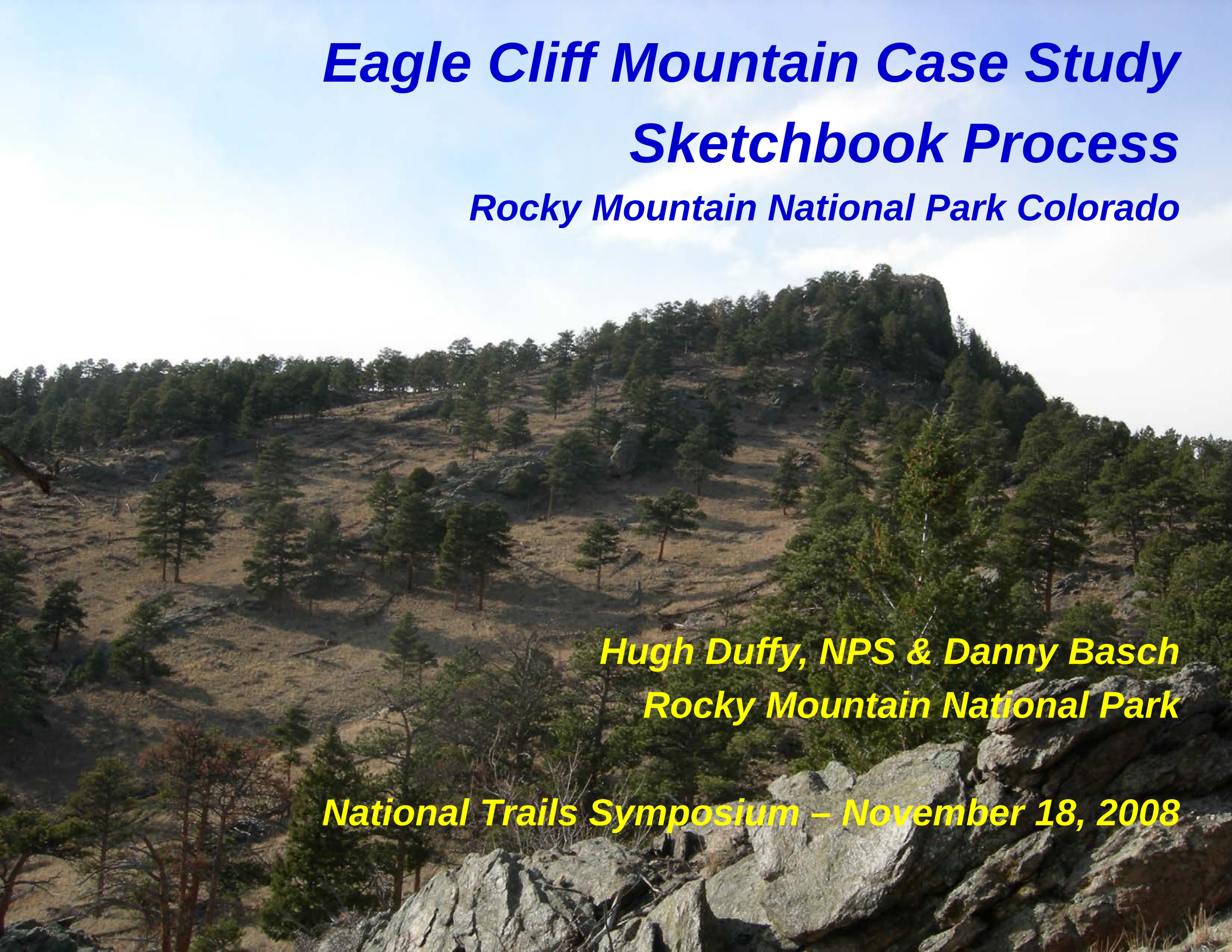
Eagle Cliff Mountain Case Study
Sketchbook Process

Rocky Mountain National Park Colorado



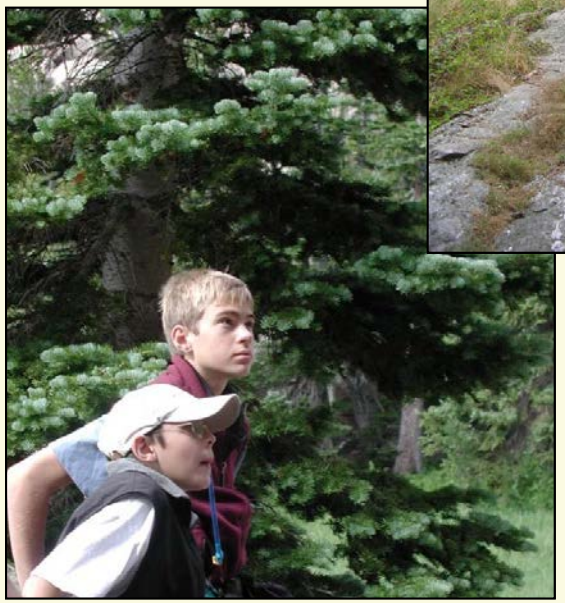
Hugh Duffy, NPS & Danny Basch
Rocky Mountain National Park

National Trails Symposium – November 18, 2008

Eagle Cliff Mountain Case Study ‘08 National Trails Symposium

1. **Towards a Mountain Trail Sustainability Ethic …**
2. **Foundations from the *Sketchbook***
3. **Eagle Cliff Mountain Case Study**
4. **Lessons Learned / Pitfalls to Avoid**
5. **The Trail Ahead**

Towards A Mountain Trail Sustainability Ethic …



Authors *

Hugh Duffy
- Project Manager
- Denver Service Center
- National Park Service

Danny Basch
- Eastside Trails Foreman
- Rocky Mountain National Park

Greg Seabloom
- Adopt-a-Peak Supervisor
- Colorado Fourteeners Initiative

John Giordanengo
- Projects Director
- Wildlands Restoration Volunteers

Presenters *

Hugh Duffy
Danny Basch

*** Master Instructors**

Colorado Outdoor Stewardship Institute

A Program of Volunteers for Outdoor Colorado.

Foundations from the *Sketchbook*

The *Sketchbook* is a niche document – intended to complement other popular trail documents:

- Sustainability criteria (narrow limits) of high-use / multiple use mountain trails;
- The "Why's?" and "How's?" of successful projects.
- Traditional landscape architectural practices customized to mountain trail projects
- *"National Park Service Guidebook"*

- Another tool for the trail advocate's toolkit.
- Recurring issues addressed …
- Generally accepted criteria … will work in most cases most of the time – can be customized without risk …
- Easy to read / easy to absorb!
- "Fix process = fix product!" The *Sketchbook* is a training product, but it is also a process document.

Purpose – Promote Excellence

1. Inspiration
2. Communication
3. "7 Realities:"
   - Funding is scarce!
   - Day labor is scarce!
   - Volunteer labor is scarce!
   - Time is scarce!
   - Materials are scarce!
   - Lessons Learned
   - Pitfalls to Avoid

Goal: Do it right the first time!

- Establish corridor.
- Major control points in planning.
- Minor control points in design.
- Incremental spot improvements or armor over time.
- Maintenance program up to 4x per year.
- Patience!

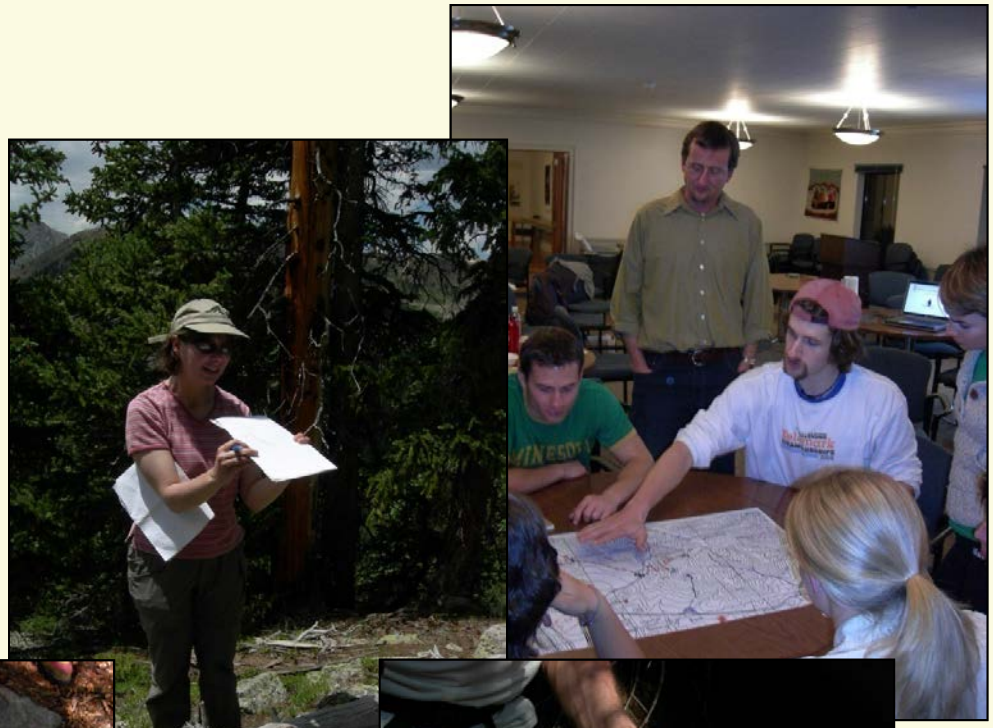
Target Audiences / Methods

Target Audiences

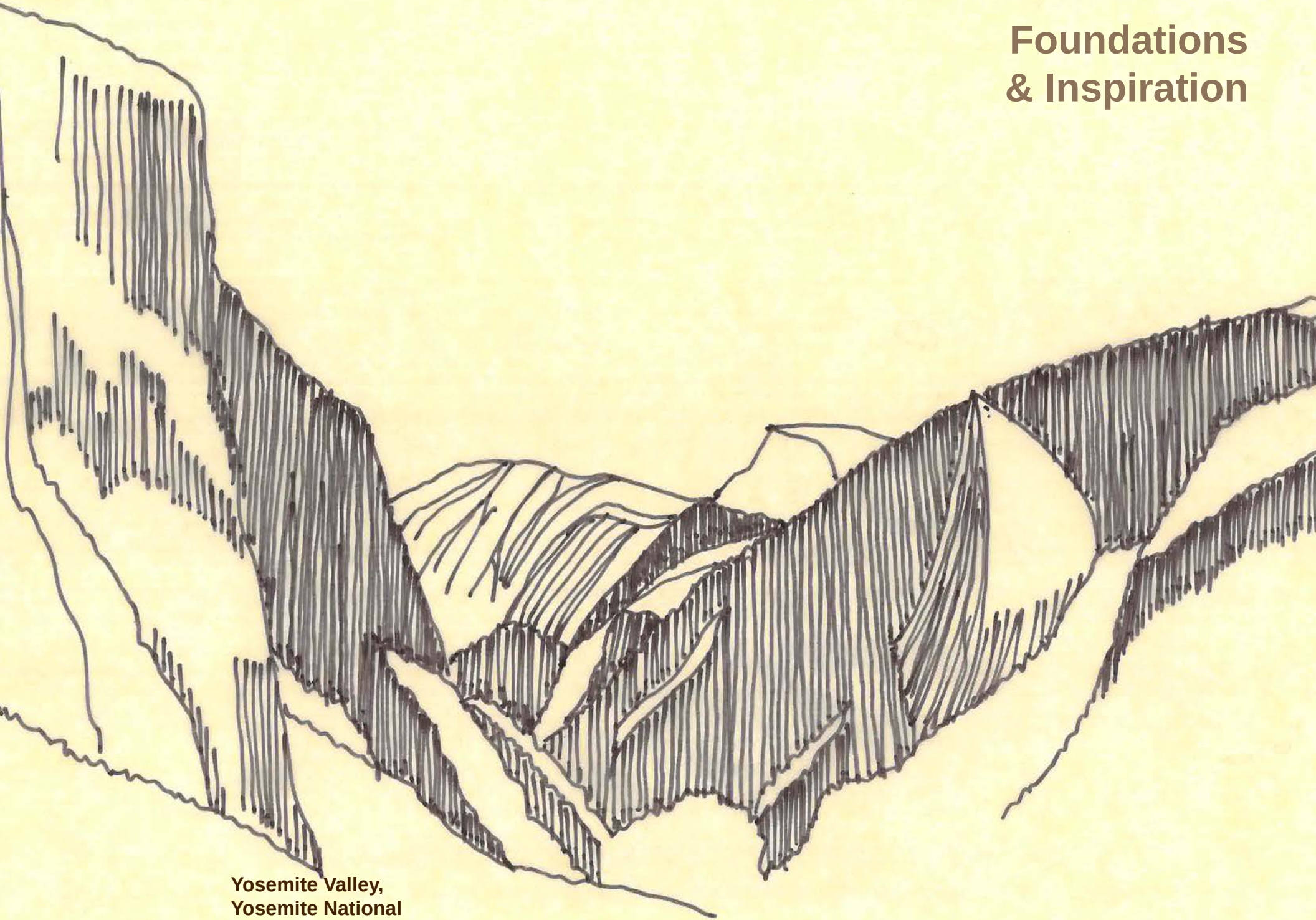
- Outdoor Stewardship Institute (OSI)
- Nonprofit / volunteer conservation community
- National Park Service community
- Trails' advocacy organizations
- College students
- Young professionals
- Professional organizations
  - American Society of Landscape Architects
  - Project Management Institute
  - American Trails members
- Land management agency staff
- Consultants / community leaders
- Granting organizations

Methods

- Expert / peer review
- Agency / customer feedback
- Synthesize into training curricula



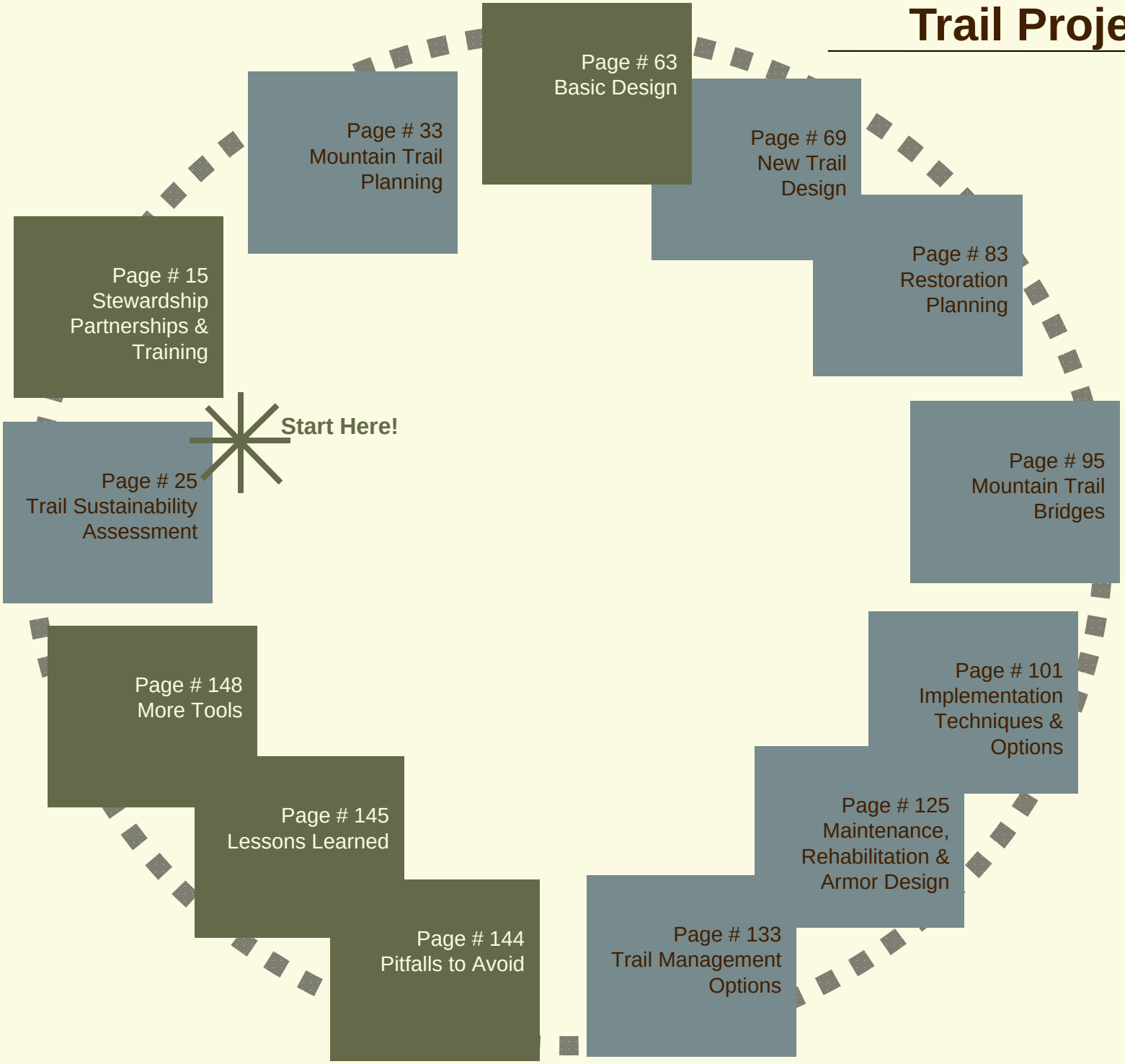
Foundations & Inspiration



Yosemite Valley, Yosemite National Park, California

Yosemite Valley,
Yosemite National
Park, California

Trail Project Cycle Tool



Partnerships with conservation nonprofit agencies are required, now more than ever, to ensure continued success of recreational trails on public lands.

All cogs of the trail project cycle would benefit from such support!

