SUSTAINABLE COASTAL & DELTA ZONE DEVELOPMENT

Integrated Coast & Delta Policy via Building with Nature® & Aquapuncture©

Building with Nature®

$$(\alpha+\beta+\gamma)_{\text{knowledge + action}} \rightarrow \Delta_{\text{sustainable}}$$

Delft University of Technology
Civil Engineering & Applied GeoScience

2020

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SUSTAINABLE COASTAL ZONE DEVELOPMENT

Flexible integration
of land in water
and of water in land

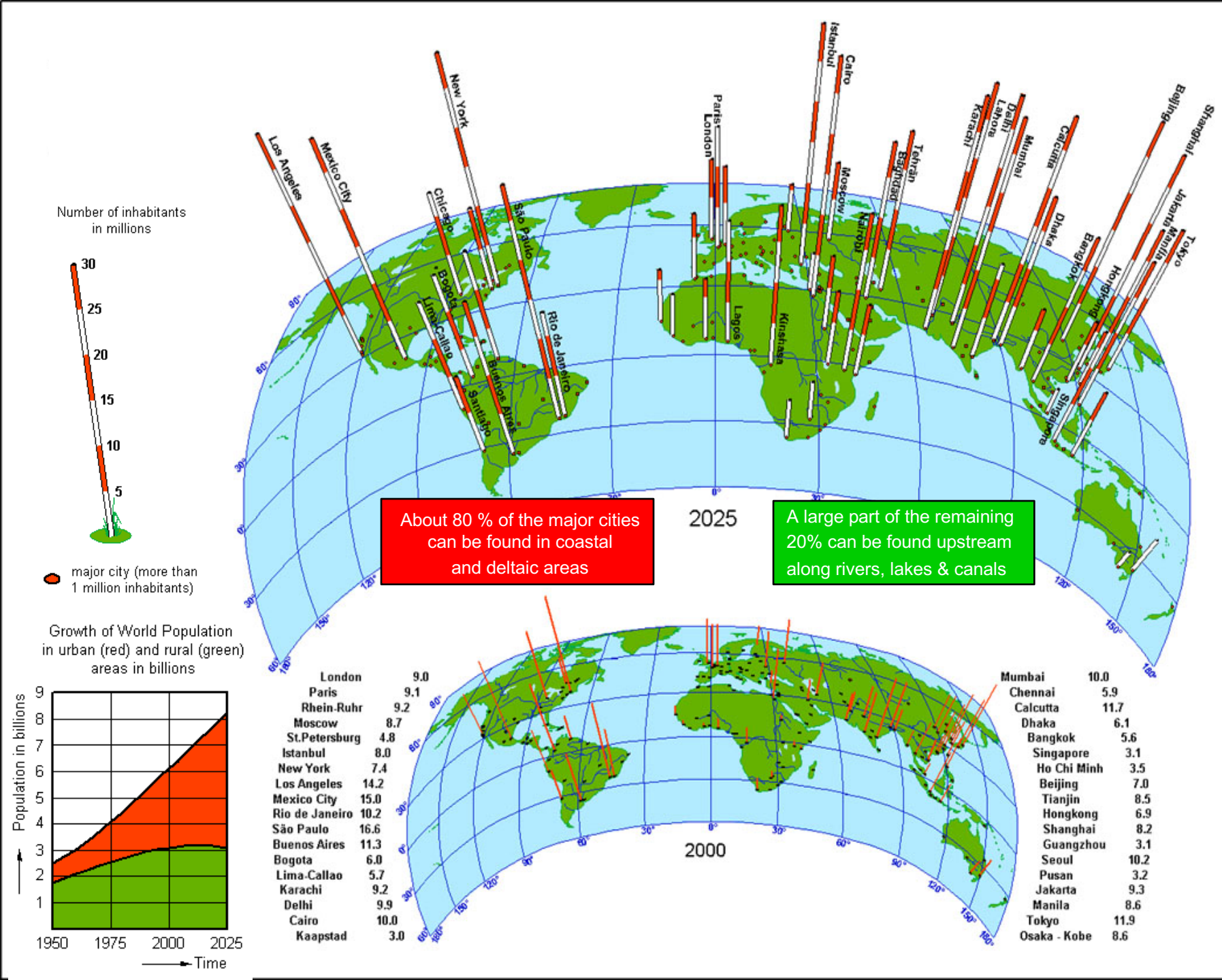
Making use of materials and forces & interactions present in nature

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Civilisations were often developed in the border zone land-water, in coastal and deltaic regions. These border-zones are very attractive for living, working, tourism & recreation, transport, water resources, food supply. They are also important for nature values, because of the presence of gradients from wet to dry, from high to low salt & chalk content, differences in height & micro-climate. Gradients are often guarantees for a large variety of species.

Therefore it is not a surprise that in the 21st century, approx. 80% of the largest population centres are found in coast & delta areas.

DEVELOPMENT OF MAJOR CITIES IN THE WORLD



SUSTAINABLE COASTAL ZONE DEVELOPMENT

About 80% of
the major cities
can be found in
coast and delta areas

A large part of
the remaining 20%
can be found upstream
along rivers, lakes & canals

Building with Nature®
Aquapuncture

Aquapuncture©
Building with Nature

In these densely populated areas there is little space available for living, working, infrastructure, recreation & tourism, and at the same time there is the need to preserve or expand valuable environment, nature and landscape.

SUSTAINABLE COASTAL ZONE DEVELOPMENT

For the scarcity of space in the Coast & Delta Zone there are 3 solutions:

- ★ **Making better use of the 3d and 4th dimension**
- ★ **Using space in the existing hinterland**
- ★ **Seaward option or combinations**

SUSTAINABLE COASTAL ZONE DEVELOPMENT

As an answer to this scarcity of space is:

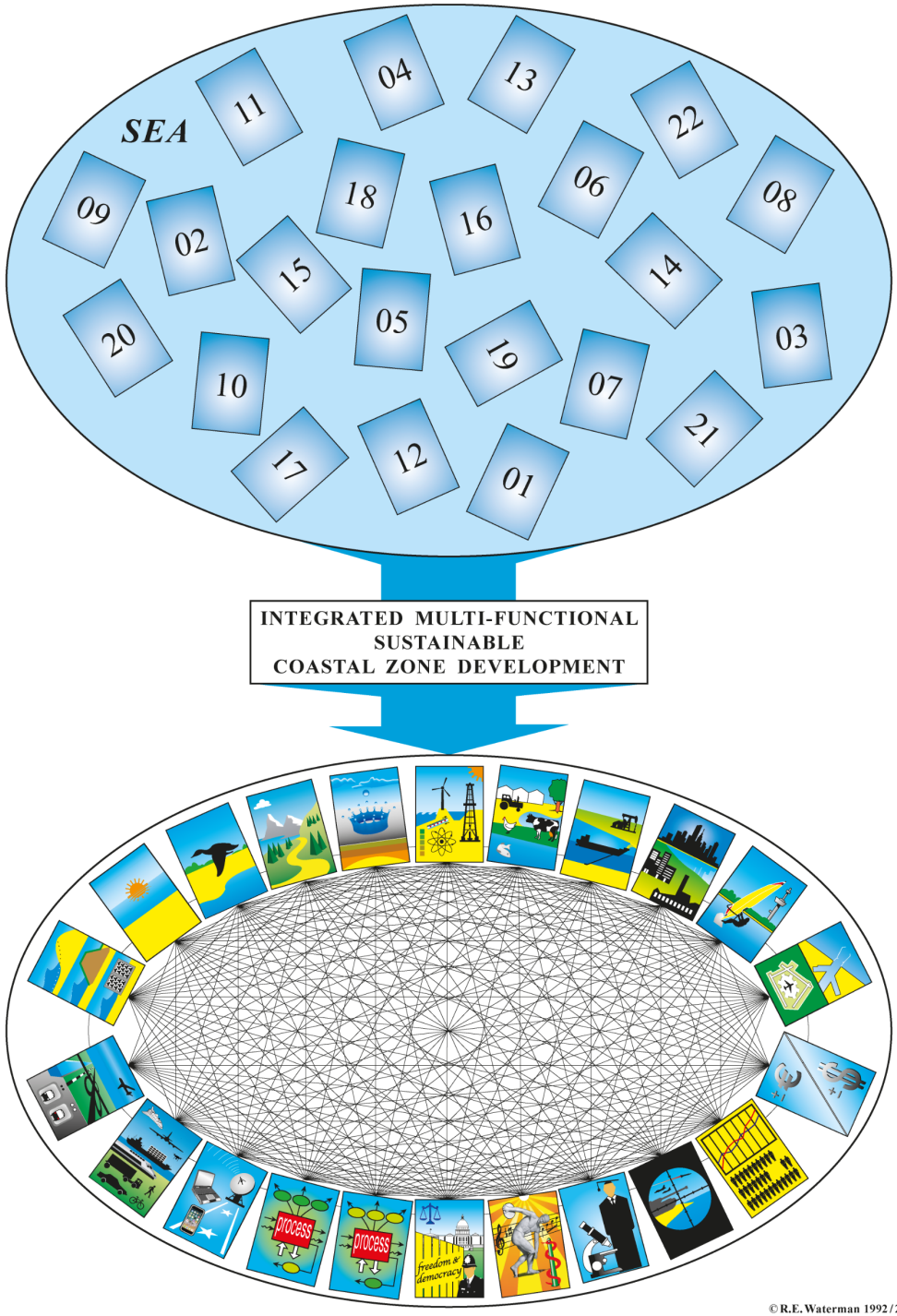
Reclaiming Land in Sea
and
Water in the new & old Land !

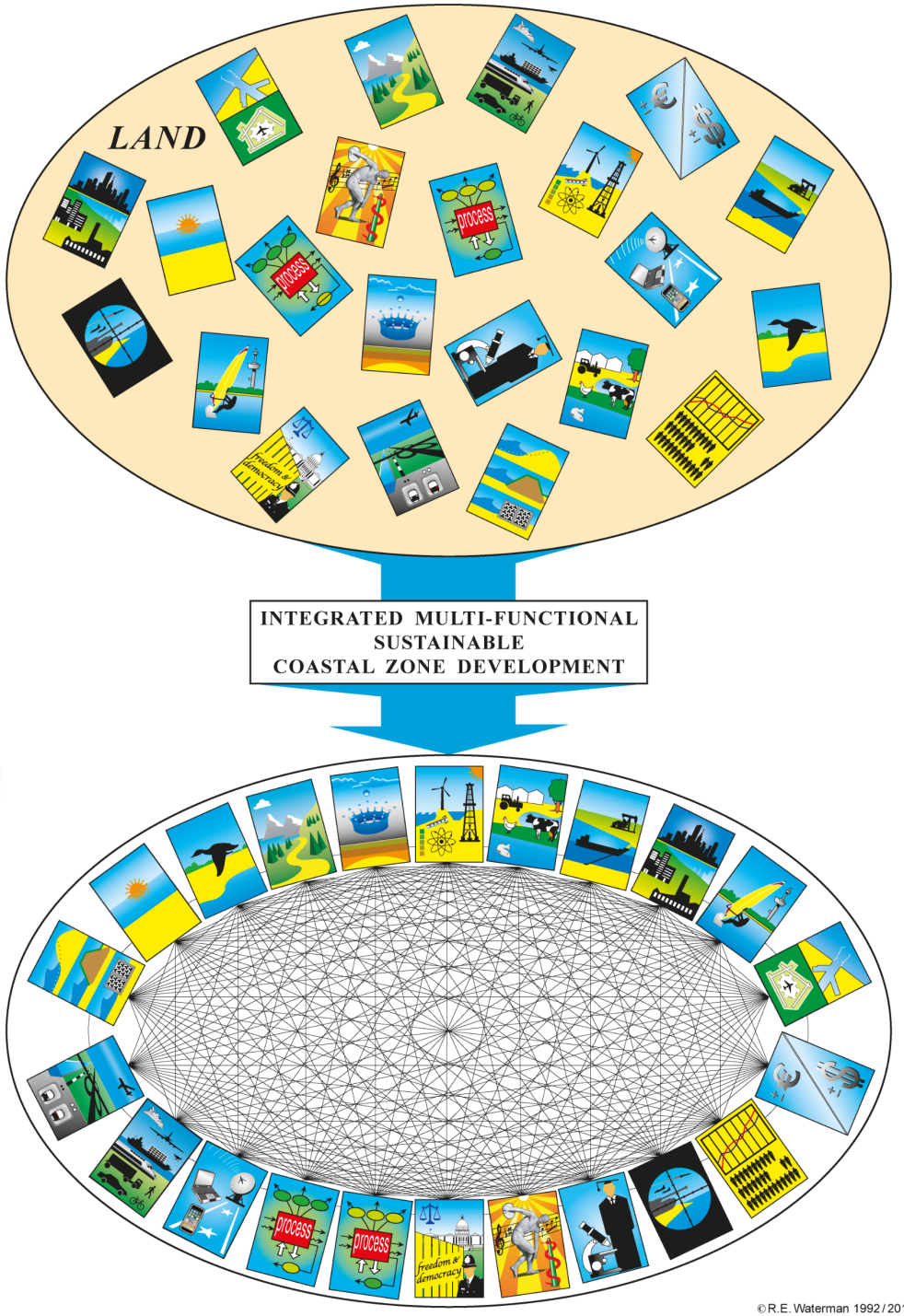
BUILDING WITH NATURE

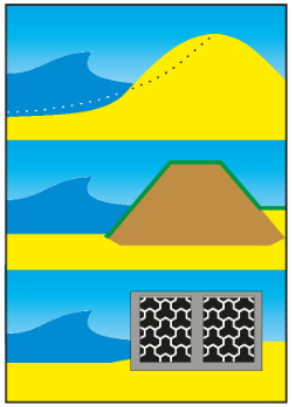
Integrated Approach **to the coast & delta zone, including new and old land & sea.**

Many functions have to be considered, while using many different disciplines.

Integrating land in sea and water in new and old land, thereby solving many existing and future problems in relation to the hinterland and the bordering sea, while creating added value.







SAFETY with regard to:

- flooding
  (including effects:
  sea level & river level rise)
- drought
- coastal erosion
- land subsidence
- salt water intrusion
- natural disasters
- human activities

01

ENVIRONMENT
(IN GENERAL)

environmental
compartments:

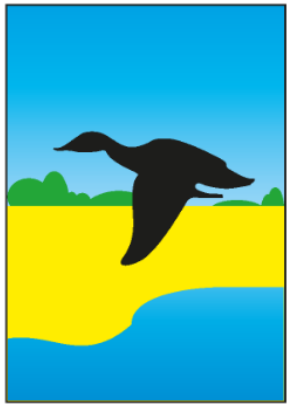
- air
- water
- land

02

NATURE

- micro-organisms, flora,
  fauna (incl. people)
- eco-systems
- nature conservation
- nature development
- bio-diversity
- bio-diversification

03



LANDSCAPE

- landscape conservation
- landscape development

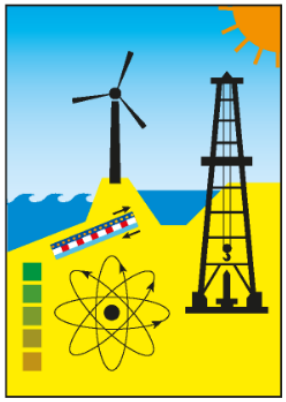
SEASCAPE

04

WATER RESOURCES MANAGEMENT
- water quantity
- water quality
- groundwater
- surface water
- dune infiltrated water
- (desalinated) sea-water
- sewer systems
- waste water purification

€ $ ±

05



ENERGY
- natural gas, oil, coal, etc.
- biomass (wood, etc.); organic wastes
- nuclear energy
- solar-, wind-, water-, geo-energy
- combined cycle, isolation, etc.

€ $ ±

06

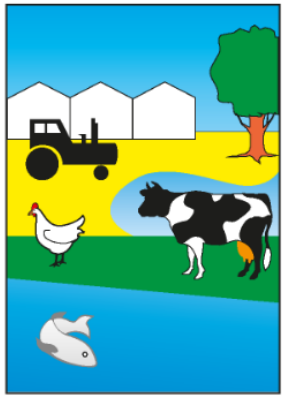
AGRICULTURE
horticulture, forestry, cattle & poultry breeding

FISHERY

AQUACULTURE

± $ €

07



MINING / EXTRACTION & STORAGE

in / on

Land / Sea-bed / Sea / Air

± $ €

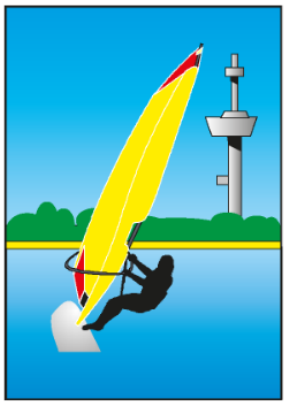
08

Functions 01 / 08

BUILDING SITES FOR LIVING & WORKING

- houses & apartments
  + facilities
- industries & offices
  + facilities
- urban development

09



RECRATION & TOURISM

10

TRANSFER / DISTRIBUTION CENTRES & RELATED ACTIVITIES

- seaport
- riverport,
- lake port
- airport,
- landport

11

INFRASTRUCTURE

- roads
- railroads
- waterways
- underground systems
- airlanes
- electronic highway

12

TRANSPORT MODULES

- bicycle, motor-car, bus, tram, train, maglev (magnetic levitation train),
- metro
- ship,
- container
- drone, airplane, rocket, satellite

13

INFORMATION COMMUNICATION TECHNOLOGY

DATA ACQUISITION
DATA STORAGE
DATA TRANSMISSION
DATA PROCESSING

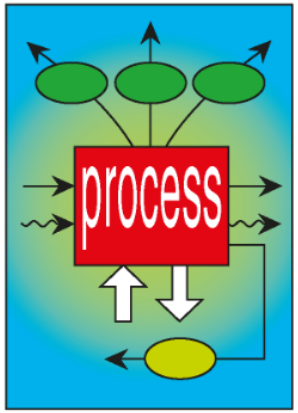
A.I.

14

ENVIRONMENT (IN PARTICULAR)

Air- / Water- / Soil-quality by improvement of conversion processes and by end of pipe purification

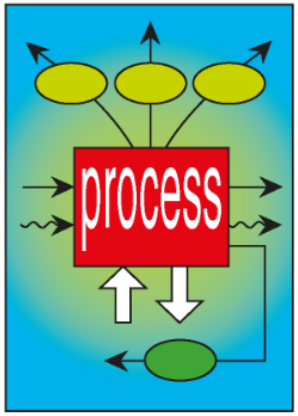
15



ENVIRONMENT (IN PARTICULAR)

solid waste reduction by improvement of conversion processes and by environmental friendly collection - transport - storage - processing - recycling - usage

16



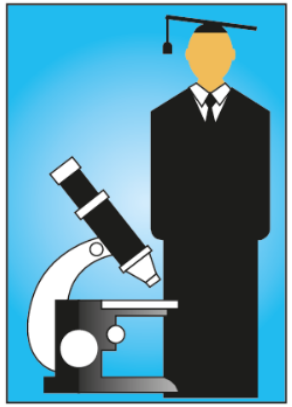
GOVERNMENTAL
INSTITUTIONS
NON-GOVERNMENTAL
INSTITUTIONS
CITIZEN GROUPS
INDIVIDUAL CITIZENS
PEOPLE'S
PARTICIPATION
LAW - JUSTICE - ORDER

17

HEALTH & WELFARE
SPORT / PLAYGROUND
HISTORY & CULTURE
RELIGION
PHILOSOPHY OF LIFE
VALUES & STANDARDS
SOCIOSPHERE

18

EDUCATION
&
RESEARCH

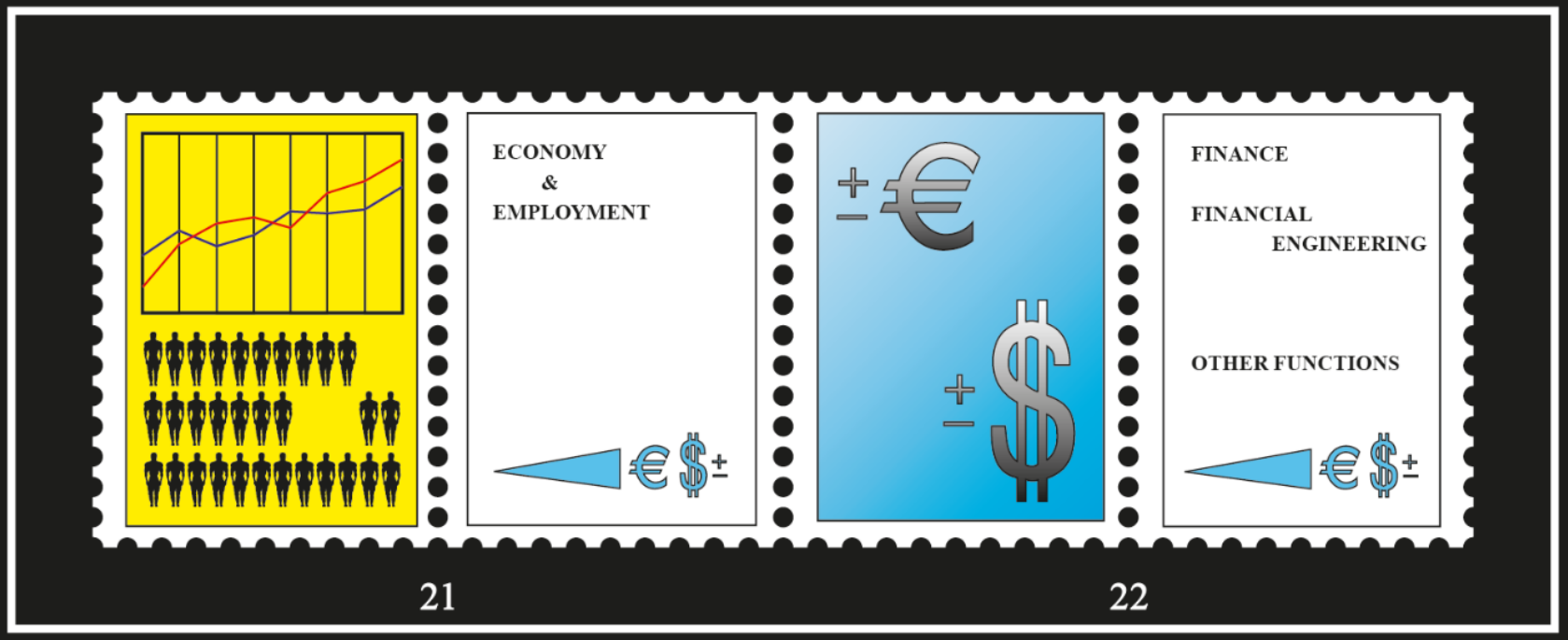


DEFENCE
&
RISK MANAGEMENT

SAFETY & SECURITY

19

20



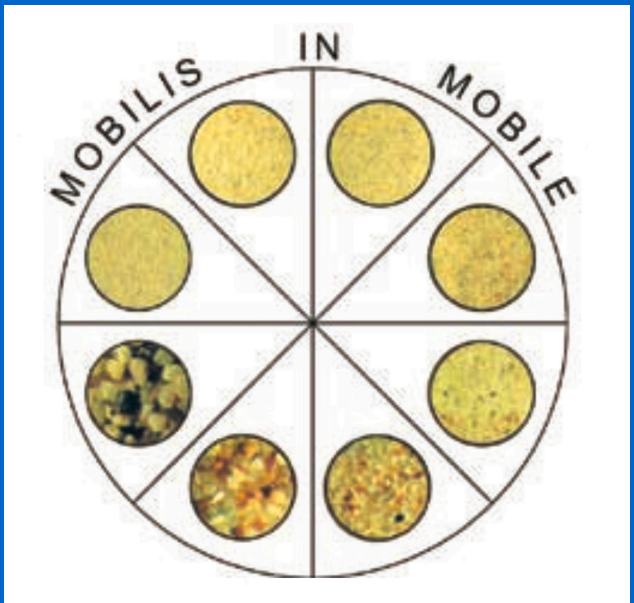
BUILDING WITH NATURE

Realisation of new land, where nature allows us to do so, using the principle of *Building with Nature*.

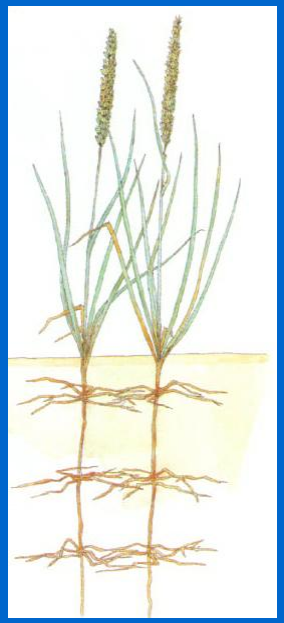
The essence of this principle is:

Flexible integration of land in sea and of water in the new land, making use of materials and forces/interactions, present in nature, taking into account existing and potential nature values, and the biogeomorphology & geohydrology of coast and seabed.

BUILDING WITH NATURE



Loose mobile material sand & silt from coarse to fine and the forces & interactions to which they are exposed



INORGANIC MATERIALS
gravel/sand
silt/clay

ORGANIC MATERIALS
flora & fauna

FORCES & INTERACTIONS:

01. Tidal action (ebb & flood)

02. Wave action (specifically in the breaking zone) and swell action

03. Sea currents other than tidal currents

04. River outflow (as force and as supplier of freshwater and sediment)

05. Gravity

06. Wind

07. Rain

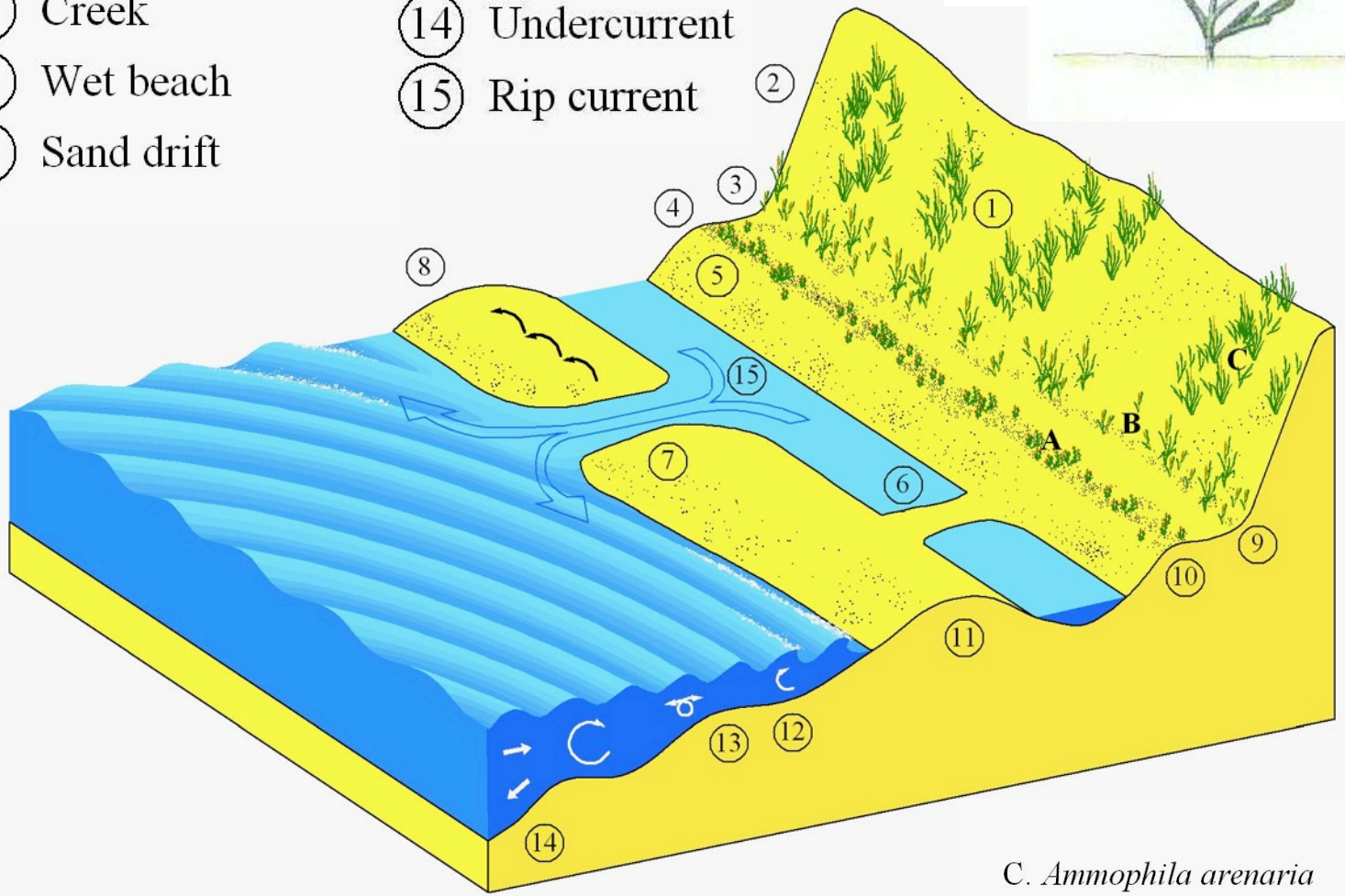
08. Solar radiation

09. Interaction dunes - vegetation (root system vegetation keeps together sand/silt)

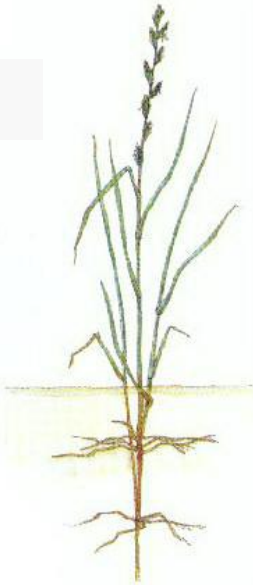
10. Complex interaction marine organisms - sand/silt.

BIOGEOMORPHOLOGY & GEOHYDROLOGY OF COAST AND SEABED

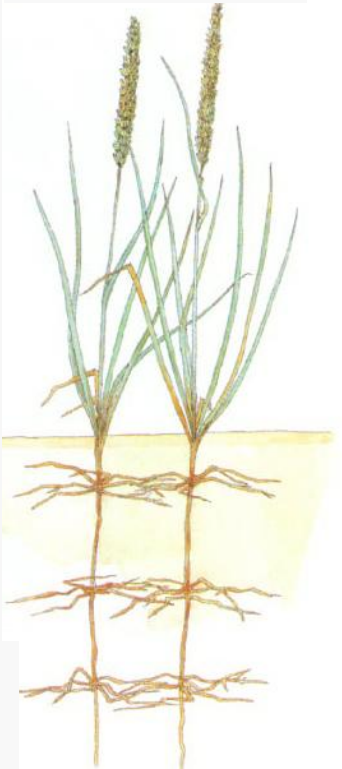
1. Dune
2. Coastal strip
3. Dune toe
4. Flood mark
5. Dry beach
6. Creek
7. Wet beach
8. Sand drift
9. High water during storm surge
10. High water
11. Low water
12. Geo valley in surf zone
13. Geo ridge in surf zone
14. Undercurrent
15. Rip current



A. *Cakile maritima*



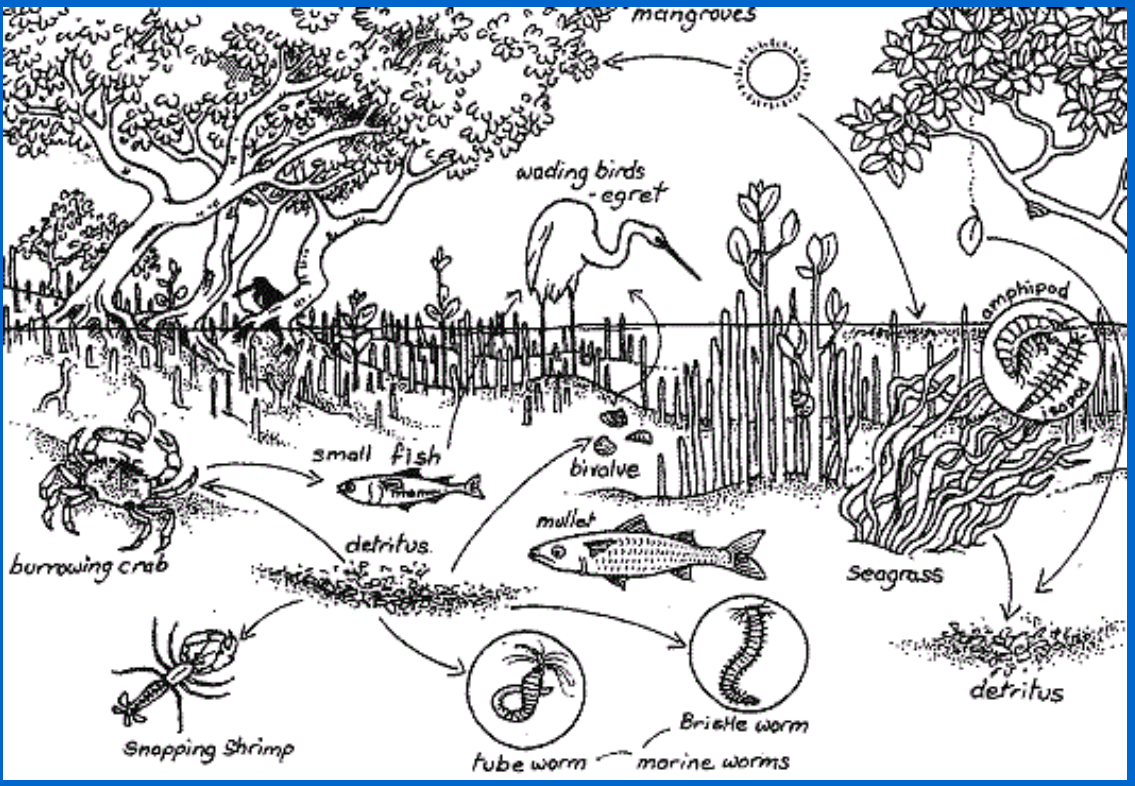
B. *Elytrigia juncea*



C. *Ammophila arenaria*

Application of mangroves in silty coastal zones for coastal protection & nature development especially in tropical & subtropical areas

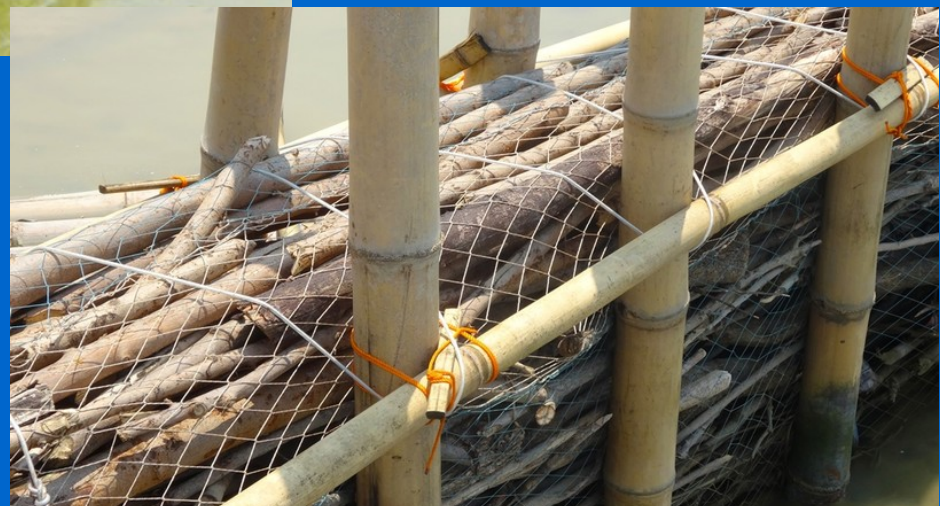
Mangroves



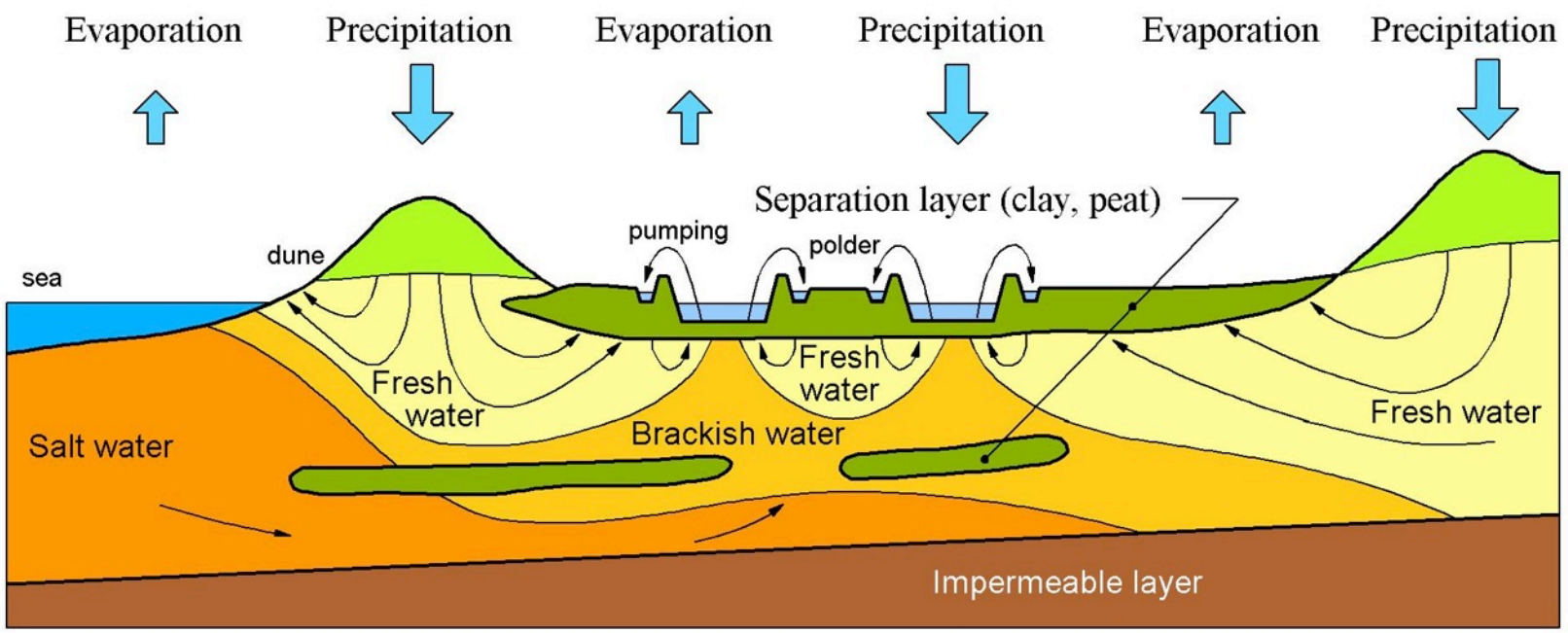
- **Shoreline protection from erosion**
- **Basis for the complex marine food chain**
- **Creation of breeding habitats**
- **Protection for maturing offspring**
- **Filtering and assimilation of pollutants from upland runoffs**
- **Stabilisation of bottom sediment**
- **Improvement of water quality**

