WSDOT Draft Report:

I-5 protection from 13th Street to Mellen Street near Centralia and Chehalis

Draft — August 17, 2012

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Executive Summary

This report summarizes work by the Washington State Department of Transportation (WSDOT) to evaluate projects to protect Interstate 5 (I-5), the Chehalis-Centralia Airport, and improve access to medical and other critical facilities during flood events.

This work is part of a larger effort to identify potential flood hazard mitigation projects in the Chehalis River Basin. In 2011, as part of the capital budget (ESHB 2020, Section 1033) the Washington State Legislature required the Office of Financial Management (OFM) to prepare a report on alternative flood damage reduction projects and -- in coordination with tribal governments, local governments, state and federal agencies -- to recommend priority flood hazard mitigation projects in the Chehalis River Basin for continued feasibility and design work.

WSDOT evaluated six alternatives that could be used to protect I-5 from flooding. Due to time and funding constraints, WSDOT has done a limited amount of design work to define and evaluate these approaches. If the legislature or others decide any of these alternatives warrant further consideration, more effort would be needed to define, refine, and evaluate them. This would include additional work to refine the analysis done to identify potential impacts to buildings in the floodplain.

Some of these alternatives could be considered in conjunction with other flood hazard mitigation projects in the Chehalis Basin, like a dam or flood bypasses. If so, they would be refined to be more compatible with the other solutions.

- **Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee** – provides protection of I-5 and the Chehalis-Centralia Airport in flood events up to the 2007 or simulated 100-year flood level. It improves conditions for approximately 1030 buildings, but has a negative impact for approximately 140 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. Alternative 1 does not address the need to widen I-5 in the future. Alternative 1 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation efforts in the Chehalis Basin.

- **Alternative 2: I-5 Raise and Widen Only** – provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 840 buildings, but has a negative impact for approximately 300 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. Alternative 2 does address the need to widen I-5 in the future. Alternative 2 appears to warrant further

consideration as an independent project or in combination with other flood hazard mitigation efforts in the Chehalis Basin.

- **Alternative 3: I-5 Express Lanes** - provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 890 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. There are significant uncertainties with Alternative 3, including whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost. However, Alternative 3 does address the future need to widen I-5 at a significant cost savings. If Alternative 3 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 4: I-5 Temporary Bypass** - provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 900 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, including whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost. Alternative 4 does not address the future need to widen I-5. If Alternative 4 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 5: I-5 Viaduct.** WSDOT does not consider this a viable alternative due to high costs and increased flood elevations in the urban areas of Centralia.

- **Alternative 6: I-5 Relocation.** WSDOT does not consider this a viable alternative due to high costs and impacts to the built and natural environment surrounding Chehalis and Centralia.

WSDOT encourages comments on this draft report. ***Please submit comments by Friday, August 31, 2012.***

Email: melissa.kuehne@wsu.edu

Postal mail: Melissa Kuehne,
Ruckelshaus Center, WSU West
520 Pike Street, Suite 1101
Seattle, WA 98101

All comments received will be taken into consideration as the report is finalized, and included in an appendix to the final report. The final report is expected to be available in late September, in conjunction with the Ruckelshaus Center flood hazard mitigation alternatives report.

Introduction and Background

This report summarizes work by the Washington State Department of Transportation (WSDOT) to evaluate projects to protect Interstate-5 (I-5), the Chehalis-Centralia Airport, and improve access to medical and other critical facilities during flood events. This is part of a larger effort to identify potential flood hazard mitigation projects in the Chehalis River Basin.

In 2011, as part of the capital budget (ESHB 2020, Section 1033) the Washington State Legislature required the Office of Financial Management (OFM) to prepare a report on alternative flood damage reduction projects and — in coordination with tribal governments, local governments, state and federal agencies — to recommend priority flood hazard mitigation projects in the Chehalis River Basin for continued feasibility and design work.

Some of the projects WSDOT evaluated have the potential to also reduce the negative effects of flooding on nearby people and communities. Where possible, those potential benefits have been optimized. On the other hand, some projects have the potential to increase the negative effects of flooding on people and communities, particularly on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum creeks. Where possible, these effects have been avoided and minimized. Where negative effects are still anticipated, project cost estimates include funding for mitigation efforts, such as raising buildings, moving buildings, fully purchasing impacted properties, and other measures.

Six primary project alternatives were evaluated:

1. I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee;
2. I-5 Raise and Widen Only;
3. I-5 Express Lanes;
4. I-5 Temporary Bypass;
5. I-5 Viaduct; and,
6. I-5 Relocation.

Project Area and History of Flooding

The project area is in Lewis County and the cities of Chehalis and Centralia, Washington, along a five-mile stretch of I-5 that begins near the 13th Street interchange at milepost 76 and extends north to the Mellen Street Interchange at milepost 81.

This stretch of I-5 is a midpoint between Seattle, Washington and Portland, Oregon, connecting two of the West Coast's major population and industrial centers. I-5 is vital to the state's economy and acts as the West Coast's major north-south transportation corridor. The uninterrupted movement of cars,

trucks, freight, and recreational vehicles along I-5 is essential to the quality of life and economic vitality in the region.

Chehalis Basin floods in February 1996 and December 2007 closed I-5 at Chehalis and Centralia for four days each, and flooding in January 2009 closed the same stretch for two days. WSDOT estimates the total cost of the closure and delays in 2007 alone in the tens of millions of dollars. The major costs come from limited freight movement through the area, including costs incurred by private companies as a result of that limited movement. WSDOT has a detour route that takes drivers around I-5 using SR 7 and US 12, but this route is limited to critical freight only. It can handle only about 25 percent of the freight that typically travels this section of I-5. A more efficient, longer term solution during flood events is still needed.

Photo courtesy of *The Chronicle*, Centralia, Washington

Other Flood Hazard Mitigation Projects Under Consideration in the Basin

The William D. Ruckelshaus Center, a joint effort of the University of Washington and Washington State University (more information available at www.ruckelshauscenter.edu), is under contract with OFM to coordinate development of the report using technical information provided by other agencies and organizations. The report is intended to provide the Washington State Legislature and other decision makers with information to aid their decisions and set the course for effective solutions that reduce

negative impacts of flooding while supporting the economic prosperity of communities in the Basin and protection/restoration of fish and other natural resources.

Review and Comments on the Draft Report

WSDOT encourages comments on this draft report. ***Please submit comments by email or postal mail by August 31, 2012.***

Email: melissa.kuehne@wsu.edu

Postal mail: Melissa Kuehne,
Ruckelshaus Center, WSU West
520 Pike Street, Suite 1101
Seattle, WA 98101

All comments received will be taken into consideration as the report is finalized. The final report is intended to be available in late September, in conjunction with the Ruckelshaus Center flood hazard mitigation alternatives report.

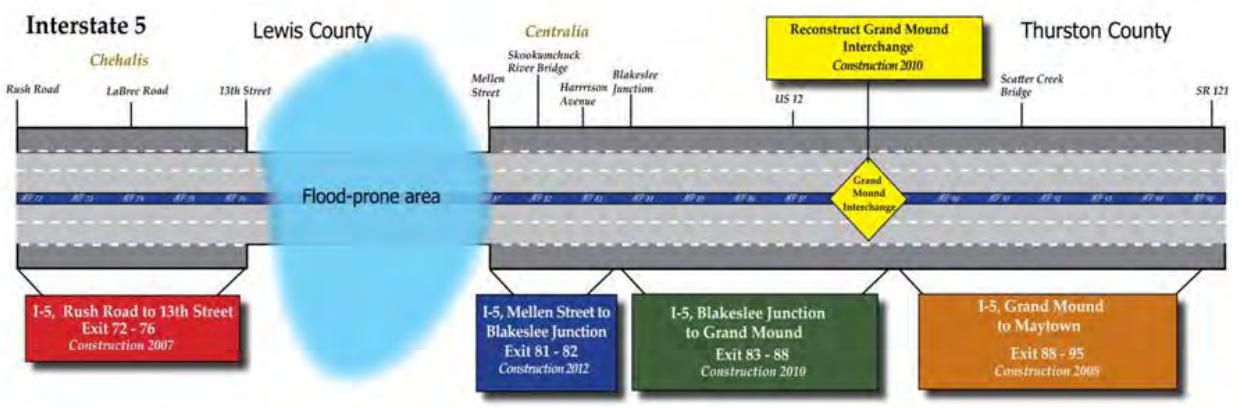
Project Context

This section provides background information on recent and ongoing projects along I-5 at Chehalis and Centralia, and each of the flood hazard mitigation projects considered.

Recent and Ongoing Improvements to I-5 in the Chehalis and Centralia Area

Since 2007, Washington State has invested $365 million in improving I-5 in the Chehalis-Centralia area. Between Exit 72 and Exit 95, 18 miles of I-5 have been or are being widened from four to six lanes.

Figure 1: Overview of I-5 Improvements between Exit 72 and Exit 95



The I-5 Mellen Street to Blakeslee Junction (MTB) project (currently under construction and scheduled for completion in fall 2014) improves access to I-5 from Centralia during flood events. Residents who are able to reach I-5 during flooding will have improved ability to reach the hospital in Centralia. The project also will reduce flood levels at some homes and businesses in the nearby area to a limited degree. The MTB project does not completely resolve the issue of hospital access during flooding. In an event the size of the 2007 flood, residents to the south in the city of Chehalis will still likely not have access to the hospital, because floodwaters will block access to I-5 and other local roads.

The Future Need to Widen I-5 from 13th Street to Mellen Street

In addition to being susceptible to flooding, the stretch of I-5 from 13th Street to Mellen Street has not yet been widened to six lanes. WSDOT plans to widen this section of I-5 to six lanes; however, it is unlikely widening will happen without a broader solution to flooding along this corridor. A widening project for this stretch of I-5 by itself would cost $250-350 million, and funding is not readily available. To ensure funds are invested properly and minimize the potential for "re-work" when I-5 widening along this stretch occurs, WSDOT evaluated whether each flood hazard mitigation project alternative

addresses the need for future widening of this stretch of I-5, and considered future widening needs in project design.

Potential for a Dam on the Chehalis River

Following the major flood in 2007, the Chehalis Basin Flood Authority began to evaluate whether flood retention structures in the Chehalis River Basin might be a solution to basin-wide flooding. The water retention alternative still under consideration in the Chehalis Basin is a multi-purpose dam located upstream of Pe Ell on the Upper Chehalis River. At an estimated cost of $245 million, the dam would be 288 feet high with 80,000 ac-ft of dedicated flood control storage, and a flow augmentation/hydropower storage capacity of 65,000 ac-ft.[1]

If a dam were constructed, it would reduce flood elevations throughout much of the upper Chehalis Basin and in the Centralia and Chehalis area, but it would not fully protect I-5. Each flood event is unique, but historically, any large flooding in the Basin affects the movement of traffic on and around I-5.

In 2007, a dam would not have prevented flooding where Salzer and Dillenbaugh creeks flow under I-5, or the flooding of the State Route 6 on-ramp to I-5. In 2009, water inundated the area through the Newaukum River and Dillenbaugh Creek rather than the main Chehalis River channel. A dam would not have prevented I-5 from being flooded in at least one location on the west side of I-5, north of the 13th Street interchange. In several other locations, floodwaters would be within several inches of the road surface, likely requiring the closure of I-5 to ensure safety.

[1] EES Consulting. 2011. Chehalis River Flood Water Retention Project: Phase IIB Feasibility Study Report. Final Submitted April 14, 2011.

Project Goals

Photo courtesy of *The Chronicle*, Centralia, Washington

The goal for all projects is the full protection of I-5 from 13th Street to Mellen Street, protection of the Chehalis-Centralia Airport, improved access to infrastructure, and optimization of any potential ensuing benefits to people, communities, and the environment. It is only appropriate to spend hundreds of millions of dollars on a project if it will provide full protection. Therefore, WSDOT has analyzed and chosen a conservative measurement between the potential flood water surface and the top of the flood hazard mitigation element. This measurement is called "freeboard," and WSDOT has chosen a measurement similar to that used by the US Army Corps of Engineers: three feet above the 100-year flood level. Any modification or new construction of dikes or levees should be built at this level to ensure robust, reliable protection for I-5 and the Chehalis-Centralia Airport. See Appendix A for a more detailed technical description on how WSDOT determined freeboard.

Project Alternatives

WSDOT considered six main alternatives to protect I-5, the airport, and infrastructure in the Centralia and Chehalis area.

1. I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee;
2. I-5 Raise and Widen;
3. I-5 Express Lanes;
4. I-5 Temporary Bypass;
5. I-5 Viaduct; and,
6. I-5 Relocation.

For each alternative, this section describes the project details, potential costs and implementation issues, and potential impacts to nearby people and communities, major infrastructure, and the environment. A side-by-side project comparison table is provided at the end of this section.

ALTERNATIVE 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee

Alternative 1 would protect I-5 with a combination of five miles of earthen levees and structural walls along I-5, two miles of improvements to the existing Chehalis-Centralia Airport levee, and a new one-mile-long levee in southwest Chehalis.

Alternative 1 includes replacing five bridges (four over Dillenbaugh Creek and one over Salzer Creek) with bottomless box culverts, and construction of stormwater treatment areas to store and treat stormwater runoff from I-5. Stormwater treatment is necessary because the water that flows during storm events need to be collected and stored until flood waters recede to prevent pooling on I-5. Treatment of runoff is also required to address water quality concerns.

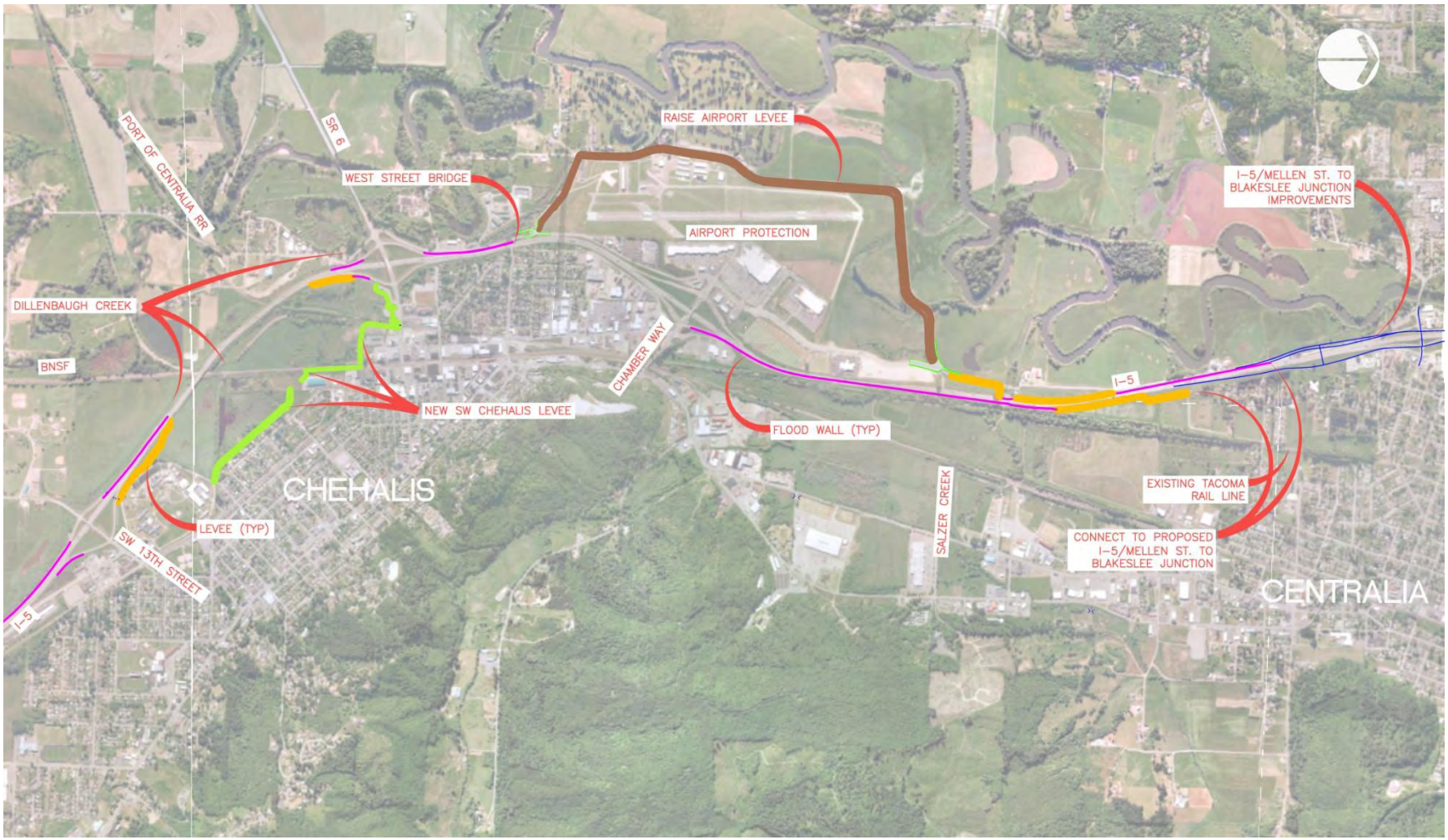
Table 1: Alternative 1 – Location and Length of Levees

Alternative 1: Levees and Walls, No Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Levees and Walls	5
Total Cost: $80 to 100 million	

Levees would be used away from I-5, where impacts to property would be minimized and levees could utilize existing high ground topography. Walls would only be used in areas where levees are not possible, such as areas with space constraints.

