CITY OF Burlington
SKAGIT COUNTY, WASHINGTON INCORPORATED 1902

Flawed Analysis is Producing Inaccurate Base Flood Elevation Maps in Skagit County

Background Paper prepared for the U.S. Chamber of Commerce July 13, 2007

1) The actual flood risk in the Skagit Valley is very serious, but manageable. A flawed analysis by the Corps of Engineers will cause the problem (on paper) to become catastrophic and unmanageable.

2) Skagit County engaged the Seattle District, Corps of Engineers in 1996 to conduct a General Investigation (GI) study of Skagit River flooding. This study is under-funded and not expected to be completed until at least 2014.
   a) But the Corps study has generated intermediate work products: hydrologic and hydraulic analyses of Skagit River flooding which are being used by FEMA to re-set base flood elevations.
   b) The Corps hydrologic analysis is wrong, resulting in a hydraulic model that is wrong.
      i) Corps hydrologic analysis relies on estimates of the magnitude of floods occurring near the turn of the 19th century, prior to the 1924 installation of a river gage near the town of Concrete, WA.
      ii) Comparing 80 years of actual gage data to the historic estimates clearly indicates the historic estimates are skewed high.
      iii) This concern with the historic estimates has long been recognized by experts. Additional analyses conducted over the past 5 years have provided technically substantial, compelling, and defensible new information clearly indicating the historic estimates used in the flood frequency analysis should be reduced.
   c) The Corps so far has declined requests to revise the historic estimates, and continues to use the unmodified estimates in its analysis. Therefore, the Corps hydrology and hydraulic model significantly over-estimate the magnitude of a Skagit River 100-Year flood.

3) FEMA contracted with the Corps to use the Corps-generated hydrology and hydraulic model to form the basis for FEMA's revised flood elevation maps.
   a) Since the Corps overestimates the magnitude of a 100-year event, FEMA's preliminary revised flood maps will overestimate the 100-year base flood elevations.

4) Meanwhile, the proposed new Federal Energy Regulatory Commission (FERC) license for the Baker Hydroelectric Project calls for additional flood storage to be put in place.
   a) But approval of more flood storage is tied to the Corps' GI process. This process will cause additional flood storage to be rejected because more storage would be overwhelmed by the (artificially high) theoretical Corps 100-year flood.
   b) Paradox: although additional flood storage is badly needed to provide flood managers with a tool to help reduce a very serious flood threat, it will be precluded due to the Corps' flawed analysis.

5) Agency response to these concerns has generally been that the difference "only amounts to around 15% or so. And, it is good to be conservative in an analysis."
   a) Conservatism is generally good but not in this case. Corps theoretical flood volumes will exceed the levee system capacity for over two days – a huge wall of water well beyond anything remotely experienced in 80 years of recorded Skagit flood history.
   b) We are concerned this overly-conservative analysis puts affordable flood measures out of reach; paradoxically precluding a solution to a flood risk the Corps analysis characterizes as catastrophic.

Atch: 1. Basis of Analysis Indicating the Historic Flood Estimates Should be Revised
2. Dataset comparisons, including comparison of Corps of Engineers and PI Engineering regulated flood hydrographs at Sedro-Woolley

Chal A. Martin, P.E. / cmartin@ci.burlington.wa.us / (360) 755-9715 / July 7, 2007

Basis of Analysis Indicating the Historic Flood Estimates Should be Revised

(Note: please review www.skagitriverhistory.com for source documents and additional information)

1. Historic document review of newspaper reports of the time, as well as a review of the work products of James Stewart, the hydrologist who estimated the historic events
    a. Newspaper accounts of the floods describe events much less devastating than would be expected for floods of the magnitude of the historic estimates, based on what we know today
    b. Historic rainfall data, although sporadic and not from consistent locations, does not provide the basis to generate floods larger than those recently experienced over the past 15 years

2. Technical analysis of the Concrete reach conducted by PI Engineering, 2005 pointing out:
    a. Stewart flows could not have exceeded 202,000 cubic feet per second without overflowing the river banks at the Dalles. But Stewart, pursuant to in-depth on-site study shortly after the 1921 flood, said no overflow happened. So the peak flow then could not have been 240,000 cfs, as is currently shown in the USGS data for that station
    b. Stages of the historic floods were not transferred correctly to the new gage location
    c. The coincident flows recorded at Sedro-Woolley for the historic events were much lower. This would seem to indicated significant channel storage between the two locations -- but that storage does not exist

3. Independent technical review conducted by Northwest Hydraulic Consultants (**nhc**), 2007
    a. In-channel storage sufficient to attenuate flows between Concrete and Sedro-Woolley does not exist. Therefore, either the Concrete estimates are too high, or the Sedro-Woolley estimates are too low. But **nhc** stated that nothing in the record indicates the Sedro-Woolley estimates are too low – in fact, the 1897 and 1909 estimates should be further reduced
    b. The use of a methodology called “Expected Moments Algorithm” would indicate an unregulated peak flow estimate similar to that calculated by PI Engineering

