CABLE LAYING IN THE WADDENZEE

CEDA – BREDA 22 November 2005

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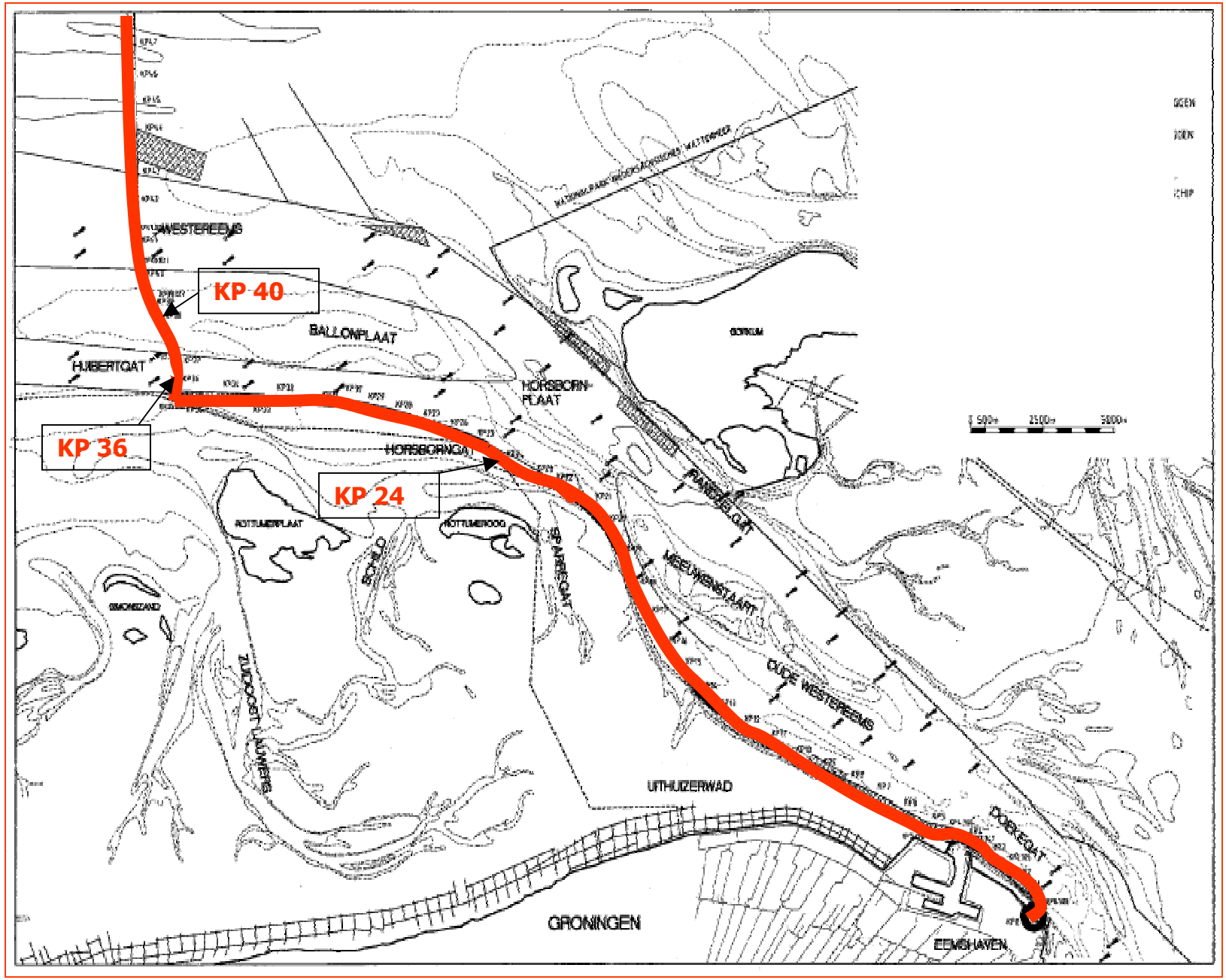
KP 40
KP 36
KP 24
BALLONPLAAT
HUBERTGAT
HORSBORN PLAAT
HORSBORNGAT
ROTTUMERPLAAT
ROTTUMERGAT
SPARREGAT
MEEUWENSTAART
OUDE WESTEREEMS
UITHUIZERWAD
DOLLARDGAT
GRONINGEN
EEMSHAVEN

TWO ALTERNATIVES FOR CABLE BURIAL

- BURIAL BELOW LOWEST EXPECTED SEABED PROFILE DURING SYSTEM'S LIFETIME
- LESS BURIAL AND ACCEPTING THAT LATER RETRENCHING MAY BE NEEDED

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RESULTS OF A STATISTICAL ASSESSEMENT OF THE SEABED MORPHOLOGY

KP_1	Depth 1995/96	(1) Average depth	(1) Standard Deviation	Max. depth 1/100 years (m to NAP)	Max. depth below 95/96 1/100 years	Min. - max. depth, survey 1996(*)/97	Min. - max. depth (2), survey 1999
9 – 10	11.4	14.0	1.0	16	5	12 - 13	
10 – 11	13.4	13.6	1.0	16	3	12.5 - 13.5	
11 – 12	13.5	14.0	1.1	17	3	10.5 - 12.5	
12 – 13	11.6	14.0	1.3	17	5	9.5 - 10.5	9 - 10.5
13 – 14	10.2	14.0	1.5	18	8	10 - 12	10 - 12
14 – 15	11.2	14.0	1.6	18	7	11 - 12	11 - 12
15 – 16	11.5	13.9	1.7	18	6	11 - 12	11 - 11.5
16 – 17	12.2	14.7	1.8	19	7	12 - 13.5	10.5 - 11.5
17 – 18	14.4	15.8	1.9	20	6	13.5 - 15	11.5 - 12.5
18 – 19	15.8	15.2	2.4	21	5	13 - 14.5	9.5 - 11.5
19 – 20	13.7	13.4	4.6	24	10	6 - 13	4 - 10
20 – 21	8.2	10.1	4.9	22	14	4 - 8	5 - 9
21 – 22	6.8	8.0	3.2	15	8	7 - 8	8.5 - 10.5
22 – 23	8.3	7.9	2.4	13	5	assum. 7 - 8	9 - 11
23 – 24	9.0	8.7	2.0	13	4	assum. 7 - 8	7.5 - 9
24 – 25	11.2	9.6	1.8	14	3	8 - 10	7 - 11
25 – 26	9.5	10.8	1.5	14	5	7.5 - 10	
26 – 27	9.1	10.6	1.3	14	5	7.5 - 10	
27 – 28	10.0	10.7	1.2	13	3	10 - 11	

(1) The values in the columns for "Average depth" and "Standard deviation" have been prepared on the basis of depth measurements up to 1995/1996.

