White River Shoreline Erosion Hazard Assessment and Monitoring Report #3

Crystal River Ranch Homeowner's Association

Pierce County, WA

June 2017

Larry Dominguez, Senior Ecologist

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Introduction

Since the mid 1990s, the Crystal River Ranch Homeowner's Association (CRR) has been addressing risk of shoreline loss as related to community property and infrastructure. Increased interest in 2006 following successive major high flow events led to a series of management actions. In 2010, major measures were undertaken to address the issue. This included placement of 14 buried rock vanes. Extensive vegetation planting occurred landward of the Ordinary High Water Mark. These buried structures were an appropriate application to define the limits of a modified migration corridor. The design minimized the regulatory effort needed for bank protection, however CRR realized that monitoring would be needed to access the functional states and effectiveness of the structures. Undocumented year-to-year variation in bank loss, channel shifting, tree loss and vegetation changes can mislead as to how extensive and at what rate the erosion occurs.

From 2013 to 2016, CRR secured the services of independent contractor Senior Ecologist Larry Dominguez who is now an employee of KPFF Consulting Engineers Lacey, WA (www.kpff.com). Mr. Dominguez worked with CRR Board members to institute a rapid assessment and monitoring protocol for documenting the changing characteristics of the shoreline and to consult on peripheral issues related to the long-term protection of the community wellhead infrastructure and community properties. A complete record of the project history, construction and follow-up technical memorandums can be found at the Crystal River Ranch website under the shoreline tab http://crystalriverranch.org/shoreline-erosion/.

