US Army Corps of Engineers®
Sacramento District
Engineering Division

Yuba River Ecosystem Restoration Feasibility Study

Yuba County, California

Appendix C: Draft Engineering Appendix

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C-1. General

C-1.1. Format and Organization. This document and the associated plates and attachments comprises the Engineering Appendix to the Yuba River Ecosystem Restoration DRAFT Feasibility Report/Environmental Assessment. This document has been constructed following ER 1110-2-1150 Appendix C - CONTENT OF ENGINEERING APPENDIX TO FEASIBILITY REPORT. Several sections of ER 1110-2-1150 Appendix C are not applicable to this Ecosystem Restoration Study and are thus not addressed, though the headings are still listed; many other sections demand only brief explanation, non-applicable sub-sections are omitted without comment. The sections most relevant to this Study are C-2 Hydraulics and Hydrology, C-6 Civil Design (which features elements of C-4 Geotech and C-7 Structural Design), C-3 Surveying, Mapping, and Other Geospatial Data Requirements (though elements are covered in Section C-6 Civil Design), and C-19 Cost Engineering; plates and attachments are contained following a references section at the end of this Appendix.

C-1.2. Study Area. The Yuba River Watershed (Figure 1) encompasses 1,340 square miles on the western slopes of the Sierra Nevada Mountain Range, and is located in portions of Sierra, Placer, Yuba, and Nevada counties (Reynolds *et al*., 1993). The Yuba River is a tributary of the Feather River which, in turn, flows into the Sacramento River near the town of Verona, California.

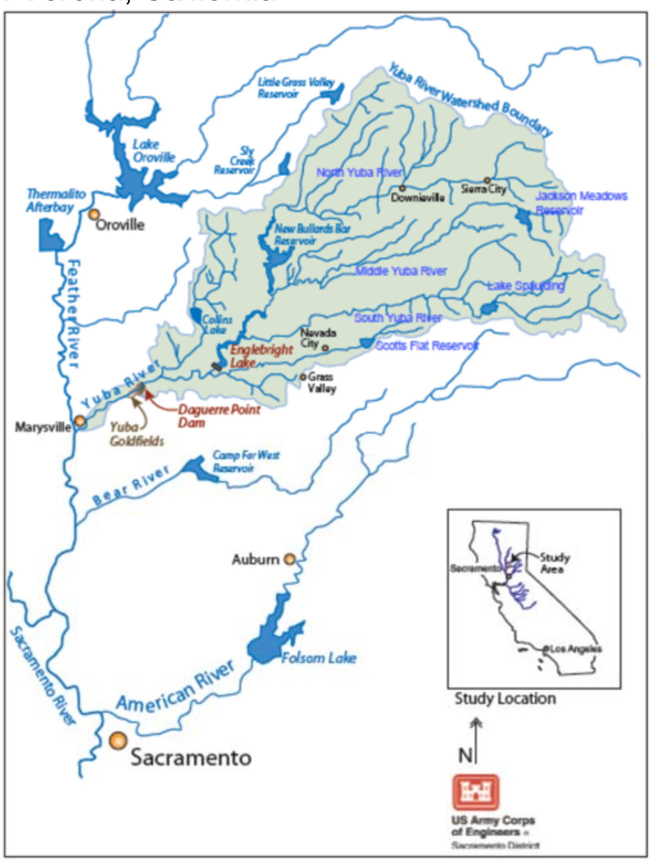

Figure 1. Study Area Map (not to scale).

The Yuba River flows through forest, foothill chaparral, and agricultural lands. Levees are absent from most of its course except for near the river's confluence with the Feather River. At that point, the Yuba River is bounded by setback levees for approximately six miles.

The study area for the Yuba River Ecosystem Restoration Feasibility Study (YRERFS) included proposed project area and extends beyond it both upstream and downstream, with an upstream boundary approximately 2 miles downstream of Englebright Dam and a downstream boundary at the confluence of the Yuba River and the Feather Rivers.

C-1.3. Project Purpose. The goal of the YRERFS is to explore opportunities and identify a National Ecosystem Restoration (NER) plan for ecosystem restoration within the Yuba River watershed. The identification of an NER plan involves evaluating and comparing the relative benefits and costs of proposed actions through use of the cost effectiveness / incremental cost analysis (CE/ICA) tool. Ecosystem outputs (benefits) for proposed actions were developed through use of a Habitat Evaluation Procedures (HEP)-based assessment approach.

Initial alternatives spanned from collections of habitat measures (e.g. floodplain grading, side channel excavation, tree planting) to large structural measures including juvenile fish collection facilities at and upstream of Englebright Dam as part of fish collect and transport schemes. Through screening phases based on risk, estimated benefits, and cost ranges the final array of alternatives emerged as five habitat restoration increments (groups of measures). It is the engineering and modeling of this final array of alternatives that is detailed in this Appendix. Ultimately, Alternative 5 was selected as the Tentatively Selected Plan (TSP, also referred to herein as the Proposed Plan or Project)

C-1.4. Workflow Description. The engineering work performed for the Final Array of Alternatives concerns

1. Design and placement of habitat features

2. Assessment of habitat feature performance through the quantification of without-project (current conditions) and with-project benefits over a relevant period of performance and range of conditions

The design philosophy and criteria for habitat features is documented in YRERFS Design Criteria.pdf (YCWA 2016, Attachment CV-A).

In order to quantify ecological benefits, a benefit evaluation methodology must be selected. For this Study, a Habitat Evaluation Procedure using Habitat Suitability Indices for three representative indicator species was determined to be the appropriate evaluation method.

To evaluate benefits,

- Existing topography must be evaluated and imported into GIS so that without-project conditions can be defined, discretized, and available for hydraulic modeling

- Habitat features, once designed, must be mosaicked into existing topography in GIS so that with-project conditions can be defined, discretized, and available for hydraulic modeling

- Hydrologic analyses are necessary so that
  - representative flows can be selected
  - associated frequency weighting of those flows can be employed to capture variability in the system for habitat performance assessments

- Hydraulic modeling of the flows selected in hydrologic analysis, for without and with-project topography, is necessary to
  - discretize habitat types via wetted perimeter for each flow scenario
  - generate depth and velocity data for HSI determination for each flow scenario

- GIS software must be populated with
  - programmed HSI relationships (via lookup tables)
  - habitat measure attributes
  - hydraulic modeling results (including weighting from hydrologic analyses) in order to output effective acreages (HSI x measure area) for post-processing toward final benefit calculations in Excel.

To evaluate costs and risks,

- Excavation quantities, access, staging, identification of placement sites, and other Civil Design work must be performed on with-project topography to inform environmental impacts and cost estimates for each measure

- A construction/sequencing schedule must be developed for cost estimating purposes based on civil design information

- Measures must be grouped in a logical fashion to form increments for evaluation in screening.

This workflow allows for the ultimate comparison of benefits and costs in the final array of alternatives, through use of CE/ICA, so that a National Ecosystem Restoration (NER) Plan can be selected. The order of this workflow does not fully coincide with the layout of ER 1110-2-1150 Appendix C - CONTENT OF ENGINEERING APPENDIX TO FEASIBILITY REPORT, the format of the ER guidance has been adhered to with references either previous or subsequent sections of this Appendix as appropriate.

C-2. Hydrology and Hydraulics

The ecological function and value of riverine and adjacent riparian habitat types would be expected to vary with normally occurring, seasonal fluctuations in flow; therefore several flows were incorporated into the hydraulic modeling to ensure the full range of habitat value was appropriately evaluated. Evaluating a range of flows serves to provide understanding of habitat value as it varies spatially (depths, velocities, cover associated with shallow water habitat) and temporally (as flows fluctuate throughout the year). The range of flows selected for evaluation are described in more detail below. Ultimately, habitat units calculated for different flows will be combined into a single weighted average output based on relative frequency of each flow. An additional benefit of incorporating a range of flows into the hydraulic modeling assessment approach is that it mitigates risk associated with design.

C-2.1. Hydrology. The final array of alternatives are located just upstream from the Yuba River near Marysville gage (Gage Number 114121000). There is very little contributing drainage area between the proposed alternatives and the gage. Therefore, this gage reflects the flow conditions at each of the proposed restoration sites. Flows on the Lower Yuba River are highly influenced by upstream reservoir regulation for flood management, hydropower, and water supply purposes. As a result, flows measured at the gage prior to 1972 are not considered representative of the current hydrologic conditions with the reach. Annual peak flows measured from Water Years 1970 through 2016 (45 years of record) at the Yuba River near Marysville gage have ranged from 673cfs in water year 1977 to 161,000 cfs in water year 1997. The Sacramento District USACE conducted a hydrology study of the Central Valley in 2015 for the California Department of Water Resources. The study, titled “Central Valley Hydrology Study, 29, November 2015”, presented Annual Chance of Exceedance (ACE) estimates for peak flows measured at the USGS Yuba River near Marysville Gage. The estimates were made using reservoir simulations of rare floods and the results were presented for a range of flood magnitudes from 10% (1/10) ACE to 0.002 (1/500) ACE. Table 1 presents these results in tabular format. These flows are considered suitable for evaluation of the ecosystem restoration alternatives presented in this report.

Table 1. Peak discharges and associated annual chances of exceedance.

Annual Chance of Exceedance	Peak Discharge (CFS)
10% (1/10)	71,700
2% (1/50)	112,000
1% (1/100)	178,000
0.5% (1/200)	212,000
0.2% (1/500)	305,000

C-2.1.1. Modeled Flow Selection. The selection of flows to incorporate into hydraulic modeling was based on two primary considerations: (1) the range of flows needed to facilitate an evaluation of the natural range of hydrologic conditions in the Yuba River as they relate to assessing ecosystem outputs of proposed actions, and (2) the incorporation of flows into the hydraulic modeling should be done in a manner consistent with the level of detail of the overall assessment approach. Given these considerations, it was decided that a low flow case, medium flow case, and high flow case would be modeled.

For the purpose of the YRERFS a low flow case was based on minimum flow requirements in the Lower Yuba River described by the Yuba Accord (YCWA 2007), a medium flow case was based on an approximation of average annual discharge, and a high flow case was based on approximate bankfull discharge. Although peak annual flows often greatly exceed the bankfull discharge, those high flows are less relevant to the evaluation as the proposed actions are designed to address habitat suitability at lower, more frequent discharges. The high; medium and low flows are representative of around 94% of occurring annual flows. 42 years of flow record representing the Yuba River below Deer Creek were obtained from the Proposed Project and Base Case scenarios from the YCWA relicensing website (YCWA 2012a, 2012b). The flow record was utilized to develop an annual average flow and bins of flow frequency over the period of record. 42 years of mean daily data is a robust data set that allows for a straightforward frequency analysis based on number of observations in a range vs total observations for the data set. The methodology for determining these high, medium, and low flows is given below.

C-2.1.1.1. Average Annual Flow. Flow observations for each calendar year were averaged, giving a data set of 42 average annual flow rates. Outlier flows greater than bankfull flow were assigned a bankfull value of 5,000 cfs for purposes of determining an average annual flow, so that outliers (extreme, infrequent events) did not disproportionately skew the average. The 42 average annual flow rates were then averaged, yielding an annual average of 1816 cfs. This average annual value was rounded to 1,850 cfs and was chosen as the target value for a bin, since average annual is an intuitive and representative value for the system.

C-2.1.1.2. 700 to 800 cfs bin. Current and future operations call for a minimum flow of 700 cfs, thus the lower bound for this bin was defined as ≥700 cfs. In order to not fall below that minimum flow, a practical low flow of ~730 cfs to 750 cfs is expected in future operations. Defining <800 cfs as the upper bound to this "low" bin yielded an average value of 750 cfs for all observations with the bin, giving a reasonable flow condition to model and a reasonable 100 cfs bin range (a smaller bin range could be problematic due to the accuracy of flow rate data). 7,205 observations fell within this ≥700 and <800 cfs bin, resulting in a frequency weighting of 7,205/14,610 = 49.3%.

C-2.1.1.3. 800 to 3240 cfs bin. With ≥800 cfs as a lower bound, the goal of this "med" bin was to have the average of the observations within the bin to be close to the annual average flow of 1850 cfs. Setting the upper bound at <3240 cfs resulted in an average bin flow of 1852.7 cfs. This ≥800 and <3240 cfs bin contains 3,666 observations, resulting in a frequency weighting of 3,666/14,610 = 25.1%.

C-2.1.1.4. 3,240 to 8,000 cfs bin. With ≥3,240 as the lower bound, the goal of this "high" bin was to have the average of the observations within the bin to be near the bankfull flow value of 5,000 cfs. Using the full data set without outlier (>5,000 cfs) value reassignment, an upper bound of <8,000 cfs results in a bin average 5,000 cfs. The number of observations in the full data set contained within this ≥3,240 and <8,000 cfs bin is 2,815, resulting in a frequency weighting of 2,815/14,610 = 19.3%.

C-2.1.1.5. 8,000+ cfs bin. The remaining observations greater than or equal to 8,000 cfs have a frequency weighting of 924/14,610 = 6.3%. These flows were considered to be outlier flows, resulting in hydrologic conditions beyond the range of anticipated performance for proposed actions. During high flows, the Lower Yuba overtops its normal banks and spreads out over a broad area; the benefits of the proposed restoration features would not be expected to be significant under these conditions. Therefore, while a fourth bin of flows was identified, these flows were not included in the hydraulic modeling. For the purpose of the ecosystem modeling, these flows (weighted at 6.3%) were assumed to have 0 value for both Future Without Project (FWOP) and Future With Project (FWP) conditions.

C-2.1.2. Summary of Flow Bins. A summary of the bins and the observations within them for the 750, 1,850, and 5,000 cfs flow scenarios is presented in Table 2 below.

Table 2. Summary of hydraulic modeling representative flows and binning of observations, Yuba River below Deer Creek.

	Low Flow	Medium Flow	High Flow	Flood Flows
Target Average Flow (cfs)	750	1,850	5,000	None
Lower Bound of Bin (≥limit)	700	800	3,240	8,000
Upper Bound of Bin (<limit)	800	3,240	8,000	143,500
Number of observations (14610 total)	7,205	3,666	2,815	924
Weighting (% of total flows)	49.3%	25.1%	19.3%	6.3%
Average Flow (cfs)	751	1,853	5,001	15,745

C-2.1.3. Hydraulic Modeling Inputs. The low, medium, and high flow scenarios developed from site hydrology were used as inputs to RAS2D hydraulic modeling for both FWOP and FWP conditions

C-2.2. Hydraulics

C-2.2.1. Topographic Data. Existing topography and bathymetry were used for the study's hydraulic modeling efforts.

The topography for the HEC-RAS 2D model was previously collected by 1) the University of California at Davis and 2) Under contract for the Central Valley Floodplain Evaluation and Delineation (CVFED) Task Order 24. Base Terrain was taken from the Central Valley Floodplain Evaluation Delineation (CVFED) LIDAR 2008 data set for without-project, and this base was supplemented with the design measures for with-project topography (See C-3-GIS and C-6-Civil Design for more detail on the nature and design of these measures).

Roughness values were developed from the National Land Cover Database (https://www.mrlc.gov/index.php, https://pubs.usgs.gov/fs/2012/3020/).

All topographic data references the North American Vertical Datum of 1988 (NAVD88) and the North American Datum of 1983 (NAD83), projected in California State Plane Zone 2. The units are in feet.

C-2.2.2. Study Approach. This Study used the HEC-RAS 5.0.3 (RAS) as a 2-dimensional gridded hydraulic model. This RAS version uses an Implicit Solution Volume algorithm as its 2D unsteady flow equations solver. RAS is used to produce the necessary outputs of Depth, Velocity Water Surface Elevation, and Floodplain Extent. Using these parameters along with known Habitat Suitability Indices (HSIs), the environmental evaluation of restoration alternatives of the without-project and with-project condition will be evaluated.

The selected peak flow values for analysis are 1) 750 cfs, 2) 1,850 cfs, 3) 5,000 cfs, which represent a range of river flows that exist in the Yuba River greater than 90% of the time. To evaluate floodplain wetted area effects, model runs were made at 21,200 cfs and 84,000 cfs. Selection criterion for peak flows used are in C-2.1 Hydrology and the Yuba River Ecosystem Restoration Modeling Flow Considerations Technical Memorandum (TM 7-10, YCWA 2013). Floodplain delineations and hydraulic properties presented in this Study are based on individual steady flow model analysis of the Yuba River.

Efforts recommended for further design refinement:

- Sediment Transport
- Channel stability

- Bank Protection, Bridge Scour
- Fluvial geomorphology

The key assumptions for each analysis are listed in Table 3.

Table 3. YRERFS hydraulic analyses and key assumptions.

YRERFS Hydraulic Deliverables	Key Assumptions
Future without-project condition analysis (HEC-RAS)	The project area adequately represents the Yuba River from the Confluence to 2 miles downstream of Englebright Dam.
Evaluation of final alternatives for evaluation (HEC-RAS)	For alternative analysis, 44 separate features have been evaluated as the with-project conditions.
Potential hydraulic impacts (HEC-RAS)	The baseline for potential hydraulic impacts is the without-project condition
Residual risk (HEC-RAS)	Not evaluated at this time
Interior drainage	Not evaluated at this time
Systems risk and uncertainty	Seasonal flow selections are based upon values within 90% seasonal flows (YCWA 2013)
Climate change	Not evaluated at this time
Sea level rise	Not evaluated at this time.
Erosion (including riverine/bank, wind-wave, and channel stability)	Limited analysis conducted, coordinating with ongoing design efforts that are not yet complete.

C-2.2.3. CHANNEL HYDRAULICS

C-2.2.3.1. Model Mesh. The model mesh for YRERFS was generated from a combination of available terrain along with the project related features to be evaluated. These individual project related features were added to the existing terrain dataset using GIS. These features, called Action Groups were segregated into subtypes labeled Side Channel, Riparian Planting and Floodplain Lowering. Figure 2 illustrates one of these features. Detailed descriptions of these features are contained in Section C-6 Civil Design.

The extent of this model spans approximately 22.2 miles of the Yuba River, from the confluence with the Feather River to about 2 miles downstream of Englebright Dam. It is 500 feet (ft.) wide at the upstream boundary and 2,800 ft. at the confluence of the Feather River, with a maximum width of 8750 ft. about 3 miles upstream. The model mesh was generated over the supplied terrain with a Computational Points Spacing of DX=100 and DY=100. This 100 (ft.) grid contains 39,199 cells where the average cell size is 7,907 square feet (sq. ft.), the maximum cell size is 25,343 feet, minimum cell size is 103 sq. ft.

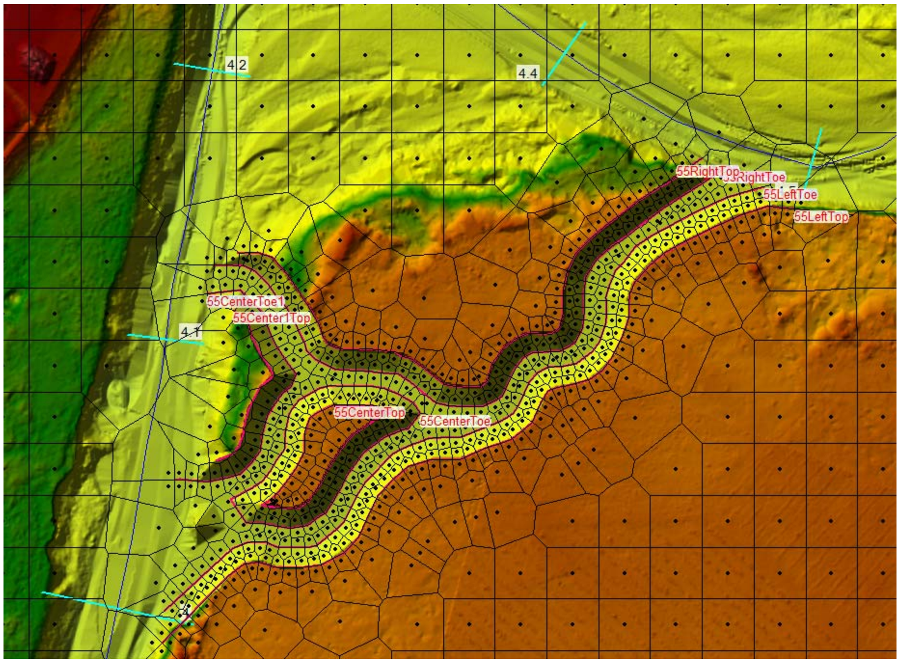

Figure 2. With-Project Mesh Feature (Measure 55).

The mesh also includes break lines that help define 14th Street, the railroads, Simpson Lane and additional topographic features; plates HD-1 through 5 show the mesh for the entire model domain.

C-2.2.3.2. Selected Upstream Boundary Condition Discharges. Modeled flows (cfs) for habitat modeling were selected from datasets developed by the Yuba County Water Agency (YCWA) in support of their Federal Energy Regulatory Commissions' (FERC) hydroelectric relicensing. The selected peak steady flow values for analysis are (1) 750 cfs, (2) 1,850 cfs, (3) 5,000 cfs, (4) 22,100 cfs, and (5) 84,000 cfs represent a range of river flows that exist within the Yuba River greater than 90% of the time during the period of Record of USGS Gage 1148000, Yuba River below Englebright Dam, near Smartsville. The use of steady flows is predicated on the fact that the hydrologic model used was considered appropriate for all computations. Figure 3 shows an illustration of the Steady Inflow Hydrograph used for analysis. Note the 1 day duration used for warmup for this 5,000 cfs inflow hydrograph.

C-2.2.3.3. Selected Downstream Rating Curve. Due to the lack of available calibration data from previous modeling, a downstream boundary rating curve was created for this modelling effort using iterative normal depth calculations using the Manning's equation. Using the supplied terrain data a cross section (See Figure 4) was taken at the boundary of the model mesh far away from any point of interest to avoid the introduction of boundary condition errors. Using the Manning's equation a Slope of 0.002 ft/ft with Manning's roughness of 0.08 was assumed to produce the rating curve as shown in Figure 5.

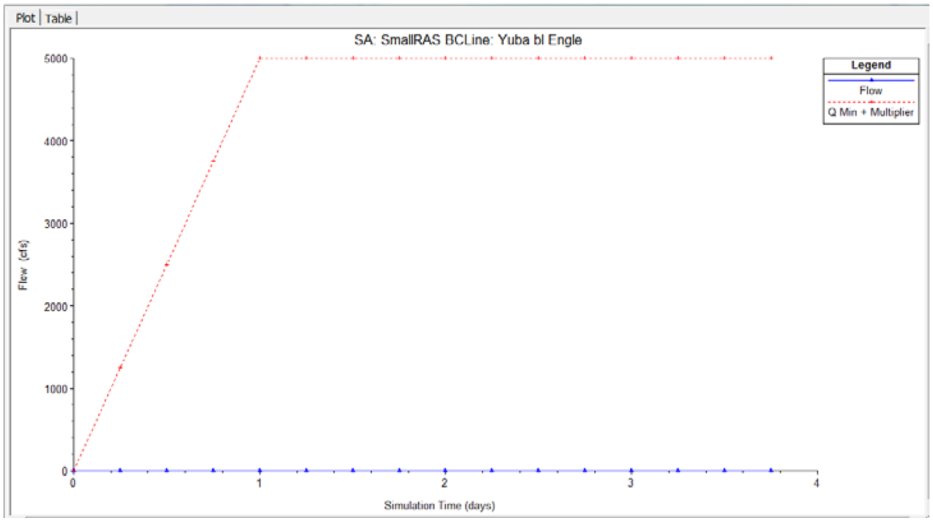

Figure 3. Sample of the Steady Flow Hydrograph (5,000 cfs).

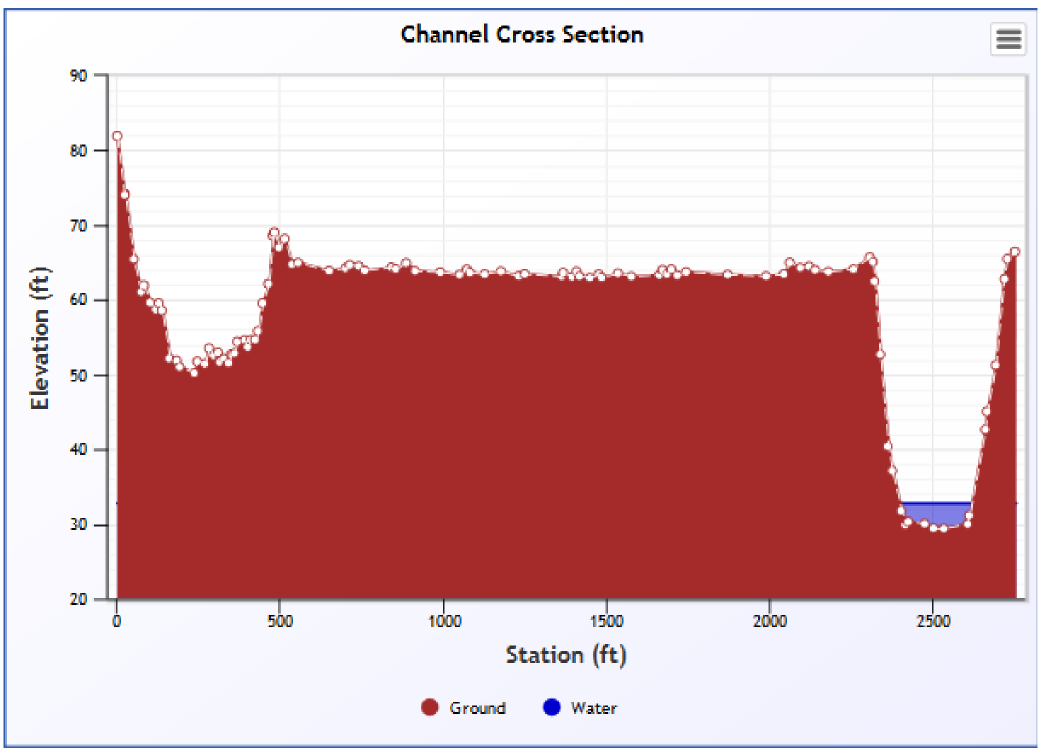

Figure 4. Channel Cross Section.

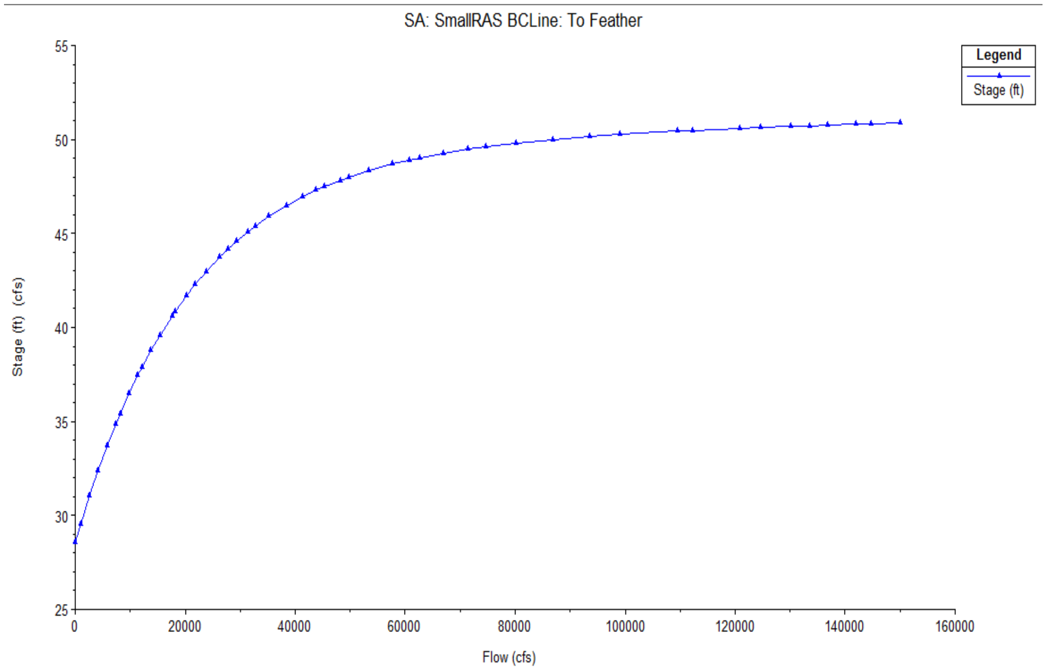

Figure 5. Yuba River Station 0.19 Downstream Boundary.

C-2.2.4. Model Calibration

The model was calibrated to a downstream flow using values from the USGS Gage 11421000 labeled "Yuba R NR Marysville, CA"; upstream calibration data was not available. Therefore water surface profiles within the proposed restoration sites are not considered calibrated. Calibration efforts involved multiple adjustments to model warmup times, roughness, mesh size and computational interval to reach a satisfactory calibration. Figure 6 below illustrates model results before and after District Quality Control review.

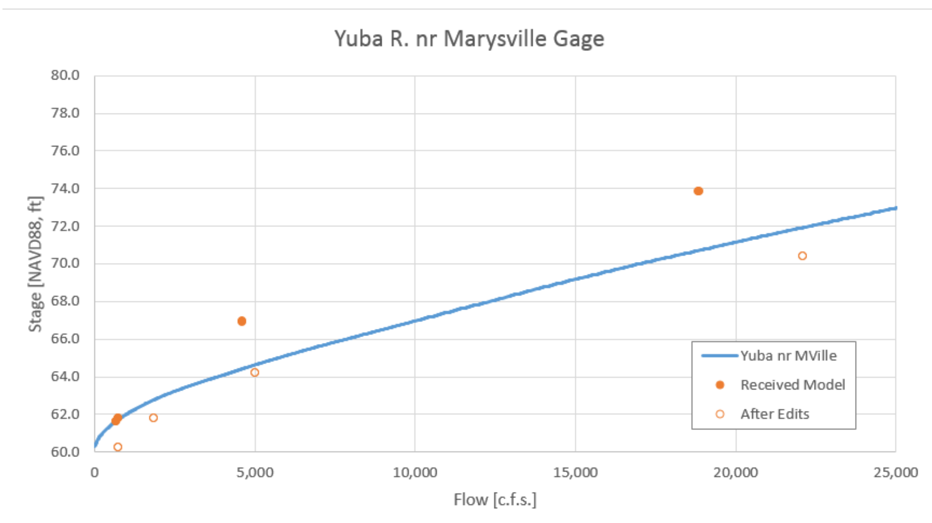

Figure 6. Model Calibration.

