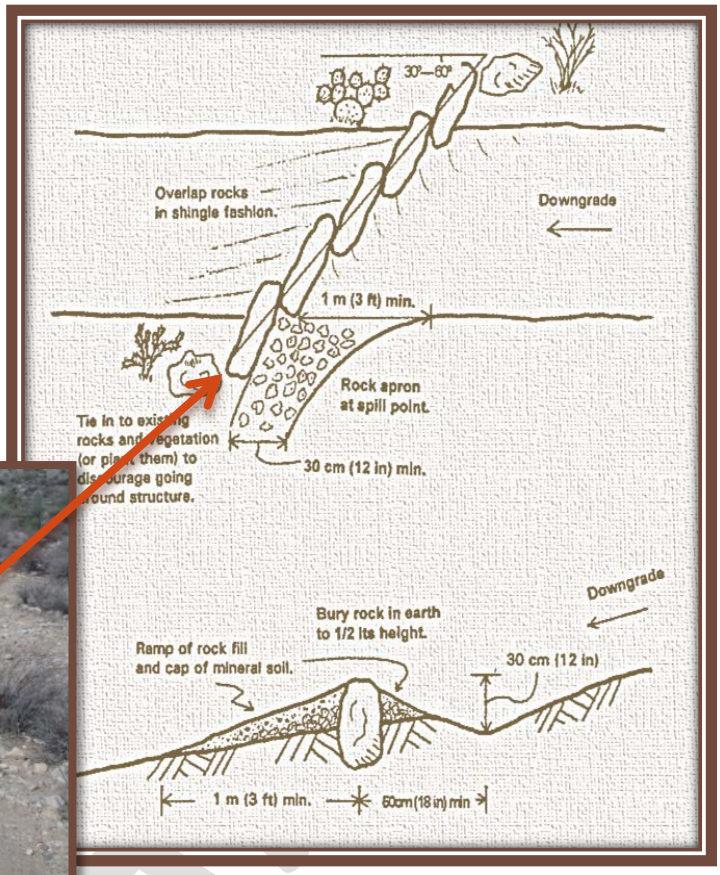


Illustration 8 - Rock Waterbar

A finished waterbar has an appearance similar to a grade dip. Use fill material to create an embankment against the downgrade side of the waterbar to act as a ramp. A smaller embankment is compacted against the upgrade side to serve as a shorter ramp and to guide water into the drain spillway.

A drain ditch should be constructed to provide proper runoff from the tread. It should be at least 30cm wide (12in) and 24cm (8in) deep. Install a rock apron where there is potential for erosion at the spillway. Place rocks in a manner which do not obstruct water flow. Typically it is necessary to place loose rocks, deadwood, and/or transplanted vegetation at the trail edges to discourage travelers from going around the structure.

On a sustained downgrade, a regular spacing of waterbars is required. As noted in Section 3.3, a frequency of one dip per 15m (50ft) is appropriate. Tie in the spacing to natural cross drains whenever possible.

Construct as shown in Illustration 8.1. Embed large rocks into the tread. A rectangular shape is best,

and rocks must be large enough not to be knocked over by travelers, including livestocks, nor spilled over by water. Bury at least ½ of the rock depth into the tread. All rocks will be set in a shingle fashion, tightly overlapping each other towards the downslope side. Compact rocks and fill dirt around the base of the rocks to solidify the structure. Add fill material to make rolling ramps as described above.

Culverts

This work consists of excavation, installing a metal, plastic, or rock culvert, backfilling, and constructing headwalls. In the Sonoran Desert where most arroyo channels flow only seasonally, culverts should only be used sparingly as may detract from the natural environment. They require more maintenance than a drain dip or waterbar, and may cause damage to the tread if clogged.

Culverts should only be installed where maintaining a gentle grade is essential such as a barrier-free trail. They might also be installed as an outlet for an upslope drain ditch.

Culverts are most effective in natural drains where minimum excavation is required. To facilitate continued performance, the culvert drain is inclined at a downstream gradient of at least 3%. Utilize a drain diameter no less than 30cm (12in) for ease of cleaning.

The length of the culvert should be a minimum of 30cm (1ft) longer than the tread width. The tread should be raised a minimum of 15cm (6in) above the top of the culvert pipe or rocks. Install end scoops if appropriate. The headwall will wrap over the top of the culvert to the tread edge.

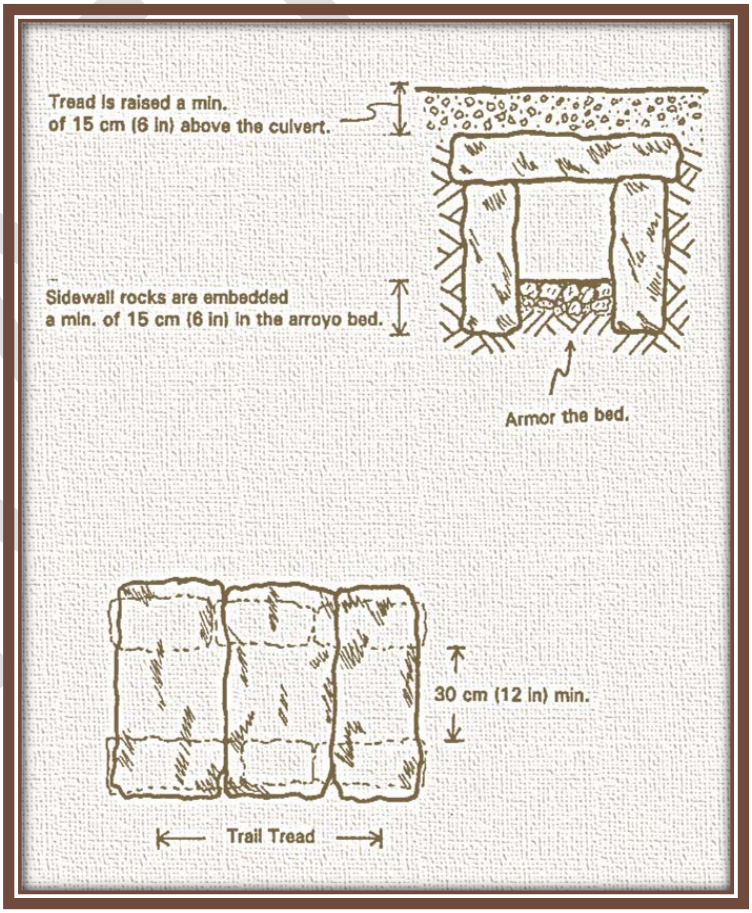


Illustration 9 - Rock Culvert

Rock Culvert

A rock culvert requires careful selection of rocks that are of sufficient size, proper shape, and firmly embedded into the arroyo bed to support travelers. The base of the drain is armored with rocks to prevent erosion. These rocks should be placed in an excavated terrace so that they will not obstruct the flow of water. Construct a headwall of native stone to armor the outside faces of the tread crossing and to ensure visual quality. Embed the stones

into the arroyo bed and banks. All stones should be placed firmly, with the same stability of a retaining wall. See Illustration 9.

Pipe Culvert

The pipe should be bedded in a stable foundation of gravel and soil shaped to fit the pipe exterior, then backfill the area with compacted gravel and soil and paint the exposed culvert. Remove deadwood, rocks, or other debris which may clog the pipe from the area. Construct a headwall of native stone or railroad ties to armor the outside faces of the structure. Do not allow the ends of pipes to visibly protrude beyond the headwalls. Embed the stones into the arroyo bed and banks. All stones should be placed firmly, with the same stability as a retaining wall. See Illustration 9.1.

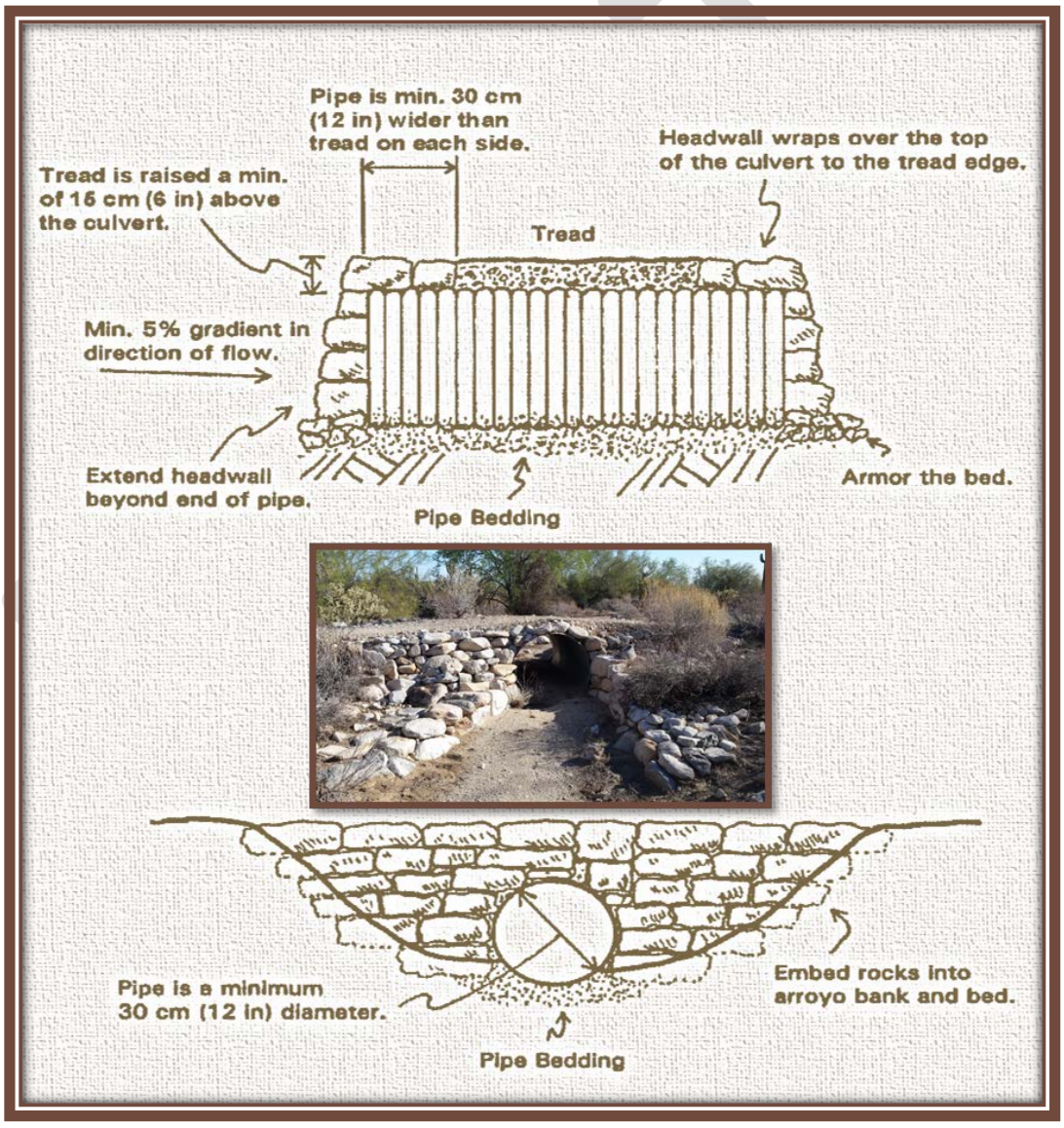


Illustration 9.1 - Pipe Culvert

Slope Structures

Retaining Walls

This work consists of gathering rocks or lumber to the installation site, excavating a terrace, placing rocks, backfilling, and finishing the tread. Walls are designed to support the tread on a side slope where a bench cannot be cut into the slope, at sites prone to severe washout, and on steep sideslopes. A wall is much more solid than rip-rap as it has a steep-angled face and supports the full weight of the tread. Rock is the preferred material for construction; wood will rot eventually and requires additional material for anchoring.

