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TECHNICAL MEMORANDUM

APPENDIX A
PARISH CREEK FISH HABITAT IMPROVEMENT

For: City of Bremerton, WA

By: Rex Meyer, P.E.

January 2013

PROJECT OVERVIEW / INTRODUCTION

This Technical Memorandum has been prepared to study the feasibility and concept alternative review for Parish Creek fish habitat improvements located in rural Kitsap County near Kitsap Square Dance Association at 6800 W. Belfair Valley Road in Gorst, WA. This memorandum explores fish passage problems encountered in Parish Creek downstream of the W. Belfair Valley Road crossing and also includes bank overtopping flood problems from Parish Creek, beginning upstream of the road crossing at the Kitsap Square Dance Association. This portion of Parish Creek was one of 16 sites identified in the Existing Drainage Deficiencies Technical Memorandum prepared as part of the Gorst Creek Watershed Characterization Plan.

The objective of this Fish Habitat Improvement Project technical memorandum is to provide solutions to fish passage in the problem area. To determine the most feasible solution(s), viable alternatives are discussed that generally consider the physical constraints, regulatory requirements, and cost comparisons.

DESIGN AND ANALYSIS METHODOLOGY

Conceptual designs and drainage analysis are developed using Washington State Department of Ecology standards. For preliminary design calculations, the 100-year flow for Parish Creek is based on FEMA Federal Insurance Study No. 53035CV000B, November 4, 2010. The 100-year flows at the mouth of the river about 700' downstream from W. Belfair Valley Road are noted as 255 cfs.

The 100-year flood levels for the Gorst Creek Watershed are illustrated on the FEMA Flood Insurance Map shown below in Figure 1.

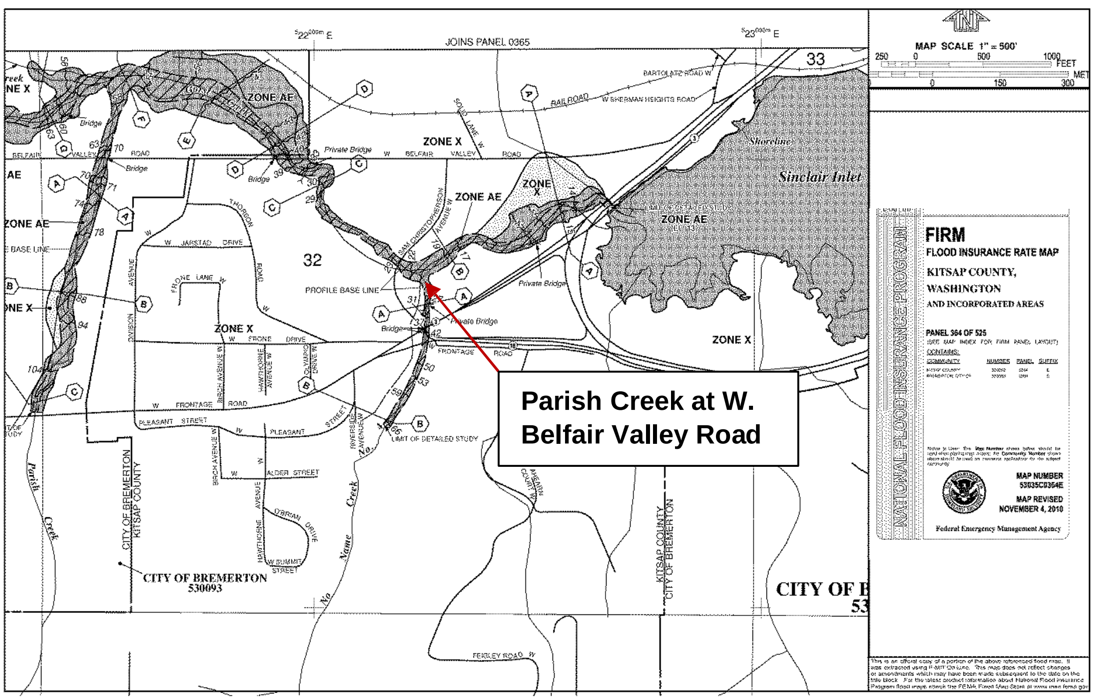


Figure 1 Gorst Creek Watershed Flooding (draining to Sinclair Inlet)

EXISTING SITE CONDITIONS

Parish Creek Subbasin is 1.8 square miles fully encompassed by the 8 square miles of the Gorst Creek Watershed. It originates outside of Water Utility properties in the unincorporated Sunnyslope area to the south. The Parish Creek subbasin drainage flows northward beneath Highway 3 west of Division Street and crosses beneath the W. Belfair Valley Road before joining Gorst Creek where it flows east through unincorporated

Gorst and into Sinclair Inlet. Parish Creek soils for the subbasin are classified by the U.S. Geologic Survey generally as erodible type sandy loam or gravelly sandy loam soils.

Parish Creek Road Culvert

Where Parish Creek crosses under the state highway (W. Belfair Valley Road), the creek enters a 5' diameter CMP culvert. The defined creek channel is approximately 6' to 8' wide at the culvert but the banks taper up gradually and are heavily vegetated. A 5' wide x 5' tall concrete channel carries the outlet flow of the culvert to a 5' tall weir approximately 100' to 150' downstream as shown in photos 1 and 2. Just downstream, a concrete channel was built 70 years ago and used for water supply operations near Otto Jarstad Park and is likely the reason for the existing channel and culvert design at Parish Creek.

Photo 1 North outlet end of 5' diam. CMP culvert at W. Belfair Valley Road

Photo 2 Looking north downstream of culvert

CULVERT FISH PASSAGE

The concrete channel and culvert increase and accelerate the stream flow velocity. The weir may be helpful in slowing the flow through the culvert and concrete channel. However, it may present a barrier to fish passage even if the salmon are able to navigate over the weir during major storm events.

During the major storm event on November 19th, it rained a total of 4.09 inches in 24 hours. Flow depth levels in this culvert were observed to be 2.5'. Based on observations on November 19th, the flow through the 5' CMP culvert with a 1.4% slope was calculated to be nominally 57 cfs with a 5.8 ft/s velocity. Considerable flow bypassed the culvert with upstream bank overflows. More than 50% of the creek flow at the culvert.

This culvert crossing appears to confine and constrict the channel or floodplain. It breaks ecological connectivity, alters channel processes, and changes adjacent channel character and shape by affecting the movement of flood waters and aquatic and terrestrial organisms. Cumulative impacts and risks for the crossing can be avoided or minimized by employing a full-span bridge to replace the culvert simulating a natural channel.

The concrete channel can be replaced with a newly constructed channel that replicates a more natural stream system and provides spawning, rearing, and riparian habitat for salmonid species as well as other wildlife.

The future design of the bridge span will need to:

- Be wide enough to minimize erodible velocities on the stream bed bottom under the bridge.
- Maintain fish passage flow and velocity requirements for target sizes and species of fish.
- Match the backwater elevation of the new stream section that is replacing the concrete channel.
- Handle the design flood flow.
- Accommodate shifting bed material changes in the stream profile.

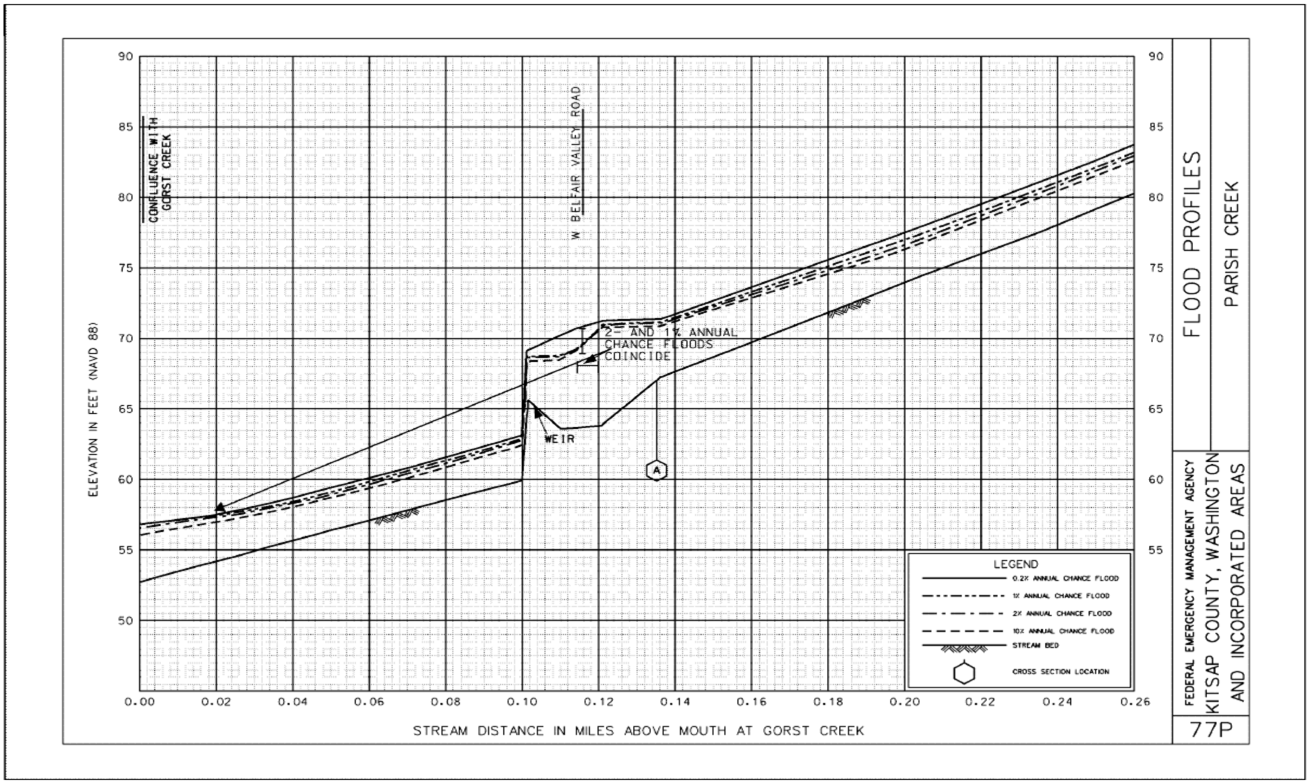


Figure 3 Parish Creek Profile Showing Weir

Cost-effective bridge types that were considered to replace the culvert include a steel arch, 3-sided precast box culvert, and a flat slab bridge. The bridges would need to span 20’ to include the creek channel and floodplain edges of the flow path for estimating purposes. Costs are estimated to be between $130/sf to $180/sf

PARISH CREEK BANK OVERTOPPING

During high flows, Parish Creek jumps the narrow and shallow creek bed channel into surrounding floodplain areas to the east, approximately 400 feet upstream of the West Belfair Valley Road culvert. The stream channel profile flattens from a 2.9% grade to a 1.4% grade within the vicinity of the Kitsap Square Dance Hall facility. Over the years, high-flow events have brought sediment into this area causing loss of the main channel due to filling, and creating braiding and broad floodplain overflows into the adjacent areas (see photo 3 and 6). From this location, floodplain drainage tends to flow through the Kitsap Square Dance Association gravel parking lot to the northeast corner. During the past four storms over the last seven years, the sheet flow from the dance hall facility washed over W. Belfair Valley Road and down both road shoulders toward the road’s sag point at the Gorst Creek crossing, 800’ to the east.

