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Technical Memorandum

Date:	7/5/2022
To:	Dick Vander Schaaf, Project Manager Associate Coast and Marine Conservation Director The Nature Conservancy of Oregon
From:	Curtis Loeb, PE, Principal Engineer Wolf Water Resources Portland, OR
Project:	Porter Tract Restoration - Kilchis Estuary Preserve
Subject:	Technical Response to Hydraulic Review of Kilchis Estuary Reserve Project

Introduction

The Nature Conservancy of Oregon (TNC) is continuing efforts to restore and enhance tidal wetland habitats along the margins of Tillamook Bay with restoration of the Kilchis Estuary Preserve (Preserve or Project) located in the floodplain of the Kilchis River in Tillamook County west of Highway 101 and north of the town of Tillamook. The overall goal of restoration of the Kilchis Estuary Preserve is to restore freshwater and tidal hydrologic connections, provide off-channel rearing habitat for salmonids, and reestablish spruce swamp habitat.

The Preserve is comprised of two former land tracts: the Dooher Tract, which was the original Kilchis Preserve wetland restoration project that was constructed by TNC in 2015; and the second tract, the

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Porter Tract located immediately north of the Dooher Tract has been designed but not yet constructed. The cumulative area of these restoration efforts would result in 127 acres of high functioning estuarine habitat. Both tracts are located in the lower Kilchis River watershed, approximately one mile from the mouth of the Kilchis River, and the general region is influenced by both river flow and ocean tides.

As part of the recommendations from the Tillamook County project review process for the Porter Tract, TNC and other County stakeholders solicited a third-party review (Hydraulic Review) of the completed restoration phase (Dooher Tract) and the proposed Porter Tract phase (NHC 2021). The NHC Hydraulic Review included three primary sections: (1) observed (water level logger) water level and hydraulic model review; (2) review of Dooher Tract impacts, and (3) review of proposed Porter Tract impacts. The scope and purpose of this technical response memo is primarily to consider and respond to comments in these three sections related to observed water level reviews of Dooher Tract and Porter Track impacts:

- Stasek Slough and other water level data logger station datum estimations, specifically those related to Dooher restoration observations that resulted in higher water on farmlands along Stasek Slough at times during winter flows.
- Water levels and sedimentation related to Dooher Tract restoration
- Other related issues and/or limitations of the Hydraulic Review and implications on both Dooher and Porter Tract restoration.

Response to water level analysis and review (Section 2.1 of Hydraulic Review)

NOAA Garibaldi Gage Translation

The Hydraulic Review commented that summer tidal water levels at the NOAA Garibaldi tide gage were used to estimate corrections for TNC water level records measured at Stasek and Hathaway Sloughs. The Hydraulic Review stated that data from Stasek and Squeedunk gages were adjusted until a good match was achieved with Garibaldi stages at high tide levels.

In general, it is agreed that using observed summer (non-fluvial or those with a lower fluvial influence) water levels at an established NOAA tidal gage may be the best available way to estimate those at other locations. However, adjusting observed water level tidal amplitudes to a known established tidal gage can be problematic or have limited usefulness for several reasons. One primary reason is that there is no consistent way to estimate differences in high tide levels (either decreases or increases) from a known gage to another location. High tide water levels can vary by important magnitudes (i.e., those on the order of 1 foot or less) due to several mechanisms including minor (summer base flow) fluvial inputs, estuary or embayment constrictions or expansions that

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cause water levels to either magnify or be muted, and differences in the hypsometry (the shape or tidal prism volumes across a range of elevations) from one location to the other. Thus, it may be acceptable to use established water level station data for general or comparative purposes; but, relying heavily on water levels corrected by nearby, but still-distant, stations for precise or specific purposes may have limited usefulness.

Because minor-to-moderate differences typically exist at individual sites, it is always a best practice to install water level gages locally and establish site-specific tidal datums. Small differences in water levels are much more important in tidally-driven systems than in fluvially-driven systems because of the relatively low energy, high frequency, and narrow band of water levels that influence tidal marsh vegetation and productivity.

