LJK COMMENTS ON NHC DRAFT FEB 2007 REPORT RE SKAGIT HYDROLOGY

2.1 Verification of Manning's Roughness

Verification of "n" using data from the flood of October 2003 is discussed by Mastin and Kresch (2005). High water mark (HWM) data from the October 2003 flood were apparently difficult to identify in the field and show a substantial scatter. It was perhaps unfortunate that the USGS chose to publish this "n" verification work since the scatter in the data have been used by some parties in an attempt to call into doubt the applicability of slope-area techniques on this reach of the river. The slope-area measurement is a well established technique for estimating river discharges and in our opinion is reasonably well-suited to this reach, provided reliable water level data are available. The USGS used the HWMs from the October 2003 flood to determine a range of "n" values from a low of 0.024 to a high of 0.032. When applied to the HWMs from the December 1921 flood, these "n" values in turn result in a peak discharge for December 1921 in the range 215,000 cfs ("n" of 0.032) to 266,000 cfs ("n" of 0.024). The range of "n" values determined by the USGS is, in our opinion, so large as to be of little value in verifying Manning's roughness and does not contribute to improving confidence in the reliability of the 1921 peak discharge measurement. (Page 3)

LJK COMMENTS: The comments highlighted above give credence to the lack of confidence in the USGS "rush to judgment" Mastin Report and more importantly show the unreliability of taking "flood marks" (i.e. mud on trees and rocks) months after a flood event let alone what Stewart tried to do attributing mud marks to floods 4 years to 102 years preceding his investigation. MOST importantly is that once again it shows us the importance of the "n" value and how just tweaking the figure .008 can influence the flood flows from 266,000 cfs to 215,000 cfs or a difference of 51,000 cfs. This difference seemingly means little to USGS or the Corps but results in multiple millions of dollars in additional flood control project costs.

. . .

nhc's estimate of "n" from analysis of the November 2006 flood data is consistent with Benson's estimate of "n" based on data from the November 1949 flood and his recomputation of the peak discharge for the December 1921 flood of 225,000 cfs. Since this estimate was only 6% lower than Stewart's original estimate, no change was made to the then-published value of 240,000 cfs. Nevertheless, the USGS n-verification for the November 1949 flood, under conditions closer to the those of 1921 than today's conditions, together with supporting evidence from the November 2006 event, indicate that the 240,000 cfs published value for December 1921 is conservatively high, other possible sources of uncertainty notwithstanding. (Page 4)

LJK COMMENTS ON NHC DRAFT FEB 2007 REPORT RE SKAGIT HYDROLOGY

LJK COMMENTS: Does the above highlighted text imply that only one "n" value should be used for the entire reach above and below The Dalles? What was wrong with the way Riggs and Robinson computed the flows using different "n" values in 1950?

2.2 Consistency of December 1921 Data with Published Rating Curve

. . .

A measurement taken in October 2003 (discharge 138,000 cfs, gage height 38.68 ft) agrees very closely with those of February 1932, confirming and validating the rating at least up to about 150,000 cfs. The close agreement between the highest measured discharge in February 1932 and the October 2003 measurement suggests that changed channel conditions downstream of the gage site (primarily changes in vegetation on the right bank gravel/cobble bar) have had no discernible impact on the stage-discharge rating at the gage site, at least for discharges up to 150,000 cfs. At this discharge, we estimate the bar to be covered by from 5 ft to 8 ft of water. The effect of the gravel/cobble bar on upstream conditions at the gage site can be expected to decrease at higher discharges because of the hydraulic control imposed by the contraction at The Dalles. Given the stability of the channel at the gage site, there is no reason to expect a material change in the high water rating between 1921 and present at this location. (Page 5)

LJK COMMENTS: So one can infer from the above verbiage that the gravel bar/island downstream of The Dalles is not a serious player in determining flood flows which I have no problem with I just want to make sure that I am understanding what **nhc** is stating. What about "changed channel conditions" upstream of the gage as described by Riggs and Robinson and later Benson.

