This monitoring information is submitted
in accordance with the approved Experimental Test Plan for
Hillsboro Beach Pressure Equalizing Modules Experimental Project,
Permit No. 0269543-001-JC for the monitoring period March 2008 – August 2009

Hillsboro Beach, Florida
PEM project
6 months results and
18 months report

Prepared for
Florida Department of Environmental Protection (FDEP)
3900 Commonwealth Boulevard
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November 25, 2009

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Subject	Table of Contents	Page

Table **List of Tables** **Page**

Figure	**List of Figures**	**Page**

***Front page photo**: Port de Mer at the time of the 18 months survey*

1.0 Executive summary

The PEM system is designed to reduce beach erosion on a stand alone basis or in combination with beach nourishment, and has been used world-wide for over a decade. This report describes the 18 months results of the first PEM installation in the USA, in the Town of Hillsboro Beach, Florida on a critically eroding beach on the Atlantic coast.

The test area is two miles long of which one mile in February 2008 had 90 PEMs installed vertically in the beach in 33 lines perpendicular to the shoreline. The beach had lost a lot of sand prior to the installation, and over half of the PEMs had to be reduced in size as the layer of sand was very thin.

Two minor truck hauls have taken place in and around the project area, and the effect of these have been filtered out in all the volume calculations below.

Above –5ft NAVD the volume changes from March 2008 to August 2009 are +5.96 cubic yards per shore foot (cy/ft), +0.91 cy/ft, +2.04 cy/ft in the PEM, North Control, and South Control area, respectively. See Fig. 1.

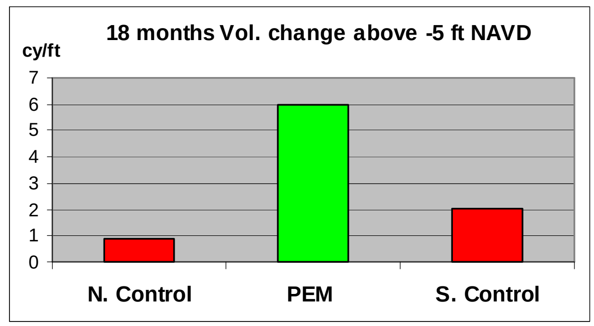

Fig. 1: Volume change above -5ft NAVD compensated for nourishment. Source: SDI/EcoShore

The volume changes from March 2008 to August 2009 above Depth of Closure (DOC –15.67ft NAVD) are +1.2 cy/ft, –3.32 cy/ft, and –3.24 cy/ft in the PEM, North Control, and South Control area, respectively. See Fig. 2. This equals a difference in volume of 24,300 cubic yards.

The Town has hired the Coastal Engineering Consultants (CEC) to perform independent calculations of the results.

Above Depth of Closure CEC came to the following result: +1.48 cy/ft, –3.32 cy/ft, and –3.07 cy/ft in the PEM, North Control, and South Control area, respectively, which equals a difference of 25,400 cubic yards above Depth of Closure.

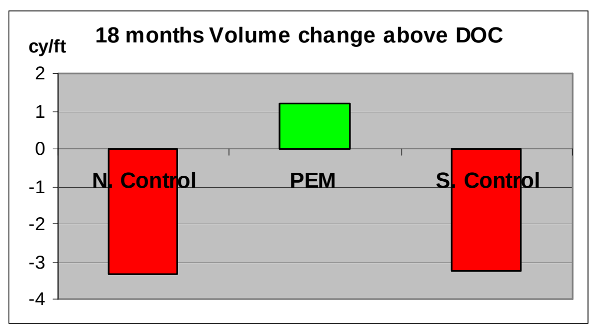

Fig. 2: Volume change above depth of closure compensated for nourishment. Source: SDI/EcoShore

No negative effects were noted downdrift, where the beach advanced 2.5ft in 18 months.

The potential effect on turtles has been investigated by Curtis M. Burney, PhD, Nova Southeastern University, Oceanographic Center, Florida. No negative effects were found on turtle nesting, nesting success or hatchlings emergence.

Similarly no effects on shorebirds were reported either, and no other adverse effects have been noted.

Qualitatively the beach looks in better shape than prior to the project, and the Beach Raker, who drives the beach every day, claims that for the first time in several years, he is able to drive the entire coastline from Port de Mer to south of the project area on the dry beach.

The latest major nourishment took place in 1998. Report[1] shows a volume increase from pre- to post-construction between R7 and R8 of 86,000 cubic yards (= starting point and 100%). As it is common with traditional beach nourishment the sand gradually eroded. In 12 month the volume was reduce to 66,000 cy equal to 77% and the loss continued to 28,000 cy 50 month after the nourishment, equal to 33% of the sand remaining. See blue line in Fig. 3

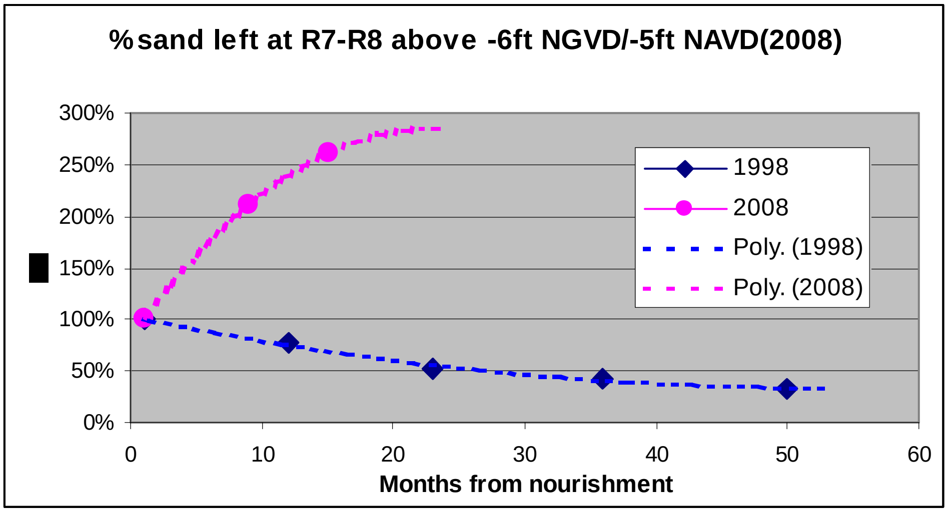

Fig. 3: The graph show how much sand is left after nourishment. The blue graph represents the 1998 nourishment where sand gradually disappeared. The purple graph (round dots) shows the 2008 truck haul where PEMs are installed. The volume of sand is not eroding but actually increasing over time.

The same area (R7-R8) was nourished in 2008 during the Port de Mer truck haul.

However this time PEMs had been installed before new sand was added. PEMs work best when a lot of sand is available, and work well with nourished sand.

After the truck haul the volume increase between R7 and R8 was 7,200 cy (= starting point and 100%). Nine months after the truck haul the volume between R7 and R8 had doubled, and after 15 months the amount of sand had increased to 260% of the original volume between R7 and R8. See Fig 3.

This indicates that the PEMs work very well in Hillsboro provided they have enough sand to work with.

Financially the town has profited from PEM. At the price the neighboring town paid for trucked in sand the town should have paid over $1.2 million for the approximately 25,000 cy sand that represents the difference between the PEM and Control areas. The Town paid less that $250,000 and saved over $1 million in 18 months.

[1] Hillsboro Beach Deerfield Beach Nourishment Project 4th Year Post-Construction Monitoring Report Oct 2002, Table 3.5

2.0 Reports

This is the third report from EcoShore describing the PEM project at Hillsboro Beach.

Report # 1 and 2 described the results after 6 and 12 months of installation.

This report describes the result after 6 months, as the permit requires 6 months reports, however it focuses on the results after 18 months.

3.0 Introduction

Hillsboro Beach is located in northern Broward County along the barrier island. It extends from slightly north of Broward County R-7 south to Hillsboro Inlet at R-24. Most of the coastal area is highly developed with quality homes, motels, and hotels.

According to the FDEP the Town of Hillsboro Beach is a 3.2 mile long critically eroded area.[2]

In 2005 the Town Commission investigated several types of innovative technologies to reduce erosion at Hillsboro Beach at the same time as the Town was preparing for a traditional renourishment project.

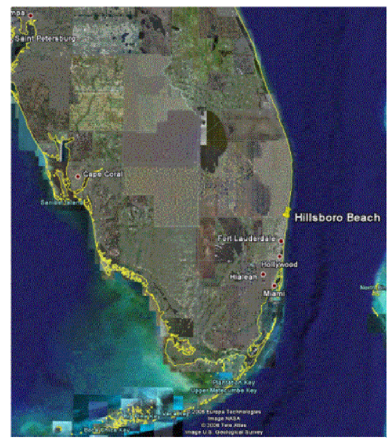

Fig. 4: South East Florida and Hillsboro Beach

In 2006 a contract was signed with EcoShore Int'l, Inc, Boca Raton, Fl. to install a PEM system, the first in the USA. The system was installed in February 2008.

PEMs are independent permeable drain tubes installed vertically into the foreshore, ranging from the dune foot to the shoreline, to build a beach or mitigate erosion. The modules are intended to equalize water pressure and result in a subtle increase in inter-granular friction near the shoreline. The waves infiltrate the beach easier during uprush, leaving sediments on the beach. PEMs will retain sand from littoral drift provided enough sand is available or they can be used in combination with beach nourishment where they hold on to the sand, as have been demonstrated in Teluk Chempedak, Malaysia in a pocket bay in front of the Hyatt Hotel (Paper presented at ICCE, Hamburg 2008).

The PEM project area in Hillsboro Beach is approximately 1 mile long and extends from 250 ft. north of R7 to 250 ft. south of R12. North and south of the PEM project area are two approximately ½ mile long control areas. The entire project is approximately 2 miles long and extends from R4 to R15.

Fig. 5: Test area

[2] SBMP Broward Dade beaches, May 2008

4.0 History of the Project Area

According to Coastal Systems International (CSI) (2005), the first recorded beach nourishment project was carried out in 1957. In 1958 a groin field, which consisted of 40 groins spaced 100 ft. apart, was constructed. The construction helped stabilize the shoreline north of R-6 but at the same time intensified the downdrift erosion occurring along the north portion of Hillsboro Beach.

Due to the severe erosion, a rock revetment was constructed spanning from R-7 to 250 ft. south of R-8. A large beach nourishment project was conducted in 1970 when 360,000 cubic yards of sand were placed on the beach from approximately R-7 to R-12.

The latest nourishment project in the area was carried out in March 1998 when 550,000 cubic yards of sand were placed along 6,120 ft. of shoreline spanning from R-6 to R-12.

The erosion rate since the sixties has been 2 to 12 ft. per year averaging 5 to 6 ft/yr.

5.0 Coastal Processes

CSI (2005) performed an analysis of meteorological and hydrological factors that impact local sediment transport and morphology change. The Hillsboro Beach shoreline is influenced by semi-diurnal tide with average range of 2.52 ft. and spring tide range of 2.82 ft. in the vicinity of Hillsboro Inlet. The tidal period is approximately 12.4 hours.

A statistical analysis of wind data shows that winds are predominantly from the northeast, east, and southeast.

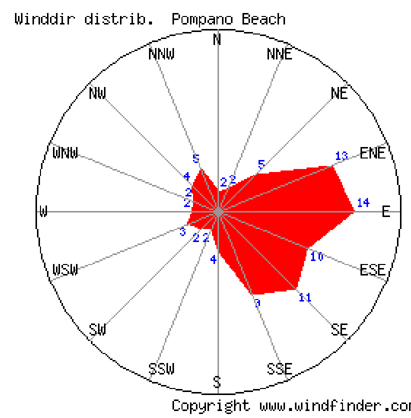

Fig. 6: Full year wind direction at Pompano Beach, a few miles south of the Test area

A statistical analysis of waves indicates that the dominant wave directions are from the northeast and east, with 79% of occurrences, which results in a net sediment transport toward the south. During summer, the dominant wave directions are from east and southeast resulting in a northerly sediment transport. During winter, larger north and northeasterly waves dominate resulting in a north to south sediment transport.

6.0 Characteristics of the PEM technology

Pressure Equalising Modules (PEM) are hollow tubes made of HDPE. They are up to approximately 6 ft in length and 2.5 in. in diameter, closed at the bottom and vented in the top. The top quarter part is solid and the bottom three quarters is slotted to allow water into the tube while sand is kept out. See Fig.7.

The PEMs are installed in rows perpendicular to the beach from the mean low water line to the dune 1-2 ft below the sand. To be out of reach from turtles they were installed 3 ft below the dry sand. The distance between the PEMs in each row is normally 10 m (30 ft).

Fig. 7:PEM module

The rows are typically spaced 100 m however in Hillsboro Beach the narrow stretch of beach dictated a closer spacing and the rows are 50 m apart. The beach has 33 rows and 90 PEMs installed.

7.0 Project activity

During the second year no new PEMs have been inserted.

A new set of temperature and humidity loggers have been installed as was done during year one.

Fig 8 below illustrates the PEM Project area, North and South Control areas, the areas used to determine if the functional success criteria (FSC) has been fulfilled, as well as the June 08 truck haul at Port de Mer.

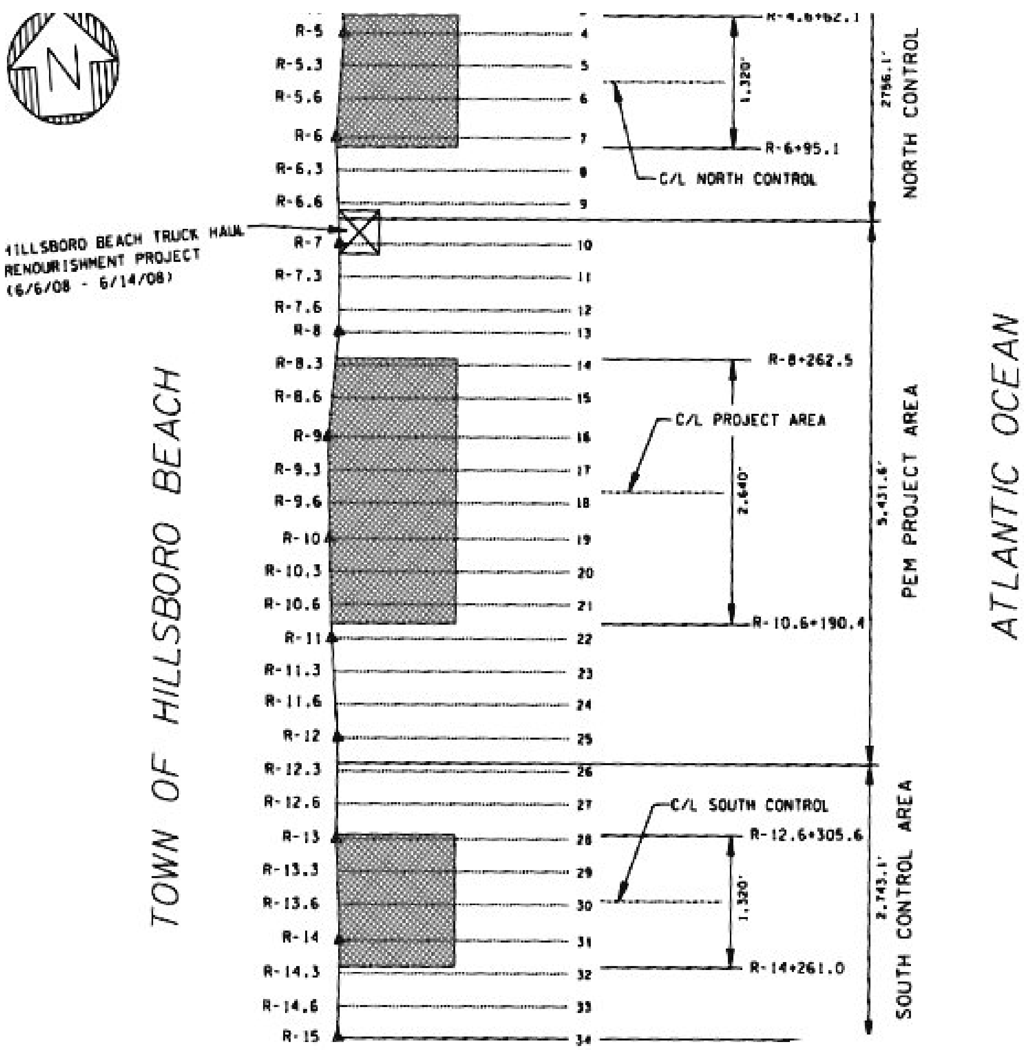

Fig. 8 The tests area with Project area, control areas, FSC areas (dark boxes) and June 08 truck haul

8.0 Truck hauls

Two truck hauls (beach re-nourishments) have been conducted within the test area during the project.

1. R7 at Port de Mer in June 2008
2. From the Pier to R5 at Deerfield Beach in January 2009

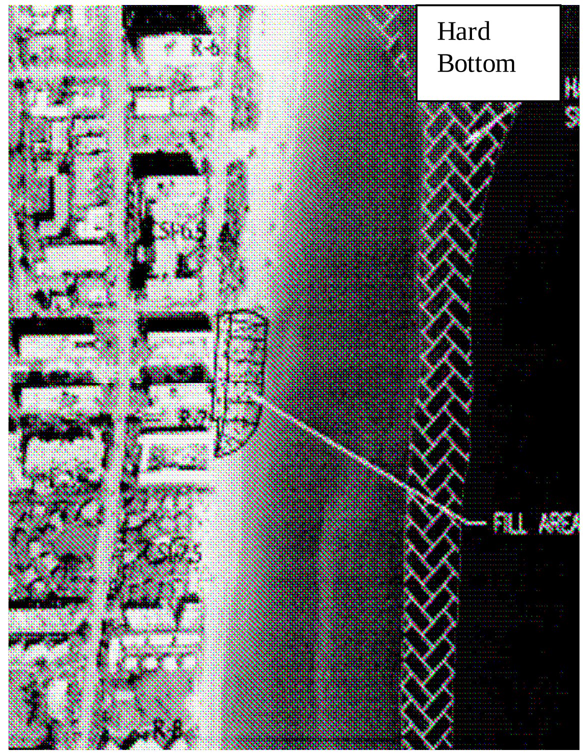

Fig. 9: Port de Mer Truck Haul

8.1 Port de Mer Truck Haul

A truck haul emergency fill was conducted in June 2008 at the North end of the town near Port de Mer.

The permitted Project consisted of approximately 14,000 cubic yards of beach quality fill material to be placed along 430 feet of shoreline extending from 100 feet south of R-7 and 330 feet north of that same monument. Overall approximately **8,900 cubic yards** of material were placed within the fill template during the nine (9) days of construction. The construction was completed on June 15, 2008.

Last time the area was nourished was in 1998. The area between R7 and R8 experienced a volume increase of 86,127[3] cy compared to the pre nourishment volume.

86,127 cy is the "starting point" and equal to 100%. A year later 66,325 cy remained (77%) and after 2 years 45,520 cy remained (53%). Se Table 1.

No PEMs were installed in 1998, but in 2008 PEMs were installed between R7 and R8 in Feb 2008, and sand placed on top of the PEMs in June 2008. If they work as designed, more sand should stay in place compared to 1998. After the truck haul the area between R7 and R8 experienced a volume increase of 7,217 cy most of which was due to the truck haul. The 7,217 cy becomes the "starting point". Table 1 shows that in stead of a falling volume it is actually increasing to 260% in 15 months, compared to the reduction to 77% and 53% in 12 and 23 months, respectively, following the 1998 nourishment.

Table 1 – Sand retention after nourishment in 1998 versus truck haul in 2008

	Hillsboro Beach. Sand remained after nourishment						
* Note that they operate with NGVD and NAVD	**Above –6 ft NGVD* No PEM installed**				**Above -5 ft NAVD* PEM Installed**		
	1/98-3/98	**1/98-2/99**	**1/98-1/00**		**3/08-8/08**	**3/08-3/09**	**3/08-8/09**
Time from nourishment	starting point	**12 months**	**23 months**		starting point	**9 months**	**15 months**
R7 – R8	**86127**	**66325**	**45520**		**7217**	**15189**	**18816**
Percentage retained	**100%**	**77%**	**53%**		**100%**	**210%**	**260%**

[3] Hillsboro Beach Deerfield Beach Nourishment Project 4th Year Post-Construction Monitoring Report Oct 2002 Table 3.5

8.2 Deerfield Beach Truck Haul

In Jan 2009 Deerfield Beach conducted a beach fill from the pier to R5 i.e. into the North control area. A total of **7,350 cubic yards** (cy) were placed on the beach. It is not known how much was placed in the North control area and how much was placed north of the control area. The cost was $430,000 according to Minutes of Meetings from Deerfield Beach..

9.0 Survey Methodologies, Equipment and QA/QC Procedures

The information below has been provide by Sea Diversified (SDI).

General

The survey included onshore and offshore profile data collection from R4 through R15 in Broward County, Florida. The survey was conducted in accordance with the latest update of the Beaches and Coastal Systems (BBCS), Monitoring Standards (Standards) for Beach Erosion Control Projects. Additionally, the survey was conducted in compliance with the Minimal Technical Standards set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 61G17-6, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes. All work was conducted to the highest level of industry standards and under the responsible charge of a Professional Surveyor and Mapper registered in the State of Florida.

Horizontal and Vertical Data:

Horizontal Data:

Feet, relative to the Florida State Plane Coordinate System, East Zone, High Accuracy Reference Network, North American Datum (HARN NAD), 83/90

Vertical Datum:

Feet, relative to the North American Vertical Datum of 1988 (NAVD 88)

Horizontal / Vertical Control Verification:

Profile control used for the survey was provided by BBCS. The horizontal and vertical position of all found and used monuments for the survey was verified by SDI using Real-Time Kinematic GPS. Where monuments were not found Temporary Bench Marks (TBM's) were set with the objective to set the TBM at the reference monument location, if practical. If the specified location was not practical, the TBM was set at a more suitable location either landward or seaward along the specified profile azimuth. A tabulation of all published, found and used monuments and TBM's was included as part of the final survey charts. The tabulation included the monument identification, establishment date, coordinates, elevations and profile azimuths.

Onshore Profile Data Collection:

Onshore data collection extended seaward to approximate wading depth (-5 feet NAVD) as required to overlap the offshore profile data. Data collection extended upland to the profile monument or approximately 150 feet landward of the vegetation line, whichever was most seaward. In the event there was a physical barrier on line between the beach and the monument, every reasonable attempt was made to extend the survey beyond the barrier to the reference monument position. Profiles terminated due to impassable barriers were noted in the field books.

Profile data was collected using conventional differential levelling and Real-time Kinematic Differential Global Positioning techniques. Data was collected at a maximum interval of twenty-five (25) feet and at all grade breaks (exceeding six inches) and material changes along the profile. The reference monument was recorded as range 0.0 along the profile with positive ranges extending seaward of the monument and negative ranges extending landward of the monument.

Digital Photography:
During the course of field data collection, digital photographs were taken at approximate mid-beach along each profile line. Three (3) photographs were captured, one each shore-parallel north and south of the profile and one towards the monument location. An additional photograph of the monument was taken with sufficient clarity to read the monument stamping, as applicable Digital images were provided along with the survey charts on DVD media in .jpg format at a minimum 640 x 480 resolution.

Offshore Profile Data Collection:
Offshore profile data collection extended seaward 2500 feet from the approximate shoreline maintaining a minimum fifty (50) foot overlap with the onshore profile data. Offshore profile data was collected using an automated hydrographic system comprised of a survey launch equipped with a marine grade sounder, differential global positioning system and computer-based navigation / data collection system. Prior to the start of the survey a tide staff was established in proximity to the project for recording water levels during the course of the data collection activities. The tide staff was set relative to published control in the vicinity of the project.

Data Processing and Final Deliverables:
Upon completion of field survey activities, data was edited and reduced to the project datum and translated to an x,y,z, ASCII format for submittal to the BBCS. In addition, and in accordance with Standards, the following deliverables were provided:

- Survey report / monument control report certified by a Professional Surveyor and Mapper.
- Copies of field books and data collection files, as applicable. (hardcopy and PDF format)
- Description of all monuments and TBM's used for the survey, including identification, stamping, coordinates, elevations and profile azimuths. Control description were provided in both hardcopy and digital formats (ASCII and Excel)
- Final profile data in ASCII x,y,z format and FDEP distance / depth format with associated header records
- ASCII raw data file
- Digital photographs in .jpg format with appropriate labeling
- Plan / profile charts in AutoCAD .dwg format
- Plan / profile charts in hardcopy format (24"x 36")

QA / QC Procedures:
SDI maintains standard QA/QC procedures for obtaining beach profile data that conforms to the FDEP's beach and coastal monitoring requirements. Offshore data collection is performed during high tide to minimize the swim portion of the upland data collection. The landward ranges collected with the survey vessel are tabulated and provided to the beach crew to ensure adequate overlap between the onshore and offshore data.

Upland profile and near shore profile data were collected using standard rod, level, hand-held laser distance measuring device or standard Real-Time Kinematic GPS methods comprised of a Trimble 5800 Dual-Frequency GPS base station and rovers. Prior to data collection the equipment was either peg tested or calibrated to existing published 2nd Order horizontal and vertical control stations. Horizontal tolerances were maintained within +/- 1 meter and vertical tolerances within +/- 4-5 cm.

Offshore data was collected from a semi-enclosed 23-foot survey vessel utilizing a Differential GPS, Odom Model MK3 electronic chart recording echo-sounder with a 200kHz narrow beam (2.9 degree) transducer. The transducer is in a vault located in the center of the vessel to minimize the effects of pitch and roll. The echo-sounder was calibrated via a standard bar check at the start of each survey day and conducted to the manufactures specifications. Horizontal position checks were performed prior to data collection at published 2nd order survey control stations. Latency was accounted for by collecting sounding data in opposing directions in an area with steep slopes of significant changes in bottom conditions and proper time offsets were applied to account of inherent navigation software and system processing delays or latency. Corrections for tides were observed from a tide staff set within the project limits and set relative to the project datum, NAVD 88. Tides were recorded at ten-minute intervals during the conduct of the offshore data collection.

Offshore data collection was limited to sea conditions with wave height of two (2) feet or less. Sounding data was collected continuously along each profile with final processed data separated to ten (10) feet. Final processed data was reviewed, corrected for tides, merged with upland and near shore swim profile data and imported for final charting.

Data Analysis:
Upon completion of the data processing, SDI prepared a report of shoreline and volumetric changes between the initial post-construction survey in March, 2008 to the current eighteen -month monitoring survey (Aug 2009).

The shoreline position at each profile line relative to the control monument was computed for each survey event with the change in position tabulated in feet. The shoreline is defined as the location of the Mean High Water (MHW) contour, which is at elevation +0.25 feet, NAVD (+1.81 feet, NGVD). Tidal datum information was obtained from NOAA Tide Station number 872-2861, Hillsboro Inlet.

Volumetric changes between the March 08 and Aug 09 survey events were computed from the upland limits of the survey to the MHW line and to the Depth of Closure. An elevation of –16.57 feet, NAVD (-15.0 feet, NGVD) was used to describe Depth of Closure based upon a the Hillsboro Beach / Deerfield Beach Nourishment Project, 4th Year Post-Construction Monitoring Report prepared for the Town of Hillsboro Beach by Coastal Systems International, Inc., dated October 2002. Review of comparative profiles between previous March and September surveys indicate this elevation to be an accurate representation of the approximate point of closure between the subsequent survey events. The Depth of Closure used for the analysis was also confirmed to be consistent with that used by Broward County for their countywide monitoring activities of the coastline. Volumetric changes were computed and tabulated separately for the PEM project area and two (2) control areas.

10.0 Physical monitoring

Monitoring was conducted according to the NAVD 88 norm. For this report the volumetric change analysis was recorded at 0.25 ft. (MHW) and –16.57 ft. (DOC) and –5 ft. NAVD.

Further analyses were made 0 NGVD equal to -1.57 ft. NAVD because 0 ft. NGVD shall be used for evaluating Functional Success Criteria (FSC) according to the contract between the Town and EcoShore.

The area analyzed extended from R4 to R15. To accommodate contract terms (FSC) the middle ½ mile of the PEM project area shall be compared to the average of the middle ¼ mile of the two control areas.

Volumetric analysis

Volumetric analysis and shoreline change from start of the project to 6 and 12 months was conducted as follows:

- Functional Success Criteria (FSC)
- Shoreline change at MHW
- Volume change R-monument line to Mean High Waterline (MHW)
- Volume change R-monument line to depth of closure (DOC)
- Volume change R-monument line to –5ft NAVD

10.1 Functional Success Criteria (FSC)

As stipulated in the contract between the Town and EcoShore the FSC results shall be evaluated after 6 and 12 months. The requirements of the FDEP also includes FSC monitoring.

Functional Success Criteria (FSC)

For the test to be successful and FSC fulfilled the following sand volume values in cu. yards per shore ft shall be achieved (A or B):

A. In case of sand accretion in the Test Area
The volume of sand accreted in the Test Area must be at least 25% higher than the avg. volume of sand accreted in the Control Areas. Example: The Control Areas have accreted an average 10 cubic yards sand per shore foot. The Test Area must have accreted at least 12.5 cubic yards per shore foot.

B. In case of erosion in the Test Area
The erosion must be at least 25% higher in the Control Areas. Example: Test Area has lost 10 cubic yards sand per shore foot. For FSC to be fulfilled the Control Areas shall in average have lost at least 12.5 cubic yards per shore foot

During the past 6 months from Mar 09 to Aug 09 the middle ½ mile of the PEM project area from R monument line to –1.57 NAVD (equal to 0-NGVD) experienced accretion of 3.09 cubic yards per shore foot. The middle ¼ mile of the two Controls averaged accretion of 0.07 cubic yards per shore foot (-2.10, 2.23) and the FSC was fulfilled with and without compensating for nourishment. See Table 2.

The 18 months survey from Mar 08 to Aug 09 shows that the middle ½ mile of the PEM project area from R monument line to –1.57 NAVD (equal to 0-NGVD) experienced erosion of 0.24 cubic yards per shore foot. The middle ¼ mile of the two Controls averaged erosion of 1.7 cubic yards per shore foot (-3.37, -0.03). FSC was fulfilled with and without compensating for nourishment. See Table 3.

Table 2 – FSC calculation during the past 6 months

FSC calculation during the past 6 months Uncompensated / Compensated for nourishment						
		N. Control cy/ft	S. Control cy/ft	Avg. N+S Con	PEM cy/ft	Extra accretion in PEM
FSC	Uncompensated	-2.10	2.23	0.07	3.09	4310%
FSC	Compensated	-2.83	2.23	-0.30	2.40	>25%

Volumes computed by SDI / EcoShore

Table 3 - FSC calculation during the past 18 months

FSC calculation during 18 months Uncompensated / Compensated for nourishment						
		N. Control cy/ft	S. Control cy/ft	Avg. N+S Con	PEM cy/ft	Extra erosion in control
FSC	Uncompensated	-3.37	-0.03	-1.70	-0.24	608%
FSC	Compensated	-4.10	-0.03	-2.07	-0.93	122%

Volumes computed by SDI / EcoShore

The Towns consultant (CEC) concludes that in 18 months the middle ½ mile of the PEM project area from R monument line to –1.57 NAVD (equal to 0-NGVD) experienced erosion of 0.27 cubic yards per shore foot. The middle ¼ mile of the two Controls averaged erosion of 1.7 cubic yards per shore foot (-3.37, -0.03). Without taking nourishment into consideration FSC was fulfilled. See Table 4.

If compensation for nourishment is included in the 18 months calculation the CEC concludes that the PEM area had lost 1.65 cubic yards per shore foot while the controls on average had lost 2.43 cubic yards, and the FSC is still fulfilled. See Table 4.

Table 4 – CEC's calculation uncompensated and compensated for nourishments

CEC VOLUME ESTIMATES
18 MONTH SUMMARY

9/30/2009

Volume ID	Description	Mar-08 to Aug-09 cy/ft				FSC Met?
		North Control	South Control	North and South Control Average	Project	
MHW*	To +0.25 feet NAVD	-0.76	0.29	-0.24	-0.25	Y
FSC**	To -1.57 feet NAVD (=0.0 feet NGVD)	-3.37	-0.03	-1.70	-0.27	FSC E
-5-ft*	To -5.0 feet NAVD	1.56	0.59	1.08	3.88	S
DOC*	To -16.57 feet NAVD	-1.87	-3.07	-2.47	2.86	

*computed along the entire 1/2-mile (control) and 1-mile (project) area
**computed along the middle 1/4-mile (control) and 1/2-mile (project) area

Volume ID	Description	Mar-08 to Aug-09 Adjusted cy/ft				FSC Met?
		North Control***	South Control	North and South Control Average	Project****	
MHW*	To +0.25 feet NAVD	-2.21	0.29	-0.96	-1.63	Y
FSC**	To -1.57 feet NAVD (=0.0 feet NGVD)	-4.82	-0.03	-2.43	-1.65	FSC E
-5-ft*	To -5.0 feet NAVD	0.11	0.59	0.35	2.50	S
DOC*	To -16.57 feet NAVD	-3.32	-3.07	-3.20	1.48	

*computed along the entire 1/2-mile (control) and 1-mile (project) area
**computed along the middle 1/4-mile (control) and 1/2-mile (project) area
***adjusted to account for 1,400 out of 8,900 cy of sand placed in truck haul at Port de Mer and 2,600 cy of sand placed in truck haul at Deerfield Beach which equates to 1.45 cy/ft of sand along 2756-foot long North Control Area
****adjusted to account for 7,500 cy out of 8,900 cy of sand placed in truck haul at Port de Mer which equates to 1.38 cy/ft of sand along 5432-foot long Project Area

10.2 Shoreline change

The June 2008 truck haul at Port de Mer resulted in an advance of the shoreline at R7 which is clearly visible on the blue graph in Fig. 10 (compare to 0-line). Similarly the Jan 2009 truck haul at Deerfield beach resulted in a wider beach in the North control area. The truck hauls makes comparison of shorelines of limited value.

18 months shoreline change at MHW in the North Control's 9 lines advanced a total of 9 ft. (1 ft/line) and the 16 lines in the Project area advanced 172 ft. (10.7 ft/line). South Control included 9 lines and advanced 22 ft. (2.5 ft/line). 6 months change at N. Control (-6.8 ft/line), Project area (7 ft/line). S. Control (-0.4 ft/line). Sand from truck hauls has not been subtracted.

