California
Department of Conservation
California Geological Survey

Gavin Newsom, Governor
David Shabazian, Director

MEMORANDUM

DATE: January 10, 2024

TO: Matthew Reischman, Deputy Director
California Department of Forestry and Fire Protection
135 Ridgway Avenue
Santa Rosa, California 95401

FROM: Patrick Brand
Department of Conservation
California Geological Survey
135 Ridgway Avenue
Santa Rosa, California 95401

SUBJECT: Engineering Geologic Review of Timber Harvest Plan 1-23-00099 SON

Inspection Date:
December 8 and 15, 2023

County: Sonoma

Silvicultural Method:
Single Tree Selection, Special Treatment Area, Variable Retention, No Harvest

Yarding Method: Ground Based

Area: 824 acres

Slopes:
Gentle to Steep

7.5' Quadrangle:
Stewarts Point, Gualala, McGuire Ridge

Watersheds: Black Point (1113.850304)
Mouth of Gualala River (1113.850202)
Big Pepperwood Creek (1113.850201)

Participants-Affiliation:
Madeline Green – RPF
Jamie Pusich – NCRM Forester
John Bennett – GRT (Dec. 8 only)
Stephen Borcic – Redwood Empire
Jesse Weaver – Redwood Empire (Dec. 8 only)
Clint Doucette – Redwood Empire (Dec. 15 only)
Jack Henry – CDFW (Dec. 8 only)
Aaron Longstreth - CDFW
Jim Burke – NCRWQCB
Kimberley Sone – CAL FIRE
Morgan Renner– CGS (Dec. 8 only)
Kevin Doherty – CGS
David Longstreth – CGS (Dec. 8 only)
Patrick Brand – CGS

Legal Description: German Land Grant; MDBL&M

Timber Owner and Plan Submitter:
Gualala Redwood Timber, LLC (GRT)

EHR: Moderate and High

Geologic Concerns: Operational impacts to slope stability (including potential impacts to residential structures and public roads), use of existing roads and skid trails, and sediment delivery to Gualala River, South Fork Gualala River, and Class II and Class III watercourses that flow to the Pacific Ocean.

References:

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CAL FIRE, 2001, Preharvest Inspection Report, THP 1-00-443 SON, Unpublished memo prepared by Ken Margiott, dated January 12.

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NAIP Imagery: 2022, 2016, 2014, 2012, 2010, 2009, 2005

Google Earth images: 39°45'17.12"N and 123°30'01.04"W; various years 7/11/1993 to 10/17/2022; accessed December 2023.

LiDAR Data: Sonoma County Vegetation Mapping and LiDAR Consortium, NASA, University of Maryland, Watershed Sciences, Inc., Tukman Geospatial LLC (http://sonomavegmap.org); LiDAR acquired 2013.

Geologic Conditions:

Timber Harvest Plan 1-23-00099 SON is located in an area underlain by Paleocene to Eocene German Rancho Formation that is locally mantled with Quaternary marine terrace deposits (Blake and others, 2002; Figure 1; Fuller and others, 2002; Figure 2; Davenport, 1984; Figure 3; Huffman and Armstrong, 1980). German Rancho Formation is described as distinctly bedded, fine- to medium-grained sandstone, mudstone, and conglomerate; while the marine terrace deposits are described as poorly to moderately consolidated deposits of marine silts, sands, and gravels (Blake and others, 2002; Fuller and others, 2002; Davenport, 1984; Huffman and Armstrong, 1980). Bedrock observed in the plan area generally consisted of yellow brown sandstone that appeared to be consistent with descriptions of the German Rancho Formation. Within the THP vicinity, Bowles and Cowgill (2012) interpret the presence of uplifted marine terrace surfaces more extensive than shown on the referenced regional geologic maps based on analysis of LiDAR data. Outcrops of marine terrace deposits were not observed during the PHI, but we noted areas characterized by white to brownish yellow sandy loam soils exposed along existing road surfaces that we interpreted to be derived from marine terrace deposits.

The THP is located as close as ¼-mile west of the San Andreas Fault Zone (SAFZ), which consists of a relatively wide, active fault zone that trends along the South Fork Gualala River valley in the THP area (Koehler and others, 2005; Blake and others, 2002; Figure 1; Fuller and others, 2002; Figure 2; Davenport, 1984 Figure 3; Huffman and Armstrong, 1980). Regional tectonic activity has regionally deformed the bedrock within the plan area, and accordingly, Blake and others (2002; Figure 1) show varying bedding orientations across the THP site (McLaughlin and others, 2001, Figure 1), ranging from 25- to 35-degree dips to the west in the northern plan area to 45 degrees to the north-northeast in the southern plan area.

Soils noted in the THP are Caspar sandy loam 15 to 30 percent slopes; Caspar sandy loam 30 to 50 percent slopes; Empire loam 30 to 50 percent slopes; Hely silt loam 30 to 50 percent slopes; Hugo loam 30 to 50 percent slopes; Josephine loam 50 to 75 percent slopes; Kneeland loam 9 to 15 percent slopes; Mendocino sandy clay loam 30 to 50 percent slopes; Noyo coarse sandy loam 0 to 15 percent slopes; and Rohnerville loam 9 to 15 percent slopes (USDA, 2023). Soils observed during the PHI generally consisted of loam and sandy loam that appeared moderately well drained. Site inspection concurs with the Moderate and High Erosion Hazard Rating calculations included with the THP.

The proposed harvest units are located on gentle to locally steep slopes (<10 to 75± percent gradients) that primarily drain to the Pacific Ocean via unnamed Class II and Class III watercourses; however, the northern and northeastern portions of the plan area drain to the Gualala River and the South Fork Gualala River, respectively. Blake and others (2002; Figure 1), Fuller and others (2002; Figure 2), Davenport (1984; Figure 3), and Huffman and Armstrong (1980; Figure 4) each identify landslides and geomorphic features related to landsliding within portions of the proposed THP area. Blake and others (2002; Figure 1) identify a very large (>1,500 acres) landslide along northeast-facing slopes that drain to the South Fork Gualala River. Similarly, Huffman and Armstrong (1980; Figure 4) identify a very large (>2,000 acres) landslide along northeast-facing slopes that drain to the South Fork Gualala River. Within the remainder of the plan area, Huffman and Armstrong (1980) classify slopes in the THP area as being in the Relative Slope Stability Category “B” described as “areas of relatively stable rock and soil units, on slopes great than 15%, containing few landslides” or Category “Bf” describe as “locally level areas within hilly terrain; may be underlain or bounded by unstable or potentially unstable rock materials”. Along the northeast facing slopes draining to the South Fork Gualala River where Blake and others (2002; Figure 1) and Huffman and Armstrong (1980; Figure 4) identify a very large landslide feature, Fuller and others (2002; Figure 2) interpret smaller dormant deep-seated landslides, with intervening areas underlain by German Rancho Formation bedrock. Elsewhere in the plan area, Fuller and others (2002; Figure 2) identify one debris slide, two small landslides, and areas of debris slide slopes. Finally, Davenport (1984; Figure 3) also identifies one debris slide, two small landslides, and areas of debris slide slopes (same as Fuller and other, 2002; Figure 2) within the northwest portion of the THP area. Additional observations related to landsliding in the THP area are discussed below.

