Skagit River Revised Flood Insurance Study Levee Scenario Discussion



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US Army Corps of Engineers, Seattle District
8/9/2007

Skagit Levee Failure Scenarios

- Challenges of Defining Levee Failures
- FEMA Regulations
- Implementation of Regulations
- Comparison to Actual Observations

Past Skagit River Levee Failures



Isolated Levee Failures



Systemwide Levee Failures



General FEMA Levee Failure Policy

Guidelines and **Specifications** Flood Hazard **Mapping Partners**

Appendix H: Guidance for Mapping of Areas Protected by Levee Systems

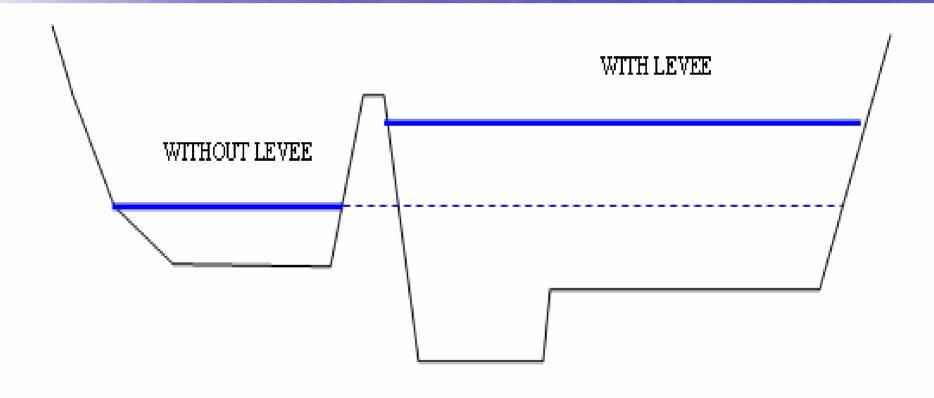
http://www.fema.gov/library/viewRecord.do?id=2206

General FEMA Levee Failure Policy

• If the subject levee does not meet the requirements stated in Section 65.10 of the NFIP regulations, as verified by the RPO, the Mapping Partner shall recompute the 1-percent-annual-chance flood elevations as if the levee did not exist.

(page H-11)

One Levee System



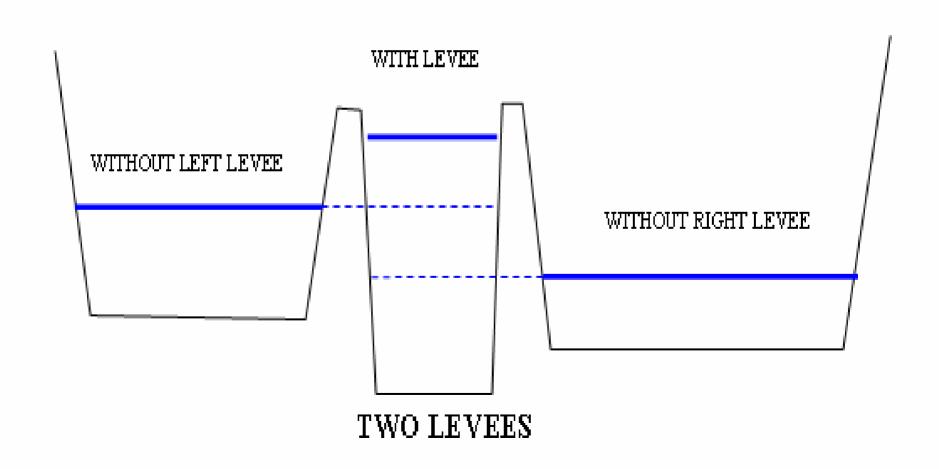
SINGLE LEVEE

General FEMA Levee Failure Policy

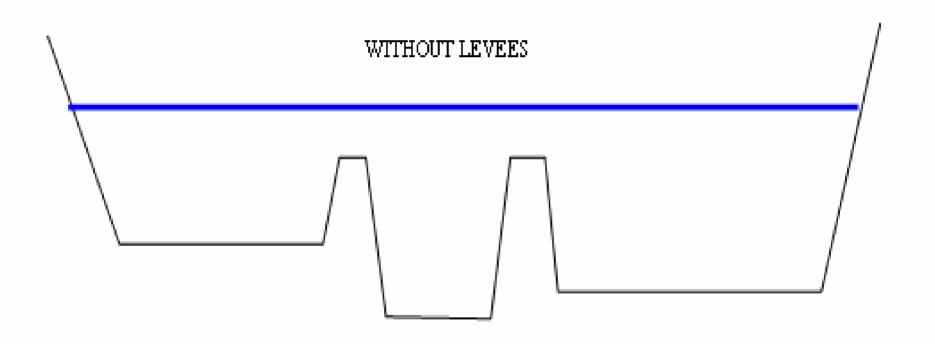
The above procedures for the determination of BFEs and regulatory floodways also apply to the conditions where levees exist on both sides of the stream. In these cases, the evaluation shall include the possibility of simultaneous levee failure, failure of only the left side, and failure of only the right side, and shall consider simultaneous levee failure for both the BFE and regulatory floodway computations. The Mapping Partner shall contact the RPO for guidance on the evaluation of levee systems under these circumstances.

(page H-12)

Levees on Both Sides of the River



Levees Inundated



LEVEES INUNDATED

General FEMA Levee Failure Policy

 For levee systems where an area of land may be totally or partially surrounded by levees or where two or more flooding sources join that have levees on both sides of the stream, the Mapping Partner that is performing the analysis shall contact the RPO before proceeding with any analyses for levee failures. For these complex situations, the flood hazard in the area that would have been protected by the non-failed levee(s) must be based on selection of failure scenarios that yield the highest BFE or flood hazard.

(page H-12)

