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September 1, 2009

TO:	Paul Levesque, Rick Klumph, Design Team-Oregon Solutions
FROM:	Vaughn Collins, P.E.
CC:	Dave Boatman P.E., Jeff Johnson, P.E.
RE:	**Evaluation of Flood Durations and associated issues for First Flood Control Project**

Concerns were raised with alternative 4 as presented at the August 2, 2009 Oregon Solutions Design Team meeting by Leo Kuntz via email. No other technical comments have been received. The concerns related to adverse impacts on water levels in the lower Tillamook and Trask Rivers due to removing the levees that currently act to separate the Wilson River from the Tillamook-Trask.

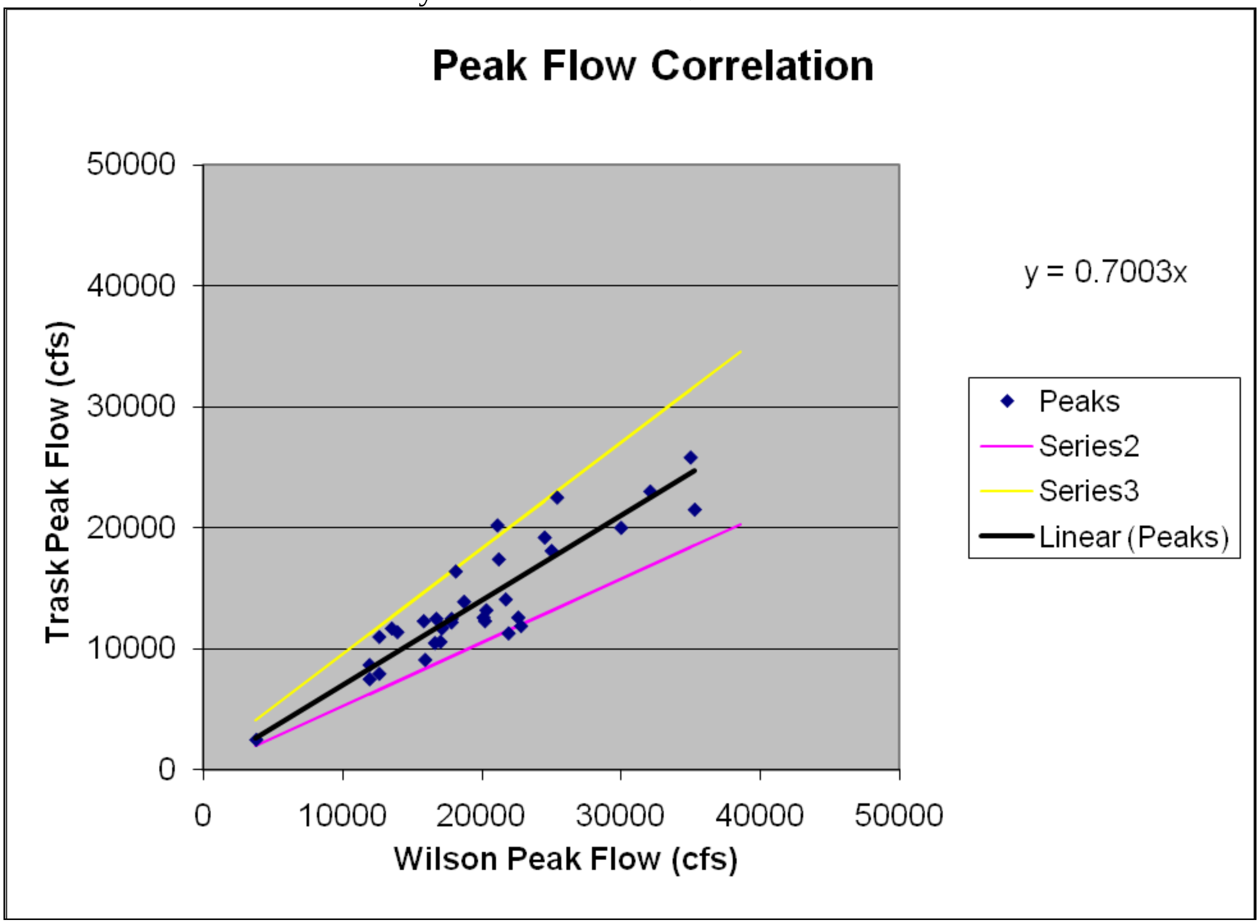
Under current conditions, the Wilson River runs higher than the Tillamook very near to the bay and it has been observed that the Wilson River tends to flow at a higher level for longer durations than the Tillamook- Trask. Our modeling results agree with these observations.

If by removing the levees in Alternative 4 the higher water levels in the Wilson were propagated over to the Trask-Tillamook system adverse impacts could occur. The Tillamook River exhibits the greatest sensitivity to increased water levels due to its very flat slope – prior work shows backwater effects can extend miles up the system. We agreed to look at duration and volume issues for these alternatives as a result of these comments.