Shoreline change at MHW, 0.25 ft. after 6, 12 and 18 months

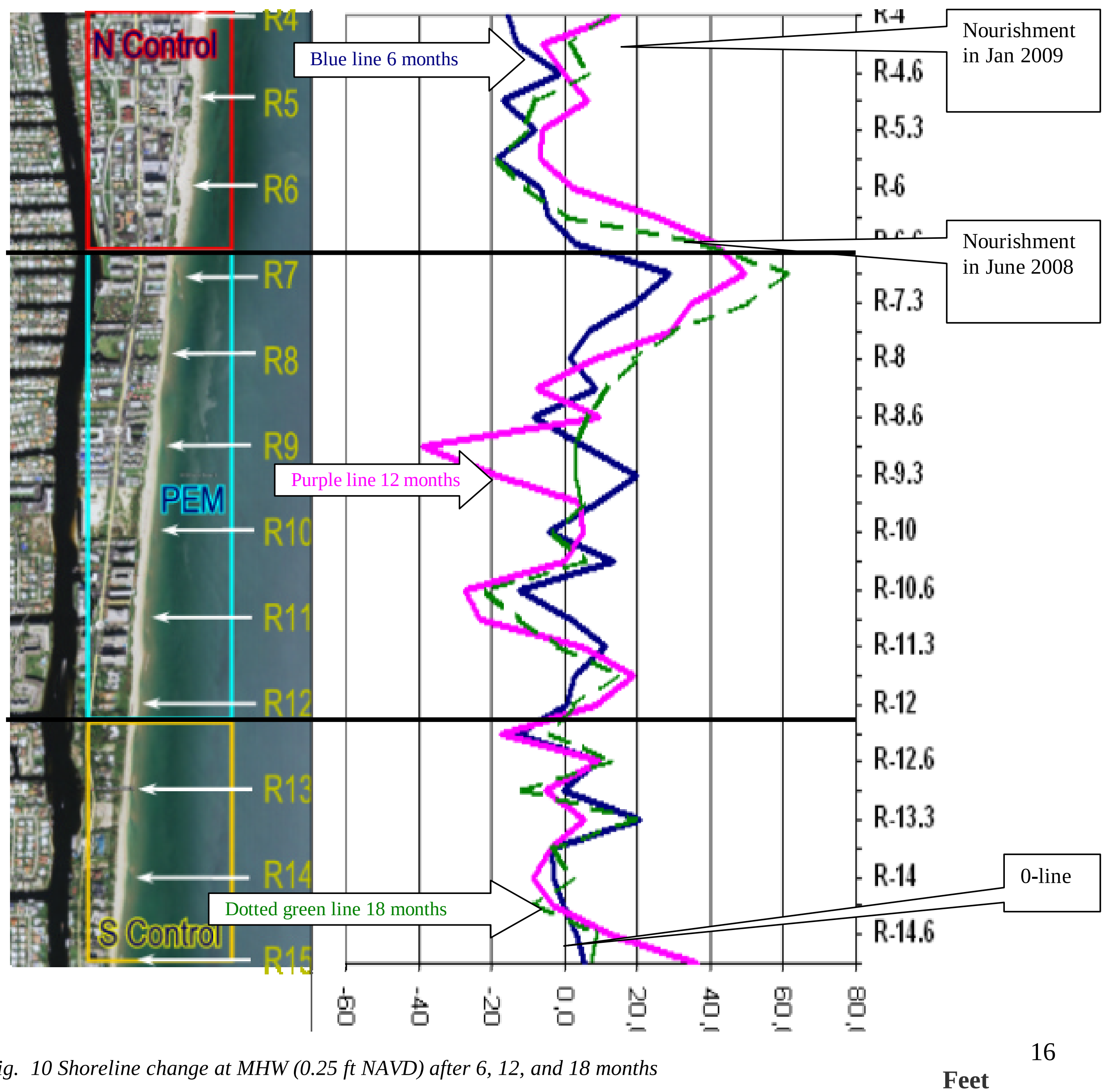

Fig. 10 Shoreline change at MHW (0.25 ft NAVD) after 6, 12, and 18 months

Table 5 - Shoreline change from March 2008 to March 2009

Table 5 presents shoreline change that occurred between March 2008 and March 2009
Sand from truck hauls has not been subtracted.

SHORELINE POSITIONS - Distance in feet from the profile control monuments to the 0.25' NAVD contour (MHW)				
		DISTANCE FROM MONUMENT (FEET)		
PROFILE CONTROL	**LOCATION DESIGNATION**	**PRE/POST-CONSTRUCTION (MARCH, 2008)**	**MARCH, 2009**	**CHANGE FROM MARCH 2008 SURVEY**
R-4	NORTH CONTROL	174,4*	189,41	15,0
R-4.3	NORTH CONTROL	157,3	151,03	-6,3
R-4.6	NORTH CONTROL	139,1	138,64	-0,5
R-5	NORTH CONTROL	128,3	134,54	6,2
R-5.3	NORTH CONTROL	138,5	132,37	-6,1
R-5.6	NORTH CONTROL	139,4	132,74	-6,7
R-6	NORTH CONTROL	202,1	204,26	2,2
R-6.3	NORTH CONTROL	166,4	191,89	25,5
R-6.6	NORTH CONTROL	91,9	133,28	41,4
R-7	PROJECT SITE	23,7	73,35	49,6
R-7.3	PROJECT SITE	24,9	59,95	35,1
R-7.6	PROJECT SITE	27,0	56,36	29,4
R-8	PROJECT SITE	22,3	30,52	8,2
R-8.3	PROJECT SITE	16,1	8,71	-7,4
R-8.6	PROJECT SITE	16,8	26,28	9,5
R-9	PROJECT SITE	118,3	79,31	-39,0
R-9.3	PROJECT SITE	108,0	89,68	-18,3
R-9.6	PROJECT SITE	94,8	99,13	4,3
R-10	PROJECT SITE	105,1	110,21	5,1
R-10.3	PROJECT SITE	80,8	80,89	0,1
R-10.6	PROJECT SITE	97,9	70,85	-27,1
R-11	PROJECT SITE	90,8	67,50	-23,3
R-11.3	PROJECT SITE	72,8	77,60	4,8
R-11.6	PROJECT SITE	64,0	83,18	19,2
R-12	PROJECT SITE	60,9	69,68	8,8
R-12.3	SOUTH CONTROL	73,4	56,24	-17,2
R-12.6	SOUTH CONTROL	53,9	63,55	9,7
R-13	SOUTH CONTROL	89,3	84,26	-5,0
R-13.3	SOUTH CONTROL	67,8	73,29	5,5
R-13.6	SOUTH CONTROL	82,5	78,54	-4,0
R-14	SOUTH CONTROL	68,6	60,37	-8,2
R-14.3	SOUTH CONTROL	75,7	72,21	-3,5
R-14.6	SOUTH CONTROL	76,7	88,81	12,1
R-15	SOUTH CONTROL	111,8	148,28	36,5

* Note: In **Tables 5 through 12** commas are used as decimal points in numbers. Profile R4 reads 174,4 which is 174.4 feet

Table 6 - Shoreline change from March 2008 to Aug 2009 and for the latest 6 months

Table 6 presents shoreline change that occurred between March 2008 and August 2009 and between March 2009 and August 2009

SHORELINE POSITIONS - Distance in feet from the profile control monuments to the 0.25' NAVD contour (MHW)						
		DISTANCE FROM MONUMENT (FEET)				
PROFILE CONTROL	**LOCATION DESIGNATION**	**PRE/POST-CONSTRUCTION (MARCH, 2008)**	**AUGUST, 2009**	**CHANGE FROM MARCH 2008 SURVEY**	**Chg past 6 months**	
R-4	NORTH CONTROL	174,4	185,7	11,3	-3,69	
R-4.3	NORTH CONTROL	157,3	158,8	1,5	7,76	
R-4.6	NORTH CONTROL	139,1	145,4	6,3	6,73	
R-5	NORTH CONTROL	128,3	120,9	-7,4	-13,60	
R-5.3	NORTH CONTROL	138,5	127,4	-11,1	-5,02	-61,4
R-5.6	NORTH CONTROL	139,4	121,2	-18,2	-11,55	
R-6	NORTH CONTROL	202,1	191,5	-10,6	-12,74	
R-6.3	NORTH CONTROL	166,4	166,7	0,3	-25,19	
R-6.6	NORTH CONTROL	91,9	129,2	37,3	-4,13	
R-7	PROJECT SITE	23,7	84,6	60,9	11,23	
R-7.3	PROJECT SITE	24,9	75,2	50,3	15,22	
R-7.6	PROJECT SITE	27,0	56,4	29,4	0,05	
R-8	PROJECT SITE	22,3	41,2	18,9	10,72	
R-8.3	PROJECT SITE	16,1	28,2	12,1	19,53	
R-8.6	PROJECT SITE	16,8	23,8	7,0	-2,48	
R-9	PROJECT SITE	118,3	121,5	3,2	42,17	
R-9.3	PROJECT SITE	108,0	110,7	2,7	21,07	112,6
R-9.6	PROJECT SITE	94,8	99,6	4,8	0,48	
R-10	PROJECT SITE	105,1	102,0	-3,1	-8,18	
R-10.3	PROJECT SITE	80,8	86,1	5,3	5,18	
R-10.6	PROJECT SITE	97,9	76,7	-21,2	5,86	
R-11	PROJECT SITE	90,8	77,8	-13,0	10,26	
R-11.3	PROJECT SITE	72,8	70,7	-2,1	-6,88	
R-11.6	PROJECT SITE	64,0	78,5	14,5	-4,66	
R-12	PROJECT SITE	60,9	62,7	1,8	-6,95	
R-12.3	SOUTH CONTROL	73,4	69,1	-4,3	12,90	
R-12.6	SOUTH CONTROL	53,9	66,4	12,5	2,83	
R-13	SOUTH CONTROL	89,3	77,3	-12,0	-6,98	
R-13.3	SOUTH CONTROL	67,8	87,3	19,5	13,98	
R-13.6	SOUTH CONTROL	82,5	79,2	-3,3	0,69	-3,6
R-14	SOUTH CONTROL	68,6	70,7	2,1	10,32	
R-14.3	SOUTH CONTROL	75,7	67,2	-8,5	-4,97	
R-14.6	SOUTH CONTROL	76,7	85,6	8,9	-3,22	
R-15	SOUTH CONTROL	111,8	119,1	7,3	-29,18	

10.3 Volume change above MHW (0.25 ft NAVD) after 6, 12, and 18 months

From Mar 08 to Aug 09 volume above MHW in the N. Control lost 2,090 cy (-0.76 cy/ft), the PEM project area lost 1,231 cy (-0.23 cy/ft) and the S. Control gained 814 cy (0.30 cy/ft). Mar 08 to Mar 09: N. Control 0.05 cy/ft, PEM –1.73 cy/ft, S. Control –0.88 cy/ft. Mar 09 to Aug 09: N. Control –0.81 cy/ft, PEM 1.5 cy/ft, S. Control 1.17 cy/ft. Sand from truck hauls has not been subtracted.

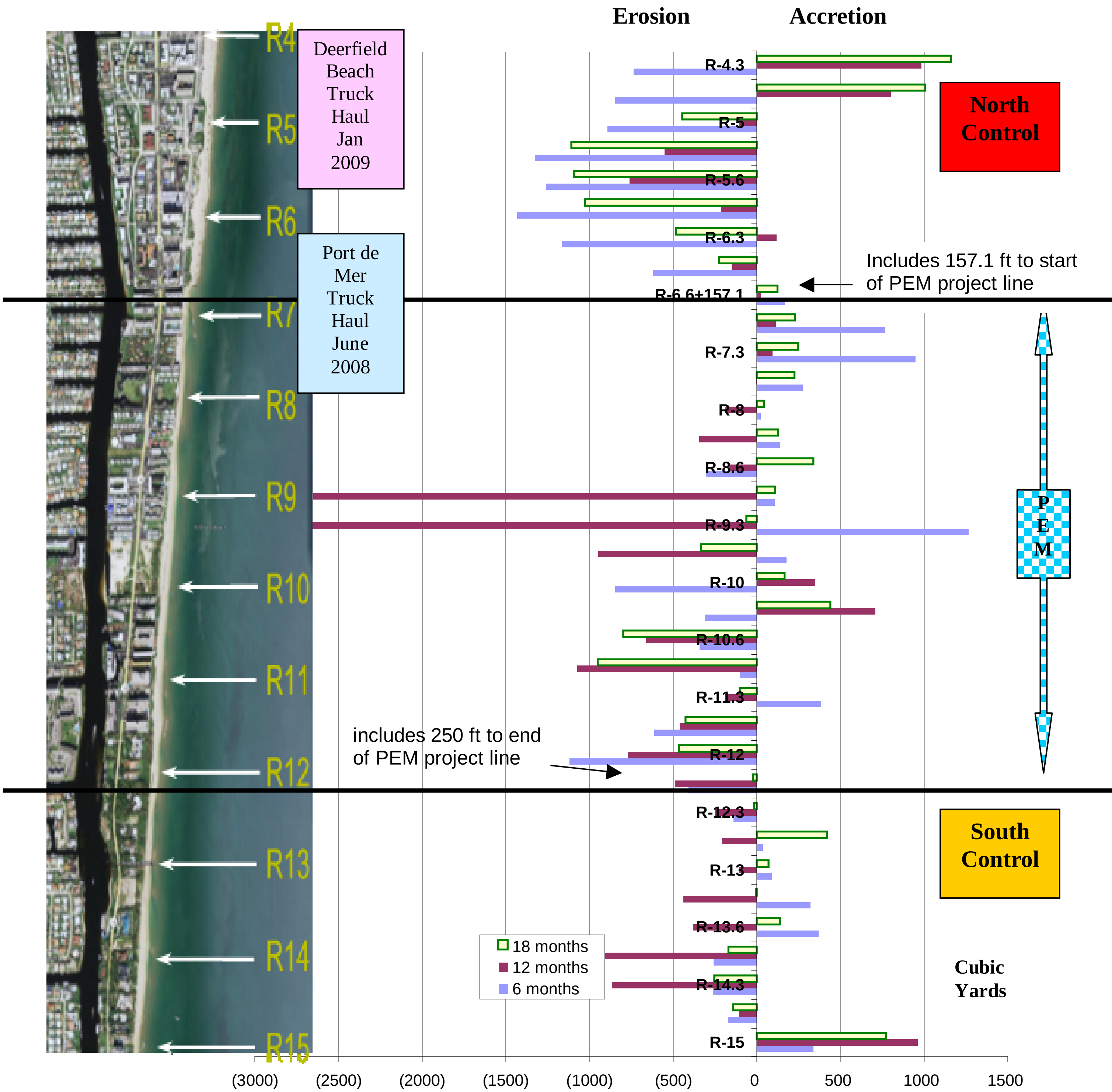

Fig. 11 Volume change from R-Monument to MHW (0.25 ft NAVD) after 6, 12, and 18 months

Table 7 - Volume change above MHW (0.25 ft NAVD) from March 08 to March 09

Table 7 presents volume change above MHW that occurred between March 2008 and March 2009 Sand from truck hauls has not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO MEAN HIGH WATER (MHW)** 0.25' NAVD (1.81' NGVD) March 2008 to March 2009							
NORTH CONTROL AREA							
PROFILE CONTROL	LOCATION DESIGNATION	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE		
		SQ. FT.	SQ. FT.	FEET	CF	CY	CY/FT
R-4	BEG. CONTROL	47,77					
R-4.3	N. CONTROL	114,38	81,08	328,0	26592,60	984,91	
R4.6	N. CONTROL	17,19	65,79	328,0	21577,48	799,17	
R-5	N. CONTROL	(40,77)	(11,79)	241,8	(2850,82)	(105,59)	
R-5.3	N. CONTROL	(49,80)	(45,29)	328,0	(14853,48)	(550,13)	
R-5.6	N. CONTROL	(75,19)	(62,49)	328,0	(20498,36)	(759,20)	
R-6	N. CONTROL	45,45	(14,87)	389,2	(5787,40)	(214,35)	
R-6.3	N. CONTROL	(25,88)	9,79	328,0	3209,48	118,87	
R-6.6	N. CONTROL	1,45	(12,21)	328,0	(4006,52)	(148,39)	
R-6.6+157.1	END CONTROL	7,45	4,45	157,1	699,09	25,89	
TOTAL NORTH CONTROL AREA				**2756,1**		**151,2**	**0,05**
PROJECT AREA							
R-7-250	BEG. PROJECT	7,45					
R-7	PROJECT SITE	17,00	12,23	250,0	3056,25	113,19	
R-7.3	PROJECT SITE	(1,87)	7,56	328,0	2481,32	91,90	
R-7.6	PROJECT SITE	1,58	(0,15)	328,0	(47,56)	(1,76)	
R-8	PROJECT SITE	(45,71)	(22,07)	227,3	(5015,37)	(185,75)	
R-8.3	PROJECT SITE	(10,98)	(28,35)	328,0	(9297,16)	(344,34)	
R-8.6	PROJECT SITE	(16,12)	(13,55)	328,0	(4444,40)	(164,61)	
R-9	PROJECT SITE	(351,65)	(183,89)	389,1	(71549,65)	(2649,99)	
R-9.3	PROJECT SITE	(99,81)	(225,73)	328,0	(74039,44)	(2742,20)	
R-9.6	PROJECT SITE	(55,94)	(77,88)	328,0	(25543,00)	(946,04)	
R-10	PROJECT SITE	109,20	26,63	355,0	9453,65	350,14	
R-10.3	PROJECT SITE	7,50	58,35	328,0	19138,80	708,84	
R-10.6	PROJECT SITE	(116,18)	(54,34)	328,0	(17823,52)	(660,13)	
R-11	PROJECT SITE	(52,07)	(84,13)	343,7	(28913,76)	(1070,88)	
R-11.3	PROJECT SITE	21,22	(15,43)	328,0	(5059,40)	(187,39)	
R-11.6	PROJECT SITE	(97,02)	(37,90)	328,0	(12431,20)	(460,41)	
R-12	PROJECT SITE	(26,74)	(61,88)	336,5	(20822,62)	(771,21)	
R-12+250	END PROJECT	(78,61)	(52,68)	250,0	(13168,75)	(487,73)	
TOTAL PROJECT AREA				**5431,6**		**-9408,4**	**(1,73)**
SOUTH CONTROL AREA							
R-12.3-78	BEG.CONTROL	(78,61)					
R-12.3	S. CONTROL	(94,79)	(86,70)	78,0	(6762,60)	(250,47)	
R-12.6	S. CONTROL	60,17	(17,31)	328,0	(5677,68)	(210,28)	
R-13	S. CONTROL	(76,45)	(8,14)	349,7	(2846,56)	(105,43)	
R-13.3	S. CONTROL	4,52	(35,97)	328,0	(11796,52)	(436,91)	
R-13.6	S. CONTROL	(67,04)	(31,26)	328,0	(10253,28)	(379,75)	
R-14	S. CONTROL	(86,85)	(76,95)	359,0	(27623,26)	(1023,08)	
R-14.3	S. CONTROL	(55,57)	(71,21)	328,0	(23356,88)	(865,07)	
R-14.6	S. CONTROL	38,27	(8,65)	328,0	(2837,20)	(105,08)	
R-15	END CONTROL	125,60	81,93	316,5	25932,43	960,46	
TOTAL SOUTH CONTROL AREA				**2743,2**		**-2415,6**	**(0,88)**
**Note: MHW Elevation based Tide Station Number 872-2862, Hillsboro Inlet (Ocean)							

Table 8 - Volume change above MHW from March 2008 to August 2009 and for the latest 6 months

Table 8 presents volume change above MHW that occurred between March 2008 and August 2009 and between March 2009 and August 2009
Sand from truck hauls has not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO MEAN HIGH WATER (MHW)** 0.25' NAVD (1.81' NGVD) March 2008 to August 2009									
NORTH CONTROL AREA									
PROFILE CONTROL	LOCATION DESIGNATION	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE				
		SQ. FT.	SQ. FT.	FEET	CF	CY	CY/FT	chg past 6 months	
R-4	BEG. CONTROL	49,12							
R-4.3	N. CONTROL	142,14	95,63	328,0	31366,03	1161,70		176,79	
R4.6	N. CONTROL	23,39	82,76	328,0	27146,38	1005,42		206,26	
R-5	N. CONTROL	(123,09)	(49,85)	241,8	(12053,63)	(446,43)		(340,84)	
R-5.3	N. CONTROL	(59,58)	(91,33)	328,0	(29956,67)	(1109,51)		(559,38)	-2241
R-5.6	N. CONTROL	(120,23)	(89,90)	328,0	(29488,46)	(1092,17)		(332,97)	
R-6	N. CONTROL	(22,10)	(71,17)	389,2	(27698,31)	(1025,86)		(811,52)	
R-6.3	N. CONTROL	(57,05)	(39,58)	328,0	(12980,93)	(480,78)		(599,64)	
R-6.6	N. CONTROL	19,86	(18,59)	328,0	(6099,05)	(225,89)		(77,50)	
R-6.6+157.1	END CONTROL	22,54	21,20	157,1	3330,29	123,34		97,45	
TOTAL NORTH CONTROL AREA				2756,1		(2090,2)	(0,76)		
PROJECT AREA									
R-7-250	BEG. PROJECT	22,54							
R-7	PROJECT SITE	26,80	24,67	250,0	6166,70	228,40		115,20	
R-7.3	PROJECT SITE	14,20	20,50	328,0	6724,18	249,04		157,14	
R-7.6	PROJECT SITE	22,78	18,49	328,0	6065,21	224,64		226,40	
R-8	PROJECT SITE	(13,02)	4,88	227,3	1108,58	41,06		226,81	
R-8.3	PROJECT SITE	34,07	10,52	328,0	3451,69	127,84		472,18	
R-8.6	PROJECT SITE	21,73	27,90	328,0	9151,87	338,96		503,57	
R-9	PROJECT SITE	(6,53)	7,60	389,1	2957,47	109,54		2759,52	
R-9.3	PROJECT SITE	(3,96)	(5,25)	328,0	(1720,82)	(63,73)		2678,47	8177
R-9.6	PROJECT SITE	(50,52)	(27,24)	328,0	(8934,70)	(330,91)		615,12	
R-10	PROJECT SITE	76,02	12,75	355,0	4525,97	167,63		(182,51)	
R-10.3	PROJECT SITE	(3,92)	36,05	328,0	11823,99	437,93		(270,92)	
R-10.6	PROJECT SITE	(127,43)	(65,68)	328,0	(21541,66)	(797,84)		(137,71)	
R-11	PROJECT SITE	(21,70)	(74,57)	343,7	(25629,11)	(949,23)		121,65	
R-11.3	PROJECT SITE	4,72	(8,49)	328,0	(2784,61)	(103,13)		84,25	
R-11.6	PROJECT SITE	(74,76)	(35,02)	328,0	(11486,07)	(425,41)		35,00	
R-12	PROJECT SITE	0,25	(37,26)	336,5	(12536,36)	(464,31)		306,90	
R-12+250	END PROJECT	(4,97)	(2,36)	250,0	(590,32)	(21,86)		465,87	
TOTAL PROJECT AREA				5431,6		-1231,4	(0,23)		
SOUTH CONTROL AREA									
R-12.3-78	BEG.CONTROL	(4,97)							
R-12.3	S. CONTROL	(6,60)	(5,79)	78,0	(451,57)	(16,72)		233,74	
R-12.6	S. CONTROL	75,99	34,70	328,0	11380,01	421,48		631,77	
R-13	S. CONTROL	(64,98)	5,51	349,7	1925,45	71,31		176,74	
R-13.3	S. CONTROL	64,15	(0,42)	328,0	(136,20)	(5,04)		431,86	3230
R-13.6	S. CONTROL	(41,61)	11,27	328,0	3697,20	136,93		516,68	
R-14	S. CONTROL	15,93	(12,84)	359,0	(4609,88)	(170,74)		852,35	
R-14.3	S. CONTROL	(57,81)	(20,94)	328,0	(6869,29)	(254,42)		610,65	
R-14.6	S. CONTROL	34,73	(11,54)	328,0	(3785,38)	(140,20)		(35,12)	
R-15	END CONTROL	96,89	65,81	316,5	20829,09	771,45		(189,01)	
TOTAL SOUTH CONTROL AREA				2743,2		814,1	0,30		

**Note: MHW Elevation based Tide Station Number 872-2862, Hillsboro Inlet (Ocean)

10.4 Volume change above Depth Of Closure (DOC) equal to – 16.57 ft NAVD

From Mar 08 to Aug 09 volume above DOC the N. Control area lost 5,145 cy (-1.87 cy/ft), the PEM project area gained 14,029 cy (2.58 cy/ft) and the S. Control area lost 8,876 cy (-3.24 cy/ft). Mar 08 to Mar 09: N. Control 3.73 cy/ft, PEM 3.36 cy/ft, S. Control –1.74 cy/ft. Mar 09 to Aug 09: N. Control –5.6 cy/ft, PEM –0.78 cy/ft, S. Control –1.5 cy/ft. Sand from truck hauls has not been subtracted.

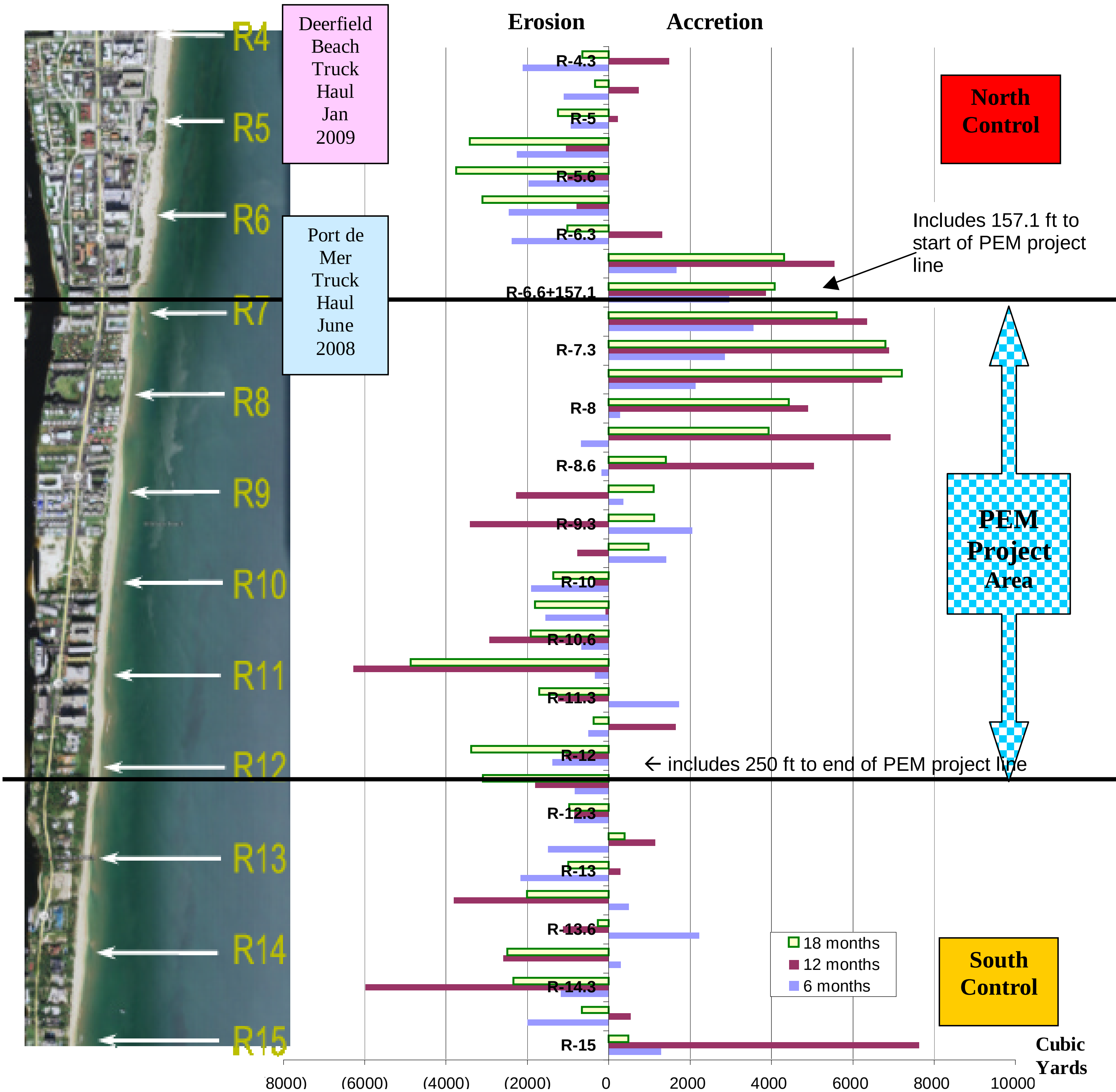

Fig. 12: Volume change from R-Monument to DOC (-16.57 ft NAVD) from March 08 to Sep 08 and March 09

Table 9 - Volume change to DOC (-16.57 ft NAVD) from March 08 to March 09

Table 9 presents volume change above DOC that occurred between March 2008 and March 2009. Sand from truck hauls has not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO DEPTH OF CLOSURE (-16.57' NAVD) (-15.0' NGVD) - March 2008 to March 2009							
NORTH CONTROL AREA							
PROFILE CONTROL	**LOCATION DESIGNATION**	**AREA CHANGE**	**AVERAGE**	**DISTANCE**	**VOLUMETRIC CHANGE**		
		SQ. FT.	**SQ. FT.**	**FEET**	**CF**	**CY**	**CY/FT**
R-4	BEG. CONTROL	247,58					
R-4.3	N. CONTROL	(4,37)	121,61	328,0	39886,44	1477,28	
R4.6	N. CONTROL	124,42	60,02	328,0	19688,20	729,19	
R-5	N. CONTROL	(72,18)	26,12	241,8	6315,82	233,92	
R-5.3	N. CONTROL	(101,38)	(86,78)	328,0	(28463,84)	(1054,22)	
R-5.6	N. CONTROL	(66,55)	(83,96)	328,0	(27540,52)	(1020,02)	
R-6	N. CONTROL	(42,96)	(54,76)	389,2	(21310,65)	(789,28)	
R-6.3	N. CONTROL	259,20	108,12	328,0	35463,36	1313,46	
R-6.6	N. CONTROL	653,66	456,43	328,0	149709,04	5544,78	
R-6.6+157.1	END CONTROL	671,70	662,68	157,1	104107,03	3855,82	
TOTAL NORTH CONTROL AREA				**2756,1**		**10290,9**	**3,73**
PROJECT AREA							
R-7-250	BEG. PROJECT	671,70					
R-7	PROJECT SITE	700,41	686,06	250,0	171513,75	6352,36	
R-7.3	PROJECT SITE	434,57	567,49	328,0	186136,72	6893,95	
R-7.6	PROJECT SITE	672,48	553,53	328,0	181556,20	6724,30	
R-8	PROJECT SITE	491,48	581,98	227,3	132284,05	4899,41	
R-8.3	PROJECT SITE	648,70	570,09	328,0	186989,52	6925,54	
R-8.6	PROJECT SITE	182,82	415,76	328,0	136369,28	5050,71	
R-9	PROJECT SITE	(498,82)	(158,00)	389,1	(61477,80)	(2276,96)	
R-9.3	PROJECT SITE	(64,31)	(281,57)	328,0	(92353,32)	(3420,49)	
R-9.6	PROJECT SITE	(62,82)	(63,57)	328,0	(20849,32)	(772,20)	
R-10	PROJECT SITE	9,27	(26,77)	355,0	(9505,12)	(352,04)	
R-10.3	PROJECT SITE	(22,45)	(6,59)	328,0	(2161,52)	(80,06)	
R-10.6	PROJECT SITE	(460,37)	(241,41)	328,0	(79182,48)	(2932,68)	
R-11	PROJECT SITE	(526,79)	(493,58)	343,7	(169643,45)	(6283,09)	
R-11.3	PROJECT SITE	319,78	(103,51)	328,0	(33949,64)	(1257,39)	
R-11.6	PROJECT SITE	(49,04)	135,37	328,0	44401,36	1644,49	
R-12	PROJECT SITE	(121,63)	(85,34)	336,5	(28715,23)	(1063,53)	
R-12+250	END PROJECT	(269,72)	(195,68)	250,0	(48918,75)	(1811,81)	
TOTAL PROJECT AREA				**5431,6**		**18240,5**	**3,36**
SOUTH CONTROL AREA							
R-12.3-78	BEG.CONTROL	(269,72)					
R-12.3	S. CONTROL	(315,92)	(292,82)	78,0	(22839,96)	(845,92)	
R-12.6	S. CONTROL	503,82	93,95	328,0	30815,60	1141,32	
R-13	S. CONTROL	(459,78)	22,02	349,7	7700,39	285,20	
R-13.3	S. CONTROL	(166,86)	(313,32)	328,0	(102768,96)	(3806,26)	
R-13.6	S. CONTROL	(18,45)	(92,65)	328,0	(30390,84)	(1125,59)	
R-14	S. CONTROL	(372,08)	(195,26)	359,0	(70100,13)	(2596,30)	
R-14.3	S. CONTROL	(613,28)	(492,68)	328,0	(161599,04)	(5985,15)	
R-14.6	S. CONTROL	700,90	43,81	328,0	14369,68	532,21	
R-15	END CONTROL	600,24	650,57	316,5	205905,41	7626,13	
TOTAL SOUTH CONTROL AREA				**2743,2**		**-4774,4**	**(1,74)**

**Note: Depth of Closure (DOC) based upon Hillsboro Beach / Deerfield Beach Nourishment Project, 4th Year Post-Construction Monitoring Report prepared for Town of Hillsboro Beach by Coastal Systems International, Inc. dated October 2002.

Table 10 - Volume change to DOC from March 08 to August 09 and for the latest 6 months

Table 10 presents volume change above DOC that occurred between March 2008 and August 2009 and between March 2009 and August 2009
Sand from truck hauls have not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO DEPTH OF CLOSURE (-16.57' NAVD) (-15.0' NGVD) - March 2008 to August 2009									
NORTH CONTROL AREA									
PROFILE CONTROL	LOCATION DESIGNATION	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE				
		SQ. FT.	SQ. FT.	FEET	CF	CY	CY/FT	chg past 6 months	
R-4	BEG. CONTROL	(95,38)							
R-4.3	N. CONTROL	(11,24)	(53,31)	328,0	(17486,34)	(647,64)		-2125	
R4.6	N. CONTROL	(44,98)	(28,11)	328,0	(9220,19)	(341,49)		-1071	
R-5	N. CONTROL	(234,72)	(139,85)	241,8	(33815,89)	(1252,44)		-1486	
R-5.3	N. CONTROL	(327,52)	(281,12)	328,0	(92207,39)	(3415,09)		-2361	
R-5.6	N. CONTROL	(290,18)	(308,85)	328,0	(101302,32)	(3751,94)		-2732	-15436
R-6	N. CONTROL	(140,17)	(215,17)	389,2	(83745,62)	(3101,69)		-2312	
R-6.3	N. CONTROL	(27,24)	(83,70)	328,0	(27454,52)	(1016,83)		-2330	
R-6.6	N. CONTROL	736,63	354,70	328,0	116340,26	4308,90		-1236	
R-6.6+157.1	END CONTROL	663,45	700,04	157,1	109976,45	4073,20		217	
TOTAL NORTH CONTROL AREA				**2756,1**		**(5145,0)**	**(1,87)**		
PROJECT AREA									
R-7-250	BEG. PROJECT	663,45							
R-7	PROJECT SITE	547,01	605,23	250,0	151307,74	5603,99		-748	
R-7.3	PROJECT SITE	572,40	559,70	328,0	183582,27	6799,34		-95	
R-7.6	PROJECT SITE	614,20	593,30	328,0	194602,27	7207,49		483	
R-8	PROJECT SITE	436,55	525,38	227,3	119418,58	4422,91		-476	
R-8.3	PROJECT SITE	209,12	322,84	328,0	105890,62	3921,87		-3004	
R-8.6	PROJECT SITE	21,63	115,38	328,0	37843,30	1401,60		-3649	
R-9	PROJECT SITE	132,01	76,82	389,1	29891,09	1107,08		3384	
R-9.3	PROJECT SITE	52,45	92,23	328,0	30251,77	1120,44		4541	
R-9.6	PROJECT SITE	108,65	80,55	328,0	26419,96	978,52		1751	
R-10	PROJECT SITE	(316,21)	(103,78)	355,0	(36842,84)	(1364,55)		-1013	-4212
R-10.3	PROJECT SITE	17,65	(149,28)	328,0	(48963,71)	(1813,47)		-1733	
R-10.6	PROJECT SITE	(334,46)	(158,41)	328,0	(51957,05)	(1924,34)		1008	
R-11	PROJECT SITE	(430,99)	(382,73)	343,7	(131543,32)	(4871,97)		1411	
R-11.3	PROJECT SITE	149,68	(140,65)	328,0	(46134,63)	(1708,69)		-451	
R-11.6	PROJECT SITE	(210,73)	(30,53)	328,0	(10012,23)	(370,82)		-2015	
R-12	PROJECT SITE	(332,59)	(271,66)	336,5	(91414,52)	(3385,72)		-2322	
R-12+250	END PROJECT	(335,94)	(334,27)	250,0	(83566,49)	(3095,06)		-1283	
TOTAL PROJECT AREA				**5431,6**		**14028,6**	**2,58**		
SOUTH CONTROL AREA									
R-12.3-78	BEG.CONTROL	(335,94)							
R-12.3	S. CONTROL	(336,98)	(336,46)	78,0	(26243,94)	(972,00)		-126	
R-12.6	S. CONTROL	401,25	32,14	328,0	10540,54	390,39		-751	
R-13	S. CONTROL	(555,38)	(77,06)	349,7	(26948,18)	(998,08)		-1283	
R-13.3	S. CONTROL	224,61	(165,38)	328,0	(54245,44)	(2009,09)		1797	-4102
R-13.6	S. CONTROL	(270,14)	(22,76)	328,0	(7466,33)	(276,53)		849	
R-14	S. CONTROL	(104,65)	(187,40)	359,0	(67274,82)	(2491,66)		105	
R-14.3	S. CONTROL	(281,36)	(193,00)	328,0	(63305,44)	(2344,65)		3641	
R-14.6	S. CONTROL	172,24	(54,56)	328,0	(17894,50)	(662,76)		-1195	
R-15	END CONTROL	(88,97)	41,64	316,5	13178,74	488,10		-7138	
TOTAL SOUTH CONTROL AREA				**2743,2**		**-8876,3**	**(3,24)**		

**Note: Depth of Closure (DOC) based upon Hillsboro Beach / Deerfield Beach Nourishment Project, 4th Year Post-Construction Monitoring Report prepared for Town of Hillsboro Beach by Coastal Systems International, Inc. dated October 2002.

10.5 Volume change from R-monument to –5 ft NAVD

From Mar 08 to Aug 09 volume above –5 ft NAVD in the N. Control area gained 5,513 cy (2.0 cy/ft), the PEM project area gained 38,368 cy (7.06 cy/ft) and the S. Control area gained 5,588 cy (2,04cy/ft). Mar 08 to Mar 09: N. Control 2.55 cy/ft, PEM 2.68 cy/ft, S. Control –1.16cy/ft. Mar 09 to Aug 09: N. Control –0.55 cy/ft, PEM 4.38 cy/ft, S. Control 3.2 cy/ft. Sand from truck hauls has not been subtracted.

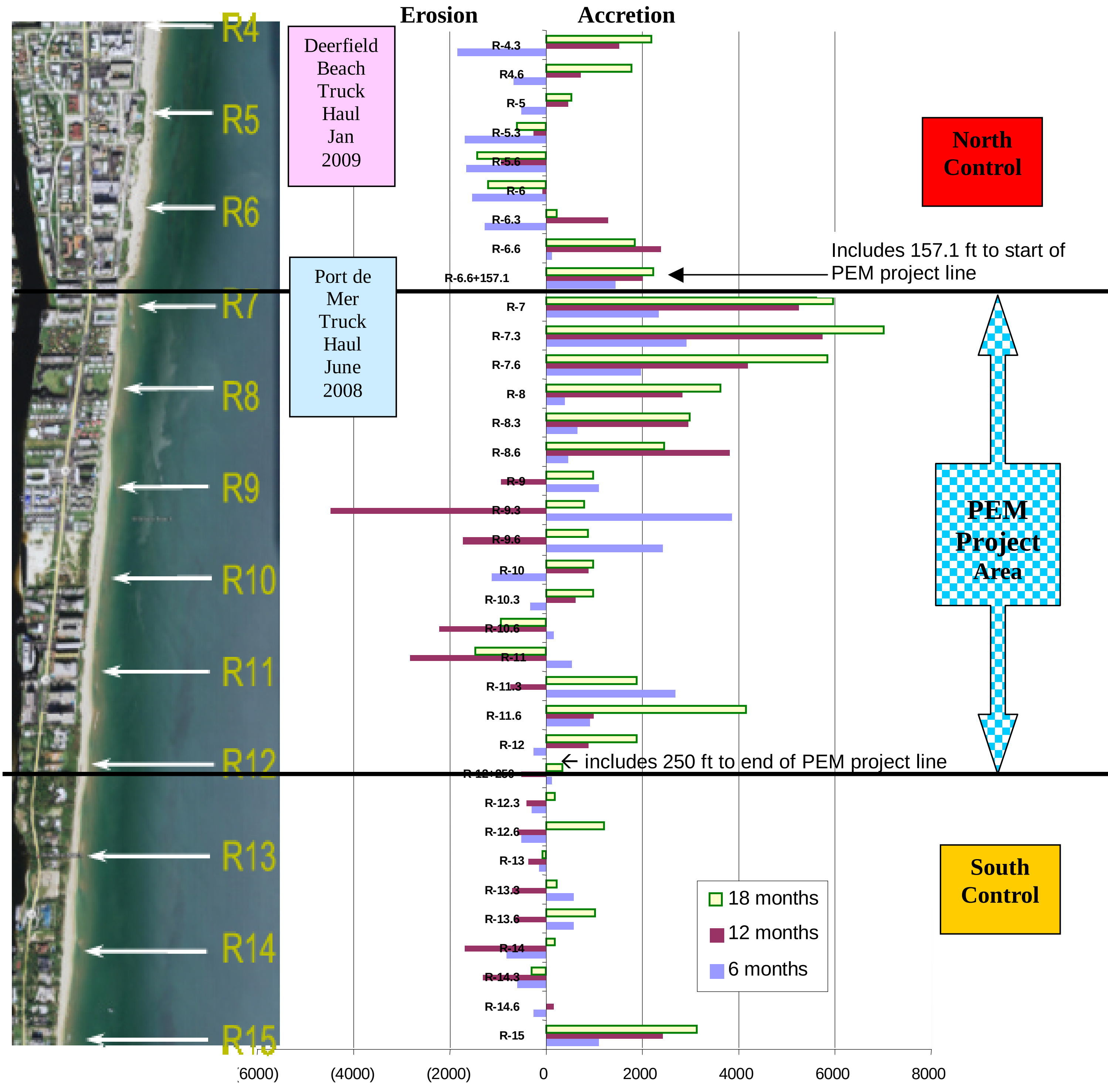

Fig. 13: Volume change from R-Monument to –5ft NAVD after 6,12, and 18 months

Table 11 - Volume change to -5 ft NAVD from March 08 to March 09

Table 11 presents volume change above – 5ft NAVD that occurred between March 2008 and March 2009 Sand from truck hauls has not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO -5.00' NAVD - March 08 to March 09							
	NORTH CONTROL AREA						
PROFILE CONTROL	LOCATION DESIGNATION	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE		
		SQ. FT.	SQ. FT.	FEET	CF	CY	CY/FT
R-4	EG. CONTRO	205,79					
R-4.3	N. CONTROL	40,25	123,02	328,0	40350,56	1494,47	
R4.6	N. CONTROL	76,53	58,39	328,0	19151,92	709,33	
R-5	N. CONTROL	21,56	49,05	241,8	11859,08	439,23	
R-5.3	N. CONTROL	(67,31)	(22,88)	328,0	(7503,00)	(277,89)	
R-5.6	N. CONTROL	(85,33)	(76,32)	328,0	(25032,96)	(927,15)	
R-6	N. CONTROL	76,14	(4,60)	389,2	(1788,37)	(66,24)	
R-6.3	N. CONTROL	136,91	106,53	328,0	34940,20	1294,08	
R-6.6	N. CONTROL	254,43	195,67	328,0	64179,76	2377,03	
R-6.6+157.1	END CONTROL	428,52	341,48	157,1	53645,72	1986,88	
TOTAL NORTH CONTROL AREA				2756,1		7029,7	2,55
	PROJECT AREA						
R-7-250	BEG. PROJECT	428,52					
R-7	ROJECT SIT	705,56	567,04	250,0	141760,00	5250,37	
R-7.3	ROJECT SIT	239,74	472,65	328,0	155029,20	5741,82	
R-7.6	ROJECT SIT	451,20	345,47	328,0	113314,16	4196,82	
R-8	ROJECT SIT	218,22	334,71	227,3	76079,58	2817,76	
R-8.3	ROJECT SIT	264,57	241,40	328,0	79177,56	2932,50	
R-8.6	ROJECT SIT	365,06	314,82	328,0	103259,32	3824,42	
R-9	ROJECT SIT	(495,26)	(65,10)	389,1	(25330,41)	(938,16)	
R-9.3	ROJECT SIT	(242,75)	(369,01)	328,0	(121033,64)	(4482,73)	
R-9.6	ROJECT SIT	(42,14)	(142,45)	328,0	(46721,96)	(1730,44)	
R-10	ROJECT SIT	175,59	66,73	355,0	23687,38	877,31	
R-10.3	ROJECT SIT	(78,41)	48,59	328,0	15937,52	590,28	
R-10.6	ROJECT SIT	(290,71)	(184,56)	328,0	(60535,68)	(2242,06)	
R-11	ROJECT SIT	(155,32)	(223,02)	343,7	(76650,26)	(2838,90)	
R-11.3	ROJECT SIT	32,29	(61,52)	328,0	(20176,92)	(747,29)	
R-11.6	ROJECT SIT	127,97	80,13	328,0	26282,64	973,43	
R-12	ROJECT SIT	12,30	70,13	336,5	23600,43	874,09	
R-12+250	END PROJECT	(124,40)	(56,05)	250,0	(14012,50)	(518,98)	
TOTAL PROJECT AREA				5431,6		14580,2	2,68
	SOUTH CONTROL AREA						
R-12.3-78	BEG.CONTROL	(124,40)					
R-12.3	S. CONTROL	(167,05)	(145,73)	78,0	(11366,55)	(420,98)	
R-12.6	S. CONTROL	67,63	(49,71)	328,0	(16304,88)	(603,88)	
R-13	S. CONTROL	(126,47)	(29,42)	349,7	(10288,17)	(381,04)	
R-13.3	S. CONTROL	6,93	(59,77)	328,0	(19604,56)	(726,09)	
R-13.6	S. CONTROL	(110,10)	(51,59)	328,0	(16919,88)	(626,66)	
R-14	S. CONTROL	(146,33)	(128,22)	359,0	(46029,19)	(1704,78)	
R-14.3	S. CONTROL	(70,04)	(108,19)	328,0	(35484,68)	(1314,25)	
R-14.6	S. CONTROL	95,96	12,96	328,0	4250,88	157,44	
R-15	END CONTROL	318,65	207,31	316,5	65612,03	2430,08	
TOTAL SOUTH CONTROL AREA				2743,2		-3190,2	(1,16)

Table 12 - Volume[4] change to –5 ft NAVD from March 08 to August 09 and for the latest 6 months

Table 12 presents volume change above – 5 ft NAVD that occurred between March 2008 and August 2009 and between March 2009 and August 2009.
Sand from truck hauls has not been subtracted.

VOLUMETRIC CHANGE ANALYSIS TO -5.00' NAVD - March 2008 to August 2009									
NORTH CONTROL AREA									
PROFILE CONTROL	LOCATION DESIGNATION	AREA CHANGE	AVERAGE	DISTANCE	VOLUMETRIC CHANGE				
		SQ. FT.	SQ. FT.	FEET	CF	CY	CY/FT	Chg past 6 months	
R-4	BEG. CONTROL	233,37							
R-4.3	N. CONTROL	128,30	180,83	328,0	59313,26	2196,79		702,32	
R4.6	N. CONTROL	162,72	145,51	328,0	47726,57	1767,65		1058,32	
R-5	N. CONTROL	(48,54)	57,09	241,8	13804,17	511,27		72,04	
R-5.3	N. CONTROL	(51,34)	(49,94)	328,0	(16380,37)	(606,68)		(328,79)	
R-5.6	N. CONTROL	(186,14)	(118,74)	328,0	(38946,31)	(1442,46)		(515,31)	**(1517)**
R-6	N. CONTROL	17,99	(84,08)	389,2	(32722,46)	(1211,94)		(1145,71)	
R-6.3	N. CONTROL	17,04	17,51	328,0	5744,25	212,75		(1081,33)	
R-6.6	N. CONTROL	286,09	151,56	328,0	49712,86	1841,22		(535,81)	
R-6.6+157.1	END CONTROL	485,40	385,74	157,1	60600,23	2244,45		257,57	
TOTAL NORTH CONTROL AREA				**2756,1**		**5513,0**	**2,00**		
PROJECT AREA									
R-7-250	BEG. PROJECT	485,40							
R-7	PROJECT SITE	802,57	643,99	250,0	160996,70	5962,84		712,47	
R-7.3	PROJECT SITE	353,31	577,94	328,0	189565,58	7020,95		1279,13	
R-7.6	PROJECT SITE	606,83	480,07	328,0	157463,07	5831,97		1635,14	
R-8	PROJECT SITE	253,07	429,95	227,3	97726,77	3619,51		801,75	
R-8.3	PROJECT SITE	238,14	245,60	328,0	80557,72	2983,62		51,12	
R-8.6	PROJECT SITE	166,17	202,16	328,0	66307,41	2455,83		(1368,59)	
R-9	PROJECT SITE	(31,12)	67,53	389,1	26274,42	973,13		1911,29	
R-9.3	PROJECT SITE	163,09	65,98	328,0	21642,46	801,57		5284,30	
R-9.6	PROJECT SITE	(20,61)	71,24	328,0	23366,85	865,44		2595,88	
R-10	PROJECT SITE	167,97	73,68	355,0	26156,47	968,76		91,45	**23788**
R-10.3	PROJECT SITE	(8,53)	79,72	328,0	26147,09	968,41		378,13	
R-10.6	PROJECT SITE	(144,10)	(76,32)	328,0	(25031,83)	(927,10)		1314,96	
R-11	PROJECT SITE	(84,40)	(114,25)	343,7	(39267,91)	(1454,37)		1384,53	
R-11.3	PROJECT SITE	398,10	156,85	328,0	51447,18	1905,45		2652,74	
R-11.6	PROJECT SITE	286,15	342,13	328,0	112217,13	4156,19		3182,76	
R-12	PROJECT SITE	15,60	150,88	336,5	50769,79	1880,36		1006,27	
R-12+250	END PROJECT	61,13	38,37	250,0	9591,94	355,26		874,24	
TOTAL PROJECT AREA				**5431,6**		**38367,8**	**7,06**		
SOUTH CONTROL AREA									
R-12.3-78	BEG.CONTROL	61,13							
R-12.3	S. CONTROL	75,34	68,23	78,0	5322,17	197,12		618,10	
R-12.6	S. CONTROL	121,30	98,32	328,0	32248,93	1194,40		1798,29	
R-13	S. CONTROL	(131,48)	(5,09)	349,7	(1778,73)	(65,88)		315,16	
R-13.3	S. CONTROL	168,27	18,40	328,0	6033,79	223,47		949,57	
R-13.6	S. CONTROL	(3,30)	82,48	328,0	27054,83	1002,03		1628,69	**8778**
R-14	S. CONTROL	31,84	14,27	359,0	5123,29	189,75		1894,54	
R-14.3	S. CONTROL	(81,53)	(24,84)	328,0	(8148,04)	(301,78)		1012,47	
R-14.6	S. CONTROL	82,24	0,36	328,0	117,56	4,35		(153,09)	
R-15	END CONTROL	454,28	268,26	316,5	84904,07	3144,60		714,52	
TOTAL SOUTH CONTROL AREA				**2743,2**		**5588,1**	**2,04**		
**Note: MHW Elevation based Tide Station Number 872-2862, Hillsboro Inlet (Ocean)									

[4] For the -5.0 feet NAVD computations the most seaward 5-foot contour is to be used in cases where there is an offshore bar with 5-foot contours on either side. This method differs from the method used by CEC and explains the variations in results

11.0 Compensation for nourishment

It is complicated to accurately compensate for the influence of nourishment that took place in June 2008 and Jan 2009. The reasons are:

> **1.** The Port de Mer truck haul of 8,900 cu ft was placed at the North end of the PEM area reaching into the North Control area. Sand was placed from the sea wall and more than 100 ft into the ocean. After 15 months of sand movement (sand was placed in June 2008) it becomes difficult to estimate how much sand moved to where. The sand is somewhere along the coastline (North/South) and somewhere between the dune and depth of closure (East/West). When compensating it is normal to estimate where the sand has moved to along the coastline (here in the North/South direction), but not the distribution from R-monument line to the sea (here East/West). If R10 has received 1,000 cy from sand that was originally placed at R7 this will be subtracted from the surveyed volume at R10. However, it is common correct the volume by subtracting the full volume (1,000 cy) from the volume recorded at MHW, MLW, -5ft etc. For this correction to be in line with reality all the sand should be placed between the R monument line and MHW, which would mean a wall of sand by the dune. If no distribution is used from R-monument line to sea, the areas that receive the highest nourishment, and therefore also has to be corrected the most, will have a too large amount of sand deducted from all surveyed volumes except depth of closure, and the distortion will increase the closer you get to the R-Monument. No exact distribution can be used as we don't know the distribution from dune to sea but one suggestion, in lack of a more precise method, would be to consider 25% of the sand to be between R- Mon and MHW, 50% between R-Mon and –1.57 NAVD, 75% between R-Mon and –5 ft NAVD and 100% between R-Mon and DOC. This calculation can be critical if a value such as the FSC is used to determine success or failure, and EcoShore strongly recommends that this model, or a similar type, is used to get as close as possible to the reality on the beach.
>
> The 18 month survey calculated by CEC showed a clear effect of PEM and a successful FSC calculation in spite that no distribution of sand from R-monument line to sea was used, and all values (MHW, -1.57 NAVD, -5ft NAVD, DOC) had the same amount of sand deducted. See Table 4 and 14.
>
> **2.** We have limited knowledge of where truck haul in Jan 2009 was placed, and it is possible that a lot of sand was placed in the North Control area, indicated by this area advancing strongly between September 2008 and March 2009.
>
> The reservations above re the East/West distribution of sand is also relevant in relation to the Deerfield truck haul in Jan 2009.

To compensate for nourishment CEC reduces all the values in the North Control area by 1.45 cy/ft and in the PEM project area by 1.38 cy/ft and nothing in the South Control. We believe it is more correct to reduce in accordance with the example given above, where the volume subtracted approaches 100% the closer you get to the depth of closure.

Our own analysis of the effect of nourishment combines the volumetric changes from tables 8, 10, and 12 computed by SDI with CEC's calculated distribution of nourished sand and the above model. The method and the adjusted volumes can be seen in Table 13 and 14.

Table 13 - Volume adjusted for nourishment March 2008 to August 2009 (18 months)

Volume adjusted for nourishment March 2008 to August 2009 (18 months)												
Vol ID	Description	Weight	Deduct from survey		N. Control cy/ft		S. Control cy/ft		Avg. N+S	PEM cy/ft	
			N. Con.	PEM	Survey	**Adjust**	Surv.	**Adj.**	**Adjust**	Survey	**Adjust**
MHW	To +0.25 ft NAVD	25%	0.36 cy	0.35 cy	-0.76	**-1.12**	0.80	**0.80**	**-0.16**	-0.28	**-0.63**
FSC	To –1.57 ft NAVD	50%	0.73 cy	0.69 cy	-3.37	**-4.10**	-0.03	**-0.03**	**-2.07**	-0.24	**-0.93**
-5ft	To –5ft NAVD	75%	1.09 cy	1.10 cy	2.0	**0.91**	2.04	**2.04**	**1.48**	7.06	**5.96**
DOC	To-16.57 ft NAVD	100%	1.45 cy	1.38 cy	-1.87	**-3.32**	-3.24	**-3.24**	**-3.28**	2.58	**1.2**

Adjusted for nourishment the FSC calculation above shows that the erosion is 122% higher in the control areas than the PEM area (–2.07 cy/ft compared to -0.93 cy/ft).

12.0 Other information

12.1 Storms prior to the 6 and 12 months tests

The 6 months test was made as Hurricane Ike went past in September 2008 which caused loss of beach. The 12 months test was similarly done after bad weather, this time due to persistent north eastern strong winds. Again the beaches took a beating and lost sand.

The 18 months test was done after a normal weather period of more than 2 weeks and was representative for how the beach had looked for several months.

12.2 Influence on down drift beaches

Since the sixties the erosion rate in Hillsboro Beach has been 2 to 12 ft. per year averaging 5 to 6 ft/yr[5]. The South Control area (down drift) gained 2.9 ft during the first year and 2.5 ft after 18 months, indicating that this area is not negatively influenced by the PEMs.

12.3 Qualitative assessment of the beaches

The Beach Raker drives the beach several times a week. Since the end of March 2009 he has not experienced any erosion and has, for the first time in several years, been able to drive on the beach from Port de Mer to south of the Test area.

12.4 Tests

A ground water test was conducted in February/March 2008 and November/December 2008. It indicated that water pressure in the beach was reduced when PEMs were inserted. The test also indicated that the beach has a high water pressure, which may be caused by a number of factors such as rainfall runoff, excessive irrigation or water pressure from intra coastal. If this shall be investigated further a more comprehensive test plan is needed with ground water monitors placed in the intra coastal, as well as monitors installed capable of measuring salinity to find the cause of the high water pressure.

[5] Town of Hillsboro Beach Experimental Test Plan December 5, 2007. Data originally from DEP/Beaches.

Turtle behavior has been monitored, and temperature and humidity in the beach has been tested in 2008 and in 2009. The 2008 data has been analysed and a report was submitted by Curtis M. Burney, PhD, Nova Southeastern University, Oceanographic Center, Florida. The executive summary reads:

- There was no evidence of a reduction of nesting in the PEM area. Loggerhead and green turtle nesting in the PEM area was similar to the south control area and higher than the north control area.
- There was no evidence of a consistent reduction in loggerhead and green nesting success (nests / total crawls). Loggerhead nesting success was both higher and lower in some project areas than in the control areas.
- There was no evidence of a consistent reduction in loggerhead or green hatchling emergence success in the PEM area. One-way ANOVA of 86 evaluated loggerhead and 12 green nests showed no significant differences in PEM and control zones, except for one PEM zone where loggerhead emergence was significantly higher than one control zone.
- Sand temperatures in the PEM area averaged slightly lower than in the control areas by less than 0.6^{o}C. but the difference was statistically significant in only one comparison.

Similarly no effects on shorebirds were reported either.

12.5 Comparison of results from SDI and CEC

Sea Diversified (SDI) is the licensed surveyor that performed all surveys. The calculation of volumes was performed by SDI and these volumes are used in this report.

The Towns consultant Coastal Engineering Consultants (CEC) has made its own calculation of volumes.

Different computer programs installed at SDI and CEC will result in slightly different volumes.

The volumes from SDI and CEC at –5ft NAVD varied more than normally and the reason was investigated. It turned out to be a question of how many crossings are included. The seabed does not fall in a straight line, and may cross the threshold (-5ft NAVD) several times, and the volume will differ depending on which crossing is used.. The SDI method include more crossings and the volumes were 82% higher in the PEM area and 88% higher in the control areas, compared to the CEC method. When the same method (crossings) was used the two engineers arrived at almost identical numbers.

As argued in Section 11 EcoShore will use a correction for nourishment that comes closer to reality, however still without being perfect. This will influence corrected volumes especially at calculations close to the dune. The different correction methods and the resulting differences can be seen in Table 14.

In this report the SDI/EcoShore method is used except where otherwise specified.

Table 14 - Comparison of volumes adjusted for nourishment. EcoShore/SDI versus CEC

Comparison of volumes adjusted for nourishment. March 2008 to August 2009 EcoShore/SDI versus CEC																
	Deduct from volume in cy (nothing deducted from S. Control)				Volume before correction						Volume after correction					
	EcoShore/SDI		CEC		EcoShore/SDI			CEC			EcoShore/SDI			CEC		
	PEM	N. Cont	PEM	N. Cont	PEM	N.C	S.C	PEM	N.C.	S.C.	PEM	N.C.	S.C.	PEM	N.C.	S.C.
MHW	0.35	0.36	1.38	1.45	-0.28	-0.76	0.80	-0.25	-0.76	0.29	-0.63	-1.12	.80	-1.63	-2.21	-0.29
FSC	0.69	0.73	1.38	1.45	-0.24	-3.37	-0.03	-0.27	-3.37	-0.03	-0.93	-4.10	-0.03	-1.65	-4.82	-0.03
-5ft	1.10	1.09	1.38	1.45	7.06	2.0	2.04	3.88	1.56	0.59	5.96	.0.91	2.04	2.50	0.11	0.59
DOC	1.38	1.45	1.38	1.45	2.58	-1.87	-3.24	2.86	-1.87	-3.07	1.2	-3.32	-3.24	1.48	-3.32	-3.07

13.0 Financial comparison

From the R-monument line to –5 ft NAVD the PEM area gained 5.96 cy/ft while the North and South Control gained an avg. of 1.48 cy/ft (N: 0.91 / S: 2.04). The difference was 4.48 cy/ft, which over a stretch of 5,432 ft is equal to 24,300 cubic yards.

The above calculations have sand deducted that was placed during truck hauls. For details see volume after correction in Table 14.

At a price of $50 per cubic yard (the neighboring town paid $58.50 per cubic yard in 2009) the 24,300 cubic yards represent a cost of over $1.2 million.

The price the Town paid for lease of PEM was below $250,000, and consequently the Town has saved over $1 million in 18 months by using PEM rather than trucked-in sand.

14.0 Conclusion

This report describes the 6 and 18 months result of the Town of Hillsboro Beach experimental PEM project. The information is designed to provide FDEP and Broward County with the necessary data to observe and assess with quantitative measurements the performance of the project, potential adverse effects and the need for adjustment or modification.

PEMs are independent permeable drain tubes installed vertically into the shore from the dune to MLW to mitigate erosion by reducing water pressure in the beach. PEMs were installed on 1 mile in Feb. 2008.

Two truck hauls have been made in and close by the experiment in June 2008 and Jan 2009. The effect of these truck hauls have been deducted in the volume estimates below.

To filter out effects of short term weather input, which can cause the dry beach to shrink or expand over a few hours, we focus on the more stable measurements at – 5 ft NAVD and Depth of Closure, DOC.

At –5 ft NAVD the PEM project area gained 5.96 cubic yards per shore foot (cy/ft) from March 2008 to August 2009 (18 months) while the North Control gained 0.91 cy/ft and the South Control gained 2.04 cy/ft. The difference between PEM and Control areas is equal to 24,300 cy.

If the area observed is widened to Depth of Closure the volumes are as follows: PEM +1.2 cy/ft, N. Control –3.32 cy/ft and S. Control –3.24 cy/ft.

The Towns consultant CEC arrives at the following DOC figures: PEM +1.48 cy/ft, N. Control –3.32 cy/ft and S. Control –3.07 cy/ft. The difference between PEM and Control areas is equal to 25,400 cy.

The volume was reduced in the South Control area, however the shoreline advanced 2.5ft in 18 months, and there are no indications that the PEM project caused downdrift erosion, and no adverse effects have been recorded as of the date of this survey.

Last time the area was nourished was in 1998 where R7 to R8 experienced a volume increase of 86,000 cy (=starting point and 100%). The volume fell to 66,000 cy (77%) and 46,000 cy (53%), 12 and 23 month after nourishment, respectively. The same area was nourished in 2008, however this time PEMs had been installed before new sand was added. After the truck haul the area between R7 and R8 experienced a volume increase of 7,217 cy (= starting point and 100%). In 9 months the volume had increased to 15,000 cy (210%), and after 15 months to 19,000 cy (260%).

No turtle issues have been reported and no shorebird problems were reported either.

A cost-benefit analysis shows that the PEM system is competitive. The Town has saved more than $1 million over 18 months, compared to what the neighboring town has paid for trucked in sand.

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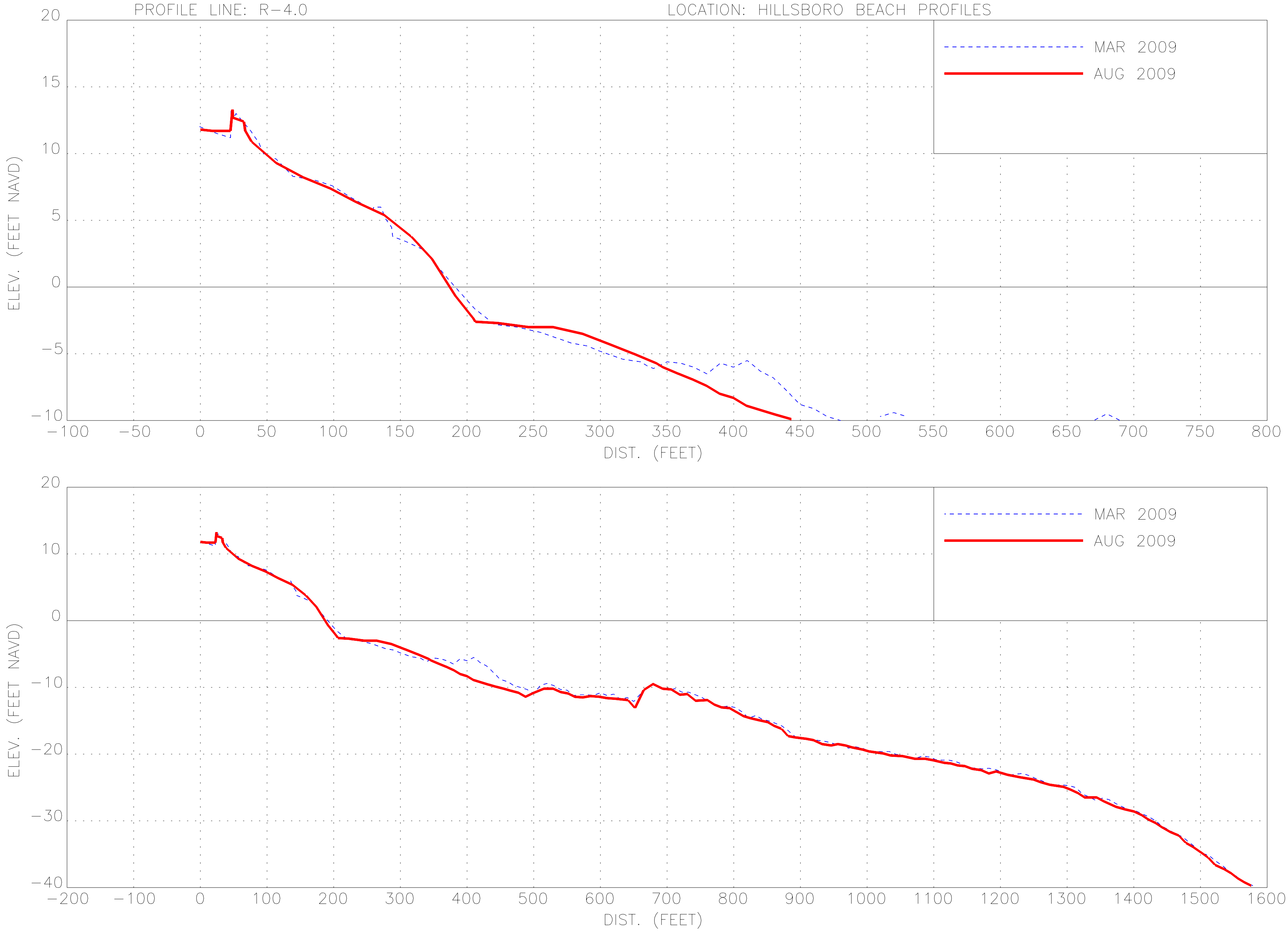
2255 Glades Road, Suite 324A
Boca Raton FL 33431
Tel: 888-733-1736, Fax: 801-740-7654
www.ecoshore.com, kwc@ecoshore.com

Appendix 1

X-Sections R4 – R15
March 2009 – August 2009



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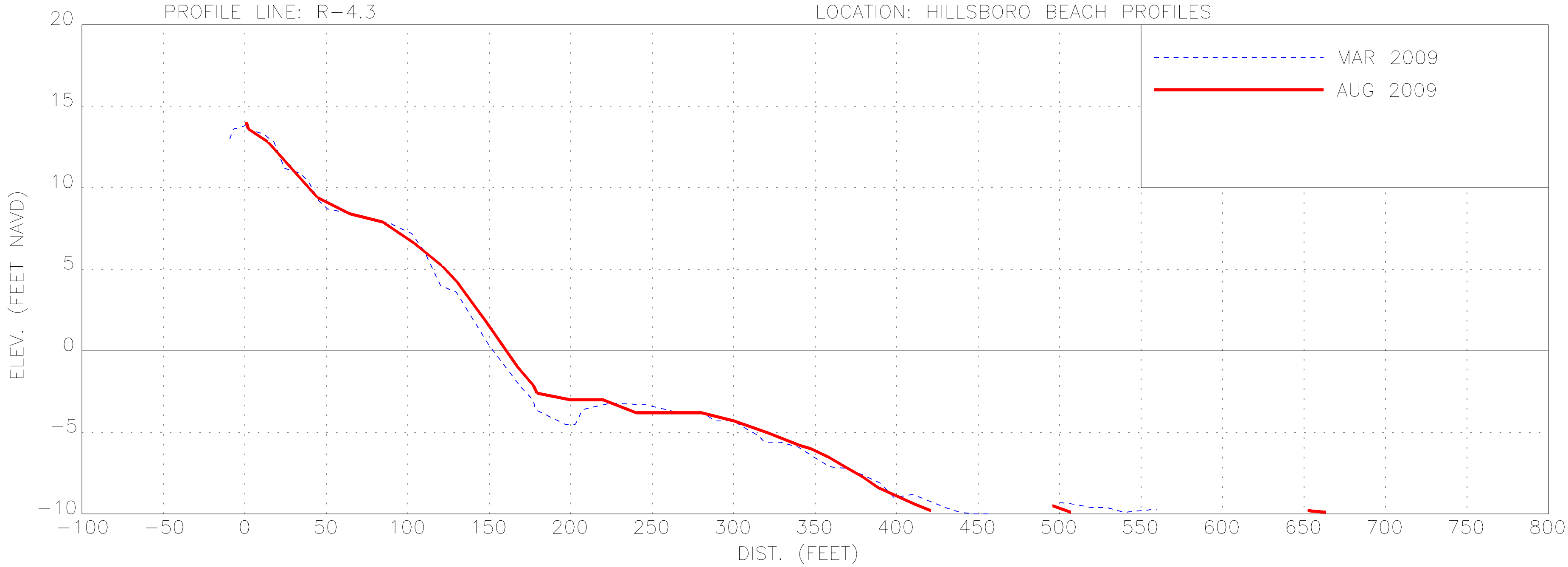
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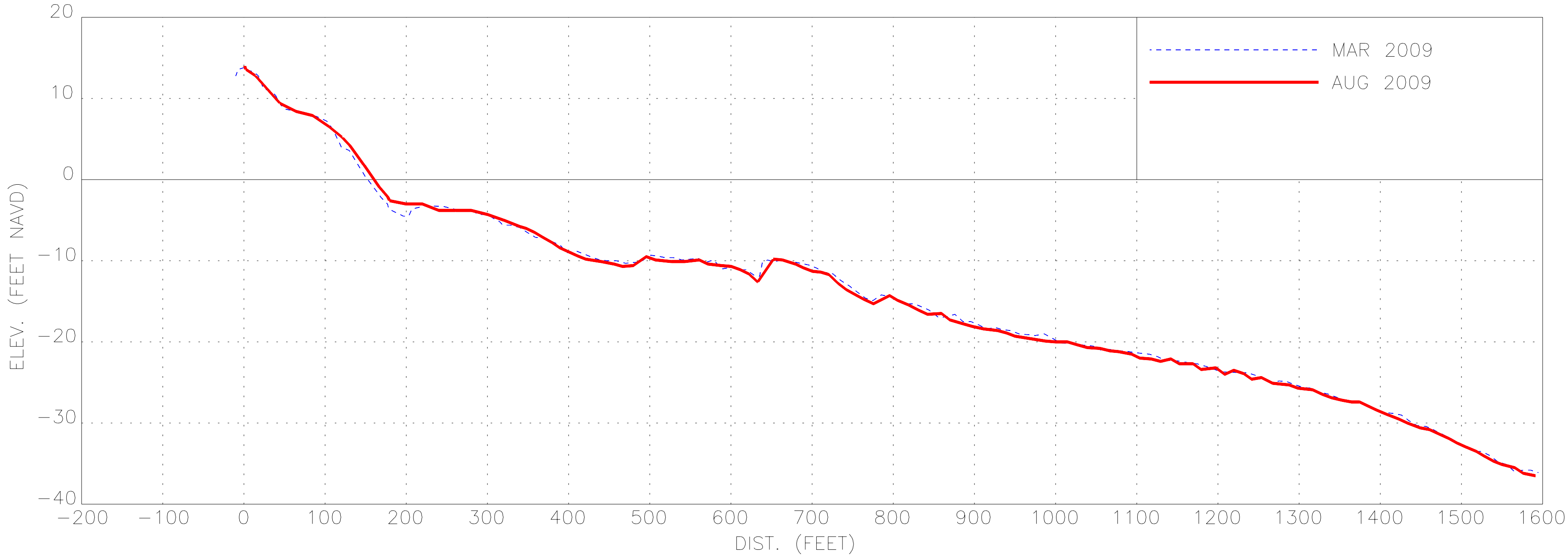
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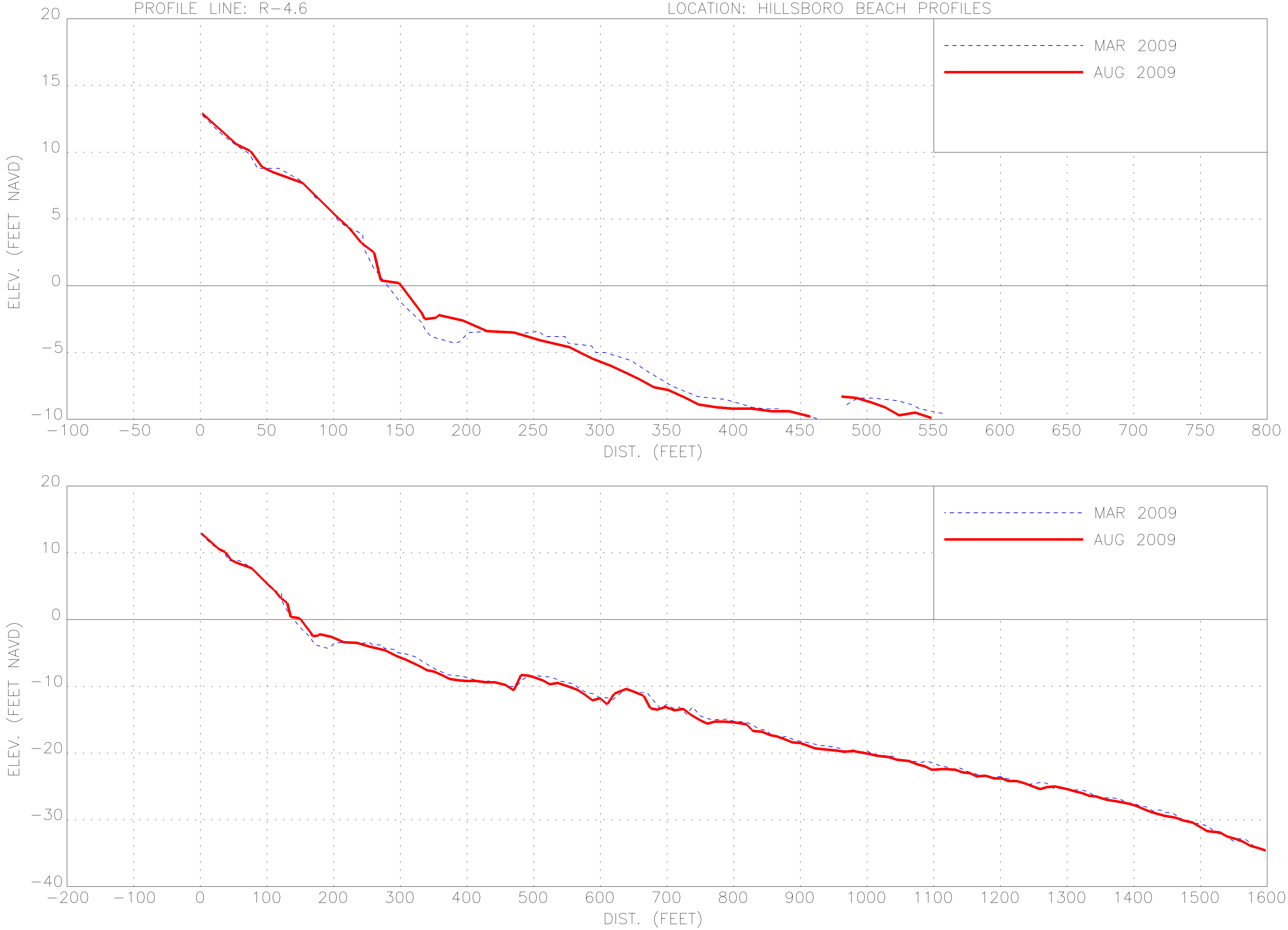

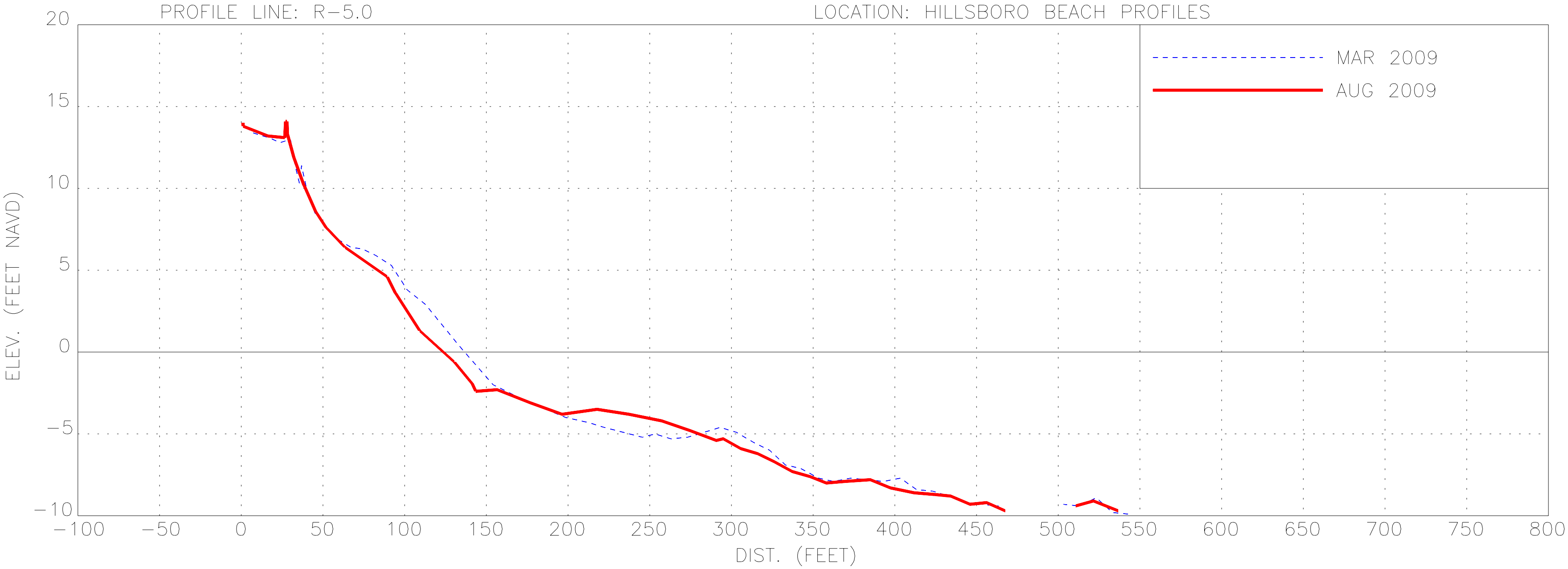
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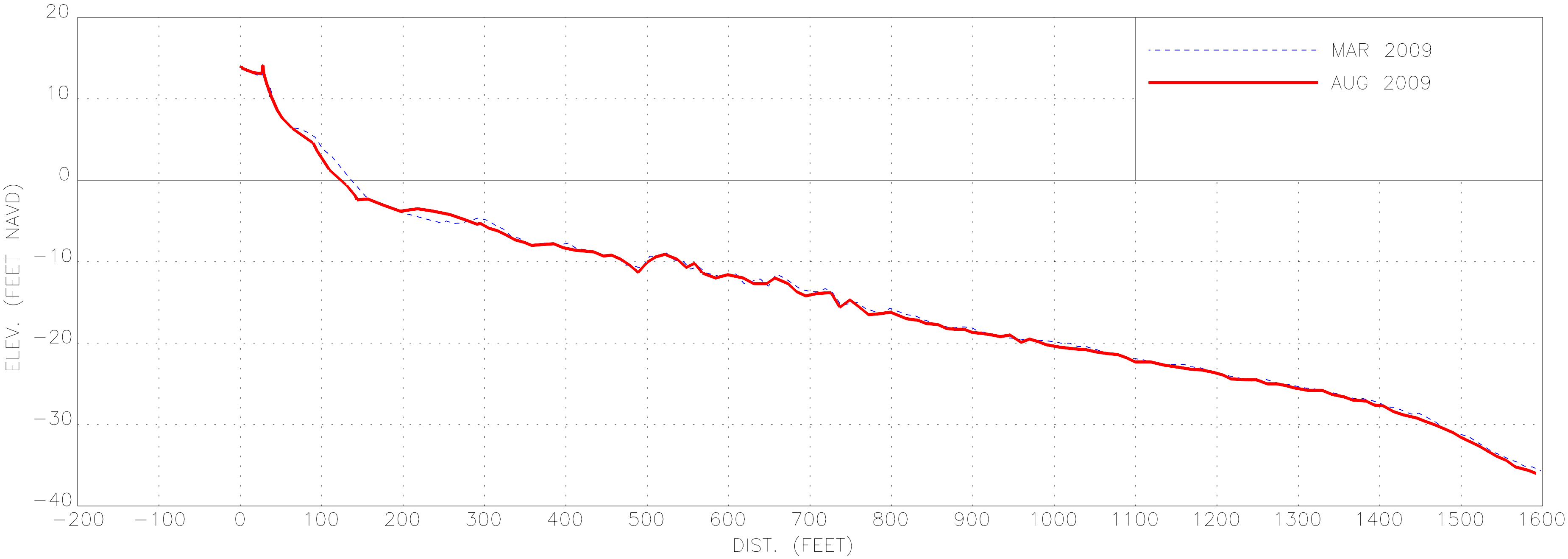
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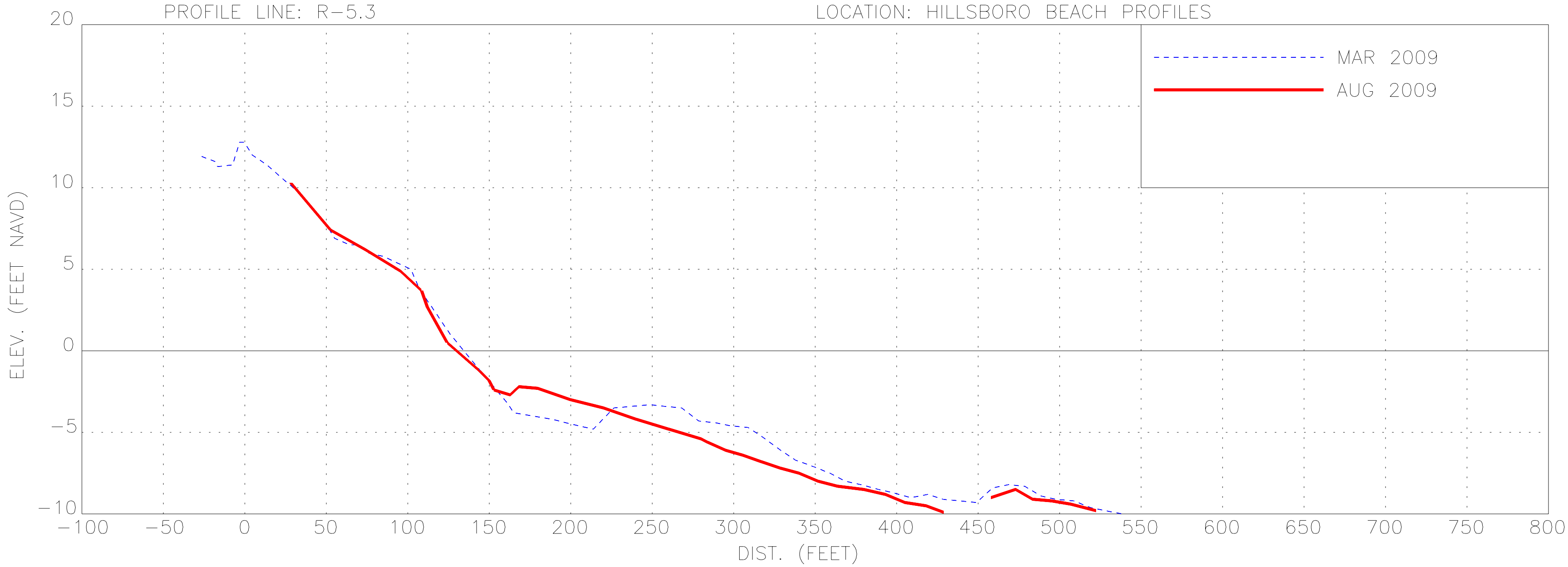

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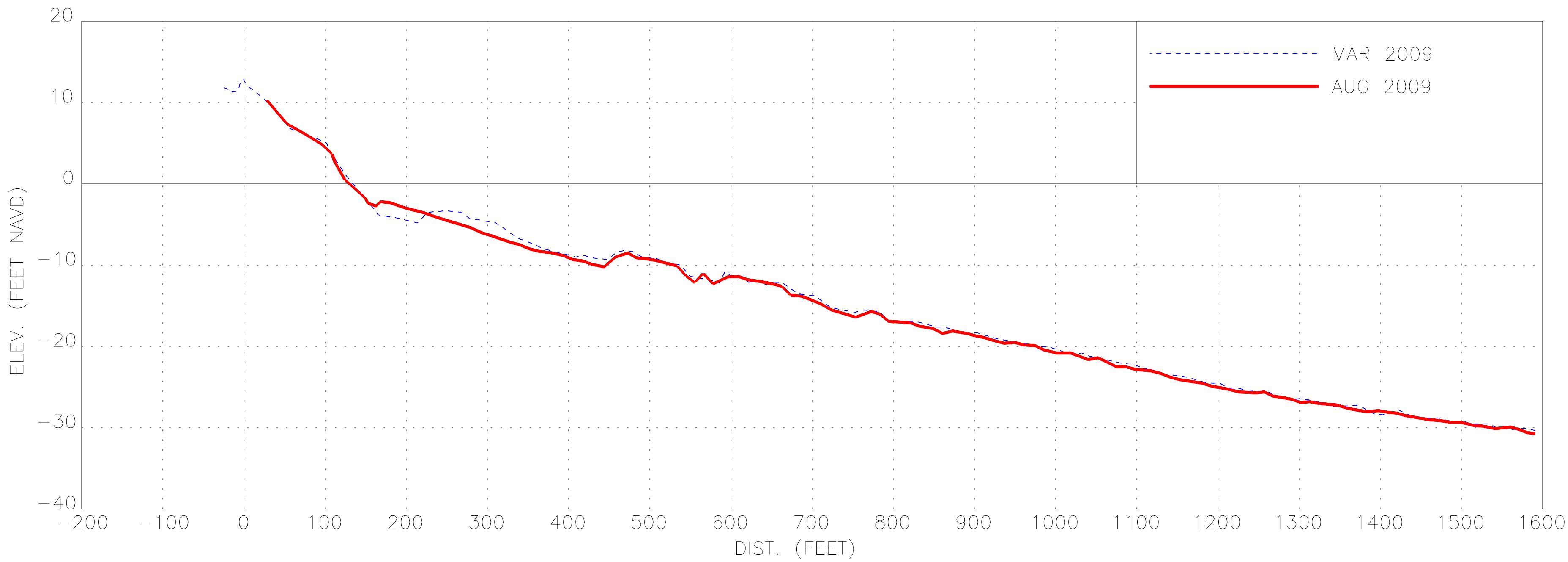

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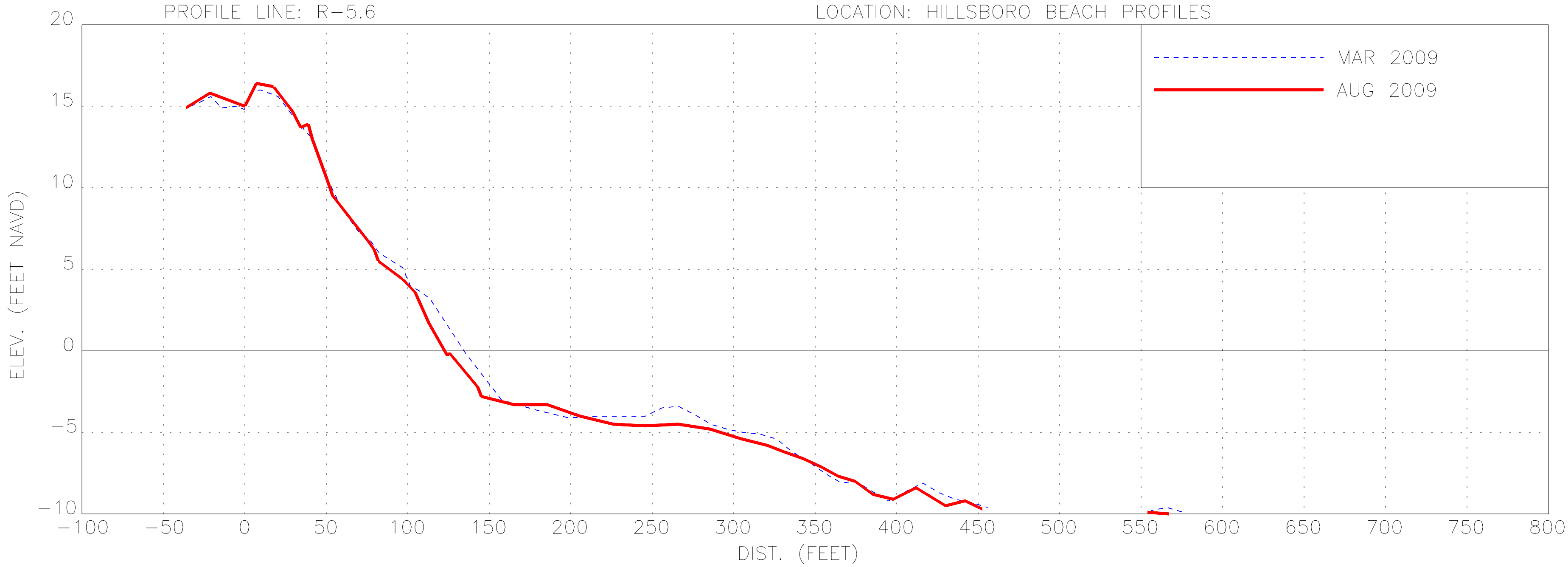
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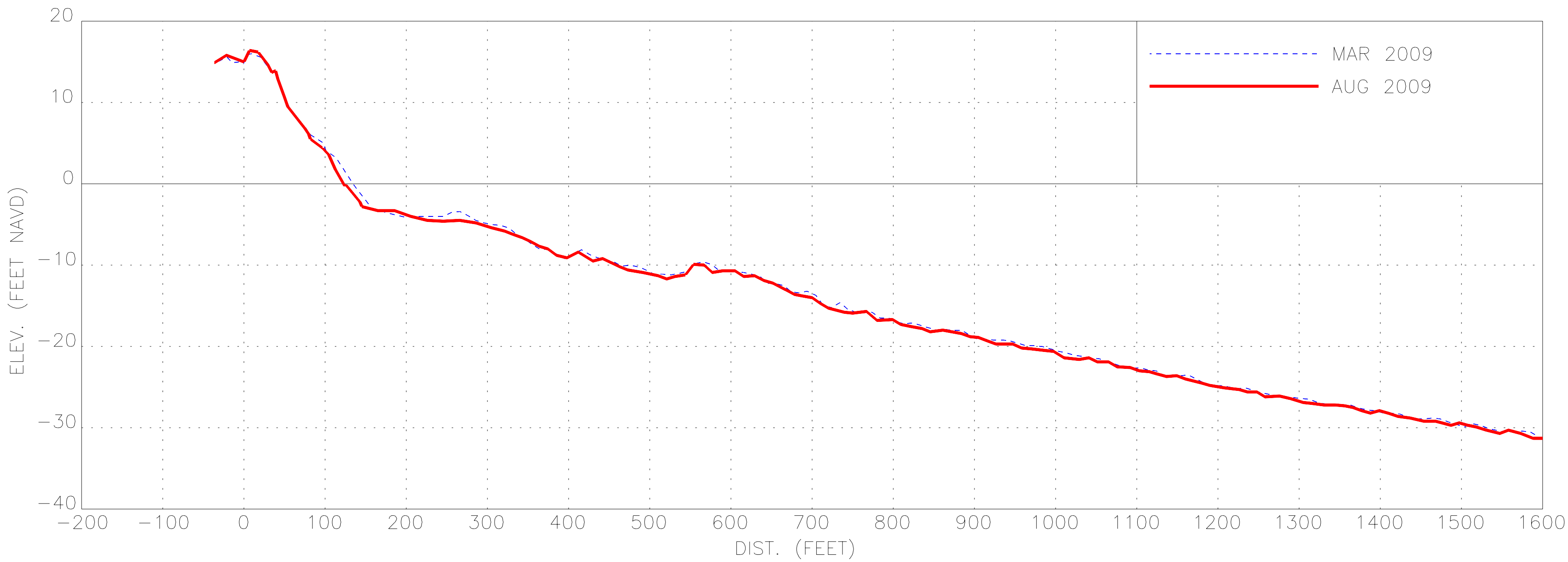
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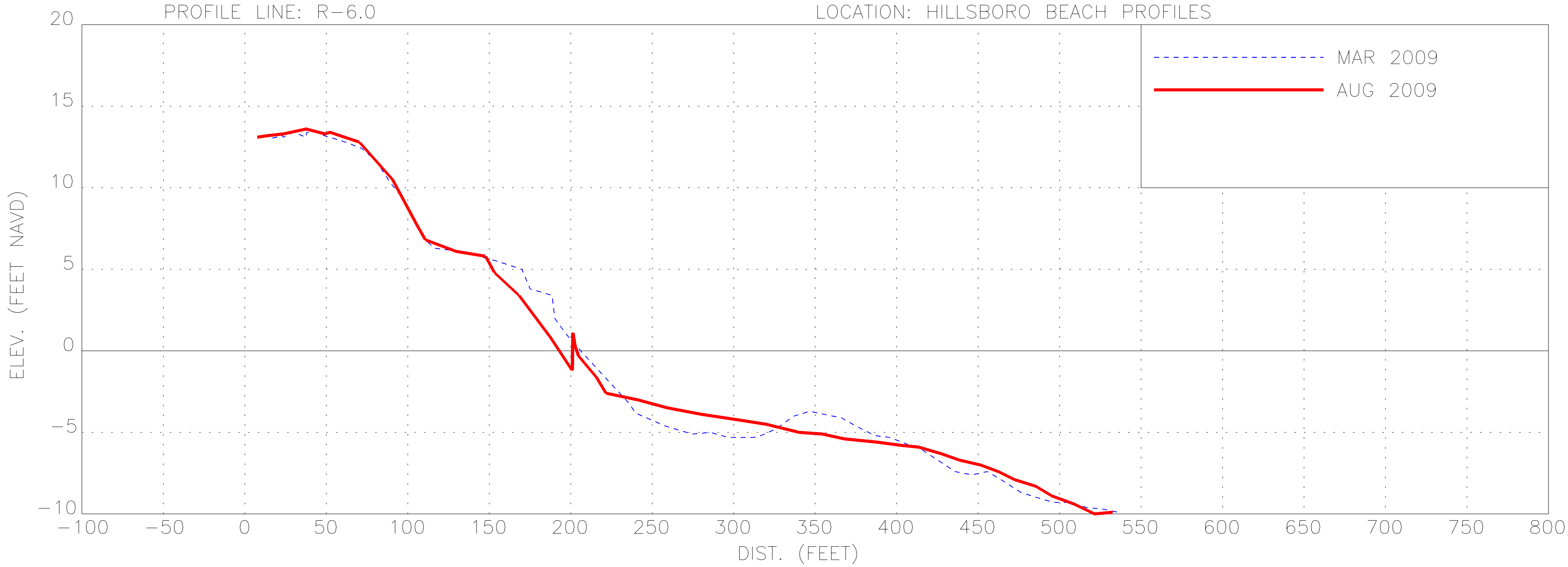
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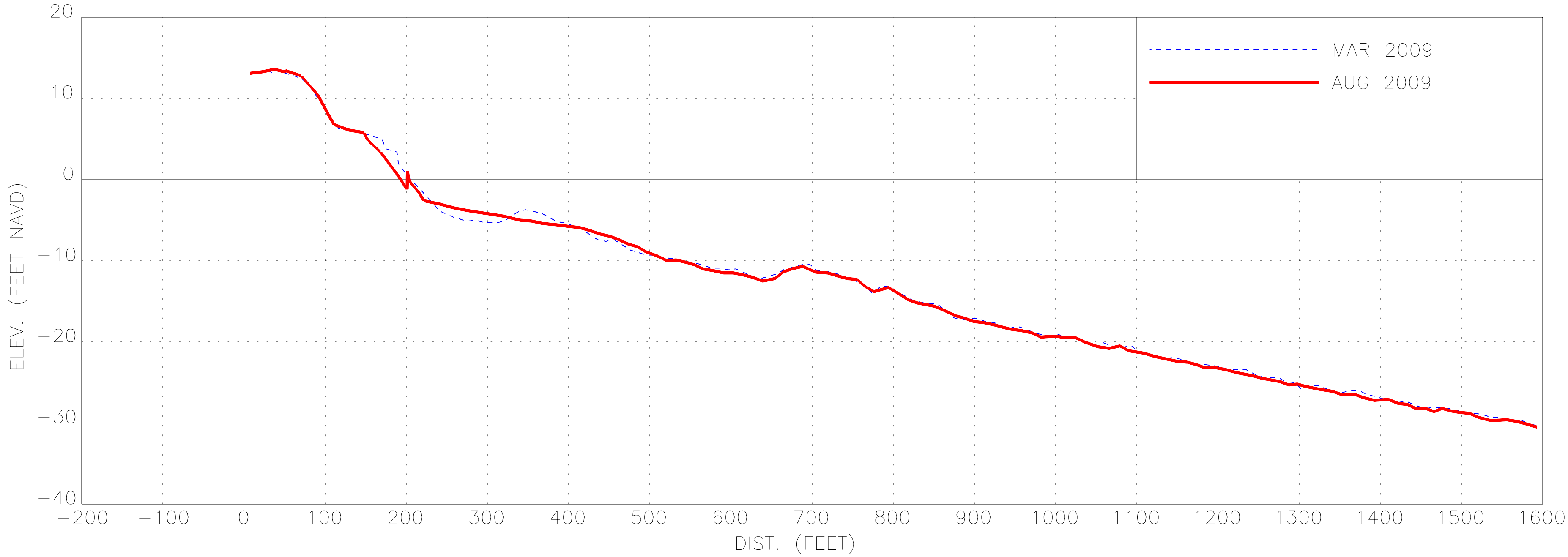
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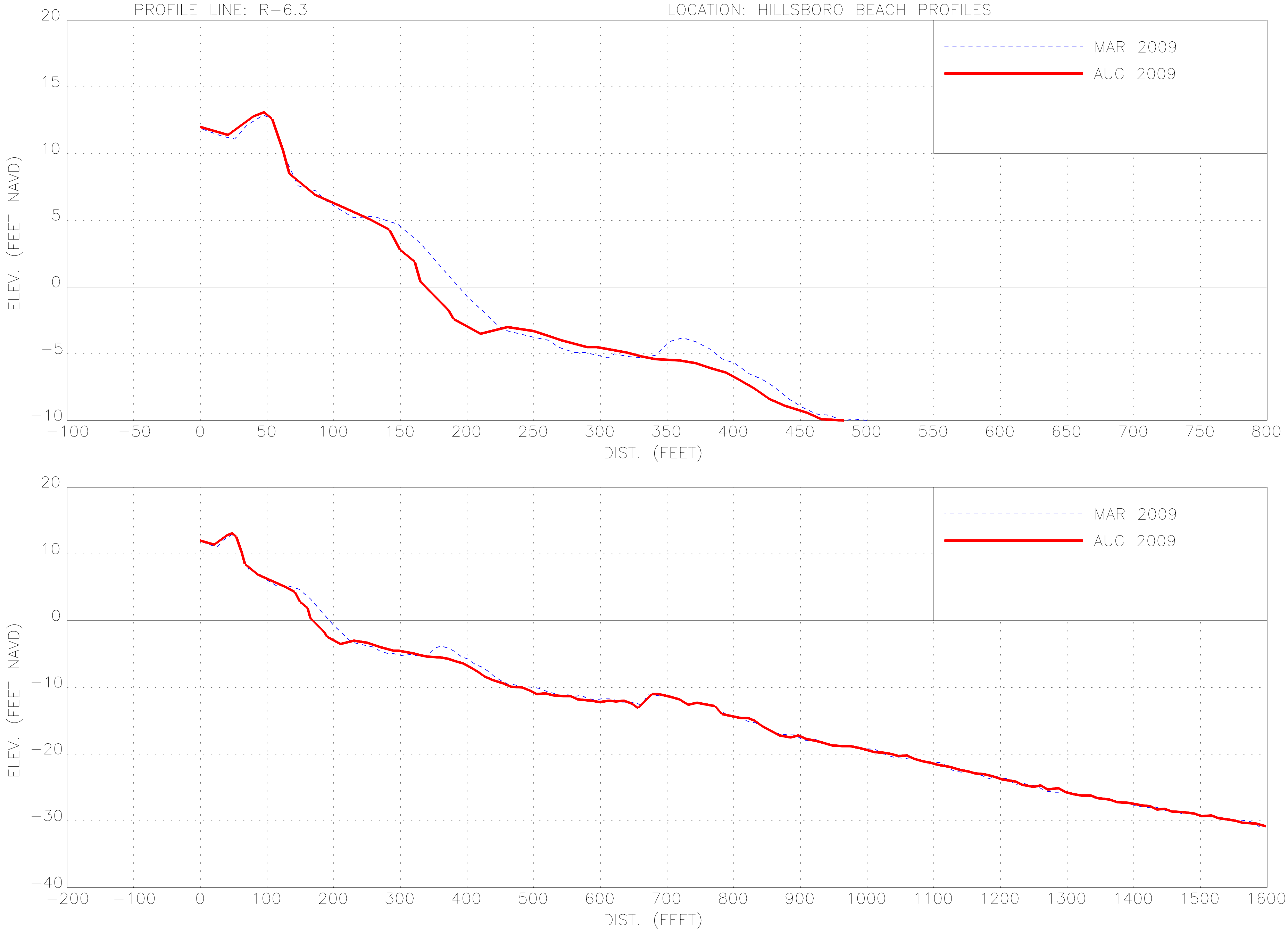
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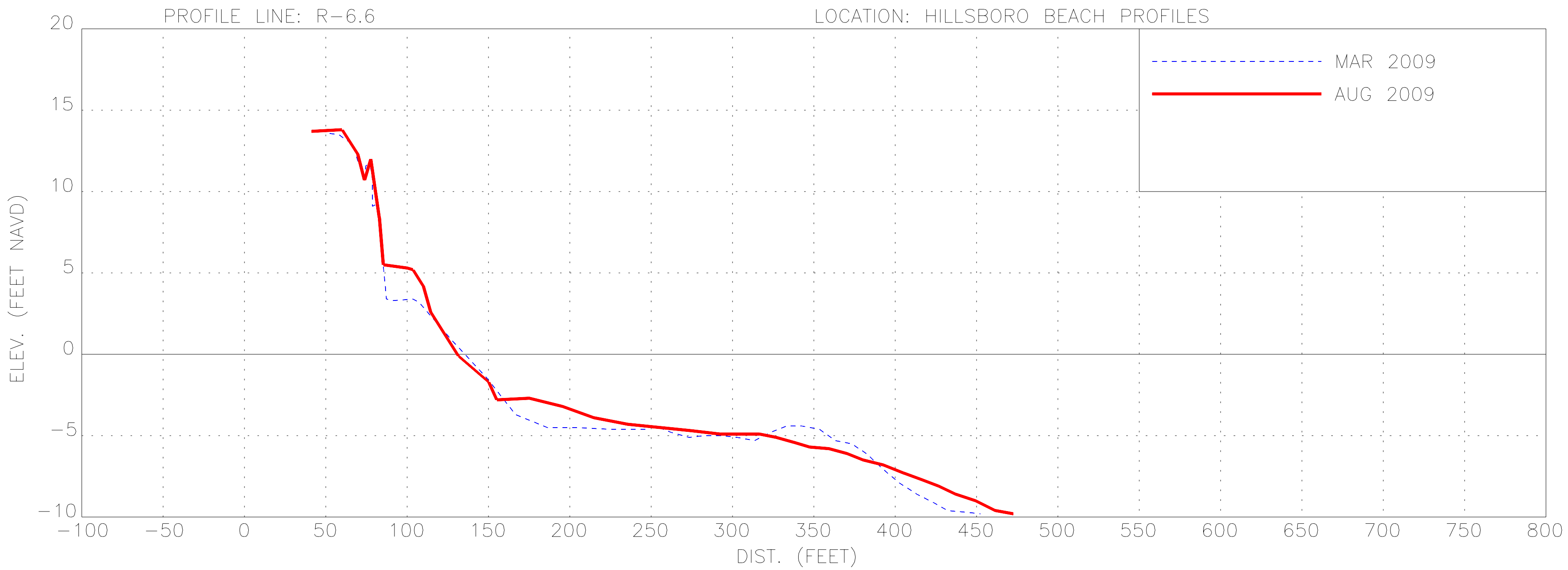
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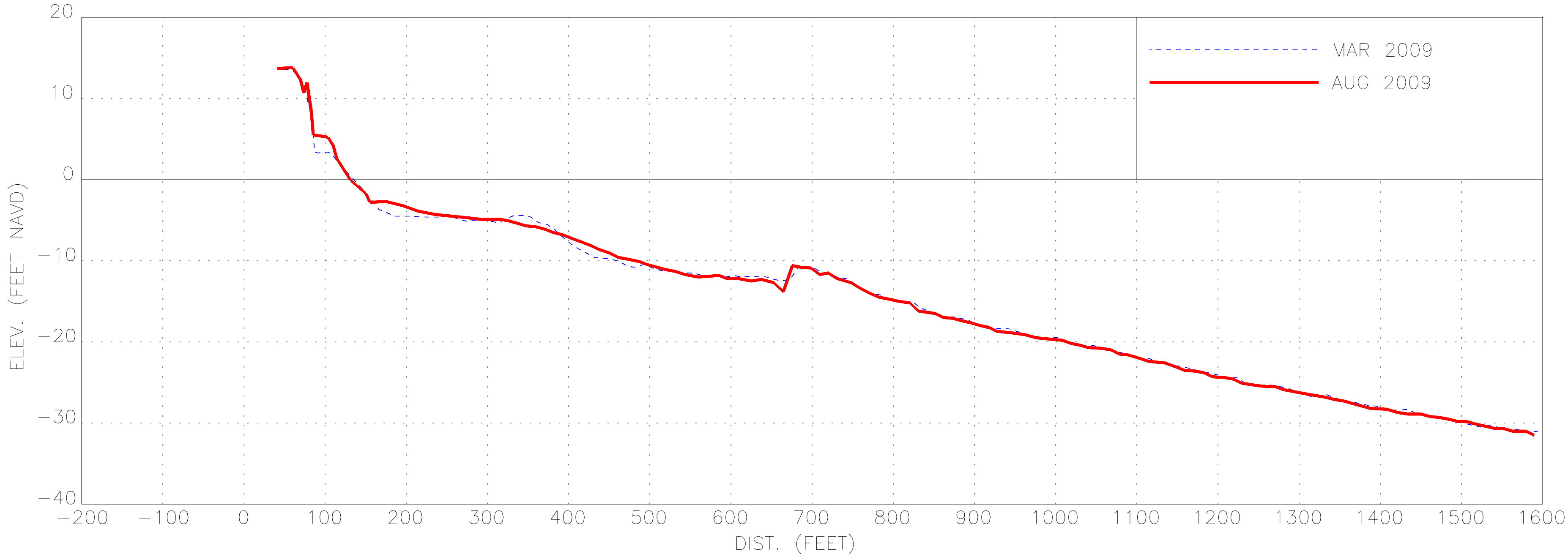
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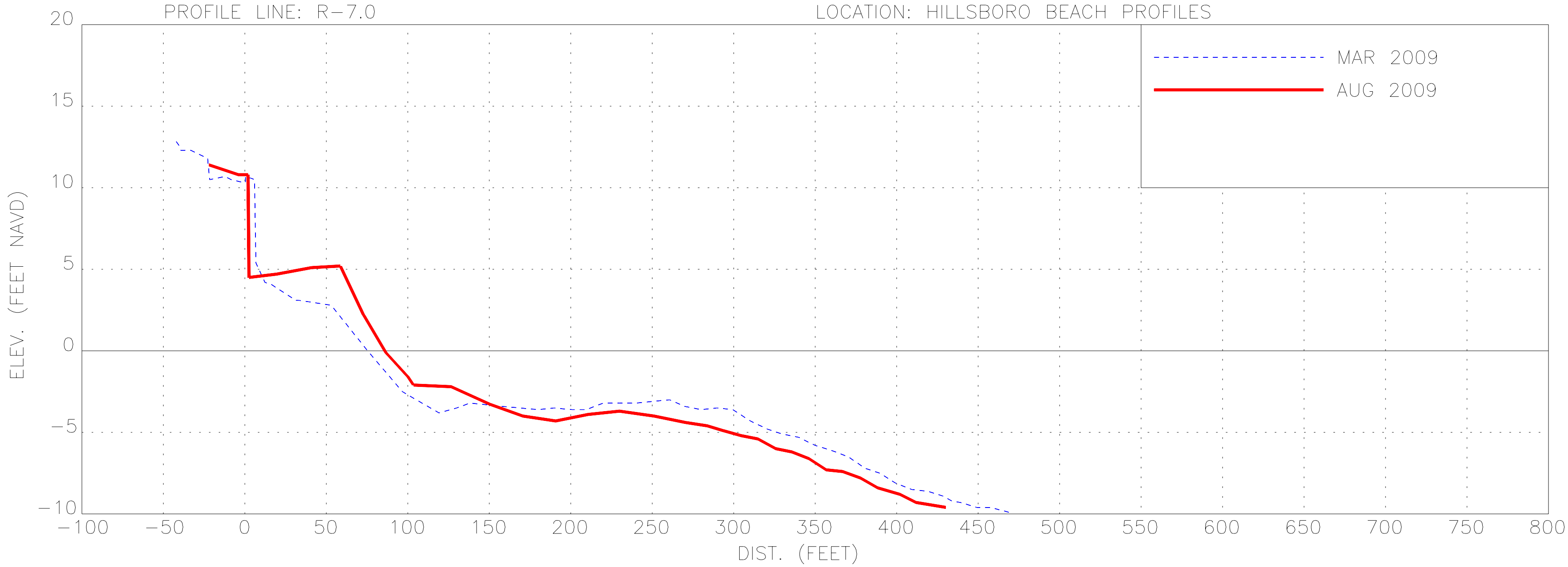
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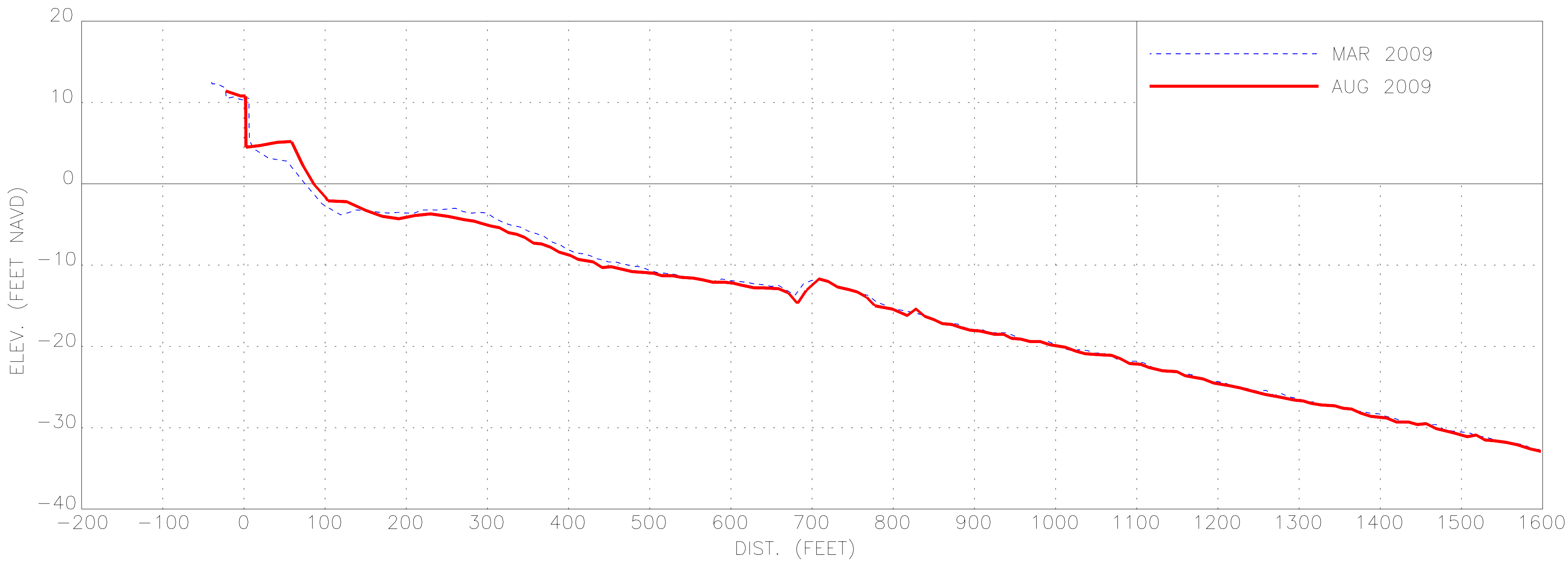
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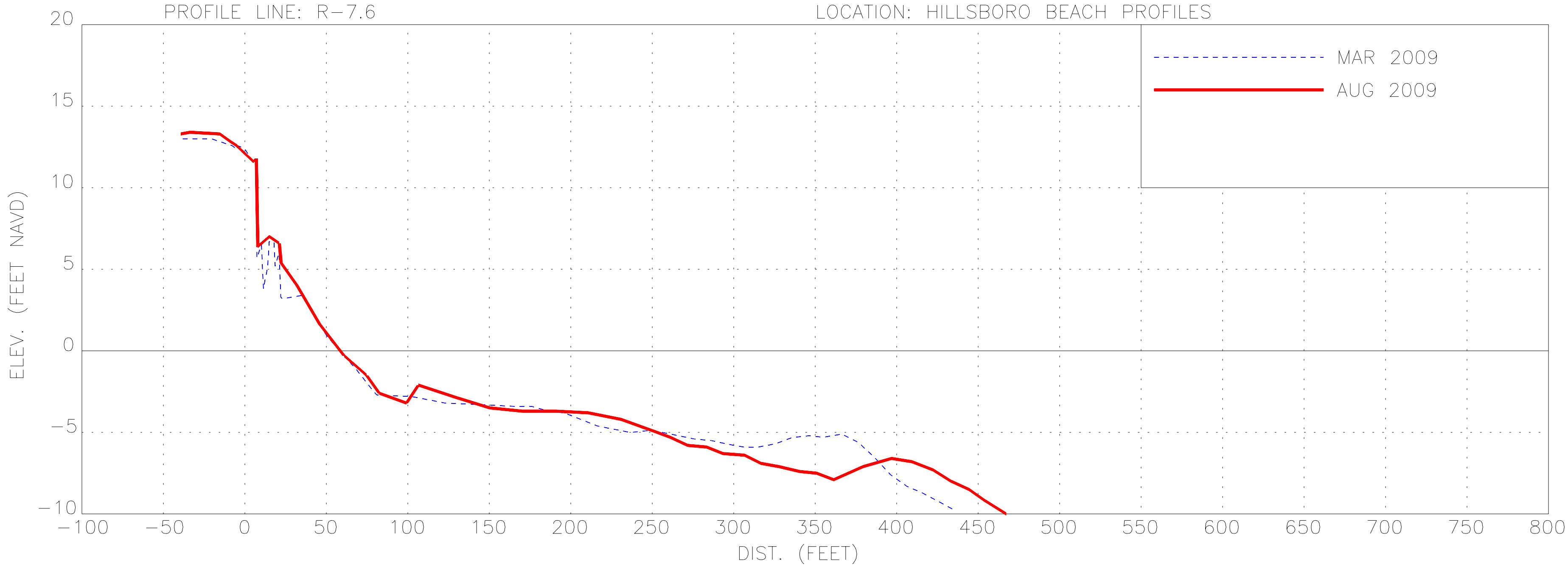

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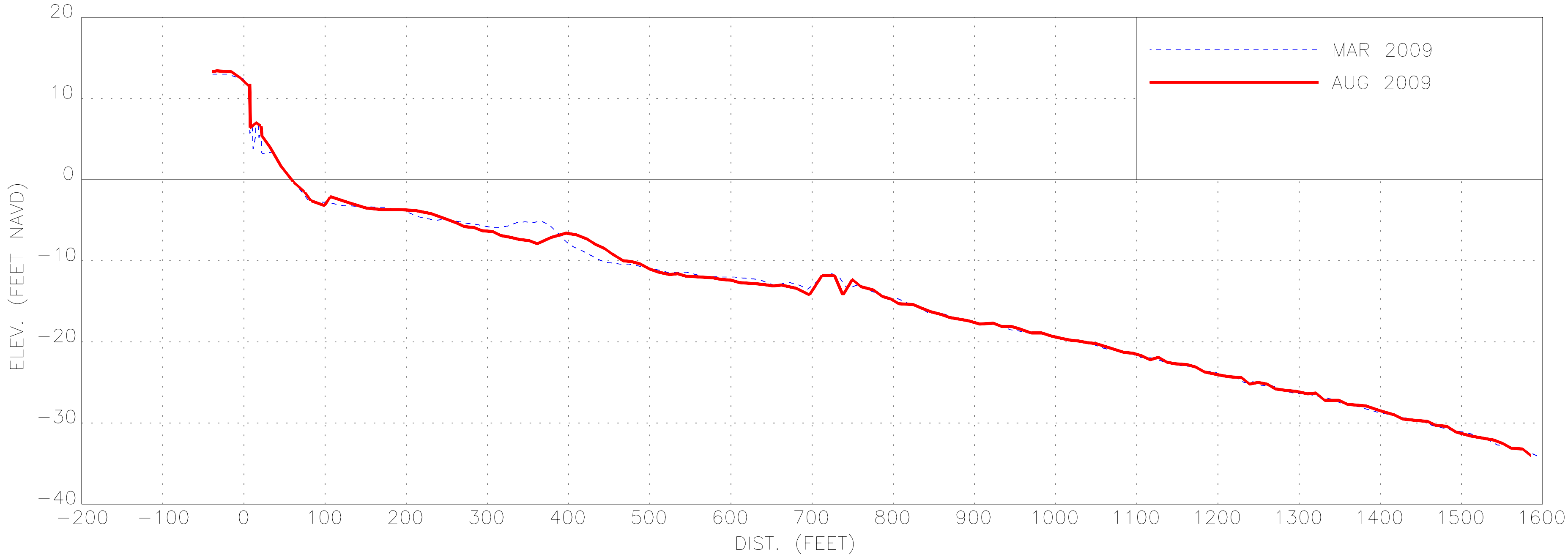

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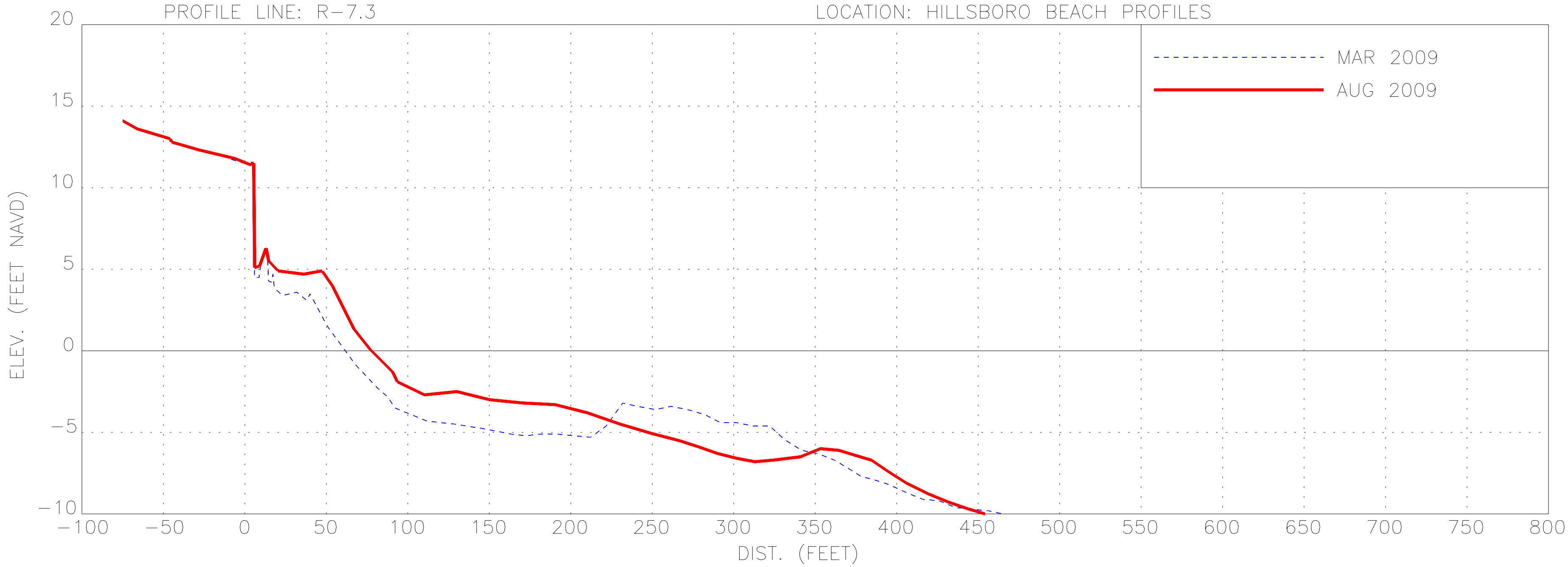

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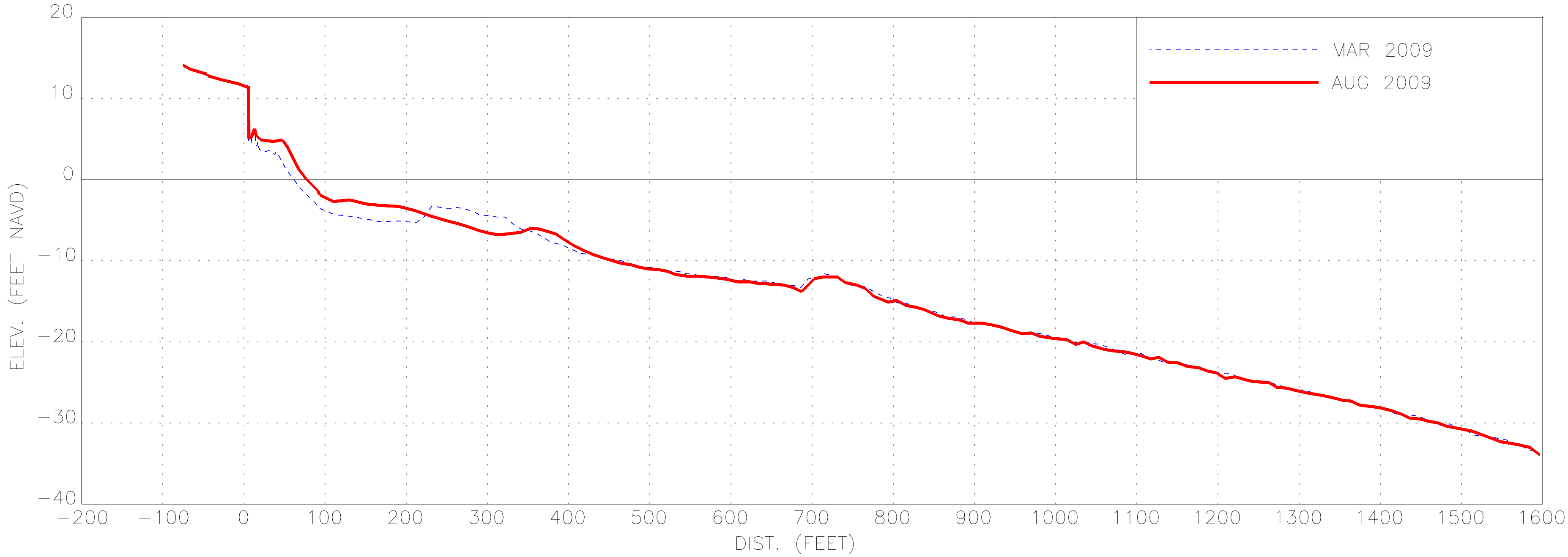

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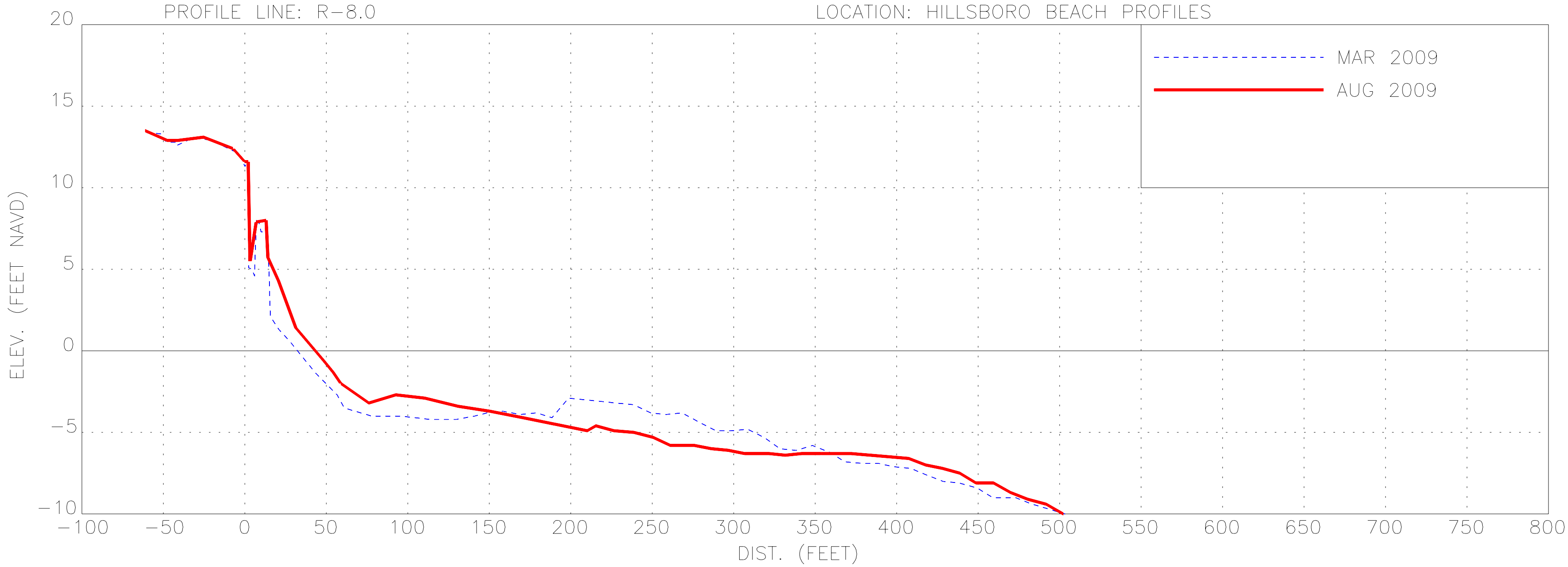
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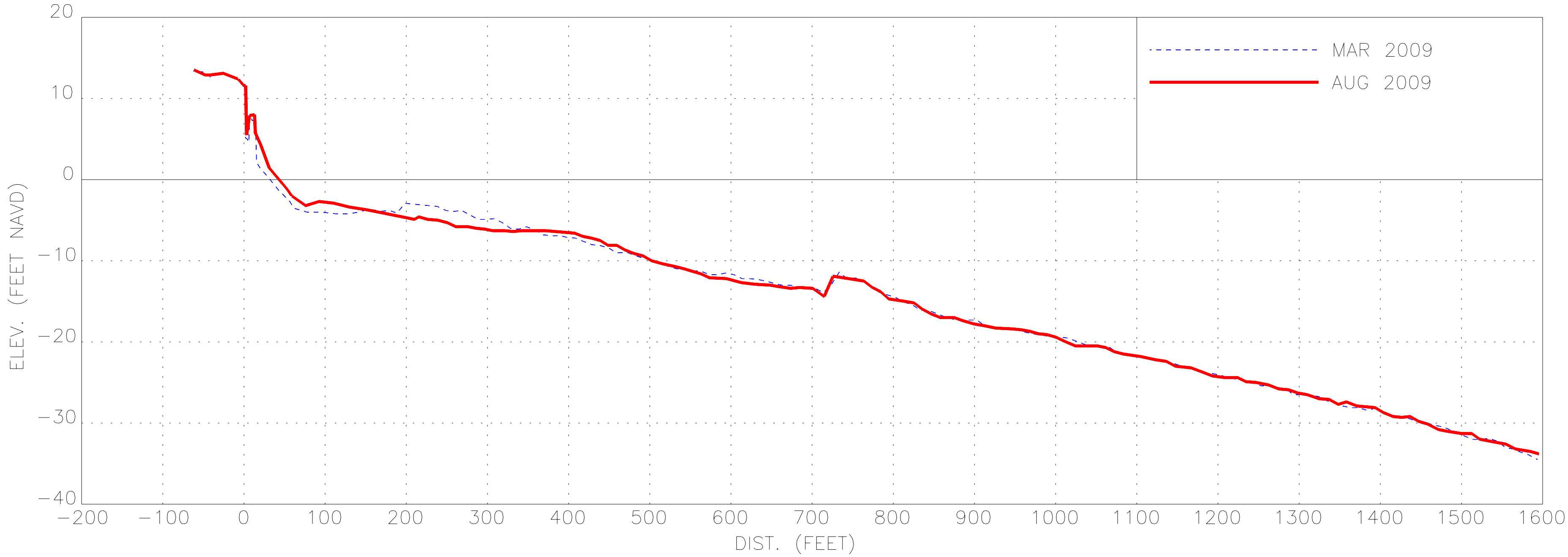
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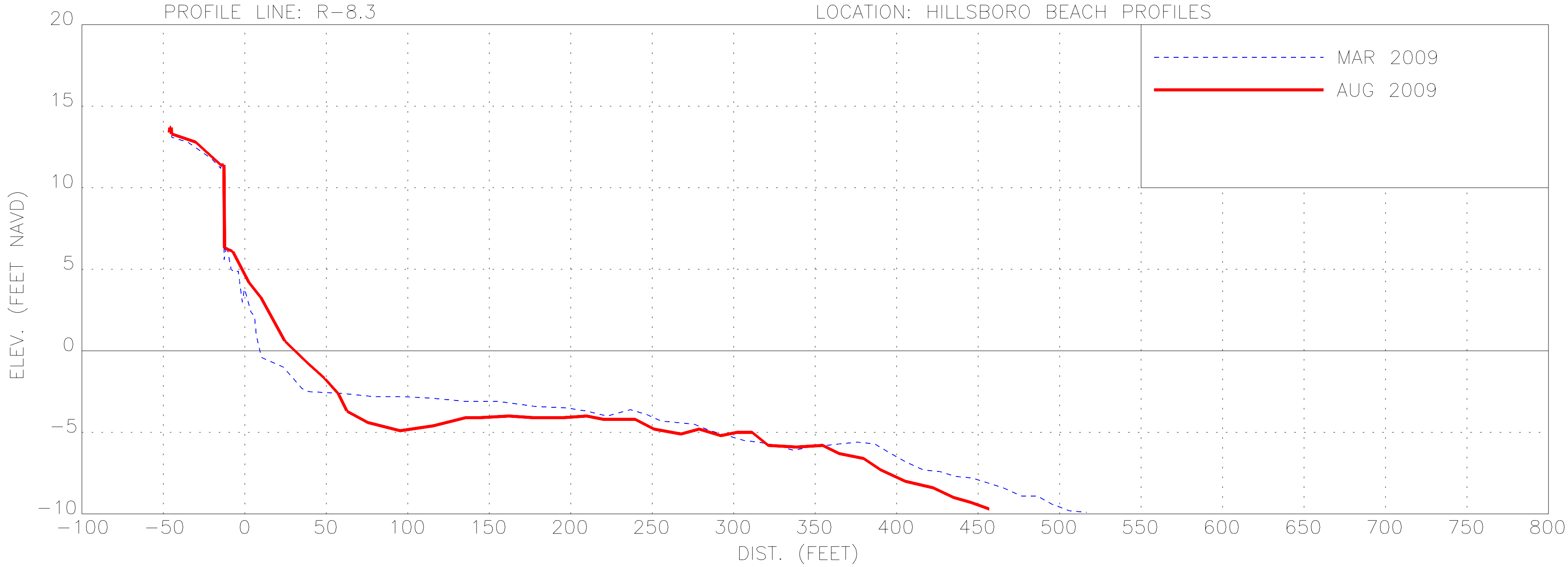
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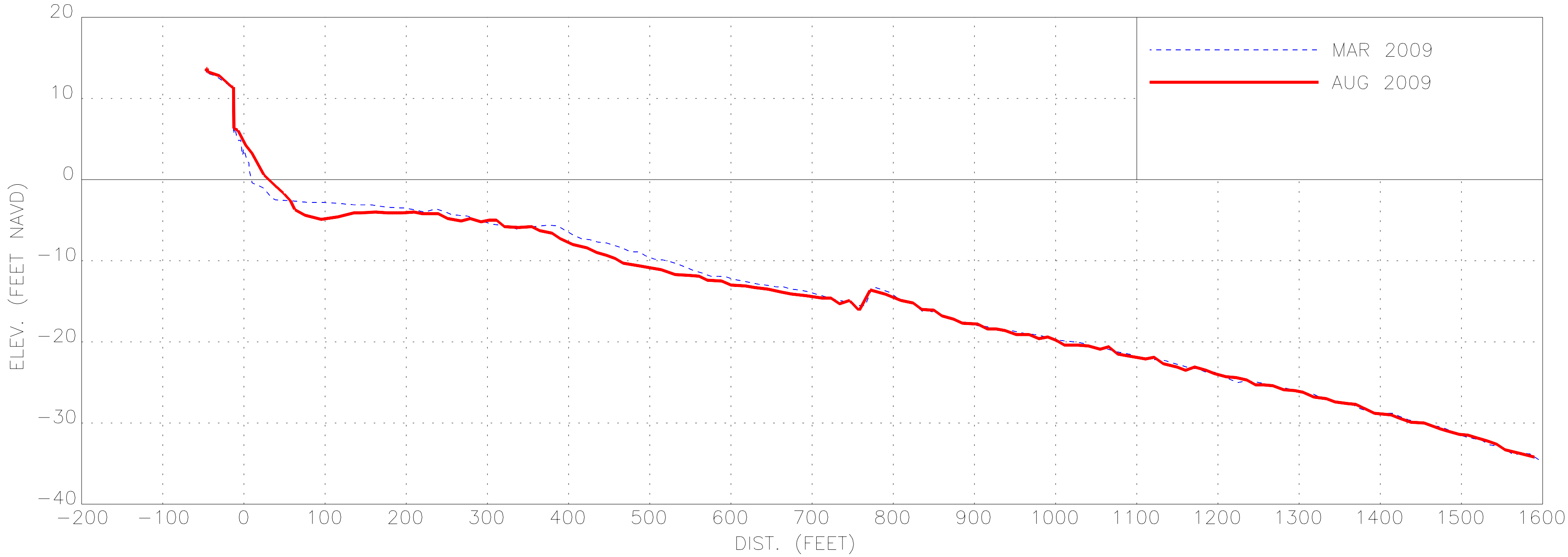
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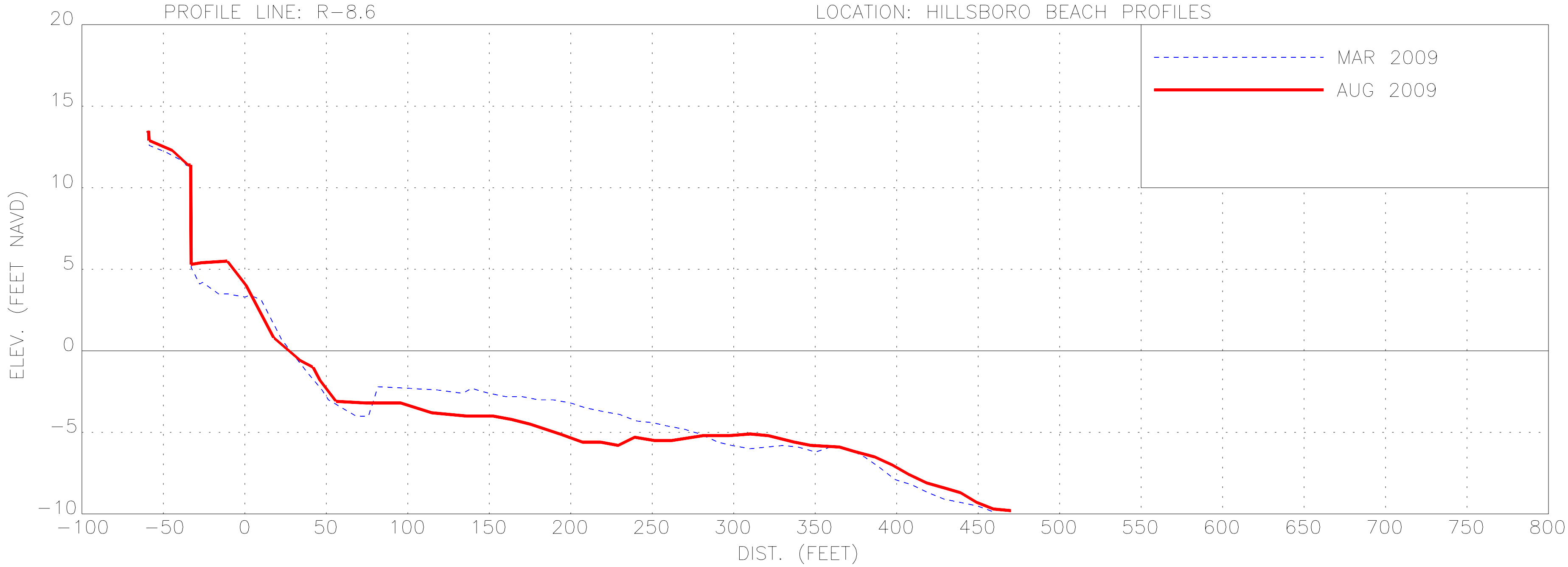

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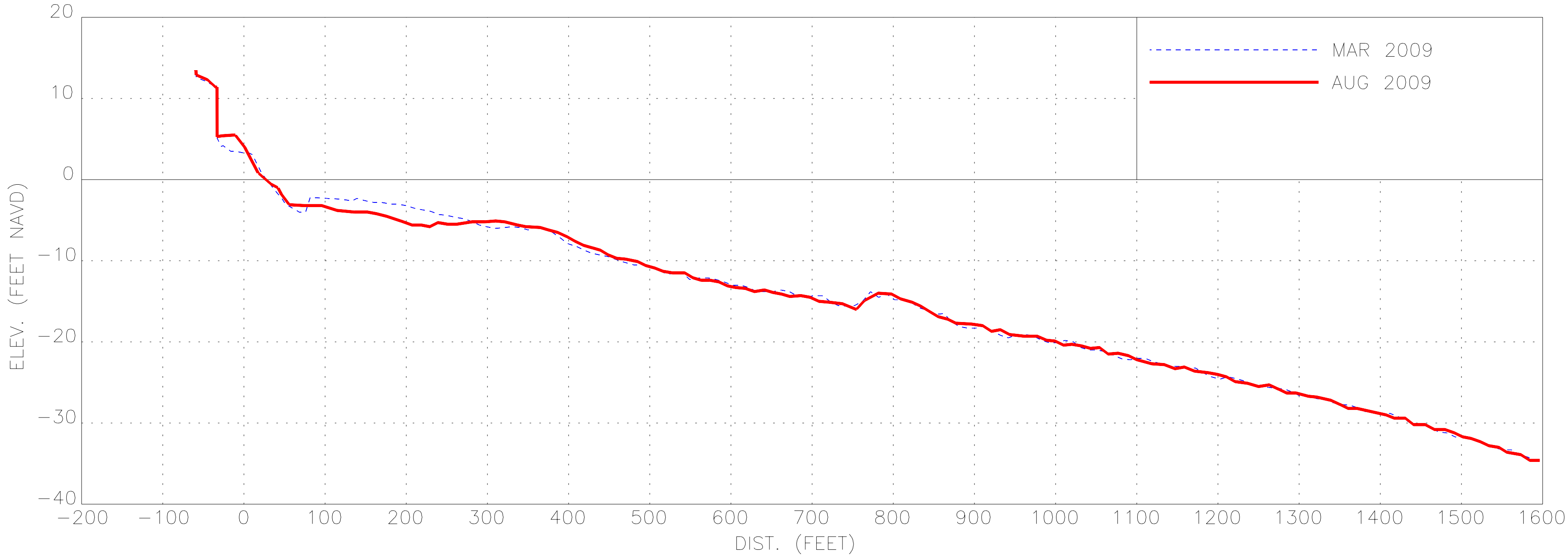

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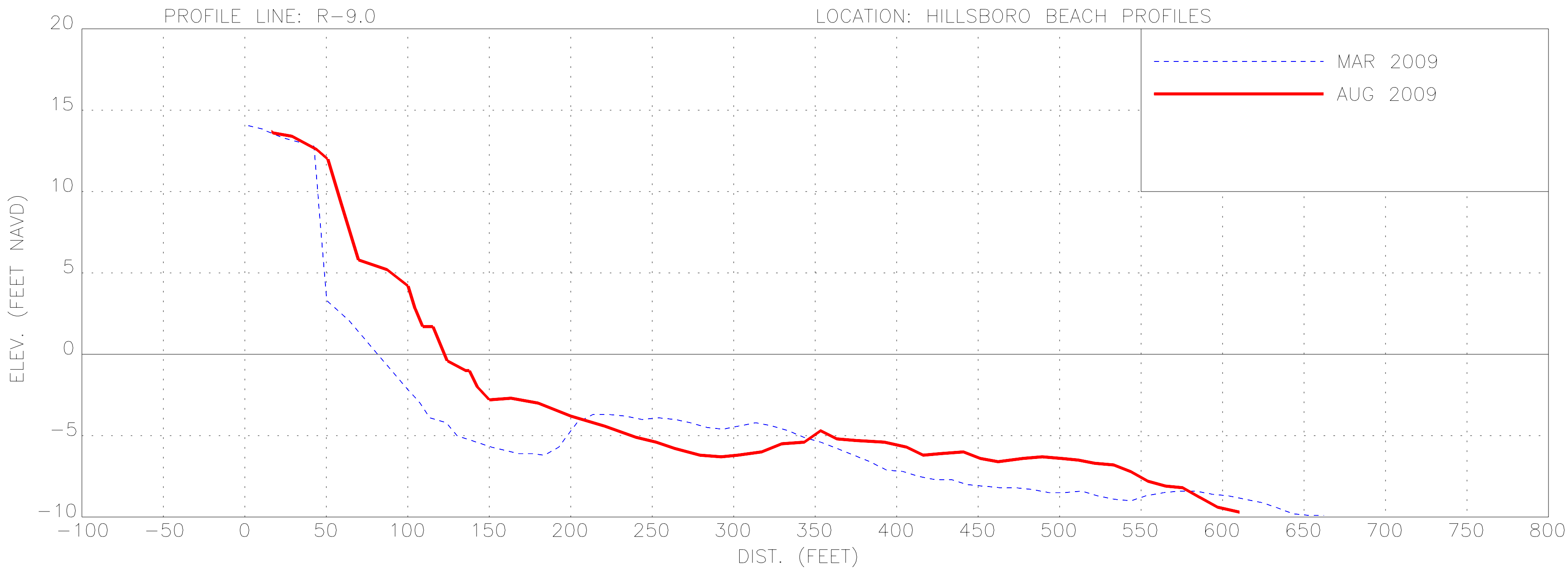
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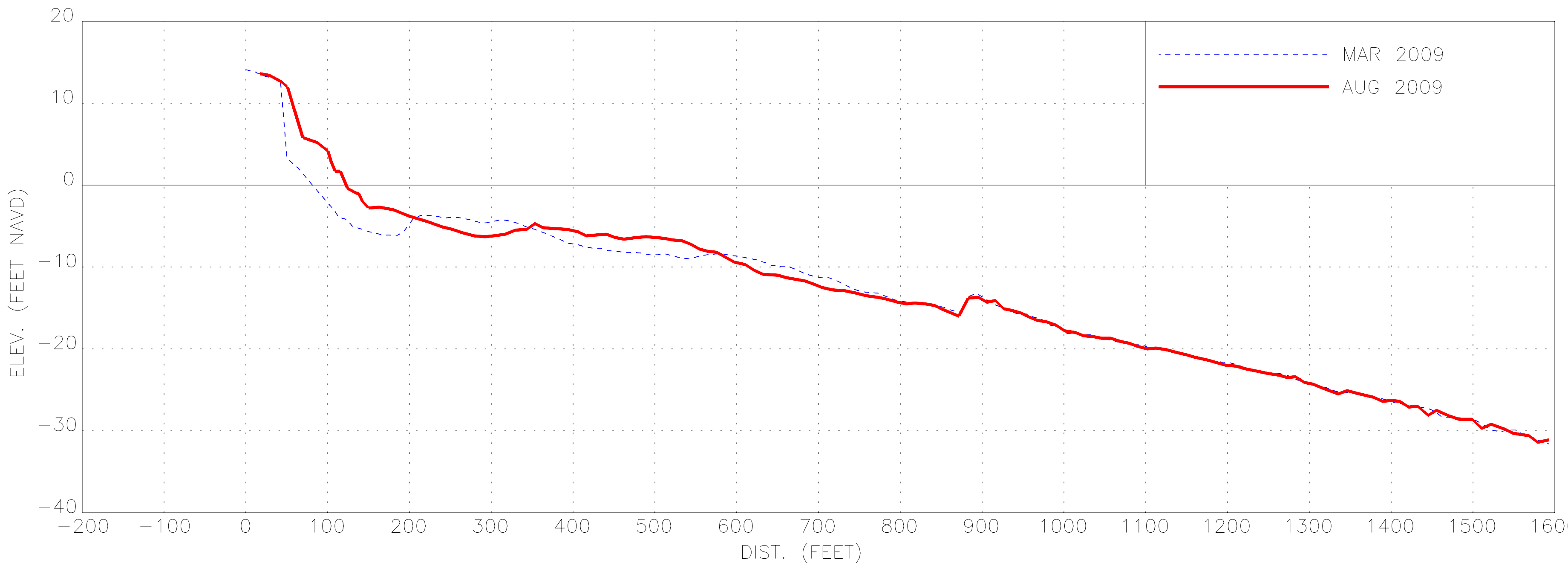
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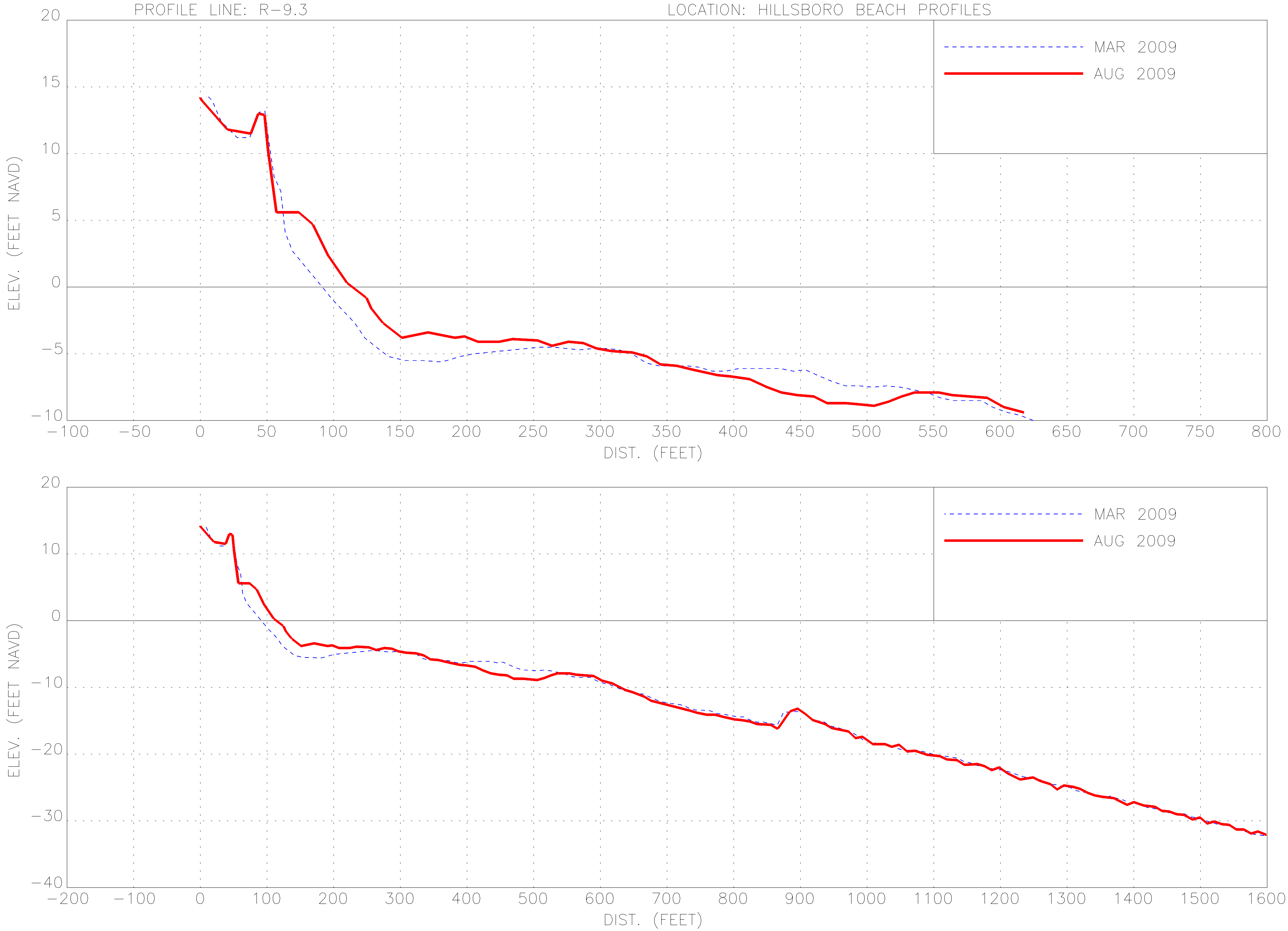
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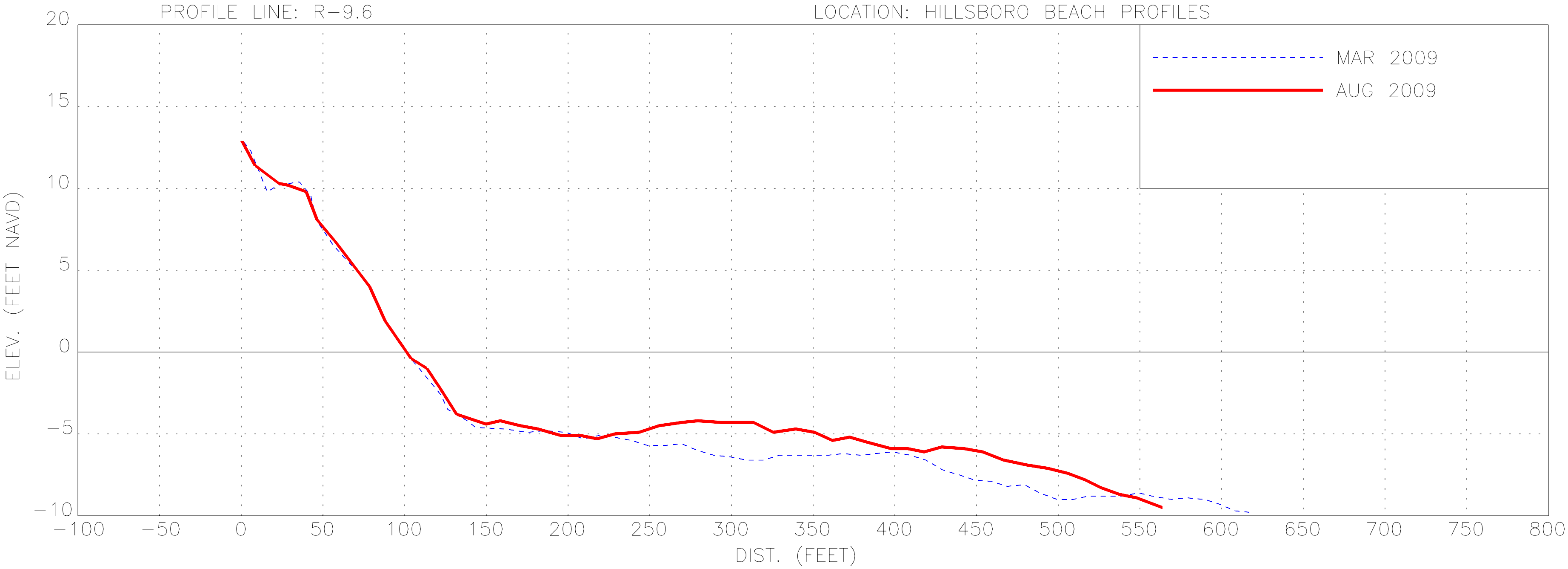

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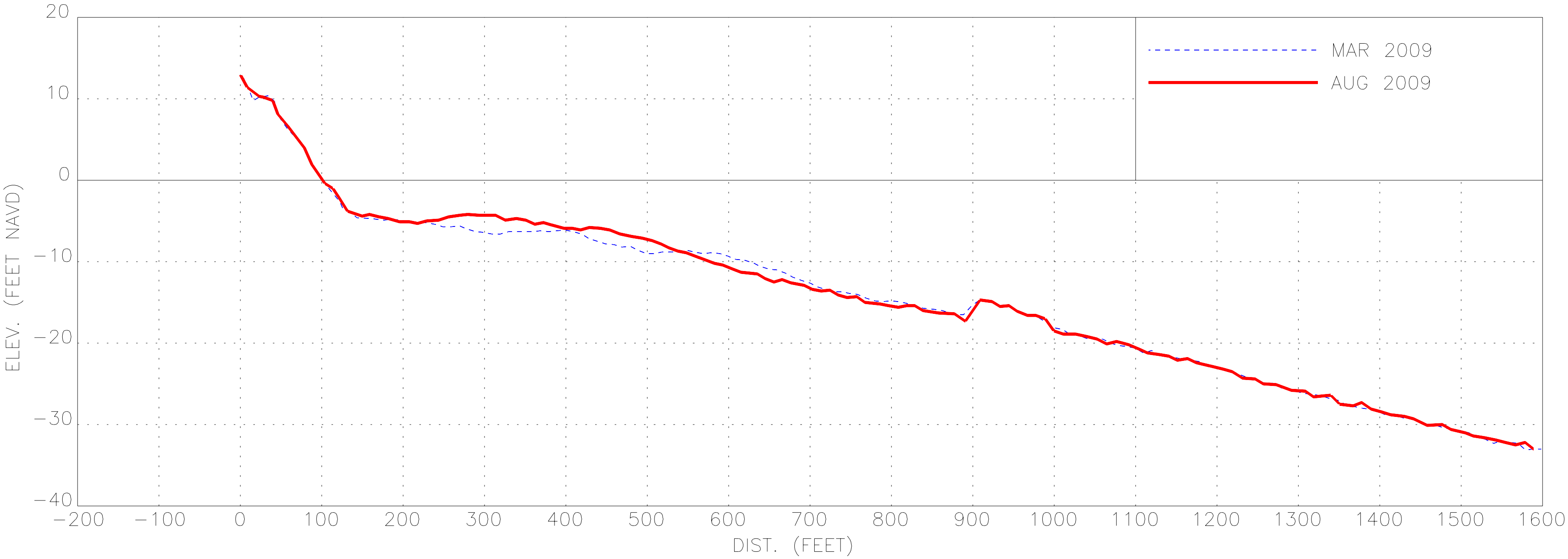

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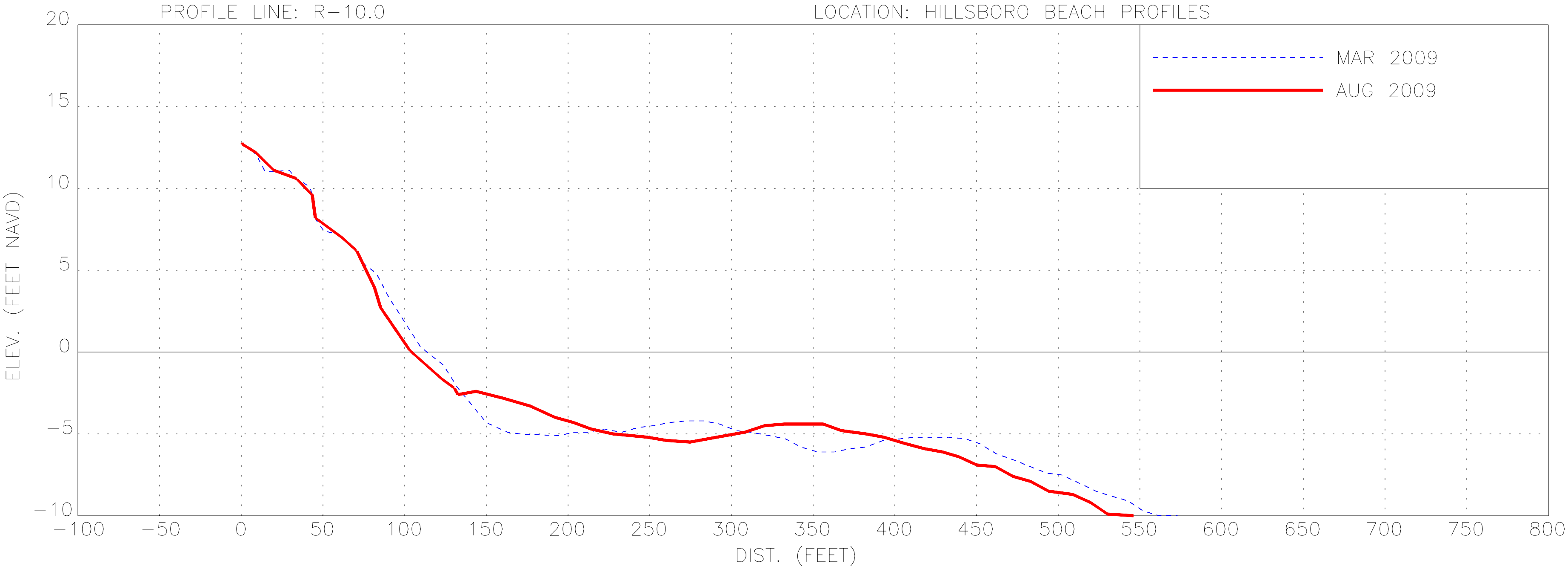
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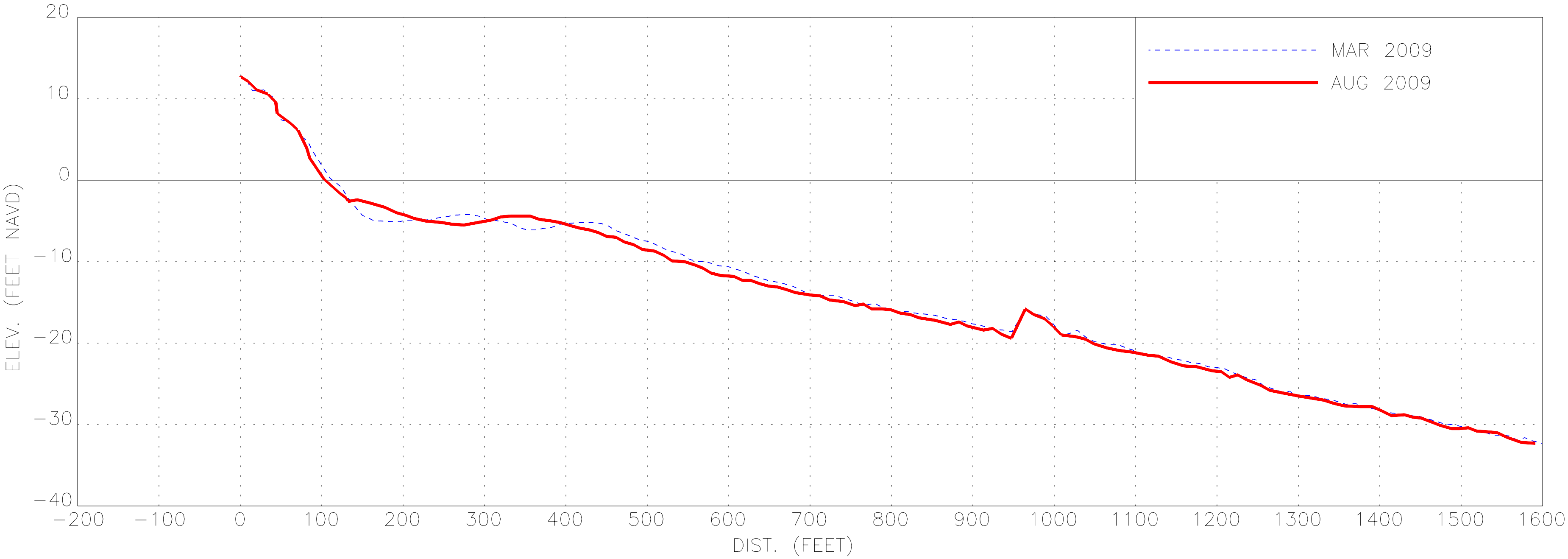
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PROFILE LINE: R-10.3
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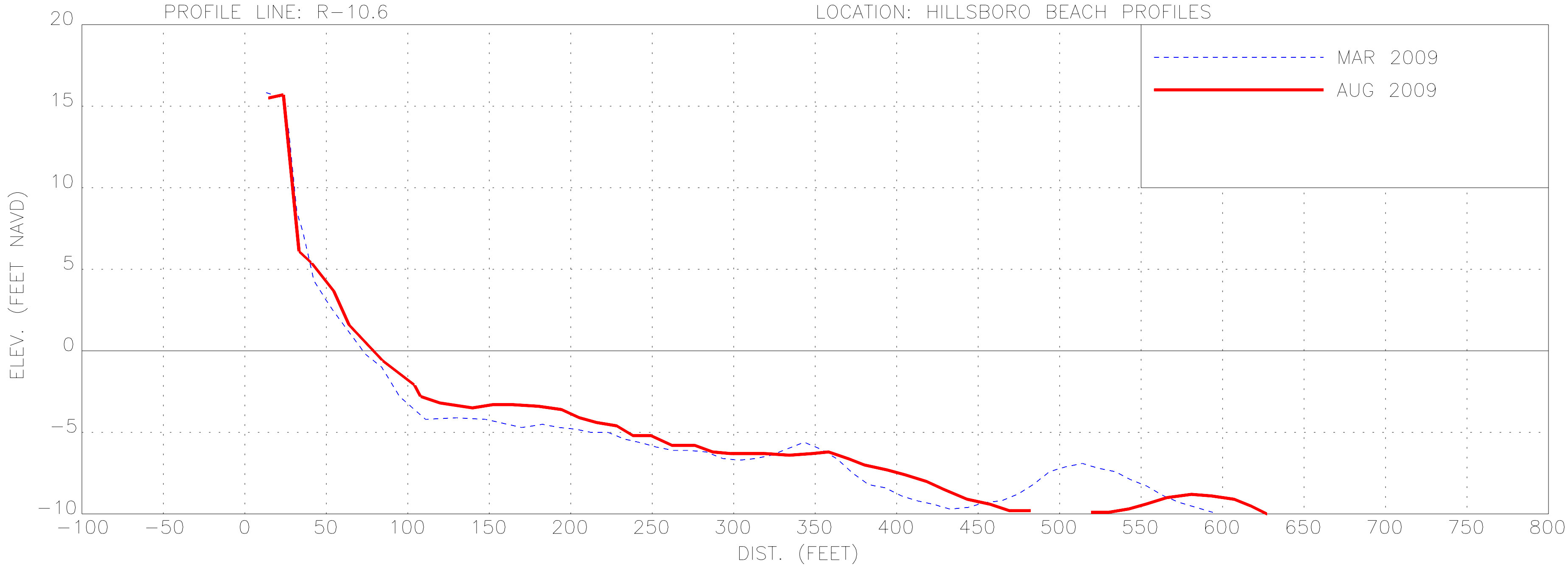
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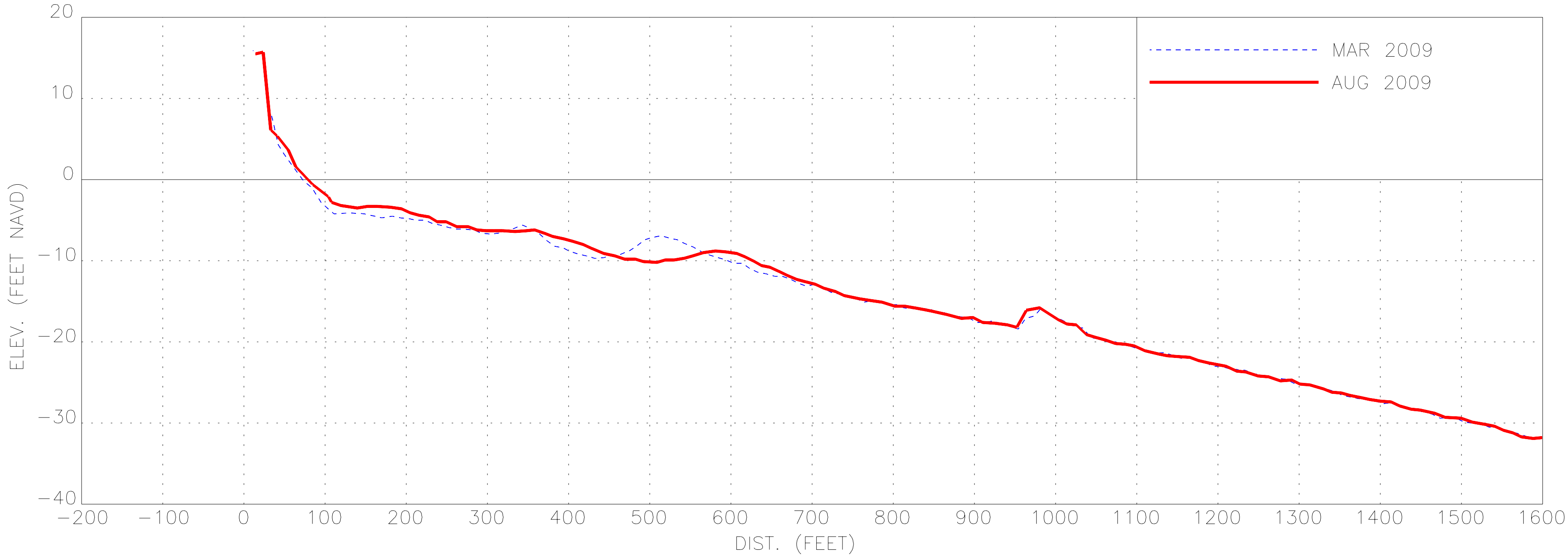
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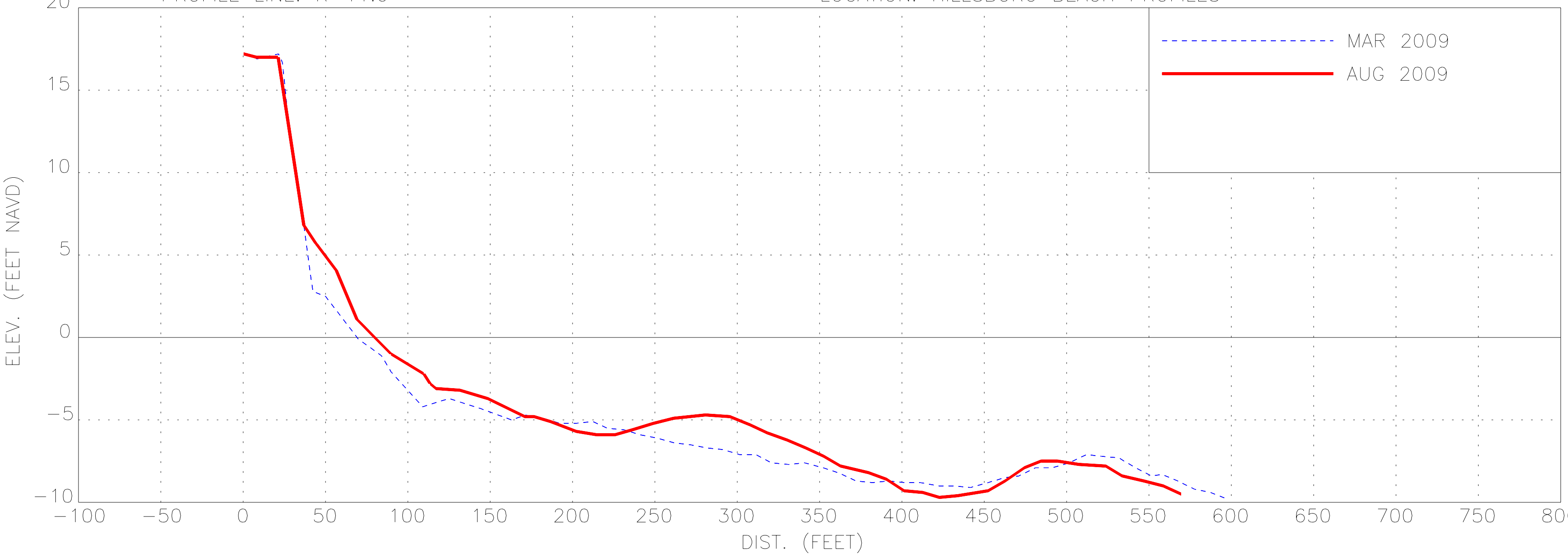
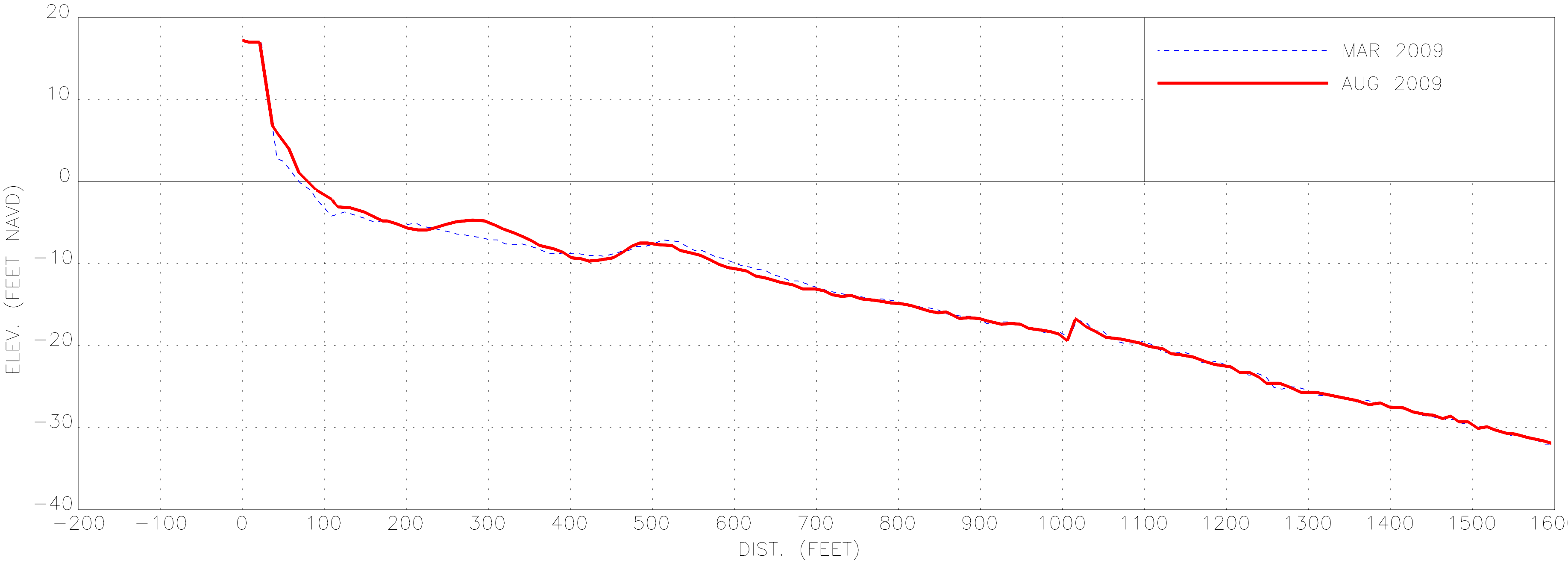
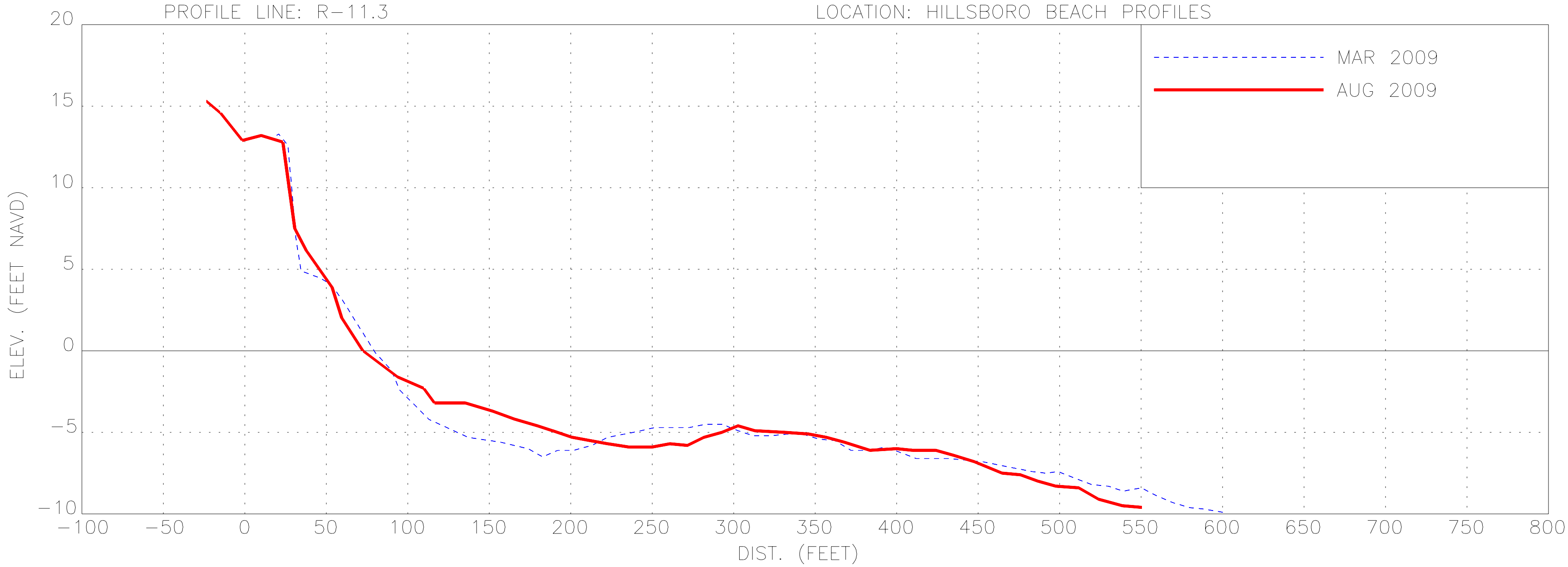
PROFILE LINE: R-11.0 LOCATION: HILLSBORO BEACH PROFILES







PROFILE LINE: R-11.3
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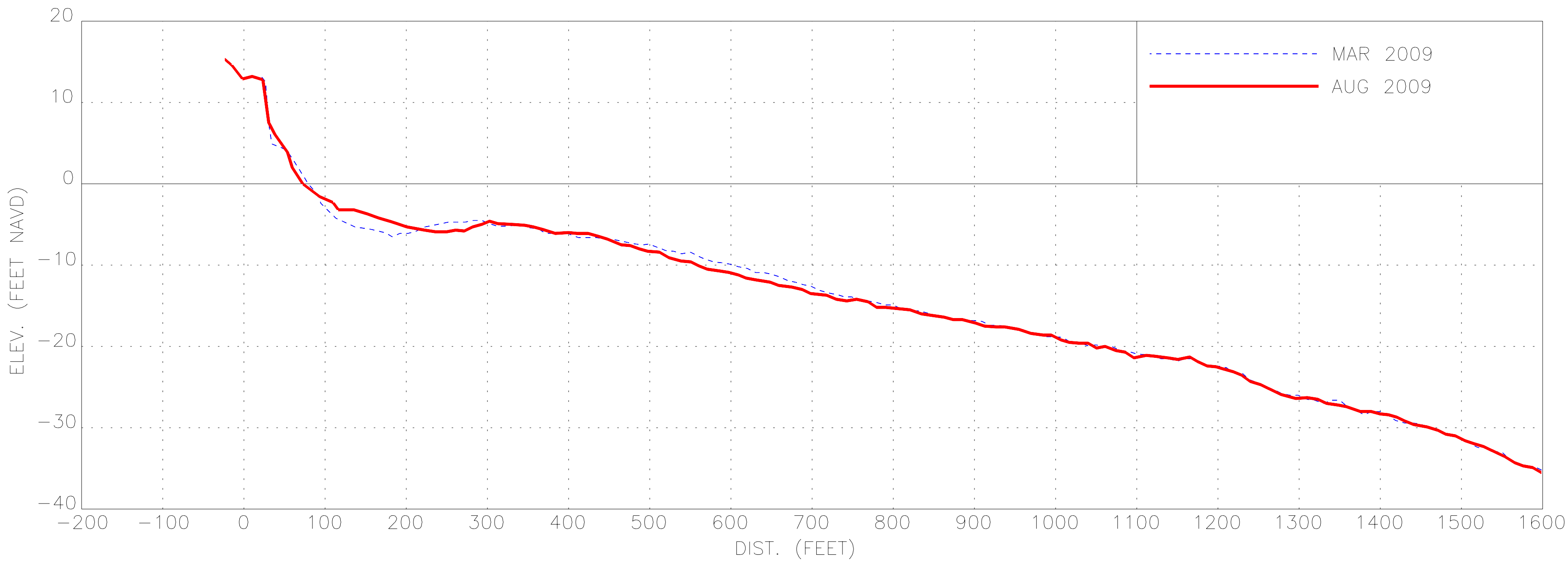

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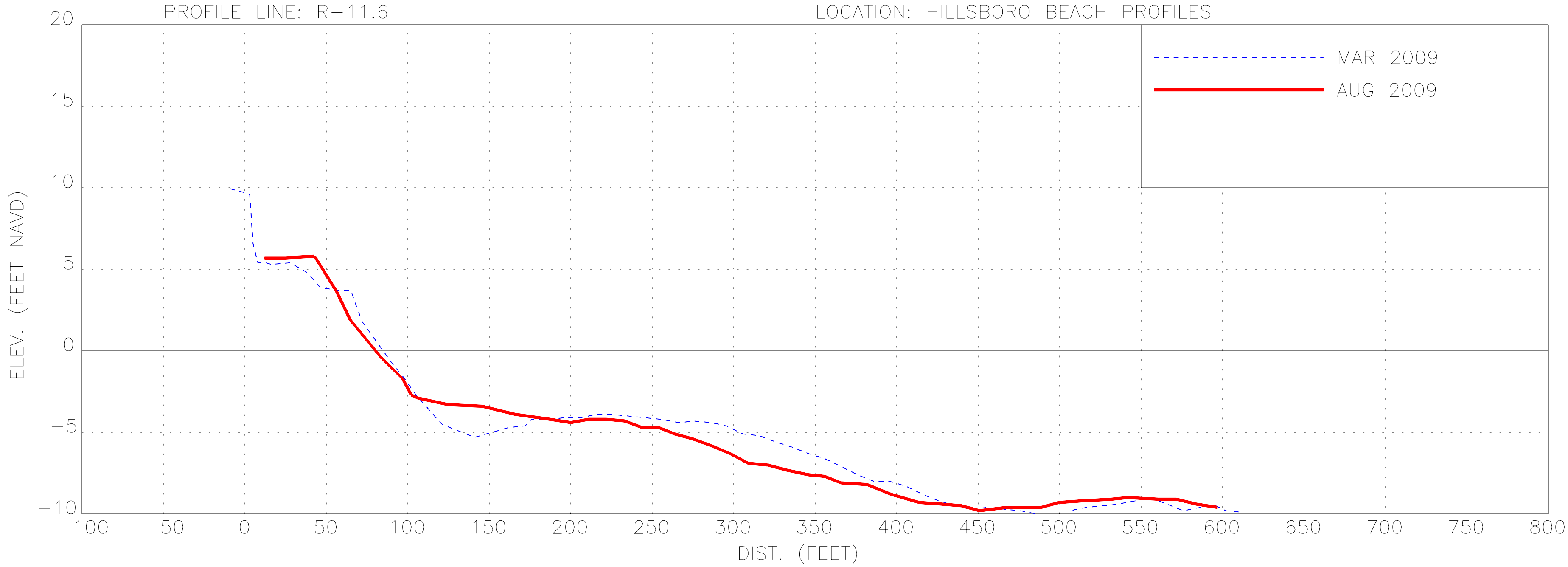

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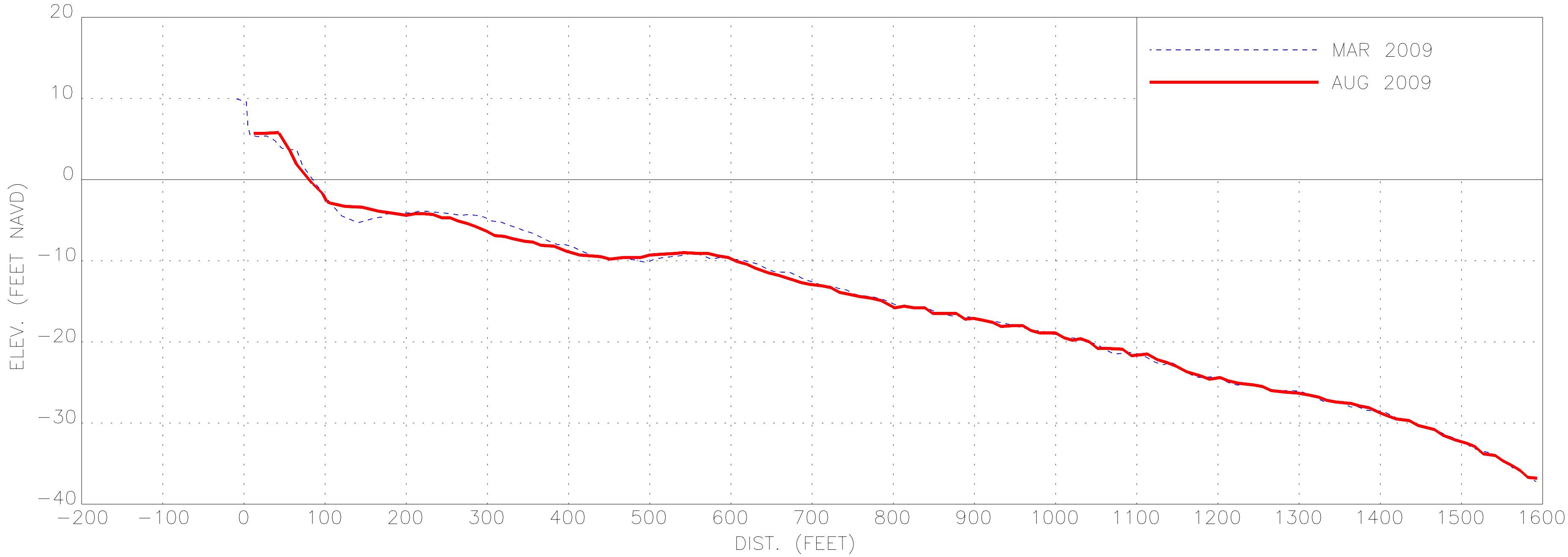

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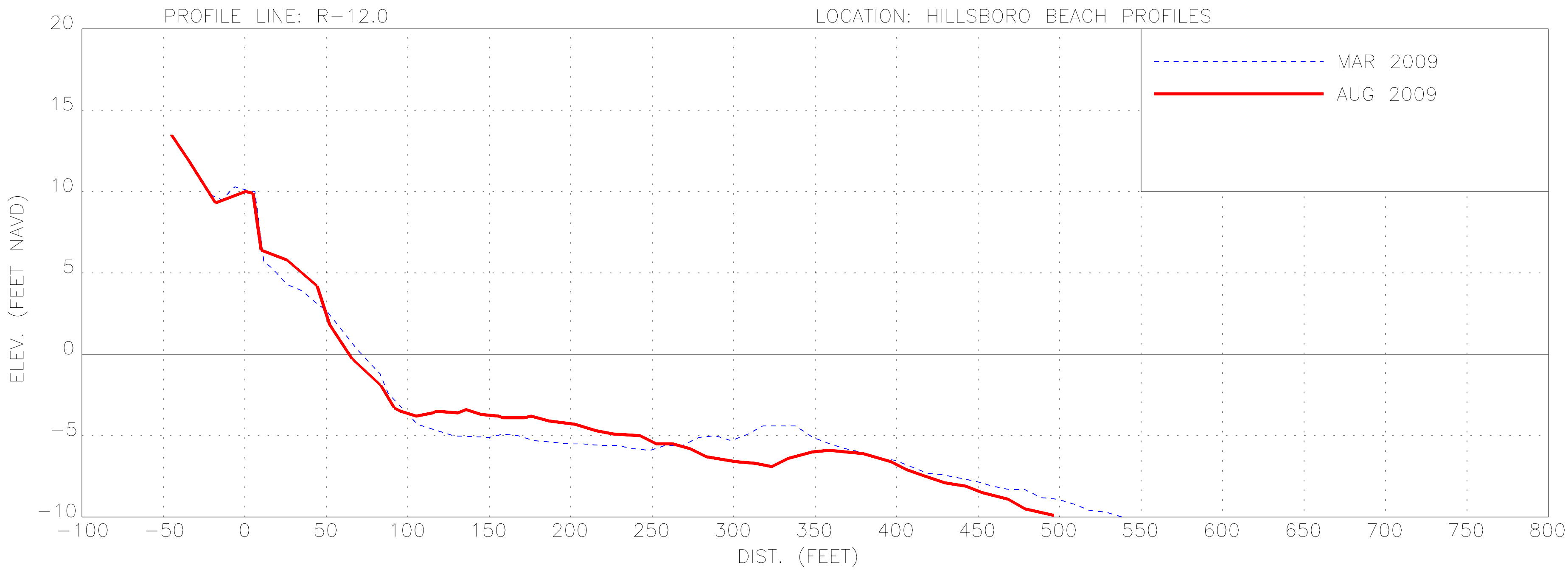
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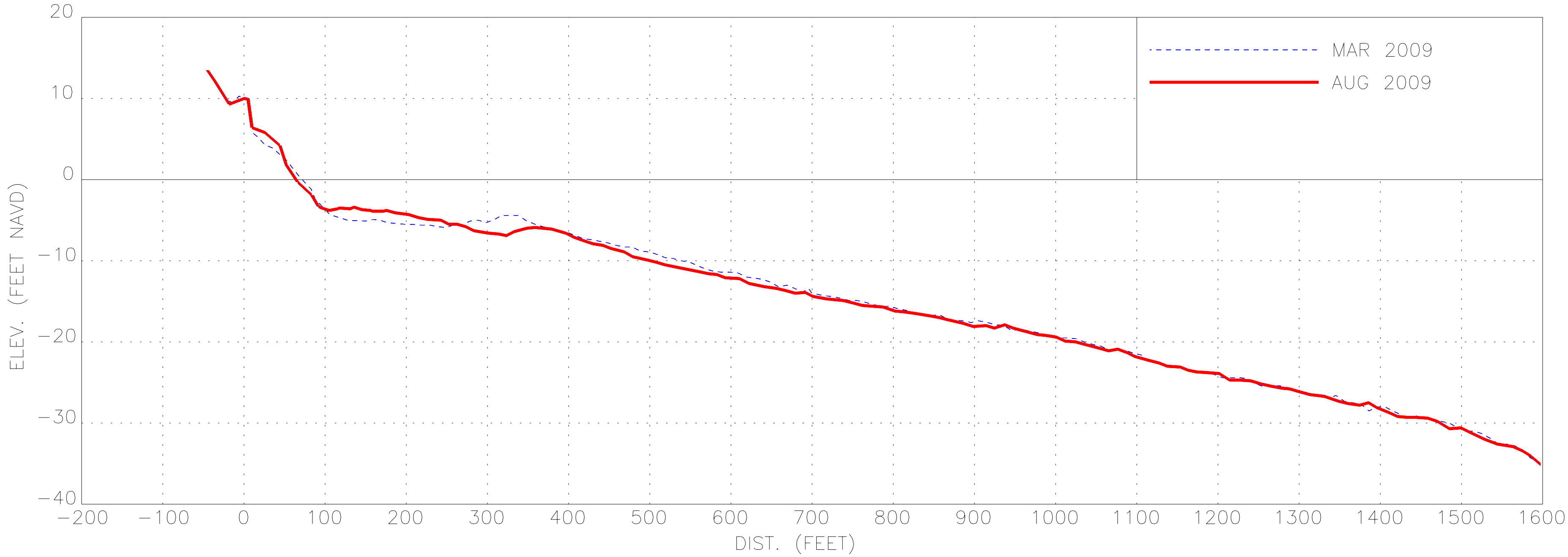
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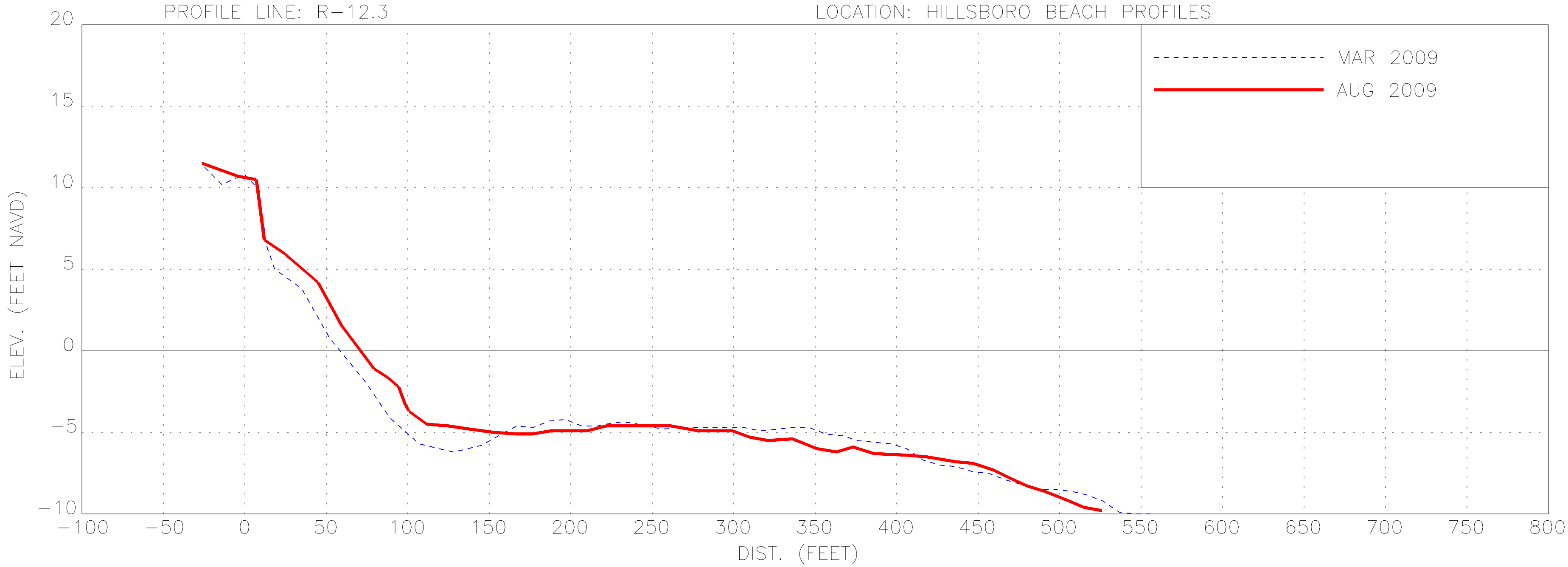
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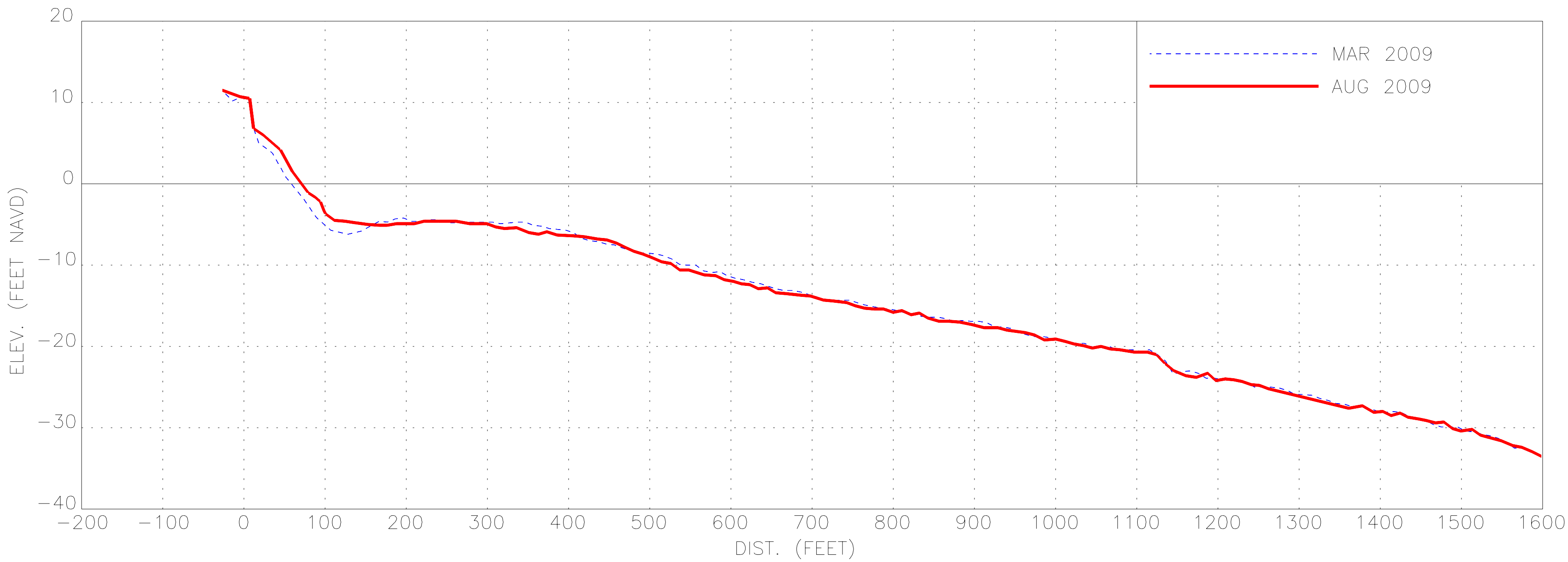
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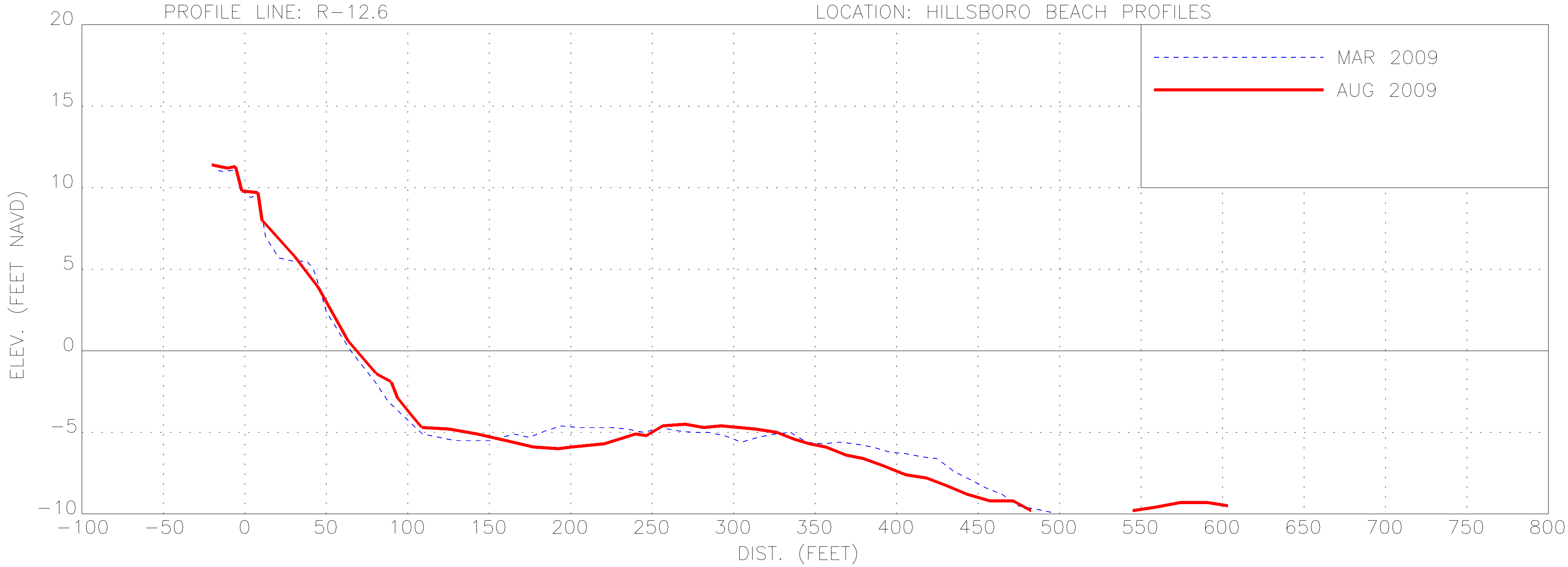
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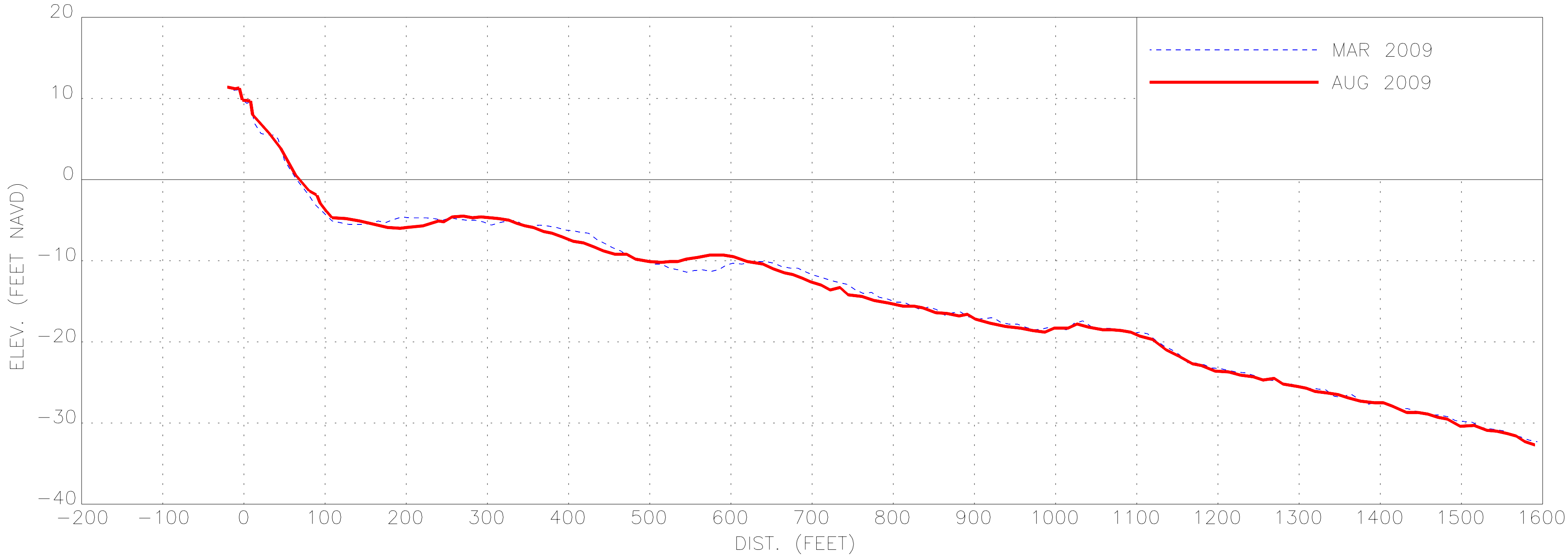
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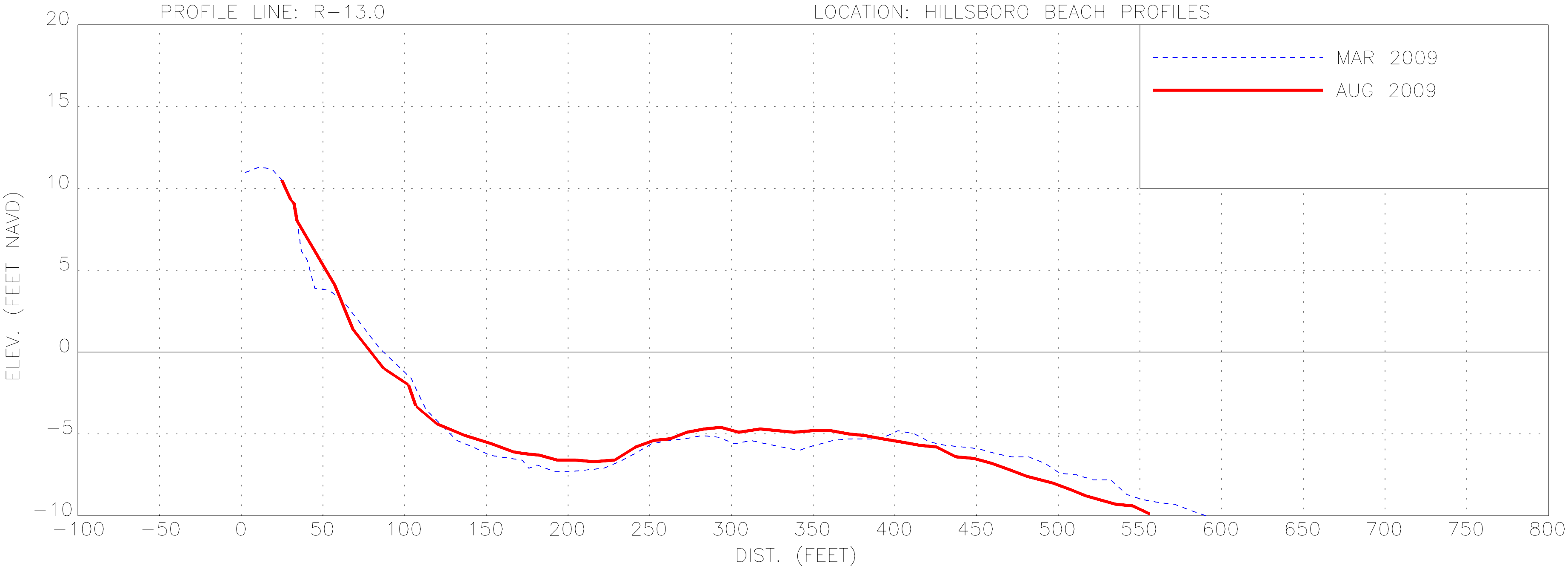
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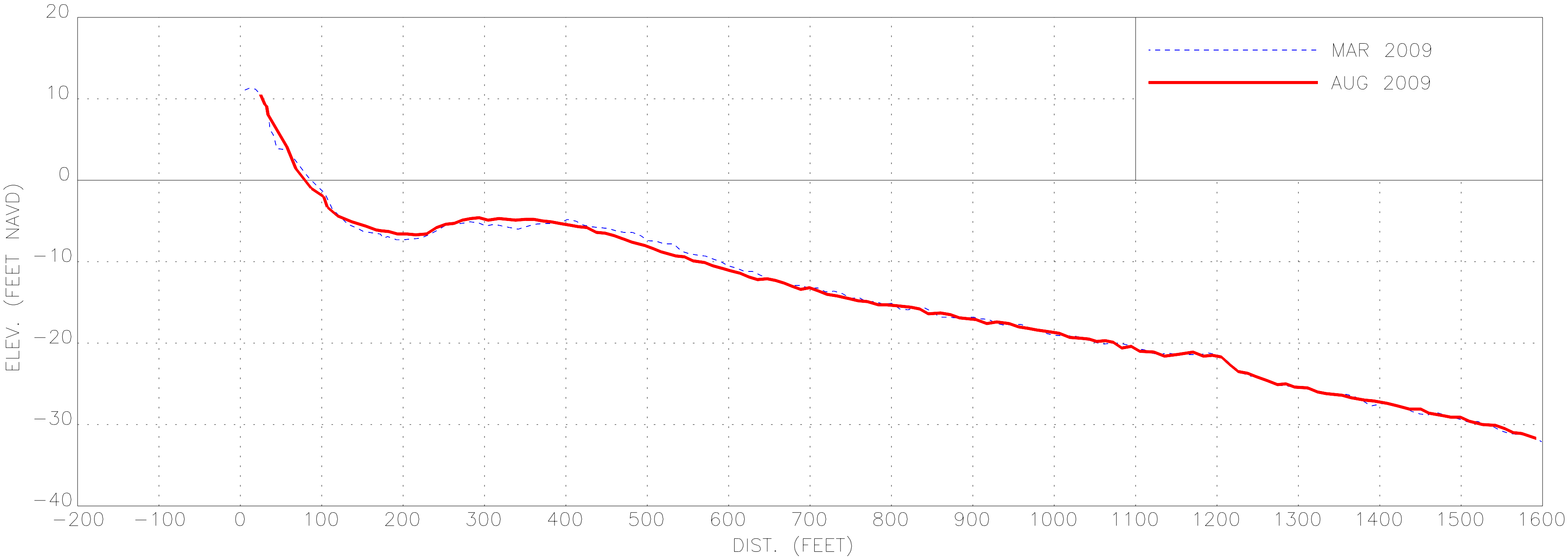
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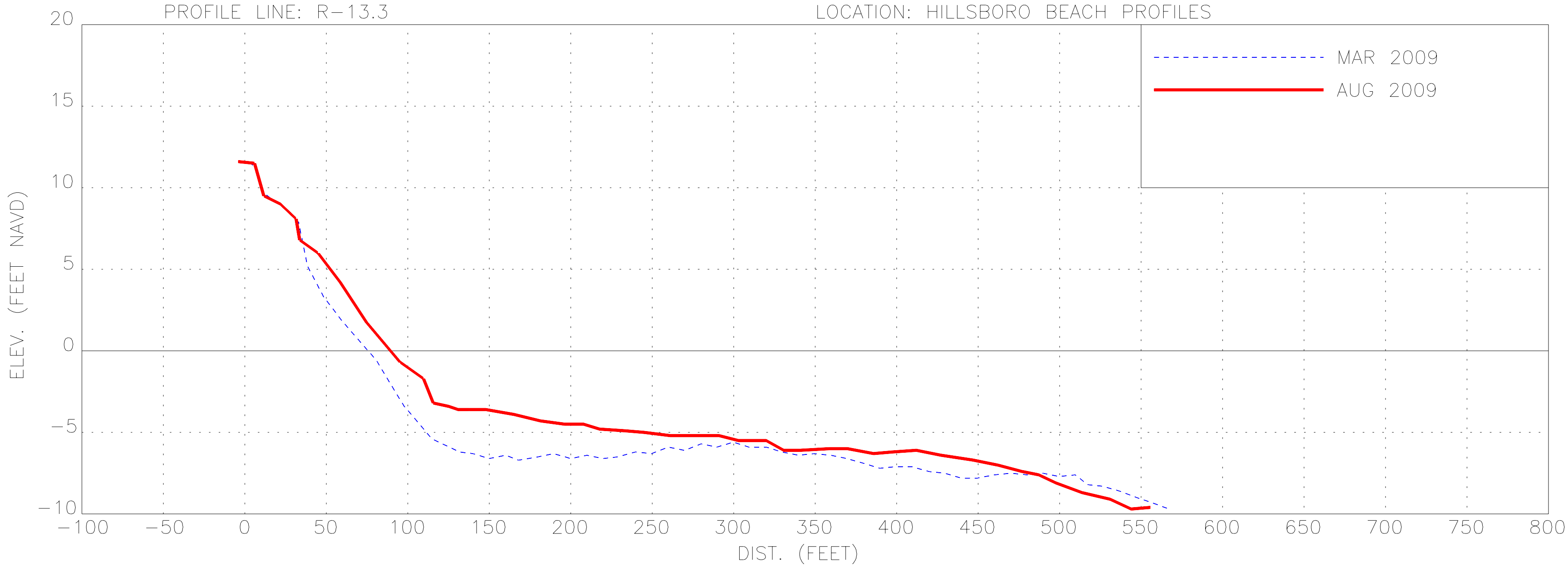

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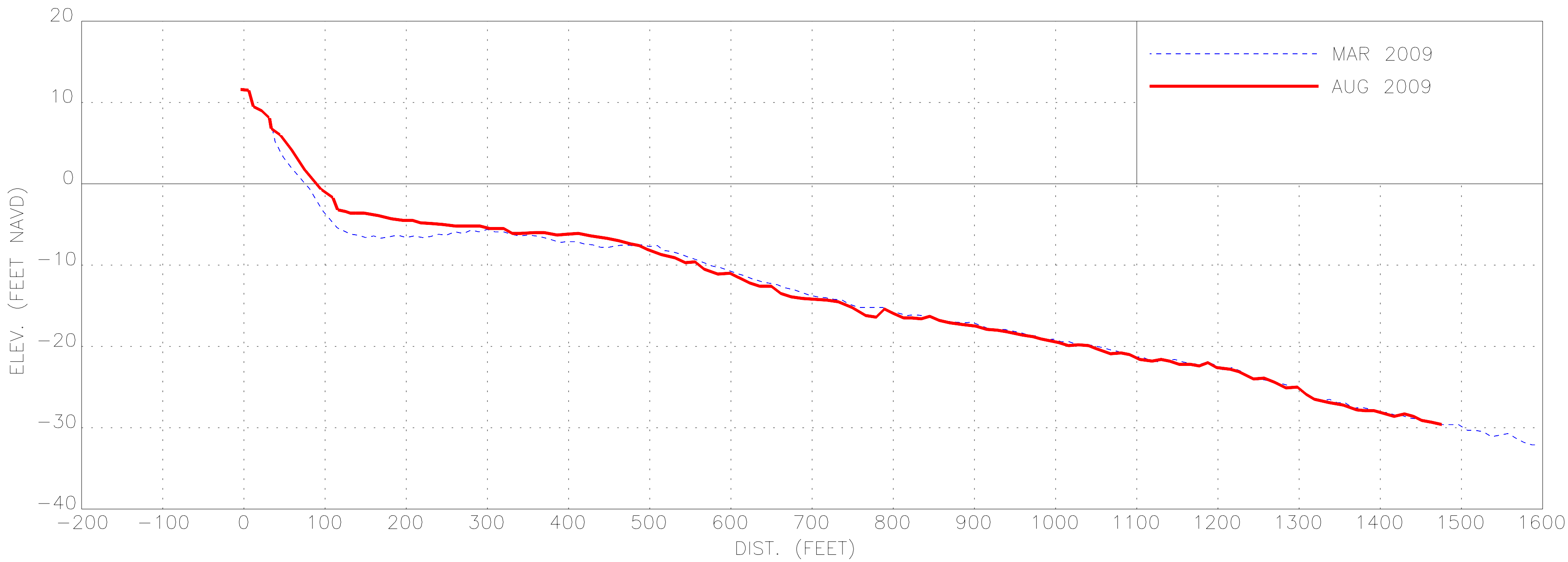

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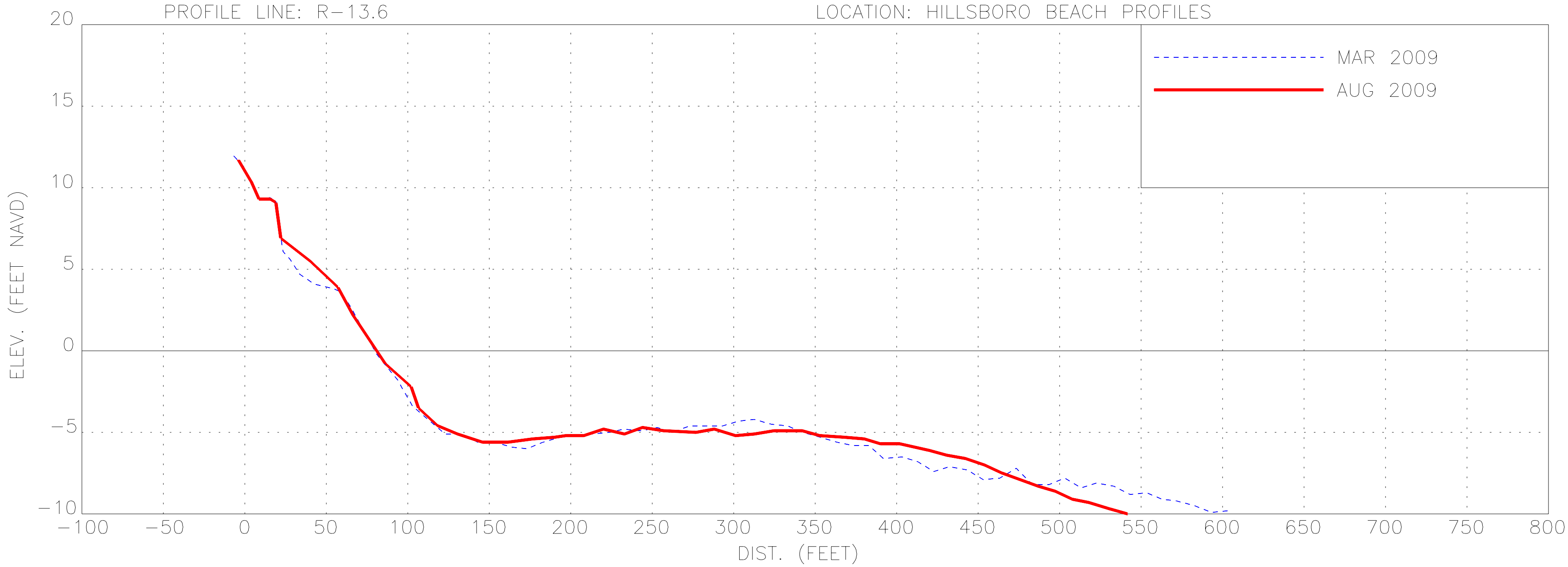
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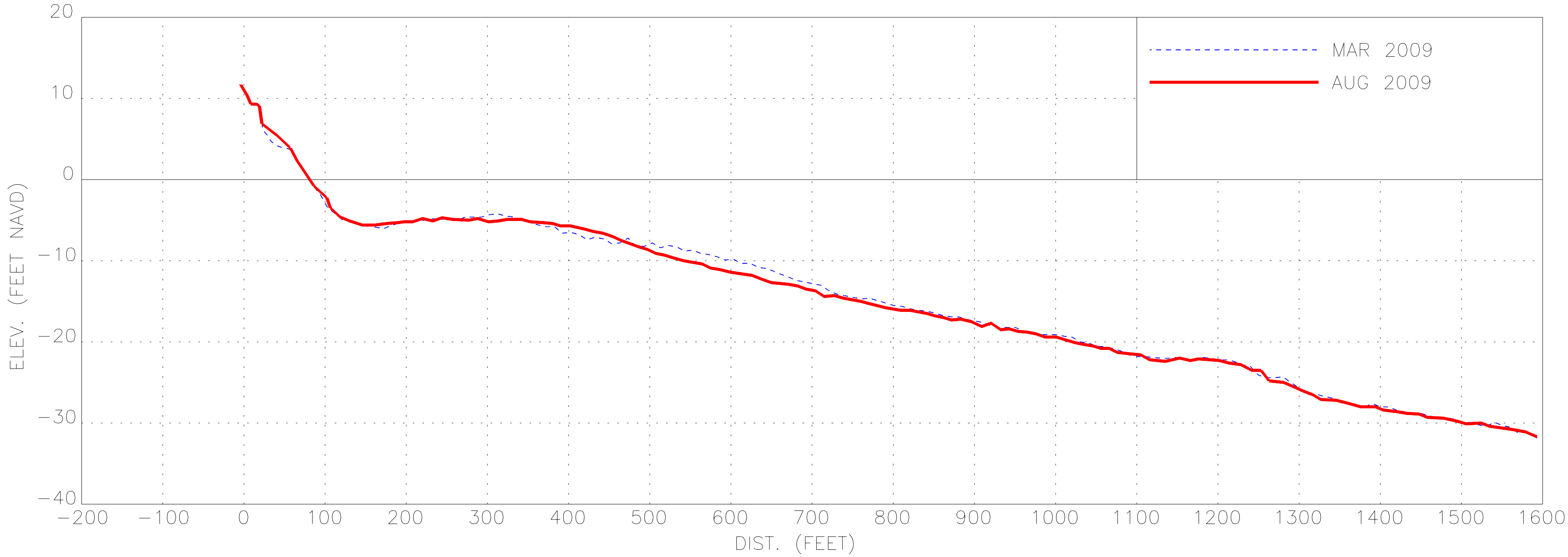
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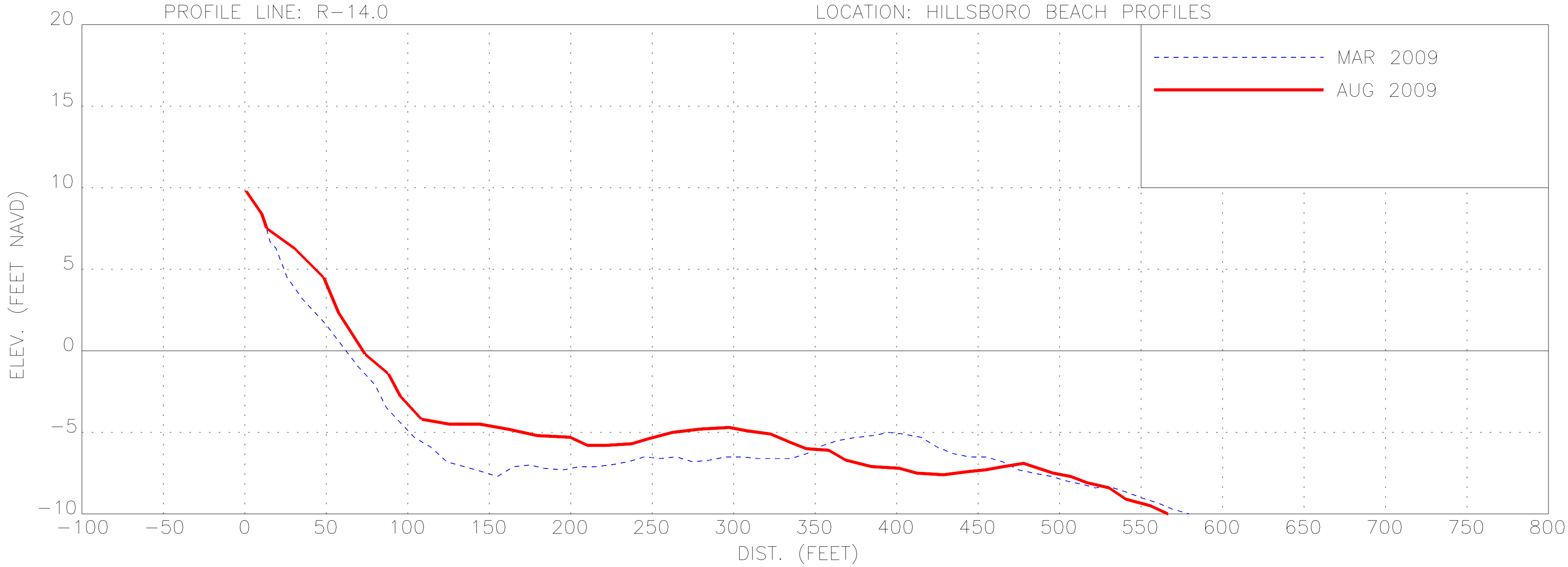
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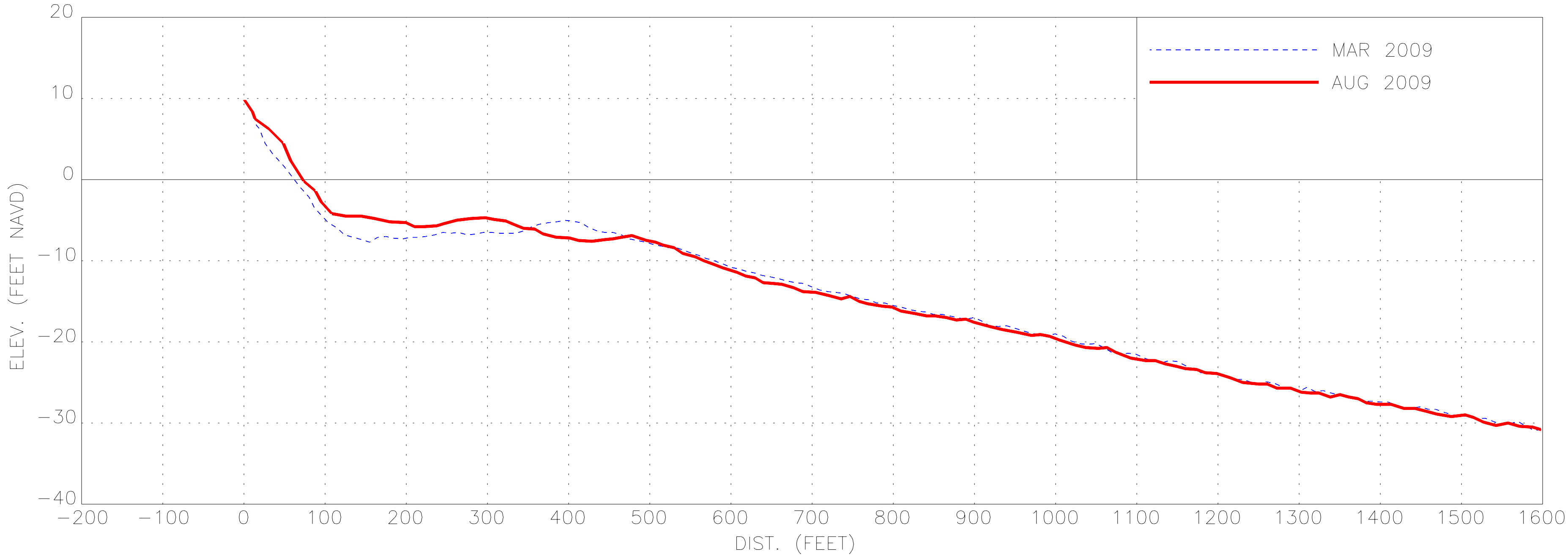
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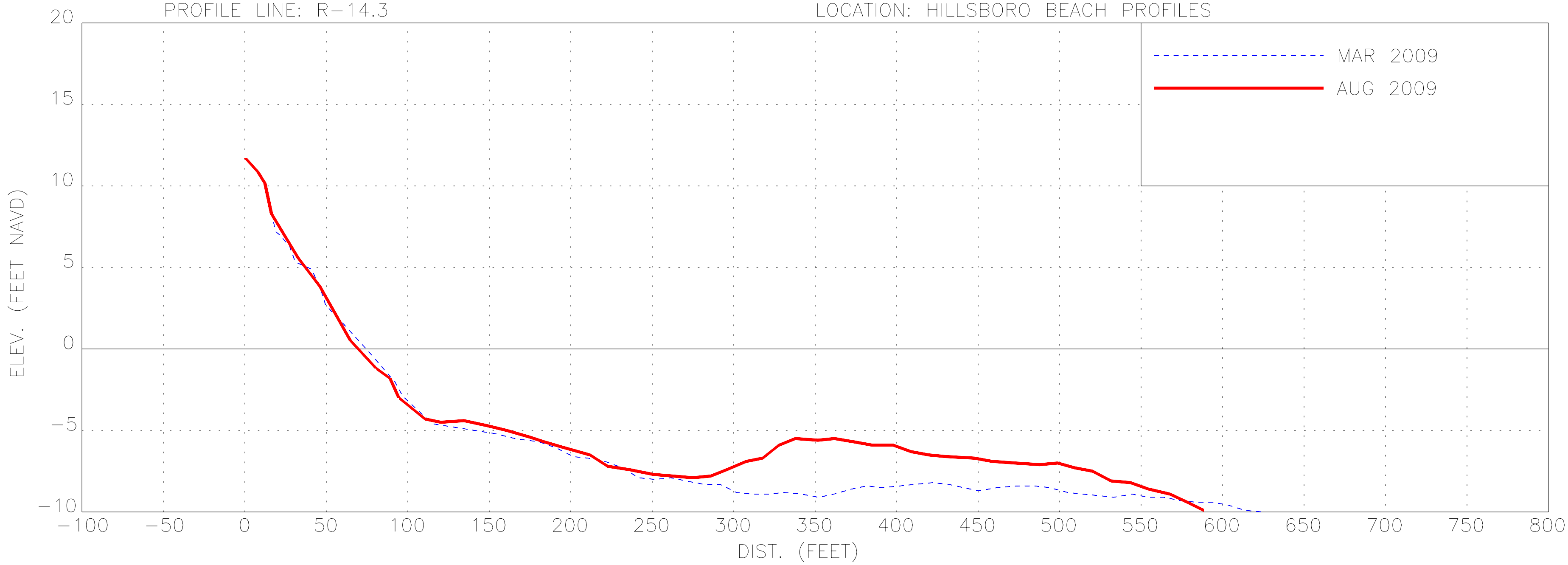
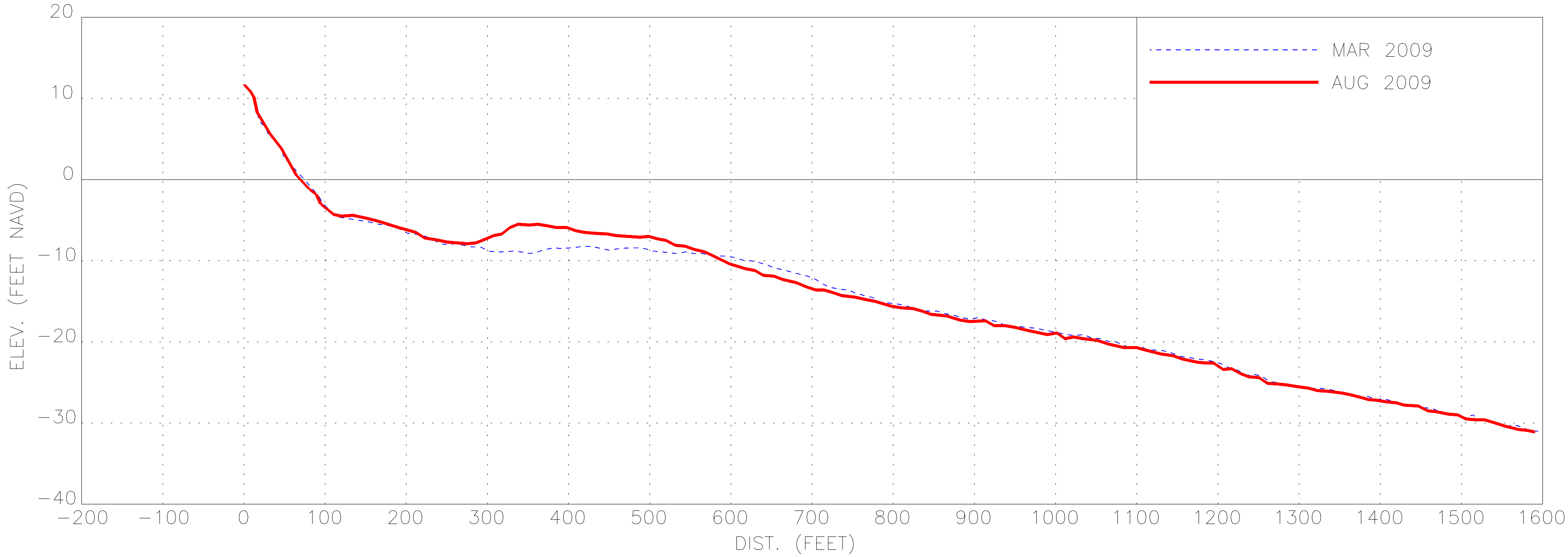
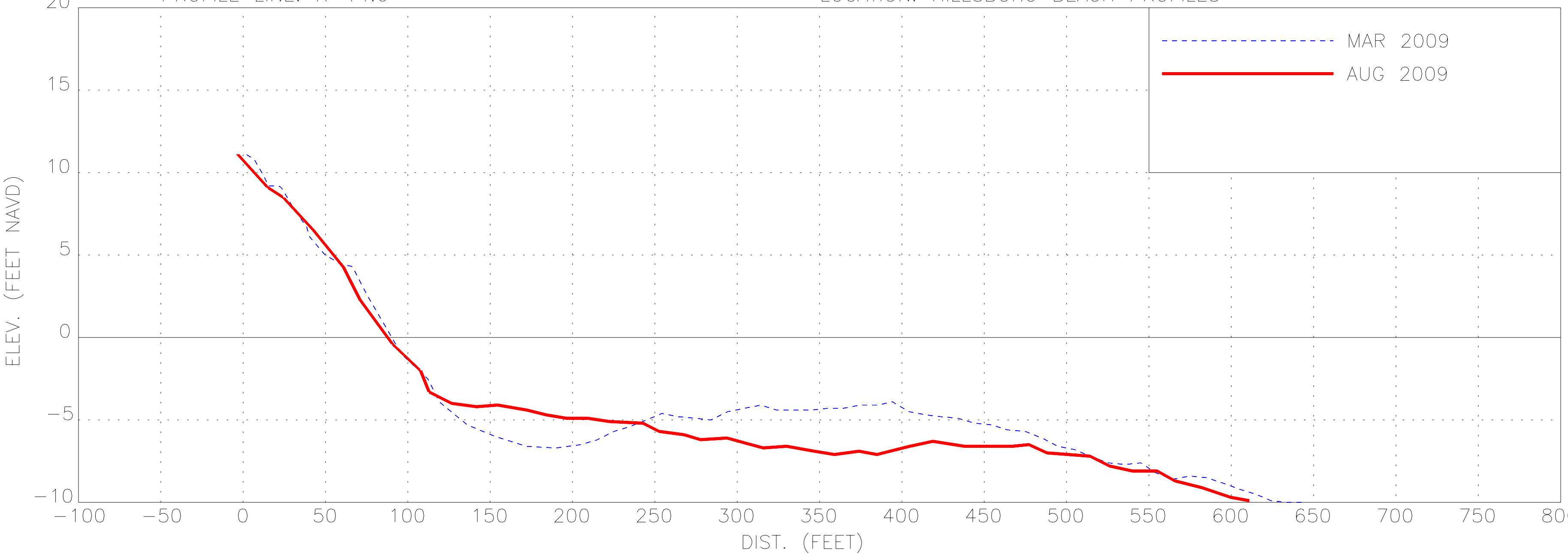
PROFILE LINE: R–14.3 LOCATION: HILLSBORO BEACH PROFILES

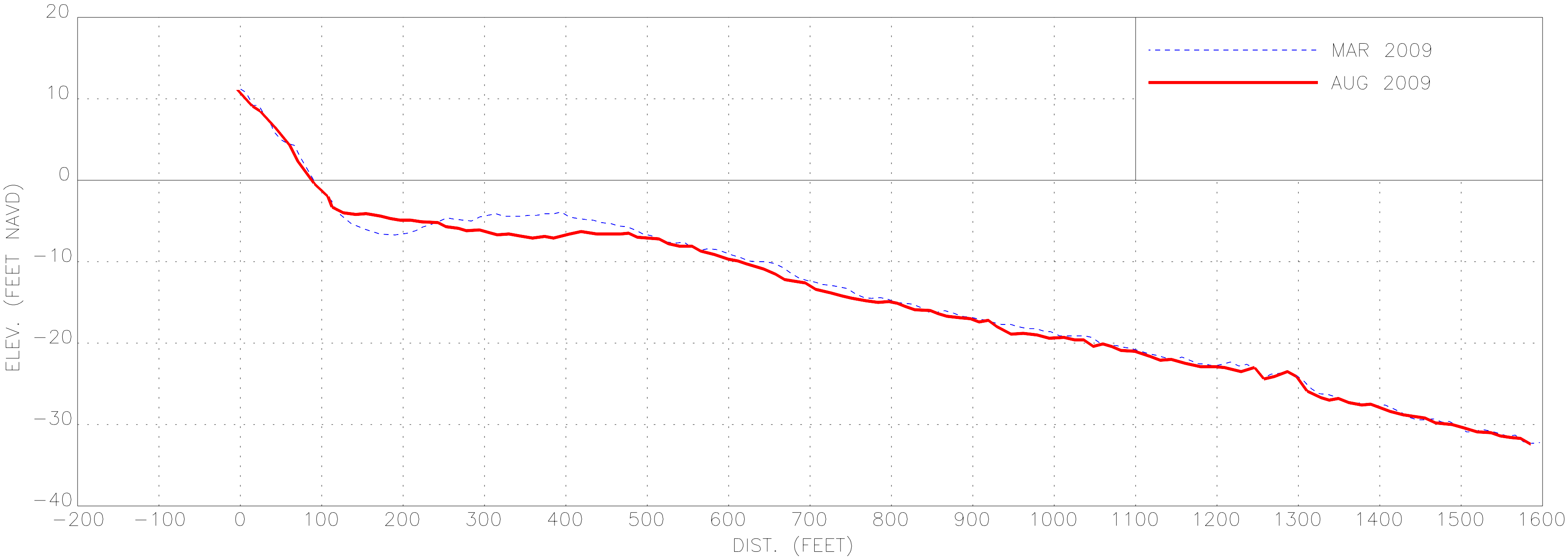


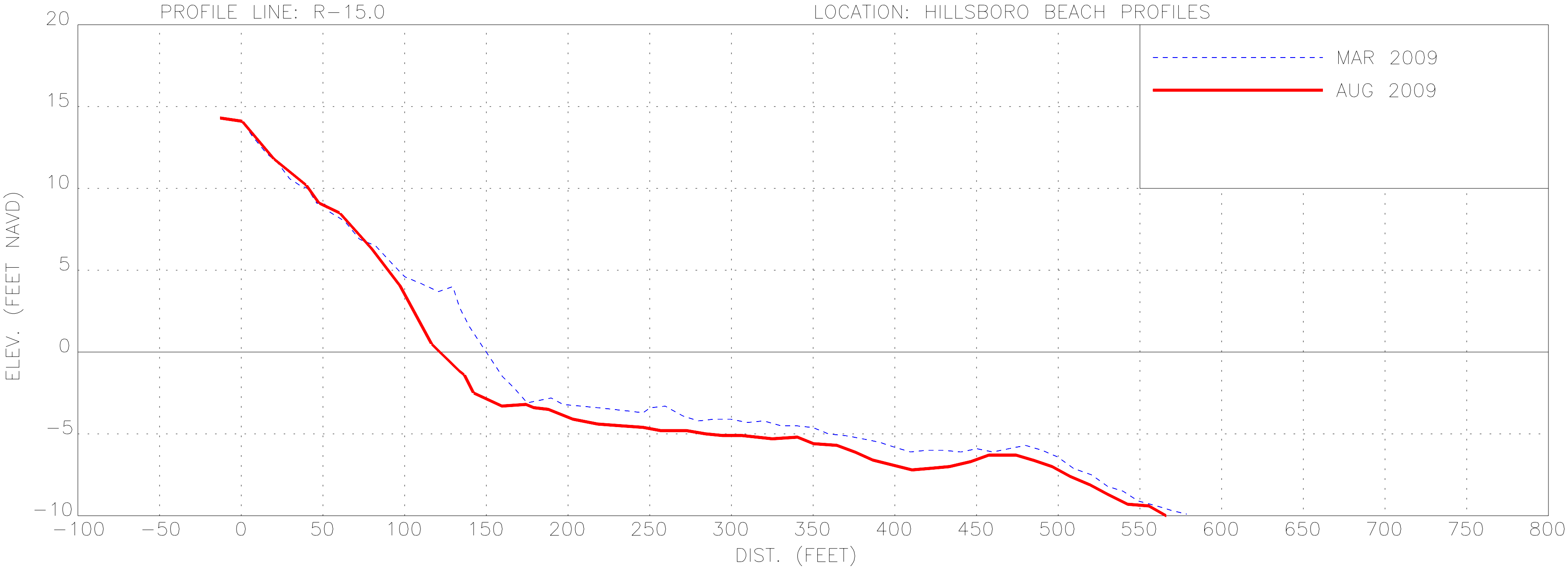


PROFILE LINE: R-14.6

LOCATION: HILLSBORO BEACH PROFILES



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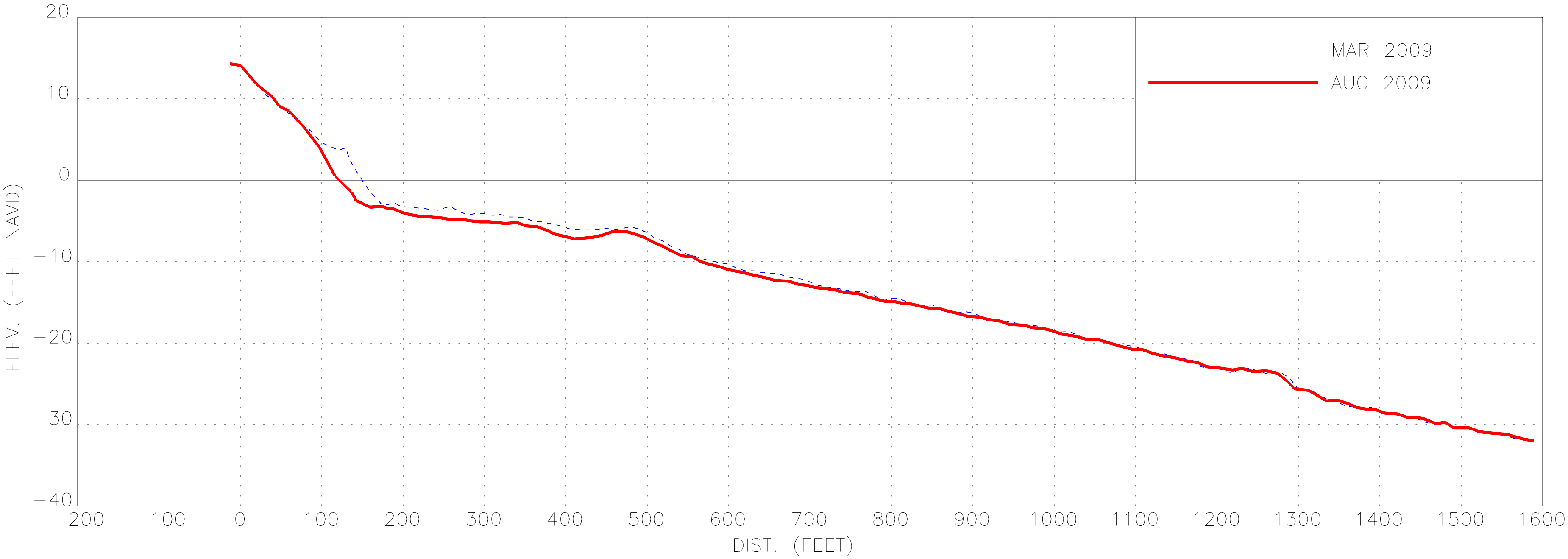
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