

Mill Valley to Corte Madera
Bicycle and Pedestrian Corridor Study

Appendix C
Drainage Study
Prepared by
Nolte Associates



August 5, 2009

Appendix C – Drainage Study, Mill Valley to Corte Madera Bicycle and Pedestrian Corridor Study

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Marin County commissioned a corridor study of three specific bike/pedestrian routes connecting the City of Mill Valley and the Town of Corte Madera. The scope of the study is to facilitate planning and conduct preliminary engineering and design work to identify the relative feasibility of each route. The three routes include the “Horse Hill/Casa Buena Route” – which follows a frontage road of U.S. 101, an existing bike path adjacent to the highway, and residential streets; the Alto Tunnel route, which would follow the former Union Pacific Railroad alignment, including reopening the Alto railroad tunnel; and the Camino Alto/Corte Madera Avenue route, which follows existing roads winding through the hills to the west of the Alto route. Nolte Engineering was retained to analyze the drainage issues and potential solutions associated with the routes. The Alto Tunnel route is the only alternative that entails major improvements along the route entailing significant issues with drainage. This analysis focuses on the drainage issues associated with the Alto Tunnel Route.

There are some existing drainage facilities on the Camino Alto/Corte Madera Avenue route that would be impacted by widening to provide bike lanes. A number of significant natural drainages, as well as some man-made drainage systems, cross the route in culverts under the roadway. The improvements would not significantly change the pattern or amount of runoff. The culverts are likely to require extension in conjunction with roadway widening. Public comments noted that the roadway is sometimes flooded when culverts overflow during storms. This is more likely to be due to leaves and debris from the adjacent wooded areas blocking the culverts, rather than the design or conditions of the culverts. Study of the drainage area, capacity, or condition of these culverts is beyond the scope of this study, but should be a part of any future project for road widening that affects the existing culverts.

EXISTING DRAINAGE SYSTEMS

The existing Alto Tunnel is aligned generally from north to south. The northerly end of the tunnel lies within the Town of Corte Madera (Town), while the southerly end of the tunnel lies within the City of Mill Valley (City).

Approximately halfway along the tunnel alignment is a break in the watersheds. The watershed limit approximately corresponds to the Town/City limits, which is just south of the Corte Madera Avenue / Chapman Drive / Camino Alto intersection. The runoff contributing to the areas just north and south of the tunnel is delineated by this watershed limit. See Sheet 1 of Attachment A for approximate project limits, location of the north and south portals and the major watersheds contributing to the project areas.

Within the project area, the average annual rainfall is 33 inches.

Northerly Drainage Patterns

The area surrounding and discharging to the north portal of the Alto Tunnel is primarily residential and open space. The residential areas tend to have lots of 0.25 acres or more. All contributing areas are relatively steep and well vegetated with bushes, trees and other plant material. In addition, some areas are composed of rocky outcrops. The contributing area extends from the southerly ridge at the intersection of Corte Madera Avenue and Chapman Drive to the north portal in the north.

The area on the north side of the tunnel is part of Marin County Flood Zone 9, the Corte Madera Creek watershed. This watershed is part of the Ross Valley Flood Protection and Watershed Program. Drainage pipes and ditches appear to contribute to the area just north of the north portal, which then flows north in an earthen channel to a pipe system to what appears to be Low Canal Creek and finally discharging to San Francisco Bay. System data received from the Town and field investigation were used to make this determination.

Using a combination of the GIS data received from LandPeople and the system mapping from the Town, it was determined that the area just north of the north portal accepts approximately 25 acres of upstream watershed. Based upon 10-year storm event rainfall intensity data and the rational method for the estimation of rainfall runoff, this area contributes approximately 36 cubic feet per second (cfs) of runoff flow.

The Alto Tunnel trail route under study is currently accessible from Montecito Avenue and Tunnel Lane. During a field visit after recent rains, it was noted that the trail alignment is within an area that is primarily used for drainage conveyance. This observation conforms to the GIS-based drainage map data received from the Town, which shows an earth channel adjacent to Tunnel Lane. This channel accepts a watershed of approximately 60 acres. Based upon 10-year storm event rainfall intensity data, this area contributes approximately 70 cfs of runoff flow. The 100-year storm event contributes approximately 105 cfs.

Sheet 2 of Attachment A presents a view of the contributing watershed and of the existing local drainage system.

Anecdotal evidence from a resident of Tunnel Lane suggests that the area at and approximately 100 feet downstream of the north portal is often inundated with stormwater runoff. The resident stated that the area is typically ponded or muddy through the June / July timeframe annually.

The portal itself does not appear to discharge runoff through the existing metal doors. Based upon available information, it appears that the ground at both ends of the tunnel slopes away from each of the portals. This supports an assumption that overland flows do not enter the tunnel portals.

Photos 1 through 3, provided in Attachment B, present photographs of the north portal area.

Southerly Drainage Patterns

The area surrounding and discharging to the south portal of the Alto Tunnel is primarily residential and open space. The residential areas tend to have lots of 0.25 acres or more. All contributing areas are relatively steep and well vegetated with bushes, trees and other plant material. In addition, some areas are composed of rock outcrops. The area contributing to the

path location is relatively small, encompassing mainly the lots to the west of the proposed path location.

The area on the south side of the tunnel is part of Marin County Flood Zone 3, the Arroyo Corte Madera del Presidio watershed. Drainage pipes and ditches appear to contribute to the Sutton Manor Branch which flows south toward Richardson Bay.

The trail is currently accessible from Vasco Court. During a field visit after recent rains, it was noted that the existing dirt pathway began to get muddy approximately 400 feet north of Vasco Court. Approximately 700 feet north of Vasco Court, the path ended in an area of ponding, estimated to be 8-12 inches deep. The area contributing to the ponding area appears to include the back of lot areas for approximately 10 parcels along Underhill Road. The contributing area is approximately 1.6 acres.

