



**Cyfoeth
Naturiol**
Cymru
**Natural
Resources**
Wales

Newborough Phase 2 Site: Zone 1 West Dune Rejuvenation Works Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 103

Date: March 2015



About Natural Resources Wales

Natural Resources Wales is the organisation responsible for the work carried out by the three former organisations, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. It is also responsible for some functions previously undertaken by Welsh Government.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future.

We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

Published by: Natural Resources Wales
Maes y Ffynnon
Penrhosgarnedd
Bangor
LL57 2DW

0300 065 3000

© Natural Resources Wales [2015]

All rights reserved. This document may be reproduced with prior permission of Natural Resources Wales

Further copies of this report are available from the library

Email: library@cyfoethnaturiolcymru.gov.uk

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

This Evidence Report series serves as a record of work carried out or commissioned by Natural Resources Wales. It also helps us to share and promote use of our evidence by others and develop future collaborations. However, the views and recommendations presented in this report are not necessarily those of NRW and should, therefore, not be attributed to NRW.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

Report series: Evidence Report
Report number: 103
Publication date: 24 August 2015
Contract number: 2013835
Contractor: Kenneth Pye Associates Ltd
Contract Manager: Dr. Emmer Litt
Title: **Newborough Dune Rejuvenation Works Topographic Survey
March 2015 Phase 2 Site: Zone 1 West**
Author(s): **Prof. Kenneth Pye & Dr. Simon J. Blott**
Approved By: Dr. Emmer Litt
Restrictions: None

Distribution List (core)

NRW Library, Bangor

Recommended citation for this volume:

KPAL (2015e) Newborough Dune Rejuvenation Works Topographic Survey March 2015 Phase 2 Site: Zone 1 West. NRW Evidence Report No. 103. Kenneth Pye Associates Ltd., Solihull.

Contents

About Natural Resources Wales..... ii

Evidence at Natural Resources Wales iii

Contents..... v

1. Job Summary 1

2. Scope and purpose.....2

3. Survey methods and error checking2

4. Sediment particle size analysis2

5. Results - particle size analysis3

6. Results - profile comparisons.....3

7. References4

8. Tables.....4

9. Figures7

10. Field photographs 19

Data Archive Appendix31

1. Job Summary

KPAL Job No:	270315
Report Date:	24/08/2015
Client:	Natural Resources Wales
Client Job Title:	Newborough Warren Dune Restoration Works: Phase 3
Survey conducted:	26 th March 2015
Instruments used:	Leica Viva NetRover controller and GS08 SmartAntenna mounted on GLS30 pole (2 m) Leica RX900 controller and ATX900 antenna mounted on GLS30 pole (2 m) Leica GX1230 RTK base station mounted on GST20-9 tripod Leica RX1210T Field Controller
No. of data points:	1197
RTK Control Station:	A Leica Smartnet GPRS signal could not be found at any point within the Zone 1 West site. A strong signal was however found on Llanddwyn Island, where a temporary benchmark (BM4) was established, surveyed-in using Leica Smartnet GPRS. The base station was mounted over this benchmark, and used to establish a benchmark (BM5) on a high vegetated part of the frontal dune in the centre of Zone 1 West. BM5 was surveyed-in using radio corrections relative to the base station at BM4. The base station was then mounted over BM5, and used to survey the rest of the site: BM4: Easting: 239034.791 m Northing: 363400.401 m Height: 10.877 m OD BM5: Easting: 239072.929 m Northing: 363802.550 m Height: 10.866 m OD
RTK Backup Station:	Three wooden posts surveyed-in using corrections relative to BM5 (see Table 2). The tops of two of these posts were previously surveyed on 8 th July 2013 using a similar RTK survey, providing an independent check on the measurements.
Fixed profiles:	Fourteen profile lines were surveyed, and compared with data surveyed before the restoration works using airborne LiDAR survey on 9 April 2014. Chainages along profile lines were interpolated at positions on a theoretical straight-line between the zero and end points of the profile.
Survey undertaken by:	S.J. Blott, A. Pye and K. Pye

2. Scope and purpose

Phase 1 dune rejuvenation trials at Newborough Warren commenced in January 2013 and involved (a) stripping of vegetation from the windward dune slopes, crests and parts of the arms and deflation corridors, (b) excavation of sand to deepen parts of the deflation corridors to encourage the development of wet slack habitat, and (c) placement of stripped turf blocks in areas on and behind the dune arms. Phase 2 works commenced in areas identified in the Newborough Forest Management Plan as Zone 1 West and Zone 1 East (see Figure 1) during 2014. The works at Zone 1 West (Traeth Penrhos) involved (a) the creation / enlargement of four ‘notches’ in the frontal dune to allow wind flow and sand movement from the beach into the back dune are, (b) removal of areas of coniferous pine plantation (including de-stumping), and (c) localised turf stripping. A baseline ground topographic survey was carried out in July 2013 and an airborne LiDAR survey was undertaken in April 2014. This report provides a summary of a post-works ground topographic survey carried out at Zone 1 West in March 2015, and comparisons which have been made with the July 2013 and April 2014 surveys.

3. Survey methods and error checking

In the March 2015 survey ground surface elevations were determined at 850 points using Leica RTK GPS SmartRover equipment listed in the Job Summary (Section 1.0) above. The distribution of survey points is shown in Figures 2 and 3. Many of the survey points were located on profile lines, chosen to measure elevations along the axes of the new notches, across the frontal dune between the notches, and along transects across the new notches. The limits of defined features, including areas stripped of vegetation, areas of windblown sand (where present), the main dune crest and base of slopes, any areas of standing water, and the position of the dune toe, were also mapped by survey points.

Average vertical and horizontal errors reported by the instrument during the March 2015 survey were well within the expected range (Table 1).

Measuring of the position and elevation of Benchmark 2 using the two instrumental set-ups (using Leica SmartNet corrections and using the base and rover set-up) showed a vertical difference of just 12 mm, which is within the errors expected for RTK GPS technique, due largely to atmospheric effects (Table 2).

Ground photographs were taken at a number of locations around the site; a selection is reproduced in Appendix 1.

4. Sediment particle size analysis

During the topographic survey a number of surface sand samples were collected for particle size analysis by dry sieving (sampling locations are shown on Figure 4). The particle size data were processed using Gradistat software (Blott & Pye, 2001) and the sediments classified using the statistical summary parameters and terminology proposed by Folk (1954), Folk & Ward (1957) and Blott & Pye (2012).

5. Results - particle size analysis

All of the sediment samples collected can be classified as very well sorted or well sorted fine sand (Tables 3 & 4). Only two samples contained small quantities (< 0.2% of) silt. The median size showed a narrow range of variation (190 to 207 microns). Material of this size is easily moved by the wind.

6. Results - profile comparisons

The locations of the profile lines selected for change comparison are shown in Figure 5. Figure 6 shows comparisons for each profile of the surface levels in July 2013, April 2014 and March 2015.

Figure 6a shows recession for the seaward side of the frontal dune ridge which occurred as a result of the storms during the winter of 2013-14.

Figure 6b shows significant change in the long (axial) profile of Notch A between April 2014 and March 2015 due to sand accumulation at the mouth of the notch and formation of a depositional sand lobe on the landward side of the notch.

Figure 6c shows that at profile 3 the ground surface behind the frontal dune was locally lowered only by a relatively small amount (up to c. 20 cm) during the de-vegetation process. At the landward end of profile 4 some small dune features were removed during the works (Figure 6d). Within Notch 4 the relatively smooth profile present in April 2014 had changes by March 2015 as a result of sand accumulation at the mouth of the notch, creating a mound, and scour immediately behind.

Profile 5 (Figure 6e) shows lowering of the surface by up to 30 cm on the de-vegetated surface.

At profile 6 (Figure 6f) the surface level at the landward side of Notch C showed minor changes between April 2014 and March 2015, but significant sand accretion is indicated in the mid part of the profile; i.e. most sand has not been trapped within the notch but has passed through to infill and cover the ground behind.

The crest of notch D (profile 7) was lowered by approximately 1.2 m between April 2014 and March 2015, while the surface behind was lowered by up to 30 cm during the de-vegetation works (Figure 6g).

At profile 8 (pre-existing path) the ground level in March 2015 was smoother than in April 2014 due to artificial removal of a small dune behind the beach and deposition of an even sand cover behind (Figure 6h).

Cross-sectional profile 9 shows widening of the notch due to wind action between April 2014 and March 2015 (Figure 6i). Profile 10 shows slight widening and deepening of Notch B (Figure 6j). Notch C shows some deposition of sand on the lower half of the eastern slope due to slumping and avalanching of sand from higher up the slope, but very little change on

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

the western slope (Figure 6k). Profile 12 across Notch D and the pre-existing path shows lowering of the dune crests by up to 1.2 m, mainly as a result of the works, with very little change in the cross-sectional profile of Notch D over the period (Figure 6l).

The long profiles 13 and 14 show only relatively small differences between the surface levels in April 2014 and March 2015, indicating that the de-vegetation works did not change the morphology of the site significantly (Figures 6m and 6n).

The total area of bare sand at the time of survey, including small areas of deposited turf /sand, was 3.85 ha, excluding small areas (total estimated to be c. < 0.05 ha) of blown sand incursion into the edge of the remaining forest (Table 5).

7. References

Blott, S.J. and Pye, K. (2001) GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. *Earth Surface Processes and Landforms*, 26, 1237-1248.

Blott, S.J. & Pye, K. (2012) Particle size scales and classification of sediment types based on particle size distributions: review and recommended procedures. *Sedimentology*, 59, 2071-2096.

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *Journal of Geology*, 62, 344-359.

Folk, R.L. and Ward, W.C. (1957) Brazos river bar: a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, 27, 3-26.

