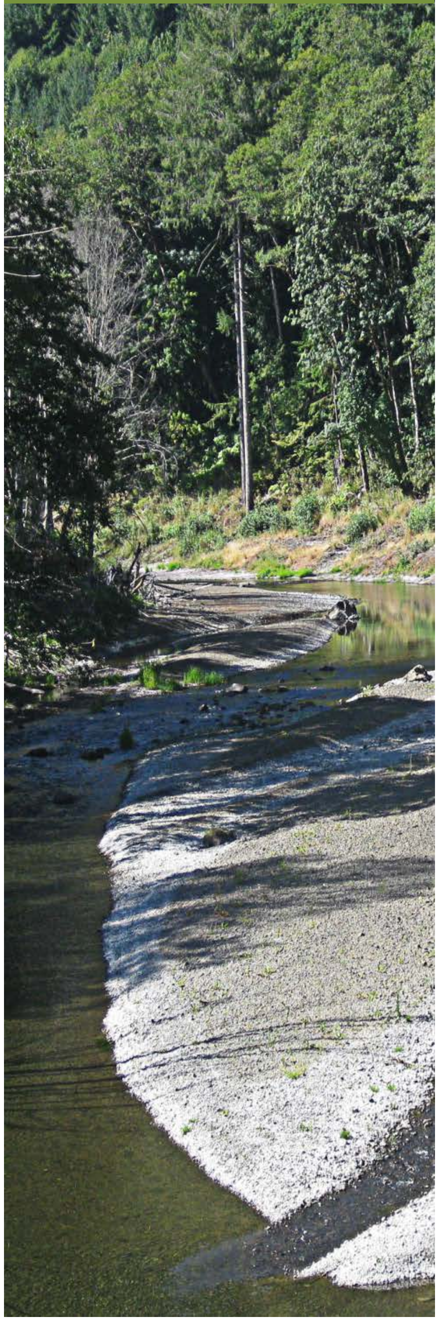
Chehalis Basin Strategy

Estimating Floodproofing Costs

Policy Workshop

September 25, 2014



Approach to Estimate Floodproofing Costs

1. Developed Database of Structures in Floodplain
2. Estimated Finished Floor Elevations
3. Computed Flood Depths using Hydraulic Model
4. Estimated Cost to Floodproof
    1. Separate approach for residential, commercial, agricultural
5. Summed Costs for Various Alternatives

Structure Database

Develop Information for Each Structure

- Height of finished floor above ground
  - 178 structures field surveyed
  - 2804 structures estimated using Google Street View
  - 2630 structures estimated using statistical averages
- Type of Structure (MOB, RES, COMM, AGR)
- Assessed Value
- Area and perimeter of structure

Google Street View finished floor data

Structure Survey Results

9,087 Structures Evaluated

Type of Structure	Lewis County	Thurston County	Grays Harbor County	Totals
Mobile Homes	326	98	0	424
Residential Structures	5,152	206	451	5,809
Commercial	1,344	29	420	1,793
Agricultural	466	161	434	1061
Totals	7,288	494	1,305	9,087

5,512 “significant value” structures; 3,575 others not assigned a value

Total Assessed Value $607 Million

Overview of Hydraulic Analysis

- Design flood events being simulated for this project:
  - Economic analysis based on 10-, 20-, 100-, and 500-year flood events, focused on main stem Chehalis River (at Grand Mound)
  - 2-year event also being simulated
  - Also simulating historical storms of December 2007, February 1996, and January 2009
- Analyzed Two Potential Climate Change Scenarios
- Floodproofing Costs computed for all structures of significant value in the floodplain

Characteristics of Historical Large Floods

December 2007 - Classic atmospheric river (pineapple express) type event with a fairly narrow focus of extreme rainfall. Highest rainfall center concentrated in the Willapa Hills in the Upper Chehalis River Basin (main stem and South Fork). Set records for 24-hour precipitation in the upper basin (heaviest precipitation was actually over about 12 hours or less).

