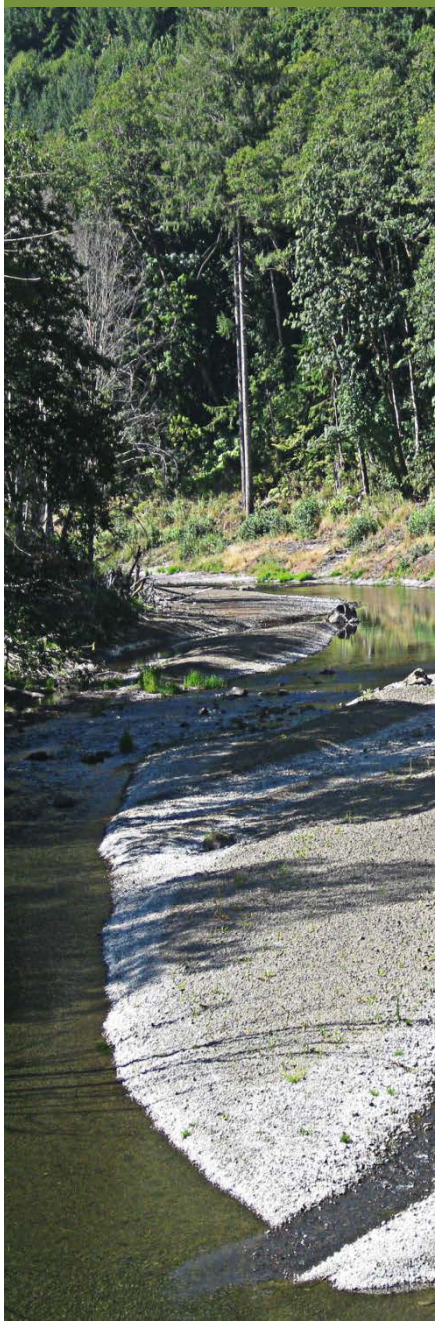
Flooding in the Chehalis Part II - Results

Chehalis Basin Strategy
"Reducing Flood Damage and Enhancing Aquatic Species"
Technical Workshop
LOTT Regional Services Center
May 7-8, 2014



Four Scenarios – Seven Events Analyzed

Scenarios Simulated

- Baseline Conditions
- With Dam and Airport Levee
- With WSDOT Alternative 1
- With Dam and WSDOT Alternative 1

Flood Events Analyzed

- 2-year
- 10-year
- 20-year
- 100-year
- 500-year
- February 1996
- December 2007
- January 2009

