Summary Report

Appeal of the
Revised Digital Flood Insurance Rate Map (rDFIRM)
and
Revised Flood Insurance Study (rFIS)
For Skagit County, Washington,
dated July 1, 2010

and Submittal to the
Scientific Resolution Panel

by the Cities of
Burlington and Mt. Vernon, Washington

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INTRODUCTION AND OVERVIEW

In 1923, J.E. Stewart of the United States Geological Service (USGS) calculated the peak discharge of the Skagit River near Concrete, Washington for the 1921 flood event. He calculated this peak discharge by surveying high water marks between 11 and 13 months after the event, and applying the slope-area method to those high water marks. From that estimate Stewart then generated estimates of the peak discharges from the earlier 1897, 1909, and 1917 historic flood events. The USGS reviewed and re-estimated the historic flood peaks several times between 1950 and 2007.

In 2007, the USGS (Mastin) revised Stewart's flow estimates of the 1921 flood.[1] This revised estimate was created by using only three of the twelve high water marks surveyed by Stewart, using a different roughness factor than Stewart, ignoring Stewart's call for an analysis of the "surge" on the high water marks, and compounding an error in cross-section noted by Stewart (this revised 2007 estimate will be referred to as the "USGS estimate" for the remainder of this paper.) Based on this new USGS estimate of peak discharge, the USGS revised the peak discharge estimates for the 1897, 1909, and 1917 historic floods calculated by Stewart.

Tellingly, to this day the USGS estimated peak discharges for those four events are larger than anything that has ever been recorded on the Skagit River gage near Concrete which began recording flows in September, 1924. More than eighty-six years into this monitored record, despite substantial evidence that the USGS peak flow estimates for the 1921 flood are too high, the U.S. Army Corps of Engineers (USACE) has incorporated all four historic peak discharges into its flood frequency analysis for the Skagit River near Concrete. This flood frequency analysis forms the hydrologic basis for the Federal Emergency Management Agency's (FEMA) revised digital flood insurance rate maps (rDFIRM) issued on July1, 2010.

Appellants' work corrects the USGS estimate by using additional, relevant information for the slope-area method and then supplements this method with two additional methodologies, all of which result in significantly lower estimates of the historic flood events. The Appellants' estimates are remarkably consistent with the systematic record, unlike the USGS' estimates. Appellants also use, in their FLO-2D model, more granular topographic information. It is on these bases that the Appellants appeal FEMA's rDFIRM and submit their own frequency analysis, FIRMs, and all necessary supporting information.

It is critically important to note how statistically unlikely the USGS peak discharge estimates are. When the USGS' four historic peak discharges are applied to the systematic record, the statistical anomalies are obvious. As indicated in the attached documentation, there is only a one in 769 chance that four events, the size estimated by USGS for 1897, 1909, 1917, and 1921, could occur in a 25 year period in light of the 86 year systematic record.

Because the hydraulic methodology employed by FEMA and its contractor, the USACE, in the determination of the BFEs is inappropriate and/or incorrect for the Skagit system, the rFIS and the rDFIRM are scientifically incorrect. Moreover, because the assumptions made as part of the methodology are inappropriate and/or incorrect, the rFIS and the rDFIRM are scientifically

[1] USGS Scientific Investigation Report (SIR) 2007-5159.

incorrect. The Appellants' use of different methodologies and different assumptions produces more accurate results, which are reflected in the revised historic record.

In addition, FEMA and its contractor, the USACE, misapplied the hydraulic methodology; utilized insufficient and poor-quality data; and included measurement errors in its data and modeling, all of which resulted in BFE's that are technically incorrect.

This appeal is based upon the following documents:[2]

- Technical Report – Supporting Data and Analysis for Skagit River RFIS Appeal, March 2011, Pacific International Engineering ("Technical Report"), and all supporting technical appendixes, computer files, and floodplain maps.

- Probability Estimates of Historical Flood Events and Recorded Floods, Skagit River near Concrete by Joseph Countryman PE with ITR by Dr. David Ford PE ("Probability Estimates (Countryman)").

- Memorandum dated March 28, 2011 raising legal and procedural issues associated with FEMA's issuance of the rDFIRM and the rFIS and its proposal to finalize these documents.

- Appellants' Response Memorandum to FEMA memorandum of May 19, 2010.

- Appellants' Response Memorandum to USGS memorandum of May 7, 2010.