Summary

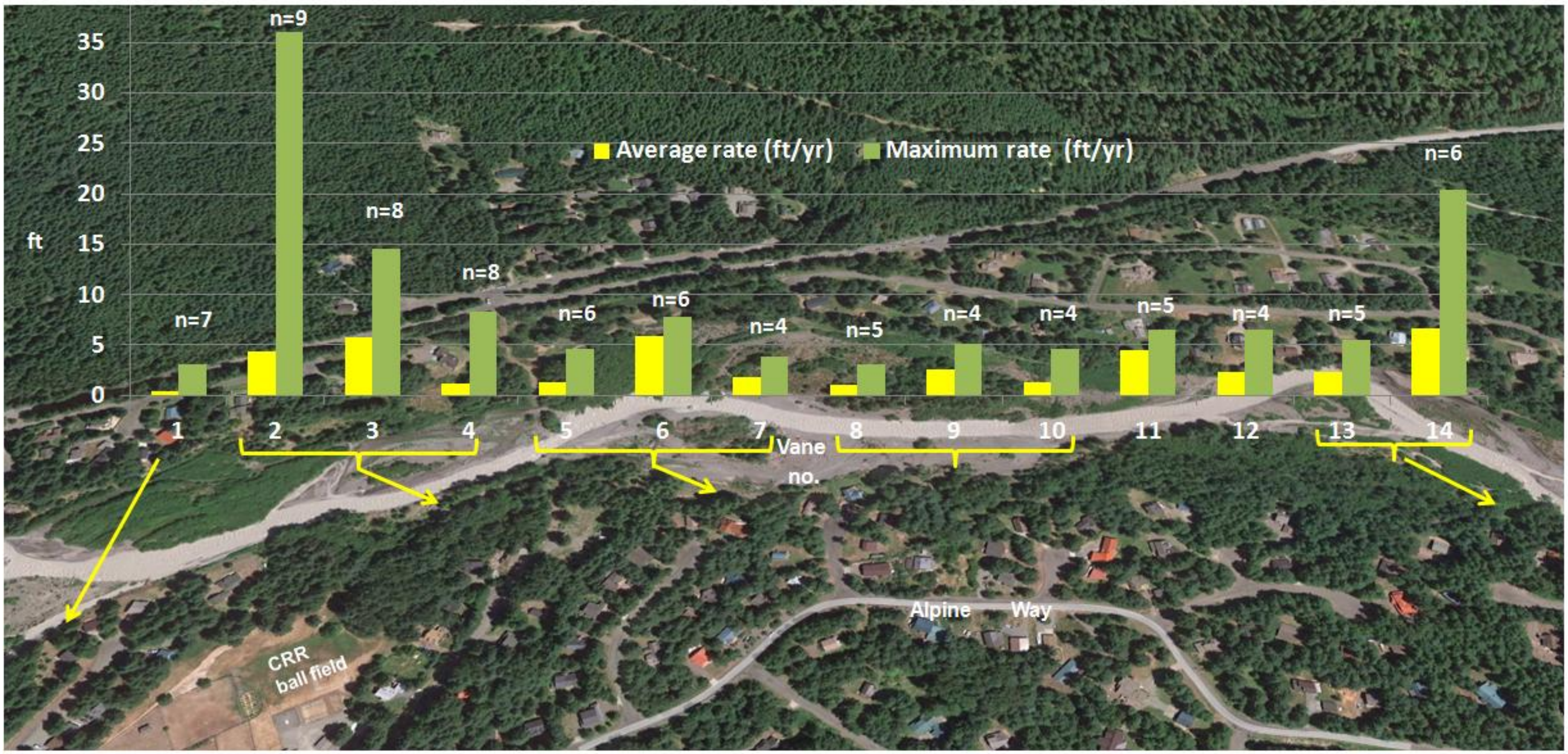
Shoreline Erosion

Erosion is a natural process in particular those with heavy sediment loads such as the White River that causes the active channels to widen. Throughout the past 5 years of assessment, we considered other causal mechanisms contributing to the erosion hazard. Two conditions may be additionally contributing to the extent of the lateral (side to side) channel movement. Namely these are the documented high bedload movements from upstream tributary sources as a result of an era of forest practices and a relatively narrow-width bridge (Crystal River Ranch Road East; NF-74) that may be affecting the sediment transport ability of the White River during high flow events. These two factors need concerted attention in long-term management plans.

Based on 3 different periods of estimating shoreline erosion extent in the project vane area from 2013 to 2017, erosion rates varied through the vane areas (see Estimated Bank Erosion Rate graphic page 4). Some areas experienced accelerated erosion rates through the 2016-2017 winter even though there was not necessarily a major flood event. The three main forces causing erosion, water (flows and rainfall), wind, and ice are all working in concert in the reaches most affected by erosion. Ancient lahar (mudflow) sediments layered with highly erodible volcanic ash and pumice content do not offer much resistance to these forces thus the continued observation of lateral erosion under normal flows. The next assessment will evaluate continuing erosion at the 14 vane sites and look at the effects of bridge width and sedimentation issues in the reach upstream.

Estimated Bank Erosion Rate (ft/year) Fall 2013 – Spring 2017 Crystal River Ranch

79 tree tags have been installed in the project reach, The arrows indicate approximate locations of a rock vane or group of vanes. The number of tree tags varies per vane. The average rate is the average of all tree tags assigned to a vane. The maximum rate is the highest measurement of one tree tag marker for a particular vane. The number of tree tags per site is represented by n.



Assessment Summary

Seventy nine reference markers placed on trees were used to measure changes in the top of bank location. The maximum bank loss rate per year was estimated by analyzing each reference marker over time. Three sets of measurements have been made; November 1, 2013, September 24, 2016 and May 16, 2017. The highest rate of erosion observed in this period of baseline assessment was 36 feet/year at Vane 2. The overall average for all sites was 3 ft/year.

Management Planning

Both Flood and Erosion Hazard exist on the community property and adjacent private properties. Cooperation with development/residential entities across the river and governmental agencies and land owners and managers with vested interest in road infrastructure should be involved with ongoing procedures for addressing the erosions and flood hazard risk in the reach. CRR is in a position to develop a coordinated reach plan to address long term shoreline management issues. They will be able to demonstrate to county and regional management jurisdictions that they have conducted due diligence to track the ongoing risk to community property.

Other Reach Observations

Bridge Effects

The CRR reach of the White River has an upstream and downstream river crossing with bridges. Downstream is the Crystal River Ranch Road East (FS Road 74) and upstream is Forest Service Road 73. They both have similar dimensions between bridge piers at just under 90 feet. Outside the bridge piers there is additional capacity for flow but substantially less for FS Road 74. Channel widening upstream of both the bridges may be an indication that the channel narrowing at the bridge spans are affecting the sediment transport capability of the stream at higher flows. Active channel estimates from field and aerial photos indicate narrow sections that are less than 100 feet wide near the crossings while wider sections are upwards of 300 feet or more.

CRR should investigate this at a larger reach level. Past hydrologic modeling conducted by WSDOT included the CRR reach but not at a frequency of cross sections that would begin to address the influence these structures are having on the reach. Past analyses that led to the design of the bridge undoubtedly considered their effects on sediment transport but may have given a greater consideration for hydraulics and meeting zero-rise analyses[1] requirements.