Flooding flows down W. Belfair Valley Road have significantly eroded the 4' to 8' gravel shoulders and threatened to flood approximately three homes on the south side near Gorst Creek. The owners of the Kitsap Square Dance Association repeatedly pumped as much as 50,000 gallons of water out of the crawlspace of the dance hall and replaced gravel in the parking lot after each of these storm events (see photo 3 and 5).

Photo 3 Creek and floodplain overflow unto the Associations property

Photo 4 Flows to Gorst Creek causing ditch and road shoulder erosion

Photo 5 Kitsap Square Dance Association parking

Photo 6 Creek bank overflow from behind first row of trees approximately 400' upstream of the road

Based on drainage records and interviews spanning the last seven years, sediment has silted in Parish Creek and created frequent flooding in the area to the east within the property of the Kitsap Square Dance Hall facility. Approximately 1,000' upstream of the West Belfair Valley Road culvert, the stream gradient and surrounding area becomes less steep. This sedimentation has been suggested as being caused by an upstream slide or increased impervious surfacing near the headwaters associated with new development that can cause increased erodible flows. Stream sediment infill creates channel braiding and broad floodplain overflows into the adjacent areas. The Association, which has owned the property for the last seven years, noted that significant increases of sand and gravel from upstream have filled in Parish Creek near the square dance facility. Parish Creek was four feet deep seven years ago, but it is no deeper than one foot today.

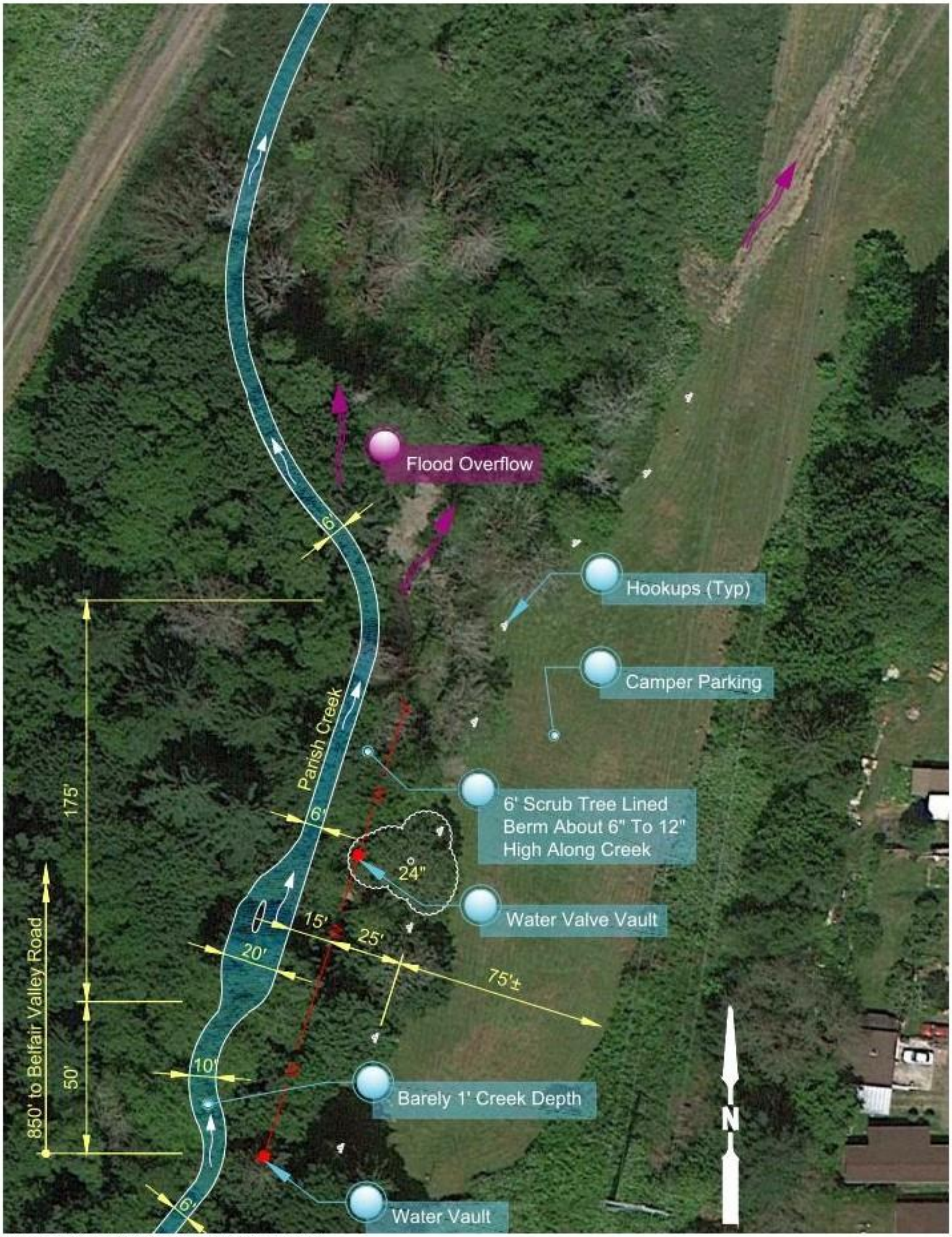


Figure 3 Parish Creek Flow Path

PARISH CREEK ALTERNATIVES

Parish Creek overbank flooding is creating a braiding effect adjacent to the Kitsap Square Dance Property. Bank overflows are diverting flow away from the main channel that is used for fish habitat and are damaging the roadway, ditches, and private property downstream. In the following alternatives discussed, the modifications to the Parish Creek crossing at W. Belfair Valley Road are assumed.

Parish Creek Berm Alternative

One way to minimize the main channel flow loss is to use a berm or levee to retain Parish Creek flows within floodplain adjacent to, but away from, the flat camper parking area as shown in Figure 3. However, the berm or levee would require construction within a 200' buffer to the creek within the floodplain. Environmentally, construction should be avoided within the floodplain and diversions of flows from the natural path of the channel should be avoided. Other feasible alternatives should be explored and ruled out. Construction within the floodplain now requires the burden of proof that construction will result in no impacts to endangered species. The Washington State Department of Fish and Wildlife has reviewed the site and the berm or levee idea was not ruled out. No additional details or comparative costs are provided at this level of review.

Flood Overflow Culvert to Parish Creek Alternative

This alternative channels the bank overflows on the Kitsap Square Dance Association property back to Parish Creek during peak storm events (see Figure 4.). A 425' ditch approximately 6' wide would be constructed on the Association property to intercept and channel the bank overflows to a 256' long 6' x 4' box culvert. The culvert crosses and then follows parallel to the state highway at a minimum grade to maintain adequate cover and to match into creek elevations downstream. The culvert is designed to redirect flows back to the direction of the downstream creek flows. Two 90 degree curved alignment bends would be used to minimize bend losses.

The culvert was analyzed for head, bend, and friction losses using a 153 cfs flow rate that is 60% of the 100-year storm flows defined by the FEMA Insurance Studies. Bend losses are almost negligible at 0.1' with the use of a curved alignment. Velocity of flow is 8.3 ft/s at a 0.30% culvert slope.

The terrain will require a survey to ensure this alternative will work. Physically, the road cover over the culvert should be deeper than the road base and a feasible downstream outlet design elevation will need to be validated. Utilities within the north ditch side of the roadway are assumed to be minimal or easily relocated. The Association has mentioned that they would be open to allowing ditch modifications on their property.

The advantages with this alternative are that flood damage to road, ditch, and private property is remedied and the alternative provides straight forward environmental compliance. The disadvantage is the larger facility cost of constructing a culvert that bypasses the creek road crossing to be modified for fish passage.

Overflow to Gorst Creek Alternative

This alternative channels the bank overflows at the northeast corner of the Kitsap Square Dance Association property across the state highway and down the north ditch side of the road to Gorst Creek for peak storm events (see Figure 5). As in the previous alternative, a 425' ditch approximately 6' wide would be constructed on the Association property to intercept and channel the bank overflows to a new box culvert. In this alternative, the 6' x 4' box culvert would be 1,120 feet long. The culvert would cross and then follow parallel to the state highway to the east and would discharge into Gorst Creek normal to the creek flow.

