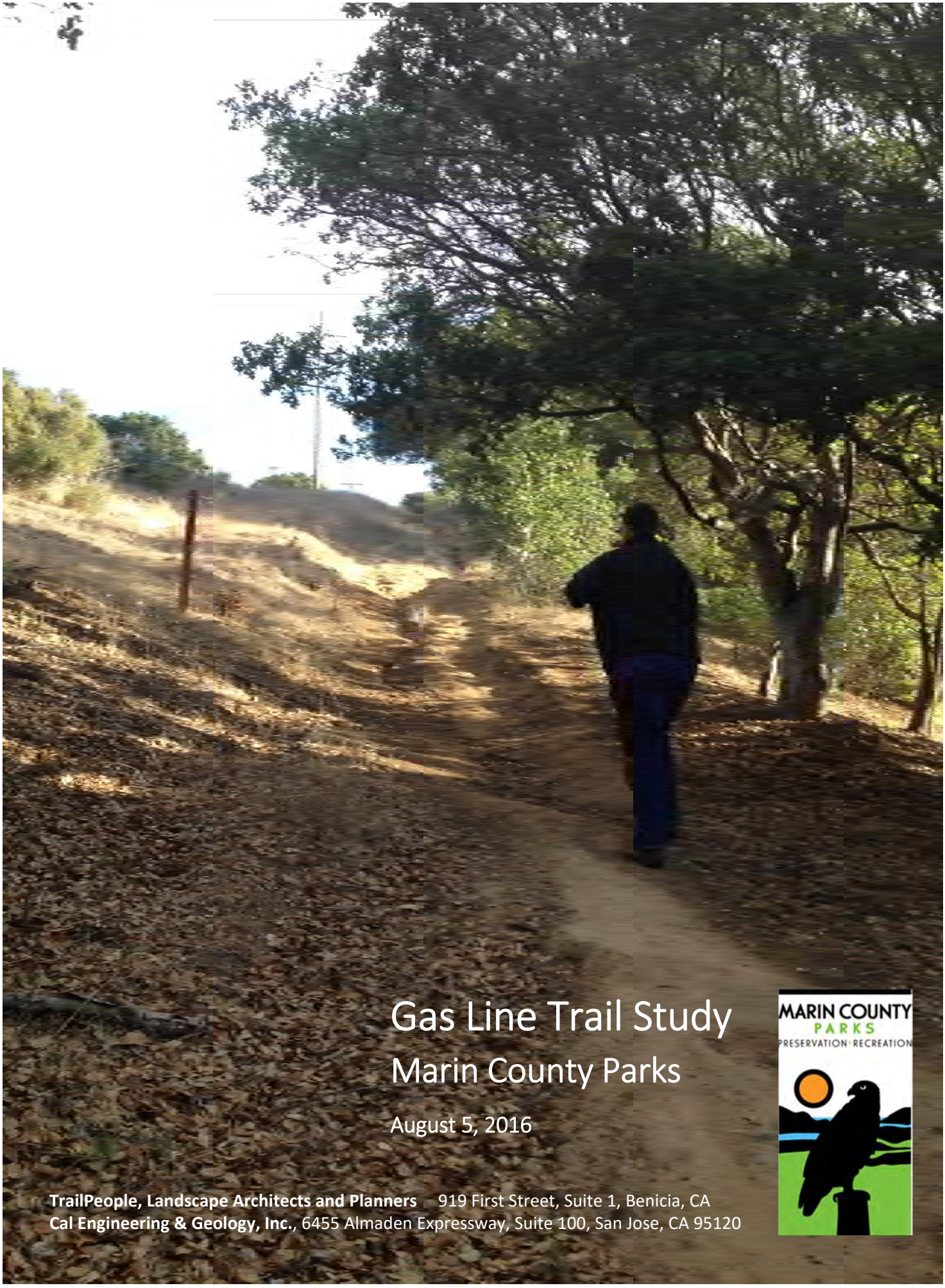

Gas Line Trail Study

Marin County Parks

August 5, 2016

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Marin County Parks

Prepared August 5, 2016, by

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Introduction

Study Scope and Objectives

The Marin County Open Space District (MCOSD) retained TrailPeople, Landscape Architects and Planners and Cal Engineering & Geology to study the Gas Line Trail in the Alto Bowl Open Space Preserve in northern Mill Valley. The specific study objectives include:

- Identify and analyze alternatives to improve trail sustainability/erosion control and to improve visitor experience on the Gas Line Trail;
- Identify potential improvements to the Horse Hill Trail for trail sustainability/erosion control and to improve visitor experience, and;
- Consider whether it is feasible and advisable to open to the Gas Line Trail and Horse Hill Trails to bicycles.

Existing Trail and Setting

The existing Gas Line Trail follows a PG&E right-of-way through the Alto Bowl Preserve in the northern portion of the City of Mill Valley adjacent to the alignment of a major gas line. The trail was created over the years by people following the disturbance created by installation of the gas line. The route is steep (up to 26% slope), eroding and unsustainable.

The Gas Line Trail connects from the Alto Bowl Fire Road on the lower/west end to the Horse Hill Trail on the upper/east end. The Horse Hill Trail connects south in an open space corridor to the Horse Hill Open Space Preserve, where the Dollar Fire Road connects to Lomita Drive (see Figures 1 and 2). These trails are open to hikers and equestrians only. The Gas Line Trail occupies a narrow ridge in a space approximately 20 feet wide between the location of the buried gas line and the preserve property line (see Figure 3).

Planning and Policy Background

On December 16, 2014, the MCOSD Board of Directors approved the first comprehensive Road and Trail Management Plan (RTMP) and associated Environmental Impact Report (EIR) to direct future use and management of roads and trails on the MCOSD's 34 preserves. These goals and policies helped guide the current study and will guide the ultimate decision on any changes or improvement projects.

Over-arching Goals of the RTMP include:

1) Establish and maintain a sustainable system of roads and trails that meet design and management standards;

2) Reduce the environmental impact of roads and trails on sensitive resources, habitats, riparian areas, native and special-status plant and animal species.

3) Improve the visitor experience and visitor safety for all users, including hikers, mountain bikers, and equestrians.

More specific "interests and concerns" supported by RTMP policies (extracted from a list given on page 4-10 of the RTMP) include:

1) Meet current and future demand for access to public lands by providing roads and trails for a variety of users.

2) Ensure a sustainable road and trail system

3) Protect sensitive resources

4) Minimize user conflicts

5) Enhance road and trail connectivity and improve the range of opportunities for visitors to experience the preserves

9) Maintain user safety

Particularly relevant RTMP policies for the current study include:

GOAL TRL-1: Trail Network Preservation and Expansion. Preserve existing trail routes designated for public use on the Marin Countywide Trails Plan maps, and expand the public trail network for all user groups, where appropriate. Facilitate connections that can be used for safe routes to school and work.

GOAL TRL-2.b: Design, Build, and Manage Trails in a Sustainable Manner. Incorporate design measures that protect vegetation, protect habitats, and minimize erosion.

Policy T1d: The MCOSD will permit bicycling and saddle animals on trails designated and signed for their use, including (a) existing trails and new trails that the MCOSD builds and designates for shared use; and (b) existing trails on newly acquired lands, when compatible with natural resource protection and the safety of trail users.

Policy SW.12: Road and Trail Connectivity. The MCOSD will strive to increase road and trail connectivity for all trail users. The MCOSD will strive to provide opportunities for short to medium distance loops and long-distance routes. The MCOSD may consider one-way, uphill-only, time separation, and single-use or priority-use trails to achieve these ends.

Policy SW.16: Prohibition of Uses. The MCOSD may prohibit certain trail uses or apply increased trail use restrictions within certain areas to enhance safety, minimize conflicts between trail users, and protect natural resources. Examples of areas where this policy may apply include, but are not limited to, those proximate to stables and those traditionally heavily traveled by equestrians, and in Sensitive Resource Areas.

Policy SW.17: Displacement of Existing Trail Users. The MCOSD will strive to prevent displacement of equestrians and pedestrians when accommodating trail access and trail connections for mountain bikers. When considering the designation of existing trails as single-use or priority-use, the MCOSD will take care to maintain connectivity between destinations for user groups historically using those trails.