Trail Project Management

Inputs

- Typical Inputs
- Foundations

Tools & Techniques

- Typical Tools & Techniques
- Lessons Learned Technique
- Trail Project Cycle Tool

Outputs

- Typical Summary Package Outputs
- Draft for Review; Final

Typical Inputs

- Foundations
- Stakeholder Analysis & Summary
- Popular Literature
- Aerial Photos, Annotated Aerial Photos
- Maps, Annotated Maps
- Data Bases

Foundations

- Inspirational Literature / Organic Act / Enabling Legislation
- Agency Management Policies & Guidelines
- Interpretive Plans
- Environmental Compliance Regulations

Typical Tools & Techniques

- Assemble Interdisciplinary Trail Team
- Popular Literature Review – Internet & More Tools
- Research / Science
- Field Work, i.e.: Field Notes, Design Notes, Thumbnail Sketches
- Drawings, Examples, Photo Collages, Photomontages
- GPS, GIS, Analytical Techniques
- Choosing by Advantages
- Estimating Tools
- Stakeholder Analysis
- Charette Techniques
- Management Team Review
- Compliance Review

Typical Summary Package Outputs

- Written Summary
- Plans Set
- Thumbnail Sketches / Drawings
- Stakeholder Summary
- Photographs
- *Lessons Learned* Summary
- Trail Management Techniques
- Actions Sequences
- Checklists

Customizing ***Tools & Techniques*** that apply to *"most projects, most of the time"* will increase achievement of sustainability on mountain trail projects.

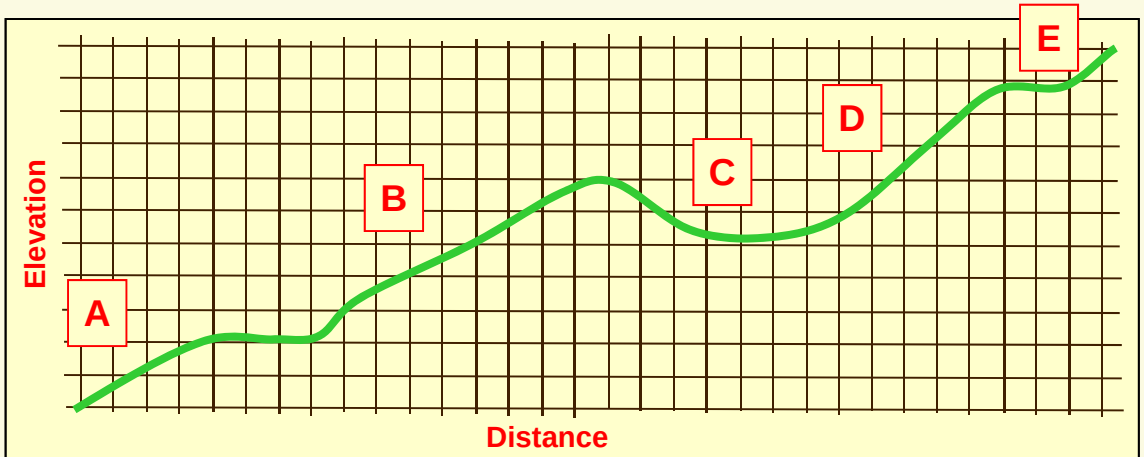
Sustainability Assessment Checklist

- ❑ Web Search / Literature Review
- ❑ Sustainability Assessment Goals
- ❑ Recreation Accessibility Potential Rating
- ❑ Trail Corridor Assessment
  - ❑ Trail Corridor Sustainability Questionnaire
  - ❑ Trail Corridor Sustainability Rating Tool
  - ❑ Travel Surface Assessment Rating Tool
- ❑ Trail Management Options Menu
- ❑ Lessons Learned
- ❑ DRAFT Sustainability Assessment Package
- ❑ Review
- ❑ FINAL Sustainability Assessment Package

Vertical Calculations

Several profile grades calculated out over the anticipated total vertical gain will portray how many horizontal linear feet of trail would be required at each profile grade.

Be sure to account for drops in grade between corridor control points, not just the raw vertical distance gain. In the case of Option #1, **A, B C, D** and **E** must be added together to determine the combined vertical gain.



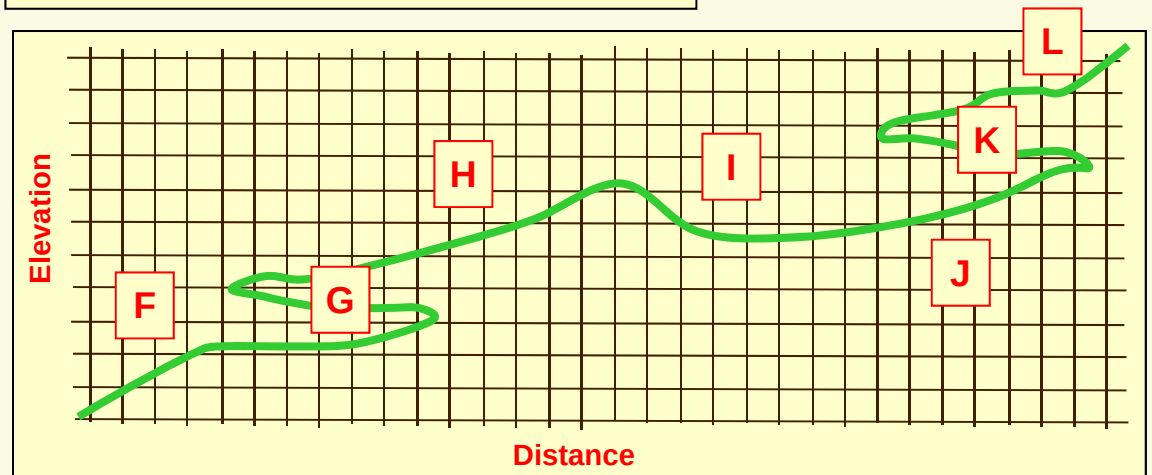
Trail Profile Option #1 – 7% Average Grade

Profile Option #2

% Grade = Vertical Difference / Linear Feet
.05 = F + G + H + I + J + K + L / LF
.05 = 1,500 / L
L = 30,000 Linear Feet of Trail **(5.68 miles)**

Profile Option #1

% Grade = Vertical Difference / Linear Feet
.07 = A + B + C + D + E / LF
.07 = 1,500 / L
L = 21,429 Linear Feet of Trail **(4.05 miles)**



Trail Profile Option #2 – 5% Average Grade (Including 4 Switchbacks)

Vertical Calculations ensure that high investment improvements such as ***Mountain Trail Bridges*** are located in permanent locations.

Table A. Opportunity for Trail Sustainability – Prevailing Cross Slope (%) & Aspect								
Prevailing Cross Slope (%)	West (W)	Southwest (SW)	South (S)	Southeast (SE)	East (E)	Northwest (NE)	North (N)	Northeast (NW)
0 – 20%	Good	Good	Good	Good	Good	Poor	Poor	Poor
20 – 40%	Excellent!	Excellent!	Excellent!	Excellent!	Excellent!	Poor	Poor	Poor
40 – 60%	Very Good	Very Good	Very Good	Very Good	Very Good	Poor	Poor	Poor
60 – 70%	Good	Good	Good	Good	Good	Poor	Poor	Poor
70% +	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Table B. Opportunity for Trail Sustainability – Prevailing Cross Slope (%) & Soils			
Prevailing Cross Slope (%)	Coarse Soils	Silts	Clays
0 – 20%	Good	Poor	Poor
20 – 40%	Excellent!	Good	Poor
40 – 60%	Excellent!	Good	Poor
60 – 70%	Good	Poor	Poor
70% +	Poor	Poor	Poor

Table C. Opportunity for Trail Sustainability – Elevation & Aspect								
Elevation	West (W)	Southwest (SW)	South (S)	Southeast (SE)	East (E)	Northwest (NE)	North (N)	Northeast (NW)
5,000 – 7,000’	Excellent!	Excellent!	Excellent!	Excellent!	Excellent!	Good	Good	Good
7,000 – 9,000’	Very Good	Excellent!	Excellent!	Excellent!	Very Good	Good	Good	Good
9,000 – 10,000’	Good	Very Good	Very Good	Very Good	Good	Poor	Poor	Poor
10,000 – 11,500’	Poor	Good	Good	Good	Poor	Poor	Poor	Poor
> 11,500’	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Mountain Trail Bridges fall into the general framework shown on the right developed at Rocky Mountain National Park, and the photographs 1 – 5 below display options used there.

1 **Simple Foot Log Bridge.** For light to medium foot traffic only across small and/or intermittent water. Minimal dimensions, tools, time and labor required. Appropriate in the frontcountry, middle country and backcountry zones. No vertical-drop of more that 5 feet anywhere along the span. Local materials typical.

2 **Simple Foot Log Bridge With Handrail.** Light to medium pedestrian use without horse or multi-accessible fords. Medium complexity of tools, labor and skills required due to the possible size and weight of materials. May incorporate an ‘island,’ pier or abutment within the water channel to support center posts for longer spans. Utilization of local native materials is common.

3 **Foot Traffic Only Bridge.** Frontcountry to backcountry distance zones with medium to heavy volume of use. May be multiple-member foot log or decked stringer type. Approach and abutment need to accommodate ford for light to heavy horse and / or multiple users. May require additional skills and tools for harvesting, moving and assembling materials for larger structures.

4 **Multiple Use Access Bridge with Handrail.** Medium to heavy volume of use. Frontcountry to backcountry distance trail zones. Decked multiple stringer design with steel super-structure preferred. Design may include mixed materials for optimum strength, life cycle and aesthetics. Will require complex logistics, skills and tools, and material handling techniques.

5 **Boardwalk.** Many design variations and definitions vary from region and agency. Basic design elevates the corridor or walking surface over wet, unsustainable tread areas. Common designs and names include turnpike, puncheon, corduroy and gadbury. Kick-rails are common with many designs.

6 **Suspension or Box-Frame Design Bridge (Not Shown).** Usually for crossing long spans or gorges. The most challenging and complex type of bridge structure. Significant cost, skills and complex tools like helicopters and high-lines will very likely be necessary for these more complex designs.

New Trail Design – *Design Notes Technique* – Example

Station	Cross Slope % (Left)	Cross Slope % (Right)	Trail Profile Grade %	Azimuth	Soils	New Trail Design Notes (Example Only)
0+00	0%	0%		108d	Good	Begin Clearing A, Begin Tread Cut 1, Typical Trail, Width = 36 in.
			3%			
1+00	0%	0%		120d	Good	Install Trail Drains A on downhill side at 1+40, 1+75 at low points.
			8%			NOTE: Good source of stone in this area, uphill from the trail.
2+00	25%	30%		125d	Good	
			12%			
3+00	40%	45%		120d	Good	3+50 Begin Retaining Stone Wall (2' H X 10' L).
			7%			
4+00	25%	20%		120d	Good	Begin Tread Cut 2 at 5+00, Typical Tread.
			6%			
5+00	45%	50%		125d	Good	Install barriers 1 and educational signage 2 for restoration area.
			7%			

Tread Cut Options	Prevailing Cross Slope (%)
1	0 – 20%
2	20-40%
3	40-60%
4	60-70%
5	> 70%
6	Crowned Trail
7	Tread Cut with Ditch

On-Trail Management Options	
1	Barriers
2	Educational Signage
3	Directional Signage
4	One-Way Routes
5	Clockwise / Counterclockwise Routing

Corridor Clearing Options	Height (H)	Width (W)
A	8 Feet	6 Feet
B	8 Feet	8 Feet
C	10 Feet	6 Feet
D	10 Feet	8 Feet
E	10 Feet	10 Feet

	Trail Drainage Options
A	Trail Drain
B	Swale Crossing
C	Paved Dip
D	Stepping Stones
E	Waterbar
F	Stone Drains

	Mountain Trail Bridge Options
1	Simple Foot Log
2	Log with Handrail
3	Foot Traffic Only
4	Multiple Use
5	Boardwalk

Case Study

Eagle Cliff Mountain *Sketchbook* Training – 2008

Tools & Techniques

- Classroom / Field Work
- Walk & Talk
- Lecture & Discussion
- Group Activities
- Individual Activities
- Reading Assignments
- Research / More Tools

Eagle Cliff Mountain Trail Plan Overview

Eagle Cliff Mountain Trail Plan Purpose

- Resource protection
- Provide a high quality recreation experience
- Educate visitors about natural & cultural resource history of area
- Improve sustainability & management efficiency
- Foundation for a restoration plan
- Foundation for a partnership

Background

- National Park Service Organic Act
  - Natural & cultural resources
  - Make available to the public
  - Unimpaired for Future Generations
- Olmsted Report
  - "Narrow Limits"
- Rocky Mountain NP Project Clearance Form
  - Internal Screening Form
  - Environmental Assessment likely
- NPS Management Policies
  - Sustainability

Stakeholders

- National Park Service
- Park Management
  - Trail Crew / Resource Staff
  - Interpretive Staff
- YMCA of the Rockies
- Rocky Mountain Nature Association
- Visitors / local / long distance
- Volunteers
- Outdoor Stewardship Institute
- Adjacent private landowners
- Schools

Park-wide Trail Plan

- Not addressed or identified
- Support / complement
- Proactive planning / reactive planning

Recent Trail Work at Rocky Mountain National Park

- Armor existing corridors
- Day labor = ~80 – 85% of trail work
- Work within resource constraints

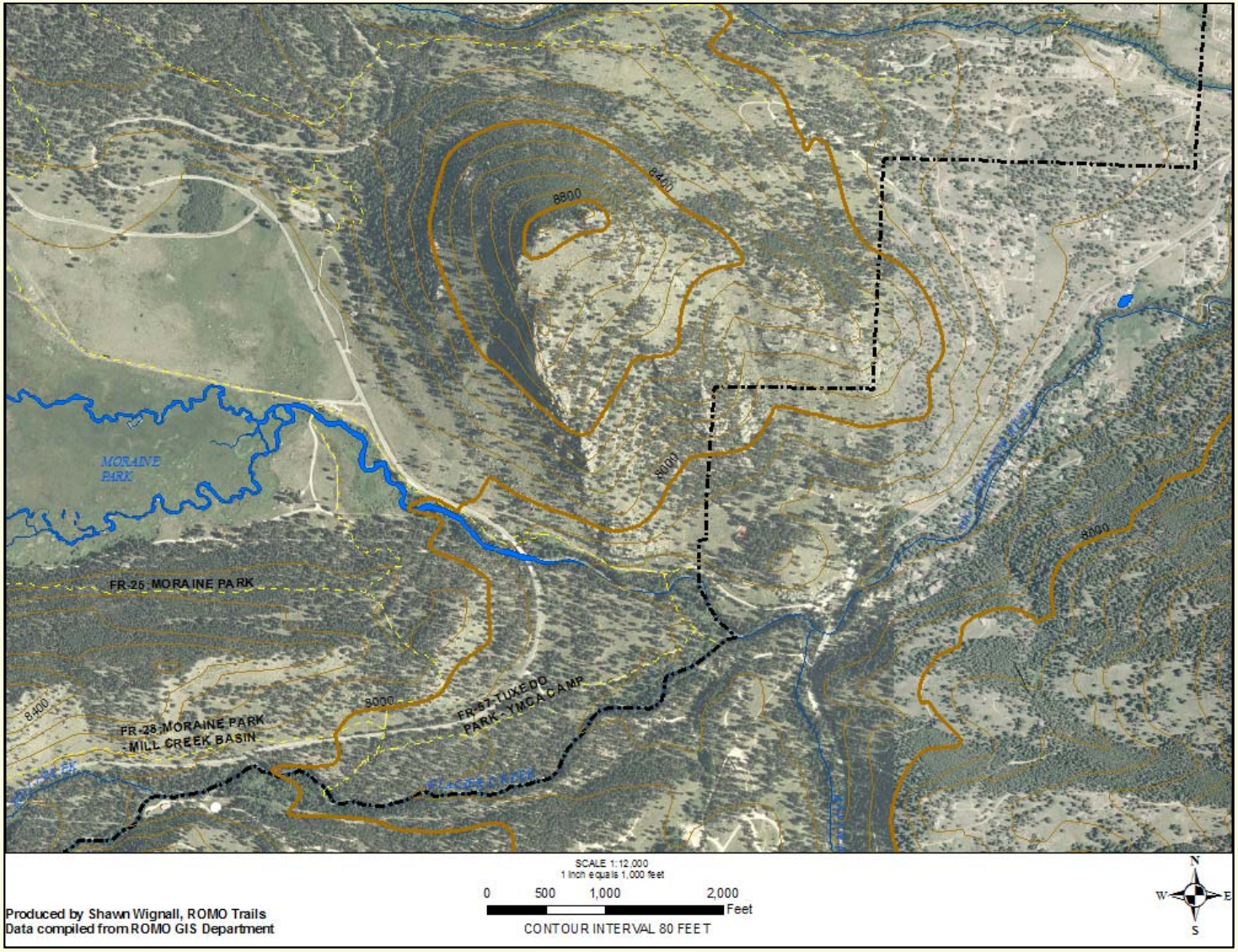
Eagle Cliff Mountain – Aerial Base Map

Eagle Cliff Mountain is on the eastside of Rocky Mountain National Park, near Estes Park in Colorado.

The Beaver Meadows Entrance Station is immediately north of Eagle Cliff Mountain.

The Big Thompson River drains Moraine Park immediately west of Eagle Cliff Mountain and towards the south.

Glacier Creek flows into the Big Thompson River just south of Eagle Cliff Mountain.