Properties along the river side of Birch Way East have a flood hazard based on their being minimal topographical rise between the main channel and properties and the continued buildup of bedload and/or logjam formation within the main channel could promote channel avulsion (rapid abandonment of the main river channel and the formation of a new river channel(s) into those properties.

Toe Erosion Bio-engineering

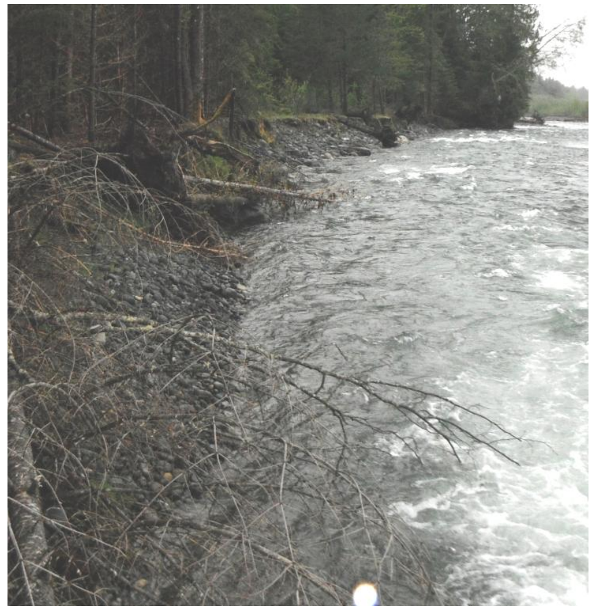
Chronic erosion is occurring at the toe of slopes amidst most all the length of the shoreline. Livestake and fascine bundles are common low-impact bank stabilization techniques. Toe stabilization using fast growing shrubs and trees has been demonstrated on the White River banks in areas that have some type of protection during flood stages such as an outcrop or debris accumulation. Such applications do not typically work well in high energy areas. Bank Stabilization Appendix C provides some stopgap measures to promote riparian vegetation growth that contributes to bank stabilization.

[1] A zero-rise analysis determines that no increase in base flood elevation, displacement of flood volume, or flow conveyance reduction will occur as a result of the development or structure.

APPENDIX A
PHOTOS

Photo Log White River Shoreline Assessment May 16, 2017

Vane 1 area has no erosion evidence and setback from the active channel.



Vane 2 (background) and Vane 3 (foreground) areas have active toe erosion at normal flows.

Vane 3 area is experiencing active toe erosion and slight exposure of the buried vane.

Vane 4 area is somewhat stable yet exposed to eroding flows at higher flow levels.

Vane 5 area is setback from the deepest part of the channel and although experiencing some chronic erosion at higher flows, over the last couple of years vegetation has established at the toe.

Vane 6 area contains some of the most at-risk, loosely consolidated soils and is an an example of significance of other types of erosion than direct flows such as rain, wind, freeze-thaw, etc.

Vane 7 area although experiencing strong turbulent flows along the channel margin during flood events is the least actively-eroding site hosting vegetation growth and woody debris collection.

Vane 8 area has accumulated logs along the channel margin but they appear somewhat transient in nature. This vane area has also experienced one of the lowest erosion rates.

Vane 9 area is experiencing minimal erosion of the top of bank but has extensive undercut. The slower erosion rate relative to other areas may be aided by recruitment of non-tagged trees recruiting and positioning at the toe.

Vane 10 area has been largely unaffected through the evaluation. Fine sediment deposition occurs during flood stage due to downstream structure causing backwater. This area is a candidate for vegetation establishment before the downstream structures break apart and the backwatering effect is lost.

Vane 11 is exposed to flowing water at all river levels at this time and actively eroding. Portions of the buried vane are exposed as evidenced by the large boulder in the foreground.

Vane 12 area has lost some tree markers due to erosion and is exposed to chronic toe erosion at normal flows. The site has some recruited wood along the toe but appears transient.

 Vane 13 area remains setback from erosive flood channel flows protected by a young alder stand.	 Vane 14 area is experiencing active toe erosion at normal flows. Loss of bank upstream is contributing to increased exposure and this area can be expected to see increased erosion rates in coming years.

The area between vanes 12 and 13 is exposed to flowing water at flood levels and is highly undercutting. Newly fallen trees, large trees on undercut banks, loosely consolidated bank material and direction of flows during flood events make this area a candidate for severe erosion in coming years.

