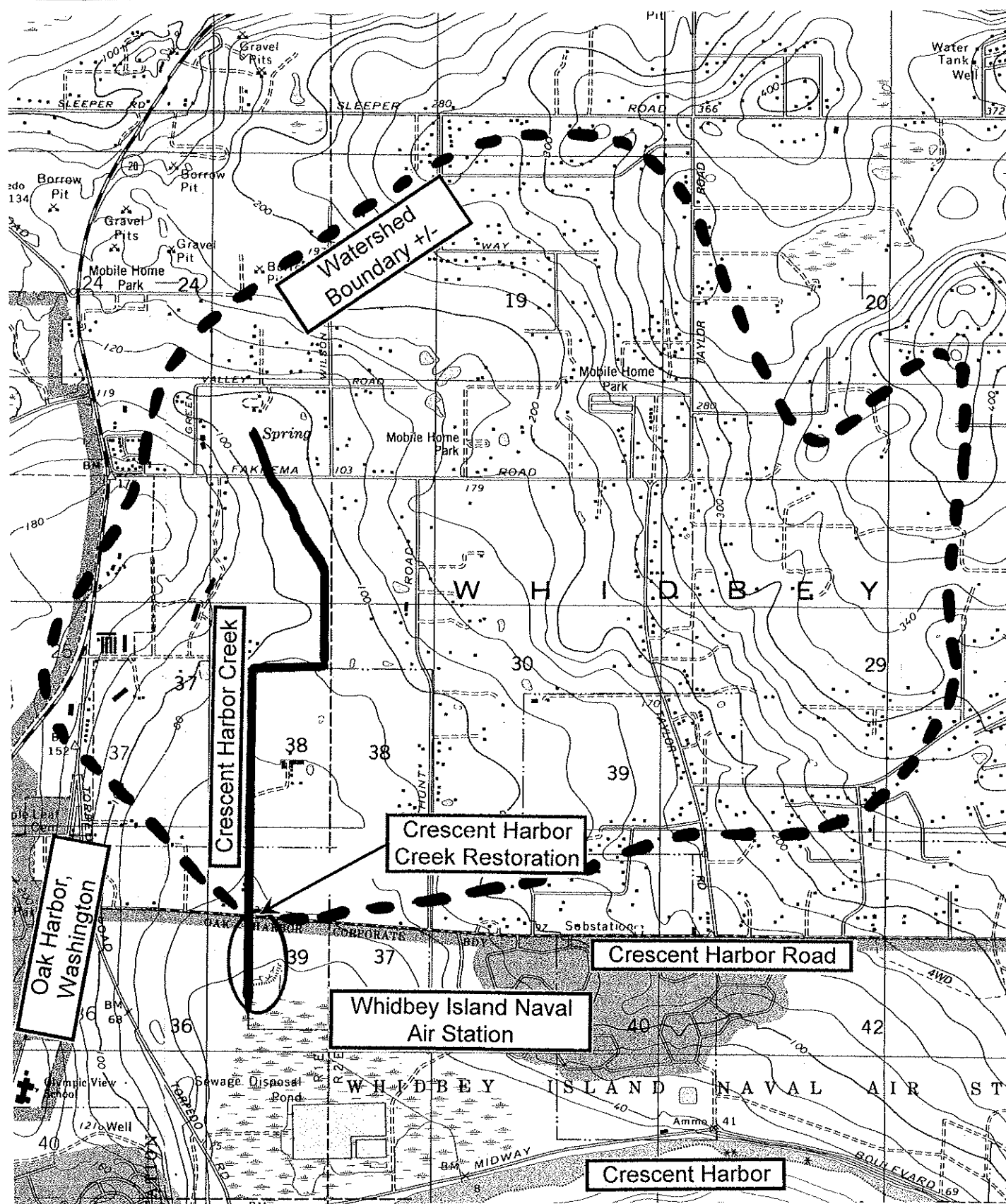




PROJECT LOCATION FOR CRESCENT HARBOR CREEK RESTORATION IS ON THE WHIDBEY ISLAND NAVAL AIR STATION BETWEEN CRESCENT HARBOR ROAD AND A TIDAL ESTUARY DIRECTLY CONNECTED TO CRESCENT HARBOR (PUGET SOUND). ALL PROJECT WORK WOULD BE SOUTH OF CRESCENT HARBOR ROAD, TO RESTORE A 1/4-MILE LENGTH OF CRESCENT HARBOR CREEK FROM A DITCHED ALIGNMENT TO NATURAL MEANDERING STREAM CHANNEL.
MAP SCALE 1:24,000 (USGS) 1" = 2,000'.

CRESCENT HARBOR CREEK RESTORATION

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La Conner, WA 98257

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emickelson@skagitcoop.org

DRAWING LIST:

- 1 PROJECT LOCATION & DRAWING LIST
- 2 SITE PREPARATION & CLEARING
- 3 STREAM RESTORATION SITE PLAN (SOUTH)
- 4 STREAM RESTORATION SITE PLAN (NORTH)
- 5 CHANNEL CROSS-SECTIONS 0+00 TO 6+00
- 6 CHANNEL CROSS-SECTIONS 7+00 TO 13+00
- 7 SUBGRADE SECTIONS & TYPICAL CHANNELS
- 8 CHANNEL CONSTRUCTION DATA
- 9 ROUGHENED CHANNEL SITE PLAN
- 10 ROUGHENED CHANNEL PROFILE & DETAILS

Notes for Potential Backwater Upstream of Existing Culvert

The project engineer completed a detailed survey near the existing culvert and prepared rating curves to quantitatively show the relationship between creek flow in cubic feet per second (cfs) and estimated water surface elevations at the downstream end existing culvert. The specific interest was whether or not the proposed channel would result in additional backwater of the existing culvert. Flow rating curves are shown in Figure 1, with all rating curves adjusted per creek alignment to hydraulically coincide with the downstream end of the existing culvert. Conclusions from the analysis of rating curves:

- On the chart (Figure 1), rating curves to the right represent channels that have higher flow capacity than curves to the left.
- For flows zero to 40 cfs, the existing culvert and downstream channel would both have slightly more flow capacity than a roughened channel at 3% slope; see the thick solid line (proposed channel) to the left of dashed lines (existing conditions) in Figure 1. Within this flow range, the proposed roughened channel would create a minor backwater within the existing culvert, up to about 0.3' deep. Slightly higher water elevations (up to 0.3' higher) upstream within this flow range were not considered any concern.
- Above 40 cfs flow in Crescent Harbor Creek to the estimated 100-year flood flow and above, the proposed roughened channel would have increasingly high flow conveyance capacity compared with existing conditions. On-site, beginning at about 60 cfs flow, there would be a small water level drop from the existing culvert into the roughened channel. This water level drop would be about 0.5'-high at the estimated 100-year flood flow; there would not be any upstream backwaters at high creek levels, or during floods.