Eagle Cliff Mountain – Natural Resource Impacts

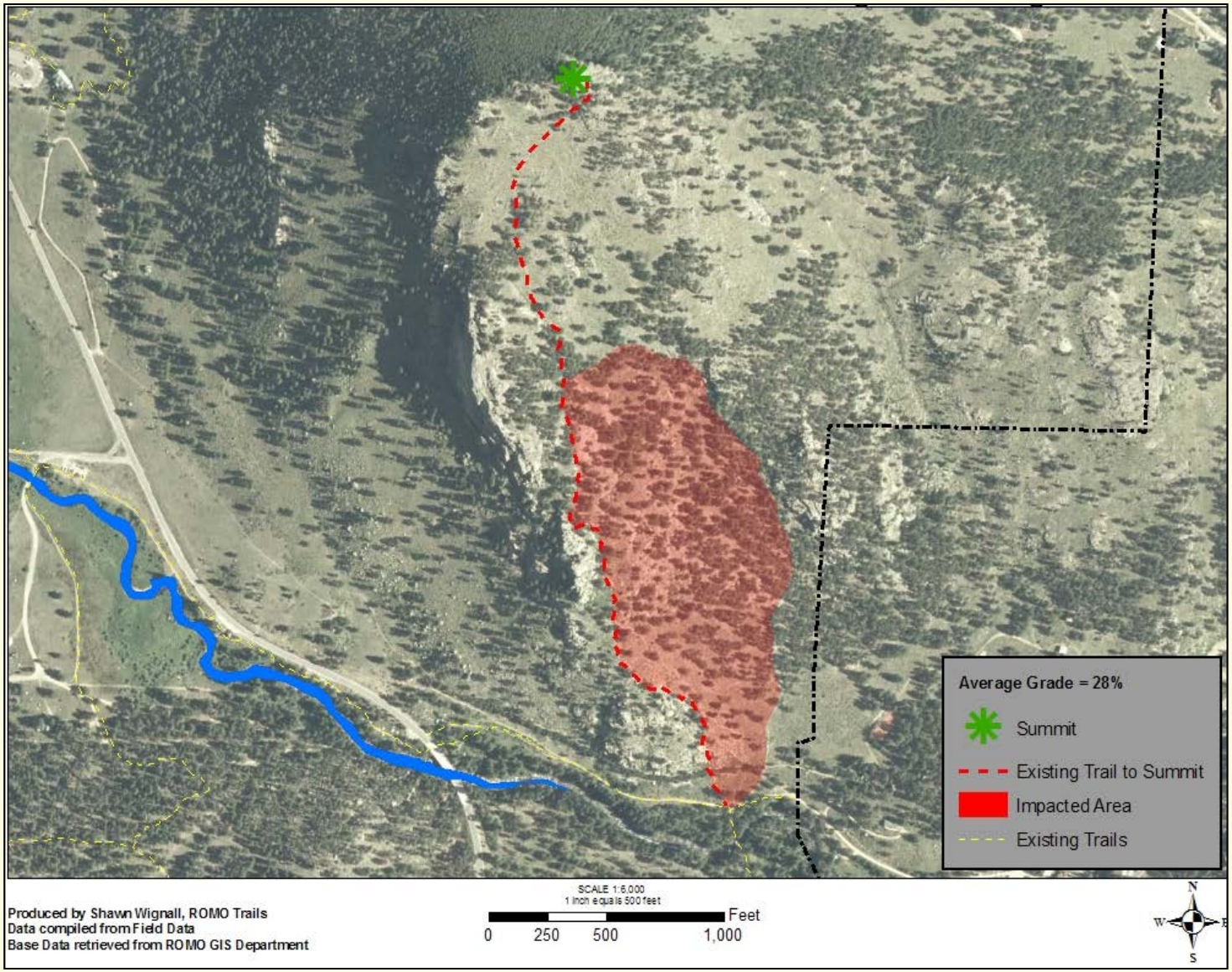
A large series of social trails has developed on the southern flank of Eagle Cliff Mountain.

In some locations there are almost 10 parallel tracks going straight up a valley confined by two ridges with stone outcrops.

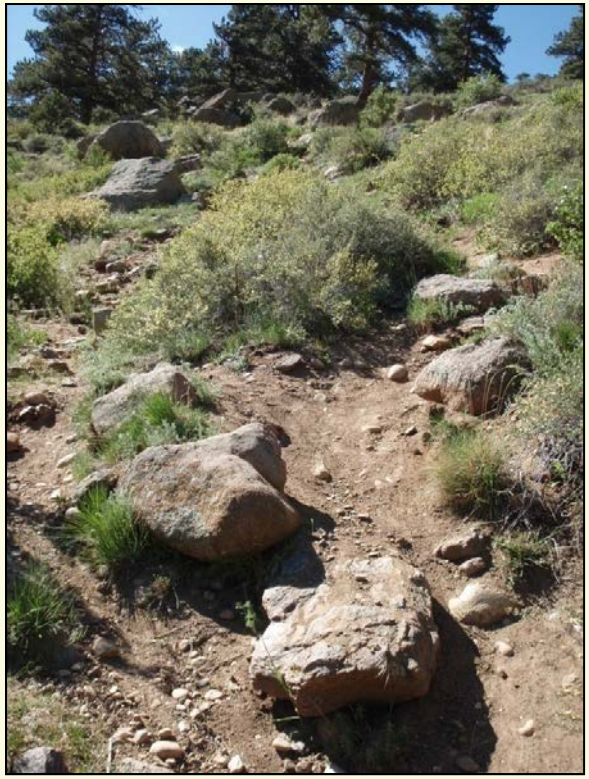
Damage to the Mountain have caused the National Park Service to start this Case Study.

It will take many years to assess the Mountain, plan for new trails, design new trails and to develop a parallel restoration plan as new trail routes are established.

The NPS is prudent to start this planning effort now before impacts get even more severe.



Eagle Cliff Mountain – Natural Resource Impacts



Social trails have developed on Eagle Cliff Mountain to the point that the National Park Service has decided to undertake a plan for trail implementation with a parallel restoration effort.

It is estimated that there is approximately 10,000 linear feet of impacted corridors, sometimes upwards of 15-feet wide and covering several acres.

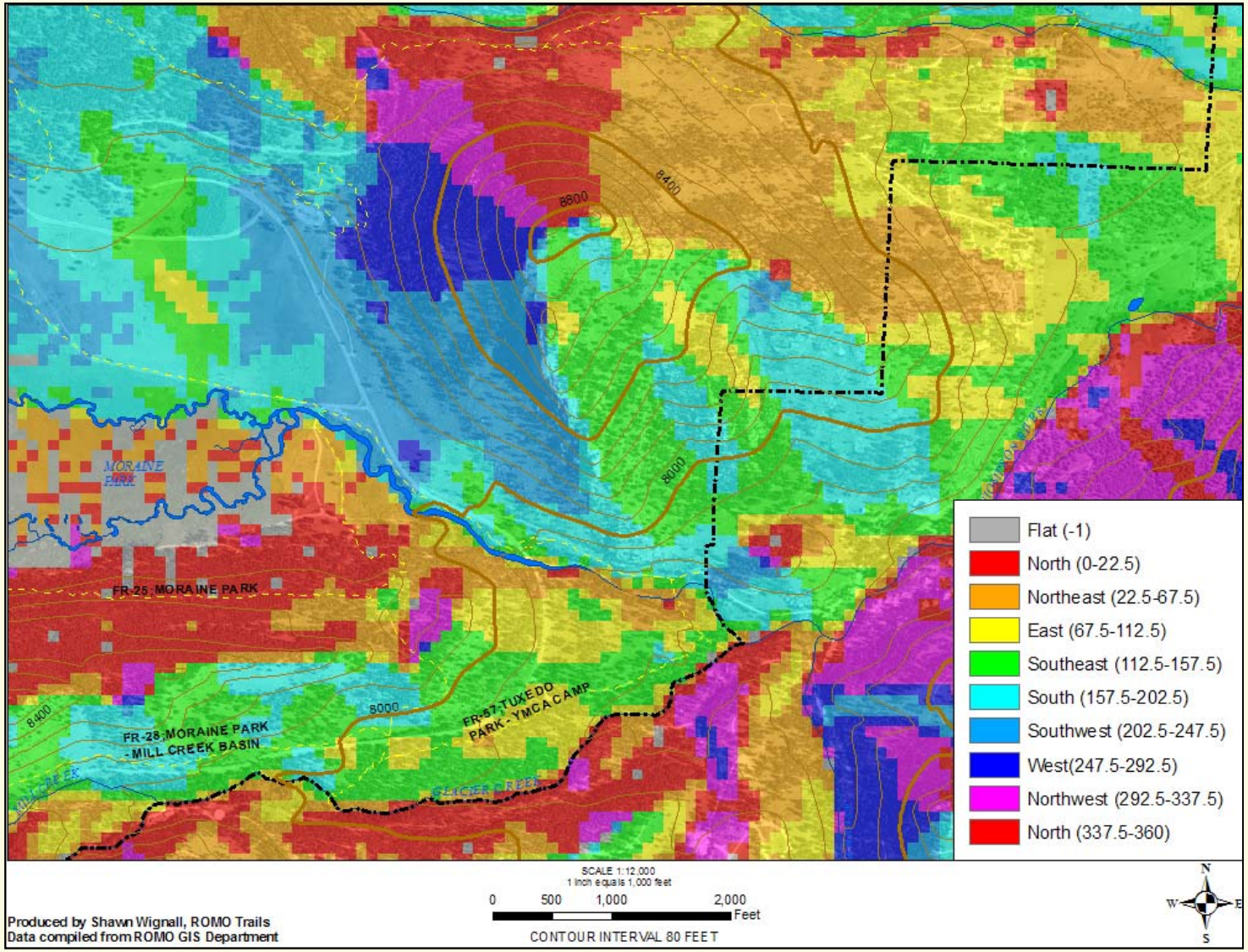
Aspect Analysis

Aspect is a predominant factor in determining mountain trail sustainability.

Eagle Cliff Mountain faces predominantly southeast, a good aspect for sustainability.

Social trails have developed on Eagle Cliff Mountain on the southeast aspects and caused impacts.

Paradoxically, natural resource impacts are harder to restore on southeast, south and southwest slopes at high elevations in Colorado.



Slope Analysis

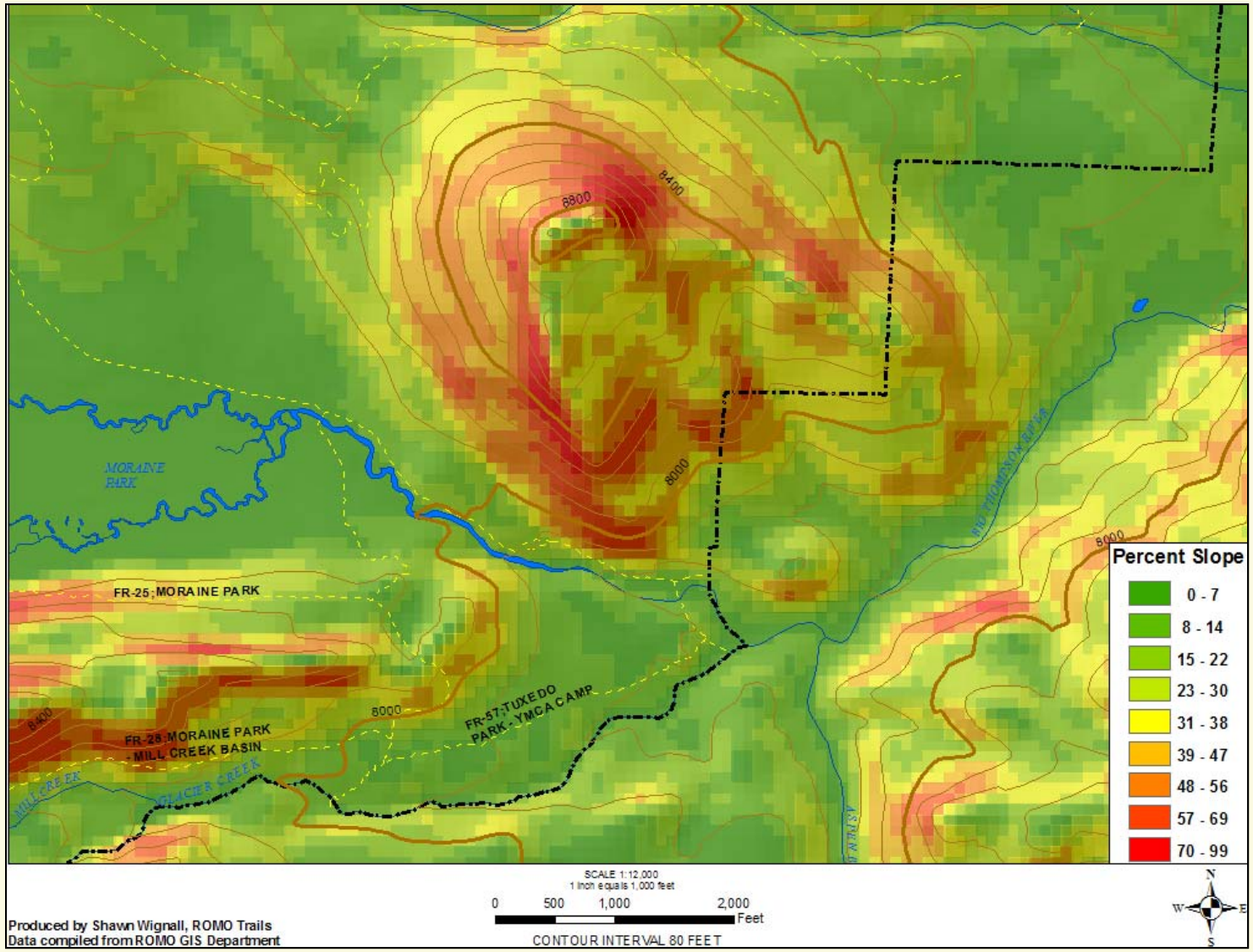
Rock outcrops are common on Eagle Cliff Mountain.

Prevailing cross slopes are a predominant factor in determining mountain trail sustainability.

Eagle Cliff Mountain displays a wide range of prevailing cross slopes.

Cross slopes are steep on the western flank of Eagle Cliff Mountain, and on some southeast aspect slopes.

Middle elevation cross slopes are moderate indicating very good to excellent opportunity to achieve sustainable mountain trails.



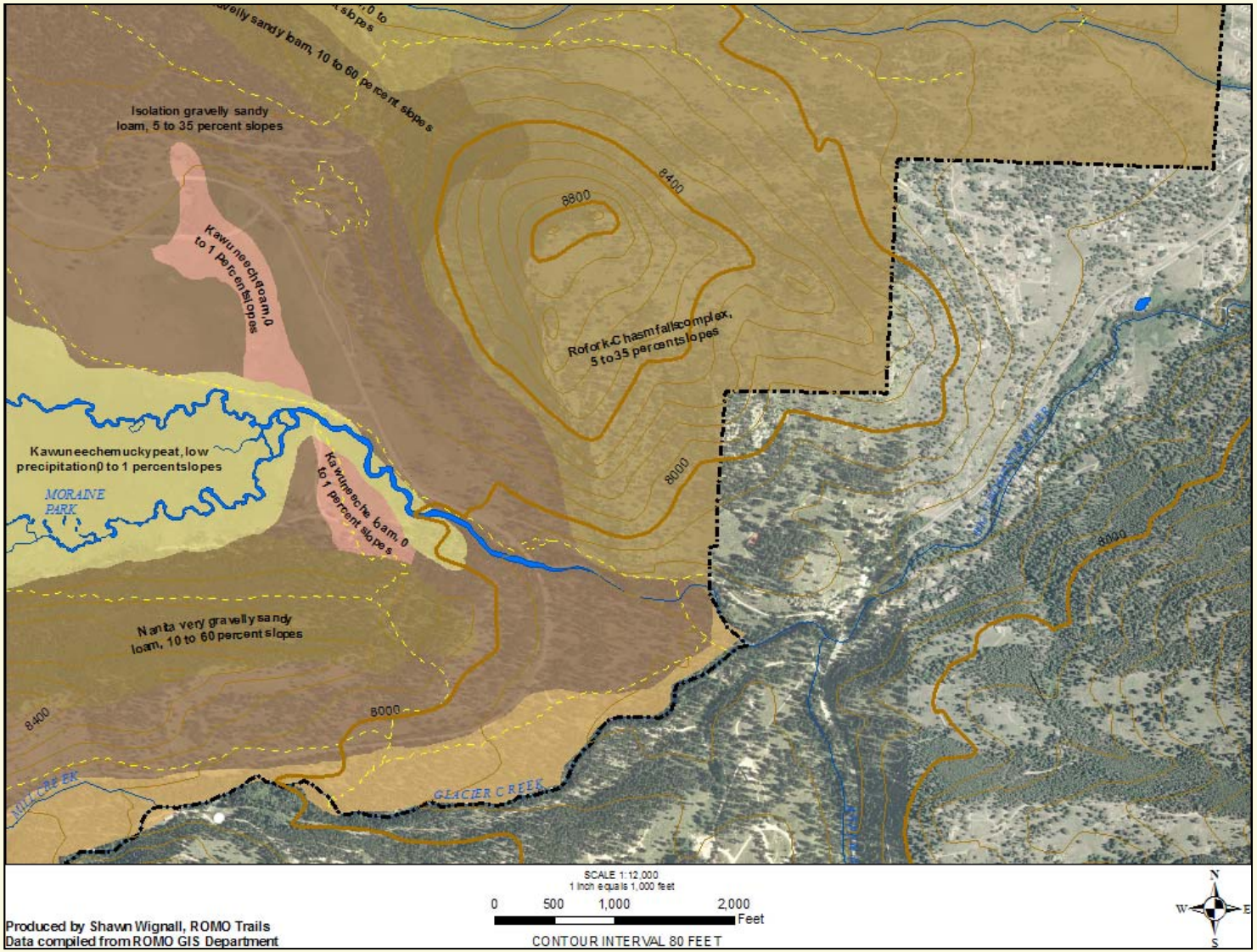
Soils Analysis

Soils are less of predominant factor in determining mountain trail sustainability than aspect or prevailing cross slopes on Eagle Cliff Mountain.

