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February 18, 2019

Mr. Peter Baye
Friends of Gualala River
P.O. Box 1543
Gualala, CA 95445

Subject: Estimation of Flood Prone Area
Little THP #1-18-095 MEN
Little North Fork Gualala River, Mendocino County, CA

Dear Mr. Baye:

This letter report presents the results of an analysis completed by Kamman Hydrology & Engineering, Inc. (KHE) to determine the flood prone area within the Gualala Redwood Timber, LLC Little Timber Harvest Plan (THP) on the Little North Fork Gualala River upstream of the confluence with the North Fork Gualala River. For purposes of this study, we adhere to the regulatory definition of flood prone area as presented in section 895.1 (Definitions) of the California Forest Practice Rules (ref, 2018), which reads as follows.

> ***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 [sic] 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 [sic] 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.*
>
> *Hydroperiod: area inundated by a 20-year recurrence interval flood flow event, 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*
>
> *Field Indicators:*

- *where valley slope begins (i.e., where there is a substantial percent change in slope, including terraces, the toes of the alluvial fan, etc.)*
- *laminated silt/leaf litter*
- *"hydric" [sic; hydrophytic] vegetation*
- *distinct change in soil/plant characteristics (alluvium/colluvium, floodplain vegetation and entisol/older terrace vegetation)*
- *outer boundary: absence of silt lines on trees*
- *residual evidence of floatable [sic] debris caught in brush or trees*

> ***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 (see Figure 1).*

Due to lack of access to the THP property and observation of field indicators, our approach was to develop a numerical hydraulic model to identify the area inundated by a 20-year recurrence interval flood event. For comparison, we also modeled the inundation areas associated with the 2-, 5-, and 10-year recurrence flood events. The following sections summarize model development and simulation results.

1.0 HEC RAS Model Geometry Development

A 1-dimensional (1D) model was generated for a single main channel alignment along the Little North Fork Gualala River upstream and including the confluence with the North Fork Gualala River. Channel and floodplain topography used to develop the hydraulic model cross-sections was taken from a bare-earth digital elevation model (DEM) generated from the FEMA Region 9 Lidar Project for Mendocino County. The DEM was produced following USGS Lidar Base Specification Version 1.2. This DEM was obtained through the USGS's National Map viewer website (https://viewer.nationalmap.gov/advanced-viewer/). The meta data file associated with the DEM downloaded from the USGS website is provided in Attachment A.

The channel alignment was digitized using the DEM topography. A total of 71 channel cross sections were generated from the DEM surface in ArcView 3.2 using the HEC-GeoRAS 3.1.1 extension and imported into HEC-RAS. The location of cross-sections are indicated on Figure 1 and were generated on an approximately 300-foot interval. Once the main channel alignment and representative cross sections were brought into HEC-RAS, the channel top of bank locations were adjusted visually based on cross-section topography and channel roughness coefficients applied.

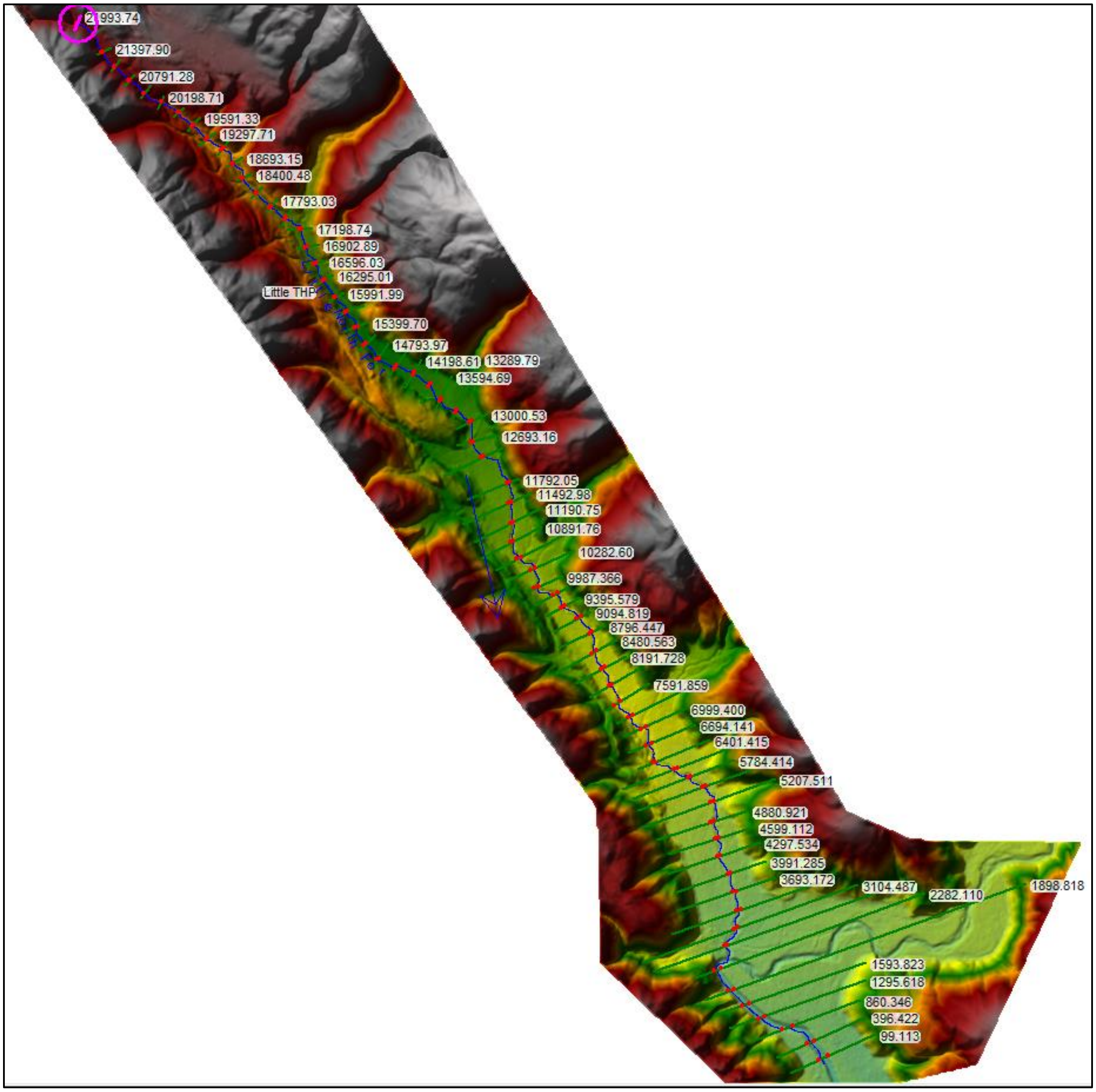


Figure 1: HEC-RAS model channel and cross-section alignments. Red circles indicate top of bank location at each cross section. Cross section stationing in feet.