C-2.2.5. Model Results. The HEC-RAS model depth and velocity results at each node in the mesh for all flow and topographic scenarios were returned to GIS for incorporation into HSI modeling. Appendix D – Environmental of the Draft Feasibility Report/Environmental Assessment describes the rasterization and manipulation of these results for subsequent use; C-3 Surveying, Mapping, and Other Geospatial Data Requirements gives a brief discussion of the use of hydraulic modeling outputs; and Attachments GIS-A through GIS-C give detailed descriptions of the use of hydraulic modeling outputs through the entire workflow of benefit calculations.

C-2.3. Anticipated frequency of induced flooding.

2.3.1. General. Implementation of the proposed plan would not affect the primary drivers of hydrology and hydraulics in the watershed; effects would be localized in nature. Inflows and outflows in the lower Yuba River would not be affected by the types of proposed actions. Localized modifications to hydrology and hydraulics could result from project actions, including direct modifications of topography and installation of riparian and hydraulic roughness features. The Proposed Plan includes modifications to terrain that involve the excavation and reshaping of terrain to create complex habitat features (i.e. construction of side channels, backwaters, and floodplain lowering). These modifications are designed to affect habitat at low to normal flow (below bankfull) conditions. Under these normal conditions, these modifications would result in additional channel capacity. During normal flood conditions, the Lower Yuba River flows into the readily accessible floodplain; during these conditions, project features would be inundated. Project features would not affect the ability of the river to access high floodplain nor would it affect the hydrology of the watershed and therefore would not result in significant effects to this resource.

Project features also include the installation of hydraulic roughness features, including planting of riparian vegetation and installation of woody material and boulders. Installation of woody materials and boulders would be limited and focused on improving and/or maintaining the hydraulic stability of constructed features. Boulders and woody material placements would not be constructed at a scale that would affect the hydrologic or hydraulic conditions of the Lower Yuba River.

The Proposed Plan includes planting of 136 acres of riparian vegetation which could affect the conveyance of flood flows through the Lower Yuba River. Potential impacts to flood flow conveyance from the planting of vegetation would be offset through the increase to channel capacity resulting from the excavation of material (on the order of 800,000 cubic yards) from topographic modification actions.

2.3.2. Climate Change. All alternatives in the final array are located along an approximately 12 mile stretch on the Lower Yuba River, therefore climate change would be anticipated to affect the alternatives in the same manner. Climate change was thus not applicable to plan selection. It is anticipated that climate change effects analysis as required by ECB 2016-25 will be addressed during feasibility level design and the final report.

C-2.4. Water Quality. Existing conditions and potential project effects on Water Quality are discussed in the Effects Analysis section of the Main Report. Water Quality concerns associated with the TSP include increases in turbidity due to induced erosion and temporary increases in suspended soil/sediment during construction; however, the primary water quality concern in the Lower Yuba River is mercury and mercury methylation. As of 3 October 2017, the Lower Yuba River is 303(d) listed for Mercury with TMDL development targeted for 2027; Copper is being considered for placement on the CWA section 303(d) List (https://www.waterboards.ca.gov/water_issues/programs/tmdl/2014_16state_ir_reports/category5_report.shtml).

Feature-specific modeling during feasibility level design and preconstruction, engineering and design will mitigate risks of project-induced turbidity increased due to erosion. This concern is intertwined with that of the structural/functional resilience and sustainability of the design features within a dynamic riverine environment (see also Section C-7 Structural Requirements).

Potential characterization methods and controls to mitigate water quality impacts with respect to mercury or other fine-grained-sediment-associated contaminants are discussed in Sections C-9 Hazardous and Toxic Materials, C-10 Construction Procedures and Water Control Plan, and C-21 Special Studies of this Appendix, and in the Effects Analysis section of the Main Report.

Overall, the long term impacts of the proposed plan are expected to provide a higher quality riverine system and improve most water quality parameters. The restored vegetated riparian areas would improve long-term water quality by providing shade that would help moderate stream temperatures and light penetration; and providing root structure and woody material that would help stabilize stream banks, moderate stream velocities, reduce channelization, and reduce erosion and suspended sediments. Long-term water quality concerns thus focus on ensuring that increased methylation of mercury is not induced by project activities.

C-3. Surveying, Mapping, and Other Geospatial Data Requirements

C-3.1. Mapping Data. Existing mapping data was sufficient for a baseline of FWOP conditions and a basis for FWP conditions for the habitat measures in the Final Array of Alternatives. Habitat features were created by HDR and mosaicked into existing topographic data by both HDR and Sacramento District staff. References and previous and subsequent sections of this Appendix describe mapping/GIS work accomplished:

- "Yuba River Ecosystem Restoration Study Feasibility Study Habitat Measures" (YCWA 2016b) details the habitat features and provided the basis for their creation in GIS

- Section C-2.2.1- Topography describes the data used for hydraulic modeling

- Attachment CV-B describes the GIS files and manipulations used in the generation of excavation and grading quantities.

- Attachment CV-A describes the design the design philosophy and criteria for habitat features.

- Section CV-6.5 and subsections discuss staging area determinations that were incorporated into GIS for cost, environmental, and real estate purposes.

C-3.2. GIS Modeling and Data Processing. Benefit evaluation is necessarily part of the Ecosystem Restoration planning process. In order to document the post-processing of hydraulic modeling results and the manipulations of tree cover, in-water cover, other parameters and HSI relationships within GIS, background on the HEP procedure for calculating benefits are presented here.

C-3.2.1. HEP Procedure and HSI Relationships. Appendix D – Environmental and the associated Attachment 8 give detailed accounts of the Habitat Evaluation Procedure (HEP) and associated Habitat Suitability Indices used in benefit determination, based largely on "Technical Memorandum 7-10 Instream Flow Downstream of Englebright Dam" (YCWA 2013). This information is summarized below.

Through an evaluation of various potential models, the project delivery team (PDT) chose to use a Habitat Evaluation Procedure (HEP) based assessment approach. The assessment approach utilizes Habitat Suitability Index (HSI) models to develop habitat units for key habitat types that are later combined into a single habitat output for each alternative. Three key habitat types to represent anticipated ecosystem outputs of the focused array of alternatives were determined:

1. Riverine habitat (Riverine habitat describes the wetted area and will vary with in flow- see Section C-2.1.2)

2. Riparian scrub-shrub (dry floodplain habitat with hydrophytic vegetation <5m in height)

3. Riparian woodland (dry floodplain moving into upland habitat with vegetation >5m in height)

Representative evaluation species were selected for each habitat type based on several criteria. Table 4 summarizes the habitat type, evaluation species, and habitat suitability criteria.

Table 4. Habitat type, evaluation species, evaluation criteria.

Habitat Type	**Evaluation Species**	**Evaluation Criteria/ Habitat Suitability Criteria**
Riverine	juvenile rearing steelhead life stage	Depth, velocity, cover
Riparian scrub-shrub	yellow warbler	Percent deciduous shrub crown cover <5m Average height of deciduous shrub canopy Percent of deciduous shrub canopy comprised of hydrophytic shrubs
Riparian Woodland	downy woodpecker	Basal area of forest

For riverine habitat, depth and velocity were parameterized from hydraulic modeling outputs (C-2.2.5), while cover (in river cover such as cobble or banks, not to be confused with trees or shrubs) was populated by map data (C-2.2.1) and wetted perimeters for each flow.

Riparian scrub-shrub and Riparian Woodland habitat were delineated on existing topography for each flow scenario by a complicated procedure that is too lengthy to represent in this Appendix. Three MS PowerPoint presentations detailing the habitat delineation features and the detailed workflow for all three habitat types are posted on the Study website as attachments GIS-A, GIS-B, and GIS-C to this Appendix, http://www.spk.usace.army.mil/Missions/Environmental-Projects/Yuba-River-Eco-Study/.

Following habitat type parameterization for without and with-project hydraulic modeling results (including wetted area) for all three modeled flows, parameters were fed to HSI relationships that were programmed into GIS for each habitat type. GIS Attachment A, shows the three lookup relationships used in GIS for velocity, depth, and cover suitability for juvenile steelhead and the total HSI equation; GIS Attachment B shows the lookup relationships used in GIS for average height, percent cover, and percent hydrophytic cover suitability the yellow warbler and the total HSI equation; GIS Attachment C shows the lookup relationships used in GIS for average height, percent cover, and percent hydrophytic cover suitability the downy woodpecker and the total HSI equation.

Once GIS was parameterized for each habitat type and lookup table values referenced, an overall suitability index was calculated for each habitat type. This Suitability Index was multiplied by the area of each habitat feature within GIS and exported to EXCEL for subsequent weighting calculations (based on C-2.1.2), comparison of without and with-project benefits, and annualization calculations.

C-4. Geotechnical

C-4.1 Geology

C-4.1.1. Site Geology. The major physiographic feature within the project vicinity is the Sierra Nevada Range, which is about 400 miles long and runs south-southeast to north-northwest in the eastern portion of California. The Sierra Nevada crest forms the eastern limit of the Yuba and Bear River Basins and trends north-northwest. Drainage within the Yuba and Bear River Basins is west to southwest from the Sierra Crest to the adjacent floor of the Sacramento Valley. To the east of the basins, down faulting of the eastern Sierra face has affected drainage evolution by creating channels that now have their headwaters facing east.

Uplifting and tilting of the Sierra Block reorganized drainage networks and initiated a period of sustained channel incision, and many of the modern river channels have elevations below Tertiary-age river channels. The ancestral (Tertiary Period) Yuba River had cut about 1,000 feet below a surface defined by San Juan, Washington, and Harmony ridges. These ancestral deep channels drained north-northwest across the strike of the modern drainages. The south branch of the ancestral Yuba River flowed north from Gold Run to Badger Hill, then southwest to Smartsville and Marysville. The ancestral channels were filled first by very coarse, boulder material rich in gold, followed by finer gravel and sand deposits, also rich in gold. These Tertiary gravel deposits are the source of the gold extensively mined in the late 1800s.

The modern Yuba and Bear River Basins drain the northwestern Sierra Nevada via a series of deep canyons separated by high, steep-sided ridges and a parallel drainage network. The parallel drainage network results in narrow ridges between small tributaries, small tributary watersheds, and low tributary sediment loads under natural conditions; prehistoric debris fans at tributary junctions were not common. Stratigraphic evidence indicates the presence of stepped, Quaternary Period terraces similar to piedmont channels flowing out of the Sierra Nevada, but these terraces were generally buried by debris and sediment associated with mining activities. Downcutting, as noted specifically in the Bear River, through the relatively soft Paleozoic metamorphic rock (Shoofly Complex) has created a deep, v-shaped canyon where short, steep-sided tributary drainages are typical. Distinctive v-shaped inner gorge areas are common in all of the major drainages in the vicinity of the projects (YCWA 2014).

C-4.1.2. Hydraulic Mining Impacts. The study area has been heavily impacted by past hydraulic mining. Extensive hydraulic mining occurred in the Yuba River watershed from 1852 until the enactment of the Caminetti Act 1893 that severely limited its use. In hydraulic mining, water cannons shot high-pressure flows out to wash away hillsides (see Figure 7.). The material that was dislodged was then sluiced to expose the gold. Gilbert (1917), as cited in Yoshiyama *et al*. (2001), estimated that "…during the period 1849-1909, 684 million cubic yards of gravel and debris due to hydraulic mining were washed into the Yuba River system – more than triple the volume of earth excavated

Figure 7 Hydraulic Mining Water Cannon

during the construction of the Panama Canal. According to Major William W. Harts of the California Debris Commission, "The low water plane of the Yuba River at Marysville was raised 15 feet between the years 1849 and 1881. Between the years 1881 and 1905 there was an additional raise of three feet, making a total raise in the low water plane of 18 feet (the actual fill in the main channel being 26 feet). The depth of fill of mining debris in the Yuba River averaged from 7 1/2 feet at Marysville to 26 feet at Daguerre Point and 84 feet at Smartsville. A short distance east from Marysville, the bed of the Yuba River was 13 feet above the level of the surrounding farms." The quantity of material lodged in the river due to mining has been variously estimated, but it seems safe to say that there are now (1905) upwards of 333,000,000 cubic yards in the bed of the lower Yuba River. This debris field is still mined for residual gold deposits and gravel. Hydraulic mining in the Yuba River accounted for 40 percent of all the mining debris that washed into the Central Valley (Mount 1995).

Hydraulic mining resulted in torrents of sediment being transported downslope to the valley and caused rapid aggradation and exacerbation of flooding along Central Valley Rivers, including the lower Yuba River (James and Singer 2008). Two major debris dams (i.e., Daguerre Point Dam (DPD) in 1906 and Englebright Dam in 1941) were constructed on the Yuba River to prevent the continued movement of sediment into the Feather and Sacramento rivers, and ultimately the San Francisco Bay-Delta.

The Yuba Goldfields, located from approximately 8 to 16 miles upstream of Marysville, are dominated by approximately 20,000 acres of dredger tailings that were reworked from hydraulic mine waste. Dredging of gold from the hydraulic waste in the Goldfields began in 1902, and by 1910, 15 dredges were operating in the lower Yuba River. The area has been dredged and re-dredged intermittently throughout the years, and dredging continues today. See Plates GT-1 through GT-5 for spatial and temporal changes in the area.

Before the advent of Hydraulic Mining, tidal effect was felt up the Feather River to Nicolaus, 19 miles below Marysville, or about 175 miles from San Francisco by river. The Feather River was navigable to Oroville, about 141 miles from the mouth of the Sacramento River and the Sacramento River itself was navigable to Red Bluff, about 250 miles from the mouth of that river. Mining debris, however, ruined navigation on the Feather River many years ago and it is not being navigated now. The Sacramento River to Colusa is now very difficult at times to navigate. Along with deleterious effects downstream due to hydraulic mining, mercury was used to process gold deposits.

According to the US Geological Survey, hundreds of pounds of liquid mercury were added to the typical sluice box for Gold extraction. Gold sank to the bottom of the sluice, while sand and gravel passed over the high-density Mercury/Gold, allowing gold to separate and sink to the bottom. In the Sierra Nevada, up to 9 million pounds of mercury were lost in this manner to the environment (Churchill 2000).

C-4.2. Groundwater Setting. The high permeability of Lower Yuba River sediments and the neighboring goldfields creates a dynamic groundwater relationship that has been described by many (e.g. California Department of Water Resources 1999). Excavation of side channels, creation of backwaters, placement of boulders and large woody material is not anticipated to alter the groundwater regime of the Lower Yuba River in any significant way, be it flow or quality. Any unforeseen groundwater considerations will be addressed through the appropriate permits as part of environmental compliance activities.

C-4.3. Grain Size, Excavatability, Construction Techniques. The coarse grained cobble, gravel and sand have been mined by local companies for many years with common heavy equipment; some silty clay lenses have been encountered in past sediment coring upstream of DPD (Alpers *et al*., 2016), which should also be excavatable with this equipment. 13 cubic yard trucks will likely be used for transport of excavated material to placement sites. Heavy blade graders and water trucks will be utilized to maintain haul roads and staging areas. Planting activities will utilize heavy loaders equipped with stingers for placement of cuttings. Temporary bridges may be used to achieve access to some bars in the river for planting or excavation.

C-4.4. Potential Borrow Sites and Disposal Sites. Borrow volumes are expected to be extremely small and any necessary borrow can be supplied by nearby excavation associated with this project. Multiple potential placement/disposal sites for excavated material are present in the project area, including the Teichert Hallwood Facility, Western Aggregates, and Butte Sand and Gravel. Placement/disposal of excavated material will likely require characterization of the material (see C-4.5. Summary of Additional Exploration, Testing, and Analysis and C-5. Environmental Engineering).

C-4.5. Summary of Additional Exploration, Testing, and Analysis. Thorough site specific characterization of proposed excavation, lowering, and grading sites has not been performed at the time of this writing; however, sporadic explorations within the study area have been completed by others that give some insight into the variability of physical and chemical variability in the project area (e.g. Hunerlach *et al*., 2001). During Preconstruction Engineering and Design (PED) and prior to excavation activities, borings will be required at excavation and grading sites to characterize soil/sediment physical and chemical characteristics. A full suite of grain size distribution characterizations and targeted bulk soil/sediment chemistry characterizations will be required to determine the disposition of material to be placed off-site. It is anticipated that these explorations can be combined for sake of efficiency. Additionally, cored soil/sediment may be retained for bioassays or other environmental risk assessment analyses for pore water and soil/sediment that could be released to the river (see C-21 Special Studies).

C-4.6. Seismicity. The projects are in an area of low to moderate seismicity, with most seismic activity concentrated east and southeast of the project areas near Lake Tahoe and to the northwest of the project areas, south of Lake Oroville. Expected seismic shaking intensities within the project area from these nearby faults are considered to be low.

A number of north-to-northwest trending faults cross the project area, most of which are associated with the Foothills Fault System. Among the more significant faults are the Grass Valley Fault, the Melones Fault Zone, the Big Bend/Wolf Creek Fault Zone, the Giant Gap Fault, and the Camel Peak Fault Zone. None of the mapped faults within the project areas has been active in Quaternary time. A portion of the Giant Gap fault south of the projects is designated as having been active in Quaternary time. The nearest active fault (defined by the California Geological Survey as movement within the past 11,400 years) is the Cleveland Hill Fault located to the northwest of the projects near Lake Oroville; that fault had recorded movement in 1975. Other active faults are located to the east and southeast of the projects near Lake Tahoe (YCWA 2014).

C-5. Environmental Engineering

As this is a proposed ecosystem restoration project, several aspects of environmental engineering are necessarily incorporated into each aspect of the project, including:

- Use of environmentally renewable materials,
- Design of positive environmental attributes into the project,
- Inclusion of environmentally beneficial operations and management for the project,
- Consideration of indirect environmental costs and benefits,
- Integration of environmental sensitivity into all aspects of the project;

Details of the items on this list are contained in C-6 Civil Design and Appendix D - Environmental.

Beneficial uses of excavated material during construction, adaptive management, and Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) is a project goal for both environmental and cost purposes. Several gravel mining operations are in the vicinity of the project site, beneficial use of excavated material will be maximized to the extent practicable considering coordination with potential placement sites and the physical/chemical characterization on the material (see 9. Toxic and Hazardous Materials for further details of potential constraints).

Any issues or concerns noted in the Environmental Review Guide for Operations (ERGO) will be addressed through the Environmental Assessment herein, all applicable clean air, water, and other permits, and through the California Environmental Quality Act.

C-6. Civil Design

C-6.1. Site Selection and Project Development. For this study, modifications to the Lower Yuba River for habitat enhancement are being considered. These include various measures that provide for habitat restoration, enhancement, and expansion. Such improvements involved a combination of riparian planting, side channel creation, floodplain grading/lowering, engineering log jam placement, bank scalloping, and formation of backwater areas totaling 32 measures detailed in "Yuba River Ecosystem Restoration Feasibility Study: Habitat Measures" (YCWA 2016b). These measures were subsequently grouped into seven increments based on geographic location and proximity to one another and using access to inform the groupings where necessary. These were further screened down to six habitat increments after being evaluated using CE/ICA analysis to identify six alternatives listed below composed of a combination of the increments and a recommended alternative was then identified.

C-6.2. List of Alternatives and their combined increments:

Alternative 1 - No action
Alternative 2 - Increment 2
Alternative 3 - Increments 2, 5b
Alternative 4 - Increments 2, 5b, 5a
Alternative 5 - Increments 2, 5b, 5a, 3a
Alternative 6 - Increments 2, 5b, 5a, 3a, 1

Alternative 6 includes Alternative 5 with the addition of increment 1.

The composition of the Tentatively Selected Plan, Alternative 5, is as follows which would provide restoration of 196 acres of habitat in the form of these primary elements:

- Excavation of 118,000 cubic yards of cobble creating backwater areas, bank scalloping, and grading suitable floodplain habitat for riparian growth.
- Planting of 101 acres of riparian habitat.
- Placement of LWMs (Large Woody Materials), ELJs (Engineering Log Jams), and boulders.

Increments 1, 2, 3a, 5a and 5b, and their respective measures are described below.

C-6.2.1. Increment 1 Measures (See Plate CV-1)

Measure 17. Side channel in Timbuctoo Bend downstream of a potential spring-run Chinook salmon spawning sanctuary area.
Create a new side channel in the Timbuctoo Bend area of the lower Yuba River, immediately downstream of a proposed location (RM 19.7) for a spring-run Chinook salmon spawning sanctuary area. In addition, riparian vegetation planting would occur along the southern bank of the side channel, extending across the existing bar from the side channel to the lower Yuba River. The upstream entrance of the side channel would be designed to match the opposing anabranching exit location downstream exit of the side channel. (Note, an anabranch is a section of a river that diverges from the main channel of the watercourse and rejoins the mainstem downstream.)

Measure 18. Floodplain grading to medial bar near Big Ravine.
On the south bank of the lower Yuba River just east of Parks Bar, floodplain excavation/lowering of the near-shore area and adjacent floodplain to a medial bar would occur. For the purposes of this Study, it is assumed that floodplain lowering would occur in areas where the depth to the water table is greater than 7 feet and less than 10 feet. Within the project footprint for this measure, these areas would be lowered down to 7 feet within the water table, and would be complemented with about 2.5 acres of riparian vegetation planting adjacent to the lower Yuba River at this location. Additionally, a large backwater area of about 6.1 acres could be created near the confluence of Big Ravine. In addition to enhancing juvenile anadromous salmonid rearing habitat, creation of a backwater in this area of the lower Yuba River is anticipated to provide enhanced habitat for use by waterfowl, amphibians and other wildlife species. Because this area is used as a launching point for drift boats to access the lower Yuba River, this measure also may provide opportunity to enhance recreational opportunities by constructing a boat ramp at the site.

C-6.2.2. Increment 2 Measures (See Plate CV-2)

Measure 19. Upper Gilt Edge Bar floodplain lowering and riparian planting.
Upper Gilt Edge Bar sits relatively high above the bankfull channel, with a shallow water table less than 7 feet from the ground surface only present in a narrow band along the channel margins, and with a limited area in the 7 to 10 feet range of depth to water table on the floodplain below the higher terraces. Floodplain areas in the 7 to 10 feet range would be lowered to facilitate more frequent inundation with planting along the margins. Planting of cottonwood or other native woody riparian species could increase structural diversity in this area over time (cbec 2013).

Measure 20. Bank scalloping at Upper Gilt Edge Bar.
Measure 20 would occur along the channel edge of Upper Gilt Edge Bar, where the bank is 8-15 feet high, and the edge of the channel is relatively monotonous

with little habitat complexity (cbec 2013). Small scallops would be excavated into the tall and steep banks to increase local topographic diversity and wetted edge. These scallops/alcoves would be excavated to create an inundated alcove at all discharges, with the steep slopes surrounding the alcoves feathered to at least a 10:1 slope to provide additional shallow inundated areas with desirable depth/velocity combinations. Initially, these scallops/alcoves would provide year-round rearing habitat to juvenile salmonids. Over time it is expected that fine sediment may deposit in the scallops creating nursery sites where natural woody vegetation recruitment/establishment could occur. The scallops would further facilitate natural recruitment of riparian vegetation, due to shallow access to the water table, and the fine texture of deposited sediments. In addition, LWM would be placed within, and protruding from the scallops. Yuba County Water Agency (YCWA 2016) defined LWM pieces as both: (1) a log with a target size of 18 feet or greater in length with an average diameter of 24 inches or greater, with attached root wad; and (2) smaller LWM pieces (minimum thickness of 10 inches diameter at breast height (dbh)) with crowns attached. Pending local availability of suitable LWM pieces with root wads or tree crowns attached, such pieces would be used preferentially. A minimum of seven pieces of LWM with root wads could be placed at each location that is identified for LWM placement, and an additional three pieces of LWM with attached crowns could be set in between the other pieces. The definition of LWM described in this TM is consistent with the mitigation plan developed by YCWA (2016) and California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS).

Measure 21. Backwater at Upper Gilt Edge Bar.
Measure 21 would enhance a backwater area and increase the extent and species richness of existing riparian vegetation. Excavation of sediment in the 7 to 10 foot range would occur to allow for backwater inundation at base flows, and potential excavation/lowering of the surrounding area to allow for inundation in a typical 99% (1/1.01) ACE to 50% (1/2) ACE flood. Riparian woody species may be planted to promote species richness and structural diversity. Additional fine material could be introduced to the upper 3 feet of the soil column in excavated areas to increase soil capillarity and the amount of soil moisture available to herbaceous riparian vegetation. LWM would be placed within the backwater to provide aquatic structure.

Measure 22. Floodplain lowering and riparian planting near River Mile 17.
The unnamed bar located on the north side of the lower Yuba River near River Mile (RM) 17 provides an opportunity to plant riparian vegetation in areas where the water table is less than 7 feet from the ground surface. The site also could be enhanced by grading/lowering areas where the depth to water is between 7 to 10 feet, which would increase lateral connectivity and provide for additional opportunity to plant riparian vegetation to increase riparian structure and species diversity.

C-6.2.3. Increment 3a Measures (See Plate CV-3)

Measure 24. Lower Gilt Edge Bar enhancement.
Floodplain areas in the 7 to 10 feet depth-to-water table range would be lowered to facilitate more frequent inundation and riparian vegetation planting. An existing swale feature (at upstream end of Lower Gilt Edge Bar) could be lowered and connected to the channel to become inundated at about 3,000 cfs. In the lower Yuba River, swale morphological units (MUs) typically activate around 3,000 cfs and provide habitat with depths in the 1 to 1.5 foot range and velocities in the 0.75 to 1 foot per second range between 3,000 and 5,000 cfs (G. Pasternack, pers. comm., as cited in cbec (2013)). An additional enhancement would be construction of a patchwork floodplain network surrounding the enhanced groundwater-fed swale to encourage fine sediment deposition and potential riparian recruitment, as well as provide edgewater refugia at flows above baseflow.

Measure 26. Riparian Planting at Hidden Island.
This measure would be located on the alluvial bar located on the northern side of the lower Yuba River downstream of Lower Gilt Edge Bar. The area would be planted with native hardwoods in areas where the maximum depth to the water table is less than 7 feet. It was previously suggested (cbec *et al*., 2010) that lowering the existing high flow side channel would allow connectivity at base flow levels. However, additional consideration (G. Pasternack, pers. comm. 2016) has resulted in not including side channel lowering or floodplain lowering at this site due to concerns regarding the potential for the main channel to redirect its course and cut off the southern portion of Hidden Island. Consequently, for the purposes of this TM, this measure only includes the features of riparian planting where the depth to water table is less than 7 feet.

Measure 28. First Island bank complexity.
First Island has large expanses of floodplain and high floodplain, and a side channel on river left provides spawning and rearing habitat. The Yuba Accord River Management Team (RMT) Monitoring and Evaluation Program Interim Draft Report (2013) found that the main channel adjacent to First Island was heavily utilized for spawning in 2009 and 2010, with some redds occurring within the side channel itself. This area may provide immediate benefit to emerging salmonid fry if allowed access to larger expanses of shallow habitat with riparian cover. cbec (2013) suggested the possibility of installing a floodplain patchwork of ELJs (Figure 8), particularly along the apex of First Island just above bankfull elevation, although no specific placement was described. The intended purpose was to encourage sediment deposition and riparian vegetation recruitment. For purposes of this Study, direct planting of riparian vegetation was substituted for ELJ placement.

Measure 29. Silica Bar channel stabilization and ELJ placement. Rock/sediment could be deposited along the left bank of Silica Bar, coupled with placement of ELJs to aid river constriction at this location. ELJ technology includes a wide range of instream and floodplain structures designed to replicate the geomorphic and ecologic functions of natural accumulations of woody material (Abbe *et al*., 1997, 2003). Generally, ELJs have a pre-determined structure consisting of large key pieces anchoring a matrix of other structural components including stacked logs, racked logs, and piles (Abbe *et al*., 2002). Distinct types of ELJs have been classified based on the presence or absence of key members, source and recruitment mechanism of the key members, ELJ architecture (i.e., log arrangement), geomorphic effects, and patterns of vegetation on or adjacent to the ELJ (Abbe *et al*., 1993). However, for preliminary planning purposes associated with this TM, the definition of an ELJ is restricted to the assumptions that are presented in the design criteria – specifically, pieces of LWM that are 25 feet in length and 2 feet in diameter.

Figure 8. Example of ELJs on the Klamath River (USFWS 2016)

Measure 30. Silica Bar floodplain enhancement.
Large wood would be placed along the margins of the downstream terminus of the existing side channel/backwater that is surrounded by an existing stand of diverse, mature, native riparian vegetation, in areas that would not disrupt existing riparian vegetation along the banks of the side channel/backwater area. Floodplain elevations less than 7 feet at Silica Bar would be planted with riparian vegetation. Floodplain areas in the 7 to 10 foot depth to water table range would be lowered to facilitate more frequent inundation and riparian vegetation planting. If needed, fine sediment would be incorporated into the upper 3 feet of the soil column, and the floodplain surface would be planted with native riparian woody vegetation.

Measure 32. Bar A enhancement.
Located on river right just downstream of First Island, this site (referred to as North Silica Bar (RMT 2009)) would be enhanced by lowering floodplain surfaces

for riparian vegetation planting and more frequent inundation between 3,000 and 5,000 cfs. Although cbec (2013) suggested that LWM placement and bank scalloping along the steeper bank downstream could increase wetted area and add complexity, these features were not included in this TM because this area was included with riparian planting.

Measure 33. North Silica Bar channel stabilization and ELJ placement.
Rock/sediment could be deposited along the left bank of Silica Bar, coupled with placement of ELJs to aid river constriction at this location. Measure 33 would be about 1.9 acres in size.

Measure 34. North Silica Bar side channel (bar opposite of Silica Bar side channel).
North Silica Bar provides opportunity to lower floodplain surfaces for riparian vegetation planting and more frequent inundation between 3,000 and 5,000 cfs. A groundwater-fed pond sits elevated above the channel and only currently connects above approximately 7,500 cfs (cbec 2013). A side channel that activates above 3,000 cfs and connects to the low lying area downstream may provide beneficial off-channel habitat with established riparian vegetation already present. This measure would create an anabranching side channel in an existing swale within a stand of relatively dense riparian vegetation that presently includes willows and cottonwoods. The approximate length of the side channel would be 4,600 feet, and the potential area about 10.5 acres.

