Wednesday, October 14, 2020

# California Fish Passage Forum

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|---|---|
| **Project Name** | Lower Stotenburg Creek Fish Passage Project |
| **Contact Name** | Monica Scholey |
| **Lead Organization** | Smith River Alliance |
| **Contact Email** | monica@smithriveralliance.org |
| **Phone Number** | (541) 286-0724 |
| **Date** | Wednesday, October 14, 2020 |

## PROJECT INFORMATION

**1. Location of Project**

Downstream End, Lat: 41.8895780; long: -124.1480910 Crossing #1, Lat: 41.888267; long: -124.146431 Crossing #2, Lat: 41.887927; long: -124.145719 Crossing #3, Lat: 41.887054; long: -124.144423 Crossing #4 at Cedar Lodge Lane: 41.88553; long: -124.141558 Upstream End, Lat: 41.8849720; long: -124.1411400

**2. Attach a map of your project**

pdf LowerStotenburgImplementationMap.pdf

**3. Description of project, including, deliverables and outcomes you seek to achieve. Please clearly describe which portion of the project Forum funding would be applied to, and the specific deliverables and outcomes expected to result from this funding.**

The Lower
Stotenburg Creek Fish Passage Project will take advantage of a valuable opportunity to partner with private landowners to remove all barriers to fish passage along the downstream-most 0.5 mile of Stotenburg Creek, while also increasing habitat complexity and improving the native riparian corridor. These actions will increase the quality and quantity of accessible productive coastal rearing habitat in the Smith River Plain. The project will improve the connection between Stotenburg Creek and the mainstem Smith River through treatment of barriers and impediments to salmonid upstream and downstream passage, by upgrading and/or removing four stream crossings. Specific activities include: 1) replacing two crossings and complete removal of two crossings that are known fish barriers; 2) installing an engineered log jam, large wood structures, and re-contouring the channel to enhance connection to the mainstem Smith River; 3) building five beaver dam analogs to increase channel complexity and winter

rearing habitat; and, 4) enhancing native riparian vegetation and cattle exclusion fencing throughout the 0.5 mile stream reach and project area.

Stotenburg Creek is a small Smith River Plain tributary, with a watershed area of 452 acres, shown to provide important non-natal winter rearing habitat for juvenile Coho salmon (Parish and Garwood 2015 & 2016). The project will treat four barriers and passage impediments that extend from the confluence of Stotenburg Creek and the Smith River, to upstream of Cedar Lodge Lane (the 4th crossing from the mouth). Overall the project will reduce the number of stream crossings, decrease flow velocities through the project reach, inundate and create additional winter rearing habitat, and reduce the potential for stranding as the stream dries in the spring.

The proposed project will meet CDFW and NOAA Fisheries fish passage criteria (see CA Restoration Manual, Part IX, Appendix A and B; and Volume II, Part XII) to the greatest extent possible at each site, allowing passage to all salmonid life stages. Crossing #1 will be converted to a bridge and have a natural channel bottom throughout the crossing site. Crossing #2 and #3 will be removed and restored to a natural channel. Crossing #4 (Cedar Lodge Lane) will convert four undersized culverts, set at various grades and lengths to a single aluminum box culvert buried below the streambed to create a natural channel bottom.

Forum funding will be used to initiate and complete the CEQA and tribal consultation processes, as well as fund subcontractor work to remove the culvert at Crossing #2. Funds will also be used to initiate project management including but not limited to coordination and with the landowner, subcontractors, and agency representatives. Fish barriers at road crossings are listed as a high threat to juvenile and smolt Coho in the Smith River Plain. The majority of the barriers that exist in the Smith Coastal Plain are on private agricultural land that cumulatively impact access to vital rearing habitats. Implementation of the Lower Stotenburg Fish Passage Project and its easy access, will serve as a site to educate other landowners and local restoration practitioners about ways to restore stream habitat while also serving the needs of the landowner. Funds from the Fish Passage Forum is key to advancing this project and ensuring implementation will occur by 2022.

**4. Select all components that apply to your project.**

Development of engineering design plans

Habitat restoration

Fish passage monitoring

**If you answered "yes" to question 6, please provide the PAD ID number(s).**

**18. Attach a copy of your monitoring plan**, (if available) and indicate the person and/or organization that will be responsible for implementing.**

pdf L.Stotenburg_Fish Passage Barrier Removal...

pdf LowerStotenburg_Literature Cited.pdf

pdf LowerStotenburg_MonitoringPlan.pdf

**If you would like to also upload a document to help illustrate the project's timeline (as described above) please do so here.**

pdf LowerStotenburg_Implementation Timeline....

**5. List all partner organizations.**

Stillwater Sciences, McCullough Construction, California Conservation Corps, Samara Restoration

**6. Does the barrier(s) being addressed through this project have a Passage Assessment Database (PAD) identification number(s)?**

YES

**7. Describe the barrier(s) under "average" conditions, if it is a complete, temporal, or partial barrier, how often passage is provided for both adult and juvenile anadromous fish, and if the information is available (e.g., meets fish passage criteria for adults 45% of the time and 0% of the time for juveniles). Please specify which species you are referring to when describing barrier status.**

Crossing #1 (PAD ID # - 765249) is identified as a partial (impassible to some fish at all times) in the PAD. Based on field surveys and fishXing software following passage parameters outlined in Taylor 2001, this crossing is a total barrier (0% passable) to juvenile and resident salmonids and not a barrier to adult salmonids (100% passible). This crossing will be removed as part of the proposed project and a bridge will be installed slightly upstream further out of the Smith River floodplain.

Crossing #2 (PAD ID # – 765239) is identified as a partial (impassible to some fish at all times) in the PAD. Based on field surveys and fishXing software following passage parameters outlined in Taylor 2001, this crossing is a velocity barrier (51.8% passable) to juvenile, and not a barrier to resident or adult salmonids (100% passible). This crossing will be removed as part of the proposed project.

Crossing #3 (PAD ID # - 765210) is identified as a not a barrier in the PAD.  This crossing is a ford that has the potential in strand out-migrating juvenile salmonids but is passable for upstream migration. This crossing will be removed as part of the proposed project.

Crossing #4 (PAD ID # - 765259) is identified as a not a barrier in the PAD. Based on field surveys and fishXing software following passage parameters outlined in Taylor 2001, this crossing is a 100% passable to all life stages of salmonids. However, this crossing is comprised of four undersized culverts with various lengths and set at various slopes. One culvert, the channel left culvert, is filled with sediment. This crossing negatively impacts natural hydraulic processes of the channel and likely delays upstream and downstream migration of juvenile and resident salmonids. This crossing will be replaced with a box culvert with a natural channel bottom as part of the proposed project

**8. Indicate how you determined that this barrier is a high priority project and/or addresses a high priority barrier. (Please check all that apply.)**

Barrier is listed in a key restoration plan for the region (see question 9 below)

Endorsed by an agency

Local knowledge/conversation with local representatives

**9. List the name(s) of the recovery plans and the specific task that name this barrier/project as a high priority, the agency that endorsed this project, or the local representative that names this project as a priority.**

Recovery Plan:
Parish Hanson, M. 2018. Smith River Plain Stream Restoration Plan, Del Norte County, California. Final Report to the California Coastal Conservancy, Contract: No. 16-027. Smith River Alliance, Crescent City, CA. 70 p.

CDFW endorsed this project in this field note and during converstations with SRA staff:
Garwood, J., S. Bauer., J. Olsen, A. Cockrill. 2013. Field Note: Juvenile Coho Salmon detection in an Unnamed Tributary to the Smith River, Smith River, California. California Fish and Wildlife. Arcata, CA. 5 pp.

Local representatives have identified the project in monitoring reports:
Parish, M. and J. Garwood. 2015. Distribution of juvenile salmonids and seasonal aquatic habitats within the lower Smith River basin and estuary, Del Norte County, California. Final report to the California Department of Fish and Wildlife, Fisheries Restoration Grants Program: P1310518, Arcata, CA.

Parish, M. and J. Garwood. 2016. Winter Distributions, Movements, and Habitat use by Juvenile Salmonids throughout the Lower Smith River Basin and Estuary, Del Norte County, California. Final Report to the California Department of Fish and Wildlife, Fisheries Grants Restoration Program, Contract: P1410545. Smith River Alliance, Crescent City, CA. 51p.

**10. The California Fish Passage Forum (Forum) has seven (7) overall objectives. Please check each objective your project will help to address. (check all that apply)**

1. Remediate barriers to effective fish migration.

**11. Provide a brief explanation of how your project addresses all of the checked boxes in question 10.**

The project will remediate four fish passage impediments along 0.5 miles of Lower Stotenburg Creek from the confluence with the Smith River to Cedar Lodge Lane.

**12. Select each anadromous fish species that will benefit from your project (select multiple if applicable).**

Coho salmon

Chinook salmon

Steelhead/rainbow trout

Pacific Lamprey

Coastal cutthroat trout

**13. Provide all relevant data on anticipated outcomes of implementing this project. ***

- 0.7 Stream miles restored or enhanced
- 8.17 Acres of habitat restored
- 4 Number of barriers removed/remediated
- 0 Outreach accomplishments (number of presentations given, materials produced, individuals reached etc.)

**14. Provide the location and distance in stream miles to downstream river structures, and whether each structure represents an insignificant, partial, or total barrier to fish passage.**

There are no barriers present downstream of the project as the project starts at the mouth of Stotenburg Creek and extends continuously along 0.5 miles of stream. The longitudinal profile of the entire project area was conducted during the design phase and implements restoration actions to address all passage concerns.

**15. Provide the location and distance in stream miles to upstream river structures, and whether each structure represents an insignificant, partial, or total barrier to fish passage.**

Along the mainstem of Stotenburg Creek, the next barrier is 256 meters upstream of Crossing #4 (Crossing #5, PAD-ID: 765226), though SRA is currently developing designs to remediate this crossing. Stotenburg Creek forks upstream of Crossing #4, with a crossing on the tributary 350 meters upstream. In total there are 470 meters of habitat upstream of Crossing #4 before any additional barriers. Therefore, implementation of the Lower Stotenburg Creek Fish Passage Project will create 1109 meters (0.7 miles) of unimpeded winter rearing habitat. SRA is also working with the landowner of Crossing #5 with funds from FRGP to design remediation of this crossing and anticipates implementation no more than two years after implementation remediation of crossings #1-4.

**16. Indicate which of the Forum's priority habitats that will be enhanced or restored as a result of this project (choose all that apply).**

Rearing habitat

**17. Has the owner and/or responsible organization/agency of the barrier(s) proposed for removal and/or remediation been identified, notified, and given permission for this project to proceed as proposed?**

YES

**If YES, please provide the name of the entity that owns/is responsible, and describe how consent to proceed was obtained/documented, and their role (if any) in any monitoring.**

Angel Lopez – lease to own: Angel has signed a preliminary access agreement for FRGP proposal
Ulrich trust – (property seller): Trustee has signed a preliminary access agreement for FRGP proposal

Both preliminary access agreements state that the landowners are willing to enter into a 10 year project specific access agreement if the project is awarded funding.

The landowners will not be involved in project monitoring, but agree to maintain riparian fence to ensure complete livestock exclusion from the riparian zone for a period of 10 years.

***The Forum recommends, as a bare minimum, applicants use the [California Fish Passage Forum's Fish Passage Barrier Removal Performance Measures and Monitoring Worksheet](), and one year minimum pre- and post-project monitoring.*

**19. Will your project be implemented within 12-18 months?** YES

### 20. Describe below the project's timeline (including permits), as well as implementation and monitoring dates. Please describe any issues that exist, if any, that could delay project implementation.

The project will be initiated with the contracted funds from Fish Passage Forum, which would be used to start the permit application process and removal of the culvert at Crossing #2. SRA will secure all permits by Spring of 2021. SRA anticipates securing the necessary implementation funds no later than April 2022. A proposal was submitted to FRGP in spring of 2020, with proposed implementation occurring in summer/fall of 2022.

The CFPF funds would ensure the project timeline continues as proposed in the attached implementation schedule and outline below. The proposed timeline accounts for the possible need that SRA seek the additional funds if the FRGP application is not awarded. Initiating the CEQA process with CFPF funds enables SRA to submit to multiple funding sources under Prop 1 and Prop 68, which require CEQA coverage prior to grant contract, and conduct implementation in 2022. Post-project monitoring and maintenance will continue past the 12-18 month time frame, but all California Fish Passage Forum funded project components will be completed by October 30, 2022.

Project implementation tasks are listed below:

Task 1- Project Management
Start Date - April 15, 2021
End Date - September 30, 2022

Task 2 - Implementation Preparation, Permitting and Environmental Compliance
Start Date - April 15, 2021
End Date - November 30, 2021

Task 3 - Project Implementation; Crossing removal and upgrades, instream and riparian restoration
Start Date - July 1, 2022
End Date - October 30, 2022

Task 4 - Project Monitoring, Maintenance and Evaluation
Start Date - November 1, 2022
End Date - November 1, 2025

**21. Attach any designs of your project as well as any photos.**

pdf Lower Stotenburg_Final Designs.pdf

pdf LowerStotenburg_Photos.pdf

pdf Lower Stotenburg BOD Report_Reduced.pdf

# PROJECT COSTS & BUDGET

**22. Total Project Cost.** 1,232,217.57

**23. Total funding amount being requested from the Forum.** 49952.20

**24. Total matching contributions (cash and in-kind) that will be included in your project. Include all matching contributions that have been secured and that are anticipated/requested.** 1182265.37

**25. Total matching funds or in-kind support secured at time of application.** 0

**26. List all partner contributions (cash and/or in-kind) using the table below:**

| | Match Source | Cash Contribution | In-Kind Contribution | Total Contribution |
|---|---|---|---|---|
| Partner 1 | CDFW (FRGP or Prop 1) | 1182265.37 | | 1182265.37 |
| Partner 2 | | | | |
| Partner 3 | | | | |
| Partner 4 | | | | |
| Partner 5 | | | | |
| Partner 6 | | | | |
| Partner 7 | | | | |

**27. Will the project be fully funded if funding being requested from the Forum is awarded?** NO

**28. Attach a project budget sheet below that describes the overal project budget. Budgets MUST include:**

- Total cost of project
- Total funding request from the Forum clearly indicating how/on what those funds will be spent.
- Monitoring costs
- Accompanying narrative explaining budget categories, amounts listed, what will be accomplished, and what deliverables are expected, etc. as needed.

If you do not have a detailed budget for your project, you can find a template and other resources on the Funding page of the Forum's website.

**Attach a project budget, including a narrative that describes the overall project budget and a detailed budget breakdown. (Word, .pdf, or .xls)**

docx LowerStotenburg_Budget Narrative.docx

xlsx LowerStotenburg_CFPF_budget_FINAL.xlsx

# PROJECT TEAM CAPABILITIES

**29. Describe the experience and capabilities of up to three of the project leaders relative to their ability to implement this project. Please also describe any other Forum-supported projects project leaders have been involved with.**

The Smith River Alliance (SRA) is a watershed organization with an office near Crescent City, California. Founded in 1980, their mission is to provide for the long-term protection, restoration, and stewardship of natural resources in the Smith River watershed. The organization is managed by Grant Werschkull, M.S. and Patty McCleary -- both of whom have extensive project management experience as environmental consultants and as former staff with The Nature Conservancy, Trust for Public Land, Land Trust Alliance, National Park Service, and the Washington Water Trust. SRA has managed watershed projects involving multiple contractors and billing to the State for services rendered.

Project implementation will be led by Monica Scholey and Marisa Parish Hanson, with over 15 years of combined experience with watershed restoration planning, landowner outreach, and project management and coordination. Marisa has been conducting monitoring and restoration efforts with private landowners in the Smith River Plain for seven years. During this time Marisa worked with state and federal agencies to identify and prioritize restoration projects in the Smith River Plain and authored the Smith River Plain Stream Restoration Plan, Del Norte County, California (Parish Hanson 2018). SRA is using this prioritization to advance high priority restoration actions, including the proposed Lower Stotenburg project.

Stillwater Sciences is a 65-person scientific consulting firm of specialists with a depth and breadth of experience across the full range of environmental restoration services, including: (1) restoration planning, including ecological and engineering considerations; (2) hydraulic, hydrodynamic and sediment transport modeling; (3) environmental investigations and hazardous materials assessments; (4) restoration design analysis and alternatives development; (5) permitting and environmental compliance support including impact analyses, endangered species consultations, cultural resources, and state and federal permit requirements; (6) real estate and appraisal services; and (7) engineering design. The lead SWS staff assisting with the project is Dylan Caldwelll (M.S., Geology), a geologist with expertise in fluvial and hillslope geomorphology, engineering geology, geotechnical investigations, slope stability assessments, watershed restoration, infrastructure improvement projects, and understanding how these topics interface with aquatic and riparian ecosystems. Mr. Caldwell's experience comes from a diverse background with more than a decade of experience in research and geotechnical and environmental consulting. Mr. Caldwell is a California licensed Professional Geologist (#9336) and Oregon Registered Geologist (#G2523).

# OUTREACH

**30. Does your project have a public and/or community outreach component? If so, please describe (e.g., public workshops, tours, signs, scientific journal articles, scientific conference presentations, educational forums, professional photo/video development, website, press release, newsletter, social media outreach, volunteers, schools, etc.)**

No outreach or educational forums are yet planned for the project. However, SRA has assisted SRF with coho confabs in past years and provided field trip opportunities. SRA staff has presented at a number of SRF conferences. We anticipate this project being a vital site to help education other private agricultural landowners in the Smith River basin as well as restoration practitioners in future workshop or conference platforms.

# ALIGNMENT WITH NATIONAL PRIORITIES

**31. Which National Fish Habitat Partnership (NFHP) National Conservation Strategies will be addressed by your project? (select all that apply)**

- 2. Restore hydrologic conditions for fish.
- 3. Reconnect fragmented fish habitats.

Review the *NFHP National Conservation Strategies*.

**32. What U.S. Fish & Wildlife Service (USFWS) Climate Change Strategies will be addressed by your project? (select all that apply)**

- 3.2 Promote habitat connectivity and integrity.
- 3.3 Reduce non-climate change ecosystem stressors.
- 3.5 Conserve coastal and marine resources.

Review the *USFWS: Rising to the Urgent Challenge – Strategic Plan for Responding to Accelerating Climate Change*.

**33. Provide specific information about how your project addresses the climate change strategy you checked in question 32.**

The Smith River is the largest free flowing river system in California and is considered a premier "Salmon Stronghold" along the Pacific Coast and described as "irreplaceable" with respect to salmonid population resiliency (Wild Salmon Center 2012). These endorsements are largely due to the public ownership and designations in the upper watershed (National Recreation Area, National and State Park, Wilderness, Wild and Scenic River). The large alluvial floodplain at the mouth of the Smith River, the Smith River Plain, is the essential connection between these protected waters upstream and the ocean.

The Smith River Plain, largely held in private ownership, is a small fraction of the total habitat in the watershed but plays a large role in salmonid productivity as it is home to low gradient streams that provide key habitats for rearing salmonids. Like many estuaries throughout the Pacific Northwest, the Smith River estuary has undergone a process of simplification and development that has led to reduced channel complexity, less off-channel habitats, and less spatial and temporal access to remaining seasonal salmonid rearing habitat. The impaired condition of the Smith River estuary has been identified as the most significant threat to salmonids in the Smith River basin (Voight and Waldvogal 2002, CDFW 2004, NMFS 2014, Parish and Garwood 2015).

Lower Stotenburg Creek restoration provides a valuable opportunity to promote habitat connectivity and integrity because patches of quality rearing habitat are present (Parish and Garwood 2015 and 2016). However, due to a lack of hydrologic connectivity throughout the first 0.5 miles of stream, sub-surface flow at the mouth, and multiple undersized stream crossings, salmonid access to this important stream is restricted. Streamflow in the Smith is directly related to rainfall, climate change will further exacerbate habitat fragmentation on the land facet level due to altered timing distribution and abundance of rainfall. Fish utilizing Stotenburg Creek during high flow events have the potential to be stranded as the stream dries during the spring and summer months (Parish and Garwood 2015 and 2016). The proposed project will increase depth and habitat complexity, which is needed as the channel is fairly uniform and remains shallow throughout the channel, even during elevated winter flows (Parish and Garwood 2016).

The proposed project will help Coho salmon recover in the Smith River by increasing habitat complexity, improving fish passage, and extending migration timing and survival for juvenile Coho salmon rearing in Stotenburg Creek. Utilization of estuarine and low gradient habitats have been shown to contribute to higher survival, greater productivity, and higher overall population life history of Coho salmon. Restoration of Stotenburg Creek is an opportunity to ensure habitat connectivity on the coastal plain, support salmonid populations in the Smith River Watershed and promote long term salmonid population resilience in the Pacific Northwest. Maintaining the health and connectivity of this coastal habitat is an essential component to maintain ecosystem integrity and restore key ecosystem processes that can build upon the habitat protections in the Smith Watershed and ensure resilience of salmonid species in the Pacific Northwest.

**34. Would an existing tribal, commercial, recreational, or subsistence fishery be enhanced as a result of the project? If yes, please describe. If not, is there a future fishery that would potentially be restored through increased habitat as a result of this project? If so, describe.**

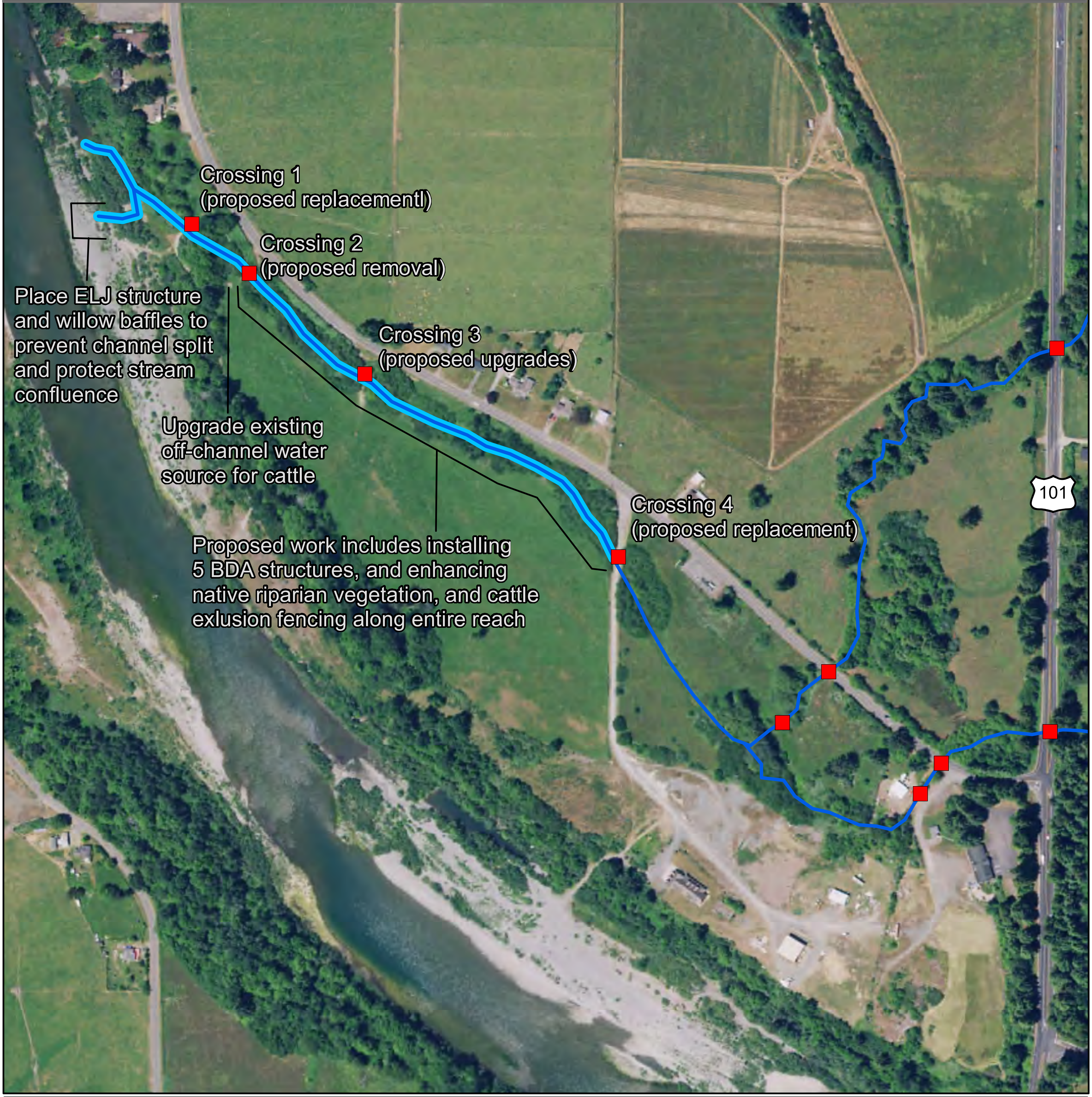
Yes, the recreation fishery on the Smith River is vital for the local community and economy. The project will provide passage to high quality productive off-channel winter rearing habitat, contribute to salmonid population recovery and benefit the recreational fishing industry and local economy.

Del Norte County is rural and sparsely populated with a county wide population of 28, 610 at the time of the 2010 Census. The towns and unincorporated areas along the Smith River are listed as economically disadvantaged and severely economically disadvantaged communities with approximately 24.6% of the population living in poverty. The recreational fishery brings anglers to the area providing an economic boost to local businesses. While no take of Coho salmon is currently allowed, other salmonid species including Chinook, steelhead and coastal cutthroat trout are expected to benefit from increased connectivity and access to low velocity winter rearing habitat. Recent studies found that juvenile salmonids that rear in tributaries and slough channels were consistently larger than their upstream cohorts that reared in natal habitats (Parish and Garwood 2016). These findings highlight the importance of Smith River Plain tributaries for the growth and survival of salmon and trout populations.

While currently there is not a subsistence fishery in the Smith River basin, there is a functioning tribal community working to contribute to the fishery and may secure rights for subsistence fishing in the coming decades.

***Thank you for your interest in the Forum, and for taking the time to submit this proposal. You will be contacted by the Forum to discuss the outcome of this funding process.***

# LOWER STOTENBURG CREEK FISH PASSAGE PROJECT




## Existing Conditions Sketch

- Crossings
- Stotenburg Creek
- Project Reach

SMITH RIVER ALLIANCE

Map Sources:
Imagery: USGS Quad Map
Imagery, roads, cities:
ESRI World Mapping Service

N

0 25 50 100 Meters

0 125 250 500 Feet

Map Location

As part of its mission to protect and revitalize anadromous fish populations the California Fish Passage Forum (Forum) is seeking data from monitoring efforts following the remediation of anadromous fish barriers.

The Forum will use these data to help quantify the benefits of fish passage improvement in California.

Your participation is voluntary and will help advance fish passage efforts in the future. In the future, opportunities may exist for the Forum to highlight your organization's project (and its results) through its own channels, as well as those of its partner organizations.

If possible, please use the monitoring worksheet below to provide this information. While the use of the worksheet is requested, all post remediation data are appreciated for this effort, including informal observations.

The Forum is particularly interested in presence/absence data and abundance data for target species both before and after barrier remediation.

Thank you for your assistance in this effort.

# California Fish Passage Forum

## Fish Passage Barrier Removal Monitoring Worksheet

**A General Info**

| | | |
|---|---|---|
| *Project Name* Lower Stotenburg Creek Fish Passage Project | | |
| *Barrier name and GPS Coordinates* Crossing #1: Lat 41.888267 Long -124.146431 | | *Lead organization* Smith River Alliance |
| *Monitoring Contact* Jolyon Walkley | *Phone* 707-954-4123 | *Email* jolyon@smithriveralliance.org |

| | PRE-IMPLEMENTATION | | POST-IMPLEMENTATION | |
|---|---|---|---|---|
| **B Project Timing** | *Anticipated Start Date* 4/1/2016 | *Anticipated End Date* 04/31/2021 | *Construction Start Date* 10/1/2021 | *Construction End Date* 11/1/2023 |

**C Basic information**

**PRE-IMPLEMENTATION**

Date final project design was completed:

*Anticipated stream miles restored* 0.5 miles

*Description of barrier*

Four crossings: Three undersized culverts and one ford. Target range jump height at post-implementation will be 0". The project includes installation of Beaver Dam Analog structures with a 9" jump height.

Landowner:

**POST-IMPLEMENTATION**

*Actual stream miles restored* miles

*Verification methods*

**D Site "Passability"**

**PRE-IMPLEMENTATION**

*Describe the following physical parameters of the project*

**Channel Width in Project Area:**

Baseline . . . . . . . . . . 5-10 ft.

Target Range . . . . . . . . . to 10-15 ft.

**Channel Slope / Gradient in Project Area:**

Baseline . . . . . . . . . . 1.1 %

Target Range . . . . . . . . . to 1.1 %

Maximum Channel Slope. . . . . . . . . 1.1 %

**Maximum Jump Height:**

Baseline . . . . . . . . . . 30 in.

Target Range . . . . . . . . . to 9 in.

**Does the project design meet regionally appropriate fish passage criteria?** ☐ Yes ☑ No

*Provide reference sources used to develop target ranges.*

See attached reference list. CDFW 2009

**POST-IMPLEMENTATION**

*Describe the as-built parameters at the site.*

**Channel Width in Project Area:**

As-Built Condition . . . . . . . . . . ft.

**Channel Slope / Gradient in Project Area:**

As-Built Overall Slope . . . . . . . . . %

As-Built Maximum Channel Slope . . . . . %

**Maximum Jump Height:**

As-Built Condition . . . . . . . . . . in.

**Does the as-built conditions fall within the target ranges listed at left?** ☐ Yes ☐ No

*Comments*

# California Fish Passage Forum



## Fish Passage Barrier Removal Monitoring Worksheet

| | PRE-IMPLEMENTATION | POST-IMPLEMENTATION |
|---|---|---|
| **E** Presence of Target Fish Species | *Identify ONE target diadromous fish species:* Oncorhynchus kisutch<br>*What is the upstream status of the target diadromous fish species?* ☑ Present ☐ Absent<br>*For which life stages is passage limited?* ☐ Adult ☑ Juvenile<br>*List other fish species that will benefit and their pre-project status:*<br>*Species:* Coastal cutthroat trout<br>☑ Present ☐ Absent<br>☐ Present ☐ Absent<br>*Describe the methodology used to determine presence/absence of the target species.*<br>Minnow trapping and PIT tagging<br>*What partner organizations will assist in monitoring?*<br>California Department of Fish and Wildlife, Stillwater scier | *What is the upstream status of the target diadromous fish species? (This may be reported annually from 1-5 years post-implementation.)* ☐ Present ☐ Absent<br>*Which life stages, if any, have been observed upstream?* ☐ Adult ☐ Juvenile<br>*List other fish species and their post-project status:*<br>*Species:*<br>☐ Present ☐ Absent<br>☐ Present ☐ Absent<br>*Describe the methodology used to determine presence/absence of the target species.*<br>*How often does monitoring occur at the project site?*<br>*What is the lead organization for monitoring?* |
| **F** Target Species Abundance | *Estimated target species abundance below barrier:*<br>No estimate of abundance is available for below the project a<br>*Estimated target species abundance above barrier:*<br>The minimum abundance estimate docu<br>*Date of estimates:*<br>11/1/16 | *Estimated target species abundance below project site*<br>*Estimated target species abundance above project site*<br>*Date of estimates:* |
| **G** Plans | *Is this barrier mentioned in any species recovery plans, watershed restoration plans, or other approved plans? If yes, what plans?*<br>Parish Hanson. 2018. Smith River Plain Stream Restoratio | |

# California Fish Passage Forum

## Fish Passage Barrier Removal Monitoring Worksheet

| | PRE-IMPLEMENTATION | POST-IMPLEMENTATION |
|---|---|---|
| **H Operating and Maintenance Costs** | *Will the barrier removal result in reduced annual operating, maintenance and/or liability costs at the site?* ☐ Yes ☑ No<br><br>*What is the estimated average **annual** operating, maintenance, and/or liability cost over the next five-year period if the barrier were to remain in place?* /year | *What is the estimated average **annual** operating, maintenance, and / or liability cost over the next five-year period without the barrier in place?* /year<br><br>*What is the **annual** average change in cost? (This will auto-fill)* /year |
| **I Public Safety** | *Will the barrier removal eliminate or diminish a documented safety hazard?* ☐ Yes ☑ No<br><br>*If yes, please describe.* | *Did the barrier removal eliminate or diminish a documented safety hazard?* ☐ Yes ☐ No |
| **J Additional Project Monitoring (if applicable)** | *Please indicate if any additional monitoring activities will be conducted at the project site.*<br><br>☐ No additional monitoring<br>☑ Juvenile surveys<br>☐ Outmigrant trapping<br>☐ Spawner surveys<br>☑ Topographic channel surveys<br>☐ Habitat evaluation<br>☑ Photo points<br>☐ Other<br><br>*If yes, please describe. Wherever possible, please include information on methodology used, as well as baseline and target conditions.*<br>Topographic surveys: Existing conditions surveys include a longitudinal profile and detailed channel cross sections. After project implementation as built surveys will be conducted.<br><br>Juvenile surveys: The sampling approach assessed summer and winter juvenile spatial structure and habitat use in the lower Smith River and tributaries. A reach-based sampling frame with GRTS drawn reaches and Apex monitoring stations were used to sample local and landscape level spatial structure. Fish sampling procedures included minnow traps, snorkel surveys, seines, fish marking with PIT tags and water quality measurements. | *If additional monitoring studies were completed, please describe post-implementation conditions.*<br>Topographic surveys: Existing conditions surveys include a longitudinal profile and detailed channel cross sections. After project implementation as built surveys will be conducted.<br><br>Juvenile surveys: The sampling approach assessed summer and winter juvenile spatial structure and habitat use in the lower Smith River and tributaries. A reach-based sampling<br><br>*Is there anything else notable associated with this project, for example, community engagement events, volunteer activities, education and outreach activities?* |

Smith River Alliance
Lower Stotenburg Creek Fish Passage Project
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# Lower Stotenburg Monitoring and Maintenance Plan

Smith River Alliance

The instream habitat features created by this project are designed to provide high quality winter rearing habitat for juvenile salmonids.

The instream and riparian habitat restoration elements are intended to be self-maintaining, not requiring additional earthwork after construction is complete. At high flows the five beaver dam analogs (BDA's) will have little to no impact on the stream size and flow, but will retain water and increase the amount of inundated area at winter and spring base flows, providing high quality rearing habitat. Physical and biological monitoring activities will provide data on the habitat change over time, inform future habitat enhancement designs and trigger maintenance activities if unfavorable physical or biological conditions develop at the site.

## Monitoring Details

Physical and biological monitoring will take place for three years after implementation is complete. The objective of Lower Stotenburg restoration is to provide unimpeded access to 0.5 miles of rearing habitat, enhance instream habitat, and promote a functional riparian forest with high primary productivity. Monitoring will help evaluate habitat use by winter rearing Coho salmon and inform project maintenance actions. Monitoring activities will include the following:

## Physical monitoring

**Photo Points:** Pre- and post-project photo monitoring will occur at established locations located with GPS coordinates at known distances from existing landmarks to ensure comparable views. Photo points will be established at locations every 400 feet. Each photo point will document a minimum of four photos in each cardinal direction. If additional photo angles are needed to record points of interest, the compass bearing from the photo point will be recorded for each additional photo.

**As-Built Plans:** Plans of the completed project will be prepared using construction plans denoting where construction activities deviated from the design plans or where additional features are located. As-built mapping will include profile and cross section surveys of the channel, bridge and culvert, BDA's and large wood placement. Where possible benchmarks established during the design process will be used for post-project surveys. If these benchmarks are no longer functional after project construction, survey benchmarks will be established to permit monitoring surveys.

**Survey of Hydraulic Features:** Hydraulic monitoring will be conducted at the remediated crossings and engineered log jam and will be tied to survey benchmarks. Surveys will be conducted with an engineer's level or total station and measurements will be collected on the channel bed and water surface at the thalweg elevation. The surveys will be conducted once each year for two years following construction and will be compared to as built and design drawings to evaluate changes to the channel, including scour and sedimentation of instream hydraulic controls.

**Survey of Beaver Dam Analogs:** SRA will complete an evaluation of changes to the BDA's over time relative to the thalweg and how the maximum depth or jump height changes over time. Surveys should be conducted during typical winter base flows, SRA will examine habitat BDA's at low flows and record inundation widths and depths to evaluate if BDA's are functioning as designed.

## Biological Monitoring

The biological monitoring plan will assess the functional use of winter rearing habitat by Coho salmon. The biological sampling will be conducted by a qualified fisheries biologist with proper handing and sampling permits.

**Pre-Project Monitoring:** Two studies were recently published describing the seasonal habitat use of juvenile salmonids in the Smith River Plain (Parish and Garwood 2015, Parish and Garwood 2016). Multiple sites along Lower Stotenburg were sampled during these studies and these data will be used as baseline data on pre-project habitat use. Data will be used to compare juvenile salmonid seasonal access, migration timing, and minimum population of Coho use of the project area.

**Timing and Methods:** Due to variable flow and water clarity conditions experienced during winter, habitat use will be conducted using minnow traps baited with frozen salmon roe. This technique was used in past Lower Stotenburg monitoring research and will be most in line with comparing to pre-project data. If feasible, snorkel surveys and beach seines may be used to increase detection of juvenile salmonids.

Minnow traps will use sampling methods developed by Wallace and Allen (2009) can be used to identify, measure fork lengths (FL) and weigh juvenile salmonids. Gee R brand minnow traps are deployed on the substrate parallel to flow in areas with flow refuge and are secured with parachute cord to anchors and deployed for a period between 80 and 120 minutes. Minnow trapping locations will be sampled monthly and trapping locations will be sampled twice over two days using the same number of traps to account for detection rates. Trapping sites will be located in main and off-channel habitats, and replicated from pre-project data where feasible.

Sampling will include monthly water quality monitoring with a YSI Water Quality meter to measure dissolved oxygen, water temperature, salinity and water conductivity data throughout the site. No fish sampling will occur if water quality thresholds are not met. The Parish and Garwood (2015, 2016) studies successfully used water quality thresholds defined by Wallace and Allen (2009) as dissolved oxygen >3.5 mg/L, salinity <5ppt, and temperature <17 degrees C to prevent stress to salmonids.

**Sampling Results:** A qualified fisheries biologist will conduct data analysis. The data will be used to evaluate the duration of suitable conditions for salmonid occupancy, and assess if fish passage and habitat enhancements objectives were met.

Results from physical and biological monitoring surveys will be summarized in a brief memorandum provided to project funders and reporting will be completed for all state and federal permits.

**Vegetation Monitoring:** Vegetation will be monitored at the project site for 3 years following project construction. If needed, funding will be secured to continue riparian restoration and site maintenance after the initial 3-year period. Once planting is complete, monitoring plots will be established and baseline data on plant vigor and health will be collected. Surveys will inform adaptive management and include seedling survival plots to initiate replanting.

Non-native invasive vegetation will be monitored and managed for a period of 3 years following project construction. Invasive plant control is important for ensuring long term riparian health. Visual surveys will be conducted in the spring and fall to assess the abundance and growth of invasive plants within the riparian corridor to determine the best strategy for long-term invasive vegetation control within the project area.

# Maintenance

While the crossings and instream restoration features are designed to be self-maintaining, there is a possibility that BDA structures will fail. The North American beaver has been documented seasonally residing in Lower

Stotenburg (Parish and Garwood 2015, 2016) and may repair any such failure as has been seen on other BDA restoration sites. Furthermore the BDAs are designed to function independently, even though the reduncancy of the features increases stability. However, if a BDA failure is identified and deemed to not fulfil project objectives, maintenance activities will be initiated. Maintenance can include adding vegetative material to posts or adding additional supporting posts. Any maintenance actions will be conducted after consultation with fisheries biologists. Maintenance activities for any restoration element, if deemed necessary, will only be conducted with all necessary permits from CDFW, Army Corps of Engineers, Regional Water Quality Control Board and the County of Del Norte.

Vegetation maintenance actions may include but are not limited to invasive plant removal, additional mulching, replanting browsed plants, fixing or installing tree protection and re-painting trees to protect from beaver damage. Container plant and bare root survival will target 80% success. SRA or landscaping contractor will account for replanting up to 40% of container plants. Invasive vegetation management strategies will include individual plant removal, mowing, mulching or herbicide applications. Any herbicide application will be conducted by a licensed applicator using a product licensed for use near waterways, following all label instructions and taking measures to avoid discharge into water or native riparian vegetation. Following invasive plant control, riparian areas may be re-seeded or re-planted with desirable native vegetation.

## Adaptive Management

All habitat restoration conducted in this era of a rapidly changing climate is undertaken with a degree of uncertainty. It is essential that we learn from ecosystem responses to restoration work in order to find what works well and be able to scale restoration to the magnitude of species loss, habitat fragmentation and a rapidly changing climate. Monitoring and project evaluation is the first step towards understanding how to effectively restore the ecosystem processes that will support fish and wildlife species into the future. Project monitoring and evaluation at Lower Stotenburg will inform maintenance and future project Phases in Stotenburg Creek, as well as across the Smith River Plain and Pacific Northwest region.