> "On the basis of a slope-area study made in the reach below the gage for the flood of November 27, 1949[1], it appears that the value of "n" used by Stewart in his 1921 flood flow computation was too low for his upper reach. It was also noted that Stewart did not take into account changes in velocity head in his computations. A recomputation of the 1921 peak by present methods using Stewart's values of A, P, and f, and "N" = .040 for the upper reach and "N" = .033 for the lower reach gives 209,000 cfs." … "I can find no data on which to base an estimate of the percentage of energy recovery for various conditions, but it might be that much of this energy is lost in moving the gravel bottom of the stream." … "The need for revision of the historic flood peaks is supported by the logarithmic extension of the present rating curve. … at those times the overflow area was heavily timbered and would carry little water. In addition, the possibility of a reduction in slope **due to log jams** downstream is to be considered. The recomputed value of 209,000 cfs mentioned above checks this logarithmic extension within 2%. The flood frequency curve shows a sharp offset to the right between recorded and historic floods and **casts further doubt on the published values for the historic floods.** ***(Source: Proposed Revision of Skagit River Flood Peaks, H.C. Riggs & W.H. Robinson, 11/16/50)***

[1] The gage in The Dalles was installed in 1924, three years after the last flood "estimated" by Stewart.

LJK COMMENTS ON NHC DRAFT FEB 2007 REPORT RE SKAGIT HYDROLOGY

"Only reach B-C used. Reach A-B is expanding and "n" for that portion of the channel is not well verified. Value of "n" for reach B-C is from verification using data from flood of November 27, 1949. ***(Source: Slope area measurement of Skagit River near Concrete for the flood of December 13, 1921, M. A. Benson, 5/5/52)***

They also feel that only the reach 2-3 of Stewart's 1921 determination should be used in computing the discharge because reach 1-2 is expanding and the "N" for that reach may be questionable. ***(Source: Skagit River near Concrete, Wash. – Verification Study by F.J. Flynn and M.A. Benson, 8/52)***

. . .

Assumptions	**Peak Gage Height or Discharge (December 1921)**	
	Gage Height (feet)	**Discharge (cfs)**
Gage height reported by Stewart with discharge from Rating 6	47.6	215,000
Gage height adjusted for 0.5 ft fall to new gage site with discharge from Rating 6	47.1	210,000
Gage height adjusted for 1.5 ft fall to new gage site with discharge from Rating 6	46.1	201,000
Gage height adjusted for 2 ft fall to new gage site with discharge from Rating 6	45.6	196,000
Gage height reported by Stewart with discharge from straight line log-log extension of Rating 6 above 140,000 cfs	47.6	222,000
Discharge reported by Stewart with gage height from Rating 6	50.2	240,000

(Page 6)

LJK COMMENTS: I'm not sure how to interpret the above table. What is Rating 6? Does the last entry suggest that in order to reach 240,000 cfs that would mean that the gage would have had to read 50.2 on the new gage instead of the USGS reported 47.6 and visa vie if the gage height was 47.6 then the Skagit would have only carried 215,000 cfs not the reported 240,000 cfs? The second entry is interesting in that it is exactly the same discharge as Riggs and Robinson came up with in 1950. ***(Source: Proposed Revision of Skagit River Flood Peaks, H.C. Riggs & W.H. Robinson, 11/16/50)***

What the above chart does show us is that Stewart could have been off by as much as 44,000 cfs which equates to approximately 4.5 feet of water which further equates to hundreds of millions of dollars in questionable flood control project costs.

2.3 Consistency of December 1921 Data with Evidence of Non-Inundation

. . .

According to research by Kunzler (2006), the Smith House in Hamilton (307 Maple Street, Hamilton) was built in 1908 and anecdotal reports indicate that it has only once been flooded above its main floor level. The house is reported to have had 2 inches of water above the main floor level during the flood of November 1995 (peak discharge at Concrete 160,000 cfs). Anecdotal reports suggest that the house was **not** flooded in earlier and much larger flood events (1910 – 260,000 cfs, 1918 – 220,000 cfs, 1922 – 240,000 cfs). If flows of the magnitude of these historic events had occurred under **current** river channel conditions, then the water levels should have been several feet above the main floor level. These apparent inconsistencies have a number of possible explanations:

- the anecdotal reports are incorrect and the house was in fact flooded above the main floor level in the earlier floods,
- the peak discharge estimates for water years 1910, 1918, and 1922 are incorrect and are too large, or,
- the hydraulic conveyance capacity of the river channel and/or floodplain in and around Hamilton was historically significantly greater than at present and was able to carry greater flows at lower water levels.