Trail corridors are many times a function of origins and destinations.

On Eagle Cliff Mountain, the predominant soil type is "Rofork Chasm Complex." Soils are shallow, uniform, and well draining.

Corridor selection will not be dependent upon soil type on Eagle Cliff Mountain.



Vegetation Analysis

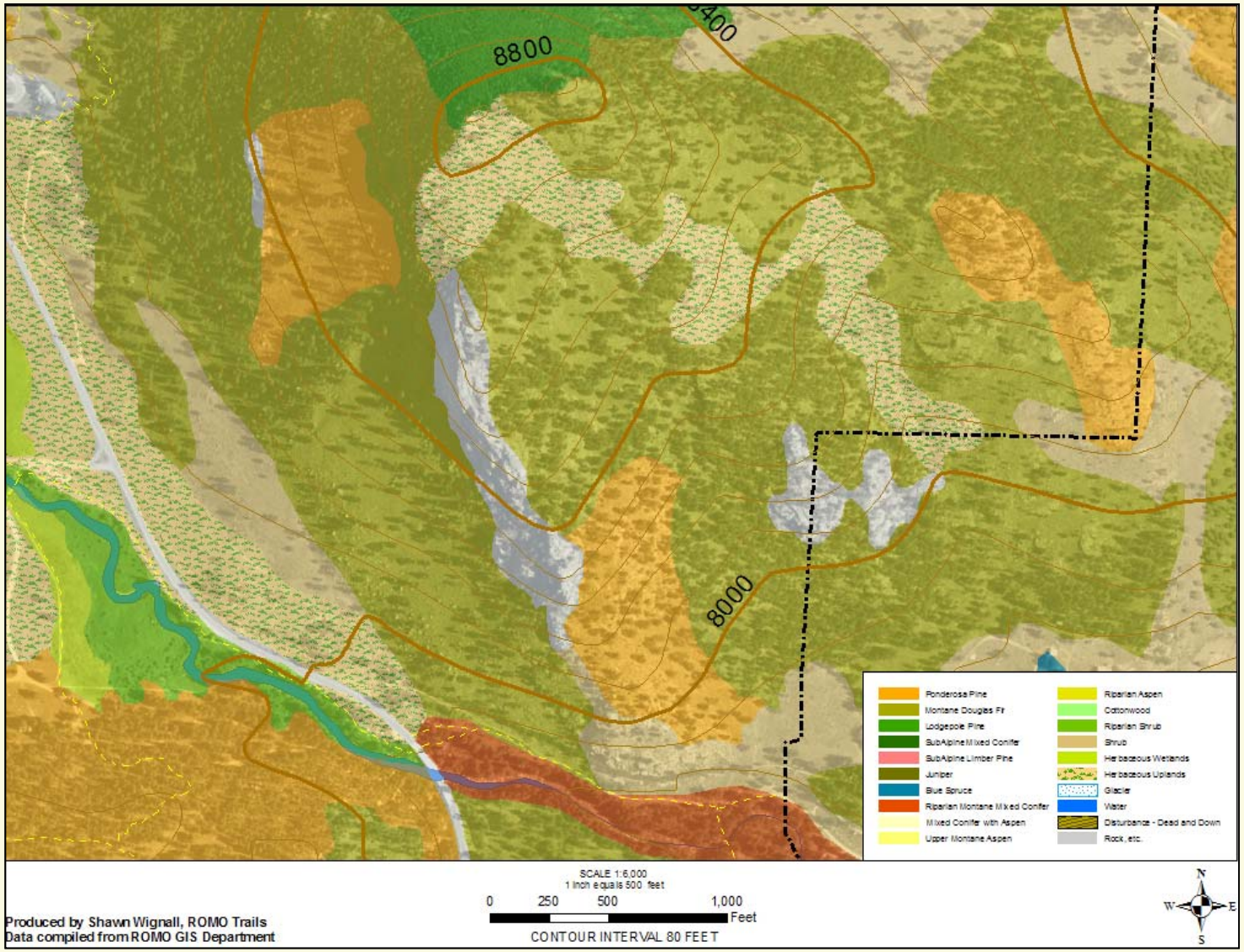
Naturally occurring vegetation is dependent upon climate, soils, aspect, elevation.

Several vegetation types on found on Eagle Cliff Mountain.

Southeast slopes are dominated by Ponderosa Pine with pockets of either Juniper or Blue Spruce.

Higher elevations are dominated by herbaceous shrubs with scattered Ponderosa Pine.

Northern slopes are dominated by Lodgepole Pine.

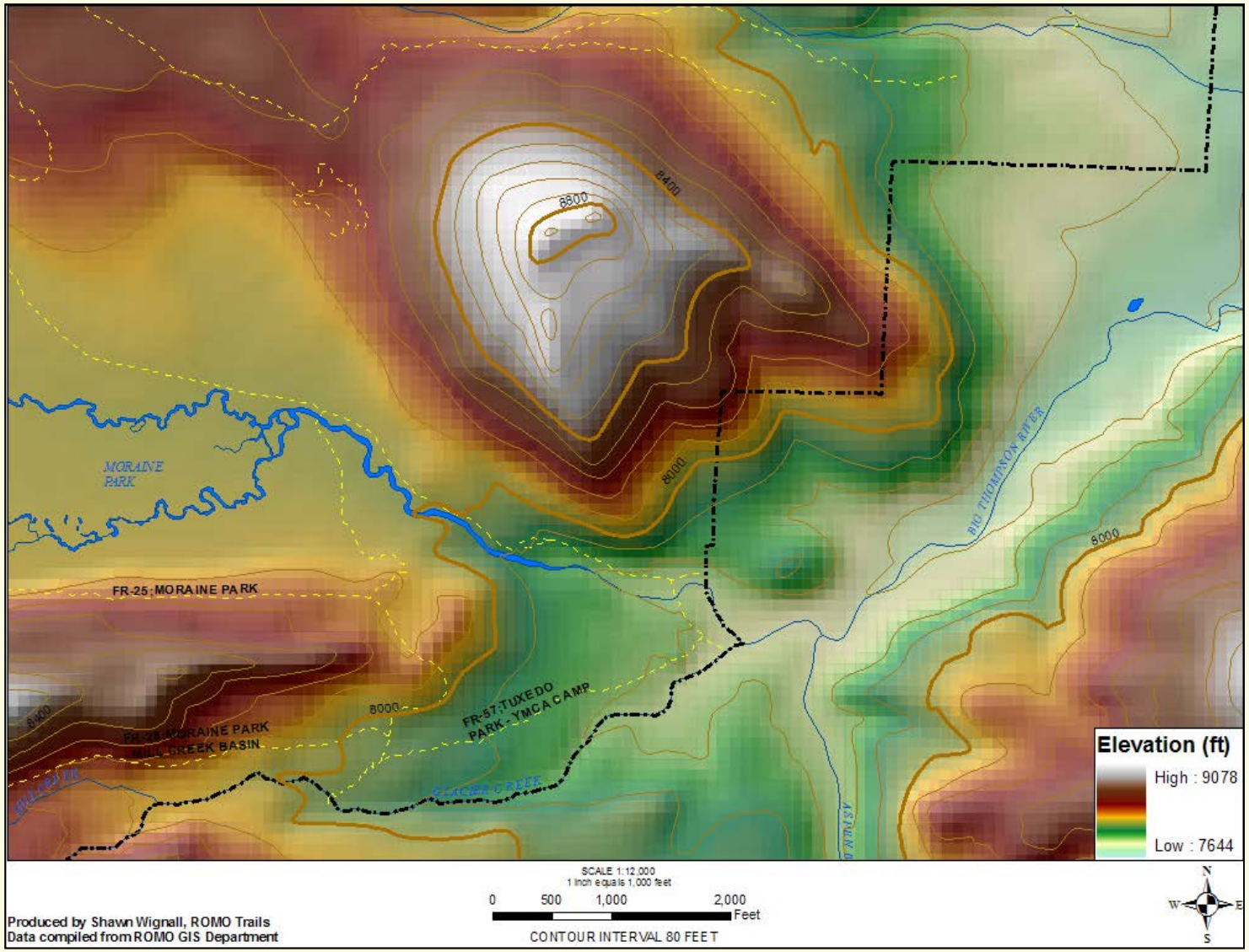


Elevation Analysis

Elevation will affect vegetation and temperatures in the mountains of Colorado.

Elevations in the vicinity of Eagle Cliff Mountain vary from approximately 7,700 feet to over 9,000 feet a difference of approximately 1,300 feet.

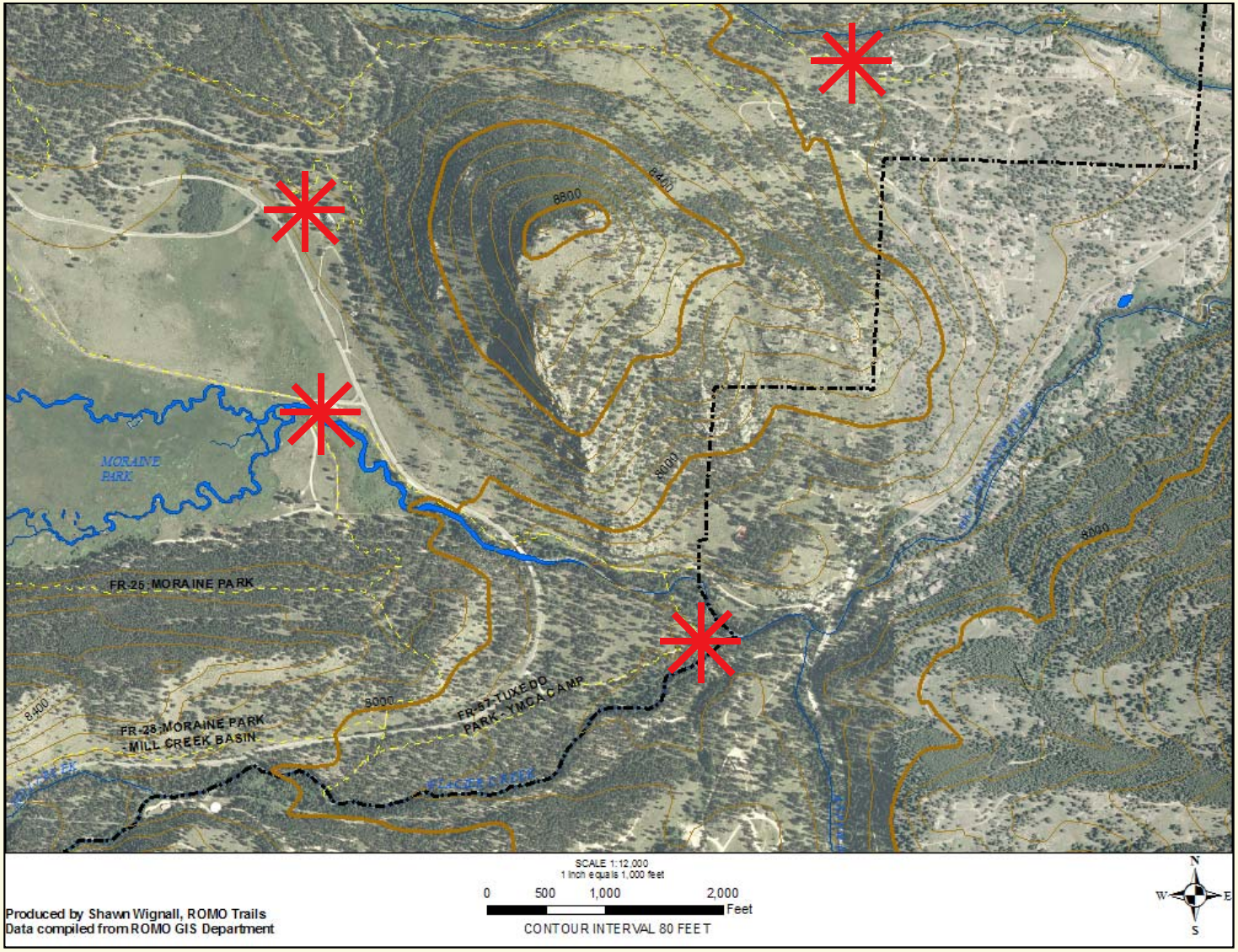
Lower elevations generally exhibit more moderate prevailing cross slopes, with higher elevations exhibiting steeper prevailing cross slopes.



Origins

Visitors to Eagle Cliff Mountain start most of their visits at 1 of 4 locations.

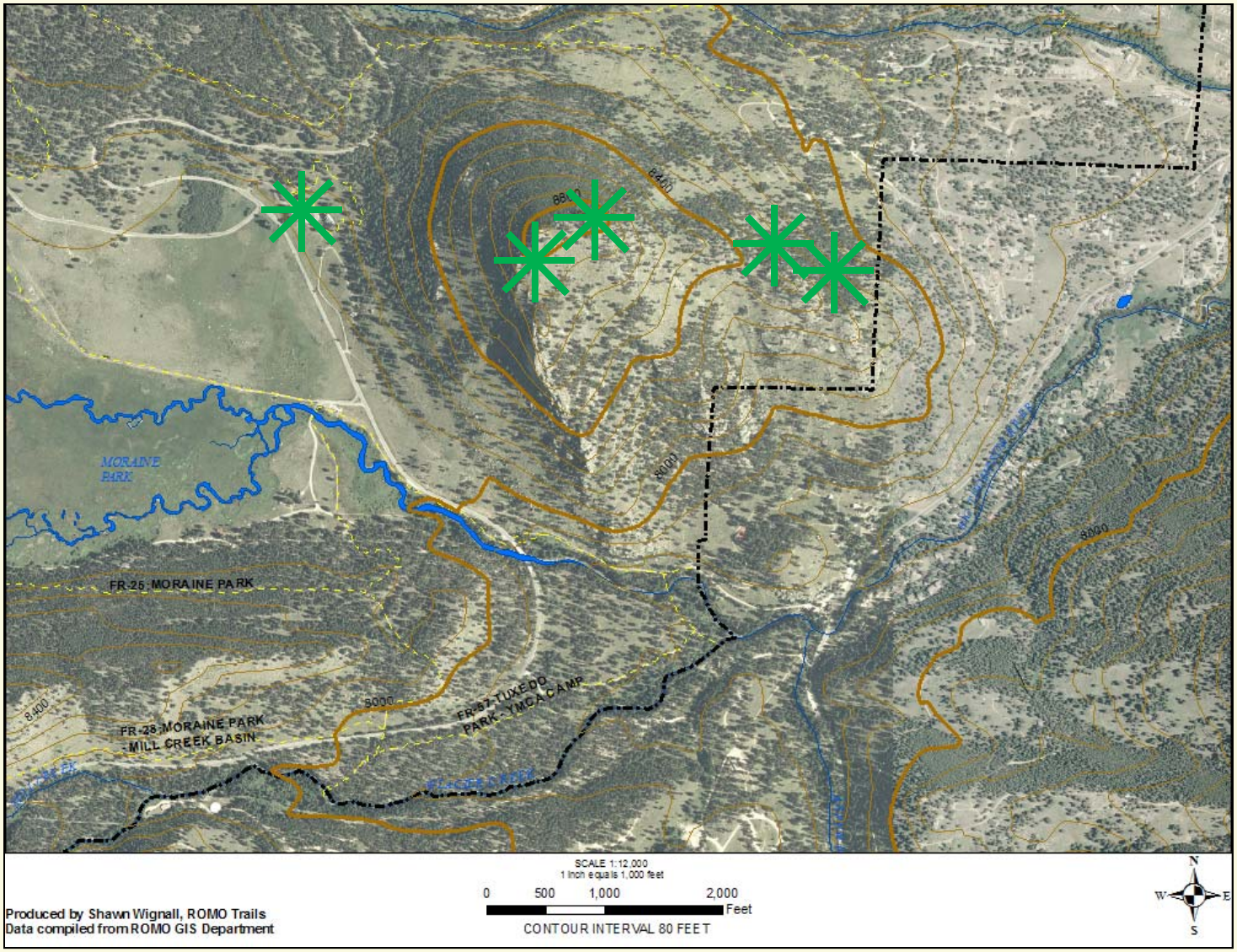
1. **YMCA of the Rockies**
2. **Moraine Park Trailhead**
3. **Moraine Park Museum**
4. **NPS Maintenance Area**



Destinations

Destinations for visitors to Eagle Cliff Mountain are most often the summit of Eagle Cliff, the Moraine Park viewpoint or the auxiliary summit east of Eagle Cliff.

Some visitors will visit the Moraine Park Museum, or continue up into Moraine Park.