Smith River Alliance
Lower Stotenburg Creek Fish Passage Project
Implementation Timeline

| Task | Deliverables | Start Date | End Date |
|---|---|---|---|
| Task 1 – Project Management | ✓ Contracts<br>✓ Invoices<br>✓ Annual Reports<br>✓ Final Report | April 15, 2021 | Ongoing<br>2 months after last report delivered. |
| Task 2 - Implementation Preparation, Permitting, and Environmental Compliance | ✓ Environmental compliance surveys<br>✓ CEQA review<br>✓ Submit and secure all necessary permits | April 1, 2021 | November 30, 2021 |
| Task 3 - Project construction/Implementation – crossing upgrades, instream and riparian restoration | ✓ Site prep and equipment mobilization<br>✓ Crossing demo/removal<br>✓ Installation of engineered log jam, willow baffles and Beaver Dam Analogs (BDA's)<br>✓ Installation of two crossings: One bridge and one culvert<br>✓ Riparian Restoration: Invasive plant removal, riparian planting, livestock exclusion fencing | July 1, 2022 | October 30, 2022 |
| Task 4 – Project Monitoring, Maintenance and Evaluation | ✓ Physical Monitoring: as built designs, low flow analysis, survey of hydraulic features and photo points.<br>✓ Biological Monitoring: Salmonid occupancy and distribution, fish passage, vegetation and seedling survival monitoring<br>✓ Riparian Maintenance: Replanting, mulching, browse protection invasive plant removal, fixing livestock exclusion fencing.<br>✓ Project Evaluation and Maintenance | November 1, 2022 | November 1, 2025 |

# LOWER STOTENBURG CREEK COHO HABITAT ENHANCEMENT FINAL DESIGN

## DEL NORTE COUNTY, CA

### GENERAL NOTES, TERMS, & CONDITIONS:

1. **DESIGN INTENT.** THESE DRAWINGS REPRESENT THE GENERAL DESIGN INTENT TO BE IMPLEMENTED AND CONTRACTOR IS RESPONSIBLE FOR ALL ITEMS SHOWN ON THESE PLANS. CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE PROJECT MANAGER FOR ANY CLARIFICATIONS OR FURTHER DETAILS NECESSARY TO ACCOMMODATE ACTUAL SITE CONDITIONS. ANY DEVIATION FROM THESE PLANS WITHOUT THE ENGINEER'S APPROVAL ARE AT THE CONTRACTOR'S OWN RISK AND EXPENSE. NOTIFY PROJECT MANAGER IMMEDIATELY OF ANY UNEXPECTED OR CHANGED CONDITIONS, SAFETY HAZARDS, OR ENVIRONMENTAL PROBLEMS ENCOUNTERED.

2. **JOB SITE CONDITIONS AND CONTRACTOR RESPONSIBILITY.** CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR SITE CONDITIONS DURING THE COURSE OF THE CONSTRUCTION OF THIS PROJECT, INCLUDING THE SAFETY OF ALL PERSONS AND PROPERTY, AND ALL ENVIRONMENTAL PROTECTION ELEMENTS, WHETHER SHOWN ON THESE DRAWINGS OR NOT. CONTRACTOR SHALL FOLLOW ALL APPLICABLE CONSTRUCTION AND SAFETY REGULATIONS. THESE REQUIREMENTS SHALL APPLY CONTINUOUSLY AND WILL NOT BE LIMITED TO NORMAL WORKING HOURS. THE CONTRACTOR SHALL DEFEND, INDEMNIFY, AND HOLD THE ENGINEER (STILLWATER SCIENCES) HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPT FROM LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE ENGINEER.

3. **DAMAGE.** CONTRACTOR SHALL EXERCISE CARE TO AVOID DAMAGE TO EXISTING PUBLIC AND PRIVATE PROPERTY, INCLUDING NATIVE TREES AND SHRUBS, AND OTHER PROPERTY IMPROVEMENTS. IF CONTRACTOR CAUSES DAMAGES TO SUCH ITEMS, THEY SHALL BE RESPONSIBLE FOR REPAIR OR REPLACEMENT IN LIKE NUMBER, KIND, CONDITION, AND SIZE. ANY SUCH COST MAY BE DEDUCTED FROM MONIES DUE CONTRACTOR UNDER THIS CONTRACT.

4. **LIMITS OF WORK, ACCESS, STAGING AND MOBILIZATION AREAS.** THE APPROXIMATE LIMITS OF WORK ARE SHOWN ON THE DRAWINGS. EXACT LIMITS OF WORK, POINTS OF INGRESS-EGRESS, CREEK CHANNEL ACCESS, MOBILIZATION, STAGING, AND WORK AREAS WILL BE FLAGGED IN THE FIELD BY THE ENGINEER. EQUIPMENT MAINTENANCE AND FUELING MUST OCCUR OUTSIDE OF THE CHANNEL AREA AS DESCRIBED IN THE ENVIRONMENTAL PERMITS FOR THE PROJECT.

5. **WORK IN STREAM CHANNELS AND STREAM DIVERSIONS.** ALL WORK INVOLVING USE OF HEAVY EQUIPMENT MUST BE COMPLETED FROM TOP OF BANK UNLESS A SPECIFIC POINT OF CREEK CHANNEL ACCESS HAS BEEN APPROVED AND IS SHOWN ON THE PLANS, AND THEN ONLY IN NON-LIVE WATER AS DEFINED BY CDFW. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING THE DEWATERING PLAN DEPICTED IN THIS PLAN SET.

5.1. CONTRACTOR IS RESPONSIBLE FOR REMOVAL AND DISPOSING OF ALL WATER CONTROL STRUCTURES AND EQUIPMENT.

5.2. THE CONTRACTOR SHALL FURNISH, INSTALL, AND OPERATE ALL OTHER NECESSARY MACHINERY, APPLIANCES, AND EQUIPMENT TO DIVERT FLOWING WATER AROUND WORK AREAS, AND TO KEEP EXCAVATIONS AND TRENCHES REASONABLY FREE FROM WATER DURING CONSTRUCTION. CONTRACTOR SHALL DISPOSE OF THE WATER SO AS NOT TO CAUSE INJURY TO PUBLIC OR PRIVATE PROPERTY, OR TO CAUSE A NUISANCE OR A MENACE TO THE PUBLIC, OR TO DEGRADE WATER QUALITY. THEY SHALL AT ALL TIMES HAVE ON HAND SUFFICIENT PUMPING EQUIPMENT AND MACHINERY IN GOOD WORKING CONDITION FOR ALL ORDINARY EMERGENCIES AND SHALL HAVE AVAILABLE AT ALL TIMES COMPETENT MECHANICS FOR THE OPERATION OF ALL PUMPING EQUIPMENT. IF THE CONTRACTOR CHOOSES TO USE A PUMPING SYSTEM FOR ANY PORTION OF THE WATER CONTROL WORK, THEY SHALL HAVE ADEQUATE BACK-UP EQUIPMENT TO ENSURE THE CONTINUOUS OPERATION OF THE EQUIPMENT.

5.3. THE CONTRACTOR SHALL AT ALL TIMES PROVIDE FOR THE ADEQUATE RETURN FLOW OF DIVERSIONS BELOW THE PROJECT SITE. THE CONTRACTOR MAY TEMPORARILY DIVERT WATER DURING CONSTRUCTION, AS OUTLINED IN THE APPROVED STREAM DIVERSION AND WATER CONTROL PLAN. THIS MAY INCLUDE FOR INSTANCE, VISQUEEN AND STRAW BALE OR SAND BAG DIVERSION DIKES AND PIPING SYSTEMS. RETURN FLOW SHALL BE FILTERED THROUGH FILTER CLOTH, STRAW BALES AND/OR THROUGH A SERIES OF STILLING BASINS WHEN REQUIRED.

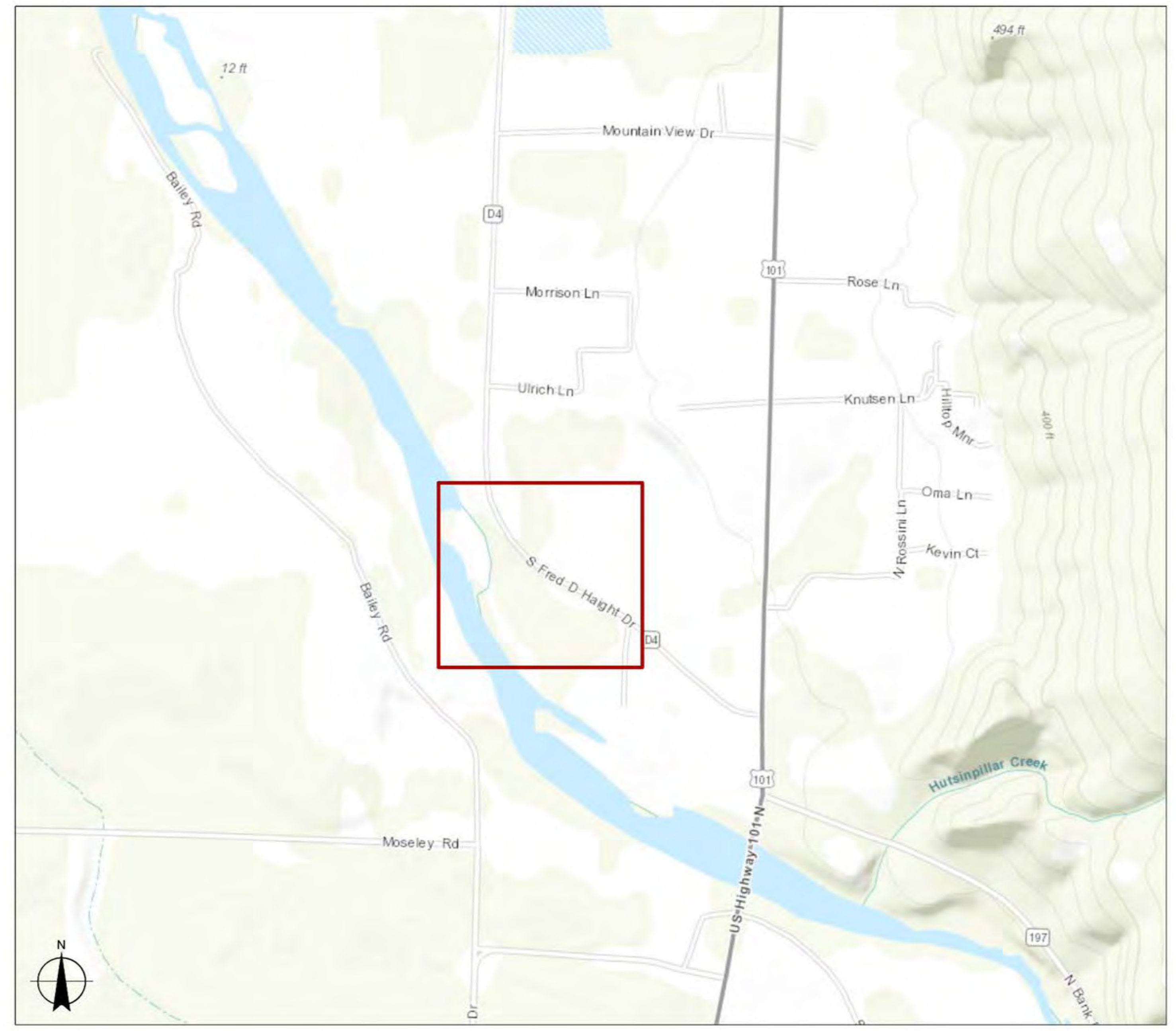
5.4. TURBID DEWATERING FLOWS SHALL BE PUMPED INTO A HOLDING FACILITY OR SPRAYED OVER A LARGE AREA OUTSIDE THE STREAM CHANNEL TO ALLOW FOR NATURAL INFILTRATION OF SEDIMENTS. AT NO TIME SHALL TURBID WATER FROM THE HOLDING FACILITY BE ALLOWED BACK INTO THE STREAM CHANNEL UNTIL WATER IS CLEAR OF SILT.

5.5. ALL HEAVY EQUIPMENT MUST HAVE A SUPPLY OF SORBENT PADS AVAILABLE TO CLEAN-UP GREASE, OIL, OR FUEL THAT DRIPS OR SPILLS INTO THE STREAM CHANNEL. USED PADS ARE TO BE DISPOSED OF PROPERLY AT CONTRACTOR'S EXPENSE.

6. **EARTHWORK QUANTITIES.** CONTRACTOR IS RESPONSIBLE FOR ALL EARTHWORK, INCLUDING GRADING, PROVISION AND PLACEMENT OF ROCK MEETING SIZE LIMITS, AS SHOWN ON DRAWINGS, AND DISPOSAL OF ALL EXCESS SOIL AND RUBBLE. EARTHWORK QUANTITIES, INCLUDING GRADING, PLACED ROCK SLOPE PROTECTION AND OFF-HAUL QUANTITY ESTIMATES PROVIDED BY THE ENGINEER ARE ESTIMATES ONLY. THE ENGINEER DOES NOT, EXPRESSLY OR OTHERWISE BY IMPLICATION, EXTEND ANY WARRANTY TO EARTHWORK CALCULATIONS

7. THE CONTRACTOR SHALL BE GIVEN COPIES OF ALL THE PERMITS, SHALL BECOME FAMILIAR WITH THE PERMIT REQUIREMENTS, AND SHALL BE RESPONSIBLE FOR ADHERENCE TO AND CONFORMANCE WITH ALL PERMIT CONDITIONS.
8. AREAS TO BE GRADED SHALL BE CLEARED OF ALL VEGETATION INCLUDING ROOTS AND OTHER UNSUITABLE MATERIAL FOR A STRUCTURAL FILL, THEN SCARIFIED TO A DEPTH OF 6 INCHES PRIOR TO PLACING OF ANY FILL.
9. AREAS WITH EXISTING SLOPES WHICH ARE TO RECEIVE FILL MATERIAL SHALL BE KEYED AND BENCHED.
10. FILL MATERIAL SHALL BE SPREAD IN LIFTS NOT EXCEEDING 6 INCHES IN COMPACTED THICKNESS, MOISTENED OR DRIED AS NECESSARY TO NEAR OPTIMUM MOISTURE CONTENT AND COMPACTED BY AN APPROVED METHOD. FILL MATERIAL SHALL BE COMPACTED TO A MINIMUM OF 90% MAXIMUM DENSITY AS DETERMINED BY 1957 ASTM D - 1557 - 91 MODIFIED PROCTOR (AASHO) TEST OR SIMILAR APPROVED METHODS.
11. CUT SLOPES SHALL NOT EXCEED A GRADE OF 1.5 HORIZONTAL TO 1 VERTICAL. FILL AND COMBINATION FILL AND CUT SLOPES SHALL NOT EXCEED 2 HORIZONTAL TO 1 VERTICAL. SLOPES OVER THREE FEET IN VERTICAL HEIGHT SHALL BE PLANTED WITH APPROVED PERENNIAL OR TREATED WITH EQUALLY APPROVED EROSION CONTROL MEASURES PRIOR TO FINAL INSPECTION.
12. BEST MANAGEMENT PRACTICES FOR CONSTRUCTION ACTIVITIES: ERODED SEDIMENTS AND OTHER POLLUTANTS MUST BE RETAINED ONSITE AND MAY NOT BE TRANSPORTED FROM THE SITE VIA SHEET FLOW, SWALES, AREA DRAINS, NATURAL DRAINAGE COURSES, OR WIND. STOCKPILES OF EARTH AND OTHER CONSTRUCTION RELATED MATERIALS MUST BE PROTECTED FROM BEING TRANSPORTED FROM THE SITE BY THE FORCES OF WIND OR WATER. FUELS, OILS, SOLVENTS, AND OTHER TOXIC MATERIALS MUST BE STORED IN ACCORDANCE WITH THEIR LISTING AND ARE NOT TO CONTAMINATE THE SOIL AND SURFACE WATERS. ALL APPROVED STORAGE CONTAINERS ARE TO BE PROTECTED FROM THE WEATHER. SPILLS MAY NOT BE WASHED INTO THE DRAINAGE SYSTEM. TRASH AND CONSTRUCTION RELATED SOLID WASTE MUST BE DEPOSITED INTO A COVERED WASTE RECEPTACLE TO PREVENT CONTAMINATION OF RAINWATER AND DISPERSAL BY WIND. SEDIMENTS AND OTHER MATERIAL MAY NOT BE TRACKED FROM TO THE SITE BY VEHICLE TRAFFIC.

### VICINITY MAP




### PROJECT LOCATION MAP


| Sheet List Table | |
|---|---|
| Sheet Number | Sheet Title |
| 1 | TITLE SHEET |
| 2 | PLAN OVERVIEW |
| 3 | STOTENBURG 1+00 TO 11+00 |
| 4 | STOTENBURG 1+00 TO 11+00 CROSS SECTIONS |
| 5 | STOTENBURG 11+00 TO 21+00 |
| 6 | STOTENBURG 21+00 TO END |
| 7 | DEWATERING PLAN |
| 8 | PLANTING PLAN |
| 9 | CULVERT AND BRIDGE DETAILS |
| 10 | ENGINEERED LOG JAM (ELJ) |
| 11 | DETAILS |
| 12 | DETAILS |

### EARTHWORK ESTIMATES:

CUT: 888 CY

IMPORT:
200 CY 0.5-2 TON RIPRAP ROCK
34 PIECES LARGE WOOD

FILL:
719 CY ON-SITE

NET: 169 CUBIC YARDS CUT

### ABBREVIATIONS AND SYMBOLS:

<E> EXISTING

<P> PROPOSED

3 — DETAIL # ON SHEET
8 — SHEET #

LOWER STOTENBURG CREEK COHO HABITAT ENHANCEMENT FINAL DESIGN

DEL NORTE COUNTY, CA


Stillwater Sciences
850 G STREET SUITE K
ARCATA, CA 95521 P: (707) 822-9607


SMITH RIVER ALLIANCE

PROJECT NUMBER: 765.00
SCALE: AS NOTED
DATE: 10/7/2019

DESIGN: DC/JM
DRAWN: RT
CHECKED: DC/JM
APPROVED: JM

TITLE SHEET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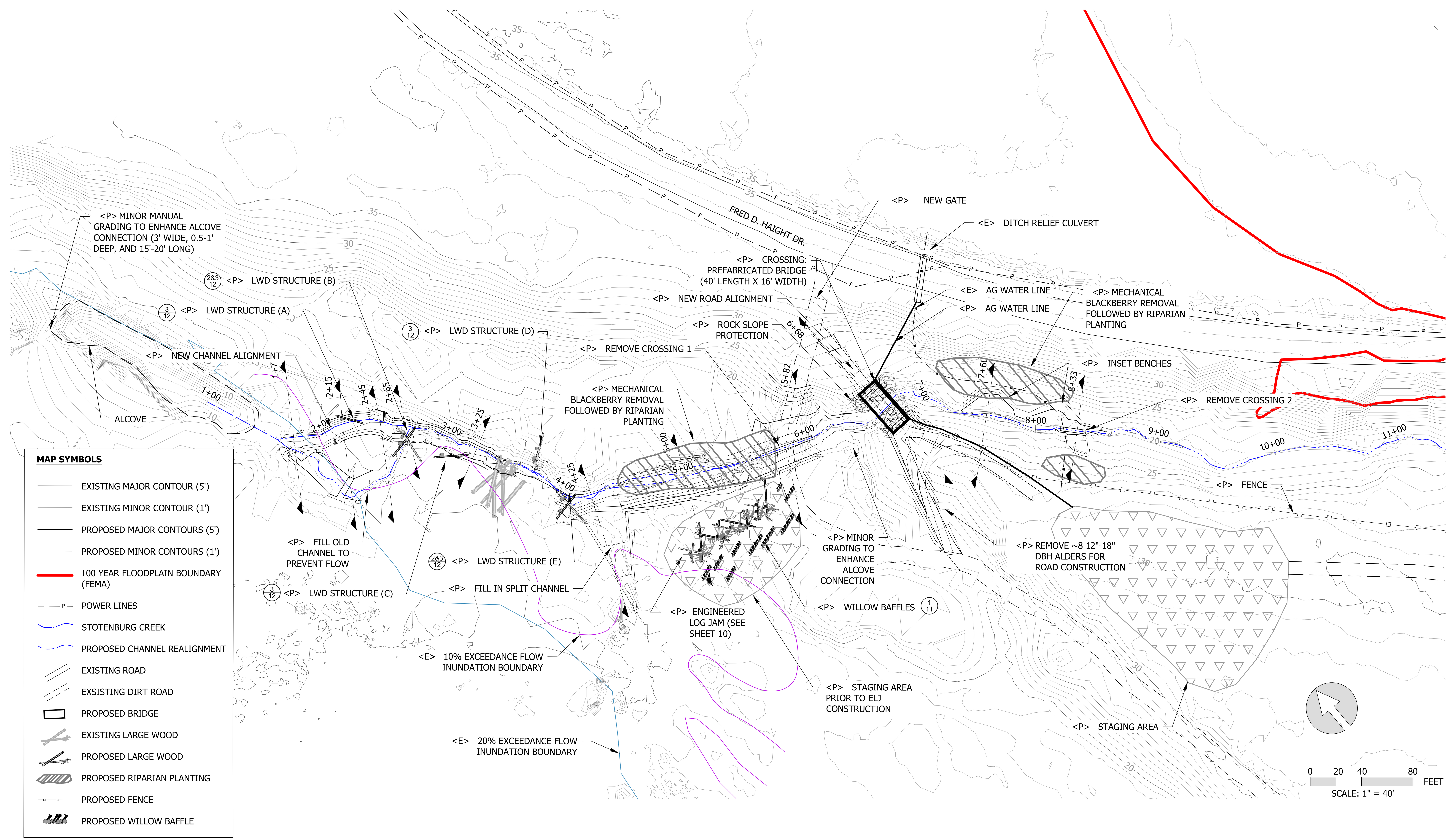
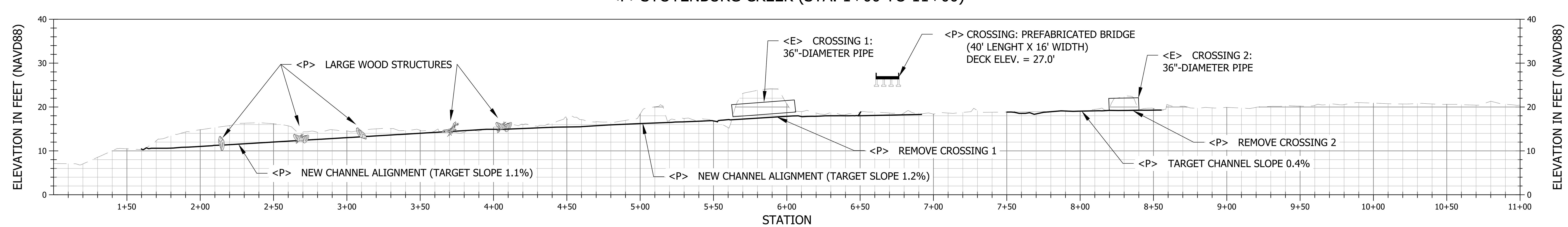
REGISTERED PROFESSIONAL ENGINEER
JOEL MONSCHKE
C 79688
EXP 9/20
CIVIL
STATE OF CALIFORNIA

PLAN OVERVIEW

SHEET 2 OF 12




## <P>STOTENBURG CREEK (STA. 1+00 TO 11+00)

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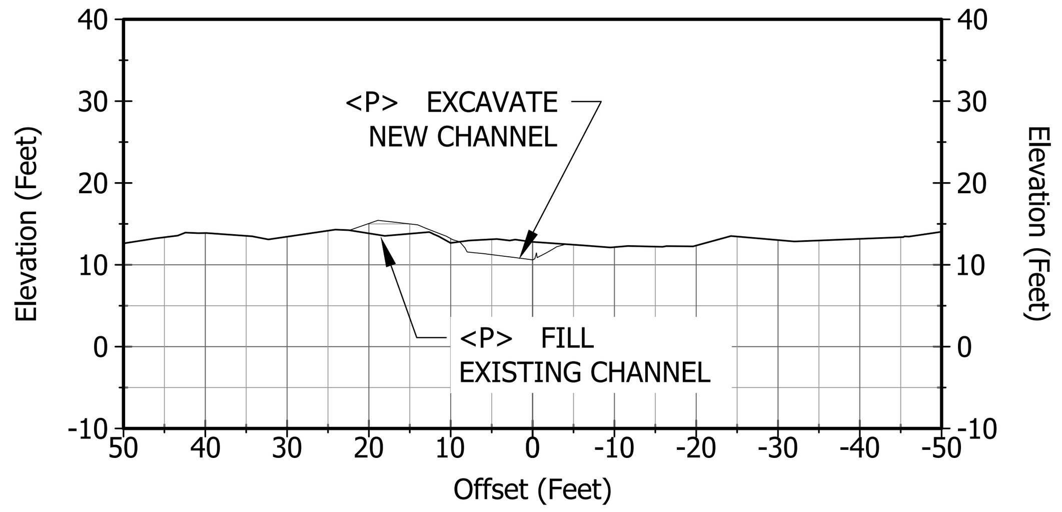
REGISTERED PROFESSIONAL ENGINEER JOEL MONSCHKE C 79688 EXP 9/30 CIVIL STATE OF CALIFORNIA

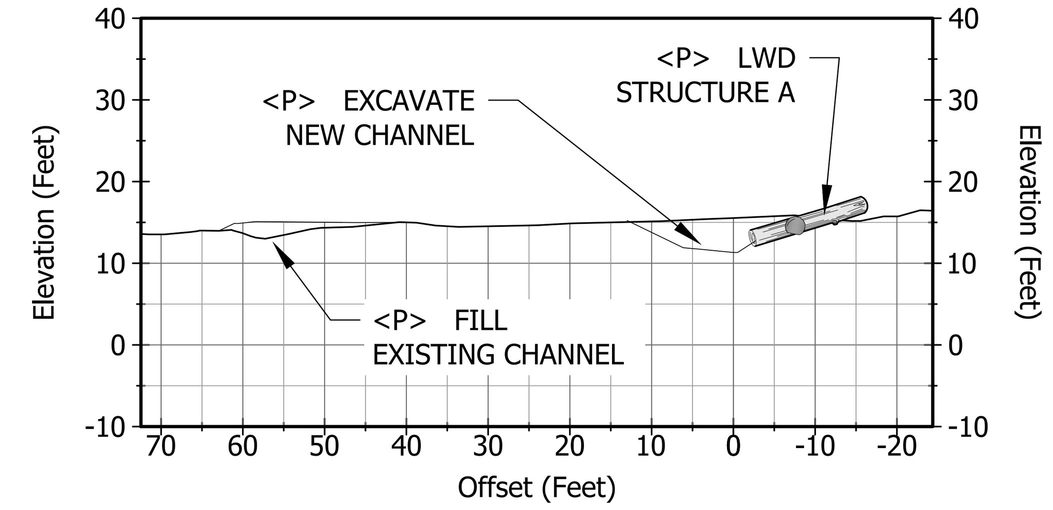
STOTENBURG 1+00 TO 11+00

SHEET 3 OF 12

1+75




2+15

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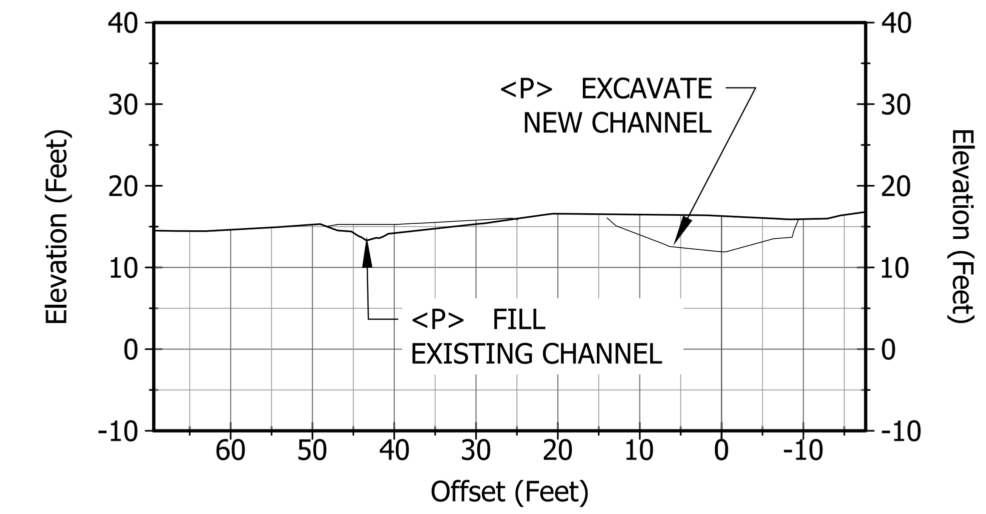


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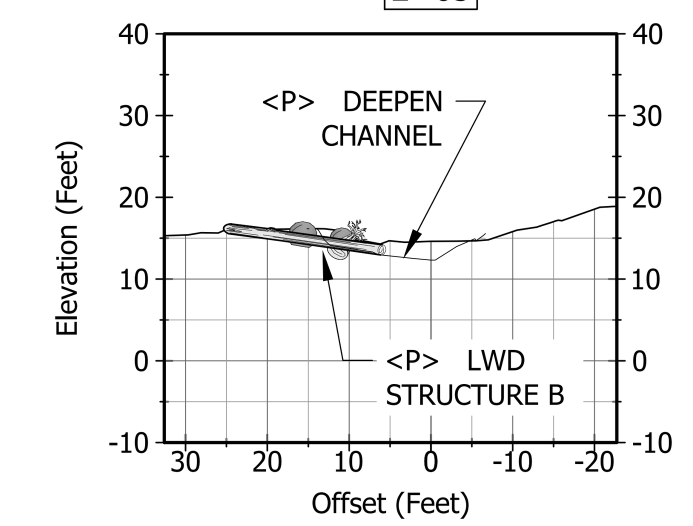
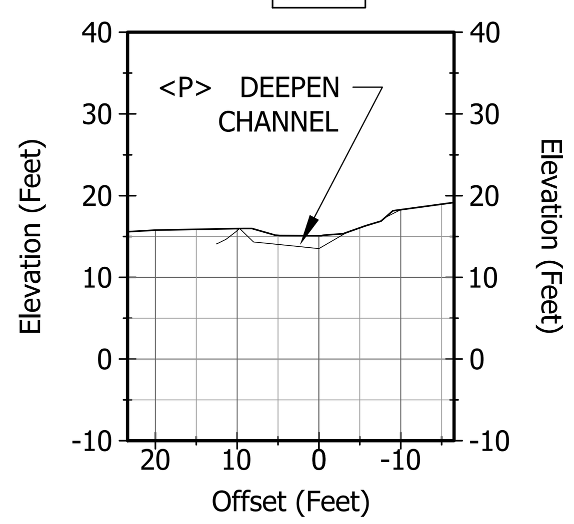



3+25

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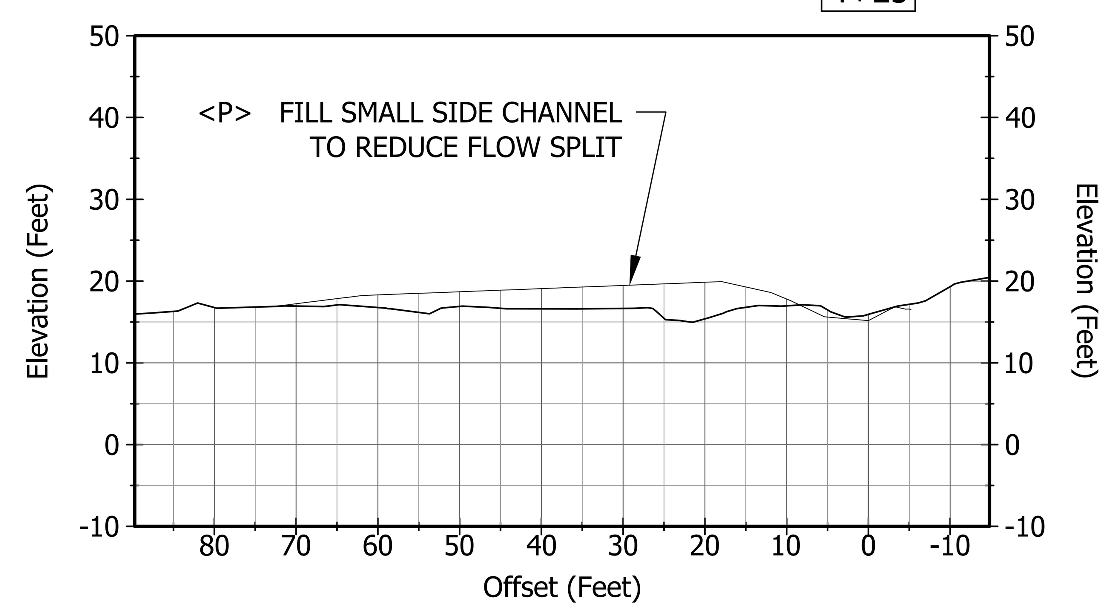
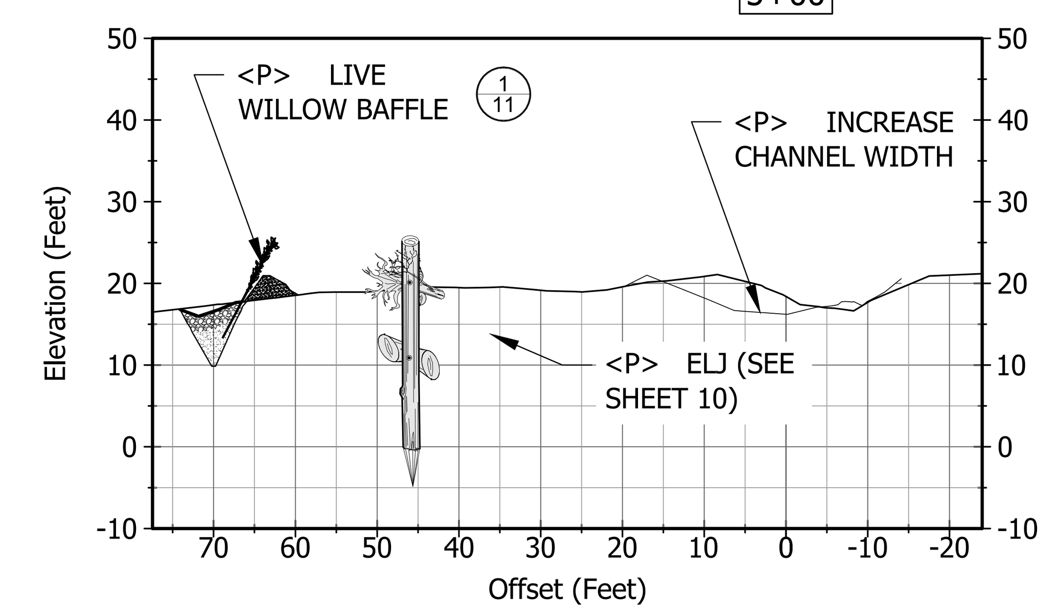
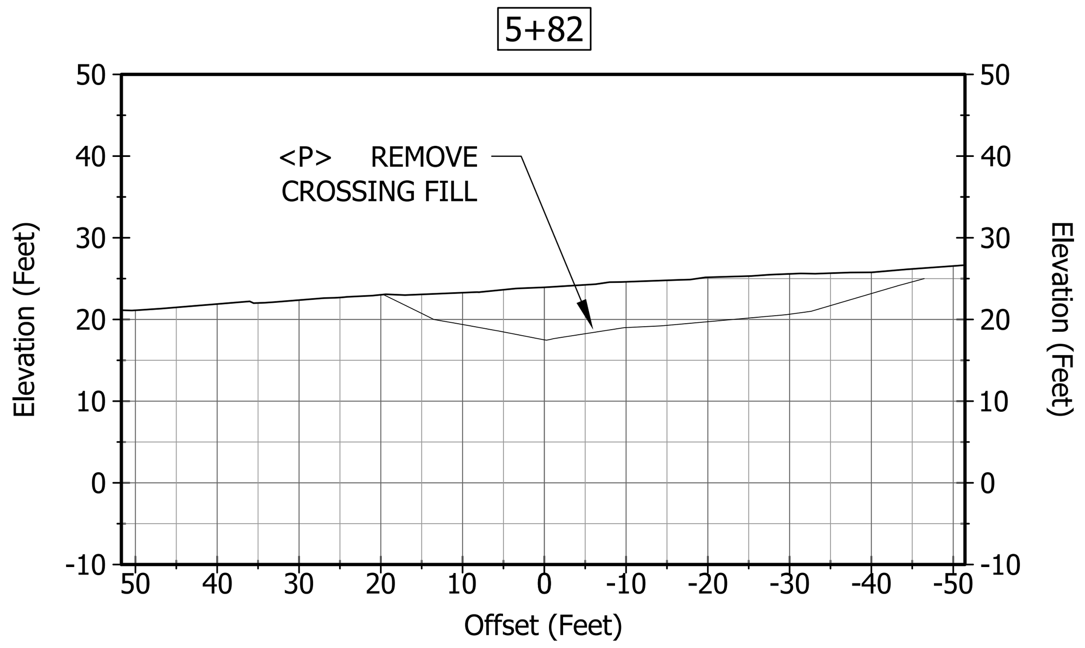


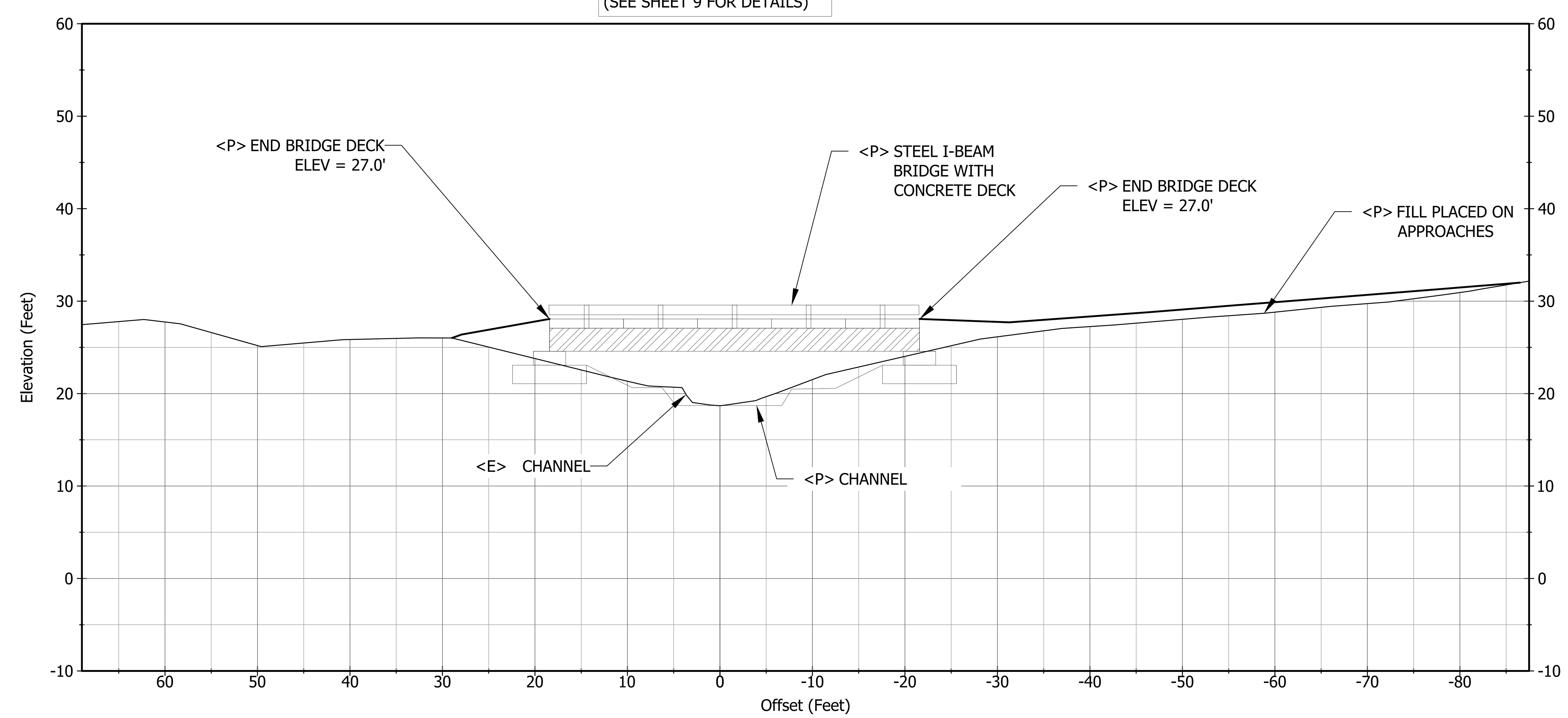

5+00



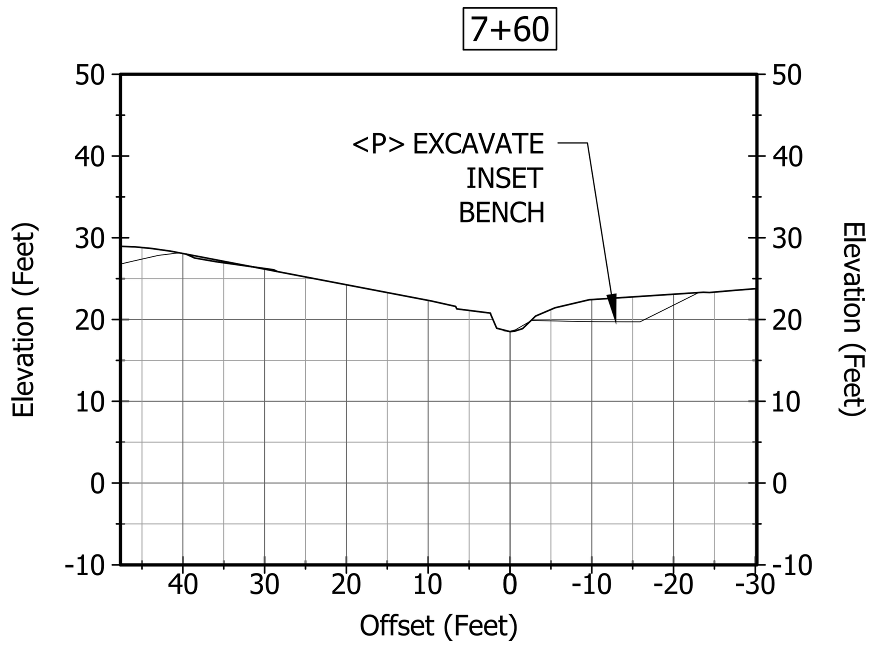

5+82




6+68 PREFABRICATED BRIDGE
(SEE SHEET 9 FOR DETAILS)