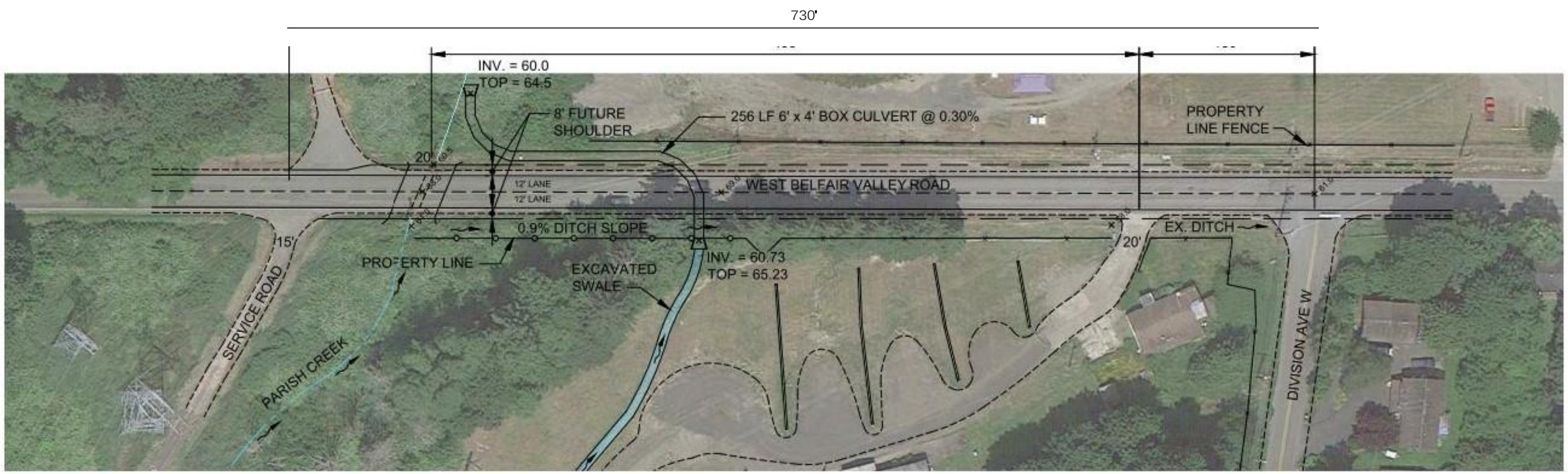
The culvert was analyzed for head, bend, and friction losses using a 153 cfs flow rate. For a culvert sloped at 2.2%, the median velocity is 17.0 ft/s. This is likely to cause cavitation to the concrete wall that occurs when velocities are in excess of 10 ft/s to 20 ft/s. The high velocity outlet flows that will be discharging perpendicular into the creek bank of Gorst Creek. The outlet will need to be designed to reduce the energy head and avoid

erosion of the receiving creek. Utilities within the north ditch side of the roadway are assumed to be minimal or easily relocated.

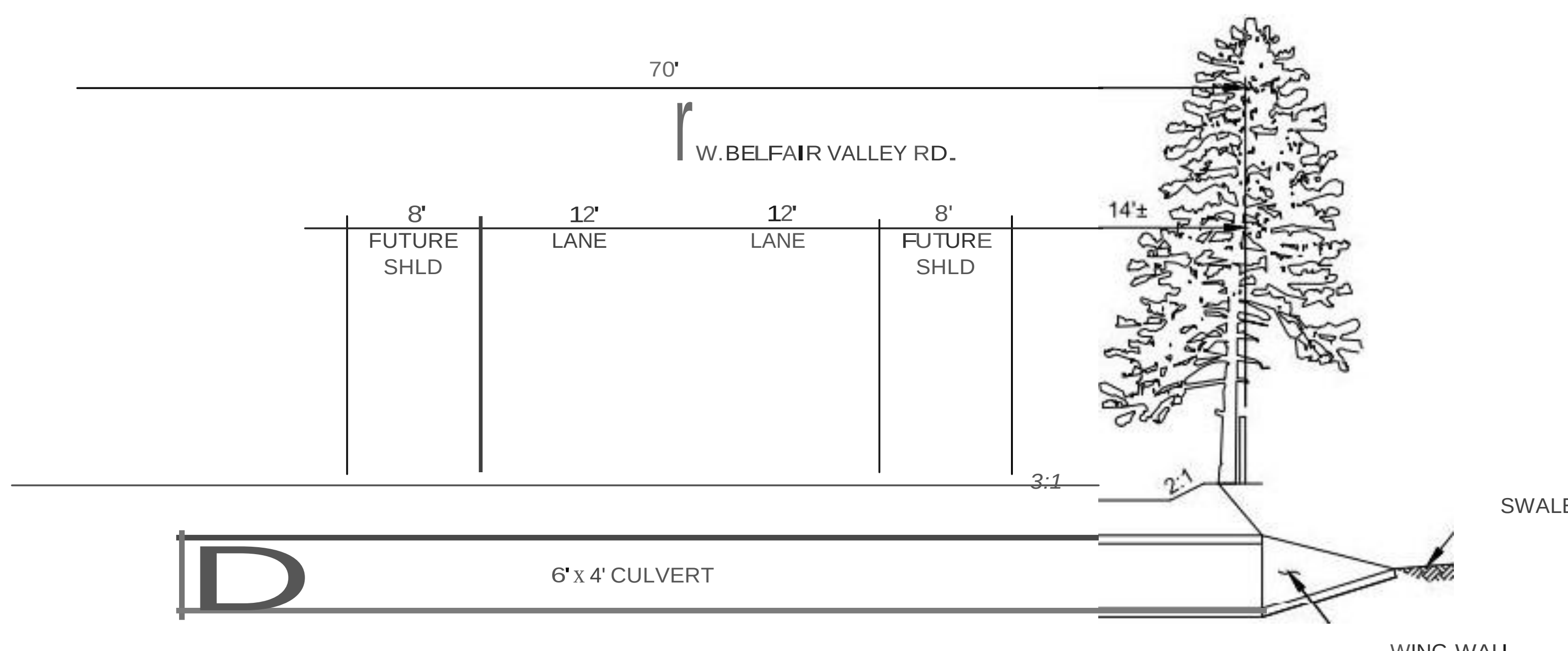
The advantages to this alternative is the same as the previous alternative in that flood damage to road, ditch and private property is addressed and the alternative provides straight forward environmental compliance. Maintaining adequate cover under the road bed is not an issue. The disadvantages include the cost of constructing a box culvert that is an additional 864' feet long and having to mitigate high velocity flows that can erode the concrete and the high velocity outlet flows that will be discharging normal to the Gorst Creek bank.

Flood Overflow Culvert to Parish Creek

ASCQM



Plan



Section

Figure 4 Overflow Culvert to Parish Creek

Figure 5 Parish Creek Overflow to Gorst Creek

ATTACHMENTS

Preliminary Engineer's Cost Estimates for Overflow to Parish Creek Alternative
Overflow to Parish Creek Alternative Culvert Analysis
Overflow to Parish Creek Culvert Entrance Loss Calculation
Preliminary Engineer's Cost Estimates for Overflow to Gorst Creek Alternative
Overflow to Gorst Creek Alternative Culvert Analysis
Overflow to Gorst Creek Culvert Entrance Loss Calculation
FEMA Insurance Study Table 4. Summary of Discharges (Parish Creek)
FEMA Insurance Study Floodway Data
Calculation of Bend Losses in Culvert Curvilinear Alignment

ATTACHMENT 1

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PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Creek Overflow to Parish Creek Option w/ Flat Slab Bridge
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: 2012

I.	RIGHT OF WAY				Cost			
	500 SF				$5		$2,500	
II.	CONSTRUCTION		Unit	Quantity	Cost	Total	$67,240	
	1	Grading / Drainage						
	1.1	Earthwork (Cut/Fill)	CY	1,921	$35.00	$67,235.00		
	1.2	Drainage	10%	Of Sections 2.3-4, & 3		N/A		
	2	Structures					$436,800	
	2.1	Bridge Structure 34' x 40'	SF	1,360	$180.00	$244,800.00		
	2.2	Culvert Structure	LF	256	$750.00	$192,000.00		
	2.3	Retaining Walls (Cut)	SF		$100.00	$0.00		
	2.4	Retaining Walls (Fill)	SF		$40.00	$0.00		
	2.5	Bridge Removal	SF		$20.00	$0.00		
	3	Surfacing / Paving					$6,008	
	3.1	HMA Paving	TN	50	$100.00	$5,000.00		
		(Assumes 50LF, 8" CSBC and 6" HMA)						
	3.2	CSBC	TN	48	$21.00	$1,008.00		
	4	Roadside Development					$61,200	
			12%	Of sections 1, 2 & 3		$61,200.00		
		(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)						
	5	Traffic Services & Safety					$61,200	
			12%	Of sections 1, 2 & 3		$61,200.00		
		(Price includes Guard Rail, Striping, Utilities, Traffic Control)						
		Construction Subtotal Items 1,2,3,4 and 5			(Round to nearest 1000)			$632,000
	6	Contingencies			20%	of Subtotal	$126,000	
	7	Construction Subtotal (Lines 1 through 6)						$758,000
	8	Mobilization -			8%	of Line 7	$61,000	
	9	Subtotal (Lines 7 & 8)						$819,000
	10	Sales Tax -			8.60%	of Line 9	$70,000	
	11	Subtotal						$889,000
	12	Construction Engineering			10%	of Line 11	$89,000	
	13	Construction Total (Lines 11 and 12)						$978,000
III.	DESIGN ENGINEERING & ADMINISTRATION				12%	of Line 13	$117,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$1,095,000

PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Creek Overflow to Parish Creek Option
w/ 3 legged 20 precast bridge span bridge
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: 2012

