Yakima River at Demarest Property
Bioengineered Riverbank Stabilization

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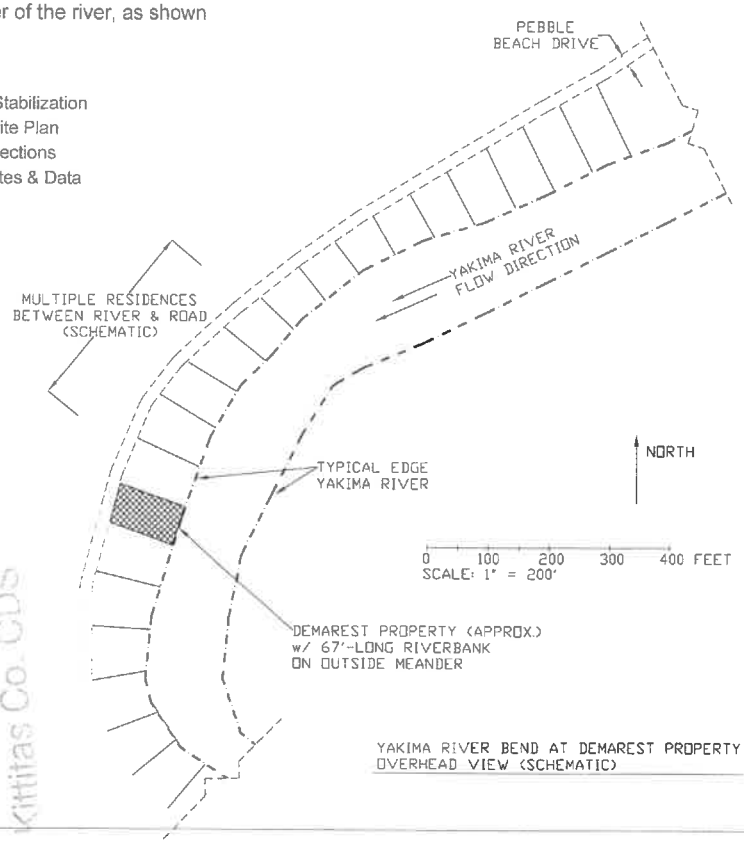
Project Location

Proposed bioengineered bank stabilization is for a 67'-long reach of Yakima River's west bank (850 Pebble Beach Drive) within the Sun Country Golf Resort about 5 miles west of Cle Elum. The site is one of many residential properties along the outside of a large, sweeping meander of the river, as shown schematically this drawing.

Drawing List



YAKIMA RIVER BEND AT DEMAREST PROPERTY
OVERHEAD VIEW (SCHEMATIC)

Overview for Bioengineered Bank Stabilization:

1. A site survey was completed by the design engineer (Paul Tappel, PE) in December 2020, after the Yakima River flow had raised about 1' from base flow, due to a rain event. Survey data were used to draw site plan and cross-section drawings included herein. River channel cross-section and water surface profile data were also collected to allow development of a flow rating curve (Figure 1).
2. Stabilization of the 40'-long reach of near-vertical slope, and the entire 67'-long riverbank on Demarest property, is proposed with a combination of: 1) Excavate the bank to 2:1 slope over 40'-long section, to be similar to adjacent naturally sloped and stable banks; 2) Install native riparian plants as shown, erosion-control seeding, and jute matting; and 3) Bury 12" to 24"-size rounded rocks (cobbles) within 40'-long section to moderately increase the size fraction of bank soils, and reduce the river's ability to convey bank soils downstream. Vegetation as listed above, and shown on drawings, should become well-established after a few growing seasons (with sprinkler irrigation) to develop an erosion-resistant matrix of roots and coarse soils.
3. See Basis-Of-Design notes & data on Drawing 4.