KPAL (2013) *Topographic Survey Report, Traeth Penrhos, Newborough Forest*. Report prepared for Natural Resources Wales, 29 July 2013. Kenneth Pye Associates Ltd., Solihull.

8. Tables

Table 1. Average error reported by the instrument for all 850 data points

	1-D quality control (height)	2-D quality control (position)	3-D quality control (position and height)
Average	10.3 mm	6.6 mm	12.3 mm
StDev	3.8 mm	2.9 mm	4.7 mm

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

Table 2. Measured locations and heights of wooden posts in the present survey (26/03/2015), and surveyed previously (07/08/2015). Note that a Leica Smartnet GPRS signal could not be found on either survey, and both were surveyed using a base-and-rover set-up using benchmarks established elsewhere on the site, resulting in a compounding of errors.

	Survey	Easting (m)	Northing (m)	Height (m OD)
Wooden post 20 m south of blowout (WP4930)	26/03/2015	239176.242	363706.857	6.174
Wooden post beside track (beside flat area used for car parking) (WP4931)	07/08/2013	239126.876	363730.877	5.238
	26/03/2015	239127.018	363731.151	5.270
	Difference:	+142 mm	+274 mm	+32 mm
Wooden post beside track at northern end of site (WP5514)	07/08/2013	239052.739	363952.047	4.539
	26/03/2015	239052.857	363952.700	4.566
	Difference:	+118 mm	+653 mm	+27 mm

Table 3. Particle size characteristics of dune samples collected at the Phase 2 Zone 1 West site on 26 March 2015. Statistics are calculated using GRADISTAT software (Blott & Pye, 2001), mean and sorting using the formulae of Folk & Ward (1957)

ID	Mean (µm & class)	D50 (µm)	Mode (µm)	Mean (phi)	Sorting (phi & description)	Gravel (%)	Sand (%)	Mud (%)
NW21	204 FS	207	215	2.29	0.27 VWS	0.0	100.0	0.0
NW22	187 FS	194	215	2.42	0.31 VWS	0.0	100.0	0.0
NW23	199 FS	205	215	2.33	0.32 VWS	0.0	100.0	0.0
NW24	200 FS	205	215	2.32	0.26 VWS	0.0	100.0	0.0
NW25	186 FS	191	215	2.43	0.32 VWS	0.0	100.0	0.0
NW26	184 FS	188	215	2.45	0.33 VWS	0.0	99.8	0.2
NW27	192 FS	199	215	2.38	0.31 VWS	0.0	100.0	0.0
NW28	197 FS	203	215	2.34	0.27 VWS	0.0	99.9	0.1
NW29	187 FS	190	215	2.42	0.39 WS	0.0	100.0	0.0

Mean Size Classification:

VCG (very coarse gravel)
 CS (coarse sand)
 MS (medium sand)
 FS (fine sand)
 VFS (very fine sand)

Sorting Descriptions:

VWS (very well sorted)
 WS (well sorted)
 MWS (moderately well sorted)
 MS (moderately sorted)
 PS (poorly sorted)
 VPS (very poorly sorted)

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

Table 4. Sediment textural classifications, according to Folk (1954) and Blott and Pye (2012), of the samples collected on 25-26 March 2015

ID	Easting	Northing	Folk (1954)	Blott and Pye (2012)
NW21	239062	363815	Sand	Sand
NW22	239080	363821	Sand	Sand
NW23	239157	363837	Sand	Sand
NW24	239015	363928	Sand	Sand
NW25	239024	363931	Sand	Sand
NW26	239041	363936	Sand	Sand
NW27	239140	363626	Sand	Sand
NW28	239123	363955	Sand	Sand
NW29	239172	363696	Sand	Sand

Table 5. Areas of bare sand at Zone 1 West. Note that small areas of blown sand entering the forest were not surveyed due to the lack of GPS signal beneath the trees. Small remaining clumps of unstripped vegetation have also not been included.

Bare sand type	Area (ha)
Vegetation-stripped	3.83
Significant sand deposition in heaps	0.01
Blown sand	0.00
Total	3.85

9. Figures

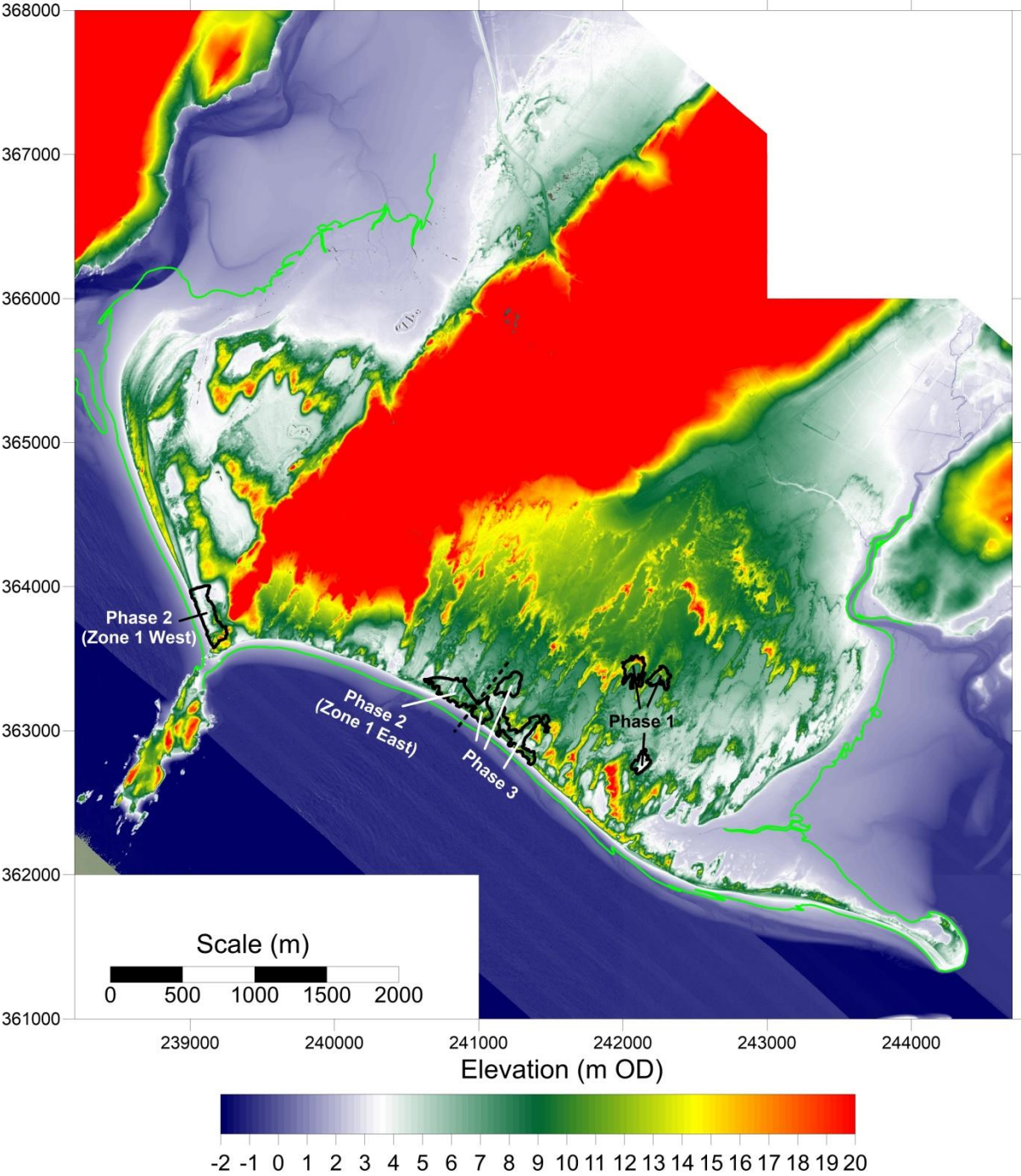


Figure 1. Locations of Phases 1, 2 and 3 dune restoration works at Newborough Warren, overlaid on LiDAR DEM flown on 9 April 2014.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