APPENDIX B
RAW DATA

Tree marker descriptions. Fourth through sixth columns list the distance between tree marker and closest undisturbed top of bank for assessments conducted November 1, 2013, September 24, 2016 and May 16, 2017. Distance is in feet. DNE means "does not exist". If DNE is in a column and measurements occur at later dates, this marker was added after original survey. If DNE is in a column after measurements occurred, the tree marker was not recovered due to the tree recruiting to the river.

Vane	Tree/mark	Description	Distance to Nearest Undisturbed Top of bank (ft)			Baseline Distance from Vane heel (ft)	azimuth from heel peg (degrees)
			Nov 1, 2013	Sept 24, 2016	May 16, 2017		
1	401	fir	7	7.0	7.0	131	239
1	402		0.1	0.1	0.1	139	236
1	406	cottonwood	13	13.0	1.5	192	248
1	405	lg central tree	93.5	93.5	93.5	52.8	
1	407	small bench	3.0	3.0	3.0	93	199
1	408	snag	0.1	0.1	0.1	151.5	
1	toe peg		6.5	6.5	6.5		
2	459	dwnstrm of vane 2, alder cluster	DNE	0.1	0.1	-	-
2	409	gone	3.5	DNE	DNE	93.9	195
2	410	gone	11.5	DNE	DNE	80.5	203
2	411	gone	4	DNE	DNE	82.5	217
2	412	cottonwood	19.5	19.5	0.0	63.3	224
2	413	gone	3	DNE	DNE	83.8	243
2	414	cottonwood	50.5	45.5	45.2	97.5	293
2	415		6	0.1	0.1	132.0	275
2	416		11	4.5	4.5	52.5	283
2	toe peg	gone	2.0	0.1	DNE		
2	460		DNE	5.7	5.7		
2	heel peg	heel peg	DNE	DNE	58.0		
3	461	grand fir; in small grove		25.2	25.2		
3	417	gone	5	5.0	DNE	75	243
3	418	gone	7.85	7.85	DNE	93	252
3	419	gone	5	5.0	DNE	105	256
3	420	gone	5.75	5.75	DNE	138	265
3	toe peg	gone	1.5	DNE	DNE		
3	heel peg		DNE	98.0	61.5		
3	462		DNE	22.0	21.0		
3	463		DNE	19.0	19.0		
4	421	ctnwd	27.3	4.0	4.0	64.6	335
4	422	gone	7.6	DNE	DNE	740.1	346
4	423	gone	6.5	DNE	DNE	59.7	5
4	424	fir	27	22.6	22.0	45.5	70
4	425	ctnwd	4.5	4.5	DNE	59.8	47
4	426	fir	8	8.0	8.0	23.4 (distance from	320
4	464		DNE	1.0	1.0		
4	470				11.5		
4	toe peg		7.5	7.5	7.5	121.8	
4	heel peg		DNE	DNE	46.5		
5	427		7.5	6.0	6.0	73.5	77
5	428		10.5	0.1	DNE	69	112
5	429		18	18	15.5	69	121
5	430		80.1	7.0	6.6	98.9	131
5	465	cedar, 10" dbh	DNE	24.6	23.5		
5	toe peg		7.0	6.0			
5	485		DNE	DNE	21		
6	431		3.75	3.0	0.1	60	65
6	432		8.45	8.45	5.5	60	81
6	433		13.4	13.4	9.2	100.5	122
6	toe peg		6	6	3.3	75	102
6	heel peg		DNE	DNE	6.2		

Tree marker descriptions continued. Fourth through sixth columns list the distance between tree marker and closest undisturbed top of bank for assessments conducted November 1, 2013, September 24, 2016 and May 16, 2017. Distance is in feet. DNE means “does not exist”. If DNE is in a column and measurements occur at later dates, this marker was added after original survey. If DNE is in a column after measurements occurred, the tree marker was not recovered due to the tree recruiting to the river.

