Rev 4.0

THE PORT of MOSTYN LIMITED

MAINTENANCE OF NAVIGATION

Mostyn Channel Monitoring Protocols

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Shoreline Management Partnership
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1.0 INTRODUCTION

The Port of Mostyn has applied for consent to dredge the Mostyn Channel between Welsh Channel and the Port (2.5km approx.) down to 4.0m below CD, over an average width of 75m (70m wide in the straight section; 100m wide in the curved section) over a period of three years. The amount of dredging is limited by the rate of deposition at Site 'A' in Mostyn Deep which has been determined for the present application to be:

Year 1 : 500,000m^3
Year 2 : 450,000m^3
Year 3 : 450,000m^3

An allowance of 50,000m^3 per annum is allowed for dredging at the berths, leaving a total channel dredge volume of 1.25 million m^3 over the three-year period. The capital dredge to achieve a 4.0m below CD channel is estimated to be 580,000m^3, which with a maintenance dredge of around 225,000m^3/annum results in a 4.0m below CD channel being achieved near the end of Year 3. The maintenance dredge allowance is less than the upper limit calculated from model results. This is based upon maintenance dredging experience over the last seven years including the effects of regular vessel traffic. The effects of the proposed dredging and deposition have been extensively studied using numerical models and results of monitoring of previous dredge and deposition consents. These studies have been carried out in the context of overall estuary evolution over the last 120 years.

The overall conclusion of the studies is that dredging of the Mostyn Channel to a depth of 4.0m below CD will have:

- local/direct effects: caused by the creation and maintenance of the channel disturbing the seabed to establish the required channel alignment and profile;

- ambient/indirect effects: caused by alterations to the tidal flow regime using the channel and adjacent banks with consequential effects on seabed levels.

The deposition of dredge arisings in Mostyn Deep at Site 'A' will result in:

- local effects: caused by the actual deposition covering the seabed;
- ambient effects: caused by alterations to the tidal flow regime and consequential sediment transport.

The physical process effects described above for the dredging and deposition operations will have consequential local and ambient biological effects.

The definition of the spatial extent and depth of the physical process effects are defined by the studies using recent and historical data from monitoring. It is important that context changes consequential to estuary evolution are also recorded so that any significant change due to natural estuary evolution can be reconciled with study forecasts of dredging and deposition affects as described above.

This report sets out the objective for monitoring of dredging and disposal operations to achieve a 4.0m below CD dredged channel to the Port and then presents a rationale for monitoring; reporting and consequential management of the operation.

2.0 MONITORING OBJECTIVES

The monitoring objectives are derived from the various study results and previous monitoring and comprise the following:

(i) To monitor the evolution of the estuary and local and ambient effects of the model studies of dredging and deposition on the integrity of the estuary and on the conservation objectives for the cSAC (especially those for the the 'Estuary' Feature which has objectives for spatial distribution of estuarine communities and the extent of notable hard substrata communities and for the 'Mudflats and Sandflats' feature which have objectives for proportions of mud and sandflat communities and the abundance of typical species);

(ii) to compare monitoring results with the estuary basis (i.e. the seabed level survey) used for model studies and the forecast effects from those studies of the dredging and deposition and quantify any differences; to assess the significance of such differences and, if necessary, review the forecast of dredge and deposition effects on the integrity of the estuary;

(iii) to inform the development of additional mitigation measures that may be required to avoid or reduce adverse impacts on the estuary;

(iv) to inform future applications for maintenance of navigation to the Port.

3.0 RELEVANT INPUTS FROM OTHER STUDIES/CONSENTS

The consent to dredge the channel from Welsh Channel to the Port to a depth of 2.0m below CD with a base width of 70/100m with deposition of dredge arisings at Site 'A' in Mostyn Deep, was issued in August 2005 for a period of two years. The consent included a Monitoring Plan prepared by the Environment Agency and monitoring requirements prepared by Marine and Fisheries Agency. Both monitoring plan and requirements were conditioned within the consents. The monitoring plan and requirements are reproduced in Annex 'A'. These monitoring conclusions have been observed over the period of the consent and beyond where such time extension was conditioned.

The principal tasks contained within the monitoring consent conditions were:

1)	Dredged channel survey	-	monthly
2)	Estuary transect survey	-	monthly
3)	Estuary seabed level surveys	-	annual (Salisbury Bank cross-channel – monthly)
4)	Salisbury Bank current monitoring	-	before and after a dredge campaign
5)	Biological survey – invertebrates	-	annual
6)	Biological survey – cockles	-	annual
7)	Biological survey – saltmarsh	-	annual
8)	Mostyn Deep seabed level surveys	-	variable (up to six surveys)
9)	Mostyn Deep sediment sampling	-	variable (up to six surveys)

The results of the monitoring undertaken since August '05 have been reported by monthly progress reports and analysis and review reports of which there have been two to date issued in March '07 and April '08 respectively. The March '07 report included the following recommendations in respect of future monitoring:

A) To place the dredged channel and flank surveys on to a two monthly interval rather than one month.

B) To place the estuary transect surveys on to a two monthly interval rather than one month.

C) To carry out a swathe bathymetry survey of Mostyn Deep and the deposition area in late April/early May of each year deposition takes place.

D) To alter the number of sample sites for the benthic communities assessment and the procedure for saltmarsh habitat assessment as set down in ABPmer report (April '08 – SMP Monitoring, 2008a).

E) To ensure that LiDAR survey and swathe bathymetry surveys are coordinated in time and extent and take place in late April/May each year.

F) To move any future consent termination date to November so that a monitoring report can be prepared in advance using the April/May surveys of that year referred to above.

These recommendations were reported in section 11.3.2 of the EIS (ERM, 2007) together with a further recommendation of an annual re-run of the numerical model using updated bathymetry to assess natural process change in the estuary. The EIS also recommended an annual report reviewing monitoring results.

The April '08 monitoring report repeated the recommendations above and also included 'early-warning' parameters of significant estuary evolutionary change in respect of forecast dredging and deposition effects.

Primary parameters:

- Maintenance or further increase of tidal energy using the Welsh channel and maintenance or diminution of tidal energy using the Hilbre channel;
- Plan location and alignment of the low water channel off Greenfield.

Secondary parameters:

- Absence of channel(s) across the southern flanks of Salisbury Bank downstream of Greenfield;
- Sustained closure of Welshman's Gut;
- Maintenance of size and location or enhancement and eastward movement of Mid-Hoyle channel;
- Confinement of central estuary low water channels within the lateral limits described in this report.

At a technical meeting with the Regulators on 9th May '08 it was agreed that the changes to the Holocene clay bank in the centre of the estuary should be added explicitly to the list of secondary parameters and the ES addendum issued in August '08 recommended inclusion of the direct effects of cockle-abundance along West Salisbury from main dredge campaigns (>100,000m^3). The locations of the 'early-warning' parameter estuary features are shown on figure 16. The estuary evolution report (SMP, 2008b) recommended that monitoring reporting should comment specifically on the primary and secondary 'early-warning' parameters.

4.0 MONITORING RATIONALE

The monitoring plan needs to contain tasks; frequencies and reporting arrangements such that there is 'early-warning' of any unforeseen adverse impact due to dredging and/or deposition becoming significant so that prior mitigation can be implemented and the integrity of the estuary safeguarded.

The monitoring plan is based upon the state of estuary evolution due to natural processes as defined by the 2006 seabed level survey and historical surveys. This basis may be summarised as follows:

(A) the low water channel upstream of Greenfield is presently stable in location even in the vicinity of Flint Point and the minor channel through Salisbury Middle has effectively closed;

(B) the central estuary continues to be volatile but the twin (or more) major channels introduced in 2004/05 rather than one major channel previous arrangement are persistent;

(C) the Holocene clay bank is actively eroding providing unique changes to seabed levels in the centre of the estuary;

(D) the Welsh channel has increased its energy profile and the Hilbre channel has reduced its energy profile since 2003 with both channels relocating towards the centre of the estuary (as recorded by north transect off the Mostyn breakwater);

(E) the Mid-Hoyle channel is migrating eastwards and is the only significant trend change within the estuary approaches;

(F) there is a nett import of sediment into the estuary each year but the annual rate is variable.

If the estuary evolution is sustained as summarised above then the Monitoring Plan needs to examine the actual local and ambient effects of dredging and deposition compared to forecast effects from the numerical modelling.

If the estuary evolution changes from that summarised above then the Monitoring Plan needs to define the changes and examine effects on the estuary basis used for the forecasts of dredge and deposition local and ambient effects.

If the estuary basis changes significantly with regard to dredging and deposition effects then these effects will need to be re-assessed by further numerical modelling.

The Monitoring Plan needs to comprise two measurement components:

- measurement of local and ambient effects from the dredging and deposition operations;
- measurement of estuary evolution.

Each measurement needs to be defined by spatial extent; frequency; threshold level for action; action options; management protocol.

The model forecasts of dredging and deposition effects provide quantified prediction with the estuary basis fixed by the seabed level survey of 2006. The estuary basis in reality exhibits fluctuations in seabed level due to the tide range variation; climatic conditions and freshwater inflow to the estuary over any twelve-month period. This complicates discrimination of local and ambient effects due to dredging and deposition. These fluctuations of the estuary basis also complicate the discrimination of trend change of the estuary basis itself.

There exists now however an extensive monitoring database collected specifically for the dredging and deposition operation since 2001. Within this database there is information on a 'tipping-point change that occurred within the central estuary in 2004/5. This change is linked to the eastward migration of Mid-Hoyle channel and its effect on flood flow directions within Welsh channel. The change represents the most rapid and most significant alteration to estuary morphology over the last seven years of dredge and deposition monitoring. The available

historical evidence shows only one similar 'tipping-point' event in 1985 when the navigable channel upstream of the Port to Connah's Quay changed from Mostyn Channel to Welsh Channel. This change is linked to the closure of Welshman's Gut and redistribution of flood flows from the Hilbre Channel into the Welsh Channel. The relevant evidence is in the form of pilot charts reproduced in Annex 'B' from which it is difficult to derive a timescale for the change. It would seem reasonable to conclude however that the flow regime alterations took place over at least a six to twelve-month period. Reference to the Middle transect data base shows that the central estuary channel development 'tipping-point' of 2004/05 was identifiable in June '04; reached its deepest profile in June '05 then transferred prominence to a further new channel in June '07.

It is concluded from the above evidence that the minimum period for estuary evolution change to be accommodated by the Monitoring Plan over the next three years is twelve-months. The available evidence shows other estuary evolution rates of change such as the easterly migration of Mid-Hoyle channel and the closure of Welshman's Gut to take place over decadal timescales. The Monitoring Plan needs to demonstrate that evolution change can be detected and, if necessary, mitigated within a twelve-month window.

(There is no evidence of dredging or deposition causing a 'tipping-point' in estuary evolution, despite the original 4.5m below CD dredged channel established in 2001 and the channel realignment at the end of 2005).

The spatial extent of monitoring needs to be defined for:

- the estuary basis;
- the local effects of dredging and deposition;
- the ambient effects of dredging and deposition.

The spatial extent of the estuary basis covers the area defined by the present evolution summary – points 'A' to 'F' above. This area extends downstream from Connah's Quay to an arbitrary straight boundary extending from Hilbre Point to Point of Ayr (Figure 18 refers).

The local and ambient effect areas for dredging and deposition are defined for monitoring purposes as follows:

Dredging — area defined westward by a line 250m west of the dredged channel centre line with a northern limit at 384000 and a southern limit at 382000. The eastern limit at 384000 to 382500 is along 316400 then along 316500 to 381200 and then linking directly to Warwick Point. The western boundary south of 382000 is defined initially by a line 250m west of the dredged channel centre line and then by the Port breakwater and shoreline upstream to Warwick Point. This area covers the principal local and ambient areas of impact as defined by monitoring and modelling respectively. The area is shown in figures 1 and 2 against a backcloth of the 2007 seabed level survey and model forecast of impact area respectively. The area south of 382000 is only to be monitored in connection with concerns over dredge effects on cockle beds of Salisbury Bank and for benthos as defined in Table 'EE' and Annex 'G'.

Deposition — rectangular area defined by the latitude and longitude of the four corners:

- 53 21.650 N 03 18.210 W
- 53 20.940 N 03 16.350 W
- 53 21.050 N 03 16.180 W
- 53 21.770 N 03 18.080 W

- plus a 250m additional strip around the rectangular area perimeter for the local area (Figure 17 refers). The ambient area is defined by that area of Mostyn Deep that lies below the 1.0m above CD contour and upstream to 316500.

It is important to discriminate between the ambient area of impact associated with dredge deposition at Site 'A' in Mostyn Deep and the potential area for dispersion of sediment deposited at Site 'A'. These two areas are substantially different. The HR (2007) model study results show the dispersion area extending upstream to Flint Point which means that there is thorough distribution of sediments throughout the estuary from this location.

The area of impact is much smaller since this represents the area of spread of any deposition within which the seabed levels are altered above daily fluctuations due to natural processes. The area of spread has to be continuous for the physics of sediment transport to be maintained. This is not related to sediment transport prediction but to the fact that the soft seabed has to respond to the prevailing hydrodynamics. Once the seabed level assumes pre-deposition levels there can be no further change in sediment transport beyond that applying before deposition was carried out. If therefore the deposition is not sufficient to divert flows and widen the channel then the deposition is dispersed as a continuous sheet extending upstream until it becomes less than daily natural process bed level fluctuations. This spread area for Site 'A' extends upstream within the Welsh and Mostyn Channels to Greenfield for typical proposed main dredge campaign quantities of around 125,000m3. Since the depth of deposition is limited to 0.2m per campaign with the potential maximum of 0.4m (over a Summer period where dispersion is reduced), the effect on the flow regime will not affect channel width – the mean flow depth is around 10.0m at Site 'A'. The spread area is calculated as the continuous sheet required to reduce a volume of 125,000m3 to a depth of 100mm – this equates to a 100m wide swathe of channel bed comprising Welsh Channel and Mostyn Channel upstream to Greenfield of 12.5km combined length.

The dispersion of the sand-sized sediment within the confines of the low water channels has been established by measurements and modelling. In order to monitor the spread of deposition material, the area has been confined upstream to 316500 within Welsh Channel. This reduced area is appropriate to allow detection of the spread if it were moving more slowly and thereby accumulating compared to forecast.

The above rationale focuses on evaluating changes to the physical environment whether these be from local/ambient effect of the proposed dredge and disposal work or from the wider patterns of change that are related to estuary evolution. This physically-focused approach will provide rapid early warning information on changes to the extent of intertidal habitats as one of the key

conservation objectives for the system (see Section 2). The approach of focusing the survey effort (and survey costs) on the physical monitoring was agreed in consultation with the regulating bodies (CCW, EA and CEFAS) at the meeting on 9th May 2008. It was also agreed that there is no value in continuing the saltmarsh monitoring work. This is because of the large distance (>10km) of the saltmarsh sampling areas from the zone of predicted local/ambient effects and because the saltmarsh sampling areas are strongly influenced by natural factors as shown by the last three year's of monitoring. The future ecological monitoring work will though retain both the benthic work (with reduced sampling intensity) and the surveys of the Holocene Clay bank.

Biological monitoring is not now considered to be necessary for the monitoring of the estuary basis, which is adequately defined by physical process measurements for the purpose of numerical modelling of estuary change. This arises from the work on estuary evolution and the results of monitoring of the dredge and deposition operation. Under the previous consent the biological monitoring sites were distributed throughout the estuary as shown on figures 4 and 5 against a background of 2003 bathymetry; on figures 6 and 7 for 2006 bathymetry and figures 8 and 9 for 2007 bathymetry.

The bathymetry change plots for 2003/2006 and 2006/2007 are provided in figures 10 & 11 and 12 & 13 respectively, with the biological monitoring sites again overlaid. Interpretation of figures 12 and 13 requires reference to the survey coverage in 2007 which is shown in figure 13a. Areas not surveyed in 2007 remain as surveyed in 2006.

The presentation of the biological monitoring sampling site locations for 2006 seabed levels bear comparison with the locations overlaid on the forecast area of impact for a 4.0m below CD channel using 2006 seabed levels, shown in figures 14 and 15.

With respect to describing the ecological quality/character of intertidal areas, then the monitoring programme is to include benthic invertebrate sampling work that concentrates on describing the areas of local/direct and ambient/indirect effect. Further benthic sampling in areas outwith the zone of direct and indirect effect is confined to that specified in Table 'EE' and Annex 'G'. A brief review of past monitoring is produced by ABPmer in Annex 'F'. There are

also a number of practical and scientific reasons for reducing the amount of ecological sampling when compared with the work that has been done over the last three years. One reason is that many of the 43 sampling sites surveyed have shown no significant change over the past 3 years and where changes have been observed they are either attributable to natural changes in estuary channel alignments or appear to reflect natural spatial and temporal variability of benthic communities even in stable areas such as the Mostyn Bank. Ultimately the final judgement about whether any benthic observed changes are linked to the dredge and disposal work always requires a return to the findings of physical monitoring work as this provides a greater spatial coverage of information and a greater degree of change quantification than can be achieved from the ecological monitoring work. The spatial and temporal variability of the benthos and the fact that ecological responses occur in response to, and at varying timescales after, physical change(s), as well as the fact that the post-sampling laboratory analysis work has a turnaround time which extends for several weeks/months, means that they are not valuable as the 'early warning' indicator that all parties need in this situation.

There is however a need to determine whether there is any effect on all the relevant conservation objectives. Particularly, there is need to understand whether and/or how the quality of the habitats are affected and especially whether the "communities and the abundance of typical [benthic] species" in potentially impacted areas are altered in ways that cannot be detected by the physical monitoring work. Comparison of figure 6 with figure 14 shows that the majority of existing biological monitoring sites lie outside the model forecast area of effect of the dredged channel. A revised biological monitoring programme has been developed with CCW, which is based upon a 500m by 500m grid resolution for Mostyn Bank and Salisbury Bank. The proposed sampling sites are defined in Table 'EE' and the CCW proposals are reproduced in Annex 'G'. Under the revised programme there will be two surveys each year – the first survey in the spring will collect samples for particle-size analysis from all the sites listed in Table 'EE' where the sea bed level is 2.0m above Chart Datum or higher. These samples will be analysed and where significant change is detected then these sites will be resurveyed in the autumn for both benthos and particle-size distribution. The benthic data will be compared against baseline data either available from previous monitoring work or obtained during the first spring survey campaign. In addition to this benthic sampling work, analysis of the changes in extent of the Holocene clay bank will continue.

The results that are obtained from the benthic monitoring can generally be compared against the extensive 43-site and 3-year dataset that exists and provides a very comprehensive description of the local and estuary-wide environment and includes a valuable indication of between-site and between-year variability. This will greatly benefit ongoing analyses because, in future years, the results obtained from sampling at the ~~10~~ proposed sites can be compared directly against this baseline dataset to determine whether these sites have changed substantially. The reasons for any such change can be determined through on-site observations, Particle Size Analysis (PSA) and the results of the other physical monitoring work. Also, if the physical monitoring work identifies areas of concern or 'threshold exceedence' (see Section 7 for list of significant changes and thresholds) outside the proposed monitoring zone then, according to the proposed annual monitoring timelines, such information will be available in advance of the autumn surveys (e.g. from April/May LiDAR surveys and/or bi-monthly transects) and, if needed, extra sampling sites could be added to address any areas of particular concern.

Figures 4 to 15 all include the locations of sampling stations for the annual 'takeable cockle surveys' of Salisbury Bank in 2007 and 2008. This work is carried out by EAW and provides adequate coverage of the important cockle beds of relevance to the dredging operation. The location of several new survey stations in 2008, along the southern perimeter of the Salisbury bed off the Port breakwater, will assist in the discrimination of any local effects due to the dredged channel, from natural process changes in cockle habitat due to increased energy in the Welsh Channel.

The close proximity of forecast sediment flux changes to the EAW 2008 cockle-abundance survey locations along the western flank of Salisbury bank is shown in Figure 15. It is proposed to carry out seabed level surveys of the area defined above south of 382000 before and after main dredge campaigns (>100,000m^3) and at four monthly intervals between such campaigns coincident with normal channel surveys. These additional surveys will be accompanied by a cockle abundance survey of the western-most sample sites used by EAW for their annual cockle-abundance surveys of Salisbury Bank.

The monitoring rationale set out above provides a logical justification based on the available evidence for definition of the spatial extent of monitoring and for the determination of the

critical timescale to be adopted within which the monitoring information needs to be appraised and action taken as appropriate to avoid environmental damage to the estuary.

Table 'EE' **Coordinates of sampling stations for PSA and infaunal sampling**

Transect	Station	X coordinate	Y coordinate	Comment
A0	4	315000	383500	Mostyn Bank
A0	5	315500	383500	Channel
A0	6	316000	383500	Salisbury Bank
A0	7	316500	383500	Salisbury Bank
A	3	314500	383000	Mostyn Bank
A	4	315000	383000	Mostyn Bank
A	5	315500	383000	Channel
A	6	316000	383000	Salisbury Bank
A	7	316500	383000	Salisbury Bank
A	8	317000	383000	Salisbury Bank
A2	3	315000	382500	Mostyn Bank
A2	4	315500	382500	Mostyn Bank
A2	5	316000	382500	Channel
A2	6	316500	382500	Mostyn Bank
B	2	315000	382000	Mostyn Bank
B	3	315500	382000	Mostyn Bank
B	4	316000	382000	Channel
B	5	316500	382000	Salisbury Bank
B	6	317000	382000	Salisbury Bank
Bu	1	317467	384133	West Buoy
C	1	316500	381000	Salisbury Bank
C	2	317000	381000	Salisbury Bank
C	3	317500	381000	Salisbury Bank
C	4	318000	381000	Salisbury Bank
D	1	317500	380000	Salisbury Bank
D	2	318000	380000	Salisbury Bank
D	3	318500	380000	Salisbury Bank

5.0 MONITORING TASK DEFINITION

The Monitoring Plan for the estuary basis definition is set out below:

Task	Frequency	Spatial Extent	Analysis	Evolution Issues
EB1 LiDAR/Swathe Survey of seabed levels	Annual	Northern limit = straight line joining Hilbre Point to Point of Ayr. Southern limit = 369000	Contour plot; Difference plot to previous survey(s); Numerical model run of morphological tide	A, B, C, D, E, F
EB2 Estuary Transects	Bi-monthly	North, Middle and South transects as presently defined.	Channel/Bank parameters; Datum level area(s) above seabed	A, B, D(part)
EB3 Mid-Hoyle/Welsh channel confluence	Bi-annual with one survey coincident with LiDAR/ Swathe survey)	Northern limit = 388000 Western limit = 312000 Eastern limit and southern limits to tie in with Mostyn Deep Survey.	Contour plot; Difference plot to previous survey; Integration with LiDAR/Swathe survey.	E
EB4 Mostyn Deep	Annual (Synchronous with Mid-Hoyle/Welsh channel confluence survey six months apart from EB1)	Flanks to 1.0m above CD and upstream limit to 316500.	Contour plot; Difference plot to previous survey; Comparison to LiDAR/Swathe survey.	C, E, D(part)
EB5 Holocene Clay Bank	Bi-annual (one survey to coincide with LiDAR/Swathe survey of seabed levels)	Area of exposed clay around (317300, 384400)	Plot extent of clay area exposed and overlay on previous surveys – assess the extent and status of piddock colonisation of the area and erosion rate of clay edge (if appropriate).	C

The Monitoring Plan for the local and ambient effects definition for dredging and deposition is set out below:

Task	Frequency	Spatial Extent	Analysis	Local/Ambient Issues
LA1 Dredged Channel Survey	Bi-monthly	Northern limit = 384000; Southern limit = 382000; Western limit = 250m west of channel centreline; Eastern limit = 316400. Survey lines to be 100m apart except for longitudinal sections A to K to be set 50m apart (see Figure 3). Survey spatial limits shown on Figures 1& 2.	Selected cross-section and longitudinal section profiles overlaid on previous surveys with correlation to dredge campaign locations and volumes.	Local – spatial extent and depth of dredging campaigns; lateral extent of profile changes due to dredging. Ambient – seabed level changes adjacent to channel over the area of impact forecast by the numerical model.
LA2 Mostyn Deep Site 'A' Deposition Area	Before/After each Dredge Campaign	Deposition Area (as defined by license) plus 250m around outside of area perimeter.	Selected cross-section and longitudinal section profiles overlaid on previous surveys.	Local – spatial extent and depth of deposition; spatial extent and depth of any dispersion outside deposition area. Ambient – using EB4 results to assess spread of deposition material.
LA3 Mostyn Deep Site 'A' Deposition Area Seabed Samples	Annual (Synchronous with EB4)	Six locations within the deposition area. Four locations outside the deposition area but within Mostyn Deep.	Visual description; Particle-size analysis; Comparison with previous PSA data.	Local – change in characteristics of seabed sediment in the deposition area. Ambient – change in characteristics of seabed sediment in Mostyn Deep.
LA4 Cockle Survey – Salisbury/ Mostyn Bank (to be supplied by EAW)	Annual	Within area adjacent to impact forecast by numerical model as shown in Figure 15.	Reconciliation of data with results of EB1 and LA1.	Local – effect of channel profile on cockle beds. Ambient – effect of channel changes to hydrodynamics on seabed levels in cockle survey area.
LA5 Benthic Survey Salisbury/ Mostyn Bank	Annual	Within and adjacent to area of impact forecast by numerical model as shown in Figure 15 and defined in Table 'EE' and Annex 'G'.	Reconciliation of data with results of EB1 and LA1.	Local – effect of channel profile on benthos of flanks. Ambient – effect of channel changes to hydrodynamics on seabed levels in forecast area of impact and on colonising benthos.

Task	Frequency	Spatial Extent	Analysis	Local/Ambient Issues
LA6 Port area survey and local cockle survey	Before/after each main dredge campaign and at four monthly intervals between coincident with LA1.	Northern limit = 382000; Eastern limit = 316500 to 381200; Southern limit = Warwick Point.	Selected cross-section and longitudinal section profiles overlaid on previous surveys with correlation to dredge campaign locations and volumes. Reconciliation of data with results of EB1 and LA1.	Local – effect of channel dredging on the western flank of Salisbury Bank. Ambient – the cockle-abundance of the western area of Salisbury Bank.

The critical timescale within which to monitor and mitigate (if necessary) changes in the estuary basis or in forecast effects of dredging and deposition was defined in section 4 as twelve months. The monitoring tasks LA1 and EB2 are proposed to be undertaken at two monthly intervals. This frequency has been derived from a consideration of monthly surveys for each of these tasks available from 2003 for EB2 and 2005 for LA1. The data sets have been analysed for monthly intervals; then for simulated two monthly intervals and a difference plot produced. The results are included in Annex 'C'. This work demonstrates that the physical changes over the period are adequately captured by the two-month interval adopted under the Monitoring Task definitions presented in the table above.

The annual interval for the LiDAR/Swathe seabed level survey (EB1) and accompanying numerical modelling is the same as the critical timescale. The monitoring tasks EB3, EB4 and EB5 provide a partial survey of the estuary at the six-month point between EB1 surveys.

The monitoring plan described above acknowledges the critical timescale operating an 'early-warning' on a two-month interval. Once a significant change in the estuary basis or significant deviation from forecast effects of dredging and deposition is flagged-up, then management (and mitigation, if appropriate) of the change can be enacted. Management and mitigation are presented in Section 7 below.

6.0 MONITORING REPORTING

The purposes of monitoring are:

- to improve the available data base for forecasting future estuary evolution;
- to confirm or otherwise the model forecasts of dredging and deposition effects and to update model forecasts as appropriate;
- to review monitoring results against the primary and secondary 'early-warning' parameters regarding estuary basis changes;
- to avoid environmental damage to the estuary;
- to keep all relevant parties informed of monitoring results;

In order to fulfil these purposes it is necessary to report progress on a regular basis to a level of detail that provides an alert of estuary behaviour outside forecast limits so that any necessary action can be implemented within the critical time period of twelve months. It is also appropriate to report in fuller detail on monitoring results on a less frequent basis including, within this report, a reconciliation to forecast behaviour of the estuary to dredging and deposition and a review of the ongoing relevance of the monitoring plan.

The minimum interval for monitoring task repetition is two months for dredged channel surveys (LA1) and estuary transects (EB2). Progress reports are therefore to be produced at two monthly intervals and pick-up all the other monitoring tasks (section 5 above refers) as they occur over any twelve-month period. The monitoring year extends from November to November so that the LiDAR/Swathe seabed level survey undertaken in Spring can be reported by November. The report in November is therefore the fuller detail report. The typical annual timetable for monitoring tasks and reporting is provided in Table 'AA'.

Progress reports to include cumulative analyses as defined in section 5 above with comparison against task thresholds (see section 7 below). Where a threshold is exceeded a short report is to be added describing the form of the exceedance; a rationale for the occurrence (where available) and a proposed course of action. The courses of action available are likely to vary considerably with the understanding of the causes for the threshold exceedance but a single page summary will be included with each progress report using a traffic light system against each monitoring task:

RED	-	threshold exceedance alert, action required.
AMBER	-	threshold exceedance recorded, under observation
GREEN	-	satisfactory

The occurrence of a 'red' alert against a monitoring task would require consultation with the Regulators and action to be agreed. The occurrence of 'amber' alerts would enable consultation with the Regulators as deemed appropriate by them.

Progress reports to be circulated electronically within one month of last date of field data collection for task LA1.

The annual report in November of each year to include the results of the numerical model run of the morphological tide using the Spring seabed level survey with a reconciliation to the results produced in 2006. This report would also include the seabed level survey difference plot against the previous year with reconciliation to other monitoring results.

The ecological survey report to be attached to the February progress report as this work will not be available in time for the November annual report.

Table 'AA' **Monitoring Timetable – Typical Year**

Month / Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
EB1				■	■							
EB2	▲		▲		▲		▲		▲		▲	
EB3				■	■					■	■	
EB4										■	■	
EB5				■	■					■	■	
LA1		□		□		□		□		□		□
LA2	◄	- - -	(As appropriate)	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	►
LA3										■	■	
LA4					◄ - - - (EAW to provide) - - - ►							
LA5									■	■	■	
LA6	◄	- - -	(As appropriate)	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	►
Progress Reports		○		○		○		○		○		○
Annual Report											●	

7.0 MONITORING MANAGEMENT/MITIGATION

The management of the monitoring plan comprises reporting of the monitoring results as described in section 6.0. The reporting will apply threshold criteria to the monitoring tasks to allow the 'traffic light' system of alerts to operate. As the estuary is subject to continuous variation of seabed levels due to the large tidal range, climatic conditions and freshwater input the application of threshold criteria requires a two-stage process:

Stage I the monitoring results move above a declared level within a declared time interval;

Stage II the monitoring results continue to move and the trend is significant in respect of one of the 'early-warning' parameters set down in section 3.0 or the movement is above the forecast level of dredging and deposition effects within the defined ambient or local areas when compared to adjacent estuary behaviour.

Stage I would trigger an 'amber' alert and Stage II a 'red' alert within the relevant progress report.

Significant change to the estuary basis comprise:

- alteration to the location and alignment of the main low water channel off Greenfield;
- re-opening of the Salisbury Bank cross-channel or Welshman's Gut;
- lateral shifting of the energy balance in the central estuary manifest by bank and channel relocations;
- reversal of the migration trend for Mid-Hoyle channel;
- lateral shifting of the location and relative location of Hilbre and Welsh channels.

Significant change to the dredging and deposition forecast effects comprise:

- increases in seabed level within the ambient areas defined for dredging and deposition above forecast, not reflected outside these areas in general estuary behaviour;
- increases in seabed level outside but adjacent to the deposition area not reflected elsewhere in Mostyn Deep;

- non-dispersion of deposited sediments from Site 'A' over a six month period;
- seabed level changes outside the 300m wide dredged central corridor not reflected in general estuary changes in the area.

There would be less concern over changes to the estuary basis comprising:

- alterations to the minor banks and low water channels where change has been previously observed;
- seasonal changes to bank and channel seabed levels;

and changes to the dredging and deposition forecast effects comprising:

- non-dispersion of deposited sediments from Site 'A' over a period less than six months;
- increases in seabed level within ambient areas for dredging and deposition reflected in general estuary behaviour adjacent to these areas;
- increases in seabed level adjacent to the deposition area reflected in general estuary behaviour within Mostyn Deep.

In order to determine suitable Stage I thresholds for tasks EB2 and LA1 recourse was made to previous survey work between 2003 to present. For the past EB2 surveys the maximum and minimum values were calculated for the various channel and bank parameters collected along each of the three transects together with the maximum change over one month (i.e. between successive surveys) over the period of survey data available. The results of this work are presented on Table 'BB'.

The previous LA1 surveys are more difficult to analyse due to channel realignment and dredge campaign effects on channel behaviour. As a consequence recourse was made to the digital ground modelling presented in *Annex A3 of the Environment Statement* reproduced here as Annex 'D'. These data show that the adjacent areas to the channel within the 500m wide corridor typically fluctuate by +/-0.5m over a monthly period.

The information derived from the past LA1 and EB2 monitoring was used to determine suitable Stage I thresholds, which are set out in Table 'CC' below.

Table 'BB' **Estuary Transect Surveys (2003 to 2008)**

NORTH Transect

	Channel A			Channel D			Channel C					Channel B					Channel E				Channel F			
	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Width (m at CD)	Effective Width (m)	Depth (mACD)	Effective Depth (mACD)	Offset (m)	Width (m at CD)	Effective Width (m)	Max Depth (mACD)	Effective Depth (mACD)	Offset (m)	Effective Width (m)	Max Depth (mACD)	Effective Depth (mACD)	Offset (m)	Effective Width (m)	Max Depth (mACD)	Effective Depth (mACD)
MAX	3000	700	-9.50	3500	600	-2.00	4000	200	450	-3.00	5.00	4750	300	1000	-3.50	8.00	2200	500	+2.00	2.00	5550	650	+3.50	2.50
MIN	2750	500	-5.00	3300	350	-1.00	3650	100	250	-1.00	2.00	4600	150	800	-1.00	3.50	2000	200	+0.00	0.00	5500	400	+3.00	2.00
MAX monthly change between Surveys	**100**	**100**	**0.50**	**100**	**50**	**0.50**	**50**	**75**	**50**	**0.50**	**1.00**	**100**	**100**	**100**	**0.50**	**1.50**	**100**	**100**	**0.50**	**1.00**	**50**	**100**	**0.50**	**0.50**

MIDDLE Transect

	Channel A			Channel B				Channel B1			Channel C			Channel D				Channel E				Channel F1				Channel F2			
	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)
MAX	4750	350	-7.50	3850	800	-8.00	8.50	3400	800	-4.00	3850	750	-1.50	850	550	+3.00	3.50	1600	1000	+3.50	3.00	6300	500	+4.50	2.00	6800	550	+3.00	4.00
MIN	4500	200	-5.00	2900	100	+1.50	1.50	3150	200	-1.00	3550	50	-0.50	600	300	+2.00	1.50	1300	800	+2.00	1.50	6050	300	+3.50	1.00	6650	250	+1.00	2.50
MAX monthly change between Surveys	**75**	**100**	**1.50**	**100**	**150**	**3.00**	**2.50**	**100**	**250**	**1.00**	**50**	**50**	**0.50**	**100**	**250**	**1.00**	**1.00**	**100**	**100**	**0.50**	**1.00**	**150**	**100**	**0.50**	**0.50**	**50**	**150**	**0.50**	**1.00**

SOUTH Transect

	Channel A1			Channel A2			Effective Width (m) A1 + A2 (at +4.0m ACD)	Effective Width (m) A1 + A2	Channel B				Channel B1			
	Offset (m)	Width (m at CD)	Depth (mACD)	Offset (m)	Width (m at CD)	Depth (mACD)			Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)	Offset (m)	Effective Width (m)	Depth (mACD)	Effective Depth (m)
MAX	1300	500	-2.00	1600	350	-1.50	1550	7.00	3700	900	+4.00	3.00	3750	300	+4.50	1.50
MIN	800	0	0.00	1300	150	-0.50	1100	4.50	2950	300	+3.00	1.00	3700	300	+4.00	1.00
MAX monthly change between Surveys	**150**	**150**	**1.00**	**200**	**100**	**1.00**	**150**	**1.50**	**100**	**200**	**0.50**	**0.50**	**50**	**0**	**0.50**	**0.50**

Table 'CC' **Stage I Thresholds – Monitoring Tasks EB2 and LA1**

Task	Parameter	Historic Monthly Variation (m)	Stage I Threshold Value (m)	Least Count (discrimination) of Task (m)
EB2	**Channel** Offset	500 – 50	150	50
	Width	50 – 250	150	50
	Depth	0.5 –2.5	1.5	0.5
	Bank Offset	(not separately	150	50
	Width	assessed – channel	150	50
	Elevation	values used)	1.5	0.5
LA1	Channel Flank – elevation	0.5	1.0	0.3
	Direct Impact Corridor Width	200 – 400 (along channel length)	100	25

The other monitoring tasks' Stage I thresholds are considered below in Table 'DD'

Table 'DD' **Stage I Thresholds**

Task	Parameter
EB1	Not applicable in progress reports since the model results will be subject to detailed assessment as a normal course within the annual monitoring report and thereby provide a culmination of the year's monitoring.
EB3	Any movement of Mid-Hoyle channel confluence with Welsh Channel westward.
EB4	Any nett accretion over the twelve month period that was equal to or greater than a mean depth change of 2.0m over the area of the 5.0m below CD contour.
EB5	Any mean monthly clay erosion of the south-western edge of the bank by more than 5.0m between successive surveys.
LA2	Not applicable.
LA3	Any change in particle-size analyses whereby any one of the following relationships is satisfied between successive samples from the same location: $d_{15} \geq d_{50}$; $d_{50} \geq d_{85}$; $d_{50} \leq d_{15}$; $d_{85} \leq d_{50}$.
LA4	Any significant change over a twelve-month period not reflected outside the forecast area of dredged channel ambient impact.
LA5	Any significant change over a twelve-month period not reflected outside the forecast area of dredged channel ambient impact.
LA6	Any significant change that correlates with main dredge campaigns.

The progress report 'traffic light' system flags-up Stage I exceedances and whilst such exceedance persists, each progress report will need to include a rationale based on the 'early-warning' parameters for not advancing the threshold status to Stage II. In the event of Stage I threshold exceedance for tasks LA1 and EB2, it would be normal practice to increase survey frequency to monthly whilst the rate of direction of change persists above threshold level. A specimen progress report is provided in Annex 'E'.

There is no Stage I threshold for task EB1 but in the event of the model results showing any significant increase in dredge and/or deposition impact then a Stage II condition would immediately apply and be presented in the annual report.

Once a Stage II threshold exceedance is declared against a monitoring task such as when the direction and rate of change triggering the Stage I flag has persisted over three consecutive surveys it is necessary to decide if the recorded change is:

- localised and not reflected in other monitoring data; this would normally extend the observation period under Stage I;

- reflected in other monitoring task data albeit not above Stage I threshold level; this would normally require an appraisal of potential impact against 'early-warning' parameters and if concluded to be low risk then consideration of mitigation such as increased frequency and/or rescheduling of monitoring tasks;

- reflected in other monitoring task data albeit not above Stage I threshold level; this would normally require an appraisal of potential impact against 'early-warning' parameters and if concluded to be significant risk then consideration of a seabed survey (EB1) with numerical model analysis. If this confirmed the risk then consideration of further mitigation of dredging and deposition operations.

Because of the range of potential situations arising under the monitoring plan it is not feasible to develop management and mitigation arrangements in great detail. Each threshold exceedance event will need to be considered on its individual merits. The procedure outlined above can be carried out within the critical timescale of twelve-months, where required, thus safeguarding the estuary against damage arising from dredging and disposal operations.

8.0 CONCLUSIONS

In order to test the monitoring plan set out in this report, the plan has been examined against:

A achievement of objectives
B ability to inform early-warning parameter assessment

A: Objectives Test

(i) To monitor the evolution of the estuary and local and ambient effects of the model studies of dredging and deposition;

This has been achieved by the task schedule presented in section 5 of the report.

(ii) to compare monitoring results with the estuary basis used for model studies and the forecast effects of the dredging and deposition and quantify differences; to assess the significance of differences and review the scale of dredge and deposition effects on the integrity of the estuary;

This has been achieved by the analysis and reporting procedures set down in sections 5, 6 and 7 of the report.

(iii) to initiate mitigation if necessary to avoid adverse impact on the estuary prior to such impact becoming significant;

This has been achieved in sections 6 and 7 of the report.

(iv) to inform future applications for maintenance of navigation to the Port.

This has been achieved by the reporting described in section 6 of the report.

B: Early-Warning Parameter Test:

Primary parameters:

- Maintenance or further increase of tidal energy using the Welsh channel and maintenance or diminution of tidal energy using the Hilbre channel;

  This has been achieved by the annual seabed level survey of the estuary and re-run of the morphological tide in the numerical model (EB1).

- Plan location and alignment of the low water channel off Greenfield.

  This is achieved by the two-monthly estuary transect surveys (EB2).

Secondary parameters:

- Absence of channel(s) across the southern flanks of Salisbury Bank downstream of Greenfield;

  This is achieved by the annual seabed level survey of the estuary and re-run of the morphological tide in the numerical model (NB. – this morphological change is linked to the location of the low water channel off Greenfield which is monitored on a two-month interval) (EB1).

- Sustained closure of Welshman's Gut;

  This is achieved by the annual seabed level survey of the estuary and re-run of the morphological tide in the numerical model (EB1).

- Maintenance of size and location or enhancement and eastward movement of Mid-Hoyle channel;

This is achieved by the six-monthly surveys of the confluence area of Mid-Hoyle and Welsh channels and Mostyn Deep (EB3 and EB4).

- Confinement of central estuary low water channels within the lateral limits described in this report.

  This is achieved by the two-monthly estuary transect surveys (EB2).

- Holocene Clay Bank Behaviour

  This is achieved by the six-monthly surveys of the exposed clay bank and the Mostyn Deep/Welsh Channel (EB4 and EB5).

- Cockle-abundance, West Salisbury

  This is achieved by the 'before and after' sea bed level surveys of each main dredge campaign (>100,000m^3) and accompanying local cockle-abundance surveys (LA6).

The primary purpose of the monitoring plan is to safeguard the integrity of the estuary against damage due to dredging and/or deposition. This has been achieved by specifying task frequencies and spatial extents with associated reporting whereby unforeseen and potentially damaging changes to the estuary basis and/or the local and ambient impacts of dredging and deposition are flagged-up promptly. The monitoring plan has been designed to flag-up such unforeseen changes; report the changes and allow for appropriate mitigation within the critical period of twelve months. This is the minimum period from available evidence over which significant changes in the estuary take place.

As a consequence it is concluded that the monitoring plan achieves the primary purpose of safeguarding the integrity of the estuary and thereby provides a no-real risk basis upon which the dredging of the 4.0m below CD channel with disposal of arisings in Mostyn Deep Site 'A' may proceed.

9.0 REFERENCES

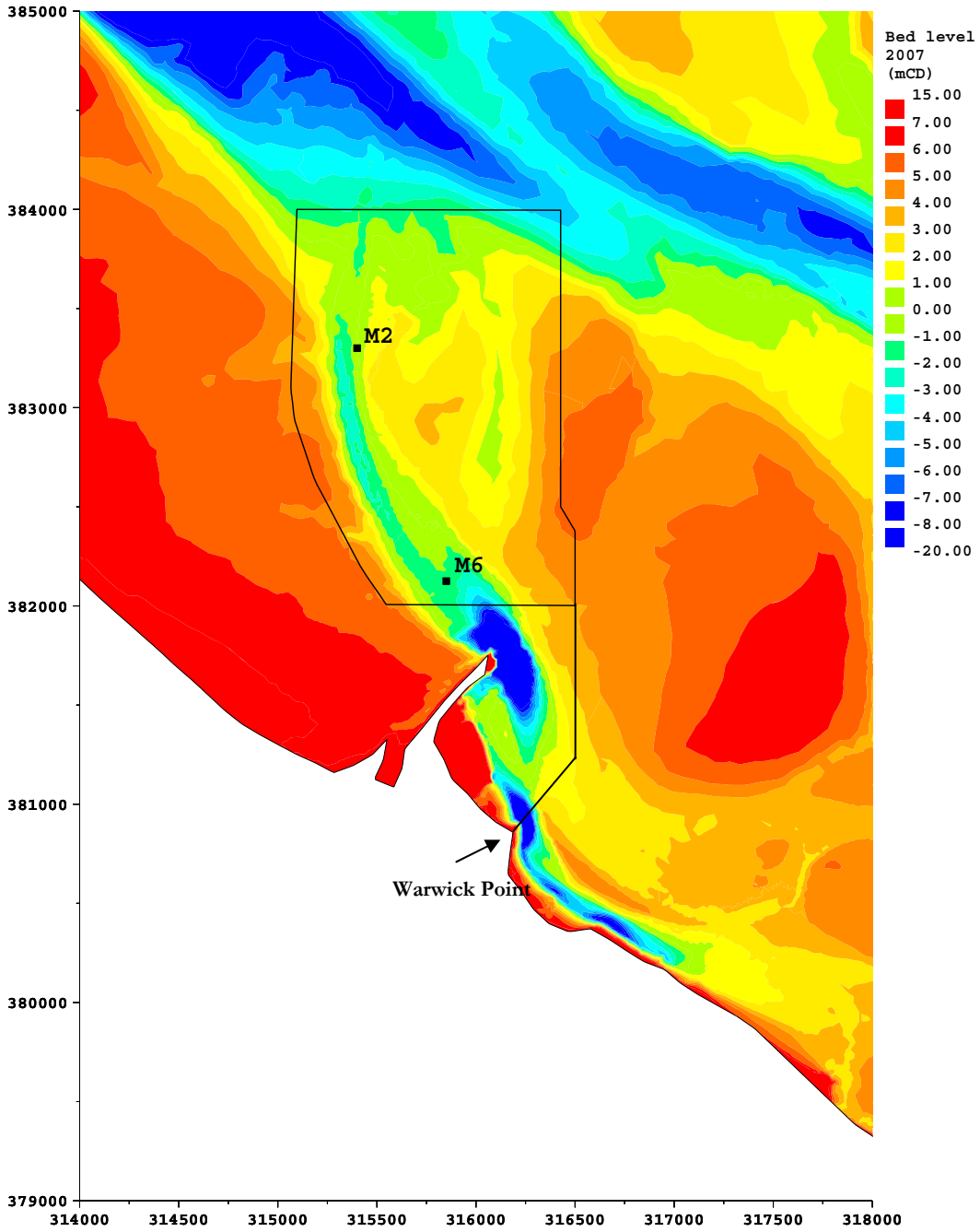
- **ERM 2007**. Port of Mostyn Dredging and Disposal Operations for Maintenance of Navigation: Environmental Statement. Environmental Resources Management, October 2007.

- **HR 2007**. Dee Estuary Modelling: Port of Mostyn EIA 2007. Hydrodynamic modelling studies. Report EX 5514 - Release 1.0, April 2007

- **SMP 2008a**. Port of Mostyn: Maintenance of Navigation – Monitoring Report. December '06 to Feb '08. April 2008.

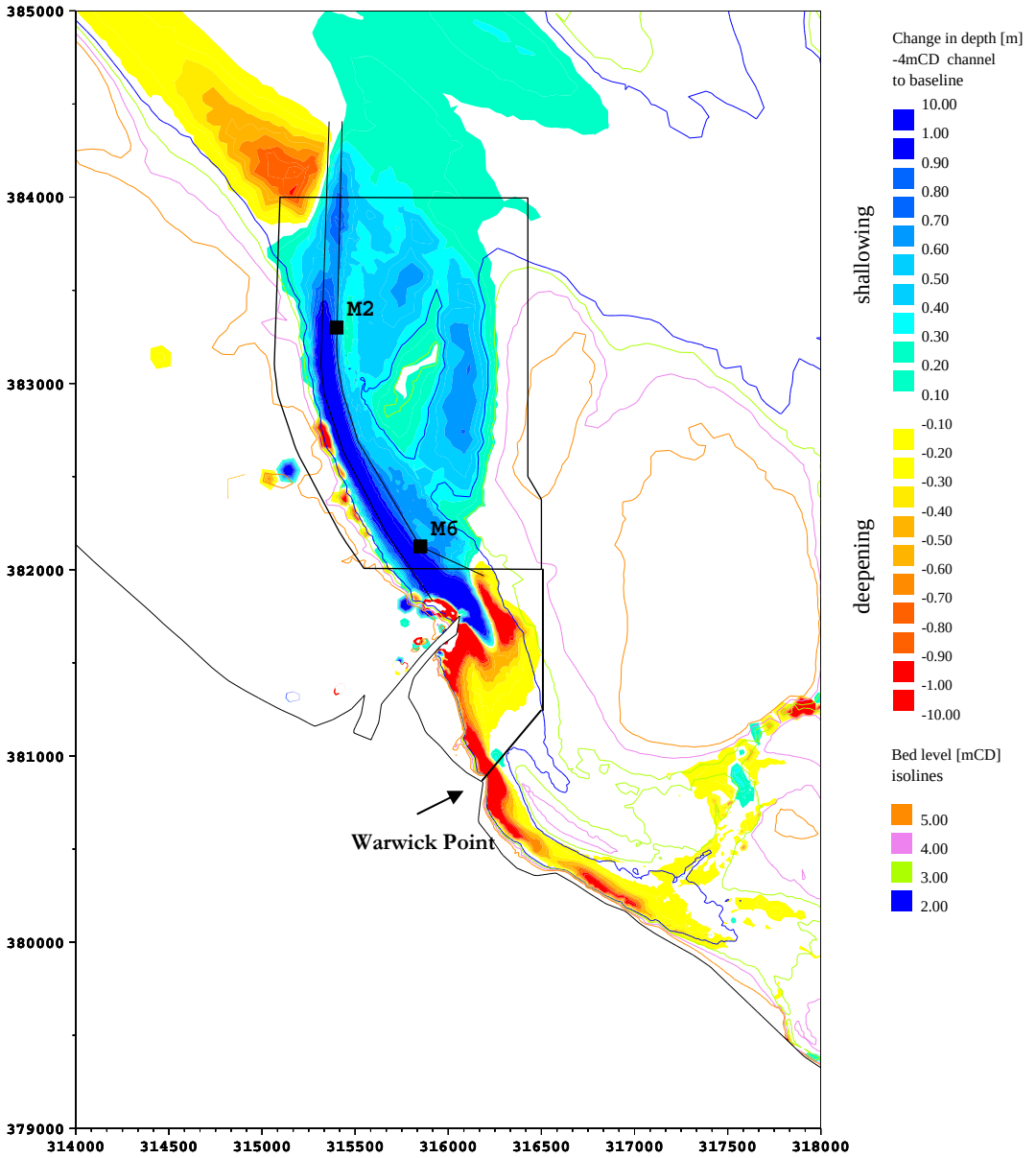
- **SMP 2008b**. Evolution of the Banks and Channels of the Dee Estuary, April 2008

FIGURES



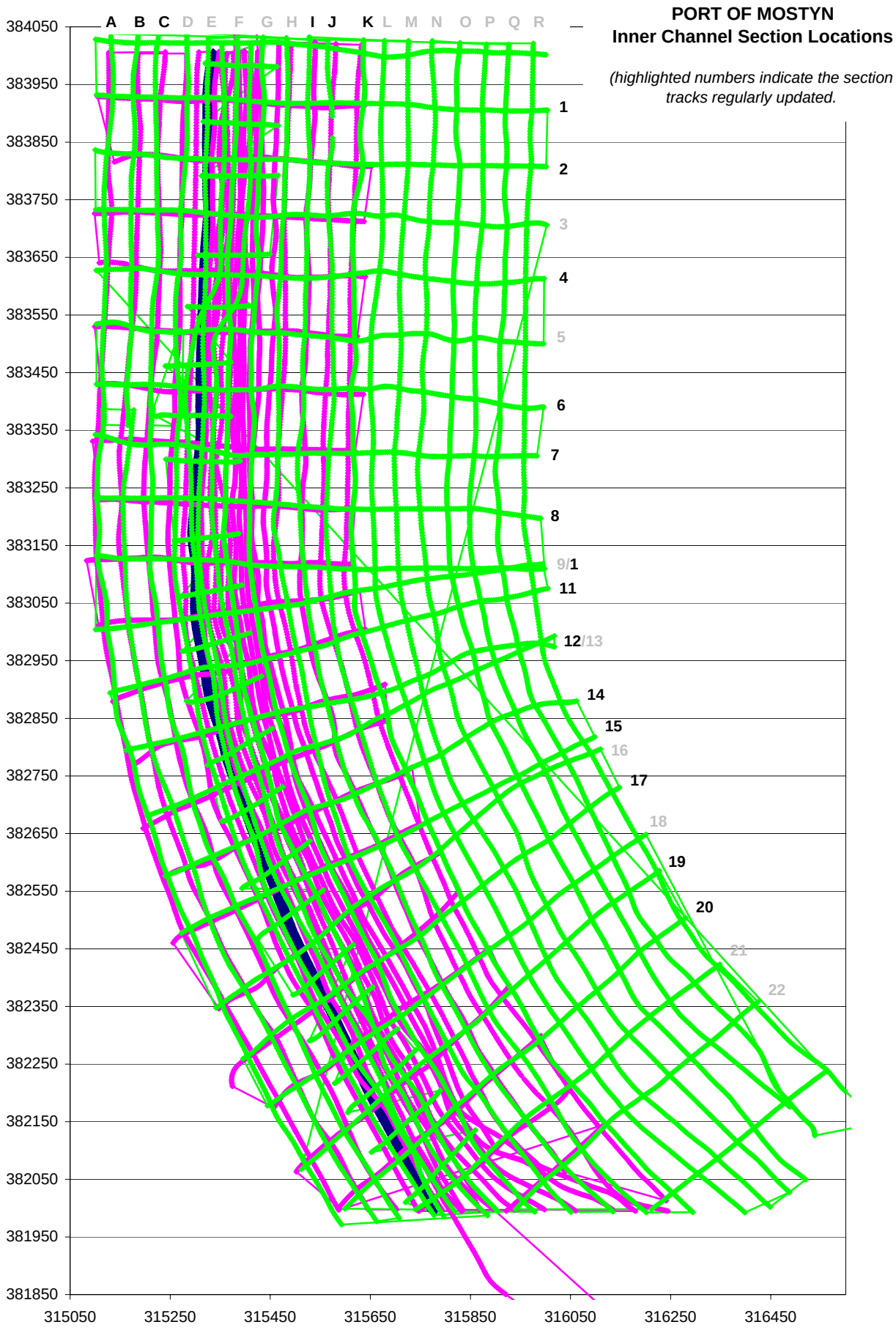
Baseline bathymetry for 2007– Port access channel, proposed Monitoring Area for ambient effects 2008 and location of buoys M2 and M6

Figure 1



Estimate of the dredging-induced change in bed level due to -4mCD channel based on the change in the sediment flux – Port access channel (from Fig 9.5 in Port of Mostyn EIS), proposed Monitoring Area for ambient effects in 2008 and location of buoys M2 and M6

Figure 2


PORT OF MOSTYN
Inner Channel Section Locations
(highlighted numbers indicate the section tracks regularly updated.
A B C D E F G H I J K L M N O P Q R
1
2
3
4
5
6
7
8
9/1
11
12/13
14
15
16
17
18
19
20
21
22
384050
383950
383850
383750
383650
383550
383450
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383250
383150
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382650
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382350
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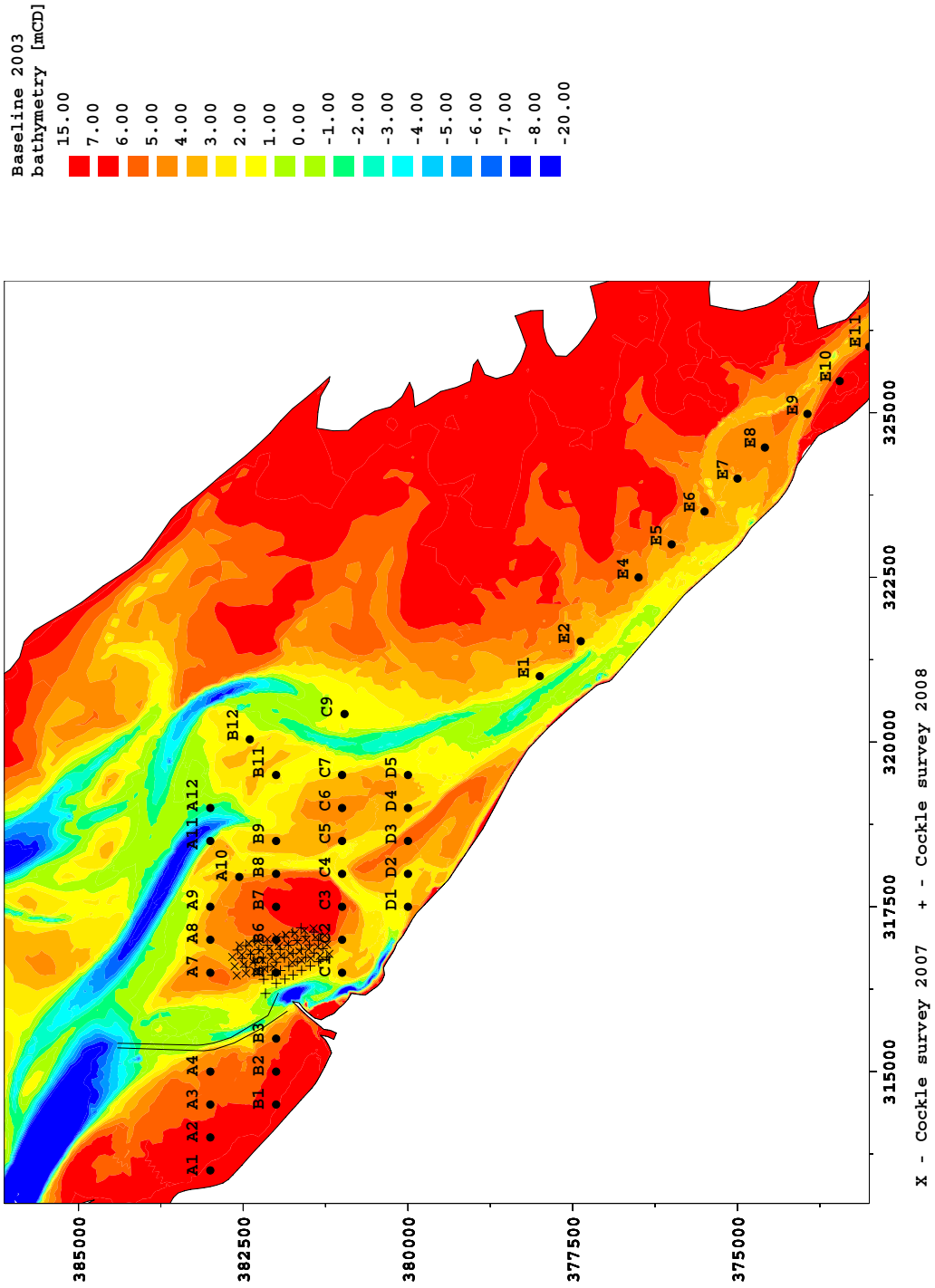
315650
315850
316050
316250
316450

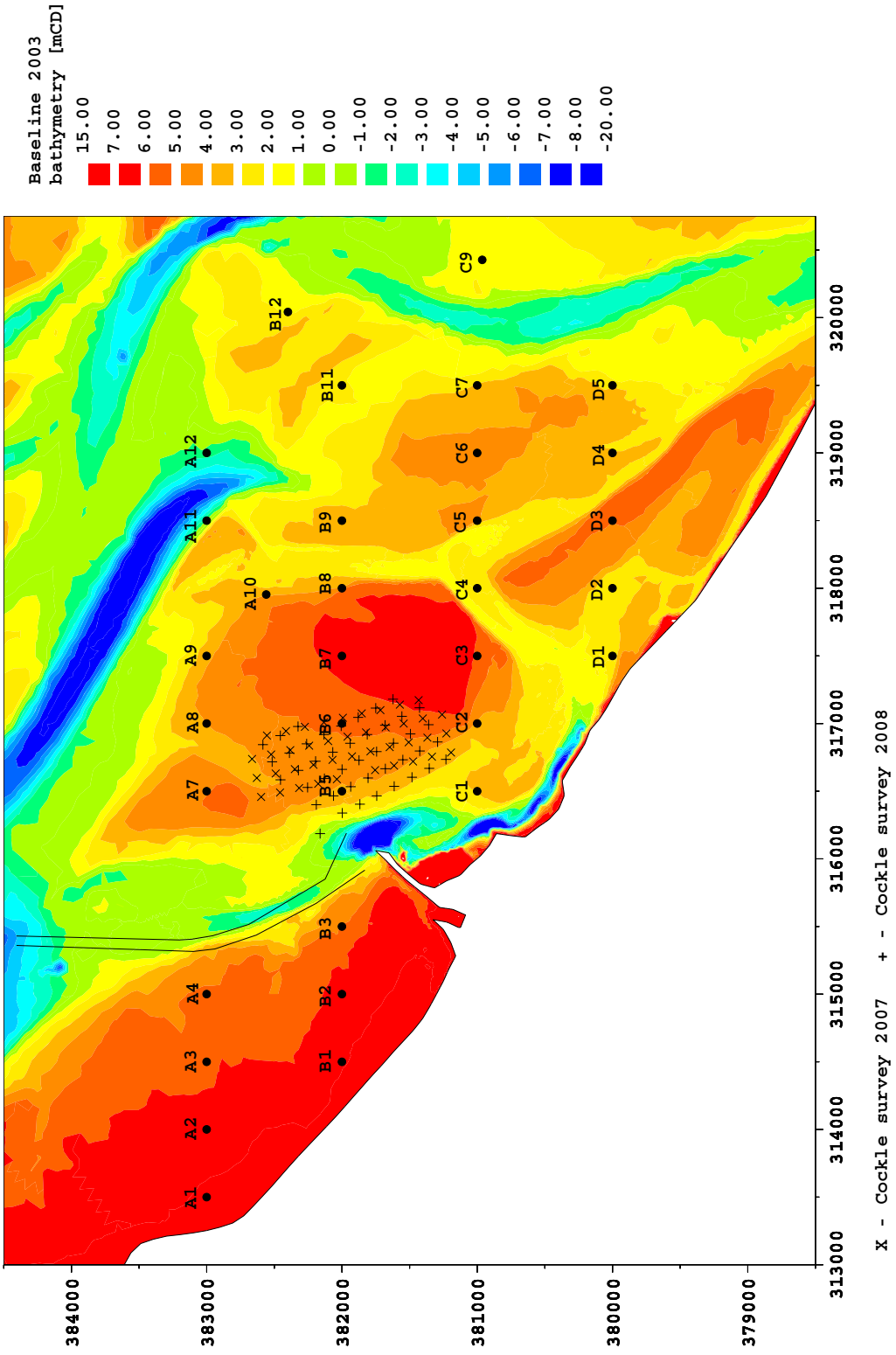
Figure 3



Baseline bathymetry for 2003 with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

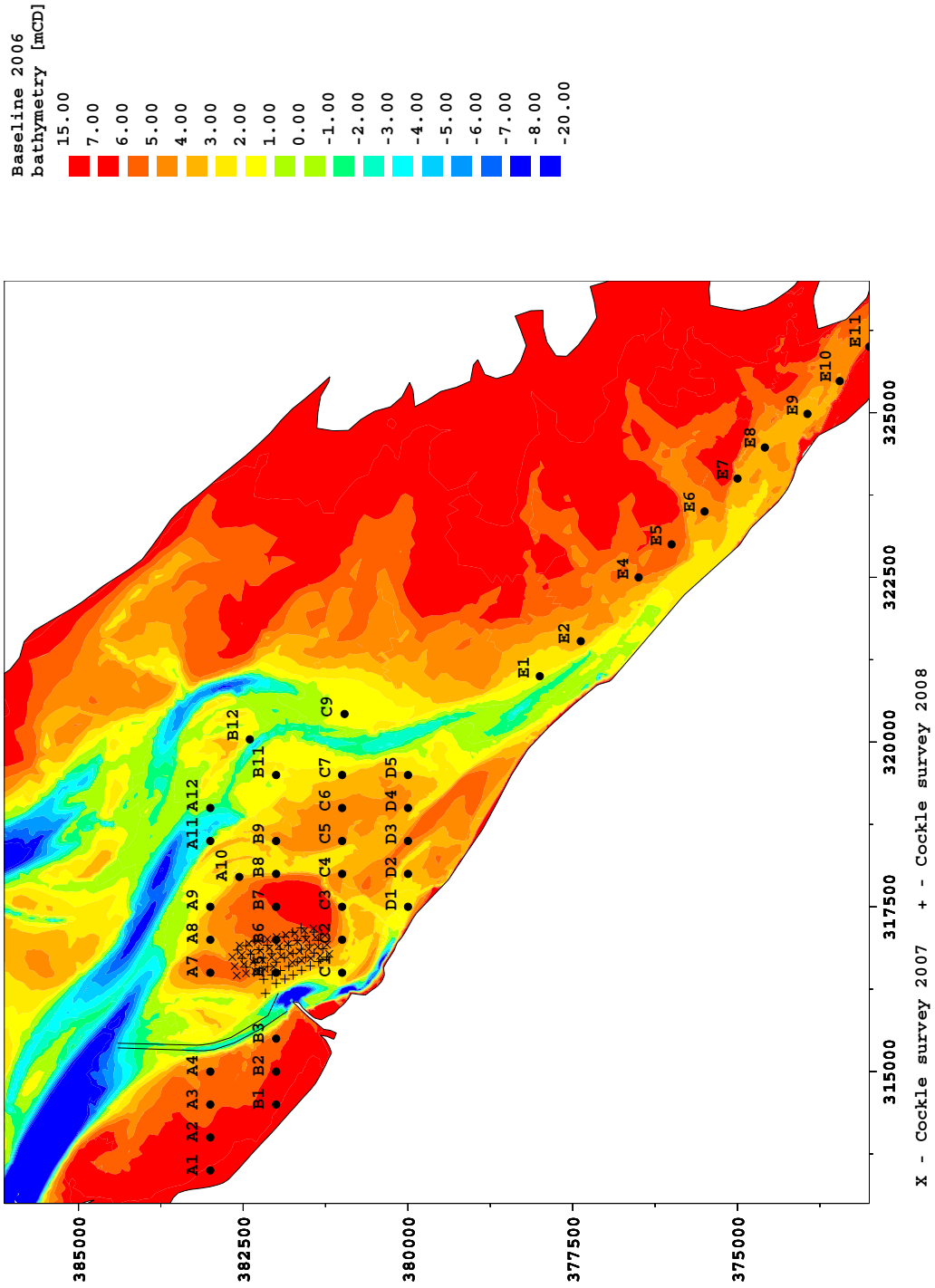
Figure 4



Baseline bathymetry for 2003 with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

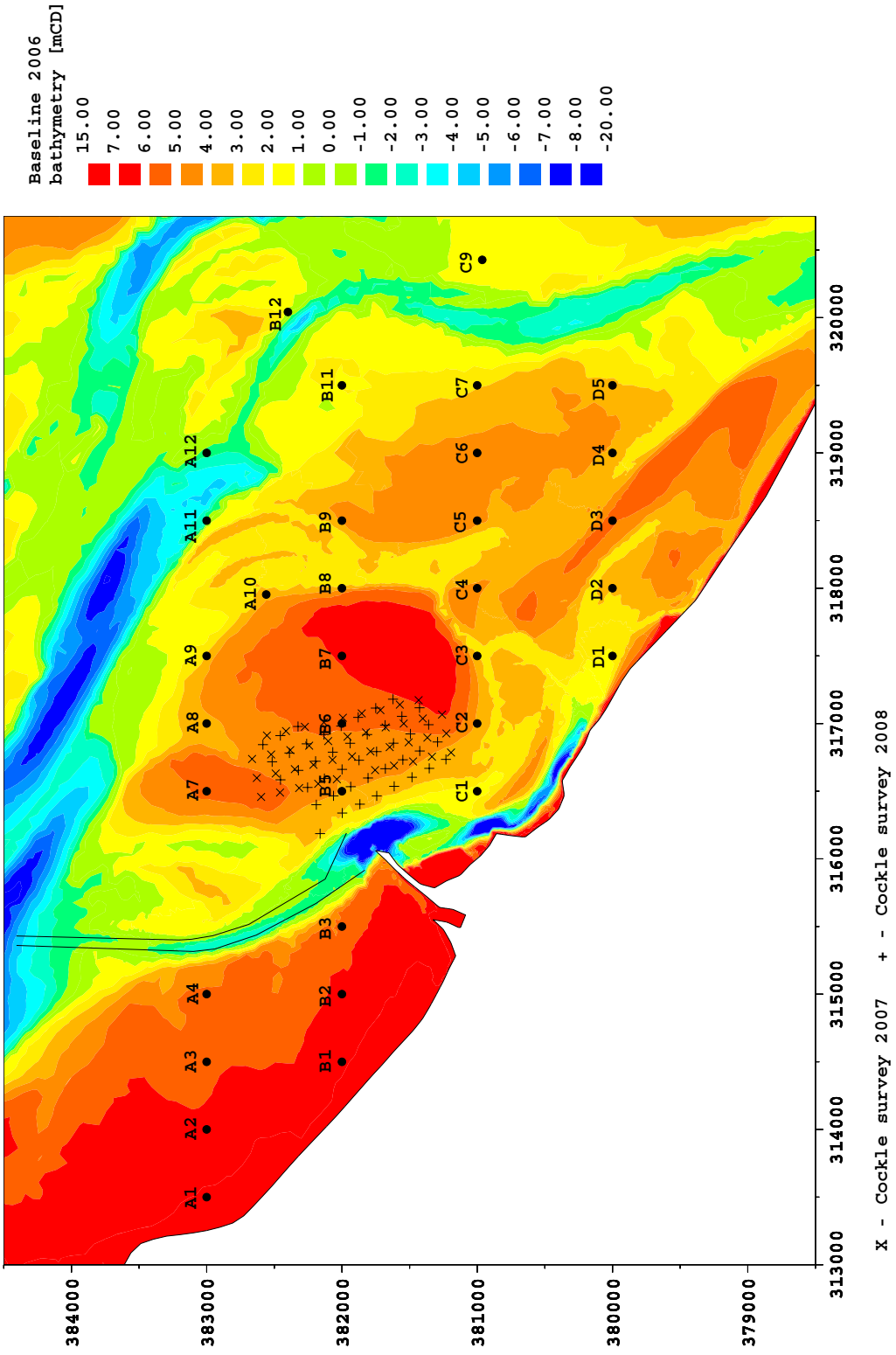
Figure 5



Baseline bathymetry for 2006 with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

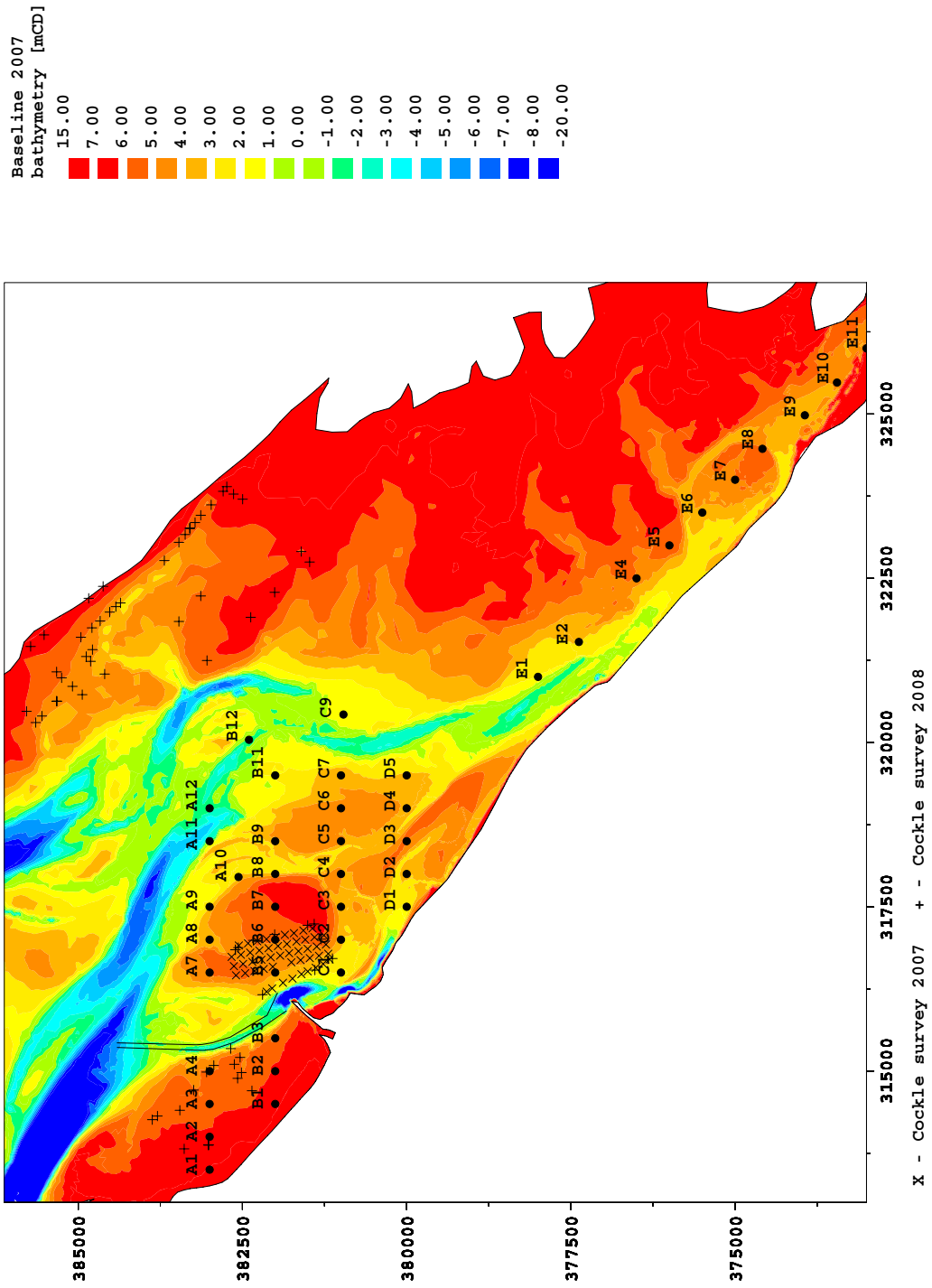
Figure 6



Baseline bathymetry for 2006 with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

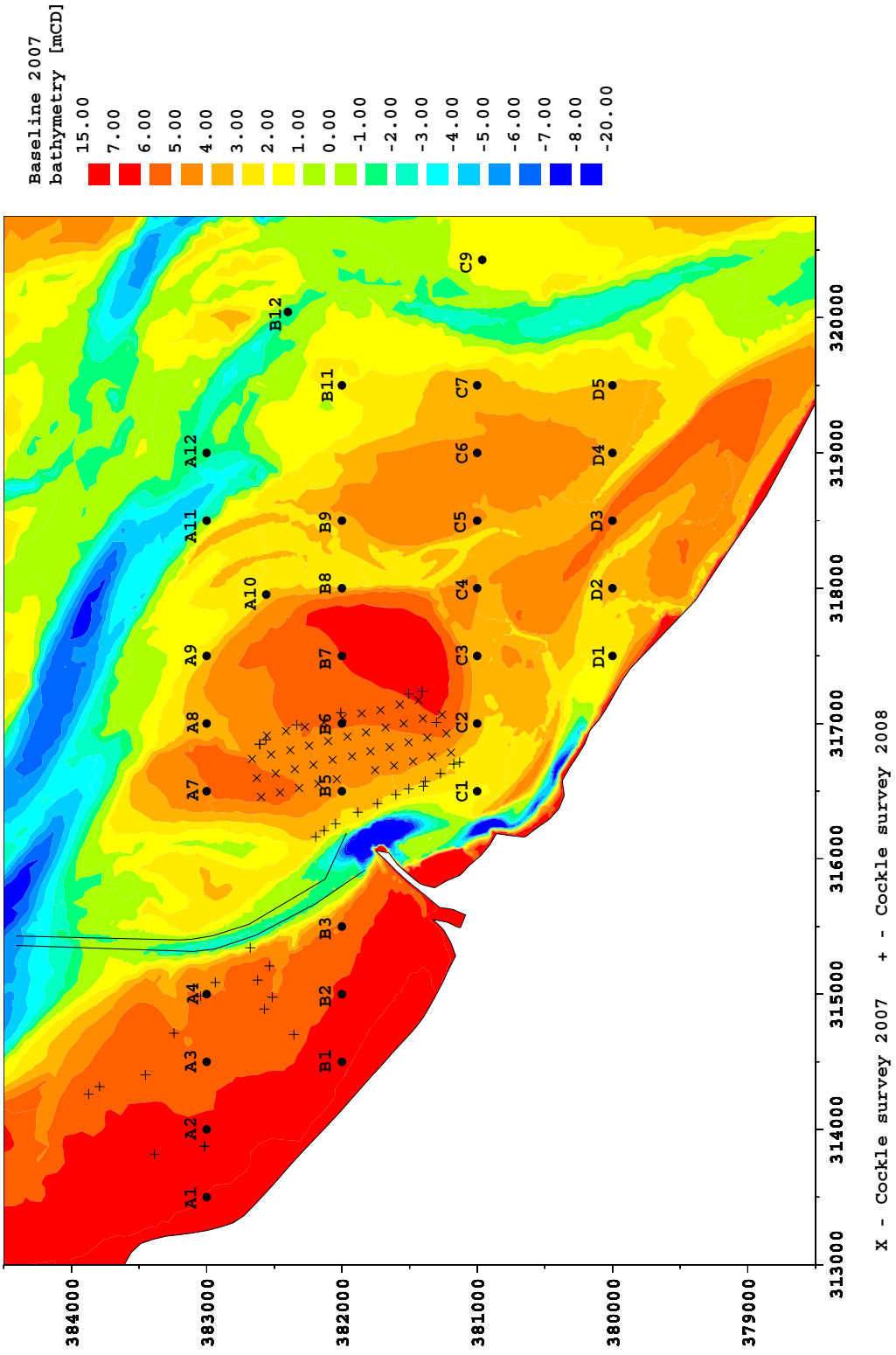
Figure 7



Baseline bathymetry for 2007 with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

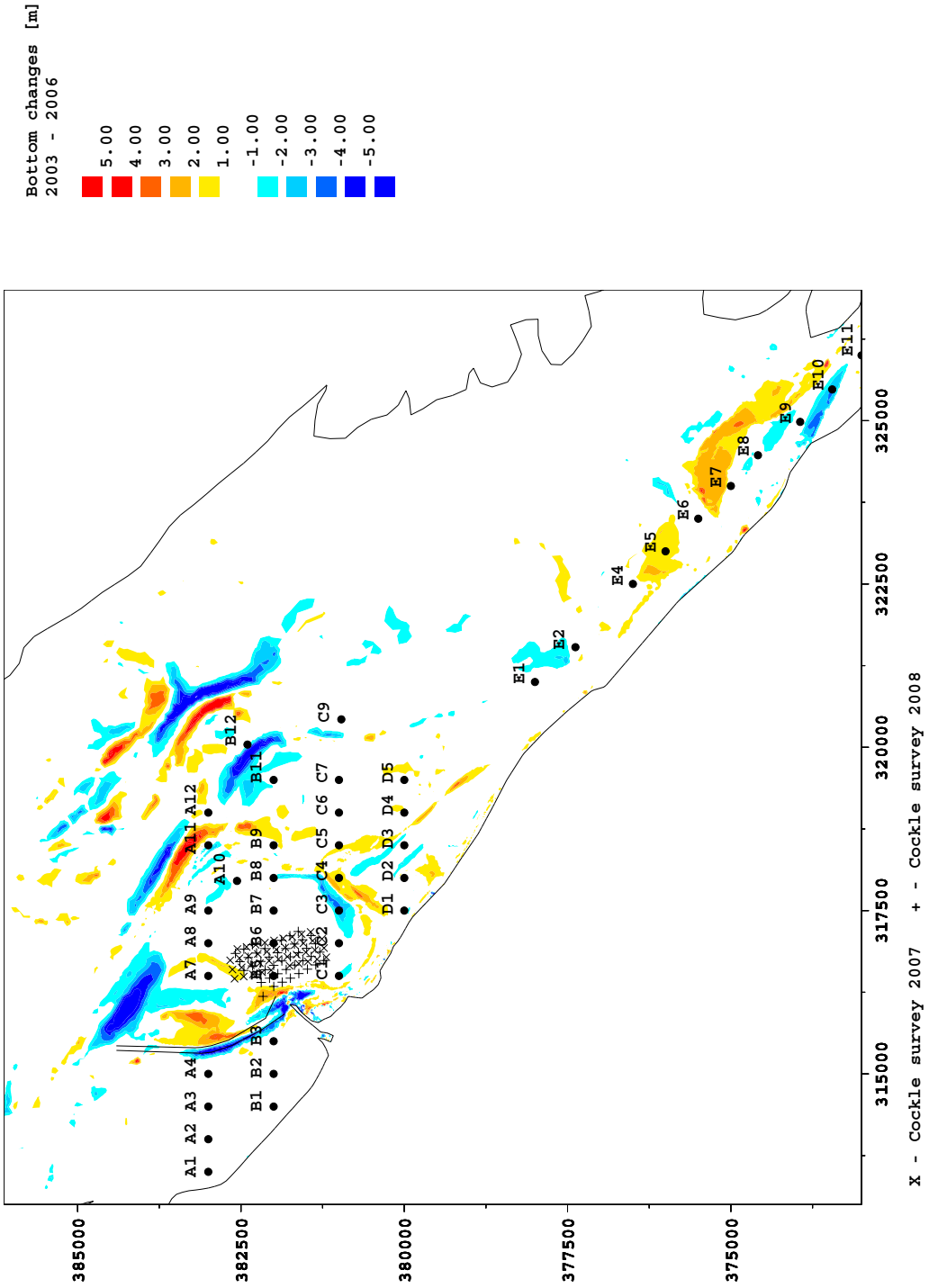
Figure 8



Baseline bathymetry for 2007 with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

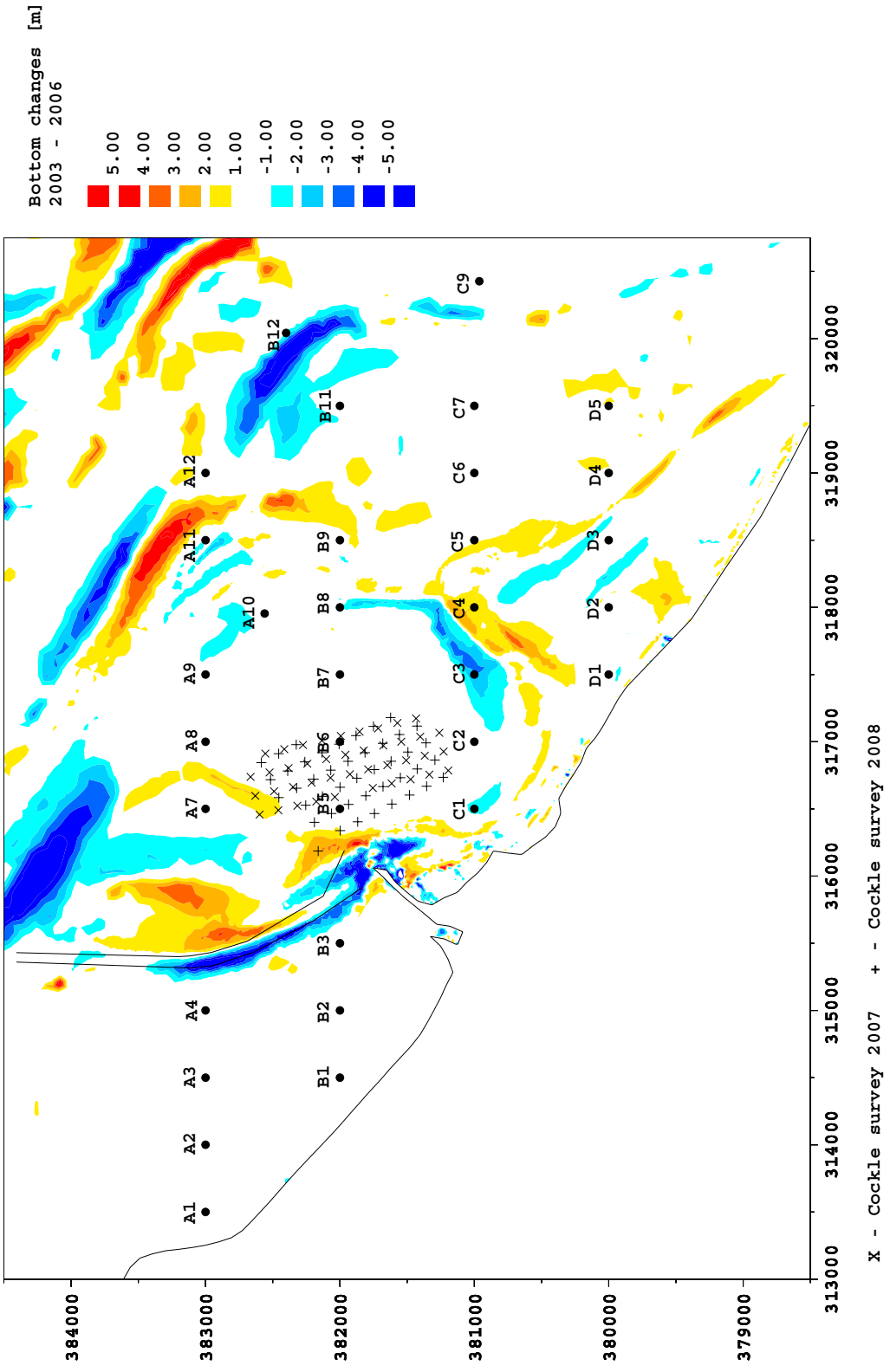
Figure 9



Change in bathymetry between 2003 and 2006, with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

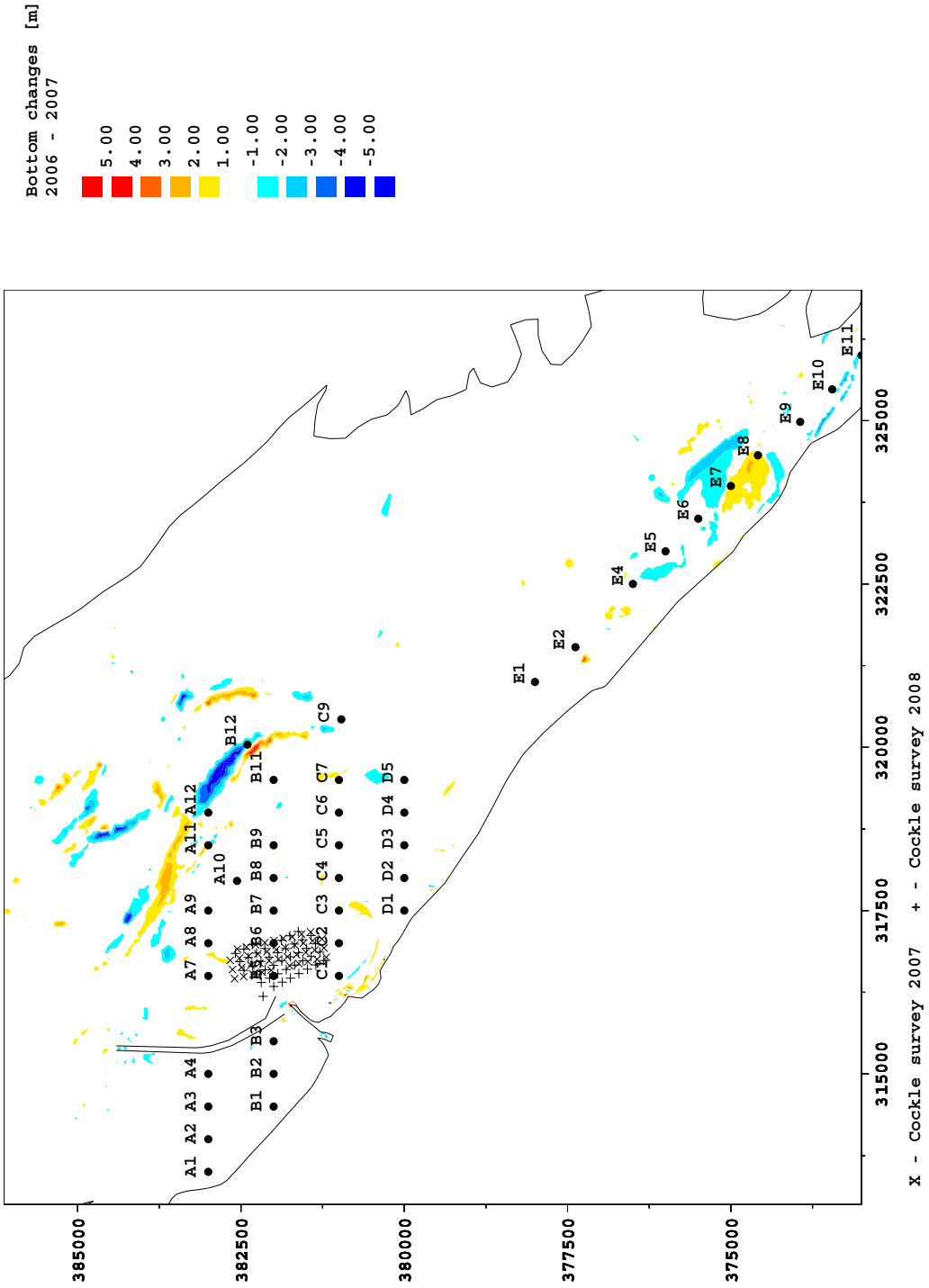
Figure 10



Change in bathymetry between 2003 and 2006, with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

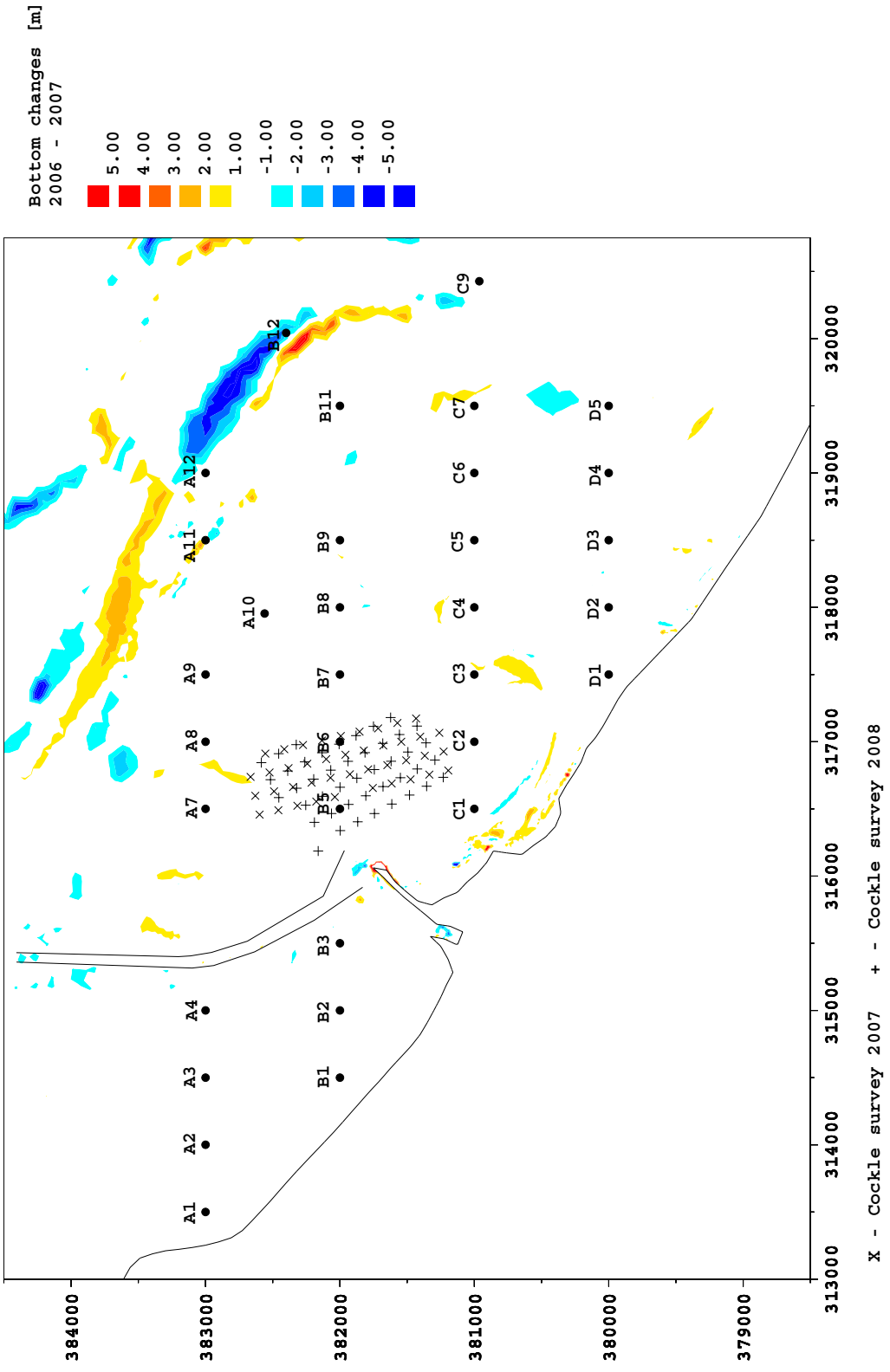
Figure 11



Change in bathymetry between 2006 and 2007, with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

Figure 12

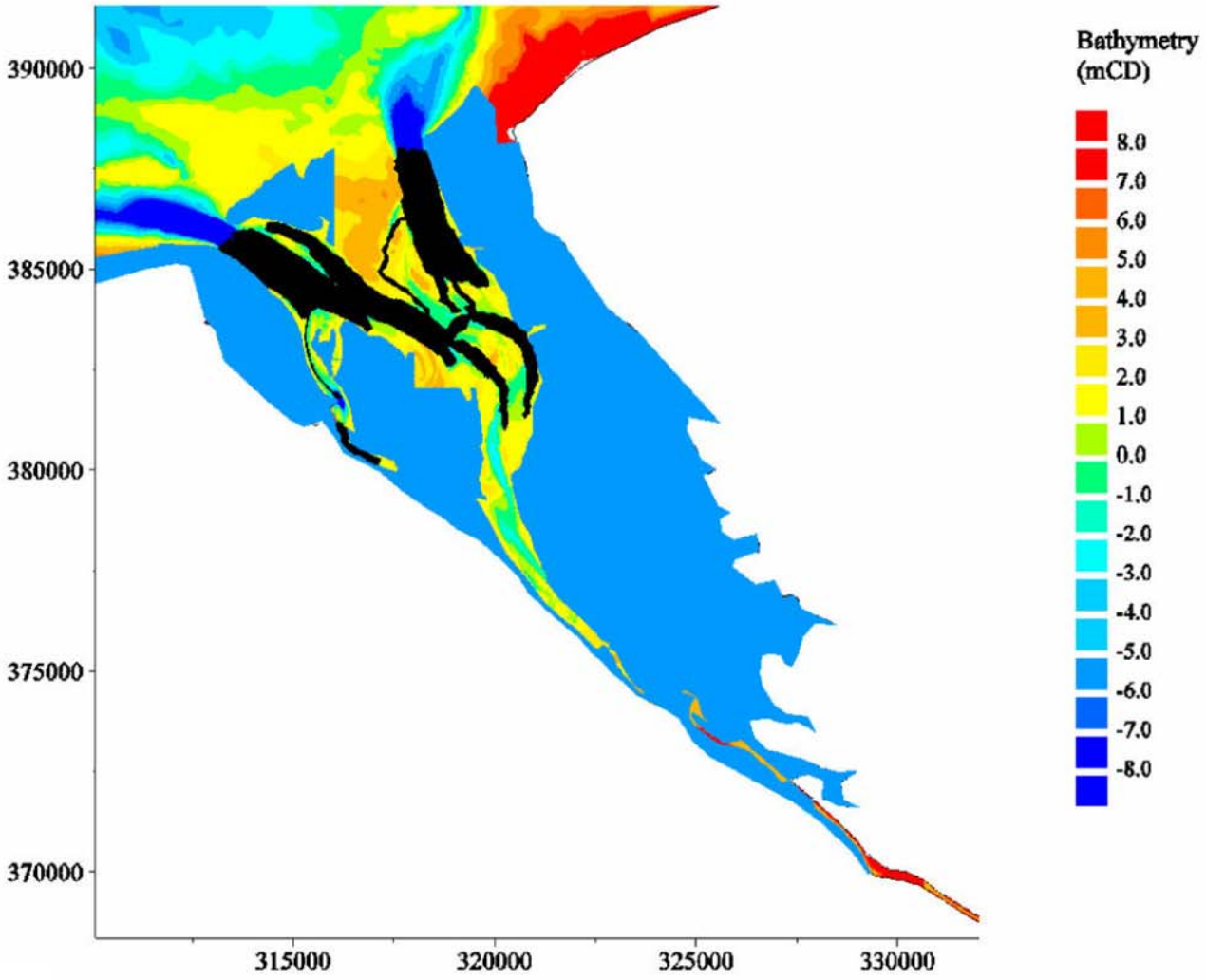


Change in bathymetry between 2006 and 2007, with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

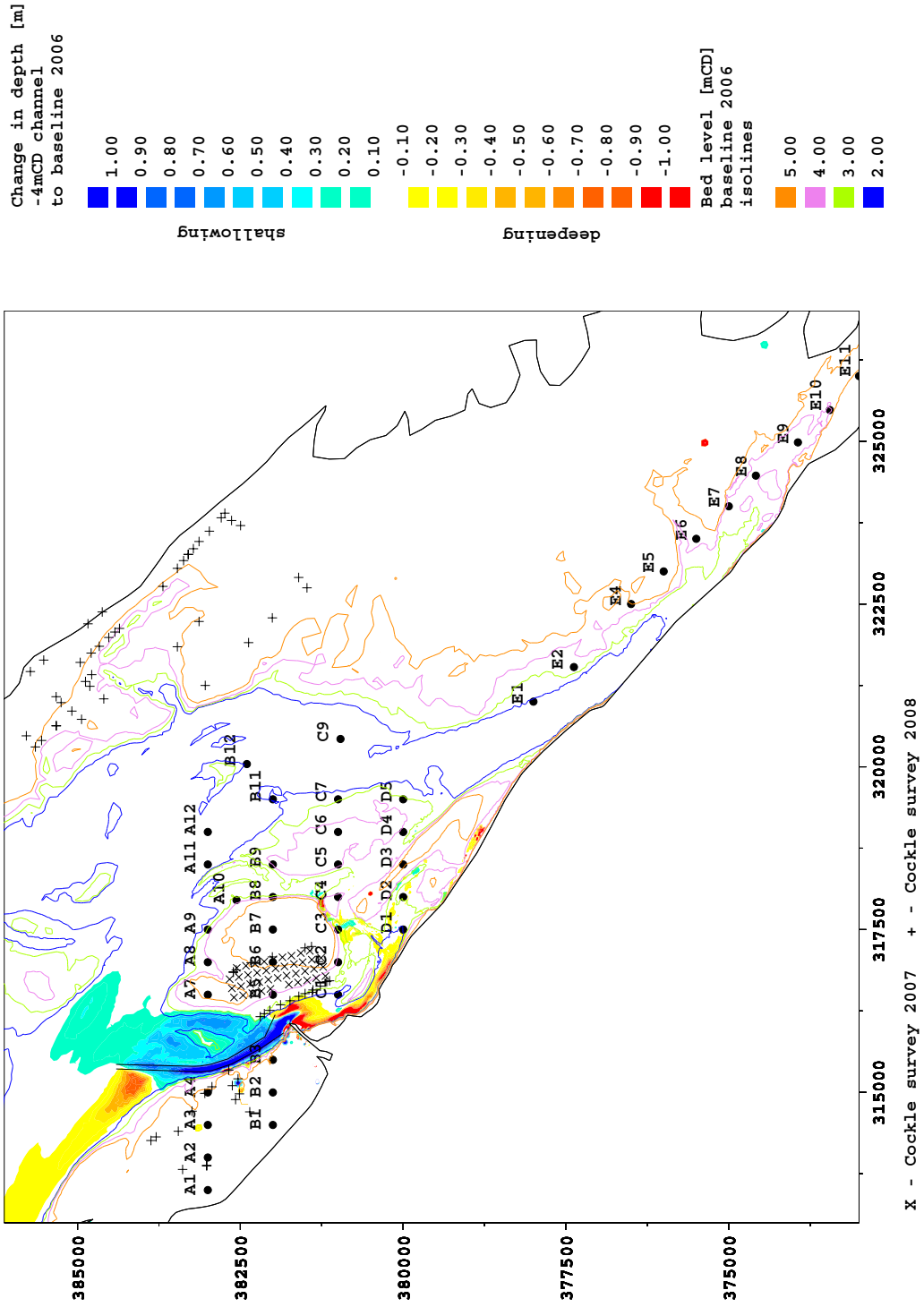
Figure 13

Seabed Level Survey 2007
Extent of data coverage



2007 Data coverage (Blue = LiDAR, Black = swathe) on 2006 model bathymetry

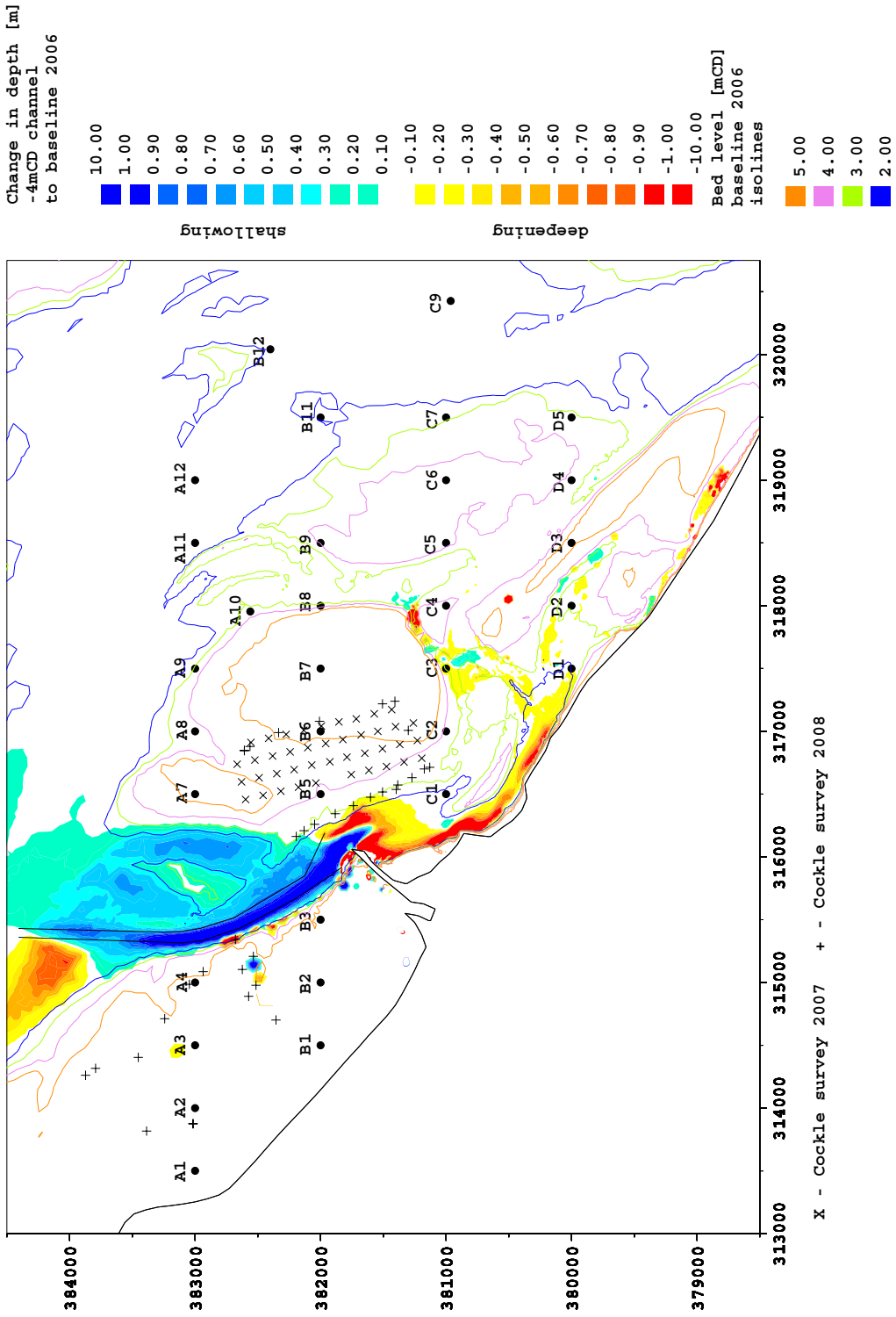
Figure 13a



Estimate of the dredging-induced change in bed level due to -4mCD channel based on the change in sediment flux, with location of benthic and cockle surveys – Dee Estuary

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

Figure 14

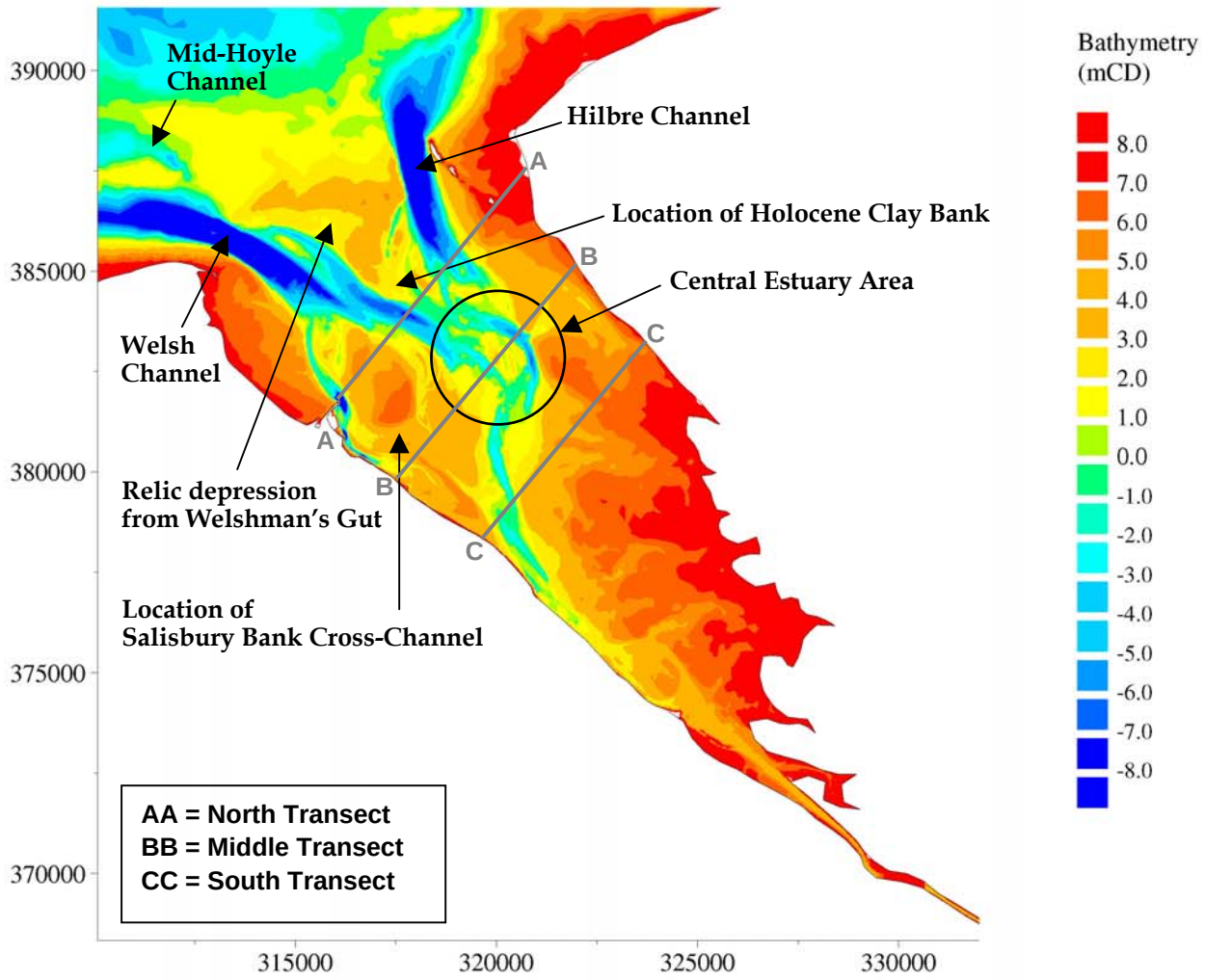


Estimate of the dredging-induced change in bed level due to -4mCD channel based on the change in sediment flux, with location of benthic and cockle surveys – Port access channel

NOTE: Figures 4 to 15 include cockle survey station data for 2008 – only figures 8, 9, 14 and 15 have the latest data as supplied by EAW on 4th June 2008

Figure 15

'EARLY-WARNING' PARAMETERS
Estuary Features Location Plan



Model bathymetry 2007 (composite of LiDAR, swathe and 2006 model bathymetry)

Figure 16

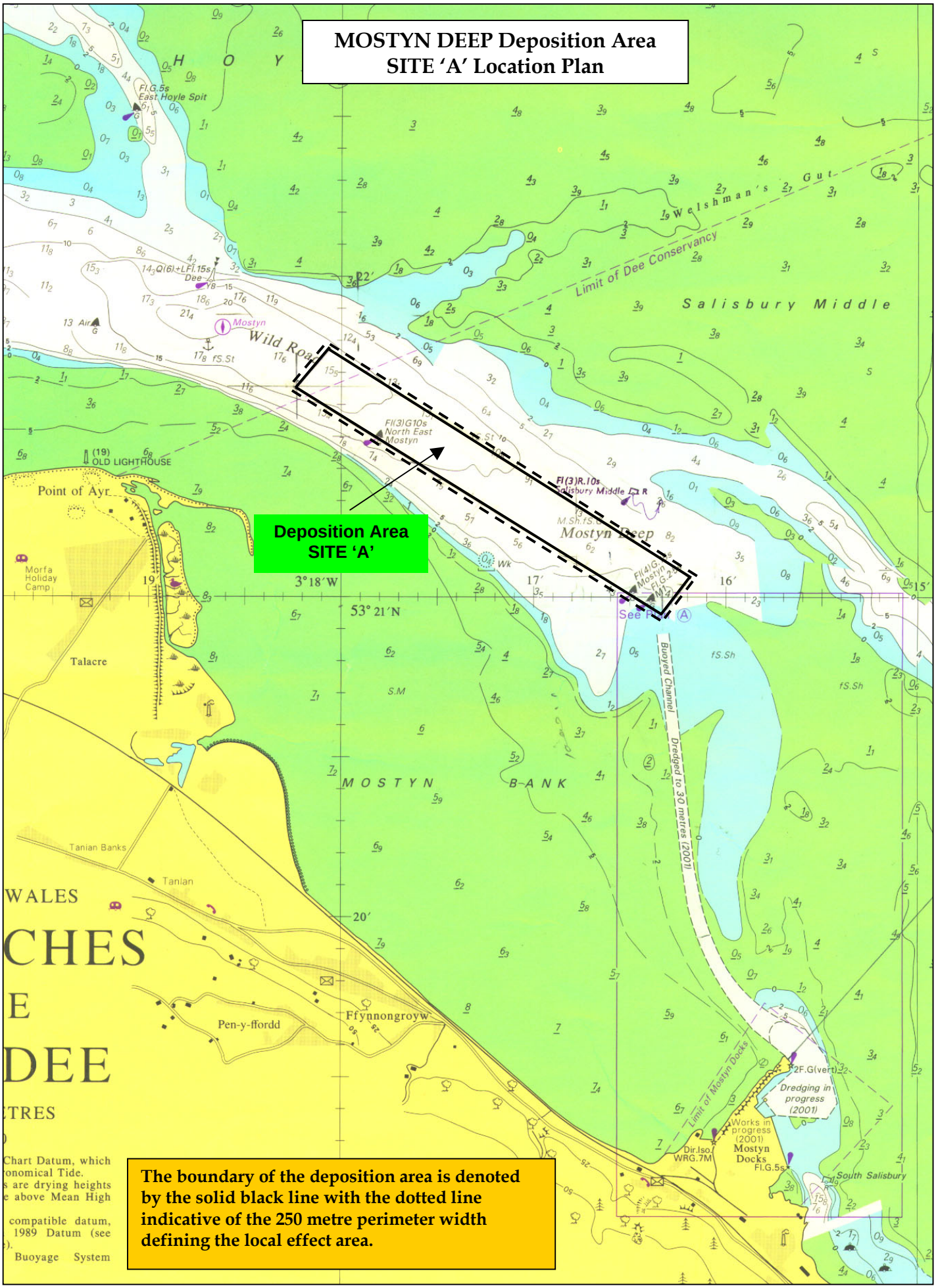
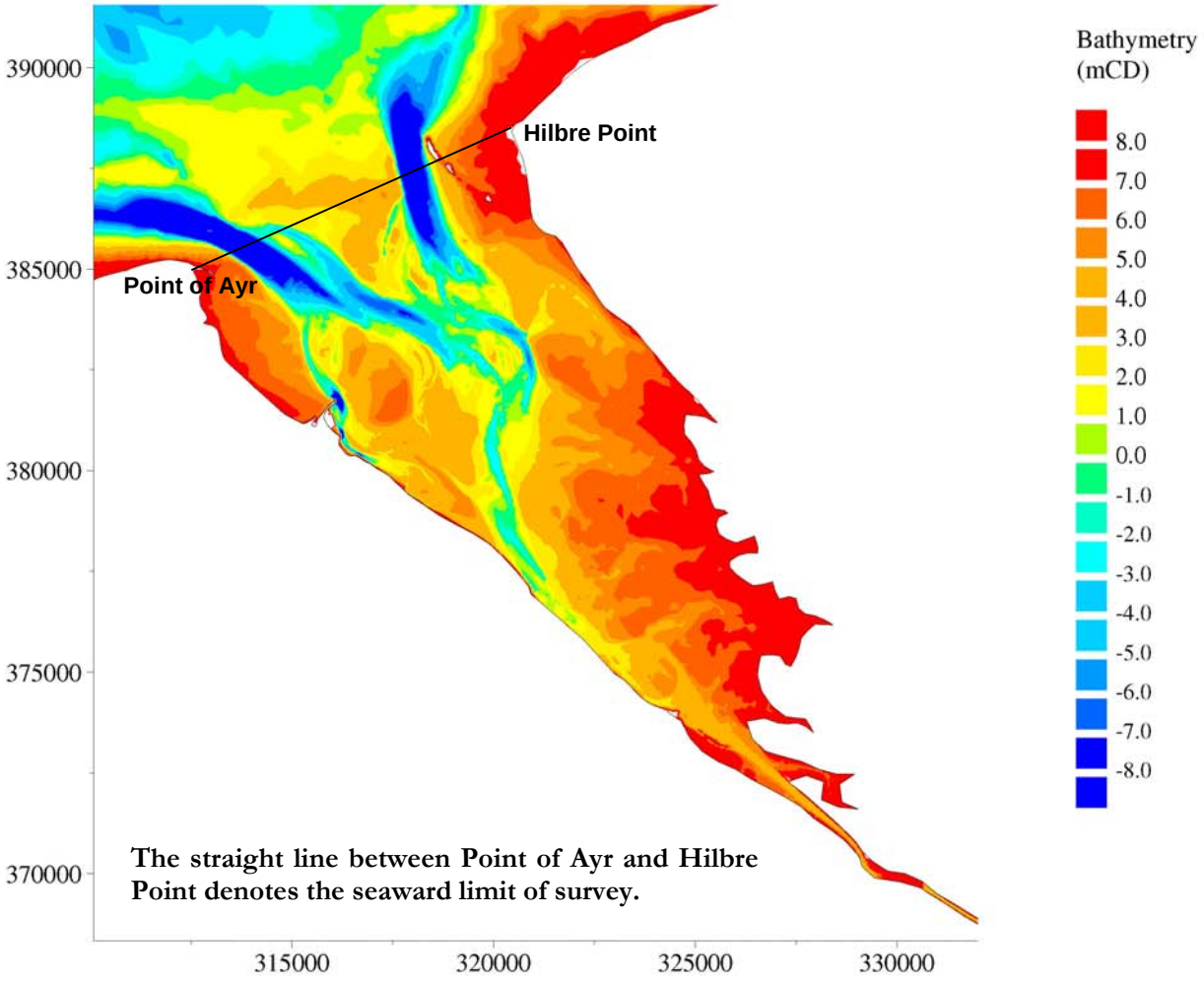

MOSTYN DEEP Deposition Area
SITE 'A' Location Plan
Deposition Area
SITE 'A'
The boundary of the deposition area is denoted by the solid black line with the dotted line indicative of the 250 metre perimeter width defining the local effect area.
Limit of Dee Conservancy
Buoyed Channel Dredged to 30 metres (2001)
Limit of Mostyn Docks
Dredging in progress (2001)
Works in progress (2001)
Mostyn Docks
Fl.G.5s
Dir.Iso.WRG.7M
Fl(3)G10s North East Mostyn
Fl(3)R.10s Salisbury Middle
Fl.G.5s East Hoyle Spit
Q(6)+LFl.15s Dee
Mostyn
Wild Road
Point of Ayr
(19) OLD LIGHTHOUSE
Morfa Holiday Camp
Talacre
Tanian Banks
Tanian
Pen-y-ffordd
Ffynnongroyw
Salisbury Middle
Welshman's Gut
Mostyn Deep
MOSTYN BANK
South Salisbury
3°18'W
53° 21'N
WALES
CHES
E
DEE
TRES
Chart Datum, which
onomical Tide.
s are drying heights
e above Mean High
compatible datum,
1989 Datum (see
Buoyage System

Figure 17

DEE ESTUARY
Extent of LiDAR Survey



Model bathymetry 2007 (composite of LiDAR, swathe and 2006 model bathymetry)

Figure 18

ANNEX 'A'

Monitoring Plan, August 2005 Consents

Appendix A – Monitoring

Monitoring of the following parameters will be undertaken according to the specification outlined in the attached monitoring plan. The rationale for these conditions, insofar as they meet the requirements of maintaining favourable conservation status for the interest features is described in appendix B.

CONDITION

1. Bathymetry of dredged channel (monitoring plan item 1)
2. Three cross estuary transects (monitoring plan item 2)
3. Topography of the banks and bathymetry of the channels within the vicinity of the Port (monitoring plan item 3).
4. Changes in tidal currents in the Salisbury cross bank channel. (monitoring plan item 4
5. Distribution of invertebrate communities and changes in sediment type/particle size on the Salisbury and S.Salisbury banks (monitoring plan item 5).
6. Extent and biomass of cockle beds on Salisbury, S.Salisbury and Mostyn banks (monitoring plan item 6).
7. Changes in community composition and sediment accretion in saltmarsh habitat (monitoring plan item 7)
8. Actions within the monitoring plan may be extended as required at the discretion of the regulator.

MONITORING PLAN (including disposal)

Item	Action	Location	Frequency	By whom
1	Monitor bathymetry of dredged channel extending 250m either side of the centre line. Submit to EAW in digital format within one month of survey being undertaken.	Between buoys M3 (northing 384000) and M6 (northing 382000).	Monthly	PoM
2	Monitor bathymetry across the estuary at 3 locations.	As identified in plan A.	Minimum 10 times/annum, average of 12/annum over 2 years.	PoM
3	1) Contribute to the monitoring of the	Banks in the vicinity of	Annually, first flight	PoM and

	topography of sandbanks above mean low water level by LIDAR	the Port as identified in plan B	by March 2006	other beneficiaries within Tidal Dee Users Group.
	2) Undertake swathe bathymetry monitoring of estuary channels within defined area	All channels within plan B	Annually	PoM
	3) Monitor the bathymetry of the Salisbury cross bank channel and topography of adjacent banks for a distance of 200m either side of the centre line of the channel. (Significant channel movement will require this distance to be increased).	As identified in plan B	12 times/annum	PoM
4.	Monitor tidal currents pre and post dredging to seek to validate hydrodynamic model predictions.	Salisbury cross bank channel.	Once pre and post dredging, further monitoring dependent on preliminary results.	PoM
5.	Survey the distribution of invertebrate communities and map sediment characteristics (appendix C)	Intertidal areas as defined in CCW plan C.	Once initially as baseline and subsequently annually	PoM
6.	Survey extent, composition and biomass of cockle populations.	Mostyn, Salisbury and S. Salisbury banks	Annually (spring and subsequent to fishery opening) Baseline established April/July 2005.	EAW
7.	Survey composition of saltmarsh communities and elevation of substrate with reference to control site at Mostyn (appendix D).	Single site as identified in fig 103 Report EX5097, coordinates 325,000, 375,000	Annually	PoM
8.*	Undertake swathe bathymetry surveys vertical control by Kinematic GPS, any errors to be within +/- 10cm.	Mostyn Deep, coordinates defined in consent.	Pre dredging, two during dredging with up to further three depending on sediment dispersion	PoM
9.*	Particle size analysis coincident with swathe bathymetry.	As above	4-6 samples	PoM
10.	Reporting (appendix E)	N/A	See App 4 and consents.	PoM

* this relates to the FEPA licence and does not form part of this consent.

Appendix B

Listed are the relevant key interest features and their conservation objectives considered in the appropriate assessment. Appropriate monitoring requirements are listed (in parenthesis) against the favourable condition criteria.

1) SPA features and conservation objectives

The following SPA features need to be considered: Internationally important wintering populations of oystercatcher and knot.

The conservation objectives describe two supporting habitat attributes that should be monitored for impacts of dredging and disposal:

The feature will be considered in favourable condition when, subject to natural variation, the following conditions are met:

1. The extent of intertidal flats and spatial distribution of their constituent sediment community types is maintained. (Items 1,2,3,4,5)

2. The abundance and dispersal of prey species are maintained at levels sufficient to support the population size.(Item 6)

The above conditions also contribute to the conservation objective to maintain bird numbers. Bird numbers on the Dee Estuary are monitored annually by the Wetland Bird Survey (WeBS), but detailed bird monitoring in the vicinity of the channel is not required. Fine-scale bird distribution is subject to factors elsewhere in the estuary, as well as external factors. The SPA monitoring programme is therefore built around direct measurement of habitat extent and quality.

2) pSAC features

Interest feature 1: The conservation objective for the estuary

The conservation objective for the "estuaries" feature of the Dee Estuary pSAC is to maintain the feature in favourable condition, as defined below:

The "**estuaries**" feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

i. the aggregate total extent of all estuarine communities within the site is maintained;(**Items 5,6**)

ii. the spatial distribution of estuarine communities within the site is maintained;(**Items 5,6**)

iii. the extent of individual estuarine habitat features within the site is maintained;(**Items 2,3,5,6**)

Interest feature 2: The conservation objective for mudflats and sandflats not covered by seawater at low tide

The conservation objective for the "mudflats and sandflats" feature of the Dee Estuary pSAC is to maintain the feature in favourable condition, as defined below:

The "**mudflats and sandflats**" feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

i. the total extent of mudflat and sandflat communities within the site is maintained;(**Items 3.1,4**)

ii. the proportions of individual mudflat and sandflat communities within the site are maintained;(**Items 3.1,4, 5**)

iii. the topography of the intertidal flats and the dynamic processes of channel migration and sinuosity across the flats are maintained;(**Items 1,2,3,4**)

iv. the abundance of typical species of the mudflat and sandflat feature within the site is maintained.(**Items 5, 6**)

Interest feature 3: The conservation objective for Salicornia and other annuals colonising mud and sand

The conservation objective for the "*Salicornia* and other annuals colonising mud and sand" feature of the Dee Estuary pSAC is to maintain the feature in favourable condition, as defined below:

The "***Salicornia* and other annuals colonising mud and sand**" feature will be considered to be in favourable condition when each of the following conditions (i) to (v) are met:

i. the total extent of pioneer saltmarsh vegetation communities within the site is maintained; (**Item 7**)

ii. the presence of pioneer saltmarsh vegetation communities as part of transitions from intertidal sediment communities to higher saltmarsh are maintained;(**Item 7**)

iii. the abundance of the typical species of the pioneer saltmarsh vegetation communities is maintained;(**Item 7**)

iv. the abundance of the notable species of the pioneer saltmarsh vegetation communities is maintained.(**Item 7**)

v. the overall extent and abundance of common cord grass *Spartina anglica* is not increasing within the pioneer saltmarsh zone (**Item 7**)

Interest feature 4: The conservation objective for Atlantic salt meadow

The conservation objective for the "Atlantic salt meadow" feature of the Dee Estuary pSAC is to maintain the feature in favourable condition, as defined below:

The "**Atlantic salt meadow**" feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:

i. the total extent of Atlantic salt meadow vegetation communities within the site is maintained; **(Item 7)**

ii. the proportions of individual Atlantic salt meadow vegetation communities within the site are maintained**; (Item 7)**

iii. the zonation of Atlantic salt meadow vegetation communities and their transitions to fresh water and terrestrial vegetation are maintained**;(Item 7)**

vi. the relative abundance of the typical species of the Atlantic salt meadow vegetation communities is maintained**;(Item 7)**

vii. the abundance of the notable species of the Atlantic salt meadow vegetation communities is maintained. **(Item 7)**

Appendix C

Port of Mostyn monitoring for intertidal pSAC features in the Dee estuary.

pSAC features and conservation objectives:

In looking for impacts (on the marine biological communities) of the dredging and disposal of sediment from the dredge channel at Mostyn the following features and conservation objectives need to be considered:

1) Estuary Feature, CO's: (ii) spatial distribution of estuarine communities, and (vi) the extent of notable hard substrata communities.

2) Mudflats and Sandflats feature, CO's: (ii) the proportions of mud and sandflat communities, and (iv) the abundance of typical species.

The FCS tables in the Draft Dee pSAC package indicate that no change from an established baseline is the desired target for the above conservation objectives. For most of them however the baseline has not yet been established. For the sample sites proposed below the CCW intertidal Phase 1 Survey will act as a baseline for CO's 1(ii), 1(vi), and 2(ii), and a partial baseline for 2(iv).

SPA features, conservation objectives and baselines:

Oystercatcher and knot COs: intertidal extent and spatial distribution of sediment types; abundance and dispersal of prey species.

The Phase 1 intertidal survey provides a baseline for intertidal habitat extent, sediment types and abundance and distribution of intertidal species. EAW's cockle stock assessments and CCW's 2003 and 2004 cockle surveys provide a baseline for cockle surveys (which will be undertaken by EAW).

Monitoring strategy

Five transects and one survey station are proposed (see attached plan C);

Direct effects of the dredging

1) to monitor for loss of or changes to intertidal communities due (transects A and B).

Indirect effects of the dredging

2) to monitor the effects of the possible draw down on the intertidal communities (transects C and D)

3) to monitor changes in erosion/accretion of substrata in the vicinity of the Holocene clay (station F). A survey station positioned on the Holocene clay bank to monitor the erosion/burial of this bank and the presence of any piddocks. This will carry on from previous work that saw the burying of posts at regular intervals to a set depth on the bank and monitoring of the changing position and height of the bank.

Effects of the disposal of material in Mostyn Deep

4) to monitor changes in intertidal communities due to changes in height of the substratum or changes in the substratum (transect E). The positioning of transect E assumes that the modelling of the fate of the spoil is correct and that if the dredge spoil is disposed of in the southern half of the disposal box in Mostyn Deep the most likely area of impact will be the southern shore of the upper estuary.

Sampling strategy:

The transects will coincide with the bird food/cockle transects previously sampled on the Dee estuary or within a 5metre radius of the point and it is envisaged that any field work would be done in conjunction with the bird food/cockle surveys in August/September each year. A spring tide will be required to reach all of the sampling locations.

Sample stations to be 500 metres apart on transects A – D, and approximately 700 m apart on transect E due to its oblique nature (the sample points would still coincide with bird food/cockle survey transects). Should the sampling location be within a channel or on a feature that is significantly different from the sediment in a 5m radius (such as a swathe of washed in weed or a small temporal muddy hollow, etc), then the next nearest point that reflects the character of the sediment in the immediate vicinity should be sampled and a note made of the position using a GPS.

At each station, a surface description of the sediment is made, 8 cores are collected and pooled (standard MNCR methodology, Hiscock 1996) and one small core of material collected for Particle Size Analysis (PSA). Samples should be processed according to 'Procedural guideline 3-6' in Davies *et al*, 2001. Cockles should be sorted using a 20mm sieve (*to retain cockles > 20mm*). Numbers and density (cockles / m2) of cockles < 20mm and >= 20mm should be recorded.

Transect A = 9 sampling stations

Transect B = 10 sampling stations

Transect C = 8 sampling stations

Transect D = 5 sampling stations

Transect E = 11 sampling stations

Total No of samples = 43

Total number of PSA cores = 43

Survey at the Holocene clay bank would consist of a yearly return to the site on the outer Salisbury bank (see attached plan). The position of the bank in relation to the wooden stakes placed by CCW in March 2003 would be pinpointed using a GPS and the presence of any live piddocks noted. Details of former work completed are available from CCW.

Sampling timetable:

Sampling would be undertaken at the outset of dredging activity to provide an initial baseline of intertidal communities and subsequently once a year to coincide with the cockle/birdfood survey in August/September whilst dredging/disposal is taking place and for two years after dredging/disposal has ceased.

Appendix D- Saltmarsh monitoring

Measure accretion / erosion rates at test and control sites using the methodology of Gerardo et al 2003 (or other agreed methodology), number of samples to be agreed with regulators. Vegetation to be monitored along a 100m length of saltmarsh for a width of approximately 50m within both the potential impact zone and and within a control area (possibly Mostyn Bank). These survey blocks will include the boundaries between Atlantic salt meadow, the Salicornia pioneer zone and the open mudflats, with a sampling regime to include no fewer than 100 quadrats per block.
Measurements will require a highly accurate GPS and an accurate measure of ground cover within the different vegetation types using a point quadrat within certain marked areas.
Reference.
Gerardo M.E. Perillo, Eder Paulo Dos Santos & M. Cintia Piccolo. 2003. An inexpensive instrument for sediment erosion-accumulation rate measurement in intertidal environments. Wetlands Ecology and Management, 11: 195-198.

Appendix E- Reporting

1. The licence holder must submit reports of the disposal operation to the licensing authority at 4 weekly intervals from the date of the first deposit during the disposal campaign and within 4 weeks of the last survey. Each report should include a description of the dredging activity, the positional log of the dredging vessel, date and time of each release, tidal state and weather conditions. GIS plots showing the swathe bathymetry, overlaid with the disposal grid and the release points should also be included in the report so that transport from the disposal site can be monitored. The LiDAR surveys of the estuary to review large-scale morphological change required for the dredging activity are also relevant to the assessment of the disposal operations and should be included with other bathymetry and biological data in an annual report to be discussed with regulators in mid 2006.
2. Surveys of all monitoring specific to the cross bank channel to be submitted digitally, changes analysed (erosion/deposition plots in plan and cross section) and reported to the Agency within 6 months of dredging.
3. Analysis of LiDAR and other bathymetric data to include erosion/deposition plots, annual change in position of Salisbury cross bank channel and conformity of estuarine behaviour to process hypothesis (SMP 2005).
4. Reporting of the intertidal community monitoring should include an analysis of the data and interpretation to:
    - Identify the intertidal biotope (biological community)
    - Identify changes in intertidal community for each sample using appropriate analytical techniques (e.g. DECORANA, MDS)
    - Draw any conclusions about broad scale changes using the data collected.
    - The Agency will expect the report to be with them within 3 months of the survey work, in order to allow review by CCW with respect to achieving the conditions of the Consent.
5. Analysis of changes in intertidal sediments, biotopes and cockle densities should be reported annually.

9. Supplementary Conditions

9.1 The Licence Holder must ensure that no disposal operations are undertaken between high water and 4 hours post high water on tides of amplitude greater than 4 metres above Ordnance Datum (AOD). Disposal operations may take place throughout the tidal cycle for tides of an amplitude of 4 metres AOD or less.

9.2 The Licence Holder is not permitted to deposit any maintenance dredging within the limits specified at paragraph 1.4 - 1.6.4 of this licence, if the dredging of those substances would cause the depth of the area being dredged to exceed that permitted by any other statutory consent in force during the period of this licence.

9.3 The Licence Holder must ensure that the quantity of material deposited does not exceed 24,000 tonnes (12,000m3) in any 24-hour period.

9.4 The Licence Holder must ensure that material is only deposited within the area of the Mostyn Deep (Maintenance) disposal site as defined by reference to the HR Wallingford Report EX5097 being an oblong joining points 1, 15, 31 and 45 at the following co-ordinates:

53 degrees 21.65N	03 degrees 18.21W
53 degrees 20.94N	03 degrees 13.35W
53 degrees 21.05N	03 degrees 16.18W
53 degrees 21.77N	03 degrees 18.08W

The disposal site, as described above, must be divided into 25 metre by 75 metre cells. The placement of material within these cells must follow a randomised sequence, excluding the perimeter cells designed to provide a safety margin. Each cell must initially only receive one 400 cubic metre load of dredged material; thereafter the sequence may then be repeated on a rolling basis.

The disposal grid is necessary to ensure that material is spread throughout the dispersive area of the Mostyn Deep (Maintenance) disposal site so as to optimise sediment remobilisation.

9.5 The Licence Holder must ensure that the co-ordinates of each deposit are recorded from the dredging vessels positioning system and are forwarded to the MCEU acting on behalf of the Licensing Authority on completion of the dredging campaign.

9.6 The Licence Holder must undertake a programme of monitoring to access the effects of the disposal operations permitted by this licence as described at 9.7 - 9.9 below. These measures shall comprise part of the overall monitoring programme to be undertaken by the Port of Mostyn Ltd to assess the effects of the dredging operation as a whole referred to in the letter addressed to the Port from Glyn Perryman, Welsh Assembly Government, dated 16 August 2005 (a copy of the overall monitoring programme is at Annex A).

9.7 The Licence Holder must ensure that Swathe bathymetry of the dredge and disposal areas is undertaken to the following specifications:

100% coverage sweeps prior to any disposal operation commencing;
100% coverage sweeps 2 weeks after commencement of dredging;
100% coverage sweeps 6 weeks after commencement of dredging.

The results of these surveys to be sent to the MCEU no later than 12 weeks after the start of works authorised by this Licence.

Dependent on the output of these surveys the Licence Holder may be required to carry out a further 2 - 3 survey in the 12 months following completion of the initial disposal campaign. The Licence Holder must ensure vertical control using either data from a deployed tide gauge or by the use of a Kinematics GPS and that all the equipment is fully calibrated with errors not expected to exceed ±10

centimetres.

9.8 The Licence Holder must ensure that 4 -6 surface sediment samples are taken within the disposal site to monitor changes in seabed composition during the disposal operation. Samples should be collected to coincide with the swathe bathymetry surveys described in 9.7, i.e. pre-disposal, 2 - weeks after commencement of dredging and 6 weeks of commencement of the dredging. The position of each sample should coincide with the disposal positions and should be recorded. Samples should be taken from the same positions in each of the required surveys. Dependent on the output of these surveys, the Licence Holder may be required to carry out a further 2 or 3 survey in the 12 months following completion of the initial disposal campaign.

9.9 The Licence Holder must submit reports of the disposal operation to MCEU acting on behalf of the Licensing Authority at 4 weekly intervals from the date of the first deposit under this Licence, continuing throughout the disposal campaign and within 4 weeks of the last bathymetric survey. Each report should include a description of the dredging and disposal activity, the positional log of the dredging vessel, date, time and position of each release of dredged material, tidal state and weather conditions. GIS plots showing the most recent swathe bathymetry, overlaid with the disposal grid and the release points should also be included in the report so that transport from the disposal site can be monitored. The LIDAR surveys of the estuary to review large-scale morphological change required for the dredging activity are also relevant to the assessment of the disposal operations and should be included in the reports when available.

9.10 The Licence Holder should make use of ploughing / water injection dredging techniques wherever practicable to minimise the quantity of material requiring sea disposal.

9.11 The Licence Holder should continue desk-based investigations (including the use of numerical models) into alternative disposal operations that fulfil the conservation objective of retaining sediment in the estuary.

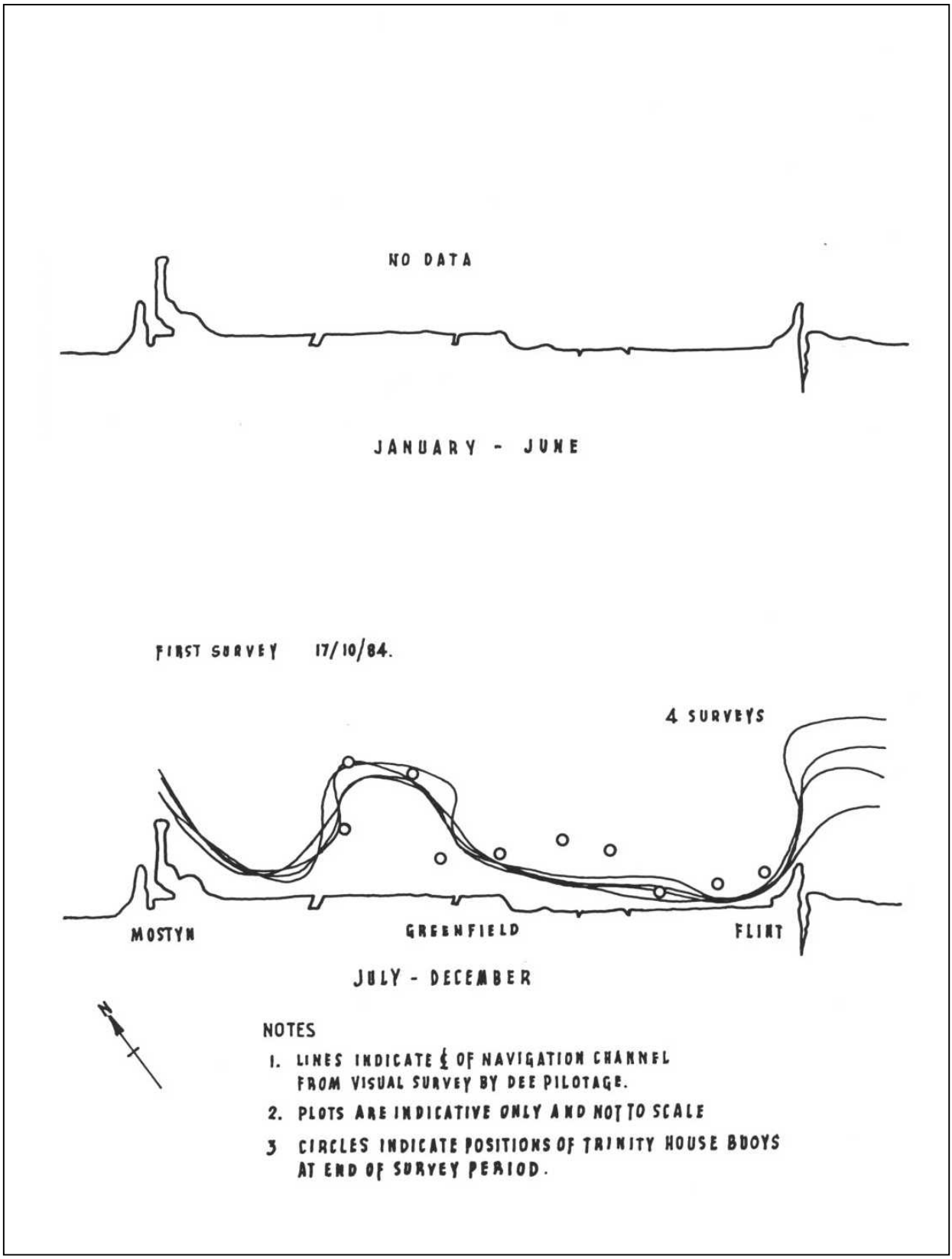
9.12 The Licence Holder must ensure that all reasonable precautions should be taken to prevent the disposal of man-made debris to sea.

9.13 In addition to the initial licence charge paid with the application (or application for renewal) relating to this licence, the Licence Holder shall pay further annual instalments of the licence charge in respect of the second period of twelve months of the licence (equivalent to the renewal charge in force from time to time at each due date). Payment of each annual instalment shall be due and be made to the Licensing Authority 28 days prior to the anniversary of the original start date of this licence (16 August 2004).

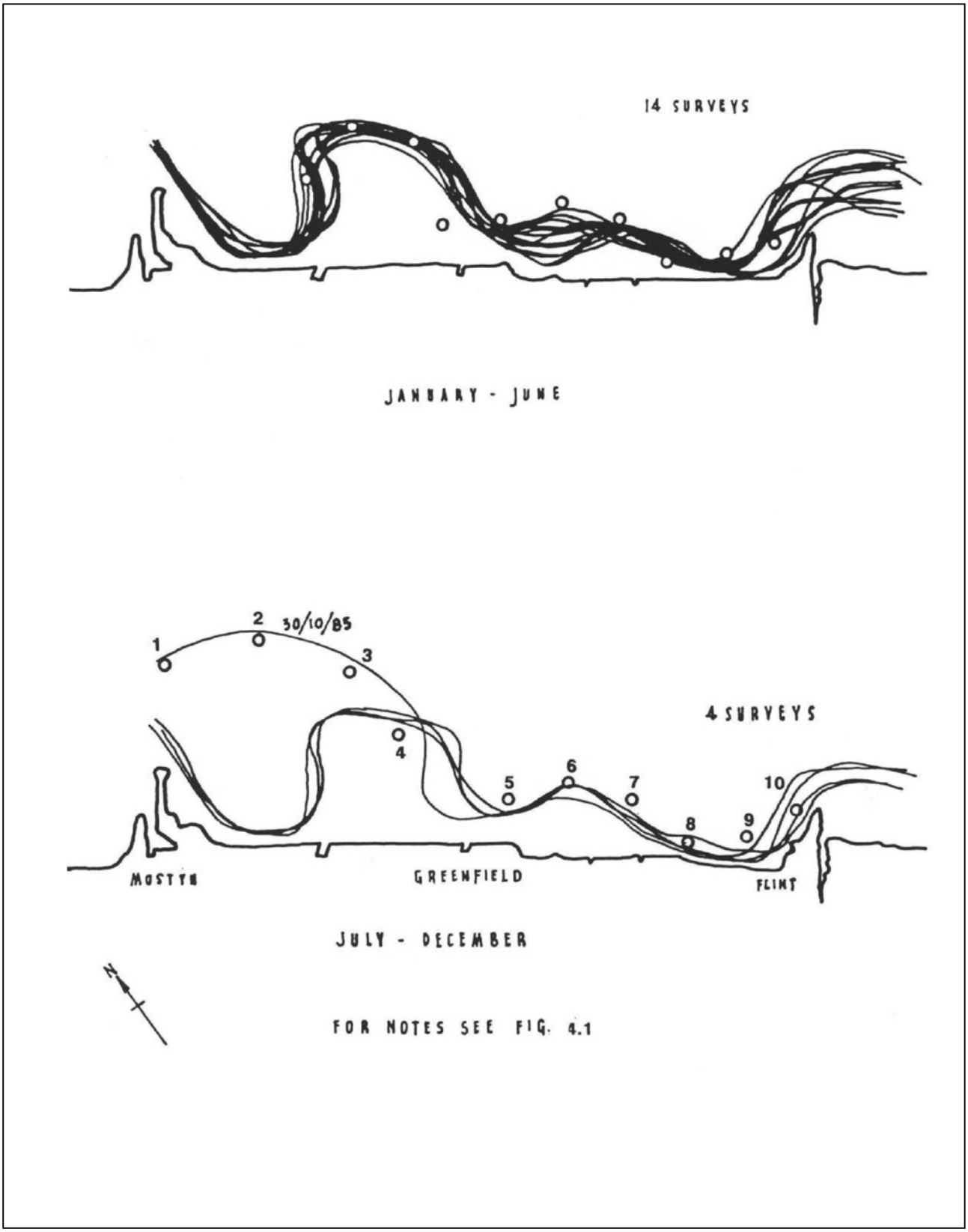
9.14 The licence shall be deemed to become invalid and shall be liable to be revoked in the event that the Licence Holder fails to make full payment of each annual instalment of the licence charge within a period of 28 days following the respective due date for payment.

ANNEX 'B'

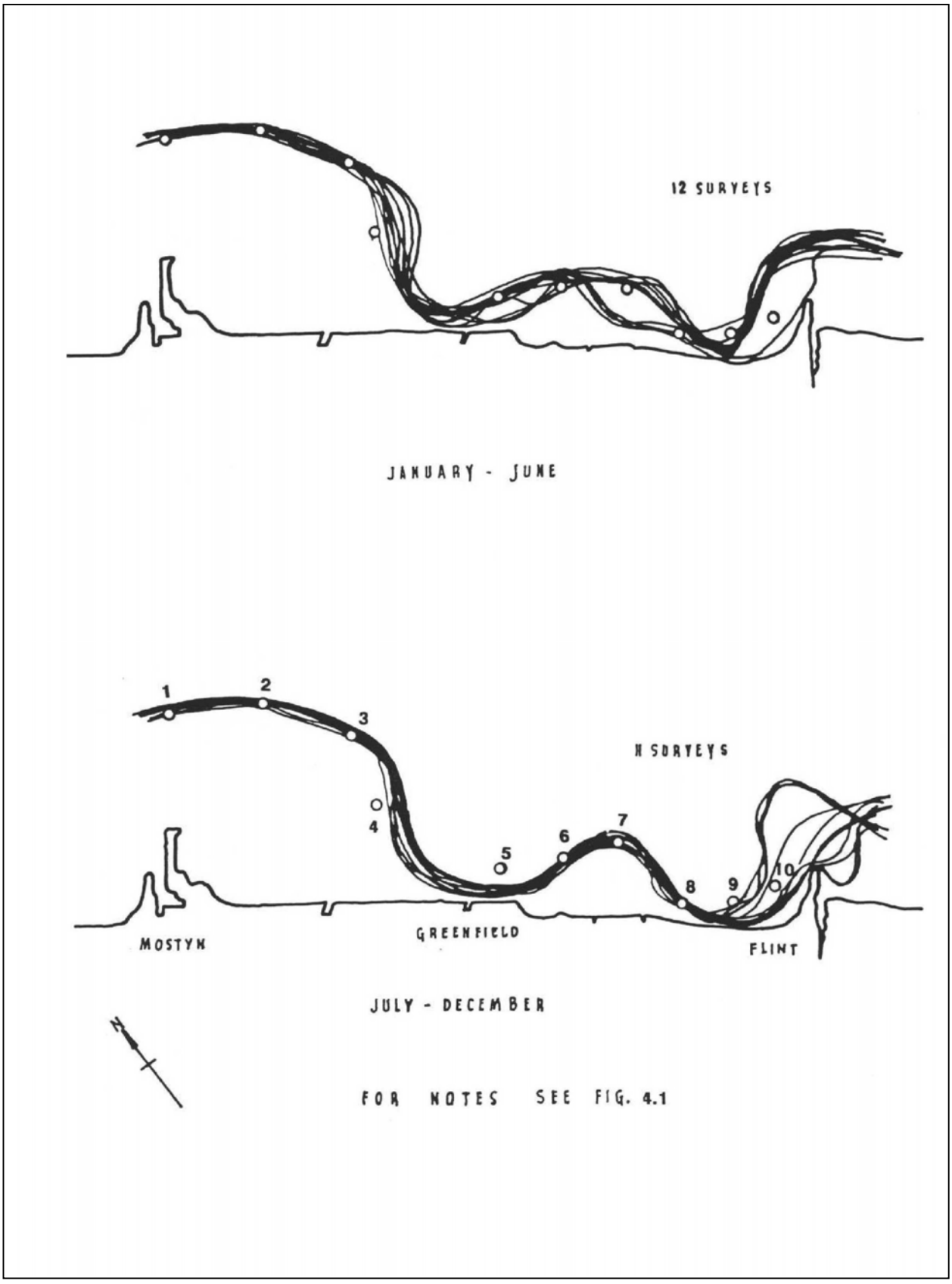
Pilot Charts – 1984 to 1989



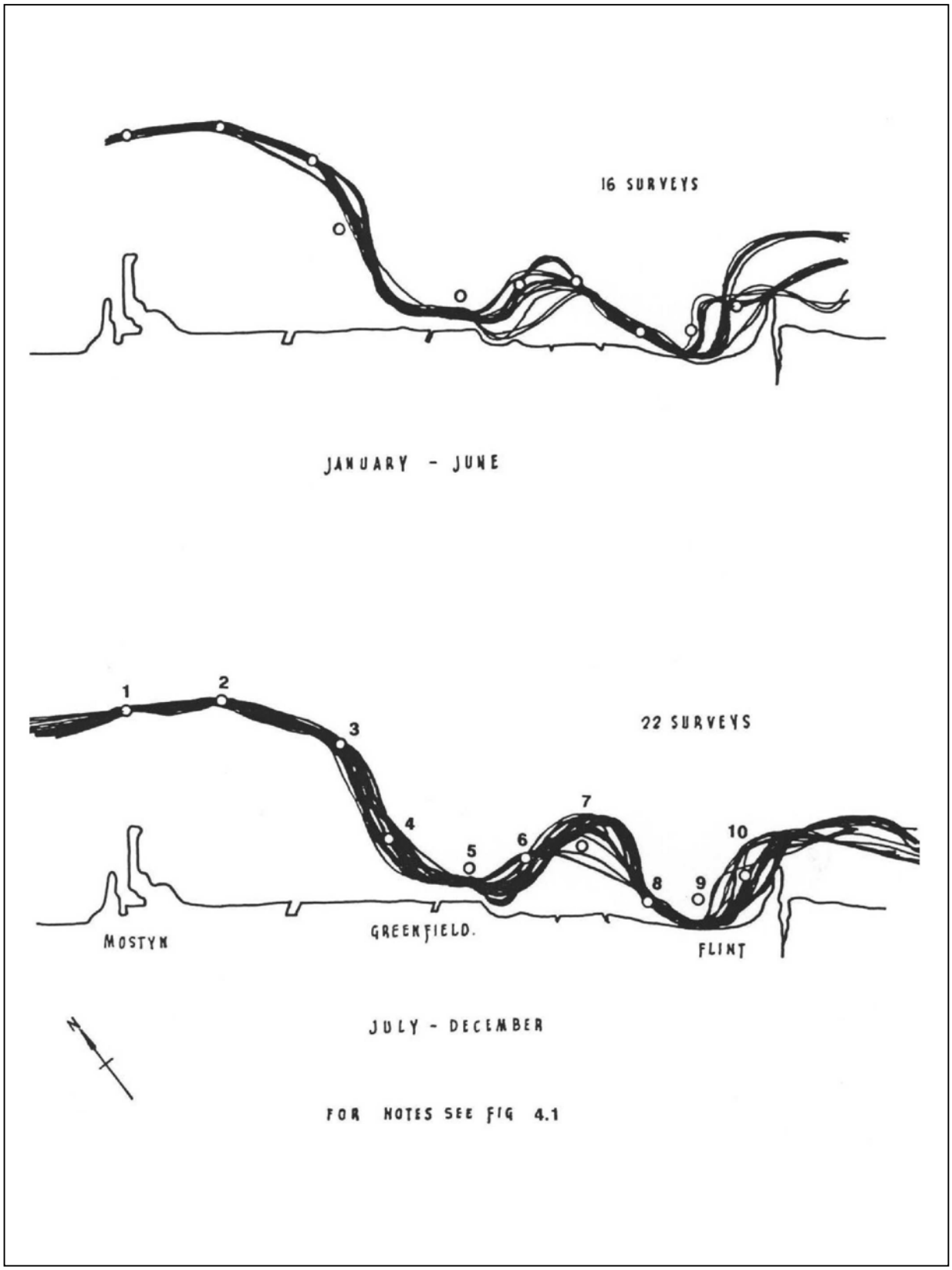
PILOT CHART, Flint to Mostyn 1984



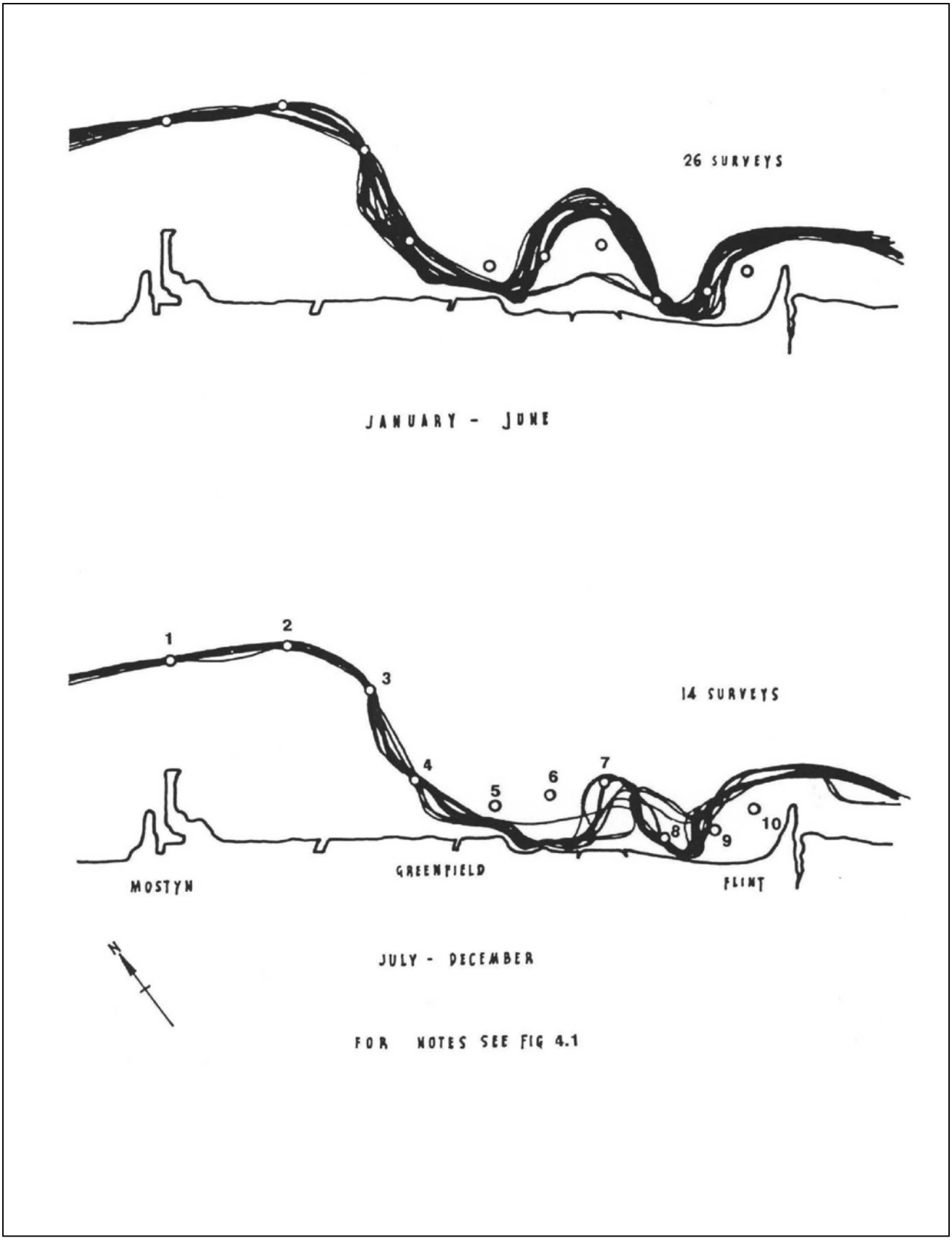
PILOT CHART, Flint to Mostyn 1985



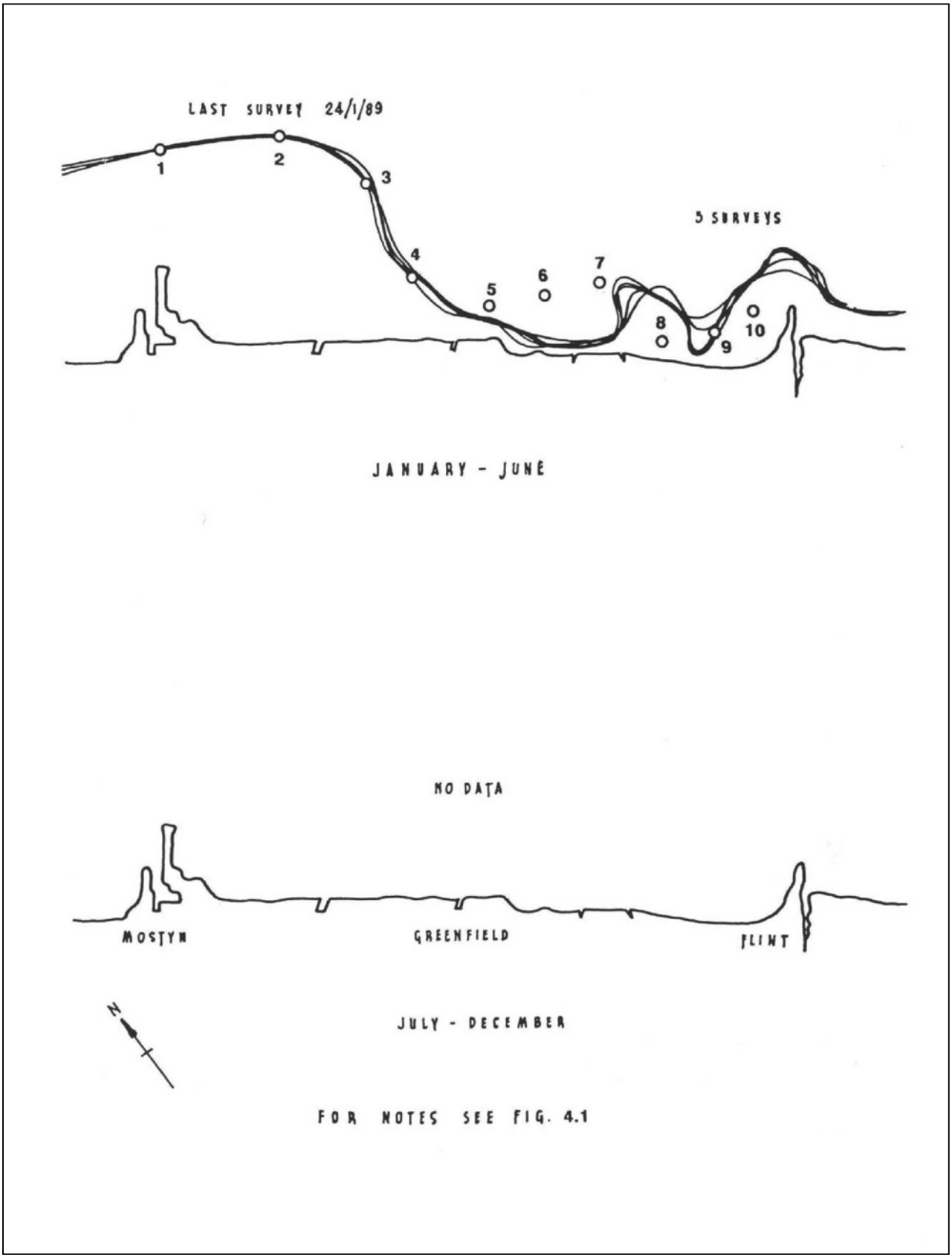
PILOT CHART, Flint to Mostyn 1986



PILOT CHART, Flint to Mostyn 1987



PILOT CHART, Flint to Mostyn 1988

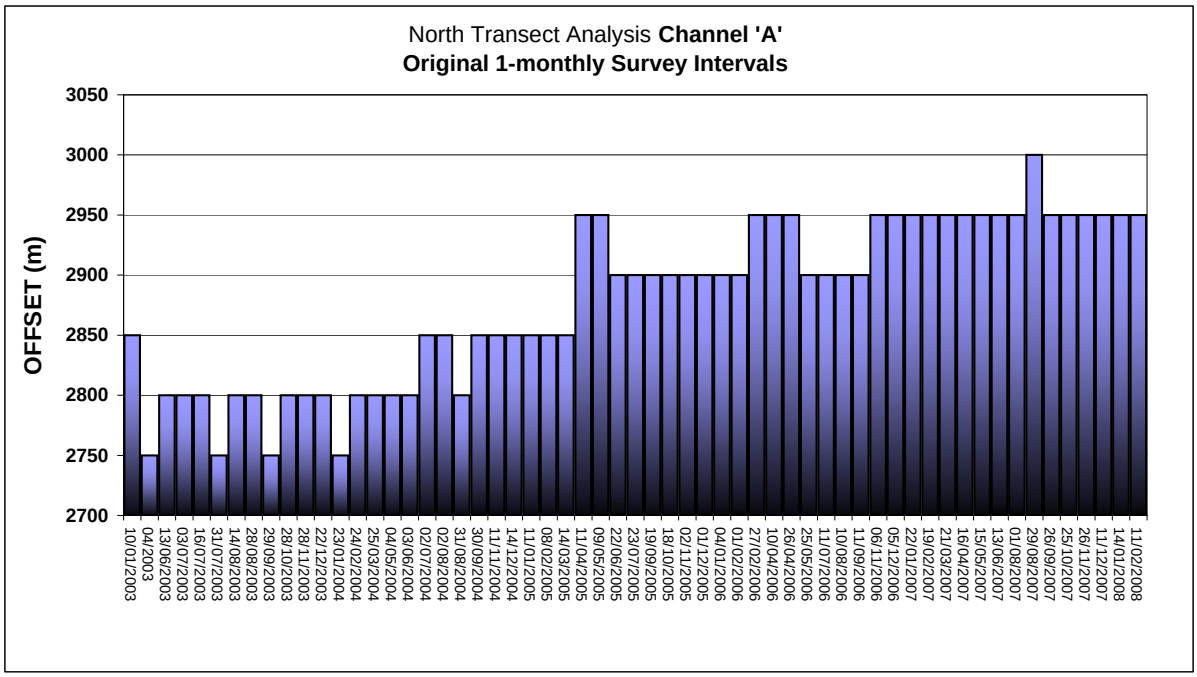


PILOT CHART, Flint to Mostyn 1989

ANNEX 'C'

Inner Channel Sections Survey

Frequency Assessment


North Transect Analysis **Channel 'A'**
Original 1-monthly Survey Intervals
OFFSET (m)
3050
3000
2950
2900
2850
2800
2750
2700
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
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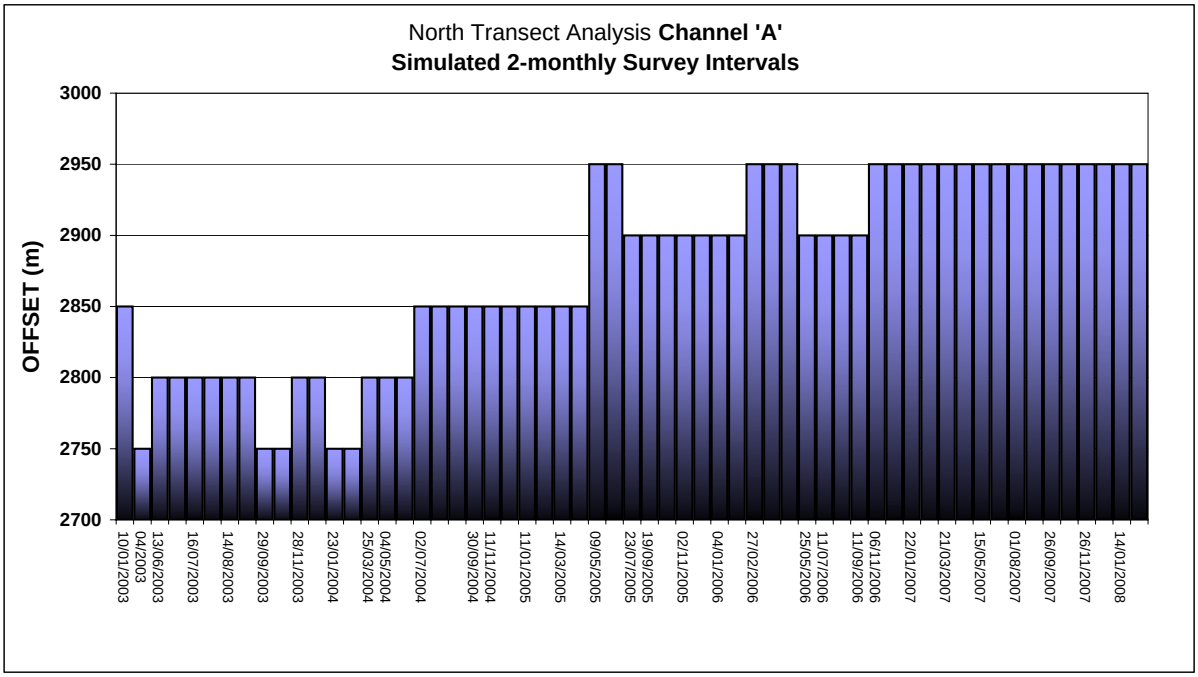
North Transect Analysis **Channel 'A'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
3000
2950
2900
2850
2800
2750
2700
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04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
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04/05/2004
02/07/2004
30/09/2004
11/11/2004
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14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
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11/07/2006
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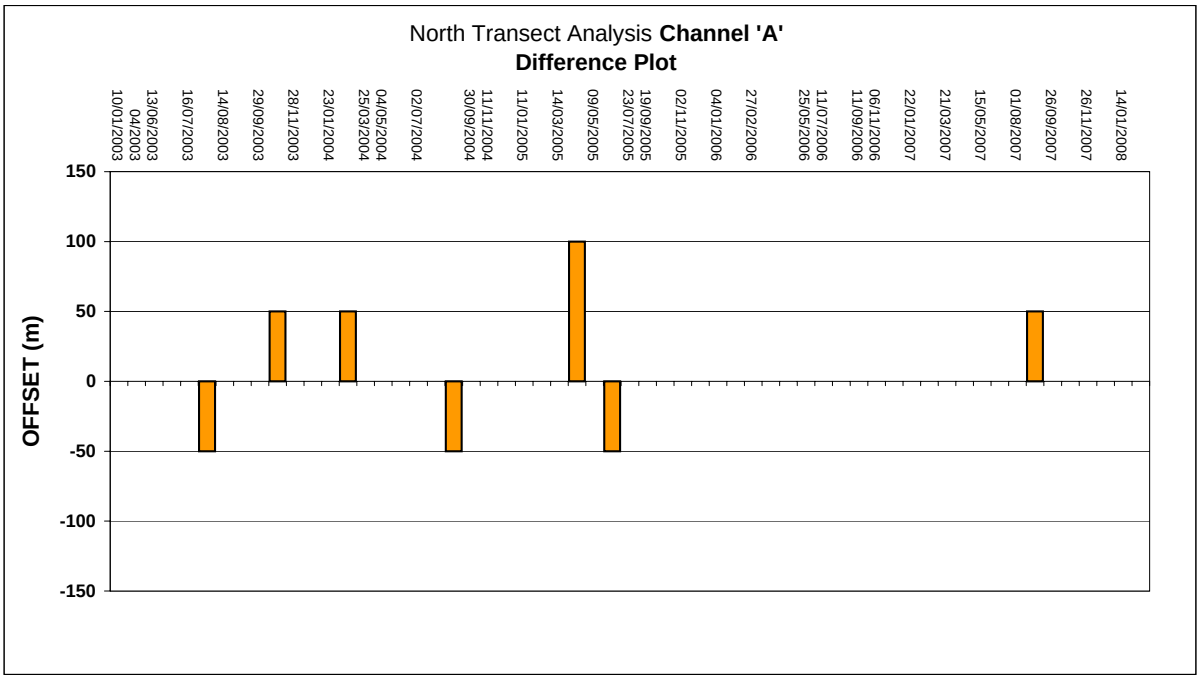
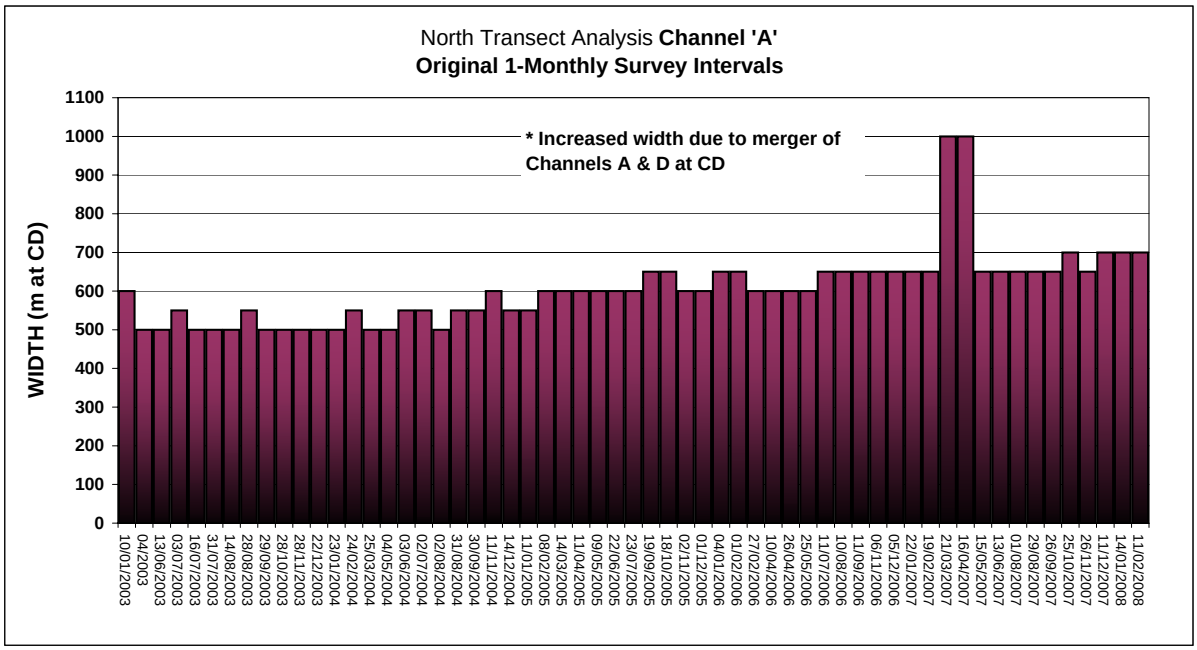
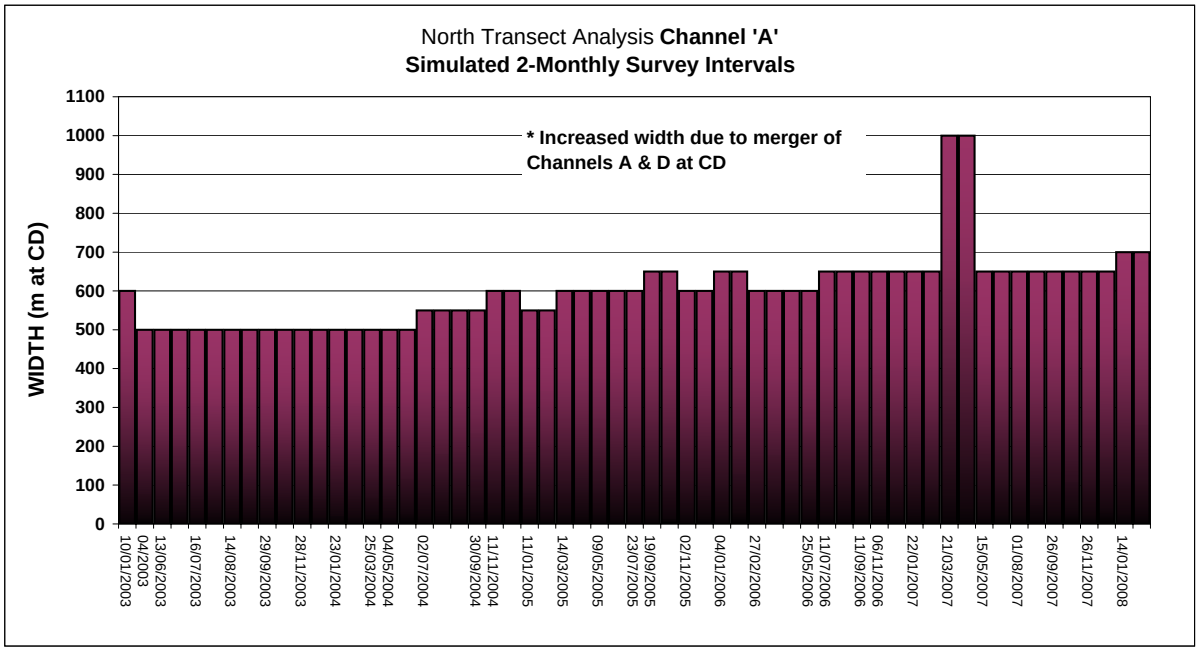
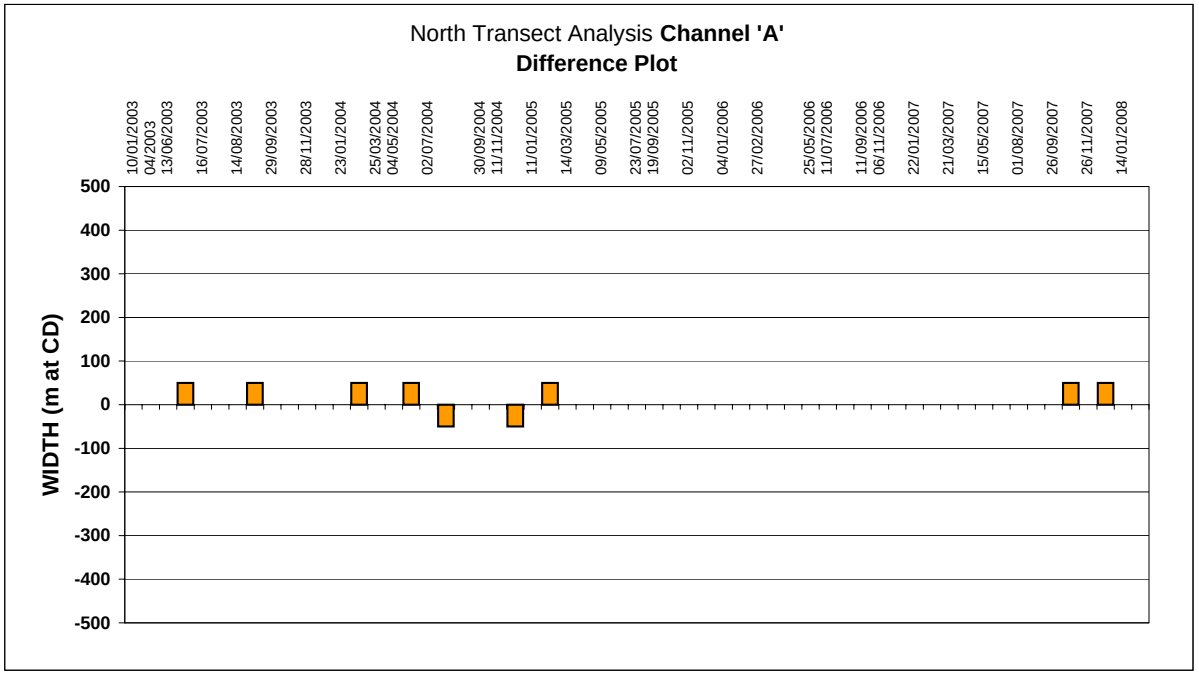
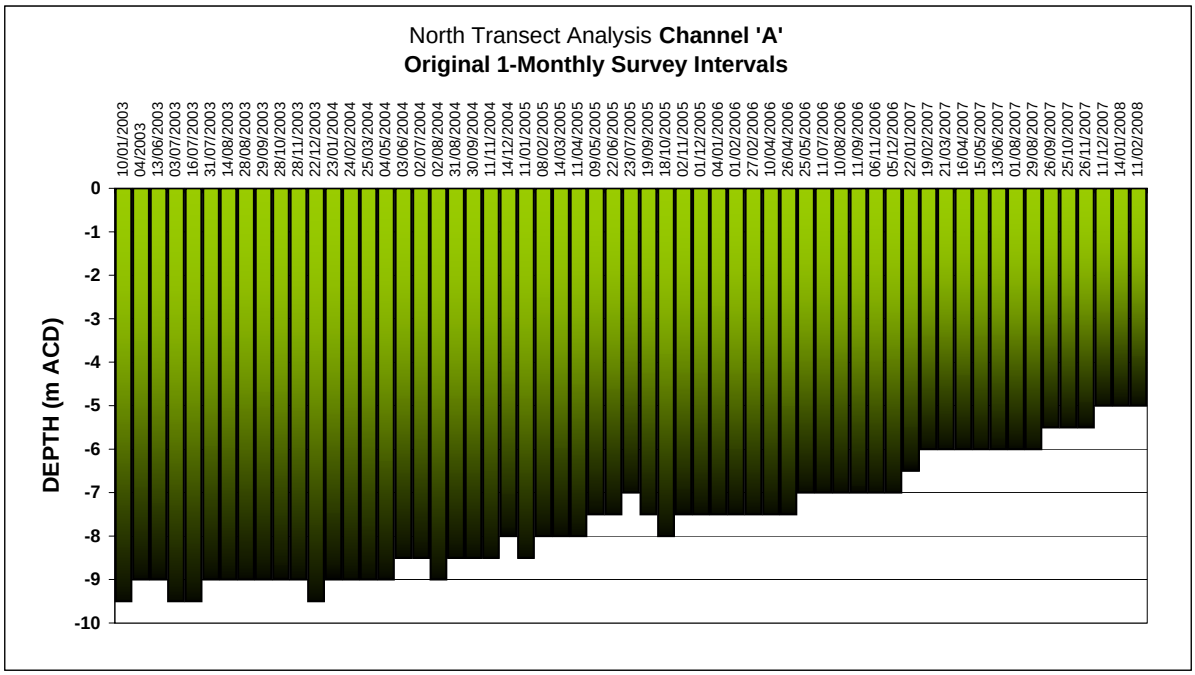
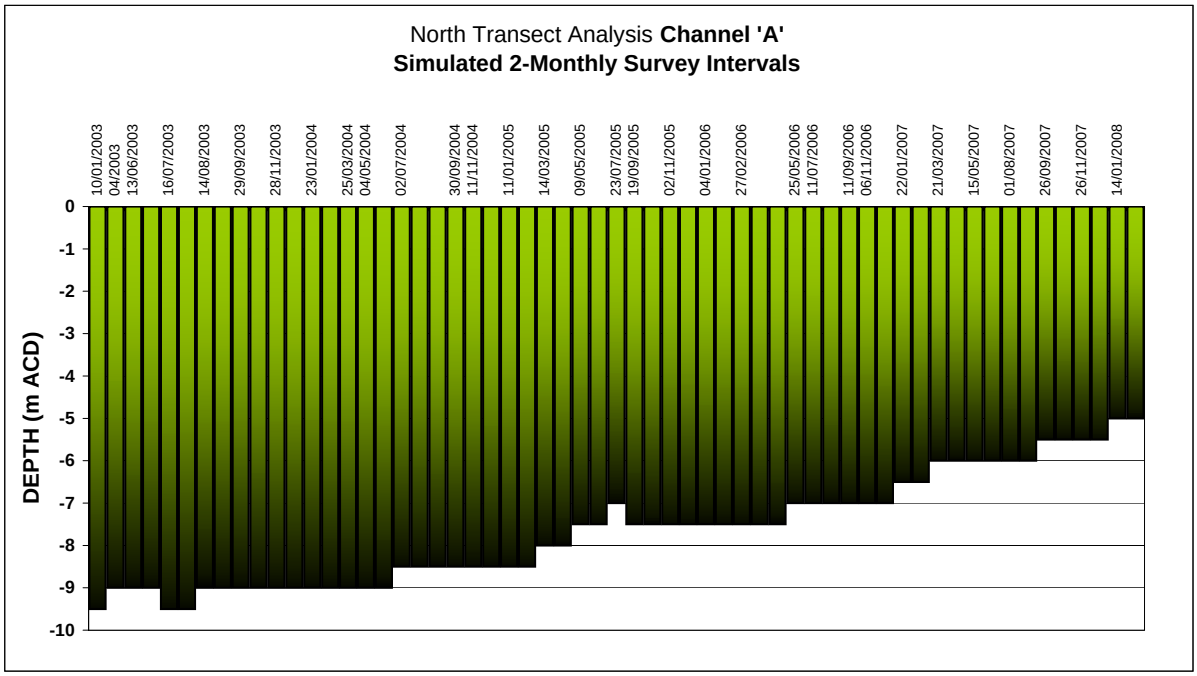

North Transect Analysis **Channel 'A'**
Difference Plot
OFFSET (m)
150
100
50
0
-50
-100
-150
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

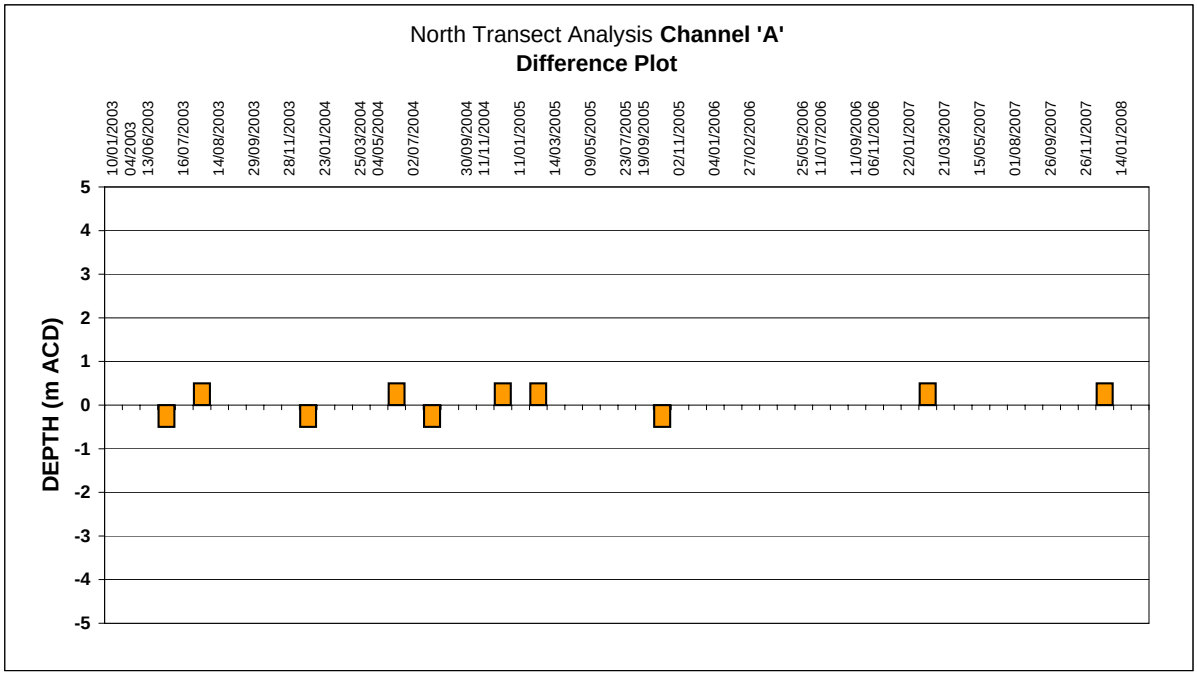

North Transect Analysis **Channel 'A'**
Original 1-Monthly Survey Intervals
WIDTH (m at CD)
* Increased width due to merger of Channels A & D at CD
0
100
200
300
400
500
600
700
800
900
1000
1100
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

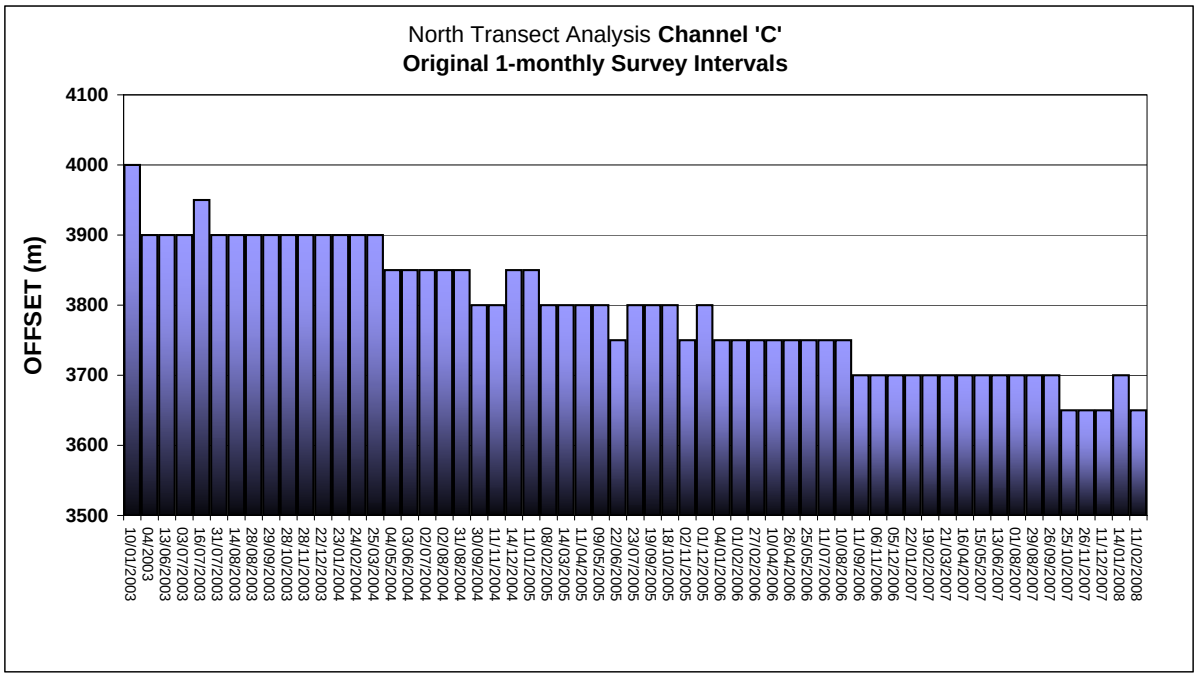

North Transect Analysis **Channel 'A'**
Simulated 2-Monthly Survey Intervals
WIDTH (m at CD)
* Increased width due to merger of Channels A & D at CD
0
100
200
300
400
500
600
700
800
900
1000
1100
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

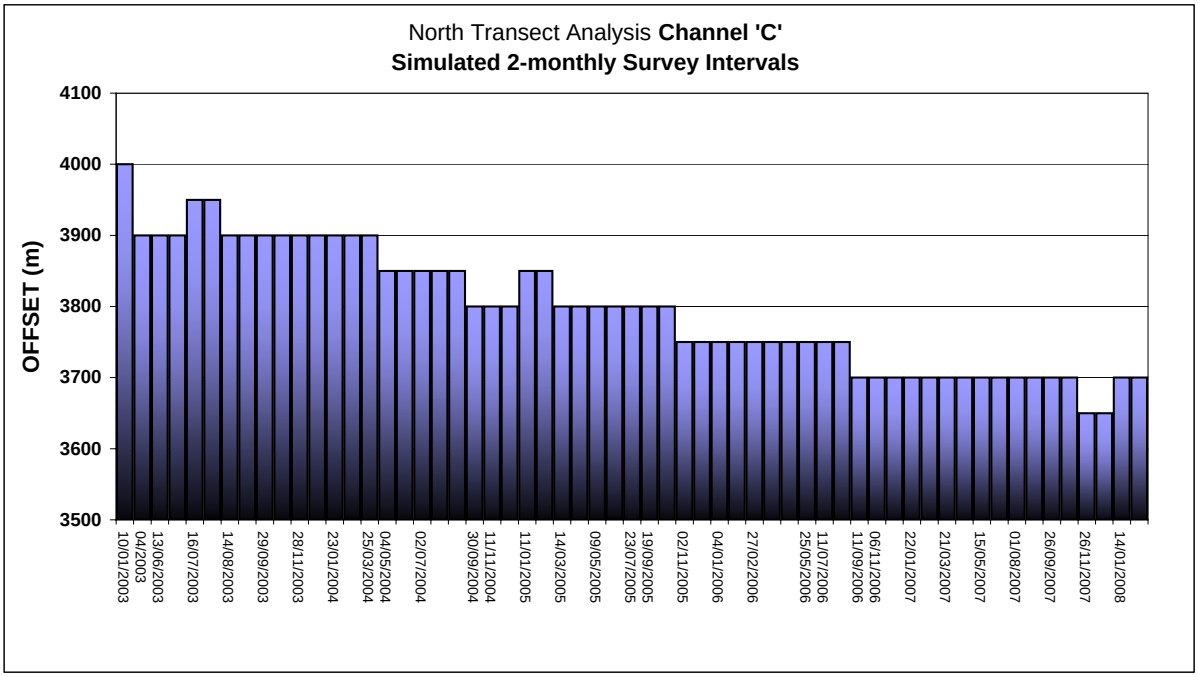

North Transect Analysis **Channel 'A'**
Difference Plot
WIDTH (m at CD)
-500
-400
-300
-200
-100
0
100
200
300
400
500
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

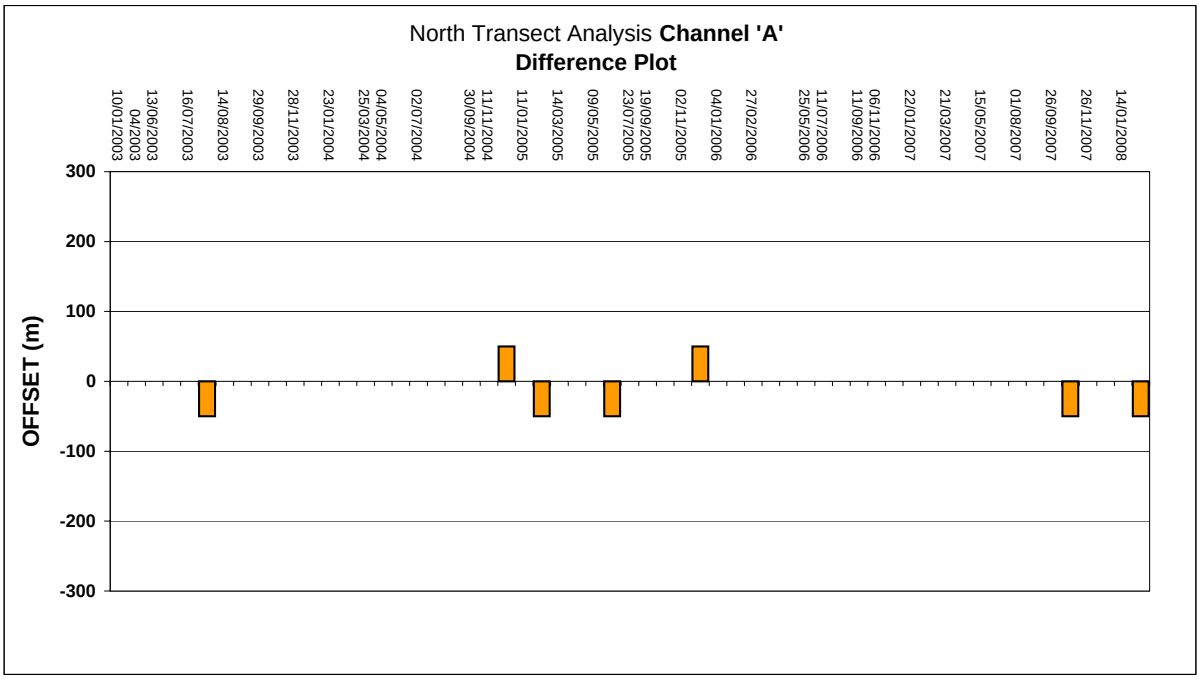

North Transect Analysis **Channel 'A'**
Original 1-Monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

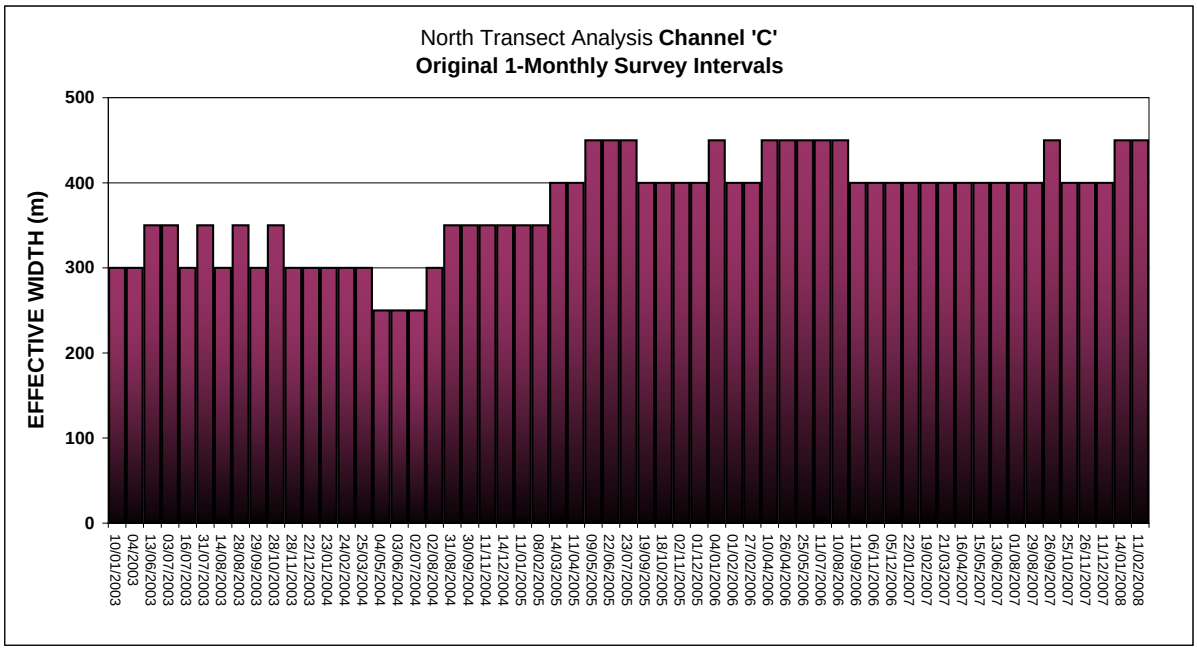

North Transect Analysis **Channel 'A'**
Simulated 2-Monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

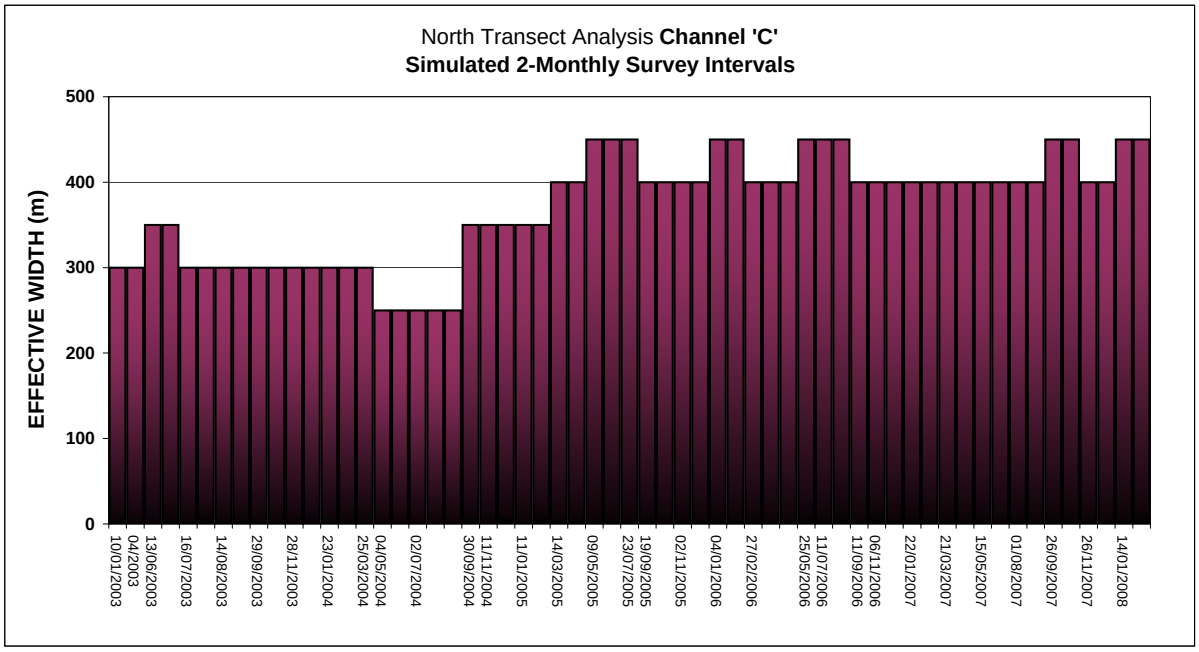

North Transect Analysis **Channel 'A'**
Difference Plot
DEPTH (m ACD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

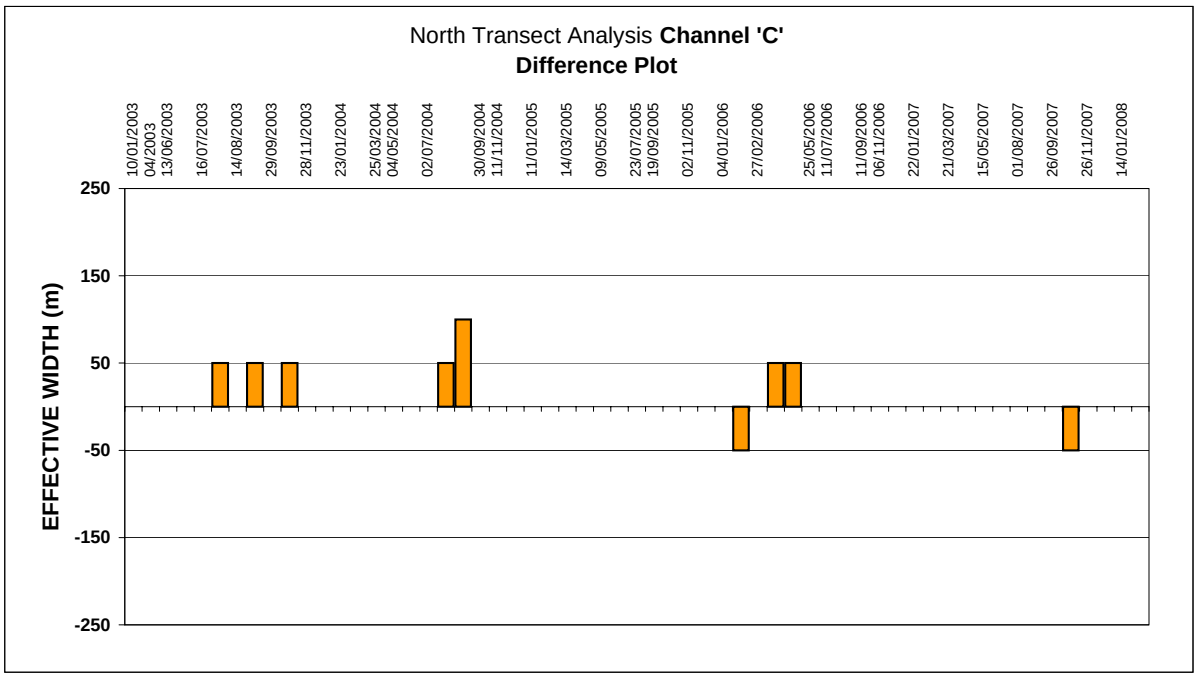

North Transect Analysis **Channel 'C'**
Original 1-monthly Survey Intervals
OFFSET (m)
4100
4000
3900
3800
3700
3600
3500
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

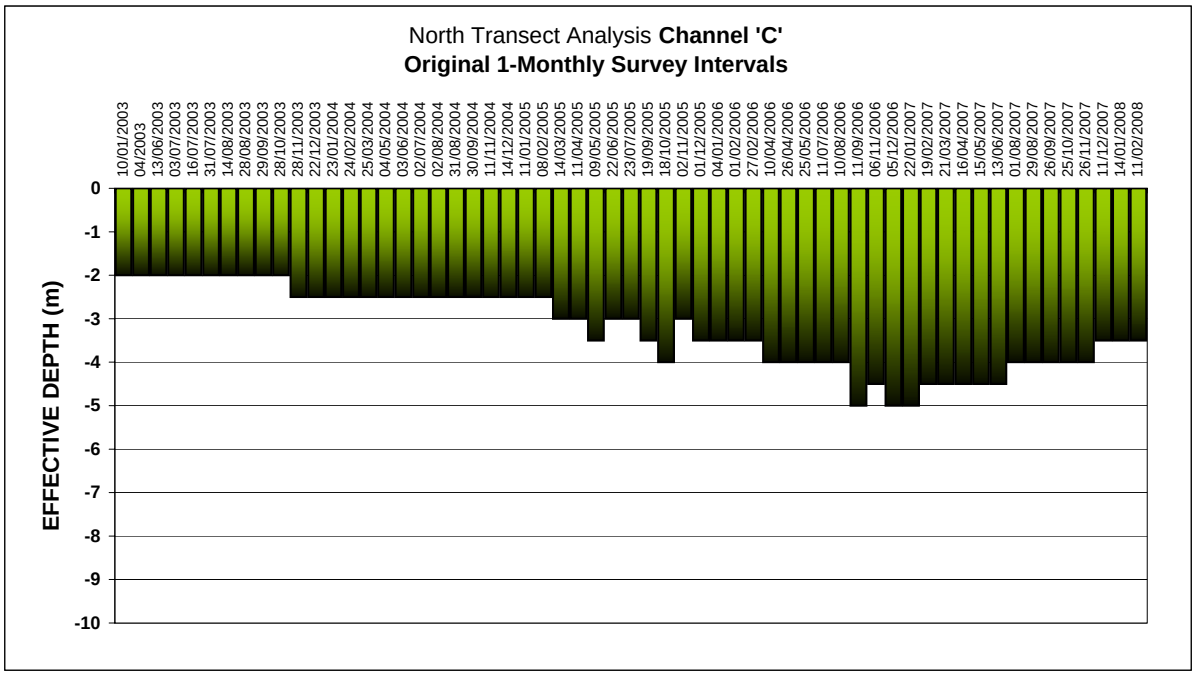

North Transect Analysis **Channel 'C'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
4100
4000
3900
3800
3700
3600
3500
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

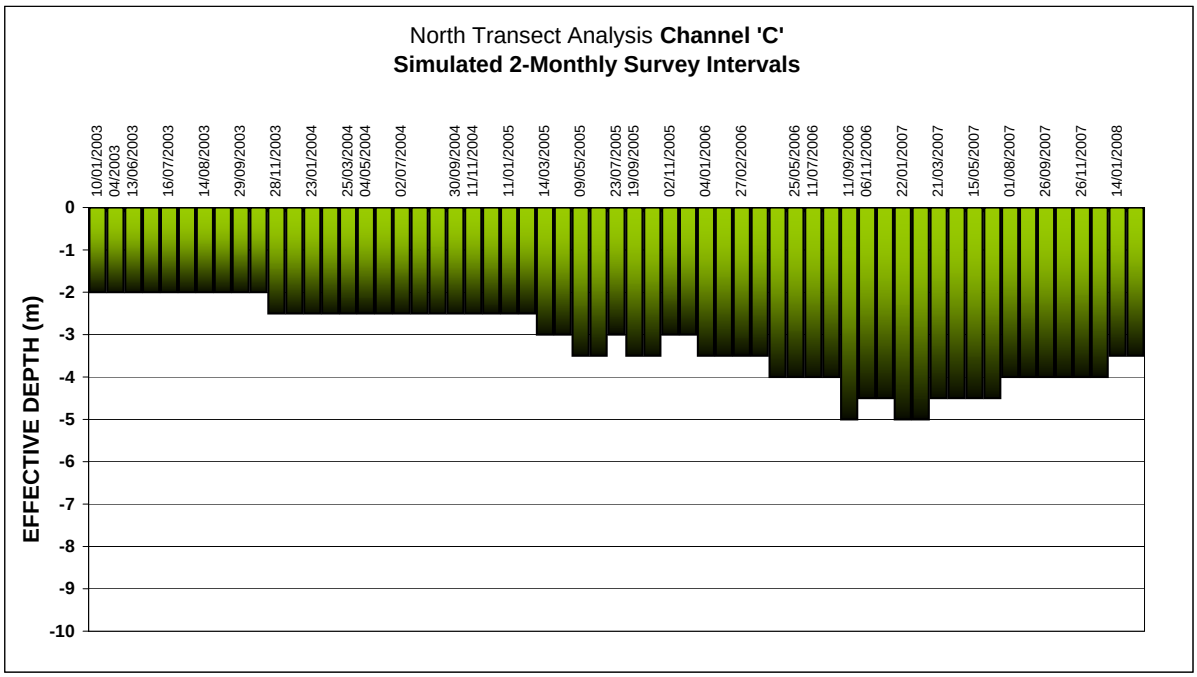

North Transect Analysis **Channel 'A'**
Difference Plot
OFFSET (m)
300
200
100
0
-100
-200
-300
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

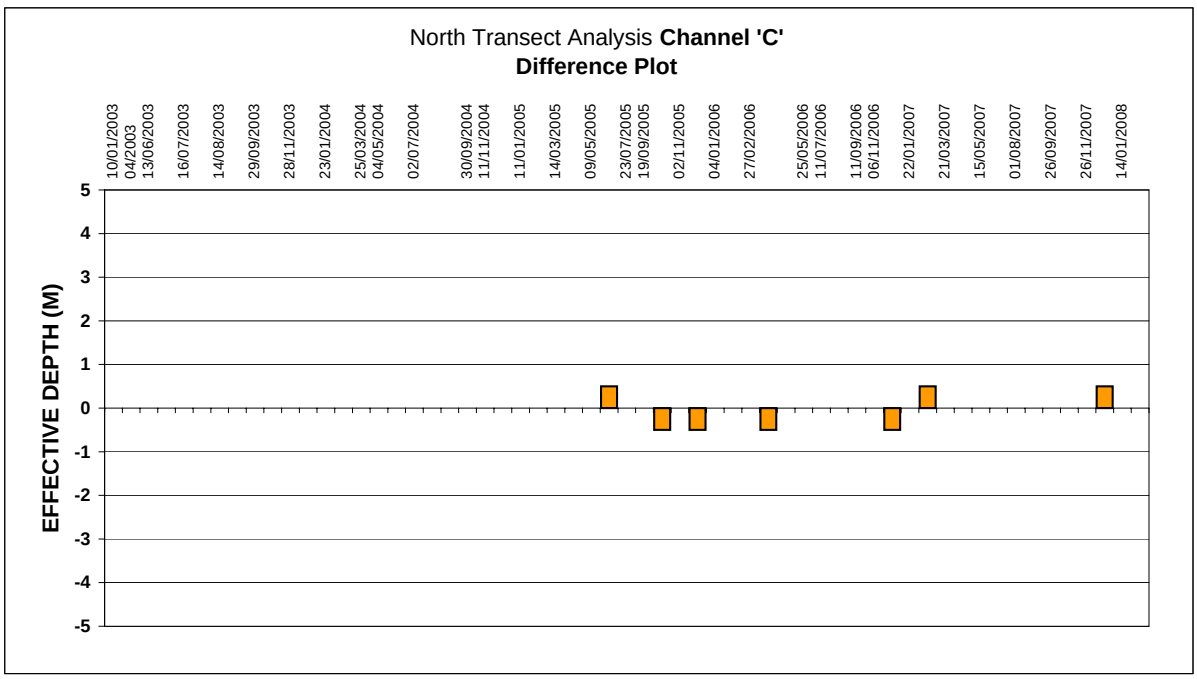

North Transect Analysis **Channel 'C'**
Original 1-Monthly Survey Intervals
EFFECTIVE WIDTH (m)
500
400
300
200
100
0
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

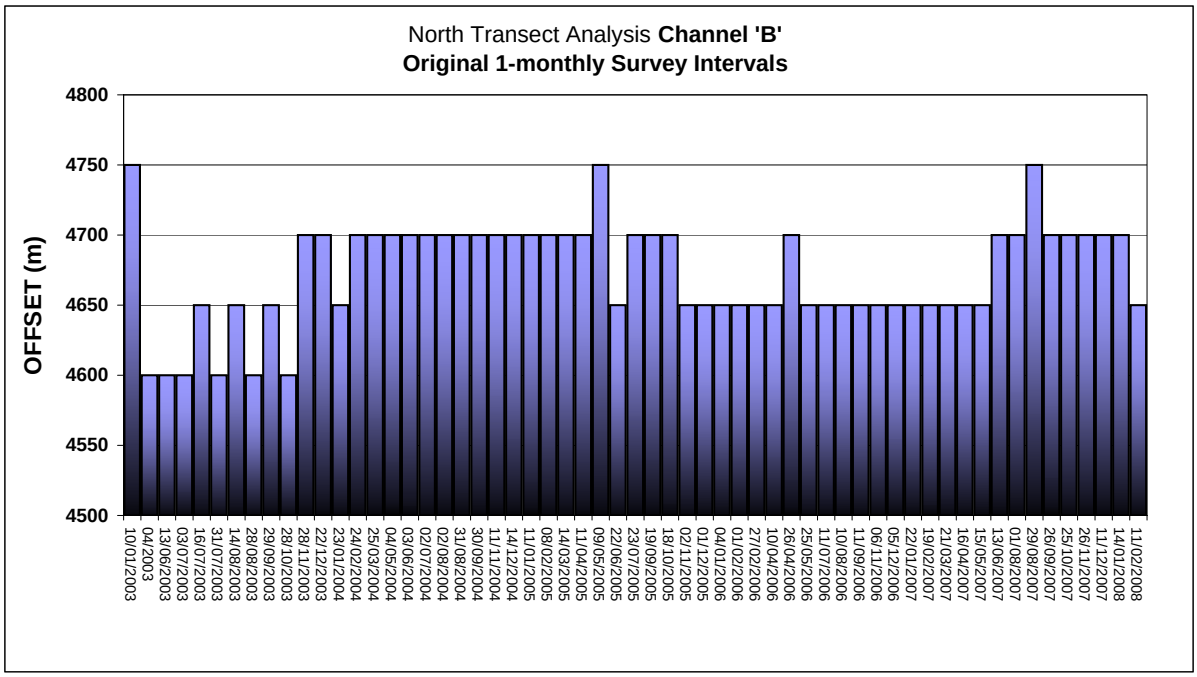

North Transect Analysis **Channel 'C'**
Simulated 2-Monthly Survey Intervals
EFFECTIVE WIDTH (m)
500
400
300
200
100
0
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

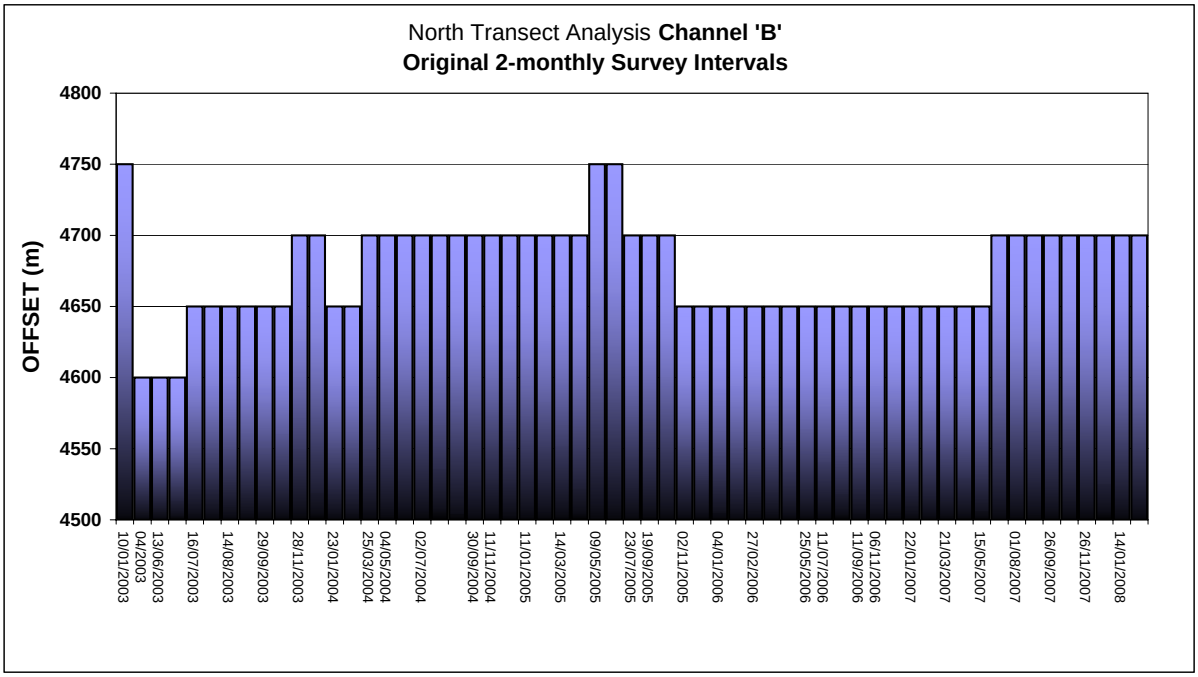

North Transect Analysis **Channel 'C'**
Difference Plot
EFFECTIVE WIDTH (m)
250
150
50
-50
-150
-250
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

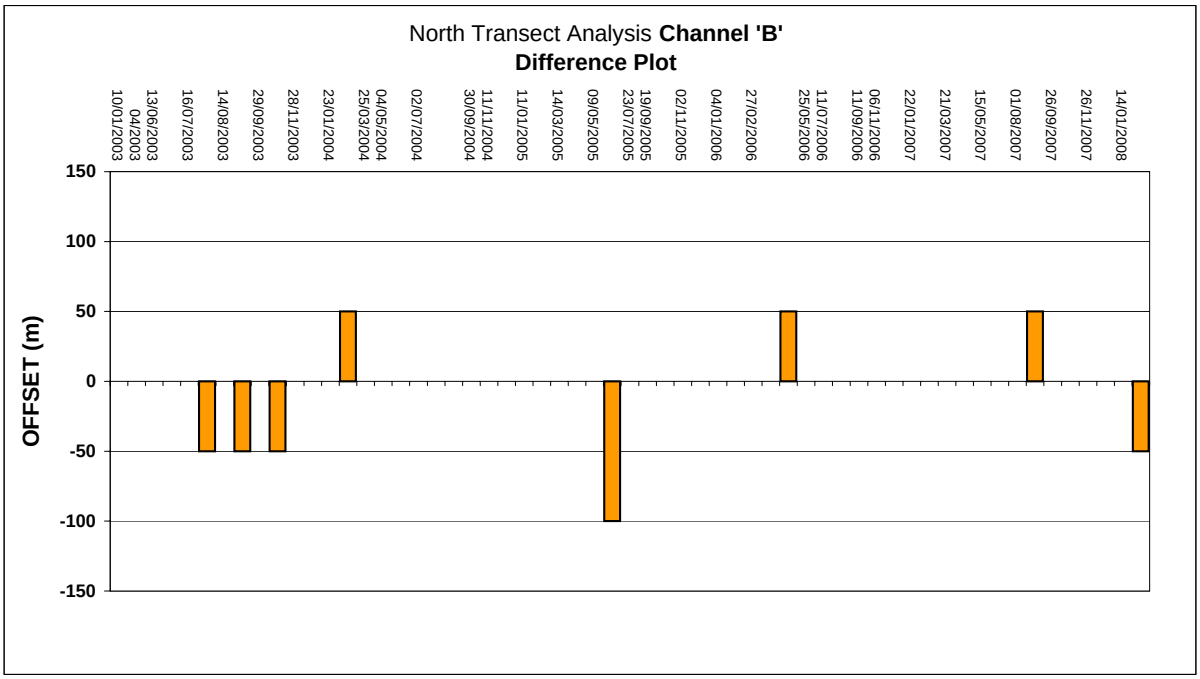

North Transect Analysis **Channel 'C'**
Original 1-Monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

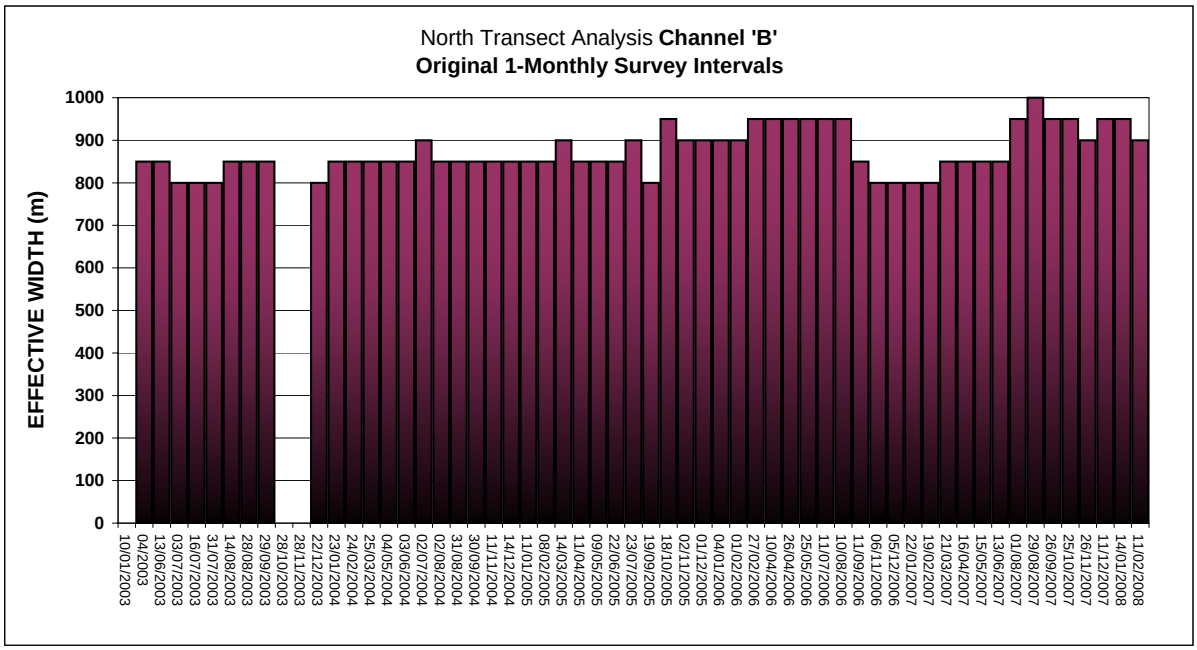

North Transect Analysis **Channel 'C'**
Simulated 2-Monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

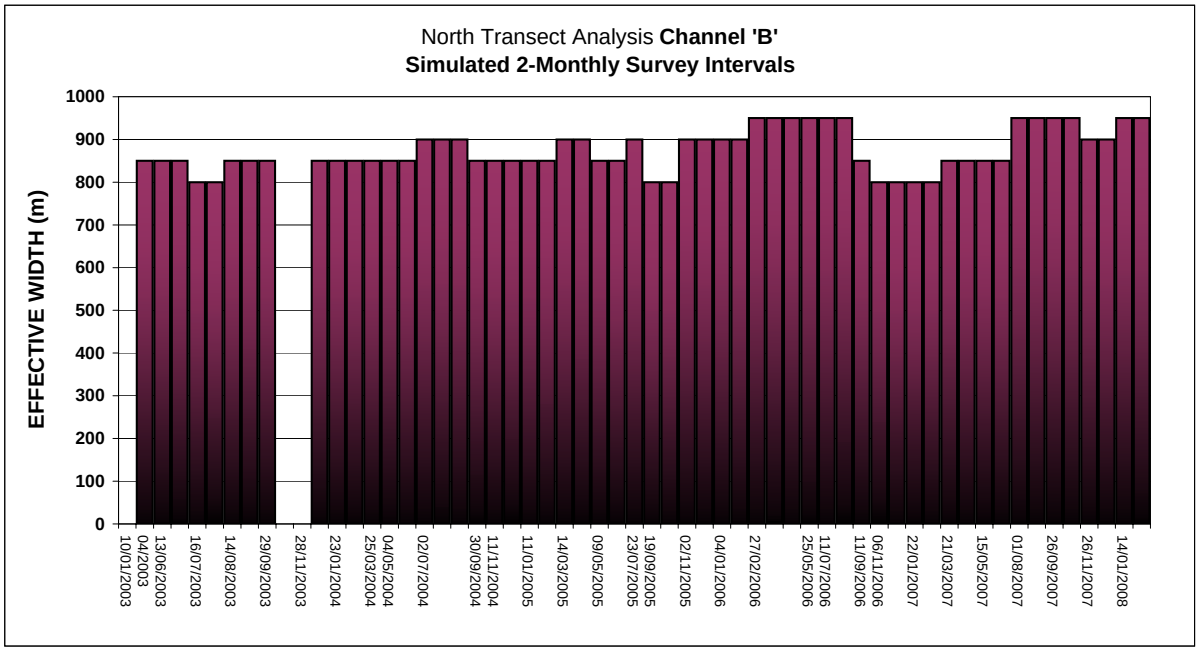

North Transect Analysis **Channel 'C'**
Difference Plot
EFFECTIVE DEPTH (M)
5
4
3
2
1
0
-1
-2
-3
-4
-5
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

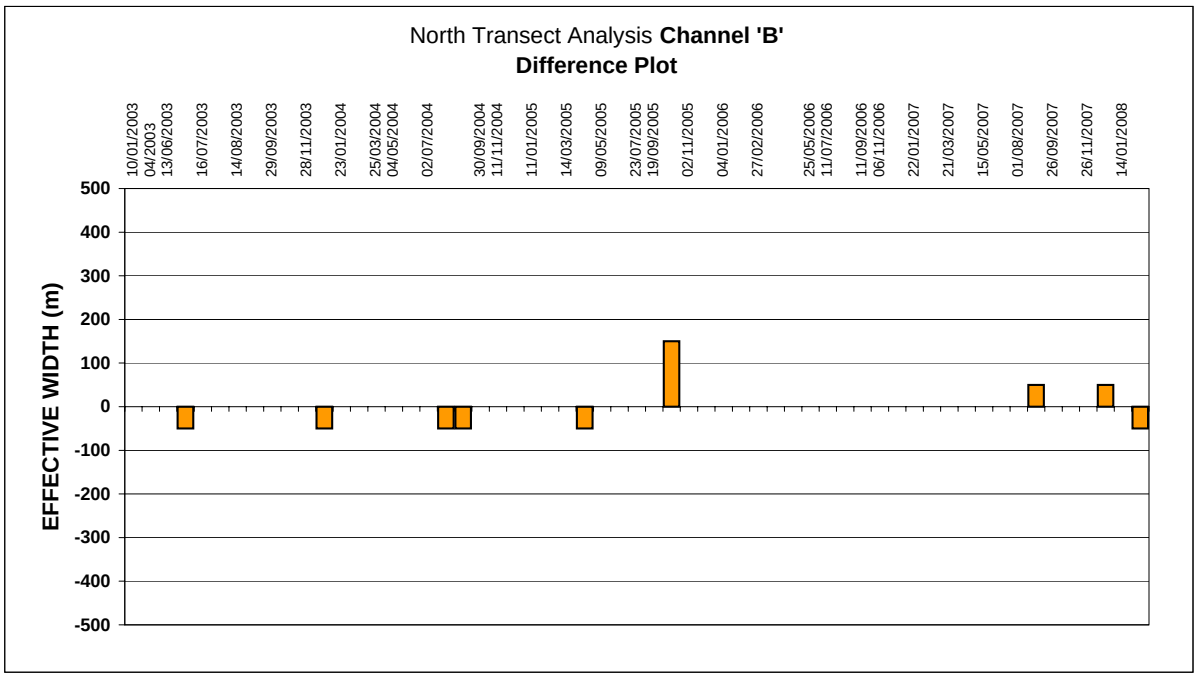

North Transect Analysis **Channel 'B'**
Original 1-monthly Survey Intervals
OFFSET (m)
4800
4750
4700
4650
4600
4550
4500
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

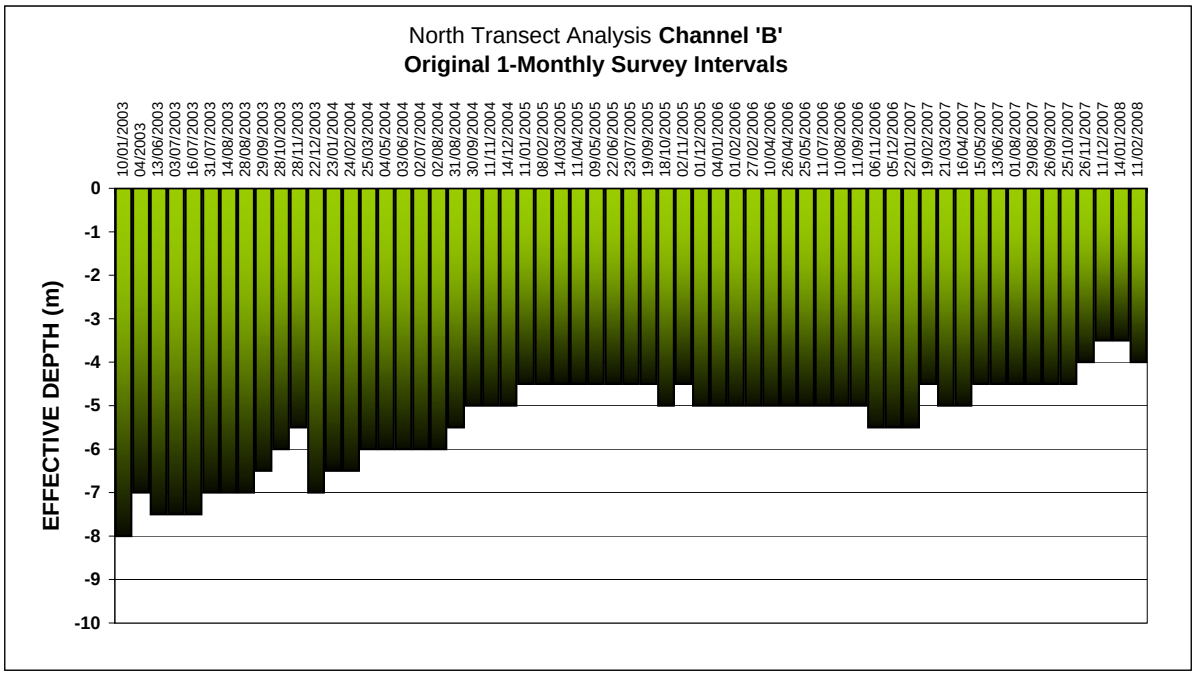

North Transect Analysis **Channel 'B'**
Original 2-monthly Survey Intervals
OFFSET (m)
4800
4750
4700
4650
4600
4550
4500
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

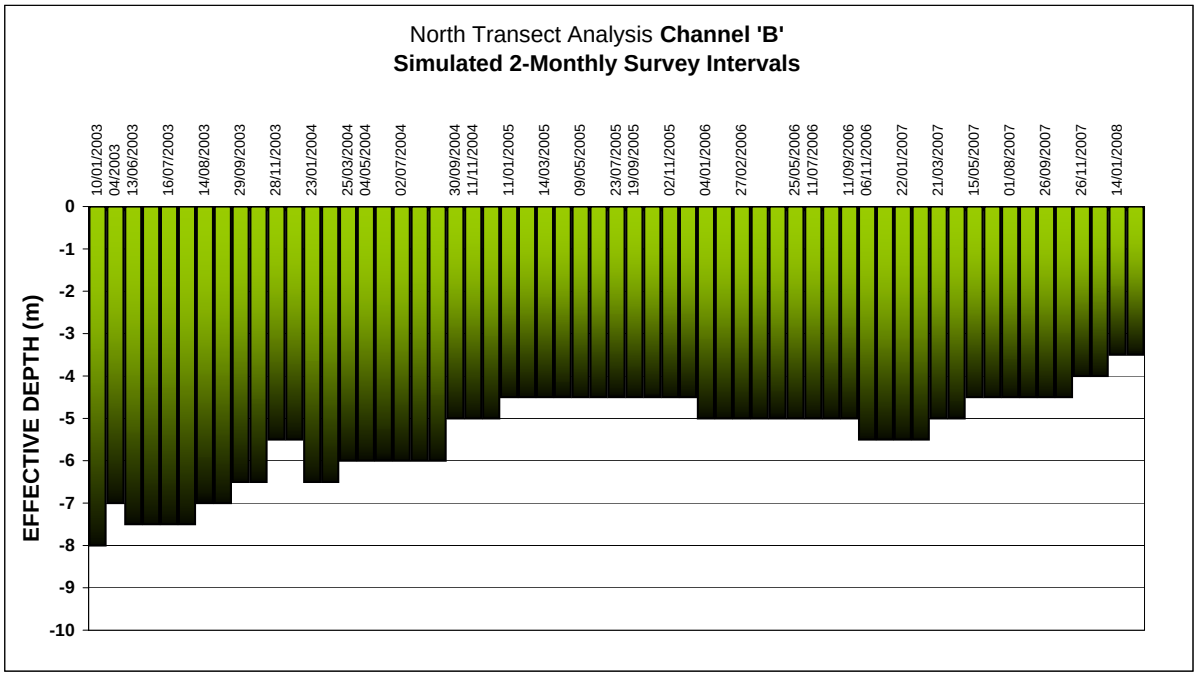

North Transect Analysis **Channel 'B'**
Difference Plot
OFFSET (m)
150
100
50
0
-50
-100
-150
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

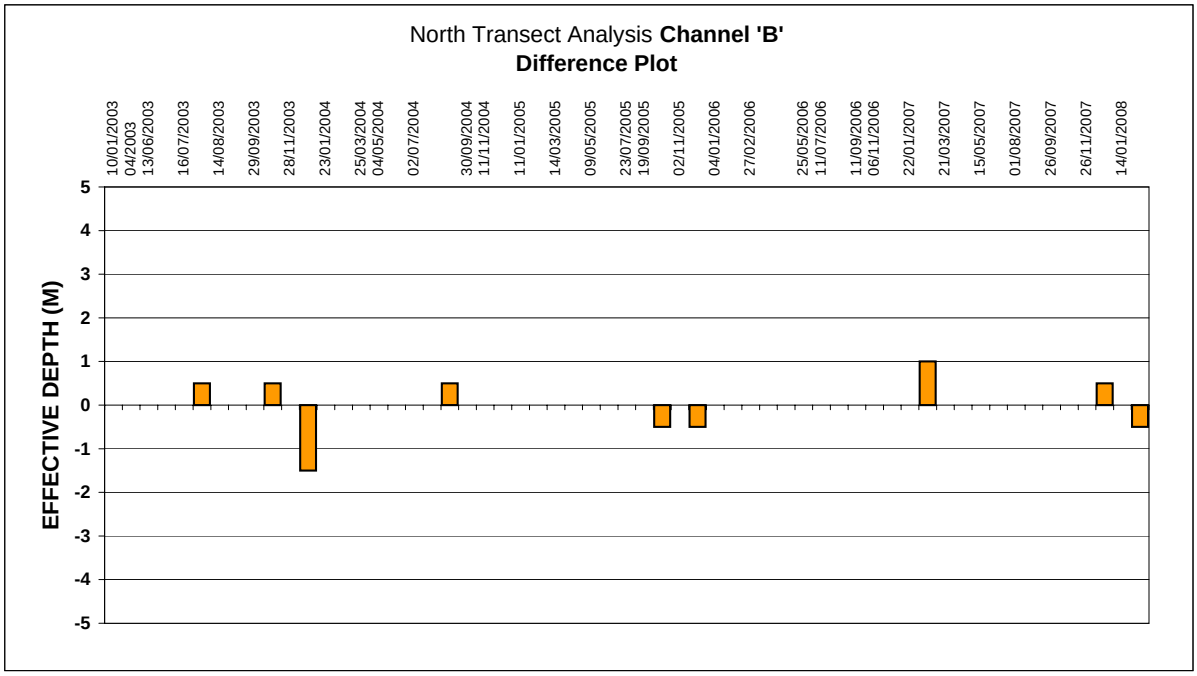

North Transect Analysis **Channel 'B'**
Original 1-Monthly Survey Intervals
EFFECTIVE WIDTH (m)
1000
900
800
700
600
500
400
300
200
100
0
10/01/2003
04/2003
13/06/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

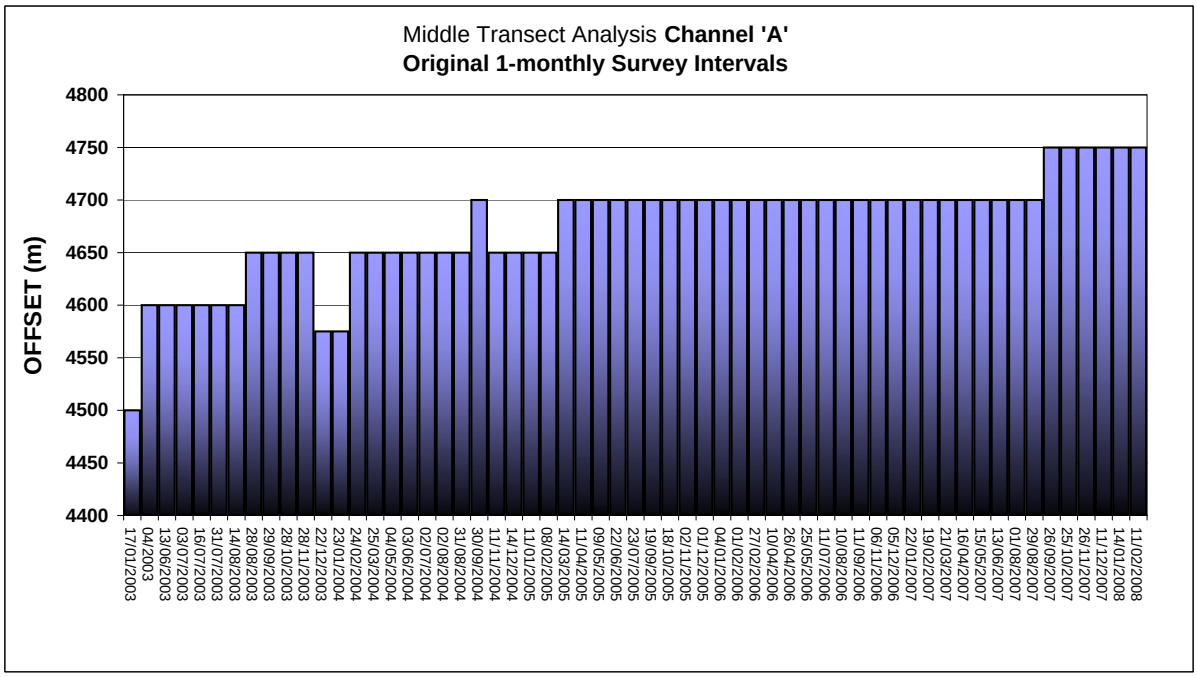

North Transect Analysis **Channel 'B'**
Simulated 2-Monthly Survey Intervals
EFFECTIVE WIDTH (m)
1000
900
800
700
600
500
400
300
200
100
0
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

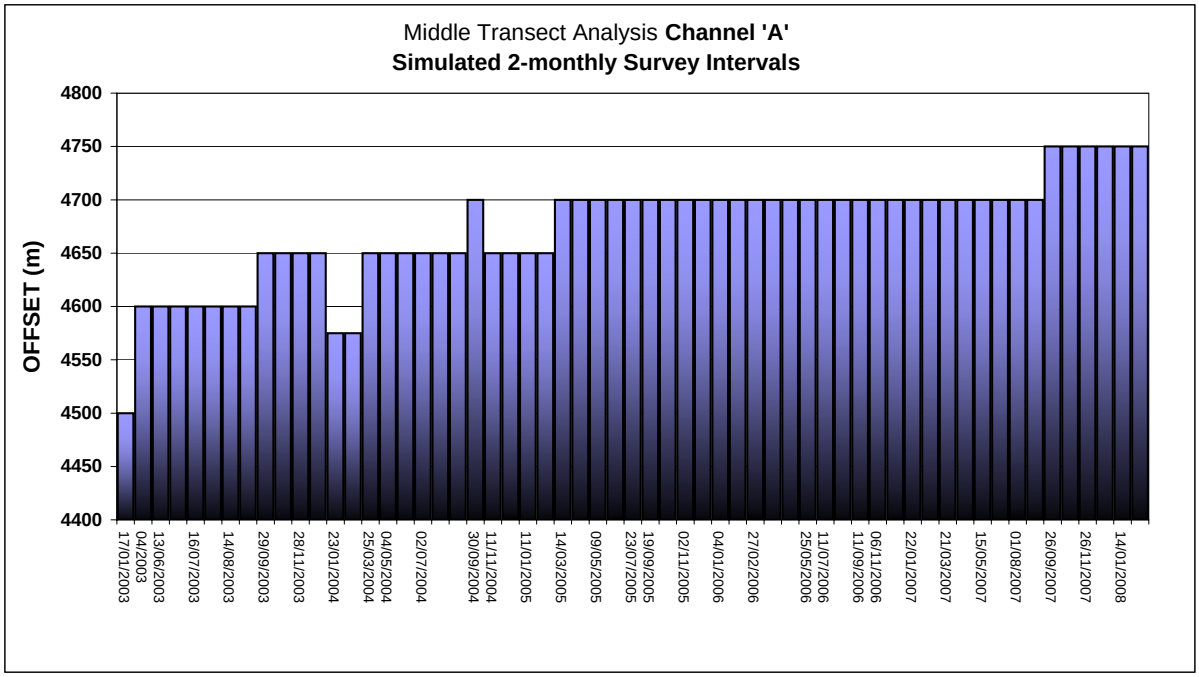

North Transect Analysis **Channel 'B'**
Difference Plot
EFFECTIVE WIDTH (m)
500
400
300
200
100
0
-100
-200
-300
-400
-500
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

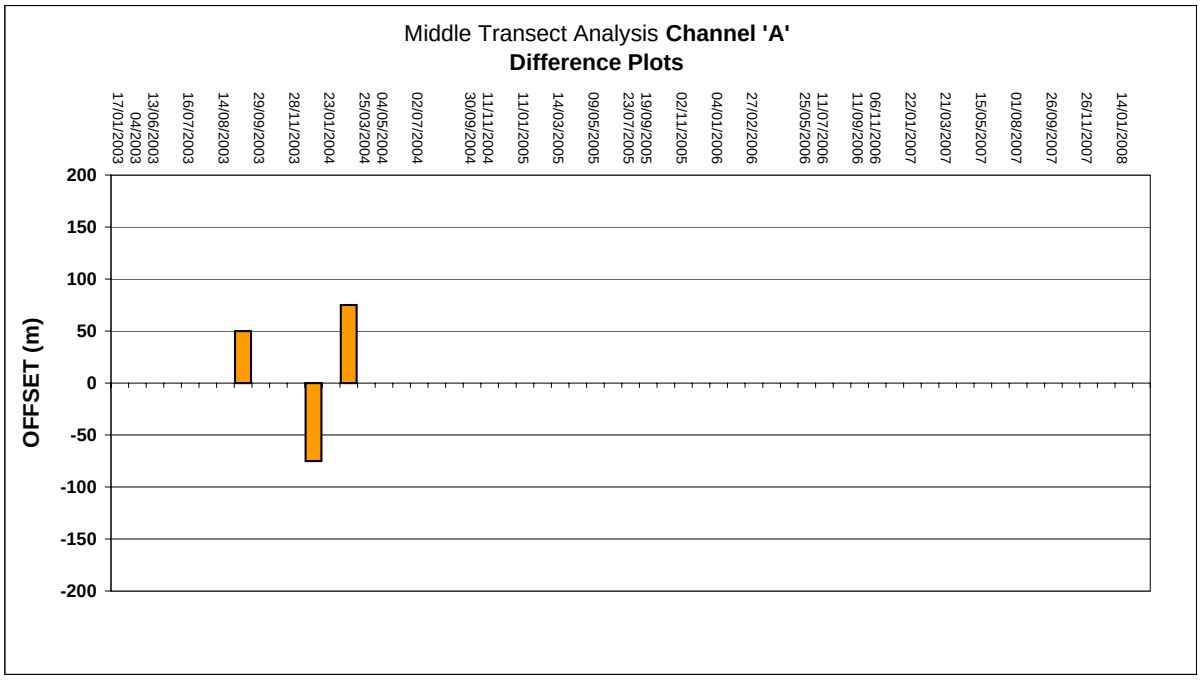

North Transect Analysis **Channel 'B'**
Original 1-Monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

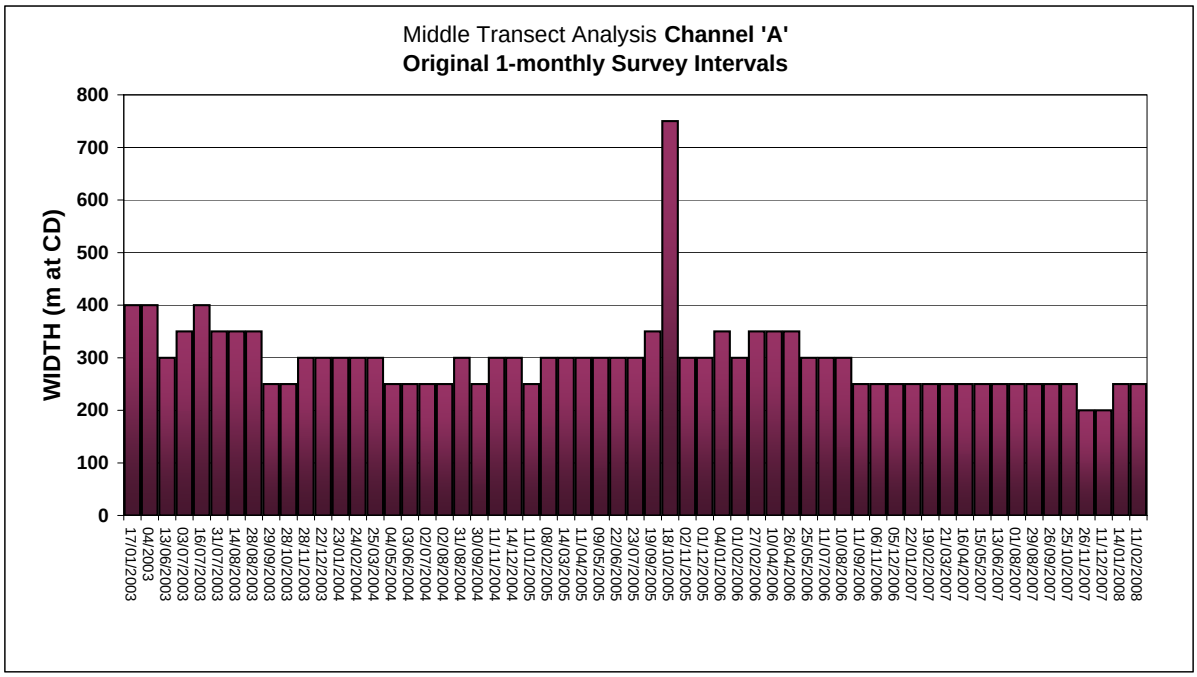

North Transect Analysis **Channel 'B'**
Simulated 2-Monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

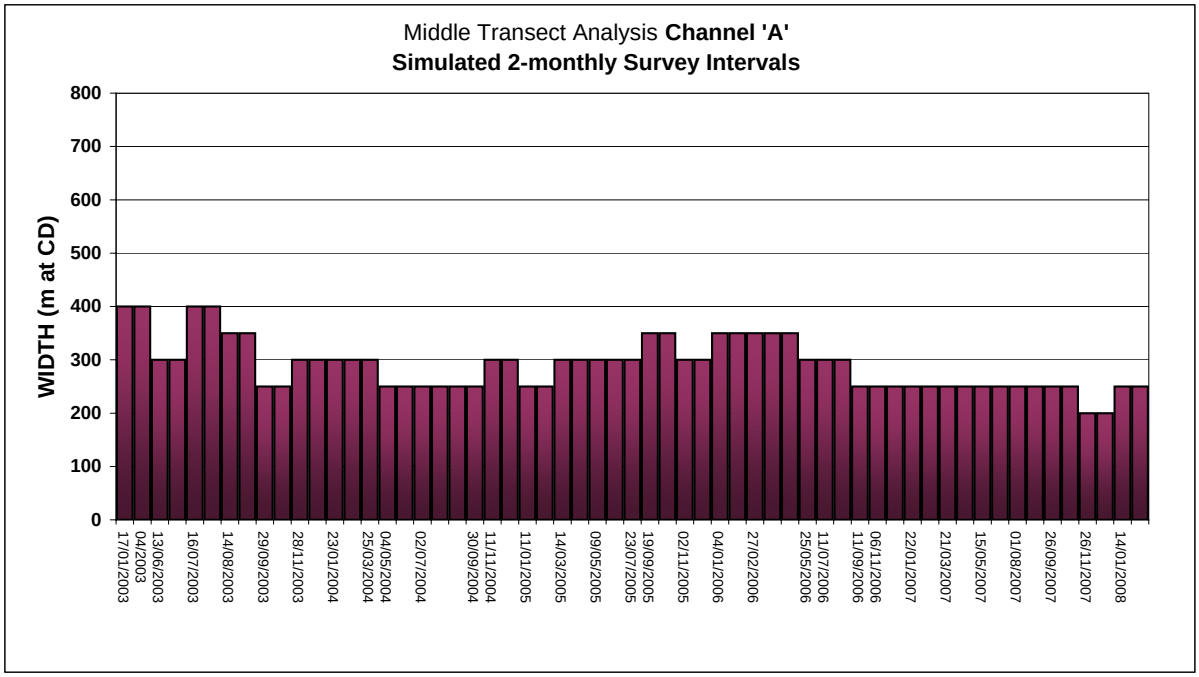

North Transect Analysis **Channel 'B'**
Difference Plot
EFFECTIVE DEPTH (M)
5
4
3
2
1
0
-1
-2
-3
-4
-5
10/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/1/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

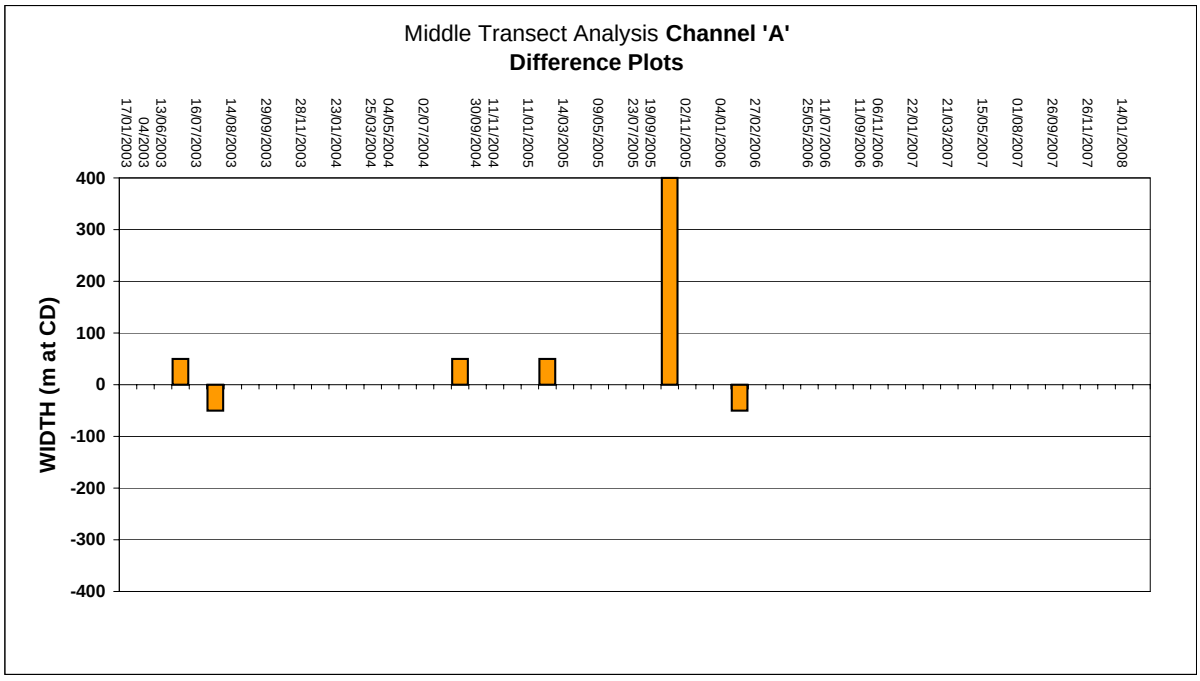

Middle Transect Analysis **Channel 'A'**
Original 1-monthly Survey Intervals
OFFSET (m)
4800
4750
4700
4650
4600
4550
4500
4450
4400
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

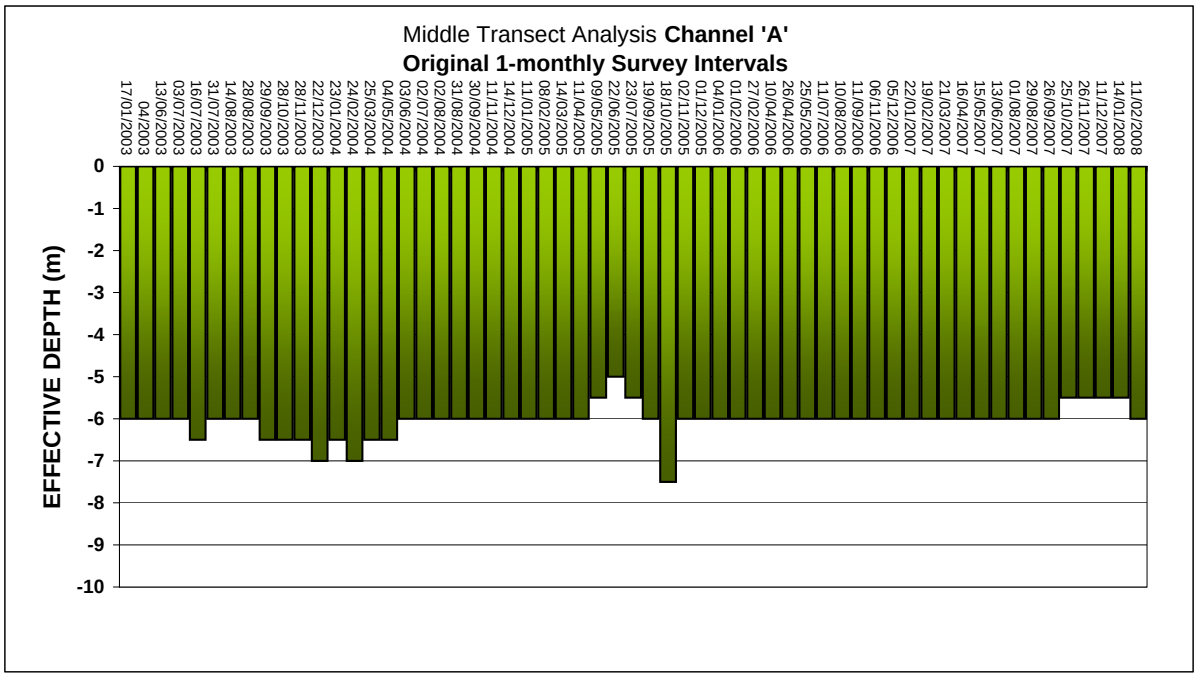

Middle Transect Analysis **Channel 'A'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
4800
4750
4700
4650
4600
4550
4500
4450
4400
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

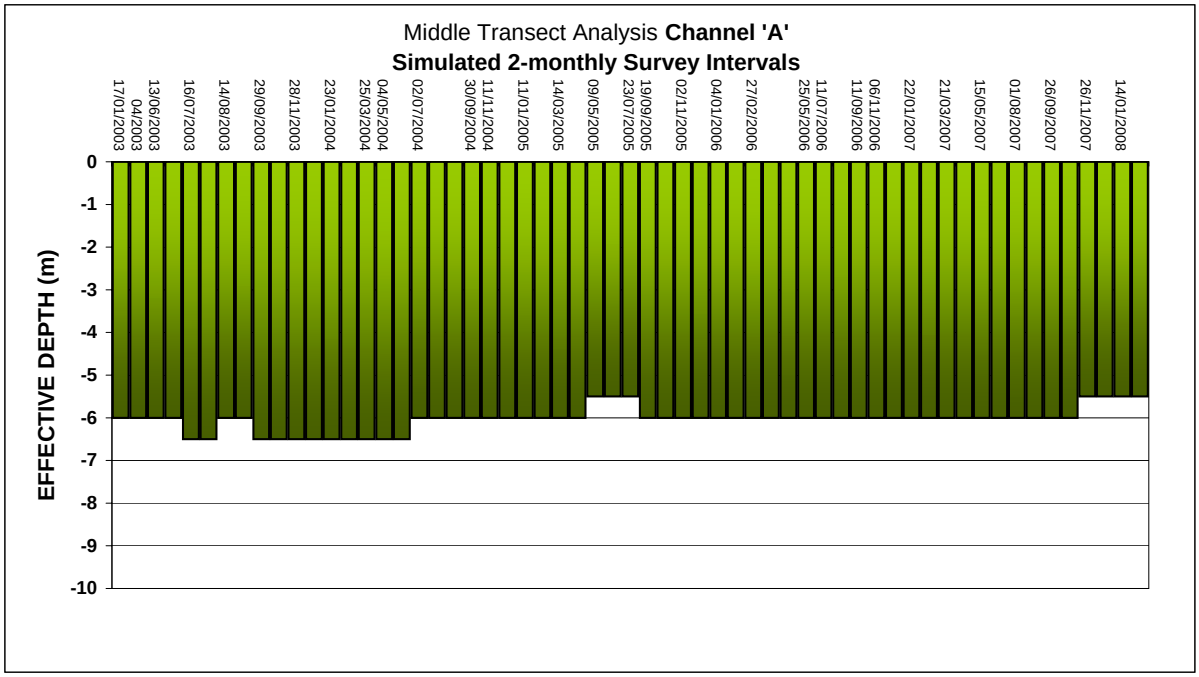

Middle Transect Analysis **Channel 'A'**
Difference Plots
OFFSET (m)
200
150
100
50
0
-50
-100
-150
-200
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

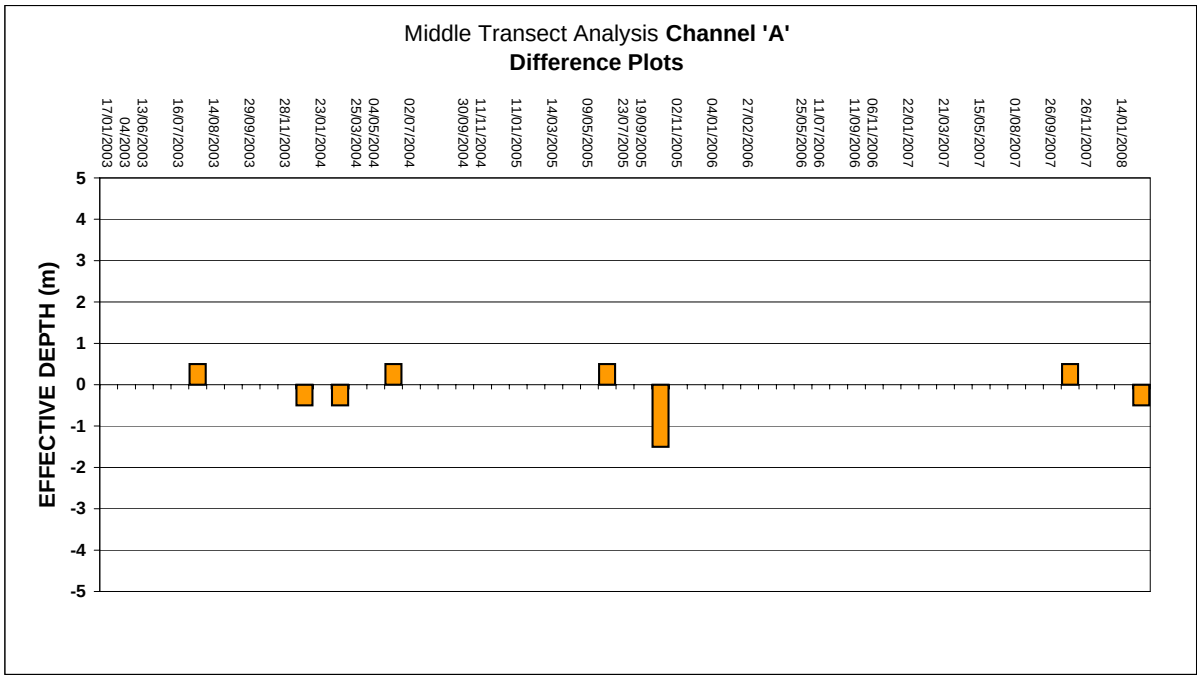

Middle Transect Analysis **Channel 'A'**
Original 1-monthly Survey Intervals
WIDTH (m at CD)
800
700
600
500
400
300
200
100
0
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

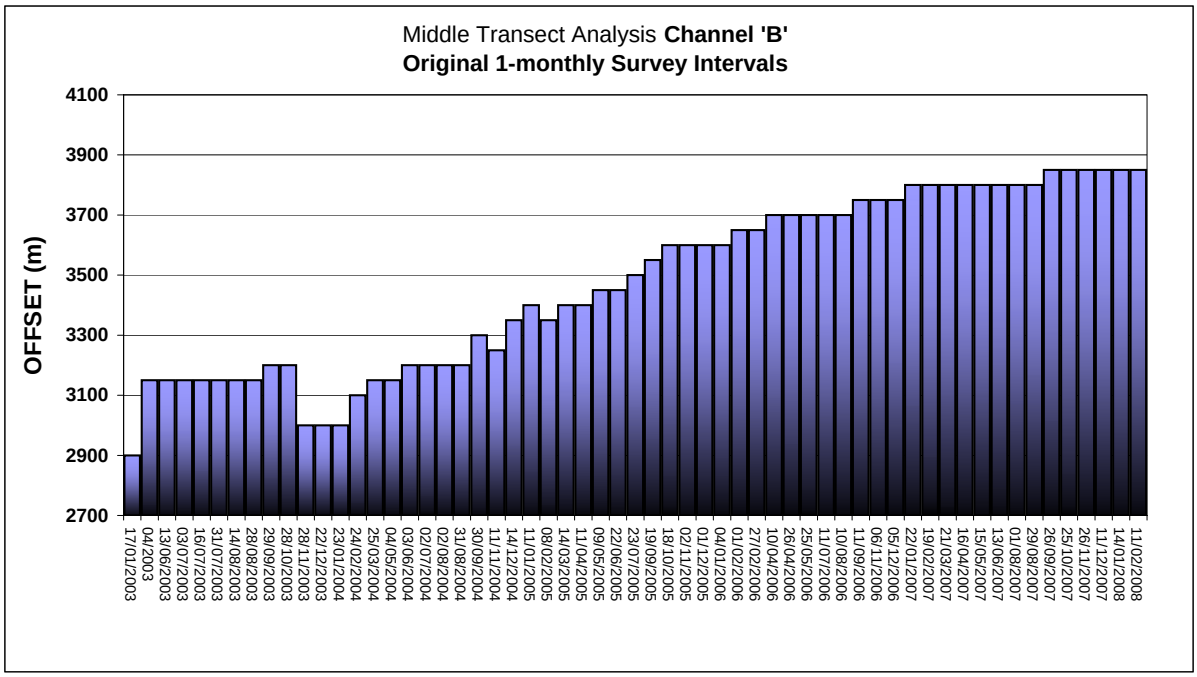

Middle Transect Analysis **Channel 'A'**
Simulated 2-monthly Survey Intervals
WIDTH (m at CD)
800
700
600
500
400
300
200
100
0
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

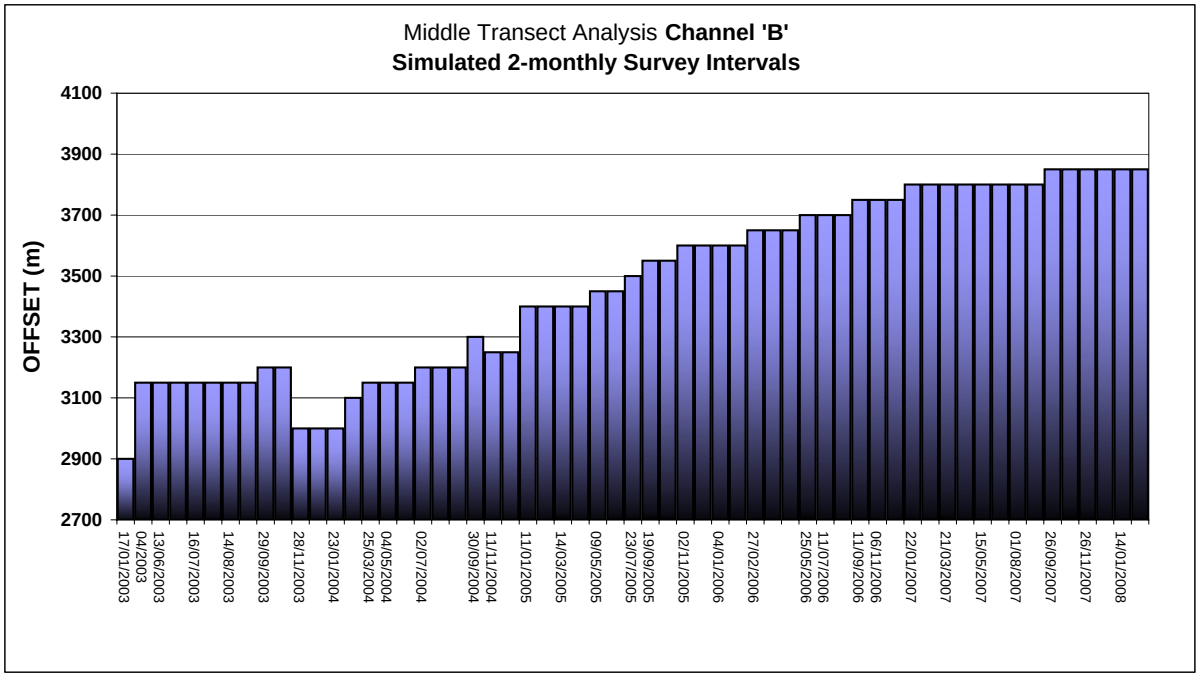

Middle Transect Analysis **Channel 'A'**
Difference Plots
WIDTH (m at CD)
400
300
200
100
0
-100
-200
-300
-400
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

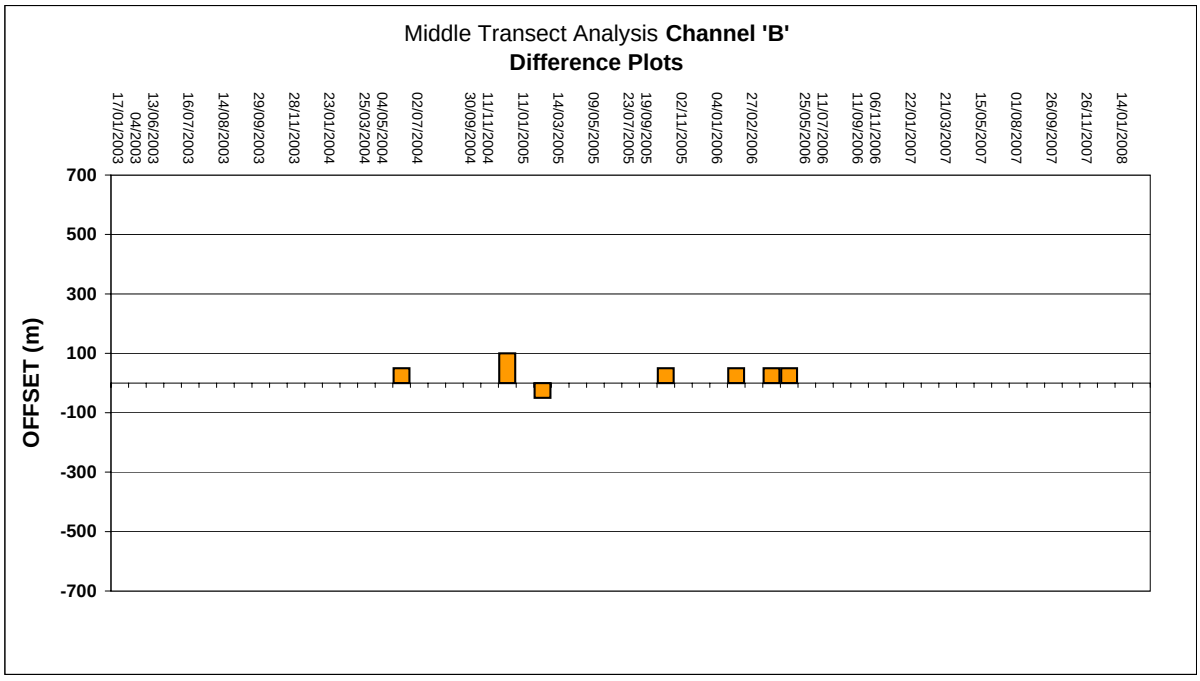

Middle Transect Analysis **Channel 'A'**
Original 1-monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

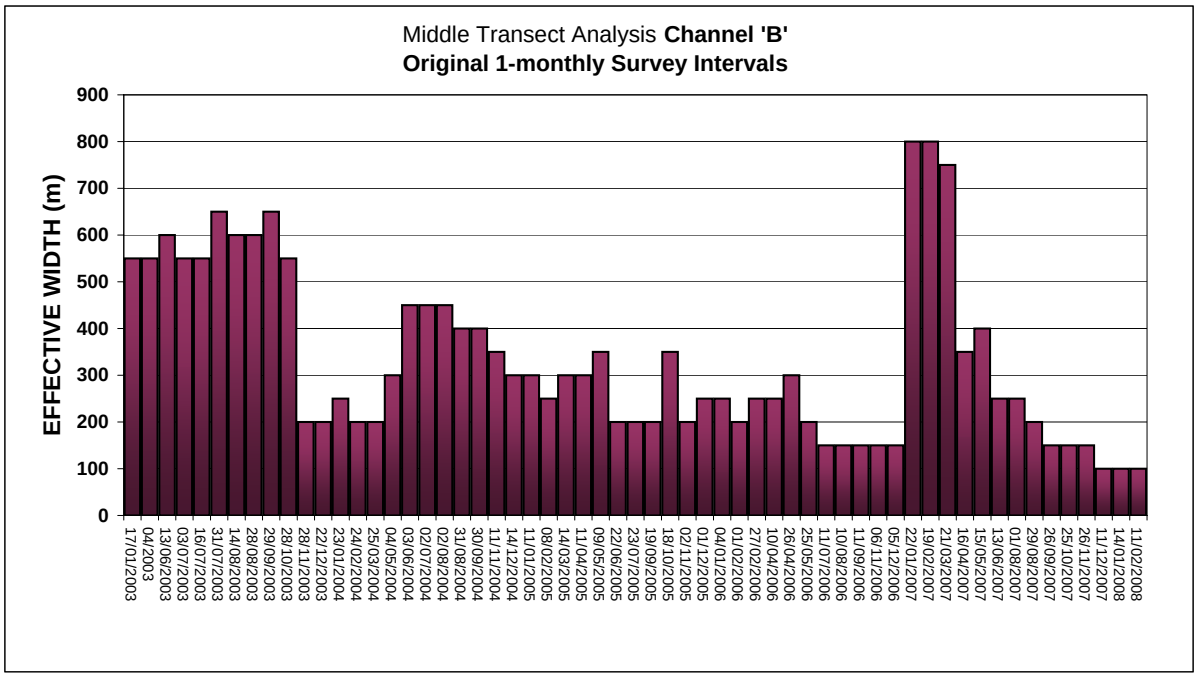

Middle Transect Analysis **Channel 'A'**
Simulated 2-monthly Survey Intervals
EFFECTIVE DEPTH (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

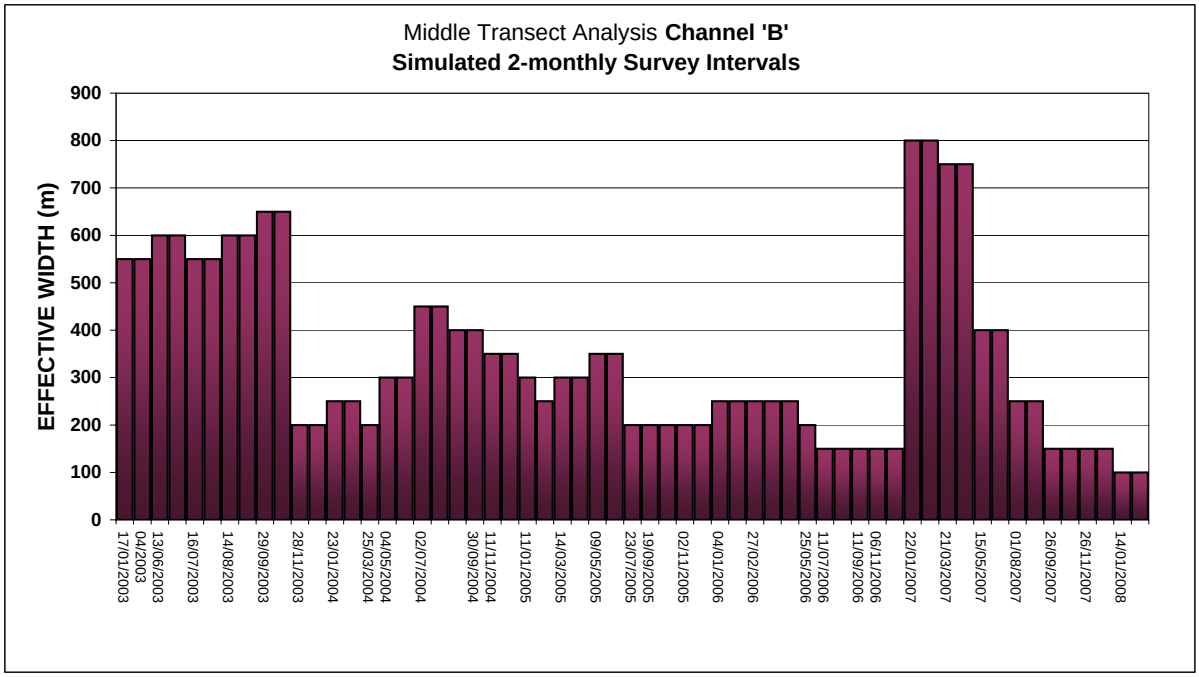

Middle Transect Analysis **Channel 'A'**
Difference Plots
EFFECTIVE DEPTH (m)
5
4
3
2
1
0
-1
-2
-3
-4
-5
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

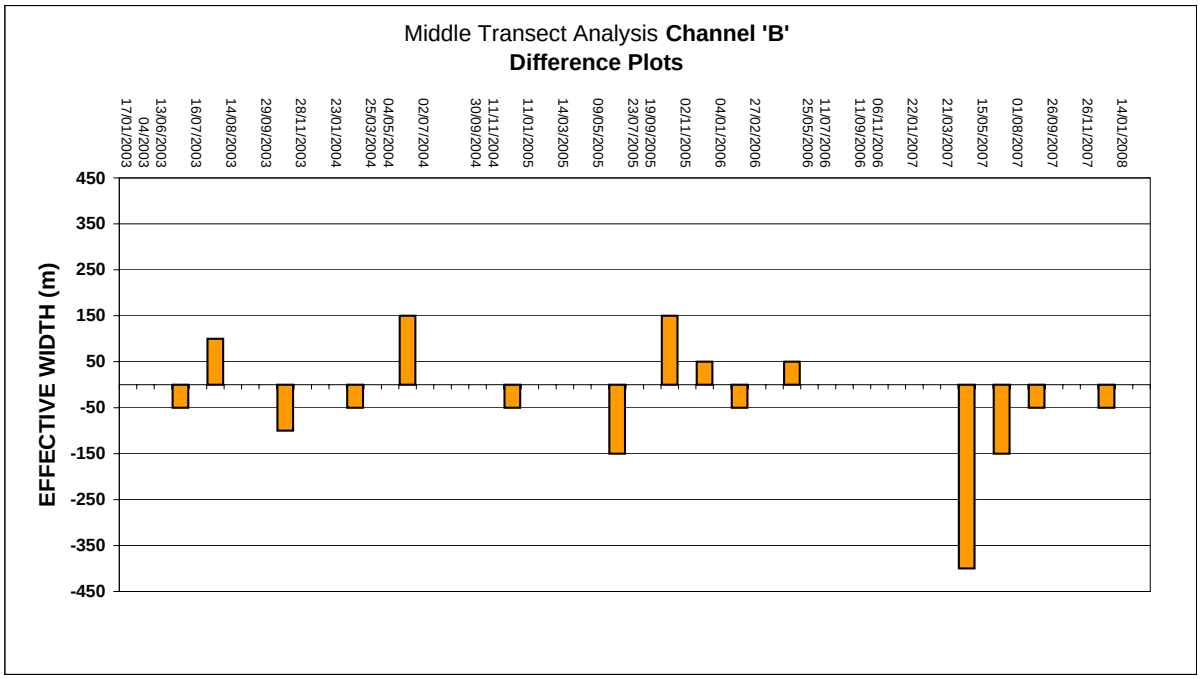

Middle Transect Analysis **Channel 'B'**
Original 1-monthly Survey Intervals
OFFSET (m)
4100
3900
3700
3500
3300
3100
2900
2700
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

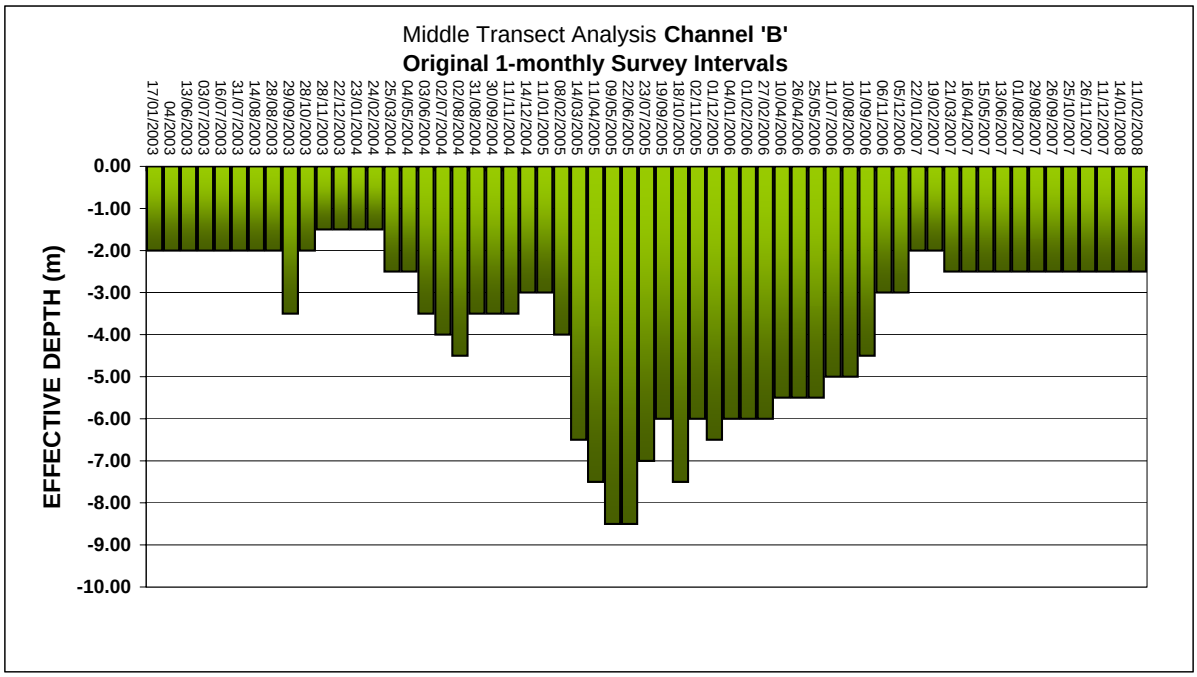

Middle Transect Analysis **Channel 'B'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
4100
3900
3700
3500
3300
3100
2900
2700
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

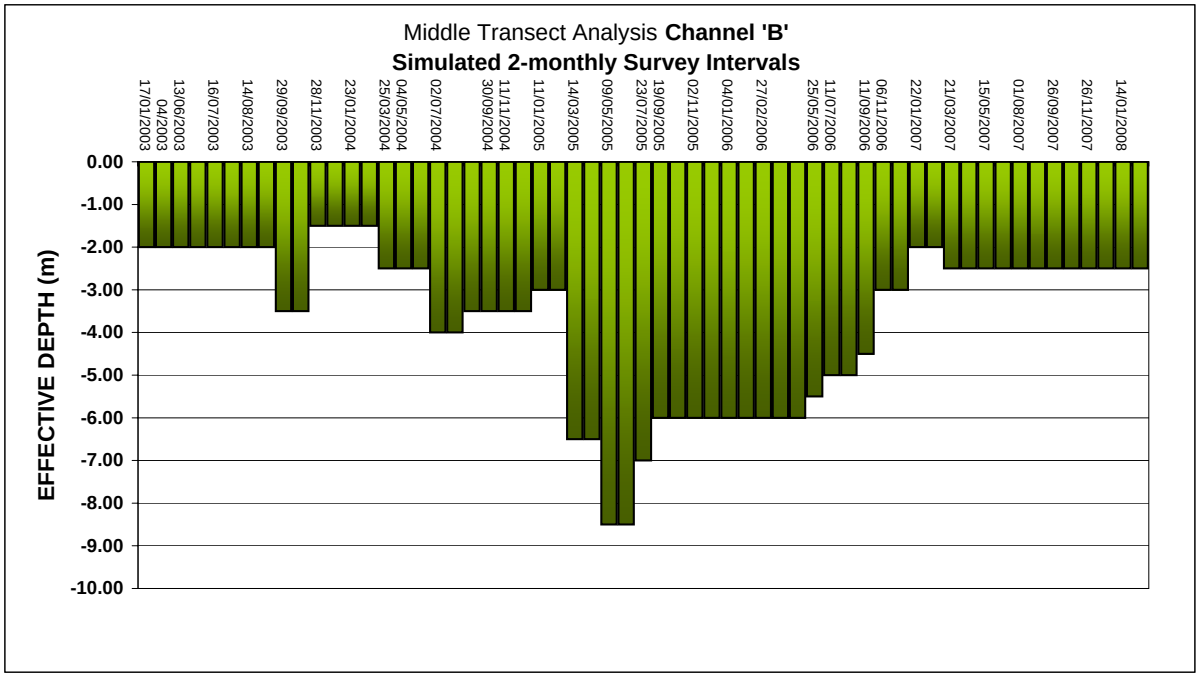

Middle Transect Analysis **Channel 'B'**
Difference Plots
OFFSET (m)
700
500
300
100
-100
-300
-500
-700
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

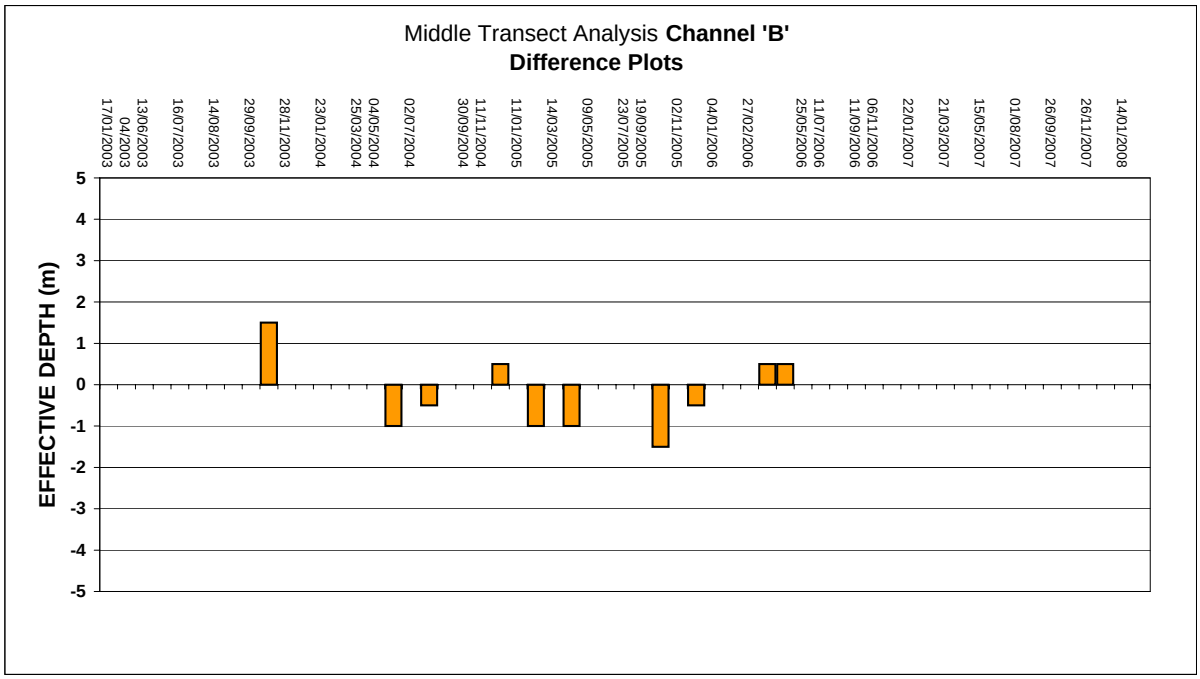

Middle Transect Analysis **Channel 'B'**
Original 1-monthly Survey Intervals
EFFECTIVE WIDTH (m)
0
100
200
300
400
500
600
700
800
900
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
01/02/2006
04/01/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

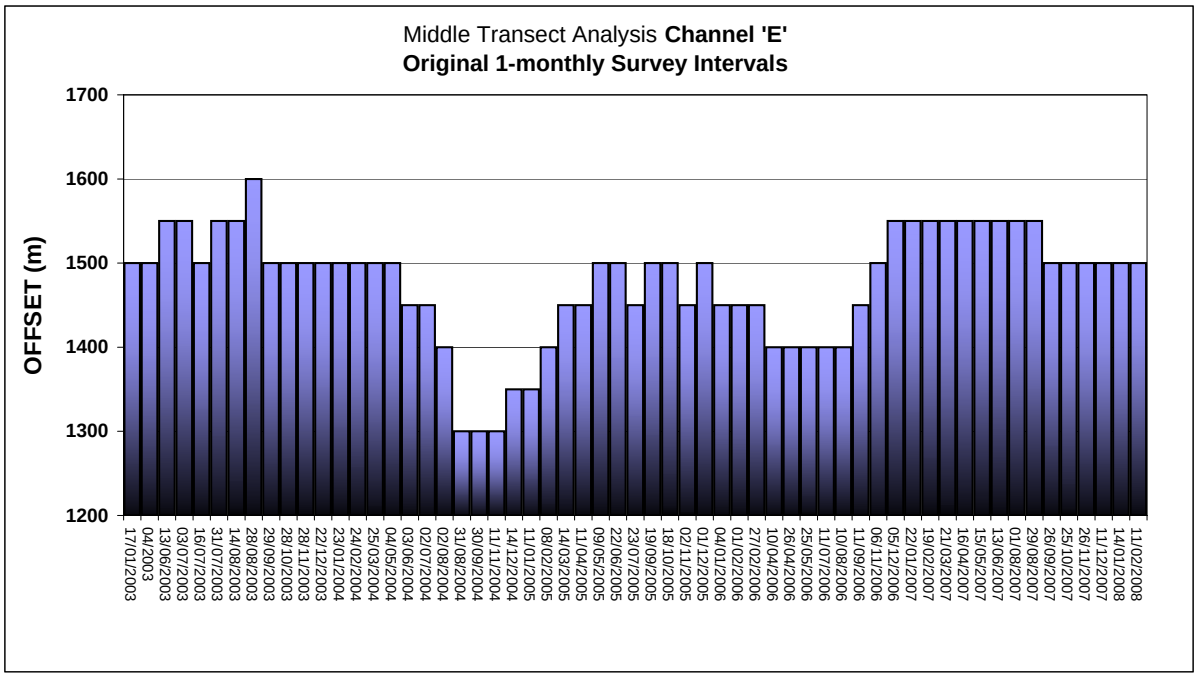

Middle Transect Analysis **Channel 'B'**
Simulated 2-monthly Survey Intervals
EFFECTIVE WIDTH (m)
0
100
200
300
400
500
600
700
800
900
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

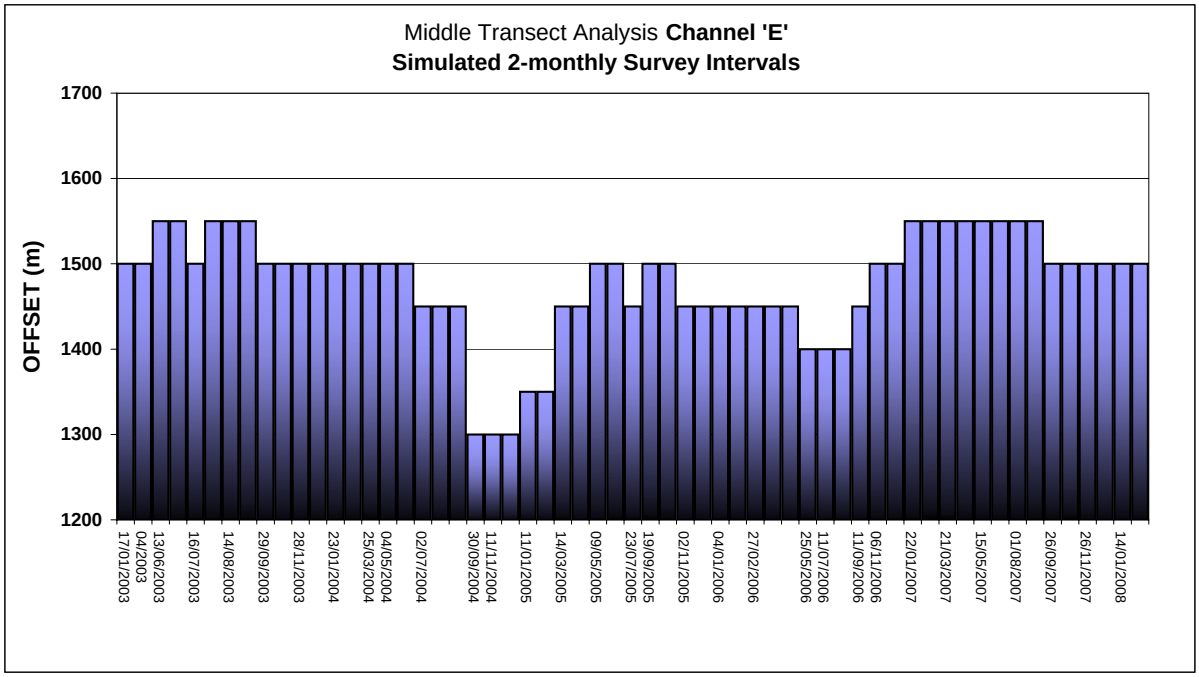

Middle Transect Analysis **Channel 'B'**
Difference Plots
EFFECTIVE WIDTH (m)
-450
-350
-250
-150
-50
50
150
250
350
450
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

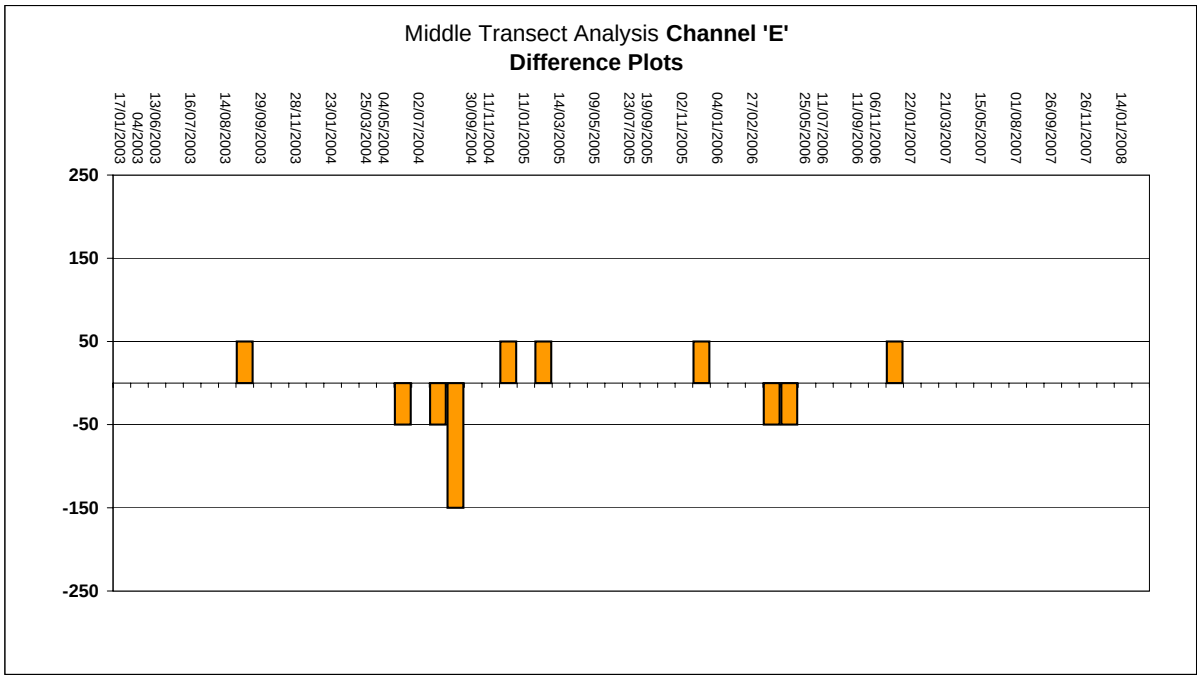

Middle Transect Analysis **Channel 'B'**
Original 1-monthly Survey Intervals
EFFECTIVE DEPTH (m)
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

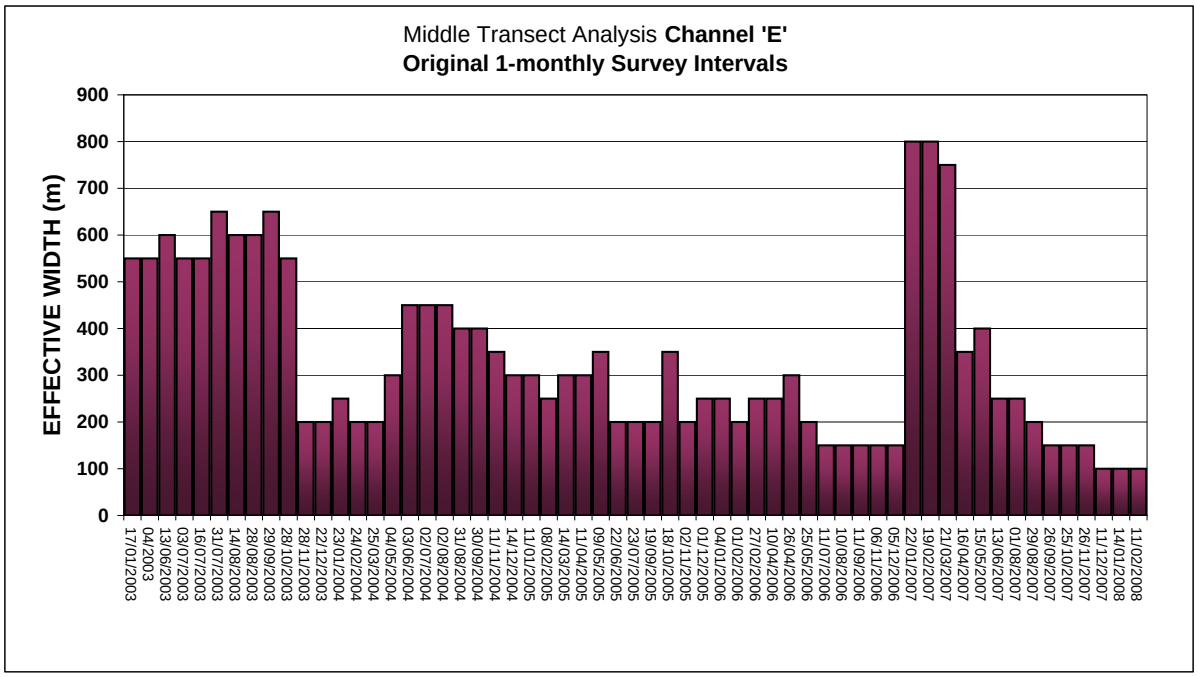

Middle Transect Analysis **Channel 'B'**
Simulated 2-monthly Survey Intervals
EFFECTIVE DEPTH (m)
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008


Middle Transect Analysis **Channel 'B'**
Difference Plots
EFFECTIVE DEPTH (m)
5
4
3
2
1
0
-1
-2
-3
-4
-5
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008


Middle Transect Analysis **Channel 'E'**
Original 1-monthly Survey Intervals
OFFSET (m)
1700
1600
1500
1400
1300
1200
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008


Middle Transect Analysis **Channel 'E'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
1700
1600
1500
1400
1300
1200
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008


Middle Transect Analysis **Channel 'E'**
Difference Plots
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008
250
150
50
-50
-150
-250


Middle Transect Analysis **Channel 'E'**
Original 1-monthly Survey Intervals
EFFECTIVE WIDTH (m)
900
800
700
600
500
400
300
200
100
0
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
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08/02/2005
14/03/2005
11/04/2005
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22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
01/02/2006
04/01/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
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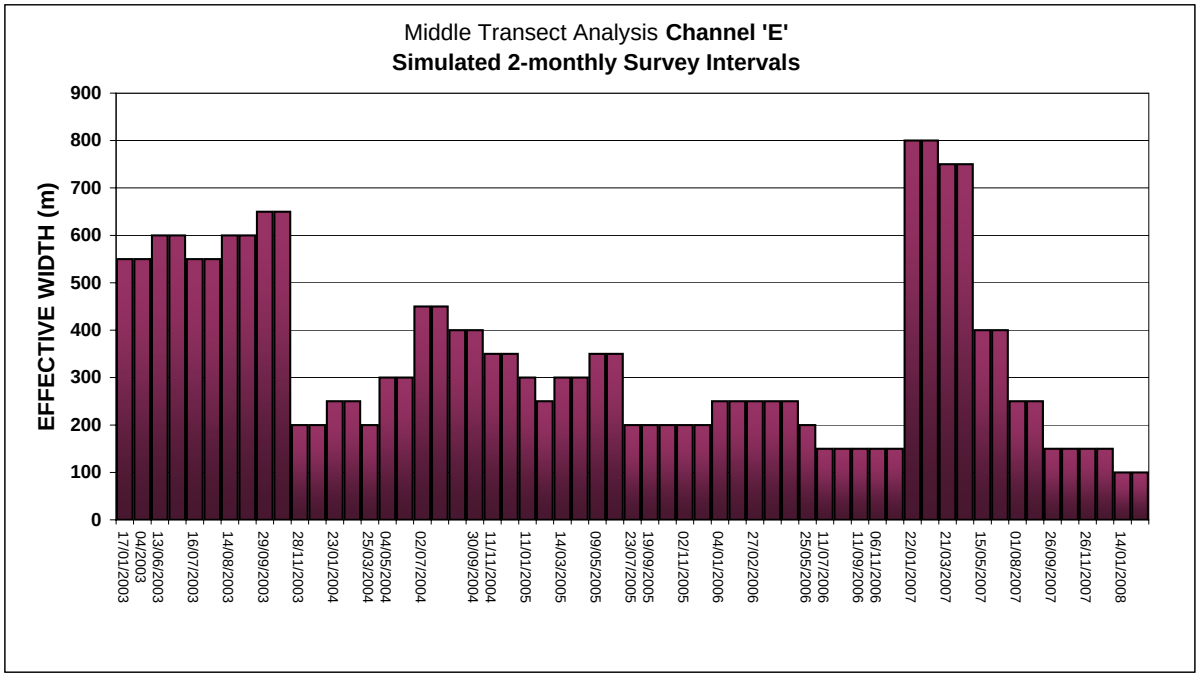
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008


Middle Transect Analysis **Channel 'E'**
Simulated 2-monthly Survey Intervals
EFFECTIVE WIDTH (m)
900
800
700
600
500
400
300
200
100
0
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
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11/01/2005
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23/07/2005
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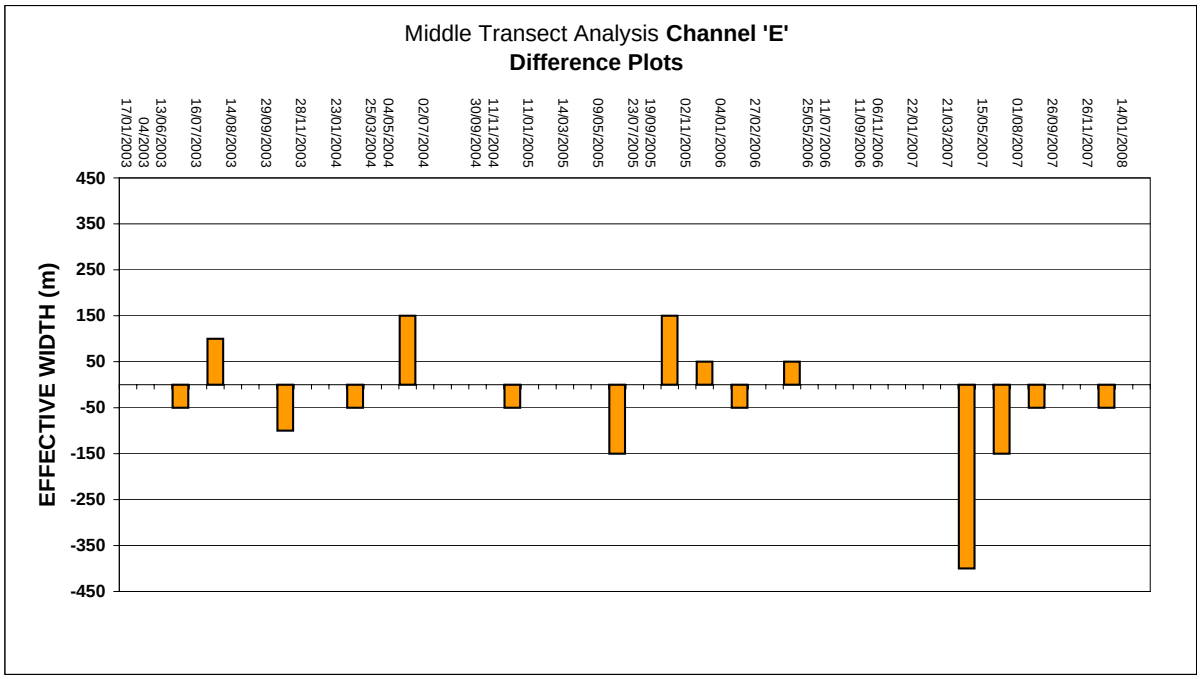
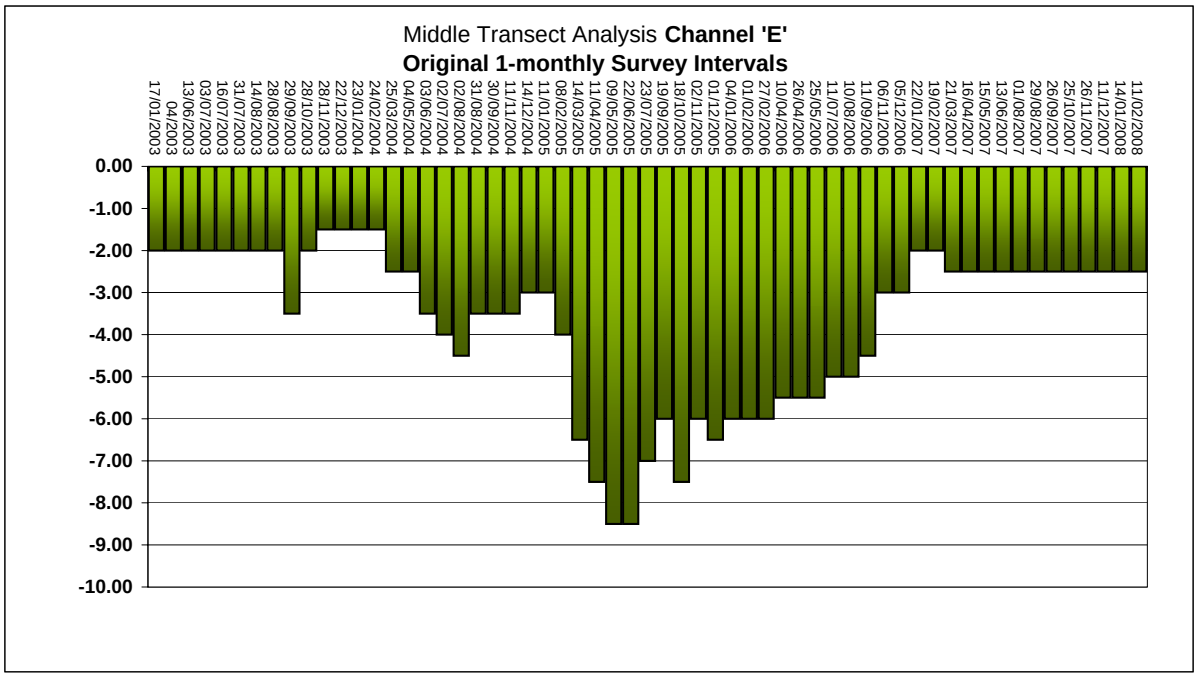
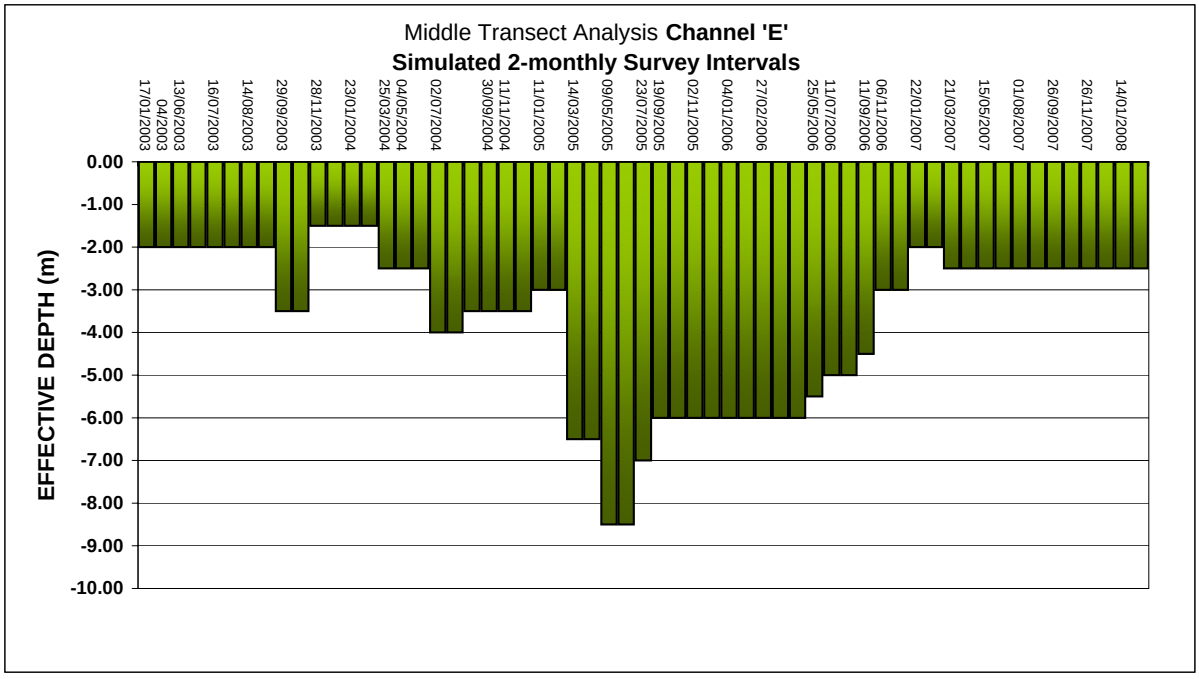
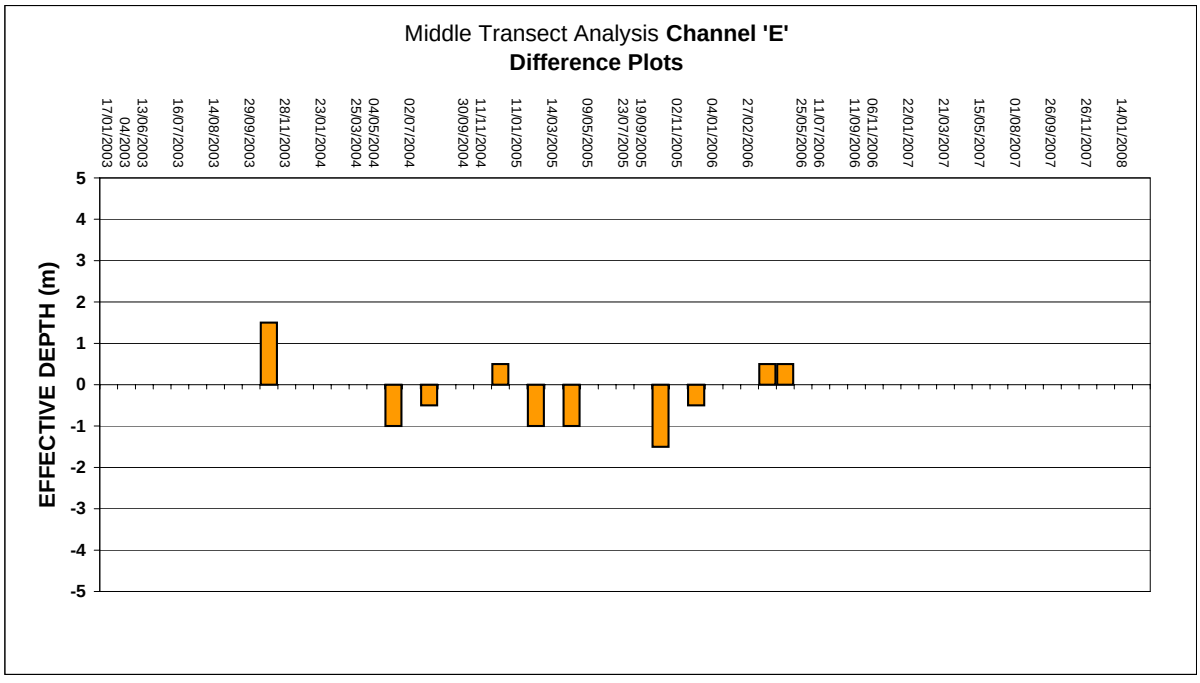
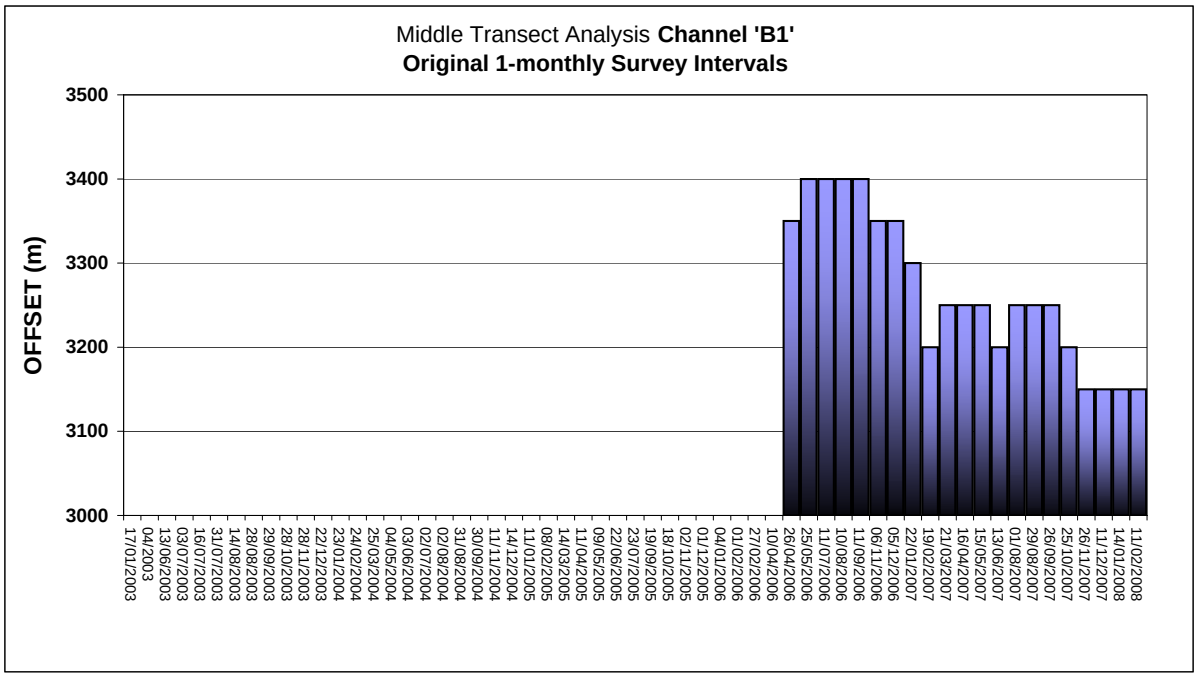
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

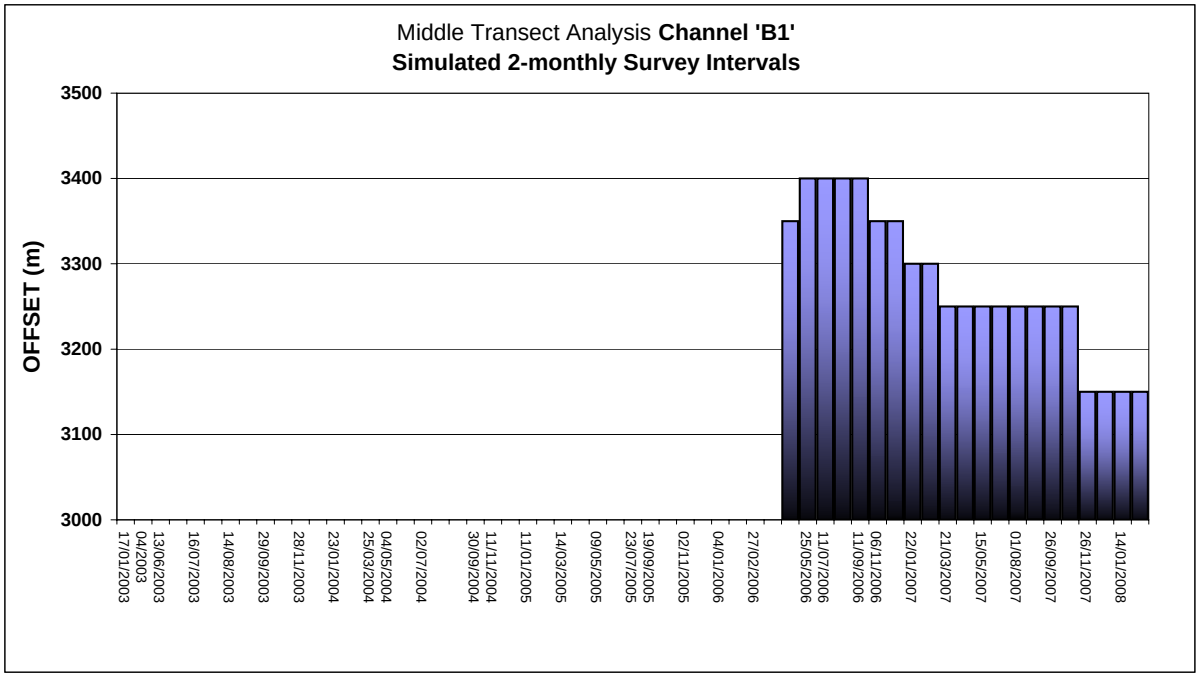

Middle Transect Analysis **Channel 'E'**
Difference Plots
EFFECTIVE WIDTH (m)
450
350
250
150
50
-50
-150
-250
-350
-450
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

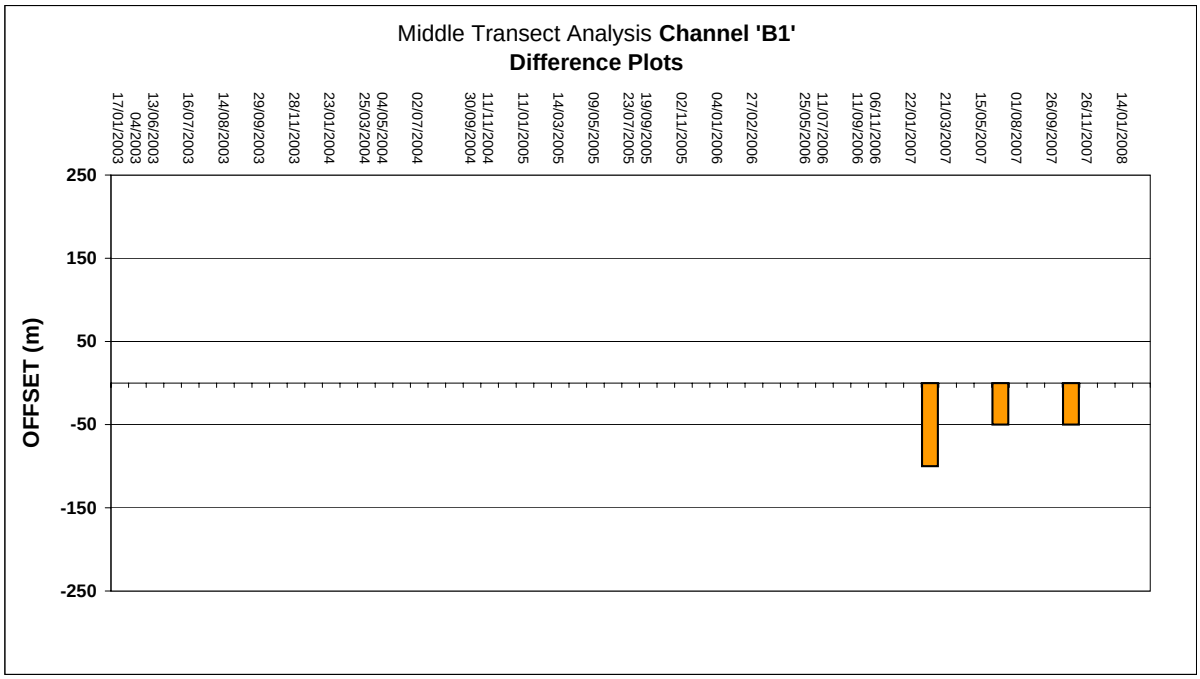

Middle Transect Analysis **Channel 'E'**
Original 1-monthly Survey Intervals
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00

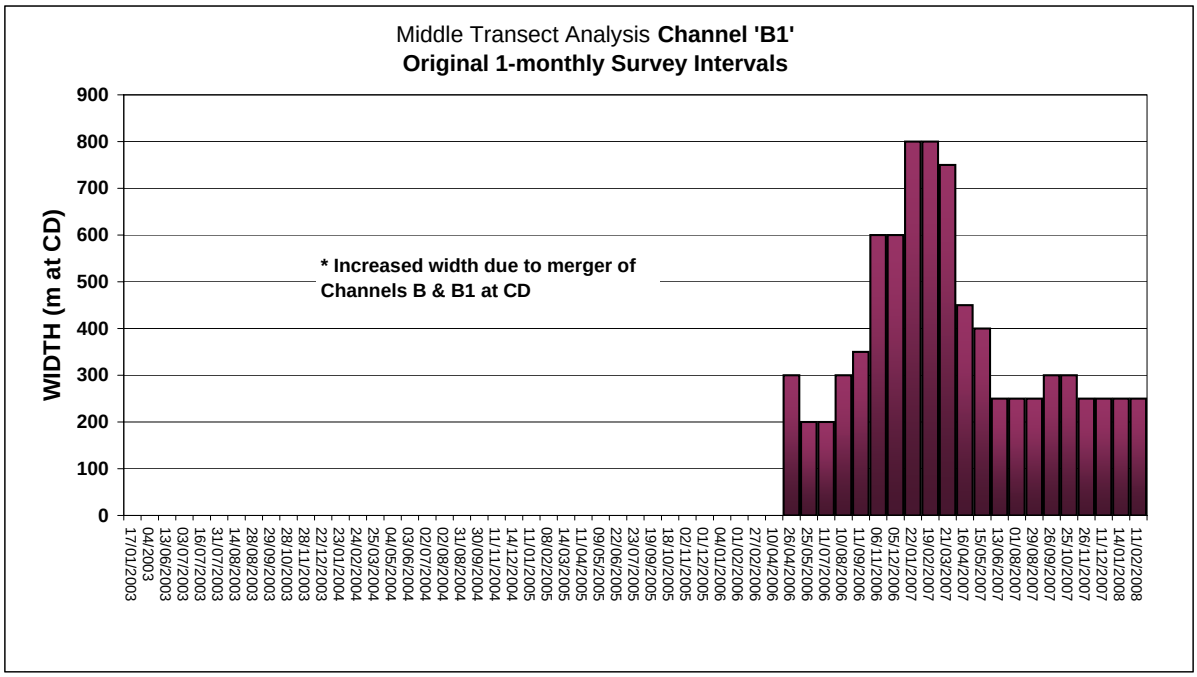

Middle Transect Analysis **Channel 'E'**
Simulated 2-monthly Survey Intervals
EFFECTIVE DEPTH (m)
17/01/2003
13/06/2003
04/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00

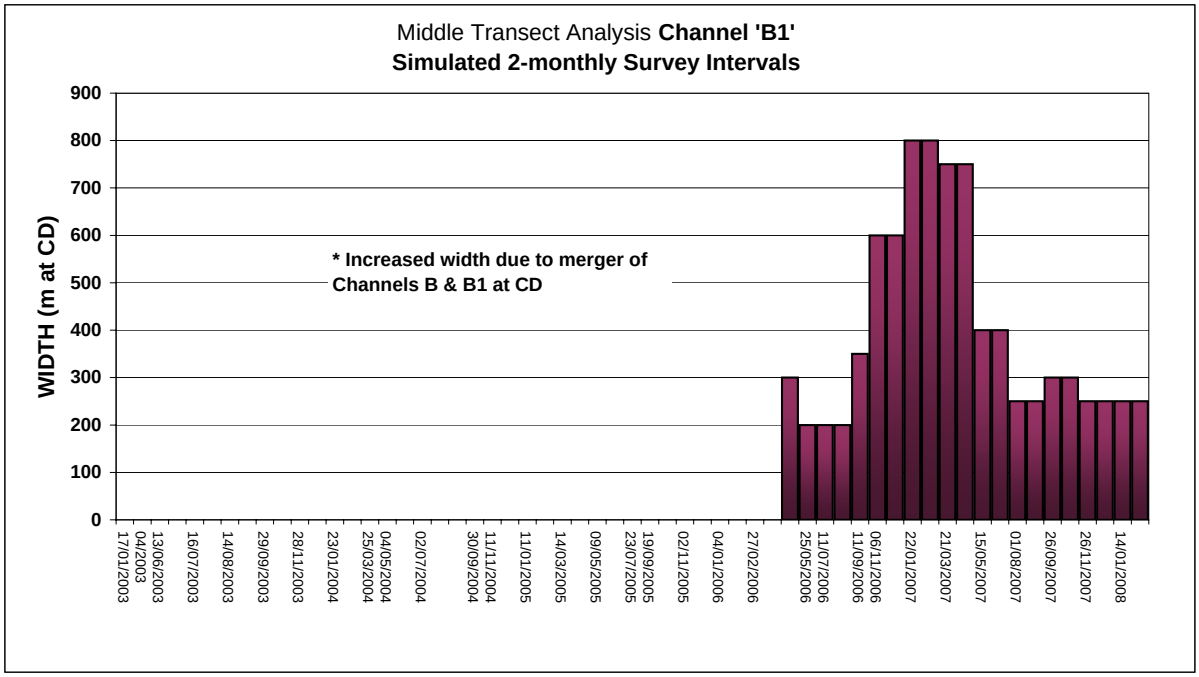

Middle Transect Analysis **Channel 'E'**
Difference Plots
EFFECTIVE DEPTH (m)
17/01/2003
13/06/2003
04/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008
5
4
3
2
1
0
-1
-2
-3
-4
-5

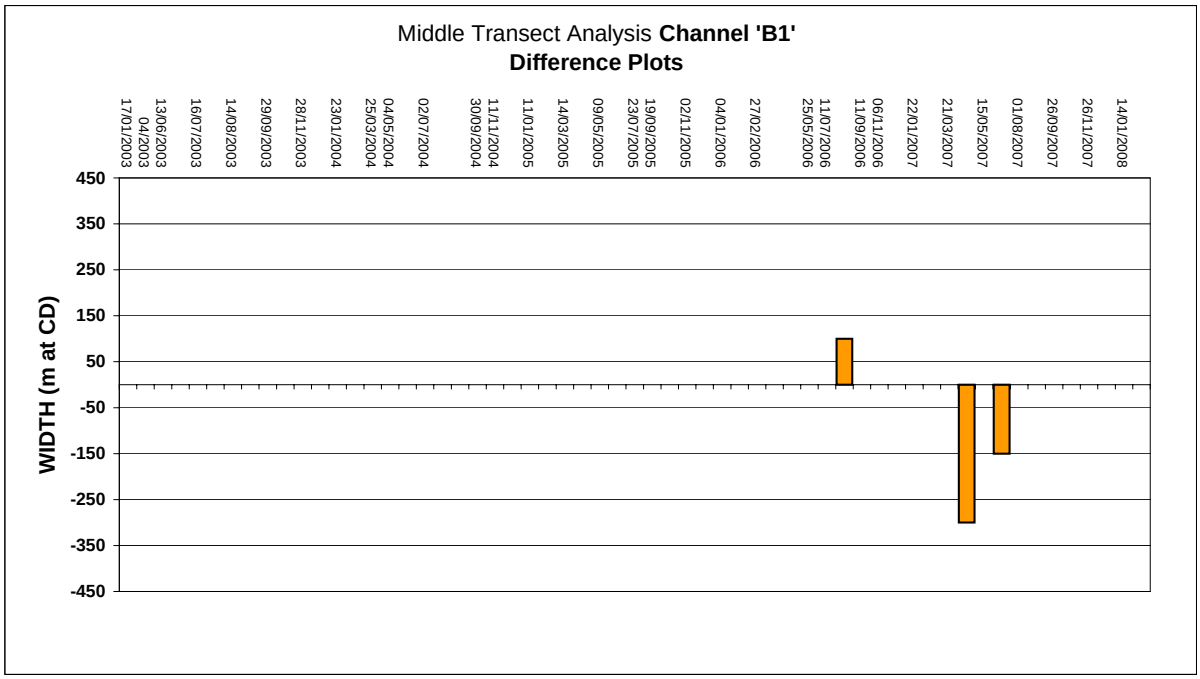

Middle Transect Analysis **Channel 'B1'**
Original 1-monthly Survey Intervals
OFFSET (m)
3500
3400
3300
3200
3100
3000
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

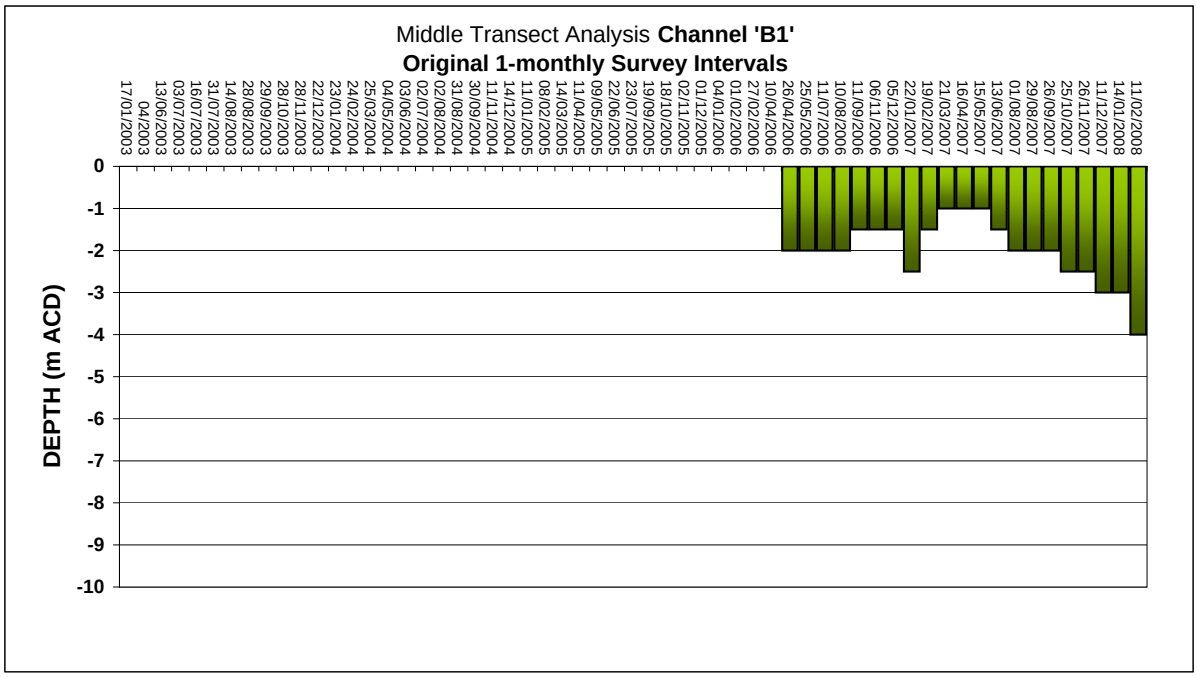

Middle Transect Analysis **Channel 'B1'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
3500
3400
3300
3200
3100
3000
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

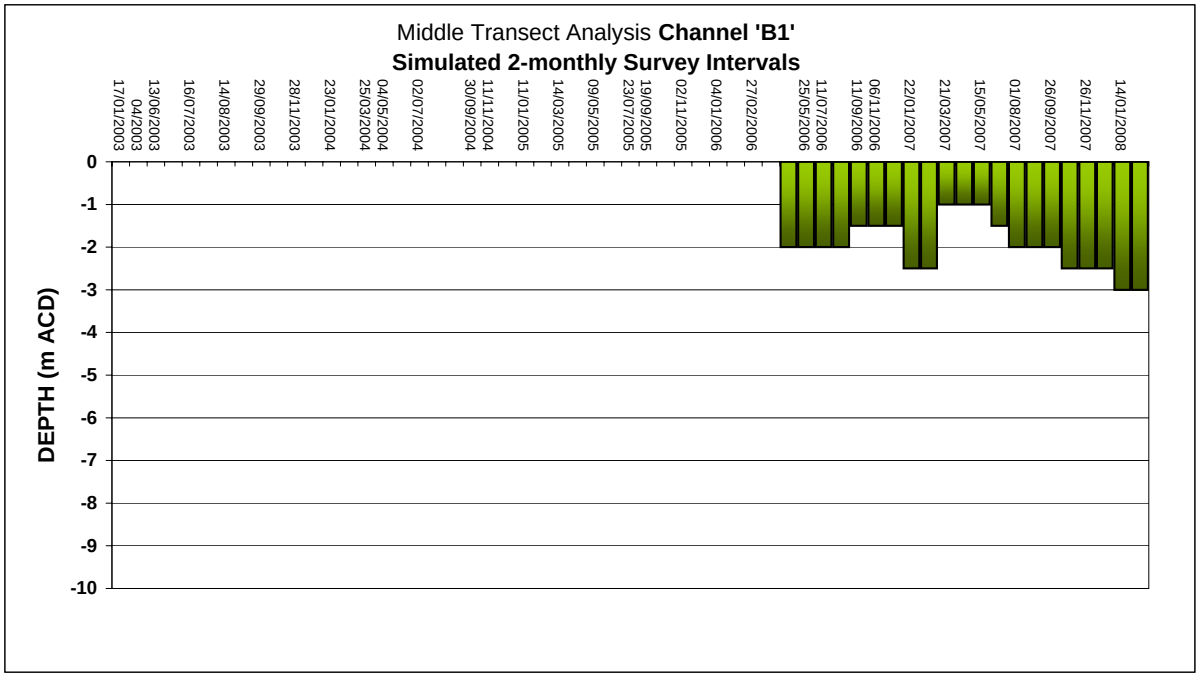

Middle Transect Analysis **Channel 'B1'**
Difference Plots
OFFSET (m)
250
150
50
-50
-150
-250
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

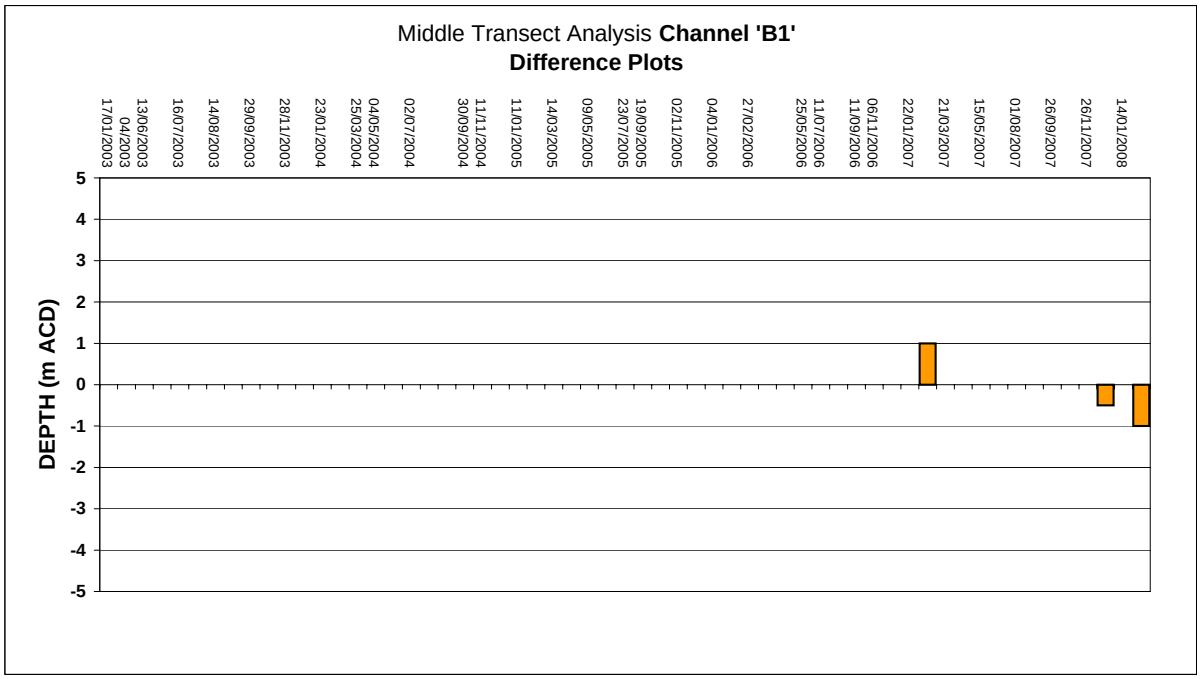

Middle Transect Analysis **Channel 'B1'**
Original 1-monthly Survey Intervals
WIDTH (m at CD)
900
800
700
600
500
400
300
200
100
0
* Increased width due to merger of
Channels B & B1 at CD
17/01/2003
04/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

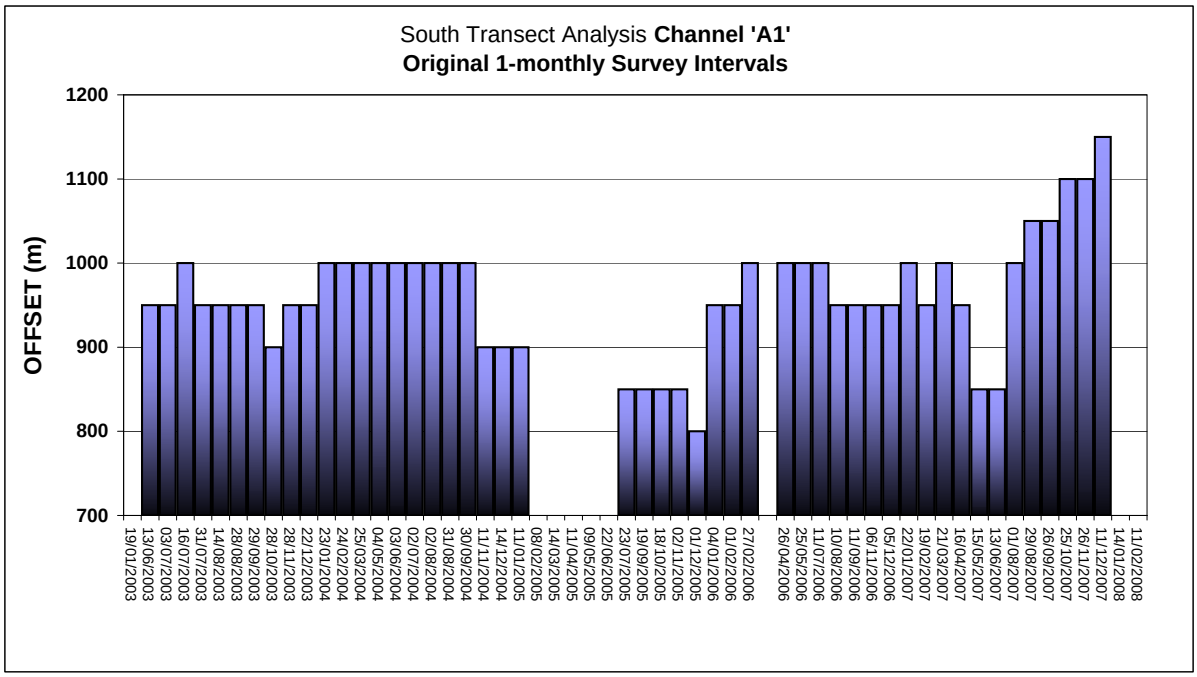

Middle Transect Analysis **Channel 'B1'**
Simulated 2-monthly Survey Intervals
WIDTH (m at CD)
900
800
700
600
500
400
300
200
100
0
* Increased width due to merger of
Channels B & B1 at CD
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

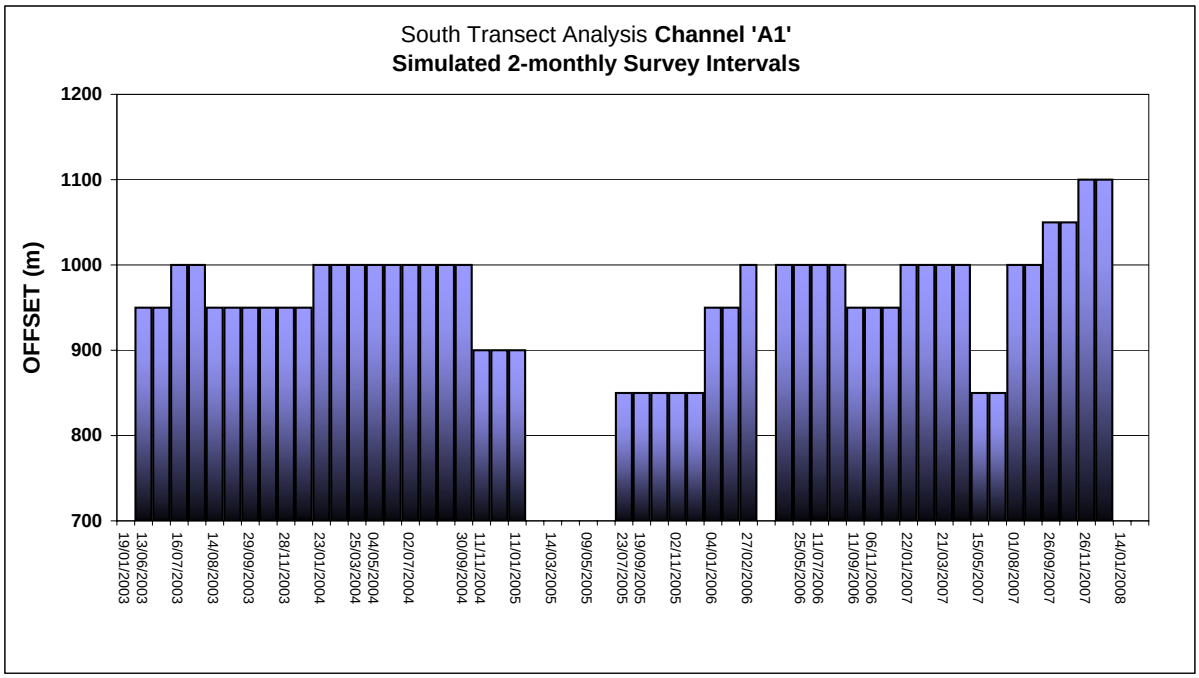

Middle Transect Analysis **Channel 'B1'**
Difference Plots
WIDTH (m at CD)
450
350
250
150
50
-50
-150
-250
-350
-450
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

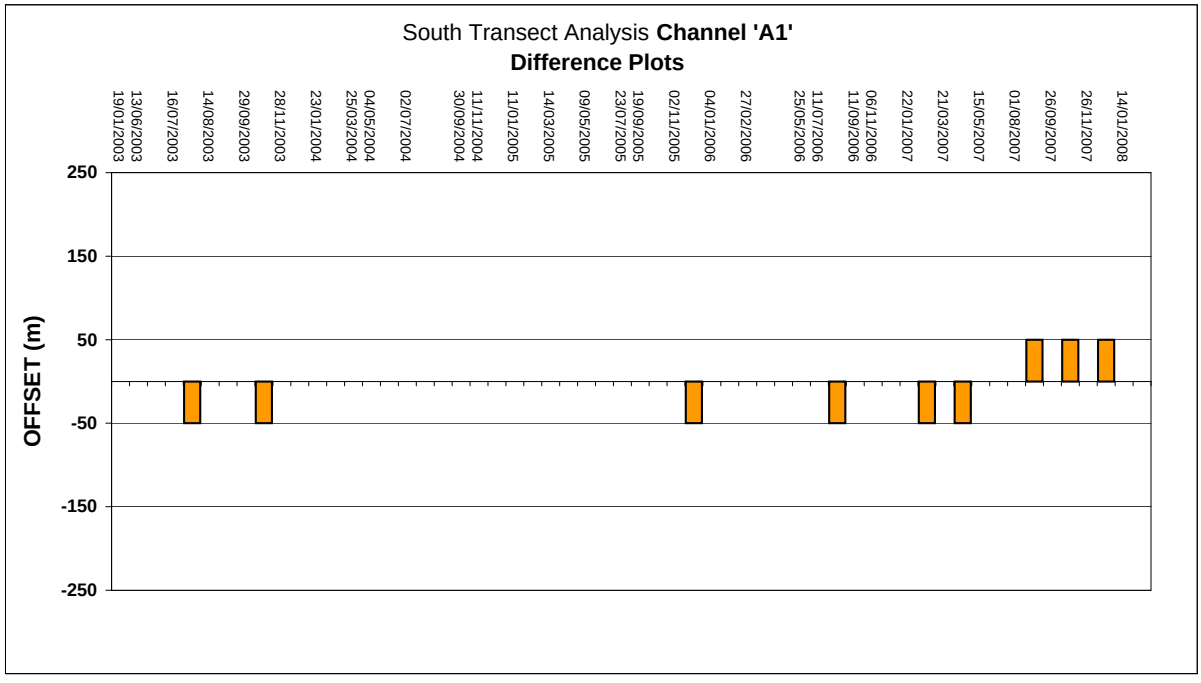

Middle Transect Analysis **Channel 'B1'**
Original 1-monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
17/01/2003
04/2003
13/06/2003
16/07/2003
03/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
10/04/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

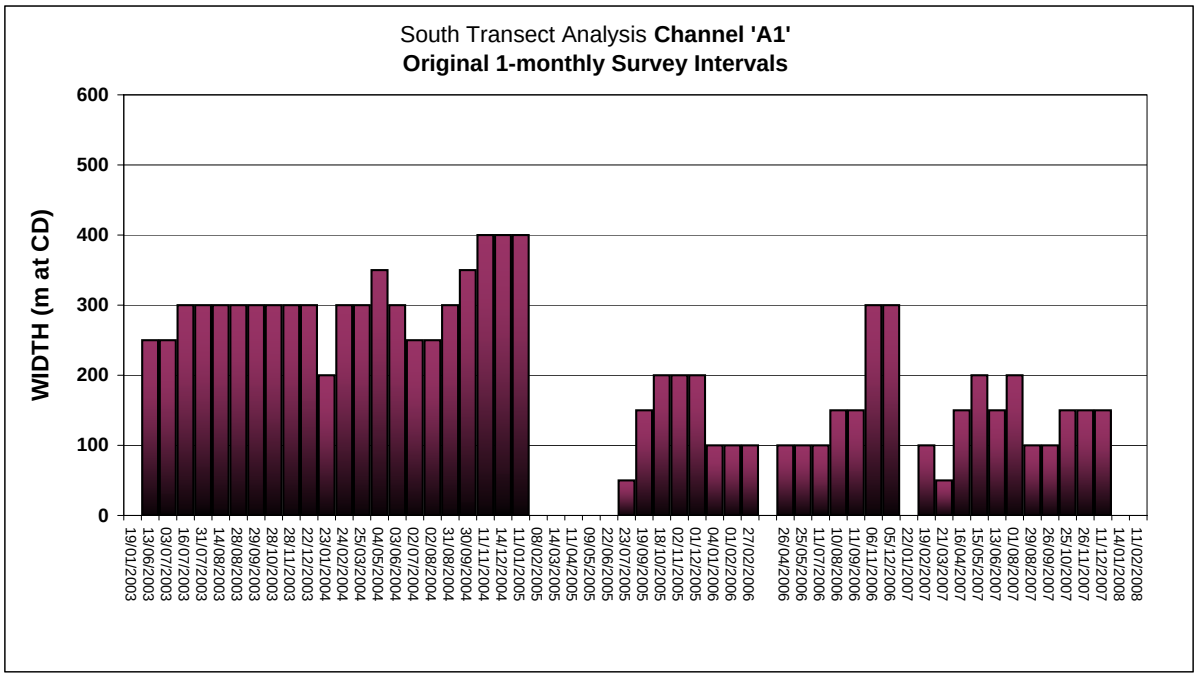

Middle Transect Analysis **Channel 'B1'**
Simulated 2-monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

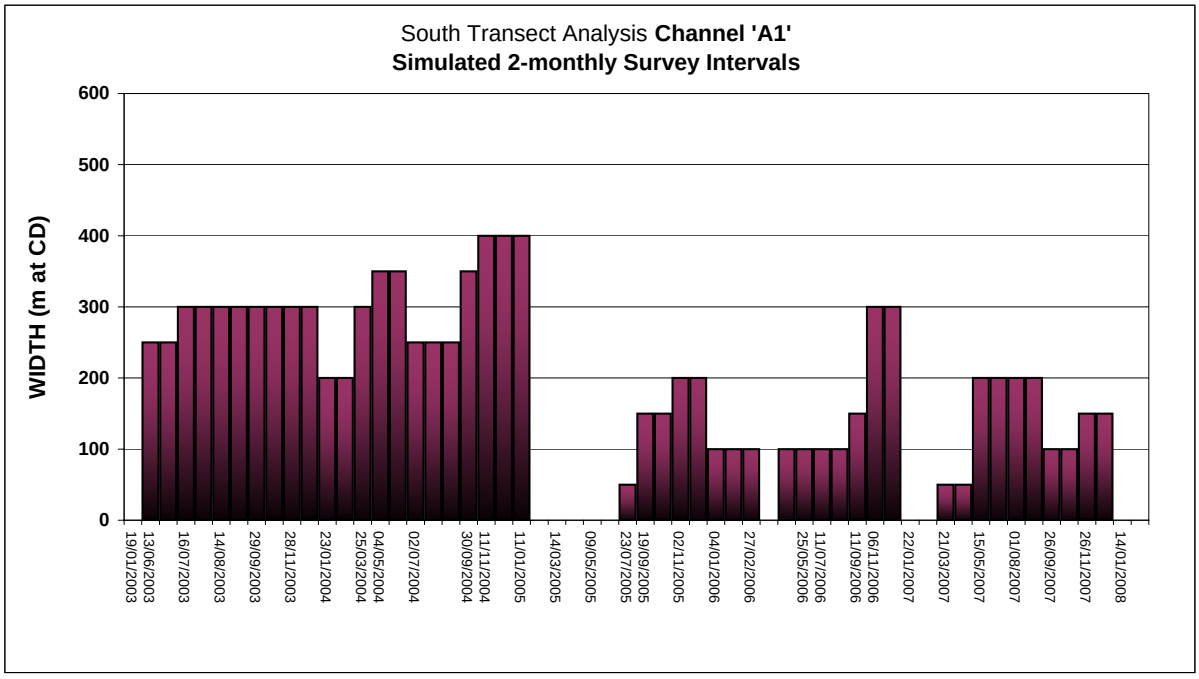

Middle Transect Analysis **Channel 'B1'**
Difference Plots
DEPTH (m ACD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
17/01/2003
04/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

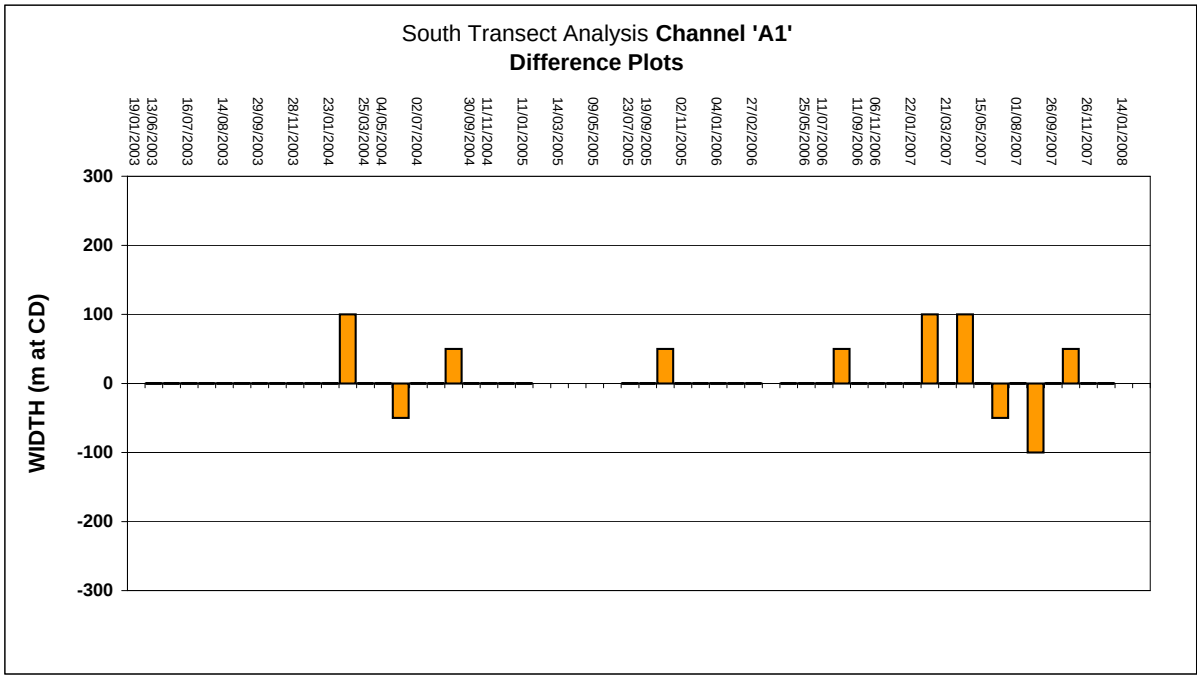

South Transect Analysis **Channel 'A1'**
Original 1-monthly Survey Intervals
OFFSET (m)
1200
1100
1000
900
800
700
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

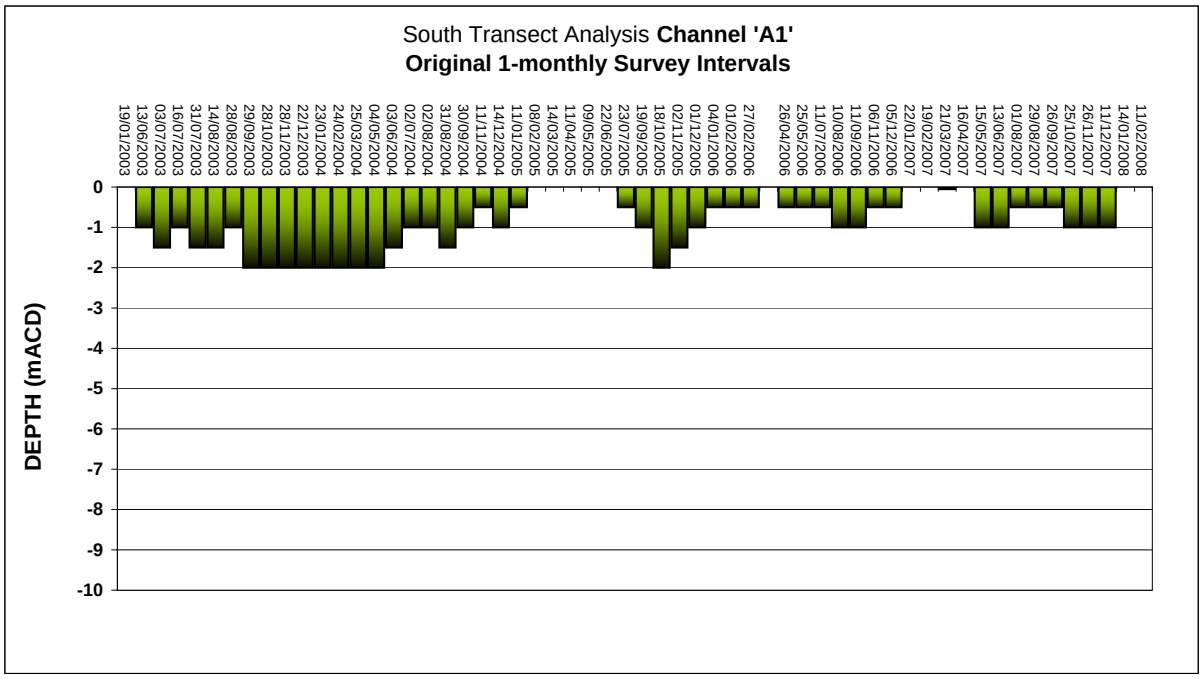

South Transect Analysis **Channel 'A1'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
1200
1100
1000
900
800
700
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

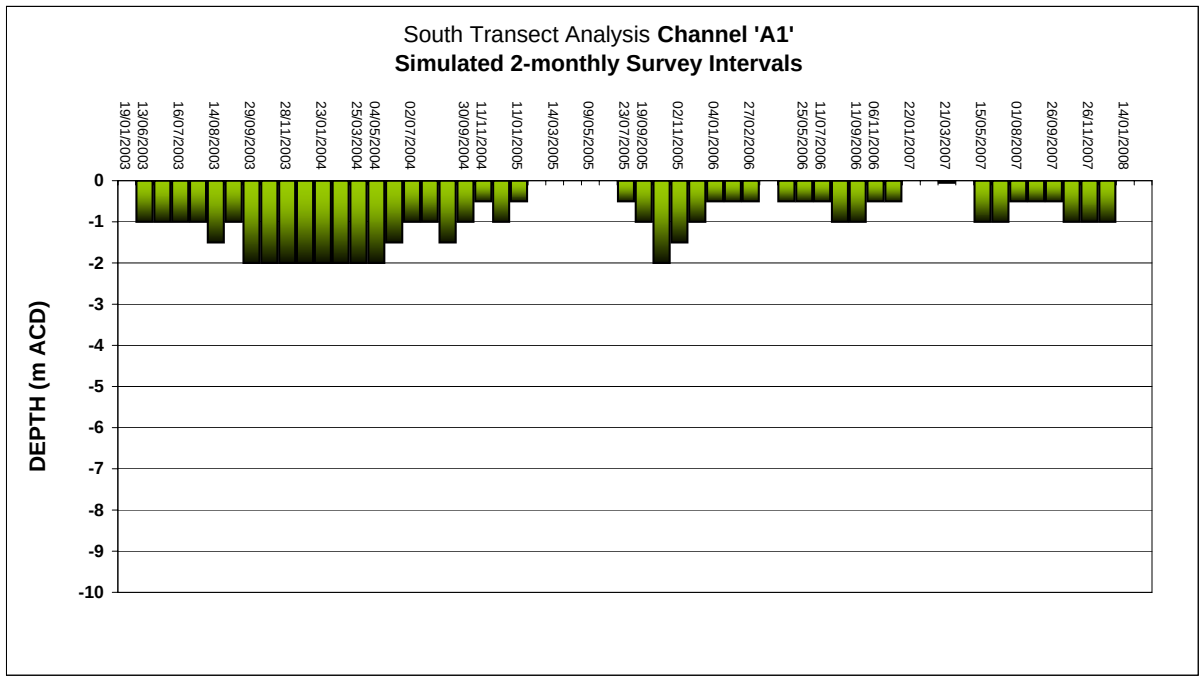

South Transect Analysis **Channel 'A1'**
Difference Plots
OFFSET (m)
250
150
50
-50
-150
-250
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

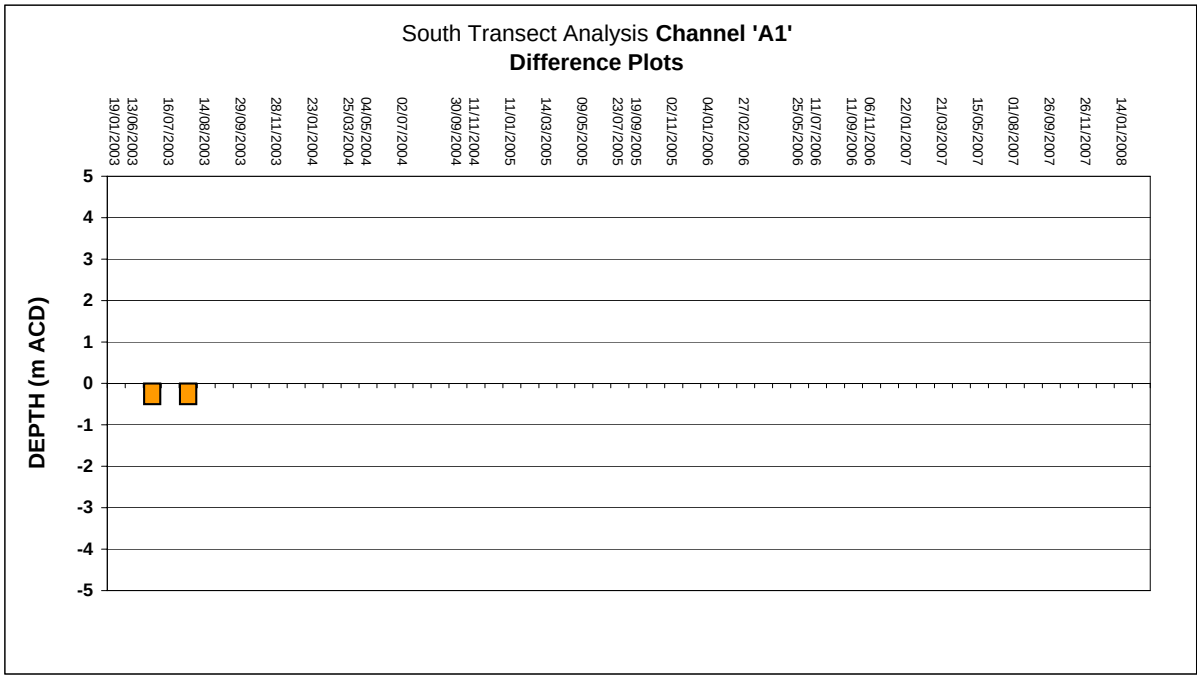

South Transect Analysis **Channel 'A1'**
Original 1-monthly Survey Intervals
WIDTH (m at CD)
600
500
400
300
200
100
0
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

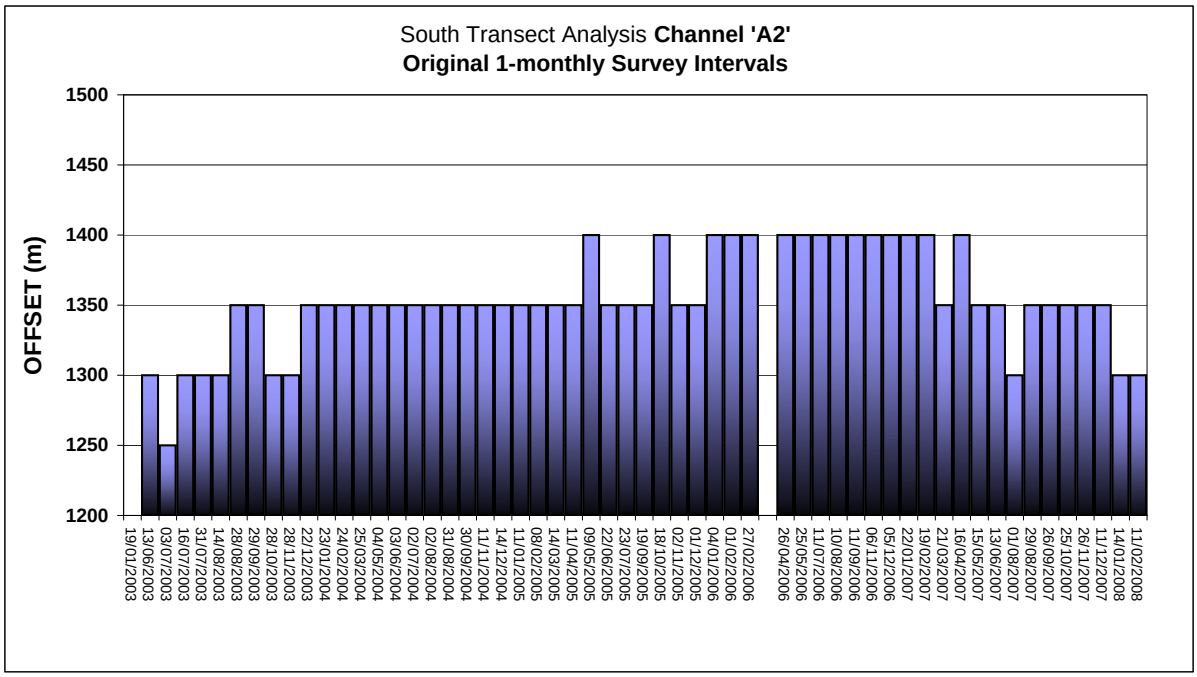

South Transect Analysis **Channel 'A1'**
Simulated 2-monthly Survey Intervals
WIDTH (m at CD)
600
500
400
300
200
100
0
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

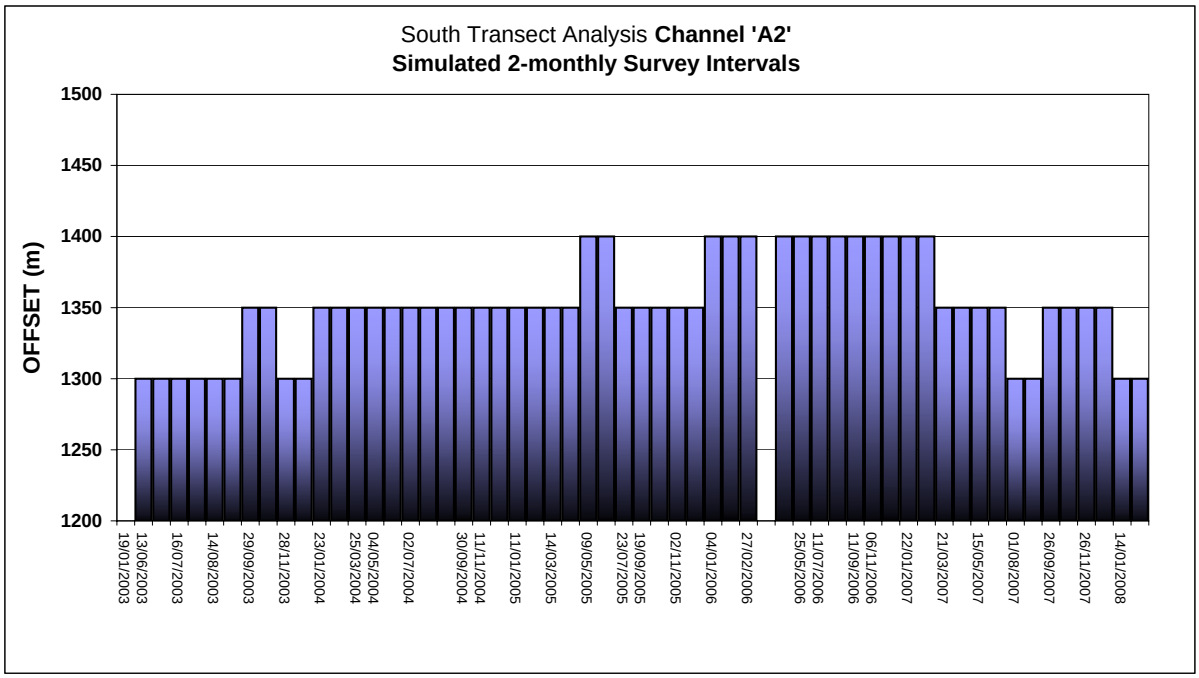

South Transect Analysis **Channel 'A1'**
Difference Plots
WIDTH (m at CD)
300
200
100
0
-100
-200
-300
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

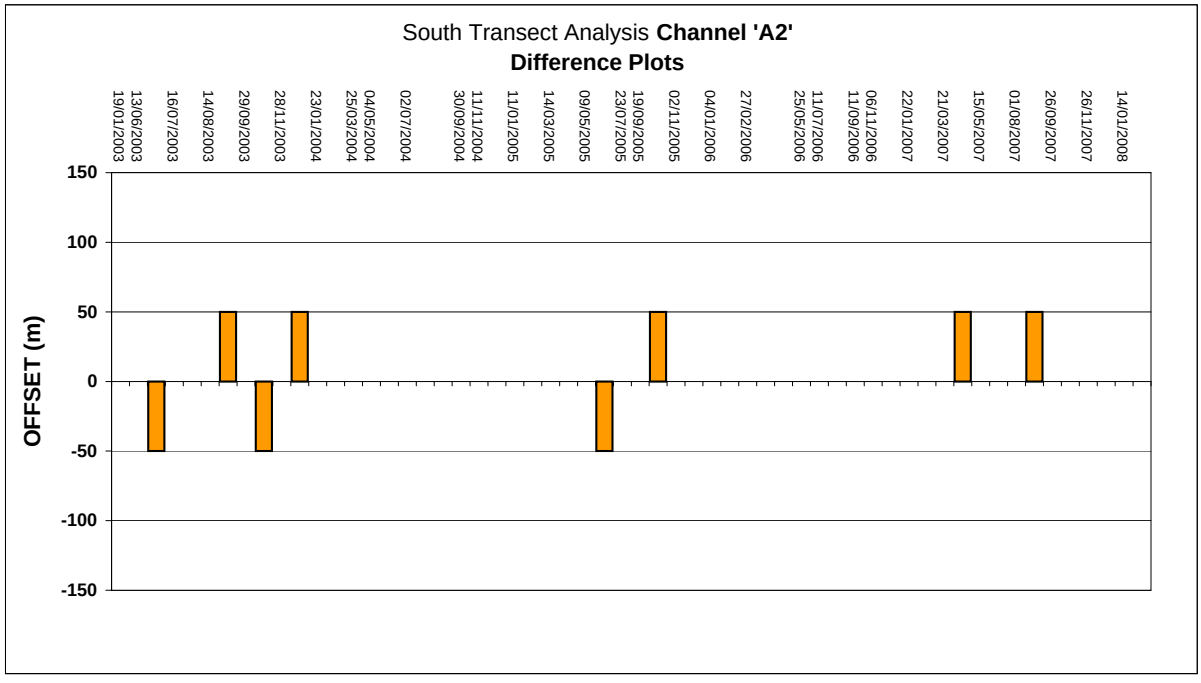

South Transect Analysis **Channel 'A1'**
Original 1-monthly Survey Intervals
DEPTH (mACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

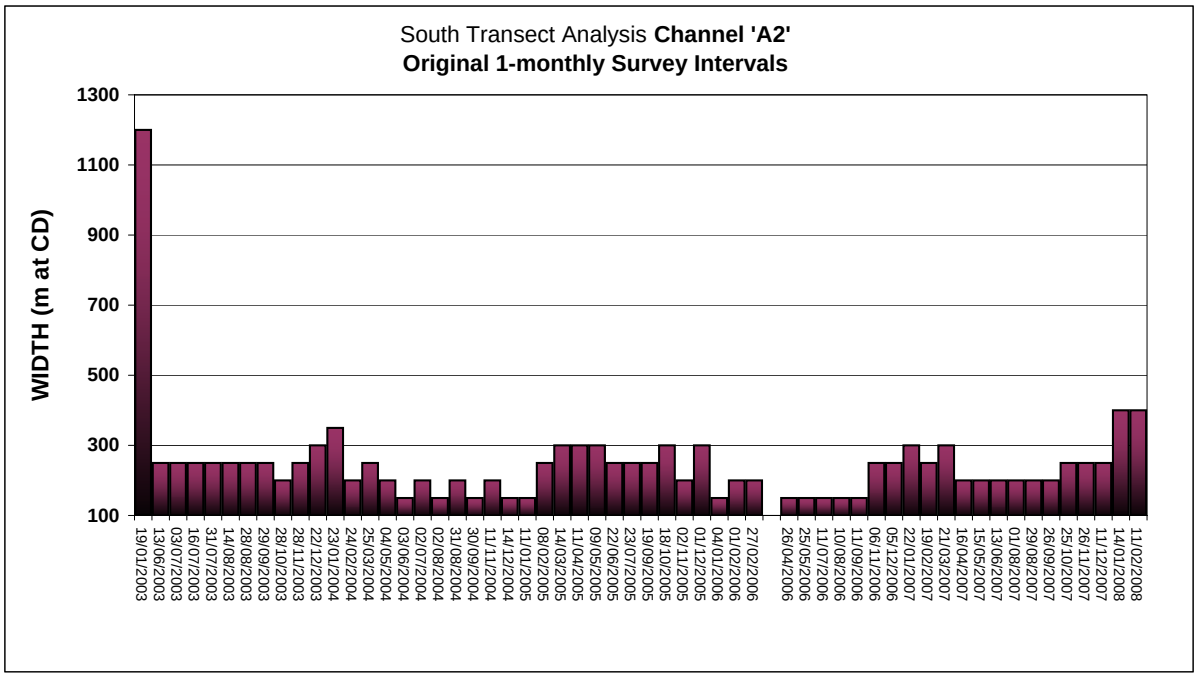

South Transect Analysis **Channel 'A1'**
Simulated 2-monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

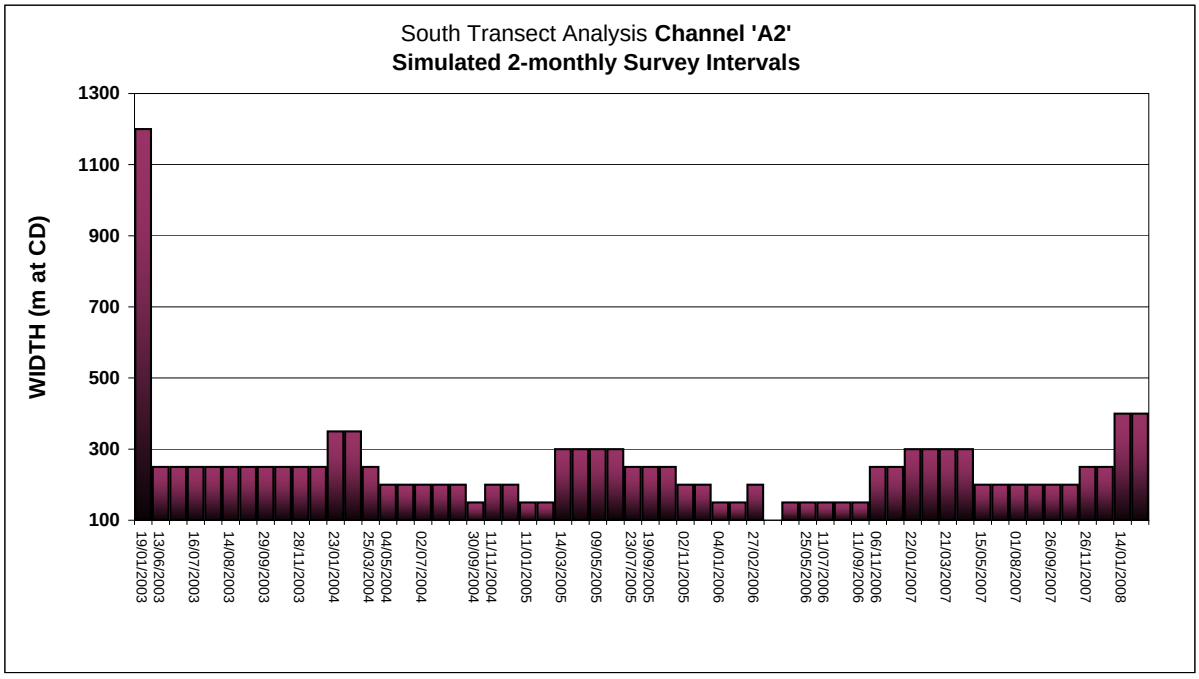

South Transect Analysis **Channel 'A1'**
Difference Plots
DEPTH (m ACD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

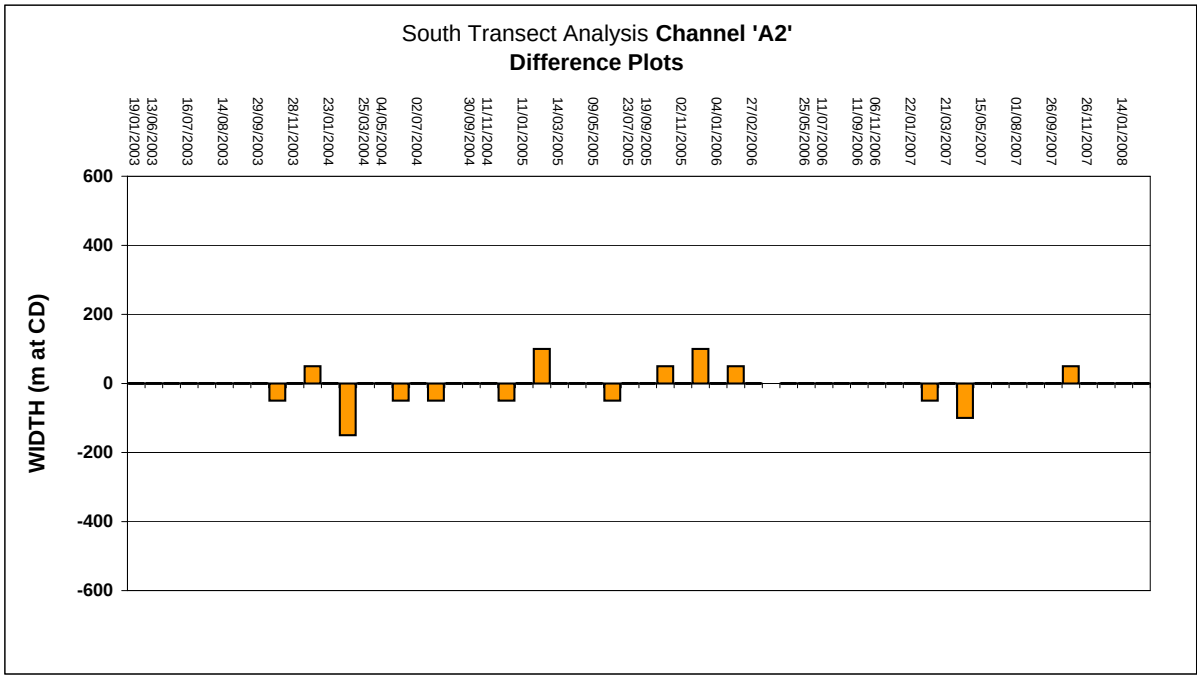

South Transect Analysis **Channel 'A2'**
Original 1-monthly Survey Intervals
OFFSET (m)
1500
1450
1400
1350
1300
1250
1200
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

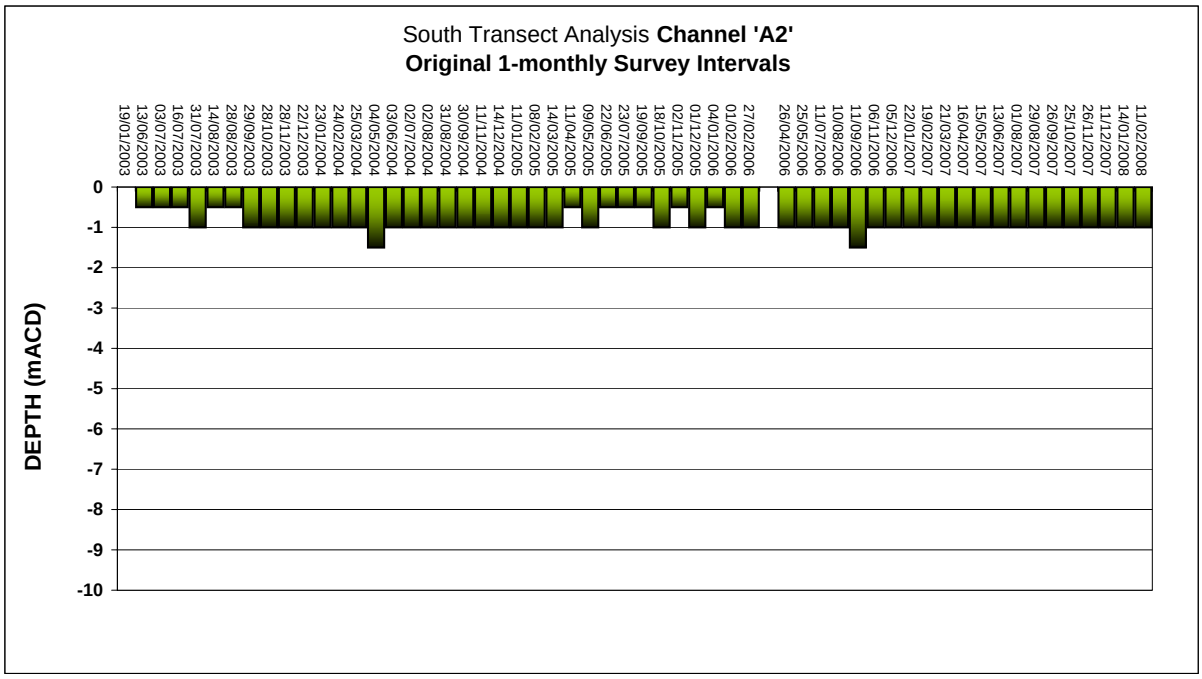

South Transect Analysis **Channel 'A2'**
Simulated 2-monthly Survey Intervals
OFFSET (m)
1500
1450
1400
1350
1300
1250
1200
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

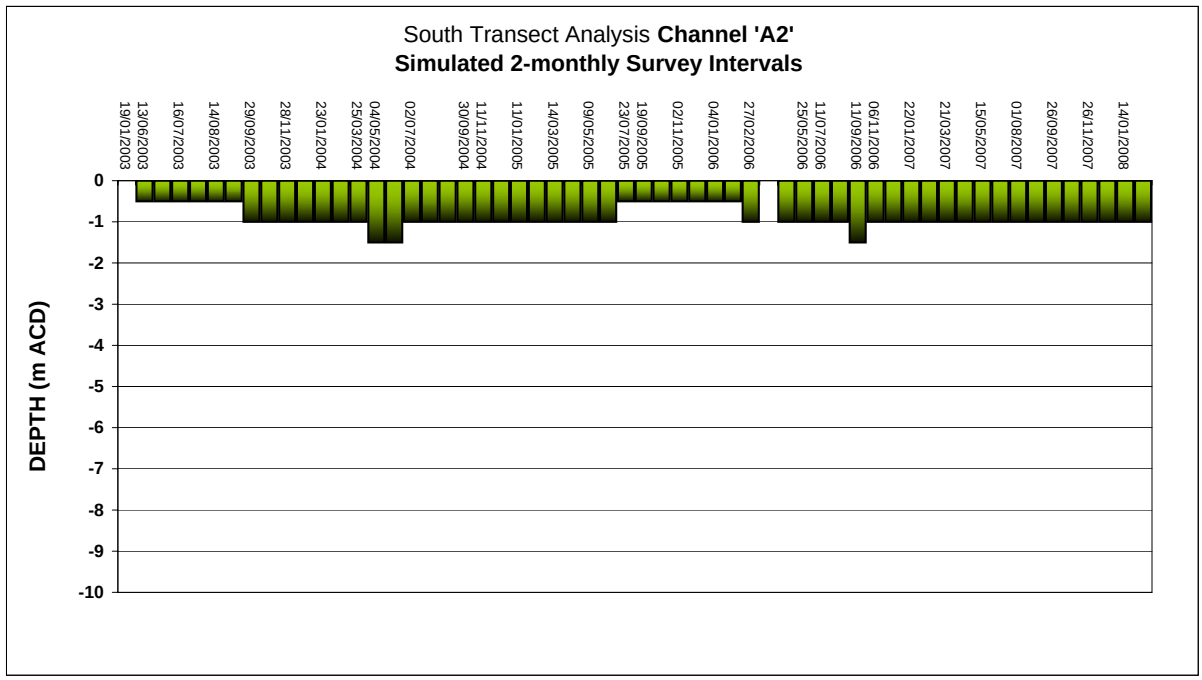

South Transect Analysis **Channel 'A2'**
Difference Plots
OFFSET (m)
150
100
50
0
-50
-100
-150
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

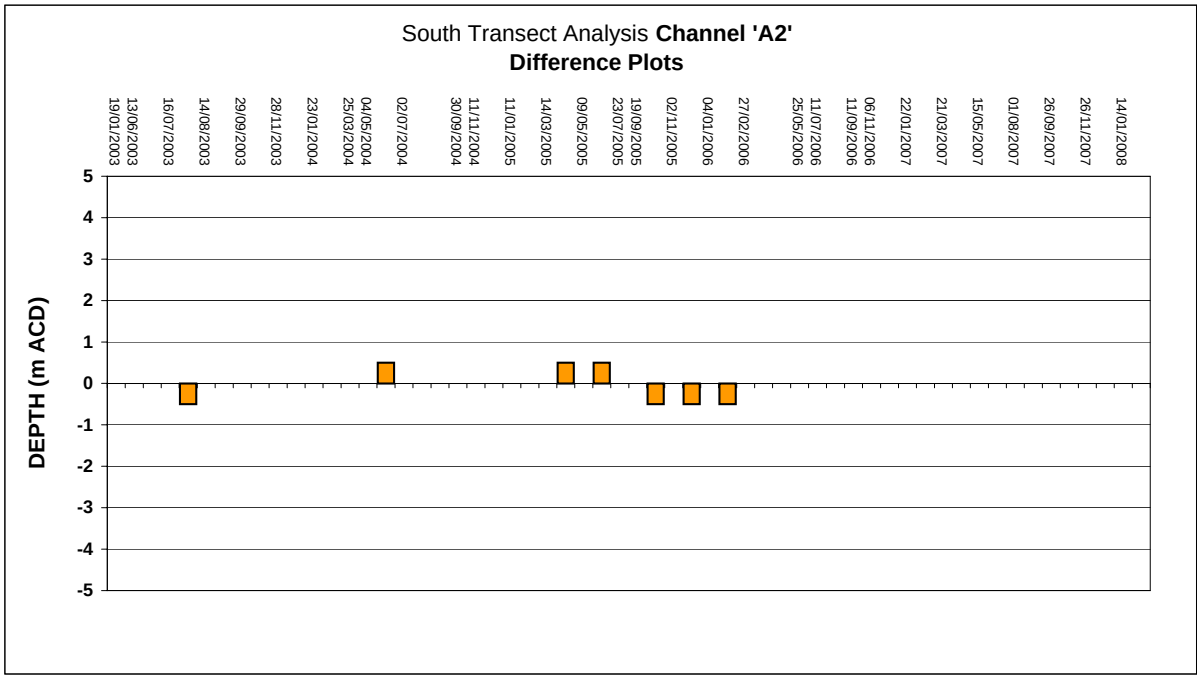

South Transect Analysis **Channel 'A2'**
Original 1-monthly Survey Intervals
WIDTH (m at CD)
1300
1100
900
700
500
300
100
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008

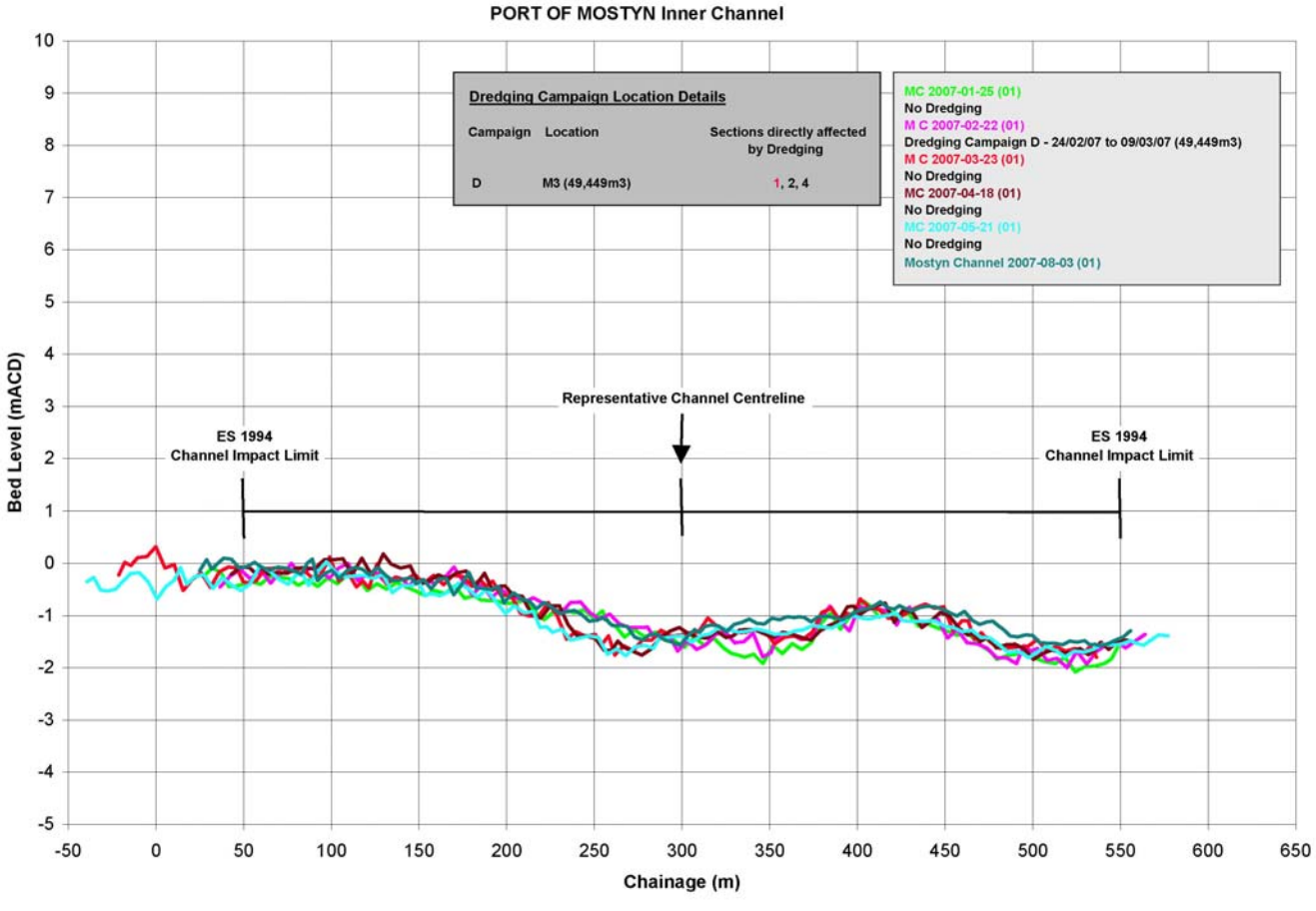

South Transect Analysis **Channel 'A2'**
Simulated 2-monthly Survey Intervals
WIDTH (m at CD)
1300
1100
900
700
500
300
100
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

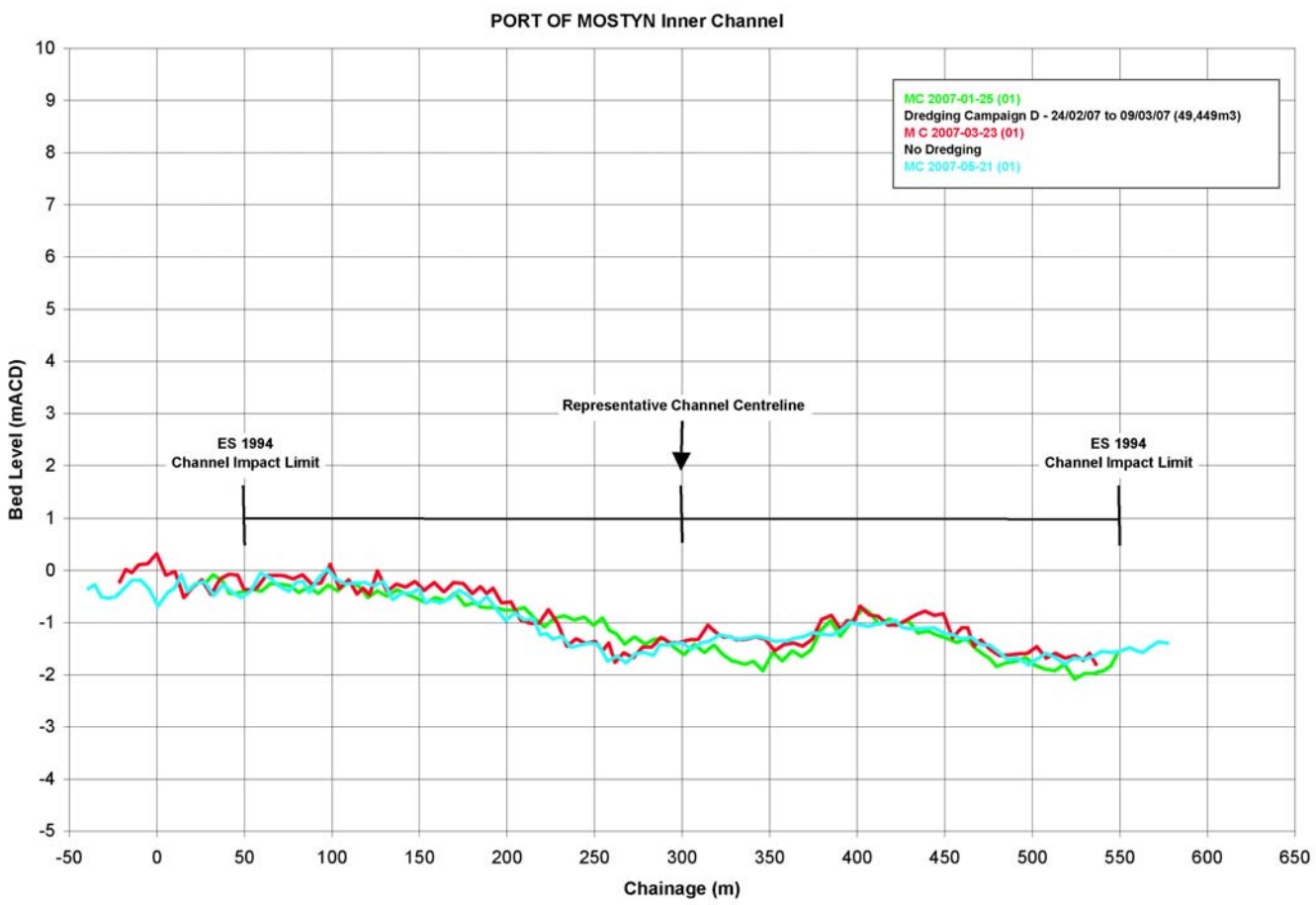

South Transect Analysis **Channel 'A2'**
Difference Plots
WIDTH (m at CD)
600
400
200
0
-200
-400
-600
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008

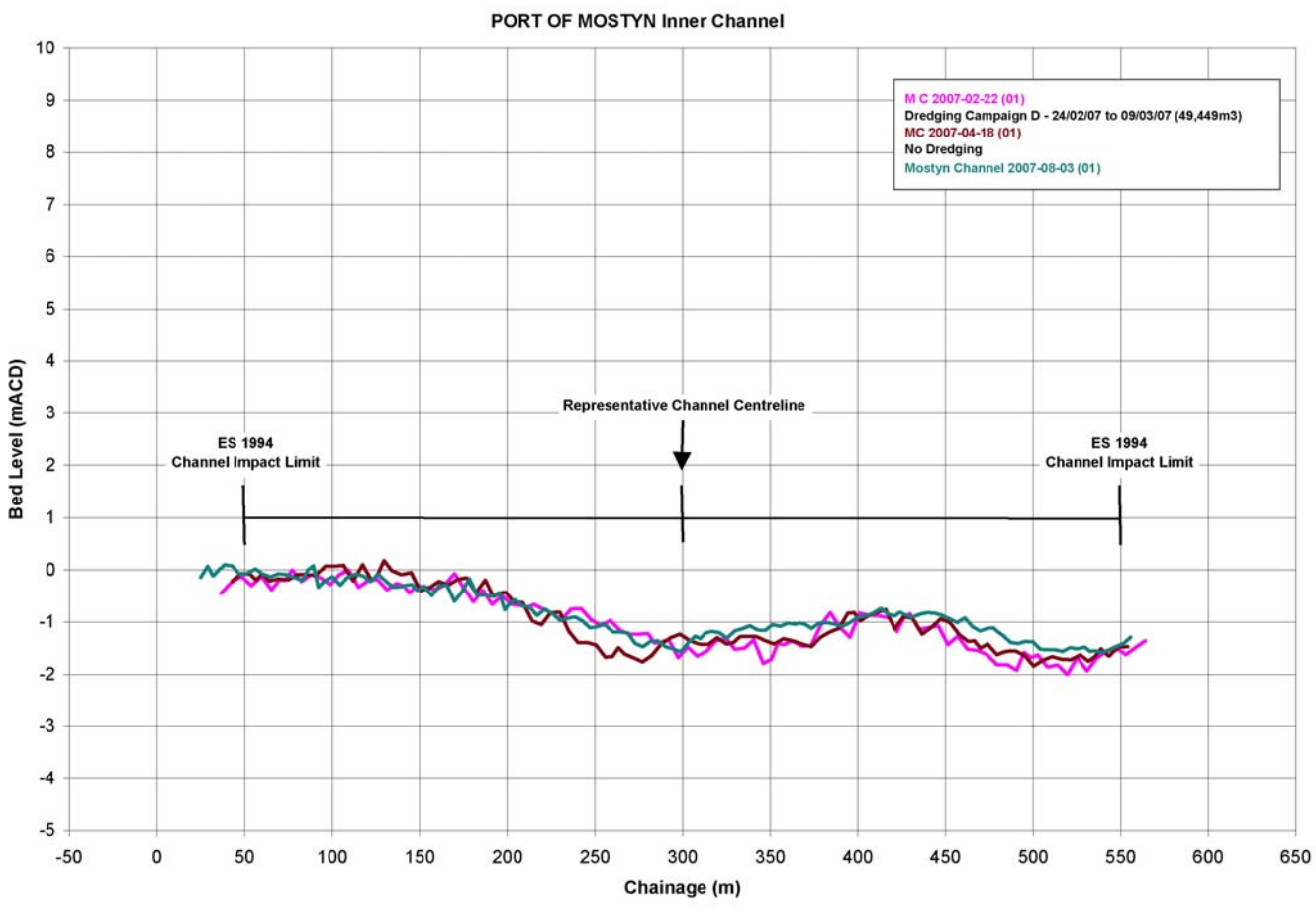

South Transect Analysis **Channel 'A2'**
Original 1-monthly Survey Intervals
DEPTH (mACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
19/01/2003
13/06/2003
03/07/2003
16/07/2003
31/07/2003
14/08/2003
28/08/2003
29/09/2003
28/10/2003
28/11/2003
22/12/2003
23/01/2004
24/02/2004
25/03/2004
04/05/2004
03/06/2004
02/07/2004
02/08/2004
31/08/2004
30/09/2004
11/11/2004
14/12/2004
11/01/2005
08/02/2005
14/03/2005
11/04/2005
09/05/2005
22/06/2005
23/07/2005
19/09/2005
18/10/2005
02/11/2005
01/12/2005
04/01/2006
01/02/2006
27/02/2006
26/04/2006
25/05/2006
11/07/2006
10/08/2006
11/09/2006
06/11/2006
05/12/2006
22/01/2007
19/02/2007
21/03/2007
16/04/2007
15/05/2007
13/06/2007
01/08/2007
29/08/2007
26/09/2007
25/10/2007
26/11/2007
11/12/2007
14/01/2008
11/02/2008


South Transect Analysis **Channel 'A2'**
Simulated 2-monthly Survey Intervals
DEPTH (m ACD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008


South Transect Analysis **Channel 'A2'**
Difference Plots
DEPTH (m ACD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
19/01/2003
13/06/2003
16/07/2003
14/08/2003
29/09/2003
28/11/2003
23/01/2004
25/03/2004
04/05/2004
02/07/2004
30/09/2004
11/11/2004
11/01/2005
14/03/2005
09/05/2005
23/07/2005
19/09/2005
02/11/2005
04/01/2006
27/02/2006
25/05/2006
11/07/2006
11/09/2006
06/11/2006
22/01/2007
21/03/2007
15/05/2007
01/08/2007
26/09/2007
26/11/2007
14/01/2008







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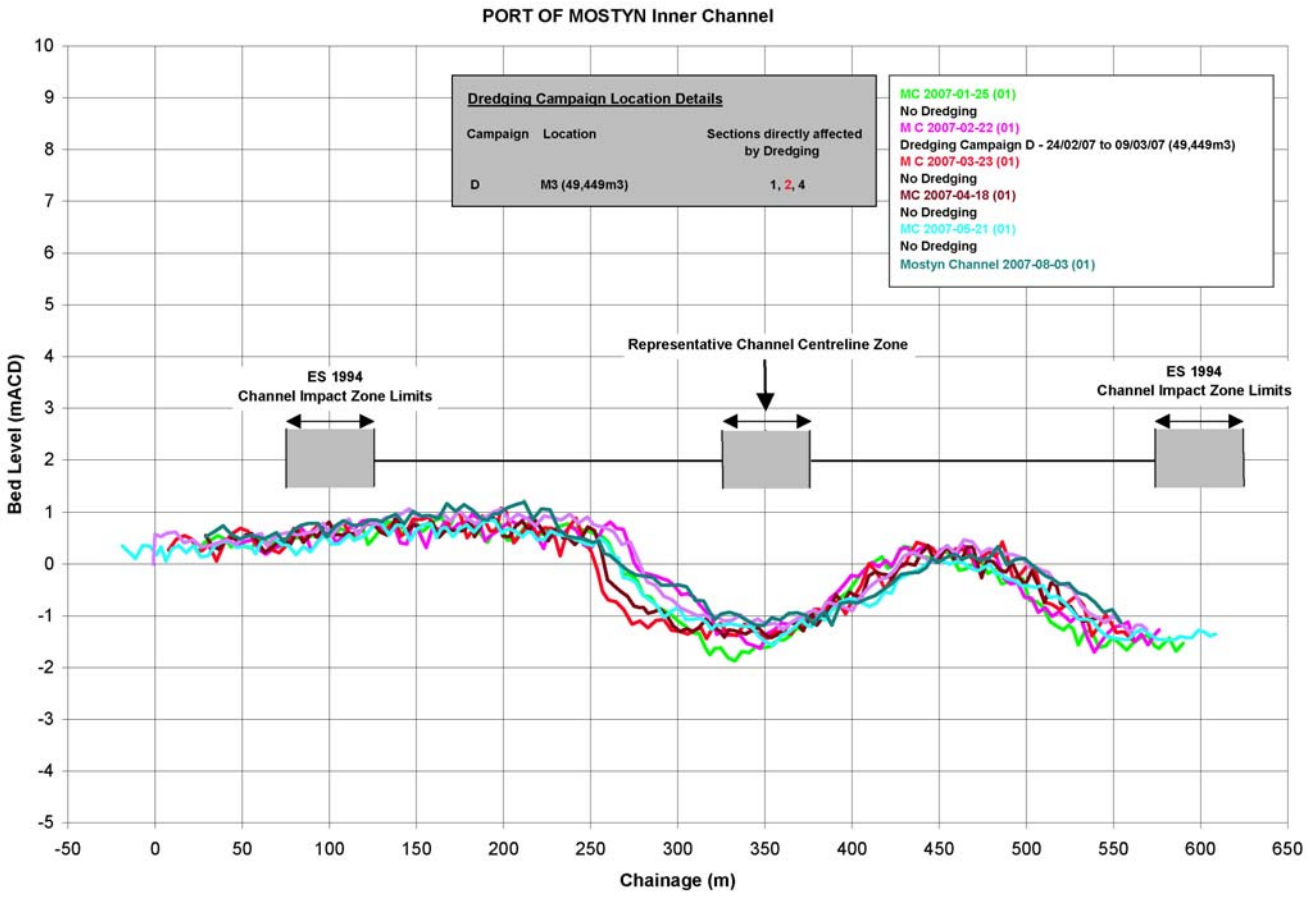
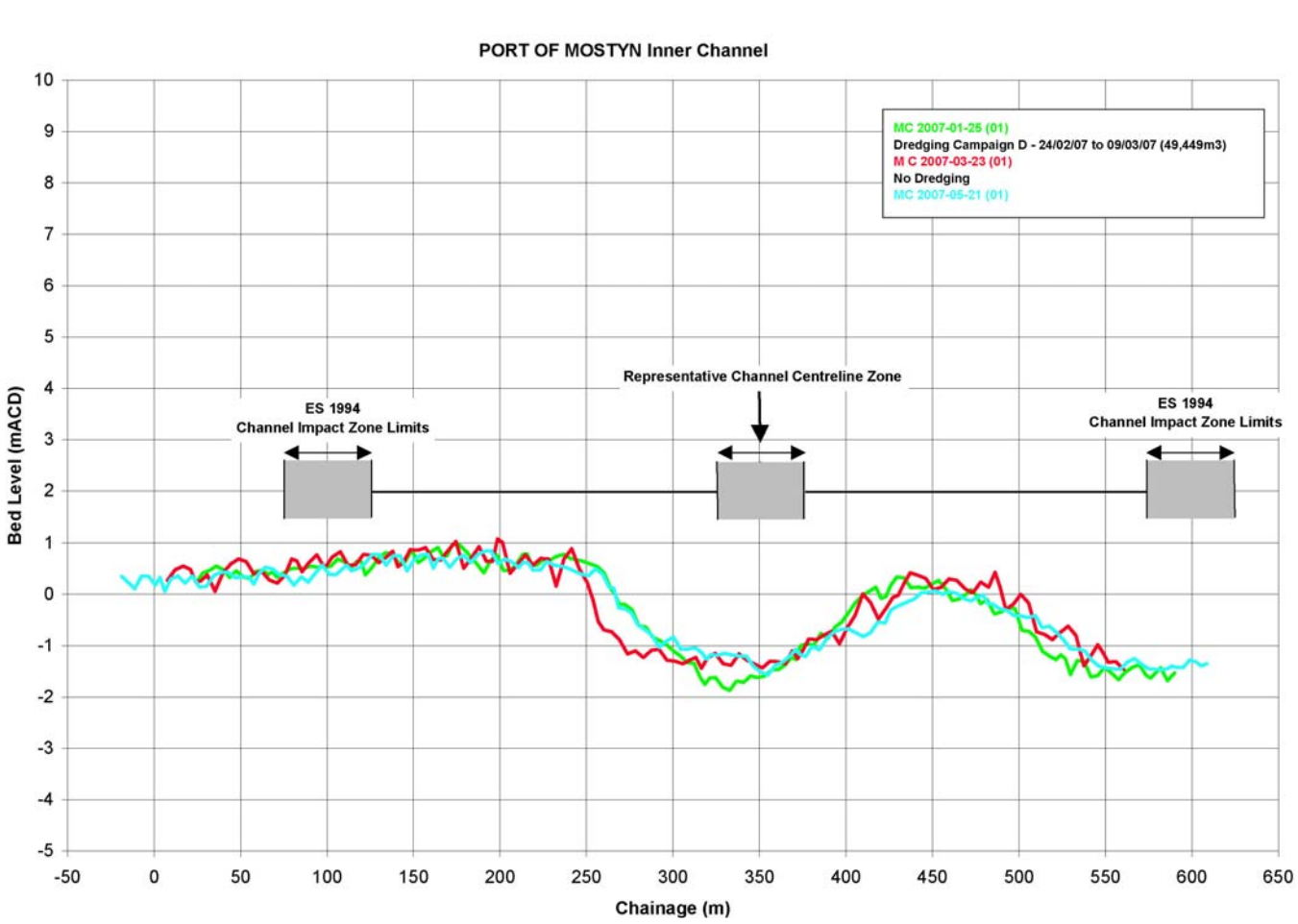
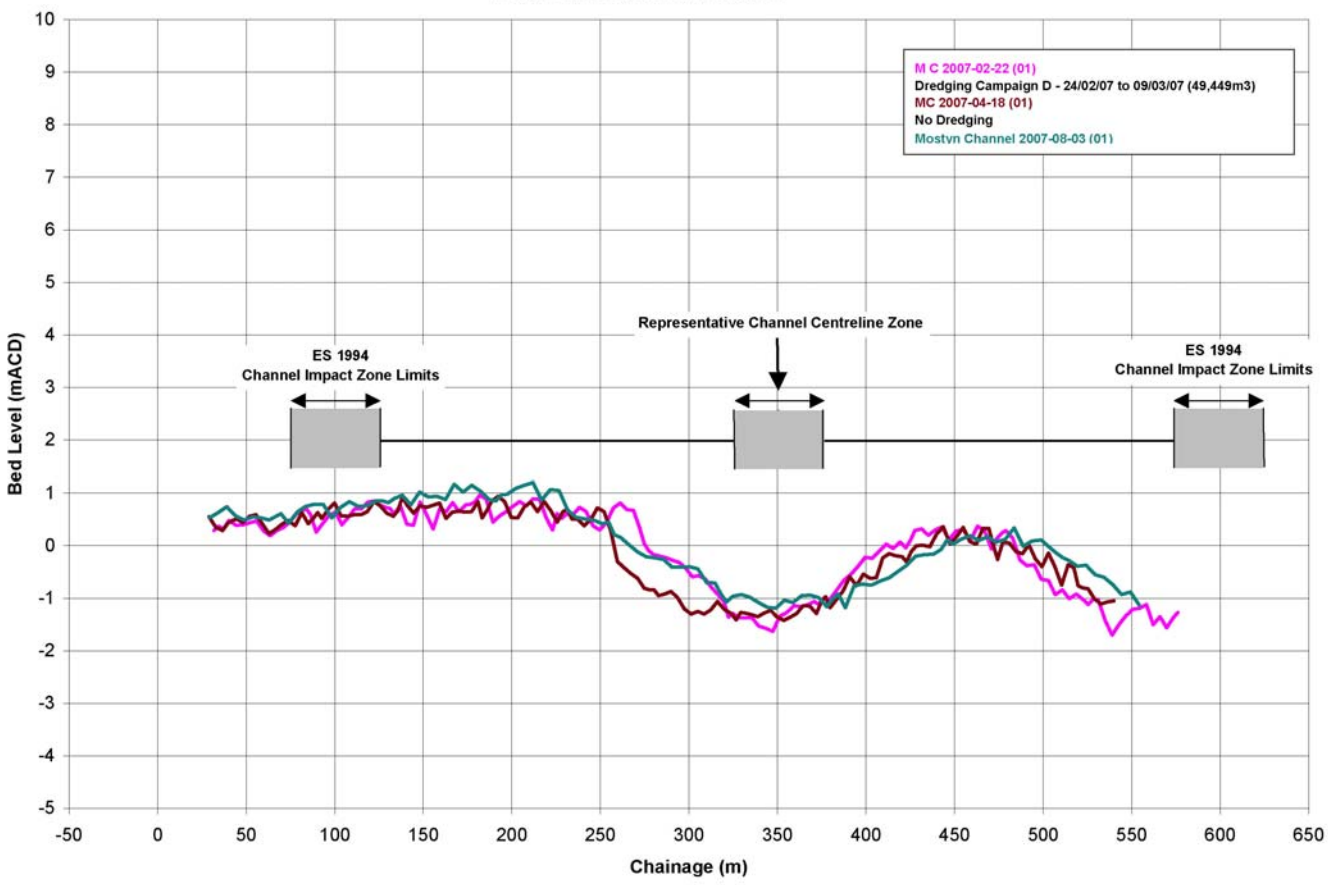
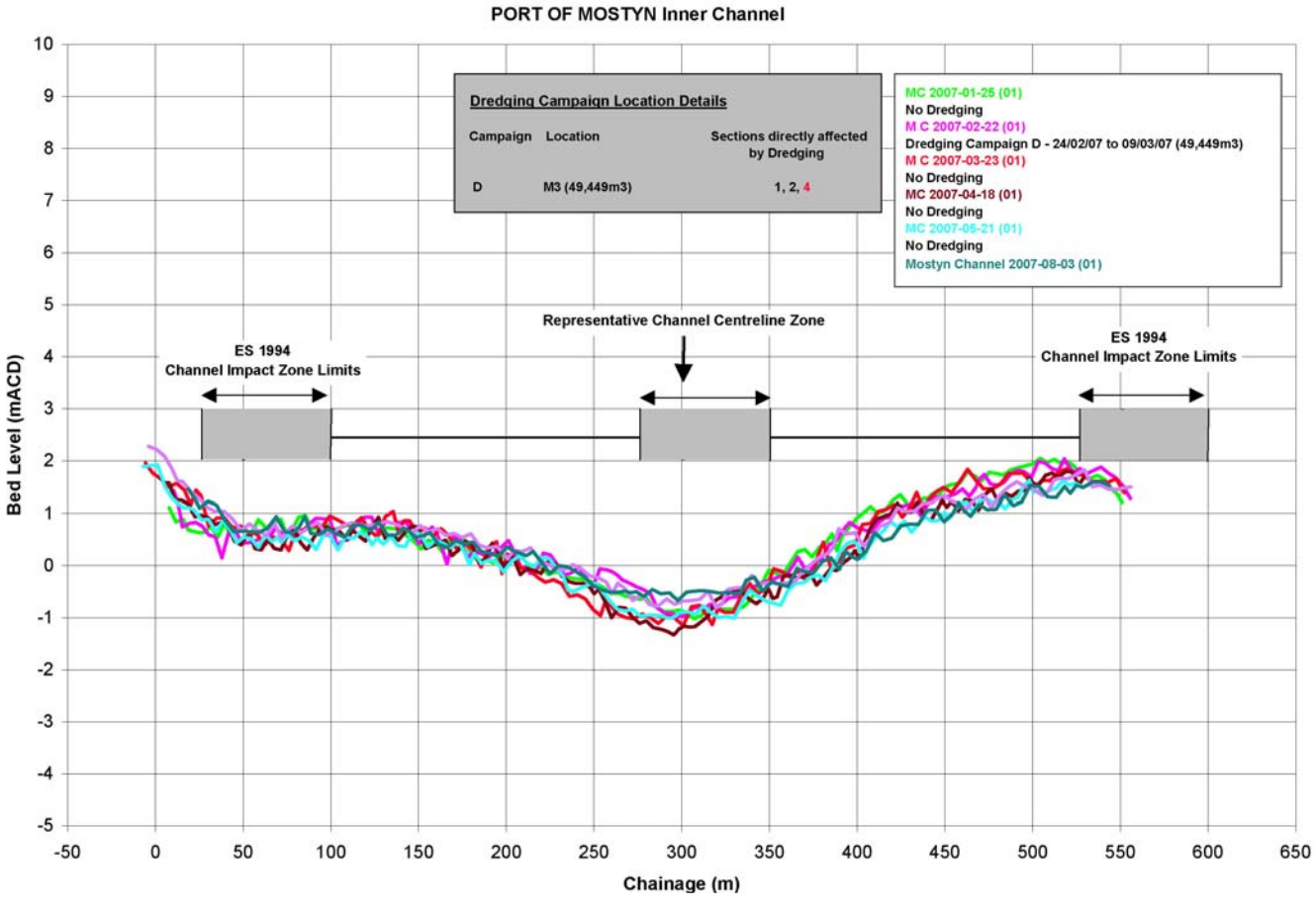
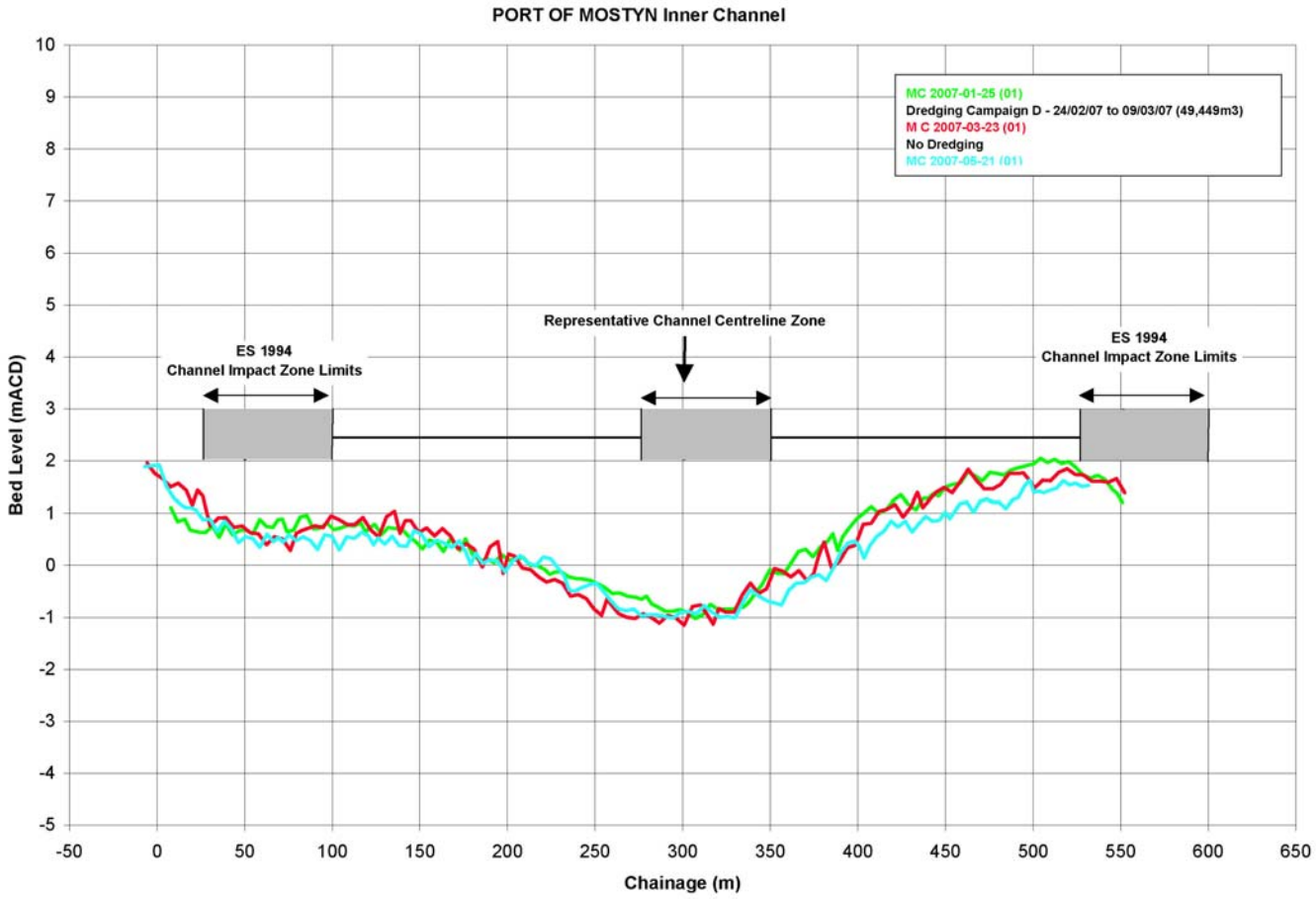


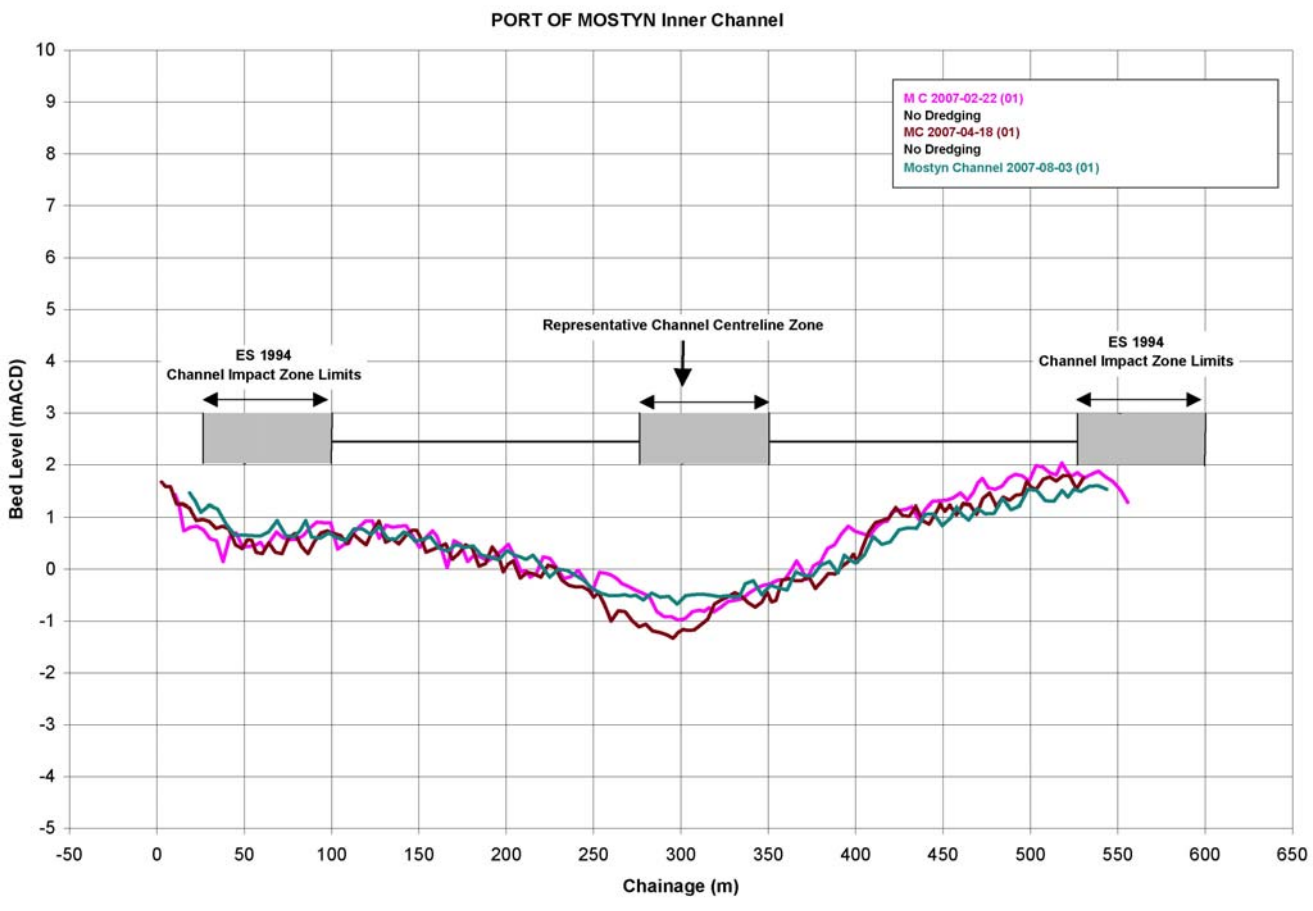




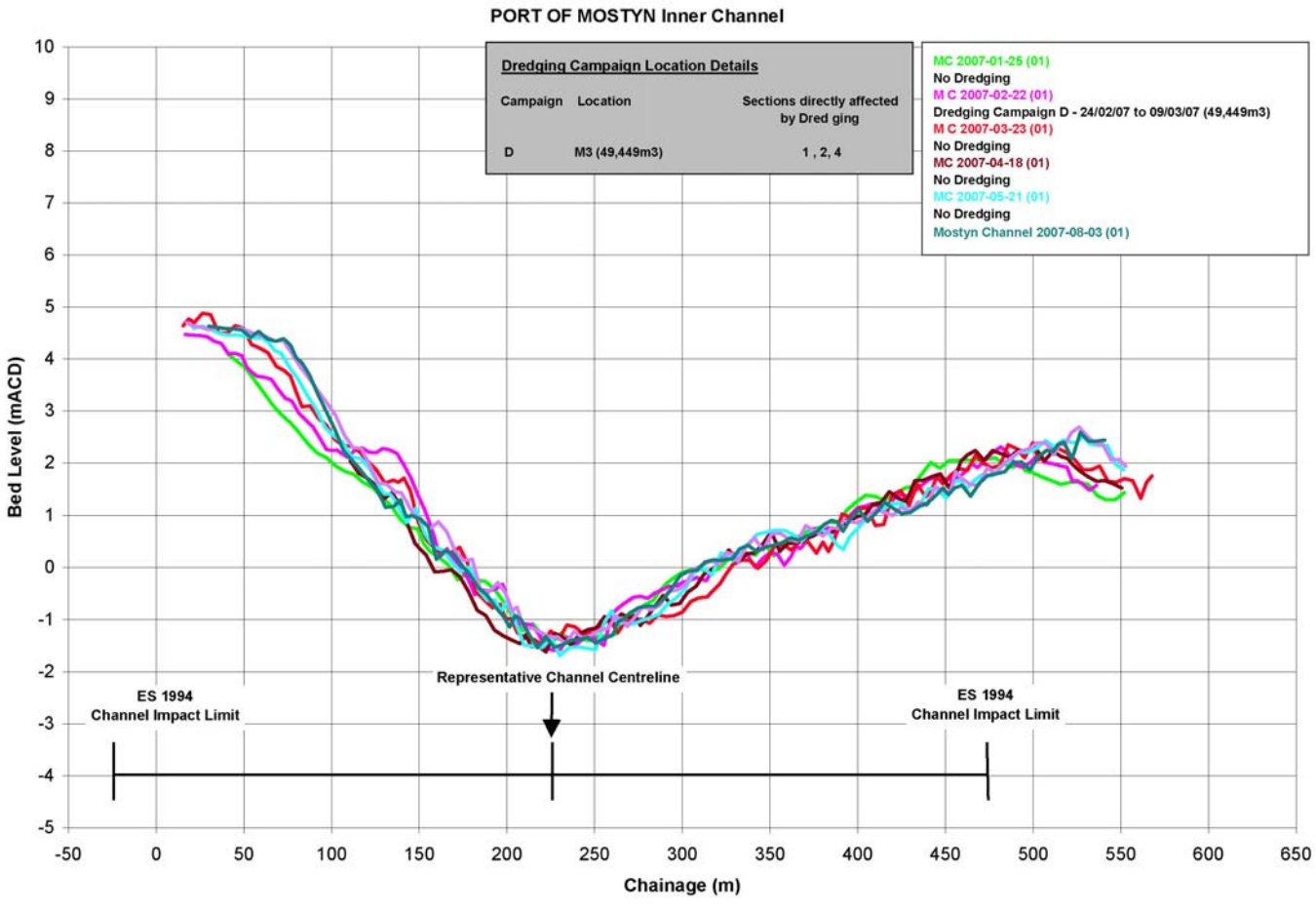
Dwg C1 (2 of 14) SECTION 02

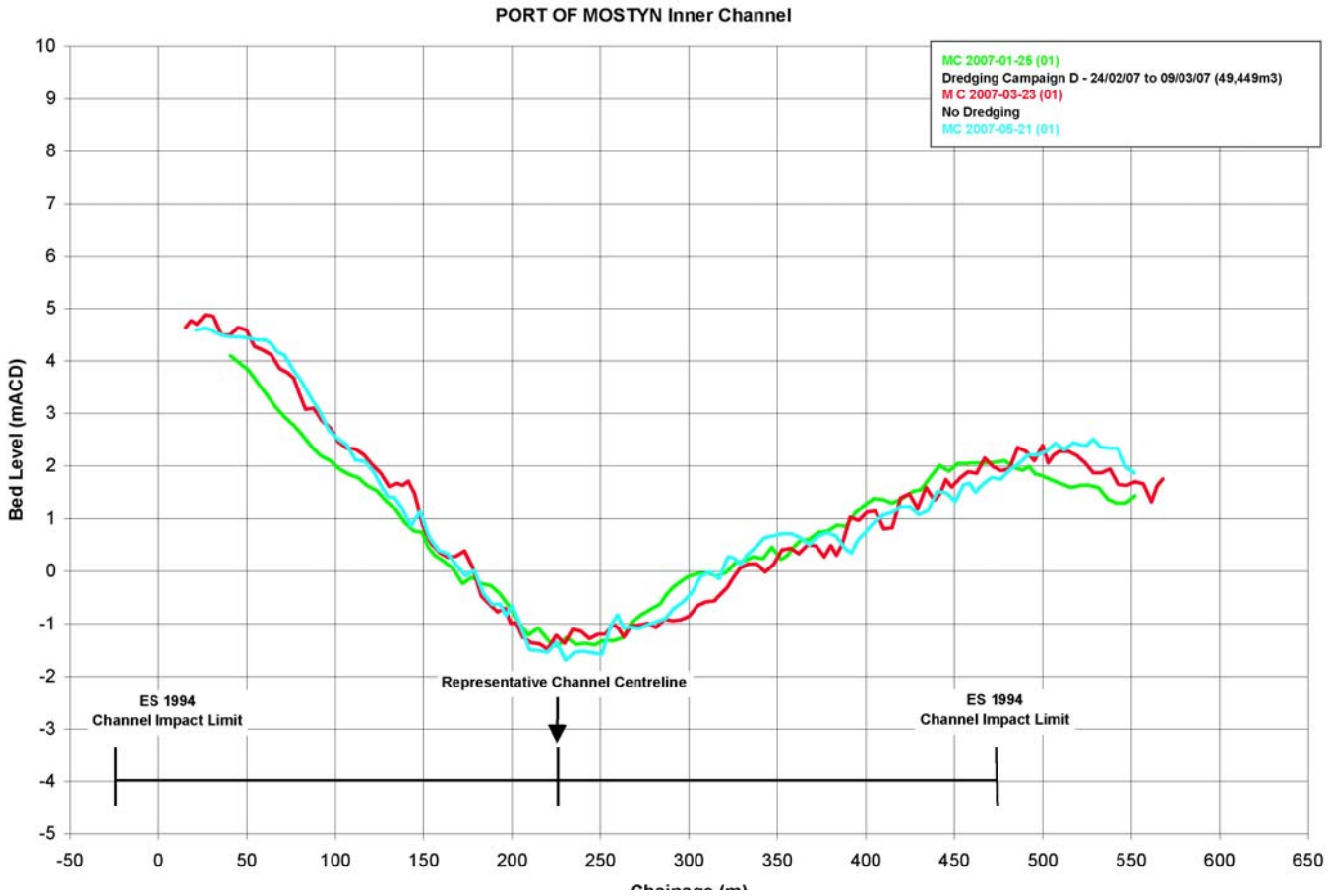


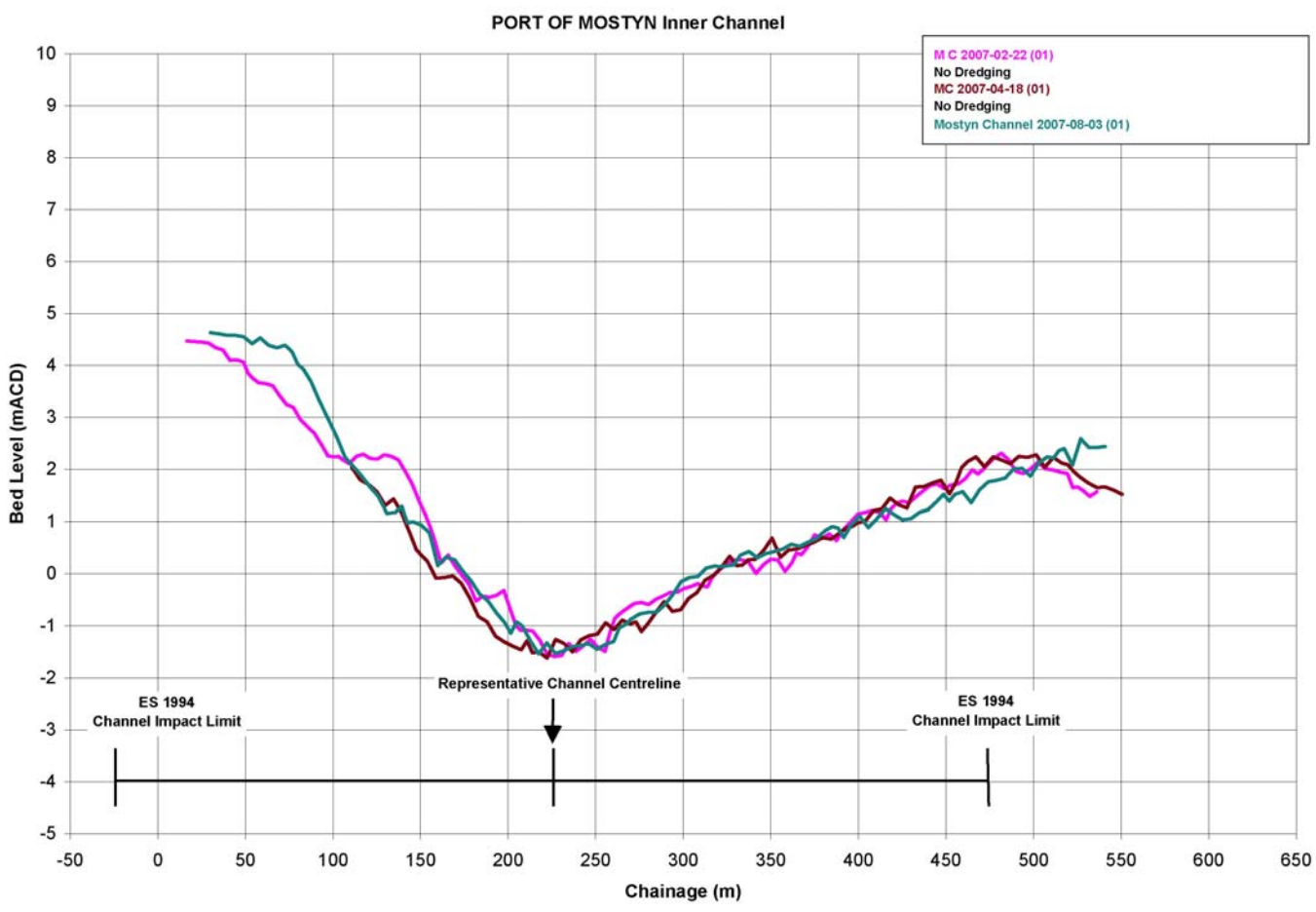




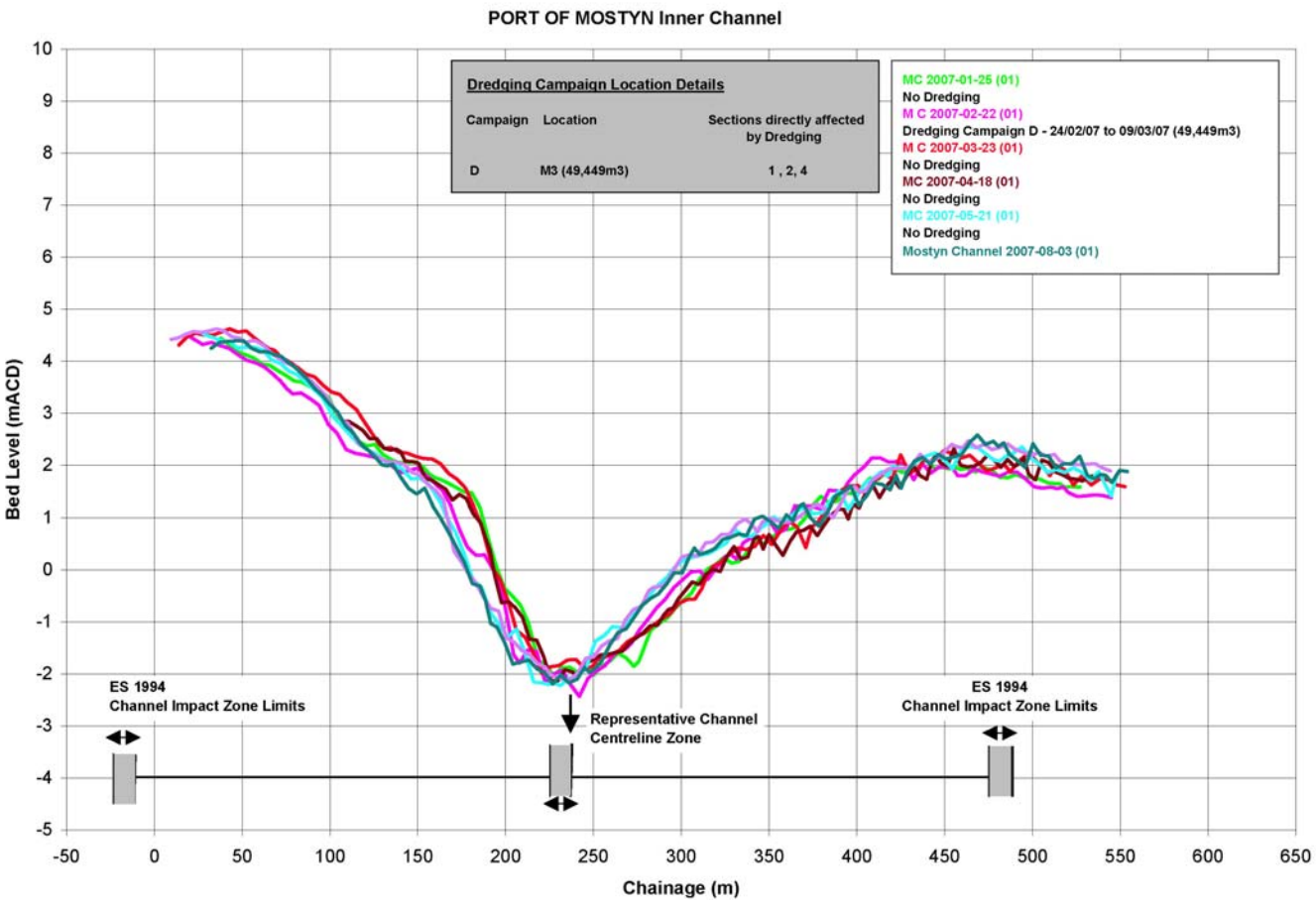
Dwg C1 (3 of 14) SECTION 04

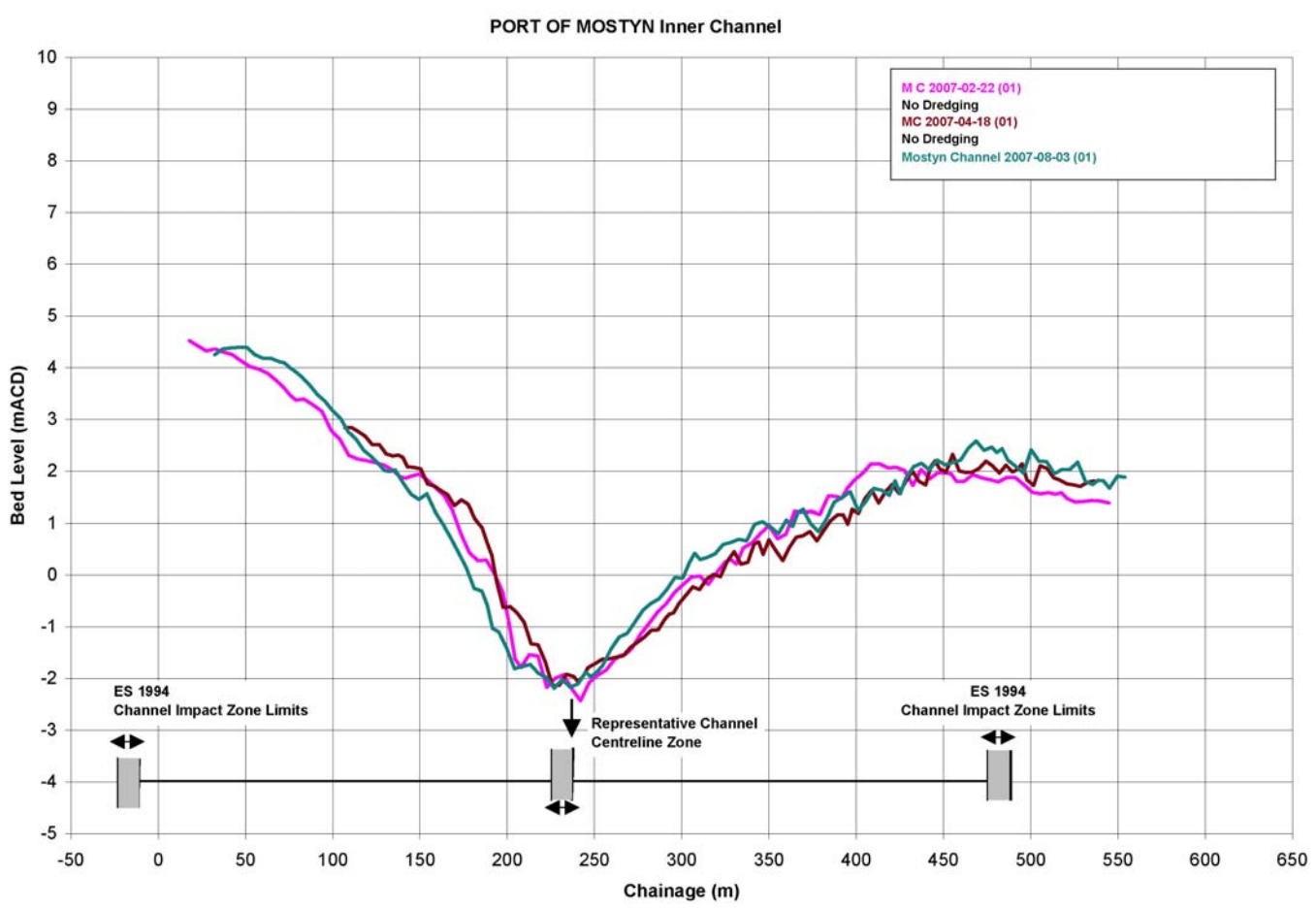






Dwg C1 (4 of 14) SECTION 06





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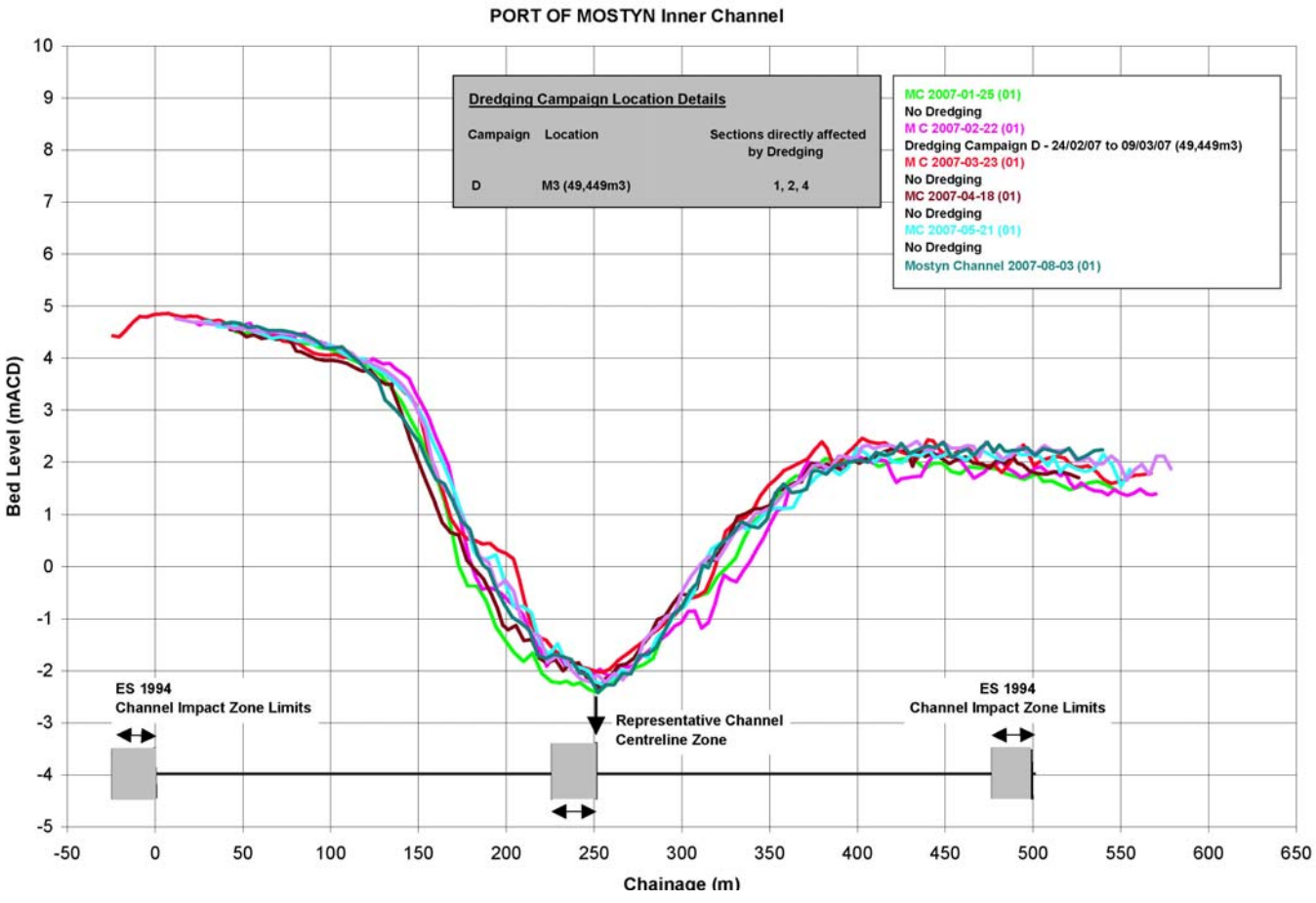

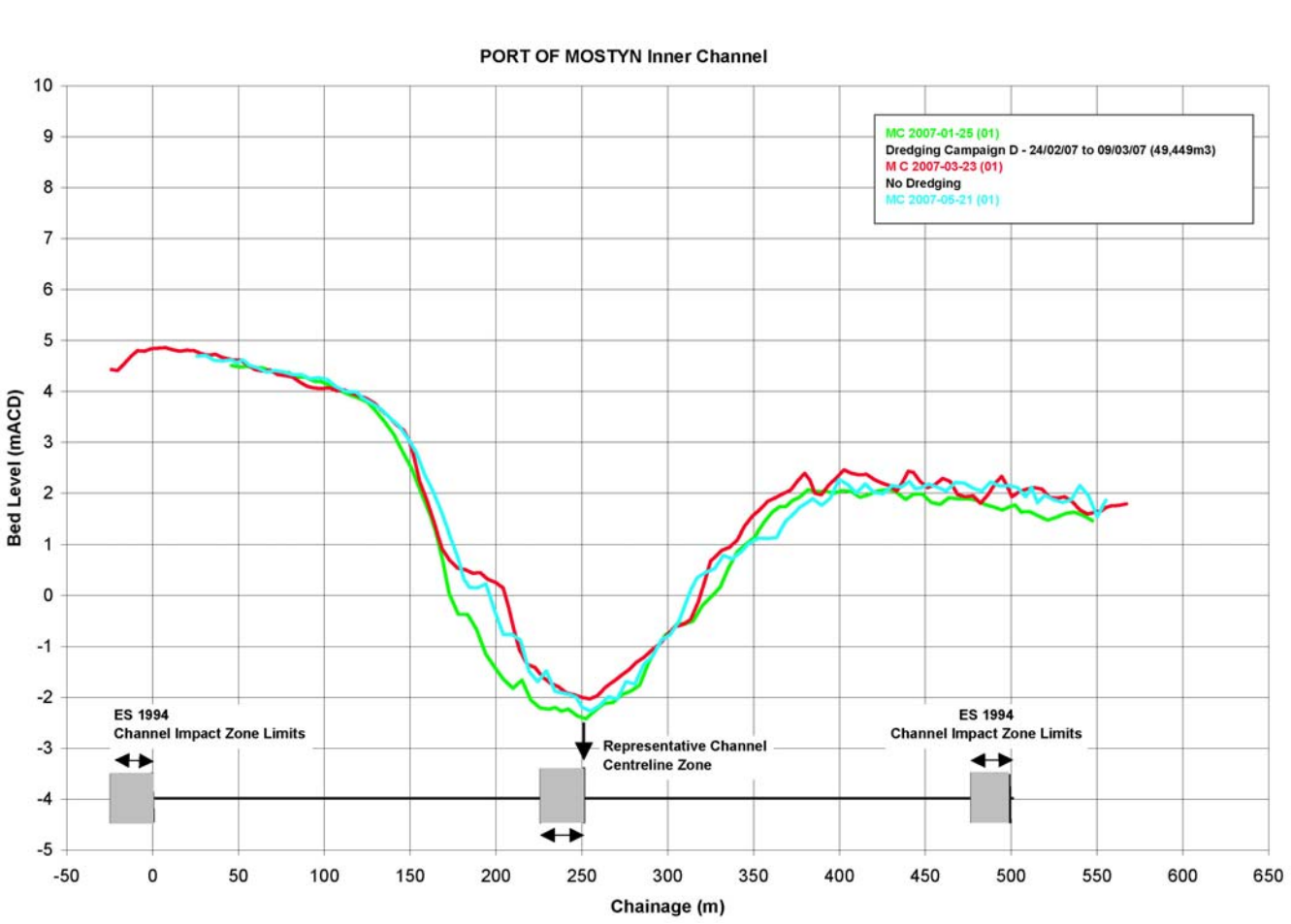

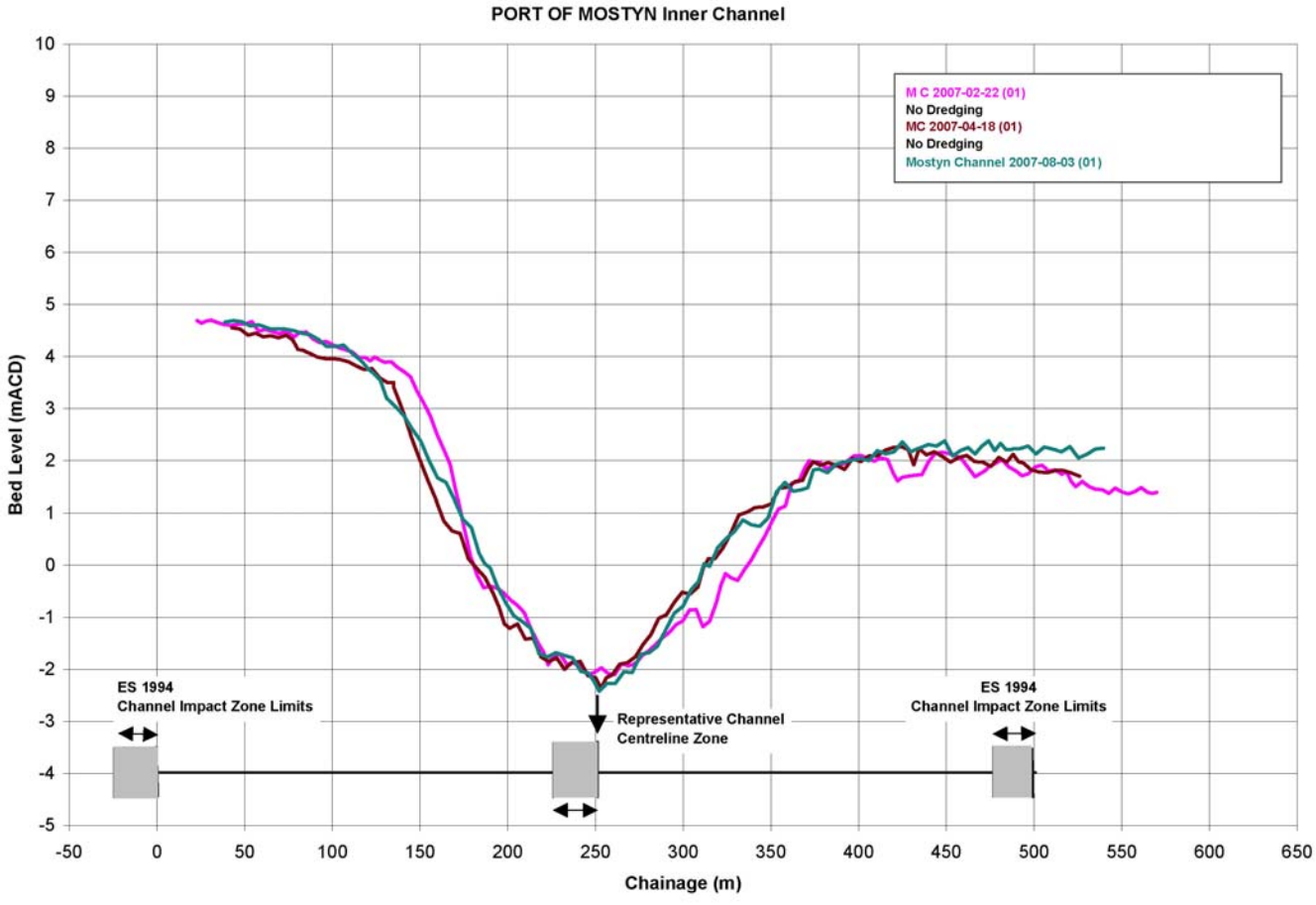

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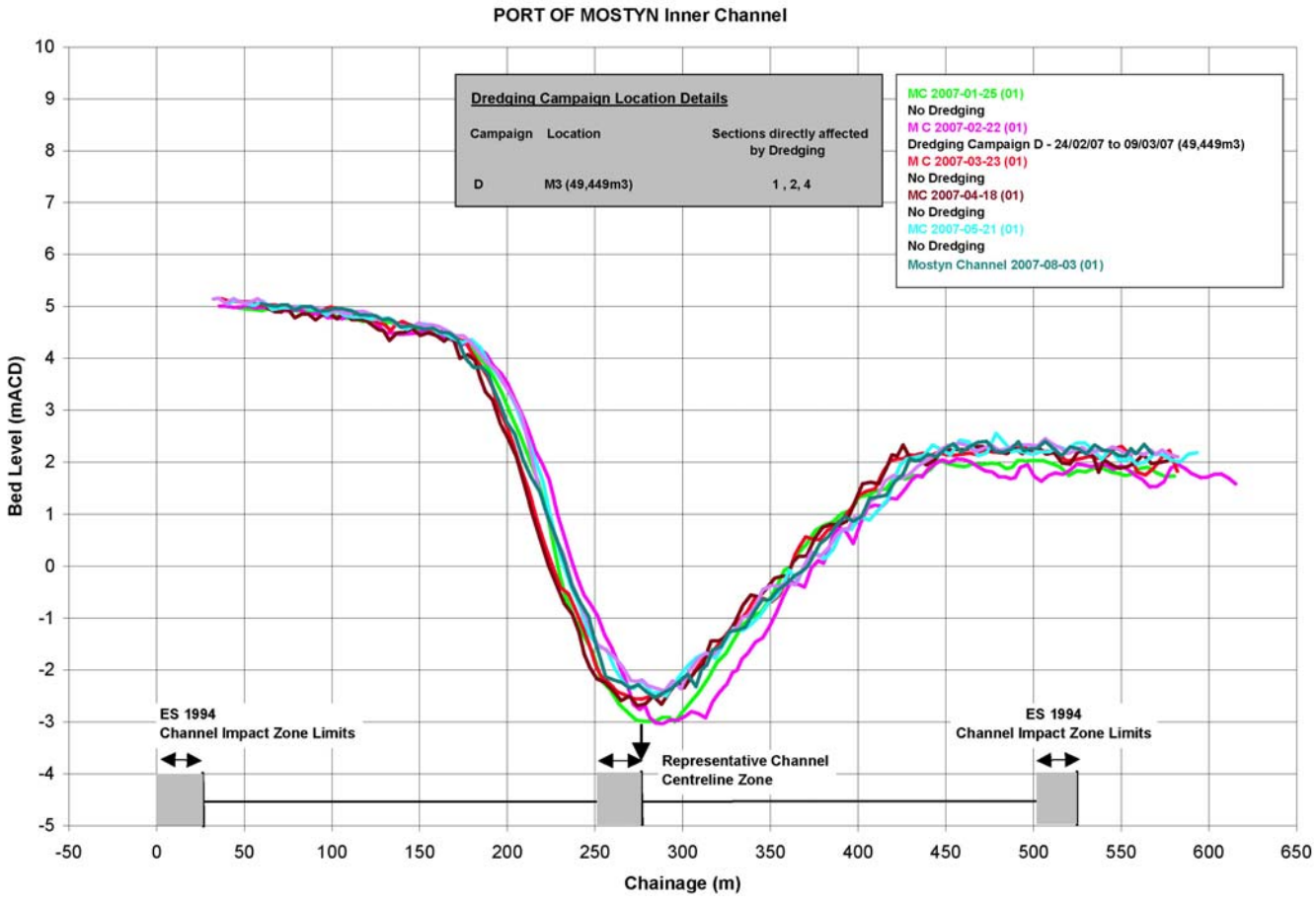
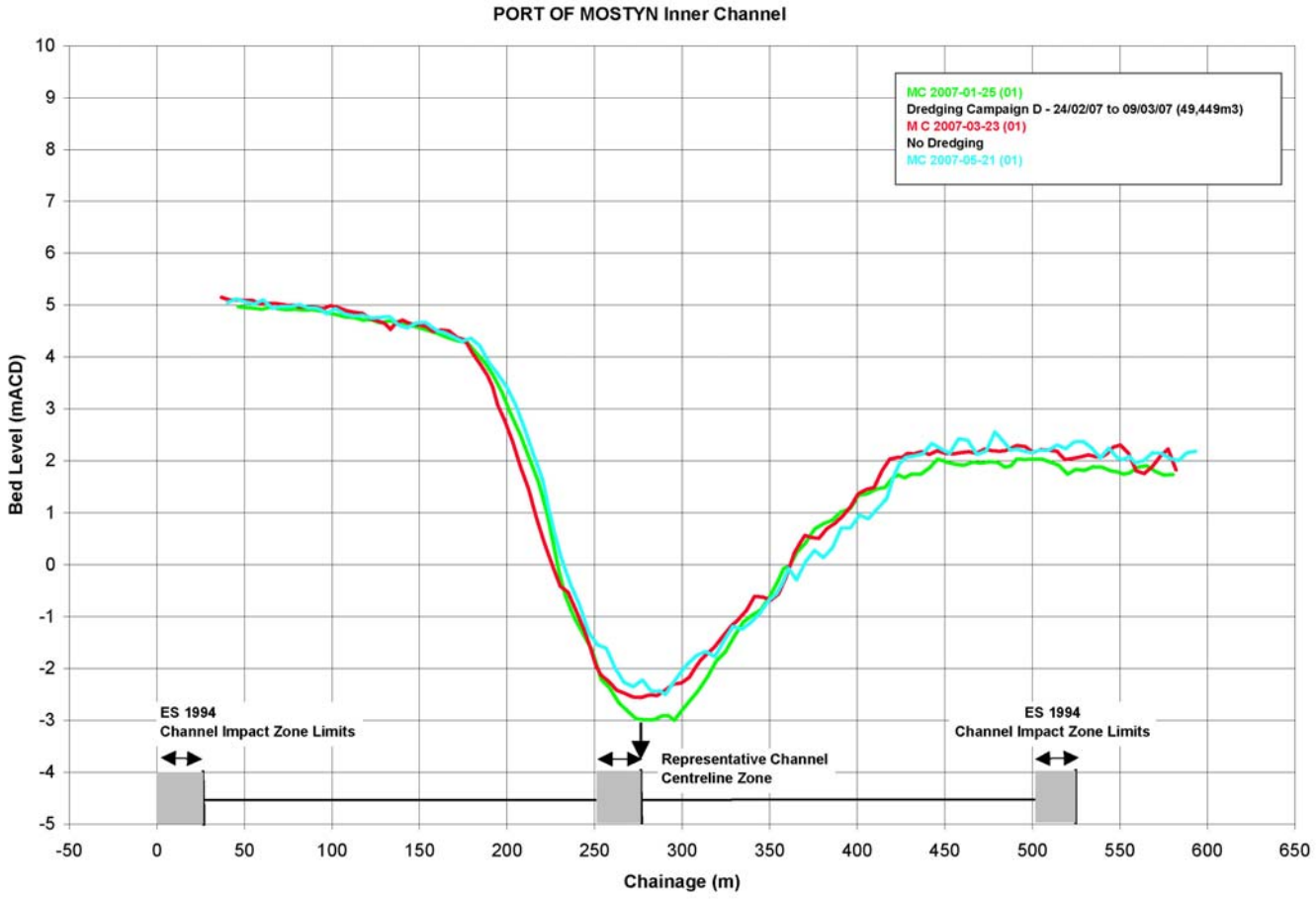
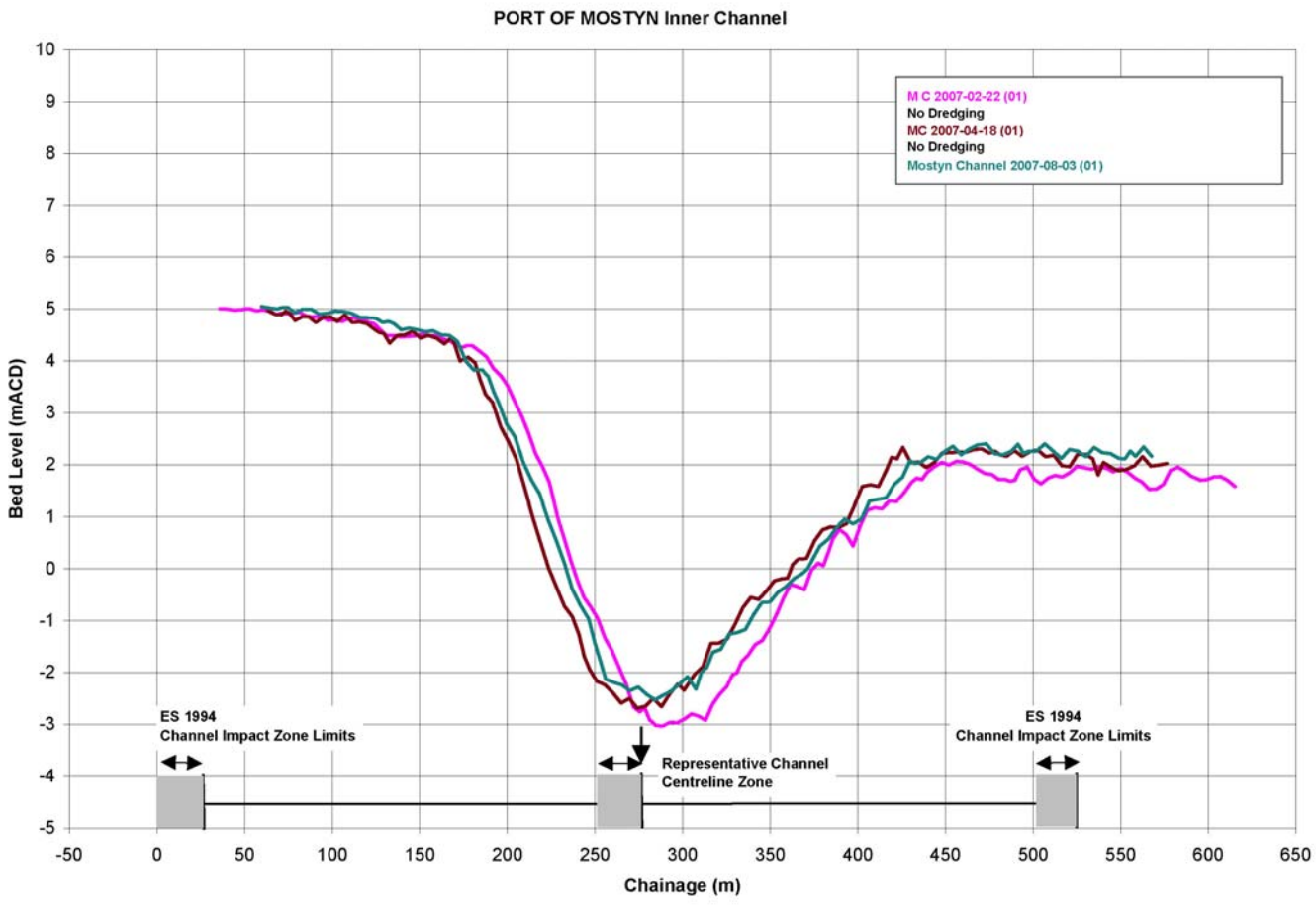
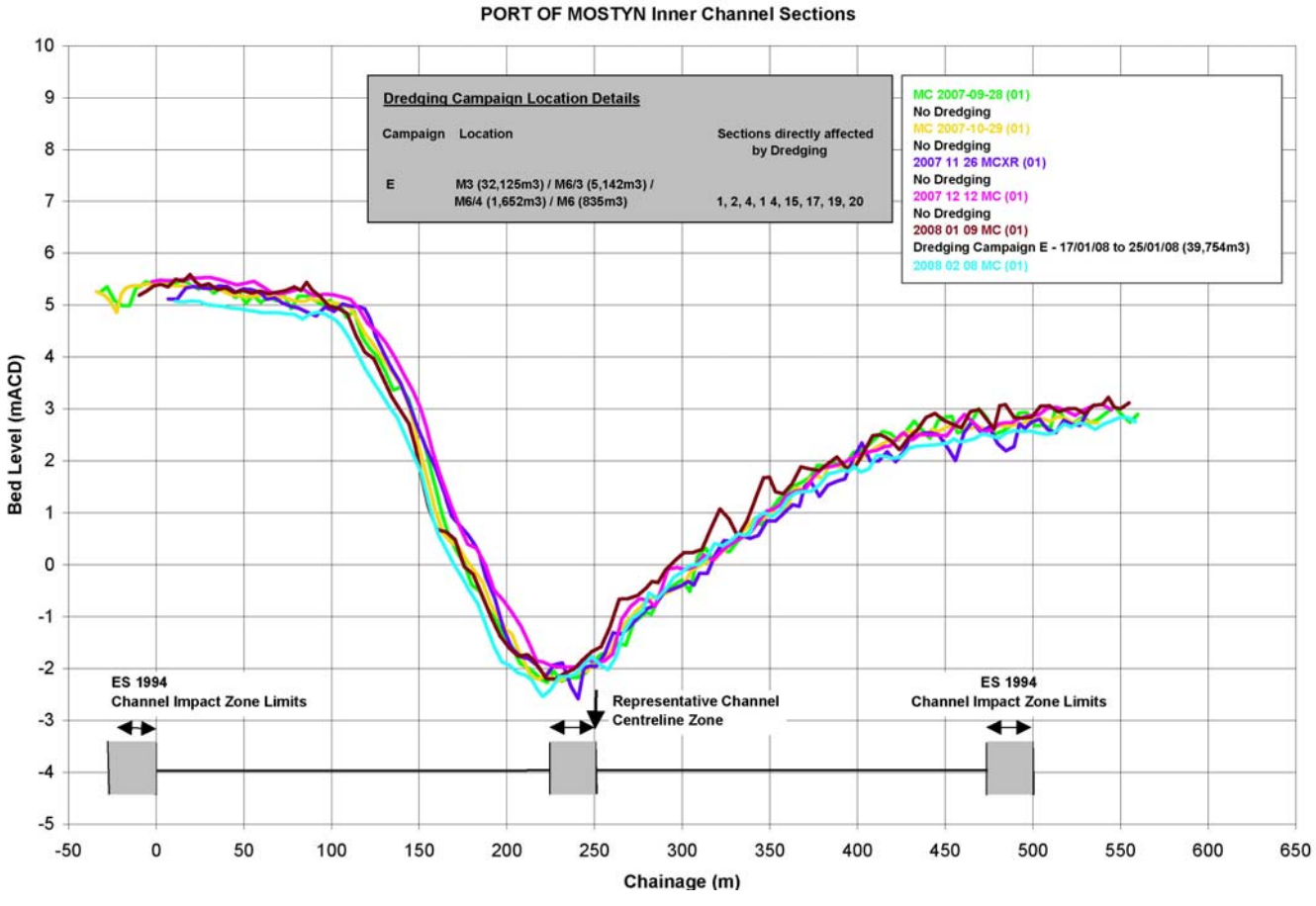
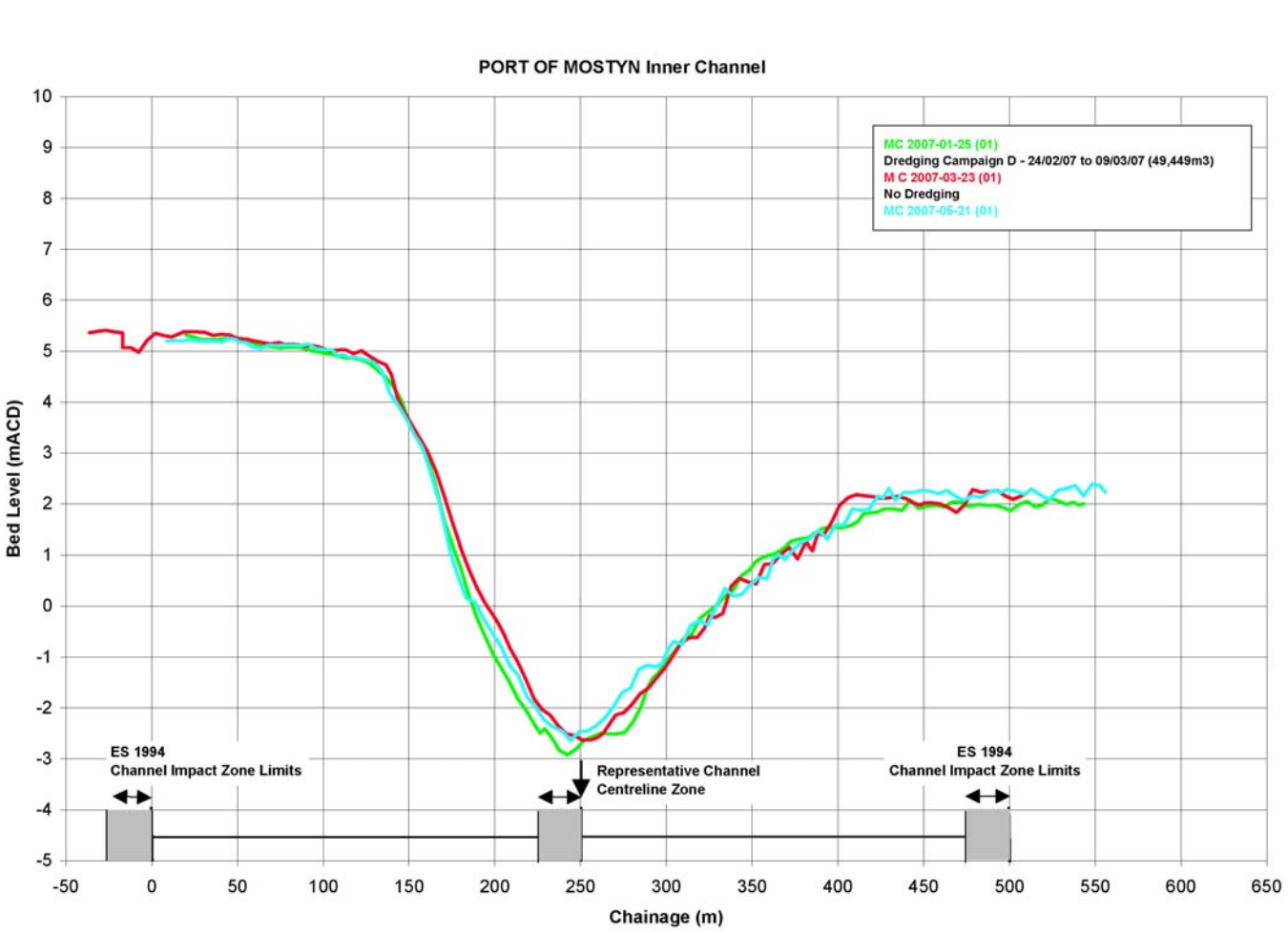


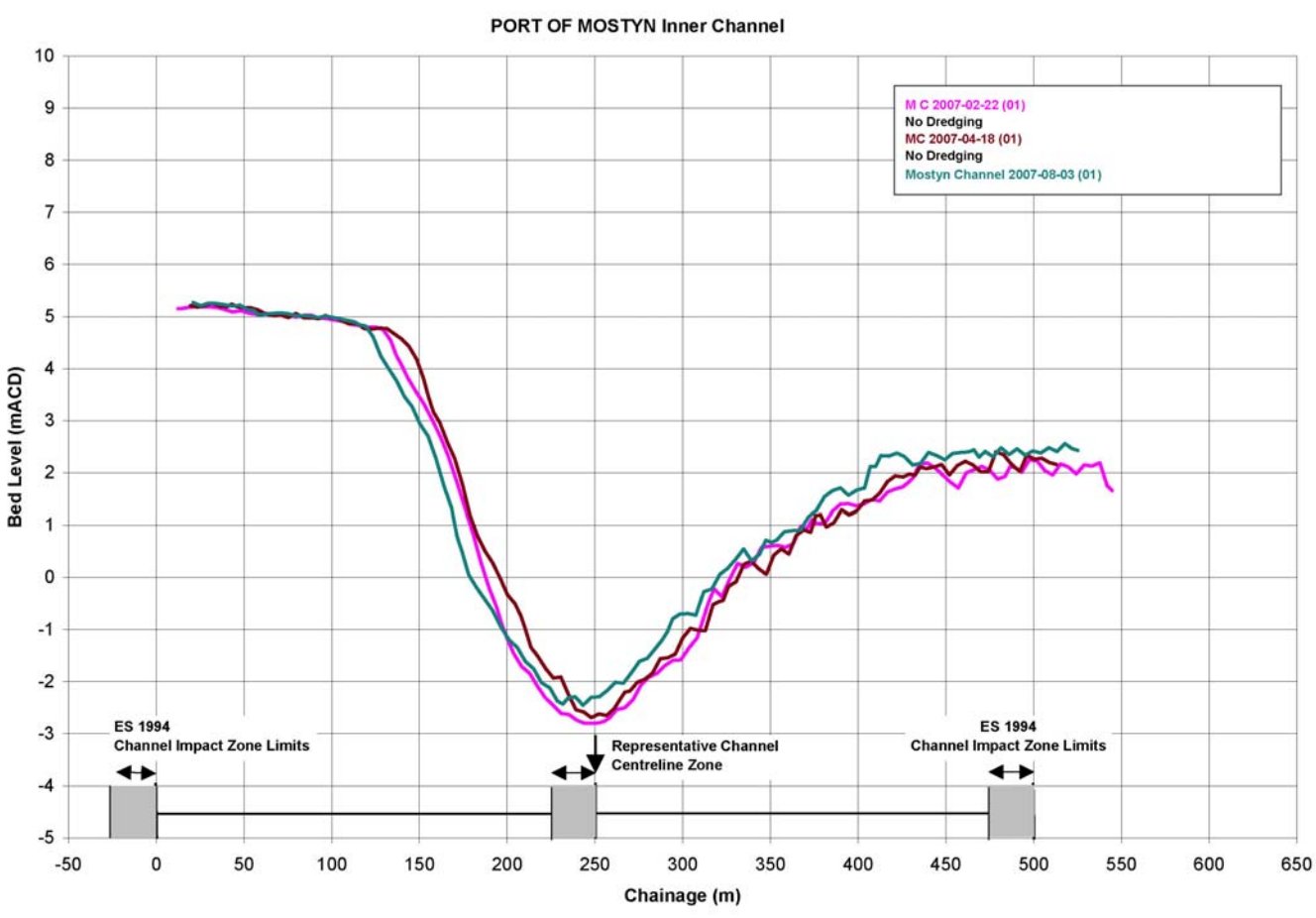




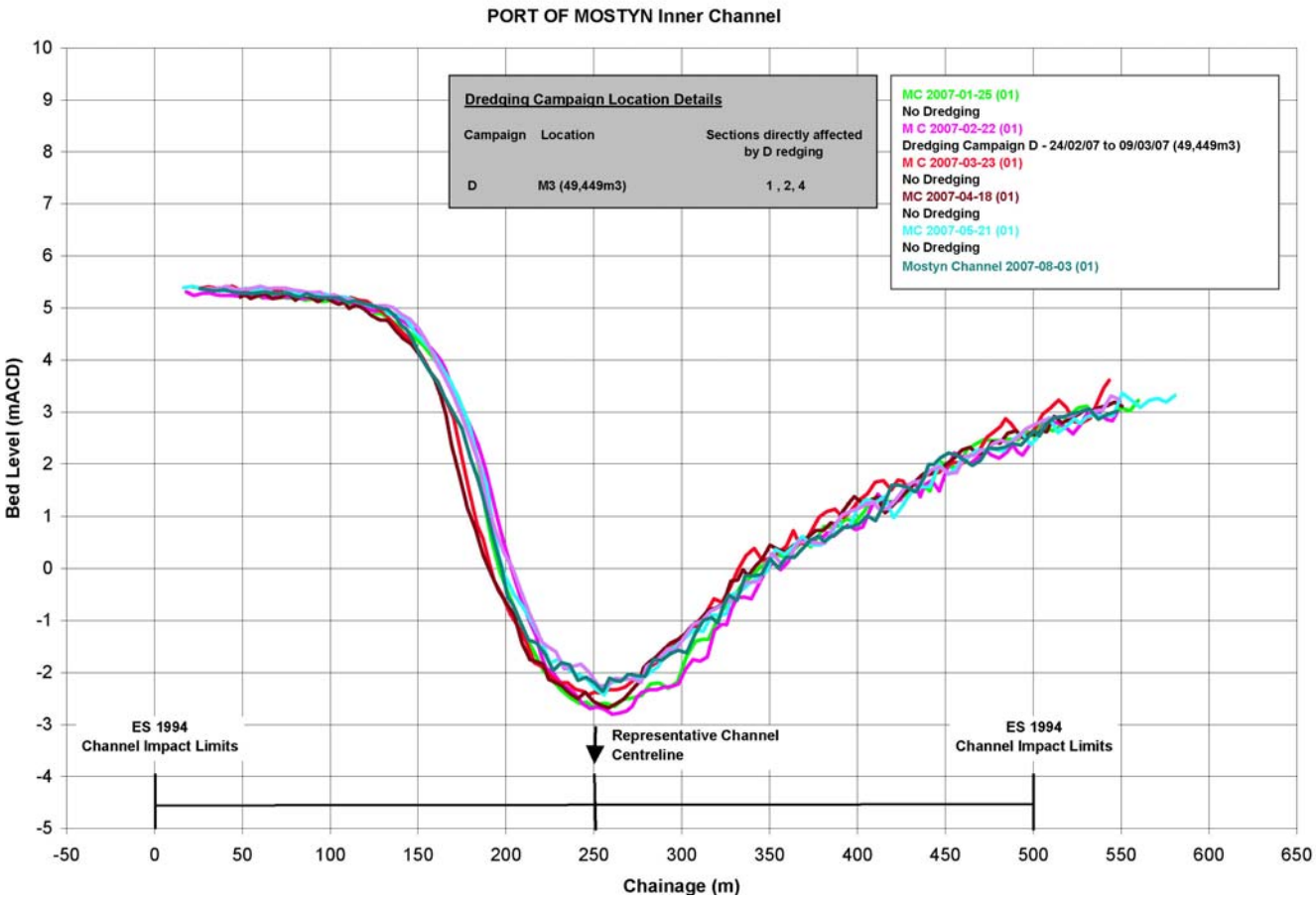
Dwg C1 (7 of 14) SECTION 10

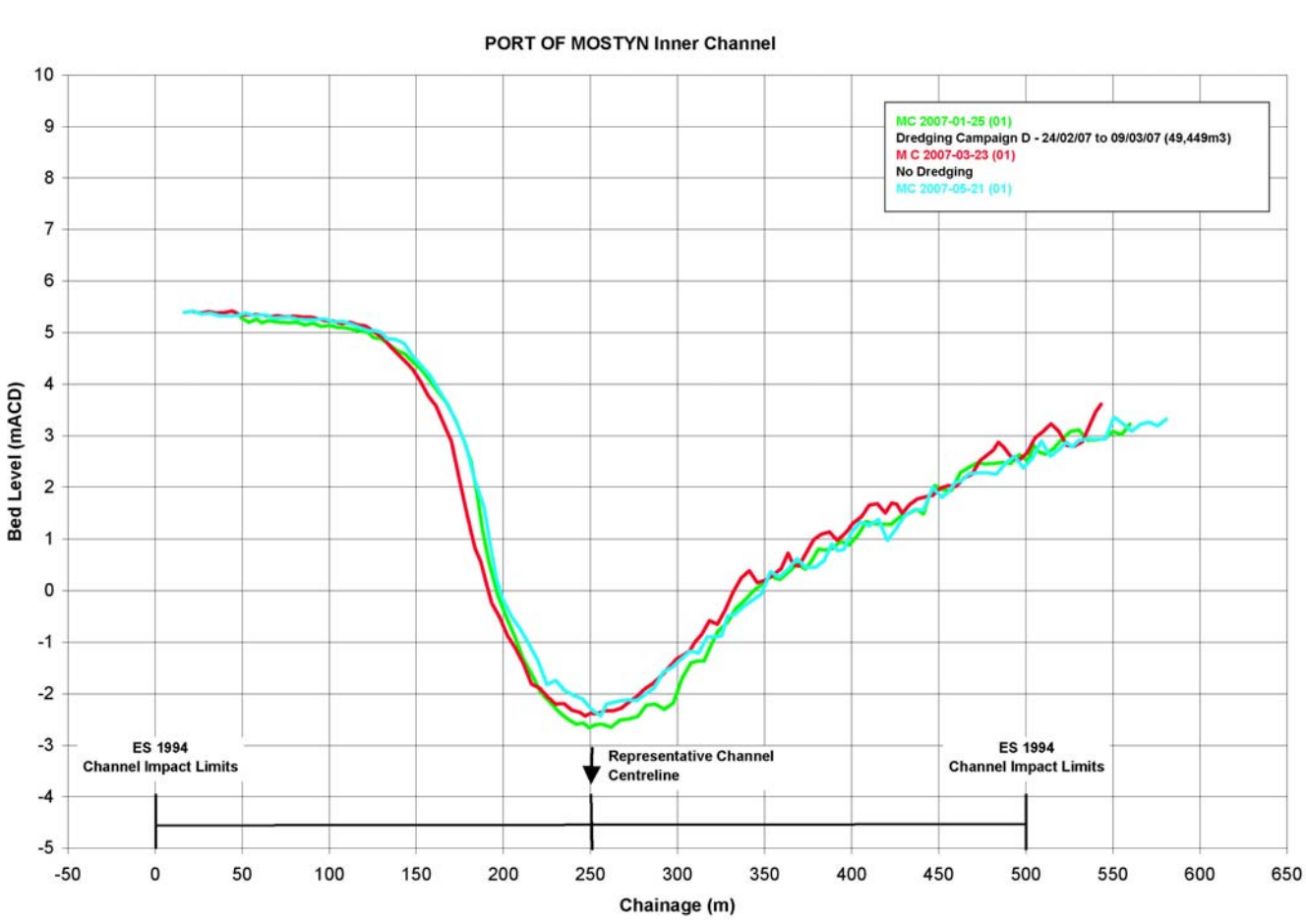


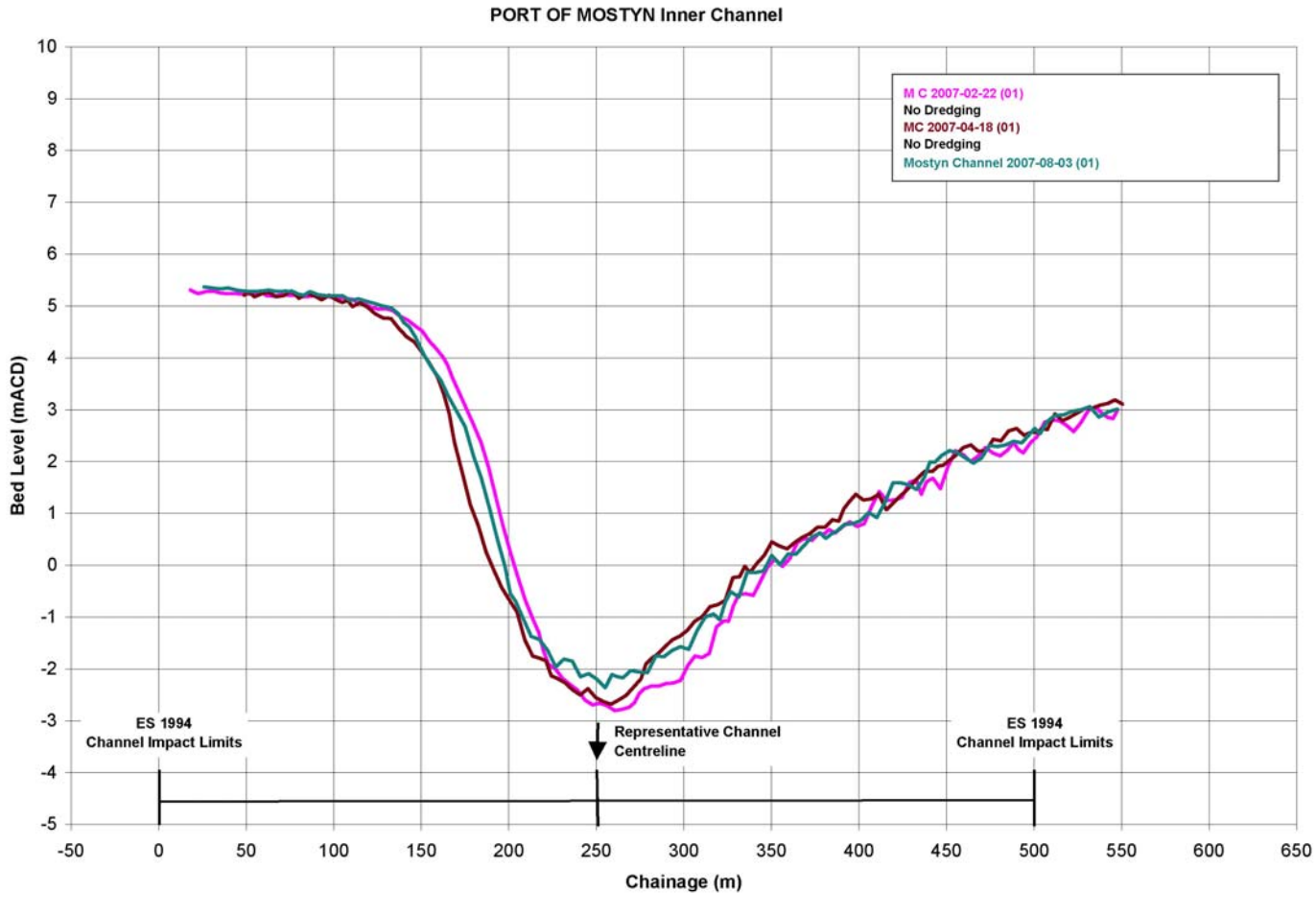




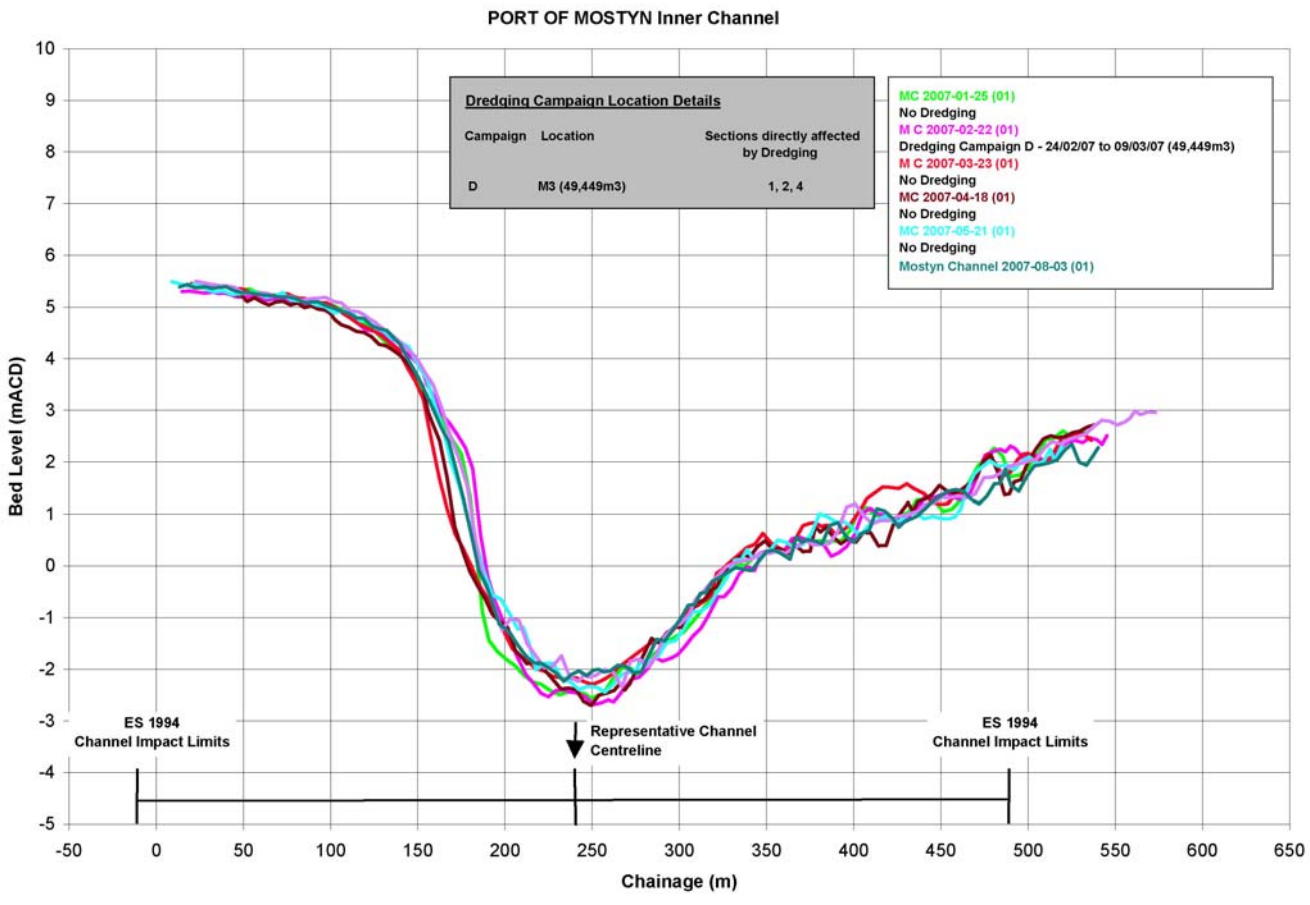
Dwg C1 (8 of 14) SECTION 11

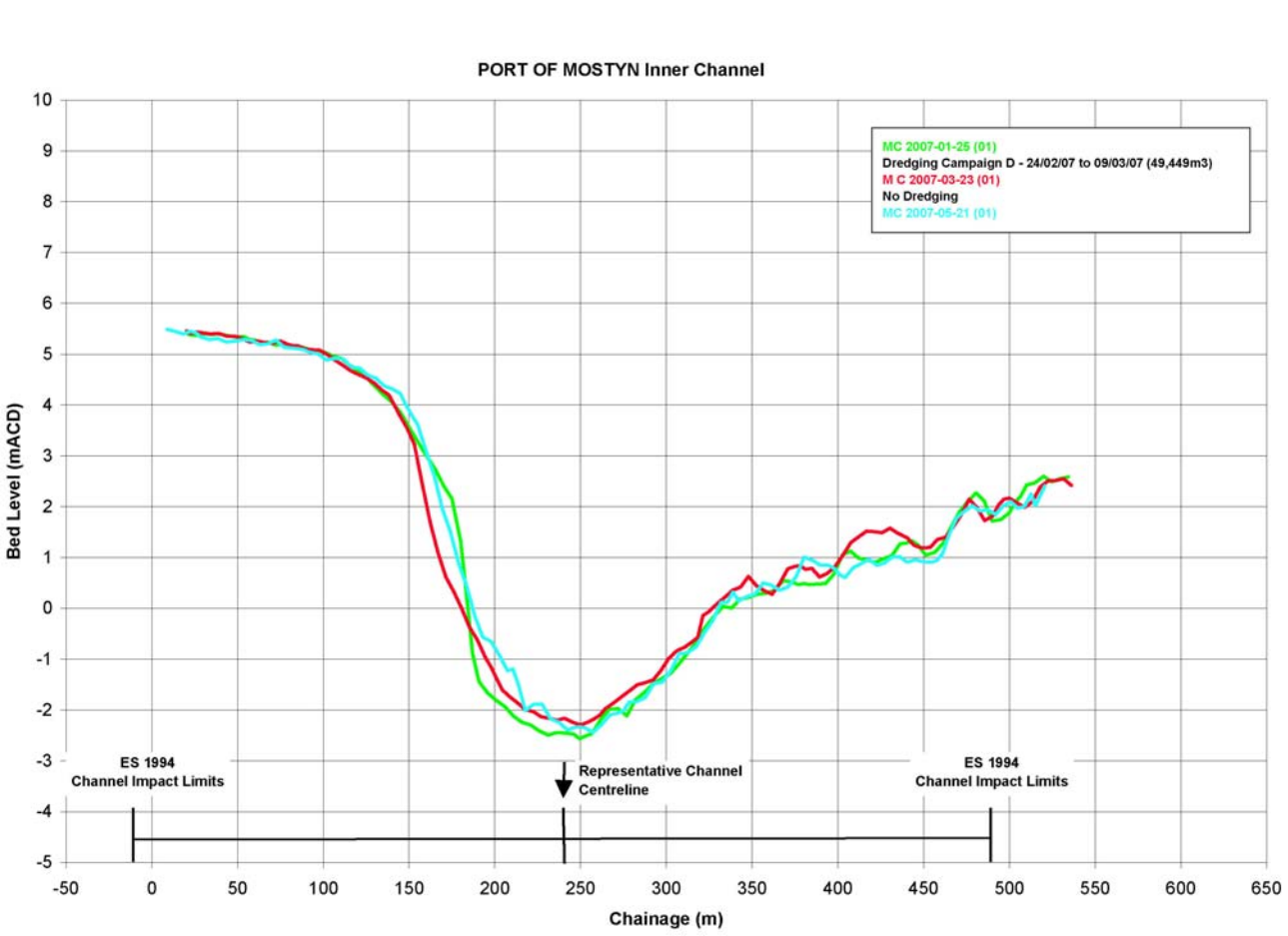




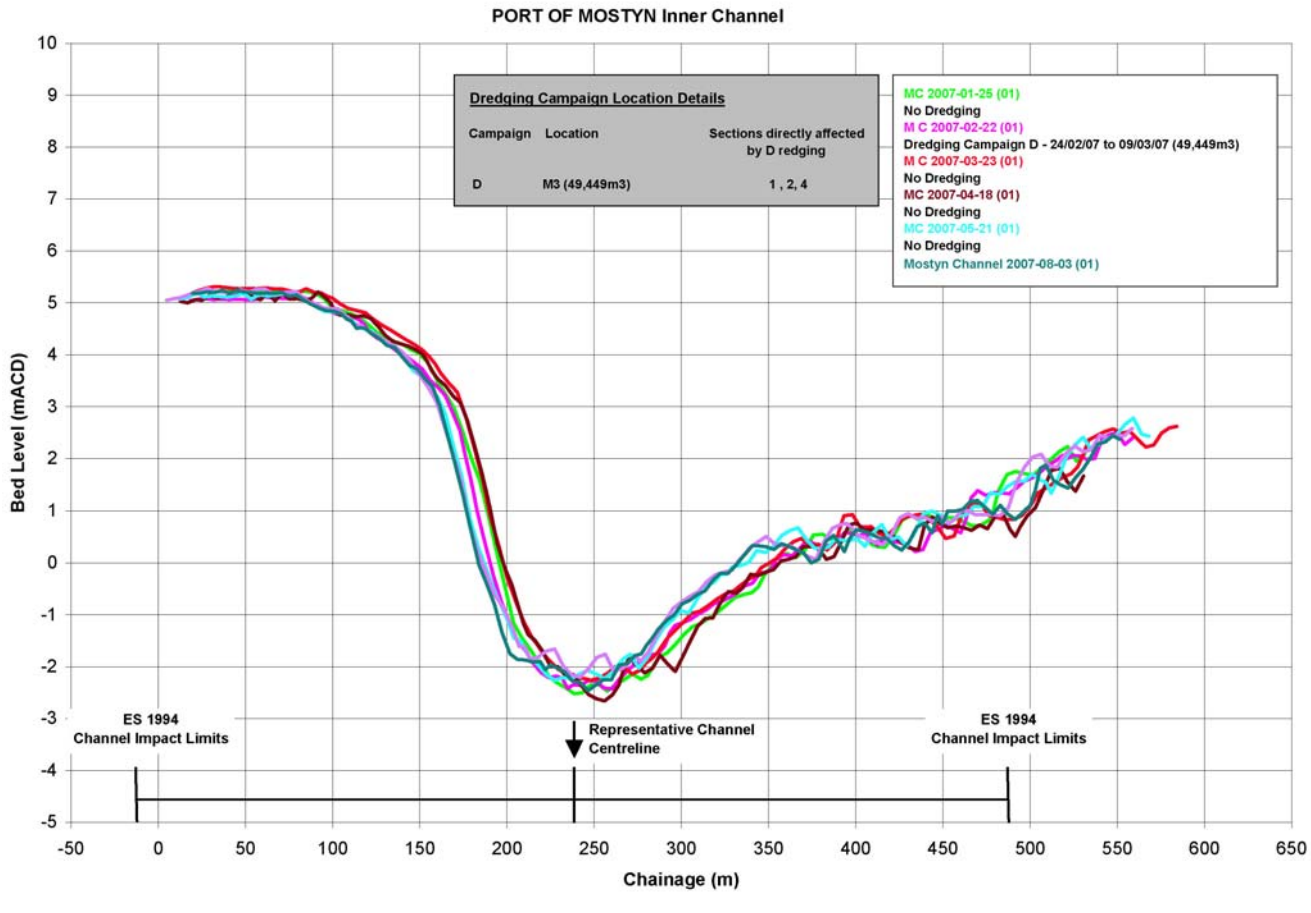


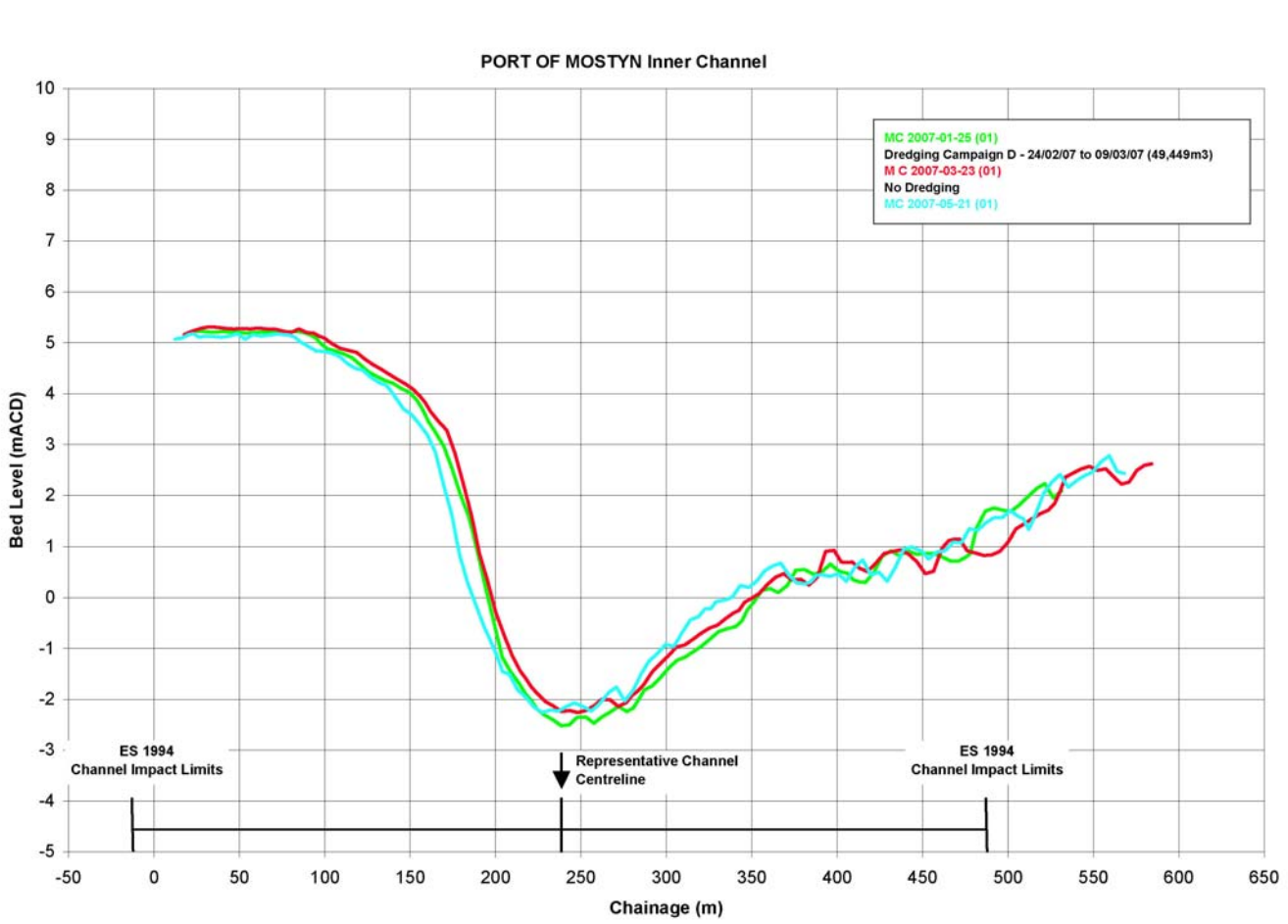
Dwg C1 (9 of 14) SECTION 12

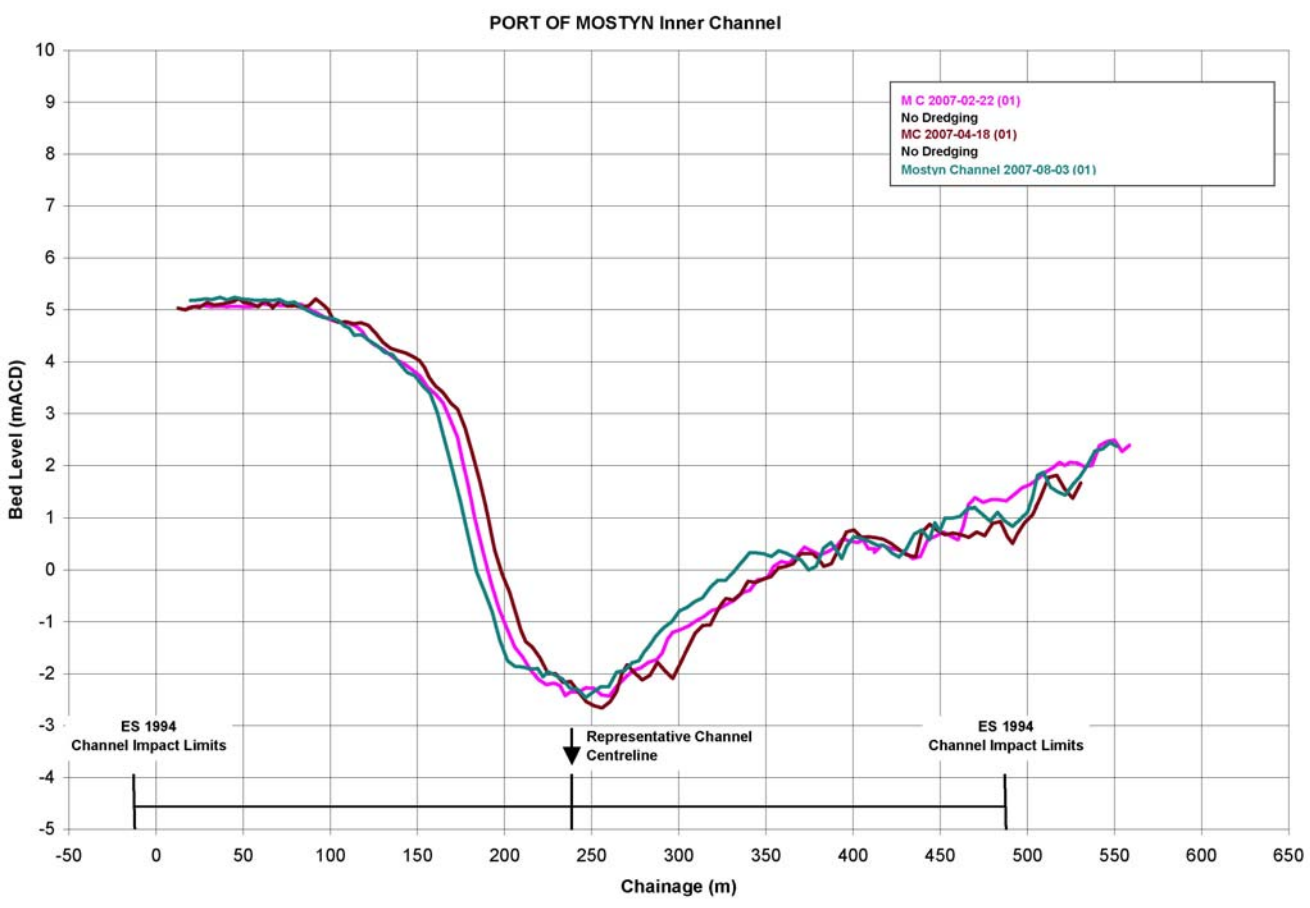




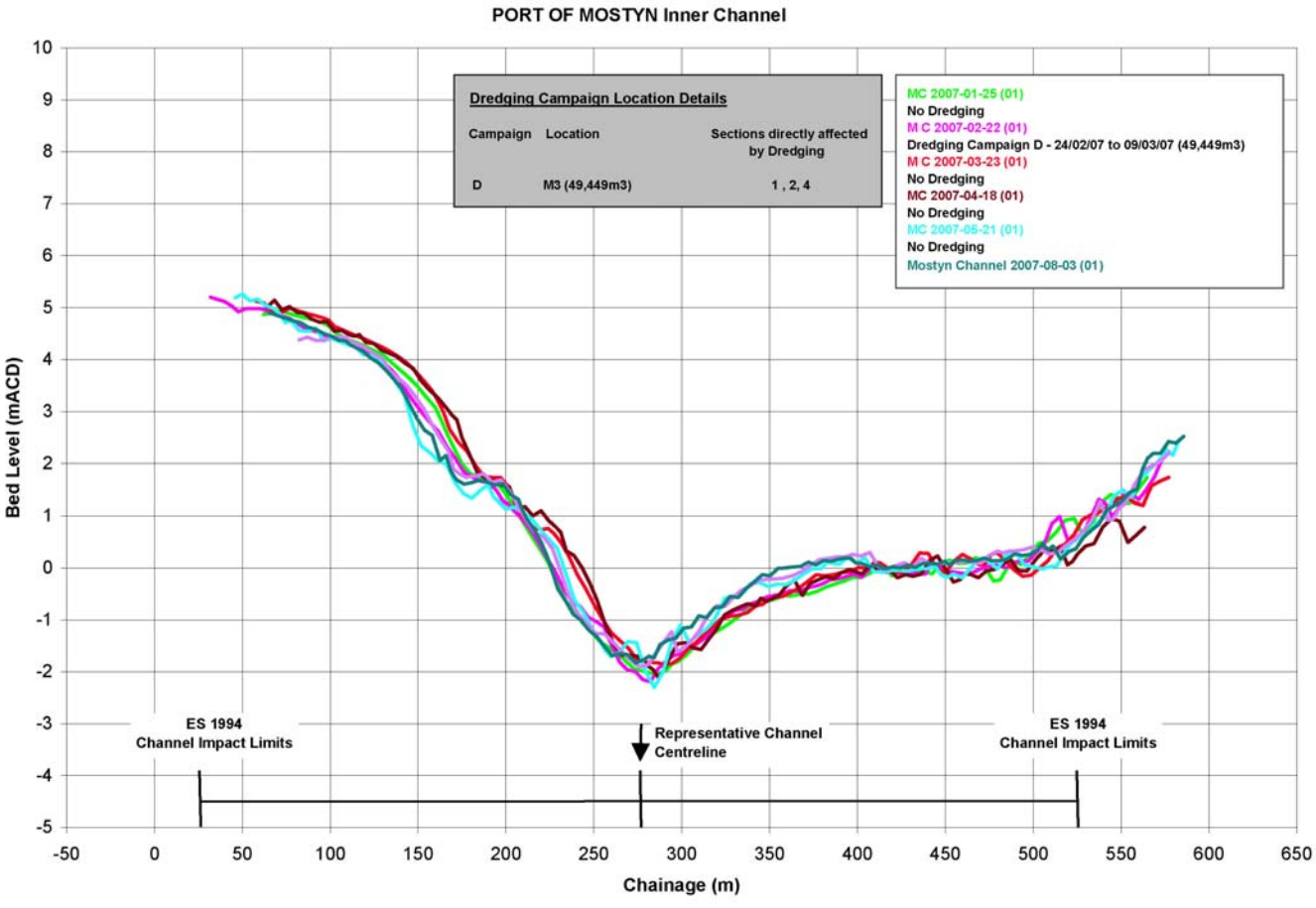
Dwg C1 (10 of 14) SECTION 14

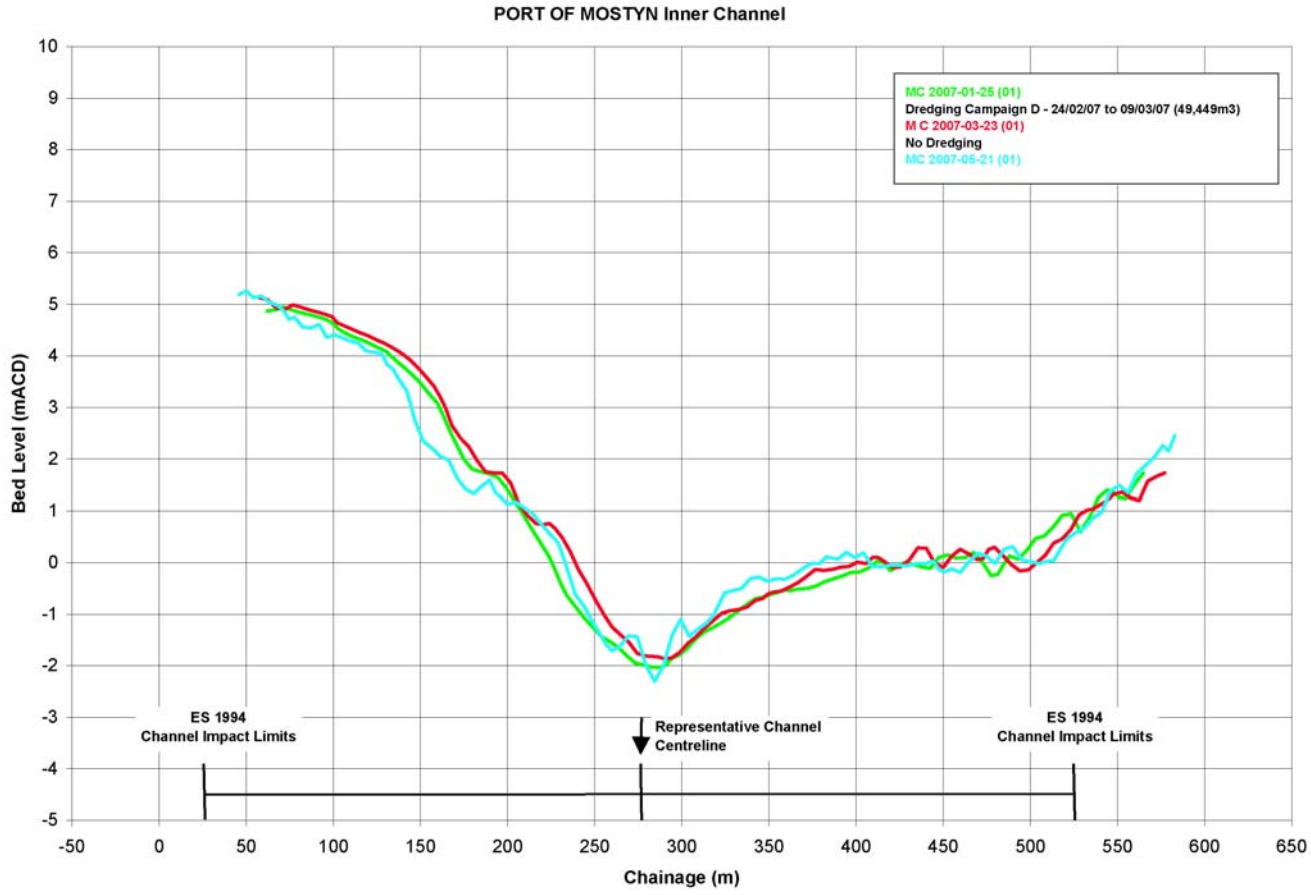


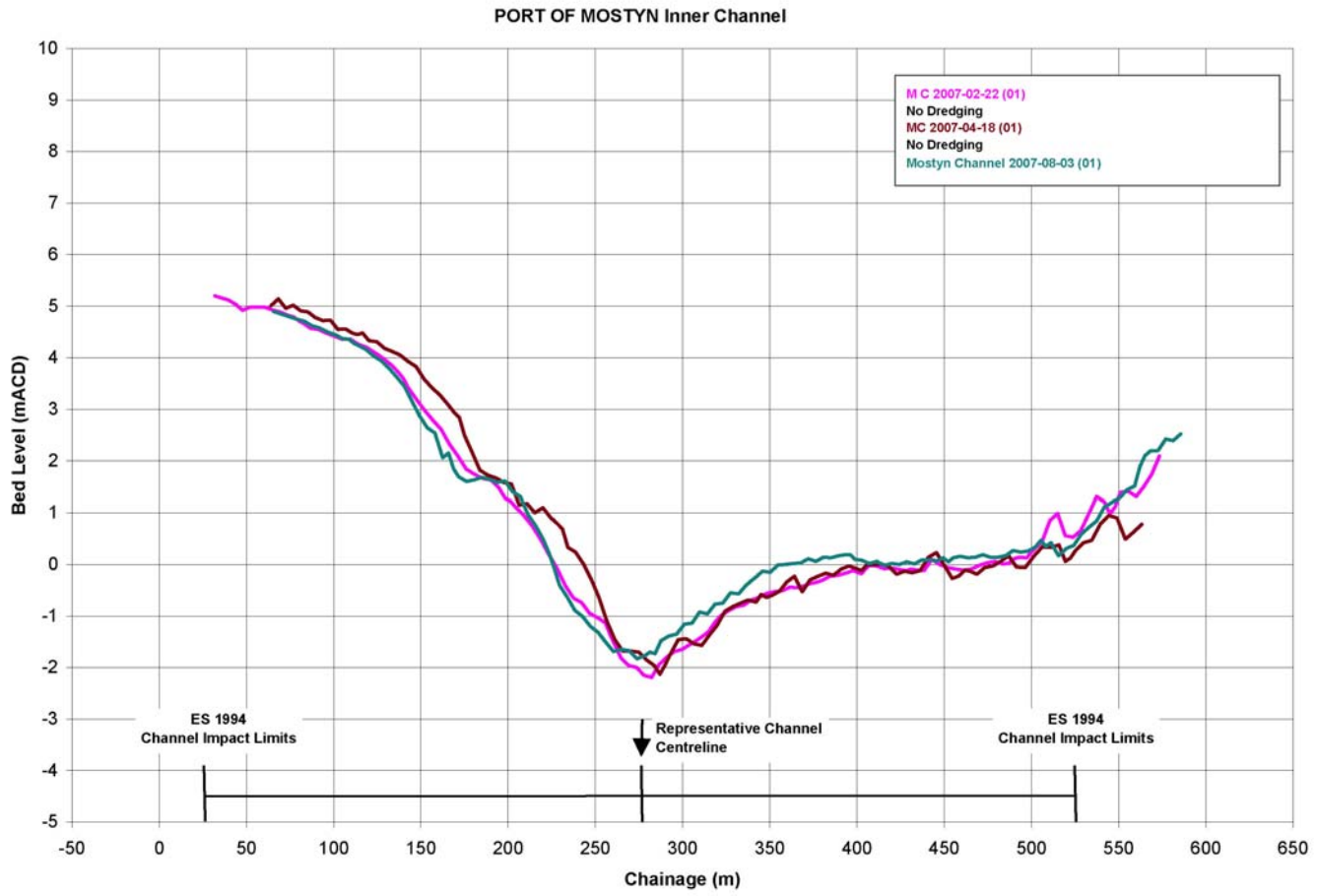




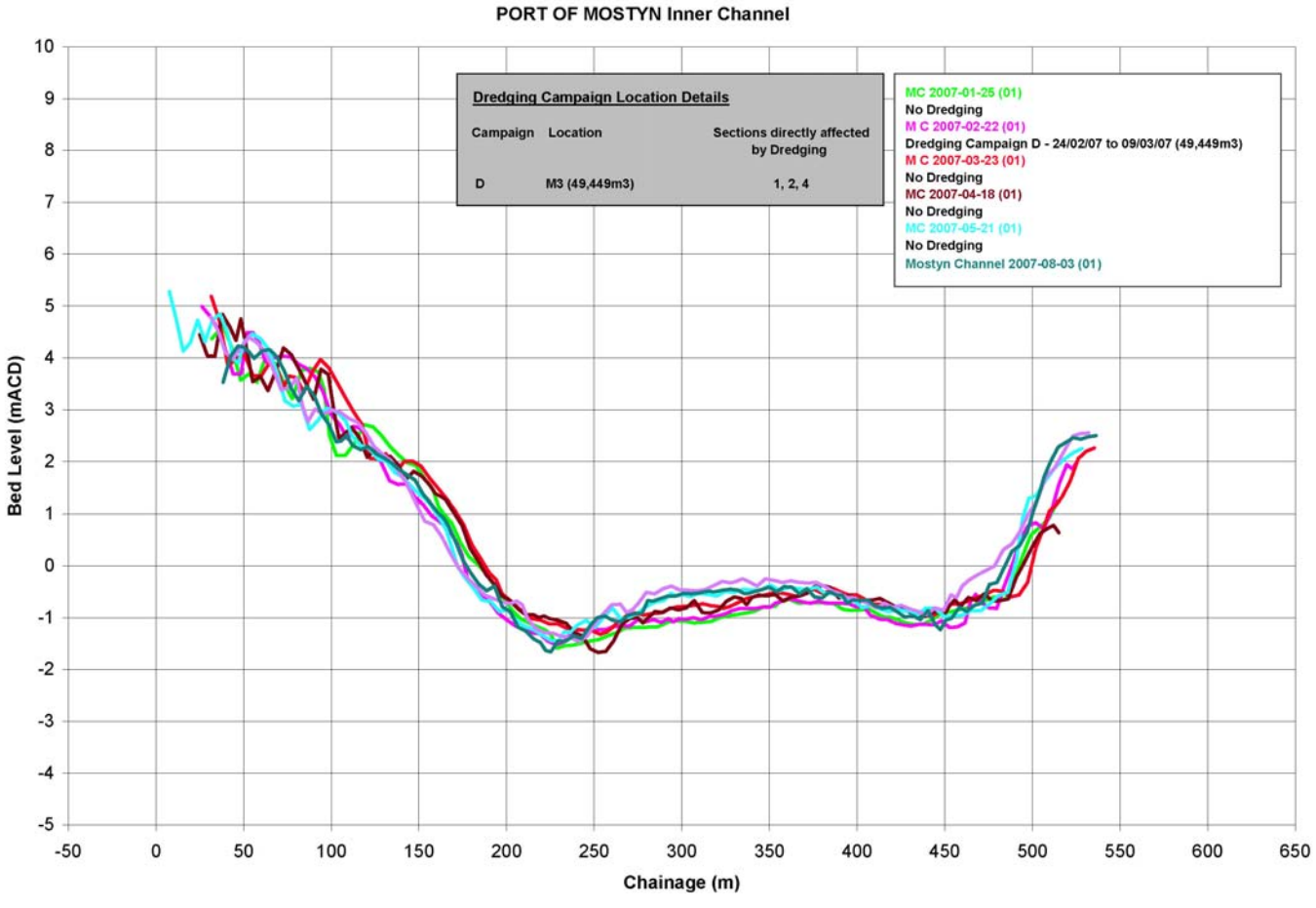
Dwg C1 (11 of 14) SECTION 15

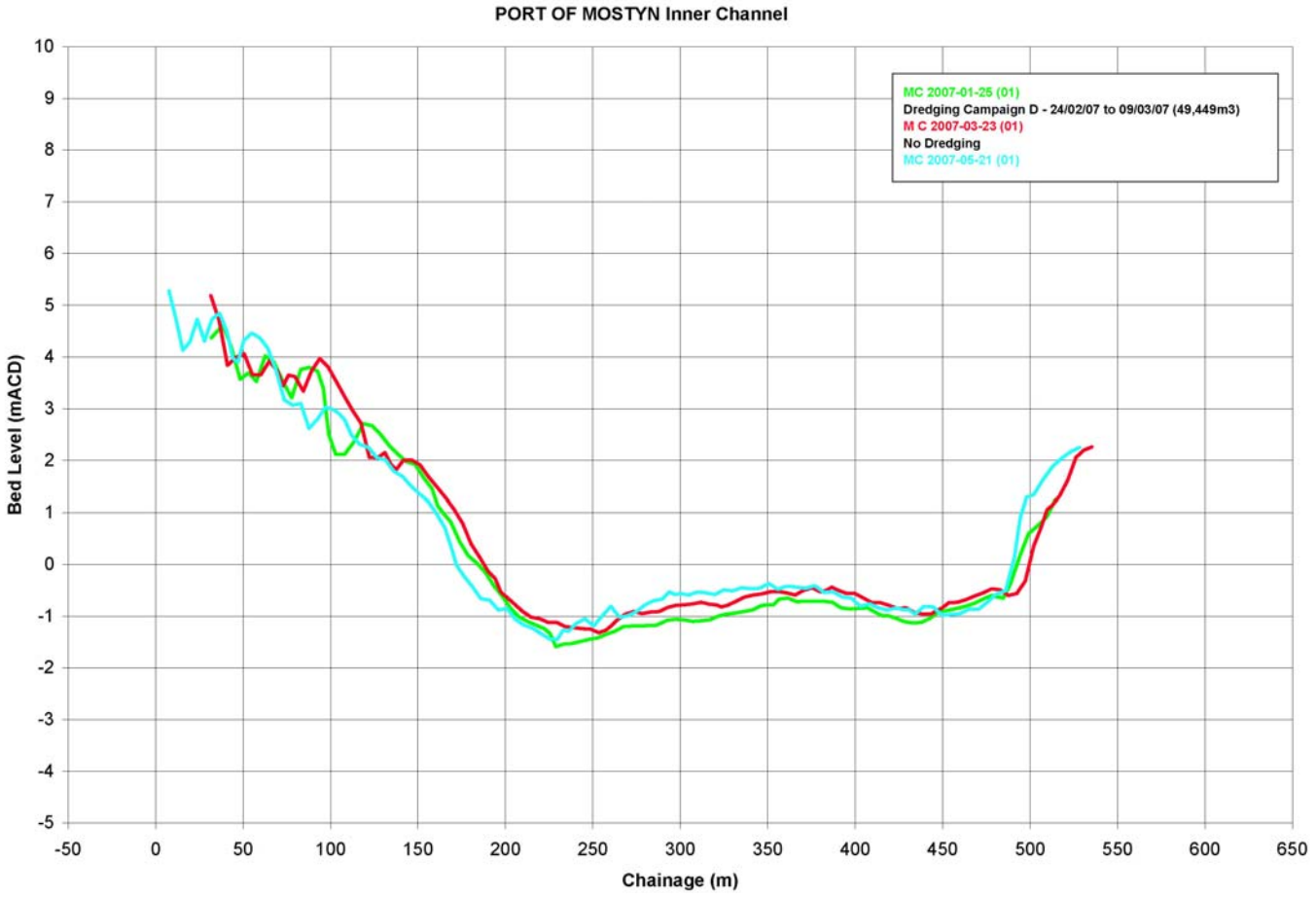


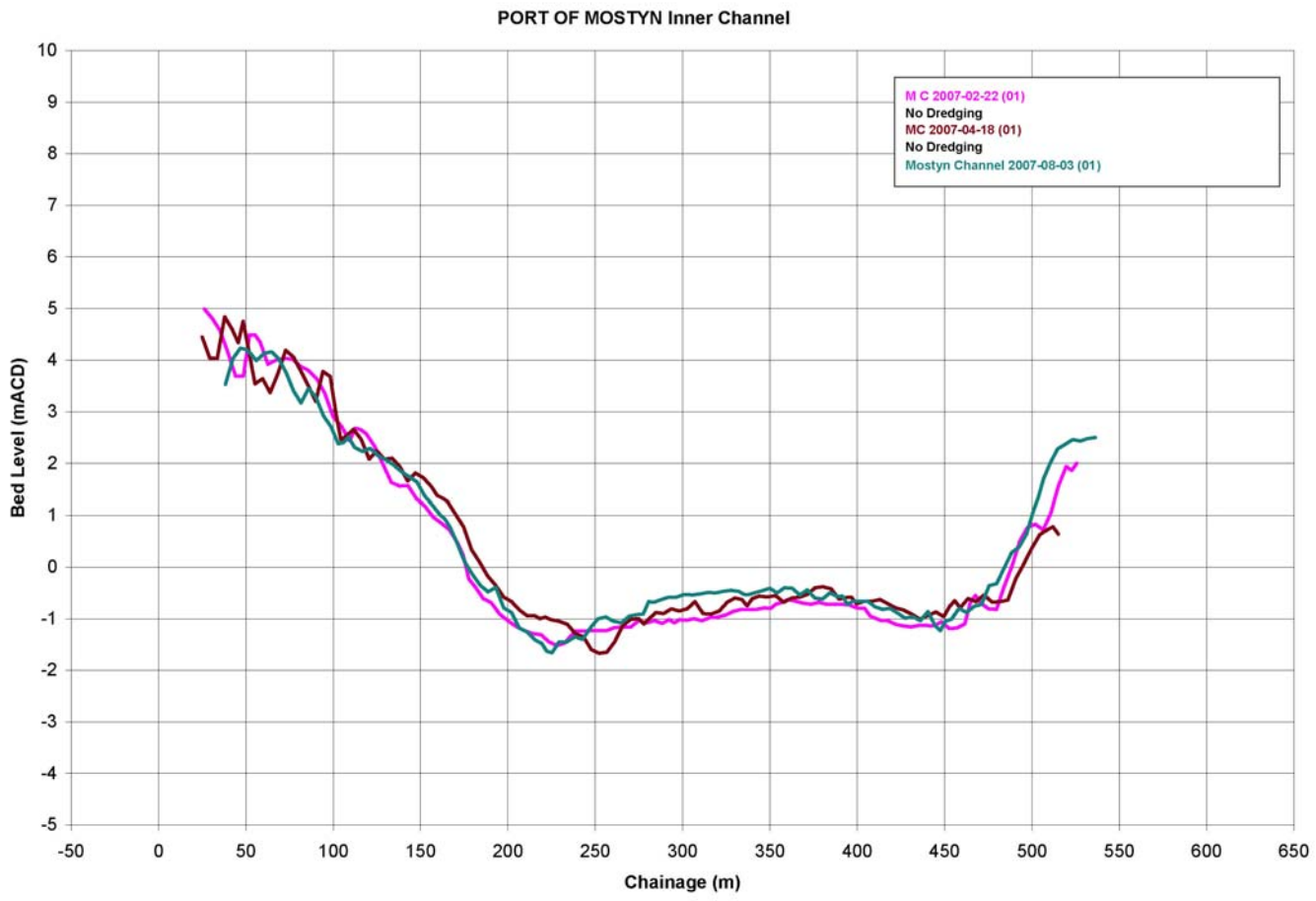




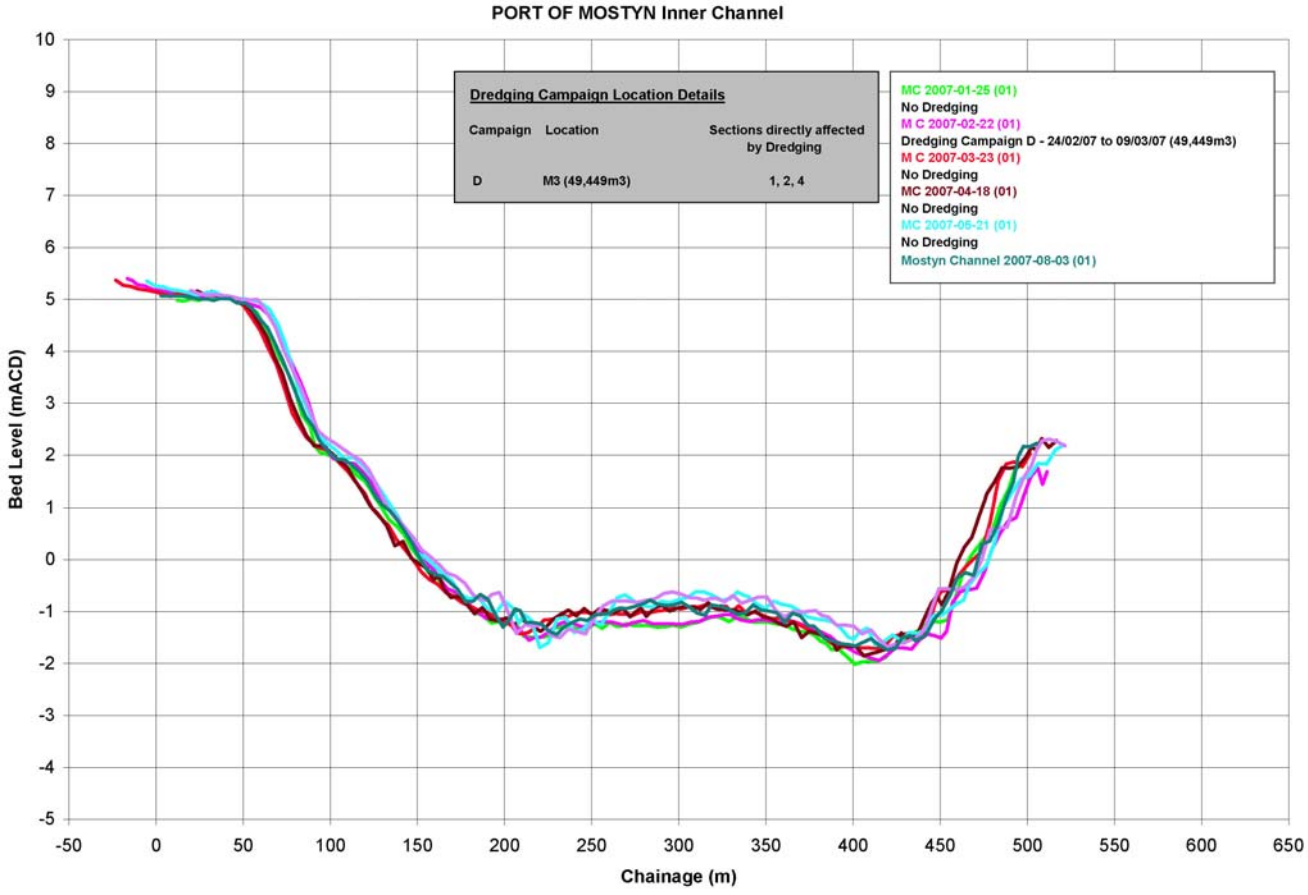
Dwg C1 (12 of 14) SECTION 17

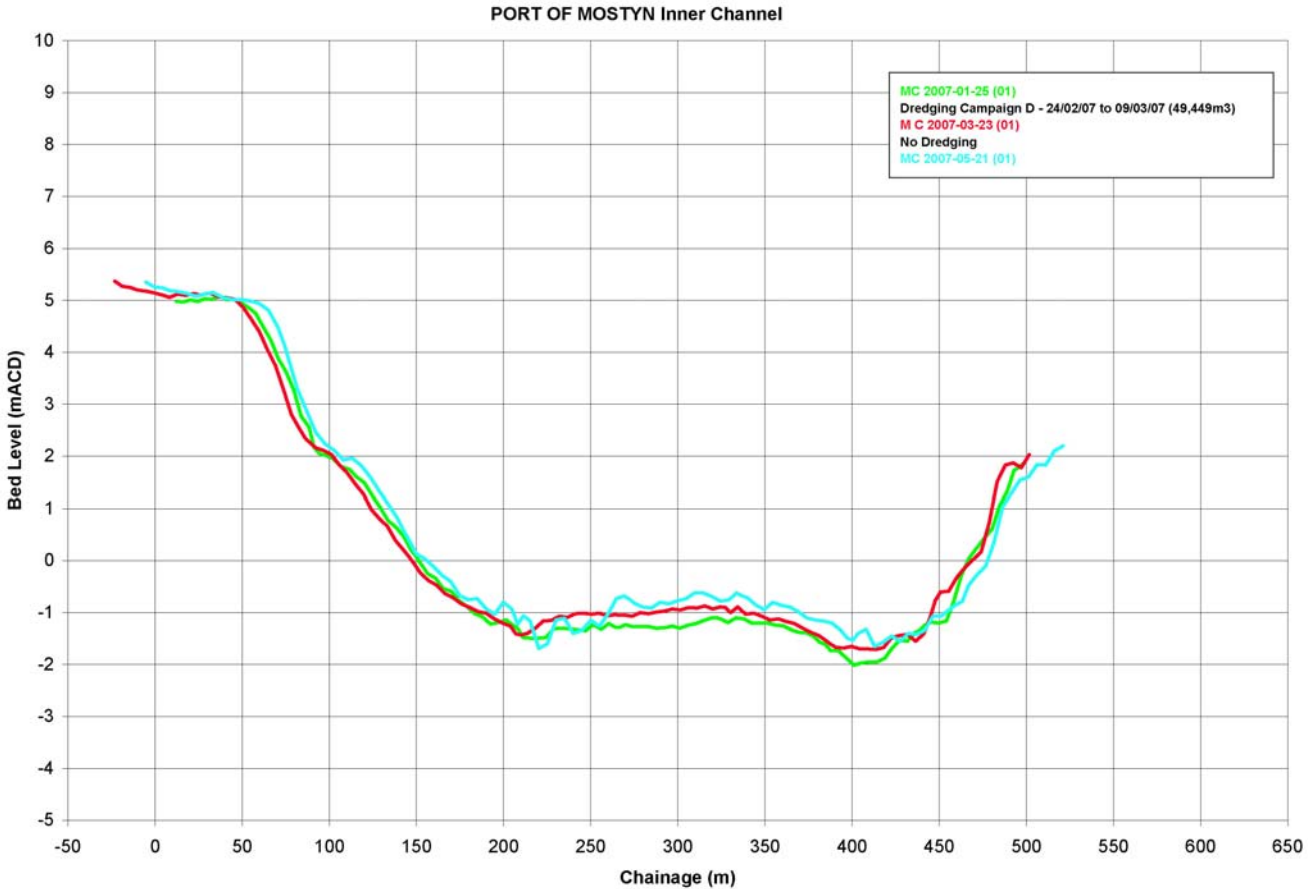


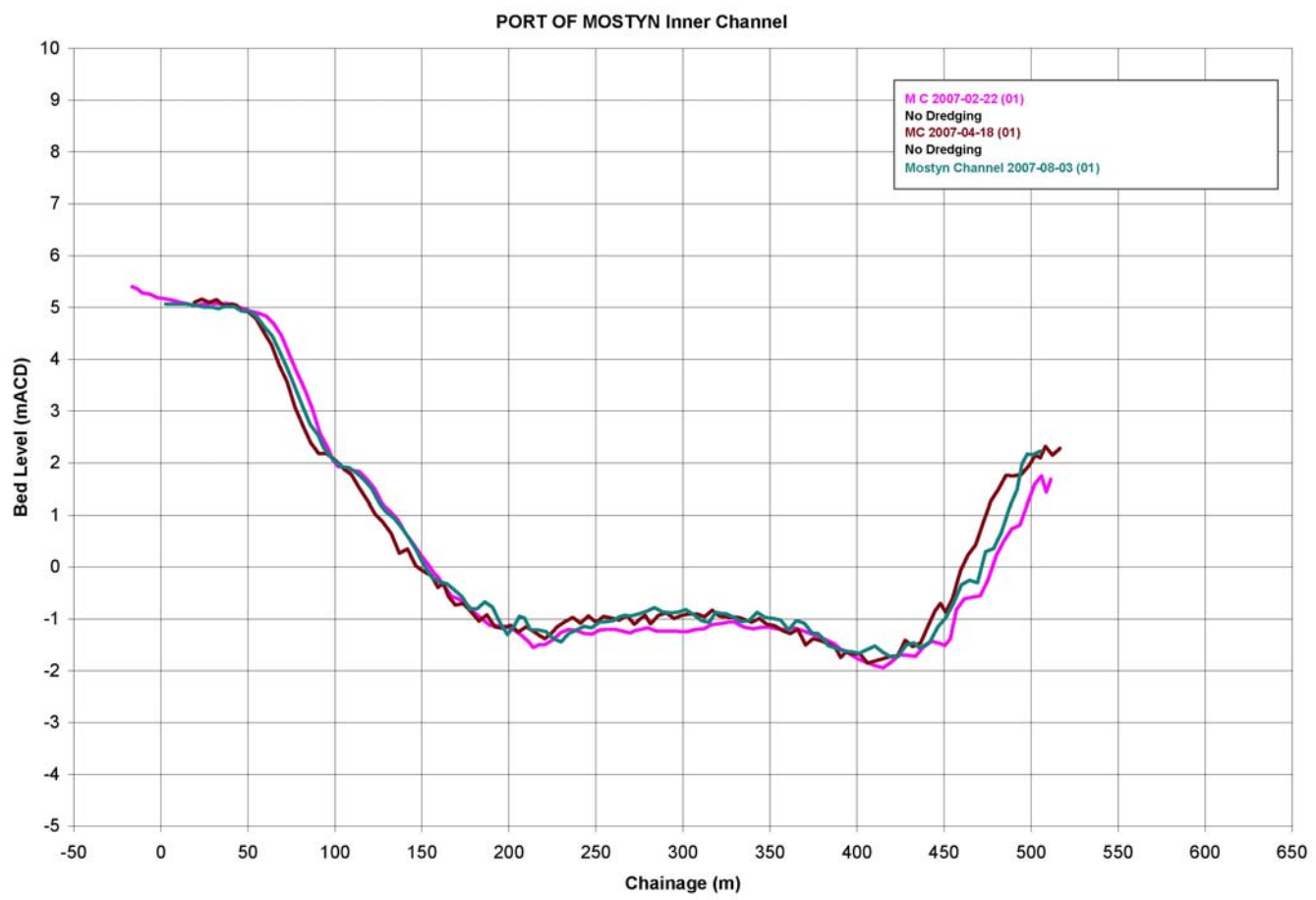




Dwg C1 (13 of 14) SECTION 19







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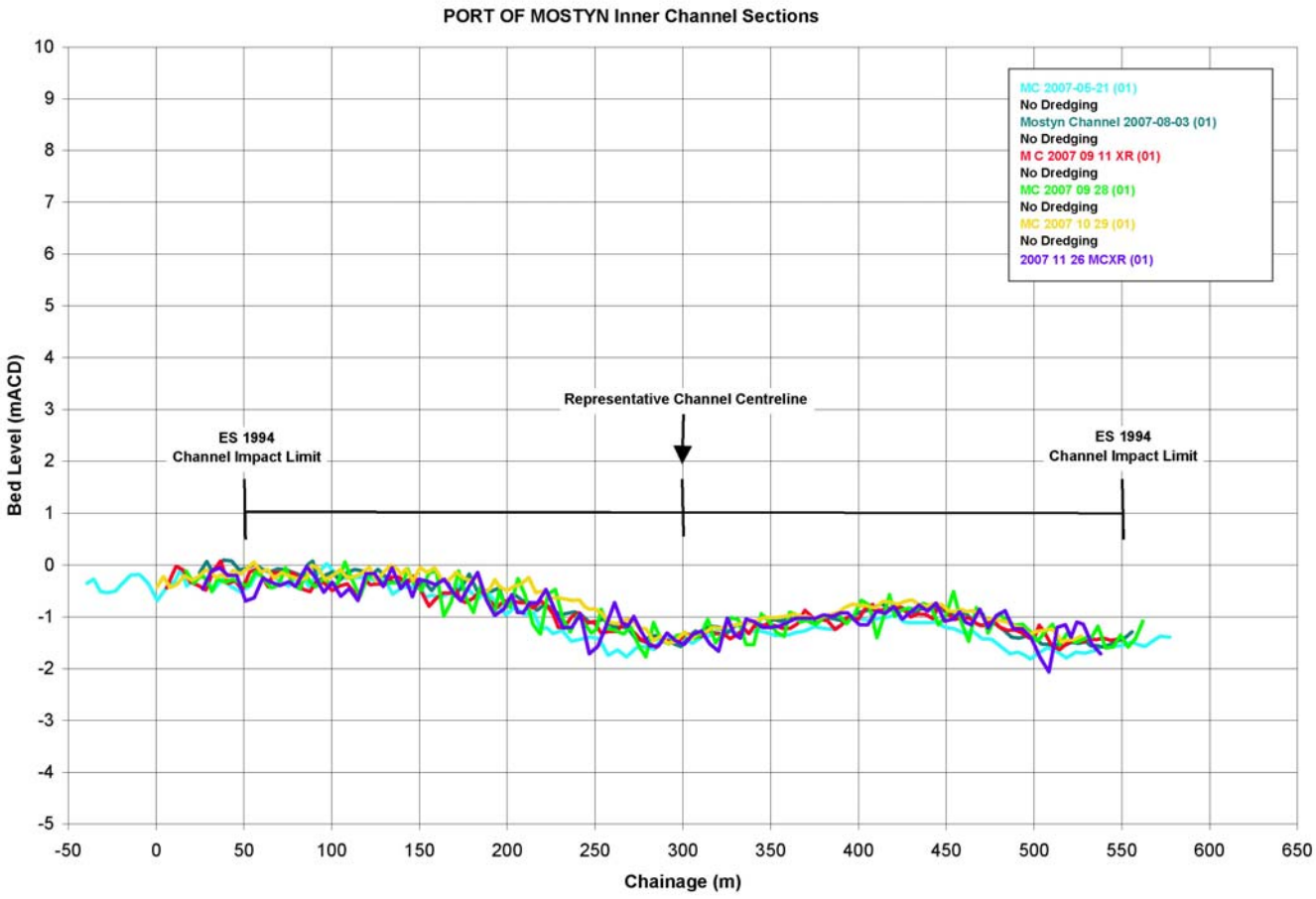
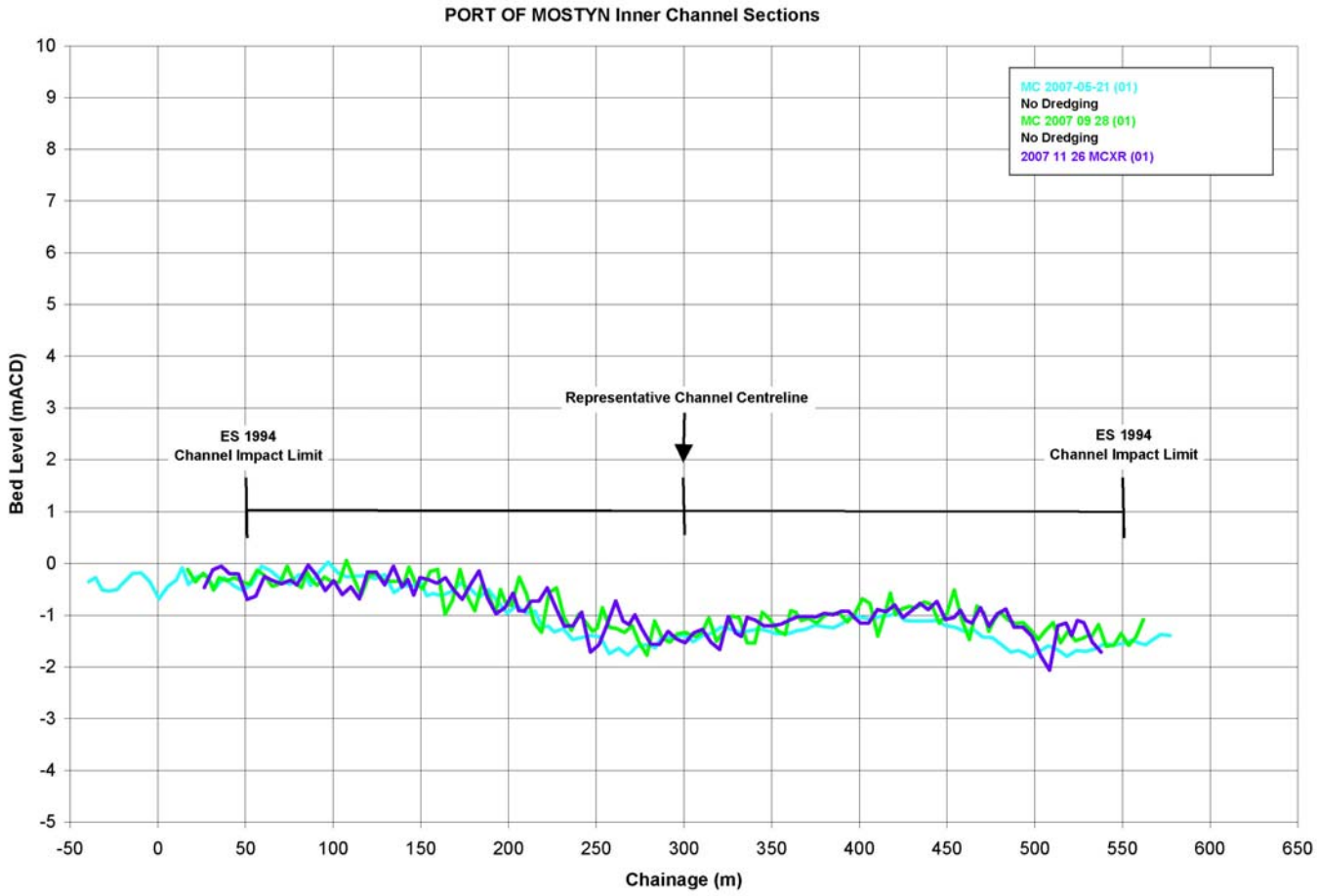
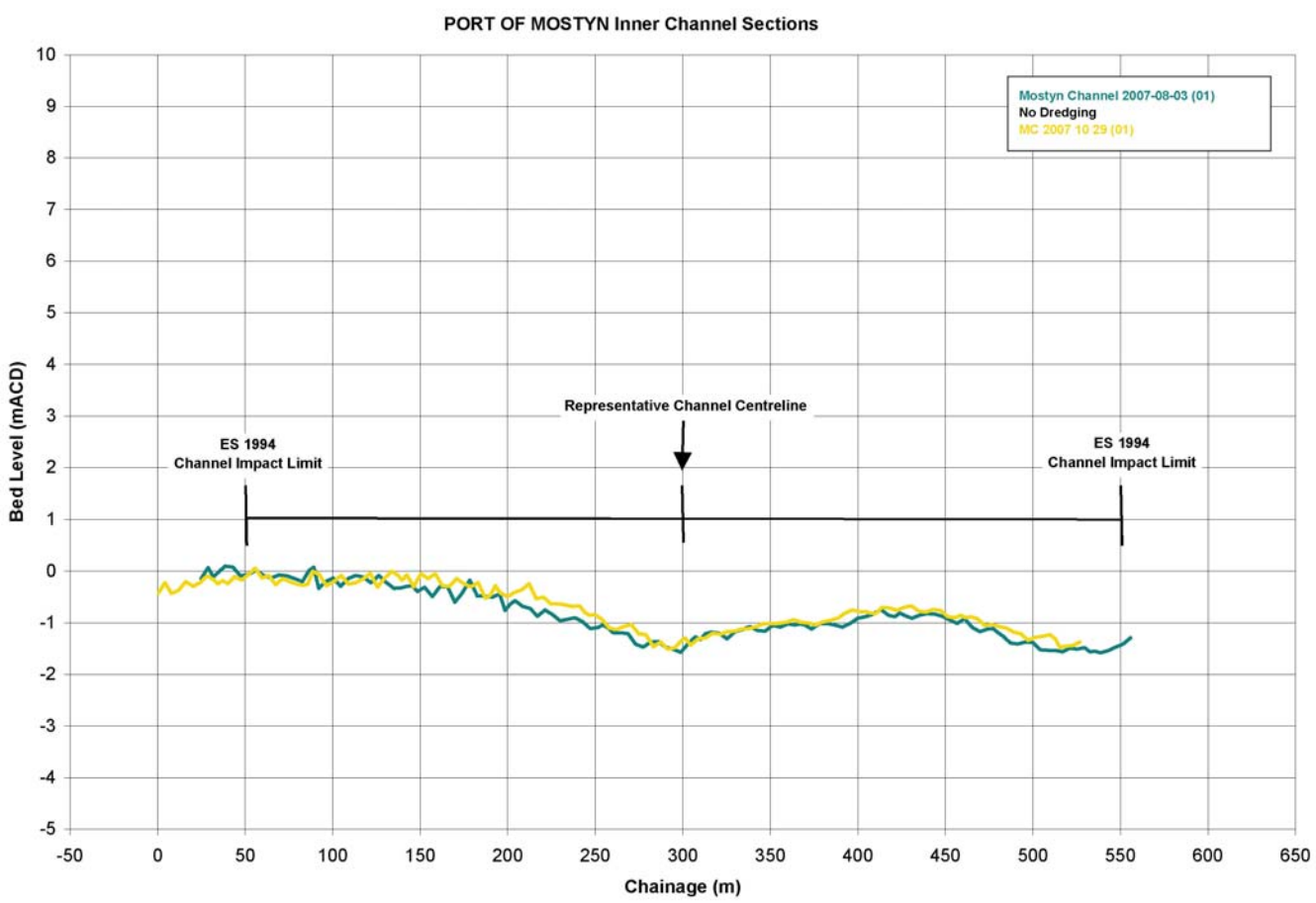
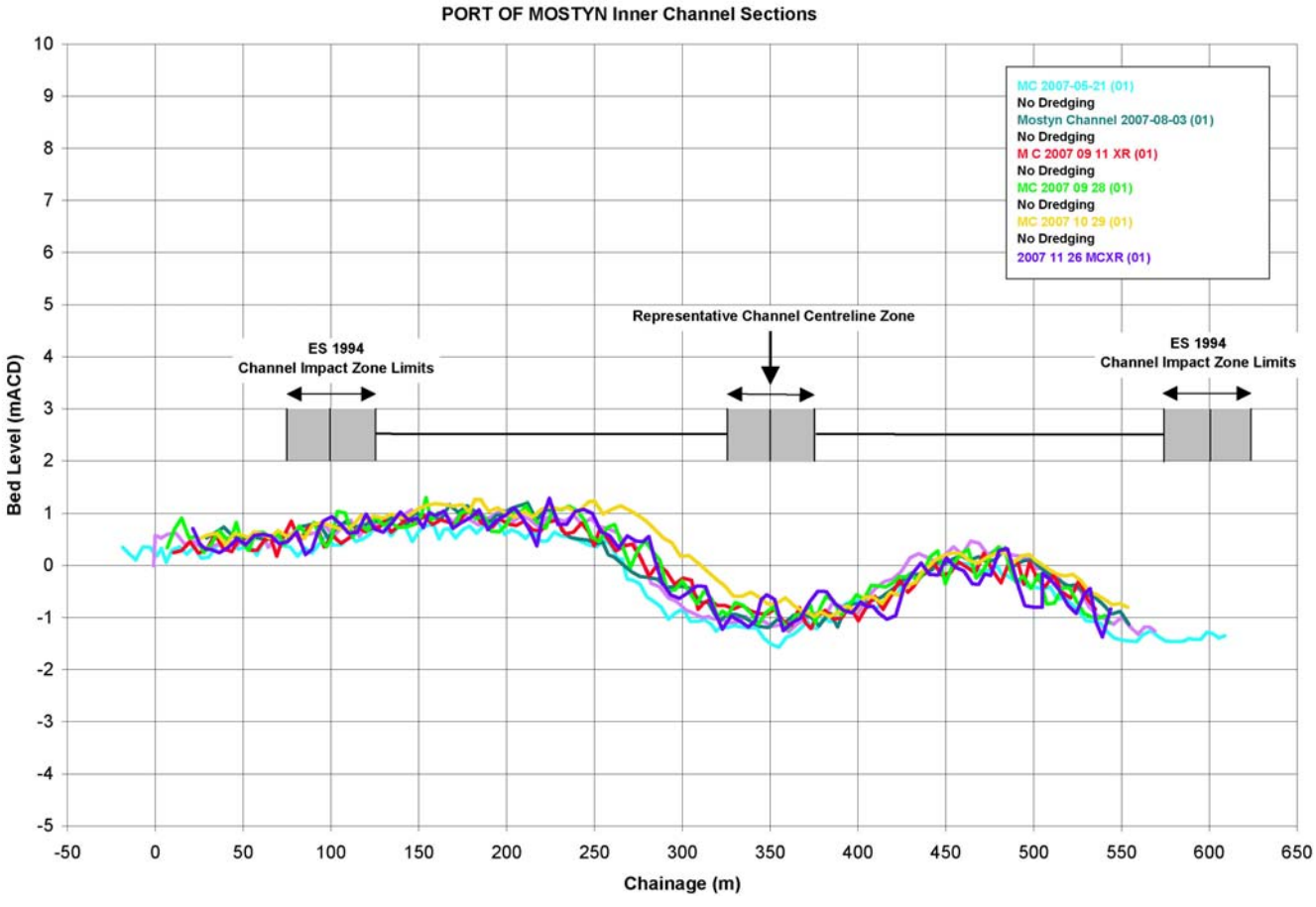
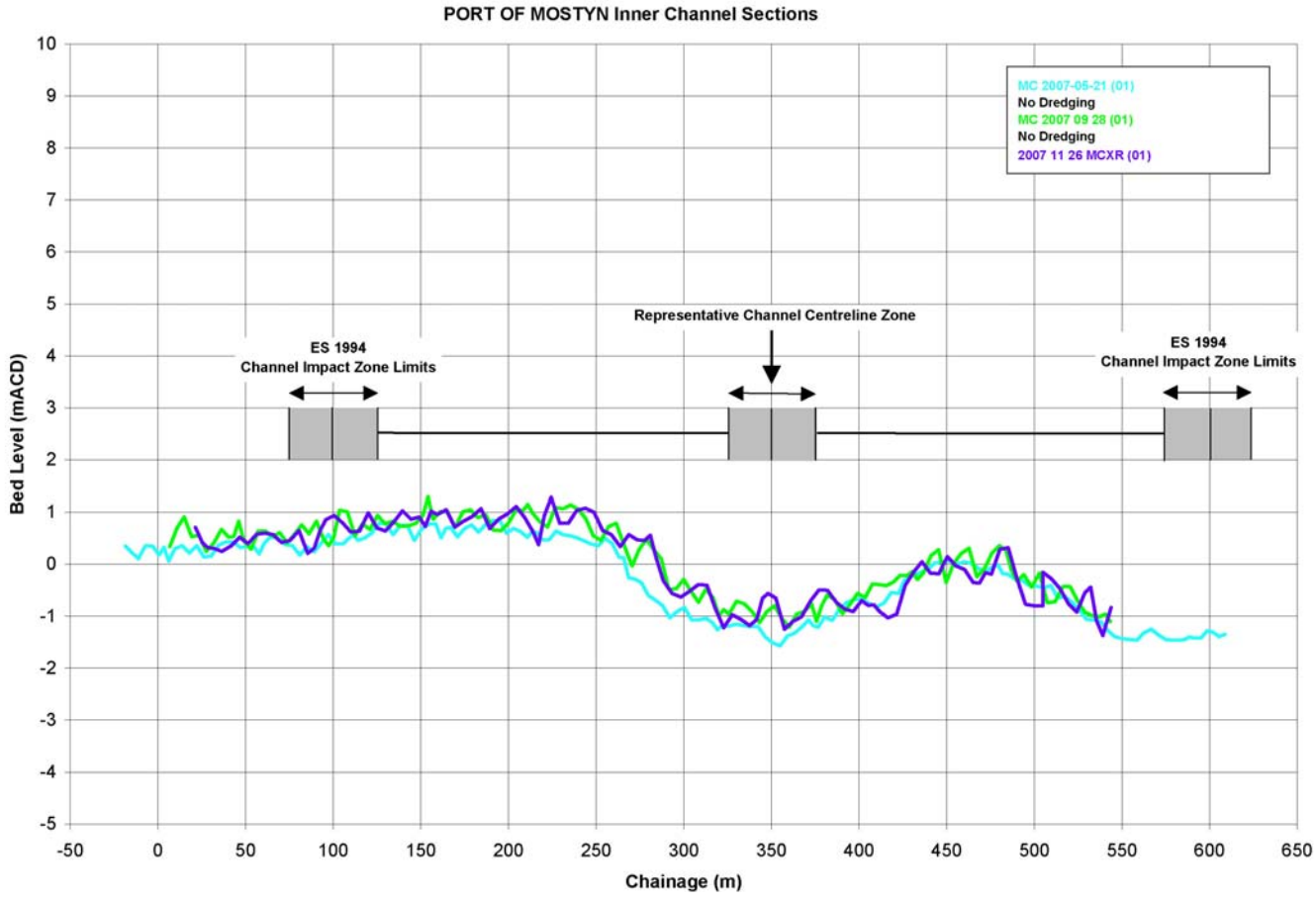


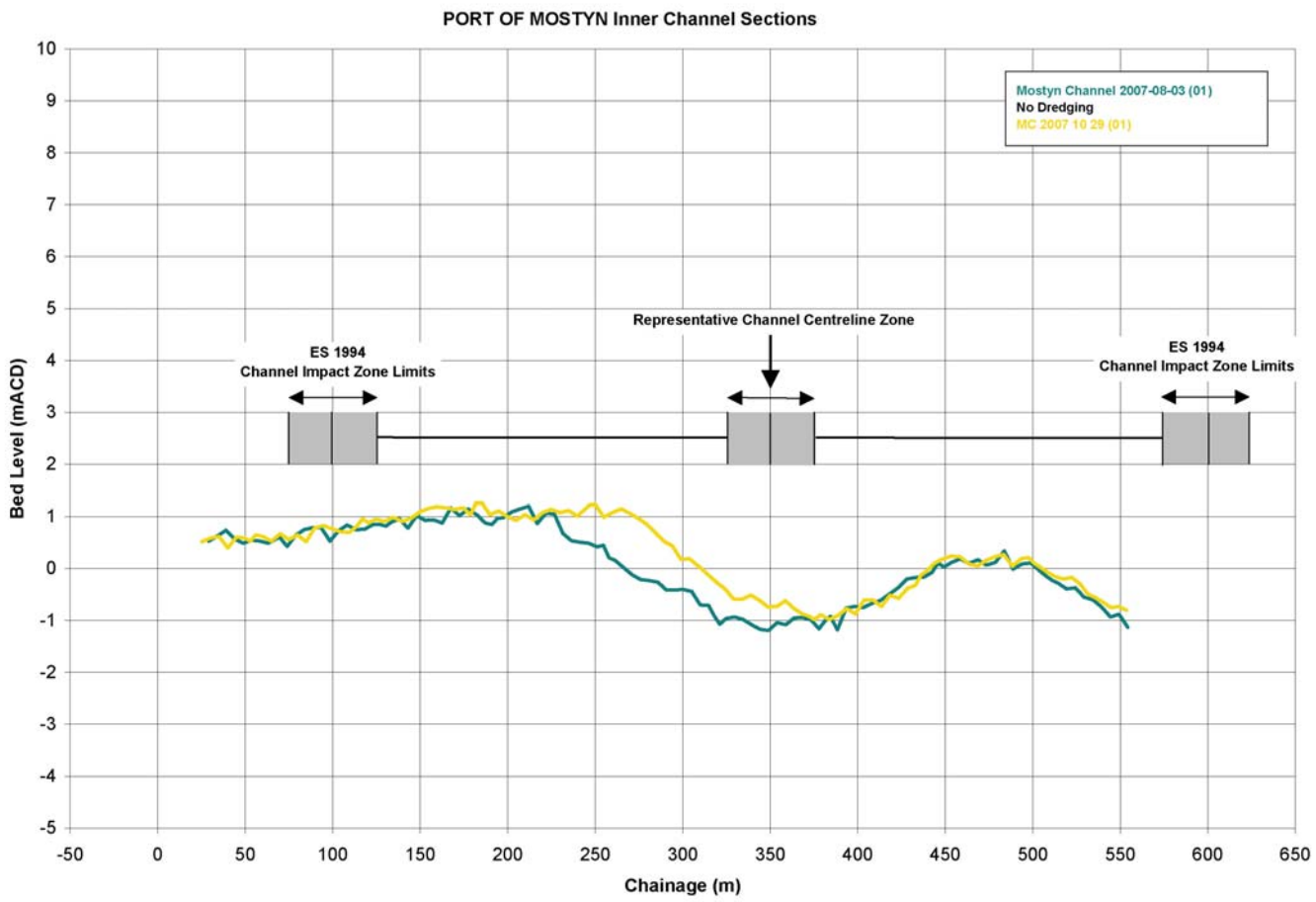




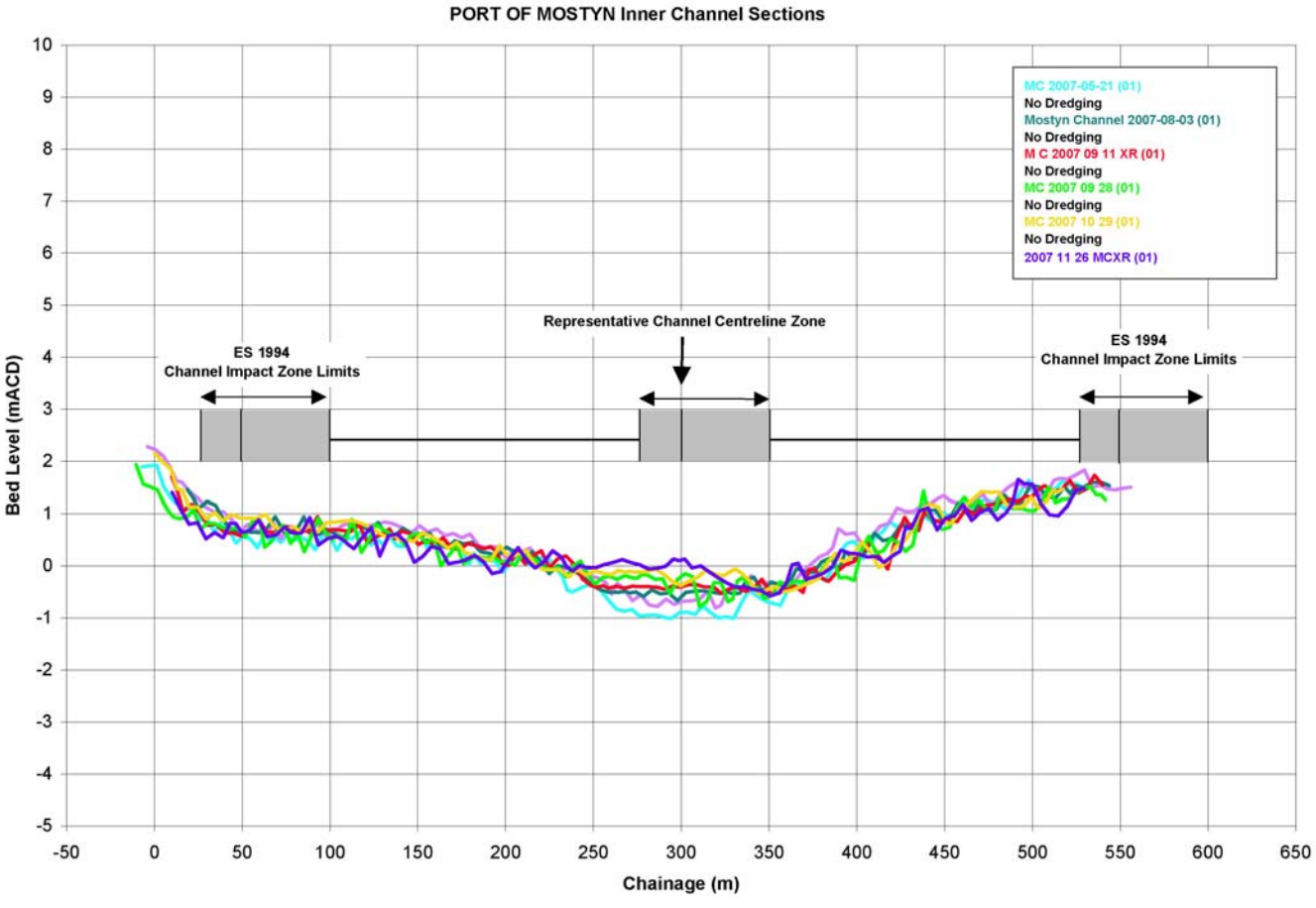
Dwg CII (1 of 14) SECTION 01

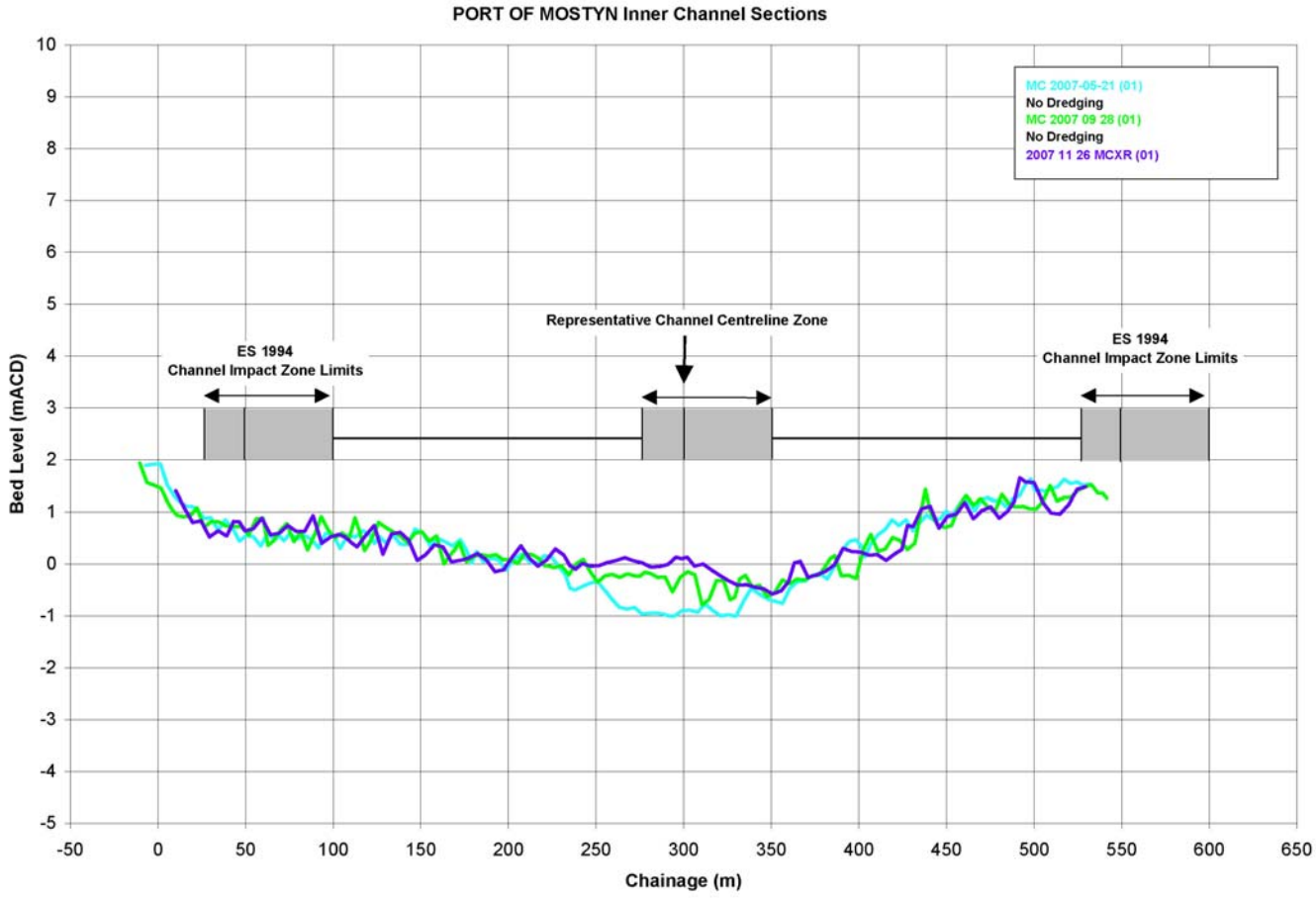


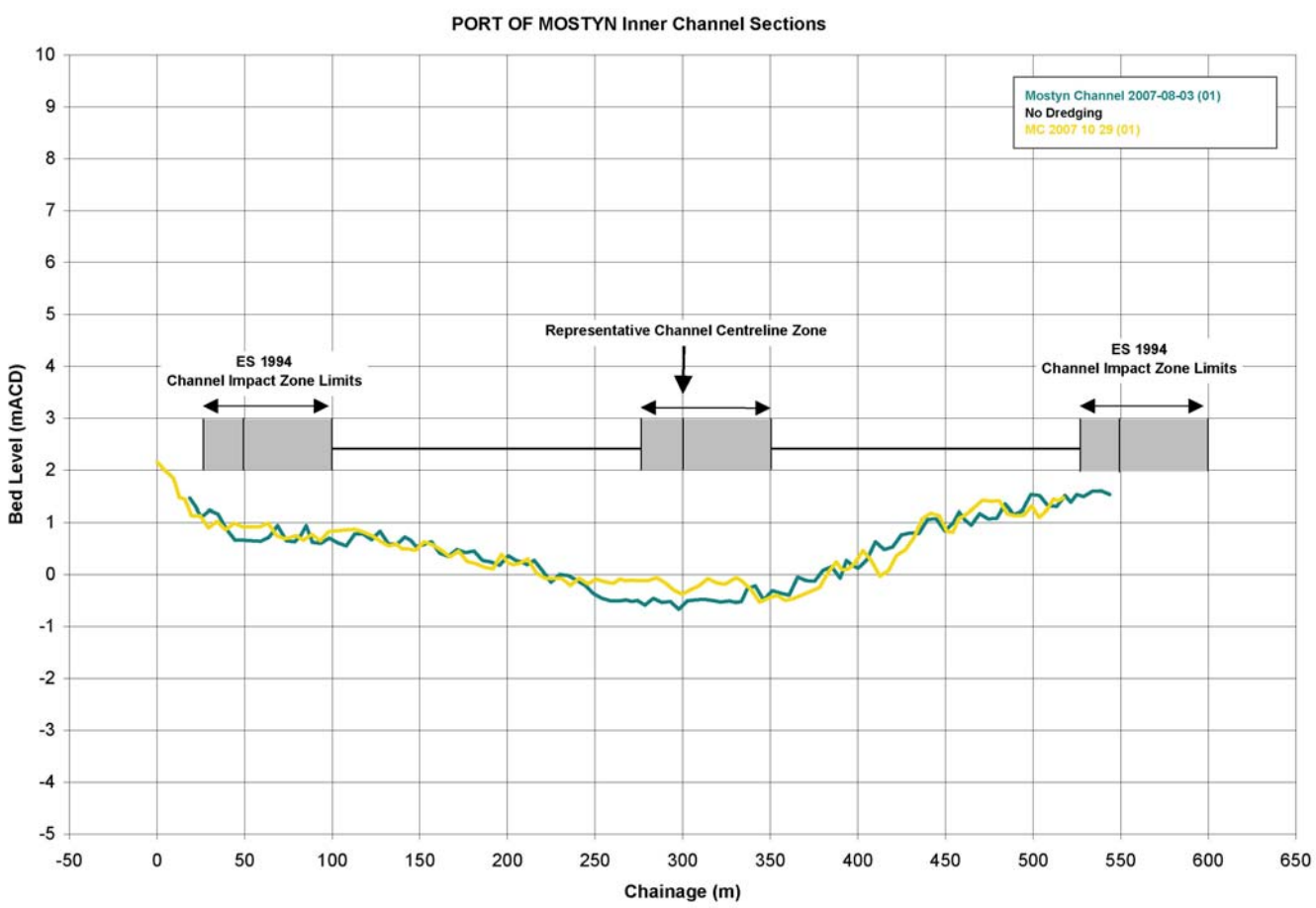




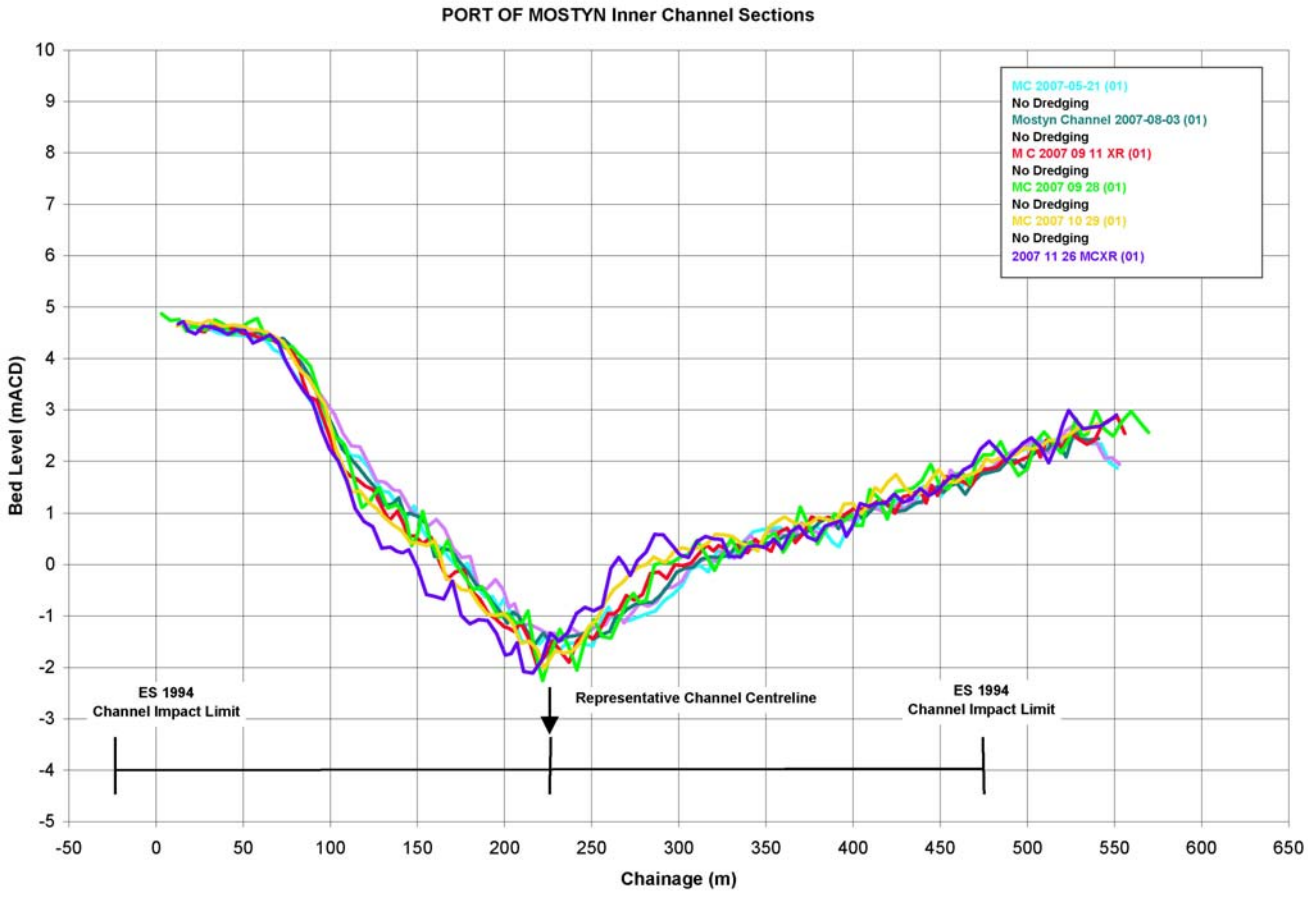
Dwg CII (2 of 14) SECTION 02

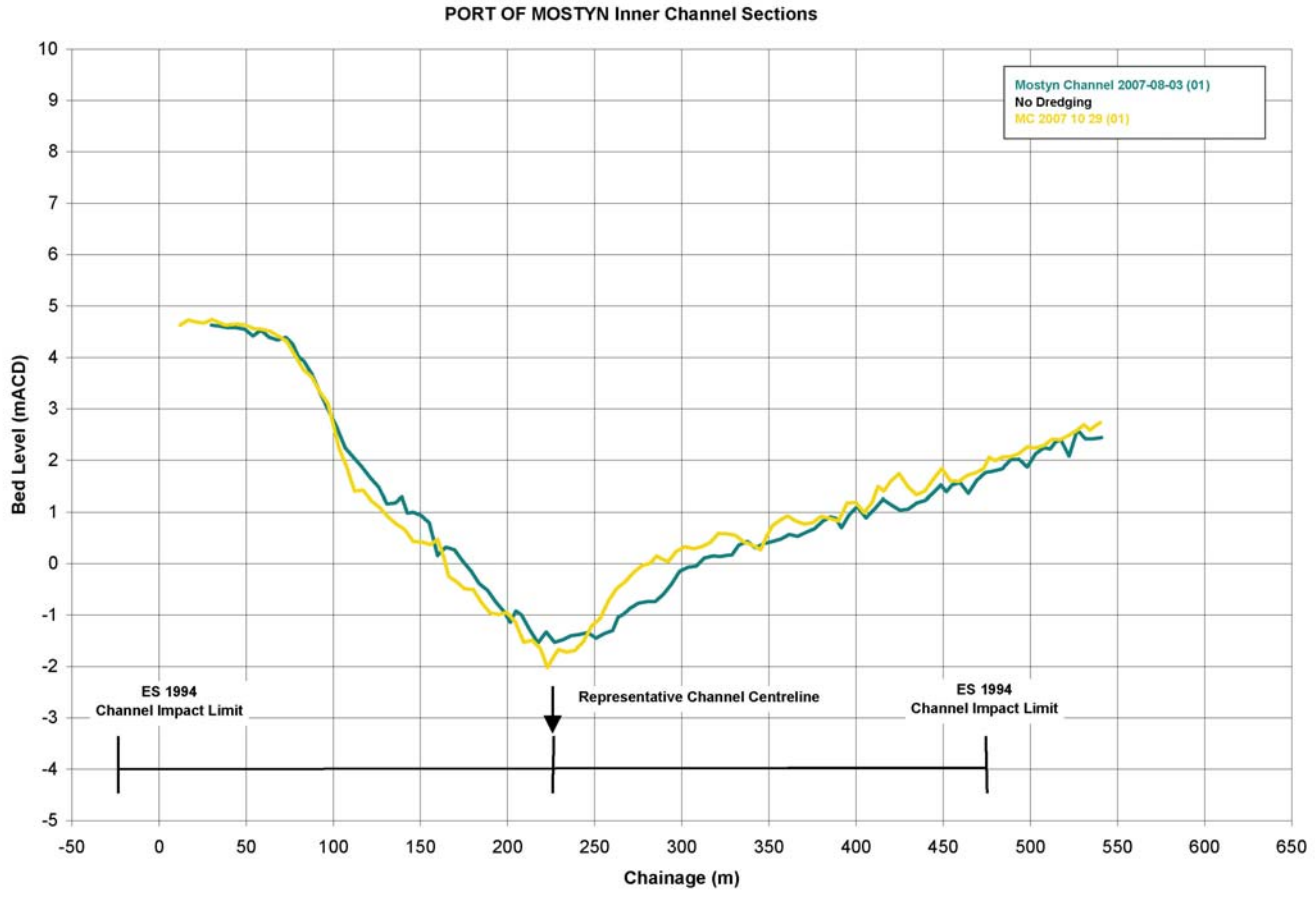




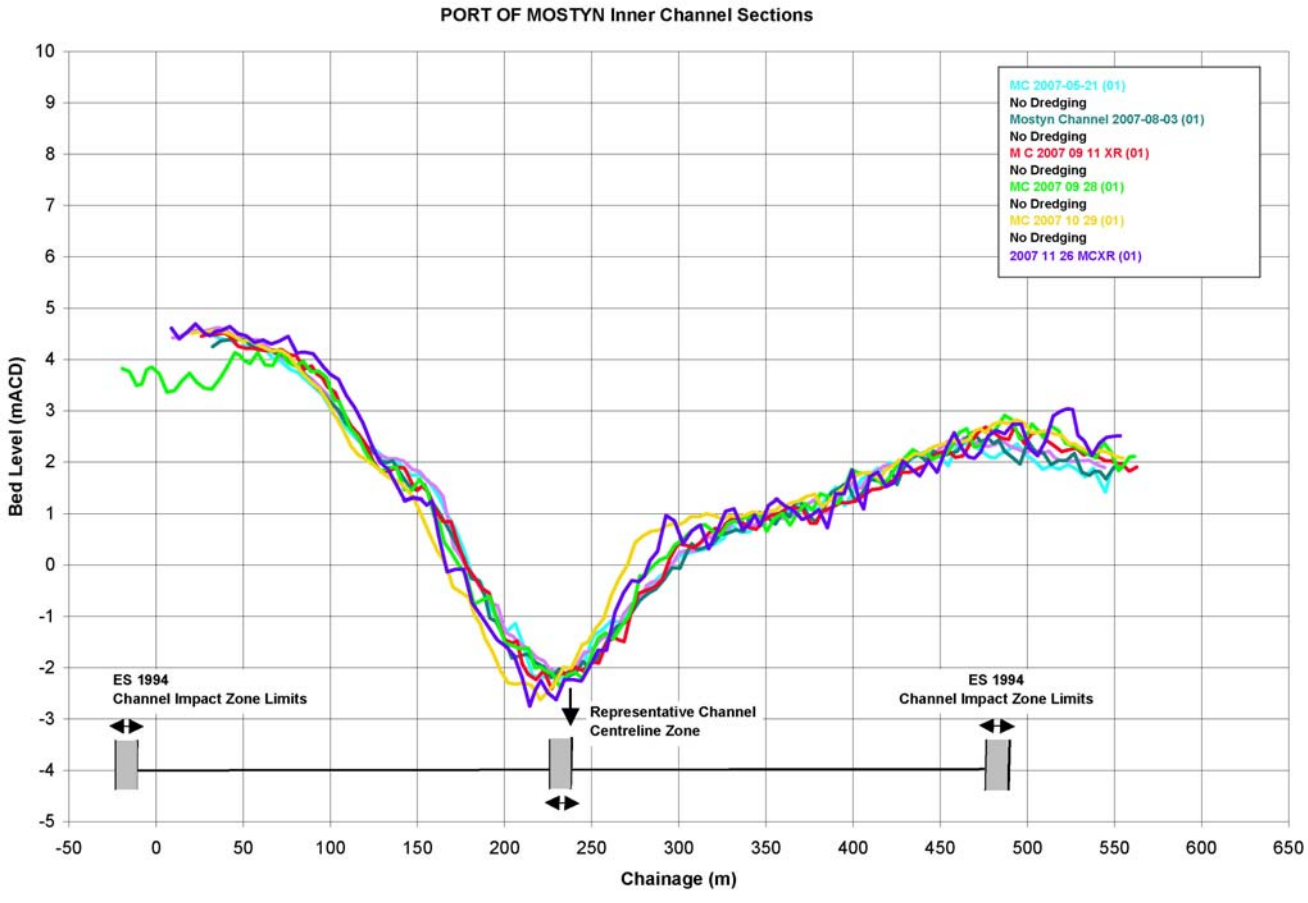


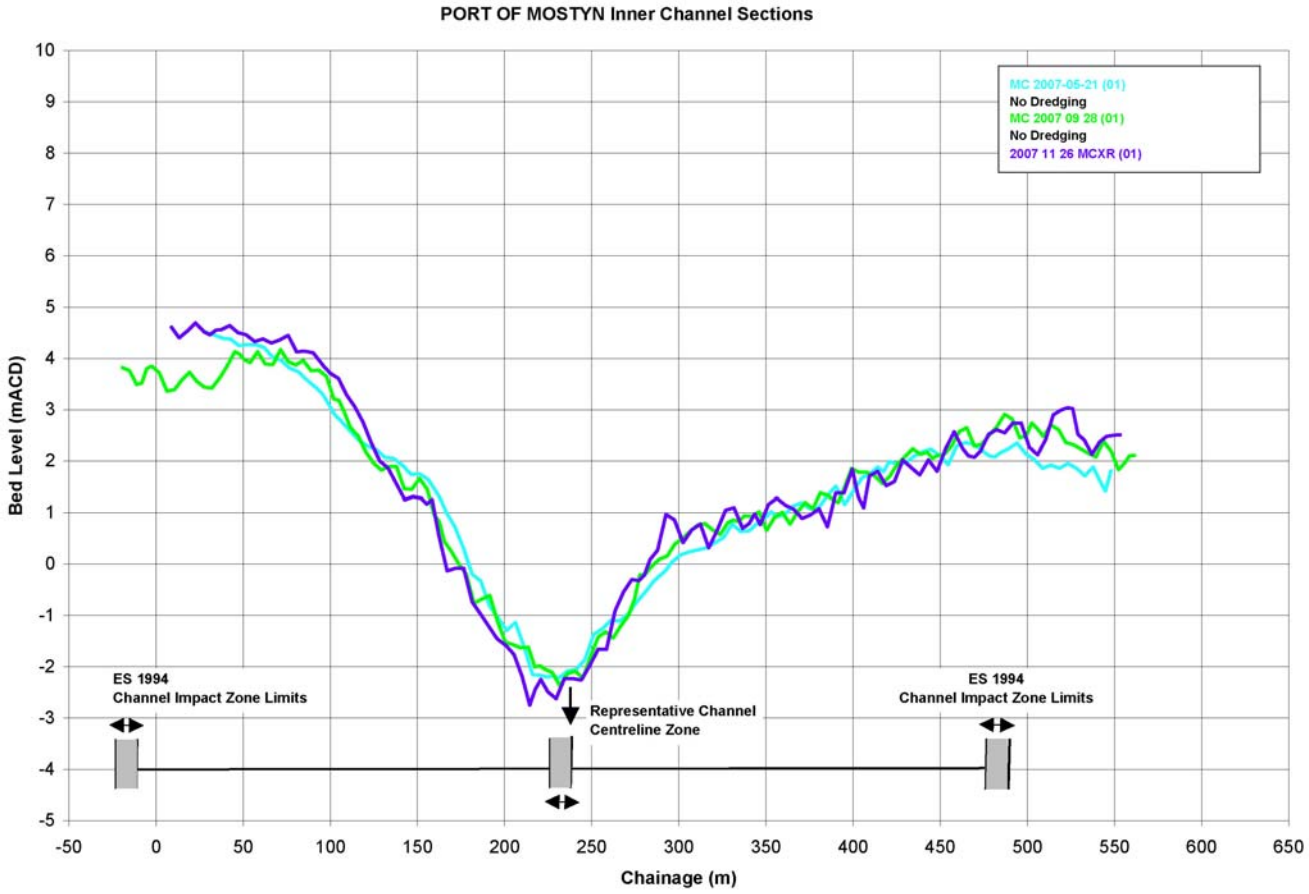
Dwg CII (3 of 14) SECTION 04

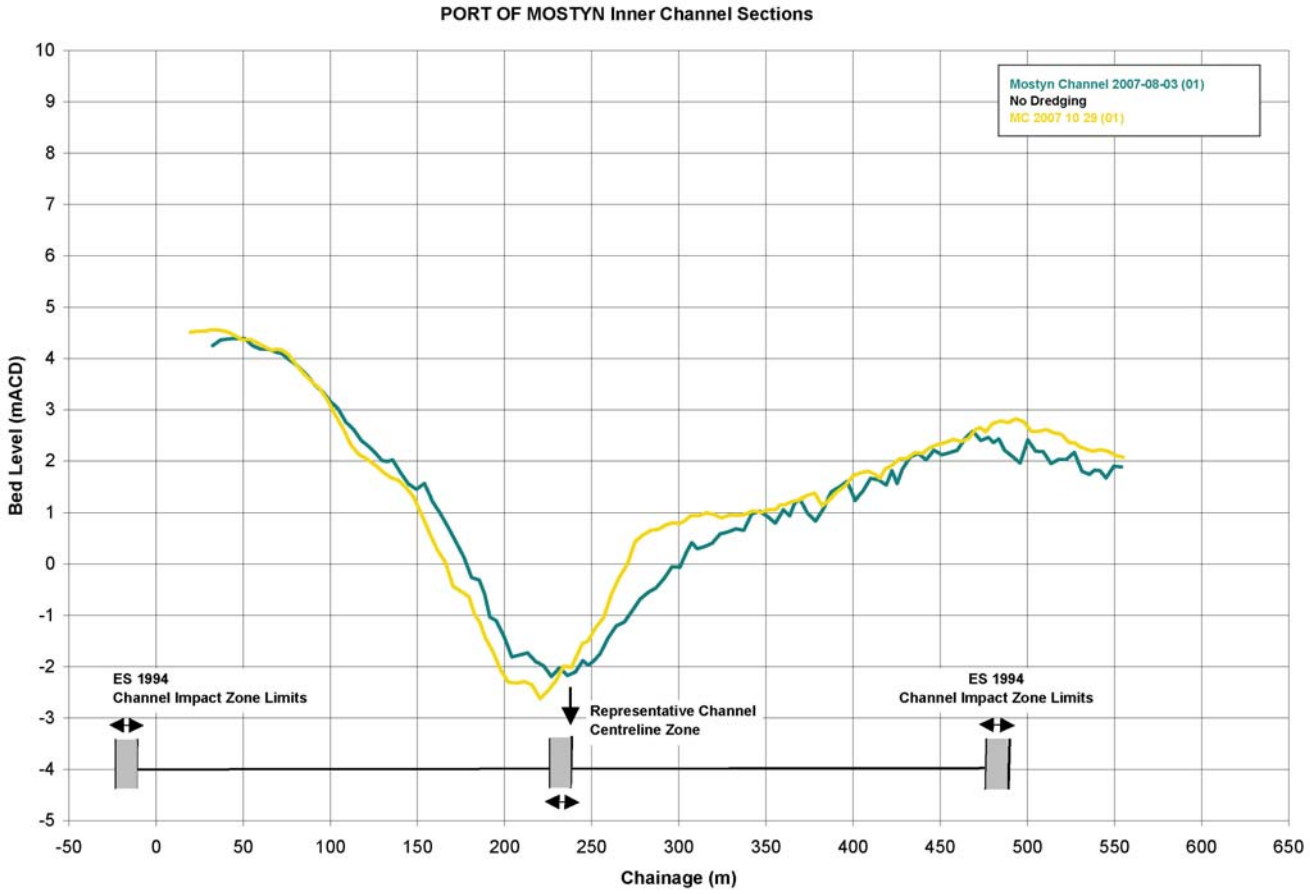




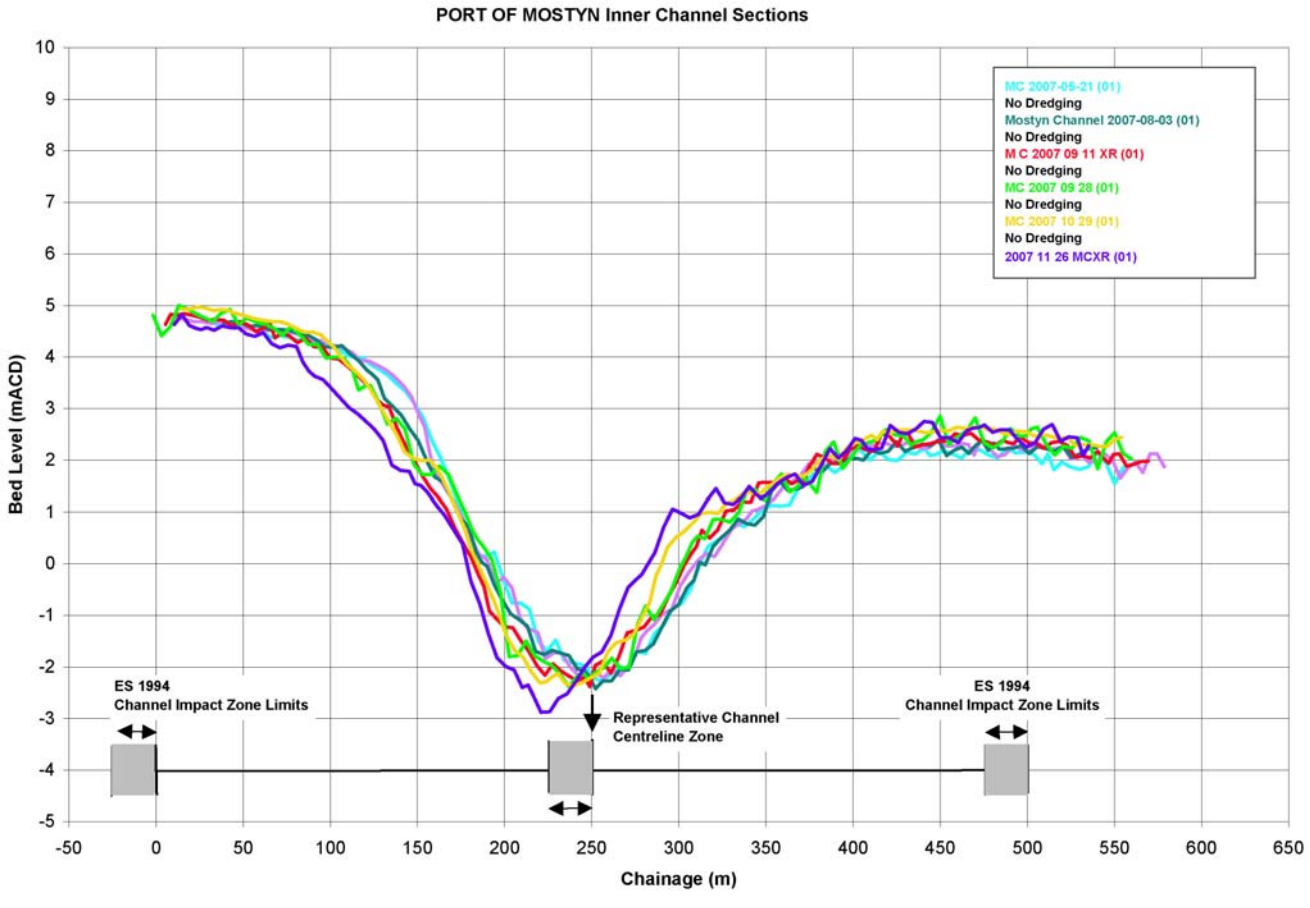
Dwg CII (4 of 14) SECTION 06

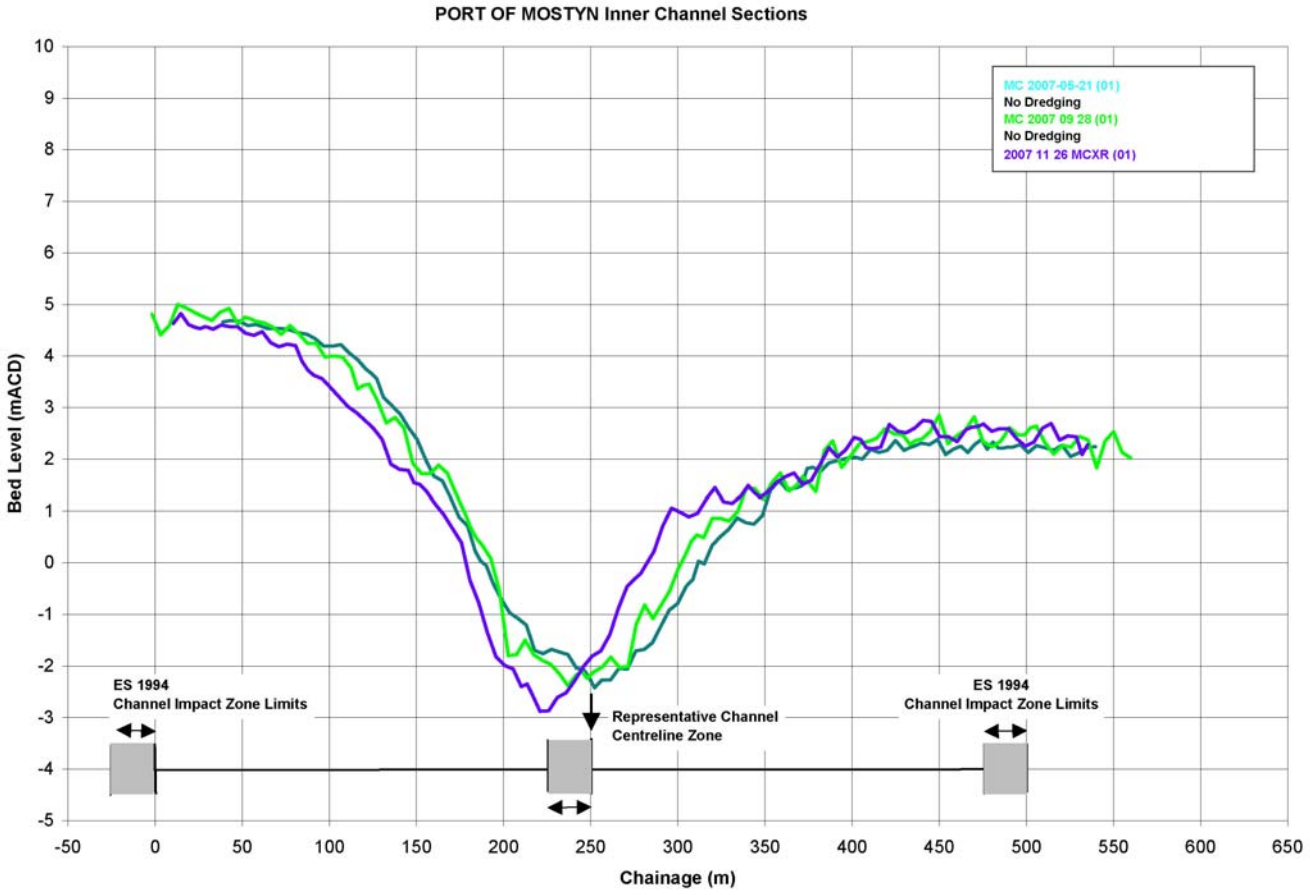


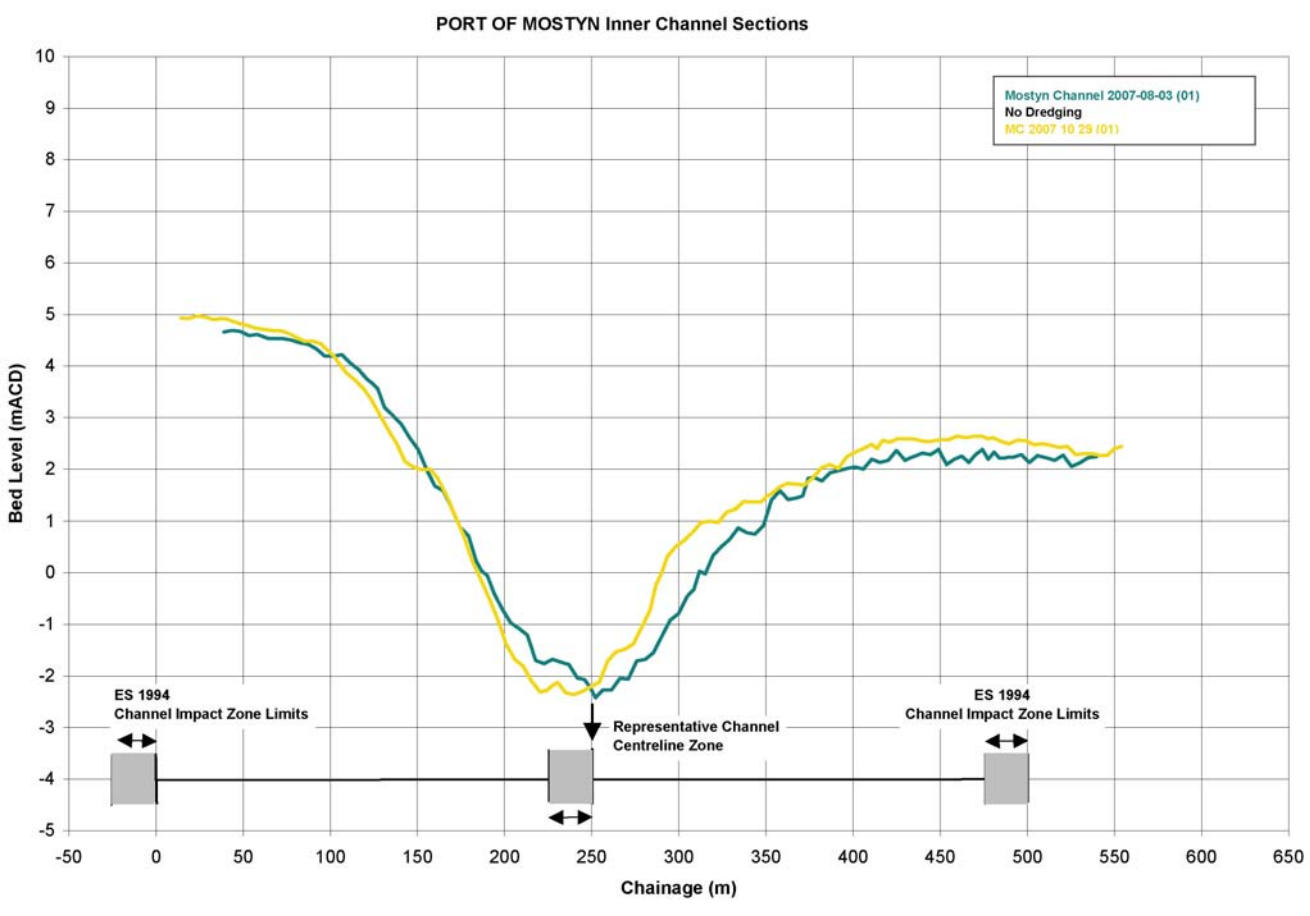




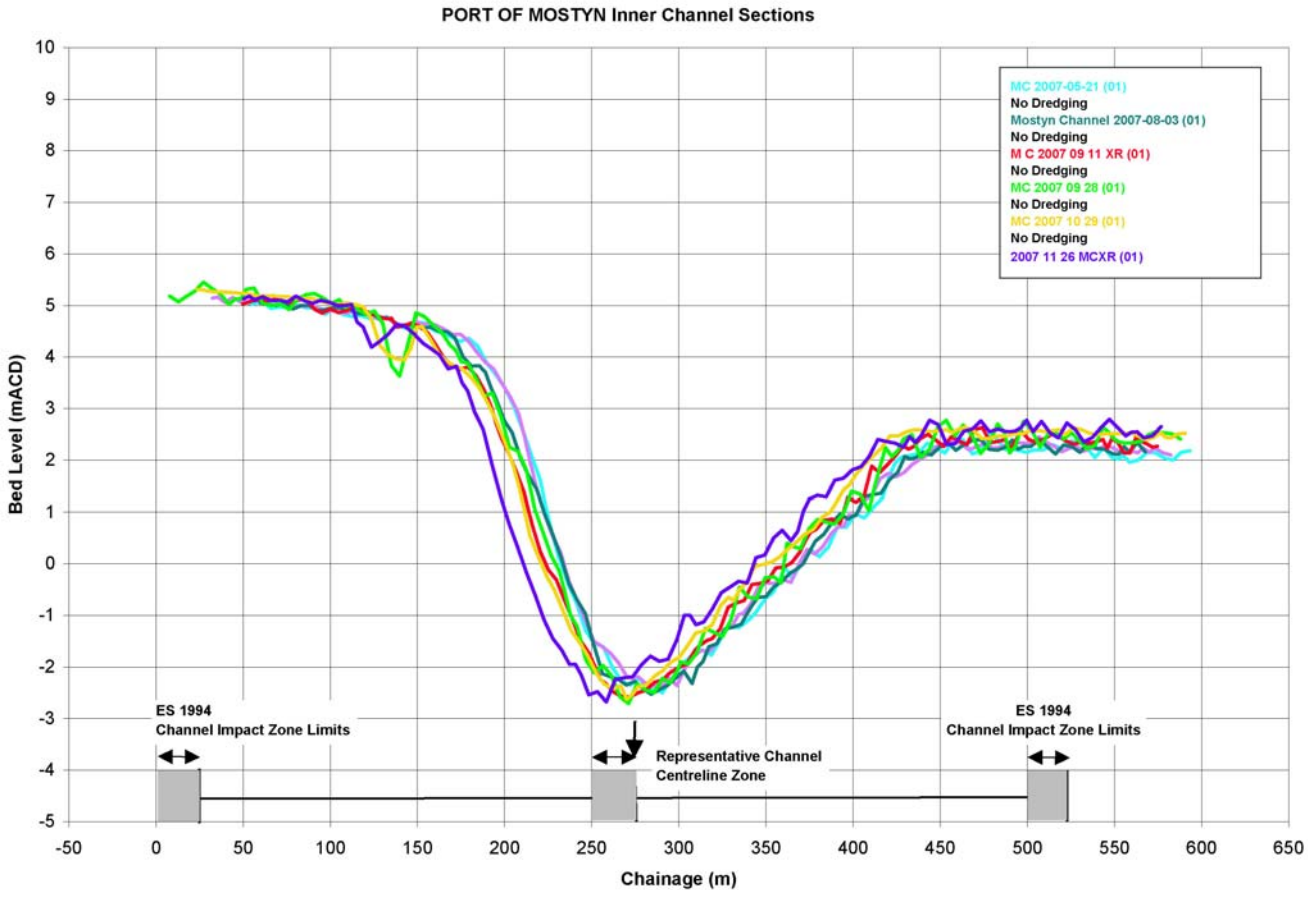
Dwg CII (5 of 14) SECTION 07

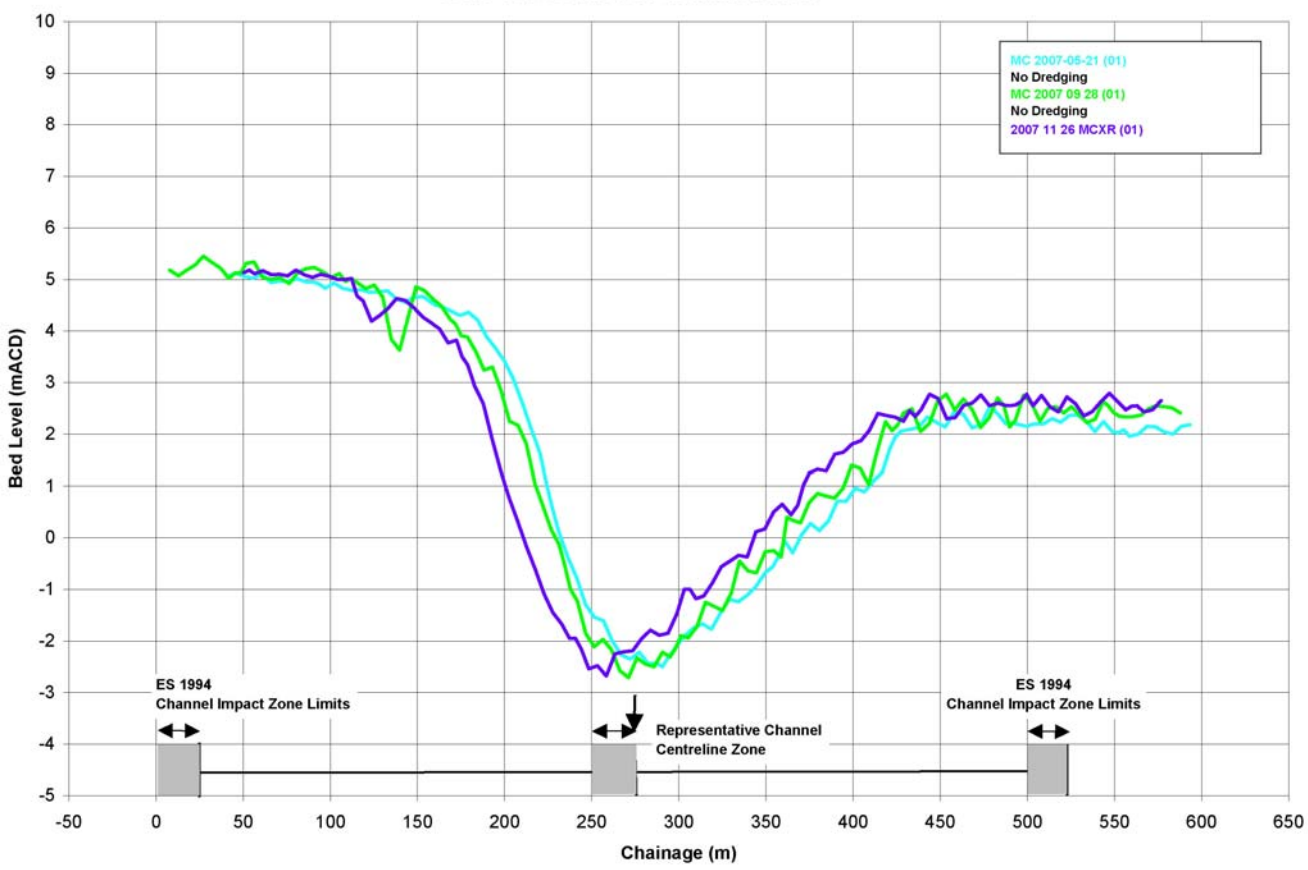


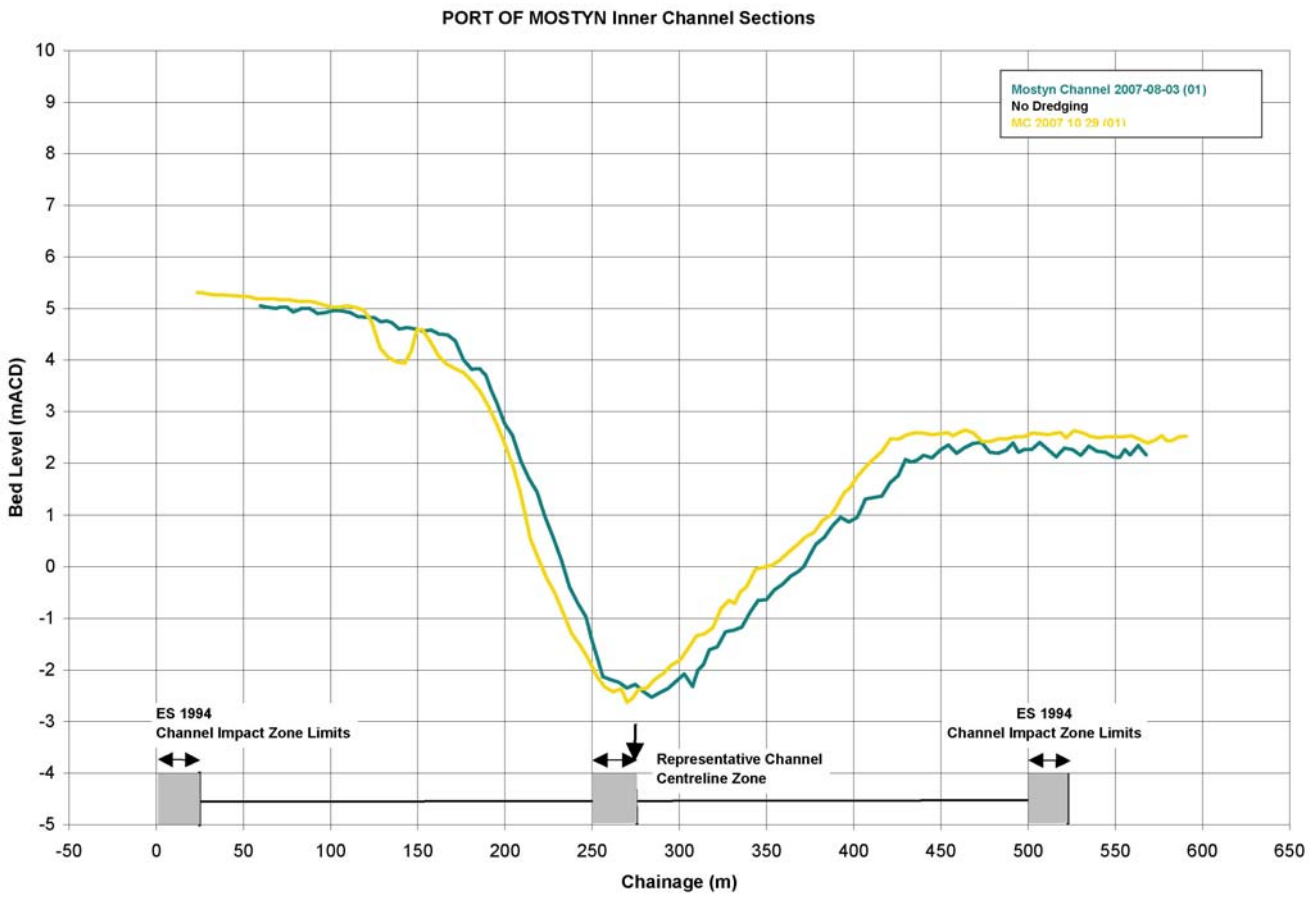




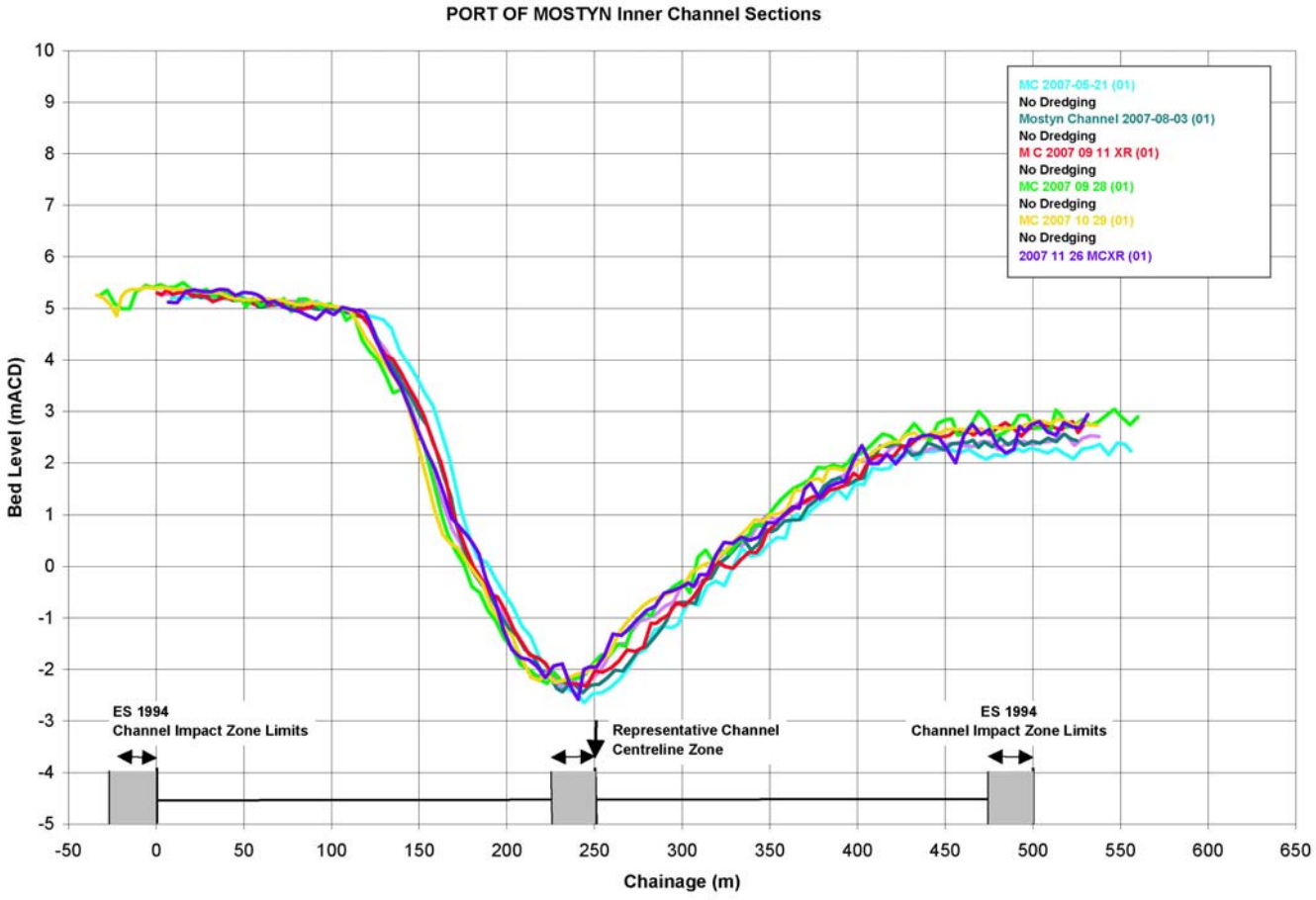
Dwg CII (6 of 14) SECTION 08

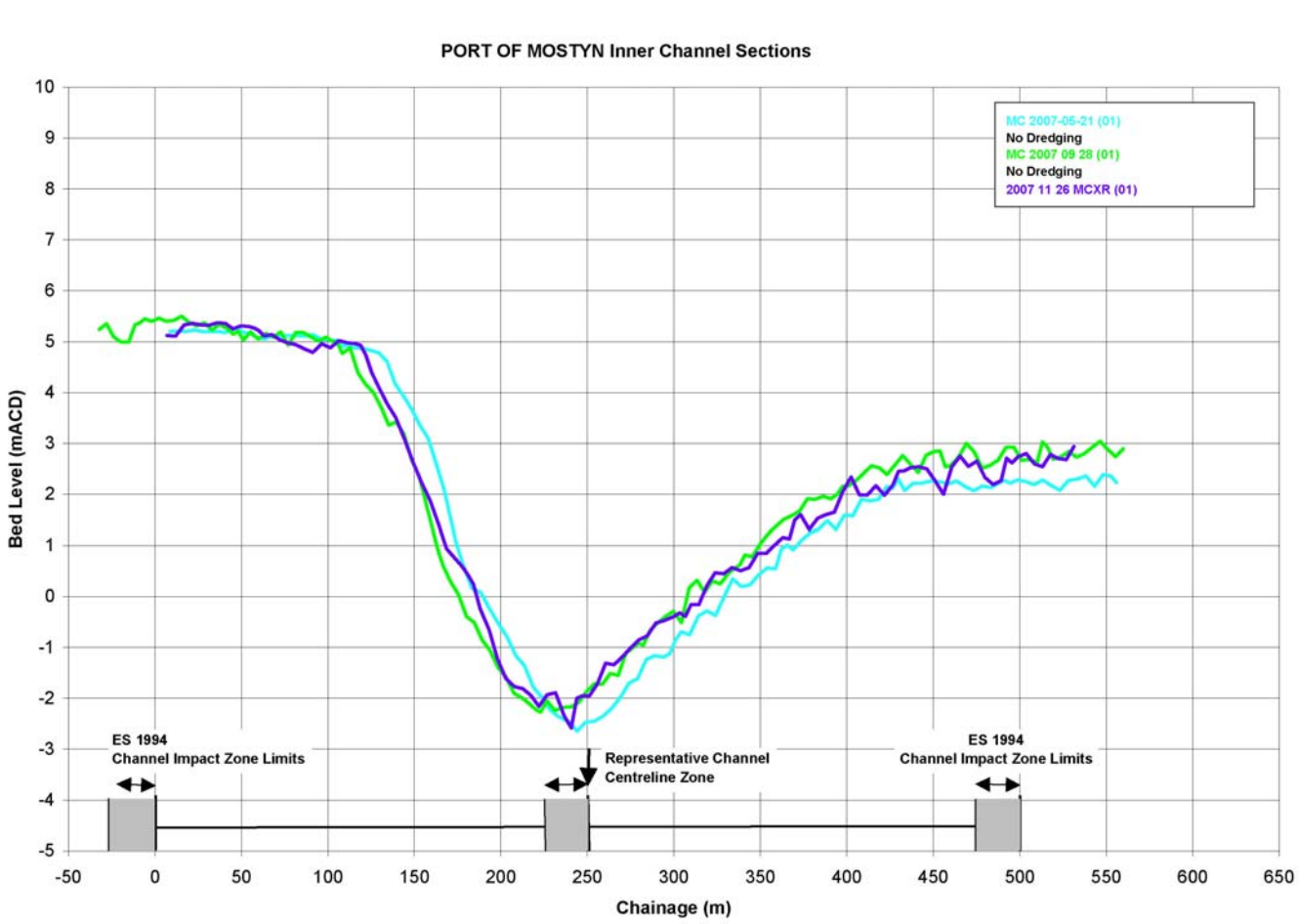


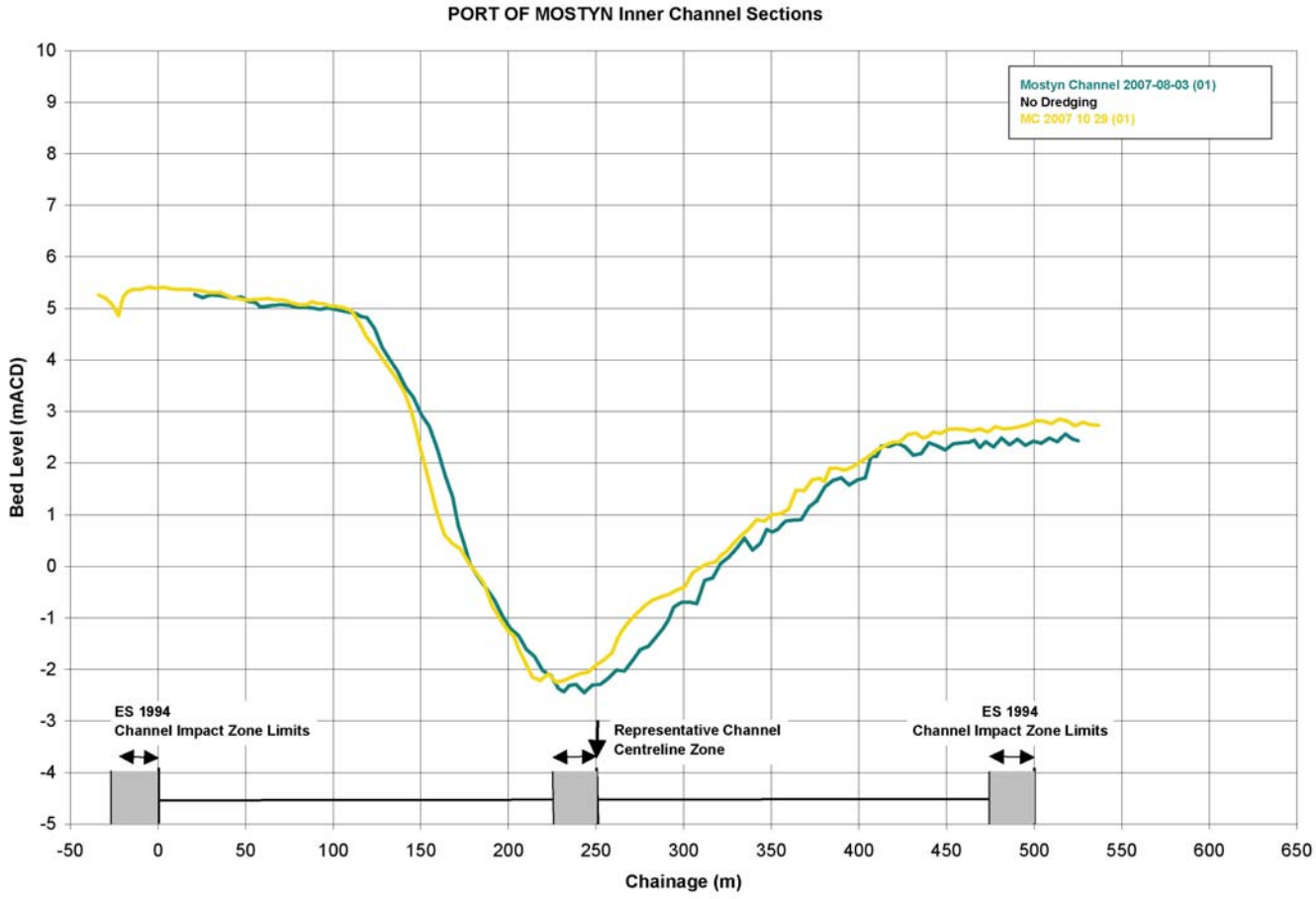




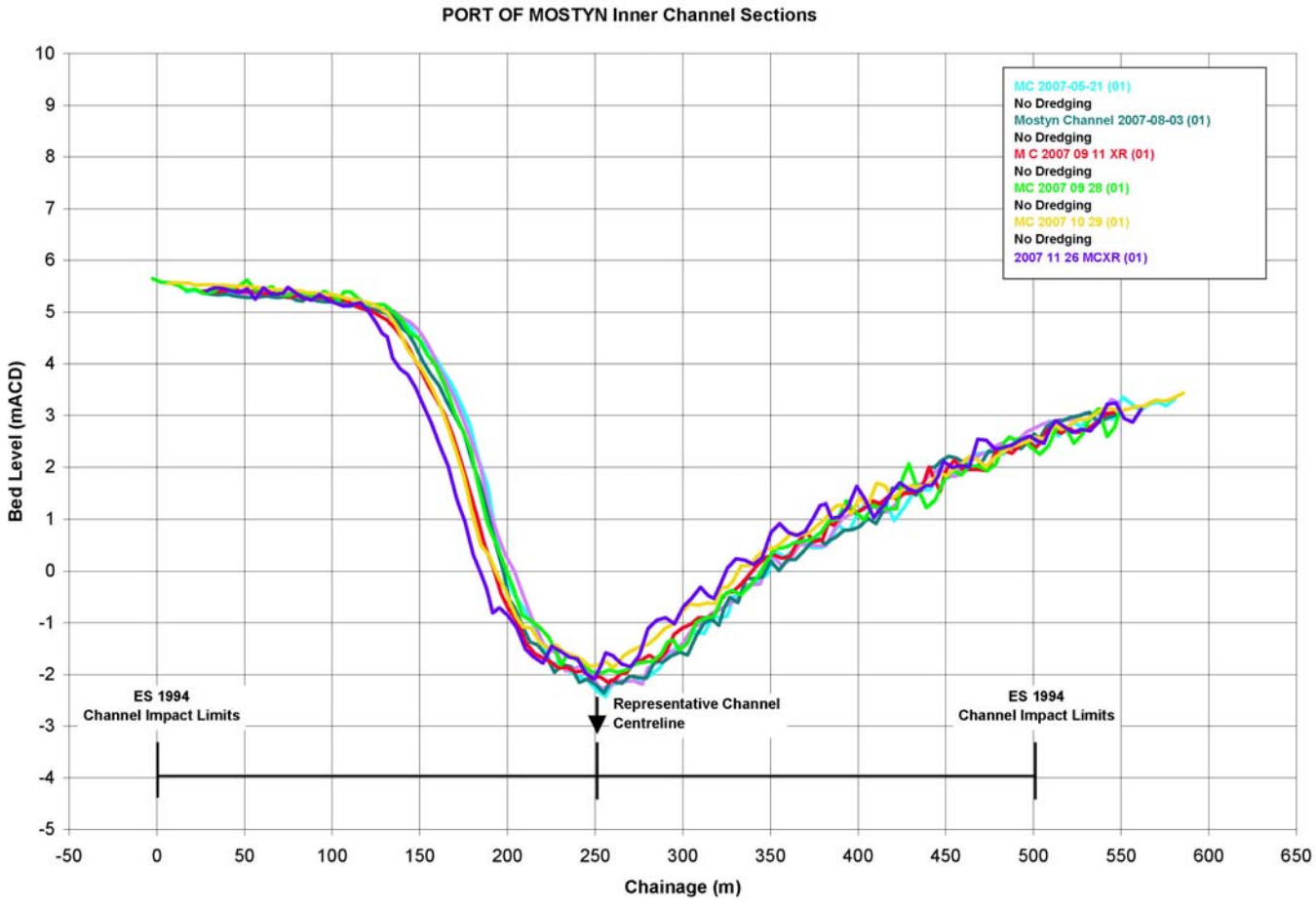
Dwg CII (7 of 14) SECTION 10

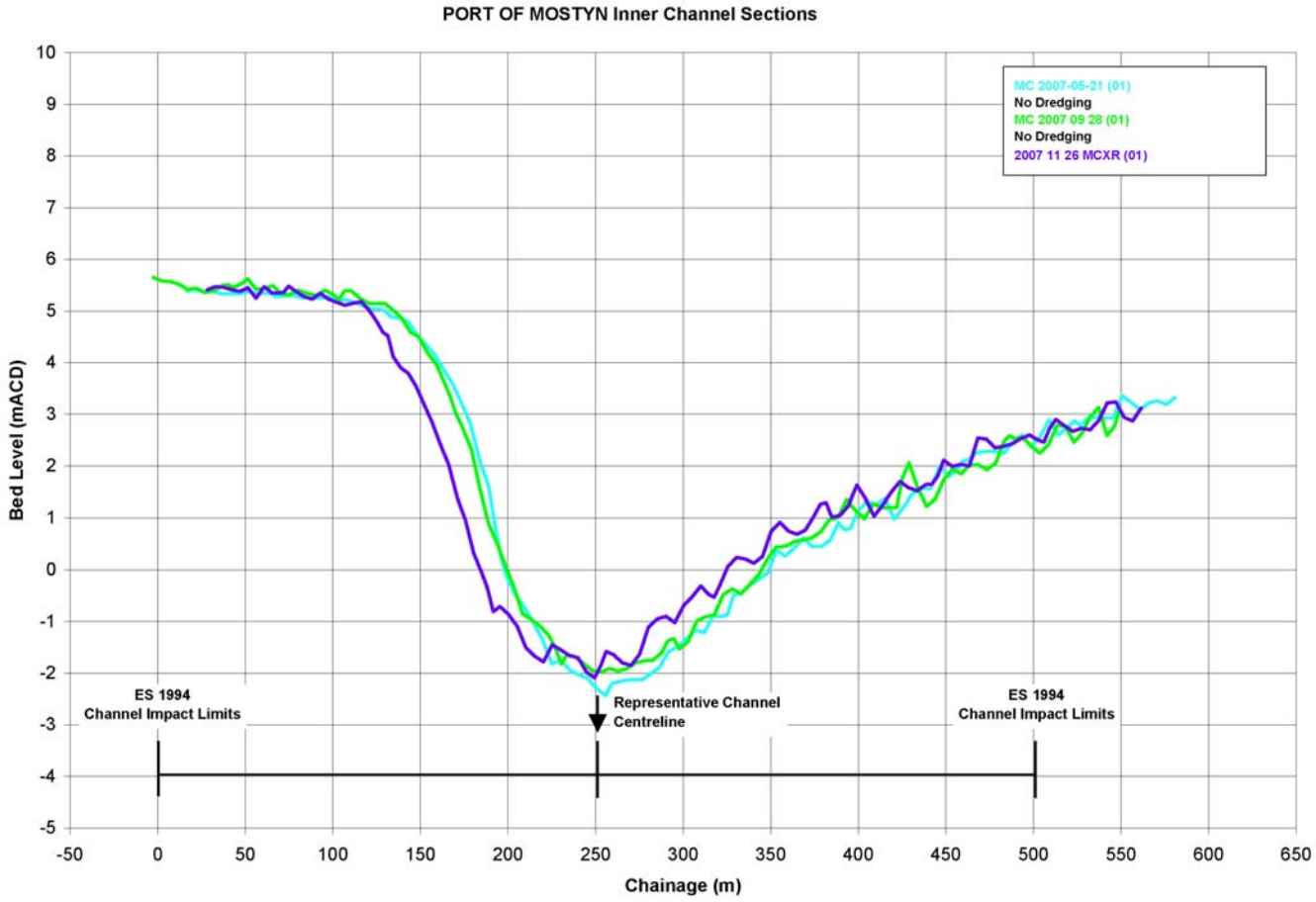


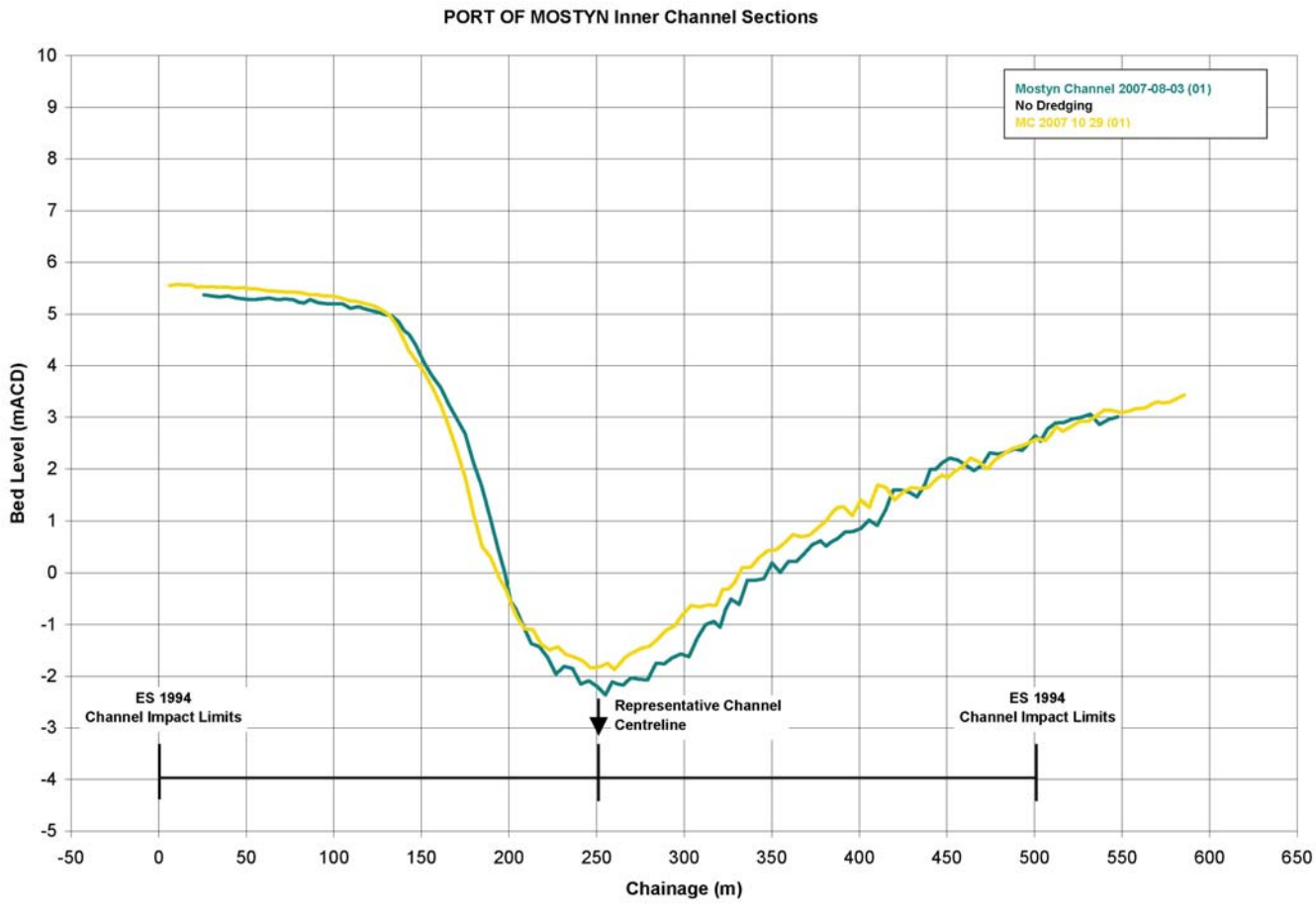




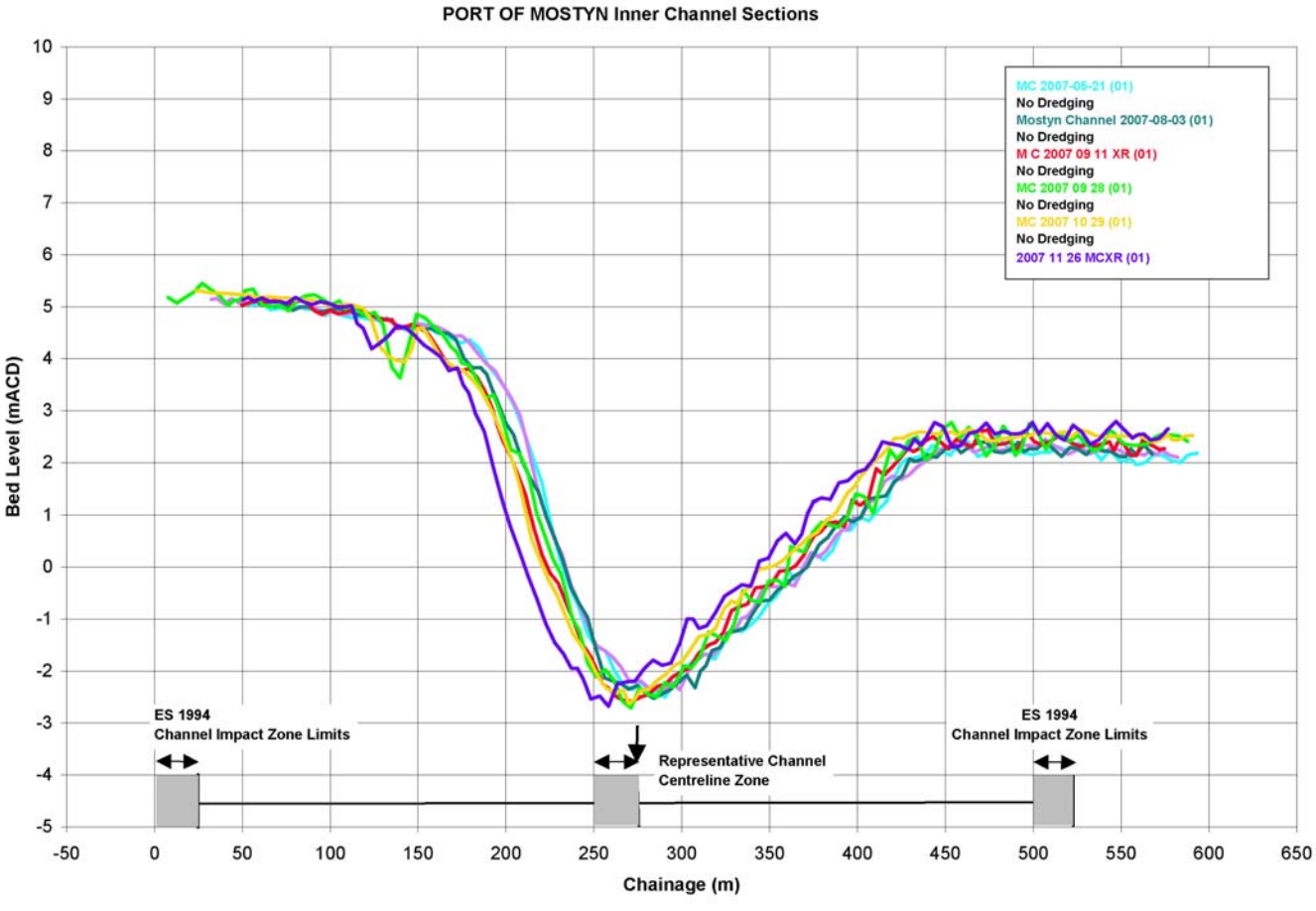
Dwg CII (8 of 14) SECTION 11

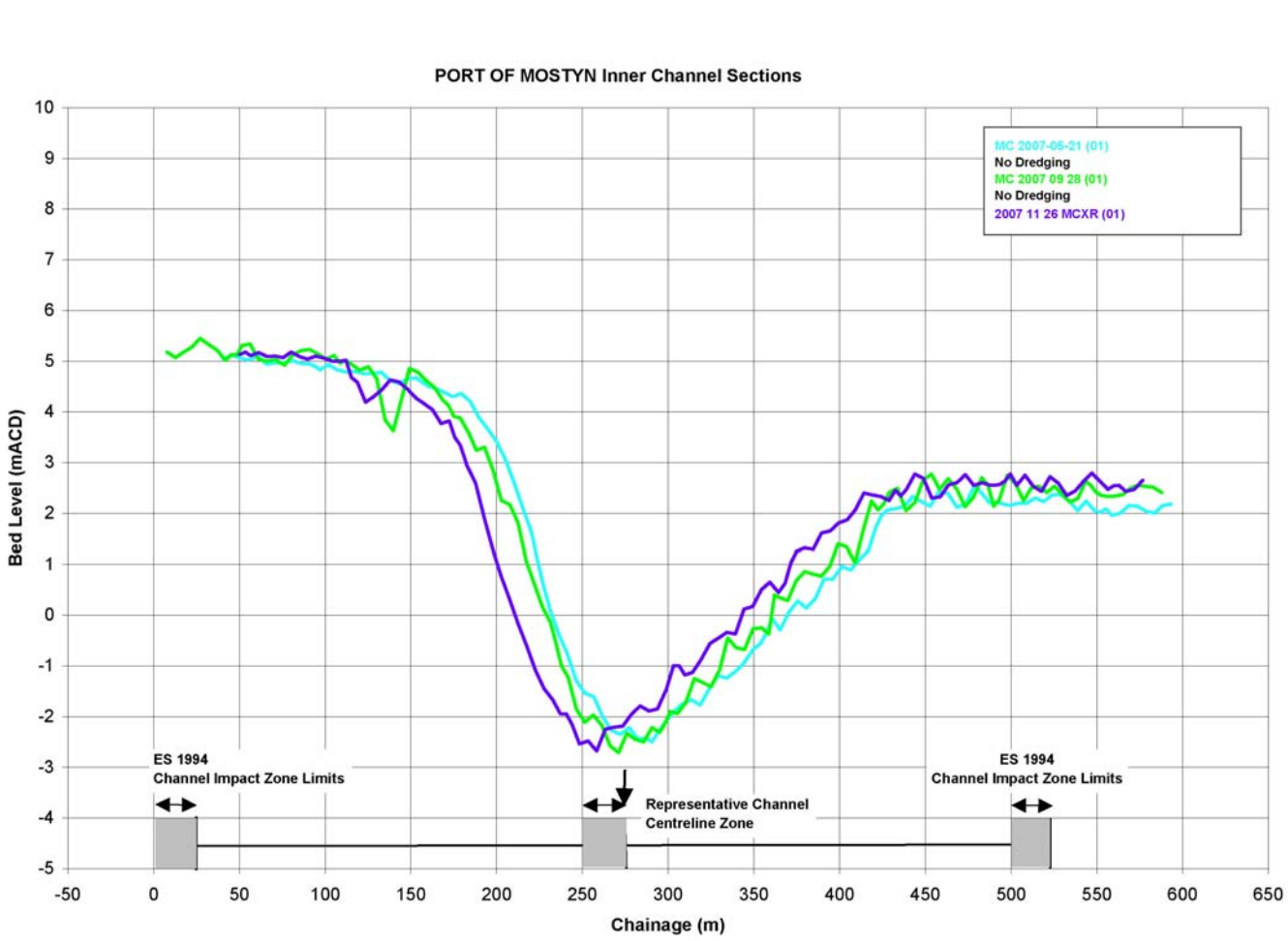


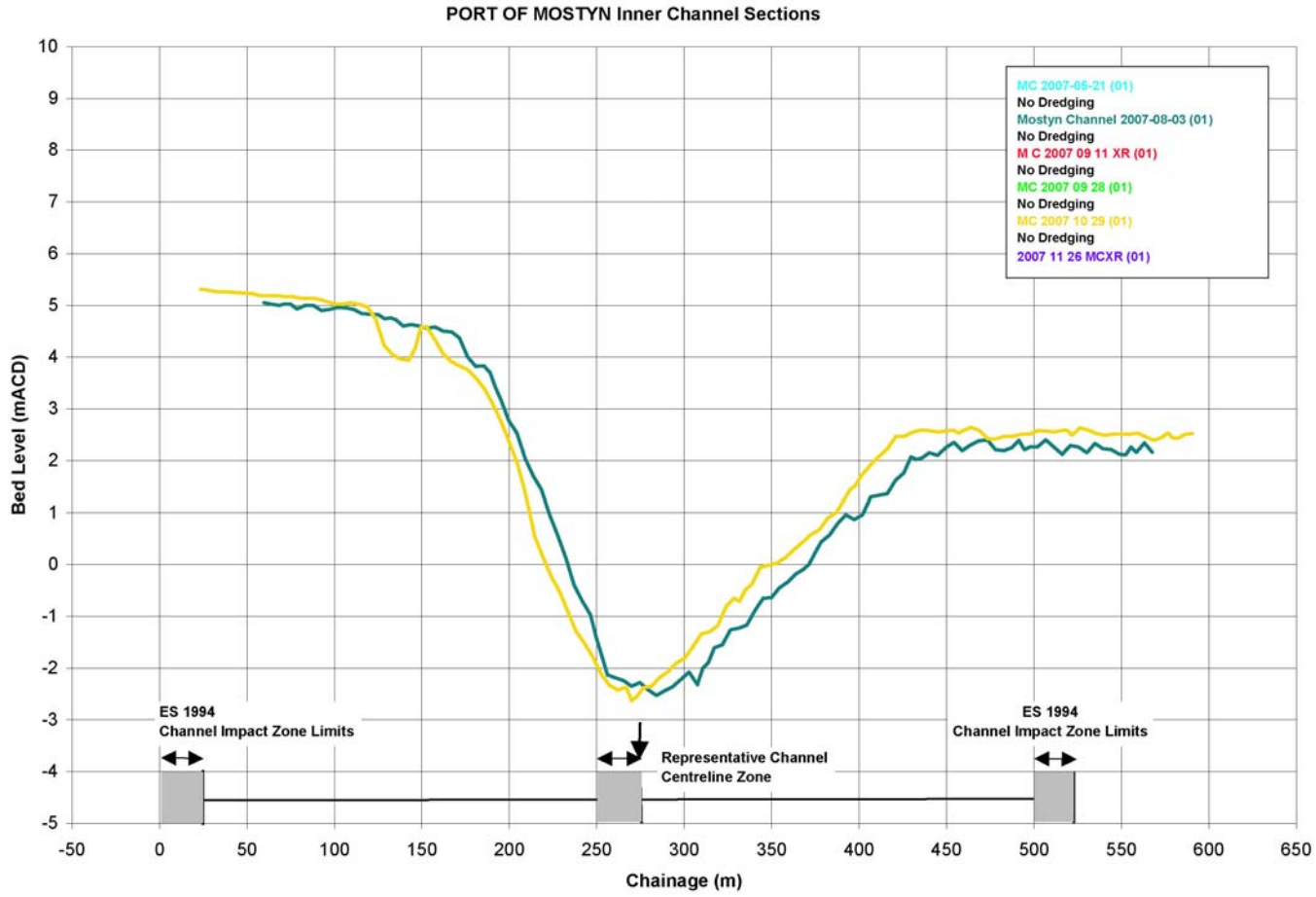




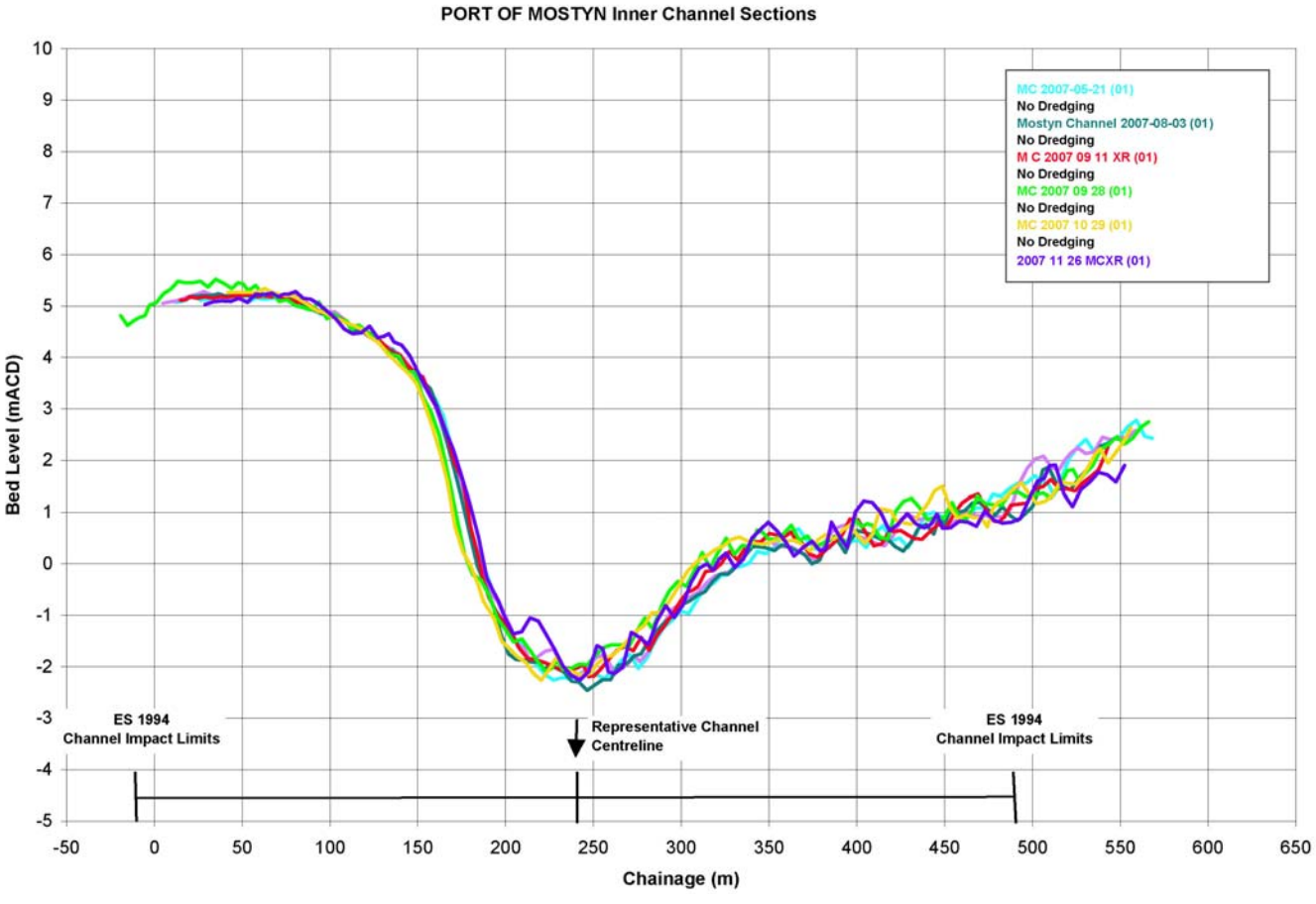
Dwg CII (9 of 14) SECTION 12

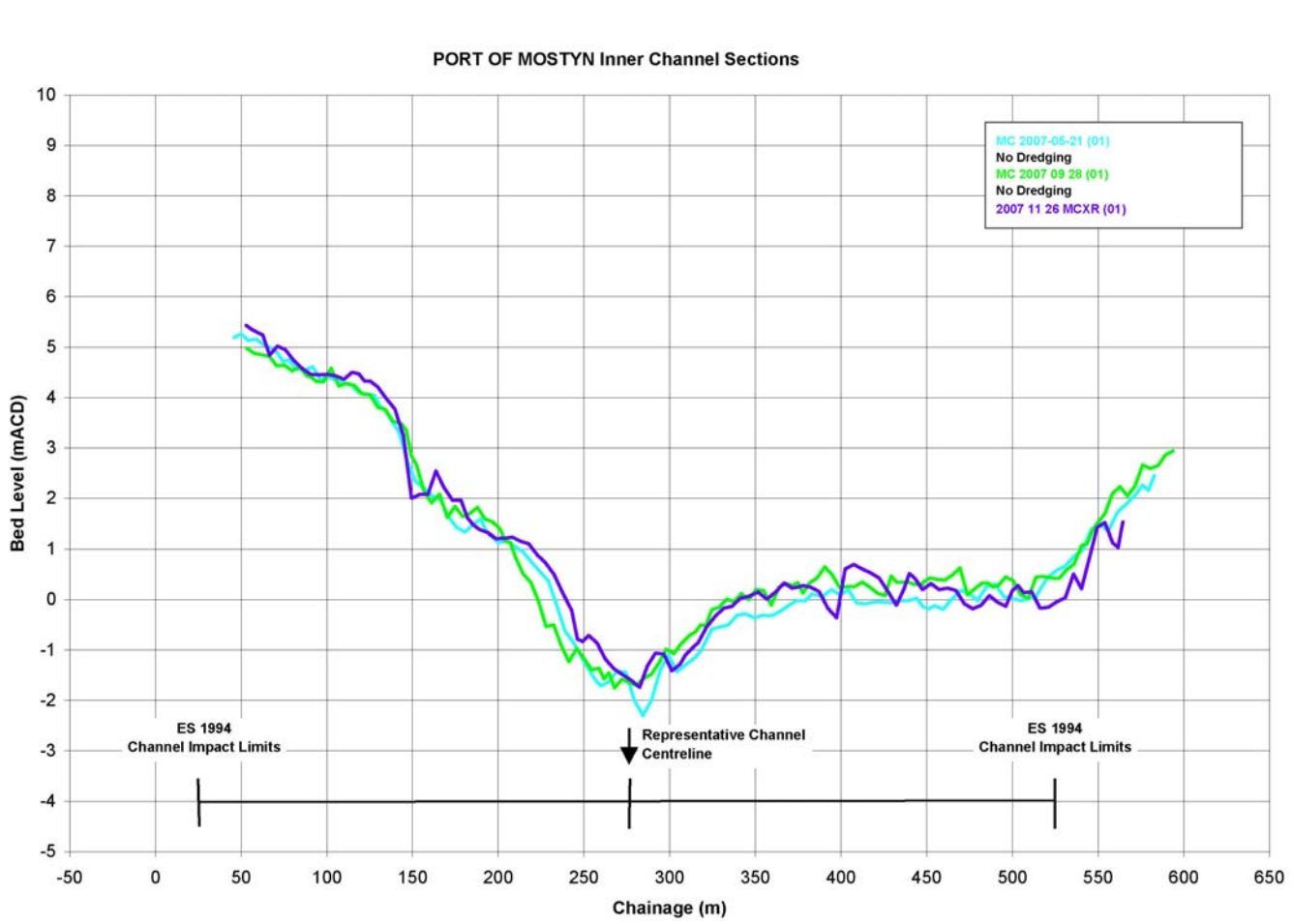


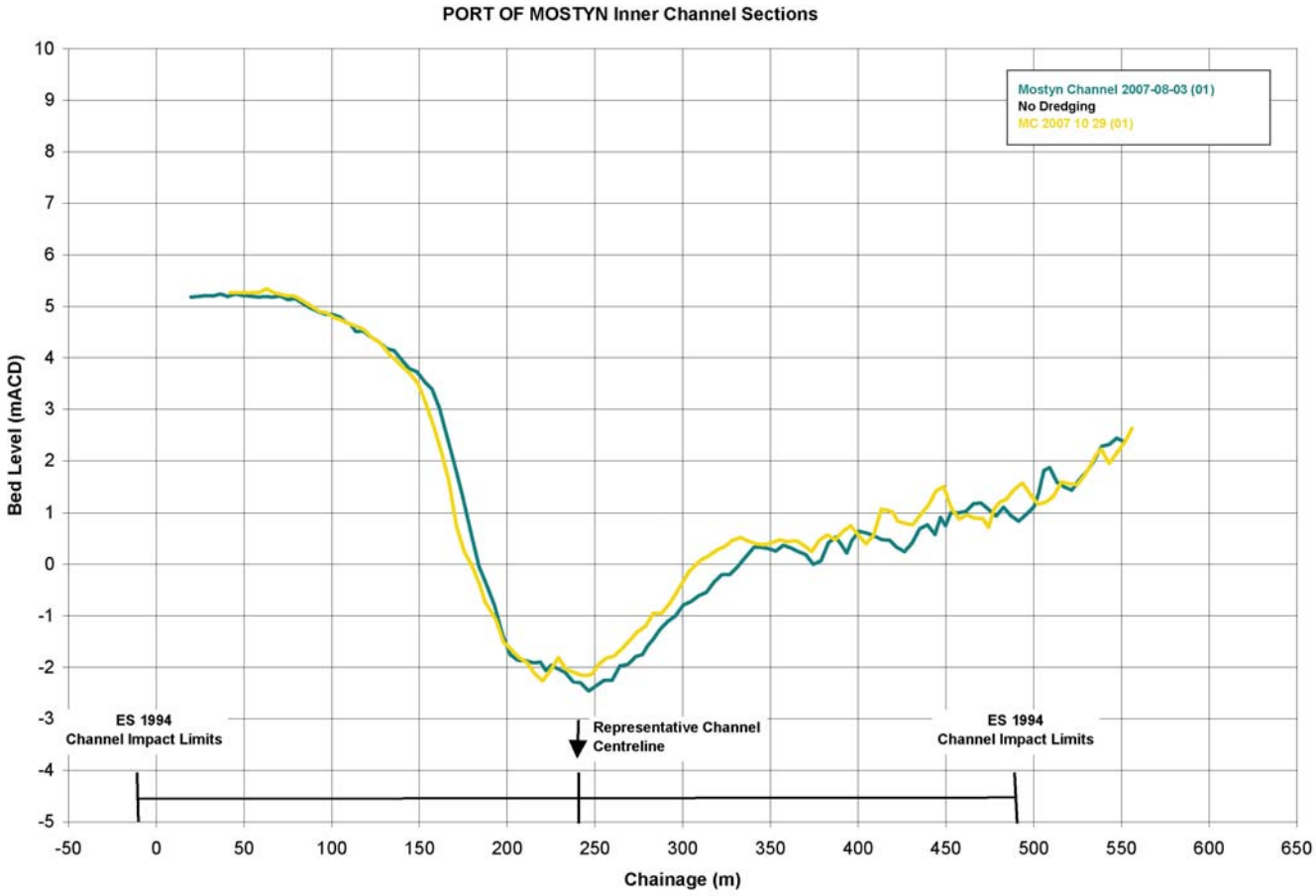




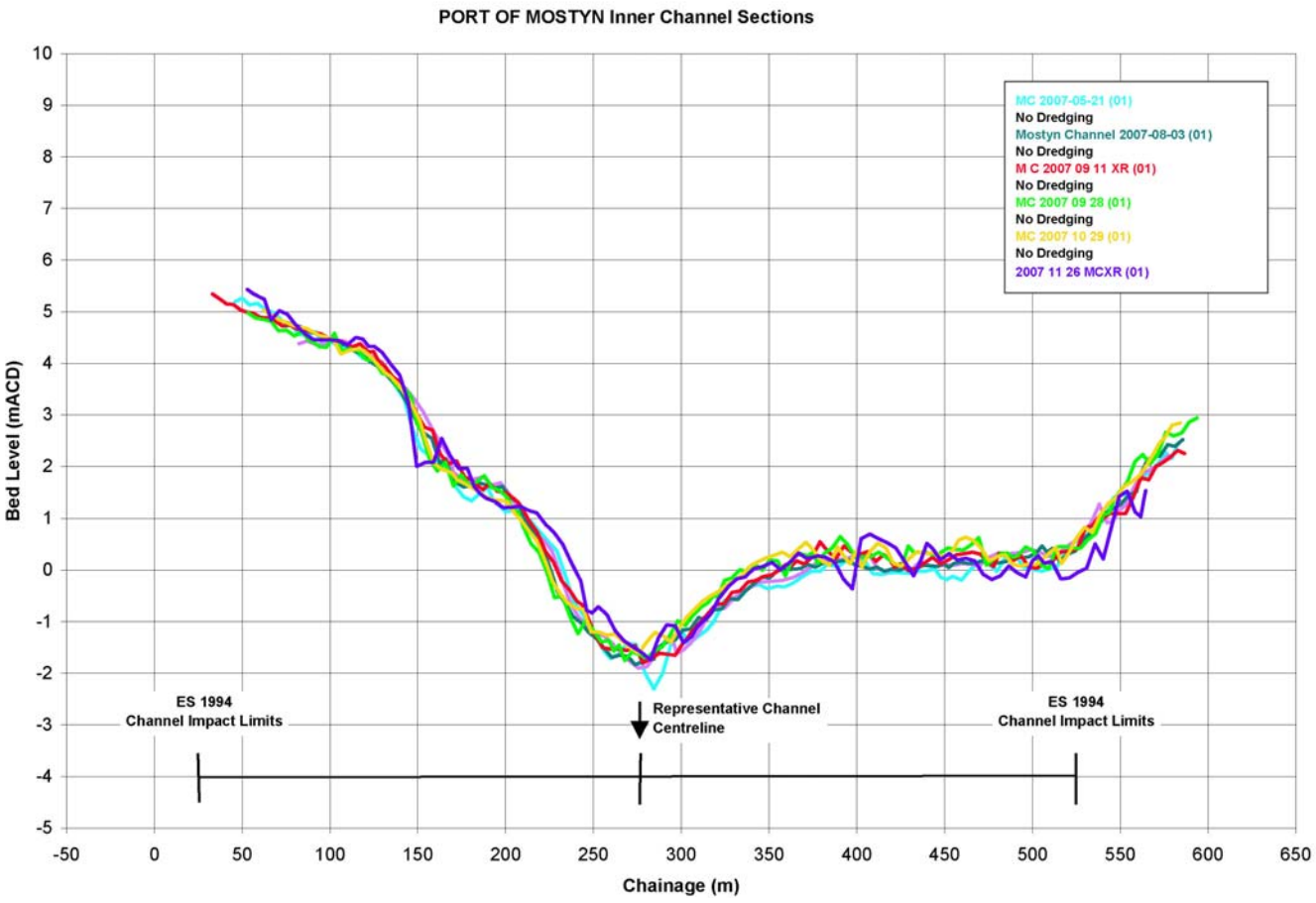
Dwg CII (10 of 14) SECTION 14

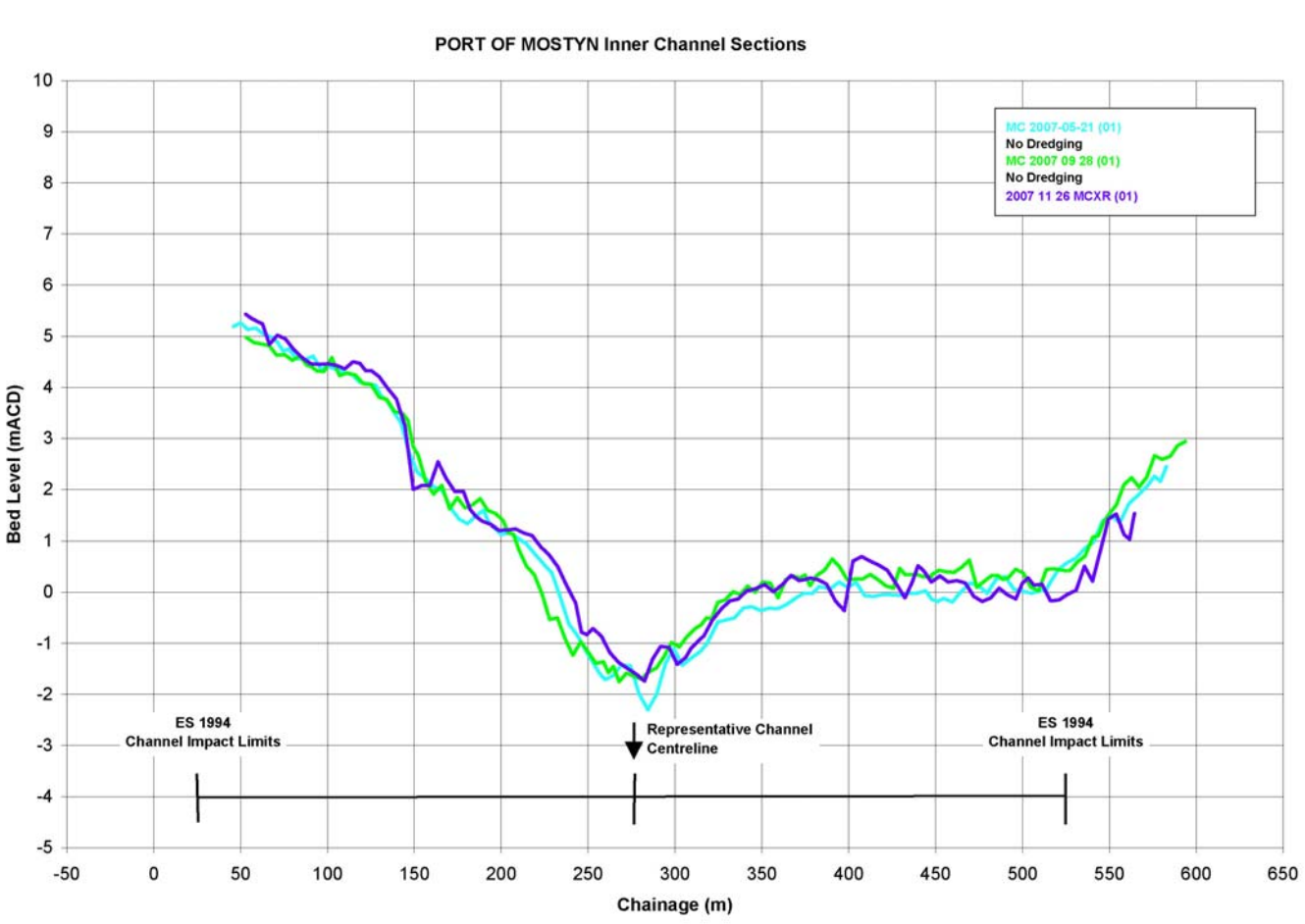


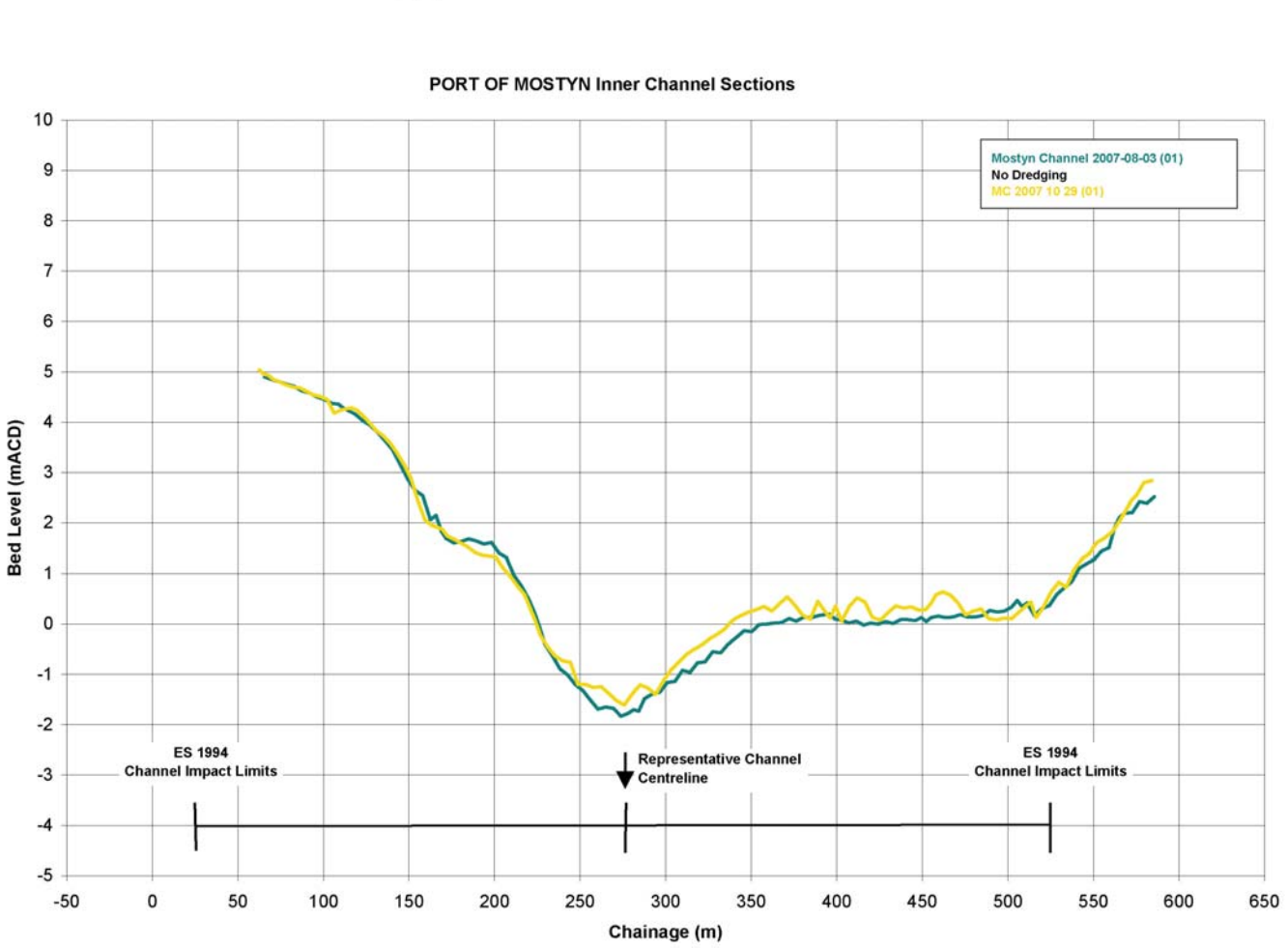




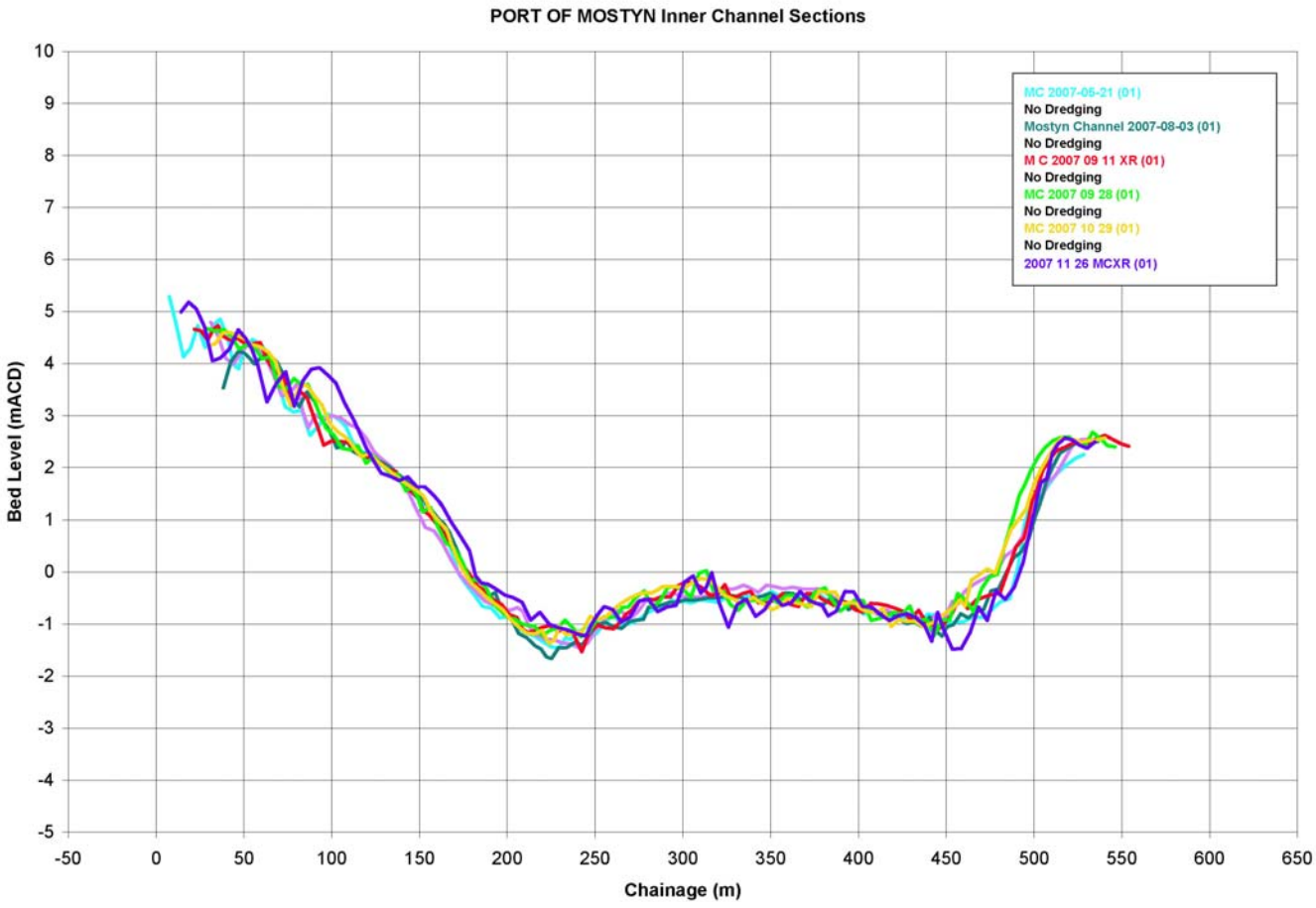
Dwg CII (11 of 14) SECTION 15

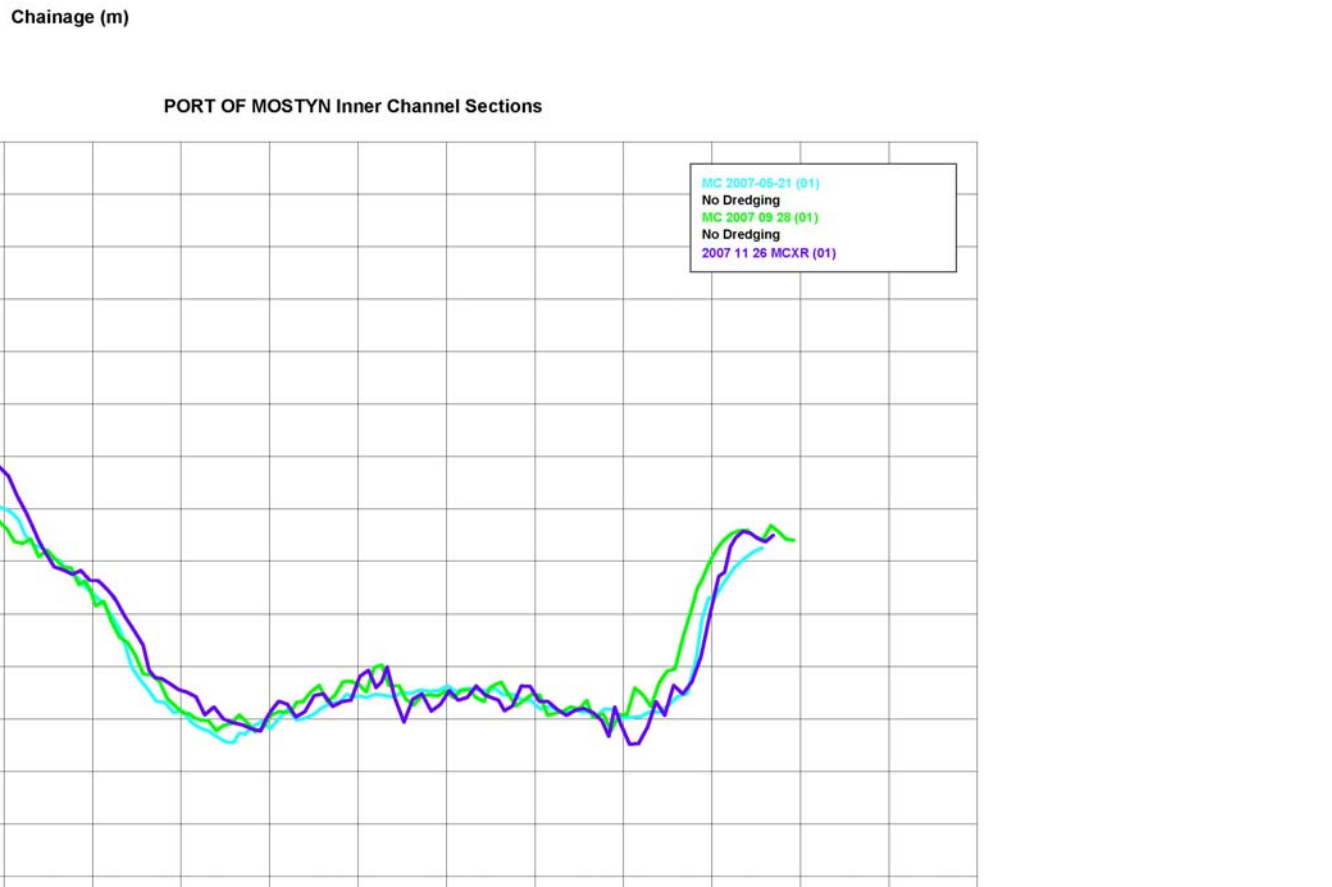




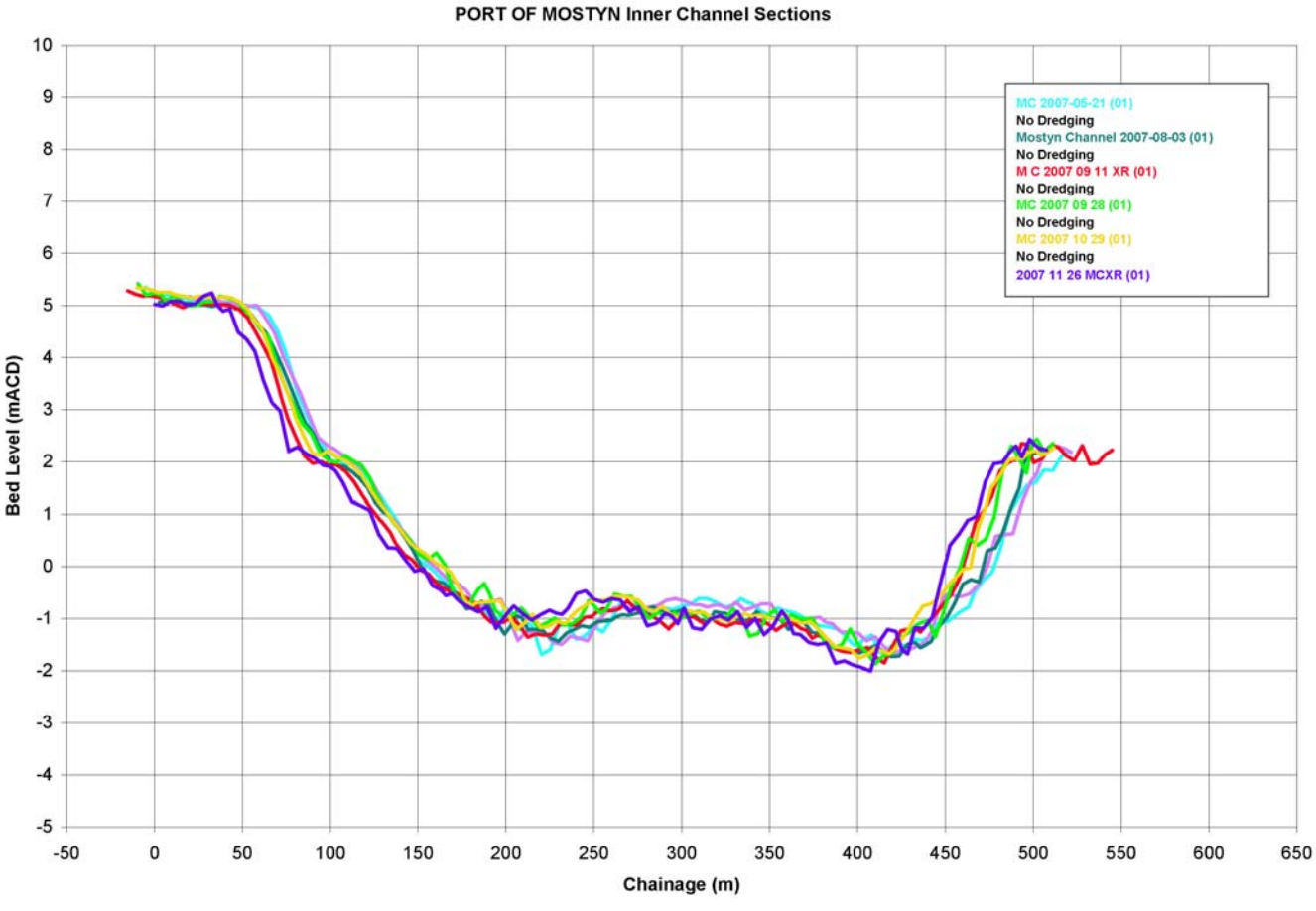


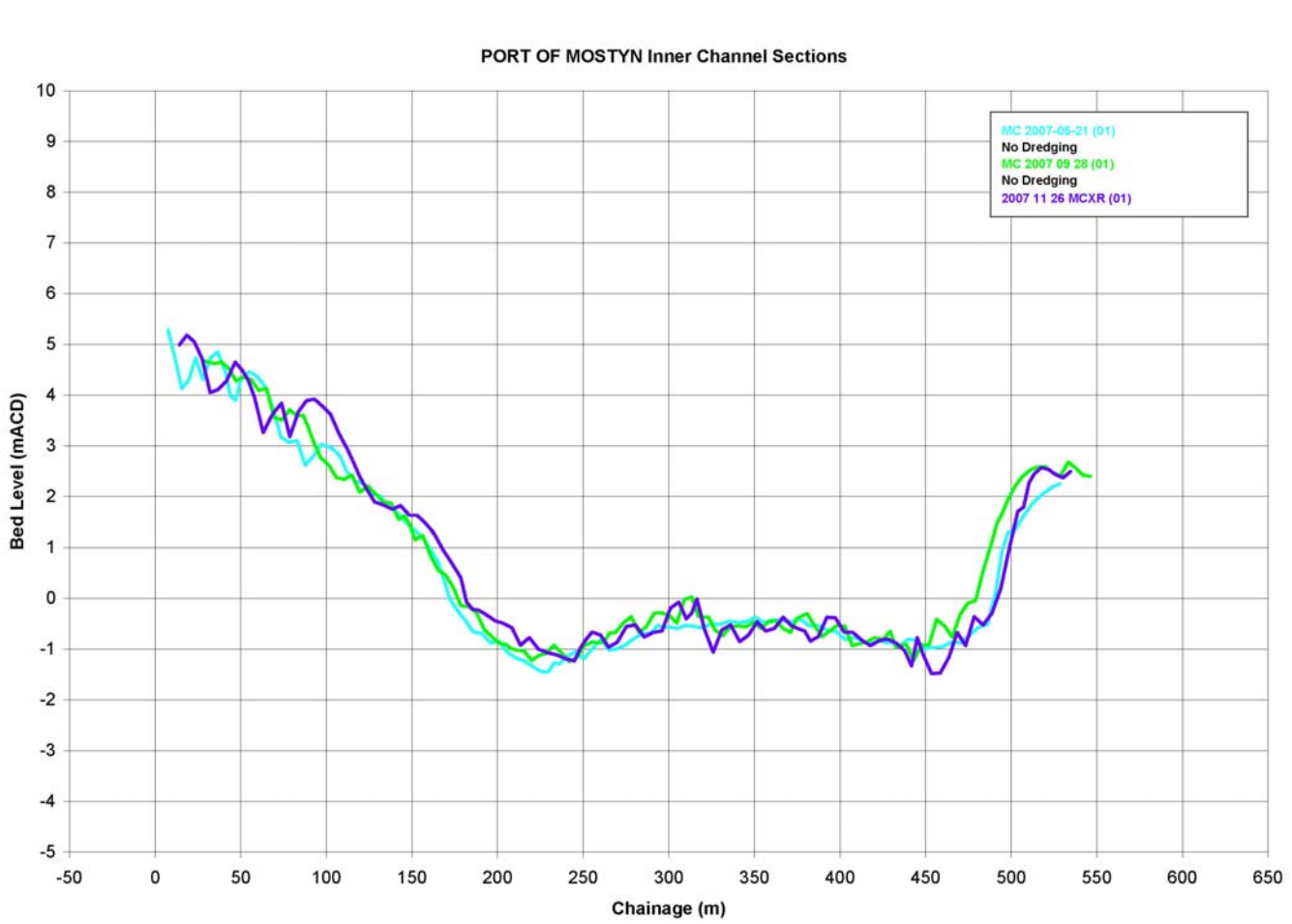
Dwg CII (12 of 14) SECTION 17

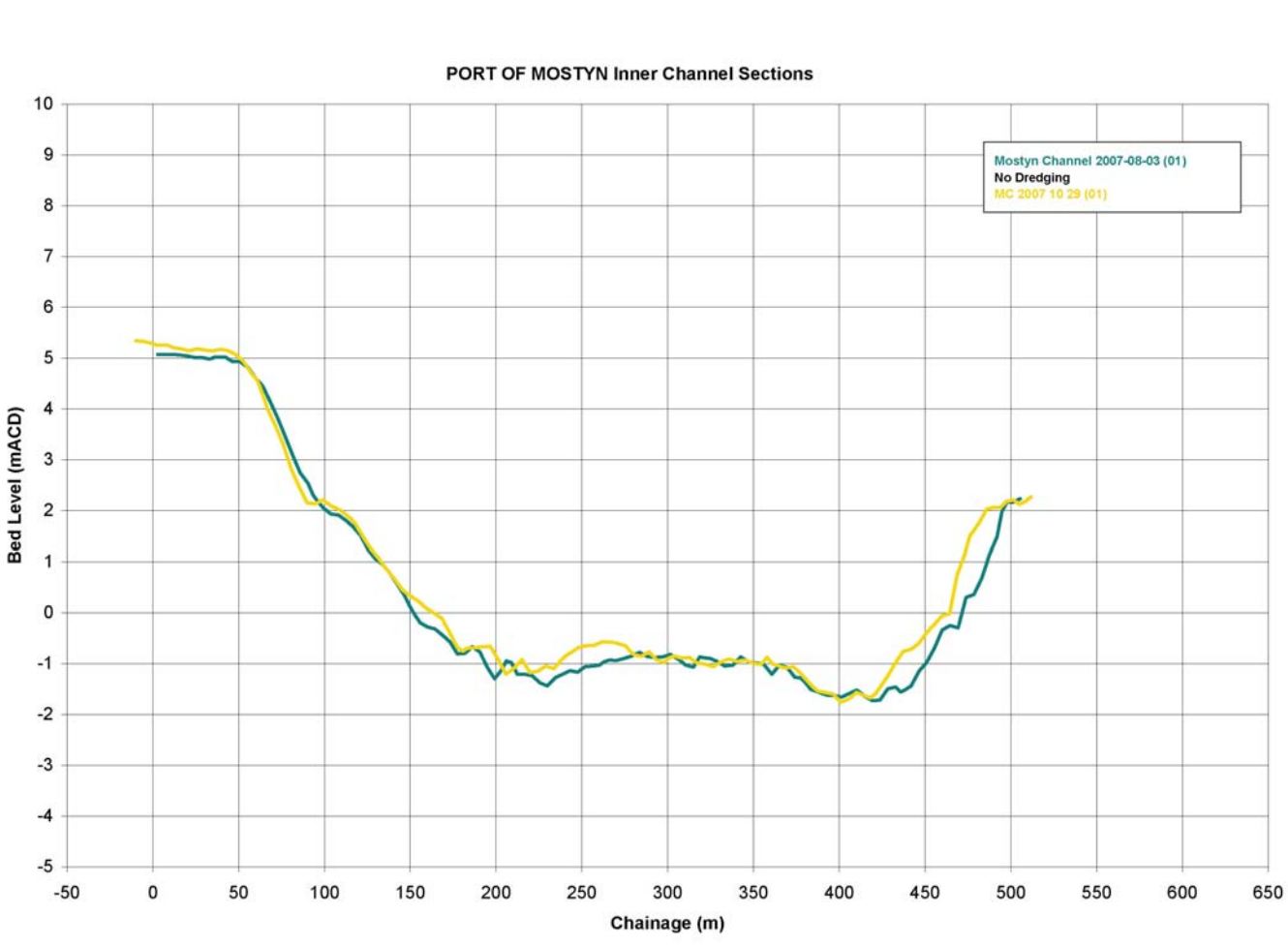




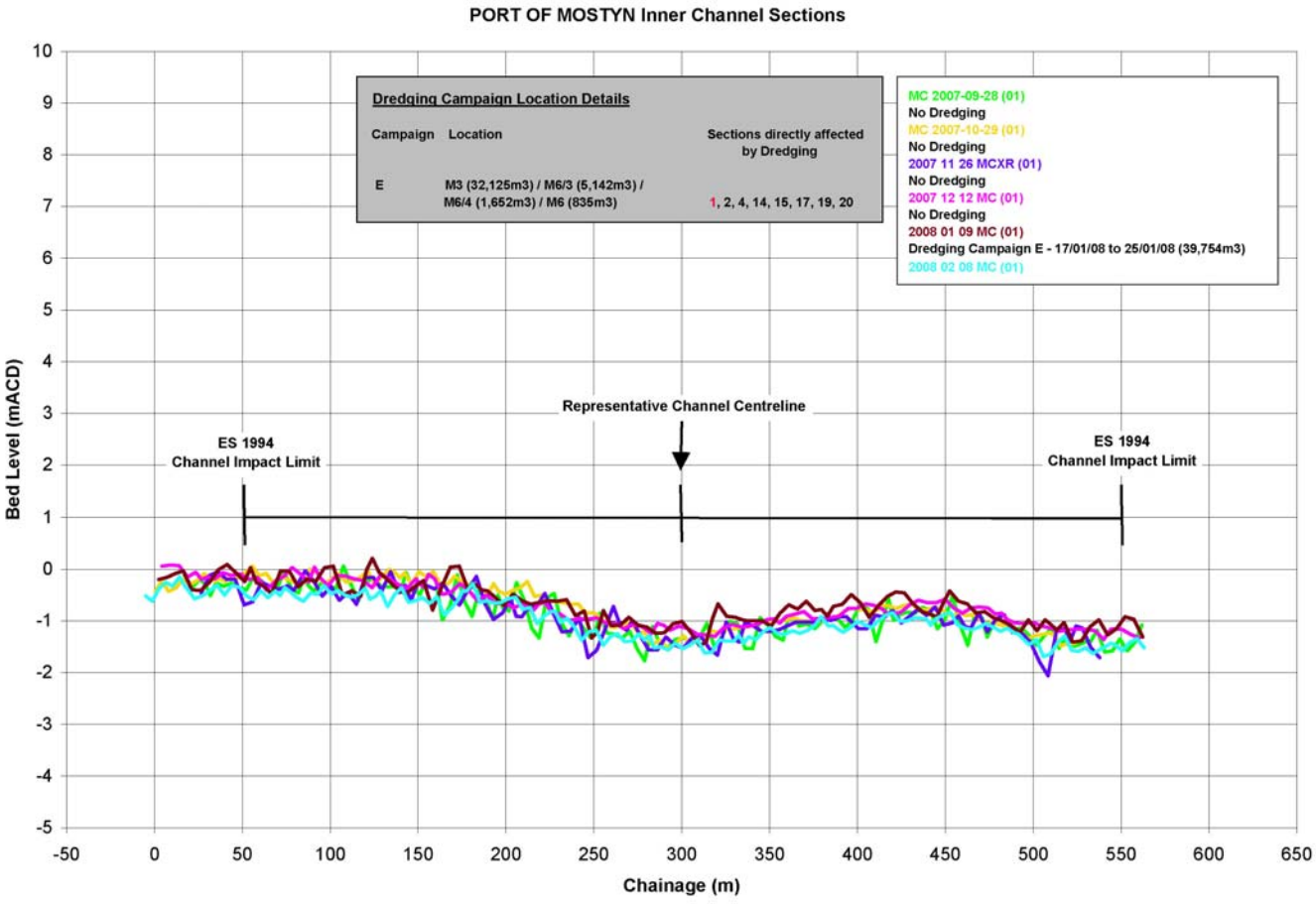
Dwg CII (13 of 14) SECTION 19

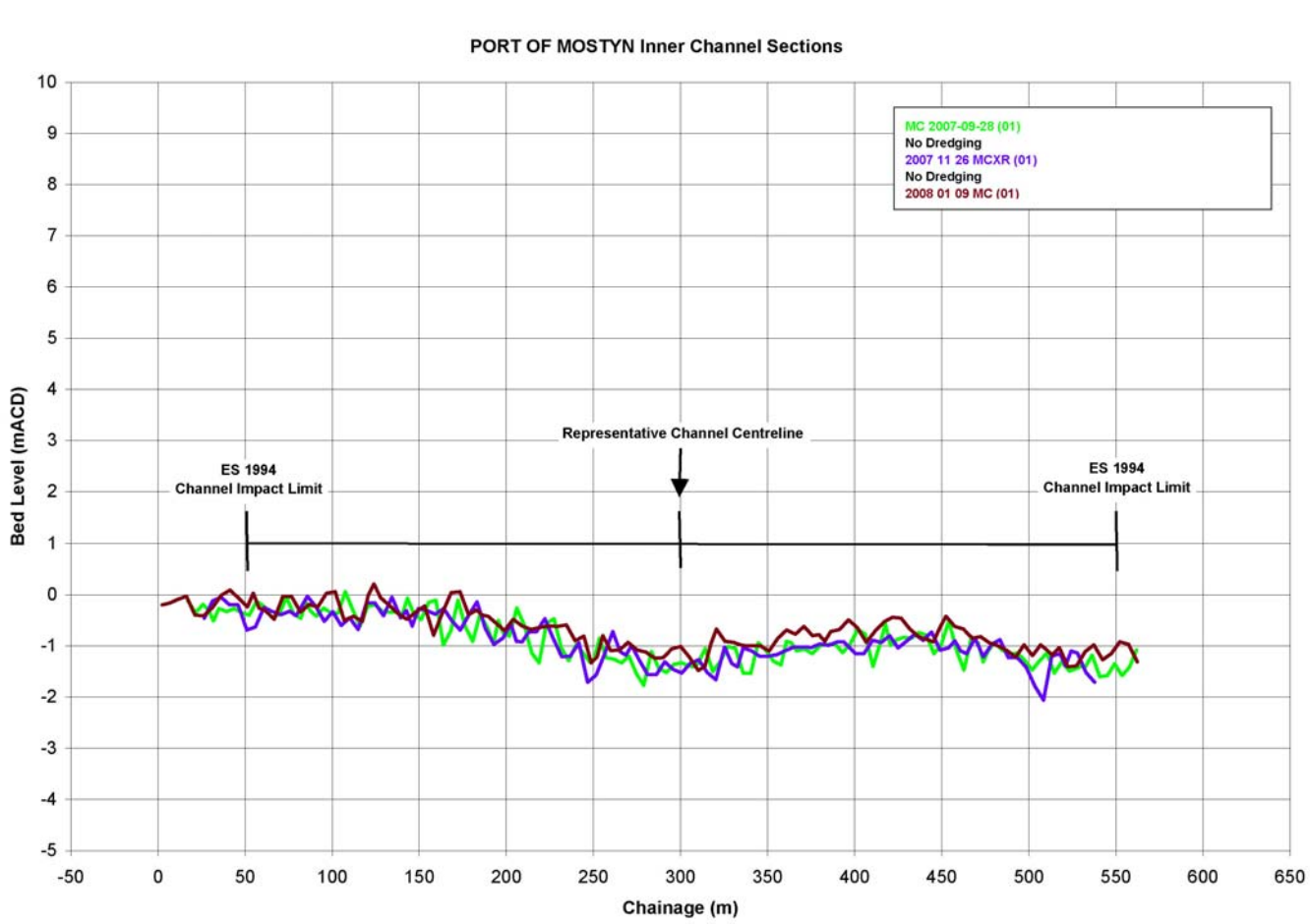


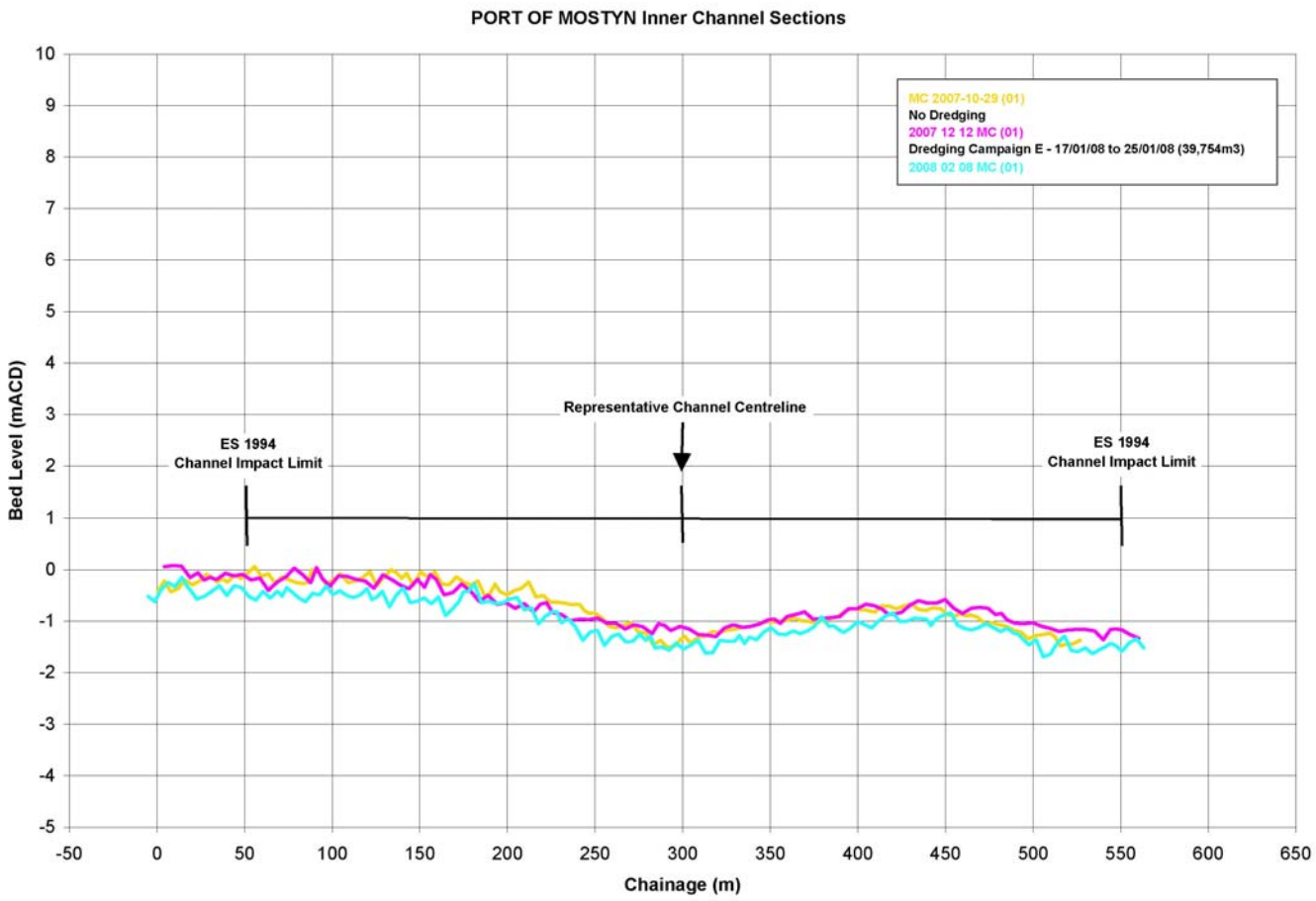




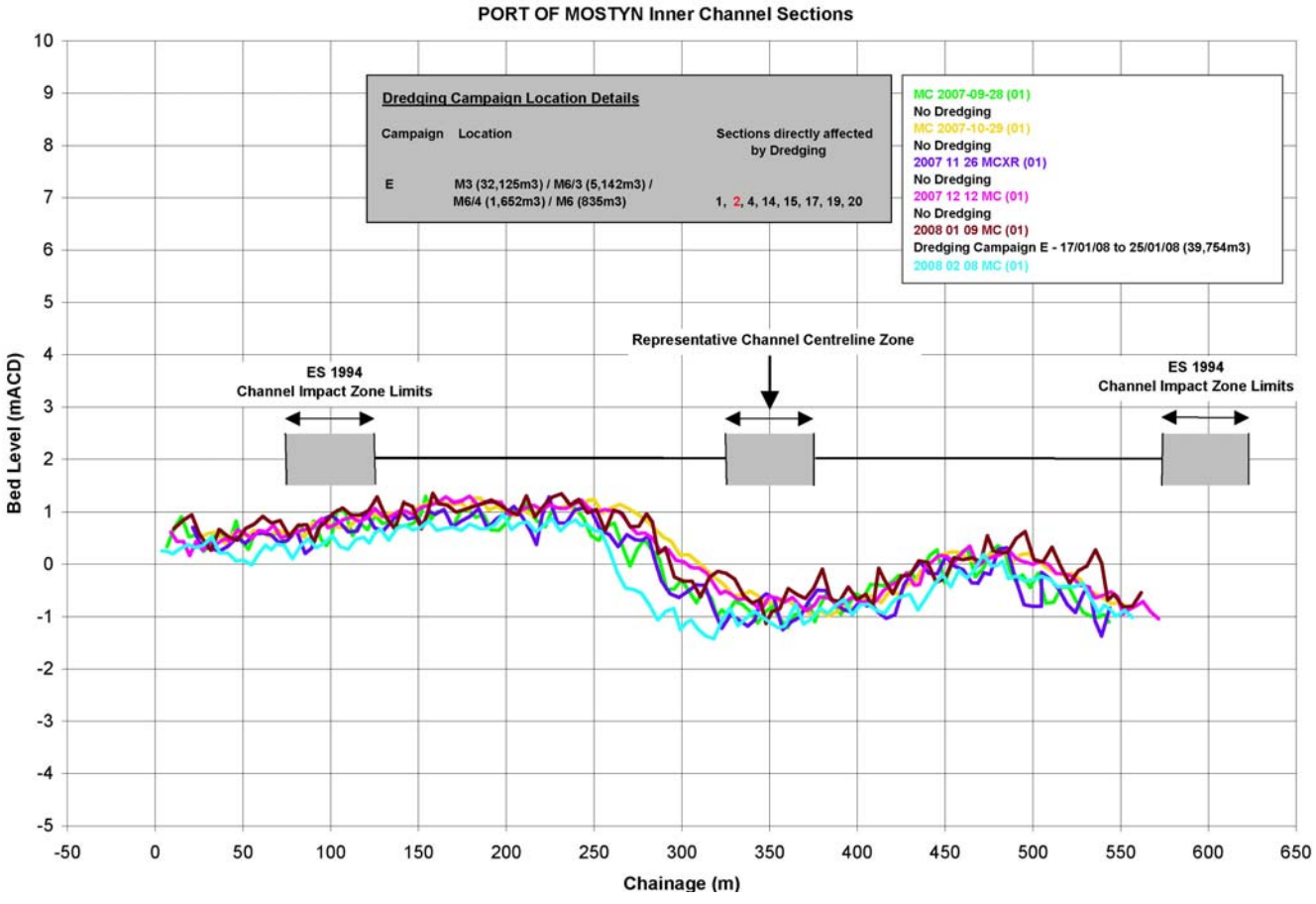
Dwg CII (14 of 14) SECTION 20

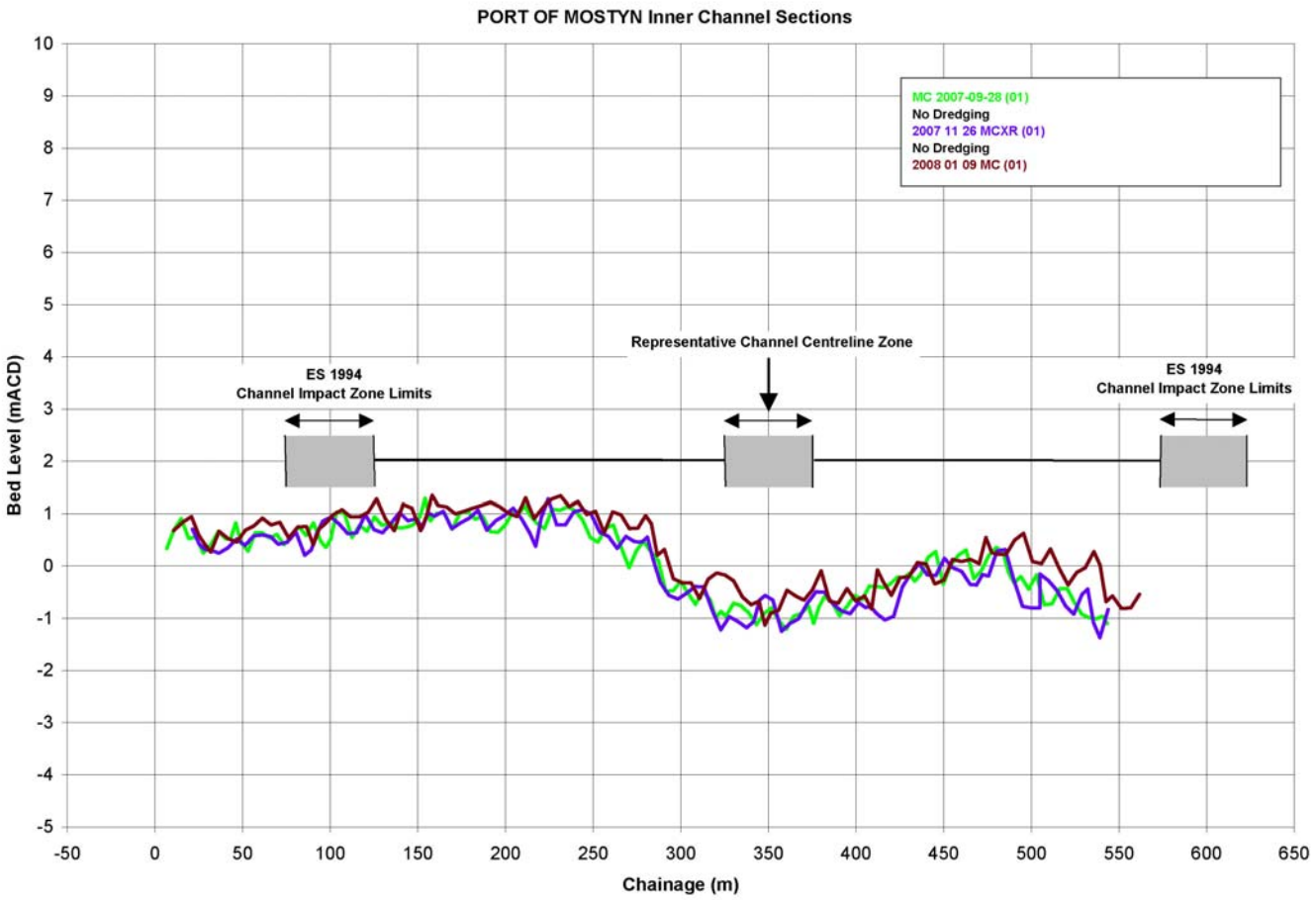


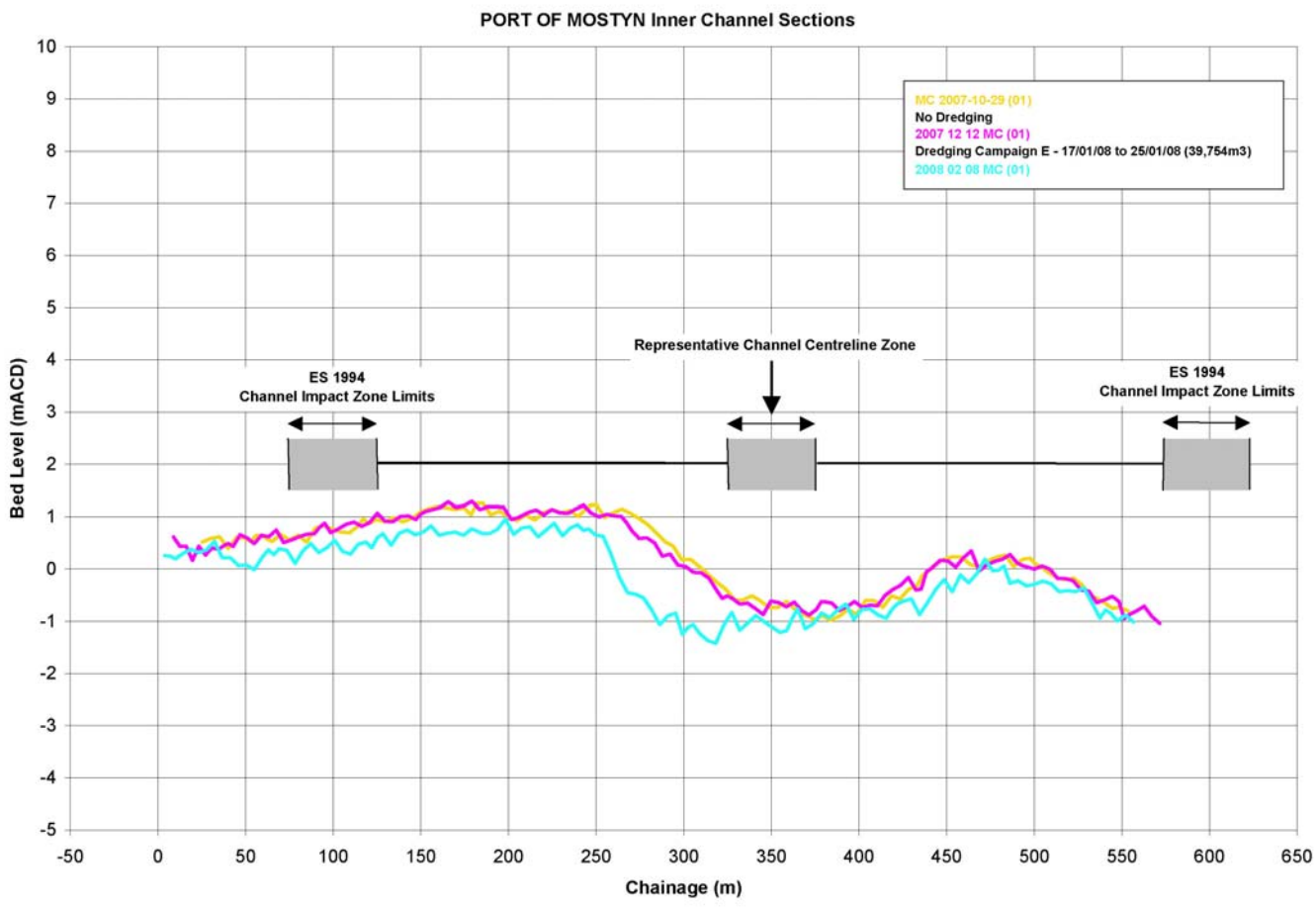




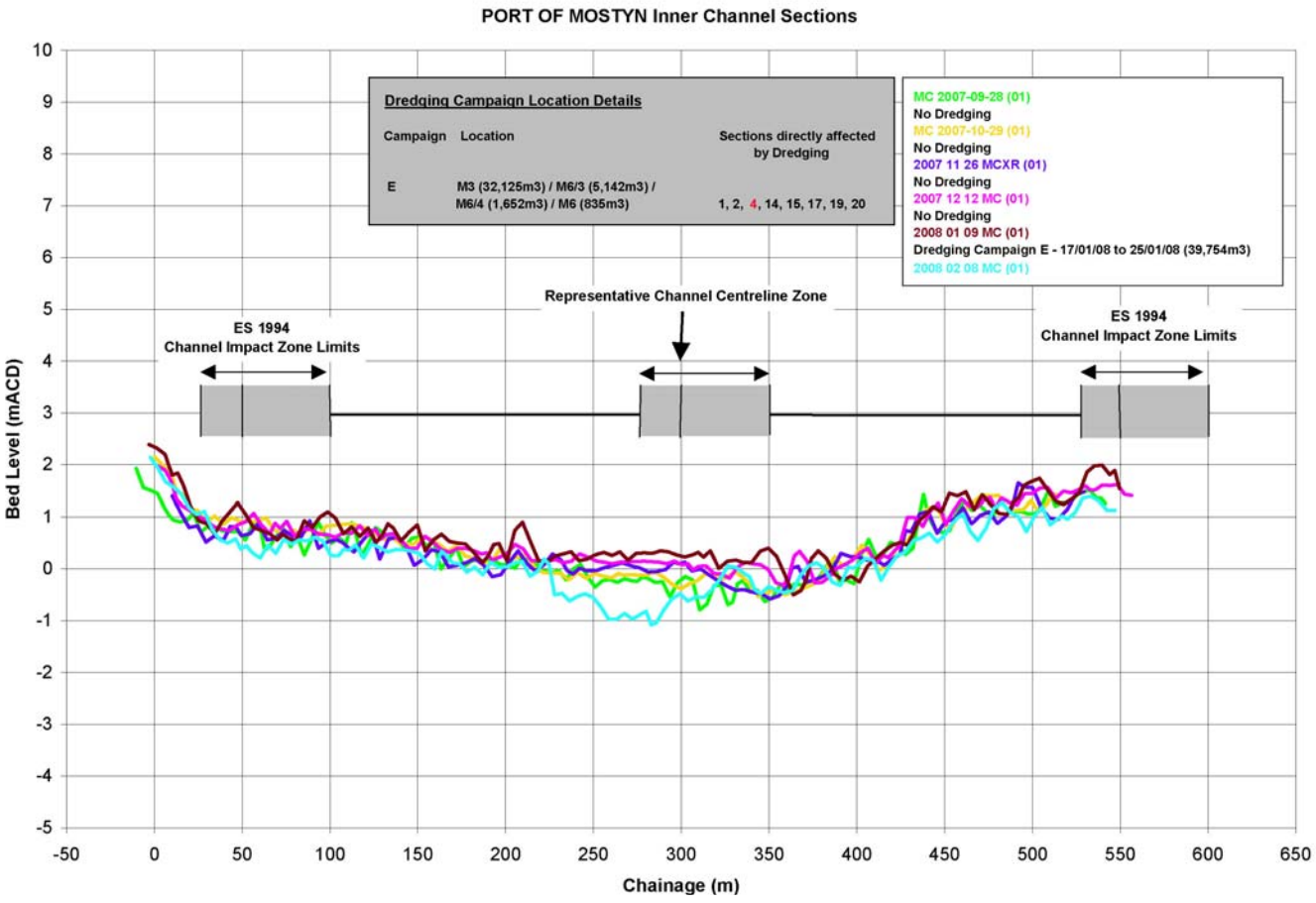
Dwg CIII (1 of 14) SECTION 01

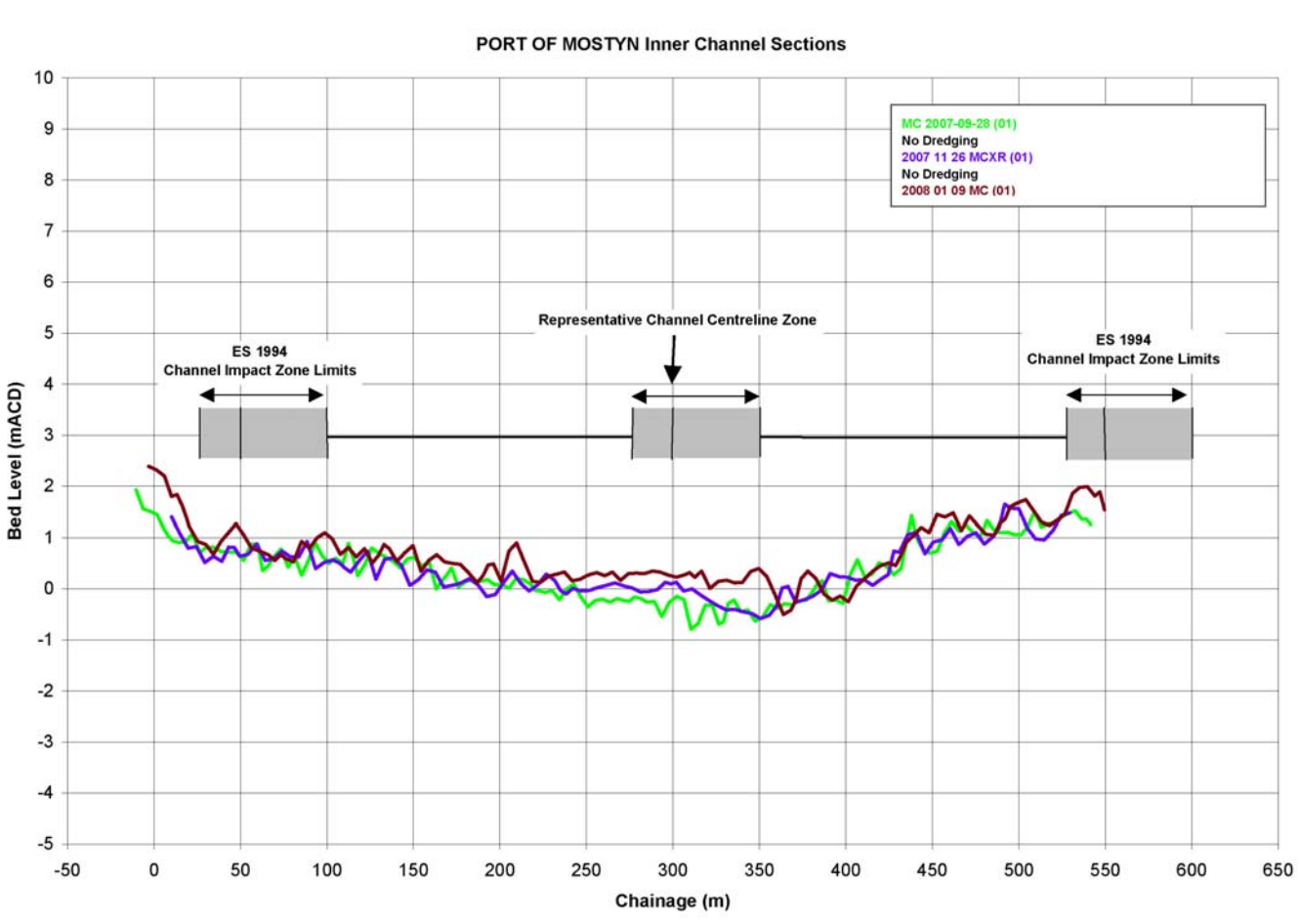


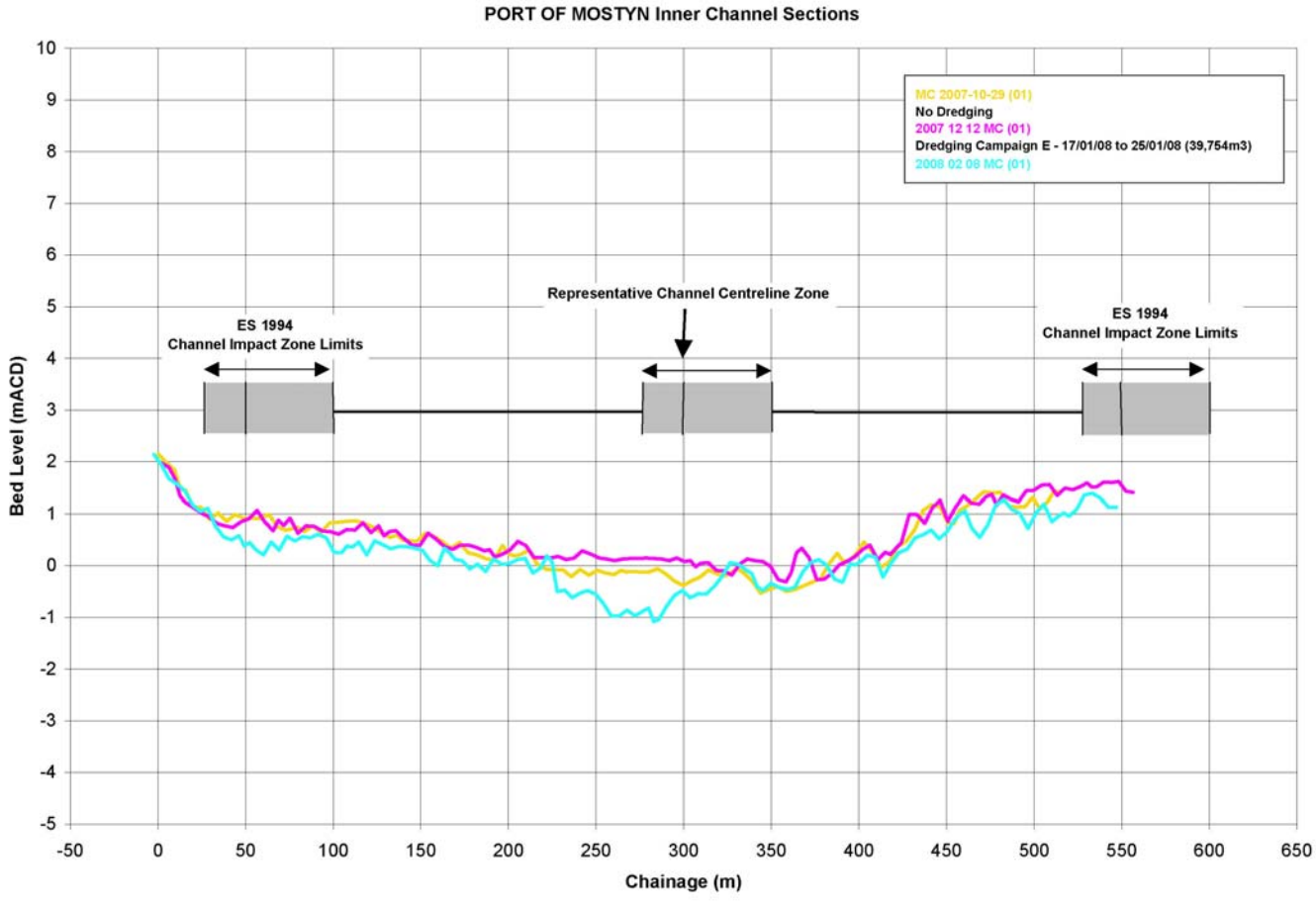




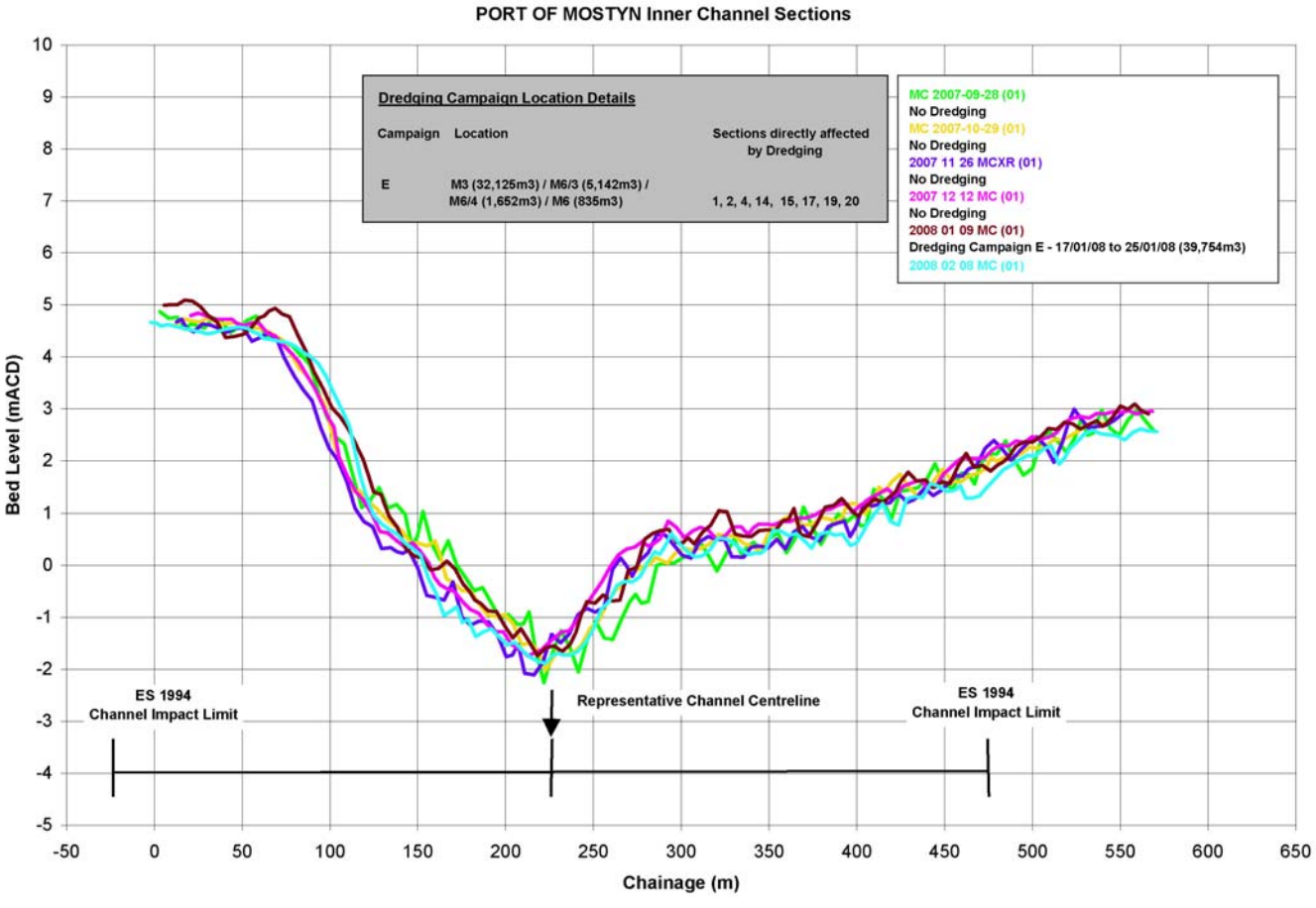
Dwg CIII (2 of 14) SECTION 02

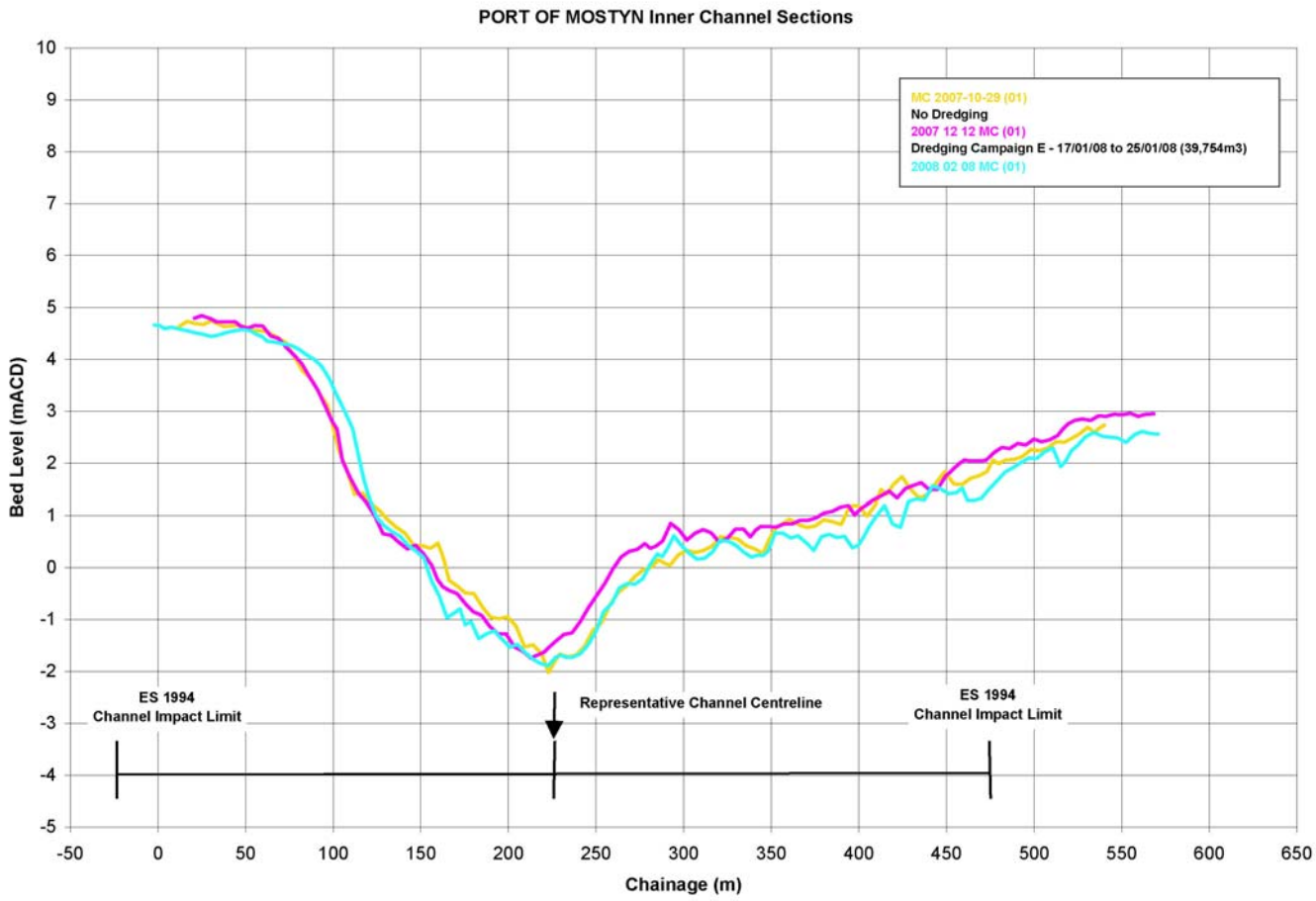




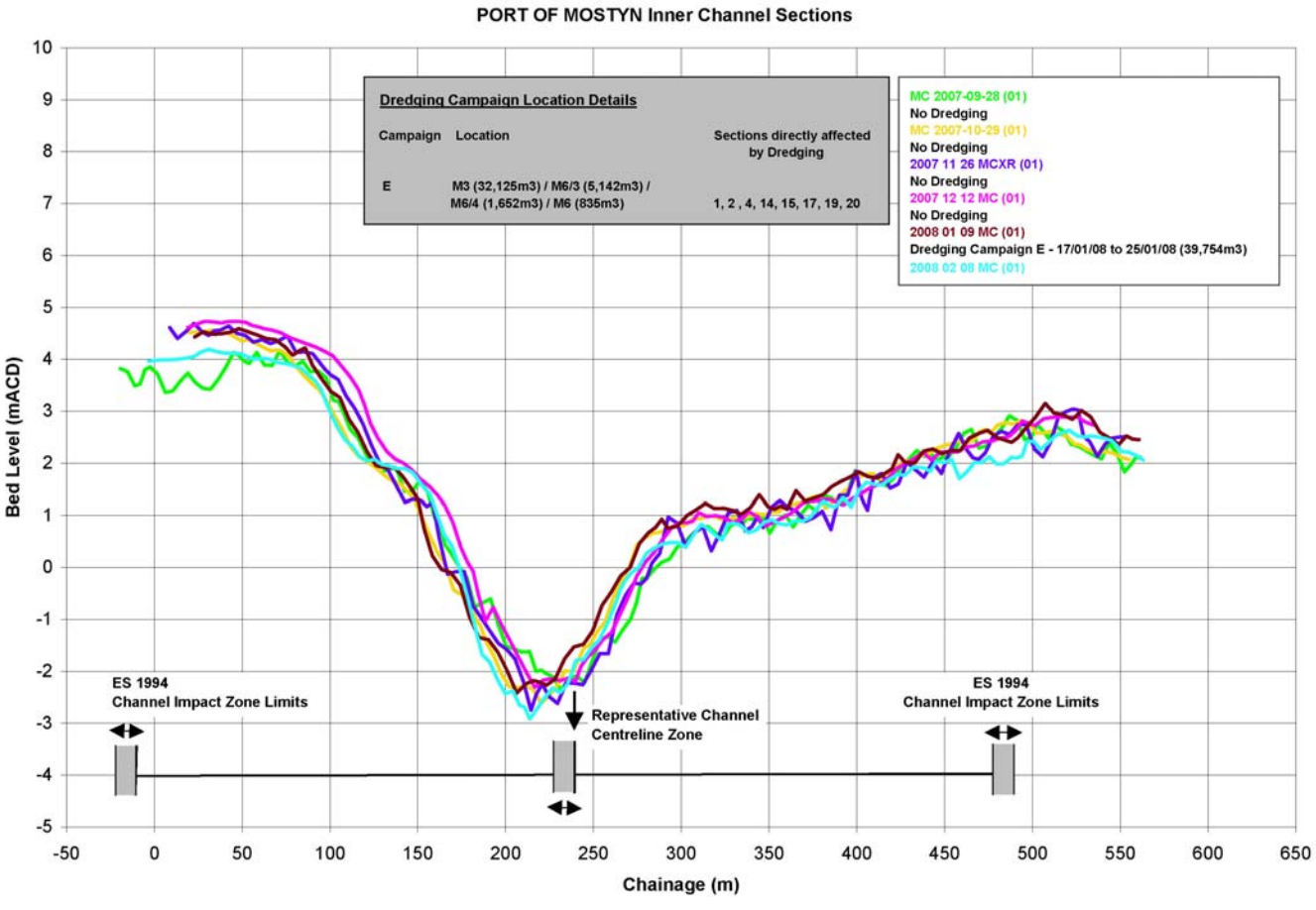


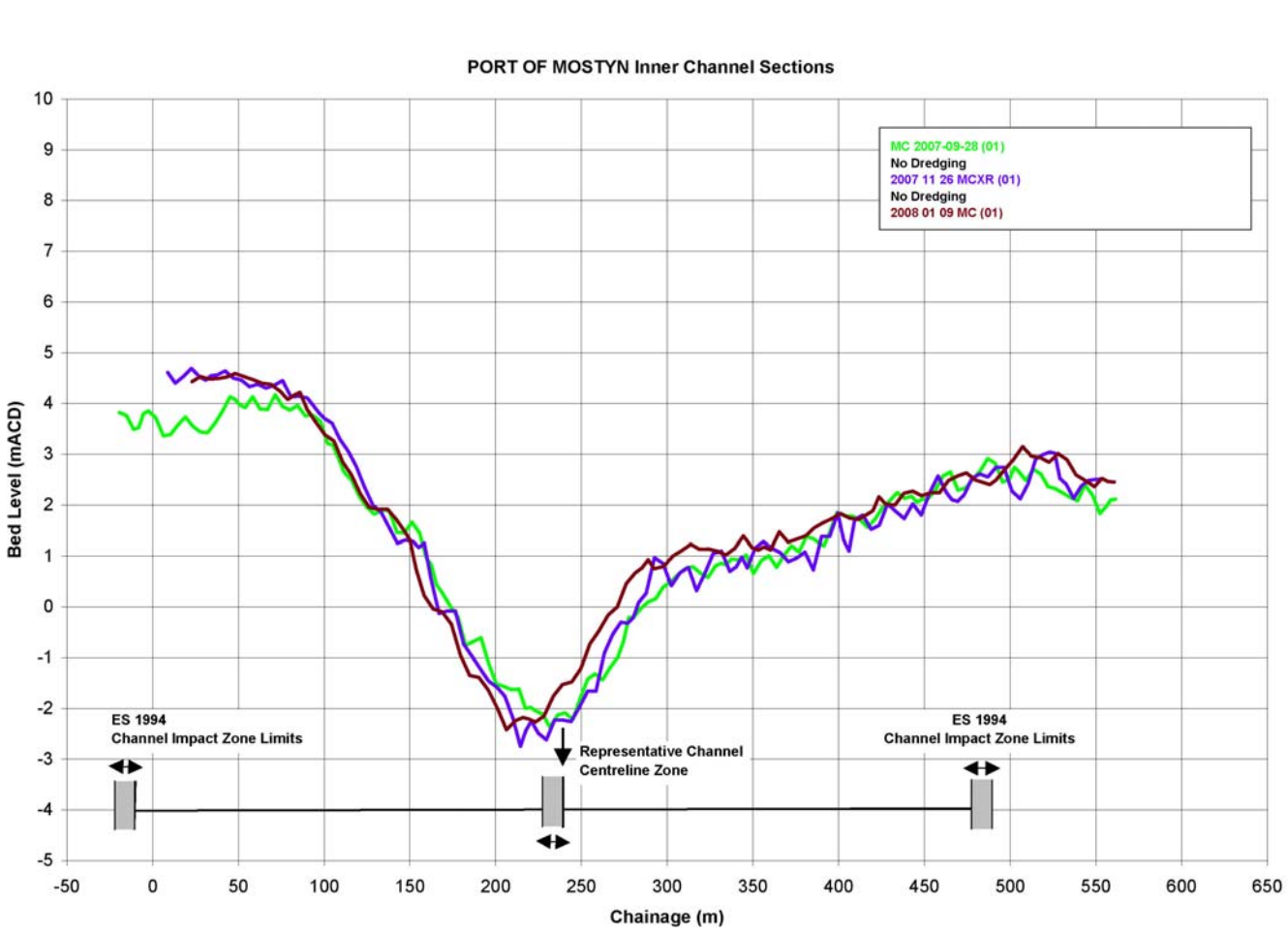
Dwg CIII (3 of 14) SECTION 04

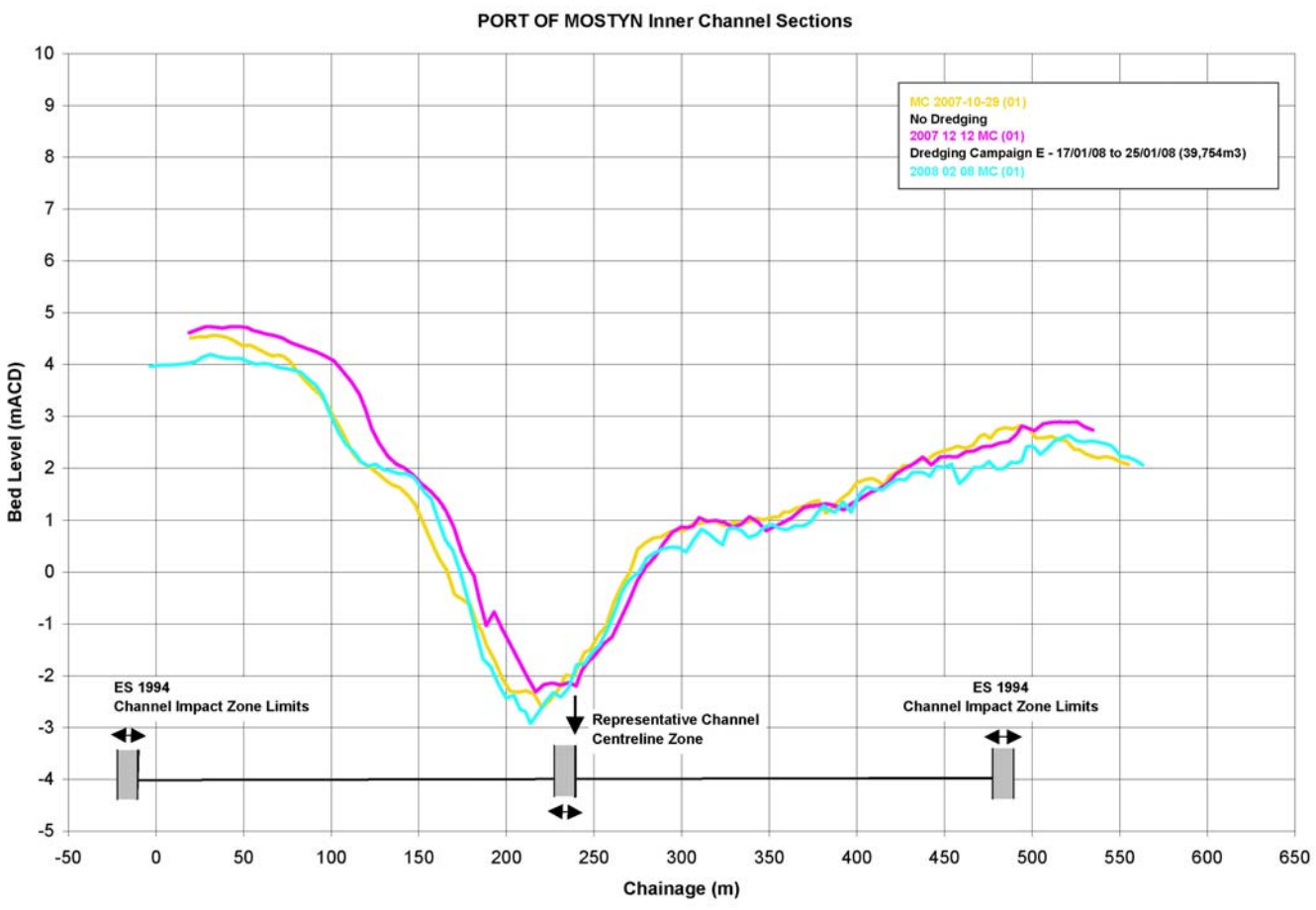




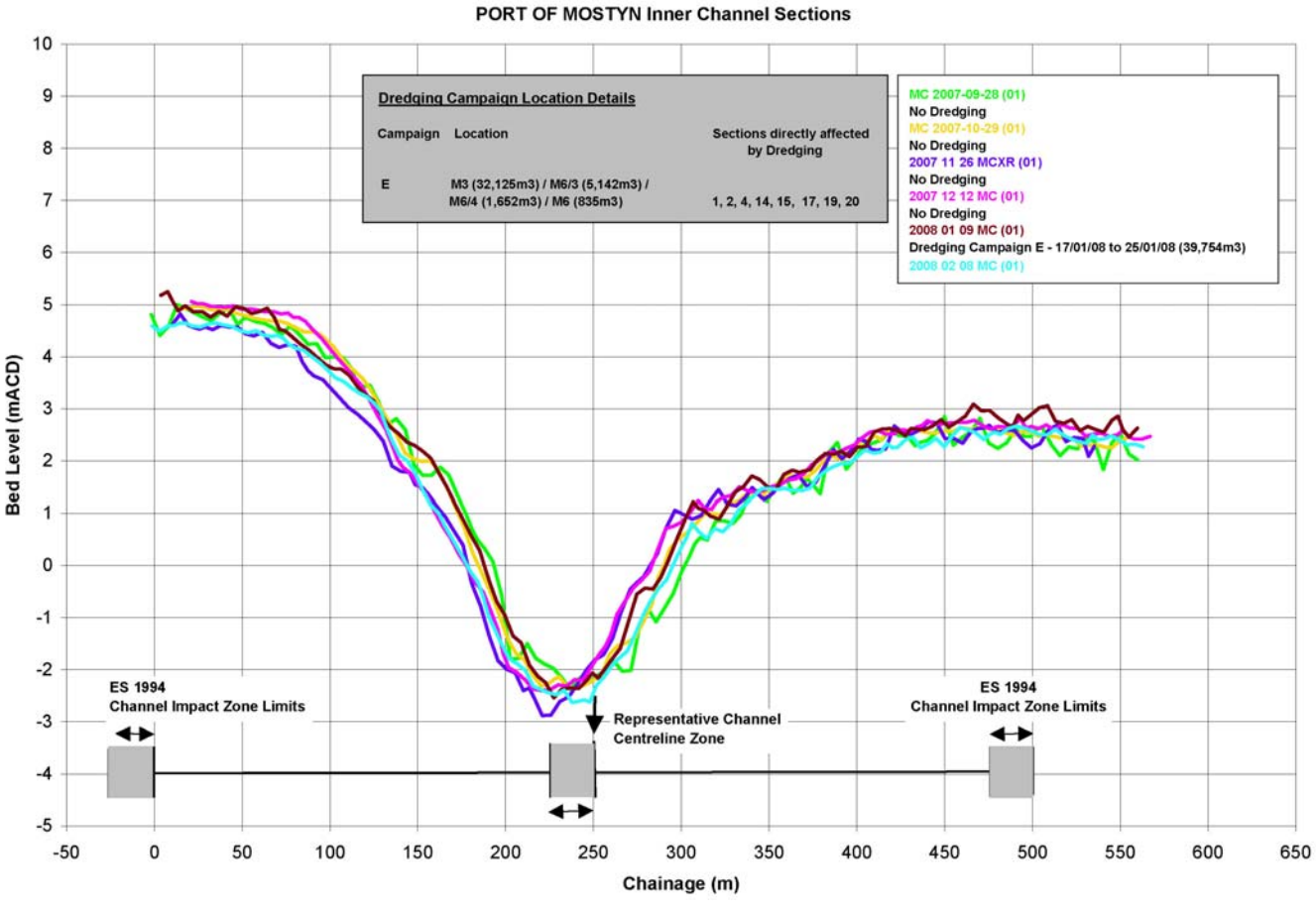
Dwg CIII (4 of 14) SECTION 06

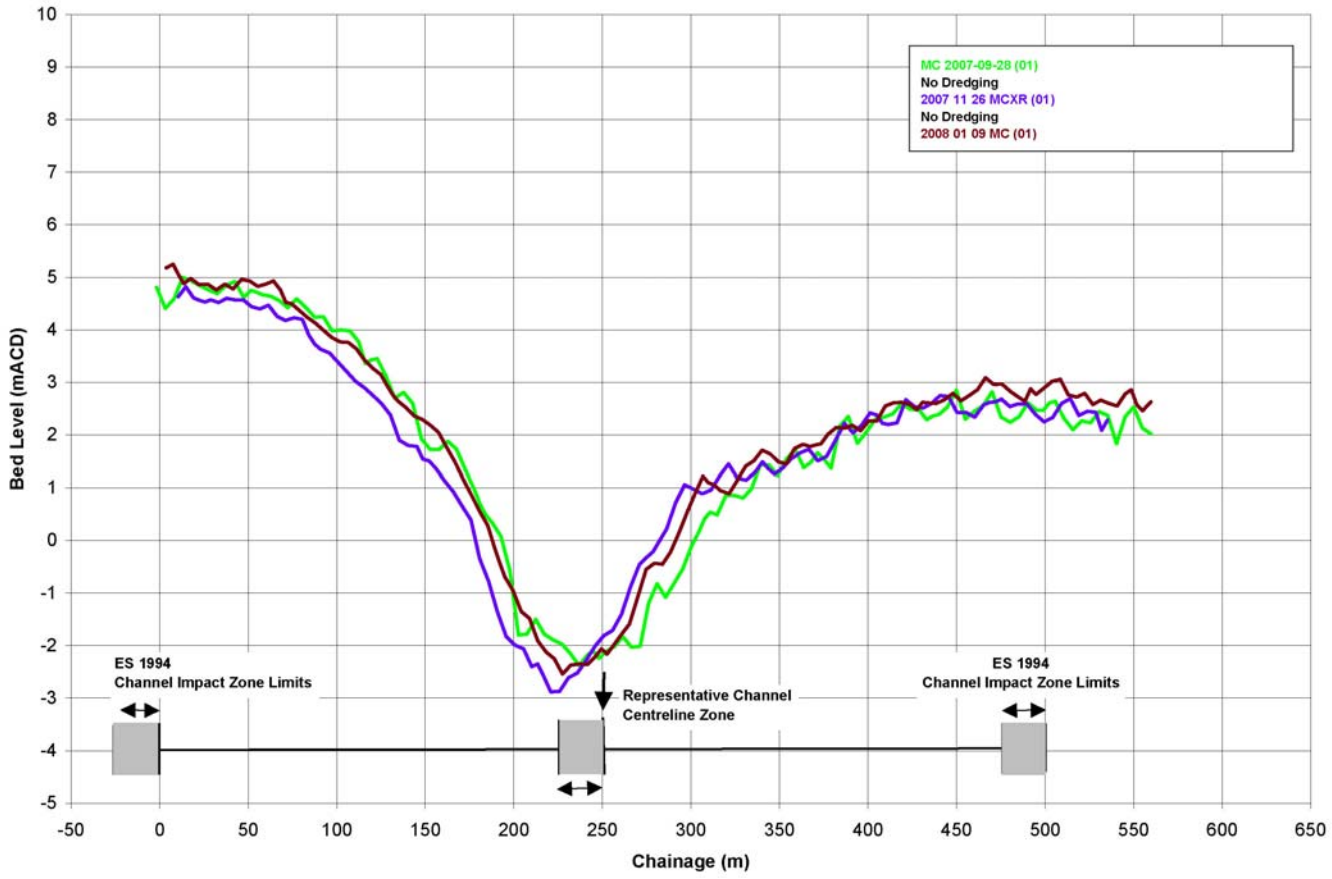


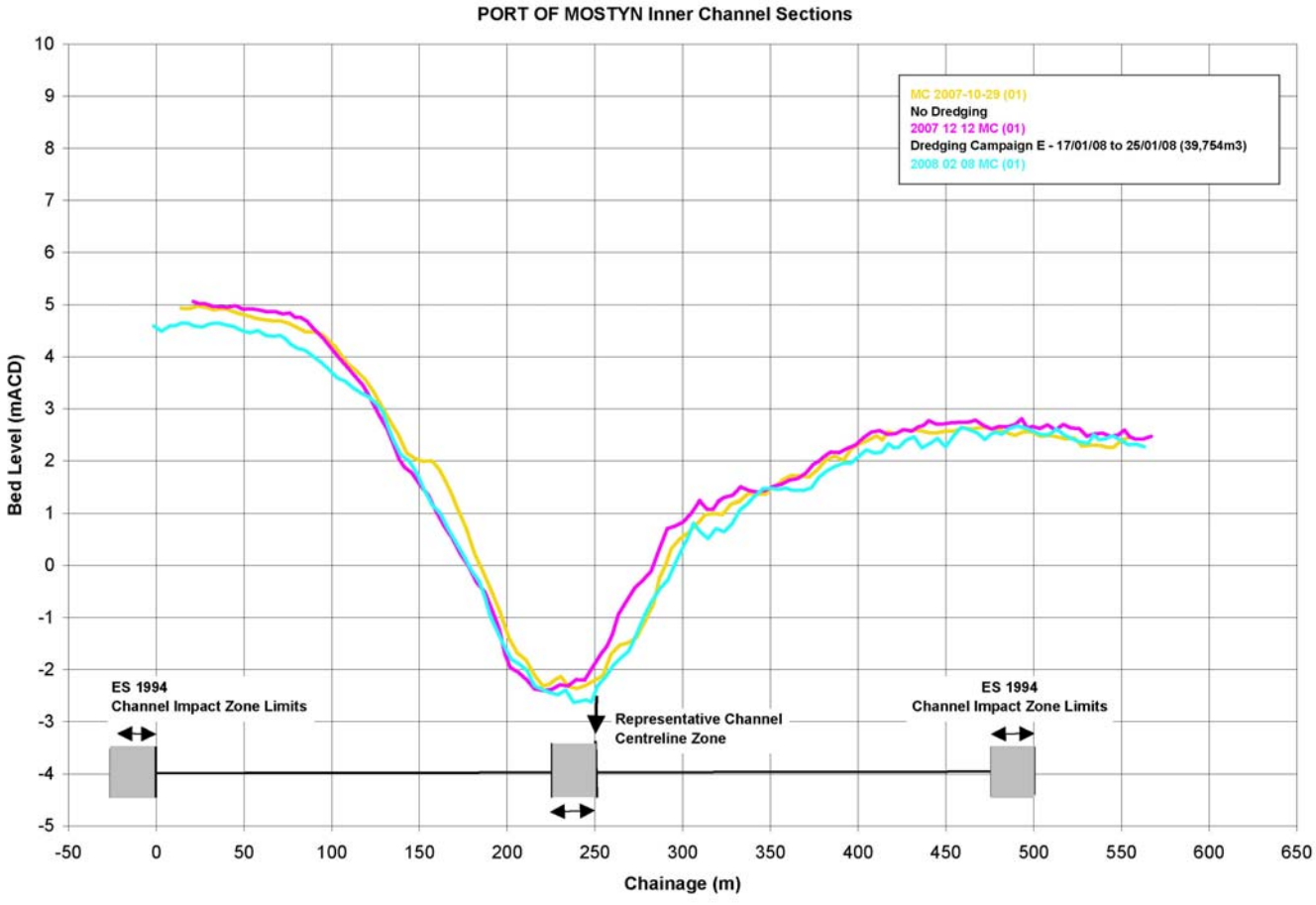




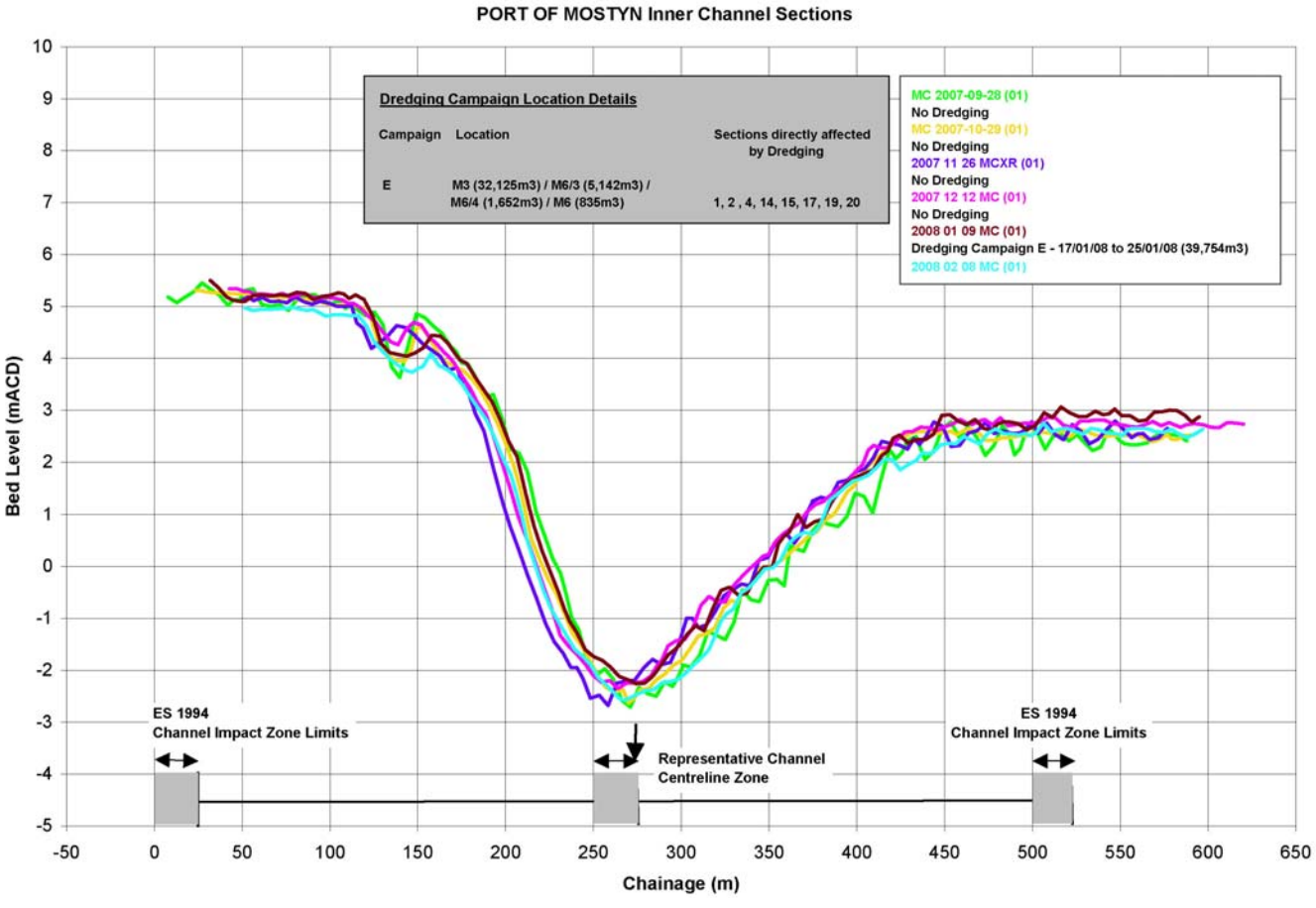
Dwg CIII (5 of 14) SECTION 07

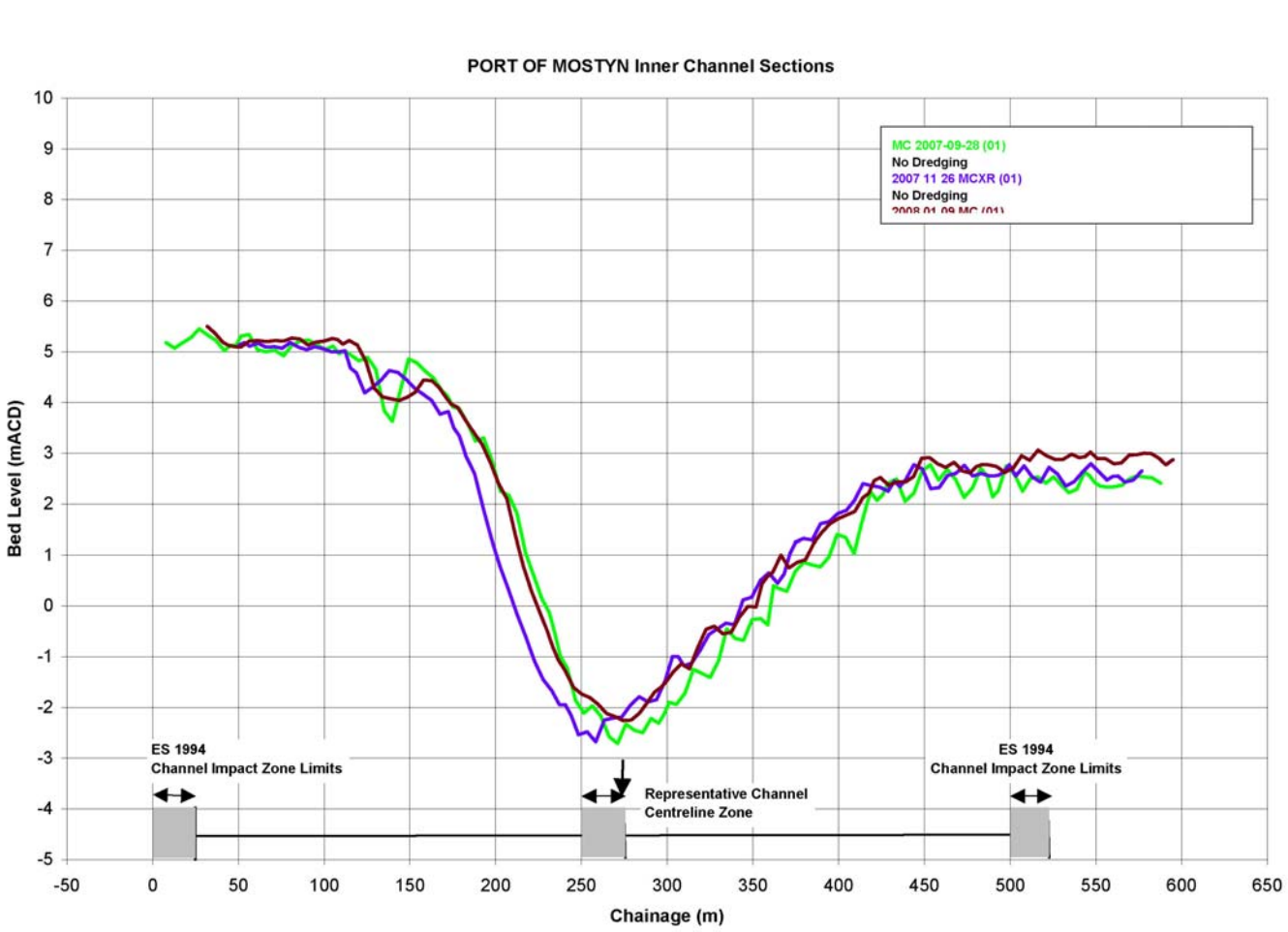


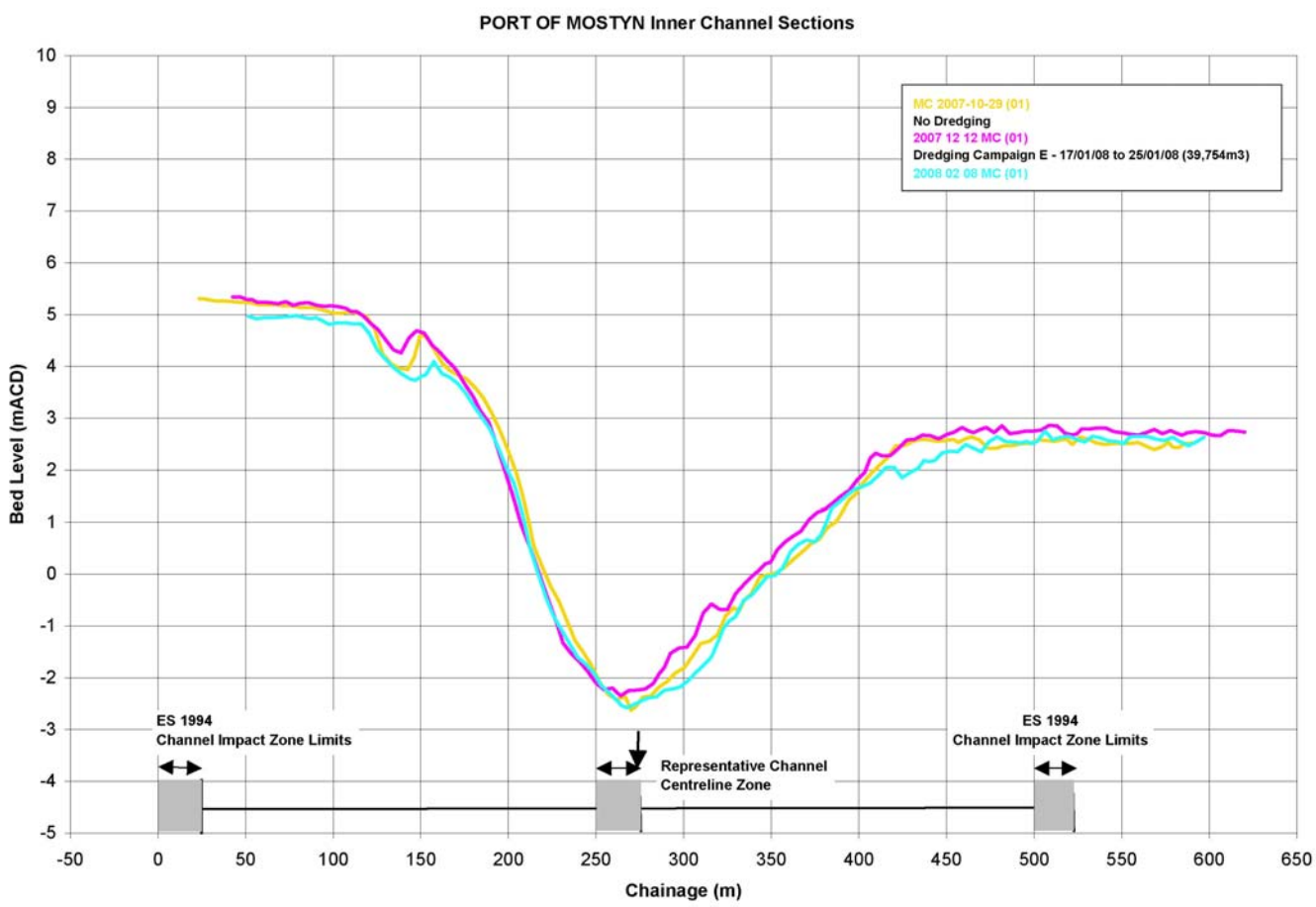




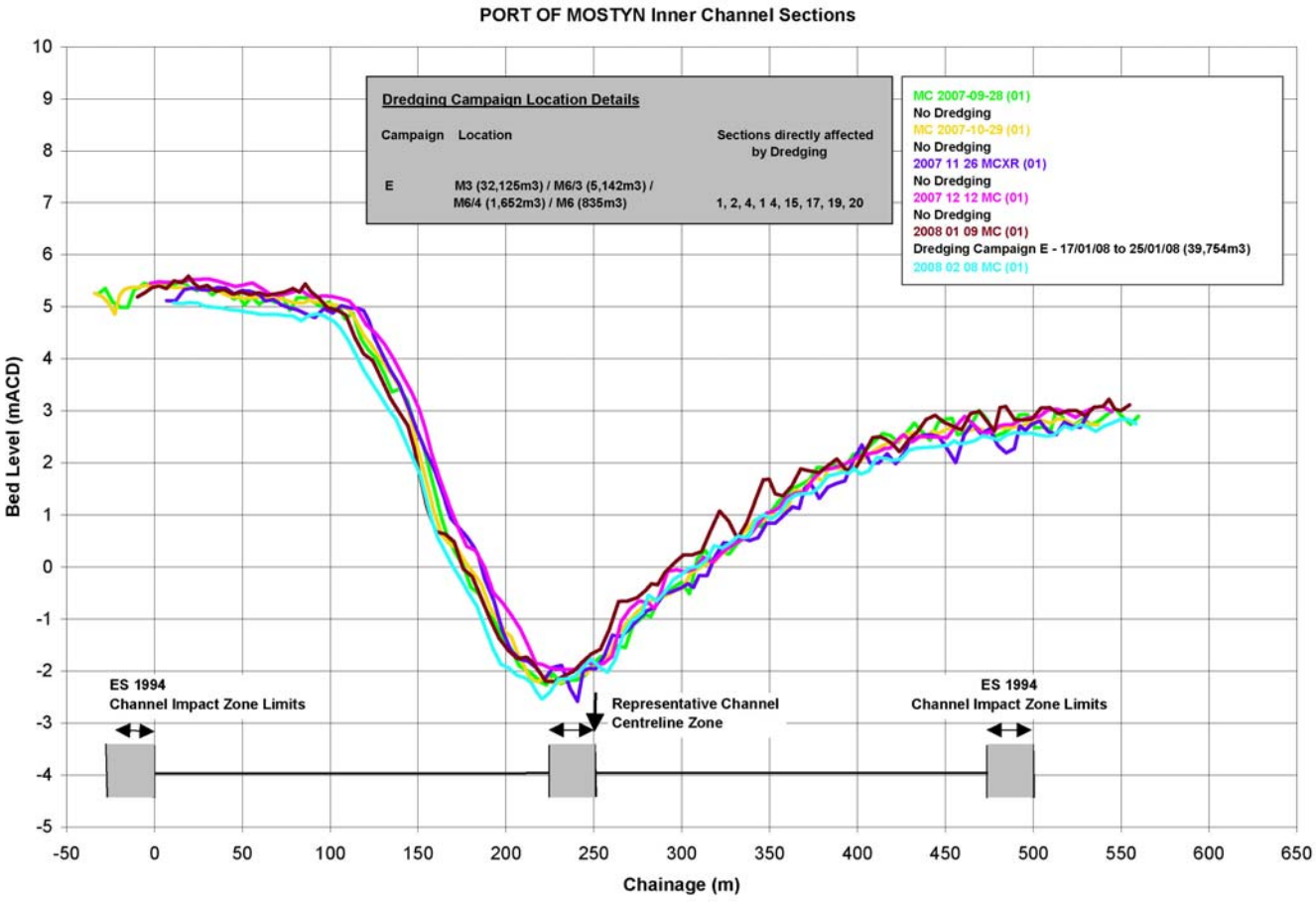
Dwg CIII (6 of 14) SECTION 08

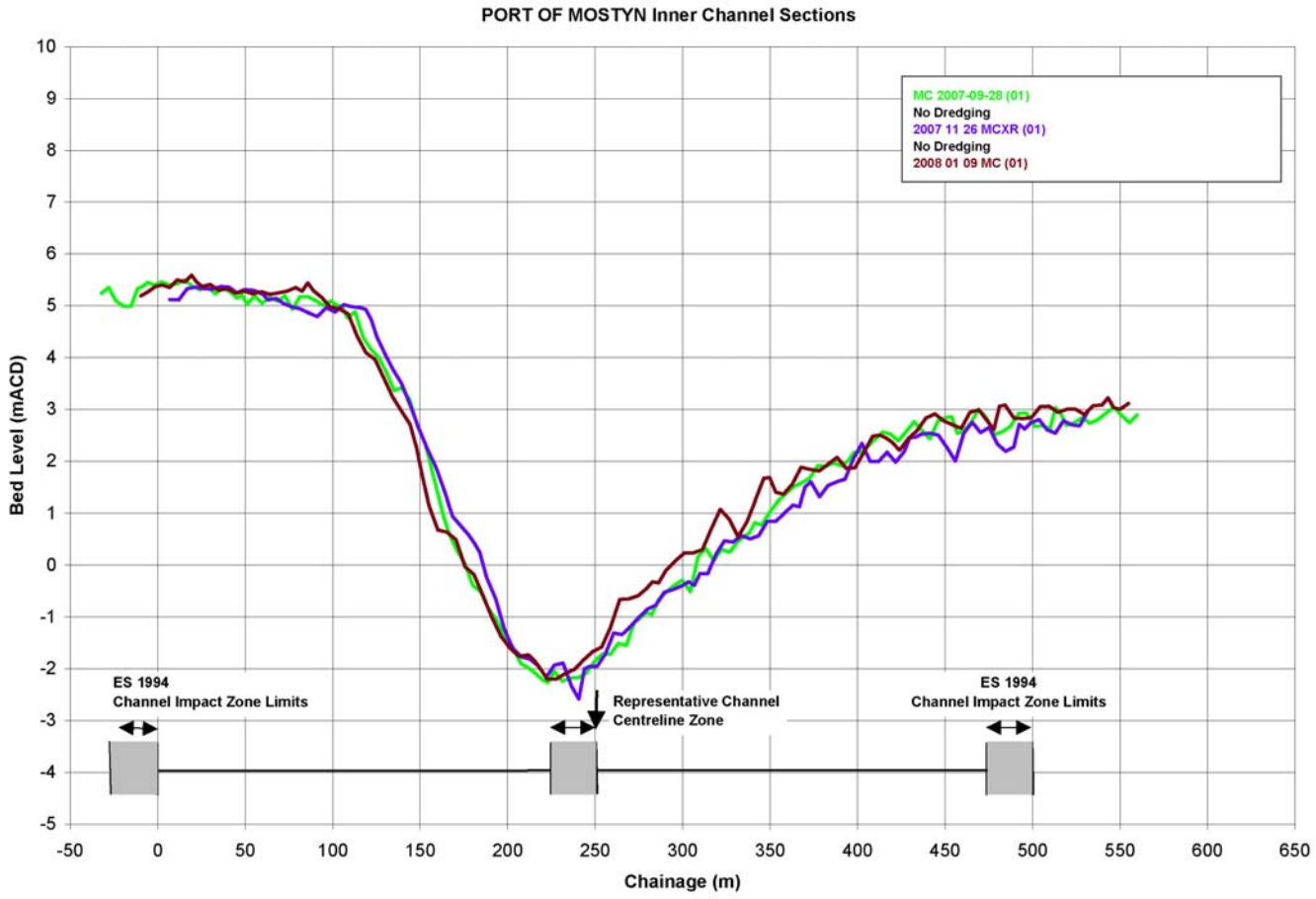


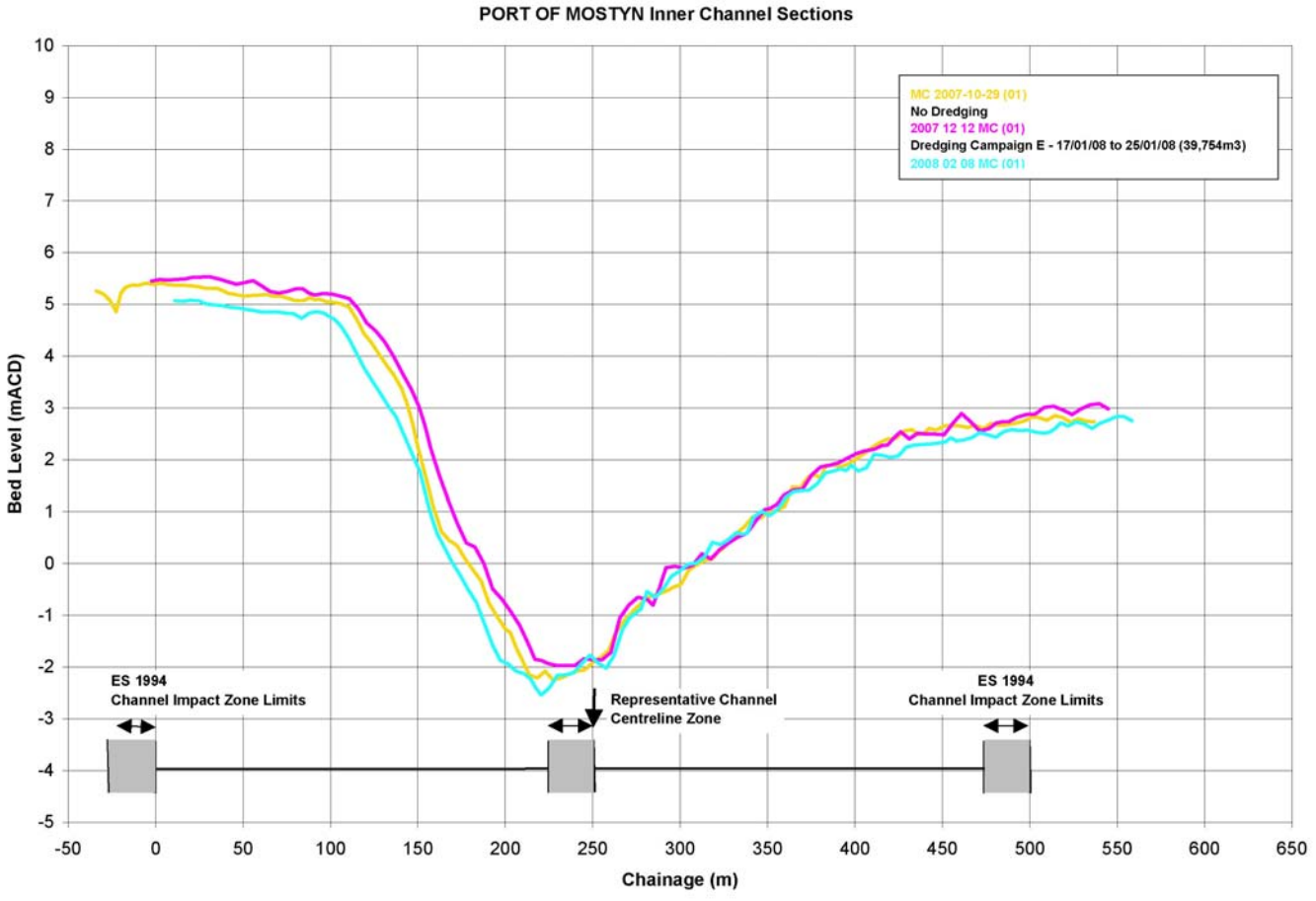




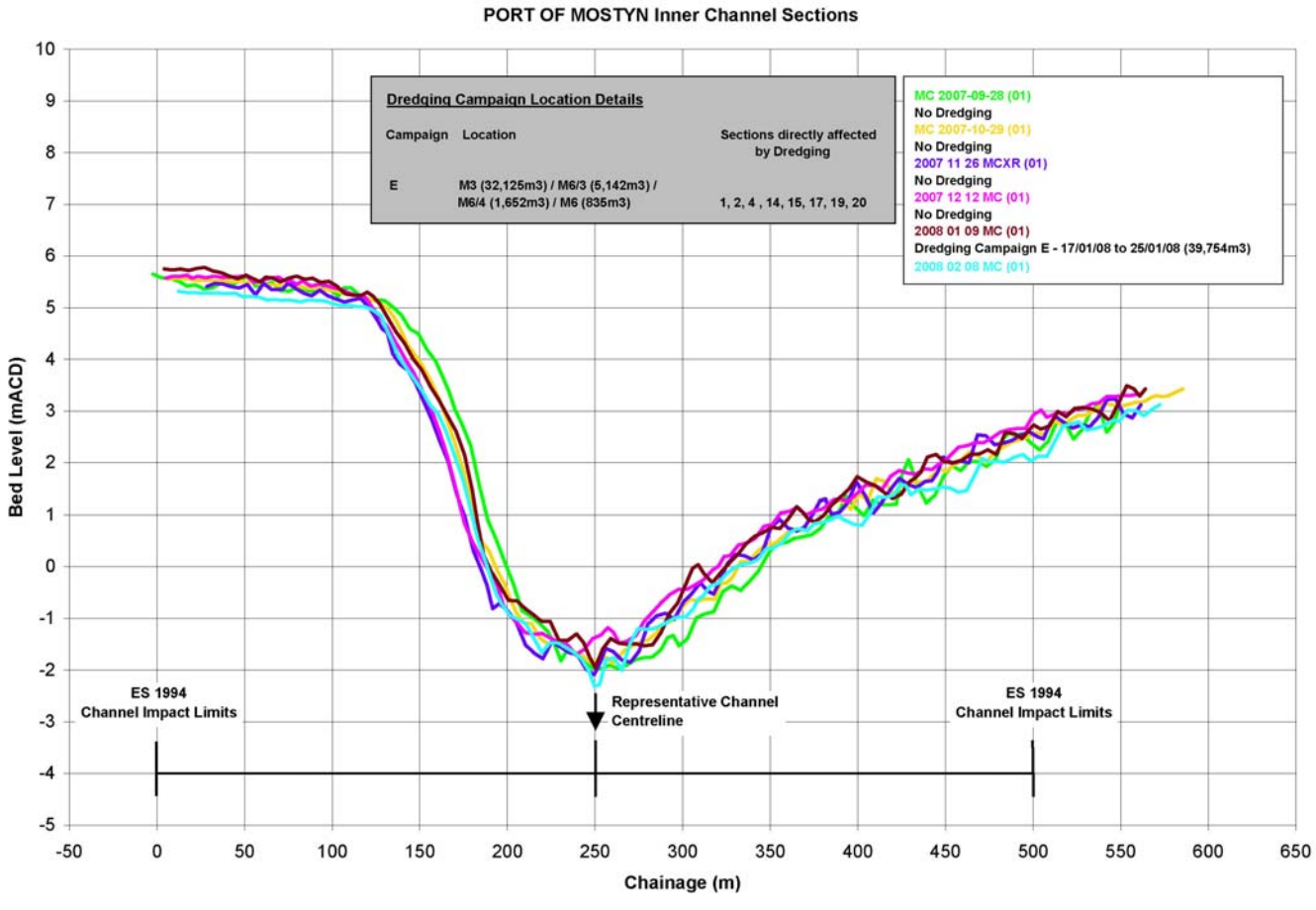
Dwg CIII (7 of 14) SECTION 10

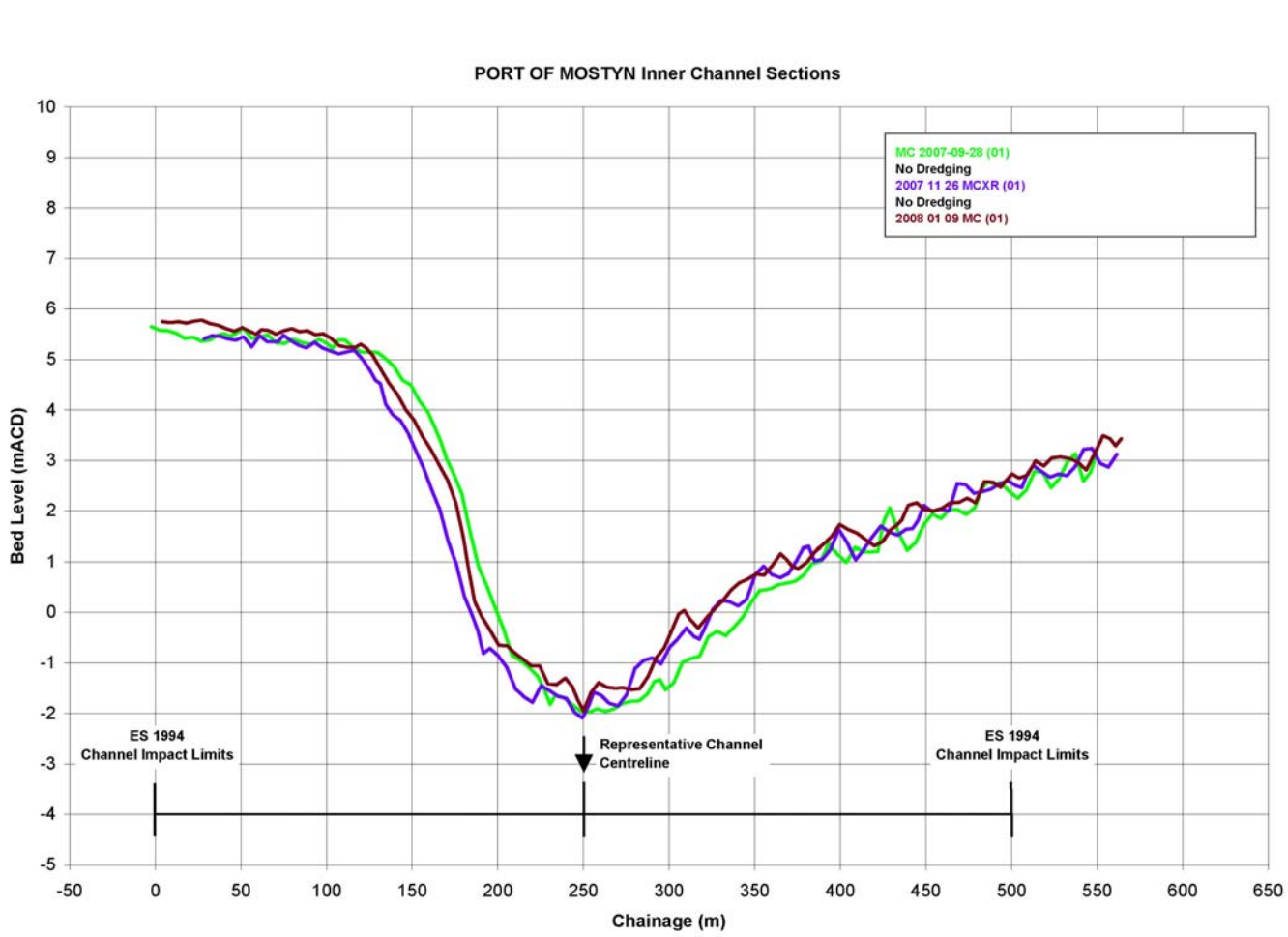


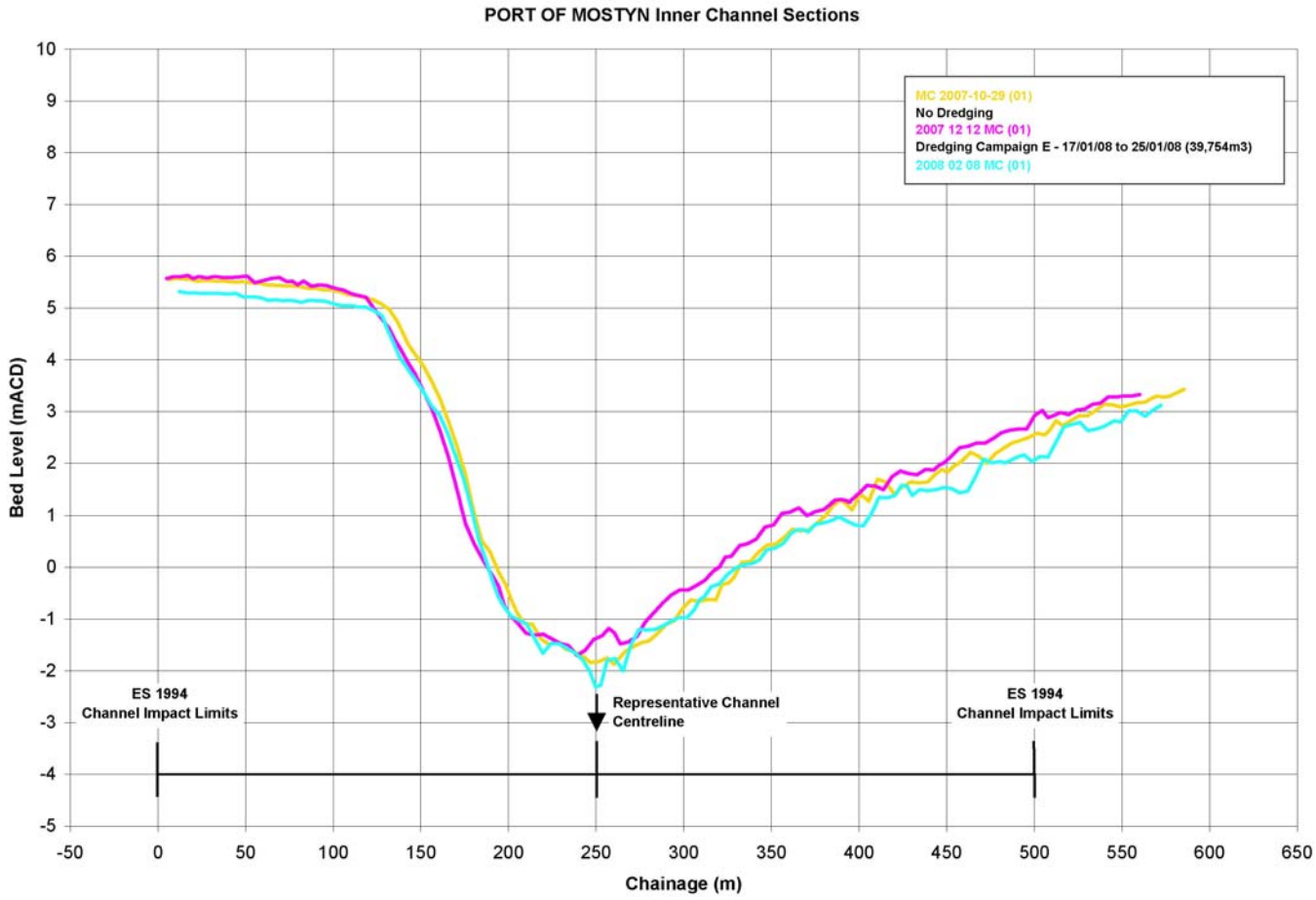




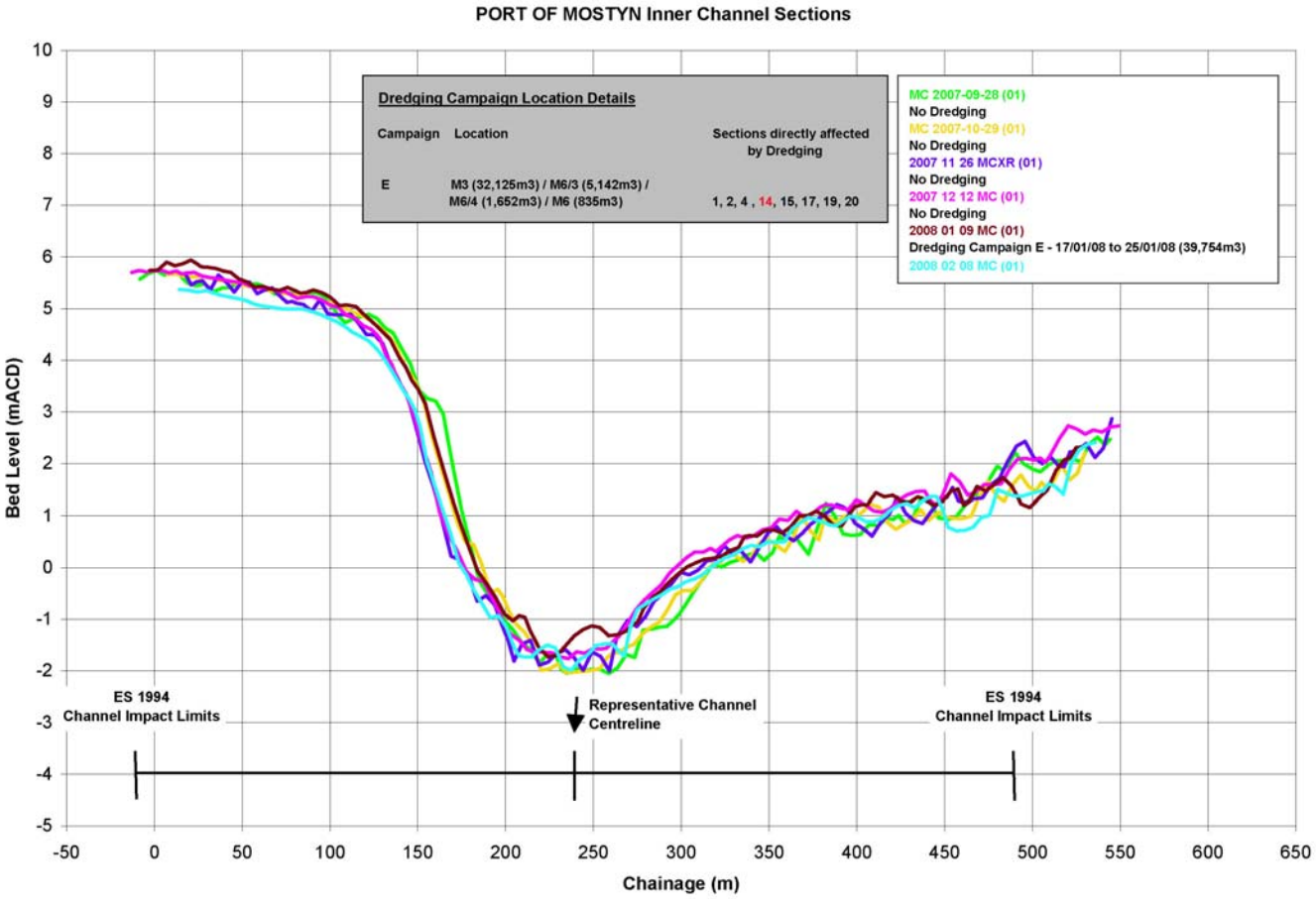
Dwg CIII (8 of 14) SECTION 11

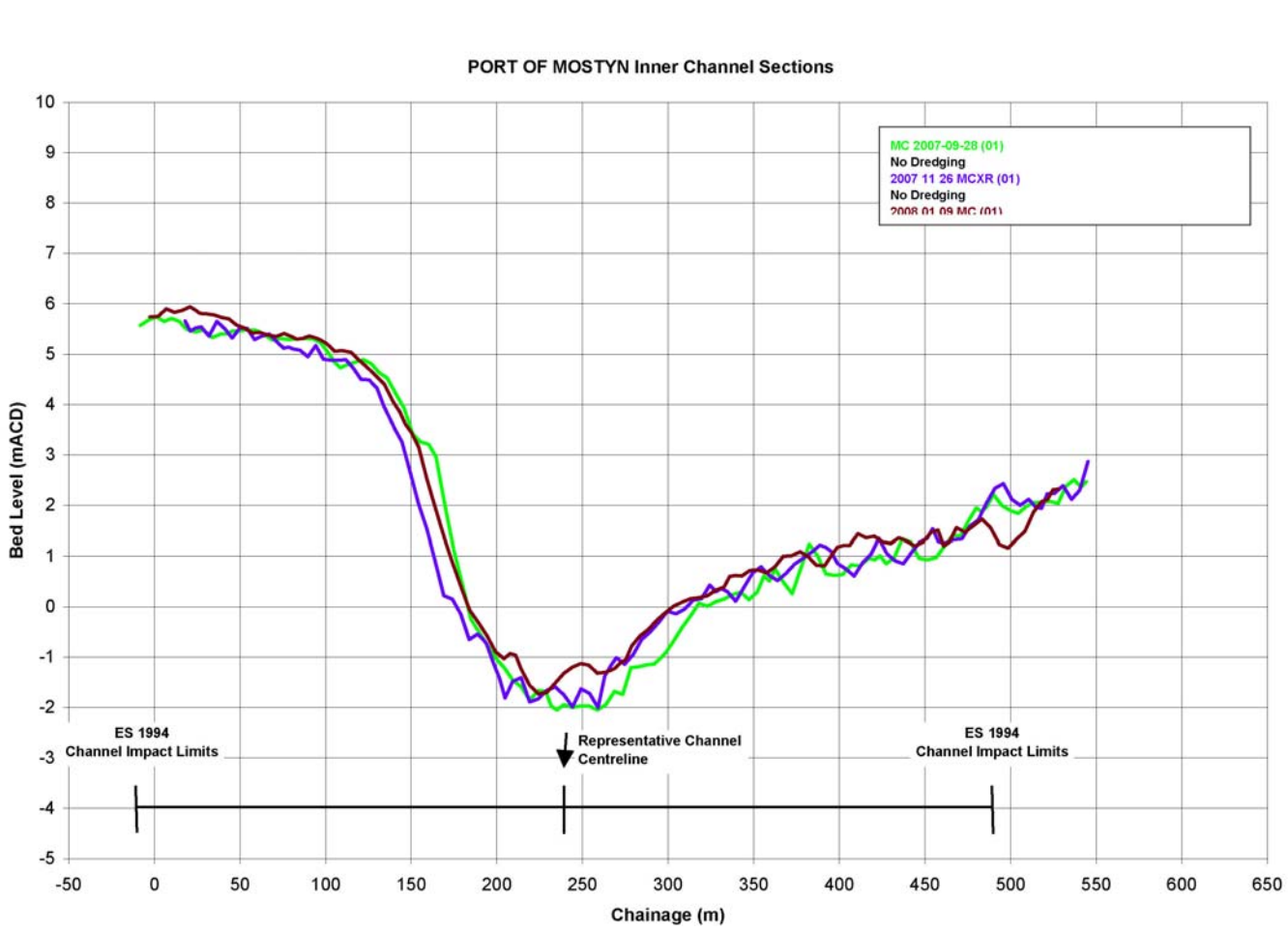


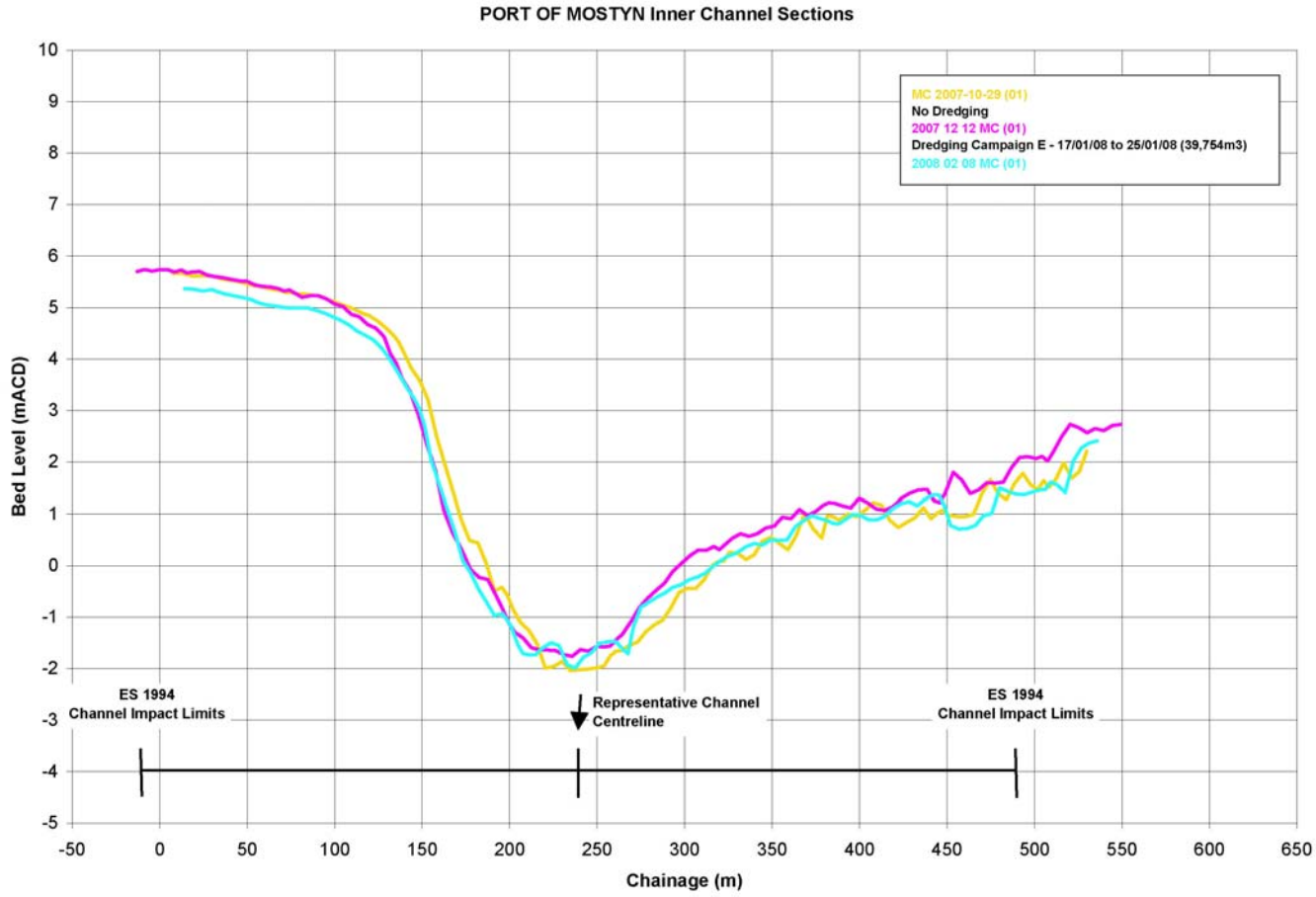




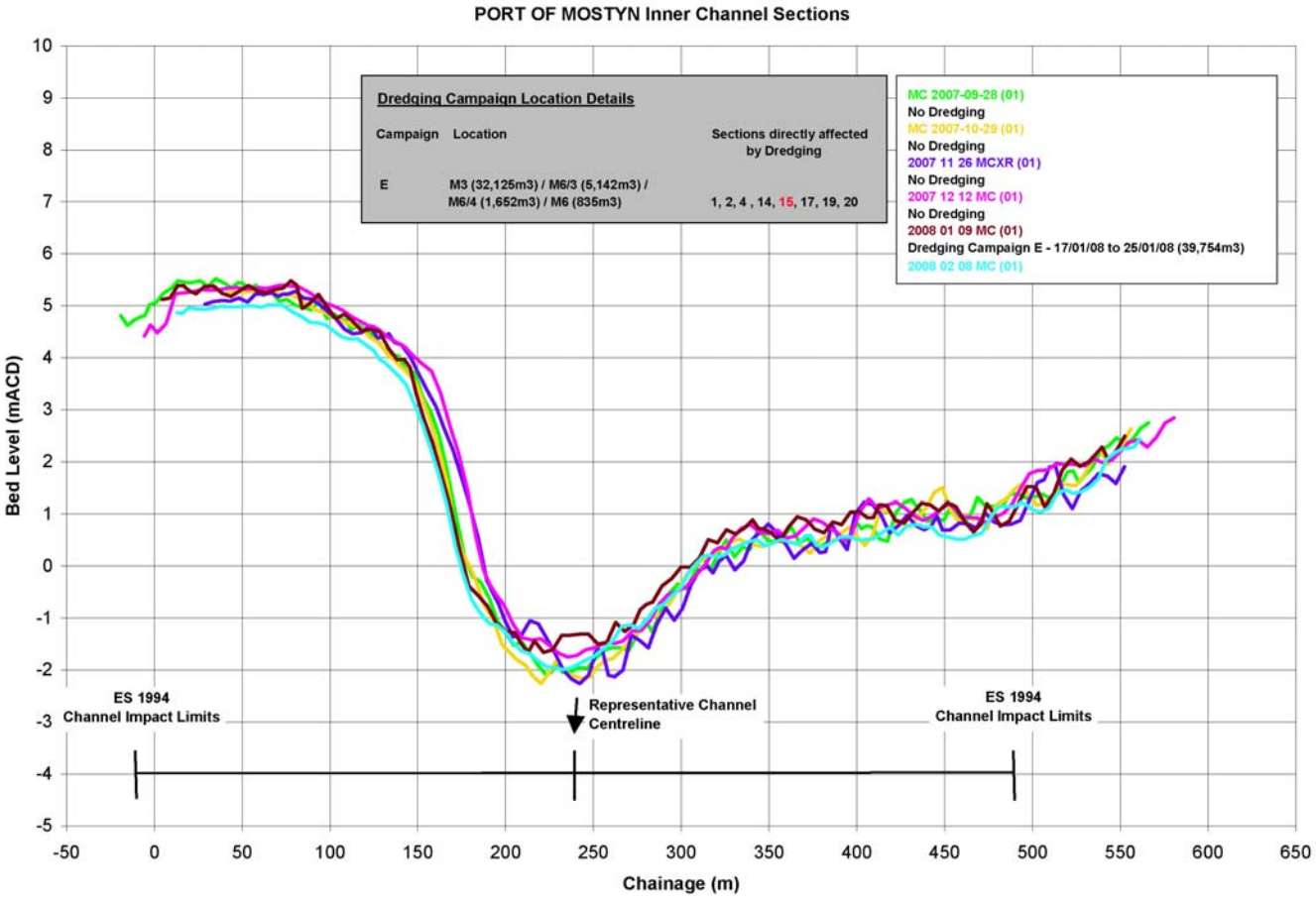
Dwg CIII (9 of 14) SECTION 12

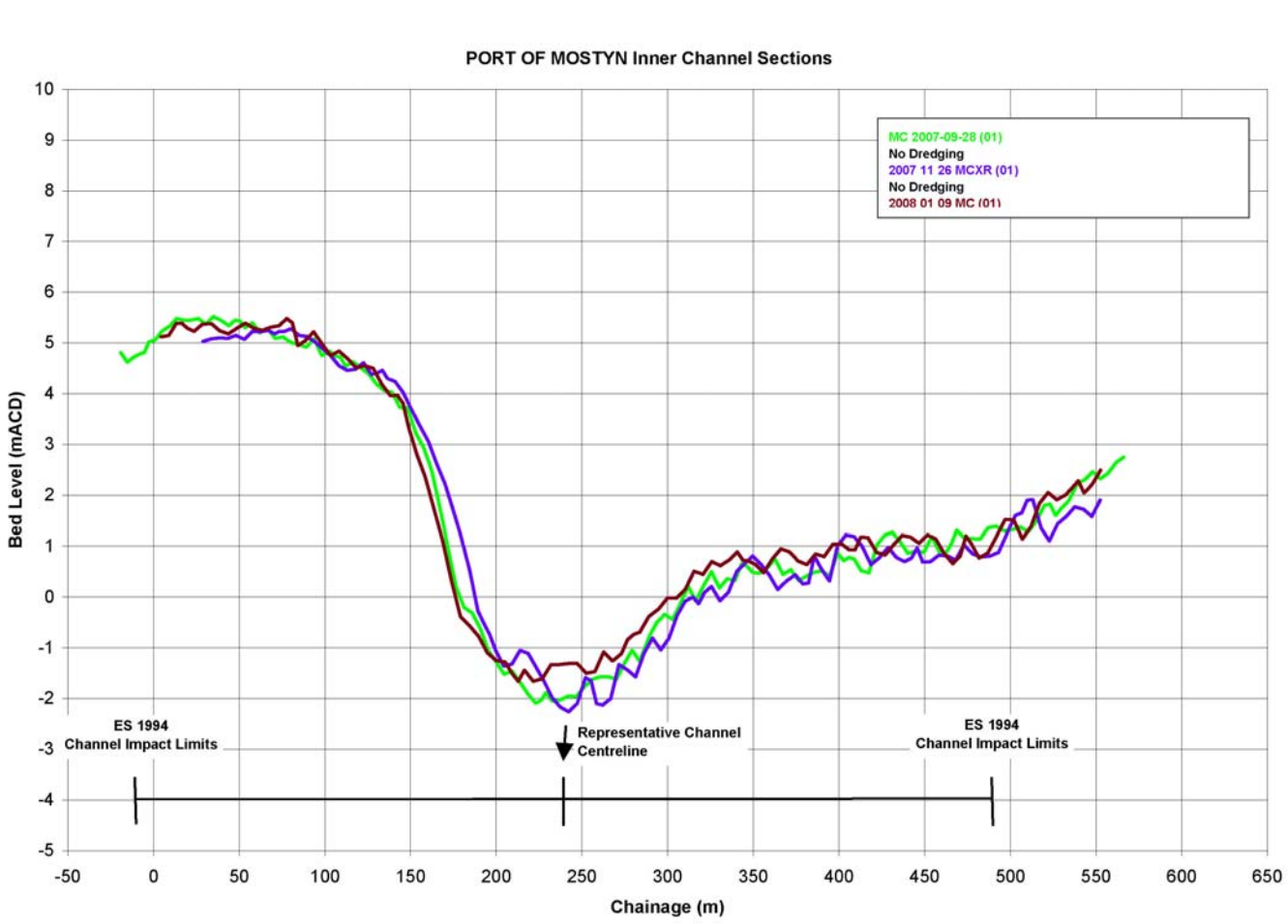


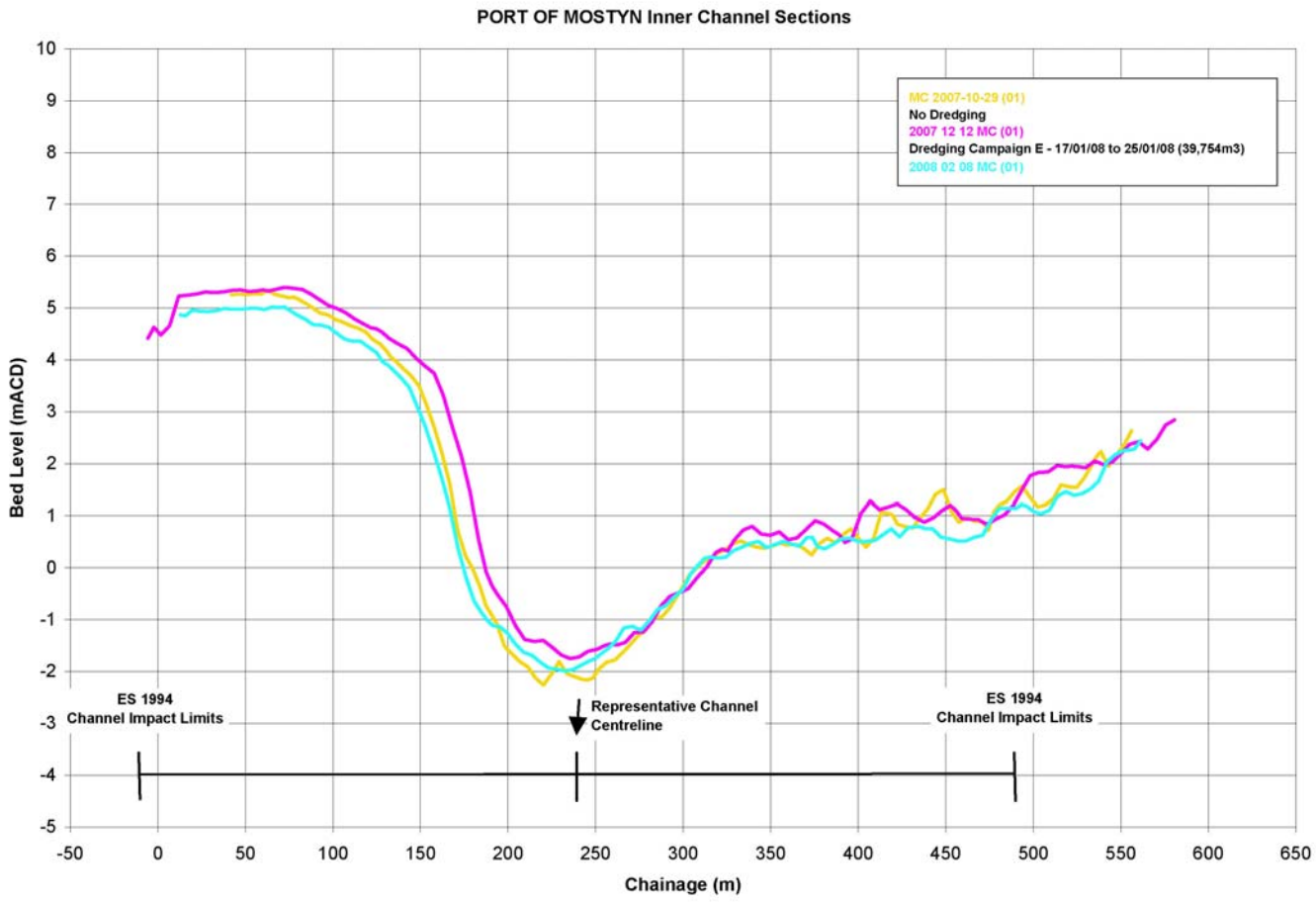




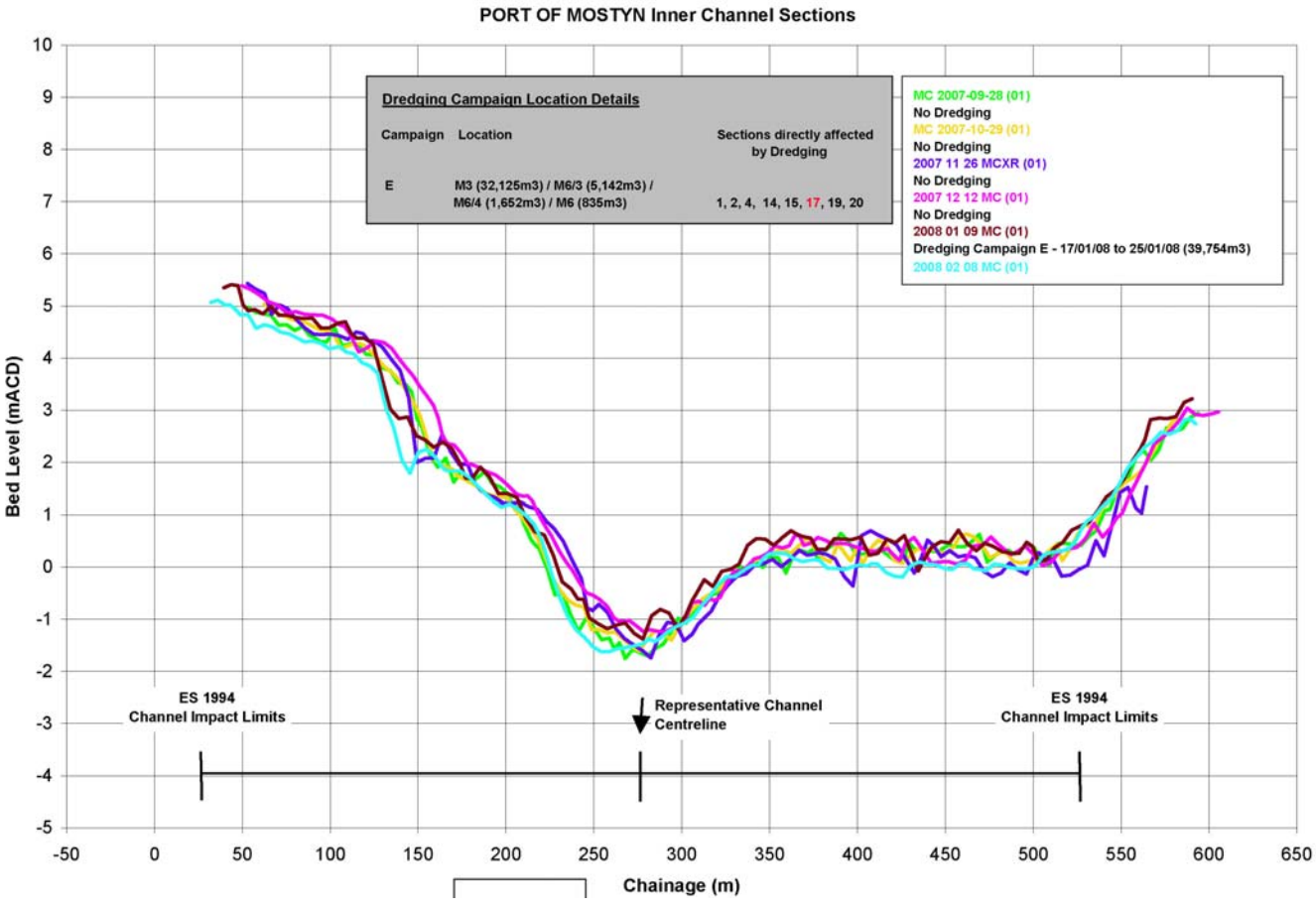
Dwg CIII (10 of 14) SECTION 14

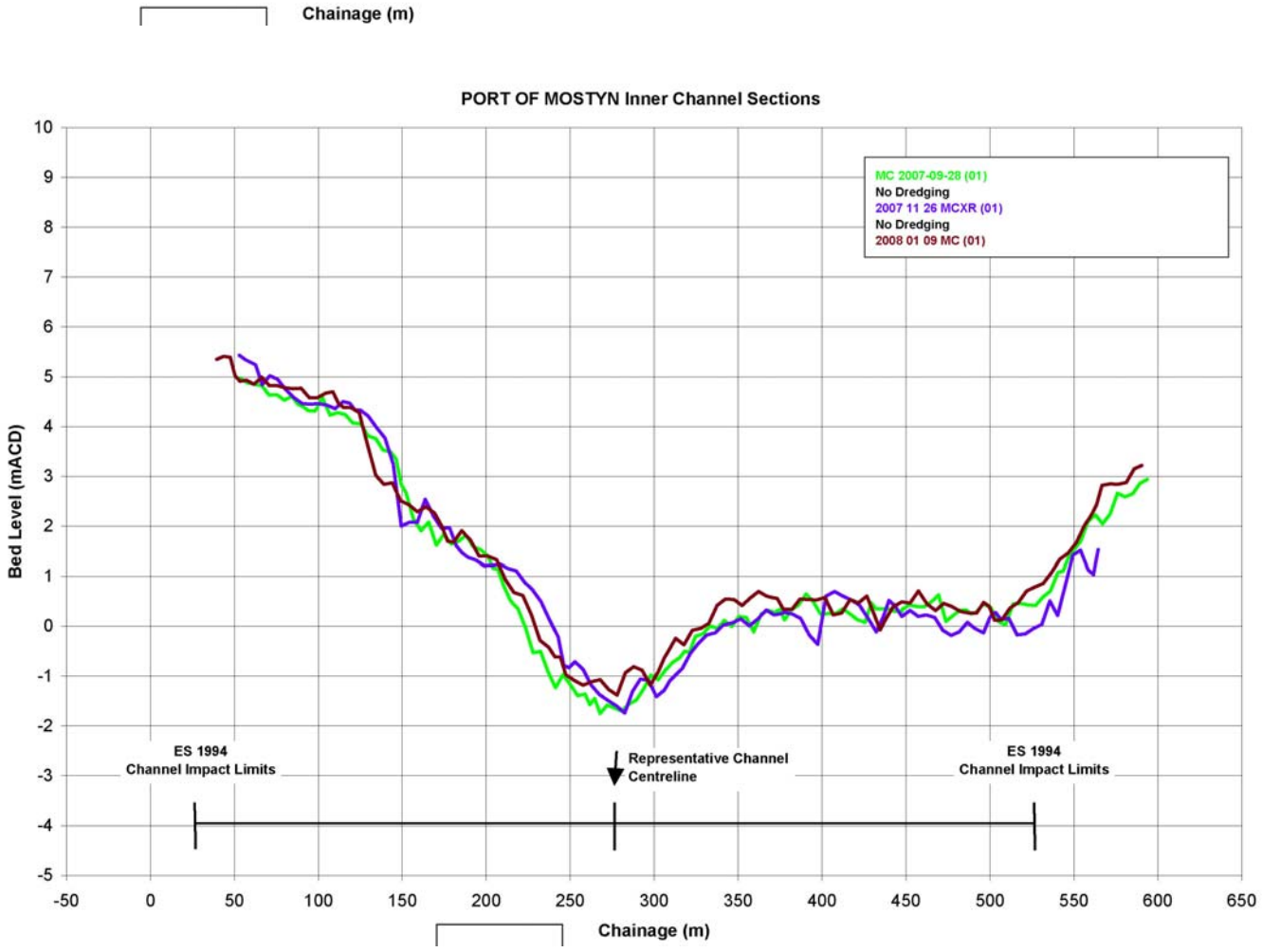


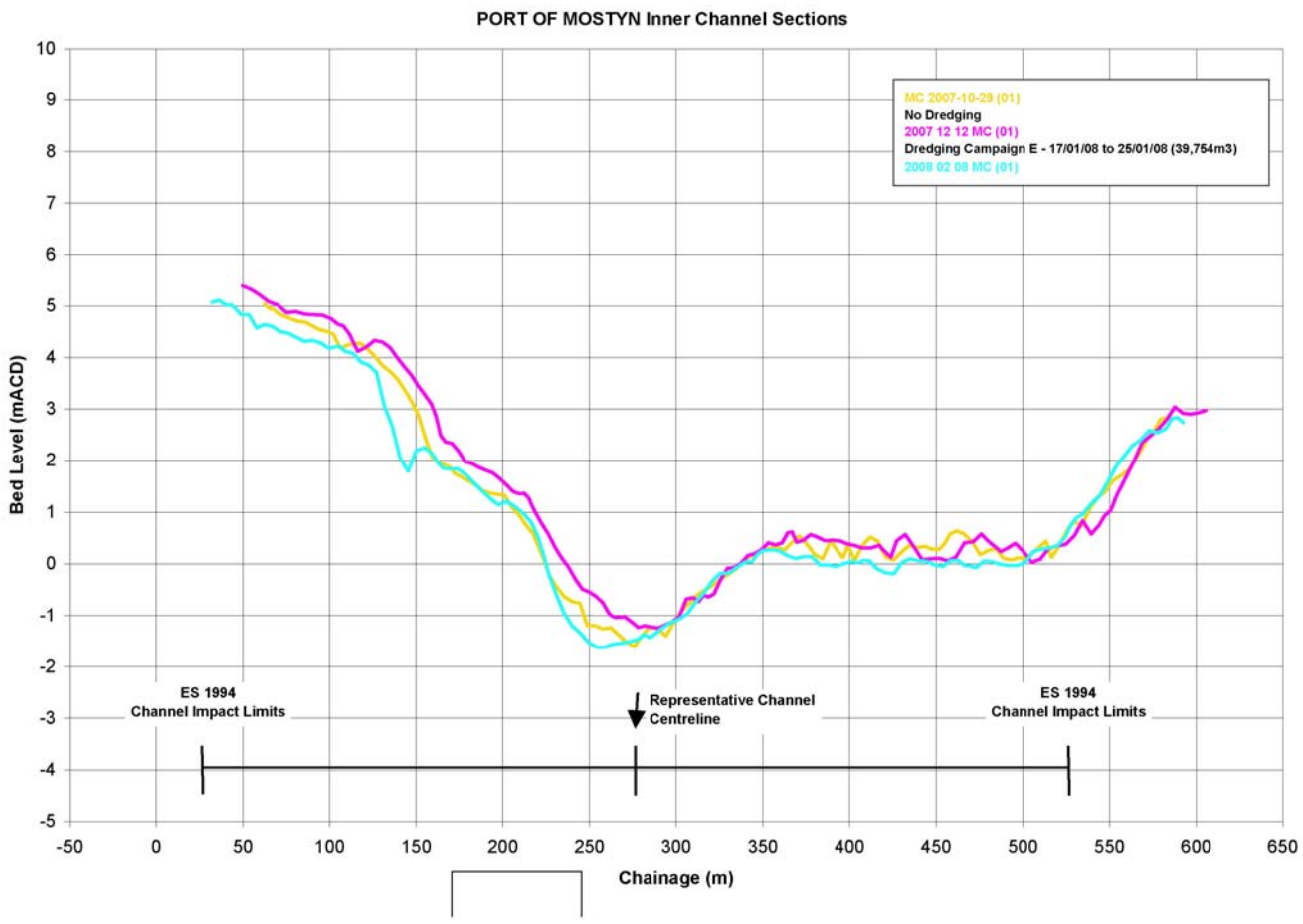




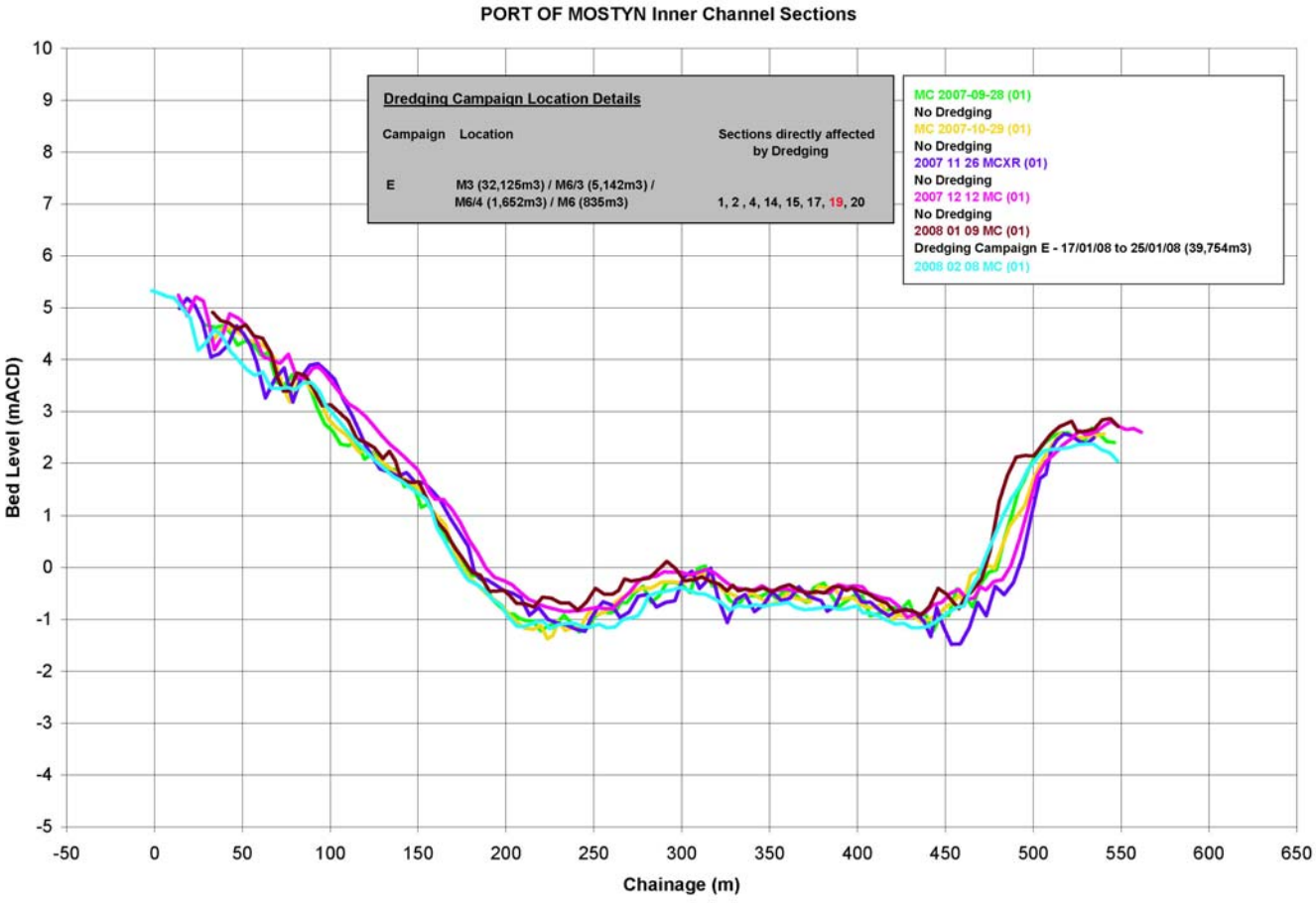
Dwg CIII (11 of 14) SECTION 15

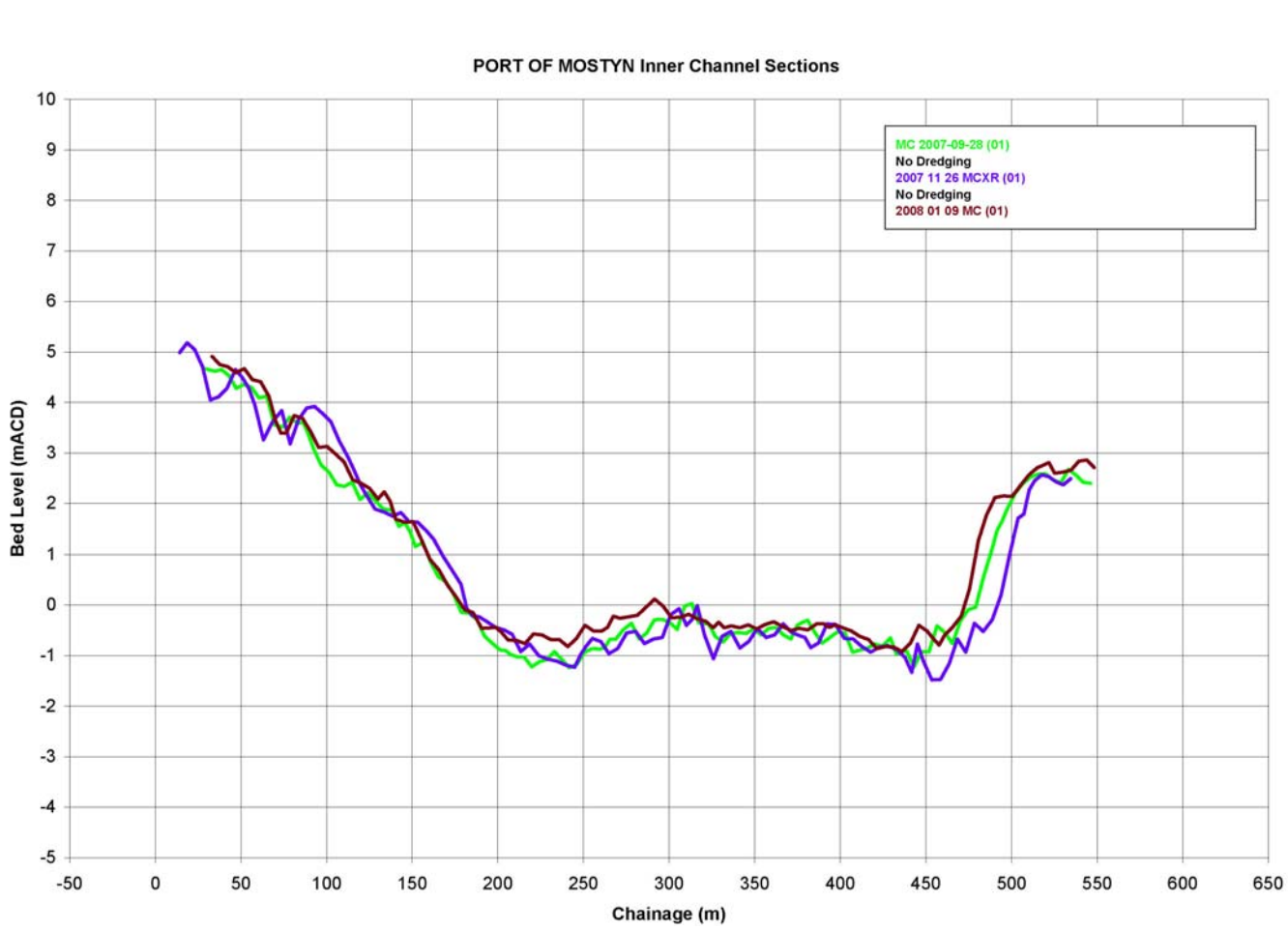


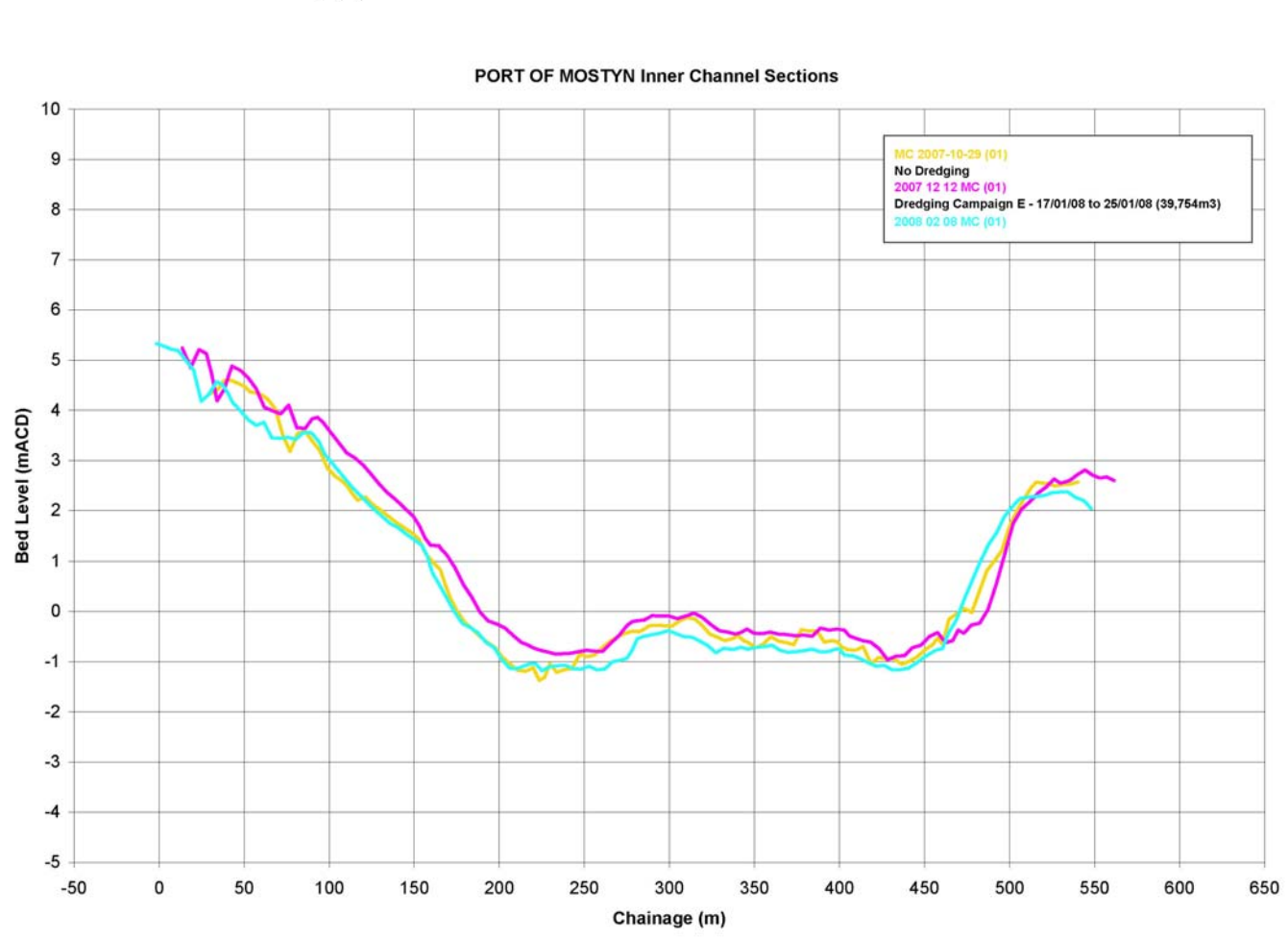




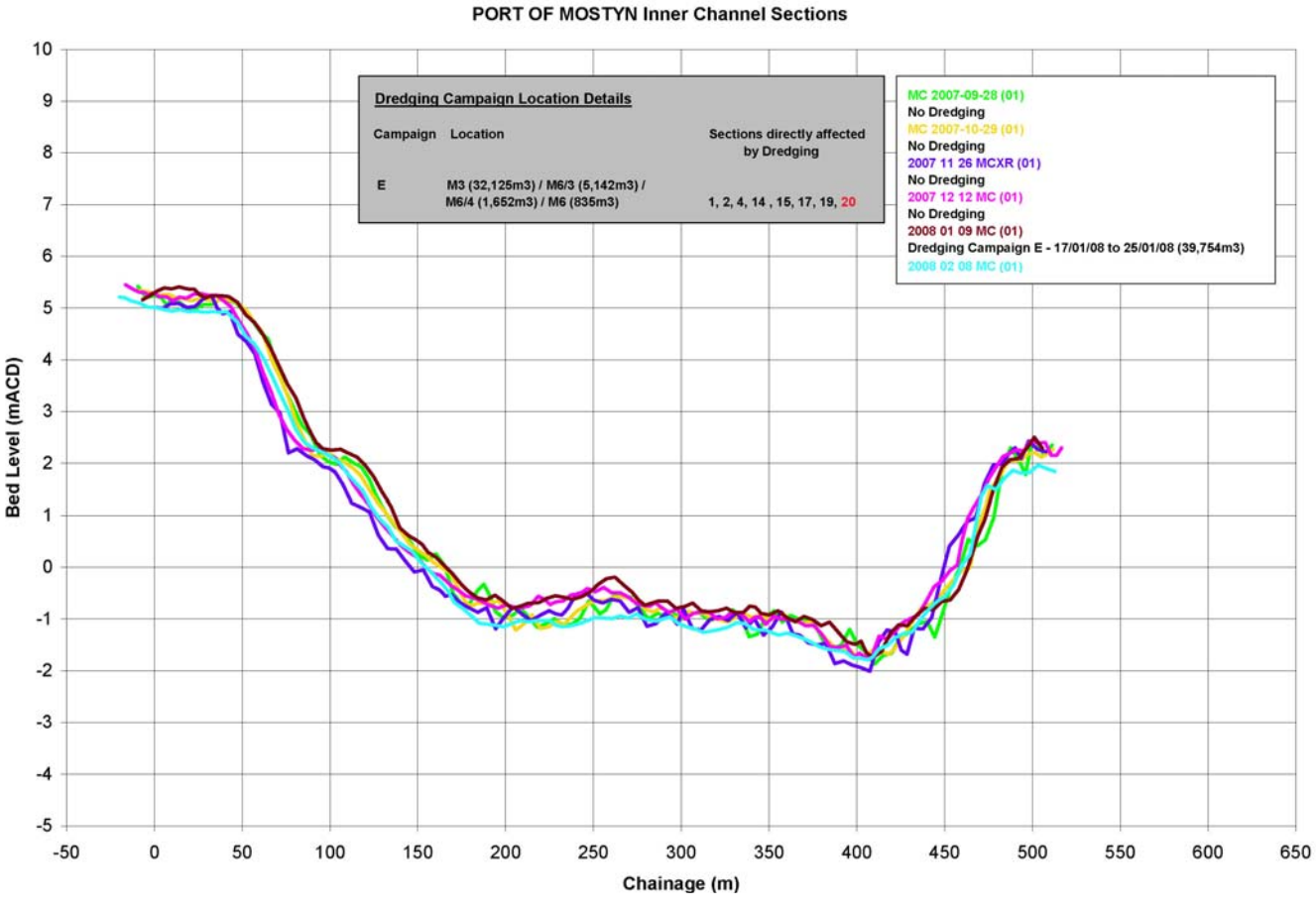
Dwg CIII (12 of 14) SECTION 17

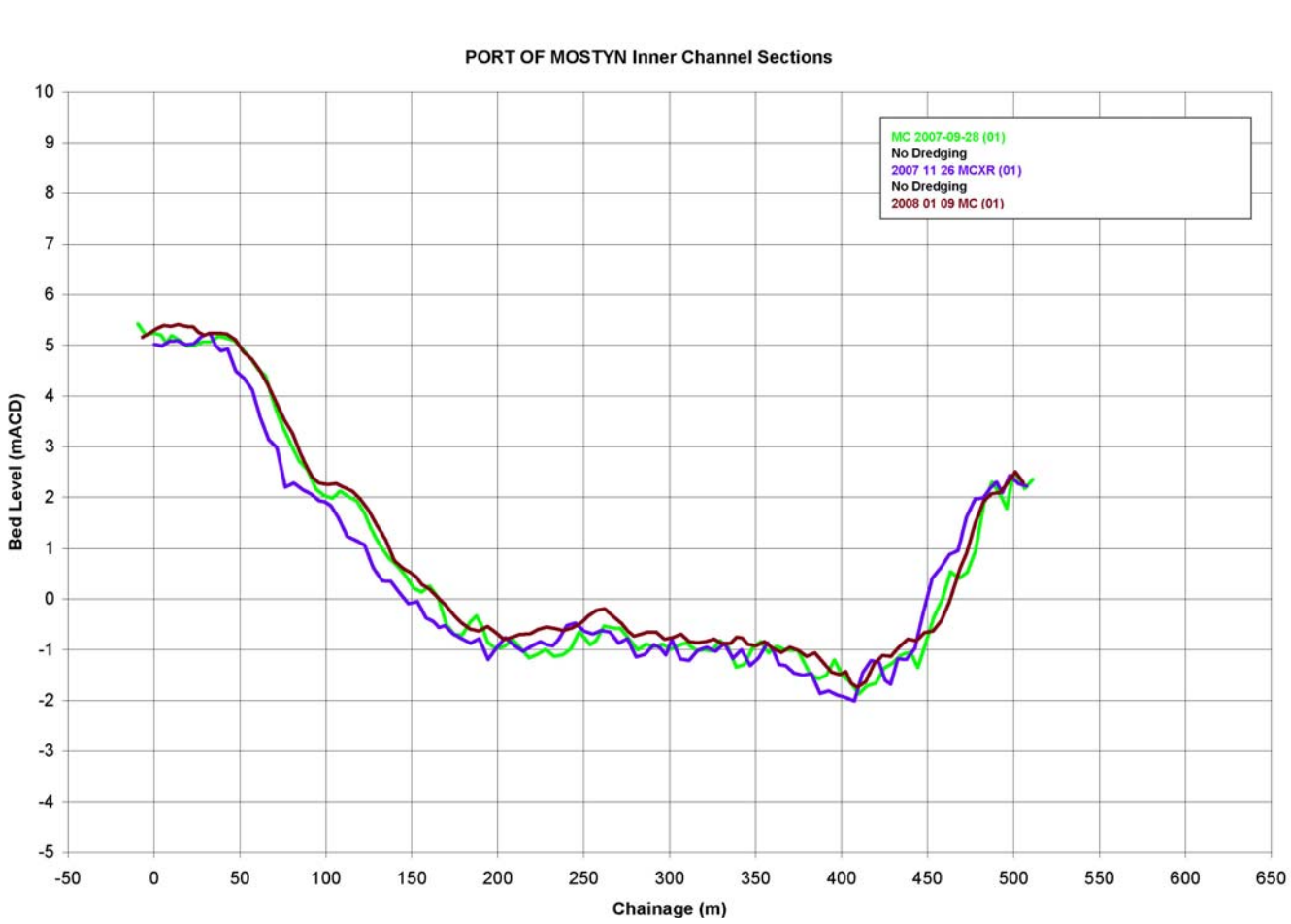


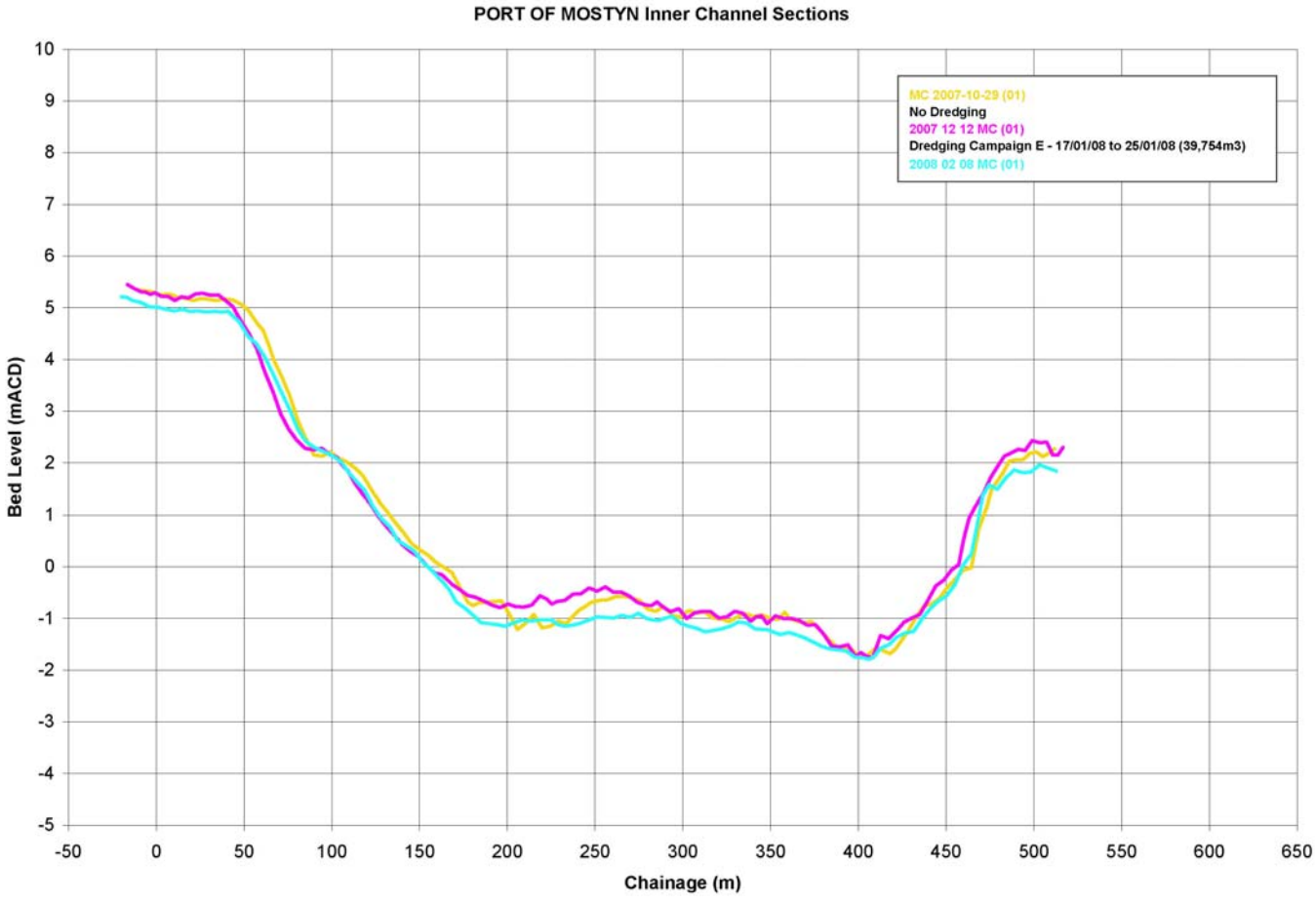




Dwg CIII (13 of 14) SECTION 19







Dwg CIII (14 of 14) SECTION 20

ANNEX 'D'

EIS Annex A3 Dredged Channel

Behaviour – Channel Surveys

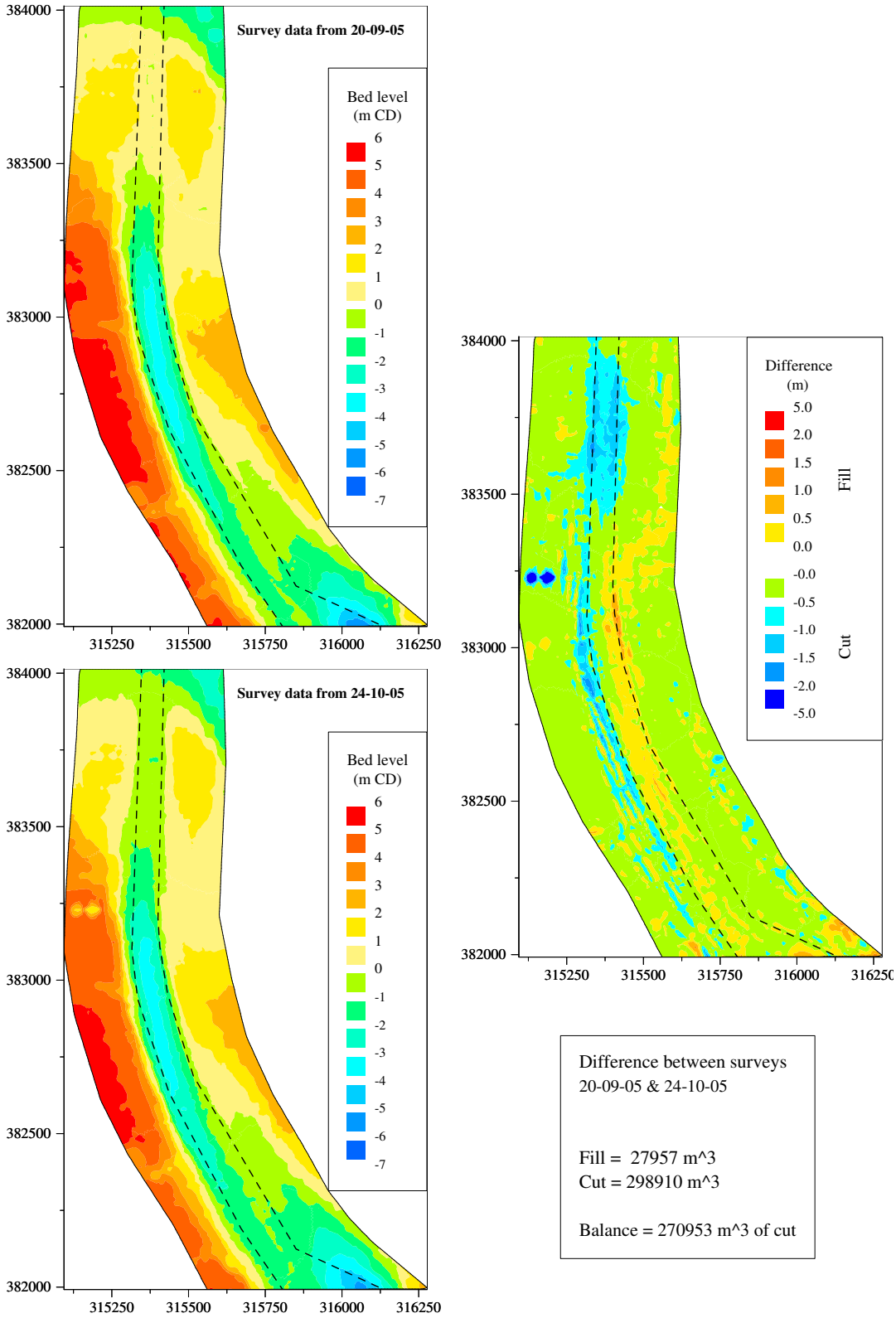


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Figure 1

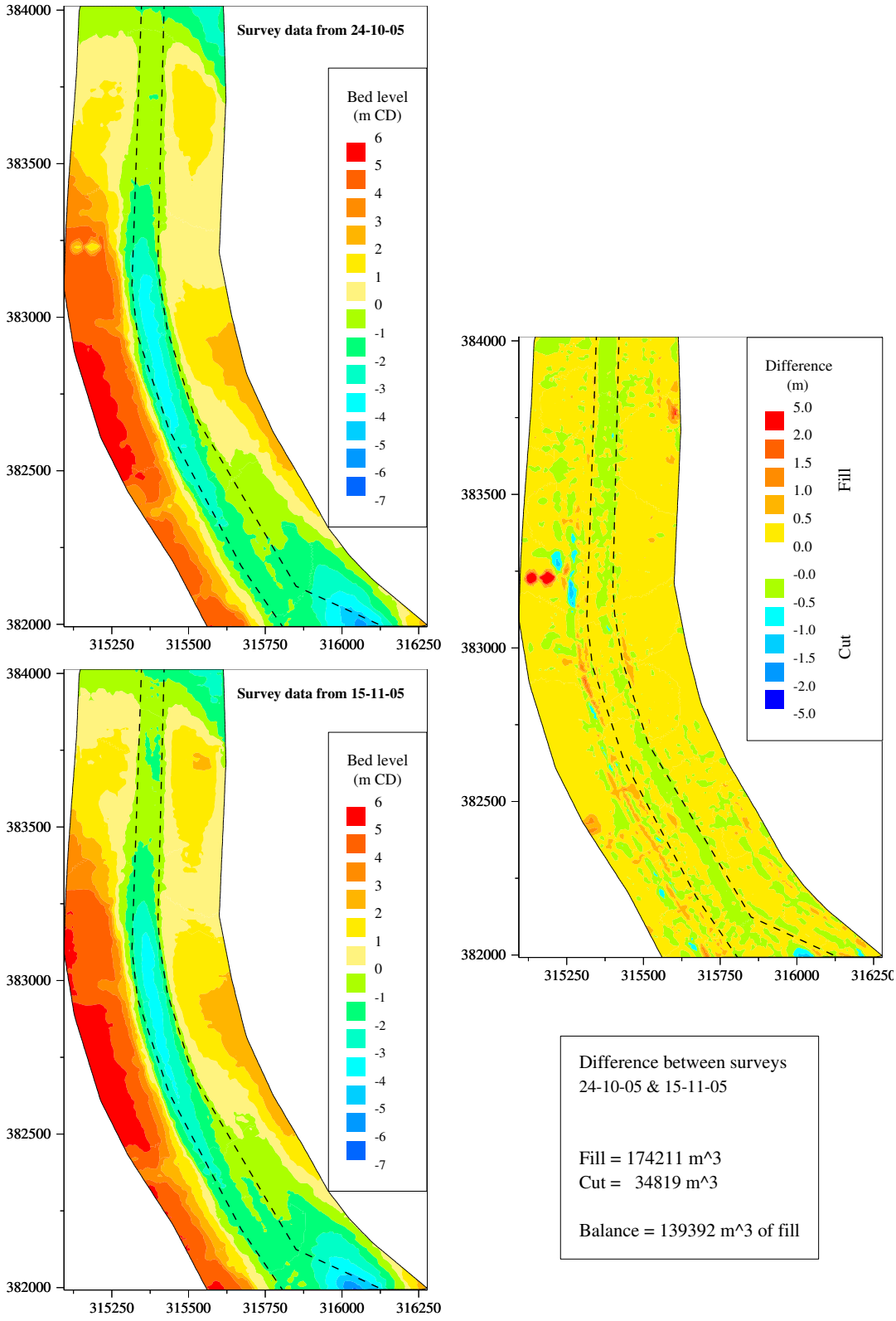

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Figure 2

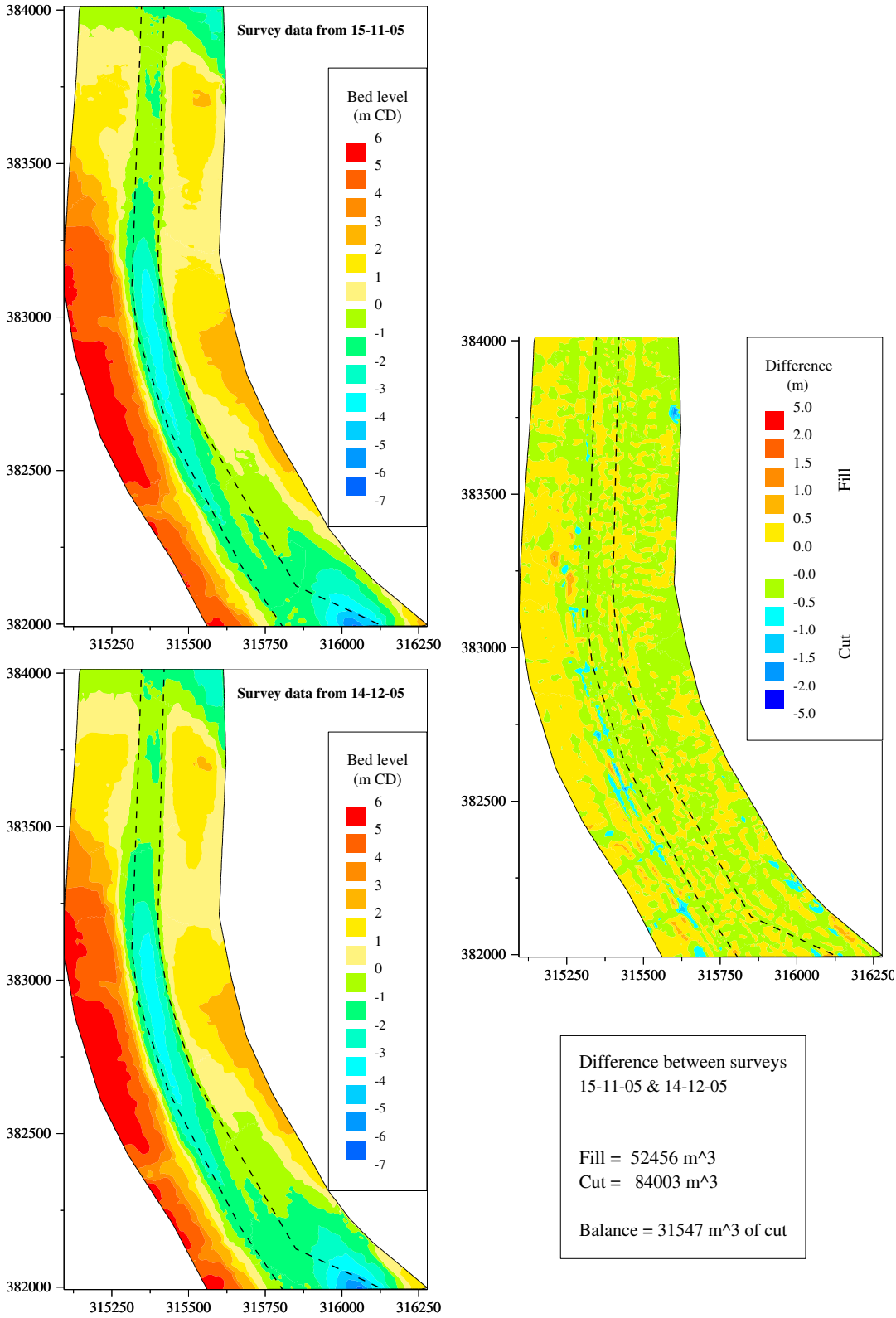

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Figure 3

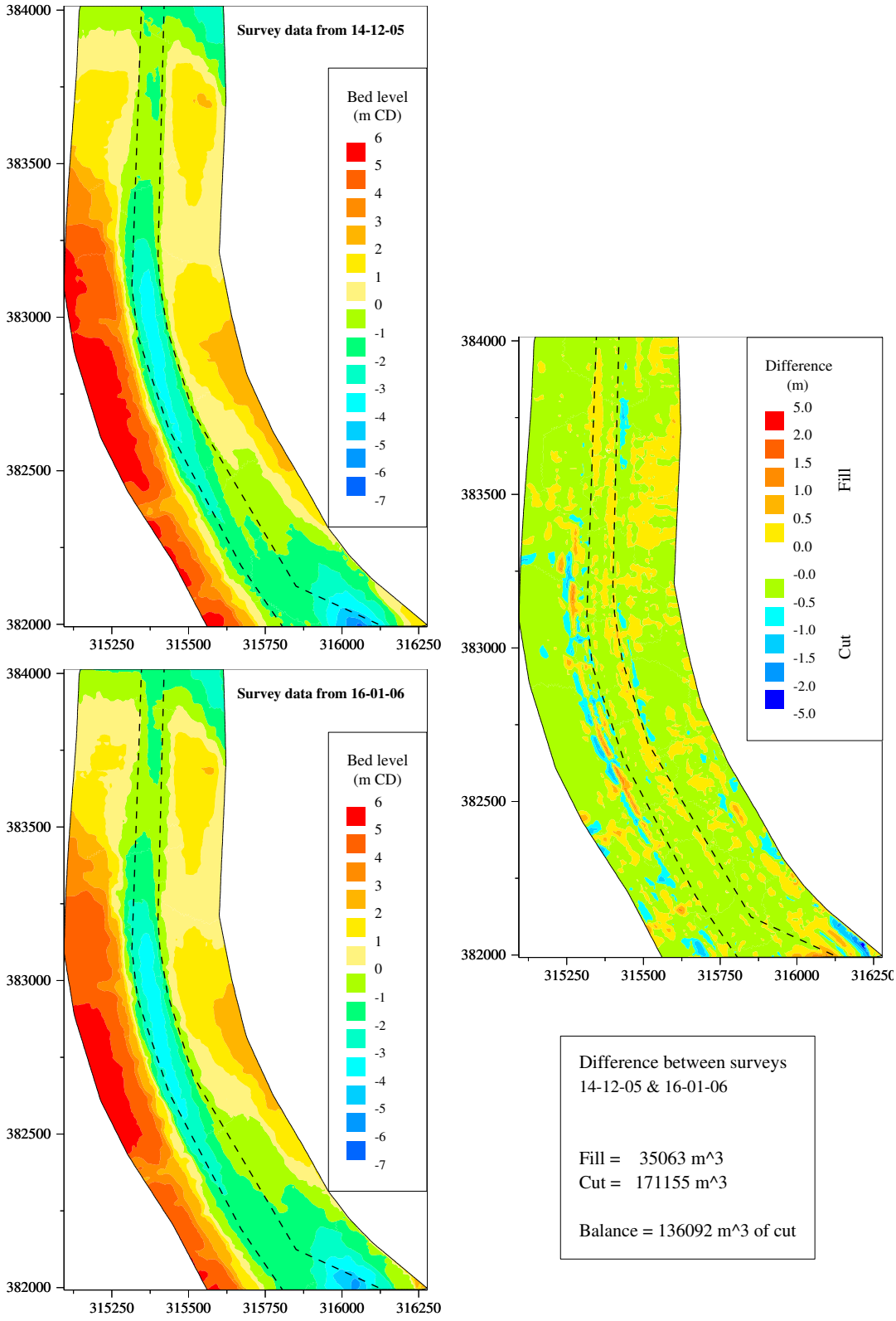

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Figure 4

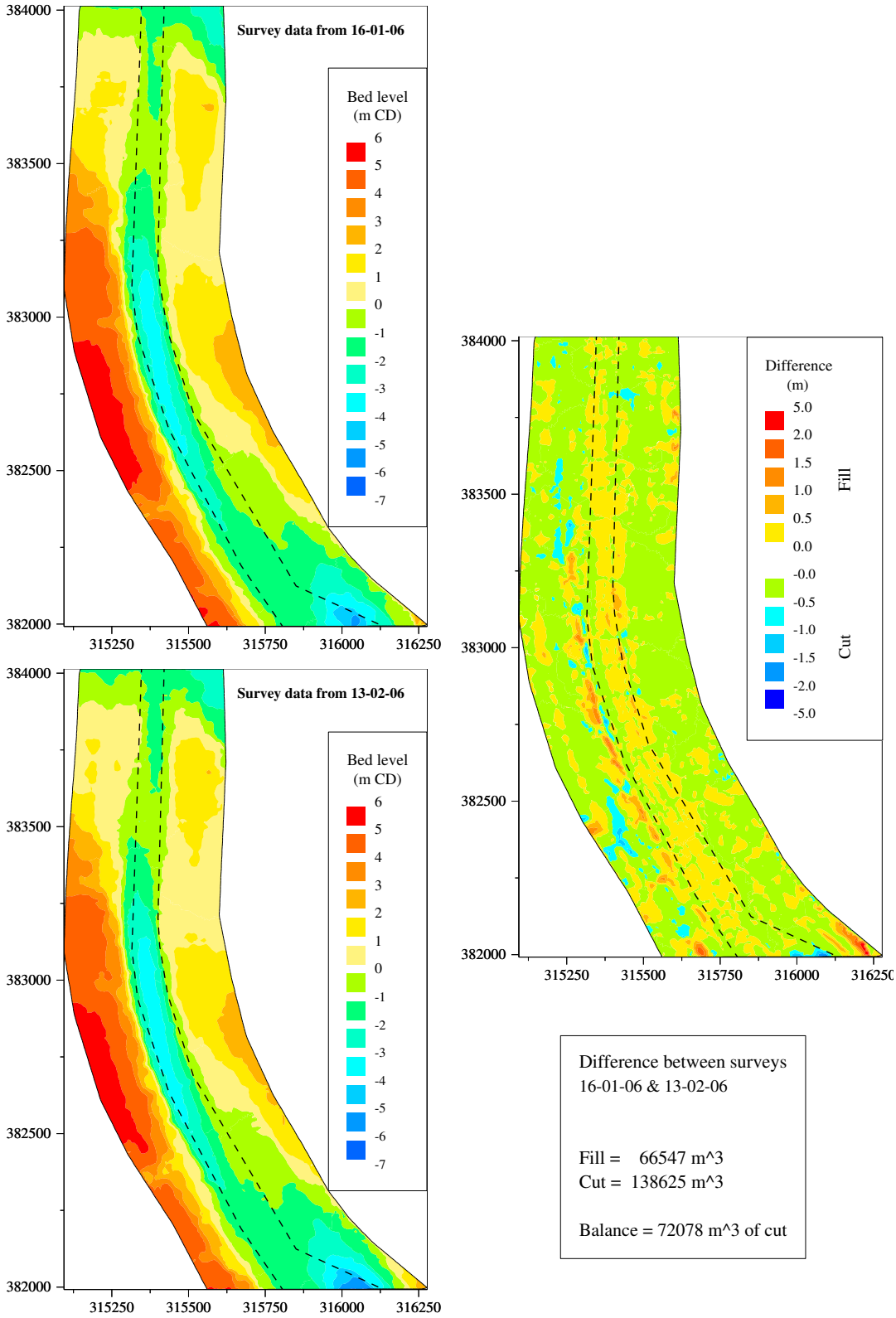

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Figure 5

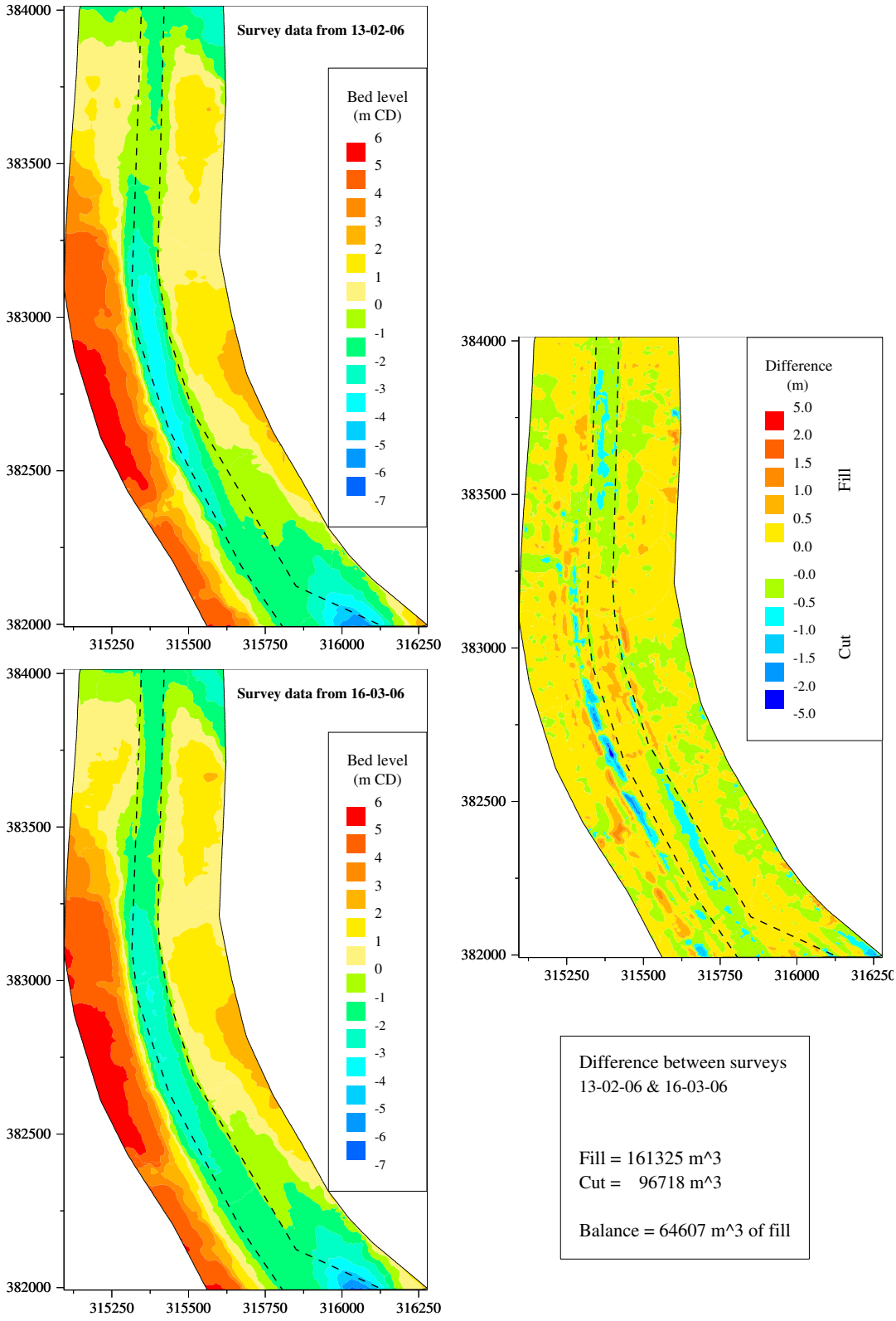

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Figure 6

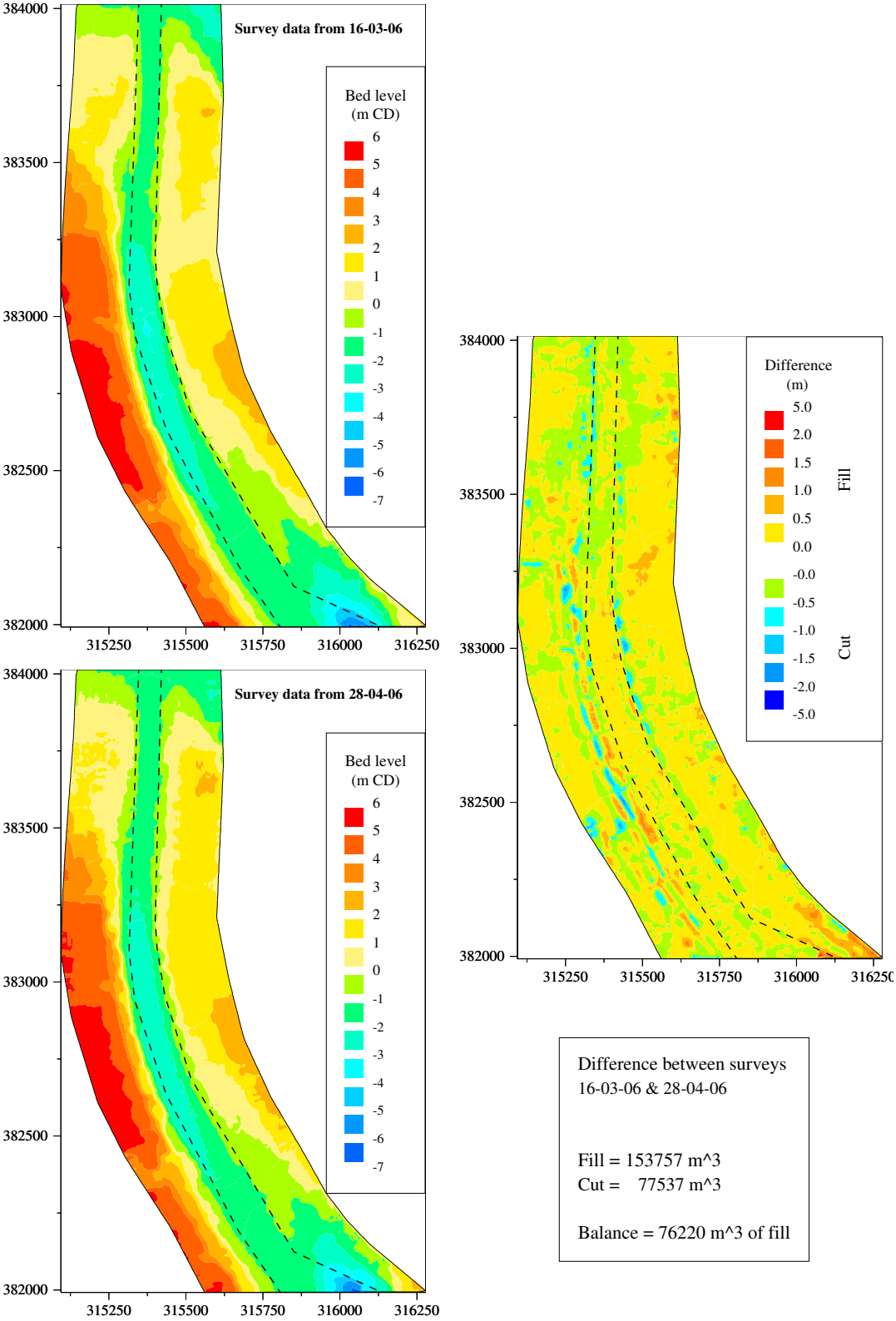

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Figure 7

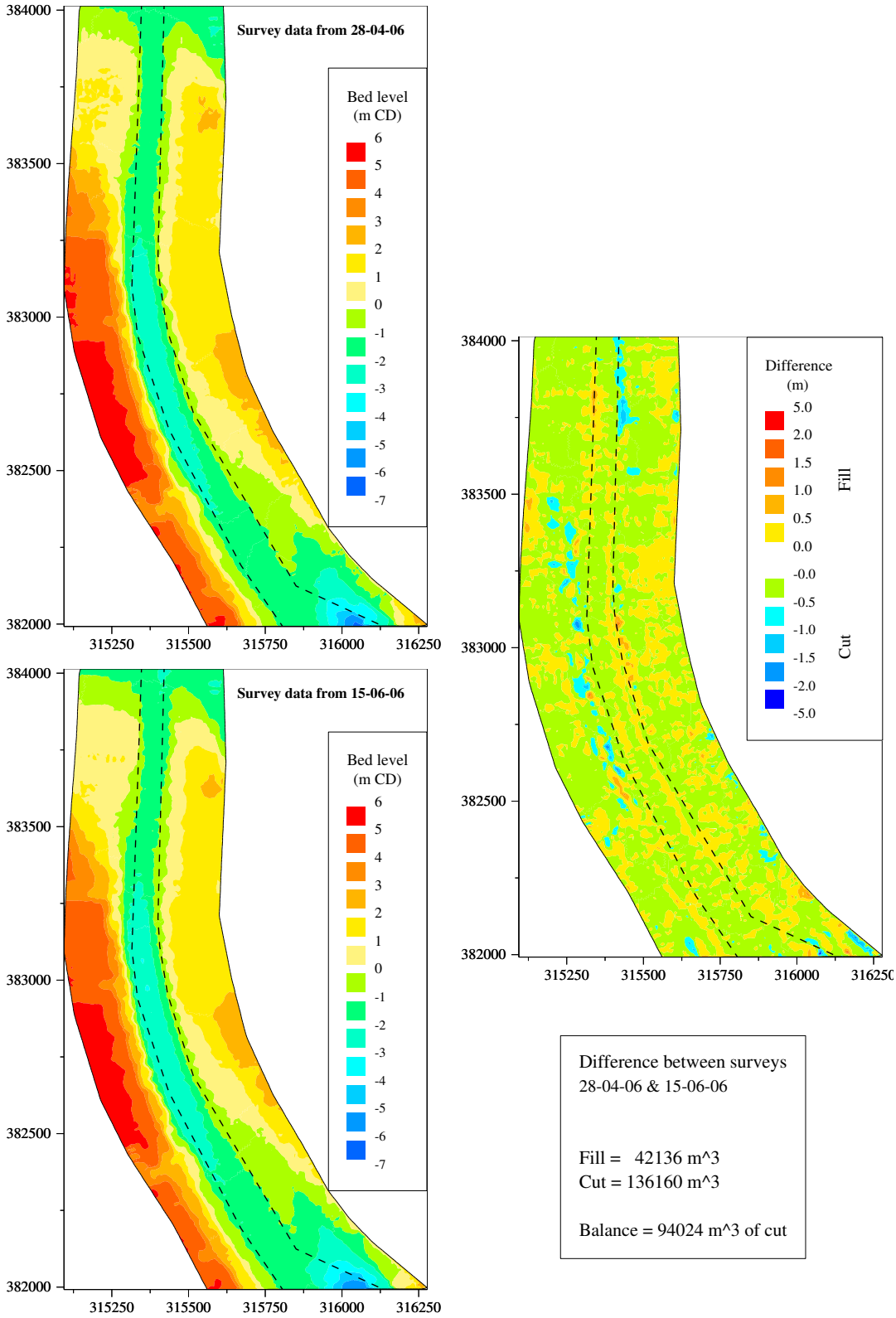

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Figure 8

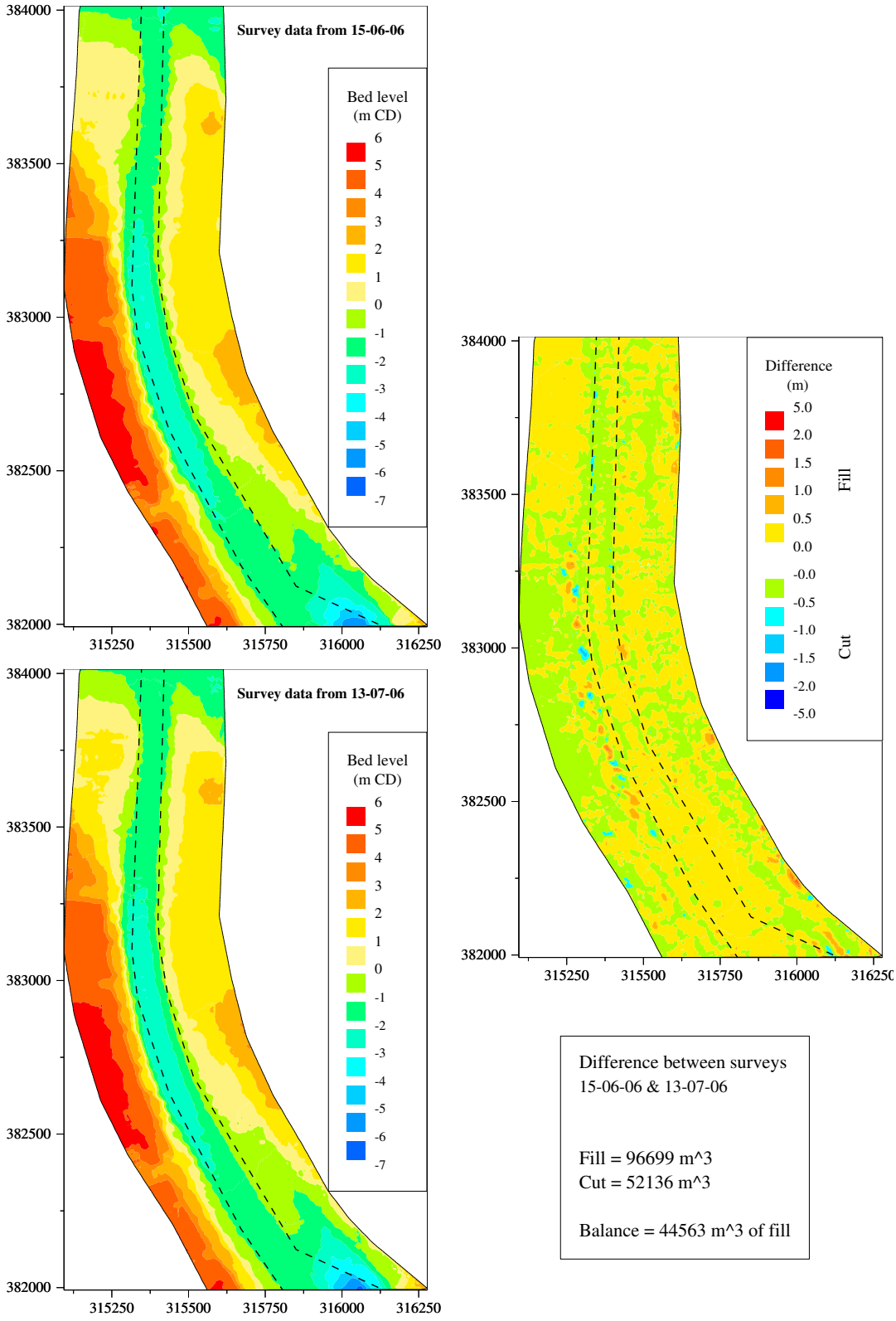

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Figure 9

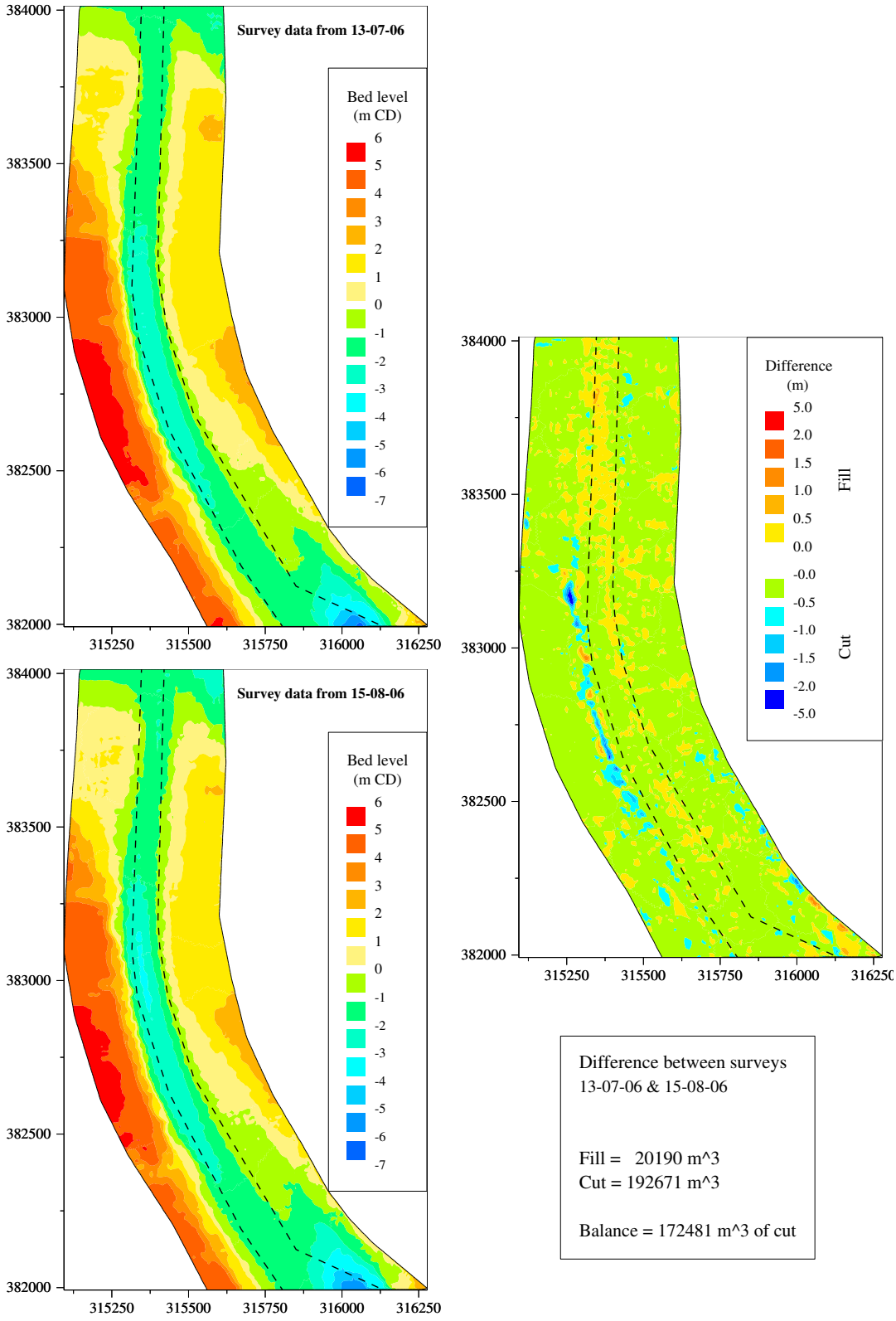

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Figure 10

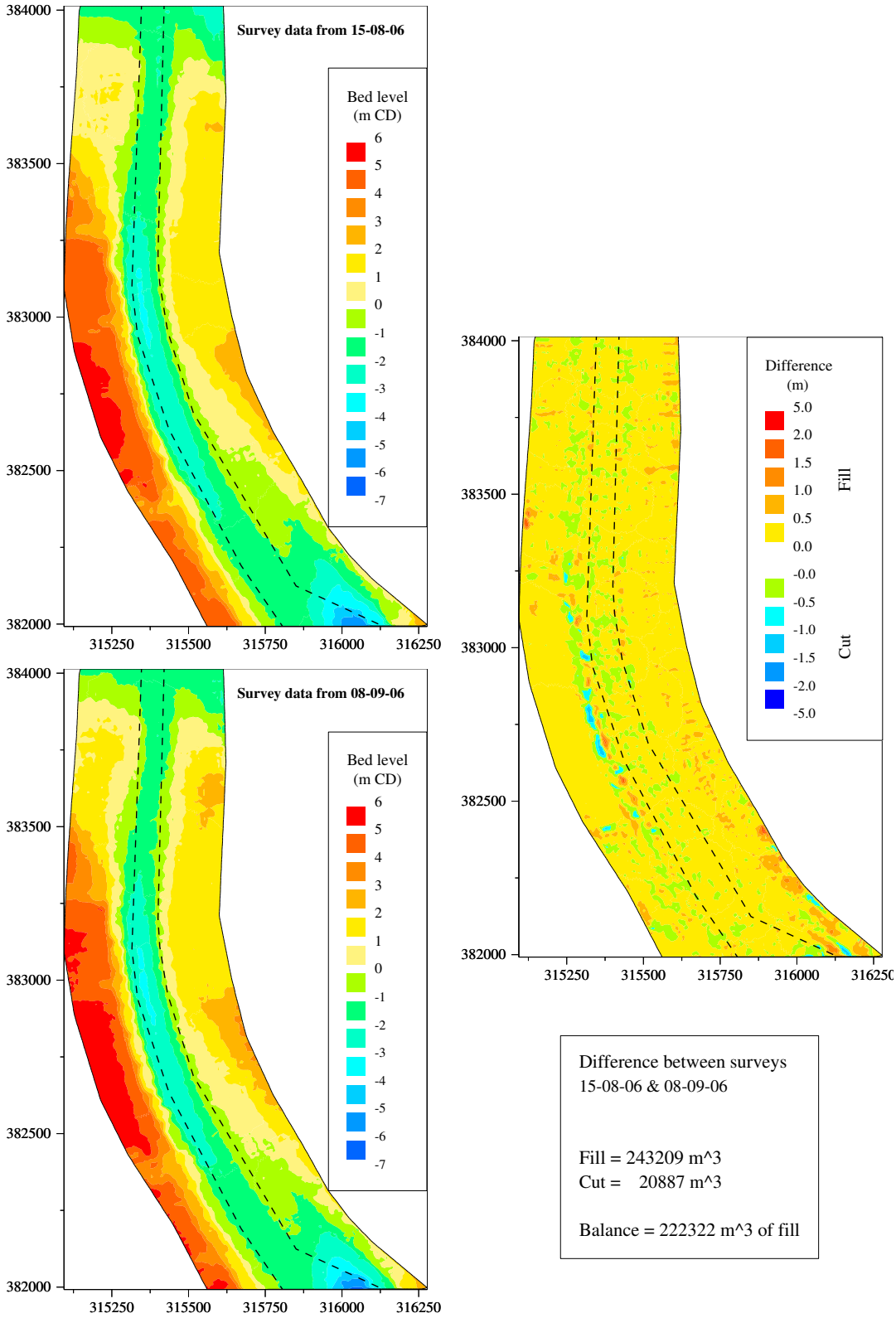

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Figure 11

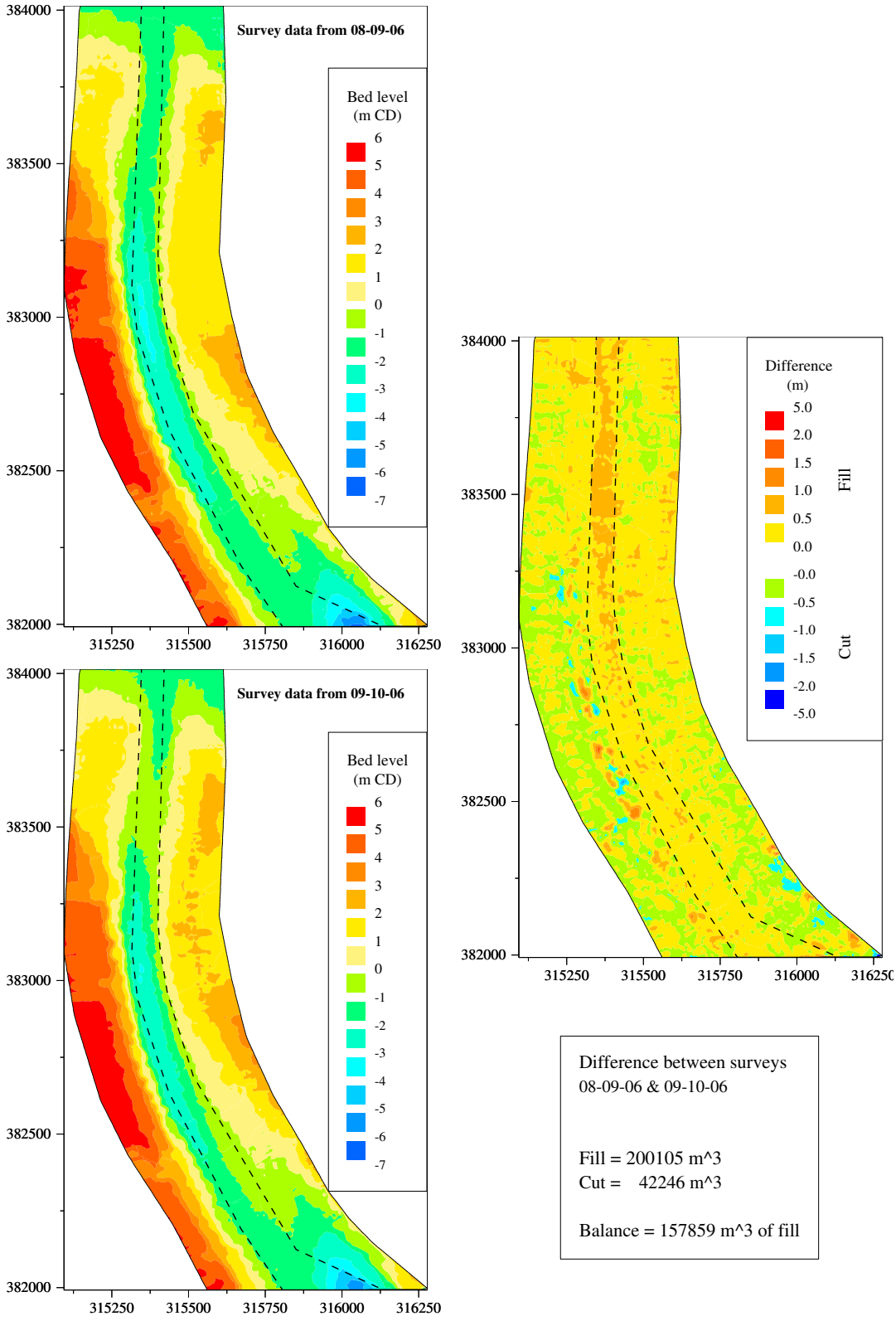

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Figure 12

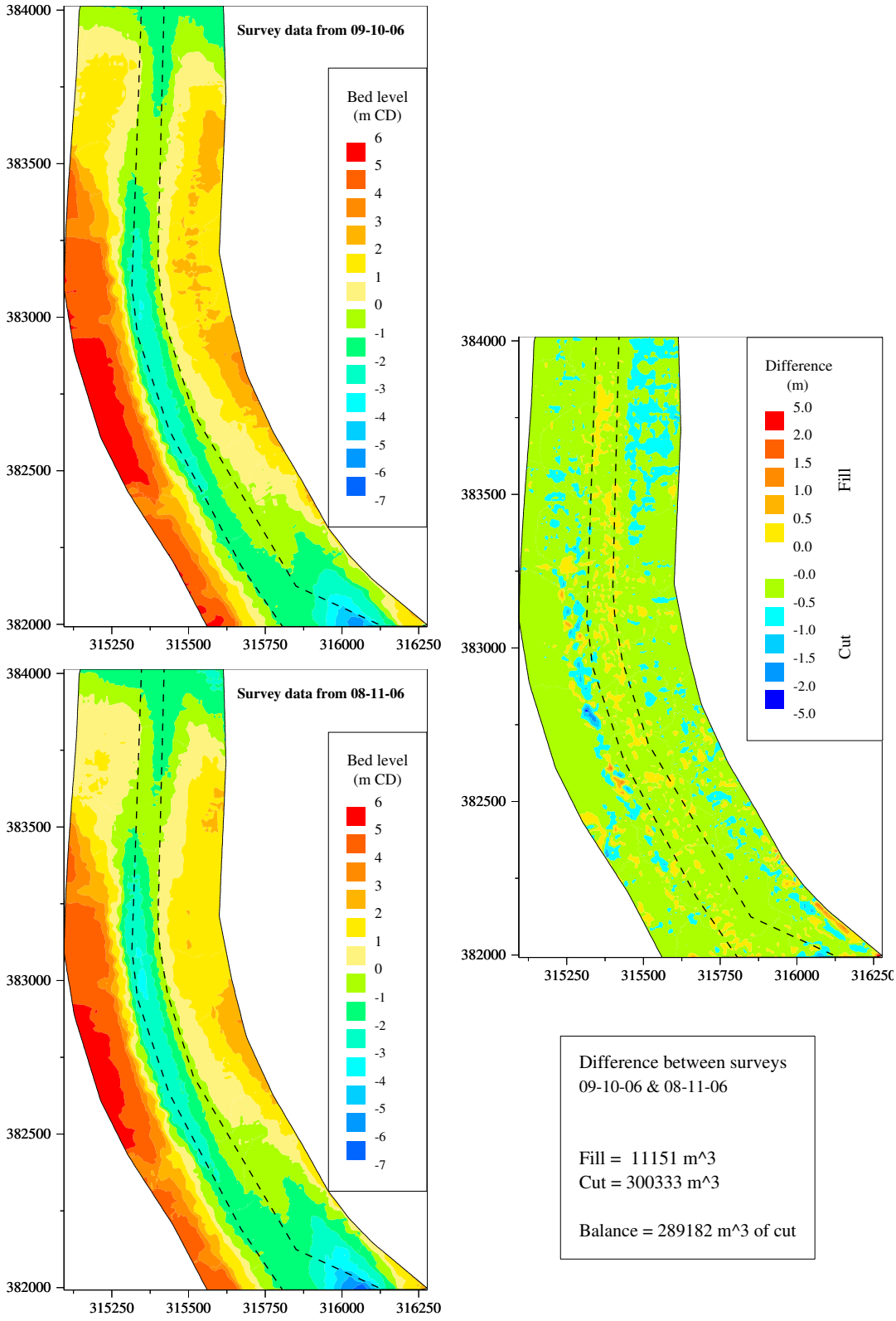

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Figure 13

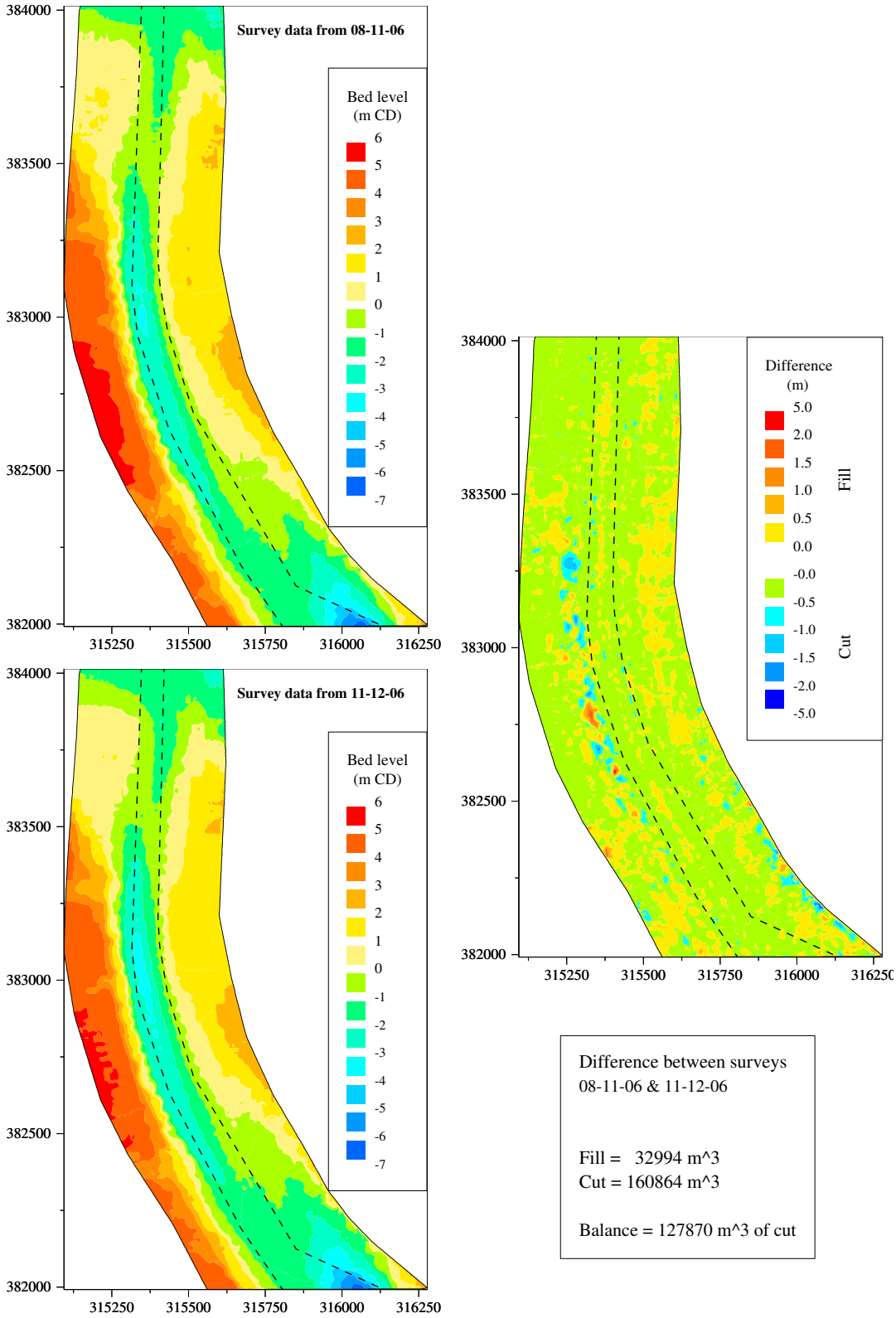

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Figure 14

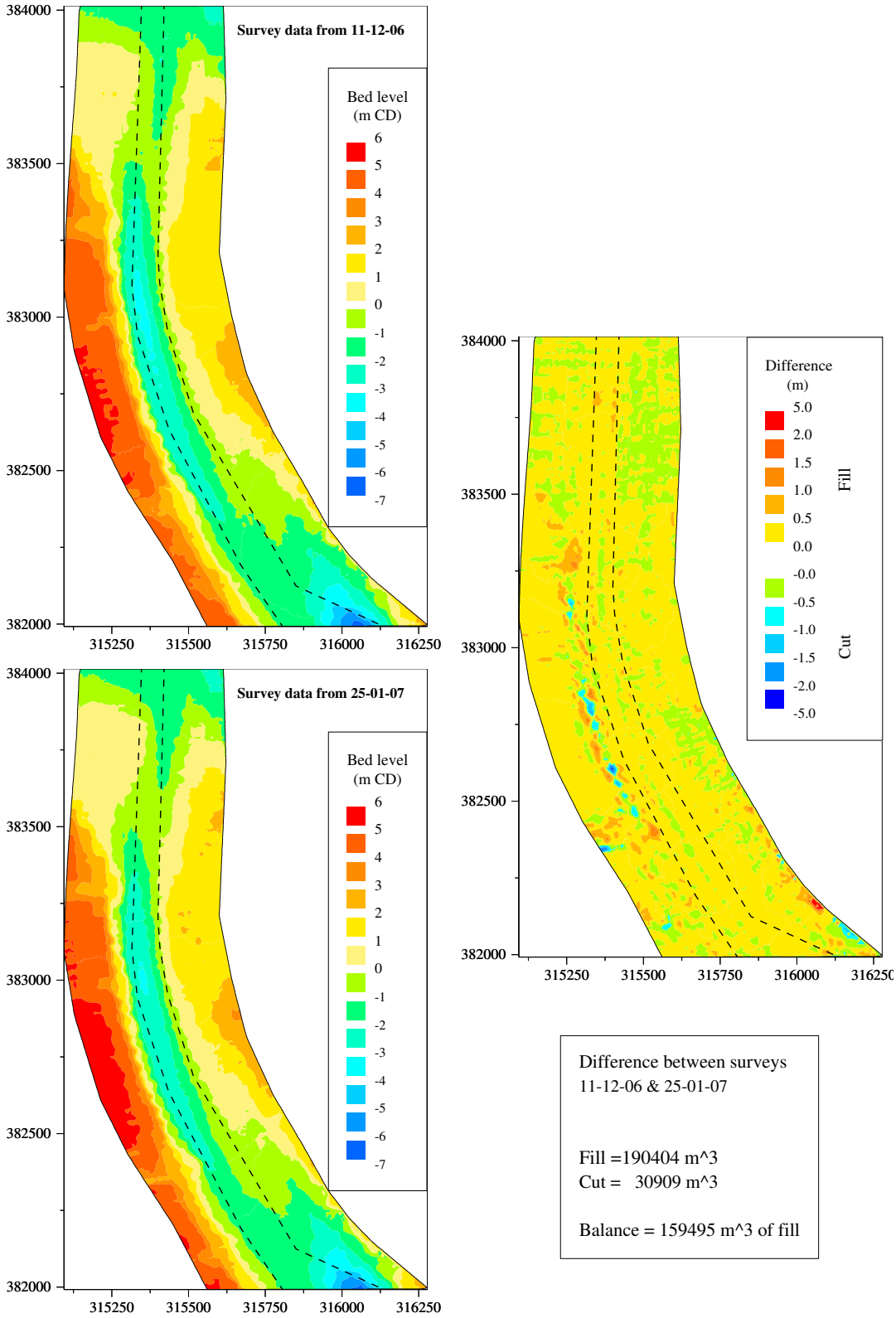

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Figure 15

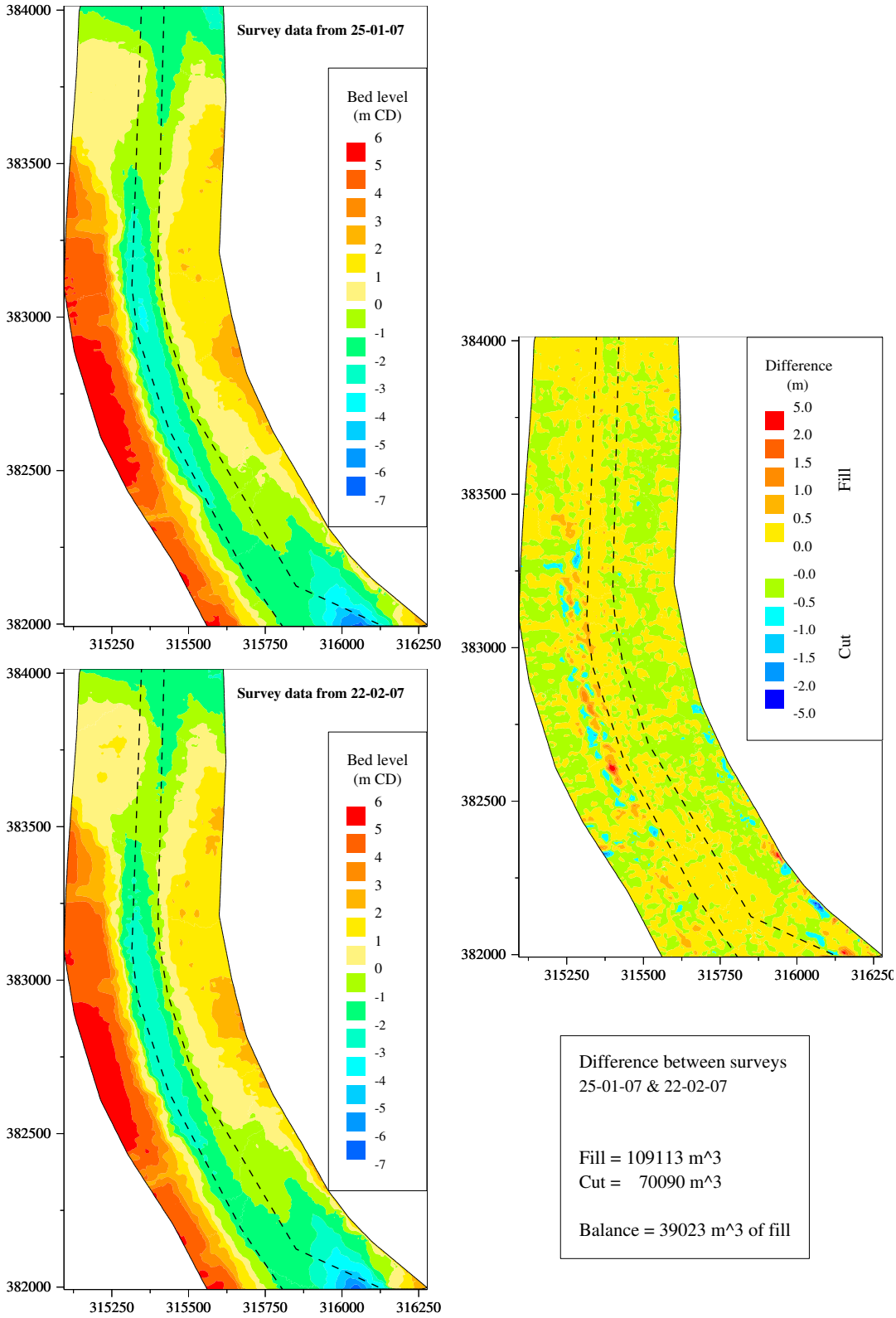

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Figure 16

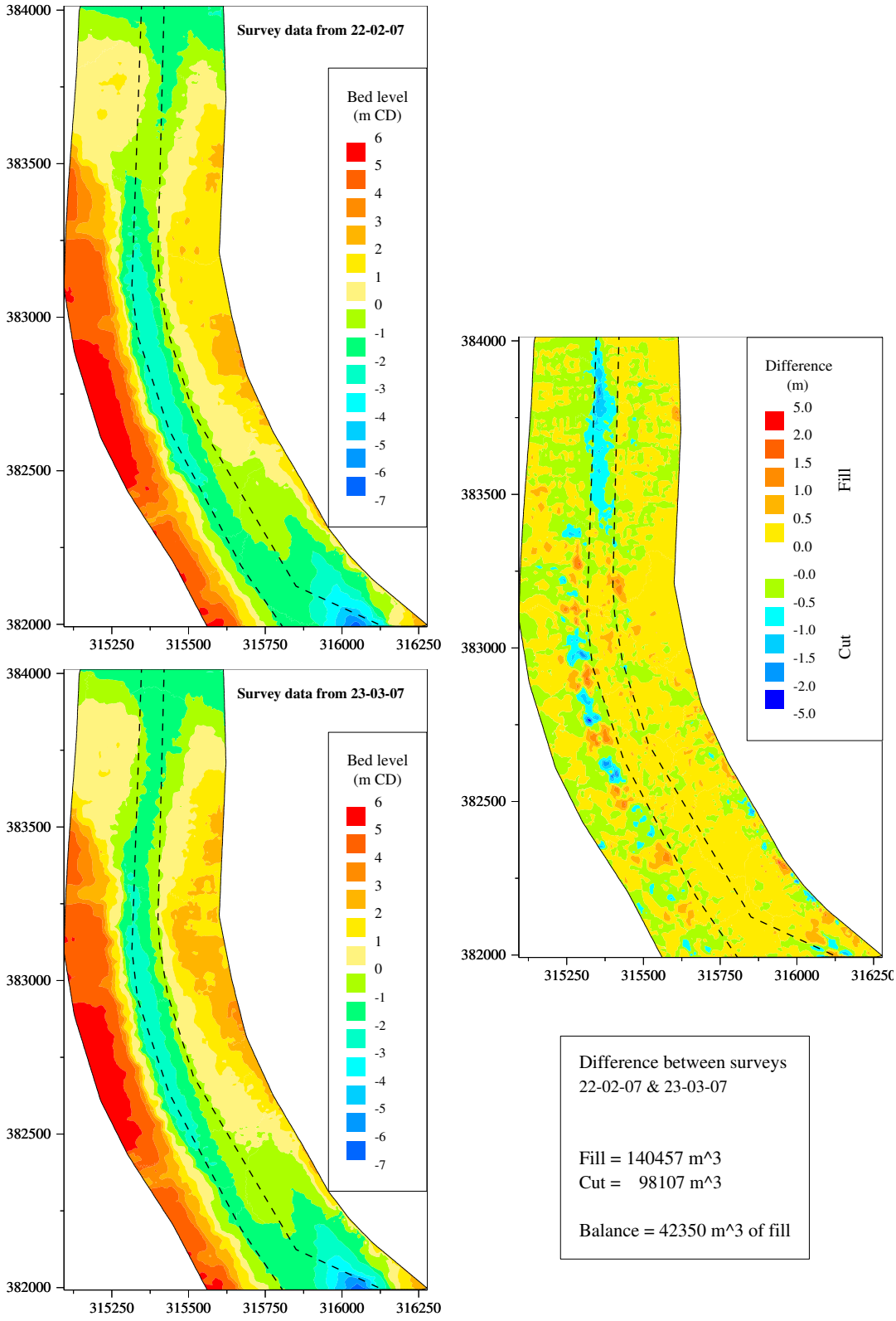

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Figure 17

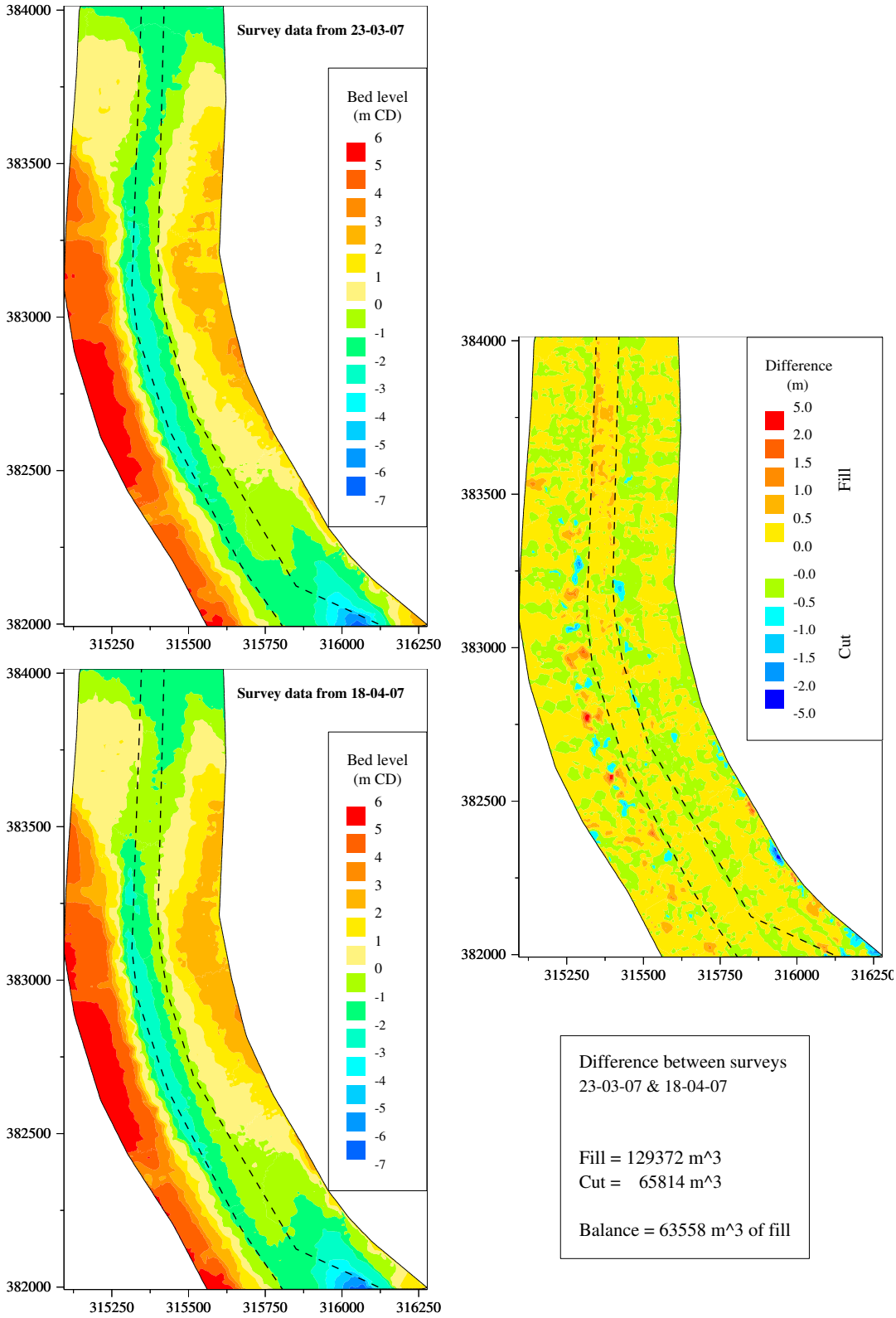

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Figure 18

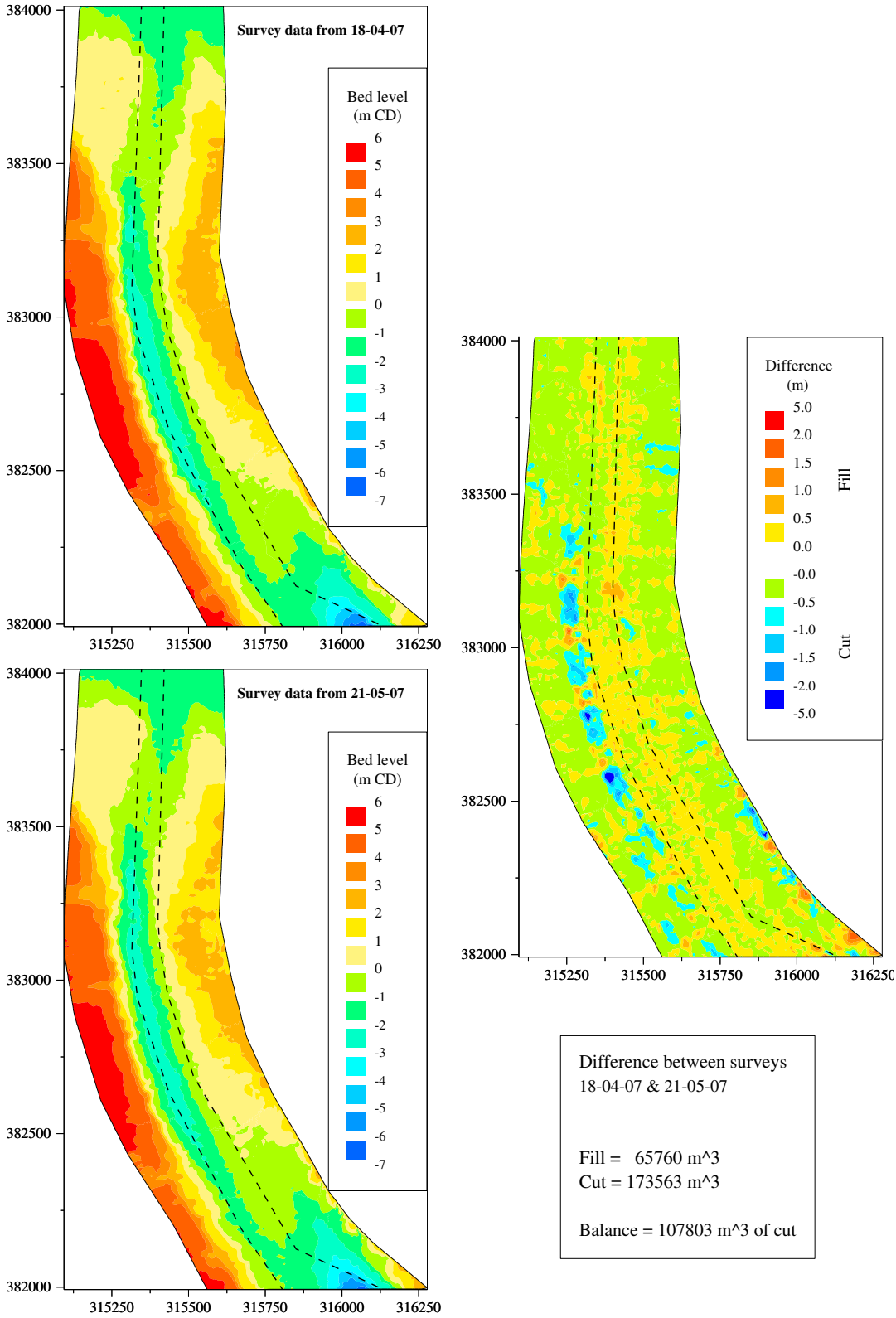

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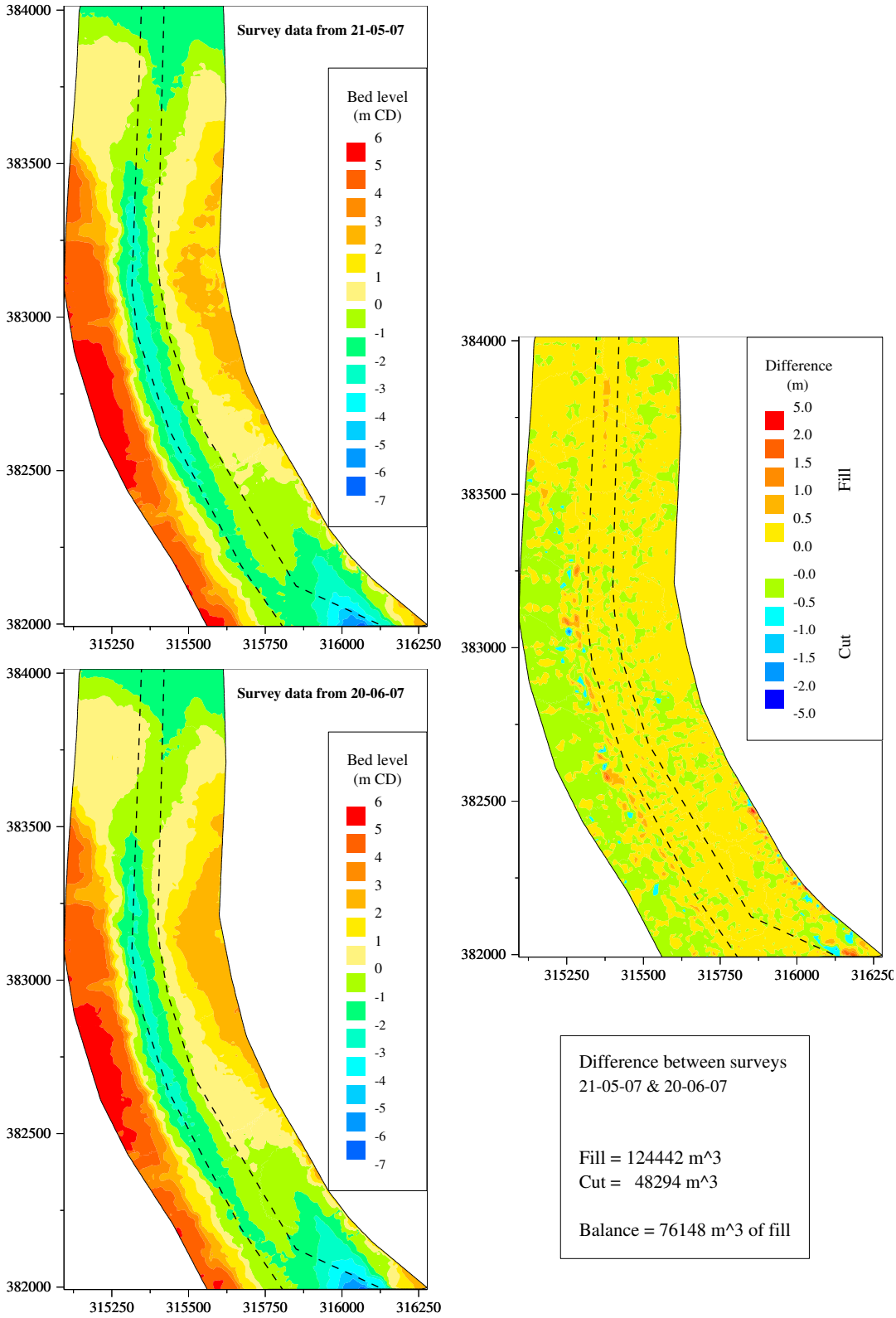
Figure 19



/HRprojects/ddr4117/model/Survey_channel_analysis/stbtel/mostyn_chan_surveys.RUB/survey_diff20.i

Figure 20

Survey Dates	Area			Channel		
	Fill m^3	Cut m^3	Balance m^3	Fill m^3	Cut m^3	Balance m^3
20/09/2005 - 24/10/2005	27957	298910	-270953	11753	62129	-50376
24/10/2005 - 15/11/2005	174211	34819	139392	14557	15471	-914
15/11/2005 - 14/12/2005	52456	84003	-31547	4394	14140	-9746
14/12/2005 - 16/01/2006	35063	171155	-136092	7036	21140	-14104
16/01/2006 - 13/02/2006	66547	138625	-72078	15630	13193	2437
13/02/2006 - 16/03/2006	161325	96718	64607	27576	38097	-10521
16/03/2006 - 28/04/2006	153757	77537	76220	25351	10421	14930
28/04/2006 - 15/06/2006	42136	136160	-94024	7512	26370	-18858
15/06/2006 - 13/07/2006	96699	52136	44563	21383	10346	11037
13/07/2006 - 15/08/2006	20190	192671	-172481	7092	23896	-16804
15/08/2006 - 08/09/2006	243209	20887	222322	26757	3338	23419
08/09/2006 - 09/10/2006	200105	42246	157859	74430	774	73656
09/10/2006 - 08/11/2006	11151	300333	-289182	2765	30398	-27633
08/11/2006 - 11/12/2006	32994	160864	-127870	2859	36764	-33905
11/12/2006 - 25/01/2007	190404	30909	159495	39409	1803	37606
25/01/2007 - 22/02/2007	109113	70090	39023	24969	5335	19634
22/02/2007 - 23/03/2007	140457	98107	42350	25169	30753	-5584
23/03/2007 - 18/04/2007	129372	65814	63558	38757	5333	33424
18/04/2007 - 21/05/2007	65760	173563	-107803	19965	12298	7667
21/05/2007 - 20/06/2007	124442	48294	76148	32558	2296	30262

Table A

ANNEX 'E'

Specimen Progress Report

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								PROGRESS REPORTING
Project				Period	From		To	
To		From		Date		Report No.		Pg.

1) TRAFFIC LIGHT – MOVING SUMMARY							
Monitoring Task	Two-Monthly						Threshold Exceedance Report
	-5	-4	-3	-2	-1	Current	
EB2	●	●	●	●	●	●	
LA1	●	●	●	●	●	●	

Monitoring Task	Bi-annual			Threshold Exceedance Report
	-2	-1	Current for this report	
EB3	●	●	N/A	
EB5	●	●	●	Enclosure 'A'

Monitoring Task	Annual		Threshold Exceedance Report
	Previous	Current for this report	
EB1	●	N/A	
EB4	●	N/A	
LA3	●	N/A	
LA4	●	N/A	
LA5	●	N/A	

Task LA2 (pre-post dredge deposition area monitoring) not included in this Table.

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								PROGRESS REPORTING
Project				Period	From		To	
To		From		Date		Report No.		Pg.

2) TIMETABLE CONCORDANCE

Task \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
EB1				■	■							
EB2	▲		▲		▲		▲		▲		▲	
EB3				■	■					■	■	
EB4										■	■	
EB5				■						■	■	
LA1		□		□		□		□		□		□
LA2	◄	- - -	(As appropriate)	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	►
LA3										■	■	
LA4					◄	(EAW to provide)	►					
LA5									■	■	■	
Progress Reports		○		○		○		○		○		○
Annual Report											●	

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								**PROGRESS REPORTING**
Project				**Period**	**From**		**To**	
To		**From**		**Date**		**Report No.**		**Pg.**

3) MONITORING PLAN REQUIREMENTS				
Task Ref	**Description**	**Reported Here (Y/N)**	**Status:** (Red/Amber/Green)	**Threshold Exceedance Report**
EB1	Estuary Seabed Level Survey	Y	Unknown, results awaited	N/A
EB2	Estuary Transects	Y	Green	N/A
EB3	Mid Hoyle/ Welsh Confluence	Y	Unknown, results awaited	N/A
EB4	Mostyn Deep	N		
EB5	Holocene Clay Bank	Y	Amber	Enclosure 'A'
LA1	Dredged Channel Survey	Y	Green	N/A
LA2	Mostyn Deep Site 'A'	Y	(Post-dredge campaign 'G') Green	N/A
LA3	Mostyn Deep Seabed Samples	N		
LA4	Cockle Survey	N	(EAW results awaited)	
LA5	Benthic Survey	N		

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								**PROGRESS REPORTING**
Project				**Period**	**From**		**To**	
To		**From**		**Date**		**Report No.**		**Pg.**

4) PROGRESS NARRATIVE		
Task Ref	**Narrative**	**Annex**
EB1	Fieldwork for LiDAR completed on …….. and swathe bathymetry on …… Data processing ongoing – results awaited.	
EB2	Survey carried out on ……. and results completed with commentary on changes.	I
EB3	Survey carried out on …….. Data processing ongoing – results awaited.	
EB5	Survey carried out on …… Results-condition amber refer to Enclosure 'A'. Basic survey results/report presented in annex.	II
LA1	Dredged channel survey completed on …….. Results present in annex.	III
LA2	Post-dredge campaign 'G' survey. Results presented in annex.	IV

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								**PROGRESS REPORTING**
Project				**Period**	**From**		**To**	
To		**From**		**Date**		**Report No.**		**Pg.**

5) MONITORING OVERVIEW

Reconciliation of results in this report with 'early-warning' parameters and estuary basis summary as set out in SMP 'Mostyn Channel Monitoring Protocols' (2008).

MONITORING BI-MONTHLY PROGRESS REPORT - Specimen for May (part completed)

Port of Mostyn								PROGRESS REPORTING
Project				**Period**	**From**		**To**	
To		**From**		**Date**		**Report No.**		**Pg.**

6) ACTIONS		
Task Ref	**Action Description**	**To be initiated by**

ANNEX 'F'

Biological Monitoring Review

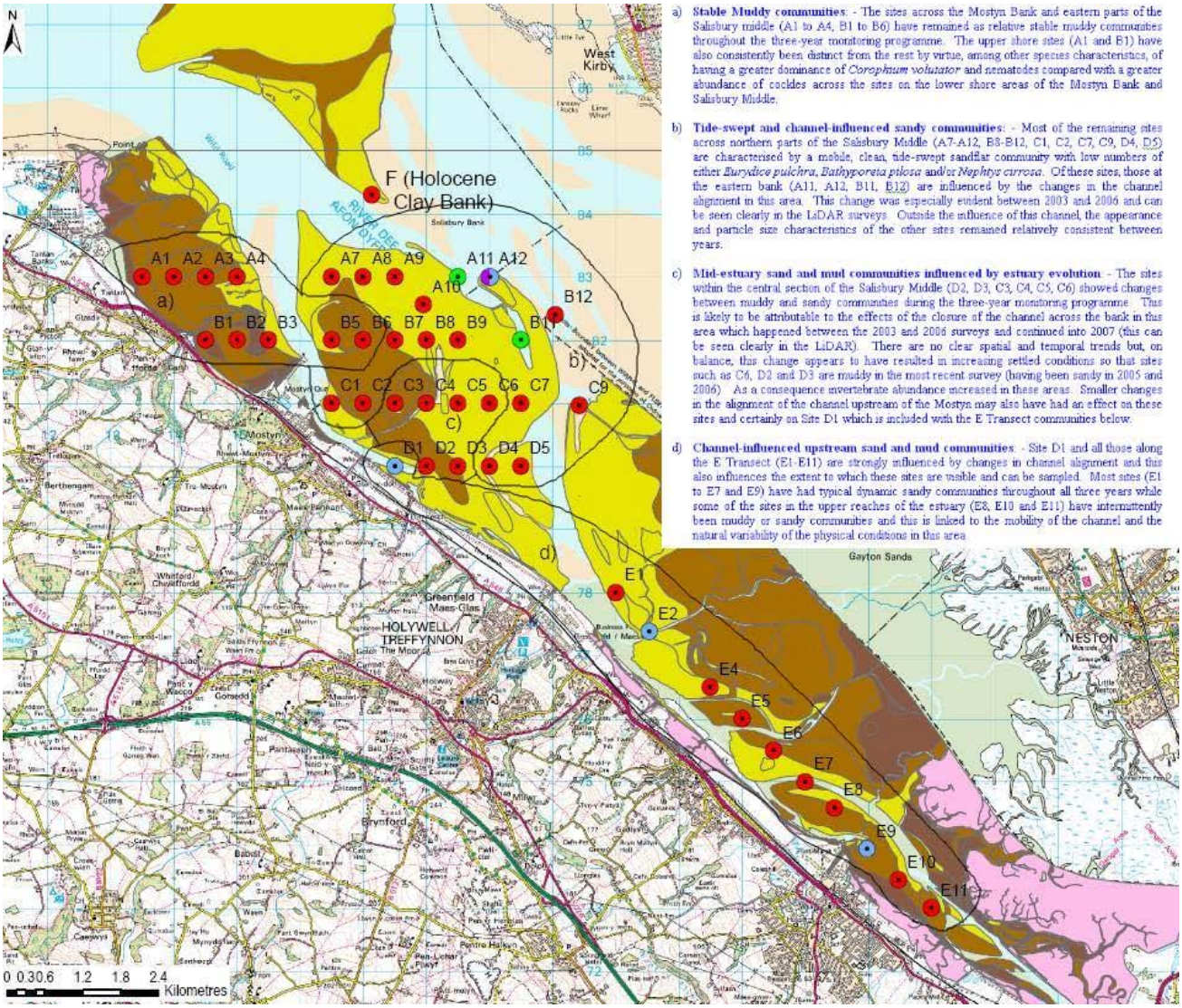
To provide a context for this ongoing monitoring, and to further inform the monitoring rationale, Figure 6 summarises the results that have been obtained so far. It is recognised that this is an inherent simplification of the process that occurs in such a dynamic estuarine system but it is considered to be a useful conceptual overview. It shows that the sites can be separated into the following categories: -

a) **Stable Muddy communities**: - The sites across the Mostyn Bank and eastern parts of the Salisbury middle (A1 to A4, B1 to B6) have remained as relative stable muddy communities throughout the three-year monitoring programme. The upper shore sites (A1 and B1) have also consistently been distinct from the rest by virtue, among other species characteristics, of having a greater dominance of *Corophium volutator* and nematodes compared with a greater abundance of cockles across the sites on the lower shore areas of the Mostyn Bank and Salisbury Middle.

b) **Tide-swept and channel-influenced sandy communities: -** Most of the remaining sites across northern parts of the Salisbury Middle (A8-A11, B8-B12, C1, C2, C7, C9, D4, D5) are characterised by a mobile, clean, tide-swept sandflat community with low numbers of either *Eurydice pulchra, Bathyporeia pilosa* and/or *Nephtys cirrosa*. Of these sites, those at the eastern bank (A11, A12, B11, B12) are influenced by the changes in the channel alignment in this area. This change was especially evident between 2003 and 2006 and can be seen clearly in the LiDAR surveys. Outside the influence of this channel, the appearance and particle size characteristics of the other sites remained relatively consistent between years.

c) **Mid-estuary sand and mud communities influenced by estuary evolution**: - The sites within the central section of the Salisbury Middle (D2, D3, C3, C4, C5, C6) showed changes between muddy and sandy communities during the three-year monitoring programme. This is likely to be attributable to the effects of the closure of the channel across the bank in this area which happened between the 2003 and 2006 surveys and continued into 2007 (this can be seen clearly in the LiDAR). There are no clear spatial and temporal trends but, on balance, this change appears to have resulted in increasing settled conditions so that sites such as C6, D2 and D3 are muddy in the most recent survey (having been sandy in 2005 and 2006). As a consequence invertebrate abundance increased in these areas. Smaller changes in the alignment of the channel upstream of the Mostyn may also have had an effect on these sites and certainly on Site D1 which is included with the E Transect communities below.

d) **Channel-influenced upstream sand and mud communities**: - Site D1 and all those along the E Transect (E1-E11) are strongly influenced by changes in channel alignment and this also influences the extent to which these sites are visible and can be sampled. Most sites (E1 to E7 and E9) have had typical dynamic sandy communities throughout all three years while some of the sites in the upper reaches of the estuary (E8, E10 and E11) have intermittently been muddy or sandy communities and this is linked to the mobility of the channel and the natural variability of the physical conditions in this area.



a) **Stable Muddy communities** - The sites across the Mostyn Bank and eastern parts of the Salisbury middle (A1 to A4, B1 to B6) have remained as relative stable muddy communities throughout the three-year monitoring programme. The upper shore sites (A1 and B1) have also consistently been distinct from the rest by virtue, among other species characteristics, of having a greater dominance of *Corophium volutator* and nematodes compared with a greater abundance of cockles across the sites on the lower shore areas of the Mostyn Bank and Salisbury Middle.

b) **Tide-swept and channel-influenced sandy communities**: - Most of the remaining sites across northern parts of the Salisbury Middle (A7-A12, B8-B12, C1, C2, C7, C9, D4, D5) are characterised by a mobile, clean, tide-swept sandflat community with low numbers of either *Eurydice pulchra*, *Bathyporeia pilosa* and/or *Nephtys cirrosa*. Of these sites, those at the eastern bank (A11, A12, B11, B12) are influenced by the changes in the channel alignment in this area. This change was especially evident between 2003 and 2006 and can be seen clearly in the LiDAR surveys. Outside the influence of this channel, the appearance and particle size characteristics of the other sites remained relatively consistent between years.

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Annex F, Figure 6

ANNEX 'G'

CCW Monitoring Proposed Consent Conditions

Conditions for consent given to the Port of Mostyn for proposed dredging and disposal activities in the Dee Estuary

Countryside Council for Wales, 25th November 2008

Summary of ecological monitoring conditions

	Condition
1	**Spring Equinox Sediment and Habitat Surveys (Mostyn Bank and Salisbury Middle)**: - The sediment particle size and the visual habitat characteristics are to be monitored in the vicinity of the inner channel to identify any change in the muddy habitat on the sediment flats. A resolution of 500 m by 500 m grid sampling is proposed (Figure 2 and Table 1). This is ideally to be completed during the spring equinox tides. It is recognised that not all the sites on this grid will be readily accessible because they are subtidal or very low in the tidal frame but the surveyor should survey on as large a tide as is feasible during this equinox period and achieve a good coverage of the sites. It is recognised that LiDAR surveys will be separately undertaken and, where the tidal elevation, visual habitat composition and or the sediment particle size have been seen to change (in a manner relative to natural variability that could signal an ecological consequence), then subsequent infaunal sampling at such sites will be needed during September of the same year. The scope of the September survey will need to be agreed in consultation with CCW and the Agency and thus the results need to be turned around by end of June in each year to allow for a Regulator's view and for the planning of the autumn equinox surveys.
2	**Autumn Equinox Sediment and Habitat Surveys (Mostyn Bank and Salisbury Middle)**: - Where, in the Spring months, the sedimentary analysis, LiDAR or swathe bathymetry indicate a substantial change (i.e. ones where, with due recognition of natural variability, the changes presage a possible ecological consequence that requires further investigation), then further particle size , infauna samples (and, if needed, measurements of other sedimentary parameters) should be taken at these locations to describe the communities that are present and allow the ecological consequence to be understood. See Methodology section below for details.
3	**Spring and Autumn Equinox Sediment and Habitat Surveys (Holocene Bank Surveys)**: - Record the extent of clay bank that is exposed from the sand. A twice yearly survey in conjunction with other ecological surveys (ideally timed to coincide with the Spring and Autumn equinox surveys) and in response to any sand inundation events identified by Condition 4. Record the presence of piddocks in the clay.
4	**Holocene Bank Sand Levels Recording**: - Frequent observation of the sand levels on the clay bank to be carried out. The means by which this is achieved can be agreed between the Port of Mostyn and CCW, but a suggested method is for observations (preferably including a photograph) to be taken from the vicinity of the West Buoy, looking north eastwards across the clay bank, at low water (<2.0mACD tide) at every possible opportunity.

Ecological monitoring rationale

The conditions expressed here have been drawn up based on the results from three years of monitoring (2005-2007), a requirement by condition of the previous consent for dredge and disposal.

The objective of this ecological monitoring program is to better inform the Regulators of ecological changes associated with the dredge and disposal activities. Modelling of the hydrodynamics and net sediment flux provides a guide to the likely locations of changes in intertidal habitats and communities. The monitoring program reflects this, and also allows for the limitations of forward projecting in such a dynamic environment. The monitoring program permits:

- Compliance with the Conservation Objectives relating to the features for each nature conservation designation;
- Confirmation that recorded changes are in line with the predicted changes according to the modelling;
- There are no changes witnessed that were not identified in the Environmental Statement.

The avifauna of the estuary are inextricably linked to the sediment infaunal communities, which, in turn are linked to changes in geomorphology. Therefore, the ecological monitoring program must be reviewed in line with any issues raised by the ongoing geomorphological monitoring, including swathe bathymetry and LiDAR surveys. Should the results of the geomorphological monitoring throw up evidence of major changes in the extent, type or quality of the habitats, this should initiate a management response that may include further ecological monitoring where appropriate in the light of geomorphological changes recorded.

The results of mandatory geomorphological monitoring will complement, inform and, on occasion, act as a surrogate for the ecological monitoring. For example, swathe bathymetry of the inner channel area will provide evidence of the channel location and shifts in intertidal banks in this area. It will also provide contextual information on changes in the estuary configuration, geomorphology and hydrodynamics.

Risk of local effects of dredging activities

Intertidal Features

Likely direct effects of the dredging are associated with the sediment banks either side of the inner channel. Evidence from previous LiDAR and swathe bathymetry suggests that the inner channel has been eroding the flank of Mostyn Bank in the vicinity of the M4 and M5 buoys, and a shift of the channel centre line to the west, since 2001. This reaction to the dredging is also identified in the modelling of the effects of the -4m dredge, based on sediment flux. The accretion on Salisbury Bank does not contain the muddy habitat species such as bivalves, large polychaetes and *Hydrobia* spp. that are present in Mostyn Bank and do not therefore balance the loss on Mostyn Bank. Although the extent of the SAC feature ‘intertidal mudflats and sandflats’ has not been reduced, the overall balance of the types of infaunal community has so far been found to be different. It is likely that this loss of muddy habitats is temporary during the dredging activity and will recover on cessation of the dredging activities.

Stage I Thresholds for the Monitoring Tasks EB2 and LA1 provide sufficient protection from excessive migration of the channel to the west. Crossing these thresholds, such that the result is erosion of the Mostyn Bank is deemed to be substantially reducing the area of the muddy habitats and no longer meets the Conservation Objectives for the ‘estuary’ and ‘intertidal mudflats and sandflats’ features of the Dee Estuary cSAC and the bird features of the SPA and Ramsar Site.

Bird features

No local effects are identified for bird life within the dredge channel, but Mostyn Bank is an important feeding ground for a number of SPA bird features. During low tide counts of the Dee Estuary SPA, it has held, as a percentage of all the birds, at low tide:

18% Oystercatchers
11% Curlews
17% Shelduck
13% Pintail
13% Dunlin

Subtidal features

The sediments to be dredged are considered to be highly dynamic sediments with a sediment community that reflects the high mobility of the substratum. CCW accepts that the sediment in the berthing area experiences ongoing disturbance from shipping activities and that all the habitats in the inner channel and berthing area, on cessation of all activities, would revert back to their original condition. No conditions are applied with respect to the ecology of the subtidal sediments in the inner channel and berthing area.

Risk of ambient effects of dredging activities

Intertidal Features

Monitoring results for 2005 – 2007 show variability in the particle size across Mostyn Bank, where a greater stability from year to year is expected. Despite the modelled estimate of dredge induced change not demonstrating changes in bed levels, insurance is required to confirm that this biologically rich area is not compromised, as it is an important component of the bird feeding areas in the Dee estuary.

Condition 1. The sediment particle size and other sediment parameters are monitored in the vicinity of the inner channel to identify any change in the muddy habitat on Mostyn Bank and Salisbury Middle and areas of change on the west flank of Salisbury Bank. A resolution of 500 m by 500 m grid sampling is proposed (Figure 2 and Table 1). This is ideally completed during the spring equinox tides. See Methodology section for detail.

Where sediment characteristics have been seen to change, then a subsequent infaunal sampling event should take place during September of the same year.

Condition 2. Where substantial change has been identified from LiDAR or swathe bathymetry, further particle size and infauna samples should be taken at these locations to confirm the communities that are present. See Methodology section below for details.

Loss of, and the continued trend of loss of the muddy habitats (through change in bed height of sediment type) of Mostyn Bank are considered to no longer meet the Conservation Objectives for the ‘estuary’ and ‘intertidal mudflats and sandflats’ features of the Dee Estuary cSAC and the bird features of the SPA and Ramsar Site.

The relocation of mobile sand habitats on Salisbury Bank are not considered of concern with respect to the Conservation Objectives of the Dee estuary.

Bird features

There has been a marked decline in some of the Dee estuary’s SPA features, such as oystercatcher and knot, as well as a ‘High Alert’ being triggered for shelduck and ‘Medium Alerts’ for grey plover, pintail and teal. The monitoring of the biological habitats and communities, however, is considered a suitable surrogate for the evaluation of the carrying capacity of this part of the estuary, for intertidal birds, through the measurement of the food source quantity and quality. Where no change in the physical nature of the substrata is identified, the infauna is assumed to be unchanged.

Subtidal features

The likely effects to subtidal communities in the vicinity of the dredging activities are not of concern, as it largely results in the relocation of the same, highly dynamic sediments. No conditions are applied with respect to the ecology of the subtidal sediments over the conditions established for evaluating effects on the geomorphology.

Risks of local effects of deposition in Mostyn Deep (Site A)

Bird features

No local effects in the Mostyn Deep are identified for bird life.

Subtidal features

The communities identified in Mostyn Deep are of highly mobile species with high recoverability and are important as part of a suite of subfeatures of the 'estuary' feature in the Dee Estuary cSAC. Mostyn Deep has previously been consented as a disposal site with no adverse effects identified on the features of interest of the cSAC. Continued disposal in this location is not considered to have an adverse effect on these recoverable subtidal communities and there are no conditions set to evaluate subtidal features.

Risks of ambient effects of deposition in Mostyn Deep (Site A)

Intertidal features

Some sampling stations from the previous ecological monitoring program have been found to be highly variable due to changes in the configuration of channels and have therefore been removed. Transect E, in particular sat along an area of continual channel migration and the eastern most stations on Salisbury Bank were also vulnerable to changes in the channel location. **There is still concern that the mid-upper estuary is the possible fate of sediment disposed of in Mostyn Deep. The combination of LiDAR and swathe bathymetry survey is considered the best means of evaluating this**.

See Conditions 1 and 2

Substantial shift in community types across the sampling area, that is not compensated for by equivalent formation of the original community type elsewhere (so as to maintain the proportions of each community type), will mean that the Conservation Objectives for the 'estuary' and 'intertidal mudflats and sandflats' features of the Dee Estuary cSAC and the bird features of the SPA and Ramsar Site are no longer met.

Holocene clay bank

There has been no clear evidence of the fate of the large volumes of sediment that have been disposed of in the Mostyn Deep between 2005 and 2007. The key role of the Holocene clay bank in constraining the configuration of the Dee Estuary and as a feature of the SSSI and cSAC (piddock community in clay) warrants monitoring of the risk of changing the sediment regime over the clay bank.

Although the clay bank is naturally subject to erosion and sand inundation, extensive sand inundation that directly relates to dredging and disposal campaigns signals that a change in the disposal program should be considered. Further evaluation of the cause of the inundation (filling of the disposal site, storm surge, particular tidal events, etc) is likely to be necessary to ensure that the situation is avoided during future campaigns. The response also requires an evaluation of the piddock status on the clay bank as described below.

Condition 3. **Spring and Autumn Equinox Sediment and Habitat Surveys (Holocene Bank Surveys)**: - Record the extent of clay bank that is exposed from the sand. A twice yearly survey in conjunction with other ecological surveys (ideally timed to coincide with the Spring and Autumn equinox surveys) and in response to any sand inundation events identified by Condition 4. Record the presence of piddocks in the clay.

Condition 4. **Holocene Bank Sand Levels Recording**: - Frequent observation of the sand levels on the clay bank to be carried out.

The means by which this is achieved can be agreed between the Port of Mostyn and CCW, but a suggested method is for observations (preferably including a photograph) to be taken from the vicinity of the West Buoy, looking north eastwards across the clay bank, at low water (< 2.0 m ACD tide) at every possible opportunity.

Persistent total smothering of the clay bank, other than through natural change in the estuary system, no longer meets the Conservation Objectives for the ‘estuary’ feature of the Dee Estuary cSAC and the feature of the Dee Estuary SSSI. The clay bank piddock population is considered ephemeral and is expected to naturally wax and wane according to the local conditions. Provided the habitat is not removed from the cSAC, then opportunist populations of piddocks are expected to be present on the clay bank. SAC feature monitoring surveys by CCW provide complementary data that provides a better understanding of the clay bank and the piddock population.

The positions of West buoy and the clay bank are illustrated in Figure 3.

Monitoring methodology

Intertidal sediment surveys

Intertidal sediment sampling and recording are to be carried out twice a year.

- Spring survey (March), collection of samples for sediment particle size analysis (PSA) and record essential sediment characteristics (surface features such as ripples, standing water, shell debris; subsurface features such as depth of black anoxic layer and presence of coarse material).

  Analysis of the spring-time LiDAR and the PSA data, collected in the field, identifies those locations where changes in sediment level or character have occurred. These locations can then be targeted during the second sampling event.

- Autumn (September), collection of infaunal sediment sample, PSA sample and sediment characteristics at each location identified as having demonstrated change between sampling events.

Sampling stations may at times be inaccessible, due to channel migration, this is understood and accepted to be a limiting factor to sampling.

PSA sample

One small core (c.5 cm diameter) of material is collected for subsequent analysis at the laboratory

Infaunal sample

The standard MNCR methodology (Hiscock, 1996) is recommended, which states that 8 cores (10.3 cm dia) are collected, pooled and sieved over a 0.5 mm mesh sieve. This is for guidance, and the actual implement used may vary, provided an equivalent sample size is collected.

Spring tides are essential to access all of the stations. If sampling stations lie within a channel or on a feature that is significantly different from the sediment in a 5 m radius (such as a swathe of washed in weed or a small localised muddy hollow, etc), then the next nearest point that reflects the character of the sediment in the immediate vicinity should be sampled and a GPS position taken.

Samples to be processed according to 'Procedural guideline 3-6' in Davies *et al*, 2001. Survey stations are as illustrated in Figure 2 and Table 1.

Table 1: Intertidal benthic monitoring transects

Transect	No of stations	Location / Habitat
A0	3 (+1 in channel)	Mostyn and Salisbury Banks
A	5 (+1 in channel)	Mostyn and Salisbury Banks
A2	3 (+1 in channel)	Mostyn and Salisbury Banks
B	4 (+1 in channel)	Mostyn and Salisbury Banks
C	4	Salisbury Bank
D	3	South Salisbury Bank

Holocene clay bank surveys

The boundary of the clay bank that is exposed from the sand is to be plotted by walking the boundary with a GPS. The presence of live piddocks is to be noted as holes in the surface and through completing a small dig (30 cm x 30 cm max) on the west end of the bank (where piddocks have previously been most numerous).

Reporting

Spring survey

Intertidal ecological monitoring should report on the PSA and clay bank, including:

- Methodology, timing and any unsuccessful sampling,
- Details of the PSA data and sediment character in spreadsheets,
- Identify and discuss changes in PSA or sediment level for each station, between sampling events,
- Photographs of the sediment surface at each station
- A photographic collection illustrating the nature of the sand on the clay bank (and levels of erosion where relevant),
- Map of the extent of the clay bank as defined by the survey work,
- Evidence and description of the status of the piddock population on the clay bank,
- Discussion of the changes that are evident on the clay bank,
- Discuss and draw any conclusions from the analysis, as to the status of the features of the Dee Estuary cSAC.

Autumn survey

Intertidal ecological monitoring should report on those items described for the spring survey plus:

- Details of the infauna and PSA data as spreadsheets,
- Interpretation of the data as intertidal biotopes,
- Identify and discuss changes in intertidal communities for each sample between sampling events, using appropriate multivariate analysis techniques (e.g. PRIMER),

Additional reporting

Further information is required to put the ecological monitoring results into context:

- The swathe bathymetry and illustrate the boundary of the intertidal in context with the dredged area,
- Losses and gains of intertidal habitats, with relevant, specific locations identified,
- LiDAR and other data that provide information on changes in heights of sediment flats and saltmarshes, estuary wide.

The Countryside Council for Wales will expect the spring report to be available within 2 months of the survey work and, for the autumn survey, within 3 months, in order to review the conclusions and make any recommendations to the Regulators.

Permission is requested for the Regulators and other agencies (Marine and Fisheries Agency, Marine Fisheries Agency, Welsh Assembly Government, Centre for the Environment, Fisheries and the Aquaculture Sciences, Environment Agency, Countryside Council For Wales, Natural England) for re-use of this data to fulfil their respective obligations.

Management responses

Should any of the licence conditions result in the identification of potentially adverse effects on the integrity of the site as a result of the activities by the Port of Mostyn, then the operator, on receipt of written notice from the Regulators, must vary the operations accordingly. Management responses may include one or more of the following:

- Redefine the scope of the activities to remove the potential effects. This may be a change in the magnitude or method of dredging, to the timing or locations of activities.
- Immediate suspension of the activities.
- Further monitoring or analysis to identify whether a change is attributable to the dredge and disposal activities.
- Additional monitoring into the 'recovery' period to ensure that the management decisions have been effective in removing the risk of affecting the features of the statutory designated sites.

The suggestions above do not rule out other means of intervention to rectify the potentially adverse effects on the integrity of the site.

Hiscock, K (ed.) (1996) *Marine Nature Conservation Review: rationale and methods.* Coasts and seas of the United Kingdom. MNCR series. Peterborough, Joint Nature Conservation Committee.

Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C. and Vincent, M. 2001 Marine monitoring handbook, JNCC. Maintained on JNCC website. http://www.jncc.gov.uk

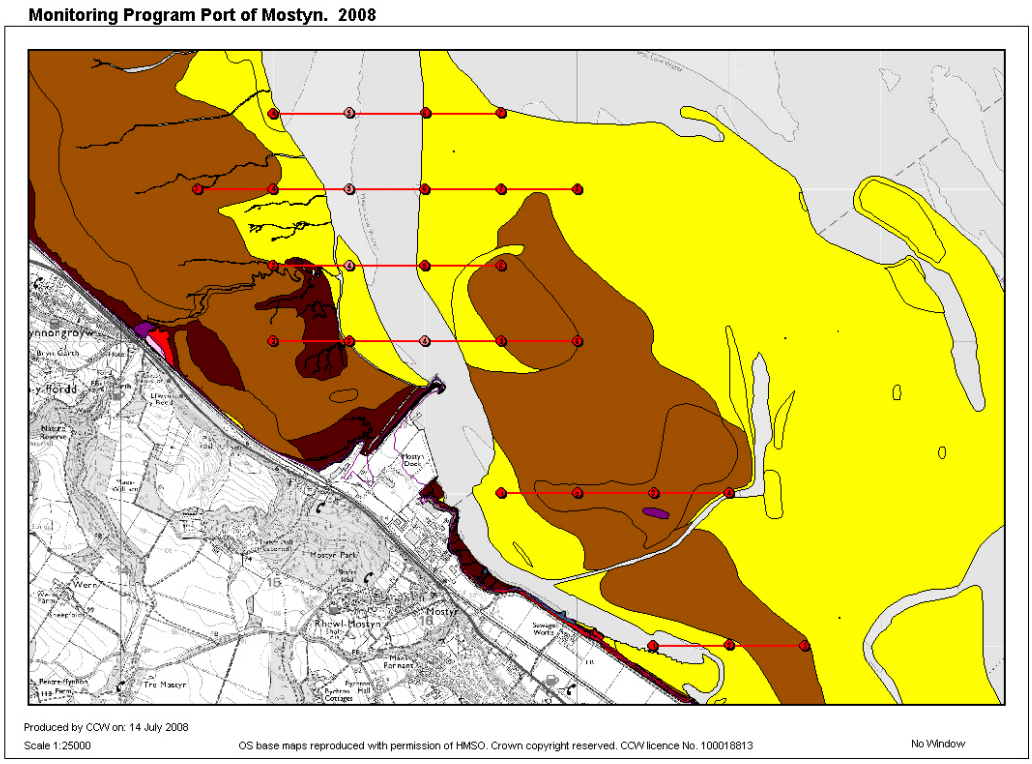

Figure 2 Monitoring transects and stations for PSA and infaunal sampling, Mostyn Bank and Salisbury Bank.

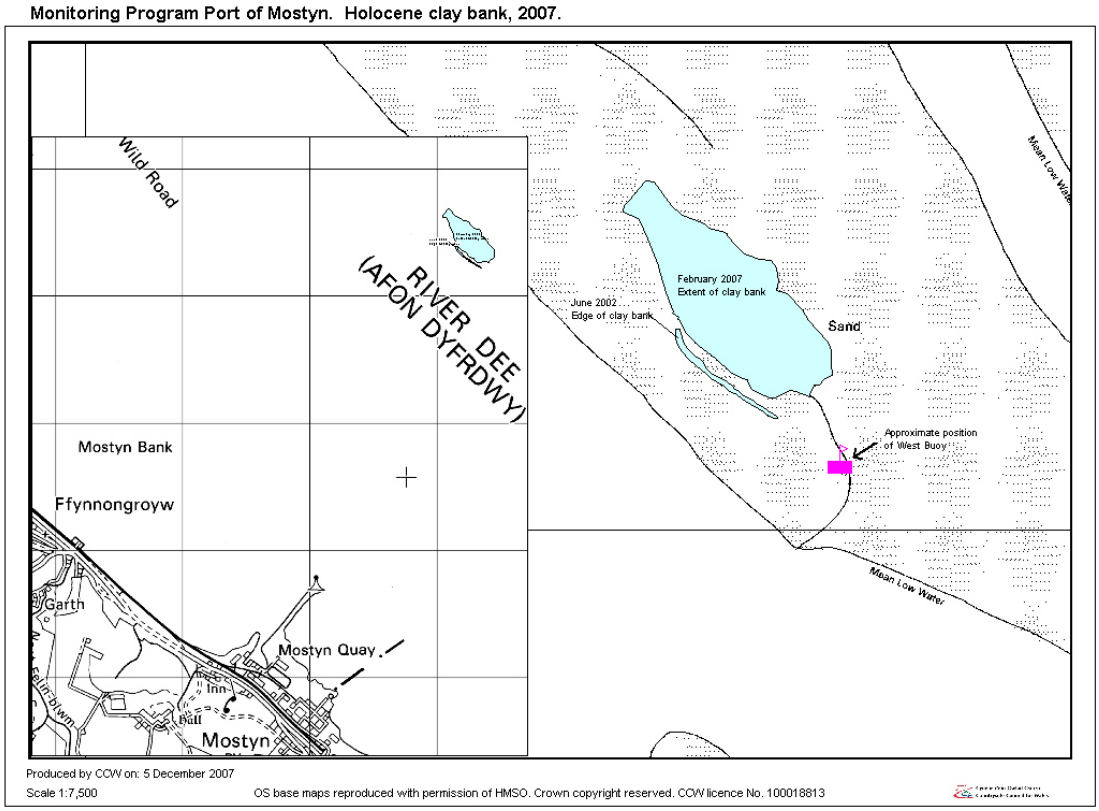

Figure 3 Locations of the Holocene clay bank and West Buoy.

Table 1 Coordinates of sampling stations for PSA and infaunal sampling (see Figure 2)

Transect	Station	X coordinate	Y coordinate	Comment
A0	4	315000	383500	Mostyn Bank
A0	5	315500	383500	Channel: surveyed if intertidal habitat available
A0	6	316000	383500	Salisbury Bank
A0	7	316500	383500	Salisbury Bank
A	3	314500	383000	Mostyn Bank
A	4	315000	383000	Mostyn Bank
A	5	315500	383000	Channel: surveyed if intertidal habitat available
A	6	316000	383000	Salisbury Bank
A	7	316500	383000	Salisbury Bank
A	8	317000	383000	Salisbury Bank
A2	3	315000	382500	Mostyn Bank
A2	4	315500	382500	Mostyn Bank
A2	5	316000	382500	Channel: surveyed if intertidal habitat available
A2	6	316500	382500	Mostyn Bank
B	2	315000	382000	Mostyn Bank
B	3	315500	382000	Mostyn Bank
B	4	316000	382000	Channel: surveyed if intertidal habitat available
B	5	316500	382000	Salisbury Bank
B	6	317000	382000	Salisbury Bank
Bu	1	317467	384133	West Buoy
C	1	316500	381000	Salisbury Bank
C	2	317000	381000	Salisbury Bank
C	3	317500	381000	Salisbury Bank
C	4	318000	381000	Salisbury Bank
D	1	317500	380000	Salisbury Bank
D	2	318000	380000	Salisbury Bank
D	3	318500	380000	Salisbury Bank