

2015 ANNUAL MONITORING REPORT – YEAR 1

**STRAWBERRY CREEK RESTORATION PROJECT – NPS REACH
HUMBOLDT COUNTY, CALIFORNIA**

CORPS FILE NO. 2009-00041N

WATER QUALITY CERTIFICATION WDID No. 1B14017WNHU

Prepared for ~

US Army Corps of Engineers

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and

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December 14, 2015

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2015 Annual Monitoring Report – Year 1

Strawberry Creek Restoration Project – NPS Reach Humboldt County, California

**Corps File No. 2009-00041N
WATER QUALITY CERTIFICATION WDID No. 1B14017WNHU**

December 14, 2015

PROJECT OVERVIEW

Permit Information

Corps File No.: 2009-00041N
Permittee: National Park Service
1111 Second Street, Crescent City, California 95531
Issuing Office: San Francisco District
1455 Market Street, 16th Floor, San Francisco, CA 94103-1398

Water Quality Certification WDID No.: 1B14017WNHU
Applicant: Redwood National Park
Receiving Water: Strawberry Creek and wetlands
Hydrologic Unit: Redwood Creek Hydrologic Unit No. 107.10
County: Humboldt
File Name: Redwood National Park, Strawberry Creek Restoration Project

Monitoring Report Preparers

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INTRODUCTION

U.S. Army Corps of Engineers, San Francisco District (Corps) issued a permit to the National Park Service on January 15, 2014 for the implementation of a stream restoration project at Redwood National Park. The North Coast Regional Water Quality Control Board (Water Board) issued a Water Quality Certification for the project on April 8, 2014. The Corps permit and the Water Quality Certification specify that annual monitoring reports shall be submitted to the Corps by December 31, and annually to the Water Board, for five years following the completion of construction. Project construction was anticipated to be completed by early spring 2015. Cost overruns during the heavy equipment phase in summer 2014 necessarily postponed completion of construction of the West Tributary portion of the project. Additional funding is being sought and was anticipated to allow implementation of the final phase of construction in summer 2015. Sufficient funding was not received in time for completion in 2015. Given the uncertainty of receiving funding in the near future, Redwood National Park has prepared the following first year annual monitoring report. When funding is secured to allow completion of the full project as permitted, those elements will be described in the respective annual monitoring reports.

Redwood National Park submitted the following Project Status forms to the Corps -

- Notice of Commencement of Work: Work commenced July 1, 2014. The form was submitted July 9, 2014.
- Notice of Suspension of Work: Work was suspended October 10, 2014. The form was submitted November 3, 2014.

The “resumption of work” has not yet been scheduled. The NPS is waiting for additional funding to complete the West Tributary culvert replacement part of the project.

MONITORING PLAN

Redwood National Park is coordinating post-project monitoring in accordance with the 2013 project monitoring plan as included in the Corps permit (Appendix A) to assess project success and guide adaptive management to meet project objectives.

SUMMARY OF RESULTS

The project was constructed in summer 2014 and is not yet complete due to cost overruns and lack of additional funding. The Strawberry Creek mainstem portion of the project was completed. The West Tributary culvert replacement was not constructed.

Wetland monitoring wells are showing changes post-project, but given variations in annual precipitation between years it is too soon to conclude possible effects of the project on wetland hydrology and vegetation.

Fish presence monitoring within the project reach has found non-salmonid fish using the area. Coho salmon (*Oncorhynchus kisutch*) have not been captured by park monitoring efforts in the

project reach, but coho were captured during monitoring by National Marine Fisheries Service staff in the park project reach in December 2014 and February 2015.

Water quality monitoring reveals that dissolved oxygen values are low during summer months and higher during winter and spring.

Riparian planting mounds were planted with spruce seedlings in accordance with planting plan, but only a portion of the alder seedlings were planted due to die-off at the nursery. Additional red alder (*Alnus rubra*) will be planted in winter 2015-2016. Monitoring plots in the riparian zone were established and provide baseline conditions for future annual monitoring.

Numerous photo points document the project before, during and after construction and are on file at Redwood National Park. Photos showing the entire stream channel banks are included in this report.

PROJECT DESCRIPTION

Purpose

The purpose of the Strawberry Creek Restoration Project on NPS lands is to restore the structure and hydrologic functions of Strawberry Creek by removing vegetation and excavating a channel to re-establish a free-flowing stream and side channels; re-establishing a riparian corridor with native vegetation to assist in the control of invasive plants in and adjacent to the stream channel; replacing culverts that impede fish passage and alter natural hydrologic and geomorphic processes; and eliminating sources of erosion to reduce sediment delivery into the stream (RNP 2014).

This action is needed to enhance populations of threatened fish species through restoring access to designated critical habitat, improving water quality, and improving biological productivity in stream channels to support non-natal rearing of salmonids (RNP 2014).

Project Location

The project is located in Redwood National Park, Northwest Humboldt County, CA near the town of Orick (Figure 1). Access to the project is from highway 101 north, turn east on Hiltons Road, go one half mile to Old SOC Access Road, go through the park gate and continue about 1 mile to the project area.

Design

The project was designed and engineered by Michael Love, P. E. and Rachel Shea, P.E. and is described in “Strawberry Creek Restoration Project at Redwood National Park Final Basis of Design Report, March 30, 2012” by Michael Love & Associates Hydrologic Solutions (MLA) (MLA 2012) and “Redwood National Park Design Plans for Construction of Strawberry Creek Restoration Project, Final Plans” (MLA 2014).

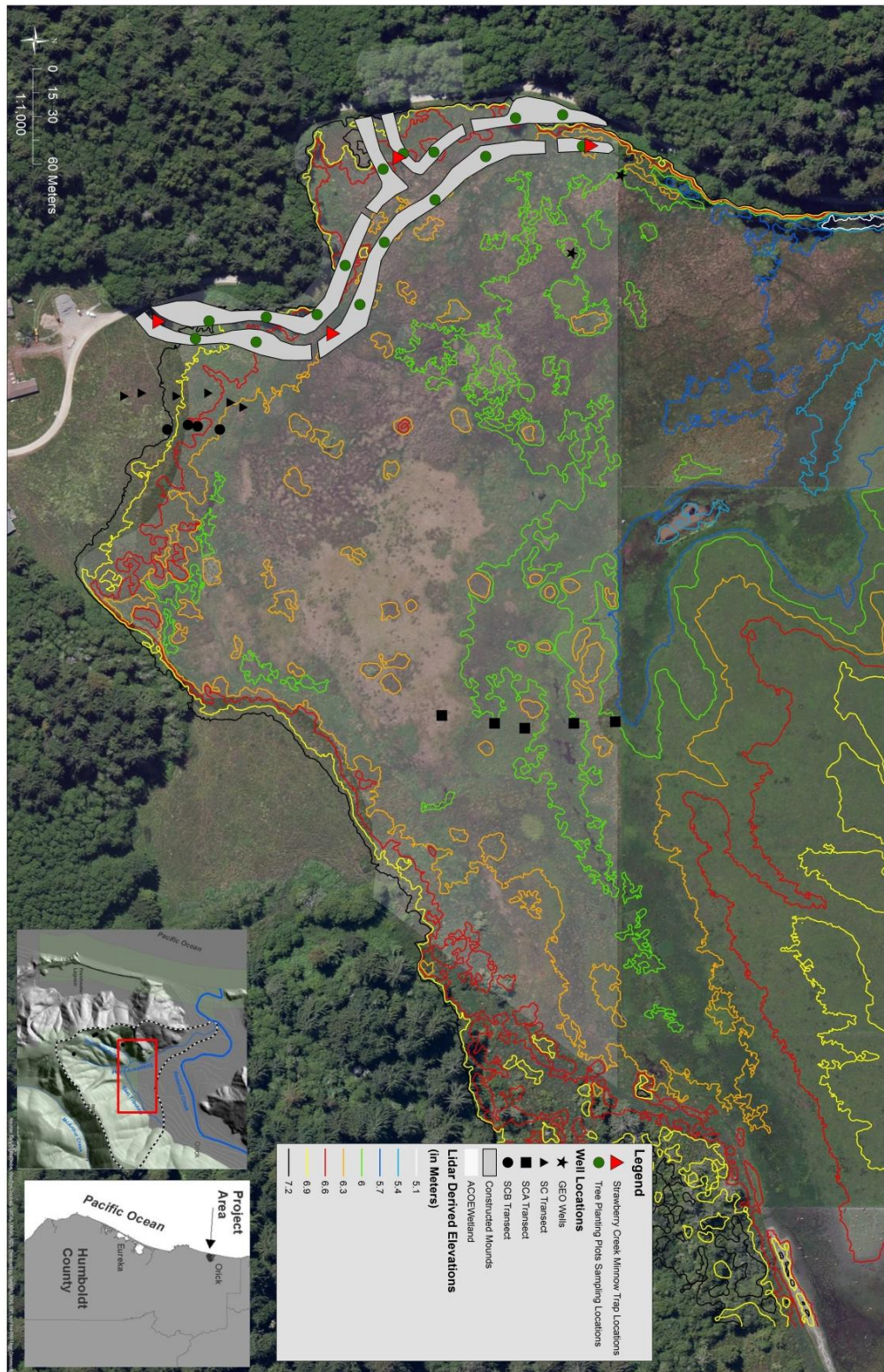


Figure 1. Location of project area near Orick, CA. Map also shows locations of wetland monitoring wells, minnow trap monitoring sites, tree planting monitoring sites and LiDAR derived elevations in meters.

In general, the project consisted of excavation of a channel approximately 1,224 feet long through a wetland that was heavily vegetated with non-native grasses, construction of planting mounds and anchoring of wood structures in the channel. Excavated materials consisted of approximately 1930 cubic yards (cy) of primarily non-native grasses and 420 cy of sediment. Excavated materials were removed and stockpiled approximately 500 feet away in stable locations away from stream courses and covered with straw mulch.

Planting Mounds

The purpose of the constructed planting mounds is to provide an area above seasonal high wetland water levels of 22 feet (NAVD88) that will support the survival and growth of Sitka spruce. Park staff estimate that 3-parameter wetland will not persist on the mounds above about 22 feet. The mound area above 22 feet is anticipated to be upland and encompasses about 0.91 acre. About 0.5 acre of the mounds that remain below the estimated elevation for wetlands will remain wetland. Prior to project implementation, these 0.5 acre were dominated by reed canary grass (*Phalaris arundinacea*) with some areas of slough sedge (*Carex obnupta*) and cattails (*Typha latifolia*). After project implementation, these areas of the mounds will be composed of planted willows (*Salix hookeriana* and *S. sitchensis*), slough sedge, red alder and Sitka spruce (*Picea sitchensis*). These plantings will increase habitat diversity in the project area by creating a riparian zone, thus increasing the suitability of the area for small and medium-sized mammals and nesting birds, and provide shade to help control non-native grasses. In addition to wetland to upland conversion there was also a conversion of wetland to Waters of the U.S. of 0.37 acre.

The predicted benefits of the project to the wetland-riparian-riverine complex were quantified using the California Rapid Assessment Method (Brown and Hancock 2012, Redwood National Park 2013, CWMW 2012). The predicted substantial increase in the CRAM scores, from pre-project score of 57 to a post-project score of 82 for one reach and 59 to 85 for the reach downstream, can be attributed to constructing a well-defined, stable channel with a functioning floodplain that will have abundant large woody debris embedded in the channel, addition of side channels and sloping mounds adjacent to the main channel, removal of non-native invasive species and planting of native riparian species.

PROJECT IMPLEMENTATION

Project implementation commenced July 1, 2014 and temporarily suspended October 10, 2014. All earthwork and channel structures were constructed by McCullough Construction, Arcata, CA. using excavators, bulldozers, dump trucks, tracked dump truck, water truck, loader and numerous hand equipment tools. The project manager was Pacific Coast Fish, Wildlife and Wetland Restoration Association (PCFWRA). Remaining culvert replacement earthwork has not yet commenced due to lack of sufficient funding.

Deviations from Design

The project was constructed according to the engineering designs with minor horizontal shifts as shown in 'As Built Drawings' in Appendix B. Maximum horizontal shifts occurred in the downstream portion of the project where a field decision was made to take advantage of existing

topography to reduce, by a small amount, the volume of imported fill needed for mound construction. This was intended to reduce costs with no expected effect on project outcome or performance. Vertical (elevation) tolerance of 1 foot was allowed by design and most of the project was constructed within this tolerance. Maximum deviations from design occurred in the thalweg of the excavated channel where some areas (sta 0+00 – 0+50 and sta 2+70 – sta 4+50) were excavated as much as 1.8 feet deeper than design. Project engineers do not expect adverse effects from these over-excavations. Bed elevation is expected to adjust as sediment moves through the system.

Each of the three constructed breaks in the mounds was constructed some distance from where engineering designs prescribed them. The changes are attributable to logistical opportunities encountered during construction, and the changed locations do not jeopardize crib wall or project performance.

Five channel grade control structures were constructed within 5 feet horizontally and 0.4 feet vertically of design, which was within design tolerances.

The rock slope protection designed for the culvert outlet at sta 12+00 was replaced with a rock weir and two log “V” weirs after excavation in the area revealed the culvert to be a 48 inch diameter culvert rather than the pre-project estimated 24 inch culvert. Project engineers designed the new outfall structures upon discovering the change and provided installation oversight.

West Fork Tributary

The West Fork Tributary culvert replacement and channel construction upstream (Sheet 9 of 33) was not constructed due to budget overruns on other design elements. This part of the project was seen as a logical element to postpone on the project without impacting function of the rest of the project elements. Funding is being sought to complete this component of the project.

Elk and Beaver Exclusion Fence

Installation of elk and beaver exclusion fencing commenced in March, 2015 and was followed by tree and willow planting. Both were completed by April 30, 2015. The electrified elk fence was installed in conformance with design. One deviation was that the fence did not follow the SOC Access Road between the Upper end of the project and the West Fork Tributary. In this area the fence was installed adjacent to the left bank (facing downstream) planting mound.

Riparian Planting

Sitka spruce and willow planting followed the planting plans with a deviation from design being that due to alder tree mortality at the nursery only 300 alder of the approximately 5,000 ordered were available and those were planted throughout the mounds. Additional alder are presently being grown to fill the full order and are scheduled to be planted in winter 2015-2016.

MONITORING

Project monitoring consists of four specialized areas of study – wetland condition, fish abundance and water quality, planted riparian survival, and channel bank photos. Each monitoring aspect was designed and carried out by Redwood National Park subject matter specialists.

Wetland Condition

Potential impacts to surface and subsurface water levels throughout the year as the result of project implementation are not entirely certain. The timing, duration and distribution of wetland water levels, both surface and subsurface may be affected by the project. Prior to the project, the majority of the wetland had standing water year round with water depths of 0.5 to 3 feet. Constructing a channel that increases flow conveyance, in conjunction with restoration work downstream of the park reach impacting the channel, suggests that alterations to wetland water levels may occur. Changes to water levels are anticipated to be permanent but the Corps Jurisdictional wetland extent is not expected to change, although plant communities and wetland functions may adjust as the result of the shift from permanently flooded to an intermittently flooded Palustrine emergent wetland (Joe Seney, personal communication, October 1, 2013). In the first year of monitoring the wetland water levels and associated vegetation, there is insufficient information to identify any lasting effects of the project on wetland hydrology or vegetation.

Precipitation Summary Data

Daily and monthly precipitation data are collected from three locations surrounding the project site: the National Weather Service (NWS) weather station at Crescent City (35 miles north of the project site), a United States Geological Survey (USGS) rain gauge station about two miles north-east of the project site, and from a park-managed gauge in RNP about one mile north-west of the project site. Precipitation data from the three locations are used to assess “normal” precipitation on a monthly and annual basis. “Normal” is the 30-year mean calculated for 1981-2010 and is used for placing recent climate conditions into a historical context.

Monitoring data for precipitation and water elevation in wells along transects SC, SCA and SCB for each month are shown in Table 1. Precipitation data are from the NWS Crescent City station. Water elevation is the average of weekly measurements for the specified month, units are feet NAVD88. “x” indicates groundwater surface was below well bottom. “x/21” means water surface elevation was below well bottom for the first two readings for the specified month. “21/x” means water surface was below the well bottom for the last two readings for the specified month.

Table 1. Monitoring data for precipitation and water surface elevation (NAVD88) in wells along transects SC, SCA and SCB for each month, October 2013 – September 2014 and October 2014 – September 2015.

	Water Year 2013-2014												
	Oct 2013	Nov 2013	Dec 2013	Jan 2014	Feb 2014	Mar 2014	Apr 2014	May 2014	Jun 2014	Jul 2014	Aug 2014	Sep 2014	Summary
Precipitation (inches)	0.1	2.5	1.3	2.2	9.5	7.3	2.3	1.8	1.6	0.2	0.04	3.6	32.4 Tot.
SC3	x	x	x	x	22.7	23	22.5	21.7	20.7	20/x	x	x	3 mos.
SC4	21	21.3	21.3	21	22.3	22	22.3	21.7	21.3	20/x	x	x	4 mos.
SC5	22	21.8	22.2	22	22.3	22	22.3	22.3	22	21/x	x	x	9.5 mos.
SC6	22	22	22	22	22.3	22	22.3	22.3	21.8	20/x	x	x	9.5 mos.
SCB2	x	x	x	21	22	22	21.7	21.5	20.5	19	19/x	x	2 mos.
SCB3	x	x	x	21	21.8	22	21.8	21.4	20.5	20	19/x	x	5 mos.
SCB4	x	x	x	21	21.1	21	21	21	20.5	20	19/x	x	6 mos.
SCA1	x	19	x	19	19.5	20	19.7	19.5	x	x	x	x	2 mos.
SCA2	19	19.2	20	20	20.3	21	20.3	20.2	19.5	18	x	x	8 mos.
SCA3	19.5	19.5	19.7	20	20	21	20	20.5	19.5	18	x	x	9 mos.
SCA4	19.9	20.2	20.1	20	20.4	21	20.3	20.3	20.7	20	19.8	19	12 mos.
SCA5	20.2	20.3	20.3	20	20.5	21	20.7	20.7	20.4	20	20	20	12 mos.

	Water Year 2014-2015												
	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	Mar 2015	Apr 2015	May 2015	Jun 2015	Jul 2015	Aug 2015	Sep 2015	Summary
Precipitation (inches)	6.3	3.8	10.7	1.8	7.9	5.5	5.2	0.01	0.56	0.1	1.09	0.9	43.8 Tot.
SC3	x	20.8	22.1	22	21.6	21	21.4	20.6	x	x	x	x	0 mos.
SC4	x/20	21	22.2	22	22.2	21	21.7	20.8	x	x	x	x	4 mos.
SC5	x/21	22	22.4	22	22.4	22	22.4	21.3	20.5/x	x	x	x	6 mos.
SC6	x/20.1	20	22	22	22.2	22	22.2	22.7	22.8/x	x	x	x	7.5 mos.
SCB2	x/20.5	20.9	21.8	22	22.3	22	21.6	20.4	19.4	x	x	x	2 mos.
SCB3	x/21.5	20.7	21.8	21	21.8	21	21.3	20.7	x	x	x	x	4 mos.
SCB4	x/20.5	20.8	21.2	21	21.4	21	21.2	20.1	19.7	x	x	x	1.5 mos.
SCA1	19.5	19.5	20	20	20	20	20	19.2	x	x	x	x	4 mos.
SCA2	20	20	20.4	20	20.6	20	20.5	20.3	19.2	x	x	x	9 mos.
SCA3	19.5	19.7	20.7	20	20.5	20	20.5	20.3	19.4	x	x	x	9 mos.
SCA4	19.8	20.2	20.8	21	21	21	21	20.6	20.2	19	18.6	x	11 mos.
SCA5	20.2	20.4	20.7	21	20.7	21	20.7	20.5	20.2	19	19.1	x	11 mos.
Colored cell explanation:													
Precipitation is less than 30 year "Normal" for the month													
Precipitation is Wetter than "Normal" for the month													
Water surface elevation is within 12 inches of ground surface, meets ACOE wetland hydrology													
Summer Draw Down													

Water Surface and Groundwater Levels

To assess the effects of the project on water levels and plant communities in the wetland surrounding the project, three monitoring transects were established in and adjacent to the wetland roughly perpendicular to the wetland edge so as to cross the present wetland margin edge (Figure 1). Each transect contains either five or six sites where a pair of wells (one to a depth of 12 inches and the other to a depth of 30 – 60 inches) were installed to measure water elevation (Figure 2). Transect SC and Transect SCB are both on the southern side of the wetland which is immediately adjacent to the project. Transect SCA is on the northern side of the wetland. A “T” fence post marks the location of each pair of well/piezometer along all three transects. Two gauge plates are used for measuring surface water below the dense floating mat that surrounds the gauge sites. One gauge plate is on Transect SC plot 6, the other is on Transect SCA plot 5. A Solinst Mini Water Level Meter is used to measure depth to groundwater to the nearest 0.01 feet. Surface and groundwater data are collected approximately once per week throughout the year (Table 1). Data have been collected weekly (with a few exceptions) since October 2013.



Figure 2. Photo of typical pair of two monitoring wells at Transect SCA plot 3. Note ponded wetland water surrounding wells at time of photo.

The park established two water surface elevation monitoring stations near the downstream extent of the project in 2009 to aid in engineering design of the project. These gauges continue to be monitored using a continuous recording meter. Data from these stations are not anticipated to

reflect effects of the project on stream or wetland hydrology due to their location at the downstream end of the project. These stations are anticipated to reflect changing conditions downstream on the private lands as channel grasses continue to grow in abundance and raise water levels in the park reach or when channel grasses are removed from the channel and water levels in the park channel become lower.

All water surface gage site elevations are surveyed in NAVD 88.

Summary Observations for Precipitation and Water Surface Elevation

Precipitation for water year (WY) 2013-14 was about 32.4 inches and for WY 2014-15 was about 43.8 inches. Total annual precipitation for both WYs was substantially below the 30 year average of 71.2 inches. Total precipitation for WY 2014-15 was approximately 25 percent higher than for the previous year, WY 2013-14.

The majority of monitoring well sites (7 of 12) showed a 1 to 3 month reduction from the previous year in meeting ACOE wetland hydrology criteria (groundwater elevation within 12 inches of ground surface). Two of the well sites showed an increase from the previous year in meeting ACOE wetlands hydrology criteria. Three of the well sites show no change in the number of months that water elevation meets ACOE wetland hydrology criteria.

Summer draw down occurred earlier in the first summer following project implementation – in June 2015 (WY 2014-15) compared to occurring in mid-July to mid-August in the summer of project implementation (WY 2013-14).

Channel excavation commenced in July 2014 and a pronounced drop in groundwater levels along transects SC and SCB (about 125 and 160 feet respectively from project area) was observed, although groundwater level along transect SCA (about 1,000 feet from the project area) was unchanged.

Wetland Vegetation Cover

At each wellsite sampling location, a four square meter vegetation monitoring plot was established in June 2014. Each site was re-sampled in June 2015. At each monitoring plot plant species were identified and percent cover for each species was estimated to the nearest 5 percent, or if less than 5 percent, was described as 1 or 3 percent (Table 2).

Wetland Vegetation Observations for 2014-2015 Monitoring Period

- Nearly all plots are dominated (> than 50% relative cover) by non-native, FAC grasses
- OBL and FACW plant species relative cover generally decreased from 2014 to 2015 at five plots and remained the same at nine plots.
- Native plant species relative cover decreased from 2014 to 2015 at five plots, increased at two plots and remained the same at seven plots
- Vegetation plots that experienced higher water levels for longer duration have a higher relative percent cover of OBL and FACW plant species. This was observed at; SC5, SC6, SCA2, SCA3, SCA4, SCA5, SCB2 and SCB3.
- Plots with higher water levels for longer periods of time have a higher percent cover of native species (SC5, SCA2, SCA3, SCA4, SCA5, SCB2 and SCB3)

- A California Rapid Assessment Method (CRAM) analysis was completed for the pre-project wetland conditions and estimated for post-project condition (Brown and Hancock, 2012, Redwood National Park, 2013, CWMW 2009, 2012). CRAM analysis will be redone in year two (2016) or year three (2017) post- implementation. Two of the baseline CRAM study transects are located proximal to the wetland monitoring transects SC and SCB. The third CRAM study transect is located within the footprint of the project and is now occupied by planting mounds. CRAM will not be used on the planting mounds. Planting mound vegetation is being monitored for mortality separate from the wetland monitoring study.

Table 2. Relative percent cover for obligate and facultative wetland (OBL & FACW) species and native species at each monitoring site along transects SC, SCA and SCB for 2014 and 2015.

Transect and vegetation plot	2014	2015	2014	2015
	OBL & FACW Species		Native Species	
	Relative Percent Cover (%)		Relative Percent Cover (%)	
SC2 - in upland	0	0	0	0
SC3 - in wetland	12	9	12	9
SC4 - in wetland	18	3	0	0
SC5 - in wetland	55	40	55	40
SC6 - in wetland floating mat	100	94	1	14
SCA1 - in wetland	3	8	2	4
SCA2 - in wetland	73	73	8	32
SCA3 - in wetland	100	98	62	41
SCA4 - in wetland	81	85	42	40
SCA5 - in wetland floating mat	56	81	33	39
SCB1 - in upland	0	0	0	0
SCB2 - in wetland	45	19	45	19
SCB3 - in wetland	52	39	43	30
SCB4 - in wetland	62	29	45	28

Fish and Water Quality

Methods

There are four fish and water quality monitoring sites within the restoration project, a plunge pool below the SOC culvert at the head of the project channel (GPS 410187E/4569821N); within the West Tributary (GPS 410084E/4569973N); and two locations within the slough: upper

channel at a constructed large woody structure (LWD) (GPS 410195E/4569931N) and lower channel at another constructed large woody structure (GPS 410076E/4570093N).

To monitor fish and other aquatic species presence, roe baited minnow traps (16.5 inches long, 7.4 inches in diameter at the end, with a 1 to 1.5 inch opening in the cone) are used in Strawberry Creek. The traps, one at each location, are placed in pools and areas protected from stream flow in water deep enough to cover the trap. Soak time is less than four hours. Captured fish and amphibians from the retrieved traps are transferred to a small dishpan, anesthetized with carbon dioxide solution (Alka Seltzer), identified to species, counted, and the salmonids and amphibians measured to the nearest 1 mm on a wetted measuring board. The fish recover from the carbon dioxide in aerated buckets and are released back into Strawberry Creek.

Water quality parameters; water temperature (°C), dissolved oxygen (mg/l), specific conductivity (µS), salinity (o/oo), and water depth (ft) are measured with a YSI Model 85 hand held meter at each site in conjunction with fish trapping.

Additional fish and water quality monitoring is done at five locations downstream of the park restoration reach on private and county property.

Results

Monitoring began within the restored stream channel on 11/19/2014 and this report provides data to 12/1/2015. Results are presented in Table 3. Species caught within the project area in order of abundance were Threespine stickleback (*Gasterosteus aculeatus*), Rough-skinned newt (*Taricha granulosa*), Coastal Giant Salamander (*Dicamptodon tenebrosus*) [formerly known as Pacific Giant Salamander], and ammocete. No salmonids were captured during monitoring by Redwood National Park, however, National Marine Fisheries Service captured three coho salmon (*Oncorhynchus kisutch*) juveniles on 12/22/2014 and one again on 2/18/2015 within the project area. Amphipods (Gammarus) are present at the plunge pool below SOC culvert site, and macroinvertebrates such as dragonfly and caddisfly nymphs are also caught. A cormorant was seen diving and presumably fishing in the restored reach on 9/23/2015.

Downstream of the project reach, coho juveniles were consistently captured at Wooden Bridge at Barlow Pasture, the next nearest downstream monitoring location 400 meters below the restoration reach (Table 3). Other fish captured downstream in the past were coastal cutthroat trout (*O. clarki*) and steelhead trout (*O. mykiss*).

The fish consistently caught within the project area are indicative of the some of the poorer water quality parameters measured. Threespine stickleback are able to tolerate lower dissolved oxygen and higher temperatures, parameters where coho salmon would be absent.

Water temperature measurements show seasonal and spatial differences. Strawberry Creek water temperatures within the project area ranged from 6.3 to 18.8°C, with values warmer in the summer and cooler in fall and winter (Appendix C, Figure C-1). Both the upper and lower slough channel sites were warmer than the upper channel plunge pool below the SOC culvert and the West Tributary.

Dissolved oxygen measurements showed some of the same seasonal and spatial differences (Appendix C, Figure C-2). Dissolved oxygen ranged from 2.8 to 10.5mg/l, the best values, 9.9 to 10.5 mg/l, measured at the upper channel plunge pool below the SOC culvert at the head of the restored channel. This is consistent throughout the year as the channel is steeper and the water well mixed. In the slough channels, where there is less mixing, dissolved oxygen values are lower, and lower in the summer versus winter. Though it is the first year of monitoring, the grass growing on the banks into the slough channel may further decrease dissolved oxygen values.

Table 3. Results of fish and amphibian presence/absence monitoring using baited minnow traps within and downstream of the restored park Strawberry Creek channel. Number within parentheses indicates number caught.

Strawberry Creek Location	Sample Date						
	11/19 2014	1/22 2015	3/24 2015	5/26 2015	7/20 2015	9/23 2015	12/01 2015
Plunge pool at head of channel	0	Coastal Giant Salamander (1)	0	0	Threespine Stickleback (3)	0	0
Upper channel LWD	Threespine Stickleback (2)	0	Rough-skinned newt (1)	Rough-skinned newt (3) Threespine Stickleback (12)	Rough-skinned newt (2) Threespine Stickleback (26)	Threespine Stickleback (1)	Threespine Stickleback (36)
West Tributary	Threespine Stickleback (1)	0	0	Rough-skinned newt (1) Threespine Stickleback (5)	Rough-skinned newt (6) Threespine Stickleback (8)	Threespine Stickleback (13)	Threespine Stickleback (120)
Lower channel LWD	Rough-skinned newt (1)	0	Threespine Stickleback (2)	Threespine Stickleback (3)	Rough-skinned newt (2) Threespine Stickleback (61)	Threespine Stickleback (76)	Threespine Stickleback (119)
First Monitoring Site Downstream of Park Restored Reach							
Wooden bridge at Barlow Pasture	Coho (1) Threespine Stickleback (1)	Coho (8)	Coho (1) Cutthroat (1)	Coho (11) Threespine Stickleback (1)	Rough-skinned newt (1) Threespine Stickleback (61)	Threespine Stickleback (44)	Threespine Stickleback (13)
Ammocete observed within project on 1/22/2015							

Specific conductivity measurements also show some of the same seasonal and spatial differences (Appendix C, Figure C-3). Specific conductivity within the project reach ranged from 95.9 to 141.8 μ S, which reflects the low conductivity of streams within the Redwood Creek watershed (Anderson 1980). Values were generally lower in March and probably are a reflection of more rain events. The plunge pool below SOC, the upper-most site, is consistently lower in value, the water source coming from upstream versus the slough channels and West Tributary where there is more influence from the surrounding wetlands.

Riparian Mound Vegetation Monitoring

Riparian planting on the mounds included the use of three genera of tree species, Sitka spruce, red alder, and willows. The project design was to plant these trees in the following manner, spruce on the top third of the mound, then merging with alder in the middle third, which will merge with willows on the lower third (when looking at the mound in profile). All spruce trees were one year old stock planted in April 2015 spaced about 2.5 feet apart. About 300 alder trees were planted at the same time and not in the quantity specified due to tree mortality at the nursery. Replacement trees are being grown at the nursery and will be planted in winter 2015 – 2016. Willow stakes were planted in April – May 2015 along the entire water's edge and up approximately one foot. Additional planting of willow is planned for the future to infill in areas to accelerate shading.

Methods

Riparian planting monitoring included the establishment of 16 plots measuring 9 square meters along the planting mounds on both sides of Strawberry Creek. The planting mounds were broken into 7 sub-mounds, using inlet breaks and the ends of the mounds to define the sub-mounds. These sub-mounds were numbered sequentially starting from the NE sub-mound, #1 (downstream right side mound), circling around in clockwise fashion to the NW sub-mound, #7 (downstream left side mound). Seven plots were established on the three eastern sub-mounds and 9 on the four western sub-mounds. Monitoring plot locations were established 50 feet from sub-mound end points. The plot locations were staggered across the three sides of the planting mounds, i.e. eastern, top, and western sides, to monitor growth and development of trees across all exposures and gradients. The 16 plots were established and sampled in late July 2015. Data collected at each plot included a count of planted tree seedlings by species, an ocular estimate of cover by species, an ocular estimate of overall planted stock cover, and number of dead mortality/missing trees. Some physical parameters for each plot were also determined. No data on volunteer vegetation was recorded, although some big leaf maple trees (*Acer macrophyllum*) were observed on the mounds along with abundant horse tail fern, clover and some non-native vegetation.

Results

The first year planting of spruce recorded 180 seedlings planted within the 16 sampling plots with all but one surviving to the sampling date of late July. Few alder were planted this past year and willow was only planted along the very edge of the creek where a beaver exclusion fence was installed that prevents sampling of the willow. Within the established plots 179 live spruce, 1 dead spruce, and one volunteer maple (*Acer macrophyllum*) were counted. The average

number of spruce per plot was 12 (± 5), with a high of 21 and a low of 5. The average cover across all plots was 3% but varied by nearly as much across all plots. One plot recorded a 10% cover estimate, while three plots were barely recorded at 1%.

Discussion

Results were better than expected given the dry weather on the north coast in 2015. There was mortality of spruce occurring on the mounds outside of the sampling plots, and subsequent sampling years may reveal additional mortality. Park managers engaged in monthly watering of the mounds during the summer to help seedlings survive. Estimates of cover are essentially meaningless at this early stage of the project, particularly with spruce as the primary species providing the data this year. Cover estimates will become more relevant in later years after all planting has been completed. At this stage, the project has a good baseline dataset of spruce to follow over time. The lack of alder will be remedied during the upcoming 2016 winter, as this species will be planted. The lack of willow may be improved by additional planting a little farther up the slope and above the beaver fence. The volunteer maple, alder, and spruce observed but not sampled is a good sign and may indicate good site fertility for the planted stock.

Channel Bank Condition

Photo points have been established throughout the project area to document anticipated changing conditions over time. A series of photographs that document the channel bank for the entire reach of the project is in Appendix D.

Of primary note is the invasion of non-native grass, primarily *Glyceria fluitans*, along nearly the entire length of the slough channel edge. Project partners are investigating various options for controlling the grass including the use of herbicides and physical barriers such as burlap. The park is receiving technical assistance for herbicide use in a coho bearing stream from NOAA.

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APPENDICES

Appendix A. Strawberry Creek Restoration – NPS Reach, Redwood National Park Project Monitoring Plan. March 2013.

Appendix B. As Built Drawings by Michael Love and Associates. November, 2014.

Appendix C. Water Quality Monitoring Graphs

Figure C-1. Bi-monthly water temperatures (°C) at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Figure C-2. Bi-monthly dissolved oxygen (mg/l) values (°C) at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Figure C-3. Bi-monthly specific conductivity (µS) values at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Appendix D. Aerial Photo from Google Earth, Channel Photos taken in summer 2015 and photo sequence of lower reach.

Appendix A.