Figure 1: Regional Location Map

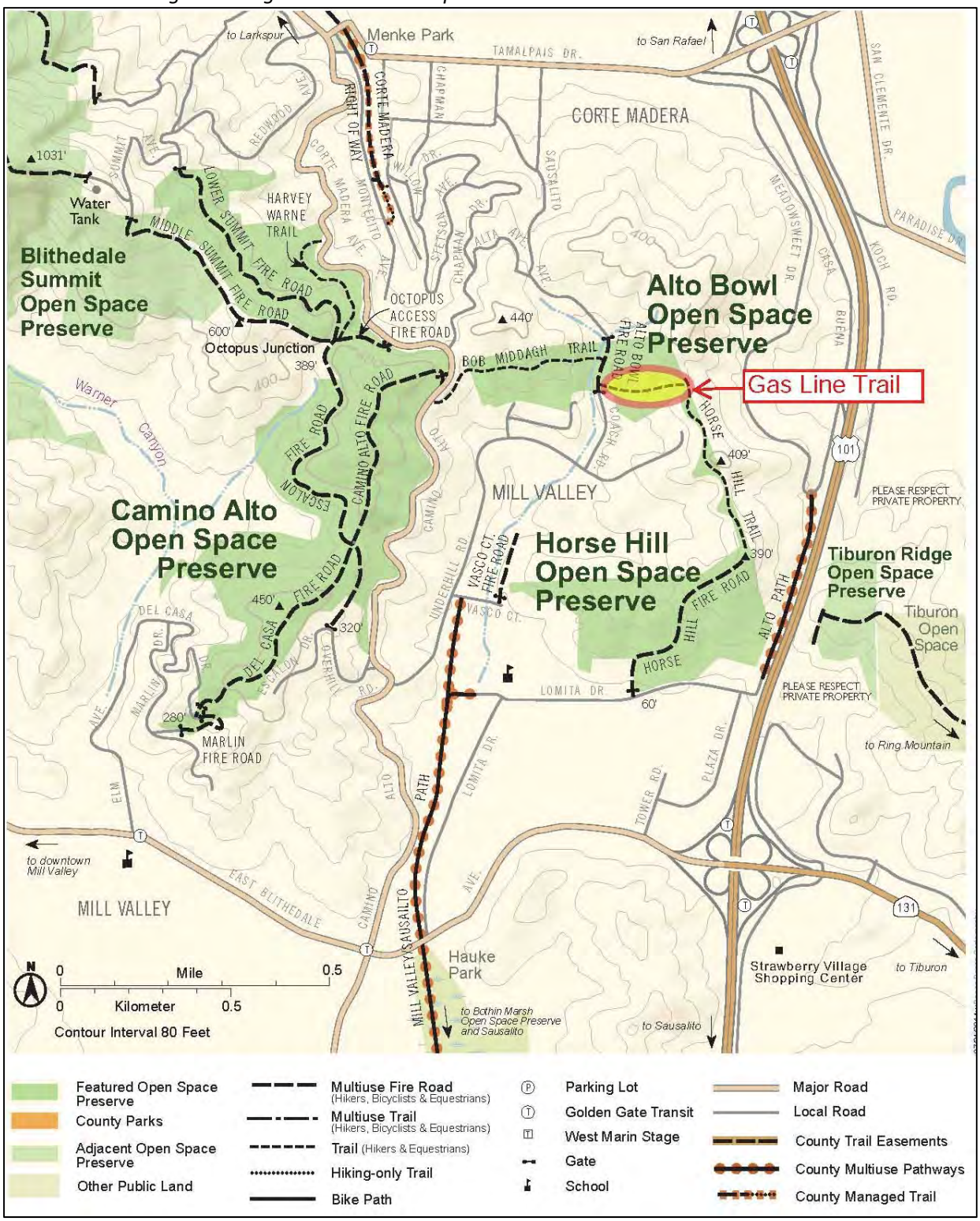


Figure 2: Site Vicinity Map

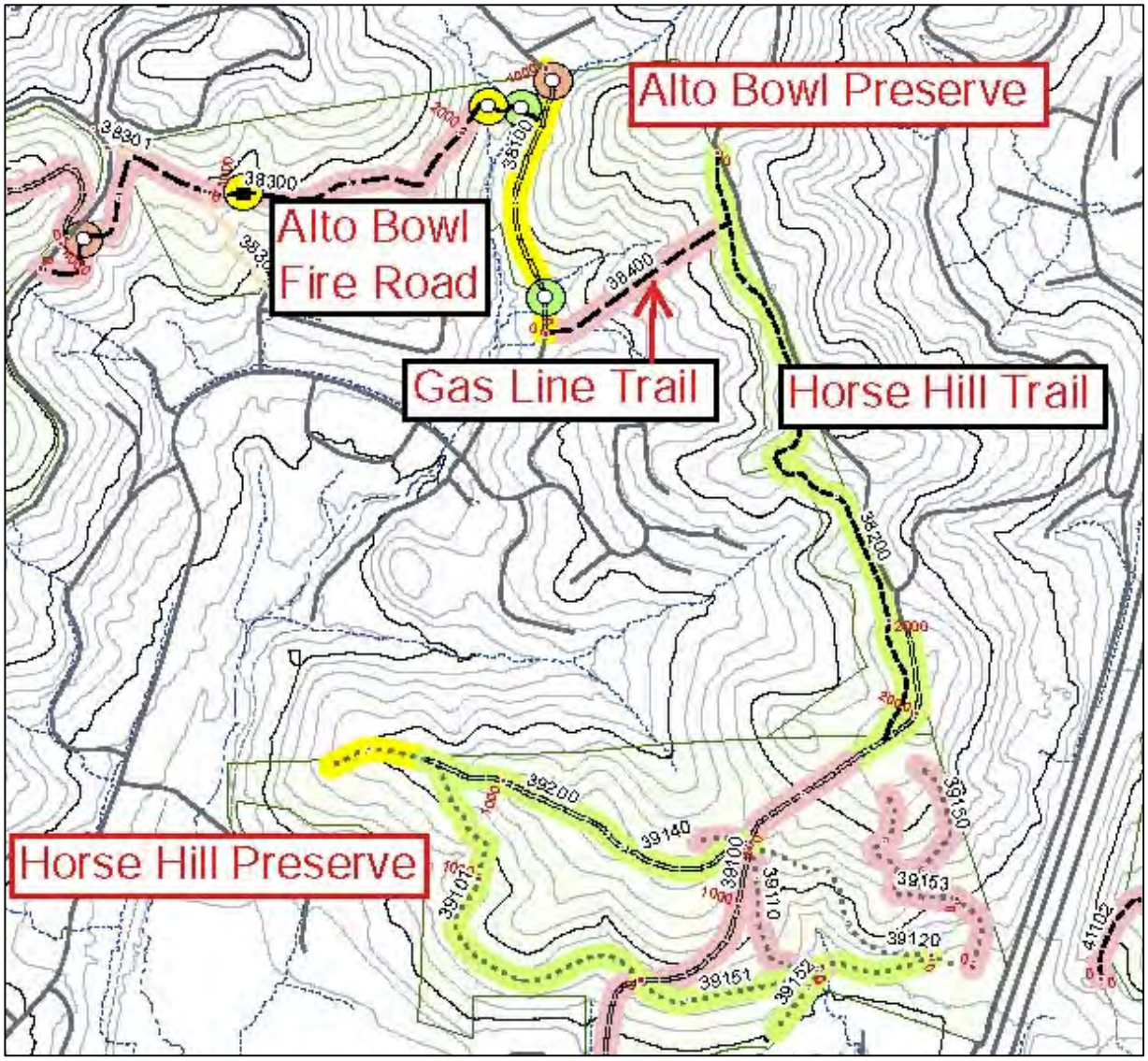
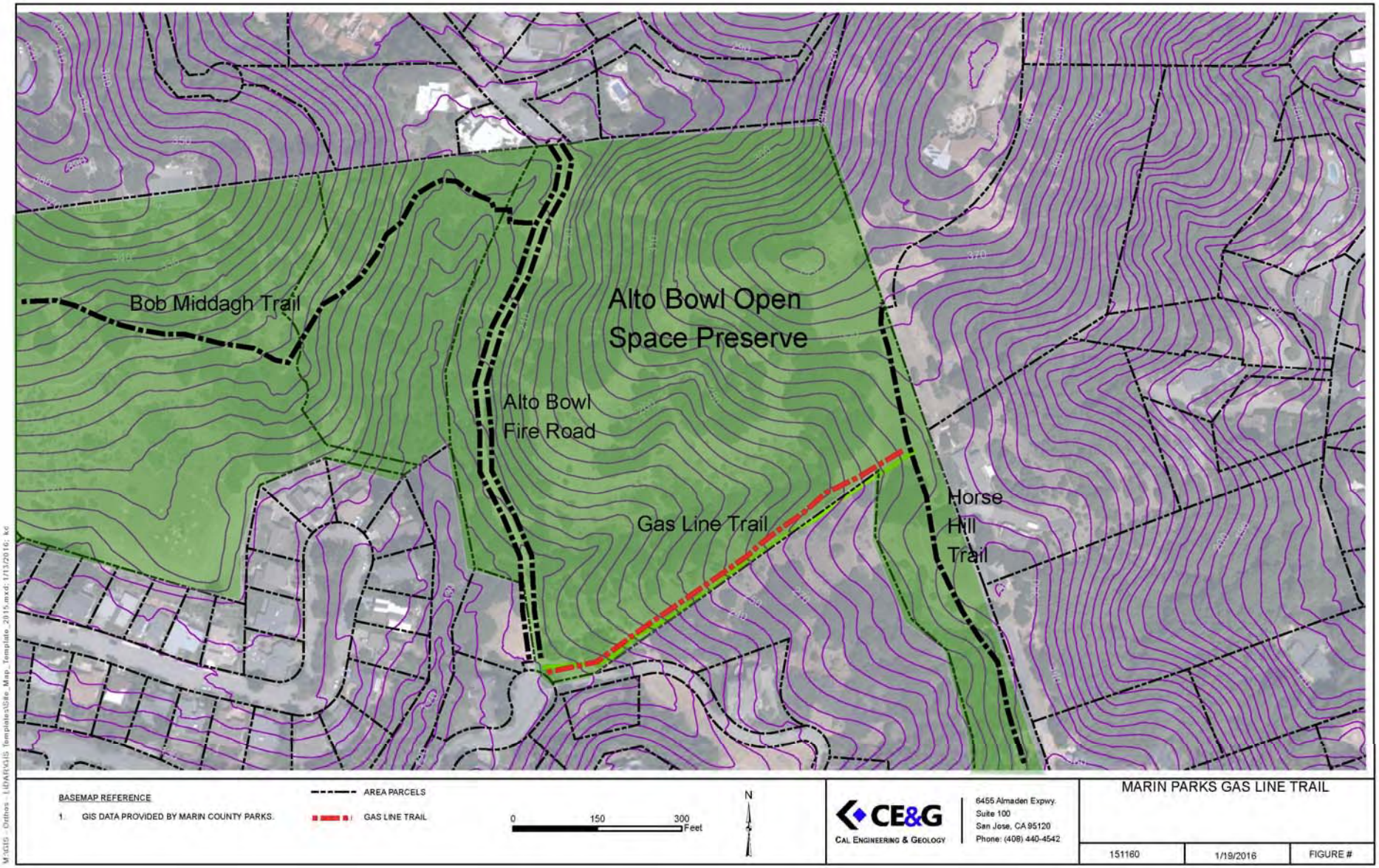


Figure 3: Gas Line Trail Site Map



Alternatives Considered

Based on study of existing physical conditions, research on PG&E easement access and maintenance conditions, and consideration of RTMP policies, three options for improving the Gas Line Trail were identified and analyzed:

1: Reconstruct the trail in the current corridor with a reduced gradient of approximately 10% using "stacked" switchbacks;

2: Reconstruct the trail in the current corridor with timber steps;

3: Construct an alternative trail alignment on the preserve hillside to the north and close or "retire" the existing trail and restore it to a more natural condition.

The existing Horse Hill Trail connection was evaluated for improvements to sustainability and visitor experience.

Analysis of Existing Conditions

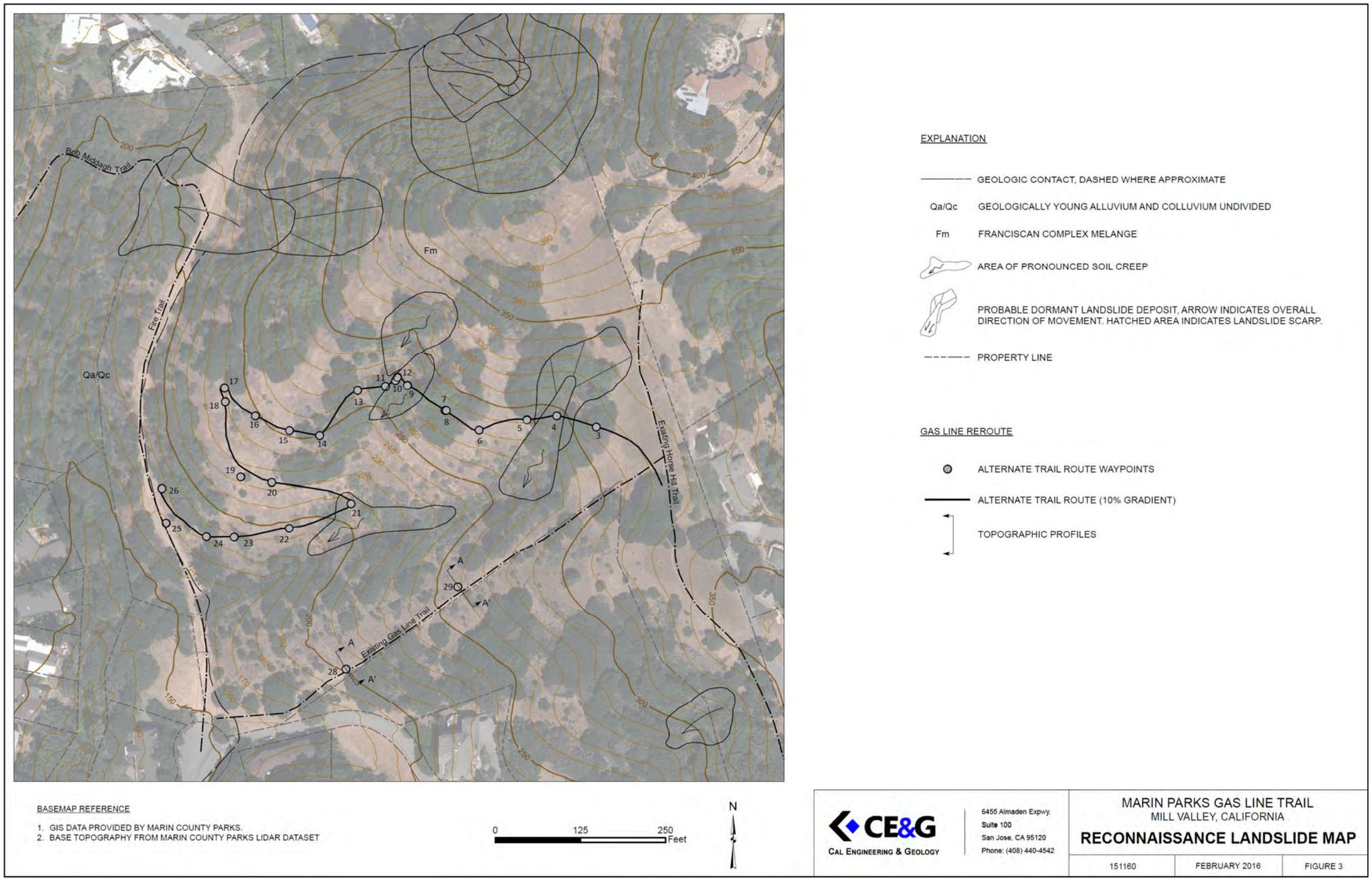
Local Geologic Setting

Bedrock in the vicinity is Franciscan Complex melange, which contains relatively hard blocks of various rock types, within a sheared matrix of softer, more shale-rich rock (see Fig. 4). Weathered bedrock is exposed in the existing trail bed and gullies, indicating that the colluvium (surficial soils) is only about a foot thick. This inferred surficial geology is shown on our Topographic Profiles (see Figures 5 and 6).