2.0 HEC-RAS Design Flows (Boundary Conditions)

There are a number of subwatersheds that feed into the mainstem channel of the Little North Fork Gualala River through the modeled reach. A total of 24 subwatershed areas were delineated that introduce flow changes to the model as indicated on Figure 2. Peak flow estimates from each watershed were derived from a flood frequency analysis using available annual peak flow data from the USGS's gauges on the South Fork Gualala River. Although the USGS maintains a gauge on the North Fork Gualala River, there are only three years of annual peak flow data available – an insufficient data set for flood frequency analysis. For purposes of this study, a minimum of 25 years of annual peak flow measurements were deemed necessary to complete a flood frequency analysis.

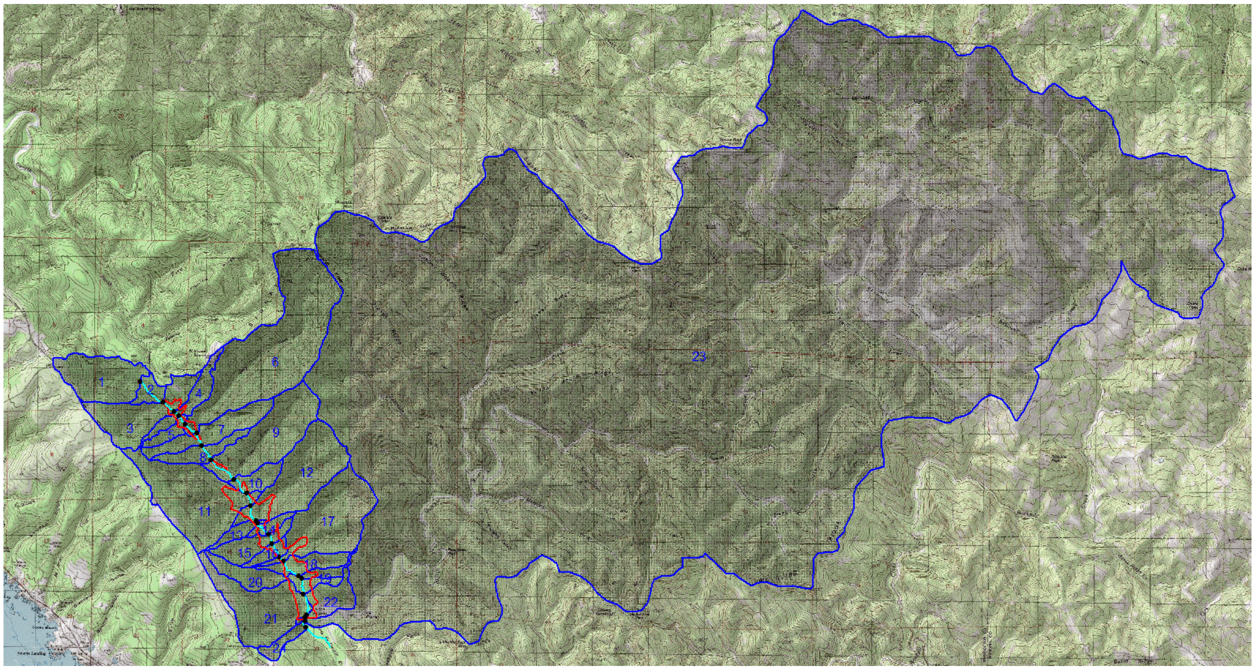


Figure 2: Subwatershed areas (24) contributing flow changes to the mainstem Little North Fork Gualala River model. Black points indicate model flow change locations. Red polygons indicate approximate boundary of Little THP.

The USGS has maintained two gauges on the South Fork Gualala River; USGS 11467500 South Fork Gualala River near Annapolis for the period 1951-1971 and USGS 11467510 South Fork Gualala River near the Sea Ranch for the period 2008-2017. Using the combined 31 years of annual peak flow data, KHE completed a flood frequency analysis using the annual-maximum series method. The data and resulting flood frequency curve are presented in Attachment B.

From the flood frequency analysis, the unit area peak flow rates were determined for floods have a 20-, 10-, 5- and 2-year recurrence intervals. These estimates are presented in Table 1.

Table 1: Peak unit area flow estimates for South Fork Gualala River near The Sea Ranch

Prob. Of Occurrence	Return Period (yrs)	Unit Area Q (cfs/sq. mi.)
5%	20	291
10%	10	269
20%	5	231

50%	2	145

Using the unit area peak flow estimates presented in Table 1 and drainage areas for each subbasin identified in Figure 2, peak flow and model flow change estimates were calculated and are presented in Table 2.