The south end of the tunnel was not viewed in the field. The area is overgrown with bushes and the portal itself is buried. Based upon field observations, two pipes drain to the area assumed to be the south portal location. Both pipes are collecting runoff from the public right-of-way. The pipes discharge to ditches in an empty lot south of Underhill Road, between Middle Court and Upperhill Road. The ditches confluence approximately 50 to 100 feet downstream of the ends of pipes and flow south in a larger ditch. This area does not appear to discharge to the area of ponding discussed above. This ditch appears to flow south and confluences with the Sutton Manor Branch approximately 800 feet south of Underhill Road. Based upon Nolte's field visit, it appears that Sutton Manor Branch is separated from the existing pathway and boggy area by a small hill (minimum 8 feet higher than the pathway).

Photos 4 through 7, provided in Attachment B, present photographs of the north portal area.

POTENTIAL IMPROVEMENTS AND DESIGN CRITERIA TO FACILITATE PATH

At both portals, drainage improvements will be required to facilitate the trail. In support of these improvements, consistent design criteria should be utilized.

Based upon the contributing areas, the rational method is an appropriate calculation methodology. The requirements of Marin County Department of Public Works, the Town and the City shall be incorporated into the project design.

At both portals of the path, there are multiple issues and design elements to consider. Below is a list of the elements common to both the north and south portal:

- Collection and conveyance of off-site runoff
- Collection and conveyance of runoff from the path
- Conveyance of runoff beyond the 10-year event
- Treatment of stormwater runoff from the impervious improvements

For purposes of this project, drainage improvements shall be designed to convey the 10-year storm event. The County has indicated that it will be acceptable to allow storm events in excess of the 10-year storm event to inundate the path.

Based upon the Stormwater Quality Manual for Development Projects in Marin County, prepared by the Marin County Stormwater Pollution Prevention Program (MCSTOPPP), stormwater treatment is required for this project. The anticipated impervious surface for the project is estimated to be over 10,000 square feet. Controls required include providing stormwater treatment via the use of post-construction Best Management Practices (BMPs) and maintaining pre-project runoff rates.

North Portal

At the north portal, off-site runoff includes flows that overtop the tunnel portal, discharge from Tunnel Lane and discharge from Montecito Avenue. Together, the off-site runoff contributes an approximately 60 acre watershed to the proposed path location.

Between the north tunnel portal and the existing improved path (approximately 1,000 feet to the north), there is limited area to place a path with an adjacent ditch. The side slopes of the existing earth channel are steep. The use of pipe appears to be the appropriate drainage methodology.

Collection and Conveyance of Runoff. The 60-acre contributing area and subsequent flows are large enough to create high velocities, even when pipe is placed at a relatively shallow slope. Therefore, it is suggested that the project utilize corrugated interior pipe, such as corrugated metal or high density polyethylene (HDPE) pipe. Reducing the pipe velocities will limit or eliminate scour and extend the system service life. See Sheet 4, Attachment B, for a potential layout at the north portal. Sheet 6 represents a typical cross section depicting the pipe's relationship to the path.

To assist with compliance for NPDES stormwater regulations, it may be prudent to maintain separation between the on-site and off-site drainage systems. Further details of this requirement are provided in the "**Stormwater Treatment**" section, below.

To reduce the footprint of the project, it is suggested that the pipe be placed within the paved shoulder of the path. Manholes will be provided to facilitate maintenance at maximum intervals of 350 feet. Inlets will be provided as necessary to provide a safe, relatively dry facility for users. The pipe system should discharge to the existing channel approximately 100 feet upstream of the existing 36-inch pipe. The discharge should include a flared end section and rock slope protection to provide energy dissipation and to prevent erosion of the channel.

Off-Site Runoff. The off-site runoff contributes to the path area from three concentrated points. These points are: (1) above the tunnel portal, (2) 15-inch pipe from Montecito Avenue on the west and (3) a 12-inch pipe from Tunnel Lane on the east. Other, minor off-site flows enter the path area via sheet flow down the side slopes of the existing ravine.

The discharge point above the tunnel portal conveys runoff from an approximately 25-acre watershed. To prevent erosion on the hillside adjacent to the portal, it is suggested that the project provide a downdrain to convey the flow from the 100-year storm event.

Based upon available information, it appears that the discharge point from Montecito Avenue conveys runoff from an approximately 19 acre watershed. However, this area may be smaller, depending upon roadway cross sections and other surface features. To prevent erosion on the hillside adjacent the path, the pipe should be extended to the base of the slope and tied into the proposed system designed to convey the 10-year storm event. Flows in excess of the 10-year storm event are not intended to be conveyed via pipe. The project will not hinder the existing flowpaths.

The discharge pipe from Tunnel Lane appears to convey runoff from an approximately 4 acre watershed. To prevent further erosion (the existing pipe discharges approximately 8 feet above the existing earth channel), the pipe should be connected to a down drain and extended to the proposed system designed to convey the 10-year storm event. Flows in excess of the 10-year storm event are not intended to be conveyed via pipe. The project will not hinder the existing flowpaths.

Stormwater Treatment. As stated above, the NPDES permit requires that stormwater controls be provided for impervious surfaces. These controls include both treatment, in the form of BMPs, and flow attenuation to pre-project levels.

First, low impact design (LID) elements should be incorporated into the project as much as possible. LID elements include reducing impervious surface. This option should be explored during the design phases of this project. The reduction of impervious surface reduces the size of treatment elements required and reduces the infrastructure required to attenuate additional flows due to project improvements.

Potential Improvements. The assumed improvements for drainage at the north portal include:

North Portal Improvements

- Headwall and Rock Slope Protection for collection of flows above tunnel portal
- 555 feet of 48-inch corrugated metal pipe (CMP)
- 105 feet of 12-inch pipe corrugated metal pipe (CMP)
- One 12-inch down drain with required anchors (from Tunnel Lane)
- 30 feet of 15-inch pipe corrugated metal pipe (CMP)
- One 15-inch down drain with required anchors (from Montecito Drive)
- 5 storm drain manholes
- 5 storm drain inlets
- Headwall and Rock Slope Protection to existing channel at the north end of the proposed path. The channel discharges to an existing, piped system parallel to Stetson Avenue which conveys runoff to the Corte Madera Creek in the north.

South Portal

At the south portal area, the majority of off-site runoff is separated from the path area and has its own conveyance to the South Manor Branch. A minor amount of off-site runoff, approximately 2 acres, which contributes to the path alignment, is residential in nature. Existing pipes crossing the path limits, located in the field, shall be maintained to prevent impacts to current drainage paths.

