

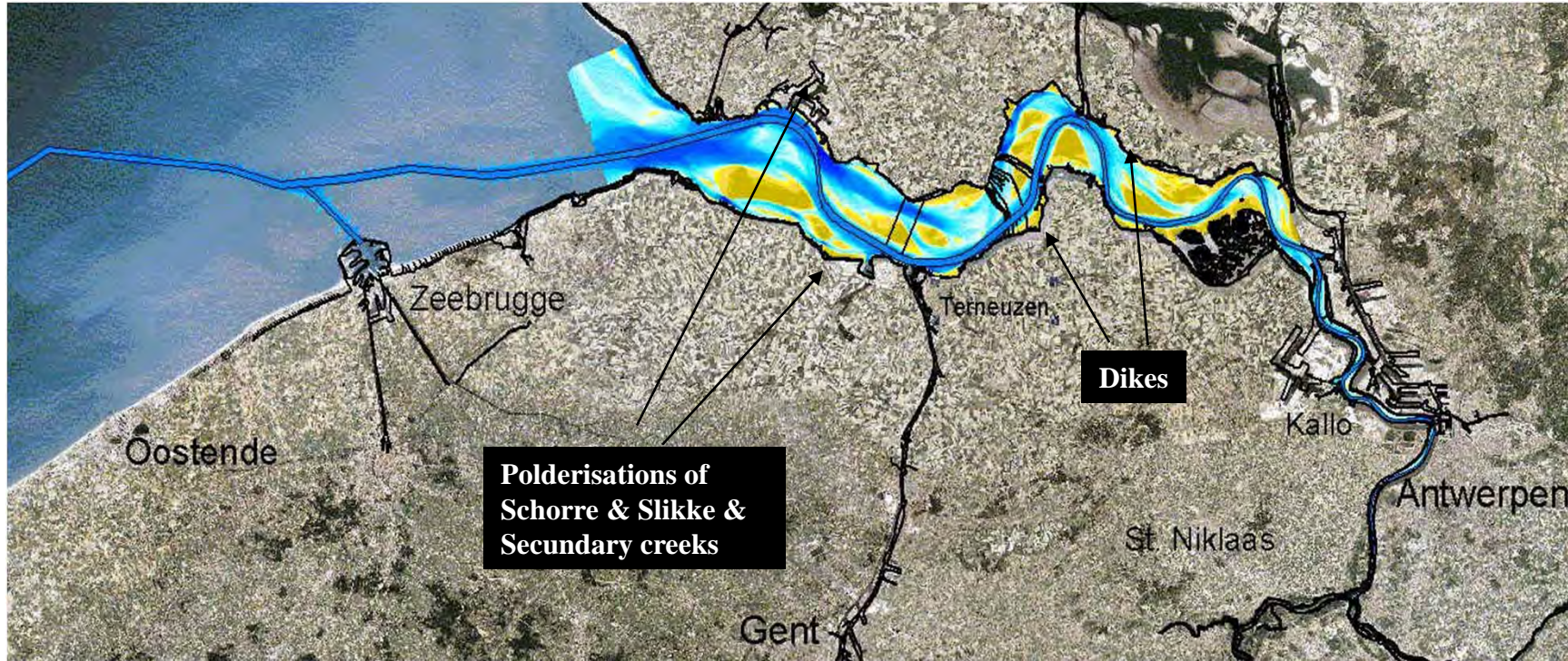


DREDGING AND MARITIME CONSTRUCTION

INTRODUCTION
by

ir Bernard Malherbe
Director Project Development Jan De Nul Group

Western Scheldt Estuary: a creek-system that evolved towards an estuarium with heavy traffic (> 60.000 channel-bound ship movements per year)



Dredging on shoal-crossing bars



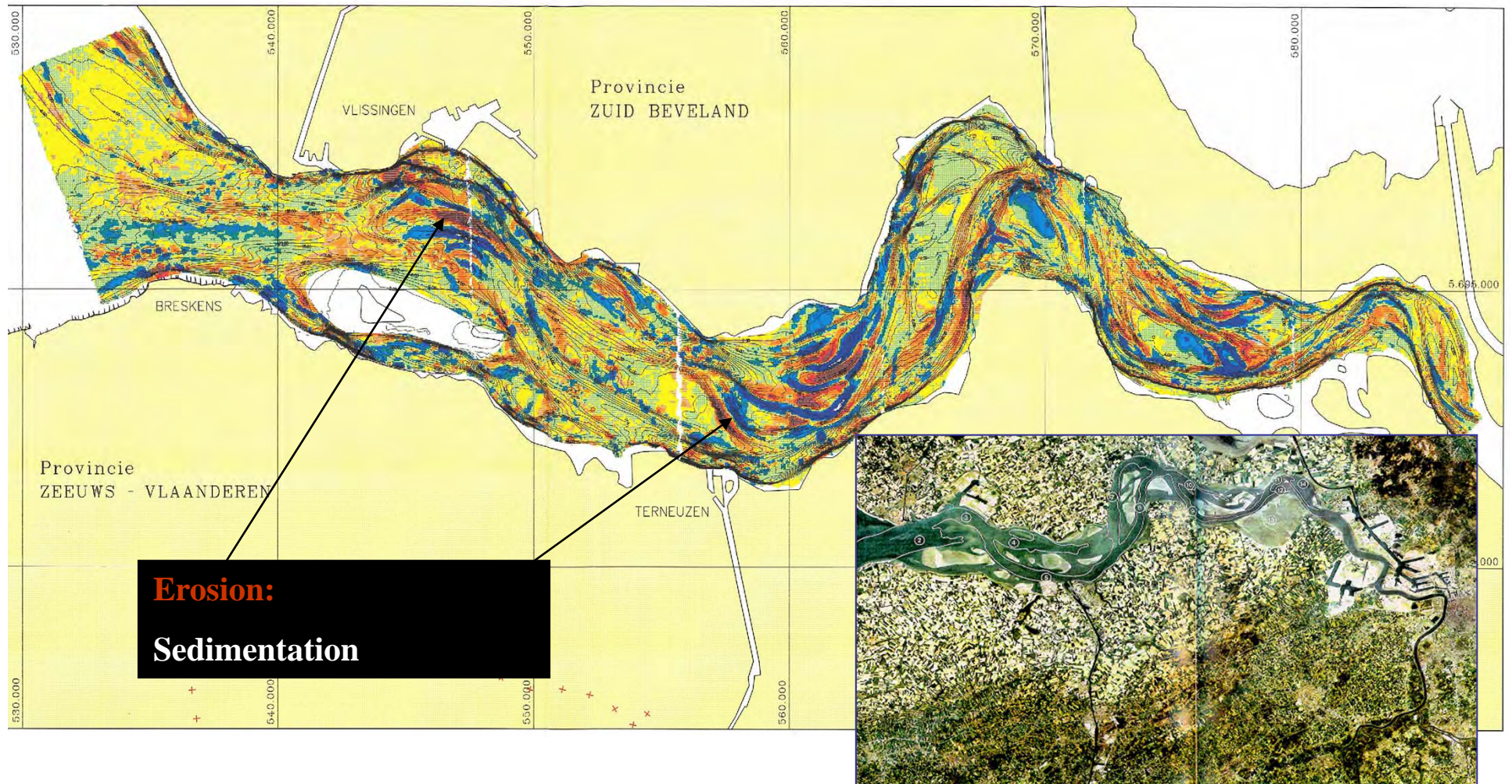
MAINTENANCE DREDGING



Maintenance and Deepening Works in the Western Scheldt
and the Scheldt Estuary - Belgium | 2006-2013

Dredging: sand 13,000,000 m³/year, silt 1,500,000 m³/year | Reclamation: 13,500,000 m³

Analysis of morphological changes of the estuary bed (1992-1994) in a period with no deepening dredging works (ref HAECON 1996)





TSHD “Alexander von Humboldt” dredging Port of Zeebrugge



Port extension of Zeebrugge: Engineering Design and Construction of Rubble Mound Breakwaters

Design: 1976 – 1982

Construction: 1980 – 1986

Investment: 1,75 bn Euros

Port of Zeebrugge (1906), anno 1970



Port of Zeebrugge , anno 1988





TSHD “Alexander von Humboldt” reclaiming Port area West, Zeebrugge





Port extension of Zeebrugge: Engineering Design and Construction of Rubble Mound Breakwaters

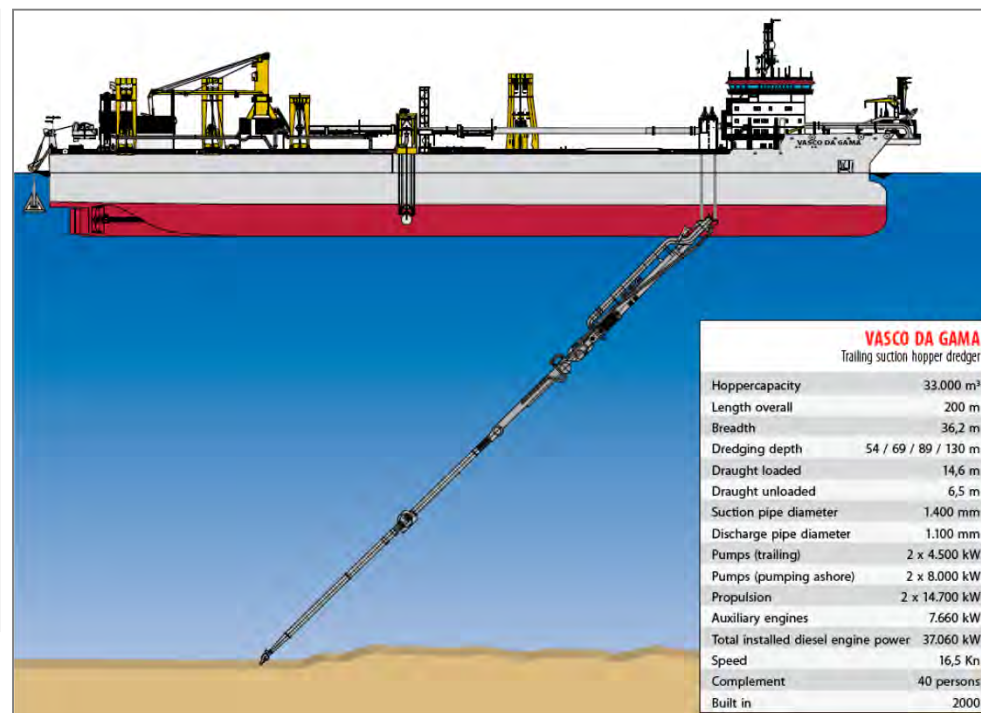
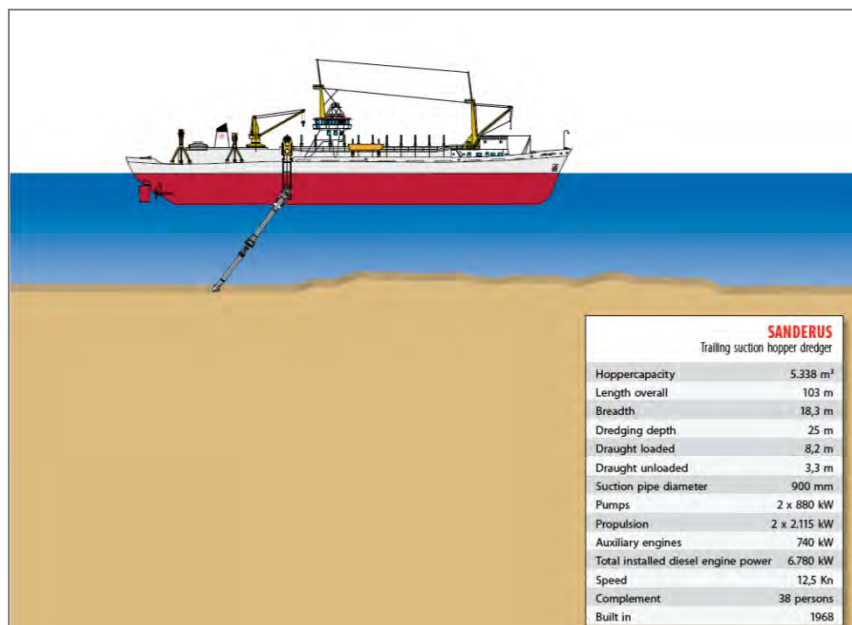
Port of Zeebrugge , anno 1988



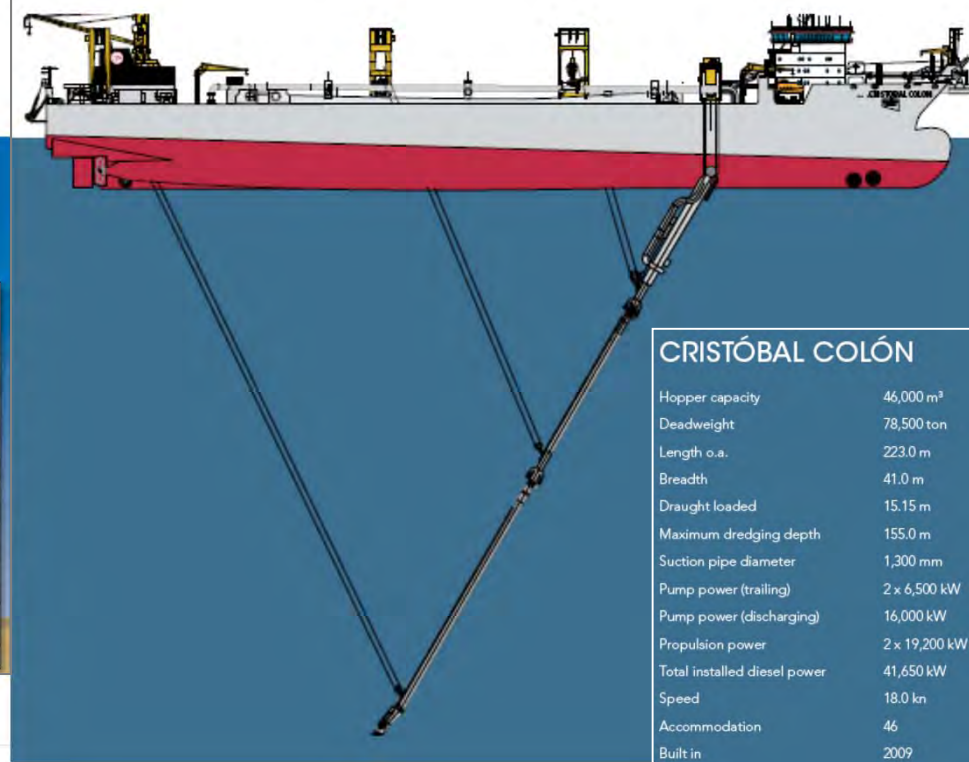
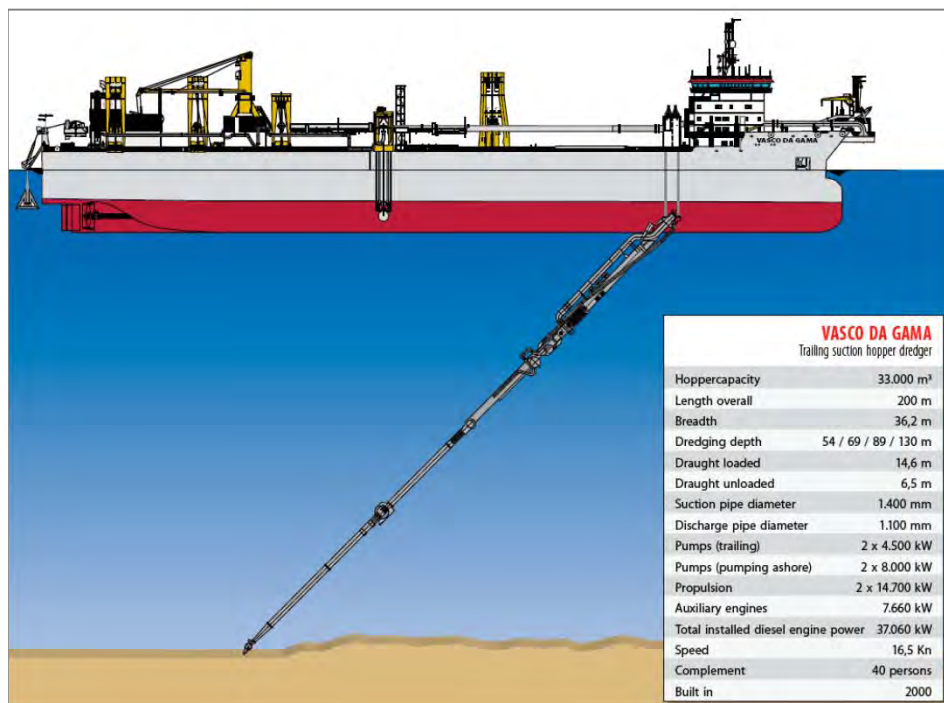
Port of Zeebrugge , anno 2003