Viewpoints

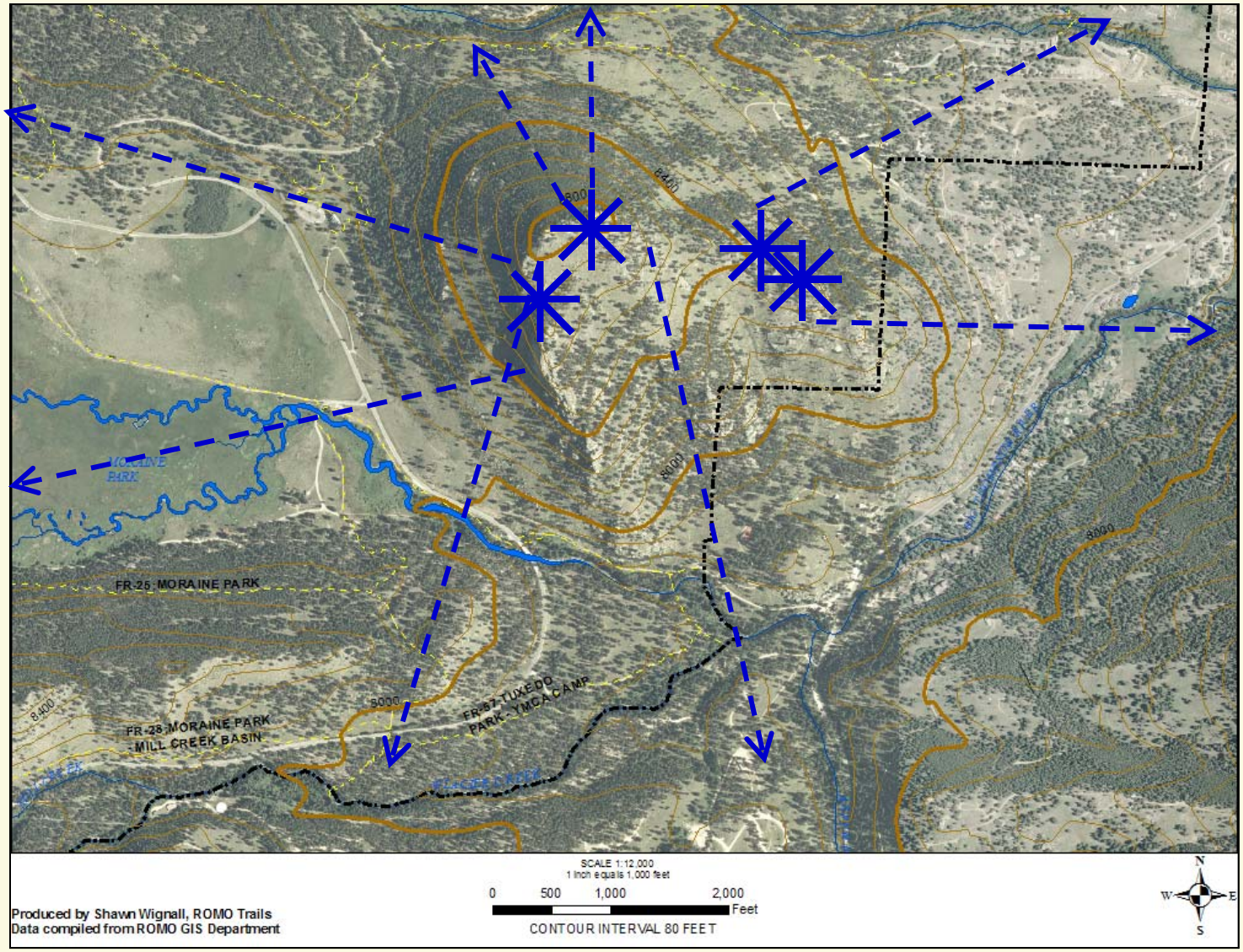
Viewpoints on Eagle Cliff Mountain are spectacular.

Views to the south include views to Longs Peak.

Views to the north are of the Beaver Meadows and the Mummy Range.

Views to the west are of Moraine Park and the Continental Divide in the distance.

Views to the east are of the Estes Park Valley.



Planning Context – Site Analysis

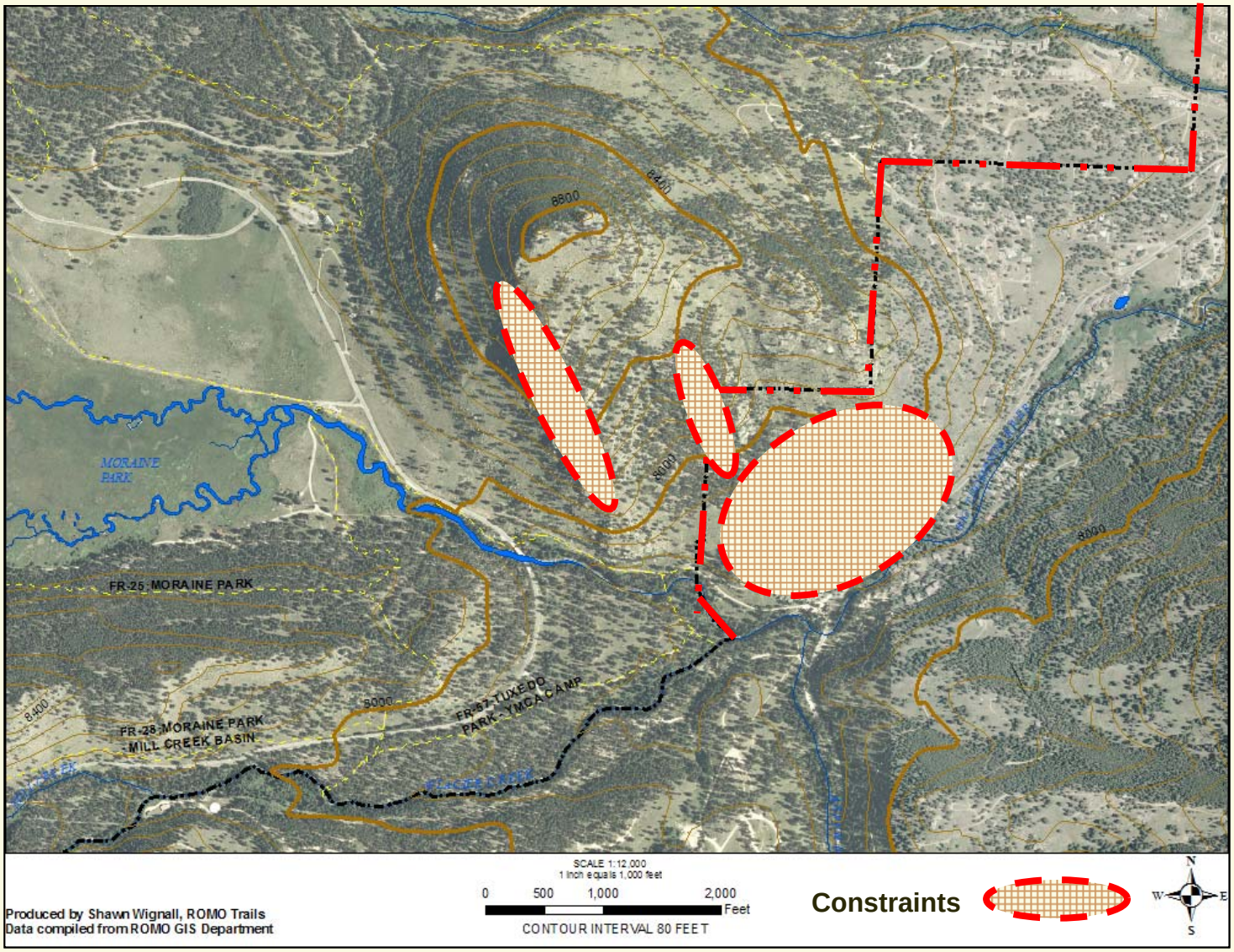
An escarpment dominates the western flank of Eagle Cliff Mountain.

Rock outcrops are scattered throughout the mountain.

There is also a ridgeline on the southeast face of Eagle Cliff Mountain.

The NPS boundary is a significant constraint.

Private residences are just over the boundary.



Viewsheds

North **– Beaver Meadows Entrance, Mummy Range in distance.**

West **– Moraine Park, Continental Divide in clouds**

East **– Estes Park, Lake Estes, Front Range**

South **– YMCA of the Rockies, Longs Peak in clouds**

Major Control Points

Major control points are those that must be established during the planning process.

Trail intersections

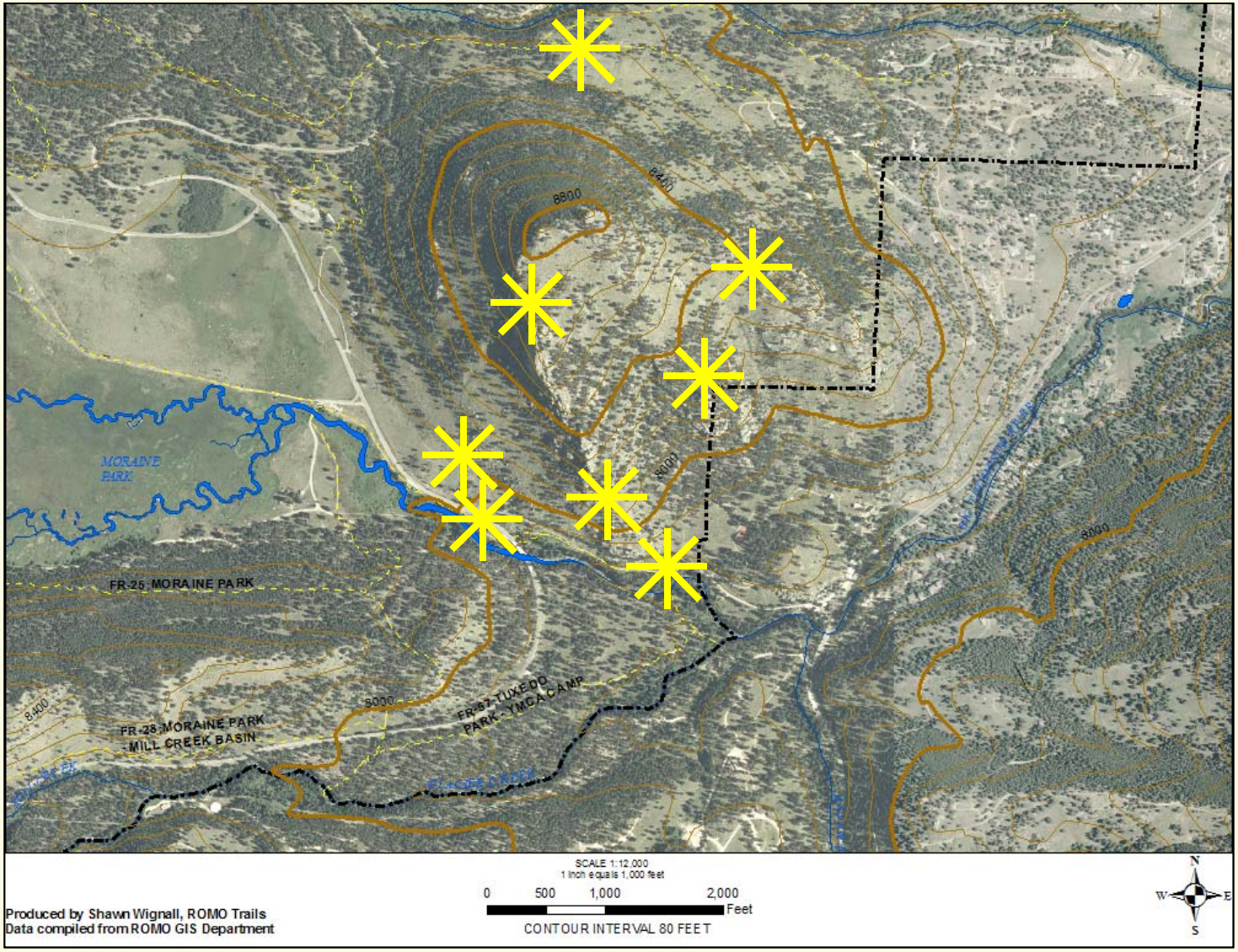
Topographic saddles

Ridgeline

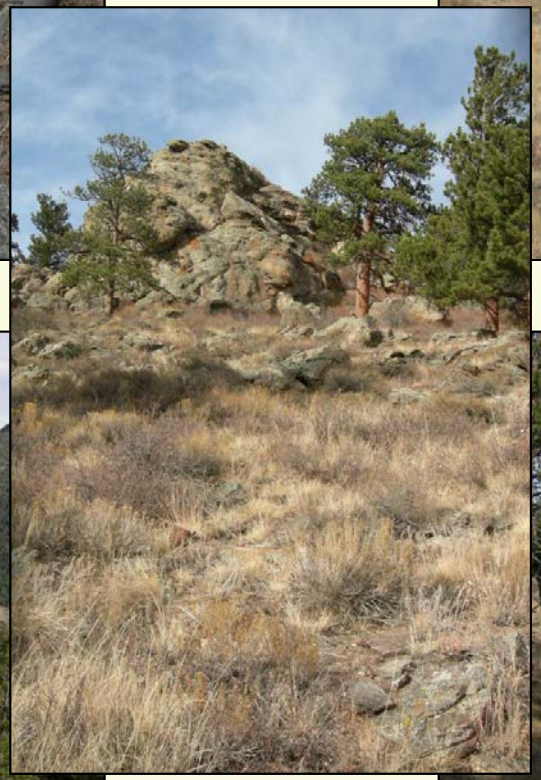
Bridge (vehicular) crossing of the Big Thompson River

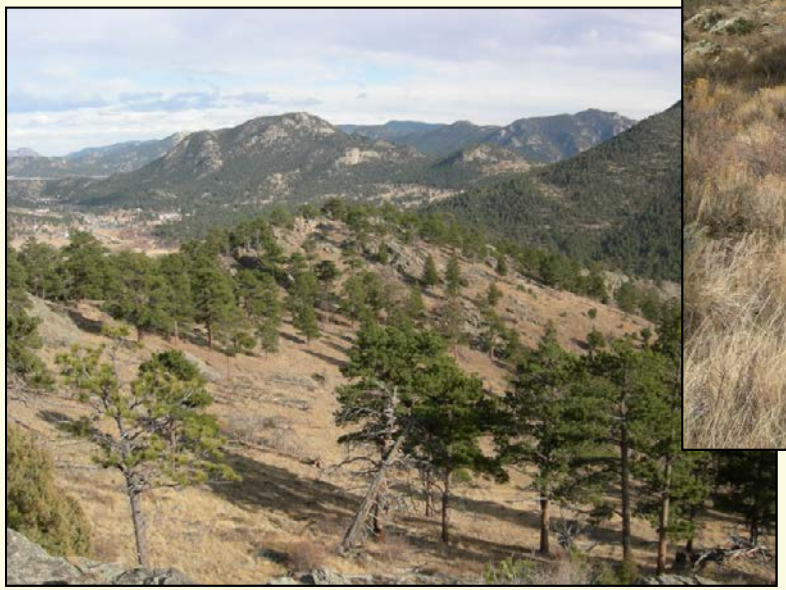
Existing multiple use bridge

The NPS boundary corner significantly affects corridor selection opportunities.