It is expected that the project will avoid impacts to Sutton Manor Branch. By maintaining the existing berm between the path area and Sutton Manor Branch, the project will avoid impacts to a creek and to existing drainage patterns.

Between the south tunnel portal and Vasco Court (approximately 1,300 feet to the south), there appears to be sufficient space to place path with an adjacent ditch. The use of a ditch which conveys runoff to existing pipe crossing appears to be a feasible approach for drainage. See Sheet 5, Attachment B, for a potential layout at the south portal. Sheet 6 presents a typical cross section and the ditch's relationship to the proposed path.

Off-site Drainage. As stated above, off-site contributing areas are limited due to the existence of a ditch conveying runoff from the 35-acre watershed north of the south portal. Based on the assumptions provided (attached), this ditch is expected to convey approximately 70 cfs, which is estimated to be equal to or less than the 100-year storm. Therefore, to limit the drainage improvements on the path, it is important to keep the flows in the existing channel from Underhill (which discharges to Sutton Manor Branch) separated from the path.

During design, the soils over the south portal should be investigated to determine if surface drainage is contributing to soil saturation and leakage in tunnel. If soils are saturated, one option may be to require waterproofing from existing pipes discharging just south of Underhill Road approximately 150 feet uphill of south portal. This effort may involve hardening the channel(s) over the tunnel.

For the minor, 2-acre area from the west contributing to the path, the project should collect runoff in a ditch. Because of the flow path of this runoff, it is preferable to have the ditch on the west side of trail. This ditch will convey runoff to existing pipes which appear to cross the trail approximately 600 feet and 400 feet north of Vasco Court. The remaining stretch of ditch from this crossing to Vasco Court would require a new pipe crossing near Vasco Court.

Stormwater Treatment. As stated above, the NPDES permit requires that stormwater controls be provided for impervious surfaces. These controls include both treatment, in the form of BMPs, and flow attenuation to pre-project levels.

First, low impact design (LID) elements should be incorporated into the project as much as possible. LID elements include reducing impervious surface. This option should be explored during the design phases of this project. The reduction of impervious surface reduces the size of

treatment elements required and reduces the infrastructure required to attenuate additional flows due to project improvements.

The ditch proposed to convey the 10-year runoff flows may also be designed as a stormwater treatment element. Specifically, the ditch may be designed as a vegetated swale. Per the California Stormwater Quality Association (CASQA), design features of a vegetated swale for water quality treatment include limiting the slope to 2.5% and providing a water depth of no more than 4 inches. Of course, local maintenance requirements would also need to be considered for the design of this element.

Potential Improvements. Assumed improvements at the south portal include:

South Portal Improvements

- Provide a ditch adjacent to path (includes grading, planting, potential turf reinforcement mat, 6-inch diameter underdrain pipe). Ditch dimension shown in Sheet 6 (Attachment A).
- 24-inch pipe crossing the path to existing, easterly drainageways
- 2 outfalls (Headwall and Rock Slope Protection at upstream and downstream ends of 24-inch pipe)

RECOMMENDATIONS AND CONCLUSION

Drainage improvements are anticipated to be required at both the north and south portals. These improvements are intended to serve to:

- maximize the use of the path
- provide conveyance for a designated design storm (10-year suggested)
- provide stormwater treatment capabilities
- Reduce and prevent erosion of site soils

At the north portal, a piped system is recommended because of the limited space within the cross section of the path. This system will collect runoff from surrounding areas and convey it to the existing downstream ditch and piped system. At the south portal, space is available to provide more natural means of drainage. Significant surrounding areas do not appear to discharge to the path area. Therefore, a ditch is recommended to potentially provide stormwater treatment and to convey runoff from the path to Sutton Manor Branch.

ATTACHMENT A – PRELIMINARY PLAN SHEETS

- Sheet 1: Overall Site Location
- Sheet 2: Existing Infrastructure and Drainage Patterns – North Portal
- Sheet 3: Existing Infrastructure and Drainage Patterns – South Portal
- Sheet 4: Proposed Drainage Infrastructure – North Portal
- Sheet 5: Proposed Drainage Infrastructure – South Portal
- Sheet 6: Typical Sections

ATTACHMENT B – PROJECT SITE PHOTOS

REFERENCES

Alta LandPeople, GIS Topographic, Planimetric and Property Line Data (multiple files), received January 12, 2009

City of Mill Valley Department of Public Works, GIS Data (MV_sanitary_sept1708.mdb; streets, watersheds and conveyance system), received February 12, 2009

Jacobs Associates, County of Marin, CA, Mill Valley to Corte Madera Bike & Pedestrian Corridor Study, Alto Tunnel Existing Condition, Drawings 1 and 2, December 2008

Marin County Department of Public Works Flood Control Zone , White Paper, “Flood Management Practices within the City of Mill Valley”, August 21, 2006

Marin County Stormwater Pollution Prevention Program (MCSTOPPP), Guidance for Applicants: Stormwater Quality Manual for Development Projects in Marin County, February 6, 2008

Marin County Stormwater Pollution Prevention Program (MCSTOPPP), www.mcstoppp.org (“Resources for” link), last viewed April 17, 2009

Marin County Watershed Program website,
http://www.marinwatersheds.org/app_pages/view/77#acmdp

Nolte Associates, Field Visit notes and photographs, February 18, 2009

Ross Valley Flood Protection and Watershed Program Website (maps),
<http://www.rossvalleywatershed.org/Content/10004/watershed.html>, Copyright 2006

Town of Corte Madera Public Works, Storm Drainage Block Map, received January 22, 2009