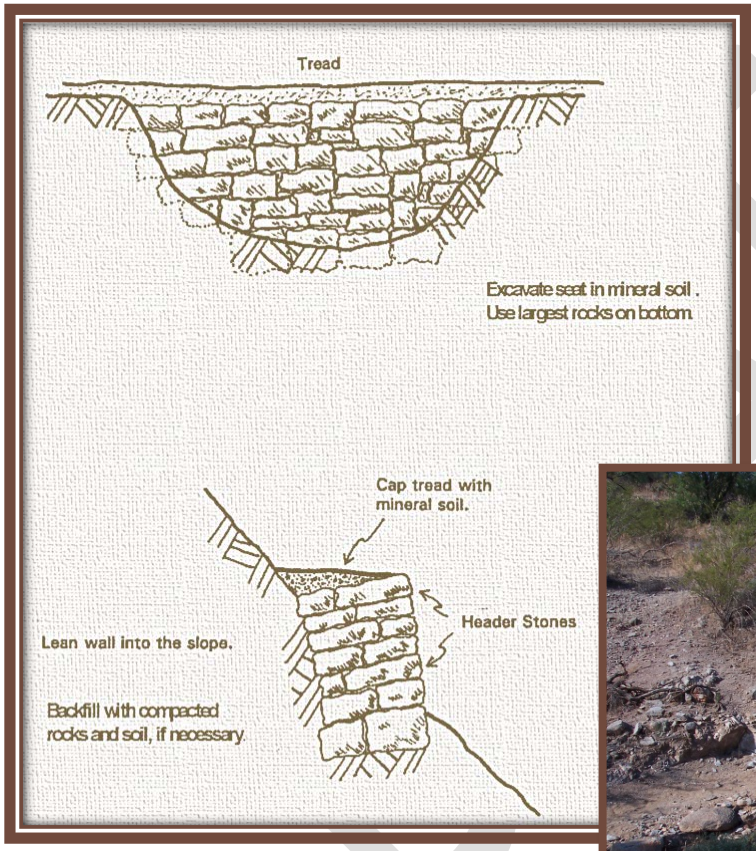


Illustration 10 - Rock Retaining Wall

Rock Wall

Construct as shown in Illustration 10. All rock must be large and of a general rectangular shape. Shaping with a rock hammer may be necessary to achieve a proper fit. Excavate a terrace in the slope to provide a foundation for the wall. The terrace must be stable mineral soil. Embed the base rocks into the terrace and sides of the slope.

Vertical joints should be staggered horizontally from any vertical joint in an adjoining layer. At least 25% of the rocks in the wall should be uniformly distributed 'header stones'. All header stones should be placed with the lengthwise dimension extending into the bench. At the wall edges, headers must be placed extending into the slope. Place all other rocks parallel to the face of the wall.

Each rock must be fully stable. The largest rocks are placed on the bottom layer. Voids may be filled with small stones or fragments.

The wall should lean into the slope. As the wall is raised, backfill with small rocks and soil. Compact this backfill and break up larger rocks. Place a cap of at least 10cm (4in) of mineral soil on the tread. The top of the wall should be flush with the tread edge to maintain a proper outslope.

Railroad Tie Wall

Construct as shown in Illustration 10.1. The excavation of a terrace and placement of the ties is similar to the construction of a rock wall. Instead of headers, however, stability should be ensured with the use of rebar for pinning together each layer of ties.

Excavate a terrace and pin the base layer into the ground. Cut ties to size for layering and place the next row with joints staggered in relation to the previous row. Join each subsequent layer together with rebar spikes. The wall should lean slightly towards the slope. As needed, backfill the wall with rock and soil as it is raised. Cap the tread with mineral soil and maintain outslope.

For walls taller than two rows, secure the wall with support posts wired to anchors as shown in Illustration 10.1. The top of the support post must be below the top of the wall; cut to size if necessary.

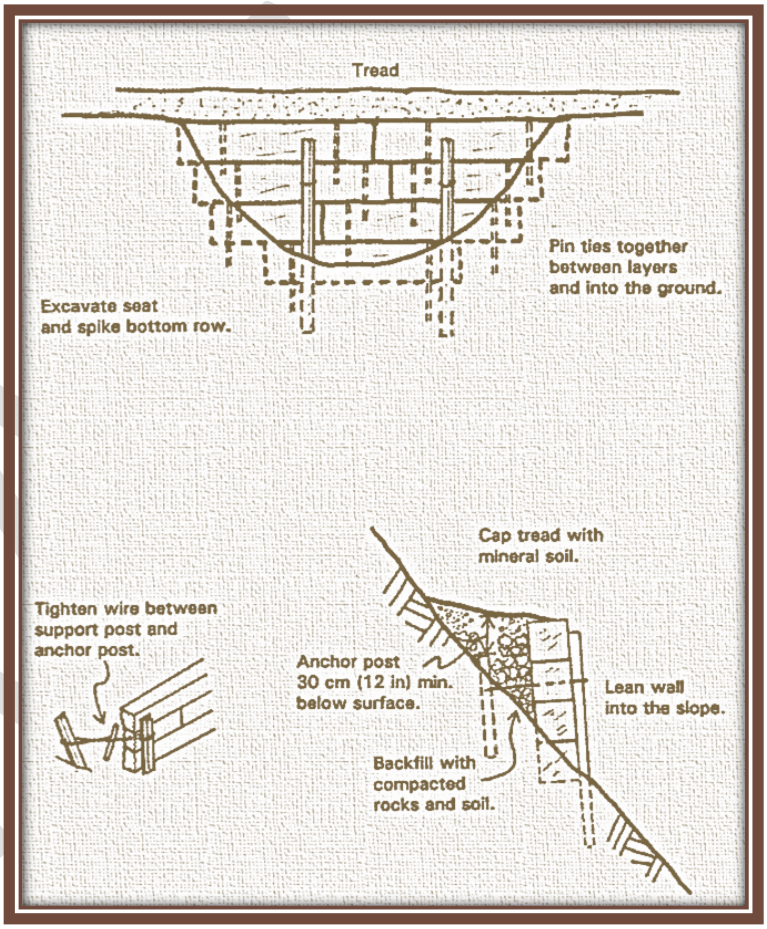


Illustration 10.1 - Railroad Tie Retaining Wall

Rip-Rap

Rip-rap is a structure for stabilizing slopes below and/or above the trail tread; unlike a wall, rip-rap does not support the weight of the tread bench. Rip-rap is used at locations such as potential washouts, between switchback approaches, shortcut closures, and below the tread on steep sideslopes. Construct as shown in Illustration 10.

Excavate a terrace and firmly place large base rocks; hand place rocks on the existing slope until the

structure is just below the tread level (maintain outslope). The sides should angle towards the center as each layer supports the rocks above. Work around existing vegetation.

Railroad ties or logs may serve as the bottom layer supporting the rocks. Excavate a terrace and set the lumber into place with rebar spikes. Hand-place rocks on the slope as described above.

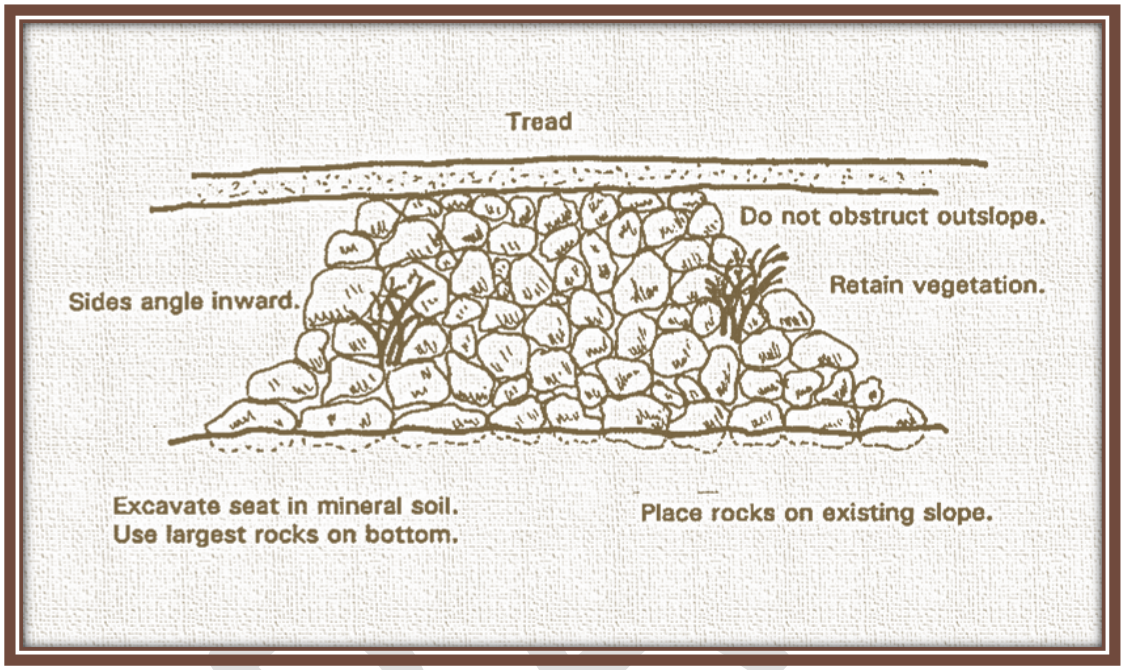


Illustration 11 - Rip Rap

Fords and Arroyo Crossings

This work consists of constructing watercourse crossings with rock structures. Since most fords and arroyos flow only during large storms, the primary concern is stabilizing the crossing to withstand flood conditions.