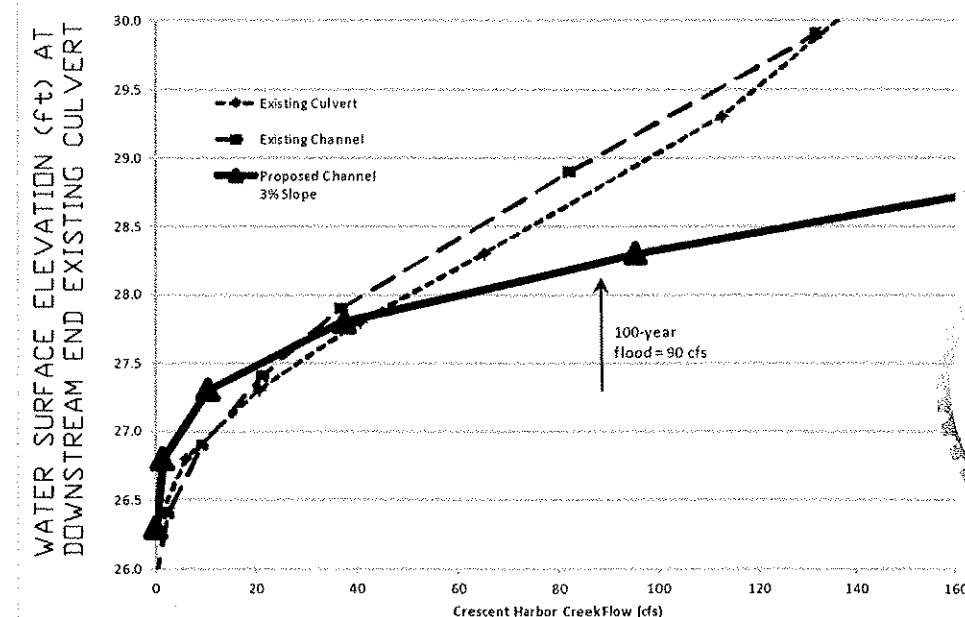
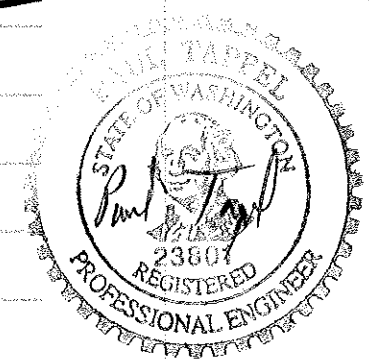


Figure 1. Rating curves for Crescent Harbor Creek, with channel data adjusted to estimated water surface elevations at the downstream end existing culvert. Rating curves to the right on this chart represent channels with higher flow capacity than curves to the left, per water surface elevations on the vertical axis.



JUNE 2016



PROJECT LOCATION IS
NEAR THE EASTERN EDGE
OF OAK HARBOR, WASHINGTON

CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE

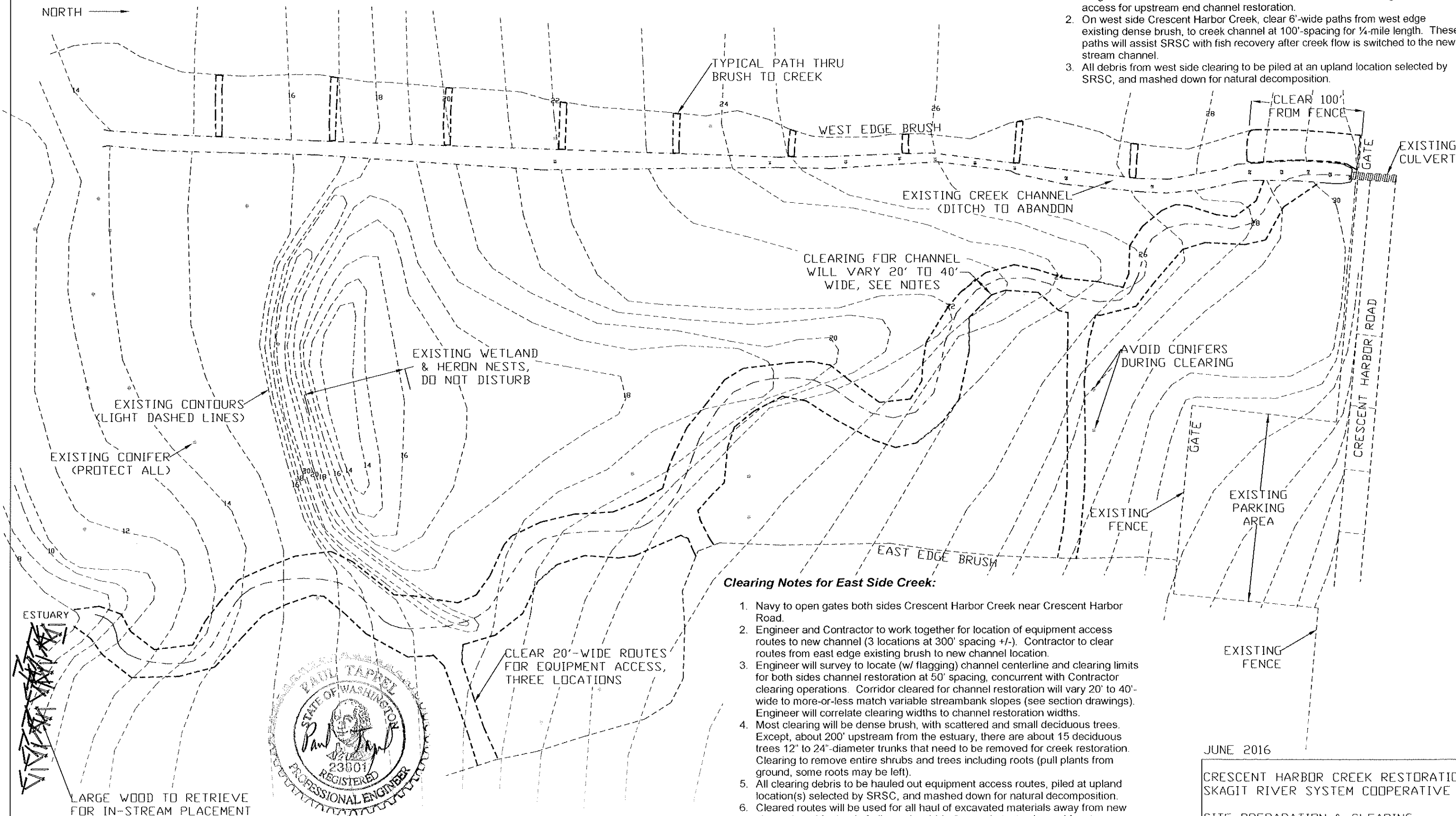
PROJECT LOCATION & DRAWING LIST
DRAWING 1

0 40 80 120 160 FEET
SCALE: 1" = 80'

NORTH →

Clearing Notes for West Side Creek:

1. Clear entire west bank from fence to 100' downstream (south) from edge of existing brush and trees, to west edge water for Crescent Harbor Creek. The roughened channel will be constructed from this side, and clearing will allow access for upstream end channel restoration.
2. On west side Crescent Harbor Creek, clear 6'-wide paths from west edge existing dense brush, to creek channel at 100'-spacing for ¼-mile length. These paths will assist SRSC with fish recovery after creek flow is switched to the new stream channel.
3. All debris from west side clearing to be piled at an upland location selected by SRSC, and mashed down for natural decomposition.