TSHD “Sanderus” (1968) vs. TSHD “Vasco da Gama” (2000)



TSHD “Sanderus” (1968) vs. TSHD “Vasco da Gama” (2000)



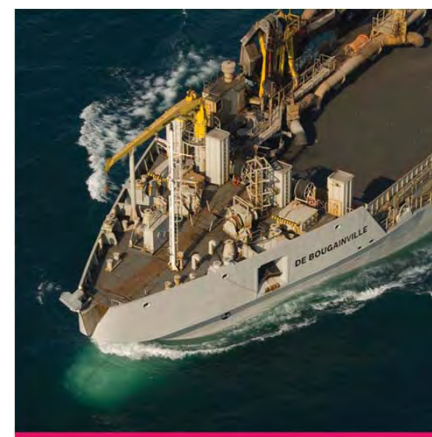
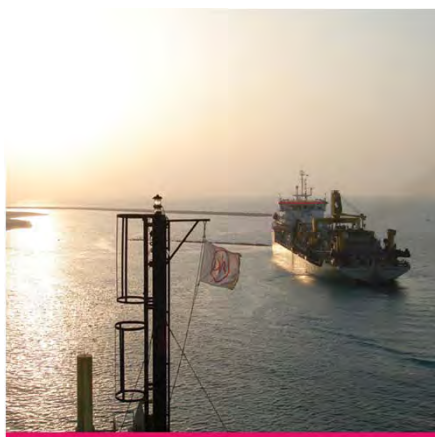


TRAILING SUCTION HOPPER DREDGERS

- Dredging loose material: sand, clay or gravel
- Suction tubes with drag head
- Stored in the 'hopper' of the vessel
- Dump the material through bottom doors
- Rainbowing technique
- Floating pipeline technique
 - Vasco da Gama
 - Cristóbal Colón
 - James Cook...



WORKING PRINCIPLES





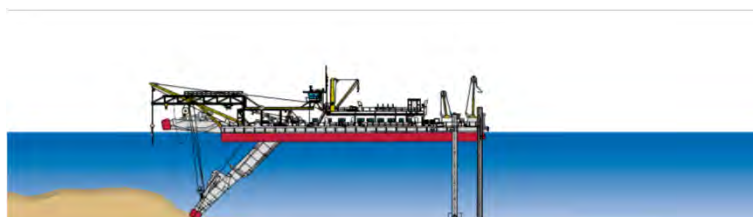
TRAILING SUCTION HOPPER DREDGERS



JDN 8035

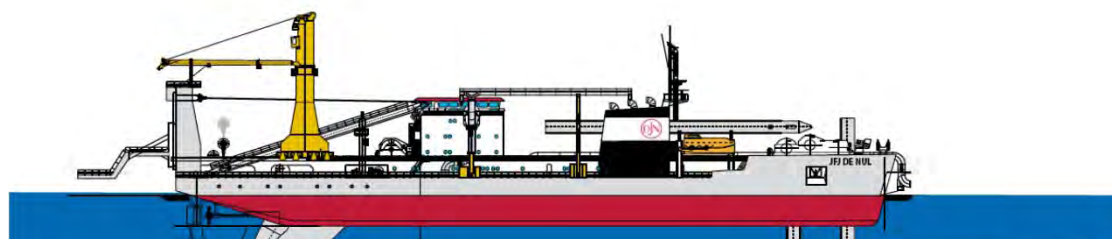


CSD “Ortelius” (1965) vs CSD “JFJ De Nul” (2003)



ORTELIUS	
Cutter suction dredge	
Length overall	81 m
Length overdeck	42,5 m
Breadth	12 m
Depth	3,75 m
Draught	2,2 m
Dredging depth	20 m
Suction pipe diameter	800 mm
Discharge pipe diameter	800 mm
Cutterpower	885 kW
Submerged pump	960 kW
Inboard pumps	2.575 kW
Total installed diesel engine power	5.140 kW
Built in	1965 / 1978

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JFJ DE NUL	
Self-propelled cutter suction dredger	
Length overall	140,5 m
Length overdeck	120,5 m
Breadth	27 m
Depth	8,8 m
Draught	5,5 m
Dredging depth	35 m
Suction pipe diameter	1.000 mm
Discharge pipe diameter	1.000 mm
Barge-loading pipes diameter	1.000 mm
Cutterpower	6.000 kW
Submerged pump	3.800 kW
Inboard pumps	2 x 6.000 kW
Propulsion	2 x 3.800 kW
Total installed diesel engine power	27.240 kW
Speed	11,5 Kn
Complement	60 persons
Built in	2003

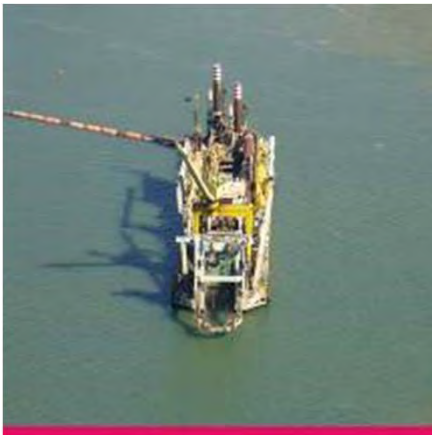
Jan De Nul GROUP
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CUTTER SUCTION DREDGERS

- Stationary
- Rotating cutter head
- Dredge pumps
- Pumped ashore using pumps and a floating pipeline
- Loaded into a split hopper barge moored alongside
 - J.F.J. De Nul
 - Leonardo Da Vinci
 - Ibn Battuta...



WORKING PRINCIPLES





J.F.J. De Nul

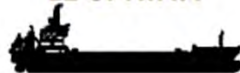


SPLIT HOPPER BARGES

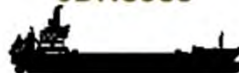
L'AIGLE



LE SPHINX



JDN8583



MAGELLANO



VICTORIA



LA BOUDEUSE



ASTROLABE



JDN8584



CONCEPCIÓN



GEELVINCK



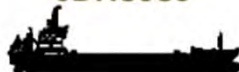
L'ETOILE



BOUSSOLE



JDN8585



SANTIAGO



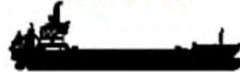
NIJPTANGH



LE GUERRIER



JDN8582



VERRAZZANO



TRINIDAD



WESELTJE





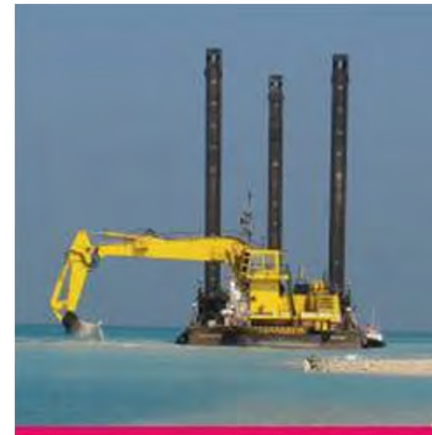
L'Aigle | La Boudeuse | L'Etoile | Le Guerrier | Le Sphinx

BACKHOE DREDGERS

- Common type of dredger, generally non-self propelled.
- Hydraulic excavator, performing the dredging operation
- Mounted on a pontoon stabilized by means of spuds.
 - Vitruvius
 - Mimar Sinan
 - Jerommeke...



WORKING PRINCIPLES

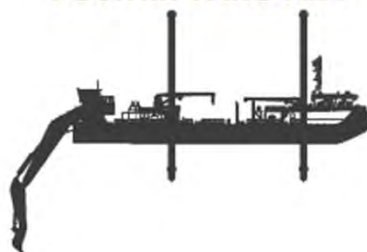


BACKHOE DREDGERS

VITRUVIUS



POSTNIK YAKOVLEV



JEROMMEKE



MIMAR SINAN



IL PRINCIPE





Vitruvius

SUB SEA ROCK INSTALLATION

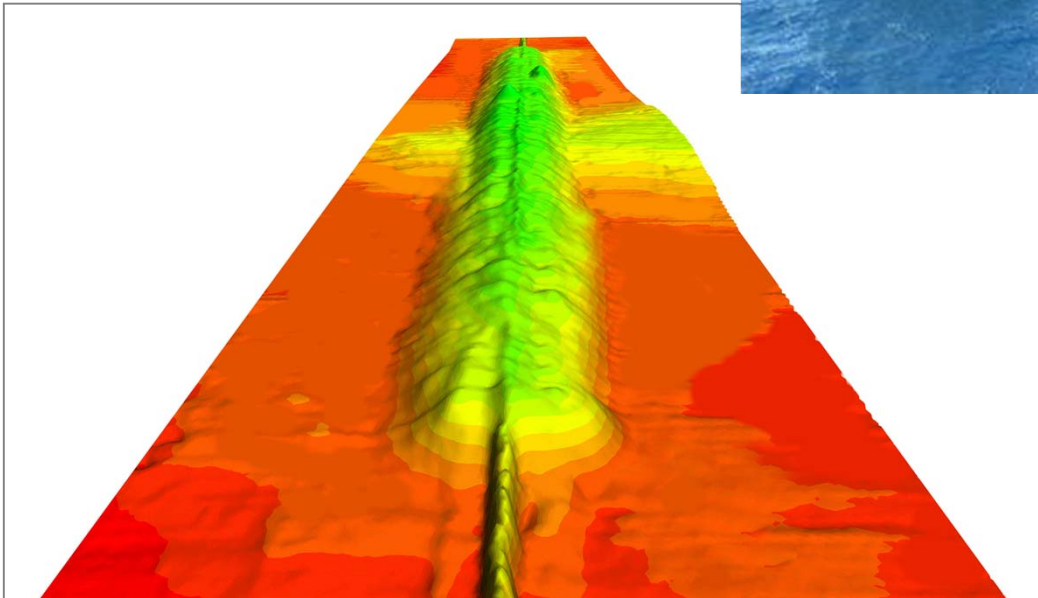
- Side Dumping Vessel
 - Willem De Vlamingh
 - Pompei
- Stone Dumping through Fall Pipe
 - Simon Stevin
 - La Boudeuse





La Boudeuse | Dynamic Positioned Flexible Fall Pipe Vessel

Simon Stevin on Pluto
Pipeline Cover Work,
Australia



Hong Kong: Chek Lap Kok Airport



Key Figures:

Client : Provisional Airport Authority

Surface of land to create : 1.510 ha

Volume of reclamation: 198 Mm³

Length of Breakwater : 10.200 m'

Period: 1992 – 1996

Investment : 1.159 M \$

Chek Lap Kok island in Pearl River estuary



Hong Kong: Chek Lap Kok Airport



Preliminary earth-moving works



Hong Kong: Chek Lap Kok Airport

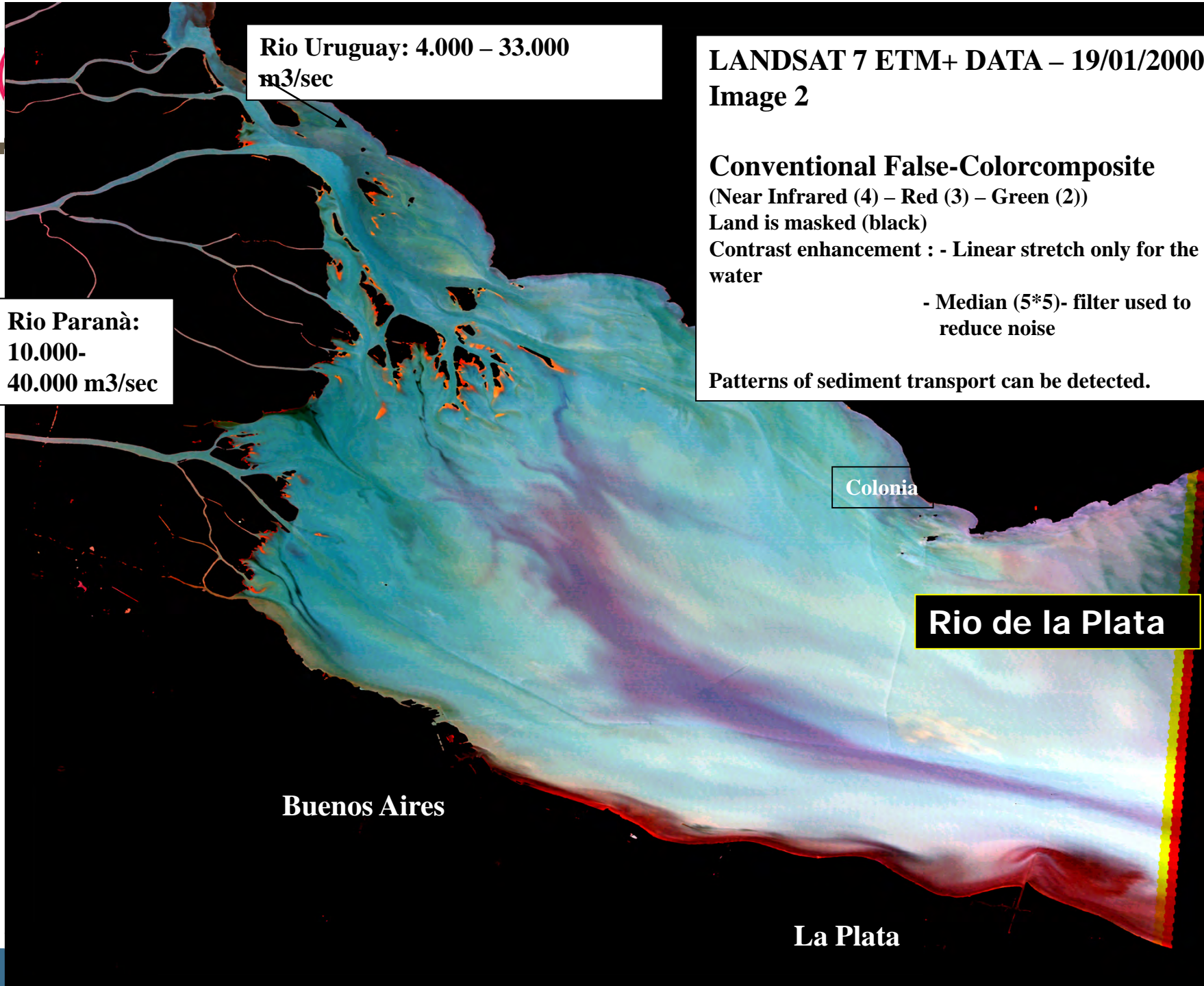


HIDROVIA S.A.