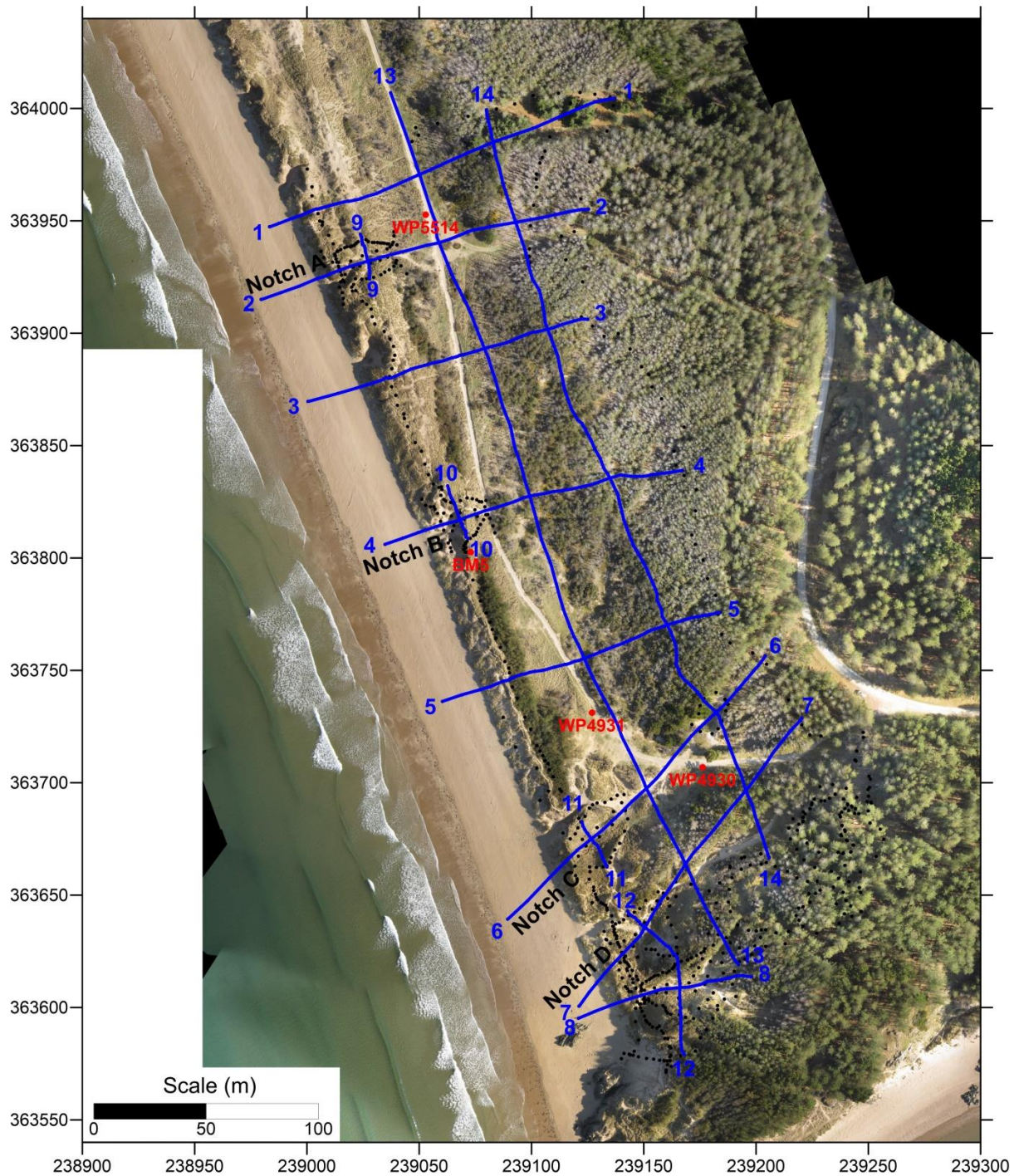


Figure 2. Locations of March 2015 data points (black dots), benchmarks and wooden posts (red dots) and cross-profiles (blue lines) in Zone 1 West, overlaid on air photographs flown June 2013 (by exeGesIS).

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

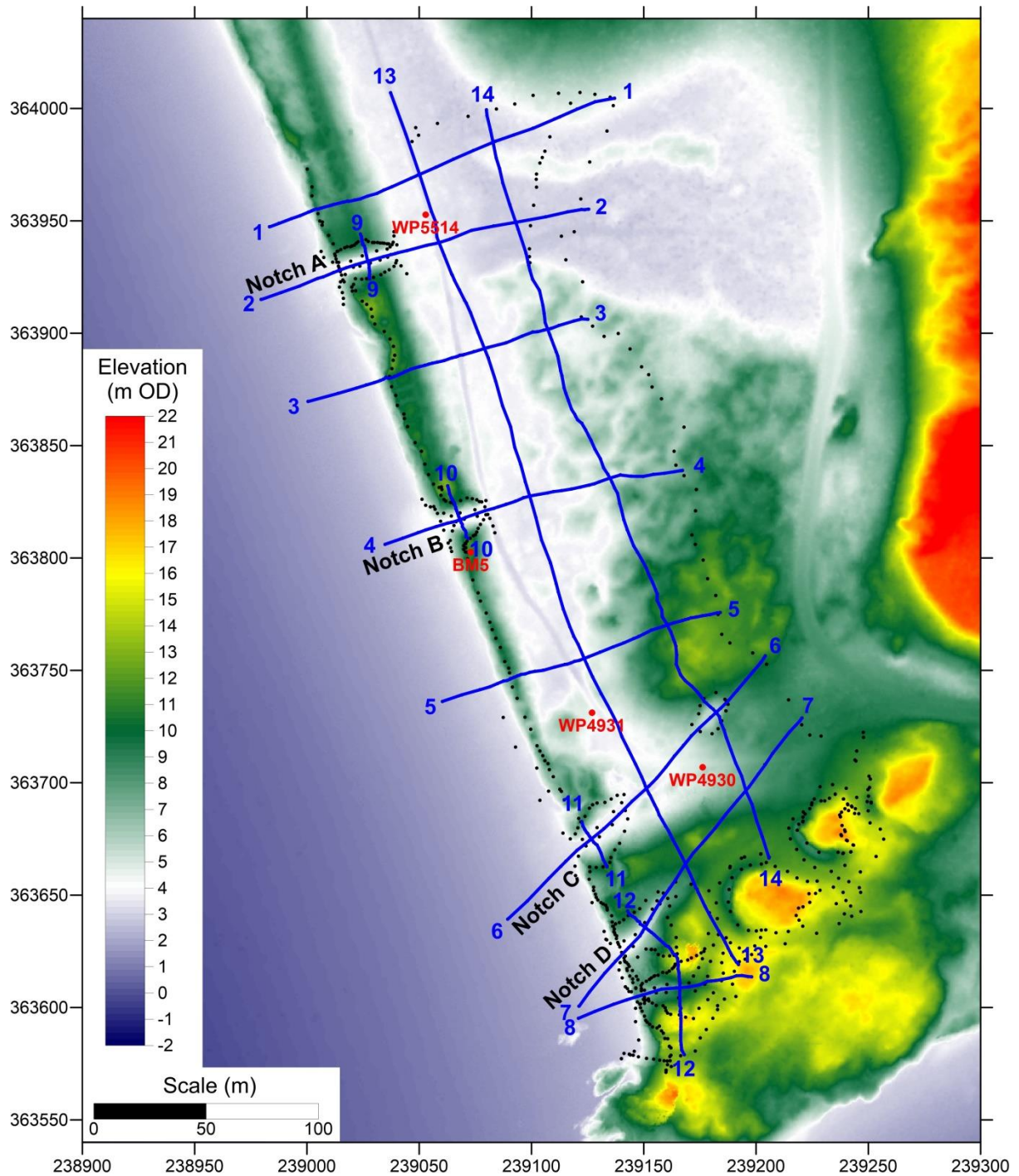


Figure 3. Locations of March 2015 data points (black dots), benchmarks and wooden posts (red dots) and cross-profiles (blue lines) in Zone 1 West, overlaid on LiDAR DEM flown on 9 April 2014.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

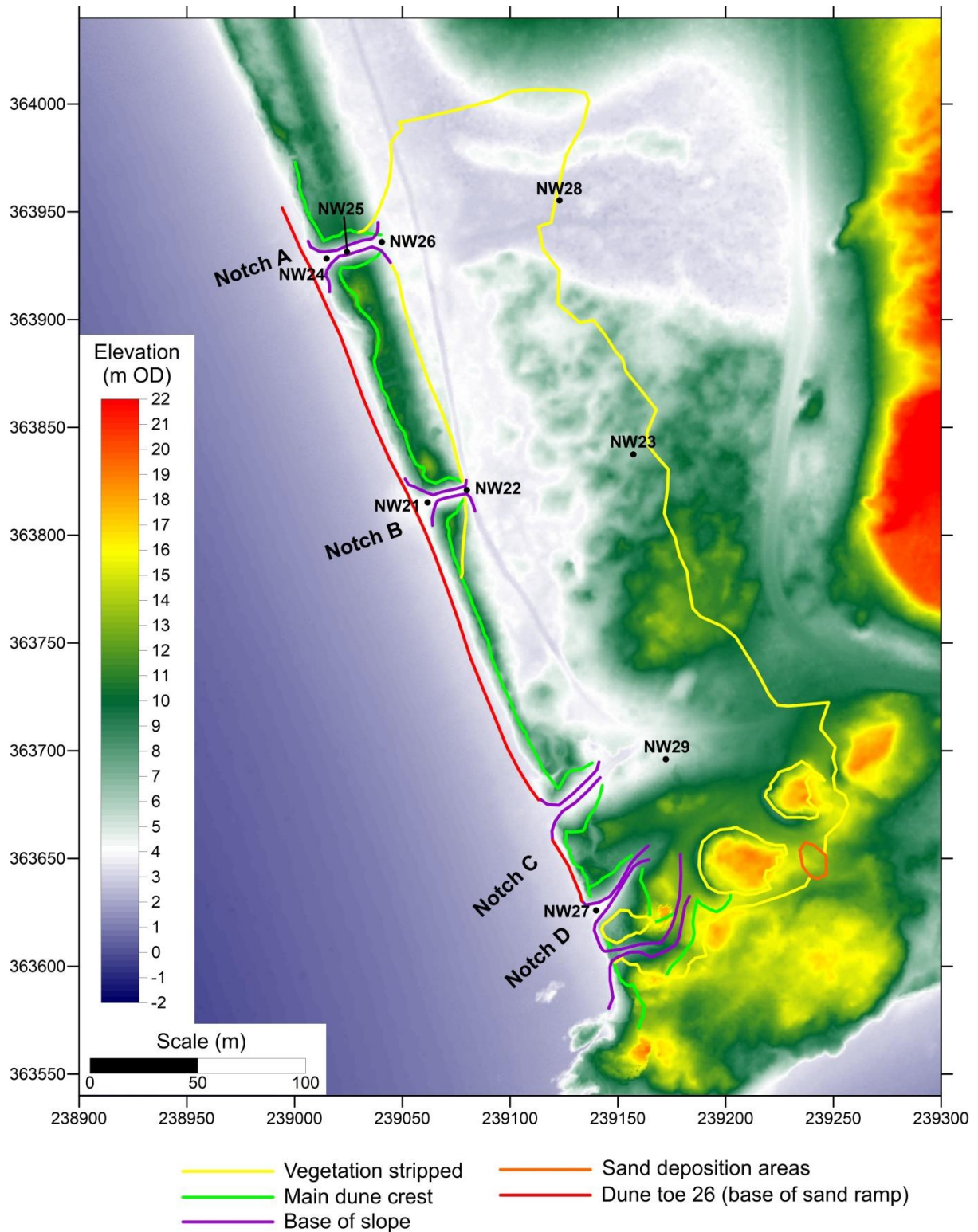


Figure 4. Locations of sediment samples collected in the Zone 1 West area, overlaid on LiDAR DEM flown on 9 April 2014, with features mapped from Figure 4.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