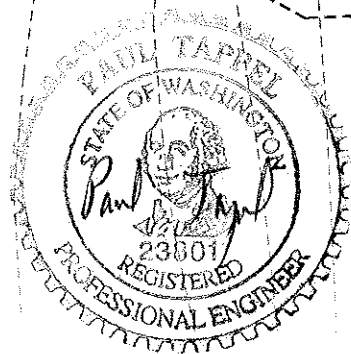


Clearing Notes for East Side Creek:

1. Navy to open gates both sides Crescent Harbor Creek near Crescent Harbor Road.
2. Engineer and Contractor to work together for location of equipment access routes to new channel (3 locations at 300' spacing +/-). Contractor to clear routes from east edge existing brush to new channel location.
3. Engineer will survey to locate (w/ flagging) channel centerline and clearing limits for both sides channel restoration at 50' spacing, concurrent with Contractor clearing operations. Corridor cleared for channel restoration will vary 20' to 40'-wide to more-or-less match variable streambank slopes (see section drawings). Engineer will correlate clearing widths to channel restoration widths.
4. Most clearing will be dense brush, with scattered and small deciduous trees. Except, about 200' upstream from the estuary, there are about 15 deciduous trees 12" to 24"-diameter trunks that need to be removed for creek restoration. Clearing to remove entire shrubs and trees including roots (pull plants from ground, some roots may be left).
5. All clearing debris to be hauled out equipment access routes, piled at upland location(s) selected by SRSC, and mashed down for natural decomposition.
6. Cleared routes will be used for all haul of excavated materials away from new channel, and for haul of all wood, cobble & gravel etc. to channel for stream restoration.

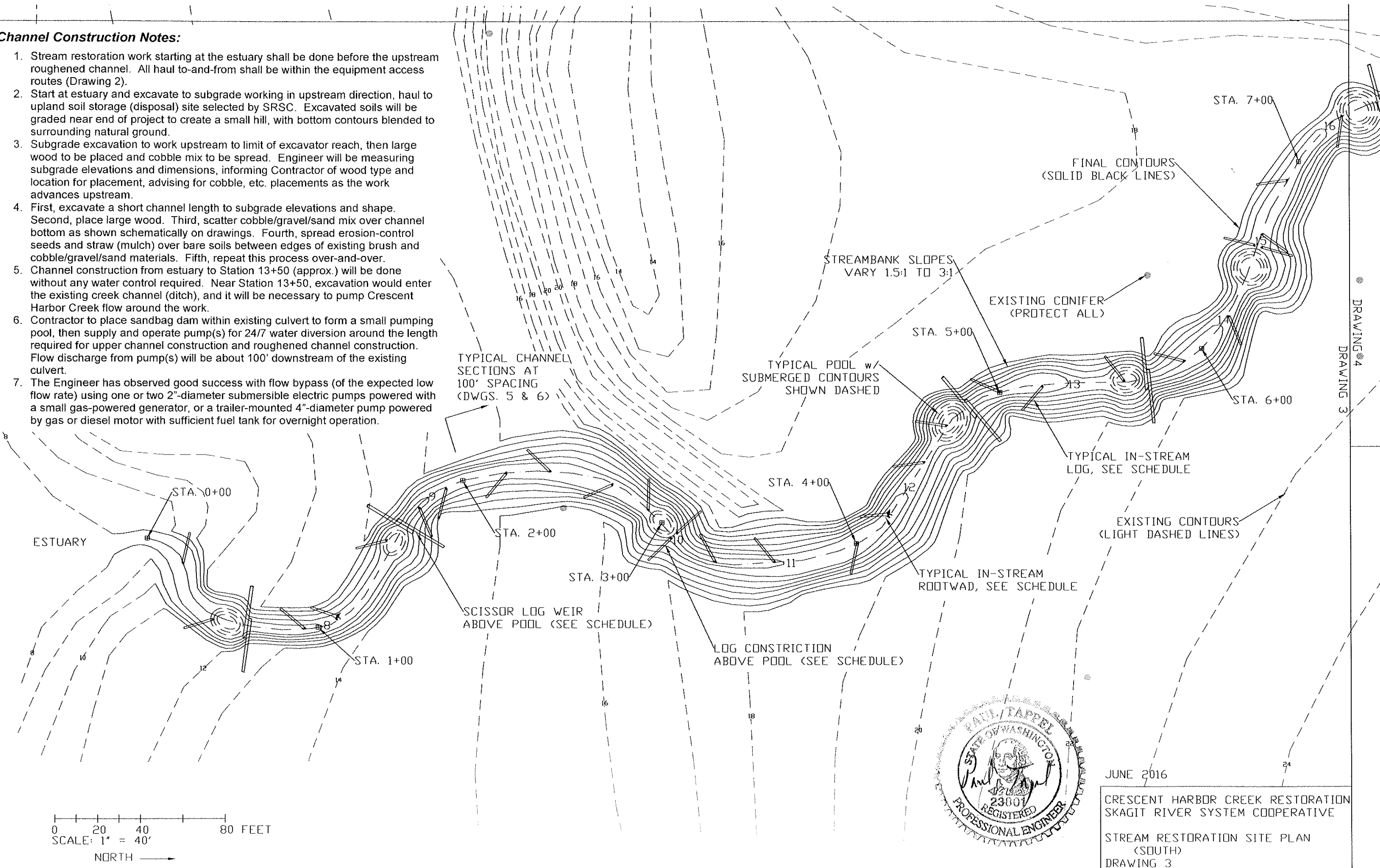
JUNE 2016

CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE
SITE PREPARATION & CLEARING
DRAWING 2



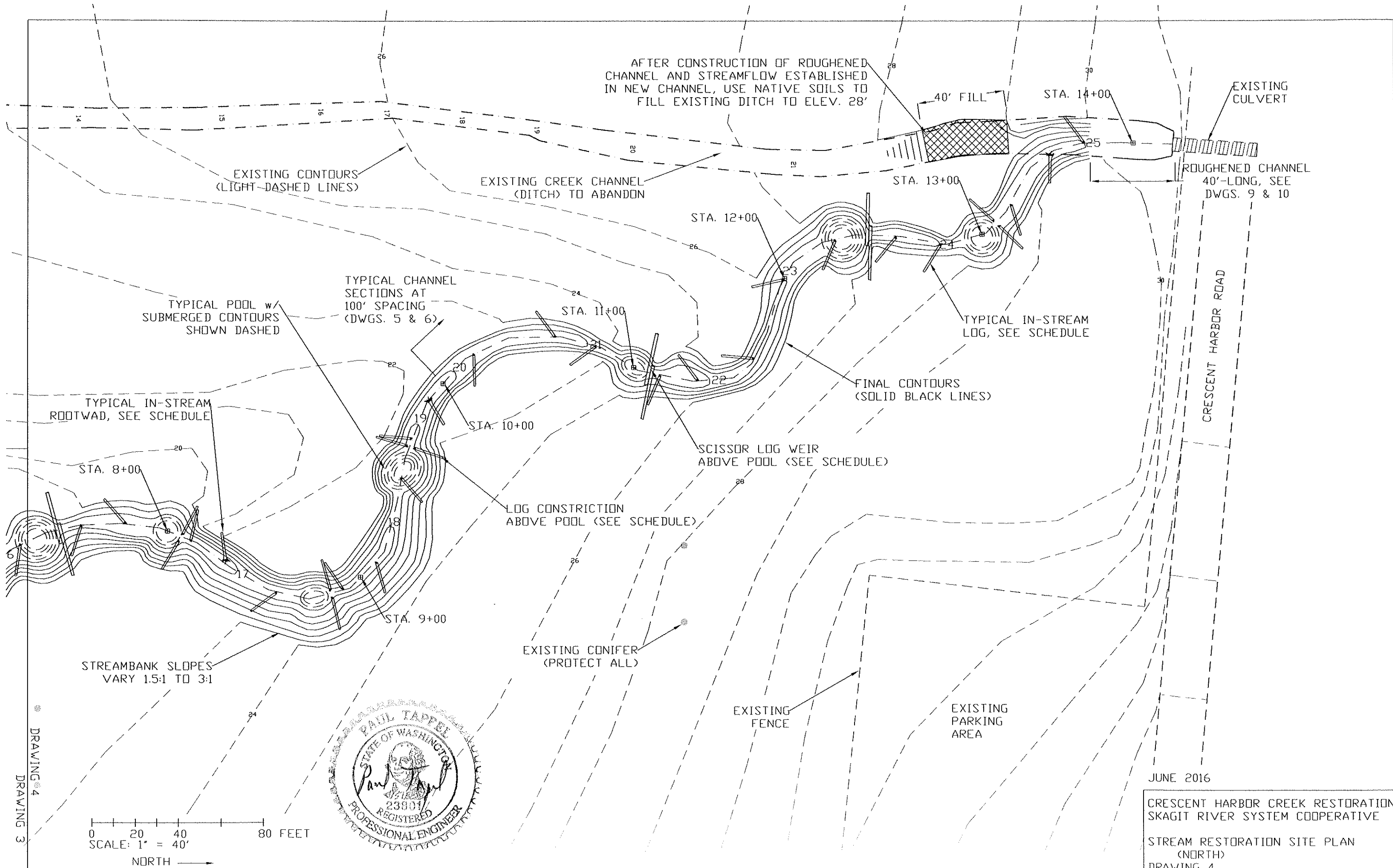
Channel Construction Notes:

1. Stream restoration work starting at the estuary shall be done before the upstream roughened channel. All haul to-and-from shall be within the equipment access routes (Drawing 2).
2. Start at estuary and excavate to subgrade working in upstream direction, haul to upland soil storage (disposal) site selected by SRSC. Excavated soils will be graded near end of project to create a small hill, with bottom contours blended to surrounding natural ground.
3. Subgrade excavation to work upstream to limit of excavator reach, then large wood to be placed and cobble mix to be spread. Engineer will be measuring subgrade elevations and dimensions, informing Contractor of wood type and location for placement, advising for cobble, etc. placements as the work advances upstream.
4. First, excavate a short channel length to subgrade elevations and shape. Second, place large wood. Third, scatter cobble/gravel/sand mix over channel bottom as shown schematically on drawings. Fourth, spread erosion-control seeds and straw (mulch) over bare soils between edges of existing brush and cobble/gravel/sand materials. Fifth, repeat this process over-and-over.
5. Channel construction from estuary to Station 13+50 (approx.) will be done without any water control required. Near Station 13+50, excavation would enter the existing creek channel (ditch), and it will be necessary to pump Crescent Harbor Creek flow around the work.
6. Contractor to place sandbag dam within existing culvert to form a small pumping pool, then supply and operate pump(s) for 24/7 water diversion around the length required for upper channel construction and roughened channel construction. Flow discharge from pump(s) will be about 100' downstream of the existing culvert.
7. The Engineer has observed good success with flow bypass (of the expected low flow rate) using one or two 2"-diameter submersible electric pumps powered with a small gas-powered generator, or a trailer-mounted 4"-diameter pump powered by gas or diesel motor with sufficient fuel tank for overnight operation.

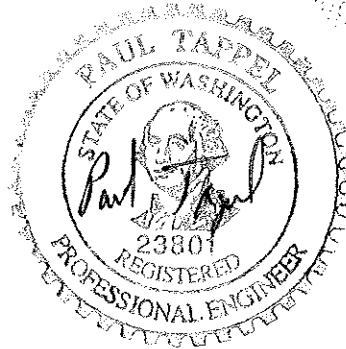
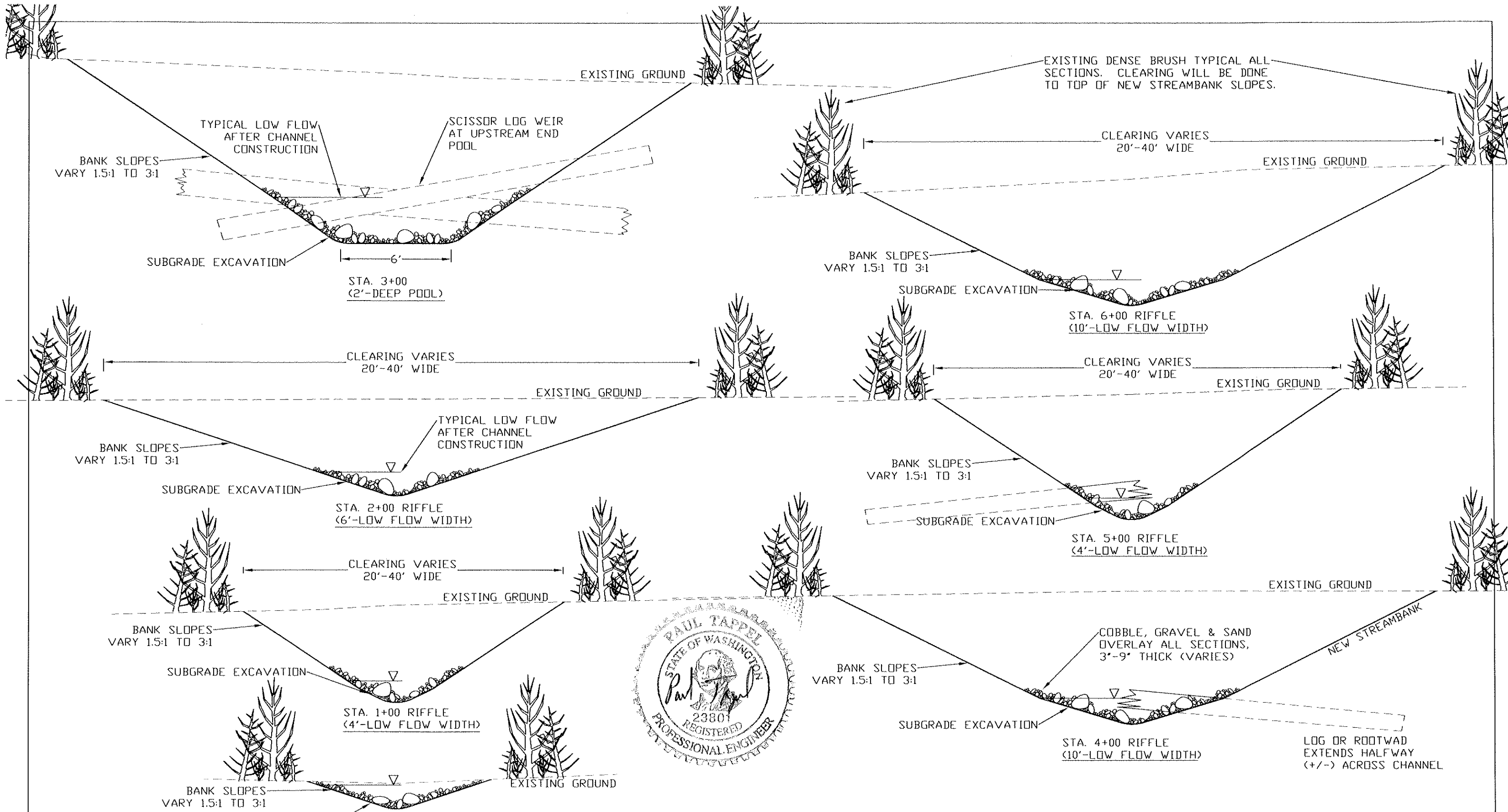


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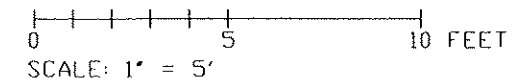
CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE
STREAM RESTORATION SITE PLAN
(SOUTH)
DRAWING 3



