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May 30, 2013

Ms. Letitia Wheeler
Wheeler Consulting Group
PO Box 1404
Burlington, WA 98233

Re: Swift Creek Sediment Management Alternatives – North Fork Swift Creek Reroute

Dear Ms. Wheeler:

PROJECT BACKGROUND

Whatcom County Public Works Department, on behalf of the Flood Control Zone District (FCZD) prepared the Swift Creek Sediment Management Action Plan (SCSMAP) to address sedimentation and flooding on Swift Creek that may result in damage to agricultural, residential, and public assets and has the potential to affect public health. Proposed actions to reduce flooding consist of four primary and one alternate sediment management projects under Phase 1 of the SCSMAP. Primary proposed projects include one setback levee, one debris deflection levee, in-stream sediment traps, and sediment basins. A second setback levee is proposed as an alternative to development of the sediment basin.

The SCSMAP also includes another sediment management strategy, the rerouting of the North Fork of Swift Creek to reduce the volume of sediment transported to the lower creek reaches (SCSMAP Sediment Management Strategy 4.2E). This strategy was not included in the SCSMAP Phase 1 Project Plan, but is under consideration for SCSMAP Phase 2 implementation.

Watershed Science and Engineering (WSE) was retained by Wheeler Consulting Group on behalf of Whatcom County to review information related to the SCSMAP and offer an opinion on whether or not the North Fork Swift Creek Reroute should be carried forward for further consideration. To provide support for this opinion WSE performed the following tasks:

1. EXISTING DOCUMENTATION REVIEW

   Available literature regarding North Fork Swift Creek flow conditions and basin sediment quantity and grain size data were reviewed. This review included the following consultant reports:
   (i) Northwest Hydraulic Consultants 2010 HEC-RAS model
   (ii) KWL grain size analysis
   (iii) Whatcom County sediment/grain size data
   (iv) Converse Davis Dixon/BGC sediment core results and analyses

2. DATA ANALYSIS

   Existing hydrologic and hydraulic data were examined to better understand the effect of North Fork Swift Creek flow in relation to sediment movement through the Swift Creek system. The analysis included use of work completed by others and did not include new data collection or modeling.

PROJECT SETTING

The upper Swift Creek drainage system consists of two primary tributaries, the North Fork and South Fork. According to the SCSMAP, the North Fork is slightly larger in watershed area than the South Fork, 1.10 verses 1.05 square miles respectively. It originates at 3,350 feet elevation and has an average gradient of 25% over a distance of 2.25 miles from its headwaters to its confluence with the South Fork. The South Fork originates at 2,700 feet elevation and has an average gradient of 23% over a distance of approximately 1.9 miles. The North Fork joins the South Fork approximately 900 feet downstream from the apex of the Swift Creek alluvial fan. Downstream from the confluence, Swift Creek works its way through a variety of landscapes gradually decreasing its gradient as it travels approximately 2.8 miles to its confluence with the Sumas River.

Sediment deposition within the channel has created chronic flooding and water quality problems for many years, especially within the lower 2 miles of Swift Creek. Most of the sediment is originating in the South Fork basin, primarily from an active landslide that encroaches into the stream channel.

PROPOSED NORTH FORK REROUTE

The concept behind the North Fork reroute is to reduce bedload sediment transport in Swift Creek by decreasing flow rates downstream from the North and South Fork Confluence. The North Fork would be diverted to the Breckenridge Creek watershed which is the adjacent watershed to the north.

The North Fork Reroute is included in the SCSMAP as Sediment Management Strategy 4.2E. The SCSMAP notes in its discussion of Strategy 4.2E that the reroute would be a complicated and potentially expensive alternative, as it would involve crossing high pressure gas pipelines, South Pass Road, Goodwin Road, and numerous privately-held properties. Regulatory permitting challenges are also noted in the discussion.

DATA ANALYSIS

Hydrology

The North Fork and South Fork watershed are approximately equal in size and contribute approximately equal flows to the reach downstream of the confluence. Peak flow data, as determined from USGS regional regression equations using the on-line StreamStats tool, are summarized in Table 1.