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

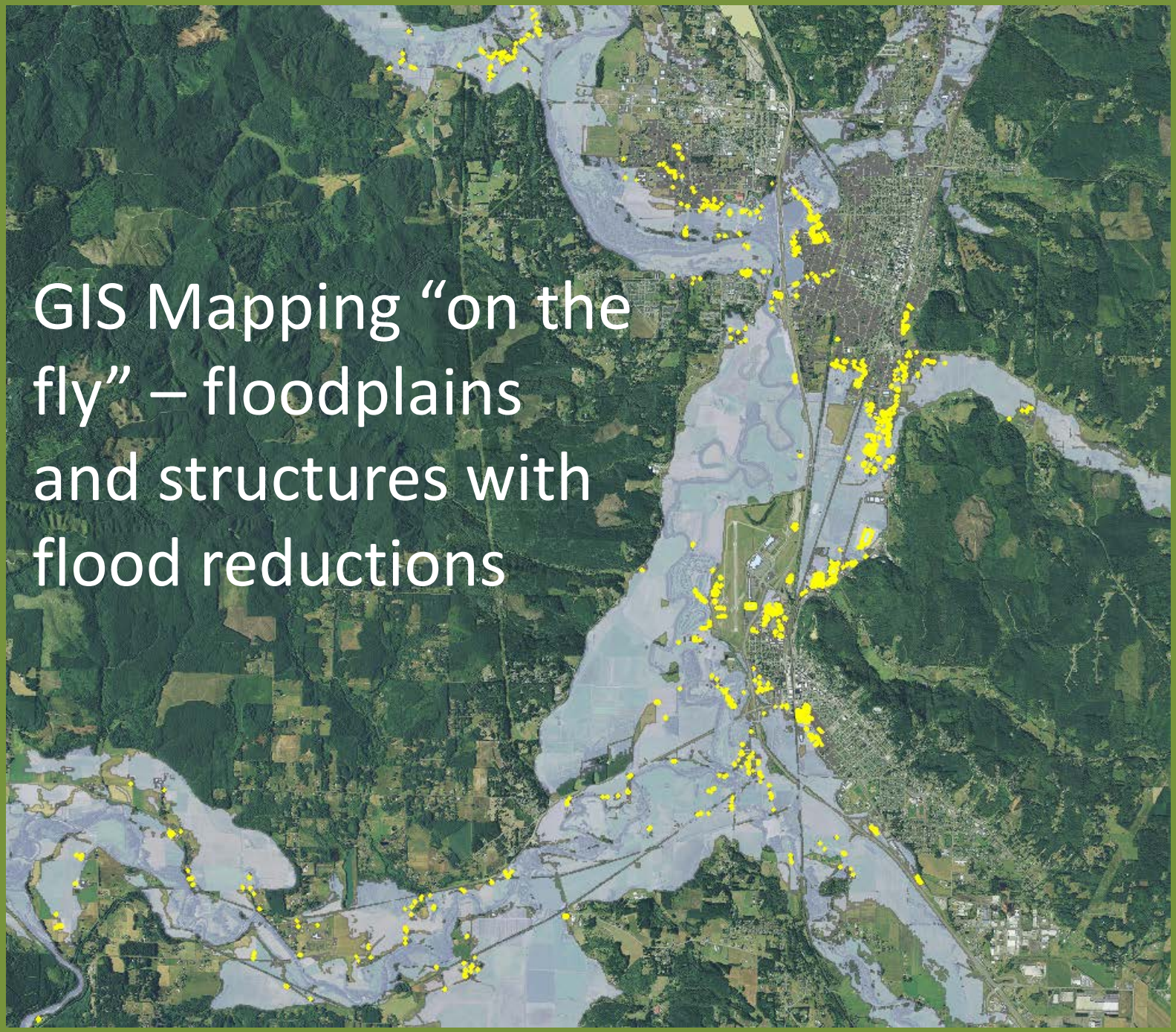
December 2007 – 79,100 cfs

February 1996 – 74,800 cfs

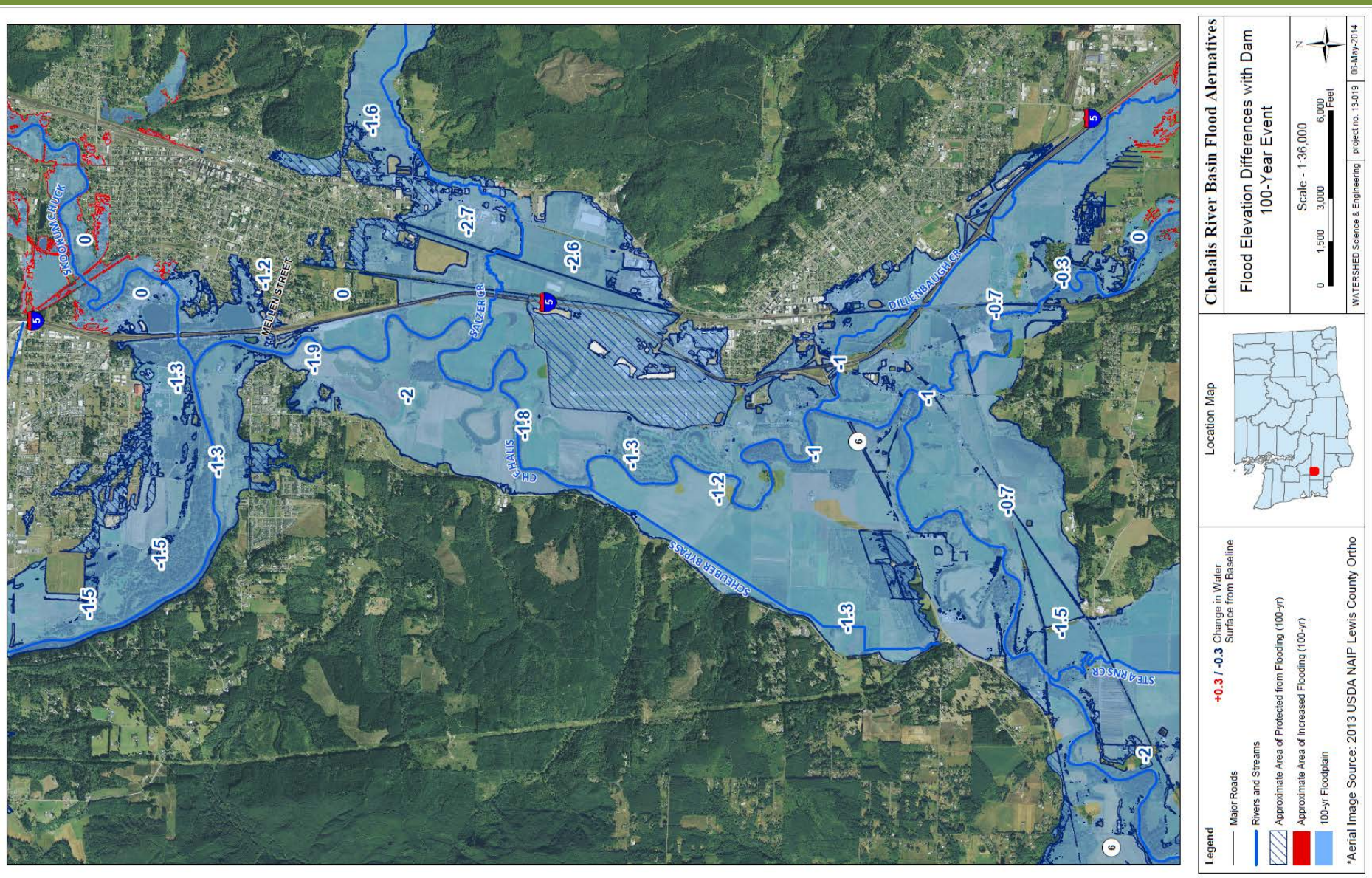
January 2009 – 50,700 cfs

Analyses Conducted

- Mapping of Flood Depths/Water Levels
- Analysis of Structure Flooding
  - Depth of flood above finished floor
  - Assessed value of flooded structures
  - Change from baseline conditions
  - Estimated Cost to floodproof
- Evaluation of Highway Overtopping (I-5, US 12, SR 6)
  - Maximum Depth of Flooding
  - Duration of Flooding


GIS Mapping “on the fly” – floodplains and structures with flood reductions

Mapping Changes in Water Surface Elevations – With Dam versus Baseline Conditions



Structures Affected

Summary of Structures At Risk of Flooding in Chehalis River Floodplain																
Number of Structures	Baseline					With Dam and Airport Levee			With WSDOT Alt 1			With Dam and WSDOT Alt 1			100-Year w Climate Change	