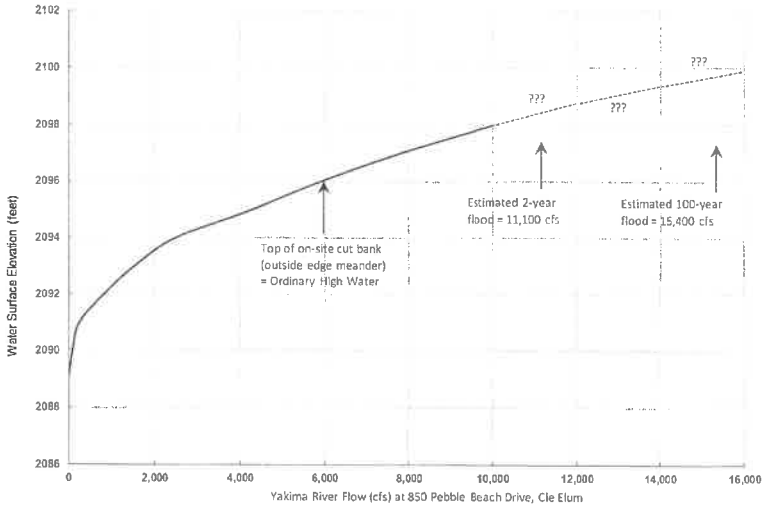


Figure 1. Flow rating curve for Yakima River at 850 Pebble Beach Drive, Cle Elum. Solid line based on site survey of river channel dimensions, slope, and Manning's equation. Dashed line based on extrapolation of rating curve to 100-year flood flow (approximate) because overland flooding would occur east bank (opposite Demarest) above 2097.5' elevation.
Note: All elevations are based on assumed vertical datum, and will not match actual site elevations (per NGVD 1929).

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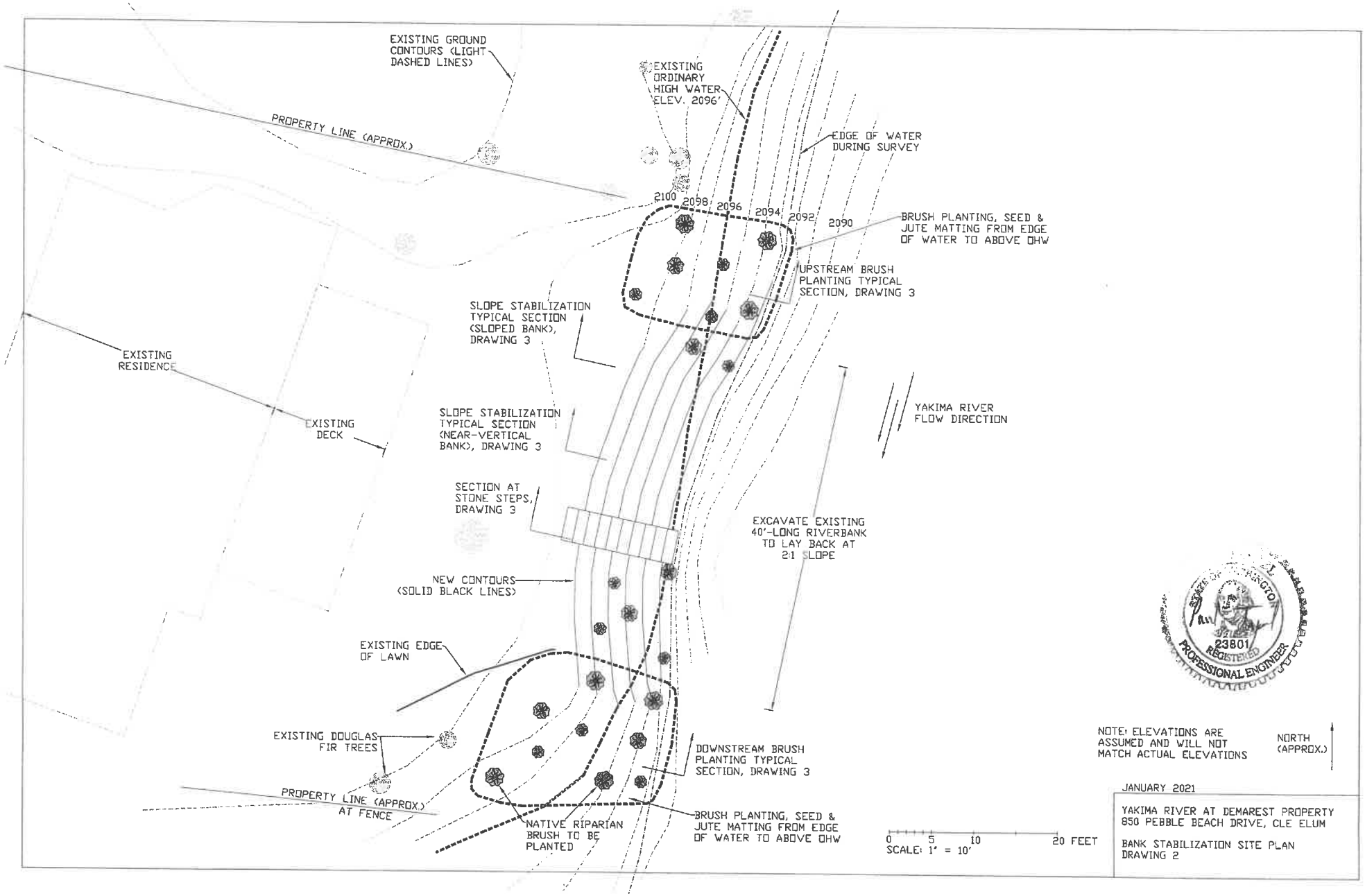
YAKIMA RIVER AT DEMAREST PROPERTY
850 PEBBLE BEACH DRIVE, CLE ELUM