The Hydraulic Review also noted a -0.30-foot adjustment or relationship between Mean Lower Low Water (MLLW) and the NAVD88 vertical datum was determined by the Tillamook County surveyor at the NOAA Garibaldi tidal station. This value is consistent with, though slightly less than, the -0.33-foot difference reported in Table 3-2 of ESA PWA 2013b (originally cited by NOAA 2004) which shows a similar conversion between MLLW and NAVD88.

Observed Stasek and Hathaway Slough Water Levels

Section 2.1 of the Hydraulic Review also describes challenges with periods of observed water levels in Stasek and Hathaway Sloughs and associated corrections made. It is agreed that summer high tide water levels in and around relatively small sites like the Hathaway and Stasek Slough network should be similar, within a few tenths of a foot.

Truncated low tides. However, the Hydraulic Review also notes numerous periods when water level records (particularly Stasek Slough post-2016 data) "went dry" at low tide and corrections were made. Figure 1 below is a repeat of the graph from the Hydraulic Review (Figure 3, page 7 of NHC 2021) shown for convenience, and this figure shows the low tide correction in dashed blue.

It is unclear from the data and Hydraulic Review if these data loggers go dry, or if they have truncated low tides due to relatively high gravel bars in the channels downstream that limit drainage of the low tide. The truncated low tide and surveyed gravel bars (i.e., low point "sills" in the gravel bars at approximately elevation +4 feet NAVD88) were noted and observed originally in the 2013 Kilchis Dooher Tract Restoration Conceptual Design Report (ESA PWA 2013b). If the water level time series had "gone dry," it would be expected that the low tide values would go the zero (or close to it reflecting 0.0 feet of water pressure and only barometric pressure), rather than much higher flat (constant water level) readings in the 4 to 5 feet range. In summary, this low tide correction may not be especially consequential (since it appears that the overall time series including tidal peaks was not corrected uniformly), though the correction could overstate low tide drainage from the sloughs.

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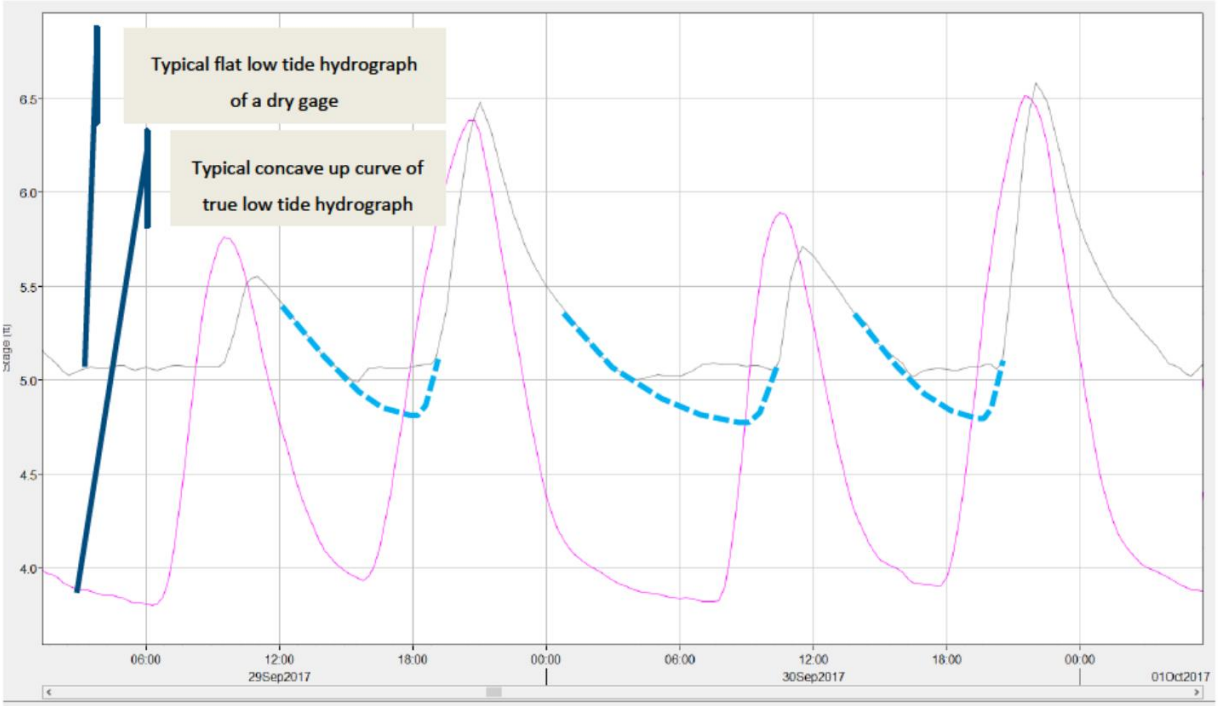