A Unique Project: the concession for capital dredging, maintenance dredging, buoyage and toll of more than 700 km of waterways

Welcome to Argentina and the mother of all estuaries: the Rio de la Plata





Rio Uruguay: 4.000 – 33.000 m³/sec

Rio Paranà: 10.000-40.000 m³/sec

**LANDSAT 7 ETM+ DATA – 19/01/2000
Image 2**

Conventional False-Colorcomposite

(Near Infrared (4) – Red (3) – Green (2))

Land is masked (black)

Contrast enhancement : - Linear stretch only for the water

- Median (5*5)- filter used to reduce noise

Patterns of sediment transport can be detected.

Colonia

Rio de la Plata

Buenos Aires

La Plata



TSHD Captan Nuñez maintenance dredging



CSD Marco Polo widening the Paranà River



HIDROVIA Waterway Concession

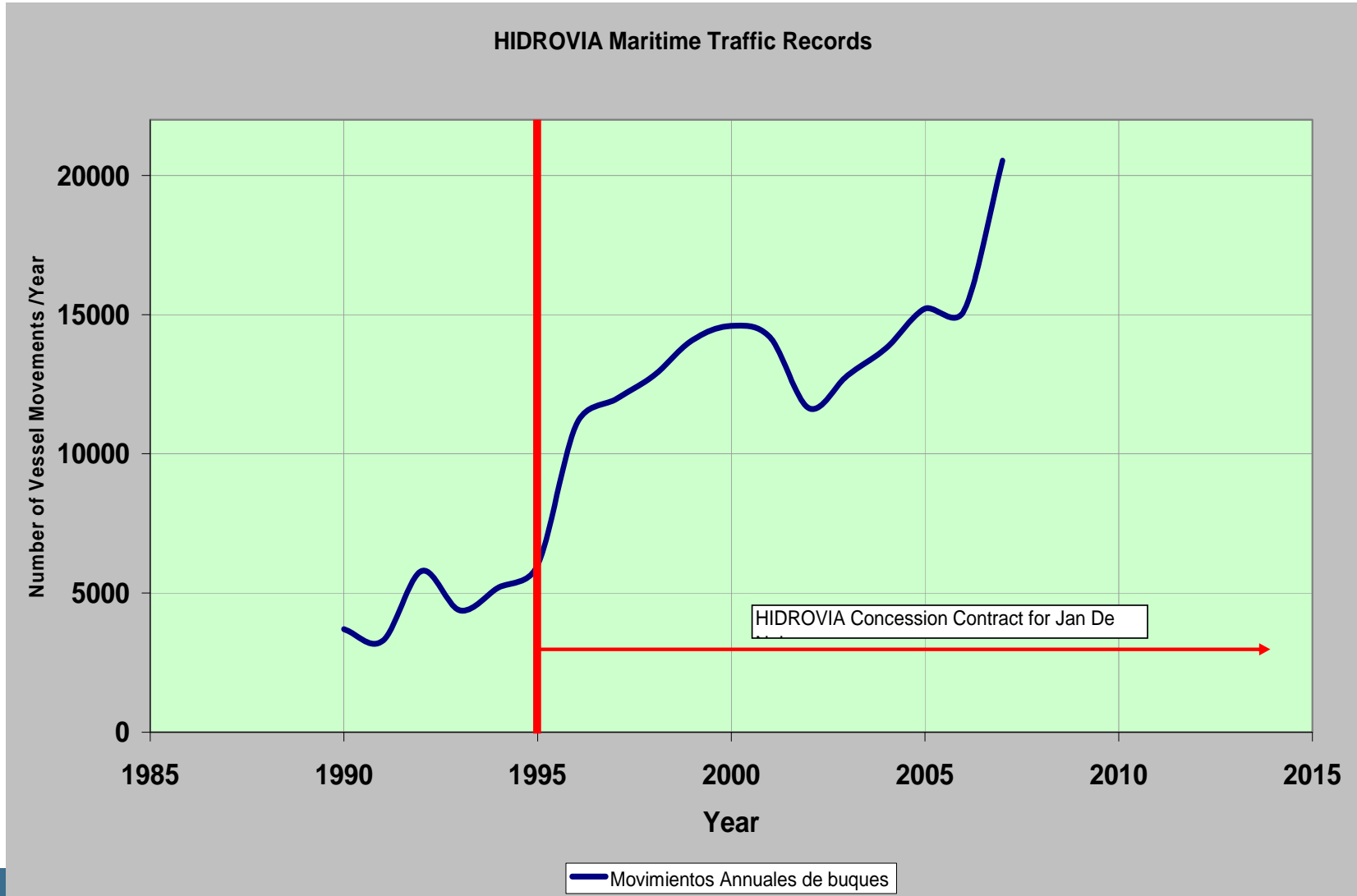
- Cereals and derivates

	1995	2005	Growth
Area Fields	21 Mill Ha	40 Mill ha	90%
Production	40 Mill ton	70 Mill ton	75%
Exported via Hidrovia	21 Mill ton	45 Mill ton	114%
Export river/total country	70%	80%	
Total export Argentina	27 Mill ton	50 Mill ton	86 %

- Containers

	1995	2005	Growth
TEU movement Buenos Aires	750.000 teu	1.100.000 teu	47%

Rio de la Plata before and after implementation of Hidrovia project





Montevideo Access Channel Dredging - Uruguay | 2005-2008

Singapore: Reclamation of Pulau Ubin and Pulau Tekong Islands



Key Figures:

Client : Housing and Development Board

Surface of land to create : 1.480 ha

Volume of Sand to reclaim: 164 Mm³

Length of Breakwater : 14.800 m'

Period: 2000 – 2005

Investment : 850 M €



Area A- at Pulau Tekong Kechil, June 2002



*Area D1, November 2001
Southern part of Pulau Tekong*



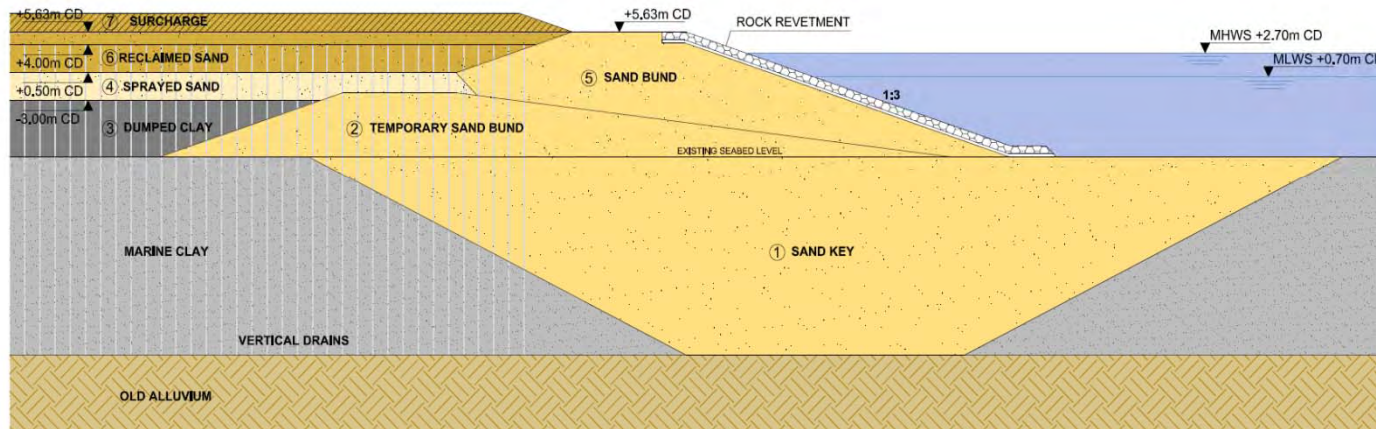
TSHD “Vasco da Gama” reclaiming at Pulau Ubin Tekong, Singapore

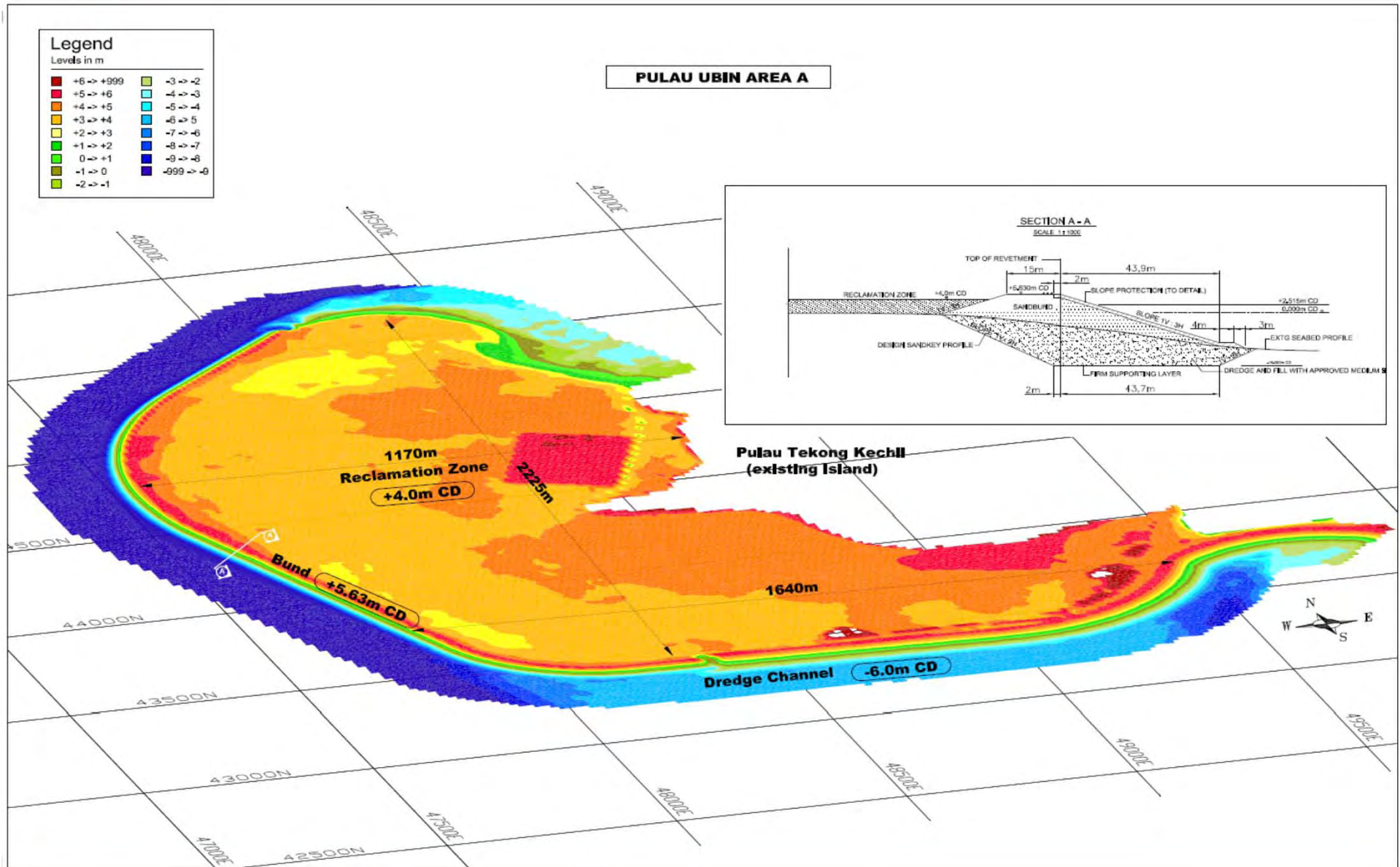




Design Elements:

- Storm Surge level: CD + 3m
- Natural waterdepths: CD- 2 to -20m
- Design Wave Height: $H_s = 0,6$ m
- Design Wave Period : $T_m = 2,9$ sec
- $V_{curr} = 1,5$ m/sec





Dubai, Palm Jebel Ali Island

Key Figures:

Client : Nakheel, Dubai World
Surface of land to create : 950 ha
Volume of Sand to reclaim: 155 Mm³
Length of Breakwater : 17.000 m'
Rock volume breakwaters: 5 Mm³
Period: 2004 – 2008
Investment : 735 M €

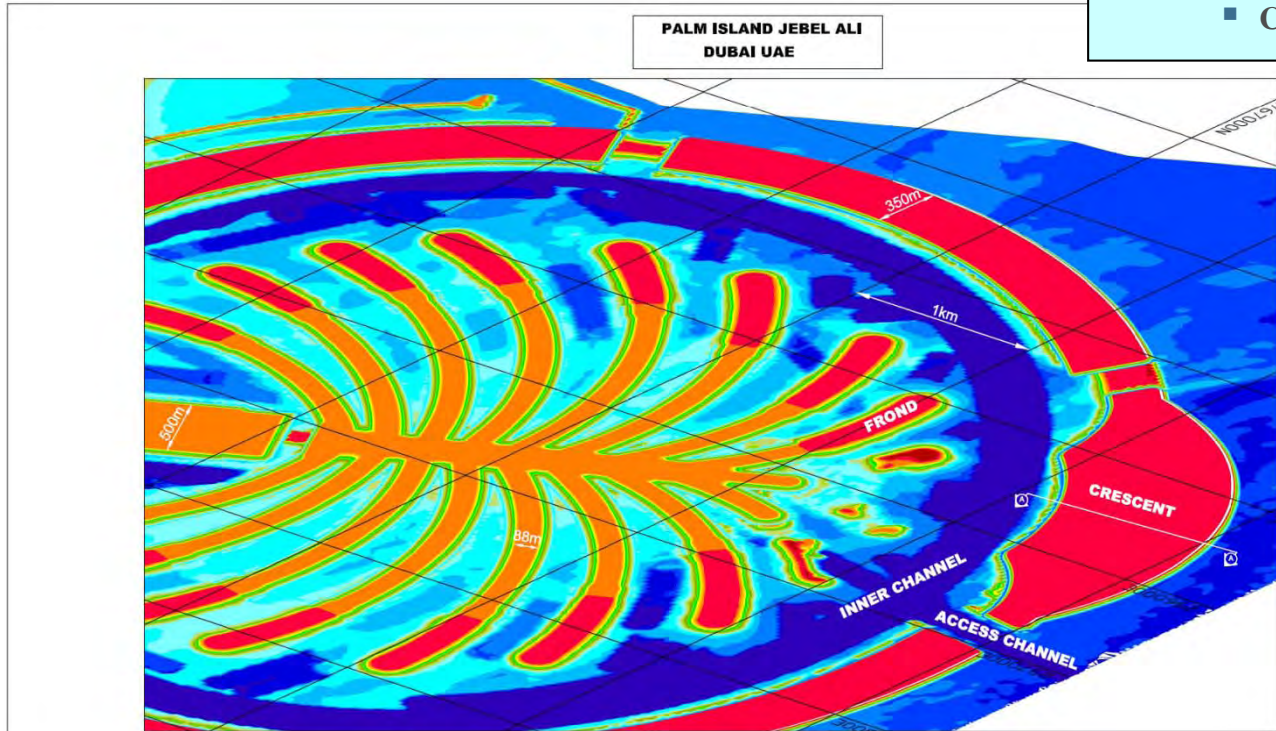


December 2004



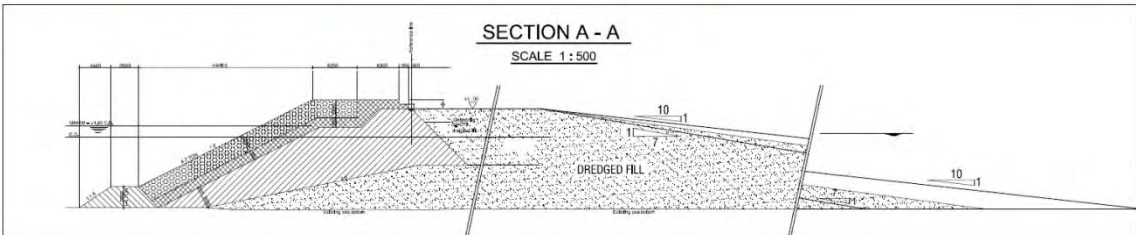
August 2008

- **Design Elements of Breakwaters:**
 - Storm Surge level: DMD + 2,85/ 2,70 m
 - Natural waterdepths: CD- 5 to - 8 m
 - Design Wave Heighth: $H_s = 4,3 - 3,2$ m
 - Design Wave Period : $T_m = 10,4$ sec
 - Currents = $v_{max} = 1$ m/sec