- Letter from Pacific Surveying & Engineering dated March 29, 2010.

DISCUSSION

A. The Determination of Appropriate Hydrology for the Skagit River

In preparing its own analysis to generate a 100-year flow estimate, the Appellants applied the Guidelines for Determining Flood Flow Frequency (Bulletin 17B) to generate a scientifically and technically correct flood frequency curve. The Appellants accepted the systematic records for the Skagit River from Water Years 1925 to 2008 presented by the USACE but modified those records in two important ways to make them more accurate:

[2] These documents collectively demonstrate that an inappropriate or incorrect hydraulic methodology has been used, the hydrologic methodology applied was not applied correctly, and insufficient or poor-quality data were used. As a result, these documents include the following: (1) New hydraulic analysis based on alternative methodologies; (ii) an explanation for the superiority of the alternative methodology; (iii) revised flood profiles; (iv) revised floodplain maps; (v) new hydrologic analysis in which the original methodology has been applied differently; (vi) data which we believe to be better than those used in original hydrologic analysis; (vii) documentation for the sources of data; and (viii) an explanation of the improvements resulting from the use of new data. (Appellants observe that the floodway boundary has not been delineated for the Skagit below Sedro-Woolley, and thus have not included a revised floodway boundary.)

- First, the Appellants included five years of data the USACE did not include and for which there is not a legitimate reason to exclude (Water Years 1931, 1937, 1992, 1993, and 2008). See Technical Report section 2.5.1.

- Second, the Appellants also corrected an error in the calculation performed by the USGS to convert the 1932 regulated peak flow to an unregulated peak flow. The mathematical error made by USGS was based on incorrect timing for the routing of flows. See Technical Report section 2.4.

Consistent with Bulletin 17B, the Appellants then sought to include historic flood data in the frequency computations.

Appellants Evaluated the USGS' Use of Historic Events: As required by Bulletin 17B, the reliability of the historic flood data calculated by USGS was evaluated and the Appellants concluded that the USGS estimated peak discharge for 1921 was not reliable and not technically correct because:

- The estimate is calculated using high water marks based upon observations first made by Stewart between 11 and 13 months after the event. While later marking of high water events is not automatically unreliable – such as where the marks are based on personal observation (e.g., "I recall the water coming up to the windowsill") – in this case the three high water marks used by USGS were first identified by Stewart 11 to 13 months after the high water event by observing twig, moss, mud, and leaf debris. Contributing to the uncertainty of the flood estimate is the high velocity within the Dalles and the consequent surge effects and sensitivity to slope determinations and average water surface elevation determinations. See information on variability of measured high water marks in Technical Report sections 2.2.5 and 2.2.6.[3]

- The peak discharge for the slope-area sections calculated by USGS is based upon only three of the 12 high water marks made by Stewart in that reach: using the slope between two of the three cross sections created by Stewart – cross-sections 2 and 3 only – with two points existing at cross-section 3 and a single point at cross-section 2. See Technical Report sections 2.1.4 and 2.2.6.

- The peak discharge calculated from the slope-area method by USGS ignores an additional cross-section measured, monitored, and modeled by Stewart. Stewart also calculated the slope-area method using additional high water marks located at or along cross-section 1. See Technical Report sections 2.1.4 and 2.2.5.

- The peak discharge calculated from the slope-area method by USGS uses an incorrect flow area based on incorrect channel topography due to an error noted by Stewart himself in his notes (related to a survey line stretching five percent). The USGS corrected this

[3] A wide variation in high water marks recorded in the Dalles reach by Stewart and others significantly after the high water events, especially when dealing with extremely high velocities, creates a significant question as to the reliability of the surveyed marks used for the slope-area method calculations by the USGS. For example, in the 2003 USGS study, the USGS field team retrieved high water marks in the Dalles reach which varied by as much as 12 feet at a particular location. Even with the elimination of the outliers the uncertainty range was still 3 to 4 feet at locations. See Technical Report figure 9.

error, but also corrected it for a cross-section survey which did not contain the error, thus introducing a new error. See Technical Report sections 2.2.5 and 2.2.6.

- USGS (as well as Stewart with his original calculation) failed to consider velocity head impacts. In the reach in which the high water marks were recorded, extremely high velocities result in an 18 inch or more differential between the "shore" high water mark (representative of the Energy Grade Line) and the section-mean high water elevation used to calculate flow in the slope-area method. This differential has a significant impact upon the estimated peak discharge. See Technical Report sections 2.1.4, 2.2.5, and 2.2.6.