4. Hamilton “Smith” house investigation, conducted by the City of Burlington in 2007:
    a. Highest flood mark on the “Smith” house, constructed in 1908, is just above the floor boards (from 1995 flood event, discharge 160,000 cubic feet per second.) But higher marks from the historic events (260,000 cfs in 1909) should have been visible. They were not.
    b. Further analysis conducted by PI Engineering indicated the maximum discharge from the historic floods that would not have exceeded the 1995 event would have been 188,000 cubic feet per second

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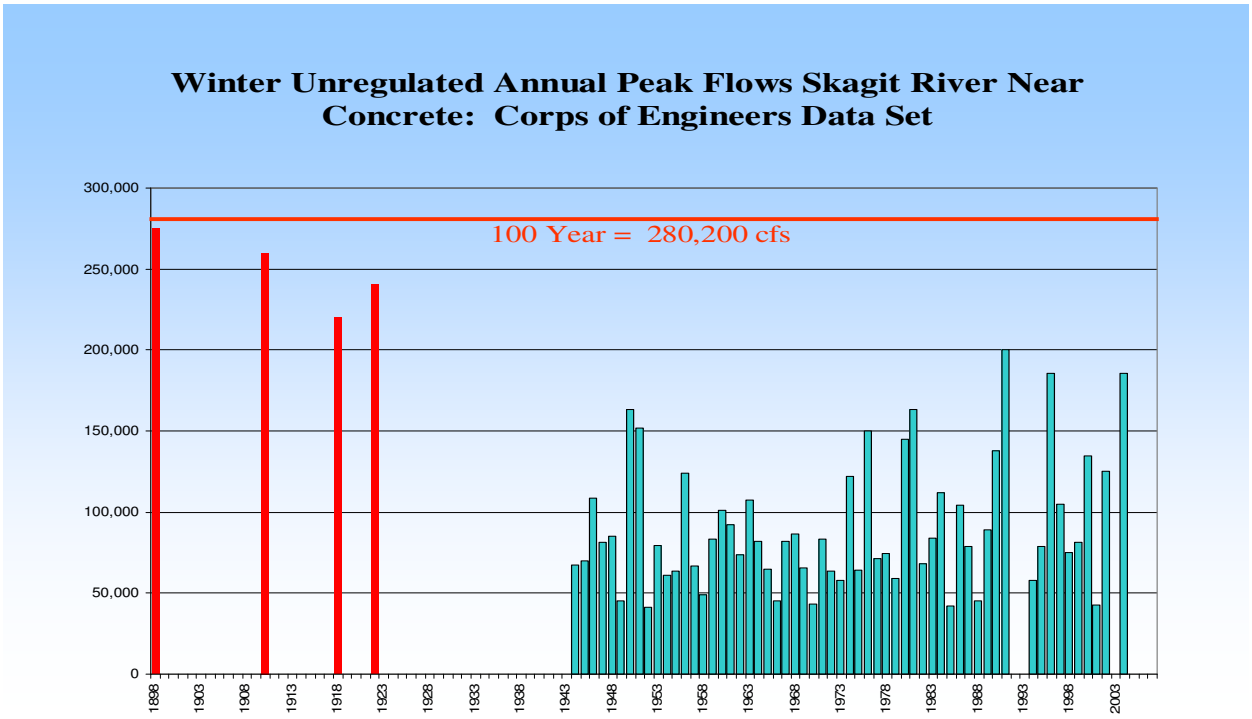
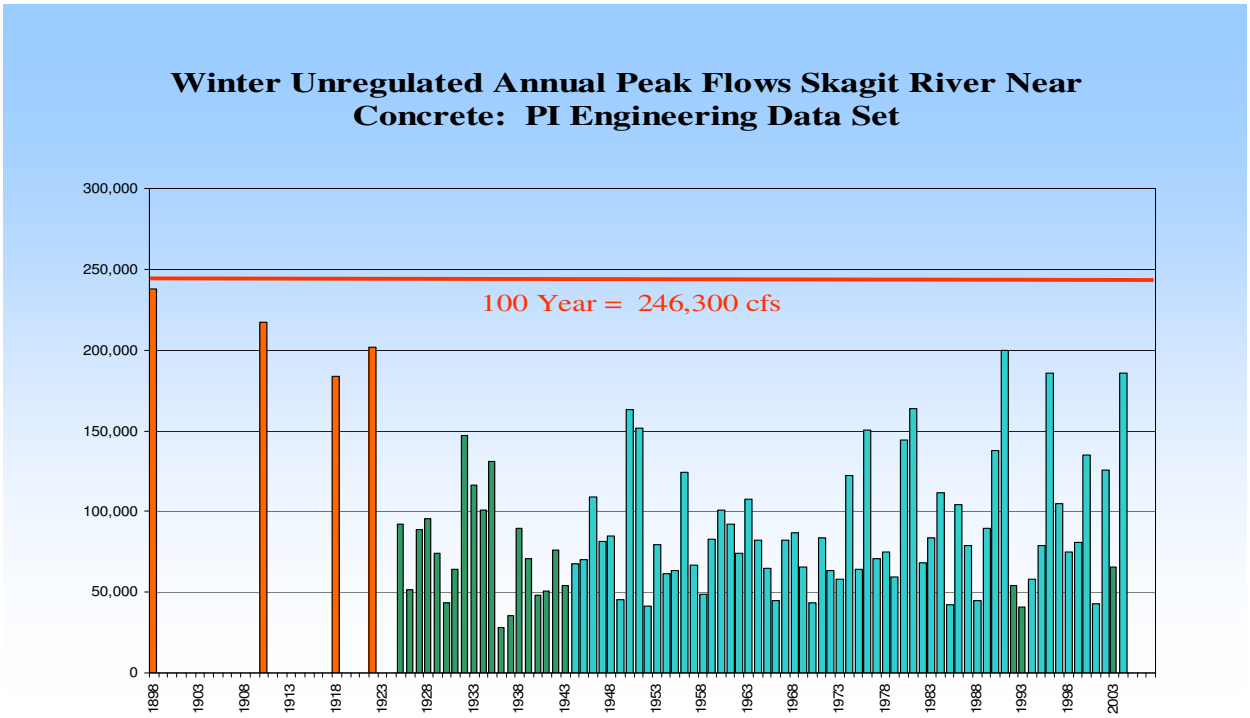
900 E. Fairhaven Ave., Burlington, WA 98233 • Phone (360) 755-0531 • Fax (360) 755-9565 • cityhall@ci.burlington.wa.us