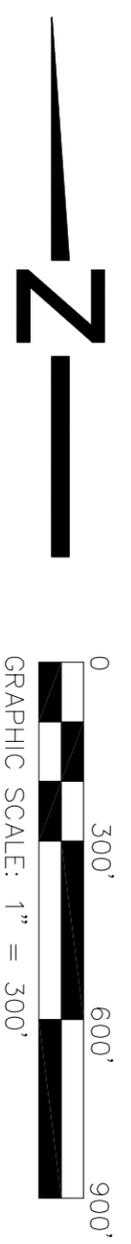
Attachment A
Preliminary Plan Sheets

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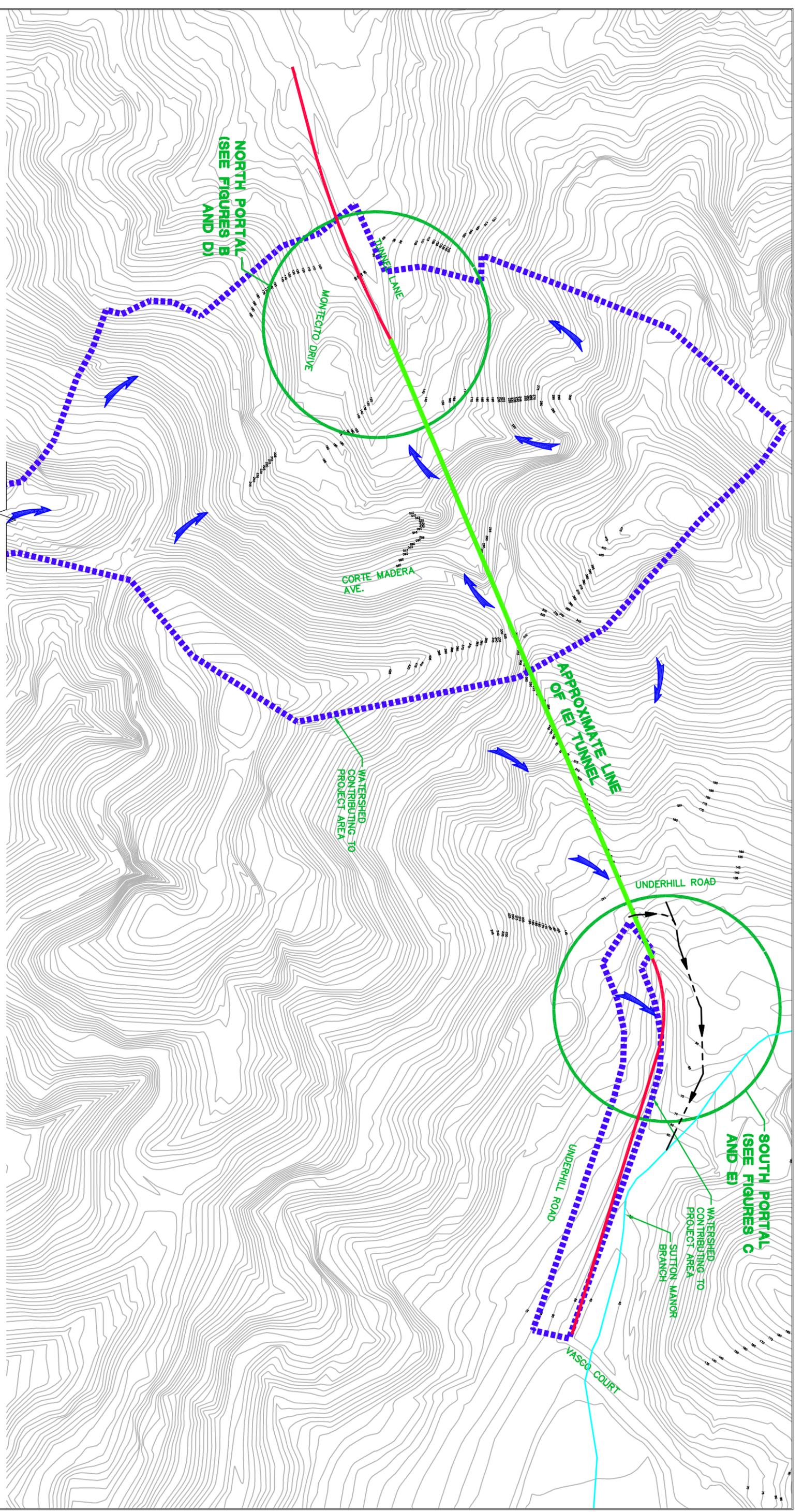
MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
OVERALL SITE LOCATIONS, CONTRIBUTING WATERSHEDS AND DRAINAGE PATHS
PREPARED FOR: COUNTY OF MARIN