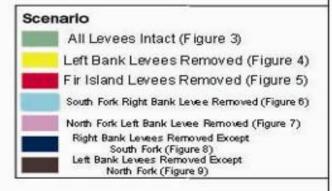
Surrounded by Levees



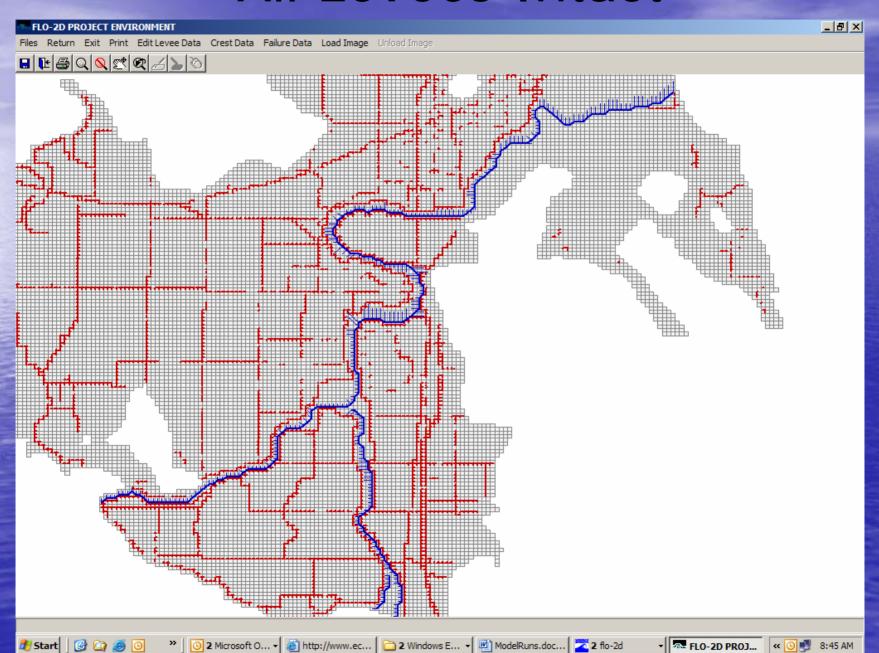
Levee Scenarios



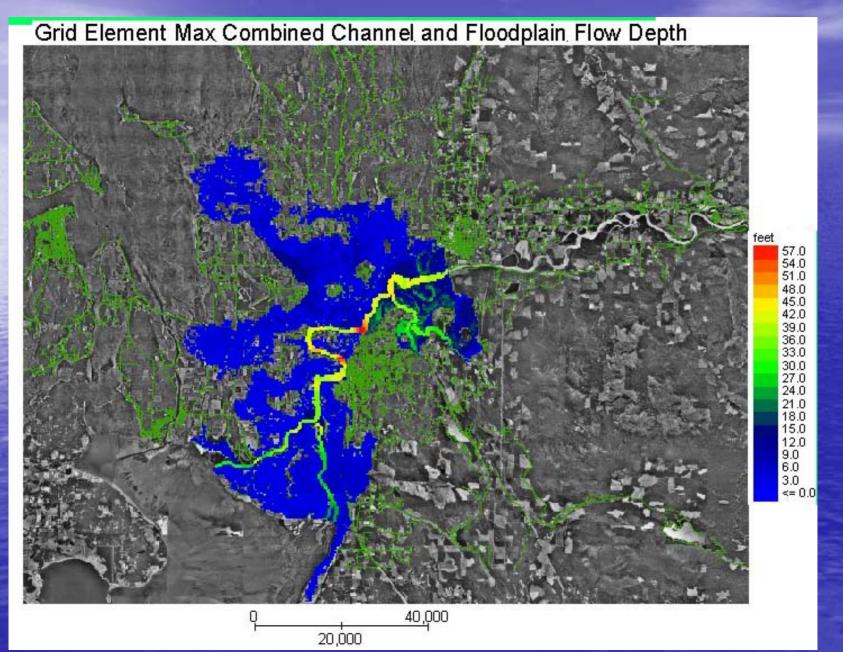




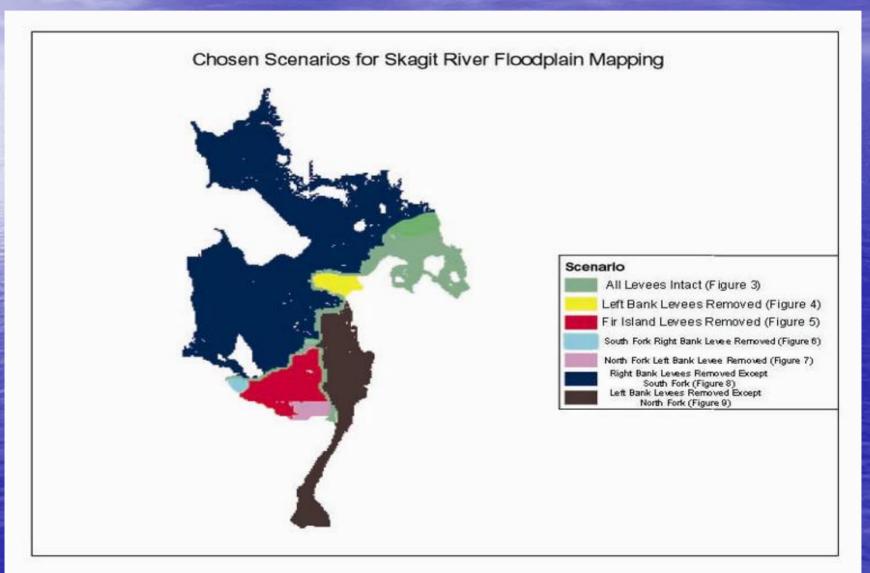
All Levees Intact



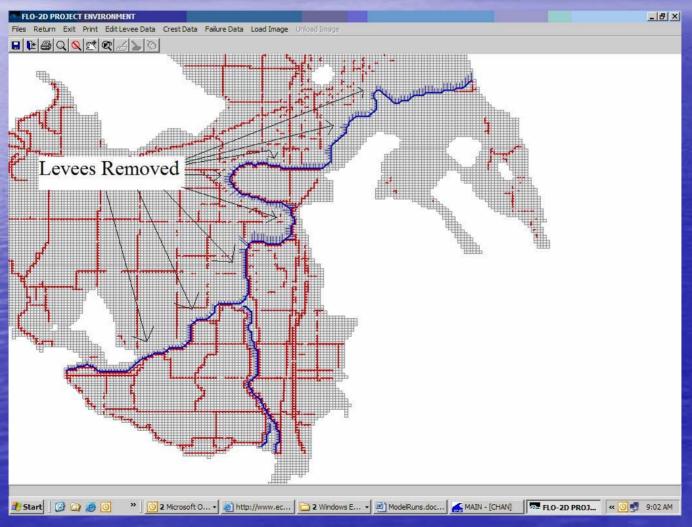
All Levees Intact



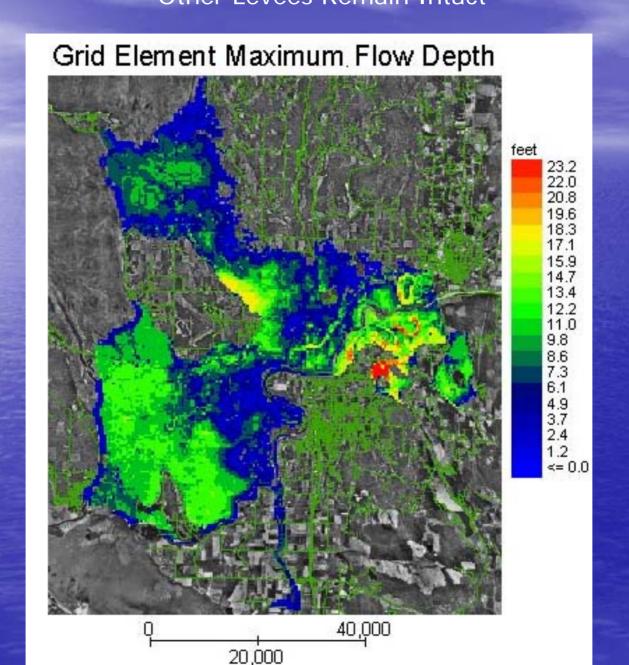
Right Bank Levees Removed Burlington to Samish and Padilla Bays Dark Blue Area