Table 1. Swift Creek Basin Characteristics and Peak Flow Quantiles

Location	Peak Flow Quantiles (cfs)						Drainage Area (sq. mi.)	Precipitation (inches)
	2-year	10-year	25-year	50-year	100-year	500-year		
Swift Creek u/s of confluence	44	81	100	119	133	176	1.05	58.8
N. Fork Swift Creek u/s of confluence	46	84	104	123	138	183	1.10	58.4
Swift Creek at Goodwin Road	96	173	214	252	284	374	2.64	57.3

If flows contributed by the North Fork are diverted from Swift Creek, discharges below the confluence would decrease. For example, the 100-year flood at Goodwin Road has a current peak discharge of 284 cfs. Approximately half of this flow is contributed by the North Fork. Removing the North Fork flow would lower the discharge in Swift Creek to approximately 150 cfs which is less than the 10-year flood under current conditions.

Hydraulics and Sediment Transport

NHC (2010) developed a HEC-RAS hydraulic model for Swift Creek that begins at Goodwin Road and extends upstream beyond the confluence of the North Fork and South Fork. NHC computed water surface profiles for flows with recurrence intervals ranging from the 2-year to the 500-year, and an additional "extreme" flow of 5 times the 100-year discharge. NHC reported average velocity and bed shear stress calculated by the model at each cross section for each simulated flood.

Numerous factors influence bedload transport rates, of which velocity and bed shear stress are two important variables. Typically, the higher the velocity or bed shear stress, the higher the bedload sediment transport rate. Using the hydraulic data provided by NHC, one can see how velocity and bed shear stress change with discharge in Swift Creek. Table 2 below compares NHC reported average channel velocities and bed shear stress for the 10-year and 100-year floods at five representative cross sections located downstream from the North Fork/South Fork confluence.

Table 2. Average Channel Velocities and Bed Shear Stress at Five Cross Sections for the 10-year and 100-year Flood Events as Calculated by the NHC HEC-RAS Model (2010).

Cross Section ID	Average Velocity 10-year Flood (fps)	Average Velocity 100-year Flood (fps)	Percent Difference Average Velocity	Bed Shear Stress 10-year Flood (fps)	Bed Shear Stress 100-year Flood (fps)	Percent Difference Bed Shear Stress
828	4.3	5.2	17%	3.1	3.8	18%
2289	5.2	6.3	17%	1.1	1.2	8%
4026	4.9	5.8	16%	1.5	1.9	21%
5513	3.7	3.8	3%	0.9	1.2	25%
6736	6.3	7.2	13%	0.7	0.9	22%

The comparisons in Table 2 show that both average channel velocity and bed shear stress increase as flow rates increase (or decrease with decreasing flow). This indicates that the bedload sediment transport rate in Swift Creek would be expected to decrease with the lower discharges that would be seen if the North Fork flows were diverted out of the system . Unfortunately, it is not possible to quantify the magnitude of any potential reduction in sediment transport because the available data and reports to not provide any detailed sediment transport calculations or model results.

CONCLUSION

Based upon our review of existing data, it appears that rerouting the North Fork flows from Swift Creek could result in a decrease in the amount of bedload sediment that is transported and deposited within lower Swift Creek. Before additional technical analyses are completed we recommend that potential costs for the North Fork reroute be estimated so that the costs and benefits can be reasonably compared. If implementation of the North Fork reroute appears feasible, then additional technical analyses, beyond the velocity and bed shear stress data shown above, should be completed to quantify the potential benefit. Recommended additional analyses to quantify the potential sediment reduction benefit of SCSMAP Strategy 4.2E include hydrologic analysis to estimate durations at different flow levels, refinement of the hydraulic modeling, and quantitative sediment transport analyses under conditions with and without the North Fork reroute.

This concludes our review of the existing Swift Creek data available to support SCSMAP Strategy 4.2E. We trust that you will find our opinions useful. If you have questions please do not hesitate to call.

Very truly yours,
Watershed Science & Engineering Inc.

Larry M. Karpack, P.E.

Jeff P. Johnson, P.E.

References

NHC, 2010. "Swift Creek HEC-RAS Model". Memorandum from Vaughn Collins of NHC to Element Solutions dated October 15, 2010.