Hydrology | Hydraulics | Geomorphology | Design | Field Services

TECHNICAL MEMORANDUM

Date:	June 6, 2016
To:	Noah Hume (Stillwater Sciences)
From:	Chris Campbell, April Sawyer
Project:	15-1028 Decker Island Habitat Restoration Project
Subject:	Final Baseline and Preferred Alternative Modeling Results

1 INTRODUCTION

cbec, inc. eco engineering (cbec), at the request of Stillwater Sciences (SWS), performed site scale hydrodynamic modeling to evaluate restoration design alternatives at Decker Island in support of the California Department of Water Resources (DWR) Decker Island Habitat Restoration Project. cbec used an existing Digital Elevation Model (DEM) (see Section 2) to develop site scale geometry for 2-dimensional (2D) hydrodynamic modeling of five initial screening alternatives provided by DWR for tidal and moderate flood conditions. This technical memorandum describes the post-screening alternatives results, including the baseline and revised Alt 2 preferred project condition.

1.1 BACKGROUND

Details of model development are provided in the *Model Approach and Design Criteria Technical Memorandum (TM)* distributed to DWR 1 December 2015 (cbec, 2015a). Subsequent changes to the original model approach and design criteria are summarized here along with model results. After distributing the *Preliminary Model Results Summary and Catalog TM* on 22 December 2015 (cbec, 2015b), cbec and SWS presented the preliminary screening results to DWR on 12 January 2016. Five initial screening alternatives, listed below, were all analyzed for two flow conditions (tidal and moderate flood):

- Alt 1: One breach, no starter channel
- Alt 2: One breach, no starter channel, small north levee degrade
- Alt 3: One breach, large north levee degrade
- Alt 4: Two breach, partial starter channels
- Alt 5: Two breach, full starter channel.

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The results presented included a) a set of 10 animations showing the depth and depth-averaged velocity vectors with a water surface elevation time series, b) maximum velocity maps, c) velocity exceedence plots at the north degrade and south breach, d) flow through the north degrade and south breach, and e) inundation exceedence of modeled water surface elevation in the Decker Island interior related to local tidal datums.

As an outcome of this meeting, DWR requested cbec perform exploratory advection-dispersion modeling using a conservative tracer release for Alts 1, 3 and 5 to understand residence (or flushing) time. An arbitrary concentration released within the island interior was monitored and the flushing time, or the average amount of time mass spends within the system under each alternative, was computed per Monsen et al. (2002). Results were presented at the 12 January 2016 meeting in the form of animations and computed flushing times, which ranged from 25 to 65 hours. Given the relatively short flushing times, the team reviewed these results and determined Decker Island functions primarily as intertidal habitat, thus advection-dispersion modeling was not performed for the conditions presented in this TM.

The 12 January 2016 meeting resulted in DWR selecting Alt 2, which has one breach at the south end, no starter channels and a small 300-foot wide levee degrade at the north end. The rationale for selecting an alternative without starter channels was to maximize the duration of inundation below mean tide level, which may provide desirable conditions for primary productivity, as channels at both the south and north drain the island interior more efficiently. Also, the channels in the north also lacked long-term scouring velocities for self maintenance, and as such, may be prone to colonization by aquatic vegetation.

As an additional outcome from the 12 January 2016 meeting, DWR requested that cbec and SWS simulate the existing (baseline) conditions to better understand relative changes, as well as a refined Alt 2. Revisions to Alt 2 were needed to address concerns regarding property line boundaries, construction constraints, and preserving existing vegetation at the south breach. Details and model results pertaining to baseline conditions and a refined Alt 2 are provided below.

2 MODEL SETUP AND DESIGN CRITERIA AMENDMENTS

2.1 BASELINE CONDITIONS

To produce an accurate baseline DEM, confirm vegetation locations, and inform constructability of the design, DWR performed additional field surveys during the week of 22 February 2016. A final baseline DEM was distributed to cbec via SWS on 12 April 2016.

2.2 REVISED ALTERNATIVE 2

cbec and SWS coordinated with DWR to develop a revised Alt 2 south breach design cross section. It was observed that the original Alt 2 breach invert, set to the culvert invert elevation of -0.45 m NAVD88 (-1.5 ft), created a low lying depression that could potentially serve as a predator refuge. Thus, the group discussed and finalized a 36.6 m NAVD88 (120 ft) top width, two stage channel with an inset bench at 1.22 m NAVD88 (4 ft) and a low flow invert elevation at 0 m NAVD88, tying into a localized drainage feature. SWS provided cbec on 27 April 2016 with a final Alt 2 design DEM integrating into the baseline DEM the DWR 30% design contours and the proposed breach cross section (Figure 1). This DEM will also be used by RMA to support the CVFPB Encroachment Permit modeling.

3 RESULTS

Primary results from this analysis included maximum velocity across the site and velocity exceedence at breach and levee degrade locations, and an inundation comparison between baseline and revised Alt 2. Overall, the site shows increased inundation under both tidal and flood conditions, adequate self-maintenance velocity, and a reduction in peak velocity at the south breach under both tidal and flood conditions.

3.1 MAXIMUM VELOCITY AND VELOCITY EXCEEDENCE

Maximum velocity was compared for baseline and the revised Alt 2. The maximum velocity for the baseline tidal condition is shown in Figure 2, with highest velocities concentrated at the existing south breach and exceeding 1 m/s. Baseline flood condition velocities in the existing south breach also exceed 1 m/s (Figure 3). In comparison, Alt 2 tidal condition maximum velocity shows slightly lower velocities through the widened south breach in the 0.5 - 1 m/s range (Figure 4), yet this is still expected to facilitate breach self-maintenance. Maximum velocity at the north degrade for the tidal condition is lower than at the southern breach (0.2 - 0.4 m/s), though less frequently inundated due to local marsh elevations. For the flood condition, the south breach maximum velocity for Alt 2 is again lower than baseline due to the wider cross section (Figure 5).

Exceedence plots of velocities at the south breach and north degrade comparing baseline and Alt 2 also show a reduction in maximum velocity from baseline to Alt 2 (Figures 6 and 7). Despite a reduction in maximum velocity from 1.9 to 1.5 m/s, Alt 2 shows higher velocities more frequently under the tidal condition, still promoting south breach self-maintenance (Figure 6). For the flood condition, a reduction in maximum velocity at the south breach from > 3 m/s to 1.5 m/s also reduces likelihood of flood-induced scour at the breach (Figure 7).