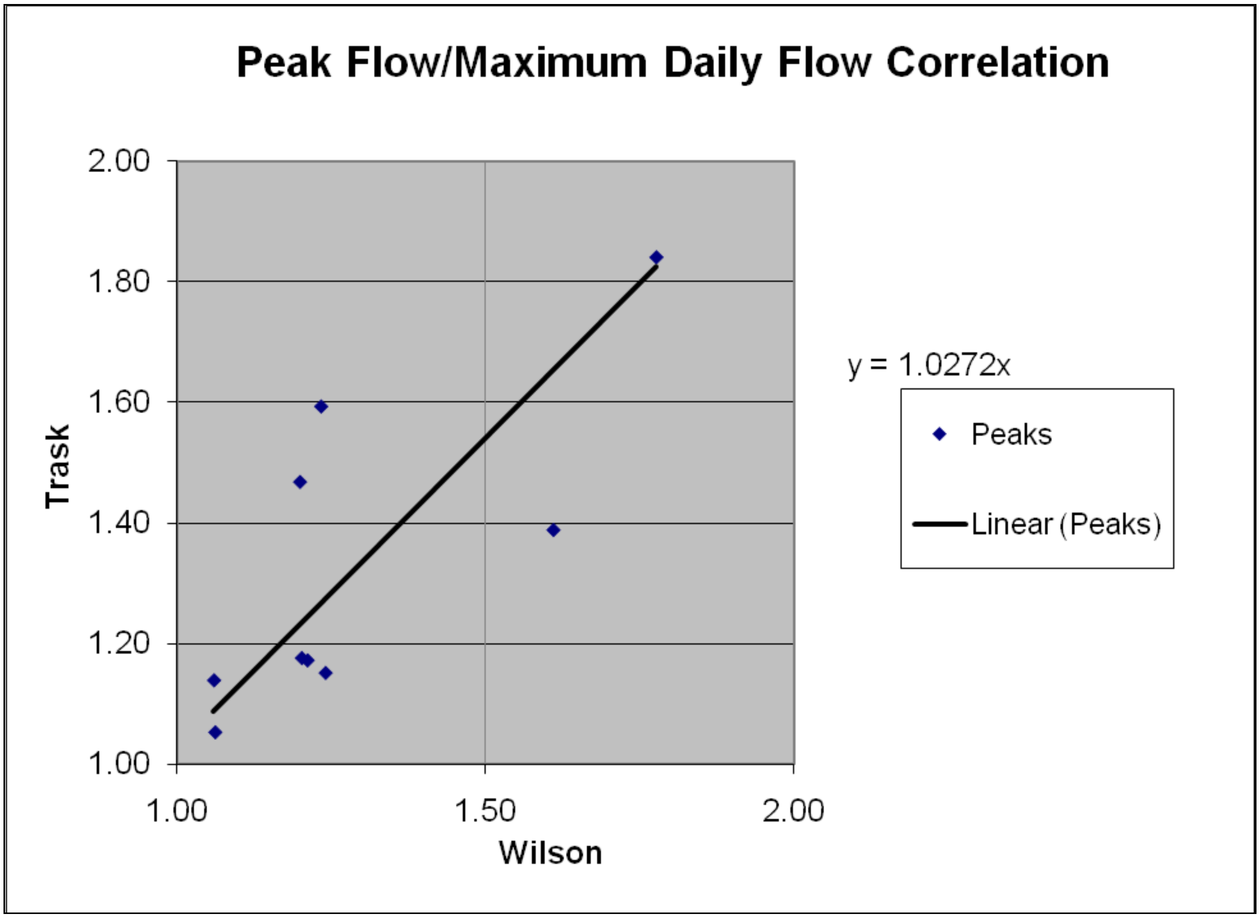
Here we briefly present our analysis of this issue. We investigated both the hydrology of the Wilson and Trask River systems to characterize their differences in flow durations and volumes, and also model results in the lower reaches of these rivers in order to see if the complex interactions and flow transfers that occur during floods are important factors.

Hydrologic Analysis:

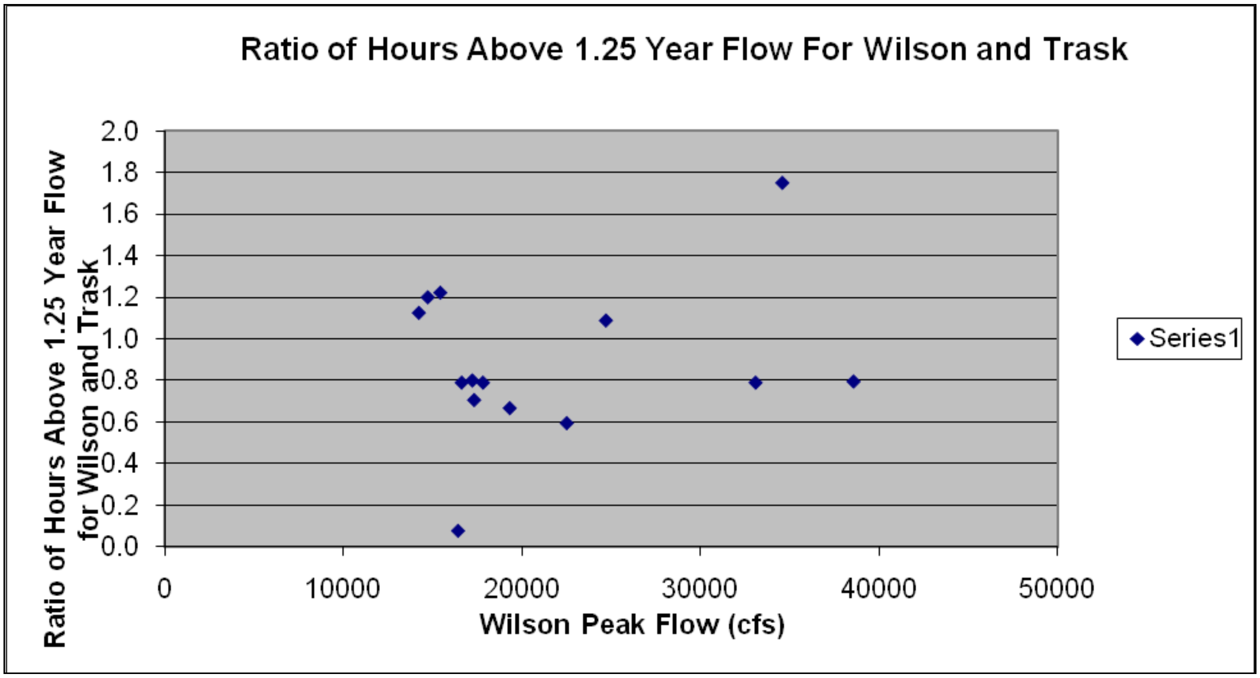
We obtained peak flow and hourly flow records for the Wilson River and Trask River USGS gages and conducted some correlation analysis of the two rivers.



The above figure plots the Wilson and Trask River peaks at the USGS gage sites for all available years. On average, the Trask peak flow is 70% of the Wilson peak, but has varied up to 25% above or below this ratio (yellow and pink lines). In other words, Trask River peaks flows have varied from around 50% to 90% of Wilson River peaks over the years of record.



Plotting the peak flow to maximum 24 hour flow ratio gives an indication of the typical length of flood and flood volumes. Data were available for nine recent events. The linear correlation slope is very close to 1, indicating that flood shape and duration over 24 hours are very similar on the two rivers. The peak flow ratio is 66% and the 24 hour flow ratio is 57% for the two rivers. This indicates the Wilson has somewhat greater volumes in addition to higher peaks, although the difference in ratios is relatively small.



We calculated the number of hours each river ran at flows above a 1.25 year flood (approximately bankfull) and then created a ratio of the two. A ratio above 1 indicates the Trask ran longer above bankfull than the Wilson, and below 1 the reverse. The Trask spent less time flooding in two thirds of the events, but more time in one third. Note than the Trask was above bankfull 80% longer in the second largest flood shown.