Strawberry Creek Restoration – NPS Reach,
Redwood National Park Project Monitoring Plan
March 2013

Strawberry Creek Restoration – NPS Reach, Redwood National Park Project Monitoring Plan

March 2013

Following completion of project implementation, Redwood National Park will coordinate post project monitoring to assess project success and guide adaptive management to meet project objectives. The following implementation objectives have been established for Strawberry Creek restoration:

- Restore portions of the stream channel to re-establish natural geomorphic processes and allow fish passage.
- Remove and control invasive reed canary grass from portions of the stream channel, wetland, and floodplain.
- Revegetate the riparian corridor with native species.
- Fence the new plantings along the riparian corridor to prevent damage by elk browsing and associated streambank erosion and to keep beavers out.
- Replace an undersized stream crossing that impedes fish passage and alters natural geomorphic processes.

Restored Stream Channel

As built drawings - Drawings will be prepared at completion of the project to provide a basis for comparing possible changes in the project area due to channel or structure adjustments or vegetation mortality. They will also document channel complexity.

Photo Points – Photo points will be established and will be used to document before and after conditions of the project. Photo points will be repeated to capture the evolution of the project area.

Improved Stream Habitat for Fish

Fish distribution monitoring – Fish monitoring will document salmonid presence in the project area where presently there are none. Strawberry Creek has been monitored at more than six locations since 2006. The fish monitoring stations throughout Strawberry Creek range from upstream of the proposed project reach to the confluence of Strawberry Creek at Redwood Creek estuary south slough. Monitoring is presently a joint effort of Redwood National Park and NOAA Fisheries Restoration Center. The current locations (Figure 1) from upstream to downstream are:

1. Old SOC culvert – immediately upstream of the project area
2. Wooden bridge at Barlow pasture – 1,294 feet downstream of the downstream boundary of the project
3. Hiltons Road culvert – downstream of project area
4. Highway 101 bridge – downstream of project area

5. Humboldt County Waste Transfer Station box culvert – downstream of project area
6. Humboldt County Waste Transfer Station- below beaver dam – downstream of project area.

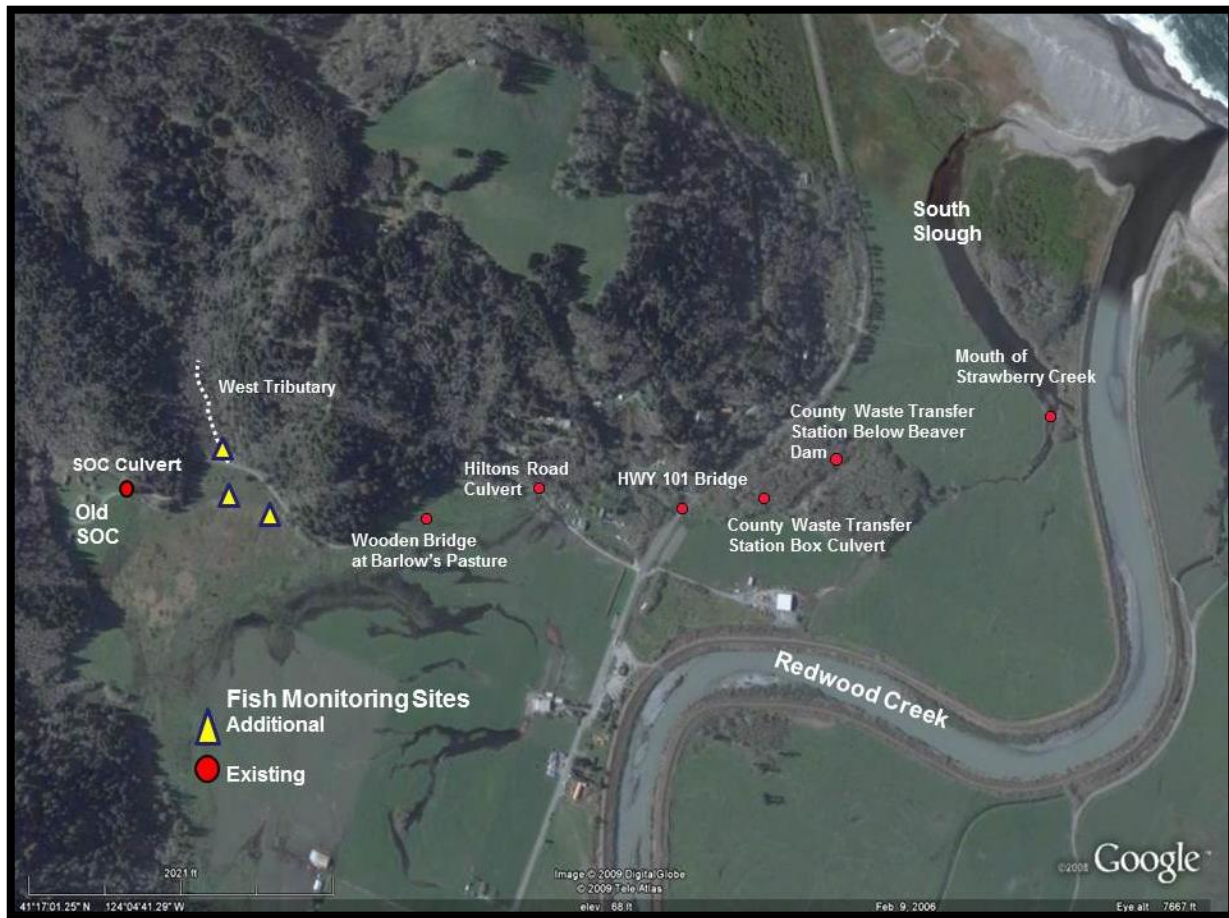


Figure 1. Existing and proposed additional fish monitoring sites on Strawberry Creek.

Coho salmon, cutthroat trout and steelhead have been trapped at the Hilton Road culvert. Steelhead trout have been trapped upstream at the wooden bridge at the Barlow pasture. As salmonids are present as far upstream as Hiltons Road culvert, when project construction is complete, trapping will be concentrated upstream of Hiltons Road culvert and additional sites will be established within the project area (Figure 1). The number of sites will be determined later, but will include the channel at the downstream end of the project, the confluence of the mainstem channel and West Tributary, and upstream of the West Tributary culvert. Presently (2013), there are no fish, salmonid or otherwise, upstream of the West Tributary culvert and no open water/channel where the mainstem channel is proposed to be excavated.

Fish monitoring methodology will use salmon roe baited minnow traps deployed for three hours on a single day. Electrofishing of channel reaches may be used, depending on the newly excavated channel bottom. If the channel bottom is unconsolidated, deep mud would preclude wading to electrofish the channel.

Water Quality – As fish distribution within the project is contingent on passage downstream of the project, several water quality parameters will be measured to determine an improvement in existing water quality that would be a proxy for suitable fish habitat. These are dissolved oxygen (mg/l), water temperature (°C), and specific conductivity (µS). Water quality measurements will be done at the time of fish trapping.

Control of Reed Canary Grass

The stream channel will be surveyed to determine if reed canary grass as a mat is covering the stream channel and the extent, if any, of reed canary grass in the channels. Photo points will capture changes in vegetation throughout the project area.

Riparian Vegetation Establishment

Photo points - will be established and reoccupied throughout the project area to document riparian vegetation establishment and growth. The photo points will also document the condition of channel form, culvert inlets and outlets, crib wall and log habitat structures, log steps and weirs, wetland side channels and overall project area.

Adjacent Wetland Effects

Water level monitoring - Presently, two recording stage gages record stage level in the project area. One is located in the main channel at the downstream end of the project reach, and another is located approximately 150 feet away within the adjacent wetland. A third gage, at a location to be determined, will be added in 2013 to measure water levels near the furthest extent of wetlands. In addition, the recording gages continuously measure water temperature at one hour increments, data that will be incorporated in the water quality measurements.

Wetland plant species composition – Between the third gage and margin of the wetland, 12 one square meter plots will be established and reoccupied to monitor wetland plant community. At three locations (the third gage, a stake equidistant between the gage and wetland margin, and at the wetland margin) photographs at the four cardinal directions will be taken 10 to 20 feet out from the center (stake). The vegetation composition will be measured in one meter square area plots at the four cardinal directions at each location.

Reporting

Summary reports will cover the first five years.

Appendix B.

As-Built Engineering Drawings

Dated: November 17, 2014.

Redwood National Park
Design Plans for Construction of
Strawberry Creek Restoration Project
Redwood national Park (RNP)

March, 2012 Final Plans

Prepared For:
Redwood National Park (RNP)
Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA)

By Michael A. Love
Michael Love & Associates



Technical Memorandum

Date: February 10, 2015

To: Mitch Farro, Projects Manager, Pacific Coast Fish, Wildlife and Wetlands Restoration Association

From: Rachel Shea, P.E., Engineering Geomorphologist, Michael Love & Associates, Inc.
Michael Love, P.E., Principal Engineer, Michael Love & Associates, Inc.

Subject: Interim As-Built Survey for the Strawberry Creek Restoration Project at Redwood National Park in Orick, CA (CDFW FRGP #P1110508)

CC: Darci Short, Redwood National Park

Summary

The memo presents the results of the interim as-built for the portions of the Strawberry Creek Restoration Project constructed in 2014. As-built drawing are shown as redline changes to the design plans (March 2012, Revision 1), and are presented in Attachment A. The as-built survey was conducted only for the project components constructed during the summer and fall of 2014, which included:

- Mainstem of Strawberry Creek from Station 0+00 to 11+96
- West Tributary Slough Channel from Stations 0+00 to approximately 2+00
- 5 Log Step and Pools
- 2 Log V-Weirs and Pools
- 1 Rock Weir and Pool
- 8 Log Habitat Structures
- 8 Crib Walls
- 10 Nurse Logs
- 600 feet of side channel

At the time of the as-built survey, the fencing was not installed and the project area was not planted.

The West Tributary culvert replacement and restoration of approximately 150 feet of the West Tributary upstream of the culvert shown on the design plans were not constructed.

Staff from PCFWWRA supervised the construction, with input from Michael Love & Associates (MLA) regarding log structure installation and channel grading.

The constructed channels and planting mounds matched the design plans within acceptable tolerances and it is expected that the constructed portions of the project will perform as designed once fencing and planting are completed.



As-Built Survey Results

MLA performed an as-built survey of the construction portions of the project on November 7, 2014. The survey was conducted using a total station. Horizontal and vertical control was based on the temporary and permanent benchmarks established by MLA prior to construction. Data collected included:

1. Thalweg survey of the Mainstem and West Tributary channels with point spacing approximately every 25 feet
2. Invert elevations of Log Step structures
3. Centerlines of Planting Mounds with point spacing approximately every 50 feet
4. Locations of Log Habitat Structures and Nurse Logs
5. Nine cross sections extending across the channel from the outside edges of the Planting Mounds

Field inspections and the as-built survey documented the following deviations from the plans:

- 1) The downstream portion of the Strawberry Creek Mainstem and east Planting Mound were realigned to the west between Stations 0+00 and 2+75 to reduce the amount of gravel and fill material needed for the planting mound on the west side of this portion of channel. This was performed at the direction of MLA during construction.
- 2) The two side channels to the west of Station 6+00 were eliminated due to construction access difficulty with inundated ground. Equivalent lengths of side channel were constructed along the south side of the West Tributary Planting Mound and along the west side of the Strawberry Creek Planting Mounds from the West Tributary and connecting to the side channel at the existing CMP outfall to the northwest of the West Tributary. This was performed at the direction of MLA during construction.
- 3) Nurse Log placement was revised by MLA as necessary to place them adjacent to the constructed side channels.
- 4) The Log Crib Walls at the East Tributary and downstream reach of the existing Strawberry Creek channel were field located by PCFWWRA during construction.
- 5) Log Habitat Structures were installed in locations directed by MLA.
- 6) Upon excavation, it was determined that the buried CMP near station 12+00 of Strawberry Creek was found to be 48" in diameter, and the outlet invert was found to be approximately 1.5 feet lower than shown on the design plans. Therefore, the 1.5-foot drop at the culvert outfall shown on the design plans did not exist. To facilitate fish passage to the culvert, the Facing Class RSP was eliminated and one Rock Weir and two log Vee Weirs were constructed to create 6-inch drops in the water surface profile from the culvert outfall to the new channel thalweg. The rock weir was installed 0.6 feet above the culvert invert to retain natural streambed material within the culvert.



- 7) The Planting Mound on the east side of Strawberry Creek was extended upstream from station 9+50 to Station 10+25 due to lower than expected existing ground in this area. The extended Planting Mound will provide suitable elevations for planting spruce and alder trees.
- 8) The As-Built cross sections and profiles reflect minor deviations from the design. The deviations will not affect the anticipated performance of the project.

This As-Built plan set represents an interim as-built document for the project. A final As-built plan set will be completed once the West Tributary culvert replacement and channel restoration are implemented.

Attachment 1: Interim As-Built Plans (11,7/14)

REDWOOD NATIONAL PARK

DESIGN PLANS FOR CONSTRUCTION OF

STRAWBERRY CREEK RESTORATION PROJECT

REDWOOD NATIONAL PARK (RNP)
March, 2012
FINAL PLANS

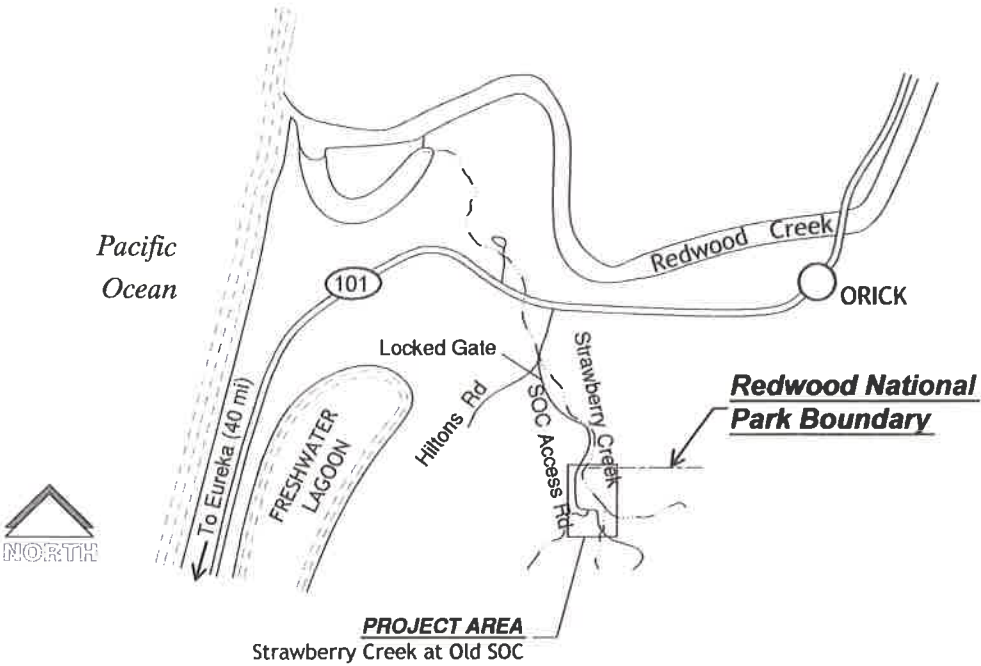
Prepared For:

- Redwood National Park (RNP)
- Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWRA)

Michael Love 4/14/2014
DESIGNED— Michael A. Love
Michael Love & Associates



SHEET No.	DESCRIPTION
1	TITLE SHEET
2	ABBREVIATIONS, LEGEND AND GENERAL NOTES
3	SITE OVERVIEW PLAN
4	NOTES
5	EROSION CONTROL AND WATER MANAGEMENT PLAN
6	WATER MANAGEMENT DETAILS
7	LAYOUT SHEET 1
8	LAYOUT SHEET 2
9	LAYOUT SHEET 3
10	STRAWBERRY CREEK PROFILE SHEET 1
11	STRAWBERRY CREEK PROFILE SHEET 2
12	STRAWBERRY CREEK PROFILE SHEET 3
13	WEST FORK TRIBUTARY PROFILE
14	STRAWBERRY CREEK TYPICAL CROSS SECTIONS
15	STRAWBERRY CREEK GRADING CROSS SECTIONS 1
16	STRAWBERRY CREEK GRADING CROSS SECTIONS 2
17	STRAWBERRY CREEK GRADING CROSS SECTIONS 3
18	STRAWBERRY CREEK GRADING CROSS SECTIONS 4
19	WEST FORK TRIBUTARY TYPICAL CROSS SECTIONS
20	WEST FORK TRIBUTARY GRADING CROSS SECTIONS 1
21	WEST FORK TRIBUTARY GRADING CROSS SECTIONS 2
22	WEST FORK TRIBUTARY CULVERT DETAILS 1
23	WEST FORK TRIBUTARY CULVERT DETAILS AND NOTES
24	PLANTING MOUND DETAILS
25	ROCK WEIR DETAIL
26	LOG STEP POOL DETAILS
27	LOG WEIR AND POOL DETAILS
28	LOG STRUCTURE NOTES AND ANCHORING DETAIL
29	LOG CRIB WALL DETAILS
30	LOG HABITAT STRUCTURE DETAILS
31	PLANTING PLAN
32	PLANTING DETAILS AND NOTES 1
33	PLANTING DETAILS AND NOTES 2
AB-1	AS-BUILT CROSS SECTIONS



LOCATION MAP
NOT TO SCALE

AS-BUILT

Date: Nov 7, 2014

Michael Love & Associates
PO Box 4477 Arcata, CA 95521 • (707) 476-8938
PROJECT: Pacific Coast Fish, Wildlife and Wetlands Restoration Assoc.

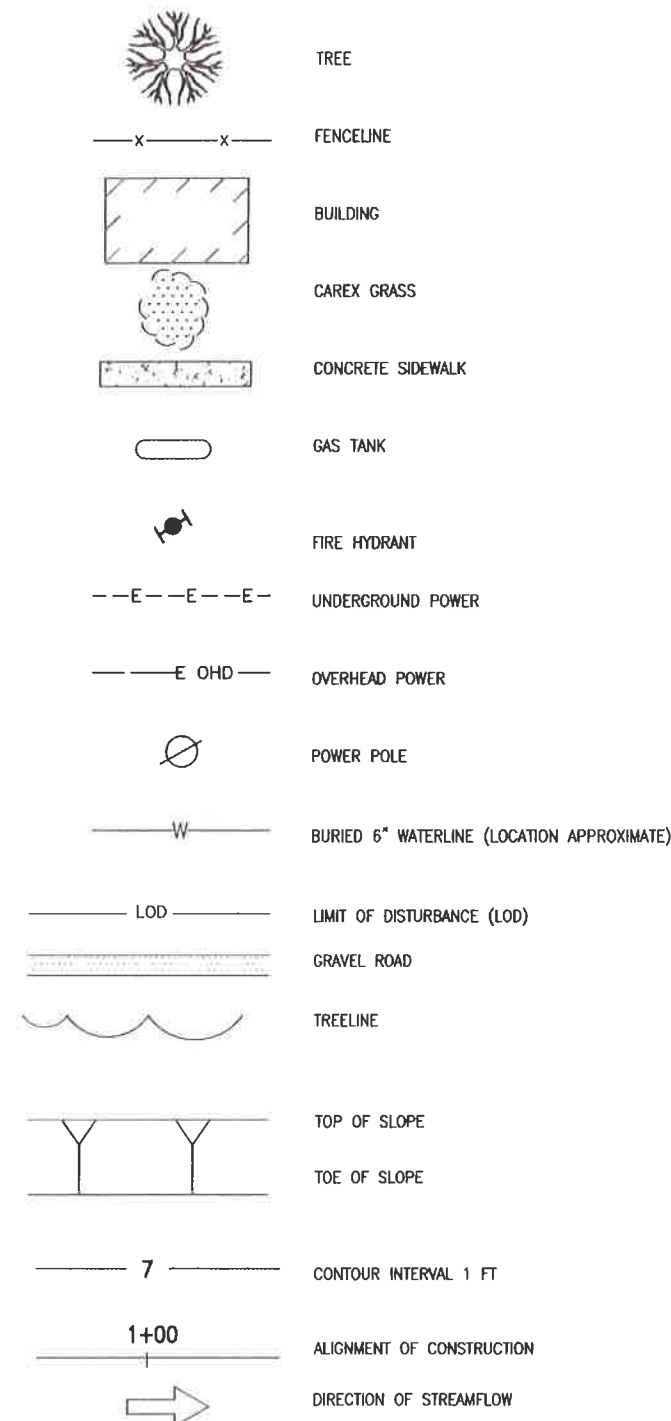
REVISIONS:
4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

TITLE SHEET

DATE: March 2012
SUBMITTAL: FINAL
DESIGN: ML / RS / AL
DRAWN: Llanos
SHEET

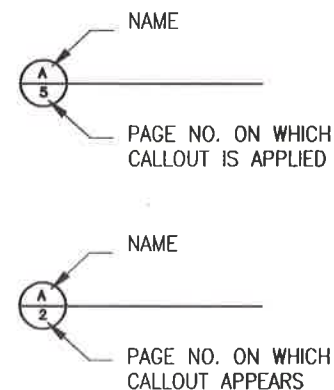
Legend



Standard Abbreviations

APPROX	APPROXIMATELY
CL	CENTERLINE
CONC	CONCRETE
CMPA	CORRUGATED METAL PIPE ARCH
DIA	DIAMETER
(E)	EXISTING
ELEV	ELEVATION
FT	FEET
FL	FLOW LINE
(X:1)	HORIZONTAL : VERTICAL
IN	INCHES
EG	EXISTING GROUND
FG	FINISHED GROUND
LOD	LIMIT OF DISTURBANCE
MAX	MAXIMUM
MIN	MINIMUM
(N)	NEW
NTS	NOT TO SCALE
O.C.	ON CENTER
O.D.	OUTSIDE DIAMETER
RSP	ROCK SLOPE PROTECTION
STA	STATION
TYP	TYPICAL
TBD	TO BE DETERMINED
W/	WITH

DRAWING SYMBOLS



Survey Control Notes

1. Survey conducted by MLA, November 18, 2009. Based on Control set by Graham Mathews & Associates.
2. Horizontal Datum: NAD83, California State Plane Zone 1 (feet)
3. Vertical Datum: NAVD88 (feet)

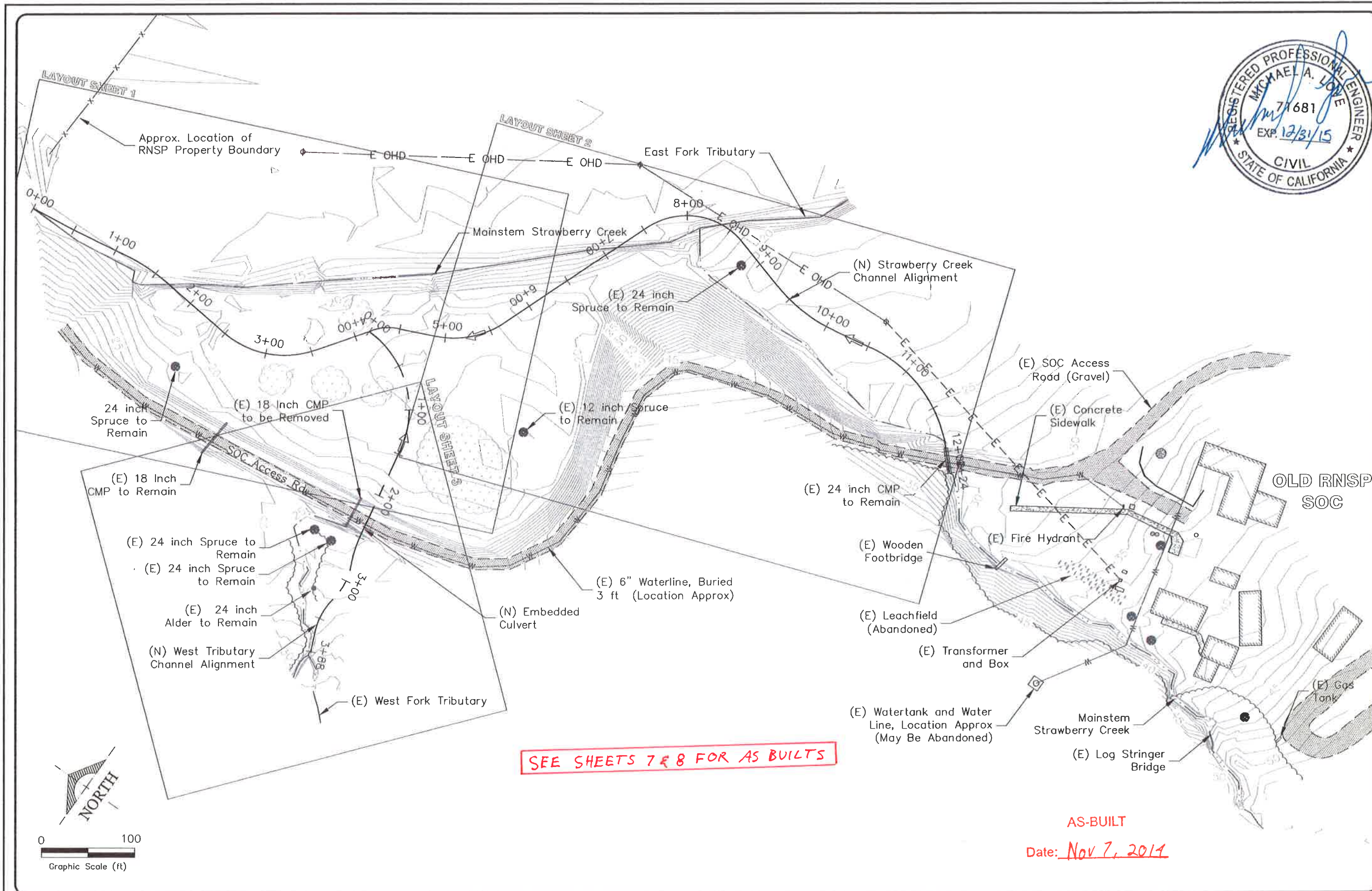
General Notes

1. The term "Owner" is defined as an authorized representative of designated by the National Park Service (NPS). All improvements shall be accomplished under the approval, inspection and to the satisfaction of the Owner
2. In the unlikely event cultural resources (i.e., historical, archaeological, and paleontological resources, and human remains) are discovered during grading or other construction activities, work shall be immediately suspended until a qualified NPS cultural resources specialist has evaluated the find. Additional consultation and protection measures may be required under Section 106 of the National Historic Preservation Act and its implementing regulations 36 CFR 800. If any fragment of or complete human burials or human remains are encountered work shall be immediately suspended in that location until the coroner, NPS Law Enforcement Officers and qualified NPS cultural resources specialists have evaluated the find.
3. If hazardous materials or what appear to be hazardous materials are encountered, stop work in the affected area immediately and contact 911 or the appropriate agency for further instruction.
4. All work shall comply with State of California Department of Transportation May 2006 Standard Plans & Specifications (Caltrans 2006) and the Contract Documents unless noted otherwise.
5. Contractor is responsible for complying with all project permits. Owner is responsible for obtaining and providing copies of all necessary project permits. Copies of all permits shall remain on site.
6. All utilities shown (if any) were located from above ground visual structures. No utility research was conducted for the site. Notify Underground Service Alert (DigAlert) prior to any grading or excavation within the site by calling 1-800-227-2600.
7. Placed materials not conforming to specifications shall be removed and replaced as directed by the Owner at no additional cost to the Owner.
8. The contractor, before submitting a bid for this project, shall visit the construction site and thoroughly familiarize themselves with all existing conditions above and below ground. Before submitting a bid, Bidders shall be satisfied as to the accuracy and completeness of these Specifications and Construction Documents regarding the nature and extent of all work described.
9. The contractor shall immediately notify the Owner upon discovering significant discrepancies, errors or omissions in the plans. Prior to proceeding, the Owner shall have the plans revised to clarify identified discrepancies, errors or omissions.
10. Traffic control shall conform to Caltrans, 2006, MUTCD, and of the MUTCD California Supplement.
11. Contractor shall maintain a clean and orderly work site.
12. Contractor shall be responsible for providing their own water and power for operations, irrigation and dust control. Water shall not be pumped from the creek for use in construction activities.

AS-BUILT

Date: Nov 7, 2014





Michael Love & Associates
PO Box 4477 • Arcata, CA 95521 • (707) 476-8838
PROJECT: Pacific Coast Fish, Wildlife and Wetlands Restoration Assoc.

REVISIONS:
4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

SITE OVERVIEW PLAN

DATE: March 2012
SUBMITTAL: FINAL
DESIGN: ML / RS / AL
DRAWN: Llanos
SHEET:

3 of 33

Clearing and Grubbing Notes

- 1. Clearing and Grubbing shall be in accordance with Caltrans, 2006 Section 16 and WQCB (2003) EC-2.
- 2. Invasive Grass Grubbing shall occur to the Limits of Grubbing Shown. Grubbing depths of up to 3 feet are expected to fully remove invasive grass. Grubbing shall be directed by Owner.
- 3. Invasive grass material grubbed from the project area and Himalaya Berry plants shall be stockpiled on the SOC property in locations designated by owner. Grubbed material contains a noxious weed and shall be isolated from other construction materials at all times.
- 4. The limit of disturbance does not denote the limit of clearing and grubbing. The extent of clearing shall be minimized to the extent possible to allow maneuverability of equipment.
- 5. Woody material shall be dispersed throughout the project area at the direction of the Owner. All trees designated to remain shall be protected.
- 6. Tree protection shall consist of blaze orange fence installed around the drip line of the tree. Fencing shall be installed prior to Clearing and Grubbing. No heavy equipment shall be used within the limit of tree protection.

Sequence of Construction

Work phasing shall occur as follows:

- 1. Mobilization
- 2. Installation of fish screens and removal of fish from work area.
- 3. Installation of cofferdams, clear water diversions dewatering, and sediment control as needed within work area.
- 4. Clearing and grubbing of work area.
- 5. Installation of Temporary Access Road for West Tributary Culvert installation.
- 6. Installation of New West Fork Tributary culvert.
- 7. Removal of the Temporary Access Road and Construction of Planting Mound Ceres as necessary for construction access.
- 8. In-stream channel work, placement of wood structures and construction of Planting Mounds.
- 9. Removal of fish screens, clear water diversions, cofferdams, and dewatering devices.
- 10. Stabilization of the work area and planting, installation of Elk Exclusion Fencing, and planting.
- 11. Demobilization.

Construction Sequencing and Access Notes:

- 1. Contractor shall sequence operations to provide weed free excavated material for Planting Mound construction.
- 2. Imported Borrow cores in Planting Mounds shall be used for construction access and work platforms within the wetland area.
- 3. The SOC Access Road shall remain open during construction of the West Tributary Culvert replacement. Contractor is responsible for maintaining access to the old SOC area.
- 4. Buried telephone, electric, water and other utility lines shall be protected or temporarily relocated during construction to prevent interruption of service.

Excavation Notes

- 1. Excavation, backfill, and embankment construction shall be in accordance with Caltrans 2006 Section 19 Earthwork, specifically Section 19-2, and 19-6 unless otherwise specified.
- 2. Excavation will include excavation and handling of saturated soils. Contractor shall be prepared to dewater and /or transport saturated soil in a manner that prevents excess discharge or spillage of soils or water within the construction access area or on adjacent properties or roadways. Should any discharge occur, the Contractor shall be responsible for immediate and complete clean up. Multiple handling of materials may be necessary.
- 3. Unless otherwise specified, finished grading shall be plus or minus 0.1 foot. The tolerance for horizontal locations shall be plus or minus 1 foot.
- 4. At the completion of construction, portions of the SOC Access Road used for construction access shall be restored to pre-construction or better conditions.

- 5. The ground surface after grubbing will serve as FG unless otherwise specified. FG in grubbed areas shall be constructed to maintain positive drainage towards the stream channel.

Erosion & Sediment Control Notes

General Notes

- 1. Erosion and sediment control shall comply with the California Stormwater Quality Association Stormwater Best Management Practice Handbook for Construction, 2003 (WQCB, 2003).
It is the responsibility of the contractor to minimize erosion and prevent the transport of sediment to the adjacent stream and sensitive areas. Unless otherwise noted, apply WQCB (2003) Best Management Practices (BMP's).
The Contractor, as necessary, shall implement other BMP's specified in WQCB (2003) dictated by site conditions. Contractor shall be responsible for all fines and cleanup resulting from a stormwater pollution violation.
- 2. Contractor shall keep project areas generating dust well watered during the term of the contract (WE-1).
- 3. Discharges of potential pollutants from construction sites shall be prevented using source controls to the maximum extent practicable. Potential pollutants include but are not limited to: sediment, trash, nutrients, pathogens, petroleum hydrocarbons, metals, concrete, cement, asphalt, lime, paint, stains, glues, wood products, pesticides, herbicides, chemicals, hazardous waste, sanitary waste, vehicle or equipment wash water and chlorinated water.
Other solid waste, trash, and debris, shall be placed in collection areas or containers. Food waste and other animal attracting trash shall be placed in bear-proof containers and daily removed off site. The construction site shall be cleared of solid waste daily, or as necessary, and regular removal and proper disposal shall be arranged. (NS-8,9,10, WM-1,2,4,5,6,9,10).
- 4. Soil and material stockpiles shall be properly protected to minimize sediment and pollutant transport from the construction site (WM-3).

Temporary Stream Isolation, Diversion, and Dewatering Measures

- 1. Temporary Stream Isolation, Diversion, and Dewatering will be necessary during in-channel construction and shall conform to these construction documents and the following specifications. See Typical D1 Sheet 6 and WQCB (2003)::
 - a. NS-2 Dewatering Operations
 - b. NS-5 Clear Water Diversion
 - c. EC-9 Earth Dikes and Drainage Swales
 - d. EC-10 Velocity Dissipation DevicesCaltrans 2003 19-3-03 (Temporary Sheet Pile Cofferdam)
- 2. Prior to commencing any excavation or demolition work, the fish screens shall be installed and fish and other aquatic organisms removed from the work area. Contractor shall coordinate with the Owner who will be responsible for removing fish and for scheduling placement of fish screens, stream isolation, and dewatering measures. The Owner's designated Fisheries Biologist is responsible for siting the best location for fish screens.
- 3. Filter Fabric Isolation shall be used as necessary with other isolation measures to construct the Imported Borrow cores of the Planting Mounds that will be used for construction access.
- 4. Temporary Cofferdams shall consist of super sandbags, driven sheet pile, or another approved device to minimize inflow of water to the work area. Driven Sheet Piles shall only be installed where specified. Additional Super Sand bags can be used within the work area as necessary.
- 5. Earth dikes shall be constructed of salvaged material. Material shall only be salvaged from the existing stream channel in locations where excavation is specified. Sand / gravel bags are acceptable. Burlap shall not be used. Earth dike shall be located as specified and as necessary within the work area.
- 6. For pumped clearwater diversions, contractor shall be responsible for providing pumps and pipes with adequate capacity to maintain suitably dewatered conditions in the work area during construction and to divert streamflow during non-work hours.
- 7. Dewatering of the isolated work area may be necessary during in-channel

- construction. Contractor shall be prepared to implement dewatering operations so that dewatering occurs in a timely manner and does not negatively impact the construction schedule.
- 8. Contractor shall coordinate with Fisheries Biologist during work area dewatering for additional fish removal.
- 9. Contractor shall use gravity stream diversion pipe as much as feasible. Overtopping of Clearwater Diversion Earth Dikes shall not be allowed during operation of the gravity pipe stream diversion.
- 10. The outlet of the gravity pipe, stream bypass pump or any other concentrated flow shall be placed on a washed cobble energy dissipater at least 3 feet x 3 feet and 1-foot thick placed in the channel upstream of the downstream fish screen.
- 11. The outlet of the dewatering pump shall be to a suitably sized gravity bag filter or other approved dewatering device a minimum of 50 feet from the work area on a flat area able to receive water and allow it to percolate into the soils.
- 12. Any pumps used on-site shall be placed on absorbent pads. The contractor shall have spill containment materials located at the site, with operators trained in spill control procedures.
- 13. When required Temporary Clearwater Diversion shall be continually operated until work area is fully stabilized.
- 14. Fill from earth dikes and sand bags shall be incorporated into the planting mounds or disposed of off site.

