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RE: SKAGIT RIVER FLOOD STUDY DRAFT FR/EIS -- COMMENTS

I make these comments with great concern and astonishment after having read the recent June, 2014, USACE PowerPoint presentations in Skagit County and perused the Draft FR/EIS (FR/EIS) sufficiently, I think, to understand the basic nature of the current USACE Skagit River proposal. I hope I am missing something, but in case I understand your proposal correctly I make the following observations that suggest your proposal is technically and hydraulically fatally flawed and a threat to public safety and a vast waste of public funds to the tune of about $220,000,000 plus the usual budget inflation.

Figures 3-2 and 3-7 of the FR/EIS show the existing condition hydraulically modeled water depths in the floodplain for a "100 year flood" based on assumed likely levee failure points based on existing dike conditions. Failure points are shown as green circles with black center dots in the Figures.

Figure 3-12 of the FR/EIS shows the proposed system of urban levee improvements which is the essence of the current USACE proposal. Levees would be raised, improved and constructed around the south, east and north sides of Burlington (urban levee sections 3 to 7) to contain a 250 year flood (June Skagit County power point presentations), but no levee would be constructed on the west side of Burlington and consequently Burlington would remain open to back-flooding from the rural floodplain west of I-5 with associated rural area levees remaining at about the current 25 year flood level or whatever the Dike Districts unilaterally decide to do with their rural dikes.

Similarly, left bank levees and a new Riverbend cutoff levee would be raised to provide 250 year flood protection for most of Mount Vernon east of the Skagit River (levee sections 8 to 14). And the right bank levee would be raised to 250 year flood protection on the river bend around West Mount Vernon (levee sections 15, 16). <u>However, the west side of West Mount Vernon and south Mount Vernon would not be levee protected and would be vulnerable to back-flooding from the adjacent rural floodplains where rural area levees remain at about the 25 year flood level or whatever the Dike Districts unilaterally decide to do with their rural dikes</u>.

Because the current probable levee breach points at Burlington and Mount Vernon shown in Figures 3-2 & 3-7 are now plugged with the higher urban levee system, USACE illogically assumes that the rural 25 year flood levees outside of the urban levee corridor that protect the rural flood plain west of Burlington and west and south of Mount Vernon will not overtop or fail in a 100 to 250 year flood event--although, the USACE does assume a left bank breach of the rural 25 year levee in the Riverbend area and thus proposes the section 9 & 10 Riverbend cutoff levee to prevent back-flooding into Mount Vernon from the rural Riverbend area.

Incredibly, USACE assumes this scientifically, technically, hydraulically flawed proposal will work because they only "allow" a right bank channel breach in the Sterling area east of Burlington which forces flood flows around the north end of Burlington where they will preferentially flow "downslope" northwest and southwest to marine waters and conveniently keep the unprotected sides of Burlington and Mount Vernon essentially flood free as depicted in Figure 3-15 of the FR/EIS. <u>USACE needs to provide a technically valid argument as to why rural 25 year flood levees will successfully contain floods up to the 250 year level and thus prevent back-flooding into the unprotected western flank of Burlington and the unprotected western and southern flanks of Mount Vernon. Or USACE needs to specify what magic wand or incantation will prevent 100 to 250 year floods from over-topping and breaching 25 year rural levees</u>.

USACE's egregiously fatal error is to assume that the likely levee breach points used for the flood plain hydraulic study as shown in Figures 3-2 & 3-7 are the only points at which a 25 year flood levee system can fail in any flood level up to a 250 year flood! Thus, if you plug the arbitrary breach points in the urban levees with an improved urban levee system, you've got the problem solved.

The USACE initially considered an "Urban Areas and Critical Infrastructure Protection Preliminary Alternative" which would have provided ring dike protection around all sides of Burlington and West Mount Vernon, but not south Mount Vernon (see Figure 3-10, FR/EIS). USACE provides no explanation for the inconsistency of leaving Mount Vernon unprotected from back-flooding from the south in this alternative when their hydraulic modeling (Figure 3-2) shows potential back-flooding up to 10' or more in south Mount Vernon in a 100 year flood which could presumably back-flood into downtown Mount Vernon. USACE removed this alternative from further consideration because "*it would not provide flood risk reduction for rural areas and has high residual life safety risk for residents within the urban ring levees*" (FR/EIS, page 43). <u>In light of their statement just placed in italics, USACE provides no explanation why the current proposal was chosen when it also increases flood risk in portions of the rural flood plain and increases "residual life safety risk" for urban residents by breaking the ring dikes and leaving Burlington and Mount Vernon at risk from back-flooding from adjacent rural areas with minimal 25 year flood levees</u>.