DATASET COMPARISONS and RESULTING 100-YEAR REGULATED FLOOD HYDROGRAPHS



Corps flood frequency dataset showing unmodified Concrete estimates and 58 years of gage data



PI Engineering flood frequency dataset showing modified Concrete historic estimates and 80 years of gage data

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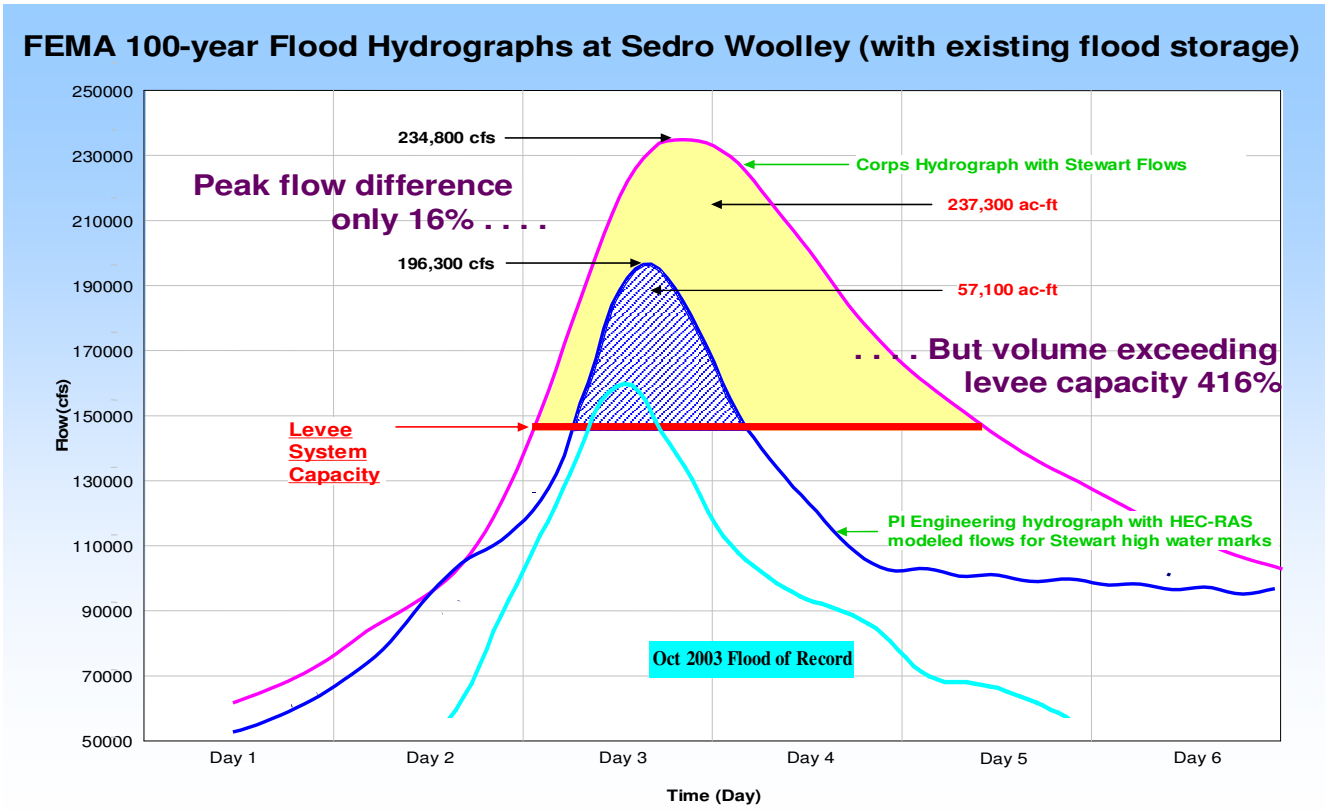
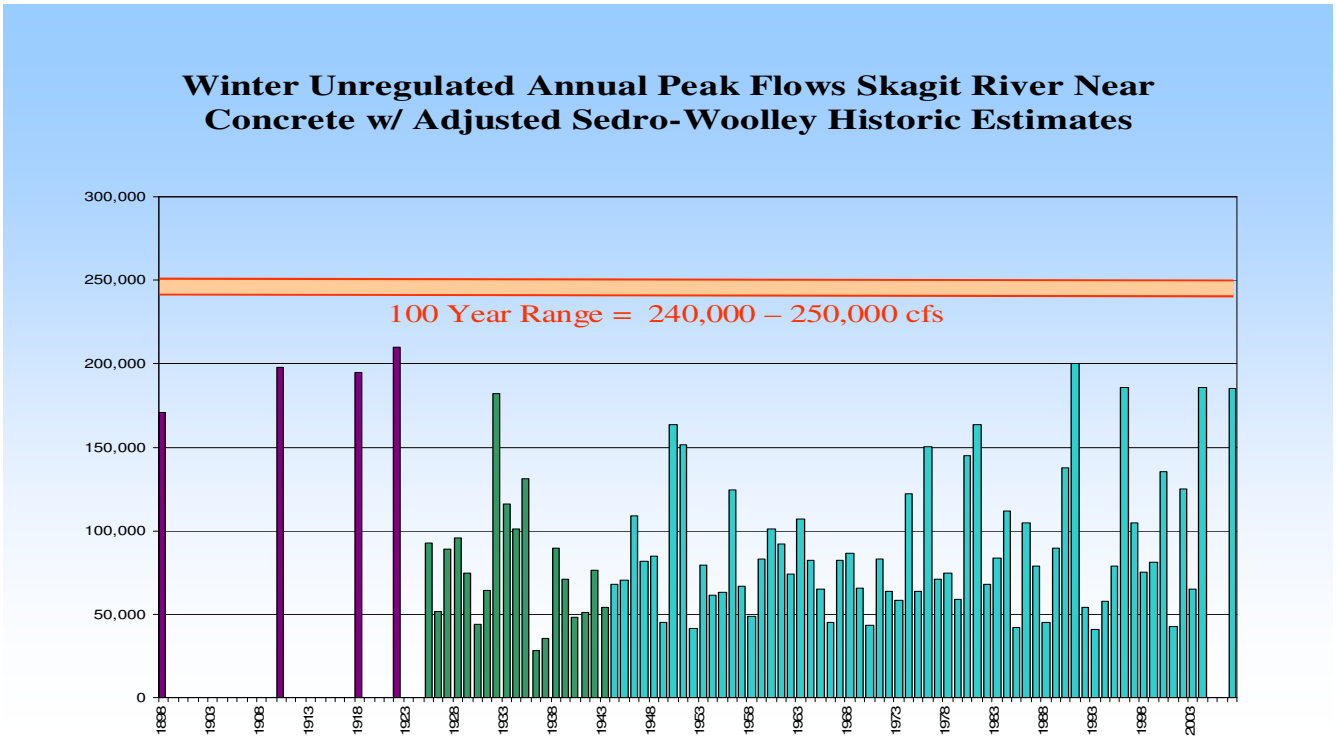


Regulated flood hydrographs at Sedro-Woolley resulting from Corps dataset (yellow) and PI Engineering dataset (blue) compared to October 2003 Flood of Record (aqua)



Nhc-inferred flood frequency dataset including reduced Sedro-Woolley 1897 and 1909 historic estimates, an increased 1932 estimate, and including the 2006 unregulated flood peak estimate

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