Permanent Seeding and Straw Mulching

- 1. Site stabilization, shall include the following, unless otherwise noted:
 - a. Seed Mix: at discretion of Owner.
 - b. Straw Mulch in accordance with EC-6. Straw shall be certified 100% weed free.
- 2. Permanent seeding and straw mulch shall be installed in all areas disturbed by the project, above bankfull elevation, unless specified otherwise.

AS-BUILT

Date: Nov 7, 2014

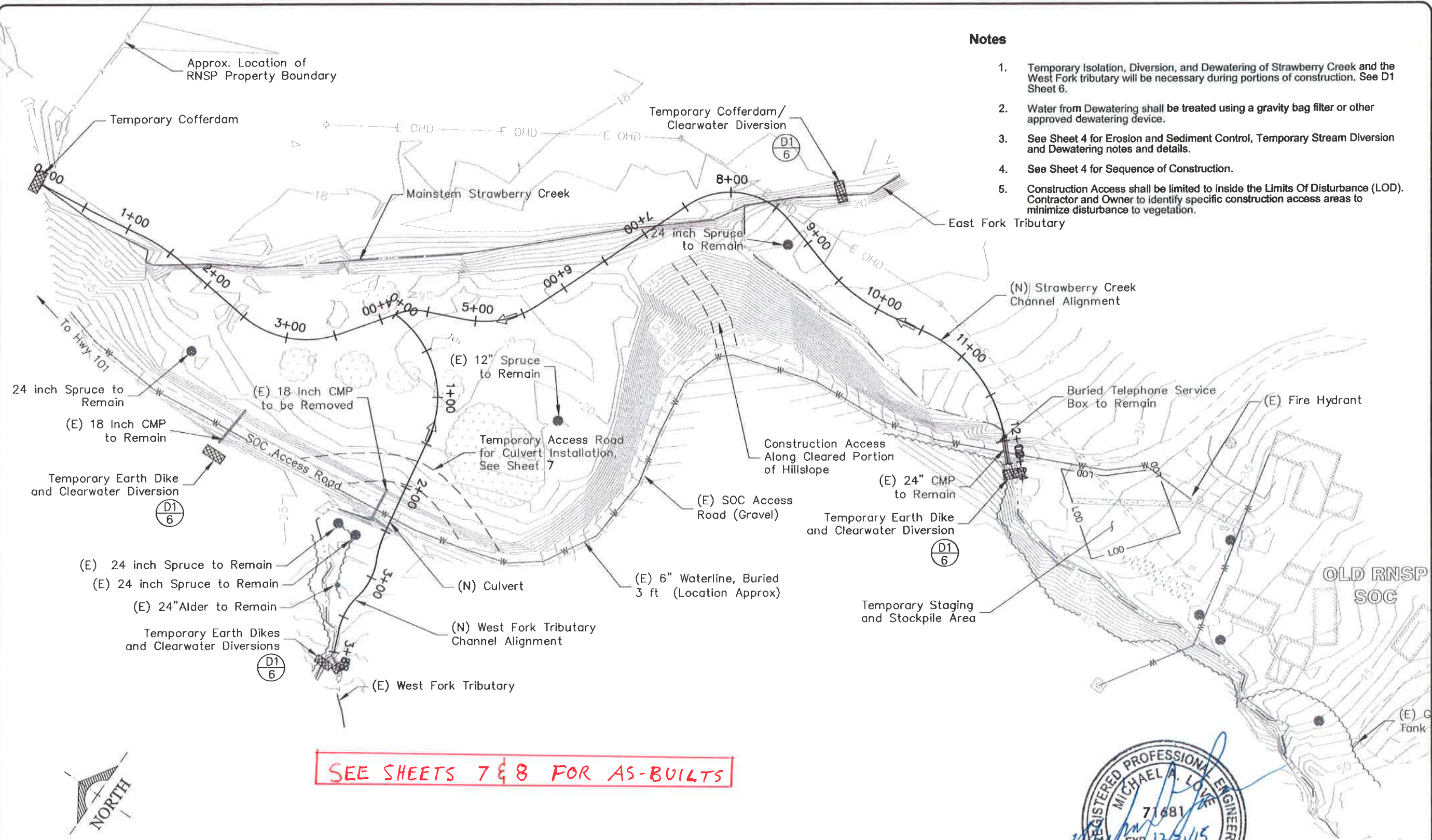


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4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project
NOTES

DATE: March 2012
SUBMITTAL: FINAL
DESIGN: ML / RS / AL
DRAWN: Llanos
SHEET: 4 of 33



Notes

1. Temporary Isolation, Diversion, and Dewatering of Strawberry Creek and the West Fork tributary will be necessary during portions of construction. See D1 Sheet 6.
2. Water from Dewatering shall be treated using a gravity bag filter or other approved dewatering device.
3. See Sheet 4 for Erosion and Sediment Control, Temporary Stream Diversion and Dewatering notes and details.
4. See Sheet 4 for Sequence of Construction.
5. Construction Access shall be limited to inside the Limits Of Disturbance (LOD). Contractor and Owner to identify specific construction access areas to minimize disturbance to vegetation.

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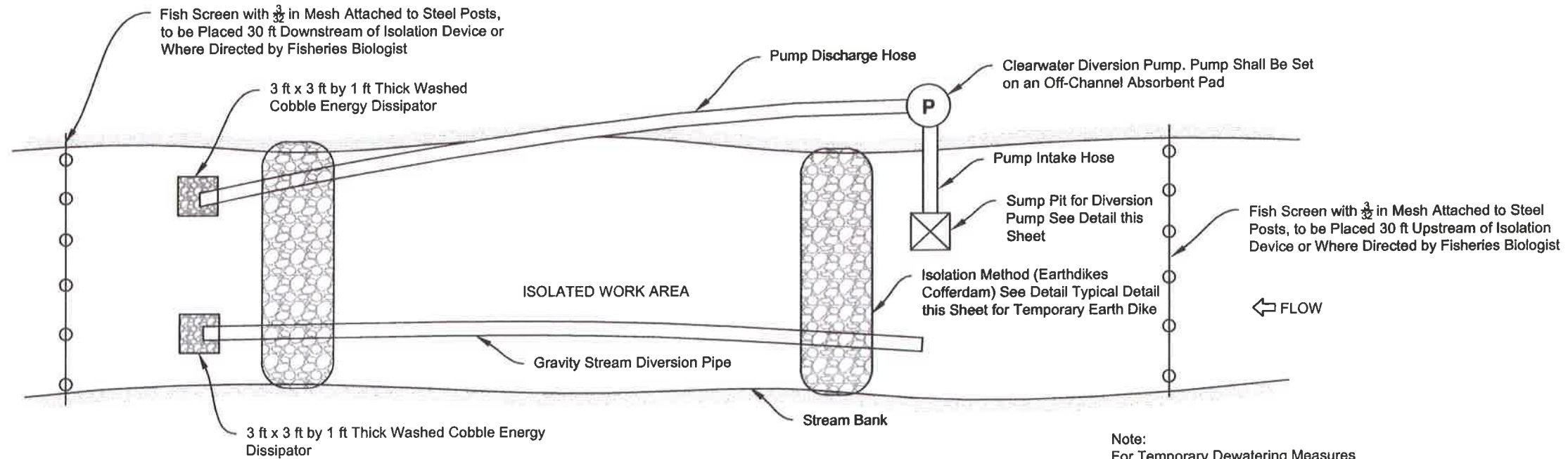
REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

**EROSION CONTROL
AND WATER
MANAGEMENT PLAN**

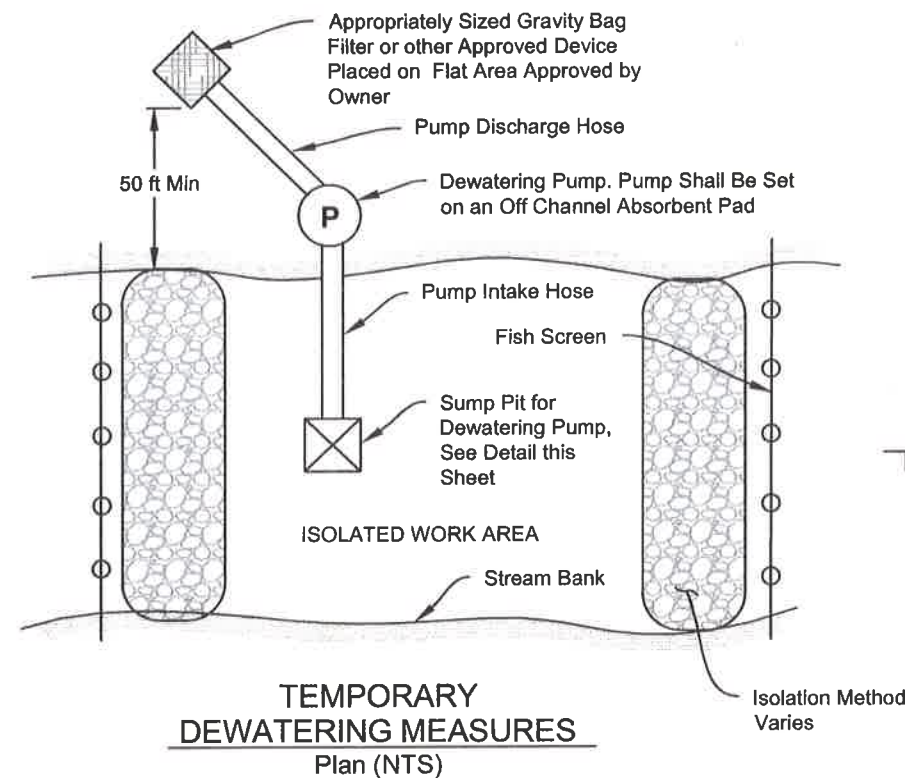
DATE
March 2012
SUBMITTAL
FINAL
DESIGN
ML / RS / AL
DRAWN
Llanos
SHEET



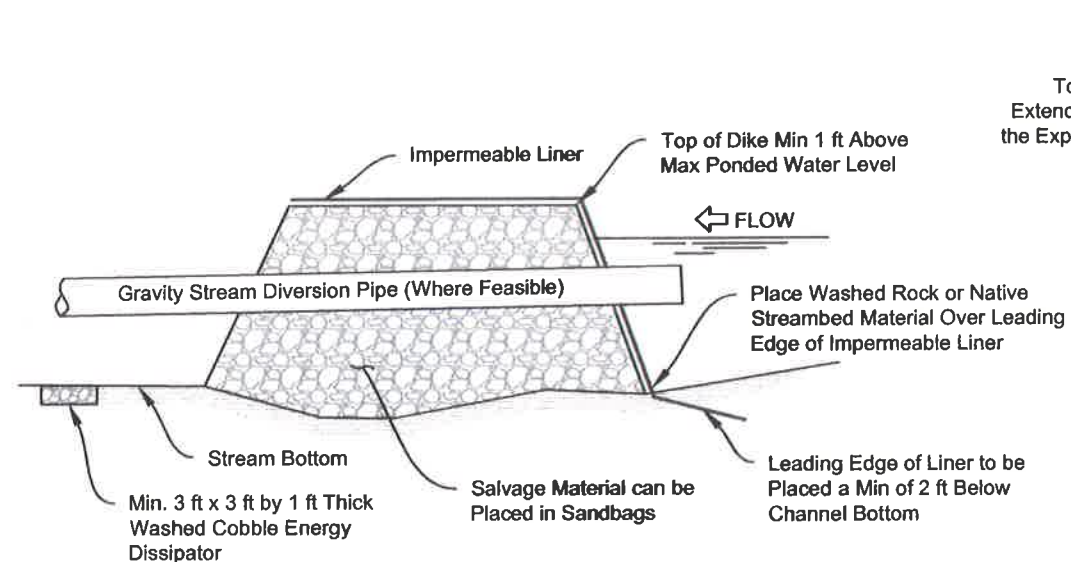
AS-BUILT
Date: Nov 7, 2014



TEMPORARY CLEAR WATER DIVERSION
Plan (NTS)

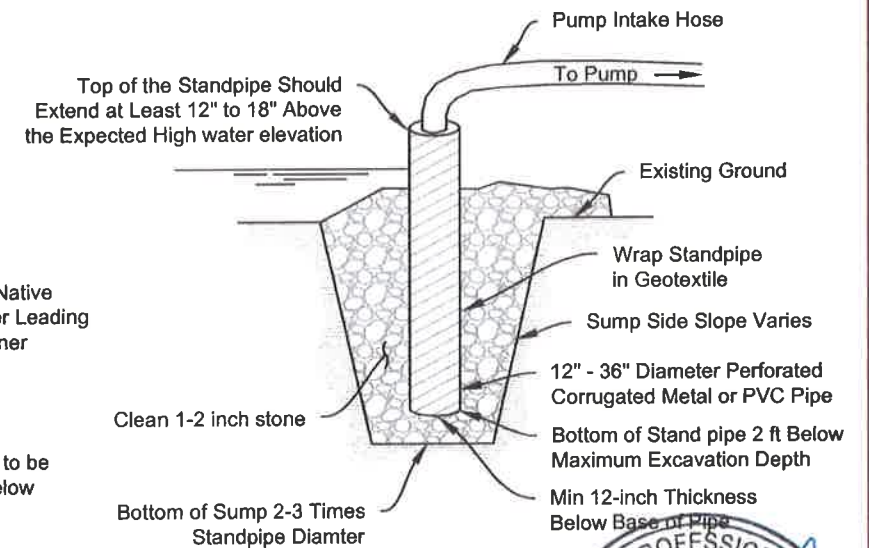


TEMPORARY DEWATERING MEASURES
Plan (NTS)



TEMPORARY EARTH DIKE
Profile (NTS)

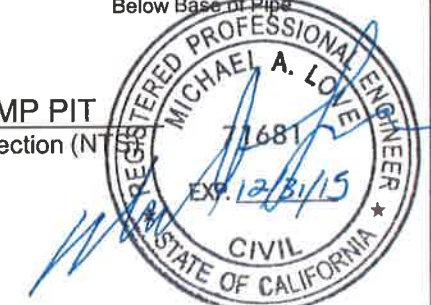
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Details

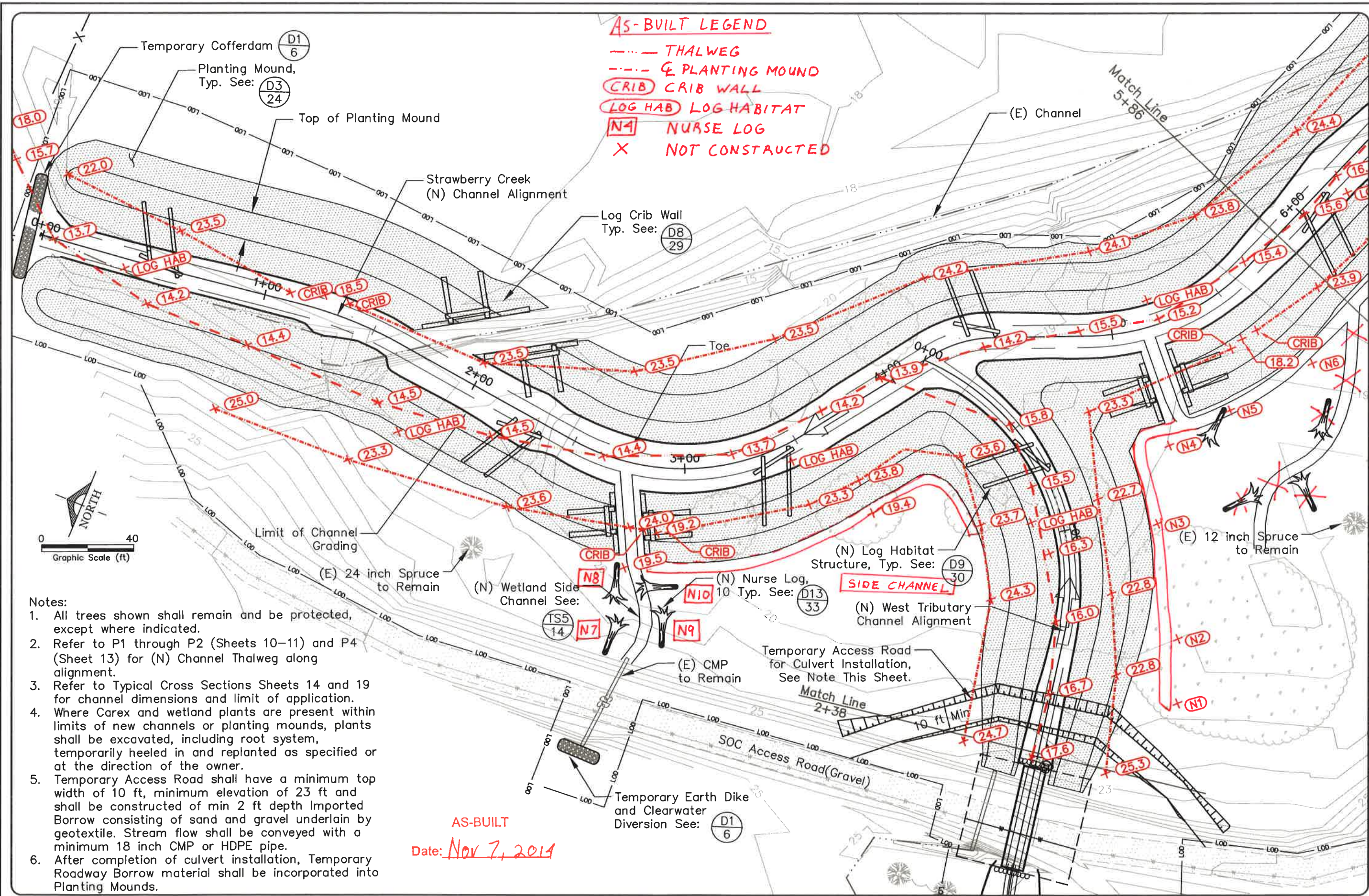


SUMP PIT
Cross Section (NTS)

AS-BUILT

Date: Nov 7, 2014





AS-BUILT LEGEND
--- THALWEG
--- & PLANTING MOUND
CRIB CRIB WALL
LOG HAB LOG HABITAT
N4 NURSE LOG
X NOT CONSTRUCTED

- Notes:
1. All trees shown shall remain and be protected, except where indicated.
 2. Refer to P1 through P2 (Sheets 10-11) and P4 (Sheet 13) for (N) Channel Thalweg along alignment.
 3. Refer to Typical Cross Sections Sheets 14 and 19 for channel dimensions and limit of application.
 4. Where Carex and wetland plants are present within limits of new channels or planting mounds, plants shall be excavated, including root system, temporarily heeled in and replanted as specified or at the direction of the owner.
 5. Temporary Access Road shall have a minimum top width of 10 ft, minimum elevation of 23 ft and shall be constructed of min 2 ft depth Imported Borrow consisting of sand and gravel underlain by geotextile. Stream flow shall be conveyed with a minimum 18 inch CMP or HDPE pipe.
 6. After completion of culvert installation, Temporary Roadway Borrow material shall be incorporated into Planting Mounds.

AS-BUILT
Date: Nov 7, 2014

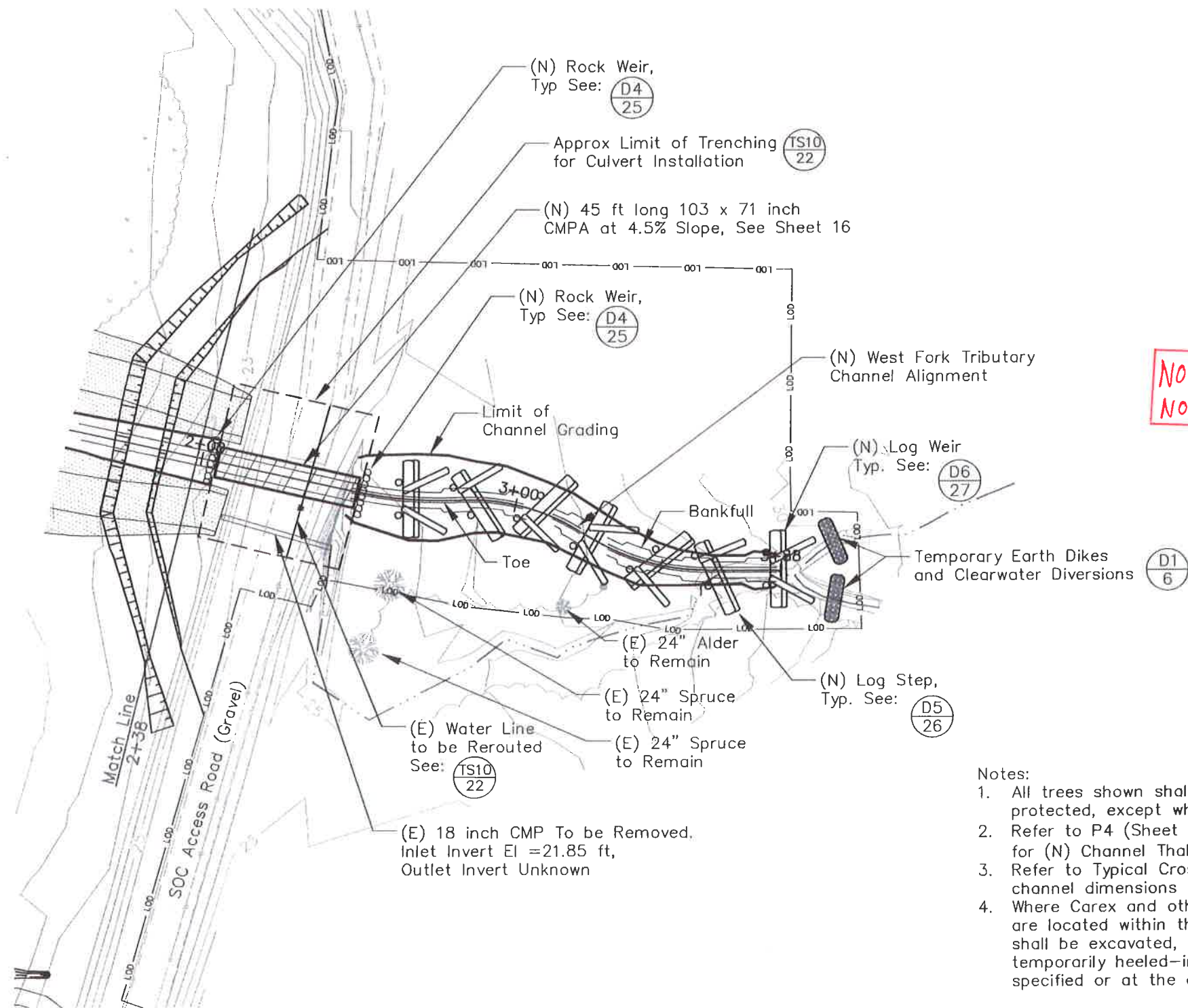
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4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

LAYOUT SHEET 1

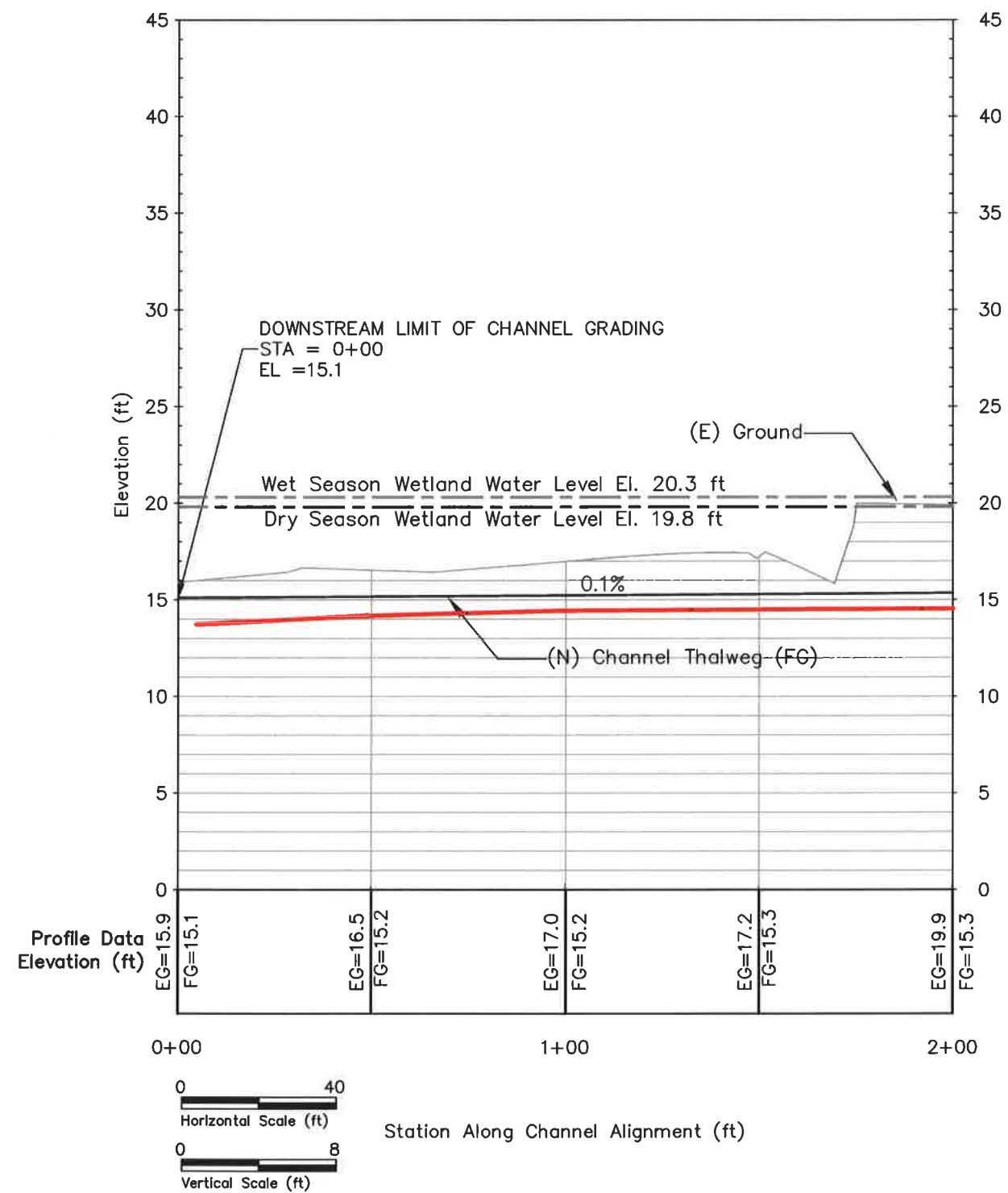
DATE	March 2012
SUBMITTAL	FINAL
DESIGN	ML / RS / AL
DRAWN	Llanos
SHEET	



NOT CONSTRUCTED
NOV 7, 2014

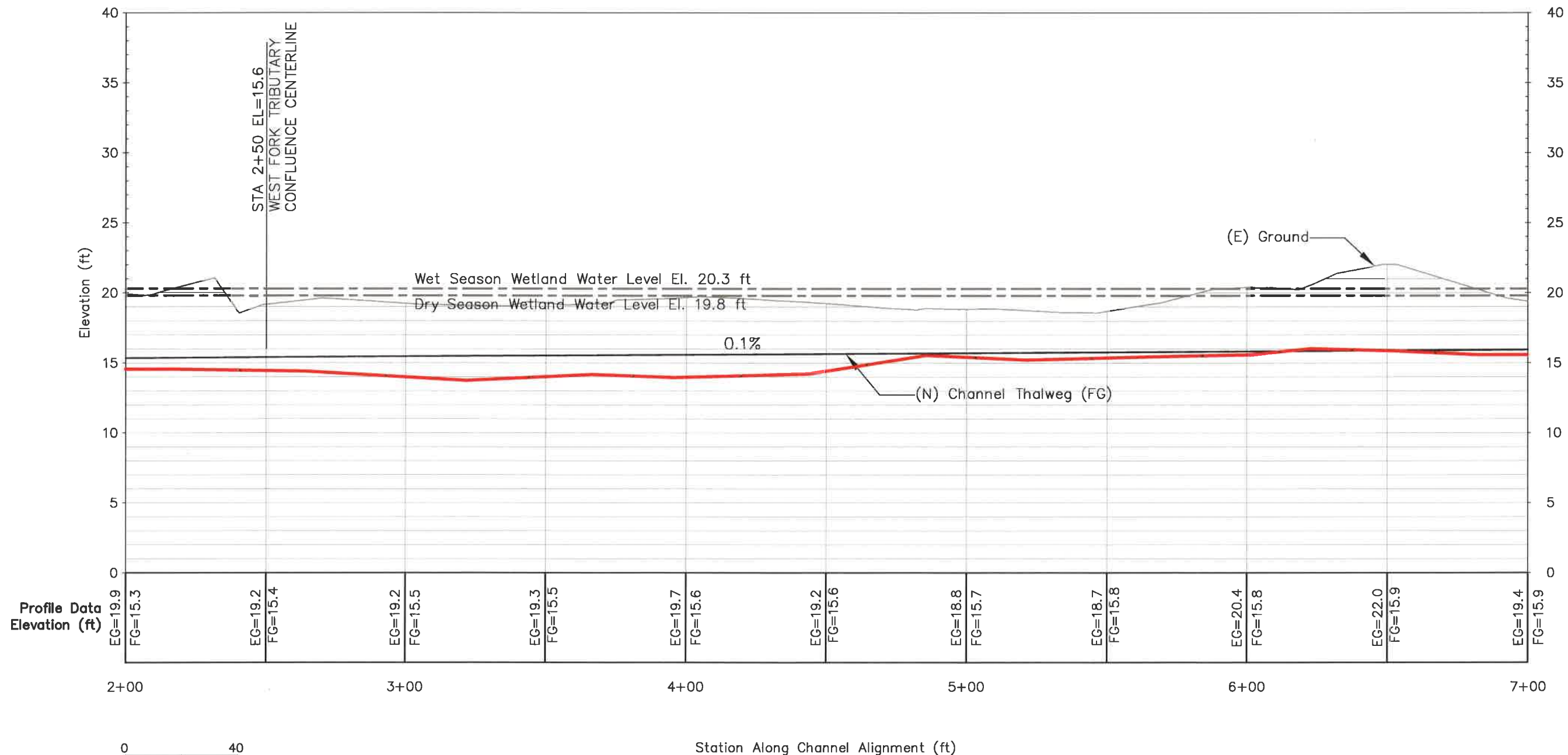
- Notes:
1. All trees shown shall remain and be protected, except where indicated.
 2. Refer to P4 (Sheet 13) and P5 (Sheet 22) for (N) Channel Thalweg along alignment.
 3. Refer to Typical Cross Sections Sheet 19 for channel dimensions and limit of application.
 4. Where Carex and other native wetland plants are located within the limit of grading, plants shall be excavated, including root system, temporarily heeled-in and replanted as specified or at the direction of the Owner.