The orientation of layering (where visible in the existing trailbed) in the bedrock appears to be favorable, and to not facilitate deep-seated landsliding. Where landsliding was noted in the project vicinity, it is primarily shallow, involving mainly the colluvium. The uppermost weathered bedrock is relatively soft, as evidenced by the observed gullying.

Based on our analysis of a LiDAR dataset provided by Marin County Parks, there appear to be scattered small to moderate-sized, dormant probable earthflows, and areas of accelerated soil creep, in some topographic swale areas.

Figure 4: Reconnaissance Landslide Map



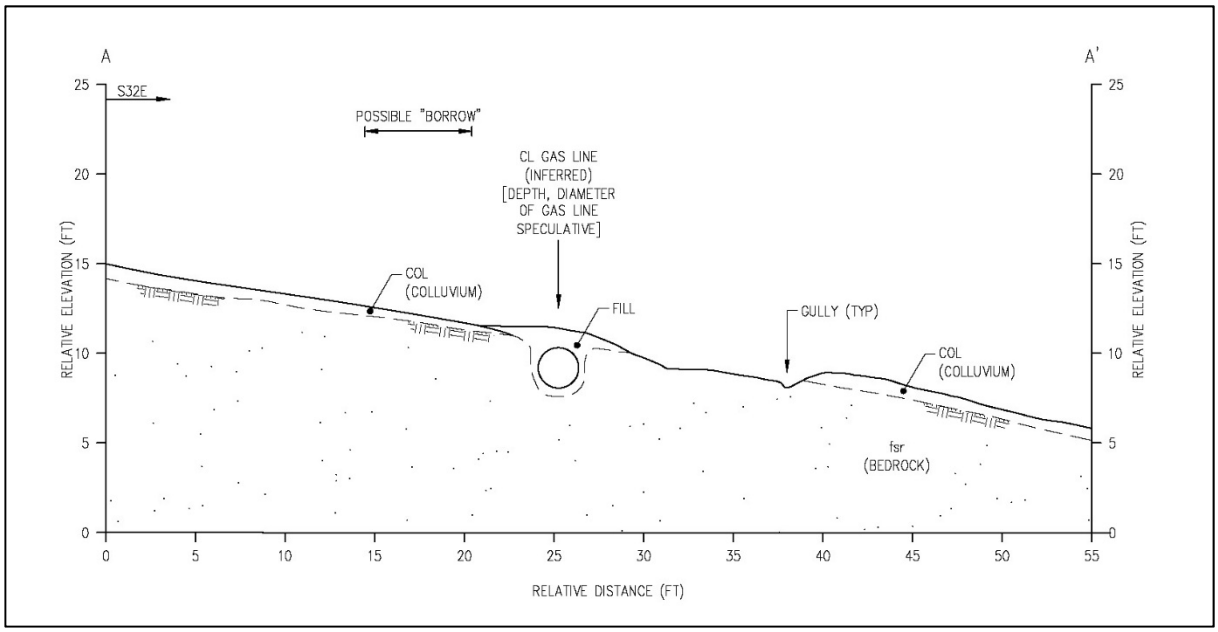
Existing Trail Conditions

The existing trail is aligned straight down the slope and has sections locally as steep as 28 to 30%. With approximately 175' in elevation gain over a distance of 655' it has an average measured slope of 26%. In general the lower one-third of the trail has the steepest inclination. The uppermost one-third is the most gently sloped (at 8%), so the maximum slope is much higher than the average.

The location of the gas line is locally marked by flexible cautionary stakes. Along the trend of these stakes, there is commonly a low berm, which we infer to be earth mounded over the gas line (see Topographic Profiles, Figures 5 and 6). We suspect that the gas line itself was constructed in a trench of unknown depth, and then soil from either side of the gas line was scraped up and mounded over the gas line. Construction activity and equipment likely used the southeast side of the gas line for access, as has equipment needed for service of existing overhead utilities, and this cleared swath over the years has been attractive as a trail.

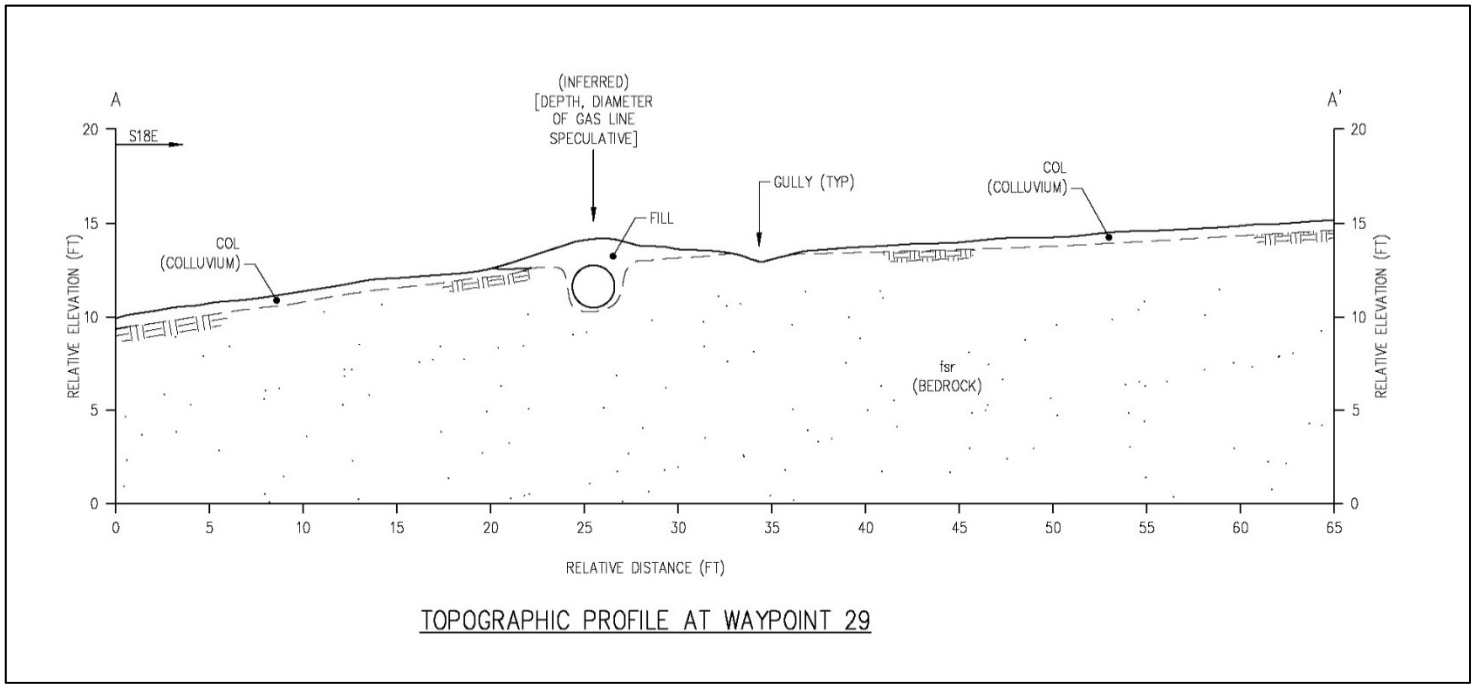
View upslope along lower portion of existing Gas Line Trail, in vicinity of field-measured topographic profile at Waypoint 28 (see Figure 4 for waypoint location, Figure 6 for topographic profile). Berm over gas line visible at left; gullied area exposes deeply weathered rock.

Figure 5: Cross-Trail Profile Lower 1/3 of Gas Line Trail



(see Figure 4 for locations)

Figure 6: Cross-Trail Profile Middle 1/3 of Gas Line Trail



Runoff and Erosion Patterns

Natural runoff in the vicinity is by sheetflow toward adjacent topographic swales, unless diverted by surface features. The natural slopes and swale axes in the project area do not appear to commonly experience gullying.

Unfortunately, the gas line and trail do serve to divert runoff. The existing Gas Line Trail is oriented nearly down the fall line, and even though it is largely located on the spine of a spur ridge, there are few opportunities to direct water off the trail, resulting in erosion gullies. The most basic improvement that could be made, which should occur even if the trail is "retired" and restored back to natural habitat, would be to install drain dips or water bars where feasible to direct water from the trail. The locations for each of the following photos are shown on Figures 7 and 8.

A – the lower portion of the existing trail has an existing water diversion that could be improved (view upslope)

B – higher up this same trail segment, the only option to divert water would be to install a berm to direct it to the left (view downslope)

C – the same vicinity as (B), looking uphill. Note exposed weathered rock.

D – upslope portion of trail, looking downhill. The trail could be routed around the pole at right to reduce overall grade in this segment

E – upper portion of existing trail. Grade could be reduced by realigning so as to traverse the area at left

F – the same vicinity looking downhill

Gas Line Trail Alternatives Evaluation

Objectives

This study assesses the potential to realign and improve the Gas Line Trail in the existing corridor. Important objectives are: 1) to avoid impacting the existing natural gas main on the alignment, which is assumed to eliminate the possibility of any grading involving cuts below the existing surface or significant structures in the vicinity of the gas line; 2) to provide a trail that is sustainable with respect to erosion control and maintenance, and 3) provide a trail that is more usable and enjoyable for users, which include hikers and equestrians.

Option 1: Reconstruct with Switchbacks

To retain and improve the Gas Line Trail as a sustainable and enjoyable trail meeting the objectives of the RTMP a significant reduction in the gradient of the trail would be needed. This is a challenge because the available trail corridor is constrained on the southeast by the posts that mark the preserve boundary (only a few feet southeast of the existing trail), and on the northwest by the steep, wooded northwestern flank of the spur ridge. In any case, significant cuts and fills or trail structures, such as retaining walls, cannot be built within 5 feet of the existing gas line, further constraining the available corridor.

While horses would be able to use the existing gas line trail in spite of its steep gradient, it would not be sustainable due to the impact of their hooves combined with the difficulty of preventing runoff from flowing directly down the trail due to its alignment on the fall line. It is also too steep to be enjoyable or safe for pedetrians, especailly in wet weather.

Given the narrow trail corridor, the only way to reduce the gradient and provide more opportunities to direct water off the trail would be to create a series of “stacked” switchbacks or climbing turns, as illustrated in Figures 7 and 8 below. Stacked switchbacks are undesirable from an aesthetic standpoint, and also because there is an inherent opportunity for trail users to cut corners. Additionally, switchbacks require relatively significant construction and maintenance effort.

The switchbacks, or wider “climbing turns” illustrated in Figures 7 and 8 would reduce the average gradient from 26% to 17% (175’ of elevation in 1044’) - still undesirably steep for a multi-use trail. Some additional reduction may be feasible, but 15% would probably be the best achievable. Figure 9 shows a concept for this type of switchback, which would probably require retaining walls such as the block units illustrated, and railings or split rail for safety and to prevent cutting of the switchbacks. Construction of the trail and switchback would require significant cut and fill, and potentially imported fill, and construction of short walls. Construction of the short walls to retain this fill would entail some manner of excavation or drilling, and would not be allowed by PG&E within 5 feet of the gas line (see cross-trail profiles in Figures 5 and 6).