Legend
Levels in m

>> +6	-3 -> -2
+5 -> +6	-4 -> -3
+4 -> +5	-5 -> -4
+3 -> +4	-6 -> -5
+2 -> +3	-7 -> -6
+1 -> +2	-8 -> -7
0 -> +1	-9 -> -8
-1 -> 0	-9 >
-2 -> -1	



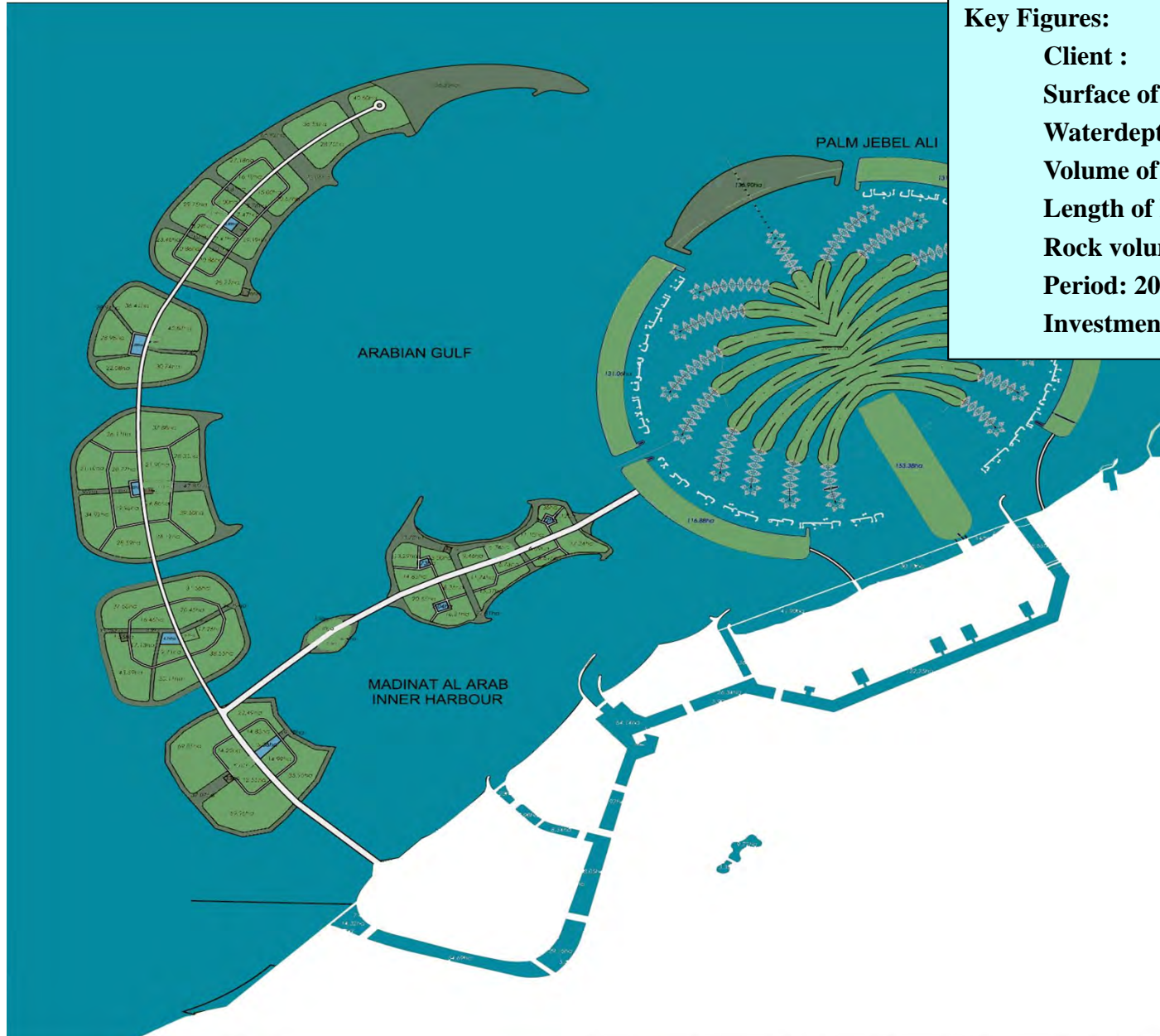








CSD 'Marco Polo' with spray-pontoon dredging caprock



Key Figures:

- Client :** Nakheel, Dubai World
- Surface of land to create :** 2.500 ha
- Waterdepths:** DMD – 6 to -11m
- Volume of Sand to reclaim:** 350 Mm³
- Length of Breakwater :** 42.000 m'
- Rock volume breakwaters:** 14 Mm³
- Period:** 2006 – 2009
- Investment :** 1.350 M €





The Palm, Deira

The World

The Palm, Jumeirah

Dubailand

Jebel Ali International Airport

Arabian Canal

The Palm, Jebel Ali

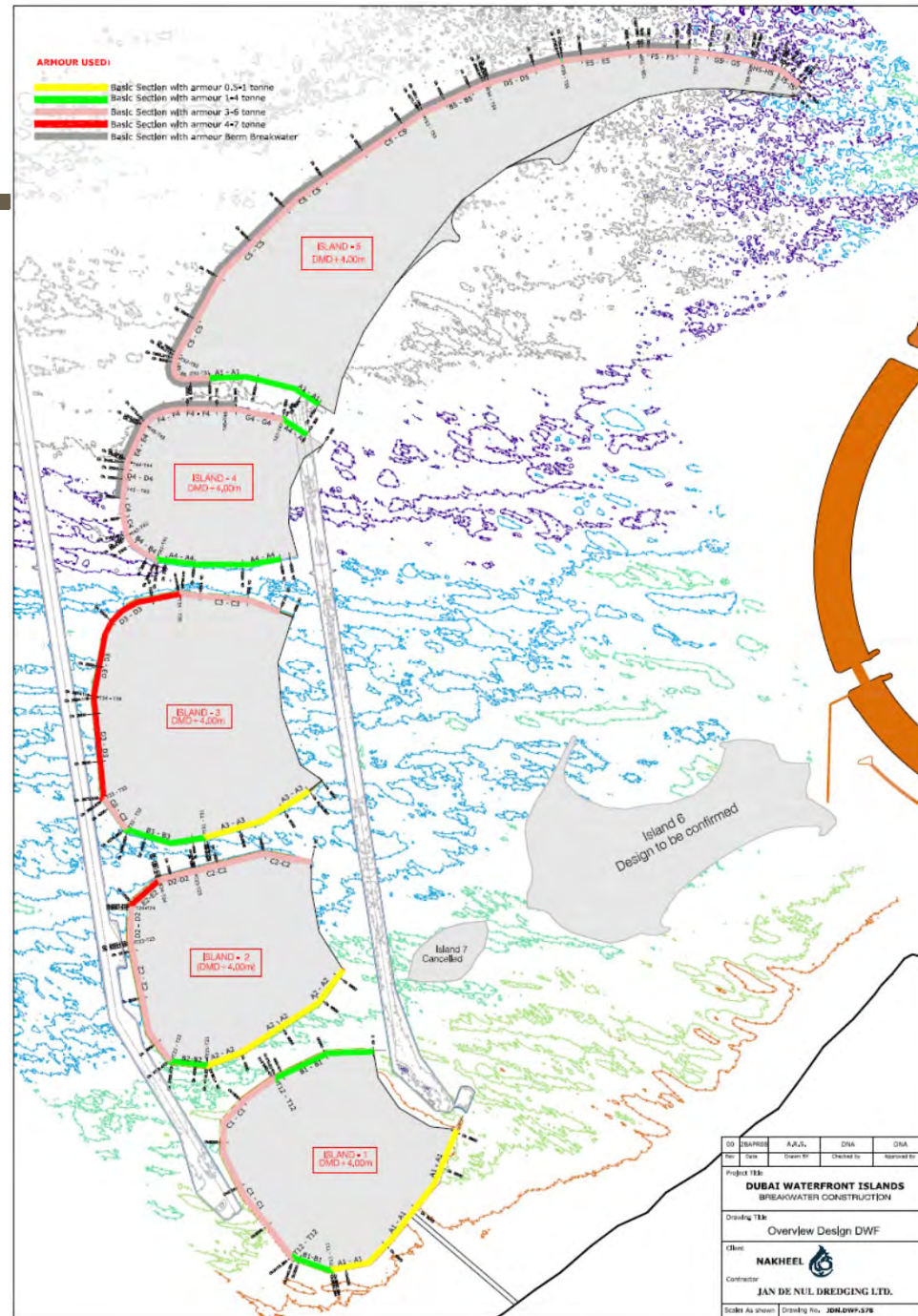
Dubai Waterfront

The Artist's Renderings are for illustration purposes only, and are subject to change without notice.

DUBAI WATERFRONT



Physical tests of Berm Breakwater (Wave Flume)



Palm Jebel Ali Crescent

Dubai Waterfront Islands

nr 1 & nr 2

Sea-defence rock-works

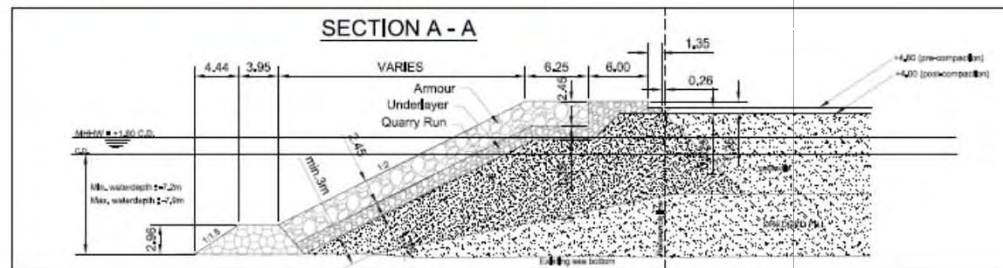
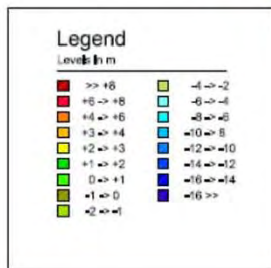
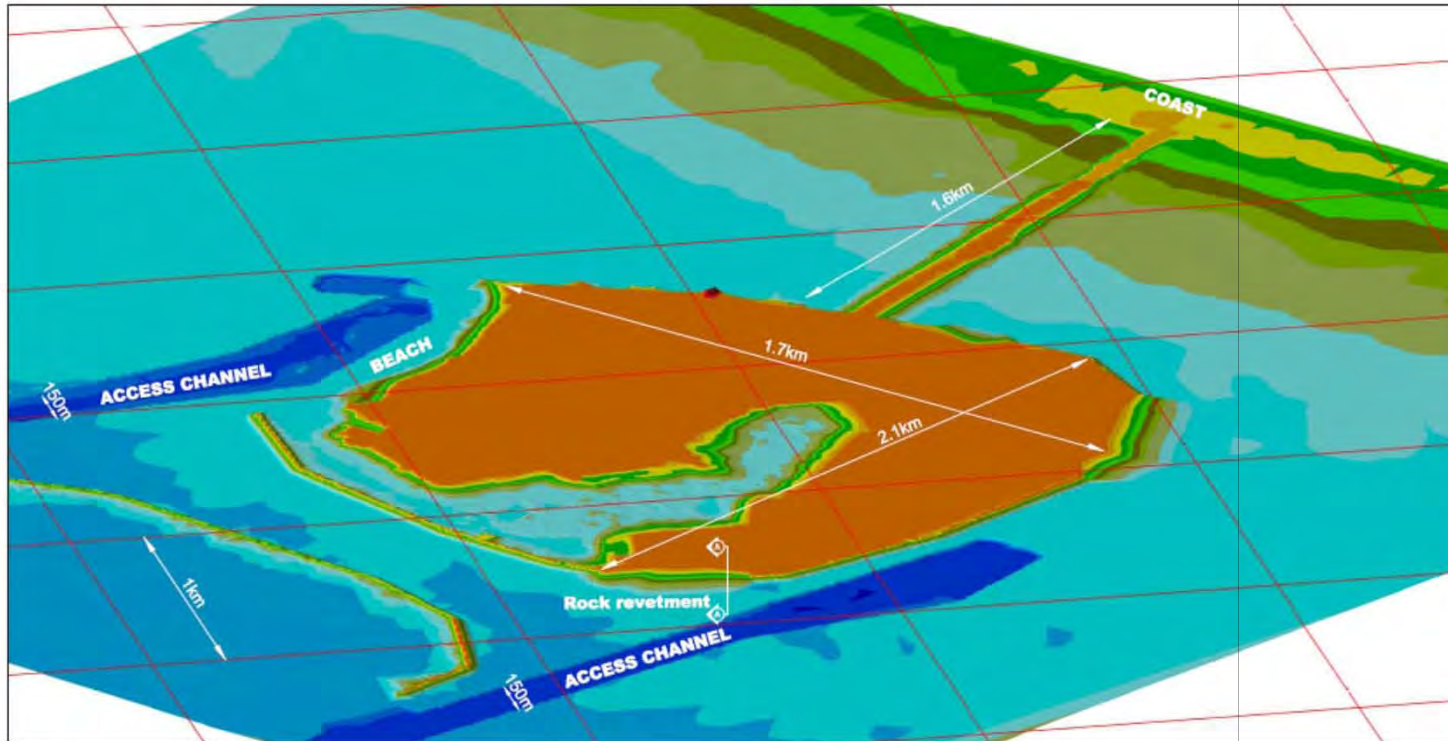
**Work Progress as per
September 2007**