Semi Permeable Dam

To initiate intertidal silt sedimentation for natural mangrove formation



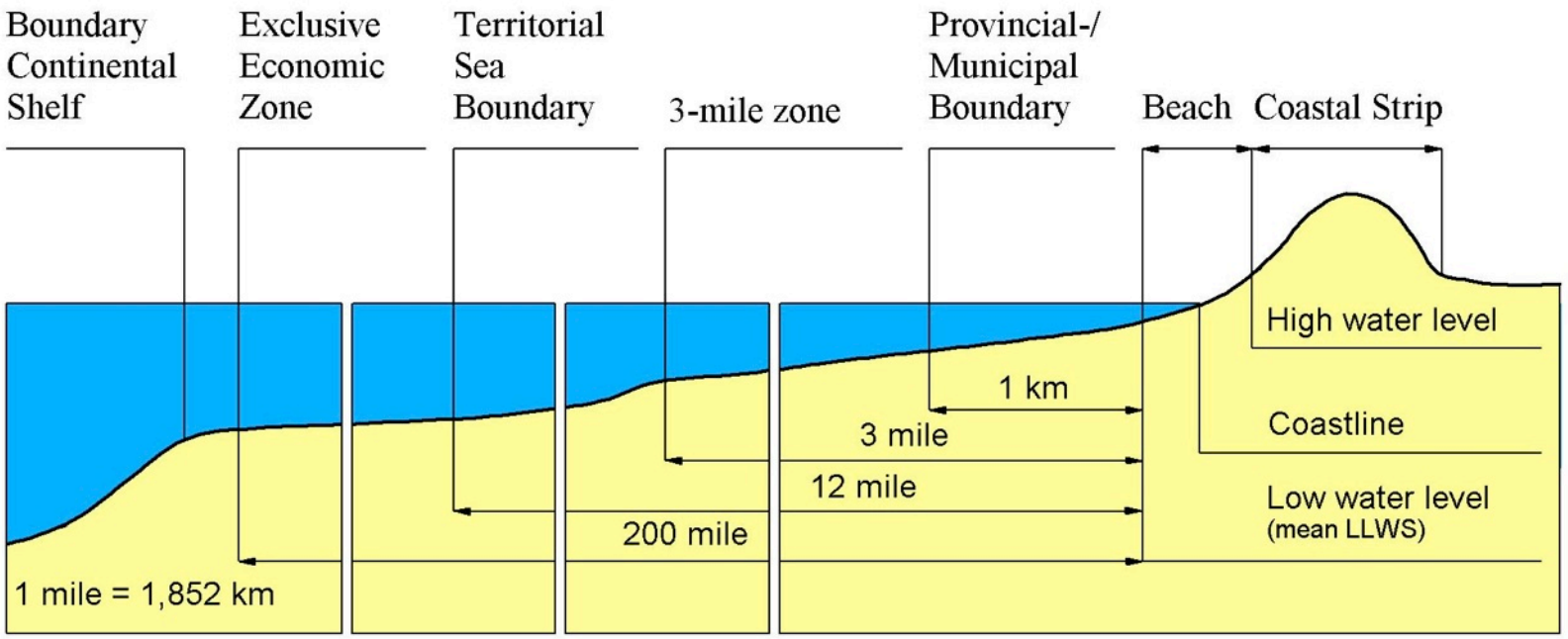
BUILDING WITH NATURE



CROSS SECTION SUBSOIL OF WEST-HOLLAND

Data: Rijks Geologische Dienst - S. Jelgersma

BUILDING WITH NATURE



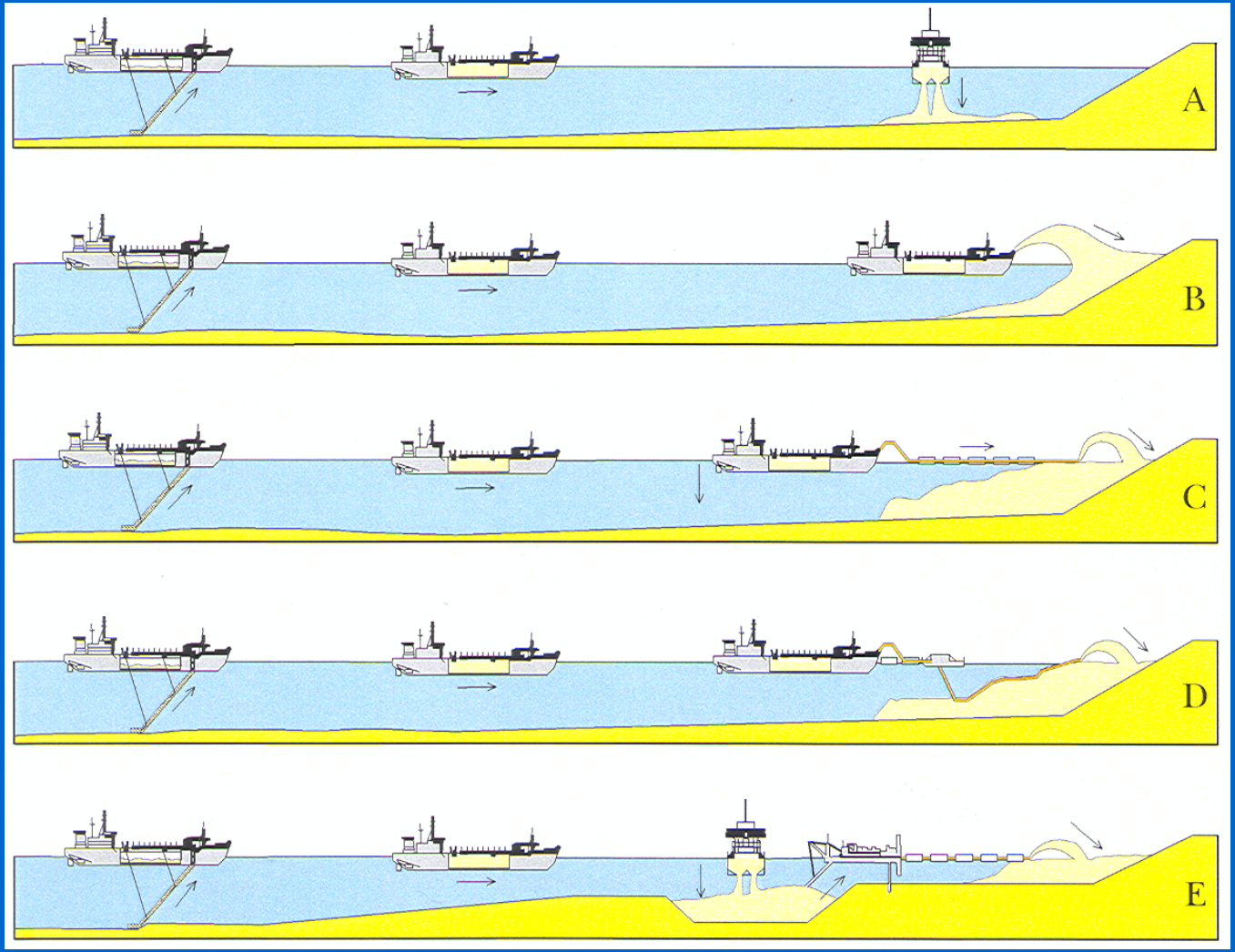
CROSS SECTION COASTAL ZONE

with national & international boundaries

Data: Chef der Hydrografie W.A. van Gein

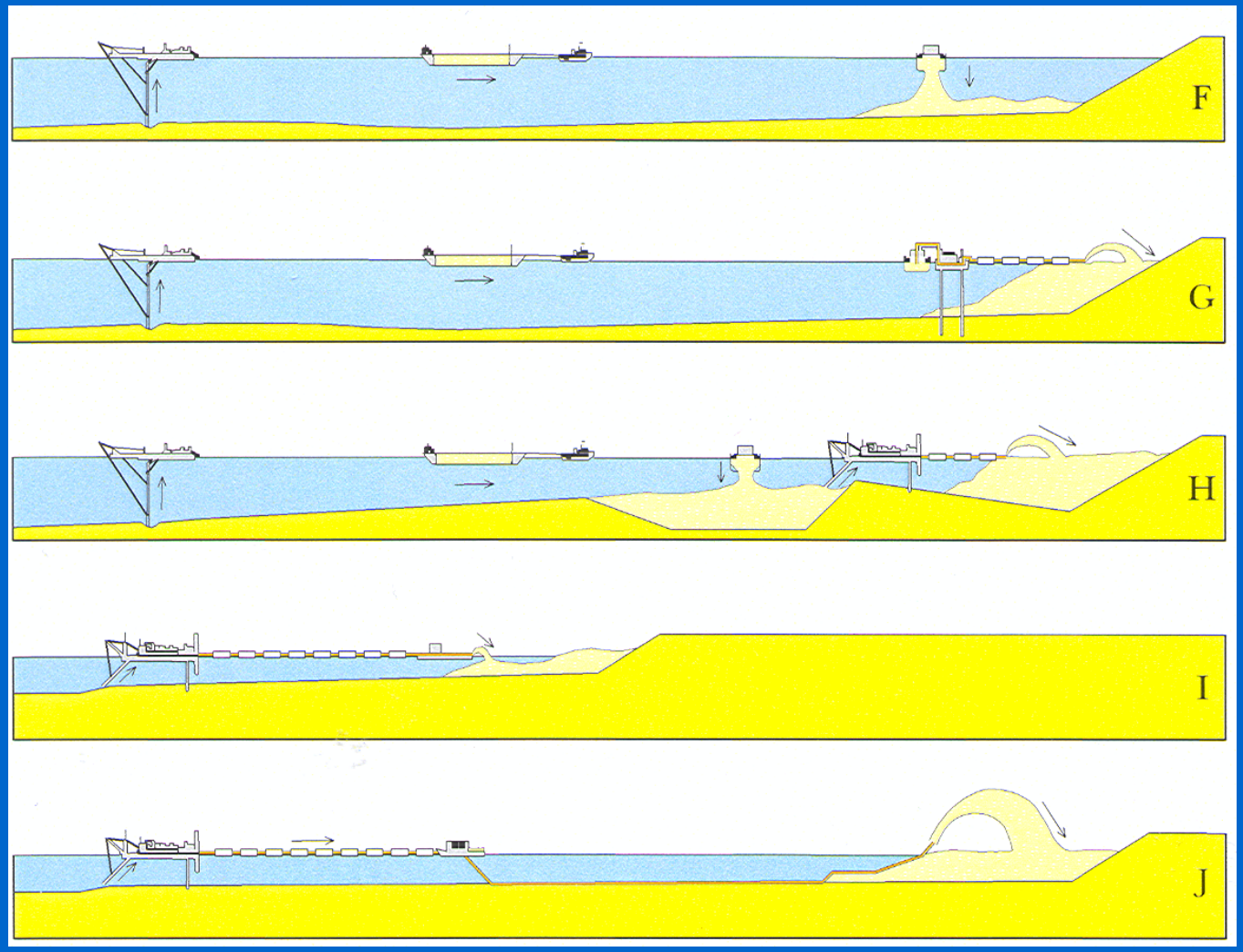
Dredging for Land Reclamation & Beach Nourishment

BUILDING WITH NATURE



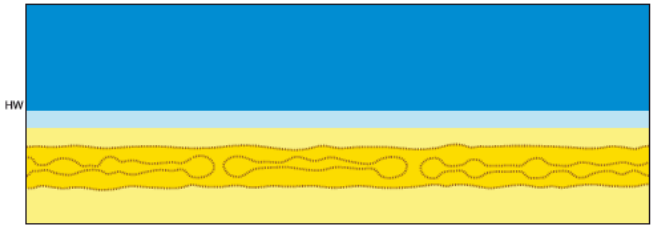
Dredging for Land Reclamation & Beach Nourishment

BUILDING WITH NATURE

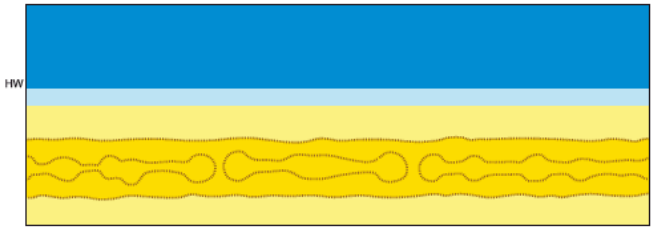


SOLUTIONS IN FULL HARMONY WITH NATURE: NATURAL BEACHES AND DUNES

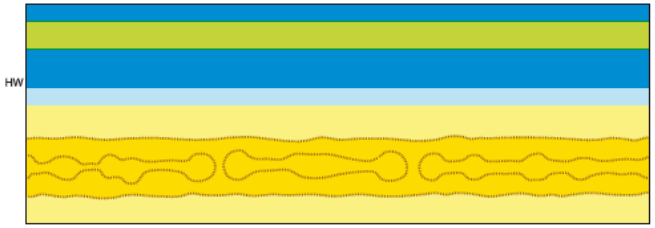
I.A.1
Existing Coastline
with Beach and Dunes



I.A.2
Dune and Beach
Nourishment

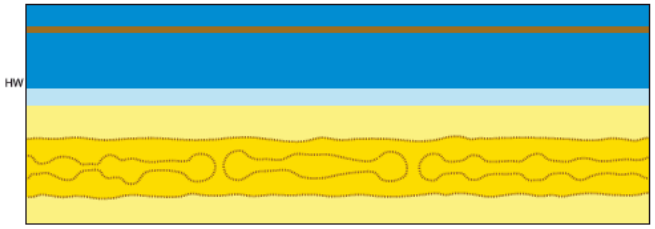


I.A.3
Foreshore Nourishment

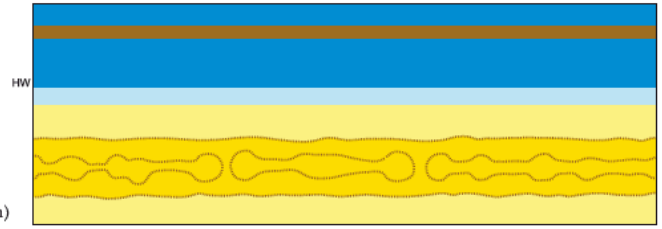


SOLUTIONS USING ARTIFICIAL STRUCTURES IN HARMONY WITH NATURE

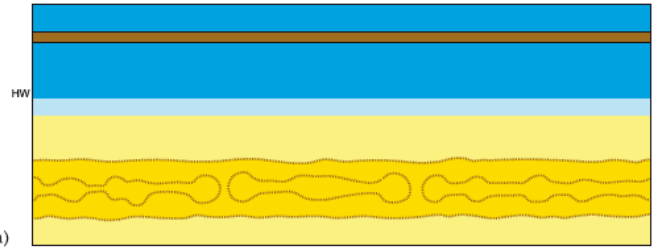
I.B.1
Submerged
Parallel Berm /
Perched Beach
(Sand Retaining Dam)



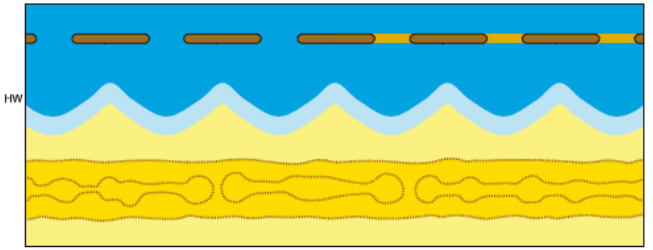
I.B.2
Submerged Offshore
Breakwater - Reef Type
(Sand Retaining Dam,
Wave Energy Reduction)



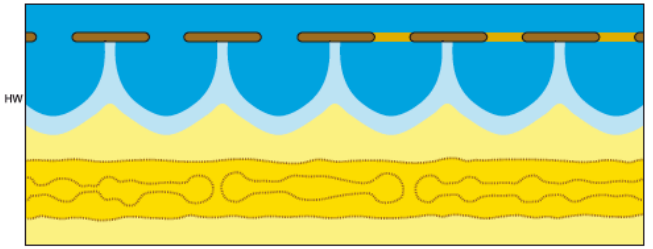
I.B.3
Offshore Breakwater
(Sand Retaining Dam,
Wave Energy Reduction)



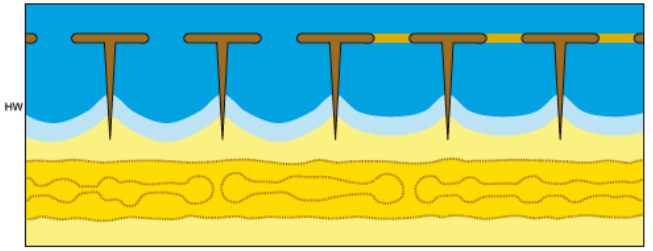
I.B.4
Multiple Offshore
Breakwaters without or
with sills
(Salient Beaches)



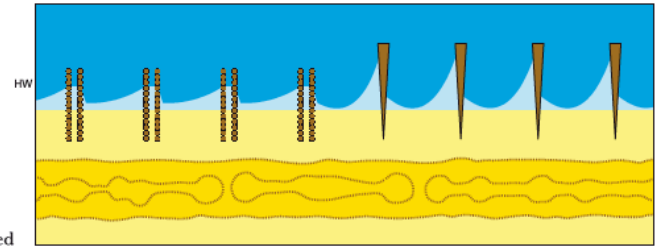
I.B.5
Multiple Offshore
Breakwaters without or
with sills
(Tombolo Beaches)



I.B.6
T-shaped Breakwaters
without or with sills
(Pocket Beaches)

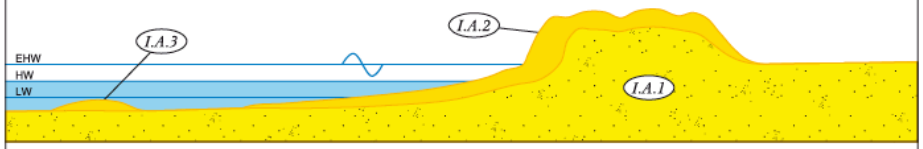


I.B.7
Groynes, Open or Closed



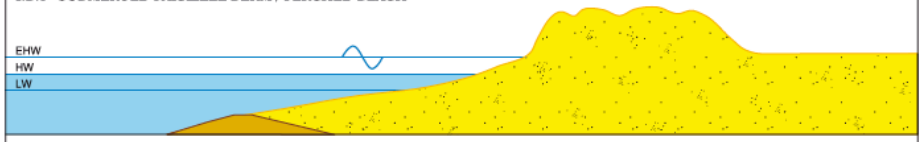
NATURAL BEACHES AND DUNES

I.A.1,2,3 WITH OR WITHOUT FORESHORE AND ONSHORE NOURISHMENT

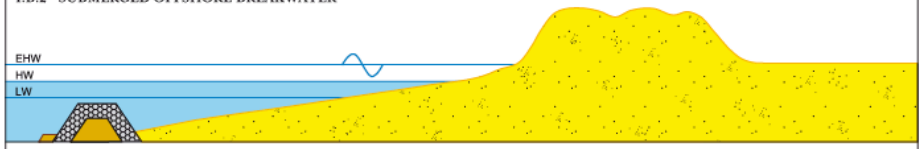


SEMI-NATURAL BEACHES AND DUNES

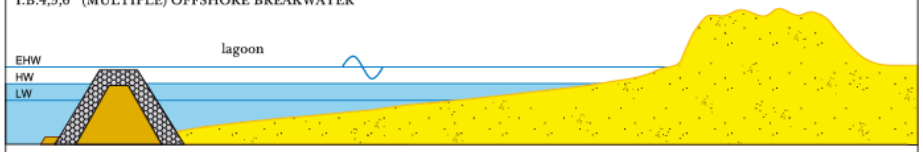
I.B.1 SUBMERGED PARALLEL BERM / PERCHED BEACH



I.B.2 SUBMERGED OFFSHORE BREAKWATER

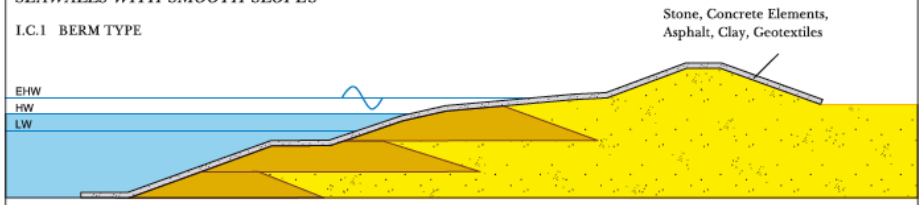


I.B.4,5,6 (MULTIPLE) OFFSHORE BREAKWATER

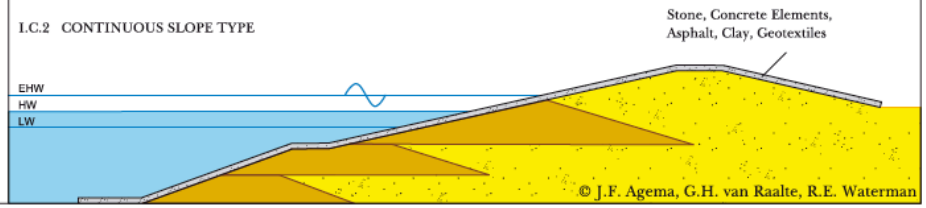


SEAWALLS WITH SMOOTH SLOPES

I.C.1 BERM TYPE

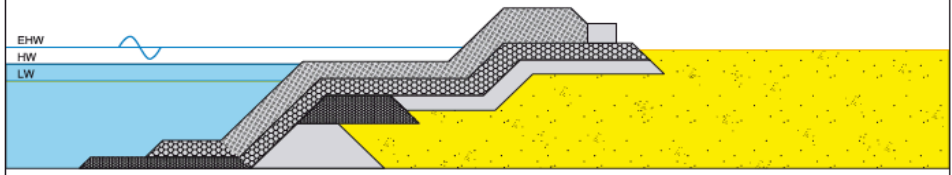


I.C.2 CONTINUOUS SLOPE TYPE

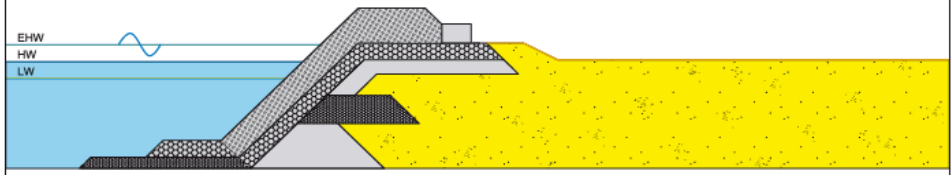


SEAWALLS WITH STEEP SLOPES

I.D.1 BERM TYPE

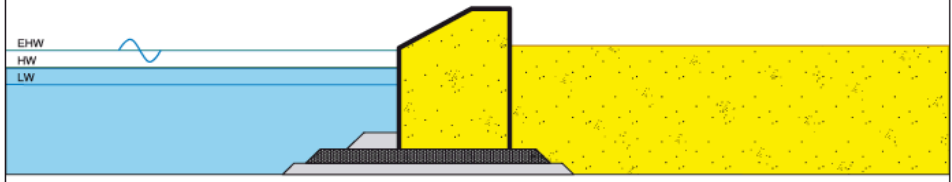


I.D.2 CONTINUOUS SLOPE TYPE

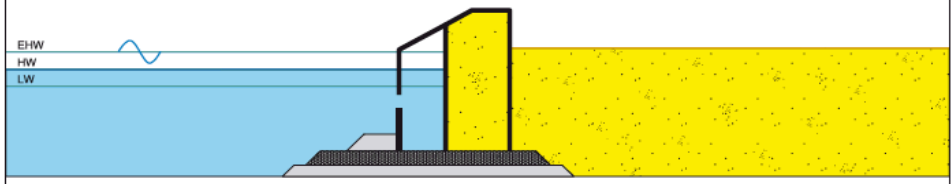


SEAWALLS WITH CAISSONS

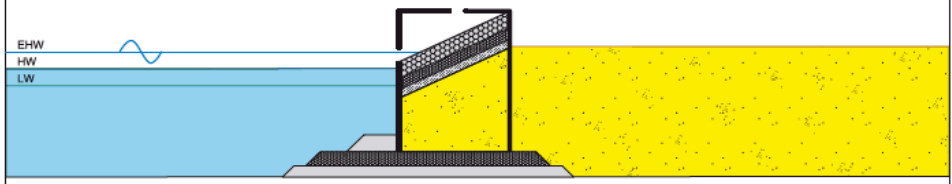
I.E.1 HANTSHOLM TYPE

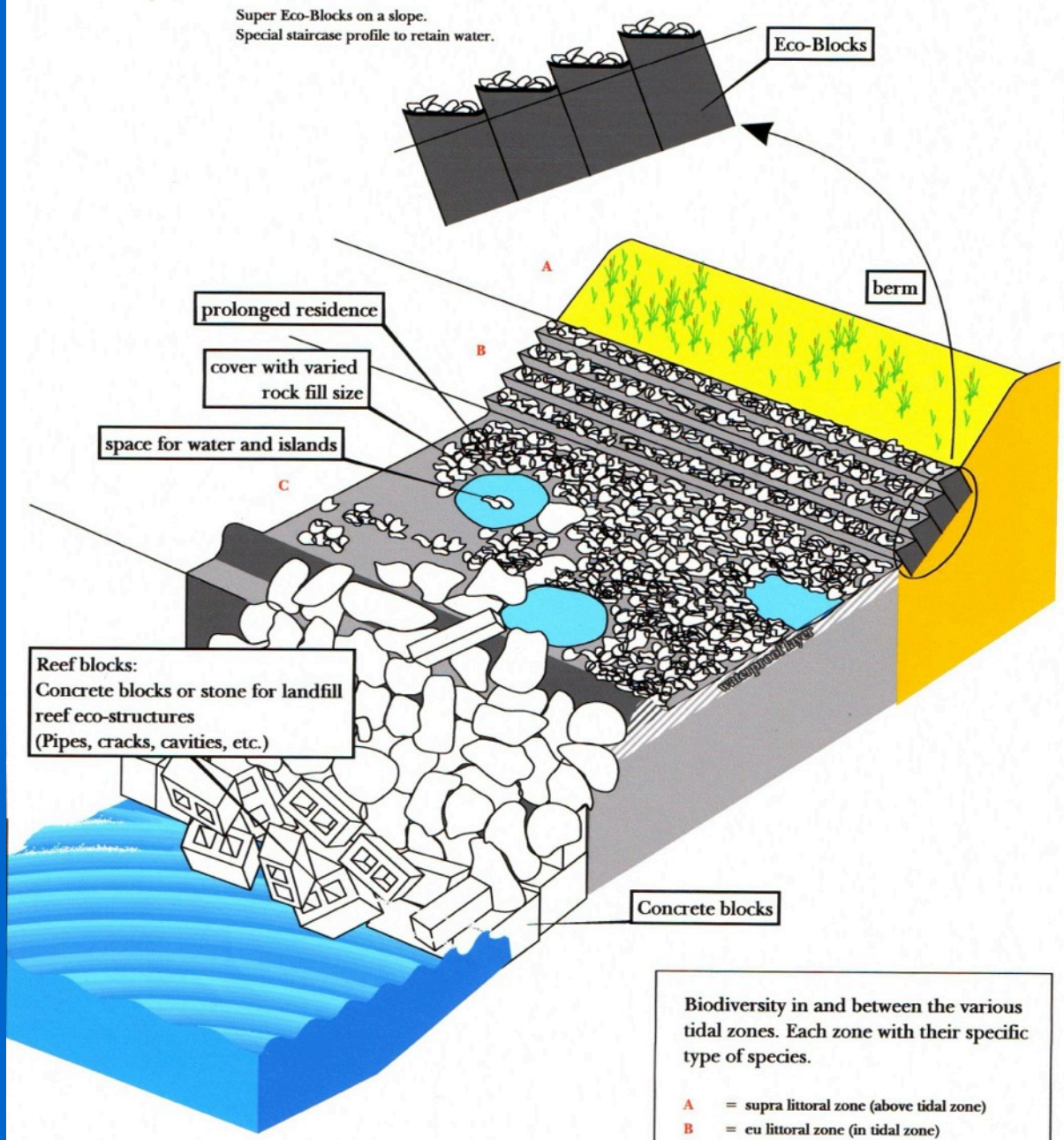


I.E.2 HANTSHOLM TYPE PERFORATED



I.E.3 HANTSHOLM TYPE PERFORATED WITH INTERNAL ROCK SLOPE





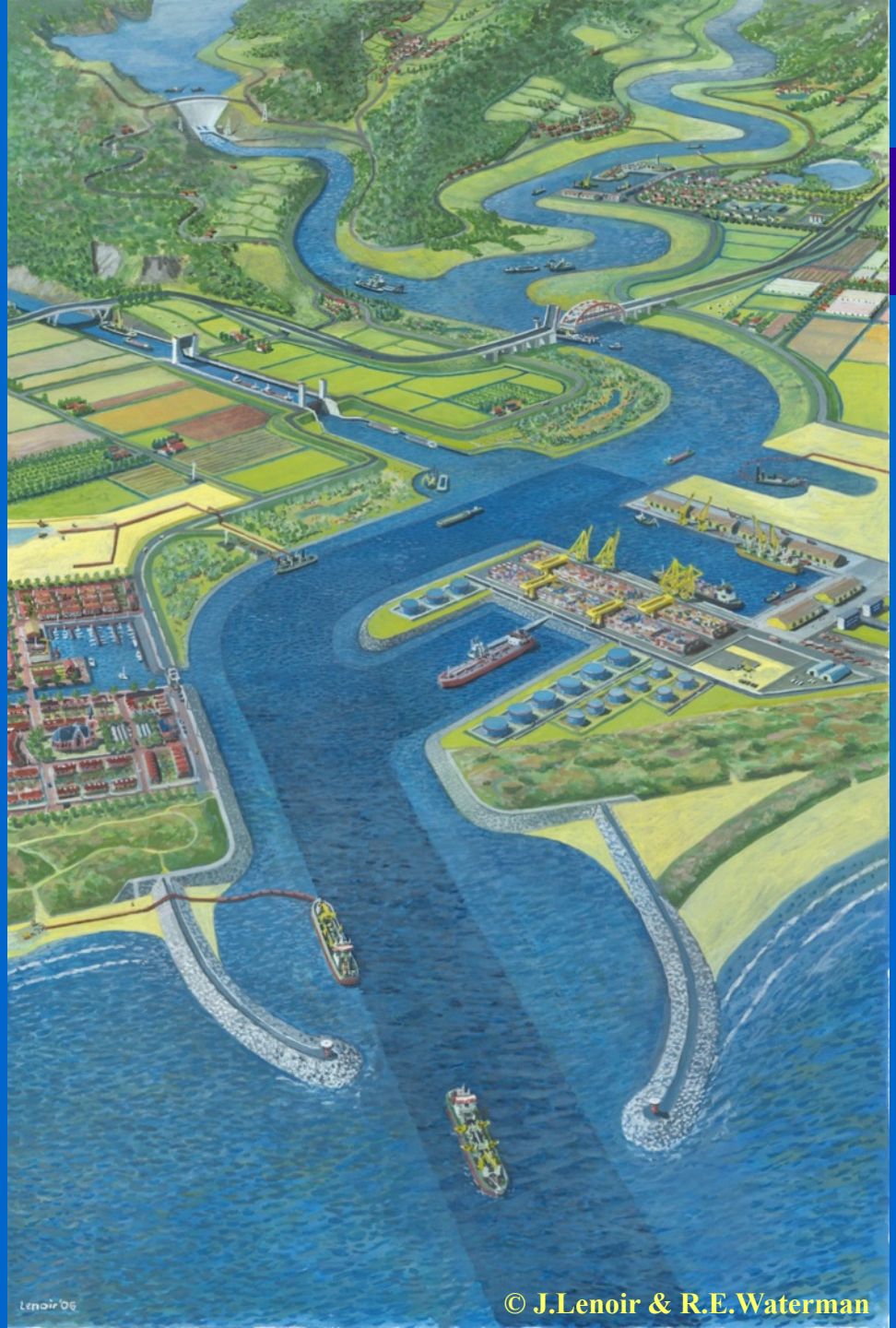
ECO DAM / ECO DIKE

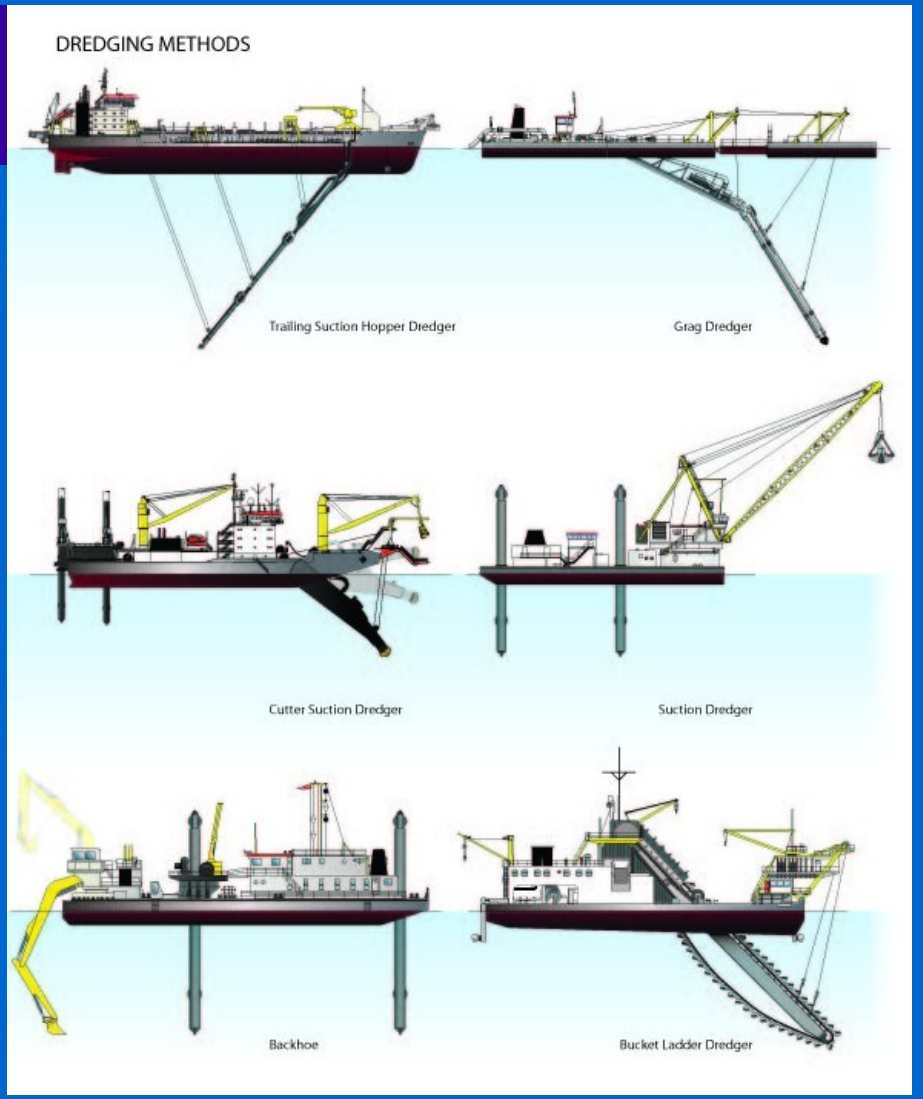
Eco X-block

Concrete eco elements

after 6 months

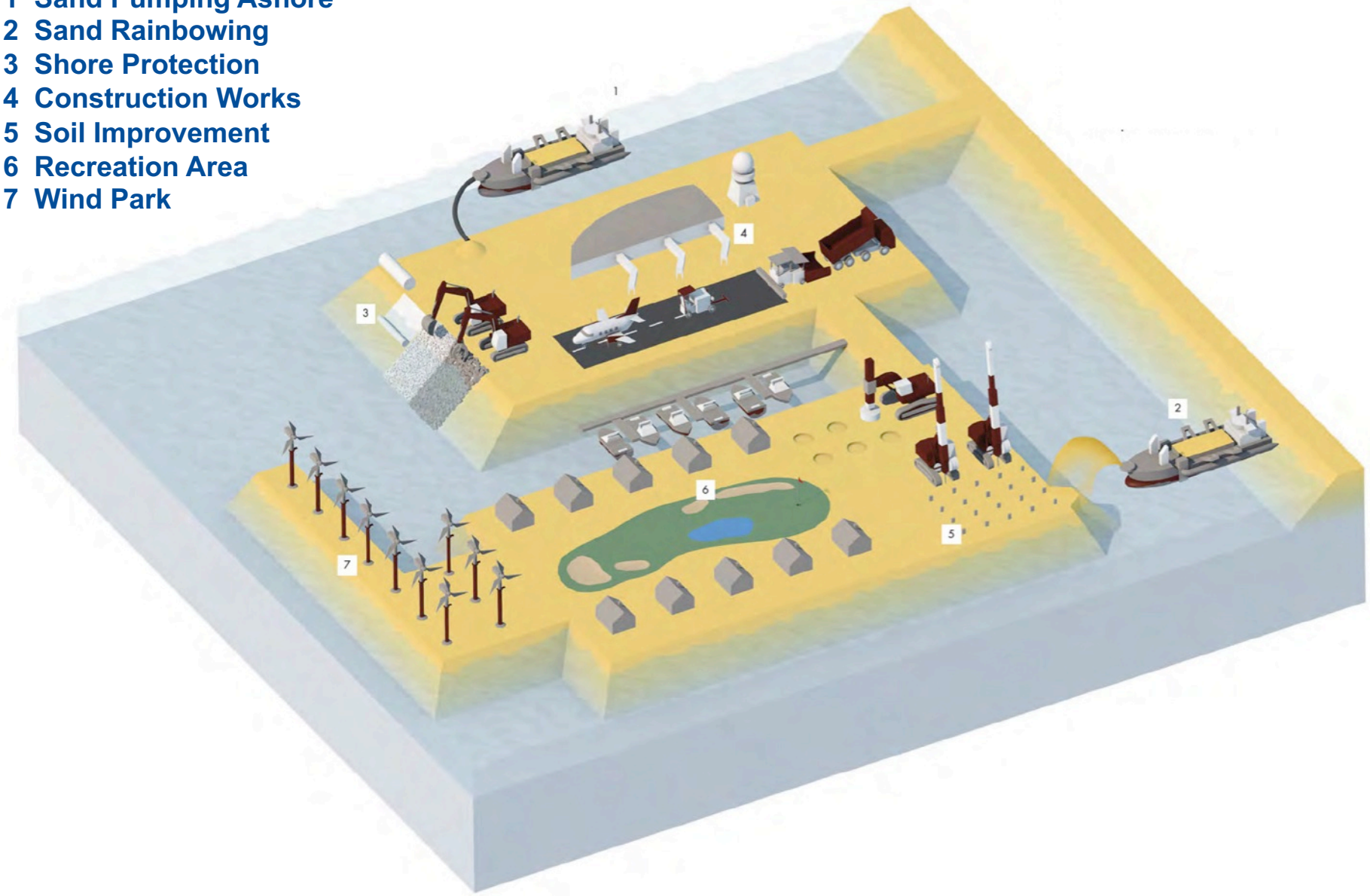
Dredging Methods





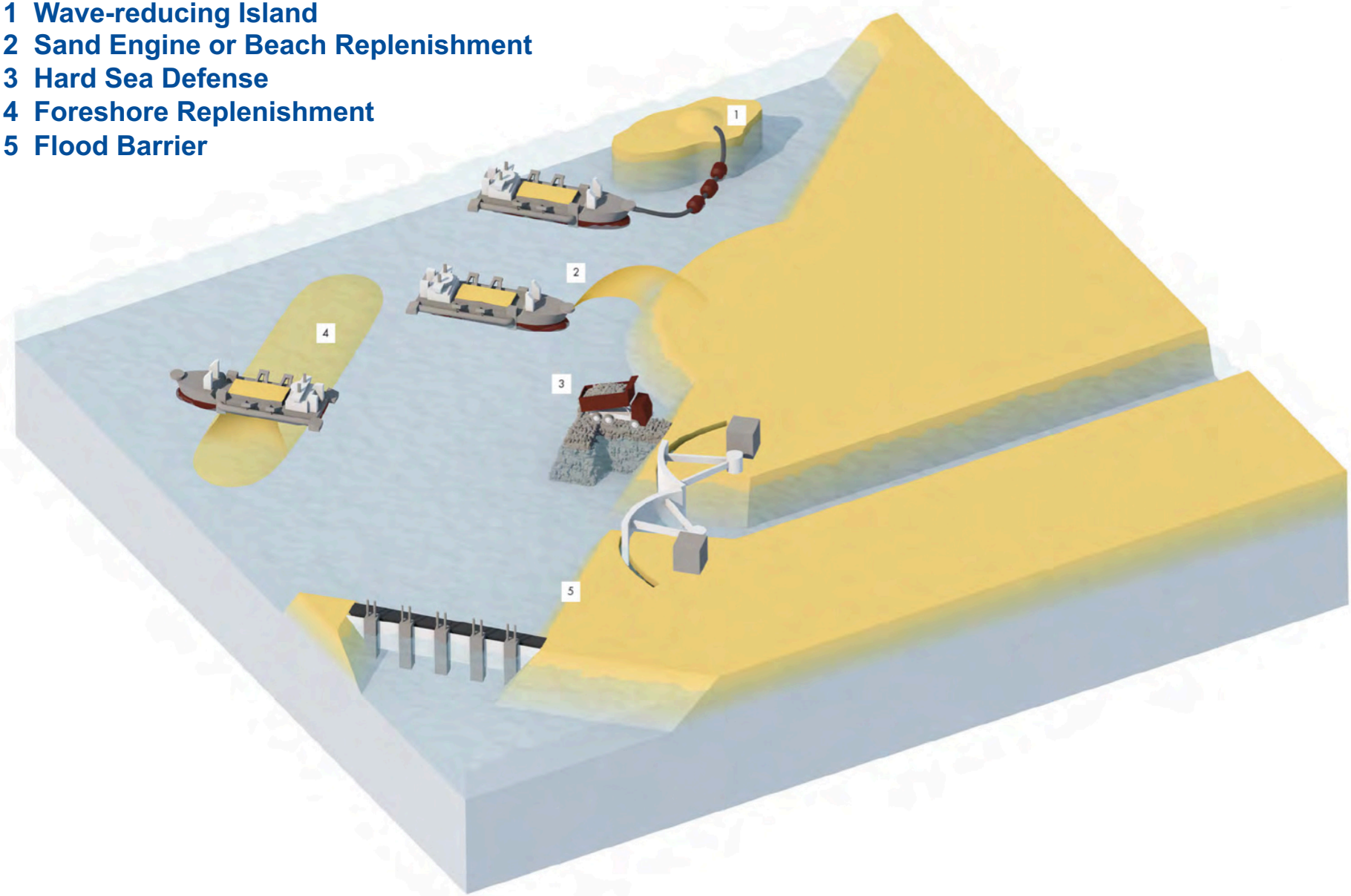
Land Reclamation

1 Sand Pumping Ashore
2 Sand Rainbowing
3 Shore Protection
4 Construction Works
5 Soil Improvement
6 Recreation Area
7 Wind Park