A detailed map showing the layout of the walls and levees is provided in Figure 2.

Figure 2: Alternative 1 - I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee



How does the project increase or decrease flood levels in nearby areas?

In a 2007 flood event, Alternative 1 would decrease water surface elevations (the height of floodwaters) east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally between 1.4 and 1.8 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to generally increase between 0.2 and 1.8 feet, but by as much as 2.0 feet in some locations. Increases in water elevations are largely because walls and levees would prevent floodwater from crossing over (or under) I-5 from west to east, resulting in more water staying to the west of I-5.

In a simulated 100-year flood event, Alternative 1 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally between 0.5 and 0.8 feet. The drop in flood storage would be more than 11 feet in some places protected by the raised Airport levee. In the area west of I-5 and west of the Airport levee, which is closer to the river and more rural, water surface elevations are predicted to generally increase between 0.2 and 1.2 feet, but by as much as 1.3 feet in some locations. Increases in water elevations are largely because walls and levees would prevent floodwater from crossing over (or under) I-5 and over the Airport levee from west to east, resulting in more water staying on the side of I-5 and the Airport levee closest to the river.

Appendix B provides a detailed map showing representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the depth of flooding were conducted in July 2012.[2]

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 1 would lower flood elevations at 760 residences and 280 commercial buildings generally east of I-5. Of these, 460 residences and 140 commercial buildings would no longer be flooded. Alternative 1 would raise flood levels at a total of 120 residences and 30 commercial buildings located mostly west of I-5, but no new structures would be flooded. Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 2 summarizes and rounds the results of the structure analysis conducted in August 2012.

[2] Note that model simulations used in the draft Ruckelshaus Center report current out for public review were conducted at an earlier date. The most recent model simulations will be used in finalization of both this and the larger flood reports.

Table 2: Flood Mitigation in Twin Cities Area by Alternative 1

	I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	70	80	**150**
-2 to -1	480	130	**600**
-1 to 0	210	70	**280**
Sum Decreased Flooding	**760**	**280**	**1030**
0 to 1	90	20	**100**
1 to 2	30	10	**40**
>2	0	0	**0**
Sum Increased Flooding	**120**	**30**	**140**

	I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	0	**0**
Buildings No Longer Flooded[3]	460	140	**600**

What are the potential impacts to natural resources?

Alternative 1 would create impacts to wetlands and cultural resources due to the excavation and fill necessary to build the floodwalls, levees, and stormwater treatment. Most wetland impacts would likely be mitigated at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 1 may impact fish passage at these crossings due to the length of culverts needed to protect I-5, but there are mitigation opportunities nearby. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish passage at these locations.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent Alternative 1 from moving forward. In addition, the natural resource impacts anticipated for Alternative 1 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes; therefore, these environmental impacts likely will occur regardless of whether Alternative 1 is constructed.

[3] Language edited for clarity on 8-20-12

How much does the project cost?

Alternative 1 has an estimated cost of $80 -100 million. This cost estimate includes funding for mitigation for affected properties, as described above.

Does the project protect the Chehalis-Centralia Airport?

Yes, Alternative 1 includes improvements to the Chehalis-Centralia Airport levee that would protect the airport in a flood up to the 2007 level.

Does the project address future widening of I-5?

Yes. While it does not actually widen I-5, the improvements built as part of Alternative 1 will be needed when I-5 is widened in the future, avoiding additional costs to build those improvements at a later date. Additionally, elements of Alternative 1 would be designed to continue to provide flood protection when widening occurs. These include:

- Airport Levee – The levee would not be impacted by widening of I-5.
- Protection of SW Chehalis Ave. – Any wall or levee constructed to protect southwestern Chehalis between Main Street and the Green Hill School would not be impacted by widening I-5 to six lanes.
- Bridges – The project includes replacing five bridges (four over Dillenbaugh Creek and one over Salzer Creek) with culverts. These culverts will be designed to remain in place when I-5 is widened, although the Salzer Creek culvert may need to be lengthened for the widening project. Because the bridge crossings will be improved as part of the flood protection effort, WSDOT would save $15-$20 million on bridges in a future widening project.
- Right of Way acquisition – Any property acquired for the protection of I-5 would also serve the needs of any future widening project.
- Stormwater Collection, Conveyance, and Treatment – The facilities constructed to collect, convey, store and treat stormwater runoff from I-5 will be preserved where possible. Treatment facilities are designed so they can be expanded if needed when I-5 is widened. If stormwater collection, conveyance, and treatment facilities are built as part of I-5 flood protection, they will be sized adequately where possible to serve any future widening project.
- Chamber Way Pump Station – This facility has been sited to accommodate future widening and can be preserved for continued use after widening.
- Levees – Levees have been designed and located to accommodate I-5 widening and would not need to be moved or reconstructed.
- Walls – Walls can be preserved in sections where widening will occur solely on the opposite side of I-5 (for example, adjacent to the railroad tracks).

Does the project improve access to the hospital in Centralia?

Yes, in a flood event up to the 2007 level, Alternative 1 improves access to the hospital if drivers can reach I-5 from the south or from the north.

Would the project change if a dam were to be built on the upper Chehalis?

Yes, because a dam would lower flood levels in the project area, walls and levees along I-5 could be smaller in some places and would not be needed in other places. The total cost of the project would be reduced by $20 million. Table 3 shows the differences in the length of walls and levees, and total costs, in a with/without a dam scenario.

Table 3: Difference in Length of Levees and Total Costs in a With and Without Dam Scenario

Alternative: Levees, No Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Walls and Levees	5
Total Cost: $80 to 100 million	

Alternative: Levees with Dam on Upper Chehalis	
Protective Measure	**Length (Miles)**
Airport Levee	2
SW Chehalis Levee	1
I-5 Walls and Levees	4
Total Cost: $60 to 80 million	

ALTERNATIVE 2: I-5 Raise and Widen Only

Alternative 2 would raise I-5 using fill material in areas where the interstate falls below the desired flood protection elevation, and widen I-5 from four to six lanes. It also would raise bridges within the project to above the flood elevation.

Raising I-5 using fill material would require reconstruction of all pavement, stormwater systems, illumination systems, and guardrail in the project area. In addition, because raising I-5 would reduce

clearance for existing ramps and overpasses, it would require reconstruction of all aspects of the 13th Street, State Route 6, and Chamber Way interchanges and the West Street bridge.

Alternative 2 does not include raising the Chehalis-Centralia Airport Levee or building a new SW Chehalis Levee. However, these elements could be added to the project or constructed independently to provide additional protection in those areas.

How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 2 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally from 1.4 to 1.9 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to generally increase between 0.2 to 0.9 feet, but by as much as 1.2 feet in some locations.

In a simulated 100-year flood event, Alternative 2 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally from 0.6 to 0.9 feet, but by as much as 1.9 feet lower in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to generally increase between 0.1 to 0.6 feet, but by as much as 0.8 feet in some locations.

Appendix C provides a detailed map showing representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the depth of flooding were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 2 would lower flood elevations at 660 residences and 180 commercial buildings, generally east of I-5. Of these, 360 residences and 40 commercial buildings would no longer be flooded. Alternative 2 would raise flood levels at a total of 170 residences and 130 commercial buildings located mostly west of I-5. Fewer than 10 additional buildings would be newly flooded (i.e., would experience flooding under this scenario when they have not been flooded before). Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 4 summarizes and rounds the results of the structure analysis conducted in August 2012.

Table 4: Flood Mitigation in Twin Cities Area by Alternative 2

	I-5 Raise and Widen Only, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	30	0	**30**
-2 to -1	440	120	**560**
-1 to 0	190	60	**250**
Sum Decreased Flooding	**660**	**180**	**840**
0 to 1	170	130	**300**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**170**	**130**	**300**

	I-5 Raise and Widen only, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	0	**0**
Buildings No Longer Flooded[4]	360	40	**400**

What are the potential impacts to natural resources?

Alternative 2 would impact wetlands and cultural resources due to the excavation and fill necessary to raise I-5, and require stormwater treatment. Most wetland impacts would likely be mitigated for at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 2 may impact fish passage at these crossings due to the length of culverts needed to protect I-5, but there are mitigation opportunities nearby. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish passage at these locations.

Noise analysis may show there would be an increase in noise levels in surrounding neighborhoods. This would only be slightly more of an increase than if I-5 were only widened and not raised. A noise analysis would determine if any noise mitigation (such as noise walls) would be appropriate.

[4] Language edited for clarity on 8-20-12

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. In addition, as with Alternative 1, the natural resource impacts anticipated for Alternative 2 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes; therefore, these impacts likely will occur regardless of whether Alternative 2 is constructed.

How much does the project cost?

Alternative 2 has an estimated total cost of $450-550 million. To widen I-5 only would cost $250-350 million; to raise I-5 only would cost $350 - $450 million.

Does the project protect the Chehalis-Centralia Airport?

No, Alternative 2 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

Yes. Alternative 2 includes both raising and widening I-5 because WSDOT determined that it is not cost effective to only raise I-5 and defer widening. Both raising and widening I-5 would require reconstruction of the 13th Street, State Route 6, and Chamber Way Interchanges, and West Street bridge. Raising and widening at the same time prevents rework in these areas and increased costs.

The cost range to only raise I-5 as part of one project (i.e. rebuild four lanes at higher level) is $350-450 million.

The cost range to raise and widen I-5 (i.e. rebuild six lanes at higher level) is $450-550 million.

The cost range to only raise I-5 today is $350-450 million as noted above. The cost range to widen I-5 through a separate future project, after I-5 is raised, is $120-170 million. The total cost of raising I-5, then widening I-5 as a separate project is $470–620 million. This means it would cost an additional $20-70 million to raise and widen separately.

Raising I-5 requires a complete rebuild of the interstate for the full width of 88 feet (four lanes and four shoulders). This includes stormwater treatment, illumination, pavement, concrete barrier, and all other elements of the Interstate. Although a raise only project would not widen I-5 to six lanes, where possible, it would likely construct various elements to accommodate future widening to six lanes. For example, the bridges over I-5 at SR 6 and Chamber Way would be built long enough to accommodate a six lane I-5. Overbuilding these structures as part of raising I-5 would require more upfront costs. However, it would avoid costly demolition and reconstruction as part of a future widening project.

Raising and widening I-5 at the same time also requires a complete rebuild of the interstate to a width of 112 feet (six lanes and four shoulders). It also requires stormwater treatment, illumination, pavement, concrete barrier, and all other elements of the interstate. Since all of these facilities must be rebuilt whether I-5 is four lanes or six, widening adds only the costs associated with the additional 24 feet of width for two more lanes.

Although various structures (i.e. bridges over I-5 at SR 6 and Chamber Way) would be constructed to accommodate a future six lanes, returning at a later date to widen I-5 to six lanes after only raising it could require the tear out and reconstruction of portions of stormwater facilities, illumination, and various other elements, and would include another round of traffic control costs, temporary walls, temporary water treatment, etc. At each interchange, a portion of all four ramps would need to be constructed to properly tie into the new lanes added on the outside of I-5.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 2 improves access to the hospital if drivers can reach I-5 from the south or from the north.

Would the project change if a dam were to be built on the upper Chehalis?

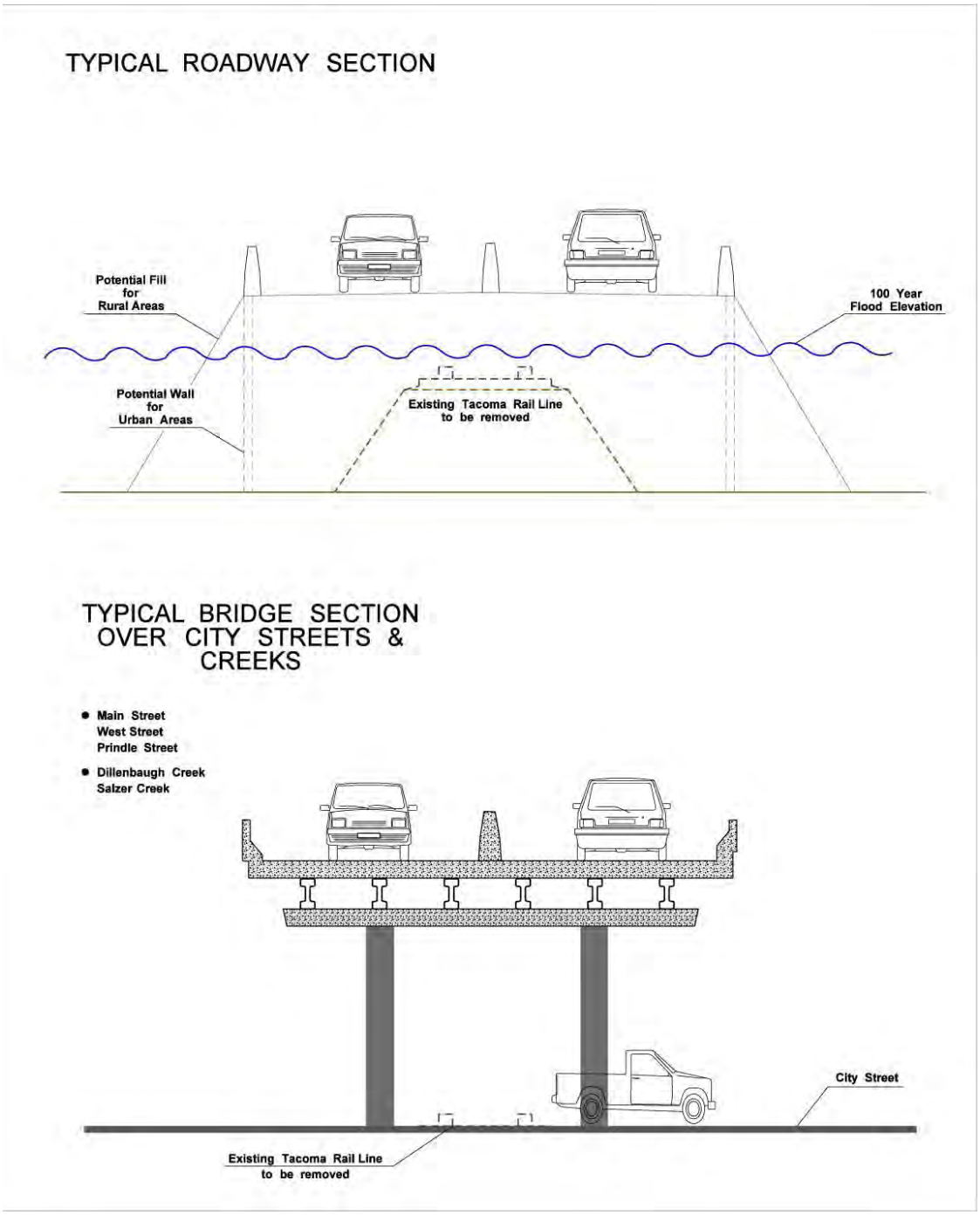
Yes. Because a dam would lower flood levels in the project area, WSDOT would not need to raise I-5 quite as high, would use less fill material, and create a smaller overall footprint. The total cost of the project would drop approximately five to ten percent.

ALTERNATIVE 3: I-5 Express Lanes

Alternative 3 would construct new express lanes adjacent to I-5. Express lanes would be four miles in length and one lane in each direction, constructed a minimum of three feet above the 100-year flood elevations. This would provide traffic the opportunity to bypass I-5 if the main interstate was closed by major floods. Outside of any flood events, express lanes also would be available to traffic 24 hours a day, seven days a week.