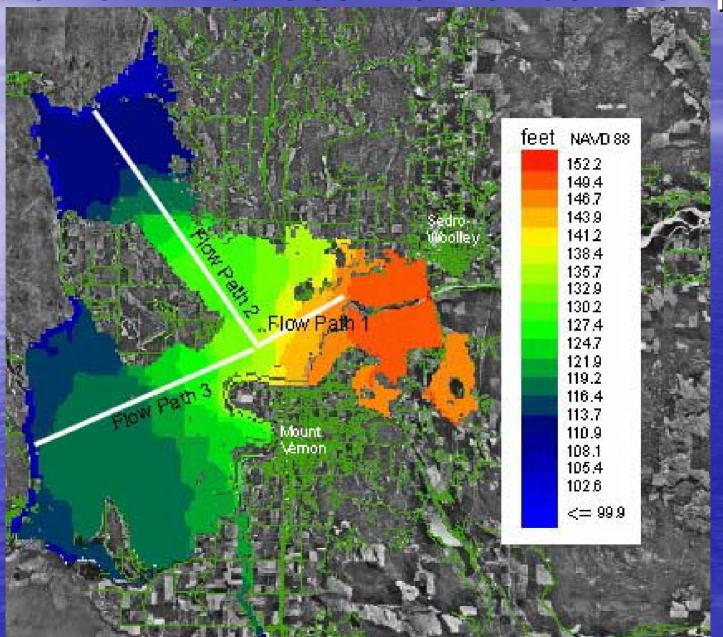
Right Bank Levees on Mainstem and North Fork Skagit River Removed While All Other Levees Remain Intact



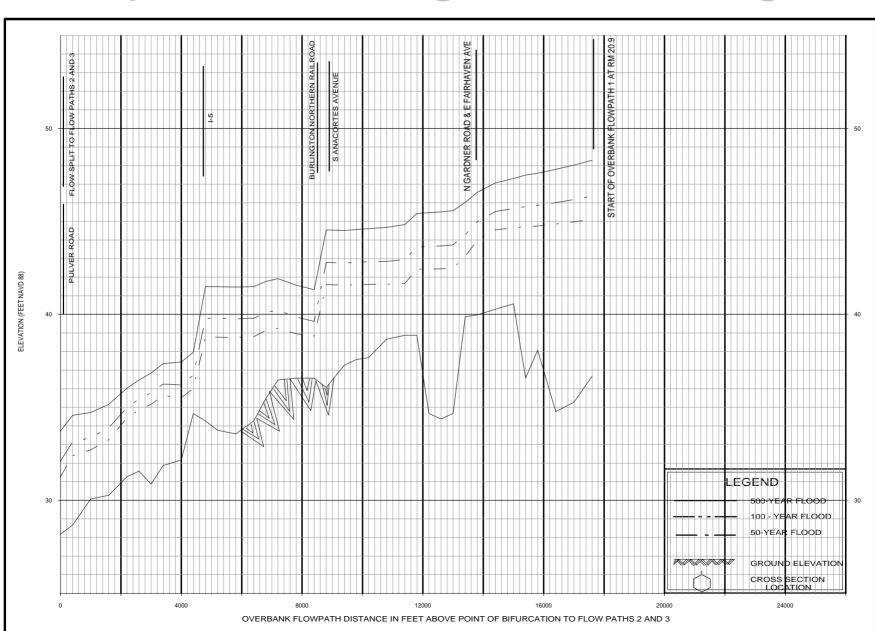
Right Bank Levees on Mainstem and North Fork Skagit River Removed While All Other Levees Remain Intact



Right Bank Levees Removed Flowpaths



Flowpath 1 Burlington Area (Page 60)



SKAGIT RIVER DELTA, OVERBANK FLOW PATH

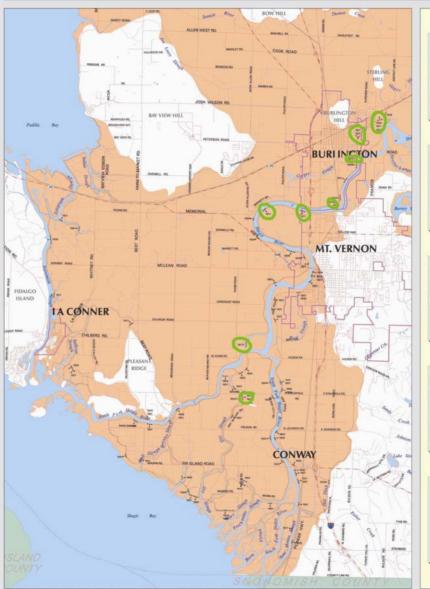
FLOOD PROFILES

FEDERAL EMERGENCY MANAGEMENT AGENCY SKAGIT COUNTY, WA (AND UNINCORPORATED AREAS)

01P

Levee Failures 1917

Major Dike Failures Lower Skagit River Basin Washington



LEGEND:

- Pleased Plate
 Contributed World Wide
- 3 River Mile
- Dies

DATA SOURCE

Data Season for dike fishing became and one on two "Phodos in the Magni Khor Swein, Wedington", U.S. Grobingkal Swein, Wedington", U.S. Grobingkal Swein, Wedington, "U.S. Grobingkal Swein, "Wedington," and office Entire will likely occur during fature works have float a 100 year floot. These Schemes will result in mandatum of Bood thin seaso.

isolisted (non flooded) areas will foring the 160 year flood, but p quaking, the entire flood plain to booksted.

100 YEAR FLOOD

The large flood depicted on this map is flacedly the FEMA mapped 100 year flood. That flood would have approximately a 17s chance of occurring on any given year. Some FEMA to apped stress within the 200 year flood have been shalled within the

If such a flood were to occur, many handreds of homes would be flooded, thousand so people may have to be even asset, and enumerary politic facilities and becimesors would be insonated, in some neighborhoods flood waters would be stop and currents is well. Many reads would become impainable and extensively determined by the stop and categories for the s

But the 100 year flood can a

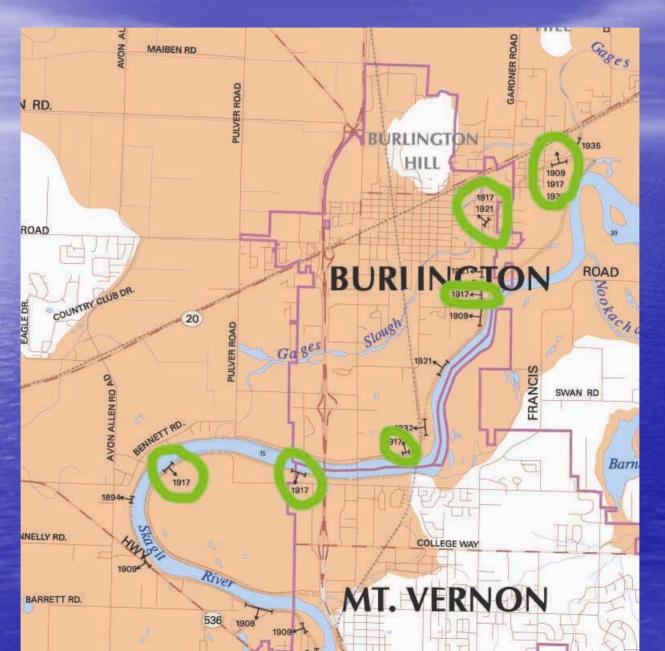
Data Source, U.S. Course Durces TRE Film & Data Developed By Hage Courts Magney Services. Contrary Generated From U.S.G.S. 72 Qued DEM Film.

the U.S. Atoy Corps of Engineers Skapt County Officials. For Such information content Skapt County Public Works, Surface Weine Management [Svivine.