Beachline

Causeway



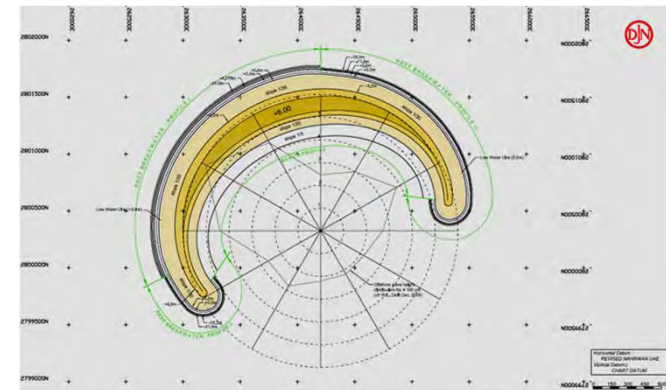
**THE WATERFRONT, ISLAND 1
DUBAI UAE**





Key Figures:

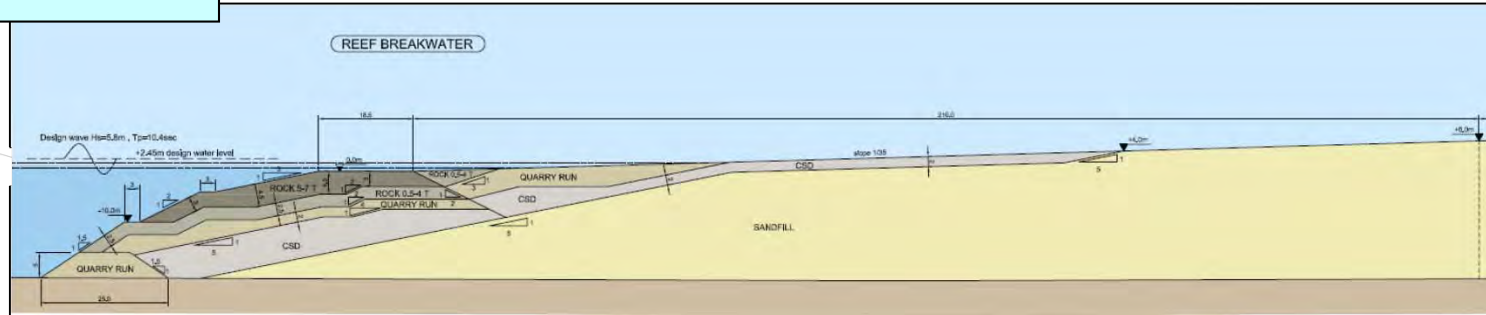
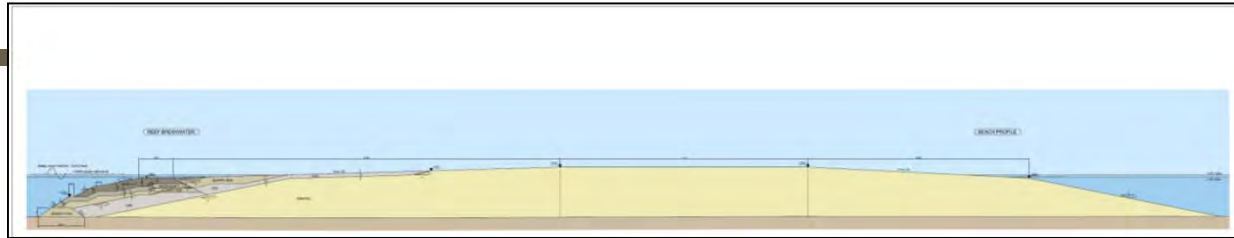
Client : Nakheel, Dubai World
Surface of land to create : 43,5 ha
Waterdepths: DMD – 22m
Volume of Sand to reclaim: 29 Mm³
Rock volume breakwaters: 3,2 Mm³
Period: 2007 – 2009
Investment : 165 M €



New Island Development: JDN introduced a new concept of Submerged 'Reef' Breakwater

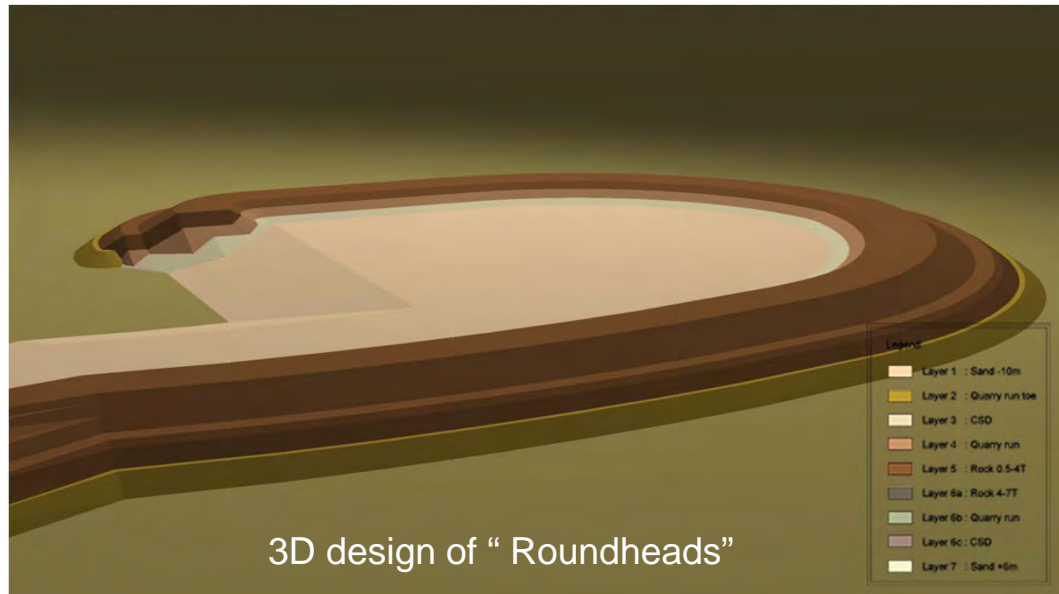
Design Elements of Breakwaters:

- Storm Surge level: DMD + 2,85m
- Natural waterdepths: CD- 22m
- Design Wave Height: $H_s = 5,8m$
- Design Wave Period : $T_p = 10,4 sec$
- Currents = $v_{max} = 1 m/sec$



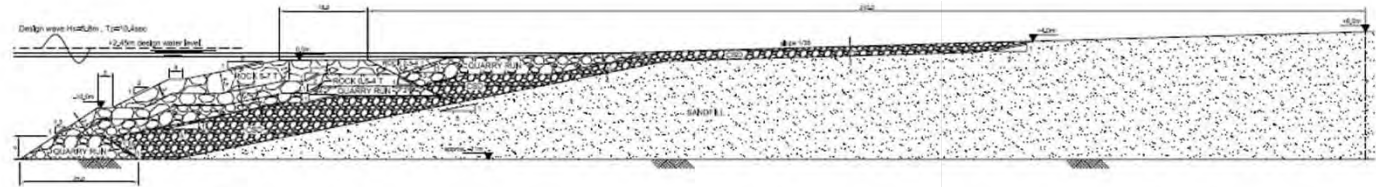
Physical Wave Flume (1/40)

Fig. 4: Large wave-flume (1/40), front view of Shield Reef Breakwater



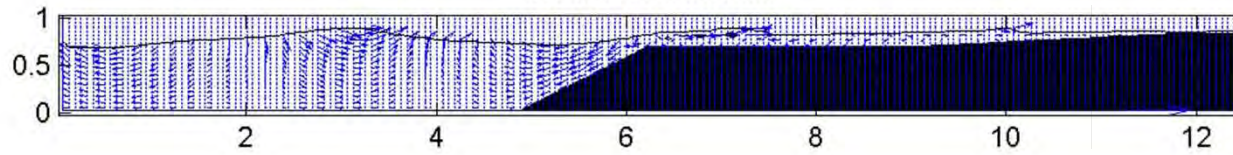
3D design of "Roundheads"

PROFILE I

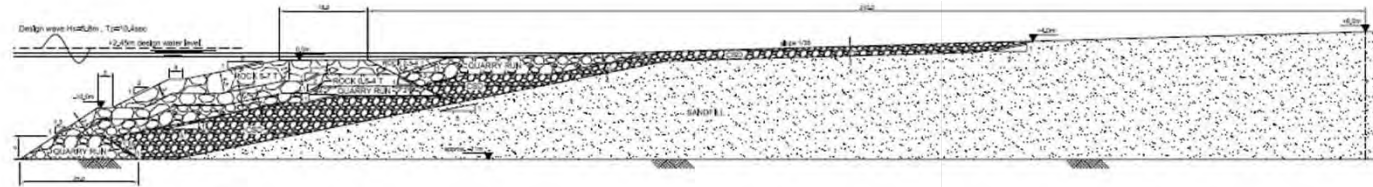


- MATERIALS:**
- ROCK 5-7 T : selected rock
 - ROCK 0.5-4 T : rock pile
 - QUARRY RUN : 20-500 kg
 - CSD : cultered caprock (d=0,1mm to 200mm / d50=14mm)
 - SAND LL : coral sand (d50=0,6mm)

Snelheidsvectorveld

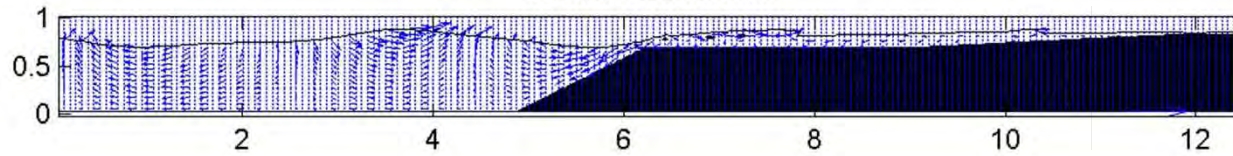


PROFILE I

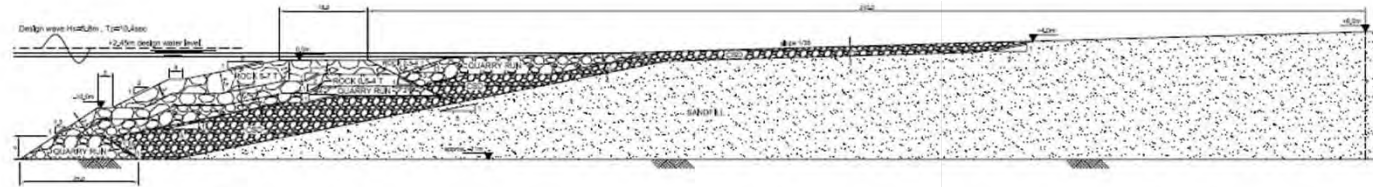


- MATERIALS:**
- ROCK 5-7 T : selected rock
 - ROCK 0.5-4 T : rock pile
 - QUARRY RUN : 20-500 kg
 - CSD : cultered caprock (d=0,1mm to 200mm / d50=14mm)
 - SAND LL : coral sand (d50=0,6mm)

Snelheidsvectorveld

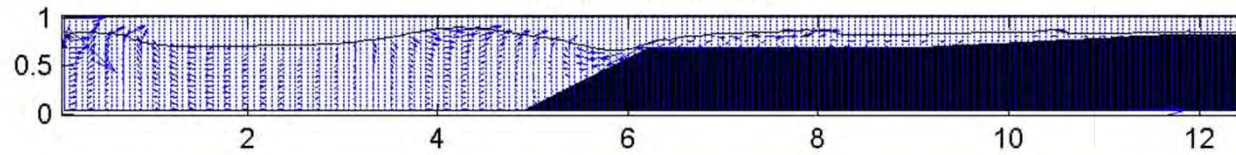


PROFILE I

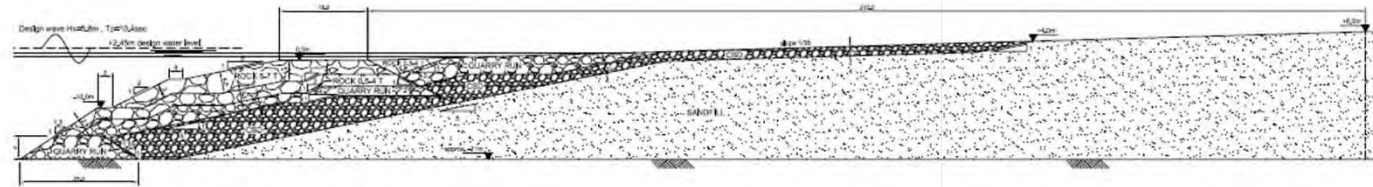


- MATERIALS:**
- ROCK 5-7 T : selected rock
 - ROCK 0,5-4 T : rock mite
 - QUARRY RUN : 20-500 kg
 - CSD : cultered caprock (d=0,1mm to 200mm / d50=14mm)
 - SAND LL : coral sand (d50=0,6mm)

Snelheidsvectorveld

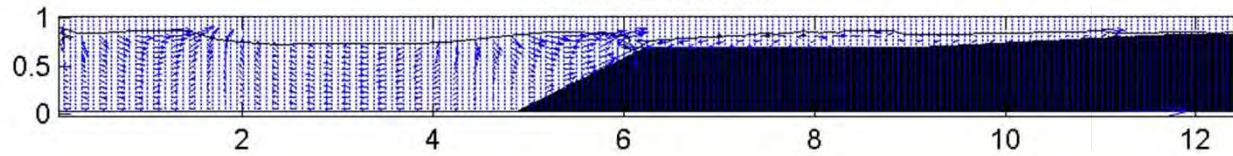


PROFILE I

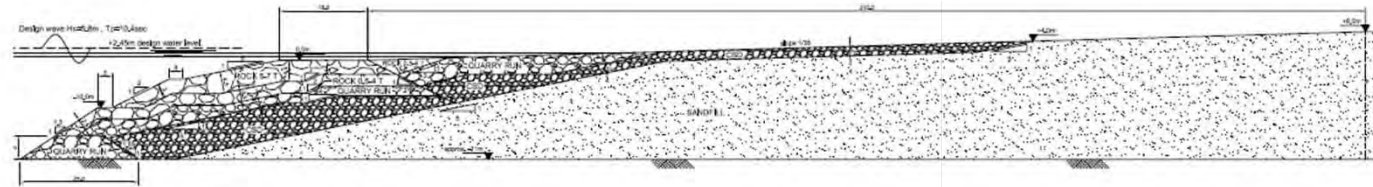


- MATERIALS:**
- ROCK 5-7 T : selected rock
 - ROCK 0,5-4 T : rock pile
 - QUARRY RUN : 20-500 kg
 - CSD : cultered caprock (d=0,1mm to 200mm / d50=14mm)
 - SAND LL : coral sand (d50=0,6mm)