I.	RIGHT OF WAY				Cost			
		500 SF			$5		$2,500	
II.	CONSTRUCTION		Unit	Quantity	Cost	Total	$67,240	
	1	Grading / Drainage						
	1.1	Earthwork (Cut/Fill)	CY	1,921	$35.00	$67,235.00		
	1.2	Drainage	10%	Of Sections 2.3-4, & 3		N/A		
	2	Structures					$296,000	
	2.1	Bridge Structure 3 legged 20' L x 40' W	SF	800	$130.00	$104,000.00		
	2.2	Culvert Structure	LF	256	$750.00	$192,000.00		
	2.3	Retaining Walls (Cut)	SF		$100.00	$0.00		
	2.4	Retaining Walls (Fill)	SF		$40.00	$0.00		
	2.5	Bridge Removal	SF		$20.00	$0.00		
	3	Surfacing / Paving					$12,016	
	3.1	HMA Paving	TN	100	$100.00	$10,000.00		
		(Assumes 100LF, 8" CSBC and 6" HMA)						
	3.2	CSBC	TN	96	$21.00	$2,016.00		
	4	Roadside Development					$45,000	
			12%	Of sections 1, 2 & 3		$45,000.00		
		(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)						
	5	Traffic Services & Safety					$45,000	
			12%	Of sections 1, 2 & 3		$45,000.00		
		(Price includes Guard Rail, Striping, Utilities, Traffic Control)						
		Construction Subtotal Items 1,2,3,4 and 5			(Round to nearest 1000)			$465,000
	6	Contingencies			20%	of Subtotal	$93,000	
	7	Construction Subtotal (Lines 1 through 6)						$558,000
	8	Mobilization -			8%	of Line 7	$45,000	
	9	Subtotal (Lines 7 & 8)						$603,000
	10	Sales Tax -			8.60%	of Line 9	$52,000	
	11	Subtotal						$655,000
	12	Construction Engineering			10%	of Line 11	$66,000	
	13	Construction Total (Lines 11 and 12)						$721,000
III.	DESIGN ENGINEERING & ADMINISTRATION				12%	of Line 13	$87,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$808,000

PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Parish to Gorst Creek Bypass Option
w/ Flat Slab Bridge
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: 2012

			Unit	Quantity	Cost	Total		
I.	RIGHT OF WAY							
II.	CONSTRUCTION		Unit	Quantity	Cost	Total	$264,390	
1	Grading / Drainage							
1.1	Earthwork (Cut/Fill)		CY	7,554.00	$35.00	$264,390.00		
1.2	Drainage		10%	Of Sections 2.3-4, & 3		N/A		
2	Structures						$1,084,800	
2.1	Bridge Structure 34' x 40'		SF	1,360	$180.00	$244,800.00		
2.2	Culvert Structure		SF	1,120	$750.00	$840,000.00		
2.3	Retaining Walls (Cut)		SF		$100.00	$0.00		
2.4	Retaining Walls (Fill)		SF		$40.00	$0.00		
2.5	Bridge Removal		SF		$20.00	$0.00		
3	Surfacing / Paving						$5,840	
3.1	HMA Paving		SF	50	$100.00	$5,000.00		
	(Assumes 50LF, 8" CSBC and 6" HMA)							
3.2	CSBC		SF	40	$21.00	$840.00		
4	Roadside Development						$162,600	
			12%	Of sections 1, 2 & 3		$162,600.00		
	(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)							
5	Traffic Services & Safety						$162,600	
			12%	Of sections 1, 2 & 3		$162,600.00		
	(Price includes Guard Rail, Striping, Utilities, Traffic Control)							
	Construction Subtotal Items 1,2,3,4 and 5				(Round to nearest 1000)			$1,680,000
6	Contingencies				20%	of Subtotal	$336,000	
7	Construction Subtotal (Lines 1 through 6)							$2,016,000
8	Mobilization -				8%	of Line 7	$161,000	
9	Subtotal (Lines 7 & 8)							$2,177,000
10	Sales Tax -				8.60%	of Line 9	$187,000	
11	Subtotal							$2,364,000
12	Construction Engineering				10%	of Line 11	$236,000	
13	Construction Total (Lines 11 and 12)							$2,600,000
III.	DESIGN ENGINEERING & ADMINISTRATION				12%	of Line 13	$312,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$2,912,000

PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Parish to Gorst Creek Bypass Option
w/ 3 legged 20 precast bridge span bridge
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: 2012

I.	RIGHT OF WAY							
II.	CONSTRUCTION		Unit	Quantity	Cost	Total	$264,390	
1	Grading / Drainage							
	1.1	Earthwork (Cut/Fill)	CY	7,554.00	$35.00	$264,390.00		
	1.2	Drainage	10%	Of Sections 2.3-4, & 3		N/A		
2	Structures						$944,000	
	2.1	Bridge Structure 20' x 40'	SF	800	$130.00	$104,000.00		
	2.2	Culvert Structure	SF	1,120	$750.00	$840,000.00		
	2.3	Retaining Walls (Cut)	SF		$100.00	$0.00		
	2.4	Retaining Walls (Fill)	SF		$40.00	$0.00		
	2.5	Bridge Removal	SF		$20.00	$0.00		
3	Surfacing / Paving						$12,016	
	3.1	HMA Paving	SF	100	$100.00	$10,000.00		
		(Assumes 50LF, 8" CSBC and 6" HMA)						
	3.2	CSBC	SF	96	$21.00	$2,016.00		
4	Roadside Development						$146,400	
			12%	Of sections 1, 2 & 3		$146,400.00		
		(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)						
5	Traffic Services & Safety						$146,400	
			12%	Of sections 1, 2 & 3		$146,400.00		
		(Price includes Guard Rail, Striping, Utilities, Traffic Control)						
	Construction Subtotal Items 1,2,3,4 and 5				(Round to nearest 1000)			$1,513,000
6	Contingencies				20%	of Subtotal	$303,000	
7	Construction Subtotal (Lines 1 through 6)							$1,816,000
8	Mobilization -				8%	of Line 7	$145,000	
9	Subtotal (Lines 7 & 8)							$1,961,000
10	Sales Tax -				8.60%	of Line 9	$169,000	
11	Subtotal							$2,130,000
12	Construction Engineering				10%	of Line 11	$213,000	
13	Construction Total (Lines 11 and 12)							$2,343,000
III.	DESIGN ENGINEERING & ADMINISTRATION				12%	of Line 13	$281,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$2,624,000

Parish Creek 6' x 4' Culvert Entrance Calc

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	153.00	ft^3/s	60% OF 100YR FLOW OF PARISH CR.
Centroid Elevation	2.00	ft	
Tailwater Elevation	2.35	ft	
Discharge Coefficient	0.50		
Opening Width	6.00	ft	
Opening Height	4.00	ft	

Results

Headwater Elevation	4.88	ft
Headwater Height Above Centroid	2.88	ft
Tailwater Height Above Centroid	0.35	ft
Flow Area	24.00	ft^2
Velocity	6.38	ft/s

PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Parish to Gorst Creek Bypass Option
w/ Flat Slab Bridge
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: **2012**

I.	RIGHT OF WAY							
II.	CONSTRUCTION		Unit	Quantity	Cost	Total	$199,680	
1	Grading / Drainage							
1.1	Earthwork (Cut/Fill)		CY	5,705.00	$35.00	$199,675.00		
1.2	Drainage		10%	Of Sections 2.3-4, & 3		N/A		
2	Structures						$1,084,800	
2.1	Bridge Structure 34' x 40'		SF	1,360	$180.00	$244,800.00		
2.2	Culvert Structure		SF	1,120	$750.00	$840,000.00		
2.3	Retaining Walls (Cut)		SF		$100.00	$0.00		
2.4	Retaining Walls (Fill)		SF		$40.00	$0.00		
2.5	Bridge Removal		SF		$20.00	$0.00		
3	Surfacing / Paving						$5,840	
3.1	HMA Paving		SF	50	$100.00	$5,000.00		
	(Assumes 50LF, 8" CSBC and 6" HMA)							
3.2	CSBC		SF	40	$21.00	$840.00		
4	Roadside Development						$154,800	
			12%	Of sections 1, 2 & 3		$154,800.00		
	(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)							
5	Traffic Services & Safety						$154,800	
			12%	Of sections 1, 2 & 3		$154,800.00		
	(Price includes Guard Rail, Striping, Utilities, Traffic Control)							
	Construction Subtotal Items 1,2,3,4 and 5			(Round to nearest 1000)				$1,600,000
6	Contingencies				20% of Subtotal		$320,000	
7	Construction Subtotal (Lines 1 through 6)							$1,920,000
8	Mobilization -				8% of Line 7		$154,000	
9	Subtotal (Lines 7 & 8)							$2,074,000
10	Sales Tax -				8.60% of Line 9		$178,000	
11	Subtotal							$2,252,000
12	Construction Engineering				10% of Line 11		$225,000	
13	Construction Total (Lines 11 and 12)							$2,477,000
III.	DESIGN ENGINEERING & ADMINISTRATION				12% of Line 13		$297,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$2,774,000

PRELIMINARY ENGINEER'S COST ESTIMATE

Gorst Creek Watershed Study
Parish Creek Flooding
Parish to Gorst Creek Bypass Option
w/ 3 legged 20 precast bridge span bridge OR ARCH
Near 6800 W. Belfair Valley Road, Gorst,WA

Kitsap County
Date: December, 2012
Date of Cost Index: 2012

			Unit	Quantity	Cost	Total		
I.	RIGHT OF WAY							
II.	CONSTRUCTION						$199,680	
1	Grading / Drainage							
1.1	Earthwork (Cut/Fill)		CY	5,705.00	$35.00	$199,675.00		
1.2	Drainage		10%	Of Sections 2.3-4, & 3		N/A		
2	Structures						$944,000	
2.1	Bridge Structure		SF	800	$130.00	$104,000.00		
2.2	Culvert Structure		SF	1,120	$750.00	$840,000.00		
2.3	Retaining Walls (Cut)		SF		$100.00	$0.00		
2.4	Retaining Walls (Fill)		SF		$40.00	$0.00		
2.5	Bridge Removal		SF		$20.00	$0.00		
3	Surfacing / Paving						$12,016	
3.1	HMA Paving		SF	100	$100.00	$10,000.00		
	(Assumes 50LF, 8" CSBC and 6" HMA)							
3.2	CSBC		SF	96	$21.00	$2,016.00		
4	Roadside Development						$138,700	
			12%	Of sections 1, 2 & 3		$138,700.00		
	(Item includes Fencing, Temporary Water Pollution Control, Environmental Mitigation)							
5	Traffic Services & Safety						$138,700	
			12%	Of sections 1, 2 & 3		$138,700.00		
	(Price includes Guard Rail, Striping, Utilities, Traffic Control)							
	Construction Subtotal Items 1,2,3,4 and 5			(Round to nearest 1000)				$1,433,000
6	Contingencies			20% of Subtotal			$287,000	
7	Construction Subtotal (Lines 1 through 6)							$1,720,000
8	Mobilization -			8% of Line 7			$138,000	
9	Subtotal (Lines 7 & 8)							$1,858,000
10	Sales Tax -			8.60% of Line 9			$160,000	
11	Subtotal							$2,018,000
12	Construction Engineering			10% of Line 11			$202,000	
13	Construction Total (Lines 11 and 12)							$2,220,000
III.	DESIGN ENGINEERING & ADMINISTRATION			12% of Line 13			$266,000	
IV.	TOTAL ESTIMATED COST		Lines I, 13 and III					$2,486,000