Hydrologic Conclusions:

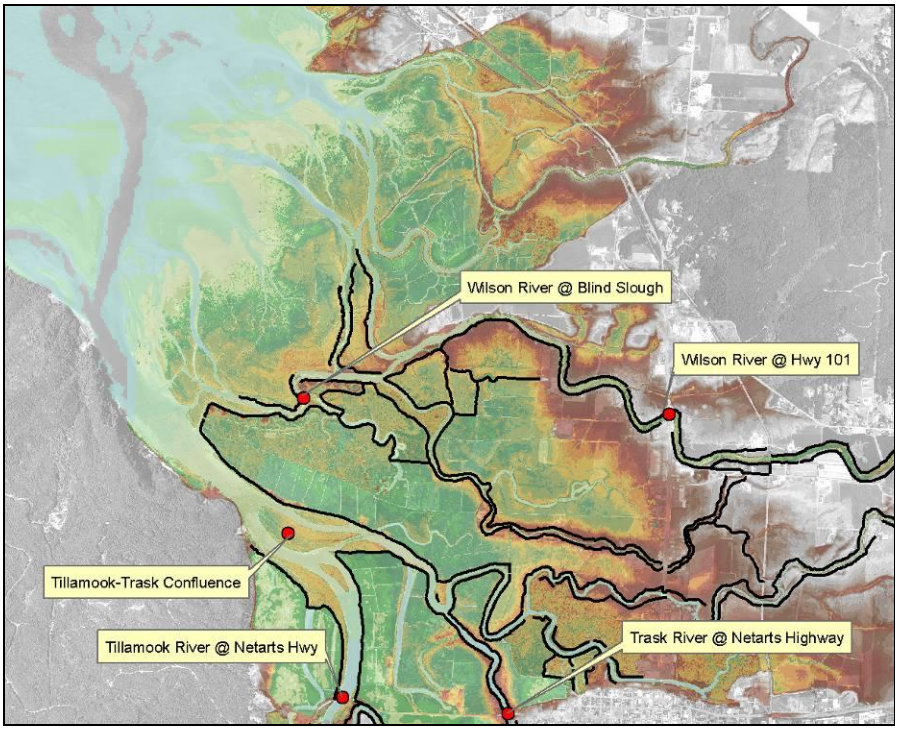
The Trask River has a smaller basin and generates smaller peak flows and volumes than the Wilson. On average, its peaks are 70% of the Wilson's, but can vary from 50% to 90%. In general, its flow volumes and durations are also less, but not significantly so. We conclude that the hydrology of the two basins is quite similar and does not fully explain the observations of flood behavior in the lower floodplains near the bay.

Hydraulic Analysis:

Having concluded that the two basins hydrology does not explain the duration differences observed, we investigated flows in the lower floodplains using the HEC-RAS model and historic events. Model runs were performed for the 1999, 2001, 2006 and 2007 floods, which range from near annual events to exceeding a 50 yr event.

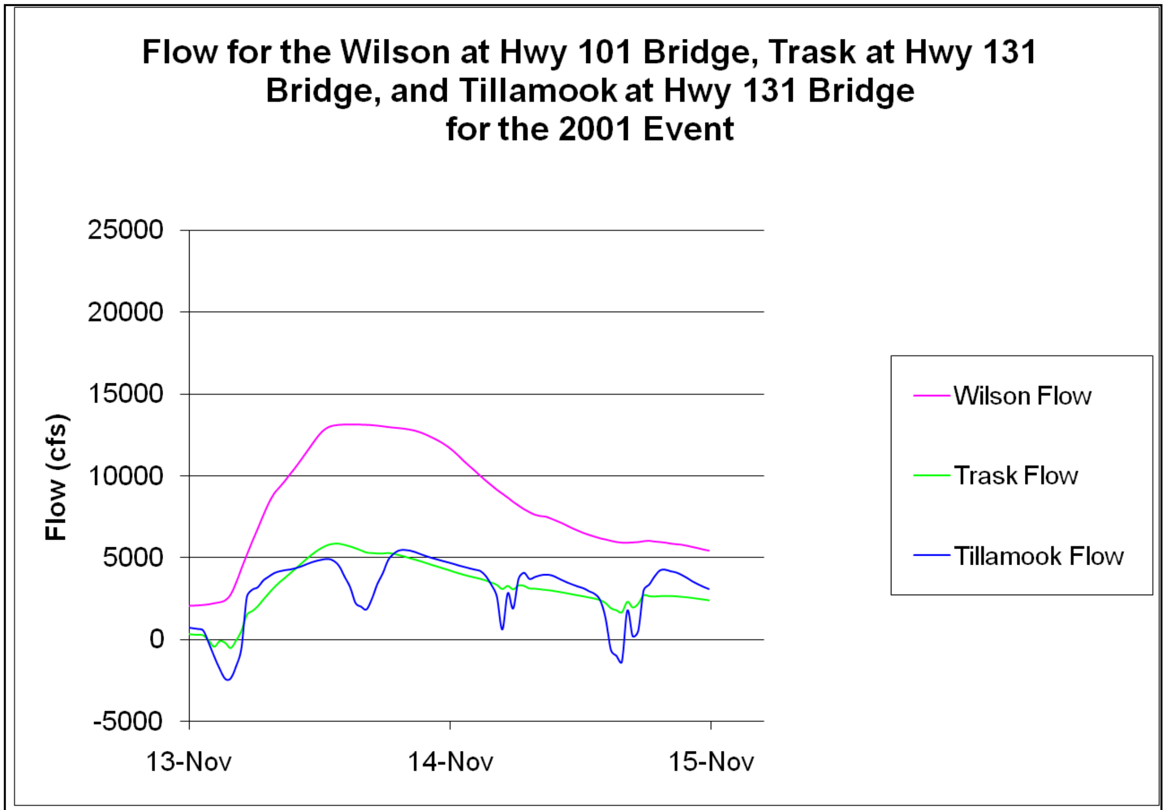
We evaluated our modeling results, looking at flood durations and timing in addition to the peak water level results previously presented. We also ran two additional scenarios, varying flows on the Trask and