Snelheidsvectorveld

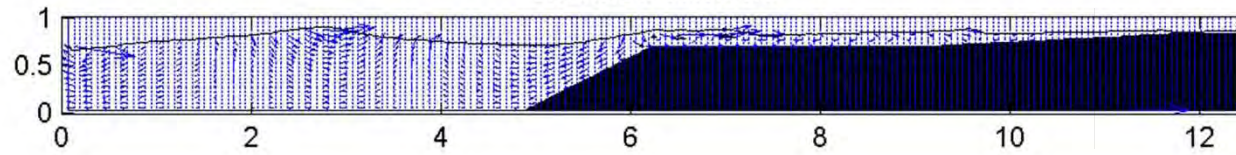


PROFILE I



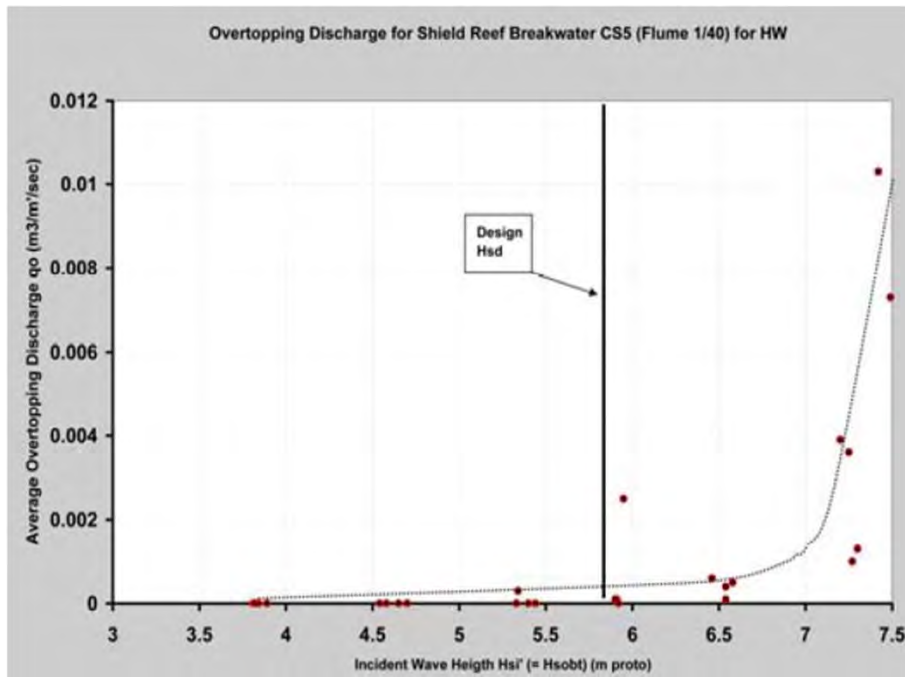
- MATERIALS:**
- ROCK 5-7 T : selected rock
 - ROCK 0,5-4 T : rock pile
 - QUARRY RUN : 20-500 kg
 - CSD : cultered caprock (d=0,1mm to 200mm / d50=14mm)
 - SAND LL : coral sand (d50=0,6mm)

Snelheidsvectorveld

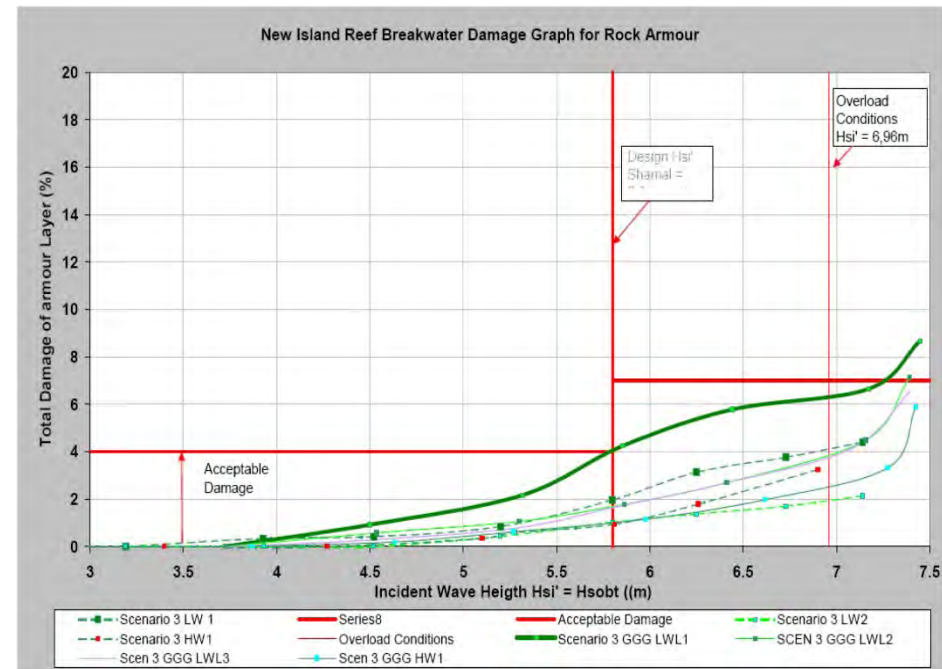




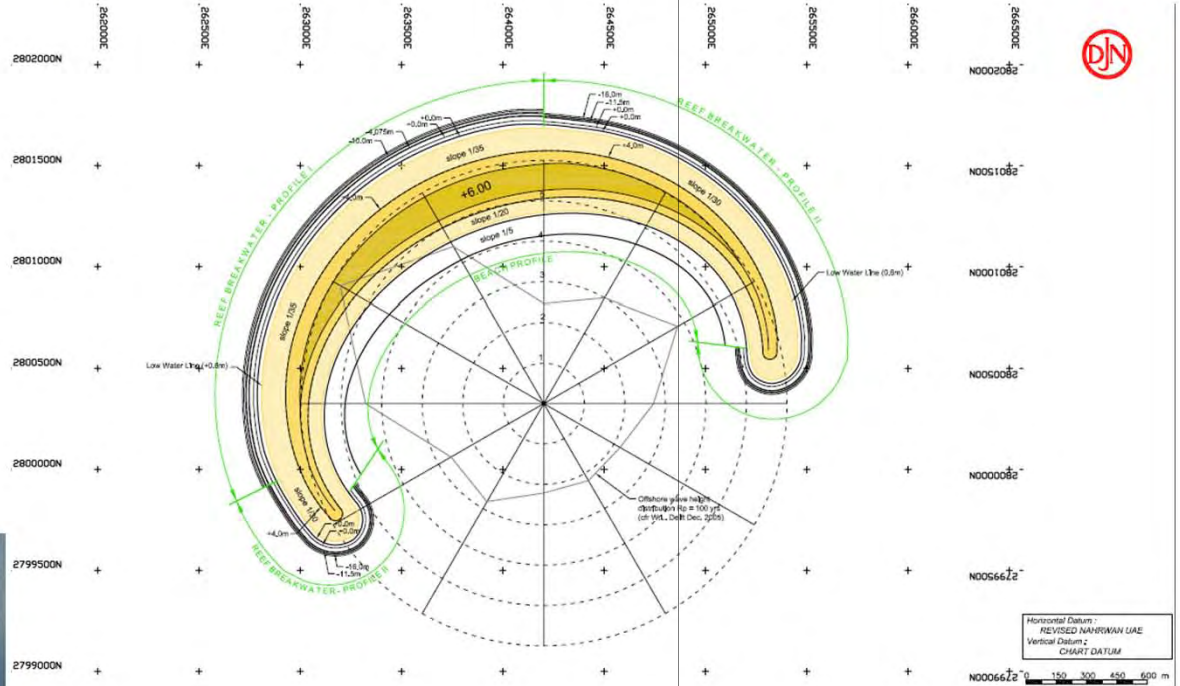
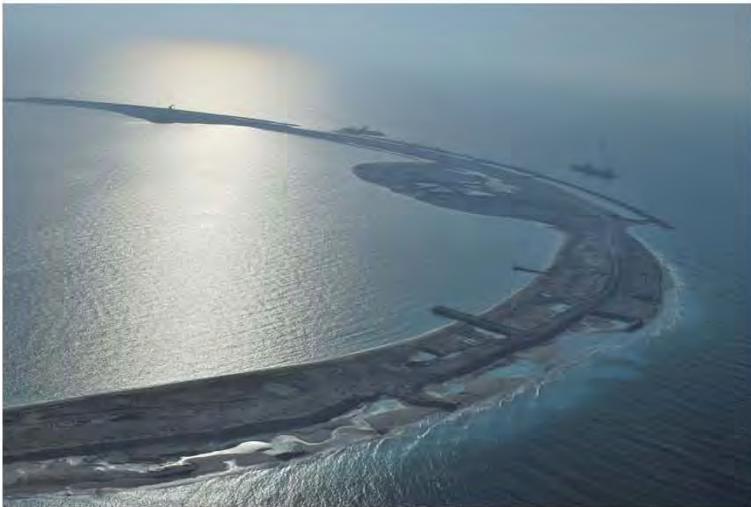
Validation of breakwater-design by Physical Model tests



Overtopping Discharge



Damage to Armour layer





Key Figures:

Client : TDIC (Tourism Development & Investment Company)

Surface of land to create : 43,5 ha

Waterdepths: DMD – 22m

Volume of reclamation: 70 Mm³

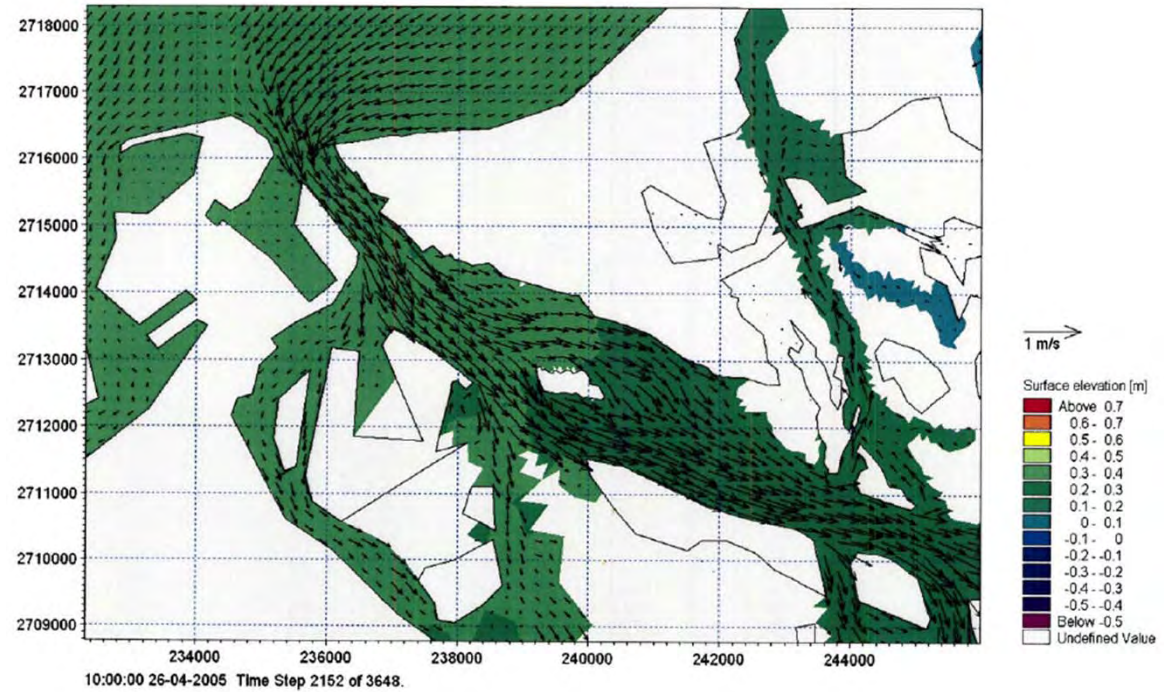
Rock volume breakwaters: 0,876 Mm³

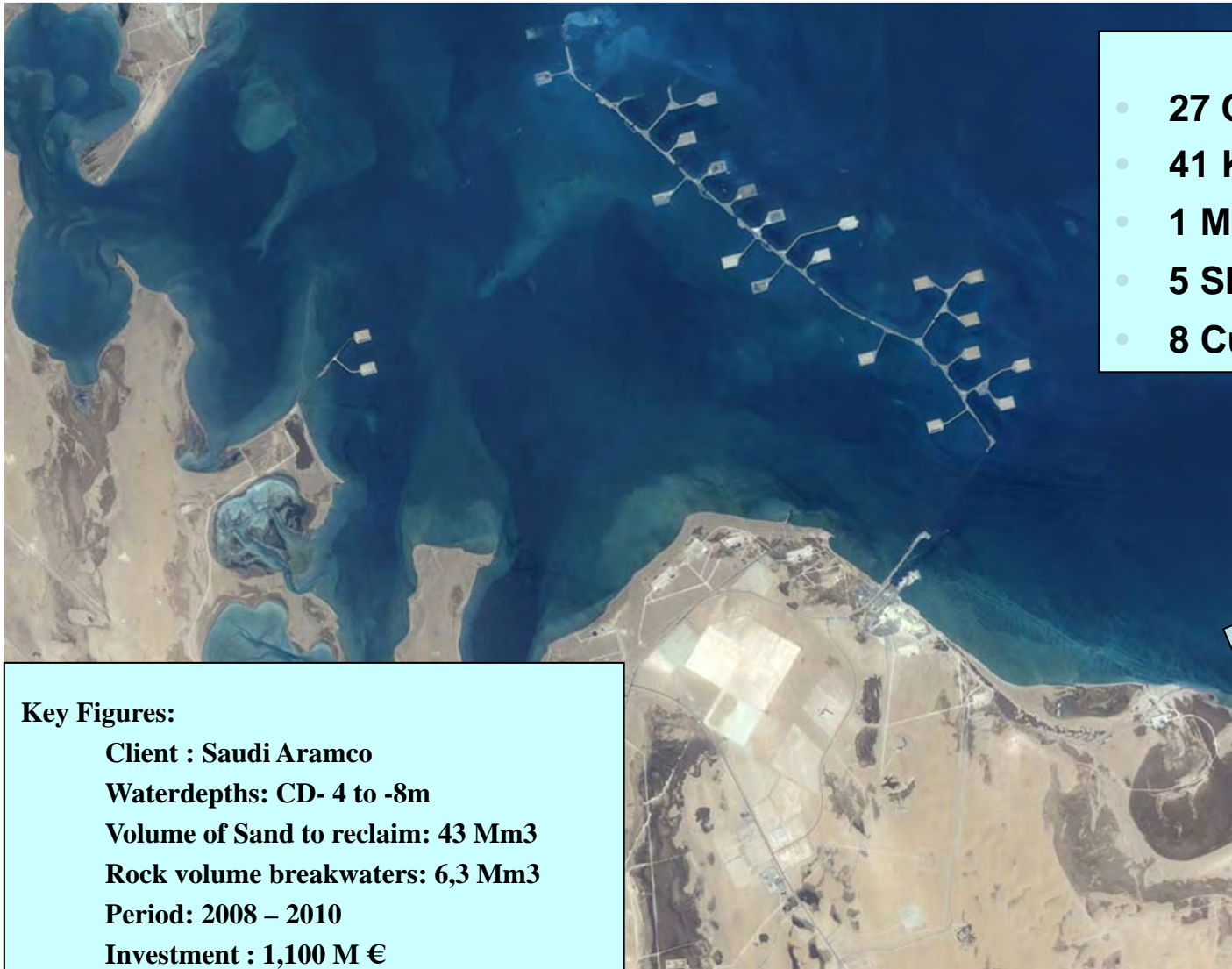
Period: 2007 – 2009

Investment : 335 M €



Numerical hydraulic studies for engineering





- ### Scope
- 27 Causeway Drill Islands
 - 41 Km. Causeway Length
 - 1 Main Bridge – 2.4 Km
 - 5 Short Bridge EA. 150 M
 - 8 Culverts EA. 50 M

Key Figures:
Client : Saudi Aramco
Waterdepths: CD- 4 to -8m
Volume of Sand to reclaim: 43 Mm³
Rock volume breakwaters: 6,3 Mm³
Period: 2008 – 2010
Investment : 1,100 M €

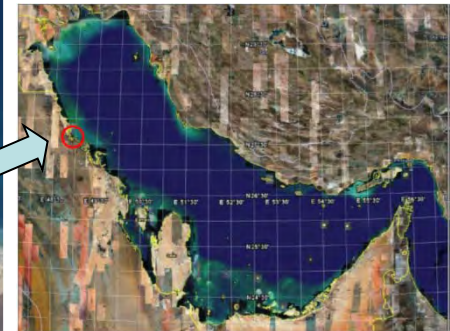


Fig 1.1 Location map. The red circle indicates the Manifa Field area.