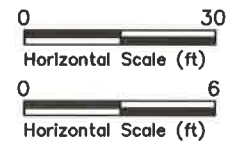
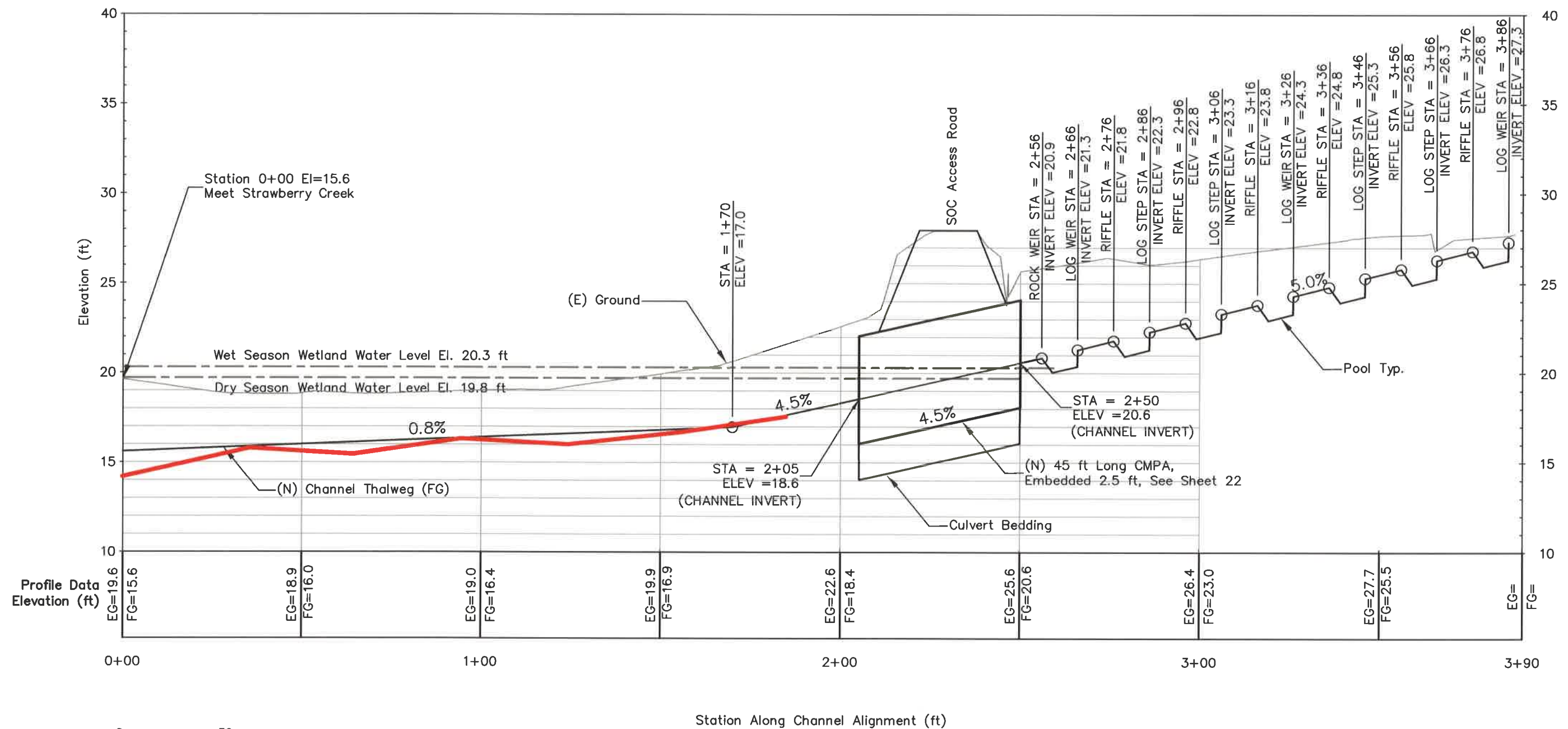
STRAWBERRY CREEK
Profile

AS-BUILT
Date: Nov 7, 2014



P2
7.8 **STRAWBERRY CREEK**
Profile

AS-BUILT
Date: Nov 7, 2014



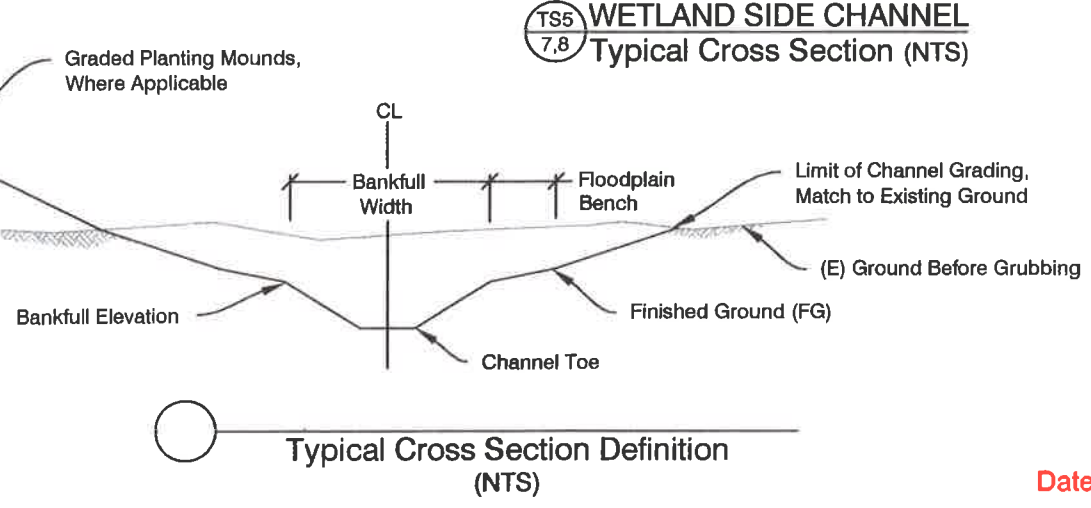
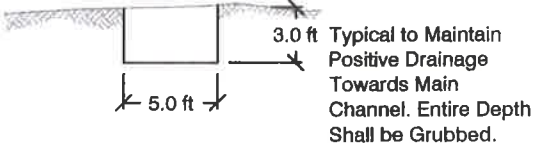
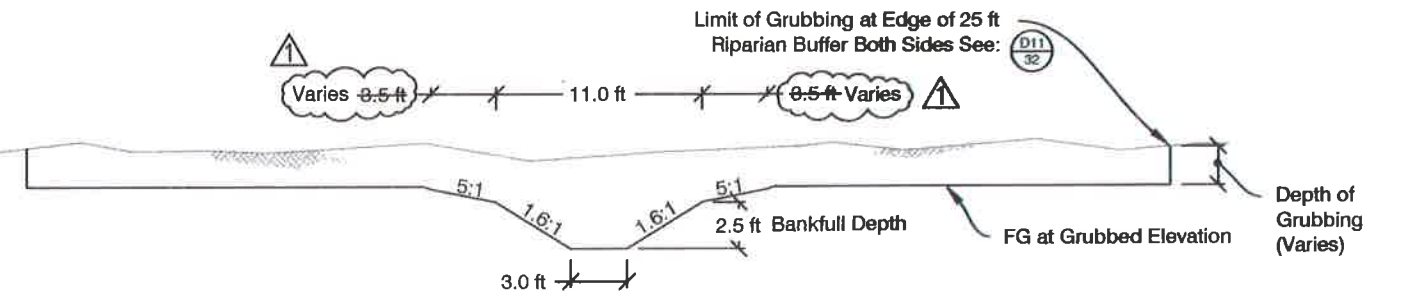
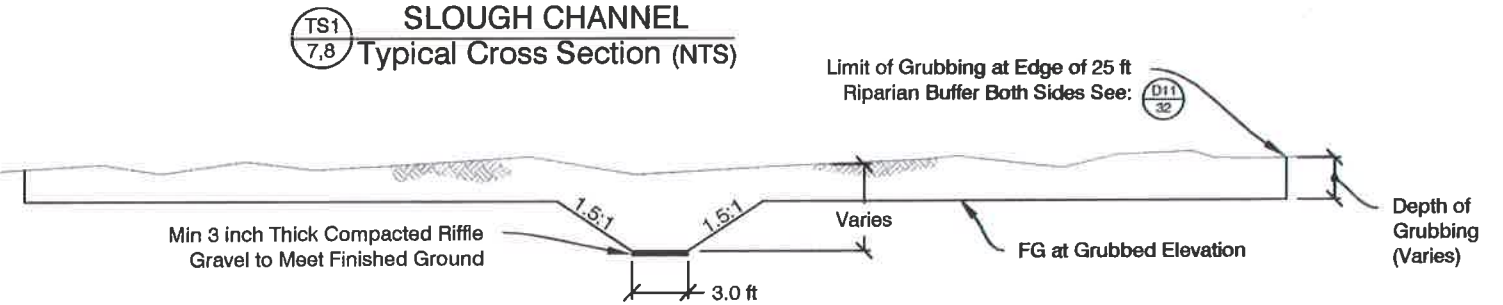
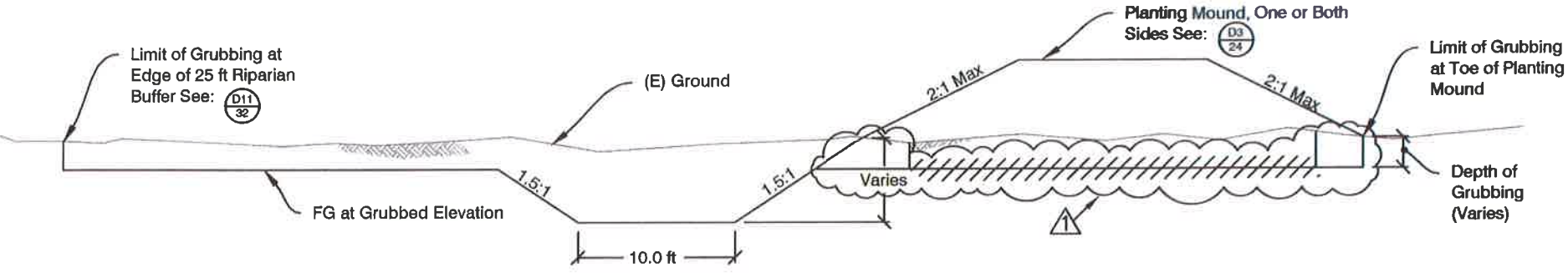
P4
7,9,26,27
WEST FORK TRIBUTARY CULVERT
Profile1

AS-BUILT
Date: NOV 7, 2014
UPSTREAM 1+85
NOT CONSTRUCTED

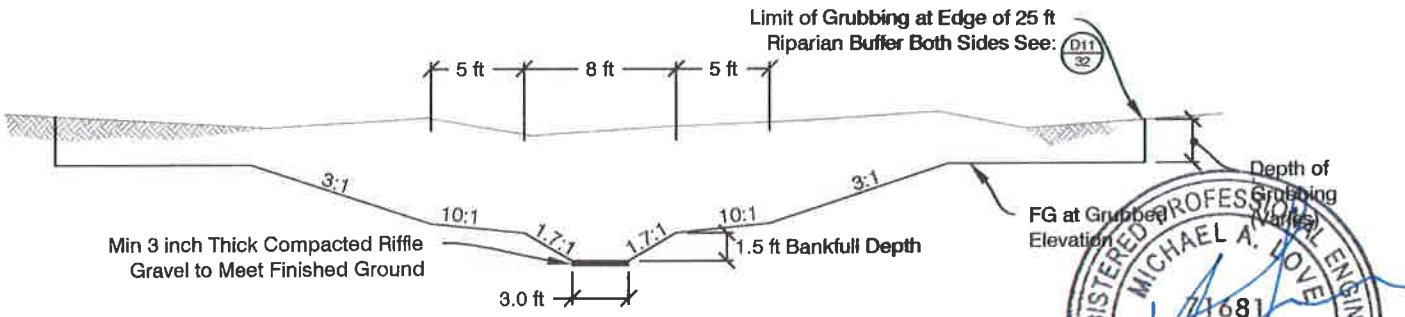
TABLE OF TYPICAL CROSS SECTION APPLICATION
ALONG STRAWBERRY CREEK ALIGNMENT

Station	to	Station	Applied Cross Section
0+00	to	9+85	(TS1) Slough Channel
9+85	to	--	(DS 26) Log Step
9+85	to	10+10	(TS4) Riffle
10+15	to	10+30	(TS3) Pool
10+30	to	--	(DS 26) Log Step
10+30	to	10+55	(TS4) Riffle
10+60	to	10+75	(TS3) Pool
10+75	to	--	(DS 26) Log Step
10+75	to	11+00	(TS4) Riffle
11+05	to	11+20	(TS3) Pool
11+20	to	--	(DS 26) Log Step
11+20	to	11+45	(TS4) Riffle
11+50	to	11+65	(TS3) Pool
11+65	to	--	(DS 26) Log Step
11+65	to	11+96	(TS2) Culvert Outlet Channel

Notes:
1. All cross sections are oriented looking up-station.
2. At stations where Typical Sections are not defined, transition gradually between defined sections upstream and downstream.
3. See Sheets 15 to 18 for detailed Grading Cross Sections.



AS-BUILT
Date: Nov 7, 2014



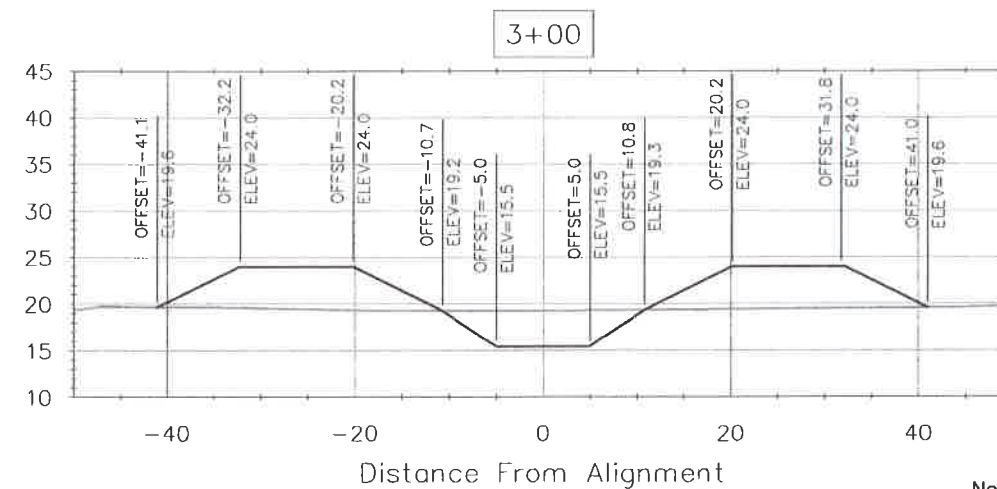
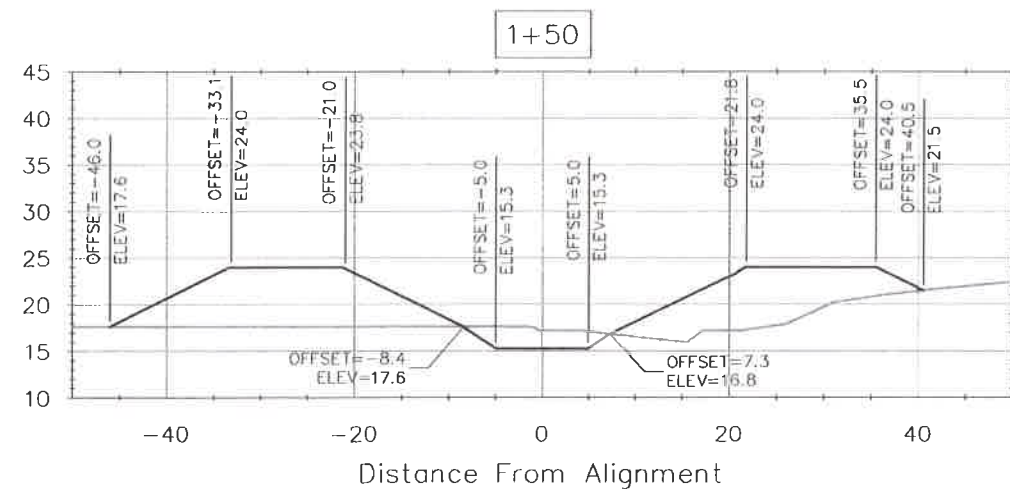
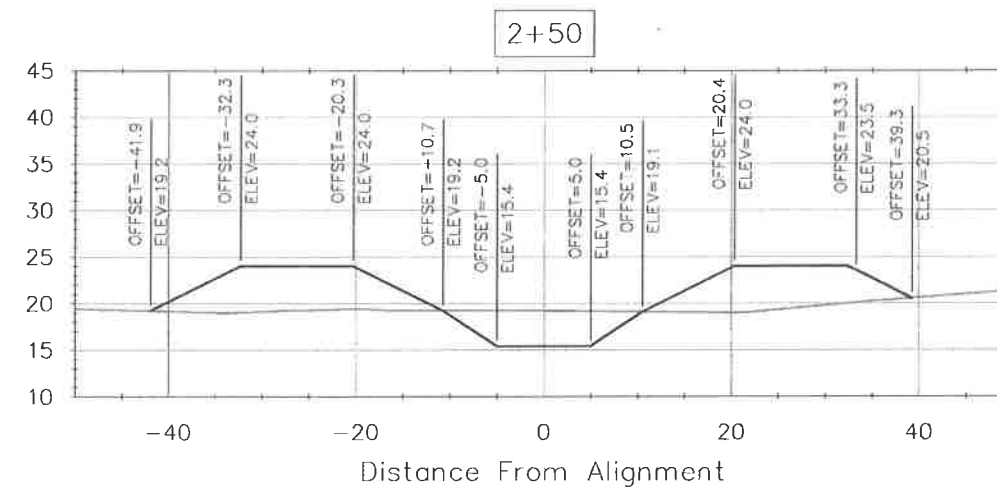
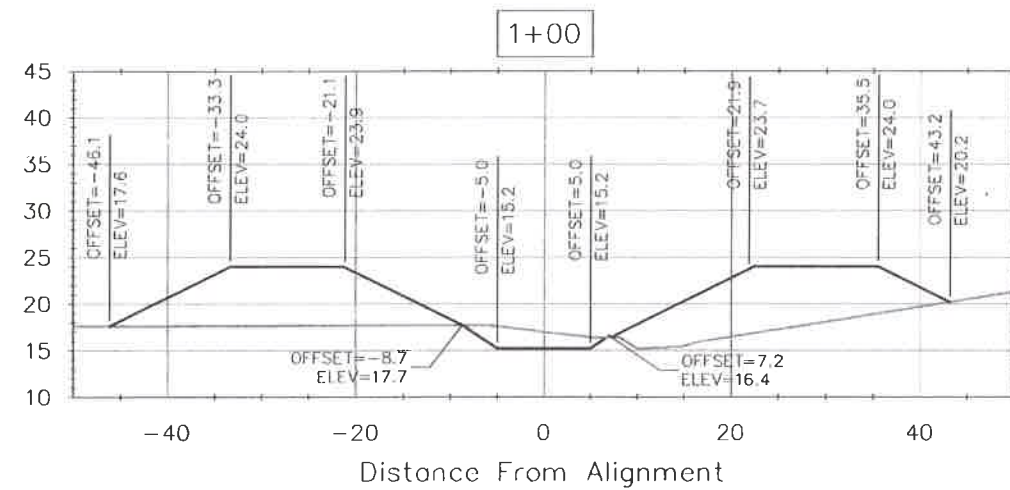
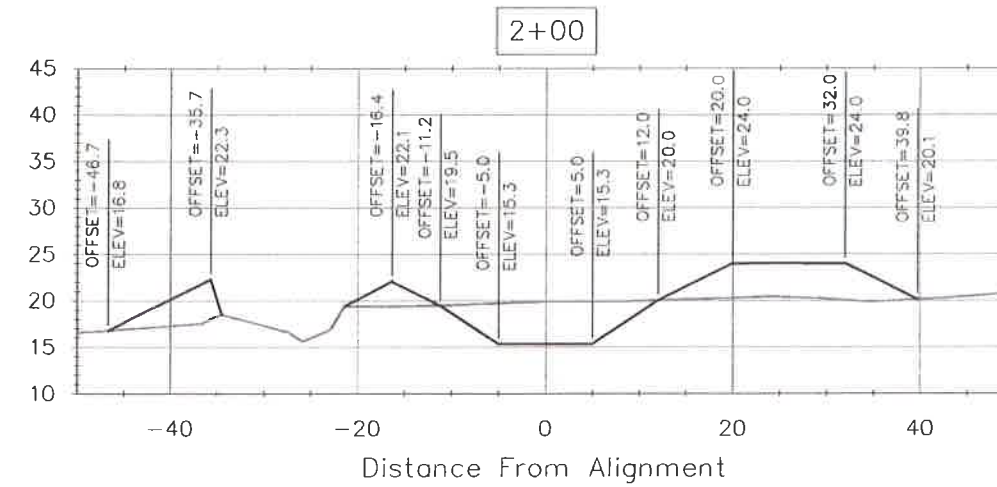
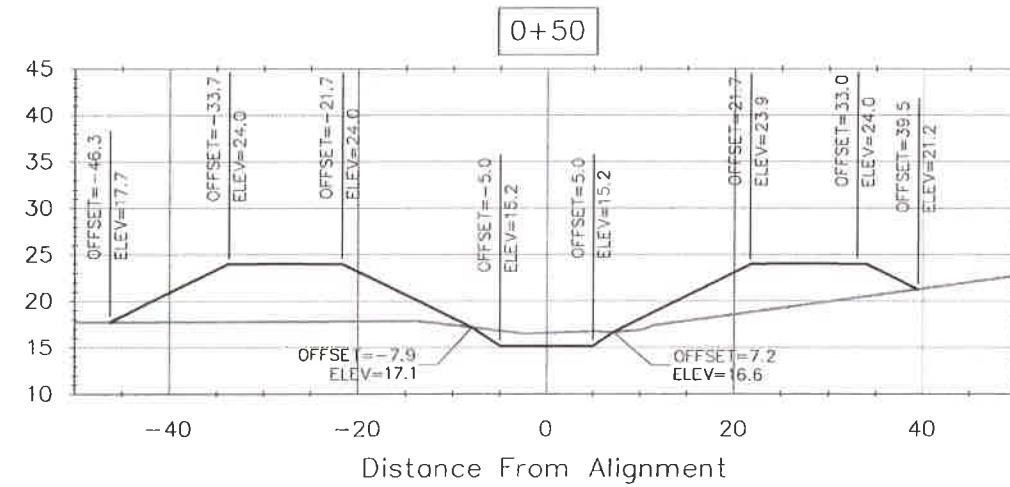
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REVISIONS:
4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

STRAWBERRY CREEK
TYPICAL CROSS SECTIONS

DATE: March 2012
SUBMITTAL: FINAL
DESIGN: ML / RS / AL
DRAWN: Llanos
SHEET:

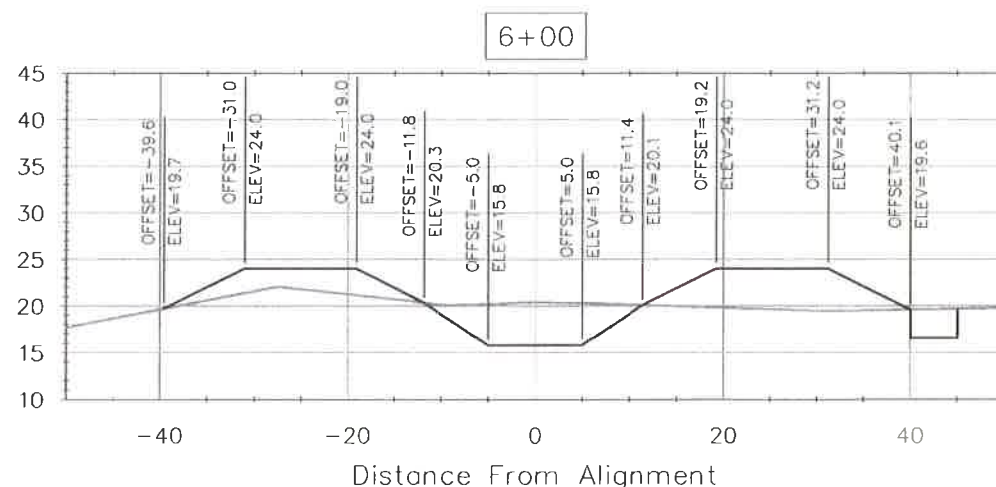
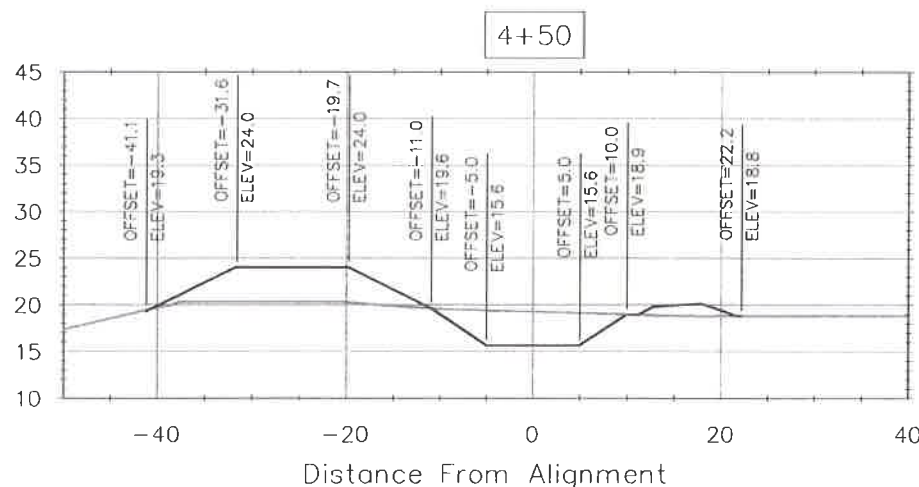
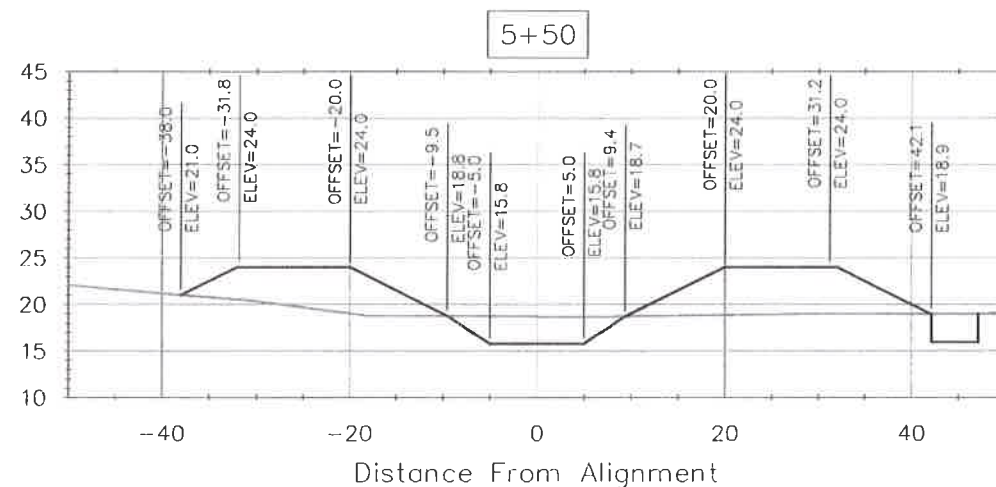
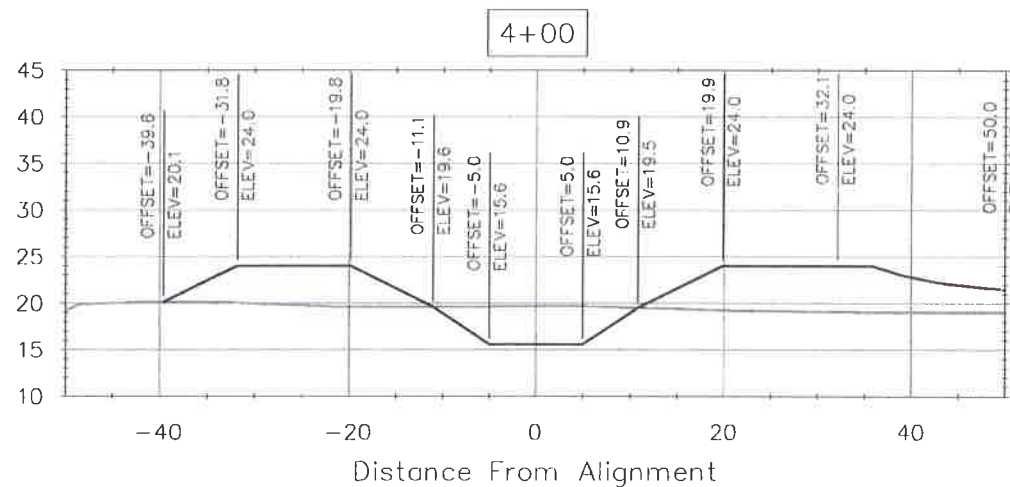
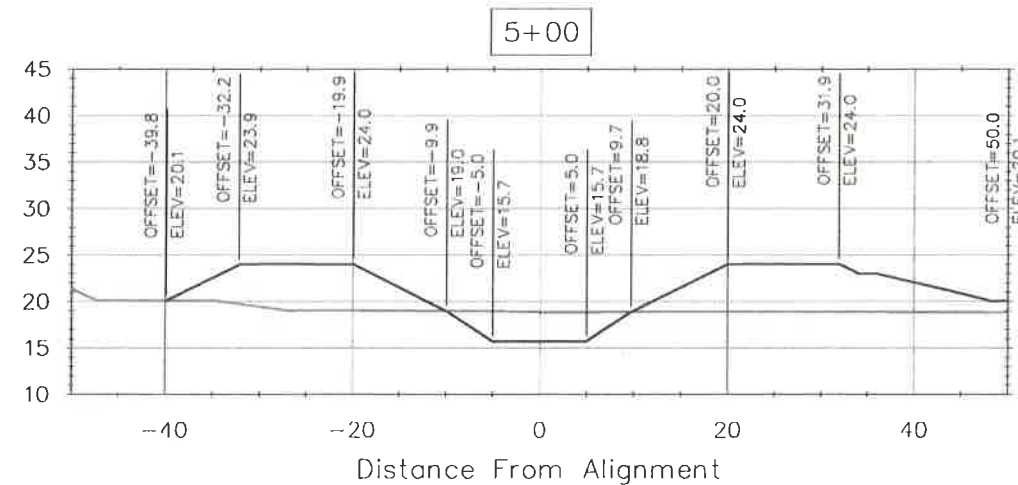
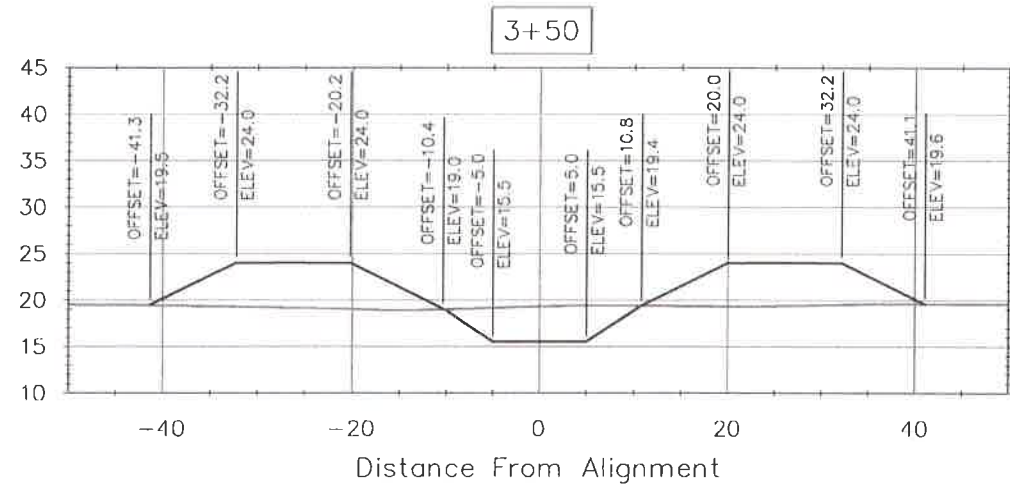


SEE SHEET AB-1
FOR AS-BUILT
CROSS SECTIONS



AS-BUILT
Date: Nov 7, 2014

- Notes:
1. All cross sections are oriented looking up-station.
 2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.

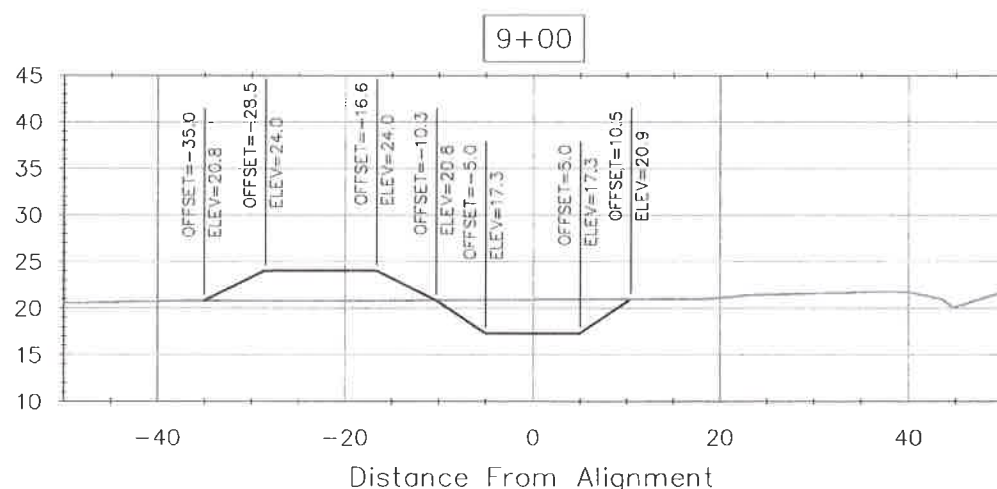
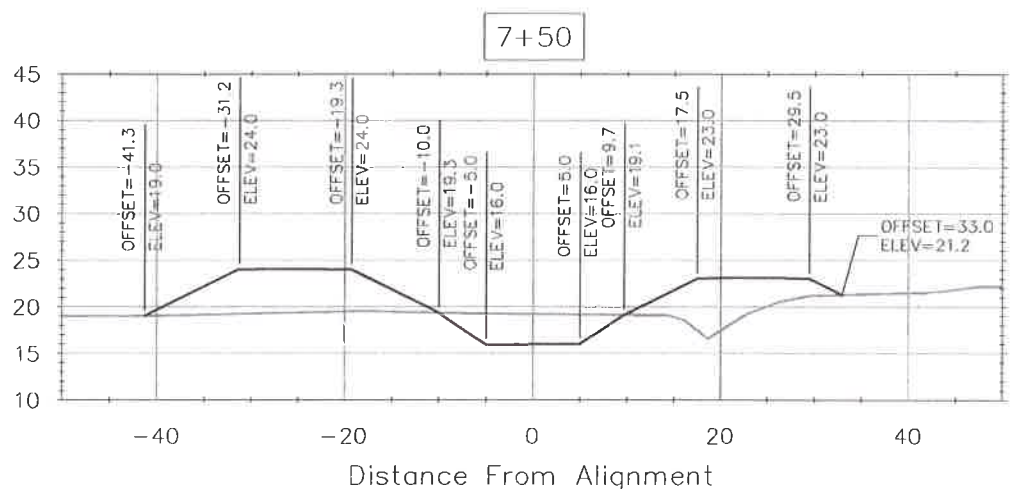
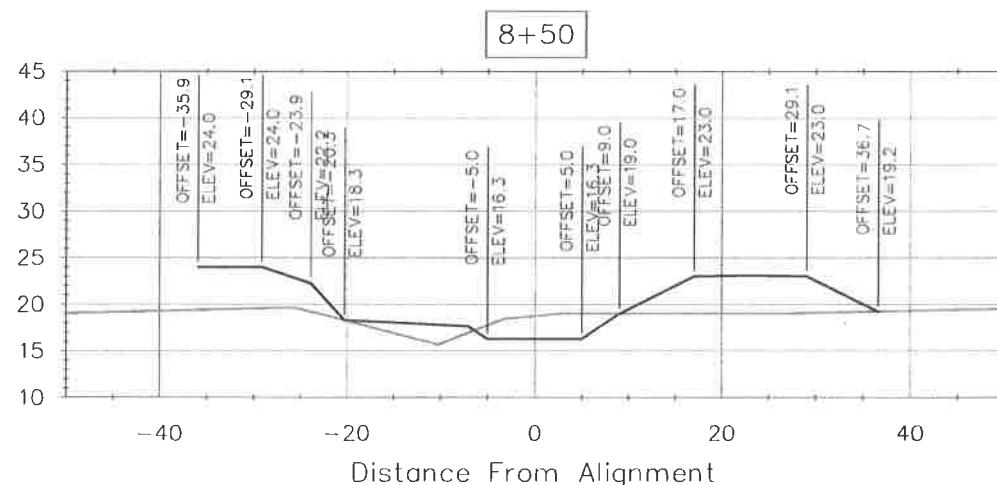
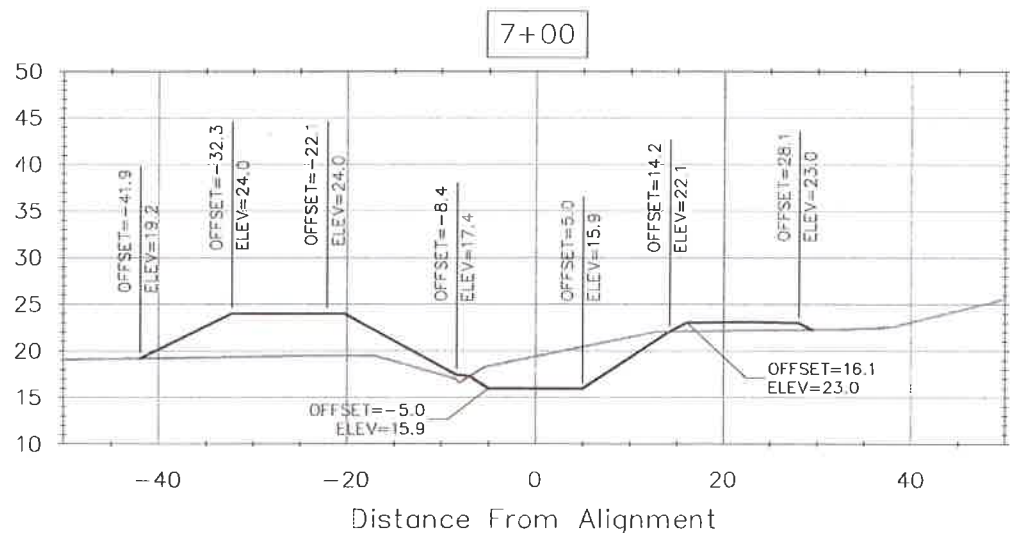
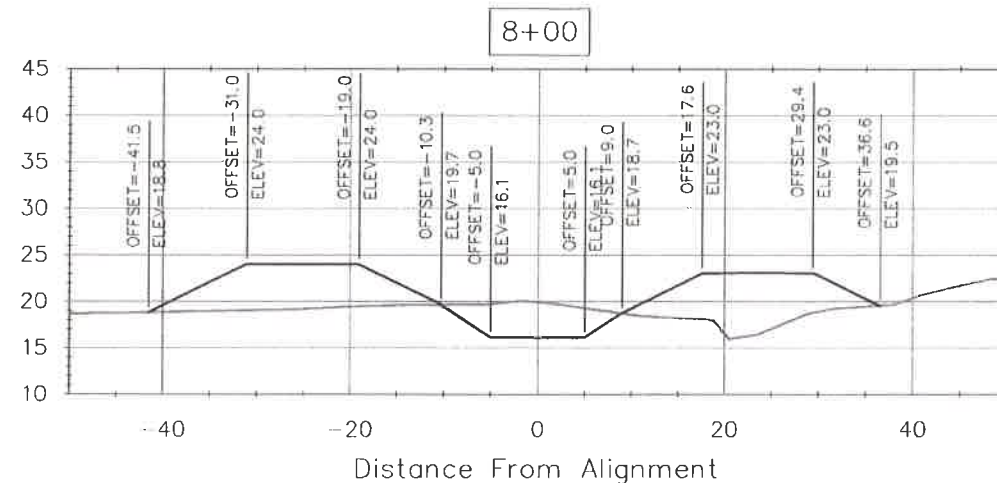
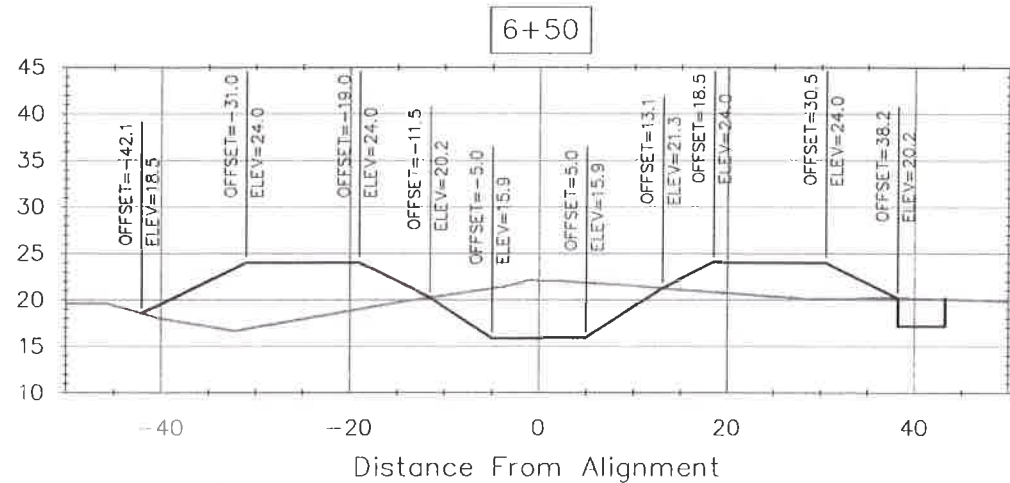


SEE SHEET AB-1
FOR AS-BUILT
CROSS SECTIONS



AS-BUILT
Date: Nov 7, 2014

- Notes:
1. All cross sections are oriented looking up-station.
 2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.