	Dec 07	500-Year	100-Year	20-Year	10-Year	Dec 07	500-Year	100-Year	Dec 07	500-Year	100-Year	Dec 07	500-Year	100-Year	100-Year	Change vs Base
	Plan 5	Plan 7	Plan 8	Plan 9	Plan 10	Plan 15	Plan 17	Plan 18	Plan 39	Plan 41	Plan 42	Plan 47	Plan 49	Plan 50	Plan 80	Percent Increase
Flooded	2040	3645	1384	372	175	753	2031	821	1707	3184	1295	699	1963	778	2202	59%
>1.0 feet	1368	2743	829	167	83	432	1306	459	1105	2322	781	390	1253	428	1462	76%
>2.0 feet	820	1926	489	76	28	241	762	241	689	1577	446	209	723	233	830	70%
>3.0 feet	470	1159	293	22	7	139	471	117	399	948	257	112	432	113	481	64%
>4.0 feet	263	657	155	6	2	65	300	54	234	559	129	50	273	53	301	94%
>5.0 feet	159	385	76	1	0	28	158	25	126	339	54	24	140	26	161	112%
Assessed Value of Improvements Inundated ($Million)	$238	$411	$137	$30	$13	$64	$206	$73	$160	$320	$112	$53	$193	$64	$255	86%
Cost to Floodproof all Inundated Structures ($Million)	$138	$256	$82	$17	$7	$42	$133	$44	$117	$224	$78	$39	$129	$42	$145	77%