7+60

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REGISTERED PROFESSIONAL ENGINEER
JOEL MONSCHKE
C 79688
EXP 9/30
CIVIL
STATE OF CALIFORNIA

STOTENBURG 1+00 TO 11+00 CROSS SECTIONS

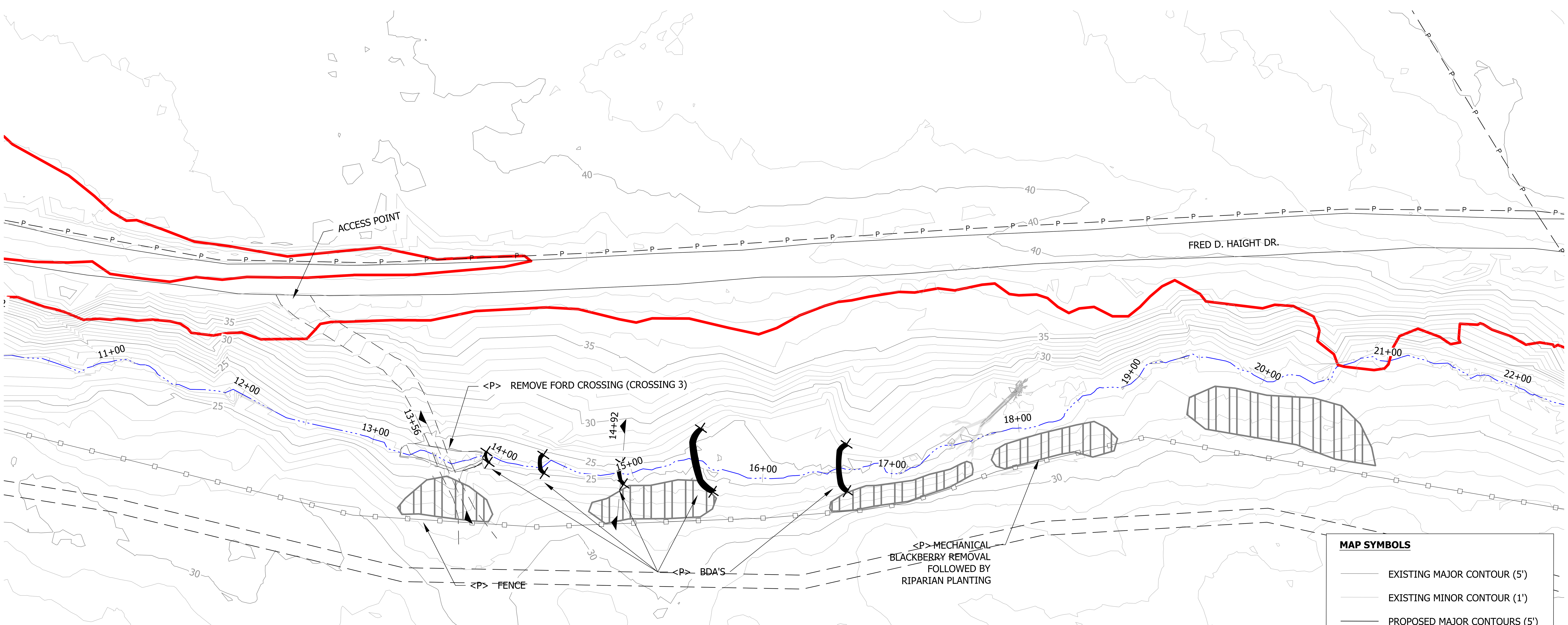
SHEET 4 OF 12

# LOWER STOTENBURG CREEK COHO HABITAT ENHANCEMENT FINAL DESIGN

DEL NORTE COUNTY, CA

Stillwater Sciences
850 G STREET SUITE K
ARCATA, CA 95521 P: (707) 822-9607

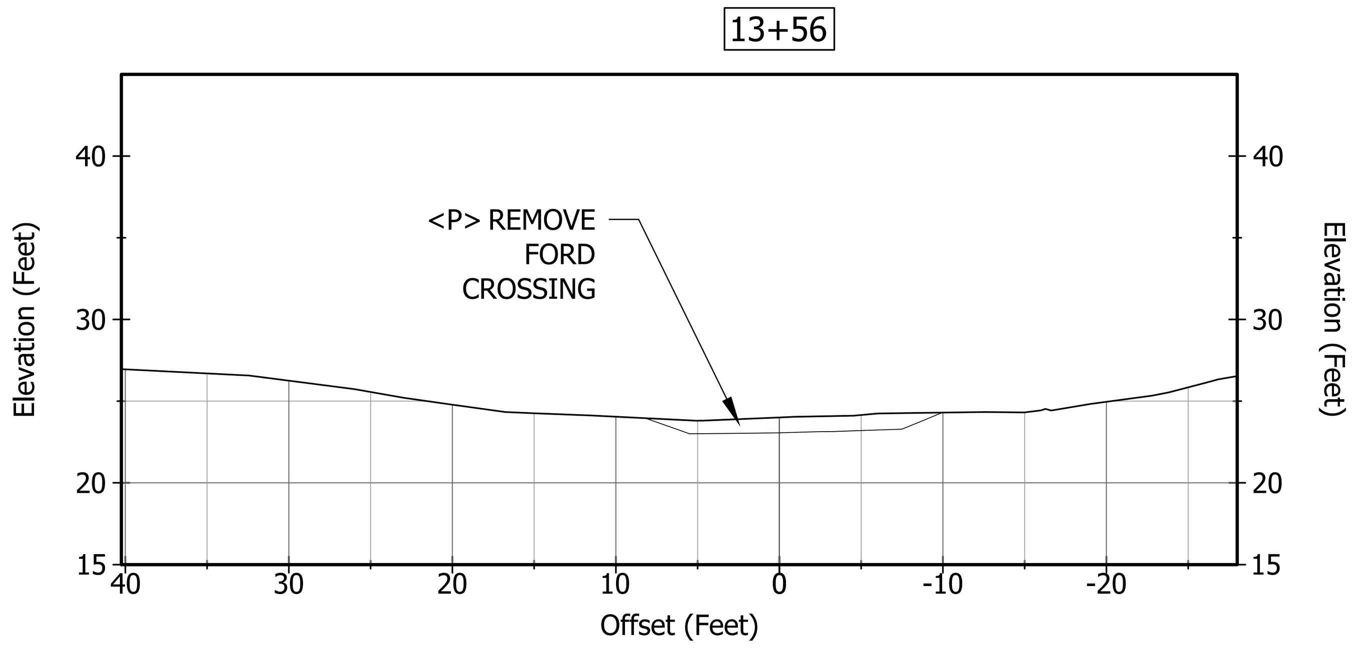
SMITH RIVER ALLIANCE



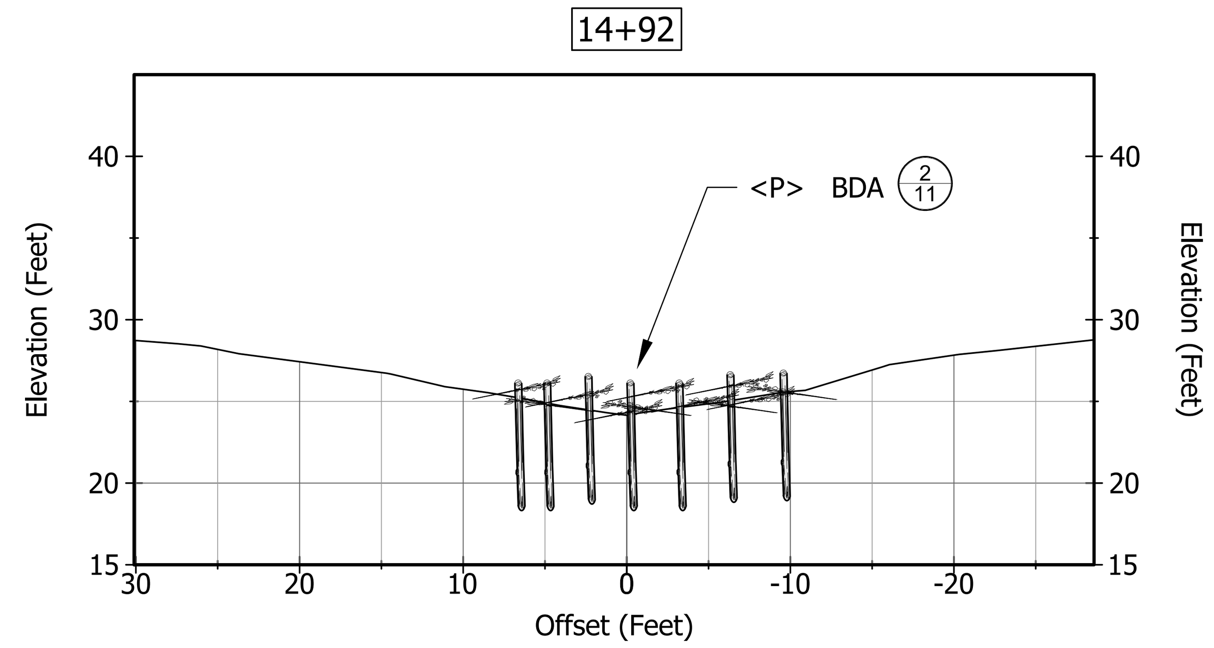

**MAP SYMBOLS**

- EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- PROPOSED MAJOR CONTOURS (5')
- PROPOSED MINOR CONTOURS (1')
- 100 YEAR FLOODPLAIN BOUNDARY (FEMA)
- POWER LINES
- STOTENBURG CREEK
- PROPOSED CHANNEL REALIGNMENT
- EXISTING ROAD
- EXSISTING DIRT ROAD
- EXISTING LARGE WOOD
- PROPOSED BDA
- PROPOSED RIPARIAN PLANTING
- PROPOSED FENCE

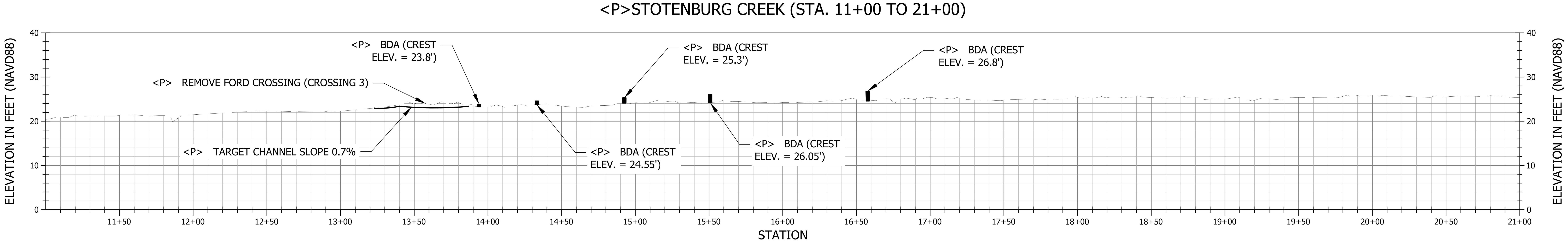
13+56




14+92




<P>STOTENBURG CREEK (STA. 11+00 TO 21+00)

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APPROVED: JM

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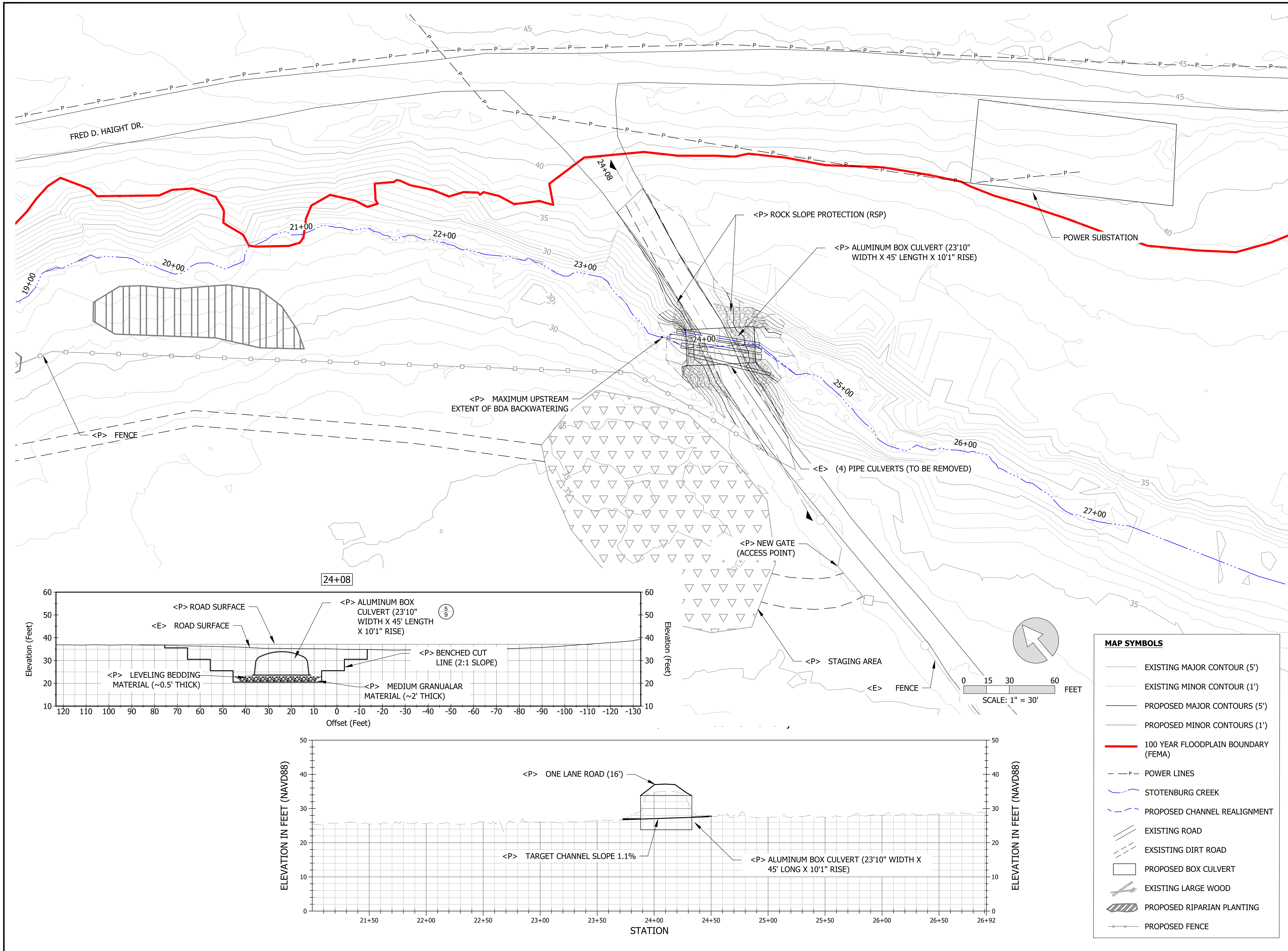
STOTENBURG 11+00 TO 21+00

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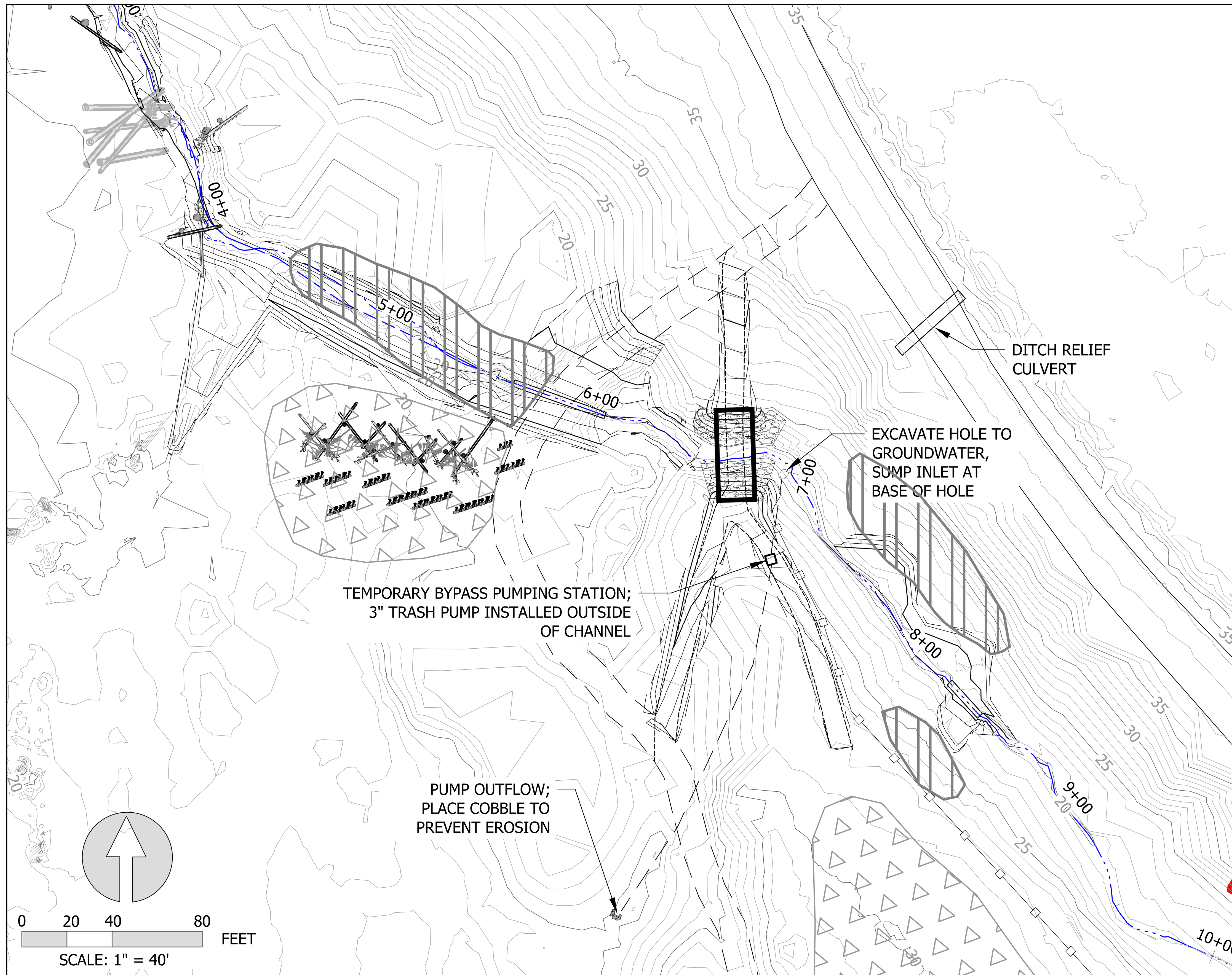
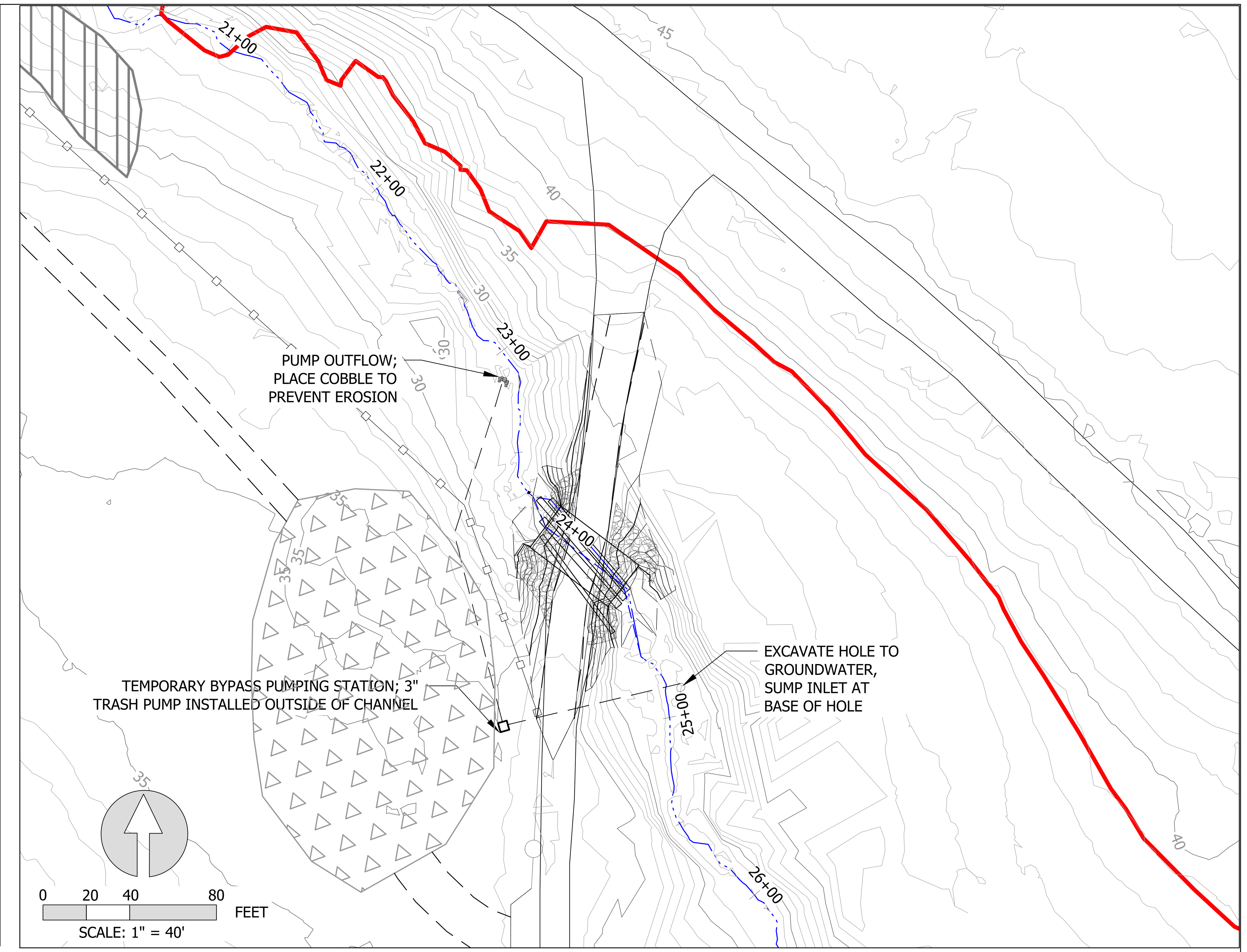
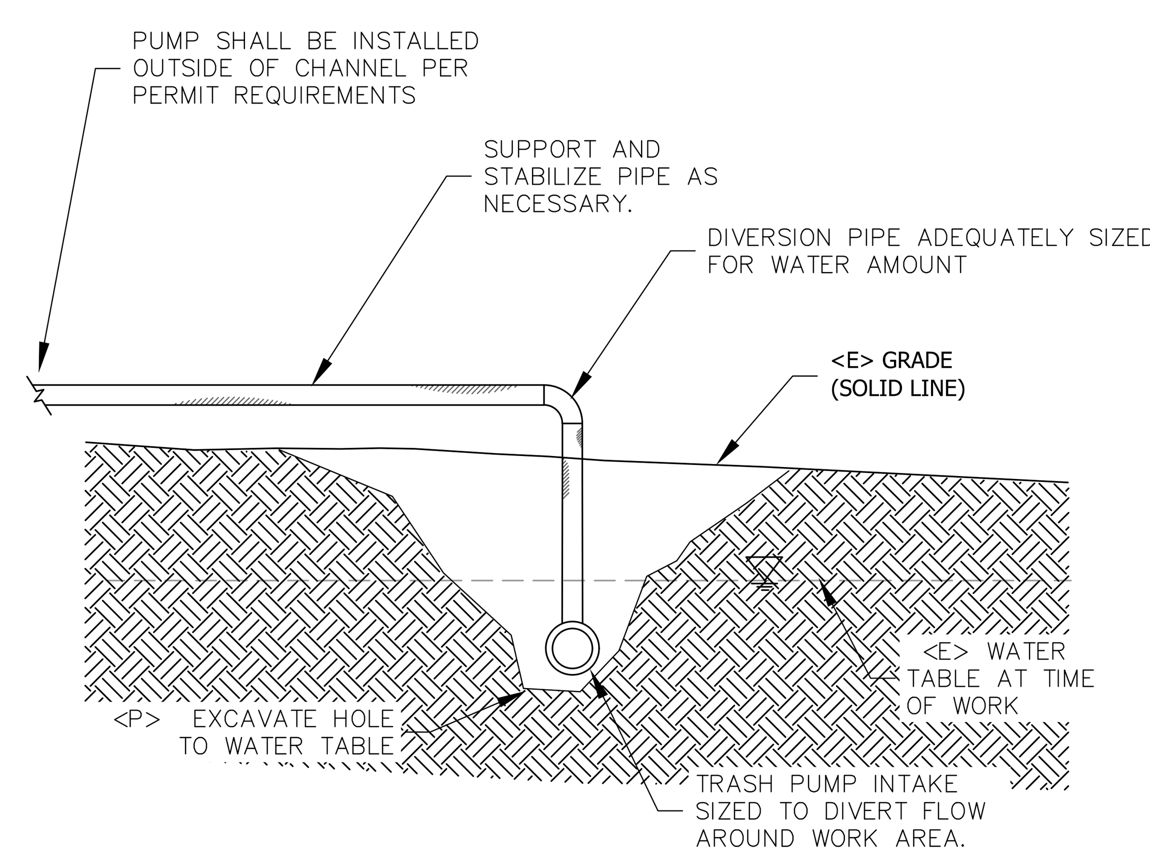
STOTENBURG 21+00 TO END




1 **DEWATERING SUMP**

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- PROPOSED WILLOW BAFFLE

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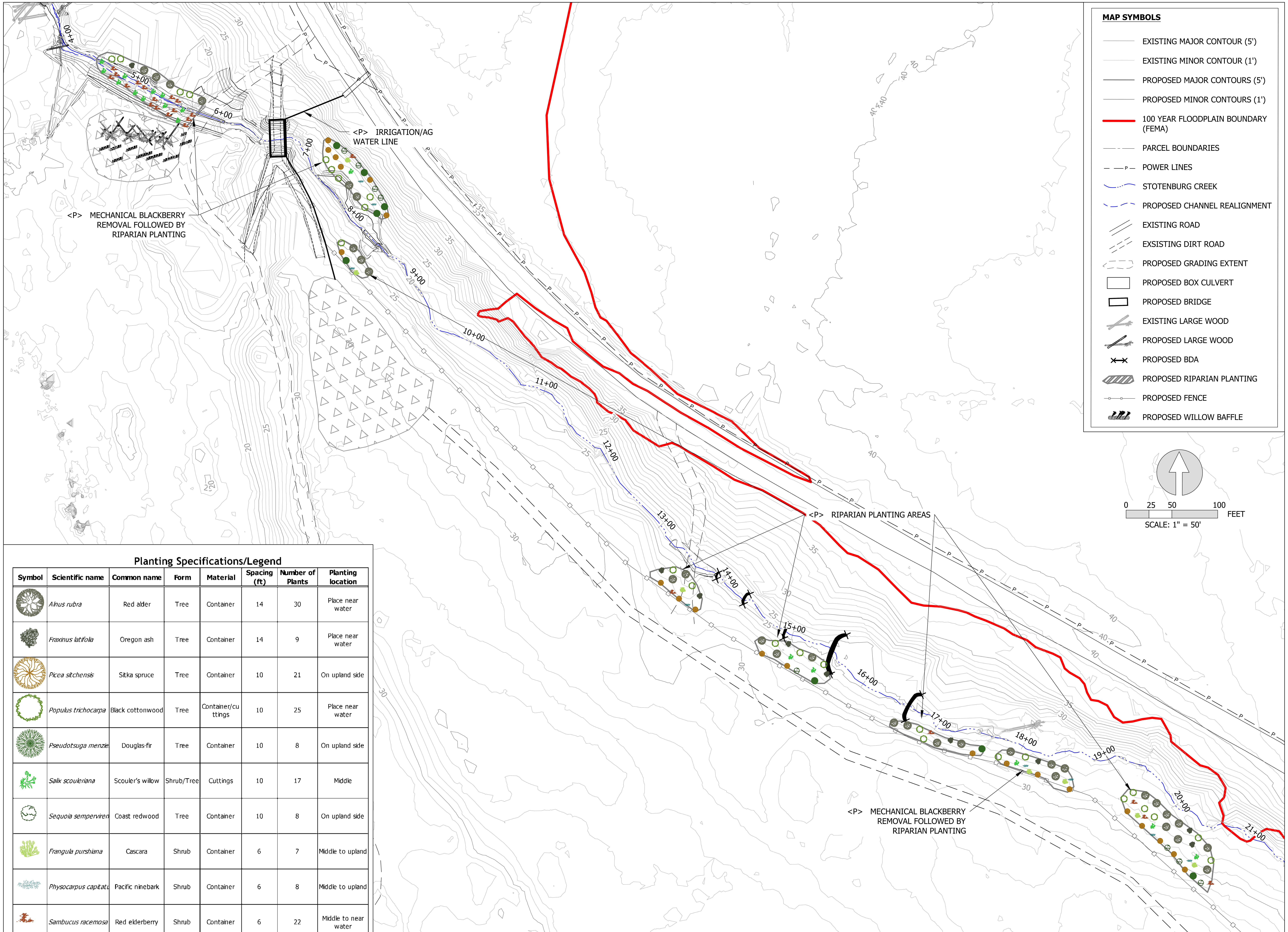
DEWATERING PLAN




## Planting Specifications/Legend

| Symbol | Scientific name | Common name | Form | Material | Spacing (ft) | Number of Plants | Planting location |
|---|---|---|---|---|---|---|---|
| | *Alnus rubra* | Red alder | Tree | Container | 14 | 30 | Place near water |
| | *Fraxinus latifolia* | Oregon ash | Tree | Container | 14 | 9 | Place near water |
| | *Picea sitchensis* | Sitka spruce | Tree | Container | 10 | 21 | On upland side |
| | *Populus trichocarpa* | Black cottonwood | Tree | Container/cuttings | 10 | 25 | Place near water |
| | *Pseudotsuga menzie* | Douglas-fir | Tree | Container | 10 | 8 | On upland side |
| | *Salix scouleriana* | Scouler's willow | Shrub/Tree | Cuttings | 10 | 17 | Middle |
| | *Sequoia sempervirens* | Coast redwood | Tree | Container | 10 | 8 | On upland side |
| | *Frangula purshiana* | Cascara | Shrub | Container | 6 | 7 | Middle to upland |
| | *Physocarpus capitatu* | Pacific ninebark | Shrub | Container | 6 | 8 | Middle to upland |
| | *Sambucus racemosa* | Red elderberry | Shrub | Container | 6 | 22 | Middle to near water |

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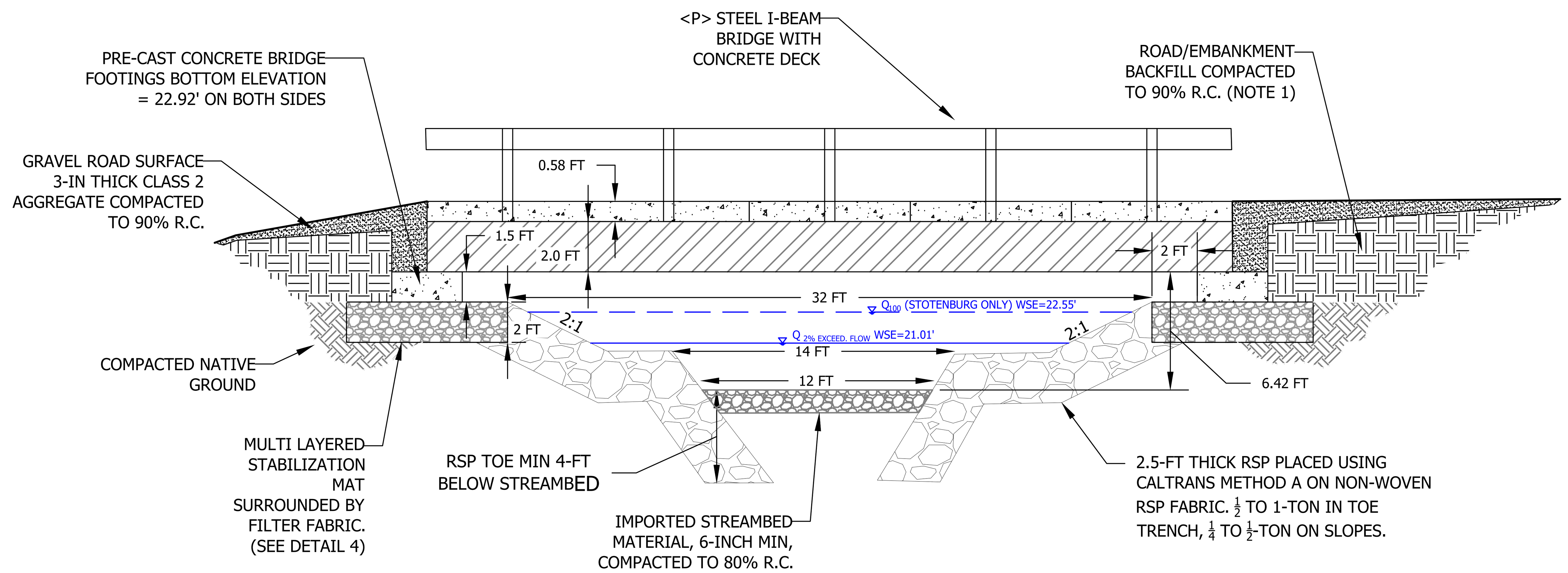
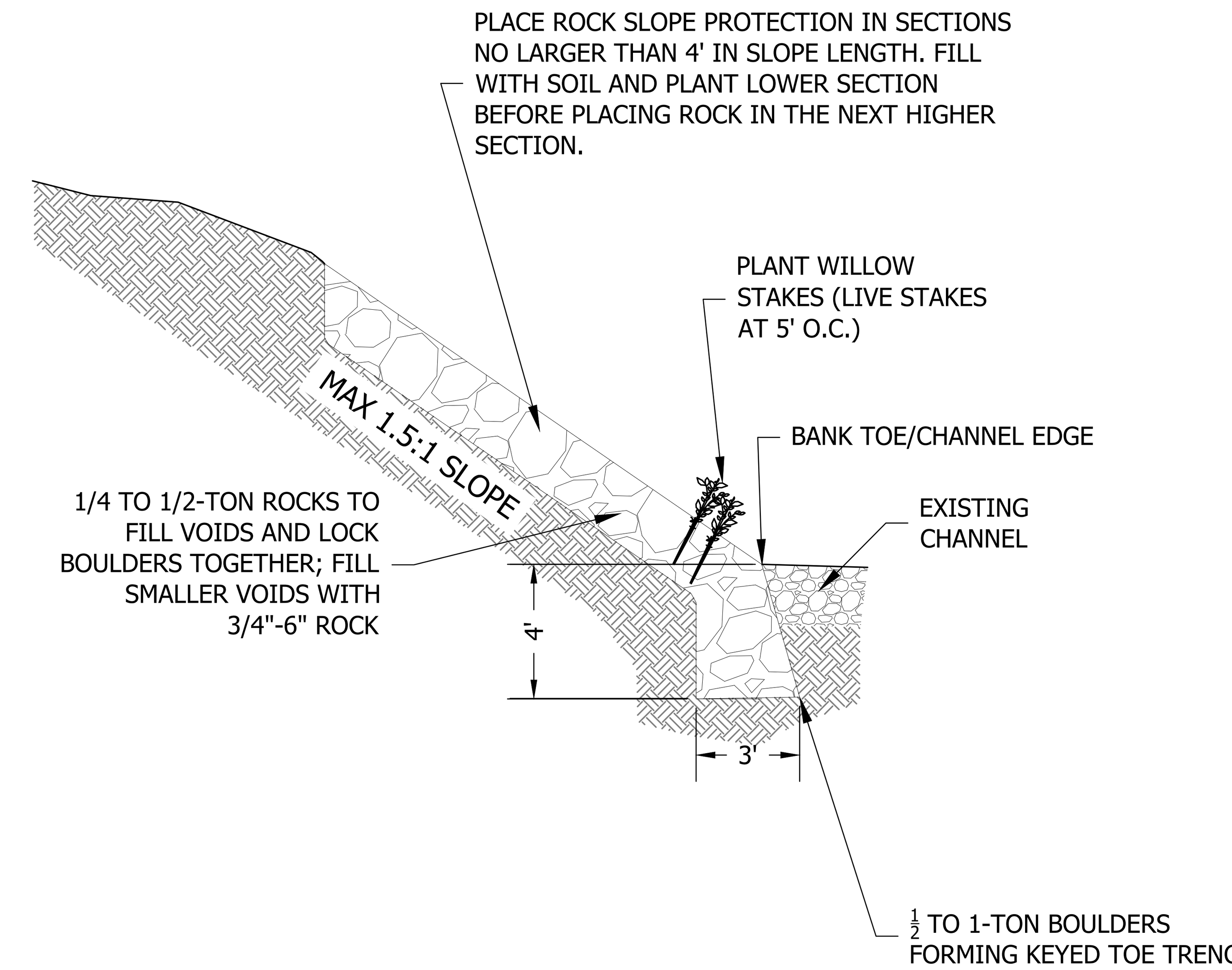
PLANTING PLAN