Coastal Protection

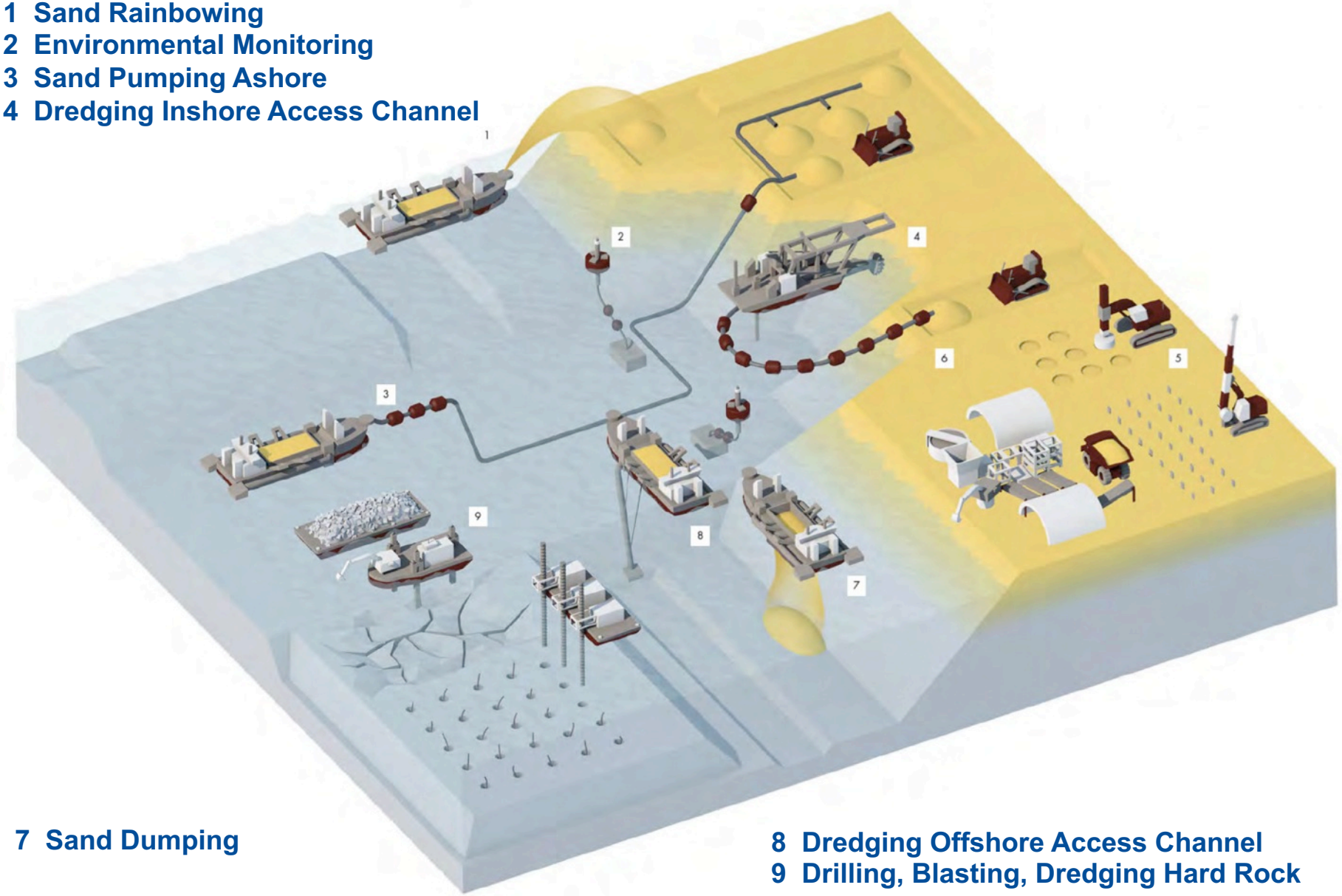
1 Wave-reducing Island
2 Sand Engine or Beach Replenishment
3 Hard Sea Defense
4 Foreshore Replenishment
5 Flood Barrier



Port Development

1 Sand Rainbowing
2 Environmental Monitoring
3 Sand Pumping Ashore
4 Dredging Inshore Access Channel

5 Soil Improvement Techniques
6 Soil Remediation

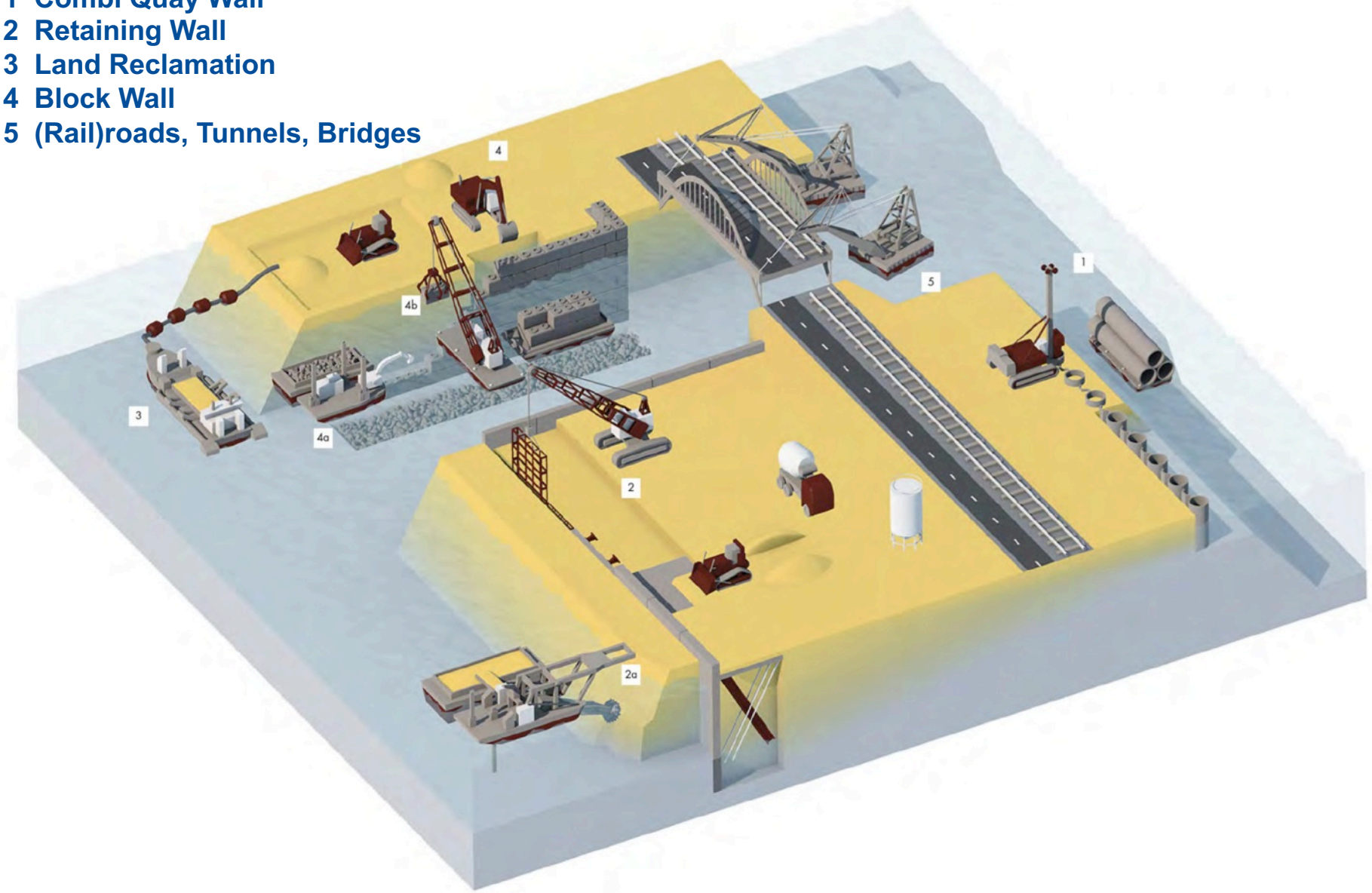


7 Sand Dumping

8 Dredging Offshore Access Channel
9 Drilling, Blasting, Dredging Hard Rock

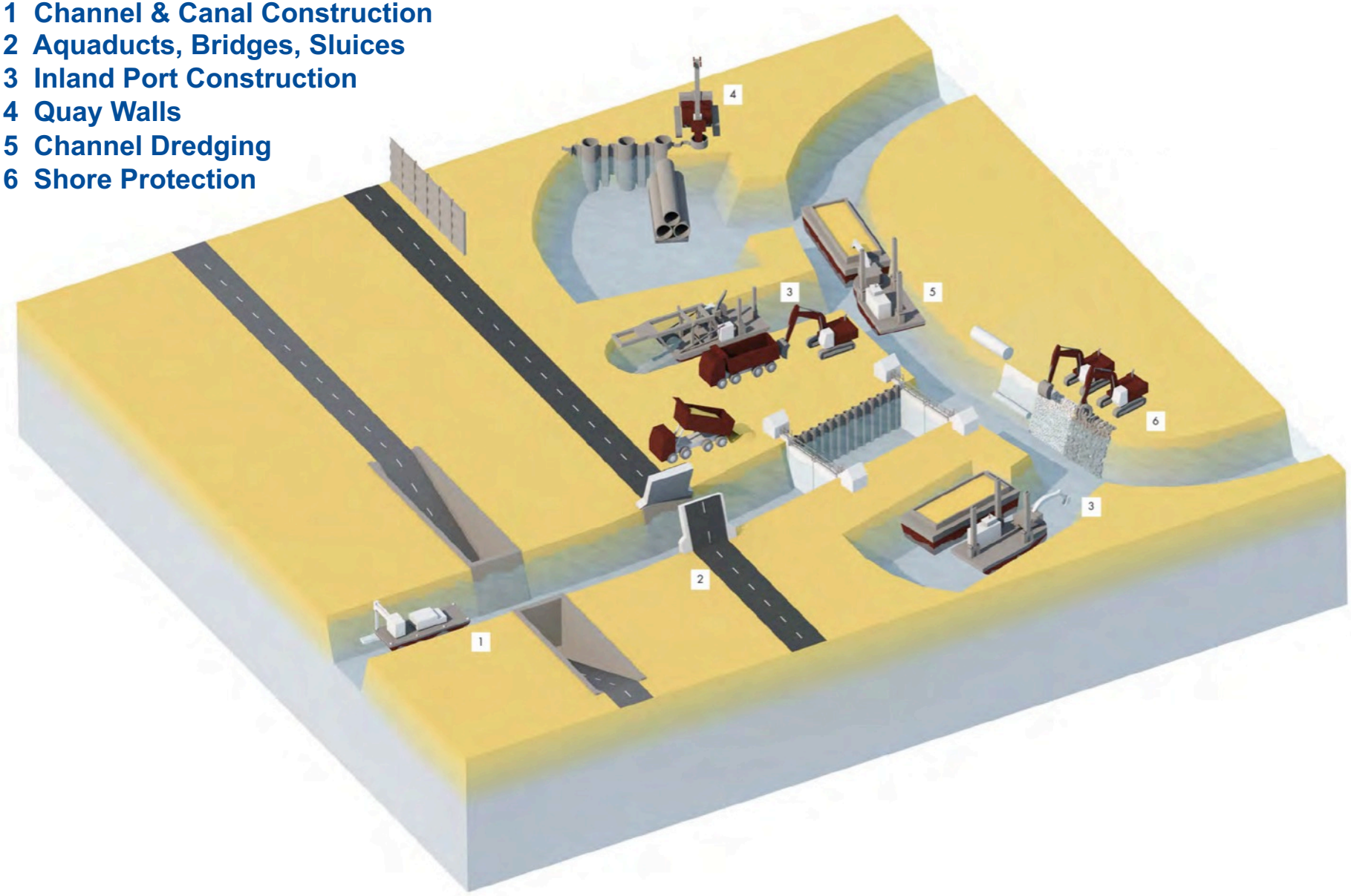
Port Infrastructure

1 Combi Quay Wall
2 Retaining Wall
3 Land Reclamation
4 Block Wall
5 (Rail)roads, Tunnels, Bridges



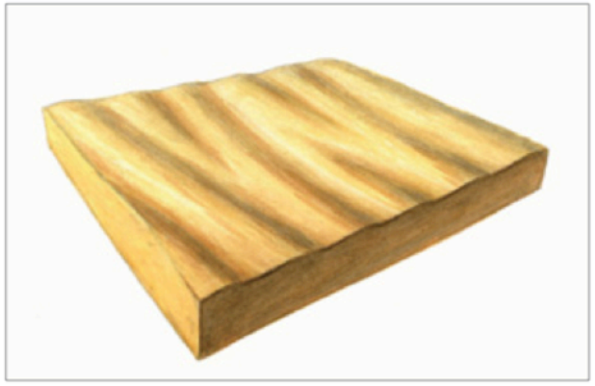
Inland Ports & Waterways

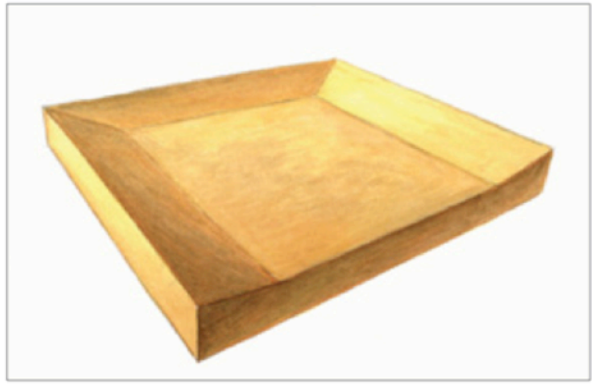
1 Channel & Canal Construction
2 Aquaducts, Bridges, Sluices
3 Inland Port Construction
4 Quay Walls
5 Channel Dredging
6 Shore Protection



ENVIRONMENT-FRIENDLY DREDGING METHODS

1. Dredging in alternate zones
2. Sub-surface dredging
3. Application of silt screens
4. Specially designed suction heads & pumping systems
5. Eco-efficient dredging: instead of shallow dredging over large areas, deep dredging over small areas, combined with seabed landscaping

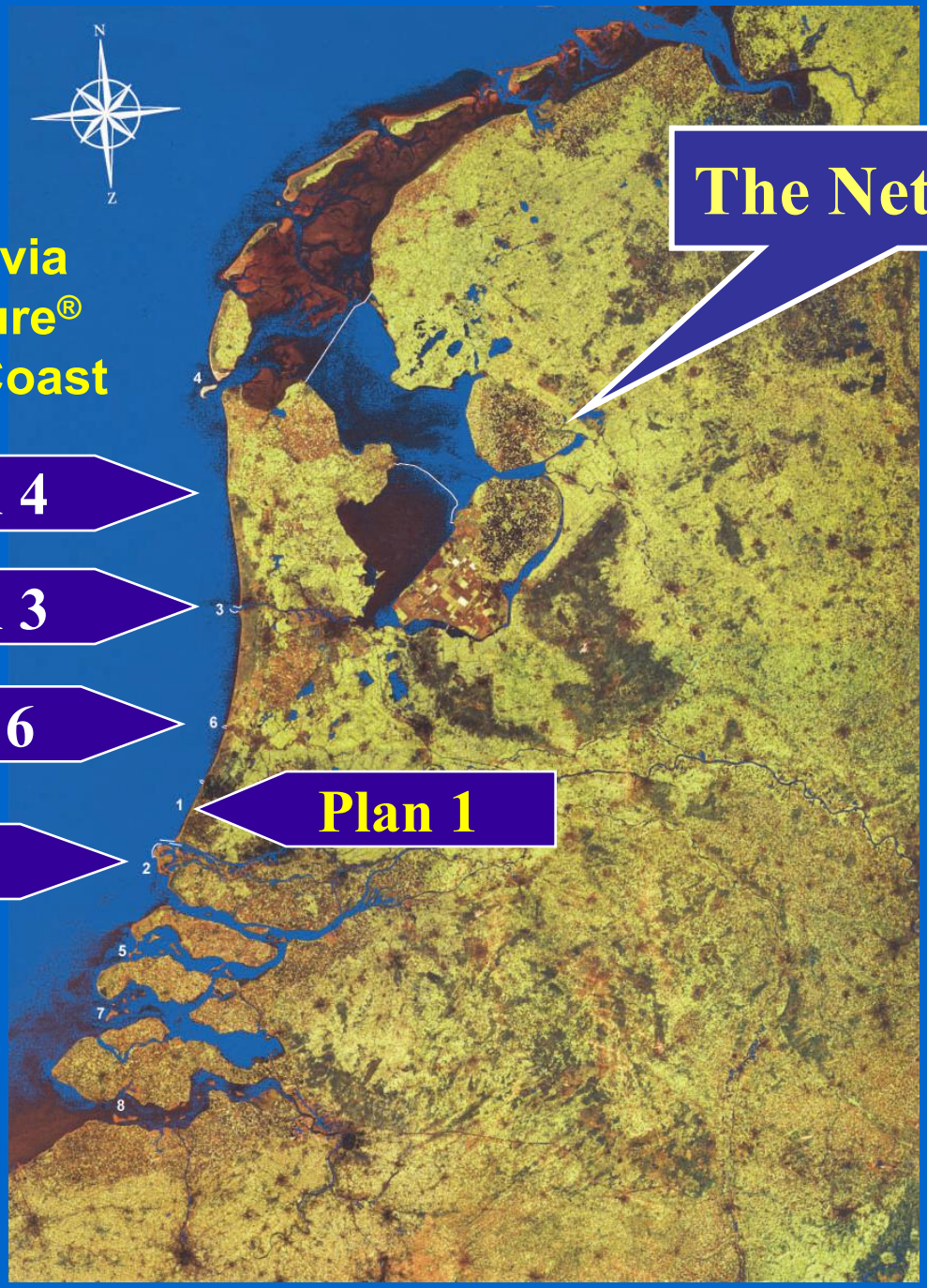




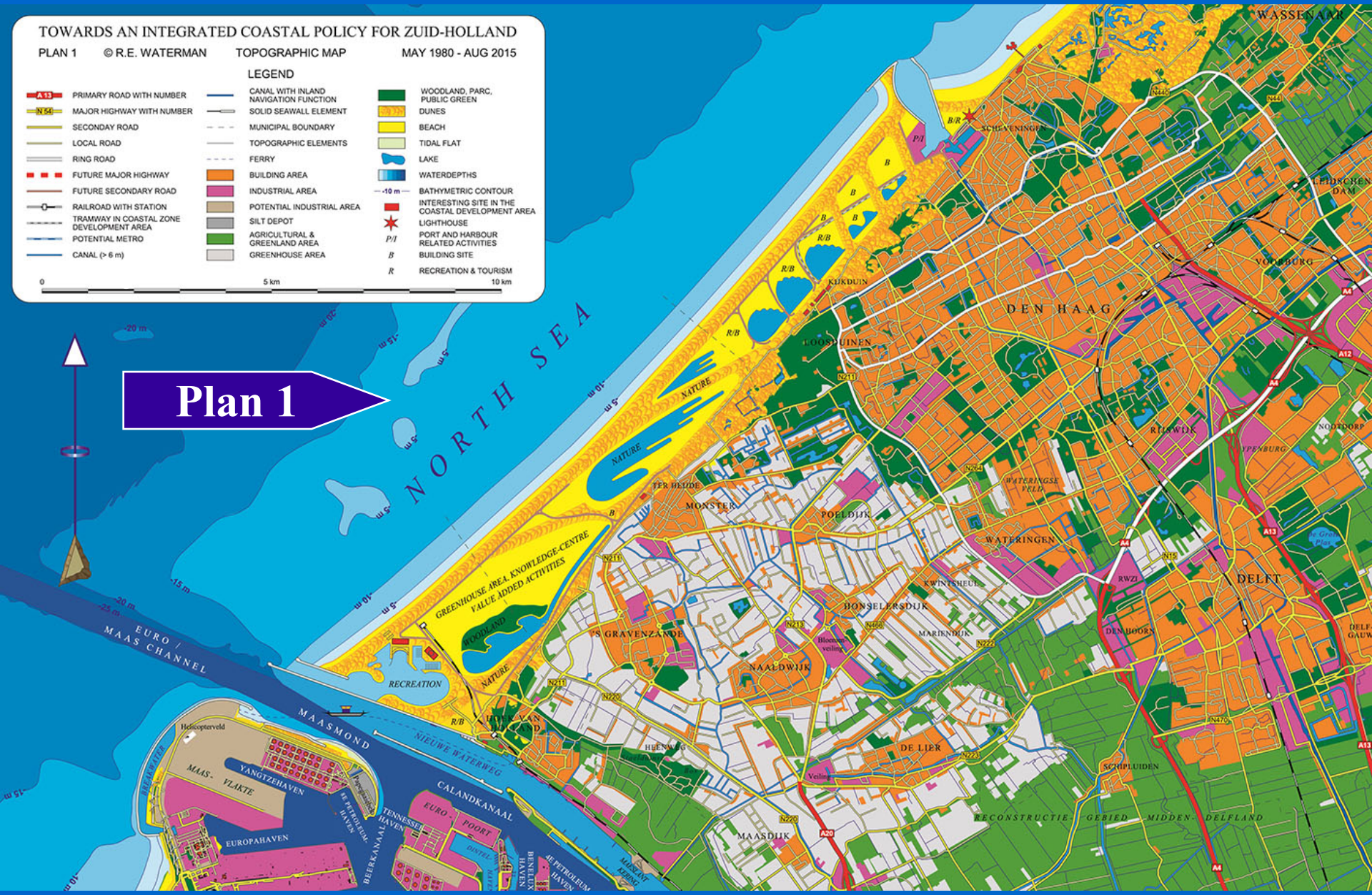
EUROPE

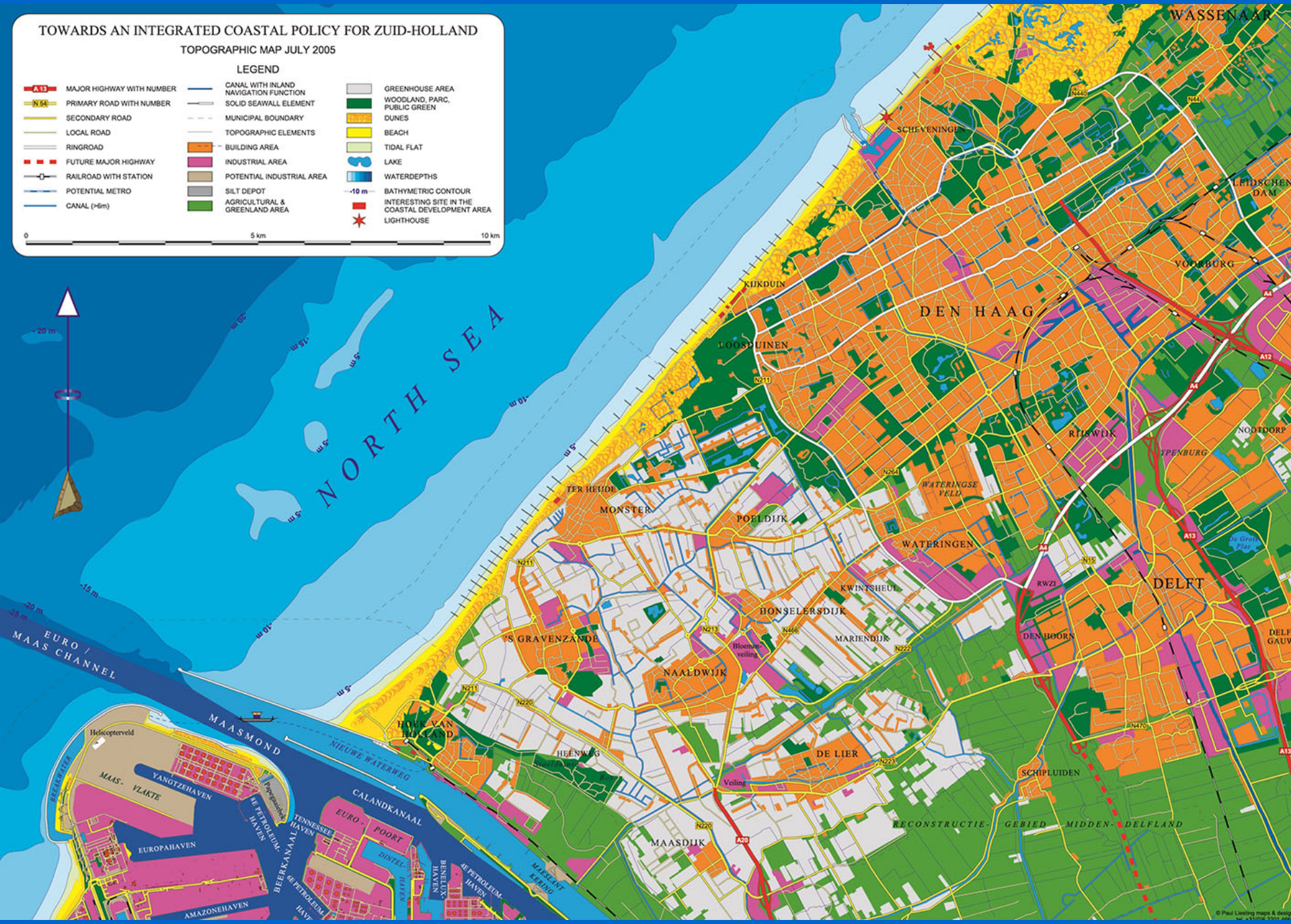
Plan A

Land reclamation via Building with Nature® along North Sea Coast



Integrated Coastal Policy via Building with Nature®


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 © R.E. WATERMAN TOPOGRAPHIC MAP MAY 1980 - AUG 2015
LEGEND
PRIMARY ROAD WITH NUMBER
MAJOR HIGHWAY WITH NUMBER
SECONDAY ROAD
LOCAL ROAD
RING ROAD
FUTURE MAJOR HIGHWAY
FUTURE SECONDARY ROAD
RAILROAD WITH STATION
TRAMWAY IN COASTAL ZONE DEVELOPMENT AREA
POTENTIAL METRO
CANAL (> 6 m)
CANAL WITH INLAND NAVIGATION FUNCTION
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
TOPOGRAPHIC ELEMENTS
FERRY
BUILDING AREA
INDUSTRIAL AREA
POTENTIAL INDUSTRIAL AREA
SILT DEPOT
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
LIGHTHOUSE
PORT AND HARBOUR RELATED ACTIVITIES
BUILDING SITE
RECREATION & TOURISM
0
5 km
10 km
Plan 1
NORTH SEA
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
GREENHOUSE AREA, KNOWLEDGE-CENTRE VALUE ADDED ACTIVITIES
RECREATION
NATURE
WOODLAND
DEN HAAG
WASSENAAR
SCHEVENINGEN
KIJKDUIN
LOOSDUINEN
MONSTER
POELDIJK
WATERINGEN
RIJSWIJK
VOORBURG
LEIDSCHENDAM
NOORDPOLDER
WATERINGSE VELD
DELFT
RWZI
KWINTSHEUL
DONSELERSDIJK
MARIENDIJK
DEN HOORN
'S GRAVENZANDE
NAALDWIJK
DE LIER
MAASDIJK
SCHIPLUIDEN
RECONSTRUCTIE GEBIED MIDDEN-DELFLAND
Helicopterveld
MAAS-VLAKTE
YANGTZEHAVEN
EUROPAHAVEN
EURO-POORT
TENNESSEEHAVEN
BEERKANAALHAVEN
BERGSE PLASSEN


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
TOPOGRAPHIC MAP JULY 2005
LEGEND
MAJOR HIGHWAY WITH NUMBER
PRIMARY ROAD WITH NUMBER
SECONDARY ROAD
LOCAL ROAD
RINGROAD
FUTURE MAJOR HIGHWAY
RAILROAD WITH STATION
POTENTIAL METRO
CANAL (>6m)
CANAL WITH INLAND NAVIGATION FUNCTION
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
TOPOGRAPHIC ELEMENTS
BUILDING AREA
INDUSTRIAL AREA
POTENTIAL INDUSTRIAL AREA
SILT DEPOT
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
LIGHTHOUSE
0
5 km
10 km
NORTH SEA
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
BEERKANAAL
Helicopterveld
MAAS-VLAKTE
YANGTZEHAVEN
EUROPAHAVEN
AMAZONEHAVEN
TENNESSEEHAVEN
EURO-POORT
BENELUXHAVEN
MAASLANT KERING
SCHEVENINGEN
KIJKDUIN
LOOSDUINEN
DEN HAAG
WASSENAAR
VOORBURG
RIJSWIJK
NOORDDORP
WATERINGSE VELD
TER HEIDE
MONSTER
POELDIJK
WATERINGEN
KWINTSHEUL
HONSELERSDIJK
MARIENDIJK
'S GRAVENZANDE
NAALDWIJK
HOEK VAN HOLLAND
HEENWEG
DE LIER
MAASDIJK
DELFT
DEN HOORN
SCHIPLUIDEN
RECONSTRUCTIE-GEBIED MIDDEN-DELFLAND
RWZI
Bloemenveiling
Veiling
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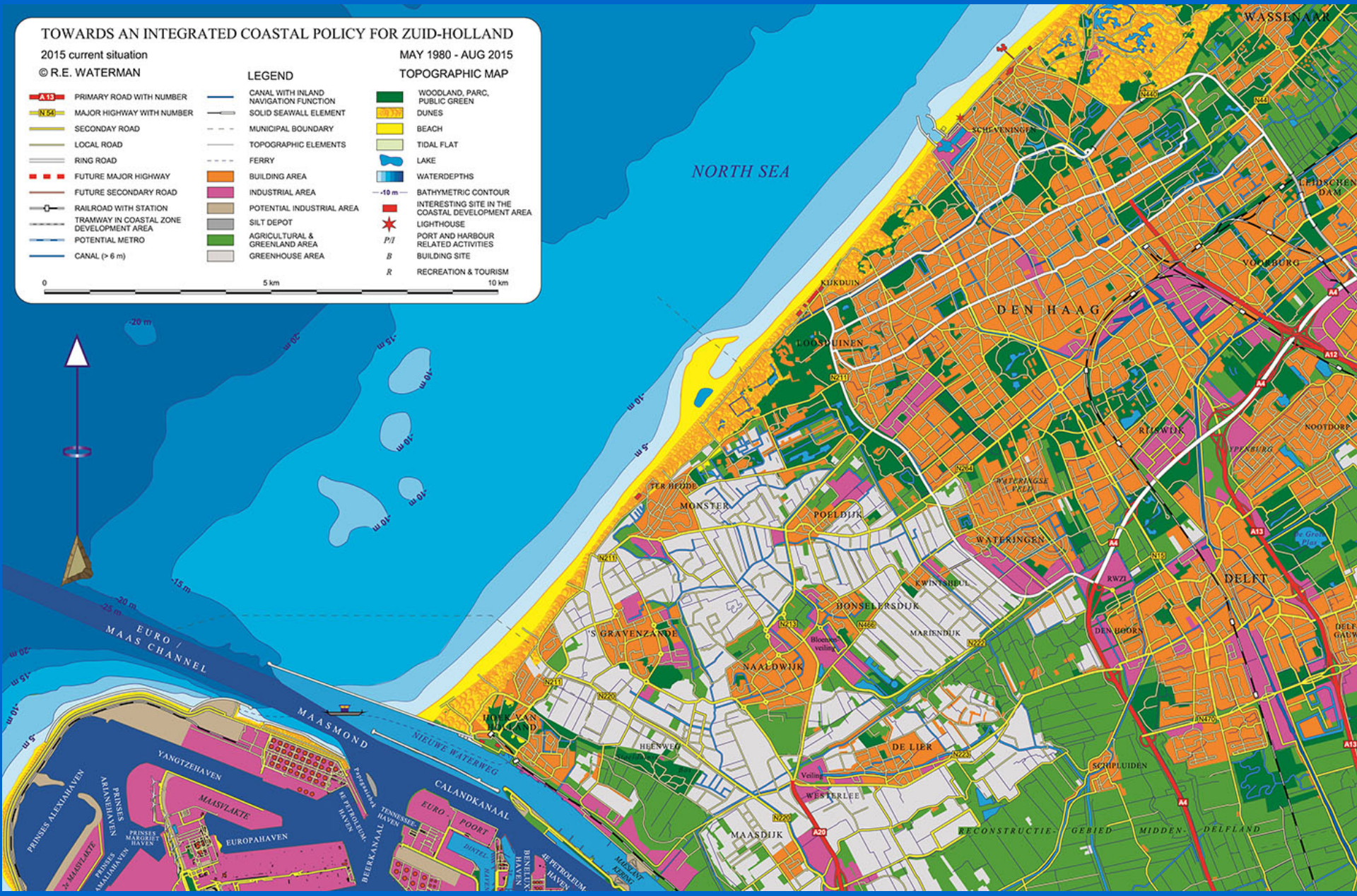
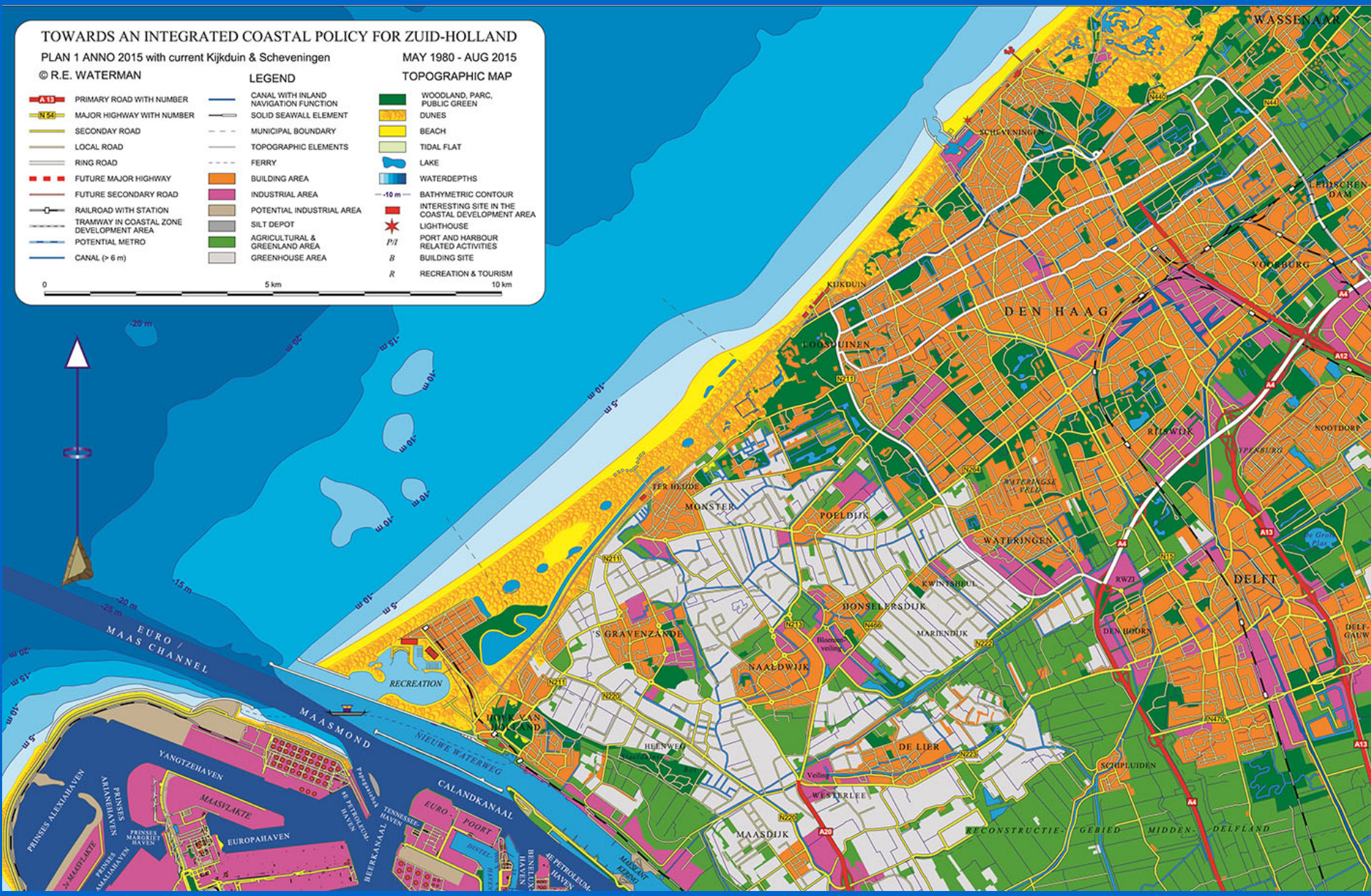

TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
2015 current situation
MAY 1980 - AUG 2015
© R.E. WATERMAN
LEGEND
TOPOGRAPHIC MAP
PRIMARY ROAD WITH NUMBER
MAJOR HIGHWAY WITH NUMBER
SECONDAY ROAD
LOCAL ROAD
RING ROAD
FUTURE MAJOR HIGHWAY
FUTURE SECONDARY ROAD
RAILROAD WITH STATION
TRAMWAY IN COASTAL ZONE DEVELOPMENT AREA
POTENTIAL METRO
CANAL (> 6 m)
CANAL WITH INLAND NAVIGATION FUNCTION
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
TOPOGRAPHIC ELEMENTS
FERRY
BUILDING AREA
INDUSTRIAL AREA
POTENTIAL INDUSTRIAL AREA
SILT DEPOT
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
LIGHTHOUSE
PORT AND HARBOUR RELATED ACTIVITIES
BUILDING SITE
RECREATION & TOURISM
0
5 km
10 km
NORTH SEA
WASSENAAR
SCHEVENINGEN
LEIDSCHENDAM
VOORBURG
KIJKDUIN
DEN HAAG
BOSDUINEN
RIJSWIJK
NOOTDORP
TER HEIDE
MONSTER
POELDIJK
WATERINGEN
DELFT
KWINTSHEUL
DONSELERSDIJK
MARIENDIJK
'S GRAVENZANDE
NAALDWIJK
DE LIER
DEN HOORN
SCHIPLUIDEN
HEENWEG
WESTERLEE
MAASDIJK
RECONSTRUCTIE-GEBIED MIDDEN-DELFLAND
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
YANGTZEHAVEN
MAASVLAKTE
EUROPAHAVEN
PRINSES ALEXIAHAVEN
PRINSES ARIANEHAVEN
PRINSES MARGRIETHAVEN
PRINSES AMALIAHAVEN
BEERKANAAL
PAPENDRECHT
SE PETROLEUM HAVEN
TENNESSEE HAVEN
EURO-POORT
BENELUX HAVEN
MAASVLAKTE 2
-20 m
-15 m
-10 m
-5 m
-25 m


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 ANNO 2015 with current Kijkduin & Scheveningen
MAY 1980 - AUG 2015
© R.E. WATERMAN
LEGEND
TOPOGRAPHIC MAP
PRIMARY ROAD WITH NUMBER
MAJOR HIGHWAY WITH NUMBER
SECONDAY ROAD
LOCAL ROAD
RING ROAD
FUTURE MAJOR HIGHWAY
FUTURE SECONDARY ROAD
RAILROAD WITH STATION
TRAMWAY IN COASTAL ZONE DEVELOPMENT AREA
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CANAL (> 6 m)
CANAL WITH INLAND NAVIGATION FUNCTION
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
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FERRY
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WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
LIGHTHOUSE
PORT AND HARBOUR RELATED ACTIVITIES
BUILDING SITE
RECREATION & TOURISM
0
5 km
10 km
WASSENAAR
SCHEVENINGEN
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VOORBURG
KIJKDUIN
DEN HAAG
LOOSDUINEN
RIJSWIJK
NOOTDORP
IJSSELBURG
IJFR BEUDE
MONSTER
POELDIJK
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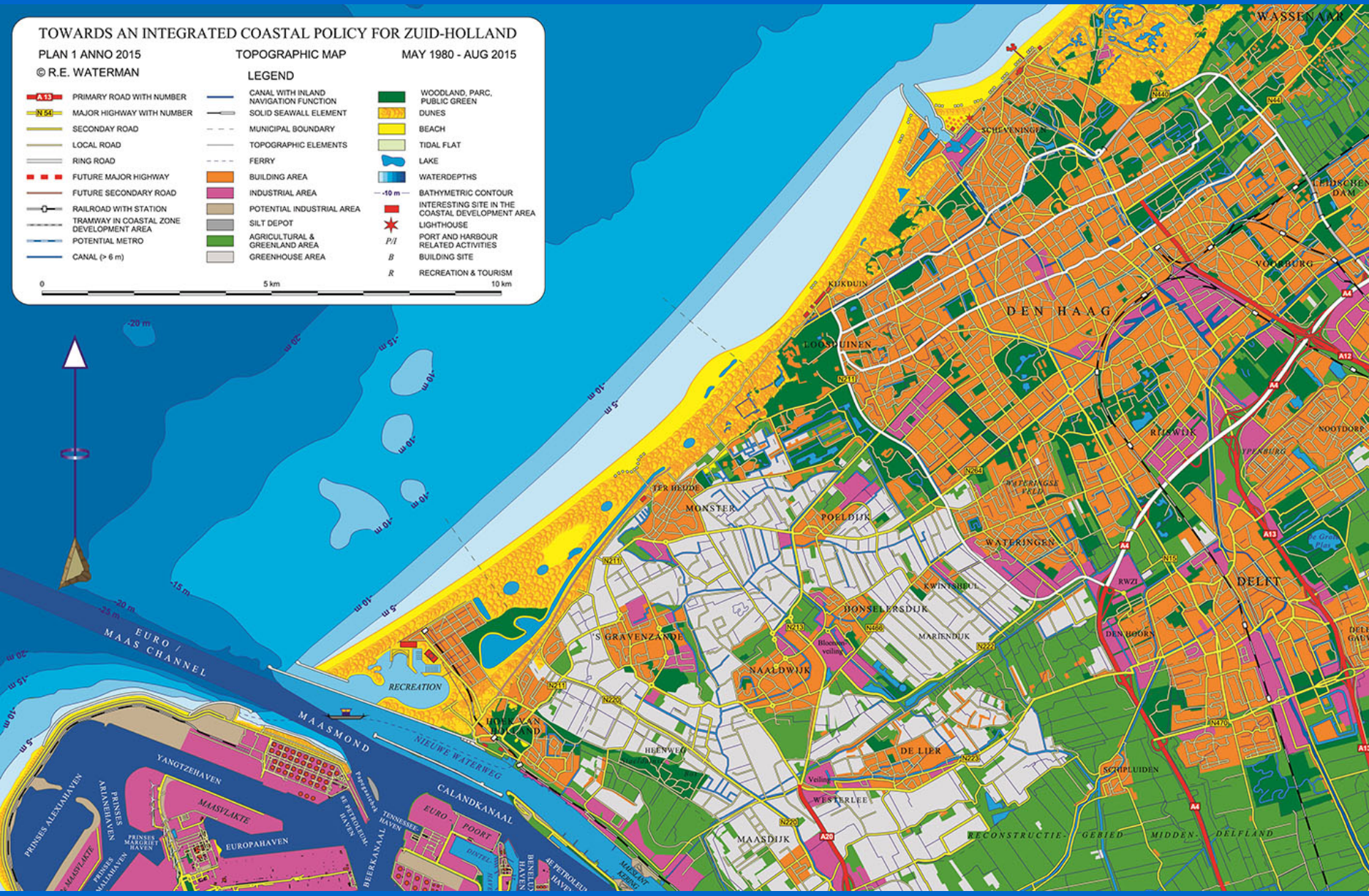
KWINTSHEUL
DONSELERSDIJK
MARIENDIJK
DEN HOORN
'S GRAVENZANDE
NAALDWIJK
DE LIER
SCHIPLUIDEN
WESTERLEE
MAASDIJK
RECONSTRUCTIE-GEBIED MIDDEN-DELFLAND
RECREATION
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
YANGTZEHAVEN
MAASVLAKTE
EUROPAHAVEN
EURO POORT
PRINSES ALEXIAHAVEN
PRINSES ARANJEHAVEN
PRINSES MARGRIET HAVEN
PRINSES AMALIAHAVEN
BEERKANAAL
TENNESSEEHAVEN
1E PETROLEUMHAVEN
2E PETROLEUMHAVEN
BENELUXHAVEN
MASSANT KEIDAM
-20 m
-15 m
-10 m
-5 m


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 ANNO 2015
TOPOGRAPHIC MAP
MAY 1980 - AUG 2015
© R.E. WATERMAN
LEGEND
A 13 PRIMARY ROAD WITH NUMBER
N 54 MAJOR HIGHWAY WITH NUMBER
SECONDAY ROAD
LOCAL ROAD
RING ROAD
FUTURE MAJOR HIGHWAY
FUTURE SECONDARY ROAD
RAILROAD WITH STATION
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WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH
TIDAL FLAT
LAKE
WATERDEPTHS
-10 m BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
LIGHTHOUSE
P/I PORT AND HARBOUR RELATED ACTIVITIES
B BUILDING SITE
R RECREATION & TOURISM
0
5 km
10 km
WASSENAAR
SCHEVENINGEN
KIJKDUIN
DEN HAAG
LOOSDUINEN
VOORBURG
RIJSWIJK
NOOTDORP
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PRINSES ARIANEHAVEN
PRINSES MARGRIET HAVEN
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TINNESSEE-HAVEN
EURO POORT
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-20 m
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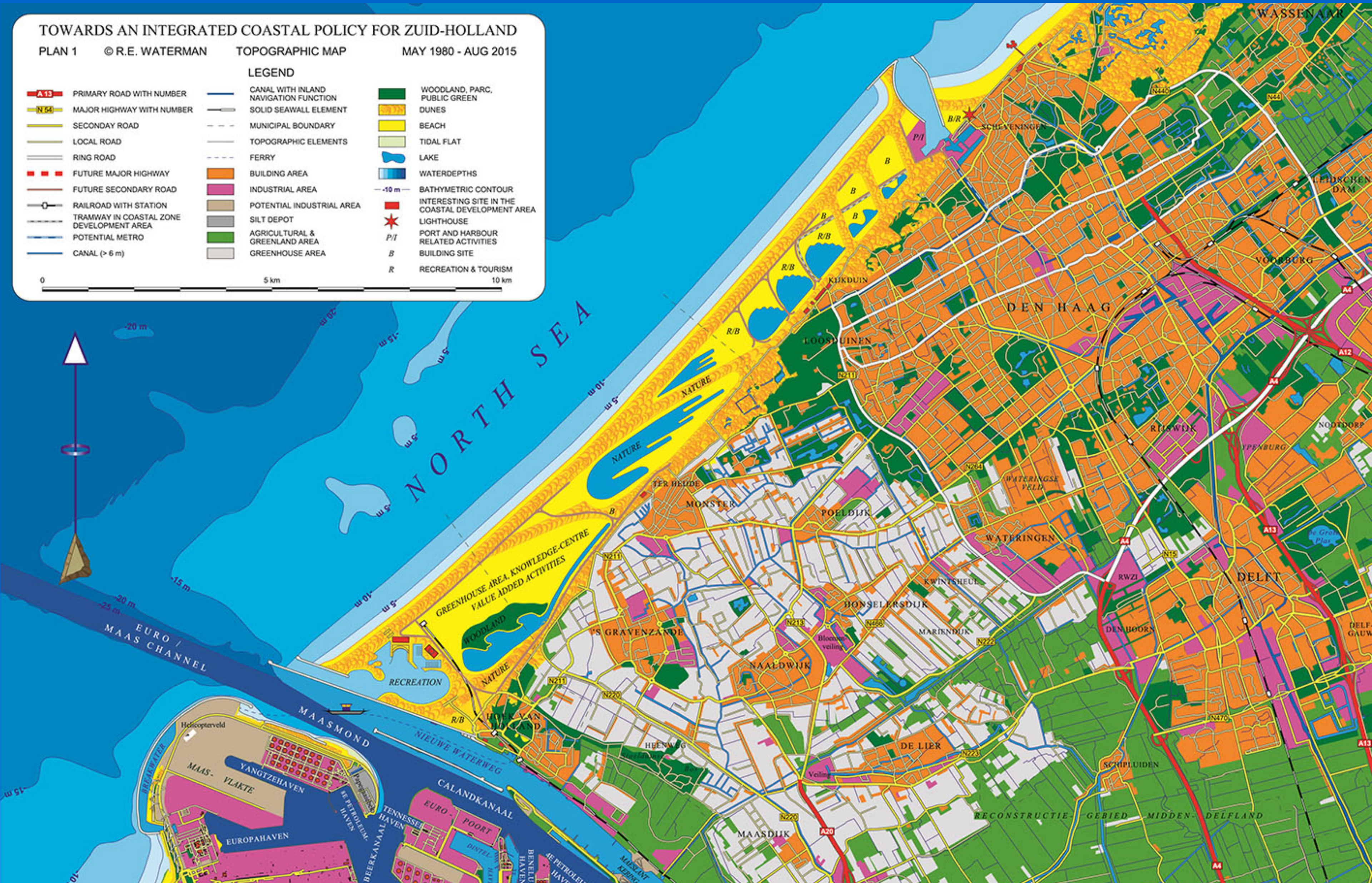
TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1
© R.E. WATERMAN
TOPOGRAPHIC MAP
MAY 1980 - AUG 2015
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PRIMARY ROAD WITH NUMBER
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PORT AND HARBOUR RELATED ACTIVITIES
BUILDING SITE
RECREATION & TOURISM
0
5 km
10 km
NORTH SEA
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
YANGTZEHAVEN
MAAS - VLAKTE
EUROPAHAVEN
EURO - POORT
BEERKANAAL
GREENHOUSE AREA, KNOWLEDGE-CENTRE
VALUE ADDED ACTIVITIES
WOODLAND
NATURE
RECREATION
WASSENAAR
SCHEVENINGEN
KIJKDUIN
LOOSDUINEN
DEN HAAG
VOORBURG
LEIDSCHENDAM
RIJSWIJK
YPENBURG
NOOTDORP
TER HEIJDE
MONSTER
POELDIJK
WATERINGEN
WATERINGSE VELD
KWINTSHEUL
HONSELERSDIJK
MARIENDIJK
'S GRAVENZANDE
NAALDWIJK
HOEK VAN HOLLAND
DE LIER
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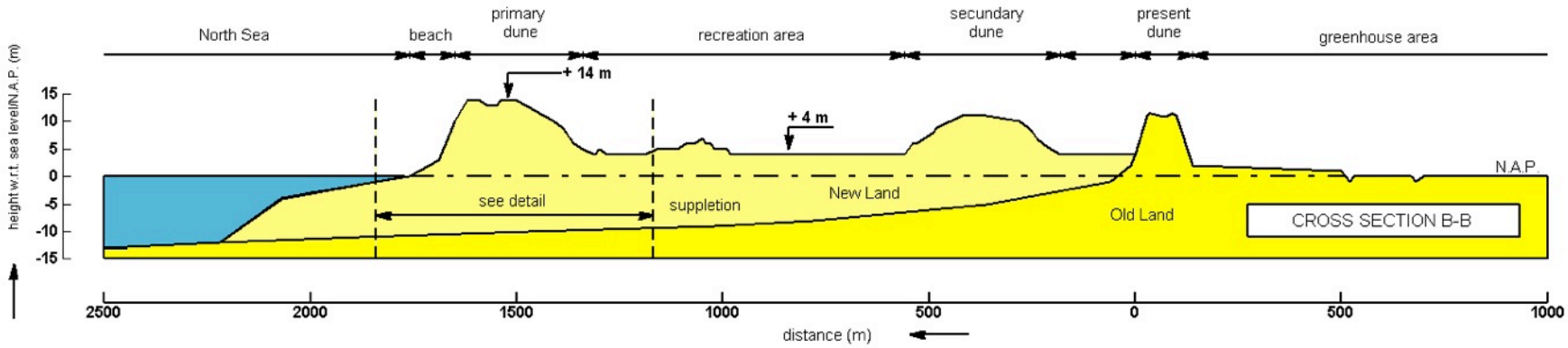
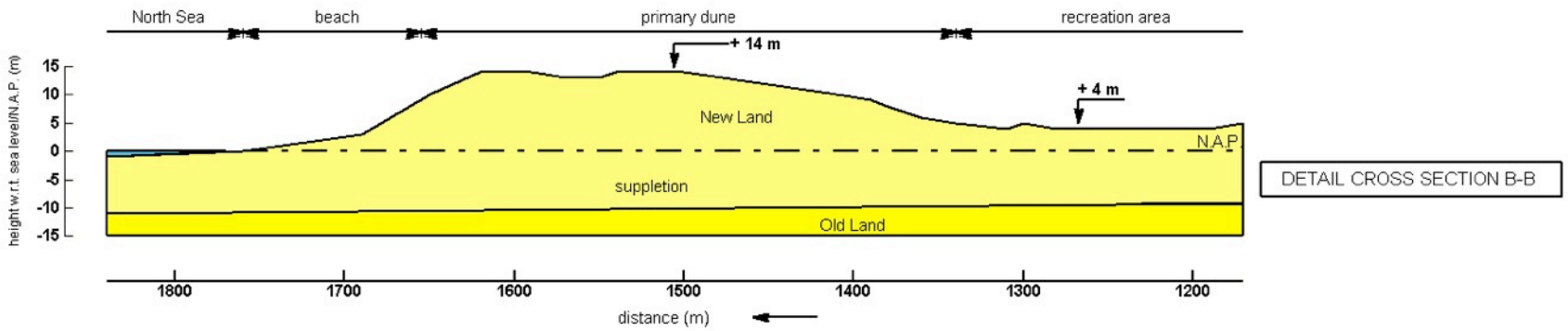
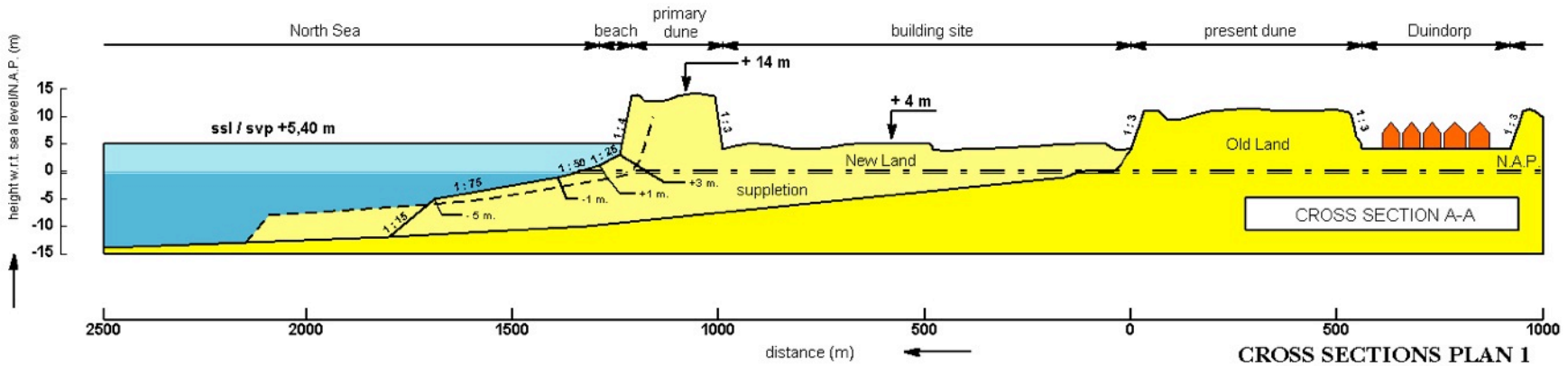
MAASDIJK
DEN HOORN
DELFT
SCHIPLUIDEN
RECONSTRUCTIE - GEBIED MIDDEN - DELFLAND
RWZI



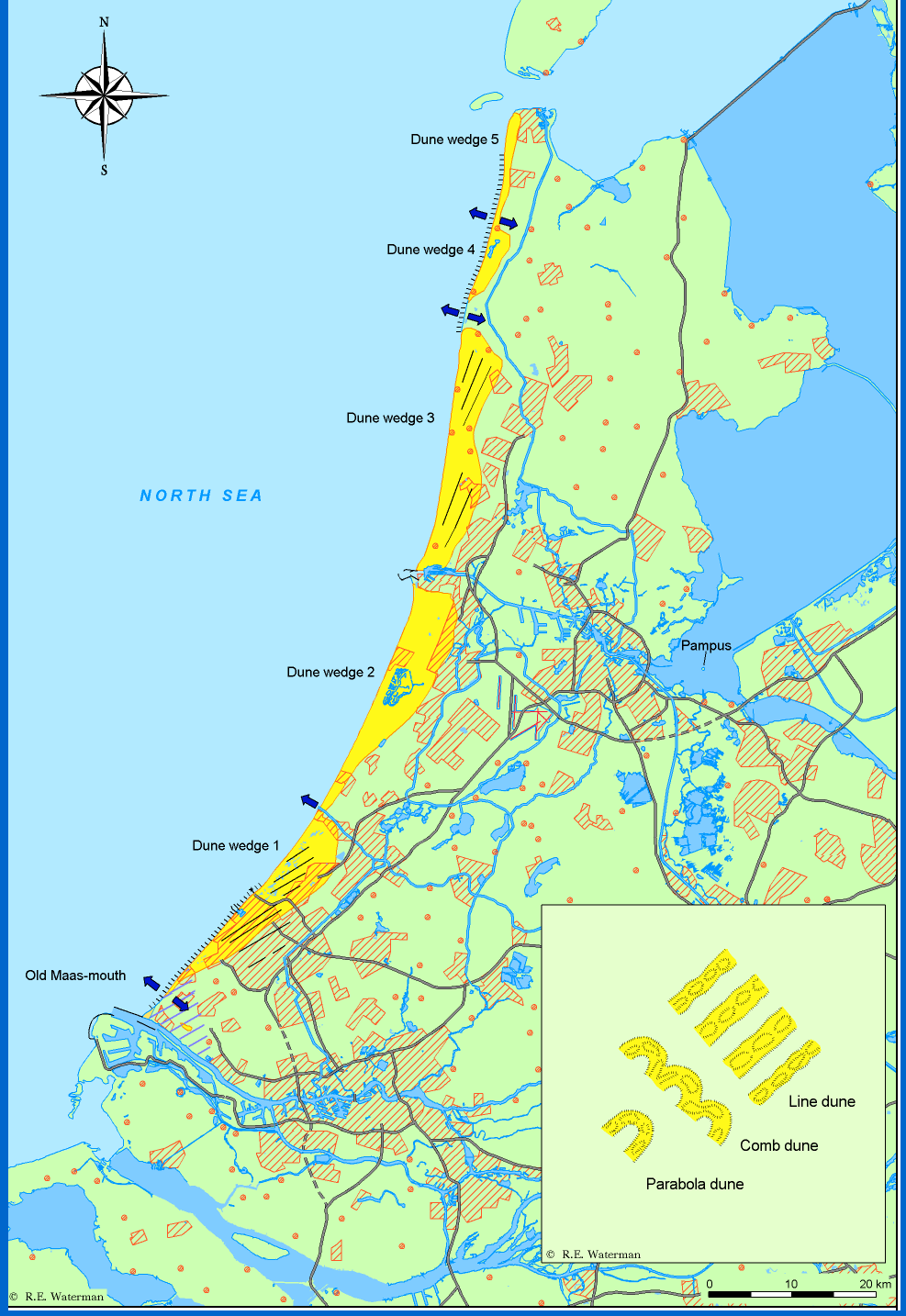




CROSS SECTIONS PLAN 1
WL / DELFT HYDRAULICS

N.A.P. = New Amsterdam Zero Reference Level

Geological Young Dune Wedges



Historical Coastline Delfland

Historical Coastlines Holland

Historic Coastlines Holland

Via the principle *"Building with Nature"* (dunes + beaches with a minimum of solid seawall elements) 1150 ha have already been realised:

van Dixhoorn-Triangle - Hoek van Holland / Rotterdam

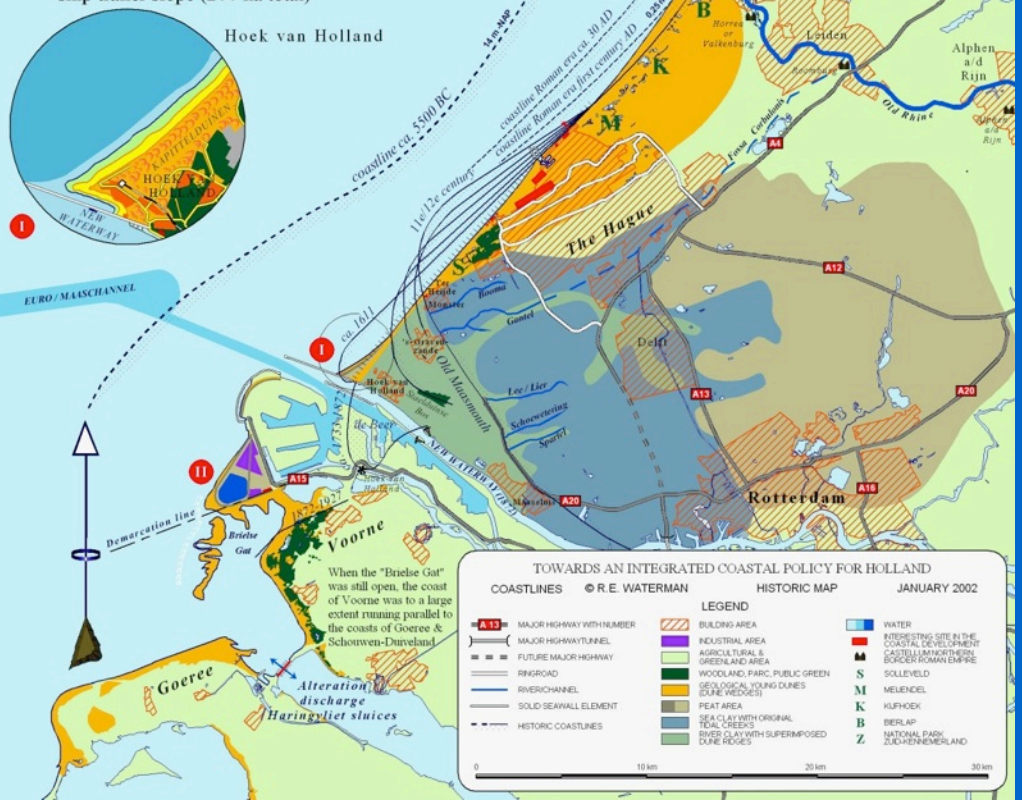
I 150 ha with Nature Reserve Area (Kapittelduinen-Zuidhollands Landschap); Extension railroad Rotterdam - Hoek van Holland; Waterway centre with 1100 houses + facilities and tidal lagoon

Slufterdam + Predecessor Slufterdam - Rotterdam

II 800 ha with Nature Reserve Area (ZHL); environmental friendly storage & processing of wastes, incl. contaminated dredged sediments; port- & port related activities; infrastructure; tourism & recreation

Seaport Marina IJmuiden / Kennemer beach - Velsen

III Nature Reserve Area (Natuurmonumenten) in relation with Kennemer dunes; lake; yachting harbour (625 berths); 84 appartments; restaurants & shops; Admiralty Club; hotel; infrastructure; ship elevator & ship trailer slope (200 ha total)



BUILDING WITH NATURE PLAN 1

COAST OF DELFLAND WITH 69 GROYNES

Rip currents alongside groynes causing sand transport towards the North Sea

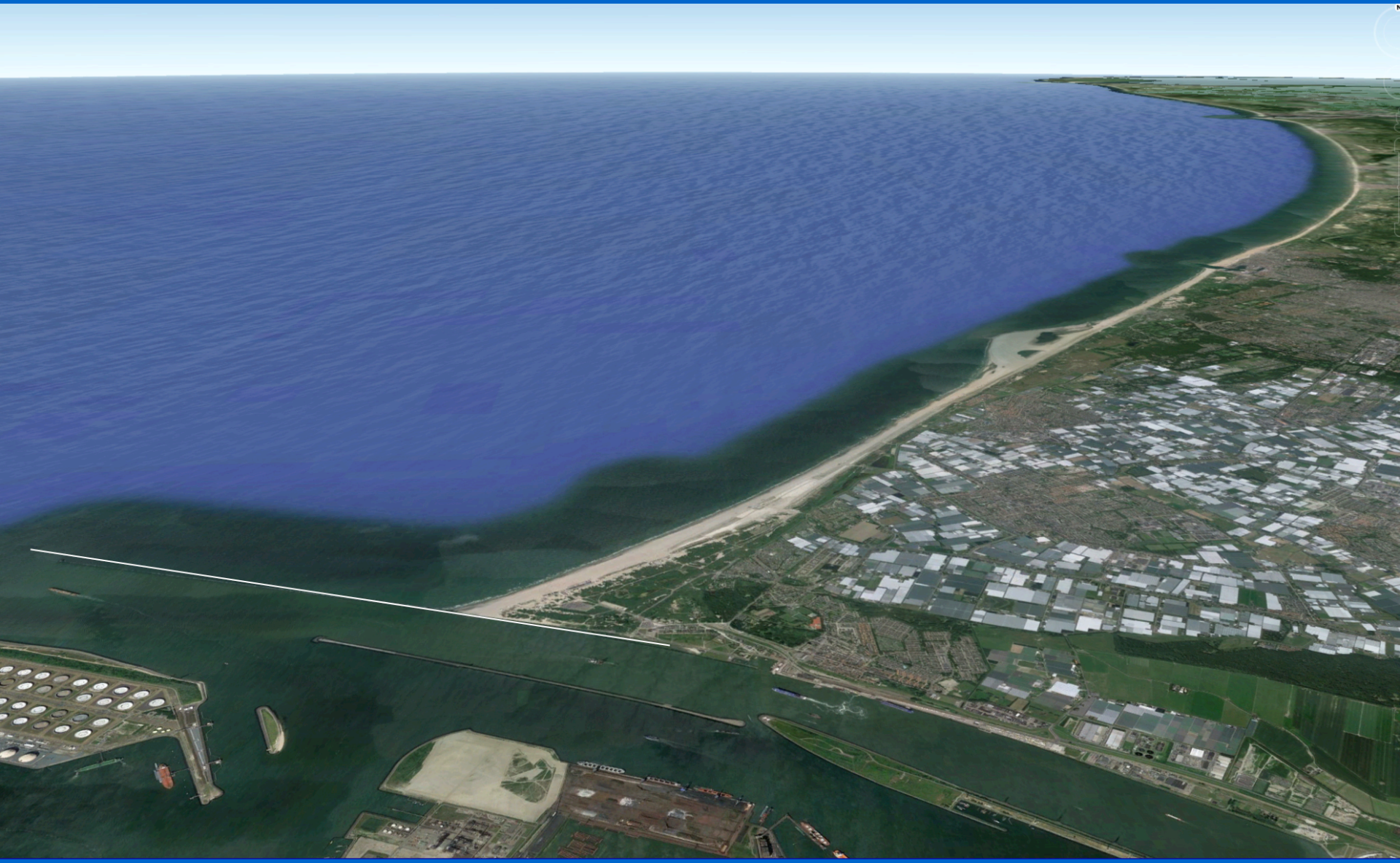
1985

BUILDING WITH NATURE PLAN 1

March 16 - 1981

FIRST REALISED SEGMENT OF PLAN 1, NEAR HOEK VAN HOLLAND

Narrow endangered coast of South-Holland near Ter Heijde 16-3-1981




Delfland coast nature reserve


Tidal lagoon Hoek van Holland

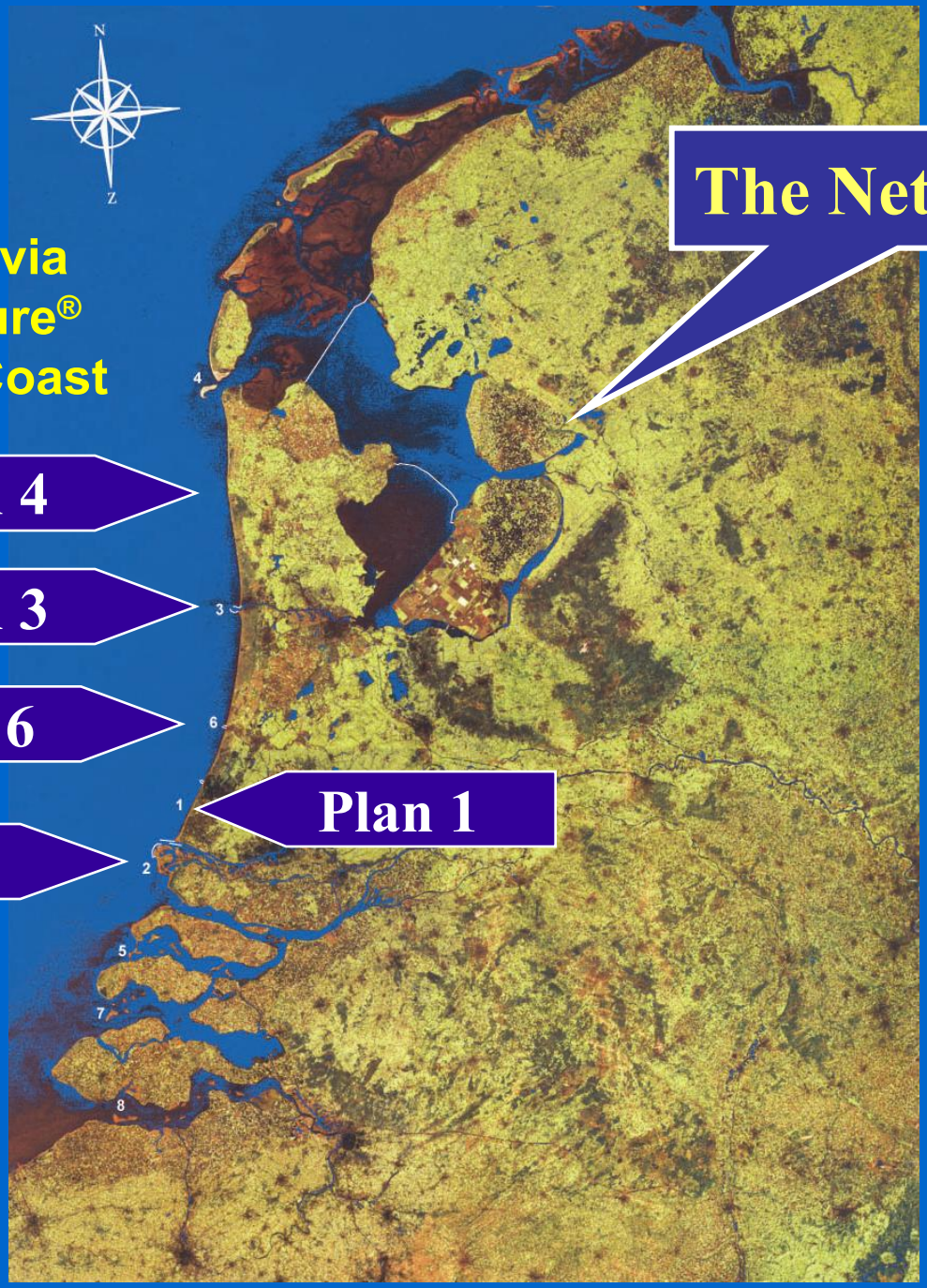
Scheveningen 4th harbour
with dune/beach expansion
on each side