I provide more detailed comment in the following sections.

Rural Skagit Floodplain

The planned increased in flooding across Hwy. 20 in the Sterling area and around the north end of Burlington is an obvious feature of this proposal and I expect that affected residents and businesses, and hopefully Skagit County government, will have plenty to say about this. <u>However, increased potential for rural flooding elsewhere is erroneously ignored in this proposal</u>. I discuss this issue in the following sections related to likely breaches and failures of the proposed rural levee system.

Sedro-Woolley

This proposal carefully avoids any direct discussion of the implications for Sedro-Woolley. However, increased backwater effects and flood elevations in the Nookachamps and Sterling areas are given a few brief sentences and these effects can be extrapolated to the adjacent Sedro-Woolley area. Sedro-Woolley government appears to have latched on to these camouflaged implications and I leave it to Sedro-Woolley to express their concerns directly.

Burlington and Mount Vernon

250 year flood protection for the urban floodplain areas of Burlington and Mount Vernon would seem to be the focus of this proposal. However, the proposed levee system is fatally flawed with respect to this protection. The following sections discuss these flaws in more detail.

I can only hit the most essential points in this comment letter. A detailed technical critique of all of the documents behind this proposal would reveal many more errors of approximation, estimation, averaging of conditions, modeling errors, factual errors, unwarranted and misdirected assumptions, ignored conditions and effects, logical fallacies, mental confusion, and general professional and technical hubris.

Critical Nature of the BNSF Railroad Bridge

The irony of this proposal is that what was recently considered a serious impediment to flood control--the flow restrictive, log jam prone, 100 year old, rusting, obsolete, pier washed out, BNSF railroad bridge-- is now the essential center piece of this proposal. The current flow conditions and restrictions of this bridge are essential to limiting downstream flood elevations and raising upstream flood elevations so flood waters in excess of channel capacity will flow across Hwy. 20 in the Sterling area and around the north end of Burlington (for instance, see the analyses in Appendix B - Hydraulics and Hydrology of the FR/EIS (referred to as HH)). The bridge is now so essential to this proposal that USACE must guarantee the perpetual existence of the current flow restrictive BNSF bridge. This guarantee must include the likely future events of (1) bridge failure if a massive log jam builds against the horizontal bridge girders during a major flood when river levels are above the base of the girders, and (2) eventual replacement of the 100 year old rusting obsolete bridge with a new one of modern design.

In spite of the critical nature of the current BNSF bridge to the proposed flood control plan, this proposal takes no responsibility whatsoever concerning the future conditions and existence of this bridge, which is one of the egregious and potentially fatal flaws in this proposal.

Calculations of flood elevations downstream from the BNSF bridge in HH assume 6,000 square feet of debris blockage at the bridge (HH Section 5-4, page 32). However, this assumption is unwarranted since there is no “guarantee” that such a blockage will occur or coincide with high water level. Such was the case in the 1995 flood. No debris conditions result in 100 year flood elevations significantly higher downstream from the bridge than those modeled in HH Figures 5-4, 5-5 and 5-6 (see HH PDF page 381).

At Section 2-4, HH recognizes that significant permanent riprap around bridge piers would limit the extent of channel scour under the bridge, but HH then chooses to ignore this scour limiting effect even though there is NO SPECIFIC INFORMATION on the extent of riprap scour protection which may involve most of the channel bottom. If any areas of the channel are not so protected, scour could undermine the riprap leading to riprap failure and potentially pier failure. The HH assumption of significant channel scour offsetting much of the debris blockage is thus entirely unwarranted, and all of the model calculations of high flood flow under the bridge and associated upstream and downstream water levels are of questionable accuracy.

Problems Associated With Rural Dikes Maintained at Current Circa 25 Year Flood Level

Appendix B - Hydraulics and Hydrology of the FR/EIS (HH) establishes the Probable Non-Failure Point (PNP) as the standard for estimating levee reliability throughout the river levee system (HH Section 5-2, page 29). The PNP is the flood water elevation where the probability of levee failure in the adjacent levee is 15%. However, this safety/reliability criterion is then ignored in the current FR/EIS proposal with regard to the reliability of the future rural levee system. Especially troubling is the reliability of the right bank rural levee around the west side of the Riverbend area. A breach failure of this levee would back-flood Burlington and/or West Mount Vernon through their unprotected western sides, and yet USACE refuses to contemplate such a levee failure even though 100 to 250 year floods exceed the PFP over much of this levee reach even with the proposed "urban levee" improvements #7 and #15 (see FR/EIS Figure 3-12 and HH Figure 5-4).

