



**Cell 1 Regional Coastal Monitoring Programme
Update Report 4: 'Partial Measures' Survey 2012**



**Sunderland City Council
Final Report**

February 2013

Contents

Disclaimer	i
Abbreviations and Acronyms	ii
Water Levels Used in Interpretation of Changes	ii
Glossary of Terms.....	iii
Preamble.....	iv
1. Introduction.....	1
1.1 Study Area	1
1.2 Methodology.....	1
2. Analysis of Survey Data.....	5
2.1 Whitburn Bay.....	5
2.2 Hendon to Ryhope (incl. Halliwell Banks)	7
3. Problems Encountered and Uncertainty in Analysis.....	11
4. Recommendations for 'Fine-tuning' the Monitoring Programme	11
5. Conclusions and Areas of Concern	11

Appendices

Appendix A	Beach Profiles
Appendix B	Cliff Top Survey

List of Figures

Figure 1	Sediment Cells in England and Wales
Figure 2	Survey Locations

List of Tables

Table 1	Analytical, Update and Overview Reports Produced to Date
Table 2	Sub-division of the Cell 1 Coastline

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition
AONB	Area of Outstanding Natural Beauty
DGM	Digital Ground Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
m	metres
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	Souter Point to Chourdon Point
HAT	3.18
MHWS	2.48
MLWS	-1.92

Source: *River Tyne to Flamborough Head Shoreline Management Plan 2.*
Royal Haskoning, February 2007.

Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1).

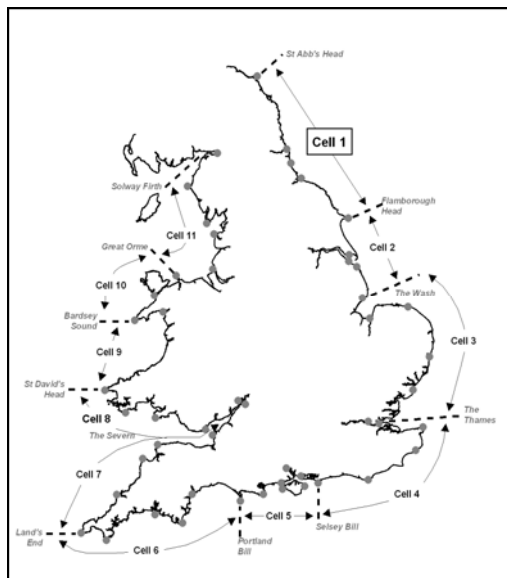


Figure 1 Sediment Cells in England and Wales

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

The beach profile surveys, topographic surveys and cliff top recession surveys are undertaken as a 'Full Measures' survey in autumn/early winter every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sept-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Feb 13 (*)	

(*) The present report is **Update Report 4** and provides an analysis of the 2012 Partial Measures survey for Sunderland Council's frontage.

1. Introduction

1.1 Study Area

Sunderland City Council's frontage extends from The Bents to Ryhope. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into three areas, namely:

- Whitburn Bay
- Sunderland Harbour and Docks
- Hendon to Ryhope (including Halliwell Banks)

1.2 Methodology

Along Sunderland City Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 58 transect lines (commenced 2009)
 - Topographic survey at Whitburn Bay (commenced 2010)
 - Topographic survey at Hendon to Ryhope (including Halliwell Banks) (commenced 2009)
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 16 transect lines (commenced 2009)
- Cliff top survey bi-annually at:
 - Hendon to Ryhope (including Halliwell Banks) (commenced 2009)

The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage on the 20th March 2012 (Whitburn Bay) and between 20th March 2012 and 21st March 2012 (Hendon to Ryhope (incl. Halliwell Banks)). During this time weather conditions varied considerably. Refer to the survey reports for details of the weather conditions over this survey period.

The Update Report presents the following:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.



KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Figure 2- Map 1
Survey Locations
Whitburn Bay
Sunderland City Council**

Update Report 4
Partial Measures Survey
Spring 2012



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www.northeastcoastalobservatory.org.uk



KEY

Topographic Profiles
 — Annual
 — 6 monthly

Topographic Surveys
 [Green Hatched] 6 monthly
 [Yellow Hatched] yearly
 [Red Hatched] 5 yearly

Cliff Top Monitoring Pegs
 [Purple] 50m centres
 [Green] 100m centres
 [Red] 300m centres
(Indicative Survey Extents shown)

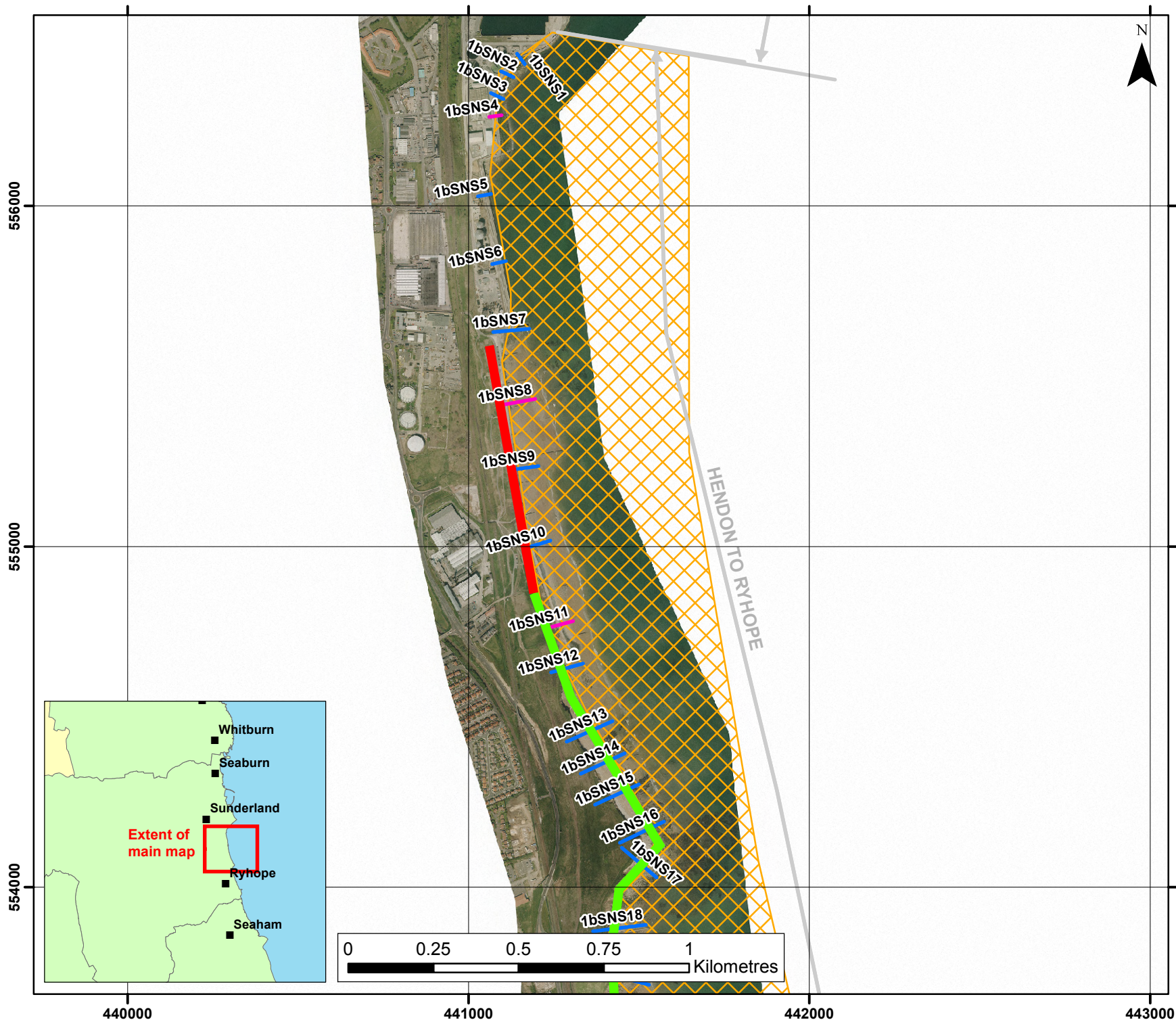
Client: North East Coastal Group
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Figure 2- Map 2
 Survey Locations
 Sunderland Harbour
 and Docks
 Sunderland City Council**

Update Report 4
 Partial Measures Survey
 Spring 2012

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KEY

Topographic Profiles
 — Annual
 — 6 monthly

Topographic Surveys
 [Green Hatched] 6 monthly
 [Orange Hatched] yearly
 [Brown Hatched] 5 yearly

Cliff Top Monitoring Pegs
 [Purple] 50m centres
 [Green] 100m centres
 [Red] 300m centres
(Indicative Survey Extents shown)

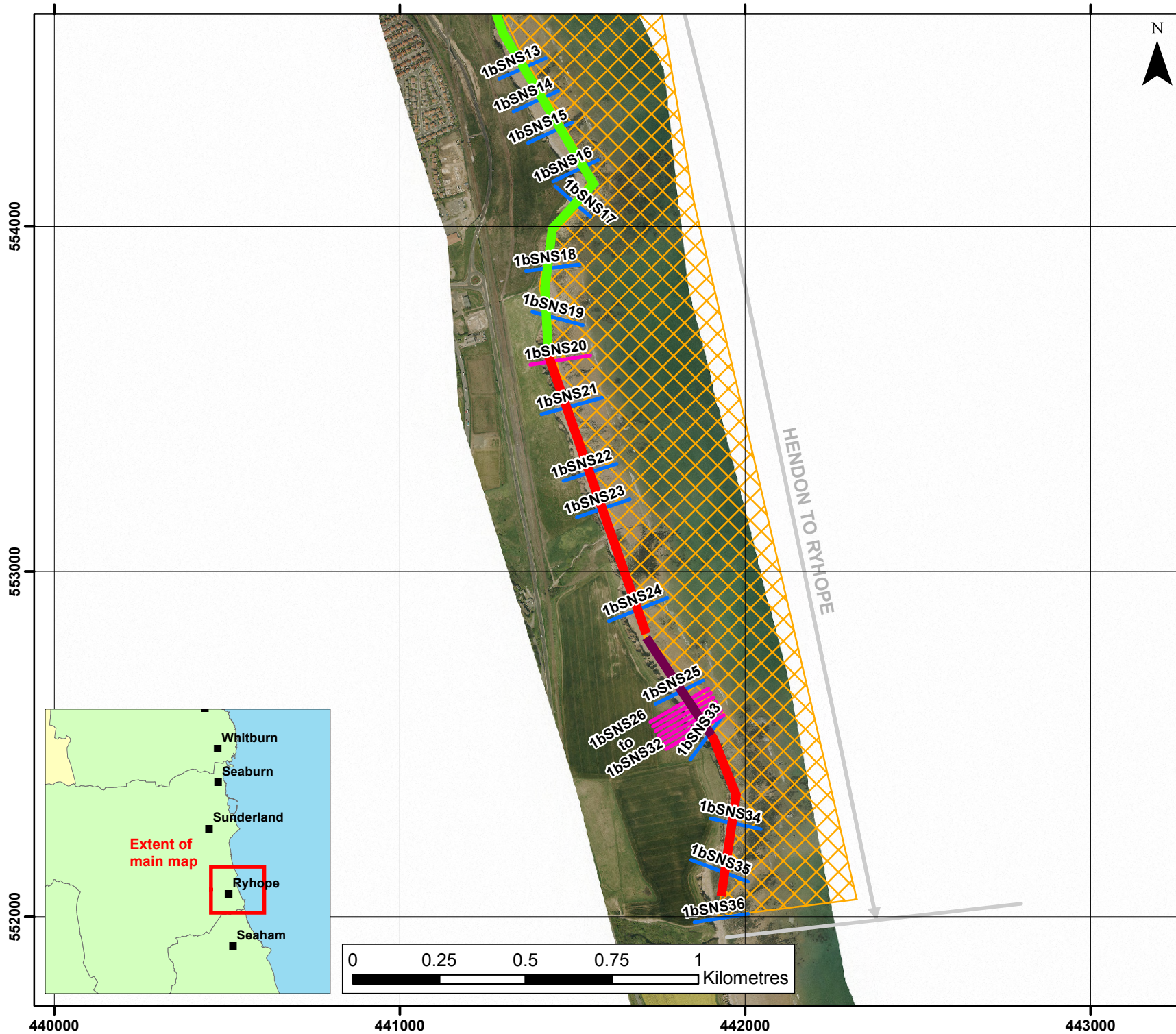
Client: North East Coastal Group
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**Figure 2- Map 3
 Survey Locations
 Hendon to Ryhope North
 Sunderland City Council**

