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State of California

Natural Resources Agency

Memorandum

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Date: November 4, 2019

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Subject: Hydrologic and Biologic Review of THP 1-18-095 MEN

This memorandum reports the results of a focused Pre-Harvest Inspection (PHI) for the Little THP (1-18-095 MEN). Field inspection participants for the PHI held on August 29, 2019 included the following individuals:

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The purpose of this focused PHI and field review was to assess whether the 2019 California Forest Practice Rules (FPRs) are accurately being followed for the Little THP regarding (1) channel migration zone (CMZ) determination, (2) flood prone area determination and protection measures, and (3) potential anadromous fisheries impacts for unconfined reaches of the Little North Fork of the Gualala River.

I. Introduction

The need for the additional focused PHI for the Little THP stems from a difference in interpretation by the Review Team agencies regarding the FPR definitions related to the Anadromous Salmonid Protection (ASP) rules and rule application of the channel migration zone and flood prone area concepts. The definition and rule application of channel migration zones and flood prone areas are linked within the FPRs such that the delineation of the channel migration zone is sometimes necessary before the extent of the flood prone area can be determined. This is the case for the Little THP. As such, the 2019 FPR rule definitions are as follows:

Channel Migration Zone means the area where the main channel of a Watercourse can reasonably be expected to shift position on its floodplain laterally through avulsion or lateral erosion during the period of time required to grow forest trees from the surrounding area to a mature size, except as modified by a permanent levee or dike. The result may be the loss of beneficial functions of the Riparian zone or Riparian habitat.

Flood Prone Area means an area contiguous to a Watercourse Channel Zone that is periodically flooded by overbank flow. Indicators of flood prone areas may include diverse fluvial landforms, such as overflow side channels or oxbow lakes, hydric vegetation, and deposits of fine-grained sediment between duff layers or on the bark of hardwoods and conifers. The outer boundary of the flood prone area may be determined by field indicators such as the location where valley slope begins (i.e., where there is a substantial percent change in slope, including terraces, the toes of the alluvial fan, etc.), a distinct change in soil/plant characteristics, and the absence of silt lines on trees and residual evidence of floatable debris caught in brush or trees. Along laterally stable Watercourses lacking a Channel Migration Zone where the outer boundary of the flood prone area cannot be clearly determined using the field indicators above, it shall be determined based on the area inundated by a 20-year recurrence interval flood flow event, or the elevation equivalent to twice the distance between a thalweg riffle crest and the depth of the channel at Bankfull stage. When both a Channel Migration Zone and flood prone area are present, the boundaries established by the Channel Migration Zone supersede the establishment of a flood prone area.

The FPRs illustrate the close spatial arrangement of the channel migration zone and flood prone area (see CCR § 895.1; page 7, Figure 1 of the 2019 FPRs). Channel migration zones are best viewed as zones of historic and potential channel erosion where the channel is likely to move through lateral erosion (e.g., meandering) or sudden shifting (i.e., avulsion) during a specified time frame (e.g., <70 years for high site coast redwood). Conversely, flood prone areas are areas of deposition and overbank flooding. Generally, channel migration zones are afforded the same protection as watercourses, whereas flood prone areas are allowed to have more intensive timber operations. As mentioned previously, a key step before determining the spatial extent of the flood prone area is to determine the presence and spatial extent of the channel migration zone.

In this focused PHI report, we provide (1) a brief historical perspective on these topics from past THP reviews and information provided in a 2005 Riparian Protection Committee final report, (2) a detailed channel migration zone evaluation, (3) a flood prone area determination for this THP, (4) a brief anadromous fisheries impact assessment, and (5) conclusions for the Little THP.

II. THP Setting and Historical Perspective

THP Setting

The Little THP is within the Doty Creek CalWater 2.2.1 Planning Watershed located at the southern extent of Mendocino County. Winter-run steelhead trout (*Oncorhynchus mykiss*) from U.S. Fish and Wildlife Service Northern California Distinct Population Segment (DPS) and coho salmon (*Oncorhynchus kisutch*) have current and/or historic populations that extend into the watershed. The Northern California steelhead DPS is listed as threatened under the federal Endangered Species Act (ESA) and coho salmon are listed as threatened under the federal ESA and endangered under the California Endangered Species Act. As a result of their presence and listing status, the Doty Creek planning watershed is identified as an Anadromous Salmonid Protection watershed and subject to the provisions of 14 CCR § 916.9.

Cassidy and Lily THPs

A historical perspective for the Little THP area is provided by PHI reports written for THPs 1-00-101 MEN (Cassidy THP) and 1-04-032 MEN (Lily THP), located in the Main Fork, the North Fork, and the lower part of the Little North Fork of the Gualala River.[1] The area included in the 032 plan was similar to what was proposed in the 101 plan. Spittler (2004a,b) reported that “Inspections of aerial photographs taken in 1936, 1984, and 2000 reveal that the channel of the North Fork Gualala River has meandered within a narrow zone between the redwood floodplains (see figure below), which has remained remarkably stable for over 60 years. The 1984 photos document a widening of the channel compared with 1936, but much of this had recovered by 2000.”

Spittler (2004b) also states “Literature on avulsion (Ashworth and others, 2004); Berendsen and Stouthamer, 2002; Bryant and others, 1995, Committee on Alluvial Fan Flooding, Natural Resource Council, 1996; Kelberer and others, 2002; Kellerhals and Church, 1989; King County Department of Natural Resources and Parks, Department of Development and Environmental Services, Department of Transportation, 2004; Mount, 1995; Pittman and others, 2003; Slingerland and Smith, undated; Washington

[1] The portion of these plans in the Little North Fork watershed was never harvested. The last entry was between 1987 and 1992.

Environmental Council, 2002), document that avulsion occurs where the elevation of an active channel is above adjacent lands. This may occur on alluvial fans, in distributary deltaic systems, along low-gradient streams with well-defined meanders next to low-lying floodplains, and adjacent to areas with abrupt channel gradient flattening. As observed in the field, the existing channels of the Main Fork, the North Fork, and the Little North Fork of the Gualala River are all lower than the adjacent floodplains. In these areas the floodplains are well vegetated with redwood and other trees. When the roughness effects of vegetation are included in the avulsion assessment, stream flow velocity exhibited as basal shear of the existing channels is substantially greater than potential flow velocities elsewhere on the floodplain...No evidence of past avulsion in the THP area was observed in the field or on the aerial photographs. While there remains a remote possibility that a major river-damming landslide could occur near the THP area, the potential for the proposed harvesting to exacerbate the avulsion potential appears to be negligible."

Cafferata (2004), in a PHI report for 1-04-032 MEN, evaluated Unit 15, which was located at the lower end of the Little North Fork watershed and encompasses the widest part of the floodplain currently included in the Little THP. It was determined that this unit was located on a more active floodplain than the other proposed logging units, based on characteristics provided in Benda (2004). It was concluded that Unit 15 was sensitive to timber harvest and should be given additional mitigation measures. These included (1) flagging all skid trails in the unit, (2) requiring all ground skidding equipment to remain on designated skid trails, and (3) requiring all side channels to remain open and free to flow water.

It is our opinion that the observations and recommendations from CGS and CAL FIRE written for the 101 and 032 plans remain relevant and should be considered during the review of the current subject THP.

Riparian Protection Committee's Flood Prone Area Considerations Report

Flood prone area determination has been heavily debated for over two decades by landowners and the Review Team agencies in California. The primary issues relate to identifying flood prone areas and determining the types and intensities of timber harvesting activities that will not adversely impact both the ecological characteristics of the floodplain and the ability of the floodplain to influence its adjacent channel (Benda, 2004). In response to these disagreements, the interagency Riparian Protection Committee was formed by CAL FIRE in 2005 to allow the state agencies to work collaboratively to reach common understandings on riparian issues related to harvesting operations on coast redwood-dominated floodplains and flood prone areas (Cafferata et al., 2005). Issues raised for THPs in the Gualala River and Big River watersheds in the early 2000's were reviewed by the Riparian Protection Committee to develop a better understanding of how to address related areas of concern in future plans.

The Riparian Protection Committee's final report describes a mutually agreeable process for flood prone area protection and restoration. The primary steps are to (1) inventory flood prone areas for all of the hydrologic, geomorphic, and biological functions present that may be affected by proposed timber operations; (2) determine the category of inundation of the flood prone area proposed for management (i.e., very frequent, frequent, moderately frequent, or infrequent), and (3) conduct an appropriate analysis for the functions present in light of possible significant adverse impacts from management.

The report also states that “disclosure and analysis requirements will increase with increased risk associated with the proposed level of activity, and with increased frequency of inundation of the flood prone area. In particular, management proposed within the 20-year recurrence interval floodplain in a watershed with anadromous fish habitat (particularly coho salmon habitat or restorable habitat) requires detailed analysis…If a flood prone area has an active channel migration zone, where a stream is prone to movement with near-term loss of riparian function and associated habitat adjacent to the stream, proposed practices will require more detailed analyses and additional mitigation than required for those channels that have remained laterally stable over many decades and can reasonably be expected to continue to exhibit stability in the future.”

Floodplain sensitivity to timber harvest activities is determined by the frequency of overtopping flows, impacts of harvesting on ecological characteristics of the floodplain, and impacts of harvesting on the ability of the floodplain to influence its adjacent channel. The Riparian Protection Committee’s final report documents that the area inundated at less than or equal to every 20 years is the most biologically critical area based on coho salmon life cycle requirements. Flood prone area frequency of inundations was defined as “frequent” for the 5-20 year recurrence interval.

Information from the Riparian Protection Committee’s final report was used when developing the Anadromous Salmonid Protection rule package that was adopted by the State Board of Forestry and Fire Protection (BOF) in October 2009 and implemented on the ground in January 2010 (e.g., CCR § 916.9 [936.9, 956.9](v)(5)—Section V site-specific riparian management).

III. Channel Migration Zone Determination

The primary goal of a channel migration zone evaluation is to predict floodplain, terrace, and hillslope areas at risk for channel erosion due to fluvial processes. This allows for the proper design and placement of watercourse and lake protection zones (WLPZs) so that riparian function (e.g., stream shading, large wood recruitment) can be protected and maintained, rather than degraded by channel erosion.

The plan proponent hired O’Connor Environmental, Inc. (OCE) to evaluate and delineate the channel migration zone for the Little THP. It is beyond the scope of this report to recreate the same analyses performed by Dr. Matthew O’Connor and his staff. Rather, the goal was to determine if Dr. O’Connor’s analysis was logical, reasonable based on the best available science, and supported by field evidence. To do so, CAL FIRE’s Watershed Protection Program (WPP) staff utilized a combination of (1) geospatial analysis of high quality digital elevation models (DEMs) available for the project area, (2) field observations made during the focused PHI, and (3) knowledge of relevant literature regarding channel migration processes and delineation.

Dr. O'Connor (Ph.D., CEG) and his staff performed the channel migration zone evaluation using the framework proposed within the Washington State Forest Practices Board (WFPB) Manual Section 2: Standard Methods for Identifying Bankfull Channel Features and Channel Migration Zones (WFPB, 2004). In turn, the WFPB (2004) Board Manual relies heavily on the method developed by Rapp and Abbe (2003) for delineating channel migration zones.

Rapp and Abbe (2003) delineate the channel migration zone based on a collection of identifiable components which include (Figure 1):

- The Historical Migration Zone (HMZ) – the collective area the channel occupied in the historical record. This is usually done through an analysis of aerial photos and satellite imagery.
- The Avulsion Hazard Zone (AHZ) – the area not included in the Historical Migration Zone that is at risk of channel avulsion over the timeline of the channel migration zone.
- The Erosion Hazard Area (EHA) – the area not included in the Historical Migration Zone or the Avulsion Hazard Zone that is at risk of bank erosion from stream flow or mass wasting over the timeline of the channel migration zone.
- The Disconnected Migration Area (DMA) – the portion of the channel migration zone where man-made structures physically eliminate channel migration.

Given these definitions, the channel migration zone can be defined by the following equation:

(1) Channel Migration Zone = HMZ + AHZ + EHA - DMA

Channel migration zone evaluations rely heavily on historical analysis and field assessments to solve Equation 1 and determine the spatial extent of the CMZ.

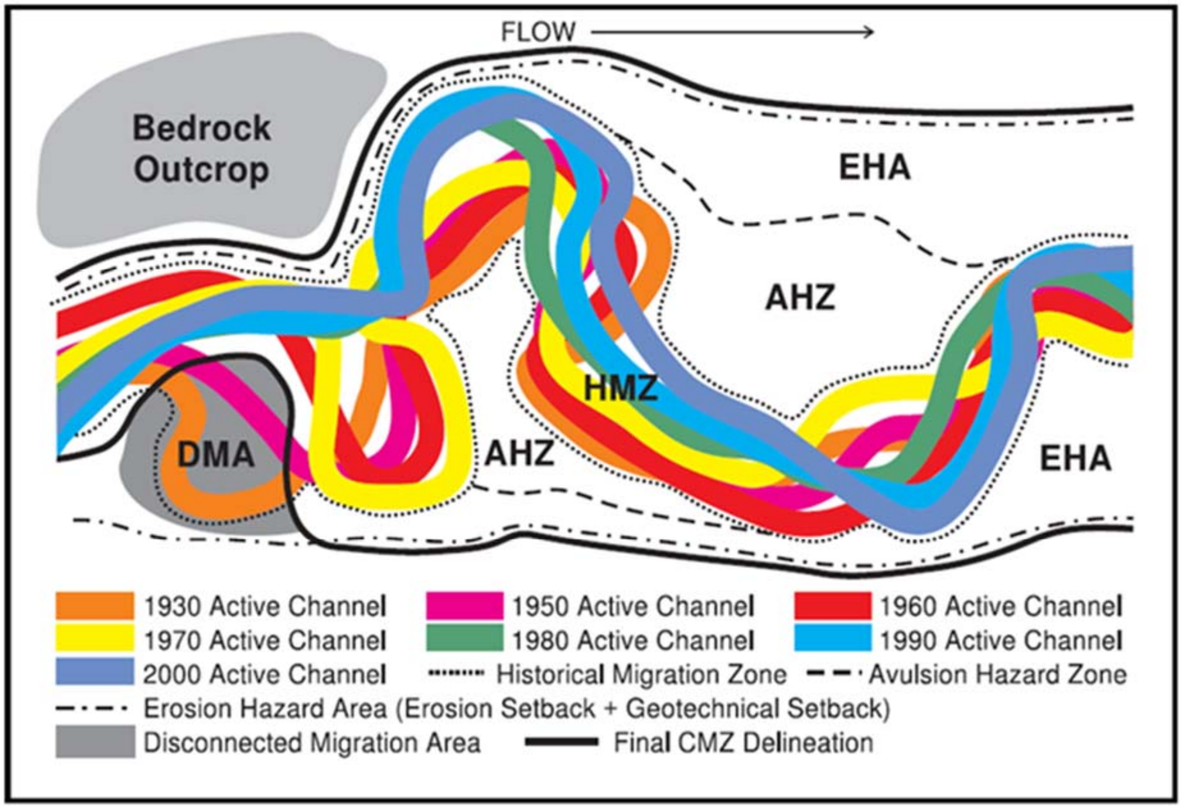

Figure 1. An example of the channel migration zone as a combination of the Historical Migration Zone, Avulsion Hazard Zone, Erosion Hazard Area, and Disconnected Migration Area based on historical and field analysis/interpretation (from Rapp and Abbe, 2003).