- Stewart did not take into consideration issues of surge he noted and which he recommended later be addressed. By accepting the same high water marks, USGS similarly did not address these issues. See Technical Report section 2.2.5.

- USGS's estimated peak discharges for the 1897, 1909, and 1917 events are not reliable:

    - Each is based upon the 1921 estimated peak discharge which is unreliable for all of the reasons noted above

    - Further, the USACE accepted the USGS calculated peak discharges for the 1897, 1909, and 1917 events, which are exclusively based on the 1921 peak discharge, and high water marks found at the Old Washington Cement Plant in Concrete. These HWMs are over 2 miles upstream from the current USGS gage near Concrete. The USGS assumed that the stage differences between 1921 and the other Historic floods would be identical at the Skagit River near Concrete gage as they were 2 miles upstream. This is despite the fact that the river cross sections are completely different between RM 56.32 and RM 54. Repeating the errors in the 1921 peak discharge and speculatively assuming the stage relationship at the two sites are the same magnifies the uncertainty of the USGS calculations. Stewart's notes indicated that the HWMs he took at the Old Washington Concrete Plant on the Baker River (and later transferred downstream for both Stewart's and USGS' calculations of the 1909, 1917 and 1897 floods) may have been affected by Baker River high flows (see Stewart's field notes). Finally, the relationships between the four events used by USGS are not consistent with surveyed high water marks of the four events by Stewart in downstream reaches.

  See Technical Report section 2.3.3, subsections entitled "Unreliable Estimate of 1897 Peak Discharge Using Questionable Flood Marks Upstream of the Dalles" and "Unsupported Relationship of the 1909, 1917, and 1921 HWMs Used in Stewart and USGS Peak Discharge Estimates."

Appellants Developed Other Analyses to Evaluate the Technical Incorrectness in USGS Hydrology: In addition to these technical deficiencies, Appellants developed several other means of "truth-checking" the USGS estimate, all of which suggest that the USGS estimated peak discharge is not technically or scientifically correct:

- The statistical probability of these four events occurring as part of the systematic record is exceedingly unlikely. For this reason, the USGS estimated historical peak discharge

appears to be very high when compared to the systematic record. Because the USGS historical flood estimates are not consistent with the systematic record they should not be used in calculating the flow frequency curve as noted in Bulletin 17B (page 19). See Probability Estimate (Countryman).

- Appellants developed two HEC-RAS models, one each for two segments (upstream and downstream from the Dalles) of the Skagit River (Concrete reach and Hamilton Lyman reach). Each model was calibrated and adjusted for 1911 surveyed channel data. Routing the USGS estimated peak discharges through the HEC-RAS models produces a calculated high water ranging from 6.5 to 8.2 feet above those measured by Stewart. See Technical Report section 2.1.2.

- The Appellants compared high water marks recorded by Stewart in Hamilton for the 1909, 1917, and 1921 events to high water marks taken from the 1995 and 2003 events. The high water marks from the two modern events were approximately five feet higher than those from the historic events. Yet, according to the USGS, the peak discharges for the modern events were significantly lower than the historic events (160,000 cfs and 166,000 cfs versus 210,000, 228,000 and 245,000 cfs). This too demonstrates that the USGS estimated peak discharges for the historic events are too high. See Technical Report section 2.1.3.

- In several other studies much lower peak discharges have been estimated for some or all of the historic flood events, including some studies commissioned by USGS itself (See Bodhaine (1954) suggested values for the four floods; Riggs & Robinson (1950) and Hidaka (1954) suggested values for the 1897 and 1909 events). See Technical Report section 2.2.1.

Appellants Developed Their Own Slope-Area Method: Noting all of these problems, the Appellants first calculated a new historic peak discharge for the 1921 event by using the slope-area method, but using different and equally realistic interpretations of data from Stewart's own notes, to provide a direct comparison to USGS's peak discharge for the 1921 event. The results demonstrate the sensitivity from modest changes in input:

- The Appellants, considering the complete set of Stewart's 1921 high water marks in the slope-area sections, developed a reasonable hydraulic grade line slope, corrected the flow area for one of the sections as noted above, and incorporated the 18-inch differential between the shore high water mark and the section-mean high water. Regarding the 18-inch differential, it is recognized that the slope-area methodology is an approximation based on the assumption of uniform flow and velocity distribution. In the case of the Dalles where the high water marks were taken, this condition does not exist, and therefore care must be taken to assure the method properly accounts for the high variation in velocity and velocity head across the channel. Because of this, the slope-area methodology has too much uncertainty associated with it and other methods outside the slope-area computation must be evaluated to develop a better estimate of the historic floods. Using these equally realistic interpretations of Stewart's data, this method generated a peak discharge of 166,000 to 173,000 cfs (depending upon Manning's N value used), averaging 169,500cfs, which is 25% lower than that calculated by USGS,

showing the tremendous variability in the slope-area method by using the limited data available from Stewart. See Technical Report section 2.3.1.