The express lanes would diverge from I-5 at 13th Street, and then follow the existing Tacoma Rail line through Chehalis, with bridges over West, Prindle, and Main streets in Chehalis. To minimize right-of-way acquisition and impacts to adjacent properties, the lanes would be built on fill material with side slopes in rural areas and would be built on fill material contained by walls in urban areas. Figure 3 provides a cross-section view of the typical roadway section and typical bridge section over city streets and creeks for Alternative 3.

Figure 3: Cross Section View of I-5 Express Lanes or Temporary Bypass



For the most part, the Tacoma Rail line runs through the industrial area of Chehalis. However, the lanes likely would be visible from some homes on the edge of the West neighborhood in Chehalis. A noise study has not been conducted yet, but cost estimates for the project include funding for noise walls in the event they are needed.

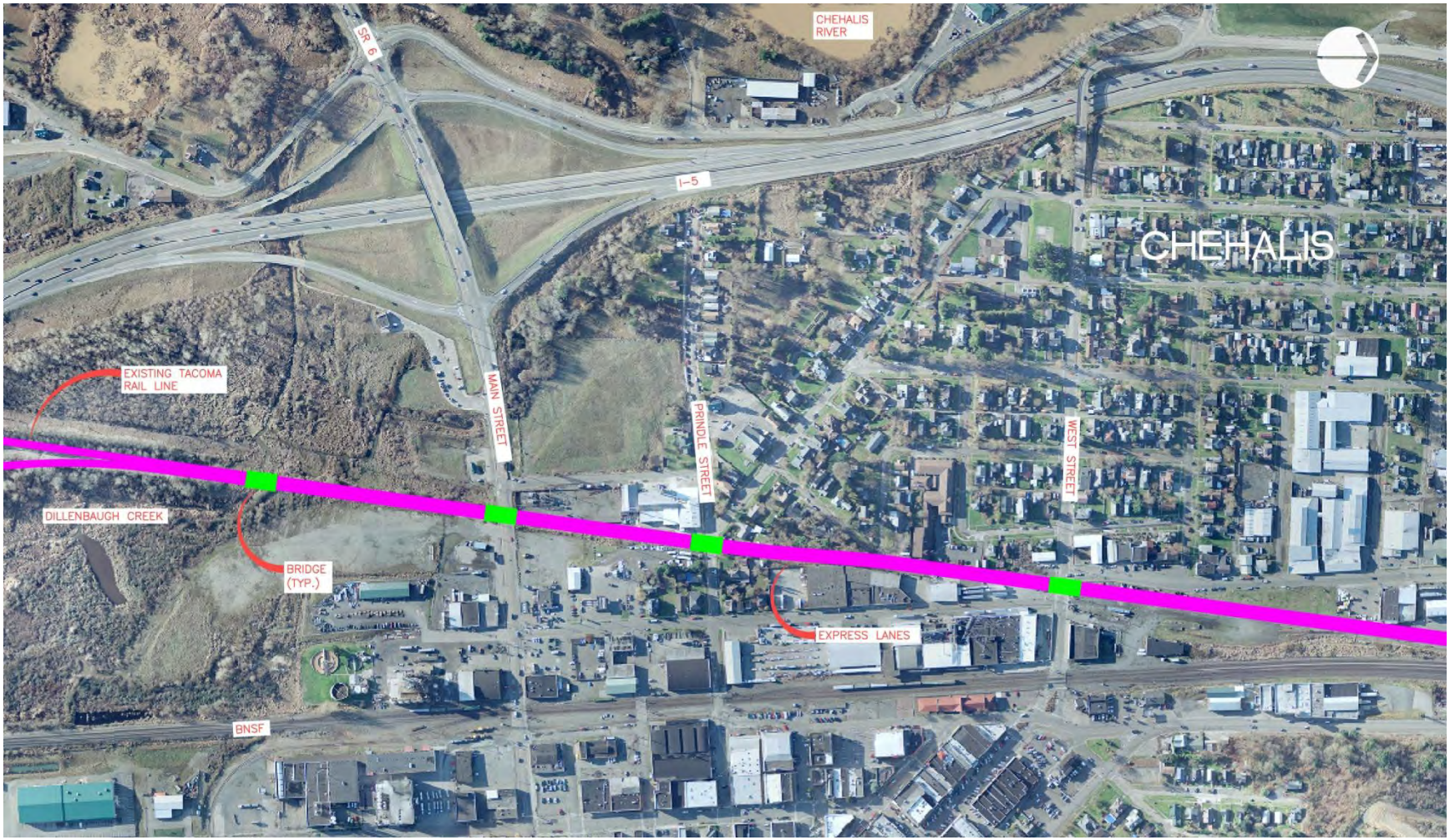
There are significant uncertainties with the express lanes. Perhaps most importantly, it is not known whether the City of Tacoma would sell the Right-of-Way along the Tacoma Rail line, and, if they would sell, at what cost. The express lanes would not provide local access to I-5 between 13th Street and Mellen Street. The City of Chehalis has expressed strong concerns about the express lanes alternative and its potential effects on the community.

Alternative 3 does not include raising the Chehalis-Centralia Airport Levee or building a new SW Chehalis Levee. These elements could be added to the project or constructed independently to provide additional flood protection. If express lanes are constructed, they would eliminate the need to widen I-5 in the future, saving $250-350 million.

A detailed map showing an overview and close-up view of the express lanes is provided in Figures 4 and 5.

Figure 4: Alternative 3 – I-5 Express Lanes Overview

Figure 5: Alternative 3 – I-5 Express Lanes Close-up Detail



How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 3 would decrease water surface elevations east of I-5, generally between 0.4 and 1.1 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to increase generally between 0.0 and 0.6 feet.

In a simulated 100-year flood event, Alternative 3 would decrease water surface elevations east of I-5, particularly the developed area between Salzer Creek and Mellen Street, generally between 0.6 and 0.9 feet, but by as much as 1.5 feet in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to increase generally between 0.1 and 0.6 feet.

Appendix D provides a detailed map showing representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the depth of flooding were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 3 would lower flood elevations at 700 residences and 190 commercial buildings generally east of I-5. Of these, 290 residences and 30 commercial buildings would no longer be flooded. Alternative 3 would raise flood levels at a total of 80 residences and 90 commercial buildings located mostly west of I-5, and 10 additional buildings would be newly flooded. Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 5 summarizes and rounds the results of the structure analysis conducted in August 2012.

Table 5: Flood Mitigation in Twin Cities Area by Alternative 3

	I-5 Express Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	0	0	**0**
-2 to -1	290	20	**310**
-1 to 0	410	170	**580**
Sum Decreased Flooding	**700**	**190**	**890**
0 to 1	80	90	**170**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**80**	**90**	**170**

	I-5 Express Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
	I-5 Express Lanes, Dec 07 Event		
	Residence	**Commercial**	**Total**
Newly Flooded Buildings	0	10	**10**
Buildings No Longer Flooded[5]	290	30	**320**

What are the potential impacts to natural resources?

Alternative 3 would impact wetlands and cultural resources due to the excavation and fill necessary to construct the lanes on top of fill, bridges over existing city streets and stormwater treatment. Most wetland impacts would likely be mitigated for at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 3 would construct an additional stream crossing at both creeks. These would be short enough that fish passage should not be compromised. If needed, there are mitigation opportunities in the area. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish at these locations.

Noise analysis may show there would be an increase in noise levels in surrounding neighborhoods. A noise analysis would determine if any noise mitigation (potentially noise walls) would be appropriate.

There may be hazardous materials to address in the industrial area of the Tacoma Rail line. Removal may not be required since the lanes would be built on top of fill material.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. As with Alternatives 1 and 2, the natural resource impacts anticipated for Alternative 3 are essentially the same as those that would occur from anticipated (pending funding) future widening of I-5 to six lanes; therefore, these impacts likely will occur regardless of whether Alternative 3 is constructed.

[5] Language edited for clarity on 8-20-12

How much does the project cost?

The estimated cost of Alternative 3 is $120 – 150 million, not including the cost for the Tacoma Rail line property.

Does the project protect the Chehalis-Centralia Airport?

No. Alternative 3 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. Therefore, those areas are not protected. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

Yes. Alternative 3 would provide the capacity needed to prevent traffic congestion on I-5. Therefore, it would eliminate the need to spend $250-350 million on a future widening project.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 3 improves access to the hospital if drivers can reach I-5 from the south or from the north.

Would the project change if a dam were to be built on the upper Chehalis?

Yes. Because a dam would lower flood levels in the project area, WSDOT would be able to reduce the height of the express lanes in the floodplain area only. The total cost of the project would be reduced by two to five percent.

ALTERNATIVE 4: I-5 Temporary Bypass

Alternative 4 would construct temporary bypass lanes adjacent to I-5. Similar to the express lane alternative, the bypass lanes would diverge from I-5 at 13th Street, and then follow the existing Tacoma Rail line through Chehalis, with bridges over West, Prindle, and Main Streets. The lanes would be built on fill material with side slopes in rural areas and would be built on fill material contained by walls in urban areas to minimize right-of-way acquisition and impacts to adjacent properties.

The bypass lanes would be four miles in length and one lane in each direction, constructed a minimum of three feet above the 100-year flood elevations. This would provide a local bypass opportunity if the main part of I-5 were to be closed by major floods. Because the bypass lanes would only be used during major flood events, they would not eliminate the need to widen I-5 in the future. In addition, the connections to and from I-5 could be built at the ground level (unlike express lanes which would require

high speed flyover ramps). See Figure 3 in the Alternative 3 section for a cross-section view of the typical roadway section and typical bridge section over city streets and creeks for temporary bypass lanes.

There are significant uncertainties with the bypass lanes. Perhaps most importantly, it is not known whether the City of Tacoma would sell the right-of-way along the Tacoma Rail line and, if so, at what cost. The temporary bypass would not provide local access to I-5 between 13th Street and Mellen Street. The City of Chehalis has expressed strong concerns about the bypass alternative and its potential effects on the community.

Alternative 4 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. These elements could be added to the project or constructed independently to provide additional flood protection.

A detailed map showing an overview and close-up view of the temporary bypass is provided in Figures 6 and 7.

Figure 6: Alternative 4 - I-5 Temporary Bypass Overview

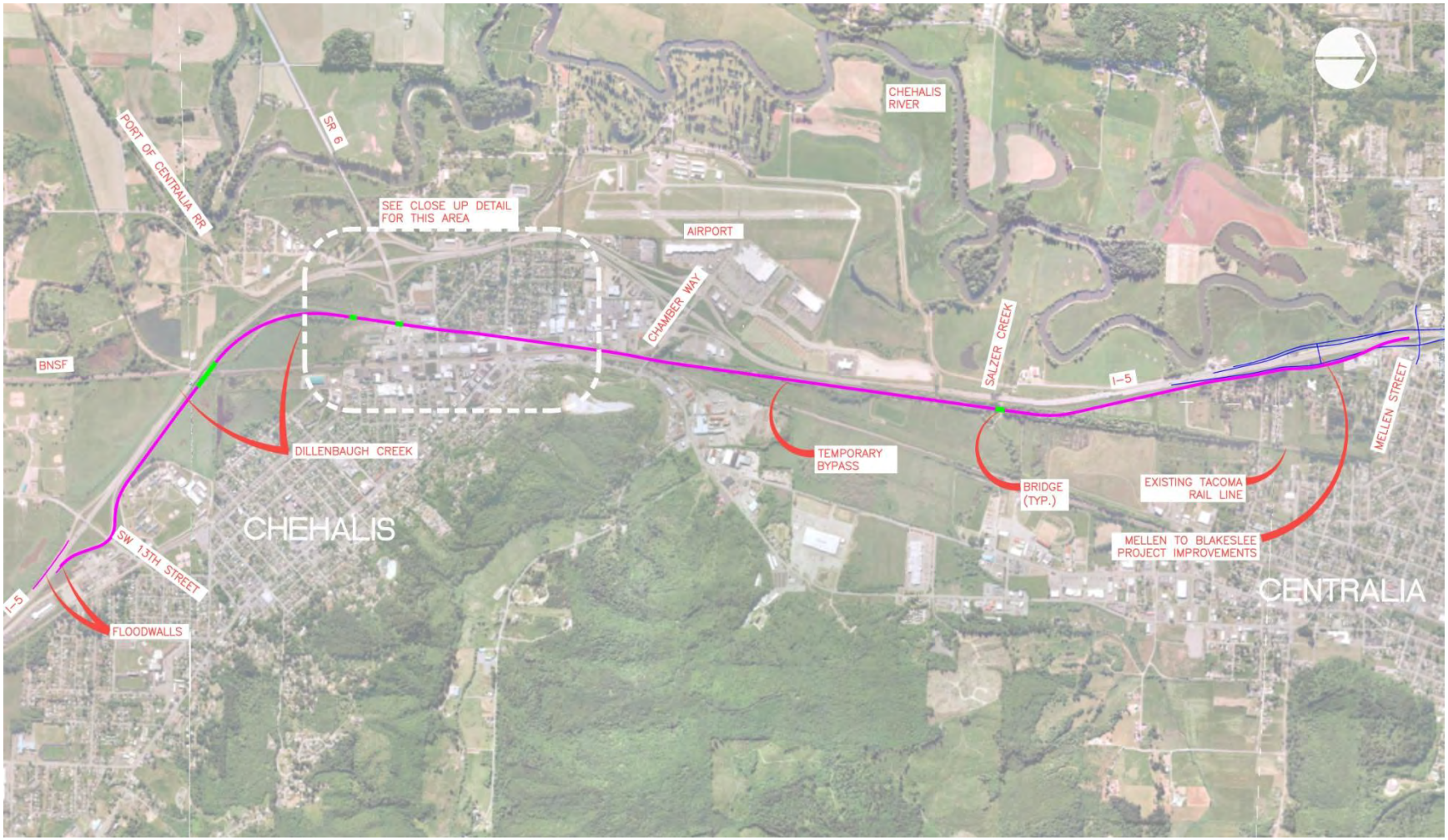


Figure 7: Alternative 4 - I-5 Temporary Bypass Close-up

How does the project increase or decrease flood levels in the nearby areas?

In a 2007 flood event, Alternative 4 would decrease water surface elevations east of I-5, generally between 0.4 and 1.1 feet. In the area west of I-5, which is more rural, water surface elevations are predicted to increase by generally 0.0 and 0.6 feet.

In a simulated 100-year flood event, Alternative 4 would decrease water surface elevations east of I-5, particularly the developed area in Centralia and along the Miracle Mile, generally between 0.6 and 0.9 feet, but by as much as 1.5 feet in some locations. In the area west of I-5, which is closer to the river and more rural, water surface elevations are predicted to increase generally between 0.1 and 0.6 feet.

Appendix E provides a detailed map showing representative changes in peak Water Surface Elevation (WSEL) throughout the project area in a 2007 and simulated 100-year flood event. The model simulations for determining the depth of flooding were conducted in July 2012.

How does the project impact surrounding residences and commercial buildings?

Based on a preliminary analysis, in events such as the 2007 flood Alternative 4 would lower flood elevations at 710 residences and 190 commercial building generally east of I-5. Of these, 290 residences and 30 commercial buildings would no longer be flooded. Alternative 4 would raise flood levels at a total of 80 residences and 90 commercial buildings located mostly west of I-5, and an additional 10 buildings would be newly inundated. Increases in flood elevation would need to be addressed through mitigation measures such as raising buildings, moving buildings, buyouts, and other measures. Project cost estimates include funding for these mitigation measures. Table 6 summarizes and rounds the results of the structure analysis conducted in August 2012.

Table 6: Flood Mitigation in Twin Cities Area by Alternative 4

	I-5 Bypass Lanes, Dec 07 Event		
Change in Water Surface Elevation (WSEL) (ft)	**Residence**	**Commercial**	**Total**
<-2	0	0	**0**
-2 to -1	290	20	**310**
-1 to 0	420	170	**590**
Sum Decreased Flooding	**710**	**190**	**900**
0 to 1	80	90	**170**
1 to 2	0	0	**0**
>2	0	0	**0**
Sum Increased Flooding	**80**	**90**	**170**

Change in Water Surface Elevation (WSEL) (ft)	I-5 Bypass Lanes, Dec 07 Event		
	Residence	Commercial	Total
	I-5 Bypass Lanes, Dec 07 Event		
	Residence	Commercial	Total
Newly Flooded Buildings	0	10	**10**
Buildings No Longer Flooded[6]	290	30	**320**

What are the potential impacts to natural resources?