Table 2: Model flow change estimates

Subbasin ID	Drainage Area (acres)	Drainage Area (sq. mi.)	20-yr Recurrence subbasin (cfs)	20-yr Recurrence Cum Flow Change (cfs)	10-yr Recurrence subbasin (cfs)	10-yr Recurrence Cum Flow Change (cfs)	5-yr Recurrence subbasin (cfs)	5-yr Recurrence Cum Flow Change (cfs)	2-yr Recurrence subbasin (cfs)	2-yr Recurrence Cum Flow Change (cfs)
1	268.7	0.42	122.3	122.3	113.2	113.2	96.9	96.9	60.8	60.8
2	51.8	0.08	23.3	145.6	21.6	134.7	18.5	115.3	11.6	72.4
3	268.7	0.42	122.3	267.9	113.2	247.9	96.9	212.2	60.8	133.2
4	102.3	0.16	46.6	314.5	43.1	291.0	36.9	249.1	23.2	156.3
5	42.9	0.07	20.4	334.9	18.9	309.9	16.1	265.3	10.1	166.4
6	899.9	1.41	410.7	745.6	380.0	689.9	325.3	590.6	204.1	370.5
7	182.0	0.28	81.5	827.1	75.5	765.3	64.6	655.2	40.5	411.0
8	90.4	0.14	40.8	867.9	37.7	803.0	32.3	687.5	20.3	431.3
9	386.7	0.60	174.7	1,042.7	161.7	964.7	138.4	825.9	86.8	518.1
10	74.2	0.12	34.9	1,077.6	32.3	997.1	27.7	853.6	17.4	535.5
11	493.0	0.77	224.3	1,301.9	207.5	1,204.6	177.6	1,031.2	111.4	646.9
12	399.1	0.62	180.6	1,482.5	167.1	1,371.6	143.0	1,174.2	89.7	736.7
13	41.4	0.06	17.5	1,499.9	16.2	1,387.8	13.8	1,188.1	8.7	745.4
14	35.1	0.05	14.6	1,514.5	13.5	1,401.3	11.5	1,199.6	7.2	752.6
15	107.9	0.17	49.5	1,564.0	45.8	1,447.1	39.2	1,238.8	24.6	777.2
16	42.7	0.07	20.4	1,584.4	18.9	1,465.9	16.1	1,255.0	10.1	787.3
17	417.6	0.65	189.3	1,773.7	175.2	1,641.1	149.9	1,404.9	94.1	881.4
18	96.1	0.15	43.7	1,817.4	40.4	1,681.5	34.6	1,439.5	21.7	903.1
19	34.0	0.05	14.6	1,831.9	13.5	1,695.0	11.5	1,451.0	7.2	910.4
20	144.0	0.23	67.0	1,898.9	62.0	1,757.0	53.1	1,504.1	33.3	943.6
21	344.1	0.54	157.3	2,056.2	145.5	1,902.5	124.6	1,628.7	78.2	1,021.8
22	113.4	0.18	52.4	2,108.6	48.5	1,951.0	41.5	1,670.2	26.1	1,047.8
23	25390.3	39.67	11,553.8	13,662.4	10,690.1	12,641.1	9,151.5	10,821.7	5,741.5	6,789.3
24	45.9	0.07	20.4	13,682.8	18.9	12,659.9	16.1	10,837.8	10.1	6,799.4

3.0 Other Model Parameters

Other parameters and model settings used in simulations include an in-channel Manning's roughness coefficient (n-value) of 0.035 and floodplain/overbank n-value of 0.12. Standard contraction/expansion coefficients of 0.1 and 0.3 were used, respectively. The downstream

Normal Depth slope was calculated at 0.0024 from the DEM. Subcritical flow conditions were assumed during each simulation.

4.0 Model (Steady-State) Simulation Results

All model runs were performed under steady state peak flow conditions. Simulated inundation areas for each peak flow simulation are presented on Figures 3 through 6. The red polygons on figures depict approximate boundaries of the Little THP.

5.0 Limitations and Recommendations

Because of the lack of site access, the HEC-RAS model developed for this study was not calibrated or validated against field data pertaining to high water marks and/or flood flow estimates. Similarly, estimates of channel and floodplain roughness are based on professional experience and field observations during prior work on the North Fork Gualala River below the confluence with the Little North Fork Gualala River. Based on my prior experience in studying the hydrology of the Gualala River watershed, it is my opinion that the peak flow estimates derived from the South Fork Gualala River gauges may underestimate modeled flood flow magnitudes on the Little North Fork Gualala River. To better address the uncertainties inherent in the existing numerical model used in this study, I recommend field reconnaissance, measurement and mapping of field indicators of past high flow events to aid in of the study reach to calibrate and validate the model.

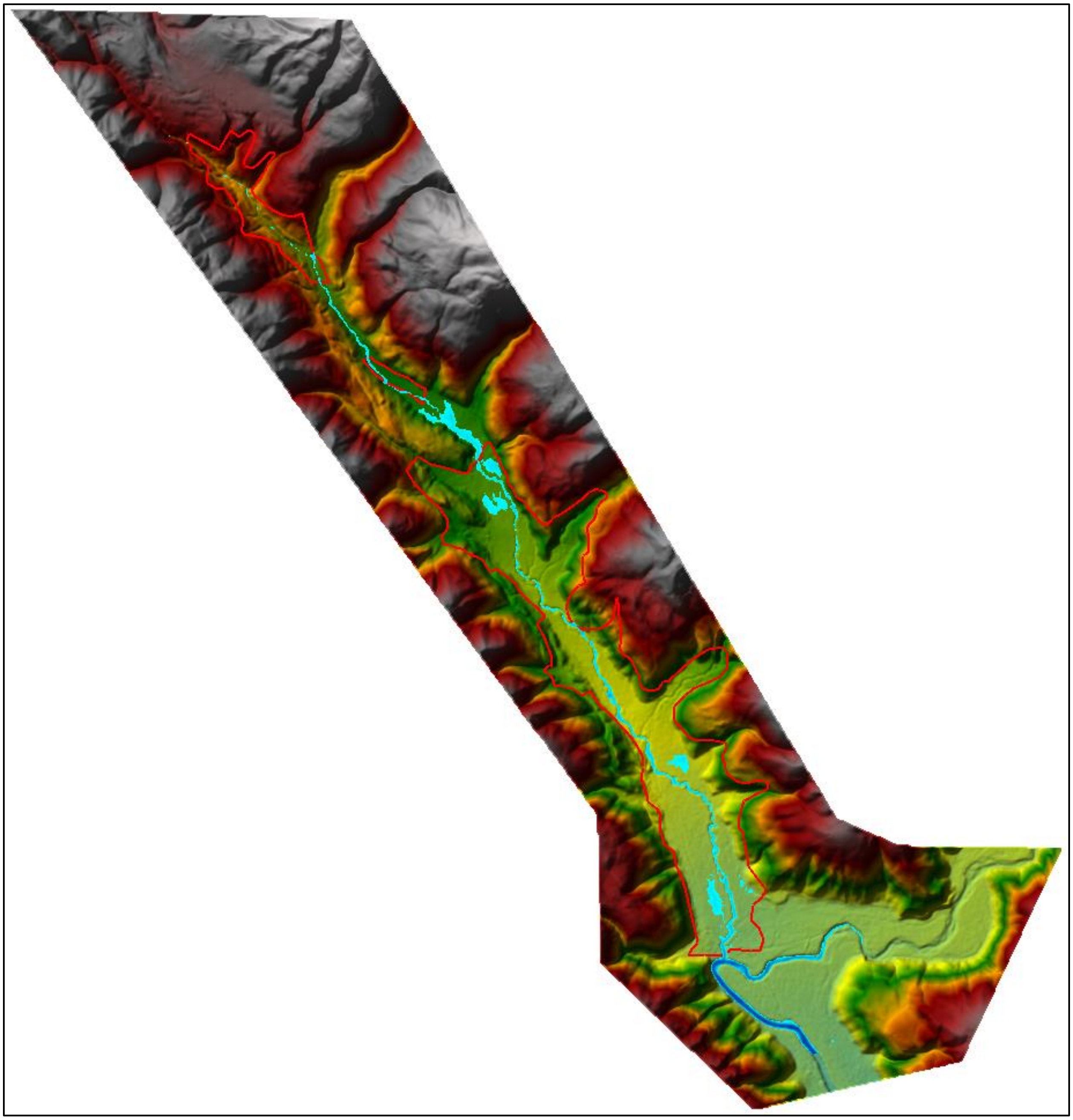


Figure 3: Flood inundation area for 2-year recurrence interval flood.