3.2 INUNDATION UNDER BASELINE AND ALT 2 CONDITIONS

Tidal datums for the site are provided in Table 1. Under the baseline conditions, the maximum inundation at the site coincides approximately with the MHW level (Figure 8) due to the muted tidal connection (Figure 8, see green line). This muted tidal connection is also reflected in how the island interior currently drains, which is slow whereby refilling begins around MTL. By breaching the island, the maximum inundation under Alt 2 coincides with MHHW, showing increased depths across the site (Figure 9, see green line) with limited impacts to island drainage (Figure 10). Under a moderate flood condition, flow through the island is increased as lower exceedence stages (10 - 50% exceedence) are reduced compared to baseline (Figure 11). However, maximum stage (< 10% exceedence) exceed baseline for the simulated event.

Table 1. Tidal datums[1]

Tidal Datum	Rio Vista Bridge (feet, NAVD88)	Rio Vista Bridge (m, NAVD88)
MHHW	6.3	1.92
MHW	5.8	1.77
MTL	4.3	1.31
MLW	2.8	0.85
MLLW	2.2	0.67

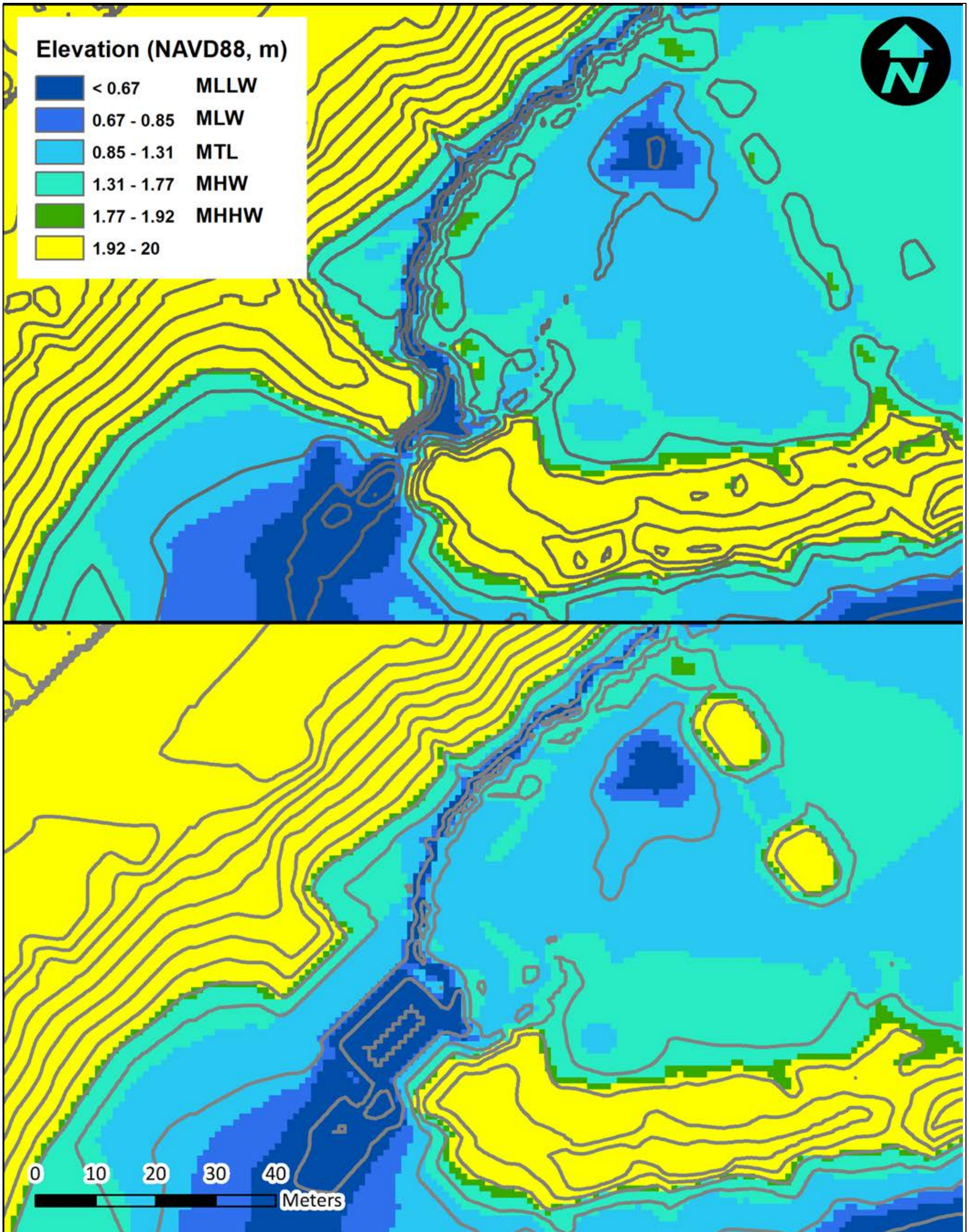
[1]Tidal datums were computed by cbec at Rio Vista for the Lower Yolo Restoration Project using National Ocean Service (NOS) analytical methods referenced to the actively-operated NOS reference station Port Chicago in Suisun Bay.