Structures Affected

Summary of Structures At Risk of Flooding in Chehalis River Floodplain								
Number of Structures	Baseline					With Dam and Airport Levee		
	Dec 07	500-Year	100-Year	20-Year	10-Year	Dec 07	500-Year	100-Year
	Plan 5	Plan 7	Plan 8	Plan 9	Plan 10	Plan 15	Plan 17	Plan 18
Flooded	2040	3645	1384	372	175	753	2031	821
>1.0 feet	1368	2743	829	167	83	432	1306	459
>2.0 feet	820	1926	489	76	28	241	762	241
>3.0 feet	470	1159	293	22	7	139	471	117
>4.0 feet	263	657	155	6	2	65	300	54
>5.0 feet	159	385	76	1	0	28	158	25
Assessed Value of Improvements Inundated ($Million)	$238	$411	$137	$30	$13	$64	$206	$73
Cost to Floodproof all Inundated Structures ($Million)	$138	$256	$82	$17	$7	$42	$133	$44

Structures Affected

Summary of Structures At Risk of Flooding in Chehalis River Floodplain							
Number of Structures	Baseline					100-Year w Climate Change	
	Dec 07	500-Year	100-Year	20-Year	10-Year	100-Year	Change vs Base
	Plan 5	Plan 7	Plan 8	Plan 9	Plan 10	Plan 80	Percent Increase
Flooded	2040	3645	1384	372	175	2202	59%
>1.0 feet	1368	2743	829	167	83	1462	76%
>2.0 feet	820	1926	489	76	28	830	70%
>3.0 feet	470	1159	293	22	7	481	64%
>4.0 feet	263	657	155	6	2	301	94%
>5.0 feet	159	385	76	1	0	161	112%
Assessed Value of Improvements Inundated ($Million)	$238	$411	$137	$30	$13	$255	86%
Cost to Floodproof all Inundated Structures ($Million)	$138	$256	$82	$17	$7	$145	77%