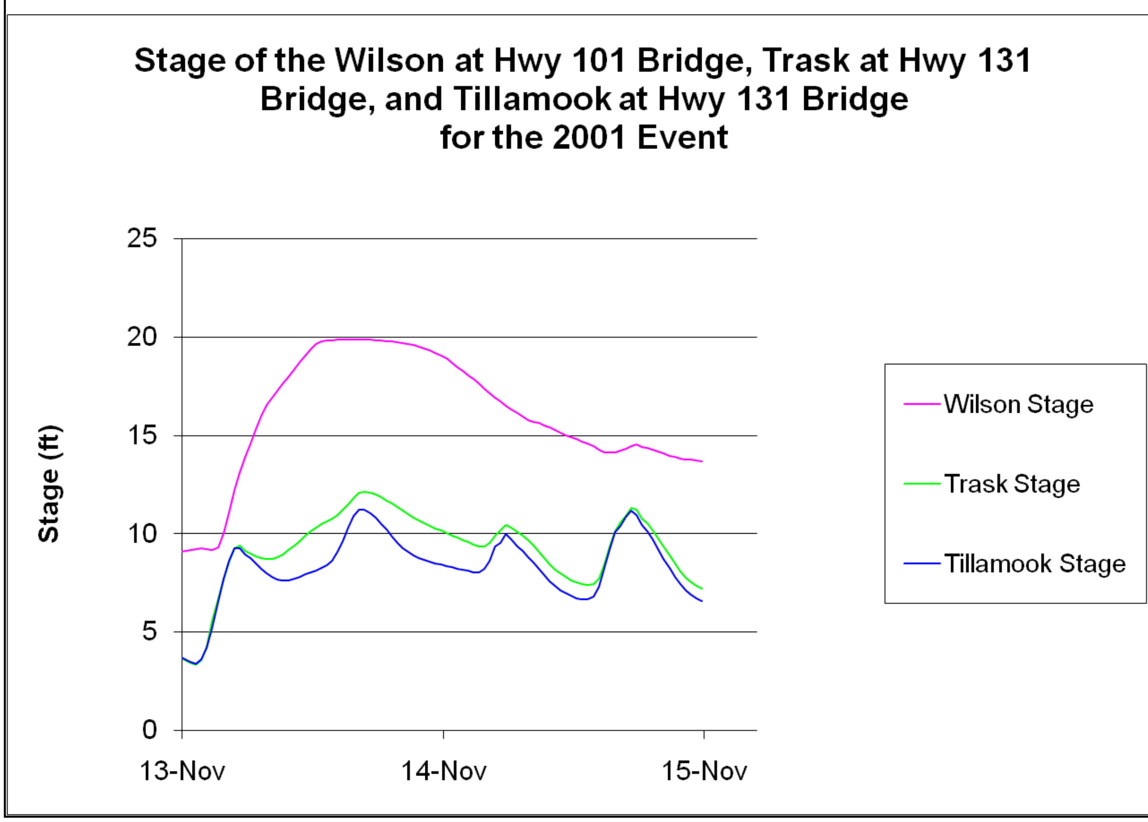
Tillamook rivers by +/- 25% for the 1999 flood. The locations of hydrographs discussed in the remainder of this report are shown in the following figure.