Figure 7:- Lower Gas Line Trail Realignment Concept

Figure 8: Upper Gas Line Trail Realignment Concept

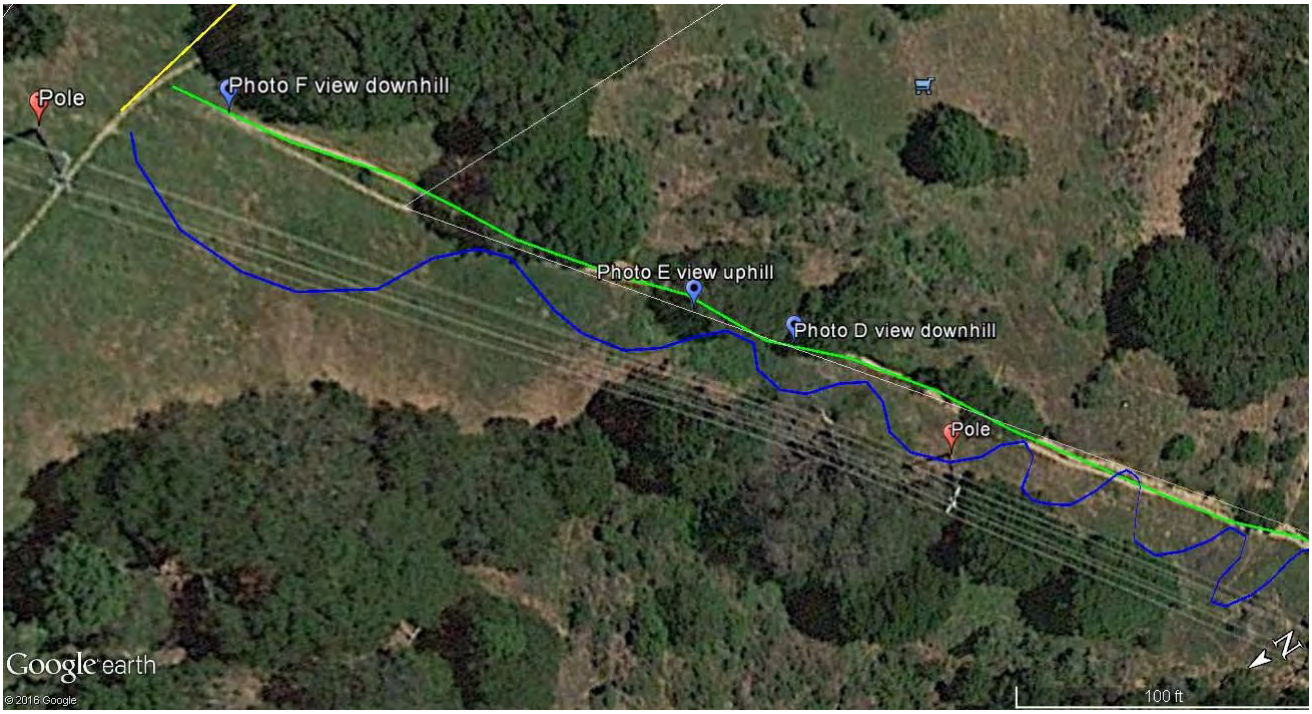
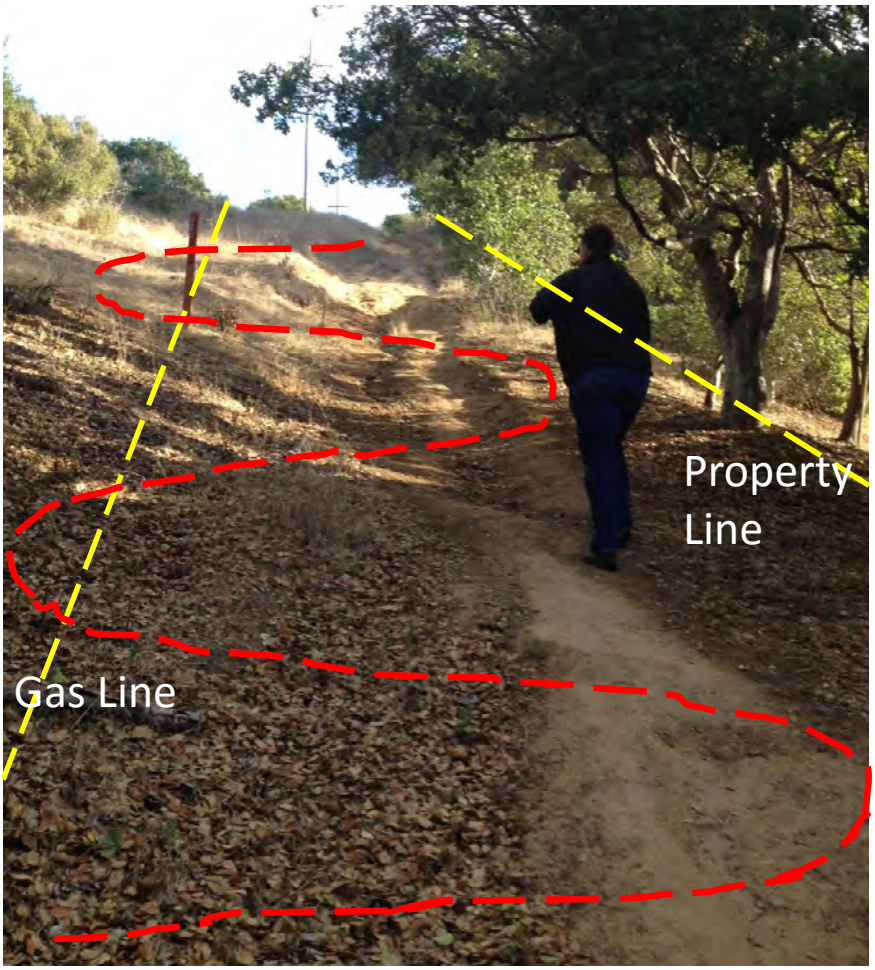


Figure 9: Conceptual Switchbacks



Example of concrete masonry unit retaining wall that could be used to support switchbacks

Conclusion

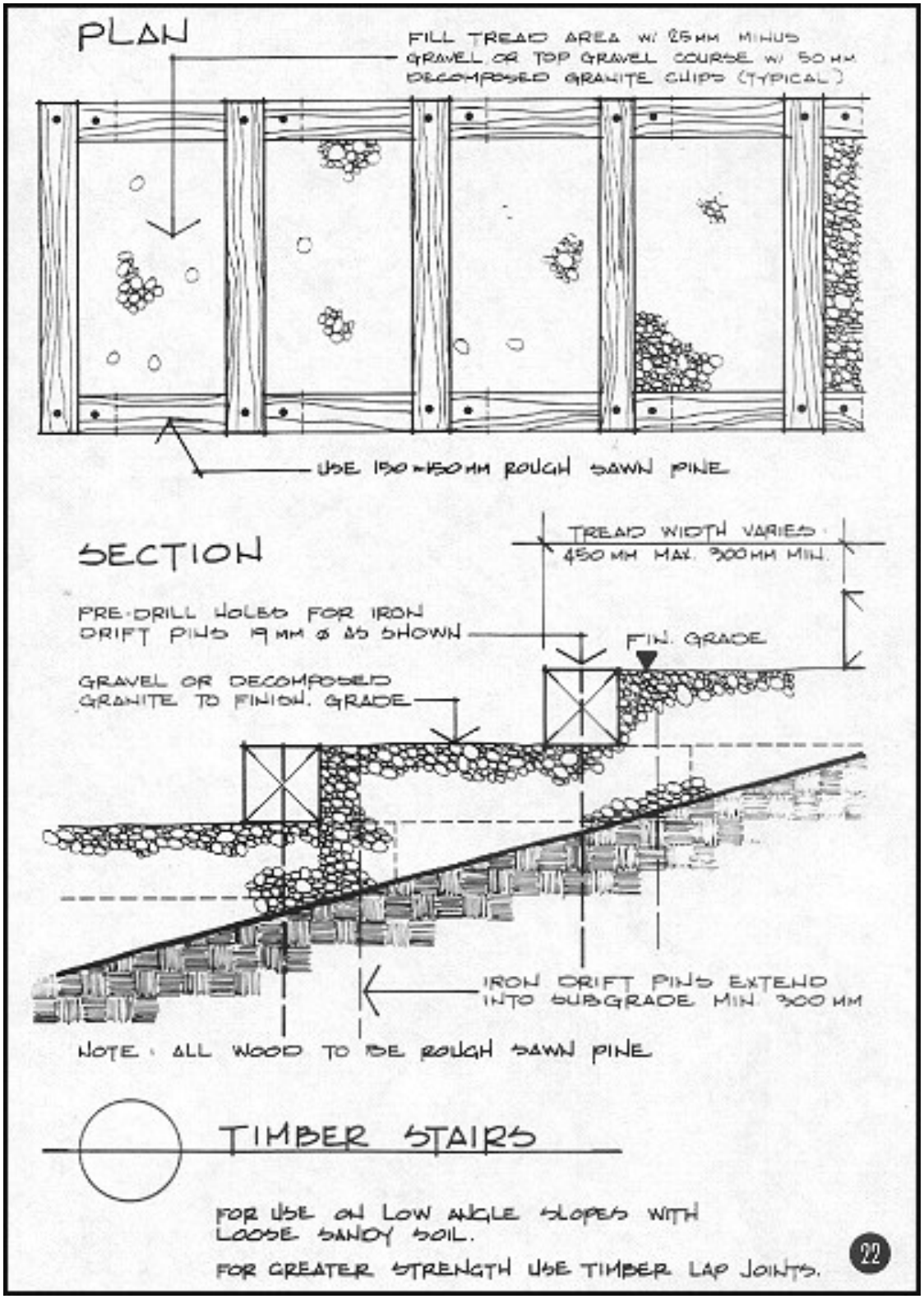
Due to the limited corridor created by the setback from the gas line and proximity to the property line it is physically infeasible to reconstruct the Gas Line Trail with switchbacks. Even if the gas line constraints were eliminated, a trail down this narrow, steep ridge would still be relatively steep, and very expensive to build and maintain compared to typical trails, and the resulting stacked switchbacks would have an aesthetic impact and need for railings and other measures to deter shortcutting.

Option 2: Reconstruct with Timber Steps

Constructing steps would be a way of maintaing the existing alignment while staying within the constrained corridor. They could be constructed to stay 5' clear of the gas line, but they would be in the way if PG&E ever needed to replace the gas line or do significant maintenance work on it. Figure 10 illustrates a concept and example for timber crib steps. Similar steps have been used on trails in Marin County and many other locations.

Figure 10: Timber Steps Concept

Figure 11: Example of Timber Steps Construction Detail



The goal in improving the Gas Line Trail is to continue to accommodate hikers and horses. Tthere are challenges in aclimating horses to use steps, and in maintaining them in a sustainable, non-eroding condition with equestrian use.

The U.S. Forest Service Equestrian Design Guidebook 1 discusses the design of trail steps for horse use:

> In areas where grades exceed 10 percent, trail steps are common. Most horses and mules navigate steps successfully, but steps sized for humans may present difficulties for stock. Some stock hesitate at steps, and some riders don't like the jostling that occurs when they're forced to navigate steps on horseback. Soils at the approach and landing areas of steps or staircases may erode quickly, leaving a gap that can catch an animal's hoof. Stock can negotiate steps with risers that are 16 inches (406 millimeters) high or higher, but many riders prefer steps with risers that are no higher than 12 inches (305 millimeters).
>
> The Student Conservation Association avoids building steps on trails used by stock (Birkby 2006). When there is no alternative, they require landings at least 4 feet (1.2 meters) deep, but prefer them to be 5 feet (1.5 meters) deep. Stones form the front and sides of the step—the crib. For crib fill, SCA uses crushed rock or other durable material that is not easily kicked loose or eroded by hoofs. SCA also recommends using visual barriers alongside steps to encourage stock to stay on the tread. Sometimes, rocks placed randomly adjacent to the trail serve this purpose.