Alternative 4 would impact wetlands and cultural resources due to the excavation and fill necessary to construct the lanes on top of fill, bridges over existing city streets and stormwater treatment. Most wetland impacts would likely be mitigated at WSDOT's North Fork Newaukum Mitigation Bank. Any adverse affects to cultural resources would be addressed through consultation with interested parties.

There are no Endangered Species present in Dillenbaugh Creek or Salzer Creek. Alternative 3 would construct an additional stream crossing at both creeks. These would be short enough that fish passage should not be compromised. If needed, there are mitigation opportunities in the area. WSDOT would continue to work with the Washington Department of Fish and Wildlife (WDFW) to determine how to address and minimize any impacts to fish at these locations.

Since the bypass lanes would be used only during flood events, the increase in noise levels in surrounding neighborhoods would be for such a short duration that a noise analysis would likely determine no noise mitigation was necessary.

There may be hazardous materials to address in the industrial area of the Tacoma Rail line. Removal may not be required since the lanes would be built on top of fill material.

Based on WSDOT's initial investigation, there appear to be no fatal flaws that would prevent this alternative from moving forward. The natural resource impacts anticipated for Alternative 4 are similar to those anticipated for Alternative 3.

How much does the project cost?

The estimated cost of Alternative 4 is $70 - 90 million, not including the cost for the Tacoma Rail line property.

[6] Language edited for clarity on 8-20-12

Does the project protect the Chehalis-Centralia Airport?

No, Alternative 4 does not include raising the Chehalis-Centralia Airport levee or building a new SW Chehalis levee. Therefore, those areas are not protected. These elements could be added to the project or constructed independently to provide additional flood protection, but they were not included in cost estimates for this alternative.

Does the project address future widening of I-5?

No, Alternative 4 does not address the need to widen I-5 in the future.

Does the project improve access to the hospital in Centralia?

Yes. In a flood event up to the 2007 level, Alternative 4 improves access to the hospital if drivers can reach I-5 from the south or from the north.

Would the project change if a dam were to be built on the upper Chehalis?

Yes. Because a dam would lower flood levels in the project area WSDOT would be able to reduce the height of the bypass lanes in the floodplain area only. The total cost of the project would be reduced by approximately two to five percent.

ALTERNATIVE 5: I-5 Viaduct

Alternative 5 would construct a viaduct by elevating I-5 on piers from south of State Route 6 to Mellen Street. This project would widen I-5 to six lanes and require reconstruction of all interchanges in the project area. WSDOT determined that widening should be included in any viaduct project because it would be completely ineffective to build only four lanes when six are needed to serve capacity.

The viaduct alternative has an estimated cost of more than $1.5 billion. It would reduce flood elevations west of I-5 along the Chehalis River, but would increase flood elevations east of I-5 in the urban area of Centralia. For these reasons, WSDOT does not consider this project a feasible alternative and did not evaluate the project in further detail.

ALTERNATIVE 6: I-5 Relocation

Alternative 6 would relocate I-5 outside of the flood area. The project would build a six-lane I-5, and would require constructing new interchanges in the project area.

The relocation alternative has an estimated cost of more than $2 billion. Relocating I-5 would diverge outside of the existing interstate and cut through Centralia and Chehalis, splitting neighborhoods and

impacting the urban and natural environment in and around both cities. For these reasons, WSDOT does not consider this project a feasible alternative and did not evaluate the project in further detail.

Side by Side Project Comparisons

Table 7: Side-by-side Project Comparison of Alternatives

Alternative	Impacts to Buildings**				Protect Airport & SW Chehalis	Ability to Meet Future I-5 Capacity Needs	Cost of Alternative *(A)*	Cost of Future I-5 Widening After Alternative is Constructed *(B)*	Total Cost of Alternative Plus Cost to Meet Future I-5 Capacity Needs *(C)* *A + B = C*
	100 Year Flood Event		2007 Flood Event						
	Positive	*Negative*	*Positive*	*Negative*					
1. I-5 Walls and Levees, Raise Airport Levee, New Chehalis Levee	510	140	1030	140	Y	Future widening required. Allows for widening.	$80 to 100 Million	$225 to 330 Million	$305 to 430 Million
2. I-5 Raise and Widen Only	430	240	840	300	N*	Provides widening of I-5.	$450 to 550 Million	$0	$450 to 550 Million
3. I-5 Express Lanes	390	180	890	170	N*	Provides capacity, future widening unnecessary.	$120 to 150 Million	$0	$120 to 150 Million
4. I-5 Temporary Bypass	400	150	900	170	N*	Future widening required. Allows for widening.	$70 to 90 Million	$250 to 350 Million	$320 to 440 Million
5. I-5 Viaduct	***	***	***	***	N*	Replaces I-5 with new facility with sufficient capacity.	Greater than $1.5 Billion	$0	Greater than $1.5 Billion
6. I-5 Relocation	***	***	***	***	N*	Replaces I-5 with new facility with sufficient capacity.	Greater than $2 Billion	$0	Greater than $2 Billion

* Chehalis - Centralia Airport Levee or new SW Chehalis Levee could be added to this alternative or constructed as an independent project.

** The positive or negative '*Impacts to Buildings*' indicates the total predicted number of buildings experiencing decreased (positive) or increased (negative) flood elevations resulting from the alternative.

*** *'Impacts to Buildings'* analysis was not conducted as this Alternative was deemed not viable for further analysis.

Conclusions and Next Steps

There are a variety of approaches that could be used to protect I-5 from flooding. Due to time and funding constraints, WSDOT has done a limited amount of design work to define and evaluate these approaches. If the legislature or others decide any of these alternatives warrant further consideration, more effort would be needed to define, refine, and evaluate them. This would include additional work to refine the analysis done to identify potential impacts to buildings in the floodplain.

Some of these alternatives could be considered in conjunction with other solutions in the Chehalis Basin, like a dam or flood bypasses. If so, these alternatives would be refined to be more compatible with the other solutions.

- **Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee** – provides protection of I-5 and the Chehalis-Centralia Airport in flood events up to the 2007 or simulated 100-year flood level. It improves conditions for approximately 1030 buildings, but has a negative impact for approximately 140 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum Creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. Alternative 1 does not address the need to widen I-5 in the future. Alternative 1 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation elements in the Chehalis Basin.

- **Alternative 2: I-5 Raise and Widen Only** – provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 840 buildings, but has a negative impact for approximately 300 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum Creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. Alternative 2 does address the need to widen I-5 in the future. Alternative 2 appears to warrant further consideration as an independent project or in combination with other flood hazard mitigation elements in the Chehalis Basin.

- **Alternative 3: I-5 Express Lanes** - provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 890 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum Creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, such whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost. However, Alternative 3 does address the future

need to widen I-5, and provides a significant cost savings over other widening approaches. If Alternative 3 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 4: I-5 Temporary Bypass** - provides protection of I-5 in flood events up to the 2007 or simulated 100-year flood level, but does not provide, or preclude, protection of the Chehalis-Centralia Airport. It improves conditions for approximately 900 buildings, but has a negative impact for approximately 170 buildings on the west side of I-5 near the Chehalis River and along Dillenbaugh and Newaukum Creeks. These negative impacts can be mitigated and funding for mitigation is included in the cost estimates for this alternative. There are significant uncertainties with this alternative, such whether the City of Tacoma would sell the right-of-way to the Tacoma Rail line and, if so, at what cost. Alternative 4 does not address the future need to widen I-5. If Alternative 4 is to warrant further consideration, more work is required to determine feasibility.

- **Alternative 5: I-5 Viaduct.** WSDOT does not consider this a viable alternative due to high costs and increased flood elevations in the urban areas of Centralia.

- **Alternative 6: I-5 Relocation.** WSDOT does not consider this a viable alternative due to high costs and impacts to the built and natural environment surrounding Chehalis and Centralia.

WSDOT encourages comments on this draft report. ***Please submit comments by Friday, August 31, 2012.***

Email: melissa.kuehne@wsu.edu

Postal mail: Melissa Kuehne,
Ruckelshaus Center, WSU West
520 Pike Street, Suite 1101
Seattle, WA 98101

All comments received will be taken into consideration as the report is finalized and included in an appendix to the final report. The final report is expected to be available in late September, in conjunction with the Ruckelshaus Center flood hazard mitigation alternatives report.

Appendix A:
Determining the right measurement for I-5 flood protection

Any major investment in flood protection must ensure that it will actually be effective in avoiding flooding and an I-5 closure under a wide range of events and potential future conditions (development, land use, climate change, etc.).

To accomplish this, WSDOT determined the distance needed from the calculated water surface during a flood to the top of the flood hazard mitigation element, to provide robust, reliable protection for I-5 and the Chehalis-Centralia Airport. This measurement is called "freeboard."

It is extremely important to identify the right measurement for freeboard. The right amount of freeboard will provide confidence that, no matter what flood protection measures the legislature directs WSDOT to build, they provide protection for predicted floods in the project area.

WSDOT determined that freeboard must be three feet above the 100-year flood level (a minimum of one foot above the 2007 flood level in the Chehalis-Centralia area). This measurement was established through analysis by WSDOT's State Hydraulic Office as sufficient to cover a potential future water flow increase of 25 percent, given variables within the Chehalis River Basin due to development, land use, climate change, etc. This measurement would have protected I-5 in the 2007 flood, which was in excess of a 100-year flood event. See Appendix A.1 for a technical memorandum on WSDOT's hydrologic and hydraulic analysis to determine freeboard.

The following factors contributed to WSDOT's determination of freeboard:

- *Safety and economic risks* – in particular, there are significant safety risks if I-5 were to be inundated;
- *The size of the investment* – any investment to protect I-5 will be substantial and there should be confidence that it will reliably prevent I-5 closures;
- *Frequency and variability of flood events in the Chehalis River Basin* – each flood event is different, and I-5 protection must work across the full range of event types;
- *Difficulty precisely predicting flood levels and complexity of flood hydrology* – because of its landscape and proximity to multiple water sources, there is significant variability in how flooding occurs in the Centralia-Chehalis area. When flooding predictions raise a serious risk that I-5 may be overtopped, safety concerns prompt a conservative decision about closing I-5. In addition to the threat of overtopping, serious concerns over the structural integrity of the Airport levee

have contributed to decisions to close I-5. During the last flood events there have been significant boils developing near the levee; these can cause the levee to breach instantly which would fully inundate I-5 very quickly, posing a serious safety risk; and,

- *Time required to close I-5* – because it takes time to safely and effectively close I-5, decisions to close the interstate must be made well in advance of potential flooding impacts.

Safety and Economic Risks

I-5 is vital to the state's economy and acts as the West Coast's major north-south transportation corridor. The uninterrupted movement of cars, trucks, freight, and recreational vehicles along I-5 is essential to the quality of life and economic vitality in the region. Interruption of I-5 significantly affects the economy of Washington State and the West Coast.

The stretch of I-5 at Centralia-Chehalis is a midpoint between Seattle, Washington and Portland, Oregon. It connects two of the West Coast's major population and industrial centers, making it the most crucial transportation link in the area.

I-5 near the Chehalis-Centralia Airport levee (and Chamber Way fill) is a low spot in the area. The Interstate is at least six to seven feet below the top of the levee, and significantly lower than other portions of I-5 and the surrounding area. It can easily and quickly accumulate deep floodwaters if any nearby part of the interstate is inundated, presenting obvious and significant safety challenges to drivers. This risk of rapid and deep inundation of I-5, from overtopping of the Airport levee or due to a structural failure of the levee, prompts WSDOT to take a conservative approach to ensuring that I-5 is fully and effectively closed whenever there is serious potential for inundation and well before there is any water actually on or across the interstate.

The Size of the Investment

Any investment to protect I-5 will be substantial and there should be confidence that it will reliably prevent I-5 closures. Therefore, WSDOT must determine a measurement for freeboard that ensures robust protection.

Frequency and Variability of Flood Events in the Chehalis River Basin

Over the past 25 years, the stretch of I-5 from 13th Street to Mellen Street has closed four times due to flooding. The 1990 flood event in the Chehalis Basin closed I-5 for one day; the February 1996 and December 2007 flood events closed I-5 for four days each; and the January 2009 flood event closed this stretch of I-5 for two days. Each flood event has been unique and their effects difficult to predict with precision.

In February 1996 the flood was the result of a large frontal storm with very broad rainfall from north of Seattle to southern Oregon; in December 2007 the storm was concentrated in the Willapa Hills in the upper Chehalis Basin; and in January 2009 the storm focused on the eastern and northern portions of the Chehalis Basin. Each of these storms was different in how it contributed to the flooding of I-5, and the uncertainties of development, land use, and climate change and how that may affect future flood events, require WSDOT to be conservative when determining freeboard (see Appendix A.1). The factor WSDOT uses must be conservative enough to ensure protective measures will remain feasible across the full range of event types and well into the future.

Difficulty Precisely Predicting Flood Levels and Complexity of Flood Hydrology

I-5 protection in Chehalis and Centralia must consider the complex hydrology of the area. I-5 can be reached by floodwaters from multiple sources, and the low spot near Chamber Way accumulates deep floodwaters easily and quickly.

During major flood events, WSDOT follows the National Oceanic and Atmospheric Administration Northwest River Forecast Center (NWRFC) hydrograph predictions to monitor the potential for I-5 to be flooded. Of particular concern are predicted flood levels near the Airport levee, which keeps the low spot near Chamber Way from quickly inundating.

The height of the Airport levee is close to the height of recently predicted flood elevations. NWRFC hydrographs predicted that the levee would be overtopped in the 1996, 2007, and 2009 storm events, and I-5 was closed in each of those instances. However, the levee was actually overtopped in only the 1996 and 2007 events. In 2009, NWRFC hydrographs predicted that the Airport levee would overtop by two feet on January 8, leading WSDOT to close I-5 from January 6 – 9 (43 hours), to ensure drivers would be evacuated before any water reached the interstate. Although a wholesale overtopping did not occur, floodwaters in 2009 did rise to the top of the Airport levee and flowed across the southwest corner of the levee.

As long as the Airport levee remains such a key part of the flood protection system for I-5, it will continue to be necessary to close the interstate whenever there is serious potential for the levee to fail or be overtopped.

It is important to note that, even if the Airport levee were raised, it still would not prevent water from flooding I-5. The levee only protects I-5 from the west, and flood waters can and do encroach on the interstate from the other three directions. In 1996 and 2007, I-5 was covered by floodwaters from the west, over the Airport levee, while at the same time backwater from the Chehalis River via the Salzer Creek Basin flooded I-5 from the east.

Time Required to Close I-5

Closing I-5 in the Centralia-Chehalis area is a complex and challenging undertaking. When I-5 is anticipated to be flooded between 13th and Mellen streets, (exits 76 and 81), WSDOT closes I-5 at the US 12 interchanges (exits 68 and 88). WSDOT then uses US 12 as the major detour route.

The US 12 interchanges were chosen as closure points in part because they are far enough away from Chehalis and Centralia that diverting traffic there minimizes the potential for thousands of interstate drivers to exit onto the limited number of local city streets in Chehalis, Centralia, and Lewis County. Limiting congestion on local streets is especially vital during major flood events, as the streets are needed for critical emergency relief and rescue operations.

Closing I-5 at the US 12 interchanges means WSDOT must block off the main interstate lanes and 10 separate interchanges at exits 68, 71, 72, 74, 76, 77, 79, 81, 82 and 88 to prevent traffic from entering I-5 in the closed area. This must be accomplished well before I-5 is inundated by floodwaters to ensure WSDOT's ability to safely evacuate drivers and move personnel and equipment into the affected area. The early flooding of some local streets adds to the difficulty of moving drivers out and resources in.

Figures 1-3 illustrate the comparison of levee heights that meet WSDOT's freeboard requirement in the vicinity of the Chehalis-Centralia Airport, Salzer Creek, and Main Street/SW Chehalis Avenue in a with and without dam scenario.