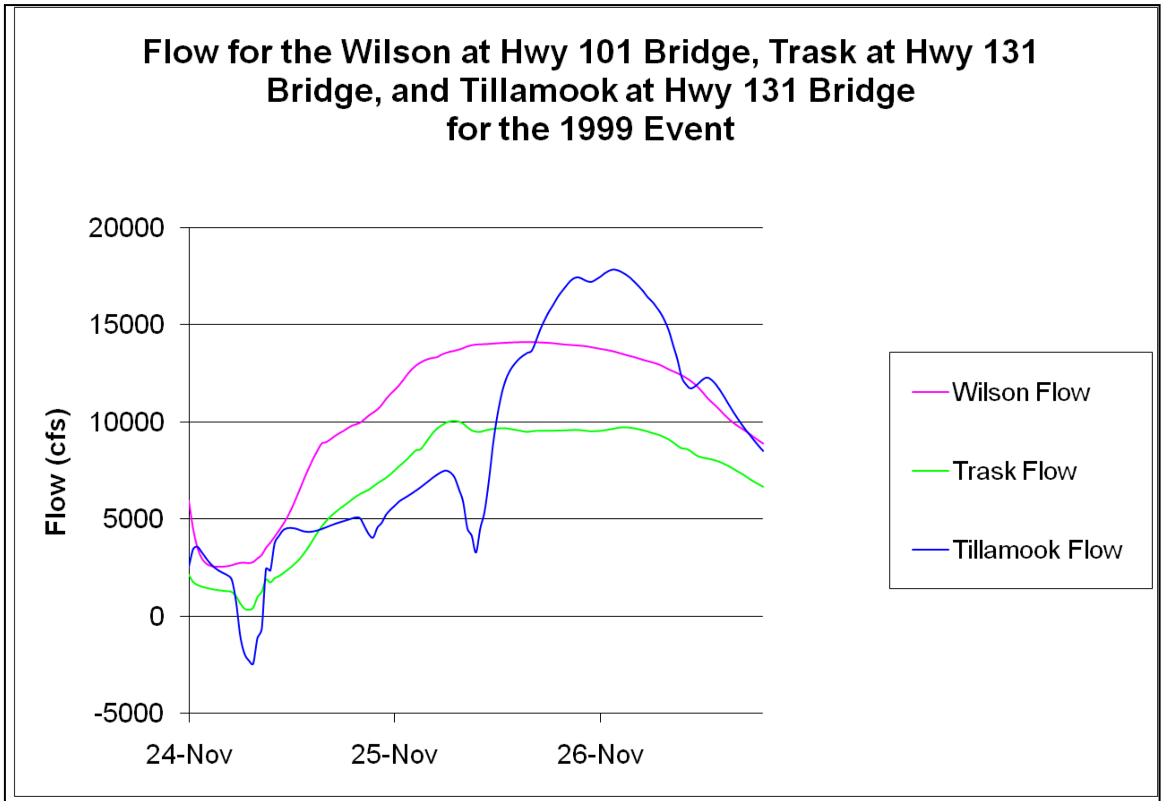


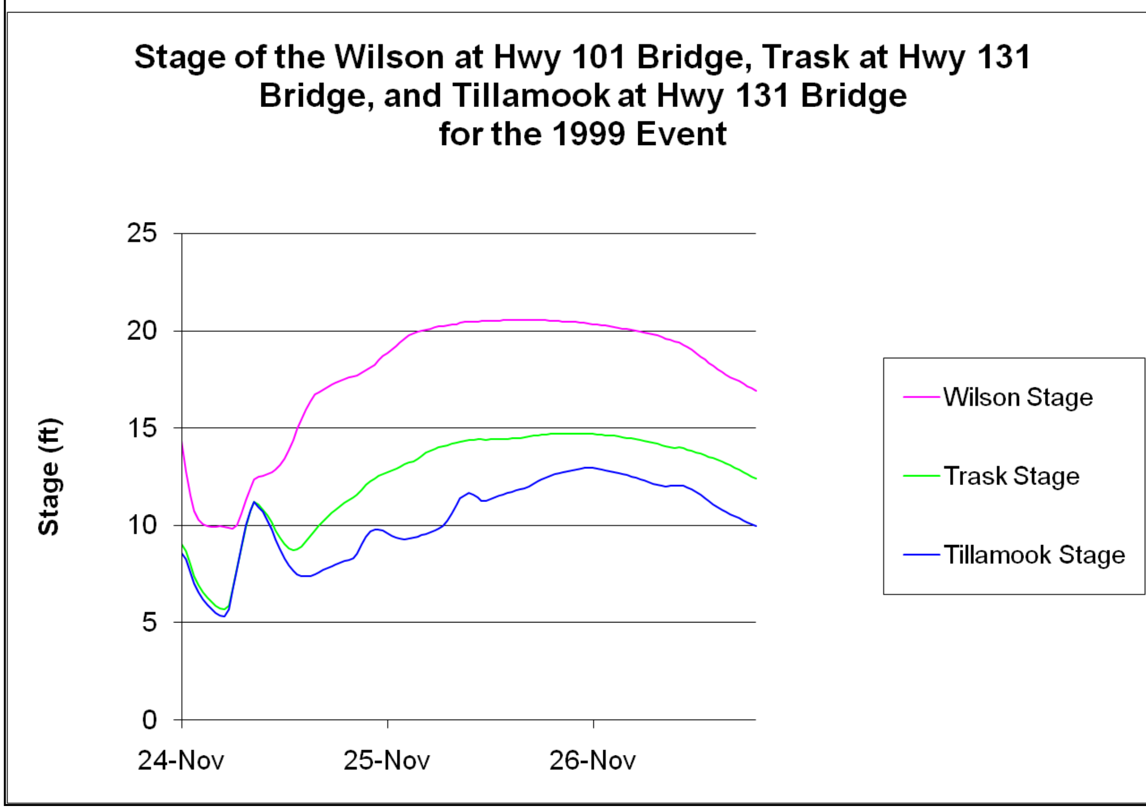
The next series of figures show the flow and stage hydrographs at three locations for existing conditions: the Wilson River at Hwy 101, and the Trask and Tillamook Rivers at the Hwy 131 (Netarts Highway) Bridge crossings. The floods are plotted in order of increasing magnitude on the Wilson River. Several consistent patterns are noted.

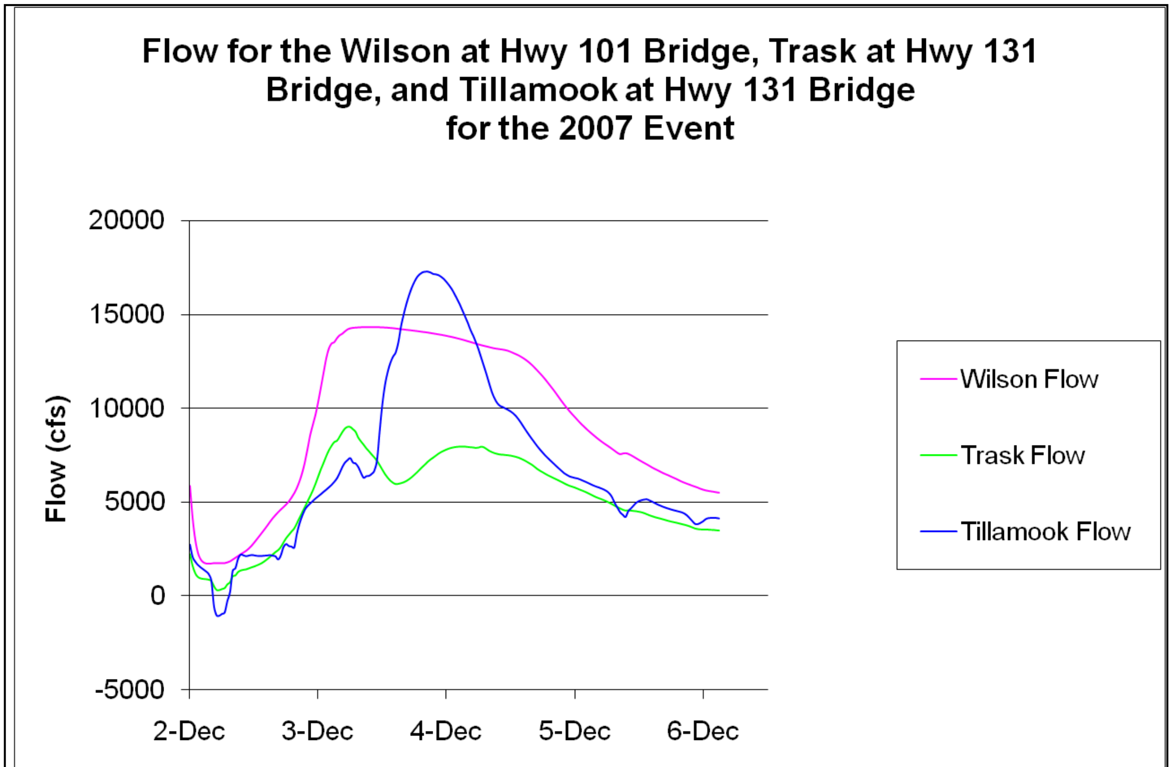
1) The Wilson River exhibits a much longer, flatter hydrograph than the other rivers
2) The Wilson peaks earlier but drops very slowly. The Tillamook River shows a substantially delayed peak in each flood. The Tillamook peak is due to the combined flows from the Tillamook and overbank flows from the Trask.
3) The shapes of the Wilson stage and flow hydrographs are always very similar. On the other hand, the Trask and Tillamook hydrographs vary quite a bit, and the stage and flow are not necessarily correlated. On the Trask River, the peak flow occurs early in each event, but peak stage is not reached until later. This is due to the influence tides have here, even at the peak of a flood.