4 REFERENCES

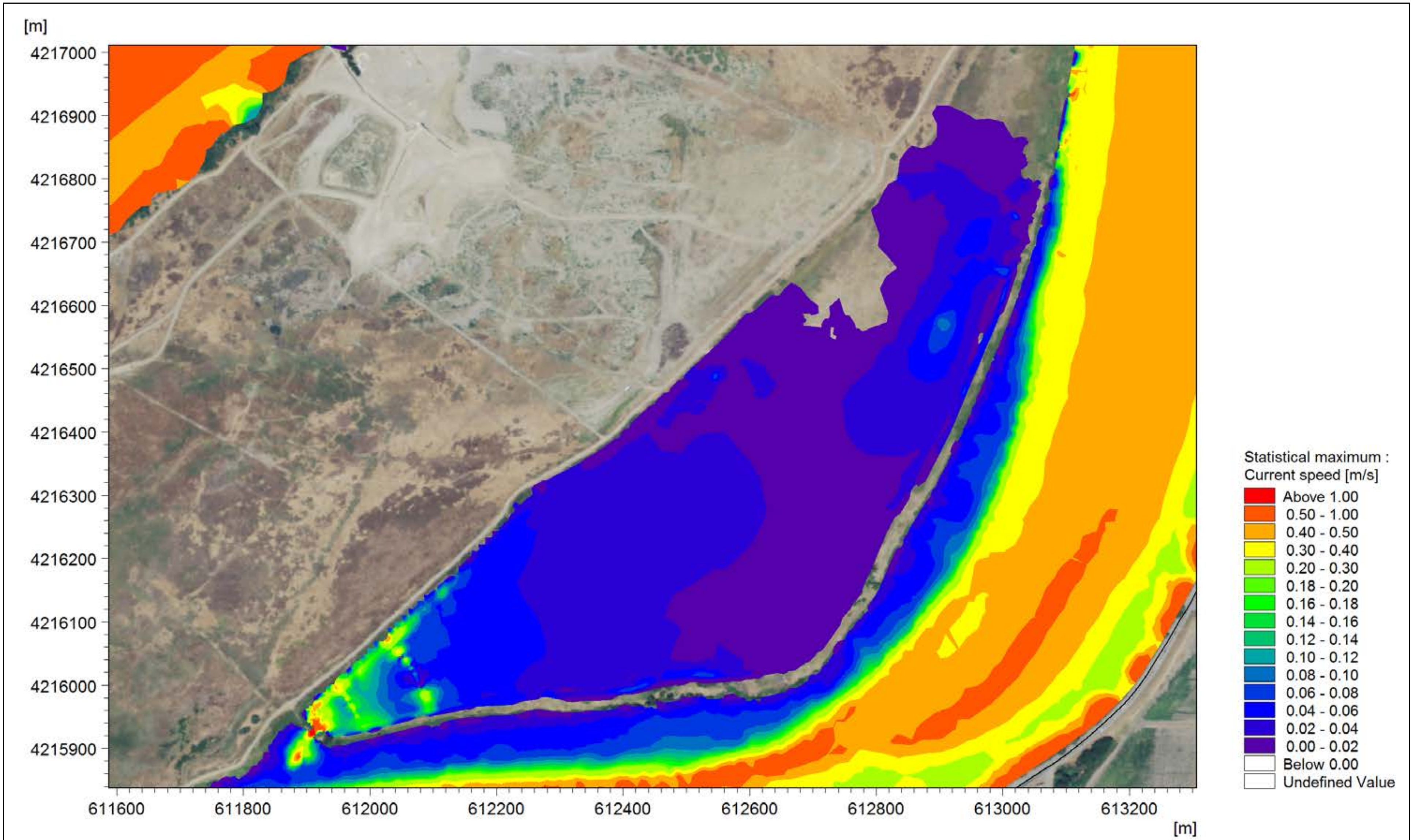
cbec. 2015a. Model Approach and Design Criteria Technical Memorandum. Distributed to DWR: 1 December 2015.

cbec. 2015b. Preliminary Model Results Summary and Catalog Technical Memorandum. Distributed to DWR: 22 December 2015.

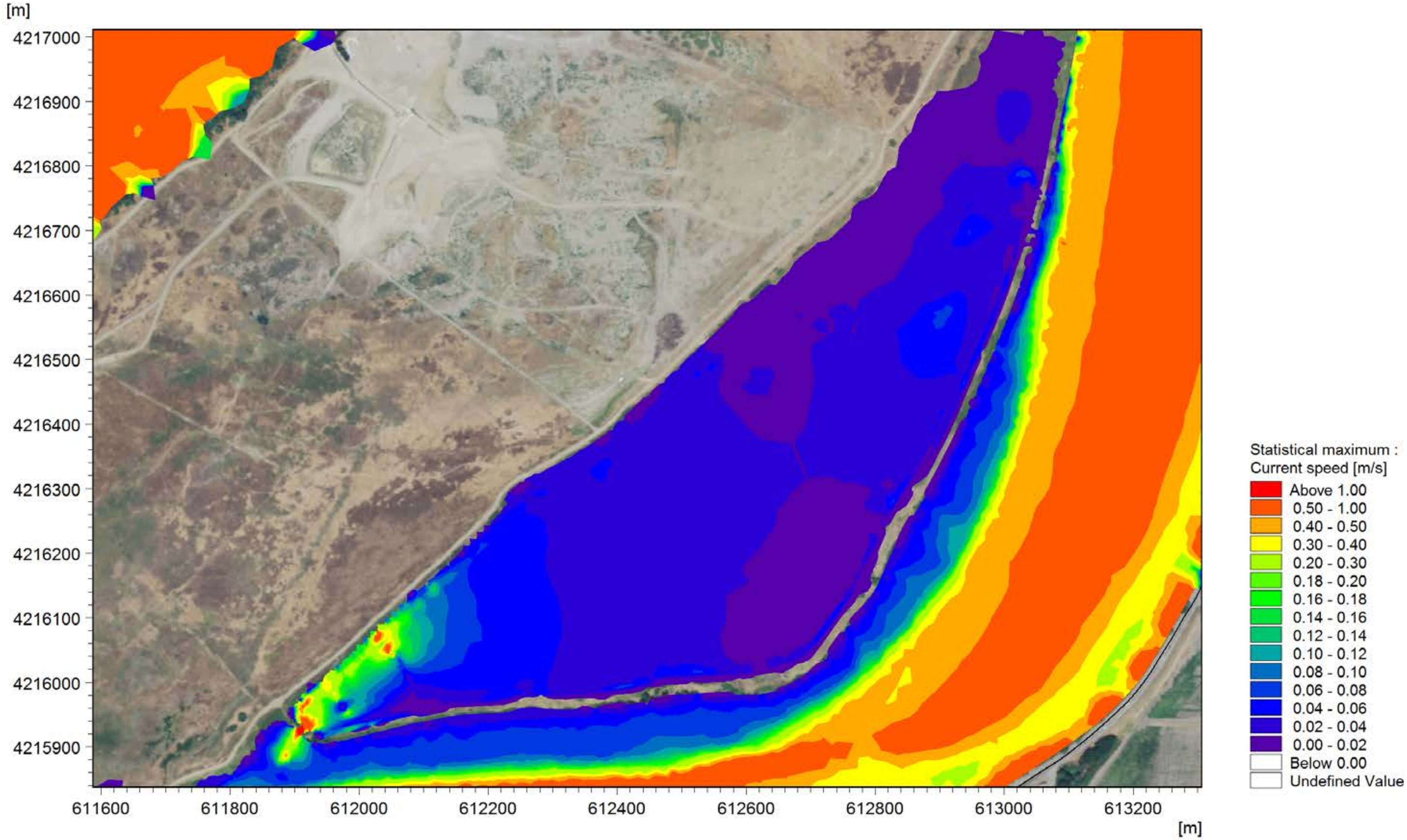
Monsen, N. E., Cloern, J. E., Lucas, L. V., Monismith, S. G., 2002. A comment on the use of flushing time, residence time, and age as transport time scales. Limnology and Oceanography, 47(5): 1545-1553.



