Figures

Photos

None

Chapter 2. Trail System Development and Management

"Trail management" is a multi-faceted process to plan, design, develop, manage, fund, and administer a trail or system of trails. This process may include:

- Establishing trail classifications, facility numbers, and standards;
- Inventorying and assessing the trail system;
- Categorizing trails into "sustainable", "unsustainable but maintainable", or "unsustainable and unmaintainable" groupings;
- Quantifying maintenance, rehabilitation, and program funding needs;
- Prioritizing trail projects;
- Securing funding to perform projects;
- Developing staff and resources to perform the projects;
- Scheduling and managing trail projects;
- Evaluating the work performed;
- Tracking project production and costs; and
- Adapting management and operations to achieve the maximum level of performance.

2.1. Trail Systems

Typically, a park has more than one trail and more than one type of trail use (hiking, biking, equestrian, etc.). To meet the long-term recreational needs of the public and to effectively budget and allocate resources, trail program managers should plan and manage for the entire system of trails in a given park unit. A system may consist of trails for hiking, biking, equestrians, interpretation, administration, or a combination thereof. To the extent possible, public land managers should strive to achieve trails that are accessible and sustainable.

A trail system also includes trail amenities such as signs (informative, interpretive, or regulatory), parking, benches, picnic tables, viewing platforms, and backcountry camps. These amenities are necessary to provide a safe and comfortable recreational experience for trail users and to reduce impacts to natural and cultural resources. These facilities must be developed and managed as part of the trail system and should be included in any trail management plans and actions.

Many land management agencies have not quantified the total needs of their trail system or the impacts that system has on the environment or operating budgets. When compared with the cost of all park operations, any sizable trail system will be one of the largest investments made by the agency. The trail system development and management processes described in this section will help trail program managers meet the needs of visitors, minimize impacts to resources, and ensure maximum usability of this important investment.

2.2. Base Map Development

The first step in trail management is to define the quantity and location of all trails in the system. This process begins with the development of a base map that identifies all the trails in the trail system. Depending on the scope of the system, the base map may include all transportation routes (e.g., roads, trails, and other routes) or focus only on recreational trails. Base maps are typically developed by walking the trails with a Global Positioning System (GPS) to collect digital points and lines, which are then incorporated into a Geographic Information System (GIS) for graphic display. Trail brochures and maps, aerial photography, USGS maps, and local knowledge also can be used to develop a base map.

2.3. Segmentation

Prior to assigning trail attributes (e.g., road or trail, use type, classification, etc.), trails on the base map are divided into segments based on trailheads, intersections, and trail ends. Segmenting the trail enables trail program managers to break the trail into manageable pieces and efficiently identify the unique characteristics of that portion of trail. Long trails may have multiple segments that may differ in attributes including distance from central visitor use areas, trail surface and structures, trail classification, and use designation. Segments are identified and stored in GIS, which allows for easy identification of specific locations along the trail.

Below are three examples of trail system mapping. Figure 2.1 shows all trails in a park, Figure 2.2 shows all trail segments, and Figure 2.3 shows trail segments grouped by name.

2.4. Assigning Trail Attributes

The term “attribute” as used in this handbook refers to the general characteristics of a trail, such as designated uses or trail classification, as well as specific characteristics such as types of trail structures, landscape features, and design failures. The assignment of attributes to a trail allows trail program managers to differentiate or group trails and trail features based on these characteristics.

2.4.1. Trail Classification

Not all trails have the same significance within a trail system. Some are critical to provide connections between visitor use facilities, major through trails, or visitor circulation routes. Some provide access to major visitor attractions or destinations. Obviously, these trails are more important than those that are not part of a loop or are a dead end trail in a remote or seldom-used area of a park. To establish a hierarchy, each trail is placed into a class.