Services.
Date: 60-15-1990 By: 30



Levee Failures 1917



Burlington 1917



Levee Failures 1909 and 1921

Major Dike Failures Lower Skagit River Basin Washington LEGEND: BAY VIEW HILL DATA SOURCE MT. VERNON 100 YEAR FLOOD FIDALGO TA CONNER CONWAY



Major Dike Failures

Lower Skagit River Basin

Washington

LEGEND:

DATA SOURCE

100 YEAR FLOOD

G15

Levee Failures 1909



Levee Failures 1921



Newspaper Documentation Burlington

Concrete Herald 12/17/1921

"The entire city of Burlington was flooded to a depth of from three to five feet"

Concrete Flow = 240,000 cfs

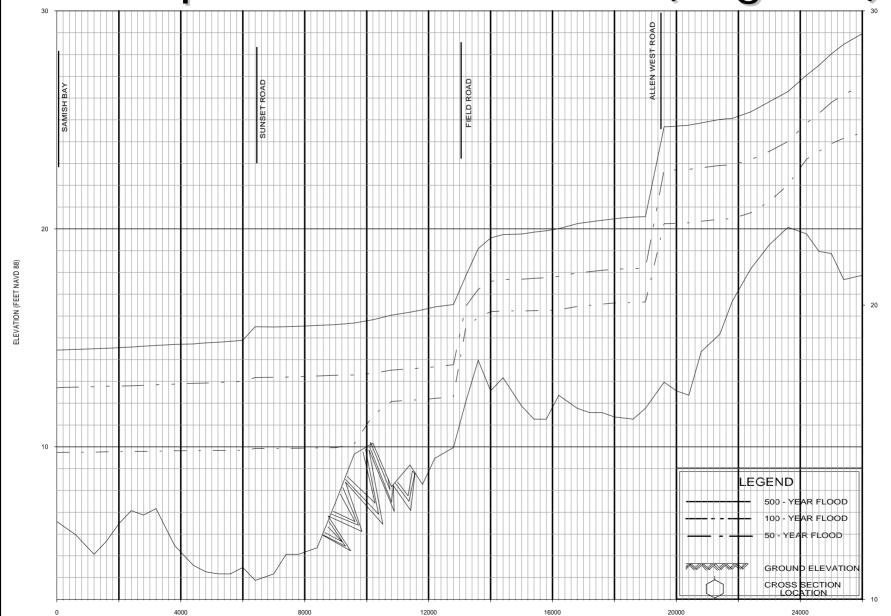
Skagit County Courier 12/2/1909

"The water broke the dykes guarding Burlington and almost the entire town was flooded. In the residence districts the water was over eight feet deep in places."

Concrete Flow = 260,000 cfs



Flowpath 2 Samish Area (Page 61) ROAD



STREAM DISTANCE IN FEET FROM SAMISH BAY

02P

SKAGIT COUNTY, WA

(AND UNINCORPORATED AREAS)

SKAGIT RIVER DELTA, OVERBANK FLOW PATH

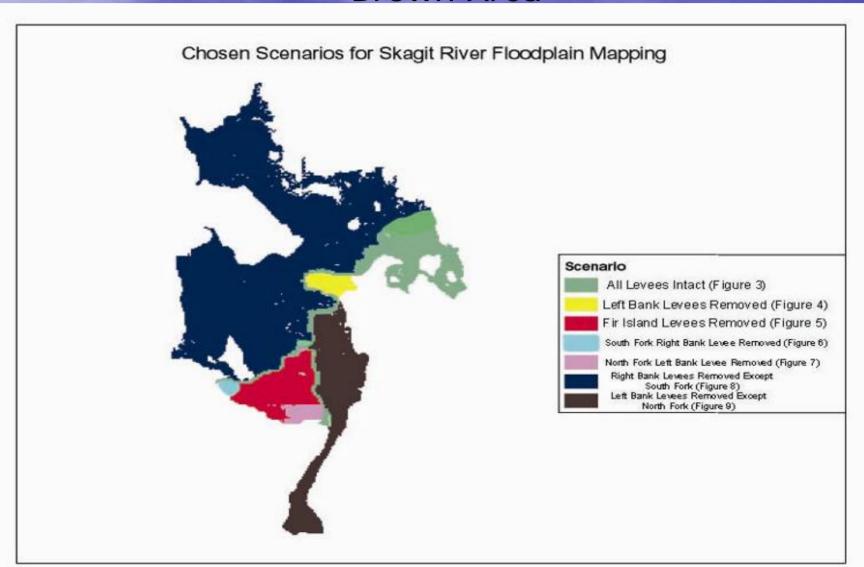
PROFILES

FLOOD

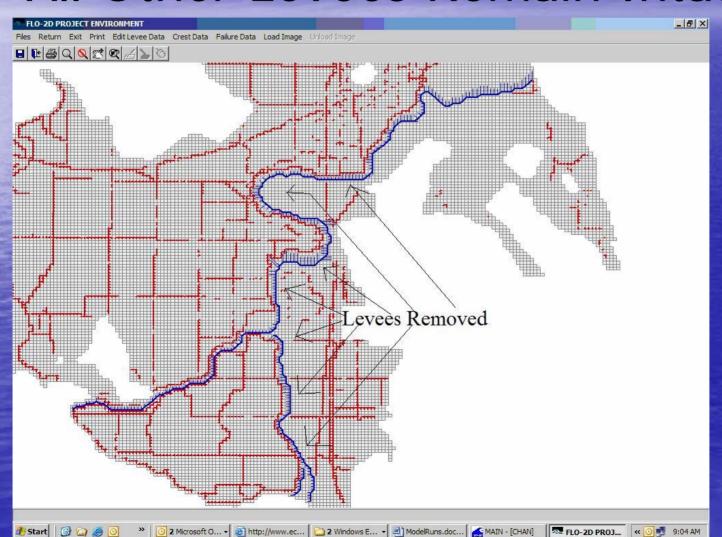
Newspaper Documentation Samish

- Mount Vernon Argus 12/15/1921
- "In some of the houses in the Samish flats water was 6 or 7 feet and the occupants were forced to move to the second story."
- Concrete Flow = 240,000 cfs

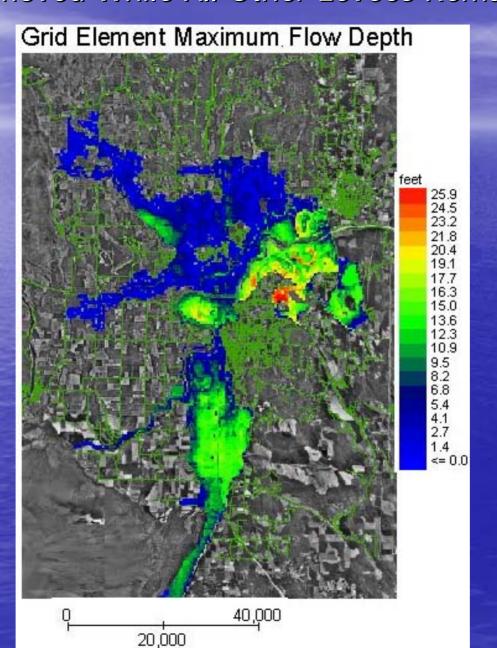
Left Bank Levees Removed Mount Vernon to Stanwood Brown Area



Left Bank Levees on Mainstem and South Fork Skagit River Removed While All Other Levees Remain Intact