Agency Questions:

1). Please evaluate the accuracy of mapped unstable areas and adequacy of proposed mitigations.

During our review, we evaluated the accuracy of mapped unstable areas and adequacy of proposed mitigations. We noted that there appeared to be unstable areas mapped in previous THP's that are not shown in the current THP and confirmed their presence during the first day of the PHI. The RPF provided updated THP maps to the review team on December 14, 2023 that include additional unstable areas at locations where unstable areas are mapped in previous THP's and include revised mapping of some of the unstable areas shown on the original THP maps. Based on our observations, the updated THP maps accurately depict the location of unstable areas, and the proposed avoidance and retention of canopy and root function on these mapped unstable areas appears adequate to minimize the potential for adverse impacts to slope stability of the unstable areas. Please refer to General Observation #4 for additional discussion.

2). Please evaluate the adequacy of proposed watercourse crossing mitigations relative to the potential for sediment delivery.

During our review, we evaluated the adequacy of proposed watercourse crossing mitigations relative to the potential for sediment delivery. Additional recommendations were developed at Map Point 1 and Map Point 55 to minimize the potential for additional erosion and/or potential sediment delivery. Please refer to Specific Observations for additional discussion of these map points and our recommendations. Based on our review, the proposed watercourse crossing mitigations, as augmented with the recommendations in this memo, appear adequate to minimize the potential for erosion and sediment delivery.

3). Residential structures are downslope of portions of the plan area. Please evaluate the potential for adverse impacts to slope stability, landsliding, and public safety.

During our review, we evaluated the potential for adverse impacts to slope stability, landsliding, and public safety relative to the residential structures located downslope of the THP area. One small unstable area was located upslope of the residential structures during the PHI. Please refer to General Observation #5 and Specific Observation (Map Point CGS-1) for discussion of our observations and recommendations below.

General Observations:

1). Background Geologic Information. During our review, we noted that the THP does not contain published and unpublished geologic information. Our observations are summarized below.

Published Landslide Mapping. During our review, we noted that the THP does not include, reference, or discuss published landslide mapping (Blake and others, 2002; Fuller and others, 2002; Davenport, 1984; Huffman and Armstrong, 1980), making it unclear to the review team if this information was reviewed, considered, and evaluated during THP preparation. We discussed that published landslide mapping showing proposed THP boundaries is commonly included in Section V of the THP so that the review team can know that the RPF utilized this information during plan preparation and can assess the proposed operations at mapped landslides.

Unpublished Landslide Mapping. During our review, we also noted that the THP does not include, reference, or discuss unpublished (but publicly available) landslide mapping that may have been reviewed during THP preparation. This includes unstable areas disclosed in THP's 1-00-360 SON, 1-00-443 SON, 1-05-146 SON, and 1-10-007 SON. As well, this includes maps and tables of unstable areas compiled by the former landowner, Gualala Redwoods Inc. (GRI), compiled from aerial photo analysis by Tim Best, CEG and field observation by foresters (GRI, 2004). This GRI landslide database has been included in the most recent THP's in the area (THP's 1-03-020 SON, 1-05-146 SON, 1-10-007 SON, 1-12-087 SON, 1-15-042 SON, and 1-17-049 SON), including following the change in timber owner from GRI to GRT (i.e., THP 1-17-049 SON). We discussed that in order to provide complete and accurate information to the review team, this relevant geologic information should be included, referenced, and/or discussed in the Section V of the THP so that the review team can know that the RPF utilized this information during plan preparation and can assess the proposed operations at previously mapped unstable areas.

<u>2). Inner Gorge Geomorphology.</u> Kelsey (1988) describes inner gorge as a physiographic feature where slopes that are adjacent to the stream channel are steeper (part of the inner gorge) than those further upslope, with a recognizable break in slope separating the steep inner gorge slopes from the upper, less steep valley slopes. Kelsey (1988) describes that inner gorge formation evolves in drainage basins with relatively competent, homogenous rock types that are undergoing persistent base level lowering (most likely through tectonic uplift), and that mass slope failures (debris slides) are the primary sculpting mechanism of the inner gorge. This process occurs over a time frame of tens to hundreds of thousands of years and can be temporally and physically intermittent depending on controlling factors.

California Geological Survey Note 50 (CGS, 2013) defines inner gorge as a geomorphic feature that consists of the area of the stream bank situated immediately adjacent to the stream channel, having a side slope of generally over 65 percent, and being situated below the first break in slope above the stream channel. They are formed by coalescing scars originating from landsliding and erosional processes caused by active stream erosion.

During our review, we noted the presence of several Class II stream channels within the plan area that are incised into the gently to moderately sloping landscape. Bowles and Cowgill (2012) interpret this landscape as uplifted marine terrace platforms, which are still undergoing tectonic uplift. Review of aerial imagery and LiDAR data show that these incised stream channels typically have steep to very steep side slopes below a well-defined break in slope. The THP identifies numerous unstable areas along these slopes. Field observation within these drainages confirmed the presence of an abrupt break in slope, typically from 15- to 35-percent gradients upslope to slopes generally exceeding 65 percent that extend down to the stream channel. Outside of the numerous mapped unstable areas where the RPF observed evidence of instability along these steep slopes, we also frequently noted the presence of vegetated bowl-shaped head scarps at or near the break in slope and spoon-/teardrop-shaped depressions/hollows extending downslope that appear to be indicative of former debris slide activity. These observations are consistent with the conditions for inner gorge formation described by Kelsey (1988) and the definition of inner gorge geomorphology from CGS Note 50 (CGS, 2013) and the Forest Practice Rules. Additionally, our review of the unpublished data discussed above (General Observation #1) revealed several instances where the GRI landslide database (GRI, 2004) records landslides in these areas with the noted "slope type" as inner gorge. Based on these observations, we conclude that the noted drainages have morphology consistent with inner gorge geomorphology. The interpreted break in slope in the areas of inner gorge geomorphology is shown on Figures 5 and 6.

During the PHI, we observed that timber operations are currently proposed in these inner gorge areas. The THP proposes selection (single-tree selection or Coastal Commission Special Treatment Area) and variable retention harvesting in these areas, though much of these slopes are encompassed by WLPZ's or in one case an aggregate retention area (Figures 5 and 6). In some cases, we observed that the WLPZ flagging is expanded up to the break in slope to include the inner gorge slopes, but we also observed locations where the flagged WLPZ does not extend up to the break in slope (Figures 5 and 6). Timber harvesting is proposed within the WLPZ areas, and several in-lieu skid trails are also proposed for use within these WLPZ areas.

We discussed our observations and that the Forest Practice Rules require that "*All operations on slopes exceeding 65% within an inner gorge of a Class I or II Watercourse shall be reviewed by a Professional Geologist prior to plan approval, regardless of whether they are proposed within a WLPZ or outside of a WLPZ*". The RPF understood this requirement and indicated that either a licensed Professional Geologist would be consulted to evaluate the proposed operations on inner gorge slopes, or that that operations would be avoided in the inner gorge areas.