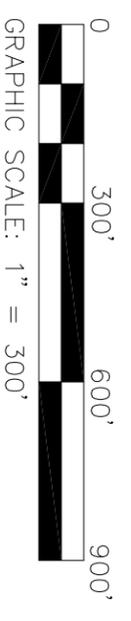
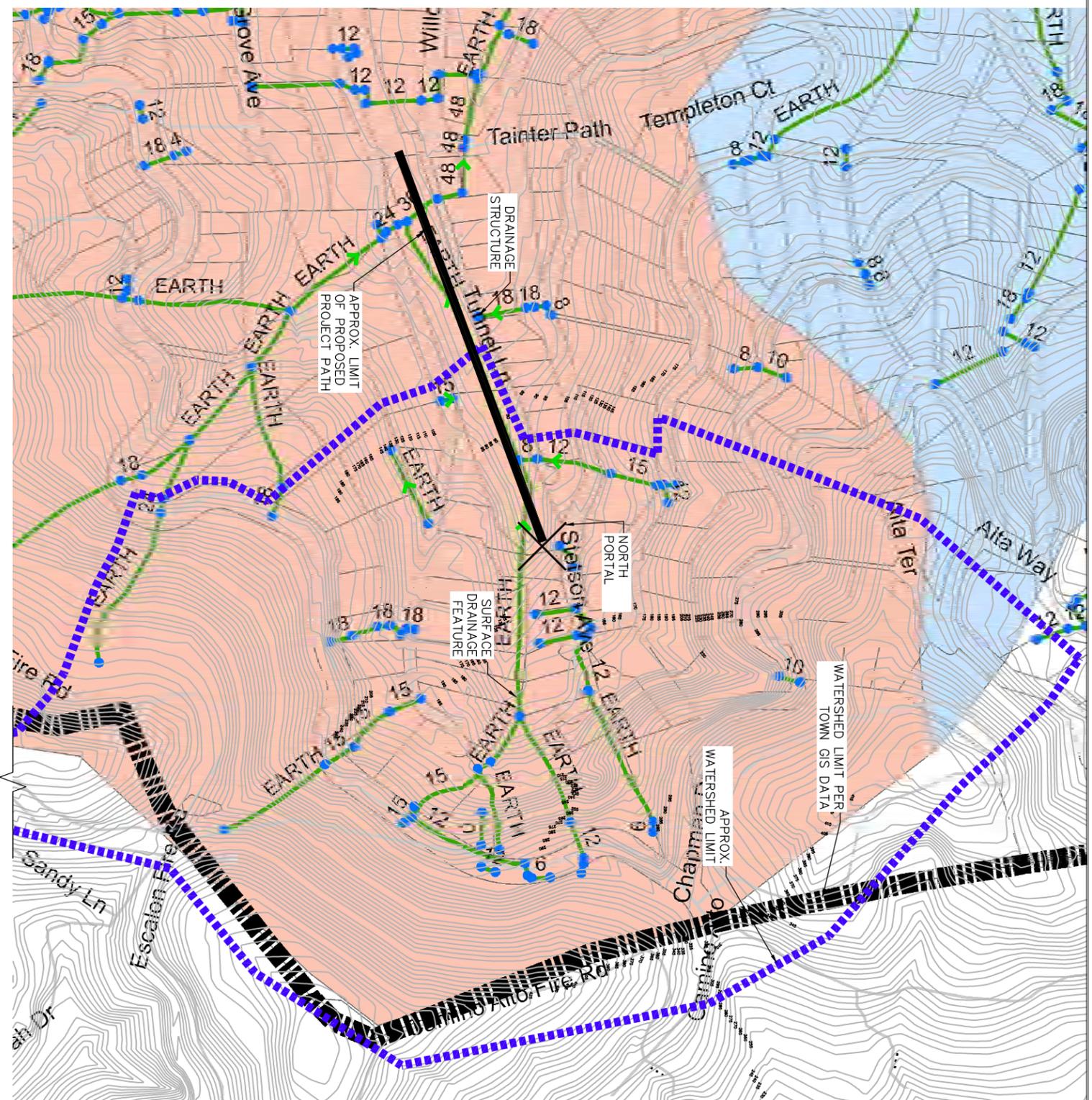
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LEGEND:
 DRAINAGE PATH
 WATERSHED DELINEATION
(DIRECT CONTRIBUTION TO PROJECT AREA)

PRELIMINARY
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MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
 COUNTY OF MARIN, CALIFORNIA
 EXISTING INFRASTRUCTURE AND DRAINAGE PATTERN, NORTH PORTAL
 PREPARED FOR: COUNTY OF MARIN
 DATE SUBMITTED: 04/17/2009

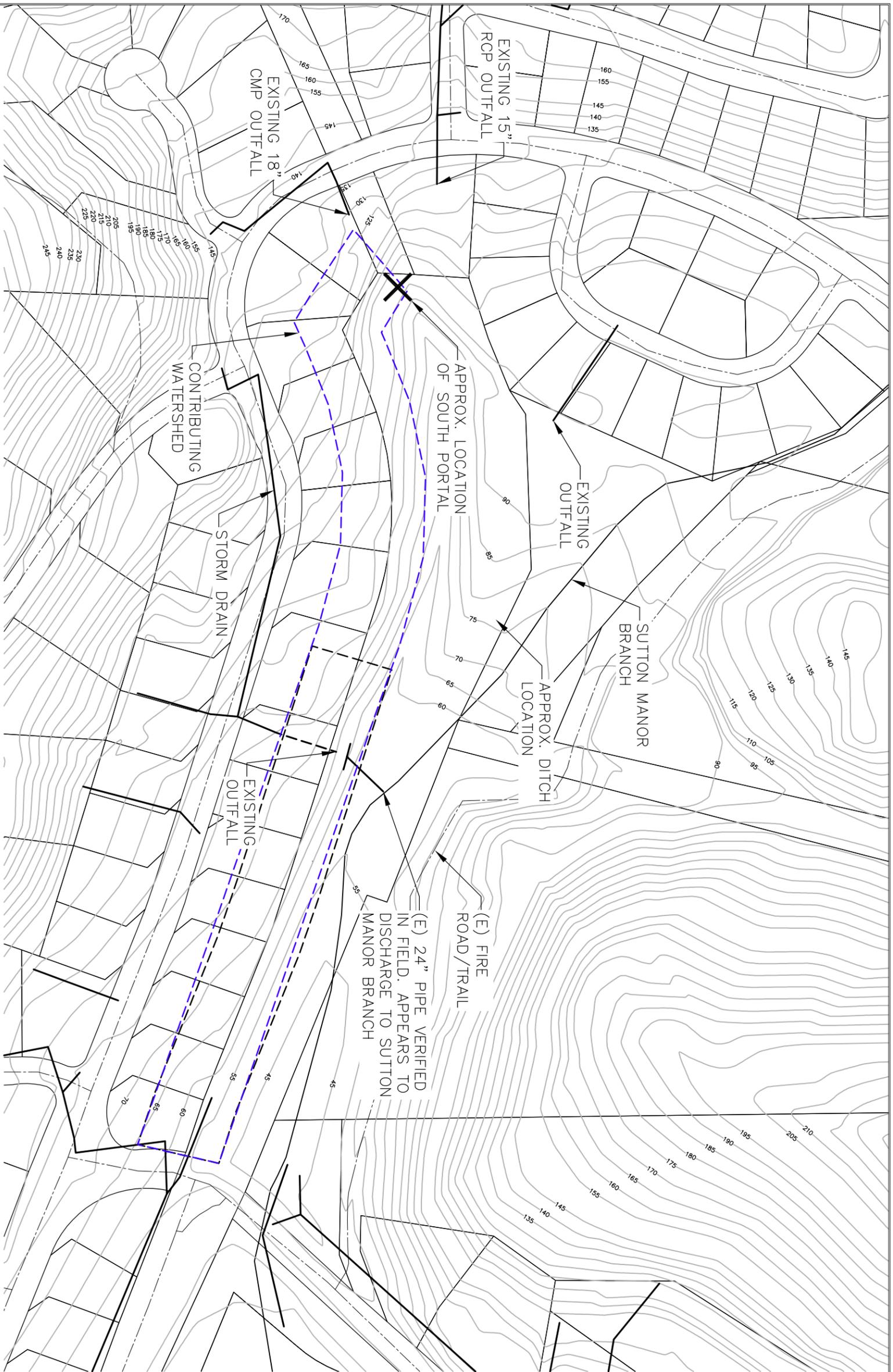
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LEGEND:

- EARTH SURFACE DRAINAGE FEATURE (DITCH)
- XX— PIPE DRAINAGE FEATURE
- DRAINAGE STRUCTURE (MANHOLE, OUTFALL)

NOTES
 1. DRAINAGE SYSTEM INFORMATION BASED UPON GIS DATA FROM THE TOWN OF CORTE MADERA.