Overflow to Gorst Creek Culvert

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.02200	ft/ft
Height	4.00	ft
Bottom Width	6.00	ft
Discharge	153.00	ft³/s

Results

Normal Depth	1.50	ft
Flow Area	9.02	ft²
Wetted Perimeter	9.01	ft
Hydraulic Radius	1.00	ft
Top Width	6.00	ft
Critical Depth	2.72	ft
Percent Full	37.6	%
Critical Slope	0.00417	ft/ft
Velocity	16.97	ft/s
Velocity Head	4.47	ft
Specific Energy	5.98	ft
Froude Number	2.44	
Discharge Full	459.47	ft³/s
Slope Full	0.19844	ft/ft
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	37.57	%
Downstream Velocity	Infinity	ft/s

Overflow to Gorst Creek Culvert

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	2.72	ft
Channel Slope	0.02200	ft/ft
Critical Slope	0.00417	ft/ft

Overflow to Gorst Creek Entrance Calc

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	153.00	ft^3/s
Centroid Elevation	2.00	ft
Tailwater Elevation	0.00	ft
Discharge Coefficient	0.50	
Opening Width	6.00	ft
Opening Height	4.00	ft

Results

Headwater Elevation	4.53	ft
Headwater Height Above Centroid	2.53	ft
Tailwater Height Above Centroid	-2.00	ft
Flow Area	24.00	ft^2
Velocity	6.38	ft/s

Table 4. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance (50 YR)	1-Percent-Annual-Chance (100 YR)	0.2-Percent-Annual-Chance (500 YR)
GORST CREEK					
At Parish Creek	6.4	650	845	930	1,190
At Mouth	7.9	800	1,040	1,145	1,460
HAZEL CREEK					
At Mouth	0.6	60	80	90	115
KITSAP CREEK					
At Mouth	3.6	155	190	210	255
NO NAME CREEK NO. 3					
At Mouth	1.1	110	140	160	205
NO NAME CREEK NO. 4					
At Mouth	0.6	65	85	90	115
NO NAME CREEK NO. 6					
At Mouth	1.9	105	155	170	230
NO NAME CREEK NO. 7					
At the Confluence with Clear Creek	3.2	150	215	250	340
→ PARISH CREEK					
At Mouth	1.8	180	230	255	325
ROSS CREEK					
At Mouth	2.1	200	265	295	375
SOUTH FORK BLACKJACK CREEK					
At Mouth	2.0	55	80	90	120
TRIBUTARY TO NO NAME CREEK NO. 6					
At the Confluence with No Name Creek No. 6	0.8	50	65	70	95
UNION RIVER					
At Hazel Creek	5.9	585	760	855	1,110
At No Name Creek No. 2	7.0	695	900	1,015	1,345
At the Confluence With East Fork Union River	10.6	1,040	1,360	1,525	1,975

Page 34 of 143 | Scale 47

100 YR

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NO NAME CREEK NO. 7								
A	103[1]	89	482	2.3	40.2	40.2	41.0	0.8
B	173[1]	139	764	1.5	40.3	40.3	41.1	0.8
C	263[1]	14	167	13.6	41.1	41.1	41.1	0.0
D	358[1]	130	817	1.4	44.5	44.5	45.4	0.9
E	442[1]	137	762	1.0	44.5	44.5	45.5	1.0
F	749[1]	59	155	4.0	44.5	44.5	45.4	0.9
G-O[2]	*	*	*	*	*	*	*	*
PARISH CREEK								
A (BELFAIR VALLEY RD.)	0.135[3]	113	142	1.8	71.2	71.2	71.8	0.6
B (HWY 3)	0.299[3]	20	32	8.0	87.5	87.5	87.5	0.0
C	0.467[3]	38	34	7.4	112.9	112.9	112.9	0.0
ROSS CREEK								
A	0.070[4]	274	2,700	0.1	17.8	17.8	17.8	0.0
B	0.150[4]	60	380	0.8	17.8	17.8	17.8	0.0
C	0.310[4]	28	44	8.6	26.0	26.0	26.0	0.0
D	0.460[4]	34	41	7.2	43.1	43.1	43.1	0.0
E	0.665[4]	51	48	6.1	63.6	63.6	63.6	0.0
F	0.835[4]	39	60	5.9	86.9	86.9	86.9	0.0
G	0.995[4]	22	35	7.6	111.4	111.4	111.4	0.0

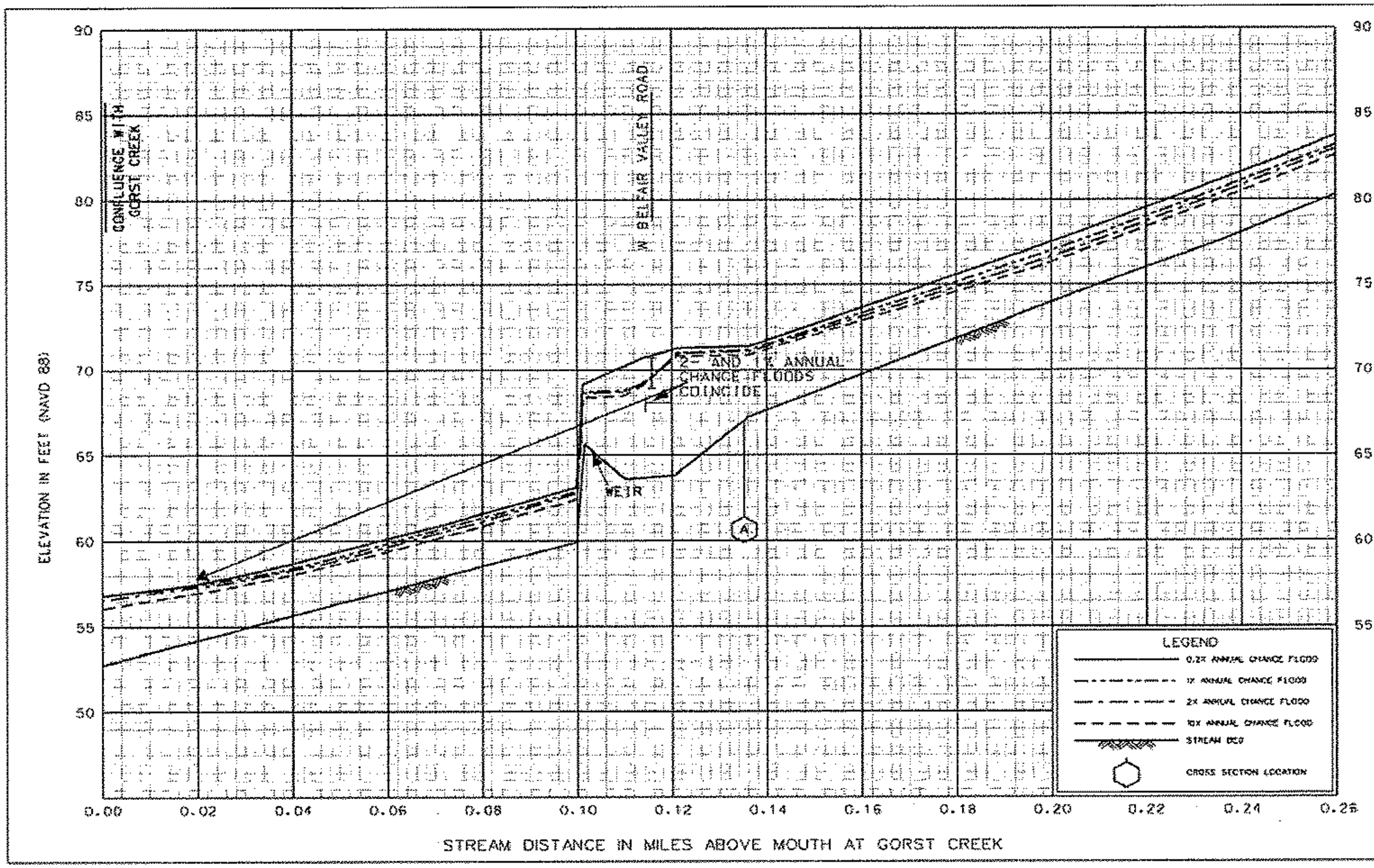
[1]FEET ABOVE CONFLUENCE WITH CLEAR CREEK [4]MILES ABOVE MOUTH AT SINCLAIR INLET

[2]DATA NOT AVAILABLE

[3]MILES ABOVE MOUTH AT GORST CREEK

TABLE 7	FEDERAL EMERGENCY MANAGEMENT AGENCY **KITSAP COUNTY, WA** AND INCORPORATED AREAS	**FLOODWAY DATA** NO NAME CREEK NO. 7 - PARISH CREEK - ROSS CREEK

$$1093\ AC \times \frac{43560\ FT^2}{AC} \times \frac{MI^2}{(5280)^2} = 1.71\ MI^2$$