. . .

Although no sign of water damage from large historic floods was evident, it is our present opinion that this does not provide **conclusive** evidence that flooding did **not** occur. Any flood marks from December 1921 would now be 85 years old. **From our limited experience with flooding of buildings, we would expect flood marks to fade with age.** At the present time, we simply do not know whether a flood mark on the interior of a wall would still be visible after 85 years. (Page 7)

. . .

Figure 3 also shows a substantial narrowing of the river channel downstream from Hamilton between 1937 and 2001. The average channel width for the approximately 1.5 mile reach through the first meander bend below Hamilton was about 750 ft in 1886 and 900 ft in 1937 compared with only 600 ft in 2001. These estimates should be used with some caution since: (1) we do not know with certainty how the river channel was delineated on the GLO maps, and (2) bank lines from the 1937 and 2001 aerials were drawn, in the absence of stereographic coverage, as the edge of continuous vegetation. The greater width in 1937 is due mostly to inclusion within the defined channel of a broad left-bank sand or gravel bar. Nevertheless the river channel in 1937 (and presumably also at the time of the historic floods) was clearly wider than at present and would have had a correspondingly greater conveyance capacity. Just how much greater is not possible to determine with any accuracy since detailed channel surveys from 1937 are not available. (Page 8)

The approximate analysis conducted for this review indicates that the Cockerham Levee raises water levels in Hamilton by about 1.2 ft for flows in the range of 240,000 cfs. With the levee in place and assuming that the Smith House was just flooded to the level of the main floor at a discharge of 160,000 cfs in November 1995, then a discharge of 240,000 cfs **with the present channel conditions**[3] would have flooded the house to a depth of about 4.2 ft. Without the levee but **with present channel conditions,** the depth of flooding would have been about 3.0 ft. **Given that the river below Hamilton was considerably wider in 1937 than today, it is possible that the river could have carried 240,000 cfs in 1921 without flooding the main floor of the Smith House.** More definitive estimates of water levels at the Smith House during the December 1921 flood are not possible given the lack of detailed channel geometry data from that period. **(Emphasis added)** (Page 9)

LJK COMMENTS: This section of the report is perhaps the most inconsistent with otherwise a great work product of documentation and research. **nhc** has concluded that because the river was wider in 1937 then it is today that it could have carried the flows in 1921 and not flooded the Smith House. Based on the following local history I would have to respectfully disagree with **nhc**.

After the 1921 flood the local newspapers reported the following:

> *At Hamilton the entire town was covered with water to a depth of from three to seven feet, the water entering every business house in town. Sidewalks were washed away and considerable inconvenience and small damage caused the residents, but no heavy losses are reported. (Source: 12/17/21 C.H.)* **(Emphasis added)**
>
> *The flood of 1921 is the biggest flood in the history of the Skagit, according to old timers, who recall the floods of 1879, 1888, 1897 and on up to the big flood of 1909 and the 1917 freshet. Mrs. Dreyer, who lives west of town, tells of the big flood of 1888, when in some places the river backed up higher than this year. She says that not so much damage was done then because there were practically no dikes and the water spread over the lowlands more gradually.* ***Measurements at the Dalles, near Concrete, show that the flood water this year reached a point two feet higher than at any previous time in the memory of the oldest settler****. Charley Moses says that it was the biggest flood, with the biggest volume of water ever carried in the Skagit. At Van Horn the water was 14½ inches higher than it had ever been.* ***In 1909 the river in the upper valley was only about two-thirds as wide as it is now.*** *Hundreds of acres of land are being washed away every year, by both Skagit and Sauk rivers. W. A. Ellison says he has been on the upper river for 21 years and this is the biggest flood he has seen or heard old timers tell about. (Source: 12/22/21 CT)* **(Emphasis added)**
>
> **Old timers in the Skagit valley, who have seen all the floods in the Skagit valley**

