SOUTHERN FLOW CORRIDOR: AS-BUILT PROJECT VALIDATION OF PEAK WATER LEVEL REDUCTION DURING THE OCTOBER 2017 FLOOD

FINAL REPORT

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EXECUTIVE SUMMARY

One of the key benefits of the Southern Flow Corridor (SFC) project is the reduction in flood levels that is projected to occur over a wide area of the lower Wilson, Trask, and Tillamook River floodplains. These predicted flood level reductions are based on numerical modeling of a range of floods. Validation of the expected flood level reduction is included as part of the post-project monitoring effort.

In October 2017, shortly after completion of the project, a flood occurred that offered the first opportunity to validate the projected flood level reductions. This flood was about a 5-year event on the Wilson River and a 3-year event on the Trask River. Tides were moderate during the event.

The SFC hydraulic model was updated to reflect as-built project conditions and re-calibrated to an extensive high water mark (HWM) dataset from the October 2017 flood. The new calibration results show a substantial improvement in accuracy over past modeling efforts. The model was then run with pre-project conditions in place. The difference in simulated maximum water surface elevation between pre- and post-project conditions was calculated. Predicted peak flood level reductions were also compared with results from prior modeling of the 1999 flood, which was almost identical in magnitude on the Wilson River, but larger on the Trask River.

Model results for the October 2017 flood show the SFC project resulted in widespread reduction in flood levels, including decreases of up to 0.7 feet along the Highway 101 corridor in North Tillamook. The duration of flooding on Highway 101 was reduced by 3-4 hours. Increases in flood level were negligible (<0.03 feet) and limited in area. In all, about 4,800 acres showed some reduction in peak flood level. The results were consistent with prior modeling of the similarly sized 1999 flood event.

The conclusion is that the SFC project has met the desired project objectives for flood level reduction during floods of around a 5-year return interval. The consistency in results also gives additional confidence in projecting that the SFC project will provide significant flood level reduction over the full range of flood events as was predicted during the design phase modeling.

1 INTRODUCTION

1.1 Purpose

This report documents numerical hydraulic modeling of the October 2017 flood in Tillamook, Oregon, with a focus on the impacts due to the Southern Flow Corridor (SFC) project. The purpose of the modeling was to document the as-built project performance in meeting the flood level reduction objectives - the flood level reductions predicted by prior modeling efforts in the project design phase formed one of the key justifications for project implementation.

1.2 Background

The SFC project, completed in 2017, is a large-scale flood relief and habitat restoration project in Tillamook, Oregon. Major project elements related to flood level reduction and flood control consisted of the removal of over seven miles of existing levee, removal of floodplain fills, construction of three separate setback levees, and construction of one flood gate structure. Additional project elements included extensive habitat restoration efforts and agricultural drainage improvements.

From the initial alternatives analysis stage that began in 2008, hydraulic modeling has been a key tool in determining the effectiveness of the SFC project in reducing flood levels, a key project objective[1]. In 2011, FEMA required a formal benefit-cost analysis (BCA) for the SFC project as a prerequisite for obtaining project funds. The BCA indicated the project would create positive economic benefits by reducing flood damages[2] through the reduction in flood levels. Flood level data was taken directly from hydraulic modeling of the project. Further model refinements were conducted in 2015, when updated channel bathymetry was incorporated into the model and an external peer review was completed as part of the Environmental Impact Statement (EIS) undertaken for the project[3]. During construction in 2016-2017, the model was again updated to reflect changes to the design that occurred and ensure project benefits would not be adversely impacted.

Additional key funding came from NOAA Fisheries. NOAA funded not only design and construction, but extensive pre- and post-project monitoring efforts. Usually, these efforts are focused on habitat processes. In this case, given the project's stated flood level reduction benefits, NOAA took the unusual step of also funding post-project monitoring of flood levels. The purpose of the post-project monitoring is to determine if the project is functioning as expected, based on the pre-project modeling results. This

[1] NHC, 2010. Project Exodus Final Report, prepared for Oregon Solutions Design Team under contract to Tillamook County. February 2010.

[2] NHC, 2011. Southern Flow Corridor Benefit-Cost Analysis, prepared for Oregon Solutions Design Team under contract to Tillamook County. May 2011.

[3] FEMA, 2015. Final Environmental Impact Statement, Southern Flow Corridor Project, DR-1733-OR, Tillamook County, OR. October 2015.

includes the extents of flood level reduction, any areas of flood level increase, and the magnitudes of change in flood level. Figure 1 and Figure 2 show the predicted change in flood depths due to the project from the EIS model – the area of flood level reduction expected from pre-project modeling ranged from about 1,000 acres in the 2001 flood (a 1.5-year event), 5,000 acres in the 1999 flood (about a 5-7-year event), and 3,500 acres in the 100-year event. In all events, the maximum reductions occur in the area downstream of Highway 101 in North Tillamook and Highway 131 on the Trask and Tillamook Rivers. However, thousands of additional acres of minor flood level reduction can occur upstream on the Tillamook River floodplain upstream for moderate floods such as the 1999 event. Combined, around 6,000 acres in total could see some flood level reduction benefit under certain flood and tide conditions.

Another important parameter is the extent of flood level increases under various floods; the expectation is that flood level increases will be limited to two areas of undeveloped agricultural land and these increases will only occur during the smallest events. The post-project monitoring also offers the opportunity to use new observed HWM and water level data to recalibrate the model and increase confidence in the results, as all prior modeling used limited observed data from floods occurring between 1999 and 2007.

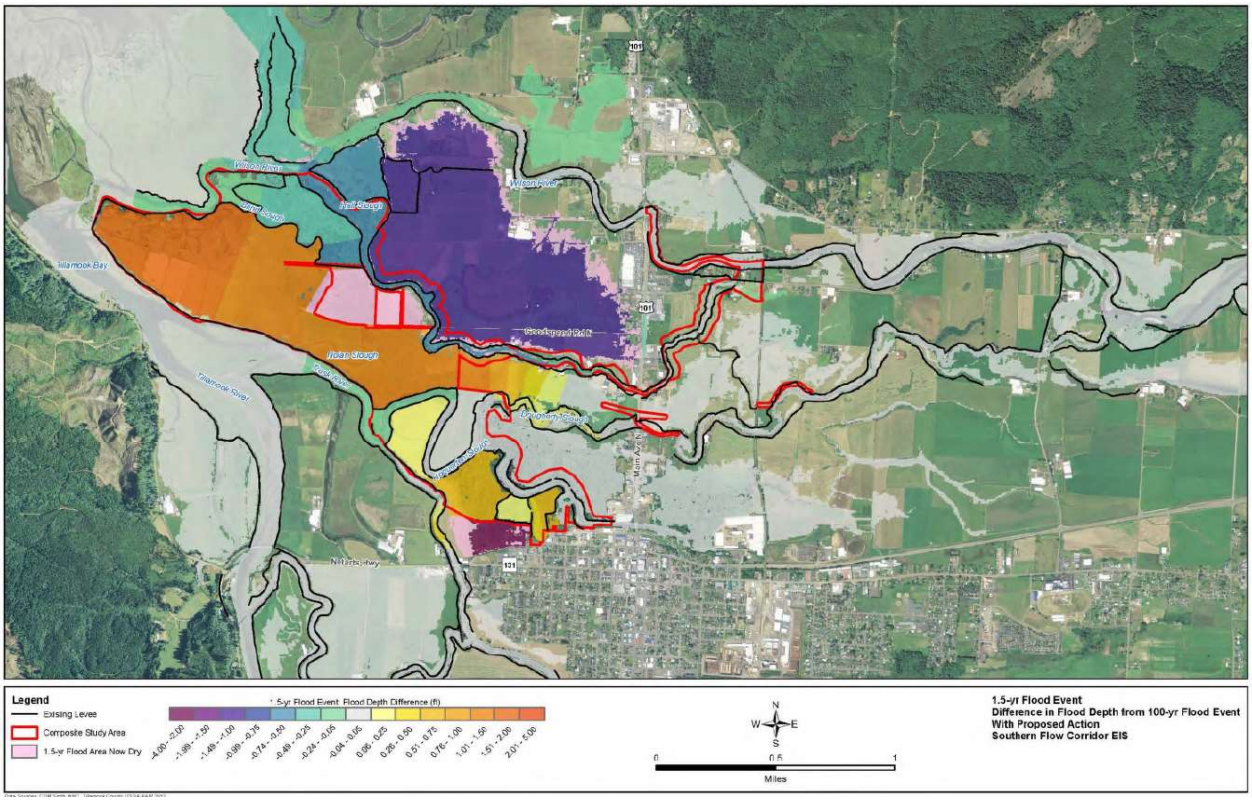


Figure 1: 1.5-year Flood Predicted Difference in Flood Depths from the SFC EIS

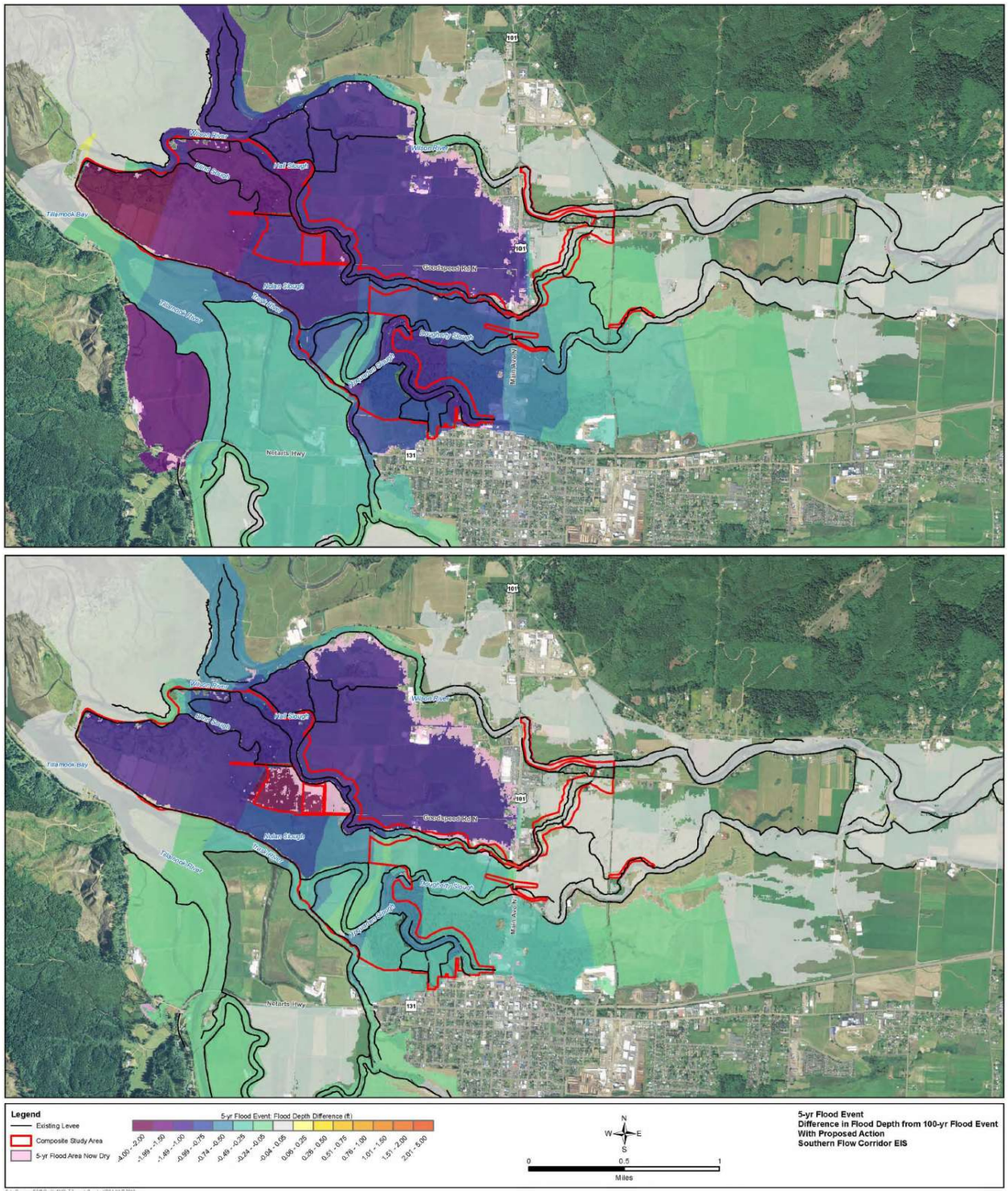


Figure 2: 100-year Flood (top) and 5-year Flood (bottom) Predicted Difference in Flood Depths from the SFC EIS

1.3 Flood Level Reduction Effectiveness Monitoring Approach

The ideal test of project performance would be direct comparison of measured HWMs for two identical floods that occurred both pre- and post-construction cannot be performed. However, due to the infrequent and unique nature of each flood, the probability of observing floods post construction that exactly match those that occurred pre construction is extremely small, even considered over many decades.

Therefore the most reasonable approach is to continue use of the hydraulic model. The project design phase used a model calibrated to pre-project flood events, which was then used to simulate with-project conditions. The project validation phase reverses this approach. With the project constructed, the method selected was to wait for a flood to occur to allow the collection of flood data, update and calibrate the model to as-built, post-project conditions, then simulate the system as if the project had not been implemented. The difference in flood levels between the two cases could then be compared with the predicted changes from the design phase and the effectiveness of the project in meeting stated flood level reduction goals evaluated. This approach also allows qualitative comparisons between pre- and post-project floods that may be similar in magnitude.

In addition, the project is predicted to provide increasing flood level reductions with increasing flood size. Once a few post-construction floods of varying magnitudes have been modeled, this predicted trend in flood level reduction can also be compared to the pre-project modeling results. Fortunately, the expectation was that the project will reduce flood levels even in very frequent events, so the probability of a suitable initial flood occurring within a few years of finishing construction was high.

2 OCTOBER 2017 FLOOD

A suitable flood for post-project monitoring occurred shortly after completion of the project in October 2017. Wilson River flows at the United States Geological Survey (USGS) gage reached 24,600 cubic feet per second (cfs), while the Trask River peaked just below 15,000 cfs (Figure 3). High tide during the flood peak on October 22, 2017 was 9.07 feet MLLW datum, or 8.74 feet NAVD88 datum, at the NOAA Garibaldi tide gage 9437540.

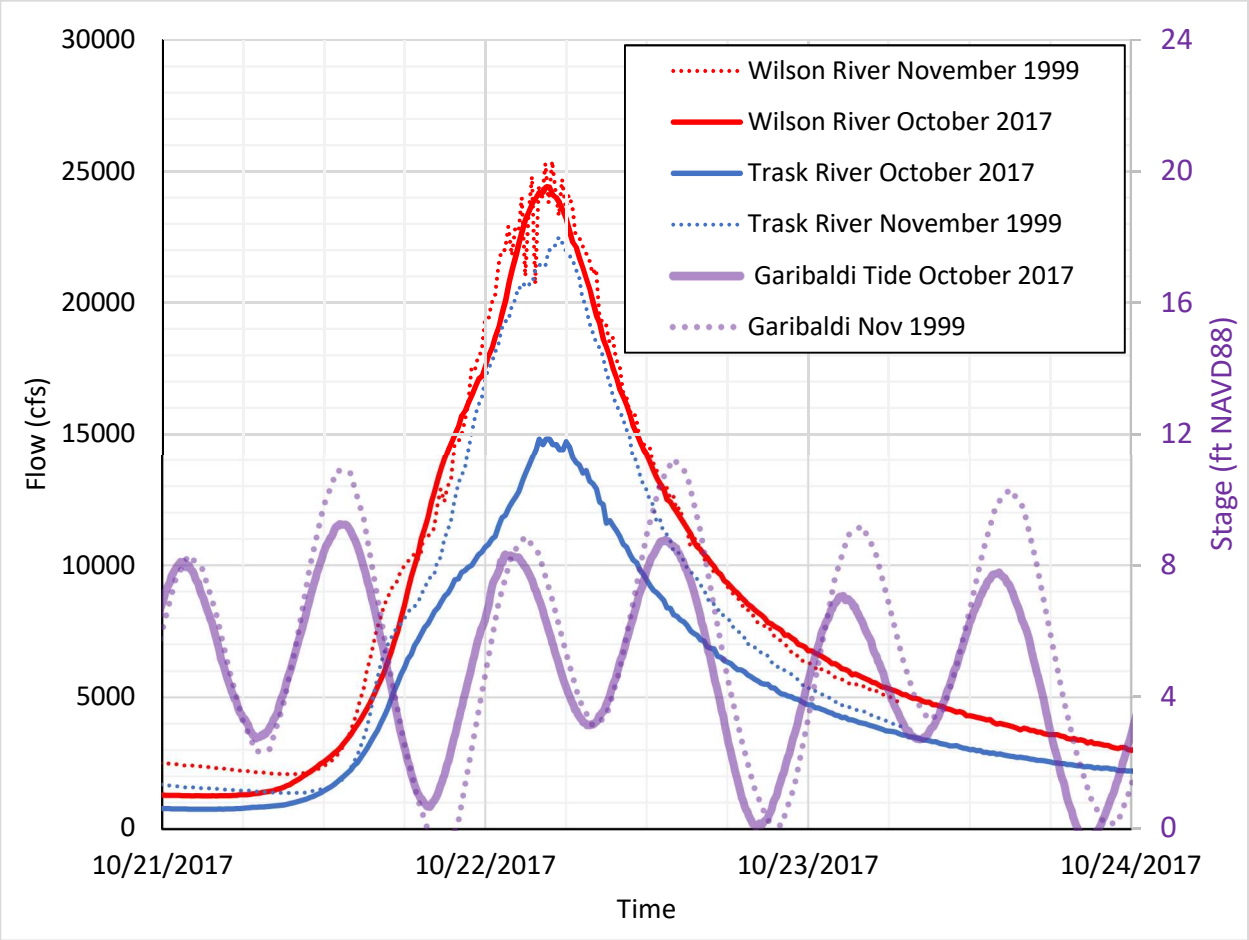


Figure 3: October 2017 and Shifted November 1999 Flood Hydrographs for the Wilson and Trask Rivers, and Garibaldi Tides

Updated flood frequency estimates for the two rivers were obtained using HEC-SSP software[4]. The full 87-year systematic record for the Wilson River was used. For the Trask River, peak flows are available from water years 1922 and 1933-1973 at historic gage 14302500, and from water years 1996-2018 at gage 14302480, located a short distance upstream. The results indicate that the peak flow of 24,600 cfs on the Wilson River was a 5-year flood event, while the 14,800 cfs peak flow on the Trask River was about a 3-year event. For a Wilson River flow of around 25,000 cfs, Trask River flows are expected to range from around 13,000 cfs to 23,000 cfs based on the historic record; the October 2017 flood falls slightly below the average (Figure 4).