Ford

A ford structure is usually constructed in small to medium-sized, and steep, "V"-shaped arroyos. See Illustration 12. The downstream edge is reinforced with a structure similar to a retaining wall. Base and side rocks should be firmly embedded. This structure may simply be built to reinforce the existing arroyo-bed level if the crossing point is suitable; if necessary, fill material is imported. Fill material should consist primarily of gravel and small rock. The upstream side is filled with a scattering of large rocks which break up and slow the water flow. The approaches to the ford must descend towards the arroyo bottom at a downgrade angle. This grade should be a minimum of 5% for all trail classifications but could (go up to a max of 20% depending on the trail class). Do not allow the water flow to be diverted from the arroyo and onto the trail. Reinforce the tread edges with rip rap if necessary.

Arroyo Crossing

Crossings of watercourses which are flat and wide consist of constructing a bench for the approach segments which descend to the arroyo bed and stabilizing with a wall or rip-rap.

Both approaches must descend towards the arroyo bottom at a 5% minimum downgrade. go up to a max of 20% depending on the trail class). This will avoid the possibility of the water being diverted from its course and flowing down the trail. Reinforce the sideslopes with a wall or rip-rap. At the edge of the arroyo bed, it may be necessary to reinforce the edge. Embed a row a large rocks, a log, or railroad tie in the bank across the trail. Ensure that water flow will not cut behind the structure.

See Illustration 12 - Ford

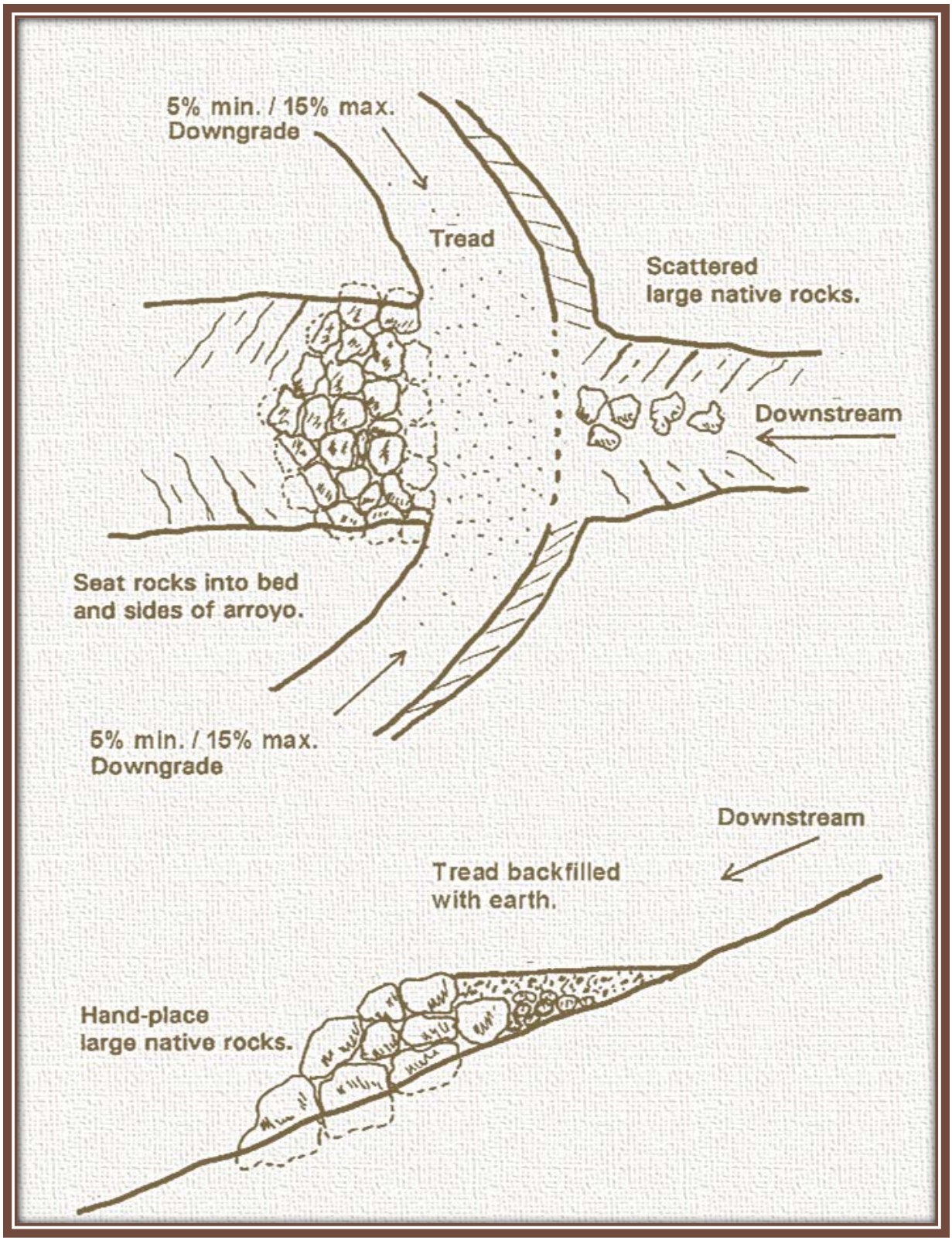


Illustration 12 - Ford

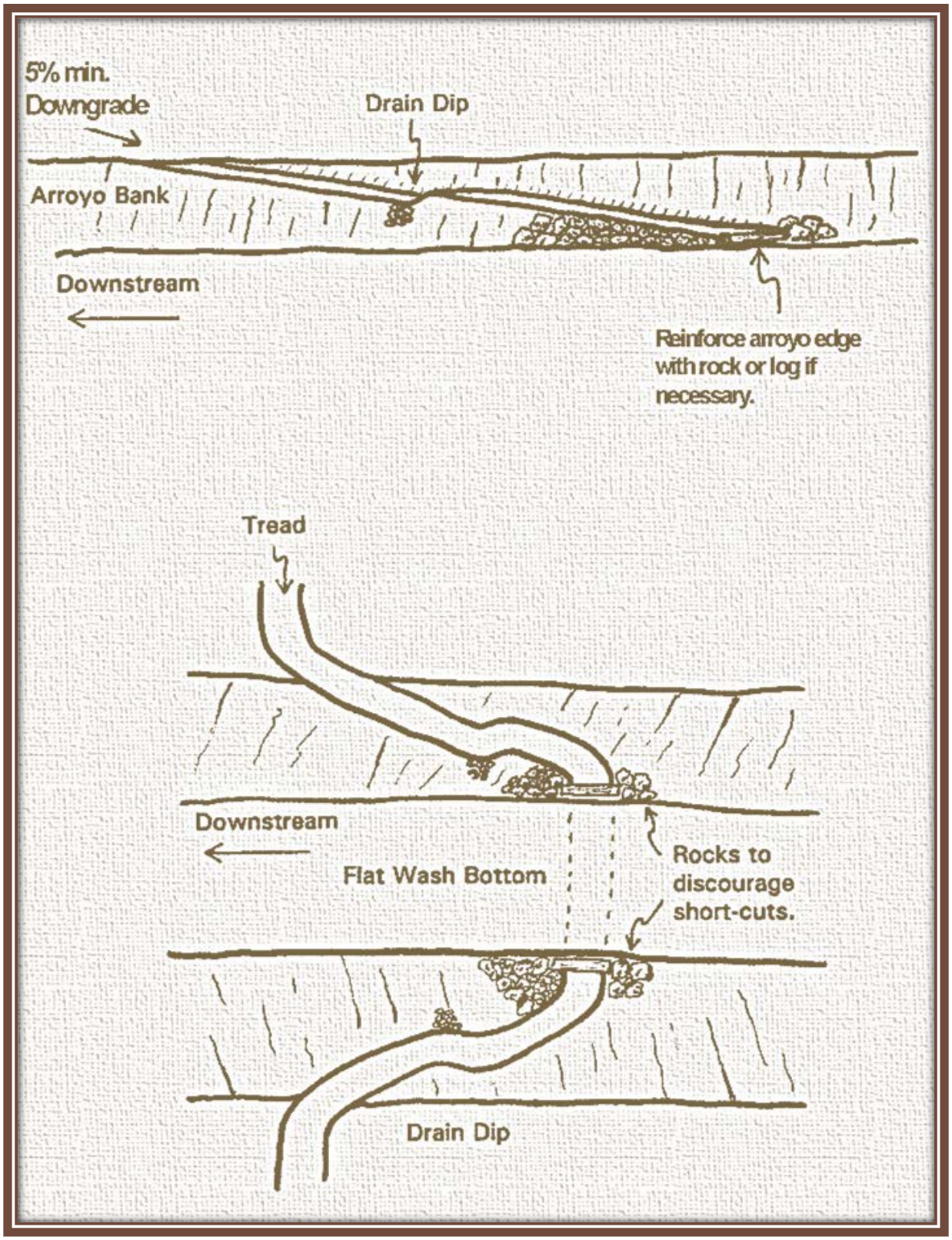


Illustration 13 - Arroyo Crossing

Switchback

This work consists of constructing a turn section, shortcut barrier, drain ditch, retaining wall, rip-rap, and approach sections. A properly constructed switchback is a C-shaped turn on a specified radius. The turning section must be at a slight grade only; do not construct a climbing turn as this will create substantial erosion and future maintenance problems. Construct a switchback only where determined to be essential as this requires a great deal of location work, excavation, and movement of earth. Utilize standards for each trail classification as per Section 4.3. Construct as shown in Illustration 14.

See Illustration 14 - Switchback

The entire tread of the upper approach should be a full bench. The lower approach section will be an excavated bench if possible, but is likely to be fill- supported by a retaining wall or rip-rap. Construct a retaining wall to support the lower approach. This retaining wall should be constructed according to specifications listed in Section 4.4. The lower approach and most of the turn section should have an outslope.

The upper approach and the upper edge of the turn section should have an inslope towards a drain ditch. This ditch should be at least 30cm deep x 30cm wide (1ft x 1ft). Construct a rock apron to protect the spill point. See Illustration 8.