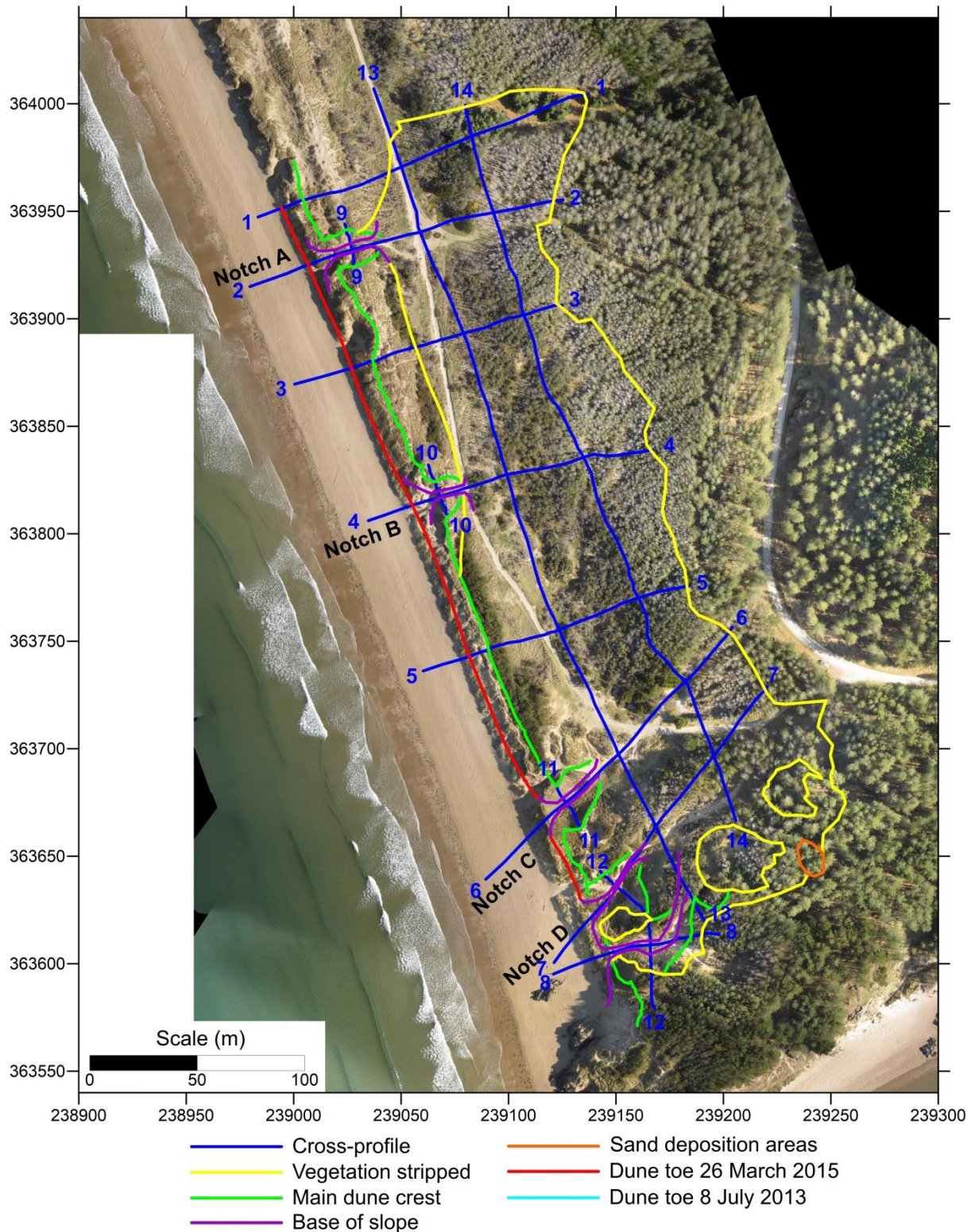


Figure 5. Locations of March 2015 data points (black dots) and cross-profiles (dark blue lines) in Zone 1 West, overlaid on June 2013 aerial photographs. The limit of vegetation stripping, areas of sand deposition (usually as sacrificial sand heaps), the main dune crests, base of slopes and positions of the dune toe (taken as the base of the sand ramp) surveyed in March 2015 are also shown. For comparison, the position of the dune toe from the July 2013 survey is also shown.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

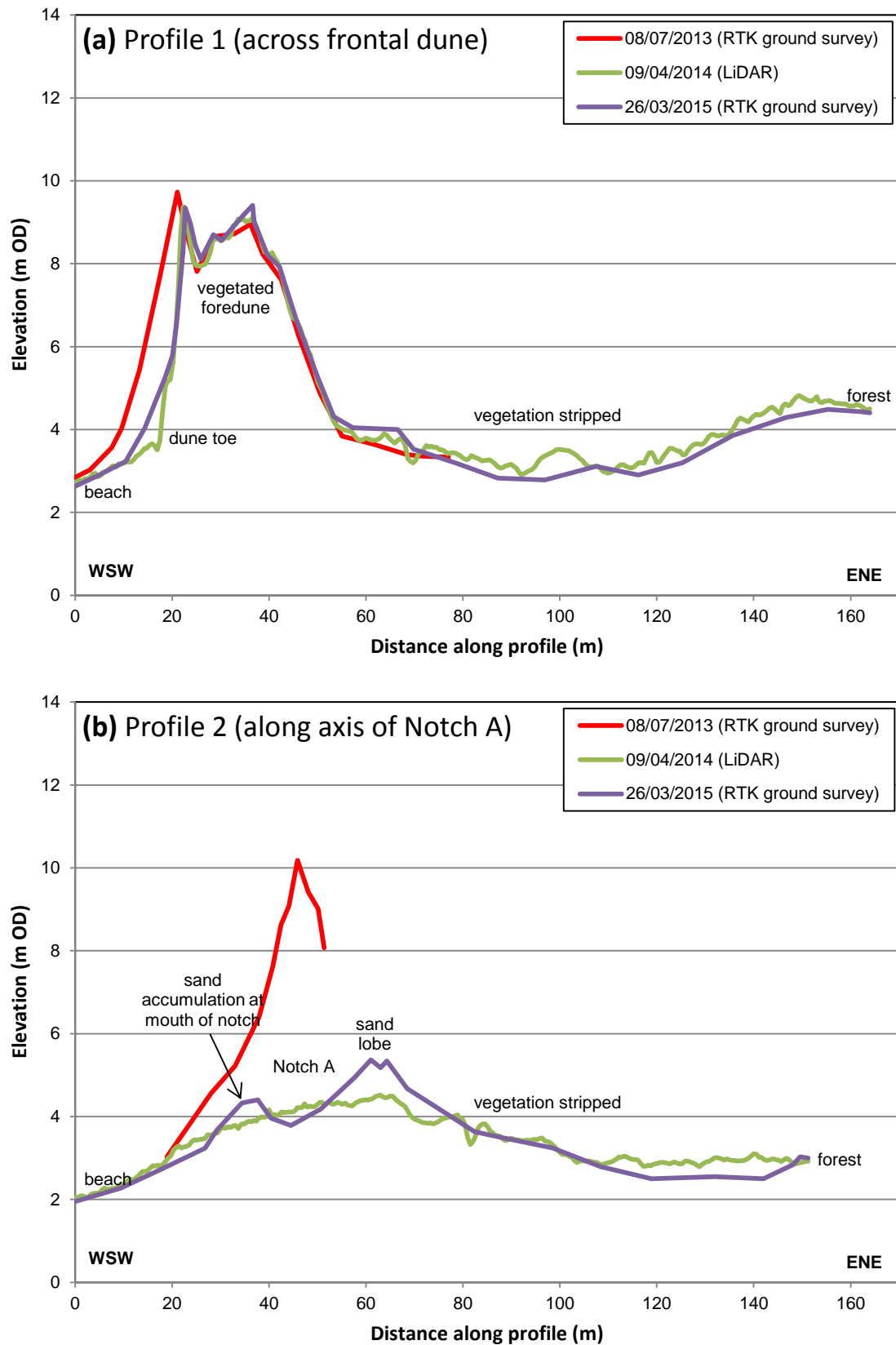


Figure 6. Comparison of surface levels at profiles 1 and 2, indicated by RTK ground survey on 08/07/2013 (pre-works), LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

