LOMR SUBMITTAL
LOWER NESTUCCA RIVER
TILLAMOOK COUNTY, OREGON

Prepared for:

TILLAMOOK COUNTY
DEPARTMENT OF COMMUNITY DEVELOPMENT
1510-B THIRD STREET
TILLAMOOK, OR 97141

Prepared by:

10300 SW GREENBURG ROAD, SUITE 470
PORTLAND, OR 97223

June 4, 2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF EXHIBITS

1. INTRODUCTION

Tillamook County, Oregon (County) was recently directed by Federal Management Emergency Agency (FEMA), Region X, to re-analysis the lower reach of the Nestucca River. As a result, the County contracted WEST Consultants, Inc. (WEST) to re-analyze the reach of the Nestucca River between its confluence with the Nestucca Bay and FEMA Cross Section F, and to prepare a Letter of Map Revision (LOMR) submittal package in support of the re-analysis. Figure 1 shows a map of the study area.

The re-analysis involved conducting a hydraulic analysis to determine the revised based flood elevations (BFEs – water surface elevations associated with the 1% annual chance event) and floodway elevations for the study reach. The hydraulic analysis utilized new topography data for the overbank area. This report, along with supporting documentation, will be submitted to FEMA as a LOMR application to request a revision to the current effective Flood Insurance Rate Map (FIRM) panels. Exhibit A includes the FEMA forms for this LOMR submittal.

Pertinent information about the request is summarized as follows:

Identifier:	Nestucca River (Cross Sections A through F)
Flooding Source:	Nestucca River
Community:	Tillamook County, Oregon
Community No.:	410196
FIRM Panels Affected:	4101960305A and 4101960315A

Unless otherwise stated, all elevations within this report are referenced to the North American Vertical Datum of 1988 (NAVD88).

2. RESEARCH

A FEMA Flood Insurance Study (FIS) is available for the Nestucca River (FEMA, 2002). The flood boundaries for the study reach of the Nestucca River are available on Panels 305A and 315A for Community 410196, i.e., FIRM panel 4101960305A and 4101960315A. The floodway boundaries for the study reach are available on the Flood Boundary and Floodway Map (FBFM) panels 4101960305 and 4101960315. WEST was not able to obtain the effective HEC-2 model from the FEMA library. Digital versions of the Tillamook County, Oregon and Unincorporated Areas FIS (FEMA, 2002), FIRM panels, and DFIRM ArcGIS shape files were obtained from the FEMA Map Service Center website. The effective FIRM, FBFM, flood profile, and floodway data table are provided in Exhibit B.

There are two bridges located within the study reach included as part of this submittal: (1) Pacific Avenue, and (2) Ferry Street over the Nestucca River. Bridge plans were obtained from Oregon Department of Transportation (ODOT) and Tillamook County. Selected plan sheets are provided in Exhibit C. The model was extended to FEMA Cross Section F to meet FEMA's tie-in requirements.

LiDAR data from the Oregon Department of Geology and Mineral Industries (DOGAMI 2009) is the main topography data available for the study area. Electronic files of the topography data

Figure 1. Project location map

are included on the CD in Exhibit K.

3. HYDROLOGY

The hydrology for this LOMR submittal is based on the hydrology defined in the effective FIS (FEMA, 2002). As discussed in the FIS, the hydrology for Nehalem River was developed by U.S. Army Corps of Engineers using a hydrologic model that was calibrated to measured data at USGS stream gage 14303600, *Nestucca River near Beaver, OR*. The peak discharges of Nestucca River for various annual chance flood events are summarized in Table 1.

Table 1. Peak Discharges for Various Annual Chance Flood Events (FEMA, 2002)

Location	Drainage Area (mi^2)	Peak Discharge (cfs) per Annual Chance Flood Event			
		10%	2%	1%	0.2%
Mouth	259	30,200	43,600	49,700	64,800
Confluence with Hartney Creek	232.5	28,100	40,600	46,300	60,300
USGS Gage near Beaver	180	23,500	34,000	38,750	50,500

4. HYDRAULICS

Information used to develop the various hydraulic models required for the LOMR submittal is provided in the following paragraphs.

4.1 Duplicate Effective Model (DEM)

The Duplicate Effective Model (DEM) is a copy of the model used in the hydraulic analysis of the effective FIS, referred to as the effective model. Ideally, an engineer would obtain the effective FIS model from the FEMA Library to reproduce the water surface elevations for a specified tolerance. This step ensures the effective model: (1) has been transferred correctly to a newer model such as HEC-RAS, and (2) has been revised with new data in order to provide a continuous effective model both upstream and downstream of the specific reach of interest.

The hydraulic analysis for the effective FIS for the Nehalem River was completed using the HEC-2 program (FEMA, 2002). WEST was not able to obtain the effective model from the FEMA Library because it was not found in the FEMA database by FEMA employees. WEST was only able to obtain the HEC-2 output tables for the FIS lettered cross sections. WEST employees worked with David Ratte (Regional Engineer, FEMA Region X) to find an alternative method to create representative cross sections of DEM model that would reproduce the 0.2%, 1% water surface elevations to within 0.5 ft tolerance. The suggested and accepted method entailed using recent LiDAR to represent the overbank terrain and using the riverbed profile to define representative channel geometry. The channel geometry and Manning's roughness values were adjusted until the simulated water surface elevations were within the 0.5 ft tolerance. A plan view showing the location of the cross sections is shown in Figure 2. As shown in the figure, new cross sections were added throughout the whole model.

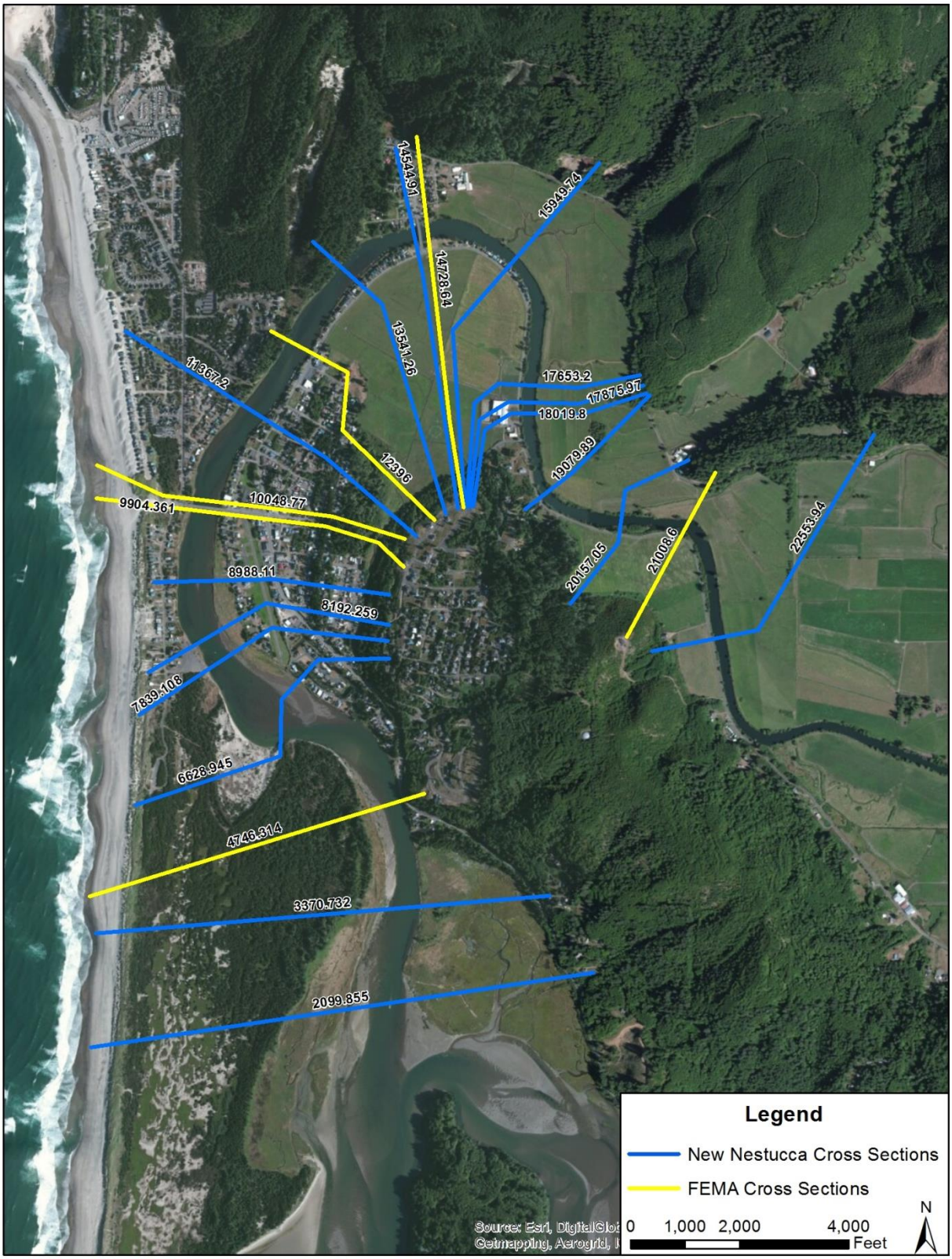

Figure 2. Layout of Cross Sections

The DEM was developed for the reach from FEMA cross section A at the downstream end to FEMA cross section F, located approximately 4.3 miles upstream from the downstream boundary. The DEM consists of 20 cross sections and 2 bridge structures that were modeled using the "Normal Bridge" approach.

The 0.2% and 1% annual chance water surface elevations (WSELs) using the DEM are summarized in Table 2. The WSELs in the table are based on NAVD88. The elevations in the effective FIS model are based on National Geodetic Vertical Datum of 1929 (NGVD29). HEC-RAS was converted to NAVD88 by using a conversion factor of 3.4 feet. As shown in the table, the WSELs computed using the DEM are within the 0.5 foot tolerance specified by FEMA for applying a different hydraulic model. A comparison of the floodway elevations was not completed since the effective hydraulic model was not available. A hardcopy of the DEM is provided in Exhibit D, and an electronic version of this model is included on the CD in Exhibit K.

Table 2. Duplicate Effective Model Results

Model RS	FIS Cross Section	Base Flood Water Surface Elevations					
		1% (100-YR)			0.2% (500-YR)		
		Effective FIS WSEL (ft, NAVD88)	DEM WSEL (ft, NAVD88)	Delta (ft)	Effective FIS WSEL (ft, NAVD88)	DEM WSEL (ft, NAVD88)	Delta (ft)
2099.9		---	14.15	---	---	15.90	---
3370.7		---	14.24	---	---	15.93	---
4746.3	A	14.58	14.58	0.00	16.38	16.29	-0.09
6628.9		---	15.79	---	---	17.77	---
7839.1		---	16.14	---	---	18.10	---
8192.3		---	16.3	---	---	18.27	---
8988.1		---	16.63	---	---	18.58	---
9904.4	B	16.98	16.82	-0.16	18.68	18.70	0.02
10048.8	C	17.08	16.91	-0.17	18.58	18.84	0.26
11367.2		---	17.57	---	---	19.50	---
12396	D	18.38	18.34	-0.04	20.18	20.39	0.21
13541.3		---	19.10	---	---	21.39	---
14544.9		---	19.17	---	---	21.47	---
14728.6	E	19.08	19.20	0.12	21.08	21.50	0.42
15949.7		---	19.30	---	---	21.60	---
17653.2		---	19.35	---	---	21.65	---
19079.9		---	19.46	---	---	21.75	---
20157.1		---	19.70	---	---	21.99	---
21008.6	F	20.18	19.85	-0.33	22.18	22.13	-0.05
22553.9		---	20.26	---	---	22.53	---

4.2 Corrected Effective Model (CEM)

The Corrected Effective Model (CEM) is the model that corrects any errors that occur in the DEM, adds any additional cross sections to the DEM, or incorporates more detailed topographic information than that used in the effective FIS model. The CEM must not reflect any man-made physical changes since the date of the effective model. An error could be a technical error in the modeling procedures, or any construction in the floodplain that occurred prior to the date of the effective model, but was not incorporated into the effective model.

The CEM was developed by updating the existing cross section with LiDAR data (DOGAMI, 2009) and adding additional cross sections for the reach. A plan view showing the location of the cross sections is shown in Figure 2. The CEM has two additional cross sections (RS 17875 and RS 18019) to incorporate a large building or barn that is located near the left bank. The two cross sections were added so the CEM and Existing Conditions Model (ECM)would have the same cross sections.

The main channel of Nestucca River within the study reach is comprised of silts and sand sized bed material with vegetated banks. A Manning's roughness coefficient of 0.03 or 0.031 was assigned to the channel area downstream of Ferry St. bridge. Above the bridge, 0.035 was assigned to the channel. The overbank areas consist of pasture grass with moderate to heavy brush and trees near the riverbanks and densely vegetated trees and brush at the outer extents of the floodway. A roughness coefficient of 0.04 or 0.05 was assigned for the grass pasture floodplains while 0.07 was assigned to the brush and tree area near the stream banks. A Manning's roughness value of 0.1 was assigned for the densely vegetated areas.

Revisions to the cross sections extracted from the LiDAR data were made to eliminate all man-made physical changes completed since the date of the effective model. Tillamook County survey team carried out a hydro survey of the Nestucca River. The data was used to update the bathymetric data from the DEM since a HEC-2 model was not available.

The 0.2% and 1% annual chance flood WSELs for the CEM and DEM are summarized in Table 3. This table also includes the difference in the WSELs between the two models. Since the HEC-2 model was not available, a comparison of the floodway was not made between the DEM and CEM. A hardcopy of the CEM is provided in Exhibit E, and an electronic version of this model is included on the CD in Exhibit K.

Table 3. Corrected Effective Model Results

Model RS	FIS Cross Section	Base Flood Water Surface Elevations					
		1% (100-YR)			0.2% (100-YR)		
		DEM WSEL (ft, NAVD88)	CEM WSEL (ft, NAVD88)	Delta (ft)	DEM WSEL (ft, NAVD88)	CEM WSEL (ft, NAVD88)	Delta (ft)
2099.9		14.15	14.15	0.00	15.90	15.90	0.00
3370.7		14.24	14.25	0.01	15.93	15.93	0.00
4746.3	A	14.58	14.80	0.22	16.29	16.50	0.21
6628.9		15.79	16.08	0.29	17.77	18.06	0.29
7839.1		16.14	16.28	0.14	18.10	18.27	0.17
8192.3		16.30	16.38	0.08	18.27	18.39	0.12
8988.1		16.63	16.63	0.00	18.58	18.63	0.05
9904.4	B	16.82	16.79	-0.03	18.70	18.72	0.02
10048.8	C	16.91	16.86	-0.05	18.84	18.84	0.00
11367.2		17.57	17.63	0.06	19.50	19.59	0.09
12396.0	D	18.34	18.43	0.09	20.39	20.50	0.11
13541.3		19.10	19.30	0.20	21.39	21.61	0.22
14544.9		19.17	19.40	0.23	21.47	21.71	0.24
14728.6	E	19.20	19.42	0.22	21.50	21.74	0.24
15949.7		19.30	19.52	0.22	21.60	21.83	0.23
17653.2		19.35	19.58	0.23	21.65	21.89	0.24
17876.0		--	19.58	---		21.89	---
18019.8		--	19.59	---		21.90	---
19079.9		19.46	19.75	0.29	21.75	22.05	0.30
20157.1		19.70	19.99	0.29	21.99	22.28	0.29
21008.6	F	19.85	20.13	0.28	22.13	22.42	0.29
22553.9		20.26	20.54	0.28	22.53	22.81	0.28

4.3 Existing Conditions Model (ECM)

The Existing Conditions Model (ECM) is a modification of the CEM to reflect any modifications that have occurred within the floodplain since the date of the effective model but prior to the floodway revision being requested. The same floodplain and bathymetric terrain as the CEM was used for the ECM. The ECM was developed by incorporating the land changes and structures built after the effective model was completed. Tillamook County supplied WEST with construction building records to help assess which lots had buildings constructed since 1978 (effective model date). The construction records showed the buildings (since 1978) were interspersed throughout the denser populated areas of Pacific City, making it unreasonable to define every house as blocked-obstructions in the HEC-RAS model. Instead, the Manning's n roughness values were increased from 0.07 to 0.08 to account for the new structures since 1978. Blocked obstructions were added to cross sections RS 17875 and RS 18019 to represent the large barn and buildings on the left bank. Blocked obstructions were used for this building because it is large and other smaller buildings are not near as compared to the houses that were built within

the more dense community streets.

The 1% annual chance flood WSELs for with and without floodway computed using the ECM are summarized in Table 4. This table also includes the WSELs computed using the CEM, and the difference in the WSELs between the two models. A hardcopy of the Existing Conditions model is provided in Exhibit F, and an electronic version of this model is included on the CD in Exhibit K.

Table 4. Existing Conditions Model Results

Model RS	FIS Cross Section	Base Flood Water Surface Elevations					
		Without Floodway			With Floodway		
		CEM WSEL (ft, NAVD88)	ECM WSEL (ft, NAVD88)	Delta (ft)	CEM WSEL (ft, NAVD88))	ECM WSEL (ft, NAVD88)	Delta (ft)
2099.9		14.15	14.15	0.00	15.15	15.15	0.00
3370.7		14.25	14.26	0.01	15.38	15.39	0.01
4746.3	A	14.80	14.60	-0.20	15.80	15.77	-0.03
6628.9		16.08	15.92	-0.16	16.87	16.85	-0.02
7839.1		16.28	16.14	-0.14	17.05	17.03	-0.02
8192.3		16.38	16.24	-0.14	17.15	17.13	-0.02
8988.1		16.63	16.51	-0.12	17.32	17.31	-0.01
9904.4	B	16.79	16.67	-0.12	17.48	17.46	-0.02
10048.8	C	16.86	16.74	-0.12	17.62	17.60	-0.02
11367.2		17.63	17.55	-0.08	18.30	18.29	-0.01
12396.0	D	18.43	18.35	-0.08	18.91	18.90	-0.01
13541.3		19.30	19.25	-0.05	19.84	19.84	0.00
14544.9		19.40	19.35	-0.05	19.92	19.92	0.00
14728.6	E	19.42	19.38	-0.04	19.95	19.95	0.00
15949.7		19.52	19.47	-0.05	20.02	20.02	0.00
17653.2		19.58	19.53	-0.05	20.10	20.11	0.01
17876.0		19.58	19.53	-0.05	20.11	20.10	-0.01
18019.8		19.59	19.54	-0.05	20.12	20.11	-0.01
19079.9		19.75	19.72	-0.03	20.25	20.27	0.02
20157.1		19.99	19.96	-0.03	20.56	20.57	0.01
21008.6	F	20.13	20.10	-0.03	20.74	20.75	0.01
22553.9		20.54	20.51	-0.03	21.21	21.22	0.01

4.4 Proposed Conditions Model (PCM)

A Proposed Conditions Model (PCM) was developed for this submittal. The PCM geometry is identical to the ECM geometry. The PCM was developed to define the revised floodplain (0.2% and 1%) inundation extents and the revised floodway.

Encroachments were applied in HEC-RAS to define the revised floodway at which would cause no more than one foot rise in water surface elevation. Exhibit G contains the output model results for the PCM. Exhibit H shows the revised flood profiles, FIRMs, and floodway data table. The revised floodway shows little difference for the upper section of the model (upper 0.4 miles). Downstream, the floodway narrows farther into the farmland pasture (at the large north bend) and in the denser community area near FIS cross section D. Between FIS cross section D and A, the revised floodplain is located near the upper banks of the Nestucca River. Table 5 shows the revised floodway widths. Notes:

1. Two values provided are provided for the effective floodway width: (1) the first value was determined from the GIS layer of the floodway boundaries, and (2) the second value, provided in the parenthesis, was obtained from the FIS (information available only for lettered cross sections).

Table 6 shows the comparison between the 1% water surface elevations and floodway elevations for the PCM model. All the surcharges are below 1 ft as required by FEMA. Table 7 shows a comparison between the effective FIS and PCM.

Table 5. Revised Floodway Widths

RS	FIS Cross Section	Effective Floodway Width (ft)[(1)]	Revised Floodway Width (ft)	Difference (ft)
2099.9		871	1,647	776
3370.7		770	989	219
4746.3	A	598 (607)	607	9
6628.9		1,110	898	-212
7839.1		1,267	660	-607
8192.3		1,222	687	-535
8988.1		1,036	702	-334
9904.4	B	744 (764)	459	-285
10048.8	C	776 (783)	470	-306
11367.2		612	395	-217
12396.0	D	728 (700)	385	-343
13541.3		2,736	1,461	-1275
14544.9		2,918	1,810	-1108
14728.6	E	2,924 (2,925)	1,850	-1074
15949.7		3,164	2,500	-664
17653.2		2,281	1,900	-381
17876.0		2,040	1,850	-190
18019.8		1,868	1,800	-68
19079.9		1,437	1,474	37
20157.1		1,500	1,500	0
21008.6	F	1,418 (1,418)	1,400	-18
22553.9		2,751	2,800	49

Notes:

2. Two values provided are provided for the effective floodway width: (1) the first value was determined from the GIS layer of the floodway boundaries, and (2) the second value, provided in the parenthesis, was obtained from the FIS (information available only for lettered cross sections).

Table 6. Proposed Condition Model Results

RS	FIS Cross Section	Base Flood Water Surface Elevations						
		Without Floodway			With Floodway			
		ECM WSEL (ft)	PCM WSEL (ft)	Delta (ft)	ECM WSEL (ft)	PCM WSEL (ft)	Delta (ft)	Surcharge (ft)
2099.9		14.15	14.15	0.00	15.15	15.15	0.00	1.00
3370.7		14.26	14.26	0.00	15.39	15.26	-0.13	1.00
4746.3	A	14.60	14.60	0.00	15.77	15.57	-0.20	0.97
6628.9		15.92	15.92	0.00	16.85	16.69	-0.16	0.77
7839.1		16.14	16.14	0.00	17.03	16.83	-0.20	0.69
8192.3		16.24	16.24	0.00	17.13	16.90	-0.23	0.66
8988.1		16.51	16.51	0.00	17.31	17.24	-0.07	0.73
9904.4	B	16.67	16.67	0.00	17.46	17.47	0.01	0.80
10048.8	C	16.74	16.74	0.00	17.60	17.66	0.06	0.92
11367.2		17.55	17.55	0.00	18.29	18.39	0.10	0.84
12396.0	D	18.35	18.35	0.00	18.90	19.03	0.13	0.68
13541.3		19.25	19.25	0.00	19.84	20.06	0.22	0.81
14544.9		19.35	19.35	0.00	19.92	20.22	0.30	0.87
14728.6	E	19.38	19.38	0.00	19.95	20.25	0.30	0.87
15949.7		19.47	19.47	0.00	20.02	20.37	0.35	0.90
17653.2		19.53	19.53	0.00	20.11	20.46	0.35	0.93
17876.0		19.53	19.53	0.00	20.10	20.47	0.37	0.94
18019.8		19.54	19.54	0.00	20.11	20.49	0.38	0.95
19079.9		19.72	19.72	0.00	20.27	20.64	0.37	0.92
20157.1		19.96	19.96	0.00	20.57	20.90	0.33	0.94
21008.6	F	20.10	20.10	0.00	20.75	21.05	0.30	0.95
22553.9		20.51	20.51	0.00	21.22	21.51	0.29	1.00

Table 7. Proposed Condition Model and Effective FIS Comparison

Model RS	FIS Cross Section	Base Flood Water Surface Elevations (1 % or 100-YR)					
		Without Floodway			With Floodway		
		Effective FIS WSEL (ft, NAVD88)	Revised WSEL (ft, NAVD88)	Delta (ft)	Effective FIS WSEL (ft, NAVD88)	Revised WSEL (ft, NAVD88)	Delta (ft)
2099.9		-	14.15	-	-	15.15	-
3370.7		-	14.26	-	-	15.26	-
4746.3	A	14.58	14.60	0.02	15.58	15.57	-0.01
6628.9		-	15.92	-	-	16.69	-
7839.1		-	16.14	-	-	16.83	-
8192.3		-	16.24	-	-	16.90	-
8988.1		-	16.51	-	-	17.24	-
9904.4	B	16.98	16.67	-0.31	17.88	17.47	-0.41
10048.8	C	17.08	16.74	-0.34	17.98	17.66	-0.32
11367.2		-	17.55	-	-	18.39	-
12396.0	D	18.38	18.35	-0.03	19.38	19.03	-0.35
13541.3		-	19.25	-	-	20.06	-
14544.9		-	19.35	-	-	20.22	-
14728.6	E	19.08	19.38	0.3	20.08	20.25	0.17
15949.7		-	19.47	-	-	20.37	-
17653.2		-	19.53	-	-	20.46	-
17876.0		-	19.53	-	-	20.47	-
18019.8		-	19.54	-	-	20.49	-
19079.9		-	19.72	-	-	20.64	-
20157.1		-	19.96	-	-	20.90	-
21008.6	F	20.18	20.10	-0.08	21.18	21.05	-0.13
22553.9		-	20.51	-	-	21.51	-

5. FEMA FORMS

As previously mentioned, completed FEMA MT-2 forms are included in Exhibit A.

6. SUMMARY

A hydraulic analysis of Nestucca River was completed for the reach between FEMA cross section A (RS 4647) and F (RS 21008.6) in the Tillamook County, Oregon. Model revisions were made only for the reach downstream of FEMA cross section F (RS 21008.6) with the upper reach being need to meet FEMA's requirements for tying into the effective hydraulic model. The hydraulic analysis was completed in support of this LOMR submittal required by FEMA for development that has occurred within the floodway boundaries since the effective hydraulic model was completed. The revised floodplain boundaries are included in the revised FIRM panel included in Exhibit H and work map included in Exhibit I. The results of the analysis indicate that there will be a reduction in the BFEs for the reach immediately surrounding the Pacific Ave. bridge and an increase in the BFEs for the reach immediately surrounding the Ferry St. bridge. The results for the far upstream reach (FIS "F") shows s slight reduction in BFEs.

A proposed condition model was presented and changes were made to the effective floodway width to eliminate the floodway encroachment on the large river bend on the north part of the project (near Ferry St. bridge). The floodway was also narrowed to the top of banks at the more densely populated areas of Pacific City (FIS cross sections "D" to "A"). The changes in the floodway widths ranged from 300 to 1000 feet reduction.

Because the BFEs and Floodway need to be revised, the Tillamook County, OR, in accordance with Part 65.12 of the National Flood Insurance Program (NFIP) regulations, will have to provide additional evidence before the effective FIRM is revised. As part of this submittal package, the following documents will be submitted by the Tillamook County, OR (furnished in Exhibit J):

1. Letter from the Tillamook County, OR stating that the County will adopt and enforce the modified floodplain and floodway.

2. Certification that no structures are located in the areas that would be impacted by the modified floodplain and floodway.

3. Documentation of individual legal notice to all impacted property owners within and outside the community explaining the impact of the revised floodplain and floodway.

7. REFERENCES

Federal Emergency Management Agency, *DFIRM Database, Tillamook County, Oregon*, 2010.

Federal Emergency Management Agency, *FIRM Panel 4101960315A, Tillamook County, Oregon*, August 1978.

Federal Emergency Management Agency, *FIRM Panel 4101960305A, Tillamook County, Oregon*, August 1978.

Federal Emergency Management Agency (FEMA), *Flood Insurance Study, Tillamook County, Oregon, Unincorporated Areas*, August 2002.

Oregon Department of Geology and Mineral Industries (DOGAMI), *LiDAR data, BE45123-F7 and BE45123-F8*, July 2009.

U.S. Army Corps of Engineers (USACE), *HEC-RAS River Analysis System User's Manual, Version 4.1*, January 2010.