Analysis of the storm event (11/02/2021-14/02/2021) along with the impact on Sidmouth (6aSU10) and Exmouth (6aSU16-1)

1. Introduction

This report briefly identifies the hydrodynamic forcing cause by storm Darcy and their resultant morphological impact identified by a post storm survey undertaken at two survey units: Sidmouth and Exmouth, both completed on the 18th of February. All hydrodynamic and meterological data has been obtained from the Dawlish directional wave rider (DWR) buoy.

Storm Darcy was the fourth named storm by the Met Office for the 2020/2021 impacting East Devon, from the 11th to the 14th of February, with wind speeds reaching up to 23mph and wind gusts reaching up to 49mph at Sidmouth; wind speeds and wind gusts at Exmouth reached up to 37 mph and 47 mph respectively.

Analysis and comparisons within this report is only undertaken on the profiles which were captured in the post-storm survey for consistency. The following sections will provide a brief background into the hydrodynamics occurring during this storm event period and an analysis into the changes to the beach's morphology.

2. Hydrodynamics

During Storm Darcy, between the 11th and 14th of February 2021, the significant wave height (H_S) averaged 2.40 m (*Table 1*) and the maximum wave height (H_{Max}) averaged 3.82 m. When compared to the February average, the storm event recorded a 31% increase in H_S and a more south-easterly wave direction (Table 1). As can be seen in Figure 1, there were three distinct peaks throughout the period under analysis whereby the storm threshold (2.64 m) was exceed by H_S. The first lasted for a duration of 10.5 hours coinciding with the spring high tide of on 11th February (18:58 at 4.2 m recorded at Dawlish), the second lasted for a duration of 7.5 hours coinciding with spring high tide on 12th February (07:20 at 4.4 m recorded at Dawlish) and the third lasted for 16 hours which coincided with the spring high tide on 14th February (08:26 at 4.4 m recorded at Dawlish); see Table 1 and Figure 1.

Table 1 – Hydrodynamic statistics recorded from Dawlish directional wave rider. H_S is wave height (m), Tp is peak wave period (s), Tz is mean wave period and Dir. is wave direction (°).

	Hs (m)	Tp (s)	Tz (s)	Dir. (°)
Storm Event Average (11/02-14/02)	2.40	7.25	5.15	131
February Average (2007-2019)	0.75	8.2	4.0	161
Storm Event Peak 1 (11/02 09:30 – 20:00)	2.71	7.7	5.39	121
Storm Event Peak 2 (12/02 03:30 – 11:00)	2.77	7.57	5.47	117
Storm Event Peak 3 (14/02 02:30 – 18:30)	2.92	7.84	5.78	157

The period under analysis recorded a maximum wave height of 4 m and a maximum H_{Max} of 7 m. The maximum values of H_S and H_{Max} can been seen to exceed the January average by around five times.