Scheveningen 4th harbour
with dune/beach expansion
on each side

Linkage of inland waterway
with Scheveningen harbour
Complete with sluice

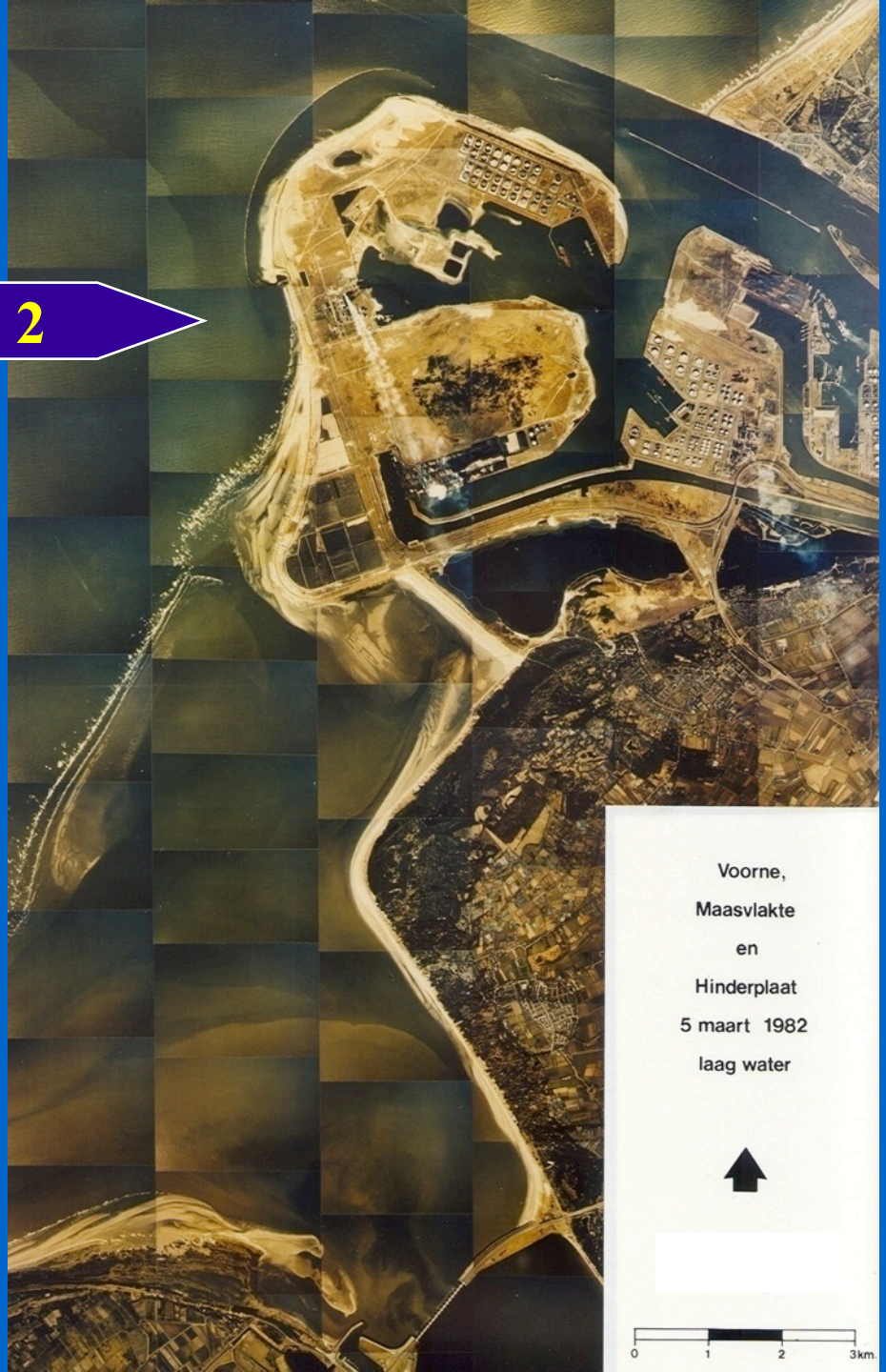
Plan A

Land reclamation via Building with Nature® along North Sea Coast

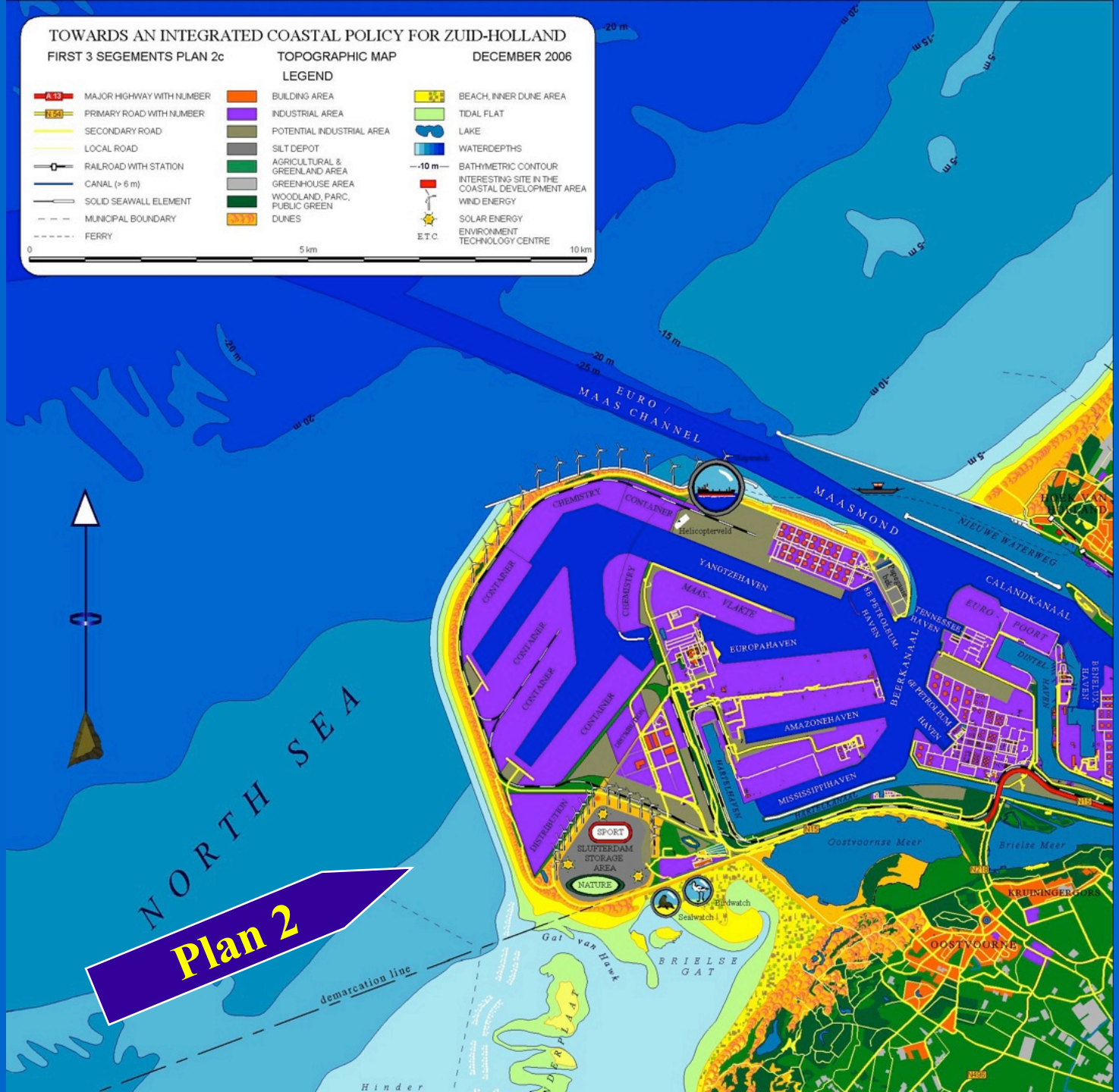


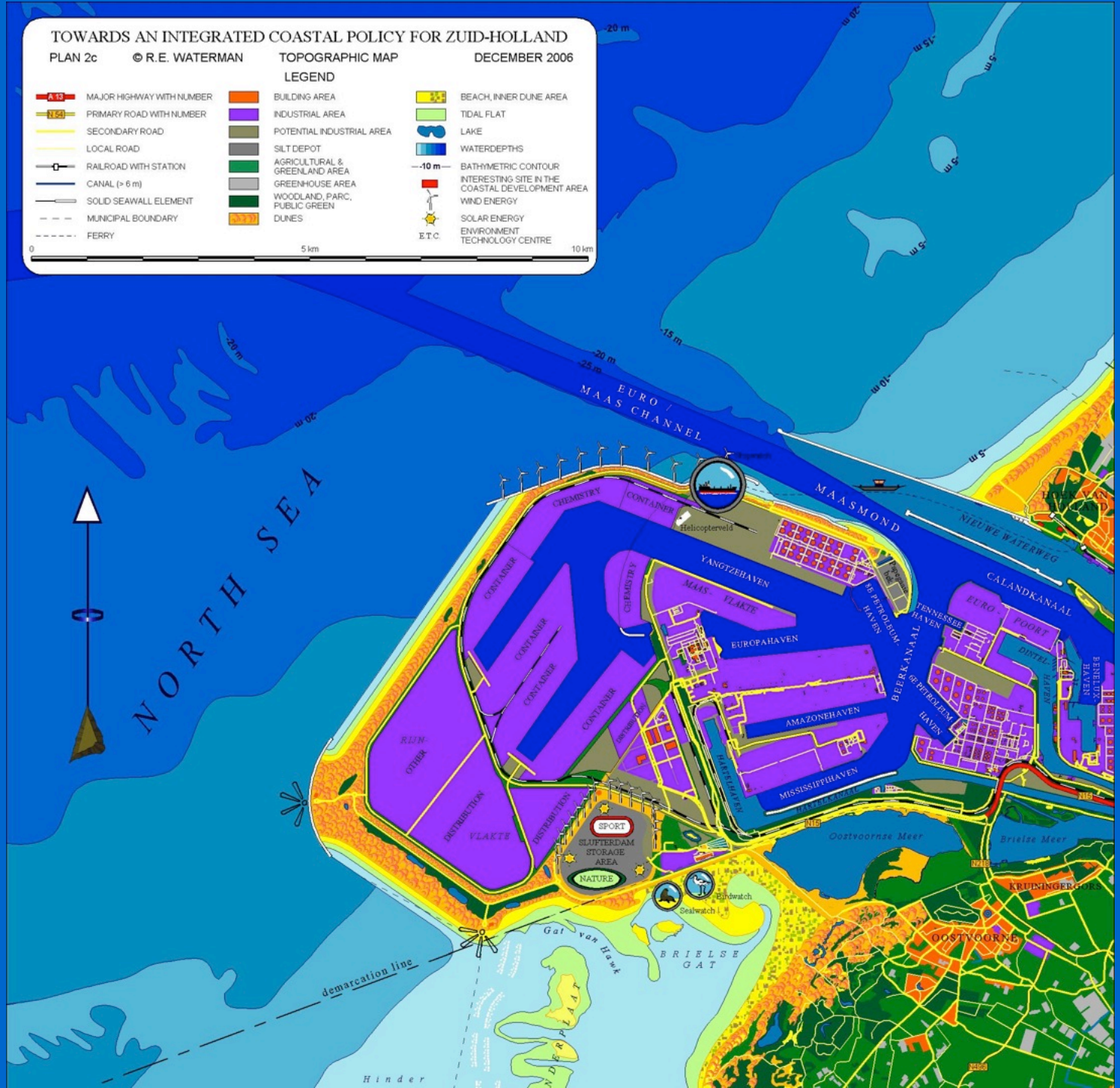
Integrated Coastal Policy via Building with Nature®

Plan 2


Voorne,
Maasvlakte
en
Hinderplaat
5 maart 1982
laag water
0
1
2
3km

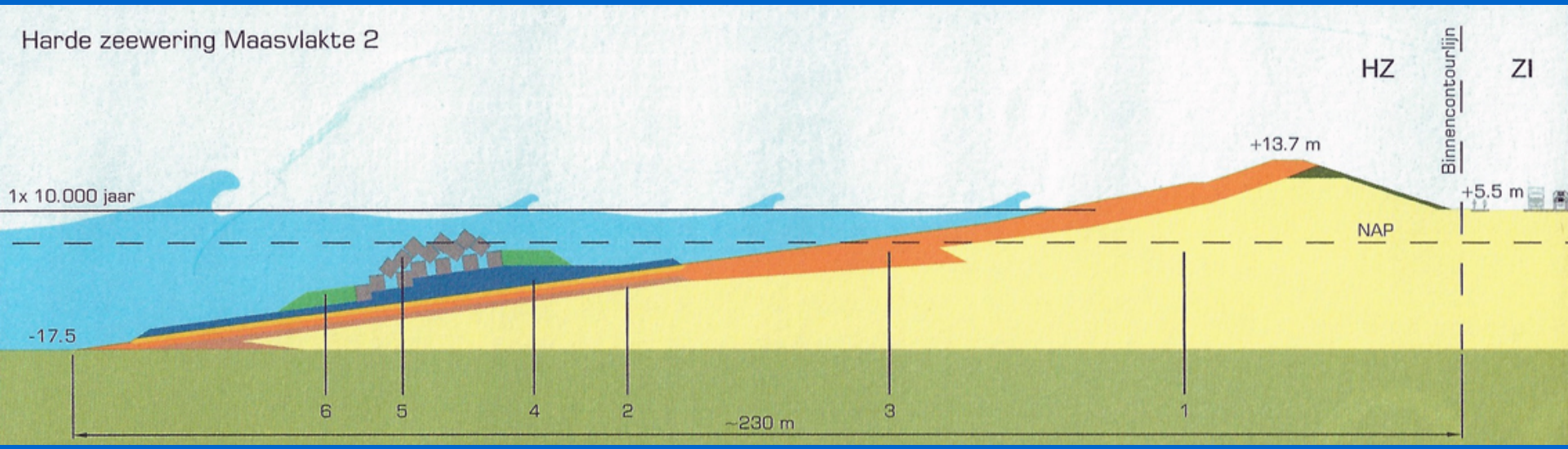
First realised segments of plan 2, created by *Building with Nature*


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
FIRST 3 SEGEMENTS PLAN 2c
TOPOGRAPHIC MAP
DECEMBER 2006
LEGEND
MAJOR HIGHWAY WITH NUMBER
PRIMARY ROAD WITH NUMBER
SECONDARY ROAD
LOCAL ROAD
RAILROAD WITH STATION
CANAL (> 6 m)
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
FERRY
BUILDING AREA
INDUSTRIAL AREA
POTENTIAL INDUSTRIAL AREA
SILT DEPOT
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH, INNER DUNE AREA
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
WIND ENERGY
SOLAR ENERGY
ENVIRONMENT TECHNOLOGY CENTRE
E.T.C.
0
5 km
10 km
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
YANGTZEHAVEN
EUROPAHAVEN
AMAZONEHAVEN
MISSISSIPPIHAVEN
BEERKANAAL
CHEMISTRY
CONTAINER
Helicopterveld
MAAS-VLAKTE
EURO-POORT
TENNESSEEHAVEN
SPORT
SLUFTERDAM STORAGE AREA
NATURE
Birdwatch
Seawatch
Oostvoornse Meer
Brielse Meer
KRUININGERGORS
OOSTVOORNE
BRIELSE GAT
Gat van Hawk
demarcation line
NORTH SEA
Plan 2

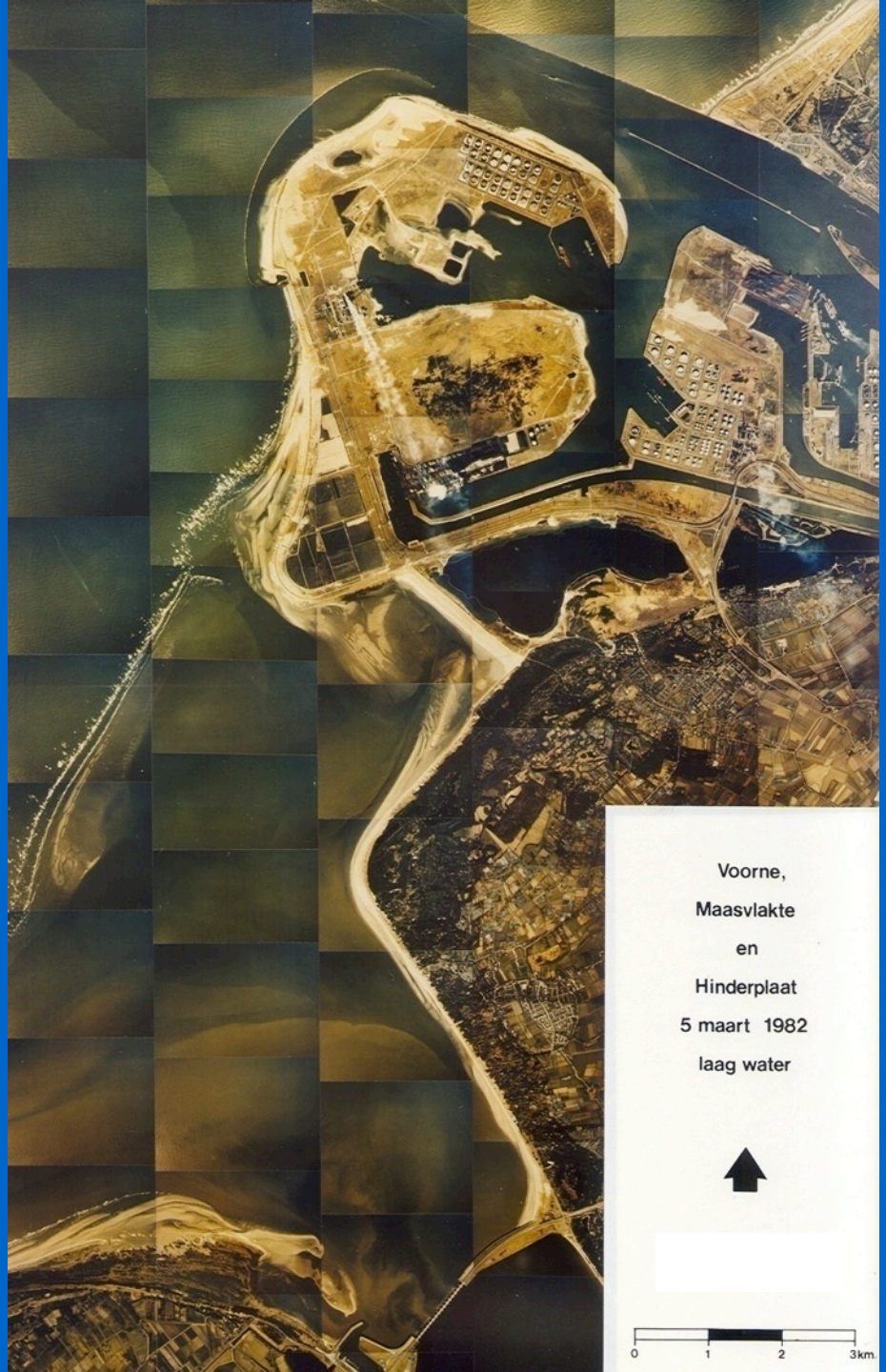

TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 2c © R.E. WATERMAN TOPOGRAPHIC MAP DECEMBER 2006
LEGEND
MAJOR HIGHWAY WITH NUMBER
PRIMARY ROAD WITH NUMBER
SECONDARY ROAD
LOCAL ROAD
RAILROAD WITH STATION
CANAL (> 6 m)
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
FERRY
BUILDING AREA
INDUSTRIAL AREA
POTENTIAL INDUSTRIAL AREA
SILT DEPOT
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH, INNER DUNE AREA
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
WIND ENERGY
SOLAR ENERGY
ENVIRONMENT TECHNOLOGY CENTRE
E.T.C.
0
5 km
10 km
NORTH SEA
EURO / MAAS CHANNEL
MAASMOND
NIEUWE WATERWEG
CALANDKANAAL
CHEMISTRY
CONTAINER
Helicopterveld
YANGTZEHAVEN
MAAS-VLAKTE
EUROPAHAVEN
AMAZONEHAVEN
MISSISSIPPIHAVEN
BEERKANAAL
TENNESSEE HAVEN
EURO-POORT
DINTELHAVEN
BENELUXHAVEN
RIJN-OTHER
DISTRIBUTION
VLAKTE
SPORT
SLUFTERDAM STORAGE AREA
NATURE
Oostvoornse Meer
Brielse Meer
KRUININGERGORS
Eendwatch
Sealwatch I
Gat van Hauk
BRIELSE GAT
OOSTVOORNE
demarcation line
Hinder

COASTAL DEFENSE MAASPLAIN 2 (RHINEPLAIN)

3,5 km hard construction; 7,5 km soft dune-beach construction



1 Sand base layer approx. 150 µm; top layer min. 370 µm
2 Filter layer gravel under concrete block dam 0,3 - 35 mm
3 Cobble layer 1 m thickness under concrete block dam up to 4 m thickness on top of gravel dune, diameter cobbles 20 – 135 mm
4 Quarry stones 150 – 800 kg on top of quarry stones 5 – 70 kg
5 Concrete blocks (17.000 blocks - 2,5 x 2,5 x 2,5 m - 40 à 43 ton) across 3,5 km coastal length
6 Toe construction with stones from 1 – 10 ton to prevent sliding of concrete blocks


Voorne,
Maasvlakte
en
Hinderplaat
5 maart 1982
laag water
0
1
2
3km

BUILDING WITH NATURE PLAN 2

March 22 - 1991

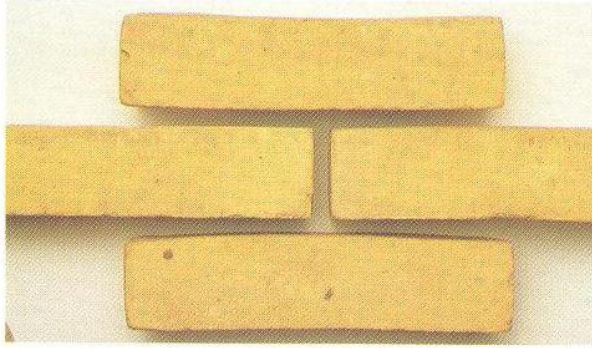
FIRST REALISED SEGMENTS OF PLAN 2

BUILDING WITH NATURE PLAN 2

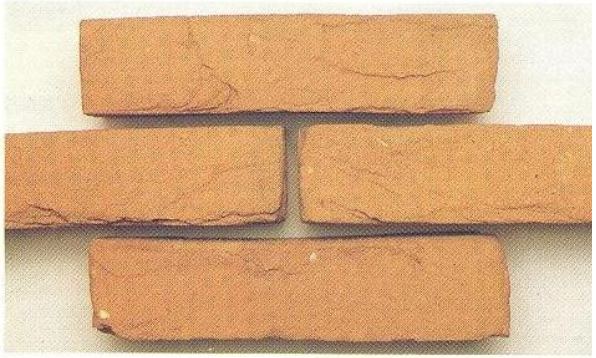
August 17 - 2000

FIRST REALISED SEGMENTS OF PLAN 2


July 2013
Hull, UK – Rotterdam, NL
Antarcticaweg
Maasvlakte
Maasvlakte – Pistoolhaven
Pistoolhaven – Landtong
Maasvlakteweg
Noordlandseweg
E30
E25
De Cordesstraat
Haaktweg
Hoeksebaan
N15
Elbeweg
Krabbeweg
N218
Brielseweg
Schrijversdijk

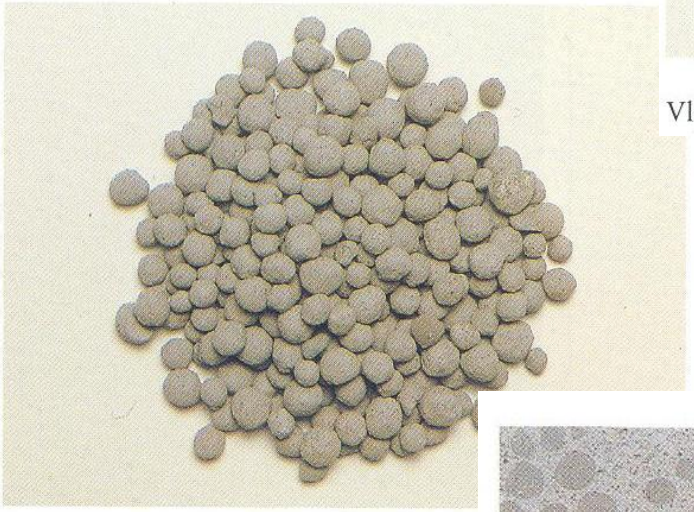


Euroklei-bakstenen uit havenslib



Vliegas van kolengestookte elektriciteitscentrale

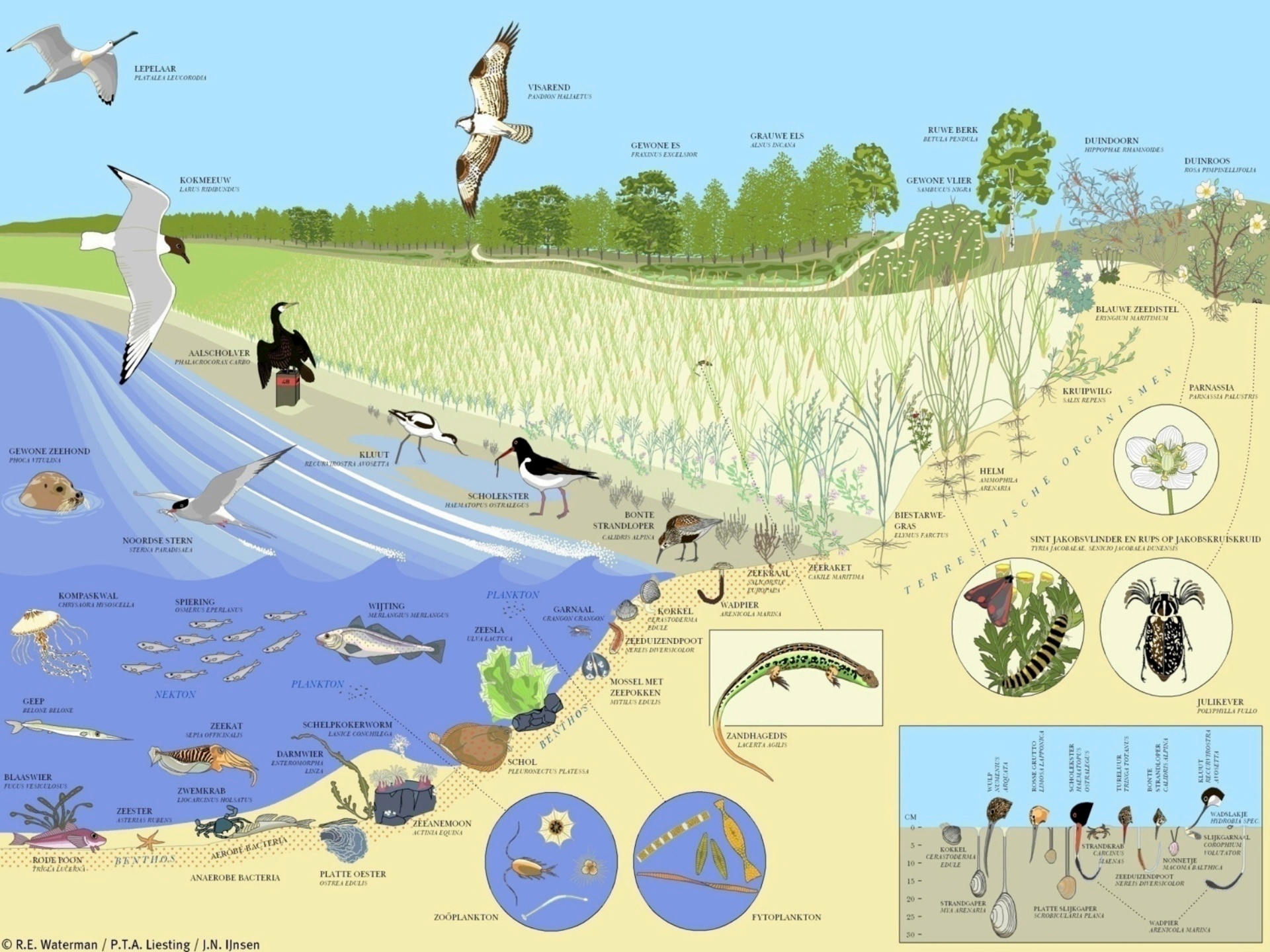
Vliegas en vuilverbrandingsinstallatie



Aardelite©, kunstgrind

Eco-grind©, kunstgrind

Aardelite©, kunstgrind in betonprodukten



BUILDING WITH NATURE

Plan 2

Parnassia

Euphorbia
Maritima


Sand Engine
August 2011
Cakile
Maritima

BUILDING WITH NATURE

Plan 2

Plan A

Land reclamation via Building with Nature® along North Sea Coast

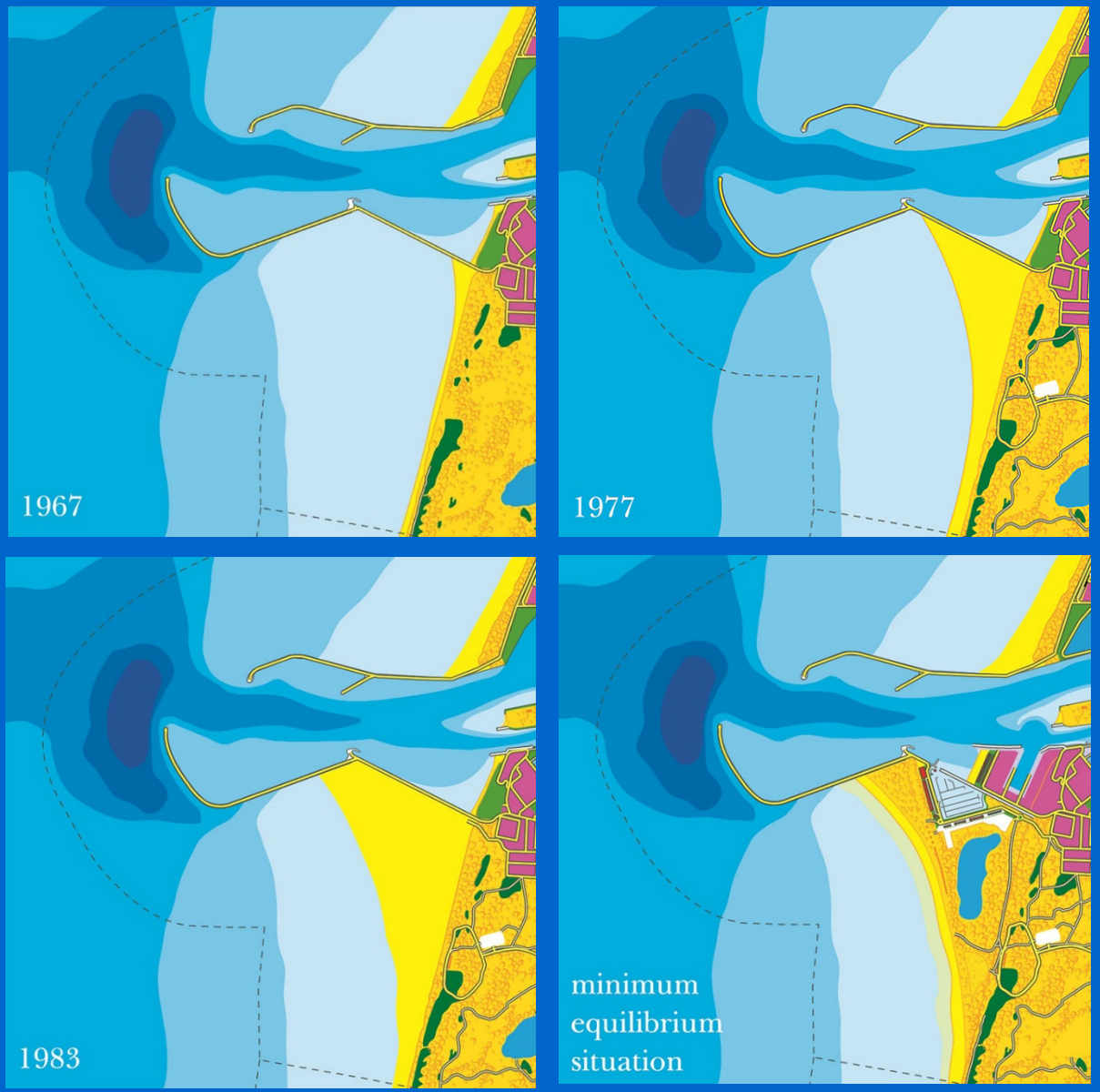
Integrated Coastal Policy via Building with Nature®

BUILDING WITH NATURE

PLAN 3a

SEAPORT MARINA IJMUIDEN

KENNEMER BEACH



Nature is already developing the new area south of the existing Southern Harbour Mole IJmuiden, owing to littoral sand transport from Province South-Holland to Province North-Holland.

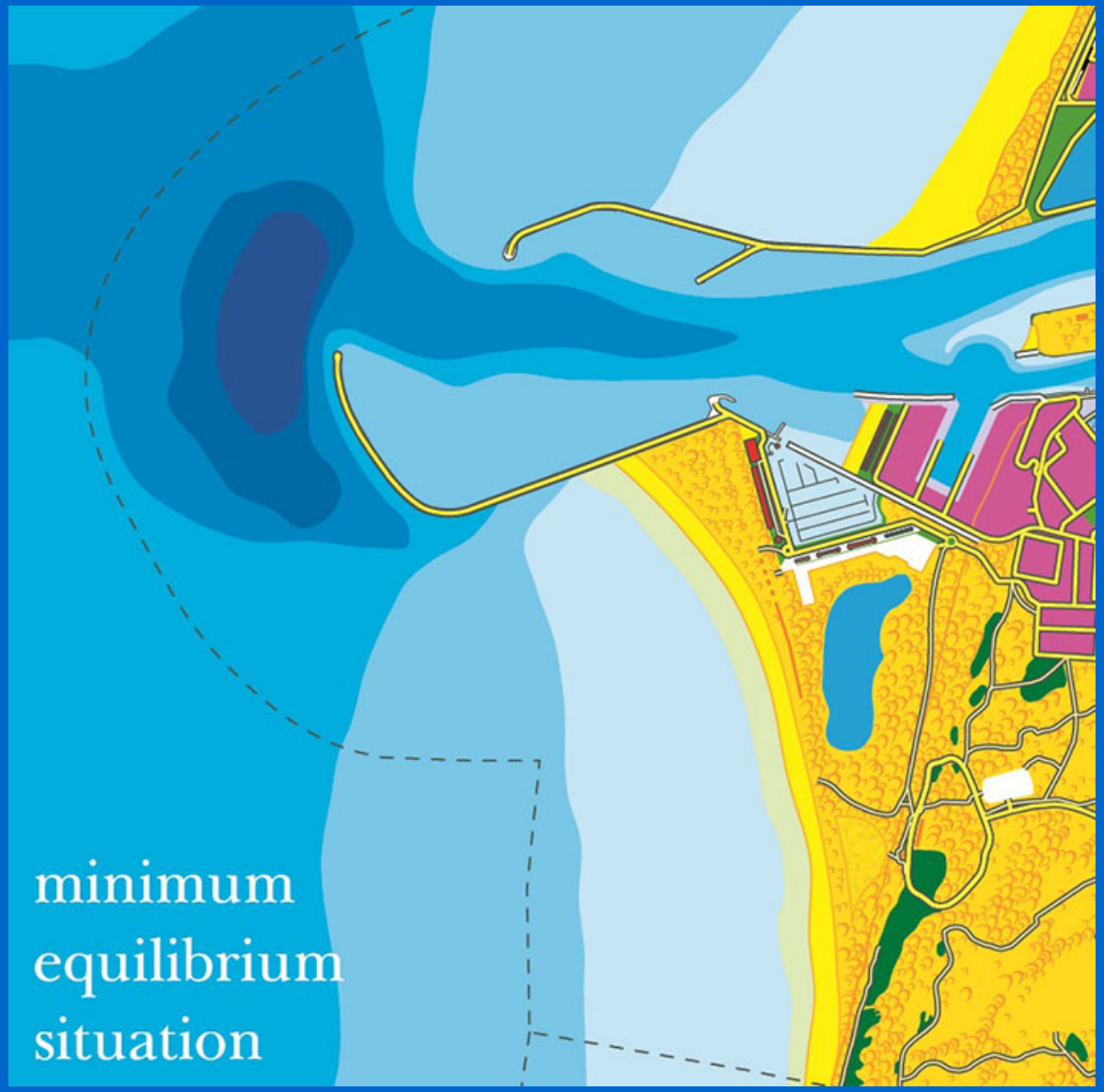
This process is quickened by external and internal dredging operations.

BUILDING WITH NATURE

PLAN 3a

SEAPORT MARINA IJMUIDEN

KENNEMER BEACH



Plan 3a is triangle-shaped and consists of a primary range of dunes with a marina, double boulevard, apartments, restaurants & shops, hotel, infrastructure, recreation & tourism; transition zone with lake; nature reserve area linked to an existing nature reserve area (Kennemer Dunes).

BUILDING WITH NATURE PLAN 3a

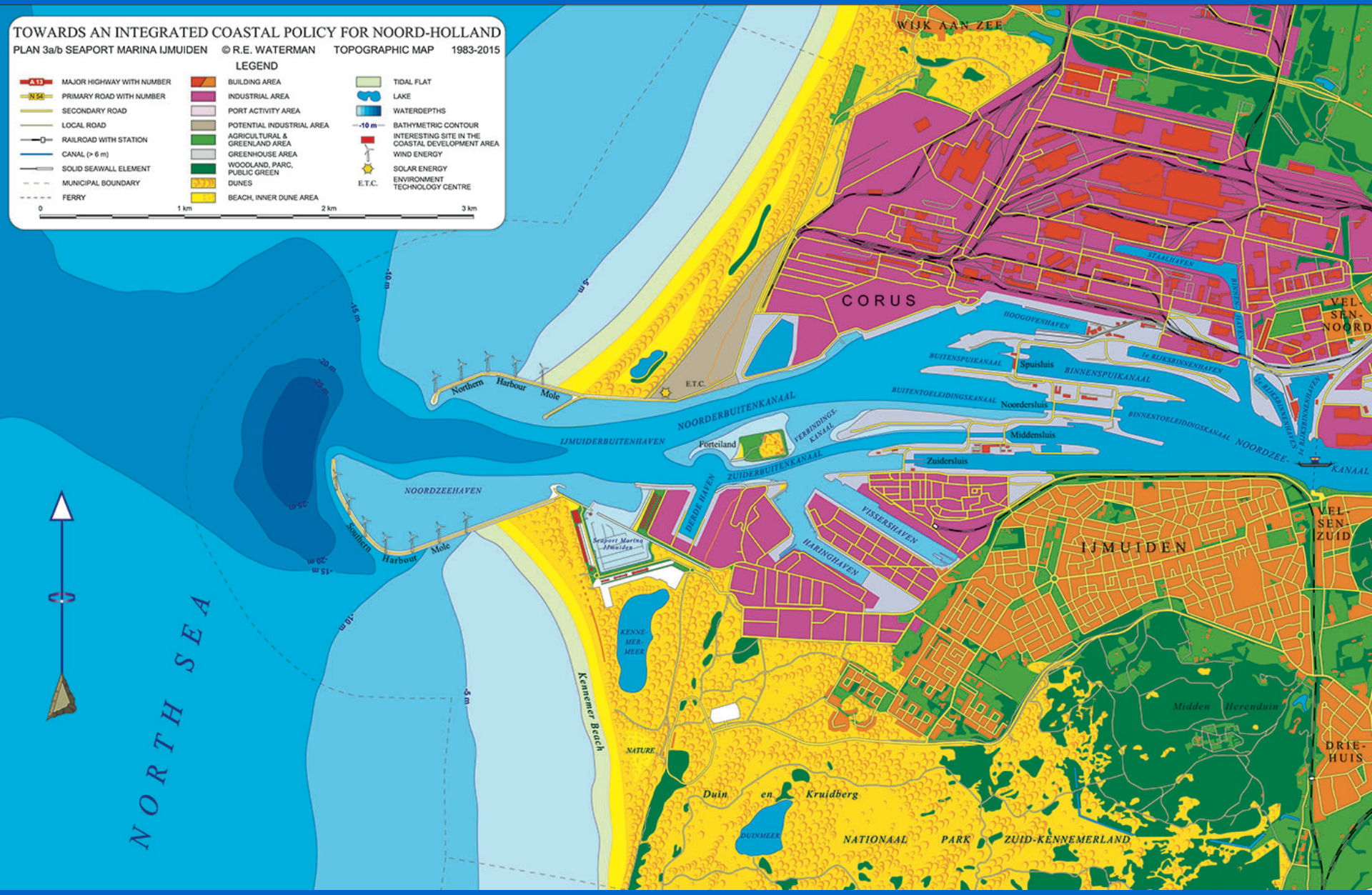
July 10 - 1997

PLAN 3a. Complete with primary range of dunes, beaches, marina, boulevard, apartments, restaurants & shops, hotel, infrastructure, lake & nature reserve area.