(2) The depth measurements in 1999 were made by use of a single beam echo sounder without any heave, pitch or roll correction. The sea was very calm during this survey, and the measurements are not much influenced by vessel movements

AUTHORITY RESTRICTIONS

- KP 0 (Eemshaven) to KP 24 : Construction only allowed between 1 April and 1 June
- KP 24 to KP 40 : Construction not allowed between 15 March and 15 April

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CONCLUSIONS OF SEABED MORPHOLOGICAL STUDY by ACRB (Romke Bijker)

- Using a Normal Distribution and statistical no risk of retrenching would need excessive burial
- Accepting a low risk of retrenching would reduce burial depths to 3m to 5m

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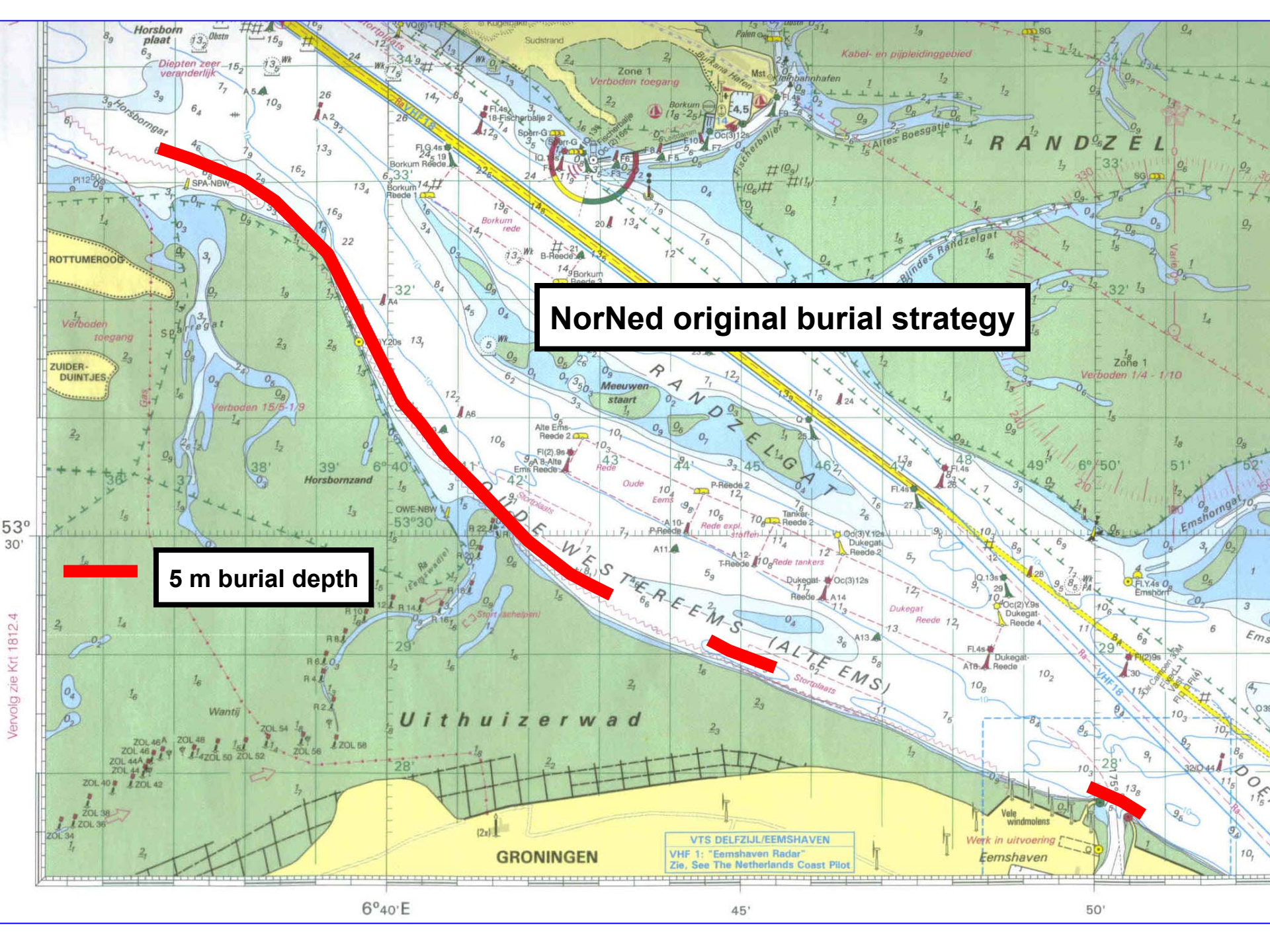
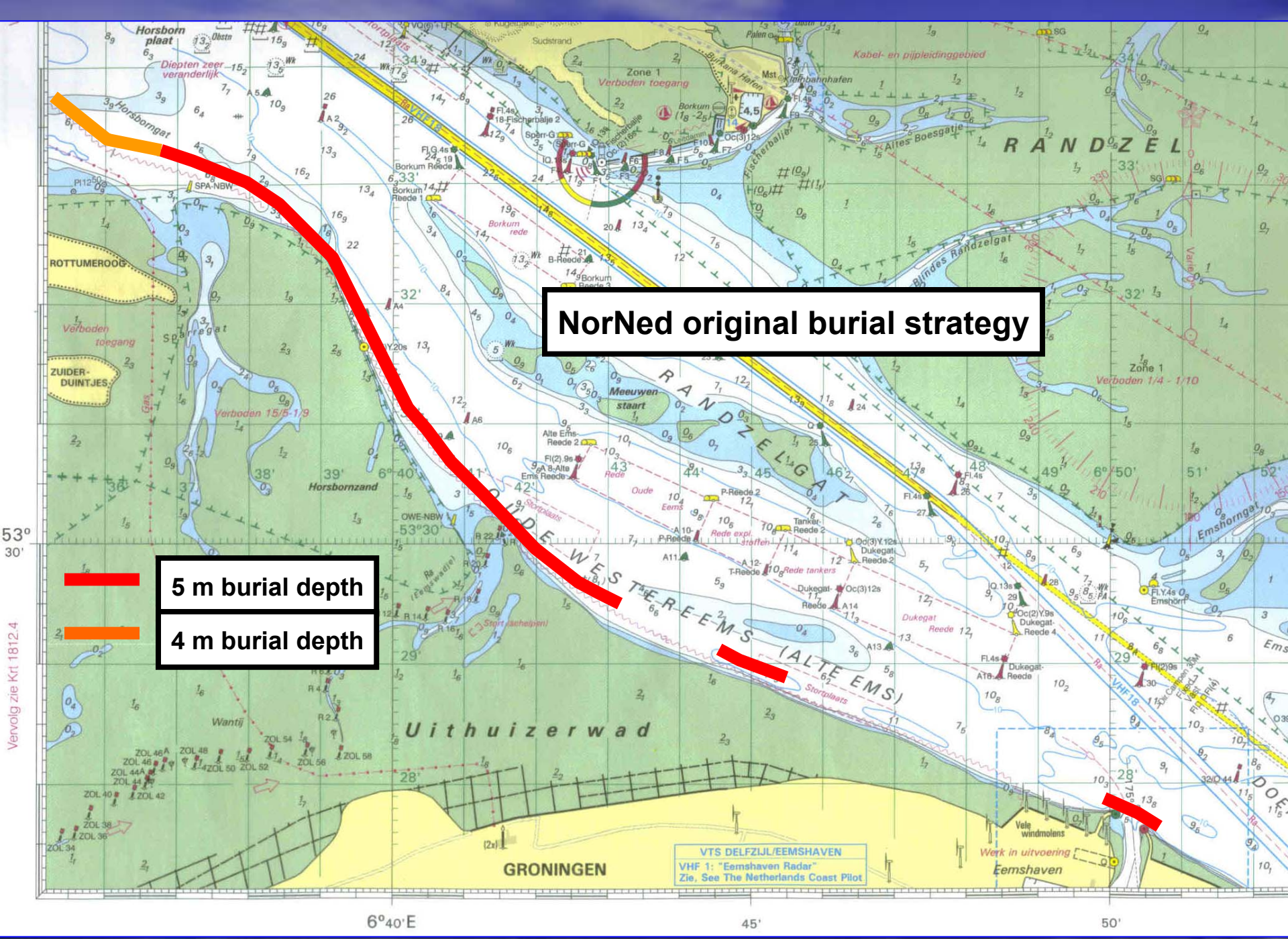