<u>3). Deep Seated Landslides.</u> Published mapping shows apparent deep-seated landslides in the vicinity of the THP area located along northeast-facing slopes that drain to the South Fork Gualala River. Blake and others (2002; Figure 1) and Huffman and Armstrong (1980; Figure 4) identify a similar very large landslide complex in this area, while Fuller and others (2002; Figure 2) interpret smaller dormant deep-seated landslides along these slopes. Review of LiDAR imagery reveals subtle, bowl shaped headscarp slopes and benched and hummocky topography across these slopes where Blake and others (2002; Figure 1) and Huffman and Armstrong (1980; Figure 4) identify the very large landslide complex. LiDAR imagery generally shows more defined landslide features with somewhat more youthful morphology nested within this large landslide complex at the locations where Fuller and others (2002; Figure 2) identify dormant deep-seated landslides. During our review, we observed that these slopes are generally forested with straight standing advanced-growth conifers and old-growth stumps. Evidence of recent large-scale, deep-seated earth movement (for example ground cracks, bare scarps, offset road prisms) was not observed during the PHI. Based on our observations, the large deep-seated landslide complex and nested blocks appear to correspond to the "dormant-mature" to "dormant-old" morphological age classification of Keaton and DeGraff (1996).

Additionally, review of LiDAR imagery reveals several areas of steep, bowl-shaped slopes with benched and hummocky topography downslope along incised watercourses in the THP area that are consistent with probable deep-seated landslides (on the order of 1- to 3-acres) that are not identified on published geologic maps. We observed that these slopes are generally forested with straight standing advanced-growth conifers and old-growth stumps, and evidence of recent large-scale, deep-seated earth movement (for example ground cracks, bare scarps, offset road prisms) was not observed during the PHI (though there did appear to be inner gorge geomorphology along the toe of these features; discussed under General Observation #2). Based on our observations, these probable deep-seated landslides appear to correspond to the “dormant-young” to “dormant-mature” morphological age classification of Keaton and DeGraff (1996).

While no evidence of large-scale, deep-seated ground movement was observed at these locations at this time, movement of the landslide features may be triggered by periodic strong ground shaking associated with tectonic movement along the San Andreas Fault Zone (SAFZ), which passes ¼- to 1½-miles to the east of the THP area (Figures 1 and 2).

The THP proposes ground-based selection silviculture within both these mapped and unmapped deep-seated landslides. Based on our review of CAL FIRE records, portions of these deep-seated landslides in the plan area were most recently harvested utilizing ground-based selection silviculture under THP’s 1-00-360 SON, 1-00-43 SON, 1-05-146 SON and 1-10-007 SON. During the PHI, the RPF generally reported that the existing conifer basal area in these areas is about 100 to 150 square feet per acre, and that a minimum conifer basal area of 75 square feet per acre shall be retained after operations. Although harvesting can potentially change the hydrologic balance due to reduced canopy cover and lessen the apparent cohesion provided by tree roots, past harvesting of these slopes does not appear to have triggered increased ground movement, supporting the observation that the proposed harvest appears unlikely to have a significant impact on the slope stability of the dormant deep-seated landslide areas in the plan area.

Retention of a distributed stand of conifer within dormant deep-seated landslides in the plan area will provide:

1) Canopy closure to intercept and attenuate rain drop effect on shallow landslide initiation (Iverson and Major, 1987),
2) Maintain a distributed, live root mass to retain significant root cohesion properties in the soil profile (Montgomery et al., 2000),
3) Sprouting tree species (redwood, tan oak) will lose some root cohesion properties but will resprout such that lost root strength is generally being regenerated after 5-7 years (Schmidt et al., 2001; Ziemer, 1981; Krogstad 1995).

<u>4). Unstable Areas.</u> The THP Operations Maps shows numerous RPF-identified unstable area polygons at throughout the plan area. During our first review of the THP, we noted that there appeared to be unstable areas mapped in previous THP’s (THP’s 1-00-360 SON, 1-00-43 SON, 1-05-146 SON and 1-10-007 SON) that are not shown in the current

THP. RPF response dated September 6, 2023 (Return No. 2 Responses) indicated that these past THP's were reviewed with respect to previously mapped unstable areas; however, during the first day of the PHI we field checked several of these locations and confirmed the presence of unstable areas that were not shown on the THP Operations Maps. After the first day of the PHI, the RPF performed additional review and field work, and submitted updated THP maps to the review team on December 14, 2023. The updated THP maps include additional unstable areas at locations where unstable areas are mapped in previous THP's and include revised mapping of some of the unstable areas shown on the original THP maps (Figures 5 and 6).
Over the course of the two-day PHI, we observed a representative sampling of the unstable areas shown on the revised THP maps (Figures 5 and 6), which generally consisted of suspended to dormant-historic debris slides, slumps, and skid trail failures that are nearly all located along steep slopes adjacent to watercourses within the THP area (some of which have inner gorge geomorphology; see General Observation #2). Item 38 (page 101) of the THP describes that all mapped unstable areas within the THP area are no-harvest equipment exclusion zones that are incorporated into the WLPZ areas. However, when submitting the updated THP maps to the review team the RPF clarified that Item 38 will need to be revised as some unstable areas extend outside of the WLPZ and are flagged with Do Not Cut flagging. Based on our observations, the updated THP maps (Figures 5 and 6) accurately depict the location of unstable areas, and the proposed avoidance and retention of canopy and root function on these mapped unstable areas appears adequate to minimize the potential for adverse impacts to slope stability of the unstable areas. One additional unstable area was observed during the PHI and is discussed under Specific Observations (Map Point CGS-1).

<u>5). Public Safety.</u> During our review of the THP, we noted that there are numerous residential structures/developments (for example Sea Ranch) and public roads and highways (for example Deer Trail road, State Route 1) downslope of the proposed THP area. We noted that the residential structures/developments are not shown on the THP maps (Figure 7). During the PHI, we discussed that these structures should be disclosed in the THP to provide complete information to the review team so that the review team can assess the proposed timber harvesting operations with respect to potential impacts to the downslope structures.

During our review, we evaluated the potential for operational impacts to slope stability that could impact these structures and developments, as well as the public roads and highways. Neither the THP, nor the published and unpublished mapping discussed under General Observation #1 identifies landslides/unstable areas along the slopes that descend toward the residential structures and development or the public roads and highways. During the PHI, we traversed portions of these slopes and observed that they are typically 30 to 45 percent gradients, with locally steep slopes and bedrock outcrops that exceed 50 percent gradients. Except for a small dormant-historic to dormant-young unstable area that was observed during the PHI (see Specific Observations below), we did not observed evidence of historic instability along these slopes. The observed unstable area was flagged for avoidance during the PHI and as such no harvesting operations are proposed on this feature (See Specific Observations below, Map Point CGS-1, for additional discussion). Based on our observations, the proposed operations, as augmented with the recommendations in this THP, appear unlikely to result in adverse impacts to slope stability that could impact the residential structures and development and the public roads and highways.

Specific Observations:

Map Point 1. An existing permanent road crosses a Class II watercourse at this location via two 36-inch diameter culverts, one of which is rusted through. The THP proposes to remove both culverts and install a 72-inch diameter culvert to watercourse grade. During the PHI, we observed that there is about 84-inches of vertical height from the culvert inlet to the road grade at the inlet side of the road. It appeared that the proposed 72-inch diameter culvert might not have adequate cover in this area without placing additional fill and building up a ramp in the road surface to provide adequate cover over the culvert. As such, the review team discussed installing an adequately sized pipe-arch culvert (aka squash pipe) so that the culvert can have adequate cover without placing additional fill on the road surface. As well, we noted that the 100-year flood flow noted in the Map Point table (page 42) is erroneous as it is not consistent with the calculated value shown on page 72 of the THP.