February 1996 - Large frontal storm with very broad rainfall (from north of Seattle to southern Oregon). 24-hour rainfall totals ranged from 10+ year to 100+ year recurrence

January 2009 - Focused primarily in the eastern and northern portions of the basin. Significant rain still fell in the upper Chehalis but flooding of Interstate 5 was caused by high flows on the Newaukum. The January 2009 event also had very high flows in lower basin tributaries (Satsop, Black, etc.).

Chehalis River at Grand Mound

Percent Chance Exceedence	Return Interval	Flow (cfs)
0.2	500	100,300
0.5	200	85,200
1	100	74,700
2	50	64,900
4	25	55,800
10	10	44,600
20	5	36,500
50	2	25,600

December 2007 – 79,100 cfs

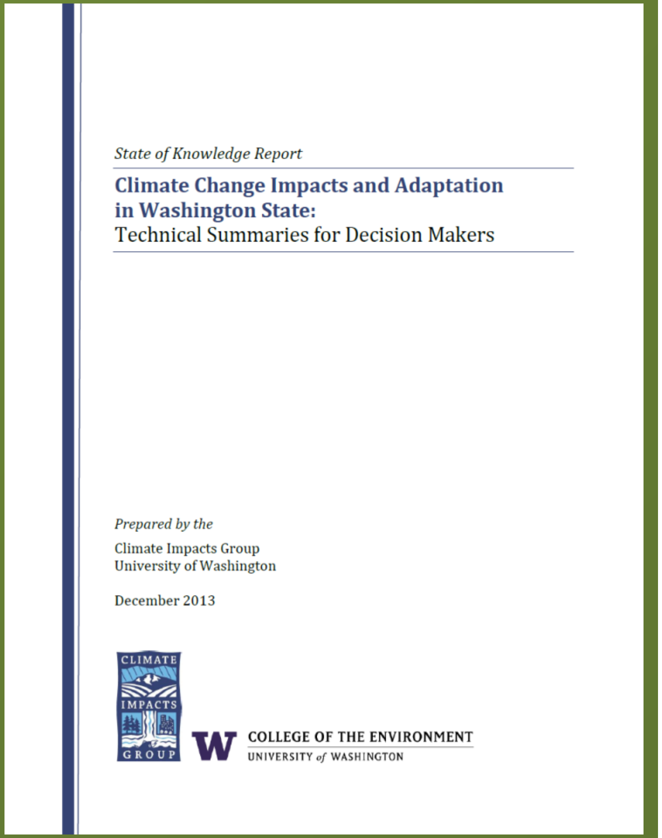
February 1996 – 74,800 cfs

January 2009 – 50,700 cfs

Climate Change Effects on Peak Flows

Latest report from the UW Climate Impacts Group (CIG) suggests:

- Rain dominant basins (like the Chehalis) will see increase in 100-year flood of 11% to 26%
- Average increase is 18%
- Does not include projected changes in heavy rainfall
- Hamlet et.al. suggests increase may be 10 – 90% or more (forthcoming paper)


State of Knowledge Report

Climate Change Impacts and Adaptation in Washington State:
Technical Summaries for Decision Makers

Prepared by the

Climate Impacts Group
University of Washington

December 2013

Change in 100-year Flows and Water Levels

	Baseline	With 18% Climate Change	With 90% Climate Change
Flow at Grand Mound (cfs)	75,500	91,350	162,900
Water Surface Elevation Upstream of Mellen Street (feet NAVD)	178.1	179.8	184.3

Climate Change Notes

- The amount of climate change is uncertain.
- The scenarios used in this study are 18 to 90 increase in peak flows.
- Other potential impacts:
  - Drier, hotter summers,
  - lower summer base flows, and
  - higher water temperatures.

Estimated Costs for Floodproofing

Residential Structures

- $35 per square foot of floor area (roof area)
- 20% contingency for escalation, contractor profit, etc.