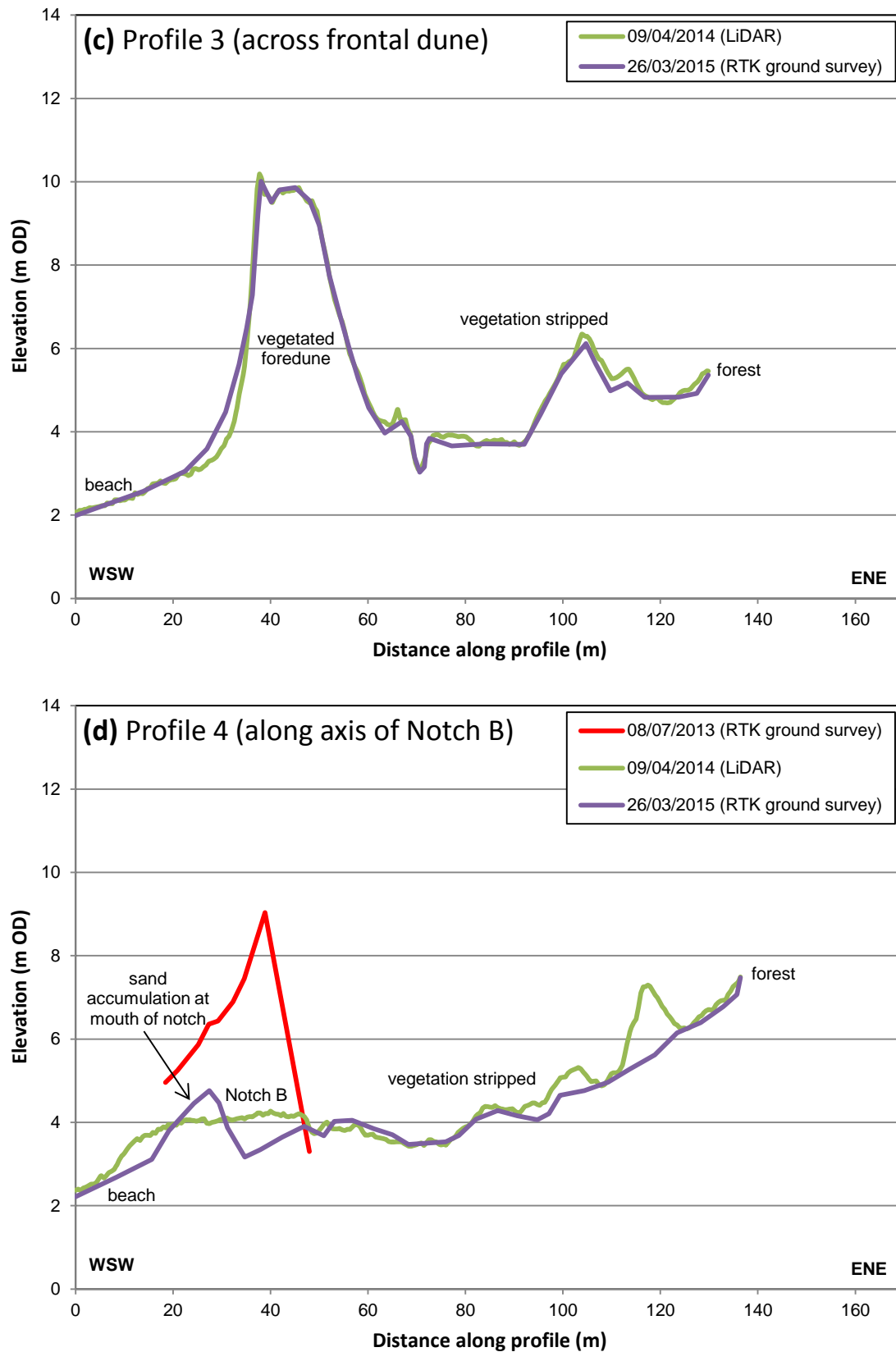


Figure 6 (continued). Comparison of surface levels at profiles 3 and 4, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015. Profile 4 was also surveyed before the works during a RTK ground survey on 08/07/2013, and this is also shown.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

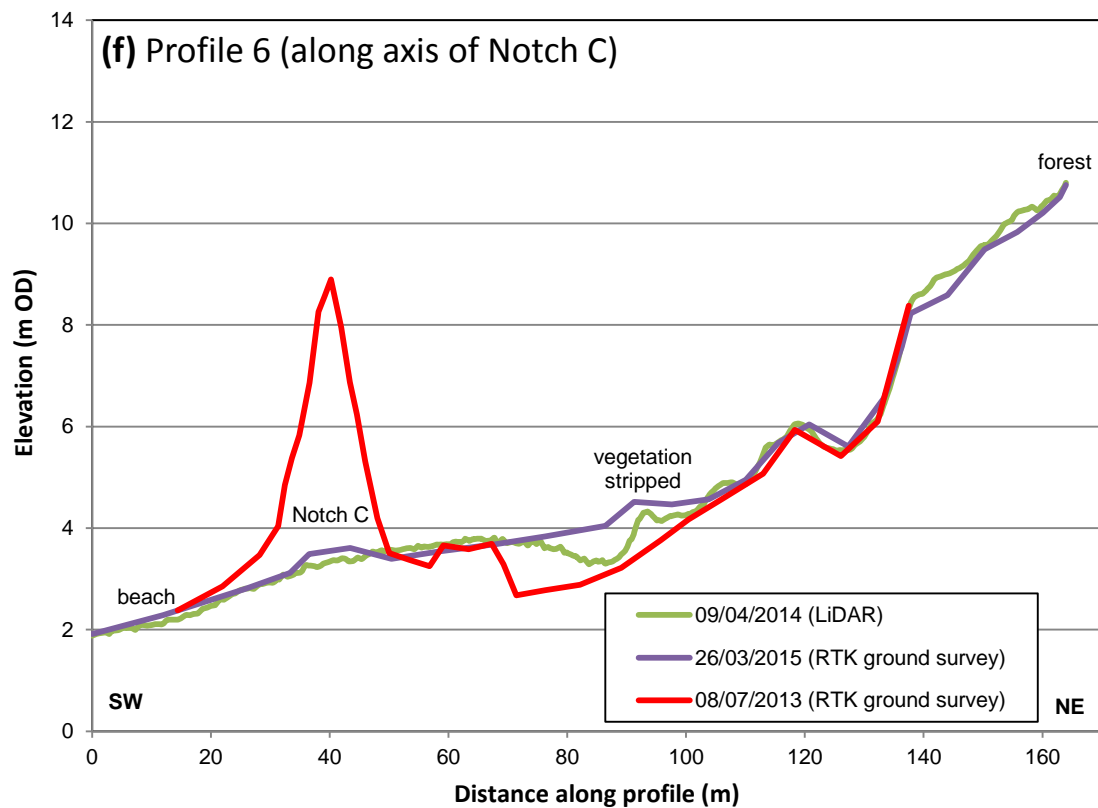
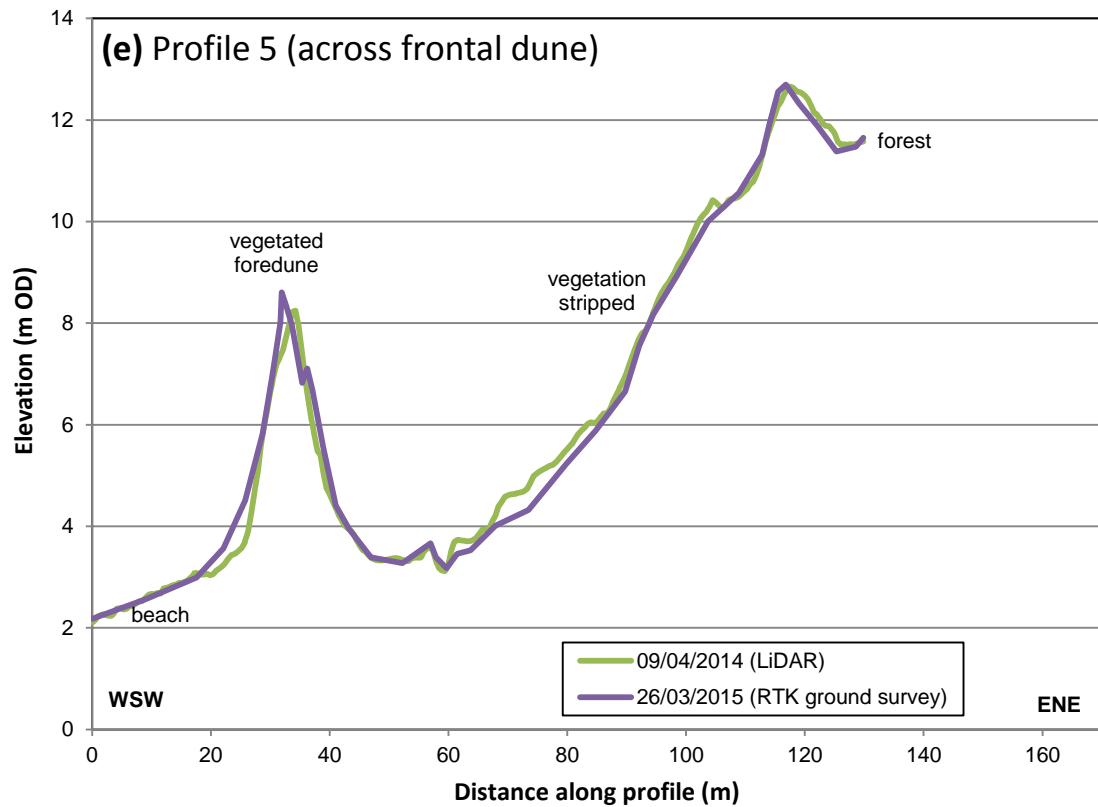


Figure 6 (continued). Comparison of surface levels at profiles 5 and 6, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015. Profile 6 was also surveyed before the works during a RTK ground survey on 08/07/2013, and this is also shown.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