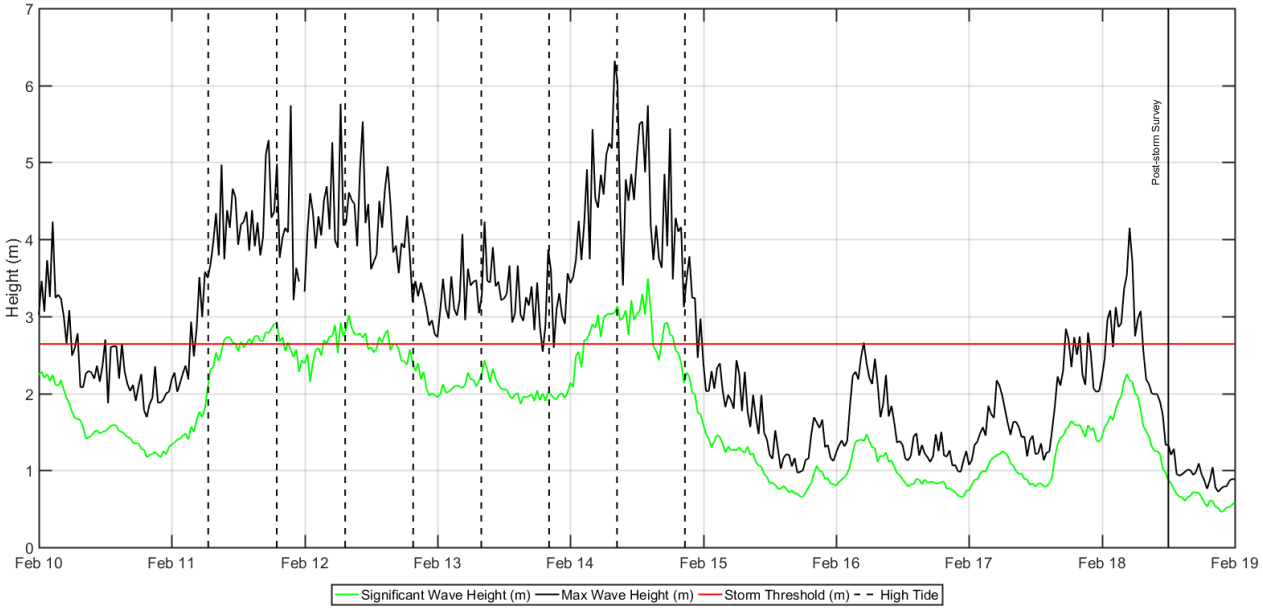


Figure 1 – Plot showing the significant wave height (H_S) and maximum wave height (H_{Max}) over a nine-day period, including the low-pressure event. High tide times during the study period are indicated with a dashed vertical black line. Data obtained from Dawlish DWR.

3. Beach Morphology Change

3.1 Sidmouth

The post-storm survey consisted of seven survey lines which, in this report, are directly compared against the previous post storm survey (18th October 2020); see Figure 2.

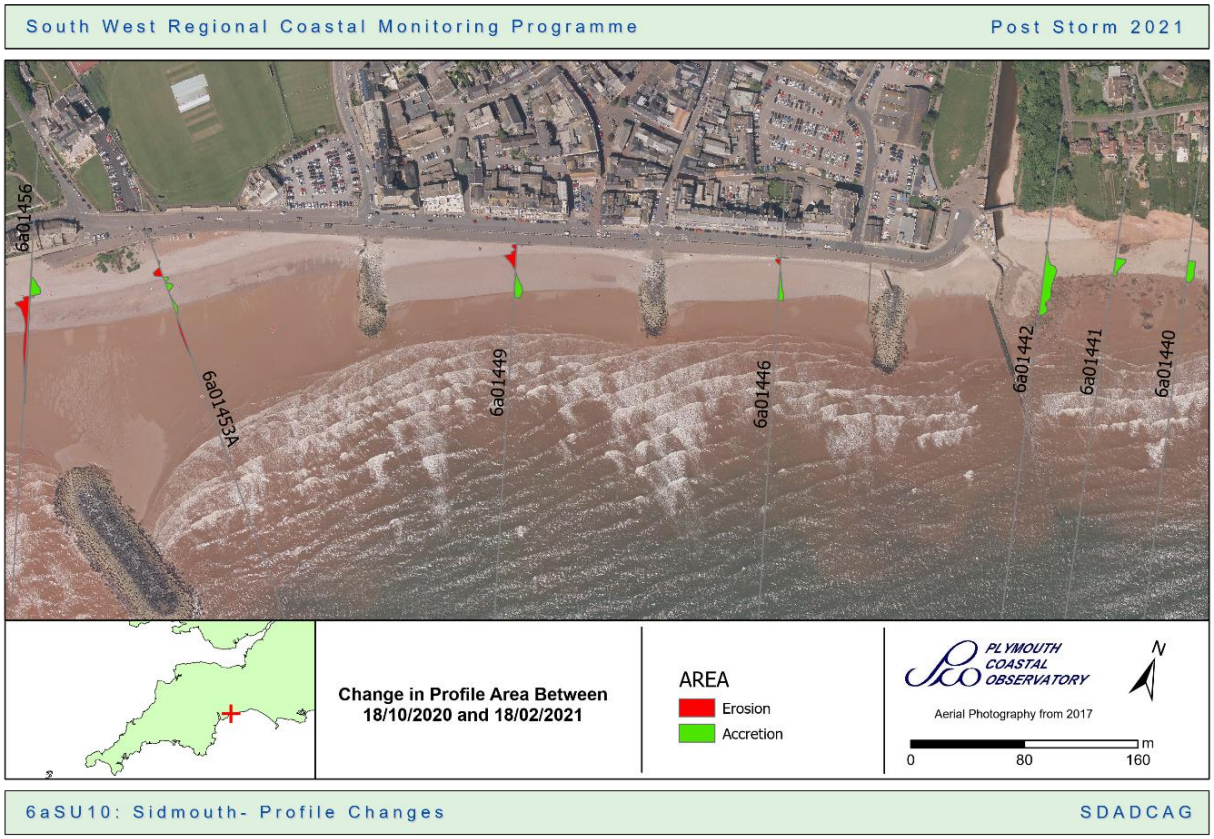


Figure 2 - Plot indicating the location of Sidmouth and the post storm profiles, along with an exaggerated overlay depicted where there has been erosion (red) and accretion (green) across each of the profiles since the previous survey (18th October 2020).