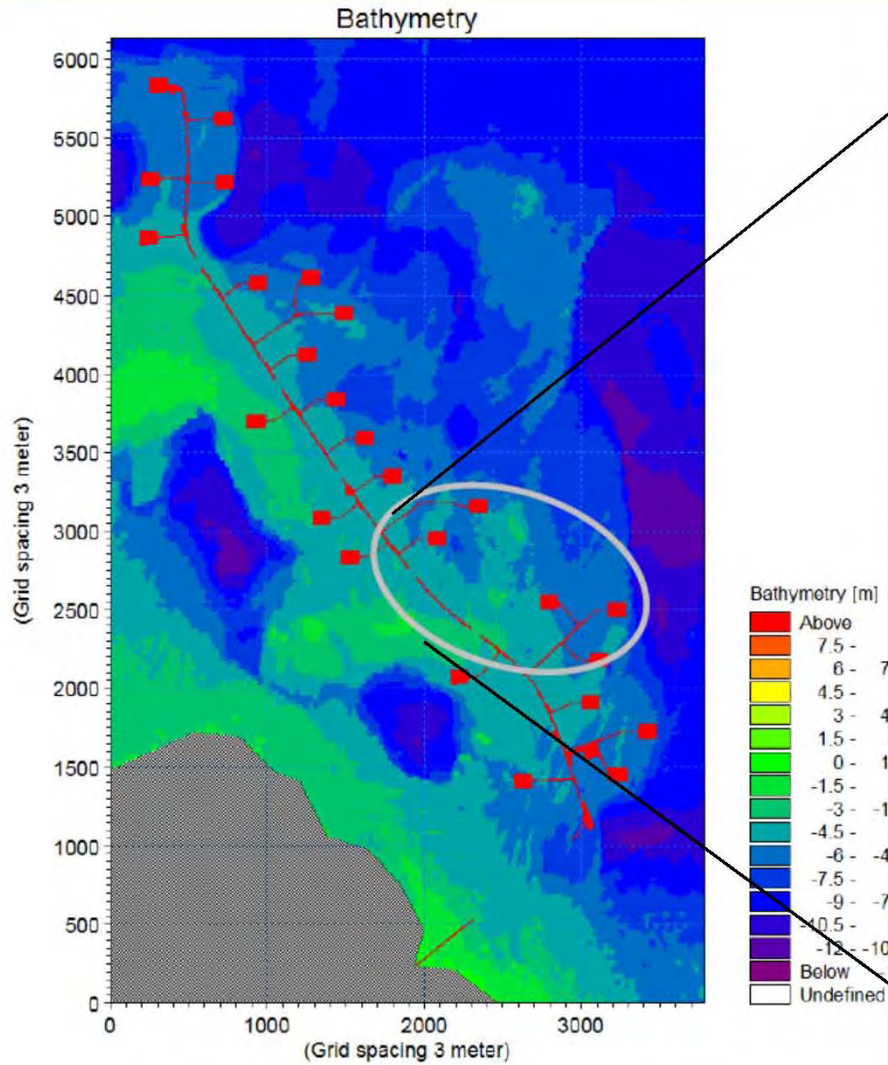


Figure 3-1: Full bathymetry Manifa Causeway Project (old alignment)

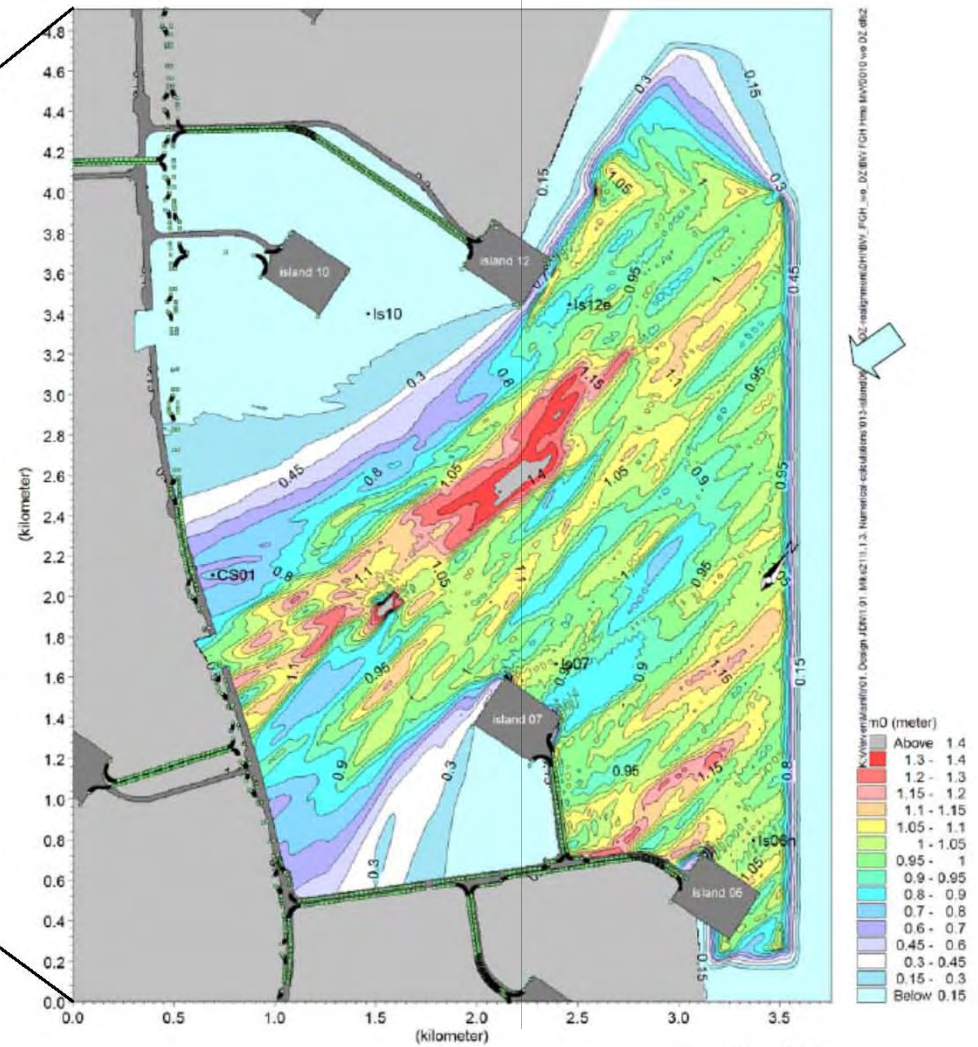


Figure 4-2: H_{m0} North direction: 10° , $T_p=9s$

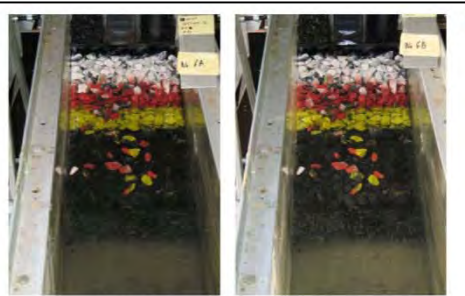


Photo 36: Section MC Run 2 after test 6A

Photo 37: Section MC Run 2 after test 6B



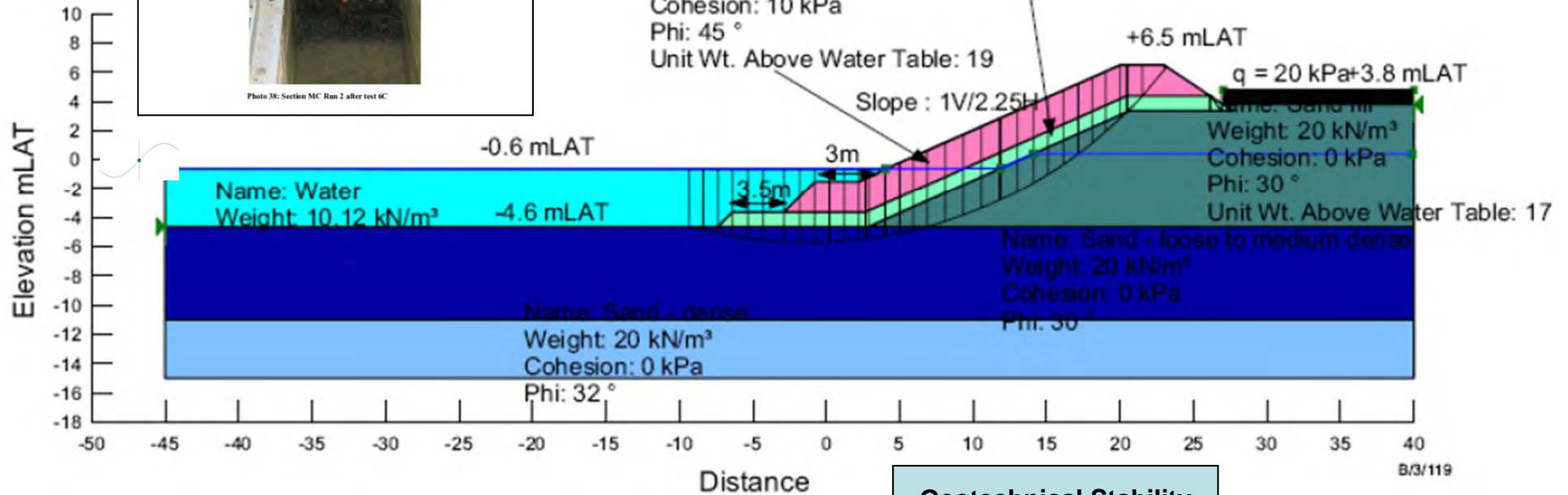
Photo 38: Section MC Run 2 after test 6C

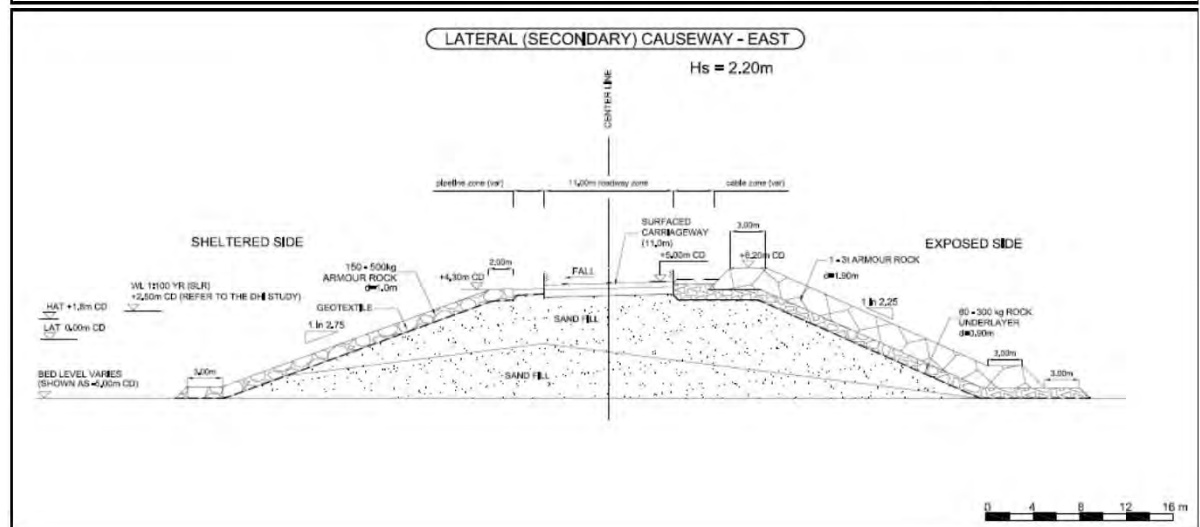
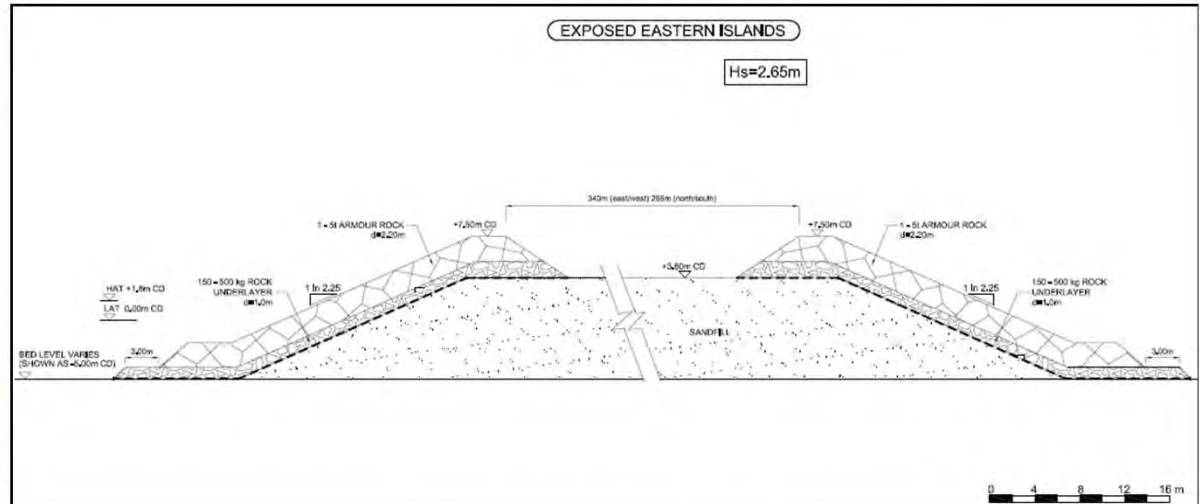
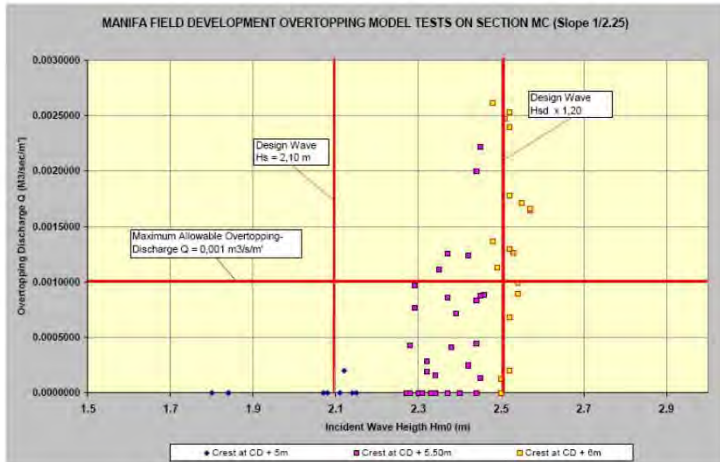
Hydrodynamic Stability