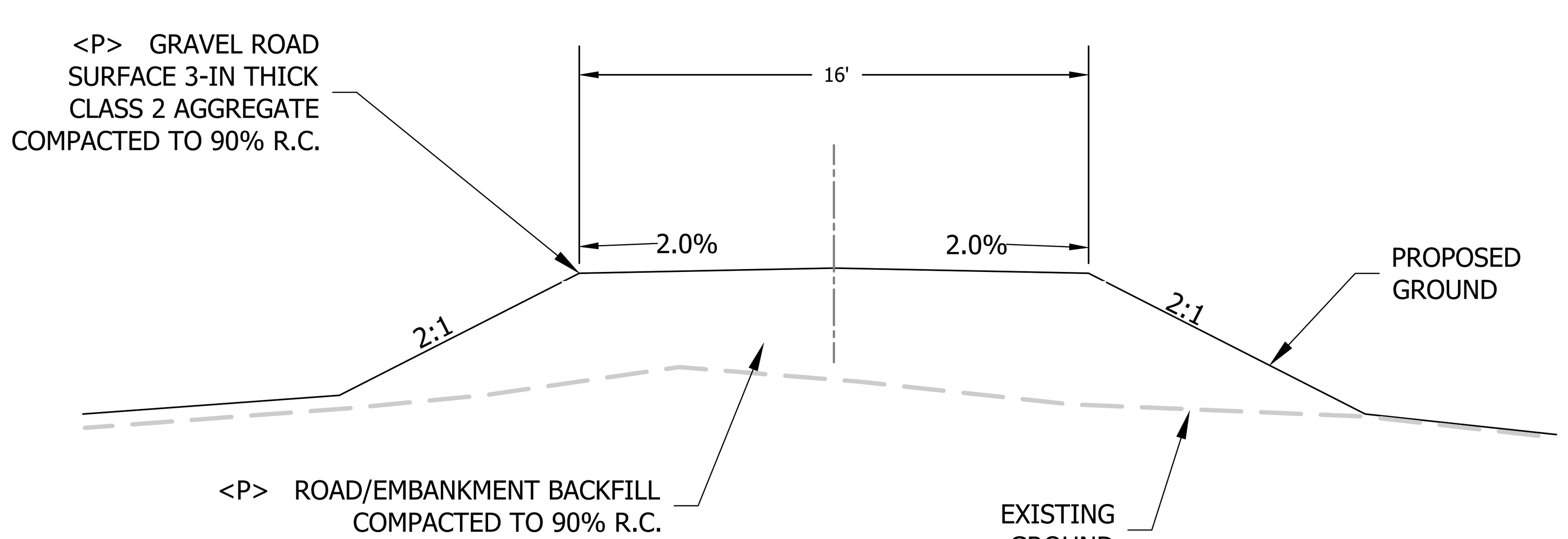

1 **CHANNEL SECTION AT BRIDGE**

0 5 10 Feet



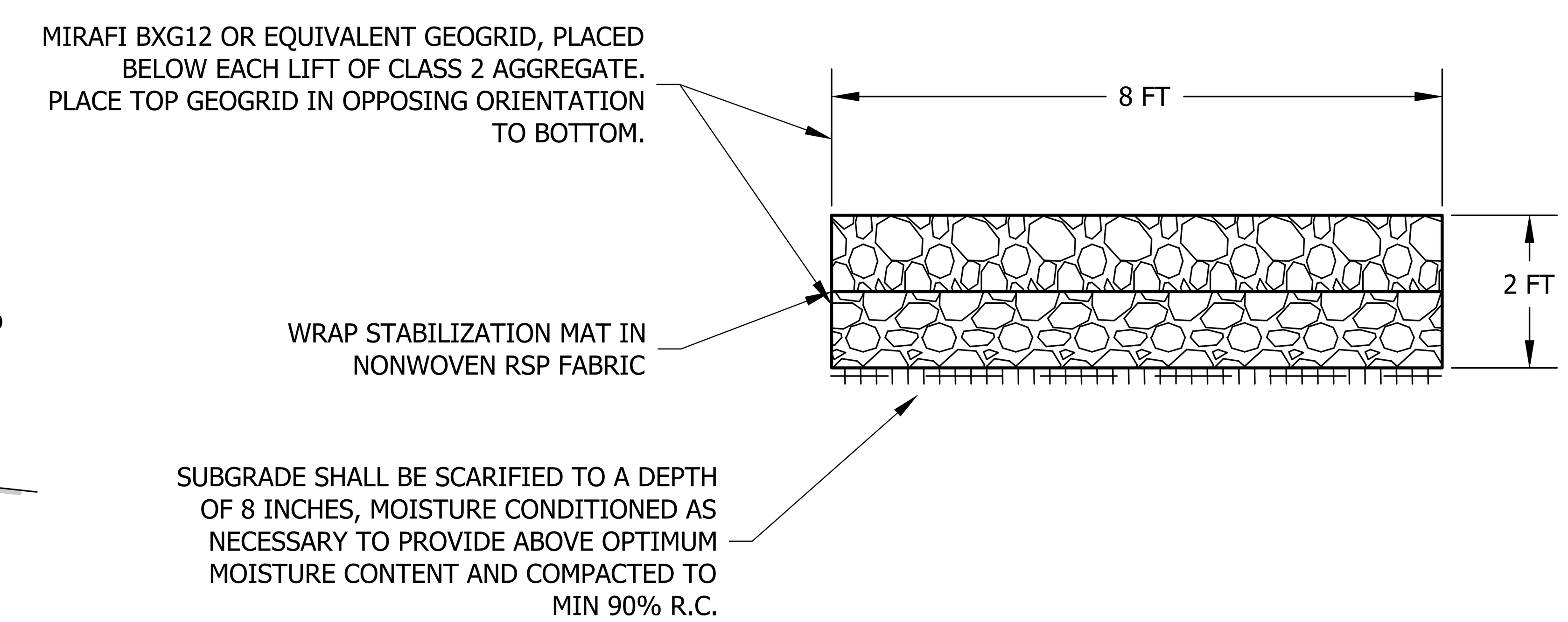

2 **WILLOW PLANTED ROCK SLOPE PROTECTION (RSP)**

NTS



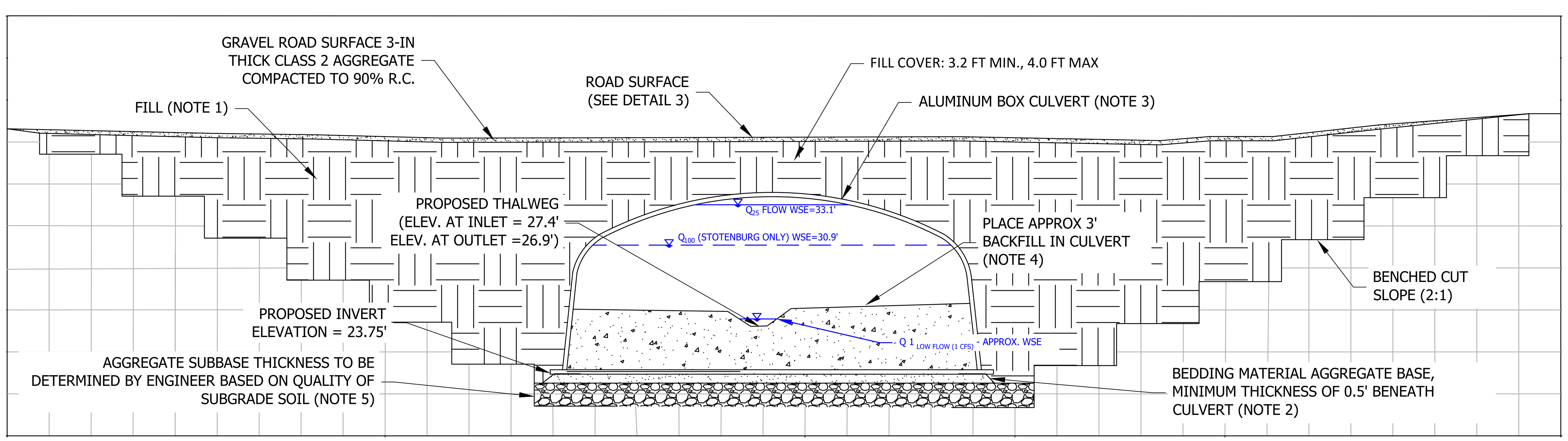

3 **TYPICAL ROAD SECTION**

0 5 10 Feet




4 **MULTILAYER STABILIZATION MAT**

0 2 4 Feet




5 **BOX CULVERT**

0 5' 10'

NOTES:

1. ENGINEERED FILL: WHERE FILL IS TO BE PLACED BEHIND OR ABOVE THE REINFORCED SOIL ZONE, IT SHALL CONSIST OF SOIL AND/OR SOIL-AGGREGATE MIXTURES GENERALLY LESS THAN 4 INCHES IN MAXIMUM DIMENSION, FREE OF VISIBLE ORGANIC OR OTHER DELETERIOUS DEBRIS, AND HAVE A LOW PLASTICITY (PI<6). TYPICALLY, WELL-GRADED MIXTURES OF GRAVEL, SAND, NON-PLASTIC SILT, AND SMALL QUANTITIES (LESS THAN 15 PERCENT) OF CLAY ARE ACCEPTABLE FOR USE AS ENGINEERED FILL ENGINEERED FILL SHALL BE UNIFORMLY MOISTURE-CONDITIONS TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT, PLACED IN HORIZONTAL LIFTS LESS THAN 8 INCHES IN LOOSE THICKNESS, AND COMPACTED TO AT LEAST 95 PERCENT RELATIVE COMPACTION DETERMINED IN ACCORDANCE WITH AASHTO T180.
2. BEDDING MATERIAL: CRUSHED STONE CONFORMING TO CALTRANS CLASS 2 AGGREGATE BASE ARE ACCEPTABLE BEDDING MATERIALS. BEDDING MATERIAL SHALL BE UNIFORMLY MOISTURE-CONDITIONED TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT, PLACED IN HORIZONTAL LIFTS OF LESS THAN 8 INCHES IN LOOSE THICKNESS, AND COMPACTED TO AT LEAST 95 PERCENT RELATIVE COMPACTION DETERMINED IN ACCORDANCE WITH AASHTO T180.
3. BOX CULVERT: 23'10" WIDTH X 45' LENGTH X 10'1" RISE CORRUGATED ALUMINUM BOX CULVERT BY CONTECH ENGINEERED SOLUTIONS, OR AN APPROVED EQUAL. THE BOX CULVERT SHALL BE INSTALLED PURSUANT TO THE MANUFACTURER'S RECOMMENDATIONS.
4. SELECT CULVERT BACKFILL: COMPOSED OF NATIVE STREAM BED MATERIAL CONSISTING OF SILT, SAND, AND SMALL GRAVEL. CULVERT BACKFILL SHALL BE PLACED TO AN ELEVATION OF 3'5" ABOVE THE BOTTOM OF THE CULVERT TO PROVIDE A STABLE, NATURAL SUBSTRATE. A 0.75' DEEP BY 3' WIDE CHANNEL SHALL BE CONSTRUCTED WITHIN THE SURFACE OF THE BACKFILL TO PROVIDE A NARROW CHANNEL TO ENSURE ADEQUATE FLOW DEPTH UNDER LOW FLOW CONDITIONS.
5. AGGREGATE SUBBASE: AGGREGATE SUBBASE BENEATH THE CULVERT SHALL CONFORM TO CALTRANS CLASS 1 AGGREGATE SUBBASE. IT SHALL BE UNIFORMLY MOISTURE-CONDITIONED TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT, PLACED IN HORIZONTAL LIFTS LESS THAN 8 INCHES IN LOOSE THICKNESS, AND COMPACTED TO AT LEAST 95 PERCENT RELATIVE COMPACTION DETERMINED IN ACCORDANCE WITH AASHTO T180.
6. "STOTENBURG ONLY" FLOWS DO NOT ACCOUNT FOR BACKWATERING FROM THE SMITH RIVER AND ONLY MODEL DISCHARGE FROM THE STOTENBURG CREEK WATERSHED. THESE FLOWS WERE MODELED TO SIMULATE AN EARLY-SEASON SCENARIO WHERE STOTENBURG CREEK QUICKLY RESPONDS TO A LARGE STORM EVENT BEFORE THE SMITH RIVER WATER SURFACE ELEVATION BACKWATERS THE PROJECT REACH. FLOW VELOCITY THROUGH THE CROSSINGS WOULD BE SUBSTANTIALLY GREATER UNDER THIS SCENARIO COMPARED TO WHEN THE CREEK IS BACKWATERED BY THE SMITH RIVER.

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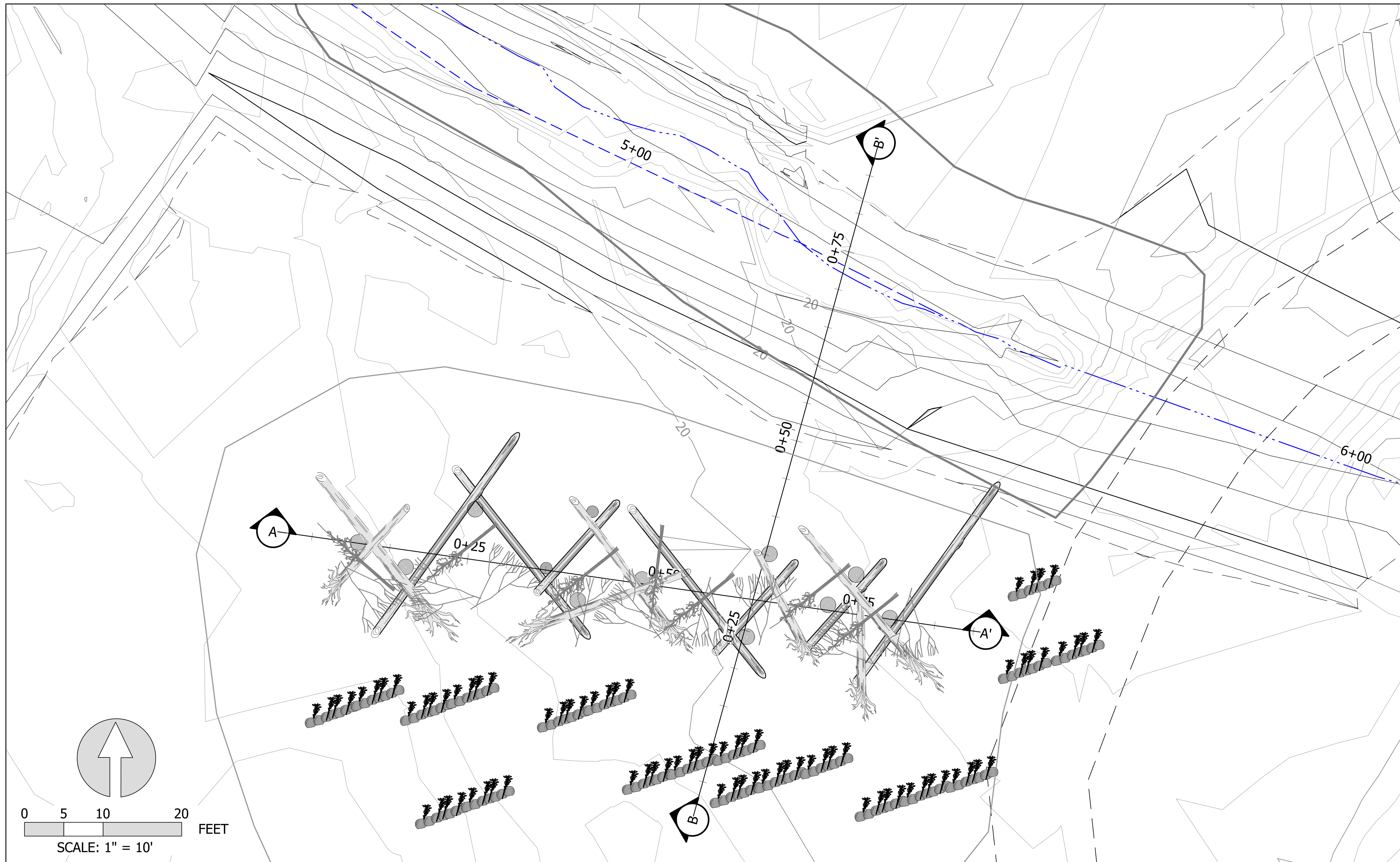
CULVERT AND BRIDGE DETAILS

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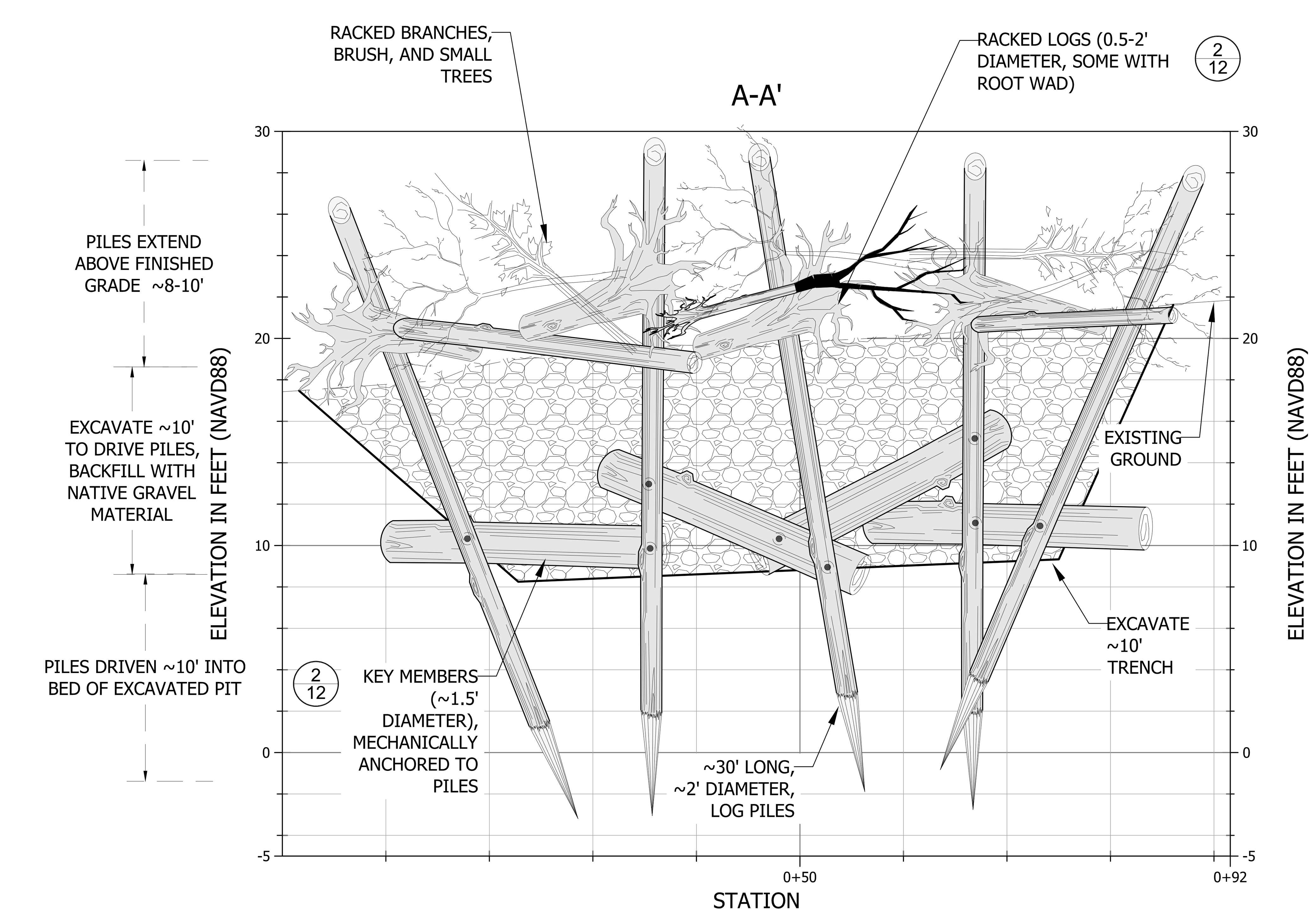


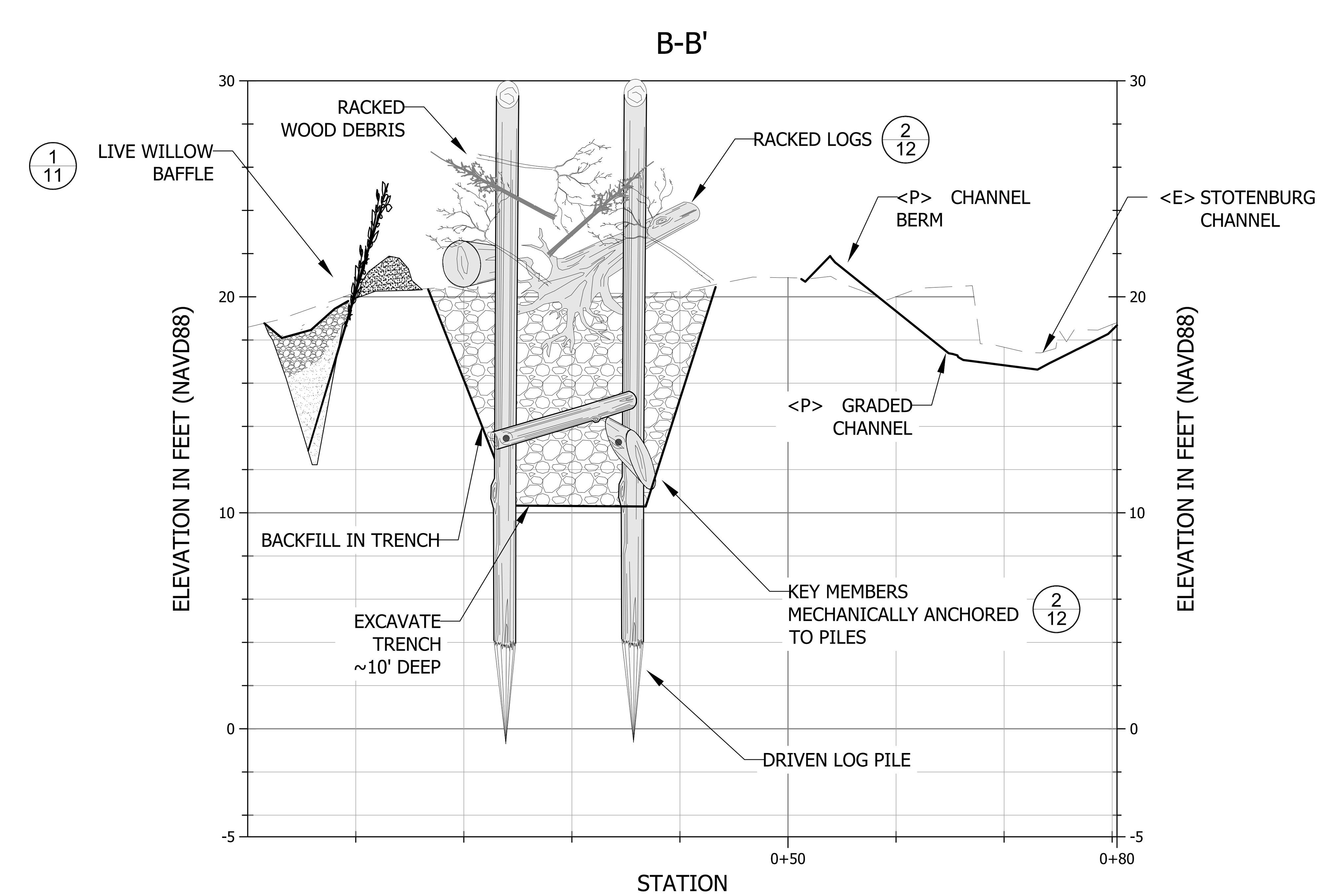


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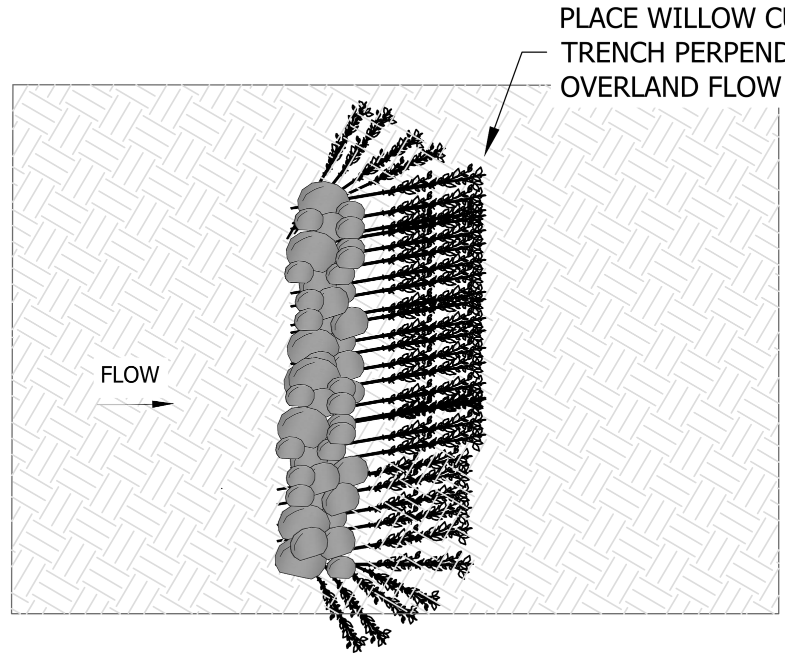
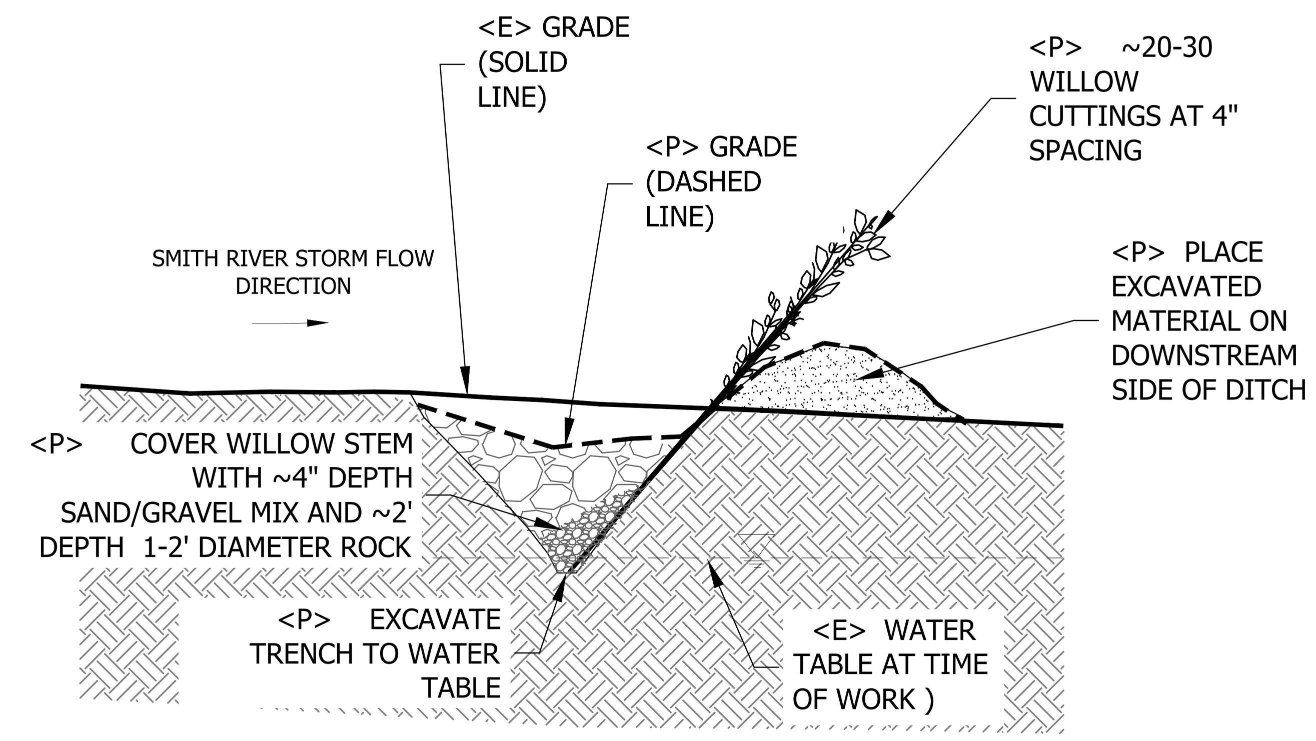
## ENGINEERED LOG JAM (ELJ)



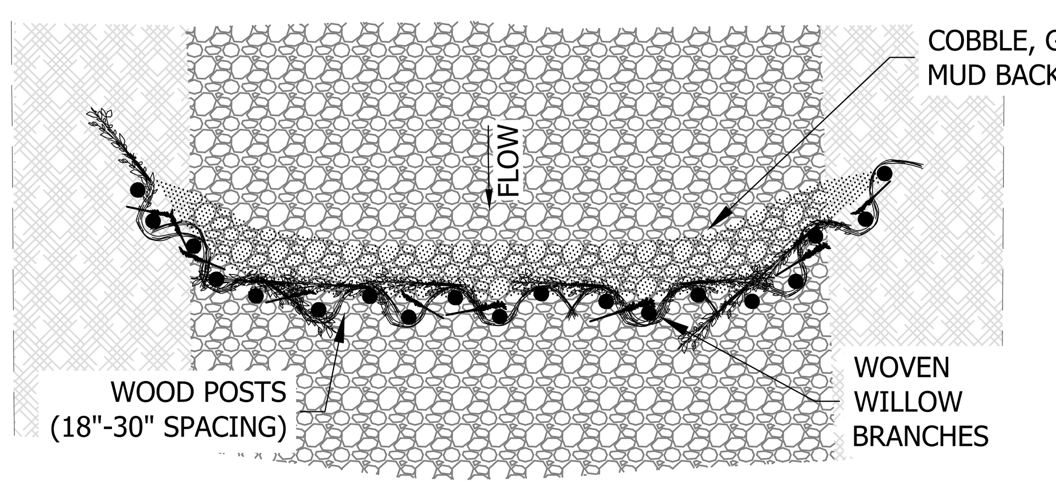

PLAN VIEW




PROFILE VIEW

## 1 LIVE WILLOW BAFFLE

NTS

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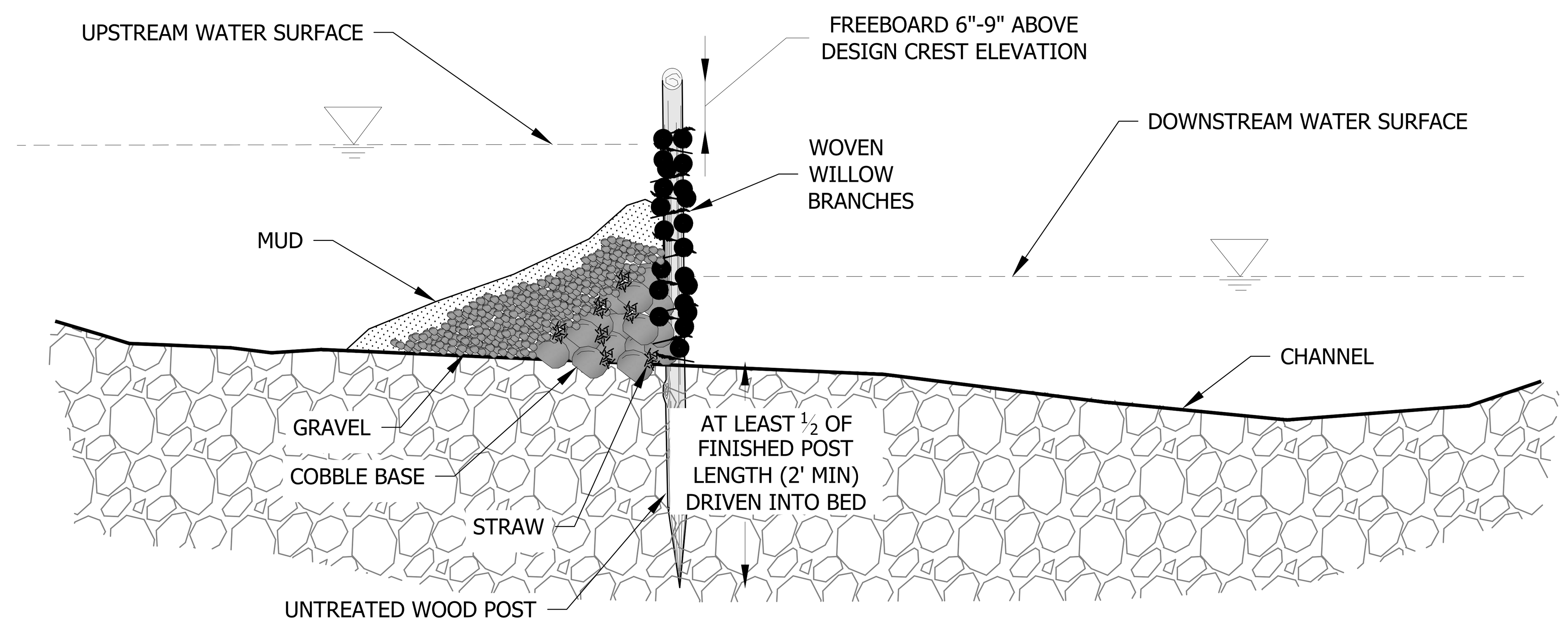
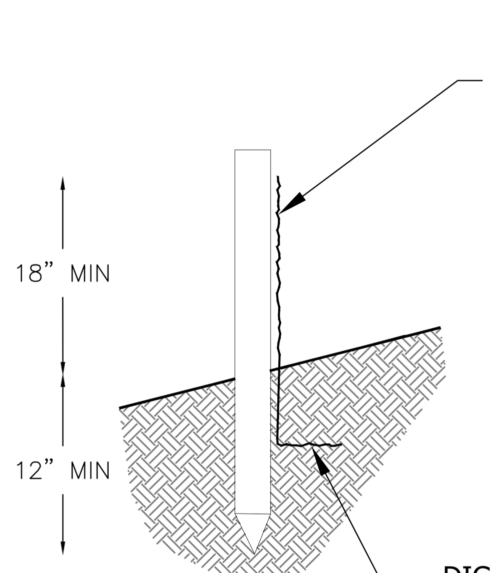


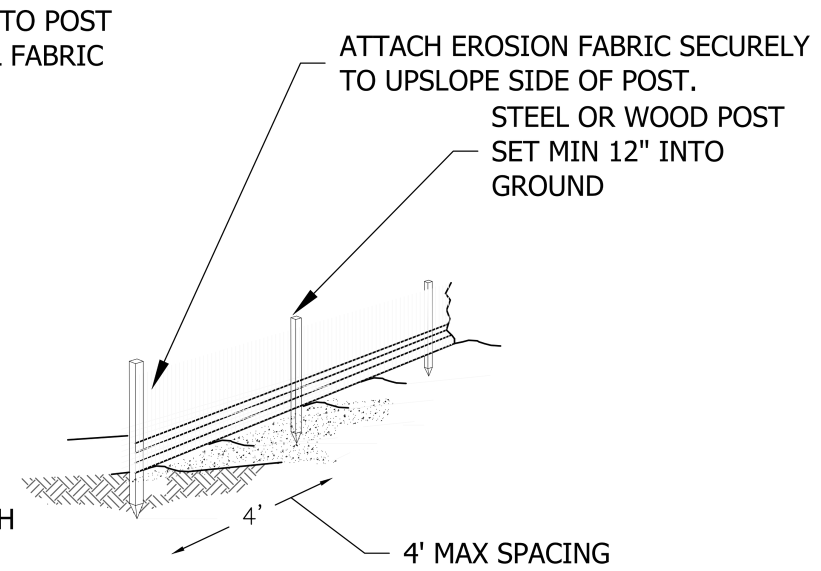

PROFILE VIEW

## 2 BEAVER DAM ANALOG

NTS



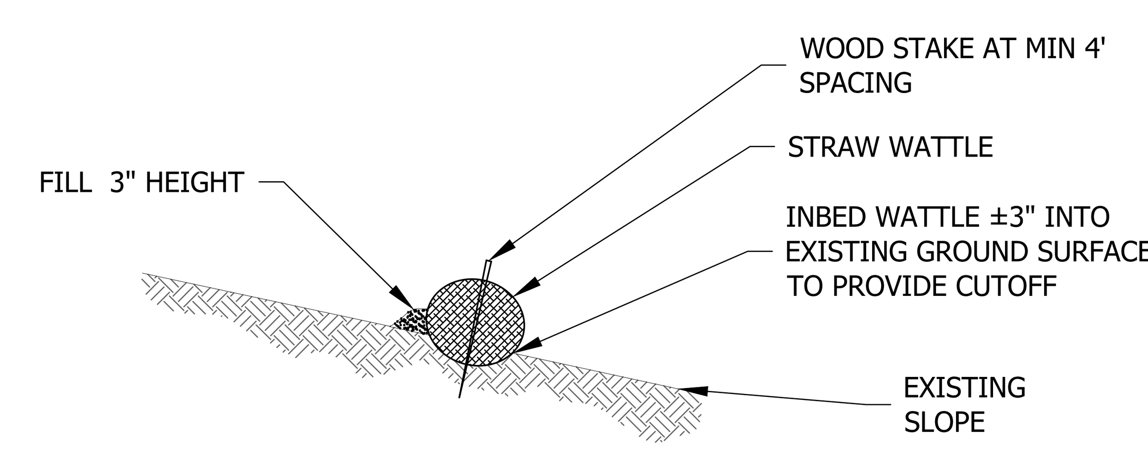

SECTION VIEW




SPACING AND LAYOUT

## 3 SILT FENCING

NTS




## 4 STRAW WATTLE

NTS

## EROSION AND SEDIMENT CONTROL NOTES:

1. EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPS) SHALL BE INSTALLED PRIOR TO THE WET SEASON (OCTOBER 1 THROUGH APRIL 30).
2. SENSITIVE AREAS AND AREAS WHERE EXISTING VEGETATION IS BEING PRESERVED SHALL BE PROTECTED WITH CONSTRUCTION FENCING; FENCING SHALL BE MAINTAINED THROUGHOUT CONSTRUCTION ACTIVITIES.
3. ALL AREAS DISTURBED DURING GRADING ACTIVITIES SHALL BE SEEDED WITH NATIVE GRASS SEED AND MULCHED WITH RICE STRAW.
4. PRIOR TO SEEDING AND STRAW, DISTURBED AREAS SHOULD BE ROUGHENED BY TRACK WALKING WITH A DOZER.
5. STRAW SHALL BE APPLIED AT A UNIFORM RATE OF APPROXIMATELY 4000 LBS PER ACRE BY HAND.
6. PRIOR TO ANY RAINFALL, A SILT FENCE SHALL BE INSTALLED AS DIRECTED BY THE ENGINEER TO PREVENT SEDIMENT FROM DISCHARGING FROM THE PROJECT.
7. ALL SEDIMENT CONTROL BMPS SHALL BE MAINTAINED THROUGHOUT THE WET SEASON UNTIL NEW VEGETATION HAS BECOME ESTABLISHED ON ALL GRADED AREAS.

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DETAILS

SHEET 11 OF 12

# LOWER STOTENBURG CREEK COHO HABITAT ENHANCEMENT FINAL DESIGN

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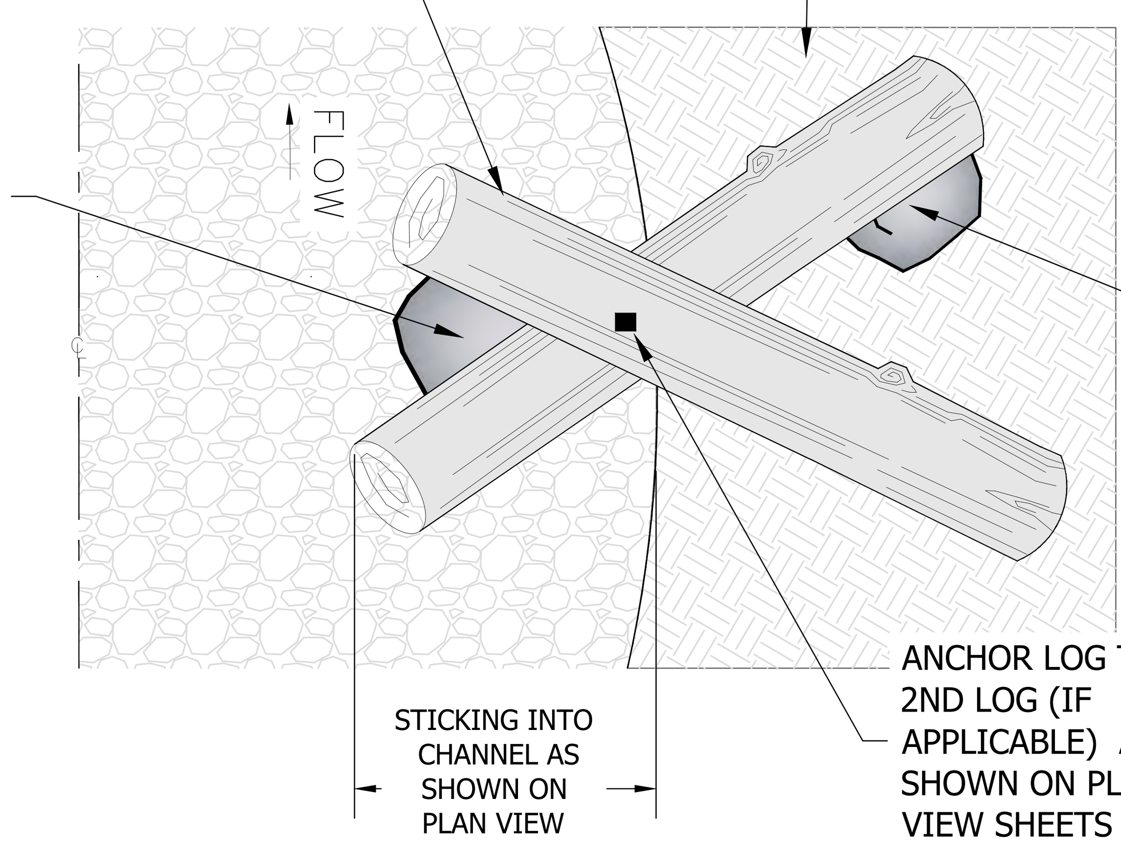
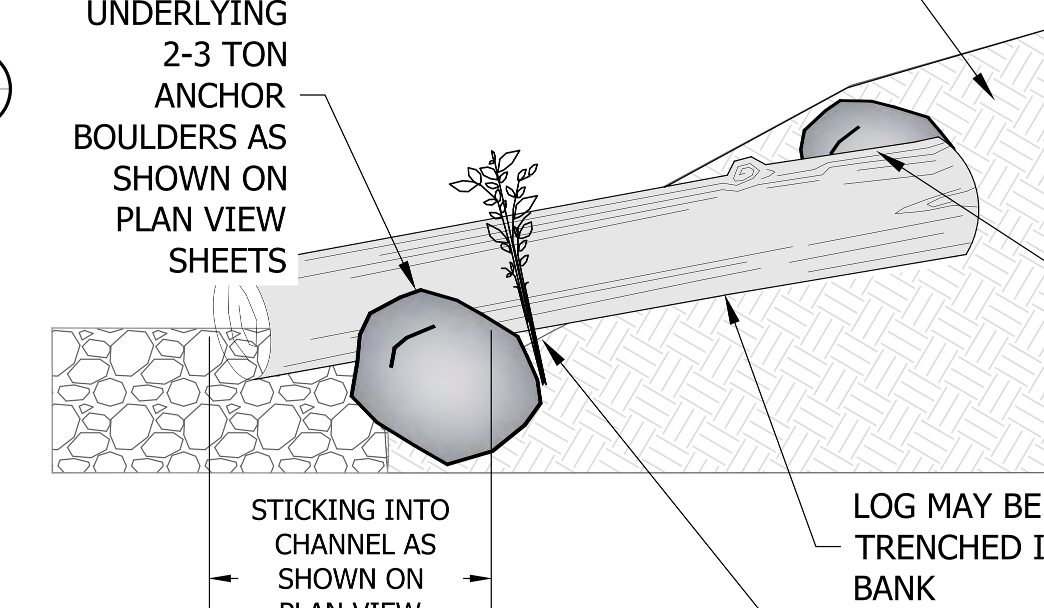
SMITH RIVER ALLIANCE


NOTES:

1. LOG STRUCTURES SHALL BE INSTALLED AS SHOWN ON PLAN VIEW SHEETS
2. WHERE BANKS ARE STEEP, LOG STRUCTURES MAY BE TRENCHED INTO THE BANK TO ALLOW FOR A LOWER ANGLE AND PROVIDE MORE WOOD VOLUME IN THE ACTIVE CHANNEL
3. LOG STRUCTURE CONSTRUCTION DETAILS MAY BE MODIFIED IN THE FIELD AS APPROVED BY THE PROJECT MANAGER OR ENGINEER



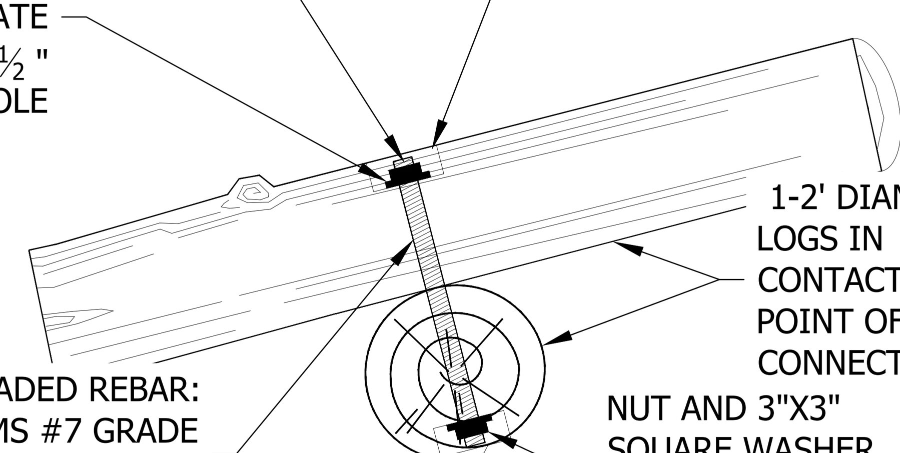

PLAN VIEW




SECTION VIEW

## 1 1- AND 2-PIECE WOOD STRUCTURE DETAILS

NTS

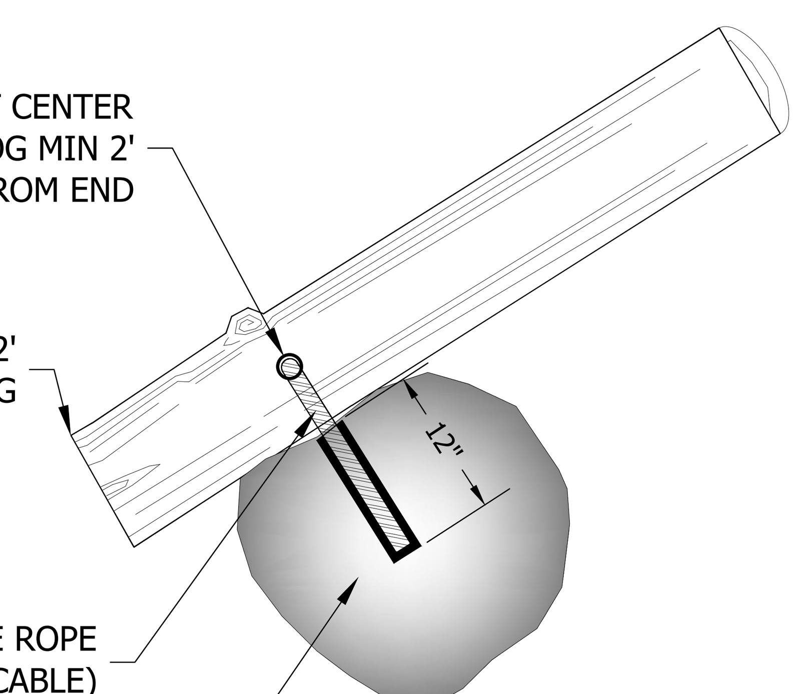



NOTES:

1. NOTCHING NOT REQUIRED ON LIVE TREES TO REDUCE IMPACTS TO TREE HEALTH

## 2 LOG-LOG ANCHORING

NTS




NOTES:

1. SECURE CABLE TO 2 TON BOULDER USING EPOXY ADHESIVE. HOLE DEPTH MUST BE SUFFICIENT TO REACH COMPETENT, UN-FRACTURED ROCK IN ORDER TO OBTAIN MAXIMUM BONDING STRENGTH. A MINIMUM OF 12 INCHES IS RECOMMENDED; 3/4" DIAMOND-TIPPED DRILL (TIGHT FIT). USE HILTI HIT-RE 500-SD EPOXY (TUBE) EPOXY CARTRIDGES, OR APPROVED EQUAL.