Update Report 4
 Partial Measures Survey
 Spring 2012

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KEY

Topographic Profiles
 — Annual
 — 6 monthly

Topographic Surveys
 [Green cross-hatch] 6 monthly
 [Yellow cross-hatch] yearly
 [Purple cross-hatch] 5 yearly

Cliff Top Monitoring Pegs
 [Purple line] 50m centres
 [Green line] 100m centres
 [Red line] 300m centres
(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2- Map 4
Survey Locations
Hendon to Ryhope South
Sunderland City Council

Update Report 4
 Partial Measures Survey
 Spring 2012

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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Mar 2011	<p>Beach Profiles:</p> <p>Whitburn Bay is covered by three beach profile lines for the Partial Measures survey (Appendix A). The last survey was full measures, undertaken in winter 2011.</p> <p>1bSNN1 is just to the south of Sunderland City Council's northerly boundary of jurisdiction. Since the last profile, beach levels at HAT (between 3.6m and 2.8m) have increased by 0.2m. The beach profile seaward of MHWS has retreated by 5m to 10m, however, the beach has retained the same form and gradient as in winter 2011. This suggests some cross-shore movement of material to the upper beach around HAT, which is likely to be due to higher water levels and waves from winter storms. The lower beach (i.e. seaward of a height of 1m / chainage 90m), with the exception of spring 2011 (partial measures) is similar to the profile observed in previous surveys.</p> <p>1bSNN7 is at Seaburn, just to the north of Parson's Rock. Since the last survey, beach levels at the toe of the seawall have dropped up to 0.4m. Seaward of a chainage of approximately 20m, there has been little movement of the beach levels. A drop in levels at the toe of the seawall would be expected over the winter in response to higher water levels and waves from winter storms.</p> <p>1bSNN10 is located approximately mid-way between Parson's Rock and Roker Pier. Since the last survey, beach levels at the toe of the seawall, from HAT to MHWS have increased by up to 0.2m. The survey photograph (see Plate 1) shows the accumulation of sand at the toe of the seawall and on the slipway. The sand is dry and looks to be blown by wind up the slipway. Between a level of 2.0m and -2.0m (chainage 35m and 130m respectively), beach levels have increased by 0.2m. Seaward of -0.2m (chainage 130m), they have increased by approximately 0.1m.</p>	<p>Since the last survey, the beach profiles in Whitburn Bay are showing signs of upper beach accretion and erosion across the middle and lower beach. This behaviour is to be expected over the winter months as some material is moved up the beach to form a berm, whilst other material is drawn down from the beach by storm water levels and waves.</p> <p>Longer term trends: The levels on the upper beach from the full measures (winter 2011) and the present partial measures surveys (spring 2012) are generally the highest observed to date. The partial measures survey for spring 2010 shows that beach levels experienced a significant reduction. Profiles 1bSNN1 and 1bSNN7 have been increasing since then, but experienced a slight reduction since the last survey. The upper beach at 1bSNN10 has continued to accrete since the last survey. This profile is located to the south of the bay and likely to be fed with material supplied from up-drift. The observed wind blown sand suggests that the beach is drying out and material is entrained from the foreshore and then trapped and deposited within the lee of the headland/ seawall/ slipway complex (seen in the photo in Plate 1).</p>



Plate 1 – Survey photograph 1bSNN10_20120320_N1.JPG

2.2 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
Mar 2011	<p>Beach Profiles:</p> <p>Hendon to Ryhope is covered by thirteen beach profile lines for the Partial Measures survey (Appendix A). The last survey was full measures, undertaken in winter 2011.</p> <p>Profile 1bSNS4 includes a seawall and rock revetment, after which it extends into water (refer to the survey photograph shown in Plate 2). Therefore it has not been analysed.</p> <p>Profile 1bSNS8 extends across the seawall, rock revetment, a rocky upper beach and sandy middle and lower beach. Since the last survey, beach levels at the toe of the rock revetment to a chainage of 65m, have increased by up to approximately 0.4m. These levels are similar to those observed at a similar time in the previous year (April 2011, partial measures, 2011). Seaward of 65m chainage, the short length of profile surveyed shows no change from the previous survey. Beach levels are similar to those last observed in October 2010 (full measures, winter 2010) and in March 2010 (partial measures, spring 2010). Between those surveys, the beach was higher, suggesting a fluctuation between seasons, whereby beach levels are higher during summer months and lower during winter months.</p> <p>Profile 1bSNS11 starts at the coastal slope/cliff backing the Hendon Sea Wall and extends across the wall and fronting rock armour before reaching sand levels and then extending down to low water. Compared to the last survey, beach levels at the toe of the rock revetment to a chainage of 72m have increased by up to approximately 0.2m. Between a chainage of 72m and 82m, beach levels remain the same. Seaward of 72m to 92m chainage, beach levels have fallen by approximately 0.2m. Beach levels are similar to those last observed in March 2010 (partial measures, spring 2010), which suggests that the beaches have recovered from a previous erosional period.</p> <p>Profile 1bSNS20 is located at Shirley Banks. Since the last survey, the top half of the cliff face appears to have advanced by approximately 0.5m-1m. The cliff has remained stable below this. This may be caused by survey interpretation or the cliffs tendency to heave seawards prior to toppling failure. Beach levels have changed across the foreshore to a chainage of 100m, but very minimally and variably, with some increase and some decrease. The beach here is mostly cobbles and rock with sand interspersed between. The largest increase is located further seaward, between a chainage if 100m and 120m,</p>	<p>Since the last survey, at Hendon (profiles 1bSNS8 and 1bSNS11) beach levels at the toe of the defences have increased. The remainder of the beach has generally remained stable.</p> <p>To the south, at Shirley Banks (south of Saltfern Rocks), the top half of the cliff face appears to have advanced, however, the bottom half of the cliffs have remained stable. The beaches have changed slightly, however, this change is similar to that observed for previous surveys.</p> <p>The cliffs at Halliwell Banks, between profiles 1bSNS25 and 1bSNS33 are eroding, which is evident by accumulation of debris at the cliff toe. Beach levels have largely stayed the same, however, between a level of 0m and 1m, beach levels have reduced by approximately 0.1m. This would be expected as sand is drawn down from the beach during from the beach by storm water levels and waves.</p> <p>Longer term trends: At Hendon, beach levels are similar to those last observed in October 2010 (full measures, winter 2010) and in March 2010 (partial measures, spring 2010), however, between those surveys, beach levels were higher. This suggests that beach levels fluctuate between seasons, being her in the summer months and lower in the winter months.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>where the beach is mostly sand. Here beach levels have increased by approximately 0.5m. This change is very similar to that observed for previous surveys.</p> <p>Profile 1bSNS25 is located at Halliwell Banks. Since the last survey, the cliff face has retained the same form and position since the last survey. Beach levels have increased slightly across most of the profile by up to 0.2m, with the exception to a level of between 0m and 1m where they have reduced. The survey photograph (see Plate 3) shows the accumulation of shingle at the toe of the cliff and across the upper beach.</p> <p>Profiles 1bSNS26 to 1bSNS33 are all located at close spacings at Halliwell Banks specifically to assess risks from erosion at a former land fill. Cliff height is characteristically around 26m and 27mODN, with beaches at the toe typically at levels between 3.3m and 3.9mODN.</p> <p>At Profiles 1bSNS26, 1bSNS28, 1bSNS30 and 1bSNS32, the cliff toe has moved seawards and beach levels at the cliff toe (around HAT/MHWS) have increased. At profile 1bSNS27, the cliff face at the top of the cliff appears to have moved seawards by about 0.5m. The survey report for Sunderland South notes that <i>'there are a number of cliff top and bottom slumps that are evident.'</i> As with the previous survey report, the changes observed for the cliffs could therefore relate to slumping of the toe of this cliff, the cliffs tendency to heave seawards prior to toppling failure, or it may be caused by survey interpretation. At profile 1bSNS29, the cliff toe has receded. At profile 1bSNS33, the cliff face has not changed in form or position since the last survey.</p> <p>At all profiles, from 1bSNS26 to 1bSNS33, beach levels have largely stayed the same since the last survey. There is noticeable trend, whereby at all profiles, between a level of 0m and 1m, beach levels have reduced by approximately 0.1m. This zone of the beach is comprised of sand, and is a well defined zone that is seawards of the upper shingle beach that has accumulated at the cliff toe. This is shown in the survey photograph for profile 1bSNS28 (see Plate 4).</p>	<p>At Shirley Banks, the cliffs have remained stable and beach levels have fluctuated, but overall remained largely stable.</p> <p>At Halliwell Banks, the cliffs have been subject to erosion. Material eroded from cliff top retreat has been deposited at the cliff toe. As the previous reports (full measures, winter 2010 and winter 2011), notes <i>'the cliffs along this frontage have a characteristic tendency to heave seawards prior to a toppling failure, leading to apparent discrepancies in the data where the cliff edge can appear to 'grow' seawards.'</i> This cliff behaviour may also result in health and safety issues for the survey team relating to the access under potentially unstable cliffs. Refer to additional data analysis of cliff top survey data below.</p> <p>Beach levels have fluctuated since the last survey (full measures, 2010), the sand portion of the beach between the shingle at the cliff toe and the shingle on the middle beach has been subject to erosion. However, over the longer term, present beach levels are the highest since those observed in March 2010.</p>
Oct 2011	<p>Cliff-top Survey:</p> <p>32 ground control points (numbered 1-32) were established along the cliff top between Hendon and Ryhope in March 2009, with a further three (28A, 28B and 28C) added in September 2009. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines and reference should be made to Appendix B - Map 1 and Appendix B – Map 2 for the location of ground</p>	<p>Since the last survey, the cliffs to the south of Sunderland Docks, at Hendon, opposite the works have eroded.</p> <p>To the south of there, Points 7 to 32 are recorded to have accreted, due to problems in identification of the cliff top where thick vegetation is present.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>control points.</p> <p>Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene.</p> <p>The results from the cliff top monitoring are anticipated to have an accuracy of $\pm 0.2\text{m}$ due to the technique used. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. Appendix B – Table B1 provides results from the March 2009 cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Also shown is the change in measurement since the original (March 2009) and previous (October 2011) cliff top surveys.</p> <p>Results show that erosion or an amount of movement greater than the survey error has occurred at 20 ground control points since surveys began in March 2009 (or September 2009 for 28A, 28B and 28C). Other locations have not changed, or erosion is within the error band.</p> <p>Since the last survey, the cliff at all but 5 points is recorded to be accreting. The 5 points are 1, 2, 4, 5 and 6 and are located to the south of Sunderland Docks, at Hendon, opposite the works. Erosion that is greater than the survey error occurred at points 1, 4 and 6 (0.8m, 0.3m and 0.4m respectively). Other locations have not changed, or erosion is within the error band.</p> <p>Points 7 to 32 are recorded to have accreted since the last survey. At 13 of these points accretion was greater than the expected survey error.</p>	<p>Longer term trends: The problems in identification of the cliff top due to growth of vegetation that make the short term change data unreliable tend to diminish over the long-term, and three zones of erosion are identified. Points 9 to 11 have long term erosion rates of between 0.5 and 1.3m/yr, points 19 to 21 have erosion of 0.7 to 1.3m/yr and points 24 to 32 have erosion of 0.4 to 1.9 m/yr. These erosion hotspots tend to be on stretches of coast that face towards the northeast, which is the dominant wave direction. Other stretches of coast, which typically have an eastwards or south eastwards aspect that are marginally more protected from the dominant wave direction, have remained stable.</p> <p>An additional assessment of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in Sept/Oct 2012 and a second repeat survey is planned for 2014. These data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report.</p>



Plate 2 – Survey photograph 1bSNS4_20120321_N2.jpg



Plate 3 – Survey photograph 1bSNS25_20120321_N4.JPG



Plate 4 – Survey photograph 1bSNS28_20120321_N4.JPG

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

Profile 1bSNS4 includes a seawall and rock revetment, after which it extends into water. Therefore it has not been analysed. It is uncertain why this profile has been surveyed, unless it is specifically to monitor changes to the rock revetment. If so, it is suggested that the method used to survey this profile is reviewed for suitability.

At profiles 1bSNS26 to 1bSNS32, the plotted profiles appear to show the cliff face to have accreted. This could be related to debris from cliff falls at the toe, slumping of the toe of this cliff, the cliffs tendency to heave seawards prior to toppling or survey interpretation (as described in Cliff Top Surveys below). Such cliff behaviour could bring about health and safety issues relating to the surveying of the cliff toe where the cliffs are unstable or overhanging, resulting in different interpretation of the survey locations.