3.1.1 Erosion & Accretion Overview

Sidmouth, as a whole, gained 43.39 m^2 of material with the smallest net gain occurring on profile 6a014523A (4.15 m^2) and the greatest net gain on profile 6a01442 (24.82 m^2); see *Table 2*. When comparing the cross-sectional area of the seven survey lines all profiles exhibited minor losses in material between the interim and post-storm survey ranging from -0.30 m^2 to -21.60 m^2, however, the gain of material on each profile is significantly higher, ranging from 5.06 m^2 to 25.12 m^2 (see *Table 2*; see Appendix A).

3.1.2 Profile Erosion & Accretion

Profile 6a01440 and 6a01441 show a clear gain of material across the entire profile length. Profiles 6a01453A and 6a01465 show a mixture of erosion and accretion along their profiles, with accretion being dominant across the upper beach face/beach crest and erosion mainly occurring on the mid-lower beach slope (see Appendix A). In comparison, profile 6a01449 shows a near 50/50 erosion and accretion with erosion being slightly more dominant. The upper-mid part of the beach has eroded whilst the mid-lower beach has accreted. The other two profiles illustrate dominant accretion along the entire beach profile with small erosion occurring above elevation 1.7 m ODN.

Table 2 – Overview of accretion and erosion rates at each post storm profile line, calculated from Topographic surveys between 18th October 2020 and 18th February 2021.

	Accretion (m^2)	Erosion (m^2)	Total (m^2)
6a01440	7.58	0.00	7.58
6a01441	5.84	0.00	5.84
6a01442	25.12	-0.30	24.82
6a01446	5.22	-1.08	4.15
6a01449	6.36	-6.99	-0.62
6a014523A	5.06	-6.83	-1.77
6a01456	6.32	-21.60	-15.28

3.2 Exmouth

The post-storm survey consisted of seven survey lines which, in this report, are directly compared against the autumn interim survey (16th November 2020); see Figure 3.