BUILDING WITH NATURE PLAN 3a

June 2000

PLAN 3a. Complete with primary range of dunes, beaches, marina, boulevard, apartments, restaurants & shops, hotel, infrastructure, lake & nature reserve area.

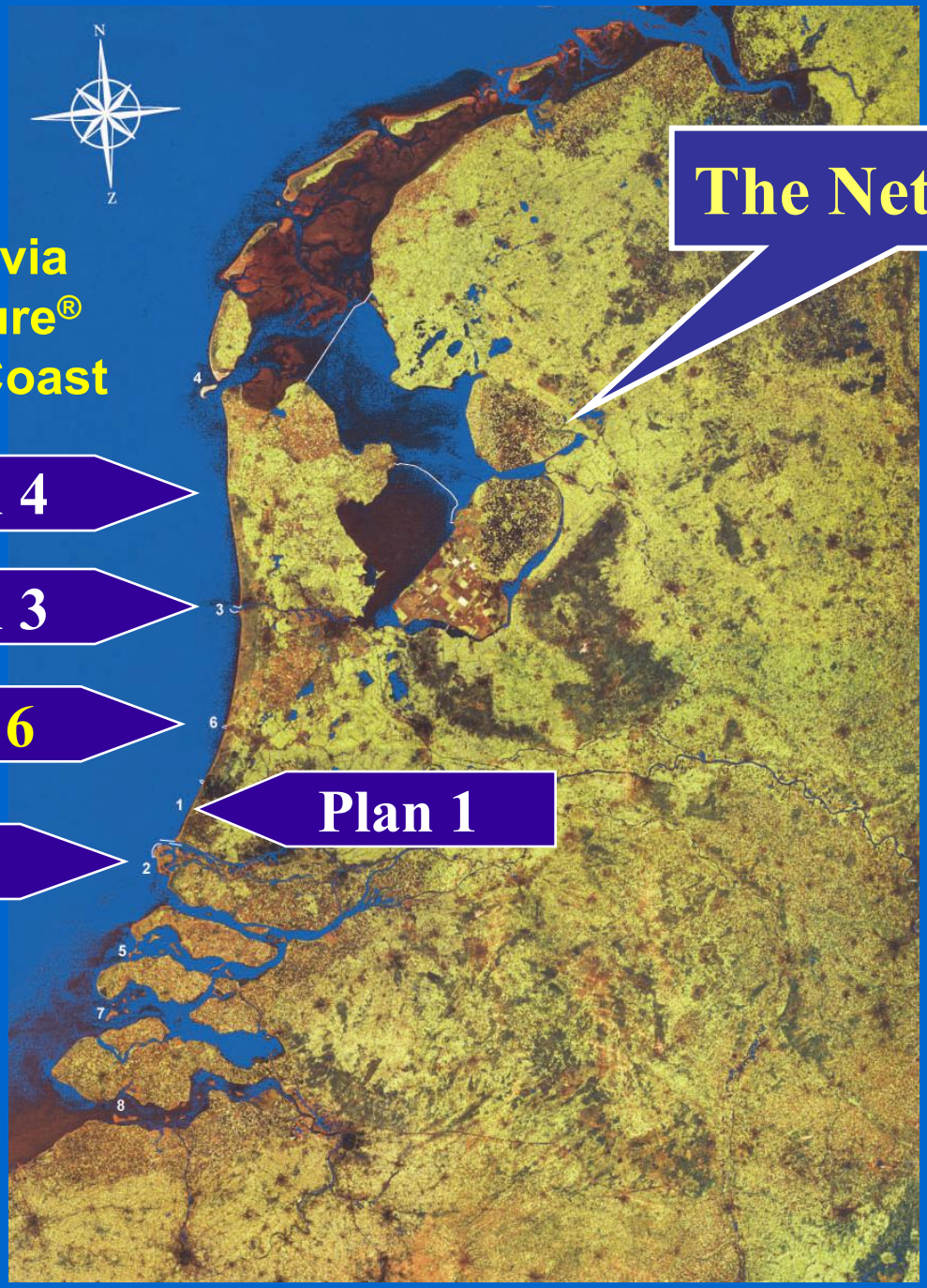

TOWARDS AN INTEGRATED COASTAL POLICY FOR NOORD-HOLLAND
PLAN 3a/b SEAPORT MARINA IJMUIDEN © R.E. WATERMAN TOPOGRAPHIC MAP 1983-2015
LEGEND
MAJOR HIGHWAY WITH NUMBER
PRIMARY ROAD WITH NUMBER
SECONDARY ROAD
LOCAL ROAD
RAILROAD WITH STATION
CANAL (> 6 m)
SOLID SEAWALL ELEMENT
MUNICIPAL BOUNDARY
FERRY
BUILDING AREA
INDUSTRIAL AREA
PORT ACTIVITY AREA
POTENTIAL INDUSTRIAL AREA
AGRICULTURAL & GREENLAND AREA
GREENHOUSE AREA
WOODLAND, PARC, PUBLIC GREEN
DUNES
BEACH, INNER DUNE AREA
TIDAL FLAT
LAKE
WATERDEPTHS
BATHYMETRIC CONTOUR
INTERESTING SITE IN THE COASTAL DEVELOPMENT AREA
WIND ENERGY
SOLAR ENERGY
E.T.C. ENVIRONMENT TECHNOLOGY CENTRE
0 1 km 2 km 3 km
WIJK AAN ZEE
CORUS
STAALHAVEN
HOOGOVENHAVEN
BUITENSPUIKANAAL
Spuisluis
BINNENSPUIKANAAL
BUITENTOELEIDINGSKANAAL
Noordersluis
BINNENTOELEIDINGSKANAAL
Middensluis
Zuidersluis
NOORDZEE-KANAAL
VEL-SEN-NOORD
VEL-SEN-ZUID
IJMUIDEN
Northern Harbour Mole
E.T.C.
NOORDERBUITENKANAAL
VERBINDINGS-KANAAL
IJMUIDERBUITENHAVEN
Porteiland
ZUIDERBUITENKANAAL
NOORDZEEHAVEN
Southern Harbour Mole
Seaport Marina IJmuiden
DERDE HAVEN
VISSERSHAVEN
HARINGHAVEN
KENNE-MER-MEER
Kennemer Beach
NATURE
Duin en Kruidberg
DUINMEER
NATIONAAL PARK ZUID-KENNEMERLAND
Midden Herenduin
DRIE-HUIS
NORTH SEA
-10 m
-5 m
-15 m
-20 m
-25 m
-15 m
-20 m
-10 m
-5 m

BUILDING WITH NATURE PLAN 3a

2012

Plan A

Land reclamation via Building with Nature® along North Sea Coast



Integrated Coastal Policy via Building with Nature®

Plan 6.
Katwijk aan Zee

Seaport Marina with dune widening on each side for Katwijk & Noordwijk

Future connection with Old Rhine River with sluice or boat conveyor

Plan 6


KATWIJK AAN ZEE
PRIMARY ROAD
SECUNDAIRY ROAD
MUNICIPAL BOUNDARY
TALUD
SOLID SEAWALL ELEMENT
BUILDING AREA
INDUSTRIAL AREA
GREENLAND AREA
BEACH
TIDAL FLAT
LAKE
WATER DEPTHS
POSSIBLE SITE FOR BUILDING 'WANTVELD'
WATER CONNECTION WITH SLUICE OR BOAT LIFT
0
500 m
© R.E. Waterman
Noordwijk aan Zee
COEPEL DUINEN
ORIGINAL COAST LINE
NOORD DUINEN
Royal Dutch Rescue Society
Camping
Wantveld
BINNENWATERING
Pumping Station
Hotel Savoy
Discharge Sluice
UITWATERINGSKANAAL
PRINS HENDRIKKANAAL
ORIGINAL COAST LINE
KATWIJK AAN ZEE
White Church
Restaurant De Zwaan
Vuurbaak
Soefi Temple
ZUID DUINEN
-10 m
-5 m
-5 m
N
S

Plan 6


KATWIJK AAN ZEE
PRIMARY ROAD
SECUNDAIRY ROAD
MUNICIPAL BOUNDARY
TALUD
SOLID SEAWALL ELEMENT
BUILDING AREA
INDUSTRIAL AREA
GREENLAND AREA
BEACH
TIDAL FLAT
LAKE
WATER DEPTHS
POSSIBLE SITE FOR BUILDING 'WANTVELD'
WATER CONNECTION WITH SLUICE OR BOAT LIFT
0
500 m
© R.E. Waterman
NORTH SEA
-10 m
-5 m
COEPEL DUINEN
NOORD DUINEN
Noordwijk aan Zee
ORIGINAL COAST LINE
-5 m N.A.P.
-5 m N.A.P.
Royal Dutch Rescue Society
Camping
Wantveld
BINNENWATERING
Pumping Station
Hotel Savoy
Discharge Sluice
UITWATERINGSKANAAL
PRINS HENDRIKKANAAL
KATWIJK AAN ZEE
White Church
Restaurant De Zwaan
Vuurbaak
Soefi Temple
ZUID DUINEN
N
S

Plan 6. Katwijk aan Zee 2008

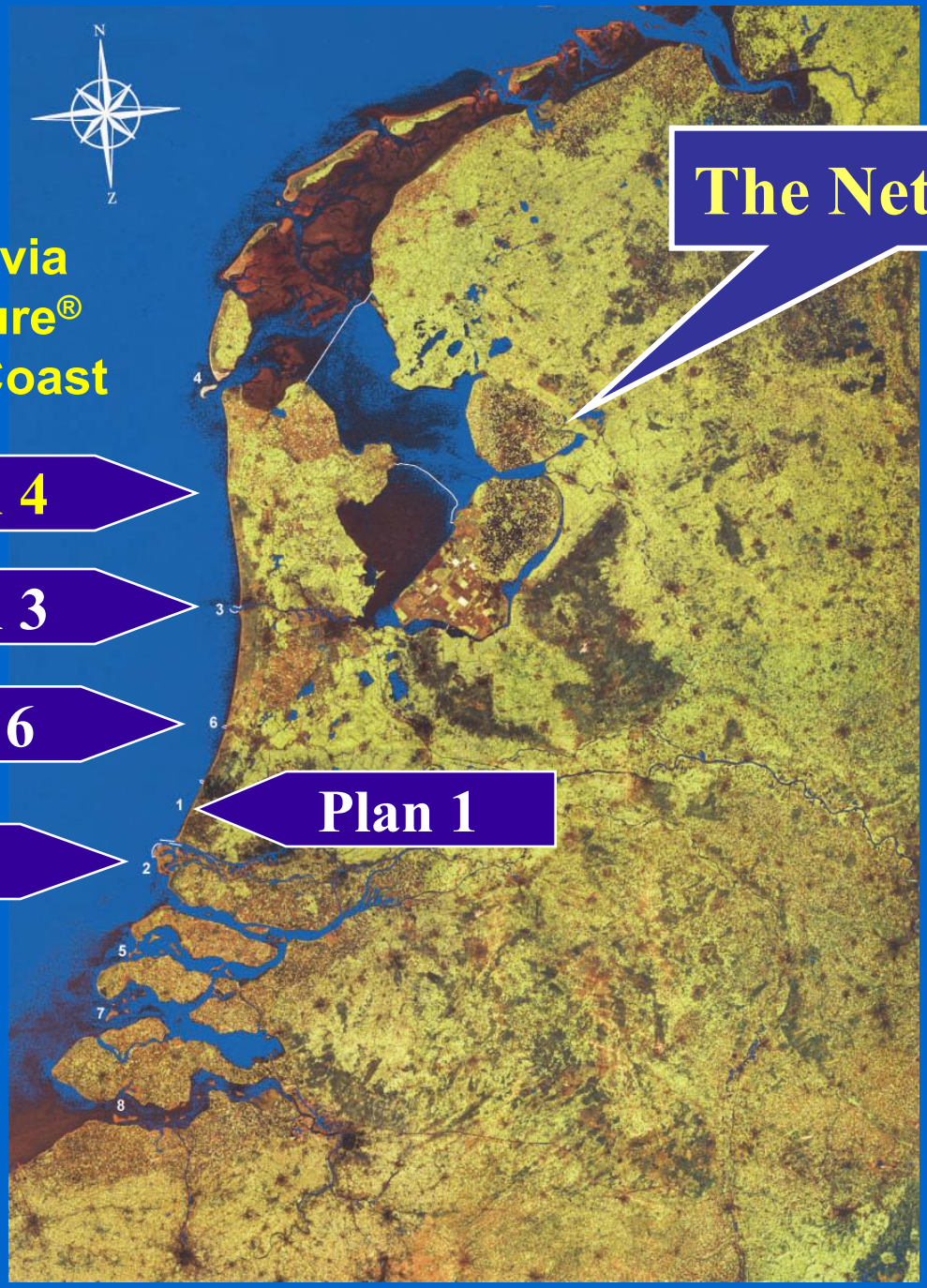
Plan 6. Katwijk aan Zee 2015

Dune with underground parking incorporated

Plan 6.
Katwijk aan Zee

Plan A

Land reclamation via Building with Nature® along North Sea Coast



Integrated Coastal Policy via Building with Nature®


Plan 4 Hondsbosche & Pettemer Sea Defence
Instead of dyke reinforcement
dune/beach protection


Plan 4 Hondsbosche & Pettemer Sea Defence
Creation of dune/beach protection
with nature & recreation


Plan 4 Hondsbosche & Pettemer Sea Defence
Creation of dune/beach protection
with nature & recreation

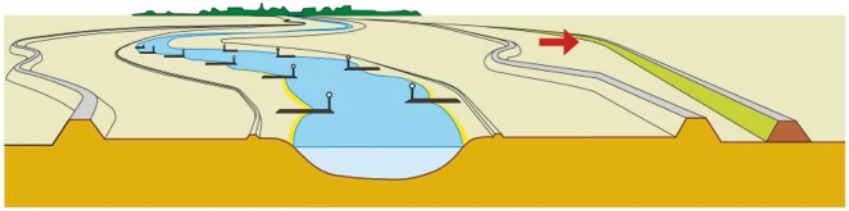
Space for the Coast
Living Coasts

Space for the River
Living Rivers

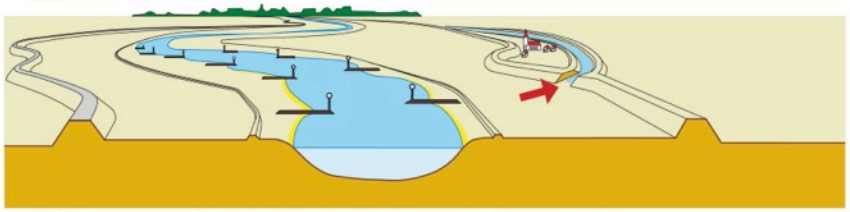
Space in & around
the Lakes
Living Lakes

Space in & around
the Estuaries
Living Estuaries

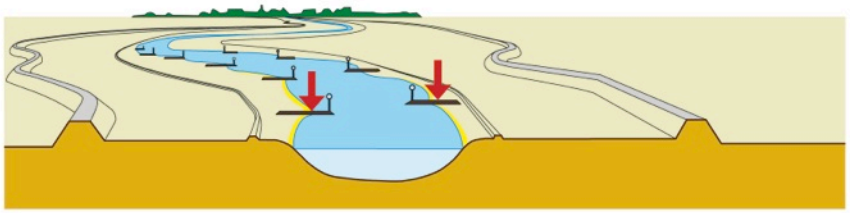
Space for the Delta's
Living Delta's



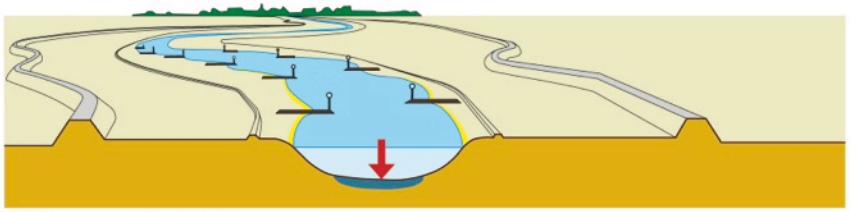
I. Op grote schaal terugtrekken van de dijken, vergroting uiterwaarden.



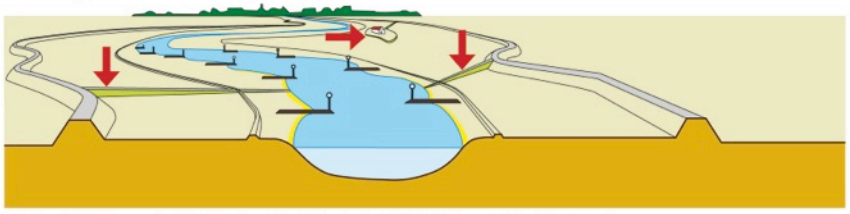
II. Rivier by-pass constructie ten behoeve van periodiek optredend hoogwaterniveau.



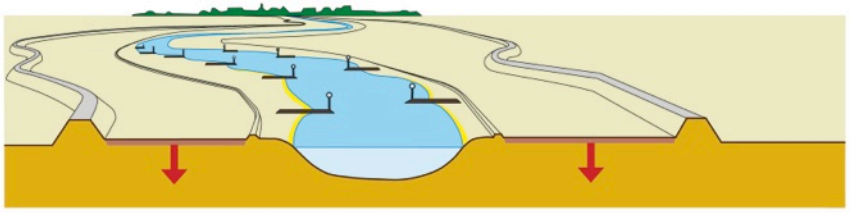
III. Verlagen van kribben



IV. Verlagen van de rivierbedding.



V. Verwijdering van hydraulische obstakels uit de rivierbedding en de uiterwaarden.

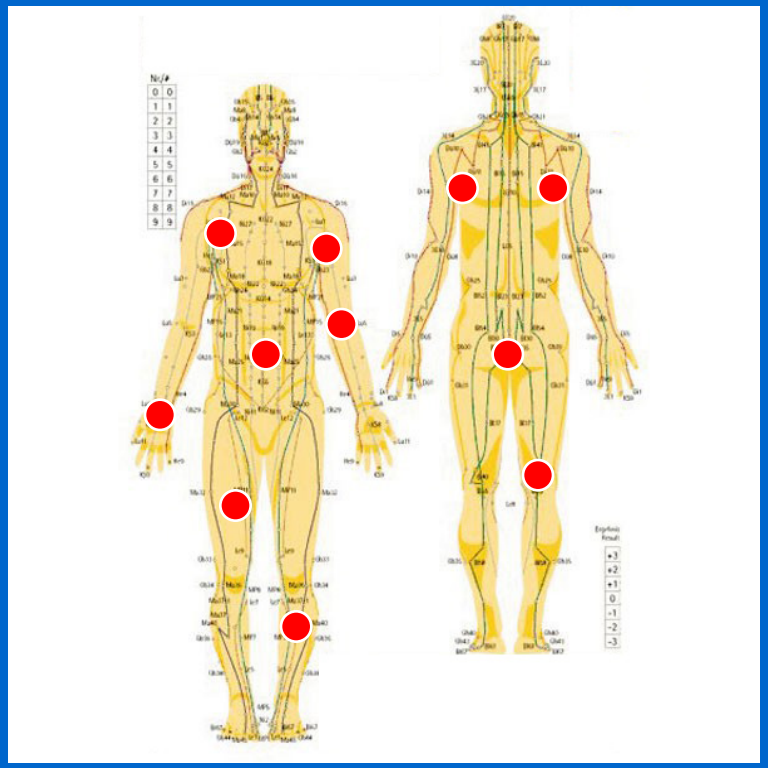


VI. Verlagen van de uiterwaarden, door onder andere het graven van geulen.

Space for the River / Living Rivers

ACUPUNCTURE

to revitalize
the Nervous System
& Human Organs



AQUAPUNCTURE

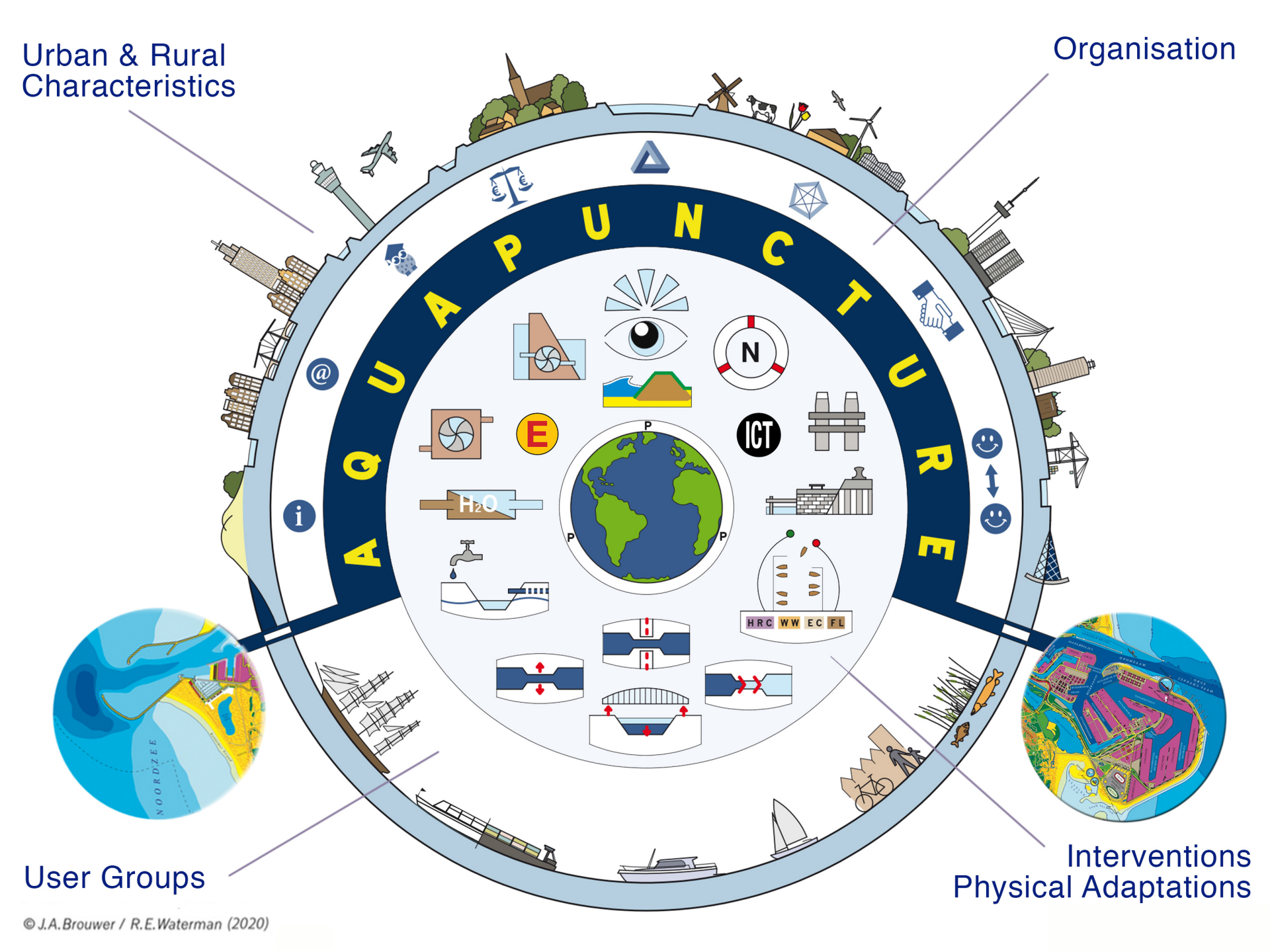
to revitalize
the Waterways & their
Water Fronts

AQUAPUNCTURE©

Introduction of AQUAPUNCTURE©

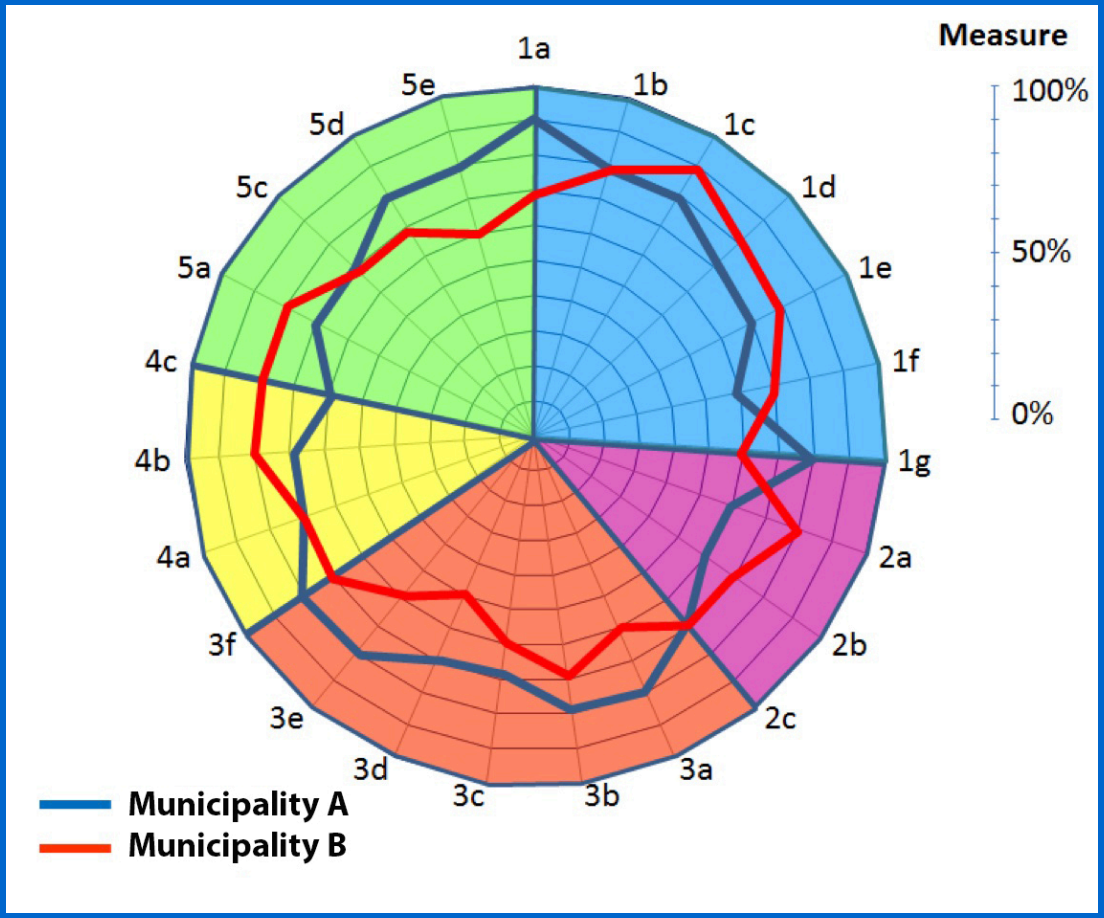
Optimal use, adaptation, experience and management of inland waterways and their waterfronts

for safety against flooding, water storage, water level regulation, water quality, navigability, economy, employment, environment and nature-landscape


Urban & Rural Characteristics
Organisation
AQUAPUNCTURE
N
E
ICT
P
P
P
H2O
HRC WW EC FL
NOORDZEE
User Groups
Interventions Physical Adaptations
© J.A.Brouwer / R.E.Waterman (2020)

Aquapuncture - Shared Value: Societal Costs & Benefits Measurement Model

Values	Objectives
1. **Water quantity**	a) Ensure flood protection b) Surface water & ground water regulation c) Drainage, irrigation for agriculture & aquaculture d) Drinking water supply e) Cooling water f) Process water g) **Water flow, thermal, osmotic energy**
2. **Water quality**	a) Improvement of water quality for environment b) Improvement of water quality for nature c) Improvement of water quality for health
3. **Navigability**	a) Commercial transport of persons b) Commercial transport of goods c) Tourism and recreation d) Special events on/at water e) Water related sports f) Waterway classification & connectivity
4. **Water front revenues**	a) Increased liveability b) Economic activities c) Increased value of property
5. **Spatial quality revenues**	a) Improved urban & rural environment b) Preservation & restoration of cultural heritage c) Attractive residential & business areas d) Leisure parks, sustainable industrial parks e) Overall sustainability, also with regard to climate & climate change



Large scale land reclamation, fresh water lakes & sea defence

ZUIDERZEE PROJECT

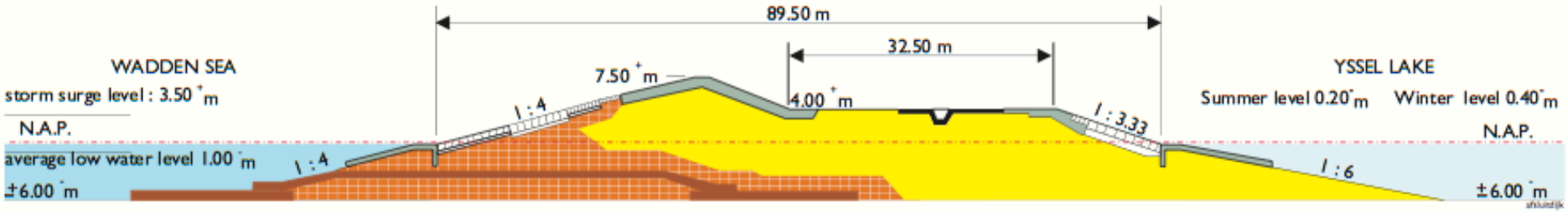
Land Reclamation	1,660 km^2
Fresh Water Lake	1,900 km^2
Enclosure Dike	32.5 km

4 Polders

Transformation of original South Sea into fresh water IJssel Lake by creating Enclosure Dike with discharge sluices and ship locks and by creating a sequence of 4 large polders with drainage canals and pumping stations

A Living Nation is Building it's Future

CROSS SECTION : ENCLOSURE DIKE / BARRIER DAM



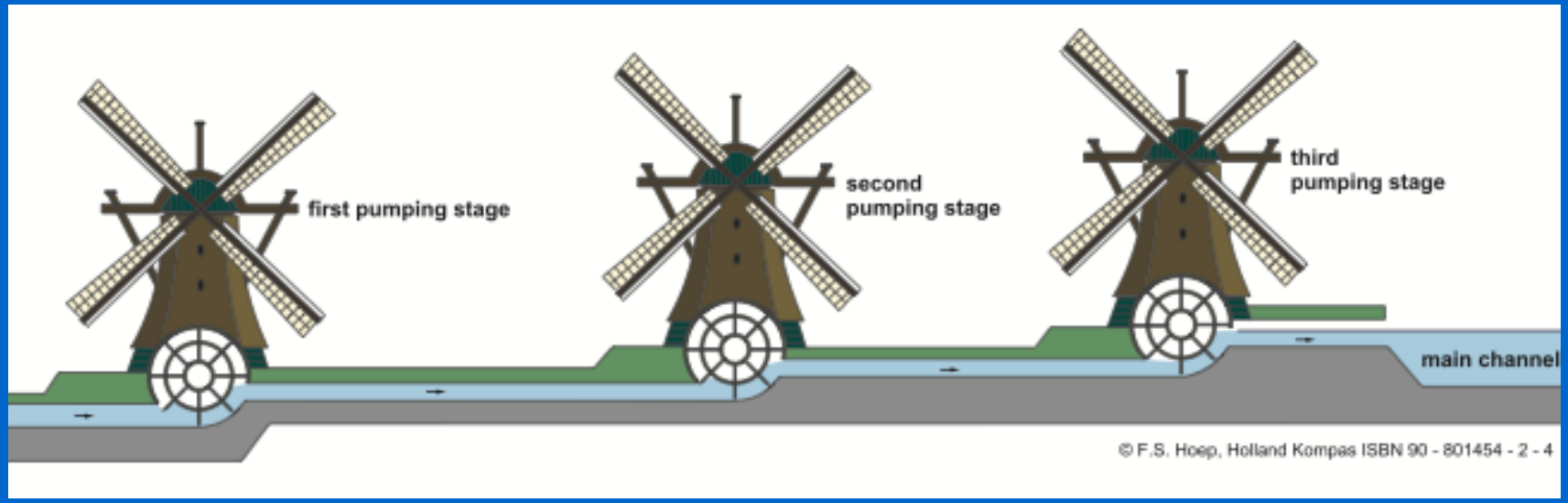
boulder clay

sand

clay

bedding matress

revetment:
cover layer + filter layer



Period of creation	Name of Polder	Area	Pumping Stations		Initially pumped out	Maintenance pumping
			number	power		
		hectares	x	MW	10^6 m³	10^6 m³/yr
1927-1932	Wieringermeer Polder	20,000	2	3.28	700	160
1937-1942	North East Polder	48,000	3	6.10	1500	400
1950-1957	East Flevoland	54,000	3	5.94	1600	800
1959-1968	South Flevoland	43,000	1	3.53	1400	

Land-Use in %	Wieringermeer Polder	North East Polder	East Flevoland	South Flevoland
Agriculture	87	87	75	50
Nature (incl. woodland & marshland)	3	5	11	18
Cities	1	1	8	25
Dikes, roads, water	9	7	6	7

GENERAL PRINCIPLE OF POLDER SYSTEMS

Dike with road

Main canal

Polder ditch

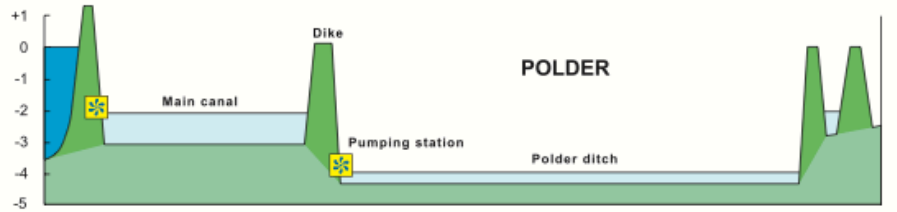
Pumping station

Discharge sluice (without pumping station)

Direction of discharge water

-4,50 Depth below sea level (m)

External water (river and sea)

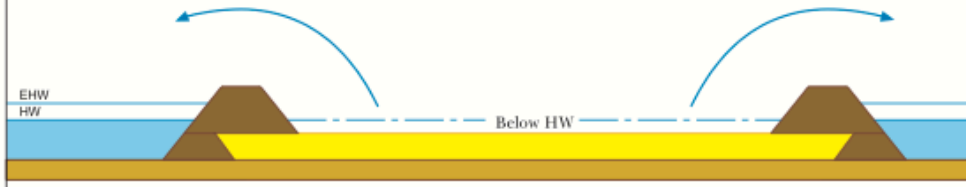


CROSS-SECTION A-B

OPTIONS FOR ISLAND CONSTRUCTION 1: DIKED AREAS

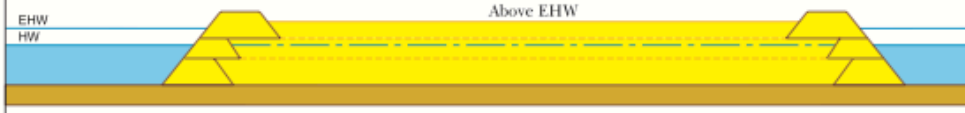
II.C.1 POLDER 1: WATER MANAGEMENT BY PUMPING

II.C.2 POLDER 2: WATER MANAGEMENT BY PUMPING IN COMBINATION WITH LANDFILL



II.C.3 LANDFILL 1: WATER MANAGEMENT BY GRAVITY DRAINAGE & PUMPING (AT EHW)

II.C.4 LANDFILL 2: WATER MANAGEMENT BY GRAVITY DRAINAGE



Europe
Netherlands
United Kingdom
Denmark
Belgium

Africa
South Africa
Tunesia
Egypt

Middle East
Israel
Jordan
UAE
Qatar

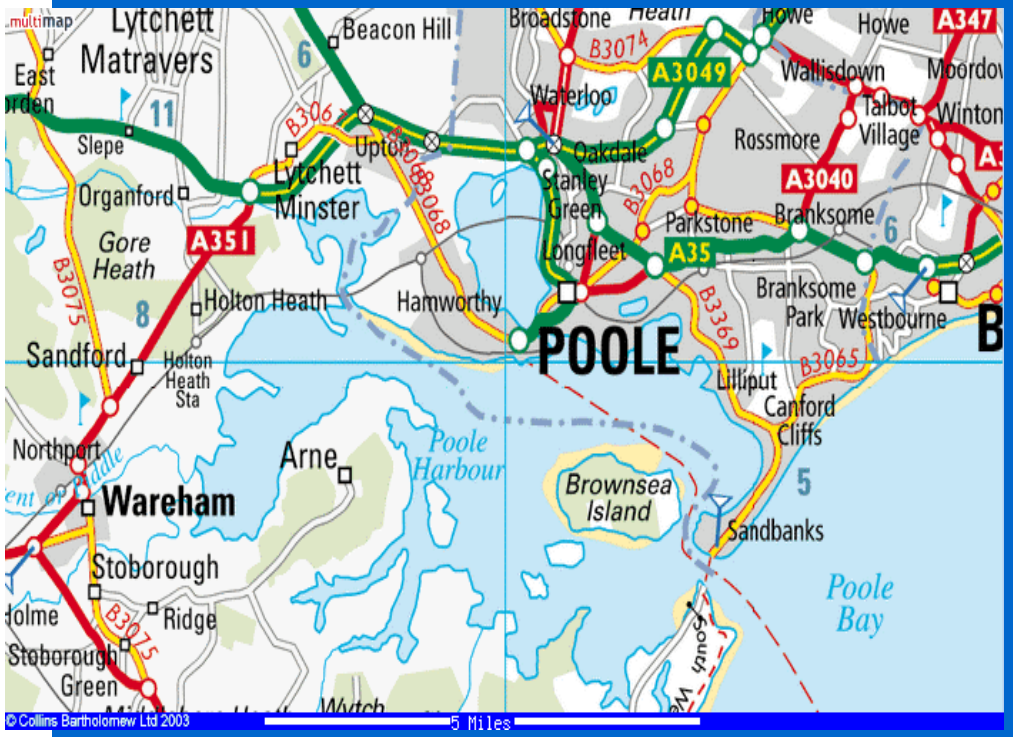
Asia
India
Bangladesh
Singapore
Indonesia
Brunei
Philippines
Vietnam
China
Korea
Japan

Americas
USA
Mexico
Curacao
Colombia
Argentine
Chile

Australia

Building with Nature®

BUILDING WITH NATURE



UK, Poole

UK, Poole **Before the land reclamation**

UK, Poole During the land reclamation

UK, Poole **After the land reclamation**

UK, Bacton Gas Terminal

Fighting coastal erosion between Bacton & Walcott using a sand engine via Building with Nature

1.8 million m3 to reinforce 5.6 km coastline

15 to 20 years coastal protection

Vier stadia van de zandmotor, van linksboven met de klok mee: begin; huidige situatie bij aanleg; vijf jaar na aanleg; eindsituatie.