C-6.2.4. Increment 5a Measures (See Plate CV-4)

Measure 46. Bar C floodplain and backwater enhancement.
Immediately downstream of the Daguerre High Flow Channel's downstream confluence with the main channel is a large expanse of floodplain with depth-to-water table exceeding 7 to10 feet in the center of "Bar C". A large backwater area with shallow groundwater and relatively extensive riparian vegetation is also currently present. Two historical channel alignments are present that floodplain grading could enhance to inundate at 3,000 cfs to function as a swale habitat with adjacent floodplain lowering. Riparian vegetation would be planted on each side of the enhanced swale/side channel, extending a minimum of about 40 feet from the wetted edge of the channel. Bar C also exhibits a large expanse characterized by 0 to 7 feet depth to water table, and additional areas on the high floodplain in the 7 to 10 feet depth range. It is assumed that the features at this site include riparian vegetation planting in areas within 7 feet of the water table. Floodplain grading in areas from 10 to 7 feet of the water table down to 7 feet of the water table also would be conducted, following by riparian planting in the newly graded areas. The upper portion of the site, immediately downstream of the Daguerre High Flow Channel, has been very geomorphically dynamic. Longevity of enhancements here for specific functions may be short, and the downstream area may yield longer term benefits. The upstream and downstream portion of Bar C also could be enhanced by placement of ELJs in a patchwork

configuration along the enhanced swale. In addition, LWM would be placed in the backwater area at the downstream end to increase structural and habitat complexity in the area.

Measure 47. Yuba Goldfields Terminus side channel.
Create a side-channel in the bar referred to as “Bar C”. The side channel would be created within a stand of riparian vegetation, extending into a current backwater habitat located at the downstream corner of the Yuba Goldfields. Note that this side channel construction would occur on a different alignment than that indicated in Measure 46. Floodplain lowering would occur on the north side of the side channel (to the extent necessary) to plant riparian vegetation in areas of Bar C that are adjacent to the north side of the channel - extending about 40 feet from the wetted edge of the channel. Boulder structures for hydraulic maintenance may be placed at the inflow section. The side channel is about 5,000 feet in length, and the potential area is about 208,000 square feet (4.8 acres) at 40 feet wide.

Measure 48. Narrow Bar side channel.
Measure 48 would create an anabranching side-channel in Narrow Bar (also referred to as Bar D). An existing swale connects across the downstream end of the bar with relatively extensive riparian vegetation, and could be extended to connect further upstream. A side channel would be located north of the main channel, following a historical channel path, and would split to form a second side channel extending in a south-west direction through the middle of the bar. Existing riparian vegetation would border the created side-channels. Boulders for hydraulic maintenance may be placed at the inflow. Approximate length is 5,500 feet, and potential area is 391,265 square feet (about 9 acres at 5,500 feet long x average width of 71 feet).

Measure 49. Bar D floodplain riparian vegetation planting.
Bar D exhibits a large expanse of shallow groundwater within 0 to 7 feet of the ground surface, and additional areas on the high floodplain in the 7 to 10 feet depth range. It is assumed that the features at this site include riparian vegetation planting in areas within 7 feet of the water table. Floodplain grading in areas from 10 to 7 feet of the water table down to 7 feet of the water table also could be conducted, following by riparian planting in the newly graded areas. Additionally, floodplain grading along the main channel could be implemented to increase inundation duration and frequency at 3,000 cfs. Large expanses of moderately shallow groundwater to facilitate riparian recruitment and the potential enhancement of the existing swale could be augmented by placement of ELJs in a patchwork configuration.

Measure 50. Narrow Bar floodplain lowering, riparian vegetation planting and ELJ placement.
This measure could involve lowering the floodplain to medial bar, planting riparian vegetation, and adding ELJs within an area of about 4 acres.

Measure 51. Narrow Bar deep backwater area.
Located on the west side of Narrow Bar near RM 6.5, this measure would involve the creation of a wide, deep backwater area extending from the lower end of the Narrow Bar side channel to the lower Yuba River. The terminus of the side channel described in Measure 48 would flow into the upper extent of the backwater area.

Measure 52. Lower Yuba River backwater area.
This measure could involve excavation to develop a backwater area of about 1 acre on the right bank of the lower Yuba River near RM 6.5.

C-6.2.5. Increment 5b Measures (See Plate CV-5)

Measure 53. Bar E riparian vegetation planting.
Bar E exhibits a large expanse characterized by depth-to-water table of 7 to 10 ft, or greater range. From 1999 to 2008, aggradation of up to 9 feet has occurred in the historical channel that now functions as a swale activating between 3,000 and 5,000 cfs, while the main channel has incised by up to 6 feet (cbec 2013). The existing swale is located at the downstream end with riparian vegetation along the levee toe just north of the diversion channel. Planting in the downstream portion of this bar surrounding a historical channel alignment may be beneficial to enhance species and structural diversity. A diversion channel is maintained across this bar, and floodplain grading is not suggested due to this constraint. Therefore, riparian planting would occur in areas of Bar E where the depth-to-water is less than 7 feet. This site also may be a good candidate location for placement of LWM in the swale/backwater downstream from the diversion point across the upstream portion of this bar.

Measure 54. Island B riparian vegetation planting.
Island B mostly is characterized by depth-to-water table in the 0 to 7 feet depth range, and as of 2009, inundates on the lower portion at 5,000 cfs. Riparian species and structural diversity could be improved by planting along the upstream portion of this island. This island also may benefit from ELJ placement in a patchwork configuration, however, as this reach is confined by levees, increases in water surface elevation may be more pronounced than at other enhancement locations.

C-6.3. Quantity Calculations. Quantities for project items related to restoration features were compiled and organized by Civil Design Section using a spreadsheet tool. This spreadsheet identified quantities for each measure of the Lower Yuba proposed project to provide to Cost Engineering. Civil Design provided quantities for the various elements based on calculations using ArcGIS via terrain modification methods leading to surface volume calculations as further detailed in Attachment CV-B, the resulting quantities are shown in Table CV-B-1.

C-6.4. Design Assumptions and Quantities Assessment. The following bullets list the design assumptions and assumptions used for estimating the excavation quantities:

- Riparian Planting: A template was developed by Landscape Architecture following the design criteria in Attachment CV-A, See Attachment CV-C.
- Mobilization and Demobilization: Each per staging area identified.
- Haul Route and Onsite-Maintenance: For dust control only and would be per staging area.
- SWPPP Design & Implementation: Required per staging area.
- Erosion Control: Required per staging area.
- Tree Removal: Only for side channel and backwater areas with thick vegetation
- Clearing and Grubbing: Would be only where digging through existing vegetation
- Deer Fence: Would be at the length to protect riparian plantings.
- Excavation: Would be for cobble and no transport is assumed.
- Fill: Would be transport only.
- Large Woody Material: assumed woody features are 25 feet in length and 2 ft in diameter. The material will be anchored in the bankline at a 45 degree angle downstream and protrude 1/3 of its total length beyond the bankline into the channel.
- Temporary Bridge: It is assumed a 10' wide and 10' long - railroad flat car bridge would be used for the measures identified.
- Boulders: Assumed 5 tons each.

C-6.5. Construction Access Roads, Haul Routes and Staging Areas.

C-6.5.1. General Assumptions. Referring to “Yuba River Ecosystem Restoration Feasibility Study: Habitat Measures” (YCWA 2016b) and related shapefiles, criteria were developed by Civil Design and Planning to develop a simple approach to identify measures where access and staging could potentially pose an issue.

This simple screening of measures included assessing access to each individual measure and grouping measures that share a potential access route and staging area. Access assessment was conducted using the document described including corresponding plates and comparing to the kmz provided by USACE GIS using Google Earth.

Access was defined as any road (dirt being "unofficial" and paved as "official") as visible on Google Earth. If no such access was visible, the shortest distance away from a road to the perimeter of a measure was determined using Google Earth, and the elevation grade was also noted if significant (greater than 1%).

For staging, half an acre to an acre was identified depending on the number and amount of measures to be completed. Note, measures identified as not part of the YESRFS study were excluded from this assessment entirely. Real Estate assumptions were made solely on if access through private property would be required, note none of the measures' access go through private property. A temporary bridge across the channel was also agreed upon as an option to provide access to a measure. No measures were screened out since no access or staging was identified on private property and measures initially deemed inaccessible were made accessible with the use of a temporary bridge. Remaining measures were then further grouped by geographic location and broken up into their corresponding increment reaches. For a detailed analysis of access and staging, including temporary bridges see Attachment CV-D.

C-6.5.2. Detailed Information (used for Effects Analysis in Main Report).

C-6.5.2.1. Staging. Proposed staging areas and access roads are located on existing dirt roads and previously disturbed areas in blue oak woodlands.

Increment 1 – There are two staging areas identified for Increment 1. The staging area at the upstream end of Increment 1 is located on an approximately 1 acre previously disturbed gravel parking lot on the north side of the Yuba River. This staging area would be accessed via Highway 20 to Peoria Road. Peoria Road turns into Scott Forbes Road/Long Bar Road. From Scott Forbes Road/Long Bar Road, the staging area is accessed via a privately owned gravel road. A temporary haul road would be constructed from the staging area to the proposed habitat restoration area.

The downstream staging area is located on approximately 1 acre of grassland adjacent to a private river access road. This staging area would be accessed via Highway 20 to Timbuctoo Place. Vehicles would continue about 0.5 mile east on Timbuctoo Place to the private access road.

Increment 2 – There are two staging area identified for Increment 2. The staging area on the south side of the river is located on approximately 1 acre of disturbed sand bar land approximately 0.20 mile downstream of the Highway 20 Bridge. Access to the Increment 2 staging area would be via Highway 20 to Timbuctoo Place. Vehicles would then loop around back under the Highway 20 Bridge to Old Bonanza Ranch Road to the staging area.

The staging area on the north side would be located on a gravel parking lot at the end of a private gravel road adjacent to the river. Access to this staging area would be via Highway 20 to the private gravel road. A temporary haul road may need to be constructed from the end of the gravel road to connect vehicles to the sand bar and its proposed restoration site.

Increment 3a – There are three staging areas identified for Increment 3a. The upstream staging area on the south side of the river is located on approximately 1 acre of disturbed sand bar land. Access to this staging area would be via Highway 20 to Timbuctoo Place. Vehicles would then loop around back under the Highway 20 Bridge to Old Bonanza Ranch Road to the staging area. This staging area is approximately 1 mile west of the Increment 2 staging area.

The downstream staging area on the south side of the river is approximately 2 acres located entirely on disturbed land on the edge of a sand bar. Access to this staging area would be via Highway 20 to Timbuctoo Place. Vehicles would then loop around back under the Highway 20 Bridge to Old Bonanza Ranch Road to the staging area. This staging area is approximately 2.5 miles west of the Increment 2 staging area.

The staging area on the north side of the river is approximately 1 acre located entirely on disturbed sand bar land. Access to this staging area would be via Highway 20 to a previously disturbed gravel access road owned and operated by SRI Sand and Gravel Co. Vehicles would then proceed westward along a dirt/gravel road for approximately 0.5 mile to the staging area.

Increments 5a and 5b – There are three staging areas identified for Increment 5. The upstream staging area on the south side of the river is approximately 1.5 acres of previously disturbed land on the edge of a sand bar. Access to this staging area would be via Highway 70 to Feather River Boulevard. Vehicles would travel northeast on Feather River Boulevard to North Beale Road and turn right. Vehicles would proceed down North Beale road for approximately 1 mile and turn left onto Hammonton Smartsville Road. Approximately 1 mile down Hammonton Smartsville Road, vehicles would turn left onto Simpson Lane, and then take an immediate right onto Simpson Dantoni Road. Simpson Dantoni Road will become Dantoni Road. In approximately 8 miles, vehicles would arrive at the staging area.

The downstream staging area on the south side of the river is approximately 1 acre of previously disturbed land alongside a sand bar and surrounded by orchards. Access to this staging area would be via Highway 70 to Feather River Boulevard. Vehicles would travel northeast on Feather River Boulevard to North Beale Road and turn right. Vehicles would proceed down North Beale road for approximately 1 mile and turn left onto Hammonton Smartsville Road. Approximately 1 mile down Hammonton Smartsville Road, vehicles would turn left onto Simpson Lane, and then take an immediate right onto Simpson Dantoni Road. Simpson Dantoni Road will become Dantoni Road. In approximately 2 miles, vehicles would turn onto an unnamed dirt/gravel farm road alongside the northeastern edge of the Peach Tree Golf & Country Club. Approximately 1 mile later, vehicles would take a right turn onto another unnamed dirt/gravel farm road. In approximately 0.25-mile, vehicles would veer left onto the next unnamed dirt/gravel farm road. The vehicles would enter the staging area approximately 0.5-mile later.

The staging area on the north side of the river is approximately 1.5 acres of previously disturbed land adjacent to a sand bar. Access to this staging area would be via Highway 20/Browns Valley Road to Hallwood Boulevard. Vehicles would proceed east on Hallwood Boulevard for approximately 2 miles to the end of the road. At the dead-end, vehicles would take a right turn onto a dirt farm road alongside an orchard. The staging area would be located approximately 0.25 mile down the farm road.

C-6.5.2.2. Access. From the proposed staging areas, vehicles accessing the restoration sites would haul primarily on the sand bars along the river. In some cases, temporary haul roads may need to be constructed in order to provide better access to the sites. Occasionally, rather than hauling on sand bars, vehicles would have access to farm roads.

In some cases, access to the restoration sites could only be provided through temporary river crossings. These would consist of 10 foot wide by 10 foot long railroad flatcar bridge that would be placed over the river channel for temporary access, when needed.

C-6.5.2.3. Disposal. Approximately 785,000 cubic yards of material is expected to be hauled away during project construction. See Section C-4.4 for further discussion.

C-6.6. Real Estate. The land surrounding the Lower Yuba River in the Yuba Goldfields are owned by multiple property owners, including Bureau of Land Management, U.S. Army Corps of Engineers, and Western Aggregate. The required construction and staging areas have been identified and found to have no negative impact in obtaining Real Estate rights.

C-6.7. Relocations. The proposed project will not require any known utility and/or facility relocations.

C-7. Structural Requirements.

In the common sense of the term, Structural Requirements are not a relevant aspect of this ecosystem restoration study. The Tentatively Selected Plan consists solely of habitat restoration measures, i.e. no concrete and steel, engineered berms or levees, etc. Information on the design and expected performance of these habitat features is contained in C-6 Civil Design and its attachments.

However, it is appropriate to note the possible need for post feasibility hydraulic design, hydraulic modeling or physical modeling in this section; one or more of these efforts may be necessary to resolve resiliency and operation and maintenance questions for the proposed ecosystem restoration for events of various Annual Chance of Exceedances (ACEs). This may include, for example, lifecycle modeling of plantings in the study area (trees may fall but become woody debris) and/or some detailed geomorphologic modeling to determine the state of restored lands following low probability high flow events.

C-8. Electrical and Mechanical Requirements.

No utility relocations are identified for the Tentatively Selected Plan. Electrical and Mechanical Requirements will thus be limited to construction activities. Construction activities are predominately excavation and hauling of coarse grained or cobble sized river and bar soils/sediments, placement of large woody material and boulders, and grading activities. Should local beneficial uses of material based on separation be identified in subsequent design or PED, additional electricity for separation technologies may be required if on-site separation is deemed most efficient. Separation activities would be ongoing, heavy load actives that would require coordination with local electricity providers. Power poles are available for residential and industrial use sporadically use through the study area.

C-9. Hazardous and Toxic Materials.

A Phase I Environmental Site Assessment was performed in conformance with the scope and limitations of ASTM Practice E 1527-13 for the Yuba River Ecosystem Restoration Project. This assessment has revealed no Recognized Environmental Conditions in connection with the project site (see Attachment ENV-A). As discussed in Sections C-4.2.1. Study Area and C-2.4. Water Quality, elemental mercury (Hg2+, CASRN 7439-97-6) and methylmercury (MeHg; CASRN 22967-92-6) are known contaminants of concern in Lower Yuba River; methylmercury is of particular concern because it is bioaccumulative, biomagnifiable through the foodchain, and toxic to humans (https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0073_summary.pdf).

The potential for the release of contaminants will be addressed through characterization and controls; however, no concentrations of any material are anticipated at levels that would be classified as Hazardous or acutely Toxic. Chronic mercury concentration in the water column (freshwater criteria 0.77 ug/L) could be concern depending on local bulk sediment concentrations.

Section C-10. Construction Procedures and Water Control Plan discusses some potential controls and Best Management Practices (BMPs) to mitigate risks from contaminant releases during construction.

Contaminant concentrations that may be environmentally relevant will be addressed through characterization, monitoring and adaptive controls through the 401 Certification process. C-21 Special Studies puts forth possible means of mitigating encountered hazardous and toxic materials. It is possible that based on Special Studies, site-specific water quality criteria for mercury will be used to address potential methylmercury effects.

C-10. Construction Procedures and Water Control Plan

Excavation and grading will be performed by standard equipment. 13 cubic yard trucks will likely be used for transport of excavated material to placement sites. Heavy blade grader and water trucks will be utilized to maintain haul roads and staging areas. Planting activities will utilize heavy loaders equipped with stingers for placement of cuttings. Temporary bridges may be used to achieve access to some bars in the river for planting or excavation.

SWPPP BMPs and other erosion and sediment control BMPs will be employed on any new access roads and in staging and construction areas for both grading/lowing/excavation phase and planting phases of the project. Floodplain lowering and grading activities may include “inside out” excavations to limit erosion and transport of sediments during construction. Side channel excavations may similarly utilize middle out construction to allow endpiece sediments to act as natural coffer dams for the bulk of the excavation. Cofferdams, curtains, or sheet pile may also be employed to control erosion and other sediment releases during excavation. Any water discharge, temporary storage, or land application will be performed in accordance with all appropriate laws and regulations, including a CWA Section 401 permit; these permits are highly site-specific in nature and will be obtained in PED.

C-11. Initial Reservoir Filling and Surveillance Plan

Initial Reservoir Filling and Surveillance Plan Flood Emergency Plans for Areas Downstream of Corps Dams is not a relevant aspect of this ecosystem restoration study.

C-12. Flood Emergency Plans for Areas Downstream of Corps Dams

Flood Emergency Plans for Areas Downstream of Corps Dams is not a relevant aspect of this ecosystem restoration study.

C-13. Environmental Objective and Requirements.

This information is provided in the main body of the report. No mitigation is expected for this proposed ecosystem restoration project. An Environmental Site Assessment Phase 1 did not identify any potential concerns (see Attachment ENV-A).

C-14. Reservoir Clearing

Reservoir clearing is not a relevant aspect of this ecosystem restoration study.

C-15. Operation and Maintenance

The final design of the habitat measures that comprise this ecosystem restoration project will be self-sustaining to the maximum extent practicable; however, ecosystem restoration of a natural hydraulic system incurs risk due to infrequent (low annual chance of exceedance) high flow events that could cause significant geomorphologic change and damage the restoration features. These risks are mitigated through monitoring and adaptive management and Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R).

Operation, Maintenance, Repair, Replacement, and Rehabilitation is inexorably tied to the design and resilience philosophy used for habitat measures; simply constructed features have a lower upfront cost but higher risk of decreased benefits due to loss of performance due to extreme events, robust features have a higher probability of survival and thus continued performance without extensive maintenance or repair at a higher initial cost. The tradeoff for the habitat measures proposed in this project thus follow the well-established axiom of “buying down risk”

For a first order analysis of OMRR&R costs, a risk-informed approach was used with assumptions about the level of repair/reconstruction necessary following events of various annual chances of exceedance.

C-15.1 Total Replacement Costs. In order to begin the analysis, assumptions for replacement costs were made based on Total Project Cost Summary (TPCS) estimates (see C-19 Cost Estimates for more information). A baseline total replacement cost was calculated for a basis of comparison to lesser repair/replacement costs for use in a spreadsheet tool using the following assumptions:

- Real Estate Costs would not be included in repair/replacement costs, since it is unlikely LERRDs would be necessary for reconstruction.

- Floodplain lowering costs would not be included in reconstruction costs. Large, destructive flows are assumed to cause significant morphological change, but not significant accretion that would require excavation (though grading may be necessary, grading costs are included in repair/reconstruction estimates).

Adjusting the TPCS first cost for the assumptions above, the total replacement cost estimate, is ~$73.4 million.

C-15.2 Repair/Replacement Costs for Different ACE Events. Table 5 lists events with various Annual Chances of Exceedance, the incremental frequency between the events, and the repair/replacement assumptions associated with each event.

Table 5. Repair/Replacement assumptions for various ACE events.

Return Frequency	Annual Chance of Exceedance (Event Frequency)	Incremental Frequency	Repair/Replacement Assumptions
>500	<.2%		total rebuild, no floodplain lowering, 50% excavation
		0.002	
500	0.2%		total rebuild, no floodplain lowering, 50% excavation
		0.003	
200	0.5%		total rebuild, no floodplain lowering, 35% excavation
		0.005	
100	1%		total rebuild, no floodplain lowering, 20% excavation
		0.01	
50	2%		replant half of established trees (50% of 65% = 32.5%), 5% excavation
		0.02	
25	4%		scaled between 10% ACE and 2% ACE event costs
		0.06	
10	10%		2 percent of replacement cost, based on qualitative assessment
		0.1	
5	20%		No replacement/repair anticipated
		0.3	
2	50%		No replacement/repair anticipated
		0.5	
<2	99.99%		No replacement/repair anticipated

Similar to the rationale for excluding floodplain lowering costs, extreme events are assumed to cause net erosion in previously excavated features; however, for very extreme events (2% ACE or smaller), entire features may be destroyed and need to be reconstructed (i.e. re-excavated). Thus, the cost for 50% re-excavation is assumed for 2% ACE and smaller events. Decreasing percentages of re-excavation are assumed for 0.5% ACE and 1% ACE events since the amount of complete excavated feature replacement is assumed to decrease with decreasing flows.

At 2% ACE excavation volumes are assumed to be vastly reduced, and tree replacement is assumed to be 50% of target establishment numbers. A qualitative assumption of 2% replacement cost is assumed for 10% ACE events, and no repair/replacement is anticipated for 20% ACE or larger events.

Table 6 shows the estimation of annualized damages by integrating the incremental damages by event frequency.

Table 6. OMRR&R cost assumptions based on risk-informed tool.

Estimated First Cost of Reconst			$73,387,500	no real estate, no floodplain lowering		
PED	16.5%					
CM	5.0%					
Conting.	33.0%					
Return Period	Event Frequency	Percent Damage	Event Damage	Incremental Frequency	Incremental Damage	Incremental Annual Damage
>500	<.002	76%	$56,083,500			
				0.002	$56,083,500	$ 112,167
500	0.002	76%	$56,083,500			
				0.003	$53,843,250	$ 161,530
200	0.005	70%	$51,603,000			
				0.005	$49,362,750	$ 246,814
100	0.01	64%	$47,122,500			
				0.01	$30,900,000	$ 309,000
50	0.02	20%	$14,677,500			
				0.02	$11,433,000	$ 228,660
25	0.04	11%	$ 8,188,500			
				0.06	$ 4,944,000	$ 296,640
10	0.1	2%	$ 1,699,500			
				0.1	$ 849,750	$ 84,975
5	0.2	0%	$ -			
				0.3	$ -	$ -
2	0.5	0%	$ -			
				0.5	$ -	$ -
<2	1	0	$ -			
				Total Annual Damage		**$ 1,439,786**

The risk-informed OMRR&R annual cost estimate is $1.44 million. As noted in C-7 Structural Requirements, this cost is inexorably tied to feasibility level design and will be refined through that phase of the project. Also of note, while the OMRR&R cost is represented as an annual cost for estimating and communication purposes, actual OMRR&R costs will likely be episodic- potentially much greater than the estimate annualize cost in some years and nearly zero in other years. When combined with an estimated $30,000 per year of routine maintenance, total OMRR&R costs are $1.47 million per year.

C-16. Access Roads

Please see Civil Design section C-6.5 for a discussion of access roads.

C-17. Corrosion Mitigation

Coatings and/or cathodic protection will be included in the design as required for materials which are installed in water or soil.

C-18. Project Security

This ecosystem restoration project, consisting only of side channel excavations, floodplain lowering, installation of large woody material and engineered logjams (see 6-Civil Design for full detail) is not anticipated to require a security plan.

C-19. Cost Estimates

C-19.1. Approach. In developing the feasibility level cost estimates of the various increments of the Yuba River Ecosystem Restoration Study, the Cost Engineering team utilized a construction methodology incorporating the estimating software MII 4.3 (MCASES Version 4.5.51209) and generated costs at a Class 4 level. Construction costs throughout initial screening through TSP selection were compiled based on: 1) historical costs obtained from projects with similar work estimated in the vicinity of the Yuba River Watershed, 2) Draft Alternative Concepts Evaluation prepared by Wood Rodgers, Inc. (2003), 3) Assessment of Infrastructure and Related Items to Support Anadromous Fish Passage to the Yuba River Watershed by Yuba Salmon Forum Technical Work Group (MWH 2013) and 4) MII 4.3 estimating software.

During the screening process the Class 4 estimates were utilized to compare the prices of each increment. These increments were designated into a single category: Habitat Increments. The estimates for each increment were produced with the MII estimating software. Each estimate was based off a collection of information provided to the cost engineer either from the Project Deliver Team (PDT), historical documents or researched acquisitions. This information was designated to the appropriate increment and is represented in the cost for each increment. The construction costs derived from the estimates were transferred to the Total Project Cost Summary (TPCS) and, along with the anticipated total project schedule (including Design & Construction), used to obtain the Estimated Total Project Cost. This summary includes costs for Lands and Damages (01 Account), Planning Engineering & Design (30 Account) and Construction

Management (31 Account). Each estimate along with its corresponding TPCS were reviewed by SPK Cost Engineering Section. When necessary, pricing as well as crew production were updated to reflect current pricing and site conditions. The accumulation of this information was utilized for the purpose of screening alternatives and for TSP selection.

The Screening Level Estimates were developed based on the initial measures. These were combined to reflect the alternatives developed by the PDT. The estimates were continuously updated to match the current design refinements and the latest information available at the time of the revisions. The costs do not account for life cycle costs.

The estimates follow the Civil Works Work Breakdown Structure (CWWBS) code of accounts. Featured codes represented in these estimates are 01- Lands and Damages, 06-Fish and Wildlife Facilities, 30-Plannning Engineering and Design and 31-Construction Management. The 30 and 31 accounts include costs associated with USACE staffing on the project. The amounts are based on historical data adjusted based upon the nature of the features of work.

C-19.2. Cost Uncertainties. There are inherent uncertainties in the costs at the pre-feasibility level of design as the result of lacking detailed design, plans or specifications. These discrepancies are reflected in the contingency acquired through the Abbreviated Cost Risk Analysis (ACRA). The uncertainty of site access significantly increased feature costs on the project. Equipment as well as personnel are required to ford the Yuba River to enter the sites. For this action to occur, temporary crossing points need to be constructed. The exact means to accomplish this task are unknown. There are a myriad of environmental rules and regulations governing construction in the vicinity of the Yuba River. The Cost Engineer assumed portable, prefabricated truss bridges will be used to maneuver across the river. The earthwork associated with the installation of these temporary structures is captured in the estimate, but the quantities are uncertain. Fill volumes are anticipated to be near negligible, and the costs is assumed to be zero based on the large amounts of excavation taking place throughout the project area that could be utilized to construct the temporary features. The disposal of excavated material may either prove to be problematic or beneficial. The estimate assumed that disposal fees would be assessed. If a material supplier is able to accept excavated material for free, only the price for hauling will be incurred. If there are no means to dispose of the material without a fee, the price for hauling and disposal will increase.

C-19.3. Total Project Schedule. Sections C-19.6 and C-20 describe the project schedule assumptions in more detail; the PED portion of the project is assumed, with optimal funding, to occur from FY 19 through FY 20 with the construction portion commencing FY 21. Construction is assumed to take 4 years. These assumptions are reflected in the TPCSs.

C-19.4. Cost and Schedule Risk Analysis. An initial Abbreviated Cost Risk Analysis (ACRA) was performed for the project. The risk analysis process involved dividing project costs into typical risk elements and placing them into a Risk Register, then identifying the risks/concerns relative to those risk elements, and then justifying the likelihood of the risk occurring and the impact if the risk occurs. A Risk Matrix utilizing weighted likelihood/impacts is used to establish the cost contingency to use for each risk element (work feature) for use in alternatives comparisons. Risk analysis results are intended to provide project leadership with contingency information in order to support decision making and risk management as the project progresses from planning through implementation. To fully recognize its benefits cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, budgeting and scheduling.

An analysis was held 16 April 2017 with the project manager and PDT members which was led by Cost Engineering. The meeting primarily focused on risk factor identification through discussions based on risks prevalent to civil works projects. The meeting encompassed risk factor assessment and quantification which resulted in revisions to the estimate. Project risks were identified and documented leading to the development of a risk register spreadsheet. Following the analysis the draft risk register was forwarded to the PDT for review.

The qualitative impacts of each risk element on costs and schedule were analyzed using a combination of professional judgment, empirical data and analytical aptitude. Risks not immediately agreed upon by the PDT were discussed at length and agreed upon in the form of inputs into the probability density functions. Quantification involved multiple project team disciplines and responsibilities. The resulting product model reflects the risk register parameters as developed by the team.

Contingency is an amount added to an estimate and/or schedule allowing for items, conditions or events for which the occurrence or impact is uncertain. It is probable these uncertainties will result in the additional costs being incurred or additional time being required. Based on ACSRA results, the contingency for the habitat measures in the Final Array of Alternatives was calculated to be 33%.

C-19.5. Review. The TSP level cost estimates and Abbreviated Cost-Schedule Risk Analysis underwent District Quality Control by senior cost engineers at the Sacramento District. A District Quality Control certificate was signed by the Cost Engineering Section Chief.

C-19.6. Key Assumptions

a. Estimate – Quantities were developed and reviewed by Civil Design based on representative samples of the work. The quantities where then provided to Cost Engineering as a basis for developing the estimate. Production was estimated based on the following assumptions

    - 4 months per year “in-water” work
    - 10 hrs/day

- 26 workdays/month (6 days/week)
- 13 cy haul trucks
- 12 trucks/hour (5 minute load time)
- 20 miles on average to representative disposal site (e.g. Butte Sand and Gravel)
- 1,560 cubic yards of excavation/day
- Red Willow $29,500 per acre
- Black Willow $35,000 per acre
- Arroyo Willow $29,500 per acre
- Cotton Wood $53,350 per acre
- TBD Trees $29,500 per acre

Material prices were obtained from local vendors. The cost engineer determined there was enough information to produce a construction estimate.

b. Haul Distances – Haul Distances were assumed to be a site 20 miles and 25 minutes from the excavation site on average. See sections C-4.2, C-5, and C-21 Special Studies for a discussion on the potential for near-site beneficial use of excavated material, which could decrease haul costs significantly. Beneficial uses were captured as an opportunity in the ACRA

c. Real Estate - Real Estate Costs used for screening and final array analysis are reasonable. Real Estate estimate errors will affect the alternatives evenly and/or not affect the ranked order of alternatives. Due to significant uncertainties regarding real estate costs and mineral rights, a 50% contingency was used for Land and Damages.

d. Quantity Uncertainty – Quantities may vary depending on uncertainties inherent in design and morphological changes in the river system between feasibility and construction. This uncertainty has been captured in the ACRA.

e. Project Schedule – 2 years of PED were assumed beginning with authorization in FY19, with 4 seasons of construction following (see C-20 Schedule for Design and Construction for details).

f. Planning, Engineering & Design Costs – A Planning, Engineering, and Design (30 Account) percentage of 16.5% was used in lieu of the usual 27.5% assumption. This reduced percentage is based on the fact that this project is ecological in nature, thus reduced costs for engineering and design are expected relative to conventional construction projects. The 30 Account estimate accounts for approximately 13 Full Time Equivalent staff members for each year of design/procurement activities which is consistent with the anticipated team composition.

g. Construction Management – A Construction Management (31 Account) percentage of 5% was used in lieu of the usual 14.5% assumption. This reduced percentage is based on the fact that this project is ecological in nature, thus reduced costs are expected relative to conventional construction projects. The 31 Account estimate accounts for approximately 5 Full Time Equivalent staff members for each year of construction activities which is consistent with the anticipated team composition.

h. Constructability - Although there are concerns about the constructability of the in-water earthwork due to depth of water and shapability of the material, this concern has been captured in the cost risk analysis and determined to be low risk of increasing cost or lengthening the schedule. Constructability with respect to excavation production is a risk not captured in the ACRA. This was mitigated by assuming a 4th season of excavation construction in the schedule (see C-20 Schedule for Design and Construction for details).