At the minimum, all migrating watercourses have Historical Migration Zones, but not necessarily an Avulsion Hazard Zone, Erosion Hazard Area, and/or Disconnected Migration Area. In the case of the Little THP, there is no Disconnected Migration Area, due to the lack of flood control infrastructure within the Little North Fork of the Gualala River floodplain. As such, Dr. O'Connor's analysis focuses on characterizing the spatial extent of the Historical Migration Zone, Avulsion Hazard Zone, and/or Erosion Hazard Area.

Dr. O'Connor's channel migration zone report (OCE, 2019a) first evaluated the extent of the Historical Migration Zone by using 14 series of aerial photographs taken over a 58-year period (1952 to 2010). Dr. O'Connor did not observe evidence of significant channel migration between photo series, but also noted that it was difficult to see the channel due to canopy. However, he did note that if channel migration occurred during this period, it would have left evidence of vegetative disturbance and/or multiple age classes of vegetation. Dr. O'Connor (OCE, 2019a) summarized his evaluation of the available aerial photography with the following statement:

> "The absence of the characteristic signature of channel migration in historic aerial photography is a significant finding. Significant channel migration by gradual

> bank erosion or by avulsion erodes the floodplain or terrace to a depth comparable to the existing channel; this erosion would undermine existing forest vegetation leaving linear or curvilinear gaps in the forest canopy that are readily apparent in aerial photography. If channel migration processes are present, there is typically evidence of past channel migration in the form of distinctive patterns of vegetation corresponding to seral stage of forest vegetation associated with disturbance. <u>In my professional and academic experience, significant channel migration on a valley floodplain of this size would be evident in this aerial photo record, particularly considering the large number of photo sets (14), their frequency (the longest gap was only 15 years from 1973-1988), and quality (photo sets complete with stereo pairs in good condition).</u>"

This clearly indicates that Dr. O'Connor found very little evidence of historic channel migration in the photo record.

Despite the photo record showing no indication of previous channel migration, it was still necessary to perform field assessments to determine whether an Avulsion Hazard Zone and/or Erosion Hazard Area were present on the floodplain. Dr. O'Connor used results from hydrologic and hydraulic modeling (OCE, 2019b), high quality topographic data, and field locations identified from previous site visits to guide in the field assessment.

CAL FIRE WPP staff used remotely sensed data to determine if the field sites investigated were appropriate and/or comprehensive enough to allow for reasonable channel migration zone delineation. The availability of 1-meter LiDAR digital elevation models (DEMs), flown in 2017 for Mendocino County, allowed for processing of the topographic data to further aid in the evaluation of the channel migration zone. The generation of shaded relief (i.e., hillshade) and a relative elevation model (REM) provide a visualization of the subtle landforms on floodplains and valley bottoms necessary for channel migration zone delineation (Olson et al., 2014).

CAL FIRE WPP staff generated multiple relative elevation model maps on a reach scale (five reaches in total) using methods contained within the Washington State Department of Ecology document titled "A Methodology for Delineating Planning-Level Channel Migration Zones" (Olson et al., 2014) to determine whether the field sites assessed during the channel migration zone evaluation were reasonable to allow for CMZ delineation (see Appendix A). These relative elevation models represent floodplain elevations relative to the stream centerline, thereby detrending changes in elevation in the downstream direction. Reaches were delineated based on changes in flow due to significant tributary influx. The modeled areas of the floodplain are shown in Figure 2.

In the following sections, the relative elevation model reach maps are used in conjunction with CAL FIRE WPP field observations to confirm or dispute the analysis performed by Dr. O'Connor.

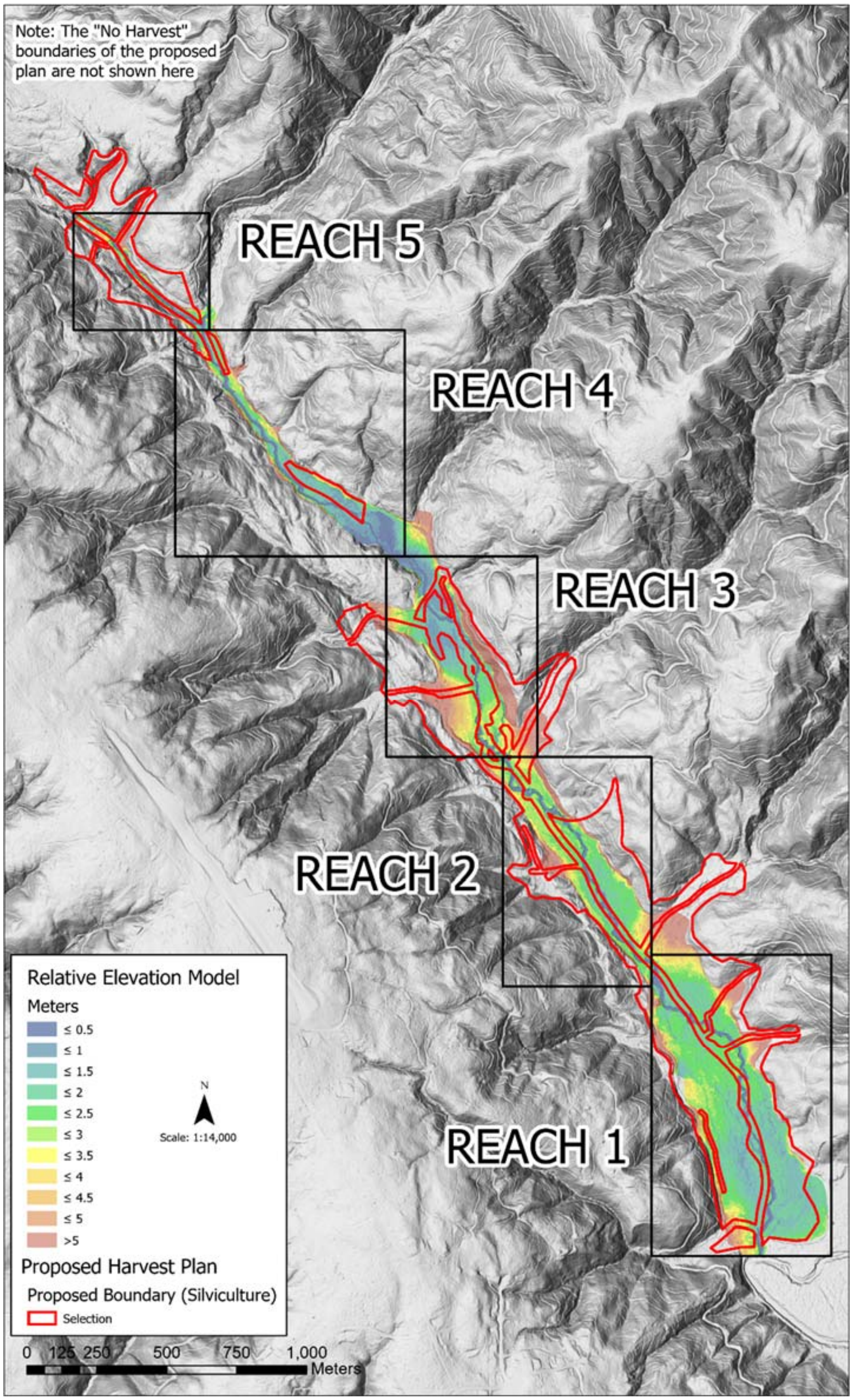

Figure 2. A relative elevation model produced by CAL FIRE WPP staff to help verify the channel migration zone evaluation provided by the plan proponent. The five relative elevation model reaches are displayed, as well as the THP unit boundaries.

Site 1

Site 1 is within Reach 1 at the lower end of the Little North Fork of the Gualala River and is shown in Figure 3. Dr. O'Connor identified and evaluated Site 1 based on concerns by CDFW that the area was subject to potential avulsion from the Little North Fork of the Gualala River. The relative elevation model confirms the presence of potential overbank flooding in the vicinity. However, the relative elevation model indicates that this flooding is generally dispersed rather than concentrated into channelized flowpaths.

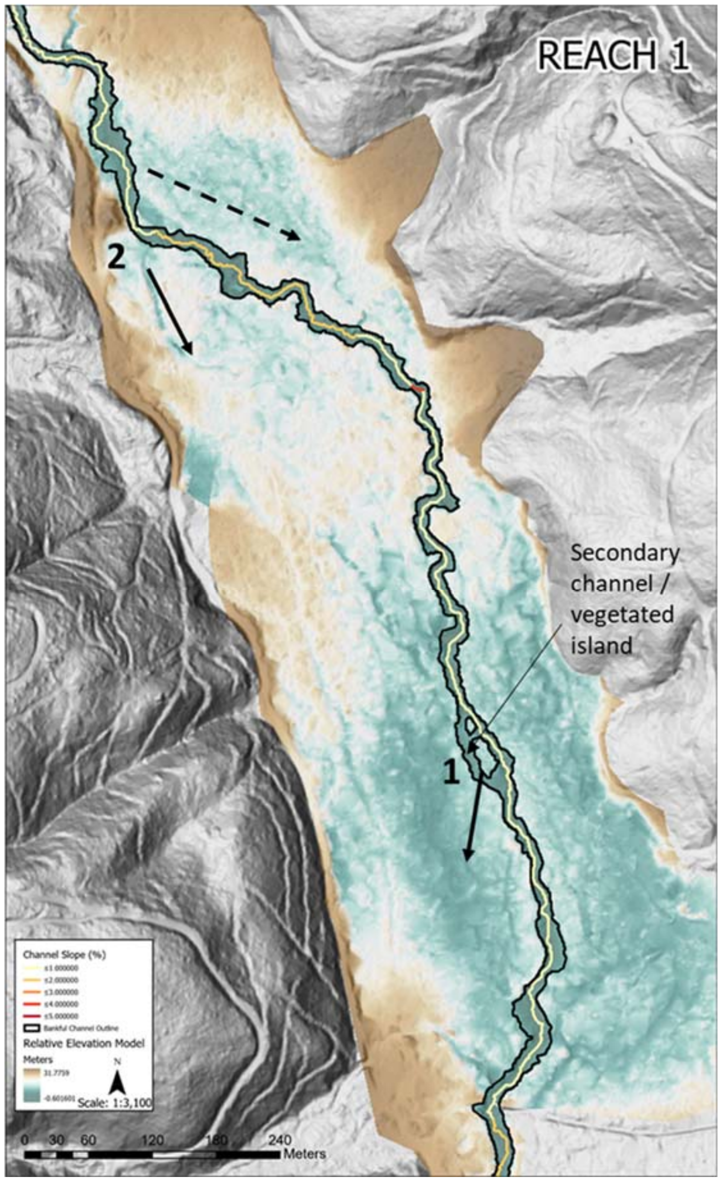

Figure 3. Relative elevation map of Reach 1 of the Little North Fork of the Gualala River. Numbers refer to sites assessed in the O'Connor channel migration zone evaluation (OCE, 2019a). Arrows represent potential flowpaths evaluated in the field.

Dr. O'Connor noted the presence of secondary channels that create small vegetated islands upstream of Site 1, and noted it as a form of small scale channel migration that is characteristic throughout the Little North Fork Gualala River. He also suggested that the secondary channel be given Class I watercourse protection. Dr. O'Connor noted that a right-bank[2] linear to curvilinear swale was present down gradient of the secondary channel (Figure 4), but stated that the flowpath was distributary in nature and did not reconnect with the primary channel. He concluded that the swale did not have the erosive power to create a new primary/secondary channel. CAL FIRE WPP staff observations were consistent with those noted by Dr. O'Connor. Avulsion potential is greatly increased when the floodplain flowpath gradient is 3-5 times greater than that of the primary/secondary channel (WFPB, 2004). Staff measured the slope of the secondary channel and swale feature and found them to be approximately equal (≈1%), indicating a relatively low potential for avulsion.

Figure 4. The secondary channel and broadly convergent right-bank floodplain surface at Site 1.

[2] Right- or left-bank refers to the location of a feature relative to the bank of the primary channel when looking in the downstream direction.

Site 2

Site 2 is within Reach 1 and is shown in Figure 3. Dr. O'Connor identified and evaluated Site 2 based on concerns by CDFW that the area was subject to potential avulsion from the primary channel of the Little North Fork of the Gualala River. The relative elevation model confirms the presence of a curvilinear feature in the vicinity that could act as a potential flowpath. The relative elevation model indicates that this feature is disconnected from the main channel in downstream direction, and is generally narrower than the active channel.

Dr. O'Connor characterized Site 2 as a right-bank floodplain feature that acted as a distributary flowpath and did not rejoin the primary channel of the Little North Fork of the Gualala River. Dr. O'Connor suggested that the feature may be an old skid trail or road. Overall, he determined the avulsion potential as being low because: water was dissipated across the floodplain in the downslope direction; the floodplain feature lacked bedload and was comprised of silt and sand deposits; and the fact that a large left-bank overflow floodplain feature (see dashed arrow on Figure 3) would moderate the amount of flow that could travel down the right-bank floodplain feature.

The observations and rationale provided by Dr. O'Connor were confirmed by CAL FIRE WPP staff. Staff determined the water surface elevation would have to rise by 5-6 feet (Figure 5) before it would access the right-bank floodplain feature. The 20-year recurrence interval storm is predicted to overtop this feature (OCE, 2019a), but did not show signs of recent overtopping. The slope of the floodplain feature was approximately three times greater than that of the primary channel (1.5% vs. 6%). However, the steeper surface only persisted for approximately 100 feet before flattening to a gentler slope. The feature does have characteristics that indicate it might have been a skid trail at one time, as the soil appeared compacted and had the same approximate width of a skid trail. The relative elevation model shows strong evidence that the feature acts more as a flooding and depositional flowpath rather than as a potential avulsion pathway. Staff also noted the presence of the left-bank overflow floodplain feature noted in Dr. O'Connor's report, and this is expected to convey most of the overbank flow, rather than the right-bank feature, during a storm event.

Figure 5. A view of the potential flowpath at Site 2. The water surface elevation would have to rise 5 to 6 feet to reach the elevation of this floodplain surface.