- This new peak discharge for 1921 more closely correlates with the frequency curve created by the systematic record and also more closely correlates with other methods used to calculate a peak discharge (see below) and with Stewart's surveyed 1921 high water marks in the Concrete and Hamilton areas. See Probability Estimates (Countryman), page 6 and Technical Report Sections 2.3.2 and 2.2.3.

Appellants Developed Alternate and Superior Methods to the Slope-Area Method: The Appellants then developed alternate, and ultimately superior, methods of calculating the peak discharge for the 1897, 1909, 1917, and 1921 events:

- As an alternate method, the Appellants calculated the historic peak discharge for the 1921 event by using the rating curve for the Concrete gage which has been in operation since 1924 and has a very reliable and stable relationship between stage and flow. Appellants plotted Stewart's high water marks from the 1921 event upstream and downstream of the Concrete gage and then interpolated a water surface at the location of the gage. Appellants then further adjusted that water surface by 0.9 and 1.6 feet, reflecting observations that the water surface within the gage well has been measured as 0 .9 and 1.6 feet below the high water marks observed on the bank adjacent to the gage in 2003 as a result of surge. Using these revised water surface elevations, and applying them to the rating curve, results in a peak discharge for the 1921 event ranging from 169,000 to 175,000.[4] While USGS did a similar calculation in 2007, it failed to account for the surge differential inside and outside of the gage and also failed to account for the slope of the water surface between the high water mark and the high water at the gage location. Instead the USGS simply took the high water mark from upstream and applied it at the gage location. Additional stage gages added in this stretch by the Appellants demonstrate that USGS ignored the natural slope of the river. See Technical Report section 2.3.2.

- As another alternate method, the Appellants calculated the historic peak discharge for the 1909, 1917, and 1921 events by generating a backwater rating curve for the USGS Baker River recording gage on the Baker River in conjunction with a HEC-RAS model and Stewart's high water marks for the Wolfe residence. When Baker River flows are low, the Baker gage registers the Skagit River backwater elevations. The rating curve was based on observed backwater stage and the recorded flow at the Concrete gage. The HEC-RAS model was calibrated for the 2003 event at the Baker gage. The model and rating curve were then revised to reflect 1911 topography. This revised rating curve was then used with a series of high water marks including an observed high water mark noted in Stewart's records for the Wolfe residence (which is in close proximity to the Baker gage) to determine the peak discharge for the 1921 flood. In this run Appellants found a

[4] As noted below, the USGS has raised the issue of whether Stewart's high water mark survey requires a 1.8 foot datum shift. However, the USGS provides no documentary support for this theory in its letter. See Technical Report section 2.2.1 subsection entitled "Gage Datum Discrepancy" and Technical Report section 2.2.2. However, even if a datum shift would be required, the calculated peak discharge based upon the Concrete gage is still significantly lower than that estimated by the USGS. See Technical Report section 2.3.2 subsection entitled "1921 Flood Peak Discharge Estimate Using Transferred Stewart's HWM Independent of Stewart's Upper Gage Datum."

peak discharge for 1921 of 169,700 cfs. Because the Wolfes had also noted a high water mark for 1917 which Stewart surveyed, Appellants were also able to directly calculate a peak discharge for that event (158,700).[5] As a result of a 1909 high water mark in the same general area, Appellants were able to calculate a peak discharge for 1909 of 179,000 cfs. See Technical Report section 2.3.3.