NorNed original burial strategy
5 m burial depth
Horsborn plaat
Diepten zeer veranderlijk
Horsborngat
ROTTUMEROOG
ZUIDER-DUINTJES
Verboden toegang
Verboden 15/6-1/9
Horsbornzand
Meeuwen-staart
RANDZELGAT
Oude Eems
Alte Ems-Reede 2
Alte Ems Reede
P-Reede 2
Tanker-Reede 2
Dukegat-Reede 2
Dukegat-Reede 4
Dukegat Reede
Rede tankers
Rede expl. storten
Zone 1 Verboden toegang
Zone 1 Verboden 1/4 - 1/10
Kabel- en pijpleidinggebied
Alles Boesgatje
Blindes Randzelgat
Emshorngat
Emshörn
Borkum Reede
Borkum Reede 1
Borkum Reede 2
Borkum rede
B-Reede 3
Fischerbalje
18-Fischerbalje 2
Sperr-G
Sudstrand
Buitenhaven
Mst
Kleinbahnhafen
SPA-NBW
OWE-NBW
Wantij
ZOL 54
ZOL 56
ZOL 58
ZOL 46
ZOL 48
ZOL 50
ZOL 52
ZOL 44
ZOL 42
ZOL 40
ZOL 38
ZOL 36
ZOL 34
Uithuizerwad
GRONINGEN
VTS DELFZIJL/EEMSHAVEN
VHF 1: "Eemshaven Radar"
Zie, See The Netherlands Coast Pilot
Vele windmolens
Werk in uitvoering
Eemshaven
Stortplaats
Ra VHF 18
Vervolg zie Krt 1812.4
53° 30'
6°40'E
45'
50'


NorNed original burial strategy
5 m burial depth
4 m burial depth
Horsborn plaat
Diepten zeer veranderlijk
Horsborngat
Sudstrand
Zone 1
Verboden toegang
Kabel- en pijpleidinggebied
Alles Boesgatje
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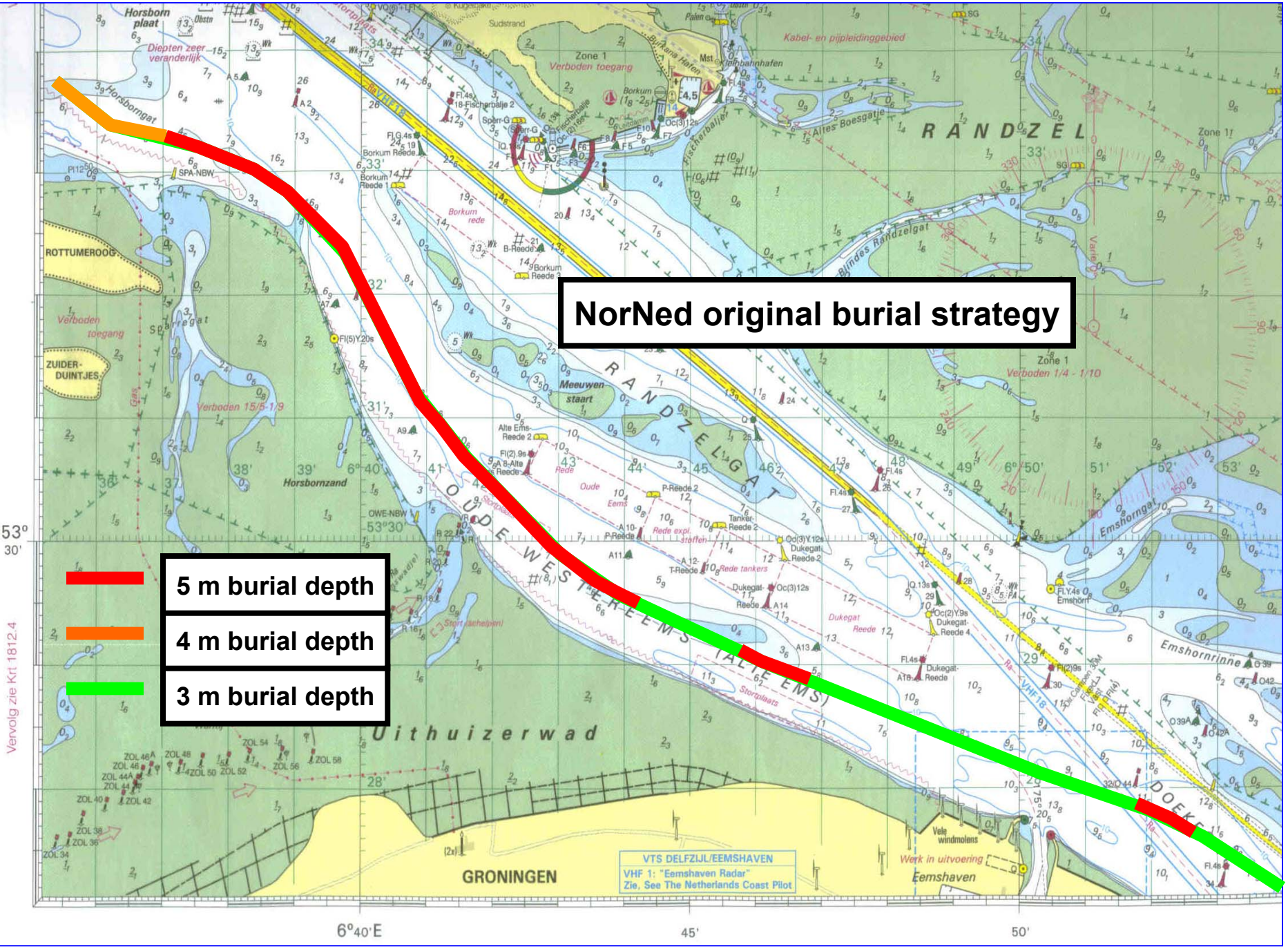
NorNed original burial strategy
5 m burial depth
4 m burial depth
3 m burial depth
Horsborn plaat
Diepten zeer veranderlijk
Horsborngat
ROTTUMEROOG
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Zie, See The Netherlands Coast Pilot
Vervolg zie Krt 1812.4
53° 30'
6°40'E
45'
50'