Map Point 2. The THP describes an inside ditch along an existing permanent road that drains a bank seep to a Class III watercourse crossing at Map Point 2 and proposes upgrades to the ditch upgradient of the crossing to minimize saturation of the road. During the PHI, we observed an approximately <1-acre landslide immediately downslope of the road at this location. We noted sharp, bare-soil scarps at the outside edge of the road at northern extent of the slide, with more weathered and vegetated scarps extending south along the outside edge of the road. The road running surface generally appears intact and can be used without modification. Downslope of the road, we observed numerous tilted trees. The landslide is located downslope of the THP boundary, and our observations were limited to those made from the road and from review of Lidar data. Based on these limited observations, the landslide appears to be an active to suspended moderately deep-seated landslide. This landslide is not disclosed or discussed in the THP.

Review team members recalled that this landslide occurred around 2006, and that it underwent agency review. However, our review of THP records did not reveal documentation of the landslide. THP 1-15-042 SON shows the landslide as a point that appears to have been excluded from that THP. THP 1-90-362 SON does not disclose a landslide at this location. The GRI landslide database (GRI, 2004) only describes the landslide occurred after 2004. Review of NAIP imagery also did not clarify when the landslide occurred.

We discussed that the use of the road and the proposed mitigations at Map Point 2 may have the potential to impact the landslide, and that the landslide (and any potential past documentation of the landslide) should be disclosed in the THP so that the review team is aware of its presence. As well, we discussed that Map Point 2 should be updated to discuss the landslide and consider potential impacts to the landslide resulting from the proposed mitigations so that the review team can assess this information.

Map Point 55. An existing seasonal road crosses a Class III watercourse at this location via a 24-inch diameter culvert set high in the fill with an attached metal flume outlet extending downslope. The THP proposes to install a new 24-inch diameter culvert to watercourse grade that outlets where the existing flume currently outlets. There is an old fillslope failure adjacent to the crossing that is adequately addressed in the THP. However, during the PHI we observed that the existing metal flume outlets onto material deposited from the old fillslope failure, which appears to have buried the watercourse channel int this area. It appeared that moving the proposed culvert outlet about 10 feet downslope of the existing flume outlet would extend beyond the fill failure deposit/debris and outlet into a well-defined watercourse channel.

Map Point CGS-1. During the PHI, we observed what appears to be a dormant-young to dormant-historic earthflow that is not disclosed in the THP. The earthflow is characterized by 2- to 4-foot tall, weathered and vegetated scarps, and hummocky, vegetated deposit downslope. The earthflow is about 20 to 40 feet wide and extends about 60 to 80 feet down 35 percent slopes, where it is deposited on the hillside. The unstable area is located about 100 feet upslope of the THP boundary, and about 175 feet upslope of a residential structure outside of the THP area. During the PHI, the extent of the unstable area was flagged with Do-Not-Cut flagging. The RPF agreed to disclose the unstable area in the THP and to avoid operations on this feature. Based on our observations, the proposed avoidance and retention of canopy and root function on the unstable area appears adequate to minimize the potential for adverse impacts to slope stability.

General Recommendations:

1). Prior to second review, Section V of the THP shall be updated to include published landslide mapping showing proposed THP boundaries. Additionally, Section V of the THP shall be updated to include the GRI unstable area database information for the THP area and to include, reference, and/or discuss the unstable area information from previous THP's. Any additional mitigations associated with this information shall be included in Section II of the THP.

2). Prior to second review, the THP shall be revised to include a geologic report with evaluation of the proposed operations on inner gorge slopes by a licensed Professional Geologist, or to show that operations are to be avoided at the identified inner gorge areas. CGS requests time to review the geologic report and additional field review may be necessary.

3). None

4). Prior to second review, Section II of the THP shall be revised to include the updated mapping of unstable areas as shown on THP maps that were provided to the review team prior on December 14, 2023 (Figures 5 and 6). Additionally, Item 38 shall be revised to discuss that some unstable areas extend outside of the WLPZ and are flagged with Do Not Cut flagging. Additionally, the RPF shall verify that all mapped unstable areas are flagged in accordance with Item 38 and that no trees are marked for harvest on mapped unstable areas prior to operations.

5). Prior to second review, the THP maps shall be updated to disclose the location of residential structures and developments that are located downslope of the THP.

Specific Recommendations:

Map Point 1. Prior to second review, the THP shall be revised to describe that a pipe-arch culvert that is adequately sized for the calculated 100-year flood flow shall be installed at this location. As well, the 100-year flood flow shown in the map point table (page 42) shall be updated to be consistent with the calculated value shown on page 72 of the THP.

Map Point 2. Prior to second review, the THP shall be updated to disclose the unstable area located downslope of Map Point 2 and to include any past documentation of the landslide. Additionally, Map Point 2 shall be updated to discuss the landslide and any potential impacts to the feature resulting from the proposed operations/mitigations.

Map Point 55. Prior to second review, Section II of the THP shall be updated to describe that the proposed culvert outlet will be located downslope of the fill failure deposit/debris where there is a well-defined watercourse channel (about 10 feet downslope of the existing metal flume outlet).

Map Point CGS-1. Prior to second review, the THP shall be revised to disclose the unstable area and describe that operations shall be avoided on the unstable area.