## 3 LOG-BOULDER ANCHORING

NTS

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DETAILS

# Photographs

More photos of each project site can be found in the basis of design report.

Figure 1. The mouth of Stotenburg Creek at the mainstem Smith River, view looking upstream.

Figure 2. The mouth of Stotenburg Creek at the mainstem Smith River, view looking downstream.

Figure 3. Stotenburg Creek downstream of Crossing 1, view looking upstream. Yellow arrow indicates flow in the split channel.

Figure 4. Split channel, yellow arrows indicate flow.

Crossing # 1 – The downstream most crossing – proposed replacement

Figure 5. Road over Crossing 1.

Figure 6. Pool at outlet of Crossing 1, view looking upstream.

Figure 7. Crossing 1 outlet. Culvert is a 3 ft corrugated metal pipe (CMP) with a shot-gun outlet that is rusting at the base.

Figure 8. View standing on Crossing 1 looking downstream.

<u>Crossing #2 – proposed removal</u>


Figure 9. Crossing 2 outlet.


Figure 10. Crossing 2 inlet.


Figure 11. Crossing 2. Flow is from left to right.


Figure 12. Current off-channel watering source. Crossing 2 visible in background.

<u>Crossing #3 – proposed upgrades/removal to reduce stranding of out migrating juveniles.</u>

Figure 13. Crossing 3, a ford will be modified Flow is from left to right.

Figure 14. Crossing 3, view looking downstream

Figure 15. Channel between Crossings 3 and 4 lacks cattle-exclusion fencing. View looking downstream.

Figure 16. Channel between Crossings 3 and 4.

Crossing #4 – proposed replacement

Figure 17. Crossing 4 outlet (taken in 2012).

Figure 19. Outlet of one of the four culverts that comprise Crossing 4.

Figure 20. Inlet of 4 culverts that comprise crossing 4.

Figure 18. Crossing 4 outlet (taken in 2017).

Figure 21. One of the four culverts at Crossing 4 that is plugged with sediment and live growing willows.

OCTOBER 2019

# Basis of Design Report & Feasibility Analyses for the Lower Stotenburg Creek Coho Habitat Enhancement Design Project

PREPARED FOR

Smith River Alliance
P.O. Box 2129
Crescent City, CA 95531

California Department of Fish and Wildlife
Fisheries Restoration Grant Program
Grant Agreement No. P1710514

PREPARED BY

Stillwater Sciences
850 G Street, Suite K
Arcata, CA 95521

Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2019. Basis of Design Report and Feasibility Analyses for the Lower Stotenburg Creek Coho Habitat Enhancement Design Project. Prepared by Stillwater Sciences, Arcata, California for Smith River Alliance, Crescent City, California.

Cover photo: lower Stotenburg Creek where it flows onto the Smith River gravel bar.

# Table of Contents

## Tables



## Figures

**Appendices**

# 1 INTRODUCTION

The Smith River Alliance (SRA) retained Stillwater Sciences (Stillwater) for the Lower Stotenburg Creek Coho Habitat Enhancement Design Project (lower Stotenburg Creek enhancement project) with the objectives of developing designs to improve fish passage and enhance seasonal rearing habitat along 0.5 miles of lower Stotenburg Creek in northern Del Norte County. This basis of design (BOD) report presents the preferred design alternative (Alternative 2) that was selected from the conceptual designs discussed during the first Technical Advisory Committee (TAC) meeting in April 2019. This report presents the final designs.

TAC members for this project include representatives from the California Department of Fish and Wildlife (CDFW) and NOAA Fisheries (Table 1-1). Other project stakeholders have been involved in the design process and/or participated in TAC meetings. Meeting notes for each TAC meeting are provided in Appendix G.

**Table 1-1.** Technical Advisory Committee members and other project stakeholders.

| **Technical Advisory Committee** | |
|---|---|
| **Member** | **Affiliation** |
| Beatrijs deWaard | CDFW |
| Mark Smelser | CDFW |
| Bob Pagliuco | NOAA Fisheries |
| Dan Free | NOAA Fisheries |
| **Other project stakeholders** | |
| Justin Garwood | CDFW |
| Jeff Daniels | Del Norte County Roads Division |
| Linda Crockett | Del Norte County RCD |
| Joey Borges | Property lessee |

## 1.1 Project Location

The project site is located along lower Stotenburg Creek approximately six miles upstream from the mouth of the Smith River, and 2.75 miles south of the town of Smith River in northern Del Norte County, California (Figure 1-1). Stotenburg Creek originates on the western slope of the Coast Range mountains and flows across the coastal plain before entering the right bank of the lower Smith River just downstream from the Highway (HWY) 101 bridge (Dr. Fine bridge). Stotenburg Creek is the first tributary to enter the Smith River after it exits its canyon and flows onto the coastal plain. The project site extends approximately 0.5 miles upstream from the Smith River confluence along a low-gradient alluvial floodplain.

## 1.2 Need for the Project

The Smith River is the largest free-flowing intact watershed in California and is considered a premier “Salmon Stronghold” along the Pacific coast and “irreplaceable” with respect to salmonid population resiliency (Wild Salmon Center 2012). However, these endorsements are largely based on the rivers undammed status, because much of the upper watershed is publicly owned and holds many designations with associated protections (e.g., National Recreation Area, National and State Park, Wilderness, Wild and Scenic River, etc.), and because land use has changed less here than in many other California watersheds (NOAA 2014). Notwithstanding, the Smith River coastal plain and estuary, the area with the greatest potential to support coho salmon (NMFS 2014), has had large reductions in available habitats and much of those remaining have been severely degraded due to anthropogenic changes related to agriculture, timber harvest, and road construction (Voight and Waldvogal 2002, NOAA 2014, Parish and Garwood 2015). These changes have resulted in reduced channel complexity, less off-channel and slough habitats, and less spatial and temporal access to remaining seasonal salmonid rearing habitats. Fish barriers at road crossings are listed as a high threat to juvenile and smolt coho salmon in the lower Smith River. Over the past decade, most major legacy barriers have been treated in reaches of the Smith River upstream of the coastal plain. However, numerous barriers in tributary streams within the estuary and coastal plain at private agricultural road crossings have received much less attention. The cumulative impact of these barriers results in decreased access to valuable rearing habitats. For these reasons, the impaired condition of the lower Smith River and estuary has been identified as the most significant threat to salmonids in the basin (Voight and Waldvogal 2002, CDFW 2004, NOAA 2014, Parish and Garwood 2015).

Tributaries within and proximal to estuaries and stream-estuary ecotones provide vital winter refuge habitat for juvenile coho salmon. These habitats contribute to higher survival, greater productivity, and higher overall population life history diversity (Otto 1971, Koski 2009, Wallace et al. 2015, Levings 2016). Recent winter surveys documented juvenile coho salmon, steelhead, and coastal cutthroat trout rearing throughout the lower 0.6 miles of Stotenburg Creek (Garwood and Bauer 2013, Parish and Garwood 2015 and 2016), including marked juvenile coho that migrated from Mill Creek to overwinter in the coastal plain (Parish and Garwood 2016). Furthermore, patches of quality rearing habitat are currently present in Stotenburg Creek, some of which have been enhanced by beaver activity (Parish and Garwood 2015 and 2016). Unfortunately, due to a lack of surface flow connection at crossings and at the creek mouth, fish utilizing Stotenburg Creek during high-flow events have the potential to be stranded as flow recedes during the late spring and early summer months (Parish and Garwood 2015 and 2016). The four privately owned crossings within the project reach are all undersized and limit fish passage to available rearing habitat and further exacerbate the threat of stranding (Garwood and Bauer 2013). Lastly, increased habitat complexity is needed as the channel remains shallow and simplified throughout the project reach, even during elevated winter flows (Parish and Garwood 2016). Despite these limitations, Stotenburg Creek was found to have an abundance of overwintering coho salmon across multiple winters based on minnow trapping surveys (Garwood and Bauer 2013, Parish and Garwood 2015). Based on sampling throughout the lower river, Parish and Garwood (2016) found Stotenburg Creek had the second highest capture rates of juvenile coho salmon after Morrison Creek, which is a much larger drainage.

By working with willing landowners, the lower Stotenburg Creek enhancement project is addressing key limiting factors for the juvenile coho salmon life stage in the Smith River, including passage barriers, the lack of floodplain and channel structure, and other impacts related to agricultural practices. The project is designed to help SONCC coho salmon recover in the Smith River by improving fish passage, enhancing habitat complexity and riparian function, and extending migration timing and survival for juvenile coho salmon rearing in Stotenburg Creek. Other salmonid species in the Smith River, including Chinook salmon, steelhead, and cutthroat trout will also benefit from this project.


**Figure 1-1.** Location of the lower Stotenburg Creek project area in northern Del Norte County.

# 2 GEOLOGY, GEOMORPHOLOGY, AND RIPARIAN VEGETATION

## 2.1 Geology and Tectonics

The Stotenburg Creek drainage is located on the western coastal portion of the Smith River watershed, on the transition from the Coast Range mountains to the Smith River coastal plain. This portion of northwestern California is in a tectonically active plate-boundary deformation zone and is defined by compression and uplift along the Cascadia subduction zone. This deformation is manifest by multiple northwest-southeast trending thrust faults (further described below) that create a dominant topographic and structural grain in the region (Kelsey and Carver 1988).

The headwater hillslopes of Stotenburg Creek are located approximately 2 miles west of the Coast Range thrust fault ("South Fork fault" of Irwin 1972), along which graywacke and mélange units of the Eastern Belt of the late Mesozoic-aged Franciscan complex are thrust below Klamath Mountain ophiolite terranes (Aalto 1989) (Figure 2-1). Overlying the Franciscan complex along the coastal plain is the Pliocene-Pleistocene marine fossiliferous siltstone and sandstone St. George formation (Diller 1902, Maxson 1933, Stone 1993, Aalto et al. 1995). The St. George formation contains trace pebbles, carbonized wood, and fragmented molluscan shells; and is exposed in the wave-cut cliffs between Crescent City and Point St. George and encountered in borings beneath the coastal plain. Overlying the Franciscan complex and St. George formation is the Battery formation, which Maxson (1933) defined as poorly consolidated marine and terrigenous sands with interbedded clay. The Battery formation, which is a marine terrace deposit with interfingering dune sands and alluvial gravels, consists primarily of medium-grained sands alternating with blue-gray silty clay and imbricated gravels. The Battery formation overlies marine abrasion platforms dated at approximately 80, 105, and 125+ thousand years old (i.e., late Pleistocene) based on fossils, soil correlation, and amino acid racemization age correlation of the clam *Saxidomus giganteus* (Addicott 1963, Kennedy et al. 1982, Polenz and Kelsey 1999). As the coast retreated westward following late Pleistocene sea-level high stands, the paleo Smith River incised into the Battery formation and deposited large alluvial terraces that cover the majority of the northern coastal plain (Delattre and Rosinski 2012) (Figure 2-1). The Project reach of Stotenburg Creek flows through these latest Pleistocene-Holocene terrace and floodplain deposits.

Faults in the project vicinity include the Bald Mountain-Big Lagoon fault zone, Lost Man fault, and the Saint George fault (Clarke and Field 1989, Clarke 1992); all of which are offshore thrust faults located to the southwest of Crescent City. The Bald Mountain-Big Lagoon fault zone is considered late Quaternary in age, meaning it has been active in the last 700,000 years (Clarke and Field 1989). Although recent displacement along the Lost Man and Saint George faults is undifferentiated, they are considered Quaternary in age (i.e., active within the last 1.6 million years). Displacement along these thrust faults has caused the uplift of the coastal bluffs between the Crescent City harbor and Point St. George, which expose Franciscan and St. George formation rocks (Figure 2-1). Tectonic thrusting has also created the broad syncline across the coastal plain. The Rowdy Creek fault ("Smith River fault" of Clarke [1992]) has been recognized in offshore seismic lines but is queried onshore due to its lack of evidence other than the topographic transition from coastal plain to upland hillslopes (Figure 2-1). The Del Norte fault was first proposed by Maxson (1933) to account for the abrupt, north-south trending eastern boundary of the coastal plain with upland hillslopes. Some researchers have adopted Maxson's proposed fault (Back 1957, Roberts and Dolan 1968, Stone 1993) while others have questioned the faults existence (DWR 1987, España Geotechnical Consulting 1993) due to a lack of exposure or other evidence.

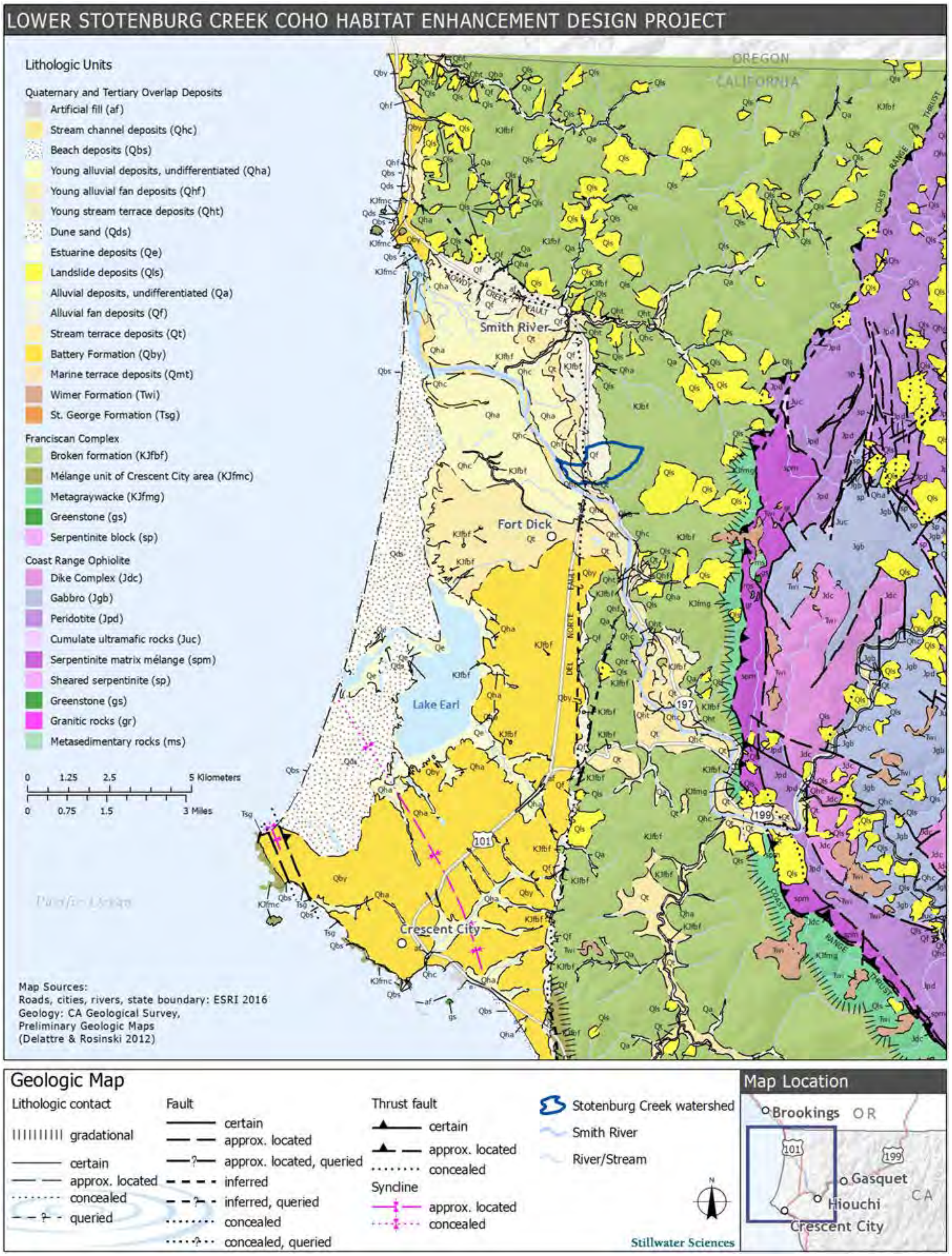


**Figure 2-1.** Geologic map of the Stotenburg Creek watershed and surrounding portions of Del Norte County.

## 2.2 Geomorphology

A geomorphic assessment was conducted to characterize the existing geomorphology of the project area, assess risks associated with potential hazards, support an opportunities and constraints assessment, and inform project designs. Specifically, the geomorphic assessment included a topographic survey that was integrated with 2010 LiDAR data, review of existing information, and a field assessment. Existing information that was reviewed include geologic mapping (Delattre and Rosinski 2012), geomorphic and landslide mapping (Davenport 1983), well completion reports filed with the Department of Water Resources (DWR), and a series of historical aerial photographs from 1942 to 2015.

Hillslope and stream channel morphologies in the Stotenburg Creek watershed are similar to others along the northern and eastern margin of the Smith River coastal plain, due to the similar topographic and lithologic transition from upland hillslopes underlain by Franciscan sedimentary bedrock to alluvial terraces and floodplains composed of late quaternary fluvial sediments. Landslides are common in the Franciscan rock although there is no evidence of moderate to large-scale hillslope instability in the upper Stotenburg Creek watershed (Figure 2-1).

Upper elevations of the Stotenburg Creek watershed are characterized by steep hillslopes (30-40%) covered with relatively thick well-drained colluvial soils and a dense second-growth conifer forest of spruce, fir, and redwood. The creek lacks a defined primary channel in the upland hillslopes. Multiple smaller channels flow through rural ranch properties across an alluvial fan at the base of the hillslope and converge to form a main channel upstream of Highway 101. Stotenburg Creek flows southwest passing under the highway and the county road (Fred Haight Dr.) before making an abrupt turn to the northwest and flowing across the flat alluvial floodplain within the project area (Figure 2-2). A second smaller channel converges with the main Stotenburg channel several hundred feet upstream of the project area. This channel also originates on the hillslopes to the east of Highway 101 and has a small on-channel pond within its alluvial fan reach.

The project site consists of the main Stotenburg Creek channel extending approximately 2,700 feet (0.5 miles) upstream from its confluence with the Smith River (Figure 2-2). This reach of the creek flows northwest through a low-gradient Smith River alluvial floodplain and along the distal edge of a broad alluvial fan. The most downstream reach of the creek flows off of the floodplain and across a vegetated gravel bar before meeting the Smith River in a backwater alcove. Pastures on the floodplain are primarily used for organic dairy production. The project site contains four private road crossings: three culverts and one ford, each with varying levels of use (further described in Section 2.2.3 *Field Assessment*). The channel within the project reach is densely vegetated with riparian trees (e.g., willow, alder, and cottonwood), invasive Himalayan blackberry, and some conifers. Although, several discrete sections of the channel lack woody riparian vegetation along the southern bank due to cattle grazing. Stotenburg Creek flows adjacent to Fred Haight Dr. throughout most of the project reach.

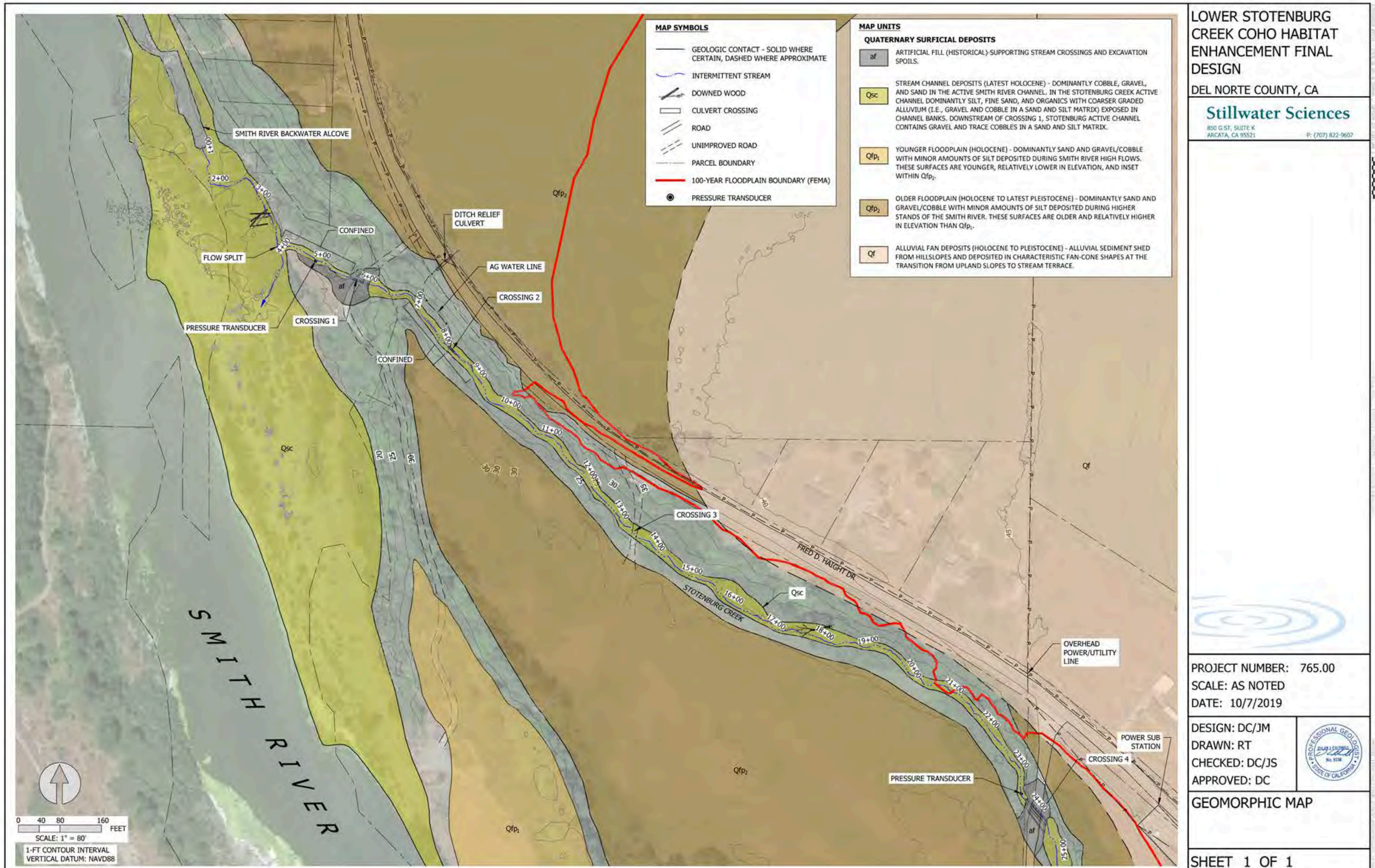


**Figure 2-2.** Geomorphic map of lower Stotenburg Creek.

### 2.2.1 Aerial photograph interpretation

The LiDAR-derived topography and historical aerial photographs were reviewed to characterize the long-term geomorphic change along Stotenburg Creek within the project area and at the confluence with the Smith River. Photographs were acquired from the U.S. Forest Service, California Department of Forestry, USGS, and Google Earth and include the following years: 1942, 1948, 1958, 1965, 1972, 1988, 1993, 2003, 2004, 2005, 2009, 2010, 2012, 2013, and 2015. Several aerial photographs had previously been compiled, orthorectified, and georeferenced to create the Lower Smith River Atlas (Laird and McBain & Trush 2004). Laird and McBain & Trush (2004) also digitized geomorphic and riparian features along the lower mainstem Smith River, including the channel thalweg, water's edge, and the boundary of active channel scour with riparian vegetation.

All aerial photographs and digitized features from Laird and McBain & Trush (2004) were reviewed and select water's edge polygons were compiled in Figure 2-3 to illustrate the dynamic nature of the Smith River within the project area. Cropped portions of each aerial photograph for the project area are located in Appendix E.

**1942 and 1948 photographs**

In 1942 and 1948 Stotenburg Creek was primarily along the same alignment as it is today. The project vicinity along the lower Smith River had already begun to be utilized for agricultural purposes, as evidenced by fences, hedge rows, and managed fields with different uses. However, the floodplain pasture along the southwestern side of the creek does not appear to have been modified for agricultural use. Portions of Stotenburg Creek upstream of the project reach and the adjacent floodplains were more forested with conifers than they are today. The current alignment of Highway 101 had not yet been built and Fred Haight Dr. was the primary road through the area. Some evidence of gravel mining is visible on Smith River gravel bars upstream and downstream from the project site. The active Smith River channel was further east than it is today and ran along the margin of the $Qfp_2$ floodplain (Figures 2-2 and 2-3). The Stotenburg Creek confluence was near the present-day location of Crossing 1, which had not yet been built. The ford at Crossing 3 is visible in the 1948 photograph.

**1965 photograph**

This photograph was taken in the summer following the historic 1964 flood, which is the flood of record for the Smith River with a flood frequency of approximately 230 years (based on a log-Pearson Type III distribution [USGS 1982]). The main Smith River corridor experienced major geomorphic changes in channel alignment, pool and bar scour, floodplain deposition, and eroding riparian vegetation. There is evidence of widespread flood damage to fields and roads across the Smith River coastal plain. The Smith River channel within the project area increased its sinuosity by migrating westward upstream of the Stotenburg confluence and eastward at the confluence (Figure 2-3). Scour along the east bank at the Stotenburg confluence threatened Fred Haight Dr. and there are anecdotal accounts of rip rap armoring being installed for bank protection in the dense brush north of Crossing 1. However, rip rap was not observed in the field. Multiple large gravel mining operations are visible throughout the lower river and were likely supplying aggregate for constructing new roads including the present-day Highway 101, and levees along the lower river downstream from the project site.

Despite the significant geomorphic changes to the Smith River, the Stotenburg Creek alignment was not altered by the 1964 flood. The largest changes to the creek appear to be removal of riparian vegetation and scouring along the lower reaches. Widespread fine sediment deposition across the $Qfp_2$ floodplain and the degree of scour along lower Stotenburg Creek indicate that the entire project reach was inundated during the flood.

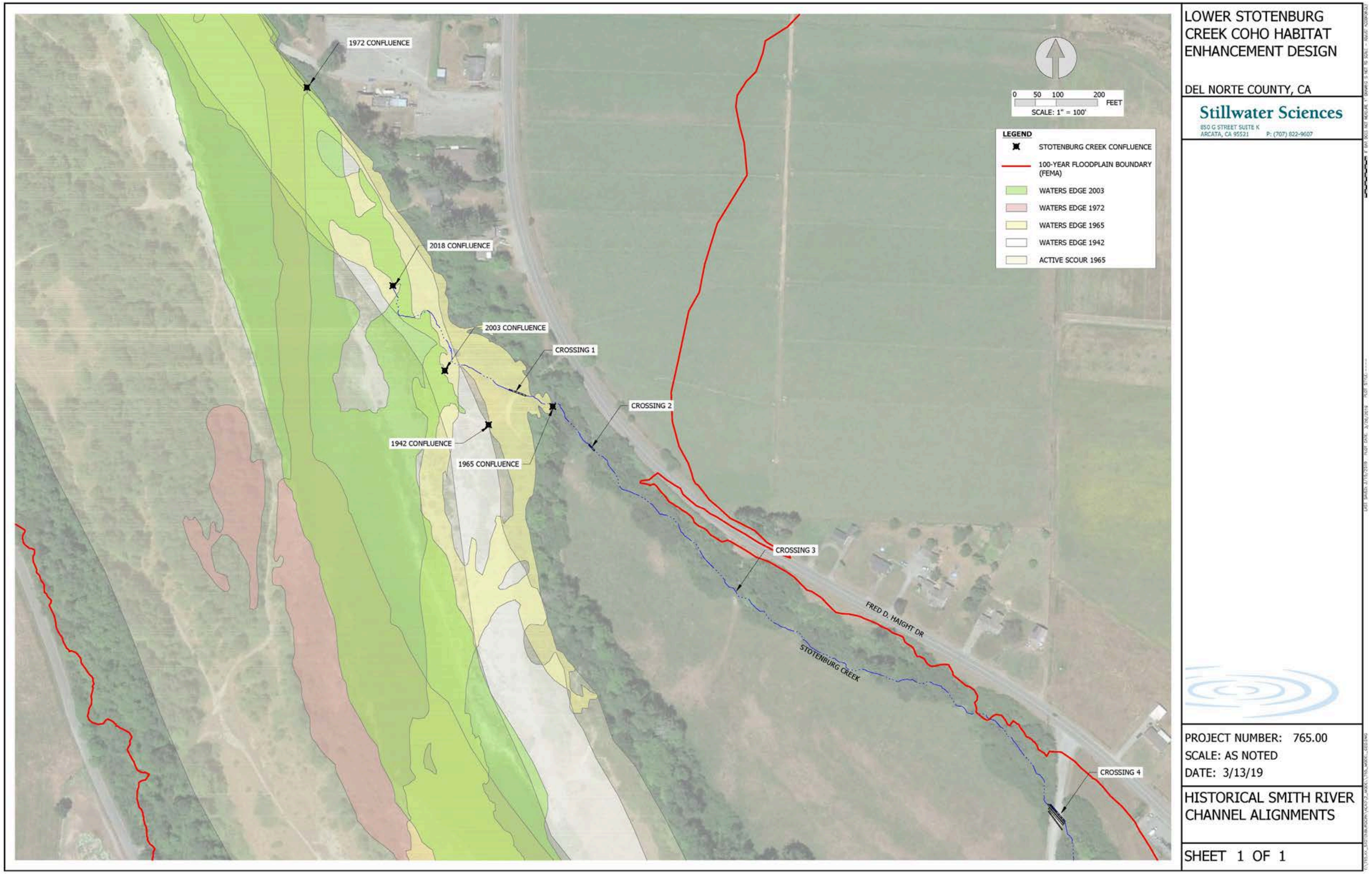


**Figure 2-3.** Current and historical Smith River channel planform alignments along the project site. Dates of the photographs are: September 11th, 1942; July 8th, 1965; August 2nd, 1972; and May 19th, 2003.

**1972 photograph**

The 1972 photograph was taken in the summer following the 1972 flood, which is the second largest on the Smith River in the period of record with a flood frequency of approximately 55 years. The primary Smith River channel migrated up to 500 feet to the west at the former location of the Stotenburg Creek confluence. The lateral gravel bars along the Smith River were largely devoid of riparian vegetation as a result of scour from the 1964 and 1972 floods. The lateral migration of the river effectively extended the length of Stotenburg Creek by more than 900 feet along the back edge of the gravel bar. It appears possible that flood flows partially inundated portions of the $Qfp_2$ floodplain to the south and west of the project reach, although the Stotenburg Creek channel alignment upstream of the Crossing 1 location remained stable and unaffected. Riparian vegetation regrowth is evident along lower Stotenburg Creek, but areas further upstream from the project reach were logged, likely to expand cattle grazing. Crossing 3 appears to be actively utilized and gravel mining operations continued on nearby Smith River gravel bars.

**1988 photograph**

The Stotenburg Creek alignment remained stable and riparian vegetation continued to expand along the creek and river corridors, as well as on the gravel bars scoured during the 1964 and 1972 flood events. Crossing 1 is evident in the photograph indicating construction occurred sometime between 1972 and 1988. The crossing appears to have been built to support gravel mining operations on the bar at the mouth of Stotenburg Creek. Mining excavations are evident on the gravel bar. Additionally, it appears Crossing 1 was initially constructed without a culvert and Stotenburg Creek was routed to the south along the back edge of the gravel bar and into the Smith River in an excavated ditch. This route follows the edge of the floodplain that was scoured during the 1964 flood. Crossing 3 continued to be actively utilized.

**1993 photograph**

The Smith River began migrating back to the east, likely occupying gravel mining excavations. Crossing 1 was rebuilt with a culvert and Stotenburg Creek can be seen flowing through the crossing and meeting the Smith River approximately 200 feet downstream at a secondary high-flow channel that begins upstream at the excavated ditch described in the 1988 photograph. The Stotenburg channel between Crossing 1 and the Smith River is straight, narrow, and is along the same alignment as it is today. This channel appears to have been excavated as part of building the crossing and spoils from the excavation still border the southwest side (left bank) of the creek today. The gravel bar at the Stotenburg Creek confluence appears freshly mobilized with little to no vegetation, whereas the gravel bar on the west side of the Smith River reestablished a riparian forest. Riparian vegetation along lower Stotenburg Creek appears comparable to previous photographs and much of the flowing channel is visible. It is possible Crossing 2 was in place in this photograph, although it is difficult to confirm because of photograph resolution.

**2003 photograph**

The project site appears relatively comparable to conditions in the 1993 photograph. Substantial changes include a large gravel mining harvest from the bar at the Stotenburg Creek confluence. The harvest consisted of skimming an area of approximately 1 acre at the Stotenburg confluence and excavating a pit (approximately 230 feet long by 60 feet wide) just downstream. At high flows Stotenburg Creek met the Smith River at the margin of the skimmed area and at low flows the creek traversed the skimmed bar and entered the excavated pit. The pit, or alcove, persists to this day and has remained relatively unchanged. Additional gravel mining and processing is evident on the gravel bar and floodplain upstream of the project site. A new road was constructed from the gravel processing area up to the southern edge of Stotenburg Creek at the Crossing 4 location. An additional Google Earth image shows that Crossing 4 was constructed between July

2003 and June 2004. Riparian vegetation along Stotenburg Creek within the project area is denser than in previous photographs.

**2005, 2009, and 2015 photographs**

The most substantial change seen across the 2005, 2009, and 2015 photographs is increased riparian growth across the entire project reach. The portion of the gravel bar at the creek confluence that was skimmed in 2003 developed a mature willow forest that subsequently recruited large woody debris (LWD) and promoted deposition of fine sediment (i.e., sands and coarse silt). These changes to the gravel bar controlled the alignment of the lowest reach of Stotenburg Creek and "locked-in" the meandering planform as it flows across the gravel bar and enters the Smith River at the excavated alcove. The alcove changed very little with only minor deposition of sands and gravel at the upstream extent at the mouth of Stotenburg Creek and in the northern corner where a nearby residence has a footpath to the river. The low-flow connection to the river in the northwest corner of the alcove is visible in all photographs since 2003. Riparian vegetation along Stotenburg Creek also expanded throughout the rest of the project reach with only a few discrete areas remaining where the channel bed is visible in photographs.

### 2.2.2 Topography

Stillwater and SRA staff conducted a field topographic survey in the fall of 2018 using a robotic total station and real-time kinematic (RTK) GPS. The primary goals of the topographic survey were to characterize the existing conditions topography to support geomorphic assessment and hydraulic modeling. The survey focused on: (1) a thalweg longitudinal profile of the project reach including channel bank tops and toes; (2) complete topography at all crossings and in areas where habitat enhancement designs are proposed; and (3) detailed cross sections spaced every 100 feet that extended beyond the channel into the adjacent floodplains. The RTK GPS was used to establish a network of survey control points throughout the project site. In the office, survey data were post-processed using an RTK base station position correction from the National Geodetic Survey (NGS) Online Positioning User Service (OPUS) and aligned to the NAVD88 vertical datum.

The field survey data were integrated with 2010 NOAA Coastal LiDAR point cloud data. The LiDAR points were shifted to better characterize local 2018 field conditions. The horizontal shift (0.12 feet south) was determined using NGS Coordinate Conversion and Transformation Tool (NCAT) to convert from the input datum (NAD83[NSRS2007]) to the output datum (NAD83[2011]) at the approximate central location of the project area. The vertical shift (+0.14 feet) was determined by comparing 2018 field-surveyed elevations collected along the Fred Haight Dr. road alignment within the project area to the horizontally adjusted LiDAR point cloud data.

### 2.2.3 Field assessment

The geomorphic field assessment of the project area consisted of evaluating floodplain and channel morphology, assessing road-stream crossings, investigating shallow stratigraphy exposed in cutbanks, identifying potential habitat enhancement locations, and measuring bankfull and active channel widths to support crossing designs. Methods for measuring bankfull and active channel widths followed Part XII of the California Salmonid Stream Habitat Restoration Manual (CDFW 2009) and the Stream Simulation approach (USDA Forest Service 2008). Results and interpretations from the field assessment are summarized below, beginning at the Smith River confluence and moving upstream. Figure 2-4 is a longitudinal profile of the project reach highlighting channel slopes and key points of interest referenced throughout the following section.