OPTIONS FOR BURIAL OF THE CABLE

- Combination of dredging and post-trenching
  1. Areas with 5m burial: 2m dredging + 3m post-trenching
  2. Areas with 4m burial: 1m dredging + 3m post-trenching
  3. Areas with 3m burial: no dredging + 3m post trenching
- Post-trenching to a depth of 3, 4 and 5m

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Final Decision

- BASE CASE: Combination of Dredging and 3m deep Post-Trenching
- ALTERNATIVE, proposed by JV: Post-Trenching only

COMPANY REQUESTED THAT FEASIBILITY OF 5m DEEP POST-TRENCHING SHOULD BE PROVEN

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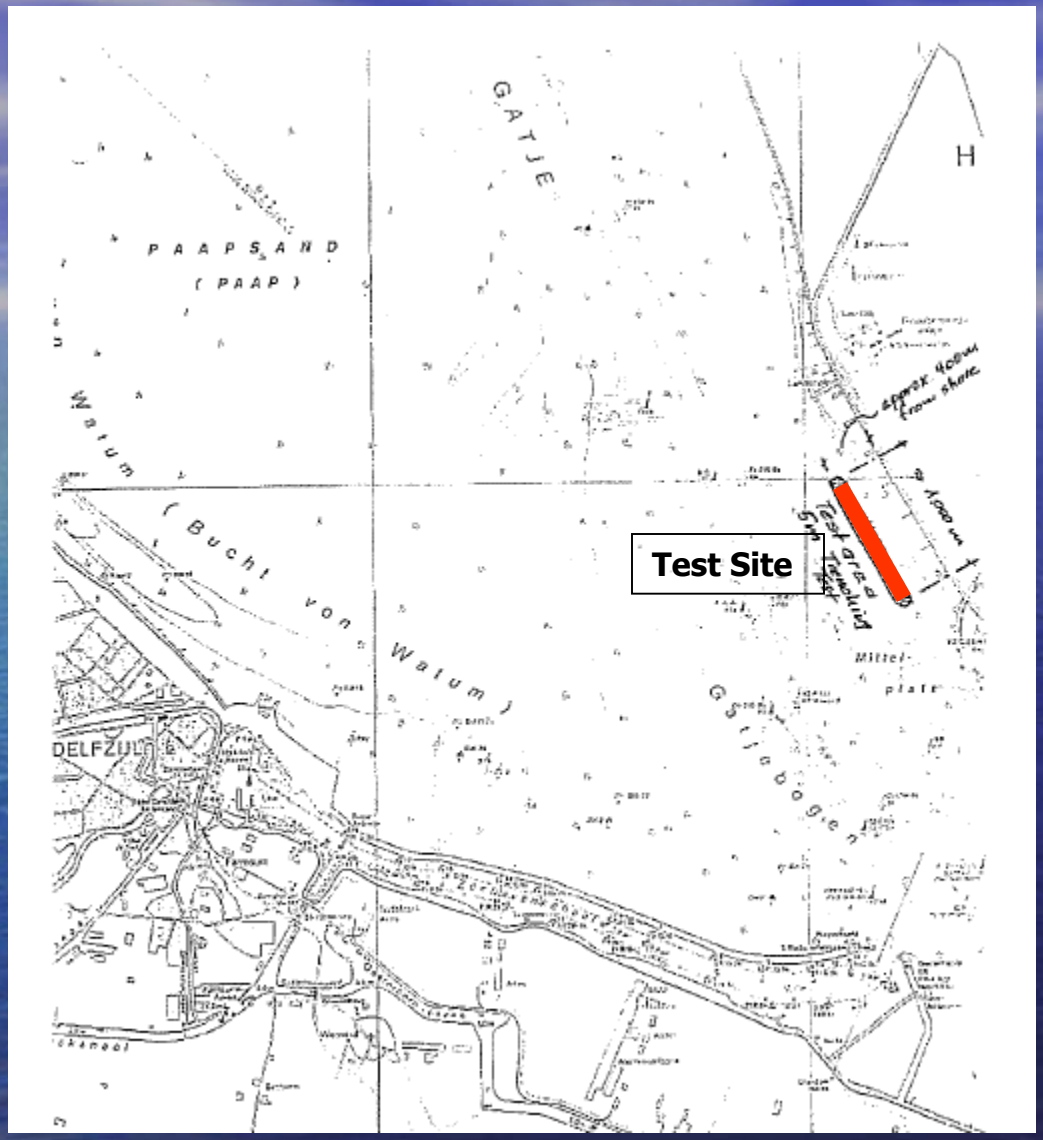