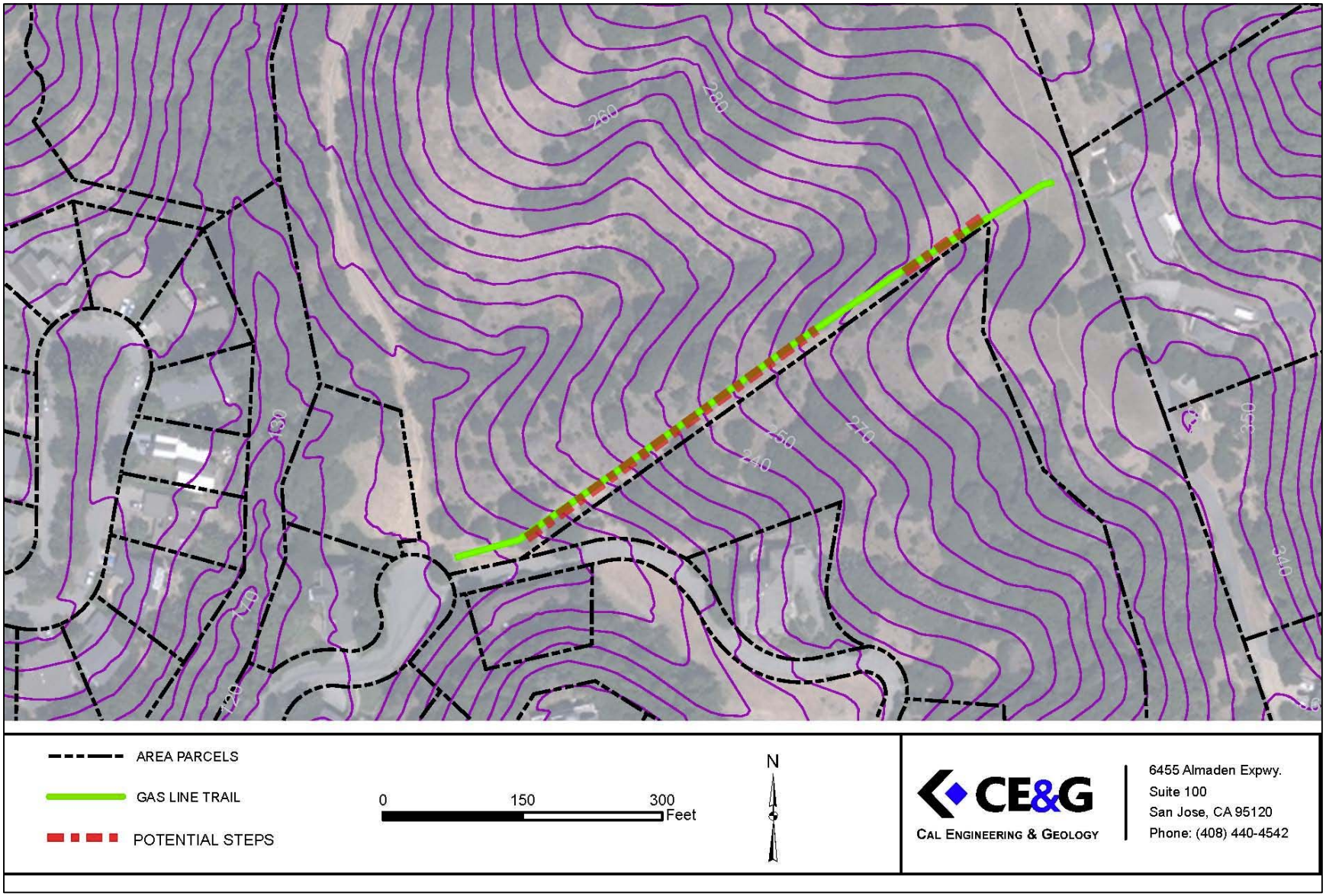
Timber trail steps are expensive to construct. Per professional trail builder Barth Campbell, the standard tread height for equestrian steps is 8' to 12" and the length of landing between steps should be 5' to 6' with a periodic longer landing of 8' to give a horse a large enough landing to stand level with all four feet. The cost can vary significantly depending on logistics of getting materials into the project site; somewhere between $475.00 L.F. to $525.00 L.F. Approximately 450 L.F. of steps would be needed to address the steep portions of the Gas Line Trail, as indicated in Figure 12. Assuming $500 per L.F. for the steps, the project would cost $225,000 to construct. It would be proportionally expensive to maintain over time.

Conclusion

Option 2, timber steps, may be feasible to PG&E. They would be very expensive to construct and maintain compared to a conventional trail. There would need to be special design elements to keep horses from stepping off the treads, as well as extra maintenance for the impacts of horses' hooves. The steps would present a barrier to people with physical limitations compared to a conventional alternative trail. Some horses also are unfamiliar with steps and may be challenged t use them.

[1] Hancock, Jan ; Vander Hoek, Kim K. Jones; Bradshaw, Sunni; Coffman, James D.; Engelmann, Jeffrey. 2007. **Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds.** 0723 2816. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center.

Figure 12: Trail Step Locations



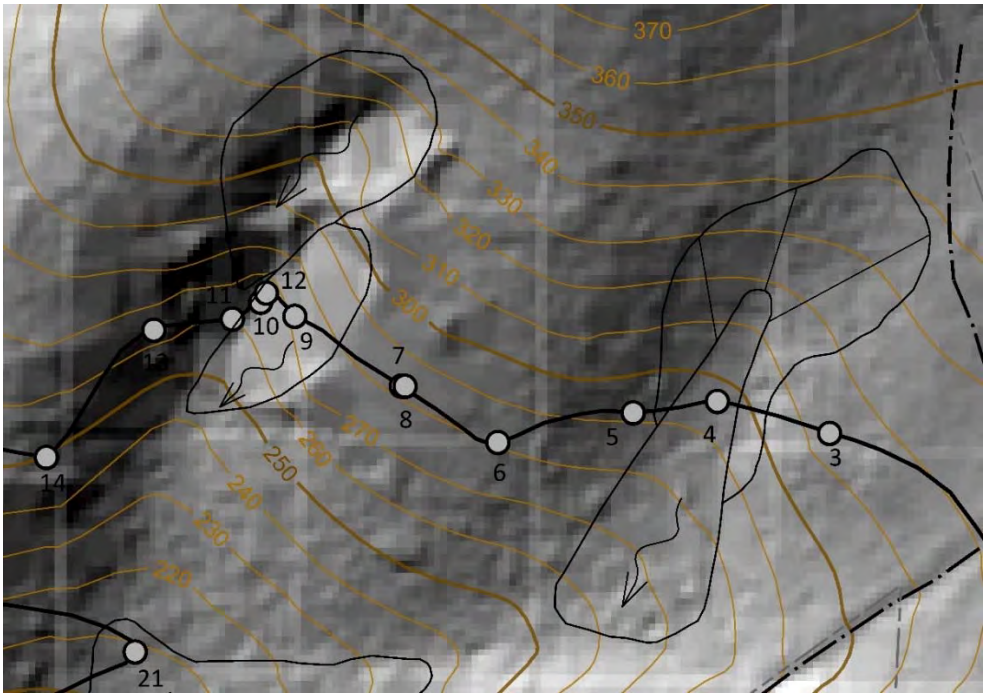
Option 3: Alternate Trail Route

Identification of Alternate Route

Available GIS (Geographic Information System), information was compiled to assist in preliminary identification of alternate trail alignments. Data considered included: property boundaries; detailed topography (from the Marin County LiDAR dataset); local bedrock geology; landslide and surficial geologic process mapping; and type/density of vegetative cover.

Based on this process, the primary candidate area for possible trail alternate route(s) is essentially confined to the large, convex topographic spur ridge north of the existing Gas Line Trail. As one descends this ridge, the slope broadens as it approaches the existing Fire Trail at the toe of the slope. This area features by relatively large mapped probable landslide areas, and relatively dense vegetation. It is constrained to the south by relatively dense vegetation in a topographic swale, and seasonally soft/wet ground. Figure 13 shows the areas of the inferred landslide geology shown on LiDAR hillshade. It illustrates topographic expression of scattered areas of probable dormant earthflow landslides and soil creep. These older slides are not a significant constrint for construction of a simple trail.

Figure 13: Landslide Areas (Excerpt of Figure 4)

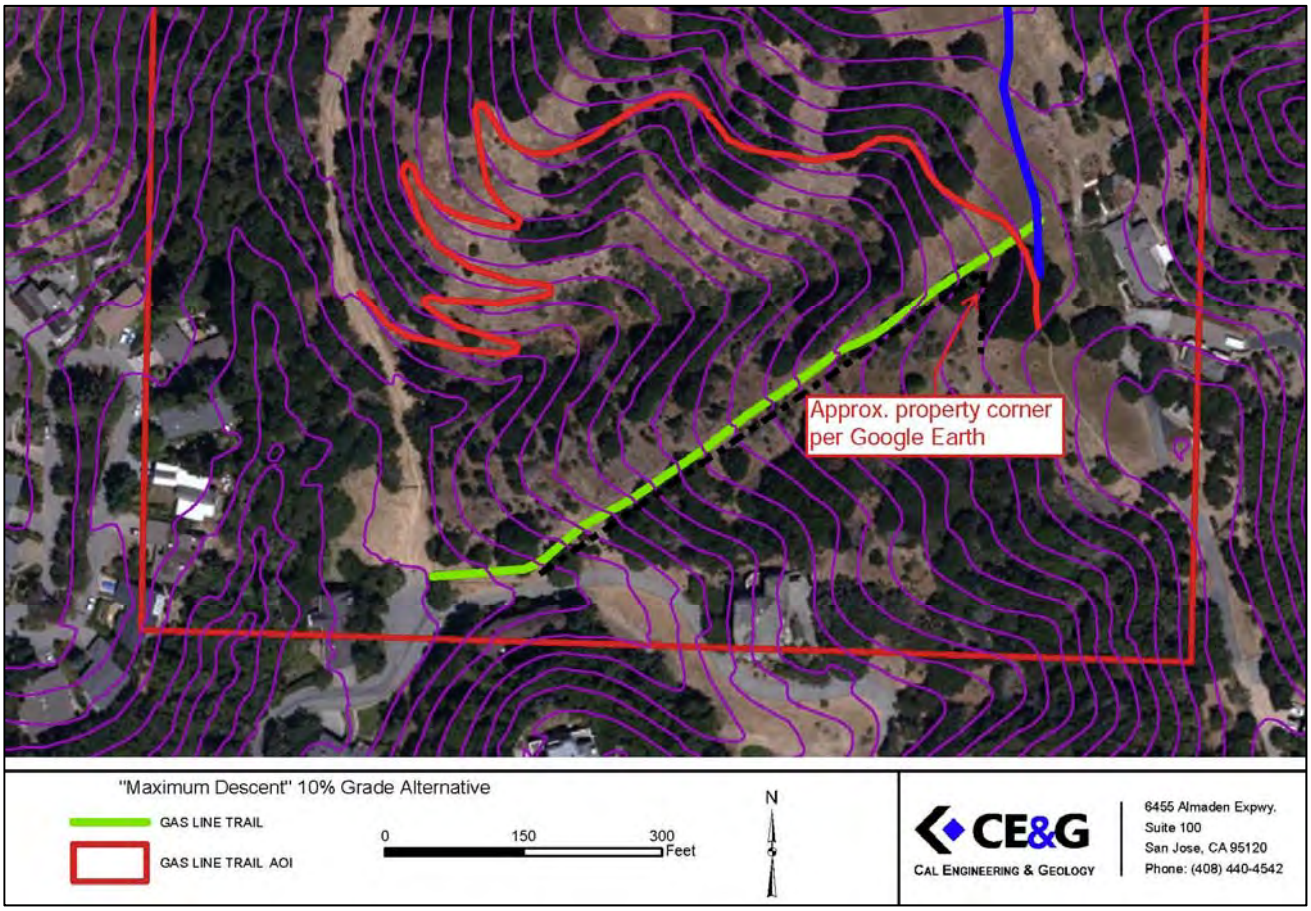


We used topographic data to preliminarily assess the shallowest trail gradient that this spur ridge area could support. We considered trail alignments at gradients on the order of 5%, 10% and greater than 10%. The necessary elevation change over the trail's length, and the limited available landscape makes a trail alignment with a lesser gradient such as 5% unworkably long (see Figure 14). Such a trail would have involved relatively extensive traverses through wooded areas, and multiple switchback turns. With any trail, localized obstacles and considerations crop up, and the greater trail length only served to

increase the number of difficulties. We considered a trail alignment greater than 10% as a "fallback," knowing that for the intended usage, such a trail gradient is generally not desirable.

An alignment that employs a 10% gradient, with localized variations, as shown in Figure 15, presented a reasonable compromise between trail gradient and environmental disturbance. Some of the overall considerations that entered in to this alignment were the limitations placed by property lines at the upper end of the trail, and the desirability of an angled, northward-descending final approach to the Fire Trail at the toe of the trail.