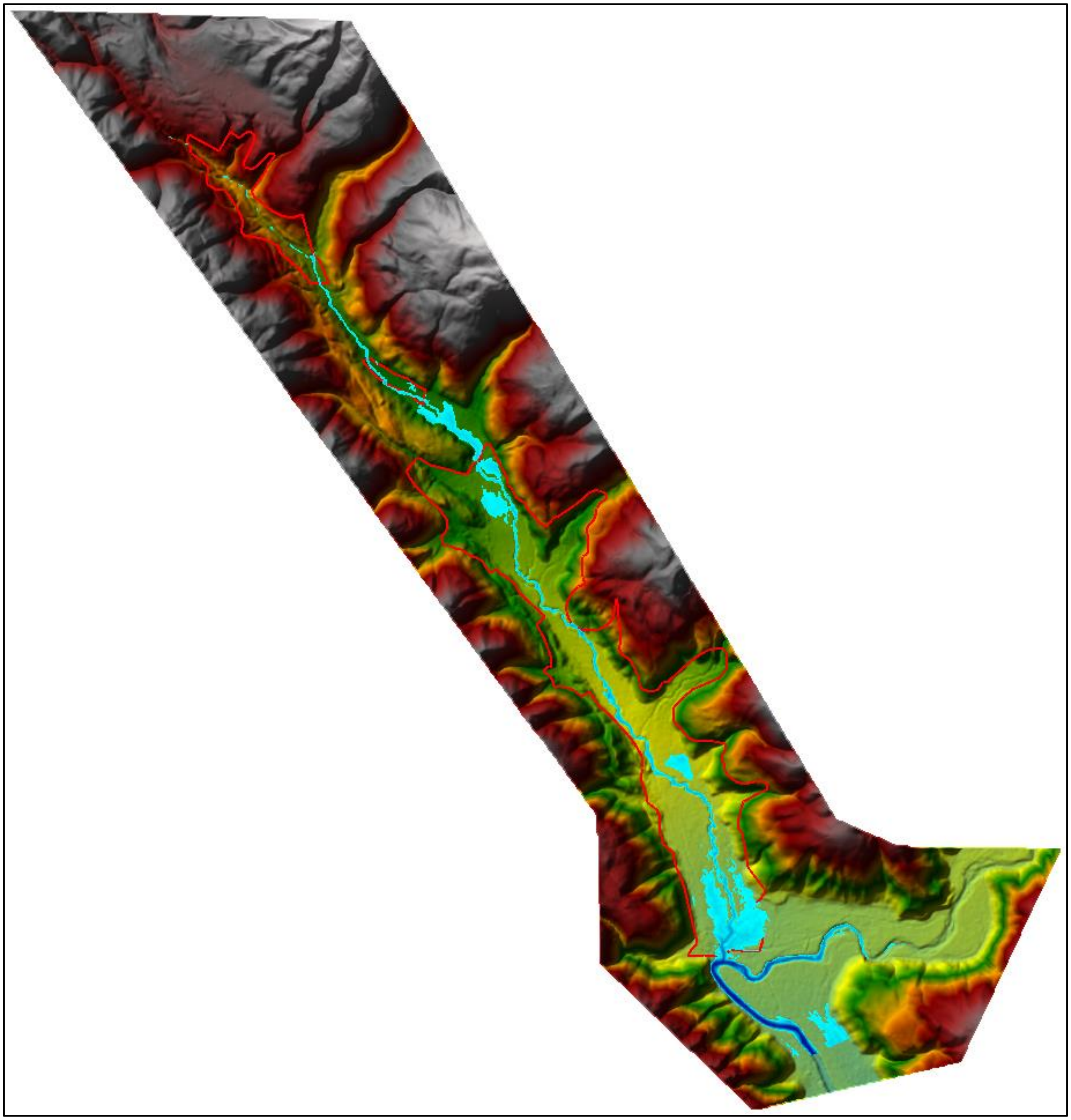


Figure 4: Flood inundation area for 5-year recurrence interval flood.