Highway Inundation – Duration

Total Hours in Event with Flooding Over Freeway																	
	SR-12		Interstate 5											SR-6			
Description	Highway 12 West of Black River Bridge	Highway 12 East of Black River Bridge	West of I-5 West of Long Road Dike	Near Salzer Creek Bridge	I-5 at Chambers Way	Airport Levee (near Airport Road)	South of West Road West of I-5	West of I-5 South of Main Street	East of I-5 South of Main Street	West of I-5 across from Green Hill School	West of I-5 South of 13th St Interchange	East of I-5 South of 13th St Interchange	Upstream end of Dillenbaugh Creek Reach	Highway 6 near Scheuber Rd	Highway 6 near Adna	Highway 6 at Boistfort Rd	Highway 6 at Rainbow Falls State Park
Model Location	SA #1203	4.12	68.67	70.18	SA #2	73.17	74.02	SA #303	0.142	1	1.5	SA #301	3.45	77.075	81.42	88.28	97.06
Low Ground Elev (Ft NAVD)	91.00	98.60	178.20	179.20	173.25	179.70	181.90	183.50	183.50	184.90	188.20	190.40	211.70	185.00	194.40	225.40	288.50
Baseline 2-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baseline 10-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0	3
Baseline 20-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	25	19	0	8
Baseline 100-Year	140	35	19	13	111	27	11	18	22	26	0	0	0	43	33	15	17
Baseline 500-Year	155	47	33	30	122	38	27	31	34	38	14	0	0	50	41	23	21
Calibration Feb-1996	0	32	15	9	47	23	7	14	19	24	0	0	0	39	29	15	12
Calibration Dec-2007	48	27	23	20	71	28	19	22	24	27	0	0	0	37	34	24	21
Calibration Jan-2009	0	17	0	0	0	9	0	0	12	28	0	0	0	26	24	0	8
With Dam and Airport Levee 2-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
With Dam and Airport Levee 10-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
With Dam and Airport Levee 20-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	9	10	0	0
With Dam and Airport Levee 100-Year	0	25	0	0	0	0	0	5	13	21	0	0	0	30	22	0	1
With Dam and Airport Levee 500-Year	124	41	25	21	0	0	20	25	29	35	8	0	0	40	31	14	11
With Dam and Airport Levee Feb-1996	0	21	0	0	0	0	0	0	8	18	0	0	0	27	22	4	0
With Dam and Airport Levee Dec-2007	0	12	10	4	0	0	9	13	16	21	0	0	0	31	27	18	10
With Dam and Airport Levee Jan-2009	0	0	0	0	0	0	0	0	0	27	0	0	0	10	2	0	0
With WSDOT Alt1 2-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
With WSDOT Alt1 10-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0	3
With WSDOT Alt1 20-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	25	19	0	8
With WSDOT Alt1 100-Year	142	35	0	0	0	0	0	0	0	0	0	0	0	43	33	15	17
With WSDOT Alt1 500-Year	155	47	0	0	0	8	0	0	0	0	0	0	0	50	41	23	21
With WSDOT Alt1 Feb-1996	26	32	0	0	0	0	0	0	0	0	0	0	0	40	29	16	12
With WSDOT Alt1 Dec-2007	50	28	0	0	0	0	0	0	0	0	0	0	0	38	34	24	21
With WSDOT Alt1 Jan-2009	0	18	0	0	0	0	0	0	0	0	0	0	0	26	24	0	9
With Dam & WSDOT Alt1 2-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
With Dam & WSDOT Alt1 10-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
With Dam & WSDOT Alt1 20-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	9	10	0	0
With Dam & WSDOT Alt1 100-Year	0	25	0	0	0	0	0	0	0	0	0	0	0	30	22	0	1
With Dam & WSDOT Alt1 500-Year	128	41	0	0	0	0	0	0	0	0	0	0	0	40	31	14	11
With Dam & WSDOT Alt1 Feb-1996	0	21	0	0	0	0	0	0	0	0	0	0	0	27	22	4	0
With Dam & WSDOT Alt1 Dec-2007	0	12	0	0	0	0	0	0	0	0	0	0	0	31	27	18	10
With Dam & WSDOT Alt1 Jan-2009	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2	0	0

Shaded values for Airport Levee (Airport Road) have been adjusted to reflect the levee raise - the existing elevation (179.7 feet) is assumed raised to 185.5 feet NAVD in all levee raise scenarios

These locations protected from flooding by floodwalls or berms, for this analysis this was accounted for by raising the highway elevations by 10 feet