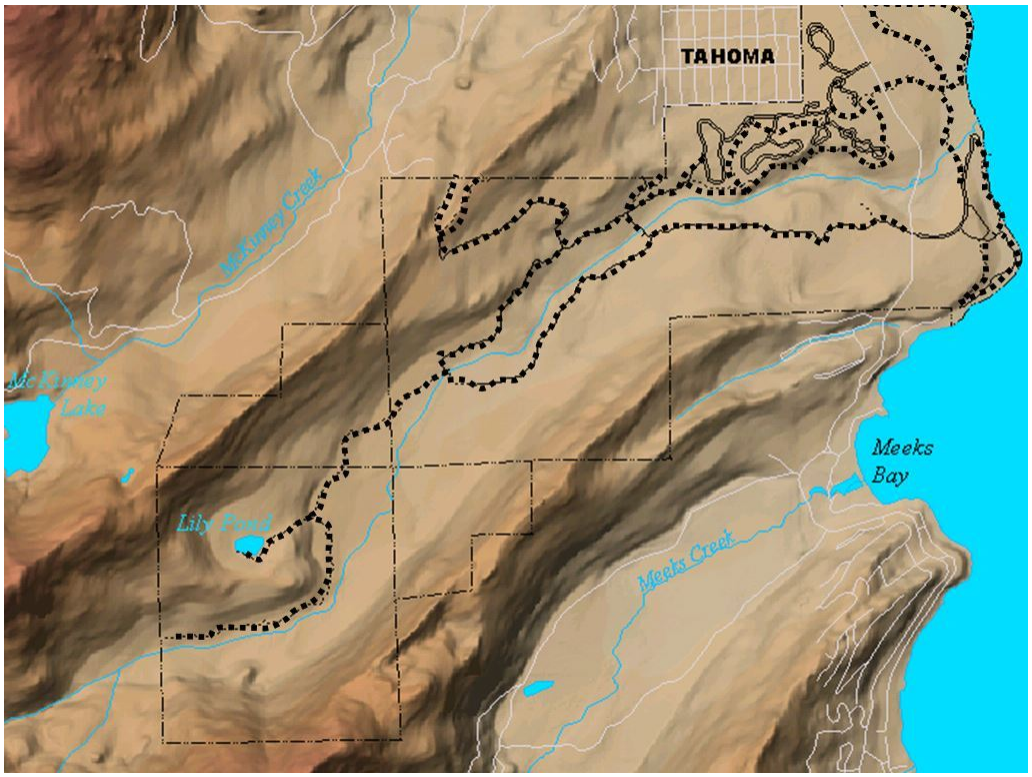

Figure 2.1 – Map of an Un-Segmented Trail System

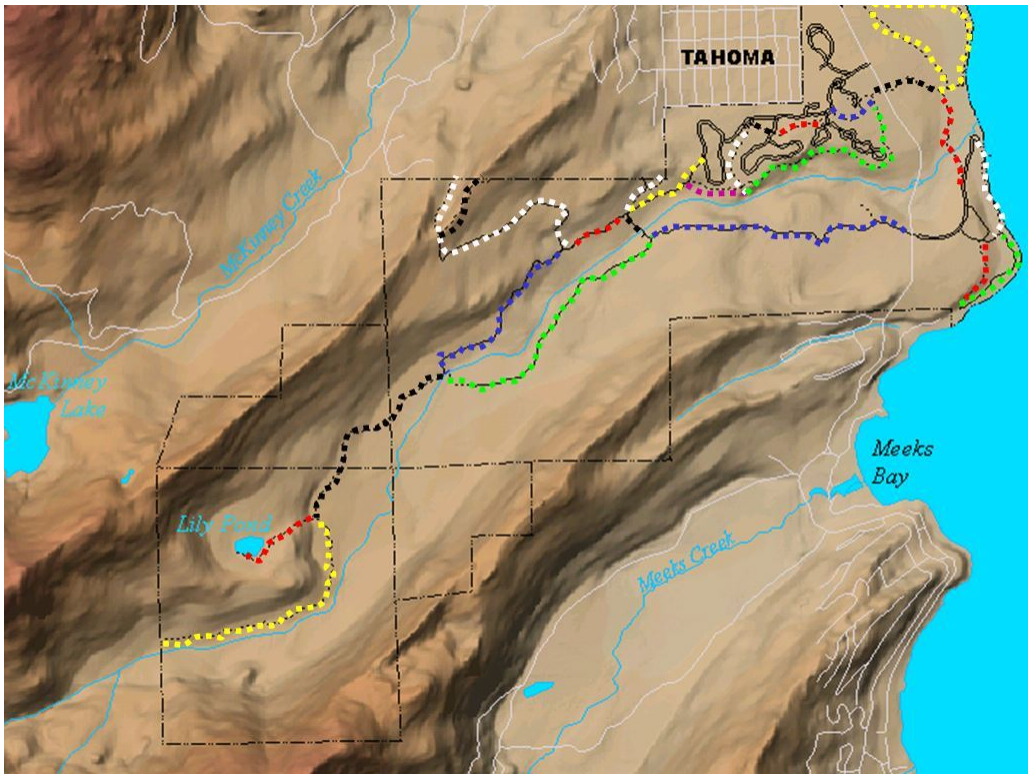

Figure 2.2 – Map of a Segmented Trail System

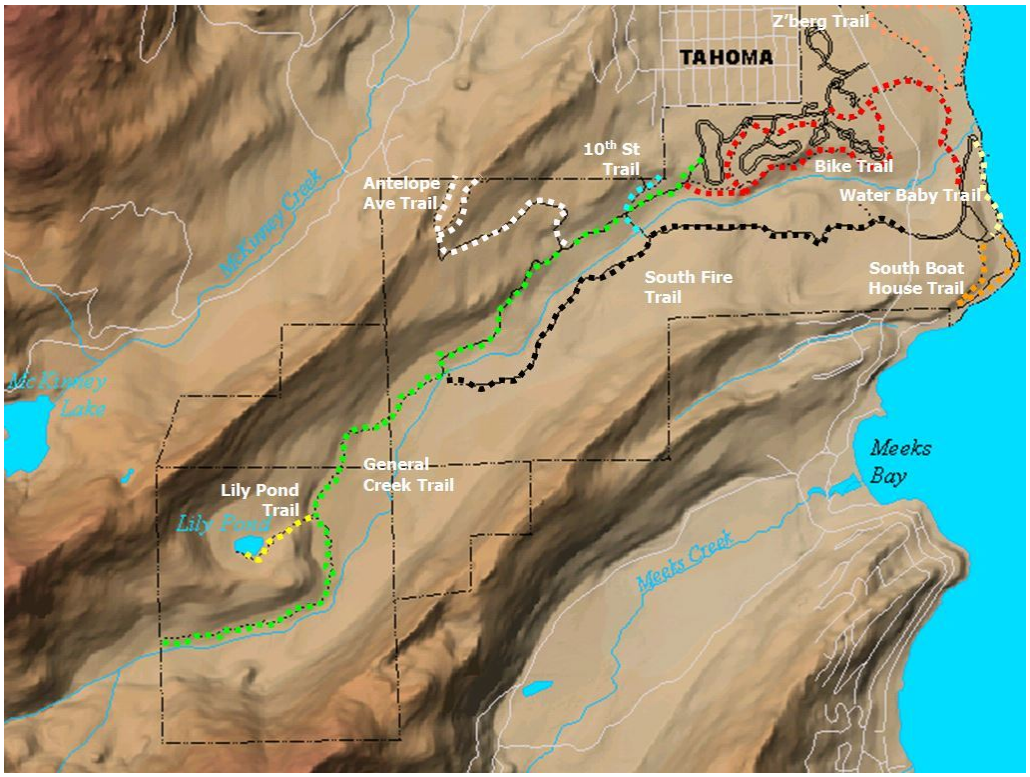

Figure 2.3 – Map of a Trail System Divided by Trail Name

The placement of trails into classes is determined with specific criteria that can be used to evaluate trails individually as well as comparatively. (See Figure 2.4.) Once each trail is evaluated, it is grouped into a class based on the total number of points it receives. For example, 30 points or greater constitutes a Class I trail, 19 to 29 points is a Class II trail, and so on.

Classifying a trail system requires input from staff that are knowledgeable about the facilities, transportation routes, circulation patterns, and trail usage. Classification should be performed at least once every five years. Facilities, sensitive resources, and visitor use patterns are subject to change, and a trail's point value may rise or fall accordingly. Periodic re-evaluation of a trail ensures that assigned standards and work priorities reflect the current system's needs.

Based on the Trail Classification Points determined below, the trail is classified as follows:

I = 30+
II = 19 - 29
III = 10 – 18
IV = 0 –9

CRITERIA	Point Value	Rating
1. Accessible – Trail meets the US Access Board and departmental standards for accessible trails.	25	
2. Interpretive – Trail has a series of interpretive signs or self-guiding pamphlets.	15	
3. Within a Visitor Use Facility – Trail originates and stays within a visitor use facility such as a picnic area or a campground.	15	
4. Multi-Use Trail – Trail for pedestrians, equestrians, and bicycles.	15	
5. Equestrian or Bicycle Trail – If already included in multi-use, do not score.	8	
6. Adjacent to Visitor Use Facility – Trail starts at a visitor use facility (VUF) or starts within a designated distance of a visitor use facility. Trail starts 0 - 1/4 mile from VUF = 12 points Trail starts 1/4 - 1 mile from VUF = 8 points Trail starts 1 – 2 miles from VUF = 4 points Trail starts >2 miles from VUF = 0 points		
7. Connection of Visitor Use Facilities – Trail connects two or more visitor use facilities.	5	
8. Parking – Parking is available at trail access points.	5	
9. Destination Oriented – Trail has a unique scenic, historical, or recreational feature. Points are given in relation to the distance from the trailhead to the unique feature. 0-1 miles = 3 points 1-3 miles = 2 points 3+ miles = 1 point		
10. Connection with other agency trail – Trail connects to another agency's trail or a regional trail system. More points are assigned for higher visitor usage.	+3 - +5	
11. Special Use or Access – Trail provides access to memorial or honor grove.	1	
12. Dead-End Trail – A dead-end trail is given zero points if it is "destination-oriented" and -3 points if it is without destination.	0 or -3	
13. Loop or Connecting Trail – More points are awarded for a trail that is part of a completed loop or forms an important connection.	+1 to +3	
14. Fragile Environment Protected by Limiting Development/Use[1] = -1 to -3 Protected by Trail Improvements[2] = +1 to +3		
15. Safety Factors – Positive value assigned to a heavily used trail. -Encourage less use by not providing improvements = -1 to -5 points -Provide and maintain improvements for higher use = 0 to +5 points		
16. Staff-Determined Use Patterns – Allows staff to adjust the trail's score based on level of visitor use. Little or No Use = -1 to -3 points High Use = +1 to +3 points		
TOTAL		

[1]Trail is designed and managed to protect fragile resources by limiting visitor use with minimal structures and amenities, and using basic design techniques.
[2]Trail is designed and managed to protect fragile resources by maximizing structural solutions, and using advanced design techniques.

Figure 2.4 - Trail Classification Matrix

2.4.2. Trail Use Type

Trails are also categorized by the type of use allowed. In addition to "accessible" or "non-accessible", trails are assigned a use designation from one of the following categories:

- Pedestrian
- Equestrian
- Bicycle
- Multi-Use

All trails within the California state park system allow for pedestrian use. Therefore, for the purposes of this handbook, it is assumed that all trails will have a pedestrian component, though pedestrian access may not be the primary use.

A "bicycle trail" designation allows for bikes on the trail, in addition to pedestrians, but the trail is not considered "multi–use" because pedestrians are allowed on all trails. It is considered a trail for bicycles and design specifications for bikes are used as the standard for construction and maintenance.

Similarly, an "equestrian trail" designation allows for horses on the trail, in addition to pedestrians, but the trail is not considered "multi–use" because pedestrians are allowed on all trails. It is considered a trail for horses and design specifications for horses are used as the standard for construction and maintenance.

When a trail is designated for bike ***and*** horse use, it then becomes "multi-use." A multi-use trail designation dictates the most sustainable and least resource-damaging design specifications that are blended from horse and bike trail standards for construction and maintenance.

Trail classifications are then assigned to each segment after each trail in the system has been classified using the classification matrix. (See Figure 2.5.)

2.5. Trail Standards

Placing trails in classes also allows the trail program manager to objectively assign standards. Class I trails are assigned the highest trail construction and maintenance standards. The standards for Class II, III, and IV trails diminish respectively, with Class IV trails receiving the lowest standards. The trail standards outlined below are considered the minimum design and construction standards for each class. (See Figure 2.6.) Additional standards are identified for each use type and trail structure in the following chapters. Selecting trails for maintenance and rehabilitation is also influenced by their classification. Assuming visitor safety, resource protection, and trail investment concerns are equal, trails with the highest classification and point totals receive the highest priority.

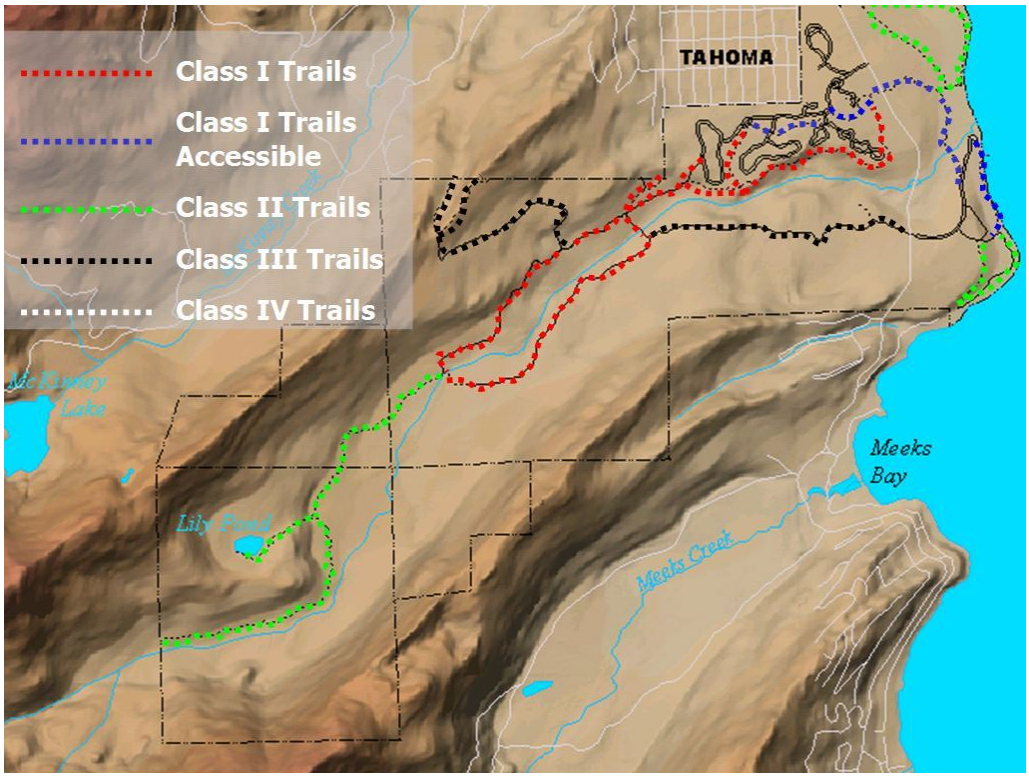

Figure 2.5 –Map of a Trail System Divided by Classification

2.6. Developing Trail Facility Numbers

In the California state park system, once the trail system is attributed, facility numbers are assigned. Trails and trail segments are not assigned unique facility numbers but are grouped together based on trail classification, designated use type, and accessibility. Trail program managers can then use these groupings to develop an appropriate maintenance budget. Trails with the same classification, designated use type, and level of accessibility require similar maintenance activities. Facility numbers allow trail program managers to group similar trails together and assign annual maintenance budgets specific to the needs of those trails.