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5m deep
Post-Trenching Jet Sled


5m deep
Post-Trenching Jet Sled
TS
LER HU 12

The HVDC 450kV bi-pole NorNed Kabel (Transport Capacity 700 MW)

Width: 217mm; Height: 136mm; Weight in air: 90 kg/m


5m Burial Sled

UPDATED MORPHOLOGY ASSESSEMENT WITH MOST RECENT RIJKSWATERSTAAT INFORMATION by ACRB (Romke Bijker)

- Tendency of sedimentation in eastern direction clearly demonstrated
- Bijker concluded that in the actual situation the risk of re-trenching was not higher with 3m deep post-trenching than previously assumed for 5m deep post-trenching
- A few weeks ago we were informed that Authorities accept 3m burial

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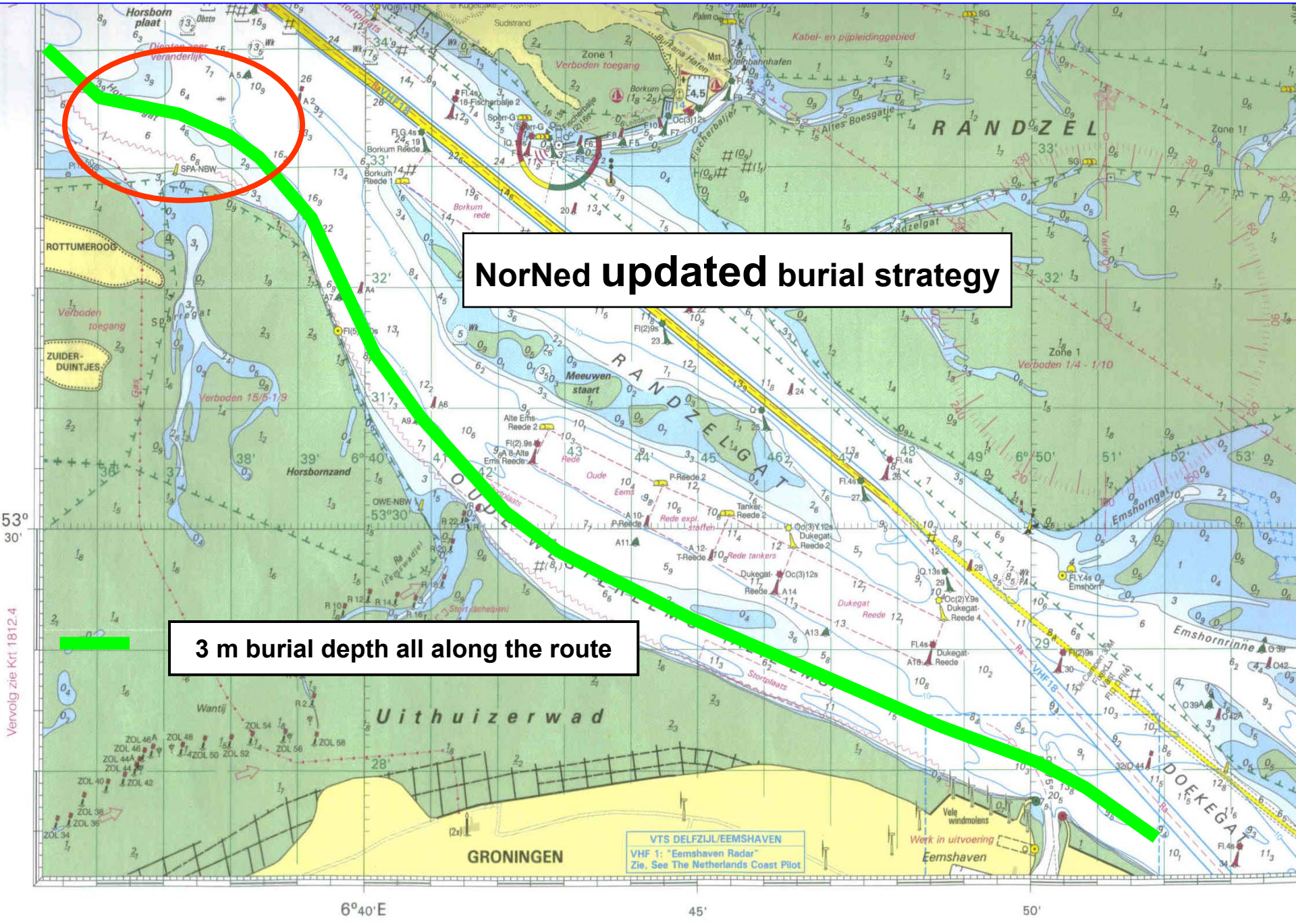
NorNed updated burial strategy
3 m burial depth all along the route
RANDZEL
RANDZELGAT
Uithuizerwad
GRONINGEN
Eemshaven
ROTTUMEROOG
ZUIDER-DUINTJES
Horsborn plaat
Horsbornzand
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Borkum Reede
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Alte Ems-Reede 2
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P-Reede 2
Tanker-Reede 2
Dukegat-Reede 2
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Altes Boesgatje
Vervolg zie Krt 1812.4
53°30'
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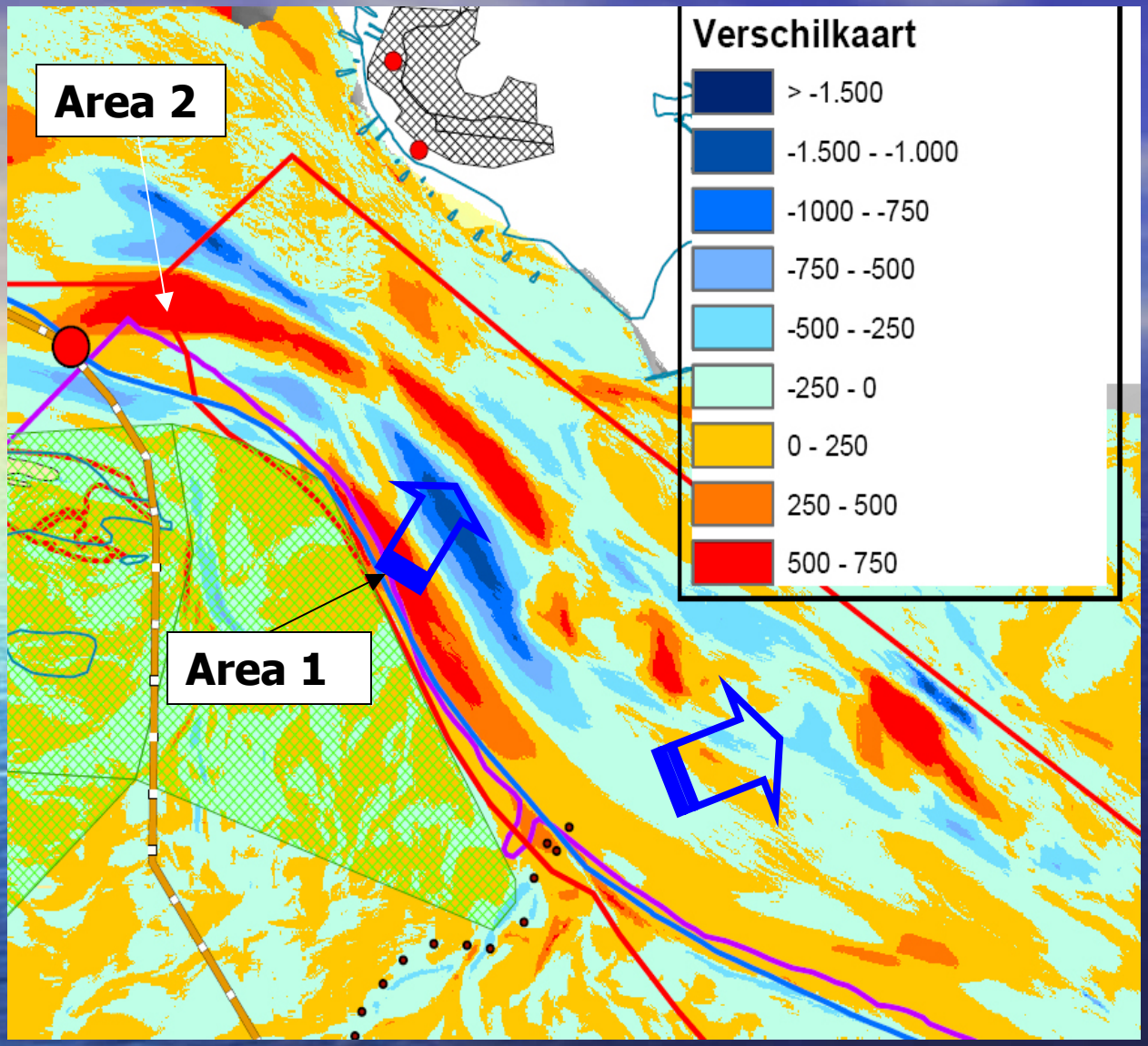
MORPHOLOGY / SEABED MOBILITY



