Trail Alternatives Comparative Analysis

The objective of this analysis is to compare and contrast different alternative designs for the trail connection, focused on the steep, forested portion of the route. The preferred design for this portion of the route will presumably continue on the existing Central Waterline Road portion of the route, and on the Southern Steep Slope section. The Northern On-Street section is assumed to be a Class I paved ADA-compliant trail to meet Caltrans standards and urban Coastal Trail objectives, while the Southern On-Street connection will be potential improvements to existing sidewalks and bike and pedestrian routes along the access road to Devils Slide Trail parking.

The analysis addresses the three trail design alternatives that were configured for the public survey and other engagement, and review by the Project Advisory Team (PAT). The comparison is not intended to select an alternative, but to examine pros and cons of different aspects of the alternatives under each of the eight performance criteria. The criteria are not necessarily quantifiable: the evaluation is somewhat general and subjective, but there are clear pros and cons for alternatives in different categories, based on the features of the respective alternatives.

The public and PAT engagement and response wasn't "which of these three alternatives do you want?" – the questions and discussions were about where the trail should fall on the spectrum of a series of trail design options:

- Width, gradient, surfacing, turn/switchback configuration, retaining wall type and extent;
- Who is accommodated vs. not accommodated;
- Relative impact on the trees and level of intrusion of the built trail in the forested setting.

The *Phase I Community, Public and Stakeholder Engagement Summary* details how the input fell on the spectrum of options. The Comparative Analysis reflects this input and summarizes how the alternative compare in achieving the project objectives. This analysis is intended to help the consultants and participants verify where the preferred trail design should fall in each spectrum based on technical considerations and public/stakeholder preferences.

Evaluation Criteria

The evaluation criteria are the same as the project objectives, with the addition of public support as #8. The considerations for scoring of each criterion are summarized below:

1. **Maximize multi-user experience**

   Accommodates the widest range of user types while minimizing conflict between user groups.

2. **Maintain natural habitat character and visual integrity**

   Alteration of the experience of the forested hillside. Includes removal of trees and displacement of native vegetation as well as introduction of intrusive elements such as extensive paving or concrete retaining walls.

3. **Maximize inclusive access; comply with applicable federal, state and local standards and guidelines**

Relates to criterion 1 above and also to specific standards for multi-use trails – Caltrans/full ADA compliance and ADA recreational trail guidelines

4. **Limit environmental impacts**

Minimizes displacement and disturbance of natural resources and tree removal; alteration or crossing of drainages

5. **Minimize construction and maintenance costs (trail resilience and longevity)**

Relative cost to construct and maintain the trail

6. **Maximize safety and emergency access**

Provides suitable turn radius and clearance for multi-use including bikes and horses; railings and barriers on drop-offs and adjacent to highway; accommodates rapid emergency access for medical, police or fire emergency.

7. **Adhere to San Mateo County Parks Trails Master Plan Guidelines and Local Coastal Programs**

Complies with pertinent standards, policies and guidelines from these documents.

8. **Public Support**

Received the most support in public outreach comments.

Analysis Methodology and Results

Table 1 presents the results of the Comparative Analysis. This table compares the performance of each of three conceptual trail alternatives in each of the 8 criteria. The rationale for each of the scores are summarized in the table. The empty, half-full and full circles give an "at-a-glance" sense of relative performance in combination with the numerical scores from 1 to 3 (the higher the number the better the performance). These are reflected in the overall scores and summaries at the bottom. The different criteria could be given different weighting (i.e. a higher scoring range for a criterion that was deemed more important), but in this analysis they are all weighted the same.

Alternative #2, the 8 foot wide, moderate gradient improved surface trail scored the highest, at 17 points overall, vs. 14 points for #1, the narrow, steep natural surface trail, and 15 points for #3, the paved ADA compliant trail. This is generally consistent with the public input trends.