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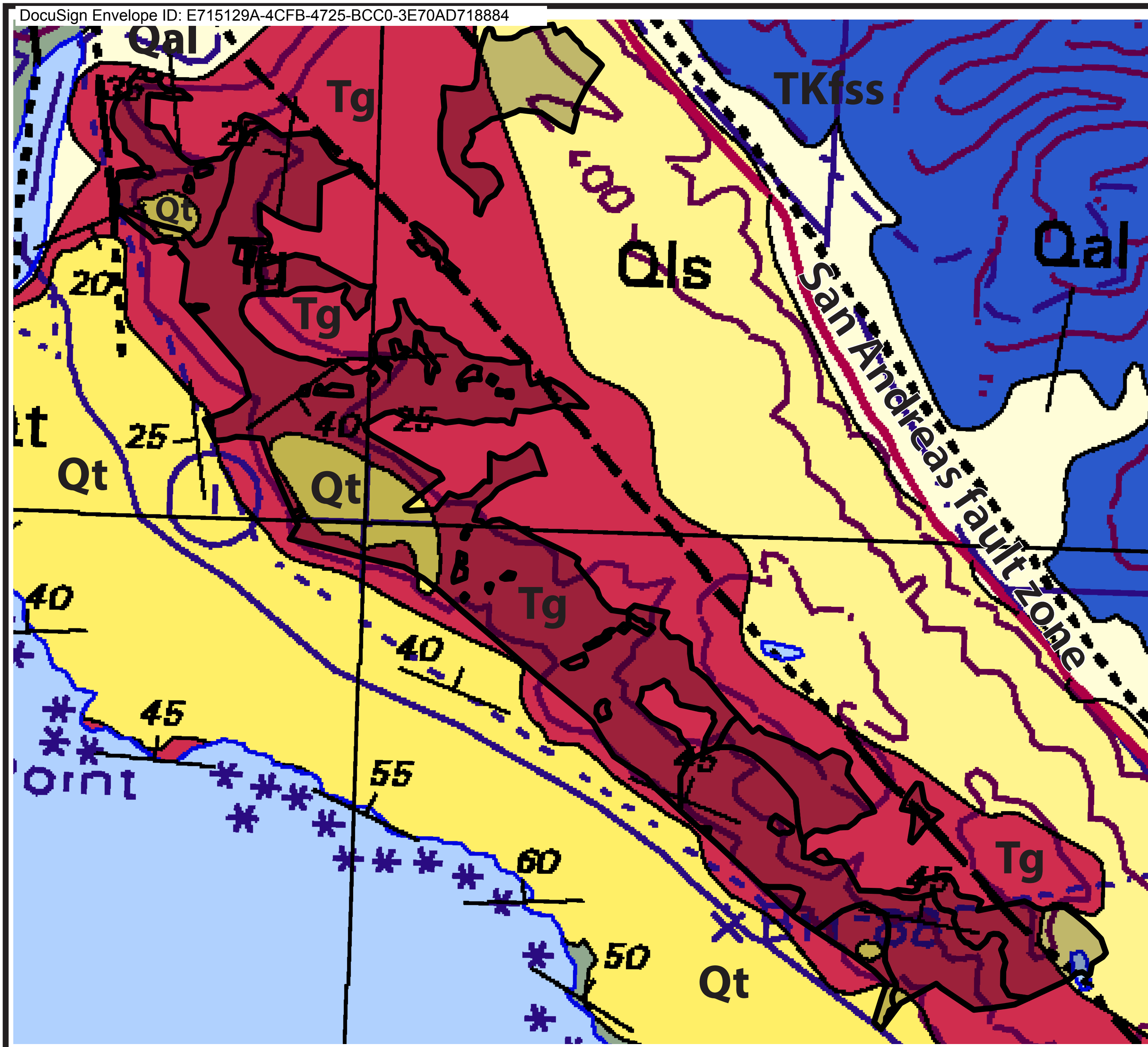
Attachments: Figures 1 through 7



Explanation

Qal	Alluvial fan and fluvial deposits
Qls	Landslide deposits
Qt	Alluvial and marine terrace deposits
Tg	German Rancho Formation
TKfss	Franciscan Complex - Coastal Belt Sandstone

Geologic contact, dashed where approximately located

Fault, dashed where approximately located

magenta is Quaternary active fault, dashed where approx. located

75 Strike and dip of bedding

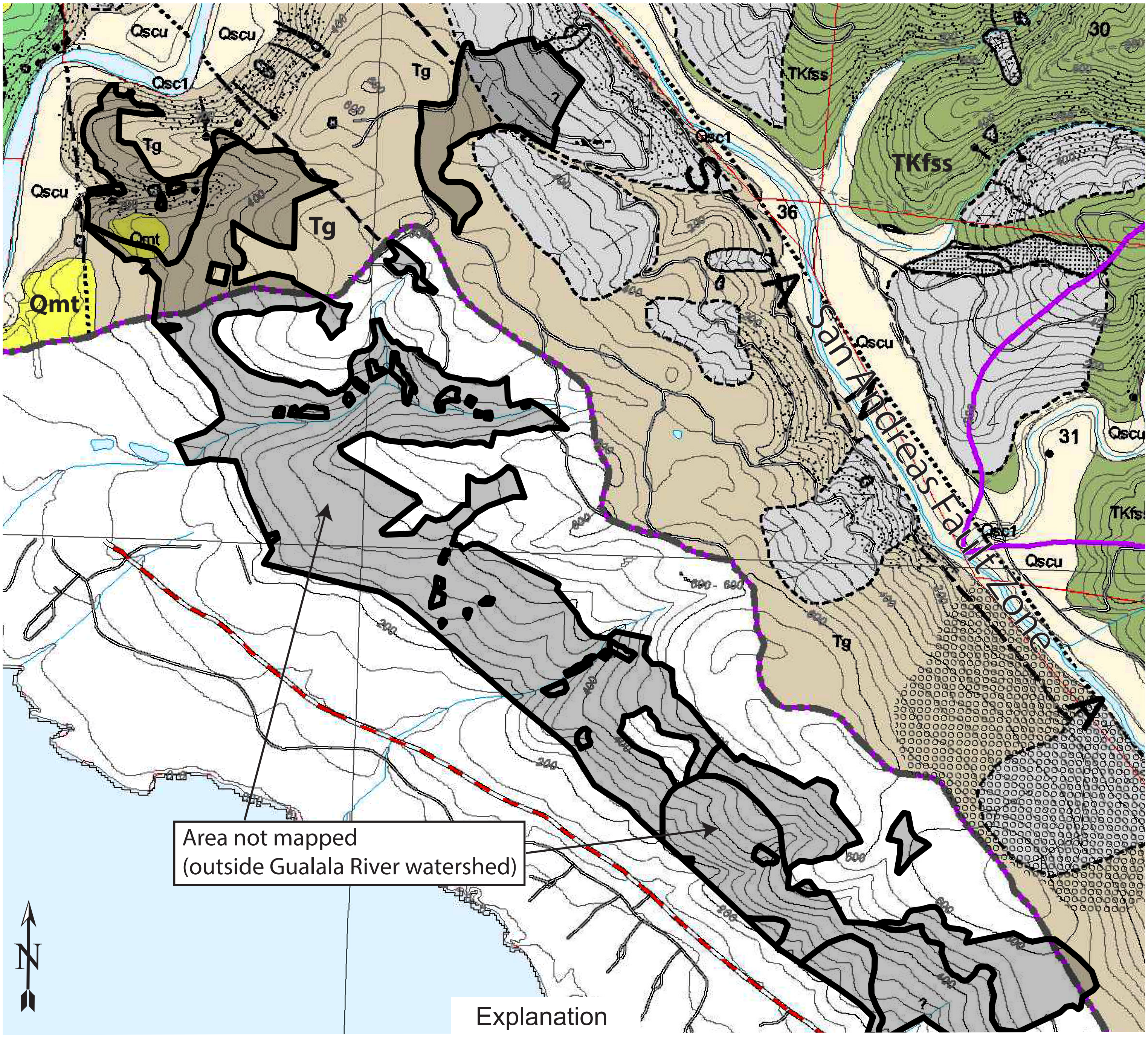
Shaded area represents estimated limits of proposed harvest area.

0 1000' 2000'

N

Base Map: Modified from Blake and others (2002)

Date: 1/2024	Regional Geologic Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON	Figure: 1
Scale: 1" = 2000'		



Explanation

0 1000' 2000'

Watershed sub-basin boundary

Geologic contact, dashed where approximately located

Inner gorge

Active Landslide (too small to show at map scale)

Rotational/Translational Landslide

Earthflow

Debris Slide

Debris Flow/Torrent Track

Debris Slide Amphitheater/ Slope

Disrupted ground

Slopes >70 percent

75 Strike and dip of bedding

Shaded area represents estimated limits of proposed harvest area.