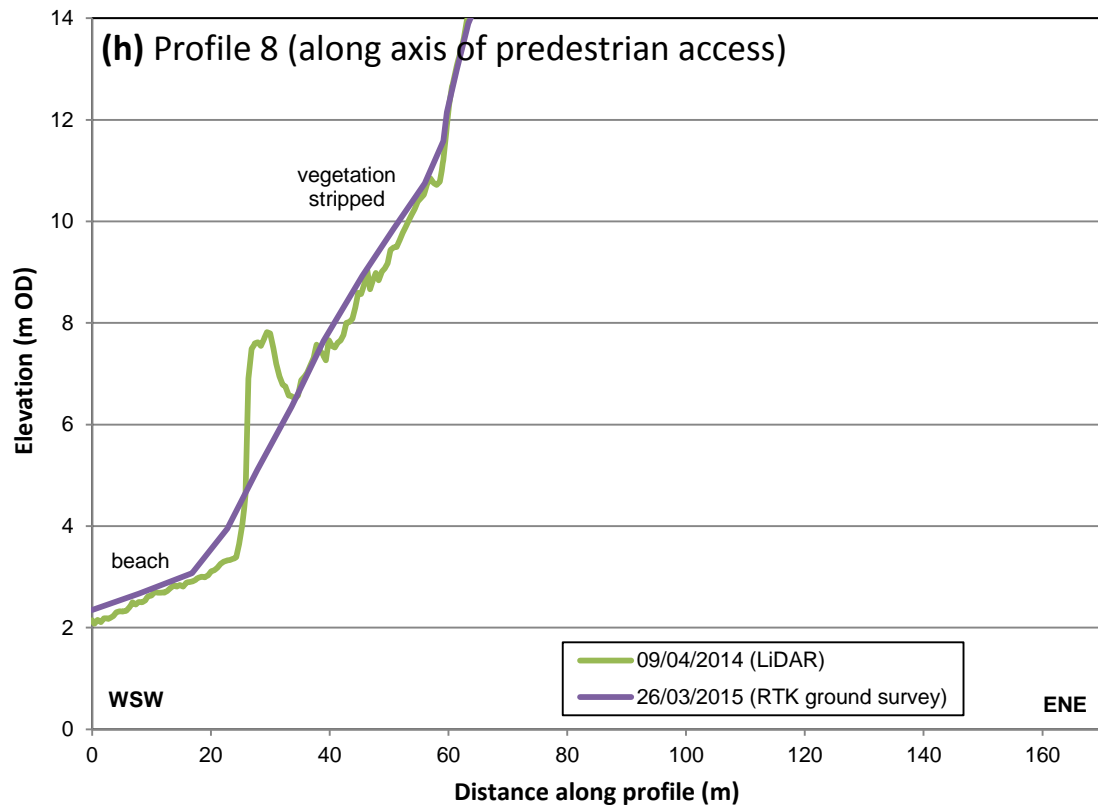
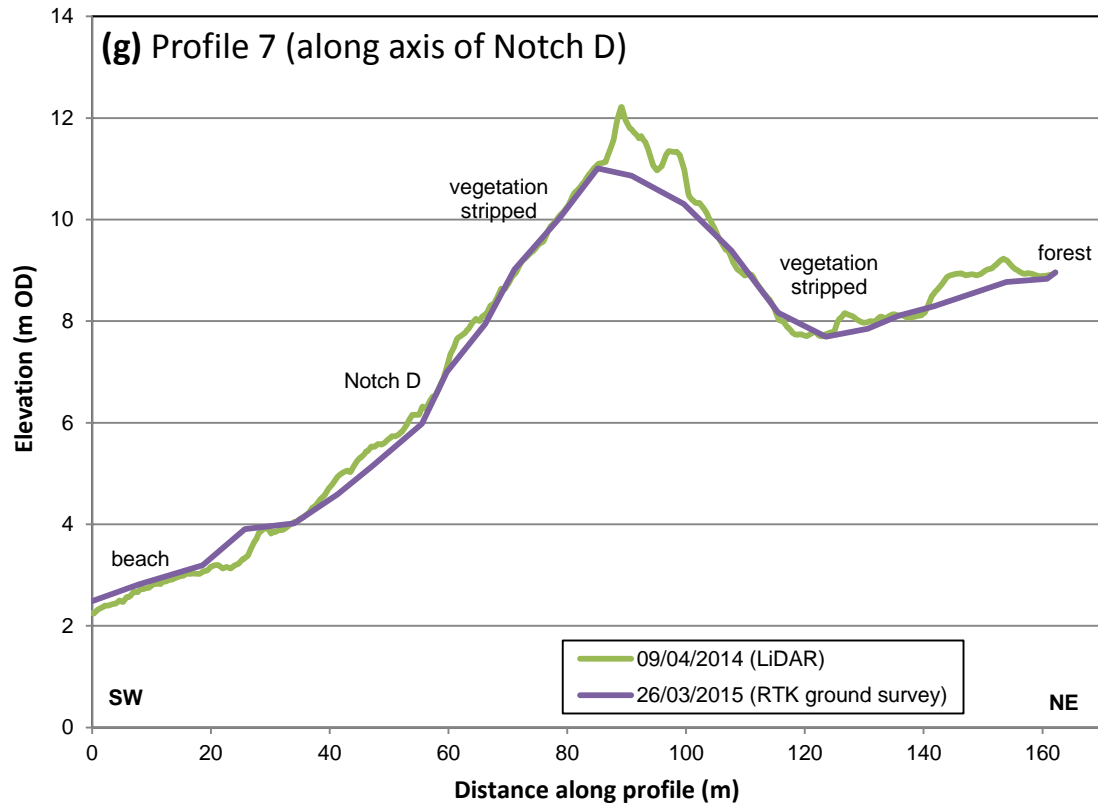


Figure 6 (continued). Comparison of surface levels at profiles 7 and 8, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

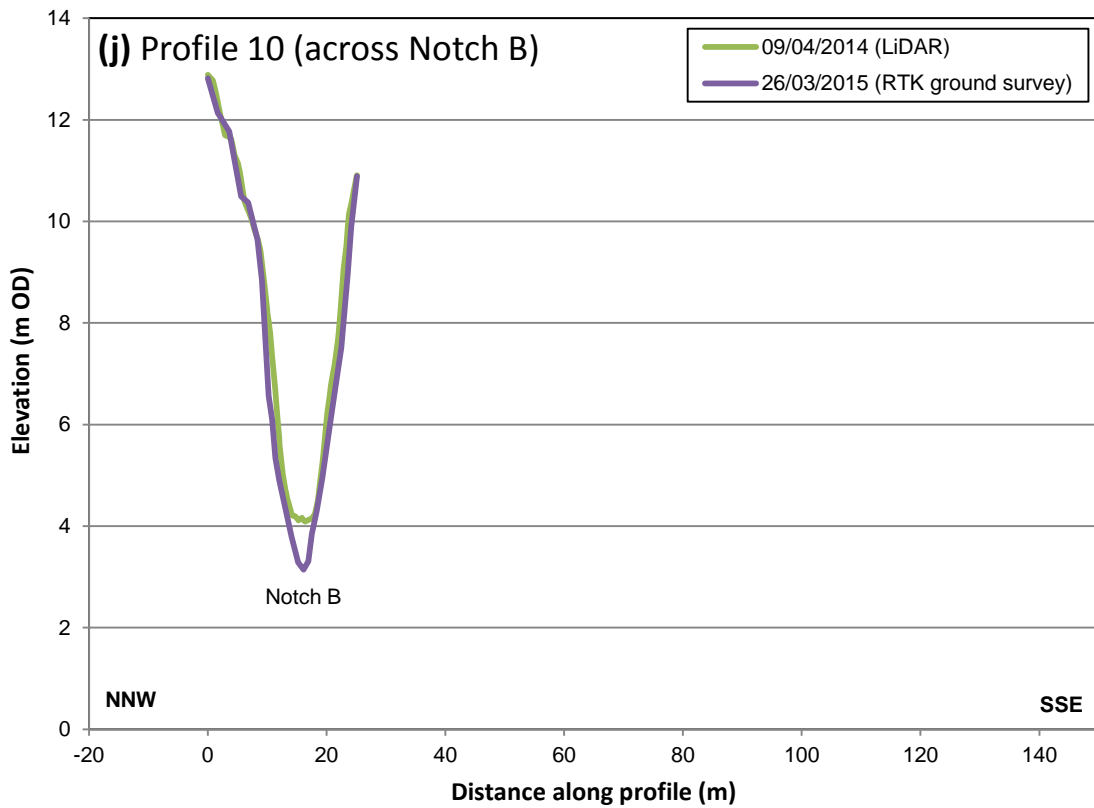
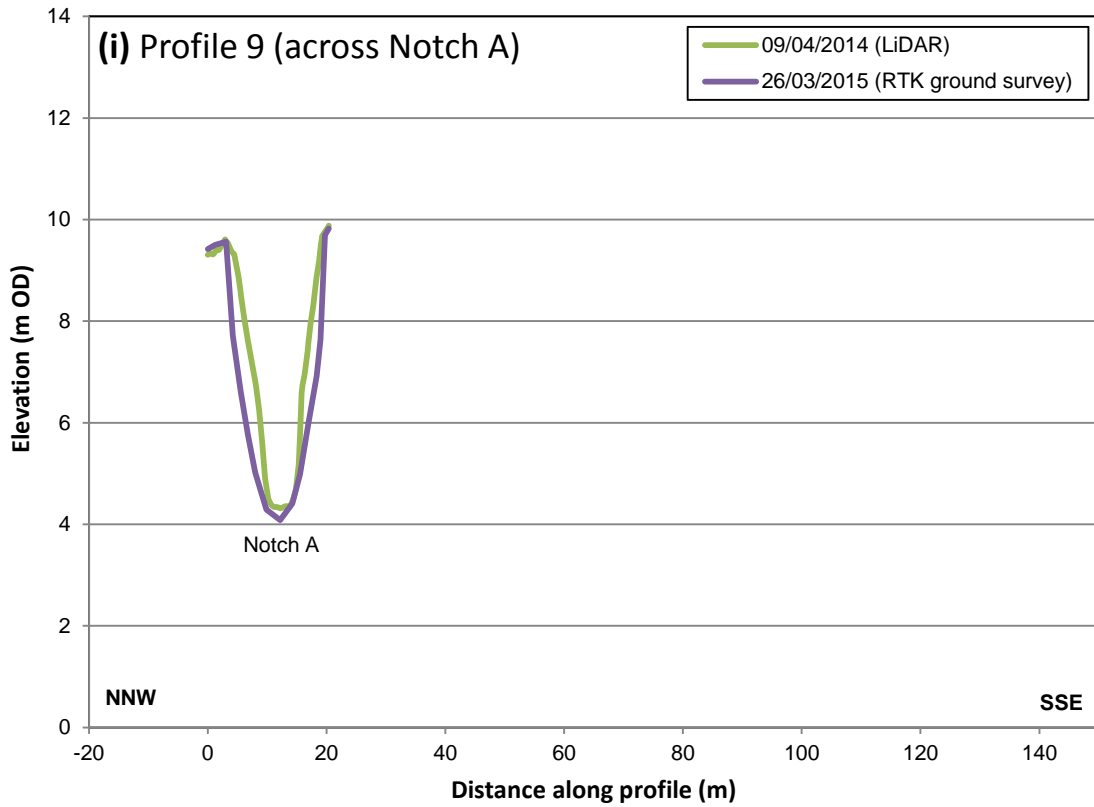