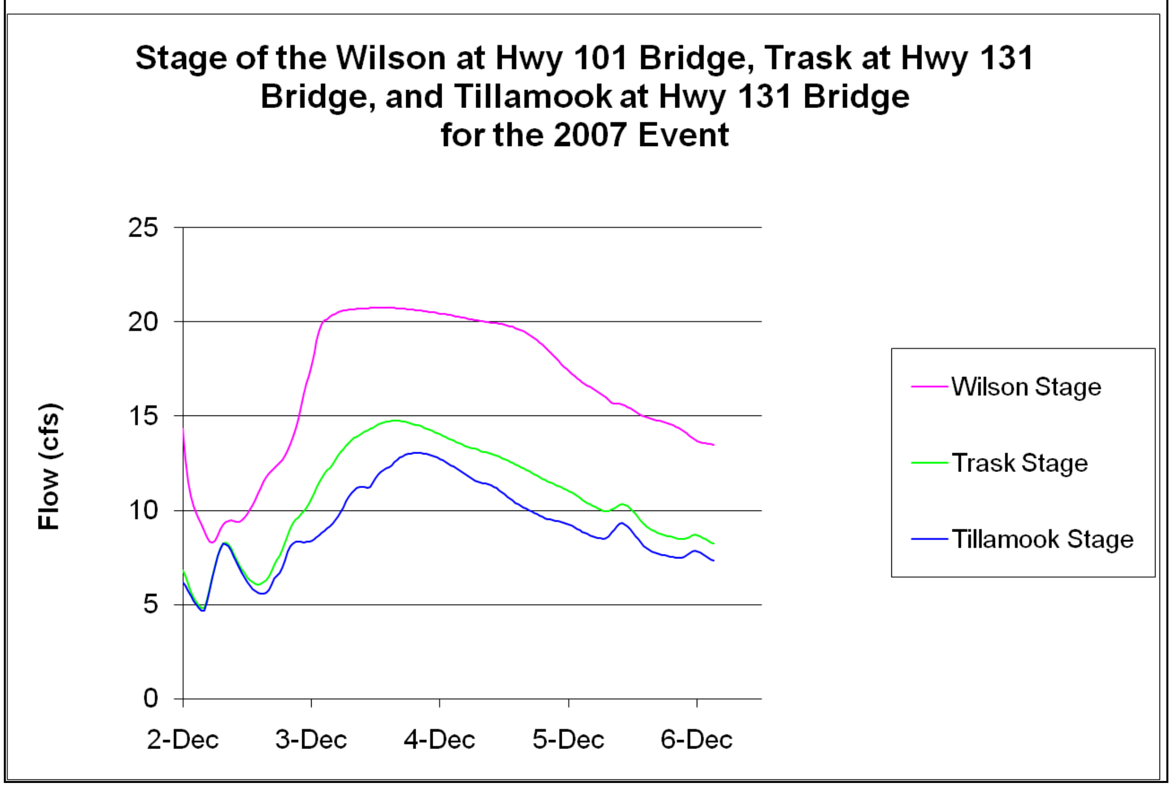

Flow for the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2001 Event
Flow (cfs)
25000
20000
15000
10000
5000
0
-5000
13-Nov
14-Nov
15-Nov
Wilson Flow
Trask Flow
Tillamook Flow

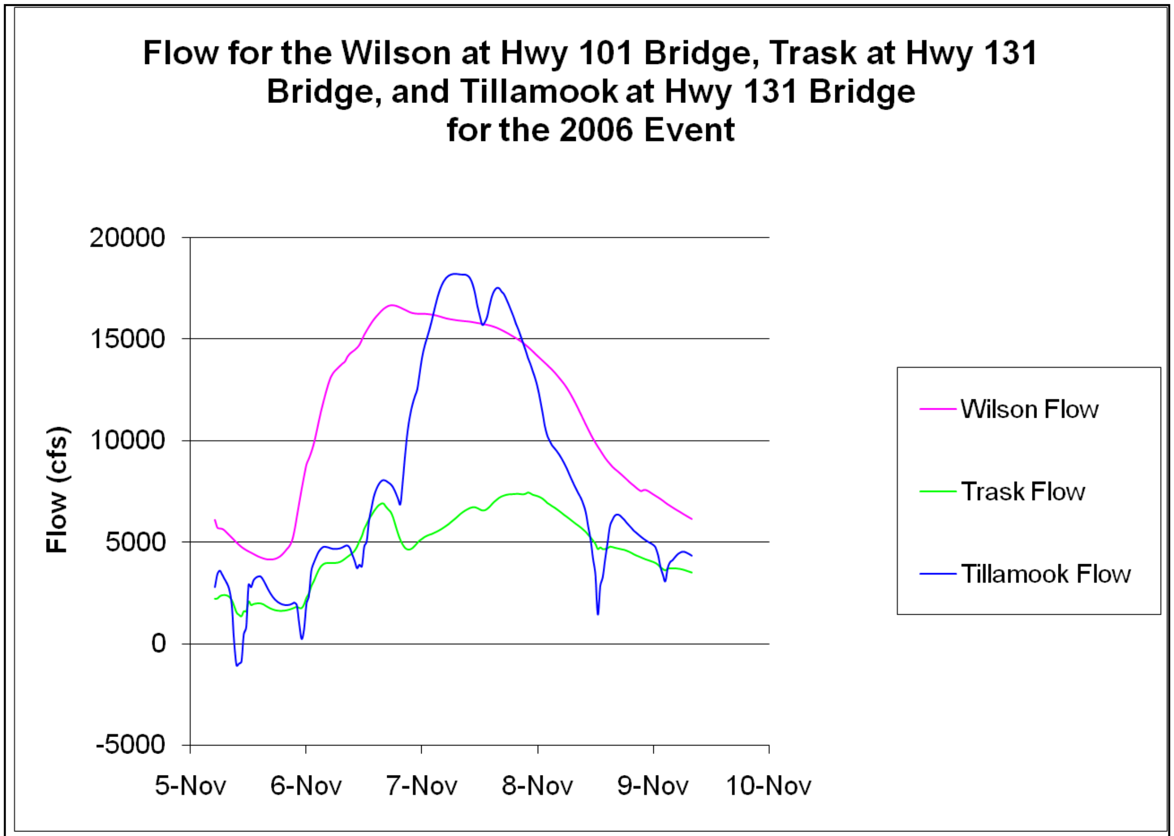

Stage of the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2001 Event
Stage (ft)
25
20
15
10
5
0
13-Nov
14-Nov
15-Nov
Wilson Stage
Trask Stage
Tillamook Stage