Table 1: Trail Alternative Comparative Analysis

		Alternatives Evaluated					
		1		2		3	
	Criteria	Narrow Natural Surface Trail (2' - 4' wide, up to 25% gradient)	Rating	Wider Improved Surface Multi-Use Trail (6' - 8' wide, 10% average gradient)	Rating	Class I ADA-Compliant Paved Multi-Use Trail (8' - 10' wide, 8.33% max gradient)	Rating
1	Maximize multi-user experience	Accommodates only serious hikers and mountain bicyclists	1 ○	Accommodates more casual hikers, people with limited disabilities, mountain bikes and hybrid bikes, equestrians	2 ◐	Accommodates full range of users, including road bikes, but detracts from nature experience	2 ◐
2	Maintain natural habitat character and visual integrity	Minimal distrubance and intrusion - only a few trees removed	3 ●	Moderate disturbance and intrusion - 8 to 10 trees removed	2 ◐	Significant disturbance and intrusion - 12 to 20 trees removed	1 ○
3	Maximize inclusive access; comply w/standards and guidelines	Minimal inclusion - only serious hikers and mountain bicyclists	1 ○	Broad inclusion - complies with recreational trail ADA guidelines; does not comply with road bike or wheelchair access standards, but still may accommodate access by some users	2 ◐	Full inclusion - complies with standards for road bike and ADA access	3 ●
4	Limit environmental impacts	Limited environmental impacts, though mt. bikers are using/building unauthorized trails	2 ◐	Moderate environmental impacts	2 ◐	Significant environmental impacts, but probably can be mitigated to insignificant	1 ○
5	Minimize construction and maintenance costs	Low cost to improve and maintain - in the 10s of thousands for improvement; a few thousand for annual maintenance	3 ●	Moderate cost to improve and maintain - in the low to middle hundreds of thousands to construct; several thousand for annual maintenance	2 ◐	Significant cost to improve and maintain - in the high hundred thousands to over $1 million to construct; several thousand for annual maintenance	1 ○
6	Maximize safety and emergency access	Minimal access for emergencies; not safe for inexperienced or physically limited trail users; not safe for multi-use	1 ○	Good on-foot acess for emergencies; safe for most trail users and for multi-use	2 ◐	Potential small vehicle acess for emergencies; safe for all trail users and for multi-use	3 ●
7	Adhere to S.M. County Parks Trails M. P. Guidelines and Local Coastal Programs	Does not meet County Trails Plan guidelines for gradient or for multi-use or Draft LCP recommendations for bicycle access to Devil's Slide Trail	1 ○	Meets County Trails Plan guidelines for gradient and partially meets for multi-use and Draft LCP recommendations for bicycle access to Devil's Slide Trail	2 ◐	Meets County Trails Plan guidelines for gradient and multi-use but not for construction on steep slopes; meets Draft LCP recommendations for bicycle access to Devil's Slide Trail	2 ◐
8	Public Support	Moderate Support	2 ◐	Strongest Support	3 ●	Moderate Support	2 ◐
	Summary	Provides good experience for serious hikers and mt. bikers, and preserves environment, but others excluded	Score = 14	Accommodates most users and works well for multi-use. A compromise in terms of disturbance and cost vs. accommodation	Score = 17	Accommodates all users, but detracts from nature experience due to extent of construction; high cost	Score = 15

Other Alternative Considerations and Trade-Offs

In public input and discussions potential sub-alternatives to the basic alternative trail designs have been identified that deserve consideration. These details and trade-offs are discussed in the *Draft Preferred Trail Design Report*. Again, these issues pertain primarily to the challenging Northern Steep Slope Connection.

Accessibility. Objective and Criterion #3 is "Maximize inclusive access; comply with applicable federal, state and local standards and guidelines." This implies that all parts of the trail should be fully accessible per the standards detailed in section 6 of the *Existing Conditions and Alternatives Analysis Report*. But for the Northern Steep Slope Connection a fully accessible Class I trail would have extremely high costs and virtually eliminate the forested setting. The latter implication caused the Pacifica community to reject the 2009 Kennedy Jenks plan for such a Class I connection. The objective for this criterion is to find a balance between inclusive access and preservation of the natural environment. This relates to trail width, gradient, and surfacing, as detailed below and in the *Draft Preferred Trail Design Report*.

Recommendation: Design to multi-use recreational trail guidelines rather than fully compliant ADA access standards.

Retaining Wall Cost Implications. As discussed in the *Existing Conditions, Opportunities and Constraints Analysis Report*, the width and gradient of the trail significantly affect both the level of site disturbance and the height and length of retaining walls required. Retaining walls are a particularly expensive part of trail construction – costing into the hundreds of dollars per face foot (square foot of wall surface). A wider gentler gradient trail will cost significantly more than a narrower steeper trail in this setting.

Recommendation: Design to balance accommodation of different types of trail users with reduction of the extent of retaining walls.

Pavement vs. Base Rock Surface. A decomposed granite (D.G.) surface with a resin binder is a smoother, harder and more stable surface that looks natural. However, a D.G. or similar surface with a binder is effectively a pavement and can cost as much as asphalt or even concrete, yet it is not as durable. Concrete is not a desirable surface for equestrians. Asphalt (A.C. or asphaltic concrete in engineering terms) is a better compromise for accommodating them.