Site 3

Site 3 is within Reach 2 and is shown in Figure 6. Dr. O'Connor identified and evaluated Site 3 based on the presence of secondary channels and a series of islands similar to those at Site 1. The relative elevation model confirms the presence of split flowpaths in the vicinity of Site 3, including some upstream of the area evaluated by Dr. O'Connor.

Dr. O'Connor characterized Site 3 as primary and secondary channels separated by vegetated islands. He further stated that the secondary channels should receive Class I protection (Figure 7). CAL FIRE WPP staff confirmed these observations and agree with the recommendation to treat the secondary channels as a Class I watercourse.

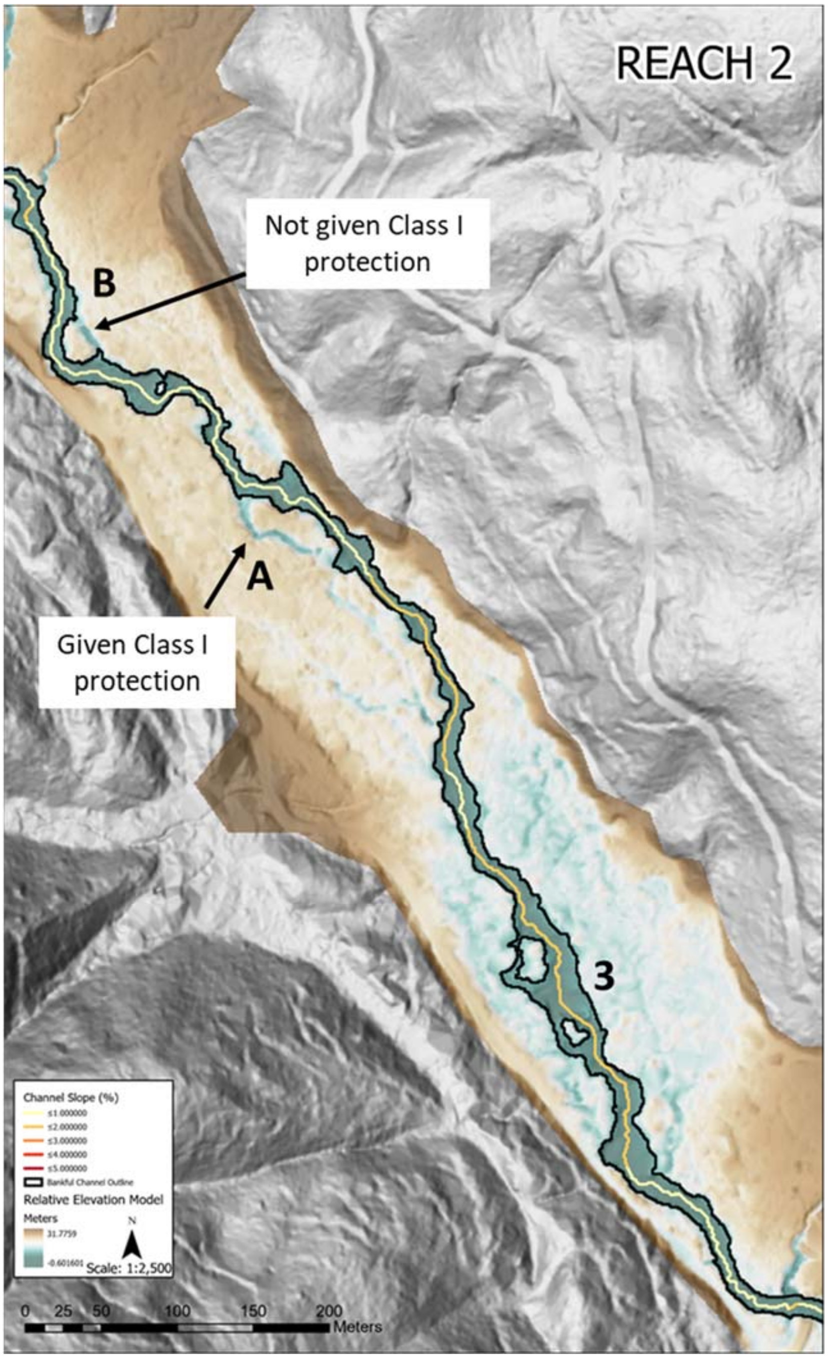

Figure 6. Relative elevation model of Reach 2 of the Little North Fork of the Gualala River. Numbers refer to sites assessed in the O'Connor channel migration zone evaluation. Alphabetical designations represent areas with secondary channel or potential secondary channels.

The relative elevation model indicates two locations upstream of Site 3 that showed similar signs of secondary channel development. Site A (Figure 6) indicates the presence of a possible secondary channel. Revised silviculture maps submitted by the plan proponent indicate this feature has proposed Class I watercourse protection. Site B (Figure 6) shows another location along the Little North Fork of the Gualala River where a secondary channel may also be present. The revised silviculture maps indicate that this potential secondary channel has not been given Class I watercourse protection. It was also not evaluated by Dr. O'Connor in his report. As a result, we suggest that this area be evaluated for the presence of a secondary channel, and the need for Class I watercourse protection (**Recommendation 1**).

Figure 7. A secondary channel at Site 3. This channel received Class I watercourse protection.

Site 4

Site 4 is within Reach 3 and is shown in Figure 8. Dr. O'Connor identified and evaluated Site 4 because it is a left-bank flowpath that was predicted to have flow with the hydraulic modeling study (OCE, 2019b). The relative elevation model shows clear evidence of a defined flowpath on the left bank that has potential upstream and downstream connectivity with the primary channel. Dr. O'Connor identified this area as possibly being influenced by an old road with a high likelihood of avulsion, and identified the area as channel migration zone for approximately 1000 feet. Additionally, red alder stands were evident in this area using the 1988 aerial photos. The area between the left-bank flowpath and the primary channel fits the criteria of an Avulsion Hazard Zone.

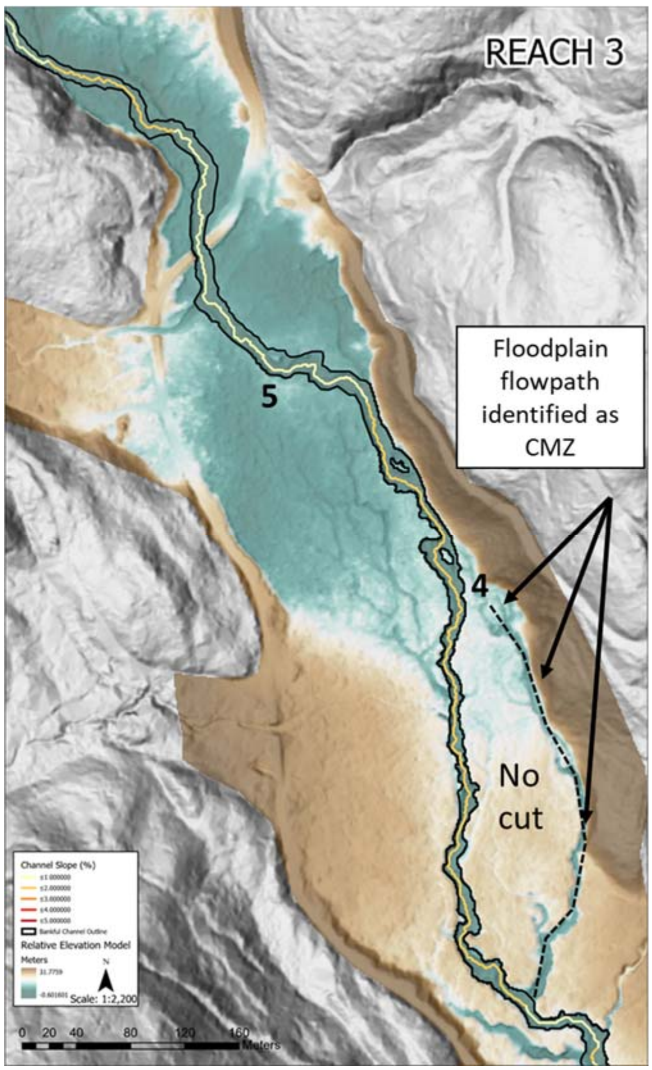

Figure 8. The relative elevation model map for Reach 3. Numbers refer to sites assessed in the O'Connor channel migration zone evaluation (Sites 4 and 5). Site 4 refers to the entire flowpath defined by the dashed line. The area between the dashed line and the primary channel, labeled as "no cut", and can be considered an Avulsion Hazard Zone.

CAL FIRE WPP staff agree with this assessment. Staff noted that the upstream end of this flowpath is approximately three feet higher than the existing channel, and is located within a bend in the channel with a large woody debris jam directly downstream. Form roughness in combination with in-channel large woody debris roughness (Figure 9) has the potential to cause a rise in water surface elevation which could shift the main flow to this left-bank flowpath.

Figure 9. The upstream end of the Site 4 flowpath. Note the large woody debris jam in the background.

Site 5

Site 5 is within Reach 3 and is shown in Figure 8. Dr. O'Connor identified and evaluated Site 5 due to its potential as a source of landslide and/or alluvial fan sediments that may affect the downstream avulsion potential at Site 4. The relative elevation model indicates that much of the floodplain is likely inundated during flood events, and there is clear evidence of an alluvial fan from a left-bank tributary upstream from Site 5. Dr. O'Connor stated that the area was subject to extensive overbank flooding but should not be considered a channel migration zone.

CAL FIRE WPP staff agree with the assessment provided by Dr. O'Connor. Evidence of abrasion on the base of snags showed that floodplain depths can reach two feet above the bankfull elevation (Figure 10). There was no evidence of abandoned channels that could act as potential avulsion flowpaths.

Figure 10. Evidence of abrasion on the base of a snag illustrating floodplain depths can reach two feet above the bankfull elevation (red line).

Site 6

Site 6 was investigated by Dr. O'Connor due to the potential presence of secondary channels as indicated by the hydraulic model simulation (OCE, 2019b). The relative elevation model (Figure 11) indicates the potential for extensive overbank flooding near Site 6. In his report, Dr. O'Connor mentioned the presence of a landslide that impinged on the Little North Fork of the Gualala River, with the potential to cause the channel to shift its position (OCE, 2019a). However, he concluded that the landslide did not trigger an avulsion of the Little North Fork of the Gualala River. Dr. O'Connor concluded that the area is not a channel migration zone.

CAL FIRE WPP staff agree with the Dr. O'Connor's assessment. Staff noted silt lines of approximately 1.7 feet on the floodplain. However, there were no signs of abandoned channels in this area. Staff noted an area of bank erosion at a small bend in the Little North Fork of the Gualala River, but it appears relatively stable as the relative elevation model shows no signs of lateral erosion (e.g., meander scrolls) nearby. A clump of large redwood trees tipped into the channel during the winter of 2018-2019 here but has not caused channel movement (Figure 12).

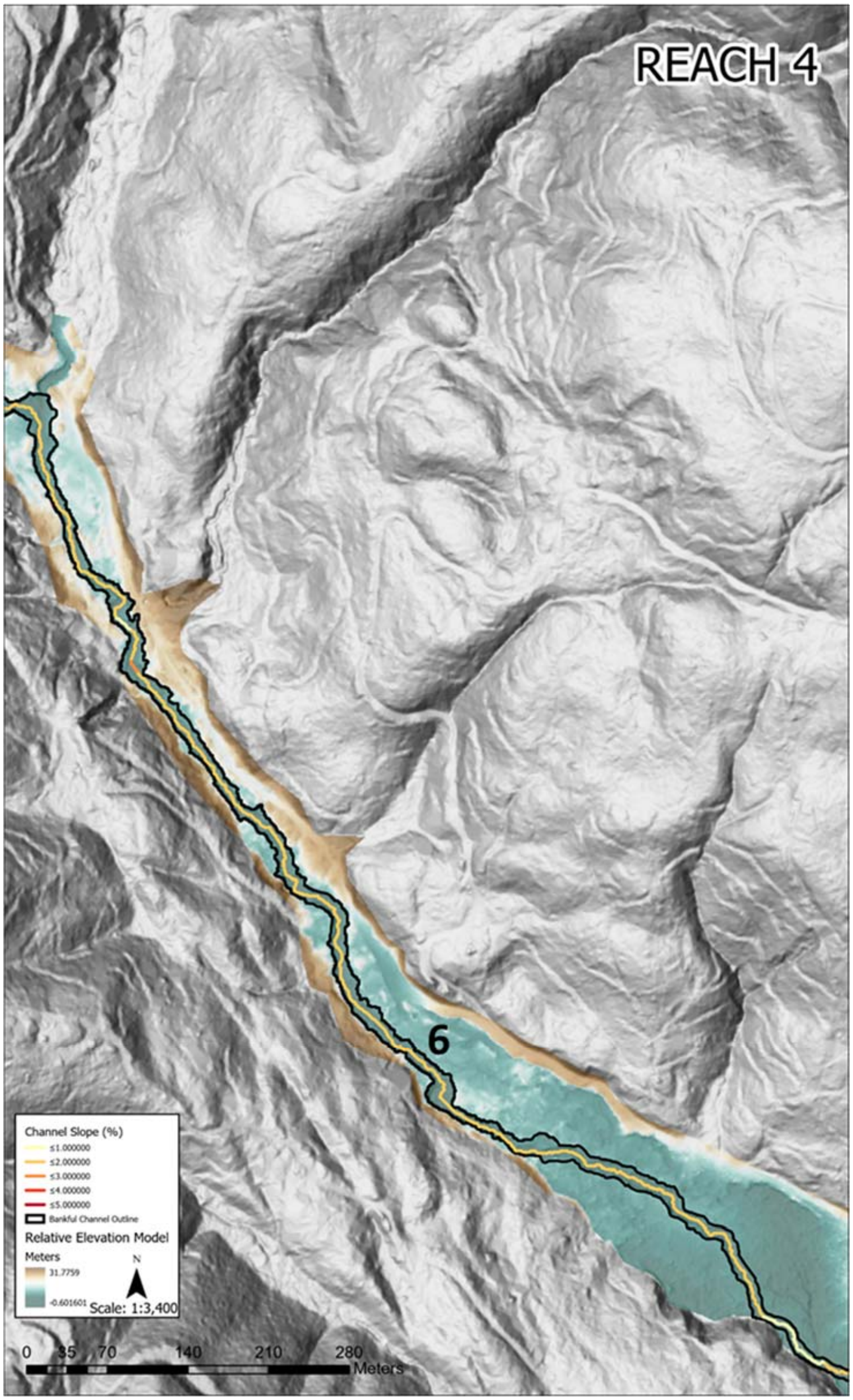

Figure 11. The relative elevation model for Reach 4. The number refers to the site assessed in the O'Connor channel migration zone evaluation (Site 6).

Figure 12. Coast redwood trees that recently entered the Little North Fork of the Gualala River channel at Site 6.