[4] www.hec.usace.army.mil/software/hec-ssp

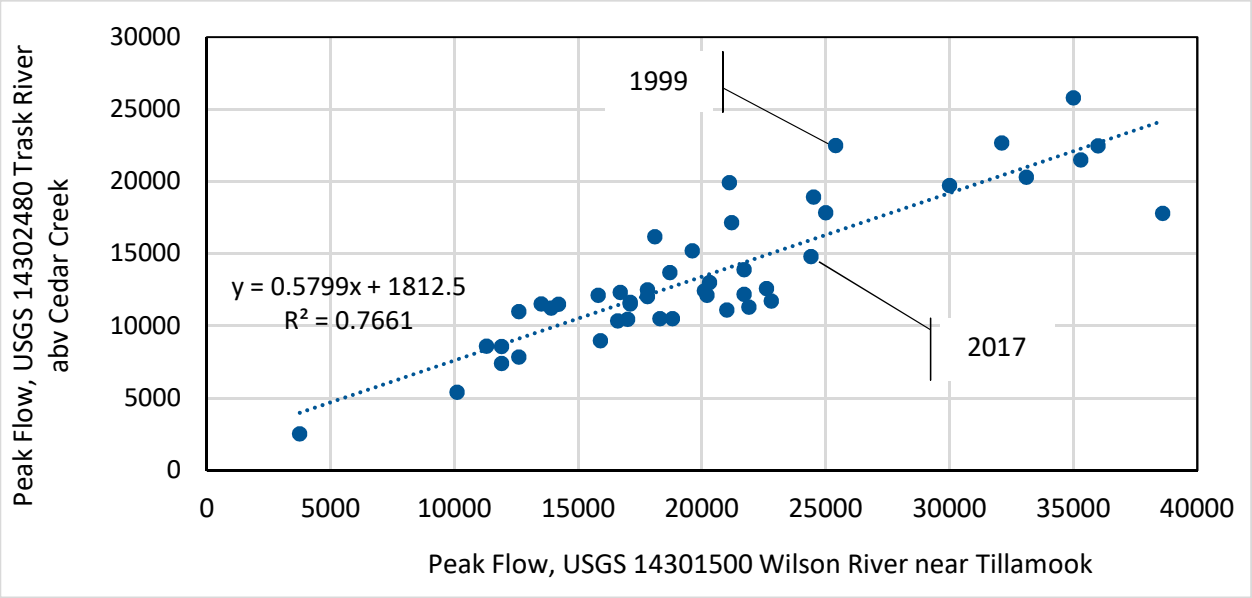


Figure 4: Concurrent Peak Flows on the Wilson and Trask Rivers[5]

The 1999 flood was modeled extensively during the project design phase for use in predicting flood level reduction benefits. This flood is the most similar to the October 2017 flood of those modeled during the design phase, allowing comparisons of model accuracy and predictions across the pre- and post-project phases[6]. Wilson River flows were virtually identical to the November 1999 flood, while Trask River flows were significantly less in 2017 than 1999 (Figure 3). Compared to the historic record, Trask River flows in 1999 were high relative to the Wilson River (Figure 4). Tides were also significantly lower in the October 2017 flood compared to the November 1999 flood (Figure 3).

3 MODEL SIMULATIONS

3.1 Model Geometry Updates

The with-project model geometry was updated to reflect as-built conditions. All existing levees that were removed (simulated as lateral or inline structures) were updated with ground surveyed finish elevation points. Similarly, the surveyed profiles of the three new levees were added to the model, along with all new flap-gated culverts and the new flood gate structure. The location of the middle levee

[5] Trask River flows are a composite of USGS stations 14302480 and the previous gage 14302500, located a short distance downstream. Data is from water years 1933-1956, 1962-1973, and 1996-2018. Years where the annual peaks were more than one day apart are not shown.

[6] The other floods modelled in the design phase were the 2001 flood, a 1.5-year event, the 2006 and 2007 floods, both greater than 20-year events, and the FEMA 100-year flood.

was moved one section downstream to better reflect its actual alignment. Cross section modifications based on survey data were used to simulate the fill removal in the Old Mill Site along Hoquarton Slough.

3.2 Boundary Conditions

Primary inflows to the model consist of the Wilson, Trask, and Tillamook Rivers. Published USGS flows for the Wilson and Trask Rivers were used, with some minor adjustment to Wilson River flows discussed in the calibration section of this report. The Tillamook River and all other smaller tributaries are ungaged. Tillamook River mainstem and tributary flows were estimated by scaling Trask River flows. The scaling factors were based on the ratio of predicted 2-year flood peaks for each river at the model boundary, as calculated by the USGS Streamstats website (www.streamstats.usgs.gov/) using regional regression equations[7]. The Little North Fork Wilson River was similarly scaled to the published USGS Wilson River flows based on the peak flow ratio. All other minor tributary inflows used the 1999 flood inflows, shifted in time to match the mainstem peaks for the October 2017 event. There are numerous steady-state baseflows used throughout the model to keep floodplain model reaches stable; these were not changed from prior modeling. Tidal boundary conditions were taken from published NOAA data for the Garibaldi tide gage, adjusting to the NAVD 1988 vertical datum using a correction factor obtained from the Tillamook County Surveyor.

3.3 Calibration

An initial simulation was made using as-built project conditions with all other model parameters unchanged from the pre-construction hydraulic model. Prior model calibration had used the 1999, 2006, and 2007 floods for calibration, with the 1999 event being the closest in magnitude to the October 2017 flood. The model's accuracy when compared to the HWMs was mediocre, so the decision was made to re-calibrate the model.

3.3.1 Observed Data for Calibration

Calibration data consisted of a set of 51 HWMs collected by NHC shortly after the flood, five water level logger datasets from the Institute for Applied Ecology (IAE), and USGS published stage for the Sollie Smith gage on the Wilson River. The locations of the gages and high marks used in the calibration are shown in Figure 5.

[7] Cooper, R.M., 2005, Estimation of peak discharges for rural, unregulated streams in Western Oregon: U.S. Geological Survey Scientific Investigations Report 2005–5116, 134 p.

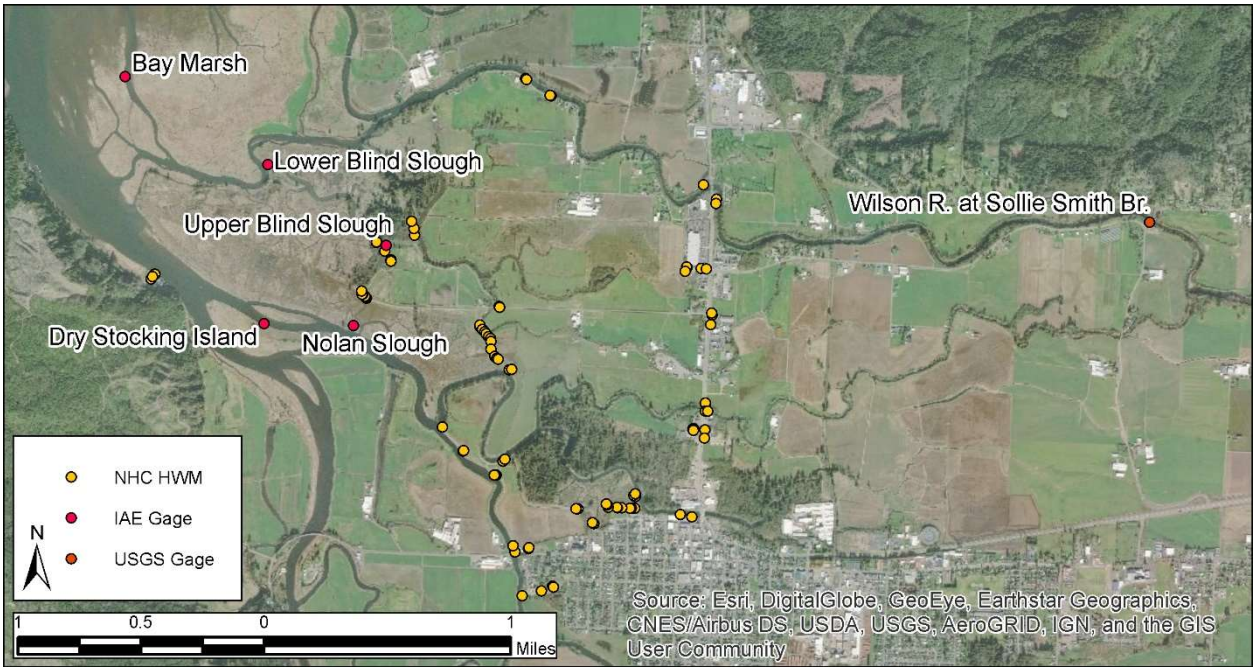


Figure 5: High Water Mark and Gage Locations

Wherever possible, multiple high marks were collected at each location to help validate the results. Where multiple HWMs were taken at a location, the mean or median result was used as a single data point for comparison with model results so as not to skew calibration statistics. Nine HWMs were rejected for use based on their being significantly lower than adjacent HWMs. The final aggregated dataset consists of 21 HWMs.

Two of the four IAE water level logger datasets were adjusted by NHC. The Lower Blind Slough logger showed an abrupt drop of 0.25 feet at the peak of the flood, consistent with the gage being bumped by flood debris. All stages after this time were adjusted upwards by 0.25 feet. The Bay Marsh gage data was delivered to NHC as depth only, due to the damaged condition and inability to survey a water level at the gage after the flood. NHC created an estimated water surface elevation dataset for this gage by adjusting the water level data until high tides at the gage during low river flow conditions closely matched high tides at the other four nearby IAE gages and the NOAA Garibaldi tide gage. The accuracy of the method is believed to be within a few tenths of a foot. The USGS Sollie Smith gage data was adjusted to the NAVD88 datum from the gage datum (NGVD29) using a corrector value of 3.41 feet obtained from Vertcon (www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl).

3.3.2 Calibration Methods

Calibration was conducted by adjusting flows, roughness values, lateral weir elevations, and lateral weir flow coefficients. Wilson River inflows were increased by 5 percent from the USGS published values. While the flow increase was applied to the Wilson River itself for simplicity in modeling, it represents the uncertainty in both mainstem and ungaged tributary inflows to the river. We note this increase is well

under the 10 percent uncertainty in peak flow estimates that most river gages will have. No other flows were adjusted.

A few lateral weir elevation profiles, weir coefficients, and channel roughness values were adjusted in order to balance flows and stages between parallel branches in the model. The adjustments were made on the Wilson River floodplain, mostly between Hoquarton and Dougherty Sloughs upstream of Highway 101. Adjustments to lateral weir elevation profiles were made using LiDAR data.

3.3.3 Calibration Results

Final calibration results comparing maximum simulated water surface elevations to observed HWMs are shown in Table 1 for all locations (including gages). In addition, Figure 6 through Figure 11 show comparison of time series results at five gage locations.

Summary statistics for the errors from Table 1 are shown in Table 2. Overall, the calibration shows no systematic bias, with a mean error near zero, and good measures of overall error with no large outliers, as shown in the mean absolute error and root-mean-square error metrics. This is substantially improved over the calibration results for the very similar 1999 flood under pre-project conditions, which are shown for comparison. (The 1999 results are from the project EIS modeling effort conducted in 2015.)

Simulation results generally matched observed flood and tidal hydrographs, with the best match during high tides and at the flood peak, and poorer performance during low tides. The time of peak flood level was about two hours early at the Sollie Smith gage (Figure 6) and six hours early on the lower gages where tidal effects are apparent. The model tends to over-simulate flood recession stages at all locations.

Overall, the model simulated peak flood levels well throughout the SFC area of project influence, and substantially better than prior modeling efforts of the similar 1999 flood. The HEC-RAS model used here has its origins in the early 2000s from the Corps of Engineers; this model version, used for the October 2017 flood, is the best calibrated of all model iterations to date.

Table 1: High Water Mark Calibration Results

No.	Model River Name	Reach	River Station	Simulated (ft)	Observed (ft)	Diff (ft) (Sim - Obs)	Location
1	Do-Tr Wils 0.73	Reach 1	-381	10.26	10.30		Blind Slough at SFC North Levee
2	Do-Tr Wils 0.73	Reach 1	-1556.62	9.57	9.90		Blind Slough at Wilson River*
3	Doug tras 0.85	Reach 1	-531.2	14.71	14.70		Highway 101 U/S Side at Blue Heron Road
4	Doug tras 0.85	Reach 1	-1788	12.09	11.60		U/S of SFC Middle Levee
5	Doug tras 0.85	Reach 1	-2010.41	11.29	11.20		D/S of SFC Middle Levee
6	Doug tras 0.85	Reach 1	-2590	10.14	10.20		Mouth of Nolan Slough at Trask River*
7	Dougherty Slough	Reach 3	-4730.6	14.42	14.60		Dougherty Slough U/S side of Hwy 101
8	Hall	Reach 1	-3854.2	10.42	10.70		Hall Slough at NE corner of SFC North Levee
9	Hall RB 3.00	Reach 1	-423.69	13.12	12.50		Hwy 101 U/S side near Fred Meyer
10	Hall RB 3.00	Reach 1	-472	12.27	12.50		Hwy 101 D/S side near Fred Meyer
11	Hoqu RB 2.20	Reach 1	-705.5	13.97	14.30		Hwy 101 U/S side at Hadley Road
12	Hoqu RB 2.20	Reach 1	-900	13.96	14.30		Hwy 101 D/S side at Hadley Road
13	Hoquarton Slough	Reach 3	-6280.6	13.50	13.90		Hwy 101 D/S of Hoquarton Slough Bridge
14	Hoquarton Slough	Reach 3	-6906.9	13.11	13.40		East end of SFC South Levee near Hospital
15	Hoquarton Slough	Reach 3	-7257.9	13.06	12.90		Middle of SFC South Levee
16	Hoquarton Slough	Reach 1	-8802.2	11.73	11.40		Hoquarton Slough at SFC Middle Levee
17	Tillamook River	Reach 2	-12198.2	9.48	9.68		Dry Stocking Island
18	Tillamook River	Reach 2	-12100	9.54	9.70		Memaloose Boat Launch
19	Trask River	Reach 2	-15397.2	14.06	13.80		Carnahan Park Boat Ramp
20	Trask River	Reach 2	-15887.7	13.34	12.70		Trask River D/S of Netarts Hwy Bridge
21	Trask River	Reach 2	-16636.1	12.36	11.60		Trask River near Hospital Hole
22	Trask River	Reach 1a	-17915.5	10.49	10.36		Trask River at Nolan Slough Mouth*
23	Wilson River	Reach 7	-8942.9	29.69	29.36		USGS 14302020 Wilson River at Sollie Smith Bridge
24	Wilson River	Reach 7	-12282.*	21.90	21.60		Wilson River U/S of Highway 101 Bridge
25	Wilson River	Reach 7	-12323.*	21.75	21.40		Wilson River U/S of Highway 101 Bridge
26	Wilson River	Reach 7	-12502.*	20.79	20.80		Wilson River D/S of Highway 101 Bridge
27	Wilson River	Reach 7	-13904.5	15.68	16.00		Wilson River along Makinster Road
28	Wilson River	Reach 7	-14341.9	14.72	15.30		Wilson River along Makinster Road
29	Wilson River	Reach 4a	-16261	9.57	9.90		Wilson River at mouth of Blind Slough*

Notes:

1. Difference column – red colors indicate negative error and blue positive. Intensity of color indicates magnitude of deviation from zero error.
2. Location column – * indicates single observed high water mark used twice in table (No 2/29 & 6/22)

Table 2: Summary Error Statistics in Feet for October 2017 and November 1999 Flood Simulations

Flood	n	Mean Error	Mean Absolute Error	Root Mean Square Error	Max Error	Min Error
October 2017						-0.58
November 1999	19		0.77	1.12	2.73	-3.42

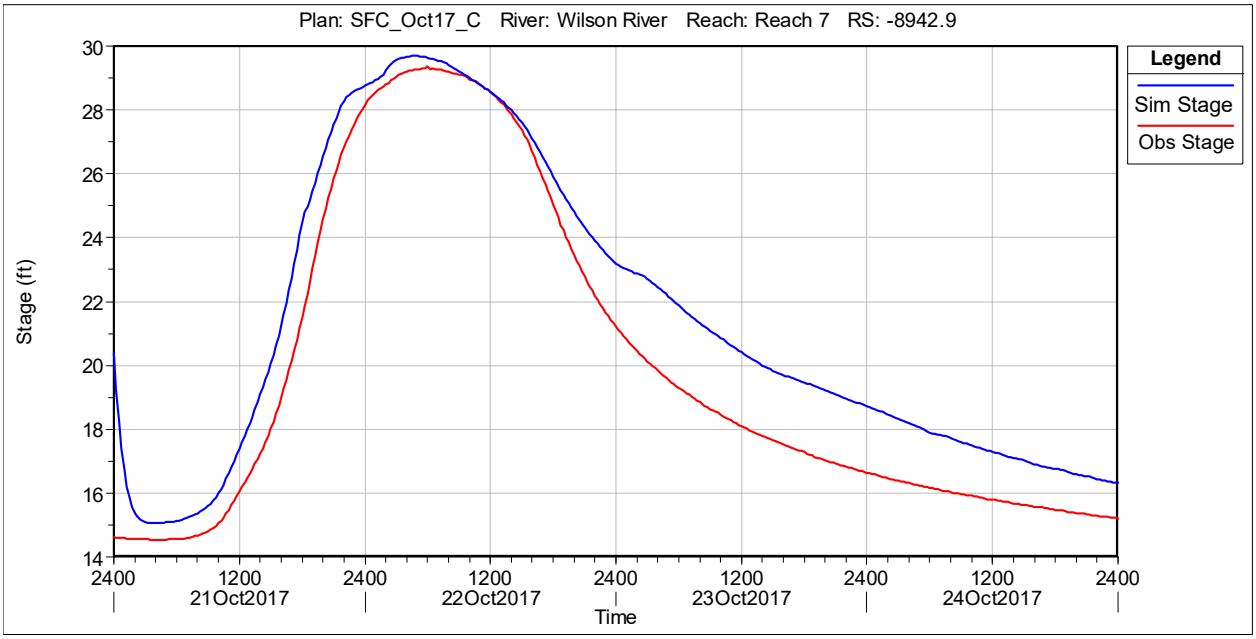


Figure 6: Simulated and Observed Stage at USGS 14302020 Wilson River at Sollie Smith Bridge Gage