FLOOD PROFILES

PARISH CREEK

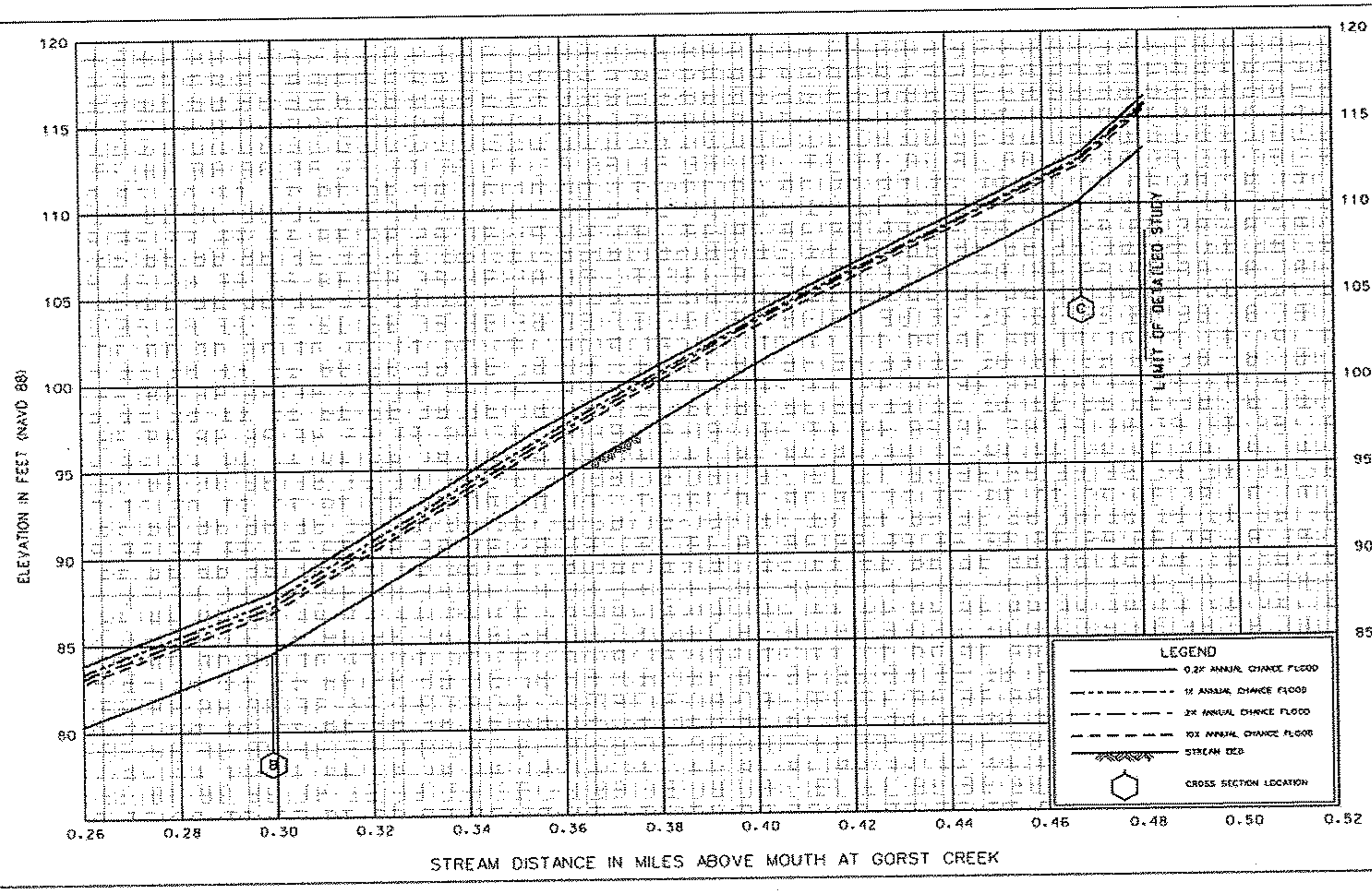
FEDERAL EMERGENCY MANAGEMENT AGENCY

KITSAP COUNTY, WASHINGTON AND INCORPORATED AREAS

77P

SLOPE = 0.002

SLOPE =



FEDERAL EMERGENCY MANAGEMENT AGENCY

KITSAP COUNTY, WASHINGTON AND INCORPORATED AREAS

FLOOD PROFILES

PARISH CREEK

78P

AECOM

JOB TITLE: LOBST CREEK WATERSHED STUDY - PARISH CREEK FLOODING
JOB NO.
CALCULATION NO.
ORIGINATOR: REX MEYER
DATE: 12/4/12
REVIEWER: BRYAN HUSCHKA
DATE: 1/2/13
SCALE
SHEET NO. ___ OF ___

CALCULATION OF FRICTION LOSSES IN PARISH CREEK SWEEPING CULVERTS

FOR 6'x 4' SWEEPING BOX CULVERT

BEND LOSSES ARE DERIVED FROM FORMULAS FROM KANSAS DEPT. OF TRANSPORTATION RPT# KTRAN KU-05-5

EXAMPLE IS SHOWN ON PAGE 33 USED FOR CALCS BELOW.

HEAD LOSS = $h_L = \beta K_b \frac{V^2}{2g}$

β = FACTOR FROM TABLE 4.3 (ATTACHED)

K_b = FACTOR FROM TABLE 3.4 (ATTACHED)

V = DOWNSTREAM VELOCITY IN CULVERT

g = GRAVITY = $32.2 \frac{FT}{S^2}$

BEND ANGLE = 90°

DETERMINING β & K_b

F_R = FROUD NUMBER = $\frac{V}{\sqrt{gY}}$ Y = DOWNSTREAM FLOW LEVEL

SEE CULVERT BOX CALCS WHERE Y = 3.08' & V = 1.06 FT/S

$F_R = 1.06/\sqrt{32.2(3.08)} = 0.11$

K_b (FROM TABLE 3.4) FOR 0.11 $K_b \approx 1.0$ (OFF THE TABLE, PRORATED)

r_c = RADIUS FOR CULVERT = 30' (SCALED)

$D_{eq} = \sqrt{4A/\pi}$ FOR BOX CULVERT = $\sqrt{4 \times (24^{\#}\text{ OF CULVERT FACE})/\pi}$ = 5.53

r_c / D_{eq} = 30/5.53 = 5.43

β (USING TABLE 4.3) FOR r_c / D_{eq} OF 5.42 β = 0.363

$h_L = 0.363 (1.0) \frac{(1.06)^2}{2 \times 32.2}$ = <u>0.006 FT HEAD LOSS</u>

(NEGLIGIBLE ENERGY GRADE LINE VARIANCE)

Grid: 4x4 = 1"

Example Problem

A 10-ft wide rectangular culvert has a gradual 50 degree bend with a radius curvature of 45 feet. The depth and velocity at the downstream end of the bend is known to be 8 feet and 6 feet per second, respectively. Estimate the bend loss. (Note that the shaded cells in Table 4.3 below are used in this example.)

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6}{\sqrt{(32.2)8}} = 0.374 \xrightarrow{Table\ 3.4\ for\ 50^\circ} K_b = 0.367$$

$$Assume\ K_b = K_{gb,1} = 0.367$$

$$D_{eq} = \sqrt{4A/\pi} = \sqrt{4(8*10)/\pi} = \sqrt{4(80)/\pi} = 10.09\,ft$$

$$r/D_{eq} = 45/10.09 = 4.46 \xrightarrow{Interpolated\ from\ Table\ 4.3} \beta = 0.454$$

$$h_L = \beta K_b \frac{V^2}{2g} = (0.454)(0.367)\frac{V^2}{2g} = (0.167)\left(\frac{6^2}{2(32.2)}\right) = 0.0934\,ft$$

r_c/D_{eq}	$\beta = K_{gb}/K_{gb,1}$									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	1.000	0.960	0.920	0.879	0.839	0.799	0.759	0.719	0.679	0.638
2	0.598	0.593	0.588	0.583	0.578	0.573	0.568	0.563	0.558	0.553
3	0.548	0.543	0.538	0.533	0.528	0.523	0.518	0.513	0.508	0.503
4	0.498	0.488	0.479	0.469	0.459	0.450	0.440	0.431	0.421	0.411
5	0.402	0.392	0.383	0.373	0.363	0.354	0.344	0.335	0.325	0.315
6	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
7	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
8	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306

Table 3.4: Loss Coefficients, K_b, for Abrupt Bends in Rectangular Channels.