Commercial Structures

- $132 per lineal foot of perimeter (+160 feet) for floodwall/berm
- $77 per square foot of door area (10% of walls to 3 feet above flood)
- $4,500 for incidental costs (backflow prevention, etc)
- 195% contingencies for escalation, contractor profit, permits etc.

Agricultural Structures

- Greater of either residential or commercial floodproofing costs

Floodproofing costs capped at value of structure plus land

Structures Affected – Baseline (No Project)

Summary of Structures At Risk of Flooding in Chehalis River Floodplain					
Number of Structures	Baseline				
	Dec 07	500-Year	100-Year	20-Year	10-Year
Flooded	2040	3633	1385	373	176
>1.0 feet	1370	2743	825	167	81
>2.0 feet	813	1912	488	69	28
>3.0 feet	469	1159	290	21	7
>4.0 feet	262	662	151	6	2
>5.0 feet	163	383	76	1	0
Assessed Value of Improvements Inundated ($Million)	$239	$411	$137	$30	$13
Cost to Floodproof all Inundated Structures ($Million)	$207	$373	$141	$34	$16
Residential ($ Mil)	$97	$194	$53	$8	$4
Commercial ($ Mil)	$84	$139	$66	$18	$9
Agricultural ($ Mil)	$26	$40	$22	$8	$3