Standards	Class I	Class II	Class III	Class IV
Trail Types	Includes accessible, multi-use, equestrian, bicycle, interpretive, and hiking trails.	Includes hiking, bicycle, and equestrian trails that provide access to areas away from developed visitor use facilities.	Includes lightly used hiking trails.	Includes special use and administrative access trails.
Example	Interpretive trail from the visitor center.	A long distance bike loop trail not close to or associated with other visitor facilities.	Backcountry hiking trail.	Paths to water system infrastructures.
Trail Tread Material	Native materials, trail hardening additives, asphalt, concrete, aggregate surfacing, rip rap, and stone pitching.	Native materials, aggregate surfacing, rip rap, and stone pitching.	Native materials, aggregate surfacing, rip rap, and stone pitching.	Native Materials
Trail Bed Width	Minimum of 40".	Minimum of 24".	Minimum of 18".	Minimum of 12"
Trail Tread Width	36" minimum, wider depending on the user group, surrounding terrain, and vegetation.	18" minimum, depending on the surrounding terrain.	12" minimum, depending on the surrounding terrain.	10" minimum, depending on the surrounding terrain.
Clearing Limits Height	8' for pedestrian and bicycle trails; 10' for equestrian and multi-use trails.	Same as Class I trails	8'	Minimum necessary for passage
Clearing Width	The clearing width is 2' beyond the top of the cut bank and outboard hinge.	Same as Class I trails	Same as Class I trails	Minimum necessary for passage
Brushing Limits Height	8' for pedestrian and mountain bike trails; 10' for equestrian and multi-use trails.	Same as Class I trails	8'	Minimum necessary for passage
Brushing Width	1.5' feet beyond the inboard and outboard hinge.	Same as Class I trails	Same as Class I trails	Minimum necessary for passage

Figure 2.6 – Trail Standards

Standards	Class I	Class II	Class III	Class IV
Trail Structures	Trail structures such as bridges (including equestrian bridges), and steps have a minimum of 60" tread width with a minimum 60" tread width between railings and posts. Causeways, turnpikes, puncheons, or other drainage structures are required in areas of trail trenching or trampling, multiple trails, or saturated trail beds.	Trail structures such as bridges (including equestrian bridges), and steps have a minimum of 48" tread width with a minimum 48" tread width between railings and posts. Causeways, turnpikes, puncheons, or other drainage structures are required in areas of trail trenching or trampling, multiple trails, or saturated trail beds.	Trail structures are to be avoided by initial layout or reroute, if absolutely necessary. Trail structures such as bridges and steps have a minimum of 48" tread width with a minimum 48" tread width between railings and posts. Causeways, turnpikes, puncheons, or other drainage structures are required in areas of trail trenching or trampling, multiple trails, or saturated trail beds.	Trails are designed to avoid the need for structures and drainage controls.
Safety Requirements	Along a precipice or hazardous area, the trail bed should be wider to provide greater safety for the user, especially if a handrail or edge protection is not provided. Posts and handrails are required on bridges when the vertical drop from the tread to the lowest elevation >4'. Railing height is 42" (54” for equestrian) from the tread surface, and a mid-rail must be installed.	Initial trail design and layout minimizes the need for bridges. Along a precipice or hazardous area, the trail bed should be wider to provide greater safety for the user, especially if a railing or edge protection is not provided. If railings are provided, they are installed to Class 1 standards.	Initial trail design and layout minimizes the need for bridges. Trail beds along a precipice or hazardous area should be wider, to provide greater safety for the user, especially if railings or edge protection is not provided. If railings are provided they are installed to Class 1 standards	Trails are designed to avoid the need for bridges or safety railings.

Figure 2.6, Trail Standards, cont.

With the implementation of MAXIMO, a uniform facility numbering system was developed for trails that all park units adopted. For additional information on the development of facility numbers, refer to *Department Operations Manual,* Section 0807.12. Facility numbers are constructed and interpreted in the following manner:

###	F	#	##	#	###
The first three digits represent the park unit.	A letter then identifies the type of facility: A–Buildings, B–Grounds, C–Roads, D–Misc., E–Systems, F–Trails.	A number identifies the trail class: 1–Class I, 2–Class II, 3–Class III, 4–Class IV, 5-Motorized Recreation Use, 6- Un-constructed Route.	Two numbers represent the trail type: 01–Pedestrian, 02–Equestrian, 03–Bicycle, 04–Multi-use, 05 – 4x4, 06 – ATV, 07 – MC, 08 – RUV, 09 – Motor. Multi-use.	One number represents the accessibility: 5-Accessible, 0–Not Accessible.	The last three digits may be used to assign a unique value to individual trails or trail segments. Currently, all trails are assigned "001."

Figure 2.7 – Facility Number Assignment

Example – **618-F-1-01-5-001**

618 – Unit number for Cuyamaca Rancho State Park
F – The type of facility is "F", trails
1 – The trail is classified as a "Class I"
01 – The use type is pedestrian
5 - The trail is accessible
001 – The standard to be used for all trail facility numbers.

Designations Possible for Trail Class and Use Type

618-F-1-01-0-001 Class I Pedestrian Trail
618-F-1-01-5-001 Class I Pedestrian Accessible Trail
618-F-1-02-0-001 Class I Equestrian Trail
618-F-1-03-0-001 Class I Bicycle Trail
618-F-1-04-0-001 Class I Multi-use Trail
618-F-2-01-0-001 Class II Pedestrian Trail
618-F-2-02-0-001 Class II Equestrian Trail
618-F-2-03-0-001 Class II Bicycle Trail
618-F-2-04-0-001 Class II Multi-Use Trail
618-F-3-01-0-001 Class III Pedestrian Trail
618-F-4-01-0-001 Class IV Pedestrian Trail—Special Use

2.7. Trail Inventory and Assessment (Zero Basing the Trail System)

Once the trails are attributed and the facility numbers are established, each trail segment is thoroughly inventoried and inspected. In trails, “zero base budgeting” is the process of inventorying and identifying all features and structures within a trail system, identifying their size, quantifying their total number, identifying the frequency for maintenance or replacement, identifying the tasks and corresponding person hours for performing this work, and identifying the costs of materials, tools, and equipment associated with these tasks. Through this process the cost for maintaining a trail system can be accurately and fairly identified. This process requires hiking each trail with a Rolatape wheel, tape measure, and a printed “field copy” of an electronic Trail Log. (See Figure 2.8.) A Trail Log is used to record the existing conditions along a trail. The inventory is completed using the standards for each trail class, use type, and trail structure. The completed Trail Log is later entered into an electronic worksheet that uses a drop down menu to help keep data entry consistent.

As the inspection team hikes the trail, they record every structure encountered onto the Trail Log, (e.g., bridges, puncheons, safety rails, retaining walls, steps). Department employees can access the latest version of a Trail Log on the intranet under the “Roads and Trails Program” link. Each structure is measured to identify its length or dimension. It is also inspected to determine its deviation from design standards, structural integrity, and general condition. Deficiencies are noted and those structures that require repairs, upgrades, or replacement are entered into the Trail Log. The team also surveys the trail bed and tread surface. Deficiencies, such as entrenching, drainage problems, exposed roots, and downed trees, are identified, measured, and logged. A GPS unit, Toughbook laptop, electronic tablet, and associated database can also be used to supplement or replace non-electronic assessment and inventory tools. Through this process, a complete inventory of trail features and structures is recorded and every deficiency is identified and quantified. (See Figure 2.8.) Base mapping should be updated to include recorded information.

Trained personnel are essential for an accurate evaluation of the facility, and those assigned to complete the inventory must understand trail construction and structures. Many structures are not seen in the trail corridor or the view shed of the hiker. For example, trail tread can have support walls in the slope below the trail and drainage lenses buried underneath the trail. Bridges may or may not have constructed abutments and associated drainage structures. Retaining walls may have footings that are anchored many feet below trail grade. Additional information regarding departmental procedures for road and trail inventory and assessment can be found in the Department’s *Guidebook for Road and Trail Inventory and Assessment* and *Field Guide for Road and Trail Inventory and Assessment.*

Trail: _____ Date: _____

Segment _____ Land Unit: _____

Begin Feet	End Feet	Action	Feature	Feature Attribute	Tread Width	Mechinized	Accessible	Wood / Plastic	Size/Qty L	Size/Qty H	Size/Qty W	Units	Comment

Figure 2.8 - Blank Trail Log (Field Copy)

Information entered into the Trail Log should be consistent. If an action is recommended, the prescribed treatment should be the same as for similar trail features. Variation between similar features can be noted in the comments section of the Trail Log. To help standardize data entry, a standard list of trail features on the Trail Feature Attribute Sheet is attached to the Trail Log. The list identifies the correct name of the feature, specific feature attributes (if any), possible construction methods and materials, appropriate units of measurement, and other data recording tips. (See Figure 2.9.)

Features are recorded in different units of measurement. For example, the appropriate measure for a turnpike is “cubic feet”; however, the beginning and ending locations of the turnpike should also be recorded. Some features, such as retaining walls, may have multiple entries and measurements, including length, height, width, beginning distance footage, ending distance footage, type of retaining wall, quantity of backfill, quantity of excavations for retaining wall footings, and logistics for transportation of backfill and wall materials. (See Figure 2.10.)

2.8. Sustainability and Maintainability

After a trail has been inventoried and evaluated, it can be categorized into “sustainable,” “maintainable/unsustainable,” or “unmaintainable/unsustainable.” Ideally all trails should qualify as sustainable, but that is not the case in most trail systems. Due to the location on the landform, some trails can never be classified as sustainable, but they are needed to provide public access to key points of interest. Other trails are so poorly designed and constructed that they can never be maintainable, or their value to the trail system is so low that resources should not be invested in them. Placing trails in one of these three categories provides the trail program manager with another tool to assess the relative health of the trail system and determine the focus of future trail management activities. A definition for each of these categories is provided below.