Figure 1: Comparison of Levee Heights in Vicinity of Chehalis-Centralia Airport – With and Without Dam

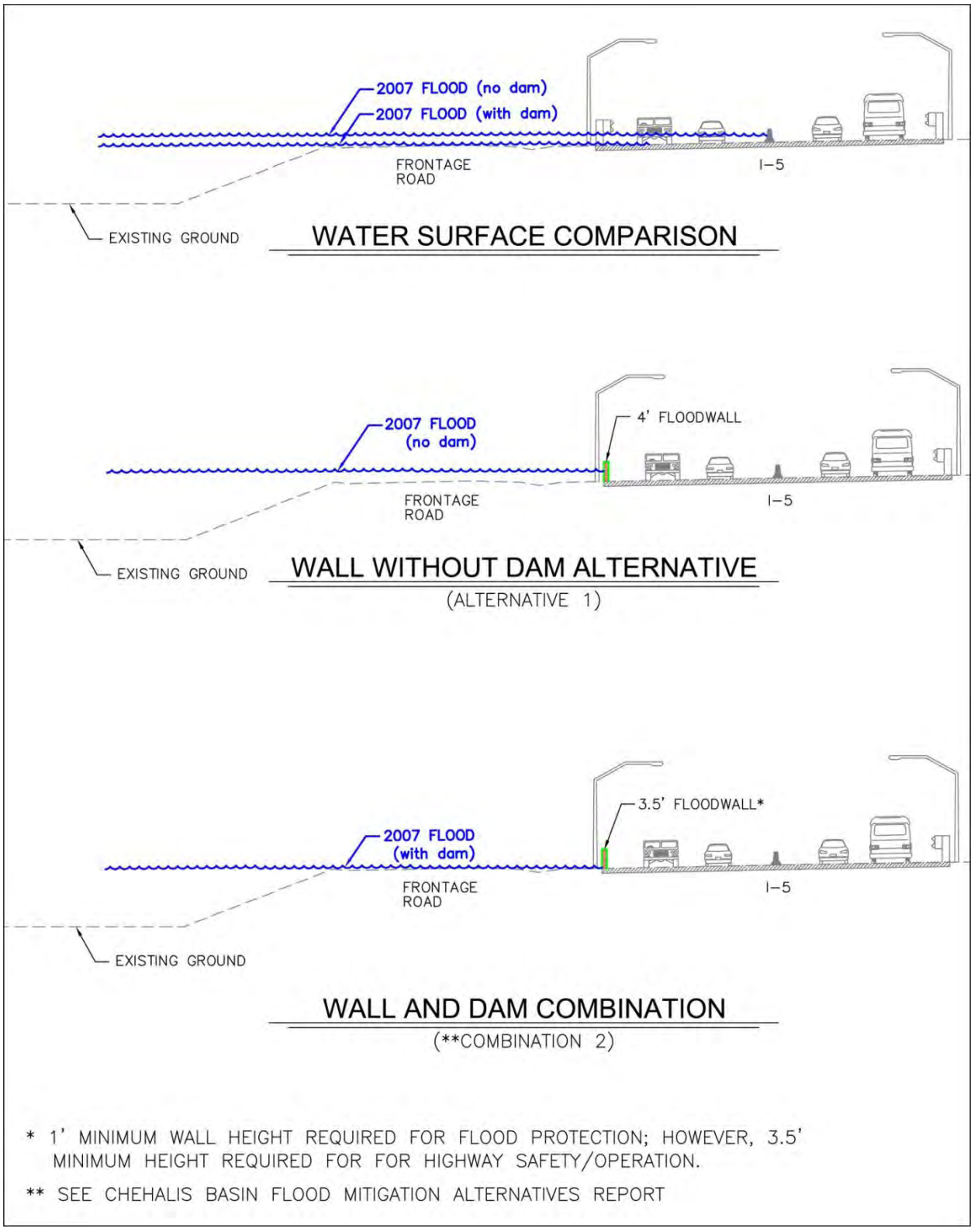


Figure 2: Comparison of Levee Heights in Vicinity of Salzer Creek – With and Without Dam

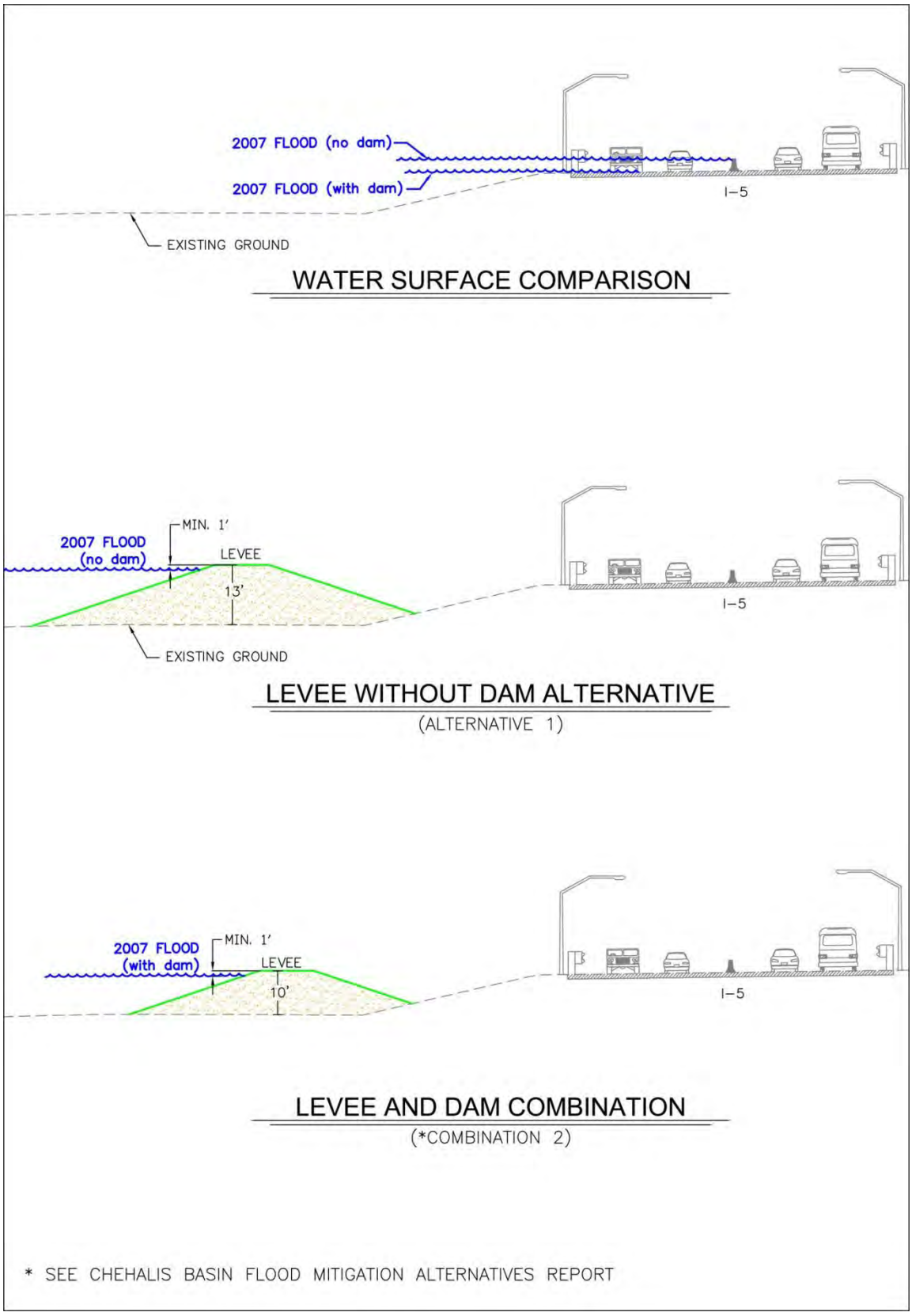
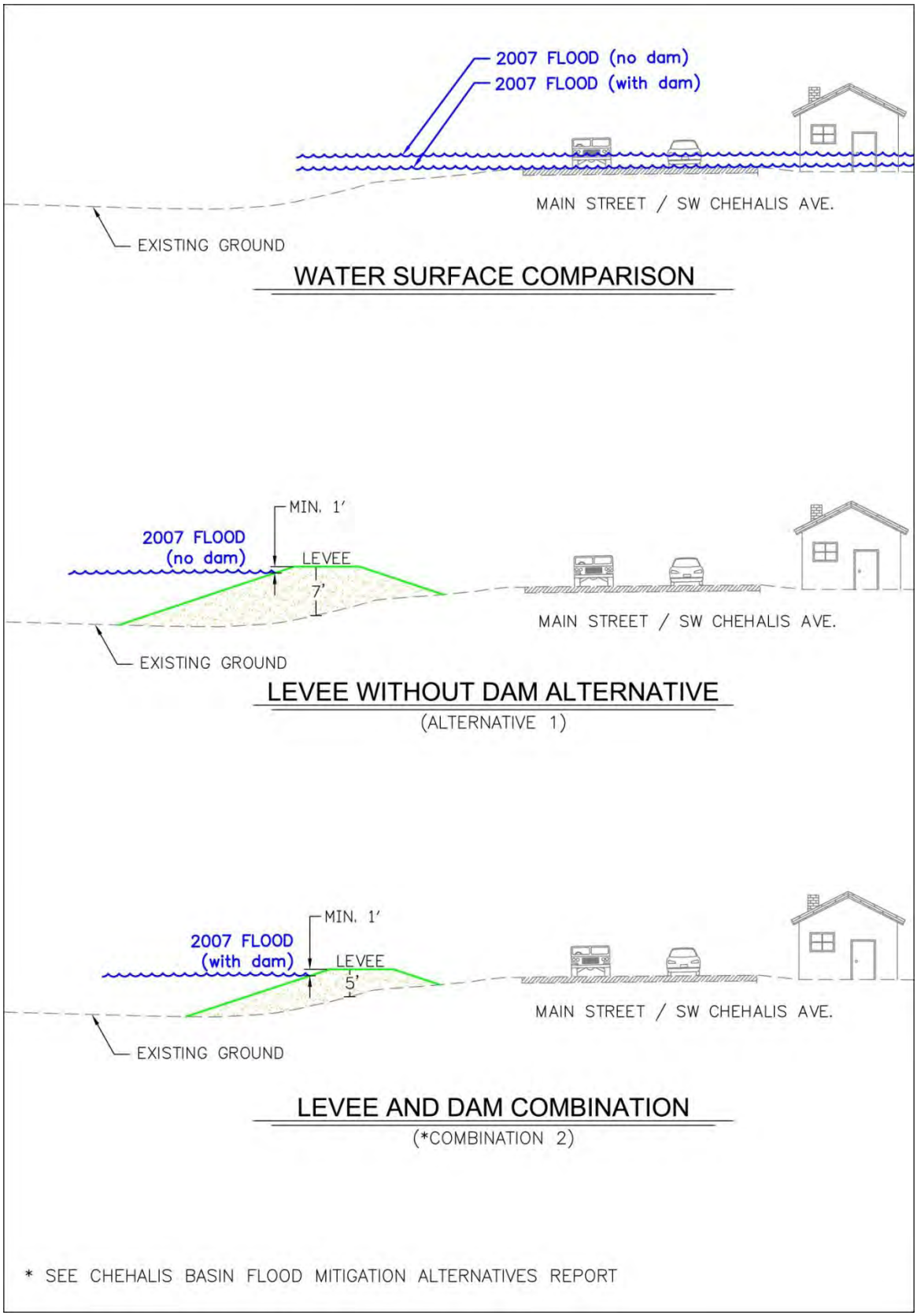


Figure 3: Comparison of Levee Heights in Vicinity of Main Street/SW Chehalis Avenue – With and Without Dam



Appendix A.1:

WSDOT - ESHB 2020 Hydrologic and Hydraulic Analysis

Memorandum

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

To: Bart Gernhart, SWR Assistant Regional Administrator

From: Casey Kramer, State Hydraulic Engineer / Katie Mozes, Hydraulic Designer

Date: 8/8/2012

Re: Engrossed Substitute House Bill 2020 Hydrologic and Hydraulic Analysis

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As requested, a detailed hydrologic and hydraulic analysis was completed to understand how flood frequency events have changed over time in the Chehalis River Basin. In 2011, the Washington State Legislature required the Office of Financial Management (OFM) to provide a report to the governor and legislature that identifies flood hazard mitigation projects in the Chehalis River Basin (Engrossed Substitute House Bill 2020 [ESHB 2020], Section 1033). This memorandum summarizes the analyses conducted by the Washington State Department of Transportation (WSDOT) to determine an acceptable freeboard height for flood hazard mitigation elements within Centralia and Chehalis, in accordance with ESHB2020.

Introduction

In the Chehalis River Basin flooding is a common occurrence often damaging infrastructure in the surrounding cities. ESHB 2020, Section (2) (c) mandates the WSDOT to "evaluate alternative projects that could protect the interstate highway and the municipal airport at Centralia and Chehalis, and ensure access to medical and other critical community facilities during flood events". In order to complete the analysis, it is important for the WSDOT to better understand the hydrology and hydraulics in the basin to determine the amount of freeboard necessary to account for potential increases in flow over time. The analysis included two main tasks, specifically a hydrologic analysis and hydraulic modeling. Each will be discussed separately in the following paragraphs.

Engineering Analysis

Hydrologic Analysis

The hydrologic analysis investigated peak flows at several United States Geological Survey (USGS) stream gages in the project area. The gages considered were the Chehalis River near Doty, WA (USGS 12020000), Chehalis River near Grand Mound, WA (USGS 12027500), Newaukum River near Chehalis, WA (USGS 12025000), and the Skookumchuck River near Bucoda, WA (USGS 12026400). Significant floods have occurred in January 1972, January 1990, November 1990, February 1996, December 2007 and January 2009. Figures 1 through 4 show annual instantaneous peak flows throughout each gage's history.