> **since the early 80's say that the recent flood carried a greater volume of water than any previous flood since the county was settled, surpassing even the famous high water of 1897. The fact that the river did not reach marks set in former years at some points in the upper valley is accounted for by the widening of the river since that time.** In all places where the banks of the river have remained unchanged the **1921 mark is considerably above that of any previous flood known to settlers.** *(Source:* ***12/31/21*** ***C.H.****)* **(Emphasis added)**

The reports are very consistent with what Mr. Slipper testified to about his house having 1-2 inches of water in it as at that time the house sat about 3 feet off the ground. (See **Declaration of Fred W. Slipper)**

According to USGS, the Corps and Stewart, the 1921 flood (240,000 cfs) was the third highest with the 1897 and 1909 floods (Stewart 275,000 cfs and 260,000 cfs respectively) being higher which would mean that the three foot depth put forth by **nhc** would have been much greater for the 1897 and 1909 flood events. Based on the local history presented herein not only are the depths of the flood events not consistent with local history neither are their order of magnitudes.

Further credence to the articles mentioned above is given by the "sounding map" performed by the Corps of Engineers in 1911. *(See* **Corps Map of Hamilton Vicinity** ***)*** The map appears to show the Skagit River in a position much more closely aligned to where the river is today then where it was in 1937. What I believe it shows us is that the river was in the process of widening itself after the 1897 and 1909 flood events, or more likely then not, due to the log rafts being floated down the Skagit during that time, the log rafts played a substantial part in erosion of the Skagit banks and the widening of the Skagit River.

One other item of interest worth mentioning is that the whole exercise with the Smith house is not to establish a "flood mark" such as a "stain" as referenced by **nhc**. Given the fact that the Skagit River has as its two main contributor's volcanic rivers (The Baker and The Sauk) and as such both, but especially the Sauk, put a tremendous amount of volcanic material into the Skagit River system. The locals refer to this material as "silt" however when the "silt" is analyzed it shows a very heavy concentration of volcanic material. Most older homes like the Smith House were constructed with "ship lathe". If the Smith House had in fact had several feet of water in it in any of the 3 historical floods (especially the 1909 flood event when the river had not widen) the ship lathe should show signs of the volcanic dust (i.e. silt). To date none has been found.

3.0 COINCIDENT FLOWS AT CONCRETE AND SEDRO-WOOLLEY

. . .

The historic data show attenuation (reduction) in peak flows between Concrete and Sedro-

Woolley ranging from 11% to 31% while the hydraulic modeling results for the 100-year regulated event show a 3% increase. The apparent discrepancy between historic data and model results may be due to one or more of the following factors:

- the hydraulic model may be unreliable
- modeled "local" inflows between Concrete and Sedro-Woolley may be too high
- differences between regulated and unregulated hydrology (i.e. unregulated historic flows would have likely been more peaked and thus more likely to show attenuation when compared to regulated flows which are already somewhat attenuated, with drawn out peaks)
- historic peak flows reported at Concrete may be too high
- historic peak flows reported at Sedro-Woolley may be too low (Page 10)

3.1 Hydraulic Modeling

. . . The primary focus of **nhc**'s review was flow attenuation within the reach from Sedro-Woolley upstream to the Baker River confluence at Concrete (RM 55.35). All cross-section data upstream from Sedro-Woolley are taken from 1975 surveys from the effective FIS (published in 1984), and are spaced on the order of 0.5 to 1.0 mile apart (excepting interpolated sections added for model stability). Downstream cross-sections within the area of greater interest to the Corps study were resurveyed in 1999 by Skagit County. . . . (Page 11)

Given the age of the cross-section surveys, their rather wide spacing, and the uncertainty in calibration and n-values, the localized accuracy of computed water levels at specific locations within this reach may be questionable. (Page 11)

. . .

Even with the most extreme of the above scenarios (no local inflow between Concrete and Sedro-Woolley and the time base of the hydrographs halved) it is not possible for the hydraulic model to reproduce the attenuation implied by the historic flood data from Concrete and Sedro-Woolley, which strongly suggests that either the historic peak discharges reported for Concrete are too high or the corresponding discharges reported at Sedro-Woolley are too low. (Page 12)

. . .