Notes: Baseline DEM (top) provided by DWR and Alt 2 (bottom) surface created by SWS	cbec eco engineering	*Decker Island Habitat Restoration Project* **Baseline and Alt 2 DEM comparison**		
		Project No. 15-1028	Created By: AMS	**Figure 1**



Notes:	cbec eco engineering	*Decker Island Habitat Restoration Project* **Baseline - Tidal condition, maximum velocity**		
		Project No. 15-1028	Created By: AMS	**Figure 2**



Notes:

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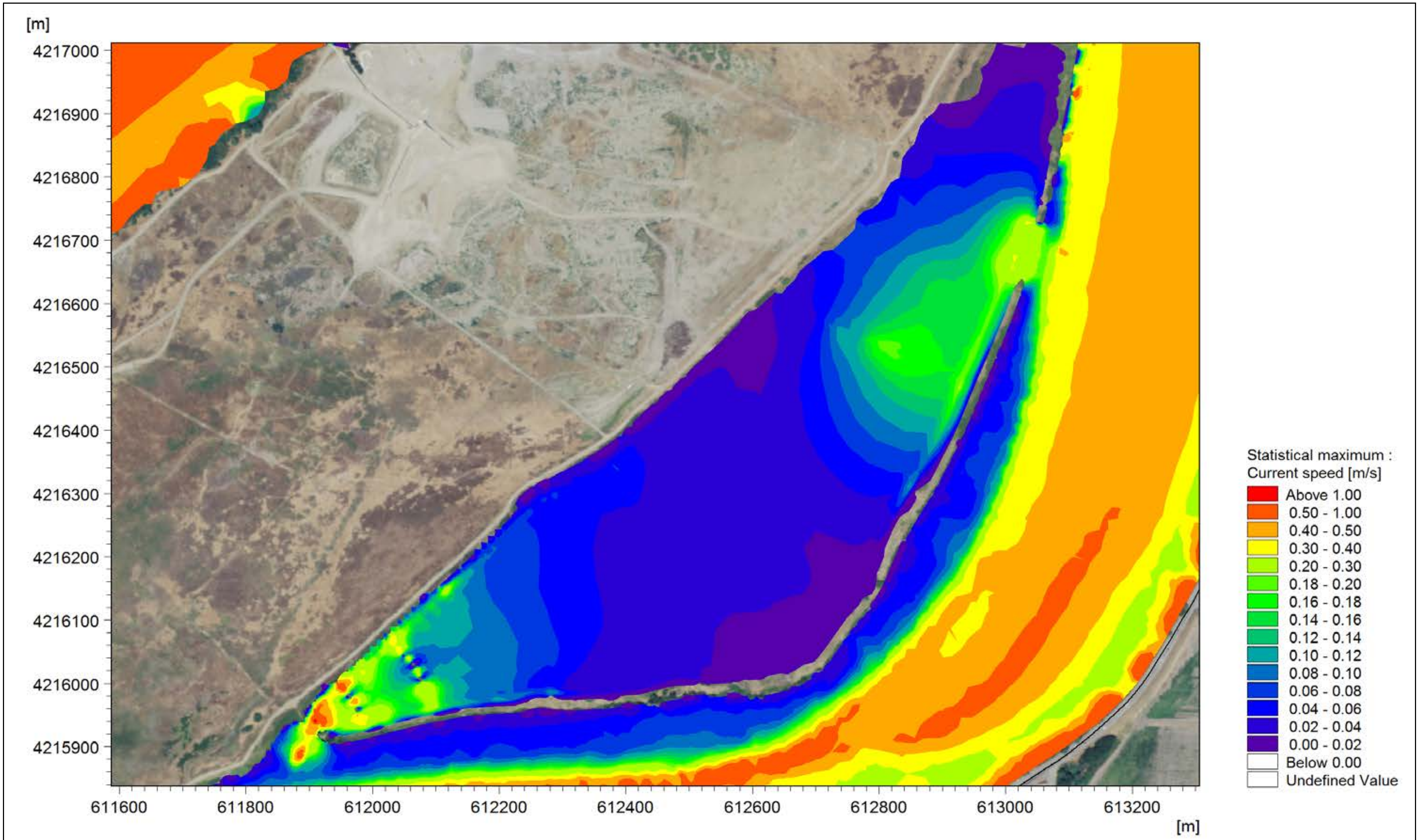
Baseline - Flood condition, maximum velocity

Project No. 15-1028	Created By: AMS	**Figure 3**



Notes:

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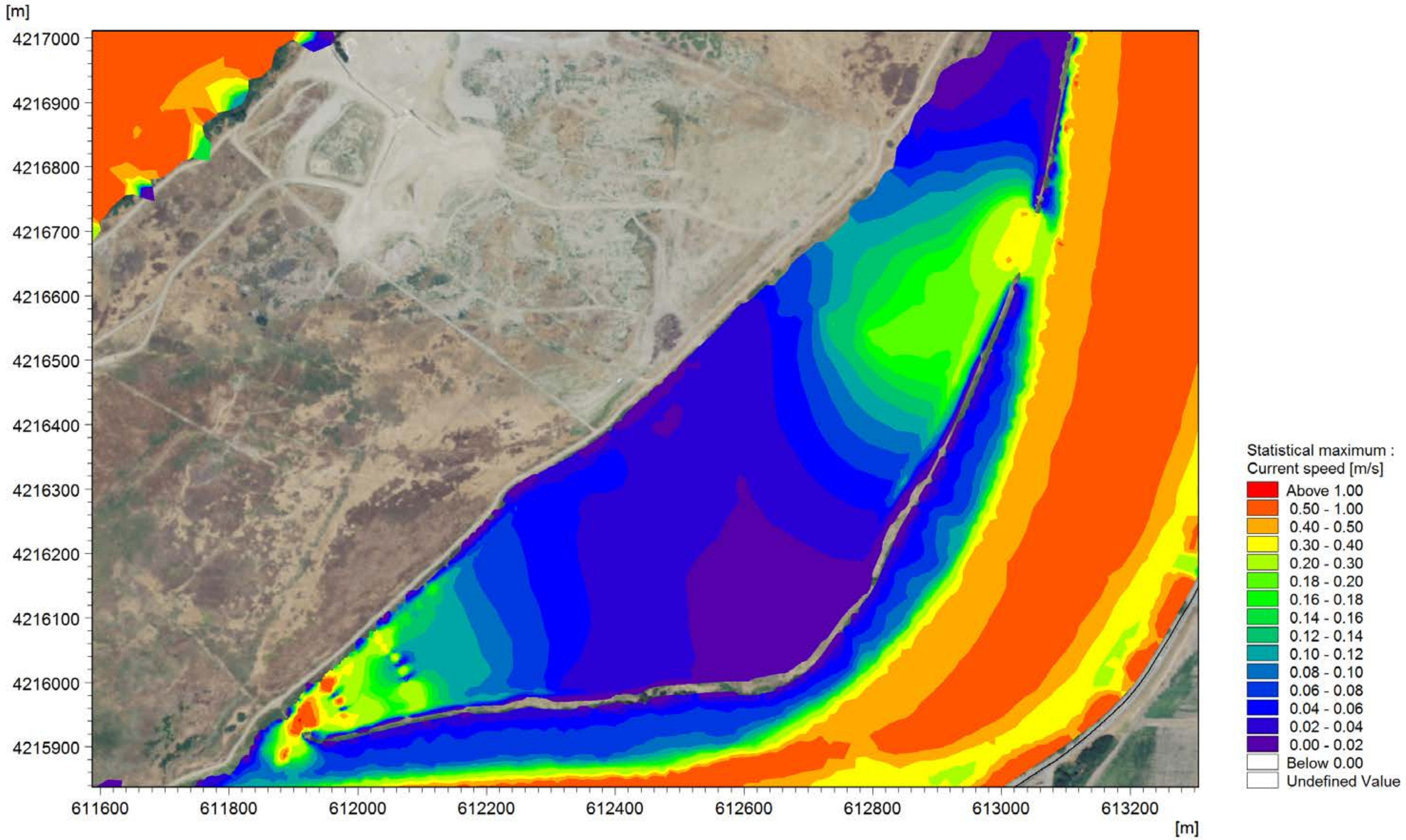
Alt 2 - Tidal condition, maximum velocity