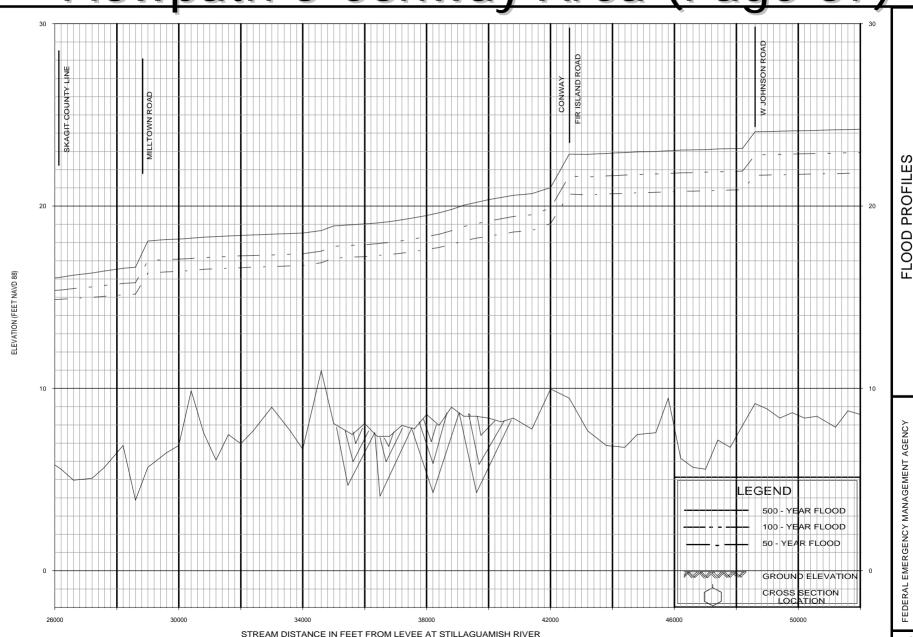
Left Bank Levees on Mainstem and South Fork Skagit River Removed While All Other Levees Remain Intact



Left Bank Levees on Mainstem and South Fork Skagit River Removed While All Other Levees Remain Intact



Flowpath 5 Conway Area (Page 67)



SKAGIT RIVER, OVERBANK FLOW PATH 5

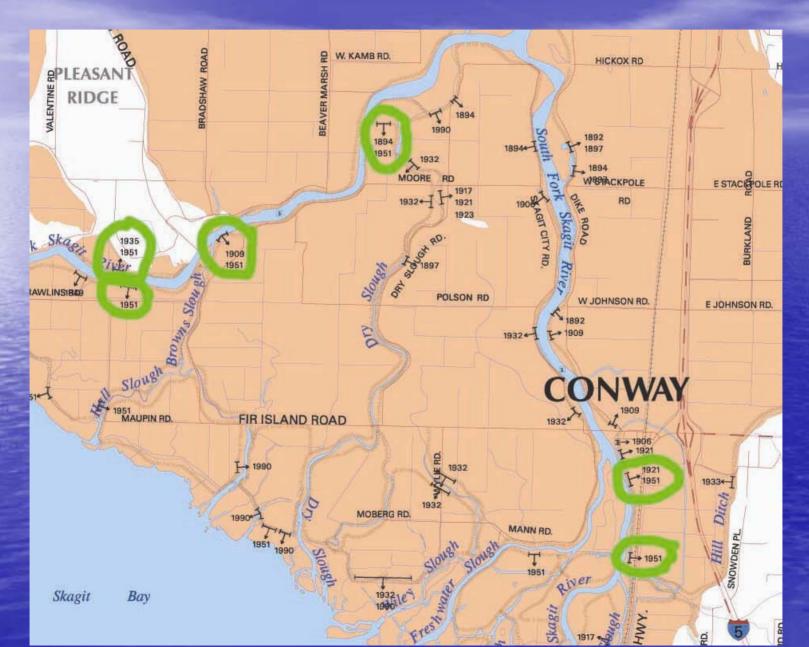
DERAL EMERGENCY MANAGEMENT AGE SKAGIT COUNTY, WA (AND UNINCORPORATED AREAS)