Estimated Costs for Floodproofing

Baseline conditions 100-year event totals

Residential Structures - $53,000,000

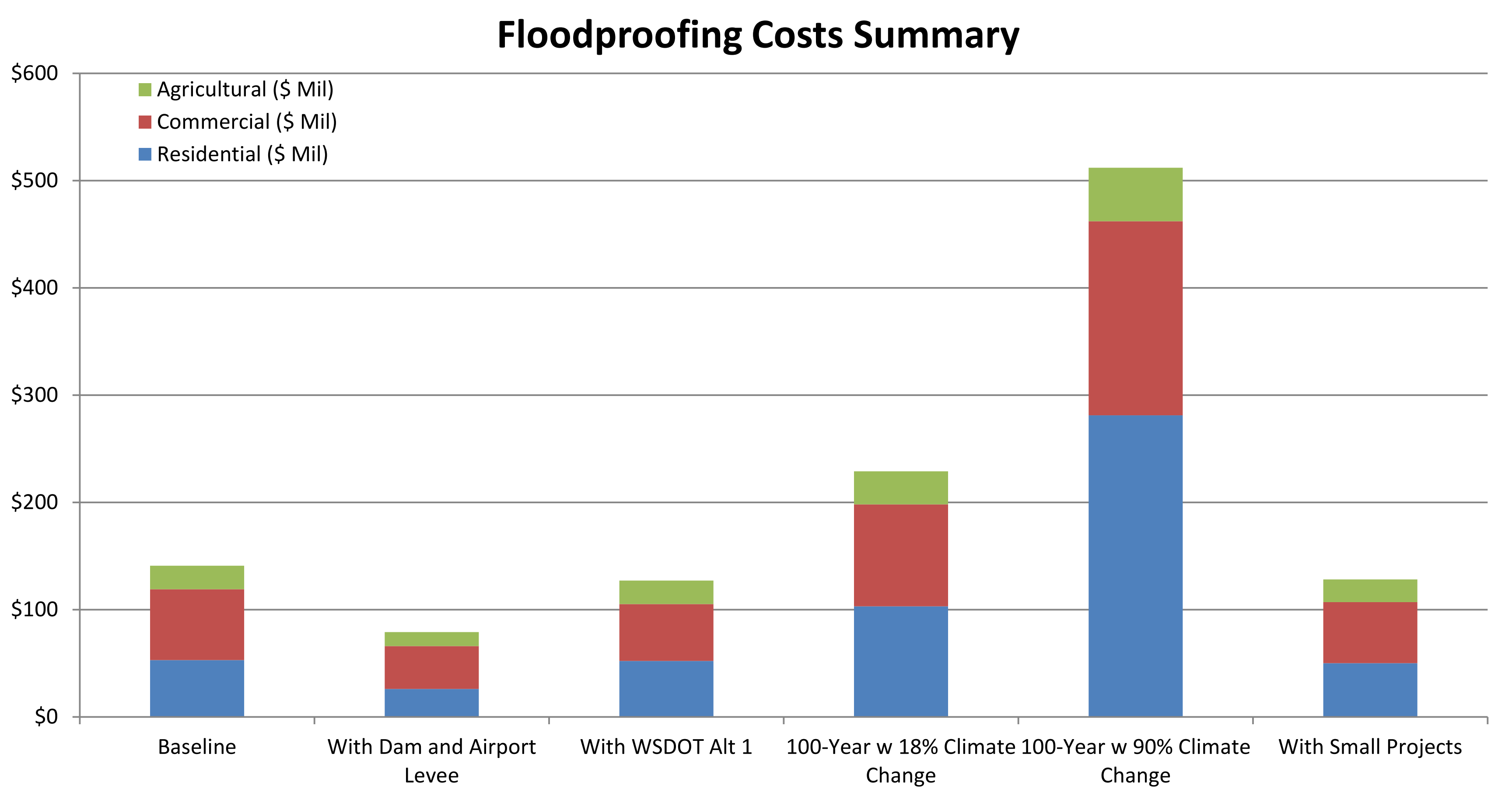
Commercial Structures - $66,000,000

Agricultural Structures - $22,000,000

Total - $141,000,000

Estimated Costs for Floodproofing

100-year event totals



COA Flood Proofing Modeling

- Modeled:
  - Costs
  - Impacts
- Remember analysis is based on expected annual impact
- Used Data from Flood Proofing Analysis from WSE
- If assessed value of property and structures is less than flood proofing cost, then it is assumed property is purchased

Flood Proofing Achievability

- Assume flood proofing (or acquisition) for all applicable residential buildings in 100 year flood
- Commercial Buildings (includes businesses, schools, churches, public buildings, etc.)
  - Based on input by business owners, it is not feasible to flood proof 100% of commercial buildings.
  - Assumed 25% would be flood proofed in the base case
  - Assumed 10% would be flood proofed in the low case
  - Assumed 50% would be flood proofed in the high case

Model Assumptions

EXPECTED CASE 100% RESIDENTIAL AND 25% ACHIEVABILITY FOR COMMERCIAL $2014					
	BUILDINGS IN 100-YEAR FLOODPLAIN	BASELINE	WITH I-5 PROJECT	WITH STORAGE	WITH I-5 PROJECT AND STORAGE
Residential Buildings	677	677	653	368	354
Non-Residential Buildings	446	112	95	71	64
Total Buildings Flood Proofed		789	748	439	418
Cost, Millions		$91.5	$87.3	$49.0	$46.8

Flood Proofing Impacts

- Flood proofing impacts the structure, content and inventory damage estimates.
- Assume 100 year (and smaller) residential structure, content & inventory damaged are eliminated
- Estimate Commercial damage reduction based on achievability % used for costs
- No adjustments done to 500 year flood, thus impacts are likely underestimated.

Model Impacts

100-YEAR NPV ($2014), MILLIONS					
	IMPACTS		PROJECT IMPLE-MENTATION COSTS	NET BENEFIT	BENEFIT/ COST
	FLOOD DAMAGE REDUCTION	ENVIRON-MENTAL (USE VALUES ONLY)			
Floodproofing Only - State	$148	$0	$92	$56	1.6
Floodproofing Only – Basin	$148	$0	$92	$56	1.6
Floodproofing Only – Federal	$83	$0	$92	-$8	0.9

Flood Proofing Considerations

- Properties are still flooded, thus residents still may need to be relocated and may not be able to get to work
- The ability to flood proof commercial building has been questioned by business owners. In addition, even if flood proofed, businesses are not likely to be able to open for business during a flood.