Project No. 15-1028	Created By: AMS	**Figure 4**



Notes:

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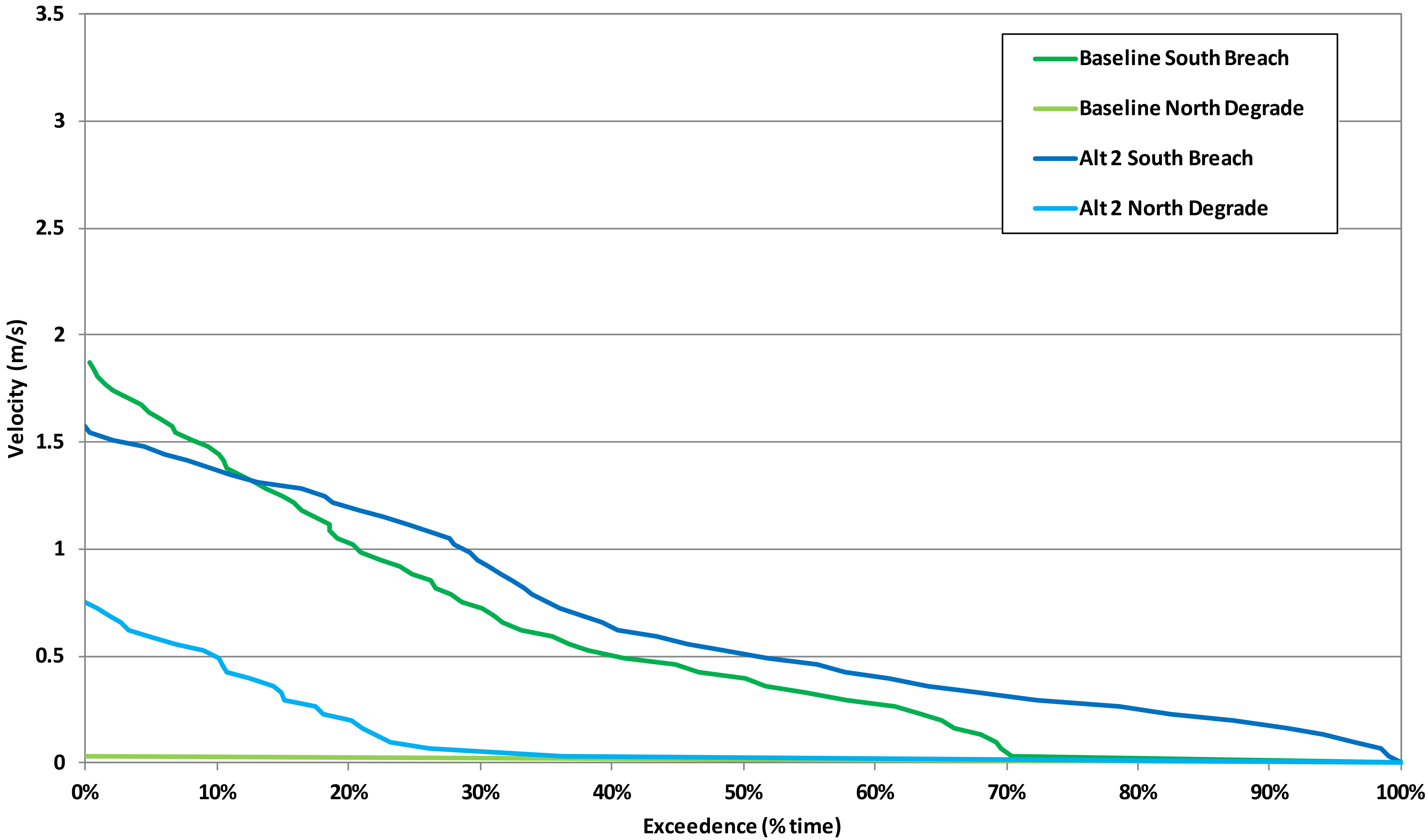
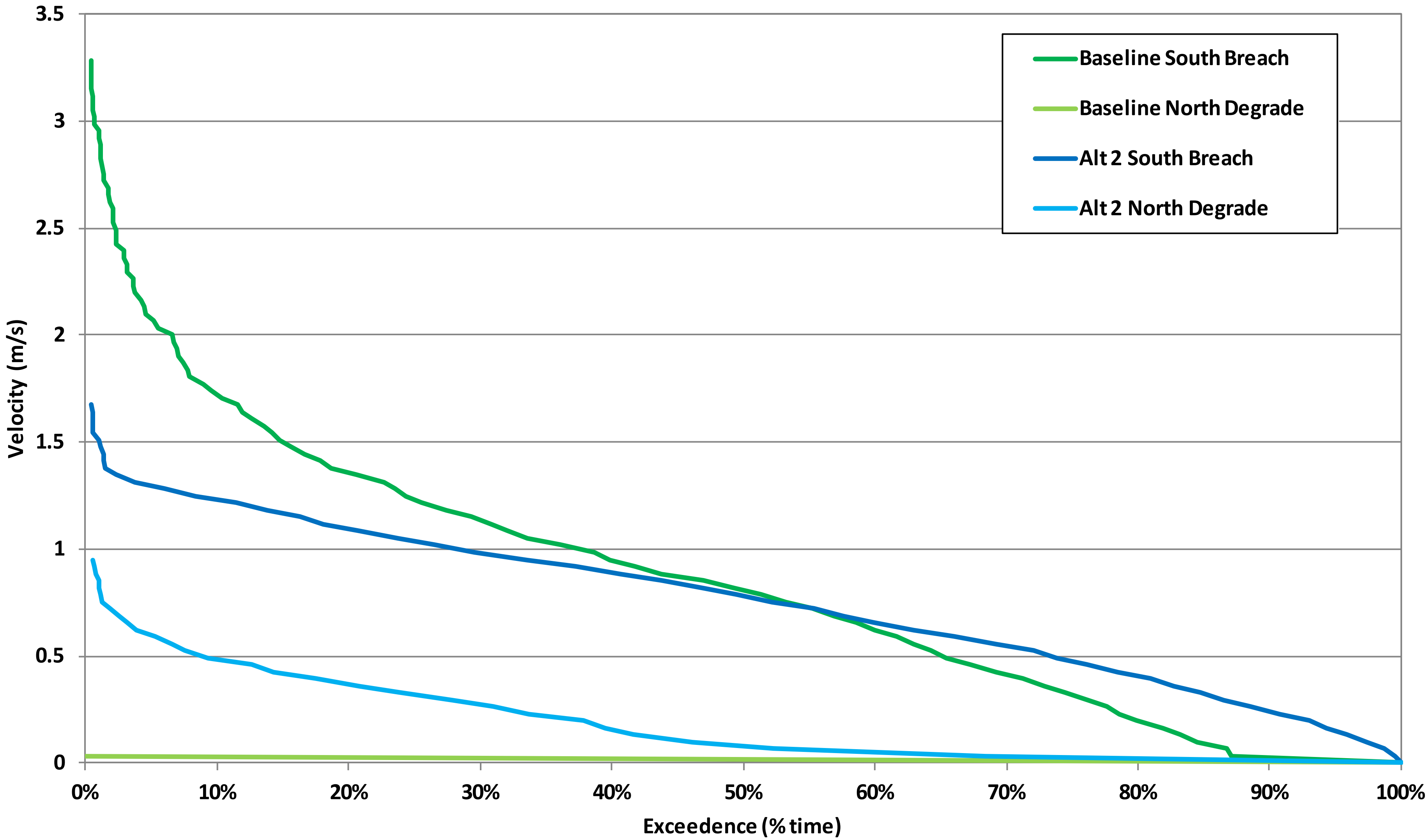
Decker Island Habitat Restoration Project