. . . The final and apparently overriding review by Bodhaine (1954) concluded, on the basis of very little quantitative data, that peak discharges estimated by Stewart for 1918 and 1922 were probably "quite reliable" but that peak flows for the earlier events in 1898 and 1910 were probably about 10% high. Bodhaine points out that the "maximum change of 10.8% seems small when all of the possible sources of errors are considered", and recommends that Stewart's values continue to be used. Bodhaine also notes that "the peaks near Concrete probably should be revised if those near Sedro-Woolley are changed." . . . Nevertheless, the consensus amongst the USGS reviewers of the 1950s was that the published **Sedro-Woolley peak flows were high and if that is the case then peak flow estimates at Concrete must also be high.** (Page 14) ***(Emphasis added.)***

LJK COMMENTS: The first thing this lengthy and in-depth section reveals to us is that as a lot of us suspected, nothing has been "studied" between Concrete and Sedro-Woolley since 1975 and that work is at best questionable. However with respect to the 4 historic floods it might not matter as I couldn't have said it better then **nhc** did:

> *Even with the most extreme of the above scenarios (no local inflow between Concrete and Sedro-Woolley and the time base of the hydrographs halved) it is not possible for the hydraulic model to reproduce the attenuation implied by the historic flood data from Concrete and Sedro-Woolley, which strongly suggests that either the historic peak discharges reported for Concrete are too high or the corresponding discharges reported at Sedro-Woolley are too low.* (Page 15) . . . . . . the consensus amongst the USGS reviewers of the 1950s was that the published **Sedro-Woolley peak flows were high and if that is the case then peak flow estimates at Concrete must also be high.** (Page 14)

4.2 Treatment of Historic Data

The flood frequency analyses conducted by the Corps follow the guidelines of USWRC Bulletin 17B. This is the widely accepted standard approach to flood frequency analysis. However, as pointed out by several researchers (e.g. Stedinger and Cohn 1986), the Bulletin's approach to treatment of historic data is inefficient and Bulletin 17B itself (page 28) acknowledges the need for "Alternative procedures for treating historic data". (Page 18)

LJK COMMENTS: I'm glad to see **nhc** have this discussion. It has been my position for some time now that use of the 4 historic floods actually violates the spirit and intent of 17B which by the way is the only thing that the Corps of Engineers has to rely on for usage of the USGS data. (See **17B Analysis**) Contrary to what we were told by the former Colonel of the Seattle District, there is no regulation that requires the Corps of Engineers to use USGS data.

5.0 UNCERTAINTY

USGS staff have repeatedly stressed that all discharge measurements are uncertain and, depending on circumstances, may be good to only within ±25%. Furthermore, upon review, the USGS has taken the position that measurements of peak discharges for the historic floods of 1898, 1910, 1918, and 1922 for the Skagit River near Concrete should not be downgraded and will remain part of the official record. The US Army Corps of Engineers has in turn accepted the USGS position and has determined that the historic events be incorporated into its analysis of flood risk in the Skagit Valley.

We agree with the USGS and the US Army Corps of Engineers basic positions with respect to the historic events for the following rather simple reasons:

- there is convincing evidence that significant floods occurred in those years
- exclusion of those data from the analyses could result in an understatement of flood risk

We are also of the opinion that uncertainty should be incorporated into the analysis of flood risk in the Skagit Valley and that planning for flood hazard management, including the current flood damage reduction study, should incorporate safe-fail features.

. . .