Channel Migration Zone Determination for the Little North Fork of the Gualala River

In his summary statement, Dr. O'Connor stated that within the Little North Fork of the Gualala River floodplain there is a lack of visible channel migration processes in the aerial photo record (OCE, 2019a). This indicates that the Historical Migration Zone is very limited in its spatial extent. A combination of field evaluation and hydraulic model simulations suggest that the spatial extent of channel migration is limited to a narrow band around the primary channel where woody debris can split flow and cause the development of secondary channels. Most of the secondary channels have been given Class I watercourse protection apart from area B identified within Reach 2 (Figure 6). The exception is the avulsion pathway identified at Site 4, which shows a clear abandoned flowpath with upstream and downstream connectivity. Dr. O'Connor concludes that despite the extensive evidence of overbank flow, flood flows are generally dispersed and have insufficient energy to erode channels that would trigger channel avulsion.

Data from the relative elevation model and field observations made by CAL FIRE WPP staff confirm those reported by Dr. O'Connor. Particularly, the relative elevation model supports the assertion that the floodplain is dominated by dispersed overbank flows rather than channel erosion and migration. This is evident when comparing the relative elevation model of the Little North Fork of the Gualala River to relative elevation models of rivers that migrate through a variety of avulsion processes (Figure 13). Altogether, there is lack of topographic evidence indicating active channel migration processes for the majority of the Little North Fork of the Gualala River, with the exception of Site 4.

It is important to reconsider Equation 1 in the beginning of this section, as it presents a process-based approach for determining the channel migration zone. The photo record shows a very constrained Historical Migration Zone, which indicates the Little North Fork of the Gualala River is generally stable. Furthermore, the historical photo record shows no evidence of channel migration through lateral erosion processes. Since the determination of the Erosion Hazard Area requires an analysis of the areal extent of fluvial features over time (Rapp and Abbe, 2003), and the historical record shows no clear evidence of lateral erosion, there is no clear basis to delineate an Erosion Hazard Area for the Little North Fork of the Gualala River. The analysis of Dr. O'Connor does identify an Avulsion Hazard Zone associated with Site 4.

Other lines of evidence support the conclusion that the Little North Fork of the Gualala River is generally laterally stable and limited in its ability to migrate across its floodplain. For instance, Beechie et al. (2006) classified forested channels by their planform pattern, each with a characteristic rate of channel migration (Figure 14). In general, the authors found that straight channels (i.e., primarily single thread channel, sinuosity <1.5) had the lowest rate of lateral migration, and braided channels had the highest rate of migration. Analysis of the Little North Fork of the Gualala River using LiDAR data indicate that the Little North Fork of the Gualala River fits the definition of a straight channel as defined by Beechie et al. (2016) (Table 1), and therefore likely has a relatively low migration rate.

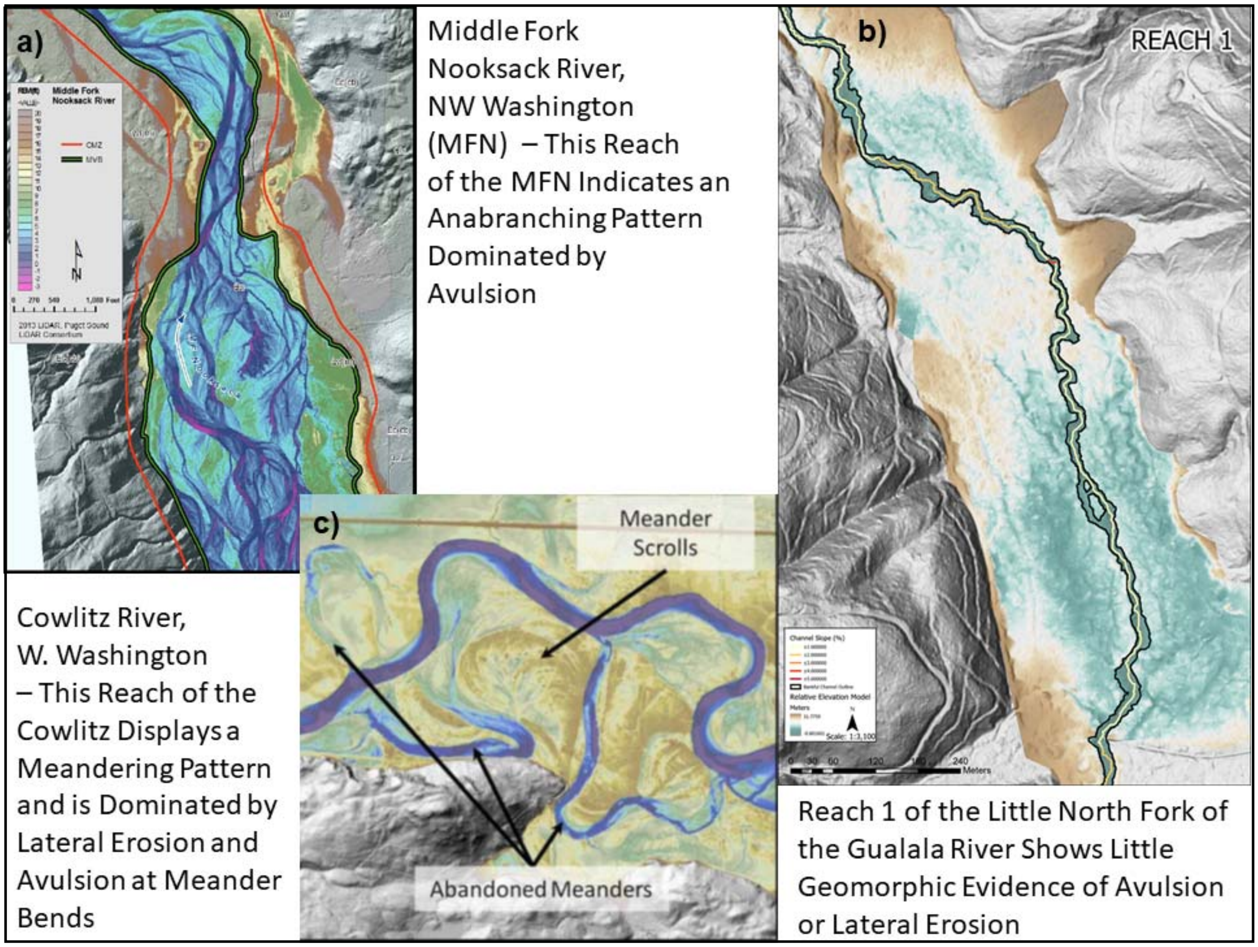

Figure 13. Relative elevation models for (a) the Middle Fork Nooksack River (MFNR) in northwest Washington; (b) the Little North Fork of the Gualala River; and (c) the Cowlitz River in western Washington. The MFNR and Cowlitz River show ample topographic evidence of channel migration processes, whereas the Little North Fork of the Gualala River shows limited evidence of channel migration.

Table 1. Channel metrics derived from analysis of the 1-m LiDAR digital elevation model data (BFW = bankfull channel width).

Full Watercourse	Mean BFW	Median BFW	Transects ≥ 15-m	Mean Slope	Median Slope	Sinuosity
	13.5 m	12.2 m	256/986	1.2%	1.1%	1.24
By Reach						
Reach 1	15.7	13.5	97/250	1.2%	-	1.27
Reach 2	15.6	12.8	70/194	0.7%	-	1.23
Reach 3	11.6	11.2	31/191	1.1%	-	1.28
Reach 4	12.5	12.1	40/227	1.2%	-	1.20
Reach 5	10.8	9.6	18/124	2.6%	-	1.18

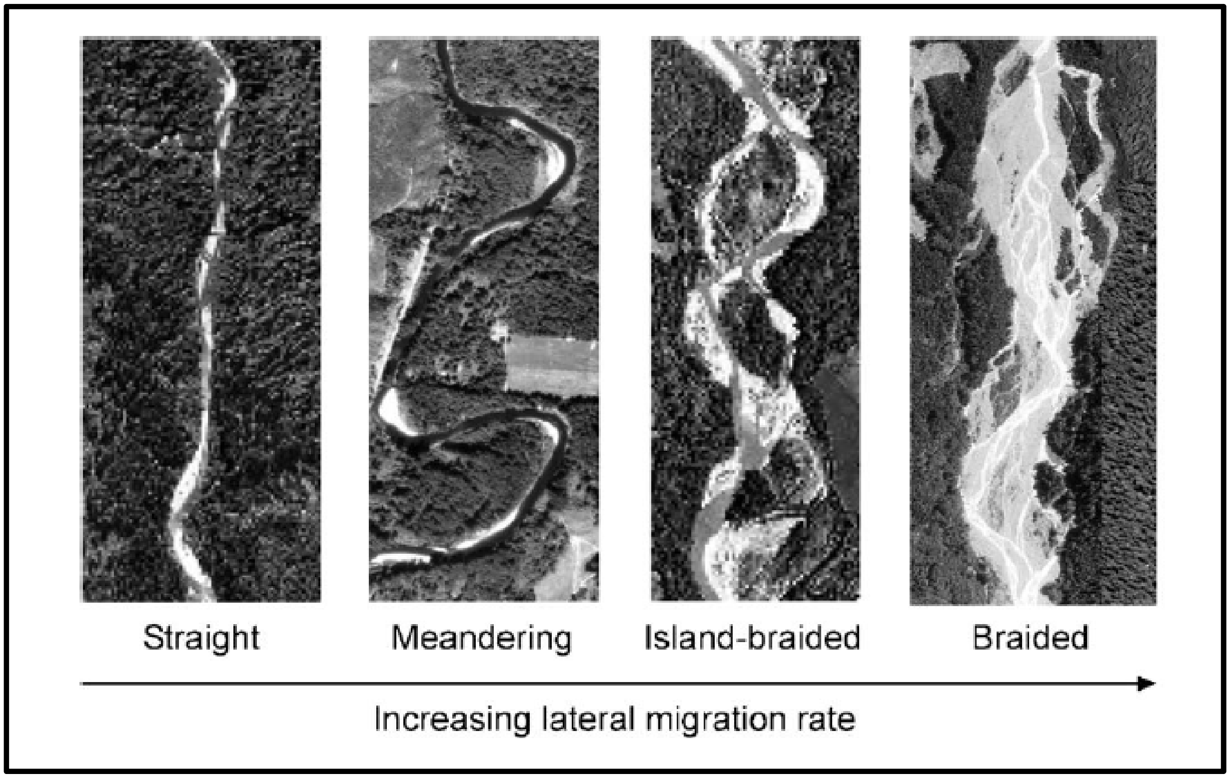

Figure 14. Illustration of the four channel patterns, indicating relative rates of lateral migration of the channel (i.e., migration that erodes floodplain surfaces). The Little North Fork of the Gualala River most resembles the straight channel pattern. Taken from Beechie et al. (2006).

Beechie et al. (2006) found a bankfull channel width threshold for channel migration across forested floodplains in western Washington for channels between 15 and 20-m bankfull width. They speculated that the bankfull width threshold was related to the water depth necessary to erode the banks beneath the roots of riparian tree species, and that channel migration became an active process once channels were able to erode beneath the rooting zone of the bank trees. We did not see evidence of extensive bank erosion and/or recruitment of trees via bank erosion in the Little North Fork of the Gualala River. The analysis of the LiDAR digital elevation model (DEM) also indicated that the Little North Fork of the Gualala River was generally below the 15 to 20-m bankfull width threshold documented for western Washington (Table 1; Figure 15). Average bankfull width for reaches 1 and 2 fell within the documented threshold for transition from non-migrating to migrating channels, but did not fall within the range of “clearly” migrating channels.

Additionally, Beechie et al. (2006) reported on areas in the Pacific Northwest with non-sprouting conifer species (e.g., red cedar, Sitka spruce, western hemlock), while the Little North Fork of the Gualala River floodplain is primarily covered with 90-100 year old coast redwood, which exhibits prolific stump sprouting. Following removal of timber from a site, the roots of non-sprouting species totally decay. While long-term studies on second-growth coast redwood root decay have yet to be completed, retrospective research on redwood root decay has shown that root biomass drops approximately 40% in 11 years, and thereafter increases (Ziemer and Lewis 1984). Live root biomass declines but does not drop to zero after logging, as coast redwood roots come into equilibrium with reduced above ground biomass. Coast redwood tree sprouting may, therefore, allow for rapid recovery of rooting strength, which may limit the potential for channel migration following disturbance compared to non-sprouting species in the Pacific Northwest.

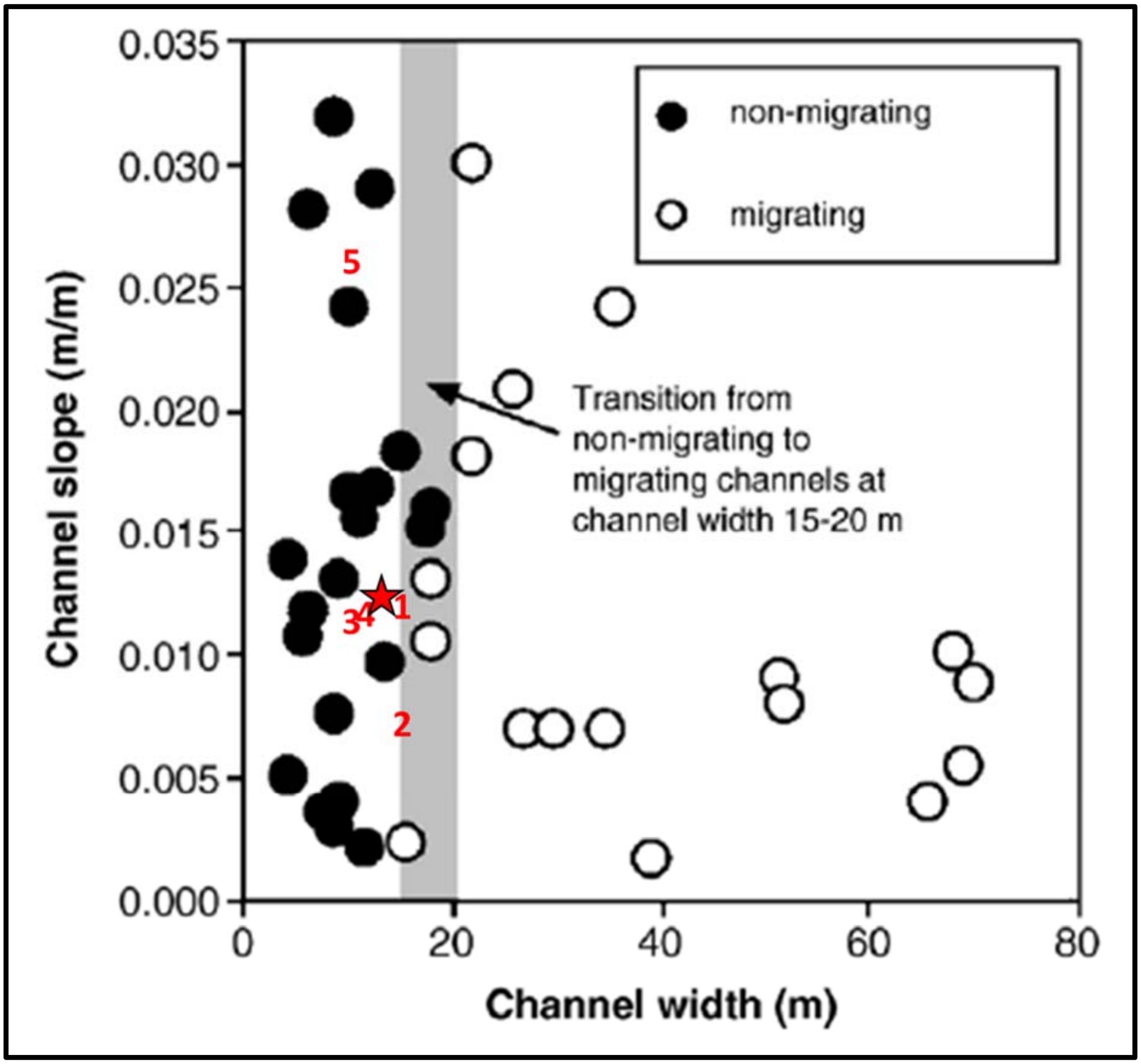

Figure 15. Reach scale slope and bankfull channel width for various reaches of the Little North Fork of the Gualala River when plotted against data from western Washington. Red numbers represent specific reaches of the Little North Fork of the Gualala River, whereas the red star represents the average for all reaches. Figure modified from Beechie et al. (2006).