NOTES
 1. LOCATION OF STORM DRAIN PIPES AND SUTTON MANOR BRANCH BASED UPON GIS DATA FROM CITY OF MILL VALLEY.

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MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
COUNTY OF MARIN, CALIFORNIA
EXISTING INFRASTRUCTURE AND DRAINAGE PATTERN, SOUTH PORTAL
 PREPARED FOR: COUNTY OF MARIN
 DATE SUBMITTED: 04/17/2009

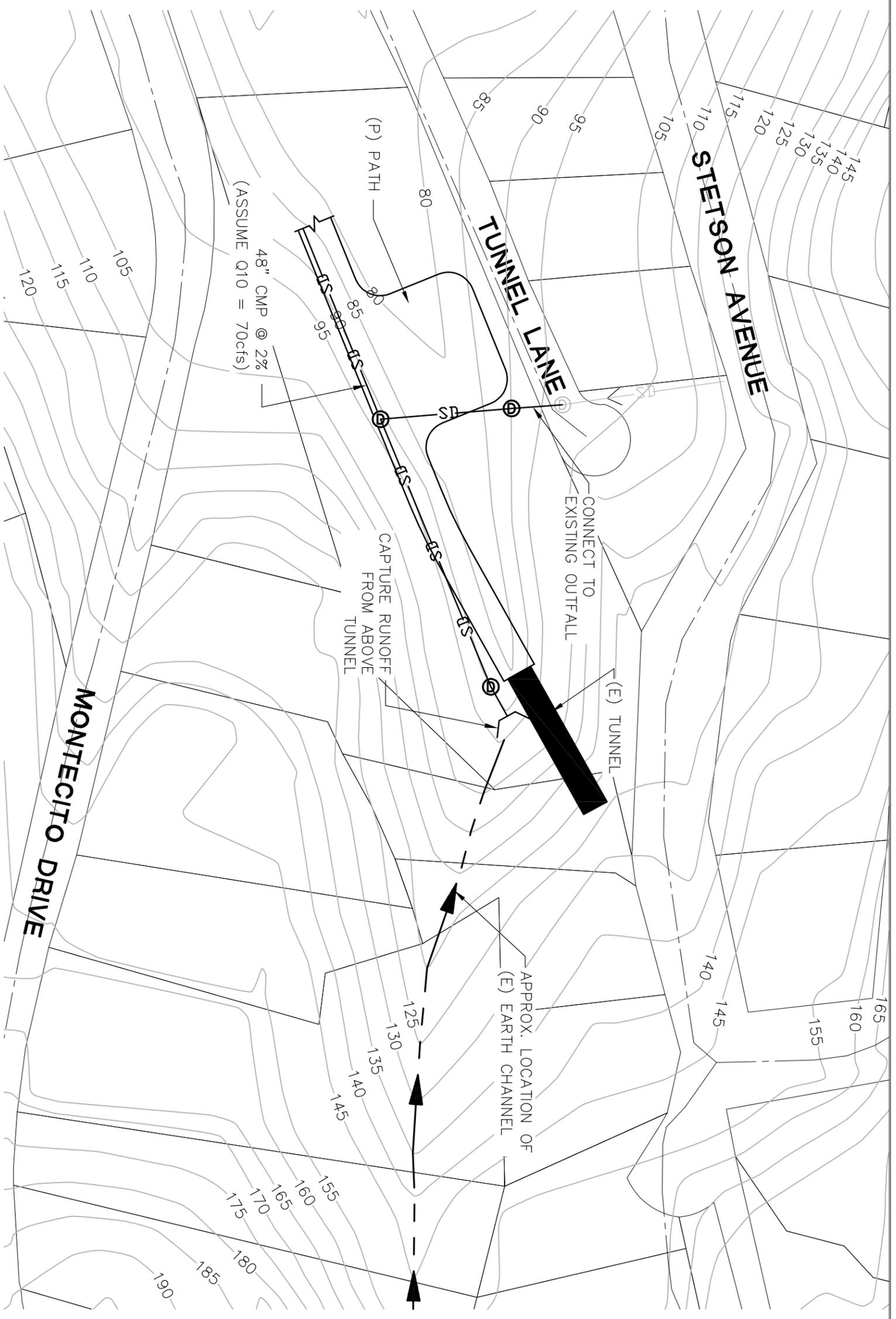
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MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
 COUNTY OF MARIN, CALIFORNIA
 PROPOSED DRAINAGE INFRASTRUCTURE, NORTH PORTAL
 PREPARED FOR: COUNTY OF MARIN