Photo: Chris Taylor

3 – COASTLINE PROJECT WITH ISLAND & LAGOON
WATERFRONT DEVELOPMENTS IN HARMONY WITH NATURE

BOUWEN MET DE NATUUR

VLAAMSE KUST 67 km

10 Gemeenten :

- Knokke-Heist
- Brugge / Zeebrugge
- Blankenberge
- De Haan
- Bredene
- Oostende
- Middelkerke
- Nieuwpoort - IJzermonding
- Koksijde
- De Panne

Blankenberge - Zeebrugge

Heist / Knokke - 't Zwin

Blankenberge – Zeebrugge

Aanleg Blankenberge havendammen
Marina & strandverbreding

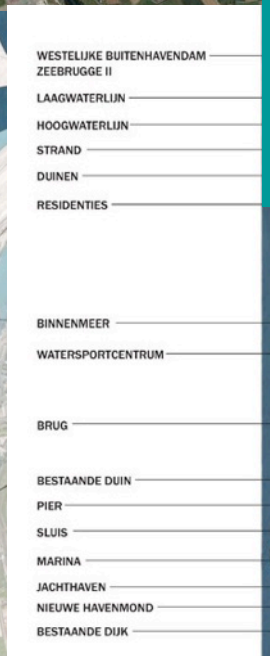
Heist

Natuurreservaat Baai van Heist
& Marina Heist

Blankenberge - Zeebrugge

Heist / Knokke - 't Zwin

Blankenberge – Zeebrugge
Aanleg Blankenberge havendammen
Marina & strandverbreding



Blankenberge – Zeebrugge
Marina Residentie & Lagune
met stranden in aansluiting
op Zeebrugge II

Oostende

Verlenging havenhoofden
Buitenhaven met Marina
Duin-strand verbreding met Resorts & voorzieningen
Nieuwe Pier met Casino

De Panne - Koksijde

Nieuwpoort

Nieuwpoort

Bestaande Jachthaven met
1800 ligplaatsen

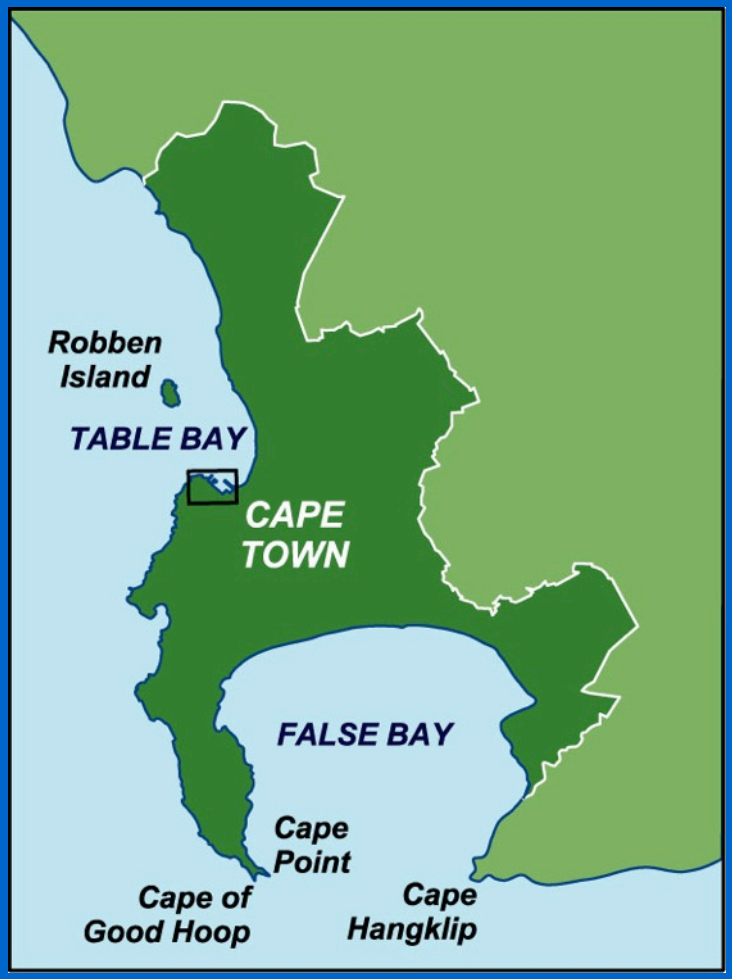
BUILDING WITH NATURE

AFRICA

BUILDING WITH NATURE

SOUTH AFRICA

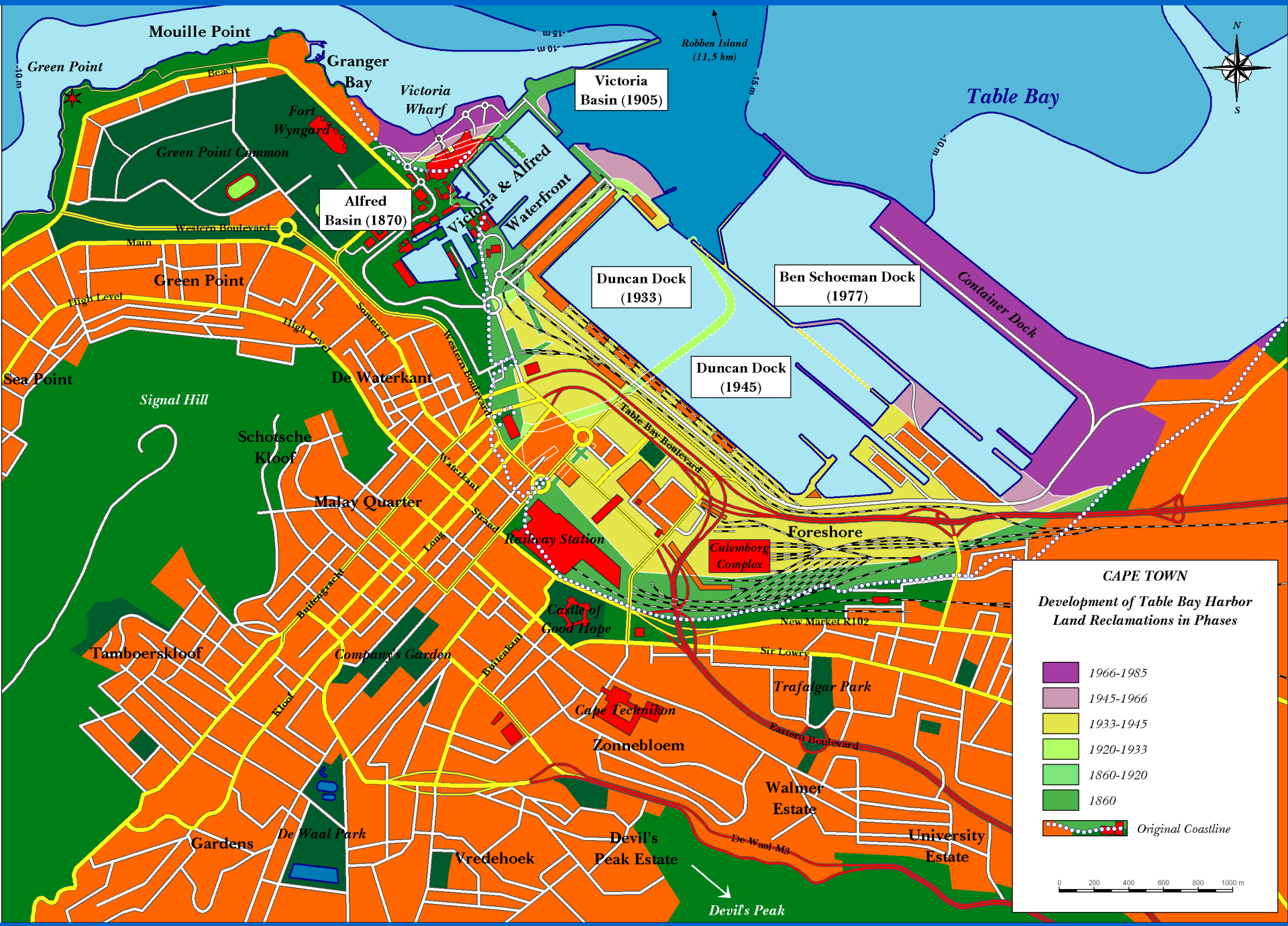
BUILDING WITH NATURE



CAPE TOWN

BUILDING WITH NATURE

CAPE TOWN


Mouille Point
Green Point
Granger Bay
Victoria Wharf
Victoria Basin (1905)
Robben Island (11,5 km)
Table Bay
N
S
Fort Wyngard
Green Point Common
Alfred Basin (1870)
Victoria & Alfred Waterfront
Western Boulevard
Main
Green Point
High Level
Somerset
Sea Point
Signal Hill
De Waterkant
Schotsche Kloof
Malay Quarter
Duncan Dock (1933)
Ben Schoeman Dock (1977)
Container Dock
Duncan Dock (1945)
Table Bay Boulevard
Railway Station
Foreshore
Culemborg Complex
Castle of Good Hope
New Market R102
Sir Lowry
Tamboerskloof
Company's Garden
Trafalgar Park
Cape Technikon
Zonnebloem
Eastern Boulevard
Walmer Estate
University Estate
Gardens
De Waal Park
Vredehoek
Devil's Peak Estate
De Waal M3
Devil's Peak
CAPE TOWN
Development of Table Bay Harbor
Land Reclamations in Phases
1966-1985
1945-1966
1933-1945
1920-1933
1860-1920
1860
Original Coastline
0 200 400 600 800 1000 m

BUILDING WITH NATURE

CAPE TOWN, SOUTH - AFRICA

BUILDING WITH NATURE

TOGO Coastal protection through Permaculture

Application of vegetable & fruit production and planting of shrubs and trees (banana, coconut) near the beach combined with soil improvement by dung & compost. Thereby strengthening the root system of the vegetation, improving beach protection as well as the local economy


© DW/N. Tadé

TUNESIA - SFAX

LAND RECLAMATION DESIGN

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal Policy via Building with Nature

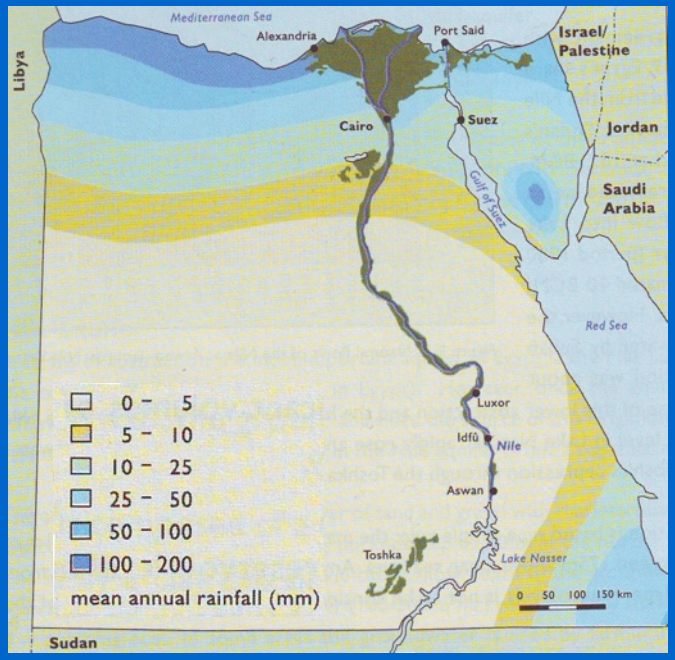
Dr. R. E. Waterman MSc

ALEXANDRIA - EGYPT
CoRI March 2010

THE HAGUE – THE NETHERLANDS
June 2012

ARAB REPUBLIC OF EGYPT
جمهورية مصر العربية

THE NETHERLANDS



SURFACE AREA

Egypt	Netherlands
1,010,000 km²	41,500 km²

INHABITANTS

Egypt	Netherlands
82 million	16.7 million

COASTAL LENGTH

Egypt		Netherlands
1,200 km	M. Coast	353 km
2,300 km	R.S. Coast	

MAIN RIVER

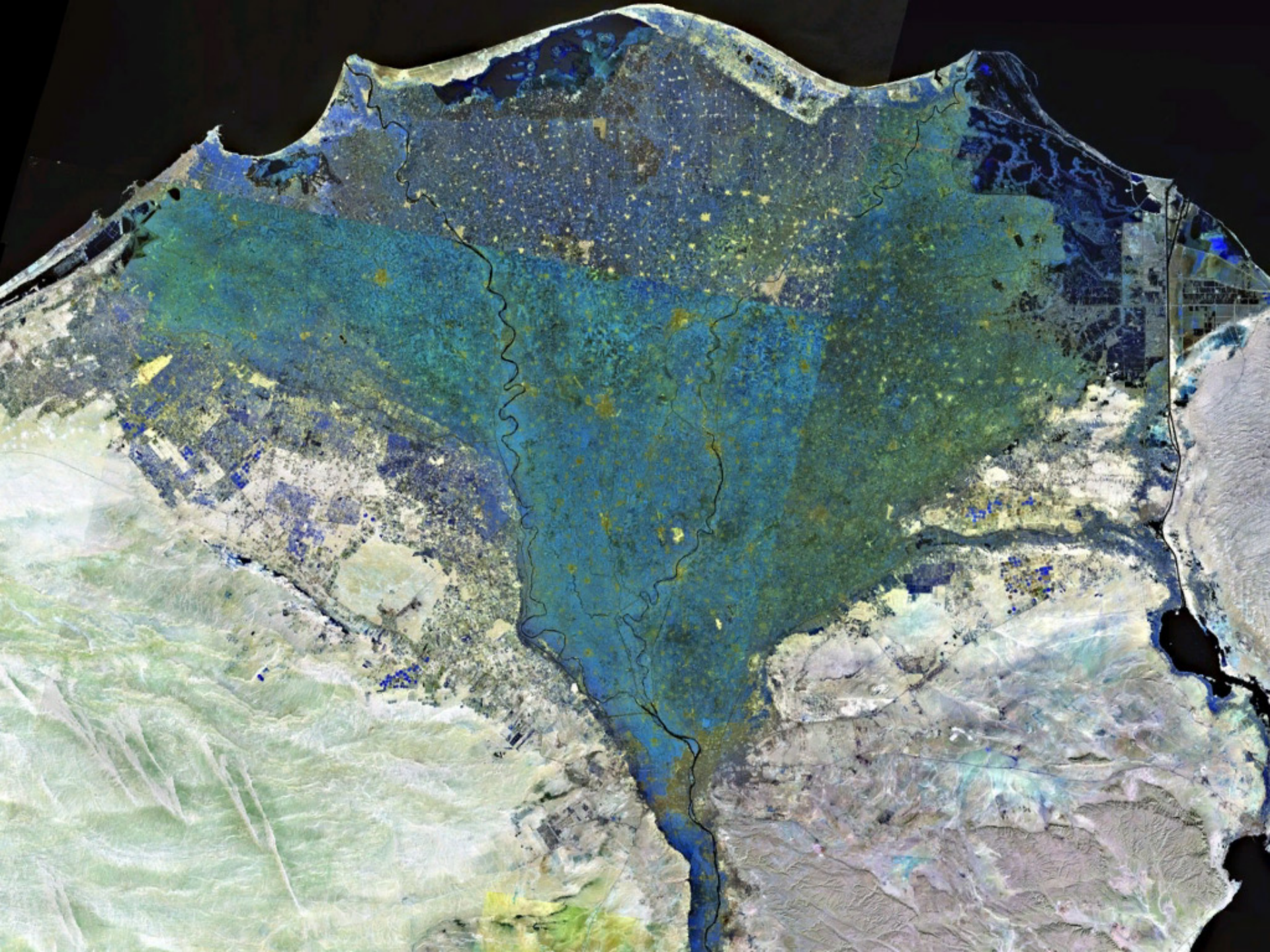
Egypt: Nile	Netherlands: Rhine
6,650 km	1,320 km
5,100 m³/s	2,330 m³/s

LARGEST CITIES

Egypt		Netherlands	
1.Cairo	8,5 million	1. Amsterdam	0,8 million
1.Cairo m.a.	20 million	2. Rotterdam	0,6 million
2. Alexandria	4,5 million	3. The Hague	0,5 million
6. Port Said	0,6 million	4. Utrecht	0,3 million
7. Suez	0,5 million	5. Rim City Holland	8,0 million

NILE DELTA:
Width 250 km
Length 150 km
Area +/- 35,000 km²

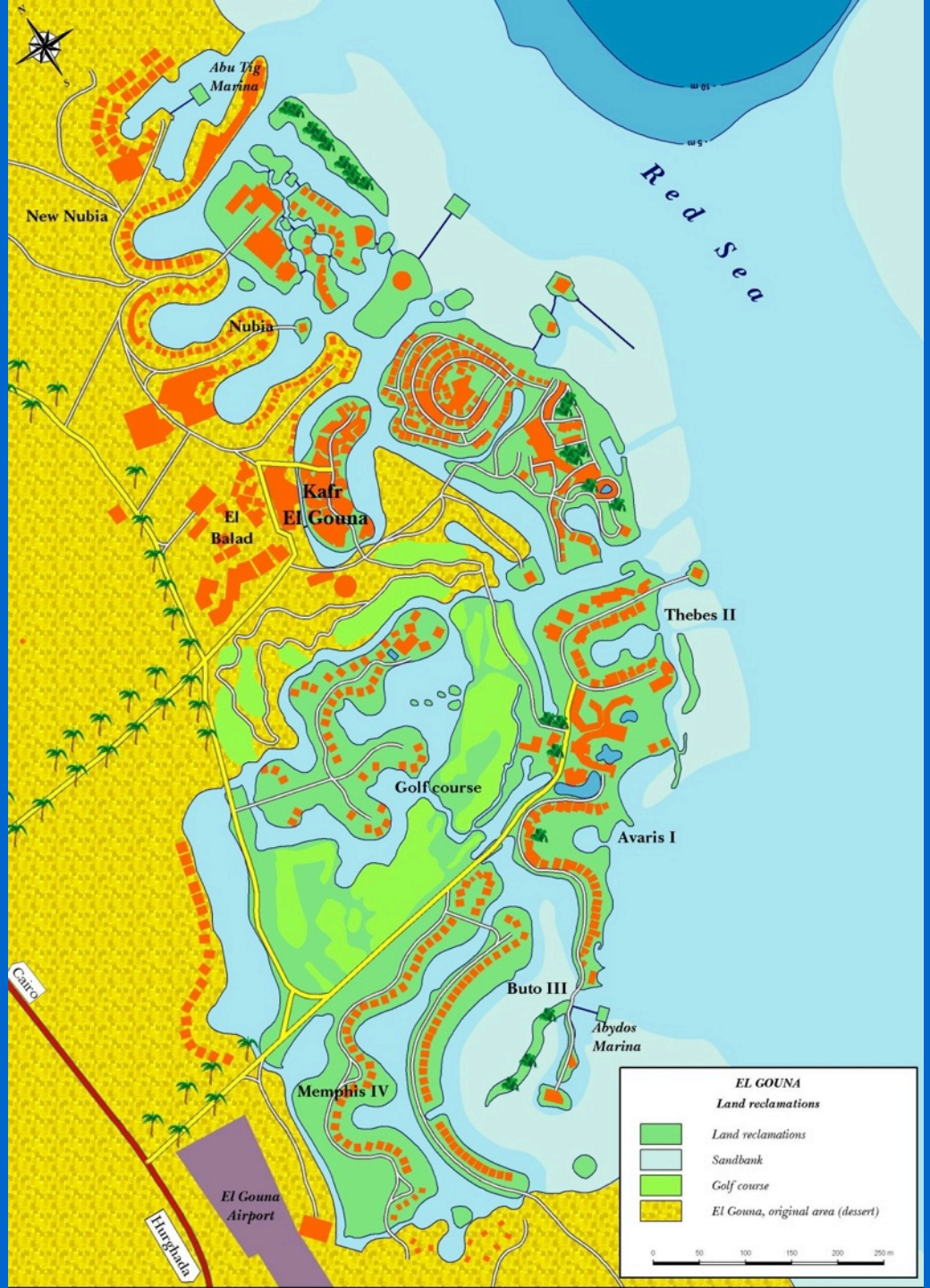
1. Lake Maryot
2. Lake Edku
3. Burullus Lagoon
4. Manzalah Lagoon
5. Bardawil Lagoon




Alexandria
Tabia

El Gouna


MEDITERRANEAN SEA
EGYPT
RED SEA
GULF OF SUEZ
EL GOUNA
EGYPT
RED SEA


Abu Tig Marina
New Nubia
Nubia
Kafr El Gouna
El Balad
Red Sea
Thebes II
Golf course
Avaris I
Buto III
Abydos Marina
Memphis IV
Cairo
El Gouna Airport
Hurghada
EL GOUNA
Land reclamations
Land reclamations
Sandbank
Golf course
El Gouna, original area (dessert)
0
50
100
150
200
250 m

El Gouna

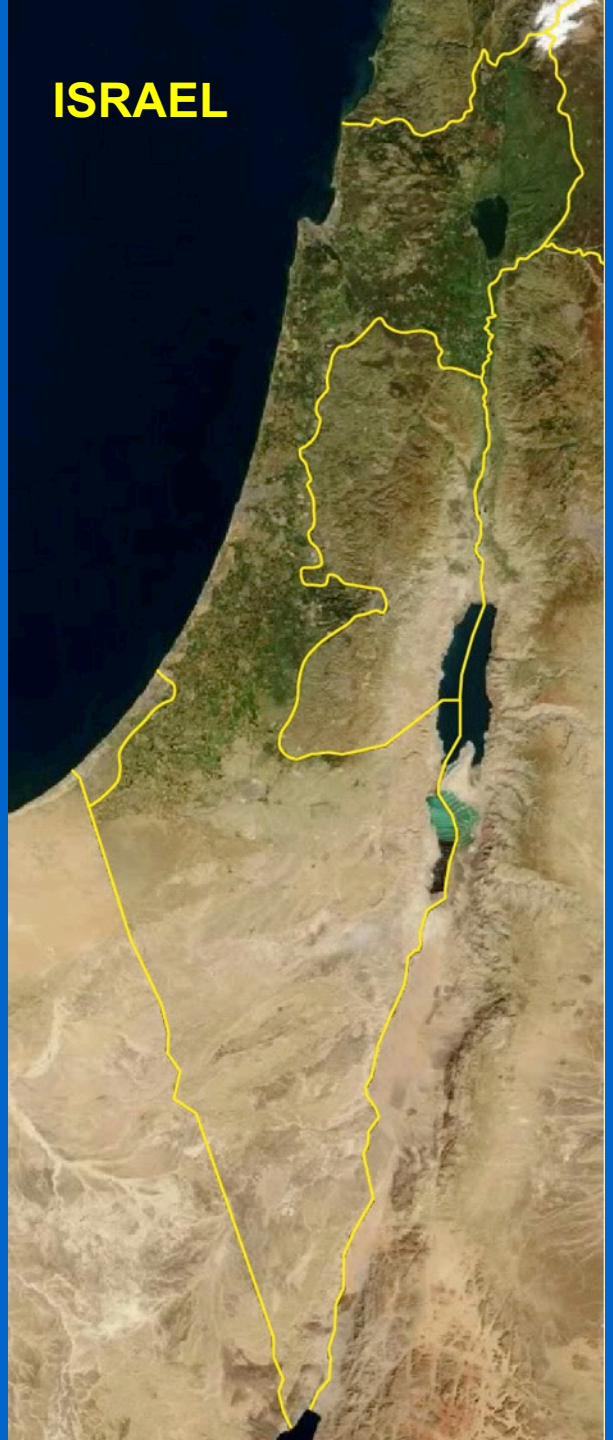
SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

ISRAEL - Tel Aviv

Coastal Extentions & Airport



THE NETHERLANDS

SURFACE AREA

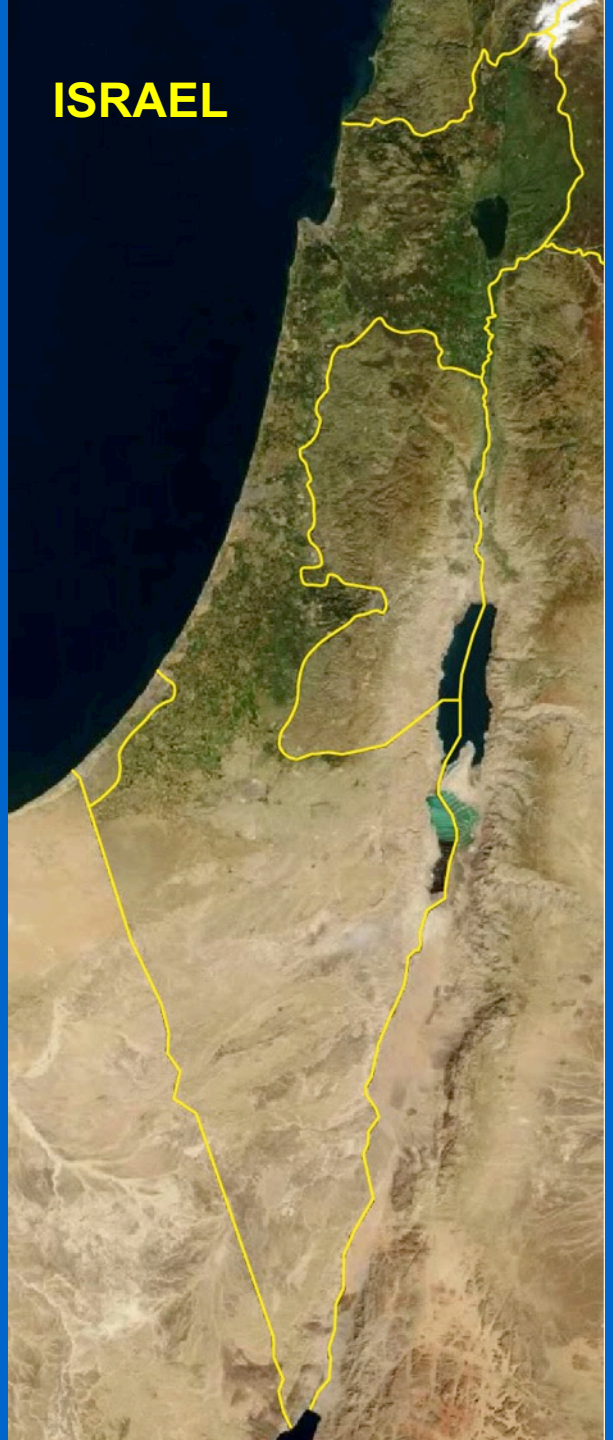
22,145 km²	33,883 km²

INHABITANTS

7.7 million	16.7 million

COASTAL LENGTH

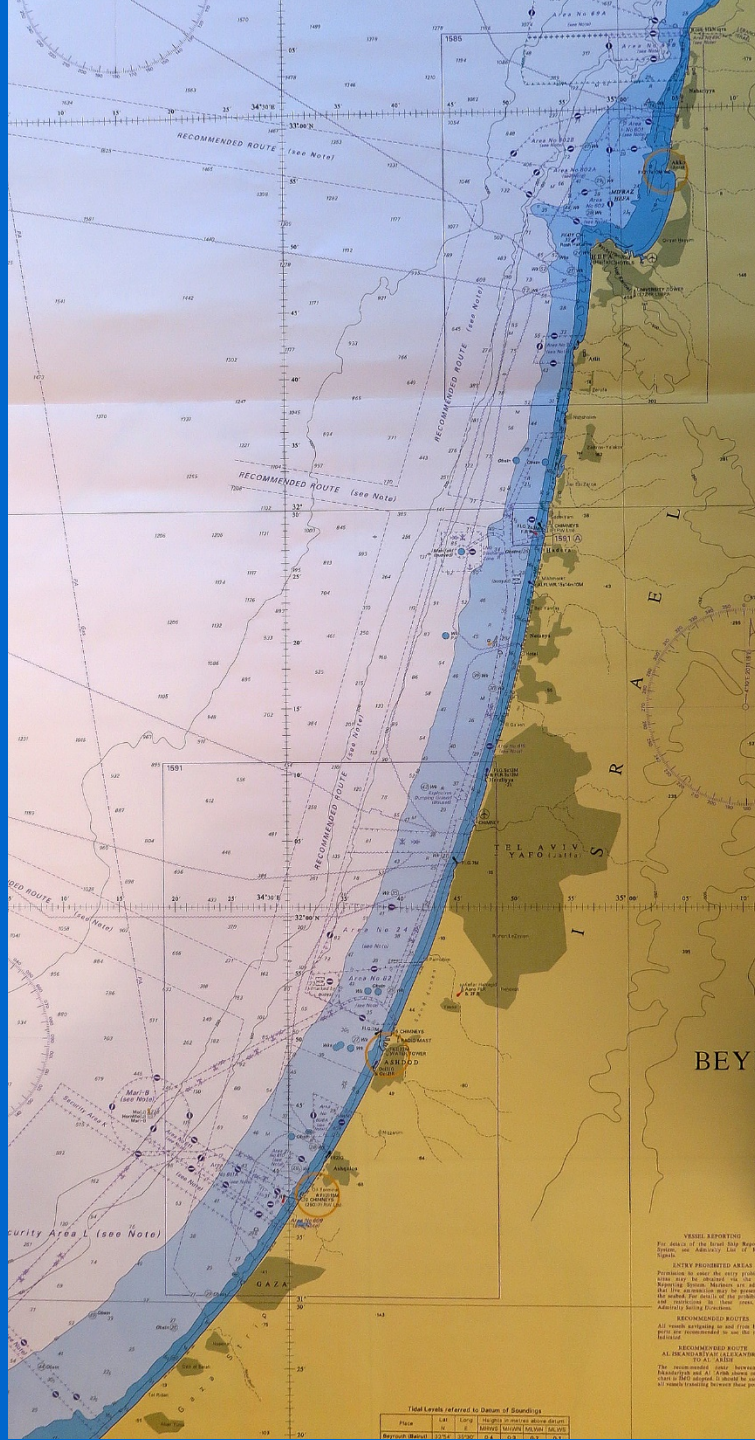
188 + 10 km	353 km

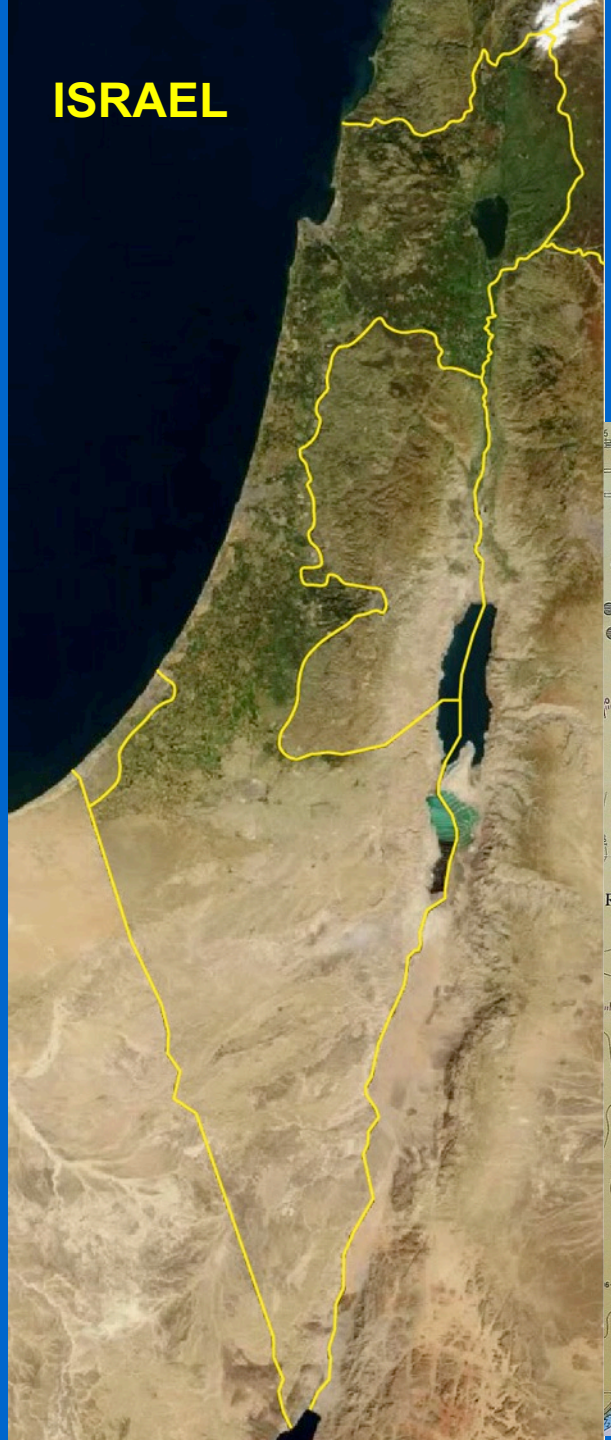


COASTAL LENGTH

188 km

Rosh Hanikra
Nahariya
Ako
Haifa
Atlit
Caesarea
Hadera
Netanya
Herzliyah
Tel Aviv
Jaffa
Bat Yam
Rishon Letsion
Palmachim
Ashdod
Ashkelon
Zikim



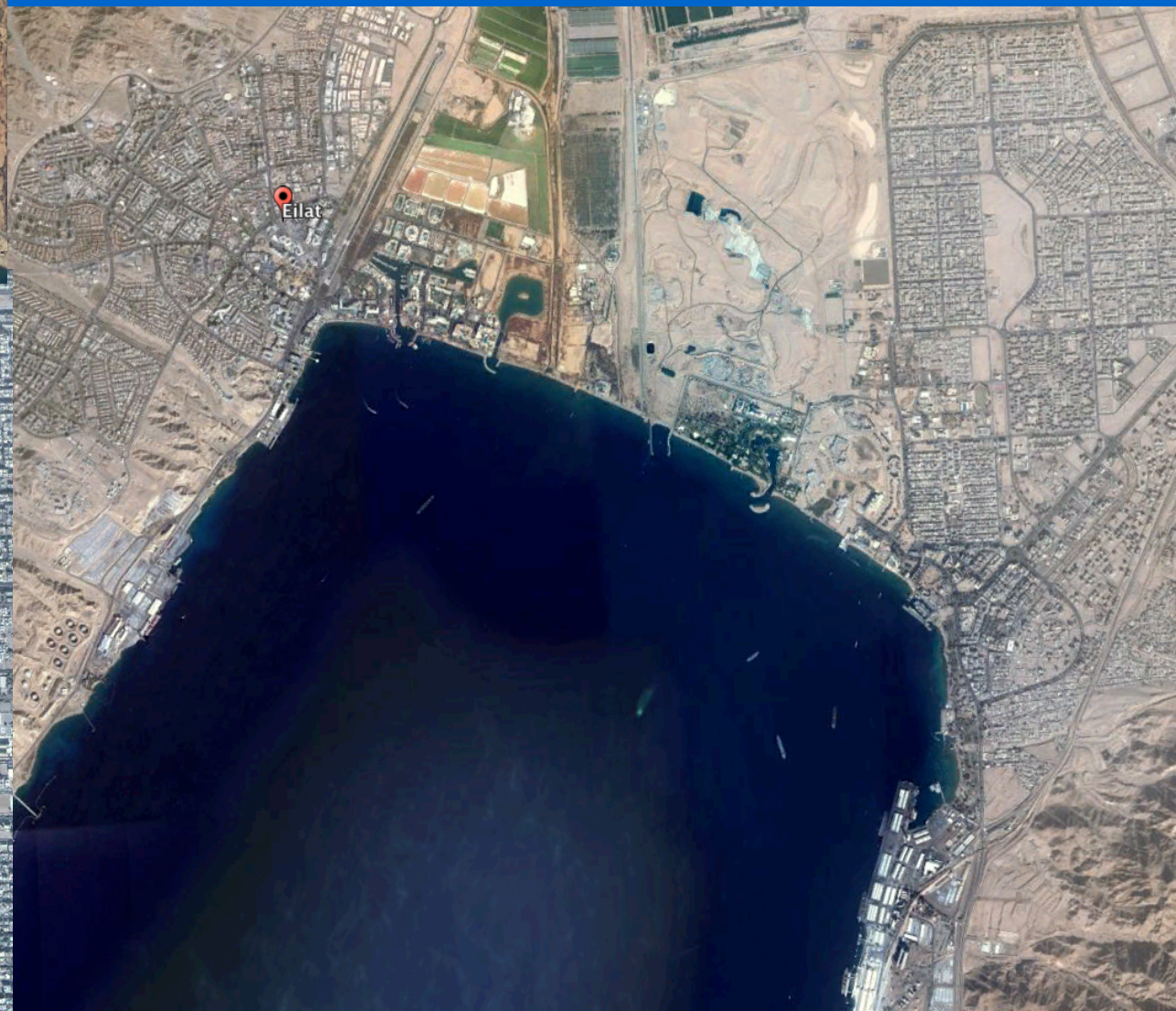


COASTAL LENGTH ISRAEL ALONG RED SEA 10 KM

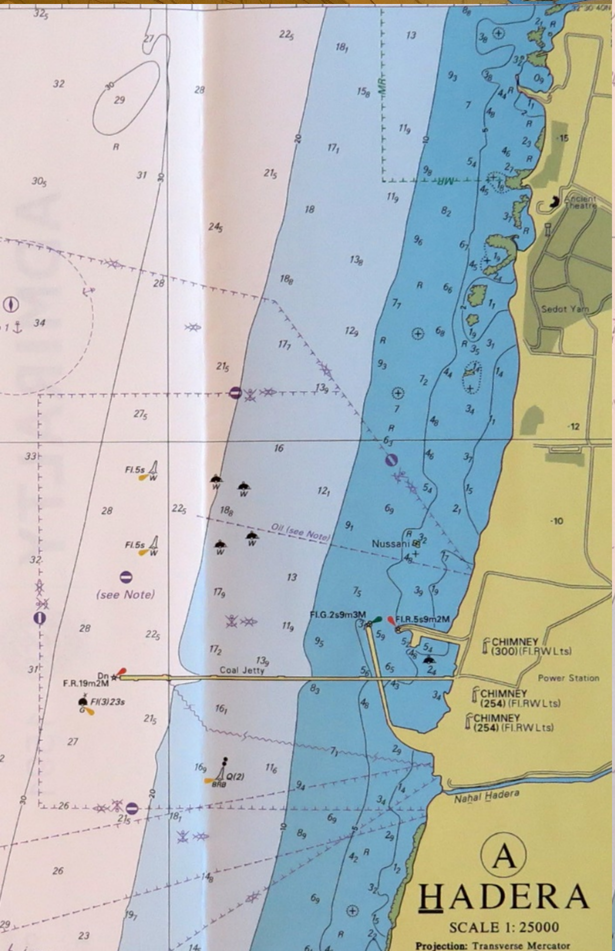
EILATH - AKABA

COASTAL LENGTH ISRAEL ALONG RED SEA 10 KM

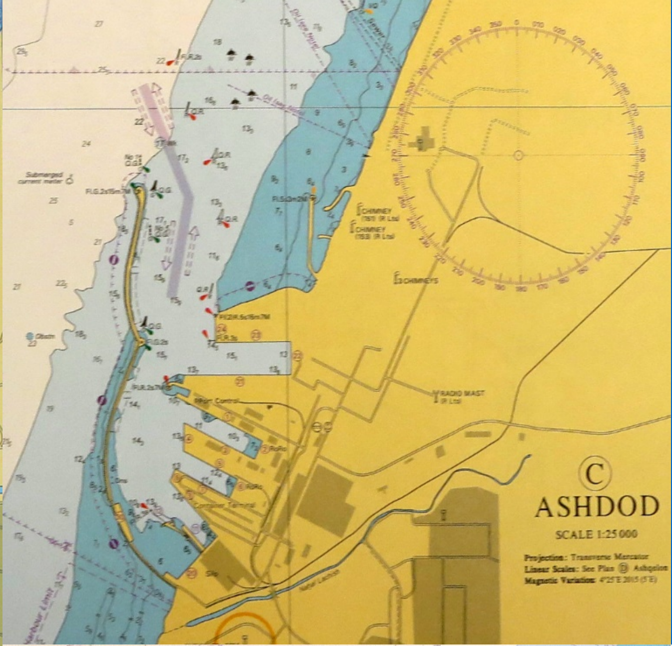
EILATH - AKABA

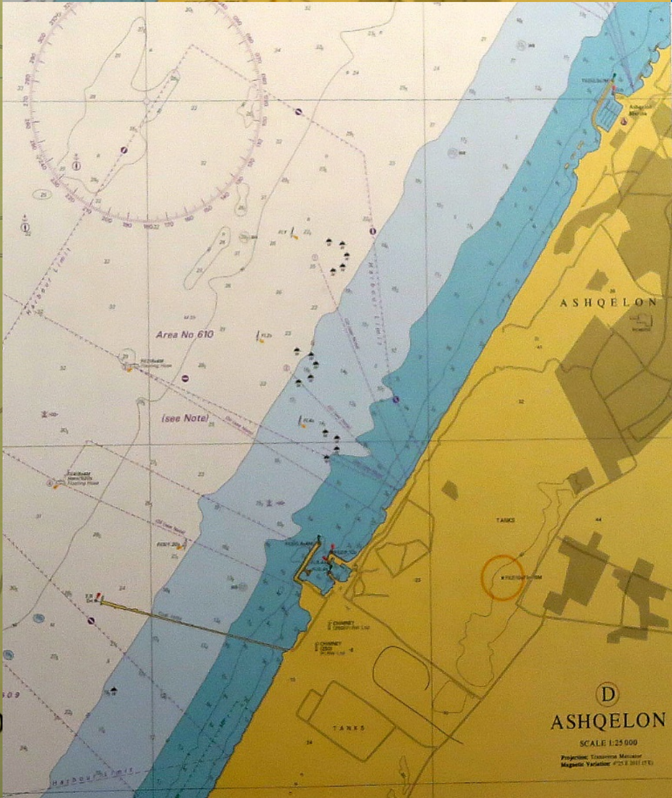



HEFA
(Haifa)
Qishon Harbour
Port Development (see Note)
Works in progress (2014)