Another conclusion of the Beechie et al. (2006) paper was that relatively stable channels were dominated by older and larger trees, whereas less stable channels were a mosaic of different age classes or dominated by younger age classes of vegetation. Section III of the THP states that the riparian stand is approximately 90-100 years old, and we infer this to mean that the stand is even-aged (i.e., a single age class of trees). This conforms with our observations in the field, where the floodplain stand appeared to be even-aged in composition, heavily dominated by coast redwood.

In summary, we conclude that the O'Connor channel migration zone report (OCE, 2019a) provides a logical and reasonable evaluation of the channel migration zone for the Little North Fork of the Gualala River. Dr. O'Connor's conclusions are supported by CAL FIRE WPP field staff observations, the general lack of topographic signatures indicating channel migration processes by the relative elevation model, as well as alternate lines of evidence suggested by relevant published literature.

IV. <u>Flood Prone Area Determination for the Little THP</u>

The 2019 California Forest Practice Rules definition for a **flood prone area** is provided in Section I of this report. The WLPZ Inner Zone B definition for flood prone areas is:

(D) Inner Zone B: The Inner Zone B is applicable when there are very wide flood prone areas. The Inner Zone B encompasses the portion of the flood prone area from the landward edge of the Inner Zone A (i.e., 150 feet from the WTL) to the landward edge of the flood prone area. The landward edge of the Inner Zone B (i.e., the landward perimeter of the flood prone area) shall be established in accordance with flood prone area definitions in 14 CCR § 895.1. Timber Operations are permitted in this zone when conducted to meet the goals of this section, including those for the Inner Zone in 14 CCR § 916.9 [936.9, 956.9], subsection (c)(2), 14 CCR § 916.9 [936.9, 956.9], subsection (e)(1)(A)-(F), or pursuant to 14 CCR § 916.9 [936.9, 956.9], subsection (v)…

CAL FIRE and CDFW provided guidance to RPFs for implementing the Anadromous Salmonid Protection rules in 2010, which was updated in 2014 (CAL FIRE and CDFW, 2014). In particular, Question and Answer No. 30 is relevant to review of the Little THP and observations made during the focused PHI.

30. <u>How will the Flood Prone Area be determined in the field?</u>

RPFs should refer to indicators described in the ASP rule flood prone area definition, as well as the document titled <u>Flood Prone Area Considerations in the Coast Redwood Zone</u> (Cafferata et al. 2005). Other helpful tools for determining the extent of flood prone areas are USGS topographic maps; LIDAR (Light Detection and Ranging) data, which provides high resolution topography; and individual county 100-year flood hazard maps, which depict with reasonable accuracy the extent of relatively flat, floodplains adjacent to streams.

> *Evidence for a flood prone area includes, but is not limited to: (1) flotsam (i.e., material floating on water) hanging in the brush and log jams on top of the surface, (2) fine sediments found in the tree moss and bark, (3) silt, sand, or gravel found immediately under the leaf layer, (4) alluvial materials consisting of silt, sand and gravel that are uncompacted and unconsolidated, (5) a wetter understory plant community with facultative wet and/or wetland obligate species present, (6) disturbance species such as willow, cottonwood and alder present in the overstory canopy, (7) evidence of flowing water, such as scour features, flattened grass or secondary channels formed by scour action of the modern river channel, and (8) the elevation of the surface lies near the elevation of the highest channel features (e.g., log jams and gravel bar surfaces). If some period of time has lapsed since a large flood event, evidence that relates directly to flooding of a surface may be muted (WFPB 2004).*
>
> *RPFs are encouraged to consult with DFW, CAL FIRE, the California Geological Survey (CGS), the Regional Water Quality Control Boards (RWQCBs), and others prior to laying out a project in an area suspected to be prone to flooding. Agency staff can help foresters determine if flood prone areas are present and answer questions about the ASP rules and agency expectations.*
>
> *It is most appropriate to determine if channel migration has historically occurred using a combination of office methods (e.g., a series of aerial photographs covering a wide time frame, topographic maps) and field inspection. CMZs are found in areas with unconfined channels (i.e., valley floor width is greater than two (2) times the bankfull channel width). Field inspections will reveal past lateral movement of the channel, often age-progressive bands of trees (e.g., red alder) on the floodplain, and at least one side channel on the floodplain at or below bankfull elevation of the main channel (WFPB 2004).*

During the focused PHI inspection held on August 29, 2019, the PHI participants observed (1) the six sites identified by CDFW as potential channel migration zone sites and discussed in detail in Section III of this report, (2) the flood prone area delineation in several locations, and (3) protection measures provided for the flood prone area and larger floodplain. Dr. O'Connor explained his findings for these sites, as documented in the O'Connor Environmental, Inc. reports prepared for this THP (OEC 2019a,b,c). We found that the area delineated as the landward edge of Inner Zone B corresponded to the mapped estimate of the 20-year flood prone area, which was based on Dr. O'Connor's detailed hydrologic and hydraulic (H&H) modeling (OCE, 2019b,c).

During the focused PHI, CAL FIRE WPP staff compared measured silt lines on trees to the water depth predicted by hydraulic model simulations using the Collector/Avenza applications on iPads. Due to accuracy of the iPad GPS under tree canopy, locations had potential errors ranging from approximately 15-40 feet. Because of this potential error, we averaged flow depths within a 20-foot radius of the measurement point. A linear regression between measured silt height and average modeled flow depth was not significant. However, the regression line is relatively close to a 1:1 relationship (Figure 16).

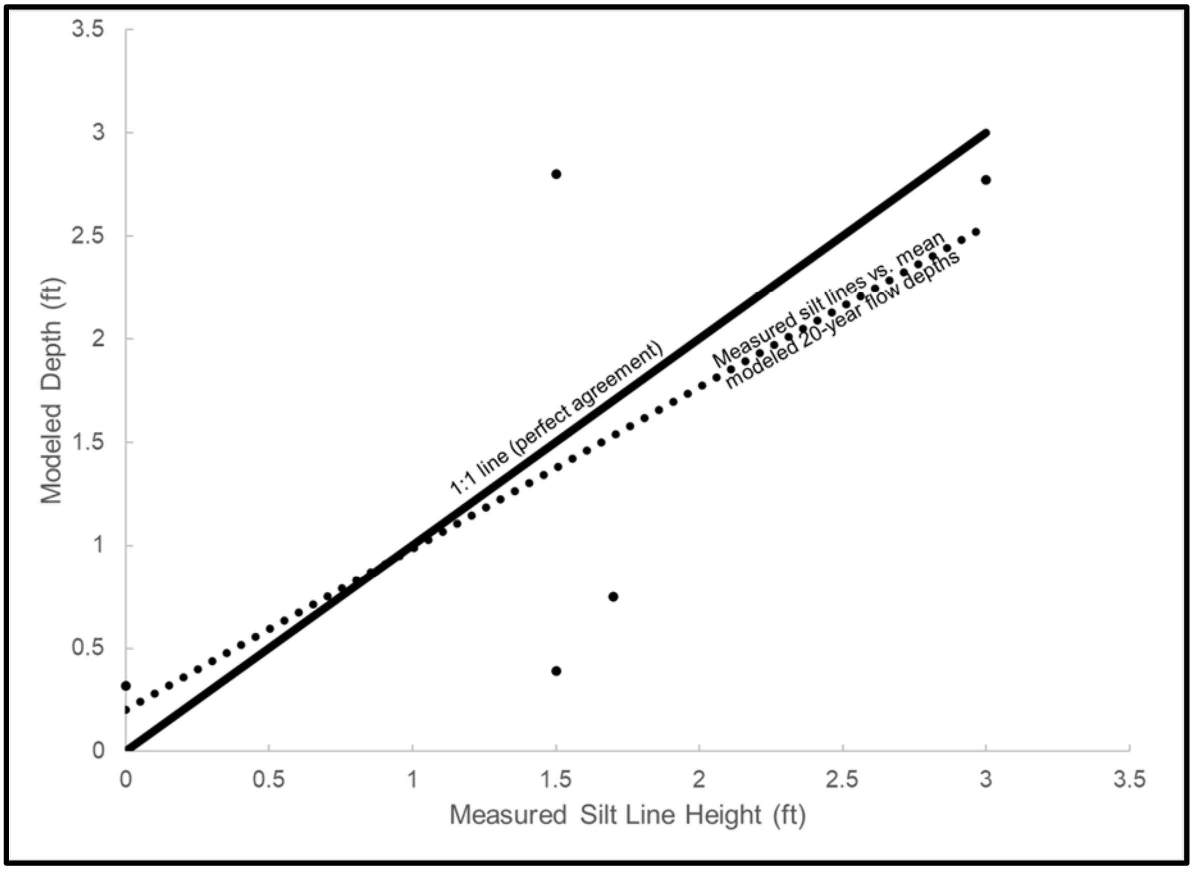

Figure 16. Relationship between measured silt line height and average modeled flow depth for five points along the Little North Fork of the Gualala River. The lack of significance is likely due to the inaccuracy of the iPad GPS and the limited degrees of freedom in the regression. Despite this, the regression line is relatively close to a 1:1 agreement.

The FPRs allow the plan proponent to use either (1) the area inundated by a 20-year recurrence interval flood flow event, or (2) the elevation equivalent to twice the distance between a thalweg riffle crest and the depth of the channel at bankfull stage (i.e., 2X bankfull stage method) to determine the edge of the flood prone area along laterally stable watercourses lacking a channel migration zone where the outer boundary of the flood prone area cannot be clearly determined using the listed field indicators.

As stated above, Dr. O'Connor and his staff have conducted detailed hydrologic and hydraulic modeling to delineate the 20-year recurrence interval flood event boundary (OCE, 2019b,c), which has been incorporated into the THP. Information provided in the

CAL FIRE and CDFW guidance to RPFs for implementing the Anadromous Salmonid Protection rules (CAL FIRE and CDFW, 2014) indicates that the 2X bankfull stage methodology (Rosgen, 1996) equates to approximately a 40-50 year return period flood event in the California Coast Ranges (based on personal communication from Dr. William Trush). As indicated in the Riparian Protection Committee flood prone area report, the most biologically critical area for listed anadromous salmonids, including coho salmon life cycle requirements, is the area inundated at less than or equal to every 20 years (Cafferata et al., 2005). Therefore, CAL FIRE WPP staff find that Dr. O'Connor's hydrologic and hydraulic modeling results are acceptable for flood prone area delineation for the Little THP. Additionally, hydrologic and hydraulic modeling is required for the development of flood insurance rate maps (FIRMs) by the Federal Emergency Management Agency (FEMA), and is a federally recognized regulatory standard for predicting flood inundation. Hence, results from hydrologic and hydraulic modeling are much more accurate and defensible than results obtained using the 2X bankfull stage methodology.

It is our opinion that the plan proponent, Gualala Redwood Timber, Inc., has utilized the key components suggested by the Riparian Protection Committee's final report to determine the flood prone area for the Little THP. We find that the flood prone area delineations flagged on the ground and mapped as part of the Little THP follow the requirements of the California Forest Practice Rules for the following reasons:

(1) The Little North Fork Gualala River channel is laterally stable and generally lacking a channel migration zone, except for the 1000-foot stretch denoted as CDFW No. 4 in the O'Connor Environmental, Inc. channel migration zone report (OCE 2019a) [see Channel Migration Zone discussion above].

(2) The factors listed in the Forest Practice Rule flood prone area definition for determining the outer boundary are to be considered in totality; the BOF did not assign greater weight to any one factor over another.

(3) We observed in the field that there were:

   a. No silt lines on the coast redwood trees beyond at the currently flagged edge of the Inner Zone B in the lower Little THP unit, even though Dr. O'Connor (OCE 2019b) documented that approximately a 20-year recurrence interval flood flow event occurred in February 2019 in the Little North Fork of the Gualala River watershed.

   b. No fresh fine sediment or silt deposits on the floodplain beyond the designated Inner Zone B boundary in the lower unit.

   c. No evidence of floatable debris (flotsam) caught in brush or trees beyond the designated Inner Zone B boundary in the lower unit.

d. No disturbance tree species in the overstory canopy (expect for the designed 1000-foot reach at CDFW Site No. 4).

e. No evidence that the elevation of the surface lies near the elevation of the highest channel features (e.g., log jams and gravel bar surfaces) (except for the designated 1000-foot reach at CDFW Site No. 4).

(4) Given that the vast majority of the Little North Fork can be considered a laterally stable watercourses lacking a Channel Migration Zone, as supported by the analysis in Section III of this report, and the outer boundary of the flood prone area cannot be <u>clearly determined</u> using the field indicators listed in the definition, as per the Forest Practice Rules, it is appropriate to determine the outer boundary of the flood prone area based on the area inundated by a 20-year recurrence interval flood flow event.

(5) The procedures described in the Riparian Protection Committee's final report have been followed and well documented in the three O'Connor Environmental, Inc. reports (OCE 2019a,b,c) written and submitted as part of this THP, as well as verbiage included in the plan by the RPF. The level of modeling and analysis completed is well beyond what is expected for a standard THP and meets the expectations for determining flood prone area delineation.