Qmt	Marine terrace deposits
Qscu	Undifferentiated stream channel deposits
Qsc1	Stream channel deposits
Tg	German Rancho Formation
TKfss	Coastal Belt Franciscan - marine sandstone

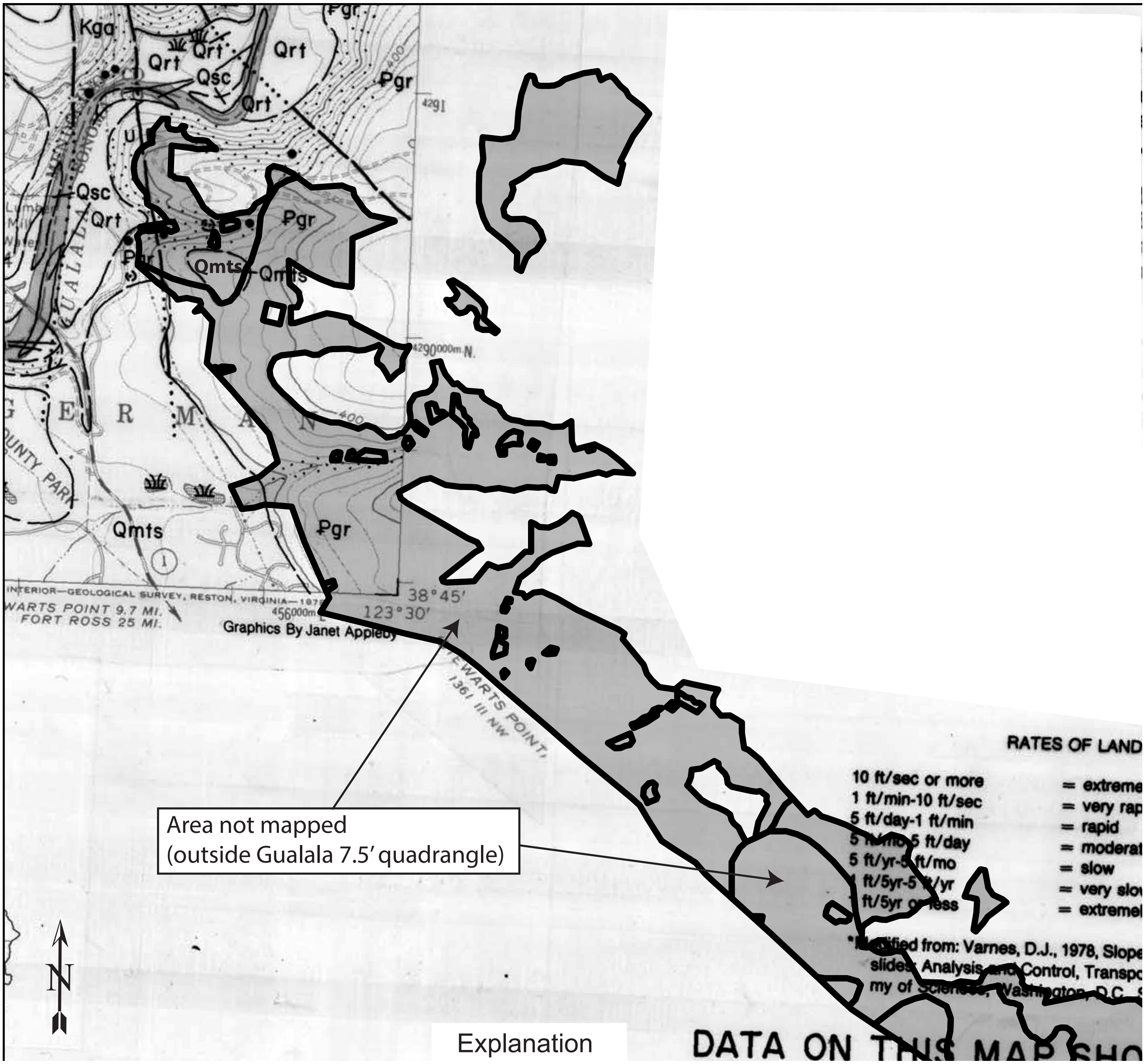
Base Map Modified from: Fuller and others (2002)

Date: 1/2024

Scale: 1" = 2000'

Regional Geologic Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON

Figure: 2



Explanation

Qsc	Stream/River Channel Deposits
Qrt	Alluvial Terrace Deposits
Qmts	Marine Terrace Deposits
Pgr	German Rancho Formation
Kga	Anchor Bay Member, Gualala Formation
TKfs	Coastal Belt Franciscan

Geologic contact, dashed where approximately located

Rotational/Translational Landslide

Earthflow

Debris Slide

Debris Flow/Torrent Track

Debris Slide Amphitheater/Slope

Inner gorge

Active Landslide (too small to show at map scale)