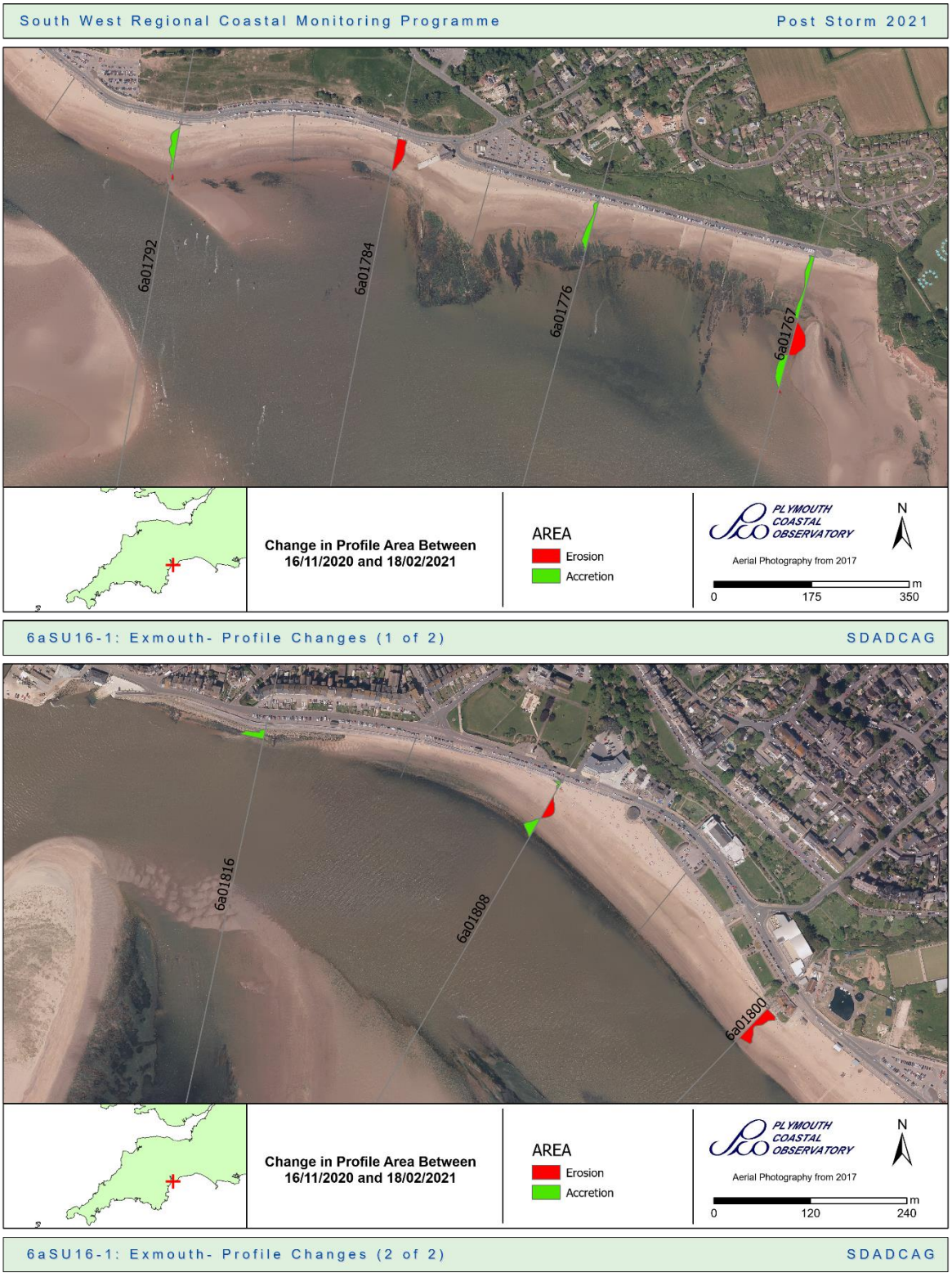


Figure 3 - Plot indicating the location of Exmouth and the post storm profiles, along with an exaggerated overlay depicted where there has been erosion (red) and accretion (green) across each of the profiles since the previous interim survey (16th November 2020).

3.2.1 Erosion & Accretion Overview

Exmouth, as a whole, gained 57.89 m^2 of material with the smallest net gain occurring on profile 6a01808 (0.74 m^2) and the greatest net gain on profile 6a01776 (21.66 m^2); see *Table 3*. The net loss at Exmouth was -43.87 m^2, illustrating the overall gain of material across the survey unit. When

comparing the cross-sectional area of the seven survey lines all profiles exhibited losses in material between the interim and post-storm survey ranging from -0.22 m^2 to -26.66 m^2, however, the gain of material on each profile is significantly higher, ranging from 0.19 m^2 to 47.05 m^2 (see *Table 3*; see Appendix B).

3.2.2 Profile Erosion & Accretion

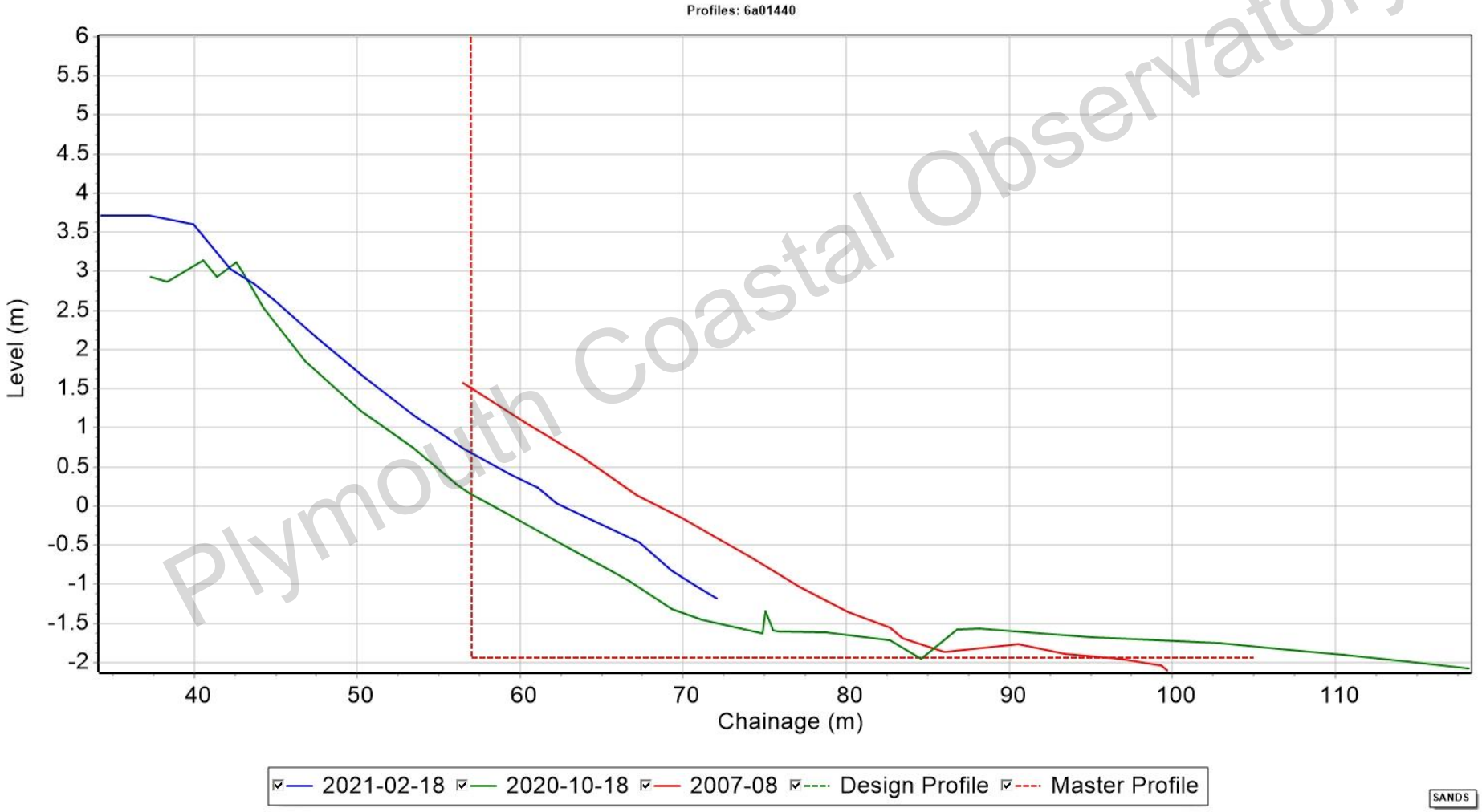
Profile 6a01784 and 6a01800 shows a clear loss of material across the entire profile length. Profiles 6a01767 and 6a01808 show a mixture of erosion and accretion along their profiles, with accretion being dominant across the seaward side of the beach slope and lower beach and erosion mainly occurring mid beach (see Appendix B). In comparison, profile's 6a01776, 6a01792 and 6a01816 show major accretion across the beach face and slope with very small erosion observed on the lower beach or near the wall. The location along the profiles, where accretion outweighs erosion, generally occurs across main beach slope whereas erosion typically occurs below -0.55 m ODN and near the sea wall (see Appendix B).