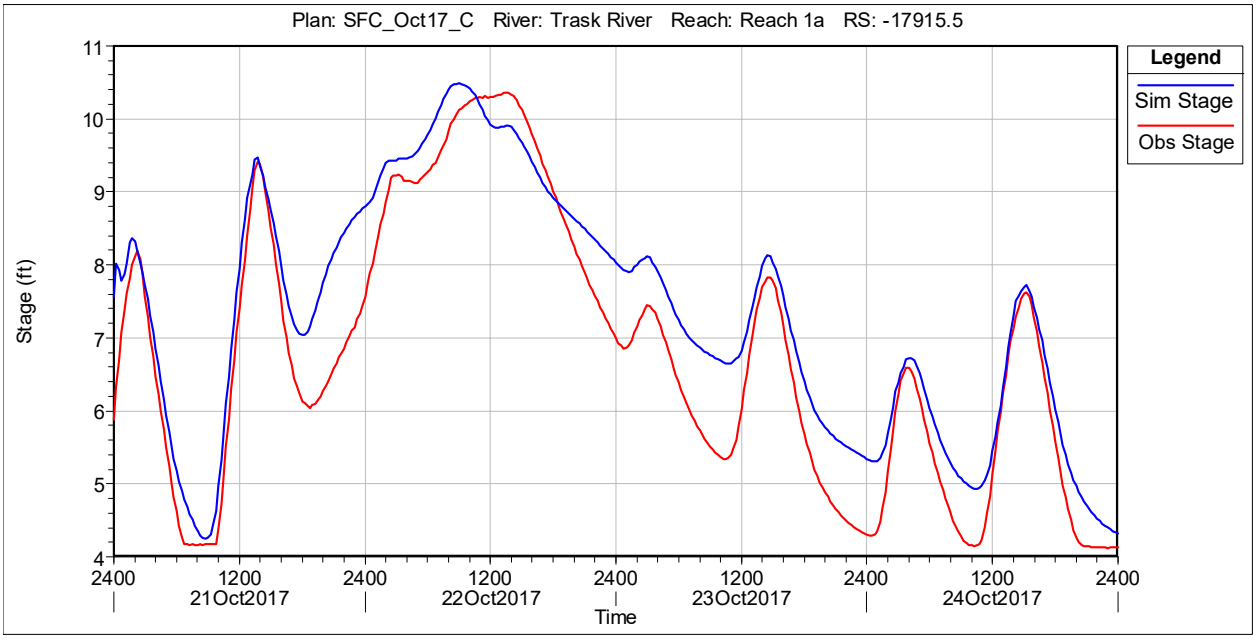


Figure 7: Simulated and Observed Stage at IAE Nolan Slough at Trask River Gage

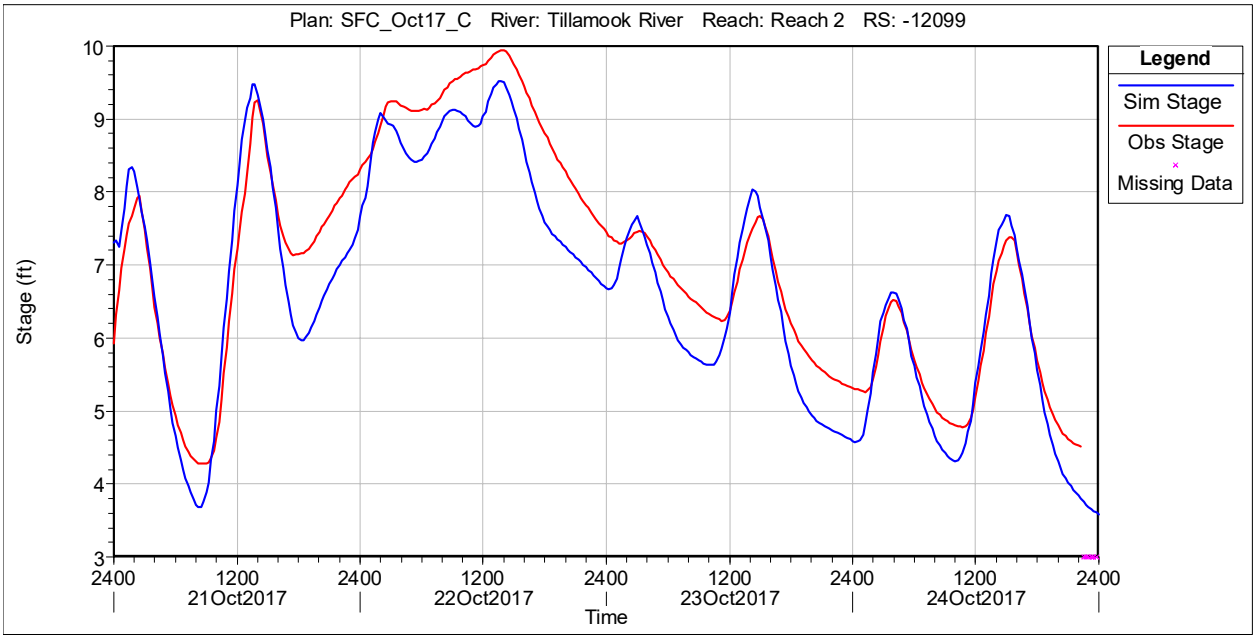


Figure 8: Simulated and Observed Stage at IAE Dry Stocking Island, Tillamook River Gage

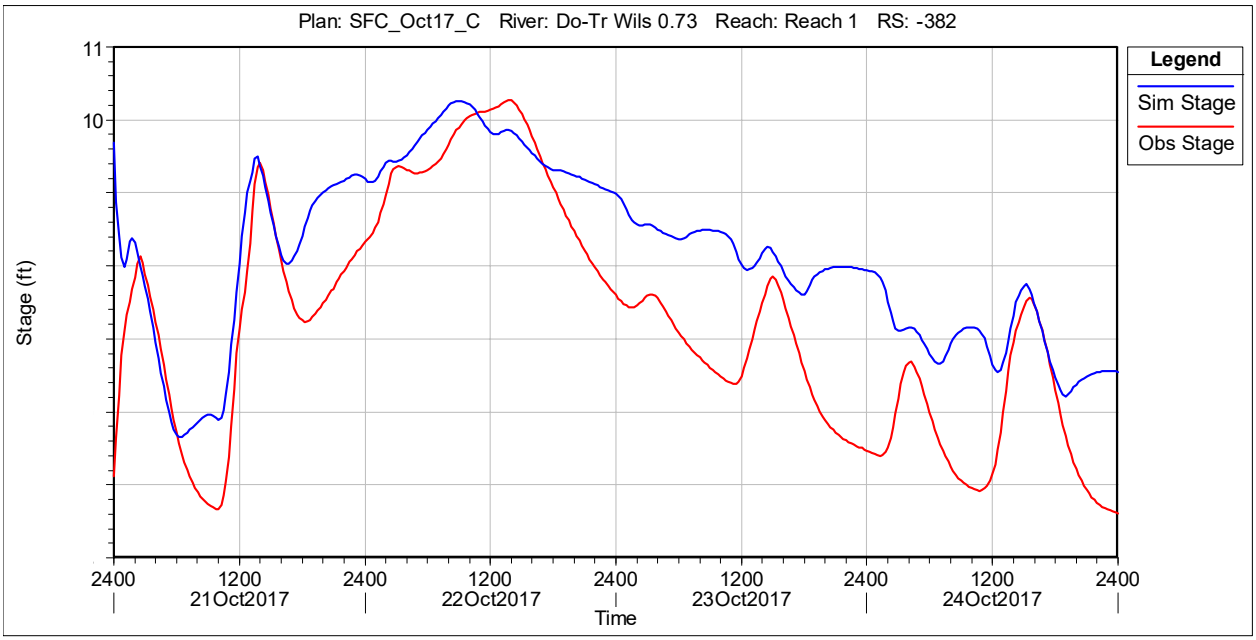


Figure 9: Simulated and Observed Stage at IAE Upper Blind Slough Gage

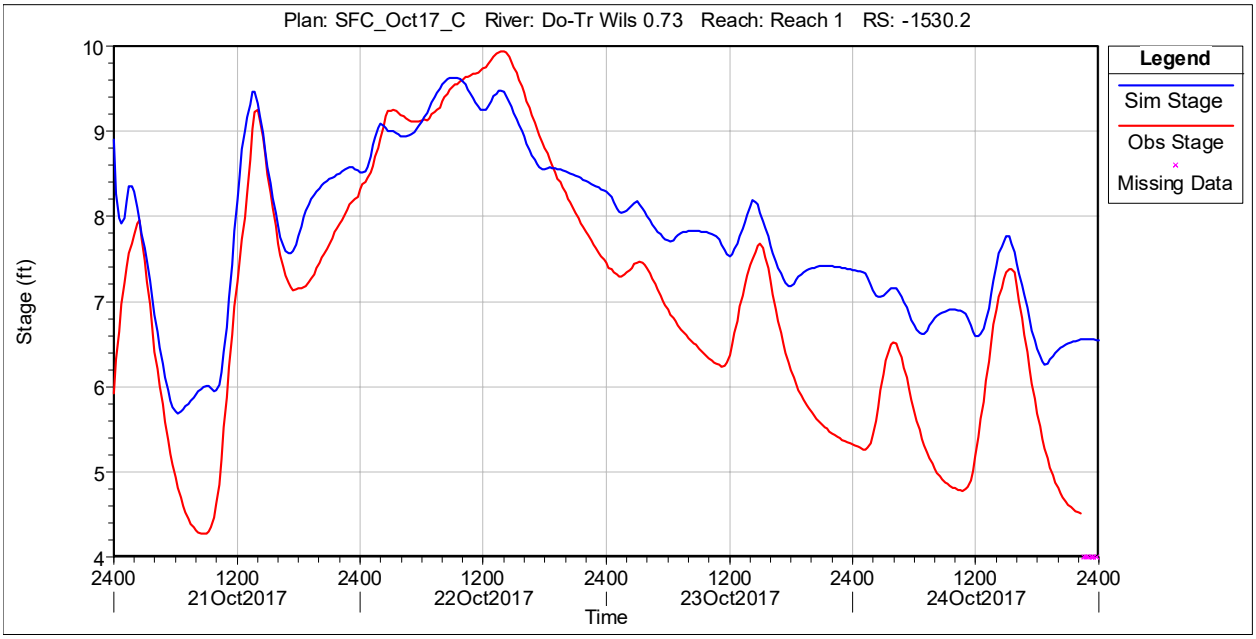


Figure 10: Simulated and Observed Stage at IAE Lower Blind Slough Gage

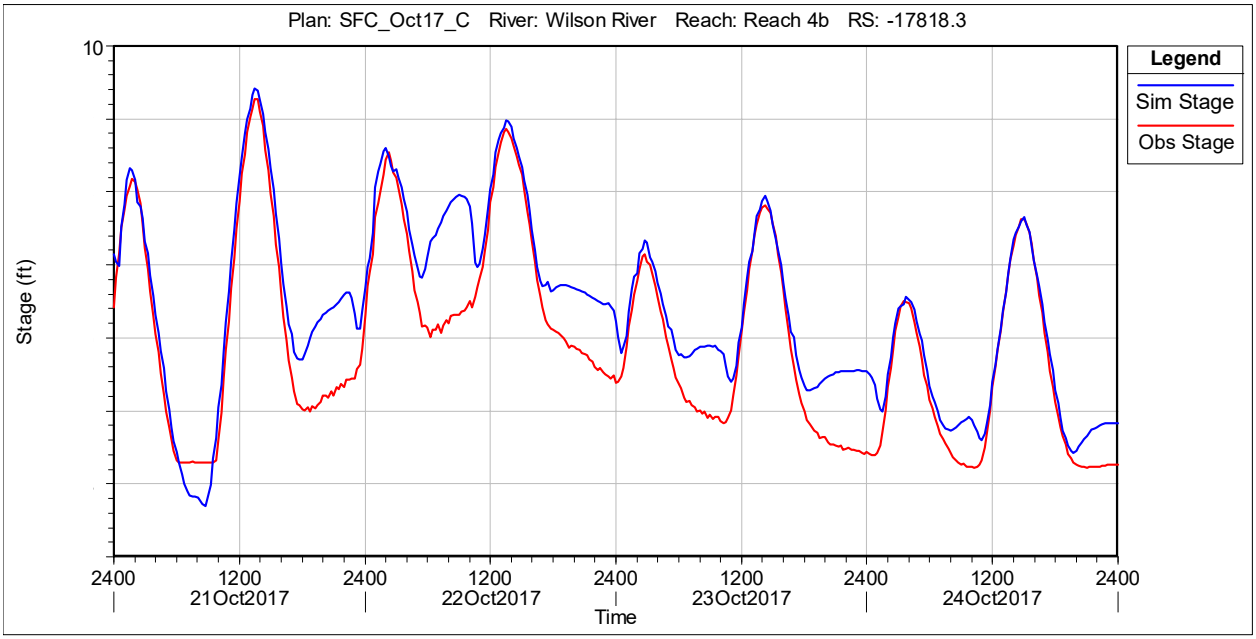


Figure 11: Simulated and Observed Stage at IAE Bay Marsh Gage

3.4 Pre-Project Conditions Simulation

Once the post-project model was calibrated, the pre-project model was modified to reflect all changes made to model parameters that were outside of the project area of construction. This ensured that the only differences between the models were those directly related to the project. The pre-project model was run with identical boundary conditions and the results processed for comparison with the post-project model.

4 RESULTS

Results for pre- and post-project conditions, and the difference between the two, are tabulated at every model cross section in Appendix 1. The locations given in Appendix 1 are shown on Figure 13 and Figure 14. Maximum depths, water surface elevations, and the difference between pre- and post-project water levels are shown graphically in Figure 15 through Figure 21.

Flood level decreases extend about 3.8 miles up the Tillamook River and 3.4 miles on the Trask River. This results in less overtopping of the levees along these rivers and consequent reductions in water level over a large area of floodplain between the Trask and Tillamook Rivers.

On the Wilson River floodplain, reduction in flood level extends upstream the farthest along the southern valley edge. Reductions within the main Wilson River channel extend to just upstream of the Highway 101 bridge. Modest reductions in flood level are also shown on the north bank of the Wilson River (around the Cheese Factory).

Flood level reductions along the Highway 101 corridor in North Tillamook, along with previous model results for the 1999 flood, are shown as a chart in Figure 12 and in plan view in Figure 20. Between Hoquarton Slough and the Wilson River, flood levels are reduced by around one-half to nearly three-quarters of a foot.

The area protected by the north SFC levee is completely dry, whereas before it flooded around five feet deep. Agricultural lands between Hall Slough and the Trask River generally have flood level reductions exceeding three quarters of a foot, as do the businesses along Front Street in the City of Tillamook.

The results show no flood level increases anywhere in the Trask, Tillamook, and Wilson River systems. Total area with some level of flood level reduction is approximately 4,800 acres.

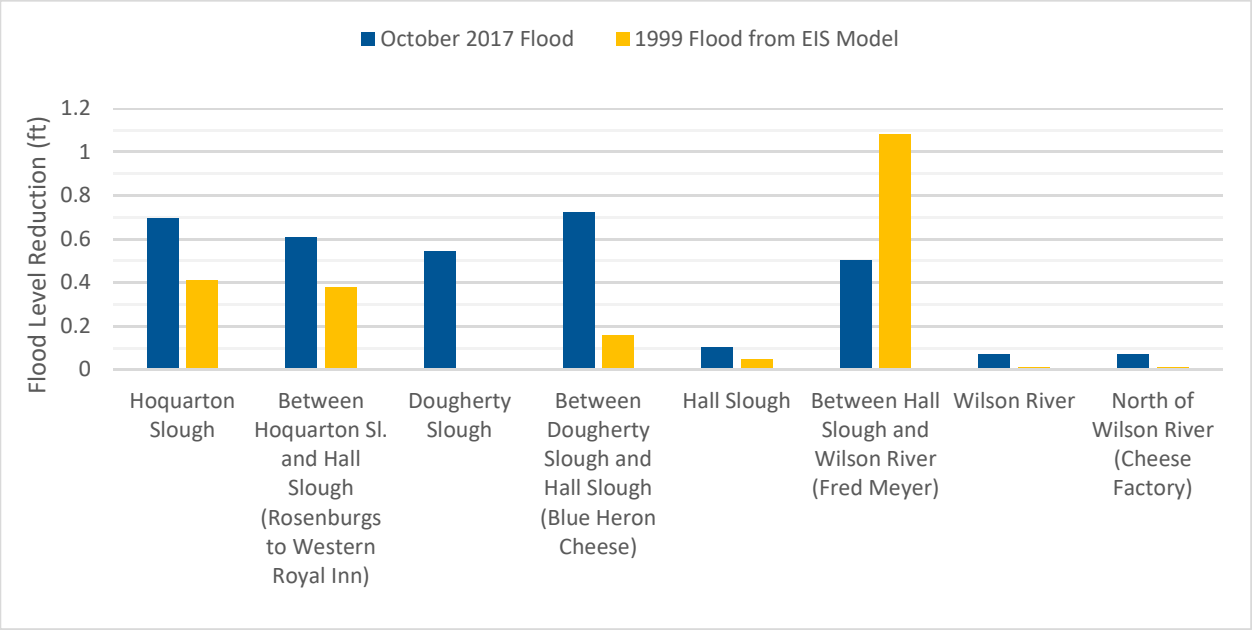


Figure 12: Predicted Flood Level Reductions along Highway 101 for the October 2017 and 1999 Floods

There are also some benefits in reduced road flood durations due to the project. Along Highway 101 between Hoquarton Slough and the Wilson River, model results show delays in the beginning of roadway flooding of between one and two hours, and flood levels receding below road elevation about two hours faster when compared to pre-project conditions.

The results are generally consistent with the modeling conducted during the project design phase. The 1999 and October 2017 floods offer the most direct comparison. As mentioned previously, flows on the Wilson River for these two events were very similar, although Trask River flows were substantially less in October 2017, and tides were also lower in October 2017. Appendix 1 shows the differences for the 1999 flood at each cross section for comparison with the October 2017 event, and Figure 21 shows the same data in graphical form. Multiple factors in addition to changes between the designed and as-built project may account for these differences, including the use of updated bathymetric data, changes in model calibration, and the differences in Trask River flows and tides.

Compared to the 1999 flood simulations completed prior to construction, the October 2017 flood simulation shows more reduction in flood levels along Highway 101 between Hoquarton Slough and Hall Slough, and less reduction between Hall Slough and the Wilson River (Figure 12). The October 2017 event also shows flood level reductions extending farther up Trask River, greater reductions over a smaller area on the Tillamook River, and some reduction on the north bank of the Wilson River around the vicinity of Highway 101. Nevertheless, the overall patterns of reductions in peak flood levels are similar between the two events – about 5,000 acres with reduced flood levels in the pre-construction 1999 flood modeling, and 4,800 acres in the post-construction October 2017 flood modeling documented in this report. Both flood models show only decreases, and no increases in flood level anywhere in the Tillamook, Trask, and Wilson River systems.