08P

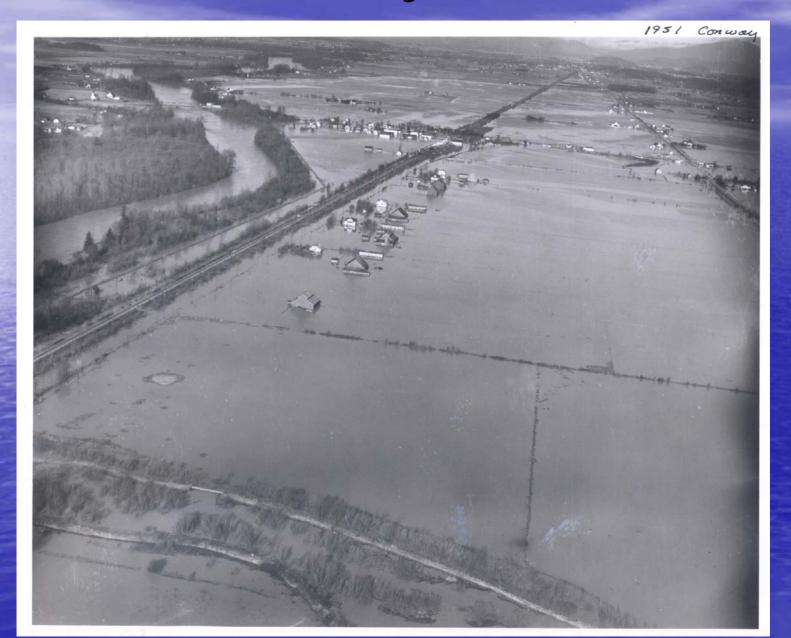
Levee Failures 1951



Levee Failures 1951



Conway 1951

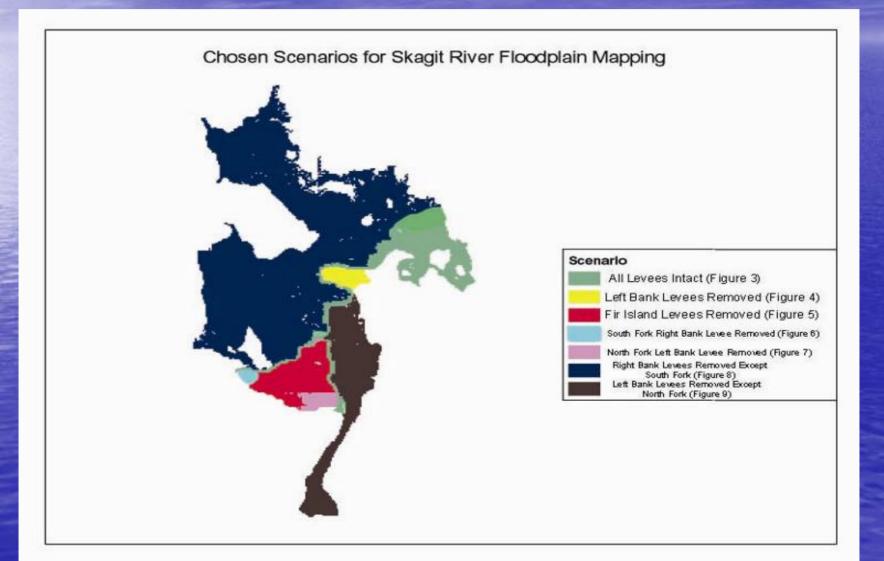


Newspaper Documentation Conway

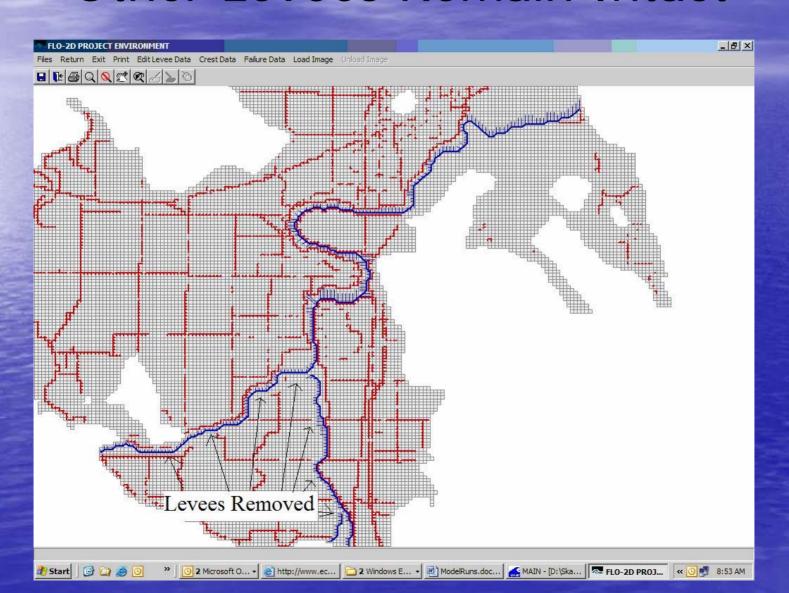
- Mount Vernon Argus 12/15/1951
- "Conway residents declared the 1951 flood was two feet, 10 inches below the 1921 inundation in their community..."

Concrete Flow = 139,000 cfs Mount Vernon Flow = 144,000 cfs

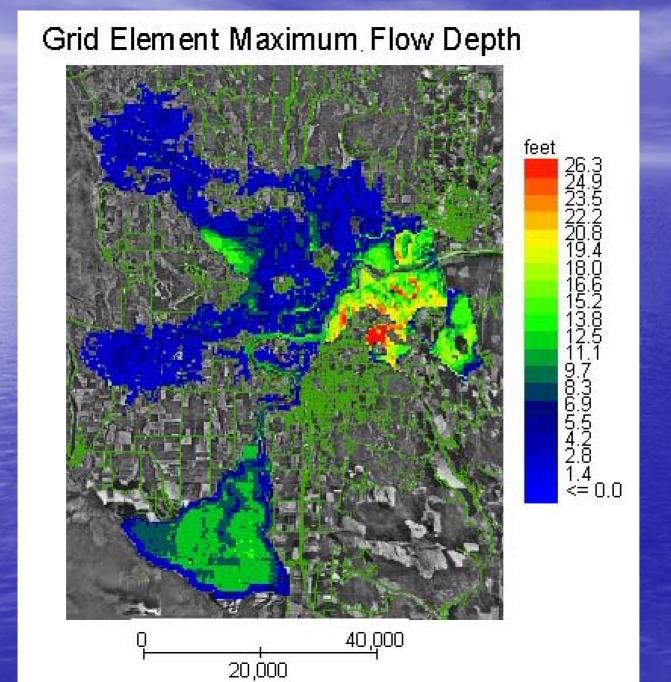
Fir Island Red, Pink and Light Blue Areas



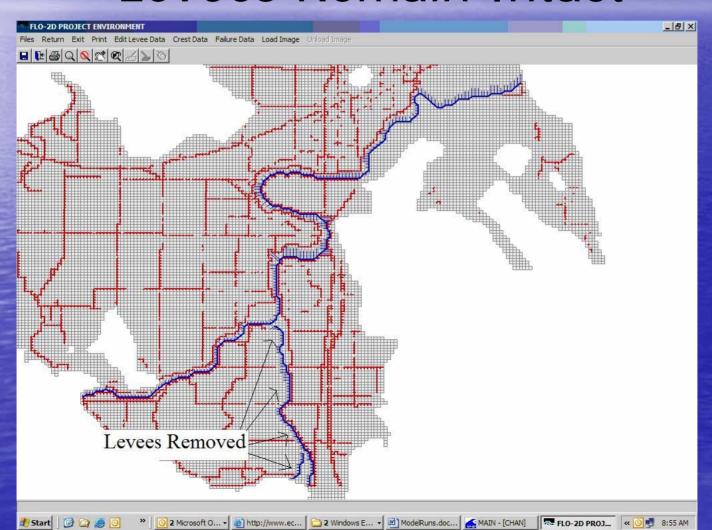
Fir Island Levees Removed While All Other Levees Remain Intact



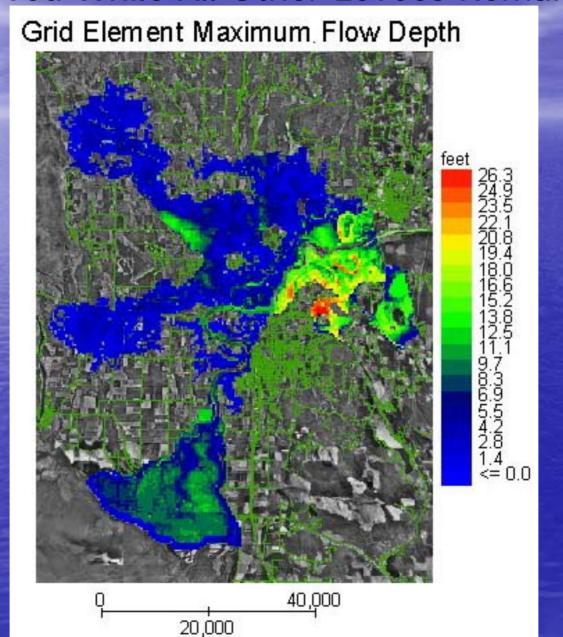
Fir Island Levees Removed While All Other Levees Remain Intact



South Fork Skagit River Right Bank Levee Removed While All Other Levees Remain Intact



South Fork Skagit River Right Bank Levee Removed While All Other Levees Remain Intact

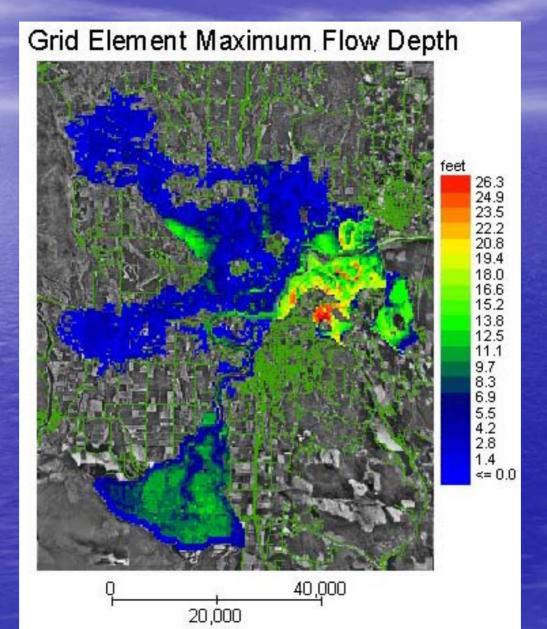


North Fork Skagit River Left Bank Levees Removed While All Other Levees Remain Intact