Vane	Tree/mark	Description	Distance to Nearest Undisturbed Top of bank (ft)			Baseline Distance from Vane heel (ft)	azimuth from heel peg (degrees)
7	434		30.0	22.3	20.2	23.4	28
7	435	gray pvc stake by new, small tree	9.8	9.8	8.0	42	83
7	436	Nahume property, fir at fenceline	27.0	27.0	27.0	69	131
7	toe peg		0.1	0.1	0.1	73.5	105
7	heel peg		DNE	DNE	43		
8	437		6.5	6.5	4.8	55.5	75
8	438		13.2	13	12.5	49.5	75
8	439		40.5	36	36	42	126
8	440		6.75	6.75	6.75	78	106
8	toe peg			7.6	7.6	61.8	98
8	heel peg		DNE	DNE	54.5		
9	441		2	2	0.1	76.5	87
9	442		5	5	5	87	101
9	443		54	41	38.2	43.5	126
9	toe peg		10.45	10.45	9.7	75	95
10	444		20.25	20.25	20.2	29.7	31
10	445		2	0.1	0.1	73.5	74
10	446		3.5	3.5	3.5	58.5	101
10	toe peg		8	8	5.5	73.4	80
10	heel peg		DNE	DNE	51.5		
11	447	alder	6.5	0.1	DNE	108	76
11	448	gone	14.65	0.1	DNE	141	91
11	toe peg		12	1.0	DNE	129	86
11	466	alder		11.7	8.2		
11	467	cottonwood 18"		19.0	16		
11	471				13.5		
12	449	gone	4.5	0.10	DNE	51	28
12	450	stump	4.3	1.0	DNE	57	82
12	451		14	14	10.5	77.5	107
12	472		DNE	DNE	22.0		
12	toe peg		0.1	0.1	DNE	73.5	107
12	heel peg				37.3		
13	452	alder	36	36	33.0	43.5	0
13	453	alder	4.4	4.4	4.4	36	64
13	454	common to vane 14	0.1	0.1	0.1	70.5	117
13	455		37.8	37.8	36	30.2	150
13	toe peg		5.55	5.55	4.0	56.4	117
13	heel peg		DNE	DNE	44.5		
14	454	common to vane 13	0.1	0.1	0.1	50.8	25
14	456	gone	0.1	0.1	DNE	94.5	125
14	457		8.15	4.0	3.0	85.5	140
14	458		26.5	16.51	16.5	67.5	145
14	468	large pistol-butt cedar		52.0	48		
14	469	cottonwood upstream	DNE	11	DNE		
14	473	large fir	DNE	DNE	31		
14	toe peg	gone	4	DNE	DNE	90.2	131

Qualitative ratings for buried rock vanes. "Vane Function" describes vane interaction with river, "Habitat Risk" regards the potential to negatively impact habitat form and function, and "Bank Erosion Trend" is the level of risk for continued erosion and severity. The ratings are described in *Technical Memorandum; Crystal River Ranch White River Shoreline Assessment and Staff/Crest Gage Siting February 2013* available at crystalriverranch.org/shoreline-erosion.

		Vane1			Vane 2			Vane3			Vane4			Vane5			Vane6			Vane7		
YR	Mo	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend
2012	Oct	1	1	3	1	1	3.5	1	1	2.5	1	1	3.5	1	1	3	1	1	3	1	1	3.5
2013	none																					
2104	none																					
2015	none																					
2016	Sept	1	1	1	3	3	4	3	3	4	1	1	2	1	1	1	2	2	2	2	2	1
2017	May	1	1	1	3	3	4	3	3	4	1	1	2	1	1	1	2	2	1.5	1.5	1.5	1
2018																						
2019																						
2020																						
2021																						
2022																						

		Vane8			Vane9			Vane10			Vane11			Vane12			Vane13			Vane14		
YR	Mo	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend	Vane Function	Habitat Risk	Bank Erosion Trend
2012	Oct	1	1	3.5	1	1	3.5	1	1	1	1	1	2	1	1	3	1	1	2	1	1	2
2013	none																					
2104	none																					
2015	none																					
2016	Sept	1	1	1	1	1	1	1	1	2	1	1	3	1	1	2	1	1	1	1	1	3
2017	May	1	1	1	1	1	1	1	1	2	3	2	3	1	1	3	1	1	1	1	1	3.5
2018																						
2019																						
2020																						
2021																						
2022																						

APPENDIX C
BANK STABILIZATION

Tree and Shrub Planting with Live Stakes

Conservation Practice Job Sheet NH-612

Definition:

A "Live Stake" is a dormant cutting of red-osier dogwood (*Cornus serecia*), gray dogwood (Cornus racemosa), silky dogwood (*Cornus amomum*) or native willow (Salix sp.). The cutting is 3 feet long and is pushed into the soil or inserted into a predrilled hole 2 feet into the ground in April.