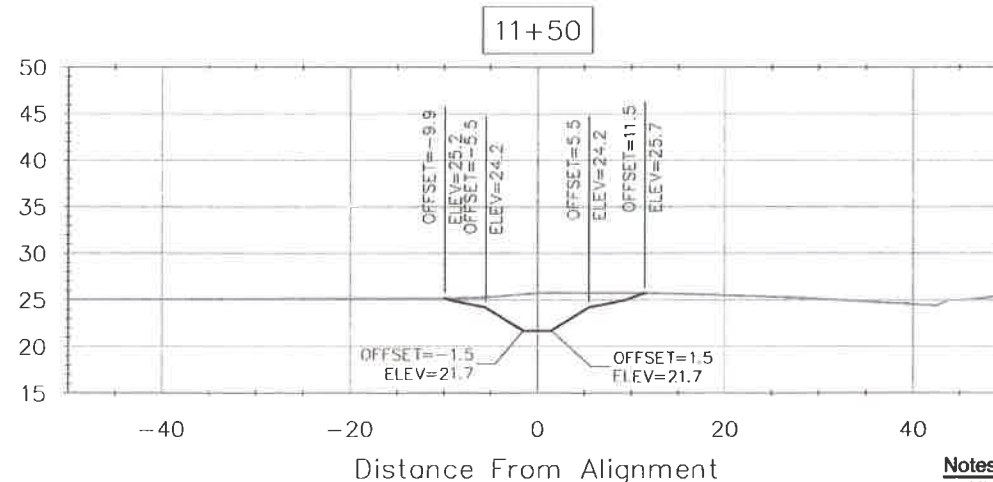
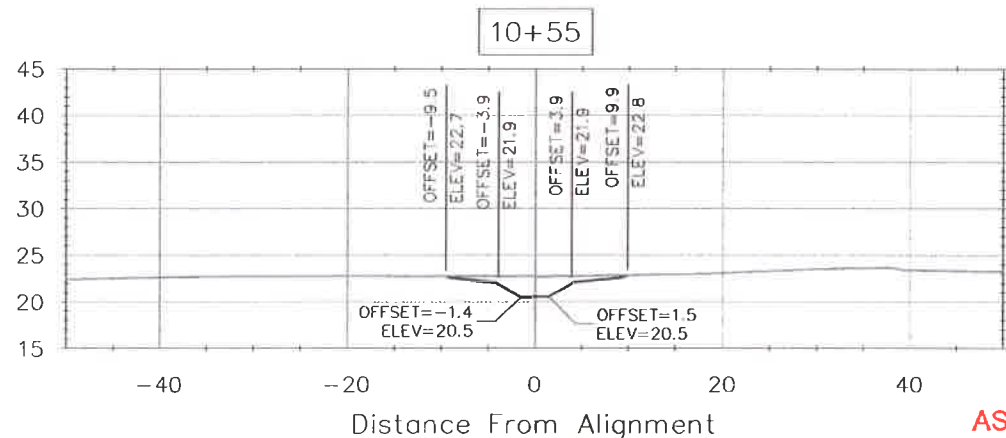
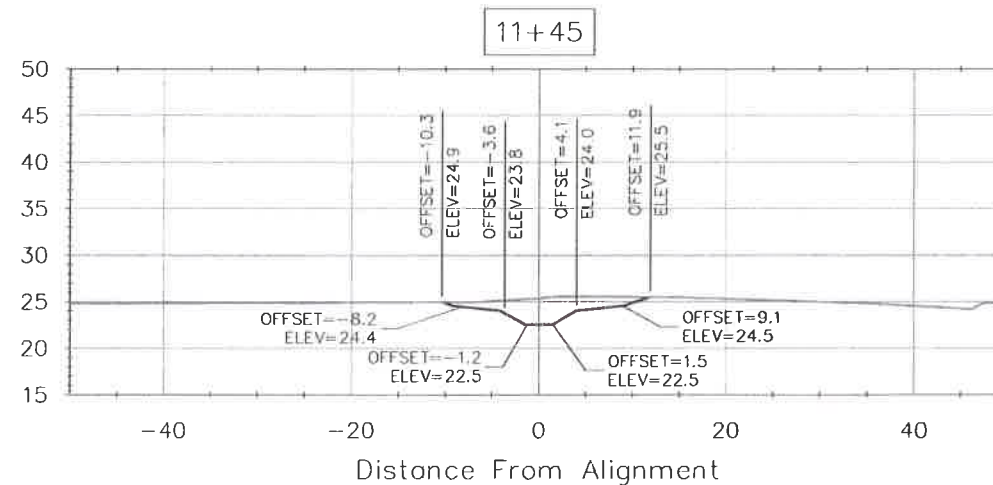
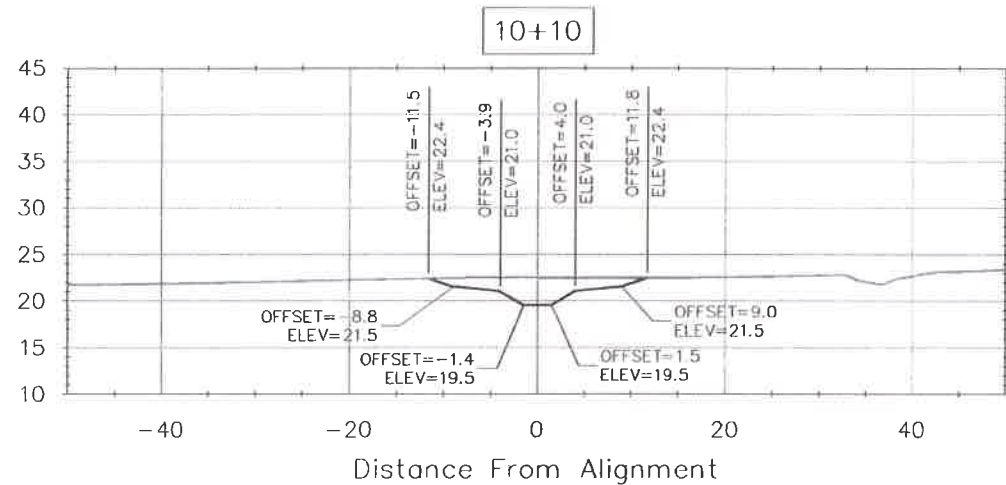
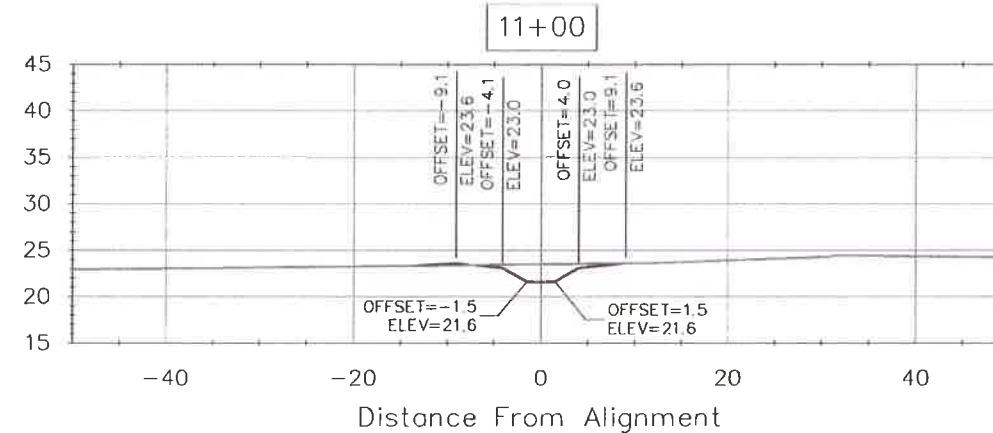
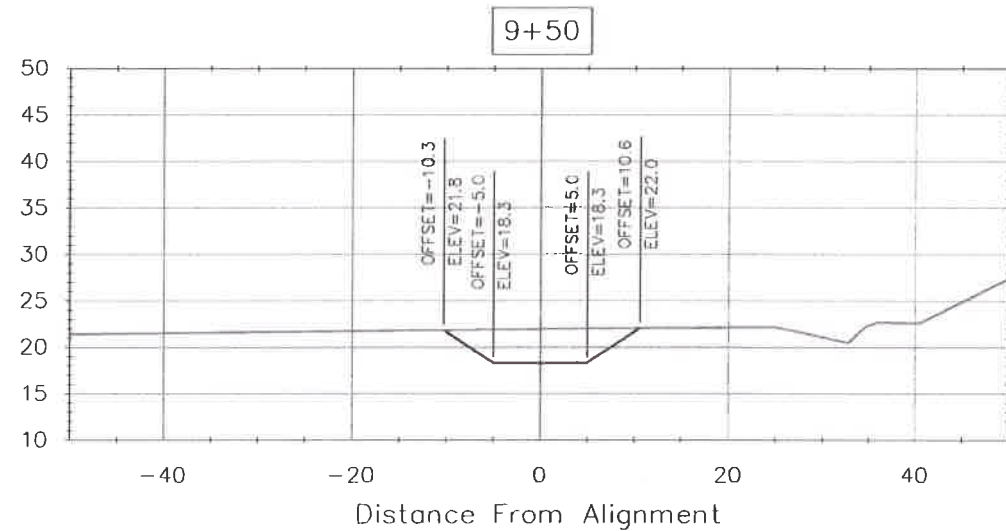


SEE SHEET AB-1
FOR AS-BUILT
CROSS SECTIONS



AS-BUILT
Date: Nov 7, 2014

- Notes:
1. All cross sections are oriented looking up-station.
 2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.
 3. Grubbing within Riparian Buffer not shown.



SEE SHEET AB-1
FOR AS-BUILT
CROSS SECTIONS



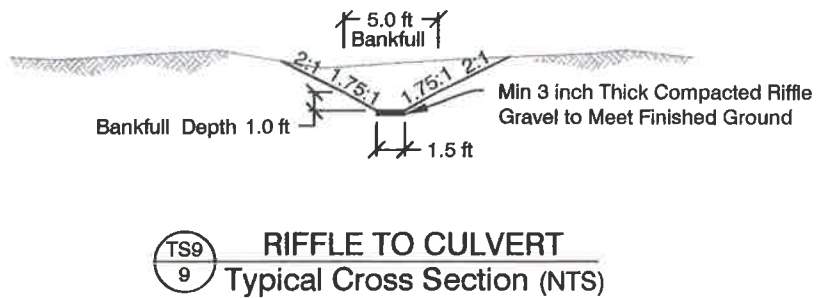
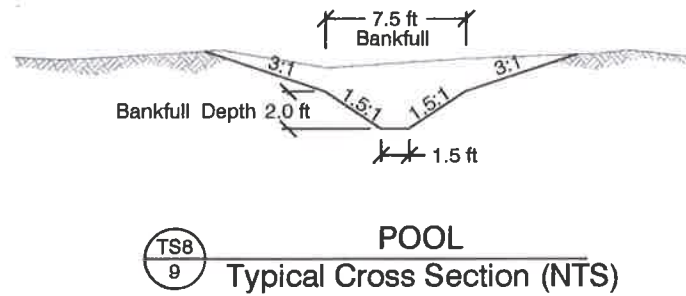
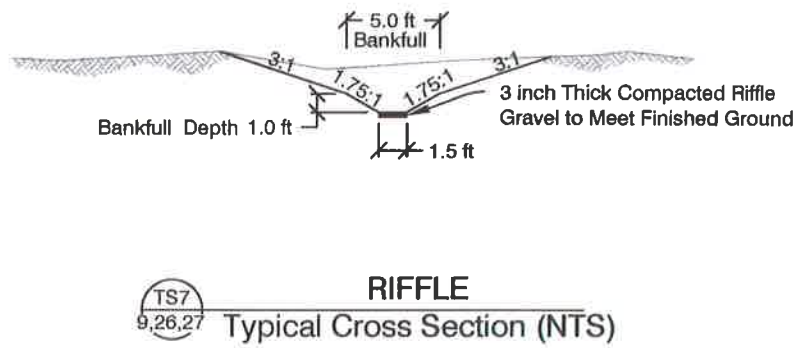
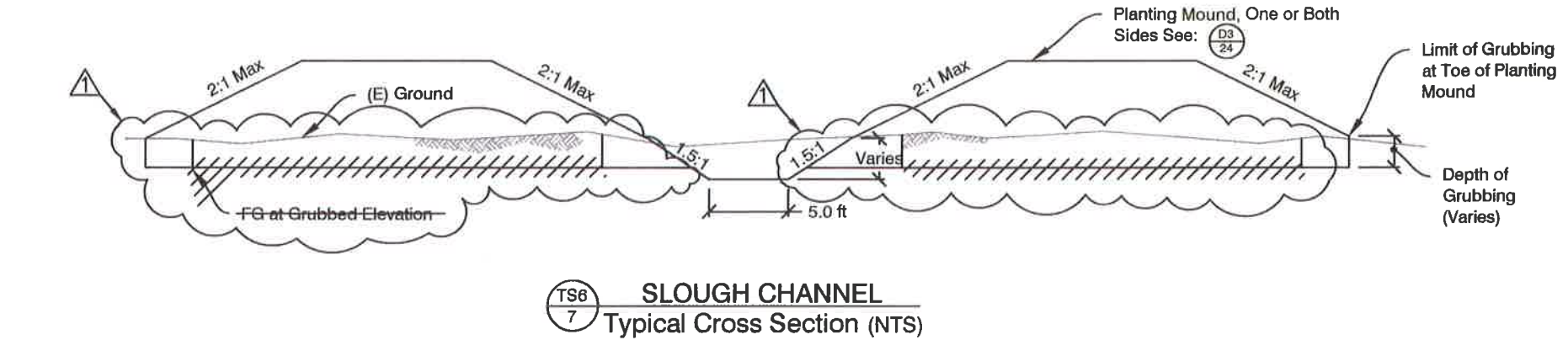
- Notes:
1. All cross sections are oriented looking up-station.
 2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.
 3. Grubbing within Riparian Buffer not shown.

AS-BUILT
Date: Nov 7, 2014

TABLE OF TYPICAL CROSS SECTION APPLICATION
ALONG WEST FORK TRIBUTARY ALIGNMENT

Station	to	Station	Applied Cross Section
0+20	to	2+05	(TS6) Slough Channel
2+05	to	2+48	(TS10/22) New Culvert
2+48	to	2+56	(TS9) Riffle to Culvert
2+56	to	--	(D6/27) Rock Weir
2+59	to	2+66	(TS8) Pool
2+66	to	--	(D6/27) Log Weir
2+66	to	2+76	(TS9) Riffle
2+79	to	2+86	(TS8) Pool
2+86	to	--	(D5/26) Log Step
2+86	to	2+96	(TS9) Riffle
2+99	to	3+06	(TS8) Pool
3+06	to	--	(D5/26) Log Step
3+06	to	3+16	(TS9) Riffle
3+19	to	3+26	(TS8) Pool
3+26	to	--	(D6/27) Log Weir
3+26	to	3+36	(TS9) Riffle
3+39	to	3+46	(TS8) Pool
3+46	to	--	(D5/26) Log Step
3+46	to	3+56	(TS9) Riffle
3+59	to	3+66	(TS8) Pool
3+66	to	--	(D5/26) Log Step
3+66	to	3+76	(TS9) Riffle
3+79	to	3+86	(TS8) Pool
3+86	to	--	(D6/27) Log Weir

- Notes:
1. All cross sections are oriented looking up-station.
 2. At stations where Typical Sections are not defined transition gradually between defined sections upstream and downstream.
 3. See Sheets 20 to 21 for detailed Grading Cross Sections.
 4. Grubbing not required up-stream of the West Tributary Culvert.



NOT CONSTRUCTED
NOV 7, 2014



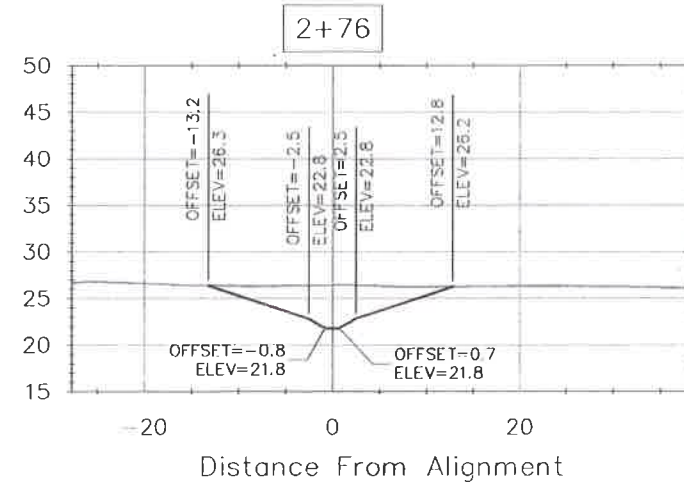
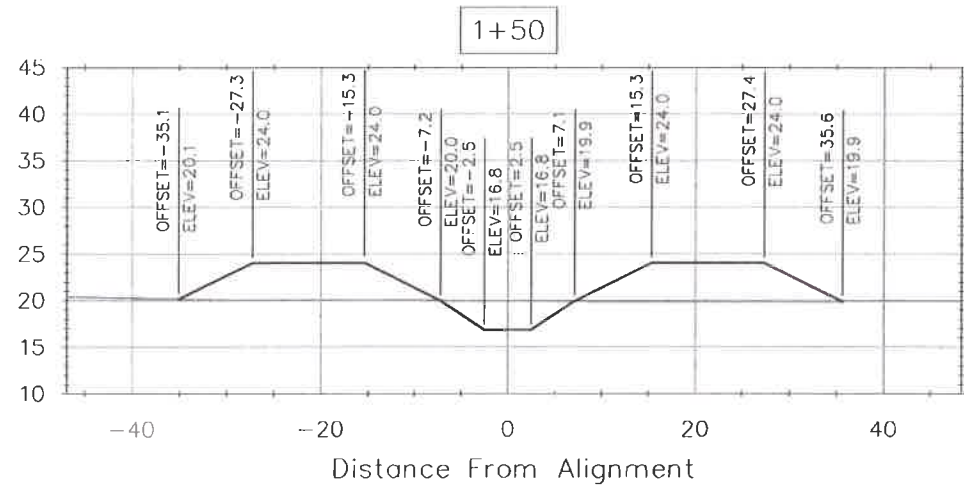
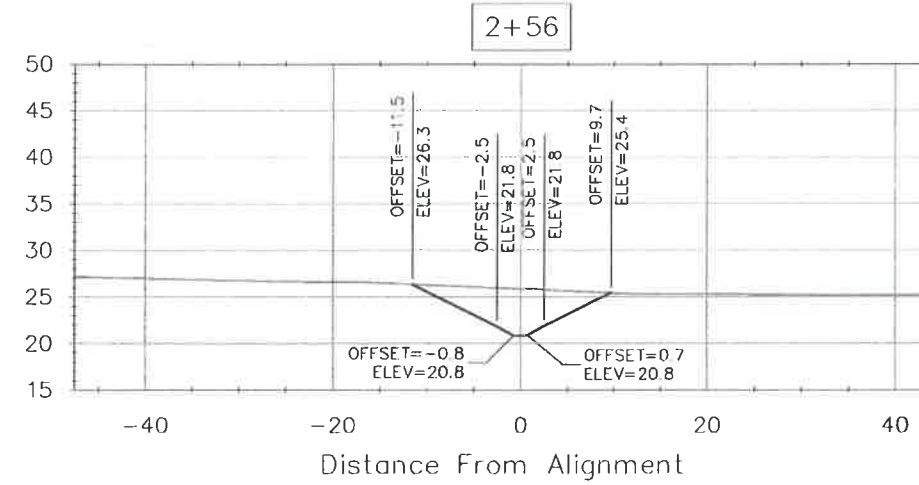
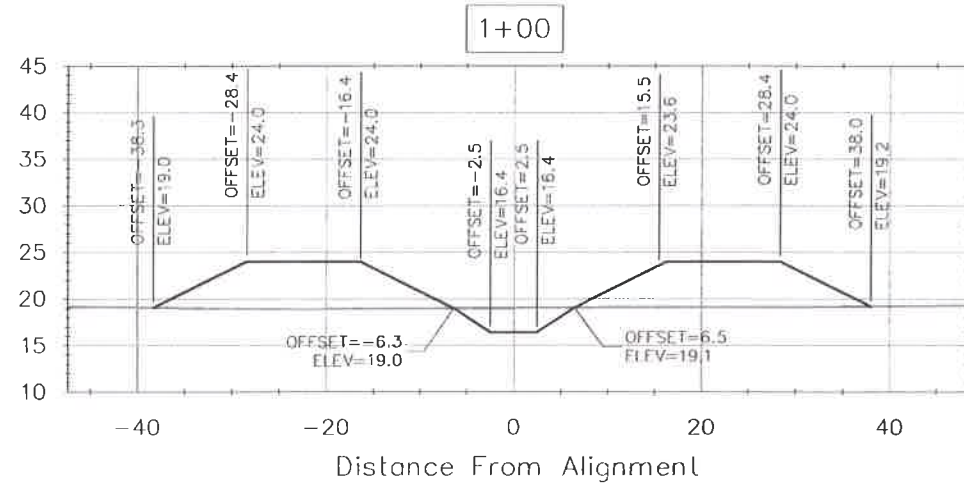
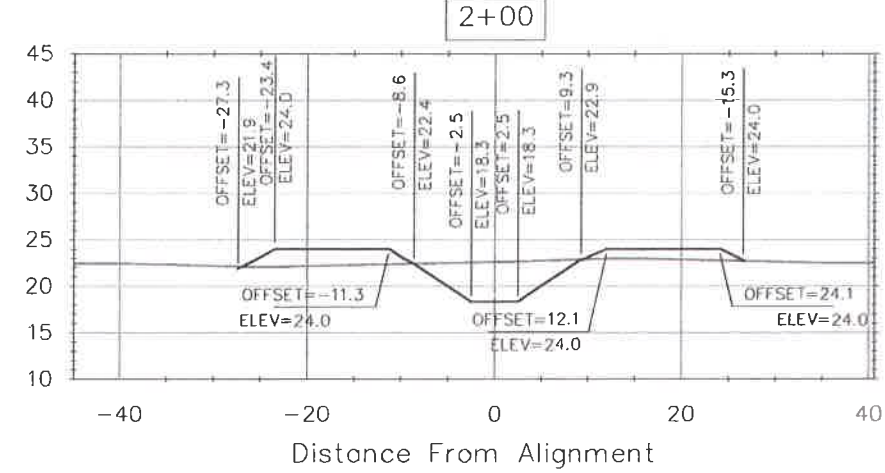
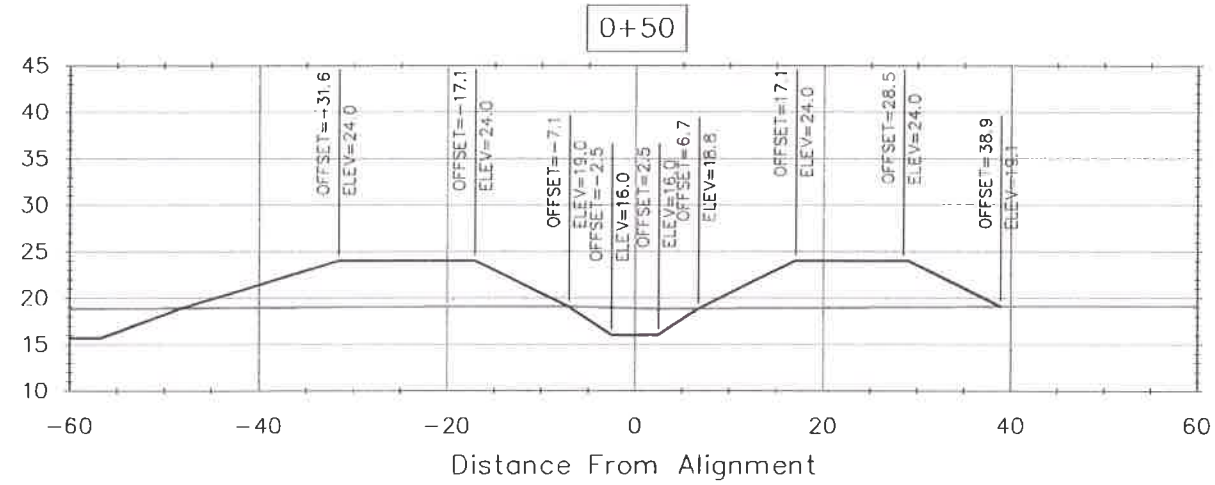
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PROJECT: Pacific Coast Fish, Wildlife and Wetlands Restoration Assoc.

REVISIONS:
4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

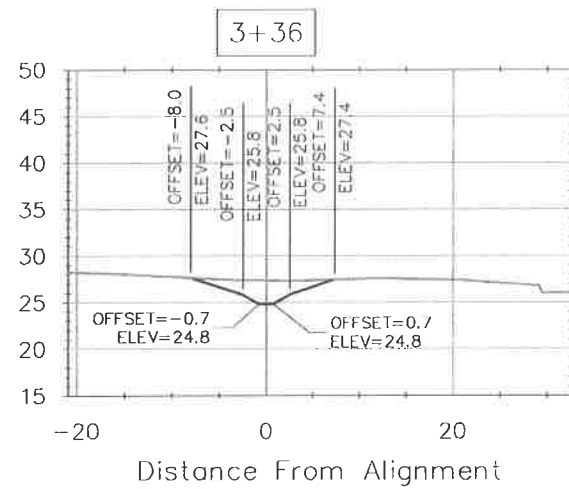
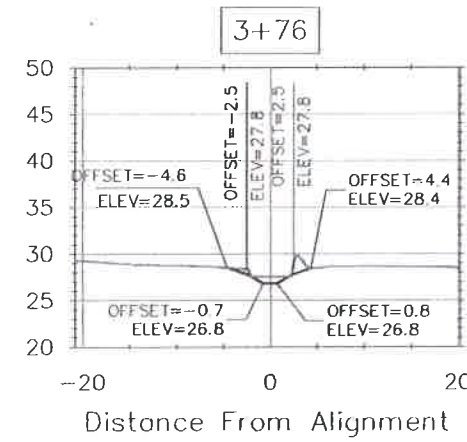
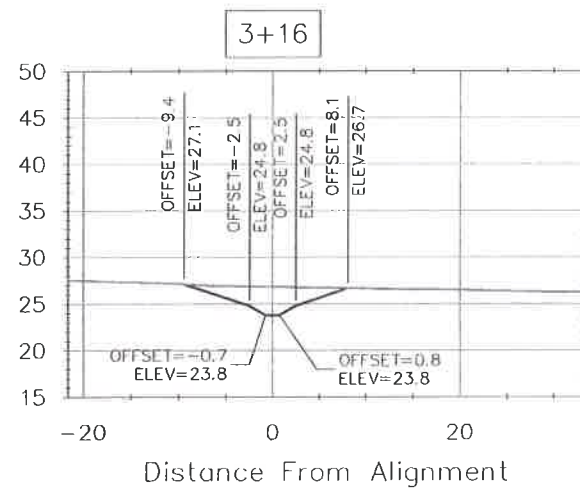
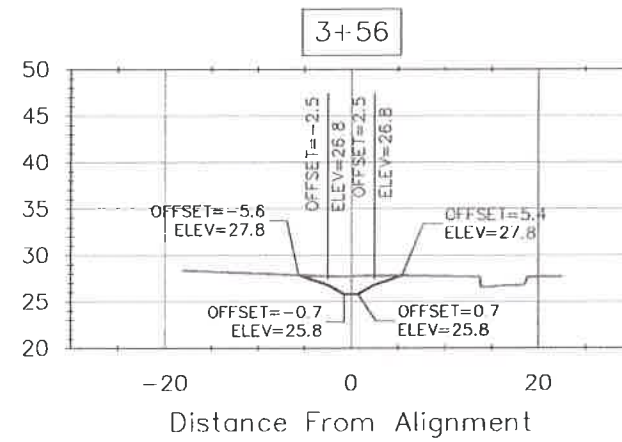
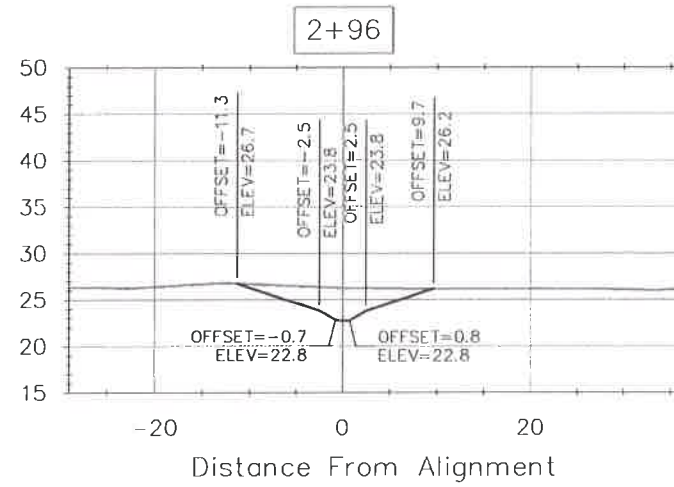
WEST FORK TRIBUTARY
TYPICAL CROSS SECTIONS

DATE: March 2012
SUBMITTAL: FINAL
DESIGN: ML / RS / AL
DRAWN: Llanos
SHEET:



NOT CONSTRUCTED
NOV 7, 2014

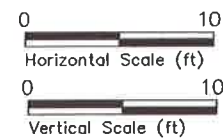
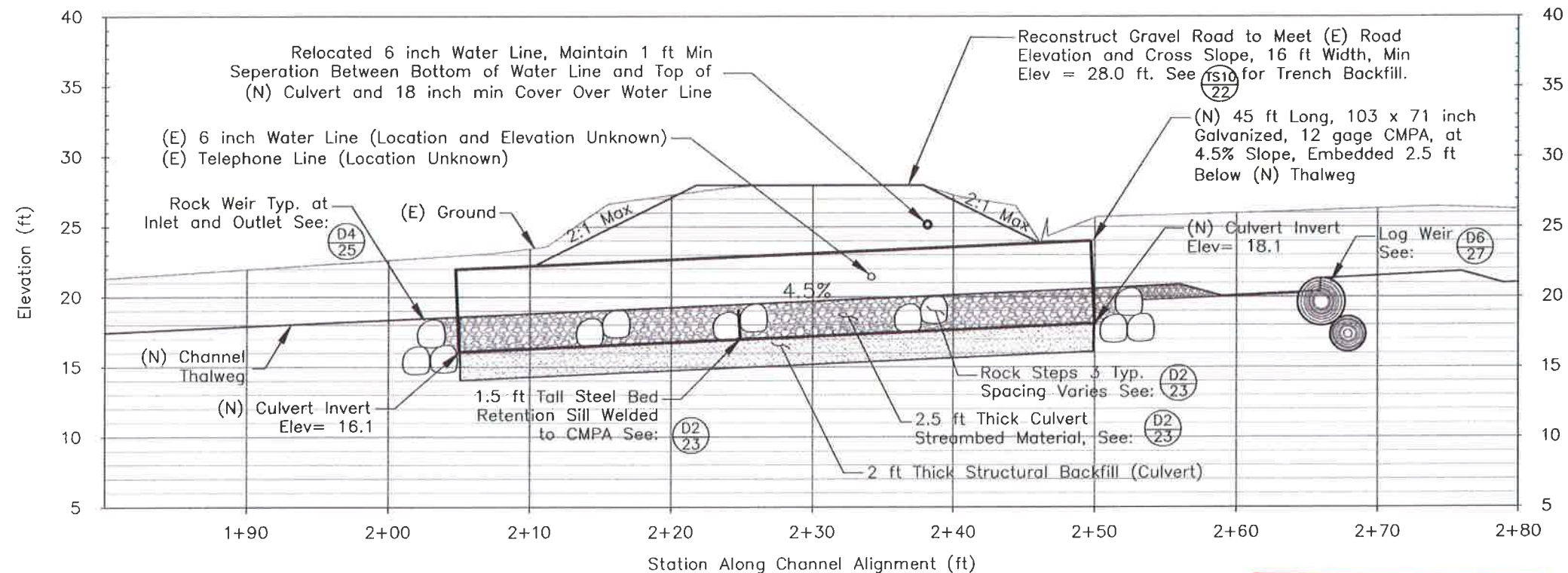




NOT CONSTRUCTED
NOV 7, 2014

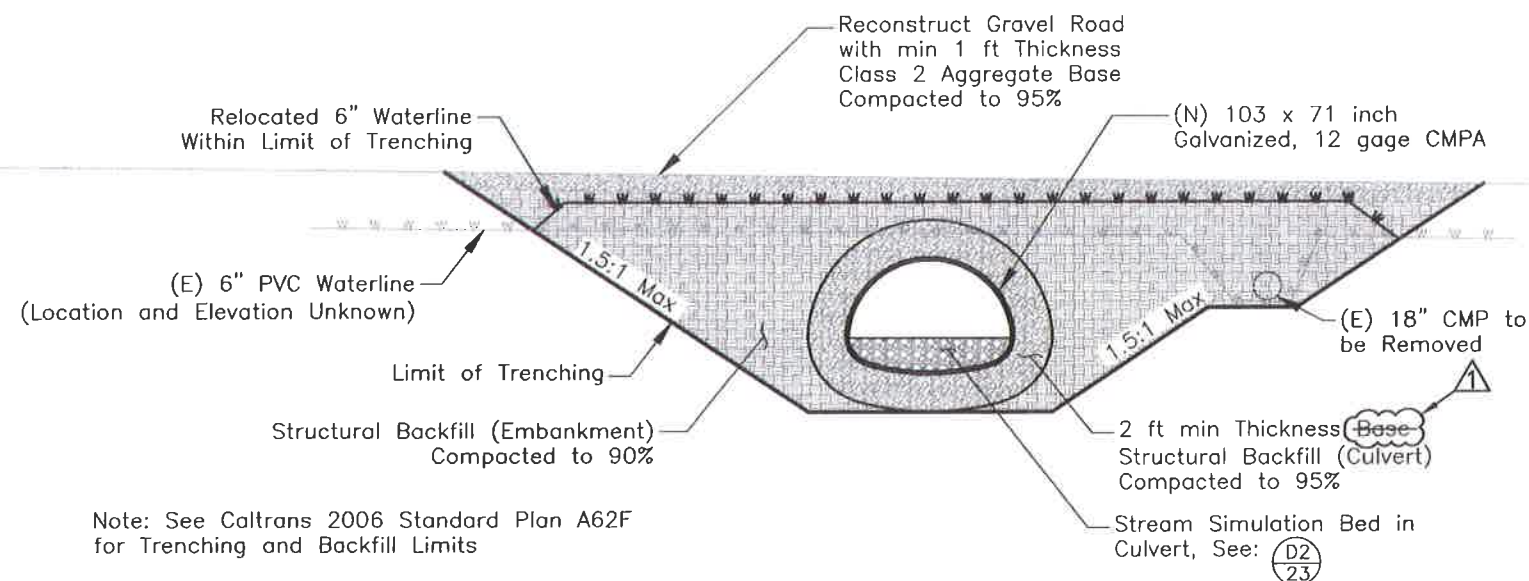


- Notes:
1. All cross sections are oriented looking up-station.
 2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.