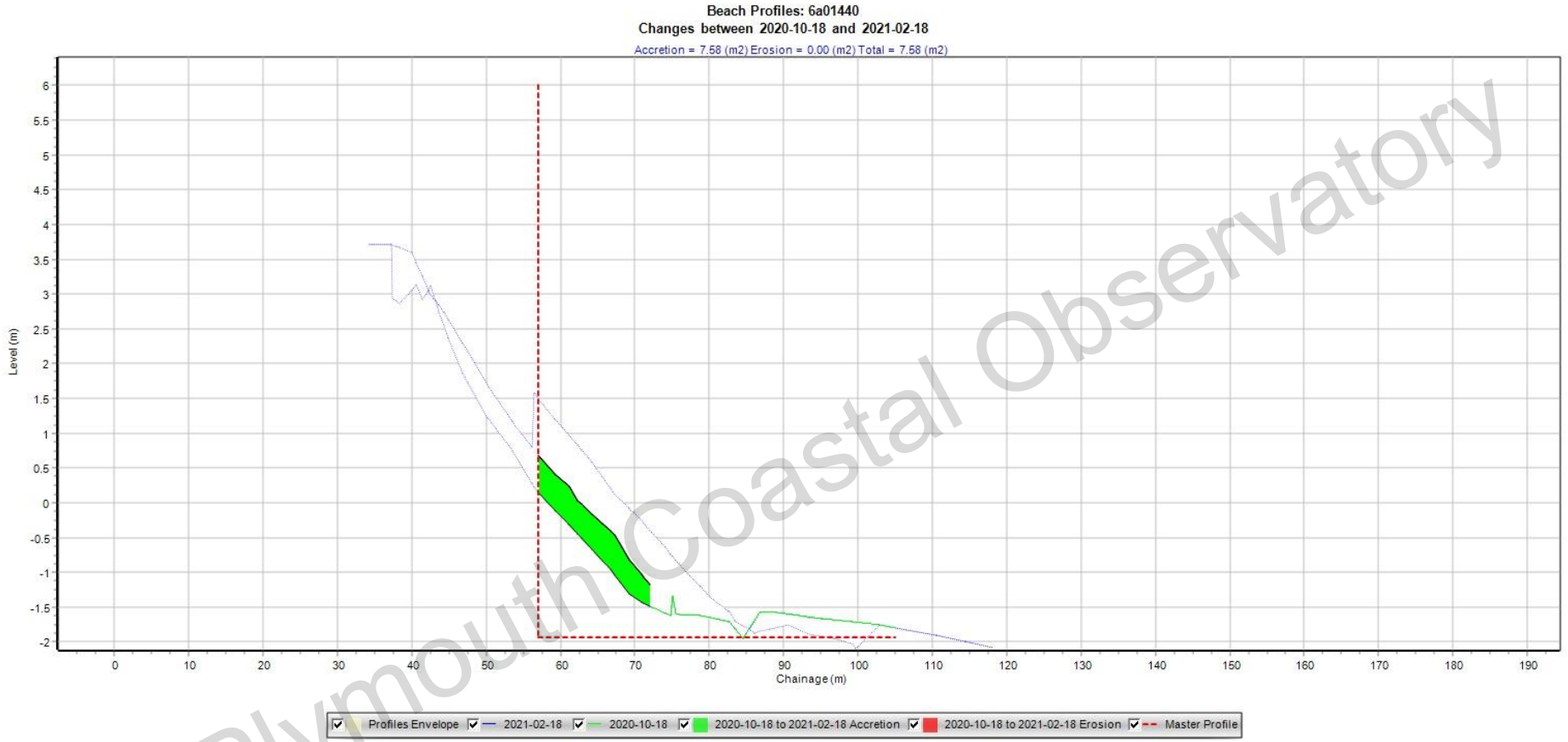
Table 3 – Overview of accretion and erosion rates at each post storm profile line, calculated from Topographic surveys between 16th November 2020 and 18th February 2021.