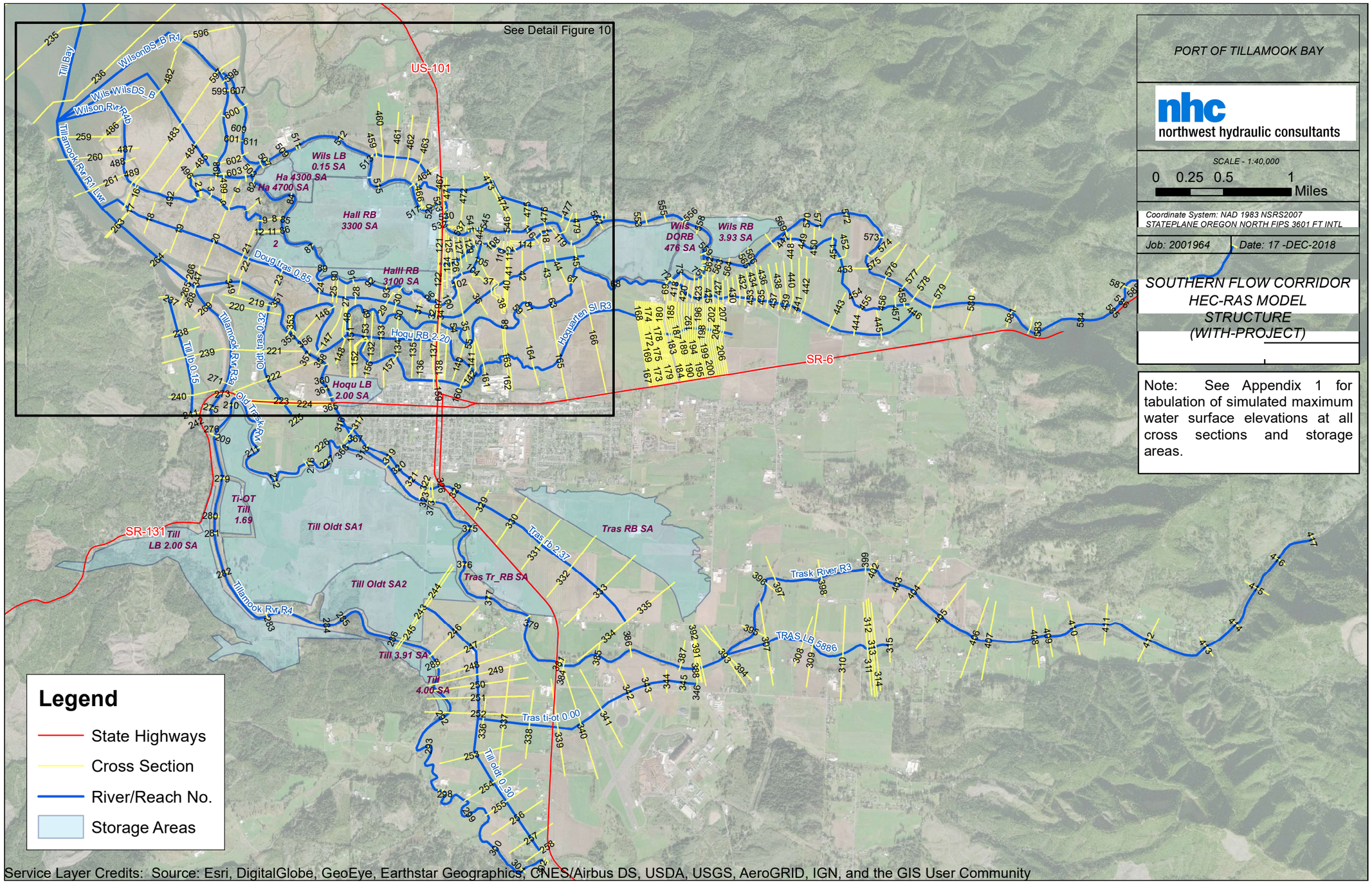
The conclusion is that the SFC project has met the desired project objectives for flood level reduction during floods of around a 5-year return interval. The consistency in results also gives additional confidence in projecting that the SFC project will provide significant flood level reduction over the full range of flood events as was predicted during the design phase modeling.

5 RECOMMENDATIONS FOR FUTURE MONITORING

It is intended that additional floods that occur in the future will also be modeled for further validation of the project's effectiveness. The following recommendations should be considered for this work.

- High water mark data. In addition to ensuring the water level logger network being operated both on and off of the SFC project continues to function, consideration should be given to installing permanent crest stage gages that will ensure accurate HWM data can be collected throughout the area in a manner that does not professional experience or electronic survey equipment.
- River and slough bathymetry. The current model uses bathymetry collected by Tillamook County in 2014. Comparison of this data with the previous survey, collected in the early 2000s, showed areas of significant aggradation, notably in the lower Wilson River. The SFC project itself also has the potential to change river channel morphology. Inaccurate representation of the river bed can lead to inaccuracies in modeling flood levels. For these reasons, repeating a bathymetric survey of the Tillamook, Trask, and Wilson Rivers and key sloughs is recommended in the next few years.
- Levee crest elevations. Levee and berm crest elevations form a critical control to flood levels in the system. Other than around the SFC project itself, virtually all of the levee crest elevation data was obtained from LiDAR data. This is generally accurate when the levee has sufficient crest width and a short grass or gravel cover. However, there are numerous small berms and levees with very narrow crests and/or heavy brush and tree cover where the LiDAR data is much more uncertain. Verifying these crest elevations with ground survey will help improve model robustness. The effort can be targeted by prioritizing levees that the model shows are responsible for large volumes of overtopping flow. One priority area is the Wilson River levee and berm system downstream of Highway 101 along Makinster Road.
- Conversion of the model to a two-dimensional (2D) model. The existing one-dimensional model has been shown to provide accurate results for a range of floods and is expected to continue doing so in the future. However, certain portions of the model are near the limits of what a one-dimensional model can accurately simulate, most noticeably in the highly sinuous Hoquarton Slough reach below Highway 101. In addition, other areas are simulated in a fairly simple way using level pool reservoirs (essentially treating areas as ponds or lakes). The figures generated for this report use custom NHC automated mapping routines that no longer fully function with the latest GIS software packages, making the level of effort for future floodplain mapping of model results potentially much greater. A two-dimensional model would resolve all of these

issues and produce more accurate floodplain mapping, especially in areas of overtopping sheet flow that the current mapping method does not capture.



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PORT OF TILLAMOOK BAY

nhc
northwest hydraulic consultants

SCALE - 1:40,000
0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 NSRS2007
STATEPLANE OREGON NORTH FIPS 3601 FT INTL

Job: 2001964 | Date: 17 -DEC-2018

SOUTHERN FLOW CORRIDOR
HEC-RAS MODEL
STRUCTURE
(WITH-PROJECT)

Note: See Appendix 1 for tabulation of simulated maximum water surface elevations at all cross sections and storage areas.

Figure 13: HEC-RAS Model Structure

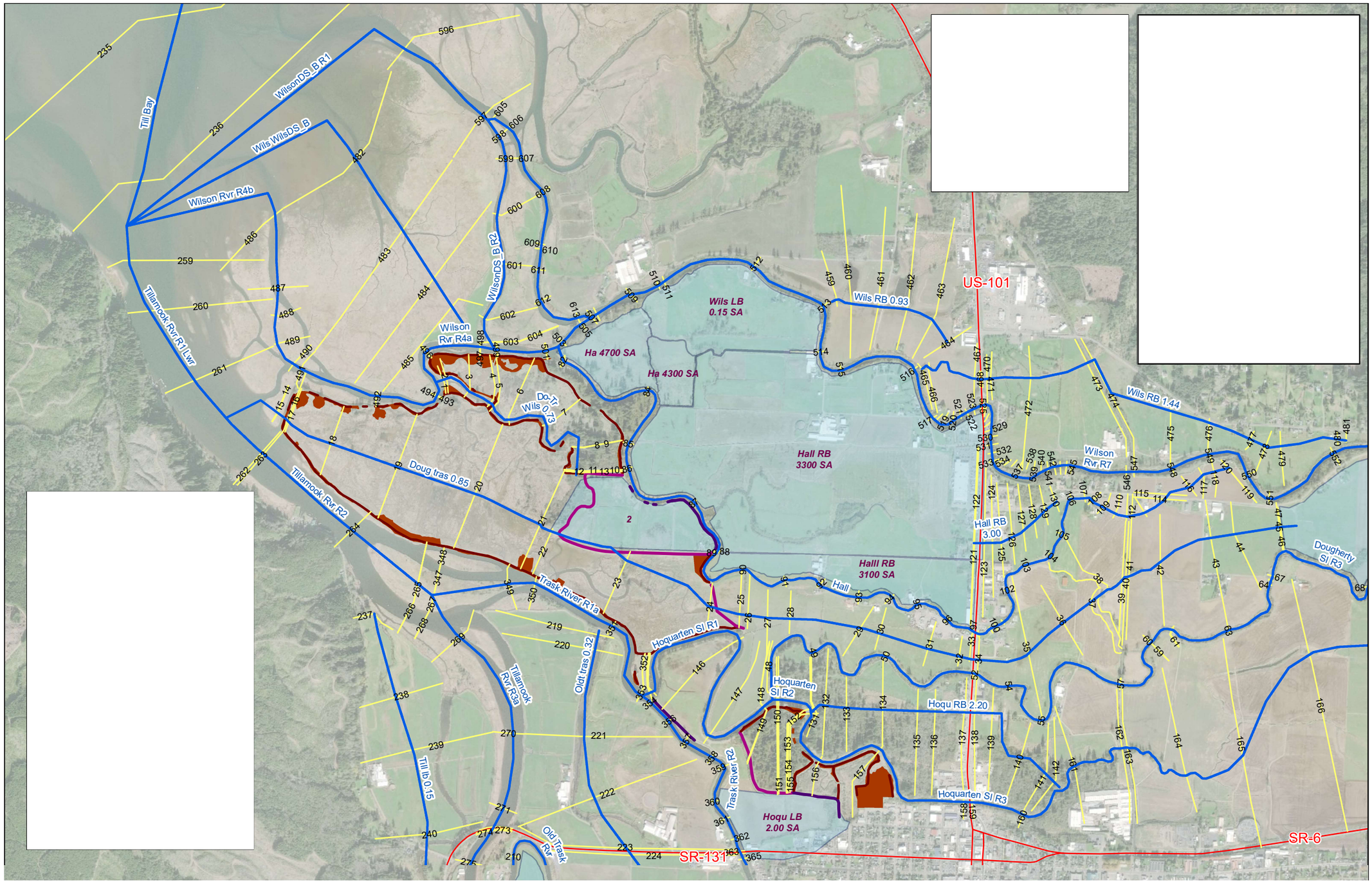


Figure 14: HEC-RAS Model Structure Detail

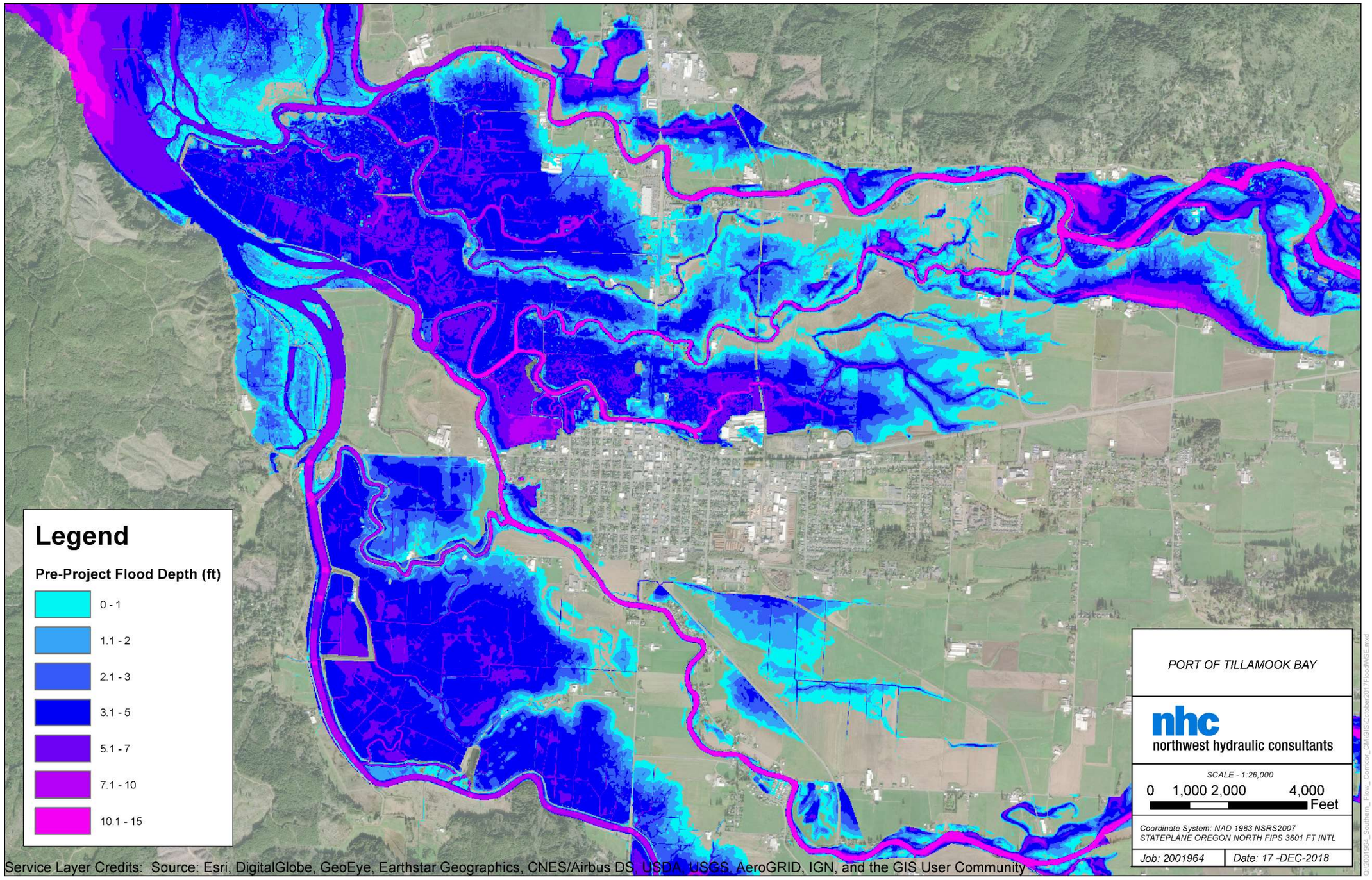


Figure 15: Simulated Maximum Flood Depths and Extents Under Pre-Project Conditions

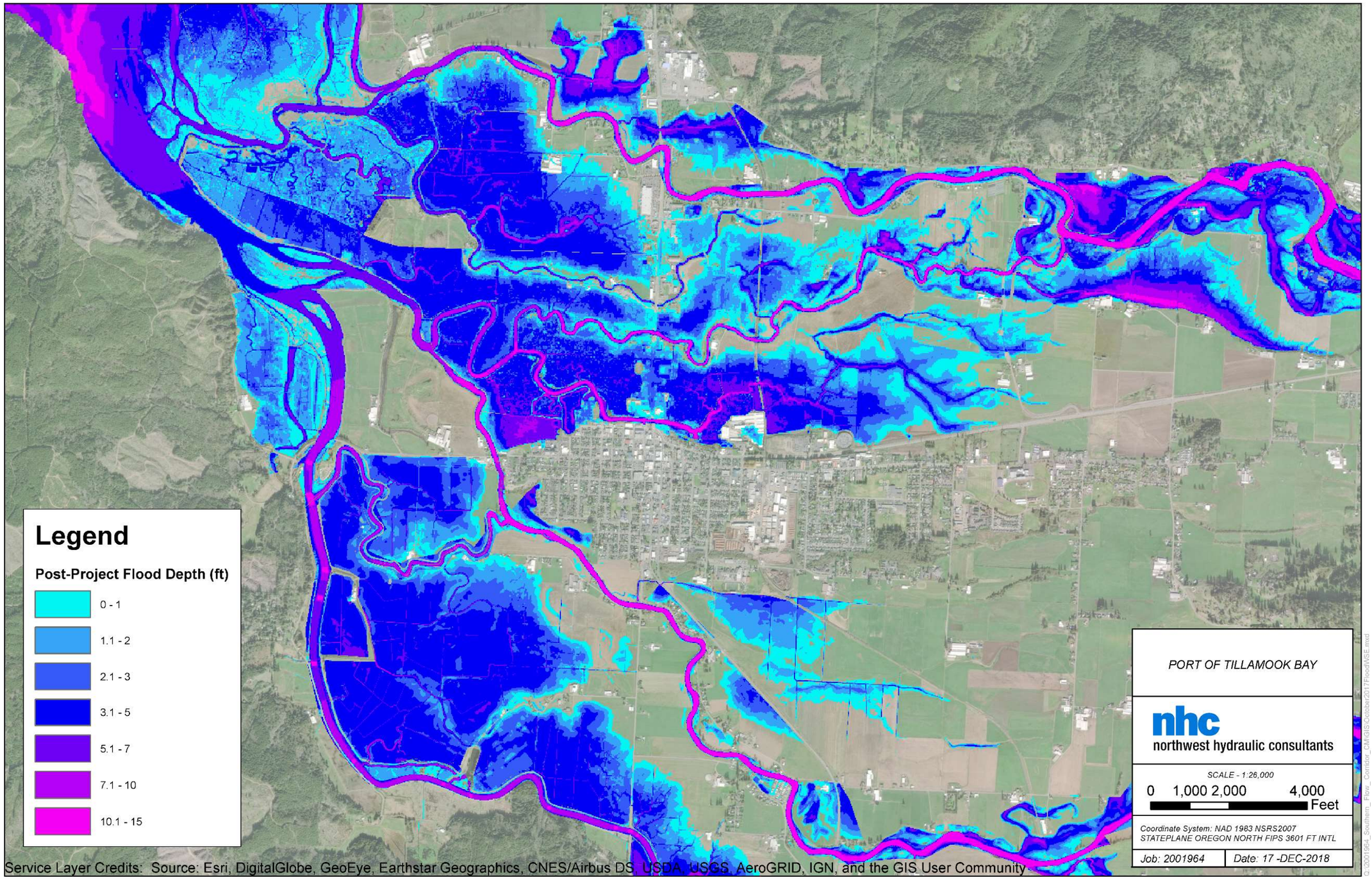


Figure 16: Simulated Maximum Flood Depths and Extents Under Post-Project Conditions