Cliff Top Surveys

Surveying any cliff top is difficult due to: (i) the Health and Safety risks posed to surveyors, especially during adverse weather; and (ii) the apparent changes that can arise due to problems in interpretation of the cliff edge on successive surveys, especially where thick vegetation is present.

For these reasons, it has been assumed that any changes of $\pm 0.2\text{m}$ may be considered as being within the accuracy of the surveying technique. The widespread reporting of cliffs advancing by over 0.2m indicates vegetation growth on the cliff top and/or slumping of superficial sediments, has made precise identification of the cliff top extremely difficult.

In the short term, more reliable assessments of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in late 2012 and a second repeat survey is planned for 2014. These data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report

4. Recommendations for 'Fine-tuning' the Monitoring Programme

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Whitburn Bay, the recorded profiles present no causes for concern.
- At Hendon to Ryhope (incl. Halliwell Banks), the recorded profiles present no causes for concern. Consideration should be given to the continuation of the cliff top survey.

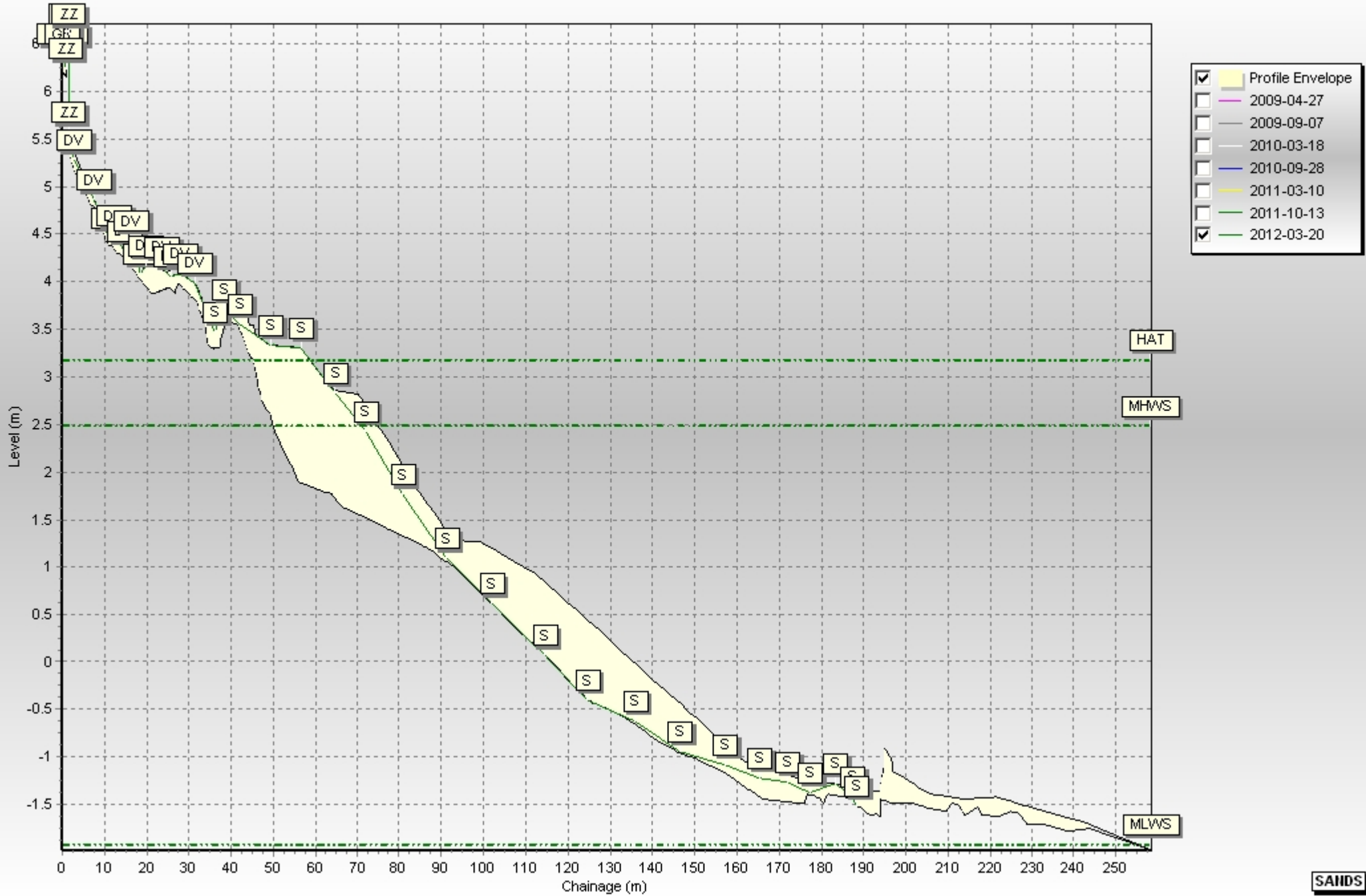
Appendices

Appendix A
Beach Profiles

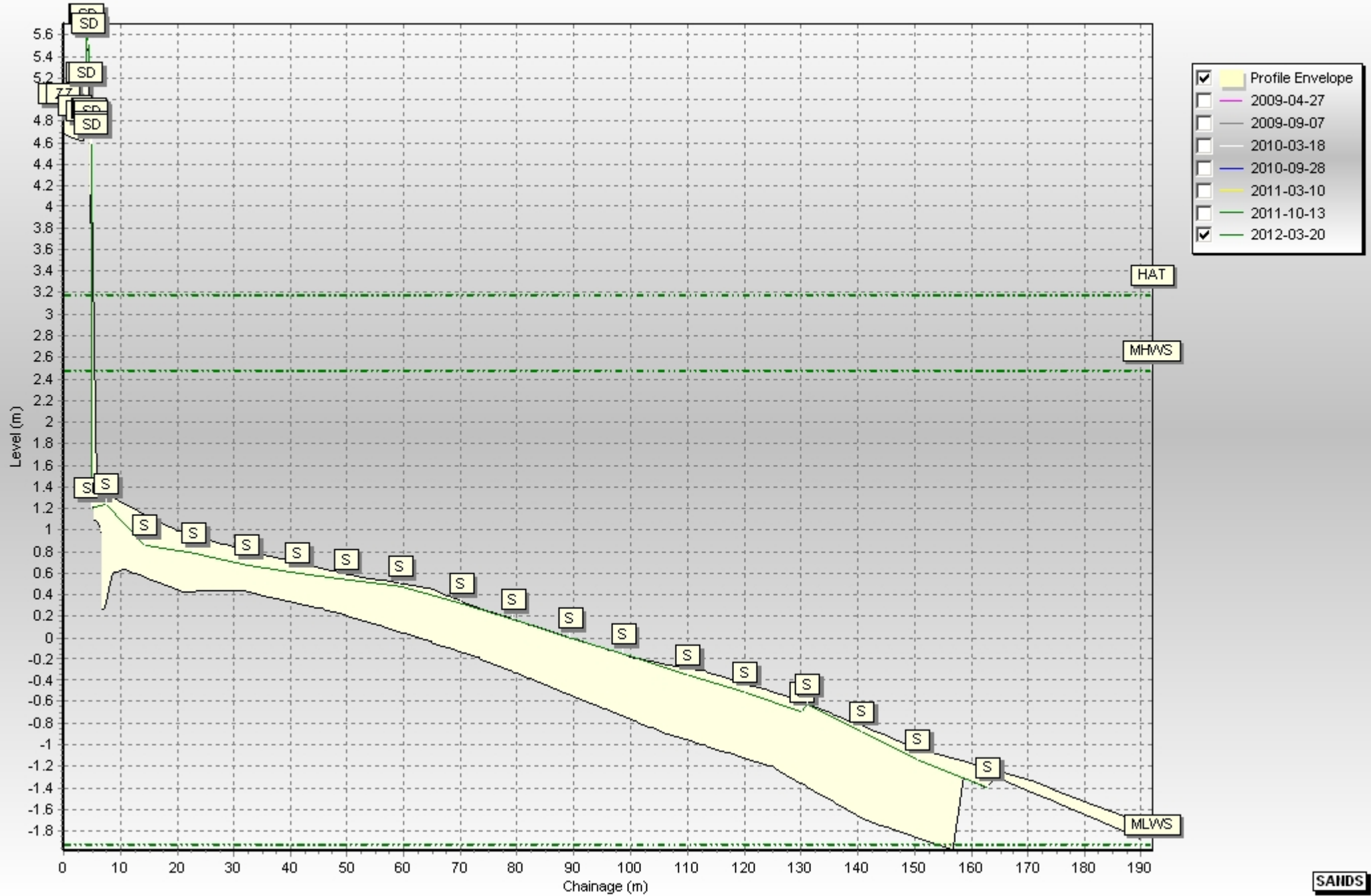
The following sediment feature codes are used on some profile plots:

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown

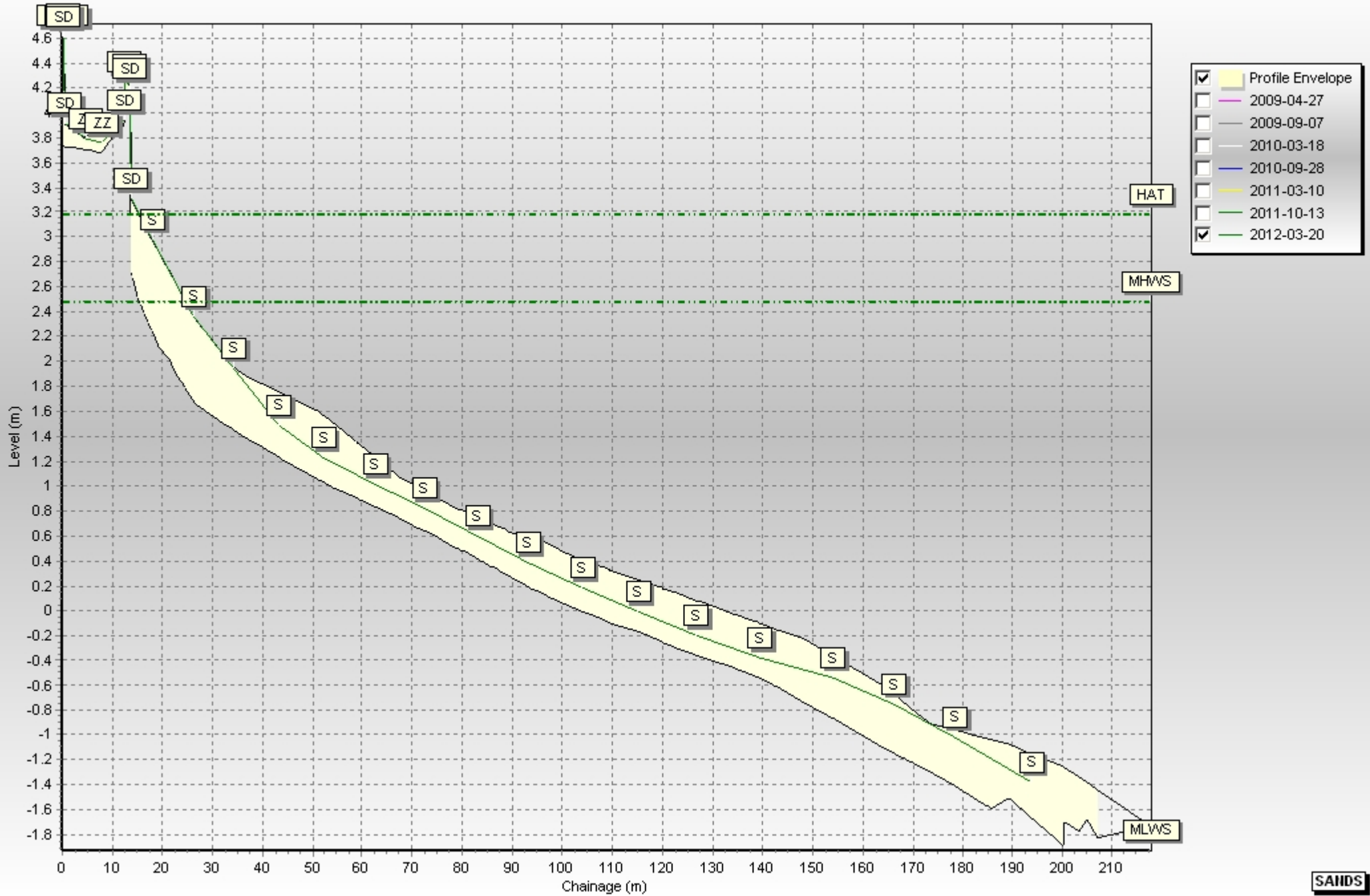
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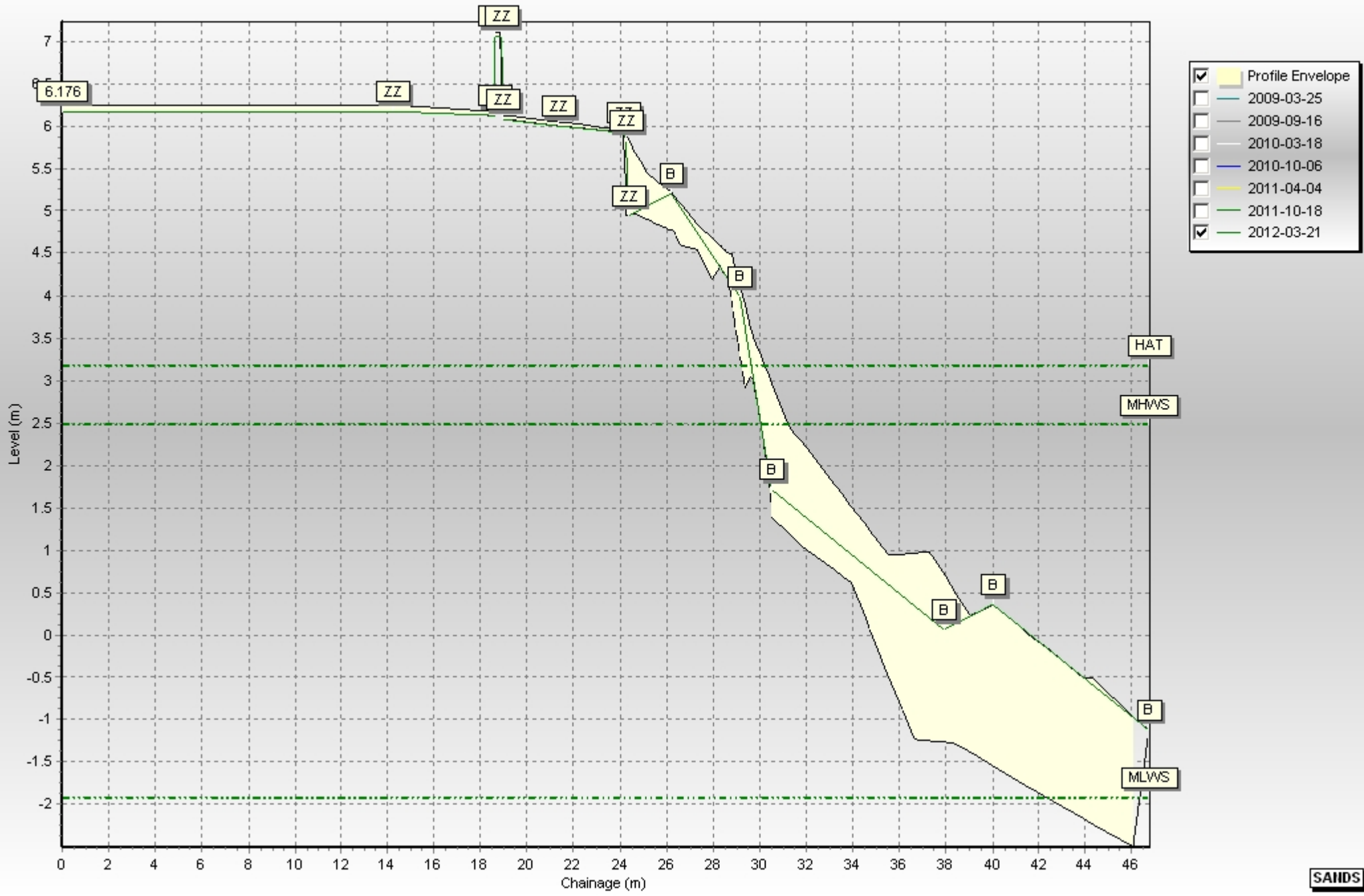
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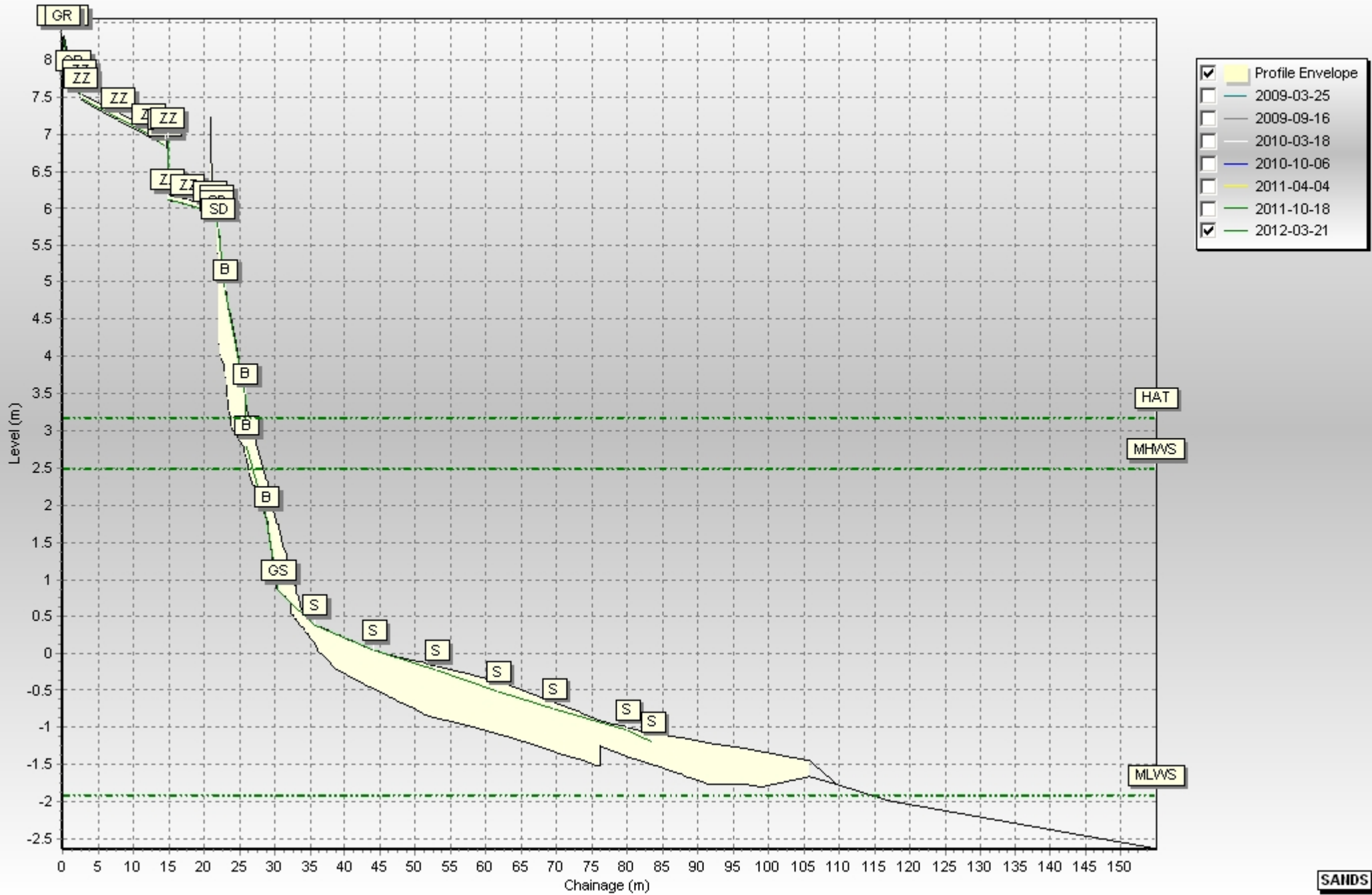
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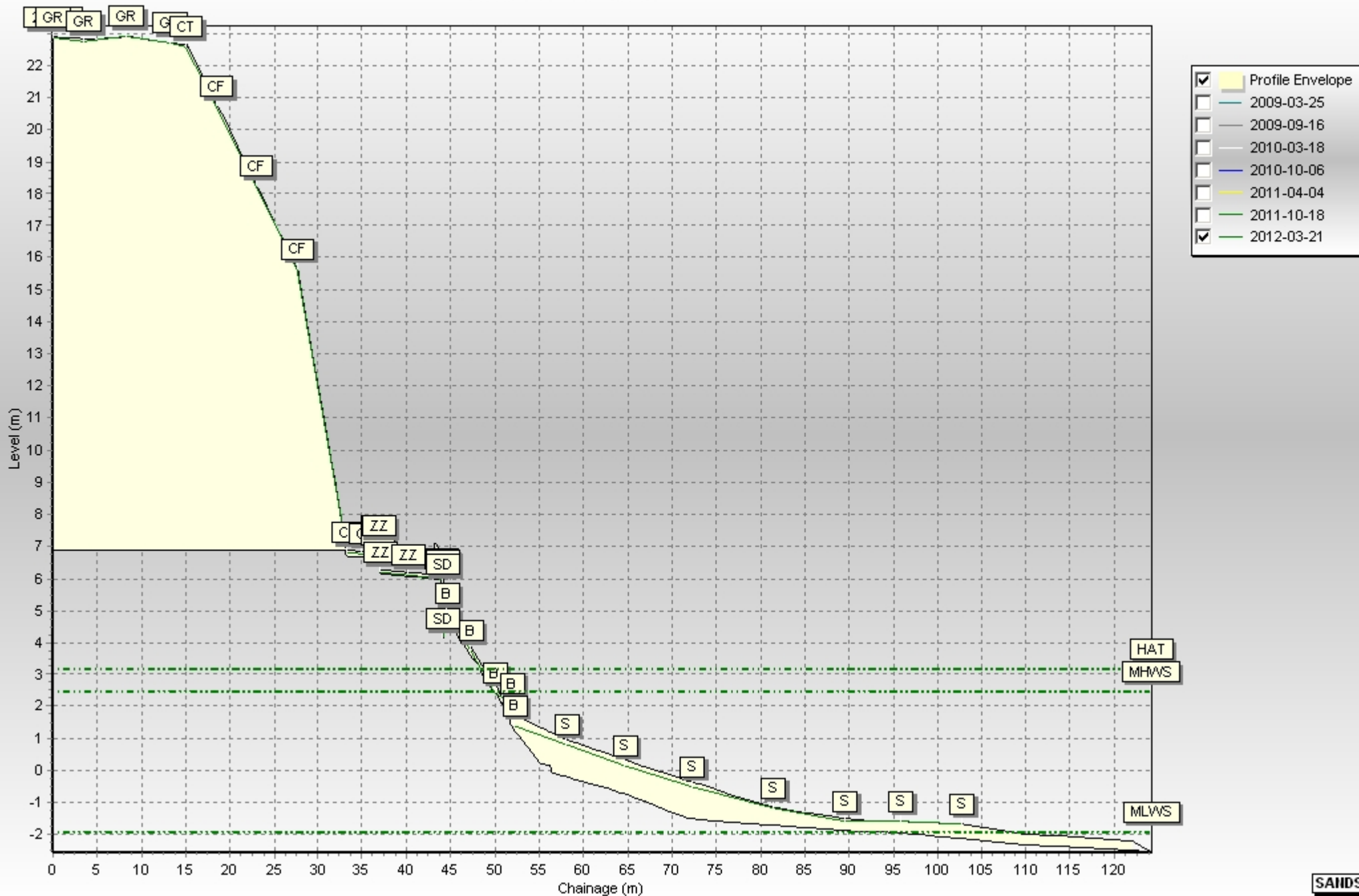