The interior of the turn and approaches should be reinforced with rip-rap which also acts as a barrier to shortcuts. If shortcuts are a serious problem, a ghost fence or hand rail barrier on the outer edge of the upper approach may be necessary.

The immediate approach sections are a gentle grade to facilitate completing the turn. The remaining length of each approach (up to 15m / 50ft in length) has a steeper grade to create separation between the approaches.

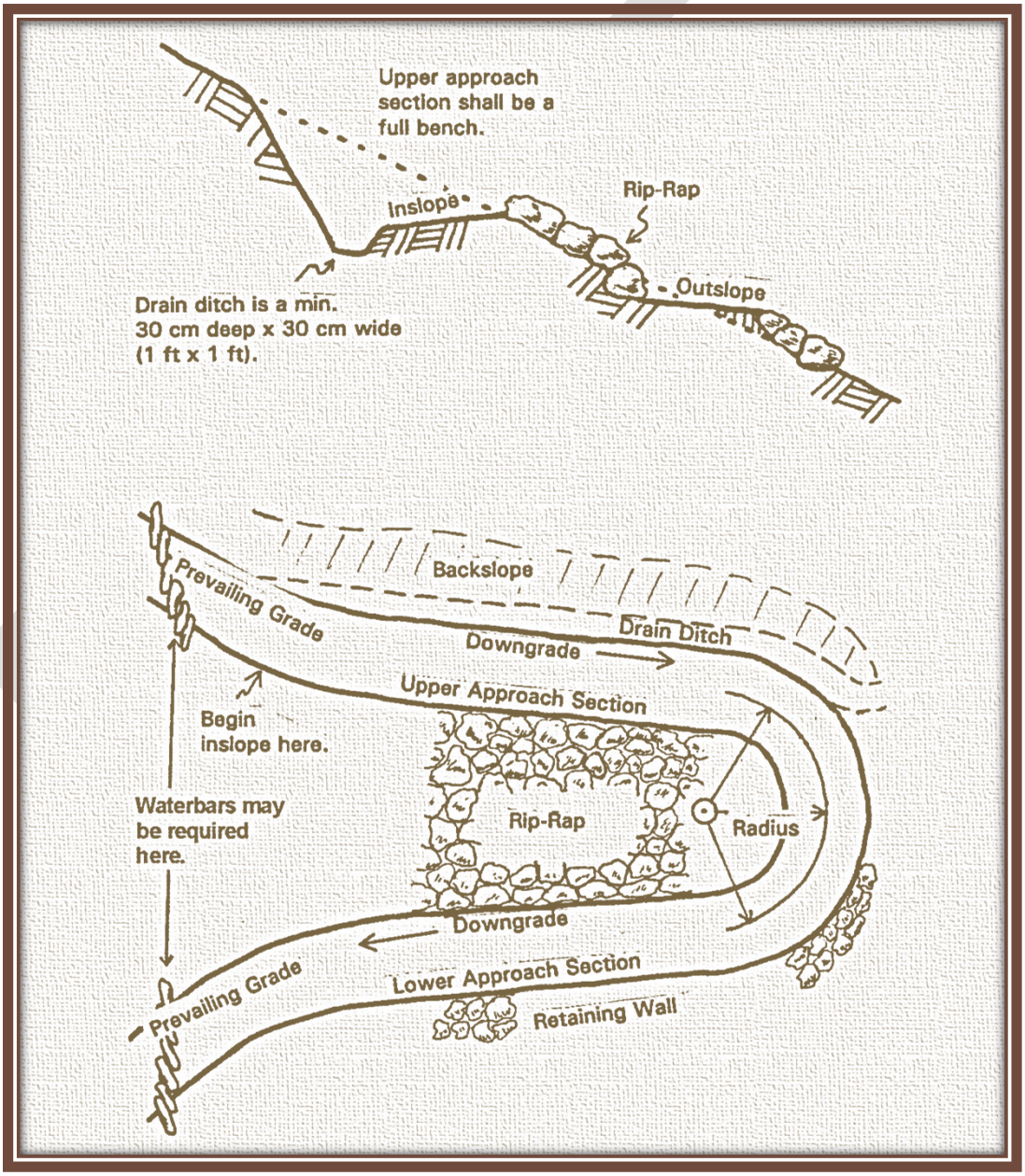


Illustration 14 - Switchback

Steps

This work consists of constructing rock, railroad tie, plank, or crib-ladder steps. Steps provide a method to gain elevation rapidly over short distances without inviting severe erosion to the hillside. The proper use of steps can allow other portions of trail to be constructed on gentler grades. The type of steps to be constructed depends on the site, materials available, and the level of visual quality to be maintained.

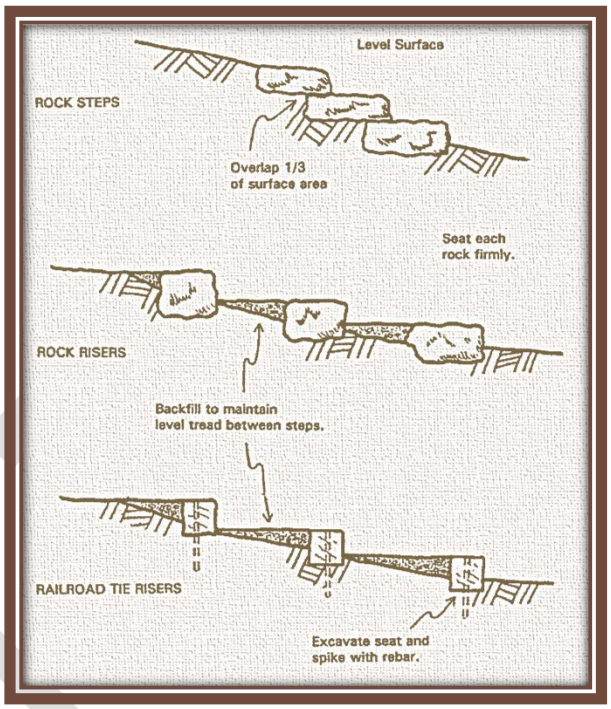


Illustration 15 - Steps

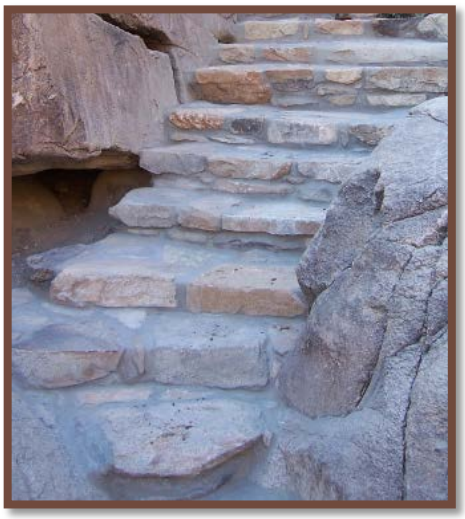
Steps may be constructed only on trails classified secondary and restricted to foot traffic only. The rise of each step should be a maximum of 25cm (10in); the run should be a minimum of 25cm (10in).

The need for handrails depends on possible safety hazards relative to the trail classification, amount of use and season of greatest use. Materials other than wood may be utilized if appropriate. See Section 4.3 (Barrier-Free Trail Specifications) for additional discussion of handrail requirements.

The key to proper construction of steps is that the top of each step is level with the bottom of the next step; do not allow a slope between steps. The steps should be level to or elevated above the adjacent ground so that water is not channeled down the row of steps. After construction, do not allow traffic on the steps until it is certain that the structure is completely stable. If any lumber deteriorates to expose spikes or otherwise becomes hazardous, replace it immediately.

Rock Risers

Riser steps are useful to reconstruct a severely eroded trail in a manner similar to block and fill or check dams. Construct as shown in Illustration 8. Choose rocks the same as noted above. The difference is that there is level fill dirt between the rock steps. Set each rock into a terrace and compact mineral soil around it for stability.



Rock Steps

Construct as shown in Illustration 15. Single rocks should form the entire tread and riser. Utilize large rocks that are rectangular

in shape; use tools to shape the rocks if necessary. Each rock must be large and heavy enough to be stable and meet rise and run requirements. Excavate a terrace, hand place each rock, and compact soil around rocks to ensure stability. Utilize concrete block to level the ground and provide additional support for the steps.

Railroad Tie Risers

Construct as shown in Illustration 15. Single ties should be used for the entire riser. Excavate a terrace to a depth necessary to provide stability. Use rebar to pin each riser into the terrace. Drill a 12mm (½in) hole through the tie 24cm (8in) from each end. Drive a 45cm (18in) long length of 12mm (½in) diameter rebar through the tie until flush, or to the point of refusal and then cut flush. Compact small rocks and fill dirt around the tie to solidify the structure.

Plank Stairway

Construct as shown in Illustration 15.1. Preservative-treated plank stairways should be constructed by laying two parallel carriages supported by a sill at each end. Each carriage should be a continuous member throughout its length.

Firmly embed each sill in the ground a minimum of 30cm (12in) deep. The planks are spiked to level notches in the carriages. Carriage lumber should be 10cm x 20cm (4in x 8in) in dimension; risers should be 5cm x 25cm (2in x 10in); sills should be 10cm x 40cm (4in x 20in).

Crib-Ladder Stairway

Construct as shown in Illustration 15.1. Preservative-treated lumber will be used for crib-ladders. Construct by laying two carriages parallel to each other and firmly supporting their entire length. Each riser should be spiked into a notch routed into the carriages, then backfill with compacted gravel and soil. Each soil step should be level. Wood, metal pipe, or other material may be utilized for Preferably Steel or lumber should be 10cm x 20cm (4in x 8in) in dimension; risers should be 5cm x 20cm (2in x 8in).