Trail Log Features
Dropdown Computer Entry Sheet Instructions

Mechanized Yes (X) or No
Accessible Yes(X) or No
Wood (W) or Plastic (P) Lumber

Rolotape	Feature	Feature Attributes	Mech	Acc	W / P	Action	Unit	Required Comment Column Sub-Identifiers	Generic Recording Tips
Footage From the Rolotape	Abutment - Concrete					Construct/Reconstruct/Remove/ Monitor	sq. ft/ cu ft.	record sq ft and cu ft of facers and wings	
	Abutment - Plastic Wood					Construct/Reconstruct/Remove/ Monitor	sq. ft	record total length and height of both facers and both wings	Identify if porous backfill material is required and record as rock crush backfill feature on a separate line
	Abutment - Rock Dry Stone					Construct/Reconstruct/Remove/ Monitor	cu. ft.	record length, height and width of both facers and both wings	Record volume of rock material and distance hauled as rock wall material feature on separate line. Identify if porous backfill material is required and record as rock crush backfill feature on a separate line
	Abutment - Rock Masonry					Construct/Reconstruct/Remove/ Monitor	cu. ft.	record length, height and width of both facers and both wings	Record volume of rock material and distance hauled as rock wall material feature on separate line. Identify if porous backfill material is required and record as rock crush backfill feature on a separate line
	Abutment - Trestle Steel					Construct/Reconstruct/Remove/ Monitor	ea	record single or double trestle, height of trestle, dimensions of concrete pad	record height of trestle in comment column
	Abutment - Trestle Wood					Construct/Reconstruct/Remove/ Monitor	ea	record single or double trestle, height of trestle, dimensions of concrete pad	record height of trestle in comment column
	Abutment - Wood Cribbed					Construct/Reconstruct/Remove/ Monitor	sq. ft	record total length and height of both facers and both wings	Identify if porous backfill material is required and record as rock crush backfill feature on a separate line

Figure 2.9 - Trail Log Features List

Trail: Pearls Beach Date: August 5, 2014

Segment Tansition off perimter road Land Unit: Angle Island

Mike Nelson, Jason spann

Begin Feet	End Feet	Action	Feature	Feature Attribute	Tread Width	Mechanized	Accessible	Wood / Plastic	Size/Qty L/each	H	W	Units	Comment	Total
0													Start Trail at Perimeter Road	
0		Construct	Split Rail Fence	Fence Railing 3 high					28.0			lin ft	Fence to parallel perimter road to deter cross-cutting of fill slope down to trail.	28.0
0	110	Brush	Trail Brushing Construction	Medium					110.0			lin ft		110.0
0	10	Construct	Retaining Wall Wood Cribbed Interlocking						10.0	2.0		sq ft	Provide landing a top of steps	20.0
0	10	Excavate	Soil	soil medium					10.0	1.0	1.0	cu ft	Wall footing	10.0
0	10	Import	Rock Crush Fill	Distance <300'					10.0	2.0	1.0	cu ft		20.0

Figure 2.10 - Example of Completed Computer Drop Down Trail Log

2.8.1. Sustainable Trails

Sustainable trails are designed and constructed so they do not adversely affect natural and cultural resources (i.e., “take”). Any impact considered “take” is avoided, and, in areas considered “sensitive,” impacts are addressed through planning and environmental review. These trails are designed and constructed to not disrupt or alter the natural hydraulic flow patterns of the landform. Sheet flow runoff is not diverted or accumulated, and runoff is allowed to continue on its normal flow path. Watercourses, including micro-watercourses, are not captured, diverted, or coupled with other watercourses by the trail. Water does not accumulate on the trail and

does not drain onto the landform where natural watercourses do not exist. These trails are designed and constructed to withstand the impacts of the intended user and the natural elements, while receiving only routine cyclical maintenance. They are designed and constructed to withstand the impact of 25 to 100 year storms. The trail tread and structures are minimally affected by these events. Storm events may include impacts above or below the trail alignment that are not attributed to the alignment, such as landslides or debris flows, and may be anticipated and avoided through good planning and design. These trails are designed to meet the recreational needs of the intended users. A high level of satisfaction by trail users results in trail users staying on the designated trail and not creating "volunteer" (sometimes known as "non-system" or "user created") trails. User satisfaction also results in the continued use of the trail.

2.8.2. Maintainable Unsustainable Trails

Maintainable/unsustainable trails do not meet the sustainable trail definition but are considered integral to park operations. Allocating maintenance or reconstruction resources can mitigate the impact of these trails on the environment. A maintainable/unsustainable trail may be one that provides access to critical park facilities or points of interest, but cannot be designed or constructed to be sustainable because of landform limitations. For example, coastal descent trails that traverse unstable bluffs or canyon trails that ascend steep cliffs are typically unsustainable. However, if these trails are not provided, the public will often develop their own access that can harm park resources, create visitor safety issues, and result in costly resource rehabilitation projects. In another example, a trail may need to have constructed drainage structures outside of natural drainage features. The use of these structures is not considered sustainable because they do not maintain the natural hydraulic patterns of the landform.

Heavy mechanical wear uses such as mountain bike free riding ("downhill riding"), recreational off highway vehicle (ATV) use, or equestrian endurance racing are examples of trail uses where the trail can be kept in proper condition with increased maintenance and reconstruction. However, these trail uses must be consistent with the mission and policies of the land management agency.

2.8.3. Unmaintainable Unsustainable Trails

Another category of unsustainable trails includes those trails that are not properly designed and constructed and cannot be made sustainable or maintainable through reconstruction or re-engineering. This group of trails represents a liability to park resources and operations and/or cost more to maintain than they are worth to park operations. These trails should be removed and rehabilitated, or removed, rehabilitated, and replaced with a sustainable trail alignment. Until the land management agency has the resources to remove these trails, they receive the maintenance necessary to minimize the impact on park resources and provide safe use.

2.9. Trail Maintenance Quantification and Budgeting

Once the Trail Logs are completed, the data is sorted by like features and subtotaled. (See Figure 2.11.) The subtotals are then complied by trail classification and by park. (See Figure 2.12.)

Trail classification totals are then entered into a modified Maintenance Budget Spreadsheet. (See Figure 2.13.) These spreadsheets are used to quantify the annual maintenance workload and cost associated with each trail class. Cost projections are determined by identifying a life expectancy for each type of trail feature and dividing the total quantity of each feature by that life expectancy. Through this process the anticipated quantity of trail features needing repair or replacement each year can be projected. For example, 360 feet of bridges with a 30-year life expectancy means that 12 feet of bridge need to be replaced annually (i.e., 360 ft. ÷ 30 years = 12 ft./year).

The labor required to perform this work is estimated through the use of production rates. Production rates are units of work (person hours required to construct or maintain a feature or structure). Production rates remain constant but the salary rates will change depending on the labor source and the respective salaries. For example, a production rate of 16 hours per foot of bridge means that 192 hours are required to replace 12 feet of bridge (i.e., 12 ft. x 16 hrs./ft. = 192 hr.). If labor costs $15.00 per hour, the estimated labor cost of replacing 12 feet of bridge is $2,880 (i.e., 192 hrs. x $15 = $2,880).

The material cost for maintenance repairs is also calculated on a unit basis. Each feature is broken down into units (i.e., linear feet of bridge, linear feet of railing, cubic yard of gravel, square foot of retaining wall) and then assigned a cost based on current vendor pricing. The units remain constant but the prices change according to the vendor. For example, repair of 12 feet of bridge that costs $435 per linear foot would cost $5,220 (i.e., 12 ft. x $435/ft. = $5,220).

Additional items that should be factored into maintenance costs include hiking time to and from the site, inspections, project planning, and supervision. Travel time to the work site varies according to the location and length of the trail and must be included when projecting labor cost.

Regardless of the labor source, experienced staff will do a site evaluation, prioritize the work, and develop drawings and plans. Once the plan is complete, the materials, equipment, and tools are purchased; projects are laid out or flagged; assignments are made to supervise and train crews and demonstrate construction techniques; daily work records are kept; maintenance records are updated; and the final report prepared. This workload represents about 15% of the total crew labor required for a project. Multiply the estimated hours of labor by 15% to calculate these costs. For example, 31.5 hours for planning and supervising is required for a project that requires 210 hours of labor (i.e., 210 x 0.15 = 31.5).

Trail: **Pearls Beach** Date: August 5, 2014

Segment Tansition off perimter road Land Unit: Angle Island

Mike Nelson, Jason spann

Begin Feet	End Feet	Action	Feature	Feature Attribute	Tread Width	Mechanized	Accessible	Wood / Plastic	Size/Qty L/each	H	W	Units	Comment	Total
			Rock Fracture Shapes 6											**30.9**
85	102	Import	Rock Wall Rock	Distance <300'					17.0	1.0	6.0	cu ft	Import rock for armored drain	**102.0**
			Rock Wall Rock Total											**102.0**
85	102	Excavate	Soil	soil medium					17.0	1.0	6.0	cu ft	Rock footings	**102.0**
10	22	Excavate	Soil	soil medium					12.0	1.0	0.5	cu ft	Step Footings	**6.0**
22	28	Excavate	Soil	soil medium					6.0	1.0	0.5	cu ft	Step Footings	**3.0**
33	38	Excavate	Soil	soil medium					5.0	1.0	0.5	cu ft	Step Footings	**2.5**
46	58	Excavate	Soil	soil medium					12.0	1.0	0.5	cu ft	Step Footings	**6.0**
0	10	Excavate	Soil	soil medium					10.0	1.0	1.0	cu ft	Wall footing	**10.0**
28	33	Excavate	Soil	soil medium					5.0	1.0	0.5	cu ft	Wall Footings	**2.5**
38	46	Excavate	Soil	soil medium					8.0	1.0	0.5	cu ft	Wall Footings	**4.0**
58	85	Excavate	Soil	soil medium					27.0	1.0	0.5	cu ft	Wall Footings	**13.5**
			Soil Total											**149.5**
0		Construct	Split Rail Fence	Fence Railing 3 high					28.0			lin ft	Fence to parallel perimter road to deter cross-cutting of fill	**28.0**
			Split Rail Fence Total											**28.0**
22	28	Construct	Steps	Wood Interlocking Double					4.0			ea		**4.0**
33	38	Construct	Steps	Wood Interlocking Double					3.0			ea		**3.0**
46	58	Construct	Steps	Wood Interlocking Double					8.0			ea		**8.0**