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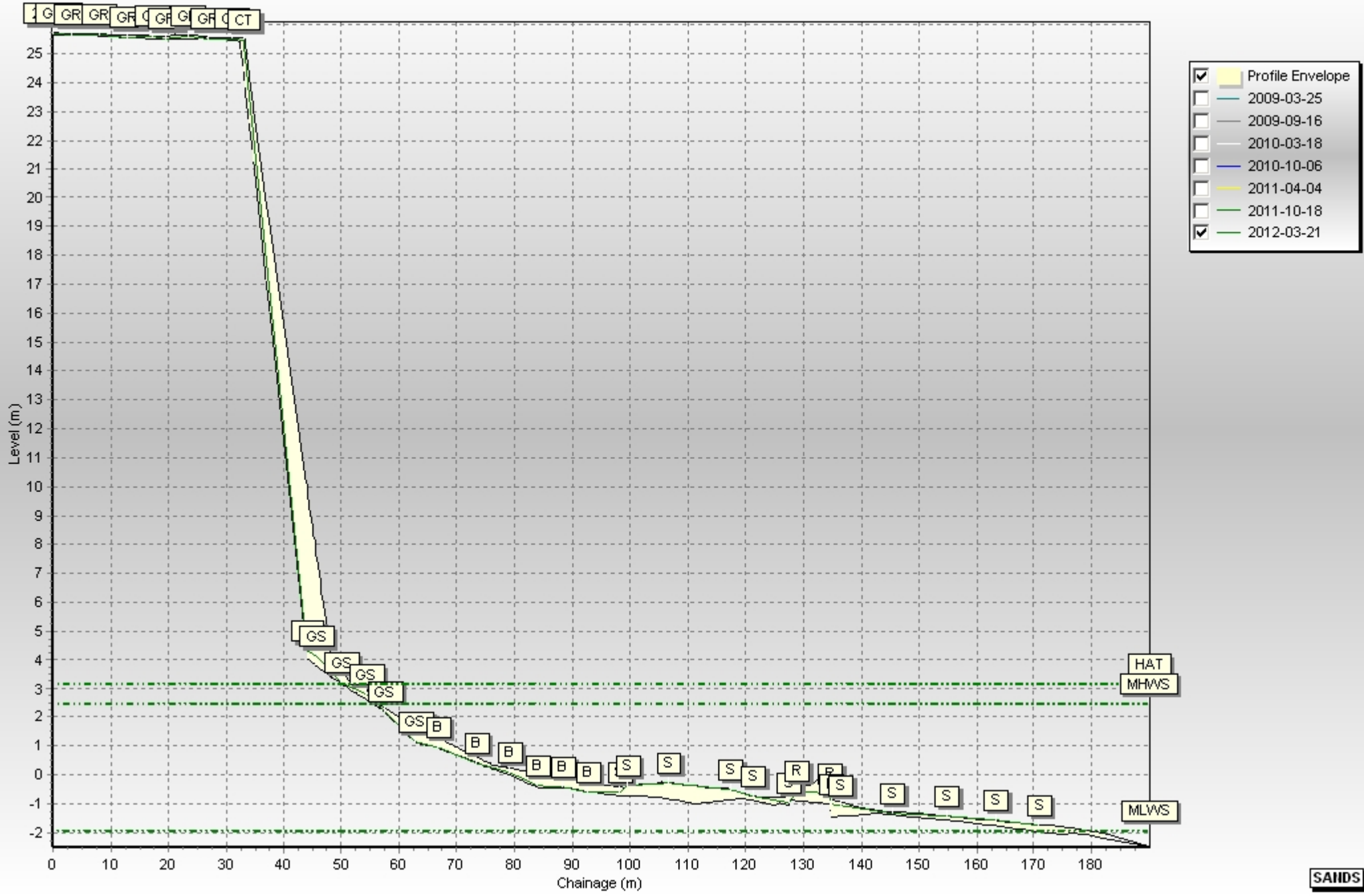
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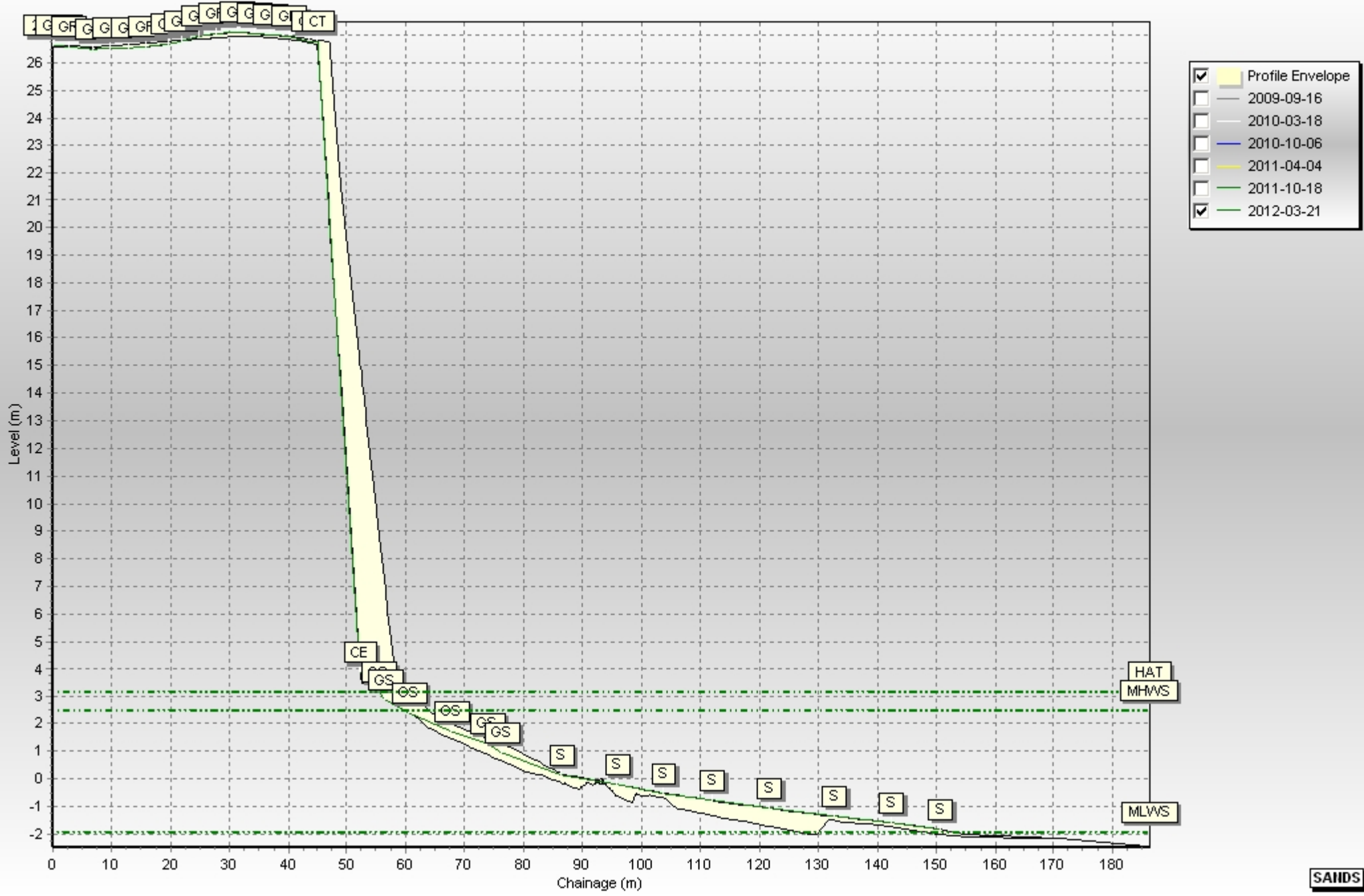
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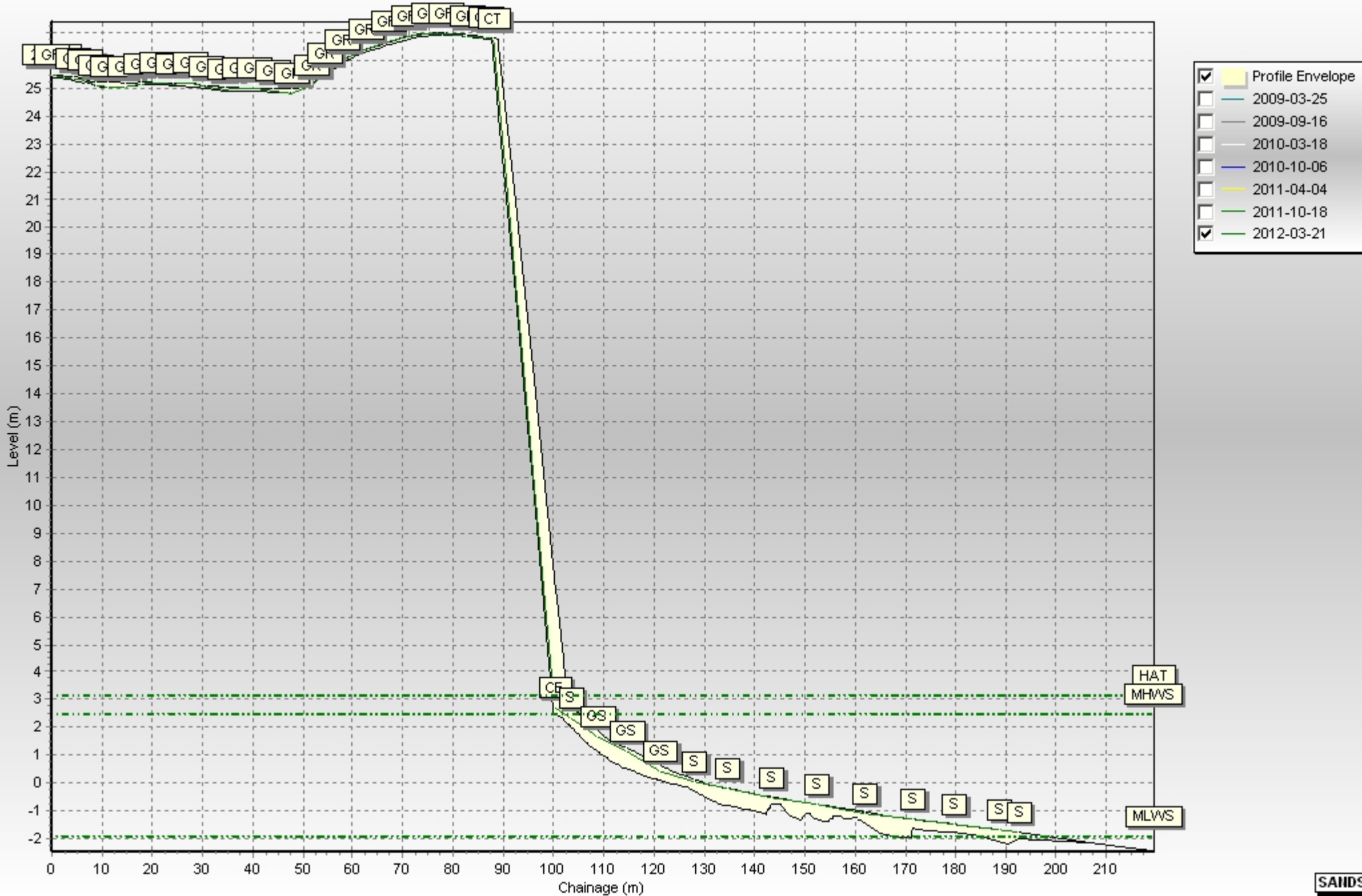