Figure 14: Conceptual Alternative Trail alignment (5% gradient)

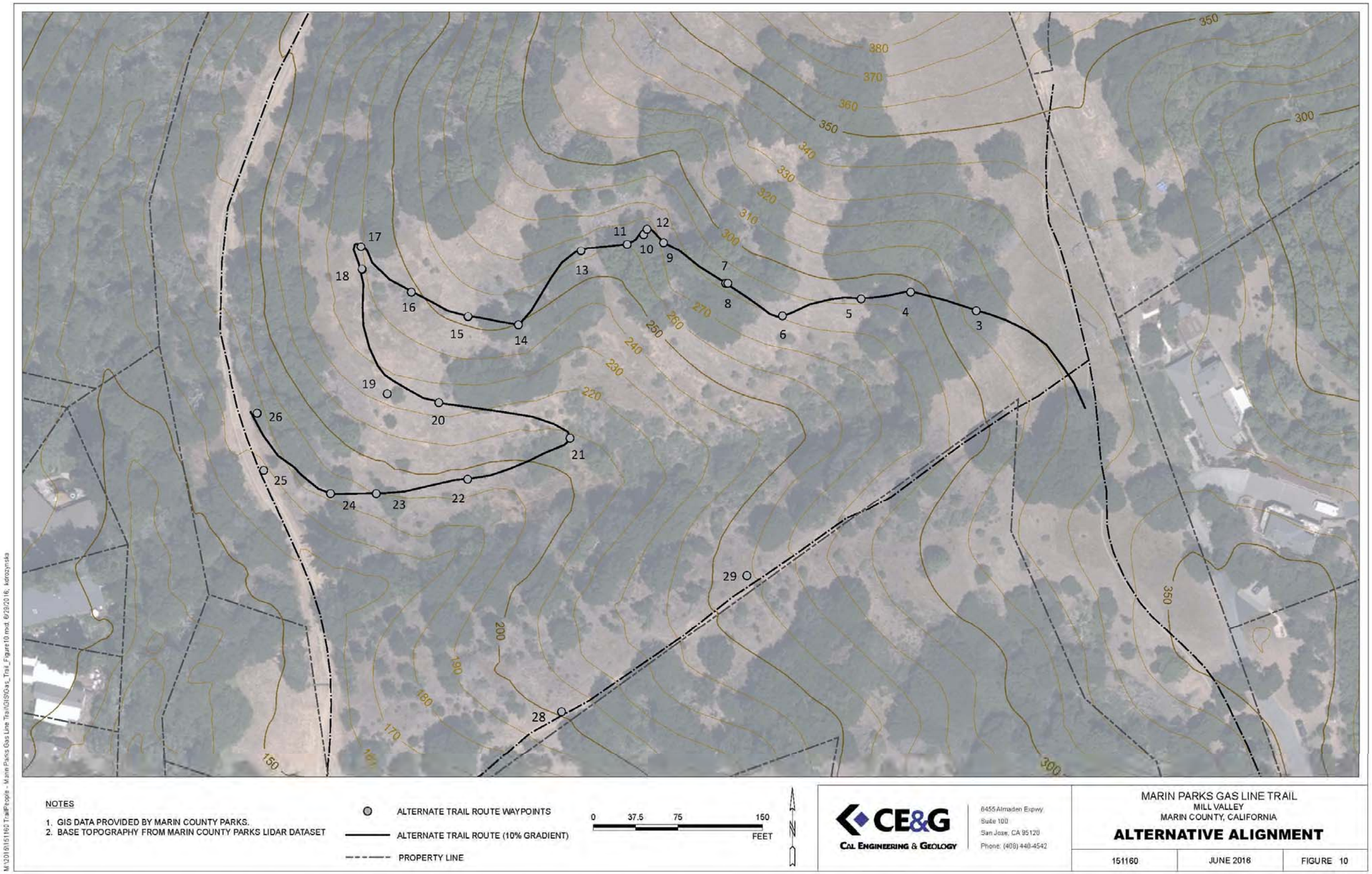


Alternate Route Description

After initial mapping based on GIS data this alignment was studied in the field, assessing areas of possible landsliding identified through our geomorphic mapping, and field-measuring gradients along the alignment to confirm and refine the gradient of segments first laid out on the base topography, and to assess the alignment's relationship to trees and localized drainages. At select key locations, we recorded waypoints using a hand-held GPS, placed pin flags, and took representative photographs.

The trail alignment was adjusted based on local conditions such as areas of soil creep, seepage, trees and other vegetation. Figure 14 shows the resulting preliminary alignment. The top of the proposed trail alignment would tie in to the existing Horse Hill Trail near an existing property corner. It would then traverse a minor, relatively broad topographic swale just upslope of an area within which soil creep appears to have at times been active. Farther west, the proposed alignment would cross a more defined topographic swale. While our analysis of imagery suggested the possible presence of landsliding upslope of this crossing, our field reconnaissance indicates that the topographic hollow reflects localized seepage such as near a spring, rather than landsliding. This swale crossing could either be hardened with rock or feature a small bridge. Once past this swale, the proposed alignment traverses and descends a broad open slope before approaching the Fire Trail at the toe of the slope.

Figure 15: Field Mapped Alternate Alignment with Waypoints (10% gradient)



Field photographs of conditions at various points along this trail alignment are presented below, in a general sequence following the alignment from the upper (eastern) end at the Horse Hill Trail, to its lower (western) end at the Fire Trail. The photographs reference waypoints near that station.


At left – View to N of upper end of trail alignment. Trail would depart from the vicinity of the Horse Hill Trail/Gas Line Trail junction, skirting trees at location of person. Near waypoint 002.
At right – View to SE from first segment under tree cover, back toward upper end of trail. Near waypoint 003.


At left and right – View down swale axis to SW. Trail would descend from the left, cross swale at location of person, continue descent at right. Swale crossing likely a rocked crossing to permit drainage, not induce rutting. Near waypoints 009, 010.


At left – View to SW down trail alignment, across typical open segment conditions. Near waypoint 006.

At right – View to W along alignment, through typical wooded segment conditions. Near waypoint 007.


At left and right – View to SW along trail alignment transition from wooded sideslope to open spur ridge crest. Near waypoint 013.


At left – View SW along alignment, toward switchback turn near brush line. Near waypoint 016.
At right – View downslope, showing conditions at switchback turn locale. Near waypoint 017.


At left – Ground conditions downslope of trail turn, necessitating siting of turn above swale axis. Near waypoint 021.
At right – View to SW along sweeping sideslope descent. Near waypoint 022.

At left – View to NW at approach to trail meetup with existing Fire Trail. Near waypoint 024.

At right – View to NW from existing top of cut to proposed bottom of transition ramp at existing Fire Trail. Near waypoint 026.

Construction Concepts

The trail would likely be a full bench cut with a 5 foot wide bench, as shown in Figure 16. Two switchbacks or climbing/descending turns are identified in the alignment. The upper turn at waypoint 17 is envisioned to have a trail centerline radius of approximately 12 feet, while the lower turn is envisioned to have a radius of approximately 8 feet. These turns would be similar to the switchback/turn detail presented in Figure 17. It may be necessary to have rail fencing along the upper leg of these turns to deter shortcutting.

Figure 16: Conceptual Trail Cross-Section

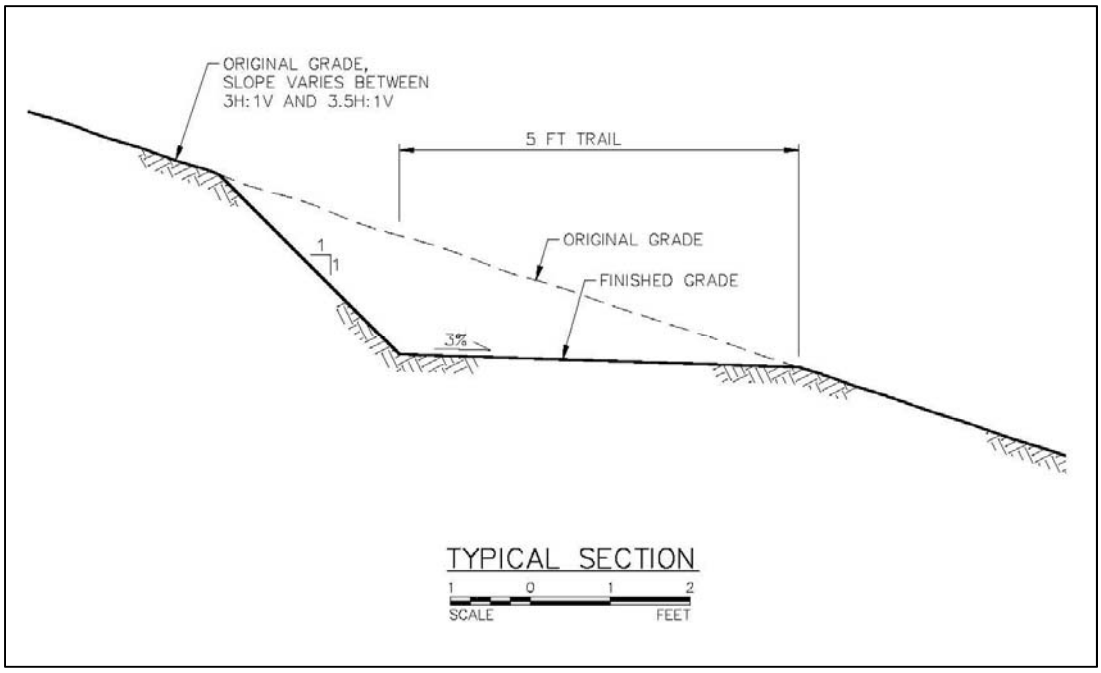
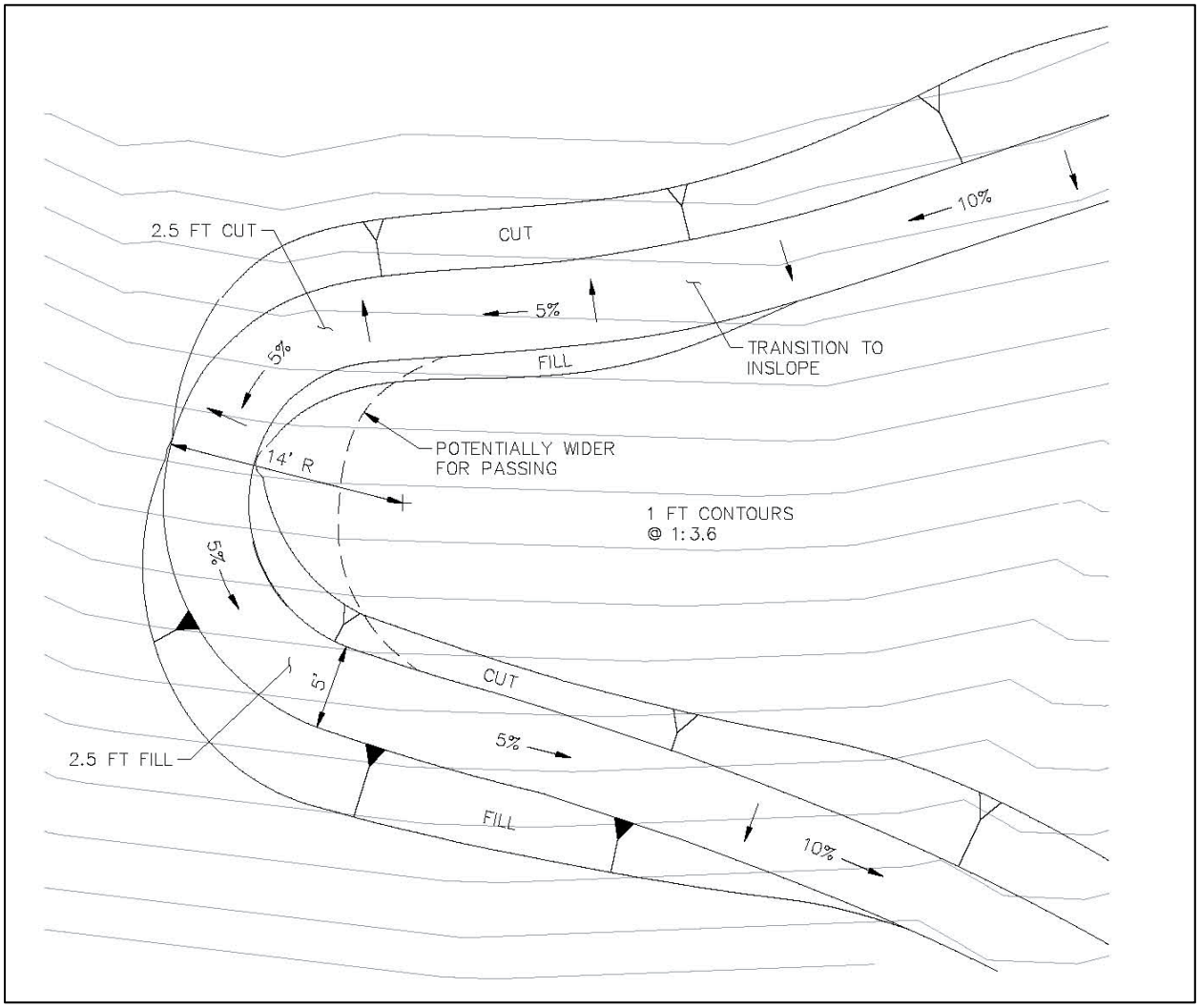


Figure 17: Conceptual Climbing Turn



Not to Scale

In order to approach the existing Fire Trail with minimum impact, the proposed alignment would almost certainly need to descend to the north as it meets and merges with the Fire Trail. This would involve modification of the existing cut slope along the Fire Trail, and possible placement of engineered fill at the toe of the cut to create a transition without obstructing emergency vehicle access (see Figure 18). Use of geogrid reinforced fill would permit a smaller footprint for any fill to be placed, and would reduce the temptation to shortcut this final ramp. A ramp that descends northward to meet the southward-descending Fire Trail also serves several purposes: 1) it lessens the vertical height of the ramp; 2) it would retard surface sheetflow as it leaves the ramp; and 3) it would provide a natural slowing/braking runout for cyclists, rather than a runout onto a continued downward slope.