Figure 2.11 - Trail Log Sorted

Sierra District Trails		Job Descriptions from Modified 473												
Park Unit **Trail Class Totals** *Trail or Trail Segment Totals*	Facility Number	Year Built	Length (FT)	# Down Trees	Length Cause- ways SQ FT	Turnpike SQ FT	Length Surfaced Areas (Non-Native) SQ FT	All Wood Steps EA	Length of Handrails	Retaining Walls-Wood SQ FT	Length of Bridges	Length of Puncheons	Retaining Wall Rock SQ FT	Retaining Wall Geotextile Fabric SQ FT
D.L. Bliss State Park														
D.L. Bliss State Park Class I	***303-F-1-01-0-001***		***27285***	***105***	***0***	***0***	***84***	***200***	***670***	***49***	***52***	***44***	***9160***	***0***
Boatcamp to Bliss		*1947*	*19432*	*46*	*0*	*0*	*0*	*0*	*670*	*0*	*52*	*20*	*6070*	*0*
Lighthouse		*1933*	*6685*	*55*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3090*	*0*
Calwee Cove			*584*	*2*	*0*	*0*	*42*	*100*	*0*	*25*	*0*	*12*	*0*	*0*
Calawee Cove 1		*1933*	*300*	*2*	*0*	*0*	*42*	*45*	*0*	*13*	*0*	*12*	*0*	*0*
Calawee Cove 2		*1933*	*284*	*0*	*0*	*0*	*0*	*55*	*0*	*12*	*0*	*0*	*0*	*0*
D.L. Bliss State Park Class II	***303-F-2-01-0-001***		***5137***	***47***	***0***	***0***	***0***	***63***	***59***	***101***	***32***	***23***	***60***	***0***
Balancing Rock		*1940*	*2077*	*12*	*0*	*0*	*0*	*63*	*59*	*101*	*32*	*0*	*0*	*0*
Lighthous Loop		*1967*	*3060*	*35*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*23*	*60*	*0*
Emerald Bay State Park														
Emerald Bay Class I Accessible	***313-F-1-01-5-001***		***11187***	***60***	***36756***	***7992***	***680***	***0***	***449***	***0***	***274***	***133***	***8983***	***580***
USFS Connector			*3756*	*0*	*15024*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*6800*	*580*
VH Grounds Trails			*7431*	*60*	*21732*	*7992*	*680*	*0*	*449*	*0*	*274*	*133*	*2183*	*0*
Emerald Bay Class I	***313-F-1-01-5-001***		***15888***	***60***	***5045***	***722***	***680***	***17***	***449***	***0***	***274***	***133***	***2183***	***133***
VH to Boatcamp	.	*1947*	*4816*	*29*	*2130*	*722*	*680*	*0*	*292*	*0*	*173*	*109*	*109*	*109*
Rubicon Extension		*1999*	*8499*	*25*	*1240*	*0*	*0*	*0*	*157*	*0*	*101*	*24*	*24*	*24*
VH to Visitors Center		*1999*	*153*	*0*	*475*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
VH to Bridge		*1999*	*539*	*1*	*1200*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*2050*	*0*
Cascade Creek		*1999*	*1881*	*5*	*0*	*0*	*0*	*17*	*0*	*0*	*0*	*0*	*0*	*0*

Figure 2.12 - Example of Park Unit Totals by Facility Number

Trail Log Inventory Totals	Unit of Measure	
Brushing Cycle	years	1
Light Brush	Footage	0
Medium Brush	Footage	0
Heavy Brush	Footage	0
Number of Down Trees from Trail Log	each	0
Down Trees Removed by Chain Saw	each	0
Down Trees Removed By Crosscut Saw	each	0
Drainage Structure Maintenance	Total	0
Cycle of Maintenance	years	1
Waterbar - wood	each	0
Waterbar - rock	each	0
Waterbar - earth or drain dip	each	0
Culverts Cleaned	each	0
Drainage Ditch Cleaned	each	0
Misc Drainage Cleaned	each	0
Slough and Berm Maintenance Cycle	years	5
Switchbacks and Climbing Turns	each	0
Switchback & Climbing Maintenance Cycle	years	5

Trail Log Inventory Totals	Unit of Measure	
Culverts		
12" Diameter	lineal feet	0
18" Diameter	lineal feet	0
24" Diameter	lineal feet	0
36" Diameter	lineal feet	0
Culvert Life Span	years	30
Wood Steps		0
Standard	each	0
Interlocking - Single	each	0
Interlocking - Double	each	0
Waterbar - wood	each	0
Cable Steps	each	0
Step Life Span	years	1
Rock Steps		
Dry Rock Steps	each	0
Dry Rock Step Life Span	years	20
Mortared Rock Steps	cubic feet	0
Mortared Rock Step Life Span	years	10

Figure 2.13 - Maintenance Budget Spreadsheet

2.9.1. Transferring Maintenance Budget Spreadsheets to MAXIMO

Developing the park unit's cyclical trail budget through the maintenance budget spreadsheets creates the total personnel, contract, materials, and equipment costs needed to populate the trails Job Plan in the Maximo program. Again, this budget is zero based or inventory-based, and the numbers in the Maximo Job Plan can be traced back from the maintenance budget spreadsheet, the totals from the trail classification spreadsheet that grouped all similarly classed trails, and the original inventory documented with the Trail Log.

The totals from the maintenance budget spreadsheets, including labor, tools, equipment, and materials, are then transferred to the Maximo Job Plan. (See Figure 2.14.) Work descriptions from the spreadsheet are entered into the "Long Description" tab for the Job Plan title.

2.9.2. Work Orders

A Work Order is created from the Job Plans. For trail facilities, Work Orders are produced once a year and encompass each maintenance activity in the maintenance budget spreadsheet. These Work Orders include the trail maintenance activities shown on the Job Plan. However, they do not identify which trail or trail structure will be worked on or the quantity of work that will be performed. Annual trail maintenance activities are identified by performing condition assessments on each trail. Every trail needs to be inspected annually, and these inspections represent the condition assessment required for state park facilities under the MAXIMO program. New deficiencies in trail structures and features are addressed in the Category 1 maintenance program (daily to annual, or two- to five- year cycles) or the deferred maintenance program (Project Infrastructure Database projects where cyclical maintenance activities will no longer address the needs and reconstruction/reengineering is required). Work Orders identify public safety and resource management problems, as well as routine maintenance problems. Once

identified, they are scheduled for correction through the annual Work Order and become scheduled maintenance. Trail inspections are performed with the aid of the Trail Log, Rolatape, tape measure, or electronic measuring and recording devices, similar to the initial inventory. However, only new deficiencies and their locations are noted on the Trail Log.

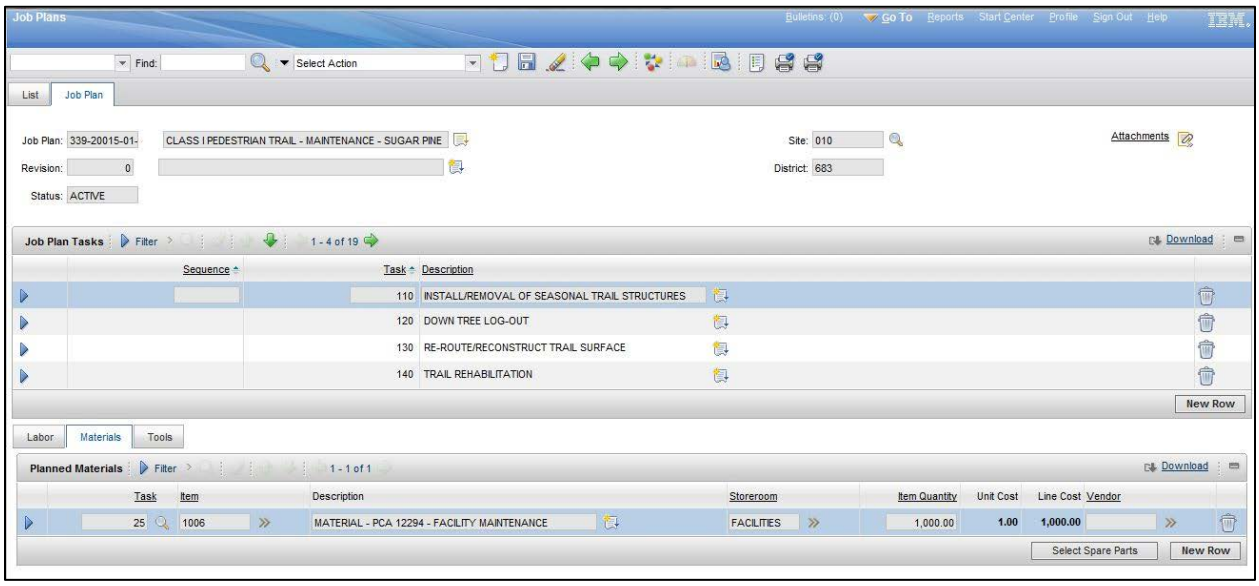

Figure 2.14 - Maximo Job Plan

2.10. Trail Project Development

A rehabilitation program may be necessary when a trail system's maintenance needs exceed the trail program's maintenance capabilities, which usually occurs due to poor initial trail design and layout, inadequate funding, poor management, lack of assigned staff, or natural disasters such as floods, storms, and earthquakes.

The process of identifying and quantifying the work in a rehabilitation program or project is similar to the general maintenance process described above, but instead of listing all trail structure/features, only those items that require repairs are identified, measured, and logged.

Trail Log totals (Figure 2.10) are sorted (Figure 2.11) and entered into Trail Cost Estimating Worksheets (Figure 2.15). These worksheets identify the labor, materials, tools, equipment, and contracts required to perform the trail construction project. Department employees can access the latest version of the Trail Cost Estimating Worksheets on the intranet under "Road and Trail Program". Costs to be identified also include project planning, management, and permitting, as well as natural and cultural resource surveys. These worksheets are very detailed and address nearly all potential costs associated with a trail construction project. Trail Structure Worksheets are linked to the main spreadsheet to calculate the labor, materials, and shipping costs associated with an individual structure. The Trail Cost Estimating Worksheet also identifies the

components, material sizes, and quantities required to construct the structure. See Figure 2.15 for selected examples of the trail cost estimating worksheets.