Benefits:

- Much cheaper than container stock.
- Easy to plant and handle.
- Dogwood provides wildlife food.
- Pussy Willow (Salix Discolor) provides early season nectar for bees.
- Great for stabilizing stream banks
- Provides a substitute for invasive plants
- Can easily be cut from power lines and other plants

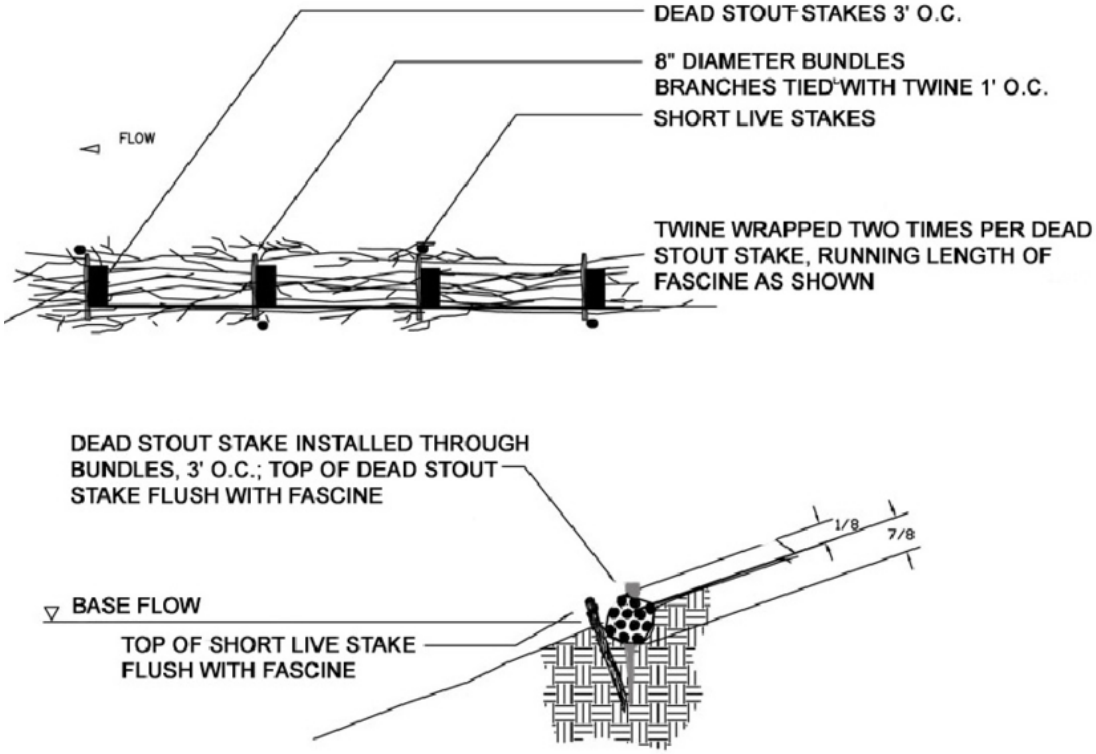
Planting Instructions:

- Plant dormant in April or November
- Plant a three foot stake 2 feet into the ground
- Cut branches with several buds and nodes as these will form roots and new branches
- Live stakes are more vigorous if planted in the spring.
- Plant them as soon as possible after cutting them or receiving them in the mail
- Keep stakes moist and cool while storing them
- Larger diameter stakes have more store energy and often sprout more vigorously
- Best if planted in soils with high water tables (hydric soils) or moderately drained soils with heavy loamy, silty or clayey textures.
- Select non-stoney soils such as flood plains for installation.
- Cut one end of the stake to a sharp point to help push it into the ground.
- Pre-drill a planting hole by hammering a piece of rebar into the ground or use an auger

Above: A red-osier dogwood, live stake which has produced leaves from nodes.

Job Sheet –Tree and Shrub Planting- 612

Livestake cutting placement is an effective method to stabilize bank and to trap flowing debris to help build the bank. Check local Conservation District for the appropriate species use. Source: *USDA Natural Resource Conservation Service*



Typical arrangements of fascine bundles

Live cuttings are dipped in rooting hormone before installation

Combining bundles with live stakes is an effective toe erosion application and helps to trap sediment

Vane Site 14 (above) and 10 (below) are reasonable candidates for fascine bundle placement and/or livestake planting. Both sites are removed from the deepest part of the channel, and dense rooting could be established within a couple of years. Green swaths suggest the location that rows of bundles and live stakes could be planted.

Habitat design engineer views a rock vane from a similar project in the area. The view is downstream with Crystal River Ranch properties on the uplands. The vane is functioning as designed by protecting the toe of the bank from high velocities during average flood flows. The backwatering area (foreground) and downstream eddying (background) that form during higher flows than pictured is settling out smaller than average substrate, trapping large and small woody debris and building bank along the channel margin where live fascine bundles had been planted about 10 years ago on a rapidly-eroding bank.