Difference plot between 1995 and 2001 seabed:
Red: sedimentation (shallower)
Blue: erosion (deepening)

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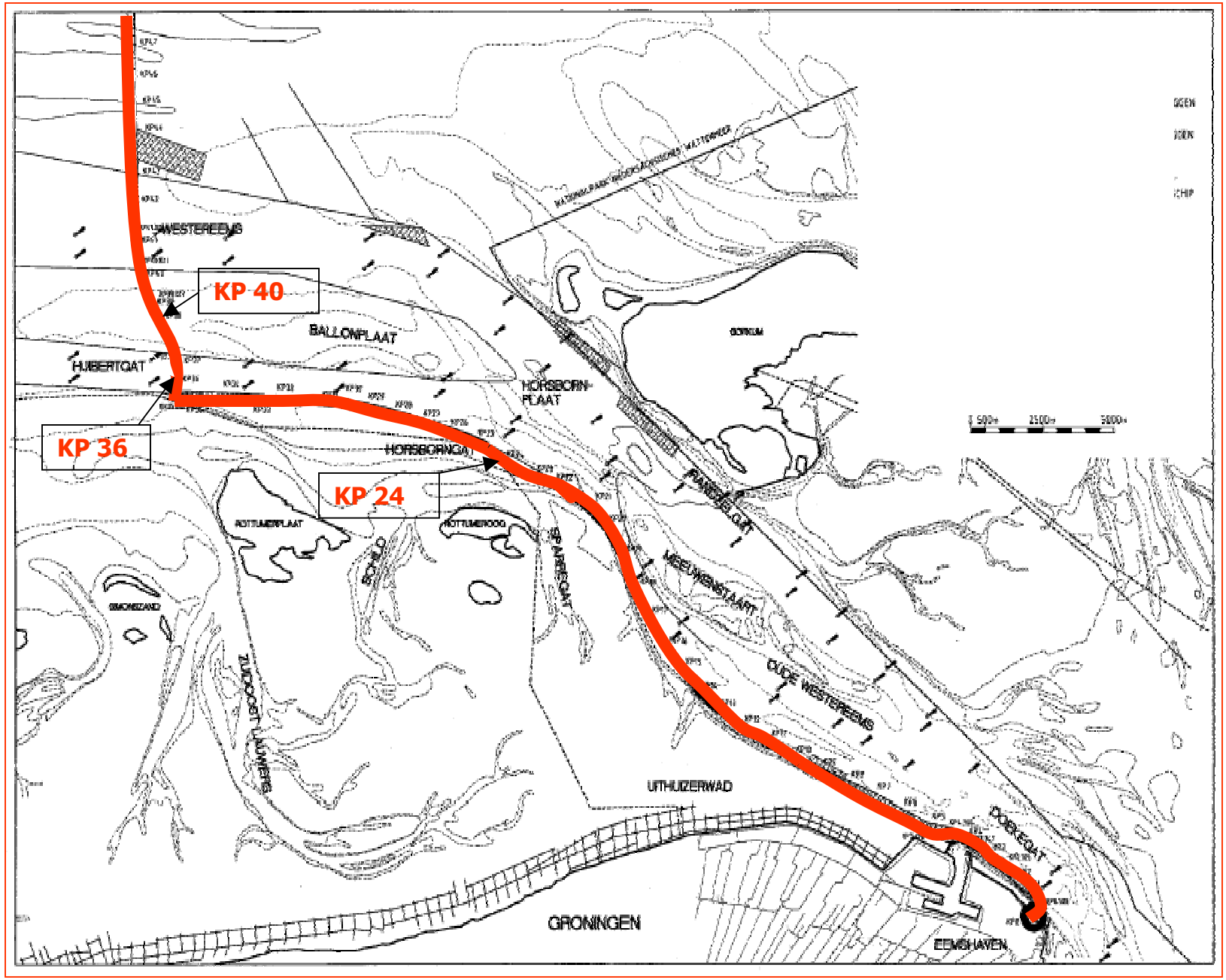
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2005 SURVEY RESULTS