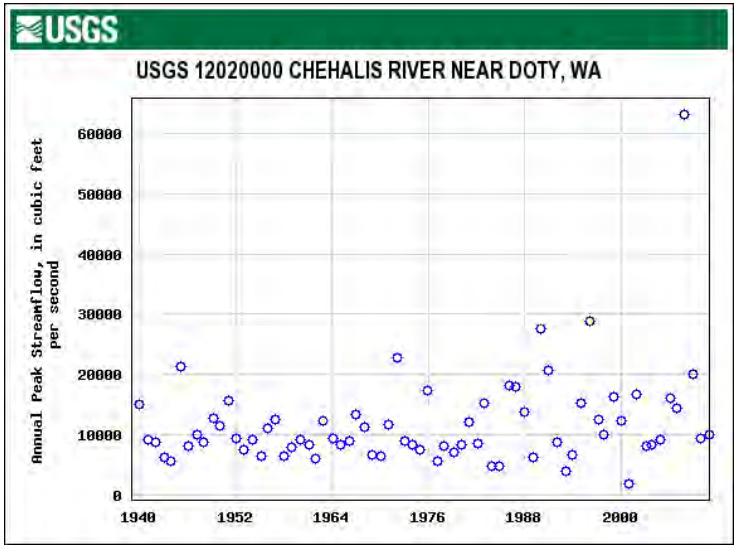


Figure 1. Chehalis River Near Doty Peak Flows

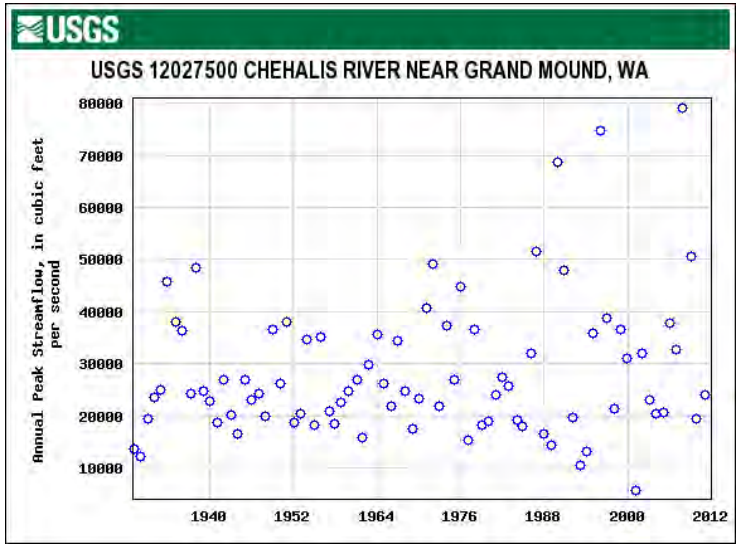


Figure 2. Chehalis River Near Grand Mound Peak Flows

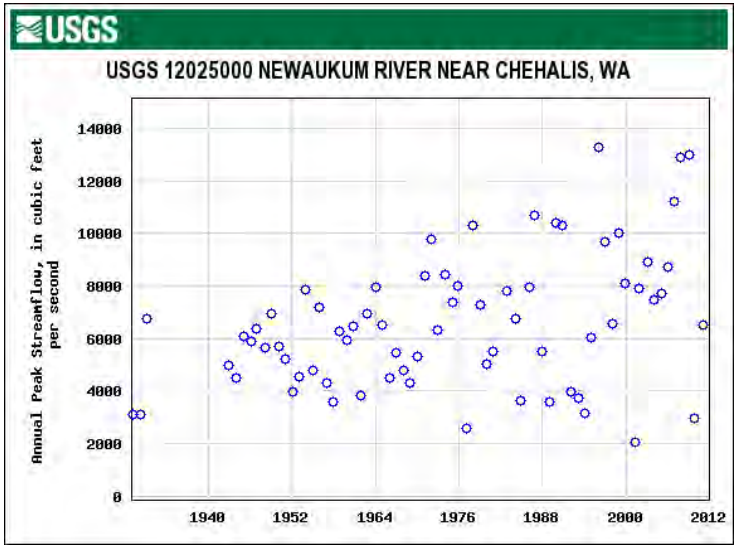


Figure 3. Newaukum River Near Chehalis Peak Flows

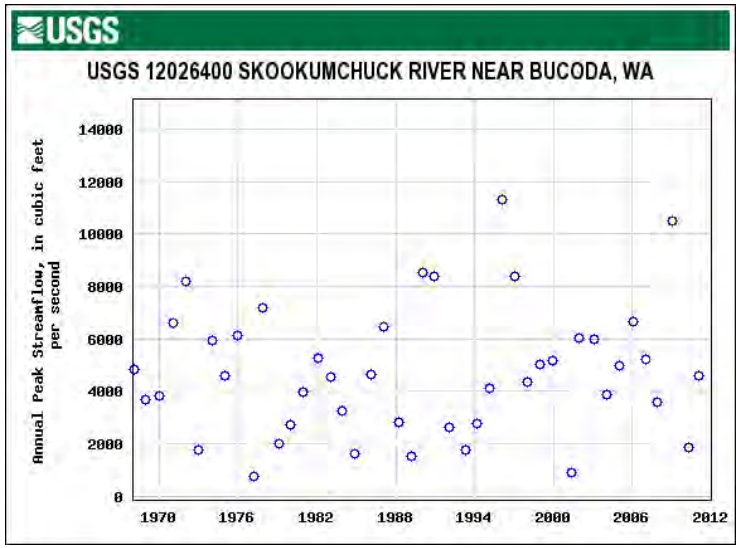


Figure 4. Skookumchuck River Near Bucoda Peak Flows

To understand how flood frequency events have changed over time, a statistical analysis was conducted following procedures outlined in Bulletin 17B of the Interagency Advisory Committee on Water Data. The statistical analysis provided estimates of instantaneous annual-maximum peak flows having recurrence intervals of 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-years. The recurrence interval or return period, is the average interval of time, expressed in years, within which the given flood will be equaled or exceeded once at a specific location, in the case of this analysis at the specific gage location. For example, a flood having a return period of 100 years (i.e. a 100-year flood) has a 1 chance in 100, or a 1-percent probability of occurring in any given year. It is important to understand that the 100-year flood is a statistical computation using as many years of data as possible and does not mean that a flood of this magnitude will only happen once every 100 years.

Peak flow estimates were determined and are plotted for the three following time periods to illustrate how flows have changed over time: 1) Beginning of gage record to 1984, 2) Beginning of gage record to 2006, and 3) Beginning of gage record to present. These time periods were chosen based on when significant floods have occurred in the basin and when other studies have been performed (e.g. 1982 FEMA Flood Insurance Study). Figures 5 through 8 illustrate the three separate flood frequency curves for each gage analyzed. All gages analyzed show that the larger recurrence flows (e.g. return period of 10-yr and greater) have increased within the period of each gage's record. Note that Skookumchuck River Near Bucoda is regulated therefore changes in recurrence flows are effected by dam operations.

It is difficult to conclude if the increases in flows will continue over time or if we are refining our estimate of a true 100-yr event with each additional year of flow data. It is well understood that flood-frequency values will change, either increasing or decreasing, as more data is collected and a new flood frequency is calculated. It was therefore determined that a flow increase of 25% provides a conservative estimate over the life of the project given uncertainties within the Chehalis River Basin such as development, land use changes, climate change, etc.

Hydraulic Analysis

To determine water surface elevations through the project area for the various flood recurrence events the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS) software was utilized. WSDOT together with multiple public and private entities collaborated to develop an unsteady hydraulic model which represents the best available science and information on hydraulic conditions throughout the Chehalis River Basin. This model was utilized to develop rating curves, plots correlating discharge with water surface elevation, for the 100-, 500-year, and 2007 events at several representative sections throughout the basin. The rating curves were utilized with the potential flow increase of 25% to determine flood elevations throughout the project reach (Table 1). The baseline conditions used for this analysis included all of WSDOT's proposed flood hazard mitigation projects.

Columns 1 and 2 show the river and cross section location, respectively. Column 3 shows the 2007 event flow and the calculated 100- and 500-year flows. Column 5 shows the potential flow including the 25% increase. Column 6 shows the existing water surface elevations for the 100-, 500-year and 2007 events for each specified location. Column 7 shows the potential water surface elevations for the 100- and 500-year events for each specified location.

The difference between the modeled and the potential future flood elevations were analyzed and are shown in Column 8. Based on the analysis it was determined that 3 feet of freeboard above the design 100-year elevation will be adequate to cover a 25% increase in flows. The 3 feet of freeboard was also determined to be sufficient to contain the 2007 flood event (flood of record on Chehalis River) as shown in Column 9.

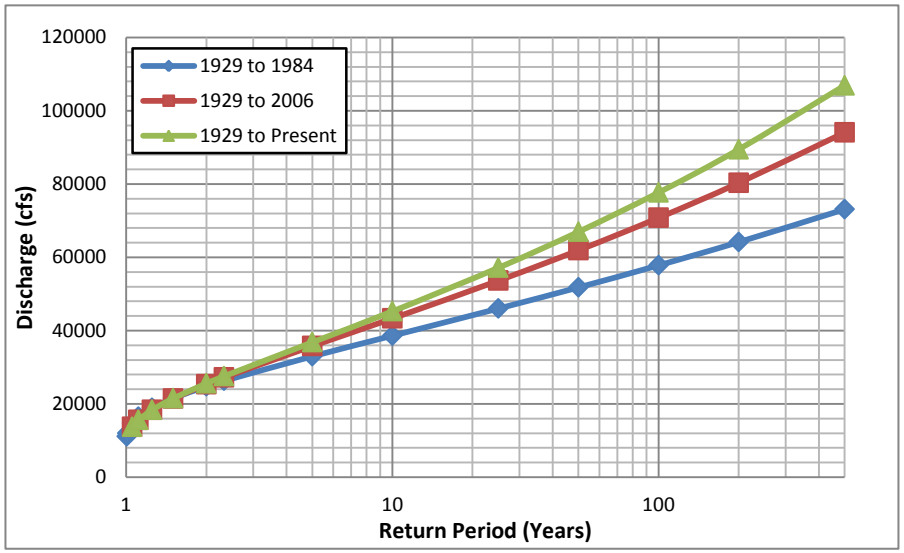


Figure 5. Flood Frequency Plot for Chehalis River Near Grand Mound, WA (12027500)

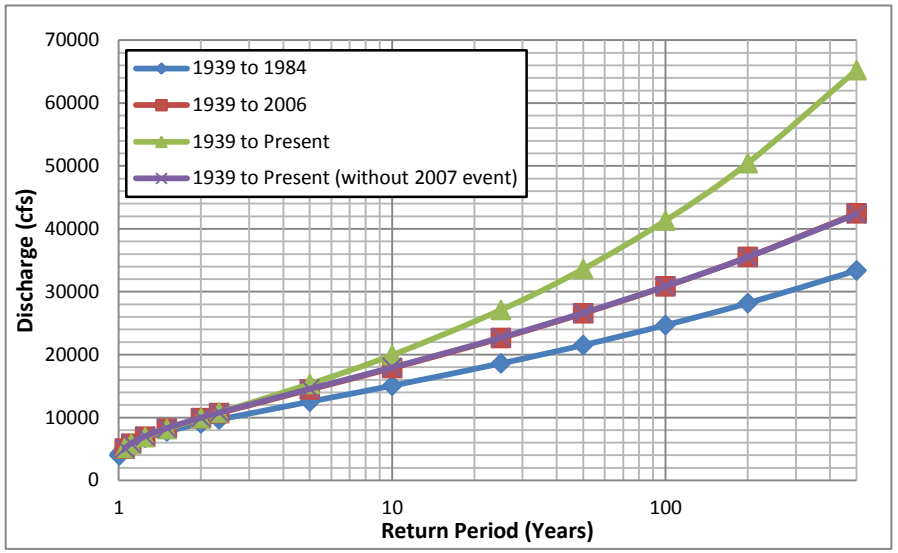


Figure 6. Flood Frequency Plot for Chehalis River Near Doty, WA (12020000)

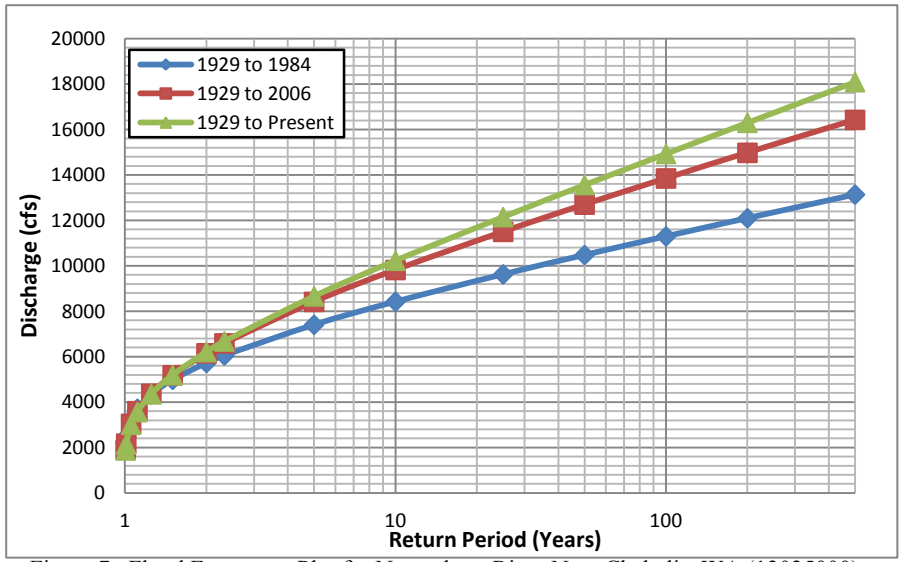


Figure 7. Flood Frequency Plot for Newaukum River Near Chehalis, WA (12025000)

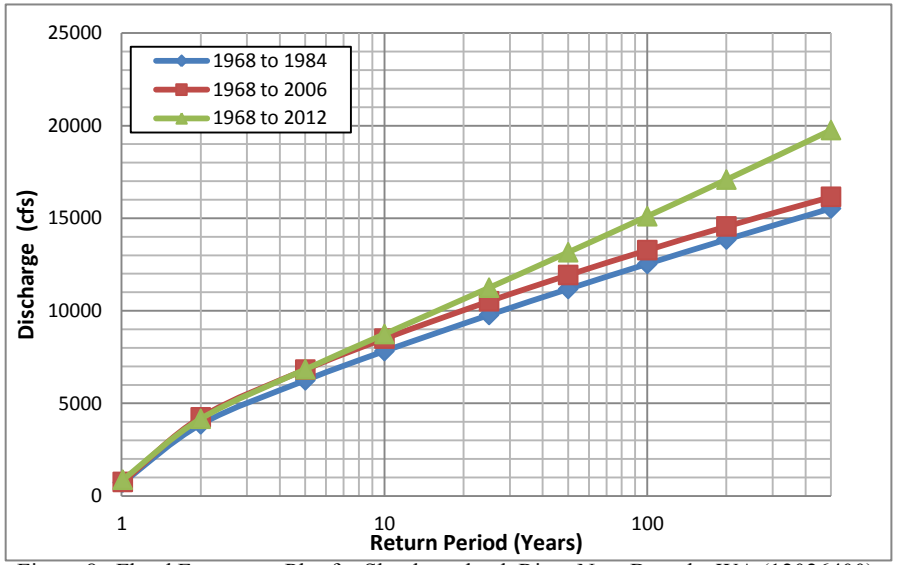


Figure 8. Flood Frequency Plot for Skookumchuck River Near Bucoda, WA (12026400)

Table 1. Hydraulic Characteristics Summary

(1)	(2)	(3)			(4)	(5)		(6)			(7)		(8)	(9)
RIVER	CROSS SECTION (RM)	EXISTING FLOW (CFS)			POTENTIAL FLOW INCREASE (%)	POTENTIAL FLOW (CFS)		EXISTING WATER SURFACE ELEVATION (FEET)			POTENTIAL WATER SURFACE ELEVATION (FEET)		MINIMUM FREEBOARD REQUIRED (FEET)	AMOUNT OF FREEBOARD AVAILABLE ABOVE 2007 ELEVATION (FEET)
		100-YR	500-YR	2007		100-YR	500-YR	100-YR	500-YR	2007	100-YR	500-YR		
Newaukum	2.27	12735	13998	12114	25%	15919	17498	191.0	191.3	190.8	191.6	191.9	0.7	3.2
	1.92	11499	12294	10589	25%	14374	15368	188.1	188.8	188.5	189.5	189.8	1.4	2.6
	1.66	11237	11350	9804	25%	14046	14188	187.4	188.3	188.1	189.7	189.7	2.3	2.3
	0.1	11701	13478	13196	25%	14626	16848	186.4	187.6	187.5	188.0	188.7	1.6	1.9
Chehalis	77.17	52911	56885	57434	25%	66139	71106	187.6	188.6	188.5	189.5	190.0	1.9	2.2
	76.36	45744	49707	49023	25%	57180	62134	186.9	188.0	187.8	188.8	189.3	1.9	2.1
	74.82	60756	67023	67081	25%	75945	83779	184.8	186.3	186.2	187.2	187.8	2.4	1.6
	72.58	45839	54730	54341	25%	57299	68413	183.1	185.0	184.7	185.3	186.4	2.2	1.4
	71.72	46492	55956	55591	25%	58115	69945	181.7	183.8	183.4	184.0	185.0	2.4	1.3
	71.48	70481	86548	85815	25%	88101	108185	181.7	183.8	183.4	183.9	185.0	2.2	1.3
	69.52	69586	85523	85325	25%	86983	106904	180.4	182.7	182.1	182.8	183.9	2.4	1.3
	69.23	65324	79582	79282	25%	81655	99478	180.4	182.7	182.1	182.9	184.2	2.5	1.3
	67.46	65120	79019	79214	25%	81400	98774	177.9	179.9	179.1	180.1	181.0	2.2	1.8

Conclusion

The analysis determined that 3 feet of freeboard above the modeled 100-year flood elevation would be sufficient to cover a potential future flow increase of 25%, given uncertainties within the Chehalis River Basin such as development, land use changes, climate change, etc. This would also provide sufficient clearance during the 2007 flood event which was in excess of a 100-yr event through the project site.