Once a trail project is scoped and the preliminary design and associated costs have been identified, it is entered into the Department's Park Infrastructure Database (PID). PID is a cross-functional database of the Department's non-recurring project needs for facilities such as trails. Users can add new projects, update project information, and rank (prioritize) projects in the PID system periodically or continuously as needed. Documents created in support of a project, including Project Evaluation Forms (PEFs), Trail Logs, and cost estimates, can be attached to the project within PID. The PID list is used by the Department to identify funding needs for non-recurring repair of park facilities.

Trail Construction Cost Estimating Worksheet

To locate construction activity within spreadsheet use key stroke "CONTROL F"

Trail:

Cells that may require data entry

Cells that may require rock totals entered into rock manufacturing, gathering & transport categories

CONSTRUCTION ACTIVITY	ITEM TOTALS	PROD. RATE	UNIT		HR. LABOR COST		LABOR COST	MATERIAL, RENTAL, & CONTRACT COST
					Crew Labor Rate			
Trail Brushing and Clearing					$17.40			
Trail Brushing maint. (light)	0	260	lin ft	@	$17.40	=	$0.00	
Trail Brushing maint. (medium)	0	160	lin ft	@	$17.40	=	$0.00	
Trail Brushing maint. (heavy)	0	120	lin ft	@	$17.40	=	$0.00	
Trail Brushing const. (light)	0	120	lin ft	@	$17.40	=	$0.00	
Trail Brushing const. (medium)	0	60	lin ft	@	$17.40	=	$0.00	
Trail Brushing const. (heavy)	0	30	lin ft	@	$17.40	=	$0.00	
Trail Brushing const. (extra heavy)	0	20	lin ft	@	$17.40	=	$0.00	
Clearing, tree& stob removal, light	0	80	lin ft	@	$17.40	=	$0.00	
Clearing, tree& stob removal, med.	0	40	lin ft	@	$17.40	=	$0.00	
Clearing, tree& stob removal, heavy	0	20	lin ft	@	$17.40	=	$0.00	
Down Tree Removal 1'- 3' chainsaw	0	2	hr/ea	@	$17.40	=	$0.00	
Down Tree Removal 4'- 6' chainsaw	0	6	hr/ea	@	$17.40	=	$0.00	
Down Tree Removal 7'- 9' chainsaw	0	12	hr/ea	@	$17.40	=	$0.00	
Down Tree Removal 1'- 3' crosscut	0	6	hr/ea	@	$17.40	=	$0.00	
Down Tree Removal 4'- 6' crosscut	0	20	hr/ea	@	$17.40	=	$0.00	
Down Tree Removal 7'- 9' crosscut	0	40	hr/ea	@	$17.40	=	$0.00	

Figure 2.15 - Trail Cost Estimating Worksheet

2.10.1. Fund Development

Funding for a trail program falls into three categories: maintenance, rehabilitation, and new trail development.

2.10.1.1. Maintenance

Maintenance funds are the most difficult to obtain due largely to the fact that trail facilities compete with all the other facets of park operations for funding and most park operations are underfunded. To be successful in competing for maintenance funds, trail program managers need to perform the detailed trail budgeting process described above. Only by implementing this “zero based” approach to budgeting can the true cost of maintaining a trail system be quantified. This fact-based information can be a powerful tool when presented to park managers and potential funding sources.

2.10.1.2. Rehabilitation

Most trail programs have a substantial amount of trail rehabilitation work to perform. These costs are identified by performing trail assessments, completing Trail Work Logs that identify the required work items, and generating cost estimates as identified in this chapter. Only by performing these tasks can a trail program manager accurately identify and quantify the trail rehabilitation needs. Having solid, defendable cost estimates gives the program an advantage in competing for rehabilitation funds. Unlike maintenance, there are many potential sources of funding for trail rehabilitation projects, including minor and major capital outlay funds, deferred maintenance funds, line item rehabilitation funds (legislation), donations, and grants. The key to successfully obtaining these funds is to have a planned, well designed, and accurately estimated project.

It is important to have multiple projects of varying cost, need, or justification ready for submission. When projects are reviewed for funding, they need to meet the criteria established for the funding program, so having a variety of projects that can fit different funding criteria is important. Similarly, having a range of funding requests increases the opportunity for receiving funding. Sometimes large projects may not be selected for funding due to stiff competition, but a small project that fits the amount of funding available or left over after the large projects have been selected can be funded.

It is also important that these projects be “shovel ready”; that is, they have already obtained the necessary environmental approvals and permits. Most project requests lack environmental approvals and control agency permits. This lack can be an issue especially if the funding source has a limited life span because the funds may expire by the time all the approvals and permits are obtained. Having the approvals and permits in advance is a huge advantage in competing for rehabilitation funds. Having projects shovel ready also puts your program in a good position to receive funding near the end of the fiscal year

when funded projects are often dropped due to approval and permitting problems or funds become suddenly available and park managers are looking for projects that can be implemented in a short time frame.

There are several trail grant funding programs available to trail program managers, including federal, state, and local government grants, as well as private donor and corporate grants. Three of the most important elements of a competitive trail grant application are an accurate cost estimate, approved environmental documents and permits, and a track record of completing “high quality” trail grant projects on time and within the allocated funds.

There is an old saying “it takes money to make money” and that saying is especially true in obtaining trail funding. It all starts with developing a solid trail program that includes a comprehensive trail facility inventory, quantification of annual and two- to five-year maintenance funding requirements, and assessment, prescriptions, and cost estimates for all trail rehabilitation needs. This effort puts the trail program in position to request more maintenance funds and be competitive for trail rehabilitation funds. As more funding become available, more effort can be put into long range projects and funding requests, making the program more competitive for capital outlay and grant funding. Capital outlay and grant funding can be used to leverage additional funding. In many cases, capital outlay and grant funding can be used for the “match funding” that is required by most grants. As project funds come into the program, the inventory of tools and equipment grows, making the program more self-sufficient.

2.10.1.3. New Trail Development

Until a trail system has been brought up to standard and has the resources to adequately maintain the entire system, it is difficult to justify support for new trail development. However, occasionally there are political and practical reasons to develop new trails. The same funding strategies employed in trail rehabilitation can also be applied to new trail projects.

2.10.2. Project Prioritization

To determine the priority of trail projects, trail deficiencies need to be assigned a severity rating. A range of points for each deficiency type enables staff to determine a score that corresponds with the relative necessity for the improvement. A higher score indicates a more deficient trail. For example, a trail with exposed rocks in the trail tread that could cause someone to trip may receive a severity rating of two, whereas a trail with a rotted safety railing on a bridge suspended 40 feet above a stream channel may receive a severity rating of ten.

2.10.2.1. Prioritization Point Criteria

To prioritize trail projects, assign points based on the criteria below. The project with the highest point total should reflect the project with the greatest priority.

Visitor Safety (1-10 points)
Trail conditions that represent a threat to the safety of park visitors, usually severe enough to warrant barricades, warning signs, and temporary or permanent trail closures, should be assigned a severity rating of one to ten points. For example, a section of step carriage and handrail on a coastal descent trail fails and requires users to traverse down a steep slope on unconsolidated soils with a precipitous drop off.

Resource Protection (1-10 points)
Trail conditions severe enough that critical resources are damaged by the trail should be assigned a severity rating of one to ten points. For example, the trail alignment captures a stream and diverts it along the trail for hundreds of feet, resulting in large quantities of sediment delivered into a stream that is critical habitat for a state and federally listed salmonid species.

Preservation of Investment (1-7 points)
Conditions that, if not repaired, will result in the need for total replacement of the structure should be assigned a severity rating of one to seven points. For example, a portion of the wood decking and railing of a bridge have rotted. If these portions are not removed and replaced, the rot will spread to the laminated wood stringers and the entire bridge will need to be replaced.

Visitor Convenience (1-5 points)
Conditions that make it uncomfortable for visitors to use the trail should be assigned a severity rating of one to five. For example, overgrown brush or fallen trees make the trail difficult or unpleasant to use.

New Trail Construction (1-3 points)
Depending on other factors such as public demand or political will, the development of a new trail that is in addition to existing trails should be assigned a severity rating of one to three points. For example, a new trail is proposed to tie two separate trails together and provide an additional hiking loop.

2.10.2.2. Project Selection Matrix

Using the Project Selection Matrix below, each trail project can be identified and easily prioritized. (See Figure 2.16.) Projects receiving the highest cumulative total are selected for implementation.

When two or more trails receive the same prioritization score, the trail with the highest classification receives the highest priority. For example, two trails receive a total score of 22 and one trail is Class I and the other is Class II, the Class I trail is prioritized. If two or more trails receive the same score and are in the same trail class, the trail with the highest trail class points is the priority. For example, if two Class I trails have the same score and one has 34 trail class points and the other has 39 trail class points, the trail with 39 points is ranked higher.

Scoring and ranking are simplified by using the Trail Project Selection Matrix. The auto sum function in the “total matrix points” cell automatically calculates the points assigned to the various deficiencies. Once the scoring is complete, the spreadsheet is sorted first by the total matrix points (descending), second by the trail class (ascending), and third by the trail class points (descending). This exercise will produce a prioritized list of trail projects, such as the one in Figure 2.17.

Once the trail projects have been ranked, cost and time estimates can be developed for the highest priority projects. Each project should have a Trail Work Log and the corresponding data entered into Trail Cost Estimating Worksheets.

In the case of annual maintenance projects, after cost and time estimates are completed, the trail program manager selects projects for scheduling until the program’s funding, staffing, and available time are allocated. Projects that cannot be funded are deferred until additional funding and resources become available or they are rolled over into the next prioritization exercise.

2.10.3. Scheduling Trail Projects

Scheduling is performed a minimum of one to three years in advance to ensure that there is adequate lead-time to complete the necessary environmental and cultural documents, surveys, and consultations, as well as obtain all required permits. (See Chapter 3, *Planning and Environmental Compliance).* Depending on the complexity of the project, it can take between three months and three years to obtain these approvals. Scheduling in advance provides the necessary time to complete this lengthy and required process.