- Finally, the Appellants sought to validate the relationship between the 1909, 1917, and 1921 peak discharge estimates by using data from a different location, and to also generate a peak discharge for the 1897 event. Appellants located in Stewart's notes a series of high water marks at the Kemmerick Ranch and the Savage Ranch, downstream of the Concrete gage, which provided measured differences between the high water marks for different events. The Appellants developed flood stage-discharge curves for this location using an updated unsteady HEC-RAS model originally developed by the USACE, Seattle District. By plotting on the curves the high water marks from the Kemmerick and Savage Ranches, the Appellants were able to validate the relationship between the peak discharges for the three historic events developed in the Baker gage backwater area, and also develop a peak discharge for the 1897 event. See Technical Report section 2.3.4.

Appellants Developed a Flood Frequency Analysis and Regulated and Unregulated Synthetic Flood Hydrographs: The Appellants developed a flood frequency analysis for unregulated peak and one-day flows using PEAKFQ software based on the systematic record. As described in Bulletin 17B, the Appellants next determined the consistency between this record and that of the historic floods. The historic floods as calculated by the Appellants were shown to be consistent[6] with the systematic record and therefore should be used in establishing the flow frequency curve. A similar check of the USGS estimated peak discharge for the historic floods was made and it was determined that USGS' estimates of the historic flood were not indicative of the extended record when compared to the systematic record. See Probability Estimates (Countryman). Therefore, the Appellants' estimates of the four historic floods, and not those of USGS, along with the flows from the Systematic record (1925 – 2008) were used for the establishment of the unregulated flow frequency curve for the Skagit River near Concrete. See Technical Report section 2.5.

The Appellants then developed the unregulated synthetic flood hydrographs for the 10-year, 50-year, 100-year, and 500-year events for the Skagit River Basin. These unregulated synthetic floods were routed through the existing reservoirs and regulated flow frequency relationships were developed with the use of HEC5. This transformation of unregulated flows to regulated flows was consistent with the USACE, Seattle District, transformations. See Technical Report Section 2.6 and the Appendix A.

[5] It should be noted that USGS has criticized inputs to this model, in particular issues of Manning's N value and concerns over expansion and contraction coefficients in the model. However, those concerns, even if valid, would apply only to the downstream reach of the model, and are not relevant at the location of the Wolfe residence (a backwater area) which has been properly calibrated by the use of two gages (Concrete and Baker) that are independent of the expansion and contraction calculations and then verified by the HEC-RAS model that includes the expansion-contraction coefficients.

[6] The Appellants' three different methodologies also generated remarkably consistent results.

B. The Development of Mapping for the Skagit River

Based on the developed hydrology, the Appellants then routed the updated regulated base flood (1 in 100 AEP regulated flow flood) event utilizing a FLO-2D model with refined topography for key parts of Burlington. Appellants updated the topography from that used by the USACE, Seattle District, instead substituting more refined topographic data developed by the City of Burlington. Appellants also corrected an error in the USACE's use of the FLO-2D model, removing an additional 1.2 miles of right bank embankment at RM 21. See Technical Report section 3.0.

The Appellants applied the revised hydrology to the revised FLO-2D model and performed new model runs for the levee removal scenarios, as determined by FEMA for the rFIS, to determine the revised base flood elevations (BFEs). The revised BFEs for portions of Burlington and Mt. Vernon show variations of between 1.32 and 2.88 feet. Revised BFEs were also developed for the areas upstream of Burlington and Mt. Vernon. FEMA has argued that the appellant's revised 100-year flows are within the expected error band and therefore it is its policy to not change the flows. But as is evident here, FEMA has a counter policy of revising flood maps if BFEs change more than 1 foot. The revisions described herein are very significant as is evident in the changes in BFEs. See Technical Report sections 4.0 and 5.0.

C. Additional Technical Support for Related Issues.

Due to the years-long consultation between FEMA and the Appellants, many technical memoranda have been produced over the years, and many technical issues have been raised. While these issues are not directly relevant to the appeal as the Technical Report and the Probability Estimates (Countryman) can stand alone, Appellants wish to ensure that any reviewer of this appeal has the benefit of the additional work product. Appellants therefore note the following:

- Appellants acknowledge that the USGS has questioned whether Appellants' method of calculating flow based on the HEC-RAS run for the Concrete gage is suspect because of a purported 1.8 foot datum shift claimed to exist by USGS but not adopted by the Appellants' (see USGS 11/5/08 letter authored by a hydrology staffer). However, this letter noted that the USGS could not provide a definitive answer on whether the shift exists or not, only that it "seems about 2 feet too low."