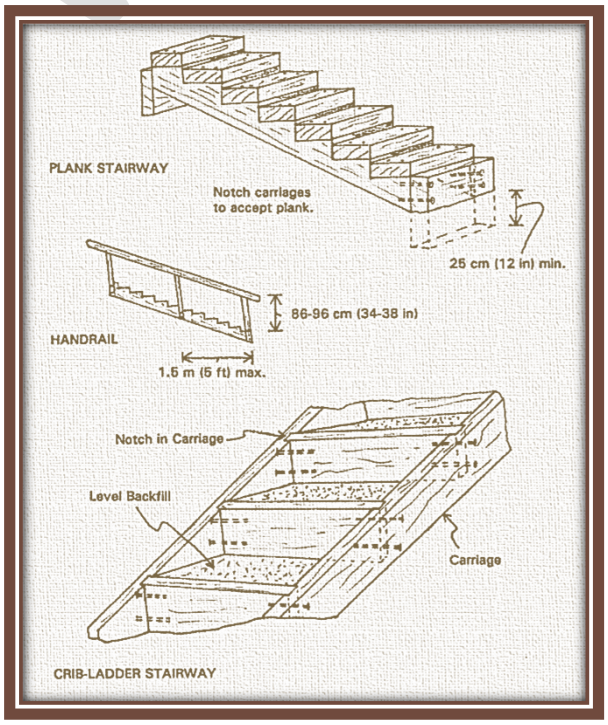


Illustration 15.1 - Steps

Handrails

Wood, metal pipe, or other material may be utilized for handrails as shown in Illustration 15.1. Handrails should be 86cm - 96cm (34in - 38in) in height with a maximum support post spacing of 1.5m (5ft). They must have sufficient strength to support as person's weight; refer to ADA Accessibility Guidelines for structural strength specifications (13). The width or diameter of gripping surfaces should be 3cm - 4cm (1.25in - 1.5in). Materials should be unfinished, or painted or stained with a color that blends with the natural environment. The surface should be free of any sharp or abrasive elements.

4.6 Trail Junction

Construct and maintain as shown in Illustration 16. Junctions should be constructed or reconstructed to reflect the nature of leisurely travel on trails. Most junctions will be "T"-shaped. Trail users traveling at a leisurely pace will have no difficulty negotiating corners.

"T" Trail Junction

Tread width will not be altered, except that corners at a trail junction should be recessed a distance equal to three-quarters of the standard tread width (i.e. 1m (3ft.) for primary trail, 0.5m (1½ft) for secondary, etc. See Section 4.3). Protect the corners from shortcuts by placing large rocks, deadwood, and/or transplanted vegetation at the trail edge and in the areas between trails as necessary.

"X" Trail Junction

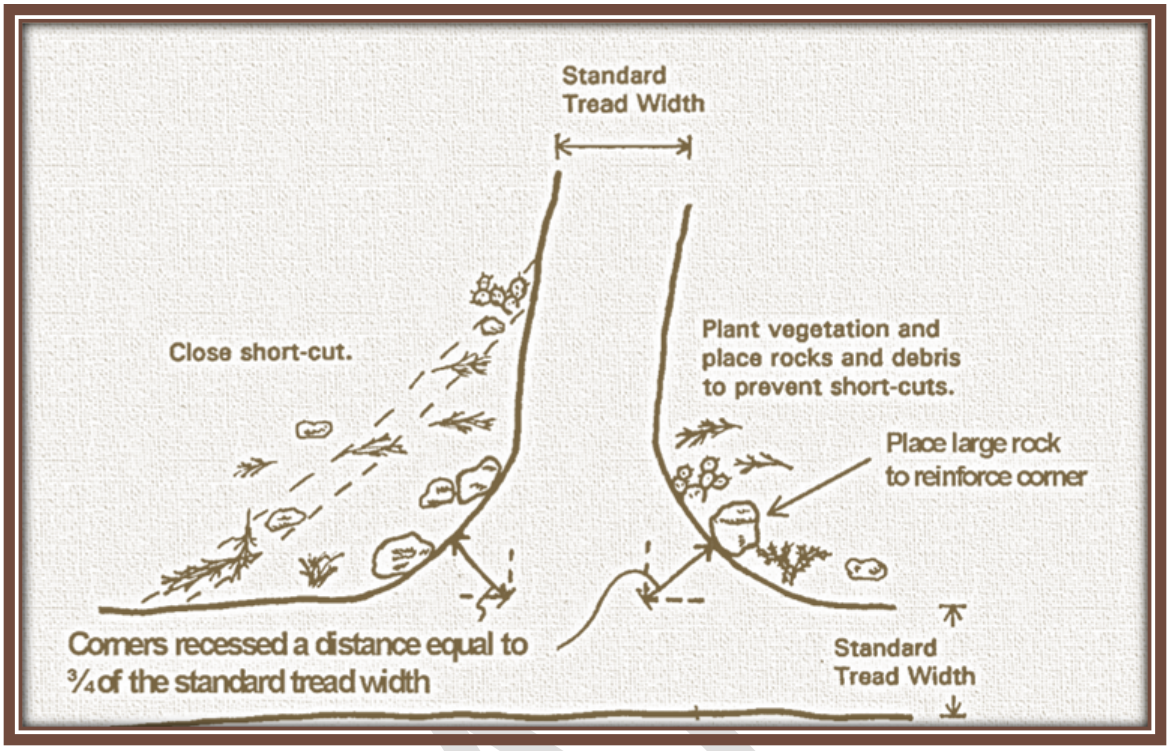


Illustration 16 -Trail Junction

4.7 Wash Bottoms

Primary and secondary trails and competitive tracks (or segments thereof) may be established in wash bottoms. Do not establish barrier-free or interpretive trails in wash bottoms. Trails or tracks within washes have minimum standards equal to the trail or track standards. That is, the natural expanse of a wash bottom may serve as the trail tread and vegetation clearance zone. Where a wash becomes narrow, the vegetation clearance will be maintained for the trail or track corridor meeting the standards for that classification.

Wash trails should only be established in broad, flat, sandy wash bottoms; avoid narrow, rocky locations. They should be developed to be in a wash bottom for its entire length. Wash trails are commonly avoided by bicycle riders and hikers.

4.8 Special Purpose Roads

Design, construction, and maintenance of the service roads are the responsibility of the Maricopa County Parks and Recreation Department. Utilize specifications established by the Maricopa County Department of Transportation for Special Purpose Roads (7). Install signs as necessary to ensure safety.

4.9 Trail Alterations

Trail Retirement and Revegetation

The purpose of trail retirement and revegetation is to restore the landscape to a natural condition, halt shortcuts, and prevent erosion. This work consists of obliterating vandal routes, abandoned roads, or abandoned trail segments, and includes scarification; placement of earth, mulch, rock, and/or deadwood; construction of check dams; shaping the landform; and planting live vegetation and native seed mix when appropriate. See Illustration 17.

In order to hide the visual corridor, utilize the surrounding native materials only. Low-lying obstacles are not enough to prevent trail users from leaving the designated trail. When the trail is out of sight the curiosity factor will also be diminished. Hiding the trail from the user's view shed will help reduce the time required for a trail to naturalize.

Revegetation

Deadwood and rocks should be placed on and across the old tread in a random manner to appear similar to the surrounding area. Debris should be place along the trail path extending away from the old tread to discourage travelers from going around the closure. Where vandalism is a problem, it may be necessary to place large quantities of debris on the route. If necessary, install ghost fences and regulatory signs. Scarify old roads, trails, and other impacted areas to the extent necessary to break up compacted earth. Install checkdams to inhibit erosion and restore the natural form of the landscape where possible. On sidehill sections, fill material should be pulled from the lower side of the tread and placed into the original cut bench to restore the natural slope.

Save live plants from vegetation clearing projects as much as possible for transplanting to revegetation

sites. Nursery stock may be utilized as well. Utilize only native, indigenous plants and seed for revegetation and/or reseeding. In order for the seed to take to the soil, the old tread must be scarified, and the seed raked into the soil for in order to achieve the best results.

Coordinate these efforts with Park staff in order to appropriately manage undesirable social behaviors that continue to be an issue in a particular area.

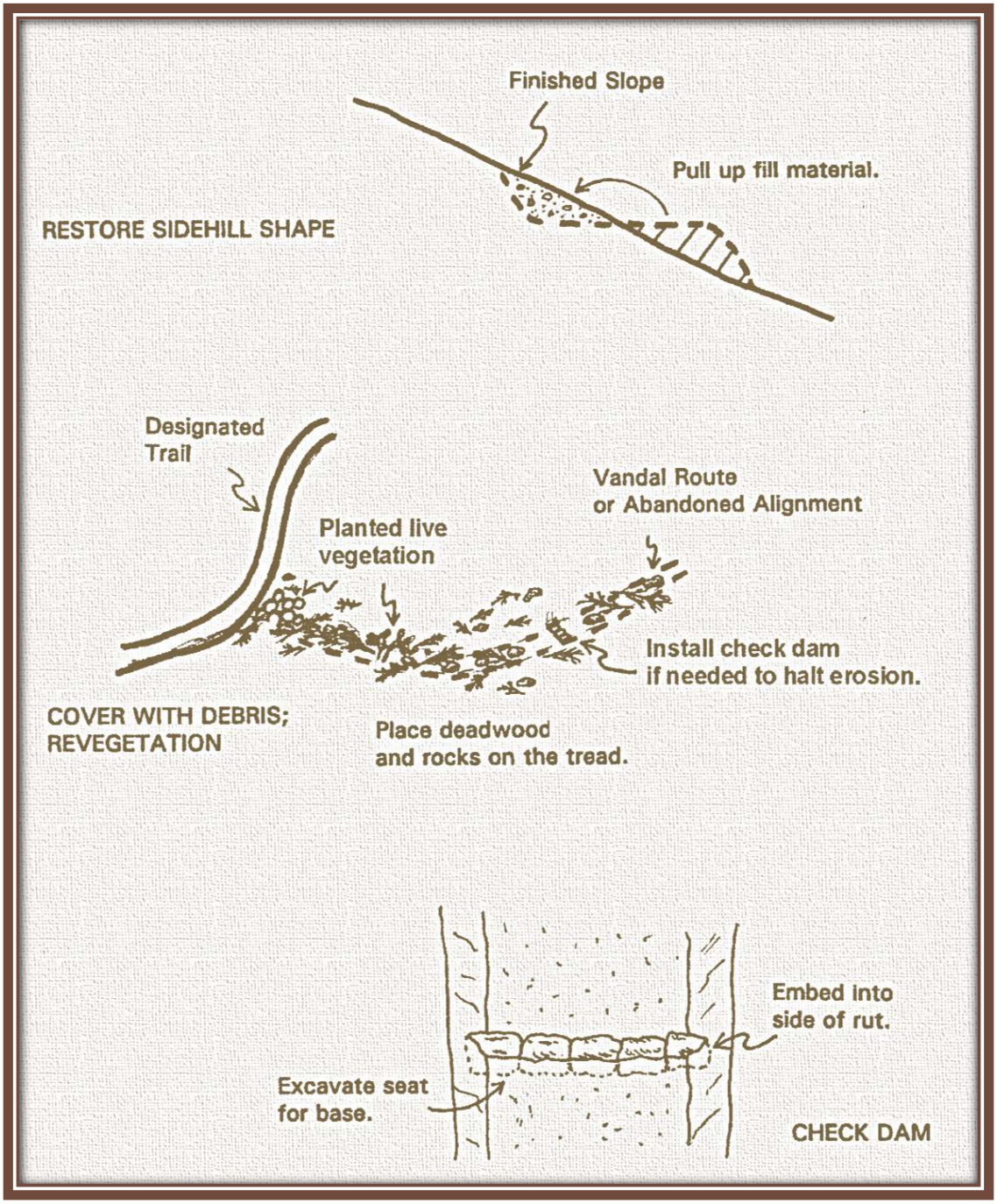


Illustration 17 - Revegetation

Trail Re-routes

In instances where rehabilitation is not possible, it may be necessary to re-route an existing trail for safety and sustainability. If a trail has safety issues or requires continuous maintenance, stepping back and assessing the route might be necessary in order to maintain the overall integrity of the trail and user safety.