Figure 6 (continued). Comparison of surface levels at profiles 9 and 10, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

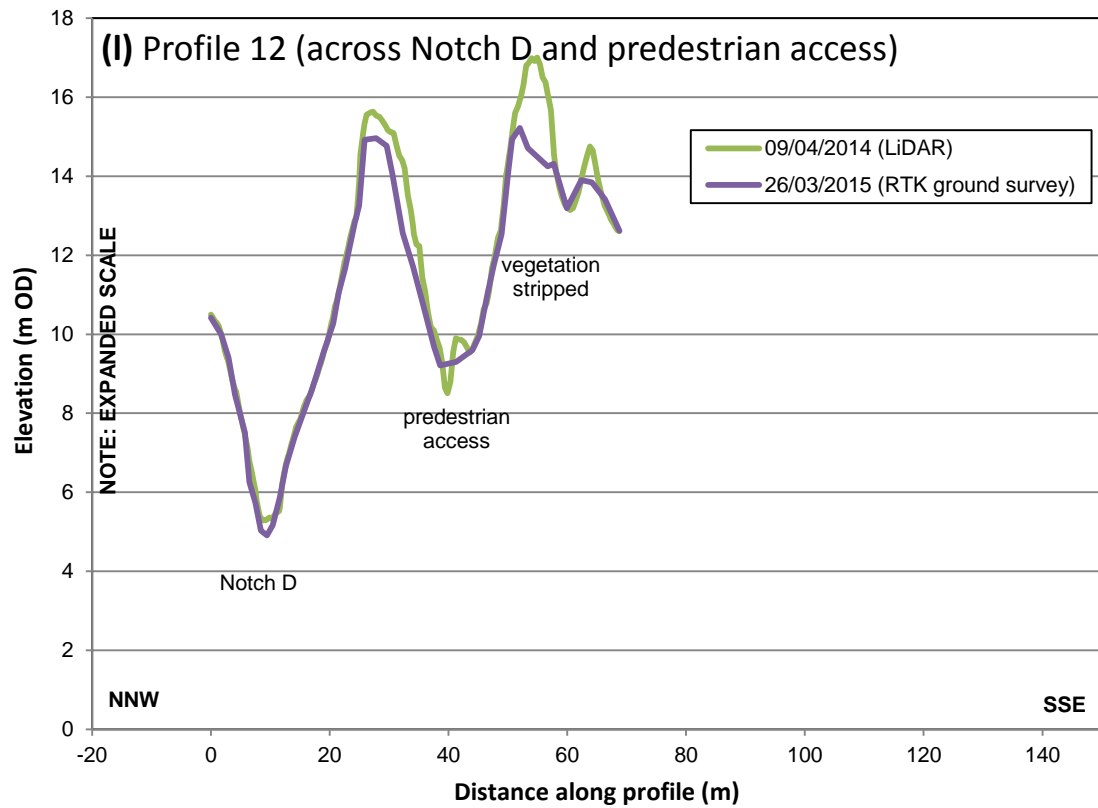
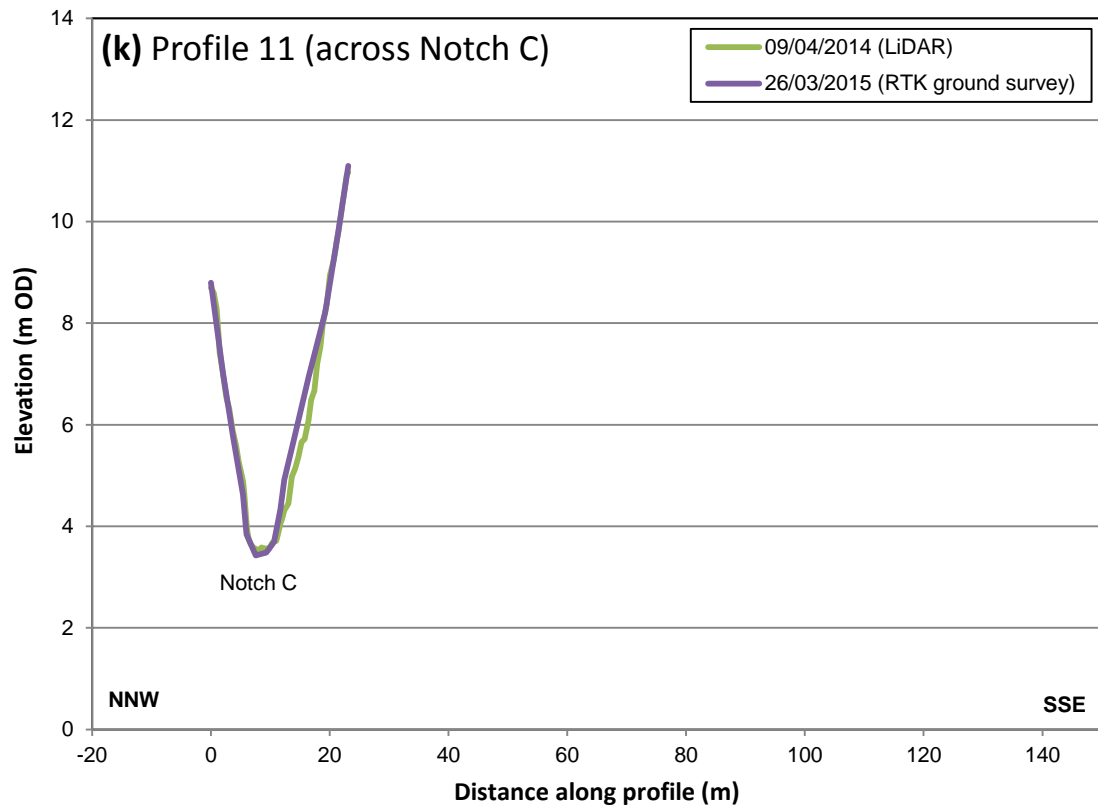


Figure 6 (continued). Comparison of surface levels at profiles 11 and 12, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015

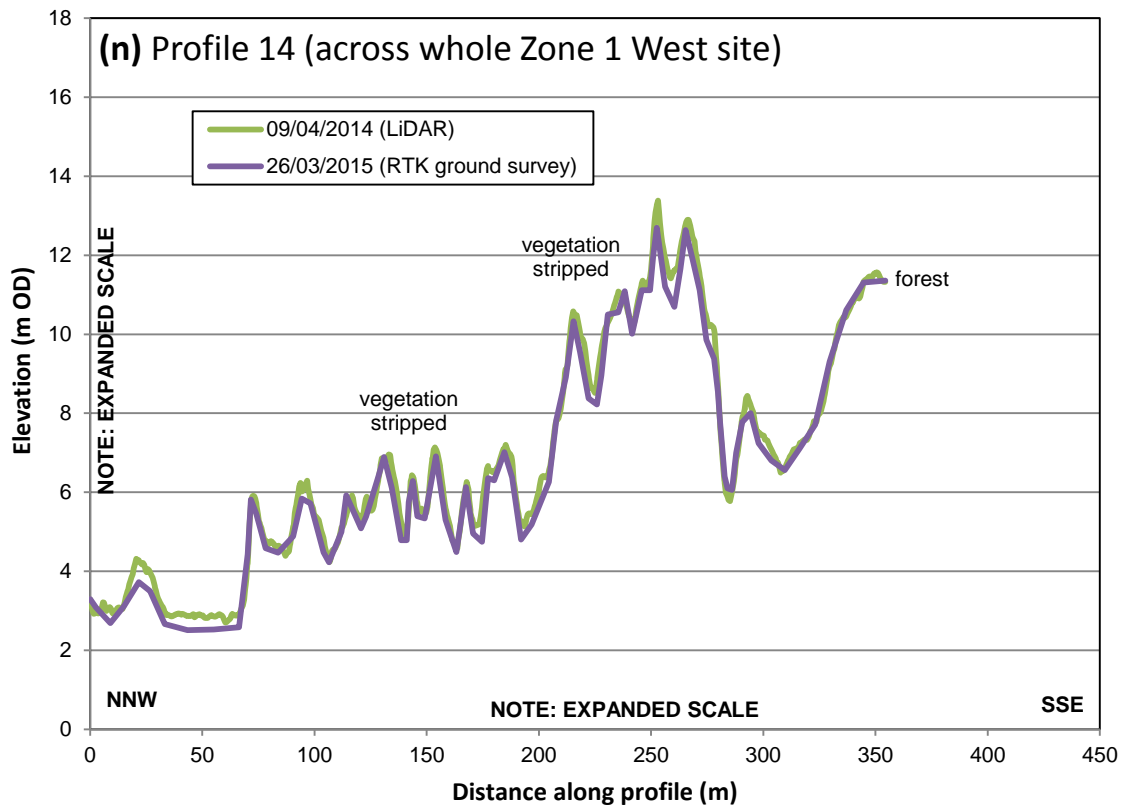
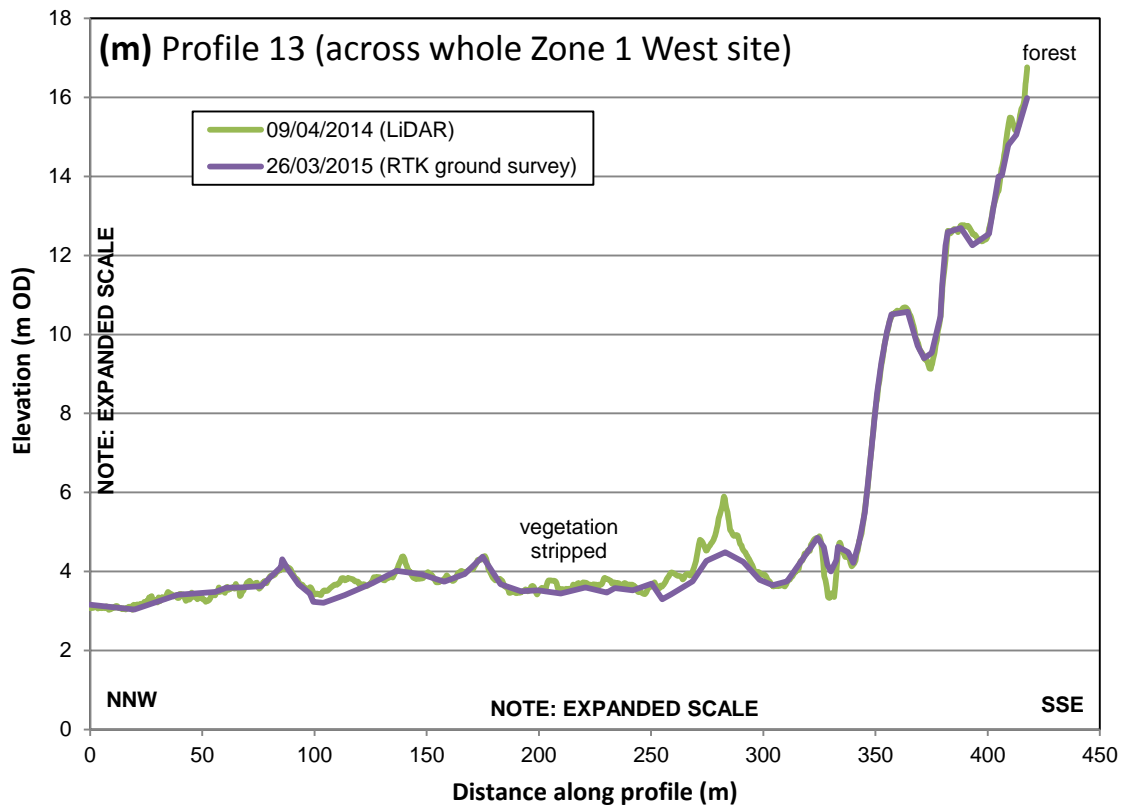