Disrupted ground

Slopes >70 percent

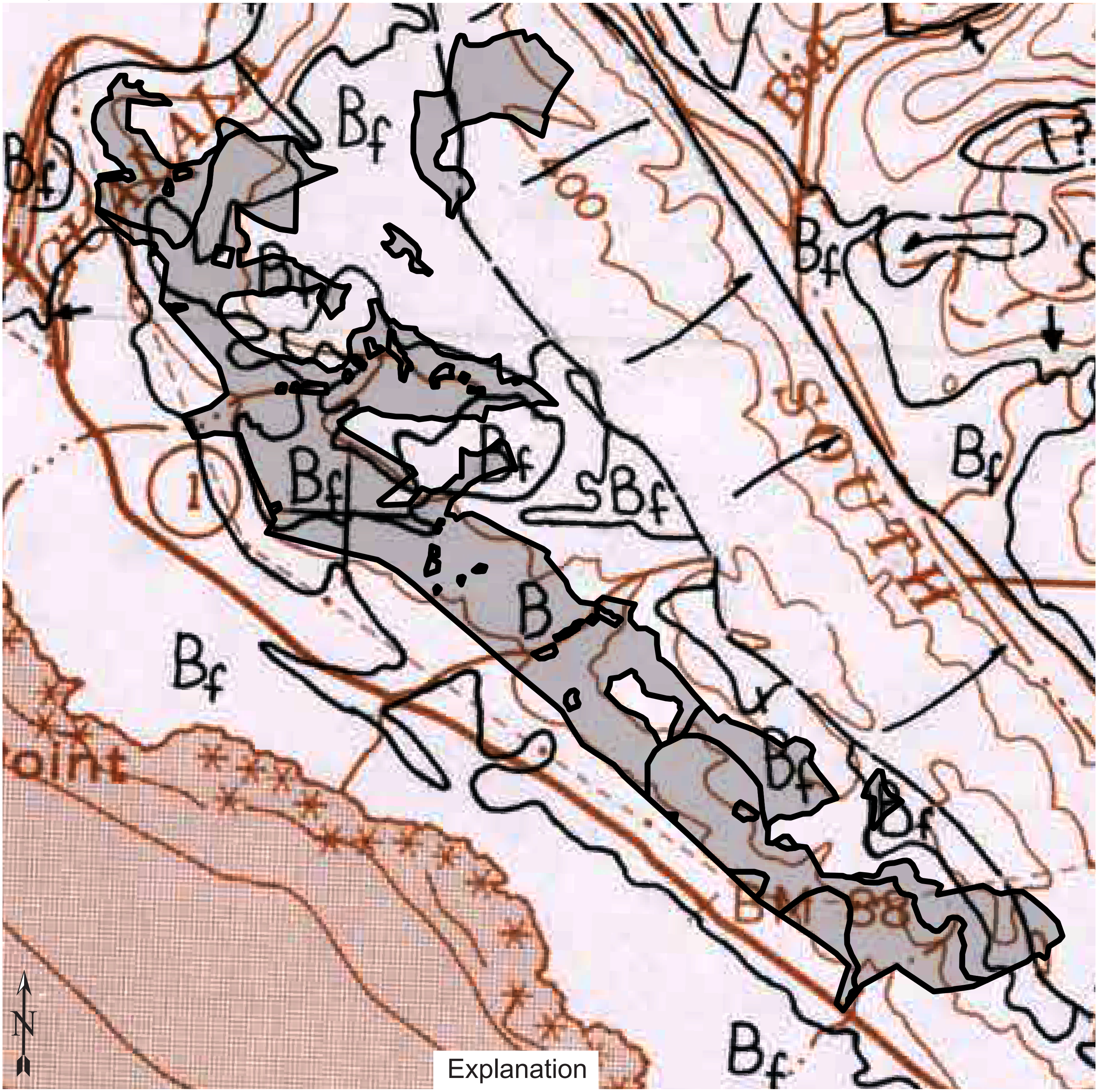
75 Strike and dip of bedding

Shaded area represents estimated limits of proposed harvest area.

0 1000’ 2000’

Base Map Modified from: Davenport (1984)

Date: 1/2024	Regional Geologic Map To Accompany Engineering Geologic Review of 1-23-00099 SON	Figure: 3
Scale: 1" = 2000'		



Explanation

Shaded area represents estimated limits of proposed harvest area.

Landslide

Questionable Landslide

Landslide or severe soil creep too small to be outlined at map scale

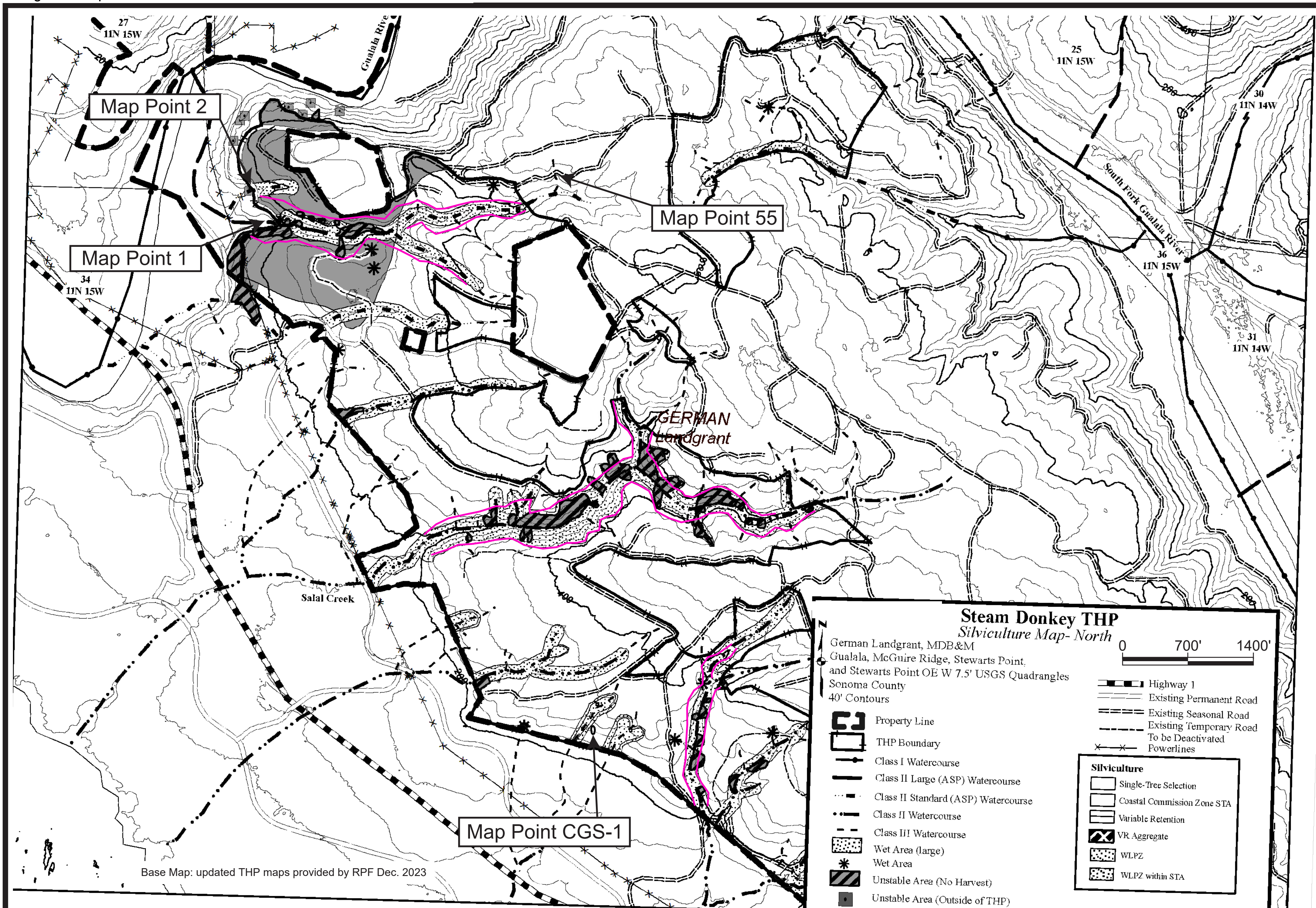
0 1000' 2000'