C-19.8. Total Project Cost Summary. Total Project Cost Summary (TPCS) sheets for increments 1, 2, 3a, 5a, 5b, and the Tentatively Selected Plan of combined 2, 3a, 5a, 5b are shown in Cost Engineering Attachment 2. Table 7 summarizes the first and fully funded costs of the increments in the final array of alternatives and the tentatively selected plan, the monitoring and adaptive management first costs from Appendix D – Environmental, Attachment 7.

Following the TSP milestone and TSP endorsement, updated real estate costs for the Tentatively Selected Plan were estimated to be $6,406,000, an increased figure from the $2,999,000 assumed in previous cost estimates, but still below 1% of the total project cost. The difference in first costs and fully funded costs are also represented in Table 7.

Table 7. Summary of costs.

Increment	First Cost	Fully Funded Cost
1	$20,241,000	$23,046,000
2	$9,194,000	$10,455,000
3a	$31,610,000	$35,982,000
5a	$24,987,000	$28,457,000
5b	$23,608,000	$26,901,000
TSP	$89,399,000	$101,795,000
TSP w/ updated RE Plan	*$93,004,000*	*$105,202,000*
Monitoring TSP	$739,200	
Adaptive Management TSP	$3,011,500	

As noted in Section C-15, a risk-based OMRR&R annual cost is estimated to be $1,470,000.

C-20. Schedule for Design and Construction

The construction schedule is assumed for cost engineering purposes to be 4 seasons/years; 3 years of excavation, grading, feature placement on Increments 2, 3a, 5a, and 5b with one further year for slippage and repair/closeout, and 3 years of plantings beginning the second season. A 4 month window for in-water work was assumed (with as much terrestrial work as possible being sequenced in the first month), and a two month planting window was assumed. A 3rd quarter of FY2022 was used as the midpoint of construction, assuming a summer FY19 Chief's Report and two years of preconstruction, engineering, and design. The construction schedule is shown in Attachment CE-B.

Note that a shorter, 3 year schedule was used for air quality modeling (Chapter 3, Environmental Effects) in order to be conservative with respect to potential environmental effects.

C-21. Special Studies

As stated in C-7 Structural Requirements, post feasibility hydraulic design, hydraulic modeling or physical modeling may be necessary to resolve resiliency and operation and maintenance questions for the proposed ecosystem restoration for events of various Annual Chance of Exceedances. This may include, for example, lifecycle modeling of plantings in the study area (trees may fall but become woody debris) and/or some detailed geomorphologic modeling to determine the state of restored lands following low probability high flow events.

Freshwater acute and chronic water quality criteria are published for total mercury, but only secondary values exist for methylmercury. Thorough characterization of material to be excavated/graded will be necessary prior to excavation activities, and additional bioassays or environmental risk assessments may be necessary to determine what contaminant release levels are ecologically significant for methylmercury in light of other ambient constituent concentrations in the system, e.g. total organic carbon.

If beneficial use of excavated material is problematic based on total mercury levels or other unanticipated contamination, study of separation or other innovative techniques to allow for beneficial use of the majority of excavated material would be desirable from both environmental and cost perspectives.

C-22. Plates, Figures, and Drawings

Figures have been embedded in line with text in this Appendix. Plates for Geotechnical Engineering (GT-1 through GT-5), Hydraulics (HD-1 through HD-5), and Civil Design (CV-1 through CV-5) follow the References section of this Appendix. Attachments for

Civil Design (CV-A through D, including associated figures and tables, e.g. Table CV-B-1) ,Cost Engineering (CE-A and B), and Environmental Engineering (ENV-A) follow plates at the end of this Appendix. GIS Attachments (GIS-A thought C) are posted on the project website, http://www.spk.usace.army.mil/Missions/Environmental-Projects/Yuba-River-Eco-Study/Modeling

C-23. Data Management.

In accordance with South Pacific Division Policy, this project utilized ProjectWise for both engineering data management and data management for other disciplines. During the feasibility study, electronic data was compiled and maintained in project folders for each discipline involved on the server. This data is backed up regularly by USACE's data manager (ACE-IT). The project information will be available for the next phase of the project.

C-24. Use of Metric System Measurements.

In accordance with SMART Planning Principles, British Units were predominantly used on this project due to the substantial existing body of available work on the watershed's use of British Units. Surveys and existing GIS and modeling work have been performed using British Units, conversion of these to metric units would be prohibitively time consuming and costly. It is anticipated that future chemical and sediment characterization work will utilize SI units (e.g. mg/L, mg/kg, kg/m^3).

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Engineering Plates

Engineering Attachments

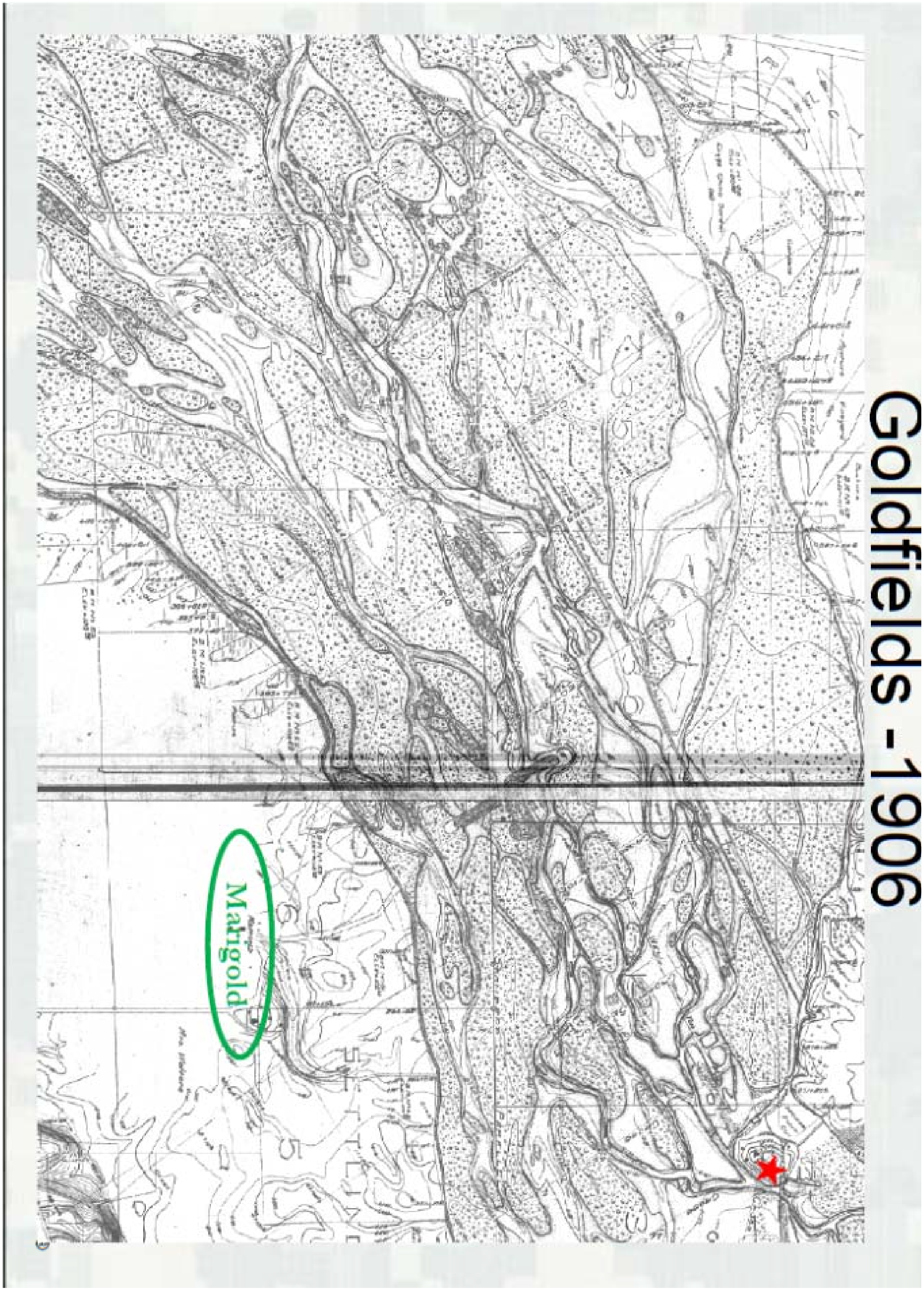


Plate GT-1 Goldfields 1906

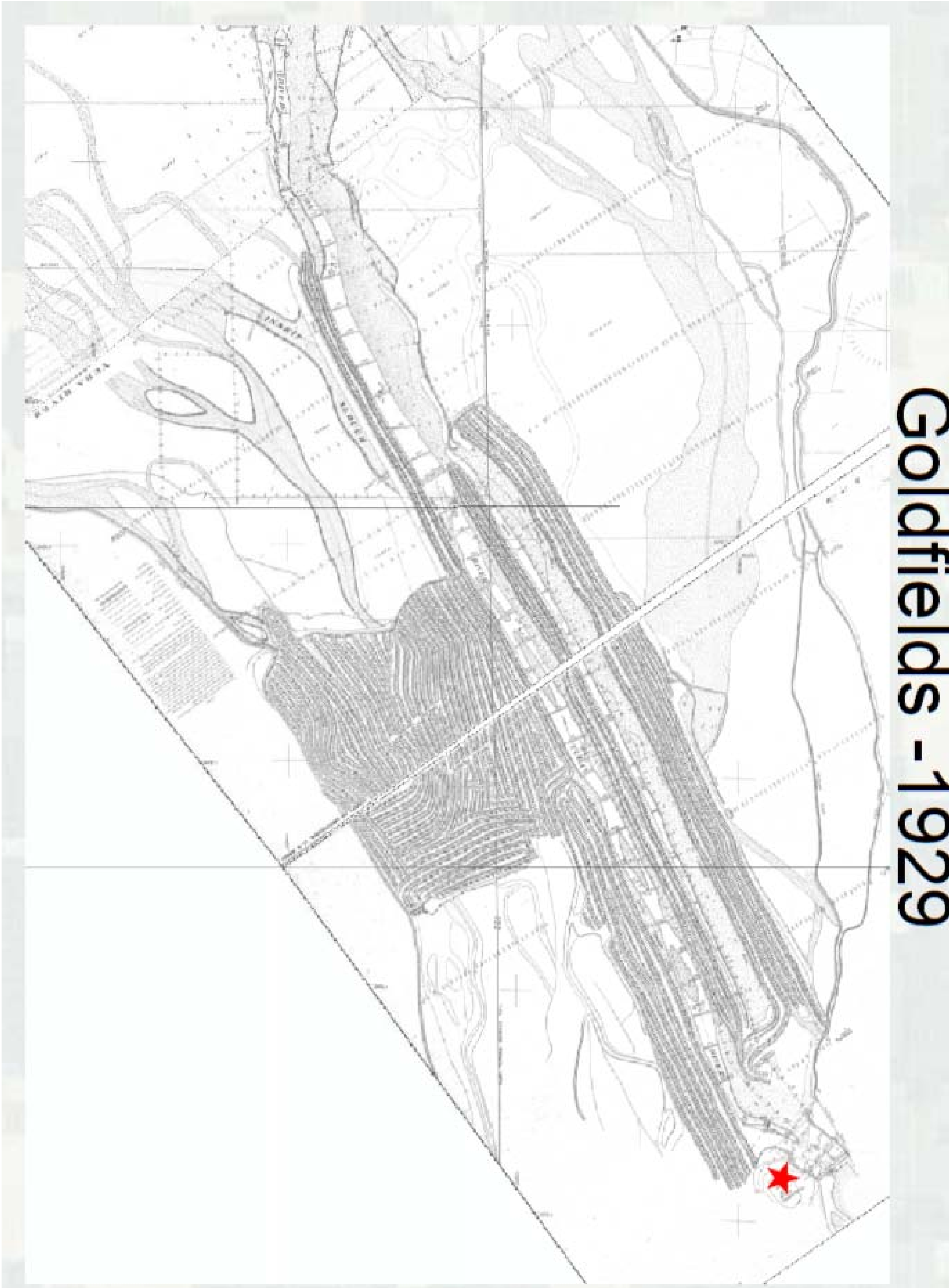


Plate GT-2 Goldfields 1929

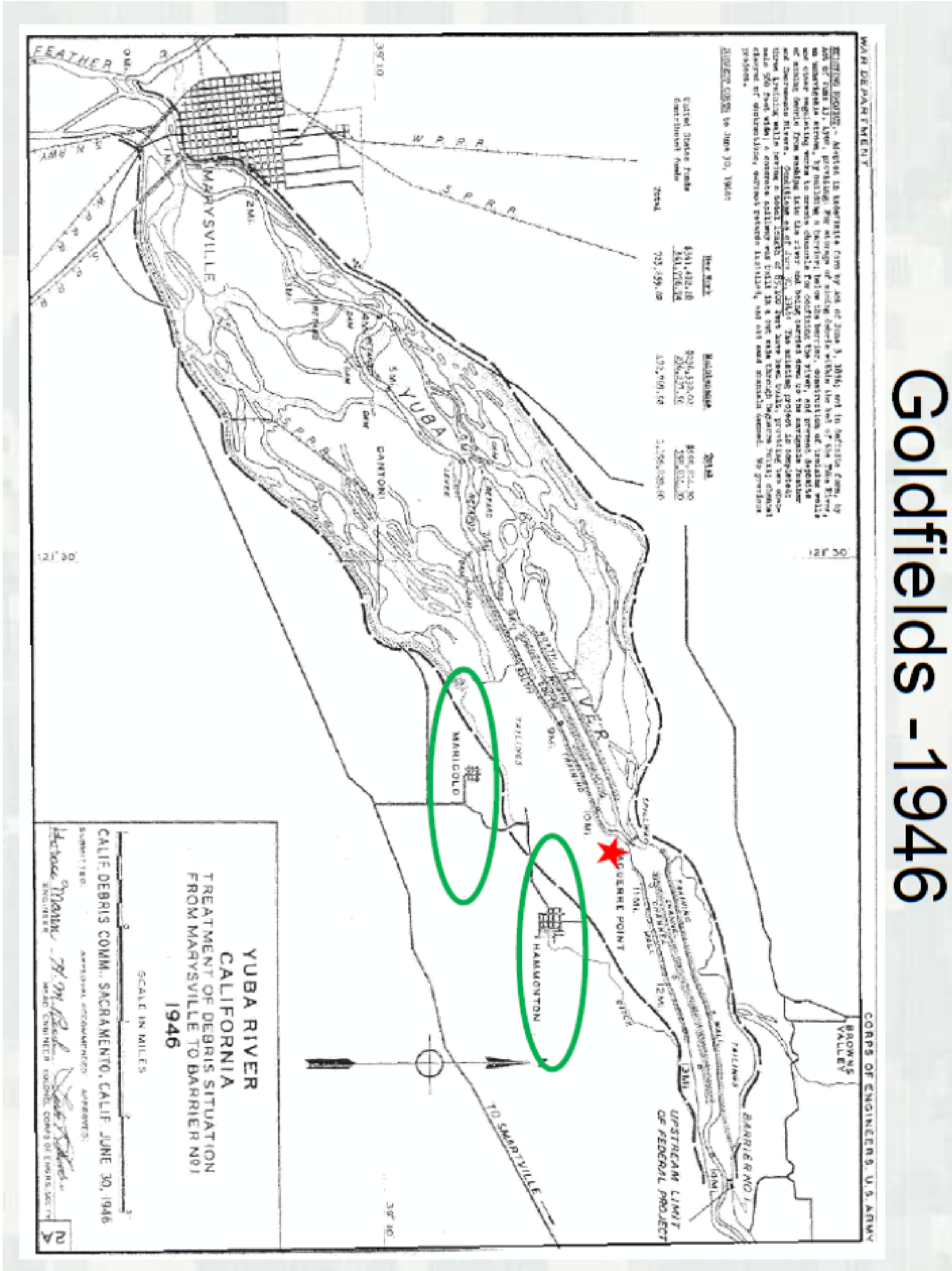


Plate GT-3 Goldfields 1946

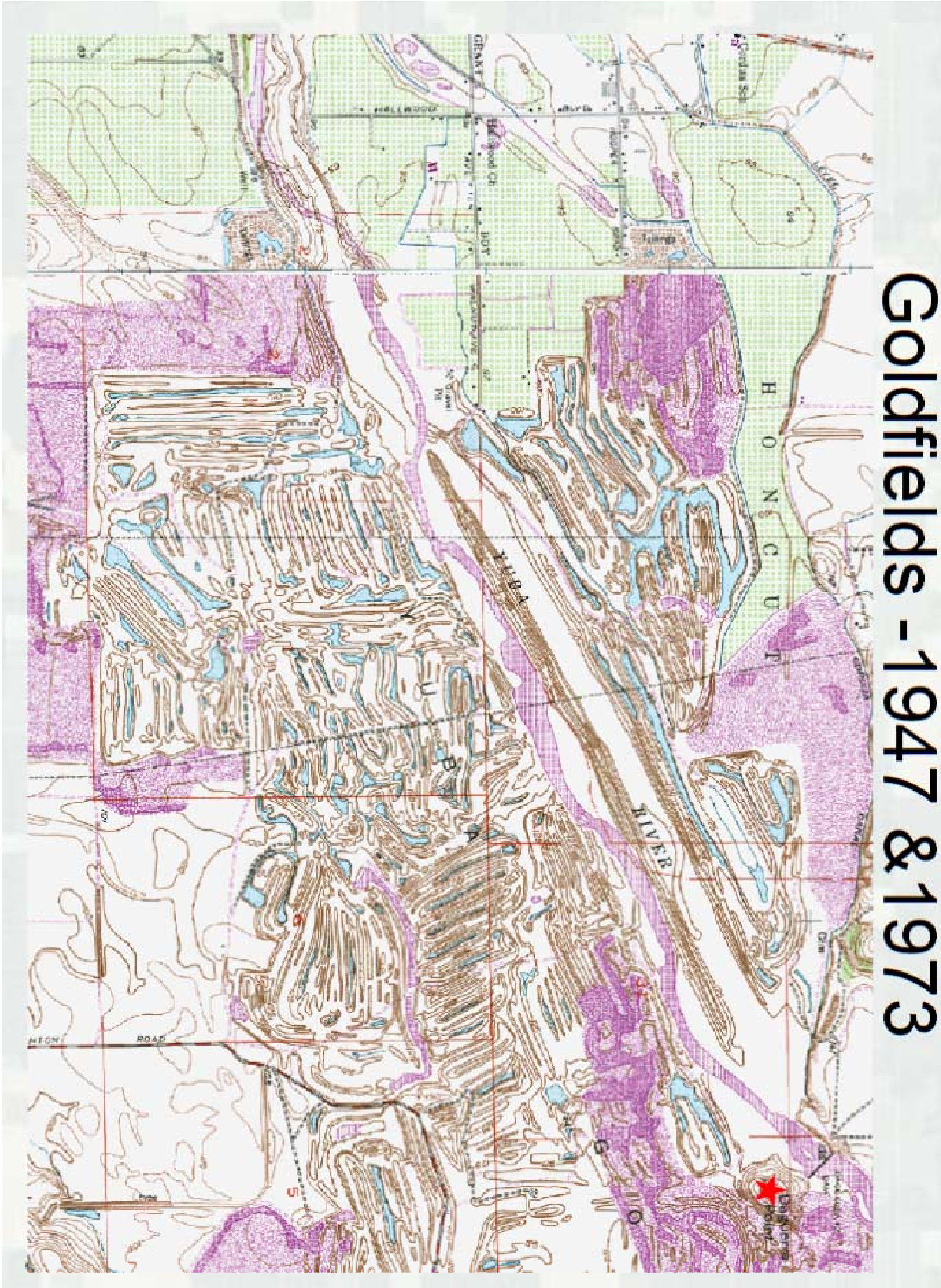
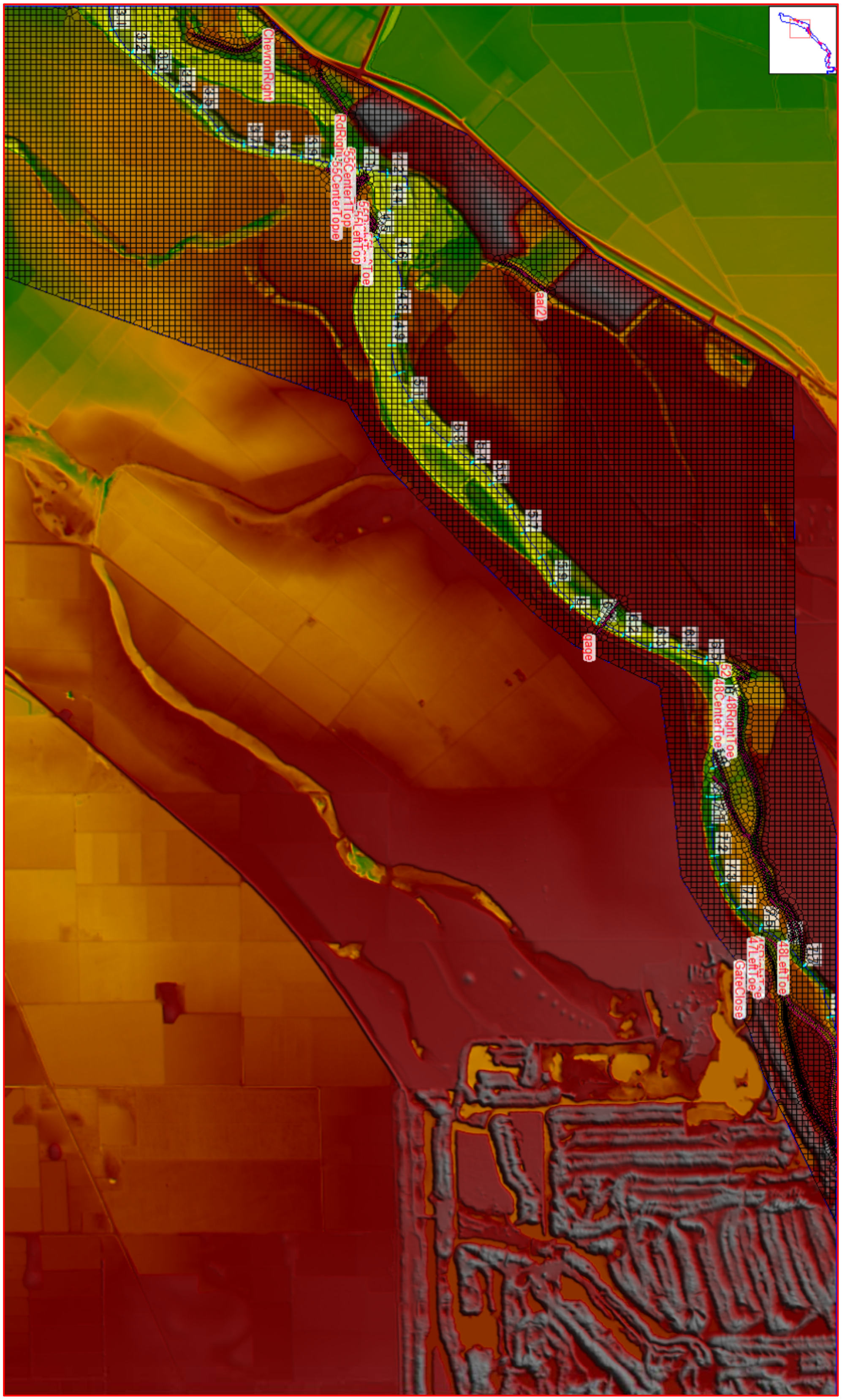


Plate GT-4 Goldfields 1947 & 1973 (Purple)

Plate GT-5 Goldfields 2005

Plate HD-1 Yuba River Mesh 1 of 5



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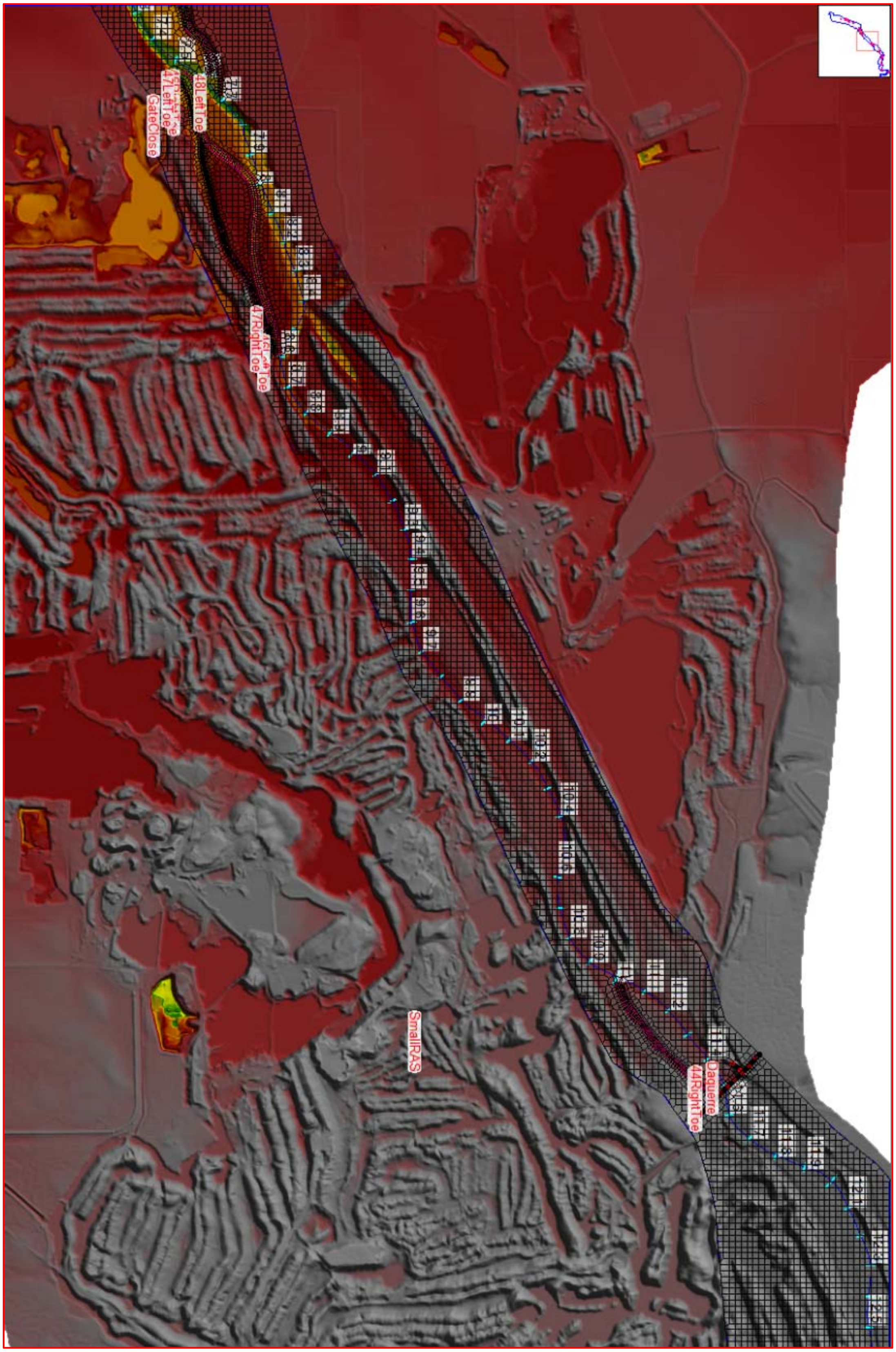

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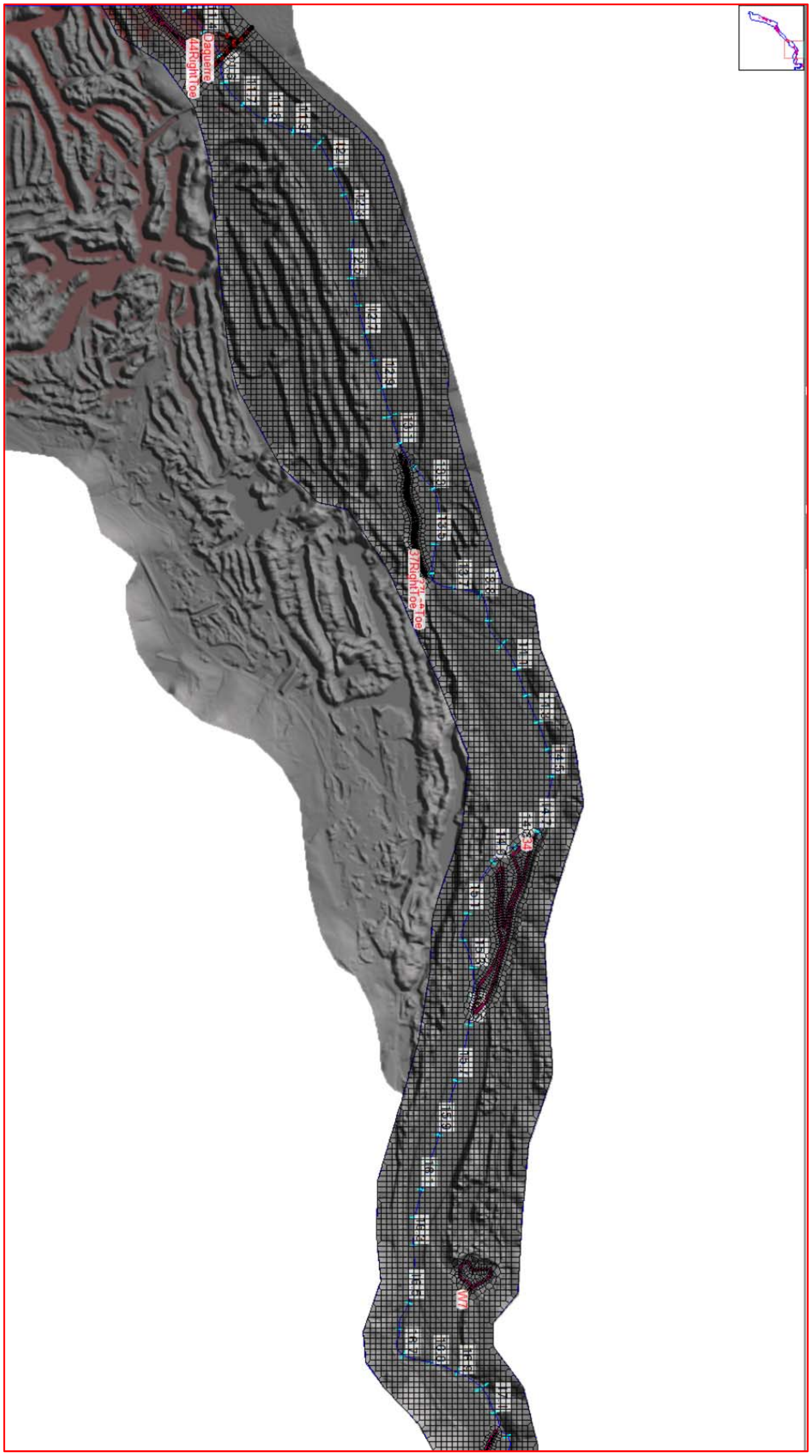