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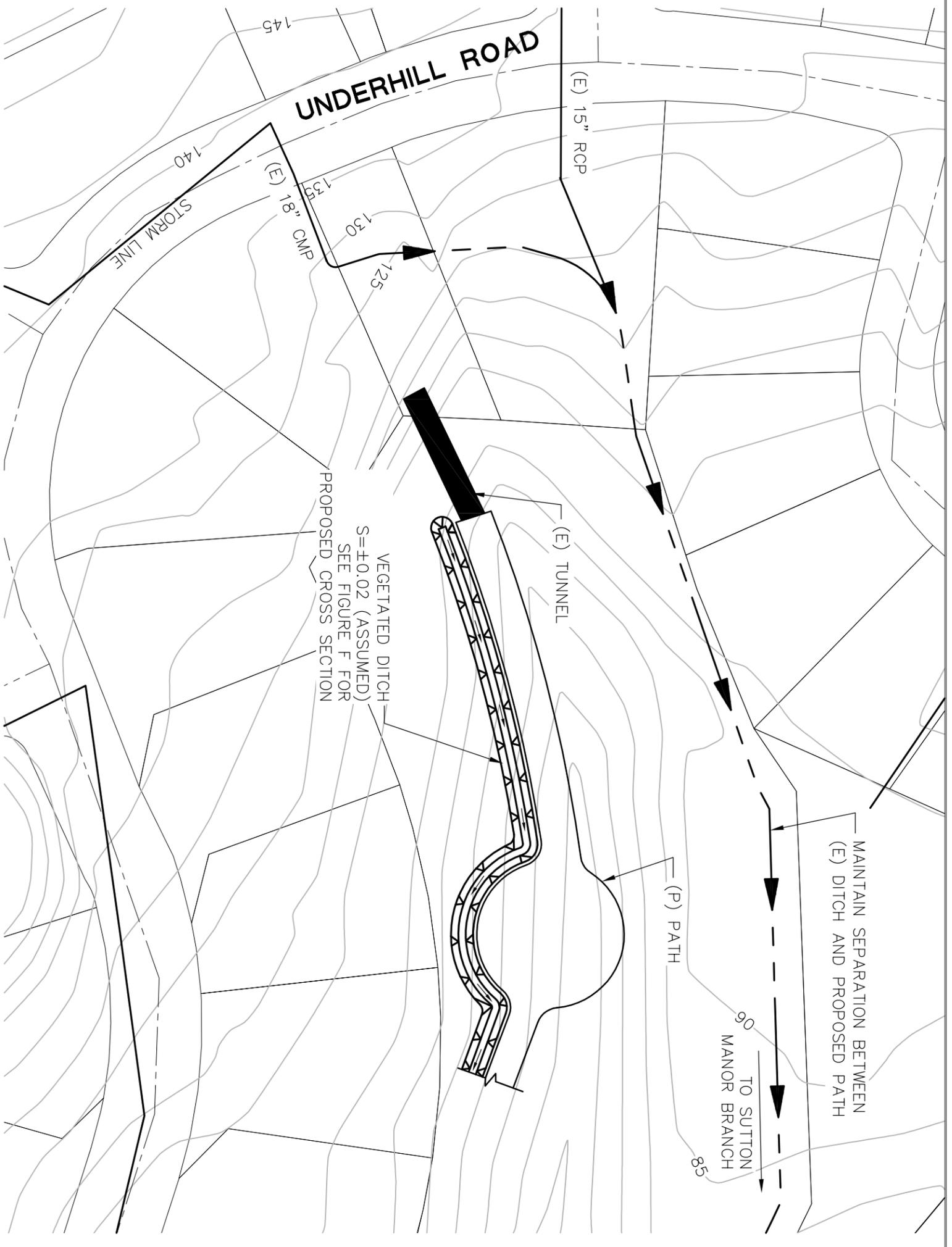
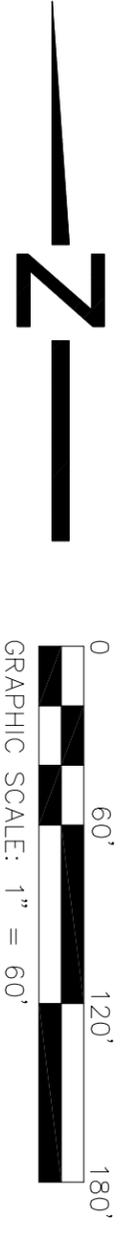
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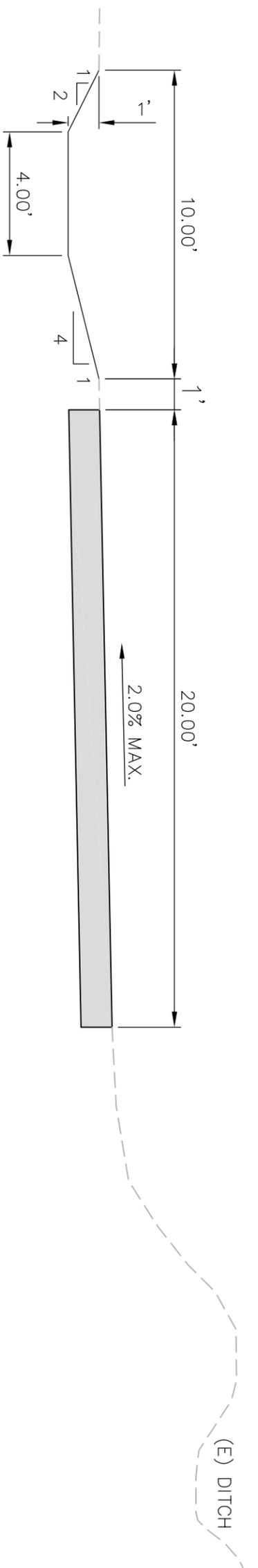
MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
COUNTY OF MARIN, CALIFORNIA
PROPOSED DRAINAGE INFRASTRUCTURE, SOUTH PORTAL
PREPARED FOR: COUNTY OF MARIN