The alternative to pavement is a "base rock" surface. Base rock is a mixture of crushed rock in a specified gradation of sizes. It is typically used in layers underneath pavement to provide a firm, stable surface, but it is also used as a surfacing on multi-use recreational trails to reduce mud and rutting (see Marin County examples in section 6 of the *Existing Conditions and Alternatives Analysis Report*).

Any paved surface requires subgrade engineering (compaction to a specified density and layers of base rock) to provide a firm, stable surface. This is part of the reason paving would be so much more expensive than a base rock surface. Achieving the necessary compaction may

require removal and replacement of the existing soil if it is too sandy or has too much organic matter to compact. This can't be determined until after geotechnical testing is completed, and unsuitable material may be discovered during construction even with such testing.

A base rock surface could be installed with much less subgrade preparation than pavement. It would be much less expensive at the outset (on the order of a fourth to a third the cost of asphalt pavement) though it would require more annual maintenance. This surface would not be as smooth and stable as asphalt and would be more challenging/uncomfortable for some users (i.e. people using strollers or wheeled walkers). However, given that it isn't practical to meet the width and gradient requirements for full ADA accessibility on the Northern Steep Slope Connection, and that this section will be a relatively long, steep climb, the accessibility benefits of paving would be much reduced. Assuming that asphalt pavement cost an additional $10 per square foot, paving the approximately 5200 foot-long trail from near ACE Hardware to the end of the existing paved trail to the south at 8 feet wide would cost an additional $416,000.

Recommendation: Use a base rock surface rather than paving for the trail connection on the Northern Steep Slope south to the end of the existing paved trail.

Different Routes for Different Users. It was suggested that a steep, narrow trail could be retained to accommodate serious hikers and mountain bikers while a more accommodating multi-use trail could be built to accommodate other users. The pros of this option are that it would reduce potential conflict and provide trails that are more suited to the desires of different user groups. Separate trails are often created in regional park and open space settings. However, the cons of this option are: 1) that Pedro Point Headlands is a nature preserve and the corridor for creating the trails is very limited. Having two different trails would disturb significantly more habitat than a single multi-use trail; 2) the steeper trail would intersect and potentially cross the multi-use trail multiple times, creating potential conflict points, and; 3) equestrian trail users, who are particularly sensitive to the behavior of other trail users, have stated that when all users are required to share the trail, users tend to be more considerate than if they have a sense of single user type "ownership" of the trail.

Recommendation: For these reasons a separate trail for different users is not recommended in this setting.

Switchbacks vs. Climbing Turns. Tight reversals of the trail work fine for hikers, and even horses can do relatively tight turns, but most bicyclists require a wider radius to easily negotiate a turn. The current preliminary design template is a 12' radius to the centerline of the trail through the turn. But this results in a 30' distance from the outside of the top of the turn to the outside of the bottom. While the trail descends through the turn, because the trail corridor has slopes as steep as 60% the wider the radius of the turn, and the wider the trail is through the turn, the higher the cuts and retaining walls will be – with relatively exponential increases.

Recommendation: find a balance between making the turn easy for bicyclists and the amount of disturbance and construction required.

A related issue is the tendency to cut switchbacks and turns. This tends to lead to erosion and disturbance of native vegetation.

Recommendation: The solution, besides admonitions not to go off designated trails, is barriers such as split rail fences or stacked rock walls where the trail doubles back to discourage cut-throughs.

Crossing Drainages and Avoiding Cut Slope vs. More Turns/Switchbacks. There are ditches constructed at the top of the cut slopes above ACE Hardware and Highway 1. The cut slope and benches south of ACE Hardware were constructed many years ago to create flat space for what eventually became the ACE hardware complex. There is also a natural drainage that descends in the center of the trail corridor.

It is desirable to avoid crossing such ditches and drainages – especially natural ones, because it requires more construction of small bridges or culverts and because it may have more environmental impact. But turns and switchbacks may have even more significant costs and impacts, so minimizing them is desirable too. This can be accomplished by using the maximum area for layout of the trail, including extending into the Caltrans right of way, and potentially part of the cut slope above ACE Hardware. It is acknowledged that disturbing that cut slope carries risks of causing a failure of that slope that would impact the structures at the base – risks that would have to be carefully mitigated.

Recommendation: the trail layout should seek to minimize crossings of the central natural drainages, and maximize use of the available property, including potentially the Caltrans right of way and the cut slope above ACE hardware, to minimize turns/switchbacks.