Landscape Character

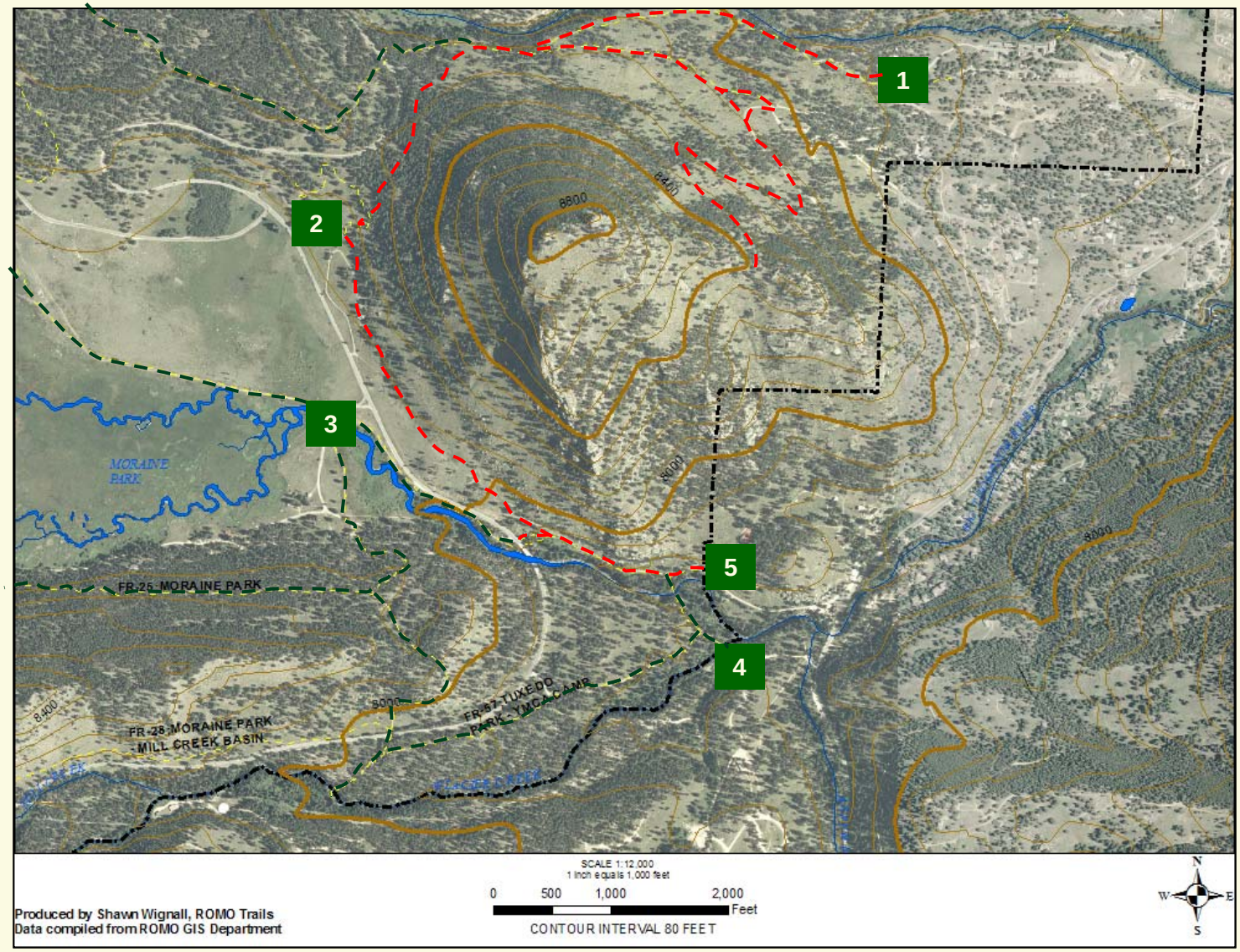




Trail Access Points

Trail Access Points

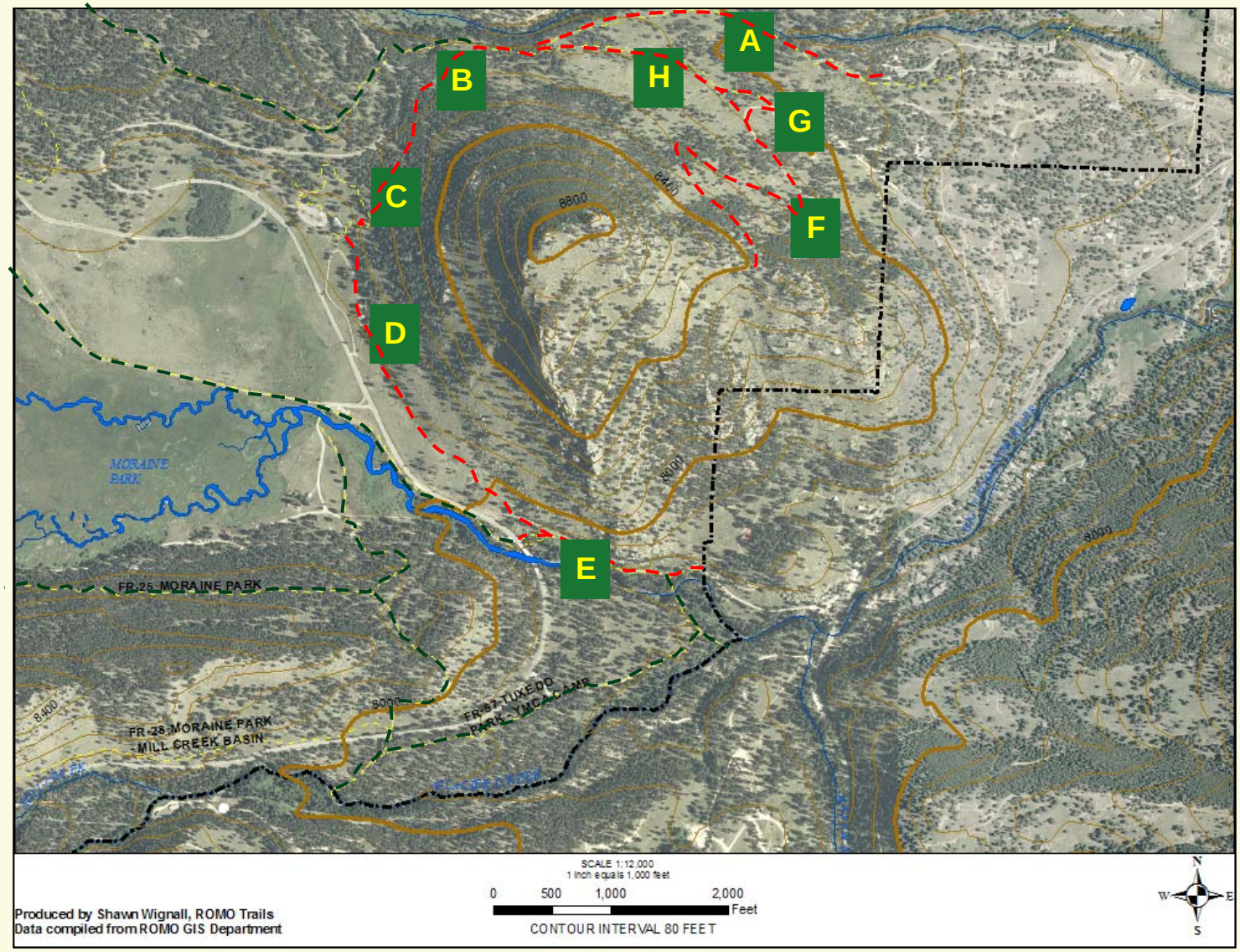
1. **Park Maintenance**
2. **Moraine Park Visitor Center**
3. **Moraine Park Parking Area**
4. **YMCA of the Rockies**
5. **Historic Park Entrance**



Planning Context – Off-Site Connections

Off-Site Connection Segments

- **A** Park Maintenance to the intersection of Segment H
- **B** Segment A to the highpoint saddle
- **C** Saddle to Moraine Park Visitor Center Nature Trail
- **D** Moraine Park Visitor Center Nature Trail to the saddle intersection of Segment E
- **E** Parallel to the Big Thompson River
- **F** Saddle east of Eagle Cliff Summit to Segment G
- **G** Spur connections to existing trails in vicinity of private residences
- **H** Segment G to Segments A & B



Off-Site Connections – Summaries

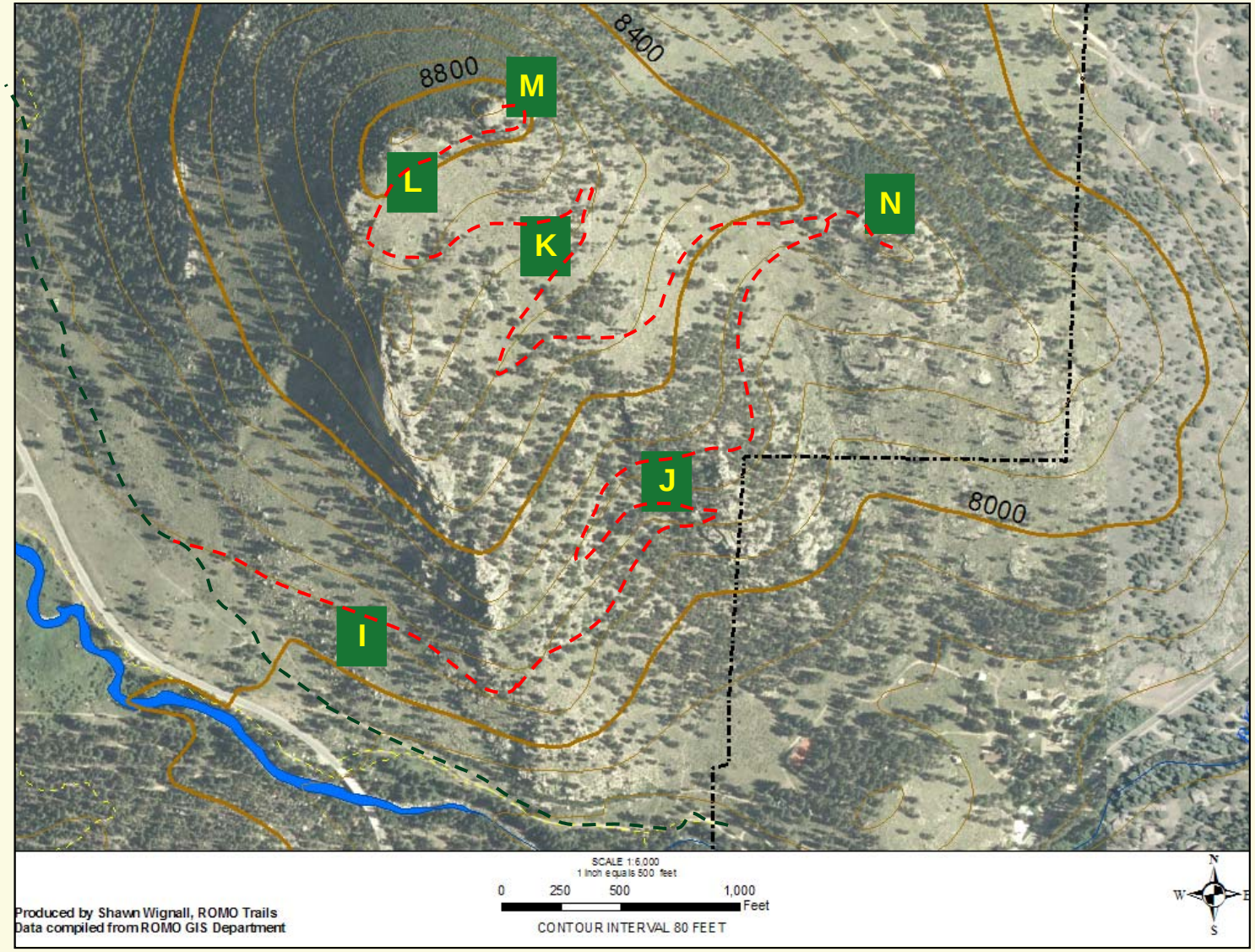
"Ballpark" Segment Data					
	Off-Site Connections	Length	Begin Elevation	End Elevation	Delta
Existing Trail	A	0.5	7875	8160	285'
Existing Trail	B	0.5	8160	8250	90'
Existing Trail	C	0.2	8250	8150	100'
Existing Trail	D	0.75	8150	7900	250'
Existing Trail	E	0.2	7900	7830	70'
New Trail Design	F	1	8400	8080	320'
New Trail Design	G	0.1	8080	8020	60'
New Trail Design	H	0.25	8080	8080	0'
	Summary	3.5 Miles			1175'

"Ballpark" Labor Estimates (Days)					
	Assessment	Planning	Design	Implementation	Maintenance Days Per Year
A	0.5	0.5	3	132	13
B	0.5	0.5	3	132	13
C	0.2	0.2	1.2	53	5
D	0.75	0.75	4.5	198	20
E	0.2	0.2	1.2	53	5
F	0	1	6	264	26
G	0	0.1	0.6	26	3
H	0	0.25	1.5	66	7
Summary	2.15	3.5	21	924	92

On-Site Linkages

On-Site Connections

- **I** Segment E to Ridgeline Control Point
- **J** Ridgeline Control Point to Saddle above Estes Valley
- **K** Saddle above Estes Valley to Saddle above Moraine Park
- **L** Saddle above Moraine Park to Base of Eagle Cliff
- **M** Eagle Cliff scramble route
- **N** Estes Valley Viewpoint scramble route



On-Site Linkages – Summaries

"Ballpark" Segment Data					
	On-Site Linkages	Length	Begin Elevation	End Elevation	Delta
New Trail Design	I	0.33	8080	8100	20
New Trail Design	J	0.67	8100	8340	240
New Trail Design	K	1	8340	8725	385
New Trail Design	L	0.33	8725	8880	155
New Trail Design	M	0.05	8880	8906	26
New Trail Design	N	0.1	8340	8425	85
	Summary	2.48 Miles			911

"Ballpark" Labor Estimates (Days)					
	Assessment	Planning	Design	Implementation	Maintenance Days Per Year
I	0	0.33	2	87	9
J	0	0.67	4	177	18
K	0	1.00	6	264	26
L	0	0.33	1.98	87	9
M	0	0.05	0.3	13	1
N	0	0.10	0.6	26	3
Summary	0	2.48	15	655	65

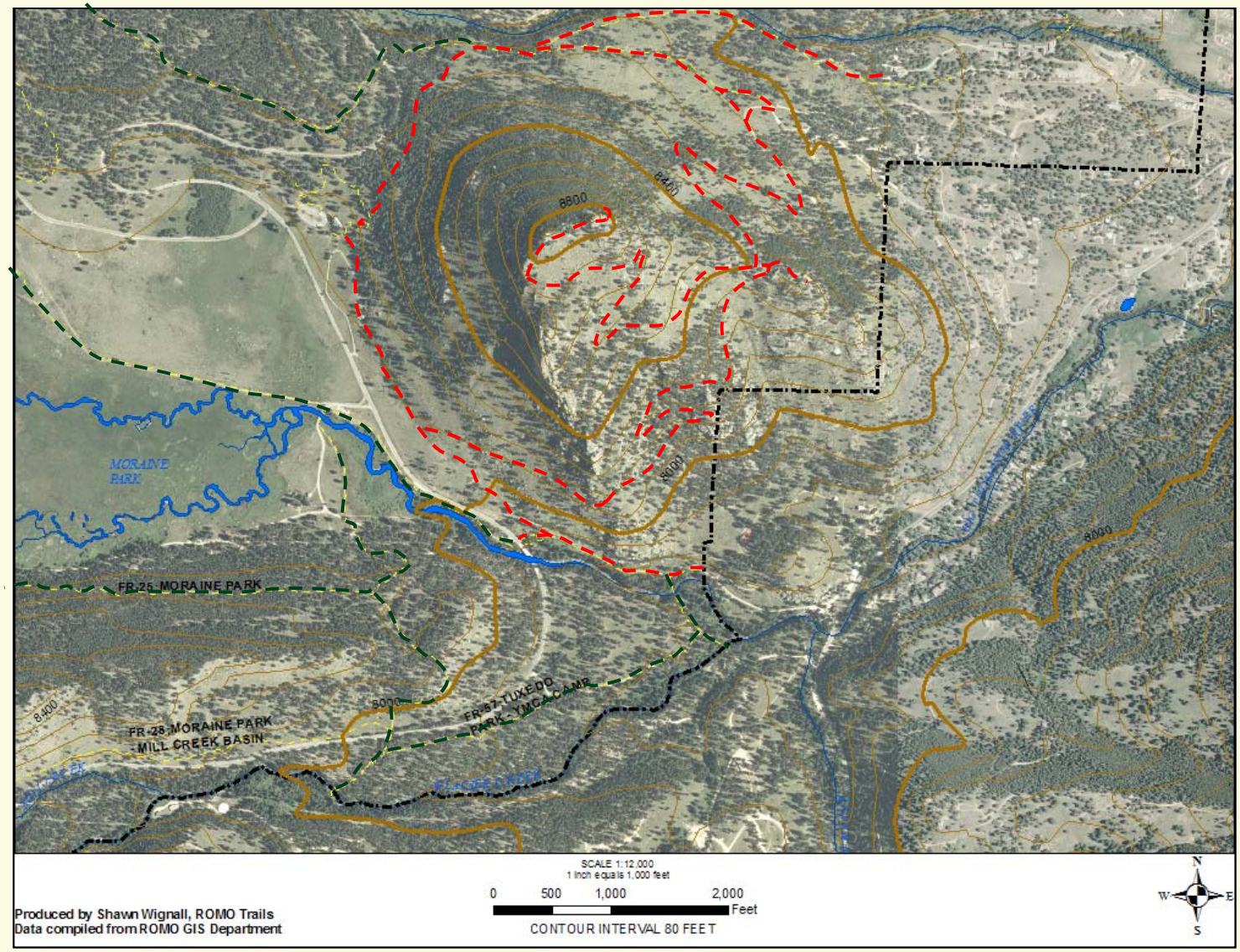
Vertical Calculations						
		Profile Grade				
	Vertical Delta	0.05	0.08	0.1	0.12	0.18
Length	750	15,000	9,375	7,500	6,250	4,167
	1000	20,000	12,500	10,000	8,333	5,556
	1250	25,000	15,625	12,500	10,417	6,944

Network

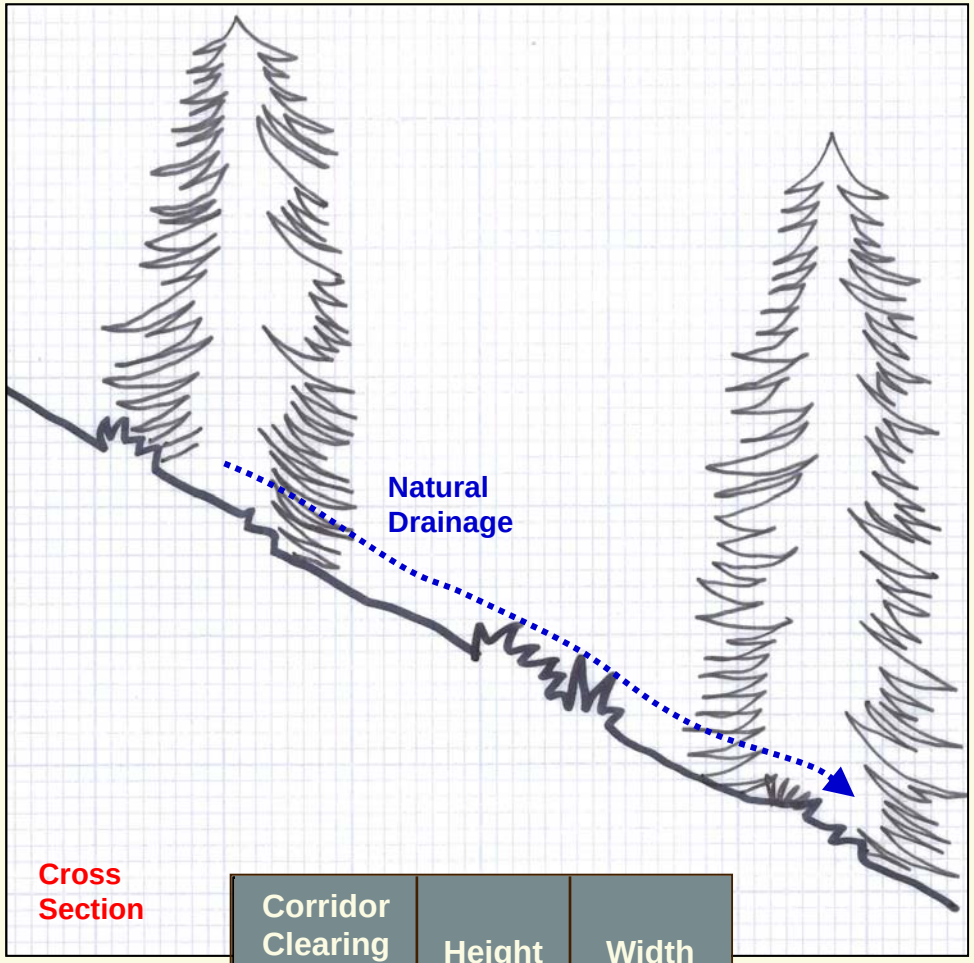
The proposed network for Eagle Cliff Mountain includes:

Off-Site Connections - Approximately 3.5 miles of existing trails to be rehabilitated

On-Site Linkages - Approximately 2.5 miles of new trail design coupled with several acres of restoration.