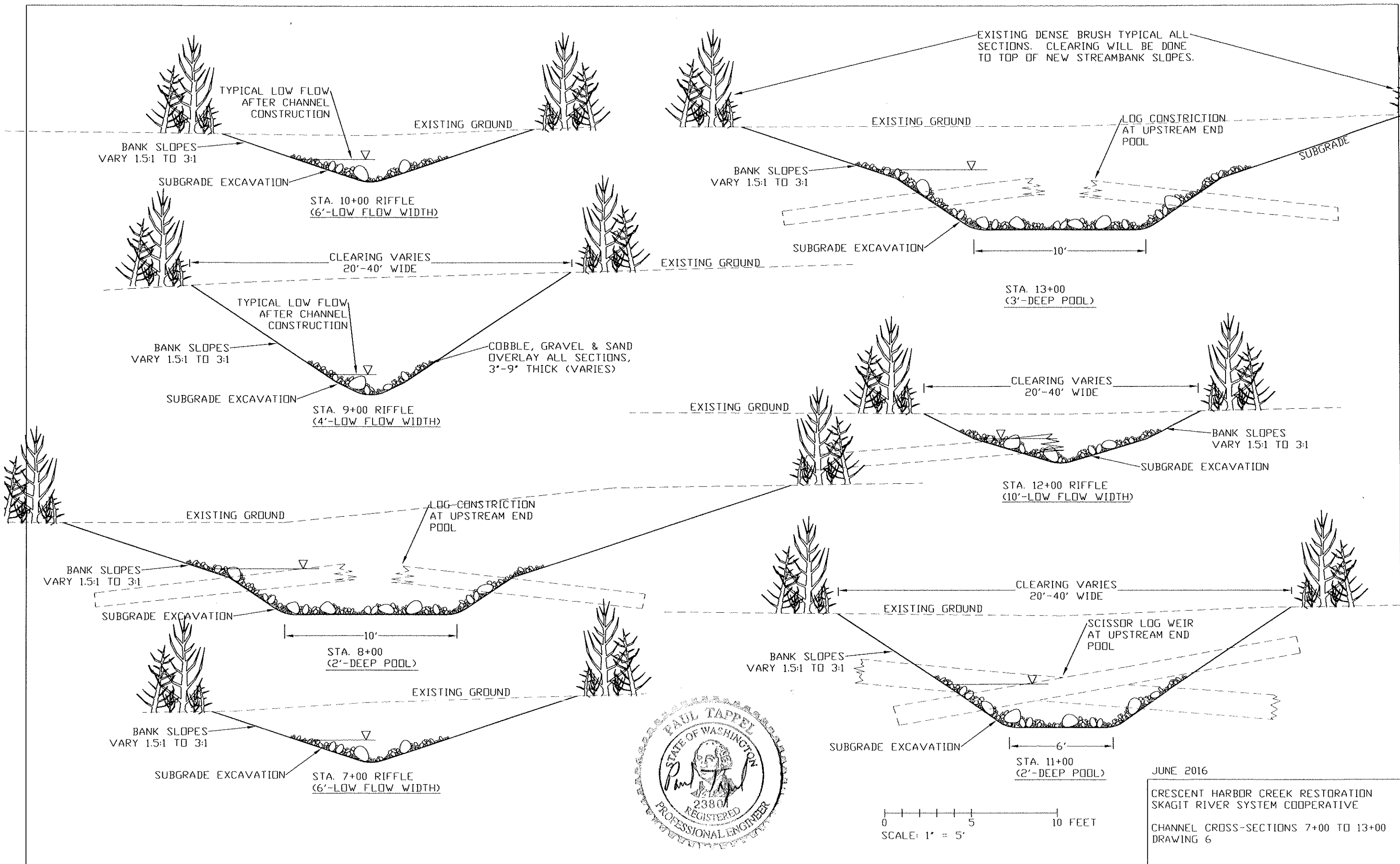
DRAWING 4
DRAWING 3



STA. 0+00 LOCATED AT ESTUARY, STA. 1+00 LOCATED 100' UPSTREAM ALONG NEW CHANNEL ALIGNMENT, etc. ENGINEER WILL LOCATE ALL CHANNEL STATIONS.



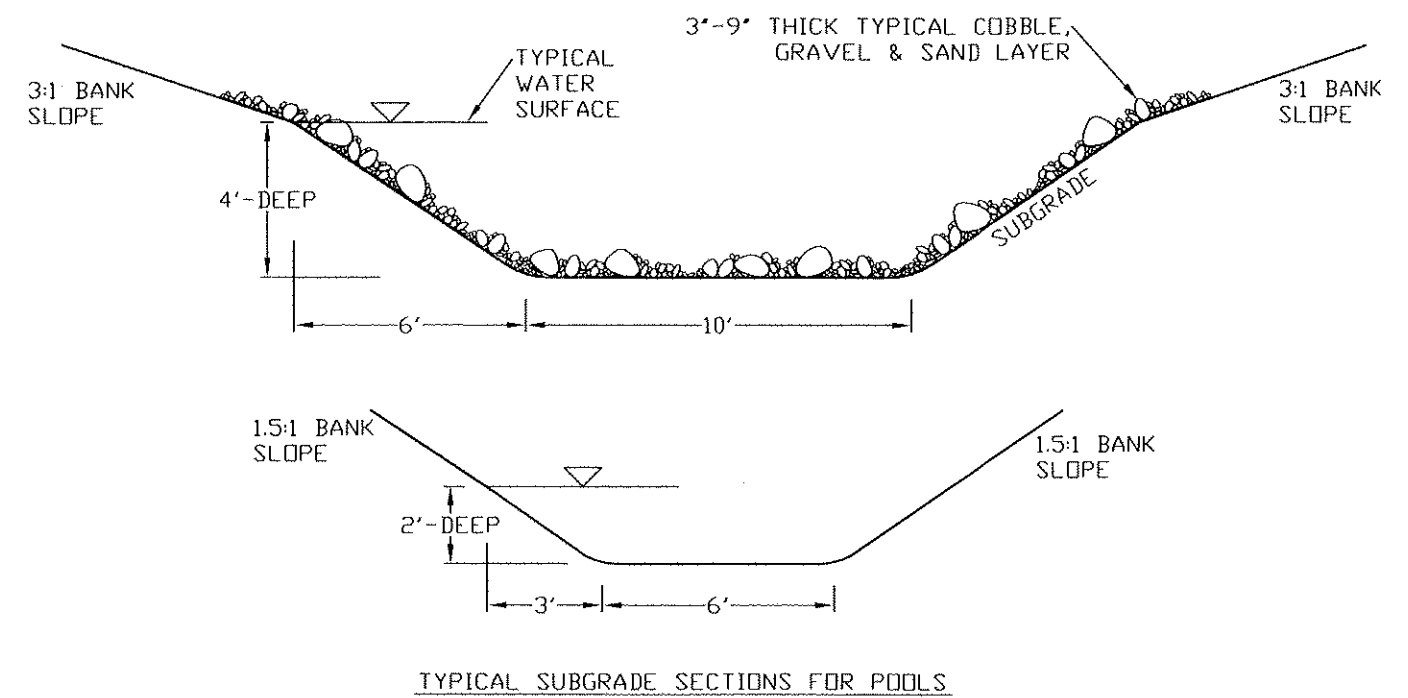
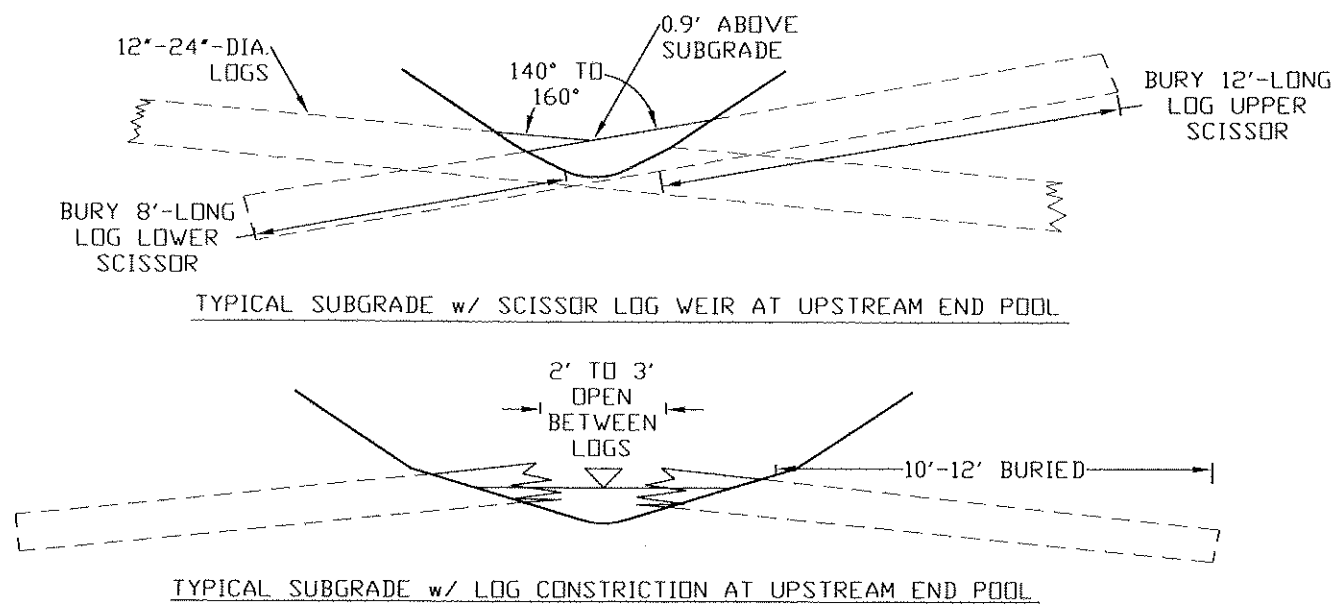
JUNE 2016
CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE
CHANNEL CROSS-SECTIONS 0+00 TO 6+00
DRAWING 5