WEST FORK TRIBUTARY CULVERT
Detail Profile

NOT CONSTRUCTED
NOV 7, 2014



Note: See Caltrans 2006 Standard Plan A62F for Trenching and Backfill Limits

WEST FORK TRIBUTARY CULVERT
Typical Section (NTS)



West Fork Tributary Culvert Replacement Specifications

Material Specifications

1. Structural Backfill (Culvert) shall conform to Section 19-3.06 of Caltrans, 2006. Shall have no less than 20% sand, and shall conform to the following gradation:

Sieve Size	Percent Passing
3"	100%
No. 4	35-100%
No. 30	20-100%

2. Structural Backfill (Embankment) shall conform to Section 19-3.06 for backfill material to be compacted to a relative compaction of no less than 90%.
3. Suitable salvaged materials for Structural Backfill (Embankment) shall be separated and stockpiled for re-use.

Installation Specifications

1. Installation of the West Fork Tributary Culvert replacement shall be installed as specified in the contract documents and in accordance with Section 19 of Caltrans 2006.
2. During Structural Excavation, suitable materials shall be separated and stockpiled for re-use as structural backfill (Embankment).
3. Structural Backfill (Culvert) shall be compacted to a relative compaction of no less than 95%.
4. Structural Backfill (Embankment) shall be compacted to a relative compaction of no less than 90%.

Temporary and Permanent Re-Routing of Existing Water Line

Material Specifications

1. Materials and work shall conform to ASTM, American Water Works, Chapter 16 Article 4 of the Title 22 of the California Code of Regulations (2010), and other relevant standards. All methods and materials shall be approved by the Orick Community Services district prior to installation.
2. All temporary pipe material shall be Schedule 80 PVC, HDPE, or steel pipe.
3. Bedding and backfill material for pipelines shall consist of Class 3 1/2 inch max Class 2 Aggregate Base as specified in Section 25 of Caltrans, 2006.

Installation Specifications

1. Contractor shall maintain an in-service water supply line to SOC buildings during the project. If continuous water service to the work area will be interrupted during portions of the work, the Contractor shall notify the Owner a minimum of one week in advance of anticipated water shutdowns. The maximum duration for a water shutdown is eight (8) hours.
2. Contractor shall be responsible for verifying pipe sizes, particularly the Outside Diameter (O.D.) of all pipes at connection points, to ensure that commonly available coupling hardware and gaskets will accommodate the existing pipes PRIOR to cutting into any pipe.
3. Water main and service pipe shall be installed in conformance with AWWA C600, and pipe manufacturer's recommendation.
4. All pipe shall be centered in the trench and laid on compacted bedding.
5. Water main and service pipe ends and service hardware shall be thoroughly cleaned before the pipe is joined. Whenever work ceases for any reason, all exposed pipe ends and hardware shall be closed with a watertight fitting, plug, or cover. The interior of the pipe shall be kept free from dirt and debris as the work progresses.
6. Pressure and bacteria testing and disinfection of new water mains and services shall be successfully performed in accordance with AWWA C600 and C651 and accepted by the Owner prior to placing the new pipeline and services into service.
7. Bedding and backfill shall be installed a minimum thickness of 1-foot completely surrounding the pipe and compacted to 95%.

Specification for Culvert Streambed Material

Material Specifications

1. Culvert Streambed Material shall meet the following gradations and shall be approved by Owner prior to Installation:
- a. 2/3 by weight Riffle Gravel, as specified in the Contract Documents
- b. 1/3 by weight 4 to 6 inch diameter angular rock

Installation Specifications

1. Culvert Streambed Material shall be installed as specified on the Contract Documents and where directed by the Owner.
2. Culvert Streambed Material shall be uniformly mixed and installed such that it does not segregate during installation.
3. Fill voids with smaller material and compact using construction equipment and flooding to obtain a compact, low-permeability mass.
4. After installation, material shall be flooded and further compacted. Continue flooding and compacting until voids are filled and water remains flowing on the surface across the entire length of the installed material.
5. No water used during the flooding process shall be allowed to discharge into the live stream, but may be reused.
6. Fine material washed downstream resulting from flooding shall be fully removed prior to releasing streamflow into project area.

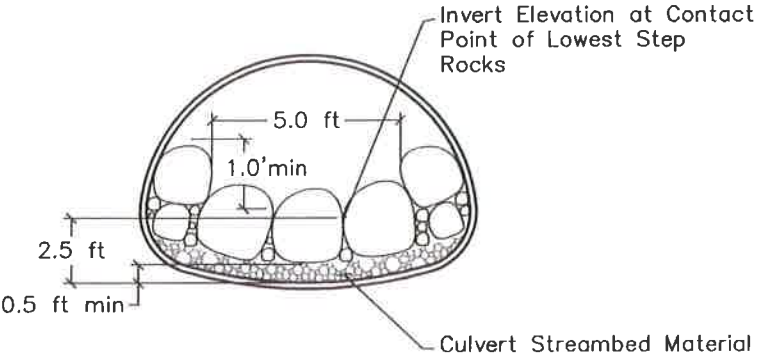
Specification for Rock Steps in Culvert

Material Specifications

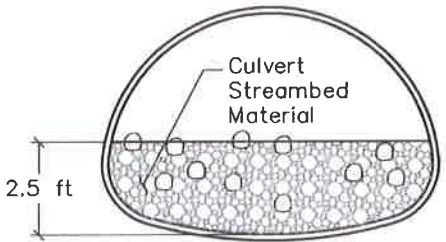
1. Rock Step rock shall meet gradations as follows:
- a. 1/4 Ton RSP
2. All rock diameters (D) are measured along the intermediate axis. The least dimension (minor axis) of an individual rock fragment shall not be less than one-third the greatest dimension of the fragment.

Installation Specifications

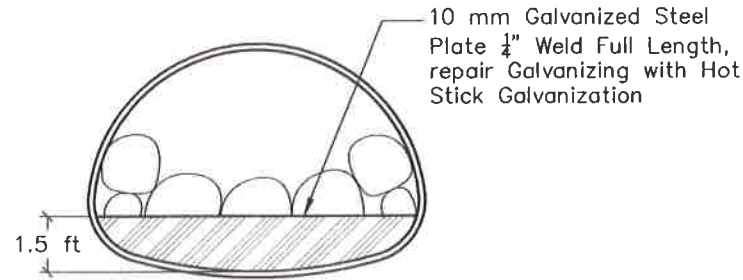
1. Rock Steps shall be installed as specified on the Contract Documents, and where directed by the Owner.
2. Rock shall be placed in accordance with Caltrans, 2006 Section 72 and using "Method A" placement as specified in Caltrans, 2006 Section 72-2.03. No filter cloth shall be installed.
3. All large rock shall be placed individually and secured by machine tamping. Rocks shall have a minimum of four contact points and be securely supported. Rocks shall not be cabled together.
4. Invert elevation of Rock Steps shall be measured at contact point between two lowest step rocks.
5. Crests of rocks shall not protrude more than 0.75 feet beyond finished grade.
6. Footer rocks shall be installed downstream of each Step rock.
7. Where bed retention sill is specified, the footer rock shall be installed downstream of the bed retention sill.



a ROCK STEP



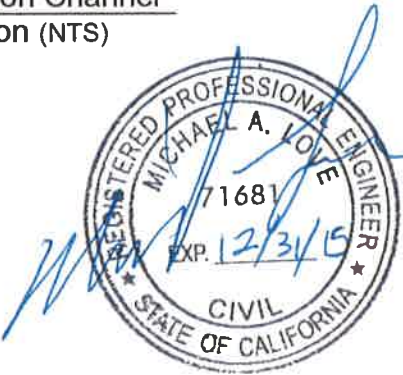
b CULVERT STREAMBED MATERIAL

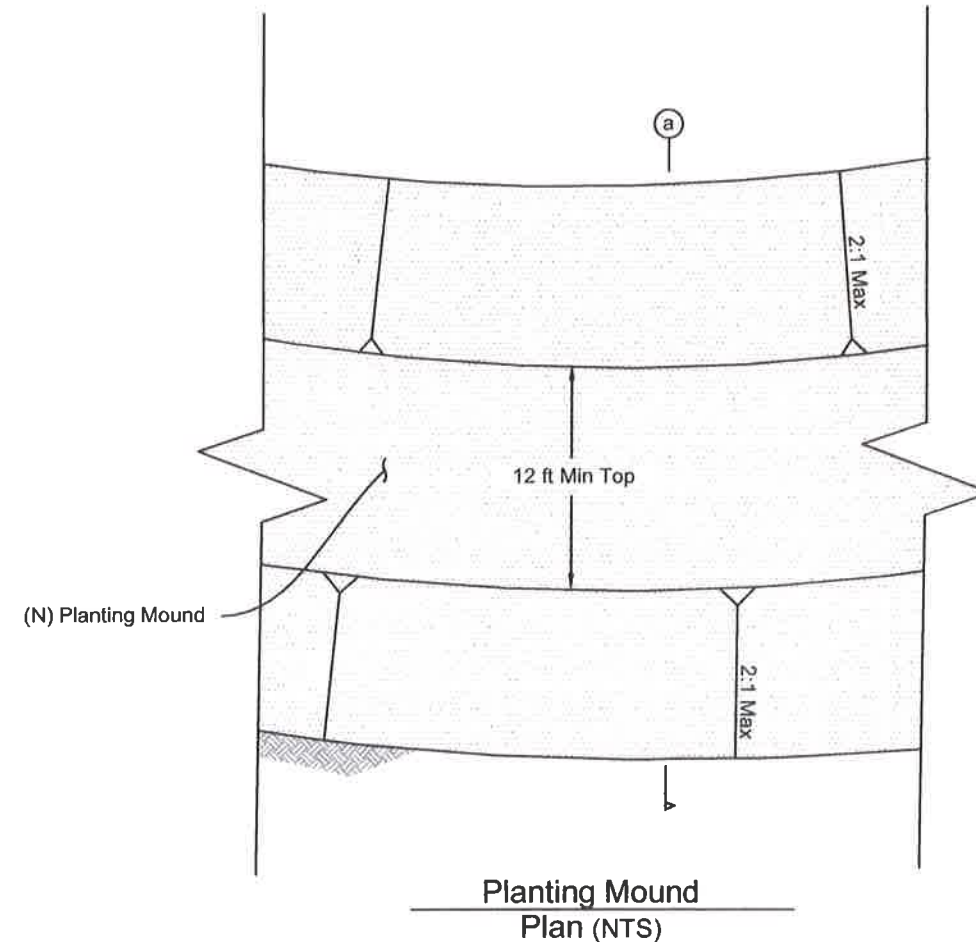


c BED RETENTION SILL

D2
22 Culvert Stream Simulation Channel
Typical Cross Section (NTS)

NOT CONSTRUCTED
NOV 7, 2014





Planting Mound Specification

Material Specifications

- Salvaged Soil shall be soil salvaged from project-related excavation activities. Manmade materials excavated will be considered unsuitable and will become the property of the contractor for offsite disposal. Grubbed Material is considered unsuitable. Other organic material will be considered suitable for use. Excavated material may require dewatering before use.
- Imported Borrow shall conform to Section 19-7 of Caltrans, 2006 and consist of a natural sand or gravel, with no individual fragments larger than 3 inches in diameter, no manmade materials, and a minimum of organic materials. After installation, the material shall remain permeable. Imported Borrow shall be approved by the Owner at the point of origin.

Installation Specifications

- Planting Mounds shall be installed as specified on the Contract Documents, and where directed by the Owner.
- Invasive grasses within the footprint 3 ft of the edge of the Planting Mounds shall be grubbed to fully remove grass roots, as directed by Owner.
- Contractor shall place Imported Borrow within the footprint of Planting Mounds for construction access. Placement of temporary Imported Borrow or salvaged soil outside the limit of the Planting Mounds is acceptable if the material is fully underlain by a material that protects wetland vegetation and if all materials are fully removed at the completion of work.
- Before placement of salvaged soil, the top surface of the Imported Borrow shall be constructed to the elevation specified.
- Place and lightly compact Salvaged Soil to meet finished grade on the Planting Mounds. Reworking of the soil after dewatering may be necessary to meet finished grade. Once soil is placed, area of placement shall not be used for construction equipment access.
- Mound top width and elevation may vary ± 0.5 ft or as directed by Owner.



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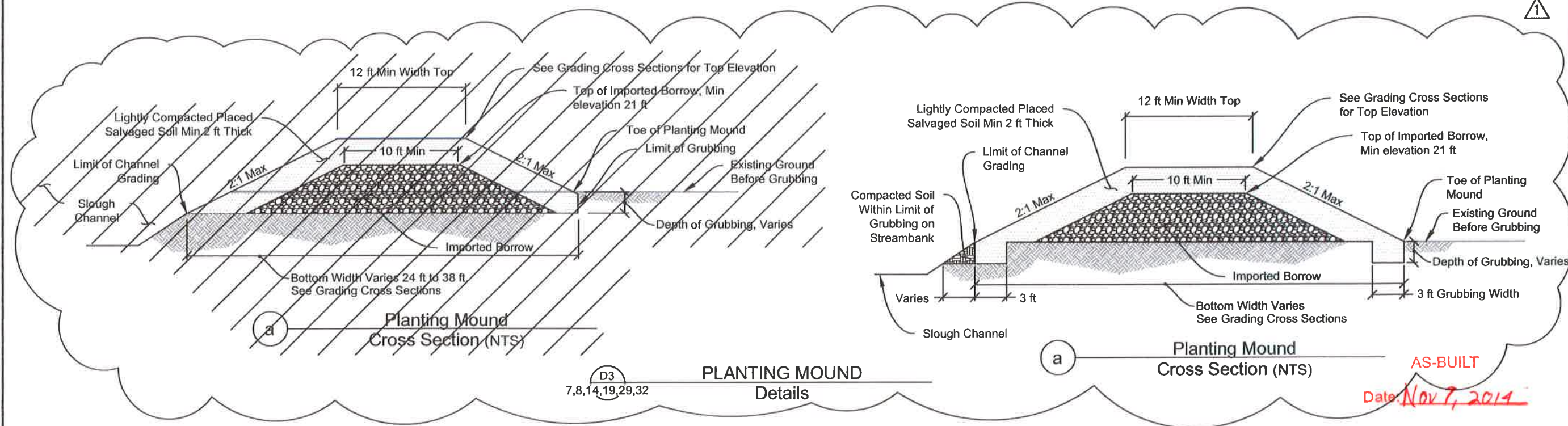
REVISIONS:
 1 4/11/2014

REDWOOD NATIONAL PARK
 Strawberry Creek
 Restoration Project

PLANTING MOUND
 DETAILS

DATE
 March 2012
 SUBMITTAL
 FINAL
 DESIGN
 ML / RS / AL
 DRAWN
 Llanos
 SHEET

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AS-BUILT
 Date: Nov 7, 2014

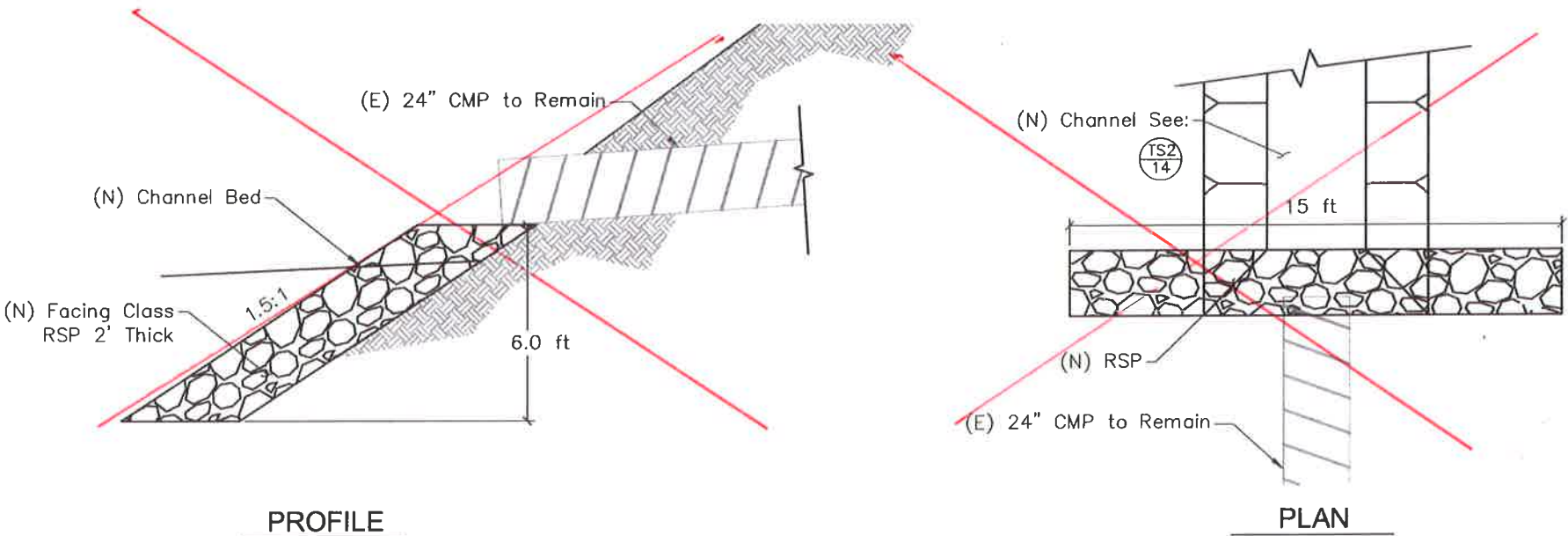
Specification for Rock Slope Protection (RSP)

Material Specifications

1. Rock shall be Caltrans (2006) Facing Class.
2. Rock shall be placed in accordance with Caltrans, 2006 Section 72 and using "Method A" placement as specified in Caltrans, 2006. No RSP Fabric shall be installed.

Installation Specifications

1. RSP shall be installed where specified.
2. Install RSP as specified to the line and grade specified on the construction documents.
3. All large rock shall be placed individually and secured by machine tamping. Rocks shall have a minimum of four contact points and be securely supported.
4. Rocks shall be placed in one-foot lifts and soil placed to fill the voids between rocks. Soil shall be placed to not hinder rock-to-rock contacts.
5. Place smaller rocks and salvaged streambed material to fill voids between larger rocks.



PROFILE

PLAN

Specification for Rock Weirs

Material Specifications

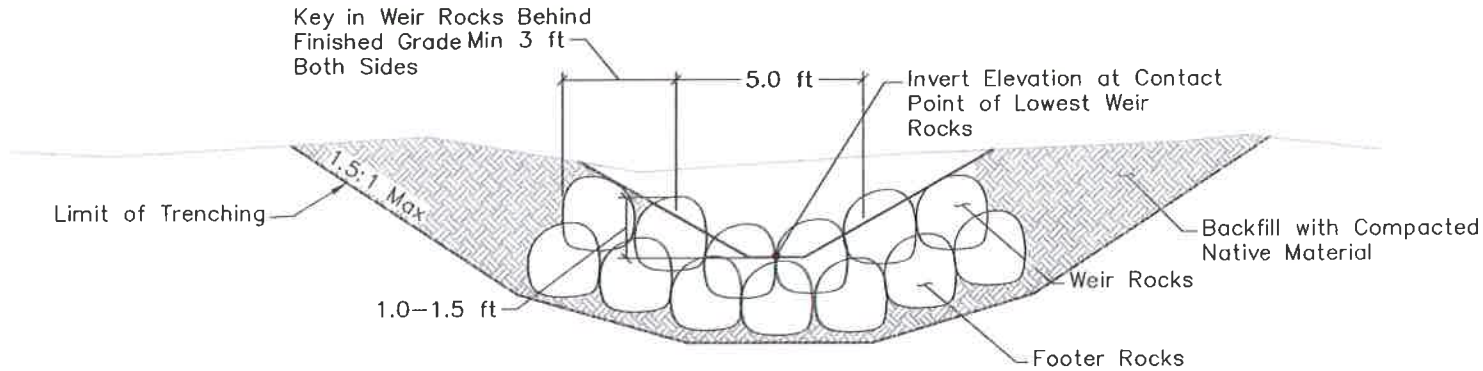
1. Rock Weir rock shall meet gradations as follows:
 - a. 1/4 Ton RSP
 - b. Riffle Gravel Shall be as specified in the Contract documents
2. All rock diameters (D) are measured along the intermediate axis. The least dimension (minor axis) of an individual rock fragment shall not be less than one-third the greatest dimension of the fragment.

Installation Specifications

1. Rock weirs shall be installed as specified on the Contract Documents, and where directed by the Owner.
2. Excavate trench to the specified minimum depth for the entire Rock Weir length.
3. Rock shall be placed in accordance with Caltrans, 2006 Section 72 and using "Method A" placement as specified in Caltrans, 2006 Section 72-2.03. No filter cloth shall be installed.
4. All large rock shall be placed individually and secured by machine tamping. Rocks shall have a minimum of four contact points and be securely supported.
5. Invert elevation of Rock Weirs shall be measured at contact point between two lowest Weir Rocks.
6. Crests of rocks shall not protrude more than 0.75 feet beyond finished grade. Rocks shall not be cabled together.
7. Fill voids with smaller material to obtain a compact, low-permeability mass.
8. Backfill channel bottom with compacted Riffle Gravel.
9. Backfill streambanks with compacted native material.

REPLACED WITH ROCK WEIR
AND 2 LOG V-WEIRS

D10 8 RSP CULVERT OUTLET DETAIL (NTS)



D4 9,22 ROCK WEIR Typical Cross Section (NTS)

AS-BUILT

Date: Nov 7, 2014



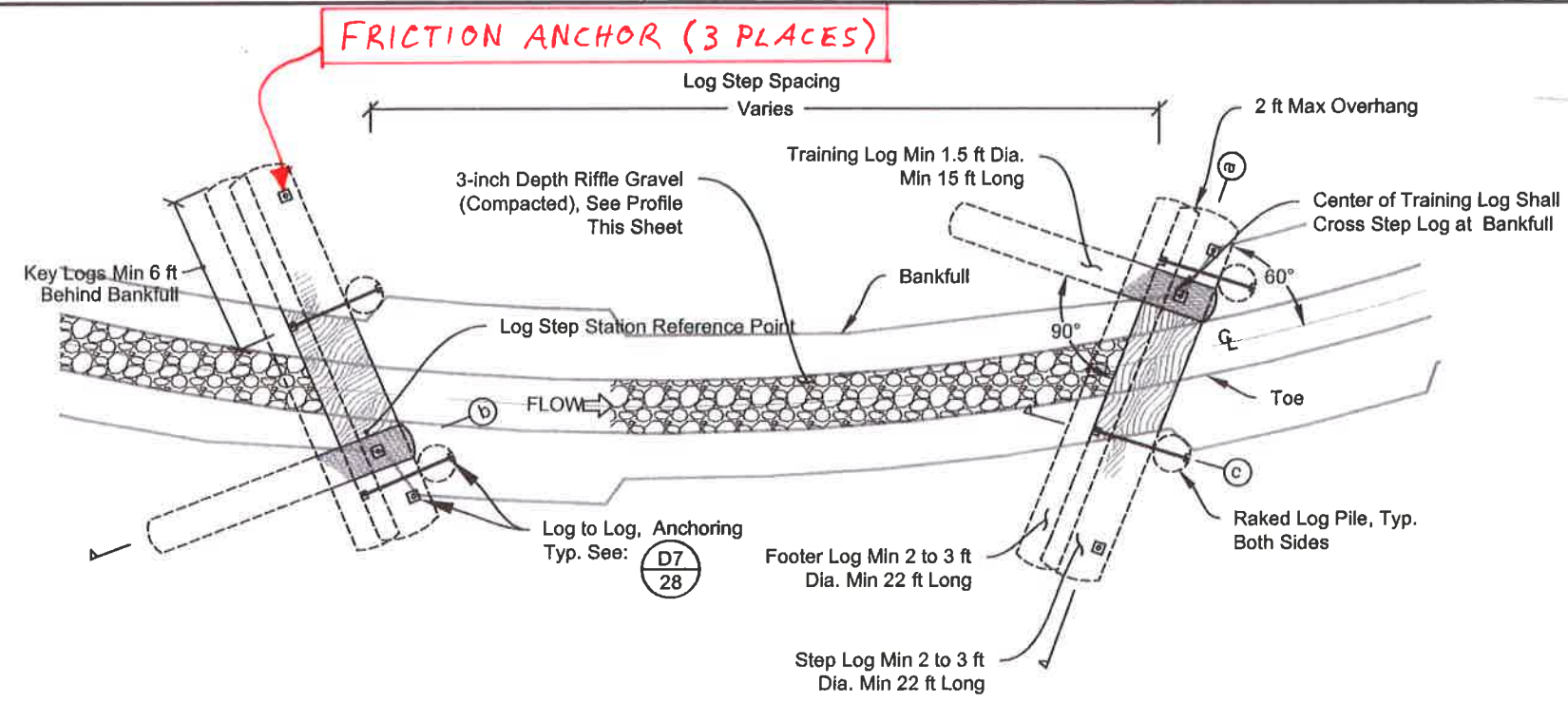
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PROJECT MANAGEMENT: Pacific Coast Fish, Wildlife and Wetlands Restoration Assoc.

REVISIONS:
4/11/2014

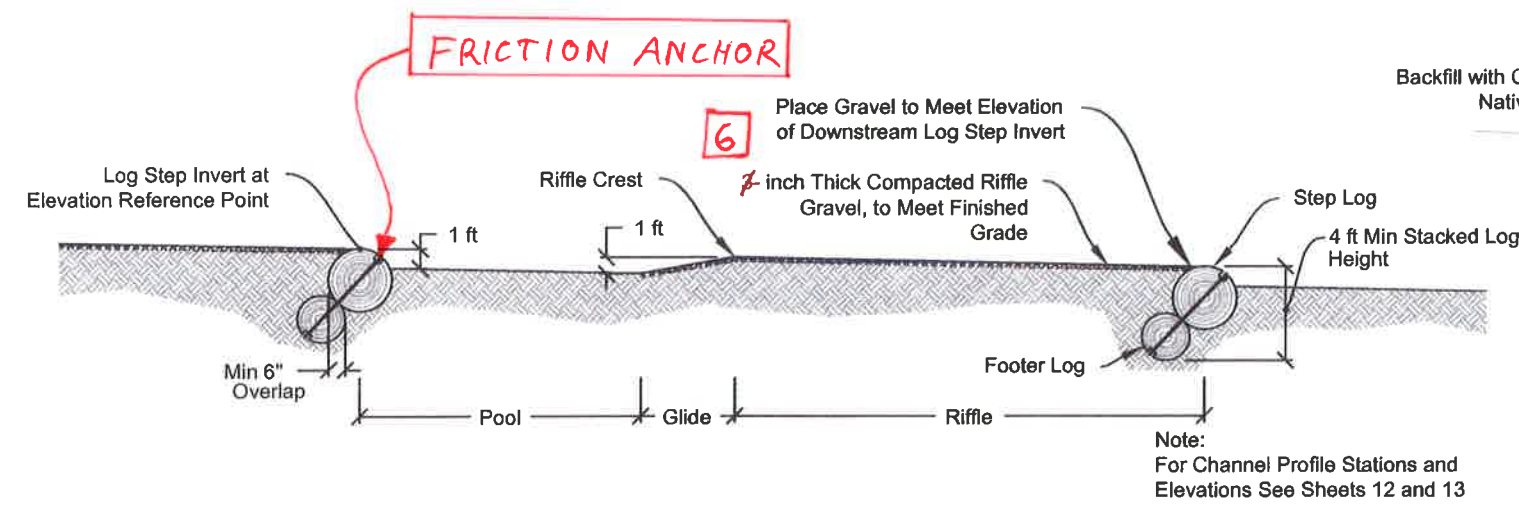
REDWOOD NATIONAL PARK
Strawberry Creek
Restoration Project

ROCK WEIR
DETAIL

DATE	March 2012
SUBMITTAL	FINAL
DESIGN	ML / RS / AL
DRAWN	Llanos
SHEET	25 of 33

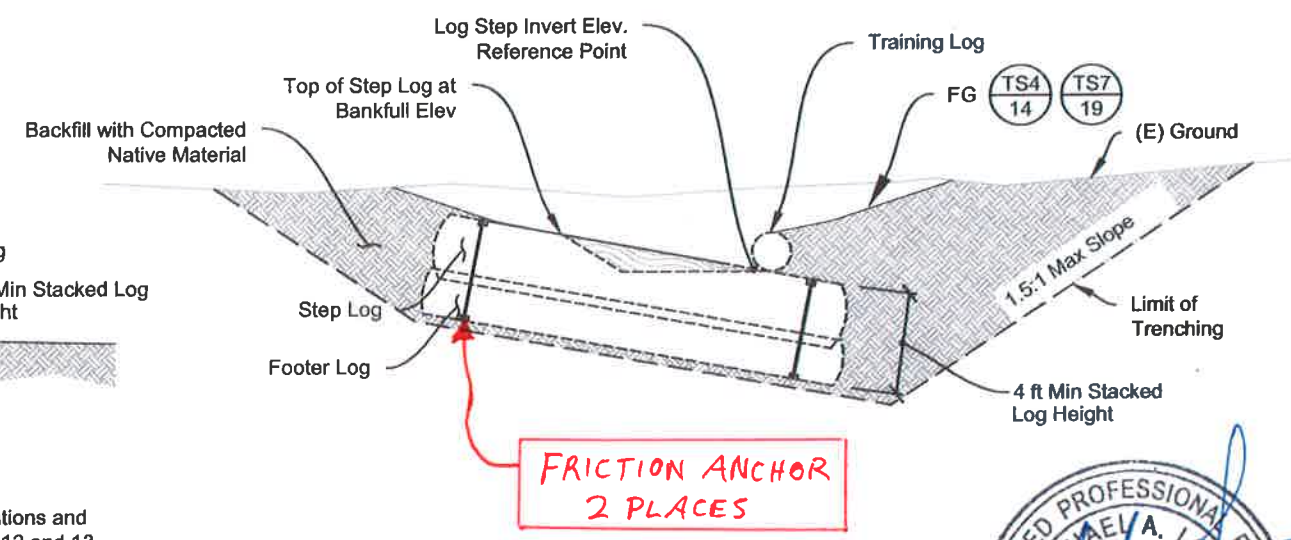
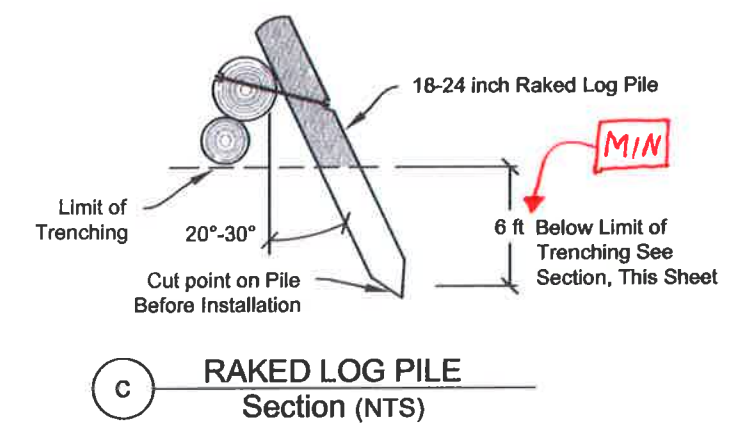
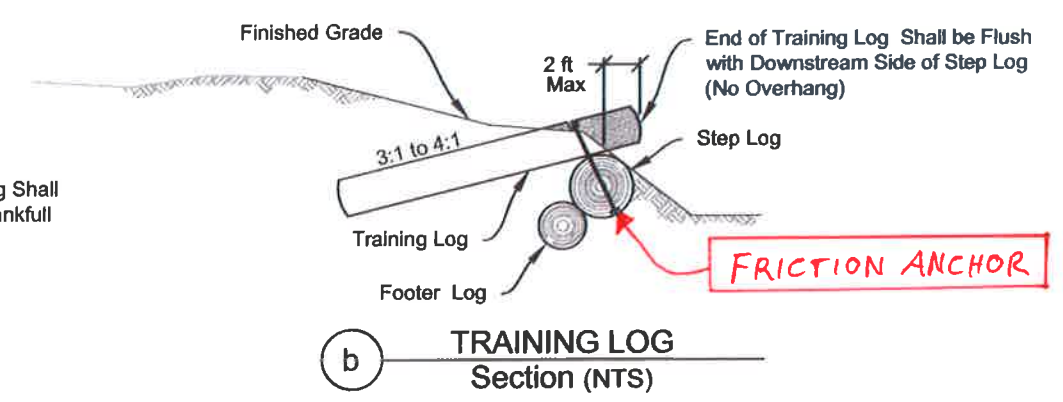