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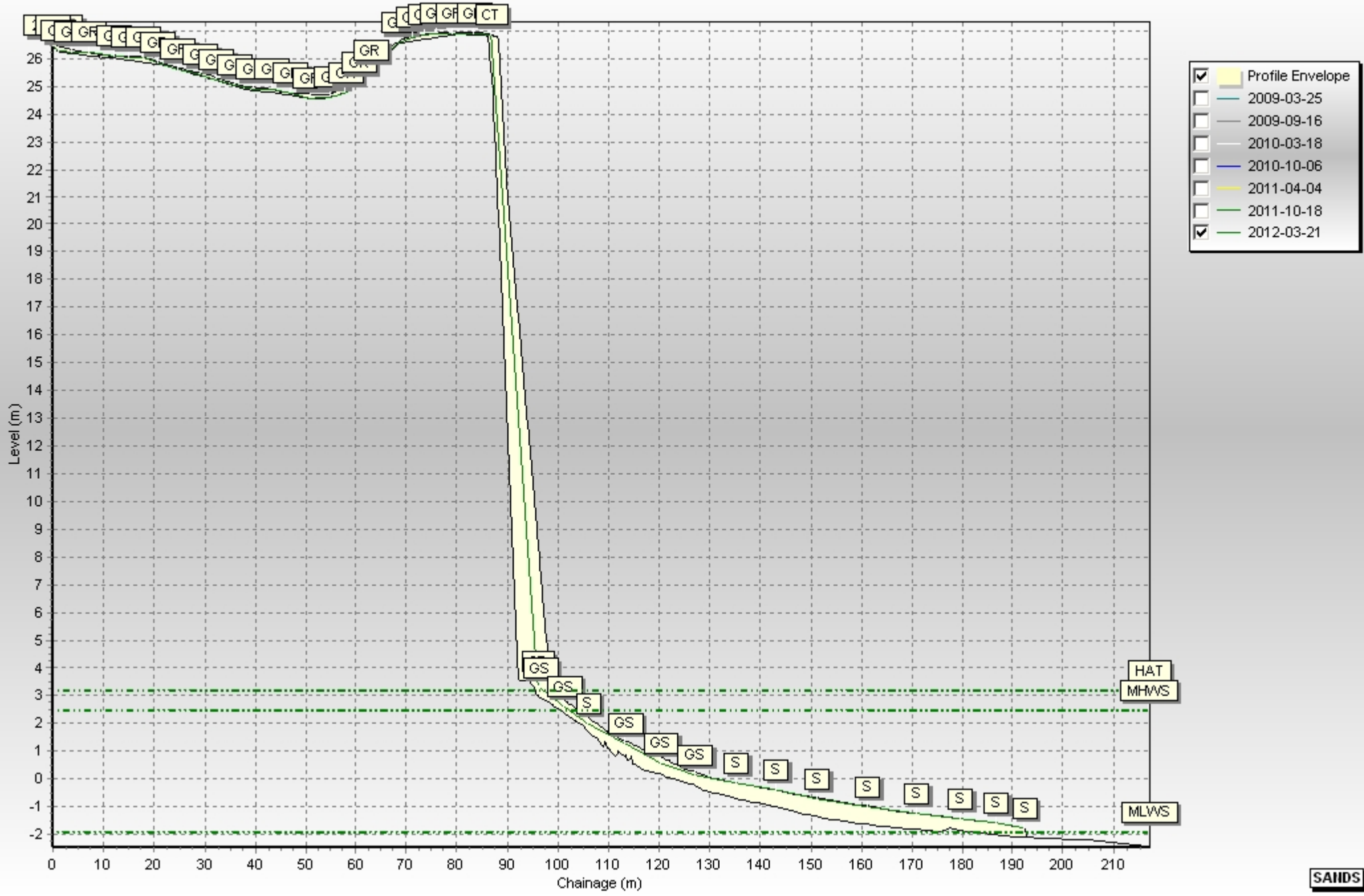
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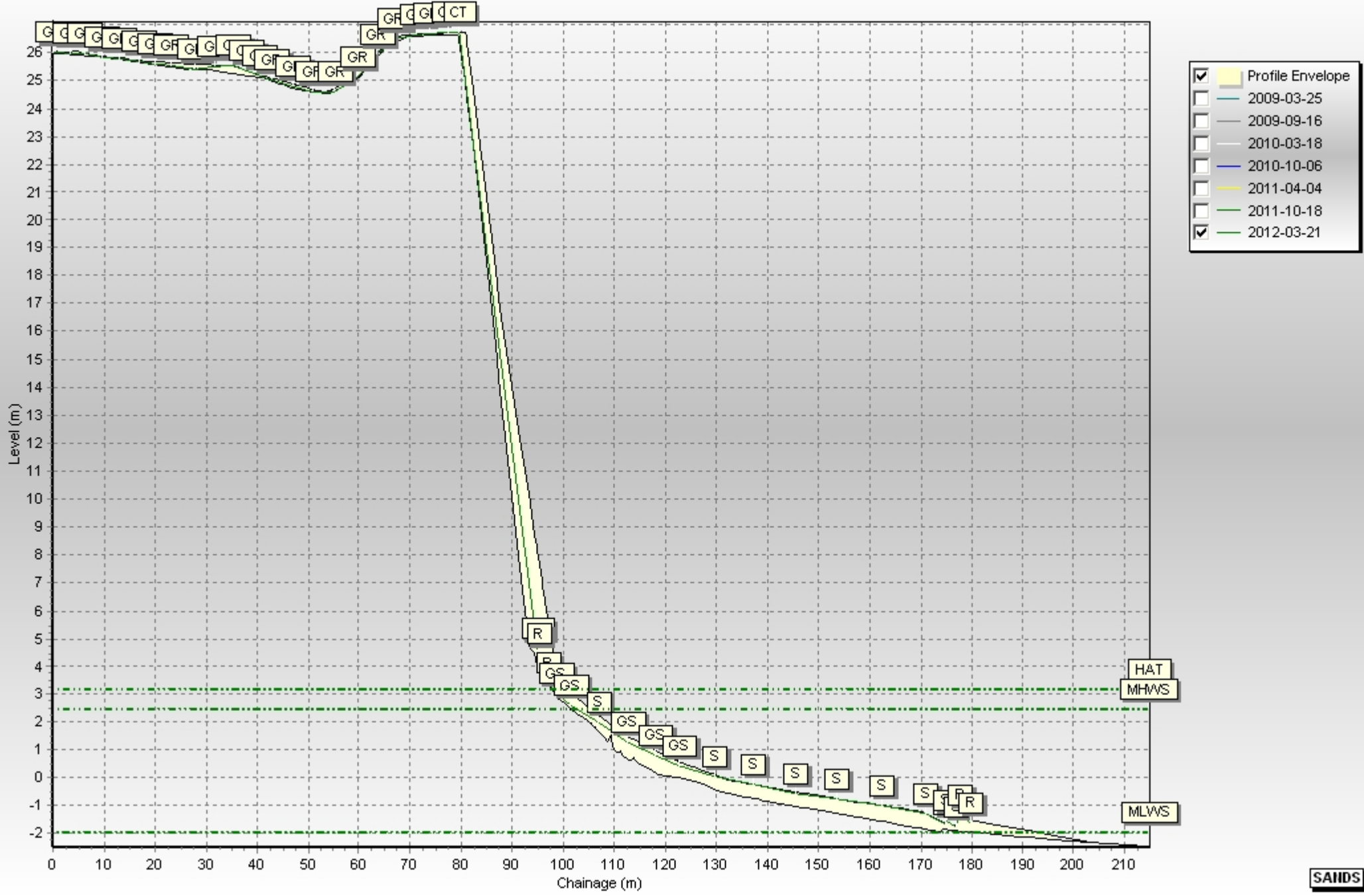
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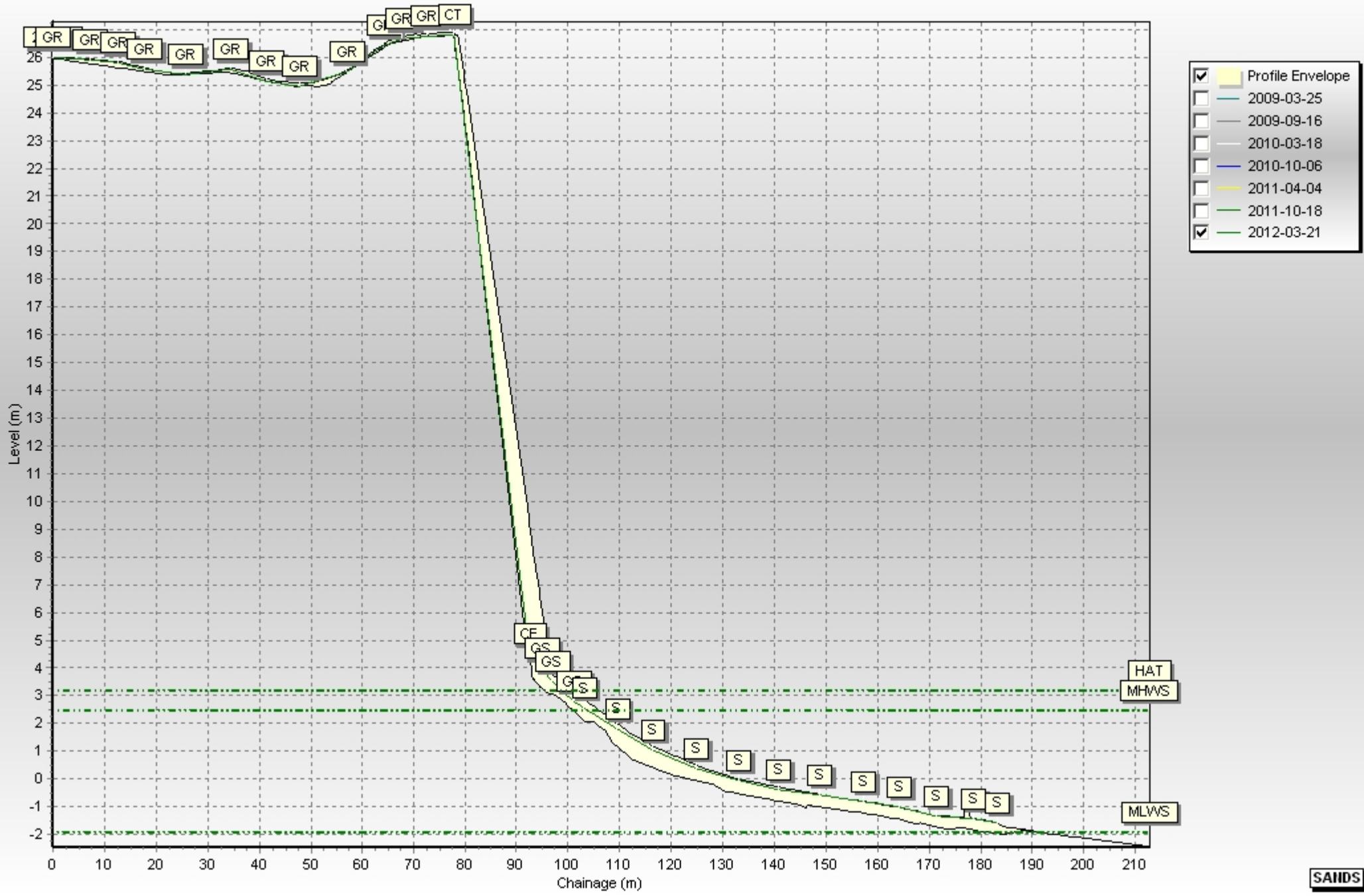
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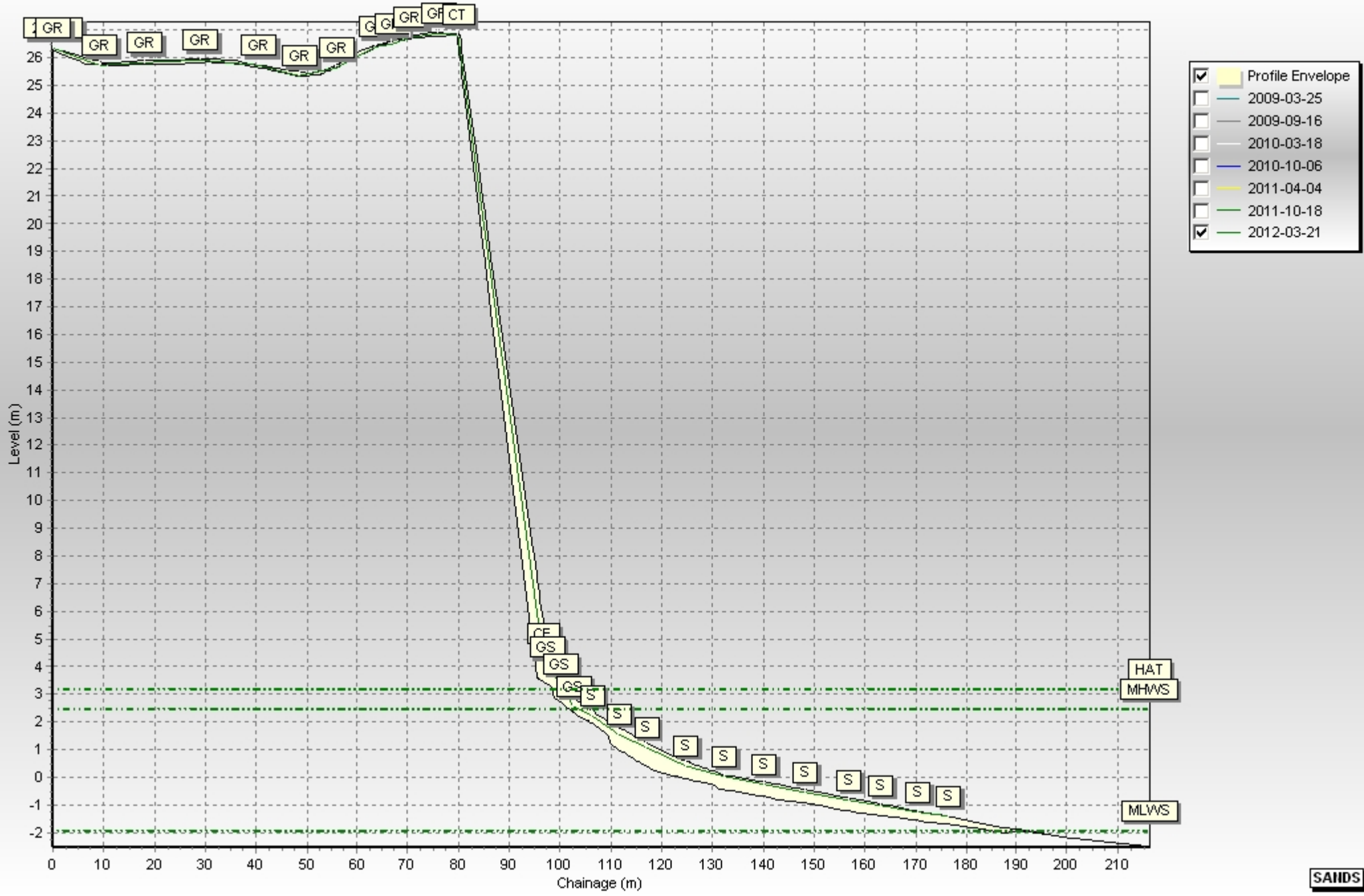
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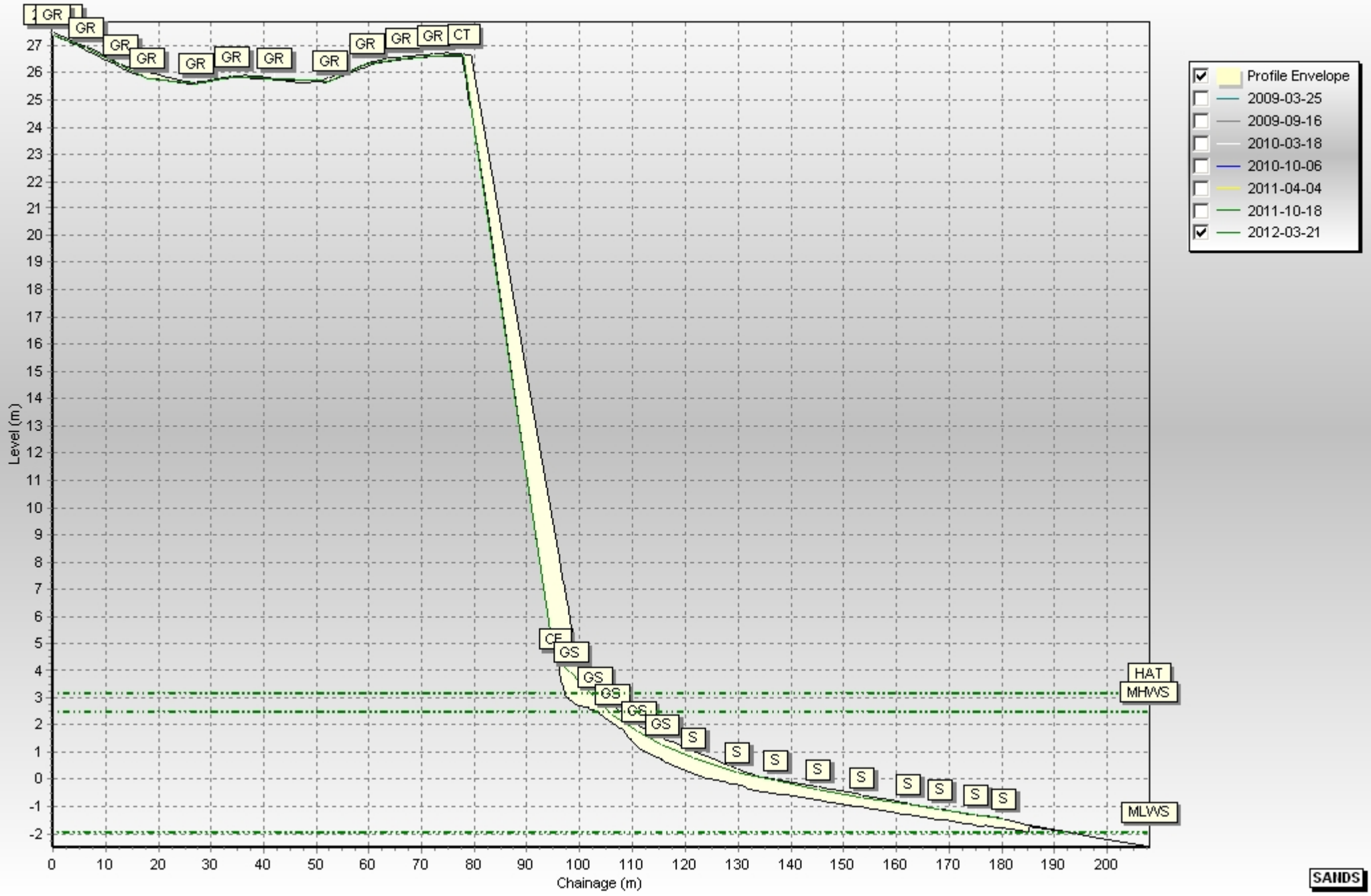
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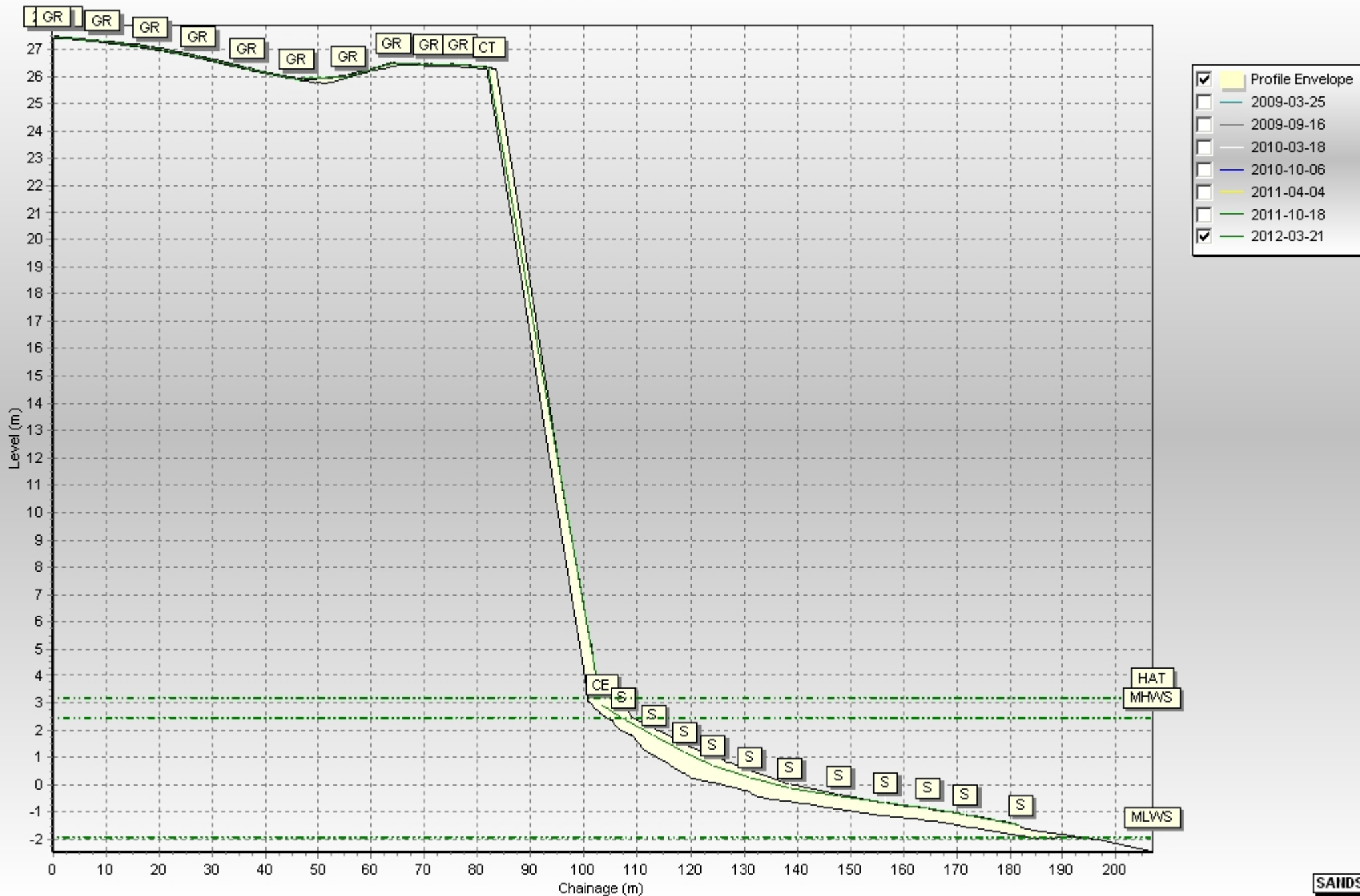
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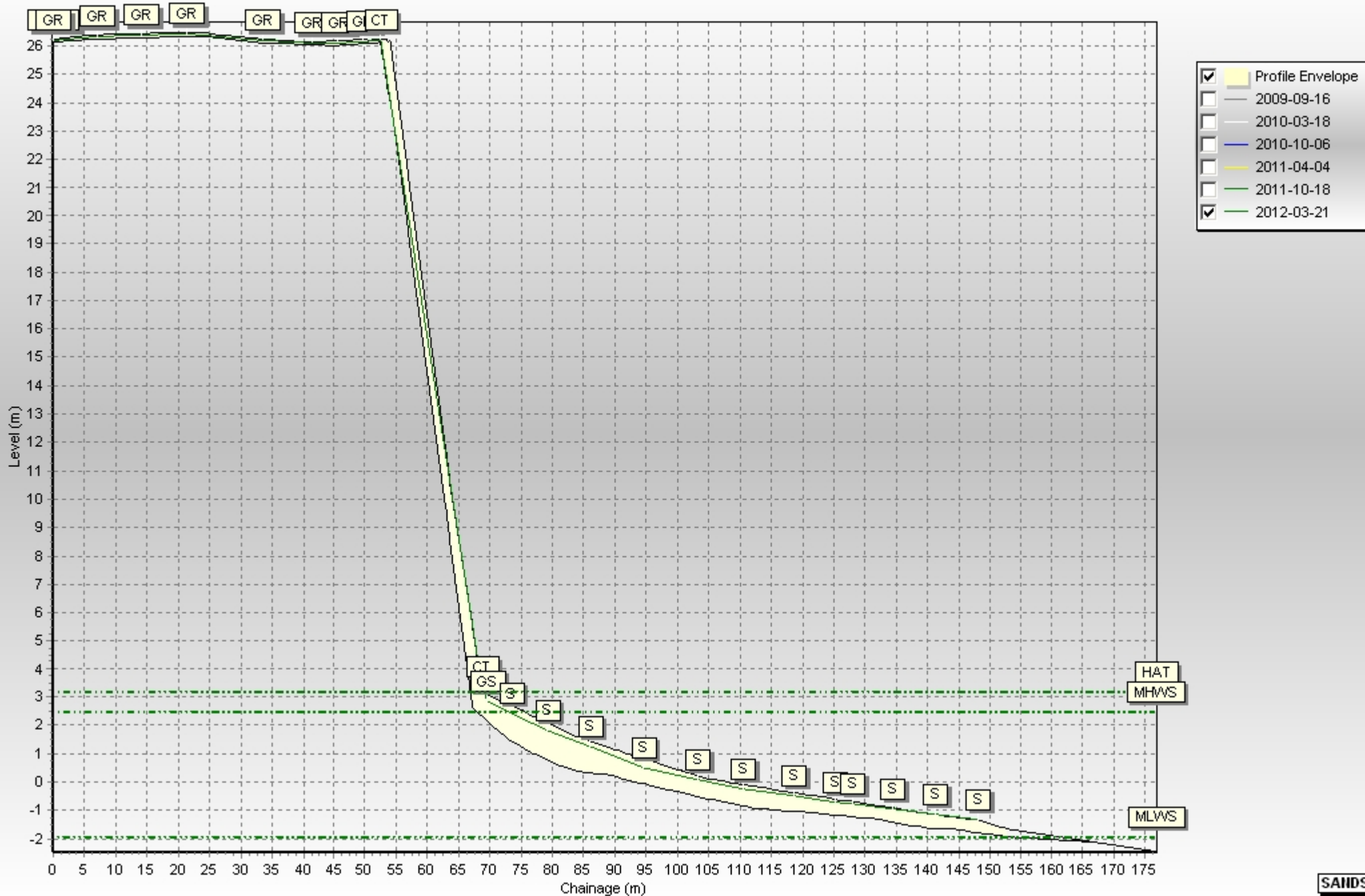
Beach Profiles: 1bSNS31