Location	Water Depths in m below MSL	
	Route Update Report 1999	OSAE Survey 2005
KP 15	11	7.5
KP 15.5	11	8
KP 16	11.8	8
KP 16.5	12.3	8.5
KP 17	13.5	8.5
KP 17.5	14.5	8.5
KP 18	14.6	7.5
KP 18.5	14.1	6.5
KP 19	13	4
KP 19	13	4
KP 19.5	10	4
KP 20	6	6
KP 20.3	4	8
KP 20.5	6	8
KP 21	8	9

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CONSEQUENCES OF SURVEY 2005

- Local dredging required for access of Cable Lay Vessel
- Several areas where the cable has to be laid with floaters and pushed laterally to its final position before lowering to the seabed

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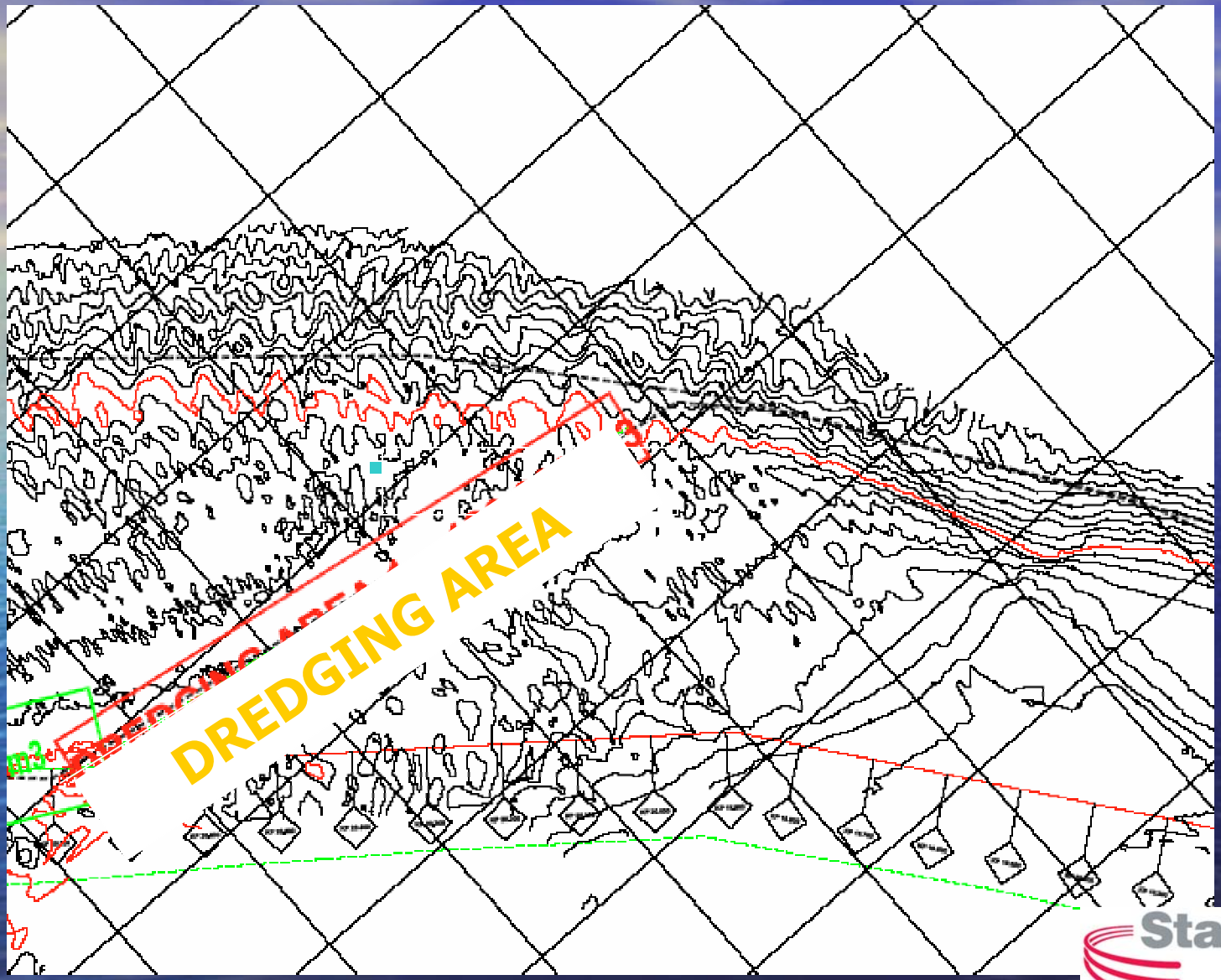