OVERVIEW FOR BANK STABILIZATOIN
DRAWING 1


EXISTING GROUND CONTOURS (LIGHT DASHED LINES)
EXISTING ORDINARY HIGH WATER ELEV. 2096'
EDGE OF WATER DURING SURVEY
PROPERTY LINE (APPROX.)
2100
2098
2096
2094
2092
2090
BRUSH PLANTING, SEED & JUTE MATTING FROM EDGE OF WATER TO ABOVE OHW
UPSTREAM BRUSH PLANTING TYPICAL SECTION, DRAWING 3
SLOPE STABILIZATION TYPICAL SECTION (SLOPED BANK), DRAWING 3
EXISTING RESIDENCE
EXISTING DECK
SLOPE STABILIZATION TYPICAL SECTION (NEAR-VERTICAL BANK), DRAWING 3
YAKIMA RIVER FLOW DIRECTION
SECTION AT STONE STEPS, DRAWING 3
EXCAVATE EXISTING 40'-LONG RIVERBANK TO LAY BACK AT 2:1 SLOPE
NEW CONTOURS (SOLID BLACK LINES)
EXISTING EDGE OF LAWN
EXISTING DOUGLAS FIR TREES
PROPERTY LINE (APPROX.) AT FENCE
NATIVE RIPARIAN BRUSH TO BE PLANTED
BRUSH PLANTING, SEED & JUTE MATTING FROM EDGE OF WATER TO ABOVE OHW
DOWNSTREAM BRUSH PLANTING TYPICAL SECTION, DRAWING 3
23801
REGISTERED
PROFESSIONAL ENGINEER
NOTE: ELEVATIONS ARE ASSUMED AND WILL NOT MATCH ACTUAL ELEVATIONS
NORTH (APPROX.)
0 5 10 20 FEET
SCALE: 1" = 10'
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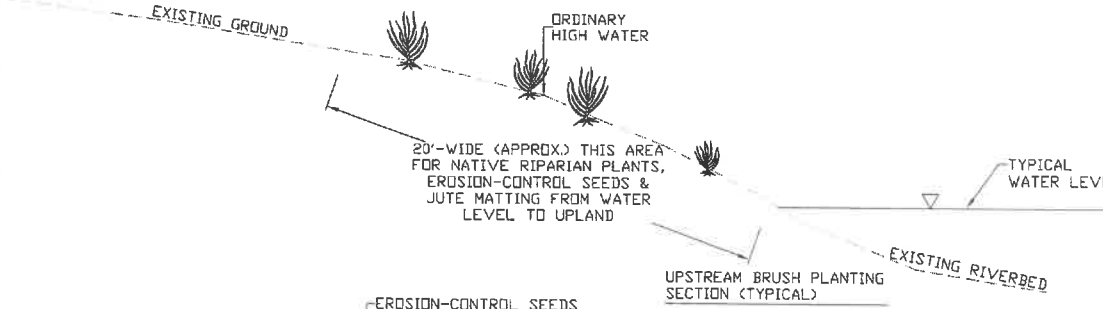
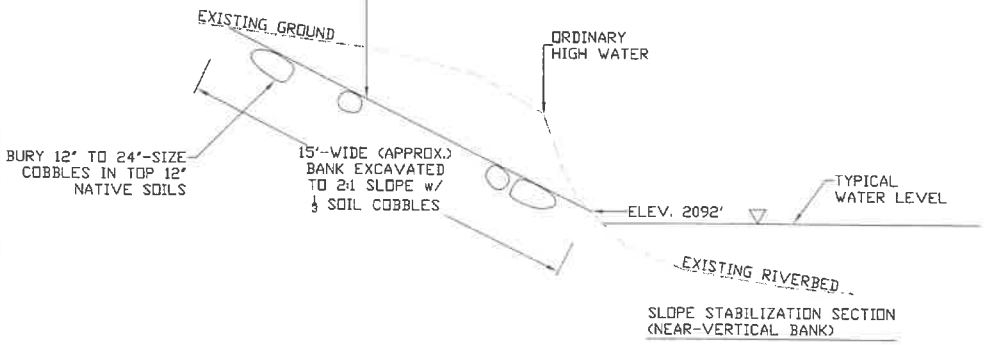
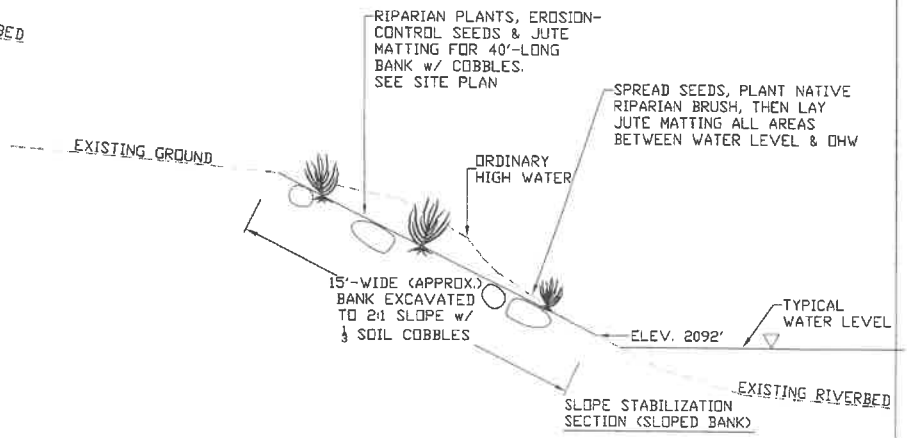
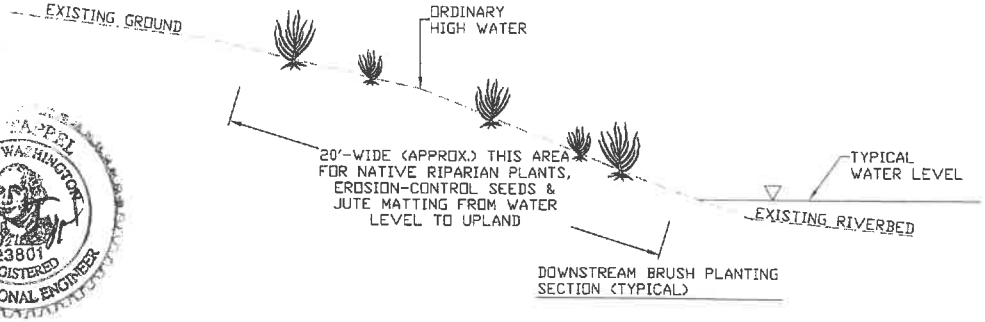
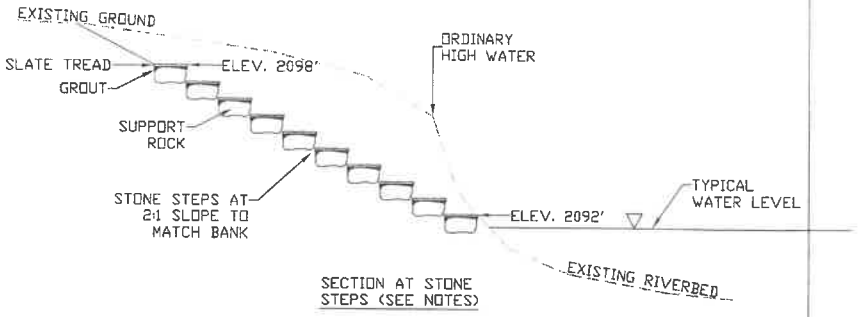
YAKIMA RIVER AT DEMAREST PROPERTY
850 PEBBLE BEACH DRIVE, CLE ELUM
BANK STABILIZATION SITE PLAN
DRAWING 2