Beach Profiles: 1bSNS32



Beach Profiles: 1bSNS33



Appendix B
Cliff Top Survey

Cliff Top Survey

Hendon and Ryhope

Thirty-two ground control points have been established between Hendon and Ryhope (Map 1 and Map 2). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

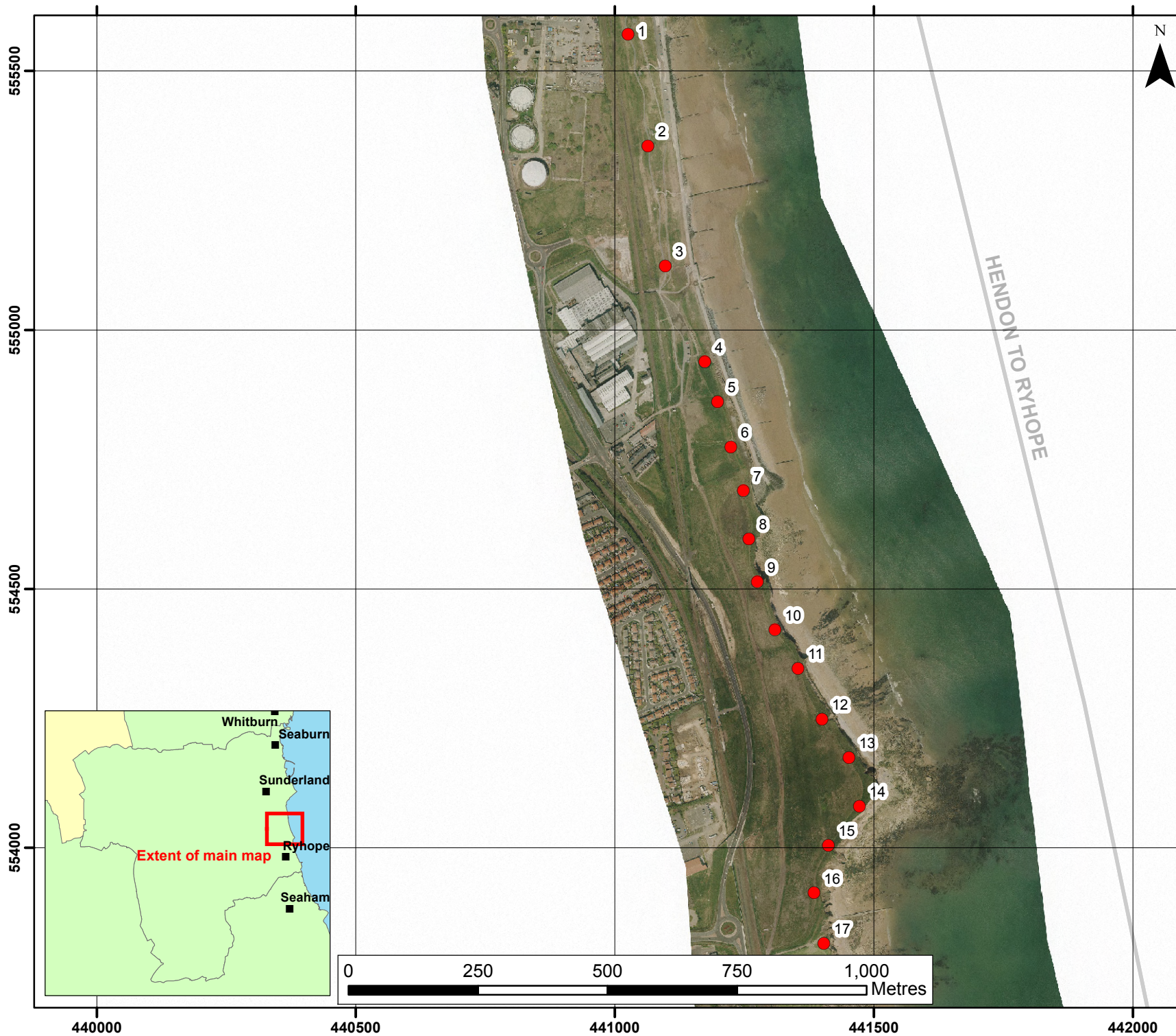
The cliff top surveys between Hendon and Ryhope are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table B1 provides baseline information about these ground control points and results from the 2009 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table B1 – Cliff Top Surveys between Hendon and Ryhope

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey (Mar 09)	Previous Survey (Oct 2011)	Present Survey (Mar 2012)	Baseline (March 2009) to Present (Mar 2012)	Previous (Oct 2011) to Present (Mar 2012)	Baseline (March 2009) to Present (Mar 2012)
1	441025.7	555571.1	75	8.16	8.7	7.9	-0.3	-0.8	-0.1
2	441064.4	555355.1	85	7.09	7.2	7.1	0.0	-0.1	0.0
3	441098	555124	82	10.01	10.4	10.4	0.4	0.0	0.1
4	441174	554938.7	65	10.3	10.7	10.4	0.1	-0.3	0.0
5	441199.1	554861.1	65	7.71	7.8	7.6	-0.2	-0.2	-0.1
6	441224.5	554774.2	71	10.83	11.2	10.8	0.0	-0.4	0.0
7	441248.4	554690.3	74	10.18	10.2	10.4	0.2	0.2	0.1
8	441259.3	554596.6	101	10.08	10.2	10.3	0.2	0.1	0.1
9	441275.8	554513.4	66	10.52	6.3	6.7	-3.8	0.5	-1.3
10	441309.4	554421.3	58	8.77	6.2	6.4	-2.3	0.3	-0.8
11	441354	554346.5	68	8.2	6.6	6.8	-1.4	0.2	-0.5

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey (Mar 09)	Previous Survey (Oct 2011)	Present Survey (Mar 2012)	Baseline (March 2009) to Present (Mar 2012)	Previous (Oct 2011) to Present (Mar 2012)	Baseline (March 2009) to Present (Mar 2012)
12	441400.2	554248.2	56	6.17	5.9	6.1	0.0	0.3	0.0
13	441452.3	554174.7	63	11.61	11.5	11.9	0.3	0.4	0.1
14	441472.3	554080.5	127	7.33	7.2	7.6	0.2	0.3	0.1
15	441413	554005.1	122	7.84	7.7	8.0	0.1	0.3	0.0
16	441384.8	553913.3	90	9.89	9.8	9.9	0.0	0.1	0.0
17	441404.1	553815.5	93	6.32	6.1	6.5	0.2	0.5	0.1
18	441404.1	553723.6	119	8.1	7.8	8.2	0.1	0.4	0.0
19	441398.5	553632.8	78	8.23	5.9	6.0	-2.2	0.2	-0.7
20	441438.3	553452.9	71	10.09	6.7	7.0	-3.1	0.3	-1.0
21	441506.1	553256.1	62	8.57	4.4	4.7	-3.9	0.3	-1.3
22	441550.1	553158.7	103	6.57	6.4	6.7	0.1	0.3	0.0
23	441585.2	553076.5	64	8.11	7.9	8.0	-0.1	0.1	0.0
24	441624.4	552870.7	69	7.53	5.0	5.1	-2.4	0.1	-0.8
25	441689.1	552758	70	14.58	8.6	8.9	-5.7	0.3	-1.9
26	441715	552713.3	54	12.87	12.5	12.7	-0.2	0.2	-0.1
27	441749.2	552674.4	62	14.56	10.4	10.5	-4.0	0.1	-1.3
28	441776.6	552629.9	57	8.62	4.5	4.6	-4.1	0.0	-1.4
28A	441798.6	552586.3	56	13.63*	12.51	12.6	-1.0	0.1	-0.4
28B	441817.4	552542.4	64	12.30*	11.07	11.2	-1.1	0.1	-0.5
28C	441852.2	552502.6	52	13.11*	12.78	12.9	-0.3	0.1	-0.1
29	441880.1	552471.6	83	15.46	15.0	15.1	-0.4	0.1	-0.1
30	441921.4	552269	97	8.55	7.8	8.0	-0.6	0.2	-0.2
31	441853.1	552094	75	11.2	7.9	7.9	-3.3	0.0	-1.1
32	441883.3	551988.5	96	9.82	7.4	7.6	-2.2	0.2	-0.7



KEY

● Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix B - Map 1
Ground Control Points
Hendon to Ryhope North
Sunderland City Council**

Update Report 4
Partial Measures Survey
Spring 2012

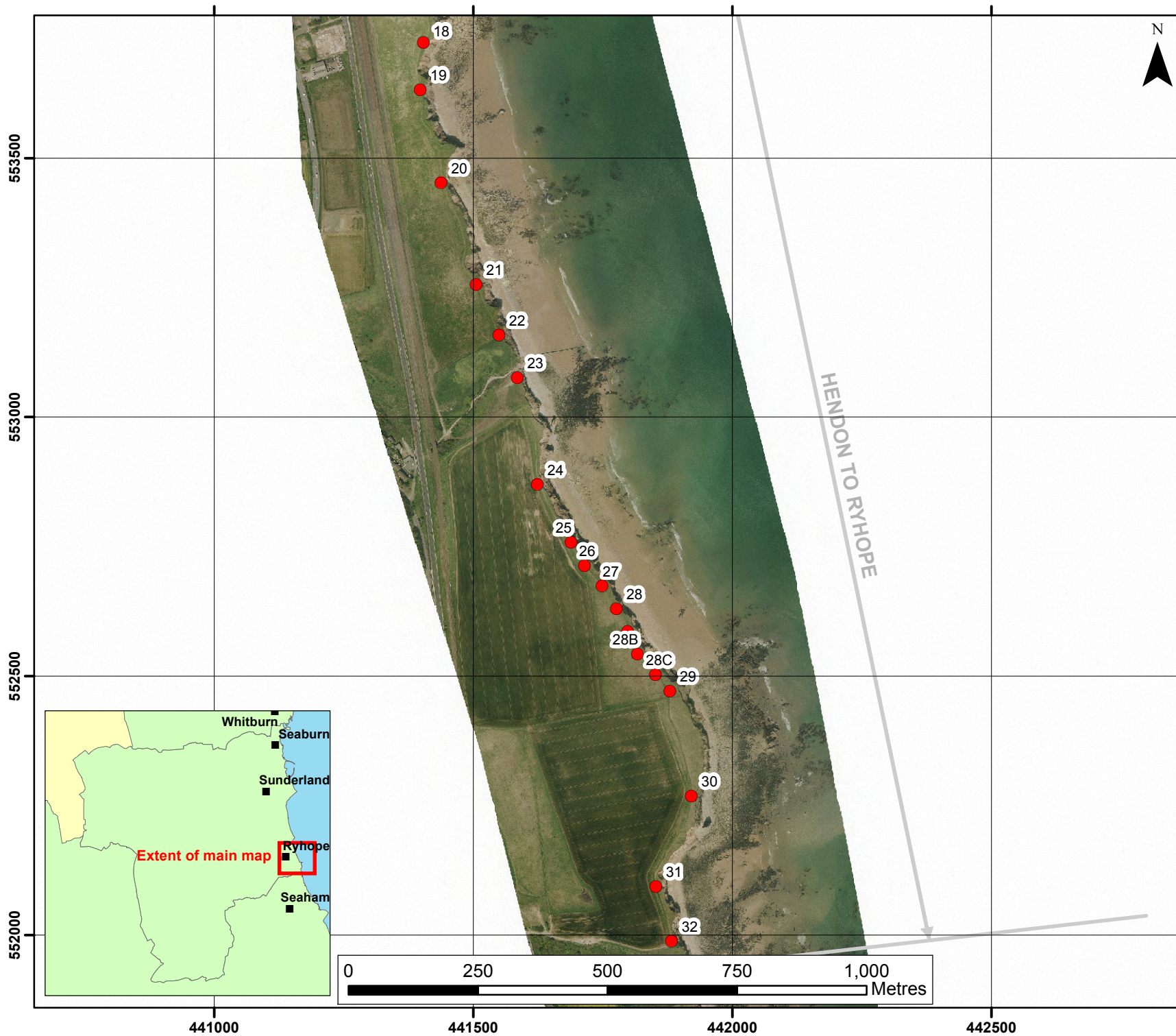


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Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk



KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix B - Map 2
Ground Control Points
Hendon to Ryhope South
Sunderland City Council**

Update Report 4
Partial Measures Survey
Spring 2012



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