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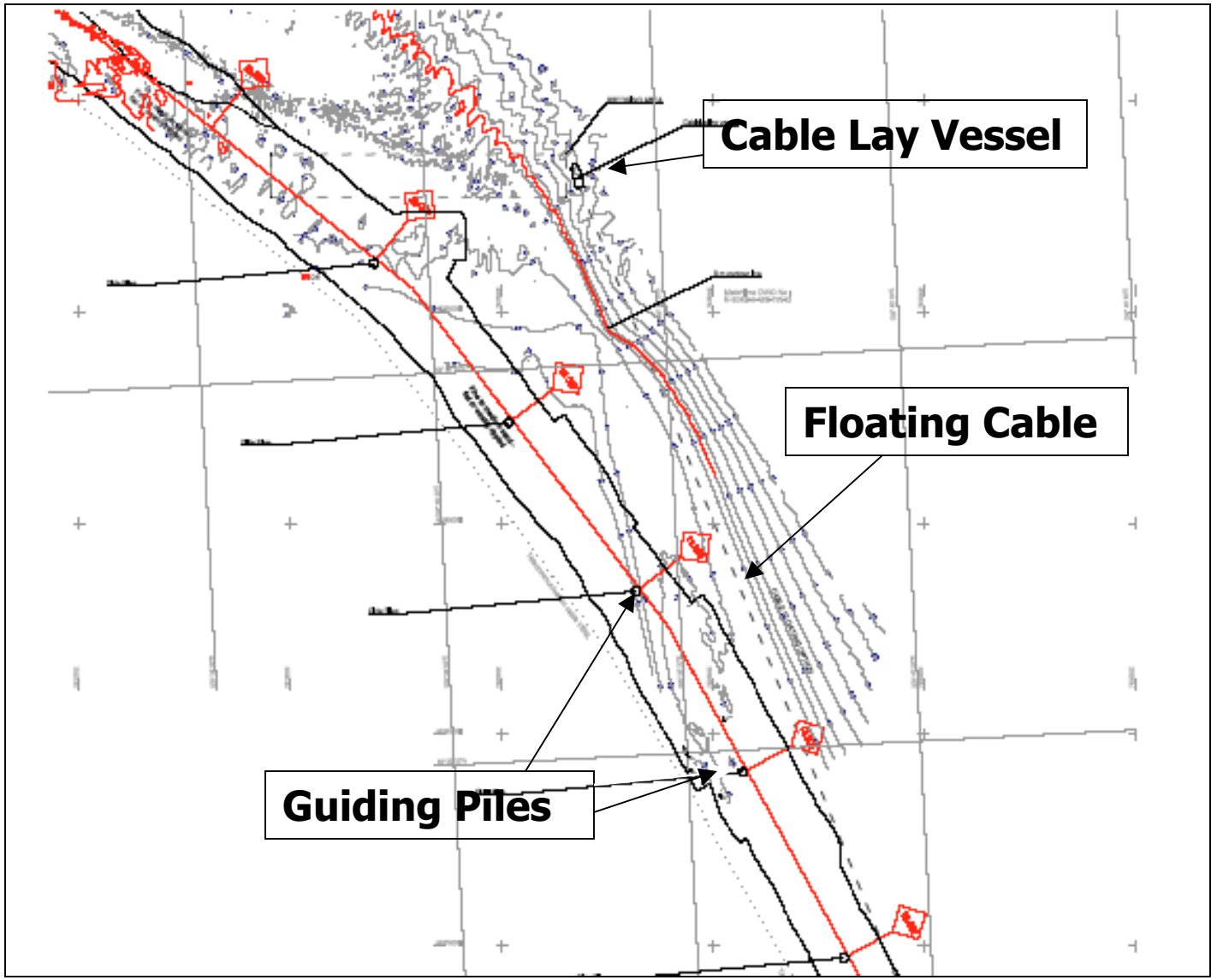

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HVDC Kabel with Floaters

Tested during Sea Trials in October 2005

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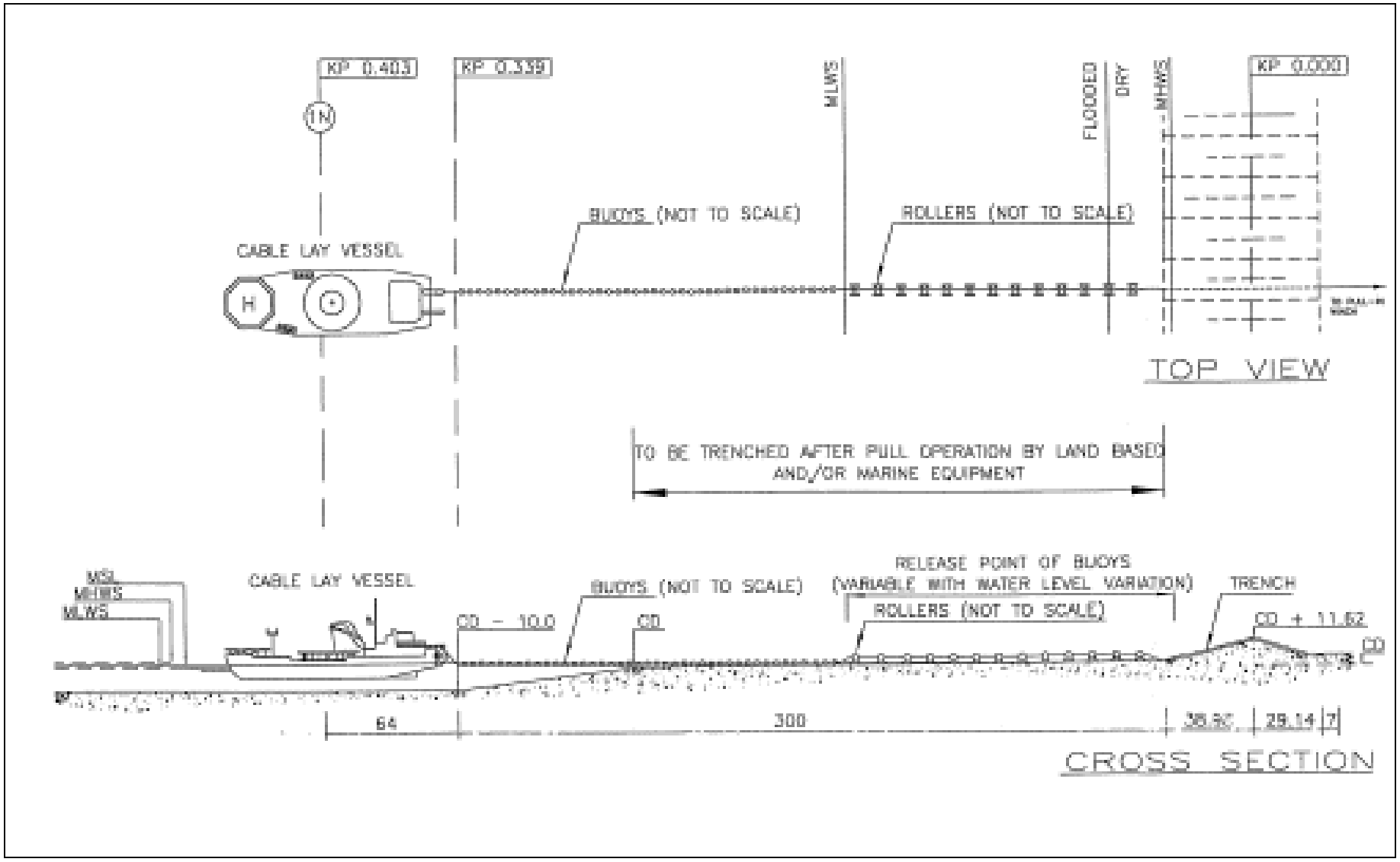

LANDFALL EEMSHAVEN

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MAIN FEATURES FOR WADDENZEE INSTALLATION

ENGINEERING OF NORNED HVDC KABEL

- Engineer the installation by Floating Cable Installation
- Determine dredging required for Cable Lay Vessel Navigation
- Do Pre-Lay Survey short before cable installation to update seabed levels just before installation
- Engineer the Eemshaven Landfall

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