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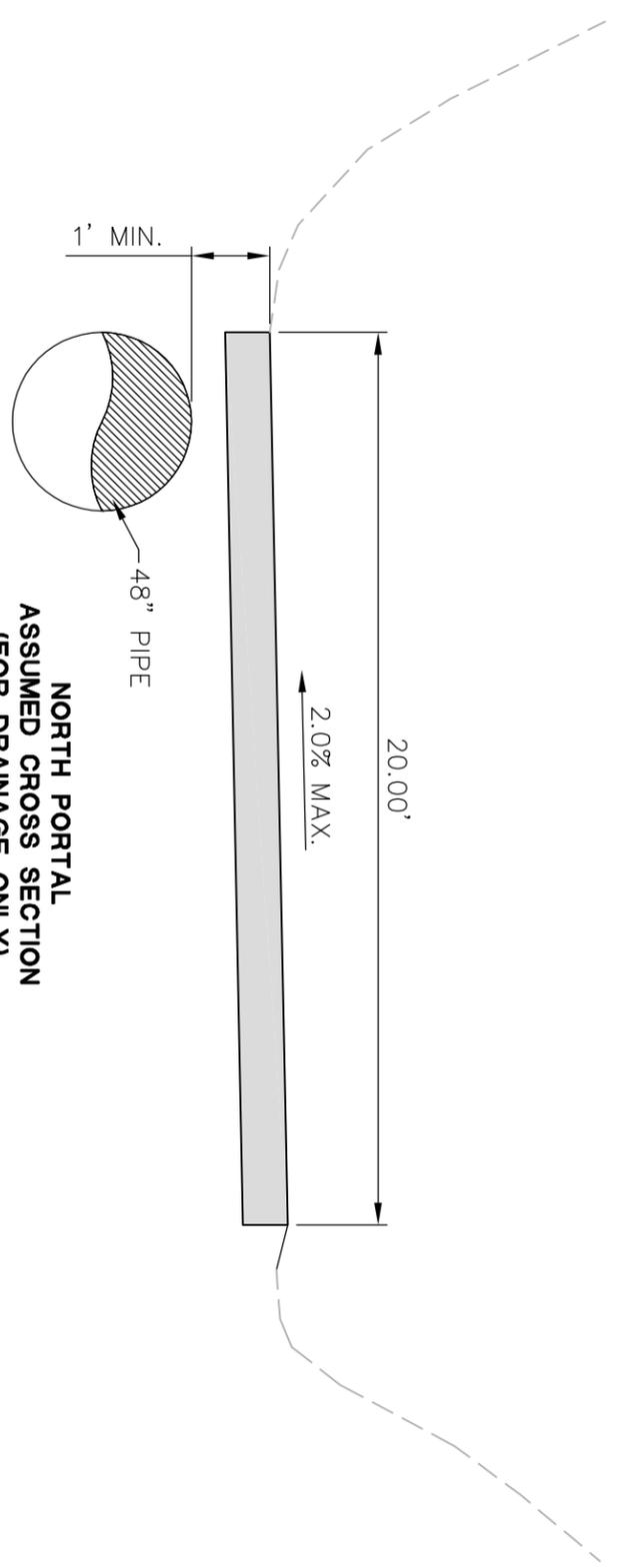


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DATE SUBMITTED: 04/17/2009



**SOUTH PORTAL
PROPOSED DITCH SECTION
(FOR DRAINAGE ONLY)
N.T.S.**



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**MILL VALLEY TO CORTE MADERA BIKE & PEDESTRIAN CORRIDOR STUDY
 COUNTY OF MARIN, CALIFORNIA
 TYPICAL SECTIONS**

PREPARED FOR: COUNTY OF MARIN

DATE SUBMITTED: 04/17/2009

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Attachment B
Project Site Photos



Photo 1: Looking south toward north portal entrance. Note the ponded area and informal low-flow channel. Based upon as-build mapping and field information, concentrated flow comes from westerly (right hand) side of portal.



Photo 2: Tunnel Lane outfall near southerly end of Tunnel Lane. Photo taken from proposed path location, looking east. Note that there is no engineered outfall protection.



Photo 3: Northerly end of path, looking north toward end of existing path. Note bollards at existing trail. On the left side of the picture is the existing ditch conveying runoff to a piped system.

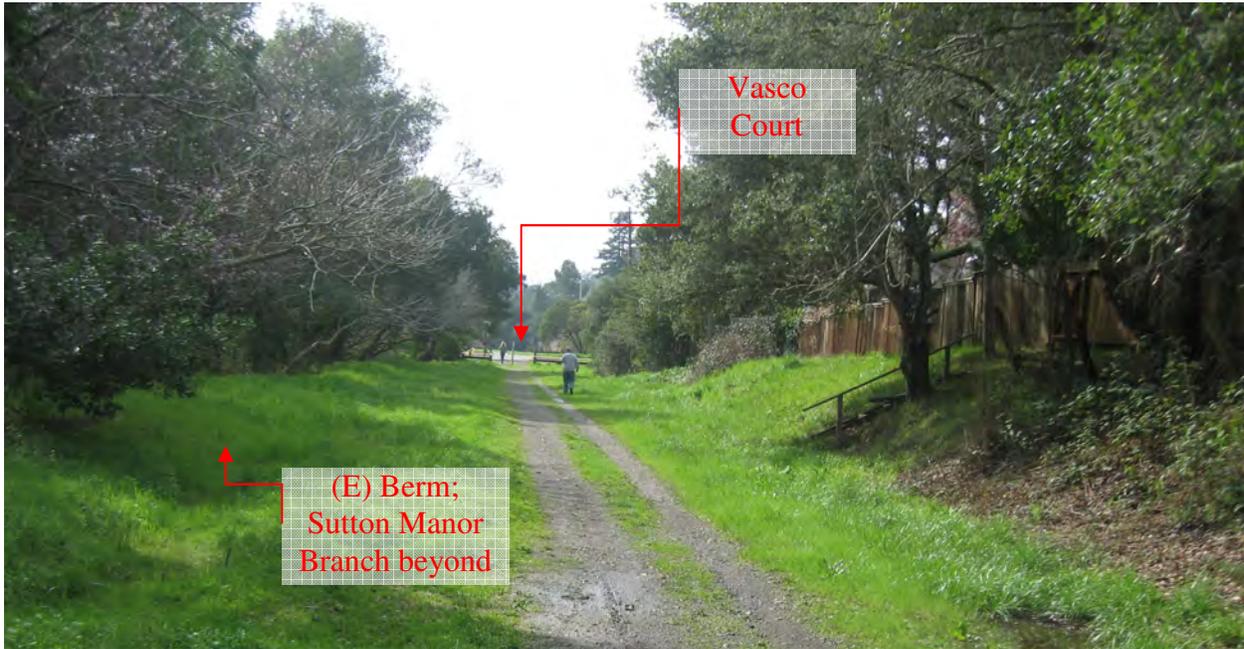


Photo 4: South Portal. Looking south, toward Vasco Court. Note raised berm on easterly side (left in photo) which separates informal path from channel.



Photo 5: Discharge (18-inch CMP) from Underhill. This is the outfall on the easterly side of the tunnel portal. Runoff flows south, then east.



Photo 6: Discharge (15-inch RCP) from Underhill. This outfall flows south, where it conflues with the runoff from the 18-inch CMP in Photo 5.



Photo 7: Existing channel to which the pipes from Photos 5 and 6 discharge. This channel flows south along the property lines. It discharges to Sutton Manor Branch approximately 1,000 feet south of Underhill Road.