Figure 18: Conceptual Ramp Design at Fire Road

Costs to construct the alternate trail segment is estimated by MCOSD staff at approximately $20,000 in labor and $3000 in materials for a total cost of $25,000, including some contingency.

Conclusion

Although an average gradient of 10% is greater than ideal, the alternative trail alignment is well within the range of typical functional and sustainable multi-use trails in the Marin Parks system and other regional systems. It could be constructed with very conventional methods – either by hand or with small mechanized equipment and hand finishing. It would be a pleasant trail for users, and require less maintenance than other alternatives. It would allow the present Gas Line Trail to be retired and restored to a more natural condition.

Gas Line Trail Retirement and Restoration

In a scenario where the Gas Line Trail is abandoned (retired) and restored to a more natural condition, the steep lower 2/3 has the most erosion and the greatest challenge for restoration. The upper 1/3 of the trail is less steep – and even reverses grade, and generally slopes to the north side. As shown in Figure 19 the middle portion of the steep segment is actually in a topographic bowl that makes it very difficult to divert water off the trail, and in any case it would be undesirable to divert water across the property line in the general direction of the slope to the south, where there is an existing residence.

The best approach is to create some water bar diversions at the top of this slope where they can be directed into the drainage to the north. These may need to be constructed entirely with fill to avoid any potential to impact the buried gas line. Below this point, the objective would be to encourage water to infiltrate directly into the slope to minimize runoff down the slope. All portions of the trail should be lightly ripped to loosen the soil. Any portions steeper than 10% should be covered with a natural fiber erosion control mat, stapled in place. All portions of the trail should be seeded with an erosion control/wildflower mix appropriate to the local biological conditions – either hand spread or hydroseeded, including over the mat.

The ends of the trail could be "brush packed" with branches to deter entry and/or short sections of split rail fence could be installed, and it would be signed as closed.

The above changes would be subject to PG&E's approval, and could not block access for inspection of the line or introduce vegetation above the gas line and access corridor over 2 feet in height.

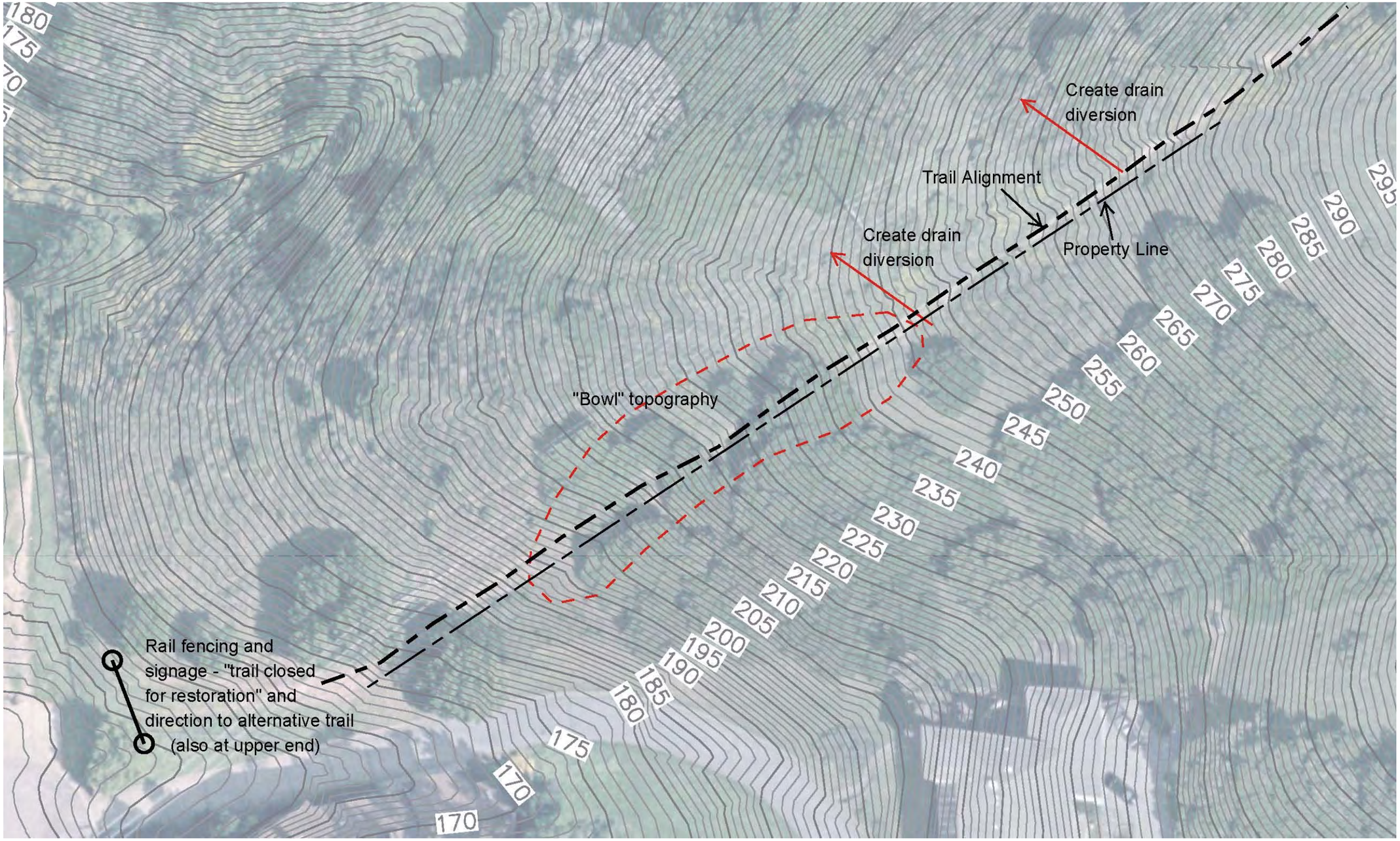
Example of a water bar drainage diversion (photo – Cornell University)

Example of erosion control mat being placed (photo – Go Native Restoration)

Conclusion

The existing Gas Line Trail is too steep to be a safe and sustainable alignment and it is exhibiting significant erosion. Assuming an alternative sustainable route is developed, the existing trail can feasibly be "retired" and restored back to a more natural condition with the relatively simple and inexpensive measures outlined above.

Figure 19: Gas Line Trail Retirement/Restoration Concept



Horse Hill Trail Improvement Study

Objective of Assessment

The objective of the assessment is to evaluate the opportunities and constraints to improve the approximately 0.4 mile trail connection from the Gas Line Trail to Horse Hill Open Space for improved sustainability and visitor experience.

Geographic Setting

Horse Hill Trail connects from a fire road extending south from Fairview Avenue in Corte Madera to the top of the Gas Line Trail and continues south to the Horse Hill Preserve, where it connects to Lomita Avenue via the Dollar Fire Road (see Figures 1 and 2)

Topographic and Geologic Setting

We briefly reviewed the site geology, examined local geomorphic features evident on a hillshade developed from the Marin County LiDAR "bare earth" dataset, and reconnoitered the uppermost portions of the slopes traversed by the existing Horse Hill Trail.

The cross slope gradients along much of the existing trail alignment are on the order of 10 to 30 % (6 to 15 degrees), steepening with distance from the overall ridge crest to on the order of 35 to 50+% (20 to 26+ degrees). In general, the cross slope gradients are steepest where the trail crosses a swale, and least where the trail crosses the spine of a spur ridge.

The local bedrock is Franciscan Complex mélange, which consists of sheared sandstone and shale matrix, locally containing larger, harder blocks. In general, the bedrock character along this stretch of trail appears to be fairly uniform, based on the overall lack of outcrops.

Based on our reconnaissance, the surficial soils (colluvium) appear to thin – on the order of 1 foot thick, thickening downslope as slopes drop into topographic swale areas. As the slopes steepen into these swale areas, soil creep becomes more apparent and surface runoff becomes more concentrated, which exacerbates the creep process.

We did not observe significant landsliding along the existing trail alignment, which we attribute to the trail's location near the local ridge crest. The short segments that cross the heads of topographic swales do exhibit soil creep, and are generally wetter.

Trail Assessment and Improvement Concepts

The assessment proceeds moving north to south with photo points as displayed on Figures 20 through 23 and described below. The current trail is a single track with a 1' to 2' tread width. It is generally in good condition, but has a few locations that are steep and eroding or wet. These short segments could be improved with re-routes and localized treatments as described below.

A – Existing trail tread is about 1’ to 2’ wide

B – same area as (A); view to S

C – as the slope gets steeper formal turnouts may be warranted; view to S

D – this steep segment (22%) could be reduced by realignment (realignment 1 on Figure 20)

Figure 20: North end of Horse Hill Connection (view is toward NE)

E – S end of realignment 1; view to S. Slope steepens with distance downslope

F – at S curve

G – lower part of S curve could be less steep and blind corner lessened by realignment 2

H - the slope in distance is steep; could be reduced by realignment 2

Figure 21 – North Central Portion of Horse Hill Connection; view to NE

I – trail could be re-routed up slope to reduce grade in the distance, but may not be warranted

J - segment has approximately 20% slope, but good sight distance, and interval is short

K – low, wet area in distance may need rock causeway. No opportunities for drainage improvement

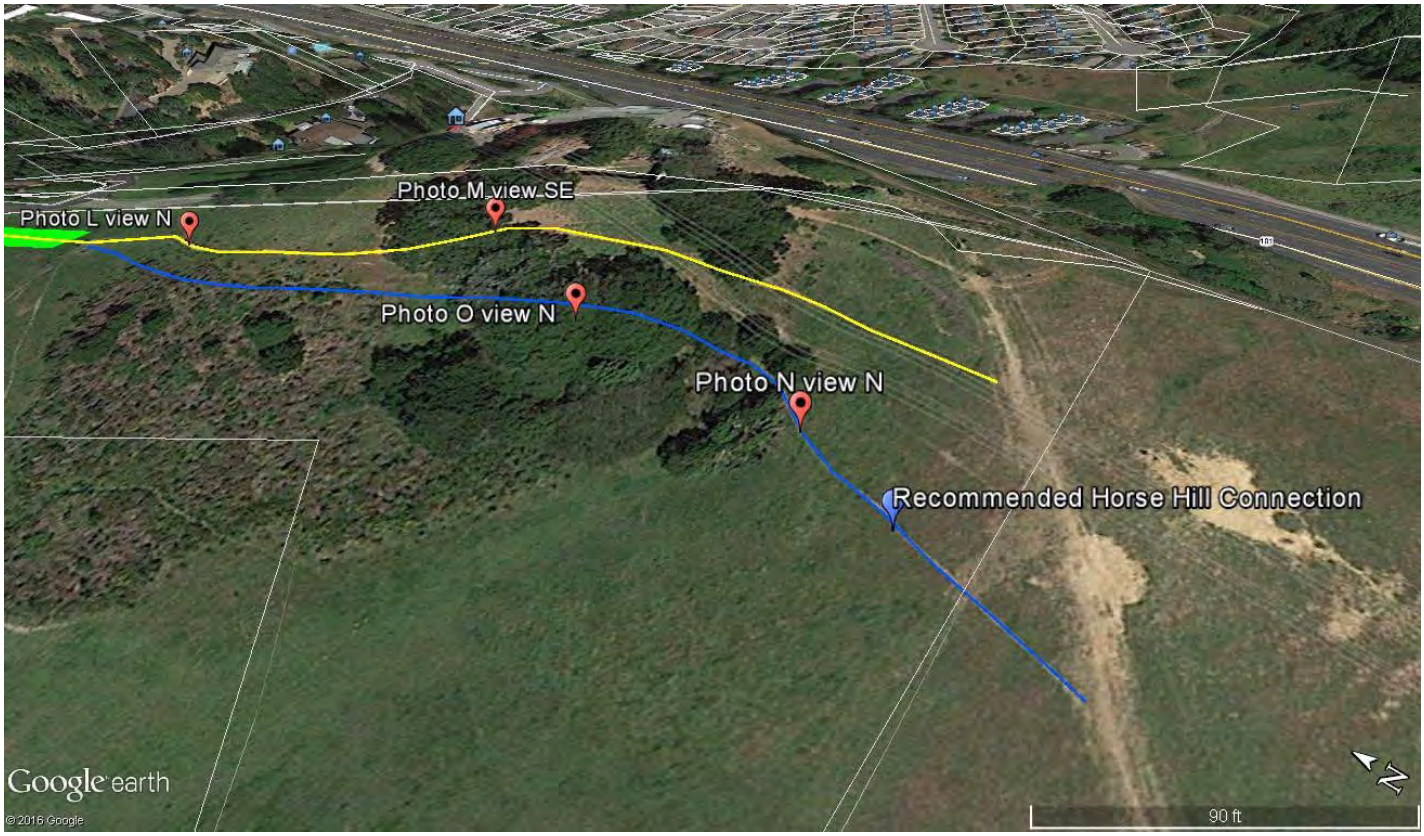
L – View to N, from Horse Hill Open Space