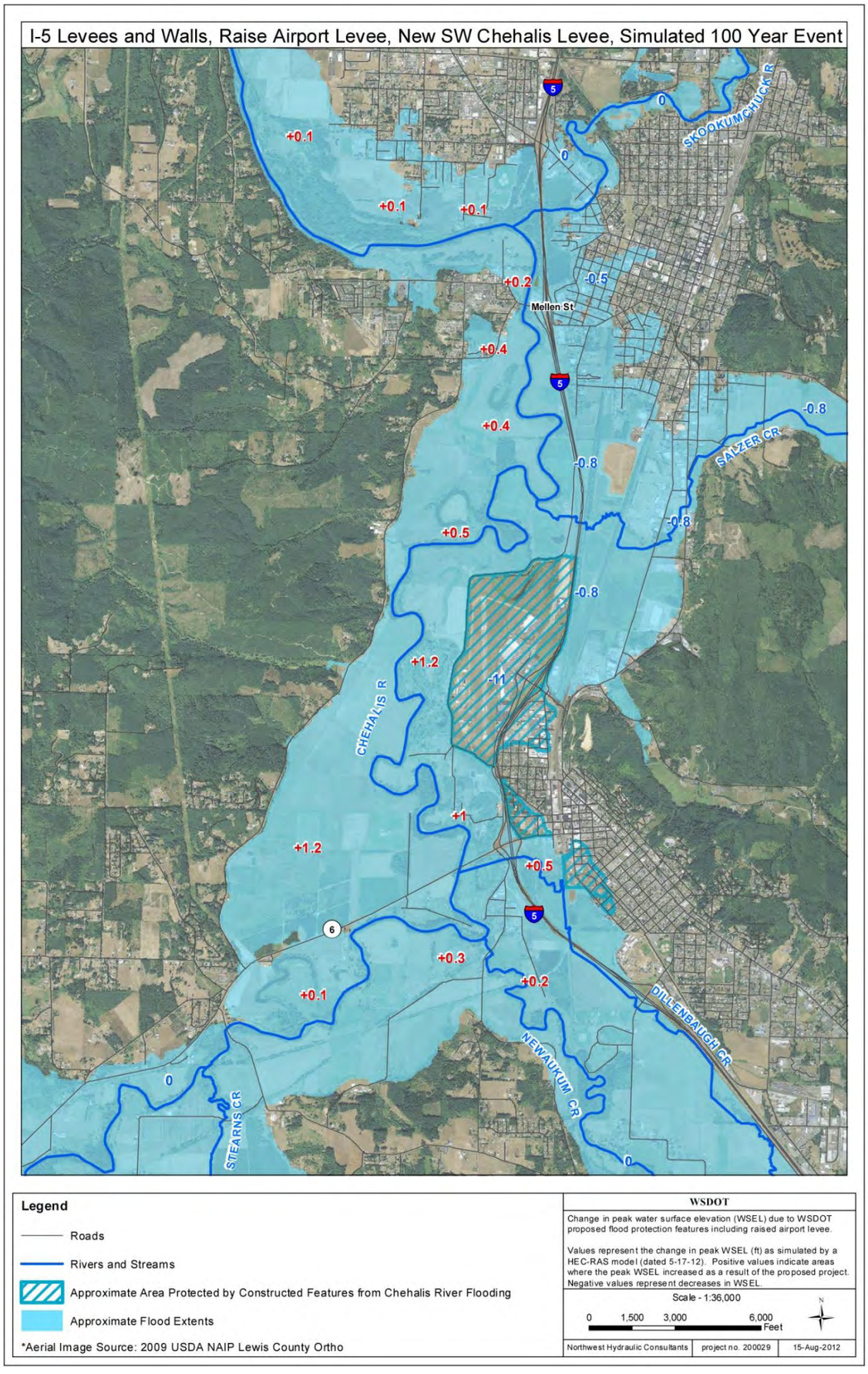
If you have any questions or need further assistance regarding the information included in this memorandum please feel free to contact Katie Mozes at (360) 705-7261 or myself at (360) 705-7262.

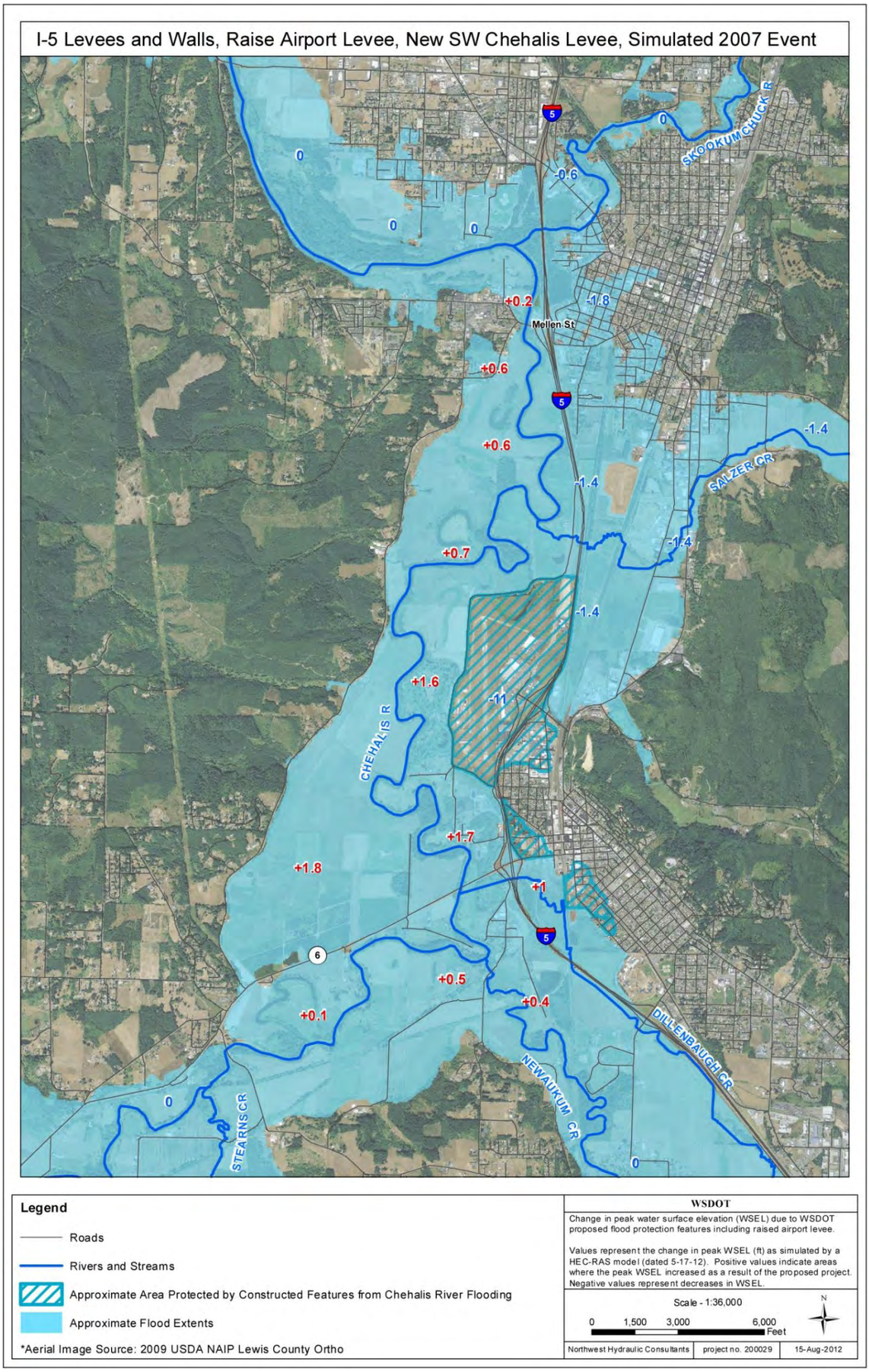
CMK

cc: HQ Hydraulics Project File

Appendix B:

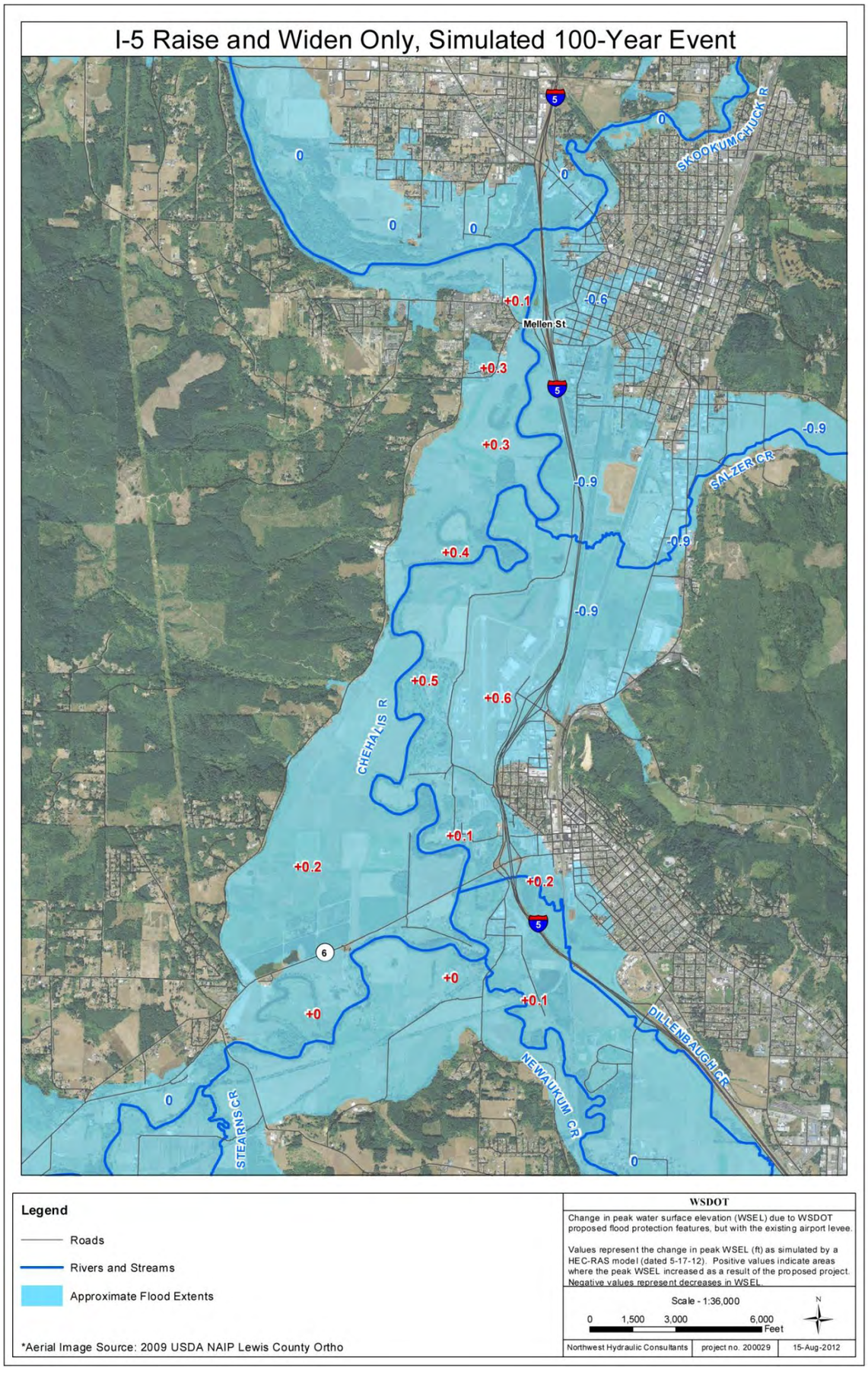
Alternative 1: I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee - Flood Relief Maps

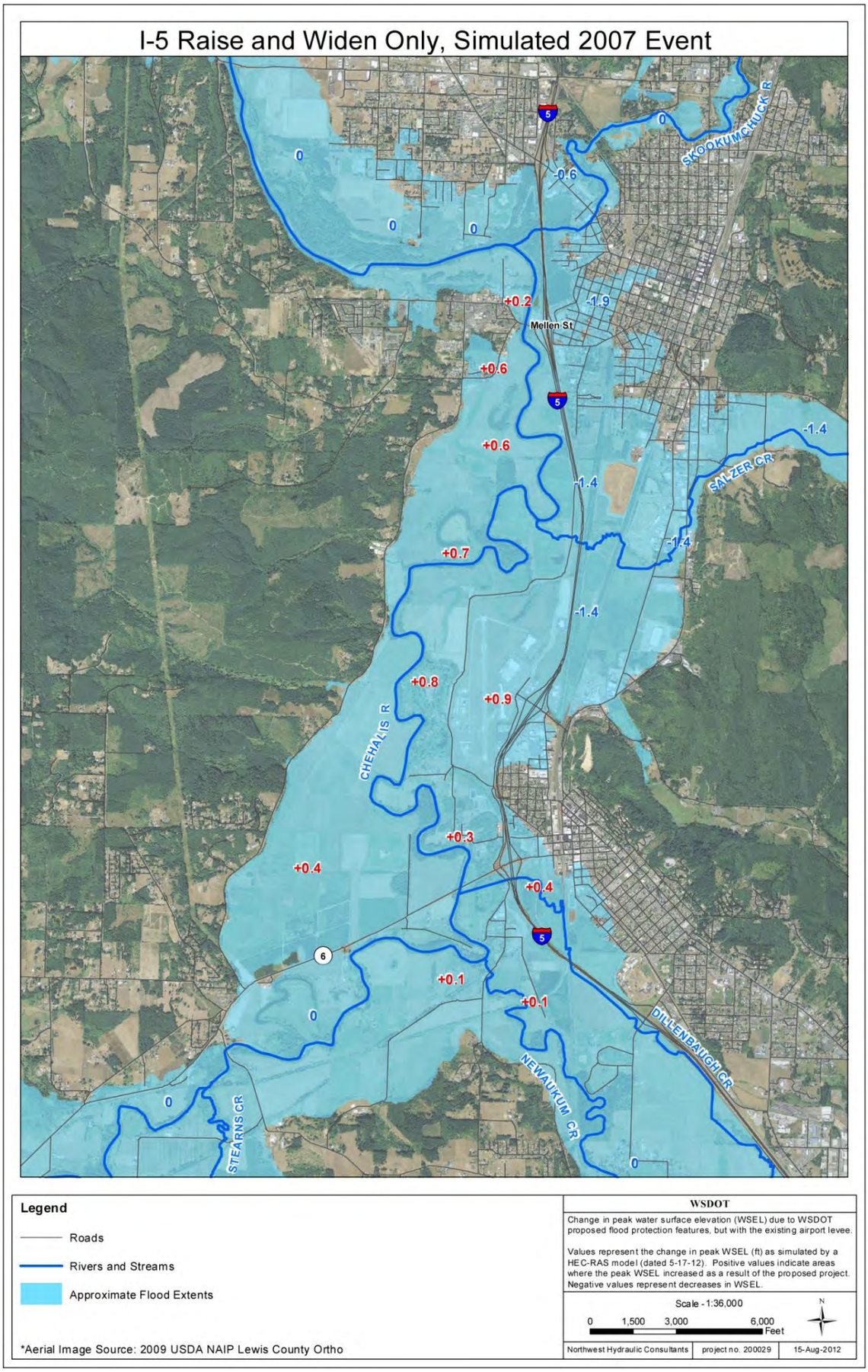



I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee, Simulated 2007 Event
Mellen St
SKOOKUM CHUCK R
SALZER CR
CHEHALIS R
STEARNS CR
NEWAUKUM CR
DILLENBAUGH CR
0
-0.6
-1.8
+0.2
+0.6
-1.4
+0.7
-11
+1.6
+1.7
+1.8
+1
+0.5
+0.4
+0.1
Legend
Roads
Rivers and Streams
Approximate Area Protected by Constructed Features from Chehalis River Flooding
Approximate Flood Extents
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho
WSDOT
Change in peak water surface elevation (WSEL) due to WSDOT proposed flood protection features including raised airport levee.
Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 5-17-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Scale - 1:36,000
0 1,500 3,000 6,000 Feet
N
Northwest Hydraulic Consultants
project no. 200029
15-Aug-2012

Appendix C:

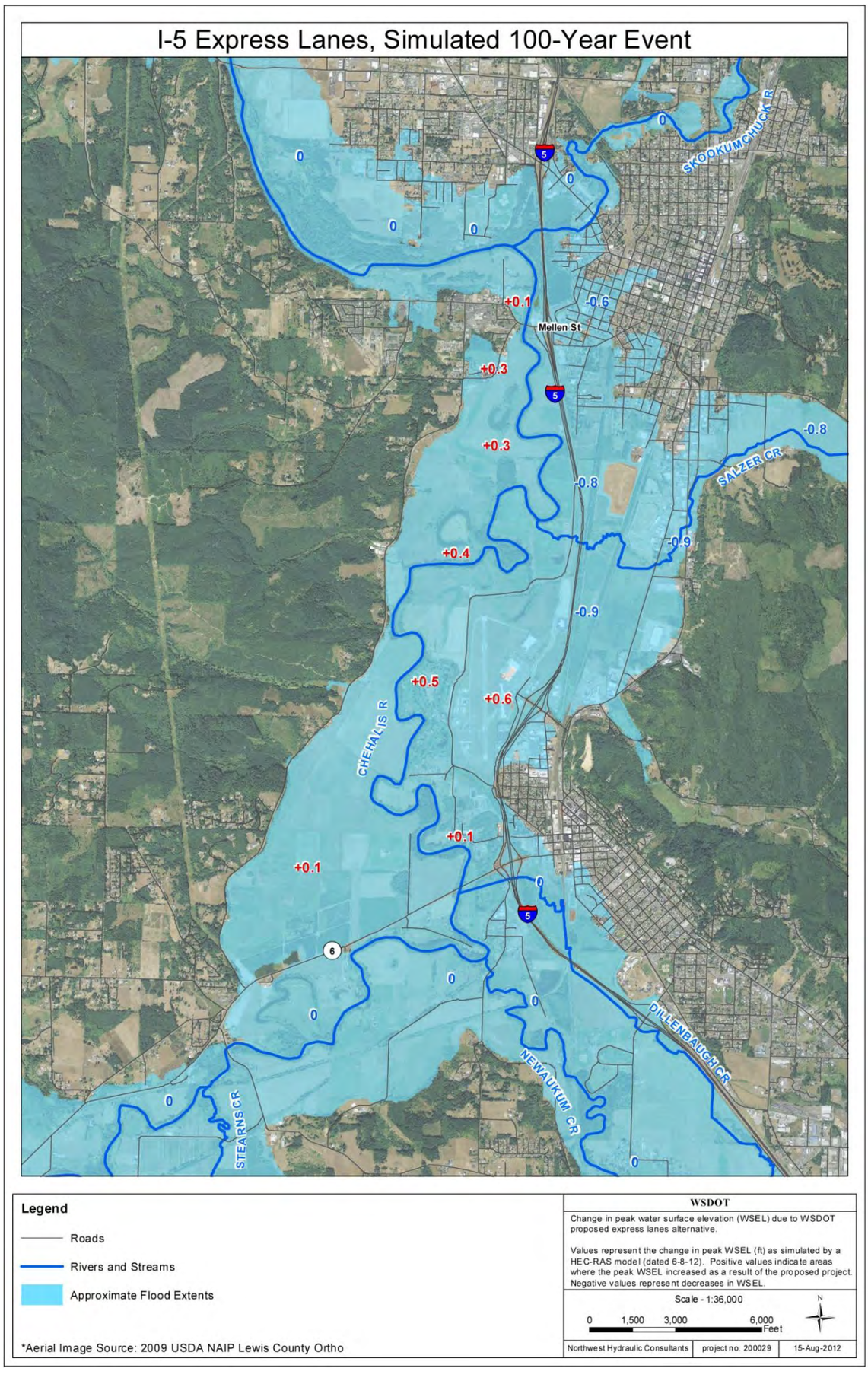
Alternative 2: I-5 Raise and Widen Only - Flood Relief Maps

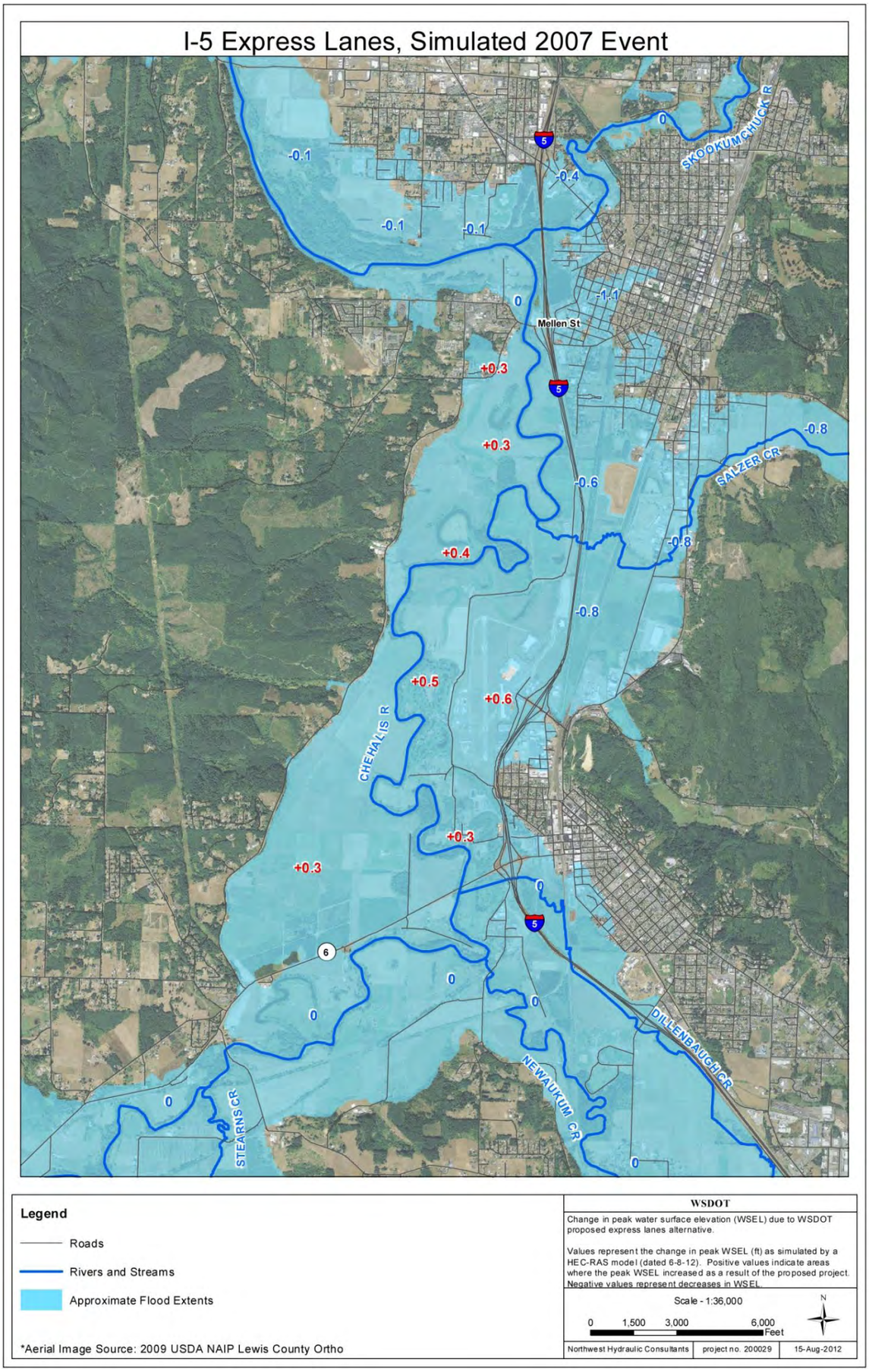



I-5 Raise and Widen Only, Simulated 2007 Event
SKOOKUM CHUCK R
Mellen St
SALZER CR
CHEHALIS R
STEARNS CR
NEWAUKUM CR
DILLENBAUGH CR
0
-0.6
+0.2
-1.9
+0.6
+0.6
-1.4
-1.4
+0.7
-1.4
+0.8
+0.9
+0.3
+0.4
+0.4
+0.1
+0.1
Legend
Roads
Rivers and Streams
Approximate Flood Extents
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho
WSDOT
Change in peak water surface elevation (WSEL) due to WSDOT proposed flood protection features, but with the existing airport levee.
Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 5-17-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Scale - 1:36,000
0 1,500 3,000 6,000 Feet
N
Northwest Hydraulic Consultants
project no. 200029
15-Aug-2012

Appendix D:

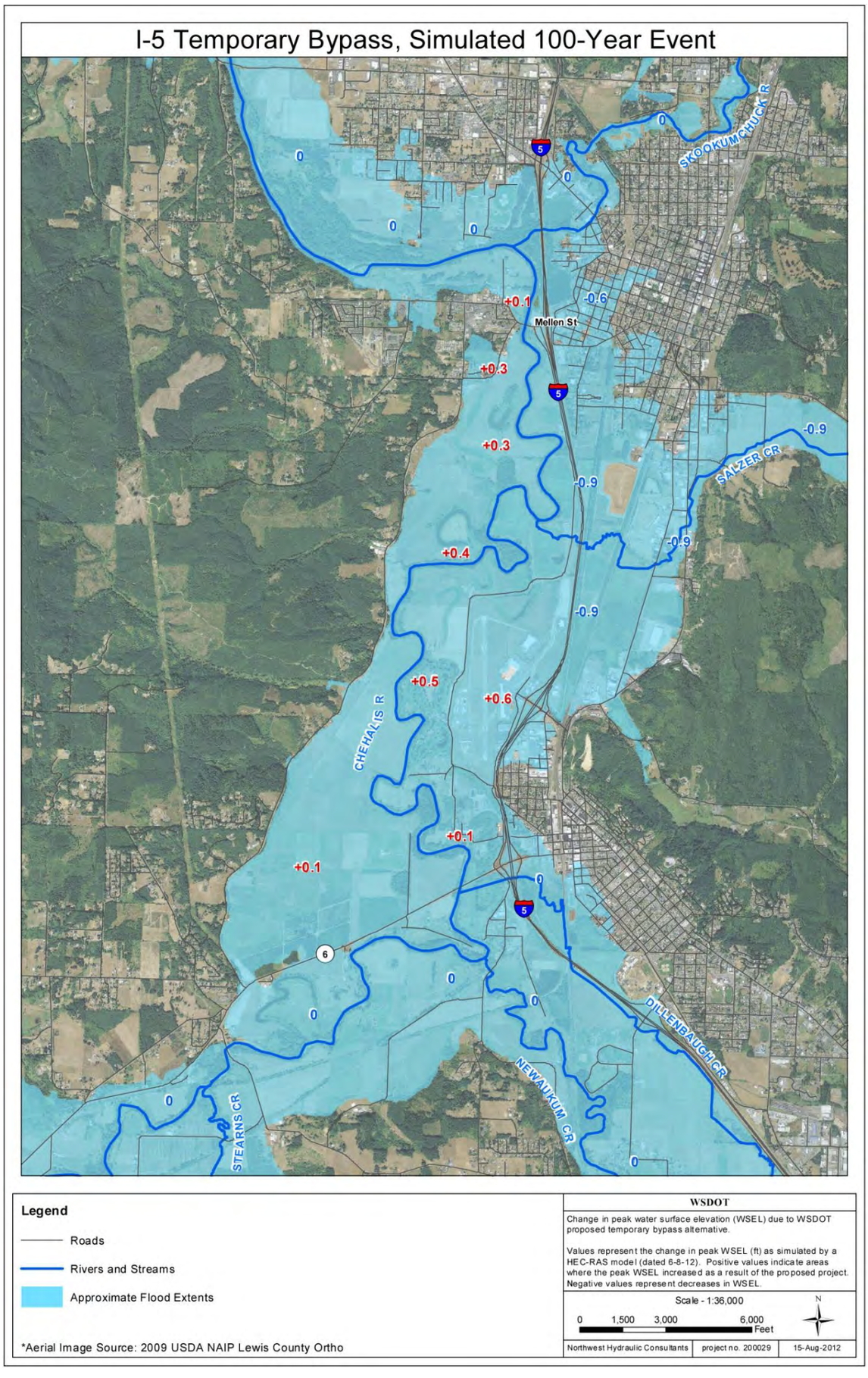
Alternative 3: I-5 Express Lanes - Flood Relief Maps

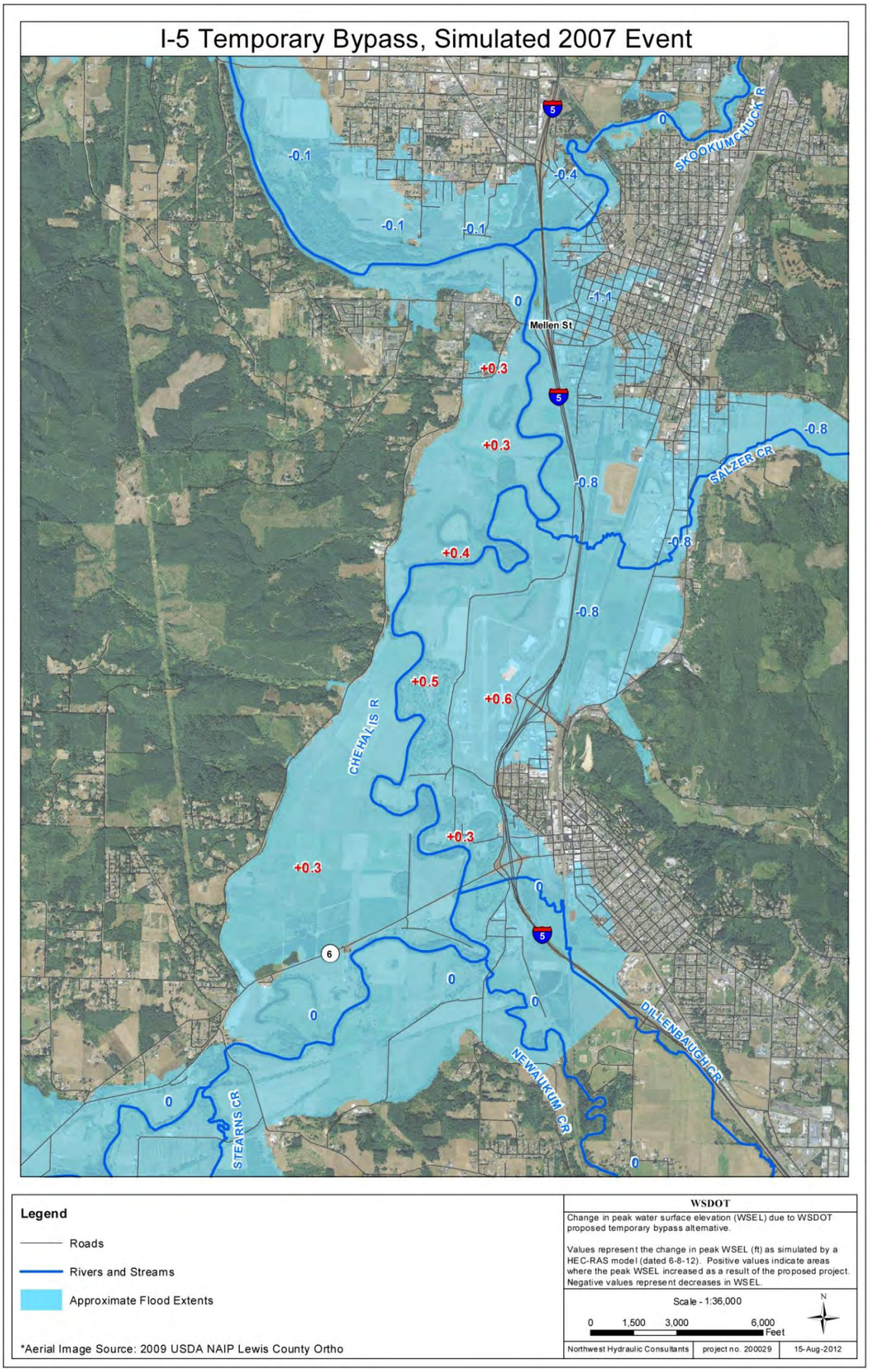



I-5 Express Lanes, Simulated 2007 Event
-0.1
-0.1
-0.1
-0.4
0
0
-1.1
Mellen St
+0.3
+0.3
+0.4
+0.5
+0.6
+0.3
+0.3
-0.8
-0.6
-0.8
-0.8
SKOOKUMCHUCK R
SALZER CR
CHEHALIS R
NEWAUKUM CR
DILLENBAUGH CR
STEARNS CR
5
6
Legend
Roads
Rivers and Streams
Approximate Flood Extents
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho
WSDOT
Change in peak water surface elevation (WSEL) due to WSDOT proposed express lanes alternative.
Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 6-8-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Scale - 1:36,000
0 1,500 3,000 6,000 Feet
N
Northwest Hydraulic Consultants
project no. 200029
15-Aug-2012

Appendix E:

Alternative 4: I-5 Temporary Bypass - Flood Relief Maps




I-5 Temporary Bypass, Simulated 2007 Event
-0.1
-0.1
-0.1
-0.4
0
-1.1
0
Mellen St
+0.3
+0.3
+0.4
+0.5
+0.6
+0.3
+0.3
-0.8
-0.8
-0.8
-0.8
-0.8
0
0
0
0
0
0
0
SKOOKUMCHUCK R
SALZER CR
CHEHALIS R
STEARNS CR
NEWAUKUM CR
DILLENBAUGH CR
5
5
5
6
Legend
Roads
Rivers and Streams
Approximate Flood Extents
*Aerial Image Source: 2009 USDA NAIP Lewis County Ortho
WSDOT
Change in peak water surface elevation (WSEL) due to WSDOT proposed temporary bypass alternative.
Values represent the change in peak WSEL (ft) as simulated by a HEC-RAS model (dated 6-8-12). Positive values indicate areas where the peak WSEL increased as a result of the proposed project. Negative values represent decreases in WSEL.
Scale - 1:36,000
0 1,500 3,000 6,000 Feet
N
Northwest Hydraulic Consultants
project no. 200029
15-Aug-2012