Base Map: Huffman and Armstroing, 1980

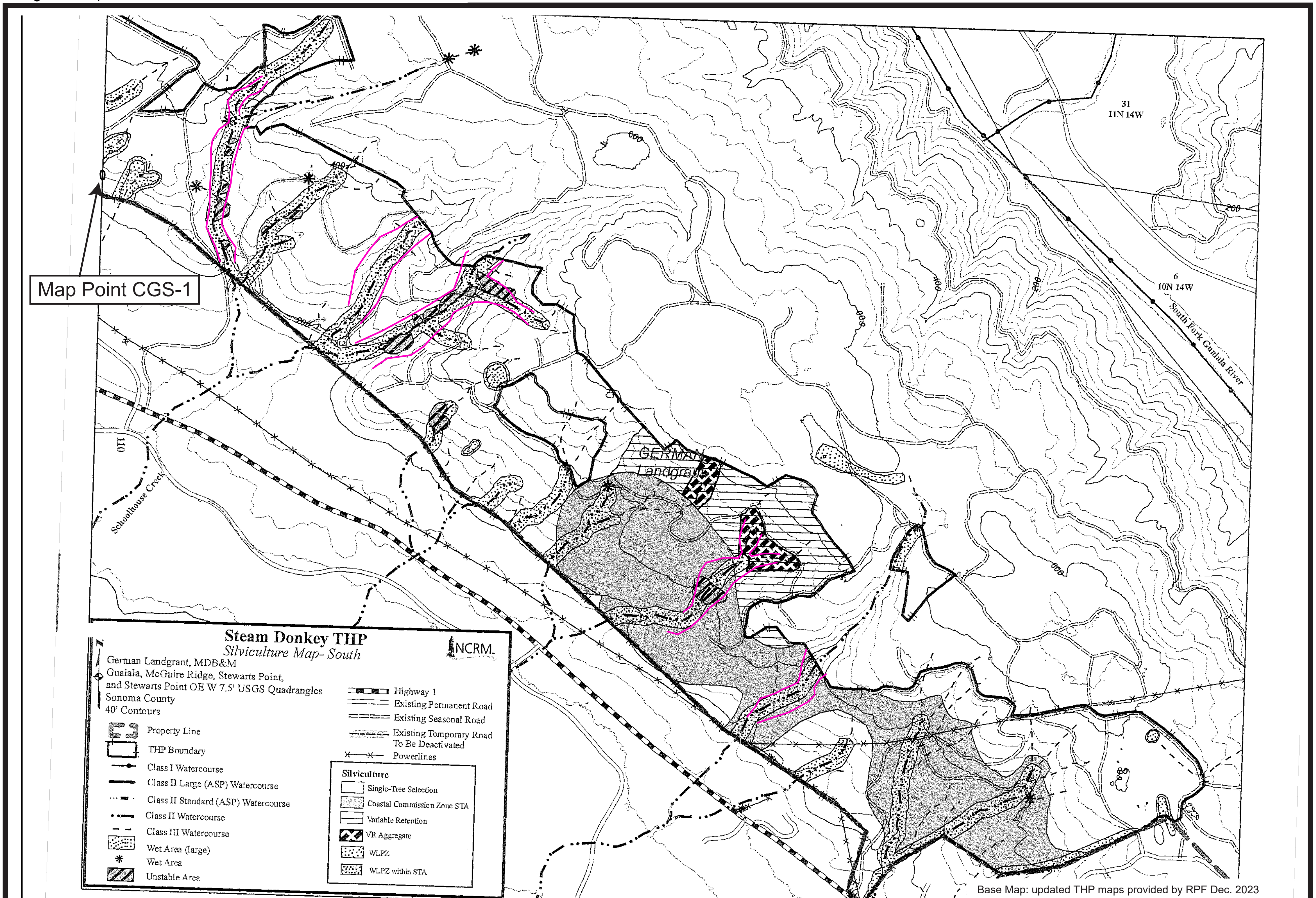
Bf = locally level areas within hilly terrain; may be underlain or bounded by unstable or potentially unstable rock materials

B = areas of relatively stable rock and soil units, on slopes great than 15%, containing few landslides

Date: 1/2024	Regional Landslide Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON	Figure: 4
Scale: 1" = 2000'		



Date: 1/2024	Site Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON	Figure: 5	**Explanation** break in slope marking upper boundary of inner gorge geomorphology within THP boundaries Map Point — CGS Map Point (see report text)
Scale: 1" = 1400'			



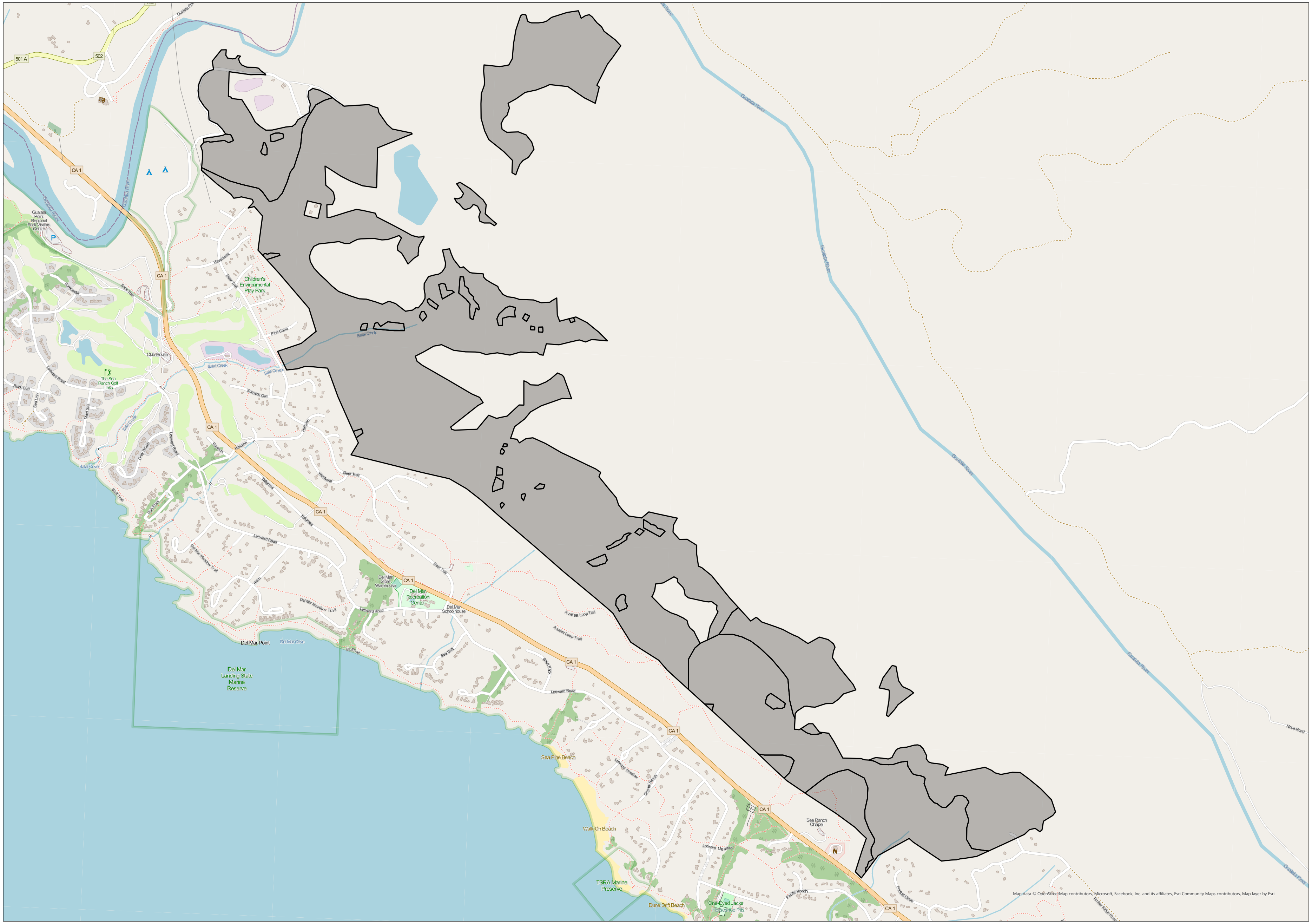
Date: 1/2024	Site Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON	Figure: 6
Scale: 1" = 1200'		

Explanation

break in slope marking upper boundary of inner gorge geomorphology within THP boundaries

Map Point — CGS Map Point (see report text)

0 600' 1200'



Date: 1/2024	Site Map To Accompany Engineering Geologic Review of THP 1-23-00099 SON	Figure: 7	Open Street Map Layer by ESRI showing public roads and highways (white and orange) and residential structures and developments (gray polygons) in proximity to THP area.
Scale: 1" = 2200'			

0 1100' 2200'