Our review of the historic data has identified or confirmed a number of indications that the discharge estimate for the December 1921 flood is likely high. Given the manner in which the discharge estimates for other historic events are dependent on the December 1921 estimate, this would imply that discharge estimates for the historic events of water years 1898, 1910, and 1918 are also high. The various indications that the December 1921 peak flow estimate is likely high include the following:

- the discharge estimate is inconsistent with extrapolation of the established stage-discharge rating and plots to the right of the curve (i.e. the discharge is higher than would be expected from the rating for the reported gage height).
- no account has been made for the drop in water level between the old and new gage sites.
- the “n” verification study of 1950 indicates that the published peak discharge is high.
- the reported attenuation in peak discharges between Concrete and Sedro-Woolley appears to be excessive. (Pages 21 and 22)

(Evidence that the Smith House in Hamilton did not flood in 1921 when it was flooded at an appreciably lower discharge in 1995 has been cited by others as a further indication that the published peak discharge for 1921 is high. However, as discussed in Section 2.3 above, changes in hydraulic conditions downstream from Hamilton appear to have significantly reduced the channel conveyance capacity between 1921 and present. With the information currently available it is not possible to say with certainty whether the Smith House would or would not have been flooded in 1921 at a discharge of 240,000 cfs).

While each of the above points could be argued, the preponderance of the evidence suggests that the current estimate for the December 1921 peak discharge is toward the high end of the range of plausibility.
(Pages 21 and 22)

Uncertain gage height and fixed roughness

Flood Event	**Range of Peak Flow (cfs)**	
November 1897	229,000	290,000
November 1909	210,000	260,000
December 1917	179,000	220,000
December 1921	196,000	240,000

With the above range of discharges for the historic floods and assuming that the 1898 flood is the largest in the period 1870 to 1898, the estimate of the 100-year unregulated discharge is reduced from 284,000 cfs to 248,000 cfs. (Pages 22 and 23)

Uncertain gage height and uncertain roughness

The effects of uncertain roughness were approximately accounted for by widening the above range of historic discharges by ±7%, representing uncertainty in Manning's roughness of ±0.002. The discharge values for the historic events were assumed as follows:

Flood Event	**Range of Peak Flow (cfs)**	
November 1897	213,000	310,000
November 1909	195,000	278,000
December 1917	166,000	235,000
December 1921	182,000	257,000

With the above range of discharges for the historic floods and assuming the 1898 flood is the largest in the period 1870 to 1898, the estimate of the 100-year unregulated discharge is reduced from 284,000 cfs to 241,000 cfs.
(Page 23)

LJK COMMENTS: I am sure that Commissioners' Dahlstedt and Munks will remember that during my James E Stewart Goes To Washington DC presentation (*See James E. Stewart Work Product Goes to D.C.),* I made the remark several times that one of the things that bothered me was one figure kept coming up no matter whose hydrology you were using. That figure was **around 40,000 cfs** at The Dalles. Riggs and Robinson in 1950 wanted to reduce Stewarts flows for the 1909 flood by **40,000 cfs** and the 1921 flood by **50,000 cfs**. ***(Source: Proposed Revision of Skagit River Flood Peaks, H.C. Riggs & W.H. Robinson, 11/16/50)*** The Corps of Engineers hypothetical 100 year flood difference between using Stewarts figures and not using Stewarts figures for regulated flows is approximately **40,000 cfs. nhc** as previously discussed herein using a Gage height adjusted for 2 ft fall to new gage site with discharge from Rating 6 results in a **44,000 cfs** reduction to Stewarts 1921 flow. And now we have **nhc**, world renown and well respected engineering company stating that the estimate of the 100 year unregulated discharge could be reduced between **36,000 and 43,000 cfs.**

The USGS, FEMA and the Corps might be comfortable with their + or – 25% and 40,000 cfs might mean nothing to them with respect to accuracy in their "in-exact" science of hydrology, but to the taxpayers of Skagit County, indeed the taxpayers of our country, this could be the difference of 100 to 200 million dollars in tax money for a flood control project. 4 feet of water is significant and + or – 25% is unacceptable. Accuracy should not be allowed to be replaced with bureaucratic obstinance.

With respect to the above comments on the Smith House, please see the previous section titled 2.3 Consistency of December 1921 Data with Evidence of Non-Inundation. I do believe that **nhc** needs to revisit this section before this report is finalized. While I am willing to accept **nhc**'s statement that the Smith House is not "conclusive" evidence I think that given the historical documents presented herein that it is at least "suggestive" evidence that the Stewart flows are too high and in fact support the rest of the **nhc** report.

7.0 CONCLUSIONS AND RECOMMENDATIONS

. . .