North Fork Skagit River Left Bank Levees Removed While

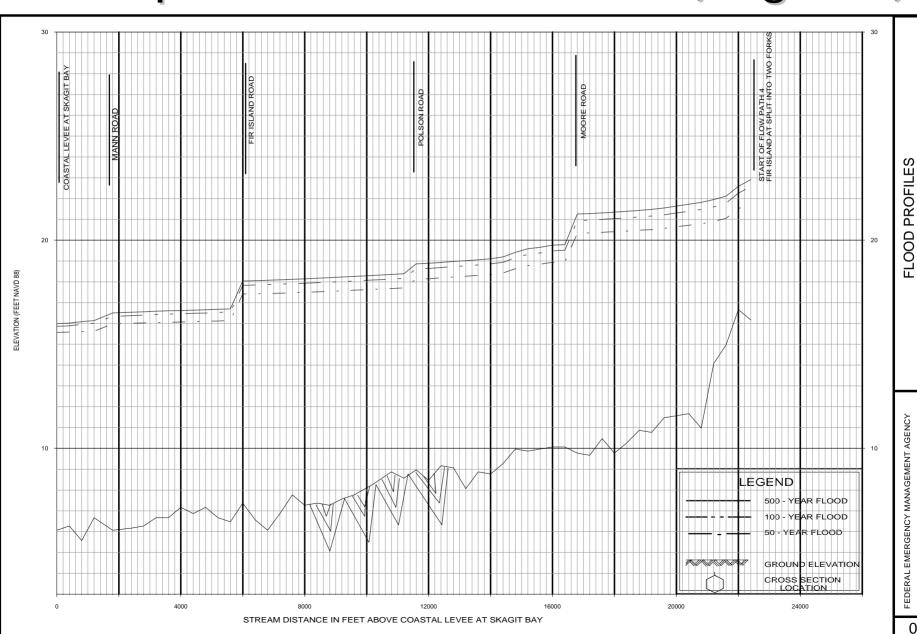
All Other Levees Remain Intact



Fir Island Flowpath



Flowpath 4 Fir Island Area (Page 65)



SKAGIT RIVER, OVERBANK FLOW PATH 4

SKAGIT COUNTY, WA

(AND UNINCORPORATED AREAS)

06P

Fir Island 1949 Flood

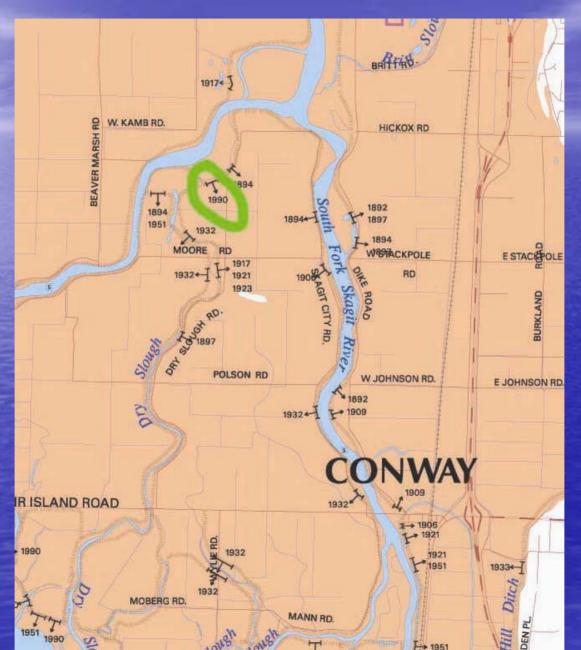


Fir Island 1990 Flood

Major Dike Failures Lower Skagit River Basin Washington



Fir Island 1990 Flood



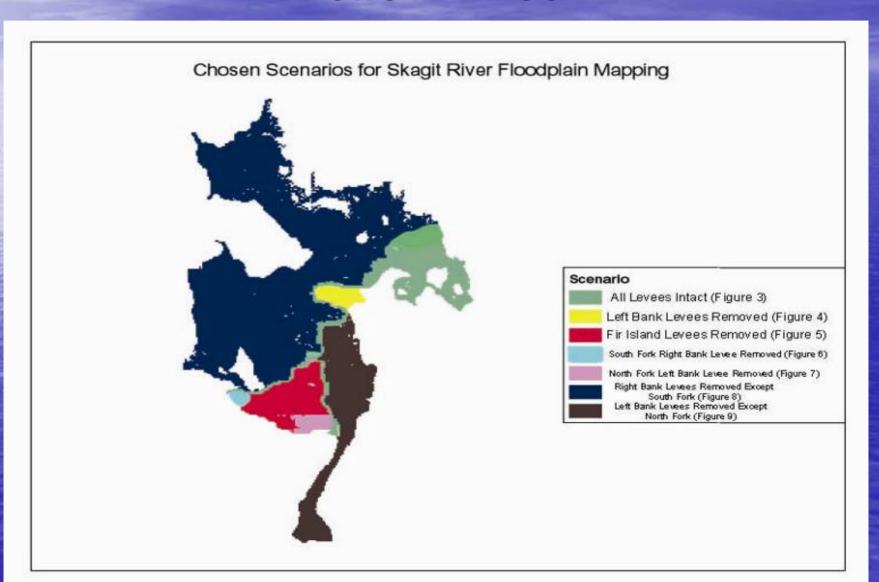
Newspaper Documentation Fir Island

Seattle Times 11/13/1990

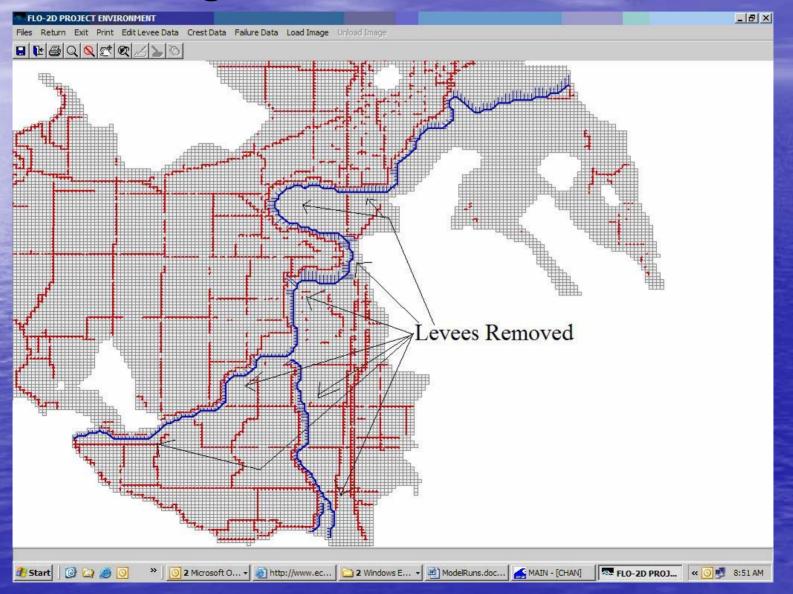
"Workers have punched a hole in a dike to drain flooded Fir Island but water from the raging North Fork of the Skagit River is filling the island faster than the water can leave...Water is reportedly as deep as 10 feet...That break sent a wall of water 10 feet high over fertile farm land...Waves were 8 to 10 feet high...He estimates he has 9 to 10 feet of water at his house."