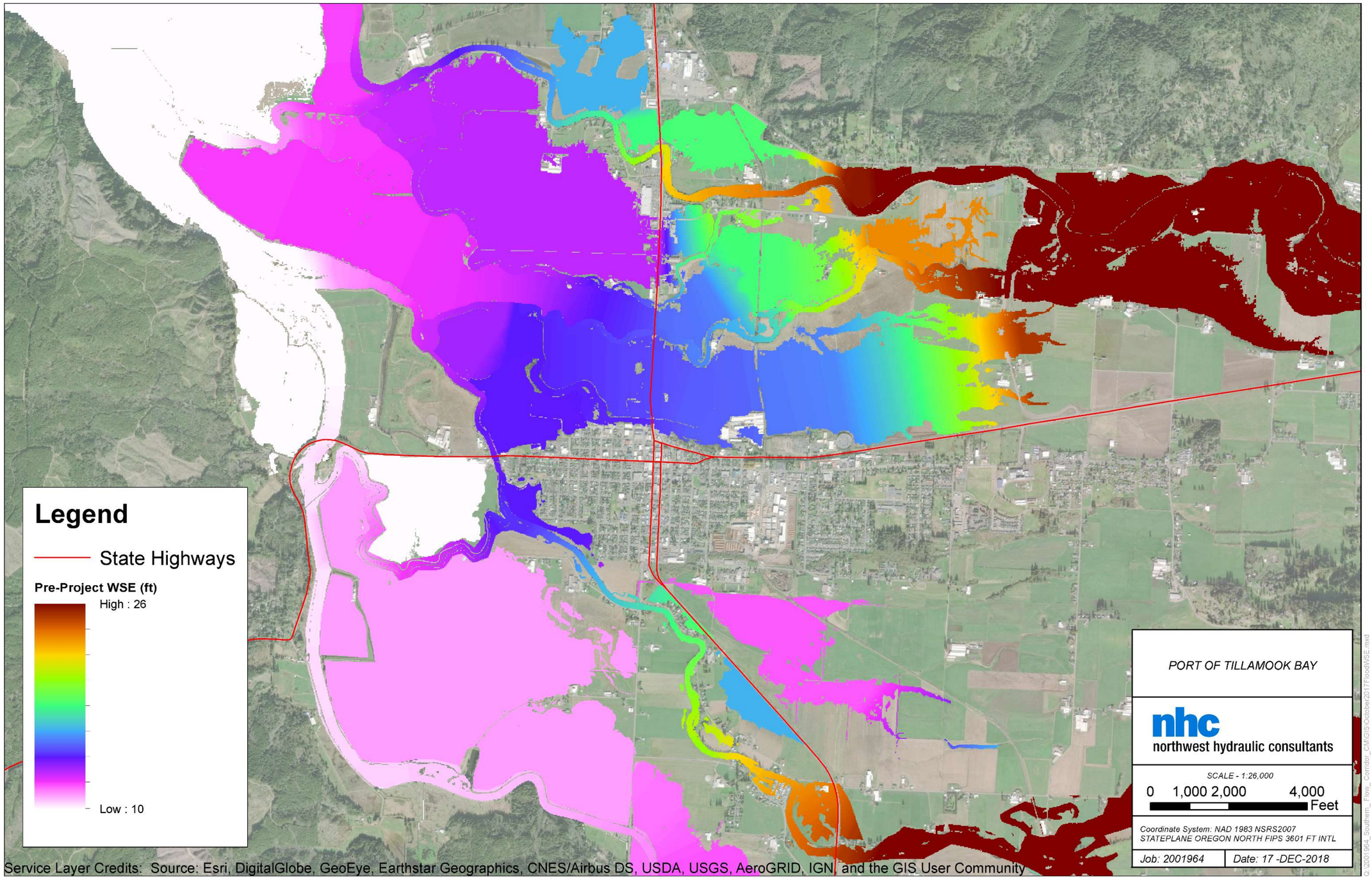


Figure 17: Simulated Maximum Water Surface Elevations under Pre-Project Conditions

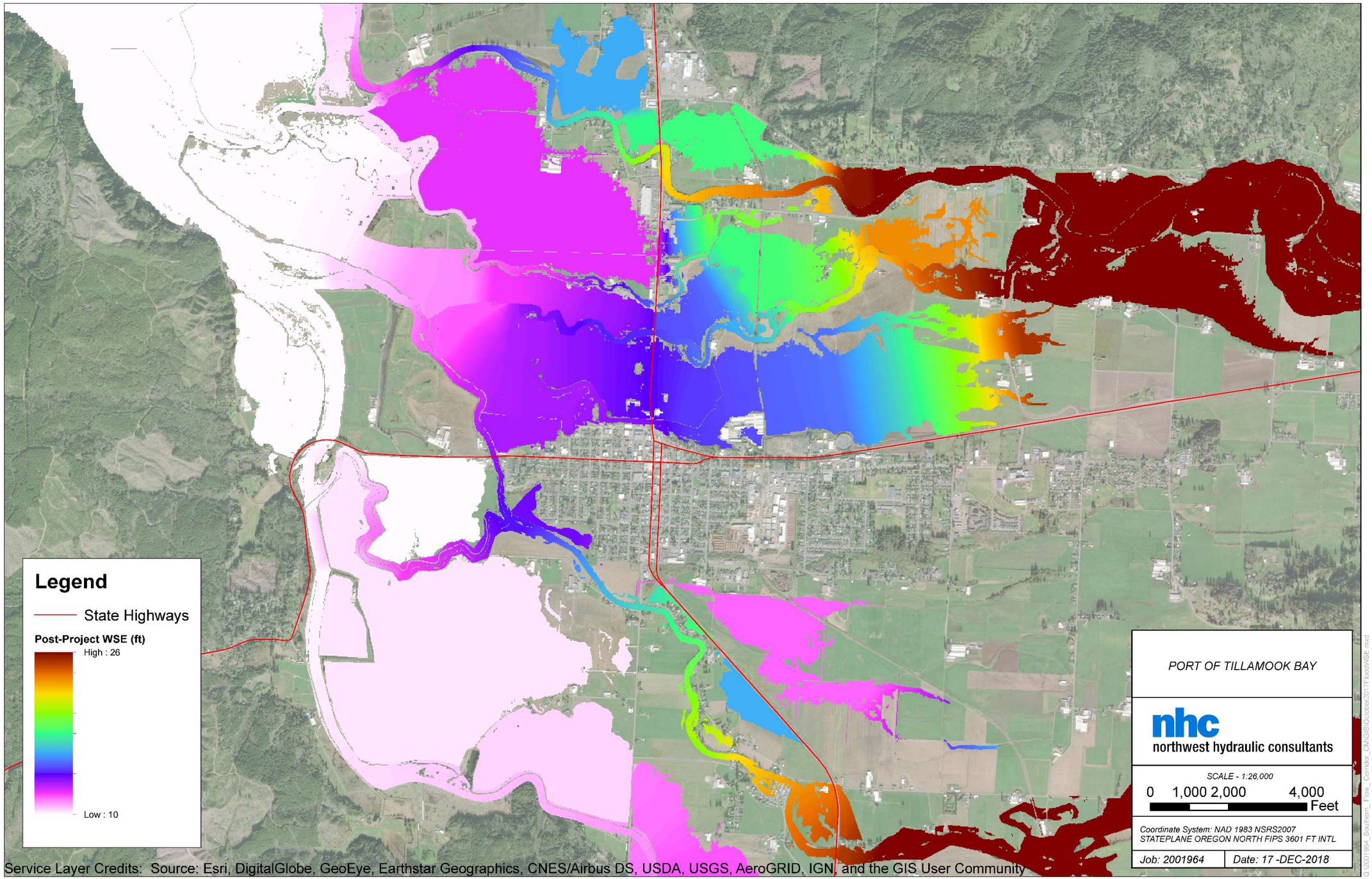


Figure 18: Simulated Maximum Water Surface Elevations under Post-Project Conditions

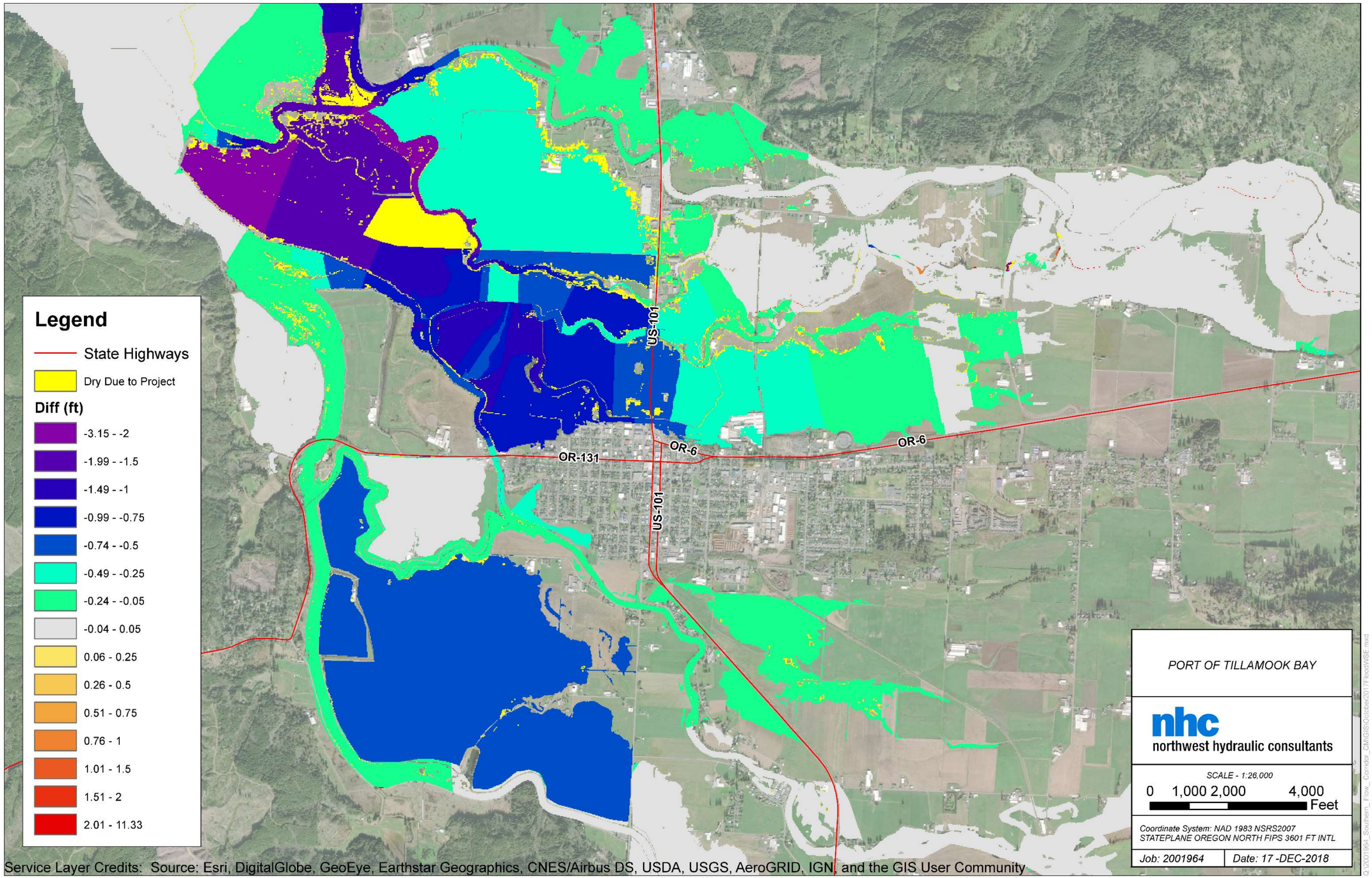


Figure 19: Simulated Difference in Flood Depths between Pre-Project and Post-Project Conditions

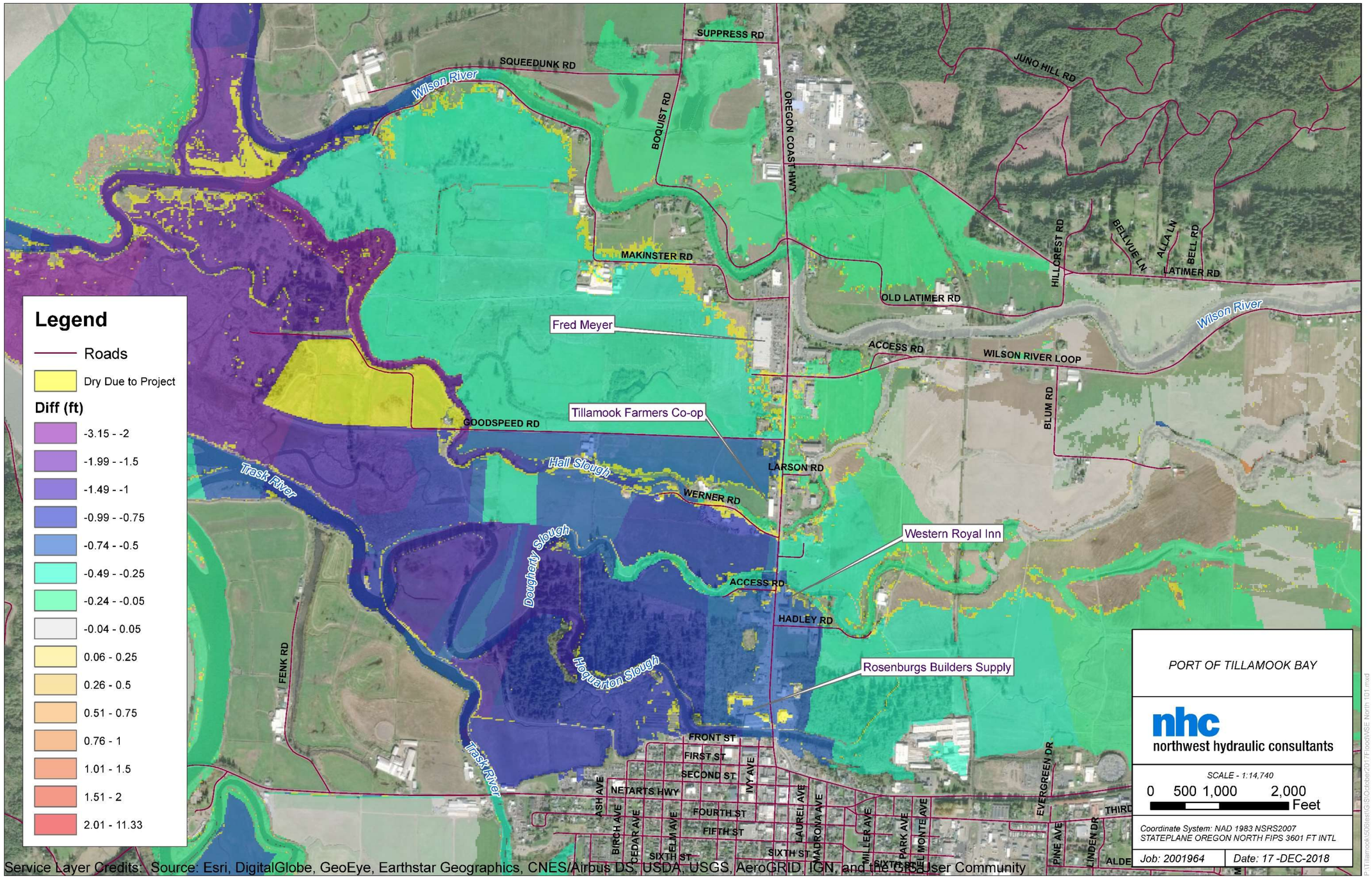


Figure 20: Simulated Difference in Flood Depths between Pre-Project and Post-Project Conditions, North Tillamook Detail

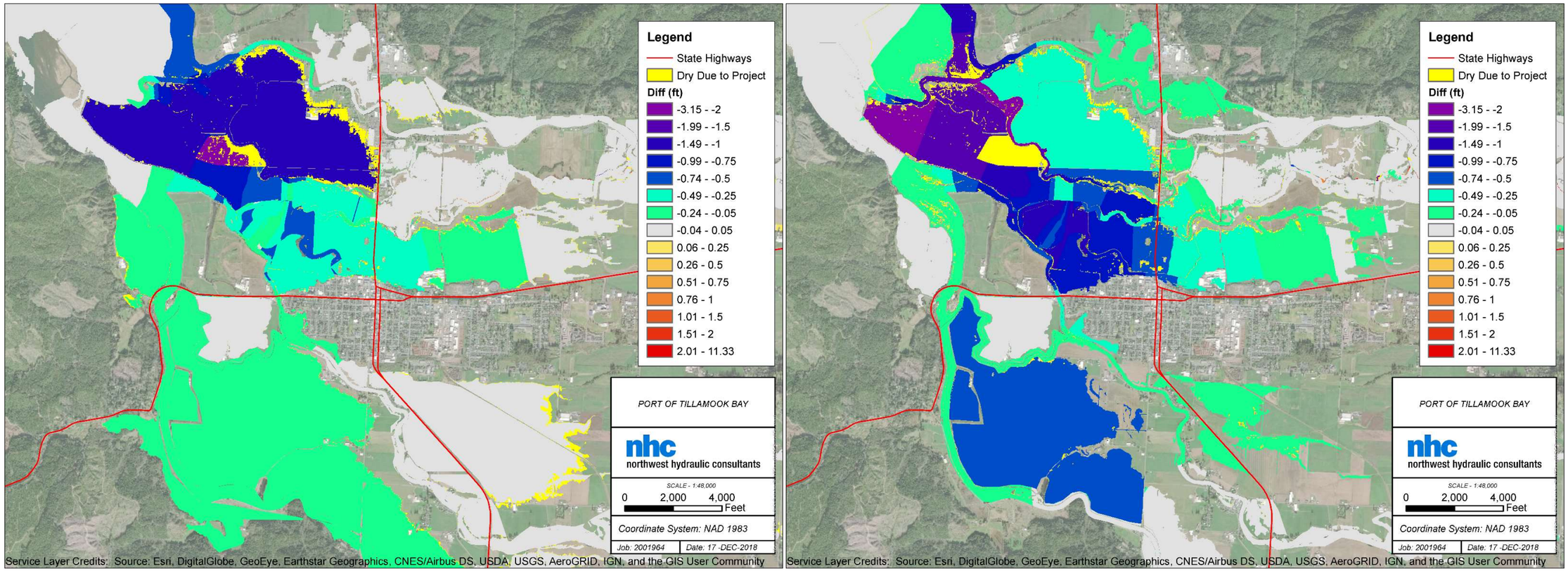


Figure 21: Simulated Difference in Flood Depths between Pre-Project and Post-Project Conditions for November 1999 (left) and October 2017 (right) Floods

APPENDIX 1: PEAK WATER SURFACE ELEVATIONS FOR PRE- AND POST-PROJECT CONDITIONS

Notes:

1) The locations of the cross sections and storage areas listed below may be found on Figure 13 and Figure 14.

2) The difference values for the 1999 flood are shown for comparison purposes. Differences are due both to changes to the model from re-calibration and using as-built project data, and from differences in the flood, especially on the Trask River. On the Wilson River, the two floods were almost identical in peak flows and volume.

3) An "N/A" indicates the cross section does not exist in both pre- and post-project scenarios and so it is not possible to calculate a difference.

4) Three cross sections at the head of floodplain reaches show larger differences that are artefacts of the model and not reflective of true flood elevations; these are noted with an *.

5) Difference values represent the post-project condition minus the pre-project condition, so a negative value indicates a reduction in peak flood level due to the project. The difference values are color shaded for clarity, using the following color scheme:

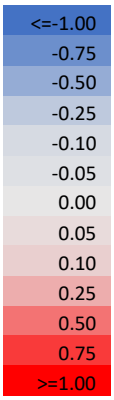


Table 3: Peak Water Surface Elevations and Differences for Pre- and Post-project Conditions

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
1	Do-Tr Wils 0.73 Reach 1:-1556.62	9.57	11.21	-1.64	-0.09
2	Do-Tr Wils 0.73 Reach 1:-1530.2	9.63	11.32	-1.69	-0.25
3	Do-Tr Wils 0.73 Reach 1:-1391.4	10.01	11.80	-1.79	-0.88
4	Do-Tr Wils 0.73 Reach 1:-1237.2	10.03	11.89	-1.86	-1.00
5	Do-Tr Wils 0.73 Reach 1:-1213.4	10.03	11.93	-1.90	-1.01
6	Do-Tr Wils 0.73 Reach 1:-1116.7	10.03	11.95	-1.92	-1.03
7	Do-Tr Wils 0.73 Reach 1:-878.4	10.04	11.99	-1.95	-1.04
8	Do-Tr Wils 0.73 Reach 1:-503.9	10.19	12.09	-1.90	-1.09
9	Do-Tr Wils 0.73 Reach 1:-502.9	10.26	12.09	-1.83	-1.08
10	Do-Tr Wils 0.73 Reach 1:-382	10.26	12.09	-1.83	-1.08
11	Do-Tr Wils 0.73 Reach 1:-381	10.26	12.09	-1.83	-1.08
12	Do-Tr Wils 0.73 Reach 1:-361	10.26	--	#N/A	#N/A
13	Do-Tr Wils 0.73 Reach 1:-360	10.26	--	#N/A	#N/A
14	Doug tras 0.85 Reach 1:-3100	9.46	9.45	0.01	0.02
15	Doug tras 0.85 Reach 1:-3080	9.46	9.45	0.01	0.02
16	Doug tras 0.85 Reach 1:-3010	9.46	11.96	-2.50	-1.11
17	Doug tras 0.85 Reach 1:-3000	9.46	11.96	-2.50	-1.11
18	Doug tras 0.85 Reach 1:-2900	9.47	11.96	-2.49	-1.09
19	Doug tras 0.85 Reach 1:-2800	9.94	11.97	-2.03	-1.07
20	Doug tras 0.85 Reach 1:-2700	10.07	12.02	-1.95	-1.05
21	Doug tras 0.85 Reach 1:-2600	10.19	12.07	-1.88	-1.05
22	Doug tras 0.85 Reach 1:-2590	10.14	--	#N/A	#N/A
23	Doug tras 0.85 Reach 1:-2529	11.12	12.13	-1.01	-0.76
24	Doug tras 0.85 Reach 1:-2010.41	11.29	12.28	-0.99	-0.74
25	Doug tras 0.85 Reach 1:-1828	12.08	12.43	-0.35	-0.72
26	Doug tras 0.85 Reach 1:-1788	12.09	--	#N/A	#N/A
27	Doug tras 0.85 Reach 1:-1695.01	12.12	12.60	-0.48	-0.24
28	Doug tras 0.85 Reach 1:-1573.81	12.22	12.76	-0.54	-0.26
29	Doug tras 0.85 Reach 1:-1240	12.87	13.67	-0.80	-0.42
30	Doug tras 0.85 Reach 1:-1126.71	13.05	13.90	-0.85	-0.46
31	Doug tras 0.85 Reach 1:-868.01	13.29	14.24	-0.95	-0.50
32	Doug tras 0.85 Reach 1:-635.31	13.67	14.47	-0.80	-0.29
33	Doug tras 0.85 Reach 1:-576.79	13.90	14.62	-0.72	-0.16
34	Doug tras 0.85 Reach 1:-531.2	14.71	15.07	-0.36	0.00
35	Doug tras 0.85 Reach 1:-256.64	14.81	15.19	-0.38	0.00
36	Doug tras 0.85 Reach 1:-6.95	15.24	15.45	-0.21	0.01
37	Doug tras 0.85 Reach 1:0	17.18	17.20	-0.02	0.00
38	Doug tras 0.85 Reach 1:5	18.15	18.12	0.03	0.00
39	Doug tras 0.85 Reach 1:10	18.16	18.13	0.03	-0.01
40	Doug tras 0.85 Reach 1:30	18.13	18.10	0.03	0.00
41	Doug tras 0.85 Reach 1:50	18.25	18.22	0.03	0.00
42	Doug tras 0.85 Reach 1:224.3699	18.31	18.28	0.03	0.00
43	Doug tras 0.85 Reach 1:498	19.15	19.14	0.01	0.00
44	Doug tras 0.85 Reach 1:665	20.50	20.50	0.00	0.00
45	Doug tras 0.85 Reach 1:696	23.24	23.24	0.00	0.00
46	Doug tras 0.85 Reach 1:698	23.35	23.36	-0.01	0.00
47	Doug tras 0.85 Reach 1:700	23.35	23.36	-0.01	0.00
48	Dougherty Slough Reach 3:-6368.2	12.98	14.04	-1.06	-0.56

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
49	Dougherty Slough Reach 3:-5836.8	13.45	14.13	-0.68	-0.42
50	Dougherty Slough Reach 3:-5274.2	14.15	14.36	-0.21	-0.25
51	Dougherty Slough Reach 3:-4760	14.24	14.79	-0.55	0.00
52	Dougherty Slough Reach 3:-4740	14.39	14.91	-0.52	-0.01
53	Dougherty Slough Reach 3:-4730.6	14.42	14.93	-0.51	0.00
54	Dougherty Slough Reach 3:-4684.9	14.87	15.22	-0.35	0.01
55	Dougherty Slough Reach 3:-4170.2	15.23	15.47	-0.24	0.01
56	Dougherty Slough Reach 3:-3477.1	16.45	16.51	-0.06	0.00
57	Dougherty Slough Reach 3:-3468	16.49	16.54	-0.05	0.00
58	Dougherty Slough Reach 3:-3467	16.49	16.54	-0.05	0.00
59	Dougherty Slough Reach 3:-3001	17.41	17.43	-0.02	0.00
60	Dougherty Slough Reach 3:-3000	17.34	17.36	-0.02	0.00
61	Dougherty Slough Reach 3:-2928.5	19.40	19.40	0.00	0.00
62	Dougherty Slough Reach 3:-2927.5	19.36	19.36	0.00	0.00
63	Dougherty Slough Reach 3:-2591	20.48	20.48	0.00	0.00
64	Dougherty Slough Reach 3:-2208.1	21.68	21.68	0.00	0.00
65	Dougherty Slough Reach 3:-2184.3	21.67	21.67	0.00	0.00
66	Dougherty Slough Reach 3:-2179.7	21.74	21.75	-0.01	0.00
67	Dougherty Slough Reach 3:-2157	22.01	22.01	0.00	0.01
68	Dougherty Slough Reach 3:-1393.8	24.39	24.40	-0.01	0.00
69	Dougherty Slough Reach 3:-700	26.08	26.09	-0.01	0.00
70	Dougherty Slough Reach 3:-690.6	26.30	26.30	0.00	0.00
71	Dougherty Slough Reach 3:-657.49	26.53	26.53	0.00	0.00
72	Dougherty Slough Reach 4:-637.49	26.53	26.53	0.00	0.00
73	Dougherty Slough Reach 4:-476.4	27.52	27.52	0.00	0.01
74	Dougherty Slough Reach 4:-292.6	29.26	29.26	0.00	0.00
75	Dougherty Slough Reach 4:-172	29.66	29.66	0.00	0.01
76	Dougherty Slough Reach 4:-108	29.91	29.91	0.00	0.00
77	Dougherty Slough Reach 4:-105	31.16	31.16	0.00	0.00
78	Dougherty Slough Reach 4:-55.7	31.20	31.20	0.00	0.00
79	Dougherty Slough Reach 4:-24.4	31.37	31.37	0.00	0.00
80	Dougherty Slough Reach 4:-1	31.55	31.55	0.00	0.00
81	Dougherty Slough Reach 4:0	32.64	31.55	1.09*	0.00
82	Hall Reach 1:-4924.5	10.34	12.53	-2.19	-0.92
83	Hall Reach 1:-4923.5	10.34	12.53	-2.19	-0.94
84	Hall Reach 1:-4378.7	10.33	12.77	-2.44	-1.16
85	Hall Reach 1:-4022.9	10.41	12.77	-2.36	-1.19
86	Hall Reach 1:-3854.2	10.42	12.77	-2.35	-1.19
87	Hall Reach 1:-3390	10.71	12.77	-2.06	-1.19
88	Hall Reach 1:-3109	11.07	12.76	-1.69	-1.18
89	Hall Reach 1:-3100.7	11.17	12.76	-1.59	-1.19
90	Hall Reach 1:-2882.7*	11.62	--	#N/A	#N/A
91	Hall Reach 1:-2446.8	11.96	12.80	-0.84	-0.58
92	Hall Reach 1:-2245.1	12.07	12.85	-0.78	-0.46
93	Hall Reach 1:-2025	12.74	13.50	-0.76	-0.38
94	Hall Reach 1:-1835.9	13.44	14.13	-0.69	-0.36
95	Hall Reach 1:-1650	13.83	14.26	-0.43	-0.25
96	Hall Reach 1:-1460.5	14.40	14.61	-0.21	-0.11
97	Hall Reach 1:-1307.6	14.81	14.91	-0.10	-0.05
98	Hall Reach 1:-1275.1	14.86	14.96	-0.10	-0.06

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
99	Hall Reach 1:-1199.6	15.22	15.30	-0.08	-0.04
100	Hall Reach 1:-1167.1	15.44	15.50	-0.06	-0.04
101	Hall Reach 1:-1123.2	15.74	15.79	-0.05	-0.02
102	Hall Reach 1:-922.7	17.26	17.27	-0.01	0.00
103	Hall Reach 1:-725.9	17.96	17.97	-0.01	-0.01
104	Hall Reach 1:-582	18.30	18.31	-0.01	0.00
105	Hall Reach 1:-451.7	18.53	18.54	-0.01	0.00
106	Hall Reach 1:-245.7	18.94	18.96	-0.02	0.00
107	Hall Reach 1:-170	19.10	19.12	-0.02	-0.01
108	Hall Reach 1:0	19.45	19.47	-0.02	0.00
109	Hall Reach 1:50	19.44	19.45	-0.01	0.00
110	Hall Reach 1:100	19.44	19.44	0.00	0.00
111	Hall Reach 1:190.222	19.44	19.44	0.00	0.00
112	Hall Reach 1:205	19.44	19.44	0.00	0.00
113	Hall Reach 1:336.154	19.44	19.44	0.00	0.00
114	Hall Reach 1:415.067	19.48	19.46	0.02	0.00
115	Hall Reach 1:416	19.59	19.60	-0.01	0.00
116	Hall Reach 1:417	20.54	20.53	0.01	0.00
117	Hall Reach 1:418	22.10	22.09	0.01	0.00
118	Hall Reach 1:419	22.61	22.60	0.01	0.00
119	Hall Reach 1:419.4	22.61	22.60	0.01	0.00
120	Hall Reach 1:420	22.61	22.60	0.01	0.00
121	Hall RB 3.00 Reach 1:-472	12.27	12.77	-0.50	-1.08
122	Hall RB 3.00 Reach 1:-471	12.40	12.78	-0.38	-0.86
123	Hall RB 3.00 Reach 1:-423.69	13.12	13.13	-0.01	0.00
124	Hall RB 3.00 Reach 1:-384.44*	14.02	14.04	-0.02	0.00
125	Hall RB 3.00 Reach 1:-345.2	15.26	15.30	-0.04	0.00
126	Hall RB 3.00 Reach 1:-284.14*	16.39	16.43	-0.04	-0.01
127	Hall RB 3.00 Reach 1:-223.08*	17.35	17.39	-0.04	-0.01
128	Hall RB 3.00 Reach 1:-162.02*	18.24	18.28	-0.04	-0.01
129	Hall RB 3.00 Reach 1:-100.96*	19.07	19.10	-0.03	-0.01
130	Hall RB 3.00 Reach 1:-39.9	19.69	19.73	-0.04	-0.01
131	Hoqu RB 2.20 Reach 1:-1582.57	13.04	14.06	-1.02	-0.54
132	Hoqu RB 2.20 Reach 1:-1541.4	13.19	14.14	-0.95	-0.50
133	Hoqu RB 2.20 Reach 1:-1389.6	13.31	14.21	-0.90	-0.48
134	Hoqu RB 2.20 Reach 1:-1176.3	13.47	14.31	-0.84	-0.46
135	Hoqu RB 2.20 Reach 1:-1000	13.67	14.42	-0.75	-0.43
136	Hoqu RB 2.20 Reach 1:-937.9	13.79	14.48	-0.69	-0.41
137	Hoqu RB 2.20 Reach 1:-900	13.96	14.57	-0.61	-0.38
138	Hoqu RB 2.20 Reach 1:-705.5	13.97	14.58	-0.61	-0.37
139	Hoqu RB 2.20 Reach 1:-500	14.10	14.65	-0.55	-0.34
140	Hoqu RB 2.20 Reach 1:-287.1	14.39	14.83	-0.44	-0.29
141	Hoqu RB 2.20 Reach 1:-108.9	14.42	14.86	-0.44	-0.28
142	Hoqu RB 2.20 Reach 1:0	14.43	14.87	-0.44	-0.28
143	Hoquarton Slough Reach 1:-9522.2	11.66	12.63	-0.97	-0.30
144	Hoquarton Slough Reach 1:-9521.2	11.66	12.63	-0.97	-0.31
145	Hoquarton Slough Reach 1:-9504.6	11.66	12.63	-0.97	-0.31
146	Hoquarton Slough Reach 1:-8802.2	11.73	13.11	-1.38	-0.35
147	Hoquarton Slough Reach 1:-8222.4	12.59	13.23	-0.64	-0.16

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
148	Hoquarton Slough Reach 1:-7876.9	12.98	14.04	-1.06	-0.56
149	Hoquarton Slough Reach 1:-7875.9	12.98	14.04	-1.06	-0.56
150	Hoquarton Slough Reach 2:-7785.5	12.98	14.04	-1.06	-0.56
151	Hoquarton Slough Reach 2:-7784.5	12.98	14.04	-1.06	-0.55
152	Hoquarton Slough Reach 2:-7578.9	13.04	14.06	-1.02	-0.54
153	Hoquarton Slough Reach 2:-7577.9	13.04	14.06	-1.02	-0.54
154	Hoquarton Slough Reach 3:-7567.9	13.04	14.06	-1.02	-0.54
155	Hoquarton Slough Reach 3:-7566.9	13.04	14.06	-1.02	-0.54
156	Hoquarton Slough Reach 3:-7257.9	13.06	14.05	-0.99	-0.51
157	Hoquarton Slough Reach 3:-6906.9	13.11	14.11	-1.00	-0.52
158	Hoquarton Slough Reach 3:-6280.6	13.50	14.20		-0.41
159	Hoquarton Slough Reach 3:-6234.9	13.73	14.38		#N/A
160	Hoquarton Slough Reach 3:-5951.1	14.37	14.85		-0.29
161	Hoquarton Slough Reach 3:-5496	14.57	14.96		-0.26
162	Hoquarton Slough Reach 3:-5150.2	14.76	15.10		-0.24
163	Hoquarton Slough Reach 3:-5141.1	14.95	15.25		-0.22
164	Hoquarton Slough Reach 3:-4698.7	15.07	15.34		-0.20
165	Hoquarton Slough Reach 3:-4364.1	15.27	15.49		-0.17
166	Hoquarton Slough Reach 3:-3684.7	17.18	17.20		-0.02
167	Hoquarton Slough Reach 3:-3116.2	20.47	20.46		0.01
168	Hoquarton Slough Reach 3:-3094.1*	20.61	20.60		0.01
169	Hoquarton Slough Reach 3:-3072.1*	20.79	20.78		0.01
170	Hoquarton Slough Reach 3:-3050.1*	21.00	21.00		0.01
171	Hoquarton Slough Reach 3:-3028.1*	21.22	21.22		0.01
172	Hoquarton Slough Reach 3:-3006.1*	21.45	21.45		0.01
173	Hoquarton Slough Reach 3:-2984.1*	21.67	21.67		0.00
174	Hoquarton Slough Reach 3:-2962.1*	21.89	21.89		0.00
175	Hoquarton Slough Reach 3:-2940.0*	22.10	22.10		0.00
176	Hoquarton Slough Reach 3:-2918.0*	22.30	22.31		0.01
177	Hoquarton Slough Reach 3:-2896.0*	22.50	22.51		0.01
178	Hoquarton Slough Reach 3:-2874.0*	22.70	22.70		0.00
179	Hoquarton Slough Reach 3:-2852.0*	22.89	22.89		0.00
180	Hoquarton Slough Reach 3:-2830.0*	23.08	23.08		0.00
181	Hoquarton Slough Reach 3:-2808.0*	23.27	23.27		0.00
182	Hoquarton Slough Reach 3:-2786	23.46	23.46		0.01
183	Hoquarton Slough Reach 3:-2776	24.09	24.10		#N/A
184	Hoquarton Slough Reach 3:-2749.7*	24.38	24.38		0.00
185	Hoquarton Slough Reach 3:-2723.4*	24.56	24.56		0.00
186	Hoquarton Slough Reach 3:-2697.1*	24.73	24.73		0.00
187	Hoquarton Slough Reach 3:-2670.8*	24.89	24.90		0.00
188	Hoquarton Slough Reach 3:-2644.6	25.08	25.08		0.00
189	Hoquarton Slough Reach 3:-2628.5*	25.08	25.08		0.00
190	Hoquarton Slough Reach 3:-2612.4*	25.08	25.08		0.00
191	Hoquarton Slough Reach 3:-2596.4*	25.08	25.08		0.00
192	Hoquarton Slough Reach 3:-2580.3*	25.08	25.08		0.00
193	Hoquarton Slough Reach 3:-2564.2*	25.08	25.08		0.00
194	Hoquarton Slough Reach 3:-2548.2*	25.08	25.08		0.00
195	Hoquarton Slough Reach 3:-2532.1*	25.09	25.09		0.00
196	Hoquarton Slough Reach 3:-2516.0*	25.10	25.11		0.00
197	Hoquarton Slough Reach 3:-2500	25.13	25.14		0.00

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
198	Hoquarton Slough Reach 3:-2490.*	25.18	25.18	0.00	0.00
199	Hoquarton Slough Reach 3:-2480.*	25.23	25.23	0.00	0.00
200	Hoquarton Slough Reach 3:-2470.*	25.30	25.30	0.00	0.00
201	Hoquarton Slough Reach 3:-2460.*	25.37	25.37	0.00	0.00
202	Hoquarton Slough Reach 3:-2450.*	25.43	25.43	0.00	0.01
203	Hoquarton Slough Reach 3:-2440.*	25.50	25.50	0.00	0.00
204	Hoquarton Slough Reach 3:-2430.*	25.56	25.56	0.00	0.01
205	Hoquarton Slough Reach 3:-2420.*	25.63	25.63	0.00	0.00
206	Hoquarton Slough Reach 3:-2410.*	25.69	25.69	0.00	0.01
207	Hoquarton Slough Reach 3:-2400	25.75	25.75	0.00	0.00
208	Old Trask River Reach 1:-3212.3	10.10	10.32	-0.22	-0.15
209	Old Trask River Reach 1:-3211.3	10.10	10.32	-0.22	-0.15
210	Old Trask River Reach 1:-2796.6	10.42	10.61	-0.19	-0.14
211	Old Trask River Reach 1:-1906.9	11.43	11.48	-0.05	-0.13
212	Old Trask River Reach 1:-1242.8	11.96	12.04	-0.08	-0.13
213	Old Trask River Reach 1:-760.5	12.52	12.64	-0.12	-0.12
214	Old Trask River Reach 1:-725.6	12.60	12.72	-0.12	-0.11
215	Old Trask River Reach 1:-718.9	12.57	12.69	-0.12	-0.11
216	Old Trask River Reach 1:-696.8	12.71	12.84	-0.13	-0.11
217	Old Trask River Reach 1:-4	14.05	14.28	-0.23	-0.09
218	Old Trask River Reach 1:-3	14.06	14.28	-0.22	-0.08
219	Oldt tras 0.32 Reach 1:-2131.43	-6.93	-3.79	-3.14	-1.96
220	Oldt tras 0.32 Reach 1:-2085.3	-6.91	-3.77	-3.14	-1.96
221	Oldt tras 0.32 Reach 1:-1634.6	-6.69	-3.57	-3.12	-1.96
222	Oldt tras 0.32 Reach 1:-1221.1	-6.42	-3.37	-3.05	-1.95
223	Oldt tras 0.32 Reach 1:-896	-6.21	-3.23	-2.98	-1.94
224	Oldt tras 0.32 Reach 1:-850	8.95	8.95	0.00	-0.03
225	Oldt tras 0.32 Reach 1:-621.9	8.95	8.95	0.00	-0.03
226	Oldt tras 0.32 Reach 1:-194.1	8.95	8.95	0.00	-0.03
227	Oldt tras 0.32 Reach 1:0	8.95	8.95	0.00	-0.03
228	Till Bay Reach 1:-900	9.24	9.24	0.00	0.00
229	Till Bay Reach 1:-800	9.26	9.26	0.00	0.00
230	Till Bay Reach 1:-700	9.28	9.28	0.00	0.01
231	Till Bay Reach 1:-600	9.31	9.30	0.01	0.01
232	Till Bay Reach 1:-500	9.34	9.34	0.00	0.01
233	Till Bay Reach 1:-400	9.37	9.37	0.00	0.02
234	Till Bay Reach 1:-300	9.40	9.40	0.00	0.02
235	Till Bay Reach 1:-200	9.42	9.41	0.01	0.02
236	Till Bay Reach 1:-100	9.43	9.43	0.00	0.00
237	Till lb 0.15 Reach 1:-1588.1	7.28	7.28	0.00	-0.12
238	Till lb 0.15 Reach 1:-1231.1	7.36	7.37	-0.01	-0.12
239	Till lb 0.15 Reach 1:-893.6	7.37	7.37	0.00	-0.13
240	Till lb 0.15 Reach 1:-521.6	7.37	7.37	0.00	-0.12
241	Till lb 0.15 Reach 1:-240	7.38	7.38	0.00	-0.12
242	Till lb 0.15 Reach 1:-120.1	7.38	7.38	0.00	-0.12
243	Till oldt 0_30 Reach 1:-3461	10.45	11.04	-0.59	-0.11
244	Till oldt 0_30 Reach 1:-3460	10.45	11.04	-0.59	-0.11
245	Till oldt 0_30 Reach 1:-3431	11.40	11.41	-0.01	-0.11
246	Till oldt 0_30 Reach 1:-2994	11.48	11.49	-0.01	-0.10

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
247	Till oldt 0_30 Reach 1:-2729	11.64	11.65	-0.01	-0.08
248	Till oldt 0_30 Reach 1:-2494	11.78	11.79	-0.01	-0.07
249	Till oldt 0_30 Reach 1:-2378	11.79	11.81	-0.02	-0.07
250	Till oldt 0_30 Reach 1:-2257	11.79	11.81	-0.02	-0.07
251	Till oldt 0_30 Reach 1:-2105	11.79	11.81	-0.02	-0.08
252	Till oldt 0_30 Reach 1:-1917	11.80	11.81	-0.01	-0.08
253	Till oldt 0_30 Reach 2:-1432	11.80	11.81	-0.01	-0.08
254	Till oldt 0_30 Reach 2:-1045	11.89	11.91	-0.02	-0.08
255	Till oldt 0_30 Reach 2:-775	11.99	12.01	-0.02	-0.07
256	Till oldt 0_30 Reach 2:-549	11.99	12.01	-0.02	-0.07
257	Till oldt 0_30 Reach 2:-258	11.99	12.01	-0.02	-0.07
258	Till oldt 0_30 Reach 2:-71.2	11.99	12.01	-0.02	-0.07
259	Tillamook River Reach 1 Lwr:-14087.4	9.43	9.43	0.00	0.00
260	Tillamook River Reach 1 Lwr:-13200	9.44	9.43	0.01	0.01
261	Tillamook River Reach 1 Lwr:-13000	9.46	9.45	0.01	0.02
262	Tillamook River Reach 2:-12823	9.46	9.45	0.01	0.02
263	Tillamook River Reach 2:-12822.7	9.46	9.45	0.01	0.02
264	Tillamook River Reach 2:-12198.2	9.48	9.46	0.02	0.02
265	Tillamook River Reach 2:-12100	9.54	9.76	-0.22	-0.03
266	Tillamook River Reach 2:-12099	9.54	9.76	-0.22	-0.03
267	Tillamook River Reach 3a:-11405	9.54	9.76	-0.22	-0.03
268	Tillamook River Reach 3a:-11400	9.54	9.76	-0.22	-0.03
269	Tillamook River Reach 3a:-11343.5	9.64	9.86	-0.22	-0.25
270	Tillamook River Reach 3a:-10731.3	9.81	10.03	-0.22	-0.19
271	Tillamook River Reach 3a:-10321.6	9.97	10.18	-0.21	-0.16
272	Tillamook River Reach 3a:-10209.1	10.02	10.24	-0.22	-0.15
273	Tillamook River Reach 3a:-10193	10.02	10.23	-0.21	-0.16
274	Tillamook River Reach 3a:-10184.5	10.03	10.25	-0.22	-0.16
275	Tillamook River Reach 3a:-9980.9	10.05	10.27	-0.22	-0.15
276	Tillamook River Reach 3a:-9731.1	10.10	10.33	-0.23	-0.15
277	Tillamook River Reach 3a:-9677.7	10.10	10.32	-0.22	-0.15
278	Tillamook River Reach 4:-9617.7	10.10	10.32	-0.22	-0.15
279	Tillamook River Reach 4:-9616.7	10.10	10.32	-0.22	-0.15
280	Tillamook River Reach 4:-9132.4	10.14	10.37	-0.23	-0.15
281	Tillamook River Reach 4:-8917.4	10.15	10.38	-0.23	-0.14
282	Tillamook River Reach 4:-8402.1	10.25	10.44	-0.19	-0.13
283	Tillamook River Reach 4:-7568.1	10.43	10.54	-0.11	-0.13
284	Tillamook River Reach 4:-6775.5	10.64	10.66	-0.02	-0.13
285	Tillamook River Reach 4:-6546.3	10.71	10.71	0.00	-0.12
286	Tillamook River Reach 4:-5725.9	10.98	11.00	-0.02	-0.12
287	Tillamook River Reach 4:-5183.2	11.17	11.19	-0.02	-0.11
288	Tillamook River Reach 4:-5074	11.21	11.24	-0.03	-0.11
289	Tillamook River Reach 4:-5060.3	11.21	11.24	-0.03	-0.10
290	Tillamook River Reach 4:-5050.3	11.22	11.25	-0.03	-0.11
291	Tillamook River Reach 4:-5004.6	11.23	11.26	-0.03	-0.11
292	Tillamook River Reach 4:-4239.6	11.50	11.53	-0.03	-0.07
293	Tillamook River Reach 4:-3532.8	11.67	11.70	-0.03	-0.07
294	Tillamook River Reach 4:-2706.2	12.39	12.40	-0.01	-0.06
295	Tillamook River Reach 4:-2658.5	12.50	12.50	0.00	-0.07
296	Tillamook River Reach 4:-2649.5	12.52	12.52	0.00	-0.07

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
297	Tillamook River Reach 4:-2648.5	12.51	12.51	0.00	-0.07
298	Tillamook River Reach 4:-2605.7	12.61	12.61	0.00	-0.06
299	Tillamook River Reach 4:-1745.8	16.00	16.00	0.00	-0.01
300	Tillamook River Reach 4:-865.4	21.63	21.63	0.00	0.00
301	Tillamook River Reach 4:-360	23.19	23.19	0.00	0.00
302	Tillamook River Reach 4:-55.4	24.01	24.01	0.00	0.00
303	Tillamook River Reach 4:-28.2	24.07	24.07	0.00	0.00
304	Tillamook River Reach 4:-18.4	24.28	24.28	0.00	0.00
305	Tillamook River Reach 4:-17.7	24.28	24.28	0.00	0.00
306	Tillamook River Reach 4:-0.6	24.38	24.38	0.00	0.00
307	TRAS LB 5886 Reach 1:-1606.8	29.73	29.73	0.00	0.00
308	TRAS LB 5886 Reach 1:-1140.4	29.73	29.74	-0.01	0.00
309	TRAS LB 5886 Reach 1:-1021	29.73	29.74	-0.01	0.00
310	TRAS LB 5886 Reach 1:-606.4	30.01	30.01	0.00	0.00
311	TRAS LB 5886 Reach 1:-272.1	33.54	33.51	0.03	0.00
312	TRAS LB 5886 Reach 1:-233.5	33.98	33.98	0.00	0.00
313	TRAS LB 5886 Reach 1:-206.1	34.49	34.47	0.02	0.00
314	TRAS LB 5886 Reach 1:-168.5	35.08	35.05	0.03	0.00
315	TRAS LB 5886 Reach 1:0	38.11	38.11	0.00	0.00
316	Tras rb 2.37 Reach 1:-4602	13.68	14.02	-0.34	-0.14
317	Tras rb 2.37 Reach 1:-4436	13.70	14.05	-0.35	-0.14
318	Tras rb 2.37 Reach 1:-4167	13.70	14.05	-0.35	-0.14
319	Tras rb 2.37 Reach 1:-3880	13.70	14.05	-0.35	-0.14
320	Tras rb 2.37 Reach 1:-3700	13.29	13.68	-0.39	-0.08
321	Tras rb 2.37 Reach 1:-3492	12.26	12.61	-0.35	0.01
322	Tras rb 2.37 Reach 1:-3319	11.57	11.71	-0.14	0.01
323	Tras rb 2.37 Reach 1:-3276	11.60	11.73	-0.13	0.01
324	Tras rb 2.37 Reach 1:-3249	11.60	11.73	-0.13	0.01
325	Tras rb 2.37 Reach 1:-3209	11.60	11.73	-0.13	0.01
326	Tras rb 2.37 Reach 1:-3090	11.60	11.73	-0.13	0.00
327	Tras rb 2.37 Reach 1:-3084	11.60	11.73	-0.13	0.01
328	Tras rb 2.37 Reach 1:-2919.4	11.60	11.74	-0.14	0.00
329	Tras rb 2.37 Reach 1:-2560.6	11.60	11.74	-0.14	0.00
330	Tras rb 2.37 Reach 1:-2150.6	11.60	11.74	-0.14	0.00
331	Tras rb 2.37 Reach 1:-1703.9	11.60	11.74	-0.14	0.00
332	Tras rb 2.37 Reach 1:-1252.6	11.60	11.74	-0.14	0.00
333	Tras rb 2.37 Reach 1:-805.8	13.08	13.18	-0.10	-0.01
334	Tras rb 2.37 Reach 1:-322.5	15.88	16.03	-0.15	0.00
335	Tras rb 2.37 Reach 1:-321.5	15.88	16.03	-0.15	0.00
336	Tras ti-ot 0.00 Reach 1:-2500	11.80	11.81	-0.01	-0.08
337	Tras ti-ot 0.00 Reach 1:-2278	11.80	11.81	-0.01	-0.07
338	Tras ti-ot 0.00 Reach 1:-1998	11.80	11.81	-0.01	-0.07
339	Tras ti-ot 0.00 Reach 1:-1689	12.33	12.36	-0.03	-0.04
340	Tras ti-ot 0.00 Reach 1:-1424	13.38	13.45	-0.07	0.00
341	Tras ti-ot 0.00 Reach 1:-1147.6	14.55	14.66	-0.11	0.00
342	Tras ti-ot 0.00 Reach 1:-798.5	15.83	15.98	-0.15	0.00
343	Tras ti-ot 0.00 Reach 1:-585.6	16.56	16.73	-0.17	0.00
344	Tras ti-ot 0.00 Reach 1:-371.5	16.97	17.15	-0.18	0.00
345	Tras ti-ot 0.00 Reach 1:-190.7	16.97	17.15	-0.18	0.00

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
346	Tras ti-ot 0.00 Reach 1:-39.9	16.97	17.15	-0.18	0.00
347	Trask River Reach 1a:-19005	9.54	9.76	-0.22	-0.03
348	Trask River Reach 1a:-19000	9.54	9.76	-0.22	-0.03
349	Trask River Reach 1a:-18077.1	10.47	11.07	-0.60	-0.27
350	Trask River Reach 1a:-17915.5	10.49	11.20	-0.71	-0.32
351	Trask River Reach 1a:-17436.4	10.91	11.77	-0.86	-0.54
352	Trask River Reach 1a:-16996.1	11.66	12.63	-0.97	-0.30
353	Trask River Reach 1a:-16995.1	11.66	12.63	-0.97	-0.30
354	Trask River Reach 2:-16926.7	11.66	12.63	-0.97	-0.30
355	Trask River Reach 2:-16925.7	11.67	12.63	-0.96	-0.31
356	Trask River Reach 2:-16782.8	11.93	13.04	-1.11	-0.36
357	Trask River Reach 2:-16636.1	12.36	13.33	-0.97	-0.30
358	Trask River Reach 2:-16468.3	12.57	13.32	-0.75	-0.28
359	Trask River Reach 2:-16393	12.53	13.23	-0.70	-0.29
360	Trask River Reach 2:-16104	12.79	13.42	-0.63	-0.27
361	Trask River Reach 2:-15986.7	13.16	13.67	-0.51	-0.22
362	Trask River Reach 2:-15959	13.21	13.70	-0.49	-0.21
363	Trask River Reach 2:-15887.7	13.34	13.79	-0.45	-0.20
364	Trask River Reach 2:-15873.6	13.35	13.80	-0.45	-0.19
365	Trask River Reach 2:-15841.6	13.32	13.78	-0.46	-0.20
366	Trask River Reach 2:-15398.2	14.05	14.28	-0.23	-0.09
367	Trask River Reach 2:-15397.2	14.06	14.28	-0.22	-0.08
368	Trask River Reach 3b:-15337.3	14.06	14.28	-0.22	-0.08
369	Trask River Reach 3b:-14787.8	15.44	15.55	-0.11	-0.02
370	Trask River Reach 3b:-14119.5	17.07	17.15	-0.08	0.00
371	Trask River Reach 3b:-14094.5	16.94	17.02	-0.08	0.00
372	Trask River Reach 3b:-14078.5	17.06	17.15	-0.09	0.00
373	Trask River Reach 3b:-14070.4	17.24	17.32	-0.08	-0.01
374	Trask River Reach 3b:-14031.1	17.19	17.27	-0.08	0.00
375	Trask River Reach 3b:-13465.6	18.66	18.73	-0.07	0.00
376	Trask River Reach 3b:-12965.6	19.97	20.03	-0.06	0.00
377	Trask River Reach 3b:-12321.2	21.83	21.87	-0.04	0.00
378	Trask River Reach 3b:-11782.6	23.10	23.13	-0.03	0.00
379	Trask River Reach 3b:-11699.4	23.37	23.40	-0.03	0.00
380	Trask River Reach 3b:-10982.9	24.69	24.71	-0.02	-0.01
381	Trask River Reach 3b:-10954.3	24.95	24.97	-0.02	0.00
382	Trask River Reach 3b:-10944.4	24.99	25.01	-0.02	0.00
383	Trask River Reach 3b:-10930.5	25.03	25.05	-0.02	0.00
384	Trask River Reach 3b:-10885.3	25.06	25.08	-0.02	0.00
385	Trask River Reach 3b:-10438.9	26.53	26.54	-0.01	0.00
386	Trask River Reach 3b:-9982.5	27.36	27.36	0.00	0.00
387	Trask River Reach 3b:-9352.5	28.20	28.21	-0.01	0.00
388	Trask River Reach 3b:-9164.6	28.52	28.53	-0.01	0.00
389	Trask River Reach 3b:-9134.5	28.63	28.63	0.00	0.00
390	Trask River Reach 3b:-9128.45	28.63	28.63	0.00	0.00
391	Trask River Reach 3b:-9120.75	28.66	28.67	-0.01	0.00
392	Trask River Reach 3b:-9090	28.83	28.84	-0.01	0.00
393	Trask River Reach 3b:-8775.8	29.73	29.73	0.00	0.00
394	Trask River Reach 3:-8755.8	29.73	29.73	0.00	0.00
395	Trask River Reach 3:-8309.6	30.99	30.99	0.00	0.00

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396	Trask River Reach 3:-7704.6	32.83	32.83	0.00	0.00
397	Trask River Reach 3:-7556.9	33.47	33.47	0.00	0.00
398	Trask River Reach 3:-6988.3	35.18	35.18	0.00	0.00
399	Trask River Reach 3:-6448.4	36.79	36.79	0.00	0.00
400	Trask River Reach 3:-6385.95	36.87	36.87	0.00	0.00
401	Trask River Reach 3:-6374	36.93	36.93	0.00	0.00
402	Trask River Reach 3:-6348.2	36.95	36.95	0.00	0.00
403	Trask River Reach 3:-6000	38.19	38.19	0.00	0.00
404	Trask River Reach 3:-5776.5	38.51	38.51	0.00	0.00
405	Trask River Reach 3:-5339.8	40.42	40.42	0.00	0.00
406	Trask River Reach 3:-4858.4	42.80	42.80	0.00	0.00
407	Trask River Reach 3:-4678	43.39	43.39	0.00	0.00
408	Trask River Reach 3:-4112.5	48.27	48.27	0.00	0.00
409	Trask River Reach 3:-3952.6	50.14	50.14	0.00	0.00
410	Trask River Reach 3:-3625.5	52.42	52.42	0.00	0.00
411	Trask River Reach 3:-3231	53.67	53.67	0.00	0.00
412	Trask River Reach 3:-2665	57.59	57.59	0.00	0.00
413	Trask River Reach 3:-1894.6	68.18	68.18	0.00	0.00
414	Trask River Reach 3:-1447.9	75.04	75.04	0.00	0.00
415	Trask River Reach 3:-941.1	80.79	80.79	0.00	0.00
416	Trask River Reach 3:-506.8	82.87	82.87	0.00	0.00
417	Trask River Reach 3:-0.3	86.61	86.61	0.00	0.00
418	Wils Doug 690 Reach 1:-2715.7	26.53	26.53	0.00	0.00
419	Wils Doug 690 Reach 1:-2661.7*	26.96	26.97	-0.01	0.00
420	Wils Doug 690 Reach 1:-2607.8*	27.31	27.31	0.00	0.00
421	Wils Doug 690 Reach 1:-2553.9*	27.64	27.64	0.00	0.00
422	Wils Doug 690 Reach 1:-2500	28.11	28.11	0.00	0.00
423	Wils Doug 690 Reach 1:-2409.9*	28.57	28.57	0.00	0.00
424	Wils Doug 690 Reach 1:-2319.8*	28.83	28.83	0.00	0.01
425	Wils Doug 690 Reach 1:-2229.7	29.17	29.17	0.00	0.00
426	Wils Doug 690 Reach 1:-2181.3*	29.40	29.40	0.00	0.00
427	Wils Doug 690 Reach 1:-2133.0*	29.57	29.57	0.00	0.01
428	Wils Doug 690 Reach 1:-2084.7	29.65	29.65	0.00	0.00
429	Wils Doug 690 Reach 1:-2017.0*	29.88	29.88	0.00	0.00
430	Wils Doug 690 Reach 1:-1949.3*	30.03	30.03	0.00	0.00
431	Wils Doug 690 Reach 1:-1881.7*	30.12	30.13	-0.01	0.00
432	Wils Doug 690 Reach 1:-1814.0*	30.20	30.20	0.00	0.00
433	Wils Doug 690 Reach 1:-1746.3*	30.25	30.25	0.00	0.01
434	Wils Doug 690 Reach 1:-1678.7*	30.29	30.29	0.00	0.00
435	Wils Doug 690 Reach 1:-1611.0*	30.32	30.33	-0.01	0.00
436	Wils Doug 690 Reach 1:-1543.4	30.37	30.37	0.00	0.00
437	Wils Doug 690 Reach 1:-1466.7*	30.38	30.38	0.00	0.01
438	Wils Doug 690 Reach 1:-1390.*	30.38	30.39	-0.01	0.00
439	Wils Doug 690 Reach 1:-1313.3*	30.39	30.40	-0.01	0.00
440	Wils Doug 690 Reach 1:-1236.6*	30.41	30.41	0.00	0.00
441	Wils Doug 690 Reach 1:-1159.9*	30.43	30.43	0.00	0.00
442	Wils Doug 690 Reach 1:-1083.2	30.47	30.47	0.00	0.01
443	Wils Doug 690 Reach 1:-702.1	30.49	30.50	-0.01	0.01
444	Wils Doug 690 Reach 1:-404.8	30.52	30.53	-0.01	0.01
445	Wils Doug 690 Reach 1:-86.1	30.97	31.35	-0.38*	0.29*

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
446	Wils Doug 690 Reach 1:401.3	34.40	34.07	0.33*	-0.44*
447	Wils LB 4.92 Reach 1:-2400	33.57	33.57	0.00	0.00
448	Wils LB 4.92 Reach 1:-2125.72	33.56	33.56	0.00	0.00
449	Wils LB 4.92 Reach 1:-1980.1	33.71	33.71	0.00	0.00
450	Wils LB 4.92 Reach 1:-1785.6	33.94	33.94	0.00	0.00
451	Wils LB 4.92 Reach 1:-1478.8	34.77	34.77	0.00	0.00
452	Wils LB 4.92 Reach 1:-1300	35.98	35.98	0.00	0.00
453	Wils LB 4.92 Reach 1:-1226.5	36.15	36.15	0.00	0.00
454	Wils LB 4.92 Reach 1:-963	37.23	37.23	0.00	0.00
455	Wils LB 4.92 Reach 1:-556.7	37.99	37.99	0.00	0.00
456	Wils LB 4.92 Reach 1:-329.4	38.29	38.29	0.00	0.00
457	Wils LB 4.92 Reach 1:-224.1	38.62	38.62	0.00	0.00
458	Wils LB 4.92 Reach 1:-223.1	38.68	38.68	0.00	0.00
459	Wils RB 0.93 Reach 1:-706	16.06	16.19	-0.13	-0.02
460	Wils RB 0.93 Reach 1:-633	16.07	16.20	-0.13	-0.02
461	Wils RB 0.93 Reach 1:-461	16.07	16.21	-0.14	-0.03
462	Wils RB 0.93 Reach 1:-289	16.08	16.22	-0.14	-0.02
463	Wils RB 0.93 Reach 1:-143	16.09	16.23	-0.14	-0.02
464	Wils RB 0.93 Reach 1:0	16.11	16.25	-0.14	-0.02
465	Wils RB 1.44 Reach 1:-2546.13	17.94	18.01	-0.07	-0.01
466	Wils RB 1.44 Reach 1:-2488.4	17.95	18.02	-0.07	-0.01
467	Wils RB 1.44 Reach 1:-2176.8	17.96	18.03	-0.07	-0.01
468	Wils RB 1.44 Reach 1:-2154.3	17.94	18.00	-0.06	-0.01
469	Wils RB 1.44 Reach 1:-2143.9	18.03	18.10	-0.07	-0.01
470	Wils RB 1.44 Reach 1:-2121.4	18.09	18.17	-0.08	-0.01
471	Wils RB 1.44 Reach 1:-2116.2	18.10	18.18	-0.08	-0.01
472	Wils RB 1.44 Reach 1:-1902.4	18.16	18.24	-0.08	-0.01
473	Wils RB 1.44 Reach 1:-1582.2	18.20	18.28	-0.08	-0.01
474	Wils RB 1.44 Reach 1:-1522.2	18.20	18.28	-0.08	-0.01
475	Wils RB 1.44 Reach 1:-1043.2	18.32	18.40	-0.08	-0.01
476	Wils RB 1.44 Reach 1:-689.3	21.71	21.75	-0.04	-0.01
477	Wils RB 1.44 Reach 1:-450	25.65	25.65	0.00	0.00
478	Wils RB 1.44 Reach 1:-400	25.70	25.70	0.00	0.00
479	Wils RB 1.44 Reach 1:-389	25.70	25.70	0.00	0.00
480	Wils RB 1.44 Reach 1:-47.3	26.79	26.78	0.01	0.01
481	Wils RB 1.44 Reach 1:0	26.79	26.78	0.01	0.01
482	Wils WilsDS_B Reach 1:-878.2	9.43	9.43	0.00	0.00
483	Wils WilsDS_B Reach 1:-554.4	9.43	9.50	-0.07	0.00
484	Wils WilsDS_B Reach 1:-230.5	9.46	9.51	-0.05	-0.01
485	Wils WilsDS_B Reach 1:0	9.47	9.65	-0.18	0.00
486	Wilson River Reach 4b:-17900	9.43	9.43	0.00	0.00
487	Wilson River Reach 4b:-17818.3	9.45	9.44	0.01	0.01
488	Wilson River Reach 4b:-17668.3	9.46	9.45	0.01	0.02
489	Wilson River Reach 4b:-17516.3	9.46	9.45	0.01	0.02
490	Wilson River Reach 4b:-17371.6	9.46	9.46	0.00	0.04
491	Wilson River Reach 4b:-17300	9.46	9.56	-0.10	0.03
492	Wilson River Reach 4b:-16888.2	9.47	10.42	-0.95	-0.01
493	Wilson River Reach 4b:-16539.4	9.56	11.20	-1.64	-0.09
494	Wilson River Reach 4b:-16538.4	9.57	11.21	-1.64	-0.09

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
495	Wilson River Reach 4a:-16261	9.57	11.21	-1.64	-0.09
496	Wilson River Reach 4a:-16260	9.58	11.22	-1.64	-0.10
497	Wilson River Reach 4a:-15968.5	10.18	11.98	-1.80	-0.59
498	Wilson River Reach 4a:-15967.5	10.19	11.98	-1.79	-0.60
499	Wilson River Reach 5:-15875.9	10.19	11.98	-1.79	-0.60
500	Wilson River Reach 5:-15874.9	10.19	11.99	-1.80	-0.60
501	Wilson River Reach 5:-15615.8	10.32	12.52	-2.20	-0.92
502	Wilson River Reach 5:-15614.8	10.34	12.53	-2.19	-0.92
503	Wilson River Reach 6:-15549.5	10.34	12.53	-2.19	-0.92
504	Wilson River Reach 6:-15548.5	10.35	12.53	-2.18	-0.92
505	Wilson River Reach 6:-15369.5	11.74	12.90	-1.16	-0.66
506	Wilson River Reach 6:-15368.5	11.74	12.90	-1.16	-0.66
507	Wilson River Reach 7:-15299.7	11.74	12.90	-1.16	-0.66
508	Wilson River Reach 7:-15271.7	11.81	12.93	-1.12	-0.64
509	Wilson River Reach 7:-15058.1	12.46	13.28		-0.51
510	Wilson River Reach 7:-14901.2	12.66	13.40		-0.49
511	Wilson River Reach 7:-14863.7	13.05	13.68		-0.43
512	Wilson River Reach 7:-14341.9	14.72	14.93		-0.17
513	Wilson River Reach 7:-13904.5	15.68	15.79		-0.08
514	Wilson River Reach 7:-13658.2	15.94	16.03		-0.07
515	Wilson River Reach 7:-13474.9	16.88	16.99		-0.05
516	Wilson River Reach 7:-13043.4	17.95	18.07		-0.03
517	Wilson River Reach 7:-12759.2	19.26	19.40		-0.02
518	Wilson River Reach 7:-12715.*	19.59	19.71		-0.02
519	Wilson River Reach 7:-12672.*	19.90	20.00		-0.01
520	Wilson River Reach 7:-12629.*	20.18	20.28		-0.02
521	Wilson River Reach 7:-12586.*	20.43	20.52		-0.01
522	Wilson River Reach 7:-12543.1	20.66	20.74		-0.01
523	Wilson River Reach 7:-12502.*	20.79	20.87		-0.01
524	Wilson River Reach 7:-12461.9	20.97	21.04		-0.01
525	Wilson River Reach 7:-12445.1	21.14	21.21		-0.01
526	Wilson River Reach 7:-12404.*	21.37	21.42		-0.01
527	Wilson River Reach 7:-12363.*	21.58	21.63		-0.01
528	Wilson River Reach 7:-12323.*	21.75	21.80		-0.01
529	Wilson River Reach 7:-12282.*	21.90	21.94		0.00
530	Wilson River Reach 7:-12242.3	22.06	22.09		0.00
531	Wilson River Reach 7:-12197.*	22.17	22.21		0.00
532	Wilson River Reach 7:-12153.*	22.24	22.26		-0.01
533	Wilson River Reach 7:-12109	22.24	22.27		-0.01
534	Wilson River Reach 7:-12066.*	22.33	22.35		0.00
535	Wilson River Reach 7:-12024.*	22.41	22.44		-0.01
536	Wilson River Reach 7:-11982.*	22.50	22.52		0.00
537	Wilson River Reach 7:-11940.*	22.57	22.59		0.00
538	Wilson River Reach 7:-11898.*	22.65	22.68		0.00
539	Wilson River Reach 7:-11856.*	22.74	22.76		0.00
540	Wilson River Reach 7:-11813.*	22.83	22.84		0.00
541	Wilson River Reach 7:-11771.*	22.90	22.92		0.00
542	Wilson River Reach 7:-11729.5	22.98	23.00		0.00
543	Wilson River Reach 7:-11696.*	23.00	23.02		0.00
544	Wilson River Reach 7:-11662.*	23.03	23.05		0.00

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
545	Wilson River Reach 7:-11629.5	23.06	23.08		0.00
546	Wilson River Reach 7:-11336.5	23.62	23.63		0.00
547	Wilson River Reach 7:-11294.6	23.58	23.58		0.00
548	Wilson River Reach 7:-11087.6	24.21	24.22		0.00
549	Wilson River Reach 7:-10871	24.67	24.67		0.00
550	Wilson River Reach 7:-10593.4	25.60	25.61		0.00
551	Wilson River Reach 7:-10411.9	26.11	26.11		0.00
552	Wilson River Reach 7:-9974.5	26.90	26.90		0.00
553	Wilson River Reach 7:-9505.3	28.12	28.12		0.00
554	Wilson River Reach 7:-9412.9	28.41	28.41		0.00
555	Wilson River Reach 7:-9187.2	28.89	28.89		0.00
556	Wilson River Reach 7:-8942.9	29.69	29.69		0.00
557	Wilson River Reach 7:-8908.9	29.70	29.71		0.00
558	Wilson River Reach 7:-8748	30.35	30.35		0.00
559	Wilson River Reach 7:-8408.5	31.09	31.09		0.00
560	Wilson River Reach 7:-8327.9	31.55	31.55		0.00
561	Wilson River Reach 7:-8326.9	31.55	31.55		0.00
562	Wilson River Reach 8b:-8219.4	31.55	31.55		0.00
563	Wilson River Reach 8b:-8096.8	31.76	31.76		0.00
564	Wilson River Reach 8b:-7990.4	31.89	31.89		0.00
565	Wilson River Reach 8b:-7762.1	32.69	32.69		0.00
566	Wilson River Reach 8b:-7658.9	33.02	33.02		0.00
567	Wilson River Reach 8b:-7283.5	33.56	33.56		0.00
568	Wilson River Reach 8b:-7282.5	33.57	33.57		0.00
569	Wilson River Reach 8a:-7143.2	33.57	33.57		0.00
570	Wilson River Reach 8a:-6848.9	35.21	35.21		0.00
571	Wilson River Reach 8a:-6674.8	35.67	35.67		0.00
572	Wilson River Reach 8a:-6286.9	36.48	36.48		0.00
573	Wilson River Reach 8a:-5716.4	37.54	37.53		0.00
574	Wilson River Reach 8a:-5449.3	38.46	38.46		0.00
575	Wilson River Reach 8a:-5274.3	39.43	39.43		0.00
576	Wilson River Reach 8a:-5010.1	39.94	39.94		0.00
577	Wilson River Reach 8a:-4778.2	40.61	40.61		0.00
578	Wilson River Reach 8a:-4549	41.21	41.21		0.00
579	Wilson River Reach 8a:-4356	42.10	42.10		0.00
580	Wilson River Reach 8a:-3885.8	43.95	43.95		0.00
581	Wilson River Reach 8a:-3379.1	45.96	45.96		0.00
582	Wilson River Reach 8a:-3074.3	46.96	46.96		0.00
583	Wilson River Reach 8a:-2973.6	48.68	48.68		0.00
584	Wilson River Reach 8a:-2408	51.33	51.33		0.00
585	Wilson River Reach 8a:-1989.6	53.75	53.75		0.00
586	Wilson River Reach 8a:-1834.3	54.57	54.57		0.00
587	Wilson River Reach 8a:-1650.7	55.29	55.29		0.00
588	Wilson River Reach 8a:-1423.9	56.93	56.93		0.00
589	Wilson River Reach 8a:-1357.5	56.76	56.76		0.00
590	Wilson River Reach 8a:-1315.9	57.29	57.29		0.00
591	Wilson River Reach 8a:-1299.9	57.41	57.41		0.00
592	Wilson River Reach 8a:-1241.1	57.23	57.23		0.00
593	Wilson River Reach 8a:-736.5	61.01	61.01		0.00
594	Wilson River Reach 8a:-3.5	66.22	66.22		0.00

No	Node	WSE (ft) Post-Project 2017 Flood	WSE (Ft) Pre-Project 2017 Flood	Diff (ft) 2017 Flood	Diff (ft) 1999 Flood
595	Wilson River Reach 8a:0	66.24	66.24	0.00	0.00
596	WilsonDS_B Reach 1:-1300	9.43	9.43	0.00	0.00
597	WilsonDS_B Reach 1:-1261.6	10.44	11.82	-1.38	-0.54
598	WilsonDS_B Reach 2:-1171.6	10.44	11.82	-1.38	-0.54
599	WilsonDS_B Reach 2:-1045.6	10.44	11.84	-1.40	-0.55
600	WilsonDS_B Reach 2:-740.6	10.45	11.89	-1.44	-0.55
601	WilsonDS_B Reach 2:-468.6	10.36	11.92	-1.56	-0.56
602	WilsonDS_B Reach 2:-150.6	10.22	11.97	-1.75	-0.59
603	WilsonDS_B Reach 2:-84.6	10.19	11.98	-1.79	-0.60
604	WilsonDS_B Reach 2:-83.6	10.19	11.98	-1.79	-0.60
605	WilsonDS_C Reach 2:-1294	10.44	11.82	-1.38	-0.54
606	WilsonDS_C Reach 2:-1234	10.47	11.83	-1.36	-0.54
607	WilsonDS_C Reach 2:-1052	10.54	11.87	-1.33	-0.54
608	WilsonDS_C Reach 2:-832	10.63	11.91	-1.28	-0.54
609	WilsonDS_C Reach 2:-544	10.97	12.11	-1.14	-0.53
610	WilsonDS_C Reach 2:-518	11.06	12.19	-1.13	-0.54
611	WilsonDS_C Reach 2:-402	11.42	12.54	-1.12	-0.59
612	WilsonDS_C Reach 2:-236	11.60	12.71	-1.11	-0.61
613	WilsonDS_C Reach 2:0	11.74	12.90	-1.16	-0.66
614	2	7.00	12.13	-5.13	-5.30
615	Ha 4300 SA	12.27	12.76	-0.49	-1.07
616	Ha 4700 SA	12.26	12.71	-0.45	-1.08
617	Hall RB 3300 SA	12.27	12.77	-0.50	-1.08
618	Halll RB 3100 SA	12.27	12.77	-0.50	-1.09
619	Hoqu LB 2.00 SA	13.04	14.12	-1.08	-0.37
620	Ti-OT Till 1.69	10.31	11.07	-0.76	-0.13
621	Till 3.91 SA	3.28	3.28	0.00	-0.12
622	Till 4.00 SA	11.43	11.47	-0.04	-0.09
623	Till LB 2.00 SA	3.28	3.28	0.00	-0.13
624	Till Oldt SA1	10.31	11.07	-0.76	-0.14
625	Till Oldt SA2	10.45	11.07	-0.62	-0.11
626	Tras RB SA	11.60	11.94	-0.34	0.00
627	Tras Tr_RB SA	16.15	17.04	-0.89	0.00
628	Wils DORB 476 SA	28.73	28.57	0.16	0.00
629	Wils LB 0.15 SA	12.28	12.77	-0.49	-1.08
630	Wils RB 3.93 SA	33.06	33.09	-0.03	0.00
631	WilsLpRdDS	23.39	23.36	0.03	0.00