Trail re-routes will be reviewed and approved by the Director in order to determine the appropriate level of public involvement in the process. Regardless of the perceived issues of a particular trail, assessing all of the options for a better route must be a public and transparent process. What one person views as an unsightly and unsustainable trail with too step a grade and bad erosion, might actually be another user's favorite trail or viewed as an exceptional challenge to be conquered.

Trail Rehabilitation Tools & Techniques	
Problem	**Spot Improvement Design Solutions**
Soil Erosion	1. De-berming (for minor erosion) 2. Combination of waterbars and check steps work well (check dams hold soil in place, waterbars divert water off of the trial) 3. Stone paving, stone stairs/ check steps or ascent route solutions on steep grades 4. Refill trail with mineral soil to original grade. Consider waterbars and check steps to prevent reoccurrences of erosion 5. Pull material from drains back onto trail tread
Muddy Areas	6. French drains 7. Turnpikes with culverts or French drains 8. Boardwalks 9. Replace trail surface with mineral soil or crushed gravel 10. Flat rocks for stepping stones
Trail Shortcuts	11. Natural physical barriers (i.e.: large stones, logs) 12. Structural barriers (i.e. wire fencing, stone retaining walls) 13. Directional signage or educational signage 14. Consider restoration and revegetation strategies
Unsafe Sections	15. Site-specific solutions required 16. Trail widening or passing points 17. Consider new trail design (re-route)
Trail Braiding	18. Consider new trail design 19. Consider restoration and revegetation strategies

San Tan Mountains Regional Park

5.0 SIGNS AND MARKERS

5.1 Trail Signs

Guidelines and Procedures

1. Procurement and posting of all trail signs are the responsibility of the Trails Supervisor.

2. Trail names are determined by the Park Supervisor, Trails Supervisor and Parks and Open Space Planner following the procedure found in section 5.1.

3. Provide the optimal number of signs necessary for easy visitor orientation, safety, and resource protection.

4. Repair or replace damaged signs immediately. Temporary signs may be installed when a sign is discovered missing or vandalized. Replace with a standard sign as soon as possible.

5. Remove all unauthorized signs immediately.

6. Informational trail signs are typically posted at trail termini, junctions, road crossings and park boundaries. Reassurance markers should be posted every half mile in order to keep visitors on the trail and provide a reference for emergency rescue. In some instances wayfinding can be made difficult due to the natural terrain or vegetation, therefore in order to maintain safe navigation of the trail, Reassurance markers may be placed every quarter mile when necessary.

7. Colors for trail sign text and symbols should be reflective-white on brown. A red slash over recreation symbols is used to show prohibited activities. Utilize the white-on-blue standard symbol to show accessibility for disabled persons.

8. The top of a sign and post should be not more than 1.8m (6ft) and not less than 1.5m (5ft) above the tread surface level.

9. Minimum information for sign is listed under specifications for each sign type. Additional text may be used if necessary for helping visitors avoid becoming lost or disoriented in backcountry locations, but care must be taken to avoid "information overload". The decision to use additional text is the responsibility of the Park Supervisor and Trails Supervisor. Text may include distance and directions to the next junction, distance and direction to the nearest trailhead or access point, and standard recreation symbols.

10. No more than two signs should be attached to a post. Additional signs may be used where determined to be essential by the Park Supervisor and Trails Supervisor.

5.2 Trail Identification

Position of Trail Signs

Trails signs are placed within a direct line of site in order to keep visitors appropriately informed as to the trail they are traveling. See Illustration 18 on page 79 for typical positioning of the signs and posts. Detailed specifications for sign locations are given in section 5.3.

Locate trail junction sign posts as shown in Illustration 18. The post should be 1.2m (4ft) from the center of the tread. The top of the post should be 1.5m -1.8m (5ft - 6ft) above the tread surface level.

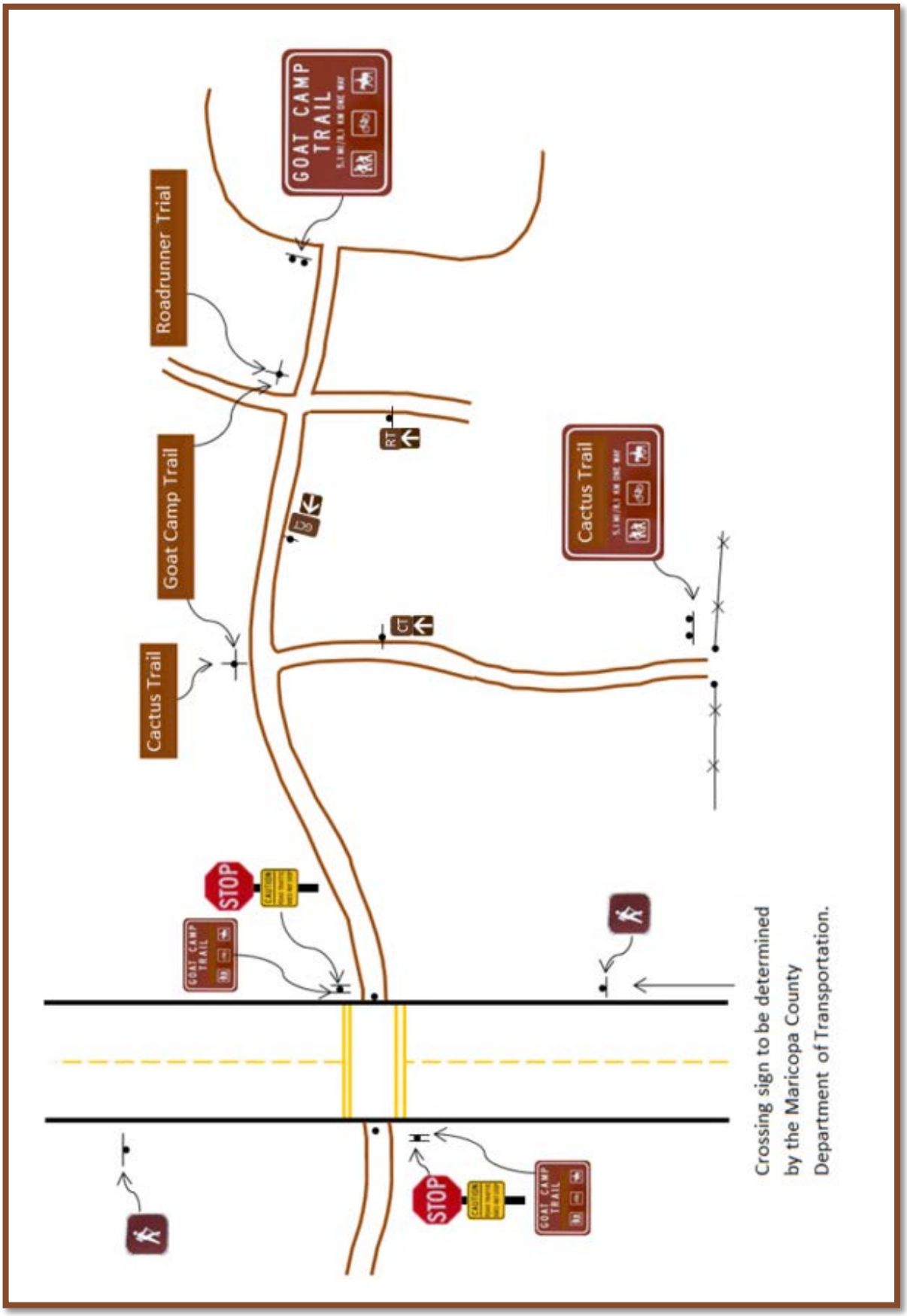


Illustration 18 – Trail Sign Location

Trail Names

The trails crew and the associated park will work collaboratively to recommend new trail names which will then be approved by the Planning Team. The following steps will be utilized for selecting names for trails:

1. Choose from nearby place names recognized by US Board on Geographic Names or the Arizona Board on Geographic and Historic Names. These names are most commonly found on USGS topographic maps.

2. Choose from commonly known formal or colloquial names specific to the area such as names of historic families or geographic features. Consent may be required for the use of certain names, such as those of American Indian origin.

3. Choose from names of natural features native to the area such as types of minerals, plants, and animals.

4. Commemorative names may only be used for those persons with a direct and long-term association with the specific park area and comply with County Policy.

Specifications for Trail Signs

Trail Junction

Minimum information that should be displayed on standard trail junction signs is the trail name and directional arrows. Additional text may be used if necessary as determined by the Park Supervisor and Trails Supervisor. Text may include the following as appropriate: trail name and directional arrows; distance and direction to the next junction(s); distance and direction to the nearest trailhead or access point; available facilities at the trailhead such as water; notation of the nearest exit point. See Illustration 18 above for examples of information that may be displayed on junction signs.

Junction signs should be metal and rectangular in shape with rounded corners. The sign size should be 20cm x 60cm (8in x 24in). Standard sign colors are reflective-white text, symbols, and border on a brown background. Size of letters and symbols is determined by the best fit to the sign size

Mount signs centered on a top-mounting bracket on a post.

Trailhead

This section covers those trail access points at parking lots within park boundaries and at park boundary points at a designated trail terminus. Minimum information that should be displayed on standard signs at trailheads is the trail name and standard recreation symbols showing user-type allowed (or prohibited). Additional text may be used if necessary as determined by the Park Supervisor and Trails Supervisor. Text may include the following: length of the trail, distance to the nearest one or two junctions, distance to another trailhead; and the visitor's current location (e.g. "You are at...")

	Trail Junction Signs	Trailhead Signs
Minimum Required Information		
Additional Information		
Most Information		

Trailhead signs are metal and rectangular in shape with rounded corners. The sign size should be 45cm x 60cm (18in x 24in). Standard sign colors are reflective-white text, symbols, and border on a brown background. Size of letters and symbols is determined by the best fit to the sign size.