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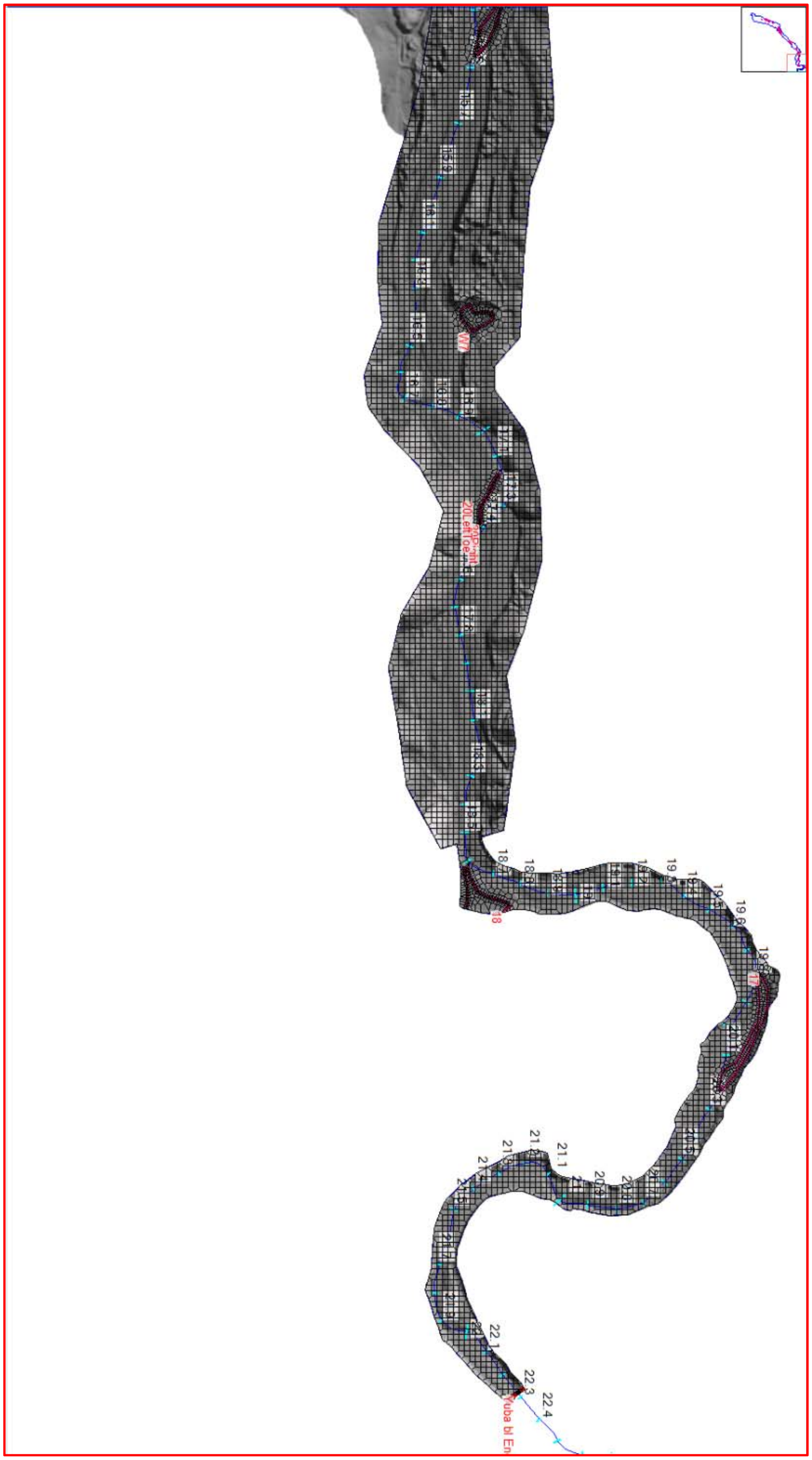

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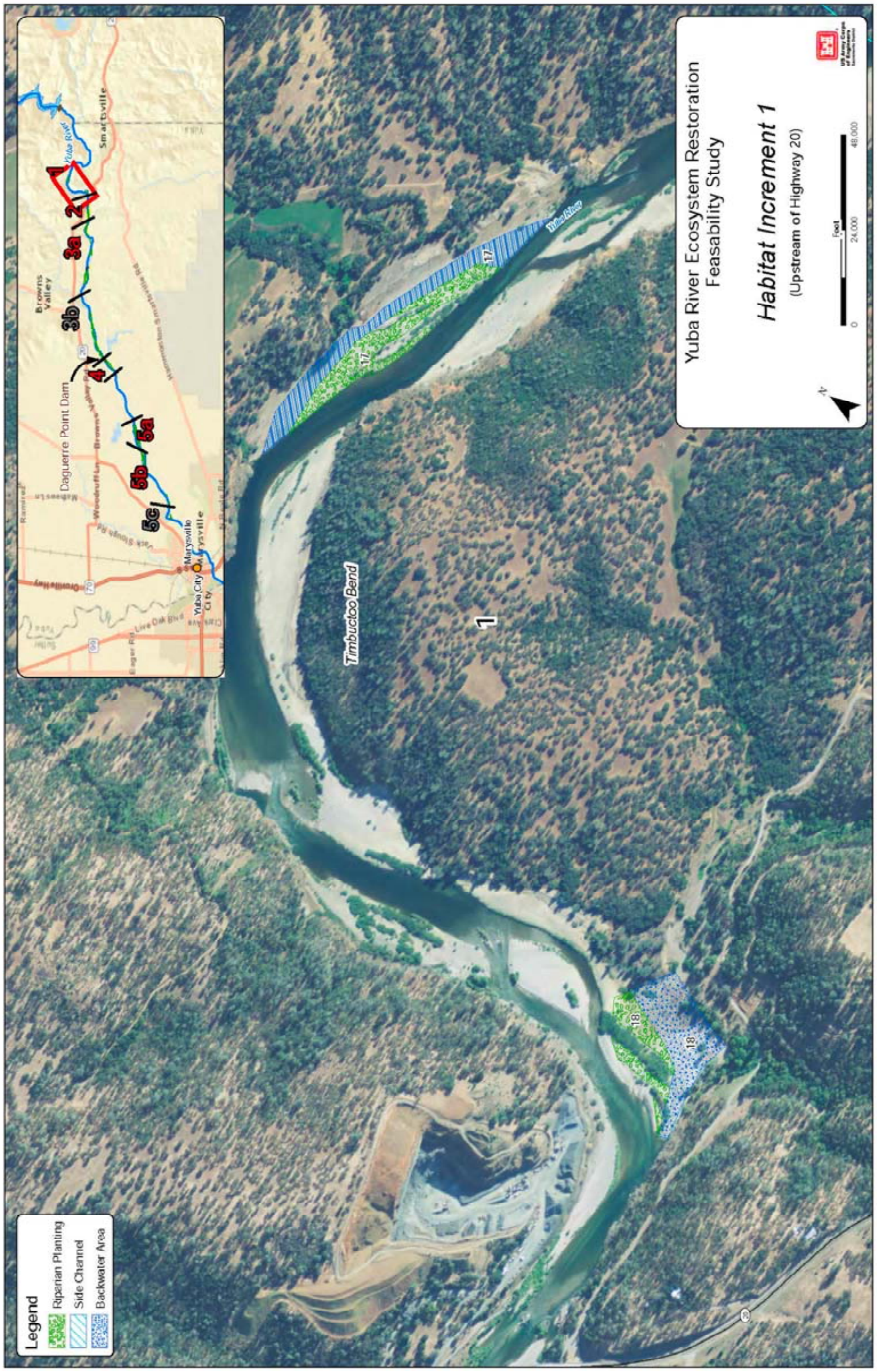

Plate CV-1. Habitat Increment 1

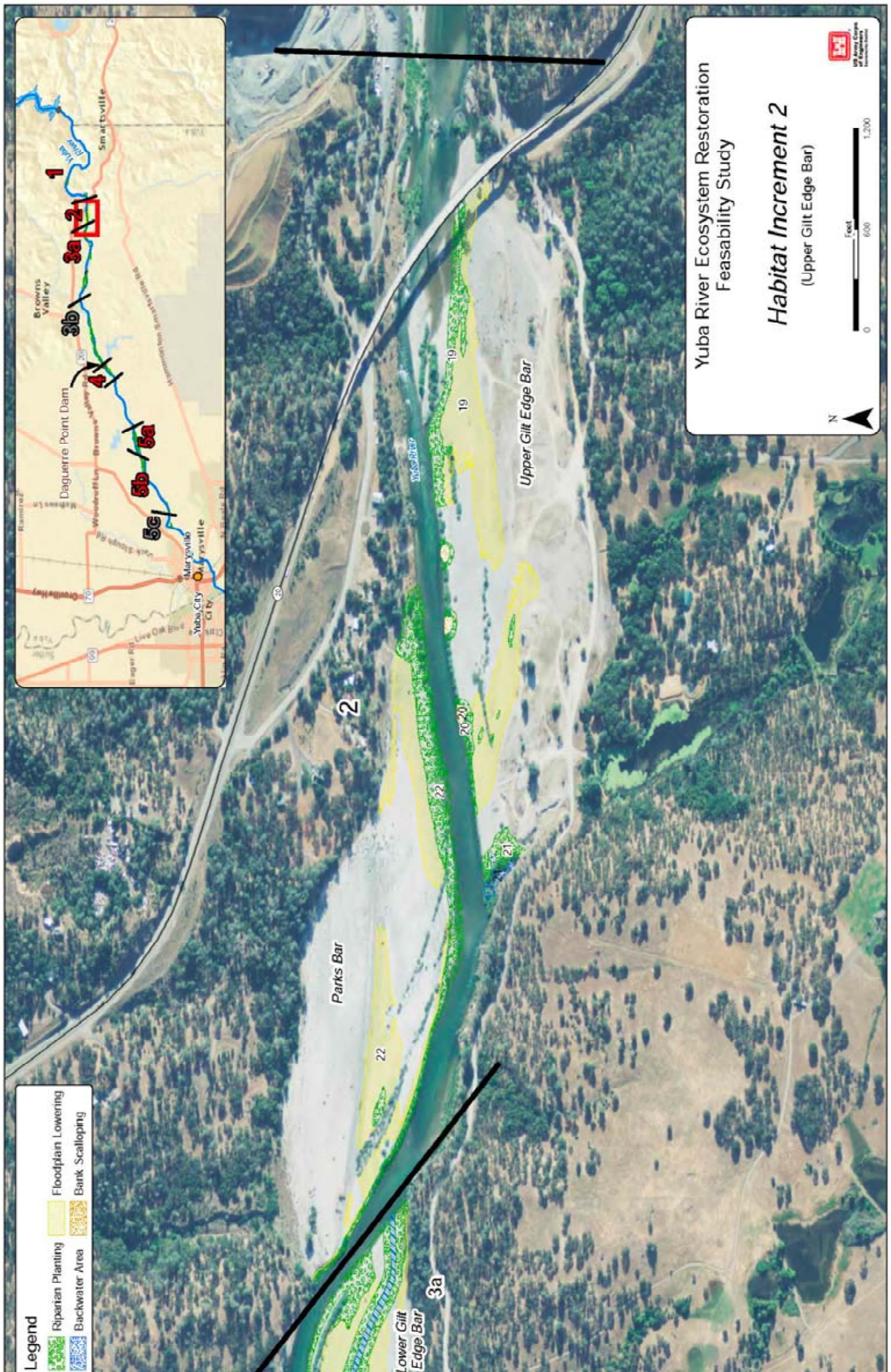

Plate CV-2. Habitat Increment 2

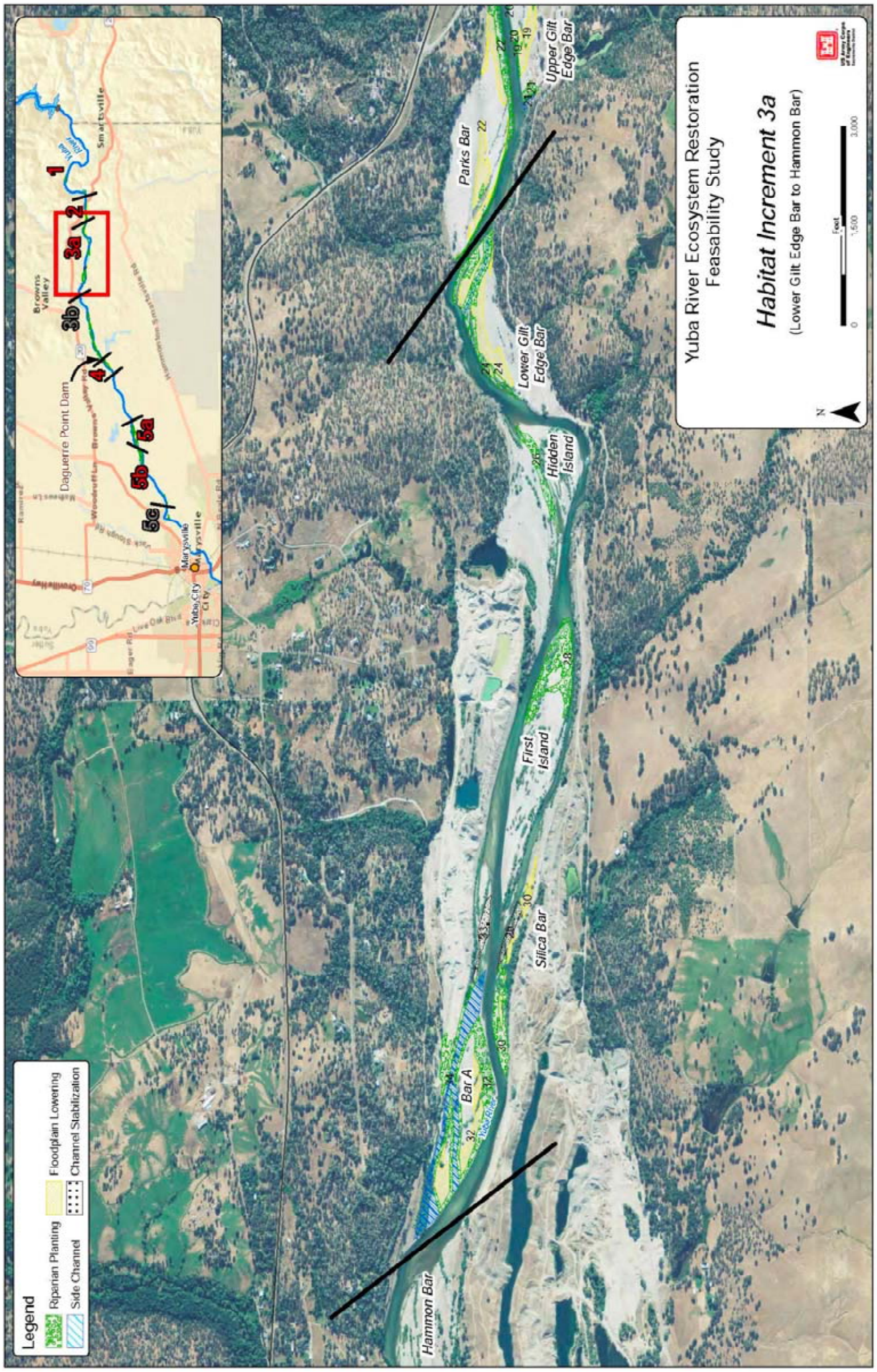

Plate CV-3. Habitat Increment 3a

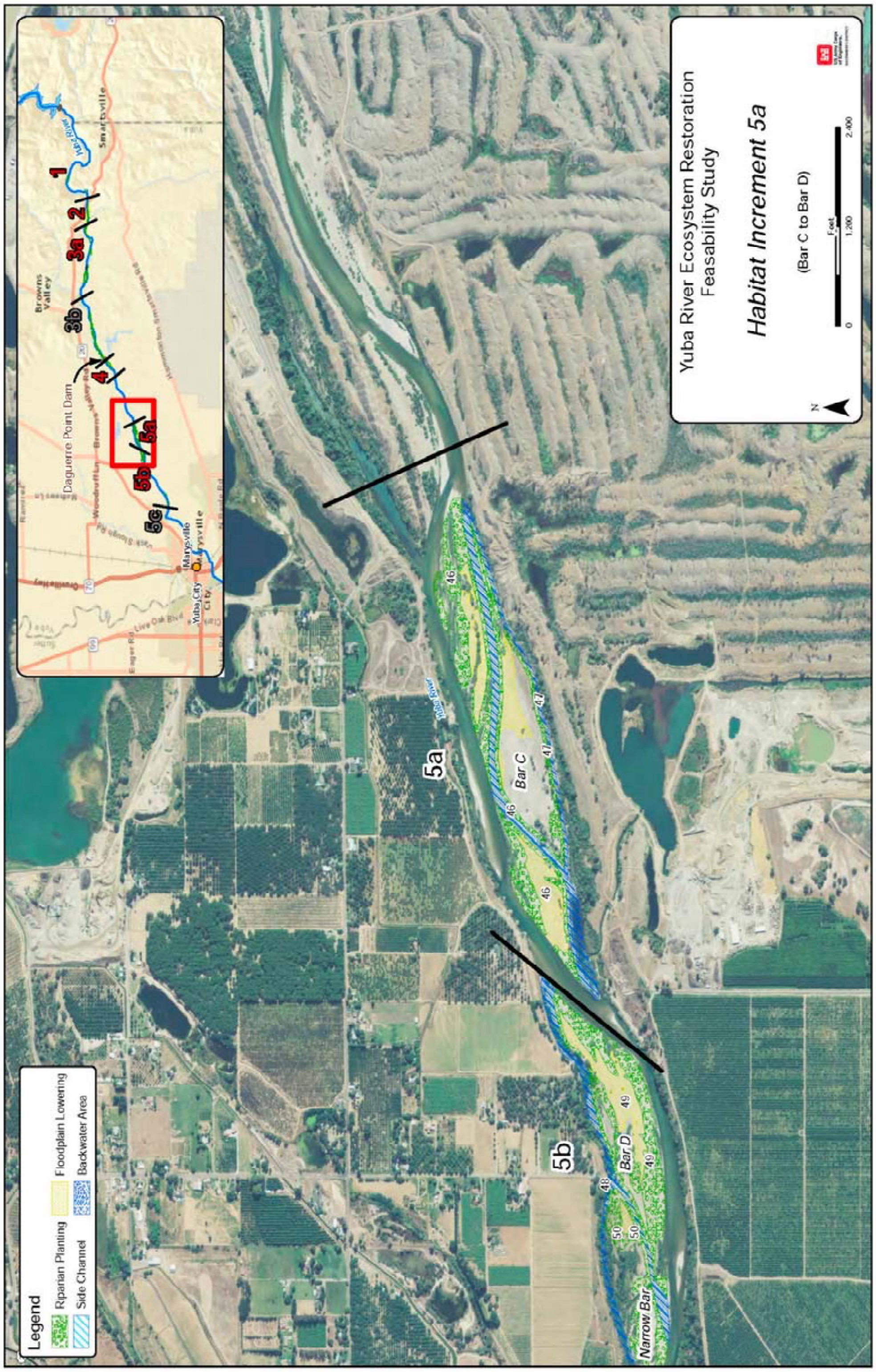

Plate CV-4. Habitat Increment 5a

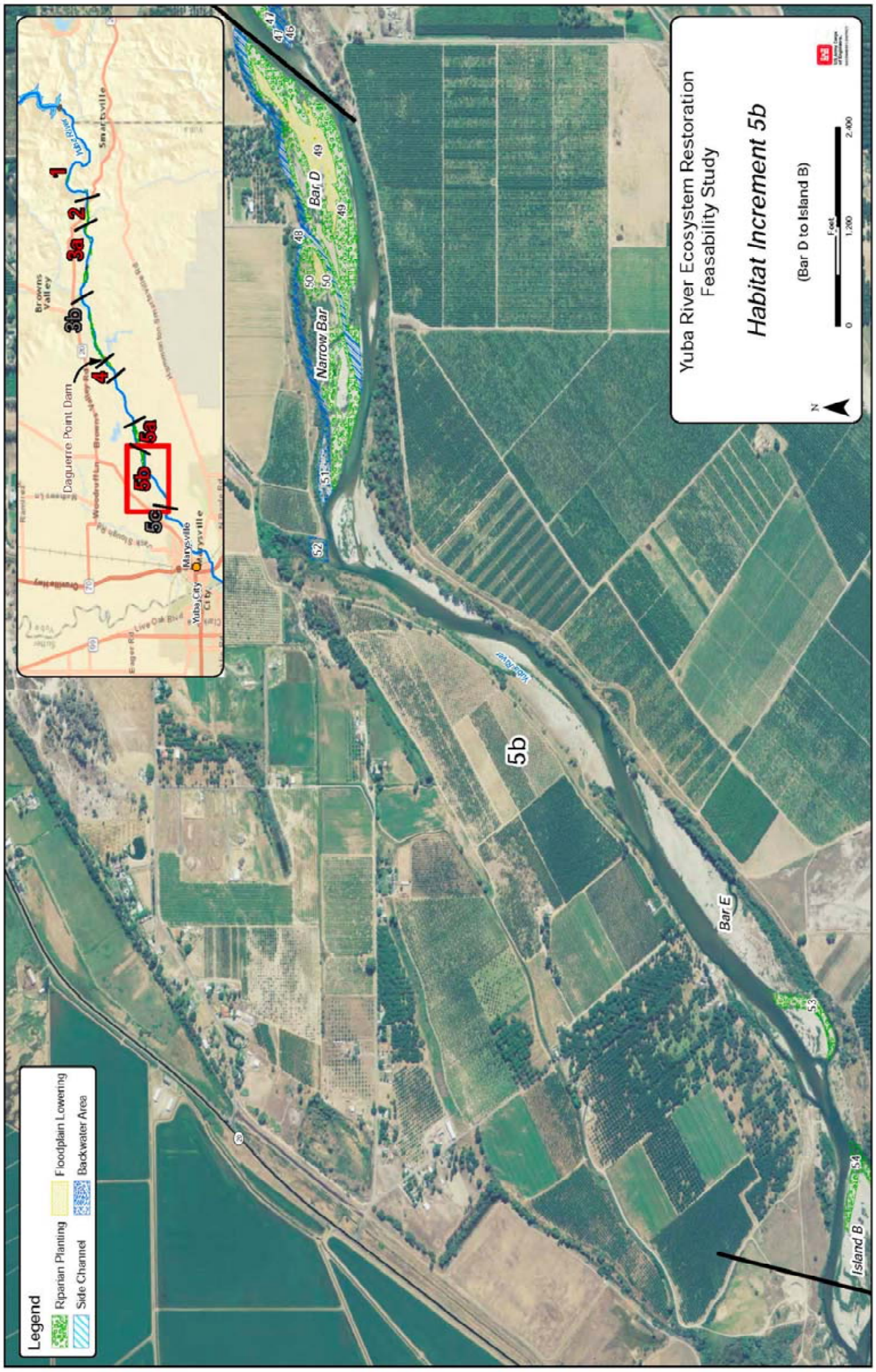

Plate CV-5. Habitat Increment 5b

Civil Design Attachment CV-A
Yuba River Ecosystem Restoration Feasibility Study
DRAFT Design Criteria Technical Memorandum

1.0 INTRODUCTION

The purpose of this technical memorandum (TM) is to document the basis for establishment of design criteria for habitat restoration measures on the lower Yuba River. Design criteria serve as the foundation by which proposed restoration actions were developed to a level of detail necessary to support evaluation of benefits and costs.

2.0 APPLICATION OF DESIGN CRITERIA AND LEVEL OF DESIGN

The purpose of these design criteria is to support the assessment of ecosystem outputs for habitat restoration measures in the lower Yuba River. The HEC-RAS 2D hydraulic model will be used in conjunction with habitat suitability relationships (Habitat Suitability Index models) for representative species. Resulting outputs (habitat units) of habitat quantity and quality will be used to evaluate and compare proposed actions. Design criteria will provide a framework for translating written descriptions of measures into a modified terrain model that will be used in the hydraulic analysis.

In line with SMART planning principles, design criteria and resulting project design will only be developed and applied at a level of detail appropriate to their roles in the planning process. Design criteria will be applied two times throughout the planning process - during evaluation of alternatives and later during a feasibility level analysis of the tentatively selected plan. The differences between benefits and costs of proposed actions are anticipated to be relatively large, which would reduce the need for a high level of detail in design; however, a certain level of design is required to ensure reasonable representative values of ecosystem outputs. Due to the complex nature of habitat restoration measures on the lower Yuba River, features need to be designed and modeled to level of detail sufficient to ensure a minimum amount of function. Furthermore, a feasibility level analysis will be performed using the designs developed for the evaluation of alternatives analysis as a starting point. Therefore, the base level of detail in design should consider efficiencies of supporting a feasibility level analysis.

Given the above considerations, a base level of design criteria will be applied in developing designs for habitat restoration measures on the lower Yuba River that ensures a reasonable representation of habitat output is developed to support an evaluation of alternatives in a CE/ICA analysis. Additional design criteria will be applied during a feasibility level analysis.

As stated above, the essential purpose of design criteria is to provide a framework for translating written descriptions of measures into a modified terrain model that will be used in the hydraulic analysis. The PDT will translate written descriptions of measures as documented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016). The descriptions of measures provided in that document will be given primary consideration. Where design details are absent from the original descriptions, the design criteria detailed in this document will be used to fill the gaps.

The overall strategy for development and application of design criteria to evaluate alternatives is summarized below.

1. Identify major features of the proposed habitat restoration measures on the lower Yuba River
2. Develop design criteria, including minimum performance and general guidelines, for each major feature type
    a. Define design intent
    b. Define design strategy
    c. Define specific design parameters based on reasonable performance goals
3. Develop a modified GIS-based terrain layer to be used in conjunction with hydraulic modeling to simulate habitat conditions resulting from implementation of the proposed habitat restoration measures.
    a. Using YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016)
    b. Applying design criteria to fill in gaps where appropriate and ensure a minimum level of performance

The major feature types included in the design criteria include side channels, floodplain grading, structural complexity features, and vegetative planting. These features were selected because they are anticipated to have the greatest effect on ecosystem output.

3.0 CRITERIA

3.1 DESIGN FEATURE - SIDE CHANNEL

- Creation of new, or enhancement of existing side channels. The following design criteria also will be applied as appropriate to features such as bank scalloping, backwaters, and/or any habitat feature with a similar design intent.

3.1.1 DESIGN INTENT

- Provide additional diverse, complex inundated riverine habitat.

<u>Design Strategy</u>

- Base the design elevation on a standardized base flow condition for each habitat/hydrologic zone, or (HZ). Define a design water depth associated with the base flow condition, and apply that resultant streambed elevation to identified potential side-channel locations. The operative strategy is to provide side channel habitat particularly during the critical oversummer (June through September) rearing period (see exceedance **Figures 1-4** and baseflow definitions, below).

3.1.2 Specific Design Parameters

- Base Flow Condition
  - Upstream of Daguerre Point Dam – 730 cfs. Base flow upstream of Daguerre Point Dam (DPD) corresponding to a Yuba Accord schedule 1, 2, 3 or 4 year that requires a minimum of 700 cfs at the Smartsville Gage from September 1 through April 15. There are no minimum flow requirements at the Smartsville Gage for the remainder of the year, when minimum flow requirements are specified by requirements at the Marysville Gage. A base flow of 730 cfs is provided as a margin of safety.

  - Downstream of Daguerre Point Dam – 530 cfs. Base flow downstream of DPD corresponding to a Yuba Accord schedule 1, 2, or 3 year that requires a minimum of 500 cfs at the Marysville Gage from June through March, mid-June through February, and September through February, respectively. A base flow of 530 cfs is provided as a margin of safety.

- Side-Channel Entrance and Exit (adapted from Hoopa Valley Tribe *et al*., 2011)
  - Side channel entrance angle should be less than or equal to 40 degrees.

  - To avoid sedimentation, either: (1) place the side-channel entrance at a location in the channel that is not transporting (and depositing) sediment; or (2) design the side-channel entrance such that it transports any coarse sediment that may enter the side-channel from the mainstem (Hoopa Valley Tribe *et al*., 2011).

  - The side channel should not convey more than 15% of the baseflow to preserve sediment transport capacity in the main channel.

  - The side channel entrance (i.e., approximate upper 1/3 of the side-channel) should not contain an abundance of added hydraulic roughness elements in order to retain sediment transport competency.

  - In the downstream 2/3 of the side channel where roughness no longer has hydraulic effect on the coarse sediment competency of the entrance, additional roughness via structural elements (e.g., large woody material (LWM), engineered log jams (ELJs), boulders) and vegetation plantings can be encouraged.

3.1.3 Footprint

- Side-channel footprint (width, length) will be based on descriptions of the proposed measures presented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016) and on previously prepared reports (RMT 2009; DWR and PG&E 2010; cbec 2013; NMFS 2014; cbec 2014).

- Area: Polygons for project footprints were developed and documented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016).