    - The USGS letter itself notes that the USGS staffer could "not find any documents that suggest the first continuous gage was at a different datum than the staff gage that Stewart used to reference his 1921 HWMs." Appellants agree. See Footnote 4 above and Technical Report section 2.2.1 subsection entitled "Gage Datum Discrepancy."

    - Further, significant evidence, including a comparison of low flow elevations, supports the conclusion that no datum adjustment is required. See Technical Report section 2.2.2.

    - Finally, as noted in the letter from Pacific Surveying and Engineering, the information available to the Appellants, including the difference in location of the two historic gages, demonstrates that there is a weakness in the process,

methodology, and results which underlie the USGS' predications and its conclusion that there should be a 1.8 foot datum shift.[7]

- Appellants properly converted the unregulated frequency analysis to a regulated frequency analysis. Reservoir flood control storages and operation as currently stipulated in the USACE' "Water Control Manuals" for reservoirs on tributaries to the Skagit were considered. The hydrology used for the analysis included (i) the use of balanced hydrographs and distribution of flows to the reservoirs; (ii) the timing of hydrographs; and (iii) comparisons of the 10-yr, 50-yr, 100-yr, and 500-year unregulated and regulated peak flows at critical Skagit River locations. A comparison of the USACE, Seattle District, calculated transformation of unregulated flows to regulated flows and the Appellants' calculated transform was conducted. Validating the use of either method, at the 100 year event, the two curves are virtually identical. The only deviation is at the 500-year flood level and this is because the USACE estimated 500-year flood is significantly larger than the Appellants' estimated 500-year flood. See Technical Report Figure 19.

- Please see attached technical memoranda prepared by the Appellants to address comments contained in FEMA and USGS memoranda:

    - FEMA memorandum of May 19, 2010

    - USGS memorandum of May 7, 2010.

CONCLUSION

The USACE hydraulics and hydrologic & BFE calculations accepted by FEMA into the rDFIRMs, are not as scientifically or technically correct as the Appellants' work for the following reasons:

- In estimating the unregulated flow frequency curve for Skagit River near Concrete the USACE excluded 5 years from the systematic record.

- The USGS improperly calculated the unregulated flow for 1932 and the USACE utilized the incorrectly estimated USGS flow in its frequency analysis.

- The USACE accepted a USGS peak discharge for 1921 that is based on just three high water marks, first noted more than 11 months after the event, and in a river reach with high velocities which makes such high water marks unreliable. The USGS also bases its peak discharge on a method with highly variable results depending upon modest changes to the inputs.

- The USACE accepted the USGS calculated peak discharges for the 1897, 1909, and 1917 events, where: (i) the 1897, 1909, and 1917 estimates are based upon the incorrect 1921 USGS estimated peak discharge, (ii) the 1897 peak discharge is based upon transported

[7] The letter also notes that these datum issues would not be present for the surveyed high water marks at the Wolfe residence where two separate surveys were run to the Wolfe residence, one month apart, with results only two one-hundreds of a foot apart.

high water marks without consideration of possible backwater or different channel topography, and (iii) the relationships developed by Stewart to calculate the 1897, 1909, and 1917 event from the 1921 event are suspect.

- The USACE analysis did not follow Bulletin 17B admonitions on verifying that the historic floods were consistent with the systematic record, and the USGS did not consider the very unlikely condition (<.2% chance) that the four historic events of the magnitude calculated by USGS could occur on the Skagit River in a 25 year period.

- The USGS and USACE did not investigate the obvious fact that peak discharges of the magnitude calculated by USGS for the 1921 flood would have flooded the Concrete and Hamilton area homes almost to their ceilings, which would have been a devastating and ruinous flood event. There is no record of such ruinous flooding occurring, despite the fact that there is an historical record of contemporary news accounts from several local newspapers.

- The USGS and USACE ignored the inconsistency between estimated flows at Concrete and at Sedro-Woolley for the Historic flood events.

- The USGS ignored other studies finding significantly lower peak discharges for some or all of the historic events.

- The USGS did not attempt to develop a Skagit River backwater rating curve for the Baker gage. This would have eliminated the need to transfer the HWMs over 2 miles to a completely different channel shape. The USACE and FEMA simply accepted the USGS incomplete work.

- The USACE did not incorporate refined topographic data available from the City of Burlington which, in combination with corrected hydrology, results in modified BFE's of over two feet lower than the USACE calculated elevations.

For these reasons, the Appellants' base flood elevations are more scientifically and technically correct than those created by the USACE and incorporated by FEMA into the rDFIRMs.