Corridor Clearing Options

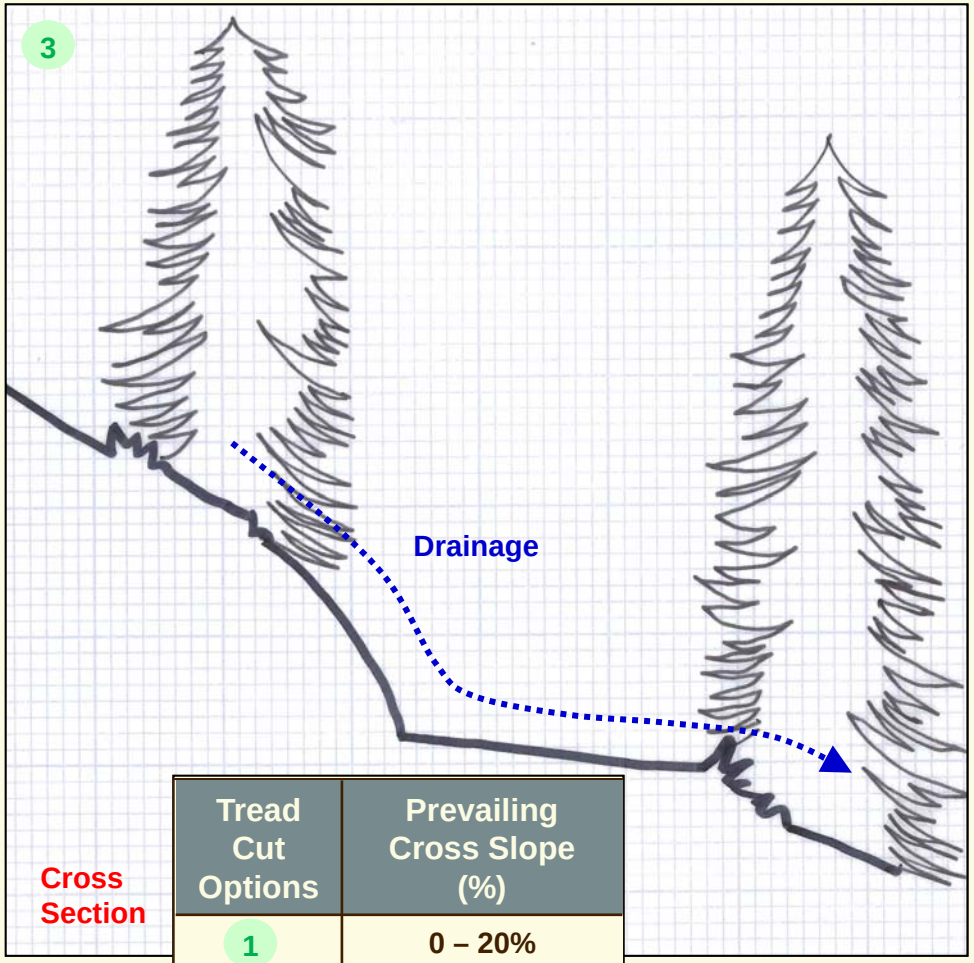


Corridor Clearing Options	Height (H)	Width (W)
A	8 Feet	6 Feet
B	8 Feet	8 Feet
C	10 Feet	6 Feet
D	10 Feet	8 Feet
E	10 Feet	10 Feet

Proper clearing / pruning can be achieved through the following:

- Proper identification of species.
- Understanding ecology of plant in question.
- Accurately predicting beneficial / adverse impacts on trail corridor.
- Deciding what to do.
- Doing this correctly.
- Realize that some plants cannot be pruned, but must be removed.

Tread Cut Options

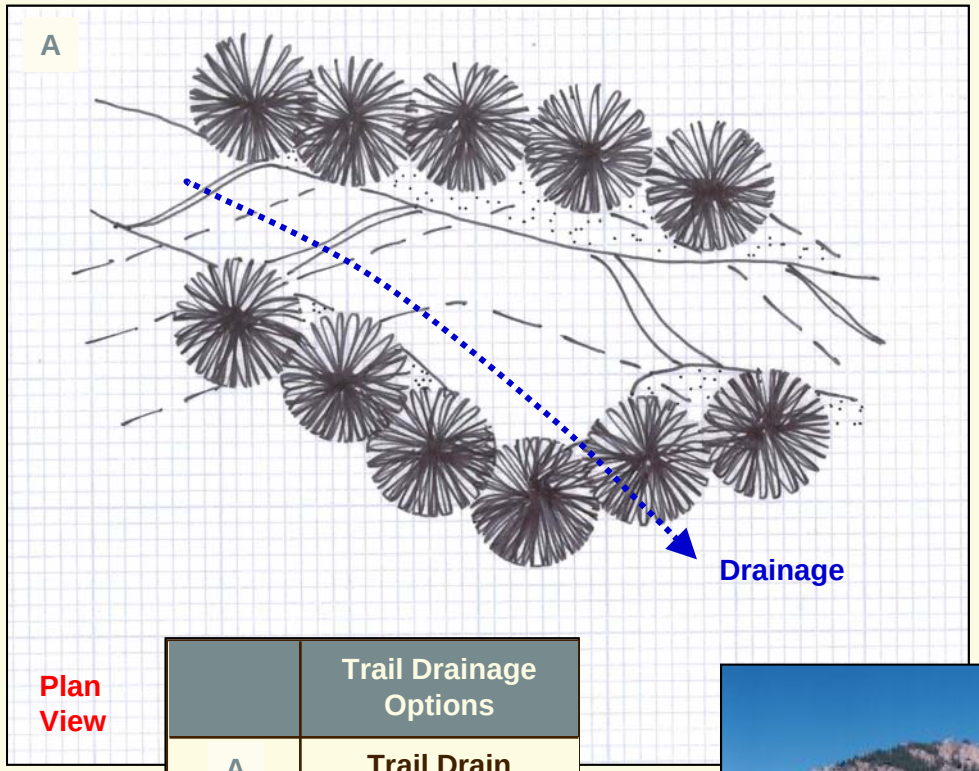


Tread Cut Options	Prevailing Cross Slope (%)
1	0 – 20%
2	20-40%
3	40-60%
4	60-70%
5	> 70%
6	Crowned Trail
7	Tread Cut with Ditch

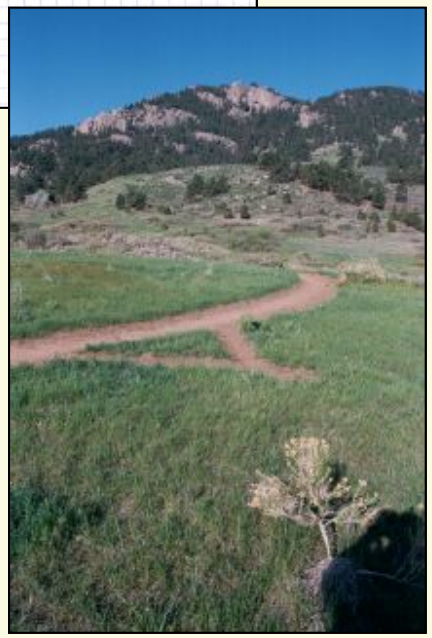
Well constructed, properly sloped, and well compacted trail tread can be attained through the following:

- Work across the trail for efficiency when cutting tread.
- Out slope trail approximately 10% (1 inch in 10 inches) to allow for drainage.
- Remove all vegetative material from the trail tread, and allow for drainage off the trail's edge.
- Back slope trail approximately 1:1 (45 degree angle) to allow for quick revegetation, see individual project specifications – back slope may approach 5:1.
- Improve inadequate surfaces with imported materials if necessary.
- Excavated materials must be disposed of according to project specifications.
- As soil is at a premium, leave as much as possible!
- Broadcast or dispose of excess materials only according to individual project specifications.

Trail Drain



	Trail Drainage Options
A	Trail Drain
B	Swale Crossing
C	Paved Dip
D	Stepping Stones
E	Waterbar
F	Stone Drains

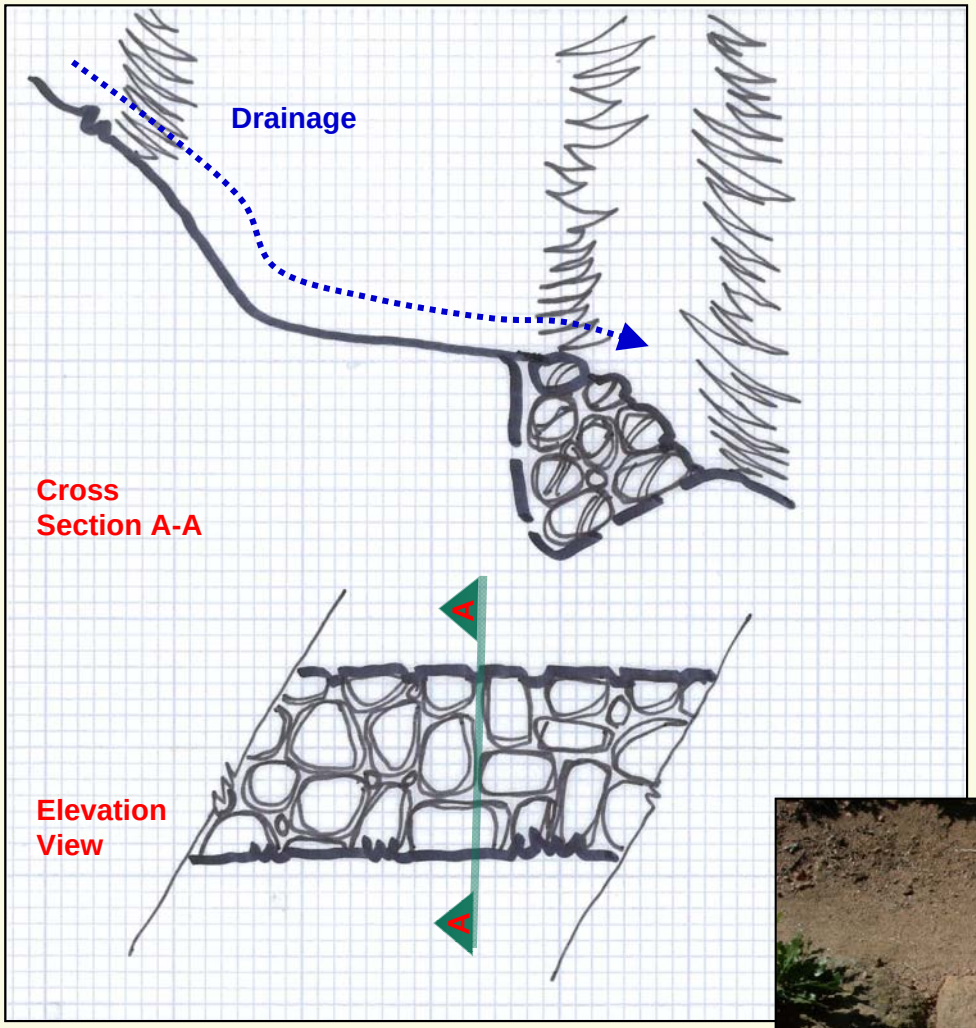


Erosion is the single greatest threat to trail sustainability. Prevention of erosion is critical to achieving sustainable trails.

- ***Trail Drains*** should be installed on trails at locations where normal cross slope will not allow for adequate drainage. In general, drainage should be studied every 25 to 50 feet, with provision made to protect the trail.
- Careful study of topography adjacent to the trail may yield an insight to maximize protection of the trail, while minimizing structures required.

"No factor in trail construction is more important than proper drainage, and many sections of good trail are damaged and destroyed by erosion which could have been prevented. All drainage should be planned for ahead of construction. The method of carrying surface water off of each trail section should be determined in advance, along with the location, type, size, and construction details of all drainage structures." – Guy Arthur, 1975.

Stone Retaining Wall



Stone Retaining Walls allow trails to be built where they normally would not be able to be built, or to improve less than adequate conditions.

- Begin by cutting a footing off the trail edge.
- The finished wall will be outside the width of the trail.
- Daylight the footing for drainage.
- Stack larger stones intermingled with medium stones near the foundation, fill voids with smaller stones.
- More contact between stones means more friction which means a better built wall.
- Stagger joints vertically and horizontally.
- Utilize gravity to advantage.
- Miscellaneous materials excavated from the trail corridor can be utilized as backfill.
- ***Stone Retaining Walls*** are indicated on the ***Design Notes*** by height (H) estimated in feet X length (L) also estimated in feet.

Stone Retaining Walls do not need to be complex. Simple walls provide great protection benefit to the trail surface and also provide easier and safer trail passage for trail users of all types.

New Trail Design – *Design Notes Technique* – Example

Station	Cross Slope % (Left)	Cross Slope % (Right)	Trail Profile Grade %	Azimuth	Soils	New Trail Design Notes (Example Only)
0+00	0%	0%		108d	Good	Begin Clearing A, Begin Tread Cut 1, Typical Trail, Width = 36 in.
			3%			
1+00	0%	0%		120d	Good	Install Trail Drains A on downhill side at 1+40, 1+75 at low points.
			8%			NOTE: Good source of stone in this area, uphill from the trail.
2+00	25%	30%		125d	Good	
			12%			
3+00	40%	45%		120d	Good	3+50 Begin Retaining Stone Wall (2' H X 10' L).
			7%			
4+00	25%	20%		120d	Good	Begin Tread Cut 2 at 5+00, Typical Tread.
			6%			
5+00	45%	50%		125d	Good	Install barriers 1 and educational signage 2 for restoration area.
			7%			

Tread Cut Options	Prevailing Cross Slope (%)
1	0 – 20%
2	20-40%
3	40-60%
4	60-70%
5	> 70%
6	Crowned Trail
7	Tread Cut with Ditch

On-Trail Management Options	
1	Barriers
2	Educational Signage
3	Directional Signage
4	One-Way Routes
5	Clockwise / Counterclockwise Routing

Corridor Clearing Options	Height (H)	Width (W)
A	8 Feet	6 Feet
B	8 Feet	8 Feet
C	10 Feet	6 Feet
D	10 Feet	8 Feet
E	10 Feet	10 Feet

	Trail Drainage Options
A	Trail Drain
B	Swale Crossing
C	Paved Dip
D	Stepping Stones
E	Waterbar
F	Stone Drains

	Mountain Trail Bridge Options
1	Simple Foot Log
2	Log with Handrail
3	Foot Traffic Only
4	Multiple Use
5	Boardwalk

New Tools & Techniques – GPS / GIS

GPS & GIS are powerful trail planning, design and assessment tools.

Using a Tremble GEO XM

- Line Data / Point Data

Utilize a Data Dictionary (Drop Down Menu)

- Assessment Notes
- Geographic Contextual Information
  - Characteristic Features
  - Off-Site Connections
  - Control Points
- Summarize Alternative Alignments
  - Options to Alignments
  - Comparison of Alternatives
- Construction Notes
- Restoration Notes

Manipulate Data

- Create Output Topographic Maps
  - Prevailing Cross Slope
  - Elevation
  - Aspect
  - Soils
- Overlay with Other Resource Information (Archaeology, T&E Species)

Benefits of GPS & GIS:

- Combination with other products
  - Aerial Photographs
  - Google Earth
  - Digital Photographs Index
  - PowerPoint
  - Adobe
- Rational / Defensible / Repeatable
- Scale-able
- Updatable with new inputs
- Exchange of information with your Interdisciplinary Team
- Administrative Record documentation
- Management updates
- Compliance documentation

Use of GPS / GIS tools & techniques improves efficiency over the trail project cycle!

Do not fear New Tools & Techniques!