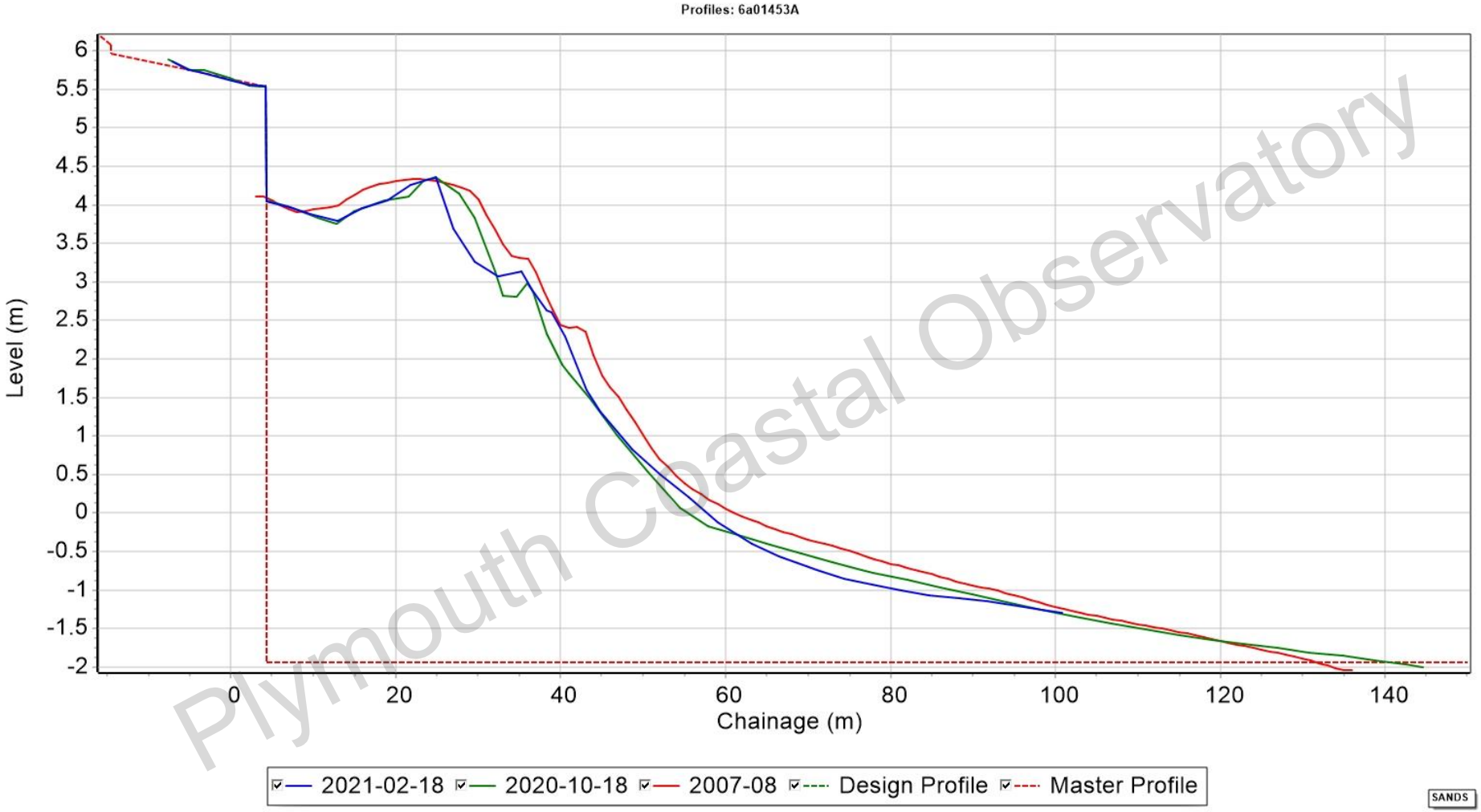
	Accretion (m^2)	Erosion (m^2)	Total (m^2)
6a01767	47.05	-37.06	9.99
6a01776	21.89	-0.22	21.66
6a01784	0.19	-26.66	-26.47
6a01792	20.84	-2.02	18.81
6a01800	0.39	-17.60	-17.21
6a01808	8.20	-7.46	0.74
6a01816	6.76	-0.07	6.69