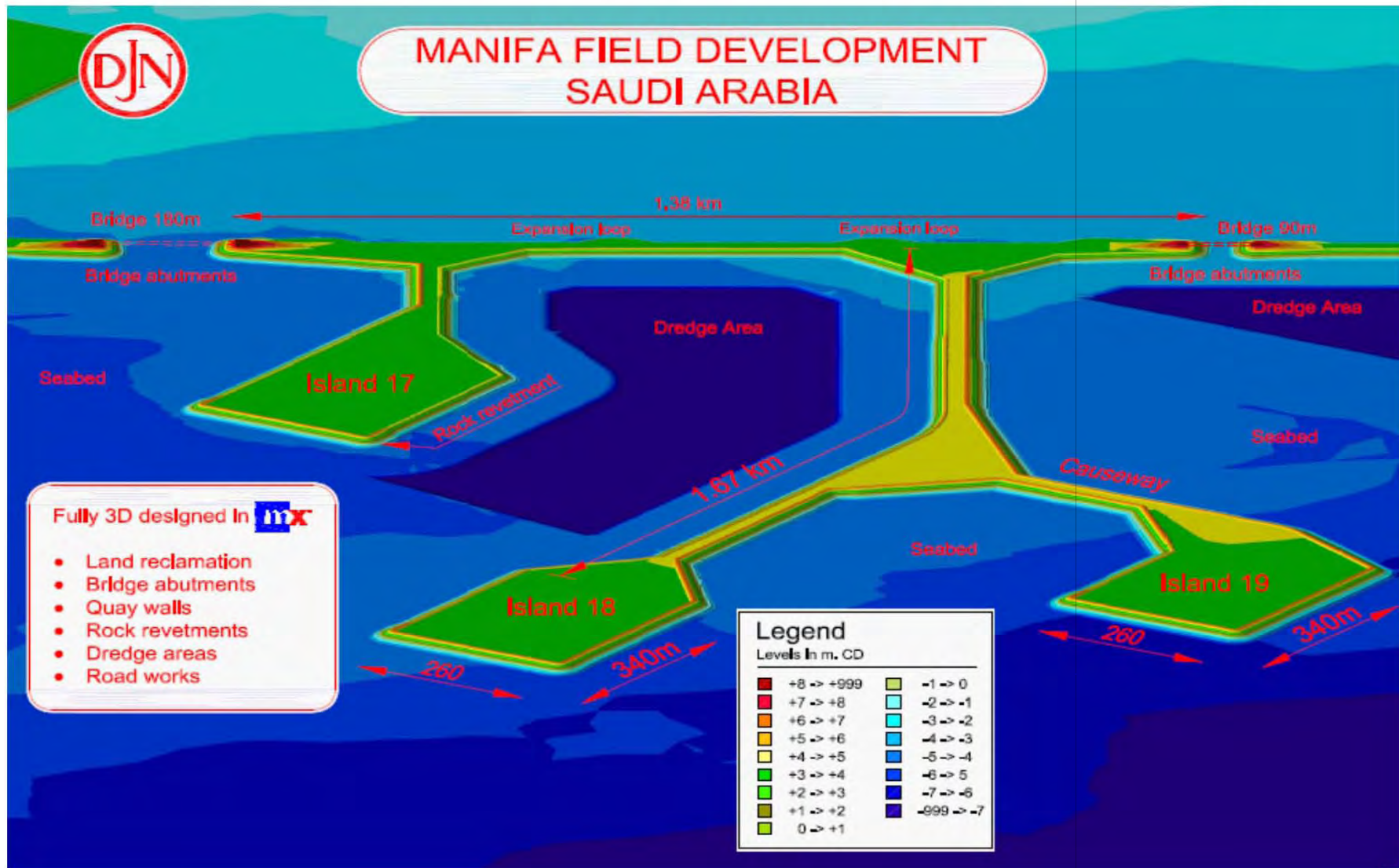


Name: Under layer 150-500 kg
Weight: 19 kN/m³
Cohesion: 10 kPa
Phi: 45 °
Unit Wt. Above Water Table: 17

Name: Armour layer 1.8-4.2 T
Weight: 21 kN/m³
Cohesion: 10 kPa
Phi: 45 °
Unit Wt. Above Water Table: 19











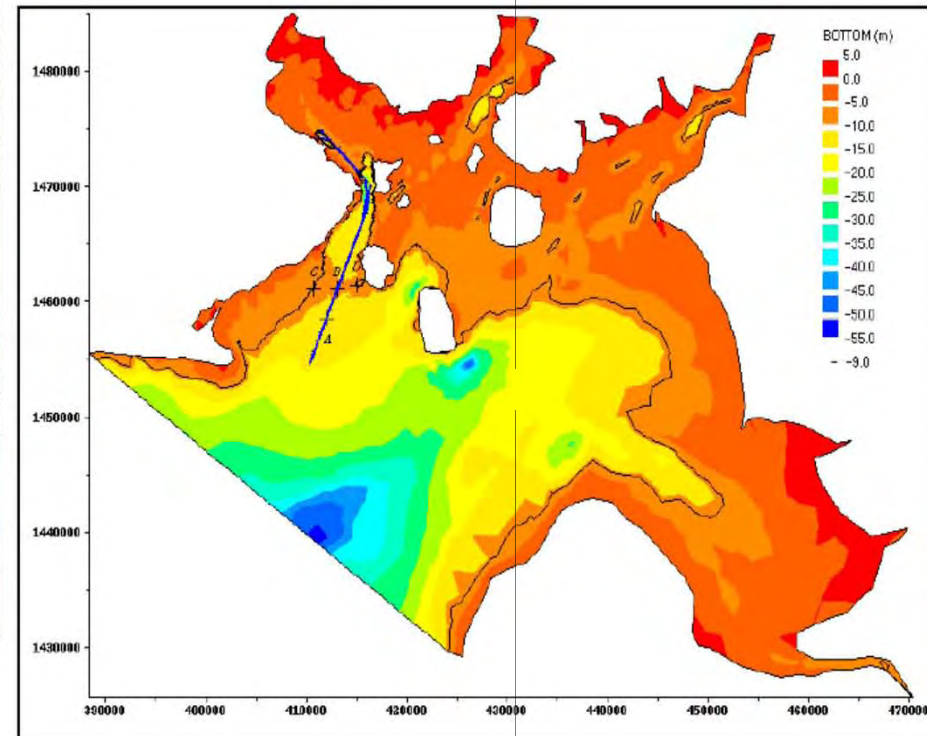
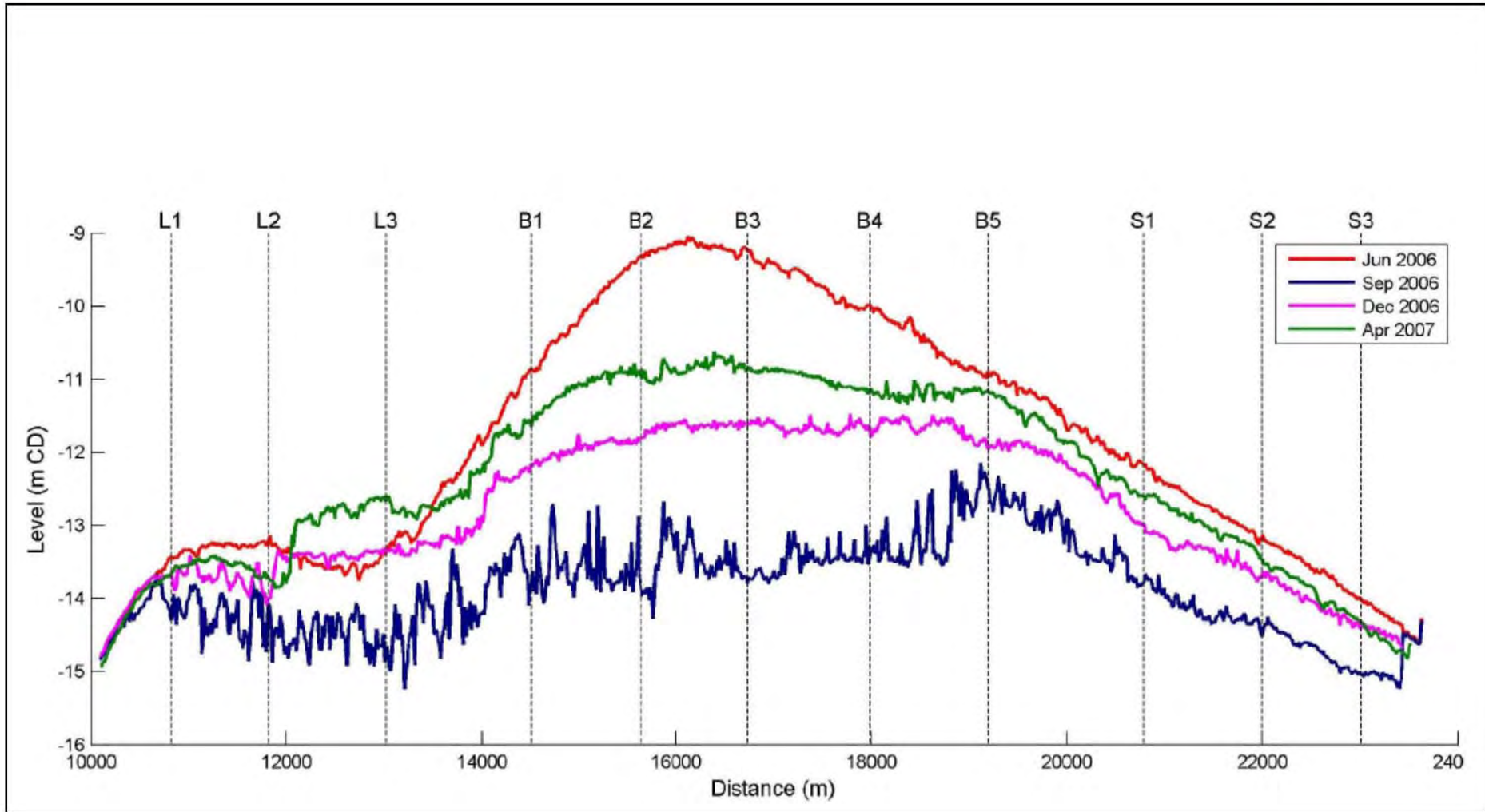


Figure 4 TELURAY model bathymetry showing location of proposed channel and nearshore wave climate prediction points

Outer Channel: observed accretion in the OC centerline (longitudinal profile)





Callao Terminal - Peru | 2008-2010
Dredging: approx. 4,000,000 m³, Reclamation: approx. 2,000,000 m³



Landfill of Quay-Platform behind Quay-wall, Callao, Peru





Dredging of Botany Bay Access-Channel, Sydney, Australia





Loading Quarry Run for Breakwater Core, Saadiyat, Abu Dhabi



Reclamation of LNG-terminal, Aniva Bay, Eastern Siberia



Seychelles, Rubble Mound Sea Defense Works for Artificial Islands (1998-2003)

130,000 tons rock works



Maintenance of cutter-Head, Ras laffan, Qatar



Dredging of Offshore Langede Gas-Pipeline Trench, Easington, UK





Jebel Ali New Container Terminal Stage 1 - Dubai (U.A.E.) | 2005-2009

Dredging: 22,000,000 m³

Reclamation: 22,000,000 m³



Land reclamation in Pipavav, Mumbai, India





CSD “Vesalius” dredging access-channel in Barbados





Dredging of the Calabar Access Channel Downstream Section - Nigeria | 2006-2007
Dredging: 12,750,000 m³



Widening and Deepening of the Atlantic entrance of the Panama Canal - Panama | 2004-2005

Dredging: 2,350,000 m³

Reclamation: 1,750,000 m³ dumped, 600,000 m³ reclaimed



Remediation and rehabilitation works at the north coastline of Sfax – Taparura project (Tunisia) | 2006-2009



Reclamation Works for the new LNG Terminal at Soyo - Angola | 2006-2009

Dredging: 24,500,000 m³

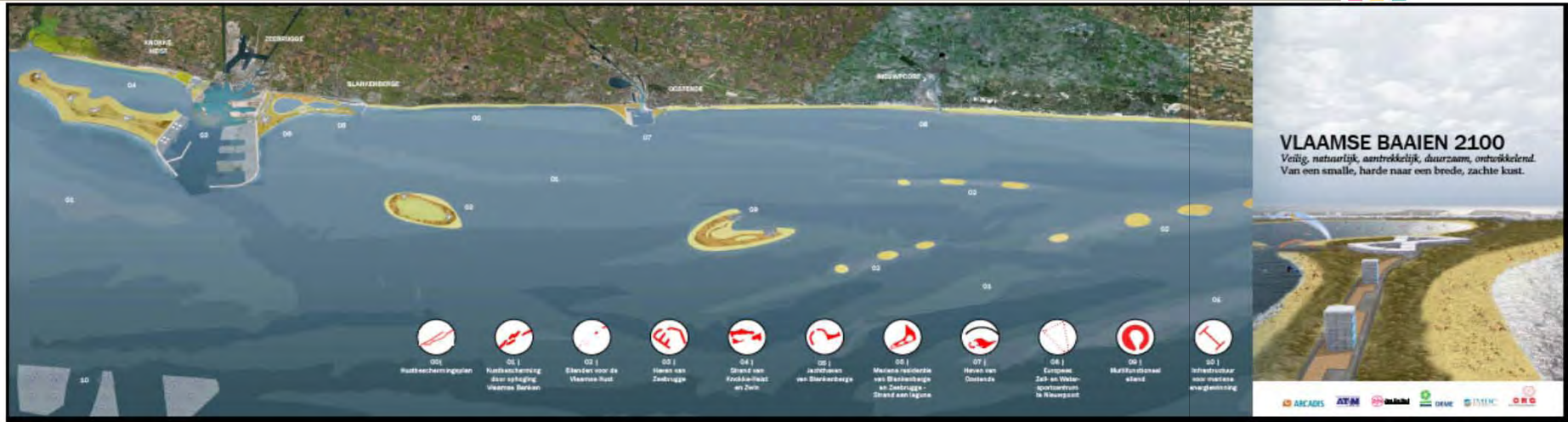
Reclamation: 9,000,000 m³



Beach Replenishment in Cancun - Mexico | 2005-2006

Dredging: 2,700,000 m³

Reclamation: 2,700,000 m³



De Panne West: hoé de natuur ons met een breed strand veiligheid biedt.



Middelkerke: hoé harde zeeeringen en uitsprongen met een nauw strand resulteren in een onveilige situatie



New Built Program

Jan De Nul Group continues its expansion, building state of the art vessels in shipyards in Holland, Spain, Croatia, Korea and China. The current **1,6 billion €** investment program 2007 – 2011 now consists of 22 vessels.

The first delivery was in 2007, and deliveries will continue until early 2011. The fleet expansion triggers an increase in Jan De Nul Group's workforce from the actual 4.200 with 850 seaman and 400 staff to over 5.250 people.





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