Figure 1. Repeated water level time series at Stasek (gray) and Hathaway Sloughs (pink) (from Figure 3 of the Hydraulic Review document – NHC 2021) showing low water level corrections.

Response to Dooher Project impact analysis (Section 3.1 of Hydraulic Review)

General – Normal Flow Impacts

The primary analysis from the Hydraulic Review focuses on "normal" (non-extreme) flows including summer low flows and higher but frequent winter flows (and tide levels – though focus was on Kilchis River flows). The historical time periods evaluated in this section considered Kilchis River flows between 400 and approximately 1,000 cfs (between a mean annual / 1.01-year flow and significantly less than the estimated 2-year flow of about 8,000 cfs (ESA PWA 2013b).

The primary basis of evaluation of normal flow impacts was comparing observed data from pre- and post-Dooher restoration periods. One period highlighted in the analyses along with their associated tidal and river levels is shown in Figure 2 below and summarized as:

- **Pre-restoration** – February and March 2014

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- Tidal peaks and overall range: most peaks >9 feet NAVD88 with the highest of the record at nearly 10′ NAVD88, and >10′ tide range (-1 to +9 feet NAVD88)
- Kilchis River flow: mostly between 400 cfs to 600 cfs with a peak near1,000 cfs

- **Post-restoration** – late October 2016
  - Tidal peaks and overall range: most tidal peaks between 8 and 9 feet NAVD88 (approximately 1′ lower than the pre-restoration period) and a slightly smaller 8 to 9′ tide range
  - Kilchis River flow: flows varying between 500 cfs and 900 cfs, which are generally about 100 cfs larger on average based on visual inspection