Fr	Abrupt Bend Angle, θ, in degrees												
	30	35	40	45	50	55	60	65	70	75	80	85	90
0.20	0.127	0.191	0.256	0.322	0.389	0.457	0.525	0.593	0.663	0.733	0.804	0.875	0.948
0.21	0.126	0.191	0.256	0.322	0.388	0.455	0.523	0.592	0.661	0.731	0.802	0.873	0.945
0.22	0.126	0.190	0.255	0.321	0.387	0.454	0.522	0.591	0.660	0.729	0.800	0.871	0.943
0.23	0.125	0.189	0.254	0.320	0.386	0.453	0.521	0.589	0.658	0.727	0.798	0.869	0.940
0.24	0.125	0.189	0.254	0.319	0.385	0.452	0.519	0.587	0.656	0.725	0.795	0.866	0.937
0.25	0.124	0.188	0.253	0.318	0.384	0.451	0.518	0.586	0.654	0.723	0.793	0.863	0.934
0.26	0.123	0.187	0.252	0.317	0.383	0.449	0.516	0.584	0.652	0.721	0.791	0.861	0.931
0.27	0.123	0.187	0.251	0.316	0.382	0.448	0.515	0.582	0.650	0.719	0.788	0.858	0.928
0.28	0.122	0.186	0.250	0.315	0.381	0.447	0.513	0.580	0.648	0.716	0.785	0.855	0.925
0.29	0.122	0.185	0.249	0.314	0.379	0.445	0.511	0.578	0.646	0.714	0.783	0.852	0.922
0.30	0.121	0.184	0.248	0.313	0.378	0.444	0.510	0.576	0.644	0.711	0.780	0.849	0.918
0.31	0.120	0.184	0.247	0.312	0.377	0.442	0.508	0.574	0.641	0.709	0.777	0.845	0.914
0.32	0.120	0.183	0.246	0.310	0.375	0.440	0.506	0.572	0.639	0.706	0.774	0.842	0.911
0.33	0.119	0.182	0.245	0.309	0.374	0.439	0.504	0.570	0.636	0.703	0.771	0.839	0.907
0.34	0.118	0.181	0.244	0.308	0.372	0.437	0.502	0.568	0.634	0.700	0.767	0.835	0.903
0.35	0.117	0.180	0.243	0.307	0.371	0.435	0.500	0.565	0.631	0.697	0.764	0.831	0.899
0.36	0.116	0.179	0.242	0.305	0.369	0.433	0.498	0.563	0.628	0.694	0.761	0.827	0.895
0.37	0.116	0.178	0.241	0.304	0.367	0.431	0.496	0.560	0.626	0.691	0.757	0.824	0.890
0.38	0.115	0.177	0.239	0.302	0.366	0.429	0.493	0.558	0.623	0.688	0.754	0.820	0.886
0.39	0.114	0.176	0.238	0.301	0.364	0.427	0.491	0.555	0.620	0.685	0.750	0.815	0.881
0.40	0.113	0.175	0.237	0.299	0.362	0.425	0.489	0.553	0.617	0.681	0.746	0.811	0.877
0.41	0.112	0.174	0.236	0.298	0.360	0.423	0.486	0.550	0.614	0.678	0.742	0.807	0.872
0.42	0.111	0.173	0.234	0.296	0.359	0.421	0.484	0.547	0.611	0.674	0.738	0.802	0.867
0.43	0.110	0.171	0.233	0.295	0.357	0.419	0.481	0.544	0.607	0.671	0.734	0.798	0.862
0.44	0.109	0.170	0.231	0.293	0.355	0.417	0.479	0.541	0.604	0.667	0.730	0.793	0.857
0.45	0.108	0.169	0.230	0.291	0.353	0.414	0.476	0.538	0.600	0.663	0.726	0.788	0.851
0.46	0.107	0.168	0.229	0.290	0.351	0.412	0.473	0.535	0.597	0.659	0.721	0.784	0.846
0.47	0.106	0.166	0.227	0.288	0.349	0.410	0.471	0.532	0.593	0.655	0.717	0.779	0.841
0.48	0.105	0.165	0.225	0.286	0.346	0.407	0.468	0.529	0.590	0.651	0.712	0.773	0.835
0.49	0.104	0.164	0.224	0.284	0.344	0.405	0.465	0.525	0.586	0.647	0.707	0.768	0.829
0.50	0.103	0.162	0.222	0.282	0.342	0.402	0.462	0.522	0.582	0.642	0.703	0.763	0.823
0.51	0.102	0.161	0.221	0.280	0.340	0.399	0.459	0.519	0.578	0.638	0.698	0.758	0.817
0.52	0.100	0.160	0.219	0.278	0.337	0.397	0.456	0.515	0.574	0.634	0.693	0.752	0.811
0.53	0.099	0.158	0.217	0.276	0.335	0.394	0.453	0.512	0.570	0.629	0.688	0.746	0.805
0.54	0.098	0.157	0.216	0.274	0.333	0.391	0.450	0.508	0.566	0.625	0.683	0.741	0.799
0.55	0.097	0.155	0.214	0.272	0.330	0.388	0.446	0.504	0.562	0.620	0.677	0.735	0.792
0.56	0.095	0.154	0.212	0.270	0.328	0.386	0.443	0.501	0.558	0.615	0.672	0.729	0.786
0.57	0.094	0.152	0.210	0.268	0.325	0.383	0.440	0.497	0.554	0.610	0.667	0.723	0.779
0.58	0.093	0.151	0.208	0.266	0.323	0.380	0.436	0.493	0.549	0.605	0.661	0.717	0.772
0.59	0.092	0.149	0.206	0.263	0.320	0.377	0.433	0.489	0.545	0.600	0.655	0.710	0.765

Table 4.3 shows β -values for r/D_{eq} ranging from 1 to 8. The table was developed from the values in Column 5 of Table 4.2 by linear interpolation. It will be assumed that the values in Table 4.2 can be applied to the abrupt bend loss coefficient defined by Eq. 3.8. The abrupt bend loss coefficient, K_b, is assumed to be equivalent to the parameter $K_{gb,1}$ in Table 4.2. Equation 4.3 shows Equation 4.1 expressed in terms of β and K_b where K_b is the bend loss coefficient for abrupt bends developed in Chapter 3 and given by Eq. 3.8.

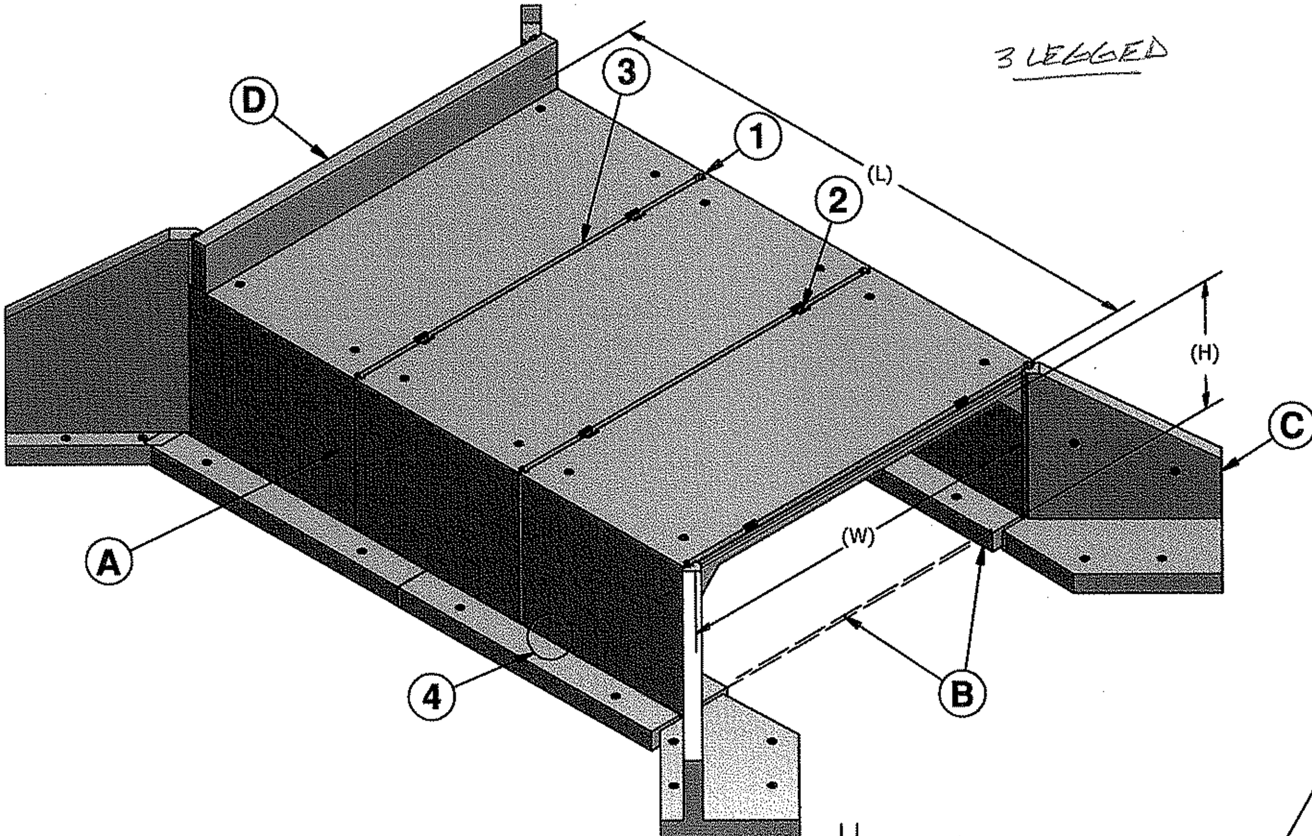
$$h_b = K_{gb}\frac{V_{ds}^2}{2g} = K_b\left[K_{gb}/K_{gb,1}\right]\frac{V_{ds}^2}{2g} = \beta K_b\frac{V_{ds}^2}{2g} \qquad \text{Equation 4.3}$$

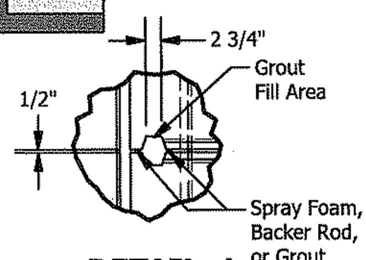
Table 4.3: β Factor versus r/D_{eq} for Gradual Bends

r_c/D_{eq}	$\beta=K_{gb}/K_{gb,1}$									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	1.000	0.960	0.920	0.879	0.839	0.799	0.759	0.719	0.679	0.638
2	0.598	0.593	0.588	0.583	0.578	0.573	0.568	0.563	0.558	0.553
3	0.548	0.543	0.538	0.533	0.528	0.523	0.518	0.513	0.508	0.503
4	0.498	0.488	0.479	0.469	0.459	0.450	0.440	0.431	0.421	0.411
5	0.402	0.392	0.383	0.373	0.363	0.354	0.344	0.335	0.325	0.315
6	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
7	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
8	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306

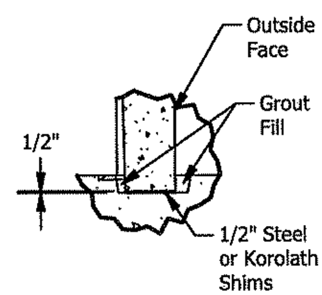
The example problem below illustrates the procedure recommended for determining the bend loss for gradual bends used in rectangular culverts using the relationships developed in this chapter.