. . .we are of the opinion that estimates of the peak discharges for the historic flood events of water years 1898, 1910, 1918, and 1922 should continue to be incorporated in analyses of flood hazard and flood hazard management in the Skagit Valley. We are also of the opinion that uncertainty in the magnitude of the historic floods should be accounted for in future hydrologic analyses.

The estimated peak discharge for the 1922 flood is of critical importance to flood hazard management since estimates of the peak discharges for the other historic events are directly dependent on the estimate for the 1922 event. **The peak discharge estimates for the historic events collectively determine the magnitude of the 100-year discharge, which in turn is the single most important hydrologic parameter for the flood damage reduction feasibility study and the flood insurance study.** ***(Emphasis added)***

It is widely recognized that the peak discharge estimates for the historic events are uncertain. Review of various factors affecting the discharge estimates indicates that the published peak discharge for the 1922 flood of 240,000 cfs at the Concrete gage is most likely toward the high end of the range of uncertainty. . . . Further work is required to establish **agreement on defensible flow ranges** in consultation with the USGS and US Army Corps of Engineers. ***(Emphasis added)***

. . .

The exploratory analyses with EMA indicate that more rigorous frequency analyses, incorporating uncertainty in the historic peak discharge estimates and taking advantage of EMA's ability to handle multiple historic periods with multiple flood thresholds, could result in a 10% to 15% reduction in the estimate of the 100-year peak **unregulated** discharge. (Page 26)

. . .

Recommendations arising from this review are as follows:

1) Given the past occurrence of major storms early in the flood control season, agreements should be negotiated with Seattle City Light and with Puget Sound Energy to ensure the availability of 120,000 acre-ft of flood control storage at Ross Dam and 74,000 acre-ft of flood control storage at Upper Baker Dam by no later than November 1 of each flood control season. Consideration should be given to conditioning flood control storage requirements in the early part of the flood control season on watershed moisture conditions and intermediate term weather forecasts.

2) The County should seek clarification from the USGS regarding the potential for proposed paleoflood studies to contribute to a more reliable characterization of flood risk. The USGS has previously proposed a paleoflood study which targets the pre-settlements floods of around 1856 and 1815. From currently available information, it is not clear whether the proposed work can be expected to both produce estimates of the magnitude of these events **and** establish a time period within which the 1815 flood was the largest such event. Information on both magnitude and time frame are necessary for risk-based analysis.

3) The County should determine whether the potential for a 10% to 15% reduction in the 100-year peak **unregulated** discharge, based on more rigorous flood frequency analysis,

warrants additional investment in hydrologic and hydraulic studies. (Pages 26 and 27)

LJK COMMENTS: For the most part I am in complete agreement with **nhc**'s conclusions and recommendations and feel completely vindicated on the work product that I have produced as a layperson over the last several years with respect to questioning the accuracy of Mr. Stewarts work product. **nhc** has stated without equivocation that there is a "uncertainty in the magnitude of the historic floods should be accounted for in future hydrologic analyses", that the 4 historic floods are what is driving the outcome of the flood insurance study and the flood reduction study, and that "**It is widely recognized that the peak discharge estimates for the historic events are uncertain.**"

Their first recommendation that additional storage be negotiated with PSE and SCL I could not be more in agreement with and would support a .005% increase in the sales tax to help pay for additional storage. As one PSE official told me in Washington DC he didn't have a problem providing additional storage so long as the utility got paid for it. So pay them for it. Given the total lack of protecting the general safety health and welfare demonstrated by FERC in not requiring additional storage, paying for it is our next best option. I think we should also consider additional storage beginning on October 1st not November 1st.

The second recommendation I'm not too keen on given how I recently began to feel about the competency of federal employees to get anything right. Having reviewed the USGS proposal I feel it raises more questions than answers.

The third recommendation should be a no-brainer for the County. A reduction of 15% to the Corps hypothetical 100 year flood would be a reduction of around **40,000 cfs** or 4 feet of flood waters. While that might not equate to a very large reduction in base flood elevations in the lower valley it certainly would make it a lot more achievable to protect our urban areas by modifying the 3 bridge corridor and our current levee system.