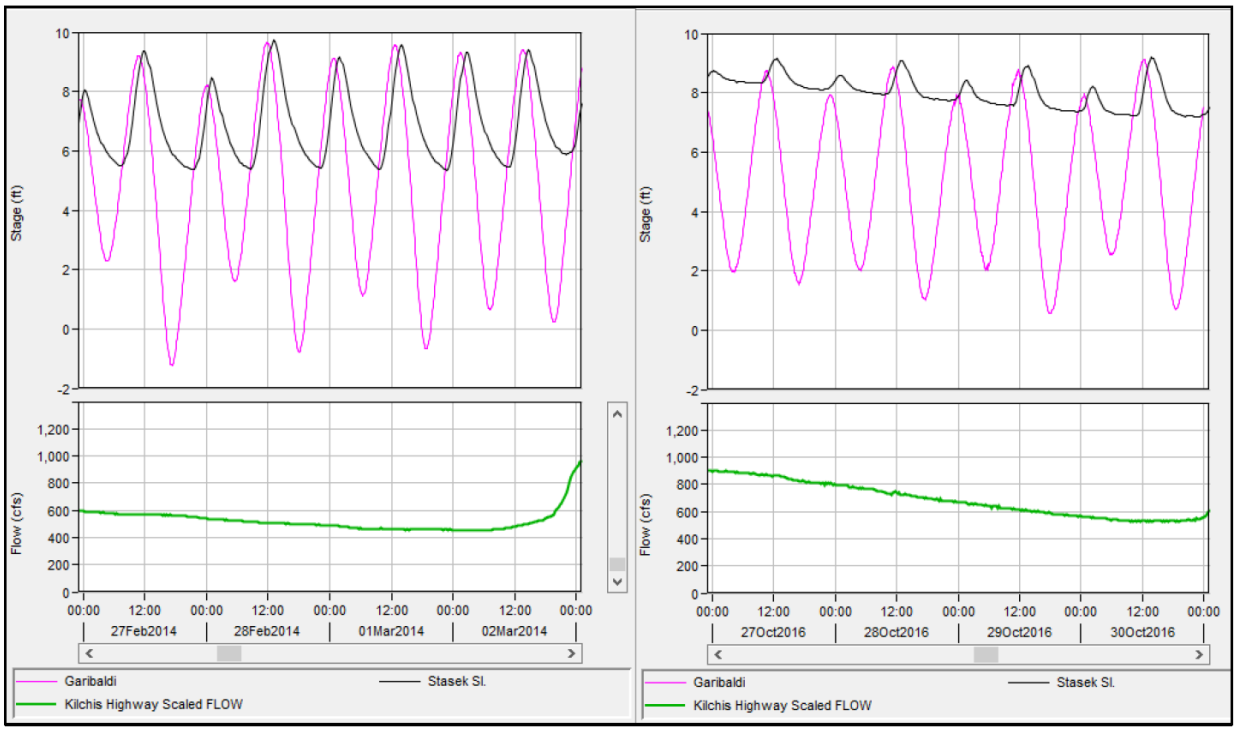

Figure 2. Repeated from Figure 4 (NHC 2021), water level time series and Kilchis River flows pre- (left) and post-restoration (right).

The Hydraulic Review continues comparison of pre- (2012 to 2014) and post-restoration (2016 to 2019) water levels and calculation of daily min/max/mean water levels averaged over a bi-weekly period, with some years without observed data). Per the Review, maximum average observed water levels in Stasek Slough increased from 7.3 to 7.9 feet NAVD88 (approximately 0.6 feet), and other

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differences on the order of a few tenths of a foot were noted at Hathaway Slough. Differences during winter periods were more significant, up to 2 feet in Stasek Slough. A maximum noted increase of 2.5 feet was seen in Stasek Slough during most sensitive flows in the Kilchis River of around 1,000 cfs.

In general, there are several important difficulties in making the above comparisons and drawing inferences between observed water levels from different time periods. These difficulties include:

- **Different hydrologic periods**: making detailed observations from two different time periods is like comparing apples and oranges because underlying precipitation, river flow, and potentially other hydrologic conditions could be vastly different during the two time periods. For example, water levels in the sloughs are likely dependent on Kilchis River flows as is mentioned in the Hydraulic Review (and as is generally accepted), but it is not clear if Kilchis River flows (e.g., mean annual flows or total water year runoff, etc.) were similar or different between 2014 (the observed time series at Stasek Slough) and the 2016 to 2019 post-restoration periods. The hydrologic year-types of 2016 to 2019 could have been much wetter than that of 2014, perhaps partially or nearly-fully resulting in higher tidal water level metrics. Thus, it is difficult to pull out or ascertain increases or decreases attributable to the restoration versus those from differing Kilchis River flows or other hydrologic differences between the periods of comparison.