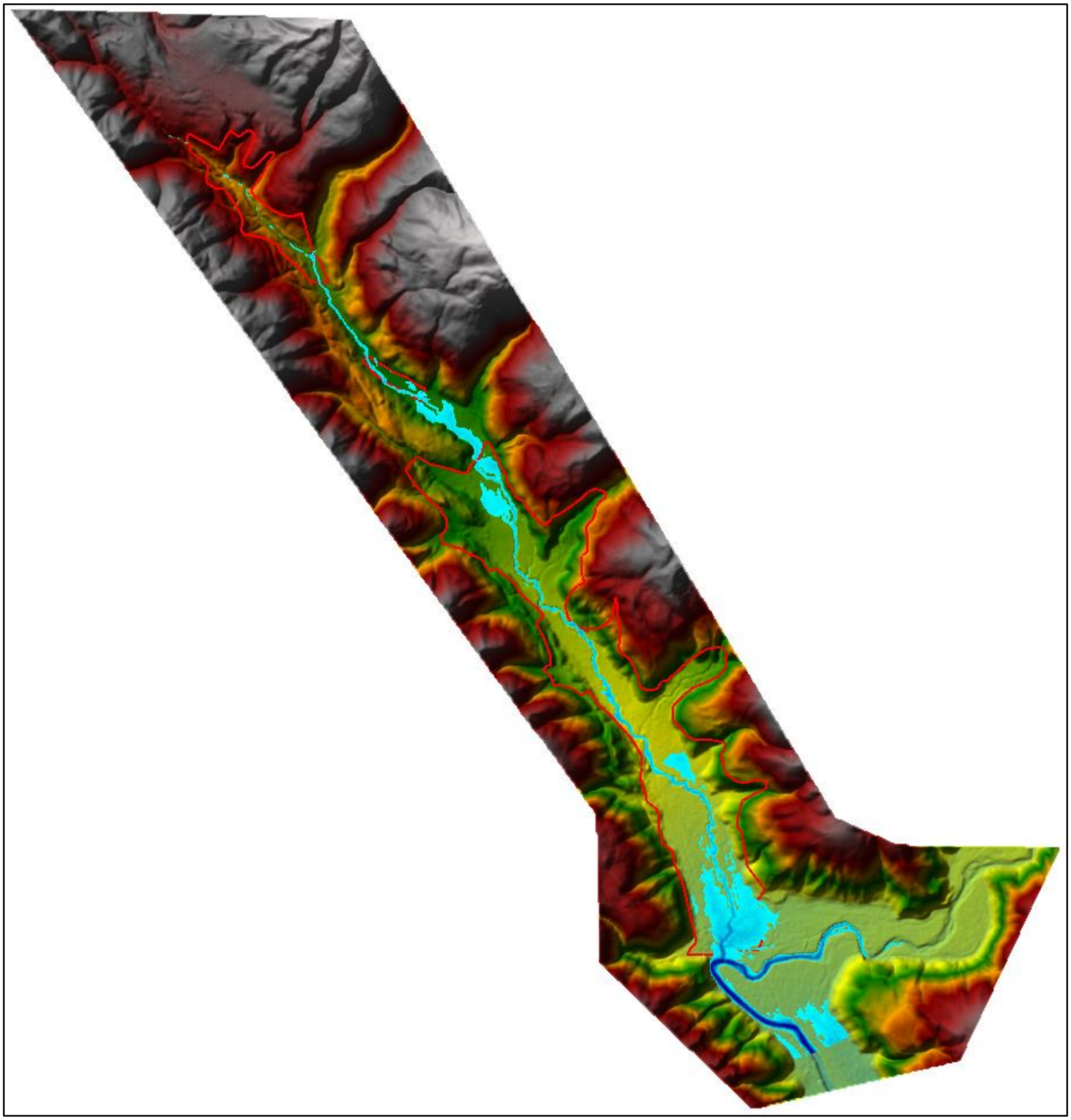


Figure 5: Flood inundation area for 10-year recurrence interval flood.

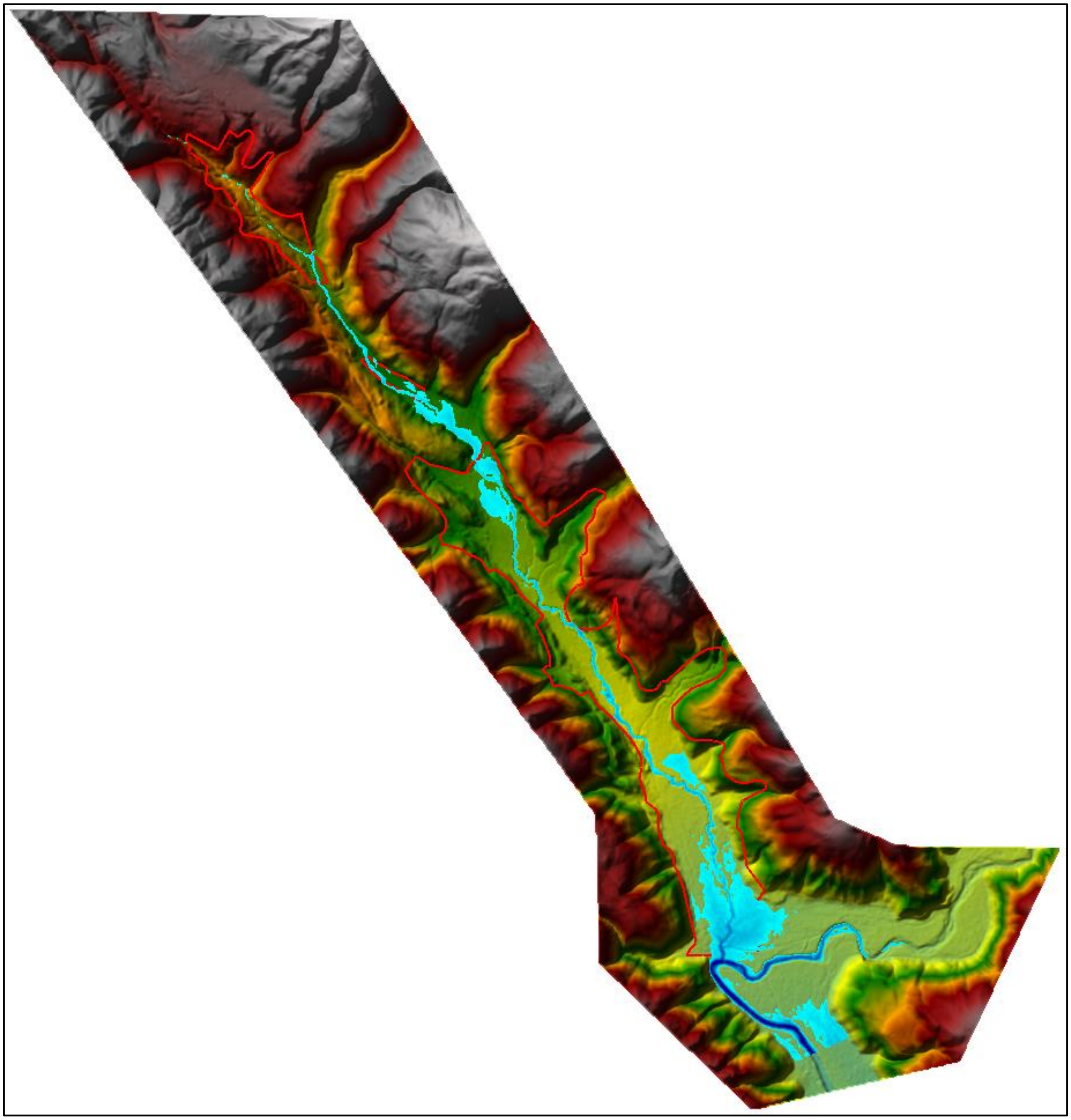
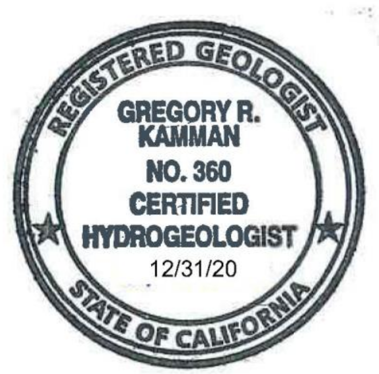


Figure 6: Flood inundation area for 20-year recurrence interval flood.

Please feel free to contact me with any questions regarding the material and conclusions contained in this letter report.