A similar problem with left bank rural levees exists south of Mount Vernon with potential back-flooding into unprotected south Mount Vernon from a levee failure downstream from "urban levee" improvement #14 (see FR/EIS Figure 3-12 and HH Figures 5-5 and 5-6). Again the USACE refuses to contemplate such a rural levee failure in contradiction of their PNP criterion.

A similar, but perhaps lesser problem exists with a potential right bank levee failure downstream from proposed "urban levee" improvement #15 and potential back-flooding of West Mount Vernon (see FR/EIS Figure 3-12 and HH Figure 5-4).

The PNP criterion itself is of questionable accuracy since it is based on "averaged" or "type location" soil conditions under levees and does not consider local weaknesses related to local atypical soil conditions which are unknown for most of the levee system. None of the existing levees have been subject to the height and duration conditions of 100 to 250 year floods in modern times, so experience with these levees is no prediction of performance in the big floods yet to come.

An additional problem is that flood elevation modeling downstream of the BNSF bridge "assumes" 6,000 square feet of debris blockage at the bridge (HH Section 5-4, page 32). However, this assumption is unwarranted since there is no "guarantee" that such a blockage will occur or coincide with high water level. Such was the case in the 1995 flood. No debris conditions result in 100 year flood elevations significantly higher downstream from the bridge than those modeled in HH Figures 5-4, 5-5 and 5-6 (see HH PDF page 381) making the above levee failure and back-flooding scenarios even worse.

The HEC-RAS model calculates a flow averaged water elevation across the channel width and is unable to model the real world cross channel elevation differences such as the significant elevation increases on the outside of a river bend and cross channel slope which provide the centripetal force required to turn the river around the bend. The HH flood elevation modeling ignores this serious defect in the HEC-RAS model and thus underestimates the actual water elevation on the outside of a river bend such as the Riverbend between Burlington and Mount Vernon. Thus, the problems with rural levee failures discussed above are even worse than the HH graphics show.

Well Known Problems and Errors Associated With the Mathematical Simplifications and Assumptions of the HEC-RAS Model

The mathematical formulas and procedures behind HEC-RAS calculations contain simplifications and approximations that produce both well known and poorly known errors in the output data. Nevertheless, HEC-RAS users rarely acknowledge such errors or apply corrections or adjustments even when such error correction is critical for evaluating flood containment and public safety. Refusal to acknowledge the limitations of a mathematical model compared to the far more complex dynamics of the "real world" is an example of the "fallacy of misplaced concreteness"--an unfortunately common professional, scientific and logical error. To quote Wikipedia "*Another common manifestation is the confusion of a model with reality. Mathematical or simulation models may help understand a system or situation but real life will differ from the model*."

When modeling errors and other uncertainties associated with estimates, averages, speculative assumptions, probabilities, etc., involve a public safety project and expense of over $200,000,000.00, this stubborn professional confusion assumes a moral and ethical dimension. The Italians have even proposed a designation of "geotechnical criminal behavior" worthy of prosecution.

This is not the place to enumerate all of the problems of the HEC-RAS model. However, one well known modeling error is critical to calculating accurate flood elevations adjacent to containment levees which is a measurement of critical centrality to this proposal.

The HEC-RAS model simplifies a real world river by mathematically straightening all the bends of the river into a straight line and thus ignores the cross channel flows, cross channel elevation differences and related velocity variations associated with the real dynamics of a meandering river. The surface elevation of a real river rises on the outside of a meander bend and the cross channel slope of a real river produces the centripetal force that forces the river to flow around the bend. This proposal confuses the flow averaged cross channel elevation output of the HEC-RAS model with the elevation profile of the real Skagit River and thus places the whole flood control scenario at risk of failure as enumerated in previous comments in this letter.

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References:

1. USACE. May, 2014. Skagit River Flood Risk Management General Investigation, Skagit County, Washington, Draft Feasibility Report and Environmental Impact Statement. 242 PDF pages. (referenced as RF/EIS)

2. USACE. May, 2014. (same as above) Appendix B - Hydraulics and Hydrology (composed of multiple documents and reports). 478 PDF pages. (referenced as HH)