(6) The protection measures provided for the delineated flood prone area and larger floodplain area (with less frequent inundation recurrence intervals) were found to be appropriate and meeting the Anadromous Salmonid Protection rule requirements. In particular, these measures include (1) pre-flagging all skid trails in the units, (2) requiring ground skidding equipment to remain on designated skid trails, and (3) requiring all side channels to remain open and free to flow water. The plan proponent has flagged skid trails to utilize existing skid trails to the maximum extent possible. In flood prone areas, crawler tractors will be required to drive with their blade elevated except as needed to move debris, resulting in no new excavation except at watercourse crossings or to improve conditions at existing site-specific problem areas.

V. Brief Anadromous Fisheries Impact Assessment for the Little North Fork of the Gualala River

The plan area is located approximately seven miles upstream from where the mouth of Gualala River meets the Pacific Ocean. At the mouth of the Gualala River is a sandbar that is a seasonal barrier to upstream fish migration. During the focused PHI, the Gualala River Timber staff stated that coho have not been present in the river for the last seven years, largely driven by storm conditions not producing runoff events large enough to breach the sandbar in time, or at all, for coho migration.

The history of coho salmon population and abundance is not well documented in Gualala River. Visual encounter monitoring in the mid-1960s estimated populations of about 4,000 annually, however the data are not considered reliable by CDFW (LeDoux-Bloom, 2002). Stocking efforts to reestablish coho populations took place from 1969 to 1999, with approximately 350,000 coho planted over the three decades, including 45,000 from 1995-1997 in the Little North Fork of the Gualala River. By the early 2000s the Coho Salmon Status Review found there were no remaining viable populations of coho in the watershed (CDFG, 2002).[3] There is speculation that the robust population estimates earlier were due to fish stocking efforts (Higgins, 1997). Church (2012), citing information from NOAA and CDFW, states that only three planning watersheds in the Gualala River watershed still have habitat for California Central Coast (CCC) ESU coho—Doty and Robinson creeks in the North Fork, and Pepperwood Creek in the South Fork.

Similar to coho, winter-run steelhead populations were visually estimated in the mid-1960s to be about 16,000, although again the data are unreliable. Stocking with hatchery-raised steelhead was done to bolster populations, and steelhead continue to persist within the watershed (LeDoux-Bloom, 2002; Church, 2012).

Juvenile coho salmon spend up to a year instream before outmigrating to the ocean. They predominantly occupy pool habitat while steelhead of similar size will dominate riffle and run habitat (Moyle, 2002). Off-channel, cold-water refugia is important for juvenile coho rearing to avoid being swept downstream by high flows and chronic turbidity (CDFG, 2004). Off-channel refugia, particularly those areas that allow for over-wintering, are found adjacent to the main Little North Fork of the Gualala River channel, and contain large woody debris for cover. Small tributaries are the primary refugia for steelhead for over-wintering and this species may temporarily use off-channel habitat during periods of flooding (Bramblett et al., 2002).

Protection measures incorporated in the THP, including skid trail pre-flagging, requirements for all ground skidding equipment to remain on designated skid trails, and requirements for side channels to remain open and free to flow water, are anticipated to be protective for the listed salmonids found in the Little North Fork of the Gualala River watershed.

VI. <u>Recommendation</u>

For Reach 2-B identified in Figure 6, the RPF is to further evaluate the site for the presence of a secondary channel, and apply Class I watercourse protection standards if appropriate.

[3] Coho young-of-the-year were observed in tributaries of the North Fork subbasin in 2002, including the Little North Fork of the Gualala River (CDFG, 2002; Church, 2012). Juvenile coho were found in North Fork tributaries in 2003 and 2004 (CDFG, 2004; TCF, 2014).

VII. Conclusions

With the possible exception of Reach 2-B (see recommendation above), the plan proponent has correctly followed the Forest Practice Rules in delineating the channel migration zone and flood prone areas for the Little THP, as well as providing the appropriate protection measures for the (1) channel migration zone and sensitive areas on the broader floodplain area, and (2) current and restorable anadromous salmonid fisheries resources.

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Appendix A: Terrain Analysis for the Little North Fork of the Gualala River Channel and Floodplain[4]

A stream network was derived within the watershed using a 1-m LiDAR DEM of Mendocino County, flown in 2017, and created using the ArcPro toolbox “Terrain Analysis Using Digital Elevation Models” or TauDEM version 5.3.7 (Tarboton, 2003). A threshold of 10,000 m^2 was used to initiate watercourse centerlines, and the main channel centerline was extracted within the valley confines for this analysis. The TauDEM toolbox includes attributes for each segment, including the slope in percent, the stream segment length, and the straight stream segment length or point-to-point distance.

A relative elevation model (REM) was created as described in the Washington State Department of Natural Resources publication “A Methodology for Delineating Planning-Level Channel Migration Zones” (Olson et al., 2014), using the Inverse Distance Weighting (IDW) method developed by Dr. Jerry Franklin, Univ. of Washington, and Patricia Olson with the Washington State Department of Ecology. This analysis used points every 10-m (32.8 feet) along the main channel centerline, and elevations were extracted to each point from the 1-m LiDAR DEM. The elevation points were used in the IDW method to create a raster (using a 200 search radius for each point and the weighting), from which the 1-m DEM elevation data were subtracted, in order to create a DEM with elevations relativized to the stream centerline, to aid in identifying channel banks within the valley confines. The process was confined to only within the valley floor, and was not continued significantly upstream into any tributary junctions.

From the relative elevation model, an initial threshold of 1-m above the watercourse centerline was used to identify the bankfull channel width. This output was further refined using the 1-m hillshade, curvature profiles created in ArcPro, and slope breaks created in ArcPro. Within a large upper portion of the watershed, significant manual editing was done to identify the bankfull channels due to the DEM resolution and subtle topography present in that location.

The watercourse centerline was smoothed in ArcPro using the “Polynomial Approximation with Exponential Kernel” approach and a 30-m threshold. This was done in order to fit perpendicular transect lines every 5-m to the centerline, and subsequently the channel itself. The transects were then intersected with the bankfull channel layer to determine channel widths. Where there were islands in the bankfull channel layer, they were removed from the layer to assess the entire channel width in the GIS, uninterrupted. Additionally, data on the watercourse centerline segment slopes and lengths (both straight line and the channel length) were extracted to determine slope metrics and sinuosity.

[4] This analysis was conducted by Will Olsen, CAL FIRE WPP Environmental Scientist - Forest Practice Monitoring Specialist.

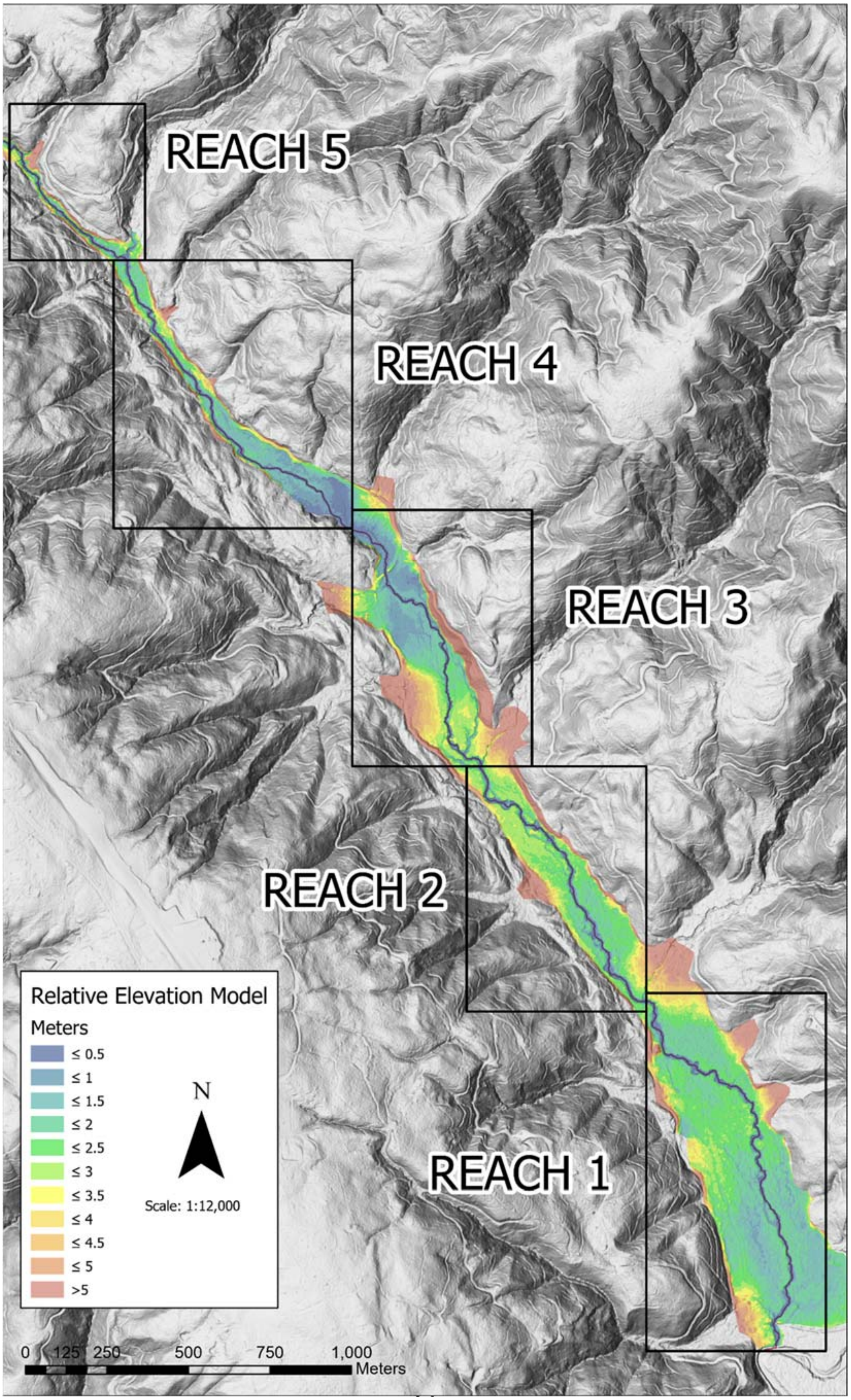
This analysis also was done on a reach by reach basis: Reach 1 initiated from the Little North Fork of the Gualala River outlet to the next significant incoming tributary; Reach 2 between two significant tributaries; Reach 3 from a large tributary to Log Cabin Creek; Reach 4 from Log Cabin Creek to Doty Creek; and Reach 5 from Doty Creek upward to the end of the plan area under consideration.

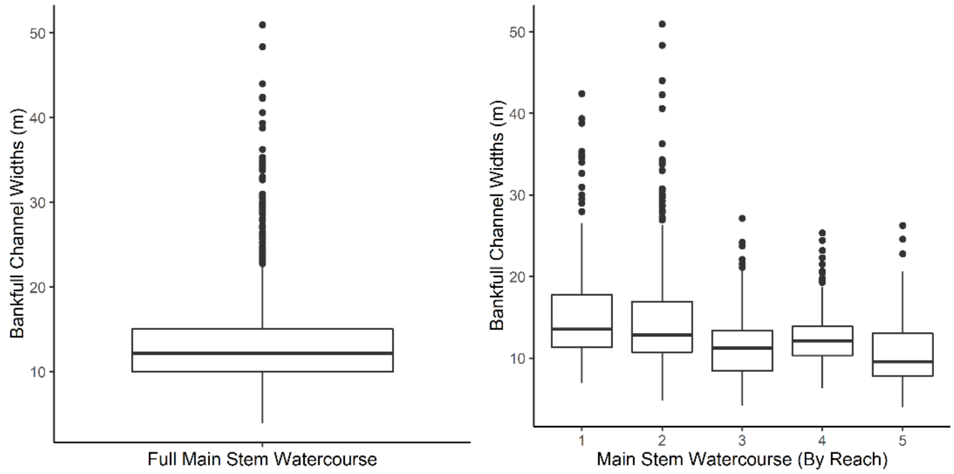
Results

Full Watercourse	Mean BFW	Median BFW	Transects ≥ 15-m	Mean Slope	Median Slope	Sinuosity
	13.5 m	12.2 m	256/986	1.2%	1.1%	1.24
By Reach						
Reach 1	15.7	13.5	97/250	1.2%	-	1.27
Reach 2	15.6	12.8	70/194	0.7%	-	1.23
Reach 3	11.6	11.2	31/191	1.1%	-	1.28
Reach 4	12.5	12.1	40/227	1.2%	-	1.20
Reach 5	10.8	9.6	18/124	2.6%	-	1.18

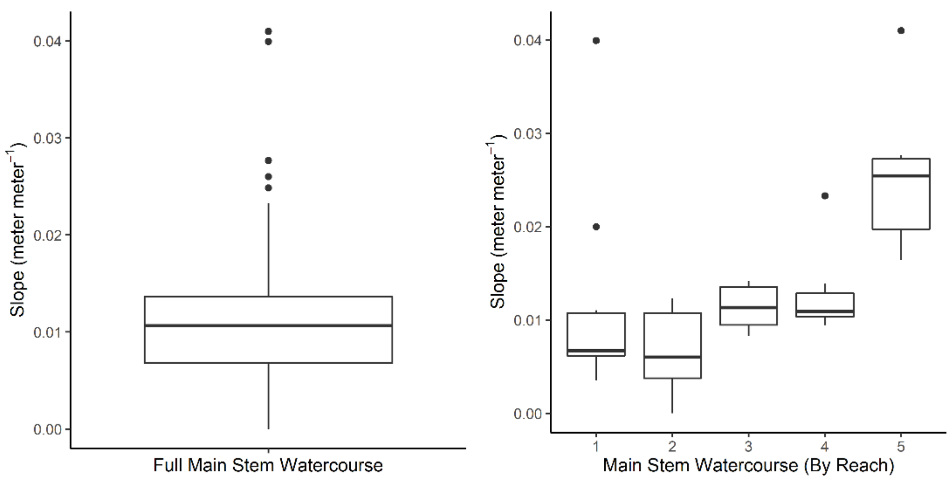
The results indicate that the full watercourse mean bankfull channel width falls below the 15-m threshold found by Beechie et al. (2006) for a migrating river channel. By reach, the mean widths for Reach 1 and Reach 2 break the 15-m threshold by 0.7 and 0.6-m, respectively, for a migrating river channel. All median bankfull channel widths by reach fail to exceed the migrating threshold. There are individual transects that exceed 15-m in length, more predominantly in the lower portion of the watershed.

The entire watercourse has a mean slope of 1.2%, while the individual reaches range from 0.7% to 2.6% at the upper end of the watershed. The sinuosity for the entire watercourse channel is 1.24, which identifies the watercourse as either a sinuous but not meandering river (Ward and Trimble, 2004), or a single thread channel (Beechie et al., 2006). The individual reaches also all fall into the same sinuous-but-not-meandering or single-thread-channel classification.