Sincerely,

Greg Kamman, PG, CHG
Principal Hydrologist



ATTACHMENT A: DEM Meta Data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			<purpose>The purpose of this lidar data was to produce high accuracy 3D elevation products, including tiled lidar in LAS 1.4 format, 3D breaklines, and 1 foot cell size hydro flattened Digital Elevation Models (DEMs). All products follow and comply with USGS Lidar Base Specification Version 1.2.</purpose>
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<horizpav>1.66 ft (50.6 cm)</horizpav>
<horizpae>The DEMs are derived from the source lidar and 3D breaklines created from the lidar. Horizontal accuracy is not performed on the DEMs or breaklines. Lidar vendors calibrate their lidar systems during installation of the system and then again for every project acquired. Typical calibrations include cross flights that capture features from multiple directions that allow adjustments to be performed so that the captured features are consistent between all swaths and cross flights from all directions. This data set was produced to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 1.35 ft (41 cm) RMSEx/RMSEy Horizontal Accuracy Class which equates to

Positional Horizontal Accuracy = +/- 3.28 ft (1 meter) at a 95% confidence level. Five (5) checkpoints were photo-identifiable but do not produce a statistically significant tested horizontal accuracy value. Using this small sample set of photo-identifiable checkpoints, positional accuracy of this dataset was found to be RMSEx = 0.66 ft (20.1 cm) and RMSEy = 0.70 ft (21.3 cm) which equates to +/- 1.66 ft (50.6 cm) at 95% confidence level. While not statistically significant, the results of the small sample set of checkpoints are within the produced to meet horizontal accuracy.</horizpae>

</qhorizpa>

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<vertacc>

<vertaccr>The DEMs are derived from the source lidar and 3D breaklines created from the lidar. The DEMs are created using controlled and tested methods to limit the amount of error introduced during DEM production so that any differences identified between the source lidar and final DEMs can be attributed to interpolation differences. DEMs are created by averaging several lidar points within each pixel which may result in slightly different elevation values at a given location when compared to the source LAS, which is tested by comparing survey checkpoints to a triangulated irregular network (TIN) that is created from the lidar ground points. TINs do not average several lidar points together but interpolate (linearly) between two or three points to derive an elevation value. The vertical accuracy of the final bare earth DEMs was tested by Dewberry with 176 independent checkpoints. The same checkpoints that were used to test the source lidar data were used to validate the vertical accuracy of the final DEM products. The survey checkpoints are evenly distributed throughout the project area and are located in areas of non-vegetated terrain (101 checkpoints), including bare earth, open terrain, and urban terrain, and vegetated terrain (75 checkpoints), including forest, brush, tall weeds, crops, and high grass. The vertical accuracy is tested by extracting the elevation of the pixel that contains the x/y coordinates of the checkpoint and comparing these DEM elevations to the surveyed elevations. All checkpoints located in non-vegetated terrain were used to compute the Non-vegetated Vertical Accuracy (NVA). Project specifications required a NVA of 0.64 ft (19.6 cm) at the 95% confidence level based on RMSEz (0.33 ft/10 cm) x 1.9600. All checkpoints located in vegetated terrain were used to compute the Vegetated Vertical Accuracy (VVA). Project specifications required a VVA of 0.96 ft (29.4 cm) based on the 95th percentile.</vertaccr>

<qvertpa>

<vertaccv>0.46 ft (14.0 cm)</vertaccv>

<vertacce>This DEM dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 0.33 ft (10 cm) RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to

be RMSEz =0.23 ft (7.0 cm), equating to +/- 0.46 ft (14.0 cm) at 95% confidence level.</vertacce>
</qvertpa>
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<vertaccv>0.89 ft (27.1 cm)</vertaccv>
<vertacce>This DEM dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 0.33 ft (10 cm) RMSEz Vertical Accuracy Class. Actual VVA accuracy was found to be +/- 0.89 ft (27.1 cm) at the 95th percentile. The 5% outliers consisted of 4 checkpoints that are larger than the 95th percentile. These checkpoints have DZ values ranging between -1.91 ft (-58.2 cm) and +2.04 ft (+62.2 cm).</vertacce>
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<procdesc>Data for the California FEMA R9 Lidar Project's Mendocino QL1 AOI was acquired by Quantum Spatial. Mendocino QL1's area included approximately 1228 contiguous square miles for the California counties of Mendocino, Shasta, Alpine, Butte, Modoc, and Lassen. Lidar sensor data were collected with the Leica ALS-80 HP lidar system. Mendocino QL1 AOI was delivered in the State Plane coordinate system, US survey feet, California Zone 2, horizontal datum NAD83, vertical datum NAVD88, Geoid 12B. Deliverables for the project included calibrated lidar point cloud, survey control, and a final acquisition/calibration report. The calibration process considered all errors inherent with the equipment including errors in GPS, IMU, and sensor specific parameters. Adjustments were made to achieve a flight line to flight line data match (relative calibration) and subsequently adjusted to control for absolute accuracy. Process steps to achieve this are as follows: Rigorous lidar calibration: all sources of error such as the sensor's ranging and torsion parameters, atmospheric variables, GPS conditions, and IMU offsets were analyzed and removed to the highest level possible. This method addresses all errors, both vertical and horizontal in nature. Ranging, atmospheric variables, and GPS conditions affect the vertical position of the surface, whereas IMU offsets and torsion parameters affect the data horizontally. The horizontal accuracy is proven through repeatability: when the position of features remains constant no matter what direction the plane was flying and no matter where the feature is positioned within the swath, relative horizontal accuracy is achieved. Absolute horizontal accuracy is achieved through the use of differential GPS with base lines shorter than 25 miles. The base station is set at a temporary monument that is 'tied-in' to the CORS network. The same position is used for every lift, ensuring that any errors in its position will affect all data equally and can therefore be removed equally. Vertical accuracy is achieved through the adjustment to ground control survey points within the finished product. Although the base station has absolute vertical accuracy, adjustments to sensor parameters introduces vertical error that