- Depth: Side-channels will be created to a water depth of 0.5 ft associated with the base flow conditions.
  - Steelhead Fry – Water depths of 0.5 ft will provide optimal depth suitability[1] (HSI = 1.0) for fry at the base flow. During the fry rearing period (April through July), flow exceedance probabilities[2] of 50% equate to flows of about 2,350 cfs upstream of Daguerre Point Dam (Smartsville Gage) and about 1,650 cfs downstream of Daguerre Point Dam (Marysville Gage). Using average stage-discharge relationships for slackwater mesohabitat types[3], those flows would provide constructed side-channel water depths of about 1.9 ft and associated HSI of 0.7 upstream of Daguerre Point Dam, and water depths of about 1.8 ft and associated HSI of 0.7 downstream of Daguerre Point Dam (**Figure 5**). Thus, fry rearing habitat would be expected to be 70 - 100% of optimal depth suitability about ½ of the time both upstream and downstream of DPD.
  - Steelhead Juvenile – Water depths of 0.5 ft will provide depth suitability of about 50% of optimal (HSI = 0.5) for juveniles at the base flow. During the over-summer juvenile rearing period (June through September), flow exceedance probabilities of 50% equate to flows of about 1,470 cfs upstream of Daguerre Point Dam (Smartsville Gage) and about 690 cfs downstream of Daguerre Point Dam (Marysville Gage). Using average stage-discharge relationships for slackwater mesohabitat types, those flows would provide constructed side-channel water depths of about 1.3 ft and associated HSI of 0.8 upstream of Daguerre Point Dam, and water depths of about 0.7 ft and associated HSI of 0.6 downstream of Daguerre Point Dam (**Figure 6**). Thus, juvenile rearing habitat would be expected to be 50 - 80% of optimal depth suitability about ½ of the time upstream of DPD, and 50 – 60% of optimal depth suitability about ½ of the time downstream of DPD.
  - Spring-run Chinook Salmon Fry – Water depths of 0.5 ft will provide optimal depth suitability (HSI = 1.0) for fry at the base flow. During the fry rearing period (mid-November through mid-February), flow exceedance probabilities of 50% equate to flows of about 915 cfs upstream of Daguerre Point Dam (Smartsville Gage) and about 905 cfs downstream of Daguerre Point Dam (Marysville Gage). Using average stage-discharge relationships for slackwater mesohabitat types, those flows would provide constructed side-channel water depths of about 0.7 ft and associated optimal HSI of 1.0 upstream of Daguerre Point Dam, and water depths of about 1.0 ft and associated optimal HSI of 1.0 downstream of Daguerre Point Dam (**Figure 7**). Thus, fry rearing habitat would be expected to be 100% of optimal depth suitability about ½ of the time.
    - Spring-run Chinook Salmon Juveniles – Water depths of 0.5 ft will provide depth suitability of about 50% of optimal (HSI = 0.5) for juveniles at the base flow. During the over-summer juvenile rearing period (June through

[1] Water depth suitabilities obtained from YRDP Relicensing Participants HSCs (YRDP TM 7-10 (YCWA 2013)).
[2] Based upon flow exceedance analyses over the 41-year period of record of daily flows derived through the YRDP daily flow model.
[3] Juvenile Chinook salmon were primarily observed in slackwater and slow glide habitat types during snorkel surveys in the lower Yuba River (RMT 2013).

September), flow exceedance probabilities of 50% equate to flows of about 1,470 cfs upstream of Daguerre Point Dam (Smartsville Gage) and about 690 cfs downstream of Daguerre Point Dam (Marysville Gage). Using average stage-discharge relationships for slackwater mesohabitat types, those flows would provide constructed side-channel water depths of about 1.3 ft and associated HSI of 0.9 upstream of Daguerre Point Dam, and water depths of about 0.7 ft and associated HSI of 0.6 downstream of Daguerre Point Dam (**Figure 8**). Thus, juvenile rearing habitat would be expected to be 50 - 90% of optimal depth suitability about ½ of the time upstream of DPD, and 50 – 60% of optimal depth suitability about ½ of the time downstream of DPD.

- o Shore slope: Side channel walls will slope at 3:1 (H:V) from the base flow condition to a design depth (0.5 ft). A 3:1 slope was selected due to relative stability. Steep side slope walls may be preferred to prevent spawning in areas prone to dewatering.

3.2 Design Feature – Floodplain Grading

- Creation of new or improvement of existing floodplain connectivity. These design criteria will also be applied as appropriate to backwater creation, bench lowering, terracing, set back of berms (floodplain expansion), and/or any habitat feature with a similar design intent.

3.2.1 Design Intent

- Create additional inundated habitat, increase the frequency and duration of inundation, and enhance access to groundwater for establishment of riparian vegetation.

3.2.2 Design Strategy

- Base the design elevation on a standardized elevation corresponding to a target flow for each habitat/hydrologic zone, or (HZ). Use existing polygons to define upper limits of floodplain grading. Identify grading locations within polygons based on a depth-to-water table of 7 to 10 feet (floodplain grading/lowering/excavation) or greater than 10 feet (terracing) at each location. Extrapolate a graded slope between base flow conditions and upper limits of grading. Floodplain grading features will need to be developed subsequent to side-channel features, because side-channel features would result in localized modifications to water surface elevations associated with standardized target flow conditions.

- Define a streambed elevation for a water depth associated with the target flow condition, and apply that resultant streambed elevation to identified potential floodplain grading locations. Design strategy for YRERFS planning purposes includes riparian vegetation planting for grading of surfaces characterized under the existing condition as a 7 to 10 ft depth to water table.

3.2.3 Specific Design Parameters

- Flow-Related Target Elevations
  - Upstream of Daguerre Point Dam – 2,000 cfs.
  - Downstream of Daguerre Point Dam – 2,000 cfs.
- Frequency of Inundation
  - A frequency of inundation of 67% (2 in 3 years) is considered to be highly supportive of salmon populations (Reedy 2016) due to increased functionality of shallow off-channel rearing habitat, and increased growth associated with refugia habitat and provision of food availability. Floodplain grading and associated riparian vegetation planting are primarily designed to provide benefit to juvenile anadromous salmonids during the spring rearing and growth period.

    Grading floodplain surfaces (e.g., bench and bar lowering) to flow-related target elevations would increase the frequency of inundation, thereby: (1) increasing the functionality of lower Yuba River in-channel bench and bar areas by providing shallow off-channel rearing habitat and refugia for juvenile anadromous salmonids; (2) providing additional growth opportunities due to more suitable water velocities; and (3) potentially increasing benthic macroinvertebrate producing habitat. The primary habitat benefit is to provide increased riparian vegetation and subsequent woody material recruitment to riverine habitats. Additional benefits may be provided by promoting riparian vegetation recruitment, instream object and over-hanging cover, and allochthonous food sources.
- Duration of Inundation
  - A 21-day duration of inundation is considered to be the minimum duration necessary to establish trophic productivity, and to provide benefits to juvenile anadromous salmonid rearing habitat functionality through provision of increased food resources and increased off-channel rearing habitat (Reedy 2016). Studies on the lower American River - a system analogous to the lower Yuba River, have shown that floodplain invertebrate densities approach main channel densities after 2 to 4 weeks of inundation (J. Merz, pers. comm., as cited in cbec 2013). In Central Valley lowland river floodplains, studies have shown increased juvenile salmonid growth rates as a result of at least 21 days on the floodplain (Jeffres *et al*., 2008; Sommer *et al*., 2001, 2002). During this time period, phytoplankton and zooplankton life cycles produce valuable food resources in relatively slow moving, shallow water with temperatures typically warmer than the main river channel (Sommer *et al*., 2004). An inundation event lasting at least 21 days would likely provide the opportunity for macroinvertebrates to colonize off-channel areas.

- Inundation Frequency and Duration Interactions

    - It previously has been suggested that lower Yuba River in-channel floodplain areas could be lowered to elevations which begin to become inundated at 3,000 cfs (cbec 2013) because floodplain areas would be shallowly inundated by a flow that persisted for a 21-day duration in 1 in 2 years during the March-June period. Areas graded to inundate at flow rates lower than 3,000 cfs would be inundated more frequently, and for a longer duration; although prolonged inundation can induce mortality of riparian vegetation seedlings, which could prevent the establishment and persistence of riparian vegetation on these lowered surfaces (cbec 2013). However, because the design strategy for YRERFS planning purposes includes riparian vegetation planting for graded surfaces previously with a 7 to 10 ft depth to water table, inundation at higher frequencies or for longer durations would be appropriate for habitat functionality.

    - A recently conducted HEC-EFM Analysis for Salmonid Rearing Habitat Flows (Reedy 2016) identified a 21-day duration of inundation both above and below DPD of about 2,000 cfs under existing conditions[4] during 2 of 3 years (67% of the time) for the February through June period. That time period encompasses the seed dispersal timeframe, and most of the spring-run YOY juvenile and steelhead fry rearing periods.

3.2.4 Footprint

- Floodplain grading footprint (width, length) will be based on descriptions of the proposed measures presented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016) and on previously prepared reports (RMT 2009; DWR and PG&E 2010; cbec 2013; NMFS 2014; cbec 2014).

    - Area: Polygons for project footprints were developed and documented in YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016).

    - Depth: Floodplain grading would be conducted with the goal of providing water depths associated with 50 – 100% of juvenile spring-run Chinook salmon optimal water depth suitability (i.e., depths ranging from about 0.5 to 3.3 ft) approximately 80% of the time during the over-summer juvenile rearing period (June through September).

    - Slope: Slope of floodplain grading features will generally follow a linear extrapolation between the waterside and landside limits of the grading area.

[4] YCWA Yuba River Development Project relicensing "Base Case" flow scenario.

3.3 Design Feature – Vegetative Planting

- Enhancing existing or planting new riparian vegetation.

3.3.1 Design Intent

- Create additional riparian habitat.

3.3.2 Design Strategy

- Conduct riparian vegetation planting corresponding to design elevations based on standardized flow conditions for each habitat/hydrologic zone, or (HZ). Use existing polygons to define areas for riparian vegetation planting. Identify planting locations based on a depth-to-water table of less than 7 feet at each location. Dormant hardwood cuttings will be planted to depth of groundwater during the late fall. The depth-to-groundwater must be known, cuttings must be properly prepared, and the selected implementation methods must be able to reach groundwater at each selected location (SYRCL 2013).

3.3.3 Specific Design Parameters

- Native Species Planting Composition

    - A combination of four native species will be planted, including: Fremont cottonwood (*Populus fremontii*), Gooddings black willow (*Salix gooddingii*), red willow (*S. laevigata*), and arroyo willow (*S. lasiolepis*). The planting design is intended to promote hardwood structure (i.e., forest and large wood production) while also providing species and structural diversity. Although arroyo willow is not a tree-type willow, it is included in the design to create structural diversity known to support neotropical bird habitat (RHJV 2004). Furthermore, arroyo willow is under-represented on the lower Yuba River compared to other shrubby willows (WSI 2012; SYRCL 2013).

    - Donor trees will be selected from existing riparian areas along the lower Yuba River. Multiple cuttings will be taken from red willow and arroyo willow shrubs, but single cuttings will be taken from the other tree species. If red willow donor tree availability becomes limited, Gooding's willow will be substituted.

- Cutting Size

    - Cuttings will be from branches or stems harvested from donor trees, and prepared as cuttings that are about 7 feet in length. Cuttings will be less than 2 inches diameter at the base.

- Equipment

    - Planting will occur with a stinger planting method that uses a specialized planting device mounted on an excavator to quickly plant cuttings one or two at a time. The stinger device can plant to a maximum depth of nearly 7 feet and a cutting of maximum diameter of approximately two inches.

- Planting Design
  - It is recommended that revegetation should not cover more than 50% of a constructed surface. Revegetating with patchy stands ensures that existing monotypic vegetation will be replaced with a desirable species composition and structural diversity on some surfaces, while leaving other portions of the constructed surface exposed for natural plant recruitment (Hoopa Valley Tribe *et al*., 2011).
  - The planting method will use a pod planting design that organizes planted cuttings into 20 foot diameter planting units (pods) (**Figure 9**). The "pod" design was developed as a way to incorporate structural diversity and spatial variability into larger riparian rehabilitation projects while still being able to contract and implement easily (e.g., Sullivan and Bair 2004; Hoopa Valley Tribe et. al. 2011).
  - Cuttings will be brought to stinger planting locations in the following combination: 6 cottonwoods and 2 of each willow species. Cuttings planted by stinger should be less than 2 inches in diameter and straight.
  - Each planting location will receive two cuttings of the same species, resulting in 12 cuttings per pod. Placing two cuttings per location is a common approach to increase success rate where some proportion of cuttings fail to root and thrive regardless of planting conditions (Hoag 2009). Each willow cutting will be planted approximately 2 inches into the groundwater. The design also specifies the planting of cottonwood cuttings 2 inches above groundwater, as cottonwood are sensitive to rotting from prolonged inundation, but have vigorous rooting to meet proximal groundwater (John Bair, pers. comm. in SYRCL 2013).
- Planting Density
  - Initially, planting density will be 1,500 cuttings per acre. If further analyses of previously conducted pilot programs indicates relatively high (e.g., 75%) survivorship, then planting density could be reduced from 1,500 cuttings an acre to 1,000 cuttings an acre, resulting in a lower cost per acre for implementation (SYRCL 2013).

3.3.4 FOOTPRINT

- Riparian vegetation planting footprint will be based on descriptions of the proposed measures presented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016) and on previously prepared reports (RMT 2009; DWR and PG&E 2010; cbec 2013; NMFS 2014; cbec 2014).

- Area: Polygons for project footprints were developed and documented in YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016).
- Depth: Depth to groundwater has been estimated by Wyrick and Pasternack (2012) and by cbec *et al*. (2010). Available information will be reviewed and modified, if necessary, to estimate depth to groundwater at the various identified riparian vegetation planting locations. Literature reviews will be conducted to identify inundation frequencies and timing to maximize cutting survival, and to provide benefit to rearing juvenile anadromous salmonids.

Riparian planting will occur in areas adjacent to all side-channel footprint descriptions associated with the proposed measures presented in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016). At select locations, the depth to groundwater is greater than 10 feet in areas that are within a minimum of 40 feet from the wetted edge of a side channel, which will require terracing to enable riparian vegetation planting. To the extent that larger areas are available adjacent to proposed side channels, and these areas are either less than 7 feet to the water table or would require floodplain grading between 7 and 10 feet of the water table, those areas also will be planted with riparian vegetation.

3.4 Design Feature – Structural Complexity Features

- Placement of new or improvement of existing structural complexity features. Structural complexity features include various types of woody material, ELJs and boulder features. Woody material features may significantly differ depending on design intent.

3.4.1 Design Intent

- Create structural complexity features to enhance microhabitat availability through the addition of physical structure and/or modification of local flows.

3.4.2 Design Strategy

For features placed with the purpose of enhancing physical structure only, utilize descriptions provided in the YRERFS Habitat Measures Technical Memorandum (YCWA and Corps 2016). The design elevation is based on a standardized flow condition for each habitat/hydrologic zone, or (HZ).

- Define a design water depth associated with the standardized flow condition, and apply that resultant streambed elevation to identified locations of structural features.

3.4.3 Specific Design Parameters

- Woody Material

- Bankline application - Where woody material is described as an addition to a bankline, assume woody features are 25 feet in length and 2 ft in diameter. The material will be anchored in the bankline at a 45 degree angle downstream and protrude 1/3 of its total length beyond the bankline into the channel. For application in the hydraulic model, these placements will be assumed to be 9 foot long and 1 meter wide polygons. Where applicable, groups of these features will be combined into reasonably proportioned polygons.
- Floodplain application – Where woody material is placed on a floodplain or seasonally inundated area, the woody material will be placed parallel with the flow, anchored with cables, boulders, and pins. For application in the hydraulic model, these placements will be assumed to be 20 feet in diameter circular polygons.

- Boulders – Boulders are assumed to be 5 ton in weight and average 1 meter in diameter. For application in the hydraulic model, the placements will be assumed to be 1 meter in diameter circular polygons.

4.0 ADDITIONAL TECHNICAL CONSIDERATIONS

This TM has been prepared for the Corps based on assumptions as identified throughout the text and upon information, data and conclusions primarily supplied by others (see the document titled "*Yuba River Ecosystem Restoration Feasibility Study Habitat Measures*", dated October 2016). The Corps and its non-federal sponsor are not in a position to, and do not, verify the accuracy of, or adopt as their own, the underlying analyses conducted by others that were used to develop the measure-specific information presented in the source documentation, which has been used to initially develop the lower Yuba River habitat enhancement measures. As a preliminary step in the planning process, design criteria have been developed by the Corps and the non-federal sponsor. The design criteria developed to date are intended to characterize habitat features associated with specific measures for the purpose of providing the Corps with a sound basis for project costing to determine if a Federal interest in the project exists, to estimate the costs associated with the ecosystem restoration alternatives being considered as part of the Feasibility Study[5], and to provide the local sponsor an indication of potential future cost-sharing apportionments. It is, therefore, recognized that considerable additional technical and engineering-related analyses will be required prior to the preparation of final design plans for measure-specific components that may be implemented in the future. Prior to any such implementation, various aspects of resource- and site-specific risk assessment, impact assessment and permit compliance will be required to fully address considerations such as structural adequacy, hydraulic functionality, channel alignment and geomorphic implications, flood risk management, and public health and safety.

[5] For additional information, refer to the CE/ICA analysis.

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FIGURES

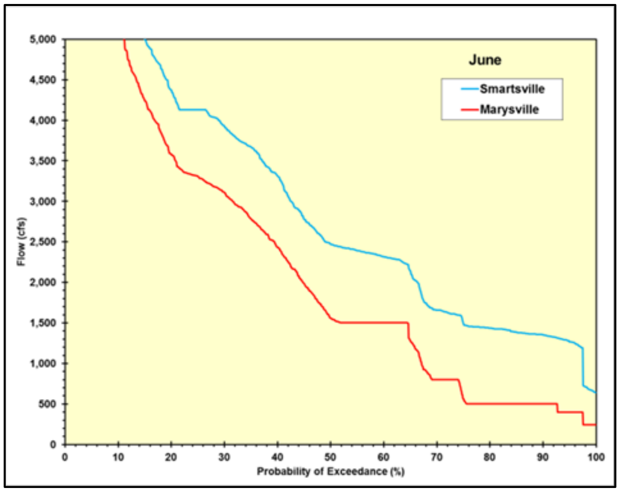


Figure 1. Lower Yuba River monthly flow exceedance during June under the YRDP Relicensing "Base Case" scenario (YCWA 2013).

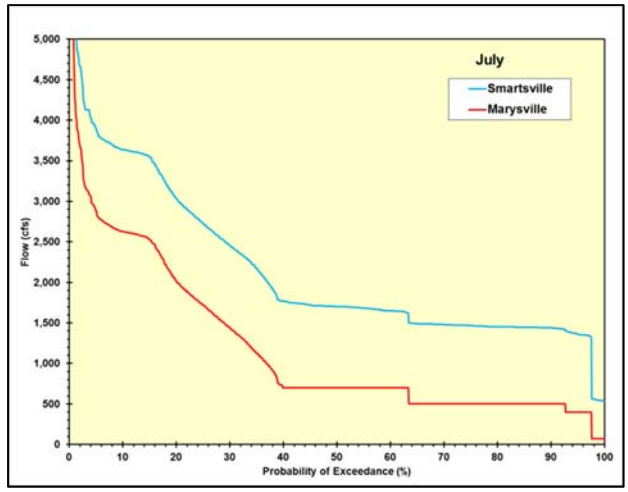


Figure 2. Lower Yuba River monthly flow exceedance during July under the YRDP Relicensing "Base Case" scenario (YCWA 2013).

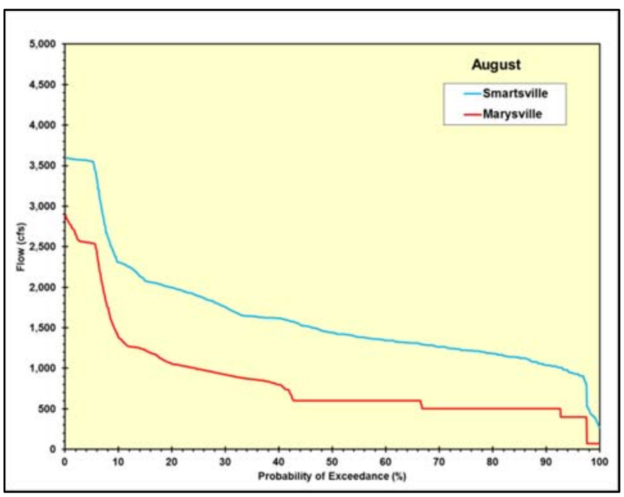


Figure 3. Lower Yuba River monthly flow exceedance during August under the YRDP Relicensing "Base Case" scenario (YCWA 2013).

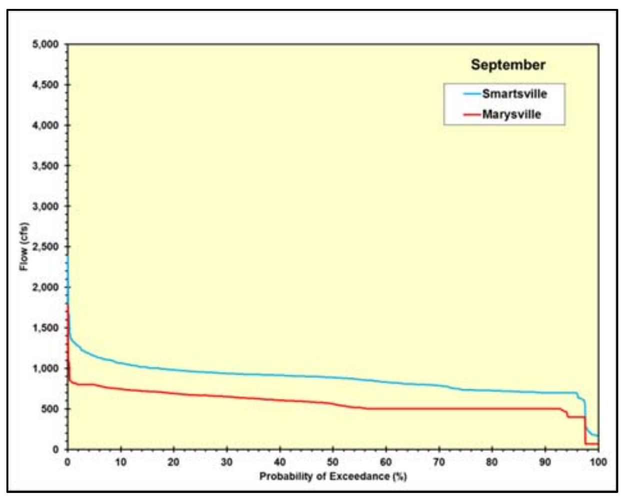


Figure 4. Lower Yuba River monthly flow exceedance during September under the YRDP Relicensing "Base Case" scenario (YCWA 2013).

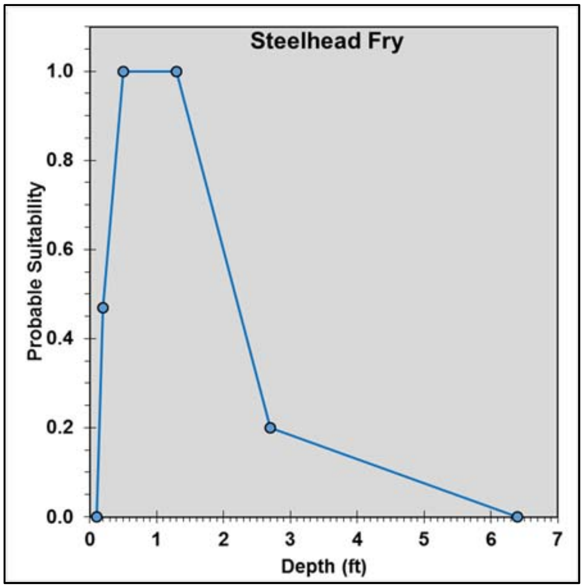


Figure 5. Steelhead fry water depth HSC from YRDP Relicensing (YCWA 2013).

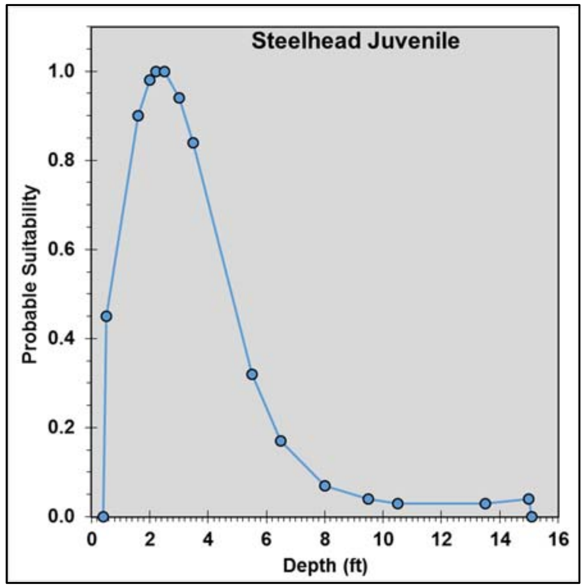


Figure 6. Steelhead juvenile water depth HSC from YRDP Relicensing (YCWA 2013).

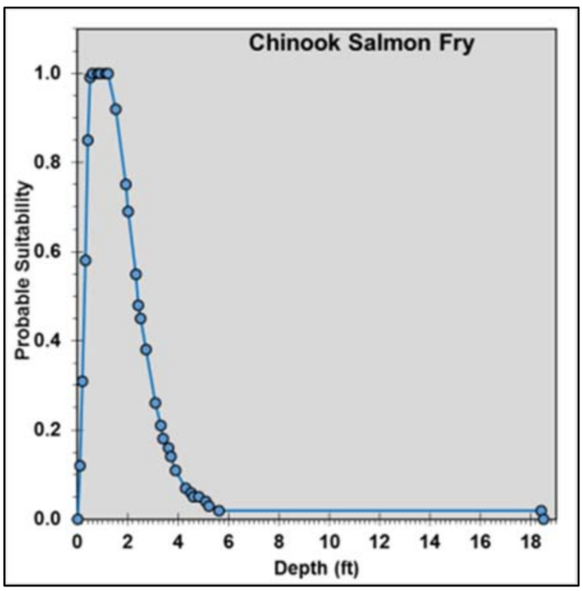


Figure 7.

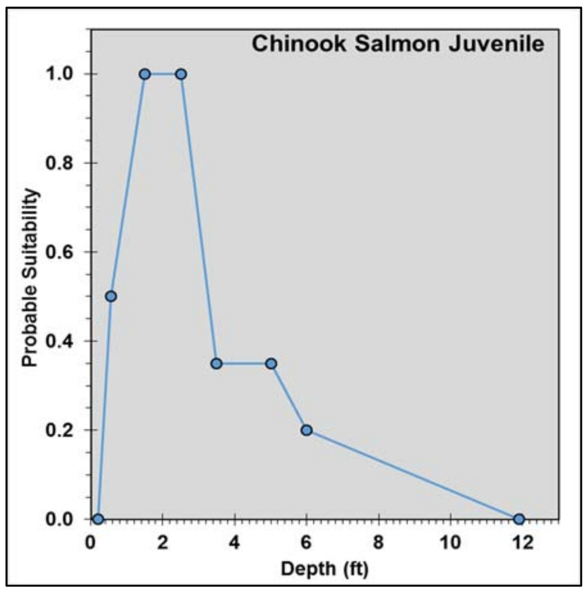


Figure 8. Chinook salmon juvenile water depth HSC from YRDP Relicensing (YCWA 2013).

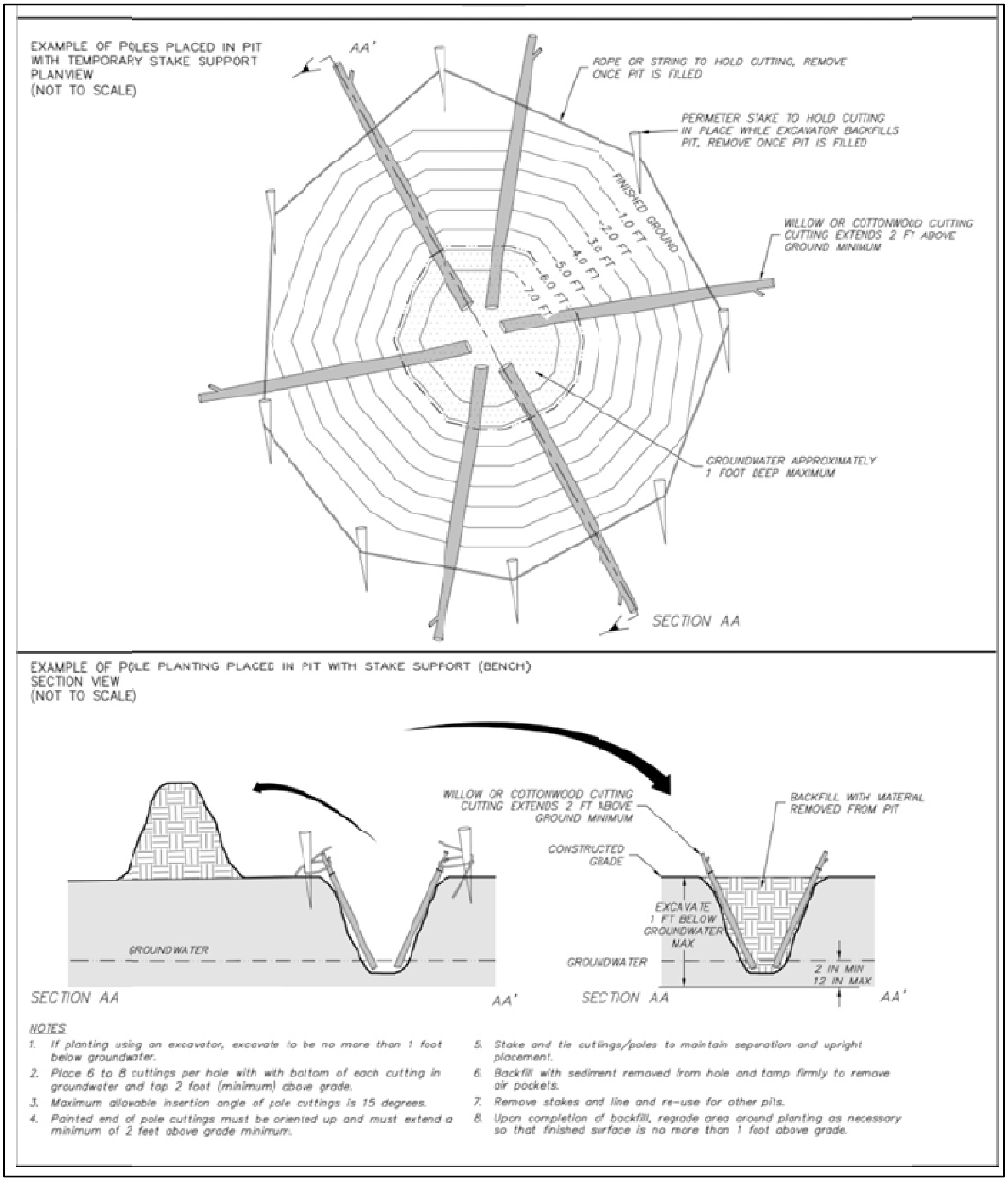


Figure 9. Example of pole planting method (Hoopa Valley Tribe *et al*. 2011).