Short Span Bridges





DETAIL 1
Wall to Wall



DETAIL 2
Wall to Base
Footing or Slab

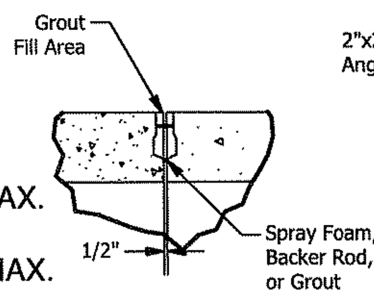
Ⓐ SHORT SPAN BRIDGE

Ⓑ OPTIONAL FOOTING OR FULL BASE SLAB

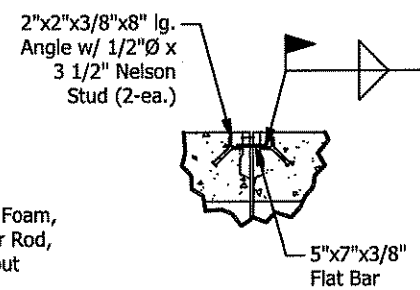
Ⓒ OPTIONAL WINGWALL

Ⓓ OPTIONAL HEADWALL

(W) VARIABLE WIDTH - (I.D.) - 6' MIN. TO 35' MAX.
(L) VARIABLE LENGTH
(H) VARIABLE HEIGHT - (I.D.) - 2' MIN. TO 10' MAX.



DETAIL 3
Top to Top

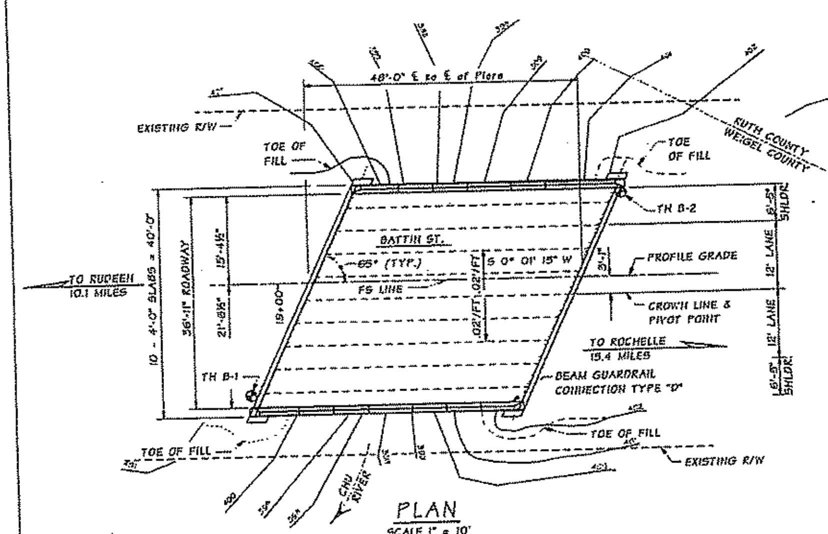


DETAIL 4
Weld Plate

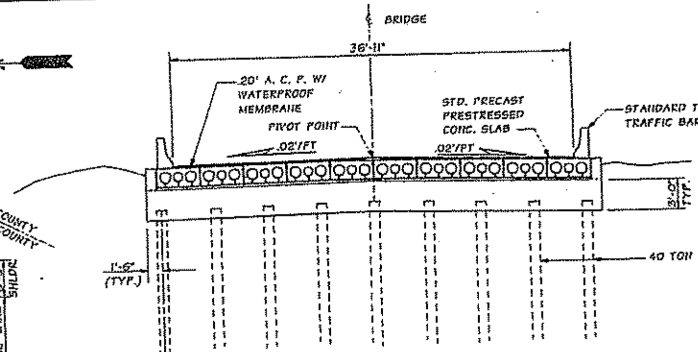
GRANITE™ PRECASTING & CONCRETE INC.
4116 BAKERVIEW SPUR • BELLINGHAM, WA. 98226 • (360) 671-2251 • 1-800-808-2251 • FAX: (360) 671-0780

FLAT SLAB (EXAMPLE)

SEC 10 T18N, R2W, W.M.



PLAN
SCALE 1" = 10'



TYPICAL SECTION
SEE "TYPICAL SECTION PIER ELEVATION ON STANDARD SINGLE SPAN PILE PIER SHEET FOR DETAILS NOT SHOWN

GENERAL NOTES

ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE STATE OF WASHINGTON, DEPARTMENT OF TRANSPORTATION, STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION DATED 2002.

THIS STRUCTURE HAS BEEN DESIGNED IN ACCORDANCE WITH THE REQUIREMENTS FOR LOAD FACTOR DESIGN, 1996 AASHTO SPECIFICATIONS 16TH EDITION. PRESTRESSED SLABS HAVE BEEN DESIGNED FOR SERVICE LOAD STRESSES AND CHECKED FOR THE REQUIREMENTS FOR LOAD FACTOR DESIGN. ALL OTHER ELEMENTS HAVE BEEN DESIGNED IN ACCORDANCE WITH LOAD FACTOR DESIGN.

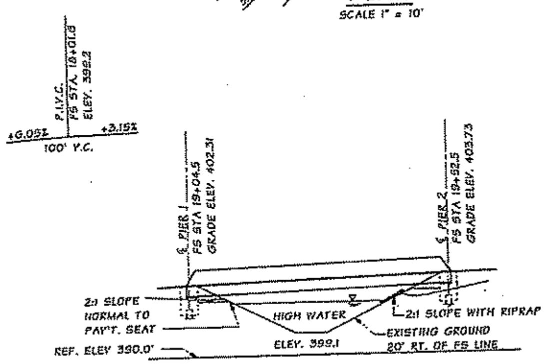
UNLESS OTHERWISE SHOWN ON THE PLANS, CONCRETE COVER MEASURED FROM THE FACE OF THE CONCRETE TO THE FACE OF ANY REINFORCEMENT BAR SHALL BE 2" AT THE TOP OF PRESTRESSED SLAB, 1" AT THE BOTTOM OF PRESTRESSED SLAB AND 1½ INCHES AT ALL OTHER LOCATIONS.

APPROPRIATE SLABS SHALL BE CAST WITH INSERTS FOR TEMPORARY AND/OR WITH REBAR FOR PERMANENT TRAFFIC BARRIER.

THE CONCRETE IN THE PRECAST PRESTRESSED SLABS SHALL BE CLASS FC MIX. ALL OTHER CONCRETE SHALL BE CLASS 4000.

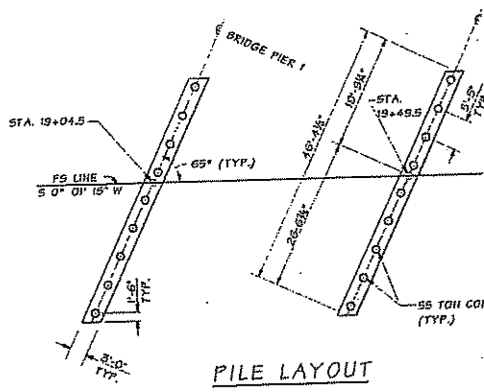
THE PRECAST PRESTRESSED SLABS SHALL BE SLAB NUMBER 26-4.

APPROACH SLABS WILL BE USED.

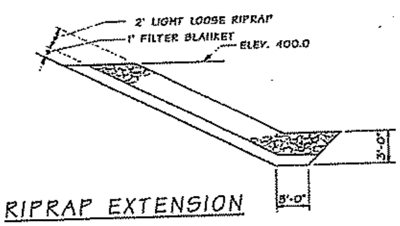


ELEVATION
GRADE ELEVATIONS SHOWN ARE FINISH GRADES ALONG ℄ FS LINE ON TOP OF CONCRETE ROADWAY

DATUM
NAT'L GEOD. VERTICAL DATUM OF 1929



PILE LAYOUT

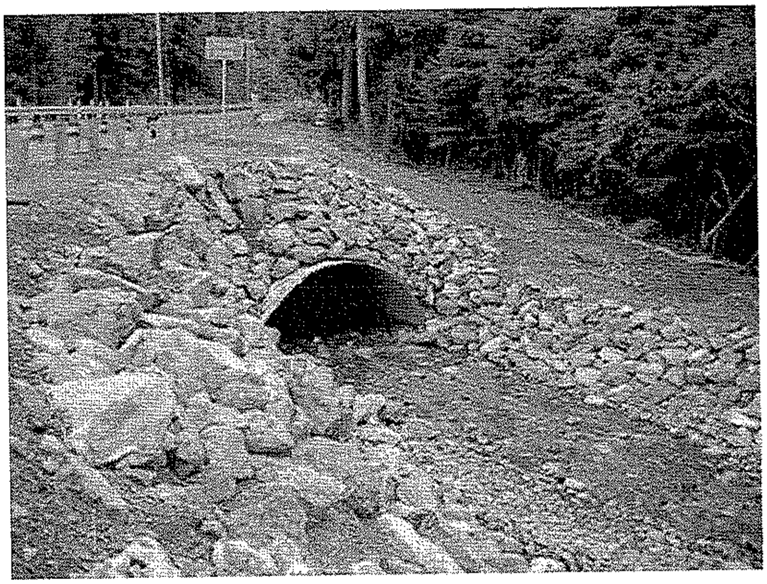


RIPRAP EXTENSION

PRECAST PRESTRESSED CONCRETE SLABS
LOADING: HS-20
OR
TWO 24 K AXLES @ 4' C'TRS.

Bridge Design Engr. / Supervisor / Designed By / Checked By / Detailed By / Bridge Projects Engr. / Prelim. Plan By / Architect/Specialist	\\BRIDGELIB\MasterG\Standards\Girders\Flat Slab\FCPS LAYOUT.man — DATE / REVISION / BY / APP'D; STATE 10 WASH.; FED. AID PROJ. NO.; JOB NUMBER	BRIDGE AND STRUCTURES OFFICE	Washington State Department of Transportation	STANDARD PRESTRESSED CONCRETE GIRDERS — PRECAST PRESTRESSED SLAB LAYOUT

Mon Aug 19 09:39:10 2002



STEEL ARCH