must be normalized in the final (mean) adjustment. The withheld and overlap bits are set and all headers, appropriate point data records, and variable length records, including spatial reference information, are updated in GeoCue software and then verified using proprietary Dewberry tools.</procdesc>
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<procdesc>Dewberry utilizes a variety of software suites for inventory management, classification, and data processing. All lidar related processes begin by importing the data into the GeoCue task management software. The swath data is tiled according to project specifications (5,000 feet x 5,000 feet). The tiled data is then opened in Terrascan where Dewberry identifies edge of flight line points that may be geometrically unusable with the withheld bit. These points are separated from the main point cloud so that they are not used in the ground algorithms. Overage points are then identified with the overlap bit. Dewberry then uses proprietary ground classification routines to remove any non-ground points and generate an accurate ground surface. The ground routine consists of three main parameters (building size, iteration angle, and iteration distance); by adjusting these parameters and running several iterations of this routine an initial ground surface is developed. The building size parameter sets a roaming window size. Each tile is loaded with neighboring points from adjacent tiles and the routine classifies the data section by section based on this roaming window size. The second most important parameter is the maximum terrain angle, which sets the highest allowed terrain angle within the model. As part of the ground routine, buildings are classified to class 6, low noise points are classified to class 7 and high noise points are classified to class 18. Once the ground routine has been completed, bridge decks are classified to class 17 using bridge breaklines compiled by Dewberry. An automated process took place after classification to assign Class 3, class 4, and class 5 based on height ranges. A manual quality control routine is then performed using hillshades, cross-sections, and profiles within the Terrasolid software suite. After this QC step, a peer review is performed on all tiles and a supervisor manual inspection is completed on a percentage of the classified tiles based on the project size and variability of the terrain. After the ground classification and bridge deck corrections are completed, the dataset is processed through a water classification routine that utilizes breaklines compiled by Dewberry to automatically classify hydrographic features. The water classification routine selects ground points within the breakline polygons and automatically classifies them as class 9, water. During this water classification routine, points that are within 1x NPS or less of the hydrographic features are moved to class 10, an ignored ground due to breakline proximity. A final QC is performed on the data. All headers, appropriate point data records, and variable length records, including spatial reference information, are updated in GeoCue software and then verified using proprietary Dewberry tools. The data was classified as follows: Class 1 = Unclassified. This class includes vegetation, buildings, noise etc. Class 2 = Ground Class 3 = Low Vegetation Class 4 = Medium Vegetation Class 5 = High Vegetation Class 6 = Buildings Class 7 = Low Noise Class 9 = Water Class 10 = Ignored Ground due to breakline proximity Class 17 = Bridge Decks Class 18 = High Noise The LAS header information was verified to contain the following: Class (Integer) Adjusted GPS Time (0.0001 seconds) Easting (0.003 m)

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<procdesc>Dewberry viewed lidar intensity stereopairs in 3-D stereo using Socet Set for ArcGIS softcopy photogrammetric software for Cow Creek, Keefer-Slough, Russian Mendocino and Alpine. The breaklines are collected directly into an ArcGIS file geodatabase to ensure correct topology. The lidargrammetry was performed under the direct supervision of an ASPRS Certified Photogrammetrist. The breaklines were stereo-compiled in accordance with the Data Dictionary. Lakes and Ponds and Streams and Rivers were collected according to specifications for the California FEMA Region IX Lidar Project.</procdesc>
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<procdesc>Kinetics used lidar intensity data and a surface terrain model in ESRI's ArcMap 10.5 and GeoCue software. The breaklines are collected directly into an ArcGIS file geodatabase to ensure correct topology. The breaklines were collected in accordance with the Data Dictionary. Lakes and Pond, Streams and Rivers and Tidal were collected according to specifications for the California FEMA Region IX Lidar Project.</procdesc>
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<procdesc>Dewberry digitzed 2D bridge deck polygons from the intensity imagery and used these polygons to classify bridge deck points in the LAS to class 17. As some bridges are hard to identify in intensity imagery, Dewberry then used ESRI software to generate bare earth elevation rasters. Bare earth elevation rasters do not contain bridges. As bridges are removed from bare earth DEMs but DEMs are continuous surfaces, the area between bridge abutments must be interpolated. The rasters are reviewed to ensure all locations where the interpolation in a DEM indicates a bridge have been collected in the 2D bridge deck polygons.</procdesc>
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<procdesc>Lidar points and surface models created from ground lidar points are reviewed and 3D bridge saddle breaklines are compiled in Terrascan. Typically, two breaklines are compiled for each bridge deck-one breakline along the ground of each abutment. The bridge breaklines are placed perpendicular to the bridge deck and extend just beyond the extents of the bridge deck. Extending the bridge breaklines beyond the extent of the bridge deck allows the compiler to use ground elevations from the ground lidar data for each endpoint of the breakline.</procdesc>
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<procdesc>Breakline QC was performed by Dewberry. Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to ESRI terrains created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between hydrographic breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the hydrographic breaklines. Once completeness, horizontal placement, and vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of ESRI Data Reviewer tools and proprietary tools. Corrections are performed within the QC workflow and re-validated.</procdesc>
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<procdesc>Class 2, ground lidar points are exported from the LAS files into an Arc Geodatabase (GDB) in multipoint format. The 3D breaklines, Lakes and Ponds, Streams and Rivers, Tidal, and Bridge Saddle Breaklines are imported into the same GDB. An ESRI Terrain is generated from these inputs. The surface type of each input is as follows: Ground Multipoint: Masspoints Lakes and Ponds: Hard Replace Rivers and Streams : Hard Line Tidal : Hard Line Bridge Saddle Breaklines: Hard Line</procdesc>
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<procdesc>The ESRI Terrain is converted to a raster. The raster is created using linear interpolation with a 1 foot cell size. The DEM is reviewed with hillshades in both ArcGIS and Global Mapper. Hillshades allow the analyst to view the DEMs in 3D and to more efficiently locate and identify potential issues. Analysts review the DEM for missed lidar classification issues, incorrect breakline elevations, incorrect hydro-flattening, and artifacts that are introduced during the raster creation process.</procdesc>
<procdate>201802</procdate>
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<procdesc>The corrected and final DEM is clipped to individual tiles. Dewberry uses a proprietary tool that clips the DEM to each tile located within the final Tile Grid, names the clipped DEM to the Tile Grid Cell name, and verifies that final extents are correct. All individual tiles are loaded into Global Mapper for the last review. During this last review, an analsyt checks to ensure full, complete coverage, no issues along tile boundaries, tiles seamlessly edge-match, and that there are no remaining processing artifacts in the dataset.</procdesc>
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ATTACHMENT B: Flood Frequency Analysis

USGS 11467500 SF GUALALA R NR ANNAPOLIS CA

Sonoma County, California
Hydrologic Unit Code 18010109
Latitude 38°42'18", Longitude 123°25'19" NAD27
Drainage area 161 square miles
Gage datum 70 feet above NGVD29