Figure 6 (continued). Comparison of surface levels at profiles 13 and 14, indicated by LiDAR survey on 9 April 2014 (after the notches had been made), and RTK ground survey on 26 March 2015.

10. Field photographs

Taken 26 March 2015

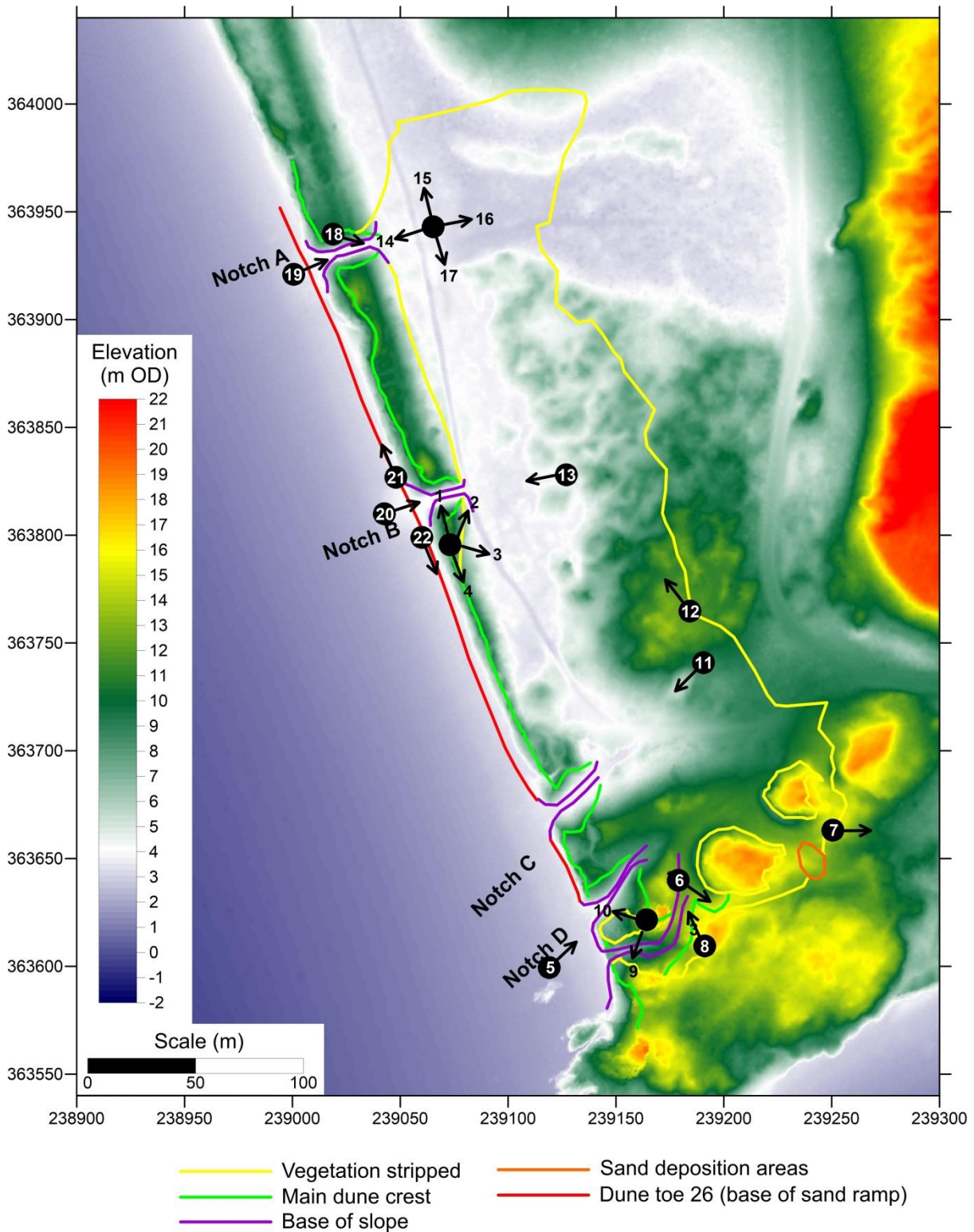


Figure A1. Locations of field photographs 1 to 22 in Zone 1 West. Arrows indicate direction of view; overlaid on 9 April 2014 LiDAR DEM

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 1. View across Notch B from the base station, looking NNW



Photograph 2. View across vegetation-stripped area from the base station, looking NNE

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 3. View across vegetation-stripped area from the base station, looking ESE



Photograph 4. View along frontal dune towards Notch C, looking SSE

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 5. View along the axis of Notch D, looking NE



Photograph 6. Sand scour around the base of rock outcrop, looking SE

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 7. Sand blowing into the forest, looking E



Photograph 8. View across vegetation-stripped area of Zone 1 West, looking NNW

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 9. View across notch caused by pedestrian access, looking SSW



Photograph 10. View across Notch D, looking SSW

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 11. View seawards over blowout along axis of Notch C, looking SSW



Photograph 12. View along treeline behind Notch C, looking NNW

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 13. View seawards towards Notch B, looking NNW



Photograph 14. View seawards along axis of Notch A, looking NNW

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 15. View along track behind Notch A, looking NNW



Photograph 16. View inland behind Notch A, looking WNW

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 17. View across vegetation-stripped area behind Notch A, looking SSE



Photograph 18. View inland across Notch A, looking ESE

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 19. View inland along axis of Notch A, looking ESE



Photograph 20. View inland along axis of Notch B, looking ESE

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 West) Topographic Survey, March 2015



Photograph 21. View along frontal dune toe and sand ramp at the top of the beach, looking NNW



Photograph 22. View along frontal dune toe and sand ramp at the top of the beach, looking SSE

Data Archive Appendix

Data outputs associated with this project are archived at 'Topographical Survey of Newborough Dune Rejuvenation project 421, media 1535' on server-based storage at Natural Resources Wales.

The data archive contains:

- [A] The final report in Microsoft Word and Adobe PDF formats.
- [B] An Excel file named (Newborough Warren Survey Data 25-27 March 2015.xlsx) of data points (x,y,z)
- [C] A zip file named (Newborough March 2015 profiles.zip) containing excel files of profile data contained within the report.
- [D] A zip file named (Newborough March 2015 Zone 1 West shapefiles.zip) containing a series of GIS layers on which the maps in the report are based.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <http://libcat.naturalresources.wales/webview/> (English Version) and <http://libcat.naturalresources.wales/cnc/> (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no [115840]

DO NOT DELETE THE SECTION BREAK BELOW



**Cyfoeth
Naturiol**
Cymru
**Natural
Resources**
Wales

Published by: Natural Resources Wales
Maes y Ffynnon
Penrhosgarnedd
Bangor
LL57 2DW

0300 065 3000

© Natural Resources Wales [2015]

All rights reserved. This document may be reproduced with prior permission of
Natural Resources Wales

Further copies of this report are available from the library

Email: library@cyfoethnaturiolcymru.gov.uk