Mount the signs flush against a post. The top of the sign should be even with the top of the post.

Post trailhead signs facing oncoming trail users to the right side of the trail (unless it makes more sense to post in another location, i.e. to the left side or centered in a wide access area). The post should be 1.2m (4ft) back from the trailhead or boundary fence and 1.2m (4ft) to the side of the trail. The top of the sign should be 1.5m - 1.8m (5ft - 6ft) above the trail surface level.

Trailhead signs may also include limited official information such as pertinent regulations, suggested visitor behavior, and/or a safety message if determined to be essential, although typically it is best to attach this information on a second sign on the same post. If it is reasonable to display numerous messages, a kiosk should be installed.

	Spur Trail Signs	Road Crossing Signs
Minimum Required Information		
Most Information		

Spur Trail

This section covers those trail access points at parking lots within park boundaries and at park boundary points at the terminus of a designated spur trail that connects to a designated trail. The minimum required information to be displayed on trail signs at spur trails is the name and direction to the designated trail and standard recreation symbols showing user-type allowed (or prohibited). Additional text may be used if necessary as determined by the Park Supervisor and Trails Supervisor. Text may include the following: distance to the connected trail, distance to the nearest one or two junctions, distance to another trailhead, and the visitor's current location (e.g. "You are at...").

Spur trail signs are metal and rectangular in shape with rounded corners. The sign size should be 30cm x 60cm (12in x 24in) with minimum information, or 45cm x 60cm (18in x 24in) if additional text is added. Standard sign colors are reflective-white text, symbols, and border on a brown background. Size of letters and symbols is determined by the best fit to the sign size.

Mount the signs flush against a post. The top of the sign should be even with the top of the post.

Post spur trail signs facing oncoming trail users to the right side of the trail (unless it makes more sense to post in another location). The post should be 1.2m (4ft) back from the trailhead or boundary fence and 1.2m (4ft) to the side of the trail. The top of the sign should be 1.5m - 1.8m (5ft - 6ft) above the trail surface level.

Spur trail signs may also include limited official information such as pertinent regulations, suggested

visitor behavior, and/or a safety message if determined to be essential, although typically it is best to attach this information on a second sign on the same post. If it is reasonable to display numerous messages, a kiosk should be installed.

Road Crossing

Road crossings should be designed with the user's safety as the main concern. Signs and/or crosswalk markings should be placed on the road facing both directions to warn drivers as determined by Maricopa County Department of Transportation (MCDOT) personnel. See Illustration 17 for a sample diagram of sign post locations.

At the point where a trail crosses a road, on both sides of the road, a trail sign should be posted 3m (10ft) from the edge of the roadway. The two signs should be facing each other across the road. Minimum information that should be displayed on a road crossing trail sign is the trail name and symbols of user type allowed or restricted (with or without red slash). Additional text may be added if necessary as determined by the Park Supervisor and Trails Supervisor. Text may include the following: the visitor's current location (e.g. "You are at..."), distance and to the nearest one or two junctions, and distance to another trailhead.

Road crossing trail signs are metal and rectangular in shape with rounded corners. The sign size should be 30cm x 45cm (12in x 18in). Standard sign colors are reflective-white text, symbols, and border on a brown background. Size of letters and symbols is determined by the best fit to the sign size.

On the same posts (on both sides of the road), but on the opposite side of the post from each trail sign, there should be posted a 45cm x 45cm (18in x 18in) stop sign. Also, post a black-on-yellow caution sign (typical text is "CAUTION – Road Traffic Does Not Stop") below the stop sign and with a size of at 45cm x 45cm (18in x 18in).

Mount the signs flush against a post. The top of the sign should be even with the top of the post. The post should be positioned 1.2m (4ft) back from the roadway (including the maintained shoulder) and 1.2m (4ft) to the side of the trail. The top of the sign should be 1.5m - 1.8m (5ft - 6ft) above the trail surface level. See Illustration 18 on page 79 for a sample diagram of sign post locations.

5.3 Competitive Track Signs

Guidelines

1. Procurement and posting of all track signs are the responsibility of the Trails Supervisor.

2. Provide the minimum number of signs necessary for visitor orientation, safety, and resource protection.

3. Repair or replace damaged signs immediately. Temporary signs may be installed when a sign is discovered missing or vandalized. Replace with a standard sign as soon as possible.

4. Determination of sign messages is the responsibility of the Park Supervisor and Trails Supervisor. Department Sign Standards should be referenced when determining style and color of signs. Sign should be mounted on channel posts or flexible posts.

5. The top of a sign and post should be not more than 1.8m (6ft) and not less than 1.5m (5ft) above the tread surface level.

6. General guidance signs (indicating direction to designated track loops or segments, to the parking lot, etc.) should be reflective-white lettering on a brown background. Sign size may vary. Specifications for Track Signs below for examples of sign sizes and text.

7. No more than three signs should be attached to a post. Additional signs may be used where determined to be essential.

8. Remove all unauthorized signs immediately.

9. Signs may be posted temporarily for general guidance during organized events. Remove all signs as soon as possible following such events or as directed by the terms of the special use permit.

Position of Track Signs

Trails signs are placed in the direct line of site to visitors informed as to the track they are traveling. See Illustration 19 below for typical positioning of the signs and posts.

Due to the higher speed of travel on competitive tracks, signs are typically placed in advance of the condition to which it calls attention; i.e. in advance of curves, steep downhill sections, etc. Destination signs at a fork in the track are placed directly at the point of divergence; this is best between the diverging track segments or as appropriate for best visibility.

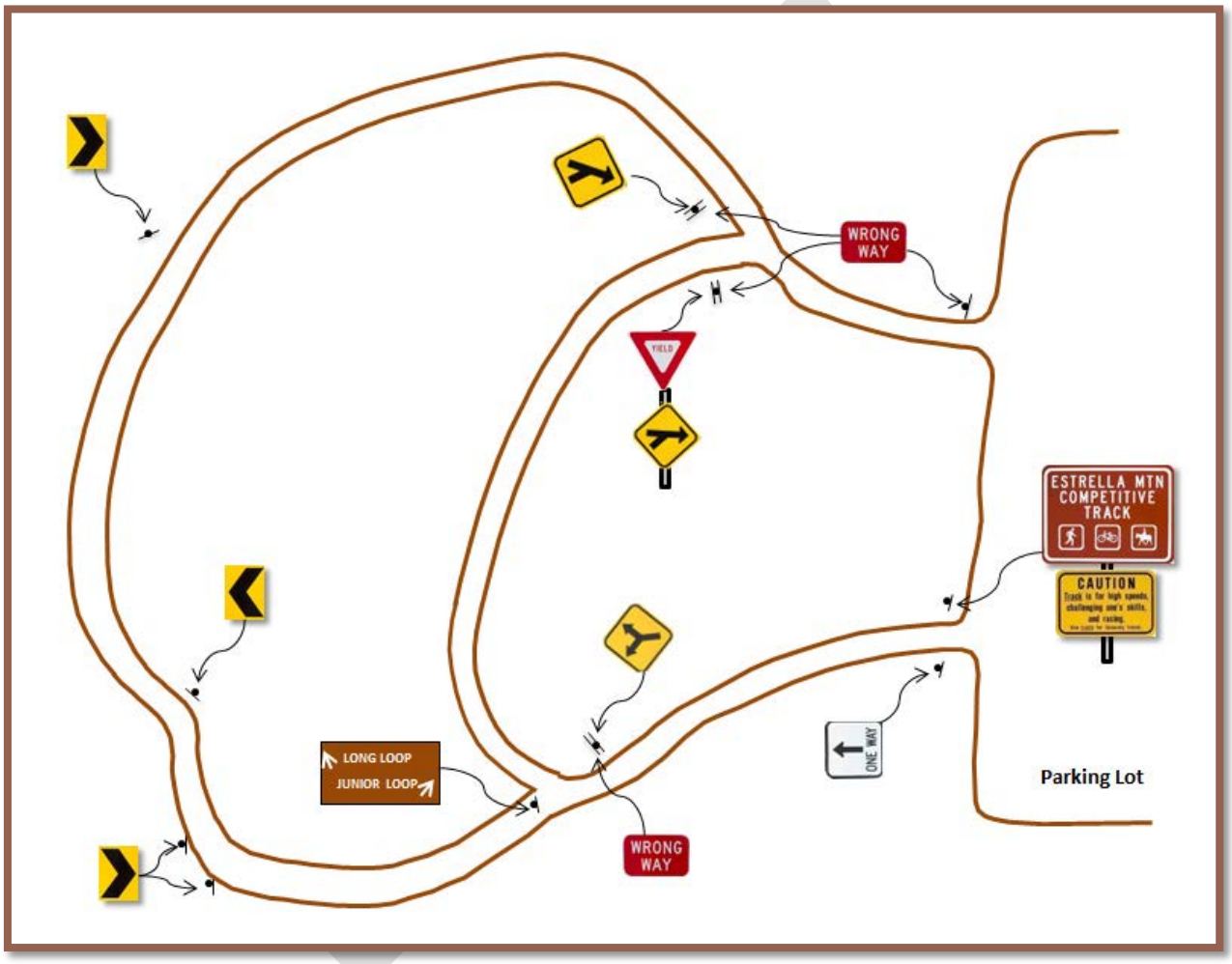


Illustration 19 - Position of Track Signs

Specifications for Track Signs

Track Trailhead Signage

The information that should be displayed on a standard track sign includes the direction of travel, divergence of track segments ('Y'), intersection of segments (junction), assignment of right-of-way (one segment yields to another), prohibited direction of travel ("wrong way"), name of designated track segment, general guidance (e.g. direction to parking lot or a designated loop), and warning of track difficulty (if appropriate). Additional messages may be posted on additional signs as appropriate and as determined by the Park Supervisor and the Trails Supervisor (see section 5.4).

Track 'Y' and Junction

'Y' and junction signs should be metal and diamond shaped. See Illustration 5 through 7 for sign messages, shapes, and sizes for typical 'Y' and junction signs. Utilize reflective material.

Mount the signs flush against a metal post. The top of the sign should be even with the top of the post. The top of the post should be 1.5m -1.8m (5ft - 6ft) above the tread surface level.

Directional signs are placed in 10m - 15m (30ft - 50ft) in advance of the track forks and junctions, to the right side of the track facing oncoming travelers. Destination or guidance signs are placed directly at the point of divergence between the track segments 1.5m - 3m (5ft - 10ft) from the tread edge; these signs may be placed to the right or left as necessary for best visibility.