YEAR	DAY	Stage (ft)	Inst. Peak Q (cfs)	Unit Area Q (cfs/sq. mi.)
1951	Dec. 03, 1950	18.16	34,100	212
1952	Dec. 01, 1951	17.01	29,500	183
1953	Dec. 07, 1952	18.1	33,900	211
1954	Jan. 17, 1954	18.6	35,900	223
1955	Apr. 21, 1955	10.26	9,870	61
1956	Dec. 22, 1955	24.57	55,000	342
1957	Feb. 23, 1957	10.53	8,760	54
1958	Feb. 24, 1958	19.56	35,400	220
1959	Feb. 16, 1959	14.71	19,100	119
1960	Feb. 08, 1960	19.07	33,700	209
1961	Jan. 31, 1961	13.68	15,900	99
1962	Feb. 13, 1962	20.18	37,700	234
1963	Jan. 31, 1963	16.86	23,000	143
1964	Jan. 20, 1964	13.6	15,000	93
1965	Dec. 21, 1964	15.94	21,400	133
1966	Jan. 04, 1966	24.09	47,800	297
1967	Jan. 21, 1967	18.45	28,900	180
1968	Jan. 10, 1968	13.44	15,200	94
1969	Jan. 13, 1969	18.54	29,100	181
1970	Jan. 23, 1970	20.72	35,800	222
1971	Dec. 03, 1970	17.98	27,900	173

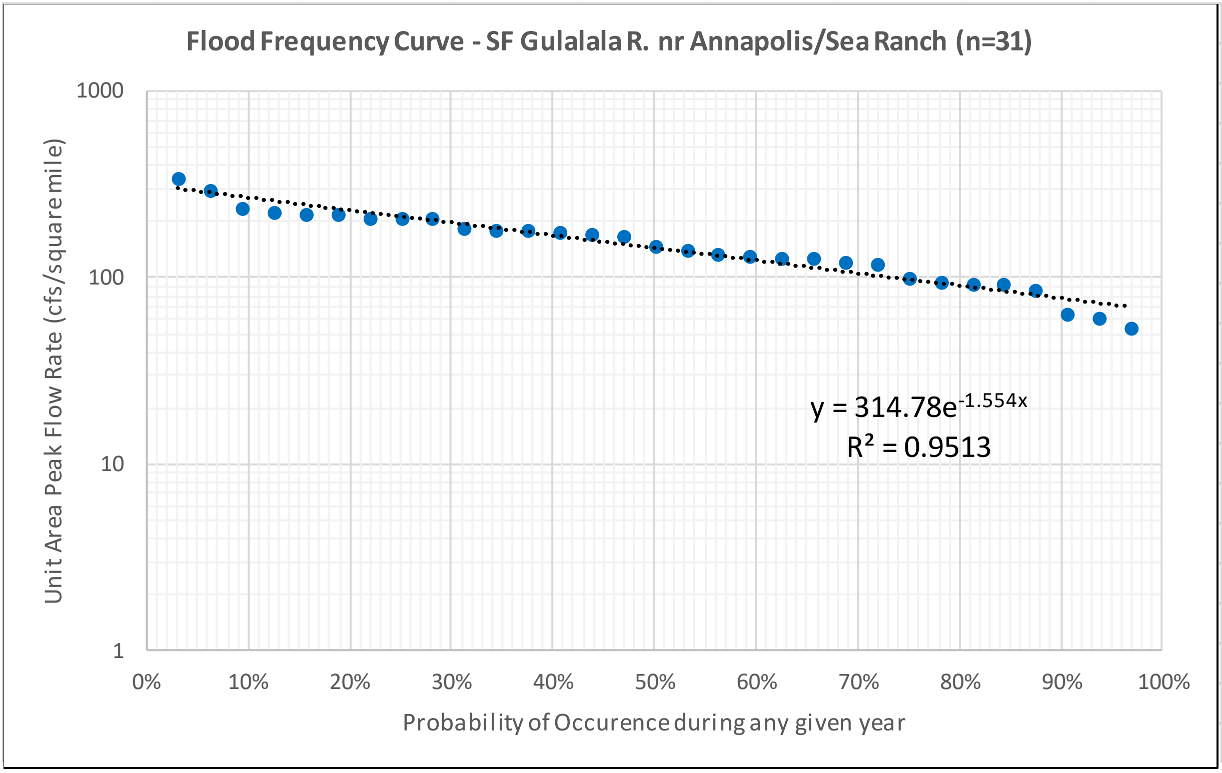
USGS 11467510 SF GUALALA R NR THE SEA RANCH CA

Sonoma County, California
Hydrologic Unit Code 18010109
Latitude 38°42'33", Longitude 123°25'32" NAD27
Drainage area 161 square miles
Gage datum 40.0 feet above NGVD29

YEAR	DAY	Stage (ft)	Inst. Peak Q (cfs)	Unit Area Q (cfs/sq. mi.)
2008	Jan. 04, 2008	27.42	26,800	166
2009	Feb. 22, 2009	17.52	10,400	65
2010	Jan. 20, 2010	24	20,500	127
2011	Dec. 29, 2010	23.85	19,400	120
2012	Mar. 27, 2012	24.36	20,400	127
2013	Dec. 23, 2012	26.06	23,800	148
2014	Feb. 08, 2014	22.05	15,000	93
2015	Dec. 11, 2014	31.58	28,500	177
2016	Dec. 21, 2015	23.32	13,900	86
2017	Jan. 10, 2017	28.56	21,300	132

Flood Frequency Analysis SF Gualala R (all data)

Rank	Year	Unit Area Q (cfs/sq. mi.)	Prob. Of Occurrence
1	1956	342	3%
2	1966	297	6%
3	1962	234	9%
4	1954	223	13%
5	1970	222	16%
6	1958	220	19%
7	1951	212	22%
8	1953	211	25%
9	1960	209	28%
10	1952	183	31%
11	1969	181	34%
12	1967	180	38%
13	2015	177	41%
14	1971	173	44%
15	2008	166	47%
16	2013	148	50%
17	1963	143	53%
18	1965	133	56%
19	2017	132	59%
20	2010	127	63%
21	2012	127	66%
22	2011	120	69%
23	1959	119	72%
24	1961	99	75%
25	1968	94	78%
26	1964	93	81%
27	2014	93	84%
28	2016	86	88%
29	2009	65	91%
30	1955	61	94%
31	1957	54	97%



Summary

Prob. Of Occurrence	Return Period (yrs)	Unit Area Q (cfs/sq. mi.)
5%	20	291
10%	10	269
20%	5	231
50%	2	145