Alt 2 - Flood condition, maximum velocity

Project No. 15-1028	Created By: AMS	**Figure 5**



Notes:	cbec eco engineering	*Decker Island Habitat Restoration Project* **Velocity exceedence, tidal condition**		
		Project No. 15-1028	Created By: AMS	**Figure 6**



Notes:	cbec eco engineering	*Decker Island Habitat Restoration Project* **Velocity exceedence, flood condition**		
		Project No. 15-1028	Created By: AMS	**Figure 7**

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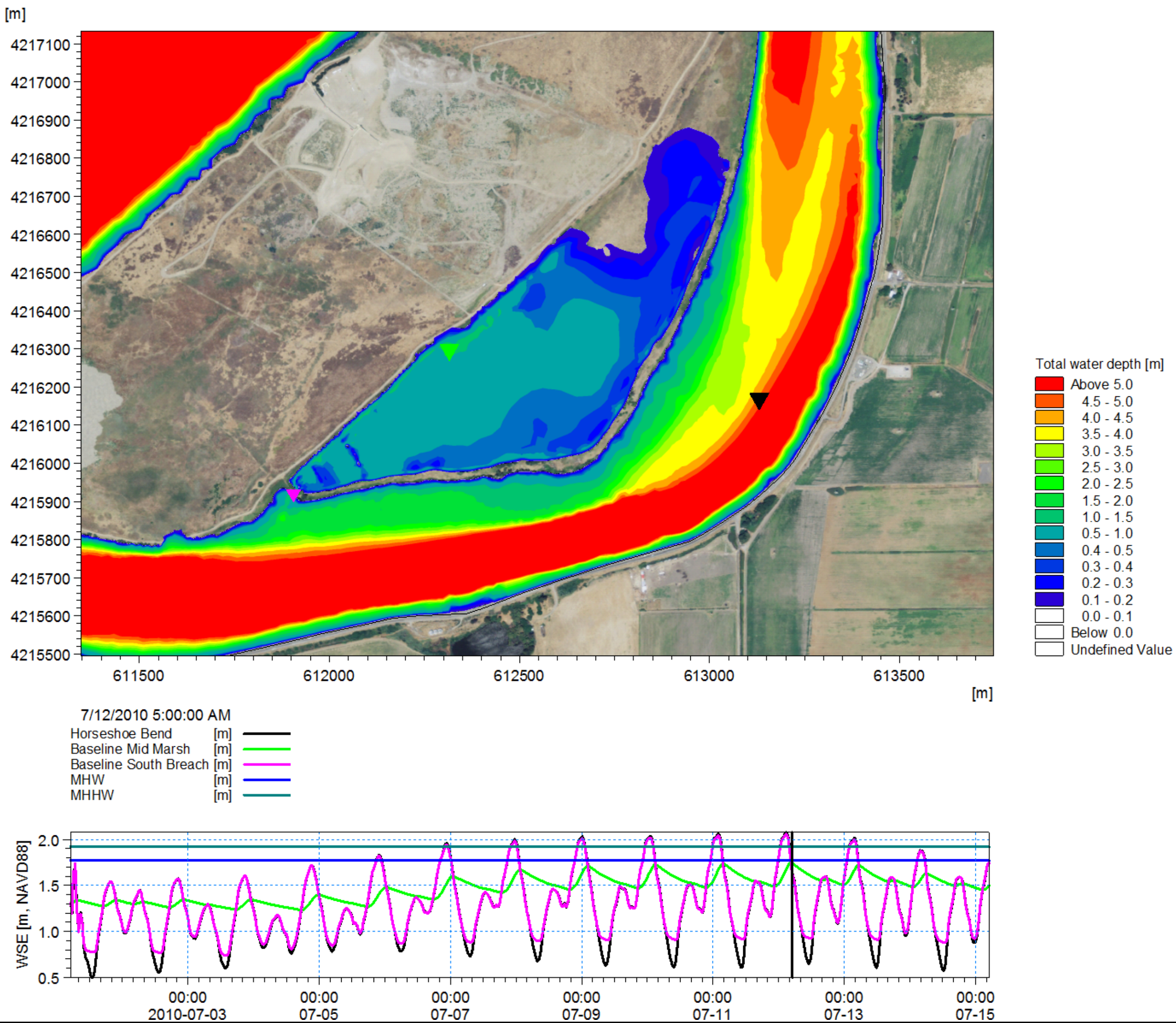