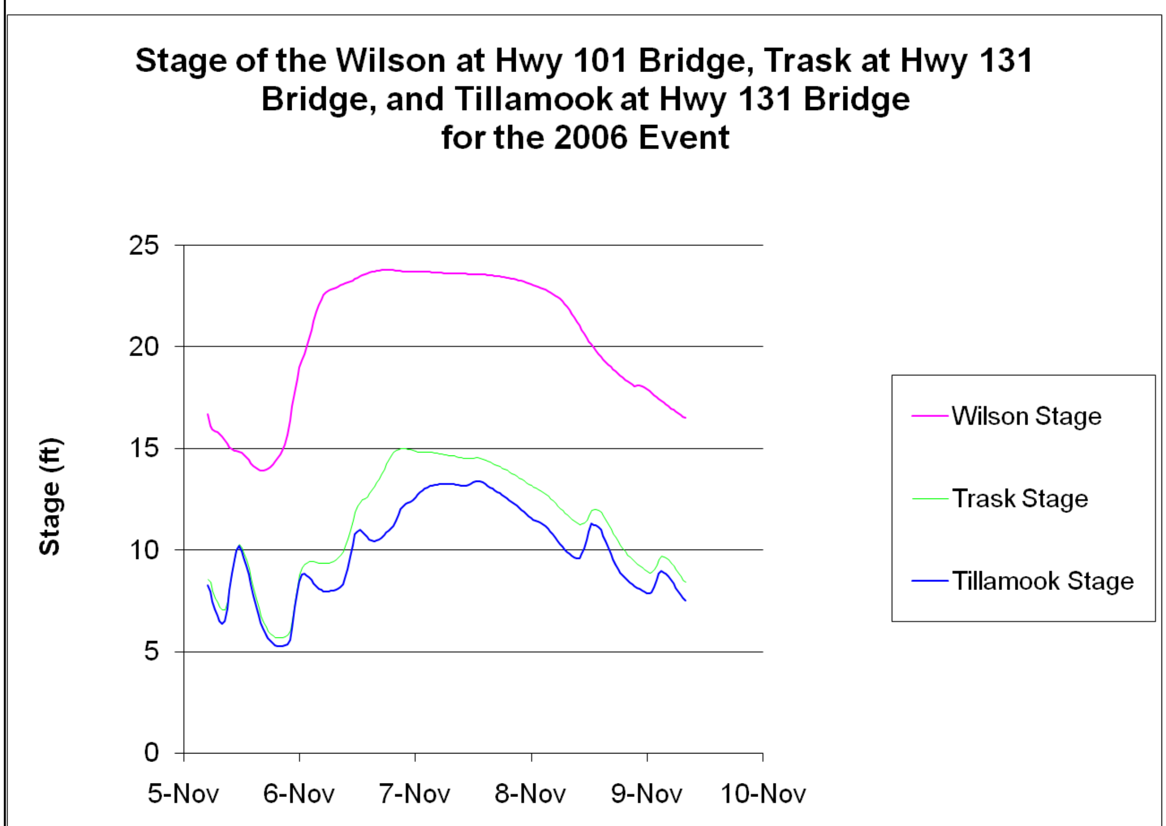

Flow for the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 1999 Event
Flow (cfs)
20000
15000
10000
5000
0
-5000
24-Nov
25-Nov
26-Nov
Wilson Flow
Trask Flow
Tillamook Flow


Stage of the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 1999 Event
Stage (ft)
25
20
15
10
5
0
24-Nov
25-Nov
26-Nov
Wilson Stage
Trask Stage
Tillamook Stage


Flow for the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2007 Event
Flow (cfs)
20000
15000
10000
5000
0
-5000
2-Dec
3-Dec
4-Dec
5-Dec
6-Dec
Wilson Flow
Trask Flow
Tillamook Flow


Stage of the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2007 Event
Flow (cfs)
25
20
15
10
5
0
2-Dec
3-Dec
4-Dec
5-Dec
6-Dec
Wilson Stage
Trask Stage
Tillamook Stage


Flow for the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2006 Event
Flow (cfs)
20000
15000
10000
5000
0
-5000
5-Nov
6-Nov
7-Nov
8-Nov
9-Nov
10-Nov
Wilson Flow
Trask Flow
Tillamook Flow


Stage of the Wilson at Hwy 101 Bridge, Trask at Hwy 131 Bridge, and Tillamook at Hwy 131 Bridge for the 2006 Event
Stage (ft)
25
20
15
10
5
0
5-Nov
6-Nov
7-Nov
8-Nov
9-Nov
10-Nov
Wilson Stage
Trask Stage
Tillamook Stage

The following figures show stage and flow hydrographs in the lower Wilson River at Blind Slough and Tillamook Trask River Confluence for the 2007 flood under existing conditions and for Alternative 4.

At the point the Tillamook River data is shown is it conveying most of the Trask, Tillamook and overbank flows from the Wilson out to the bay. Of note is the very long nearly constant flow and muted stage in the Wilson River compared to the much larger flows and stronger tidal influence in the Tillamook.