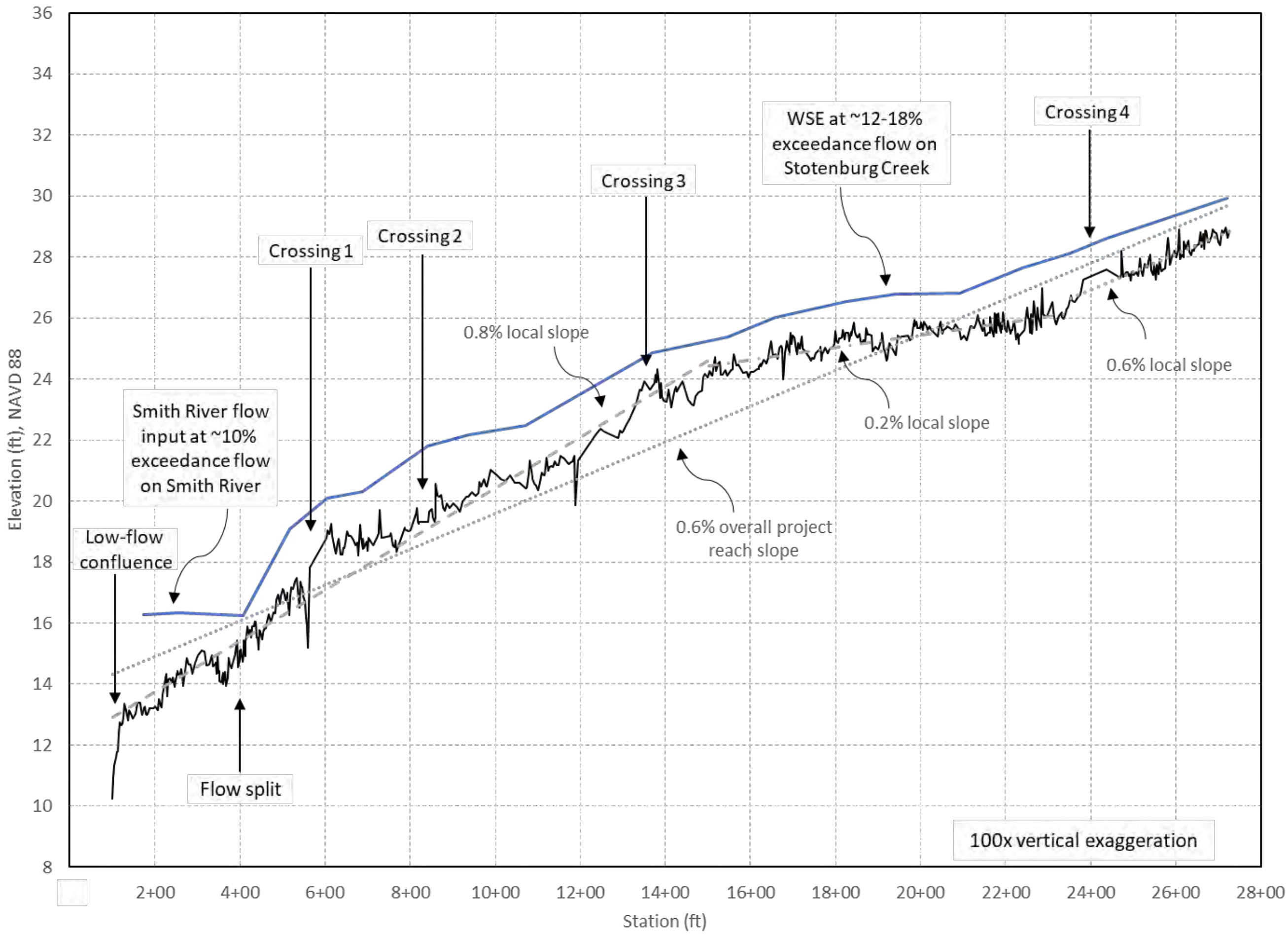


**Figure 2-4.** Stotenburg Creek longitudinal profile along the project reach.

**Stotenburg Creek – Smith River confluence**

Stotenburg Creek flows into the Smith River at a backwater alcove that was excavated into the lateral gravel bar in 2003 during a gravel harvesting operation (Figures 2-2 and 2-5). The alcove was excavated with providing off-channel fish rearing habitat as a secondary objective. The alcove was constructed with a low-flow connection point to the mainstem river channel at its downstream extent. Based on late spring/early summer onsite observations, after Stotenburg Creek has gone dry, the alcove maintains a flowing connection to the river with a depth of approximately 0.2–0.4 feet at the low-flow connection point. The increased stage in the alcove is presumably due to hyporheic flow through the gravel bar and groundwater input from the adjacent floodplain. The low-flow connection point is visible in every aerial photograph taken since the alcove was excavated in 2003. The alcove has remained stable since its construction and the most substantial changes are in the growth of a dense willow corridor surrounding the alcove and extending upstream along the lowest reaches of Stotenburg Creek. The alcove receives high-flow input on its upstream side from the Smith River through the willows at approximately an 18–20% exceedance flow, which is considered a typical winter baseflow.

Upstream from the alcove, Stotenburg Creek flows across a low-gradient lateral gravel bar deposited and mobilized by the Smith River during flood events (e.g., greater than a 1.5-year, or bankfull event). Since the gravel harvesting in 2003, riparian vegetation has established a dense willow forest on either side of Stotenburg Creek (Figure 2-6). A wood jam that first established between 2015 and 2017, and has since expanded, is located at Station (Sta) 3+50. This jam consists of several key large pieces and other racked smaller wood. The jam is primarily sourced from the river and it overhangs the Stotenburg channel. Along the eastern margin of the willow-covered gravel bar the creek has a split (Sta 4+00), with a smaller secondary channel extending to the southwest onto the gravel bar. Upstream of the flow split the creek increases in gradient, up to approximately 1.4%, and enters a narrow, confined channel that appears to have been excavated when Crossing 1 was constructed. Spoils piles are evident along the southern bank of the creek through this confined reach.

Channel substrate along the lower reaches of the creek consists of sands and gravel with some silt and trace cobbles. Comparable substrate is exposed in channel banks between Sta 2+50 and Crossing 1. Between the flow split at Sta 4+00 and Crossing 1, channel bed substrate is dominantly graded gravels with sands and some cobbles. The coarse sediment is likely eroding from the channel banks as Stotenburg Creek cuts through the $Qfp_2$ floodplain and Qsc channel deposits.

**Figure 2-5.** Stotenburg Creek enters the Smith River at a backwater alcove excavated in 2003. View looking downstream.

**Figure 2-6.** Stotenburg Creek at Sta 3+00 along the back edge of the Smith River gravel bar. View looking upstream. Person in upper left for scale.

**Crossing 1**

Crossing 1 is a 3-foot diameter corrugated metal pipe (CMP) that slopes 2.3% and is approximately 43 feet long (Figures 2-7 to 2-9). The crossing supports a single lane gravel road that was constructed between 1972 and 1988 apparently to access the Smith River gravel bar for aggregate mining. The pipe is hydraulically undersized and is a partial fish passage barrier for adult and juvenile salmonids at all flows. The inlet is at grade, however, due to its small size it is frequently blocked with branches and debris. The outlet is shotgunned and has a ~3-foot deep scour hole that has expanded over the last several years. The pipe bottom is also damaged from rust and has multiple holes at the inlet and outlet. At high flows the culvert is likely a velocity barrier to migrating juvenile salmonids. The longitudinal profile shows that up to 1 foot of sediment has aggraded upstream of the culvert, tapering back to a natural thalweg elevation approximately 100 feet upstream from the crossing.

**Figure 2-7.** Crossing 1 outlet and shotgun scour pool. View looking upstream.

**Figure 2-8.** Crossing 1 inlet. View looking downstream.

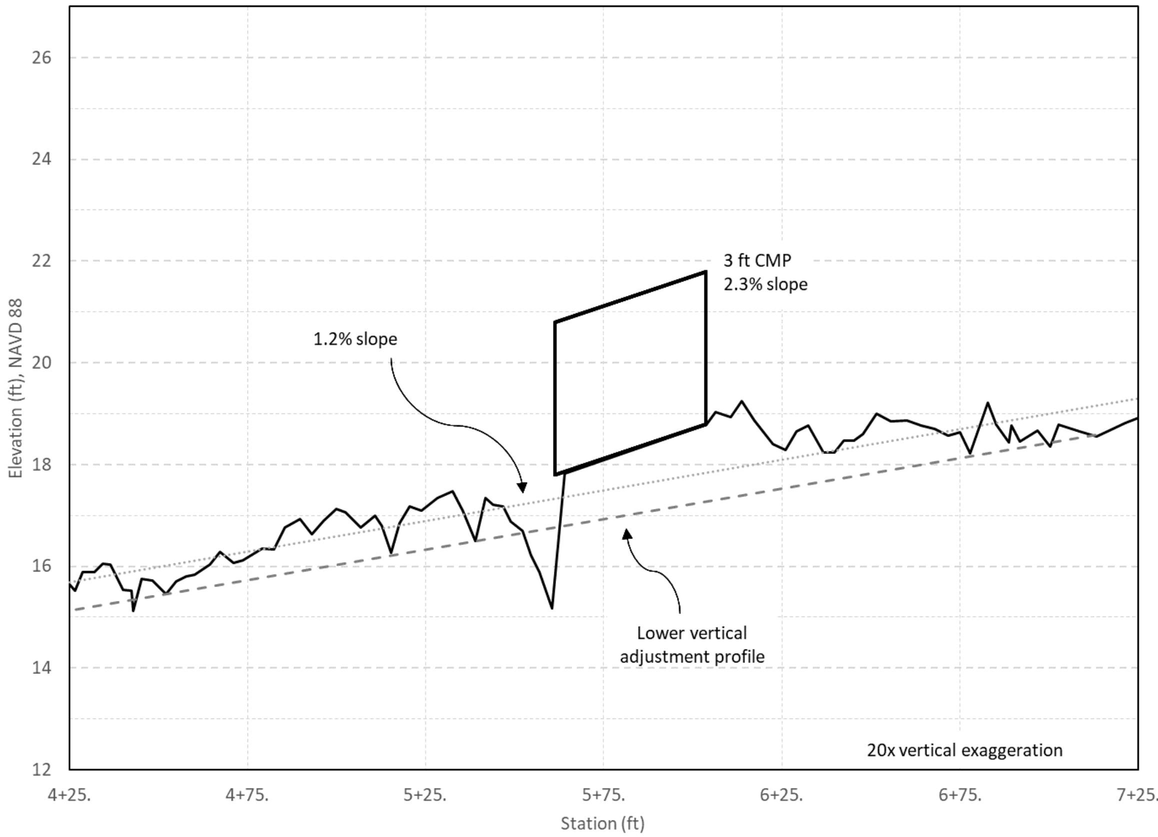


**Figure 2-9.** Longitudinal profile at Crossing 1.

**Crossing 1 to Crossing 2**

Between Crossing 1 and 2 the creek meanders through a relatively narrow and confined reach with dense riparian vegetation consisting of mature willows, alders, and Himalayan blackberry, often growing within the active channel (Figures 2-2 and 2-10). Channel bed substrate abruptly changes upstream of Crossing 1 to dominantly silt and organics with some fine sands. However, channel banks expose a similar well-graded substrate of silts and sands with some gravel and cobble. The abundant fine silt and organic deposits upstream of Crossing 1 are likely due to the crossing invert being set too high during construction and therefore causing aggradation. A depression that serves as an off-channel alcove at moderate to higher flows is located on the left bank at Sta 6+20. This depression is a result of lateral scour during the 1964 flood. Subsequent channel migration and bar deposition have created the alcove form seen today. Debris lines and leaning vegetation indicate that at high flows the Smith River inundates this depression from the south and connects to Stotenburg Creek. Onsite high-flow monitoring during the 2018-2019 winter confirms that the Smith River inundates this depression at 1.5-year (bankfull) flow events on the Smith River.

A ditch relief culvert under Fred Haight Dr. is used as a conduit for water lines that have provided irrigation and livestock water supply to the pasture southwest of the creek (see Figure 2-2 and Appendix B, Sheet 3). The flexible irrigation line is no longer used and its exact location beyond the end of the culvert is not known by the landowner or lessee. The livestock water line is a 1-inch poly pipe that supplies a trough located in the northern corner of the pasture. An additional

3-inch aluminum irrigation pipe segment is located along the top of bank near Sta 6+50, however, this pipe is no longer used and can be removed.

**Figure 2-10.** Between Crossing 1 and 2. Channel is relatively narrow and incised along this reach. View looking upstream from Sta 7+00.

**Crossing 2**

Crossing 2 is a 3-foot diameter CMP with no slope (i.e., flat) and is approximately 20 feet long (Figures 2-11 and 2-12). The crossing supports a single lane road that was likely constructed between 1988 and 1993, although it is difficult to determine in the aerial photograph record due to dense overhead canopy. The crossing was built for cattle and tractor access into the pasture. The pipe is hydraulically undersized and is likely a partial fish passage velocity barrier for juvenile salmonids. The inlet is at grade, however, due to its small size it is frequently blocked with branches and debris. The outlet is also at grade, however mature willows are growing in the thalweg approximately 3-5 feet downstream and cause debris and sediment accumulation and high turbulent flow velocities. The local reach slope at Crossing 2 is 0.6%.

**Figure 2-11.** Crossing 2 inlet behind blackberries in foreground. View looking downstream.

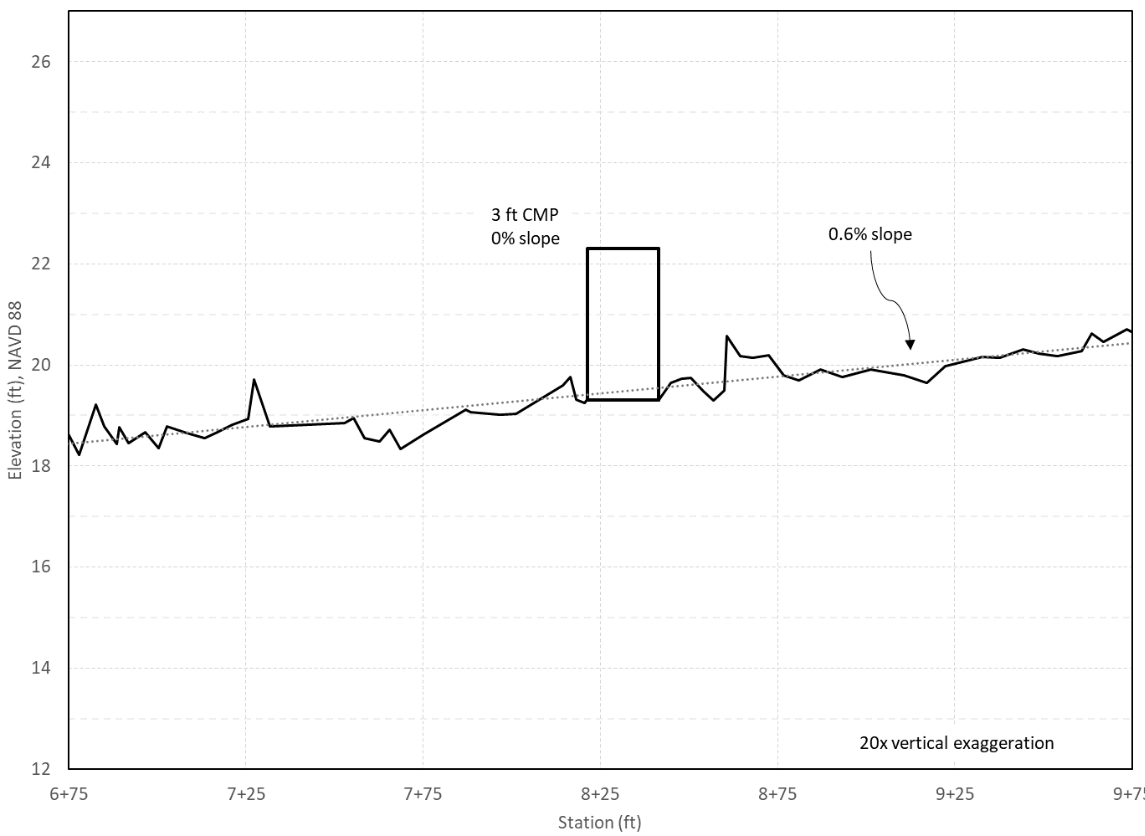


**Figure 2-12.** Longitudinal profile at Crossing 2.

**Crossing 2 to Crossing 3**

Upstream from Crossing 2 the channel remains similarly narrow and confined, as it is downstream of the crossing, for approximately 50–100 feet. The channel then slightly widens (around Sta 9+00) and continues to meander through dense riparian vegetation. Channel bed and bank substrate is comparable to downstream of Crossing 2. CDFW and SRA have maintained a seasonal passive integrated transponder (PIT) tag monitoring station along this reach for the past two years. The PIT tag monitoring is in addition to minnow trap monitoring that has been conducted in lower Stotenburg Creek since 2013. The monitoring has targeted documenting juvenile coho salmon, although juvenile trout (either steelhead or cutthroat) and adult cutthroat have also been detected.

**Crossing 3**

Crossing 3 is a rock armored ford approximately 15–20 feet wide and was constructed prior to 1948 (Figure 2-13). The crossing appears actively used in all of the historical aerial photographs following 1948 and has likely served as a regular access point to the $Qfp_2$ floodplain pasture and Smith River gravel bars. Anecdotal information from the previous landowner suggests that a ferry was located along this reach of the Smith River prior to construction of bridges further upstream near the current location of the Highway 101 bridge. The local reach slope at the crossing is approximately 0.7%, although rock placement at the road surface has caused minor aggradation (1 foot or less) extending up to 100 feet upstream (Figure 2-14).

**Figure 2-13.** Crossing 3, flow is from right to left.

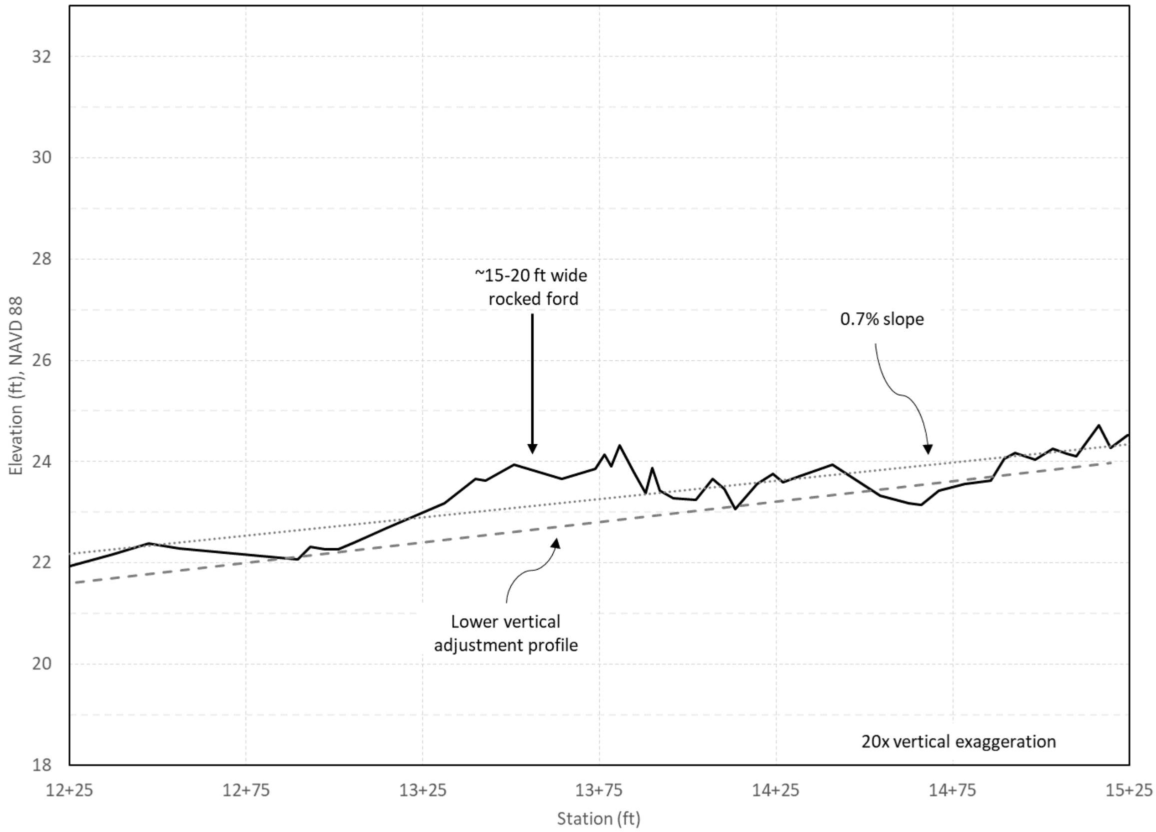


**Figure 2-14.** Longitudinal profile at Crossing 3.

**Crossing 3 to Crossing 4**

A marked change in channel slope is located between Crossings 3 and 4 at approximately Sta 15+00. The channel transitions from a general downstream slope of 0.8% to an upstream slope of 0.2% (Figure 2-4). It is possible that outward growth of the alluvail fan to the northeast of the project reach has maintained a slightly higher elevation than the surrounding floodplain over the late Quaternary-Holocene, and has contributed to the low channel slope from approximtaley Sta 15+00 to 23+00 (Figure 2-2). The low slope and wide channel bottom create a dynamic and complex habitat with multiple braided flow paths and low velocity (Figure 2-15). These conditions create high-quality rearing habitat for juvenile salmonids, however, depth likely becomes a limiting factor through this reach during late spring recessional flows. Channel bed substrate is dominantly silt and live grass vegetation. The channel is primarily surrounded with dense riparian and Himalayan vegetation, similar to downstream, although multlpe segments of the channel lack any riparian cover, likely due to intense cattle grazing. At Sta 18+00 a large cottonwood tree was naturally recruited between 2016–2017. The log has partially re-aligned the thalweg and caused some upstream backwatering (Figure 2-16).

**Figure 2-15.** The channel between Crossings 3 and 4 has good rearing habitat with multiple complex flow paths and low velocity.

**Figure 2-16.** Large cottonwood tree at Sta 18+00 that was naturally recruited between 2016–2017. The log has partially re-aligned the thalweg and caused some upstream backwatering. Flow is from right to left.

**Crossing 4 and Upstream**

Crossing 4 consists of four HDPE culverts placed side-by-side and range from 2–4 feet in diameter and 53–61 feet in length (Figures 2-17 to 2-19). The pipes have varying slopes and elevations within the road crossing fill. The northern-most pipe is set the lowest and is therefore on the thalweg alignment. Moving across the channel to the south, the pipes increase in elevation and the amount of infilling with gravel and debris. The crossing supports a gravel road that was constructed between 2003 and 2004 to provide access to the home and trucking operation on the banks of the Smith River to the south. The pipes are hydraulically undersized, and the crossing is a partial fish passage barrier for adult and juvenile salmonids. The inlets of the northern two pipes are at grade, however, due to their small size they are frequently blocked with branches and debris. The outlet of the thalweg pipe is at grade whereas the others are either shotgunned or perched within dense vegetation on the crossing fill. At high flows the culverts are likely velocity barriers to migrating juvenile salmonids. In recent years beavers have opportunistically blocked the culvert inlets to backwater a portion of the upstream channel. The longitudinal profile shows that the culverts were set approximately 0.5–1 feet above the natural thalweg profile. The local reach slope at the crossing is 0.7%. Channel substrate at the crossing and upstream is comparable to downstream with dominantly silts and some fine sand and organics.

Upstream of the crossing the channel is wide and relatively flat-bottomed. The dense riparian cover continues for approximately 250 feet upstream of the crossing before opening up to a segment of channel with only grasses and small shrubs. This transition is the upstream extent of the project reach.

**Figure 2-17.** Crossing 4 outlet. Two primary pipes visible in center-left. Other two pipes obscured in blackberries to the right. View looking upstream.

**Figure 2-18.** Crossing 4 inlet. All four pipe inlets visible. Debris and improper construction cause upstream backwatering. View looking downstream.

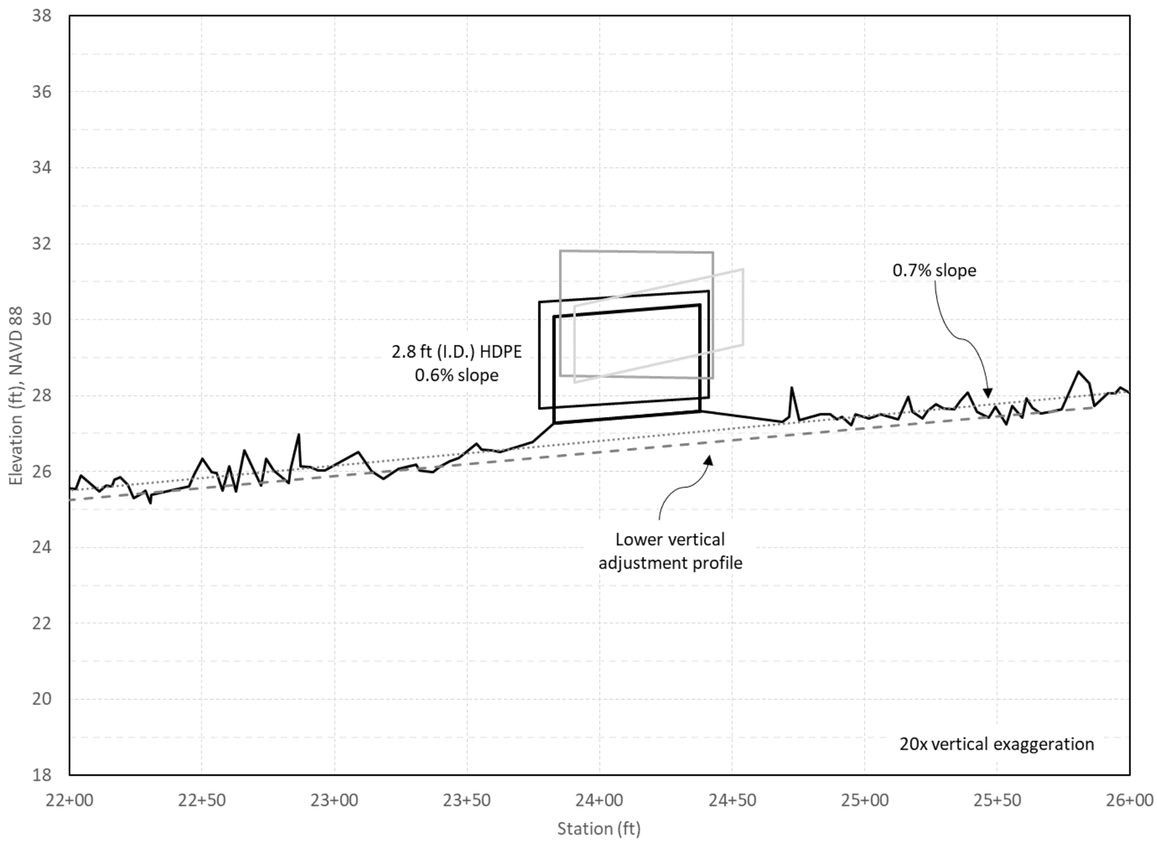


**Figure 2-19.** Longitudinal profile at Crossing 4. The culvert dimensions and slope are provided for the thalweg culvert. The culverts are color-coded with the darkest being the most northern and lightest the most southern. Refer to Figure 2-2 for the planform alignment.

## 2.3 Riparian Vegetation

The riparian vegetation field assessment was conducted in the spring of 2019 to characterize vegetation composition and structure along the riparian corridor in the project area. Results from this assessment informed the plant selection for the riparian planting plan and the recommended invasive weed removal techniques.

Riparian vegetation within the project area is primarily composed of *Salix lasiolepis* (arroyo willow) which forms a dense mid-story canopy along most of lower Stotenburg Creek. Minimal overstory riparian tree cover was observed and consisted of *Populus trichocarpa* (black cottonwood), *Alnus rubra* (red alder), *Fraxinus latifolia* (Oregon ash), *Salix scouleriana* (Scouler's willow), and *Frangula purshiana* (cascara). *Picea sitchensis* (Sitka spruce), *Pseudotsuga menziesii* var. *menziesii* (Douglas-fir), and *Sequoia sempervirens* (coast redwood) were observed upstream of the project reach and were likely a historical component to the overstory canopy along the lower creek. *Rubus armeniacus* (Himalayan blackberry), a nonnative species with a high weed rating by California Invasive Plant Council (Cal-IPC), formed dense thickets throughout the riparian understory and portions of the main channel. Native understory vegetation was low to absent in areas with a high prevalence of Himalayan blackberry. In areas with low disturbance, intact native understory vegetation included *Rubus spectabilis* (salmon berry), *Rubus parviflorus* (thimble berry), *Oemleria cerasiformis* (oso berry), *Athyrium filix-femina* var. *cyclosorum* (lady fern), *Sambucus racemosa* var. *racemosa* (red elderberry), *Physocarpus capitatus* (Pacific nine-bark), *Marah oregana* (coast man-root), *Polystichum munitum* (western sword fern), *Urtica dioica* (stinging nettle), *Ribes divaricatum* var. *pubiflorum* (straggle bush), and *Symphoricarpos albus* var. *laevigatus* (snowberry). Emergent vegetation within the channel was sparse and included native *Carex obnupta* (slough sedge) and *Potentilla anserina* subsp. *pacifica* (Pacific silverweed). Nonnative grasses, *Glyceria ×occidentalis* (western manna grass) and *Phalaris arundinacea* (reed canary grass), have established along shallow to dry portions of the channel that were devoid of riparian cover.

# 3 HYDROLOGY AND HYDRAULICS

To understand the flow dynamics along the project reach and in the Smith River, flow hydraulics were modeled using the U.S. Army Corps of Engineers' (USACE) *Hydrologic Engineering Center's River Analysis System (*HEC-RAS). HEC-RAS is widely used for floodplain mapping and estimating general flow characteristics. Hydraulic modeling was conducted using a one-dimensional (1-D) approach in Stotenburg Creek and in the mainstem Smith River within the project area. The Smith River-Stotenburg Creek confluence was also modeled using a two-dimensional (2-D) approach. The 1-D model assumes uniform flow direction and constant velocity distribution within the channel and floodplain portion of each cross section. Flow is modeled based on topography at a channel cross section without considering the effects of channel topography between cross sections. Therefore, it is important that these limitations are closely considered during hydraulic model setup, calibration, and application. The 2-D model predicts depth-averaged two-dimensional velocity and water surface elevation within a user-specified grid across a continuous topographic terrain model.

## 3.1 Stotenburg Creek (1-D Modeling)

### 3.1.1 Hydrology

#### 3.1.1.1 Determination of flows for hydraulic modeling

The first step in the hydraulic modeling process is to determine the hydrologic data that will be the principal input to HEC-RAS. Stotenburg Creek is an ungaged stream, so relevant discharges were calculated using prorations from nearby gaged streams and using regional flow regression equations. Streamflow records from U.S. Geological Survey (USGS) Gage No. 11481200 on the Little River near Trinidad and Gage No. 11476600 on Bull Creek near Weott were used in the hydrologic analysis. The Little River and Bull Creek gages were selected because: (1) they have long periods of record (i.e., greater than 50 years), (2) they have relatively comparable drainage areas to Stotenburg Creek, (3) their proximity to the project area, and 4) they have similar topography, climate, and underlying geology to Stotenburg Creek.

Peak streamflow and mean daily flow records were analyzed from the Little River and Bull Creek gages to produce flood frequency and flow exceedance probability estimates, respectively. Peak flow estimates from the flood frequency analysis have specific recurrence intervals, or frequencies (e.g., a 100-year peak flow has a 1% chance of occurring any year, or once in 100 years, on average). Smaller flood frequency flows with more regular recurrence intervals (i.e., 1.5- and 2-year flows) are biologically and geomorphically significant because they occur during most winters and can create high velocities (in undersized crossing and/or in the open channel) capable of flushing juvenile salmonids out of the creek and/or cause mortality if insufficient low-velocity refugia habitat are available. For this analysis, we assume the 1.5-year recurrence interval flow approximates the “bankfull” flow. It is also critical to analyze flows from larger flood events ranging from 2- to 100-year recurrence intervals to determine adequate sizing for stream crossings, erosion potential and flooding hazards for adjacent property and infrastructure, as well as the stability of the proposed enhancement features.

The flood frequency analysis used a Log-Pearson III distribution and methods consistent with USGS Bulletin 17B (USGS 1982). The Little River gage period of record is 62 years long (from water year 1955 to water year 2017) and the Bull Creek period of record is 57 years long (from water year 1961 to water year 2017). For the proration calculations, a drainage area of 0.73 square miles (467 acres) was used for Stotenburg Creek, which corresponds to the drainage area at crossing 1 near the confluence with the Smith River. Peak flow estimates (provided in Table 3-1) were prorated for Stotenburg Creek following the flow transference equation of Waananen and Crippen (1977):

$$Q_u = Q_g(A_u/A_g)^b$$

Where: b = 0.87 for 100- to 5-year events, b = 0.9 for 2- and 1.5-year events, and b = 1 for exceedance flows

- $Q_u$ = Ungauged discharge
- $Q_g$ = Gauged discharge
- $A_u$ = Ungauged drainage area
- $A_g$ = Gauged drainage area

**Table 3-1.** Modeled flood frequency and exceedance discharge estimates for Stotenburg Creek.

| Discharge location and description: | 100-yr peak flow (cfs) | 50-yr peak flow (cfs) | 25-yr peak flow (cfs) | 10-yr peak flow (cfs) | 5-yr peak flow (cfs) | 2-yr peak flow (cfs) | 1.5-yr bankfull flow (cfs) | 2% exceedance flow (cfs)[1] | 20% exceedance flow (cfs)[1] | Late spring/early summer low flow (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|
| Prorated from USGS Gage No. 11481200 for the Little River near Trinidad, CA (40.5 sq mi)[2] | 386 | 355 | 319 | 268 | 224 | 134 | 102 | 17 | 3 | 1 |
| Prorated from USGS Gage No. 11476600 for Bull Creek near Weott, CA (27.6 sq mi)[2] | 390 | 348 | 304 | 241 | 190 | 101 | 78 | 24 | 4 | 1 |
| USGS Streamstats for Stotenburg Creek (0.7 sq mi)[3] | 396 | 341 | 289 | 220 | 168 | 93 | - | - | - | - |
| **Average at project site (0.73 sq mi)[4]** | **391** | **348** | **304** | **243** | **194** | **109** | **90** | **21** | **3.5** | **1** |

Notes:
[1] Exceedance flows calculated using standard flow duration analysis and prorated for drainage area difference
[2] Log-Pearson Type III distribution based on USGS stream gage prorated for drainage area difference using USGS flow transference formula (Waananen and Crippen 1977)
[3] Streamstats rounds the drainage area to the nearest 0.1 square miles
[4] Measured at Crossing 1

Additional peak flow estimates were acquired from the interactive USGS StreamStats website (http://water.usgs.gov/osw/streamstats/california.html). The website uses a geographic information system (GIS) and flow regression equations to calculate storm discharges at any point along gaged and ungaged watercourses (Gotvald et al. 2012). For ungaged streams, StreamStats provides peak flow estimates for 2-, 5-, 10-, 25-, 50-, and 100-year flood events. StreamStats results for the project site are provided in Table 3-1. When selecting a point on an ungaged watercourse to determine peak flow estimates, StreamStats rounds the contributing drainage area to the nearest 0.1 square miles. StreamStats calculations likely underestimate peak flow due to a rounded drainage area of 0.7 square miles (actual drainage area is 0.73 square miles).

In addition to peak flow estimates, moderate and low flows were also modeled in HEC-RAS, which correspond to upper fish passage flows, typical winter base flow, and late spring/early summer low flow (Table 3-1). These relatively lower flows have biological significance for fish passage and habitat enhancement objectives, especially related to over-winter rearing habitat for salmonids. The 2% exceedance flow has been identified in other coastal basins as the highest flow when fish passage is likely to occur. The 20% exceedance flow represents the typical winter base flow when juvenile salmonids will be rearing in the creek. These biologically relevant exceedance flows were calculated from the Little River and Bull Creek gage records and prorated based on the drainage area ratio to the project site. Note that Stotenburg Creek is intermittent and goes dry every year in the late spring or early summer. Due to the level of detail of topographic data gathered as well as hydraulic modeling constraints, there is minimal value-added in modeling flows less than 1 cubic foot per second (cfs). Therefore, a flow of 1 cfs was selected for the typical late spring/early summer discharge. An average of the StreamStats and prorated USGS gage flows were used as input in the 1-D hydraulic model (described below in Section 3.1.2 *Hydraulic Modeling*).

#### 3.1.1.2 Additional hydrologic analyses

Based on input during the second TAC meeting (65% design submittal), additional hydrologic analyses were conducted by expanding the number of gaged stream records used in proration calculations to increase confidence in the design flows presented in Table 3-1. The Bull Creek and Little River gage records were used initially for the reasons described above in Section 3.1.1.1 *Determination of flows for hydraulic modeling*, however, these basins have drainage areas more than an order of magnitude larger than Stotenburg Creek, which can lead to inaccuracy in the proration results. To address this concern, additional flood frequency and flow duration analyses were conducted using USGS gaged streamflow records from local basins with drainage areas within an order of magnitude of Stotenburg Creek's. The additional records include Gage No. 11482468 on Little Lost Man Creek near Orick, Gage No. 14378800 on Harris Creek near Brookings, OR, Gage No. 11533000 on Lopez Creek near Smith River, and Gage No. 11480000 on Jacoby Creek near Freshwater. The results were prorated based on drainage area ratio to Stotenburg Creek, as described above, and are presented in Table 3-2.

**Table 3-2.** Additional flood frequency and exceedance discharge estimates for Stotenburg Creek.

| Discharge location and description: | Period of record (years) | 100-yr peak flow (cfs) | 50-yr peak flow (cfs) | 25-yr peak flow (cfs) | 10-yr peak flow (cfs) | 5-yr peak flow (cfs) | 2-yr peak flow (cfs) | 1.5-yr peak flow (cfs) | 2% exceedance flow (cfs)[1] | 20% exceedance flow (cfs)[1] | Late spring/early summer low flow (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Prorated from USGS Gage No. 11482468 Little Lost Man Creek near Orick, CA (3.46 sq mi)[2] | 13 | 340 | 288 | 239 | 177 | 132 | 69 | 50 | 15 | 3 | 1 |
| Prorated from USGS Gage No. 14378800 Harris Creek near Brookings, OR (1.28 sq mi)[2, 3] | 14 | 383 | 331 | 282 | 220 | 174 | 110 | 87 | - | - | 1 |
| Prorated from USGS Gage No. 11533000 Lopez Creek near Smith River, CA (0.92 sq mi)[2] | 12 | 736[4] | 596[4] | 471[4] | 327[4] | 233 | 120 | 86 | 29 | 6 | 1 |
| Prorated from USGS Gage No. 11480000 Jacoby Creek near Freshwater, CA (6.05 sq mi)[2] | 19 | 431 | 375 | 320 | 248 | 195 | 112 | 86 | 14 | 2 | 1 |
| **Average at project site (0.73 sq mi)[5] - 65% design flows from Table 3-1** | **-** | **391** | **348** | **304** | **243** | **194** | **109** | **90** | **21** | **3.5** | **1** |
| **Average at project site (0.73 sq mi)[5] using additional gage records** | **-** | **388** | **340** | **292** | **229** | **188** | **106** | **81** | **20** | **4** | **1** |
| **Percent difference** | **-** | **-0.8%** | **-2.4%** | **-3.9%** | **-5.7%** | **-3.1%** | **-3.5%** | **-9.4%** | **-3.7%** | **0.3%** | **0.0%** |

Notes:
1 Exceedance flows calculated using standard flow duration analysis and prorated for drainage area difference
2 Log-Pearson Type III distribution based on USGS stream gage prorated for drainage area difference using USGS flow transference formula (Waananen and Crippen 1977)
3 Harris Creek gage only has peakflow data available, therefore only flood frequency calculations could be performed
4 Peakflow estimates > 5-year flow are anomalously high due to short period of record that includes 1964 and 1972 floods (two largest in Smith River record), and are not used
5 Measured at Crossing 1

Expanding the number of gaged stream records used in proration calculations has little effect on the resultant average design flows as seen in the percent differences in Table 3-2. The average flows from the expanded analyses are mostly slightly lower than those used in the hydraulic modeling, which provides a small degree of conservatism and confidence in the designs considering they assumed slightly higher flows. It is important to note that the periods of record for the additional gages ranges from 12 to 19 years, which is relatively short considering the statistical assumptions in flood frequency and flow duration calculations. Overall, the expanded hydrologic analyses provide further confidence in the original proration calculations and the input flows to the hydraulic models have not been revised.

### 3.1.2 Hydraulic modeling

#### 3.1.2.1 Existing conditions hydraulic modeling

Existing conditions topography used in the HEC-RAS model was taken from the topographic survey and integrated LiDAR data that were described above in Section 2.2.2 *Topography*. Typically, cross sections are cut perpendicular to the channel thalweg.

Cross-sections of the channel were cut from the Triangular Irregular Network (TIN) surface in AutoCAD and exported to HEC-RAS to create the hydraulic model. The Manning's n roughness value of 0.055 was used for the channel, based on the HEC-RAS Reference Manual conservative recommendation for a "clean and winding natural stream with some pools, shoals, weeds, stones and ineffective slopes and sections"; and 0.065 for all banks and floodplains based on a conservative value for "medium to dense brush, in winter". Water surface elevations for the downstream boundary condition were determined by field measurements for lower flows (i.e., 1.5-year flow, 2% and 20% exceedance flows, and the 1 cfs low flow condition) and by 2-D model results for higher flows (i.e., above a 1.5-year flow). The 2-D hydraulic modeling process is described below in Section 3.2 *Smith River (1-D and 2-D Modeling)*. Flow was simulated in a subcritical regime with steady flow for each modeled run.