Highway Inundation – Max Depth

Maximum Simulated Flood Depths (feet)																	
	SR-12		Interstate 5											SR-6			
Description	Highway 12 West of Black River Bridge	Highway 12 East of Black River Bridge	West of I-5 West of Long Road Dike	Near Salzer Creek Bridge	I-5 at Chambers Way	Airport Levee (near Airport Road)	South of West Road West of I-5	West of I-5 South of Main Street	East of I-5 South of Main Street	West of I-5 across from Green Hill School	West of I-5 South of 13th St Interchange	East of I-5 South of 13th St Interchange	Upstream end of Dillenbaugh Creek Reach	Highway 6 near Scheuber Rd	Highway 6 near Adna	Highway 6 at Boistfort Rd	Highway 6 at Rainbow Falls State Park
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Low Ground Elev (Ft NAVD)	91.00	98.60	178.20	179.20	173.25	179.70	181.90	183.50	183.50	184.90	188.20	190.40	211.70	185.00	194.40	225.40	288.50
Baseline 2-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baseline 10-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.9	0.0	0.4
Baseline 20-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.5	0.0	1.6
Baseline 100-Year	0.4	1.8	1.4	0.6	7.0	2.0	0.3	1.8	1.8	1.8	0.0	0.0	0.0	2.8	7.5	5.9	3.2
Baseline 500-Year	1.9	3.1	4.7	3.9	10.1	4.2	2.4	3.6	3.6	3.4	0.7	0.0	0.0	3.7	9.3	11.1	4.6
Calibration Feb-1996	0.0	1.7	1.2	0.4	6.7	1.8	0.1	0.8	1.2	1.4	0.0	0.0	0.0	2.6	7.0	5.7	2.1
Calibration Dec-2007	0.4	1.8	3.4	2.6	8.9	3.3	1.6	1.9	2.7	2.8	0.0	0.0	0.0	3.5	9.5	13.1	4.7
Calibration Jan-2009	0.0	0.7	0.0	0.0	0.0	0.3	0.0	0.0	0.2	1.2	0.0	0.0	0.0	1.8	4.0	0.0	0.6
With Dam and Airport Levee 2-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
With Dam and Airport Levee 10-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
With Dam and Airport Levee 20-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.9	0.0	0.0
With Dam and Airport Levee 100-Year	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.0	0.0	0.0	0.0	2.1	5.1	0.0	0.1
With Dam and Airport Levee 500-Year	1.1	2.4	2.7	2.0	0.0	0.0	1.9	2.8	2.7	2.6	0.1	0.0	0.0	3.0	7.8	5.7	2.1
With Dam and Airport Levee Feb-1996	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.0	0.0	2.0	4.8	0.4	0.0
With Dam and Airport Levee Dec-2007	0.0	0.5	0.8	0.1	0.0	0.0	0.5	1.6	1.5	1.5	0.0	0.0	0.0	2.7	7.8	7.6	1.6
With Dam and Airport Levee Jan-2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.6	0.0	0.0	0.0
With WSDOT Alt1 2-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
With WSDOT Alt1 10-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.9	0.0	0.4
With WSDOT Alt1 20-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.5	0.0	1.6
With WSDOT Alt1 100-Year	0.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	7.5	5.9	3.2
With WSDOT Alt1 500-Year	1.9	3.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	9.3	11.1	4.6
With WSDOT Alt1 Feb-1996	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	7.0	5.7	2.1
With WSDOT Alt1 Dec-2007	0.4	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	9.5	13.1	4.6
With WSDOT Alt1 Jan-2009	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.0	0.0	0.7
With Dam & WSDOT Alt1 2-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
With Dam & WSDOT Alt1 10-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
With Dam & WSDOT Alt1 20-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.9	0.0	0.0
With Dam & WSDOT Alt1 100-Year	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.1	0.0	0.0
With Dam & WSDOT Alt1 500-Year	1.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	7.8	5.7	2.1
With Dam & WSDOT Alt1 Feb-1996	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	4.8	0.4	0.0
With Dam & WSDOT Alt1 Dec-2007	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	7.8	7.6	1.6
With Dam & WSDOT Alt1 Jan-2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0

Shaded values for Airport Levee (Airport Road) have been adjusted to reflect the levee raise - the existing elevation (179.7 feet) is assumed raised to 185.5 feet NAVD in all levee raise scenarios

These locations protected from flooding by floodwalls or berms, for this analysis this was accounted for by raising the highway elevations by 10 feet

Comparisons Between Alternatives

With Dam to Baseline Conditions

Dec 2007 Event - Baseline to with Dam and Airport Levee					
more flooding	1	0	dry to wet		
less flooding	2002	1287	wet to dry		
same flooding	37	753	wet to wet		
$\Delta < -2.0$	474				
$-2.0 < \Delta < -1.0$	815				
$-1.0 < \Delta < -0.5$	342				
$-0.5 < \Delta < -0.05$	340				
$-0.05 < \Delta < 0.05$	69				
$0.05 < \Delta < 0.5$	0				
$0.5 < \Delta < 1.0$	0				
$1.0 < \Delta < 2.0$	0				
$2.0 < \Delta$	0				

100-year Event - Baseline to with Dam and Airport Levee					
more flooding	26	1	dry to wet		
less flooding	1240	564	wet to dry		
same flooding	119	820	wet to wet		
$\Delta < -2.0$	111				
$-2.0 < \Delta < -1.0$	331				
$-1.0 < \Delta < -0.5$	502				
$-0.5 < \Delta < -0.05$	278				
$-0.05 < \Delta < 0.05$	138				
$0.05 < \Delta < 0.5$	25				
$0.5 < \Delta < 1.0$	0				
$1.0 < \Delta < 2.0$	0				
$2.0 < \Delta$	0				

Questions