Start and Finish Line

This section covers access points for outbound and inbound track segments at the designated parking lot. Information that should be displayed on standard start and finish line track signs includes the direction of travel, prohibited direction of travel ("wrong way"), name of designated track segment, and warning of track difficulty (if appropriate). Additional messages may be posted on other signs as appropriate as determined by the Park Supervisor and Trails Supervisor See Section 5.4.

Start and finish line signs should be metal and shaped similar to those found in the Department Sign Standards. See Illustration 19 on page 85 for sign messages, shapes, and sizes for typical start and finish line signs. Utilize reflective material.

Mount the signs flush against a metal post. The top of the sign should be even with the top of the post. The top of the post should be 1.5m -1.8m (5ft - 6ft) above the tread surface level.

Start and finish line signs are placed 3m - 6m (10ft – 20ft) back from the parking lot edge and 1.5m - 3m (5ft - 10ft) from the tread edge. The sign with the name of the track should be to the right side of the track facing oncoming travelers. See Illustration 18 on page 79 for a sample diagram of sign post locations.

At a prominent location within the parking lot, a kiosk should be constructed. See MCPRD's sign standards manual.

Warnings Signs (Curves, Steep Hills, etc.)

Warning signs may be placed where determined to be necessary to indicate existing or potentially hazardous conditions. The use of warning signs should be kept to a minimum.

Generally, warning signs should be diamond-shaped (square with one diagonal vertical) with a black border on yellow background similar to highway signs found within the USDOT Traffic Manual. Utilize reflective material.

Mount the signs flush against a metal post. The top of the sign should be even with the top of the post. The top of the post should be 1.5m - 1.8m (5ft - 6ft) above the tread surface level.

Flexible posts may be used with warning decals if appropriate for certain situations. Posts are approximately 10cm (4in) wide, posts with warning symbols include chevron arrows. The tops of flexible posts should be 1.2m - 1.8m (4ft - 6ft) above the tread surface. Install 0.5m - 1m (1.5ft - 3ft) from the tread edge.

Warning signs should be placed in advance of the condition to which it calls attention. Placement should provide adequate time for the track user to perceive, identify, decide, and perform any necessary maneuver. Typical distance of advance placement is 10m - 15m (30ft - 50ft).

Signs with additional messages may be posted where essential as determined by the Park Supervisor and Trails Supervisor (see Section 5.4).

5.4 Wayfinding and Reassurance Markers

Guidelines

1. Procurement and posting of all markers are the responsibility of the Trails Supervisor.

2. Locate markers only where necessary to guide trail users through vague or confusing areas and for visitor safety. It may be possible to clearly delineate the trail through tread maintenance or renovation instead of posting markers.

3. Provide markers for visitor orientation, safety, and resource protection.

4. Markers include flexible and metal posts with small metal signs or reflective decals.

5. Markers that note a coded point (e.g. "You are at Point 'A') may be installed on posts at selected locations or attached to a junction sign post. The point denomination should be noted correspondingly on the park visitor's map.

6. Maintain consistency in the use of markers; avoid multiple types of markers on a single trail.

7. Remove or naturalize all unauthorized markers immediately.

Specifications for Markers

Reassurance Markers

Reassurance makers are particularly helpful if the trail is hard to follow because the tread is indistinct. They can also be useful when multiple trails intersect or non-system trails (social trails) have formed, making trail location confusing.

Reassurance markers will be placed at a maximum distance of every half mile or closer as needed. Reassurance makers should consist of a post with white and brown reflective stickers approximately 10.2cm x 10.2cm (4in x 4in) on each side.

Informational content should consist of the trail initials and an arrow pointing to the trail corridor. For backcountry trails additional information such as mileage counts may also be added to these markers. The Trails Supervisor should be consulted with and agree upon the distance of sign placement prior to trail work commencing.

Standard sign colors are reflective-white text, symbols, and border on a brown background. Size of letters and symbols is determined by the best fit to the sign size.

Install reassurance markers on either side of the trail as appropriate for visibility and ease of

installation. The flat face of each plate faces the direction of travel.

Mount reassurance markers even with the top of the post. Reassurance markers are on either side of the trail as appropriate for visibility and ease of installation. The post should be 1.5m (4ft) from the edge of the tread. The top of the sign should be 1.5m - 1.8m (5ft - 6ft) above the tread surface level.

Rock Lines

A row of rocks or a rock line may be utilized if determined to be essential for control of shortcuts and to reduce impacts to off-trail areas if a rock line is needed, rocks should be spaced at least 0.5m (1.5ft) apart. Do not restrict drainage; severe erosion will occur.

Rock lines may be used to delineate the trail tread where it is vague and may cause trail users to become lost. Install rock lines temporarily and renovate the trail at the earliest opportunity.

In the case of rock lines on a trail, evaluate the trail and area to determine if the existing rock lines are necessary for trail delineation. If so, modify as needed to create required spacing for drainage. If not, naturalize the rock lines by scattering the rocks to create a natural appearance.

Rock Cairns

MCPRD does not authorize the construction or maintenance of rock cairns on any trail managed by the department. If a rock cairn is discovered within one of the parks or trails within the system, it must be removed immediately. The trails crew and park staff will analyze the trail area and determine if further action is necessary in order to keep trail users safe and on course.

Installation Specifications

Flexible Post

Flexible posts and stake/barb anchors are typically used in loose, sandy or marshy soils. Stake or barb anchors can be attached to the base of each sign in order to hold it in place. Barb anchors allow the post to be easily inset, and difficult to remove. The anchor barb grips the surrounding soil, while preventing extraction via accidental or natural forces, or vandal related.

On trails, attach decals to both sides of a flexible post. Use trail symbols showing user type (and red slash if prohibited). Colors should be reflective white on brown; use red slash to show prohibited uses

if appropriate. Install flexible post markers on either side of the trail as appropriate for visibility and ease of installation. The flat face of the post faces the direction of travel. There may be a situation such as a sharp corner that causes difficulty for travelers. In this case, decals are only on one side of each of two posts (facing the traveler from both directions approaching the corner), with a directional arrow pointing towards the continuation of the trail.

The top of flexible posts should be 1.2m - 1.8m (4ft - 6ft) above the tread surface. Install 0.5m - 1m (1.5ft - 3ft) from the tread edge. The size of decals required to fit the post; that is, 7.5 cm (3 in) wide, and length as necessary.

Metal Post

On trails, attach metal plates with trail symbols showing hiker, livestock, bicycle, and/or directional arrow symbols to both sides of the post. Colors of the symbols should be reflective white on brown; use a red slash through the image to show the prohibited uses if appropriate.

Install post markers on either side of the trail for visibility and ease of installation. The flat face of the plate faces the direction of travel. There may be a situation such as a sharp corner that causes difficulty for travelers. In this case, plates are only on one side of each of two posts (facing the traveler from both directions approaching the corner), with a directional arrow pointing towards the continuation of the trail.

Mount metal plates even with the top of the post. The tops of the posts should be 1.2m - 1.8m (4ft - 6ft) above the tread surface. Install 0.5m - 1m (1.5ft - 3ft) from the tread edge. Plates should be 15cm x 15cm (6in x 6in) in size.

5.5 Other Signs

Guidelines

1. Install signs for resource protection or visitor safety along trails or tracks where determined to be essential and when authorized by the Park Supervisor or Trails Supervisor. If feasible, make repairs immediately and remove the sign as soon as the problem is resolved.

2. Utilize the following color combinations when ordering trail signs:

Construction and Maintenance Zones
Regulation
General Warning or "Caution"
Stop or Prohibition
"Danger"

3. Signs in this section may be constructed of material as deemed necessary. They may be metal mounted on a metal post or decal affixed to a flexible post. Paper may be used for posting temporary messages so long as it is professional in appearance and the sign is replaced immediately if the sign is no longer functional or necessary.

4. Install interpretive displays on trails to inform the trail user of special areas of interest such as cultural or geological resources.

REFERENCES

1. Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds. (2007, December). Retrieved from https://www.fs.fed.us/t- /pubs/pdfpubs/pdf07232816/pdf07232816dpi72pt00.pdf

2. Fencing Guidelines. (2017, April). Arizona Game and Fish Department. Retrieved from http://www.azgfd.gov/hgis/documents/110125_AGFD_fencing_guidelines.pdf

3. Gate standards. American Trails (2017, May). Retrieved from http://www.americantrails.org

4. International Mountain Bicycling Association (International Mountain Bicycling Association (IMBA)). (2001). *Building Better Trails - Designing, Constructing and Maintaining Outstanding Trails.* Boulder, Colorado: International Mountain Bicycling Association. https://www.imba.com/

5. Manning, Robert E. (2007). *Parks and Carrying Capacity – Commons without Tragedy.* Washington, DC: Island Press.

6. Maricopa County Department of Transportation Standards. (2016, 2017). Retrieved from http://www.mcdot.maricopa.gov/190/Technical

7. Park Road System Guidelines. (2017, March). Maricopa County Parks and Recreation Department.

8. Stankey, George H. The Limits of Acceptable Change (LAC) System for Wilderness Planning. General Technical Report INT – 176. (1985, January).

9. Trail Solutions: IMBA's Guide to Building Sweet Singletrack (International Mountain Bicycling Association IMBA)) (2004). Colorado: International Mountain Bicycling Association. https://www.imba.com/

10. USDA Designing Sustainable Off-Highway Vehicle Trails - An Alaska Trail Managers' Perspective. (2013). Retrieved from https://www.fs.fed.us/t-d/pubs/pdfpubs/pdf11232804/pdf11232804dpi100.pdf

11. USDA Forest Service Standard Trail Plans and Specifications. (2017, May). United States Forest Service. Retrieved from https://www.fs.fed.us/recreation/programs/trail-management/trailplans/

12. USDA FSH 2309.18 - Trails Management Handbook. (2008, October) Retrieved from https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5403600.pdf

13. USDA Trail Construction and Maintenance Notebook. (2007, July) Retrieved from https://www.fs.fed.us/t-d/pubs/pdfpubs/pdf07232806/pdf07232806dpi72.pdf

14. Wernex, Joe. (2002, 2nd Addition). Off-Highway Motorcycle & ATV Trails: Guidelines for Design, Construction, Maintenance and User Satisfaction. American Motorcyclist Association (1984) Retrieved from http://atfiles.org/files/pdf/WernexReport.pdf

15. 2010 ADA Standards for Accessible Design. (2010, September) Retrieved from https://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm