Appendix 2

Chehalis Basin Strategy Restorative Flood Protection Alternative - Cost Assessment for Property and Transportation System Impacts

Natural Systems Design

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To: Jim Kramer, Ruckelshaus Center

From: Cynthia Carlstad, Carlstad Consulting; Tim Abbe, Danielle Devier, and Megan Nelson, Natural Systems Design; Mike Roberts, Heather Page and Bob Montgomery, Anchor QEA, LLC

Date: 3/23/2017, rev. 6/26/2019

Re: Chehalis Basin Strategy Restorative Flood Protection Alternative - Cost Assessment for Property and Transportation System Impacts

BACKGROUND

In 2016, Natural Systems Design (NSD) developed a preliminary planning-level opinion of cost for the Restorative Flood Protection (RFP) action element (Abbe et al. 2016) for the draft Chehalis Basin Strategy Economics Study Update (EES Consulting, Inc. 2016). The expected cost ranged from $940 million to $1.2 billion, and included the elements shown in Table 1.

Table 1 Preliminary planning-level Restorative Flood Protection costs from 2016.

ITEM #	DRAFT PLANNING-LEVEL RESTORATIVE FLOOD PROTECTION OPINION OF COST	$2016 LOW	$2016 HIGH
1	Estimated Easement and Relocation/Buy-out	$265 million	$505 million
2	River and Floodplain Restoration Construction	$555 million	$555 million
	Subtotal	$820 million	$1,060 million
3	Washington Sales Tax (8.7%)	$48 million	$48 million
4	Administrative and engineering fees such as permitting, planning, land acquisition coordination, project management, engineering, and construction management assistance	$55 million	$55 million
5	Monitoring	$5 million	$5 million
6	Adaptive management	$14 million	$14 million
	Total (in 2016 dollars)	$1,497 million*	$1,737 million*

Note: (*) corrected totals from Carlstad et al. 2017.

The only difference between the low and the high values was the estimated easement and relocation/buyout cost. These are the costs for property and transportation impacts that could result from establishing the restorative flood protection treatment areas. The difference stemmed from the bracketing assumption that buy-outs and easements would be needed for at least all of the properties within the 10-year future floodplain, and potentially all of the future 100-year floodplain. Due to schedule constraints, these costs were not estimated; instead placeholders were established based on assessed value of potentially impacted land. A placeholder for relocation and transportation impacts was established based on approximately doubling the assessed value of potentially impacted lands.

In October 2016, the Governor's Work Group requested that a more grounded assessment of the estimated easement and relocation/buy-out element be developed by the combined NSD / Anchor

QEA team. This memo summarizes the results of that assessment along with a more detailed analysis for low and high costs, differentiating the impacts to roads and bridges under existing conditions versus proposed conditions.

APPROACH

NSD determined that the best approach for developing the desired information was to walk through a hypothetical implementation scenario for buying-out or relocating willing sellers in the 100-year floodplain of a pilot sub-basin. The South Fork Newaukum River was selected as the pilot sub-basin for the following reasons:

1. Preliminary modeling results indicated significant flood reduction.
2. This sub-basin would not receive the potential flood damage reduction benefits from either of the dam scenarios (Flood Retention Only and Flood Retention/Flow Augmentation) evaluated in the draft Programmatic Environmental Impact Statement (PEIS).
3. The South Fork Newaukum sub-basin is recommended for further feasibility study during the 2017-2019 biennium, and this exercise will inform that work.

This study area included about 21 river miles of the South Fork Newaukum River and 1,900 acres of proposed restored 100-year floodplain (see Table 1).

Table 2 Study area size relative to total potential 100- year floodplain Restorative Flood Protection area.

AREA	PARCELS WITHIN 100-YEAR RFP FLOODPLAIN	ACRES (NOTE 1)	RIVER MILES
South Fork Newaukum River	444 parcels (15% of total) 232 mostly-in floodplain 212 mostly-out of floodplain	1,900 acres (9.0% of total)	21 river miles (15% of total)
Total Potential Restorative Flood Protection Areas	2,861 parcels 1,740 mostly in floodplain 1,121 mostly out of floodplain	21,000 acres	140 river miles

Note 1: Acreage calculation includes the river channel as part of the area estimate.

Within this focal area along the South Fork Newaukum River, Anchor QEA developed cost assessments, in 2017 dollars, for the following elements:

- Potential changes to roads and bridges
- The fair market purchase price of willingly-sold residential properties
- The fair market cost of the willing-relocation of agricultural properties

No commercial or public buildings (e.g., schools) were identified within this study area.

Roads and bridges were analyzed for potential impacts using the initial results of a modeled 100-year flood water surface elevation, which was based on proposed restored flood protection elements in the river channel and floodplain. This proposed water surface elevation was used to determine which roads and bridges may need to be elevated and/or rebuilt, or decommissioned if restorative flood protection was constructed in this reach.

Residential and agricultural properties were similarly analyzed and classified into potential easement and buyout/relocation categories. Parcels that were mostly outside of the modeled 100-year floodplain were classified as easement parcels. The remainder of the parcels, the ones that were well-within the modeled 100-year floodplain were then classified as either good candidates for buyout/relocation or easement. If a floodplain parcel was designated as agricultural in the assessor's office land use description, if it was un-forested, or if it had a structure in the inundated area, it was classified as a relocation/buyout candidate. The remainder of the floodplain parcels were classified as easement parcels, including parcels that were forested or non-agricultural parcels without valuable structures in the floodplain.

A summary of this preliminary South Fork Newaukum River impact area classification is provided in Table 3. Since a conceptual design has not yet been developed for the RFP treatment area, the assumptions about impacted roads, bridges, and properties are based only on coarse hydraulic modeling results, and could change significantly. The property classification will also change with a future design refinements and with landowner input. These classifications are only intended to further inform this planning-level assessment.

Table 3 Elements incorporated into refined South Fork Newaukum River basin Restorative Flood Protection area.

CATEGORY	SOUTH FORK NEWAUKUM RIVER BASIN FLOODPLAIN AREA SUMMARY
Roadway and Bridge	9 bridges, 4.5 miles road analyzed
Agricultural Property – Relocate/Buyout	45 parcels, 525 acres
Residential Property – Relocate/Buyout	96 parcels, 560 acres
Easement – All Land Uses	303 parcels, 815 acres

FINDINGS

The planning-level cost assessment for these features was between $58 million and $120 million (see Table 4). More detail on the cost approach, variables, and uncertainties is provided in the sections below.

Table 4 Cost Assessment Range for South Fork Newaukum relocation/buy-out costs, including roads and bridges.

Estimated Relocation/Buy-out Cost Category	\$2017 Low Cost	\$2017 High Cost
Roadway and Bridge	\$14 million	\$71 million
Agricultural Property	\$8 million	\$12 million
Residential Property	\$22 million	\$23 million
Easements	\$14 million	\$14 million
Total	**\$58 million**	**\$120 million**

Roadways and Bridges

In this analysis, the cost (in 2017 dollars) for elevating impacted roads and bridges, and removing roads that would no longer be used, ranged from \$14 million to \$71 million. Within the study area, NSD identified roads and bridges that may be affected by increased inundation within the modeled Restorative Flood Protection area. These sections were then confirmed by Anchor QEA and reviewed to determine what potential actions were needed, including the following:

- Raise the roadway
- Replace existing bridges
- Create new roadway
- Scour protection
- Abandon

Table 5 describes roads and bridges that would potentially be impacted by the RFP. Many of these are already impacted during flood events as shown in Table 5, and will become increasingly impacted by future climate conditions. The RFP would increase flood levels and increase the duration of impact in many of the cases listed.

Basis of Road and Bridge Estimate

Preliminary cost assessments were developed for each of the listed road and bridge actions. For the high cost, a total of four miles of road and five bridges were determined likely to be in need of raising to avoid impacts during a 100-year flood (see Figures 1 and 2). This high cost was developed to avoid all impacts to roads/bridges during a 100-year flood. A second, lower cost, scenario was developed that utilizes detour routes to reduce the number of bridges and roads that are raised or replaced, a strategy used in other areas such as the Snoqualmie River valley but has not yet been implemented in the South Fork Newaukum River area. Under this detour route scenario, a little over one mile of road is proposed to be elevated or created as a new road in a handful of locations, and three bridges are proposed to be raised and replaced or protected from scour. For both of these scenarios, standard cost estimating methods were used to include construction contingencies and soft costs such as engineering and permitting.

Table 5 Summary of South Fork Newaukum River valley roads and bridges impacts from a 100-year flood event under existing and proposed conditions.

No.	Road / Bridge	Impacted Under		Action Code		Water Surface Elevation (NAVD 88)		Ground Elevation (NAVD 88)	Estimated Closure Time (Hour)	
		Existing	Proposed	Low Cost Estimate	High Cost Estimate	Existing	Proposed	Road/Bridge Abutment	Existing	Proposed
1	North Fork Road			None	None	274.1	276.2	280.9	0	0
2	Middle Fork Road (Bridge)	X	X	None	**Raise, Replace**	305.7	306.3	311.0	Unknown	Unknown
2	Middle Fork Road	X	X	None	**Raise**	307.5	307.5	303.7	47	47
3	Granite Lane		X	**Abandon Rd End**	**Raise**	N/A	319.1	317.8	0	35
4	SR 508 (Main Ave. Bridge)		X	None	**Raise, Replace**	327.1	329.6	334.0	0	Unknown
5	SR 508 (Main Ave.)	X	X	None	**Raise**	332.0	334.6	326.3	84	198
6	Guerrier Road (Bridge)	X	X	None	**Raise, Replace**	340.4	342.9	343.5	Unknown	Unknown
7	Guerrier Road	X	X	None	**Raise**	341.0	343.1	340.3	25	101
8	Mosley Road	X	X	None	**Raise**	345.7	347.8	344.4	17	50
9	SR 508 (Main Ave.)		X	**Raise**	**Raise**	N/A	343.8	343.6	0	16
10	Tauscher Road		X	**Raise**	**Raise**	N/A	353.4	352.3	0	27
11	Bolduc Road		X	None	**Raise**	N/A	364.4	363.5	0	18
12	Gish Road (Bridge)			None	None	376.7	378.8	383.2	0	Unknown
13	Gish Road	X	X	**Raise**	**Raise**	376.7	378.8	375.6	42	119
14	Remy Lane		X	**Raise**	**Raise**	N/A	382.7	382.0	0	13
15	Remy Lane		X	**Raise**	**Raise**	N/A	382.7	382.6	0	13
16	SR 508 (Main Ave.)		X	None	**Raise**	N/A	395.9	394.6	0	35
17	SR 508 (Main Ave.)		X	None	**Raise**	N/A	401.3	401.2	0	18
18	SR 508 (Main Ave.)		X	None	**Raise**	N/A	409.3	408.0	0	32
19	SR 508 (Main Ave.)		X	None	**Raise**	N/A	417.5	417.1	0	20
20	Gish Road	X	X	None	**Raise**	431.1	431.8	426.0	44	121
21	SR 508 (Main Ave.)		X	None	**Raise**	N/A	430.9	430.7	0	35
22	SR 508 (Main Ave.)		X	None	**Raise**	N/A	436.6	436.6	0	15
23	Flicker Lane		X	None	**Raise**	N/A	457.2	456.6	0	14
24	Leonard Road (Bridge)			None	None	479.3	481.4	486.3	0	Unknown
25	Coughlin Road (Bridge)	X	X	**Remove, Restore**	**Raise, Replace**	503.2	506.3	507.2	Unknown	Unknown
26	Coughlin Road	X	X	**New Rd**	**Raise**	503.2	506.3	502.8	11	56
27	Jorgensen Road (Bridge)		X	**Scour Protect**	**Raise, Replace**	542.1	544.7	543.7	0	0
28	Marko Road	X	X	**Raise**	**Raise**	600.5	602.8	598.9	32	102
29	SR 508 (Main Ave. Bridge)			None	None	678.0	680.1	Unknown	Unknown	Unknown
30	Pigeon Springs Rd. (Bridge)		X	**Replace**	**Replace**	N/A	728.0	726.8	0	18
Total		**11**	**27**	**12**	**27**				**302**	**1,103**

Note: Bridges are assumed to have a 4.5-ft deck and must clear the water surface by at least 1 foot.

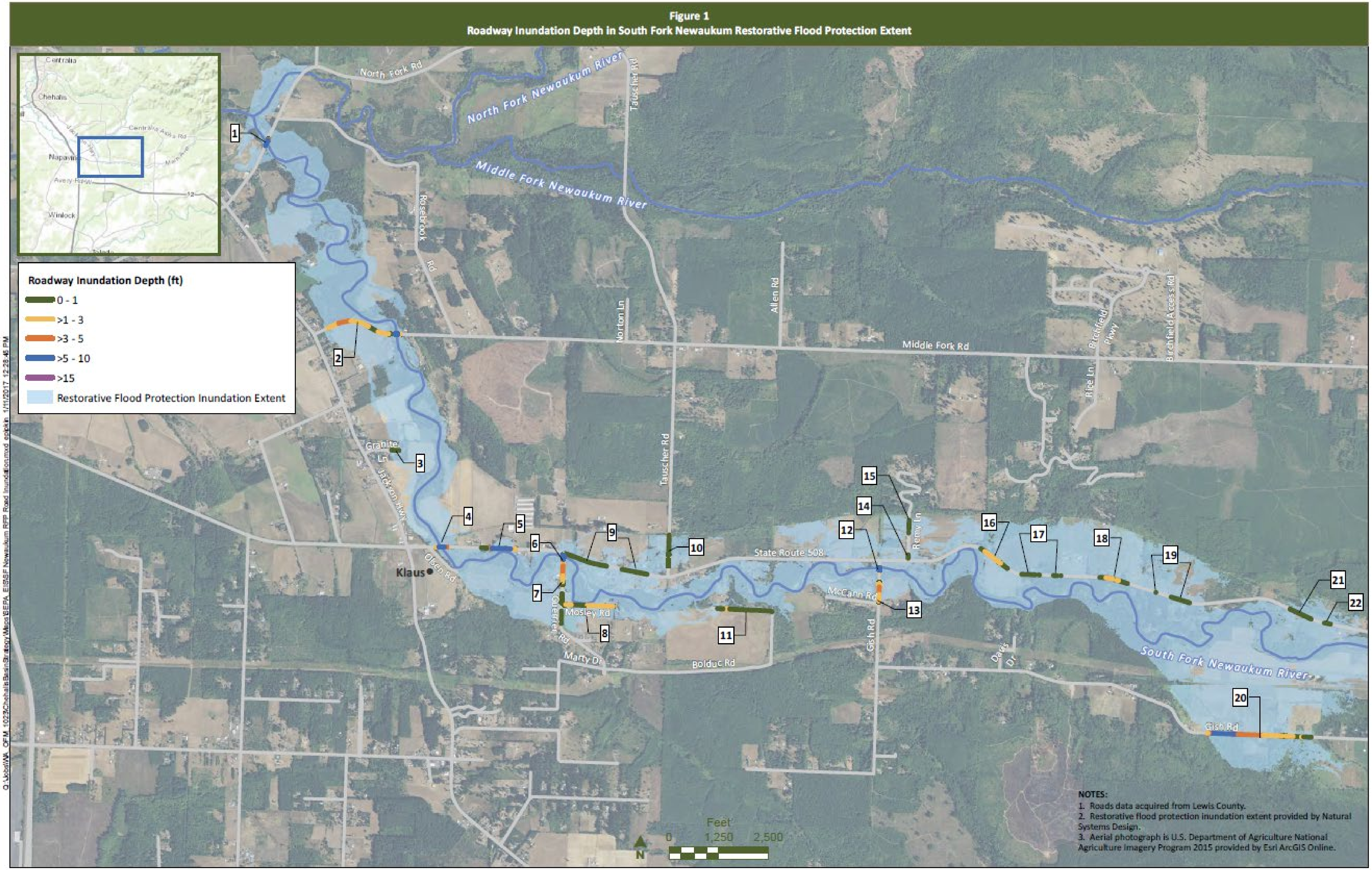

Figure 1 Roadway inundation depth in lower South Fork Newaukum River restorative flood protection extent.

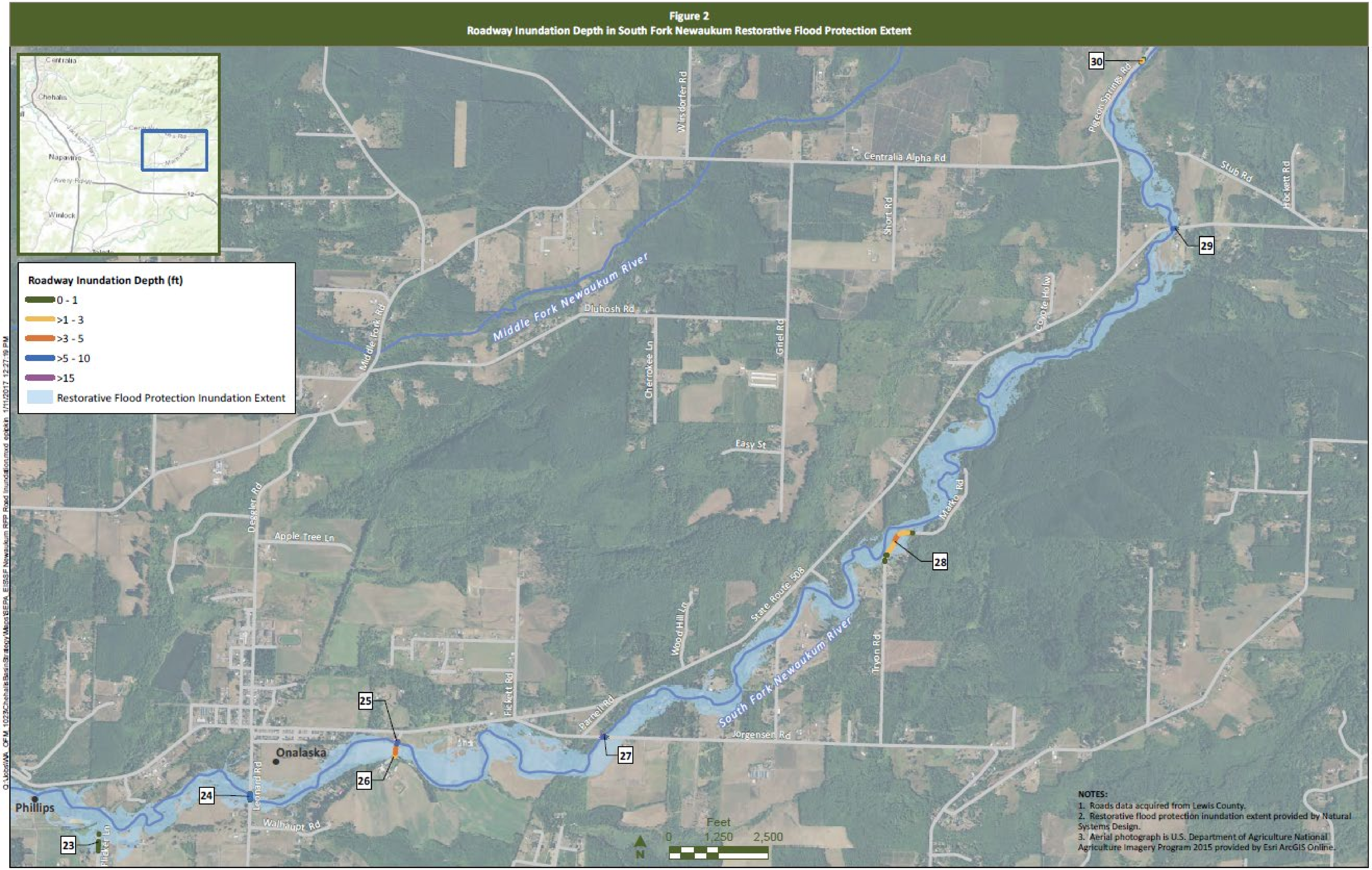

Figure 2 Roadway inundation depth in upper South Fork Newaukum River restorative flood protection extent.

As stated previously, the high end of this range assumes that all potentially affected bridges and roadways will be improved. Detailed surveys for affected roads and bridges are needed to validate the assumptions made. This survey information would need to include the depth of the existing bridges to verify how much clearance, or depth of impact, would exist in the event of a flood scenario. The low end of the estimate reflects the implementation of a detour route, only elevating roads and bridges that are needed in the detour. For comparison, the Snoqualmie River valley routinely experiences flooding and has adapted by using alternate transportation routing during flood events. The South Fork Newaukum River area would be newly flooded as a result of the RFP; the determination of whether this adaptive approach would be acceptable would need to be evaluated during the feasibility analysis in 2017-2019 in collaboration with Lewis County and affected property owners. This low-cost scenario also assumes that some roads and bridges will be impacted by flood events and will need to be repaired or replaced following a flood event. An allowance has been included for routine road maintenance following a flood event but does not take into consideration costs for replacing a bridge should one suffer irreparable harm during an event.

Roadway and Bridge Cost Estimate Assumptions

The roadway and bridge impact analysis was based on a number of assumptions:

- The primary assumption for the high cost was that all roads or bridges impacted during a 100-year flood, under existing and future conditions, would be improved.
- For the lowest cost, if a road or bridge is deemed necessary for a detour or access to isolated pockets of private land, it is included in the road or bridge low cost estimate. Some new road construction is needed to connect some roadways to provide access. This will include costs for right of way acquisition as well as the physical cost of roadway construction.
- The low cost estimate also includes high-level traffic control and road repair cost estimates for three 100-year flood events over the next 50 years.
- There appears to be minimal impact to utilities as part of this analysis.

While the uncertainties inherent in this analysis are summarized at the end of this memo, the higher opinion of cost in this analysis is considered to be conservative in assuming full replacements for impacted roads and bridges.

Agricultural Properties

The forty-five agricultural parcels that were selected as hypothetical buyout/relocation properties in this case study ranged in size from about 80 acres to a half-acre in size, with a median size of 5 acres. The dominant crop type was hay/pasture. However, many of these parcels were forested totaling about 290 acres of trees, shrubs and water. Detailed land use statistics can be found in Table .

Parcels outside of the floodplain were identified as possible relocation sites for the dominant land uses, a mix of hay/pasture and forest. This mapping exercise was done at a coarse planning-level scale and focused on converting parcels that are currently being used as managed forest to hay/pasture, orchard, and other perennial crops. This analysis took into account good soils, adjacency to other farms, parcel size, and proximity to existing roads. Preference was also given to parcels that were as close as possible to the current location of the farms in this case study.

Table 6 South Fork Newaukum River agricultural property relocate/buyout land use summary.

SOUTH FORK NEWAUKUM RIVER AGRICULTURAL PROPERTY – RELOCATE/BUYOUT LAND USE BREAKDOWN	ACRES
Hay/Pasture	200 acres
Other Crops (Christmas trees)	35 acres
Forest, Shrub, Wetland or Water	290 acres
Total	**525 acres**

For these parcels, in 2017 dollars, the total estimated cost was $8 million to $12 million for potential buyout/relocation of agricultural properties, and included the following:

- Cost of the new land, 100% of the parcel area
- Cost of building new structures, for all valuable structures
- Cost of demolishing floodplain structures
- Irrigation (high cost only)
- Water rights acquisition/transfer
- Clearing, grading, amending soils

The following assumptions were used in evaluating relocation costs for affected agricultural property:

- The cost of buying or relocating the entire parcel, and all of the valuable structures, is accounted for, regardless of current land use.
- Irrigation installation was used to differentiate the high cost from the low cost. This cost was applied to all of the agricultural buyout/relocation acreage for the high cost, and none of this acreage for the low cost.
- The cost of buying or relocating the entire parcel, and all of the valuable structures, does not exceed 3 times the current assessed value for the low cost or 4 times the current assessed value for the high cost. These thresholds represent the cumulative increase of home and land compensation above assessed value. For example, a multiplier of 1.386 or 1.575 was used to determine the market-value of a home for the low and high cost estimates, respectively. These adjustments represent the average (1.386) and 85th percentile (1.575) market value over assessed value. The additional costs of a water right, land clearing and site preparation for farming increases costs beyond 1.575. This increase varies from parcel to parcel, depending on how much land is being actively farmed. A limit of 3 times above assessed value was applied for the low cost estimate. On the high cost estimate, irrigation of the farmed land was added is added to the water right, land clearing and site preparation costs, and the threshold was increased to 4 times assessed value to account for this significant potential cost.

Residential Properties

Ninety-six residential properties were selected as hypothetical buyout/relocation properties in this case study, based on the criteria described in the Approach section. The residential properties range in size, 0.01 to 27 acres, and vary in improvements. For example, some properties have no structures or development on the residential parcel, while others contain multiple structures. Total estimated cost, in 2017 dollars, was $22.2 million to $22.8 million. This cost estimate included the following:

- Market value of both the home and land
- Cost of demolishing floodplain structures and site clean-up, including some minor grading, amending soils, and seeding.

Assessed value was adjusted to potential market value by applying a conversion factor developed from reviewing Zillow data (2017). Although the cost per square foot varied significantly, Anchor QEA determined that an adjustment value was appropriate, reflecting the average and the 85th percentile of all the evaluated properties. The average market value adjustment of 1.386 above assessed value was used for the low cost estimate and the 85th percentile market value adjustment of 1.575 above assessed value was used for the high residential cost estimate. These factors were used to account for the value of houses that did not have a market estimate available. Demolition costs were further estimated based on the size of the house.

The cost assessment assumes that residential buyout costs may result in either new construction elsewhere or purchase of an existing property, at the owner's discretion. The market value of buying the entire parcel and all valuable structures are included.

Restorative Flood Protection Easement Cost Assessment

Many parcels that are within the modeled 100-year floodplain are only slightly or mostly out of the inundated area. A parcel was identified for easement instead of a buyout/relocation when most of the parcel, and/or the main structure of a residential parcel remained out of the floodplain. Forested land, or land classified as a utility, was also classified as a good candidate for an easement. The inundated acreage of each of these parcels in the South Fork Newaukum River valley was calculated to be approximately 924 acres, dispersed between 301 parcels. The cost of the easement was calculated on a per acre basis and includes due diligence costs for the easement acquisition and maintenance. The total cost of RFP easements in the South Fork Newaukum River focal area was estimated at $14 million. This value is the same for both the low and high cost estimates. These unit costs were based on the medium unit costs developed the Aquatic Species Habitat action in the draft Chehalis Basin Strategy PEIS (December 2016) and adjusted to 2017 dollars.

The following assumptions apply to the cost assessment for easements:

1. Easements were estimated with the same unit cost, regardless of zoning or current land use. For example, it was assumed that there is no cost difference in the easement on a residential parcel versus an agricultural parcel.
2. Less expensive protective measures (e.g. berms) were not analyzed as an alternative to a flood easement. There are many cases where such measures may be utilized to avoid impacts to properties without compromising the RFP treatment effects.

IMPLICATIONS AND CONCLUSIONS

The cost assessment work described above provides better understanding about potential costs for RFP impacts to roads, bridges, and land use. However, many uncertainties remain that could affect the costs presented here. We attempted to address some of these uncertainties by presenting a cost range that we believe represents the likely costs to implement the RFP in the South Fork Newaukum pilot sub-basin.

Additional uncertainties associated with the costs presented in this memo include the following:

- Impact areas are based on coarse planning-level hydraulic modeling; future detailed modeling may indicate reduced or expanded impact areas. Furthermore, the 1-D model did not incorporate bathymetry or survey data representing the true channel bed elevations or existing bridge elevations; this data was not available.
- This cost assessment precedes development of a project design. We believe that this uncertainty skews the costs presented here higher, as there has been no effort to create a design that minimizes impacts and costs. That effort would be done through the upcoming work during the 2017-2019 biennium.
- We identified options for changes in land use for properties based on the criteria described in the Approach section of this memo, including easement, buyout, or relocation. Because landowners would, in many cases, have the choice for which option they preferred, actual results may vary from those presented here. However, we believe the cost impact of this uncertainty would be neutral.
- Actual land use varies significantly from assessor's land use classifications. For example, some parcels that are classified as residential are clearly being used as a small farm and some parcels that are identified as agricultural are not being farmed at all. A more site-specific assessment of actual land use may result in adjustments to quantities identified in this memo.
- Landowner willingness to accept any of the proposed options has not been addressed, but would be evaluated during the feasibility analysis.
- The costs presented here do not include the option of "stay-in-place" assistance to impacted farm lands because those options have not yet been developed. This includes converting pasture land to perennial crops such as berries and biofuel tree species, which could produce income for the landowner and be compatible as an RFP treatment.
- A full roadway network and transportation analysis is still necessary to determine the most cost-effective way to implement the RFP throughout the treatment area. Furthermore, realigning roads to better serve the community was not analyzed, nor was protecting roads by levees or berms.
- Raising roads could interfere with the effectiveness of the RFP by creating new barriers to floodwater storage on the floodplain. Conversely, storage areas could be created by road embankments. Neither condition was evaluated for the work presented here.

The approach used to develop this cost assessment provides a more grounded understanding about the significance of cost elements in implementing the RFP. However, because this approach was specific to the South Fork Newaukum River basin, it does not provide better knowledge about the total cost of changes to land use and transportation routes that would be caused by implementing the RFP throughout the full potential treatment area. We have considered whether a direct extrapolation to the entire RFP area is appropriate, such as based on relative impact area, river mile or number of parcels, but we do not believe we have adequate information to make such an extrapolation because of the great variation in land use and transportation within each sub-basin. However, based on the cost assessment described herein, we believe that the transportation and land use impacts have the potential to be costlier than indicated in the estimate shown in Table 1 if the high cost elements - bridge and road replacements/improvements and extensive new irrigation for agriculture - are required.

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