Notes for Stone Steps:

1. Steps to be constructed from upland (lawn) area to river edge (elevation 2092') for medium-low flow. Stair treads to be natural slate stone, with tread length 16" and rise 8" each step. Stairs to be 4'-wide to provide easy landowner access to river edge.
2. Slate tread pieces to be grouted to top of angular support rocks buried into riverbank, for example columnar basalt. Total rock fill for stairway = 36 ft^3 (1.3 cubic yard), which will mostly be within Ordinary High Water.
3. The 4'-wide x 6'-tall rock stairs will function like a very small bedrock outcropping along the Yakima River shore, with respect to all aquatic and fisheries resources.

0 1 2 3 4 5 10 FEET
SCALE: 1" = 5'

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YAKIMA RIVER AT DEMAREST PROPERTY
850 PEBBLE BEACH DRIVE, CLE ELUM

BANK STABILIZATION SECTIONS
DRAWING 3

Basis-Of-Design Notes & Data:

- The flow rating curve (Figure 1 on Drawing 1) is based on survey data combined with Manning's equation. Flood flow estimates were obtained from streamstats.usgs.gov/ss, which incorporates the USGS' (Mastin et al. 2016) methods for estimating peak flow events at ungaged stream and river locations state-wide Washington. Correlation of the rating curve to any real-time flow rate was not possible because there are no gages reasonably close and/or hydrologically comparable to the subject Yakima River site.
- The flow rating curve is considered "approximate", and suitable for design of small-scale bank stabilization. It is not intended to offer any certainty about on-site flood flow levels, floodplain submergence during high flows, or other specific quantitative measures. Regardless of limitations, the river channel data, calculations, and rating curve supported design elements for bioengineered bank stabilization.
- River gradient is quite low thru the long, gradual meander at the subject site, with water surface level surveyed to be 0.2% to 0.3% slope. Manning's equation estimated that average water velocities at the 100-year flood would be about 8 feet per second (fps); water velocities along the shoreline would be less with a range 4 to 6 fps expected. Low river gradient, and relatively low water velocities for flood events, suggested that existing riverbanks with moderate slope, some vegetation, and coarse soils should be stable; these conditions were observed upstream and downstream of the project site.
- Based on relatively low flood flow velocities and observed stable vegetated banks nearby, the existing sloped banks (approx. 2:1 slopes) at upstream and downstream ends of subject property would be considered "stable" if native vegetation could be increased to form an erosion-resistant root matrix with native coarse soils (cobbles, gravel, sand & silt). Native riparian plants (16 each) including snowberry, wild rose, and willow (same species as existing native riparian plants on-site) will be planted in these two existing sloped bank areas (7 riparian plants will be placed within other bank areas), then erosion-control native seed mix will be spread, jute matting laid out and staked along uphill side. Sprinkler irrigation by the landowner during a few spring and summer seasons should be sufficient for the plants to become well-established within these two existing sloped riverbank areas.
- A 40'-long reach of riverbank between the two sloped bank sections (above) is currently a near-vertical cut slope, characteristic for an outside edge of natural river meander which appears to be slowly advancing landward. Erosion of this cut bank appears to be on a slow progression, due to some plant roots, coarse soil composition, and relatively low flood flow velocities. Regardless, the combination of winter freeze/thaw loosening of soil particles with periodic flood flows will result in incremental collapse and conveyance of bank materials downstream. Without stabilization, this steep bank section will remain unvegetated and will gradually retreat landward by natural river erosion.

- Riverbank excavation will all be done above water level (i.e. at low river flow), and all excavation would be considered within Ordinary High Water (OHW). Total bank excavation will be 22 cubic yards (CY), with material composition a relatively coarse blend of cobble, gravel, sand & silt (i.e. historic alluvium). These existing bank materials will be hauled off-site, and used for upland fill on another private property.
- Cobbles proposed for burial within the 2:1 slope riverbank will have top surfaces at final slope level, and will be randomly placed within the top 12" of sloped bank. An estimated 8 CY of cobbles will be imported to the site and buried in the riverbank, with an equal volume of native soils removed.
- Modification of the 40'-long riverbank reach, as explained above and shown on drawings, will very slightly change river channel cross-section over this short distance; the effects on river flow, floodwater storage volume, etc. will be almost zero and certainly insignificant. For example, the existing (surveyed) river cross-section at the near-vertical bank location would be about 1,098 ft^2 if water level was at Elevation 2,098.0' (per assumed vertical datum); this water level would be close to a 2-year flood flow event (see Figure 1). At the point of maximum bank excavation (see Drawing 3), laying back the riverbank will increase channel cross-section at this flow condition from 1,098 ft^2 to 1,127 ft^2, an increase of only 2.6% floodwater cross-section over a very short reach (percentage increase at higher flows will be less than 2.6%). Any quantitative hydraulic model (e.g. HEC-RAS) based on standard step backwater calculations (including many assumptions for channel roughness factors) would not identify any changes in water or floodwater conditions between existing and proposed bank conditions.
- Small-scale bank excavation as proposed will result in an estimated 594 ft^3 (22 CY) additional storage of floodwater at the subject property, compared with floodwater storage volume with the existing bank topography. At the estimated 100-year flood flow = 15,400 cfs (see Figure 1), this additional floodplain storage would be equivalent to the volume of water conveyed downstream in $^4/_{100}$'s of a second.

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BASIS-OF-DESIGN NOTES & DATA
DRAWING 4