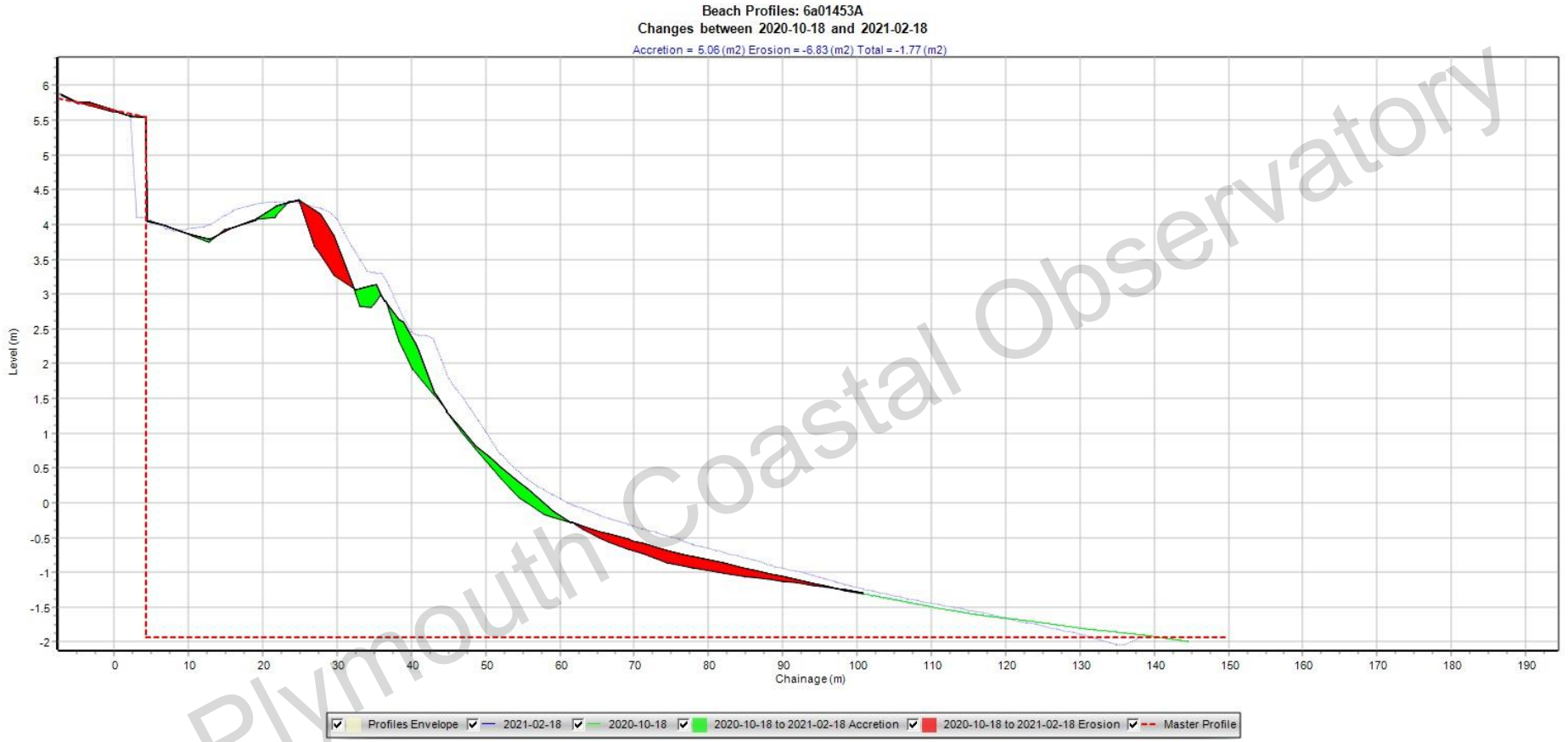
Appendix A – Sidmouth: Cross-sectional area change plots