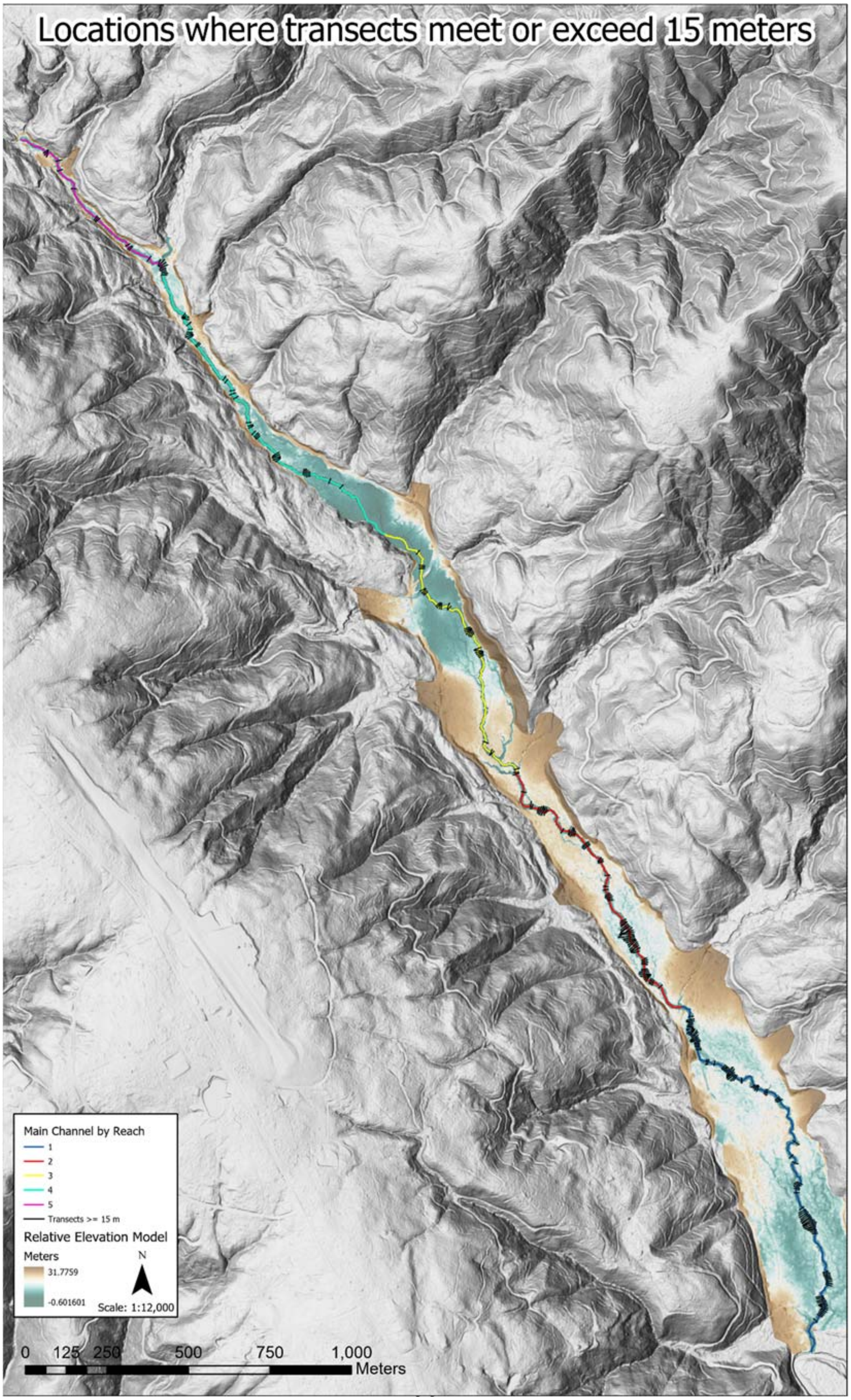

REACH 5
REACH 4
REACH 3
REACH 2
REACH 1
Relative Elevation Model
Meters
≤ 0.5
≤ 1
≤ 1.5
≤ 2
≤ 2.5
≤ 3
≤ 3.5
≤ 4
≤ 4.5
≤ 5
>5
N
Scale: 1:12,000
0 125 250 500 750 1,000
Meters

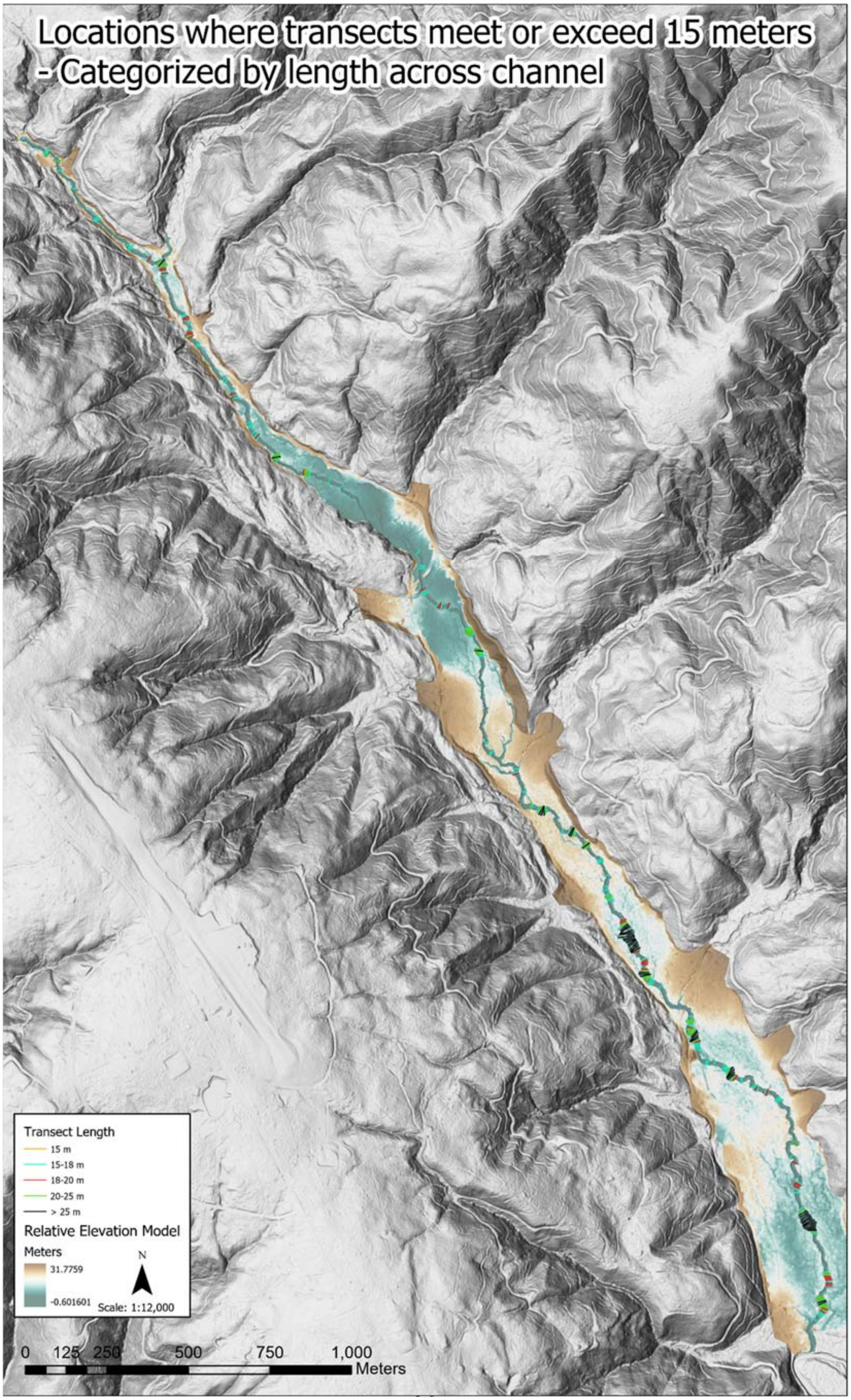


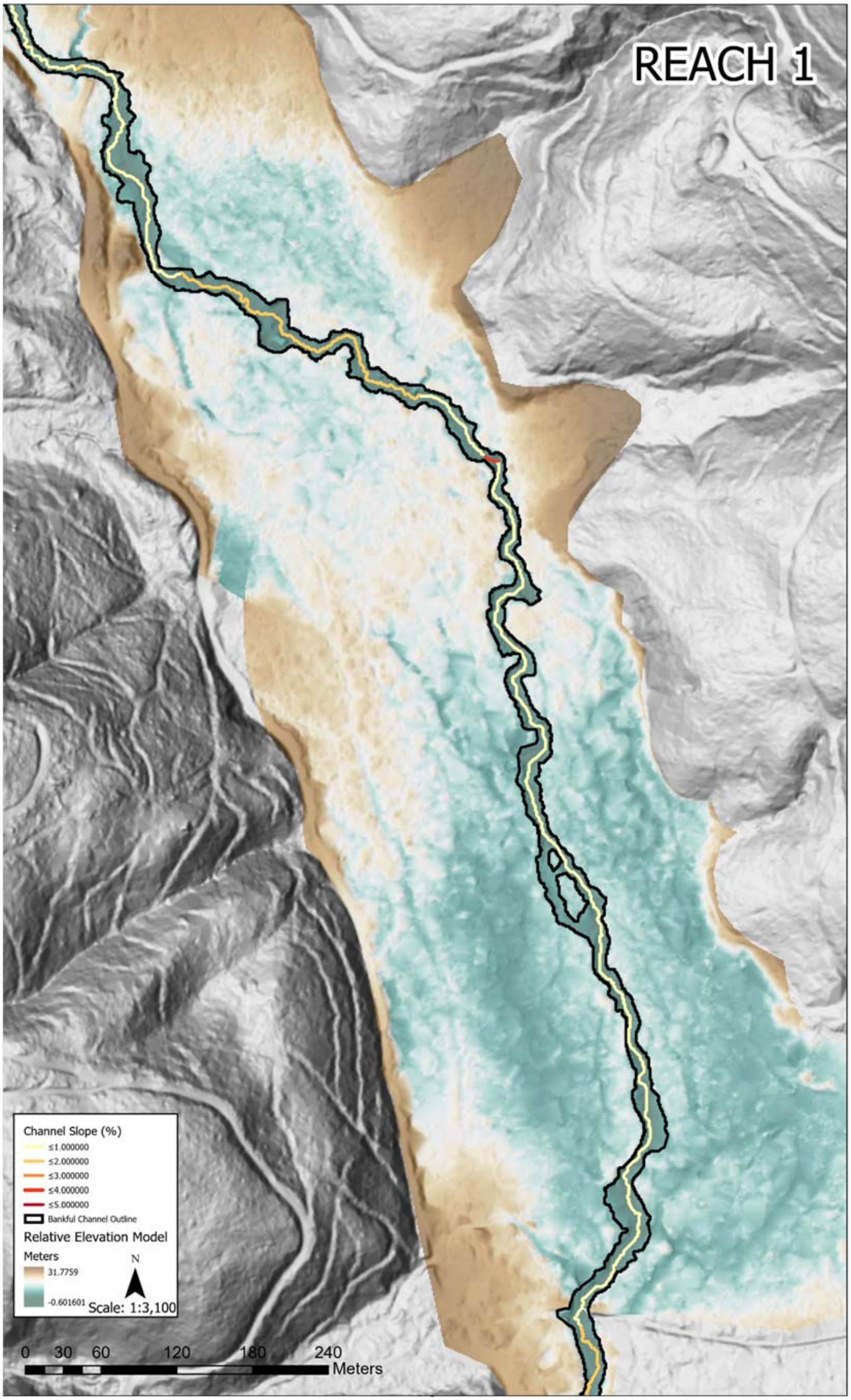
Boxplots of the channel transect lengths by the entire watercourse and by reach.