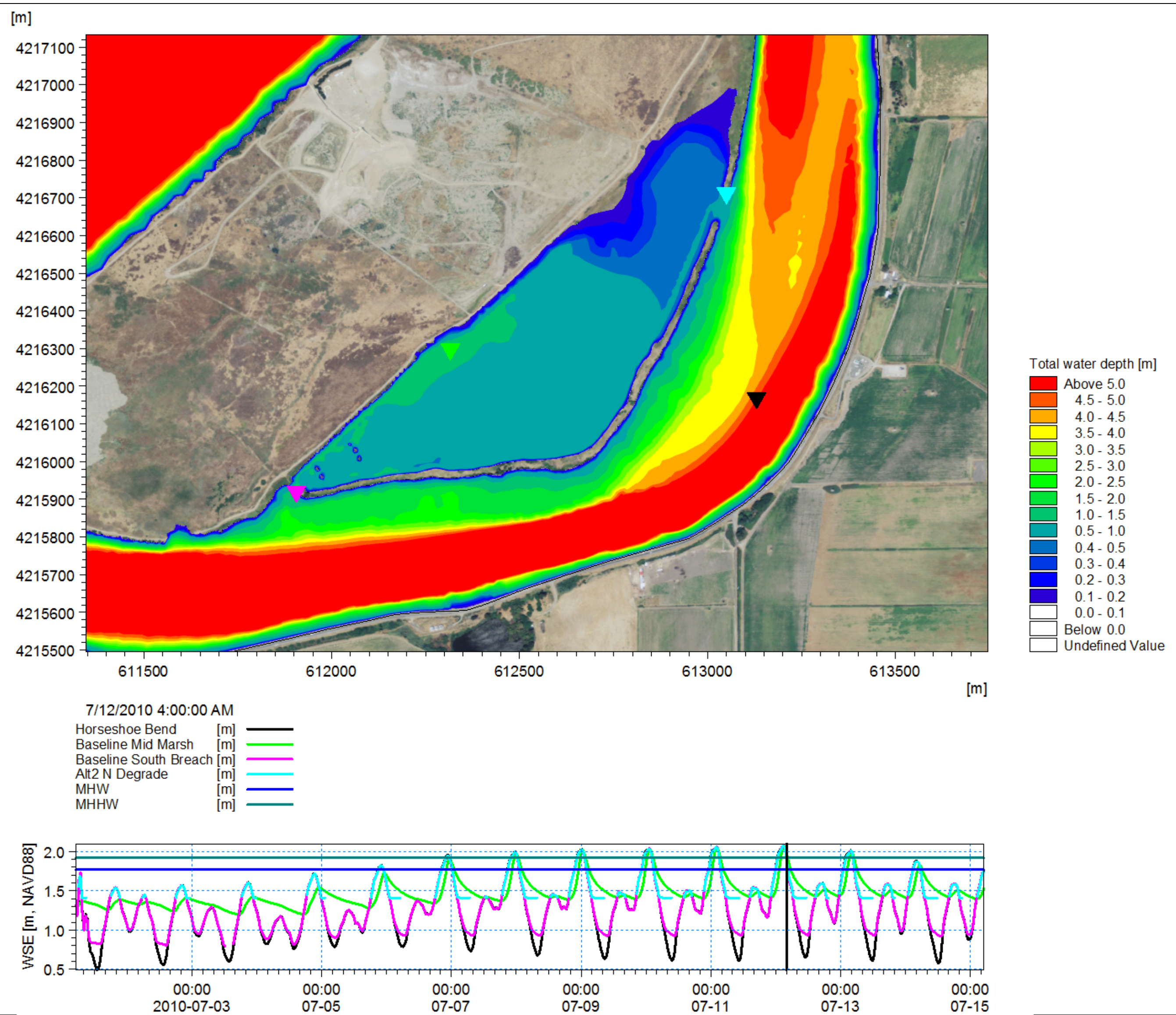


Notes: Snapshot of depth of inundation at MHW condition (see timeseries plot ticker location as vertical black line)	cbec eco engineering	*Decker Island Habitat Restoration Project* **Baseline tidal condition, depth at MHW**		
		Project No. 15-1028	Created By: AMS	**Figure 8**



Notes: Snapshot of depth of inundation at MHHW condition (see timeseries plot ticker location as vertical black line)

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Alt 2 tidal condition, depth at MHHW