Figure 22: South Central Portion of Horse Hill Connection (view to NE)

M – current trail connection is steep, little-used; View to SE

N – this lower route (see Figure 23) would be more level and direct; view to N

Figure 23: South Portion of Horse Hill Connection (view to NE)



O – a large fallen oak would need to be cleared to accommodate the (lower) route

Conclusion

The existing Horse Hill Trail is generally on a good sustainable alignment and in good shape, but there are some steep and eroding segments and wet locations, and the connection within Horse Hill Preserve is steep and indirect. The Horse Hill Trail connection could be improved for a better visitor experience and to meet District standards for sustainability with the relatively minor localized improvements, and realignments described above. No trees would need to be removed for the improvements; vegetation impacts would be limited to removal of brush and trimming of some smaller limbs on a few oaks. These relatively minor improvements would help to reduce trail maintenance costs over time.

Opening the Connection to Multi-Use

The feasiblity and desirabilty of opening the Gas Line Trail and the Horse Hill Trail to bicycles involves answering two questions:

1. What is the access need and benefit for bicyclists for connection to other trails in the system?
2. What is the compatibility with existing/historical trail and preserve uses?

If the Gas Line Trail was realigned, along with the Horse Hill Trail it potentially could provide a bicycle connection from the Alto Bowl Fire Road to central Mill Valley and the Mill Valley-Sausalito Path, and add approximately 0.83 miles of bicycle-accessible trail to the system.

The prospective connection from the Gas Line Trail and Horse Hill Trail through the Horse Hill Preserve is the Dollar Fire Road, which connects to Lomita Drive. Lomita Drive extends west through a residential neighborhood. The Mill Valley-Sausalito Path can be accessed from a corridor by Edna McGuire School, or by continuing on Lomita Drive where it turns south near the school (see Figure 24).

The alternative route for bicyclists to the above route is to continue on the Alto Bowl Fire Road to the paved portion of Coach Drive and continue south to Underhill Drive, then continue west and south on Underhill Drive to Vasco Court and connect east to the Mill Valley-Sausalito Path. There is also a route through the private Scott Valley Swim and Tennis Club parking connecting to the Vasco Court Fire Road and west along Vasco Court to the Mill Valley-Sausalito Path.

From the standpoint of an efficient connection to central Mill Valley, the latter partial on-street routes are far more direct and involve less climbing and descents than the Gas Line/Horse Hill/Dollar Fire Road Route.

From the standpoint of compatibility with existing and historic trail and preserve use, the concept of opening the route to bikes is highly incompatible with the existing and historical equestrian use.

Horse Hill Preserve is a 50 acre property that comprises the southern half of the Alto Bowl Preserve (see Figure 1). It is leased for horse pasturing by the Alto Bowl Horse Owners Association. The sight of horses grazing peacefully on this grassy hillside has been a landmark for decades. Slated for development in the 1980s, the credit for its preservation goes to the horse owners, their supporters, the Marin County Open Space District, the Marin Community Foundation, and the City of Mill Valley who together raised 2.4 million dollars to purchase the property.

Opening the connection to bikes would have bicycles traveling directly through the pasture area, and would potentially encourage bicyclists to use the route in lieu of the more direct connections below.

Policies especially relevant to the decision NOT to designate any newly constructed trail bypassing the Gas Line Trail as open to bikes include:

> Policy SW.16: Prohibition of Uses. The MCOSD may prohibit certain trail uses or apply increased trail use restrictions within certain areas to enhance safety, minimize conflicts between trail users, and protect natural resources. Examples of areas where this policy may apply include, but are not limited to, those proximate to stables and those traditionally heavily traveled by equestrians, and in Sensitive Resource Areas.

Policy SW.17: Displacement of Existing Trail Users. The MCOSD will strive to prevent displacement of equestrians and pedestrians when accommodating trail access and trail connections for mountain bikers. When considering the designation of existing trails as single-use or priority-use, the MCOSD will take care to maintain connectivity

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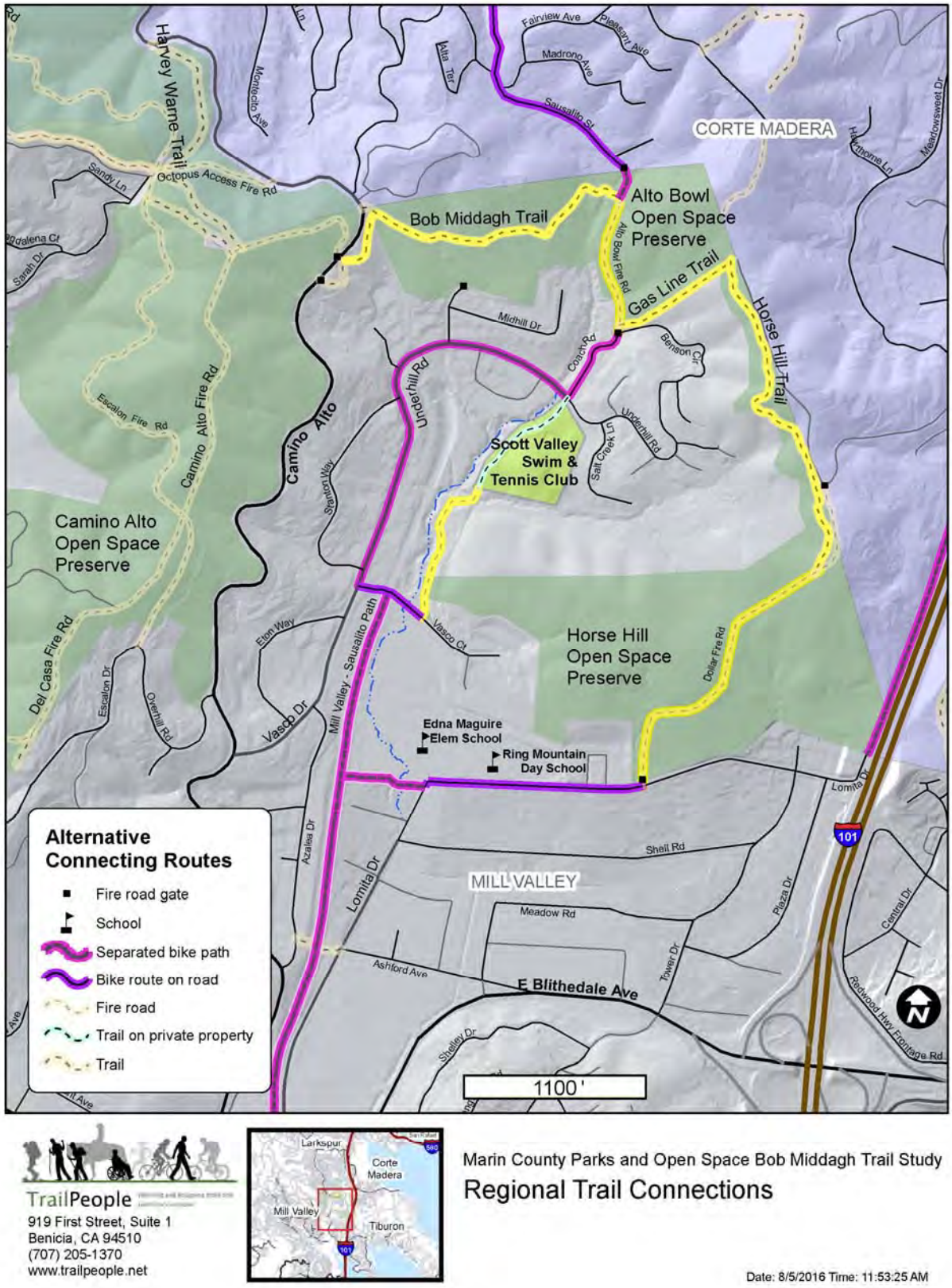
Conclusion

Bringing bicycles into the Horse Hill Preserve would conflict with the traditional horse pasturing use. There are alternative connections to the Alto Bowl Fire Road that are more direct and require less climbing if the goal is to provide access from preserves to the northwest into southern Mill Valley and Marin County via the Mill Valley-Sausalito Path.

Figure 24: Regional Trail Connections



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Marin County Parks and Open Space Bob Middagh Trail Study

Regional Trail Connections

Date: 8/5/2016 Time: 11:53:25 AM

Study Summary

Table 1 summarizes the pros and cons of the improvement options.

Option 1, stacked switchbacks, is infeasible because it would involve construction over the gas line that would be unacceptable to PG&E. In any case they would be very expensive to construct and maintain compared to a conventional trail, and would be visually obtrusive.

Option 2, timber steps, may be feasible to PG&E. They could be constructed to stay 5' clear of the gas line, but they would be in the way if PG&E ever needed to replace the gas line or do significant maintenance work on it. They would be expensive to construct and maintain compared to a conventional trail. Such steps can be used by horses, and are fine for most hikers, although they could be more challenging than a 10% grade trail for some people with physical limitations.

Option 3, Constructing an alternative 10% gradient trail alignment on the preserve hillside to the north and retiring/restoring the existing trail would provide a new open space route that meets Marin County Parks Road and Trail Management Plan (R&TMP) objectives. It would be more enjoyable for users than the current alignment and would be more accessible to people with physical limitations who would be challenged by the existing steep slopes.

Table 1: Comparison of Options for Improving Gas Line Trail

Option	Pros	Cons
1. Reconstruct existing trail with stacked switchbacks	• Could address erosion • Trail would be easier for users to negotiate	• Insufficient space to construct w/o crossing gas line – not acceptable to PG&E • Very expensive construction • Visually obtrusive • Expensive to maintain
2. Reconstruct existing trail with steps	• Could address erosion • Trail would be easier for most users to negotiate • Can stay clear of gas line	• May conflict with gas line maintenance/repair • Expensive construction (+/- $225,000) • Not accessible for people with physical limitations • Expensive to maintain • Challenging for some horses
3. Construct alternative trail on new alignment; retire/restore existing trail to more natural condition	• The most sustainable configuration • A more enjoyable trail alignment • More accessible to users with physical limitations • Least initial cost (+/- $25,000 plus restoration cost) and ongoing cost • Meets RTMP objectives	• Some initial construction disturbance • More permanent intrusion into a current undisturbed area
Improvements to Horse Hill Trail	• Improves sustainability; reduced long-term maintenance • Improved visitor experience	• Some initial cost and disturbance

The existing Horse Hill Trail connection is generally a desirable and sustainable trail, but its gradient and sustainability could be improved with some minor realignments as identified. These improvements would benefit all users, as outlined in Table 1.

Conclusion

Constructing an alternate trail north of the existig Gas Line Trail and retiring/restoring the existing alignment back to a more natural condition would be consistent with the goals and objectives of the RTMP and is the most feasible and sustainable alternative.

These trails should not be opened to bicycles because bicycle use would be incompatible with the existing/historical horse pasture use of the Horse Hill Preserve, and because there are safe, efficient alternative connections to the majority of the trail sytem.