Trail Project Selection Matrix

	Qualifying Deficiency (select all that apply and rank it on the severity scale shown)							
Trail Project	Visitor Safety 1-10	Resource Protection 1-10	Preservation of Investment 1-7	Visitor Conveinence 1-5	New Trail Construction 1-3	Total Matrix Points	Trail Class	Trail Class Points
West Ridge	5	6		4		15	3	19
Ten Taypo	8	10	2			20	3	18
Superintendent					2	2	2	22
South Fork	8	7				15	3	14
Rhododendron	5	6	3	2		16	3	18
Revelation			7			7	1	42
Ossagon	5	9				14	2	20
Little Creek		8		2		10	4	5
James Irvine	10	5	5			20	1	32
Foothill	10	6	4			20	2	25
Elk Prairie	8	7	5			20	1	38
Clintonia			6	2		8	3	15
Cathedral Trees			7	4		11	2	21
Brown Creek	2	6	2			10	2	23

Figure 2.16 - Trail Project Selection Matrix

Trail Project Selection Matrix (Sorted)

	Qualifying Deficiency (select all that apply and rank it on the severity scale shown)							
Trail Project	Visitor Safety 1-10	Resource Protection 1-10	Preservation of Investment 1-7	Visitor Conveinence 1-5	New Trail Construction 1-3	Total Matrix Points	Trail Class	Trail Class Points
Elk Prairie	8	7	5			20	1	38
James Irvine	10	5	5			20	1	32
Foothill	10	6	4			20	2	25
Ten Taypo	8	10	2			20	3	18
Rhododendron	5	6	3	2		16	3	18
West Ridge	5	6		4		15	3	19
South Fork	8	7				15	3	14
Ossagon	5	9				14	2	20
Cathedral Trees			7	4		11	2	21
Brown Creek	2	6	2			10	2	23
Little Creek		8		2		10	4	5
Clintonia			6	2		8	3	15
Revelation			7			7	1	42
Superintendent					2	2	2	22

Figure 2.17 - Trail Project Selection Matrix Sorted

When developing project schedules, the following variables need to be considered:

Visitor Use Patterns
Trail construction projects should be scheduled when visitor use is at its lowest because trail work affects both staff and visitors. The public has to walk through or around the work zone (controlled traffic) or wait until temporary closures are lifted. Staff has to answer visitor questions, listen to complaints, and enforce trail closures. The trail crew has their work disrupted by park visitors walking through or around the site, and must manage visitor traffic, answer questions, and listen to complaints.

Weather
Where possible, trail projects should be scheduled when the most favorable weather conditions exist. Weather can have a significant impact on the efficiency and quality of trail work, as well as the amount of collateral damage that occurs to park resources. Weather can also have an impact on worker safety and unfavorable conditions can lead to an increase in trail crew injuries.

Rare, Threatened, and Endangered Species Restrictions
Many parks provide critical habitat for animal and plant species. Working in and around sensitive habitats requires following established protocols that restrict activities and noise during certain times of year. When scheduling trail projects, know what sensitive species are located within or near the site, protocols for working in their habitat, and how and when you can work. This information should be identified during the environmental review process. (See Chapter 3, *Planning and Environmental Compliance*.)

Project Logistics and Access
When scheduling trail projects, logistical issues such as site access and distance, must be considered. Certain projects will have limited access and difficult logistical support issues due to remoteness, travel time, limited vehicle access, and operational restrictions based on the park's classification and local policies. The constraints may necessitate establishing spike camps near the site, working longer days, or adding commute time to the project timeline.

Soil Moisture Conditions
Trail projects that involve excavation, shaping, and compaction of soil need to be scheduled when soil moisture conditions are optimal. Soils that are too dry or wet will be difficult to shape and impossible to compact and can result in an inferior product and increased impacts to resources.

Labor Source Availability
Prior to scheduling, identify the labor source to be used and its availability. Sources may include park crews, California Conservation Corps (CCC) crews, California Department of Corrections (CDC) inmate crews, or volunteers. Scheduling trail projects one to three years in advance helps secure these crews before other competing programs can schedule them.

Matching the Labor Source to the Project
Some projects are simple and short, whereas others are complex and long. Some require substantial physical strength whereas others are relatively light in their physical demands. Because of this range, it is important to match the appropriate labor source to the project. Long technical projects may be better for park trail crews, short easy projects for volunteers, and strenuous projects for CDC inmate crews.

Meeting Crew Development and Training Needs
To develop trail crews, schedule them for projects that will improve and expand their skill sets and knowledge level. This tactic is also good for developing a viable and sustainable volunteer program. Often CCC crews and CDC inmate crews look for specific projects to help them meet program management goals. Scheduling crews with projects that meet these goals is a good investment in the future, helps build morale, and establishes strong alliances with outside agencies.

Project schedules do not have to be complex and intricate. They can be simple spreadsheets that identify the project, crew source, and start and finish dates. (See Figure 2.18.). Department employees can access the latest versions of project schedule worksheets on the intranet under the "Roads and Trails Program" link.

All trail projects must have a qualified lead person identified on the project schedule to organize and direct daily work activities, maintain quality control, ensure that the required tools, equipment, and materials are available when needed, and complete Daily Logs. This individual also provides basic crew training, coordinates project logistics with the trail supervisor, and develops one- to five-day work plans. No trail crew should ever be left unsupervised regardless of their experience.

In addition to scheduling work crews and supervision, any specialized equipment and tools also need to be secured. This equipment may include trail dozers, excavators, motorized wheelbarrows, gas powered drills, support vehicles, generators, and spike camp gear. Managing multiple projects may require more specialized tools and equipment than are available in a program. When deficiencies occur, the tools will need to be borrowed, rented, or purchased. Scheduling tools and equipment in advance for each project will identify any deficiency and eliminate conflicts over the items, project delays, and inefficiencies. (See Figure 2.19.)

Prior to finalizing the project schedule, a draft is sent out to other park operational programs to obtain their input and to ensure that there are no problems with the schedule. (See Figure 2.20.) Examples of project scheduling documents are in Appendix E, *Project Schedules*.

2.10.4. Contracting

When a park district does not have the capability to perform a trail construction project, they may be required to contract out the work. Trail construction contracts should be clear, concise, equitable, enforceable, and performance-based. They can be entered into with either government or private sector contractors. It is important to note that California contract law prohibits competition for contracts between the government and private sector. When contracting out a project, first decide which labor source is most appropriate to use.

PROJECT SCHEDULE/PROGRESS TRACKING Old Marina/Ice Box Tufa Accessible Trail				J	F	M	A	M	June				July					August				September			
Activity Name	Start Date	Finish Date	Who						1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21
Aquire Materials	2/1/08	4/30/08	Sterl/Liz		←	—	—	→																	
Set Up Spike Housing	6/2/08	6/3/08	Lori						↔																
Begin Research and Design of Interpretive Panels	2/1/08	4/1/08	M.Green		←	—	→																		
Begin Construction of Interpretive Panels	?	?	M.Green																						
Mobilization-Prep Tools	5/1/08	5/30/08	Lori					↔																	
Project Pre-start Meeting-Field Check Layout	4/15/08	4/30/08	Knapp/Cogar /Moses				↔																		
Remove Old Boardwalk	6/3/08	6/20/08	CCC						←	—	—	→													
Lay Out New Trail Alignment	6/16/08	6/20/08	Knapp/Cogar								↔														
Clear Trail Alignment			CCC								←	—	→												
Layout New Boardwalk Alignment	6/16/08	6/20/08	Knapp/Cogar								↔														
Stage Materials for Boardwalk			CCC									←	—	→											
Stage Materials for Causeway and Drainage Lenses			CCC									←	—	→											
Construction of Boardwalk			DPR/CCC										←	—	—	—	—	—	—	—	—	—	—	—	—
Construction of Causeway and Drainage Lenses			DPR/CCC										←	—	—	—	—	—	—	—	—	—	—	—	—

Figure 2.18 - Sample Trail Project Schedule

NORTH COAST REDWOODS DISTRICT

ROADS TRAILS & RESOURCE MAINTENANCE SECTION

TRAIL EQUIPMENT SCHEDULE 2004/05 ***MONTH***

	OCTOBER				NOVEMBER					DECEMBER					JANUARY				FEBRUARY					MARCH				APRIL					MAY	
	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21	28	7	14	21	28	4	11	18	25	2	9	16	23
RTR EQUIPMENT ITEM																																		
DOZER SWECO 550																																		
EXCAVATOR JD 80																																		
EXCAVATOR KIZZY																																		
TRACTOR KUBOTA																																		
DUMP TRUCK 4 YD INT.																																		
TRAILER UTILITY 9000 LB.																																		
FLATBED TRUCK 2.5 TON INT.																																		
FLATBED TRUCK 1.5 TON G.M.C.																																		
FLATBED TRUCK 1 TON CHEV.																																		
FLATBED TRUCK /RIGGING TRUCK INT.																																		
TRUCK 1 TON UTILITY FORD																																		
EQUIPMENT BORROWED																																		
DOZER SWECO STATE PARKS																																		
TRAILER UTILITY 12000 LB. PIERCY SECTOR																																		
EQUIPMENT RENTED / CONTRACTED																																		
DOZER SWECO																																		
EXCAVATOR MINI																																		
TRACTOR WITH TILLER																																		
BOOM TRUCK																																		
BOBCAT LOADER																																		
JACK HAMMER AIR																																		
ROLLER VIBRATORY																																		
VIBERPLATE COMPACTOR																																		

Figure 2.19 - Sample Project Equipment Schedule

To: All North Coast Redwoods District Personnel

Subject: R.T.R. Schedules

Please review the attached draft R.T.R. project schedules for the 2016-2017 and 2017-2018 project years. Please check for scheduling conflicts with special events, sector projects, visitor use patterns, etc. You will note that our heavy equipment schedules are light during the winter months. Please submit heavy equipment project requests that do not require a substantial amount of earth moving. Good examples include building demolition, campground barrier placement, road closures, etc. Some of the projects identified do not have a funding source as of this time. We will be seeking grant and bond funding for these projects. The equipment schedules for the road and trail equipment will be sent out after the project schedules have been finalized. Please submit your comments and project requests through your supervisor. I would like all comments and project requests to me by August 15, 2016.