TTACHMENT CV-B: GIS GENERATED QUANTITIES

Using data from HDR:

1) The original (**All**) Measures Shapefile
2) The Raster LYR LiDAR Bathy Merge UC Davis
3) Depth to Water Table Raster
4) Terrain Modification Raster with HDR Side Channels Surfaces and USACE Lowering/Backwater Surfaces
5) HDR Surfaces and TIN parts for Side Channels

Surfaces/Tin created and mosaicked into existing terrain:

Side Channel Measures: 17, 24, 34, 47, 48, 46, 55

Backwater Area Measures: 18, 21, 51, 52

Floodplain Lowering Measures: 19, 22, 24, 30, 32, 37, 46, 49, 50

Using ArcGIS 10.3.1:

Backwater Measures:

1) Designate Backwater outlines from Base Flow Contour (determine by comparing overlapping edge of Water table Raster and 2015 Aerial Imagery) of River (Inlet) and edge of Measures Polygon. (1ft Contours created from UCdavisLiDARbathyMergeFINAL.tif AKA LYR Raster) Apply Cartographic smoothing of Measures edges to retain more natural alignment with topography.
2) Interpolate Polyline extents to 3d line at LYR Raster base height. This creates a wireframe to be included in a TIN surface.
3) Add to wireframe: Design base contour from inlet to within extents to represent floor of Backwater area at elevation of base inlet Contour and inward to a moderate slope.
4) Edit and match all intersecting 3d vertices and verify in 3D viewer. These are the TIN lines.
5) Convert Polyline to Polygon for inclusion in TIN creation. This is the TIN extent (soft clip).
6) Convert TIN to Raster with 1ft cell size.
7) Backwater raster is mosaicked into the existing LYR raster to 'implement' the measure.
8) This process is repeated for all Backwater measures along the reach.

Floodplain Lowering:

Using Depth_to_Water_Table.tif and UCdavisLiDARbathyMergeFINAL.tif

1) Created Minus Raster (UCdavisLiDARbathyMergeFINAL.tif - Depth_to_Water_Table.tif) to produce @ Water Table Raster.
2) Created Raster Math Int to add 7ft to Water Table Raster (Raster @ 7ft to Table as per Design Criteria). Cut/Fill of UCdavisLiDARbathyMergeFINAL.tif and +7ft Water Table Raster.
3) Reclassify Cut/Fill to delineate Areas already/below 7ft from Water Table to Polygon. This identified 33% of (Amount of) polygons that are 5% of total area already 7ft to the Water Table.
4) Extract Cut value from Cut Fill to new Raster and Polygon Existing7ftToWaterTableCutPoly.
5) Extract by Mask Cut value Raster from 7ft to the Water Table. This creates the bottom surface of the Floodplain Lowering areas that are 7ft to Water Table with almost exactly 5% less area than original Habitat Measures Polygon.
6) Interpolate Poly to UCdavisLiDARbathyMergeFINAL.tif
7) Raster to Point
8) Interpolate Point to +7ft Water Table Raster
9) Remove point a 3 feet from inside edges (For Slope)
10) Remove more inner points where depth to +7ft Water Table Raster is greater
11) Create Tin
12) Convert TIN to Raster with 1ft cell size.
13) Floodplain Lowering raster is mosaicked into the existing LYR raster to 'implement' the measure.
14) This process is repeated for all Floodplain Lowering measures along the reach.

Side Channels:

Completed by HDR

1) Designate channel outlines as the wetted edge of the new surface Feature
2) Criteria define the slope of features to not exceed 1:3 (rise over run)
3) Extend wetted edge boundary into active existing water channel to ensure surface continuity from main channel into side channel
4) Buffer wetted edge 1.5' inside and 15' outside (allows for 0.5' water depth at start and finish of channel)
5) Assign line geometry elevations as follows: interior buffer is assigned an elevation equal to 0.5' lower than the wetted edge of the active channel (at the upstream and downstream ends of the side channel) at 530cfs/700cfs (below and above Daguerre Point Dam respectively) to ensure water depth of

0.5' at those flows. The outer buffer was assigned a value of 5' higher than the active channel water elevation. This establishes a gradient of 1:3 for the channel.

6) Line data examined in 3D viewer to verify the proper wireframe geometry of the channel.
7) Wireframe channel converted to TIN with a linear slope from upstream end to downstream end (extent limited to outer buffer of channel).
8) This channel surface is intersected with the digital surface model (DSM) TIN to establish a boundary describing channel extent that is below the existing surface of the LYR.
9) The channel TIN is converted into a raster (with same cell size, snapped to LYR surface raster) and simultaneously clipped to the intersect boundary established in Step 8.
10) Channel raster is mosaicked into the existing LYR raster to 'implement' the measure.
11) This process is repeated for all side channel measures along the reach.

Volume calculation:

1) Each Measure TIN converted to Raster (DEM)
2) Cut/Fill created for each Measure Raster with UCdavisLiDARbathyMergeFINAL.tif as original Surface
3) Each Cut/Fill exported to Table
4) Volumes calculated in Table
5) Volumes recorded in Civil Design Cost spreadsheet tool.

For other measures (20, 26, 28, 29, 33, 53, and 54) riparian planting area was calculated to determine the benefit. Quantities generated are listed in Table B-1.

TABLE CV-B-1: Increment Quantities

Measure ID	Feature Type	Acres	Volume Cu Ft
	Increment 1		
17	Riparian Planting	4.9	
17	Side Channel	5.8	3892397
18	Backwater Area	6.1	2332690.6
18	Riparian Planting	2.5	
	Increment 2		

19	Floodplain Lowering	8.1	497237.3
19	Riparian Planting	2.5	
20	Bank Scalloping	0.3	
20	Riparian Planting	0.4	
21	Backwater Area	0.3	67198.25047
21	Riparian Planting	0.6	
22	Floodplain Lowering	5.9	330942.4
22	Riparian Planting	5.2	
Increment 3a			
24	Floodplain Lowering	6.2	312326.5
24	Riparian Planting	5.0	
24	Side Channel	0.8	343737
26	Riparian Planting	2.3	
28	Riparian Planting	6.3	
29	Gravel	1.6	
30	Floodplain Lowering	1.6	74862.5
30	Riparian Planting	3.5	
32	Floodplain Lowering	5.2	365324
32	Riparian Planting	11.6	
33	Gravel	1.9	
34	Side Channel	10.5	4696875
Increment 5			
46	Floodplain Lowering	13.0	905713.1
46	Riparian Planting	16.6	
46	Side Channel	10.3	3188033
47	Riparian Planting	4.7	
47	Side Channel	4.8	2058083
48	Side Channel	9.2	3445883

49	Floodplain Lowering	6.9	232159.8
49	Riparian Planting	21.1	
50	Floodplain Lowering	0.8	30440
50	Riparian Planting	3.7	
51	Backwater Area	1.9	231342.7
52	Backwater Area	1.0	129006.8
53	Riparian Planting	2.4	
54	Riparian Planting	2.5	
55	Floodplain Terracing	12.5	3883041.3
55	Riparian Planting	3.5	
55	Side Channel	1.9	6233722

ATTACHMENT CV-C: RIPARIAN PLANTING

<u>Lower Yuba River Habitat Restoration</u>

Overview

Primary goal of riparian restoration is to create Shaded Riverine Aquatic habitat along the Lower Yuba River for listed and endangered species where such vegetation is limited and/or absent. The planting design is intended to promote hardwood structure (i.e., forest and large wood production) while also providing species and structural diversity of a self-perpetuating and sustaining nature. Supporting plates, exhibits, and detailed design will be developed at a later phase of design.

MAINTENANCE & ASSUMPTIONS

Planting

Initial planting density of 1500 plants per acre (PPA) with two plants per stinger planting pit. Assumed 30% die off in following years with 15% plant replacement on maintenance year 2 and 15% plant replacement on maintenance year 3 based off survival rates from Sponsor test planting site. Target total plant survival for establishment year 5 is 65% not counting natural recruitment or force majeure.

Table C-1 Planting Schedule

Scientific Name	Common Name	PPA	Cutting / Container Size	Planting Method
Populus fremontii	Freemont Cottonwood	450	Pole Cutting /Deepot 40	Stinger / Hand Pit
Salix gooddingii	Black Willow	300	Pole Cutting	Stinger
Salix laevigata	Red Willow	250	Pole Cutting	Stinger
Salix lasiolepis	Arroyo Willow	250	Pole Cutting	Stinger
Associate plants	To Be Determined (TBD)	250	Deepot 40	Hand Pit / Auger
Total		1,500		

*With 5 recommended which includes 101 acres of restoration planting

Donor Trees for Plant Material

Donor trees will be selected from existing riparian areas along the lower Yuba River. Multiple cuttings will be taken from red willow and arroyo willow shrubs, but single cuttings will be taken from the other tree species. If red willow donor tree availability becomes limited, Gooding's willow will be substituted.

Cutting Size

Cuttings will be from branches or stems harvested from donor trees, and prepared as cuttings that are about 7 feet in length. Cuttings will be less than 2 inches diameter at the base.

Biotechnical Methods (Brush Mattressing, Brush Layering, & Live Fascines)

Include 7,500LF for biotechnical, 2,500LF of each of the above, work that will be placed on enhanced flood plains and restored islands as a vegetative bank armorement that also functions towards the primary goal of creating desired habitat to promote hardwood structure. Plant material for Biotechnical methods are not included under Table C-1.

ATTACHMENT CV-D: MEASURES GROUPING STRATEGY – ACCESS AND STAGING

Measures were initially grouped geographically using *Yuba River Ecosystem Restoration Feasibility Study: Habitat Measures (October 2016)* by Civil Design based on shared access and staging. The PDT reviewed the initial screening using access and staging of the measures. The initial screening was revised to include temporary bridges as an assumption which allowed no measures to be screened out at that time. Civil Design regrouped measures again, now using temporary bridges, to the following. This is what was provided for quantity costs to Cost Engineering

Table CV-D-1: Access and Staging Assignments

Measure ID	Description	Staging and Access ID	Bridge ID
17	Side channel in Timbuctoo Bend downstream of a potential spring-run Chinook salmon spawning sanctuary area.	1	None
18	Floodplain grading to medial bar near Big Ravine.	2	None
19	Upper Gilt Edge Bar floodplain lowering and riparian planting	3	None
20	Bank scalloping at Upper Gilt Edge Bar	3	None
21	Backwater at Upper Gilt Edge Bar	3	None
22	Floodplain lowering and riparian plating near River Mile 17	3	1
24	Lower Gilt Edge Bar enhancement.	4	None

26	Riparian Planting at Hidden Island.	4	2
28	First Island bank complexity.	4	3
29	Silica Bar channel stabilization and ELJ placement.	5	None
32	Bar A enhancement.	6	None
33	North Silica Bar channel stabilization and ELJ placement.	6	None
34	North Silica Bar side channel (bar opposite of Silica Bar side channel).	6	None
46	Bar C floodplain and backwater enhancement.	9	None
47	Yuba Goldfields Terminus side channel.	9	None
48	Narrow Bar side channel.	10	None
49	Bar D floodplain riparian vegetation planting.	10	none
50	Narrow Bar floodplain lowering, riparian vegetation planting and ELJ placement.	10	None
51	Narrow Bar deep backwater area.	10	None
52	Lower Yuba River backwater area.	10	None
53	Bar E riparian vegetation planting.	11	None

54	Island B riparian vegetation planting.	11	None
55	Large anabranching channel near RM 4 of the lower Yuba River.	11	None

After this analysis measures were further screened out by the PDT and re-grouped again by Planning based on geographic location to define specific areas of measures using access to inform the groupings where necessary and inputted into the CE/ICA in order to determine the cost effectiveness.

Table CV-D-2: Habitat Increment Assignments

Measure ID	Access and Staging ID	Bridge ID
Habitat Increment 1		
17	1	-
18	2	-
Habitat Increment 2		
19	3	-
20	3	-
21	3	-
22	3	1
Habitat Increment 3A		
24	4	-
26	4	2
28	4	3
29	5	-
30	5	-
32	6	-
33	6	-
34	6	-

Habitat Increment 5		
46	9	-
47	9	-
48	10	-
49	10	-
50	10	-
51	10	-
52	10	-
53	11	-
54	11	-
55	11	-

Attachment CE-A. Total Project Cost Summary Sheets

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **Yuba River Ecosystem Restoration**
PROJECT NO: P2 325840
LOCATION: Yuba River Watershed

Habitat Increment 1

DISTRICT: SPK Sacramento District **PREPARED: 9/21/2017**
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2017 Effective Price Level Date: 1 OCT 16						TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	**TOTAL ($K) J**	Spent Thru: **1-Oct-16** ($K)	**TOTAL FIRST COST** ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
06	FISH & WILDLIFE FACILITIES	$12,116	$3,998	33.0%	$16,114	0.0%	$12,116	$3,998	$16,114	$0	$16,114	13.1%	$13,700	$4,521	$18,221
	CONSTRUCTION ESTIMATE TOTALS:	$12,116	$3,998		$16,114	0.0%	$12,116	$3,998	$16,114	$0	$16,114	13.1%	$13,700	$4,521	$18,221
01	LANDS AND DAMAGES	$443	$221	50.0%	$664	0.0%	$443	$221	$664	$0	$664	7.1%	$474	$237	$711
30	PLANNING, ENGINEERING & DESIGN	$1,998	$659	33.0%	$2,657	0.0%	$1,998	$659	$2,657	$0	$2,657	16.2%	$2,323	$766	$3,089
31	CONSTRUCTION MANAGEMENT	$606	$200	33.0%	$806	0.0%	$606	$200	$806	$0	$806	27.1%	$770	$254	$1,025
	PROJECT COST TOTALS:	$15,162	$5,079	33.5%	$20,241		$15,162	$5,079	**$20,241**	$0	**$20,241**	13.9%	$17,267	$5,779	$23,046

ESTIMATED TOTAL PROJECT COST: $23,046

________________ **CHIEF, COST ENGINEERING, Jeremiah Frost**

________________ **PROJECT MANAGER, Chelsea Stewart**

________________ **CHIEF, REAL ESTATE, Diane Simpso**

________________ **CHIEF, PLANNING, Alicia Kirchner**

________________ **CHIEF, ENGINEERING, Rick Poeppelman**

________________ **CHIEF, OPERATIONS, Randy Olson**

________________ **CHIEF, CONSTRUCTION, Dawn Shinsato**

________________ **CHIEF, CONTRACTING, Kim Ford**

________________ **CHIEF, PM-PB, Andrea Homer**

________________ **CHIEF, DPM, Tambour Eller**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Yuba River Ecosystem Restoration
LOCATION: Yuba River Watershed
This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

DISTRICT: SPK Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 9/21/2017

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			18-Sep-17 / 1-Oct-16	Program Year (Budget EC): / Effective Price Level Date:			2017 / 1 OCT 16					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	Habitat Increment 1													
06	FISH & WILDLIFE FACILITIES	$12,116	$3,998	33.0%	$16,114	0.0%	$12,116	$3,998	$16,114	2023Q2	13.1%	$13,700	$4,521	$18,221
	CONSTRUCTION ESTIMATE TOTALS:	$12,116	$3,998	33.0%	**$16,114**		$12,116	$3,998	$16,114			$13,700	$4,521	$18,221
01	LANDS AND DAMAGES	$443	$221	50.0%	$664	0.0%	$443	$221	$664	2020Q3	7.1%	$474	$237	$711
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$303	$100	33.0%	$403	0.0%	$303	$100	$403	2020Q3	13.8%	$345	$114	$459
1.0%	Planning & Environmental Compliance	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2020Q3	13.8%	$138	$45	$183
6.0%	Engineering & Design	$727	$240	33.0%	$967	0.0%	$727	$240	$967	2020Q3	13.8%	$828	$273	$1,101
1.0%	Reviews, ATRs, IEPRs, VE	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2020Q3	13.8%	$138	$45	$183
1.0%	Life Cycle Updates (cost, schedule, risks)	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2020Q3	13.8%	$138	$45	$183
1.0%	Contracting & Reprographics	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2020Q3	13.8%	$138	$45	$183
1.0%	Engineering During Construction	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2023Q2	27.1%	$154	$51	$205
2.0%	Planning During Construction	$242	$80	33.0%	$322	0.0%	$242	$80	$322	2023Q2	27.1%	$308	$102	$409
1.0%	Project Operations	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2020Q3	13.8%	$138	$45	$183
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$485	$160	33.0%	$645	0.0%	$485	$160	$645	2023Q2	27.1%	$617	$203	$820
0.0%	Project Operation:	$0	$0	33.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Management	$121	$40	33.0%	$161	0.0%	$121	$40	$161	2023Q2	27.1%	$154	$51	$205
	CONTRACT COST TOTALS:	$15,162	$5,079		$20,241		$15,162	$5,079	$20,241			$17,267	$5,779	$23,046

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Yuba River Ecosystem Restoration**
PROJECT NO: P2 325840
LOCATION: Yuba River Watershed

Habitat Increments 2, 3a, 5a and 5b

DISTRICT: SPK Sacramento District **PREPARED: 9/21/2017**
POC: CHIEF, COST ENGINEERING, Jeremiah Frost

This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2017 / Effective Price Level Date: 1 OCT 16									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	**TOTAL ($K) J**	Spent Thru: **1-Oct-16** ($K)	**TOTAL FIRST COST** ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
06	FISH & WILDLIFE FACILITIES	$53,594	$17,686	33.0%	$71,279	0.0%	$53,594	$17,686	$71,279	$0	$71,279	13.1%	$60,602	$19,999	$80,600
	CONSTRUCTION ESTIMATE TOTALS:	$53,594	$17,686		$71,279	0.0%	$53,594	$17,686	$71,279	$0	$71,279	13.1%	$60,602	$19,999	$80,600
01	LANDS AND DAMAGES	$1,867	$934	50.0%	$2,801	0.0%	$1,867	$934	$2,801	$0	$2,801	7.1%	$1,999	$1,000	$2,999
30	PLANNING, ENGINEERING & DESIGN	$8,839	$2,917	33.0%	$11,756	0.0%	$8,839	$2,917	$11,756	$0	$11,756	16.3%	$10,276	$3,391	$13,667
31	CONSTRUCTION MANAGEMENT	$2,679	$884	33.0%	$3,563	0.0%	$2,679	$884	$3,563	$0	$3,563	27.1%	$3,405	$1,124	$4,529
	PROJECT COST TOTALS:	$66,979	$22,420	33.5%	$89,399		$66,979	$22,420	**$89,399**	$0	**$89,399**	13.9%	$76,282	$25,513	$101,795

ESTIMATED TOTAL PROJECT COST: $101,795

________________ **CHIEF, COST ENGINEERING, Jeremiah Frost**

________________ **PROJECT MANAGER, Chelsea Stewart**

________________ **CHIEF, REAL ESTATE, Diane Simpsc**

________________ **CHIEF, PLANNING, Alicia Kirchner**

________________ **CHIEF, ENGINEERING, Rick Poeppelman**

________________ **CHIEF, OPERATIONS, Randy Olson**

________________ **CHIEF, CONSTRUCTION, Dawn Shinsato**

________________ **CHIEF, CONTRACTING, Kim Ford**

________________ **CHIEF, PM-PB, Andrea Homer**

________________ **CHIEF, DPM, Tambour Eller**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Yuba River Ecosystem Restoration
LOCATION: Yuba River Watershed
This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

DISTRICT: SPK Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 9/21/2017

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			18-Sep-17 / 1-Oct-16	Program Year (Budget EC): / Effective Price Level Date:			2017 / 1 OCT 16					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	Habitat Increment 2													
06	FISH & WILDLIFE FACILITIES	$5,391	$1,779	33.0%	$7,169	0.0%	$5,391	$1,779	$7,169	2023Q2	13.1%	$6,095	$2,011	$8,107
	CONSTRUCTION ESTIMATE TOTALS:	$5,391	$1,779	33.0%	**$7,169**		$5,391	$1,779	$7,169			$6,095	$2,011	$8,107
01	LANDS AND DAMAGES	$321	$161	50.0%	$482	0.0%	$321	$161	$482	2020Q3	7.1%	$344	$172	$516
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$135	$45	33.0%	$180	0.0%	$135	$45	$180	2020Q3	13.8%	$154	$51	$204
1.0%	Planning & Environmental Compliance	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2020Q3	13.8%	$61	$20	$82
6.0%	Engineering & Design	$323	$107	33.0%	$430	0.0%	$323	$107	$430	2020Q3	13.8%	$368	$121	$489
1.0%	Reviews, ATRs, IEPRs, VE	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2020Q3	13.8%	$61	$20	$82
1.0%	Life Cycle Updates (cost, schedule, risks)	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2020Q3	13.8%	$61	$20	$82
1.0%	Contracting & Reprographics	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2020Q3	13.8%	$61	$20	$82
1.0%	Engineering During Construction	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2023Q2	27.1%	$69	$23	$91
2.0%	Planning During Construction	$108	$36	33.0%	$144	0.0%	$108	$36	$144	2023Q2	27.1%	$137	$45	$183
1.0%	Project Operations	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2020Q3	13.8%	$61	$20	$82
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$216	$71	33.0%	$287	0.0%	$216	$71	$287	2023Q2	27.1%	$275	$91	$365
0.0%	Project Operation:	$0	$0	33.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Management	$54	$18	33.0%	$72	0.0%	$54	$18	$72	2023Q2	27.1%	$69	$23	$91
	CONTRACT COST TOTALS:	$6,872	$2,322		$9,194		$6,872	$2,322	$9,194			$7,817	$2,638	$10,455

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Yuba River Ecosystem Restoration
LOCATION: Yuba River Watershed
This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

DISTRICT: SPK Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 9/21/2017

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: / Effective Price Level:			**18-Sep-17** / 1-Oct-16	Program Year (Budget EC): / Effective Price Level Date:			2017 / 1 OCT 16					
WBS NUMBER *A*		Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
		Habitat Increment 3a													
06		FISH & WILDLIFE FACILITIES	$18,848	$6,220	33.0%	$25,068	0.0%	$18,848	$6,220	$25,068	2023Q2	13.1%	$21,313	$7,033	$28,346
		CONSTRUCTION ESTIMATE TOTALS:	$18,848	$6,220	33.0%	**$25,068**		$18,848	$6,220	$25,068			$21,313	$7,033	$28,346
01		LANDS AND DAMAGES	$771	$386	50.0%	$1,157	0.0%	$771	$386	$1,157	2020Q3	7.1%	$826	$413	$1,239
30		PLANNING, ENGINEERING & DESIGN													
	2.5%	Project Management	$471	$155	33.0%	$626	0.0%	$471	$155	$626	2020Q3	13.8%	$536	$177	$713
	1.0%	Planning & Environmental Compliance	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2020Q3	13.8%	$214	$71	$285
	6.0%	Engineering & Design	$1,131	$373	33.0%	$1,504	0.0%	$1,131	$373	$1,504	2020Q3	13.8%	$1,287	$425	$1,712
	1.0%	Reviews, ATRs, IEPRs, VE	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2020Q3	13.8%	$214	$71	$285
	1.0%	Life Cycle Updates (cost, schedule, risks)	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2020Q3	13.8%	$214	$71	$285
	1.0%	Contracting & Reprographics	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2020Q3	13.8%	$214	$71	$285
	1.0%	Engineering During Construction	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2023Q2	27.1%	$239	$79	$318
	2.0%	Planning During Construction	$377	$124	33.0%	$501	0.0%	$377	$124	$501	2023Q2	27.1%	$479	$158	$637
	1.0%	Project Operations	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2020Q3	13.8%	$214	$71	$285
31		CONSTRUCTION MANAGEMENT													
	4.0%	Construction Management	$754	$249	33.0%	$1,003	0.0%	$754	$249	$1,003	2023Q2	27.1%	$958	$316	$1,275
	0.0%	Project Operation:	$0	$0	33.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	1.0%	Project Management	$188	$62	33.0%	$250	0.0%	$188	$62	$250	2023Q2	27.1%	$239	$79	$318
		CONTRACT COST TOTALS:	$23,669	$7,942		$31,610		$23,669	$7,942	$31,610			$26,948	$9,033	$35,982

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Yuba River Ecosystem Restoration
LOCATION: Yuba River Watershed
This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

DISTRICT: SPK Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 9/21/2017

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
		Estimate Prepared: Effective Price Level:			**18-Sep-17** 1-Oct-16	Program Year (Budget EC): Effective Price Level Date:			2017 1 OCT 16					
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	Habitat Increment 5a													
06	FISH & WILDLIFE FACILITIES	$15,028	$4,959	33.0%	$19,987	0.0%	$15,028	$4,959	$19,987	2023Q2	13.1%	$16,993	$5,608	$22,601
	CONSTRUCTION ESTIMATE TOTALS:	$15,028	$4,959	33.0%	**$19,987**		$15,028	$4,959	$19,987			$16,993	$5,608	$22,601
01	LANDS AND DAMAGES	$469	$235	50.0%	$704	0.0%	$469	$235	$704	2020Q3	7.1%	$502	$251	$754
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$376	$124	33.0%	$500	0.0%	$376	$124	$500	2020Q3	13.8%	$428	$141	$569
1.0%	Planning & Environmental Compliance	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2020Q3	13.8%	$171	$56	$227
6.0%	Engineering & Design	$902	$298	33.0%	$1,200	0.0%	$902	$298	$1,200	2020Q3	13.8%	$1,027	$339	$1,366
1.0%	Reviews, ATRs, IEPRs, VE	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2020Q3	13.8%	$171	$56	$227
1.0%	Life Cycle Updates (cost, schedule, risks)	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2020Q3	13.8%	$171	$56	$227
1.0%	Contracting & Reprographics	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2020Q3	13.8%	$171	$56	$227
1.0%	Engineering During Construction	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2023Q2	27.1%	$191	$63	$254
2.0%	Planning During Construction	$301	$99	33.0%	$400	0.0%	$301	$99	$400	2023Q2	27.1%	$383	$126	$509
1.0%	Project Operations	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2020Q3	13.8%	$171	$56	$227
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$601	$198	33.0%	$799	0.0%	$601	$198	$799	2023Q2	27.1%	$764	$252	$1,016
0.0%	Project Operation:	$0	$0	33.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Management	$150	$50	33.0%	$200	0.0%	$150	$50	$200	2023Q2	27.1%	$191	$63	$254
	CONTRACT COST TOTALS:	$18,727	$6,260		**$24,987**		$18,727	$6,260	$24,987			$21,332	$7,125	**$28,457**

Filename: TCPS Yuba Habitat Increments 2, 3a, 5a and 5b.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

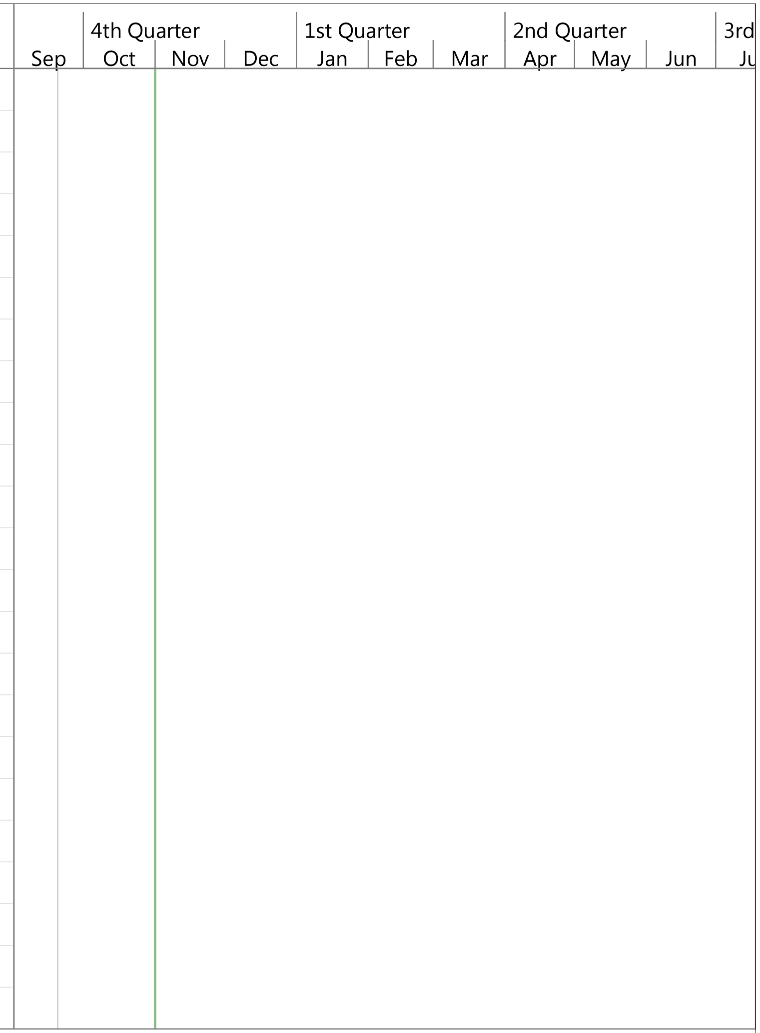
PROJECT: Yuba River Ecosystem Restoration
LOCATION: Yuba River Watershed
This Estimate reflects the scope and schedule in report; Yuba River Ecosystem Restoration - Increment Descriptions

DISTRICT: SPK Sacramento District
POC: CHIEF, COST ENGINEERING, Jeremiah Frost
PREPARED: 9/21/2017

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: Effective Price Level:			18-Sep-17 1-Oct-16	Program Year (Budget EC): Effective Price Level Date:			2017 1 OCT 16	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		Habitat Increment 5b													
06		FISH & WILDLIFE FACILITIES	$14,327	$4,728	33.0%	$19,055	0.0%	$14,327	$4,728	$19,055	2023Q2	13.1%	$16,201	$5,346	$21,547
		CONSTRUCTION ESTIMATE TOTALS:	$14,327	$4,728	33.0%	**$19,055**		$14,327	$4,728	$19,055			$16,201	$5,346	$21,547
01		LANDS AND DAMAGES	$305	$153	50.0%	$458	0.0%	$305	$153	$458	2020Q3	7.1%	$327	$164	$491
30		PLANNING, ENGINEERING & DESIGN													
	2.5%	Project Management	$358	$118	33.0%	$476	0.0%	$358	$118	$476	2020Q3	13.8%	$408	$134	$542
	1.0%	Planning & Environmental Compliance	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2020Q3	13.8%	$163	$54	$217
	6.0%	Engineering & Design	$860	$284	33.0%	$1,144	0.0%	$860	$284	$1,144	2020Q3	13.8%	$979	$323	$1,302
	1.0%	Reviews, ATRs, IEPRs, VE	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2020Q3	13.8%	$163	$54	$217
	1.0%	Life Cycle Updates (cost, schedule, risks)	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2020Q3	13.8%	$163	$54	$217
	1.0%	Contracting & Reprographics	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2020Q3	13.8%	$163	$54	$217
	1.0%	Engineering During Construction	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2023Q2	27.1%	$182	$60	$242
	2.0%	Planning During Construction	$287	$95	33.0%	$382	0.0%	$287	$95	$382	2023Q2	27.1%	$365	$120	$485
	1.0%	Project Operations	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2020Q3	13.8%	$163	$54	$217
31		CONSTRUCTION MANAGEMENT													
	4.0%	Construction Management	$573	$189	33.0%	$762	0.0%	$573	$189	$762	2023Q2	27.1%	$728	$240	$969
	0.0%	Project Operation:	$0	$0	33.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	1.0%	Project Management	$143	$47	33.0%	$190	0.0%	$143	$47	$190	2023Q2	27.1%	$182	$60	$242
		CONTRACT COST TOTALS:	$17,711	$5,897		**$23,608**		$17,711	$5,897	$23,608			$20,185	$6,717	**$26,901**