JUNE 2016

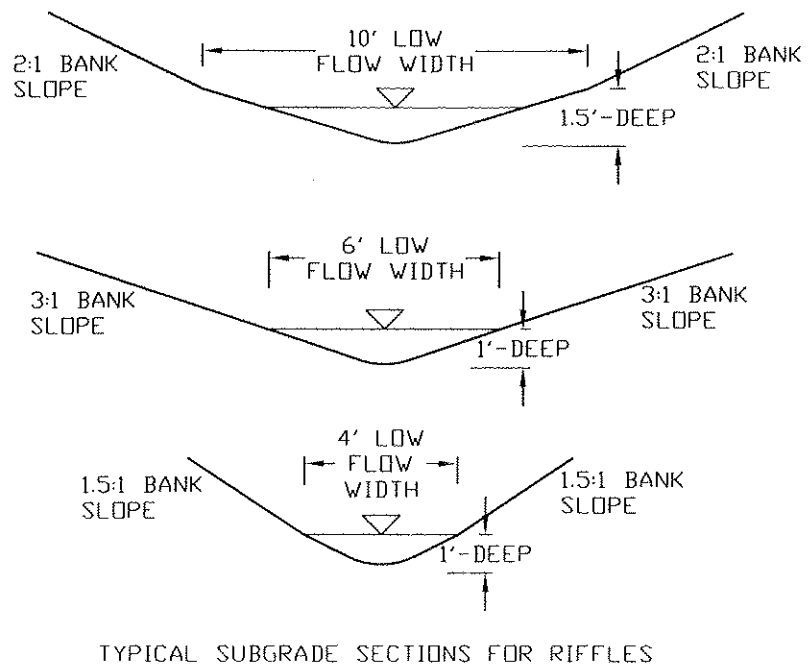
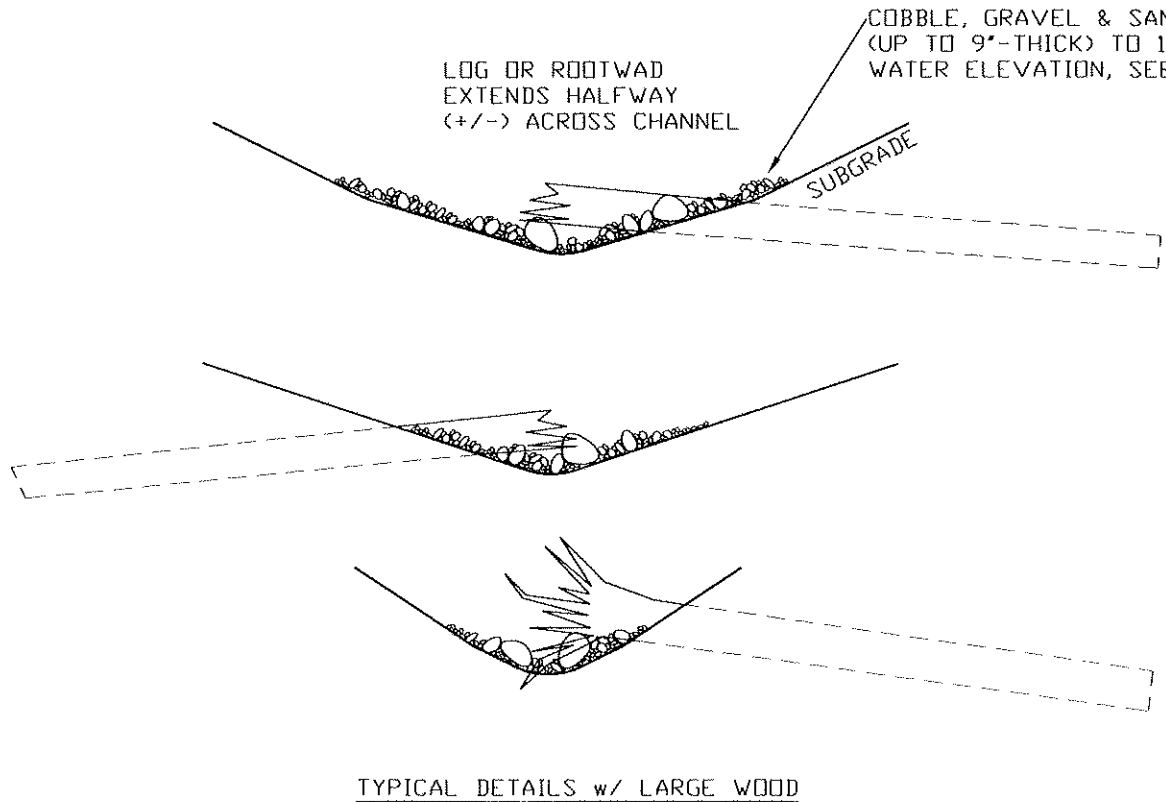
CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE

CHANNEL CROSS-SECTIONS 7+00 TO 13+00
DRAWING 6



Channel Subgrade, Large Wood & Cobble/Gravel/Sand Mix Notes:

1. Typical channel dimensions shown this drawing. Actual dimensions will vary along the restored channel length, within the limits shown.
2. Low flow riffle widths 4' to 10'-wide w/ variable bank slopes.
3. Pools 2' to 4'-deep by 10' to 20'-wide w/ variable bank slopes.
4. All logs and logs w/ rootwads to be salvaged from Crescent Harbor Creek estuary at low tide. Select logs 12"-24" trunk diameter (+/-) approx. 15'-25' long.
5. All logs extending into channel shall have broken ends (no sawn ends). Buried log ends may be sawn or broken.
6. Cobble/Gravel/Sand to contain the four materials listed below, each at 1/4 of the mix by volume:
 Rounded cobbles 6" to 18"-size.
 Gravel 2" to 6"-size
 Gravel 1" to 2"-size.
 Washed sand.
 (these size ranges may vary slightly)



0 5 10 FEET
SCALE: 1" = 5'

JUNE 2016
CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE
SUBGRADE SECTIONS & TYPICAL CHANNELS
DRAWING 7



Crescent Harbor Creek Restoration

Channel Design Data from Estuary to Crescent Harbor Road

Log & Rootwad Placement Schedule			Subgrade Slope & Elevation, Riffle & Pool Designation and Data					
Cumulative Distance from Estuary (ft)	Log or Rootwad	Streambank	Reach Length (ft)	Reach Slope	Cumulative Distance from Estuary (ft)	Subgrade Elevation (ft)	Reach Type	Wood at Upstream End Pool
20	log	west	0	0.00	0	7.1	rifle	
50	log	east	40	0.01	40	7.5	rifle	
90	log	west	5	-0.60	45	4.5	pool	
110	rootwad	west	10	0.00	55	4.5	pool	
150	log	west	5	0.60	60	7.5	pool	scissor log weir
170	log	east	40	0.01	100	7.9	rifle	
190	log	east	40	0.02	140	8.7	rifle	
220	log	east	5	-0.40	145	6.7	pool	
240	log	west	10	0.00	155	6.7	pool	
270	log	east	5	0.40	160	8.7	pool	scissor log weir
290	log	west	20	0.01	180	8.9	rifle	
330	log	west	30	0.01	210	9.2	rifle	
360	log	west	40	0.01	250	9.6	rifle	
400	log	east	40	0.01	290	10.0	rifle	
420	rootwad	west	5	-0.40	295	8.0	pool	
450	log	west	10	0.00	305	8.0	pool	
470	log	west	5	0.40	310	10.0	pool	log constriction
500	log	west	30	0.01	340	10.3	rifle	
520	log	east	30	0.03	370	11.2	rifle	
560	log	west	20	0.01	390	11.4	rifle	
590	log	west	30	0.01	420	11.7	rifle	
620	log	east	40	0.02	460	12.5	rifle	
660	log	east	5	-0.80	465	8.5	pool	
690	log	west	10	0.00	475	8.5	pool	
730	log	east	5	0.80	480	12.5	pool	scissor log weir
760	log	east	40	0.02	520	13.3	rifle	
780	log	west	30	0.01	550	13.6	rifle	
810	log	west	5	-0.60	555	10.6	pool	
830	rootwad	west	10	0.00	565	10.6	pool	
860	log	east	5	0.60	570	13.6	pool	scissor log weir
890	log	west	20	0.01	590	13.8	rifle	
910	log	east	40	0.02	630	14.6	rifle	
950	log	east	5	-0.60	635	11.6	pool	
970	log	west	10	0.00	645	11.6	pool	
990	rootwad	east	5	0.60	650	14.6	pool	log constriction
1020	log	east	30	0.01	680	14.9	rifle	
1060	log	west	40	0.02	720	15.7	rifle	
1080	log	east	5	-0.80	725	11.7	pool	
1110	log	east	10	0.00	735	11.7	pool	
1130	log	west	5	0.80	740	15.7	pool	scissor log weir
1160	log	west	20	0.01	760	15.9	rifle	
1200	log	west	20	0.02	780	16.3	rifle	
1230	log	east	5	-0.40	785	14.3	pool	
1260	log	east	10	0.00	795	14.3	pool	
1280	log	east	5	0.40	800	16.3	pool	log constriction
1320	log	east	30	0.01	830	16.6	rifle	
1350	rootwad	east	30	0.01	860	16.9	rifle	
1380	log	west	5	-0.40	865	14.9	pool	
1400	roughened channel		10	0.00	875	14.9	pool	
1420	roughened channel		5	0.40	880	16.9	pool	log constriction
			20	0.01	900	17.1	rifle	
			40	0.02	940	17.9	rifle	
			5	-0.80	945	13.9	pool	
			10	0.00	955	13.9	pool	
			5	0.80	960	17.9	pool	log constriction
			40	0.04	1000	19.5	rifle	
			20	0.02	1020	19.9	rifle	
			30	0.01	1050	20.2	rifle	
			30	0.01	1080	20.5	rifle	
			5	-0.60	1085	17.5	pool	
			10	0.00	1095	17.5	pool	
			5	0.60	1100	20.5	pool	scissor log weir
			20	0.02	1120	20.9	rifle	
			20	0.03	1140	21.5	rifle	
			20	0.01	1160	21.7	rifle	
			40	0.02	1200	22.5	rifle	
			20	0.01	1220	22.7	rifle	
			5	-0.80	1225	18.7	pool	
			10	0.00	1235	18.7	pool	
			5	0.80	1240	22.7	pool	scissor log weir
			40	0.01	1280	23.1	rifle	
			5	-0.60	1285	20.1	pool	
			10	0.00	1295	20.1	pool	
			5	0.60	1300	23.1	pool	log constriction
			20	0.01	1320	23.3	rifle	
			30	0.02	1350	23.9	rifle	
			30	0.03	1380	24.8	rifle	
			5	-0.50	1385	22.3	roughened channel	
			35	0.03	1420	23.4	roughened channel	

PAUL TAPPEL

STATE OF WASHINGTON

23801

REGISTERED

PROFESSIONAL ENGINEER

Notes to Incorporate Data into Construction:

1. Engineer will determine channel centerline alignment on-site.

2. Engineer will set clearing limits at 50' on-center for clearing.

3. Engineer will survey and measure real-time as construction work proceeds in upstream direction. On-site references will be provided to contractor including subgrade elevations and slope, pool or riffle, streambank slopes, log and rootwad placement.



Notes to Incorporate Data into Construction:

1. Engineer will determine channel centerline alignment on-site.
2. Engineer will set clearing limits at 50' on-center for clearing.
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JUNE 2016

CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE

CHANNEL CONSTRUCTION DATA
DRAWING 8



NEW STREAM CHANNEL,
DWGS. 3 THRU 8

ROUGHENED CHANNEL,
DWGS. 9 & 10

ROUGHENED CHANNEL SECTION
AT MIDPOINT, DRAWING 10

PROPOSED CONTOURS
SOLID BLACK LINES

ROUGHENED CHANNEL
PROFILE, DWG. 10

STA. 14+00

ORDINARY HIGH WATER
FOR DITCHED ALIGNMENT

THICK LINES SHOW LIMITS FOR
12" TO 24"-SIZE BOULDERS
FOR ROUGHENED CHANNEL

EXISTING CONTOURS
LIGHT DASHED LINES

0 5 10 FEET
SCALE: 1" = 5'