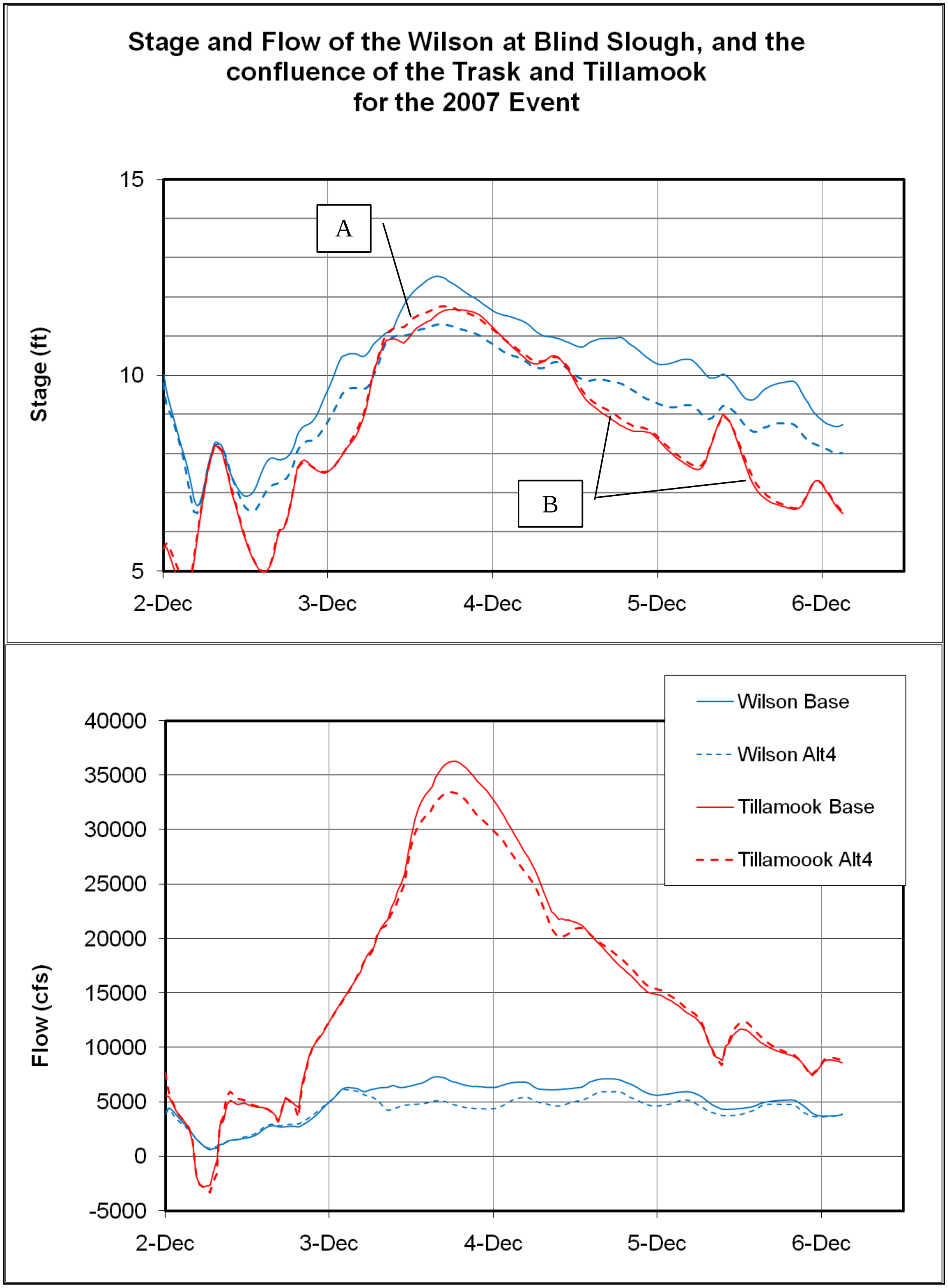
Under existing conditions we show that the Wilson is running around 1 foot higher than the Tillamook. Removing the levees between the two will result in changes to flow and stages in the area. Our modeling shows that net result is that Wilson River stages will drop, as opposed to Tillamook River stages rising, as a result of Alternative 4. We attribute this to the much greater conveyance capacity of the Tillamook River. When combined with the new conveyance through the Wetlands Acquisition area, it is able to take additional flow from the Wilson without causing a significant rise in water levels.

There are changes to flood shape from Alternative 4 on the Tillamook. The two main ones are shown on the figure:

A) The flood rises earlier, without the slight tidal "bump" shown under existing conditions. It also peaks earlier and initially drops slightly faster. For this flood, the peak is 0.02 ft higher than existing conditions. We expect this change would vary with the relative timing of the high tides and arriving flood waves in different floods.

B) As the flood recedes, the ebb tide stages drop slightly slower.

In our judgment, the changes shown are not large enough to cause any measurable adverse impacts in this area. The patterns discussed here hold true for all floods evaluated.


Stage and Flow of the Wilson at Blind Slough, and the confluence of the Trask and Tillamook for the 2007 Event
Stage (ft)
15
10
5
A
B
2-Dec
3-Dec
4-Dec
5-Dec
6-Dec
Flow (cfs)
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
Wilson Base
Wilson Alt4
Tillamook Base
Tillamoook Alt4

Summary:

Most of the observed differences between Wilson River and Trask-Tillamook flows and durations are caused by the hydraulic interactions and flow transfers in the lower valleys, not differences in flows generated in the upper basins.

The Tillamook River and the Wetlands Acquisition Area convey far more flow than the Wilson near the Bay. The combined flows from the Trask, Tillamook and most of the overbank flows from the Wilson must drain though this area. This is the reason Alternatives 3 and 4 show the effectiveness they do- they address the most important conveyance paths for flood flows.

The large increase in conveyance area under Alternative 4 more than compensates for the additional Wilson River flows that now interact with the Tillamook system across the Wetlands Acquisition Area. The net result is Wilson River stages are lowered significantly with very little change to Tillamook River stages.

Alternative 4 is shows greater benefits than alternative 3 because it completely removes the confined flow corridor in the lower Trask and Tillamook Rivers. While the new spillways that have been constructed are highly efficient high capacity structures, the conveyance gained by removing or setting back levees is much greater still.

Alternative 4 provides a greater hydraulic connection between the rivers, and results in slightly faster peak arrival time in the Tillamook-Trask confluence area, and slightly delayed ebb tides after the flood peak is passed. We found no evidence that Alternative 4 could cause adverse impacts within the range of variation of flows shown in the historic record.

We agree with Leo Kuntz's comments regarding northbound flood water flows. Big Cut and Little Cut are less effective than might be expected given their position. We believe this is likely due to the fact they flow to the mouth of the Kilchis system. This likely causes backwater effects up Big and Little Cut due to coincident flooding that reduces their conveyance. We have also noted sensitivity in the model to bank elevations in the lower reaches of the Wilson below the cuts. This indicates that project elements that lower bank elevations here could be effective in getting Wilson River floodwaters into the Bay more directly.

The Blind Slough project proposed several years ago developed plans to remove some fill in this area and lower the bank to natural elevations. This could be added as an element to either Alternative 3 or 4.

Another small project that could be tried would be to cut some small notches in the north bank of the Wilson. These would initially spill water northward when the Wilson was high. We see this as somewhat experimental – the notches may develop into tidal channels and continue to convey flows, or they may refill with sediment and build back up to natural bank height relatively rapidly-, but it would be a low-risk, low cost project to implement.