Attachment CE-B. Project Schedule for Construction

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Construction Year 1**	**152 days**	**Mon 5/3/21**	**Tue 11/30/21**
2		**Boulders and LWM**	**109 days**	**Mon 5/3/21**	**Thu 9/30/21**
3		Staging (Boulder/Large Wo	22 days	Mon 5/3/21	Tue 6/1/21
4		Placement of Boulders and	87 days	Wed 6/2/21	Thu 9/30/21
5		**Excavation**	**109 days**	**Mon 5/3/21**	**Thu 9/30/21**
6		Staging (Excavation)	21 days	Mon 5/3/21	Mon 5/31/21
7		Excavation (in-water work)	88 days	Tue 6/1/21	Thu 9/30/21
8		**Plantings**	**65 days**	**Wed 9/1/21**	**Tue 11/30/21**
9		Scout and Mark Trees	22 days	Wed 9/1/21	Thu 9/30/21
10		Harvest an Transport Trees	43 days	Fri 10/1/21	Tue 11/30/21
11		Stinger Site, Install Planting	43 days	Fri 10/1/21	Tue 11/30/21
12		**Construction Year 2**	**152 days**	**Tue 5/3/22**	**Wed 11/30/22**
13		**Boulders and LWM**	**109 days**	**Tue 5/3/22**	**Fri 9/30/22**
14		Staging (Boulder/Large Wo	22 days	Tue 5/3/22	Wed 6/1/22
15		Placement of Boulders and	87 days	Thu 6/2/22	Fri 9/30/22
16		**Excavation**	**109 days**	**Tue 5/3/22**	**Fri 9/30/22**
17		Staging (Excavation)	21 days	Tue 5/3/22	Tue 5/31/22
18		Excavation (in-water work)	88 days	Wed 6/1/22	Fri 9/30/22
19		**Plantings**	**65 days**	**Thu 9/1/22**	**Wed 11/30/22**
20		Scout and Mark Trees	22 days	Thu 9/1/22	Fri 9/30/22
21		Harvest an Transport Trees	43 days	Mon 10/3/22	Wed 11/30/22
22		Stinger Site, Install Planting	43 days	Mon 10/3/22	Wed 11/30/22
23					



Project: Project1
Date: Wed 11/1/17

Task	Inactive Summary	External Tasks	
Split	Manual Task	External Milestone	
Milestone	Duration-only	Deadline	
Summary	Manual Summary Rollup	Progress	
Project Summary	Manual Summary	Manual Progress	
Inactive Task	Start-only		
Inactive Milestone	Finish-only		

ID		Task Mode	Task Name	Duration	Start	Finish
24			**Construction Year 3**	**152 days**	**Wed 5/3/23**	**Thu 11/30/23**
25			**Boulders and LWM**	**109 days**	**Wed 5/3/23**	**Mon 10/2/23**
26			Staging (Boulder/Large Wo	22 days	Wed 5/3/23	Thu 6/1/23
27			Placement of Boulders and	87 days	Fri 6/2/23	Mon 10/2/23
28			**Excavation**	**109 days**	**Wed 5/3/23**	**Mon 10/2/23**
29			Staging (Excavation)	21 days	Wed 5/3/23	Wed 5/31/23
30			Excavation (in-water work)	88 days	Thu 6/1/23	Mon 10/2/23
31			**Plantings**	**65 days**	**Fri 9/1/23**	**Thu 11/30/23**
32			Scout and Mark Trees	22 days	Fri 9/1/23	Mon 10/2/23
33			Harvest an Transport Trees	43 days	Tue 10/3/23	Thu 11/30/23
34			Stinger Site, Install Planting	43 days	Tue 10/3/23	Thu 11/30/23
35			**Construction Year 4**	**152 days**	**Fri 5/3/24**	**Mon 12/2/24**
36			**Boulders and LWM**	**109 days**	**Fri 5/3/24**	**Wed 10/2/24**
37			Staging (Boulder/Large Wo	22 days	Fri 5/3/24	Mon 6/3/24
38			Placement of Boulders and	87 days	Tue 6/4/24	Wed 10/2/24
39			**Excavation**	**109 days**	**Fri 5/3/24**	**Wed 10/2/24**
40			Staging (Excavation)	21 days	Fri 5/3/24	Fri 5/31/24
41			Excavation (in-water work)	88 days	Mon 6/3/24	Wed 10/2/24
42			**Plantings**	**152 days**	**Fri 5/3/24**	**Mon 12/2/24**
43			Scout and Mark Trees	22 days	Fri 5/3/24	Mon 6/3/24
44			Harvest an Transport Trees	43 days	Thu 10/3/24	Mon 12/2/24
45			Stinger Site, Install Planting	43 days	Thu 10/3/24	Mon 12/2/24

4th Quarter | 1st Quarter | 2nd Quarter | 3rd
Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Ju

Project: Project1
Date: Wed 11/1/17

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

Attachment ENV-A. Environmental Site Assessment Phase 1

ENVIRONMENTAL SITE ASSESSMENT

YUBA RIVER ECOSYSTEM RESTORATION
YUBA RIVER, CALIFORNIA

Prepared By:

Bruce Van Etten, Senior Engineering Technician
Environmental Design Section
U.S. Army Corps of Engineers, Sacramento District

US Army Corps
of Engineers ®

Approved By: Date:

15 December 2017

Chris Goddard, PE
Section Chief, Environmental Design Section
U.S. Army Corps of Engineers, Sacramento District

TABLE OF CONTENTS

ACRONYMS

AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
CESPK	US Army Corps of Engineers, Sacramento District
DTSC	Department of Toxic Substance Control
EDR	Environmental Data Resources Inc.
ESA	Environmental Site Assessment
HTRW	Hazardous, Toxic, and Radioactive Waste
RCRA	Resource Conservation and Recovery Act
USEPA	US Environmental Protection Agency
UST	Underground Storage Tank

1.0 EXECUTIVE SUMMARY

The methodology of ASTM 1527-13 is used to conduct an Environmental Site Assessment (ESA) to identify Recognized Environmental Conditions in order to establish the presence or likely presence of hazardous substances or petroleum products under conditions that indicate a likely release, a past release, or a material threat of a release of those substances. This practice permits the user to qualify for the innocent landowner, contiguous property owner, or bona fide prospective purchaser limitations on Comprehensive Environmental Response, Compensation, and Liability Act liability. The ESA also provides background information for National Environmental Policy Act (NEPA) documents and can be included in the appendix of NEPA documents or included by reference.

In October 2017, USACE performed an ESA for the Yuba River Ecosystem Restoration project, in accordance with ASTM 1527-05. The ESA consisted of reviewing regulatory databases of Hazardous and Toxic Waste (HTW) sites, historical literature, and conducting interviews with people who are knowledgeable about the project site and the surrounding area. A site reconnaissance was also conducted as part of the ESA process.

The study area for this ESA of the Yuba River Ecosystem Restoration included approximately 20 miles upstream of Marysville. The project has an upstream boundary approximately 2 miles downstream of Englebright Dam and a downstream boundary at the confluence of the Yuba River and the Feather Rivers. The study area for this project included ¼ mile both north and south of the river although the project will only be +/- 200 feet from the river's edge.

Work will consist of channel alignment to be restored to inundate at 3,000 cfs and function as swale habitat. The side channel and adjacent floodplain would be lowered and graded. Additionally, riparian vegetation would be planted on each side of the restored swale/side channel. Engineered log jams would be placed in a patchwork configuration at the inflow of the swale. In addition, large woody material would be placed in the backwater area to increase structural and habitat complexity in the area.

The ESA contained herein was conducted in accordance with ASTM E1527-13 and ER1165-2-132. Although below EPA levels Mercury is a Recognized Environmental Condition identified at the project site during completion of this report. Appropriate caution should be taken during any excavating.

2.0 INTRODUCTION

2.1 *PURPOSE*

The Environmental Design Section (ED-ED) of the Environmental Engineering Branch of the USACE in Sacramento, California, has prepared this report for the Yuba River Ecosystem Restoration project.

The National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA) and USACE regulations require that an Environmental Site Assessment (ESA) be performed for this project site and its surrounding area. The purpose of the ESA is to identify and document Recognized Environmental Conditions that may have adverse impacts on the proposed project. ASTM 1527-13 defines Recognized Environmental Conditions as "...the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of future release to the environment."

In October 2017, USACE performed an ESA for the Yuba River Ecosystem Restoration project, in accordance with ASTM 1527-05. The ESA consisted of reviewing regulatory lists of Hazardous and Toxic Waste (HTW) sites, historical literature, and conducting interviews with people who are knowledgeable about the project site and the surrounding area. A site reconnaissance was also conducted as part of the ESA process.

2.2 *DETAILED SCOPE-OF-SERVICES*

The Yuba River Watershed encompasses 1,340 square miles on the western slopes of the Sierra Nevada Mountain Range, and is located in portions of Sierra, Placer, Yuba, and Nevada counties. The Yuba River is a tributary of the Feather River which, in turn, flows into the Sacramento River near the town of Verona, California.

The Yuba River flows through forest, foothill chaparral, and agricultural lands. Levees are absent for most of its course except for near the river's confluence with the Feather River. At that point, the Yuba River is bounded by setback levees for approximately six miles.

The study area for this part of the Yuba River Ecosystem Restoration included approximately 20 miles upstream of Marysville. The project has an upstream boundary approximately 2 miles downstream of Englebright Dam and a downstream boundary at the confluence of the Yuba River and the Feather Rivers. The study area for this project included ¼ mile both north and south of the river although the work for this project will only be the river and +/- 200 feet on either side of the river's edge.

Work will consist of channel alignment to be restored to inundate at 3,000 cfs and function as swale habitat. The side channel and adjacent floodplain would be lowered and graded. Additionally, riparian vegetation would be planted on each side of the restored swale/side channel. Engineered log jams would be placed in a patchwork configuration at the inflow of the swale. In addition, large woody material would be placed in the backwater area to increase structural and habitat complexity in the area.

The ESA is concerned with identifying and documenting Recognized Environmental Conditions as defined by ASTM 1527-13 on this site and the adjacent properties using commonly known and reasonably ascertainable information, such as historical records and regulatory databases.

2.3 *SIGNIFICANT ASSUMPTIONS*

There are no assumed conditions as defined by ASTM 1527-13 that would be considered a Recognized Environmental Condition.

2.4 *LIMITATIONS AND EXCEPTIONS*

The ESA does not include any sampling or testing of soil, air, water or building materials. The interiors of buildings and structures were not inspected.

2.5 *SPECIAL TERMS AND CONDITIONS*

The project site does not involve purchase of the property for commercial purposes, subsurface investigation or any construction, and as such, the conditions for the ASTM specifications are not completely applicable. Where applicable, the format and guidance recommended by ASTM is followed as stated in standard ASTM 1527-13.

3.0 SITE DESCRIPTION

3.1 *LOCATION AND LEGAL DESCRIPTION*

The ESA site has an upstream boundary approximately 2 miles downstream of Englebright Dam and a downstream boundary at the confluence of the Yuba River and the Feather Rivers.

The Lower Yuba River flows from the dam at Englebright Lake to its confluence with the Feather River, just south of Marysville. It begins the journey in a rocky basin paralleled by steep canyon walls, a deep gorge otherwise known as the Narrows. The Yuba River continues, winding its way west, down through canyons and over gravel beds until the landscape begins to flatten out just above the Parks Bar Bridge (Highway 20). From here, the river parallels the highway for the next 20 miles or so as it makes its way to the Feather. About seven miles below the bridge stands the Daguerre Point Dam. Built in the early 1900’s to prevent hydraulic mining debris from washing into the Feather River, it now acts as an obstacle to boats and fish alike.

Hammonton Road on the south side of the river, previously a private road maintained by an aggregate company, has been opened recently to public access as a result of a lawsuit. However, lack of maintenance makes the road difficult to use.

3.2 *SITE AND VICINITY GENERAL CHARACTERISTICS*

The study area has been heavily impacted by past hydraulic mining. Extensive hydraulic mining occurred in the Yuba River watershed from 1852 until the enactment of the Caminetti Act 1893 that severely limited its use. In hydraulic mining, water cannons shot high-pressure flows out to wash away hillsides. The material that was dislodged was then sluiced to expose the gold. It is estimated that during the years1849-1909, 684 million cubic yards of gravel and debris due to hydraulic mining were washed into the Yuba River system. The quantity of material washed in the river due to mining has been variously estimated, but it seems safe to say that there are now upwards of 333,000,000 cubic yards in the bed of the lower Yuba River. This debris field is still mined for residual gold deposits and gravel. Hydraulic mining in the Yuba River accounted for 40 percent of all the mining debris that washed into the Central Valley

Hydraulic mining resulted in torrents of sediment being transported downslope to the valley and caused flooding along Central Valley Rivers, including the lower Yuba River. Two major debris dams (i.e., Daguerre Point Dam in 1906 and Englebright Dam in 1941) were constructed on the Yuba River to prevent the continued movement of sediment into the Feather and Sacramento rivers, and ultimately the San Francisco Bay-Delta.

The Yuba Goldfields, located from approximately 8 to 16 miles upstream of Marysville, are dominated by approximately 20,000 acres of dredge tailings that were reworked from hydraulic mine waste. Dredging of gold from the hydraulic waste in the Goldfields began in 1902, and by 1910, 15 dredges were operating in the lower Yuba River. The area has been dredged and re-dredged intermittently throughout the years, and dredging continues today for spatial and temporal changes in the area.

Along with harmful effects downstream due to hydraulic mining, mercury was used to process gold deposits. According to the US Geological Survey, hundreds of pounds of liquid mercury were added to the typical sluice box for gold extraction.

Based on Yuba River Ecosystem Restoration Feasibility Study (dated 10/17/2017), much of this left over mercury is contained in sediment held behind the debris dams. The most concerning contaminant is mercury because large amounts were introduced into the watershed from the hydraulic mining process. However, cost risks of dealing with potential mercury are low for restoration measures. This is because the real danger of mercury contamination is the potential for methylation, which is the process that makes mercury bio-available in the environment. Materials that would be excavated for Lower Yuba River Habitat Restoration are coarser, thus trapping less mercury, and permeable and therefore likely already stripped of mercury contaminants.

Although most of the mercury is not biologically available, enough has methylated in Englebright Lake that it is bioaccumulating in the larger predatory fish. Mercury levels in the larger predatory fish are high enough that the California Office of Environmental Health Hazard Assessment issued a safe-eating advisory for Englebright Lake.

3.3 *CURRENT USE OF THE PROPERTY*

Currently, public river access is limited to just a few points: the Highway 20 Bridge at Parks Bar, Hammon Grove Park, Hallwood Boulevard, and the Highway 70 Bridge in Marysville. Motorized boats, except for research purposes, are not allowed above Daguerre Point Dam. The entire river is open to non-motorized boats. Private fishing membership clubs also have river access through the private lands along the river that they own or lease.

The Yuba River Ecosystem Restoration project site is used primarily for recreation. This river is a tail water fishery that provides year round cold water and supports a healthy population of wild steelhead and king salmon at times but the resident wild rainbows are the most sought after species throughout the year.

3.4 *DESCRIPTIONS OF STRUCTURES, ROADS, OTHER IMPROVEMENTS ON THE SITE*

The site contains scrub oak trees and natural grasses. The only evidence of any construction or man-made fixtures are:

Daguerre Point Dam. Daguerre Point Dam is located on the Lower Yuba River approximately 11.5 miles upstream of Marysville. The dam is 25 feet high and has two fish ladders. The CDC recommended the dam to prevent hydraulic mining debris from washing into navigable waters of the Sacramento and Feather Rivers. Congress authorized the dam's construction in the 1902 Rivers and Harbors Act (P.L. 57-154). The dam was built by the CDC in May of 1906 and the river was diverted over the dam in 1910. Daguerre Point Dam was rebuilt in 1965 after it was damaged and breached by floods in 1963 and 1964. The area behind the dam is filled with approximately 4 million cubic yards of sediment that has accumulated since it was rebuilt. The dam also provides hydraulic head for three non-federal water diversions. The Water Resources Development Act of 1986 eliminated the CDC and transferred Daguerre Point Dam to USACE.

Hammonton, CA. Hammonton was a company owned mining town located 10 miles east of Marysville, California. It's founding was a direct result of the gold rush of 1849 and the subsequent hydraulic mining that followed. It is a major dredge field that extends along the river about eight miles. It also is known as the Yuba River district. Bucket-line dredging began in the district in 1903 under the direction of W. P. Hammon. In 1905 his interests were taken over by Yuba Consolidated Gold Fields, which had just been organized. This concern perfected large-scale bucket-line dredging here into one of the most efficient methods for mining placer gold. Yuba Dredge No. 20 was one of the largest gold dredges in existence. The district was dredged almost continuously from 1903 to 1968 and was the principal source of gold in California for some time. The estimated total output from dredging was estimated in 1964 at 4.8 million ounces.

Operations have been gradually curtailed by 1967 only two dredges were operating. On October 1, 1968 the last dredge was shut down, thus ending a major industry that had existed for nearly 70 years. More than a billion cubic yards of gold-bearing gravels were dredged. The extensive piles of gravel have become increasingly important as sources of aggregate.

The town of Hammonton, which once housed over 1,800 at one time, is now deserted. A few structures, foundations and a water tower are all that remain.

3.5 *CURRENT USES OF THE ADJOINING PROPERTIES*

Public river access is currently limited to just a few points: the Highway 20 Bridge at Parks Bar, Hammon Grove Park, Hallwood Boulevard, and the Highway 70 Bridge in Marysville. Motorized boats, except for research purposes, are not allowed above Daguerre Point Dam. The entire river is open to non-motorized boats. Private fishing membership clubs also have river access through the private lands along the river that they own or lease.

The Goldfields are the subject of an ongoing dispute as to land title and access. Much of the land is owned by Western Aggregate, a mining company extracting gravel from the Goldfields. The remainder of the land is split between small private owners, the Bureau of Land Management, and the United States Army Corps of Engineers. The BLM land is free for the public to use for recreational purposes, but much of it is actually unreachable. Some of it can be accessed via boats on the river, but other access roads have been closed off by Western Aggregate. The parcel of land owned by the Army Corps of Engineers is technically public land, but it is also inaccessible and it is closed for recreation. Western Aggregate owns mining rights over much (but not all) of that property as a result of a purchase from a gold mining company in 1987 by its parent company Centex Construction, based in Texas. The Goldfields is the largest aggregate mine in the State of California, as well as one of only two dredge gold-mining operations in North America (as of 1989).

Besides a few scattered private residences there are three major quarries along the project site:

1. Parks Bar Quarry on the north side of the river at the Yuba River Bridge.

2. Western Aggregates on the north side of the river is a manufacturer and distributor of concrete and aggregates.

3. Teichert Materials' Hallwood Plant is located near the town of Marysville in northern California. It mines aggregate in the Yuba Goldfields along the banks of the Yuba River, producing crushed stone, sand, and gravel.

4.0 USER PROVIDED INFORMATION

4.1 *TITLE RECORDS*

Title records were not obtained as they were not required to develop a history of the previous uses of the site, per ASTM 1527-13.

4.2 *ENVIRONMENTAL LIENS OR ACTIVITY AND USE LIMITATIONS*

There are no environmental liens or activity and no use limitations for this project property. The records used to ascertain this information include: the National Priority List, Federal Superfund Liens, Federal Institutional Controls/Engineering Controls Registries, State and Tribal Equivalent NPL - State Response Sites, State and Tribal Registered Storage Tank Lists – Active UST Facilities, Aboveground Petroleum Storage Tank Facilities and USTs on Indian Land, US Clandestine Drug Labs, CERCLA Lien Information, Land Use Control Information System, Environmental Liens Listing, Military Cleanup Sites Listing, Department of Defense Sites, and Formerly Used Defense Sites.

4.3 *REASON FOR PERFORMING PHASE I*

The use of ASTM 1527-13 is to identify Recognized Environmental Conditions in order to establish the presence or likely presence of hazardous substances or petroleum products under conditions that indicate a likely release, a past release or a material threat of a release of those substances. This practice permits the user to qualify for the innocent landowner, contiguous property owner, or bona fide prospective purchaser limitations on CERCLA liability.

4.4 *OTHER*

This ESA will follow the environmental industry practice of using the guidelines set forth in the USEPA rule concerning “All Appropriate Inquiries,” the ASTM E 1527-13 standard, and USACE Engineering Regulation (ER) 1162-2-132. ASTM E 1527-13 was designed to protect persons purchasing property from liability arising from adverse environmental conditions, but also may be used for other situations per section 4.2.1 of the standard.

5.0 RECORDS REVIEW

5.1 *STANDARD ENVIRONMENTAL RECORD SOURCES*

A records review was ordered October 2017; this EDR report is included in Section 12.4. The sites found in the standard records review are investigated using publicly available information. The EDR report includes additional environmental records (see map and detailed information in section 12.4). A review of these records includes the following findings, none of which presented Recognized Environmental Conditions within the project site, therefore the data is given for information only:

1. Nine sites listed on the MINES site, which list mine site locations
2. One RCRA small quantity generator
3. One RCRA large quantity generator
4. Seven historical UST's
5. Ten sites listed under the county's CUPA site which consolidates the administration, permits, inspections, and enforcement activities.
6. Eight listed AST's

5.2 *HISTORICAL USE INFORMATION ON THE PROPERTY AND ADJOINING PROPERTIES*

ASTM E 1527-13 requires that an ESA consist of diligently conducting a reasonable search of all available information, performing a site reconnaissance, and interviewing people who are knowledgeable about the current and past uses of the project site and surrounding area, its waste disposal practices, and its environmental compliance history.

Specifically, the current search consisted of information from the following sources:

a. A reconnaissance of the entire project was performed to fulfill the requirements of ASTM E 1527-13 on April 6, 2017. Photographs of significant or typical observations were made to document the reconnaissance and to provide additional visual information. These photographs are included in Section 12.3. This site reconnaissance revealed no Recognized Environmental Conditions.

b. A search of the available records as provided by the EDR Corridor Study with GeoCheck®" dated October 2017, is included as Section 12.4.

c. Interviews of appropriate personnel that might have knowledge of recognized environmental conditions were conducted.

6.0 SITE RECONNAISSANCE

6.1 *METHODOLOGY AND LIMITING CONDITIONS*

The extent of the October 2017 site reconnaissance by Bruce Van Etten of Environmental Design Section was conducted based on previously available information. The site reconnaissance involved walking or driving the entire project boundaries of the Yuba River on both the north and south sides. Photographs taken during the site visit are located in Section 12.3.

6.2 *GENERAL SITE SETTING*

The study area for this part of the Yuba River Ecosystem Restoration included approximately 20 miles upstream of Marysville. The project has an upstream boundary approximately 2 miles downstream of Englebright Dam and a downstream boundary at the confluence of the Yuba River and the Feather Rivers. The study area for this project included ¼ mile both north and south of the river although the work for this project will only be in the river and +/- 200 feet on either side of the river's edge.

7.0 INTERVIEWS

The purpose of conducting interviews is to obtain up-to-date information and confirm known information about Recognized Environmental Conditions in connection with the site. During the ESA, only two persons who are knowledgeable about the past and present history of the project site and its surrounding area were interviewed. The interview did not reveal any REC site.

Name: Tom Ehrke, Corps of Engineers Operations Area Manager at Englebright Dam (530) 432-6427

Mr. Ehrke stated that he had no knowledge of any HTW incidents since he has been stationed at Englebright Dam.

Name: Leslie Drexel, Loma Rica/Browns Valley Fire Department Chief (530) 741-0755

Captain Drexel stated that besides the close proximity of the recent fires he is not aware of any HTW incidents that would impact this project.

8.0 FINDINGS

The ESA yielded the following results:

No Recognized Environmental Conditions were observed on the project site. All of the adjacent properties appeared well maintained and clean during the site visit.

The most concerning contaminant is mercury because large amounts were introduced into the watershed from the hydraulic mining process. However, the risks of dealing with potential mercury are low for restoration measures. It is likely that only a very small fraction of the total mercury associated with these gold mining sediments is actually 'reactive' and available to bacteria for methylation (Singer et al 2016). However, because mercury in aquatic environments preferentially partitions to soil, sediment, and suspended matter (i.e., dissolved mercury concentration is far lower than the concentration in soil, sediment, and suspended matter), most of the mercury in the water column is removed not by reduction to the elemental species, but by sedimentation of the particles to which divalent mercury and methylmercury are bound (CEPA, 2002). Additionally, restoration excavation quantities are a fraction of the quantities stored behind either dam (Yuba River Ecosystem Restoration Feasibility Study dated 10/17/2017).

9.0 OPINION

The material threat of hazardous substances release is very small. The Project site is relatively low in organic sediments and is a generally higher energy reach with flowing, well-oxygenated water resulting in reducing the likelihood of methylation. Methylation in the Goldfields, due to mining activities, has been previously found to be of 'less than significant' concern (SMGB, 2014). Although below EPA levels Mercury is a Recognized Environmental Condition identified at the project site during completion of this report.

10.0 CONCLUSIONS

A Phase I Environmental Site Assessment was performed in conformance with the scope and limitations of ASTM Practice E 1527-13 for the Yuba River Ecosystem Restoration project. Any exceptions to, or deletions from this practice are described in Section 2.4 of this report. Although below EPA levels Mercury is a Recognized Environmental Condition identified at the project site during completion of this report. Appropriate caution should be taken during any excavating.

11.0 REFERENCES

(1) ASTM, E 1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process (Phase I ESA)

(2) The EDR Radius Map Report™ with GeoCheck®, Marysville Ring Levee, Phase 2A, Environmental Data Resources Inc., February 2014.

(3) USACE, ER 1165-2-132 Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, 26 June 1992.

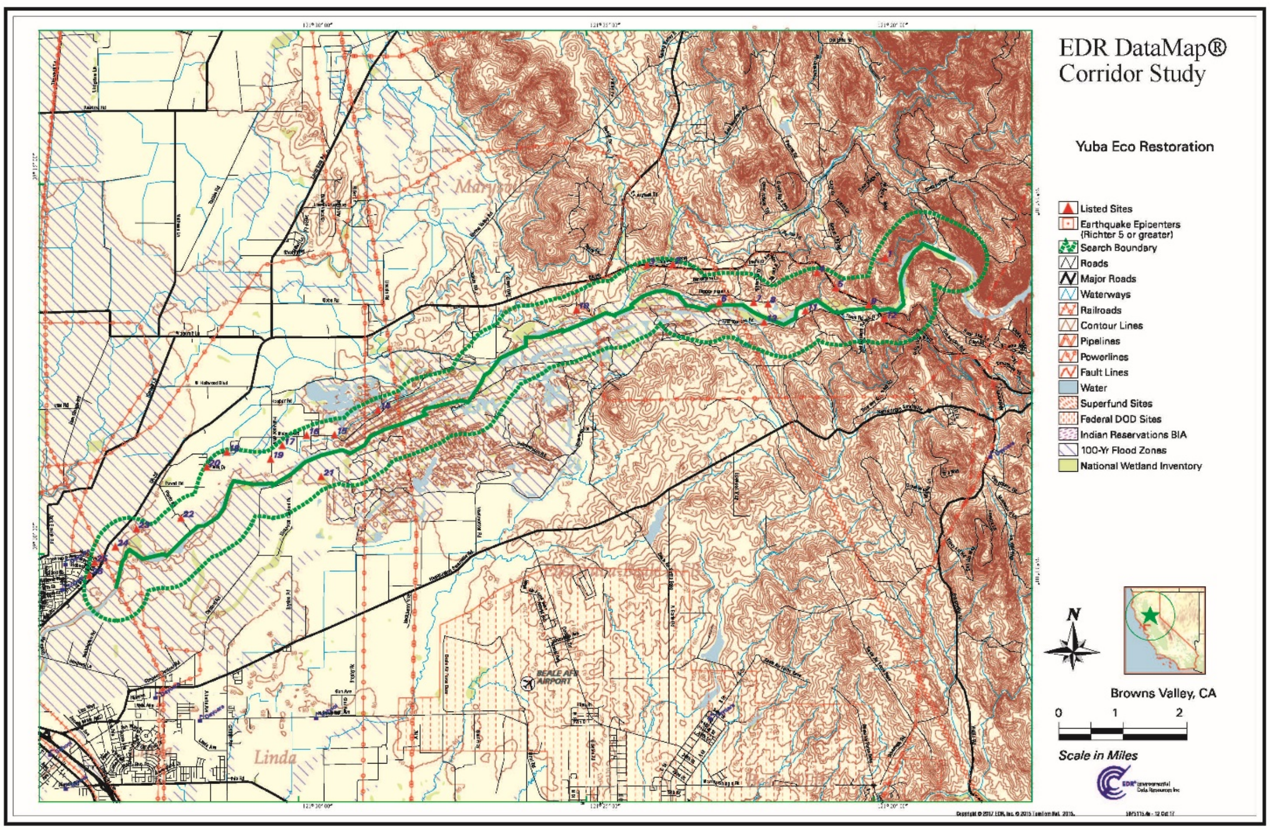
(4) Yuba River Ecosystem Restoration Feasibility Study (dated 10/17/2017)

(5) Mercury Concerns Technical Memorandum, cbec Eco Engineering, 3 October 2017

(6) State Mining and Geology Board (SMGB), October 2014. Western Aggregates LLC Yuba County Operations Amended Reclamation Plan – Draft Environmental Impact Report.

12.0 ATTACHMENTS

12.1 *YUBA RIVER ECOSYSTEM RESTORATION VINICITY MAP*



12.2 *YUBA RIVER ECOSYSTEM RESTORATION GOLDFIELDS*

12.3 *SITE PHOTOGRAPHS*

Photo 01: South side of Goldfields gravel piles looking north

Photo 02: Yuba River Ecosystem Restoration Goldfield gravel piles looking north

Photo 03: One of the buildings in the town of Hammonton

Photo 04: Water tower in the town of Hammonton, CA

Photo 05: Unknown concrete bunker in the middle of the Goldfield gravel piles