  Further, there may have been physical differences in the Kilchis River and other slough channels pre-2014 and post-2014. Physical difference could include:

  - More or less accumulation of debris or blockage in the Stasek Slough connector channel culvert (both of which are common after large events such as the 2015 storm) that would have affected the cross-drainage between Stasek and Hathaway Sloughs,

  - Adjacent landowners could have maintained dikes using Kilchis River channel sediment – also a common practice after large storms or when otherwise necessary- which could have affected river bottom elevations and associated high tide levels in different ways,

  - The Squeedunk log jam on the south bank of the Kilchis River downstream of the Dooher Tract dike removal is also very dynamic in terms of its sediment accumulation at the toe of the structure and its composition of logs. For example, this log jam caused a significant hydraulic eddy and bank erosion in 2013, eroding away an installed water level logger and a large portion of the Dooher Tract bank during a storm much smaller than the 2015 sequence of flows. This log jam likely changed significantly during the 2015 storms, potentially changing both bed elevations along the lower river reach, and the distribution of flows down Squeedunk Slough versus the river channel.

  - These and potentially other unknown physical changes further complicate evaluation of the effects of the Dooher Tract restoration based on comparison of observed water levels from two different periods.

Evaluating changes related to restoration or other 'what if' questions is often best done using hydraulic models because (1) the same hydrologic forcings can be applied, and (2) even if there are questions or limitations with a particular model, these limitations are typically minimized through model set-up; and further, any limitations or errors usually apply in similar ways to both pre- and post-restoration or other scenarios - making comparative analyses still useful.

- **2015 post-restoration Kilchis Riverbed aggradation**: the December 2015 Kilchis River storm and upstream landslide event brought debris (gravel, logs, organic material) and significant deposition of several vertical feet in the river at the Dooher Tract dike removal location. The restoration did not cause this hydrologic/watershed event, but restoration resulted in the sediment and debris deposition to focus at the dike removal location. Had restoration not occurred, this sediment and debris would have still been transported to the lower river reach downstream of Highway 101 and instead likely spread out broadly from the highway to the Hathaway Slough confluence and beyond. To some unknowable extent, this rare and impactful event would have affected slough water levels even if restoration had not occurred, making evaluation of changes due to restoration alone less clear. And, this storm-related disturbance event that occurred after the 2015 restoration is likely exaggerating the assumed effects of the Dooher restoration.

Dooher Tract Impacts on Slough Water Levels

The summary in Table 2 of the Hydraulic Review mentions higher winter levels in sloughs as a result of Dooher Tract restoration. The magnitudes of these changes should be qualified or evaluated further because they are based on comparison of different hydrologic periods and bring the associated challenges mentioned in the preceding section.

The section on Stasek Slough in Table 2 also mentions a generally higher water table in the low-lying areas around the slough in the wet season. This higher water table assertion is difficult to rely on because groundwater levels are a function of many factors including rainfall, local ponding and runoff, general ground elevations relative to high tide levels, among others. Several of these watershed/land-based factors have not changed due to Dooher Tract restoration. Water table monitoring has not been conducted within the project or adjacent areas.

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Response to Porter Project impact analysis (Section 3.2 of Hydraulic Review)

The Hydraulic Review describes that the Dooher Tract would have (has had) a greater impact on area hydrology than the proposed Porter Tract restoration would have. The larger impact from Dooher actions is due to removing the Kilchis River dike and connecting Stasek Slough directly to the river. In contrast, the Porter Tract would further increase flow and connectivity between Stasek and Hathaway Sloughs.

Under Porter Tract restoration, Stasek Slough water levels would be slightly lower by just less than 1 foot, and Hathaway Slough water levels would be slightly higher by about half a foot during Kilchis River flows between 1,000 and nearly 3,000 cfs (high winter flows), when Porter Tract effects are greatest. During the winter normal flows (500-1000 cfs), effects would be similar in Stasek and Hathaway Sloughs, but to a lesser degree than during higher river flows. The Porter Tract actions would essentially reduce the head (water surface gradient) between these tidal channel branches.

The above summary observations and conclusions, as well as those summarized in Table 3 that describe the likely combined effects of the Dooher / Porter restorations, are consistent with prior modeling observations and site understanding. In general, these observations of the Porter Tract restoration actions (alone or in combination with Dooher Tract actions) suggest that normal and flood water levels and drainage would either show no/very little change or improve if the Porter Tract restoration actions were implemented.

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