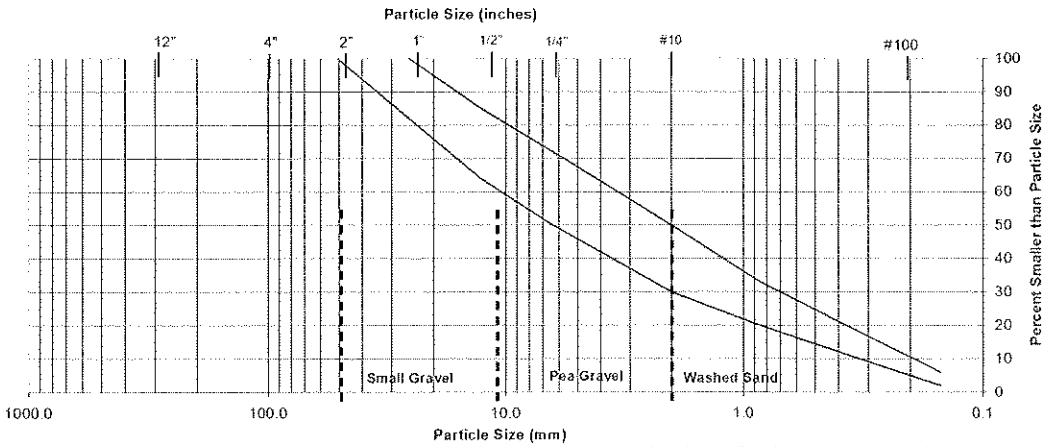
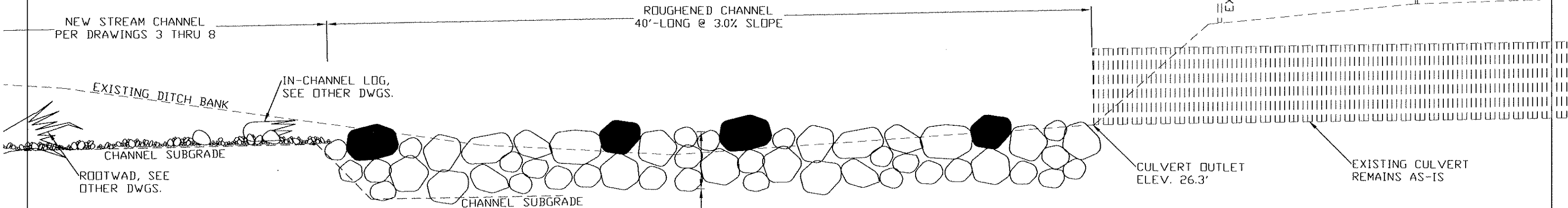
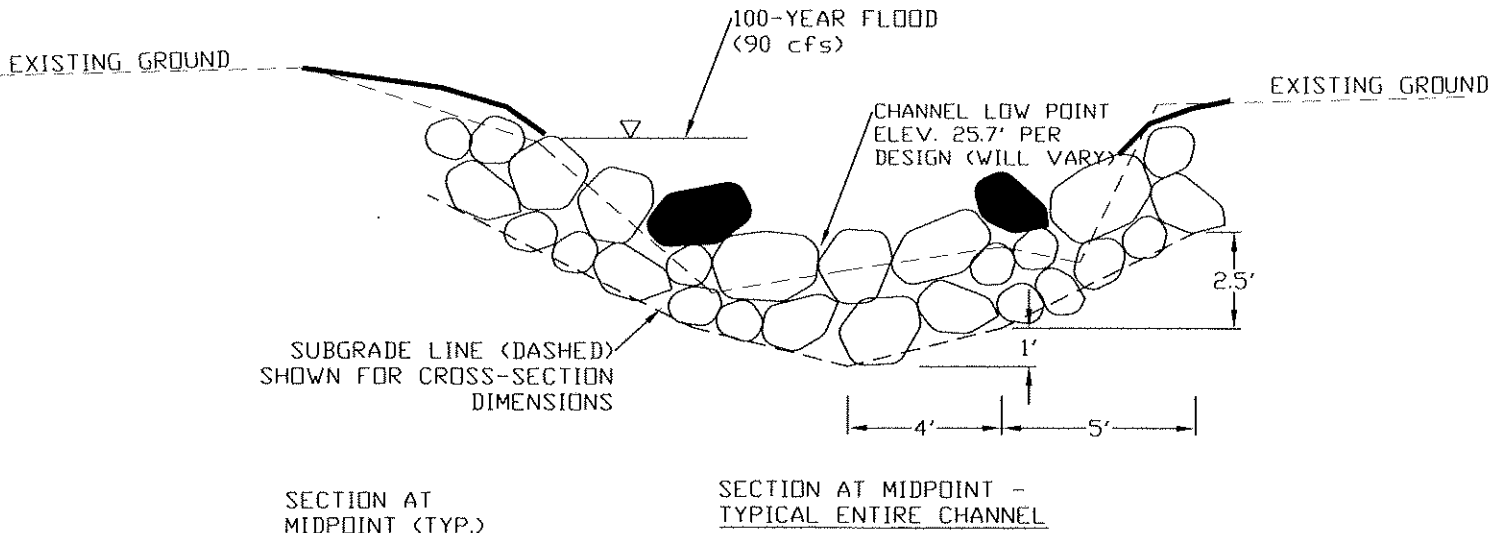
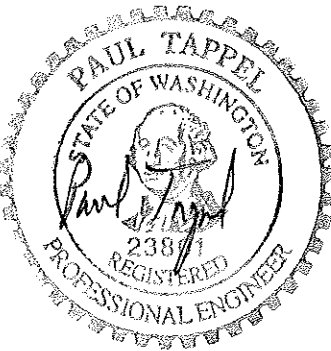
JUNE 2016

CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE

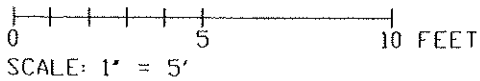
ROUGHENED CHANNEL SITE PLAN
DRAWING 9

Sequence to Construct Roughened Channel:

1. Excavate and/or fill to re-grade existing streambed and bank materials for roughened channel subgrade (Engineer will survey). Subgrade to follow bottom of boulders 3' below final surfaces, and will slope up from low point across each section.
2. Place 12" to 24"-size boulders in 3'-thick layer, with random distribution of sizes within the specified size range. Engineer will place tall metal stakes and rope lines for visual guidance to operator for boulder placements. Tops of boulders shall be within +/- 1' of elevations indicated by on-site rope lines, with the top surfaces uneven across any section.
3. Every 5th boulder (+/-) to extend about 1' above overall final surfaces, with about 1' of these boulders otherwise buried in the roughened channel fill. These boulders (for increased channel roughness) shown solid black this drawing.
4. Boulders along the channel bottom meander (low points) shall be within 0.5' of design elevation (3.0% slope) for a low flow channel width varying 2' to 4'-wide.
5. Leave a 3'-diameter void in downstream end boulder layer to allow water to pond up, then use this water for recycle sluicing of gravel & sand into voids. This opening will be left after channel construction, and will quickly fill with native streambed materials.
6. Fill all voids between boulders with gravel & sand (see chart) by sluicing and shoveling. Creek water will be recycled for the sluice operations. Sluice gravel & sand until water ponds up on the surface, over the entire low flow channel bottom; sluicing does not need to be as thorough for streambank slopes (Engineer will advise).



Gravel & sand mix to fill rough channel voids, composed of 1/4 washed gravel (1" to 2" size), 1/4 pea gravel, and 1/2 washed sand (< 2 mm size).



JUNE 2016

CRESCENT HARBOR CREEK RESTORATION
SKAGIT RIVER SYSTEM COOPERATIVE

ROUGHENED CHANNEL PROFILE & DETAILS
DRAWING 10