#### 3.1.2.2 Hydraulic model calibration

Calibration of the existing conditions 1-D HEC-RAS model was conducted using field observations of high flows from the 2018-2019 winter. Water surface elevations along lower Stotenburg Creek were either measured simultaneous with a flow event or marked and subsequently surveyed. The flows used for model calibration corresponded to approximately a 15% exceedance flow, a 1.5-year bankfull flow, and a 2.5-year flow on the Smith River. The initial HEC-RAS model runs predicted water surface elevations (WSEs) slightly lower than those measured in the field. To calibrate the model to more accurately match field observations, all Manning's n roughness values were slightly increased to values reported above, which correspondingly increased the WSEs to closely match field conditions.

#### 3.1.2.3 Existing conditions hydraulic model results

Hydraulic modeling was conducted for the existing conditions, including the culverts at Crossings 1, 2 and 4. Figure 3-1 shows the longitudinal profile of the channel thalweg and modeled WSEs throughout the project reach. Note that the values along the horizontal axis in Figure 3-1 are different than the channel station numbers because the channel alignment started at 1+00 whereas the "Main Channel Distance" begins at 0. Key results from the existing conditions model include:

- The project reach is affected by extensive backwater effect from the Smith River during high flow events above a 2% exceedance. The flat water surface profiles are due to this backwatering effect and are not produced by increased Stotenburg flows.
- Crossing 4 is overtopped in the 10- and 100-year flows due to elevated WSE along Stotenburg Creek. Crossings 2 and 1 are overtopped in the 1.5-, 10-, and 100-year flows due to the backwatering effect from the Smith River.
- Flows are typically contained within the channel and floodplain upstream from Crossing 1 for flows below a 2% exceedance with low to moderate flow velocities.
- Just downstream from Crossing 1, the channel gradient steepens, and flow velocities increase (i.e., >2ft/s) at late spring and 20% exceedance flows.
- The lower portion of the project downstream from Crossing 1 is difficult to model due to interaction with the Smith River floodplain and backwatering. See Section 3.2 *Smith River (1-D and 2-D Modeling)* below for discussion of the 2-D hydraulic modeling process.

A full tabulation of hydraulic model outputs is included in Appendix C. Proposed conditions hydraulic modeling results are discussed in Section 5.2 *Proposed Conditions Hydraulic Modeling*.

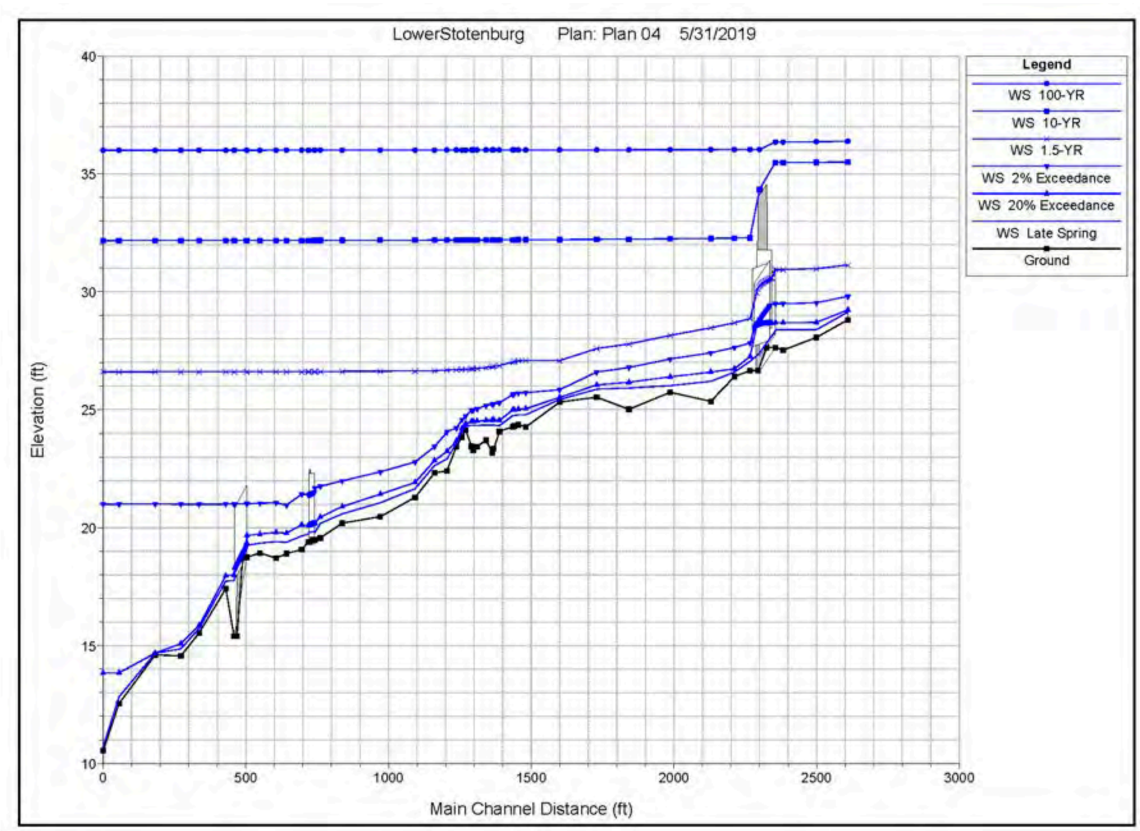


**Figure 3-1.** Modeled water surface elevations under existing conditions in the project reach.

## 3.2 Smith River (1-D and 2-D Modeling)

Flow hydraulics on the mainstem Smith River were modeled using a combined 1-D and 2-D approach. The results were used to inform large wood structure designs, conduct wood stability analyses, and refine the downstream boundary conditions for the 1-D hydraulic model on Stotenburg Creek.

### 3.2.1 Hydrology

The Smith River has two active USGS gages. Gage No. 11532500 (Smith River near Crescent City), located in Hiouchi approximately 9.5 miles upstream of the project site, provides a continuous stage and discharge record, as well as other water quality parameters. Gage No. 11532650 (Smith River near Fort Dick) is located at the HWY 101 bridge approximately 0.9 miles upstream of the Stotenburg Creek confluence and provides a continuous stage record only. Peak flow estimates and exceedance flows were calculated for USGS Gage No. 11532500 (Smith River near Crescent City) following the methods described above in Section 3.1.1 *Hydrology* and were prorated based on drainage area for the USGS Gage No. 11532650 (Smith River near Fort Dick) location at the HWY 101 bridge (Table 3-3). Additional relevant discharges were also prorated to the HWY 101 bridge gage site that were used in 2-D model calibration (further described below). These flows correspond to when the 2010 LiDAR data were acquired and when an aerial photograph showing summer low-flow conditions was taken.

**Table 3-3.** Modeled peak flow and exceedance discharge estimates for the Smith River.

| Discharge location and description: | 50-yr peak flow (cfs) | 10-yr peak flow (cfs) | 2-yr peak flow (cfs) | 1.5-yr peak flow (cfs) | 20% exceedance flow (cfs)[1, 3] | 77% exceedance flow (cfs)[1, 4] |
|---|---|---|---|---|---|---|
| Prorated from USGS Gage No. 11532500 Smith River near Crescent City, CA[2] | 194,120 | 141,670 | 84,050 | 66,710 | 5,650 | 390 |

Notes:
1 Exceedance flows calculated using standard flow duration analysis and prorated for drainage area difference
2 Log-Pearson Type III distribution based on USGS stream gage prorated for drainage area difference using USGS flow transference formula (Waananen and Crippen 1977)
3 Corresponds to discharge during LiDAR acquisition
4 Corresponds to discharge in aerial photograph showing summer low-flow conditions

### 3.2.2 Hydraulic modeling

A 1-D model of the Smith River was initially created in HEC-RAS to provide general context of inundation extent and water surface elevations across the project area at higher flood flows (e.g., above a 1.5-year flow). The model extends from the HWY 101 bridge approximately 1.5 miles downstream and includes the adjacent floodplains. Stotenburg Creek enters the river approximately 0.9 miles downstream of the HWY 101 bridge. Manning's n roughness values of 0.033 and 0.06 were used for the channel bed and overbank, respectively. The majority of the cross-section elevations were derived from LiDAR topography; however, channel bed elevations were assumed based on interpretation of channel depths from an aerial photograph that was taken during a low summer flow when the bed is clearly visible. The 1-D model was calibrated by manipulating the assumed channel bed elevations until the modeled water surface elevations closely matched the calibration points, which included:

- the USGS gage stage record at the upstream boundary of the model,
- multiple low and moderate flow surveyed water surface elevations at the Stotenburg Creek - Smith River confluence,
- the continuous water surface elevations from the LiDAR dataset, and
- the continuous water's edge from the aerial photograph showing summer low flow conditions.

Once the channel bed geometry was established based on calibration of the 1-D hydraulic model described above, a spatially continuous topographic and bathymetric terrain model was produced from the LiDAR topography, field surveyed topography of Stotenburg Creek, and bathymetric interpolation between the 1-D cross sections along the Smith River. This terrain model was used as input in the HEC-RAS 2-D hydraulic model. The terrain model uses a spatially variable mesh cell size, although the majority of the mesh consists of 10-foot square cells. Areas proximal to the Stotenburg Creek alignment, which were surveyed in the field, have a finer cell size down to approximately 3-foot square. Spatially variable Manning's n values were assigned across the model area based on channel substrate, vegetation, and land-use. Manning's n values ranged from 0.033 (main channel) to 0.1 (thick vegetation). The flows listed in Table 3-3 were ran in the 2-D model and additional calibration was performed by adjusting Manning's n values until the modeled water surface elevations closely matched the calibration points listed above. In general, the modeled water surface elevations matched the calibration points within 0.3 to 0.8 feet, and in some cases within 0.1 foot. Note that the 100-year flood discharge was not modeled due to the difficulty of modeling a flow this large in the broad alluvial floodplain setting of the lower Smith River. To accurately model the 100-year flood, the terrain model would have needed to be extended across a large area of the Smith River coastal plain, which would dramatically increase model run times and complicate variable manipulation during model calibration.

Water surface elevation and flow velocity from the 2-D modeled 50-year flow event (Figures 3-2 and 3-3) were used in the wood stability analyses (see Section 6.1 *Wood Stability Analyses*) and water surface elevations were used to provide downstream boundary conditions for the 1-D model of Stotenburg Creek.

Eddies are simulated by the HEC-RAS 2-D model although they are not prevalent at flood flows in the project area. Eddies are more common at lower flows (e.g., < than 10-year event) and along velocity and roughness transitions near the Stotenburg Creek alignment where the mesh cell size is smaller. Eddies are less common in the 50-year model run due to deep high-velocity flow moving downstream. These model results generally agree with site observations and the lack of large scour areas or substantial sand deposits. The relatively straight river channel, lack of bedrock promontories, and dense riparian stands on lateral gravel bars does not promote eddy flow. Large eddy-derived sand deposits are common approximately 0.3–0.5 miles upstream of the HWY 101 bridge in the lee of established vegetation "islands" on the gravel bar. This reach also has multiple bedrock outcrops along the right bank that produce eddy flow and large scour areas.

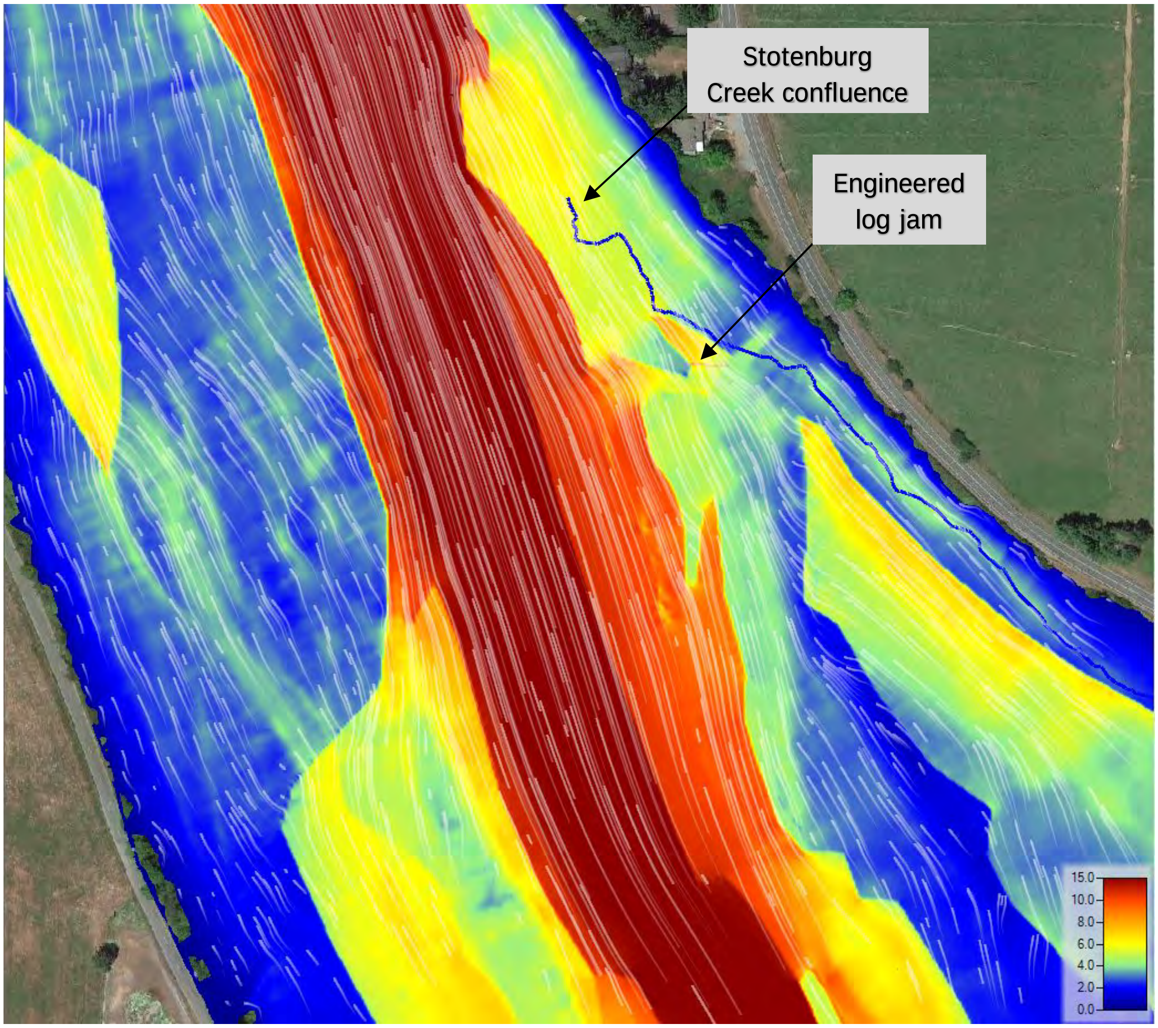


**Figure 3-2.** 2-D modeled velocity (ft/sec) from the 50-year flow event at the Smith River-Stotenburg Creek confluence.

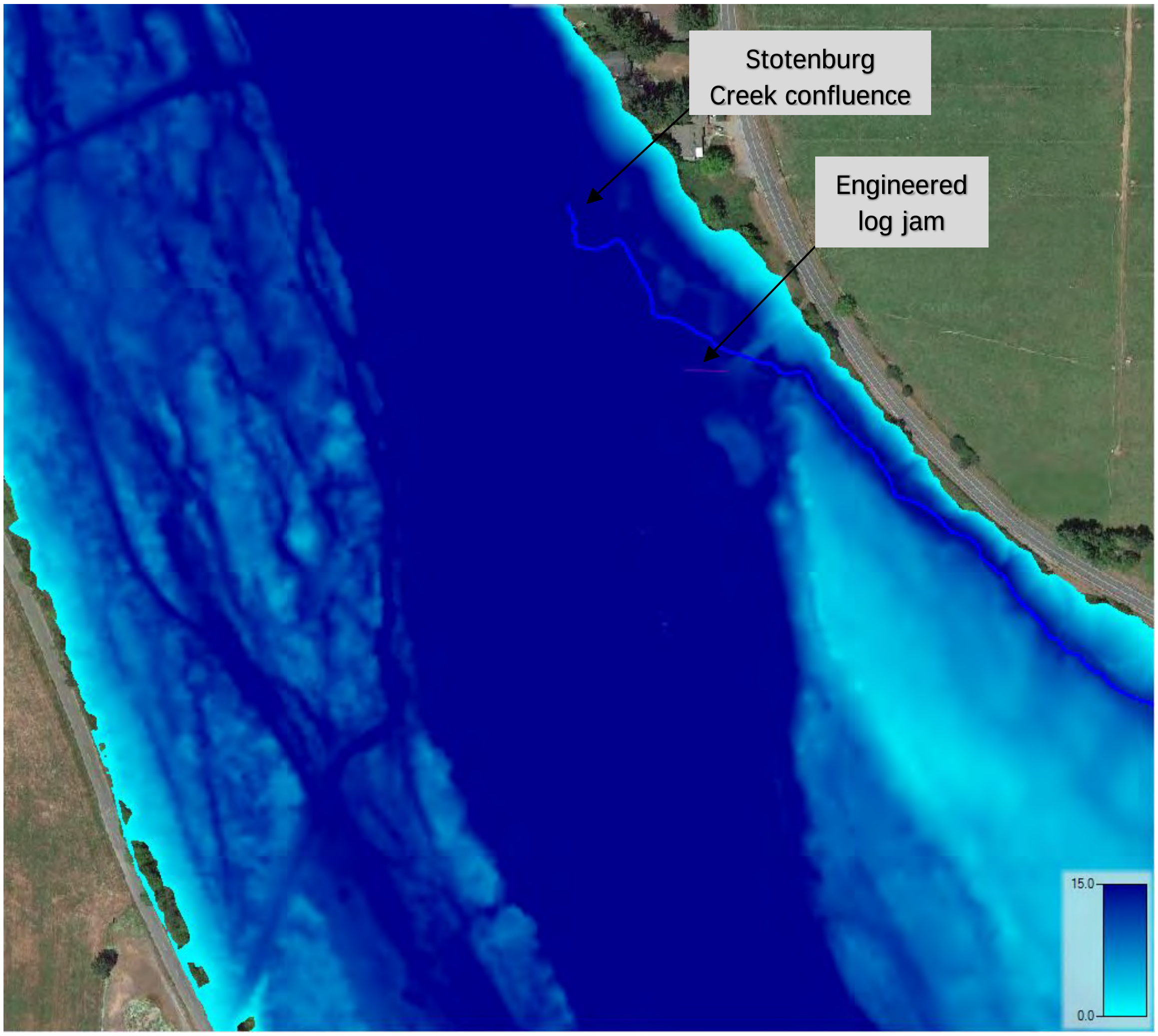


**Figure 3-3.** 2-D modeled depth (feet) from the 50-year flow event at the Smith River-Stotenburg Creek confluence.

# 4 CONCEPTUAL ENHANCEMENT DESIGN ALTERNATIVES

## 4.1 General Enhancement Objectives

Conceptual design alternatives for the lower Stotenburg Creek enhancement project are shown in Appendix A. The conceptual design plans focus on several key enhancement components including:

1. **Fish Passage** – The primary impairment to the project reach is fish passage barriers. The conceptual design plans include removing Crossings 2 and 3 and restoring natural stream channels at their locations. Crossing 1 would be relocated approximately 100 feet further upstream (Sta 6+75) at a higher elevation that places it out of the active scour range from the historic 1964 flood. Conceptual design alternatives for the new Crossing 1 include either a box culvert or bridge. The existing Crossing 1 would be restored to a natural stream channel. Crossing 4 would be replaced with a box culvert, although a bridge replacement alternative is also being considered. The crossing alternatives were designed

following the methods of Part XII of the California Salmonid Stream Habitat Restoration Manual (CDFW 2009) and the Stream Simulation approach (USDA Forest Service 2008); and are capable of withstanding a 100-year flood on Stotenburg Creek with sufficient freeboard to pass sediment and large woody debris.

2. **Winter/Spring Rearing Habitat** – Seasonal winter and spring rearing are key ecological uses of Stotenburg Creek for juvenile salmonids. Conceptual design plans include enhancing and expanding multiple seasonal rearing habitats. Enhancement objectives focus on creating low-velocity refugia by constructing inset floodplain benches in confined reaches and expanding existing quality habitats upstream of Crossing 3 by installing a sequence of beaver dam analogues (BDAs) to increase habitat complexity, expand backwatering in the upstream low gradient reach, and extend seasonal rearing into the late spring/early summer.
3. **Hydrologic Connectivity** – due to Stotenburg Creek's small drainage area and intermittent surface flow in the late spring/early summer, hydrologic connectivity can be a limiting factor to salmonid rearing in the creek. Hydrologic connectivity would be improved by removing sediments aggraded on the upstream side of crossings during the removal and replacement process. Continuity of surface flow between Crossing 1 and Smith River confluence is also a key concern. Conceptual design plans include regrading portions of this reach to reduce channel length and maintain a consistent slope.
4. **Riparian Function/Cattle Exclusion** – In general, Stotenburg Creek within the project reach is densely vegetated with riparian trees and shrubs, as well as invasive Himalayan blackberry. However, discrete sections of the channel lack woody riparian vegetation and are accessible to grazing cattle. Conceptual design plans include constructing cattle exclusion fencing along the pasture between Crossings 1 and 4, and riparian plantings in key locations along the channel.

## 4.2 Alternative 1

Conceptual Design Alternative 1 (see design plans in Appendix A, Sheets 1 through 4) consists of a suite of actions that address all key enhancement components described above, including:

- Construct a new channel alignment from Sta 1+60 to 2+75 to reduce excessive channel sinuosity, utilize existing low-lying topography, and maintain a consistent channel slope. Re-aligning the channel further to the northeast also incidentally widens the existing willow buffer distance from the Smith River, which serves to intercept fine sediment and debris during high flows.
- Fill old channel alignment downstream of Sta 2+75 and split flow channel at Sta 4+10 to keep surface flow concentrated to a single primary channel, which will maintain greater depths into the late spring/early summer.
- Grade channel from Sta 4+50 to 6+00 to maintain a consistent channel slope and widen this narrow and confined reach.
- Remove Crossing 1, regrade natural channel banks, and excavate aggraded fine sediment on upstream side (~1 foot at Sta 6+10 tapering to existing thalweg grade at Sta 6+90).
- Construct new crossing at Sta 6+75 with either:
    - **OPTION 1**: 16-foot x 40-foot prefabricated bridge (e.g., Kernen Construction prefab bridge), or
    - **OPTION 2**: 20-foot width x 30-foot length x 10-foot height box culvert (e.g., Jensen Precast segmental box culvert).

- Construct new northern road approach from existing road to new crossing.
- Construct new southern approach from new crossing with one alignment to access the pasture and a second alignment to connect to the existing road on the lower floodplain. Constructing the lower road alignment would require removing approximately eight 12-inch to 18-inch diameter at breast height (DBH) alders.
- Construct inset floodplain benches in confined reach from Sta 7+00 to 8+50.
- Remove Crossing 2 and regrade natural channel banks.
- Remove Crossing 3 by excavating road armoring and aggraded fine sediment on upstream side (up to 1-foot excavation at Sta 13+30 tapering to natural thalweg grade at Sta 13+90).
- **OPTION** – construct sequence of five BDA's with 0.5-foot crest elevation increases.
- Remove Crossing 4 and replace with a new 24-foot width x 48-foot length x 10-foot height box culvert (e.g., Jensen Precast segmental box culvert).
- Riparian and conifer plantings at select areas devoid of vegetation.
- Cattle exclusion fencing along pasture between Crossings 1 and 4.

## 4.3 Alternative 2 (Preferred Alternative)

Conceptual Design Alternative 2 (see design plans in Appendix A, Sheets 5 and 6) consists of the same suite of enhancement actions as Alternative 1 with the following additions:

- Construct willow baffles in the clearing on the Smith River gravel bar adjacent to Sta 4+50 – 5+50 to reduce flood flow velocity from the river and promote deposition of fine sediment before intersecting the Stotenburg channel.
- Construct engineered log jam (ELJ) in conjunction with willow baffles to intercept LWD from the Smith River, reduce fine sediment deposition in the new Stotenburg Creek channel, and dissipate/deflect high velocity Smith River flows.
- Construct multiple (~5) large wood structures along the margins of the new Stotenburg channel alignment from Sta 2+00 to 4+00 to strengthen channel banks and concentrate flow through the new alignment.
- Minor grading of left-bank connection with off-channel alcove at Sta 6+40 to enhance inundation and access across wider range of low flows.
- Mechanical and hand removal of invasive Himalayan blackberry throughout project reach.

## 4.4 Planning-Level Construction Cost Estimate

Tables 4-4 and 4-5 provide planning-level cost estimates for Alternatives 1 and 2, respectively. These costs assume that the project will be permitted through CDFW's FRGP programmatic permitting pathway.

**Table 4-1.** Cost estimate for Alternative 1 based on 30% design.

| No. | Item | Unit cost | Quantity | Units | Total cost |
|---|---|---|---|---|---|
| 1 | Mobilization | $10,000.00 | 1 | LS | $10,000 |
| 2 | Clearing and grubbing | $2,500.00 | 1 | LS | $2,500 |
| 3 | Dewatering | $10,000.00 | 1 | LS | $10,000 |
| 4 | Re-grade channel from Sta 1+60 to 6+50 (cut/fill balanced on site) | $40.00 | 500 | CY | $20,000 |
| 5 | Crossing 1 upgrade (new site) with 40' x 16' prefabricated bridge and new road approaches | $60,000.00 | 1 | LS | $60,000 |
| 6 | Construction of inset floodplain benches from Sta 7+00 to 8+50 | $40.00 | 200 | CY | $8,000 |
| 7 | Decommission Crossings 1, 2, & 3 | $7,500.00 | 1 | LS | $7,500 |
| 8 | Crossing 4 upgrade with 48-foot length x 24-foot width concrete box culvert | $200,000.00 | 1 | LS | $200,000 |
| 9 | Seeding/mulch/planting | $5,000.00 | 1 | LS | $5,000 |
| 10 | Cattle exclusion fencing | $8.00 | 1600 | LF | $12,800 |
| 11 | Permits (CDFW 1602) | $5,313.00 | 1 | LS | $5,313 |
| 12 | Engineering—bid support, construction oversight, as-builts | $20,000.00 | 1 | LS | $20,000 |
| **Base construction cost:** | | | | | **$361,113** |
| Option 1 | Crossing 1 upgrade: instead of prefabricated bridge, install 30-foot length x 20-foot width concrete box culvert | $100,000.00 | 1 | LS | $100,000 |
| **Construction cost including Option:** | | | | | **$401,113** |
| Option 2 | Construct 5 BDAs | $5,000.00 | 5 | LS | $25,000 |
| **Construction cost including Option 2:** | | | | **with box culvert** | **$426,113** |
| | | | | **with Kernen bridge** | **$386,113** |

**Table 4-2.** Cost estimate for Alternative 2 based on 30% design.

| No. | Item | Unit cost | Quantity | Units | Total cost |
|---|---|---|---|---|---|
| 1 | Mobilization | $10,000.00 | 1 | LS | $10,000 |
| 2 | Clearing and grubbing | $2,500.00 | 1 | LS | $2,500 |
| 3 | Dewatering | $10,000.00 | 1 | LS | $10,000 |
| 4 | Re-grade channel from Sta 1+60 to 6+50 (cut/fill balanced on site) | $40.00 | 500 | CY | $20,000 |
| 5 | Crossing 1 upgrade (new site) with 40-foot x 16-foot prefabricated bridge and new road approaches | $60,000.00 | 1 | LS | $60,000 |
| 6 | Construction of inset floodplain benches from Sta 7+00 to 8+50 | $40.00 | 200 | CY | $8,000 |
| 7 | Decommission Crossings 1, 2, & 3 | $7,500.00 | 1 | LS | $7,500 |
| 8 | Crossing 4 upgrade with 48-foot length x 24-foot width concrete box culvert | $200,000.00 | 1 | LS | $200,000 |
| 9 | Large wood structures—placed and anchored | $1,500.00 | 20 | each | $30,000 |
| 10 | Boulders—placed and anchored | $150.00 | 30 | Tons | $4,500 |
| 11 | Willow baffles structures | $30.00 | 100 | LF | $3,000 |
| 12 | Seeding/mulch/planting | $5,000.00 | 1 | LS | $5,000 |
| 13 | Cattle exclusion fencing | $8.00 | 1600 | LF | $12,800 |
| 14 | Mechanical removal of Himalayan blackberry | $10,000.00 | 1 | LS | $10,000 |
| 15 | Permits (CDFW 1602) | $5,313.00 | 1 | LS | $5,313 |
| 16 | Engineering—bid support, construction oversight, as-builts | $20,000.00 | 1 | LS | $20,000 |
| **Base construction cost:** | | | | | **$408,613** |
| Option 1 | Crossing 1 upgrade: instead of prefabricated bridge, install 30-foot length x 20-foot width concrete box culvert | $100,000.00 | 1 | LS | $100,000 |
| **Construction cost including Options:** | | | | | **$448,613** |
| Option 2 | Construct 5 BDAs | $5,000.00 | 5 | LS | $25,000 |
| **Construction cost including Option 2:** | | | | **with box culvert** | **$473,613** |
| | | | | **with Kernen bridge** | **$433,613** |

# 5 FINAL DESIGN PLANS

## 5.1 Selection of a Preferred Alternative

During the first TAC meeting on April 9, 2019 there was unanimous consent that Alternative 2 was the preferred alternative that should be advanced. The final design plans (provided in Appendix B) incorporate multiple revisions and design options that were agreed upon during the TAC meetings, including:

- The connection between the mainstem Smith River and the backwater alcove at the mouth of Stotenburg Creek will be slightly deepened by up to 1 foot using manual excavation to further enhance fish passage and water quality in the alcove.
- A prefabricated bridge (e.g., Kernen bridge or equivalent) is preferred for the new Crossing 1 instead of a box culvert due to construction access and logistics. Installing a box culvert would require the use of a crane, which would subsequently require removing more riparian trees. A prefabricated bridge can be installed more cost-effectively using lighter and more mobile equipment.
- The proposed BDAs are included in the preferred alternative design plans. The sequence of BDAs is a relatively cost-effective and limited-risk method for temporally and spatially expanding low-velocity rearing habitat. Based on input during the second TAC meeting, the jump height of the four upstream BDAs was increased from six to nine inches. The downstream-most BDA retains a six-inch jump height because we anticipate that some scour will occur on its downstream side. See Section 6.6 *Beaver Dam Analogues (BDAs)* for further discussion of jump height considerations.
- Riparian plantings will be protected from beaver and ungulate browsing by perimeter fencing around each planting polygon. Riparian plantings will be temporarily irrigated during the dry season until becoming established (2-3 years). The areas where Himalayan blackberry is mechanically removed will also be replanted with native riparian species.
- An aluminum box culvert is preferred for the Crossing 4 replacement. Given the skew of the road and the cross-sectional distance from top-of-bank to top-of-bank, a bridge replacement at this site would need to be at least 50-60 feet long. The factor of safety is unsuitable for a structure of that weight bearing on the soils typical of the site without substantial subsurface investigations and geotechnical designs of an abutment foundation system (see Section 6.5 *In Situ Soil Strength and Box Culvert/Bridge Factor of Safety* for further discussion). Based on input during the second TAC meeting, the feasibility of an aluminum box culvert was evaluated and is now the preferred design alternative for this crossing, due to cost savings. The box culvert is designed with rock slope protection on the headwalls and a full invert plate bottom that will be backfilled with select channel bed substrate (see Appendix B, Sheet 9). The box culvert is designed with a road width to accommodate a single 16-foot-wide lane.

## 5.2 Proposed Conditions Hydraulic Modeling

Proposed-conditions hydraulic modeling of the preferred alternative habitat enhancement features was conducted by grading the features in AutoCAD and re-cutting cross sections in HEC-RAS. Results from the proposed conditions model are shown on Figure 5-1. Significant reductions in flow velocities through the culverts are shown in Tables 5-1 and 5-2. Increases in water surface area in the reach upstream of the proposed BDAs are shown in Table 5-3. Flood inundation mapping is shown on Figure 5-2.

As shown in the existing conditions hydraulic model, the project reach is extensively backwatered by the Smith River during high flow events above a 2% exceedance (Figure 5-1). Under proposed conditions, Crossing 4 can pass a 25-year flow, however, flood flows on the Smith River above a 10-year event partially backwater the entire project area. The bridge superstructure at the new Crossing 1 location is between 24.4 and 27 feet in elevation. The new Crossing 1 would be inundated by Smith River backwatering at flows above a 1.5-year event. The BDAs increase water surface elevations for 2% exceedance flows and lower but have negligible effect at higher flows.

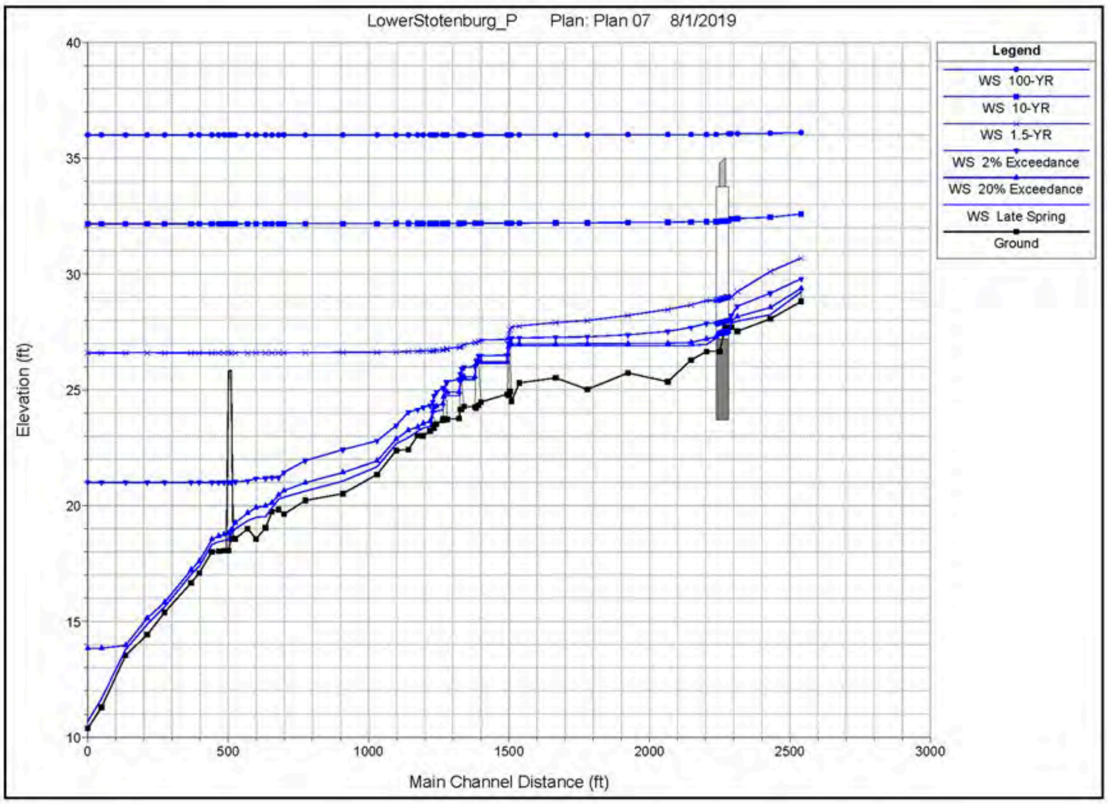


**Figure 5-1.** Modeled water surface elevations under proposed conditions in the project reach.

**Table 5-1.** Comparison of existing versus proposed HEC-RAS modeled velocities at Crossing 1.

| Flow | Crossing 1 existing velocity (ft/s) | Crossing 1 proposed velocity (ft/s) | Change in velocity (ft/s) |
|---|---|---|---|
| Late spring (1 cfs) | 2.78 | 1.01 | -1.77 |
| 20% exceedance | 3.98 | 1.40 | -2.58 |
| 2% exceedance* | 0.99 | 0.31 | -0.68 |
| 1.5-year* | 0.22 | 0.12 | -0.10 |
| 10-year* | 0.24 | 0.14 | -0.10 |
| 100-year* | 0.39 | 0.15 | -0.24 |

* 2% exceedance flows and higher are affected by Smith River backwatering

**Table 5-2.** Comparison of existing versus proposed HEC-RAS modeled velocities at Crossing 4.

| Flow | Crossing 4 existing velocity (ft/s) | Crossing 4 proposed velocity (ft/s) | Change in velocity (ft/s) |
|---|---|---|---|
| Late spring (1cfs) | 1.60 | 0.78 | -0.82 |
| 20% exceedance | 2.65 | 1.12 | -1.54 |
| 2% exceedance | 4.56 | 1.21 | -3.36 |
| 1.5-year | 6.76 | 2.18 | -4.58 |
| 10-year | 8.33 | 2.12 | -6.22 |
| 100-year* | 2.68 | 1.23 | -1.45 |

* 100-year flow is affected by Smith River backwatering

**Table 5-3.** Comparison of existing versus proposed HEC-RAS modeled water surface areas in reach upstream of proposed BDAs.

| Flow* | Existing water surface area (square feet) | Proposed water surface area (square feet) | Change in water surface area (square feet) | % increase in water surface area |
|---|---|---|---|---|
| Late spring (1 cfs) | 9,579 | 24,341 | 14,762 | 154% |
| 20% exceedance | 13,790 | 25,878 | 12,088 | 88% |
| 2% exceedance | 24,140 | 31,810 | 7,670 | 32% |
| 1.5-year | 40,717 | 42,806 | 2,089 | 5% |

* flows greater than 1.5-year recurrence interval are not affected by the BDAs

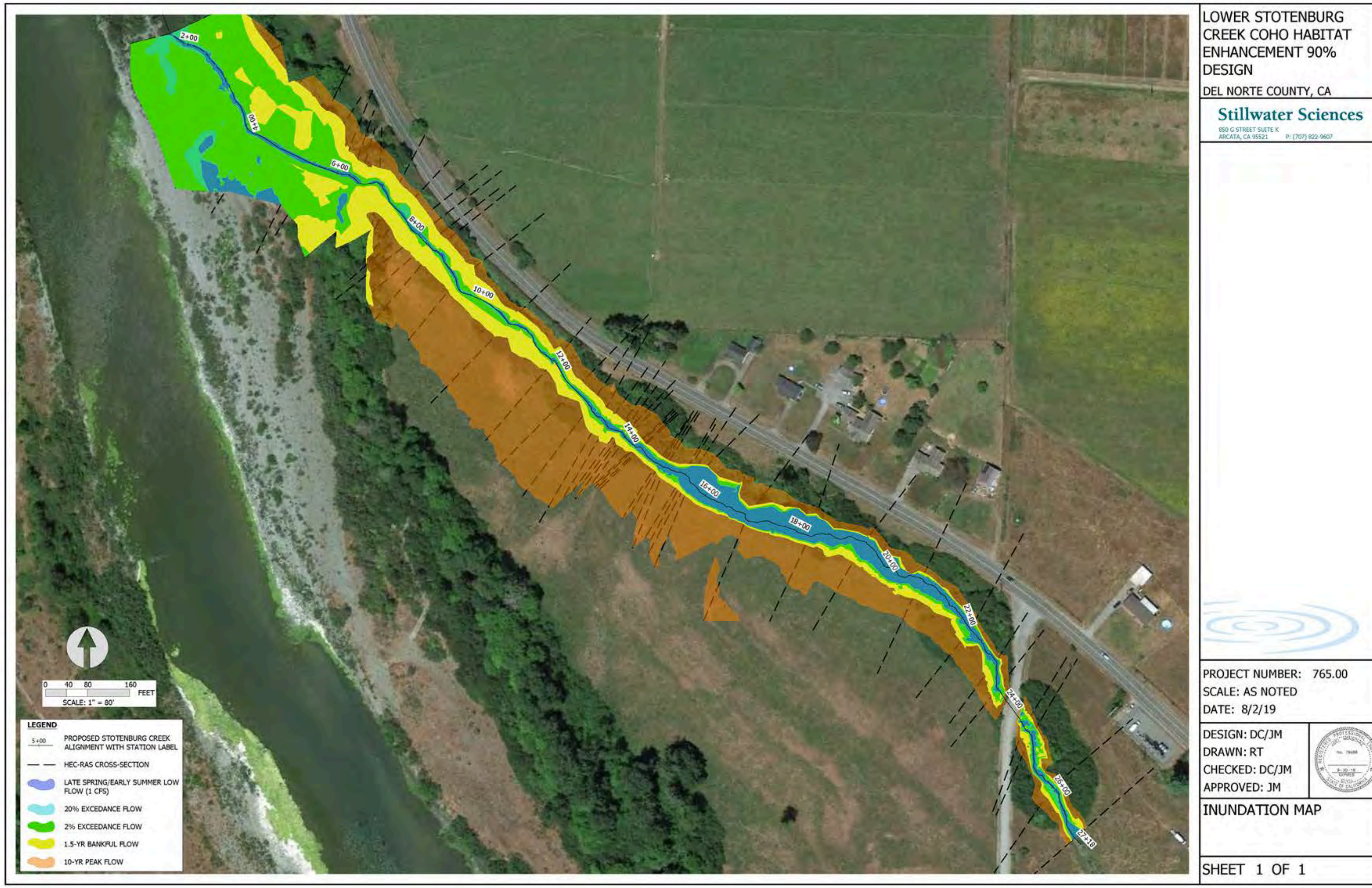


**Figure 5-2.** Modeled inundation at various flows under proposed conditions within the project reach. Note that the 100-year inundation boundary actually extends across the pasture and connects with the Smith River. Also, inundation boundaries downstream of Sta 7+00 do not accurately depict inundation because they do not account for Smith River flows. Refer to Figures 3-2 and 3-3 for 2-D modeled inundation at the Smith River – Stotenburg Confluence area.