LOG STEP POOL
Plan (NTS)



LOG STEP POOL
Profile Through Log Step Invert (NTS)

(D5) LOG STEP POOL
8,9,19,12,13,14 Details



AS-BUILT
Date: Nov 7, 2014

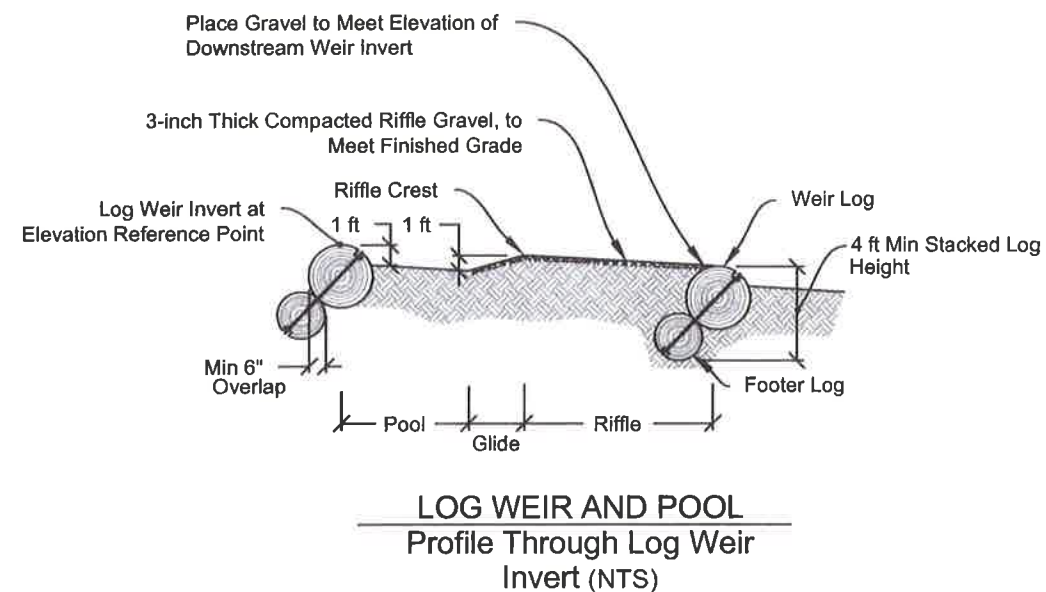
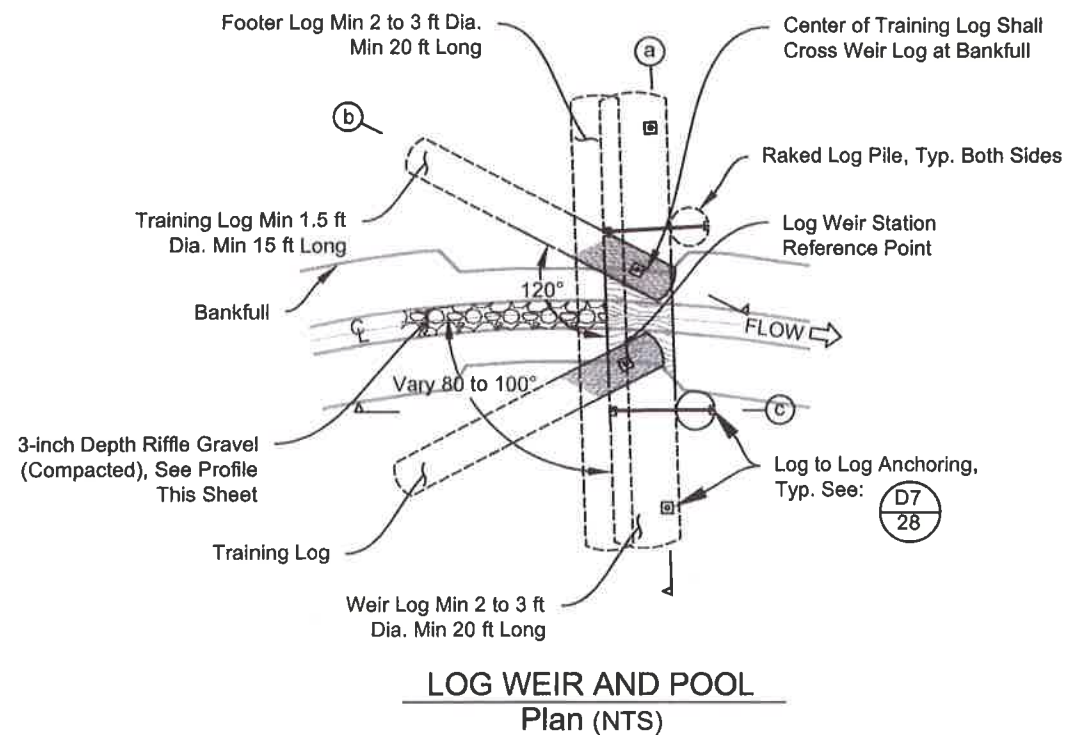


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4/11/2014

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Strawberry Creek
Restoration Project

LOG STEP POOL
DETAILS

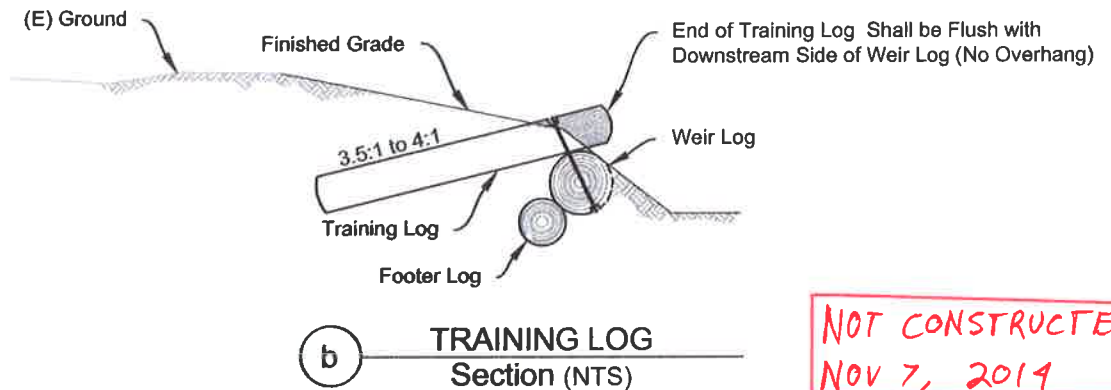
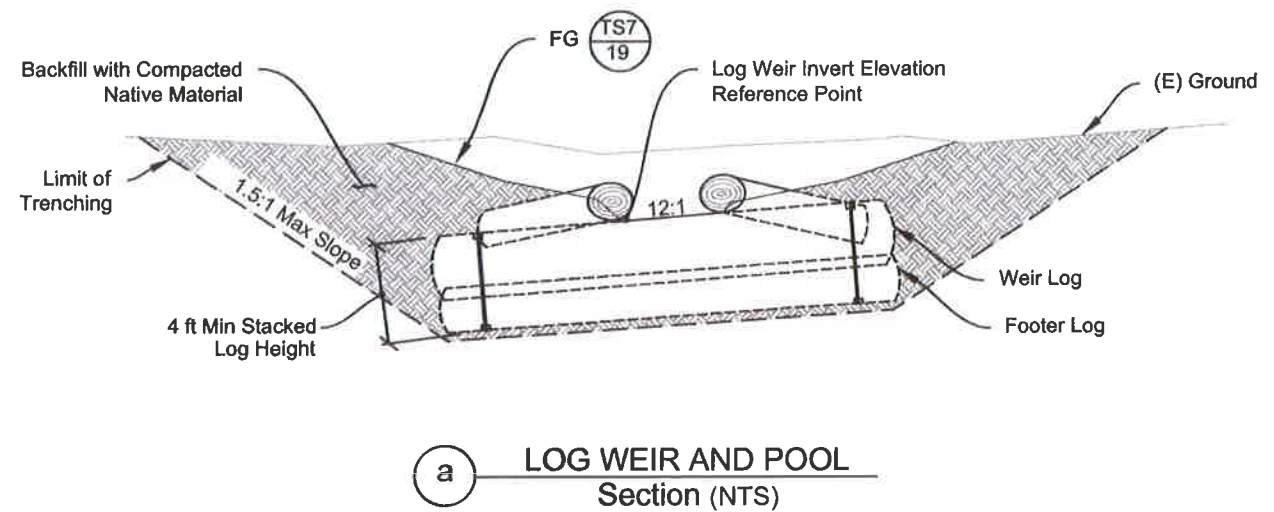
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SUBMITTAL	FINAL
DESIGN	ML / RS / AL
DRAWN	Llanos
SHEET	



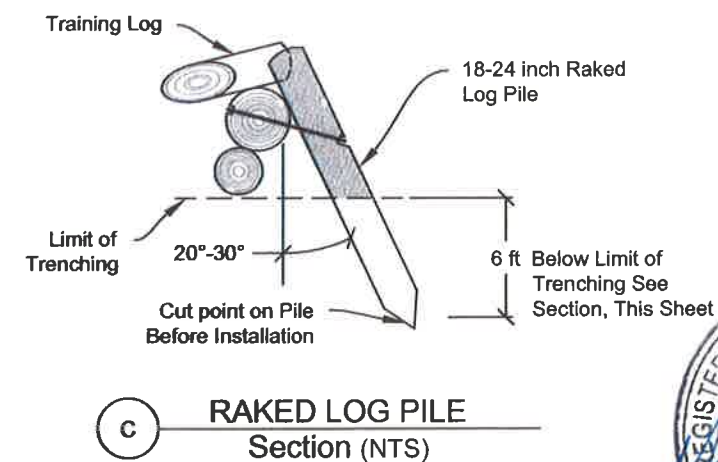
Note:
 For Channel Profile Stations and Elevations See Sheet 13

D6
 9,13,19,22

LOG WEIR AND POOL
 Details



NOT CONSTRUCTED
 NOV 7, 2014



Specification for Log Steps and Log Weirs

Material Specifications

- 1. Contractor shall use logs provided on site. Logs shall not be cut unless at the direction of the Owner.
- 2. Logs shall meet the dimensions specified in the Contract Documents. Log length shall not be accomplished with joining of multiple logs.
- 3. Pile Logs shall have bark removed.
- 4. Anchoring shall conform to Contract Documents.

Installation Specifications

- 1. Log Step and Log Weirs shall be installed as specified on the Contract Documents, and where directed by the Owner.
- 2. Excavate trench to the specified minimum depth for the entire structure.
- 3. Install logs such that the top of the Step or Weir Log forms the channel invert at the specified station, elevation, and location on the channel cross section.
- 4. The stacked log height shall be a minimum of 4 feet, measured vertically.
- 5. All logs shall be anchored where specified.
- 6. Cut point on tip of Pile Log and drive Pile Logs the specified length into the undisturbed subgrade at the specified pitch. Cut top of pile below finished grade.
- 7. Auger pilot hole may be used to facilitate driving of Raked Pile Logs. Pilot hole shall be at least 8 inches smaller than the Raked Pile Log diameter to ensure adequate skin friction is obtained.
- 8. Backfill channel bottom with compacted Riffle Gravel.
- 9. Backfill streambanks with compacted native material. Backfill under training Logs shall be hand compacted to the satisfaction of the Owner.

Specification for Riffle Gravel

Material Specifications

- 1. Riffle Gravel shall be rounded gravels meeting the following gradations and shall be approved by Owner prior to Installation:
 - a. 80% to 95% finer than 2 inches
 - b. 40% to 60% finer than 0.5 inches
 - c. 5% to 15% finer than #10 Sieve

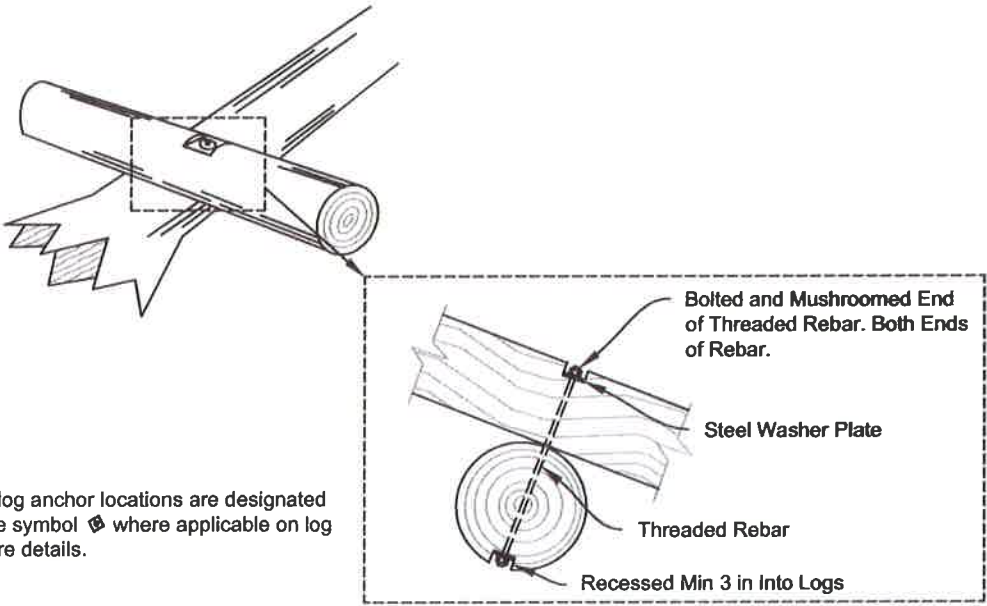
Installation Specifications

- 1. Riffle Gravel shall be installed as specified in the Contract Documents and where directed by the Owner.
- 2. Riffle Gravel shall be uniformly mixed and installed such that it does not stratify during installation. Do not contaminate the Riffle Gravel with soil.
- 3. Fill voids with smaller material and compact using vibratory methods to obtain a compact, low-permeability mass.
- 4. After installation, material shall be flooded and further compacted. Continue flooding and compacting until voids are filled and water remains flowing on the surface across the entire length of the installed material.
- 5. No water used during the flooding process shall be allowed to discharge into the live stream, but may be reused.
- 6. Fine material washed downstream resulting from flooding shall be fully removed prior to releasing streamflow into project area.

FRICTION
ANCHOR

AS-BUILT

Date: Nov 7, 2014



Note:
Log to log anchor locations are designated with the symbol  where applicable on log structure details.

D7
26,27,29,30
LOG TO LOG ANCHORING
Detail Elevation (NTS)

Specification for Anchoring Log Structures

Material Specifications

- 1. Log anchoring shall be in accordance with Contract Documents.
- 2. Threaded rebar, washer and nut shall be steel.
- 3. Threaded rebar shall be a minimum diameter of 1 inch with min 4-inch x 4-inch x 3/8 or 1/2 -inch thick steel washer plate with bolt.

Installation Specifications

- 1. Log Anchoring shall be installed as specified on the Contract Documents, and where directed by the Owner.
- 2. All logs shall be anchored where specified.
- 3. Rebar shall be inserted through the center of the log and bolted on both ends. Rebar, washer, and nut, shall be fully recessed within the log.
- 4. Anchor shall be located a minimum of 2 feet from the end of the log.
- 5. If a through-connection cannot be made with rebar, threaded rebar can be driven a minimum of 1.5-feet into an undersized hole in the bottom log. One washer and nut shall be installed so that the uppermost log cannot move vertically.
- 6. Driven rebar shall be installed where specified or with the permission of the Owner.
- 7. To minimize movement of logs, anchoring shall be installed such that connections are tight.



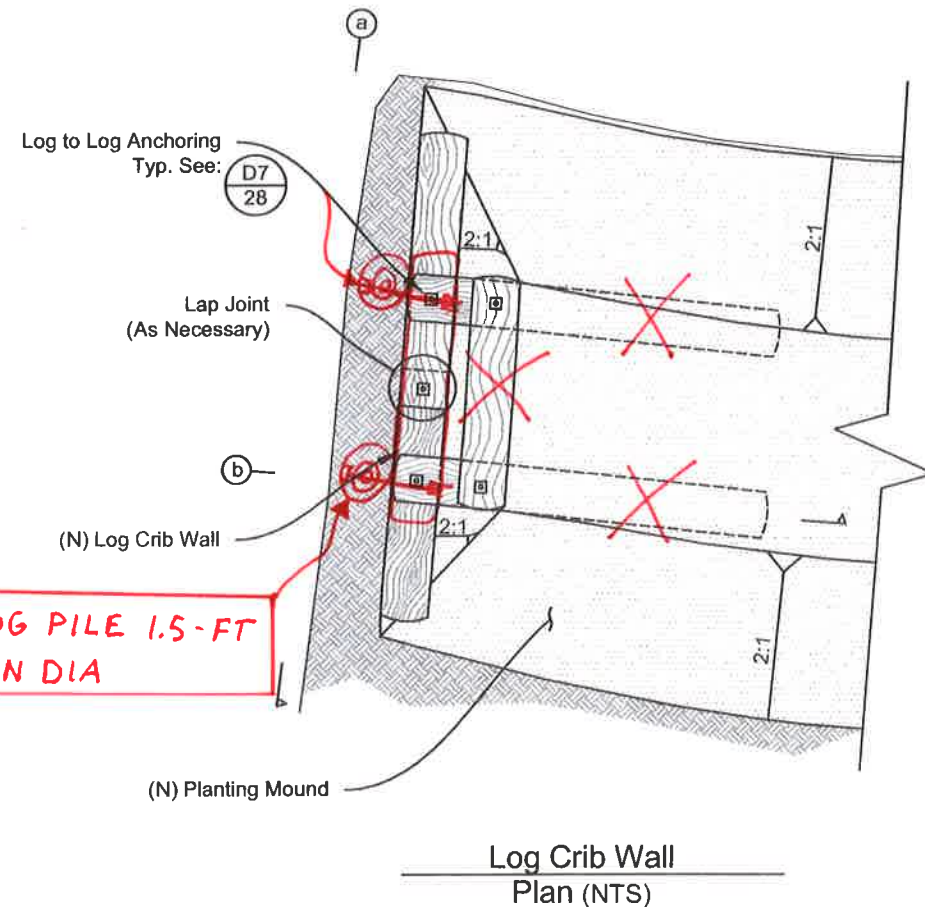
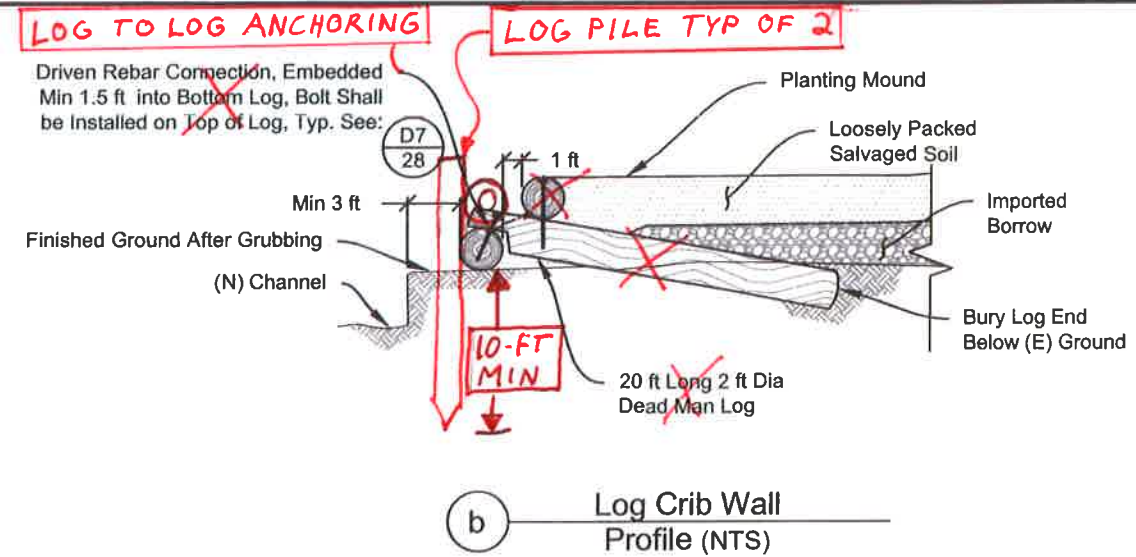
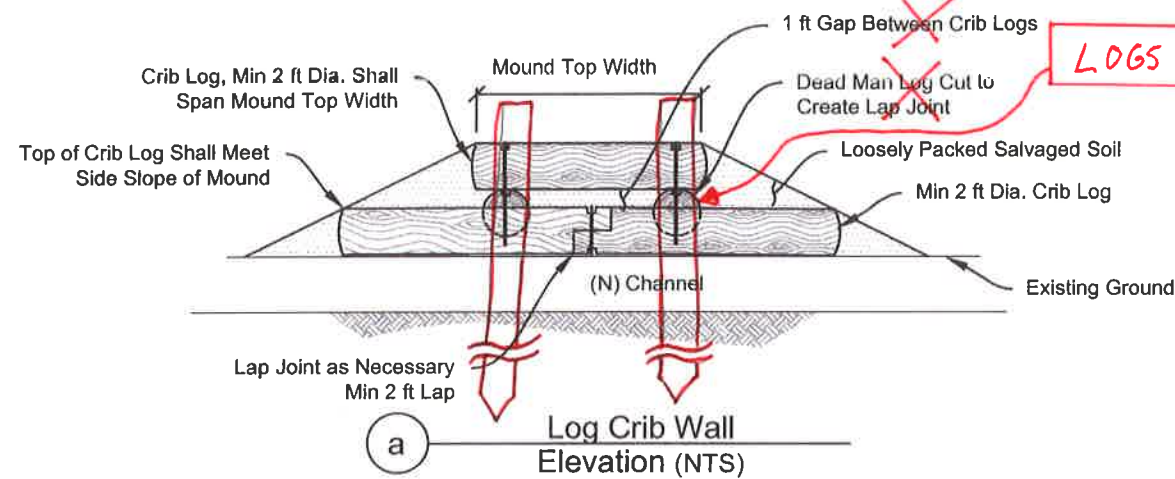
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PROJECT MANAGEMENT: Pacific Coast Fish, Wildlife and Wetlands Restoration Assoc.

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LOG STRUCTURE NOTES AND
ANCHORING DETAIL

DATE	March 2012
SUBMITTAL	FINAL
DESIGN	ML / RS / AL
DRAWN	Llanos
SHEET	28 of 33



Specification for Log Crib Walls

Material Specifications

1. Contractor shall use logs provided on site. Logs shall not be cut unless at the direction of the Owner.
2. Logs shall meet the dimensions specified on the Contract Documents.
3. No single log shall be less than 12 feet in length.
4. Anchoring shall conform to Contract Documents.

Installation Specifications

1. Log Crib Walls shall be installed as specified on the Contract Documents, and where directed by the Owner.
2. Install bottom Crib Logs on the existing ground surface at the locations specified.
3. Cut deadman logs to form a lap joint with a minimum of 2 feet overlap with the bottom crib log. Deadman log shall be cut to create an approximately 1-foot high gap between bottom and top crib logs.
4. Secure deadman to bottom crib log using a driven rebar connection, with bolt located on top of deadman log.
5. Install top crib log as specified, with a driven rebar connection with bolt located on top of crib log.
6. The cribwall height shall be a minimum of 5 feet, measured vertically.
7. All logs shall be anchored where specified.
8. If lap joints are necessary, joint shall overlap a minimum of 2 feet, anchored with Log to Log Anchoring. The surface of the lap joint shall be installed parallel to the ground surface such that the rebar connection is oriented vertically.
9. Backfill crib wall in accordance with Planting Mound Detail, (D3 24).

(D8
7,8,33

LOG CRIB WALL Details

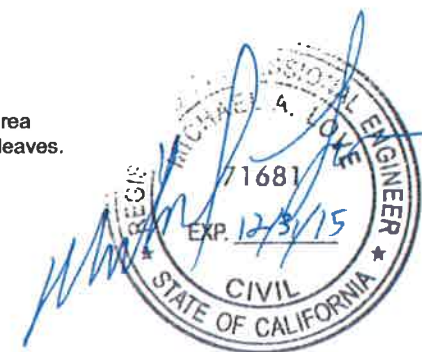
AS-BUILT
Date: Nov 7, 2014

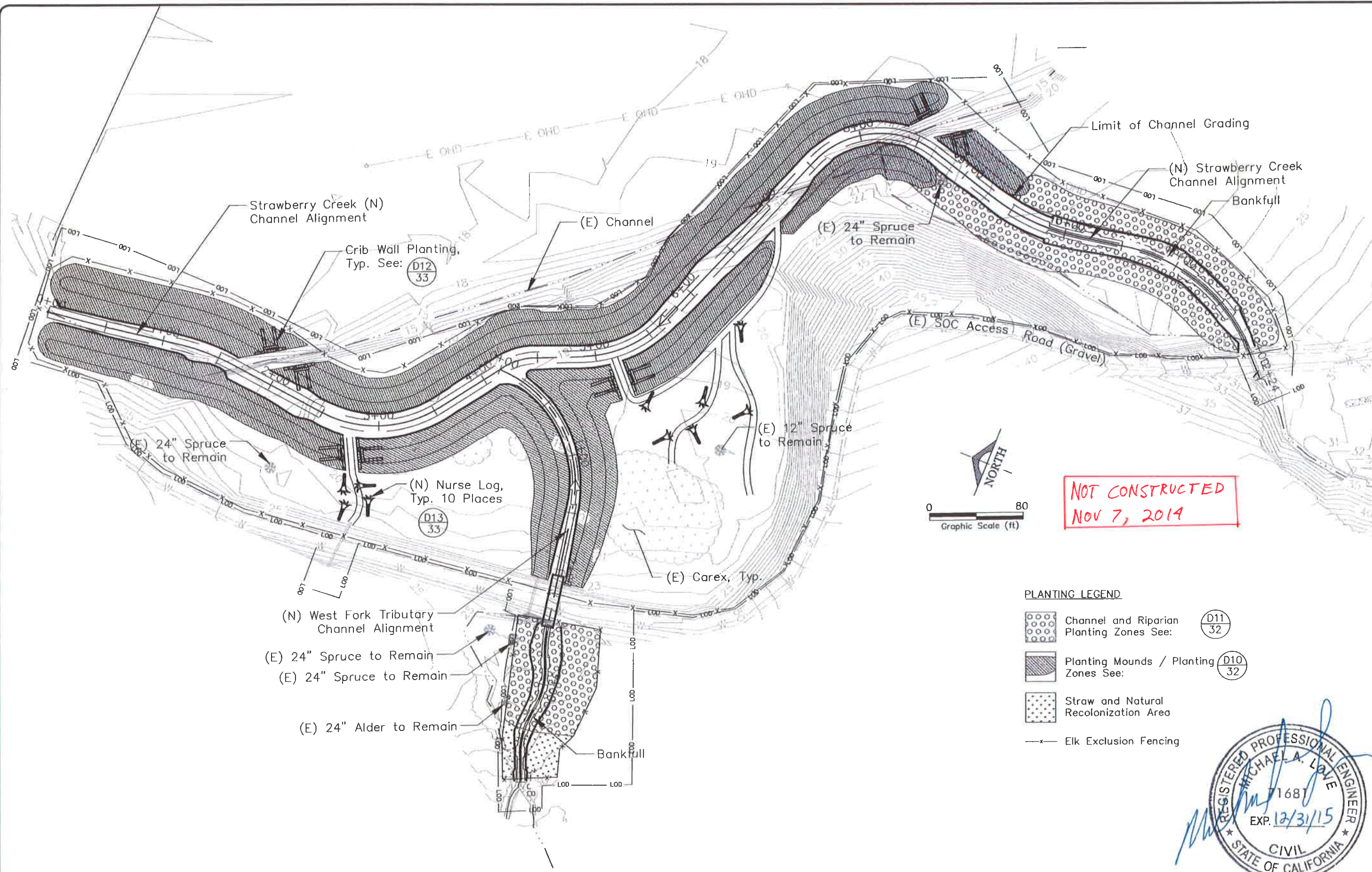




AS-BUILT
Date: Nov 7, 2019

1. Habitat Logs shall be installed as specified on the Contract Documents, and where directed by the Owner.
2. Deadman logs can be installed by either trench excavation or driving them into the streambank. Logs shall be installed so that they are roughly parallel, approximately 10 feet apart, and oriented upstream at an angle of 60 to 80 degrees from the streambank.
3. Downstream Deadman Log shall be installed sloping into the streambank at an approximately 10H:1V pitch.
4. If rootwad is present, rootwad shall face upstream.
5. Cross log shall be placed under the downstream Deadman Log near the channel bottom.
6. Where installed logs cross, provide a minimum of 1 foot overhang.
7. All logs shall be anchored where specified.
8. Backfill excavated trench with compacted native material. Loosely pack area between Cross-Log and streambank with salvaged branches, sticks and leaves.





NOT CONSTRUCTED
NOV 7, 2014

PLANTING LEGEND

- Channel and Riparian Planting Zones See: (D11/32)
- Planting Mounds / Planting Zones See: (D10/32)
- Straw and Natural Recolonization Area
- Elk Exclusion Fencing



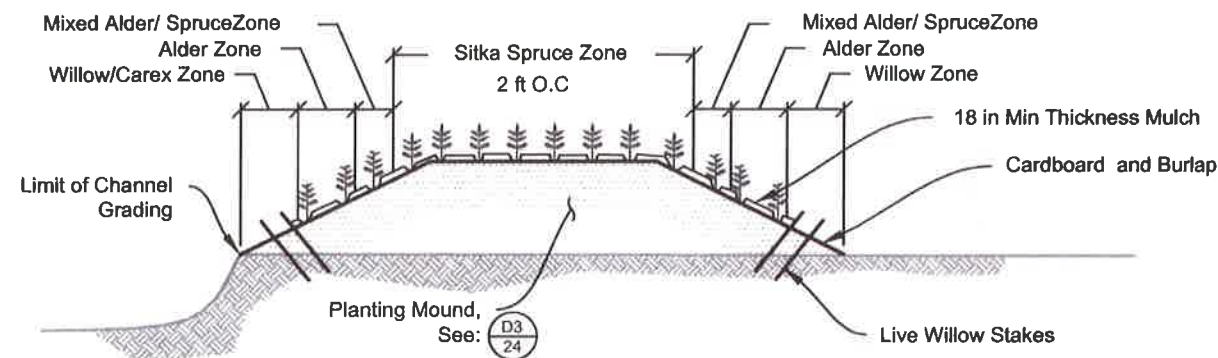
REVISIONS:

4/11/2014

REDWOOD NATIONAL PARK
Strawberry Creek Restoration Project

PLANTING PLAN

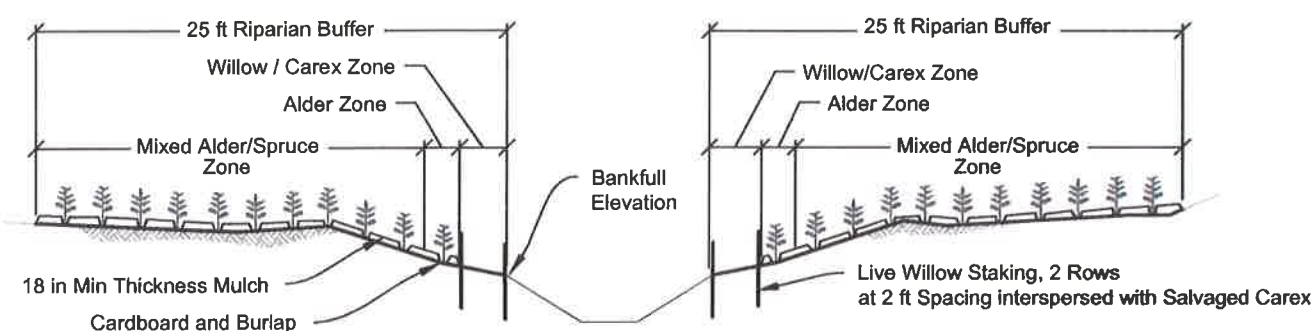
DATE	March 2012
SUBMITTAL	FINAL
DESIGN	ML / RS / AL
DRAWN	Llanos
SHEET	



**Mound Planting Zones
Detail Cross Section (NTS)**

PLANTING ZONE	PLANTING DENSITY	ELEVATIONS ON PLANTING MOUNDS
Sitka Spruce Zone	Sitka Spruce at 2 ft O.C.	Elev. 23 ft and higher
Mixed Alder/Spruce Zone	70% Red Alder, 30% Sitka Spruce at 2 ft O.C.	Elev. 22 ft to 23 ft
Alder Zone	Red Alder at 2 ft O.C.	Elev. 20.5 ft to 22 ft
Willow / Carex Zone	Live Willow Stakes at 2 ft O.C. Interspersed with Salvaged Carex	Elev. 19.5 ft to 20.5 ft

Note:
Mulch shall not be installed in the Willow/Carex Zone



**Channel and Riparian
Planting Zones
Detail Cross Section (NTS)**

Specification for Planting Mound and Riparian Area Planting Zones

Material Specifications

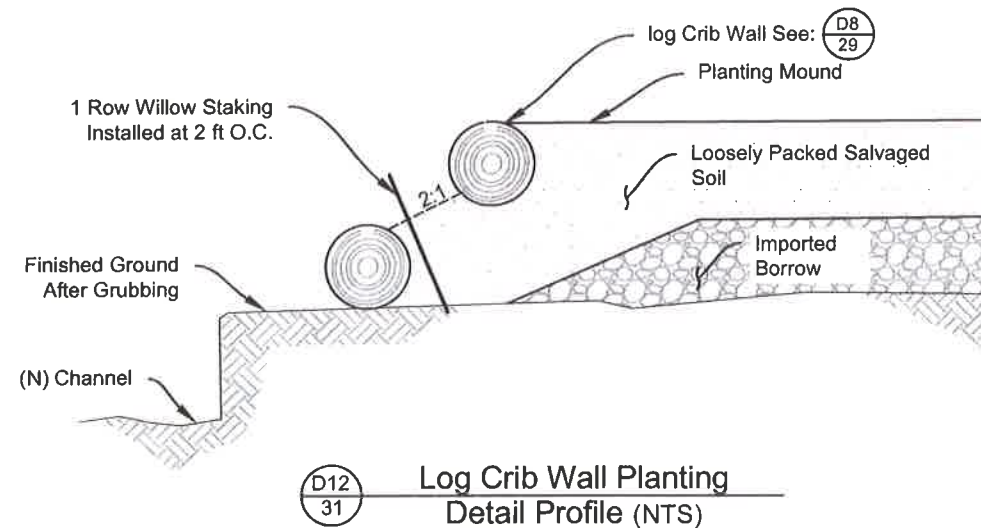
1. Plantings shall consist of 2-year old potted Sitka Spruce and Red Alder provided by Owner. Live willow stakes shall be as specified in these Contract Documents.
2. Carex shall consist of plants salvaged from the work areas and broken into clumps that contain approximately 1 quart of roots.
3. Cardboard shall consist of corrugated cardboard rolled or fanfolded with cornstarch glues. Minimum width shall be 60 inches.
4. Burlap shall consist of 10-ounce natural fibers with a minimum width of 60 inches.
5. Mulch shall consist of hog fuel and / or shredded redwood bark shredded redwood wood and bark. Mulch shall be manufactured from clean wood and shall have a particle size between 1/8 inch and 1 1/2 inches in thickness and one inch to 8 inches in length; and shall be free of salt and deleterious materials such as clods, coarse objects and rocks.
6. Staples shall be 6 inch minimum length and biodegradable.
7. No soil amendments shall be installed.
8. Owner shall be responsible for watering and maintenance after installation.