Eagle Cliff Mountain – Alternative No. 1

Alternative No. 1

10% Avg. profile grade

Hits major control points

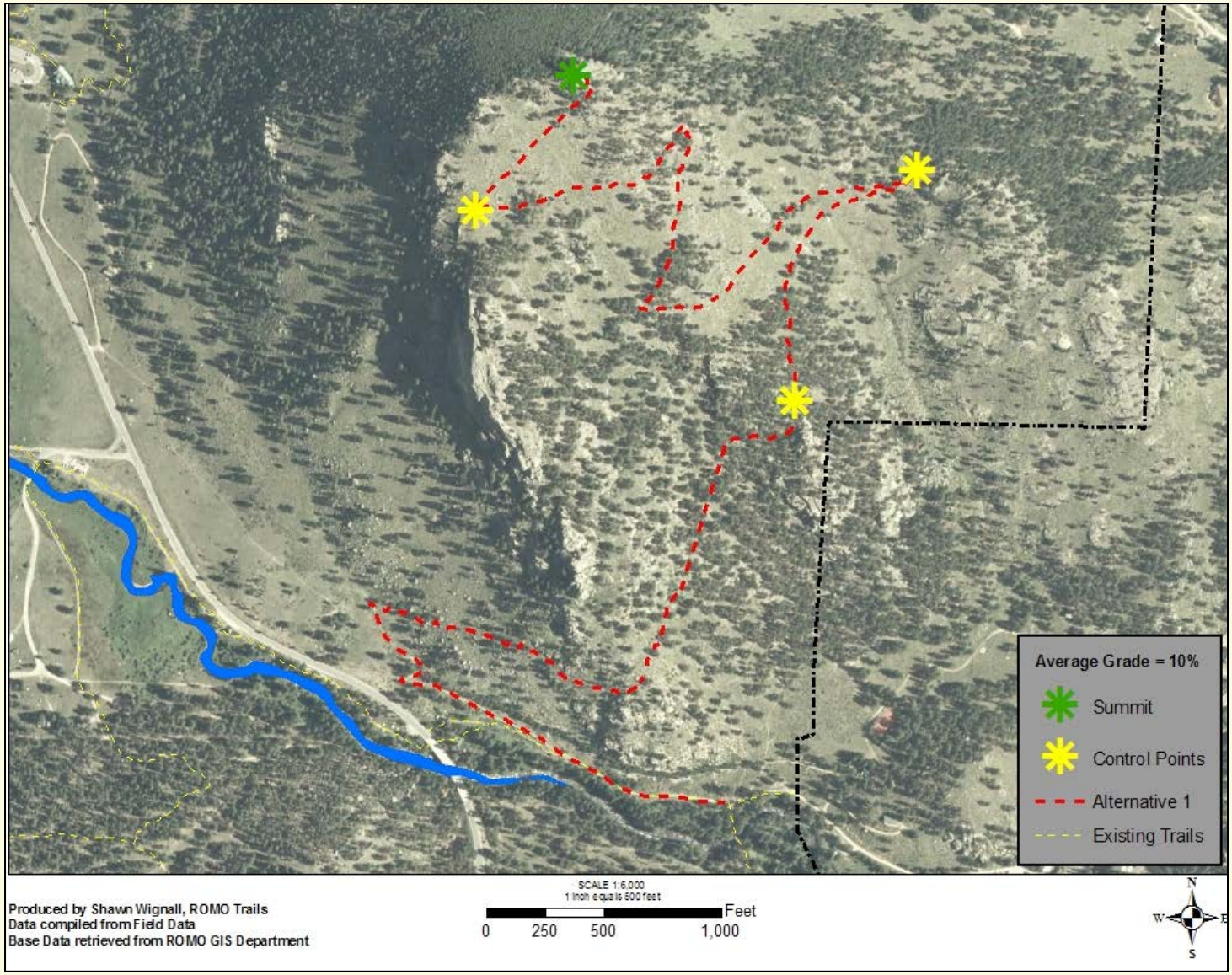
Utilizes lower break in western ridgeline

NPS boundary corner buffered by 100 feet

Takes advantage of both saddles

Ends at scramble routes to Eagle Cliff Mountain as well as the auxiliary summit.

Allows better expansion opportunities to Off-Site Connections (through auxiliary saddle).



Eagle Cliff Mountain – Alternative No. 2

Alternative No. 2

18% Avg. profile grade

Utilizes lower break in western ridgeline

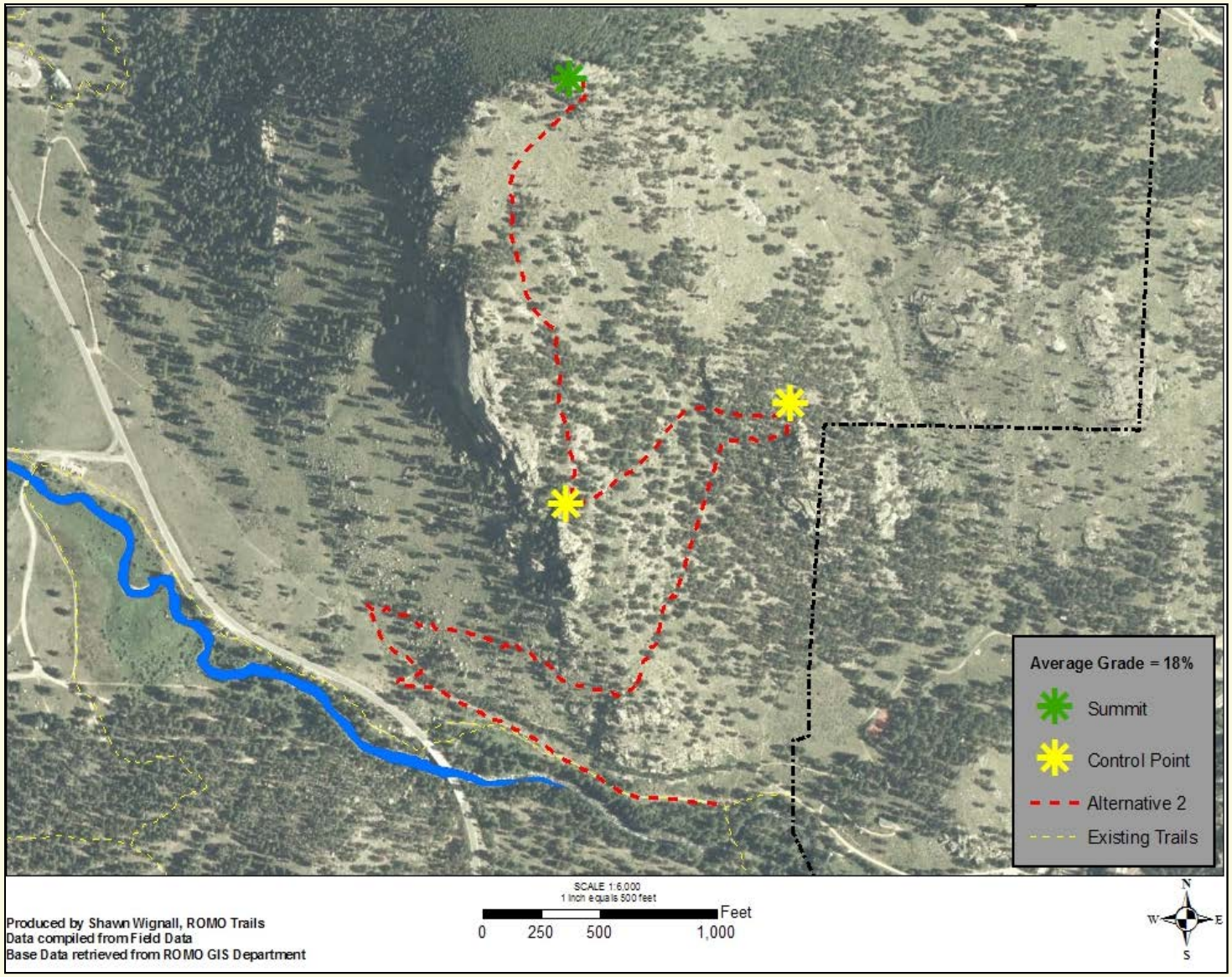
NPS boundary corner buffered by 100 feet.

Does not take advantage of auxiliary saddle.

Utilizes impact zone.

Ends at scramble route to top of Eagle Cliff Mountain.

Does not allow for efficient expansion to Off-Site Connections.



Eagle Cliff Mountain – Alternative No. 3

Alternative No. 3

18% Avg. profile grade.

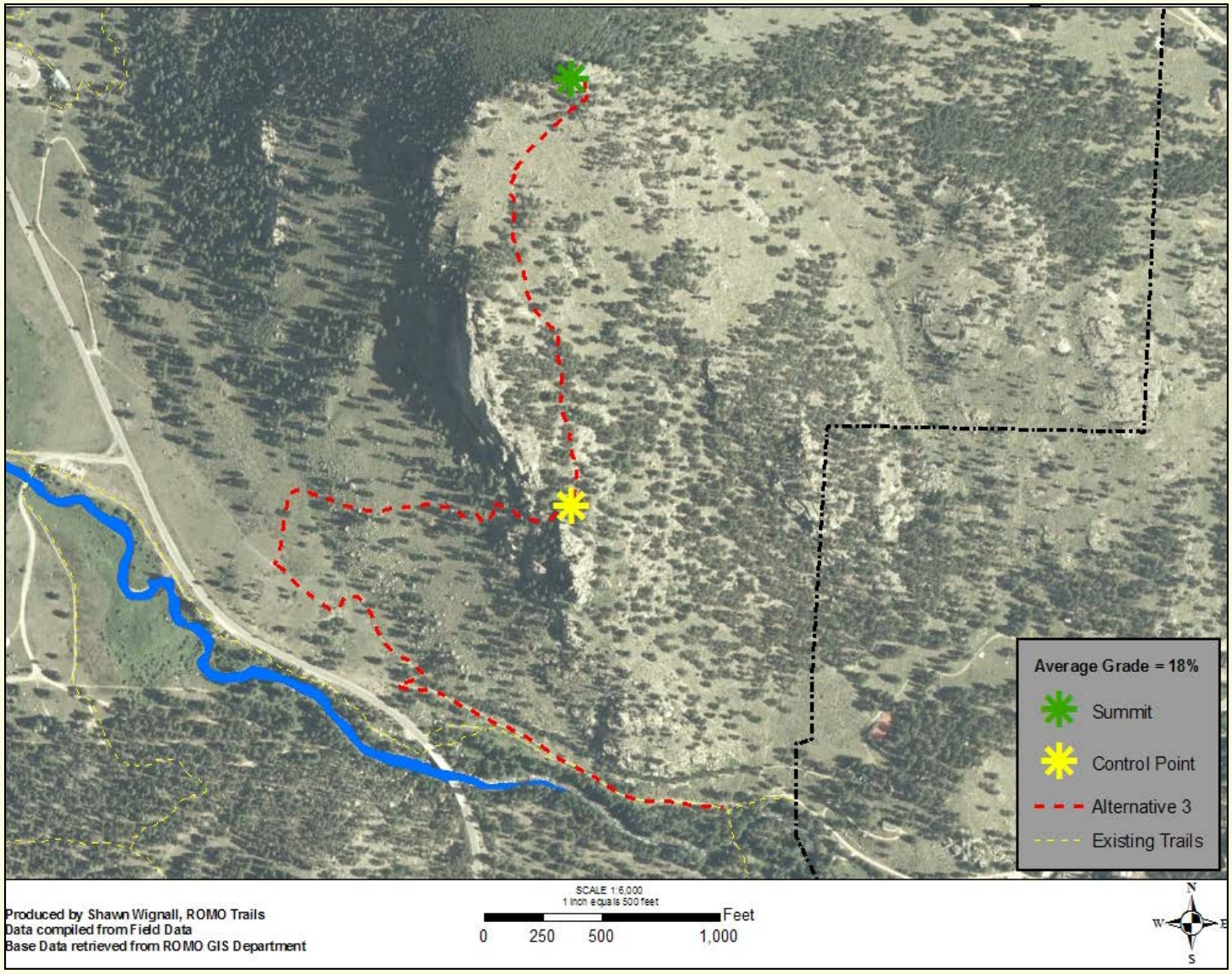
Utilizes higher break in western ridgeline.

Offers best buffer opportunity from private property and NPS boundary.

Utilizes upper portions of impact zone.

Ends at scramble route to the top of Eagle Cliff Mountain.

Does not allow for efficient expansion to Off-Site Connections.



Lessons Learned / Pitfalls to Avoid

Pitfalls to Avoid *(See Sketchbook)*

1. Failing to comply with federal law
2. Not including management
3. Using inappropriate sustainability criteria
4. Not conducting a sustainability assessment before planning
5. Not considering off-site connections
6. Not considering the planning context before designing
7. Not planning restoration activities from the outset
8. Locating significant structures in inappropriate locations
9. Crossing drainages in inappropriate locations
10. Ridgeline trails
11. Not entering into a partnership with a nonprofit
12. Not adopting a lessons learned philosophy
13. Not forming an interdisciplinary team
14. Not considering compliance

Lessons Learned *(See Sketchbook)*

1. Reduced life-cycle costs result from hard work
2. Having patience and not undertaking too-ambitious a project
3. Not exceeding recommended profile grades minimizes erosion
4. Not exceeding recommended cross slope grades minimizes erosion
5. Use of non-sustainable materials
6. Complete documentation of plans and designs assures project success
7. Time and material estimates establish the basis for priorities
8. Training activities strengthen the overall trails' program
9. Sustainable materials minimize life-cycle costs
10. Post-project lessons learned summaries

The Trail Ahead 1 of 2

Good Case Study
- Significant resource impacts
- NPS neighbors
- YMCA of the Rockies
- More or less a clean slate
- Restoration will be planned from the beginning

Yearly Summaries
- Lessons Learned
- Pitfalls to Avoid

2009 Project Foundations
- Partnership with Outdoor Stewardship Institute
- Support from Rocky Mountain Nature Association
- Engage YMCA of the Rockies
- Background information
  - Historic entrance to park
  - Native American history
  - Modern history
  - Bighorn sheep / elk
  - Rare plants
  - Interpretive opportunities

2009 Additional NPS planning
- Engage NPS management
- Resource Task Identification
  - Natural resource specialists
  - Cultural resource specialists
  - Interpretive / education staff
  - Other digital technology – Facebook, Youtube, etc.
  - Additional research
- Initiate Compliance Process
  - Project clearance form
- Initiate Stakeholder Analysis
  - Community
  - Schools
  - Clubs
- Initiate Internal NPS Programming
  - Planning units / segments
  - Work orders / estimates / capacities
  - Internal NPS training

Goal: Model Sustainable Mountain Trail Partnership for evaluation / applicability to other projects.

The Trail Ahead 2 of 2

2010 & Beyond NPS Tasks

- Crew Leader Instructor Training
- Refine interpretive opportunities
- Develop curricula for schools
- Field work / resource studies
  - Habitat Assessments
    - Rare Plants
  - Vegetation Surveys
  - Cultural Resource Review
    - Archaeology Overview
    - Cultural Landscape Inventory

2015 – 100th Anniversary of Rocky Mountain National Park

- Dedication – Continuous Route to Eagle Cliff Summit
- Celebrate Success

OSI Training (Mid-May of 2009)

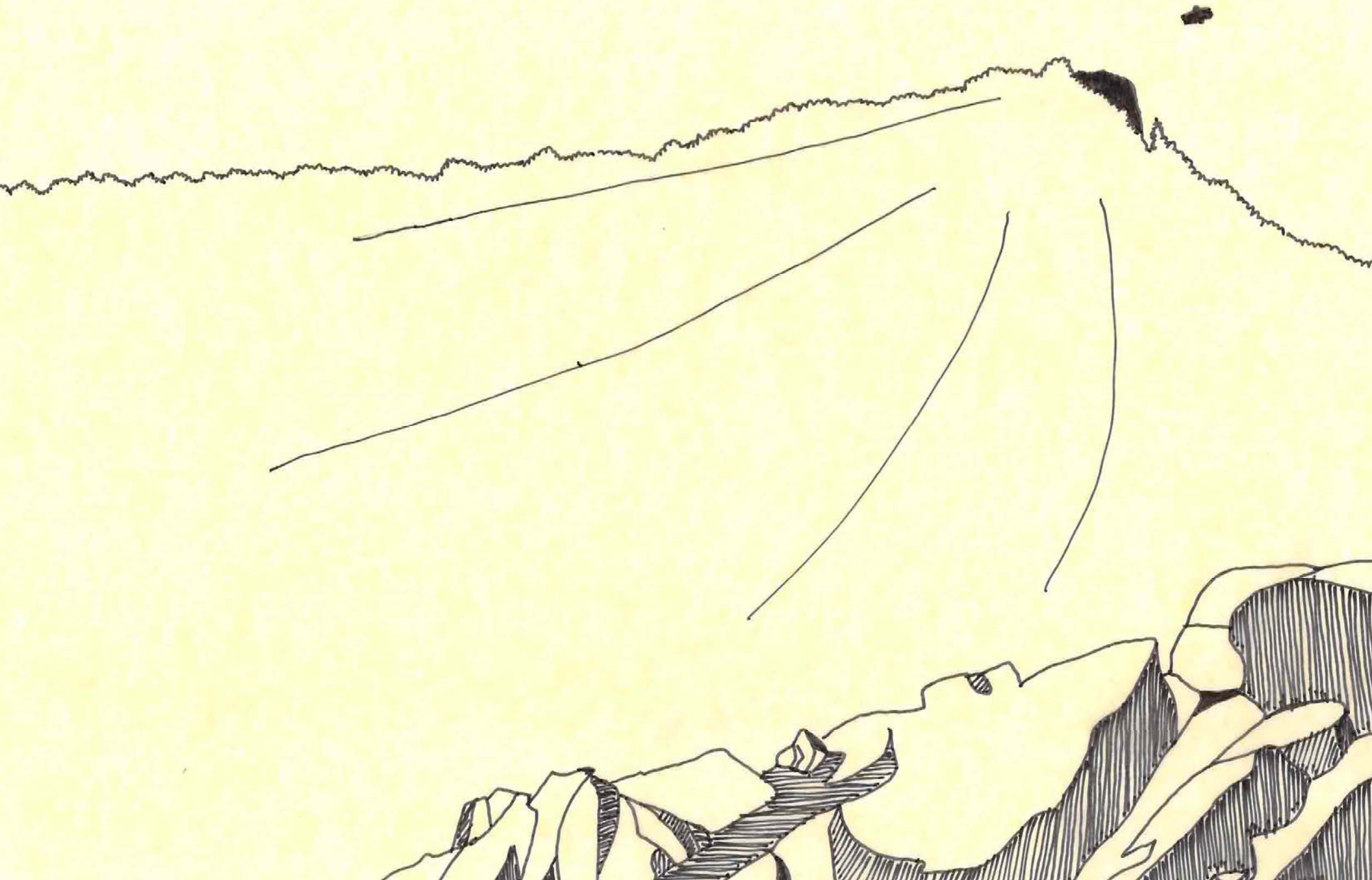
- Sustainability Assessment
- Introduction to *Sketchbook*
- Intermediate *Sketchbook*
- Advanced *Sketchbook*
- OSI Crew Leader Instructor Training for NPS staff
- OSI Crew Leader Training for NPS staff

The *2007 Edition of the Sketchbook* is on the American Trails website.

… Resources & Library
… Trail Building
… Trail Construction

How can OSI help you / networking opportunities??

See you in 2 years in Chattanooga!



End!