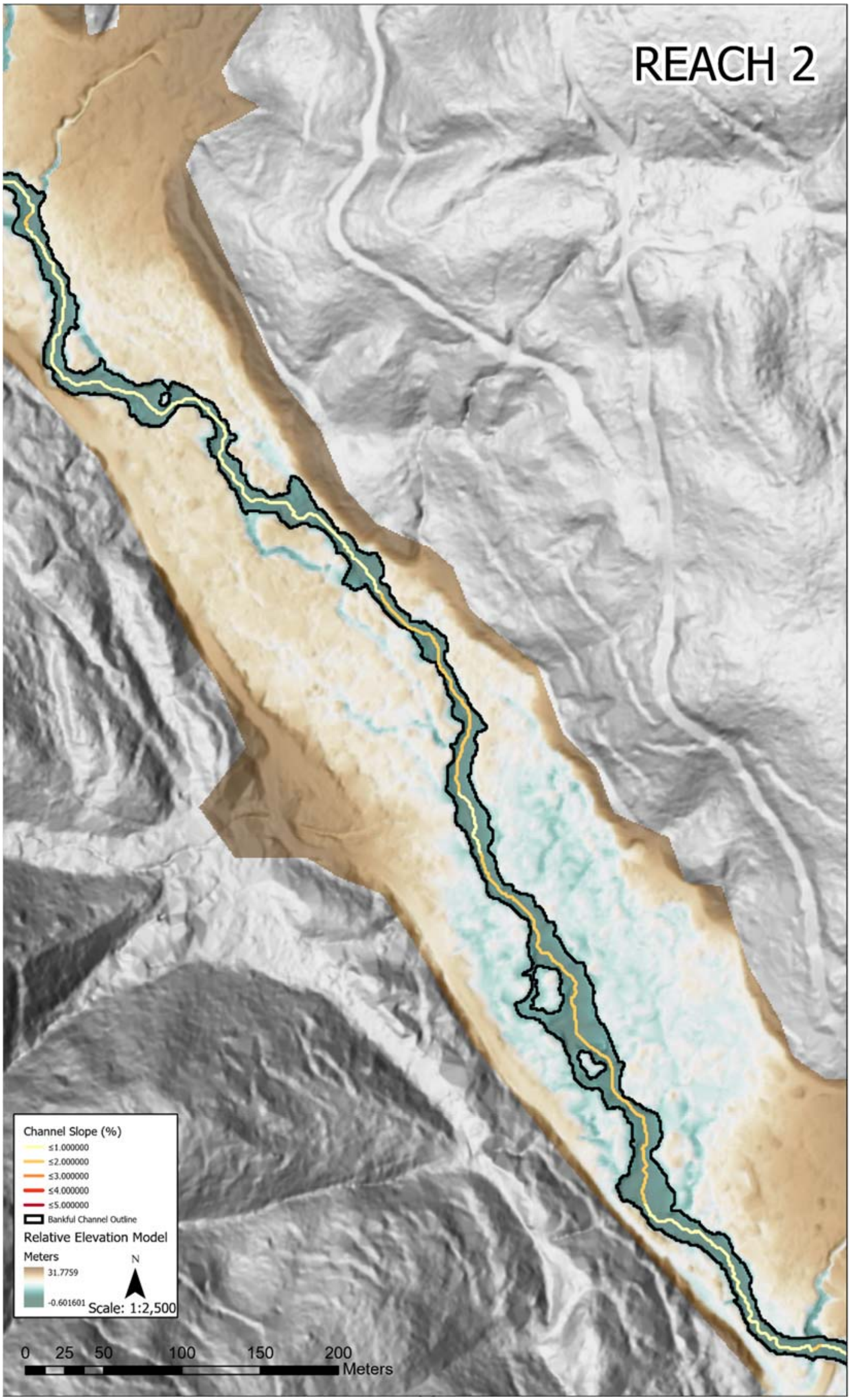


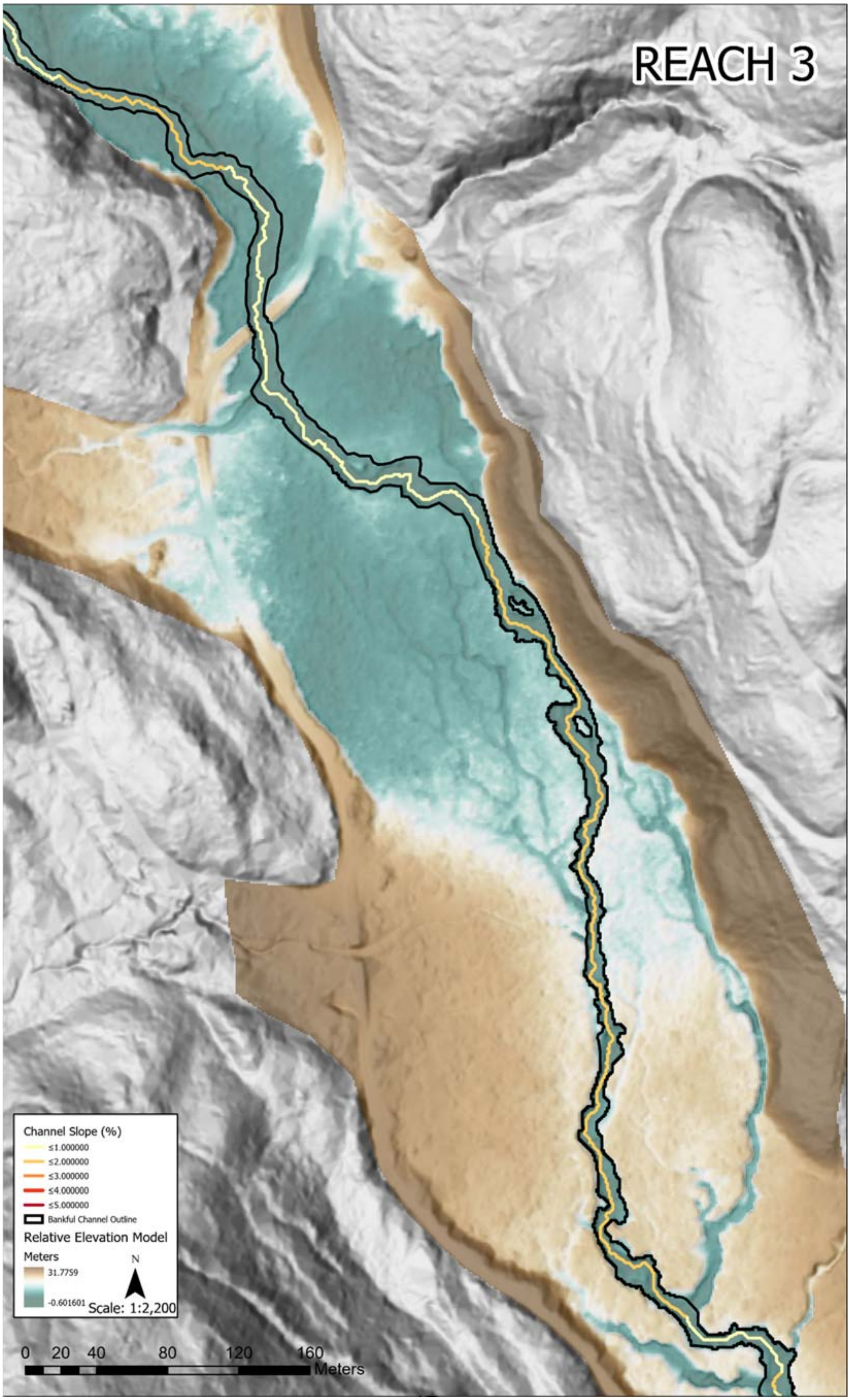
Boxplots of the segment channel slopes for the entire watercourse and by reach.

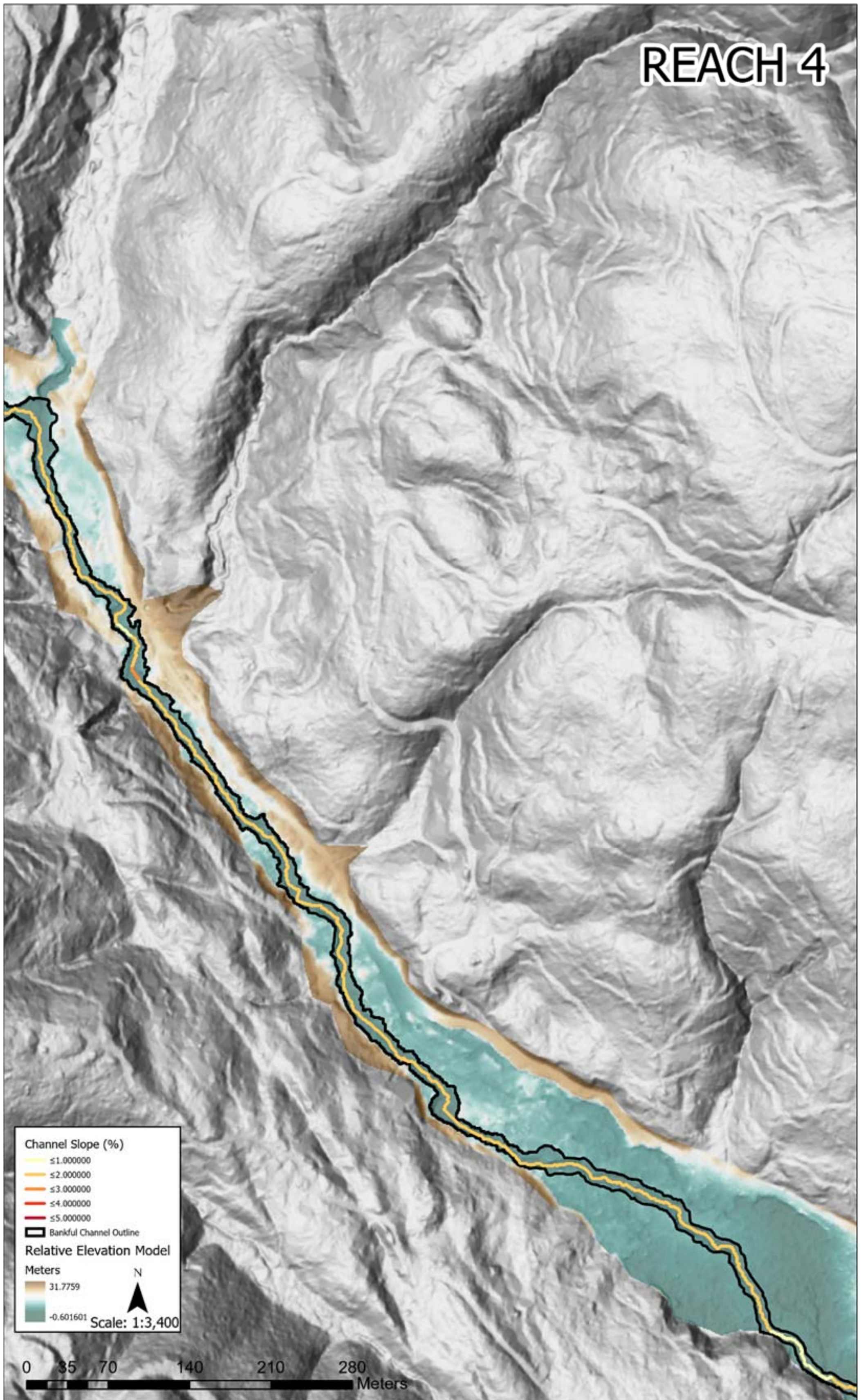

Locations where transects meet or exceed 15 meters
Main Channel by Reach
1
2
3
4
5
Transects >= 15 m
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:12,000
0
125
250
500
750
1,000
Meters

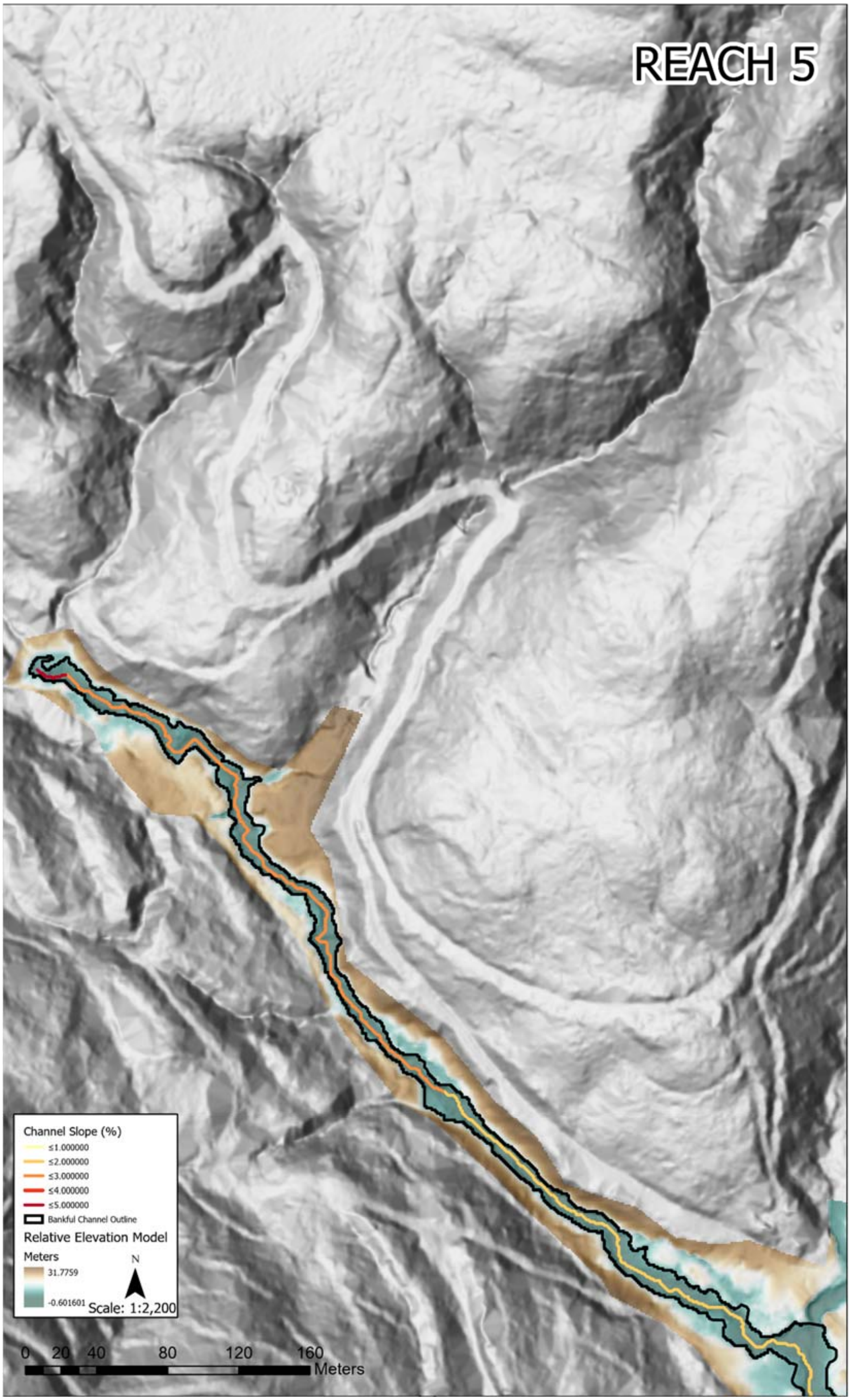

Locations where transects meet or exceed 15 meters
- Categorized by length across channel
Transect Length
15 m
15-18 m
18-20 m
20-25 m
> 25 m
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:12,000
0 125 250 500 750 1,000
Meters


REACH 1
Channel Slope (%)
≤1.000000
≤2.000000
≤3.000000
≤4.000000
≤5.000000
Bankful Channel Outline
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:3,100
0 30 60 120 180 240
Meters


REACH 2
Channel Slope (%)
≤1.000000
≤2.000000
≤3.000000
≤4.000000
≤5.000000
Bankful Channel Outline
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:2,500
0 25 50 100 150 200
Meters


REACH 3
Channel Slope (%)
≤1.000000
≤2.000000
≤3.000000
≤4.000000
≤5.000000
Bankful Channel Outline
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:2,200
0 20 40 80 120 160
Meters


REACH 4
Channel Slope (%)
≤1.000000
≤2.000000
≤3.000000
≤4.000000
≤5.000000
Bankful Channel Outline
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:3,400
0 35 70 140 210 280
Meters


REACH 5
Channel Slope (%)
≤1.000000
≤2.000000
≤3.000000
≤4.000000
≤5.000000
Bankful Channel Outline
Relative Elevation Model
Meters
31.7759
-0.601601
N
Scale: 1:2,200
0 20 40 80 120 160
Meters

From:	Cafferata, Pete@CALFIRE
Sent:	Wednesday, November 6, 2019 9:31 AM
To:	Longcrier, Jeff@CALFIRE; Sciocchetti, Lou@CALFIRE; Santa Rosa Review Team@CALFIRE; Schwab, Dominik@CALFIRE; Margiott, Ken@CALFIRE
Cc:	Eng, Helge@CALFIRE; Hall, Dennis@CALFIRE; Huff, Eric@CALFIRE; Coe, Drew@CALFIRE; Stanish, Anastasia@CALFIRE; Olsen, Will@CALFIRE
Subject:	Little THP PHI Report
Attachments:	Little THP_WPP PHI Report_(Final 11-6-19).pdf

Please see the attached final CAL FIRE Watershed Protection Program Little THP PHI report.
Thank you.
Pete

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