Installation Specifications

1. Invasive grasses within the limit of planting area shall be grubbed to fully remove grass roots, or to a maximum depth of 3 feet below existing grade. Grubbed material shall be disposed of on-site at the direction of the owner.
2. Where existing Carex grasses are present within the limits of excavation of planting mounds, plants shall be excavated to preserve root mat. Grasses shall be stored in a moist, sunny location, with roots covered with soil. Carex shall be replanted along new channel edge and bottom of planting mounds at the direction of the Owner.
3. Place cardboard on finished ground surface the full length and width of the planting zone. Cardboard shall overlap a minimum of one foot.
4. Place burlap over cardboard the full length and width of the planting zone. Burlap shall overlap a minimum of one foot. Overlaps shall be located a minimum of 3 feet away from cardboard overlaps. Install staples through cardboard and burlap at 5 ft O.C.
5. Plantings shall be installed as specified on the Contract Documents, and where directed by the Owner.
6. To install plant, cut a small hole, slightly larger than the planting stem through the cardboard and burlap.
7. Installation and mulching of plants shall conform to Caltrans, 2006 Section 20 and at the spacing and mulch depth indicated on the Contract Documents. Installed mulch shall not touch stems or branches of planting.
8. Stakes, root, or foliage protectors shall not be installed.

**NOT CONSTRUCTED
NOV 7, 2014**





NOT CONSTRUCTED
NOV 7, 2014

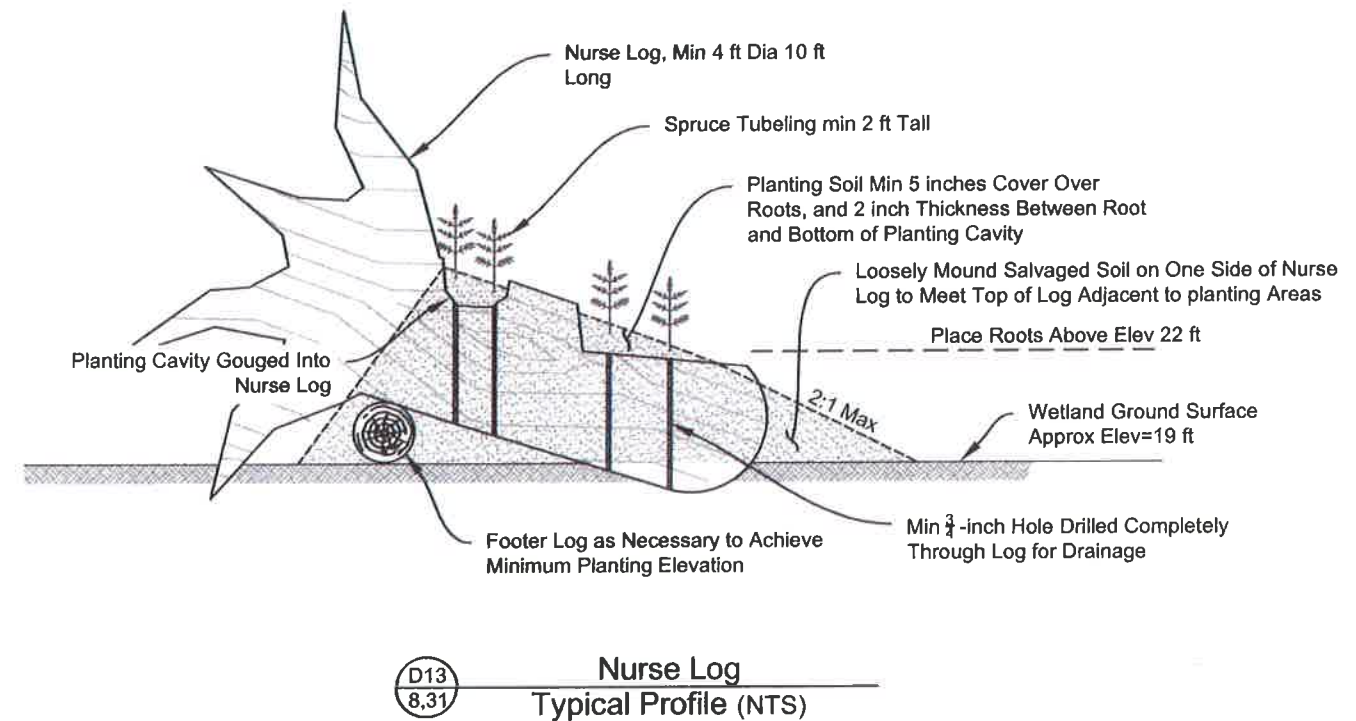
Specification for Live Willow Stakes

Material Specifications

1. Live Willow Stakes shall consist of live willow branches harvested locally at the direction of the Owner.
2. Stakes shall be straight and no shorter than 4 feet in length and ½ to 3 inches in diameter.
3. Harvested material shall be live, freshly cut, and dormant. The plant material shall be free from disease and harmful insects. Basal ends shall be cut cleanly at an angle to facilitate easy insertion into the soil. The tops shall be cut square or blunt.
4. Plant materials shall not be stored greater than 48 hours after harvesting. Plant material shall be protected from drying by means of covering with canvas, burlap or straw and shall be kept moist.
5. No soil amendments shall be installed.
6. Owner shall be responsible for watering and maintenance after installation.

Installation Specifications

1. Live Willow Stakes shall be installed as specified on the Contract Documents, and where directed by the Owner.
2. Create pilot holes to the full depth of the stake installation.
3. Stakes shall be installed at the spacing indicated on the Contract Documents, with approximately 1-foot of stake extending beyond finished grade after installation. Leaf buds shall point up.
4. Stakes shall be pushed or driven into the bank in a method that minimizes crushing and splitting of the top of the cutting. The tops of the cuttings shall be trimmed as necessary to remove split and crushed wood.



NURSE LOGS PLACED AS SHOWN, NOT PLANTED
AS OF NOV 7, 2014

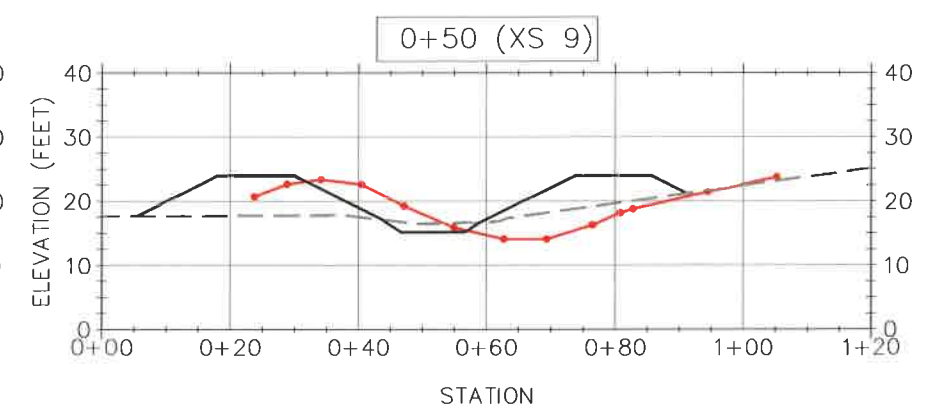
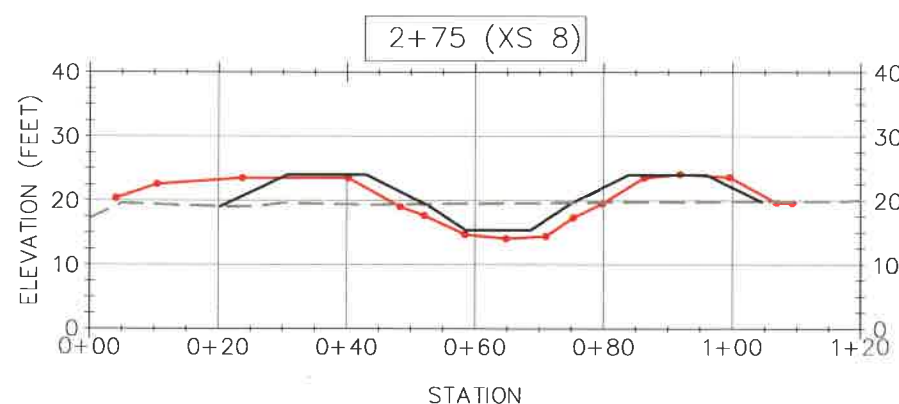
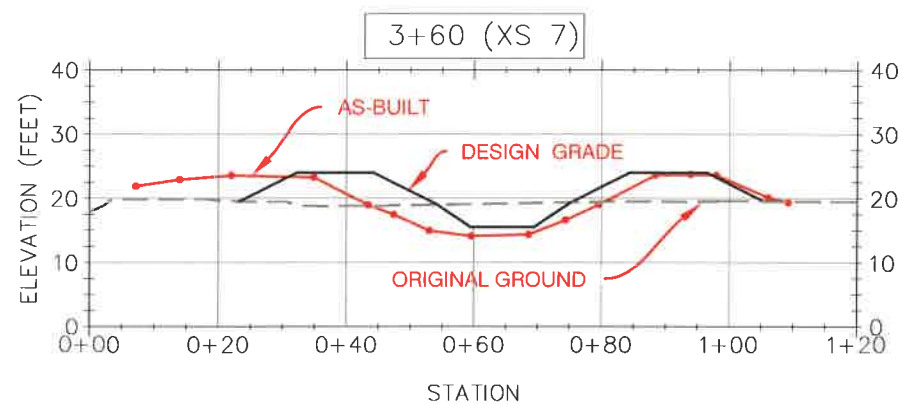
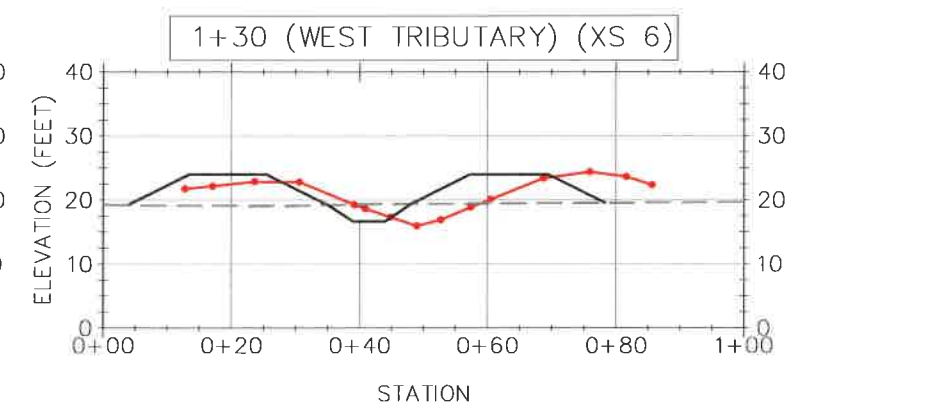
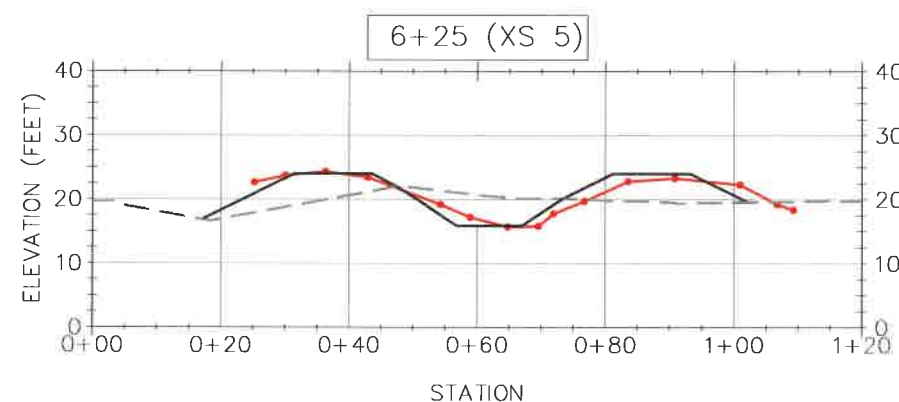
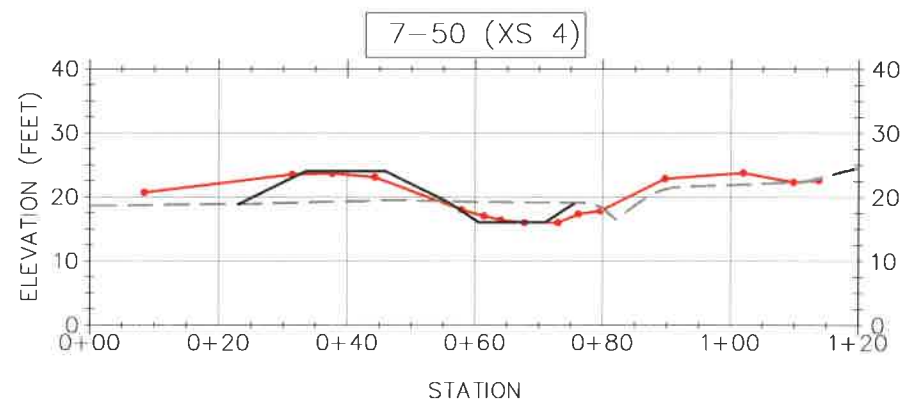
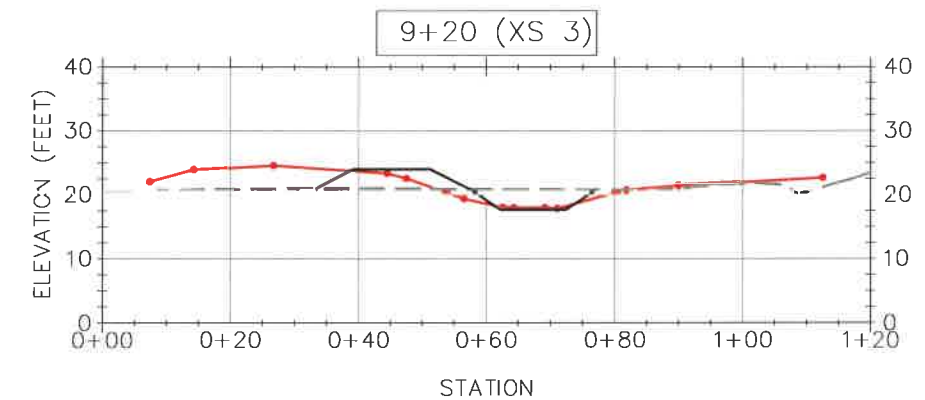
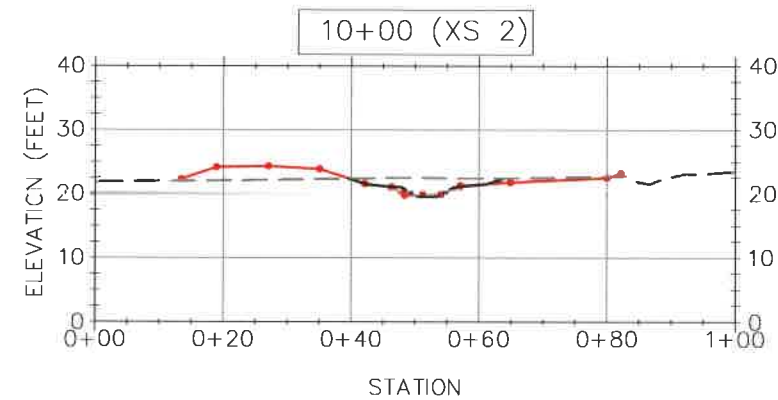
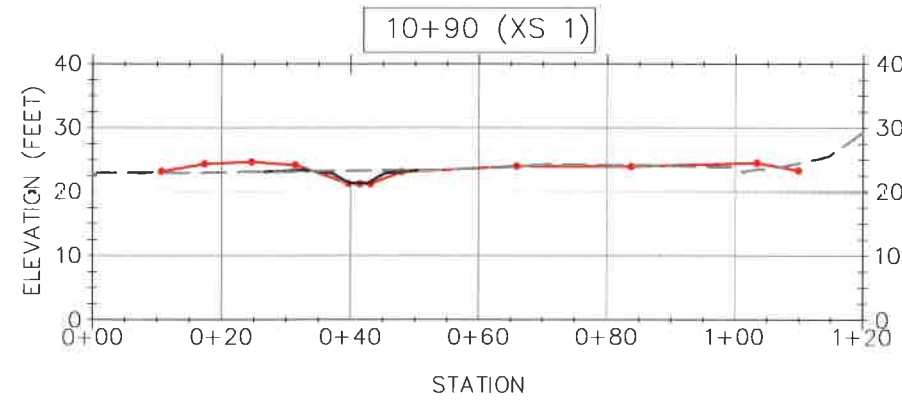
Specification for Nurse Logs

1. Contractor shall use logs provided on-site. Logs shall not be cut unless at the direction of the Owner.
2. Owner shall select logs to be used as Nurse Logs. Logs will typically be the following dimensions:
 - a. Nurse Log: 5 to 12-foot long, 4 to 6-foot diameter log
 - b. Footer Log: 5 to 15-foot long, 1.5 to 2-foot diameter logs.
3. Sitka Spruce tubelings shall have a minimum rooting depth of 5 inches and a minimum of 5 inches of healthy stem and branch growth.
4. Planting Soil shall be acidic with a uniform mix of equal quantities of sand, soil and humus or peat.
5. Soil stabilization matting shall be biodegradable woven coir matting with an open area of 39 to 50%, and a minimum weight of 20 oz/sy.
6. Logs shall not be anchored together.

Installation Specifications

1. Nurse Logs shall be installed as specified on the Contract Documents and / or directed by Owner.
2. Install logs to facilitate use of natural planting areas in logs such as rotten area, splits, or junctions between roots.
3. Cut planting shelves or trenches in nurse log that provide positive drainage. Cut areas shall be a minimum of 8 inches deep and 8 inches wide.
4. Drill drainage holes.
5. Loosely place Planting Soil in cut area.
6. Cover entire area of Planting Soil with double layer soil stabilization matting stapled to wood. Staples shall be placed every 2 inches.
7. Create pilot hole and place tubelings such that roots are covered with a minimum of 5 inches of soil and 2 inches of soil thickness between roots, wood or soil stabilization matting.
8. Plant up to 10 tubelings per nurse logs.
9. Loosely mound Salvaged Soil on one side of Nurse Log adjacent to planting areas to provide additional space for rooting.





AS-BUILT
Date: Nov 7, 2014

Notes:
1. All cross sections are oriented looking up-station.
2. Existing Ground elevation may vary from shown after grubbing. Offsets and elevations will vary with grubbing depth.

Appendix C.

Figure C-1. Bi-monthly water temperatures (°C) at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Figure C-2. Bi-monthly dissolved oxygen (mg/l) values (°C) at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Figure C-3. Bi-monthly specific conductivity (µS) values at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

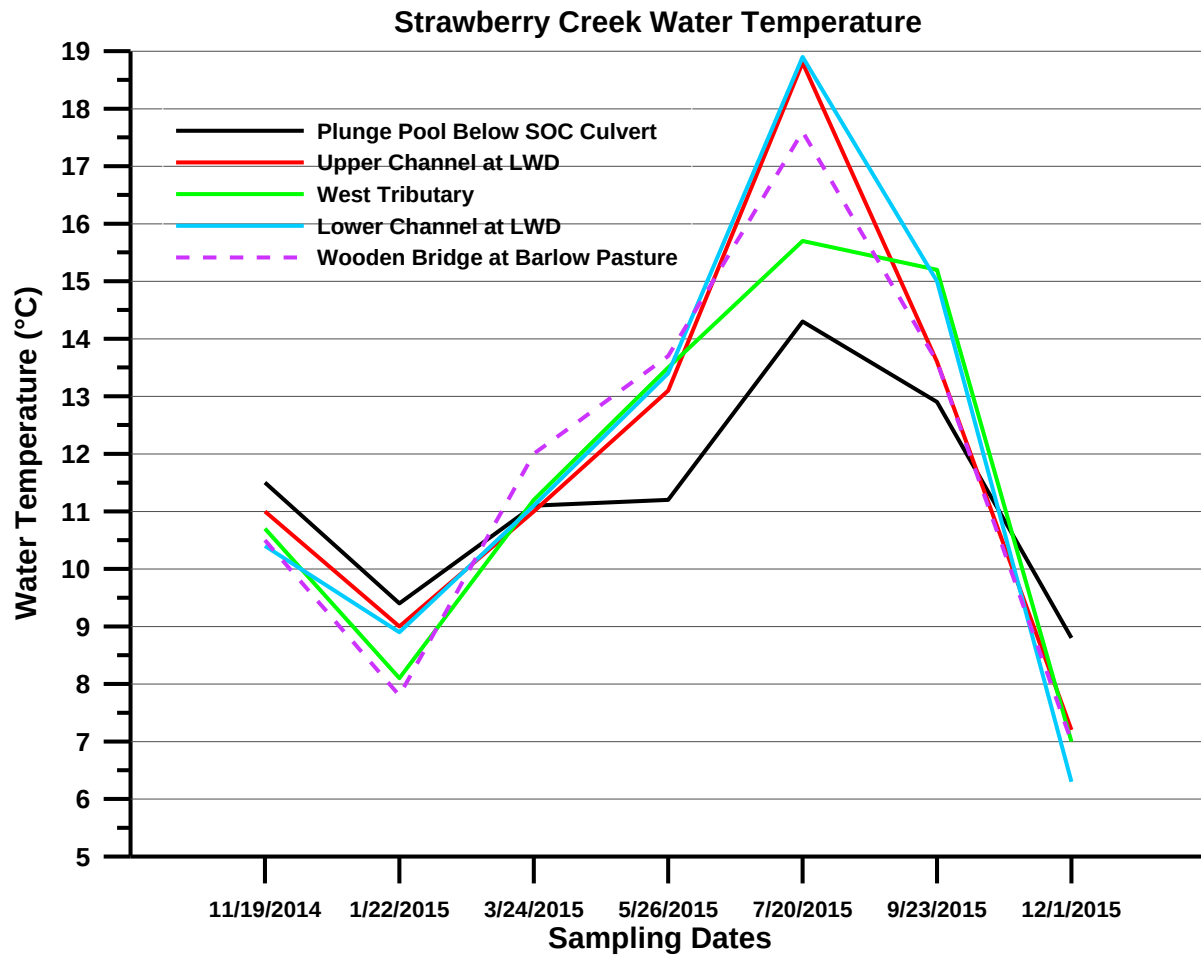


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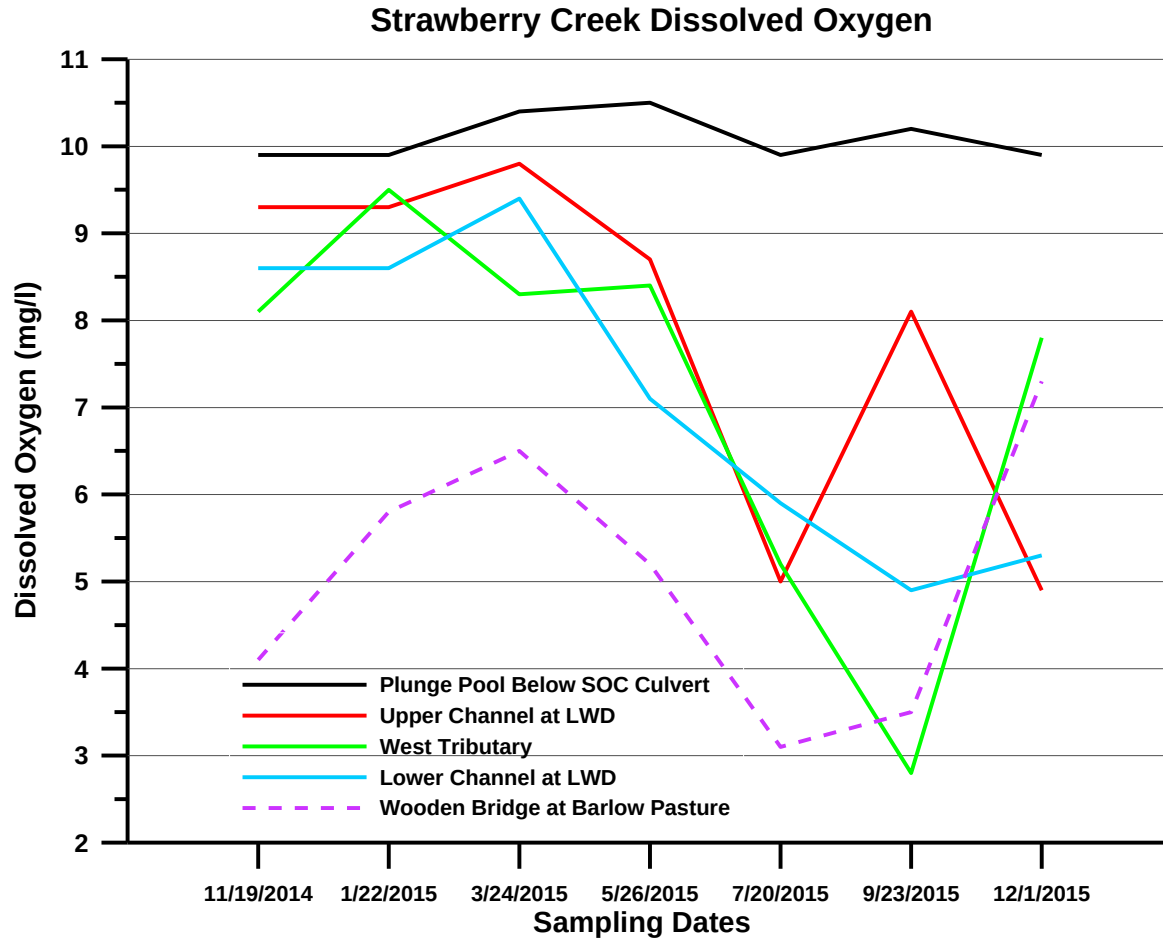


Figure C-2. Bi-monthly dissolved oxygen (mg/l) values ($^{\circ}\text{C}$) at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

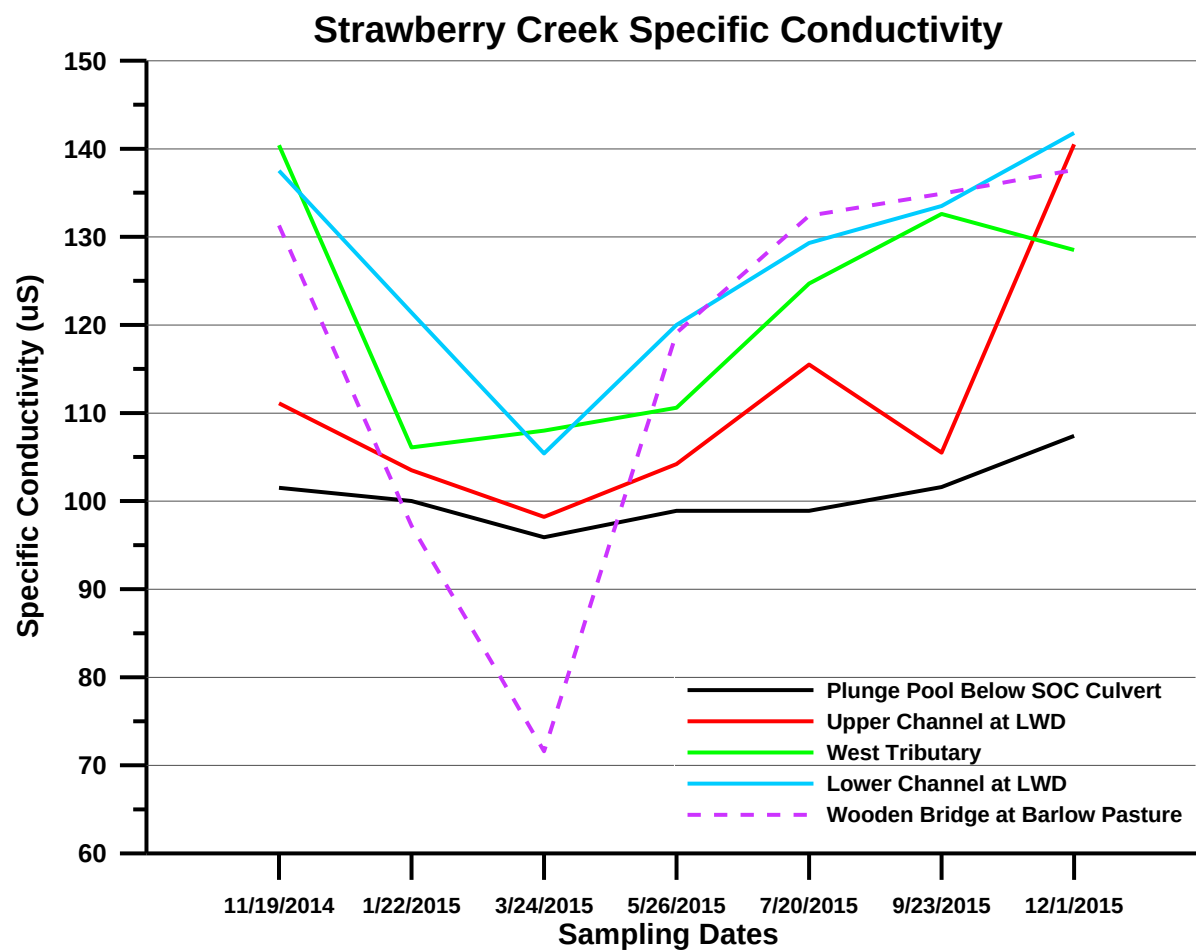


Figure C-3. Bi-monthly specific conductivity (μS) values at Strawberry Creek monitoring sites within and downstream of the park restoration project, November 2014 through December 2015. Wooden Bridge at Barlow Pasture is the first downstream monitoring site below the restored park reach.

Appendix D.

Photo points showing stream bank and channel conditions mid-summer, 2015.



Figure D-1. Google earth image dated 7/14/2015 showing the project reach approximately nine months post-construction of Strawberry Creek mainstem and portion of West Tributary reaches. Visible in photo are the crib wall structures providing conveyance of flows between wetland and constructed channel, planting mounds covered with redwood bark mulch, open water channel of mainstem and West Tributary and invasive grasses lining the bank at the water's edge. The portion of the project not yet constructed is the culvert replacement on West Tributary and log structures upstream of the culvert.

Photos of Strawberry Creek channel and banks from downstream end of project to upstream end.
Photos taken August 06 and 07, 2015.



PP 50 (STA 0+50). From mainstem right bank. View of downstream end of project, looking downstream.



PP 50 (STA 0+50). From mainstem right bank. View of downstream end of project, looking across channel.



PP 50 (STA 0+50). View from mainstem right bank, looking upstream oblique across channel to left bank. Note large spruce on right bank at upper end of reach.



PP 53 (STA 2+90). View from mainstem right bank, looking downstream oblique across channel to left bank. Note large spruce on left bank is same as in PP 50.



PP 53 (STA 2+90). View from mainstem right bank, looking directly across channel to left bank.



PP 54 (STA 4+50). View from mainstem right bank, looking downstream. Crib wall structure in distance is same as that in photo above.



PP 54 (STA 4+50). View from mainstem right bank, looking obliquely across channel to confluence of West Tributary channel with mainstream Strawberry Creek.



PP 54 (STA 4+50). View from mainstem right bank, at confluence of West Tributary channel with mainstream Strawberry Creek, looking directly up West Tributary channel.



PP 54 (STA 4+50). View from mainstem right bank, on top of mound, at confluence of West Tributary channel with mainstream Strawberry Creek, looking obliquely up West Tributary channel.



PP 55 (STA 5+50). View from mainstem right bank, on top of mound, looking across channel to crib wall structure on left bank.



PP 56 (STA 7+00). View from mainstem right bank, on top of mound, looking downstream obliquely across channel.



PP 56 (STA 7+00). View from mainstem right bank, on top of mound, looking obliquely across channel to left bank.



PP 56 (STA 7+00). View from mainstem right bank, on top of mound, looking directly across channel to left bank.



PP 56 (STA 7+00). View from mainstem right bank, on top of mound, looking obliquely upstream.



PP 57 (STA 8+30). View from mainstem right bank, on top of mound, looking obliquely downstream.



PP 57 (STA 8+30). View from mainstem right bank, on top of mound, looking obliquely upstream and across log crib structure that provides surface water flow conveyance between wetland and Strawberry Creek mainstem.



PP 58 (STA 8+90). View from mainstem right bank looking downstream.



PP 58 (STA 8+90). View from mainstem right bank looking directly across channel to left bank.



PP 58 (STA 8+90). View from mainstem right bank looking upstream.



PP 59 (STA 9+50). View from mainstem right bank looking upstream.



PP 60. (STA 11+50) View from mainstem right bank looking obliquely downstream.



PP 61. View from West Tributary (STA 0+30) right bank at confluence with mainstem looking obliquely downstream along mainstem.



PP 61. View from West Tributary (STA 0+30) right bank at confluence with mainstem looking obliquely upstream along West Tributary toward Old SOC Access Road.



PP 62. View from West Tributary (STA 1+10) right bank at near upstream end near Old SOC Access Road looking downstream along West Tributary.

All photos below are taken from near the downstream end of the project looking south east across the wetland at about photo point 2.5.



12/07/2012. Before construction



08/13/2014. Fabric (burlap) layer in place. Gravel being placed on top.



08/19/2014. Gravel portion of mounds in place allowing equipment access. Channel vegetation excavation in progress.



08/22/2014. Channel fill (clean, no vegetation) being excavated.



09/24/2014. Equipment work completed and mulch spread one day before first storm of year.



01/22/2015. Park staff sampling for fish. Note *Glyceria*. beginning to grow along channel edge.



03/02/2015. Fence construction getting underway. Excavator in distance installing 12 ft. wood posts.



03/18/2015. Fencing construction in progress.



09/22/2015. At end of first summer following project construction. Spruce seedlings are planted, but are not visible in this photo due to abundant equisetum.