## 5.3 Riparian Vegetation Enhancement

### 5.3.1 Riparian planting

The riparian restoration areas (approximately 0.35 acres total) currently lacking riparian cover along the southern side of the creek would be well-suited for revegetation by overstory riparian hardwoods and conifers. Planting taller riparian cover at these locations would provide the varied vegetation structure that is currently lacking in these portions of the project area (i.e., arroyo willow thickets). Some shrub cover is recommended to lower nonnative recruitment and provide additional forage for wildlife. Based on high cover of arroyo willow in adjacent areas, willow recruitment is anticipated without additional planting. Riparian forest would be composed of moderate to tall trees intermixed with shorter shrubs for an overall cover of at least 70%. Table 5-4 provides a list of hardwood, conifer, and shrub species recommended for planting to achieve a diverse multi-tiered canopy beneficial to wildlife and riparian function. Planting densities and spacing recommendations provided in Table 5-4 vary by species and follow guidance from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) California Electronic Vegetative Guide (NRCS 2019). In general, tree and large shrub species would be planted with 10–14 feet spacing and smaller shrubs with 6 feet spacing.

**Table 5-4.** Key native plant species for riparian habitat planting.

| Scientific name | Common name | Form | Material | Spacing (feet) |
|---|---|---|---|---|
| *Alnus rubra* | red alder | tree | Container | 14 |
| *Fraxinus latifolia* | Oregon ash | tree | Container | 14 |
| *Picea sitchensis* | Sitka spruce | tree | Container | 10 |
| *Populus trichocarpa* | black cottonwood | tree | Container/ cuttings | 10 |
| *Pseudotsuga menziesii* var. *menziesii* | Douglas-fir | tree | Container | 10 |
| *Salix scouleriana* | Scouler's willow | shrub/tree | Cuttings | 10 |
| *Sequoia sempervirens* | coast redwood | tree | Container | 10 |
| *Frangula purshiana* | cascara | Shrub | Container | 6 |
| *Physocarpus capitatus* | Pacific ninebark | shrub | Container | 6 |
| *Sambucus racemosa* var. *racemosa* | red elderberry | shrub | Container | 6 |

In addition to the proposed permanent cattle exclusion fence separating the pasture from the riparian corridor, temporary wildlife-exclusion fencing would be installed to protect the initial plantings from wildlife browsing, primarily from beaver and deer. Considering the areas planned for riparian planting are spatially discrete, the wildlife-exclusions fencing would surround each planting polygon. Individual tree shelters would not be installed initially, however if herbivory damage is noted post-implementation and is found to be impacting seedling success, then plant protectors would be installed.

Supplemental irrigation would be utilized following the initial planting effort to assist in the successful establishment of riparian plantings. Irrigation of planting basins would be temporary as riparian plants need to be self-sustaining after establishment (2–3 years). Irrigation would be sourced from existing water lines within the adjacent pasture. The irrigation system would be routinely inspected to assess any potential maintenance needs (e.g., replacement, repositioning). Upon plant establishment, all temporary irrigation systems would be removed from the site.

### 5.3.2 Invasive weed removal

Removal of Himalayan blackberry within the riparian corridor of lower Stotenburg Creek will allow for reestablishment of a diverse native understory. Since Himalayan blackberry varies in prevalence and establishment within the project area both mechanical (i.e., machinery) and manual (i.e., hand removal) control methods are recommended. Riparian areas with dense establishment by Himalayan blackberry that are easily accessible from the adjacent pasture and existing road crossings are recommended for removal by mechanized equipment (e.g., field mower/weed-eater, mini excavator, backhoe, etc.). While employing this method, above-ground damage to neighboring riparian shrubs should be minimized to the extent possible. If damage to the riparian area is considerable (i.e., large areas without riparian cover) and/or affected native woody species are not anticipated to recover (e.g., re-sprout) then additional riparian planting may be required. Prior to and/or during the Himalayan blackberry mechanized removal efforts, a botanist would inform operators on native cover and provide recommendations to minimize impacts to these species. If root crowns are left intact, multiple efforts may be required prior to the successful removal of the species. Mechanized removal methods would be conducted during the dry season or dry channel conditions.

Manual (i.e., hand removal) control methods are recommended in areas with established native understory to limit damage to native woody vegetation. These methods include hand pulling, hand hoeing, digging/grubbing, and cutting using non-mechanized equipment (e.g., machetes, loppers, clippers, hori hori, etc.). Manual removal efforts in areas with low Himalayan blackberry may be implemented year-round since manual weed removal is not restricted by stream channel conditions.

Himalayan blackberry readily propagates from root fragments and cane cuttings (Sol 2004) so slash created from either removal method would be removed from the site, burned onsite following regional ordinances, or fed through a mechanical chipper and used as mulch.

## 5.4 Final Design Cost Estimate

**Table 5-5.** Cost estimate based on final design.

| No. | Item | Unit Cost | Quantity | Units | Total cost |
|---|---|---|---|---|---|
| 1 | Mobilization | $10,000 | 1 | LS | $10,000 |
| 2 | Clearing, grubbing, and tree removal | $2,500 | 2 | LS | $5,000 |
| 3 | Dewatering | $5,000 | 1 | LS | $5,000 |
| 4 | Re-grade channel from Sta 1+60 to 6+50 (cut/fill balanced on site) | $40 | 500 | CY | $20,000 |

| No. | Item | Unit Cost | Quantity | Units | Total cost |
|---|---|---|---|---|---|
| 5 | Crossing 1 upgrade (new site) with prefabricated Kernen bridge (40' length x 16' wide) and new road approaches and gates | $65,000 | 1 | LS | $65,000 |
| 6 | Construction of inset floodplain benches from Sta 7+00 to 8+50 | $40 | 100 | CY | $4,000 |
| 7 | Decommission Crossings 1, 2, & 3 | $7,500 | 1 | LS | $7,500 |
| 8 | Crossing 4 upgrade with Contech aluminum box culvert (45' length x 23'-10" span x 10'-1" rise) | $125,000 | 1 | LS | $125,000 |
| 9 | Large wood structures—placed and anchored | $1,500 | 35 | each | $52,500 |
| 10 | Boulders—placed and anchored | $150 | 30 | Tons | $4,500 |
| 11 | Willow baffle structures | $30 | 200 | LF | $6,000 |
| 12 | Construct 5 BDAs | $5,000 | 5 | LS | $25,000 |
| 13 | Planting | $10,000 | 1 | LS | $10,000 |
| 14 | Mulch | $12 | 60 | bale, each | $720 |
| 15 | Seeding | $32 | 45 | lbs | $1,440 |
| 16 | Temporary wildlife fencing | $10 | 1000 | LF | $10,000 |
| 17 | Temporary irrigation | $4 | 1400 | LF | $5,600 |
| 18 | Removal of Himalayan blackberry | $10,000 | 1 | LS | $10,000 |
| 19 | Cattle exclusion fencing | $8 | 1700 | LF | $13,600 |
| 20 | Cattle water line | $3 | 300 | LF | $900 |
| 21 | CDFW 1602 Permit | $5,313 | 1 | LS | $5,313 |
| 22 | Engineering - bid support, construction oversight, as-builts | $25,000 | 1 | LS | $25,000 |
| **Total construction cost:** | | | | | **$412,073** |
| **Total construction cost plus 5% contingency:** | | | | | **$432,677** |

# 6 FEASIBILITY AND RISK ASSESSMENTS

Feasibility and risk assessments were conducted to identify opportunities and constraints at the project site, characterize existing conditions and potential risks, and to support design development consistent with project goals and appropriate risk management. The assessments were discussed with project stakeholders during the TAC meetings and further developed as design plans were advanced to final. The assessments focused on wood stability, Smith River high-flow dynamics, the Stotenburg Creek confluence, construction access and logistics, subsoil bearing capacity to support proposed crossing upgrade structures, BDA designs, depth to bedrock, and identifying existing quality habitat as proof-of-concept for further enhancements. Refer to the final design plans in Appendix B.

## 6.1 Wood Stability Analyses

Wood stability analyses were conducted for the smaller one- and two-log structures in the lowest reach of Stotenburg Creek (Sta 2+00 to 4+00) and the larger engineered log jam (ELJ) in the unvegetated area along the Creek's left bank (Sta 4+75 to 5+75). The different types of large wood structures necessitate different stability analyses. See Section 6.2 *Smith River High-Flow Dynamics at Lower Stotenburg Creek* for further discussion of the intended function of the large wood structures.

### 6.1.1 One- and two-log structures (Sta 2+00 to 4+00)

The wood stability analysis is based on the methodology presented in Castro and Sampson (2001). The constants, freebody diagram, and equations from Castro and Sampson are included in Appendix D. In summary, this method uses a basic force balance approach in the vertical and horizontal directions to ensure that each wood structure will be stable during a specific flow regime. The calculation process begins with a sum of vertical forces to determine the boulder weight that is necessary to give each structure a factor of safety of 1.5 for buoyancy. Then based on these boulder weights, the factor of safety for momentum is calculated and more boulders are either added or enlarged as necessary to give each structure a momentum (sliding) factor of safety of 2.0 or greater.

The following is a list of assumptions that provide the basis of these calculations:

- Analysis based on 50-year flow velocity outputs from HEC-RAS existing conditions 2-D model. Velocities used are from the location of the proposed structure and range from 5 to 5.5 feet/second.
- All boulders and logs fully submerged.
- Rootwad dimensions: 4-foot diameter x 4-foot length with porosity = 0.3.
- Channel bed and banks composed of medium gravel: Friction angle = 40 degrees, which results in coefficient of friction for bed of 0.84 (Castro and Sampson 2001).
- All wood is calculated as dry Douglas Fir: density = 33.7 $lb/ft^3$ (Castro and Sampson 2001).
- For flow force calculation on multi-log structures located along a stream bank parallel to flow, calculations may assume a shadow effect (i.e. flow does not act on all logs).
- $\Theta$ (angle from rootwad face to vertical) = 0.

There are several areas of uncertainty associated with this stability analysis, as discussed below. However, risks associated with log instability are minimized due to the factors of safety built into the calculations and the on-site engineering and geomorphic expertise that will guide the final layout and construction of the structures. In addition, long-term stability will be achieved by proper installation guided by technical oversight and described in the final design plans and specifications.

It is possible that the position of the wood structures may adjust due to scour or racking of significant new wood and debris. The structures are built along the creek banks with strong anchor points to new boulders. It is possible that minor scour and settling may help the structure stay in place because it will increase resistant forces via wedging in the dense mature willow corridor. However, some structures may have the potential to rotate and/or translate if significant scour and racking of additional wood occurs. For structures with significant potential for rotation and/or translation, it is recommended that anchor boulders be keyed deeply into the channel bed and bank and that the engineer and/or geologist is onsite for construction to ensure proper installation.

There is also the possibility of contractor error or faulty materials (wood or rock with insufficient strength) leading to failure of one or more of the anchoring connections. To further ensure the quality of anchoring, we strongly recommend that a contractor is selected that has previous experience with implementing large wood projects.

Large wood structures typically have a design life of approximately 20 years due to declining strength related to wood decay, so it is critical to design the project to account for this reality. In the event of a disarticulated wood structure we believe the risk of downstream adverse impacts is low. There are no bridges or exposed in-channel infrastructure downstream of the project area. Furthermore, the size and quantity of large wood in the proposed structures is on the low side of the range of wood material that is typically transported through the lower river during large winter storms.

### 6.1.2 Engineered log jam (Sta 4+75 to 5+75)

The stability of the proposed engineered log jam (ELJ) between Stations 4+75 and 5+75 was assessed based on the flow velocity predicted by the 2-D hydraulic model of 4 feet/second during a 50-year flood event. For stability calculations, the entire structure was treated as one unit considering the proposed mechanical anchoring components.

#### 6.1.2.1 Buoyancy stability

Vertical stability was assessed using a simple free body diagram. The primary driving forces in the stability calculations were buoyancy forces acting on the logs in the structure and resisting force of the gravel placed on top of portions of the log structures. Other vertical forces were also analyzed including lift forces due to flow and resisting forces due to the skin friction of piles, but these were found to be an order of magnitude lower than the two primary driving forces described above so they were not included in the final stability calculation. Based on the ELJ design shown in the final design plans (Appendix B), the structure has a vertical factor of safety greater than 1.5.

The following is a list of assumptions that provide the basis of these calculations:

- Analysis based on 50-year flow velocity (4 feet/second) taken from HEC-RAS existing conditions 2-D model. Velocities used are from the location of the proposed structure.
- All gravel and logs fully submerged.
- Log piles angled at 10% slope
- Backfill gravel density = 100 $lb/ft^3$
- All wood is calculated as dry Douglas Fir: density = 33.7 $lb/ft^3$ (Castro and Sampson 2001).

#### 6.1.2.2 Momentum stability

Momentum stability was assessed using an Excel macro for force calculations on embedded wood developed by Scott Wright, P.E., of River Design Group (Wright 2019). The macro is based on lateral stability of embedded poles from the Structural Engineering Handbook (Gaylord et al. 1996). Based on these calculations, ~70 feet of vertical pile would provide a factor of safety of 2.0 for momentum stability. The proposed structure has twelve proposed piles with depths of a minimum of 15 feet each (180 total feet of vertical pile), yielding a momentum factor of safety greater than 5.0.

The following is a list of assumptions that provide the basis of these calculations:

- Analysis based on 50-year flow velocity (4 feet/second) taken from HEC-RAS existing conditions 2-D model. Velocities used are from the location of the proposed structure.
- Assumes conservative (low) soil stress of 1,000 psf
- Total area of ELJ to which drag force is applied = 800 square feet
- Tree stem diameter = 1.5 feet

## 6.2 Smith River High-Flow Dynamics at Lower Stotenburg Creek

The lower reaches of the project site are impacted by high flows on the Smith River. 2-D hydraulic modeling and high-flow observations during the 2018-2019 winter show that the Smith River edge-of-water extends up to the Crossing 1 fill during a ~2% exceedance flow and a backwatering effect extends to near Crossing 3 during a 1.5-year bankfull flow (Figure 6-1). The design plans consider the potential impacts of high flows from the river by relocating Crossing 1 to a higher elevation outside of the historical Smith River scour zone. As discussed above in Section 5.1 *Selection of a Preferred Alternative*, a prefabricated bridge is preferred for the new crossing due to construction logistics and reduced impact to the riparian corridor. Additionally, in a hypothetical future historic flood scenario on the Smith River (e.g., a 100-year flood), it is possible the river could scour to near the proposed new Crossing 1 location, as it did in the 1964 flood. If the bridge was shifted or damaged during the flood event, re-installing the bridge post-flood would be substantially more cost-effective and logistically feasible than re-installing a large box culvert. The proposed ELJ should reduce the likelihood of the Smith River substantially scouring this area.

The willow baffles and large wood structures are designed to protect the lowest reach of the creek and promote longevity of the entrance into the Smith River alcove. This reach of the creek is currently protected by a dense willow corridor, as described below in Section 6.3 *Stotenburg Creek – Smith River Confluence*, however, there is a large area just downstream of Crossing 1 that is devoid of this willow protection. This opening in the willow corridor is an anthropogenic feature related to Crossing 1 and historical gravel mining. The engineered log jam (ELJ) and willow baffles are sited in this open location to provide additional protection from the Smith River by initiating a process-based approach that will promote deposition of fine material, re-orient hydraulics toward the Smith River channel, and promote riparian growth. The other one- and two-log wood structures along the margins of the new Stotenburg channel alignment from Sta 2+00 to 4+00 are designed to strengthen the channel banks and concentrate low flow through the new alignment. These structures would be secured using partial burial and anchoring to large boulders, which would be buried, where feasible. The wood stability analysis incorporated water depths and velocities from the 2-D hydraulic model of the 50-year flood event. The ELJ and large wood structures are designed to withstand flood flows on the Smith River up to a 50-year flood event. It is possible the structures would withstand a 100-year flood event given the conservative approach used in the wood stability analyses. For further details on the wood stability analyses see Section 6.1 *Wood Stability Analyses* above.

It is possible that large wood and willow baffle habitat enhancement investments might not persist after large Smith River flooding events (e.g., above a 50-year recurrence interval flow), however, we believe that the benefits of the designed structures outweigh the risks associated with natural geomorphic processes. The proposed willow baffles and large wood structures will help maintain this area for as long as geomorphically possible.

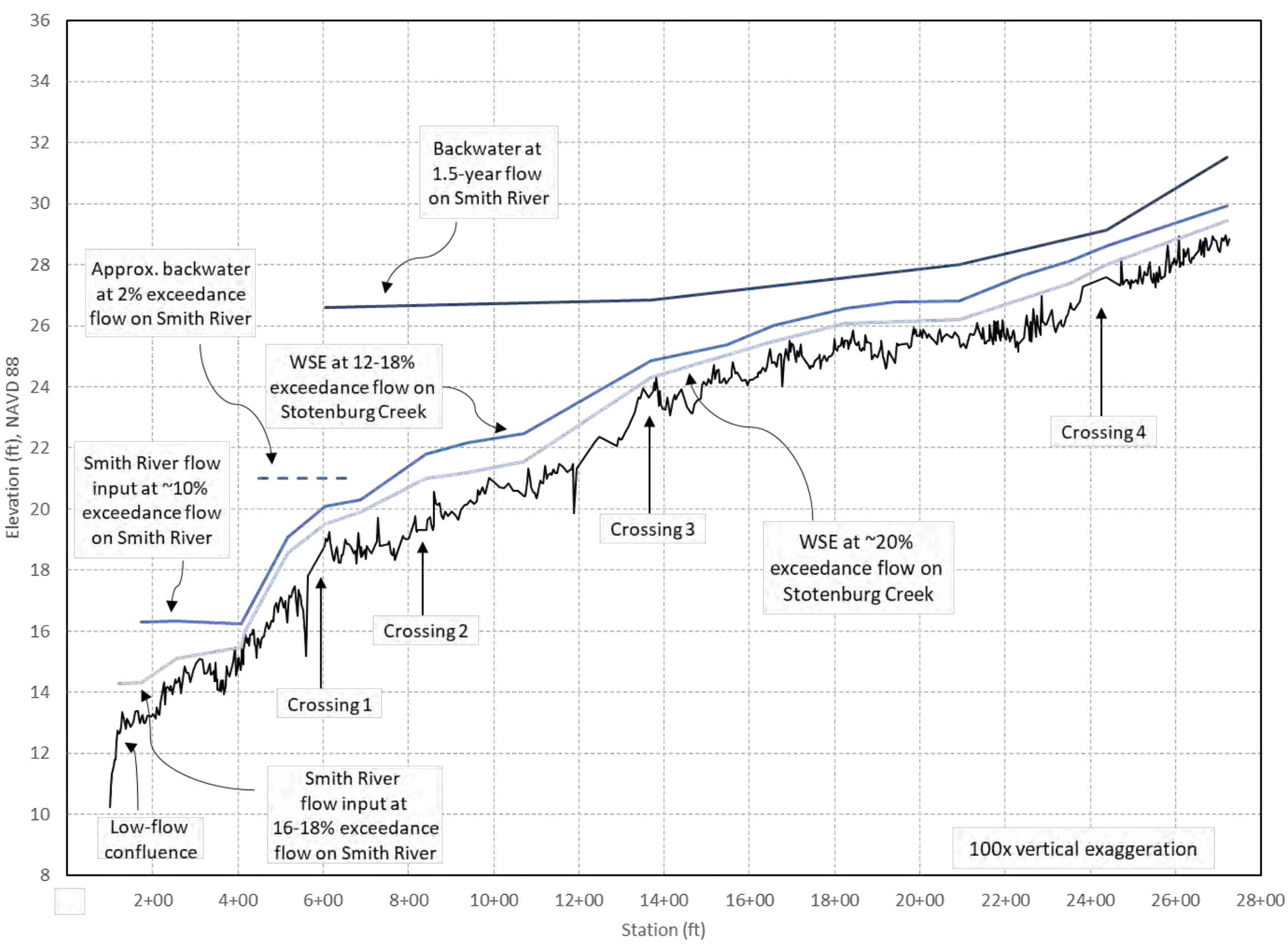


**Figure 6-1.** Longitudinal profile showing Smith River backwatering along lower Stotenburg Creek during elevated flow events.

## 6.3 Stotenburg Creek – Smith River Confluence

As described above in Section 2.2 *Geomorphology*, Stotenburg Creek enters the Smith River at a backwater alcove that was excavated in 2003 as part of a gravel mining harvest that also had a fish rearing habitat objective. The function of this alcove has implications for the creek's mainstem connection as the site evolves over time. Based on site observations over the past 6 years, review of aerial photographs, and dimensions from the gravel harvest permit application, the alcove has remained stable since its construction, with only minor deposition of sands and gravel at the upstream extent at the mouth of Stotenburg Creek and in the northern corner where a nearby residence has a footpath to the river (see aerial photographs in Appendix E). In the period since 2003, when the alcove was constructed, there have been multiple relatively large flow events including a 7-year flow (121,000 cfs in Dec 2005), 5.6-year flow (114,000 cfs in Dec 2015) and a 4-year flow (103,000 cfs in Dec 2008). The low-flow connection to the river in the northwest corner of the alcove is visible in all aerial photographs since 2003 and maintains surface flow into the river after Stotenburg Creek has gone dry. The most substantial change to the lower creek and confluence area is the growth of a dense willow corridor surrounding the alcove and extending upstream along the lowest reaches of Stotenburg Creek. This willow corridor creates a natural buffer protecting the lower creek and alcove from high-flow velocities from the Smith River, debris, and fine sediment deposition. The proposed willow baffle and large wood structures are designed to enhance this protection in several key areas, as described above in Section 6.2 *Smith River High-Flow Dynamics at Lower Stotenburg Creek*. We expect the backwater alcove and connection to the river to continue to function as they have, however, we cannot predict the specific location and degree of scour that would result from a major flood event (e.g., greater than a 25-year or 50-year event).

To further enhance and ensure volitional fish passage into and out of the backwater alcove during the seasonal rearing months in Stotenburg Creek, as well as into the summer, we propose minor widening and deepening of the alcove connection with the mainstem Smith River channel. This enhancement would also improve water quality in the alcove during summer months. The proposed excavation has approximate dimensions of 3 feet wide, 0.5 to 1 foot deep, and 15 to 20 feet long. The excavated material would be broadly dispersed to the sides and downstream extent of the alcove connection resulting in negligible alteration to the channel bed. This enhancement would be constructed with a small one- or two-man crew using McCloud hand tools, or an equivalent method.

## 6.4 Construction Access and Logistics

Equipment access to the lower reach of Stotenburg Creek, downstream of Sta 4+00, is complicated by dense willow stands, an existing wood jam, and uneven terrain. Access for proposed channel grading and large wood installation would likely require a small excavator and clearing some willows. From Sta 4+00 to 6+00 there is good equipment access for channel grading and removing Crossing 1. The gravel road extending south from Crossing 1 also provides good access for constructing the new road segment from the proposed location of the new Crossing 1. Constructing this new road segment would require removing approximately eight 12-inch to 18-inch DBH alder trees, and multiple other smaller stems less than 6 inches DBH. The access to the proposed new Crossing 1 location is difficult due to sloping terrain and dense riparian cover. Consequently, a prefabricated bridge is a more suitable alternative due to access and installation difficulty at the site. Constructing the new northern road approach to the crossing would require a short segment off the existing gravel road and removing several small alders trees less than 6 inches DBH. A new gate alignment would also likely be needed where the gravel road meets Fred Haight Dr.

There is good access to Crossing 2 for culvert removal and constructing inset floodplain benches. The 1-inch poly pipe used for livestock watering crosses Stotenburg Creek near crossing 2, although the exact location is not known by the landowner or lessee. It is understood that construction activities near Crossing 2 could likely damage the poly pipe and the landowner and lessee are interested in establishing a new alignment for the pipe along the newly constructed Crossing 1 bridge. The other flexible irrigation line that crosses under Fred Haight Dr., as well as the metal pipe segment near Sta 6+50, are no longer in use and are not expected to inhibit construction along this reach. Crossing 3 is easily accessed from both sides of the channel. There is good access throughout the pasture for installing BDAs, riparian planting, removing invasive vegetation, and removing crossings 2 and 3. Equipment access into the pasture will likely require removing a short section of fence to the south of Crossing 4 along the gravel road (Cedar Lodge Lane) and replacing it with a gate.

Crossing 4 is easily accessed along Cedar Lodge Lane and there is little to no overhead riparian canopy. Construction at Crossing 4 will require closing Cedar Lodge Lane for a period of potentially 1 to 2 weeks. An alternate access to the residence and commercial business on Cedar Lodge Lane is available along another small private road off Fred Haight Dr., behind the Calvary Chapel, approximately 0.25 miles to the southeast. The road is currently blocked by a fence and gate where it meets the commercial property and the road has not been used since around 2004. Some debris may need to be cleared and the gate may need modification, but the landowners have confirmed they are amenable to using this alternative access during construction at Crossing 4. It is possible that the HWY 101 Dr. Fine bridge replacement will occur at the same time as the Crossing 4 replacement. Caltrans has not announced the final schedule for the Dr. Fine bridge replacement; however, Caltrans staff have stated that the only portion of the lower Stotenburg project area that they plan to use is the road behind the Calvary Chapel to access the Smith River channel at the Dr. Fine bridge location. Therefore, the Caltrans project should not interfere with the lower Stotenburg project.

A small power substation is located approximately 200 feet east of Crossing 4. Overhead transmission lines to the substation run along Fred Haight Dr. and cross Cedar Lodge Lane near the intersection of those two roads (see Figure 2-2 and Appendix B, Sheet 6). The transmission lines are not expected to inhibit construction at Crossing 4. In June 2019 an underground utility locator determined that the Crossing 4 fill contains a telephone and internet data cable, but no power lines. This finding was confirmed by the local foreman who was involved with constructing Crossing 4 in 2003/2004. The commercial business' phone/internet utilities are provided from another location outside the project area and we assume the residence relies on the utility lines buried in Crossing 4. Replacing Crossing 4 will require a short-term disruption of these services and a potential temporary replacement is being discussed with the residence landowner and utility companies. Power is provided to the affected properties via overhead lines outside the project area.

## 6.5 *In Situ* Soil Strength and Bridge/Box Culvert Factor of Safety

The *in situ* silty sand and silty gravel subsoils in the project reach have a presumptive vertical foundation bearing capacity of 2,000 pounds per square foot (psf), per Table 1806.2 in Chapter 18 (*Soils and Foundations*) of the 2016 California Building Code. Subsoils were characterized from onsite observations in channel cutbanks and in well-completion reports for water wells in the project vicinity. Using this soil bearing capacity, factors of safety were computed for the different crossing replacement alternatives.

The proposed prefabricated Kernen bridge for the new Crossing 1 is supported by two precast concrete abutments. Under a dead load the bridge abutments bear 1,113 psf and under a live load of typical ranch traffic the abutments bear 1,271 psf. These loads correspond to a factor of safety of 1.8 and 1.6, respectively. The bridge abutments will be supported by relatively shallow soils, which are susceptible to settlement. To increase the factor of safety and reduce the potential for settlement, the bridge abutments are designed to be supported on stabilization mats, which consist of a multi-layered bed of well-graded crushed aggregate and two layers of geogrid (Mirafi BXG12 or equivalent), one at the base of the crushed rock, and one at mid-height. The entire mat is wrapped in filter fabric (see Appendix B, Sheet 9). The stabilization mat is a laterally constrained structure that will maintain its integrity while undergoing anticipated minor differential settlement. Additional bridge abutment protection measures include constructing rock slope protection (RSP) on the channel banks around the abutments.

The road at Crossing 4 is used by commercial truck traffic and therefore experiences large live loads up to 80,000 lbs (a single loaded 18-wheel truck). A prefabricated bridge was considered for the Crossing 4 replacement, however, a bridge long enough for this site combined with the large live load yields an inadequate factor of safety. Extensive subsurface investigations and geotechnical designs of an abutment foundation system would be required to design a bridge at this site with an adequate factor of safety and was therefore excluded from further consideration. The proposed aluminum box culvert is designed with a full plate invert across its entire base, cutoff walls at the inlet and outlet, and requires a minimum soil bearing capacity of 4,000 psf. The expected bearing capacity of the *in-situ* soils at the installation depth is 3,000 psf. To achieve the required bearing capacity the crossing is designed with a two-layer engineered foundation composed of a relatively finer crushed aggregate bedding (i.e., Caltrans Class 2) overlying a coarser crushed aggregate (i.e., Caltrans Class 1) subbase (see Appendix B, Sheet 9). The crossing designs call for only a single 16-foot-wide roadway that can support one-way traffic.

## 6.6 Beaver Dam Analogues (BDAs)

By incorporating a sequence of multiple BDAs, the designs further enhance habitat benefits as well as provide additional protection for the individual structures. As opposed to a single, isolated BDA, a sequence of BDAs provides continuous low velocity refugia by backwatering flow to the base of the next upstream structure, which promotes fish passage by reducing jump heights and flow velocities. Backwatering also provides protection from spillover scour, thereby reducing risk of dam failure. Additionally, a sequence of BDAs increases the likelihood that individual wood pieces from a disarticulated BDA would be caught in the next downstream structure. Lateral scour will be prevented by keying the end posts well into the banks and adjacent floodplain. The proposed BDAs only extend habitat benefits by expanding water surface area at lower flows between the 2% exceedance flow and the late spring/early summer low-flow. At 1.5-year flows and higher the proposed BDAs have negligible to no effect on water surface elevations and at no flow level do the BDAs inundate cattle grazing areas. This condition was important in securing landowner support with implementing BDAs in the project designs. BDA designs primarily follow the Beaver Restoration Guidebook (Pollock et al. 2018) with additional consideration to the Low-Tech Process-Based Restoration of Riverscapes Design Manual (Wheaton et al. 2019), and consultation with the Yurok Tribe and Fiori Geosciences regarding the recent BDAs they have constructed on lower Klamath River tributaries.

Although BDAs are inherently biodegradable and temporary features on the landscape with varying functions that change in response to different flows and sediment loads, the proposed BDAs for Stotenburg Creek are designed to withstand more frequent high-flow events (e.g., a 1.5-year, 2-year, or 5-year flow). To achieve the desired longevity, the posts are designed to be driven to an adequate depth to prevent toppling due to underscour. It is assumed that portions of the wood weave material would be periodically lost to high flows, but the posts should endure these more frequent flood events until they are compromised by decay. We anticipate that the habitat benefits of BDAs will continue beyond the lifespan of the proposed structures considering beaver are already present in lower Stotenburg Creek. Currently, beaver tend to preferentially construct pools by damming the inlets to the culvert crossings and construct dams just upstream of the project area. Once the crossings are rebuilt with larger structures, we anticipate beaver will maintain the BDAs and potentially construct new dams.

Based on input from the TAC, the jump height of the four upstream BDAs was increased from six to nine inches. The increased height was desired to further expand, spatially and temporally, the low velocity rearing habitat created upstream of the BDAs. A 12-inch jump height was considered but determined to be unnecessarily high considering the low-gradient nature of the stream and the substantial habitat created with only nine-inch jumps. The downstream-most BDA retains a six-inch jump height because we anticipate that some scour will occur on its downstream side. Nine inches exceeds the previously established CDFW and NMFS maximum jump height requirement of six inches for juvenile salmonids at channel-spanning structures (CDFW 2009 and NMFS 2001). However, the recently released NMFS addendum (NMFS 2019) states that the guidelines are specifically meant to apply to stream crossings (e.g., culverts and bridges) and should not be applied to BDA designs. NMFS (2019) also increases the maximum jump height for juvenile salmonids from six to twelve inches as a general guideline. For the lower Stotenburg Creek enhancement project the NMFS stream crossing guidelines do not apply, and no permitting variance request will be needed for implementing the BDAs (NMFS 2019 and B. Pagliuco, Marine Habitat Resource Specialist, National Marine Fisheries Service, pers. comm., September 2019). Based on guidance from CDFW TAC members, there is no formal agency policy regarding jump height requirements at BDAs. CDFW considers BDAs experimental and will likely require a letter of concurrence to be developed during the permitting and implementation phase of the project.

Additionally, recent studies of fish passage at BDAs on Sugar Creek in the Scott River watershed have demonstrated that juvenile salmonids are capable of jumping BDAs with jump heights substantially higher than six inches (Yokel et al. 2016 and 2018). The studies assessed juvenile coho and *O. Mykiss* migration pathways through a series of BDAs using a multi-pathway array of PIT tag antennas. The juvenile fish had a choice of either swimming around the BDAs up a steep roughened riffle or jumping over them. The two BDAs in the study had jump heights of 12 and 15.8 inches. There was a slight preference for swimming around the BDAs, but 49% of the juvenile coho jumped over at least one of the BDAs and the majority that jumped did so over the BDA with the 15.8-inch jump height. Passage around the BDAs was evaluated but not included in the lower Stotenburg Creek designs considering this would require constructing roughened channels using imported coarse gravel-cobble substrate – material that is not naturally deposited in low gradient floodplain creek channels. Also, we do not anticipate the nine-inch jump heights to preclude juvenile fish passage considering the jump capabilities documented by Yokel et al. (2016 and 2018). Previous fish monitoring on lower Stotenburg Creek just upstream of the project reach has documented non-natal juvenile salmonids upstream of a naturally built beaver dam with an approximate jump height of eight to ten inches (M. Parish-Hanson, Program Director, Smith River Alliance, pers. comm., October 2019).

As part of the permitting and implementation phase of the lower Stotenburg Creek enhancement project, the project team plans to include a monitoring and adaptive management plan. We recommend continued fish monitoring and PIT tagging to assess fish passage through the 5 BDAs. As Stotenburg Creek is a non-natal rearing stream, documenting juvenile salmonids upstream of the BDAs would provide evidence that juvenile salmonids are able to successfully migrate upstream of the structures. Continued operation of the CDFW PIT tag antenna downstream of the BDAs would confirm that fish marked upstream of the structures are able to migrate downstream in the spring. This monitoring effort would guide the adaptive management process to determine if and what type of modifications to the structures may be needed. Evaluating beaver activity in the project reach would also be included in the monitoring and adaptive management plan to determine if beaver are maintaining the BDAs.

## 6.7 Depth to Bedrock

There are no bedrock outcrops in the project area. Bedrock outcrops on the coastal plain are isolated to dispersed relic sea stacks composed of lithologically competent Franciscan Broken formation. Nearby well-completion reports indicate the bedrock contact is multiple tens of feet below the ground surface. Therefore, it would not be expected to encounter bedrock during subgrade excavation for box culverts, bridge abutments, or pier and post driving for large wood structures and BDAs.

## 6.8 Habitat Enhancement Proof-of-Concept

The existing high-quality habitat from Sta 15+00 to 22+00 during elevated flows (e.g., 20% exceedance) illustrates intrinsic habitat value within this reach. The proposed BDA's would extend this habitat benefit further into the spring as flows recede. Additionally, the proposed inset floodplain benches in the confined reach from Sta 7+00 to 8+50 would provide similar low-velocity habitat across a widened wetted channel cross section.

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# Appendices

# Appendix A

# Conceptual Alternative Design Plans

# Appendix B

# Final Design Plans

# Appendix C

# HEC-RAS Hydraulic Model Outputs

Appendix C-1:  1-D model output for existing conditions

Appendix C-2:  1-D model output for proposed conditions

# Appendix C-1: 1-D model output for existing conditions

# Appendix C-2: 1-D model output for proposed conditions

# Appendix D

# Wood Stability Analyses

Appendix D-1: One- and two-log stability analysis

Appendix D-2: Engineered log jam (ELJ) stability analysis

# Appendix D-1: One- and two-log stability analysis

# Appendix D-2: Engineered log jam (ELJ) stability analysis

# Appendix E

# Historical Aerial Photographs

Appendix E-1: Photographs of project area from 1942 to 2015

Appendix E-2: Photographs of Smith River - Stotenburg Creek confluence from 2003 to 2015

# Appendix E-1: Photographs of project area from 1942 to 2015

Appendix E-2: Photographs of Smith River - Stotenburg Creek confluence from 2003 to 2015

# Appendix F

# Construction Specifications

# Appendix G

# Technical Advisory Committee (TAC) Meeting Notes

Smith River Alliance
Lower Stotenburg Creek Fish Passage Project
Budget Narrative

The budget covers all costs associated with permitting, implementation, and monitoring activities to successfully complete construction and evaluate project effectiveness. SRA will conduct project management, contracting, permitting, and assist with construction oversight and post project monitoring.

Stillwater Sciences SWS will provide construction oversight throughout the duration of project implementation with an anticipated onsite presence by a licensed professional of 50% of the time. The Project Geologist, Senior Engineer, and Project Engineer will collaboratively conduct construction oversight with emphasis on habitat enhancement features that include critical design elements (e.g., large wood structures, channel re-alignment, crossing removal/replacement, tree removal, road construction, and BDA's). SWS will also conduct post-implementation topographic surveys of certain design elements/sites to document constructed habitat enhancement features follow final design plans and for use in project monitoring and performance evaluation.

McCullogh Construction will conduct all equipment operations necessary to implement all project designs. Samara Restoration will lead riparian revegetation. SRA will lead CCC crew while brush clearing and willow collection tasks are conducted and will assist Samara in revegetation implementation and monitoring.

A total of $30,809.76 of SRA staff budget and $22,989 of Stillwater Sciences budget will be used for post-project monitoring activities outline in the monitoring plan.

**Name of Project: Lower Stotenburg Creek Fish Passage Project**

| Category | Rate | Total Hours | CFPF Funding Requested | Partner Contributions (cash) | Partner Contributions (in-kind) | Total |
|---|---|---|---|---|---|---|
| **Salaries and Wages** | | | | | | |
| Executive Director - Patty McCleary | $ 51.67 | 214 | $1,105.74 | $9,951.64 | | $11,057.38 |
| Program Director - Marisa Parish | $ 40.00 | 224 | $448.00 | $8,512.00 | | $8,960.00 |
| Project Manager - Monica Scholey | $ 30.00 | 839 | $2,517.00 | $22,653.00 | | $25,170.00 |
| Project Manager - Jolyon Walkley | $ 24.00 | 232 | $0.00 | $5,568.00 | | $5,568.00 |
| Contract Manager | $ 51.67 | 137 | $0.00 | $7,078.79 | | $7,078.79 |
| Landscaper (Prevailing Wage) | $ 57.95 | 360 | $0.00 | $20,862.00 | | $20,862.00 |
| | | | | | | |
| **Employee Benefits** | | | | | | |
| Executive Director - Patty McCleary | 34.00% | | $375.95 | $3,383.56 | | $3,759.51 |
| Program Director - Marisa Parish | 14.00% | | $62.72 | $1,191.68 | | $1,254.40 |
| Project Manager - Monica Scholey | 34.00% | | $855.78 | $7,702.02 | | $8,557.80 |
| Project Manager - Jolyon Walkley | 34.00% | | $0.00 | $1,893.12 | | $1,893.12 |
| Contract Manager | 14.00% | | $0.00 | $991.03 | | $991.03 |
| Landscaper (Prevailing Wage) | 60.00% | | $0.00 | $12,517.20 | | $12,517.20 |
| | | | | | | |
| **Supplies - Permits** | | | | | | |
| Printing | $ 200.00 | 1 | 0 | $ 200.00 | | $200.00 |
| ArcGIS Non-Profit License | $ 100.00 | 1 | 0 | $ 100.00 | | $100.00 |
| Hand tools | $ 40.00 | 8 | 0 | $ 320.00 | | $320.00 |
| LSAA permit | $ 5,500.00 | 1 | 0 | $ 5,500.00 | | $5,500.00 |
| Coastal Grading Permit (+CEQA filing f | $ 16,645.00 | 1 | $ 16,645.00 | $ - | | $16,645.00 |
| CWA - 401 | $ 1,949.00 | 1 | 0 | $ 1,949.00 | | $1,949.00 |
| | | | | | | |
| **Contracted Services** | | | | | | |
| Stillwater Science | $ 93,782.00 | 1 | $7,700.00 | $ 86,082.00 | | $93,782.00 |
| McCullogh Construction | $ 742,219.00 | 1 | $12,984.00 | $ 729,235.00 | | $742,219.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Samara Restoration | $ 40,750.00 | 1 | 0 | $ 40,750.00 | | $40,750.00 |
| CCC | $ 34,160.00 | 1 | 0 | $ 34,160.00 | | $34,160.00 |
| | | | | | | |
| **Travel** | | | | | | |
| Mileage | $ 0.59 | 2256 | 0 | $ 1,319.76 | | $1,319.76 |
| | | | | | | |
| **Administrative Overhead** | 17% | | $7,258.01 | $180,345.56 | $0.00 | $187,603.58 |
| | | | | | | |
| **TOTAL** | | | $49,952.20 | $1,182,265.37 | $0.00 | $1,232,217.57 |