Project No. 15-1028	Created By: AMS	**Figure 9**

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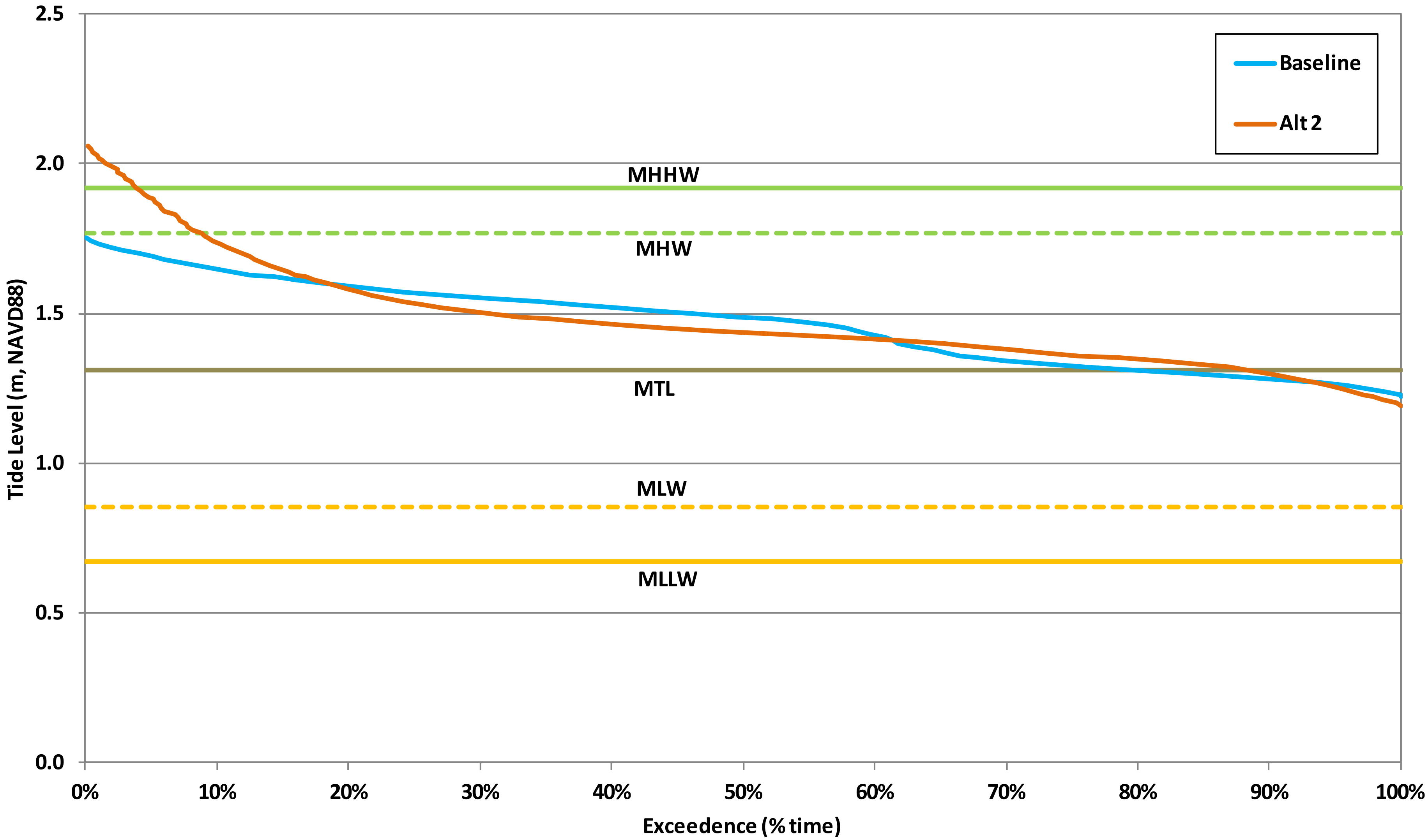

Notes:		*Decker Island Habitat Restoration Project* **Inundation exceedence, tidal condition**		
		Project No. 15-1028	Created By: AMS	**Figure 10**

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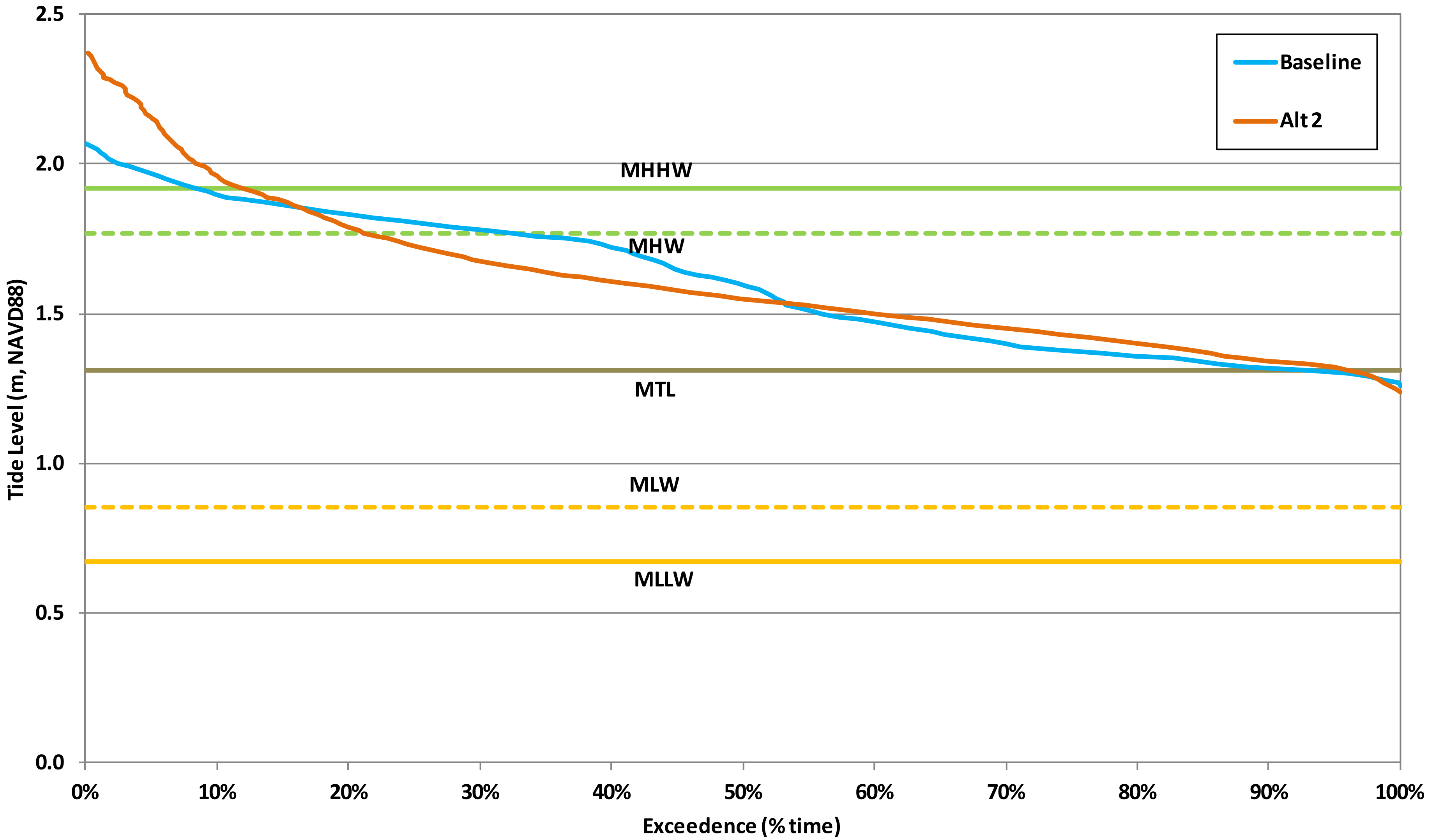
6/3/2016



Notes:	cbec eco engineering	*Decker Island Habitat Restoration Project*		
		Inundation exceedence, flood condition		
		Project No. 15-1028	Created By: AMS	**Figure 11**