Don Beers
Supervisor, R.T.R. Section
North Coast Redwoods District

Figure 2.20 - Sample Project Review Letter

Government contractors, such as the CCC, do not require competitive bids and can be hired through an interagency agreement. These agreements usually only cover labor and operational costs (like spike camps) but can also include materials. Contracts entered into with government contractors should be based on the amount of trail work produced ("performance based"). Hourly and lump sum contracts should be avoided as they can result in excessive labor costs, change orders, and quality control issues. Contract documents need to include a summary of work to be completed. (See Appendix F, *Contracting*.)

2.10.5. Project Implementation

Before starting any trail project, all environmental and cultural approvals, surveys, permits, and consultations must be completed. The content and conditions of these documents should be reviewed with the project leader and crew, and copies of the documents kept at the site during the work. (See Chapter 3, *Planning and Environmental Compliance.*)

The necessary materials, tools, and equipment must be secured prior to the start of a project. Not having these items available at the beginning of a project results in poor morale and the loss of crew production.

2.10.6. Production Rates/Daily Work Records

Production rates vary depending on the labor source, skill level, organizational capability, and supervisor skills. However, by maintaining accurate records over an extended period of time, an average can be developed for the various categories of trail construction work. It is important to note that these production rates are “averages.” Some trail construction elements may take more or less time based on the site conditions. An experienced and skilled trail designer will adjust the production rates to fit a specific trail project. A simple example would be brushing and clearing production rates. The species and density of trees and brush are such that clearing and brushing the trailway will take longer than the average “heavy” production rates in the trail estimating worksheets. So the designer reduces the production rate to reflect the site conditions. Another example is constructing multi-tier dry stone rock retaining walls. Local rock is the only practical source but its shape is such that it will require additional work with rock shaping tools to achieve good contact. Again, the designer lowers the production rate to reflect the additional labor required to shape the rocks. The more experience the trail professional has designing and building trails and working with production rates, the more accurate their cost estimates become. It is also important to continue to collect production rate information. The more data collected, the more valid the averages become. In addition, as new materials, tools, equipment, and construction techniques develop, production rates must be collected that reflect the changes.

See Figure 2.21 for an example of a daily work record and Figure 2.22 for the list of trail features to be used in completing the daily work record. The trail features list should be used to provide standard construction descriptions and associated units of measurement in recording daily work completed. Note that there may be more trail construction tasks than those identified on this list of trail features. Tasks are added to the list of trail features as necessary so as to capture of all work associated with the project.

Recording the work completed on a daily basis is necessary for production-based contracts. If work is not captured as it is completed, it becomes difficult if not impossible to quantify at a later date. It is also a good practice to have the project leader and the contractor sign the daily work record verifying the quantities of work recorded.

Daily work records can also be a useful tool to monitor the progress of a trail crew. By reviewing daily records, project leaders and program supervisors can determine if the crew is meeting production goals. If not, they can determine the cause and make the necessary corrections. Low production rates could be the result of deficiencies in crew or project organization or supervision, tools and materials, weather, or crew skill level, training, or work ethic. The sooner problems are recognized and corrected, the sooner the project will be back on track. A typical mid-project production summary below illustrates project monitoring and evaluation. (See Figure 2.23.)

Trail Construction Daily Work Record

Project: _____

Date: _____

Construction Activity	Quantity of Work	Units	Total Crew Hours

Project Supervisor Signature _____

Crew Supervisor Signature _____

Figure 2.21 - Daily Work Record

2.10.1. Project Communication and Evaluation

Frequent communication should be maintained between the project leader and the program supervisor to keep the supervisor abreast of the project's progress and issues that may affect the project. The goal is to correct small problems before they become large problems. In addition, program supervisors must perform regular inspections of on-going trail projects. Substandard work must be corrected in a timely fashion or crew production and morale will suffer. Frequent small corrections are better than having the crew redo several weeks' worth of work.

Mechanized Yes (X) or No
Accessible Yes(X) or No
Wood (W) or Plastic (P) Lumber

Feature	Feature Attributes	Mech	Acc	W / P	Action	Unit	Required Comment Column Sub-Identifiers
Abutment - Concrete					Construct/Reconstruct/ Remove/ Monitor	sq. ft/ cu ft.	record sq ft and cu ft of facers and wings
Abutment - Plastic Wood					Construct/Reconstruct/ Remove/ Monitor	sq. ft	record total length and height of both facers and both wings
Abutment - Rock Dry Stone					Construct/Reconstruct/ Remove/ Monitor	cu. ft.	record length, height and width of both facers and both wings
Abutment - Rock Masonry					Construct/Reconstruct/ Remove/ Monitor	cu. ft.	record length, height and width of both facers and both wings
Abutment - Trestle Steel					Construct/Reconstruct/ Remove/ Monitor	ea	record single or double trestle, height of trestle, dimensions of concrete pad
Abutment - Trestle Wood					Construct/Reconstruct/ Remove/ Monitor	ea	record single or double trestle, height of trestle, dimensions of concrete pad
Abutment - Wood Cribbed					Construct/Reconstruct/ Remove/ Monitor	sq. ft	record total length and height of both facers and both wings
Armored Stream Crossing					Construct/Reconstruct/ Remove/ Monitor	cu. ft.	
Armored Swale Crossing					Construct/Reconstruct/ Remove/ Monitor	cu. ft.	
Asphalt Removal	distance hauled <300', >300'<800', >800'<1300', >1300' <1800, >1800'<2500'	X			Remove	sq. ft	record mech./non mech., distance <300',>300'<800', >800'<1300',>1300'<1800',>1800'<2500'
Bench			X		Install/Remove/Monitor	ea	record type of bench, wood slab, wood lumber
Boardwalk - Diamond Pier					Construct/Reconstruct/ Remove/Monitor	lin. ft.	
Boardwalk - Helical Anchor					Construct/Reconstruct/ Remove/Monitor	lin. ft.	
Boardwalk - Mud Sill Fiberglass					Construct/Reconstruct/ Remove/Monitor	lin. ft.	
Boardwalk - Mud Sill Wood					Construct/Reconstruct/ Remove/Monitor	lin. ft.	
Boardwalk - Post and Pier					Construct/Reconstruct/ Remove/Monitor	lin. ft.	
Bridge - Fiberglass I Beam					Construct/Reconstruct/ Remove/ Monitor	lin. ft.	
Bridge - Fiberglass Pony Truss					Construct/Reconstruct/ Remove/ Monitor	lin. ft.	

Figure 2.22 – List of Trail Features

Once the project is completed, the trail is re-inventoried and the Trail Log updated. The data from the new Trail Log is sorted and entered into the maintenance budget spreadsheet to ensure that the maintenance budget remains current.

Post-project evaluations are conducted to identify both the positive and negative attributes of the project. This exercise identifies what went well with the project, why it worked, and how those positive attributes can be replicated in future projects. Also consider how these positive attributes can be improved. Improvements that are identified need to be included in future projects. Similarly, identify what did not go well with the project. Once these problems are identified, solutions must be developed so they do not occur in future projects.

When working with youth corps organizations, it is good practice to have them participate in the evaluation process. Only by recognizing what is being done well and what is being done poorly and making the necessary corrections and

improvements can trail project implementation be improved. This critical evaluation process is part of "adaptive management." Good trail program managers are constantly evaluating their work, looking for better and more efficient methods of performing trail work, and improving operations.

Project Trail Work Production Rates Summary Miners Ridge Trail *NOTE: ph=person-hour*				
			Production Rates	
Work Activity	**Quantity**	**Hours**	**Actual**	**Standard**
Bridge construction-std. design	12 linear feet	80.0	6.67	5 ph/foot
Bridge tread maintenance	40 linear feet	35.0	1.14	1.25 feet/ph
Way trail removal	1350 square feet	74.5	18.12	100 sq. feet/ph
Puncheon construction	220 linear feet	651.5	0.34	1.33 feet/ph
Turnpike install 3 ft. width >300 ft.	801 linear feet	860.0	0.93	2.5 feet/ph
Retaining wall construction/wood	81 square feet	17.0	4.76	1 sq. feet/ph
Safety rails	24 linear feet	7.0	2.92	4 ph/10 feet
Single wooden step construction	61 each	205.5	0.30	1/ph
Trail reconstruction med. 3 ft. width	54 linear feet	3.8	14.4	5 feet/ph
New trail const. light 3 ft. width	1104 linear feet	395	2.79	7 feet/ph
Switchback reconstruction 3 ft.	2 each	28.0	14.0	16 ph each
Trio maintenance	21780 linear feet	550.0	39.6	75 feet/ph
Downed trees - 1.5 feet diameter	34 each	18.0	0.53	2 ph/tree

Figure 2.23 - Project Production Summary

2.10.2. Monitoring and Adaptive Management

A common mistake in trail programs is that managers don't go back and evaluate how a project performs over time. Most projects will appear to be preforming as designed soon after they are completed, but the true test is how they are performing after one, three, or ten years. A long term project monitoring program will be able to ascertain whether trail design, structures, materials, and workmanship are performing as intended. The easiest way to establish long term monitoring is to integrate it into the annual conditions assessment. It may be necessary to include written or photo documentation of projects that can be referred to by new staff. For trail monitoring forms and additional information on project monitoring refer to Appendix G, *Trail Monitoring*.

Adaptive management is a systematic approach for improving resource management by learning from and responding to management outcomes. Although management outcomes can be derived by the monitoring procedures described above, it is up to the manager to evaluate these outcomes and generate alternative approaches as necessary for improved project performance. Adaptive management is an ongoing process used by trail managers to continually monitor, evaluate, reassess, and make educated decisions to improve trail system performance.