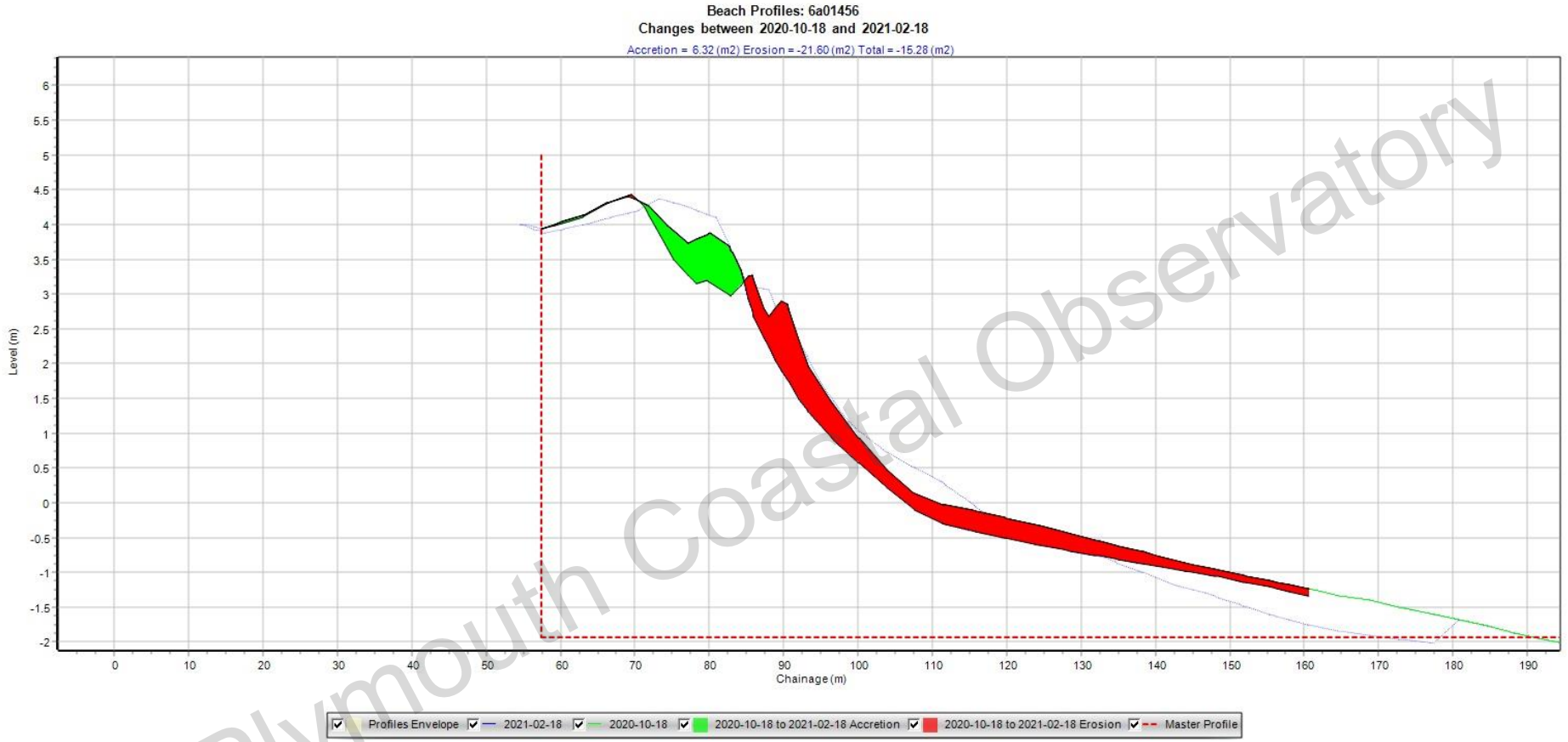
Each profile highlighted in Figure 2 is shown below, comparing the autumn interim and post-storm survey cross-sectional areas. Each plot has an accompanying profile change plot, displaying green as accretion and red as erosion for ease of visualisation.











Appendix B – Exmouth: Cross-sectional area change plots

Each profile highlighted in Figure 3 is shown below, comparing the autumn interim and post-storm survey cross-sectional areas. Each plot has an accompanying profile change plot, displaying green as accretion and red as erosion for ease of visualisation.