Concrete Flow = 149,000 cfs Mount Vernon Flow = 142,000 cfs

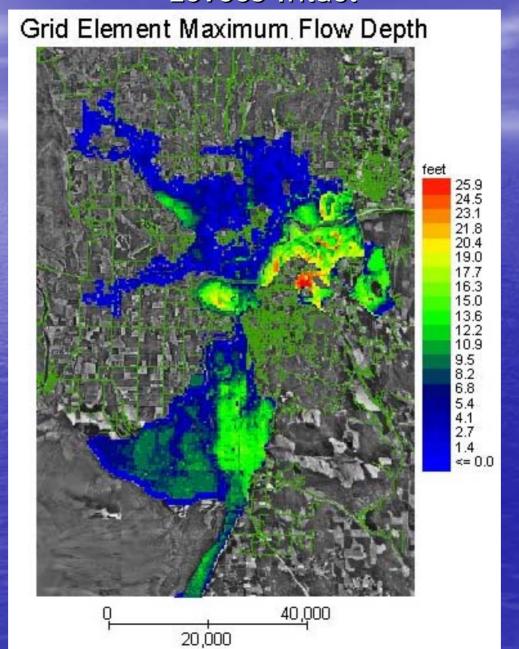
Big Bend Area Yellow Area



All Left Bank Levees Removed with Right Bank Levees Intact



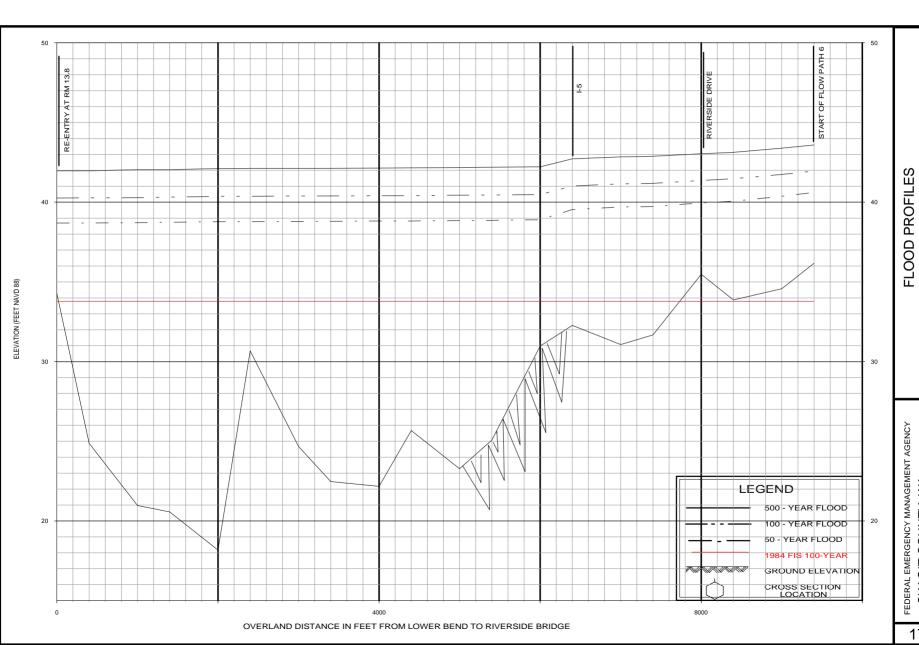
All Left Bank Levees Removed with Right Bank Levees Intact



Big Bend Flow Path



Flow Path 6 - Big Bend

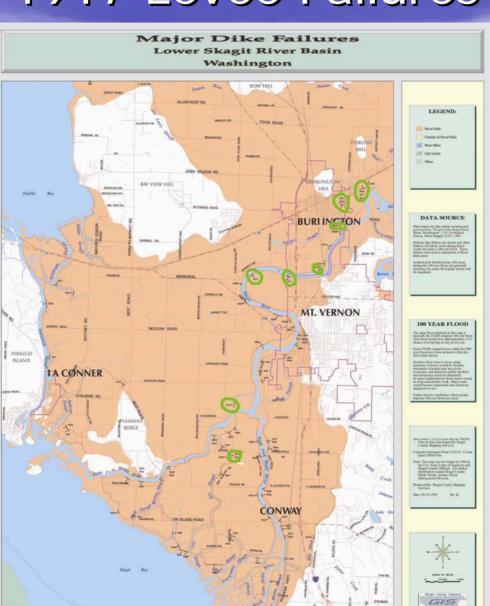


SKAGIT RIVER, OVERBANK FLOW PATH

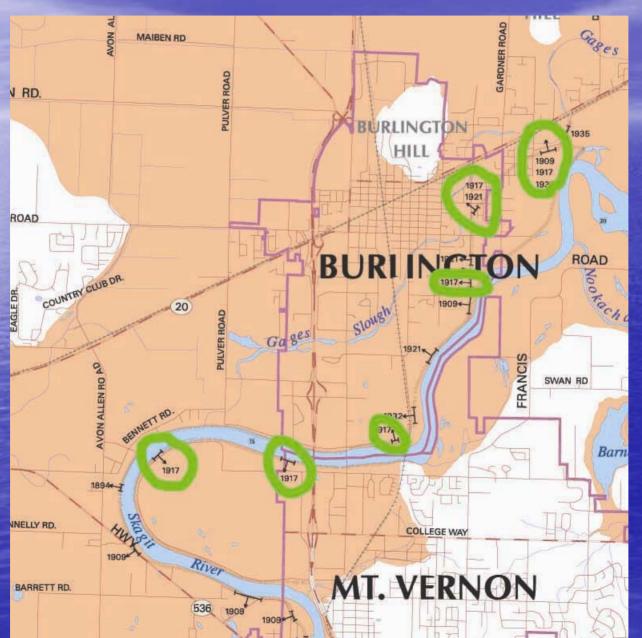
DERAL EMERGENCY MANAGEMENT AGEN
SKAGIT COUNTY, WA
(AND UNINCORPORATED AREAS)

17P

1917 Levee Failures



1917 Levee Failures

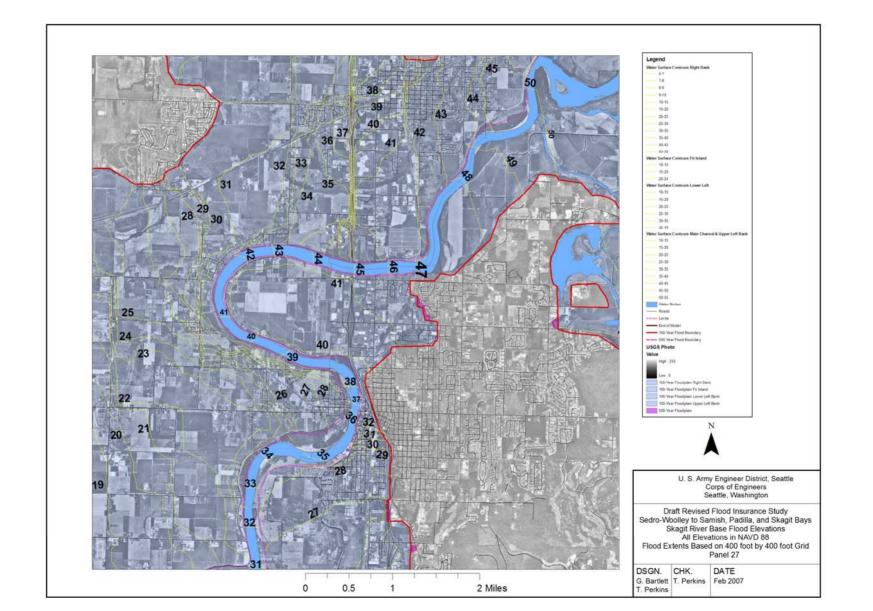


Newspaper Documentation Big Bend – North Mount Vernon

- Burlington Journal 1/4/1918
- "The Riverside district south of the river on the Pacific highway to Mt. Vernon's limits suffered...The highway was under from **two to ten feet** of water..."
- Mount Vernon Herald 1/3/1918
- "The Riverside section was badly hit, in some places as much as **fifteen feet** of water covered the ranch property."

Concrete Flow = 220,000 cfs

Base Flood Elevation Map



Questions/Comments/Concerns?