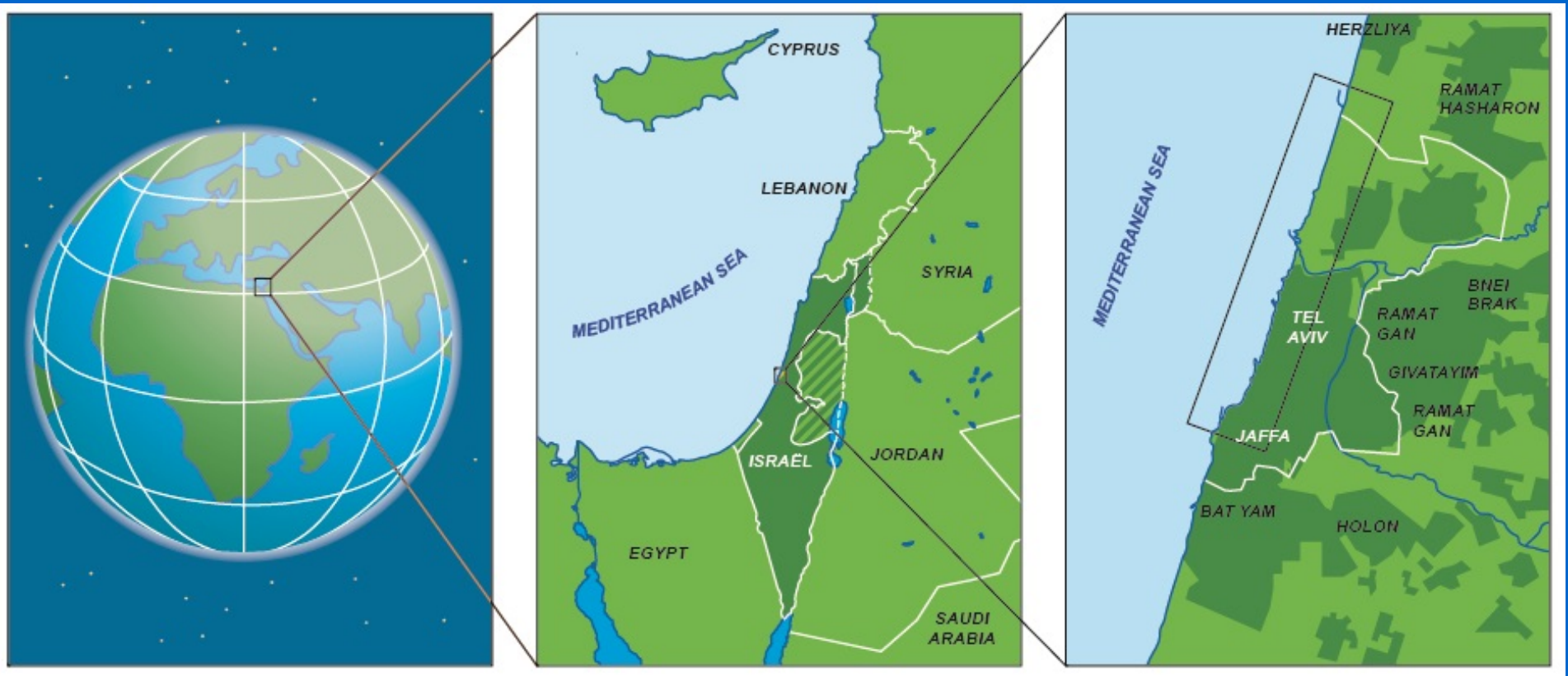

A
HADERA
SCALE 1: 25000
Projection: Transverse Mercator
Sedot Yam
Ancient Theatre
Nussani
(see Note)
Oil (see Note)
Coal Jetty
Power Station
CHIMNEY (300) (F.R.W Lts)
CHIMNEY (254) (F.R.W Lts)
CHIMNEY (254) (F.R.W Lts)
Nahal Hadera
Fl.G.2s9m3M
Fl.R.5s9m2M
F.R.19m2M
Fl(3)23s
Fl.5s
Q(2)


B
TEL AVIV AND YAFO
SCALE 1: 25 000
Projection: Transverse Mercator
TEL AVIV
YAFO
(JAFFA)
Tel Aviv Port
Nahal Yarqon
POWER STATION
CHY (R&G Lts)
Tel Aviv Marina (25m)
Hotel
Hotels
Shalom Tower
Andromeda Rock (1.2)
LT HO (disused)
Harbour Limit
Oil (see Note)
Sewer
Fl(2)R.5s9m2M
Fl(5)G.20s10m
Fl.G.4s7M
Q.Y.2M
F.R(occas)
Obstn
Wk

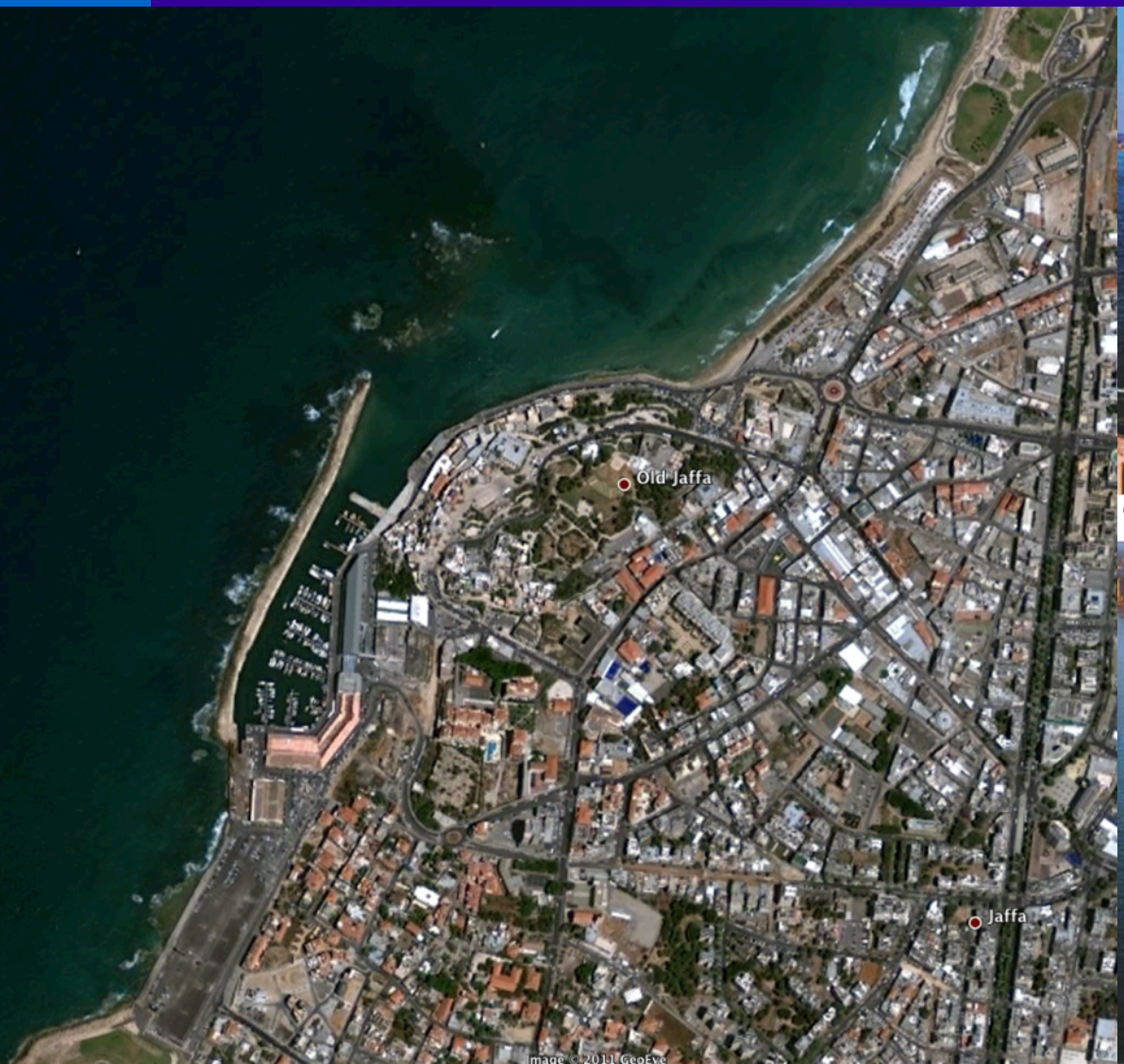

C
ASHDOD
SCALE 1:25 000
Projection: Transverse Mercator
Linear Scales: See Plan D Ashqelon
Magnetic Variation: 4°25'E 2015 (5'E)
RADIO MAST (R Lts)
CHIMNEYS
Submerged current meter
Nahal Lakhish


D
ASHQELON
SCALE 1:25 000
ASHQELON
Area No 610
(see Note)
TANKS
Harbour Limit

Tel Aviv - Jaffa



Jaffa



OLD JAFFA, VIEW TO TEL-AVIV

OLD JAFFA

JAFFA

Marina / Ferry Port & Seashore development

Promenade / boulevard

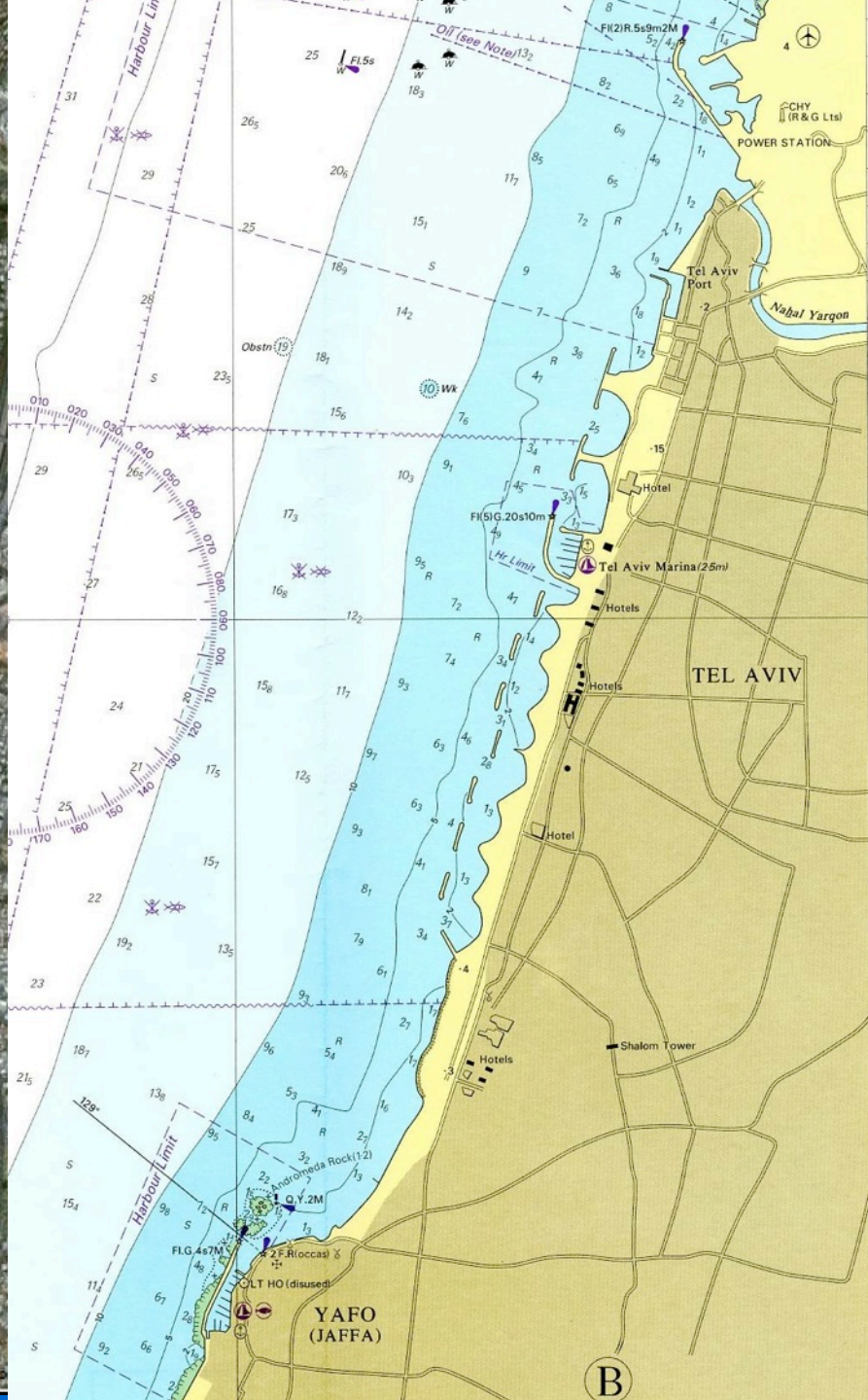
Original Coastline

1. terminal
2. large yachts & tour boats & ferry
3. club / restaurant
4. bathing beach
5. yacht anchorage
6. residential area
7. residential & hotel area
8. fishermen's store house
9. Jaffa shore park
10. marina services
11. marina dock yard
12. club house

- park, bathing beach & promenade (1500 ha)
- berthing capacity for 400-500 yachts
- ferry harbour & promenade
- residential area (450 units)
- hotel & residential area (350 units or hotels)
- existing Jaffa port area
- underground parking for 2300 cars

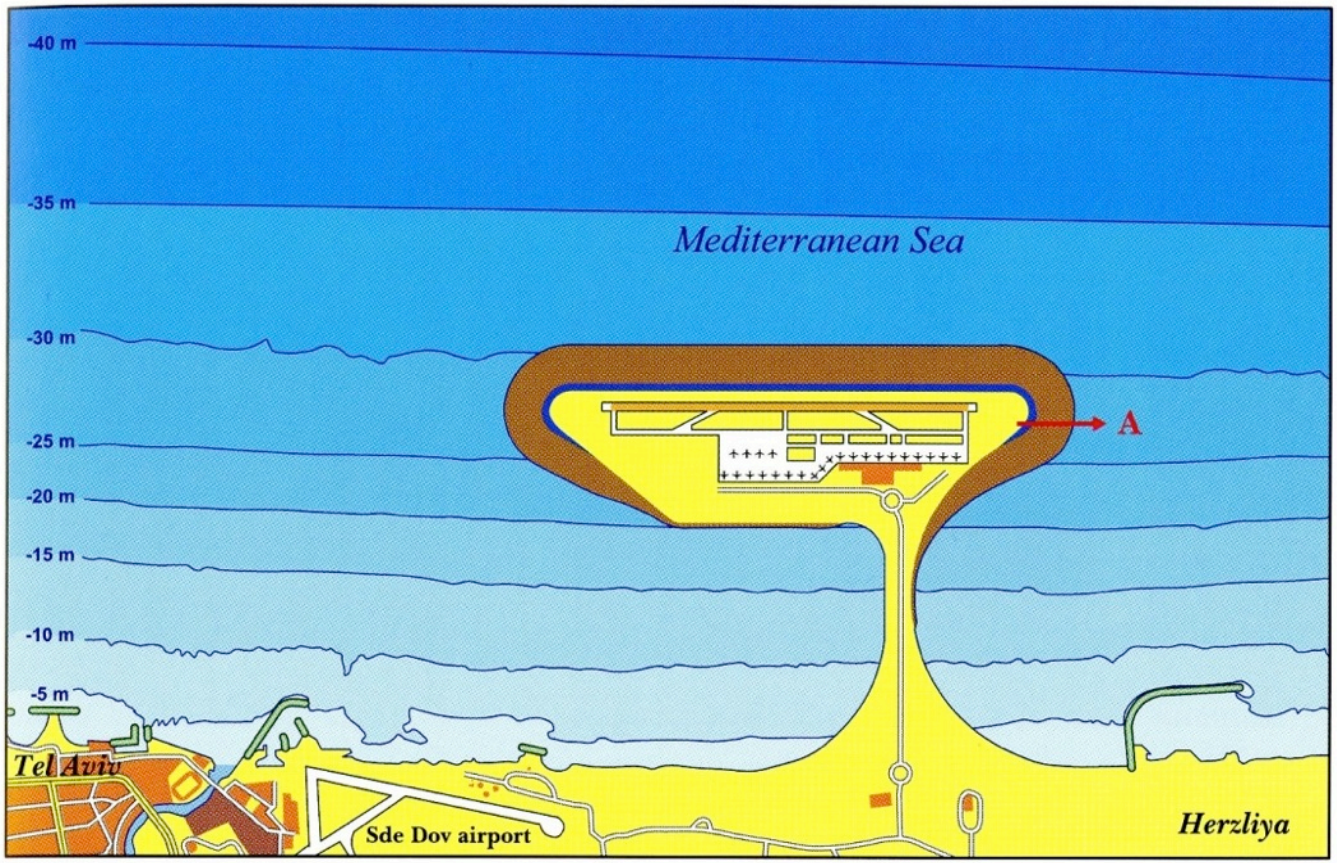
0 50 100 150 200 250 m

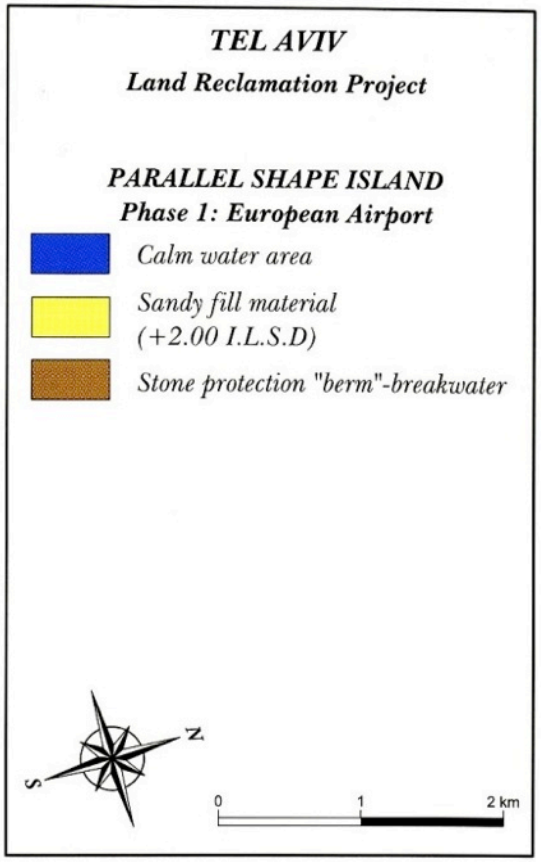
Tel Aviv Jaffa



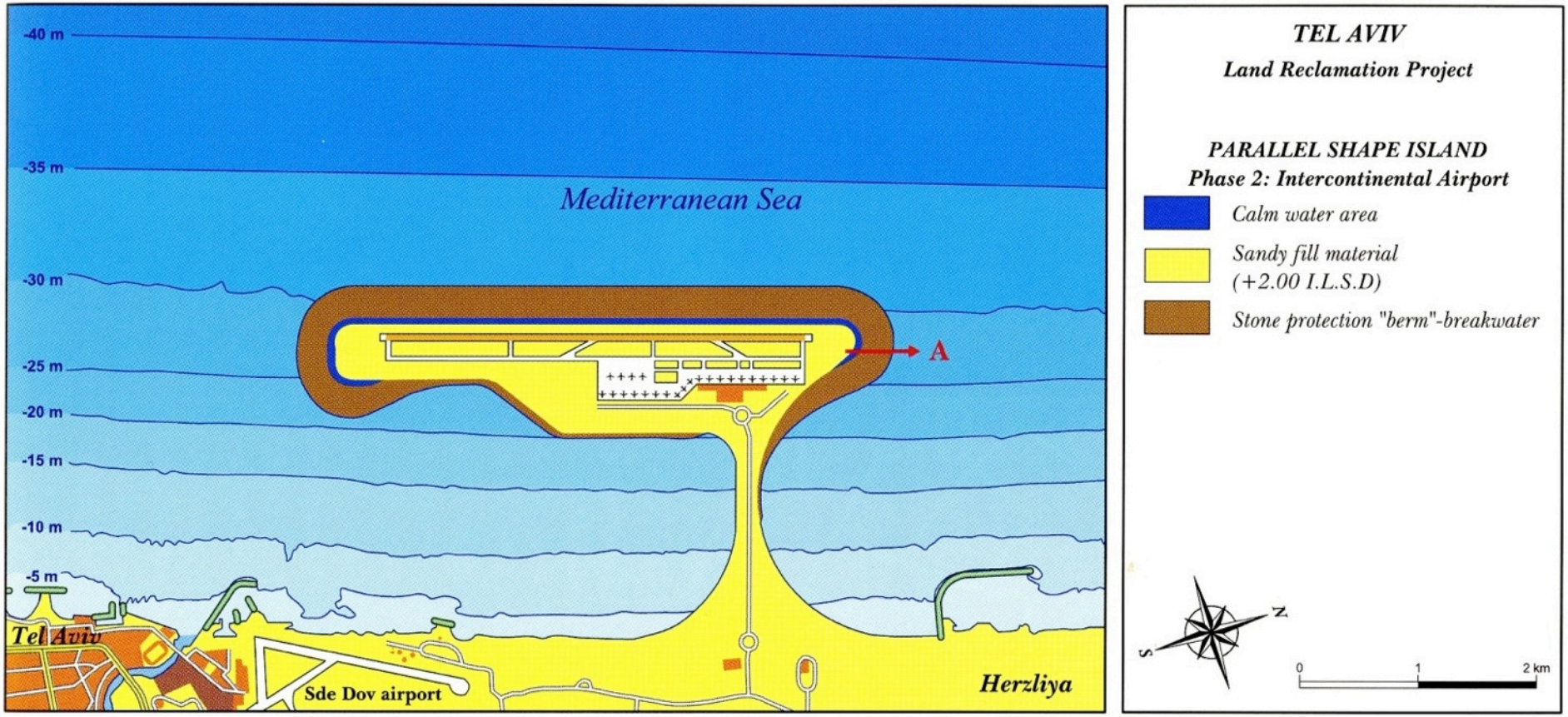

Tel Aviv
Jaffa
Sde Dov
Herzlia

Tel Aviv

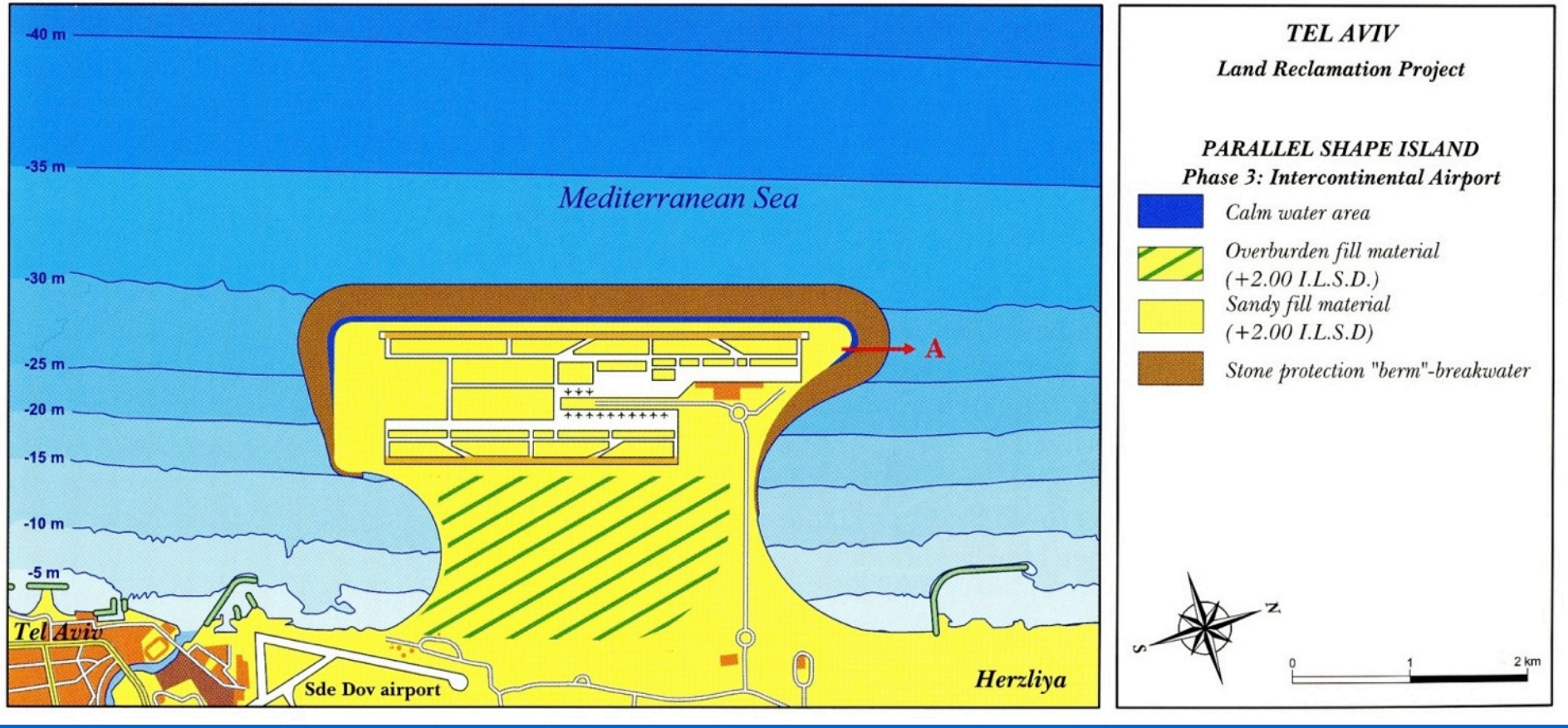

-40 m
-35 m
Mediterranean Sea
-30 m
-25 m
-20 m
-15 m
-10 m
-5 m
A
Tel Aviv
Sde Dov airport
Herzliya


TEL AVIV
Land Reclamation Project
PARALLEL SHAPE ISLAND
Phase 1: European Airport
Calm water area
Sandy fill material
(+2.00 I.L.S.D)
Stone protection "berm"-breakwater
N
S
0
1
2 km

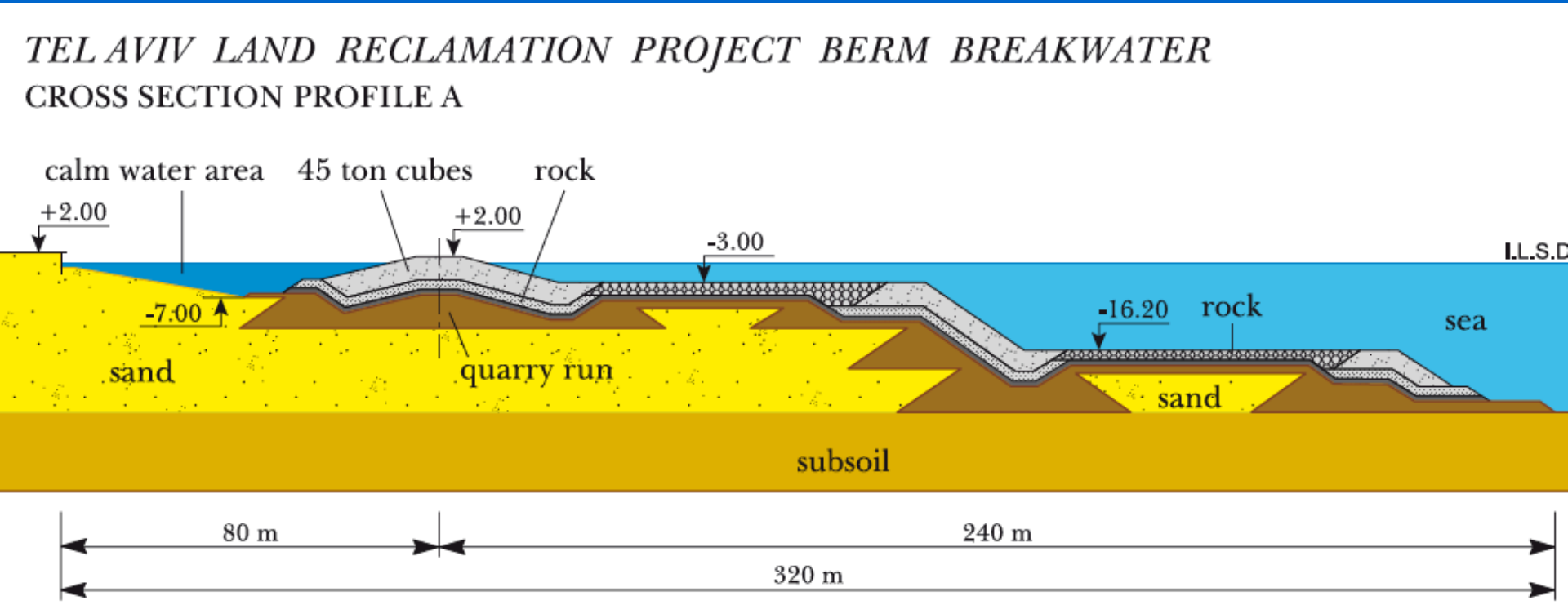
Tel Aviv


-40 m
-35 m
Mediterranean Sea
-30 m
-25 m
-20 m
-15 m
-10 m
-5 m
A
Tel Aviv
Sde Dov airport
Herzliya
TEL AVIV
Land Reclamation Project
PARALLEL SHAPE ISLAND
Phase 2: Intercontinental Airport
Calm water area
Sandy fill material
(+2.00 I.L.S.D)
Stone protection "berm"-breakwater
N
S
0
1
2 km

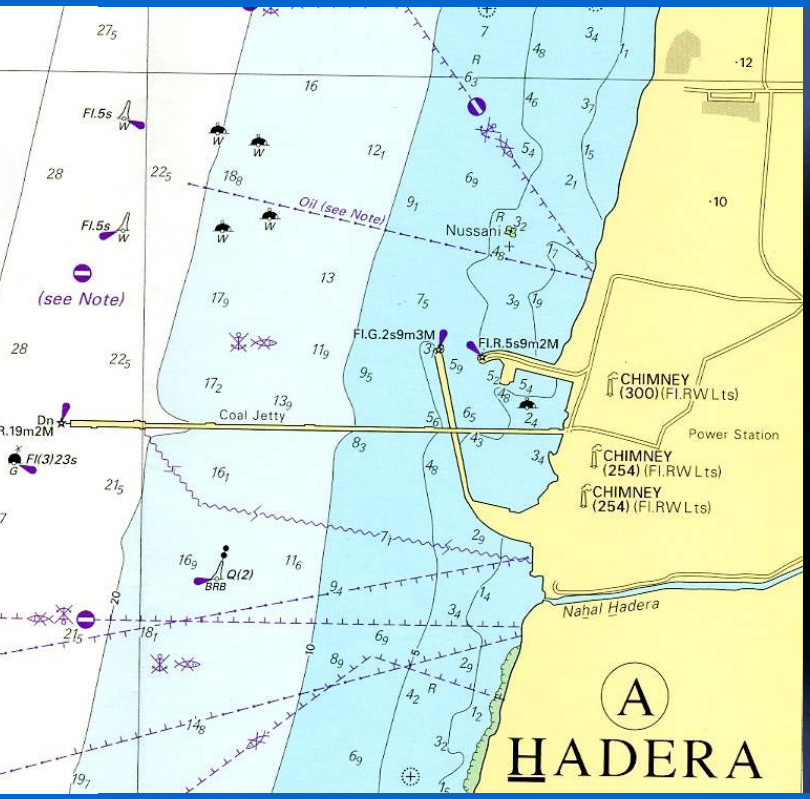
Tel Aviv

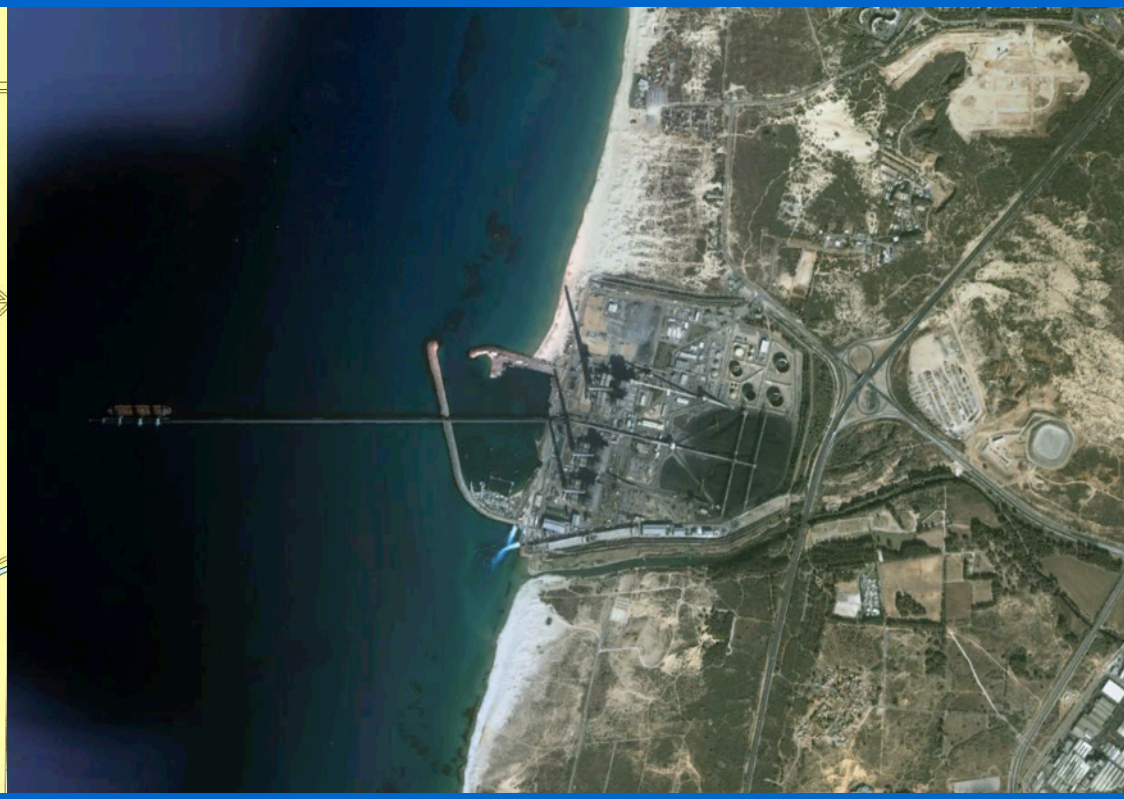

-40 m
-35 m
-30 m
-25 m
-20 m
-15 m
-10 m
-5 m
Mediterranean Sea
A
Tel Aviv
Sde Dov airport
Herzliya
TEL AVIV
Land Reclamation Project
PARALLEL SHAPE ISLAND
Phase 3: Intercontinental Airport
Calm water area
Overburden fill material
(+2.00 I.L.S.D.)
Sandy fill material
(+2.00 I.L.S.D)
Stone protection "berm"-breakwater
N
S
0
1
2 km

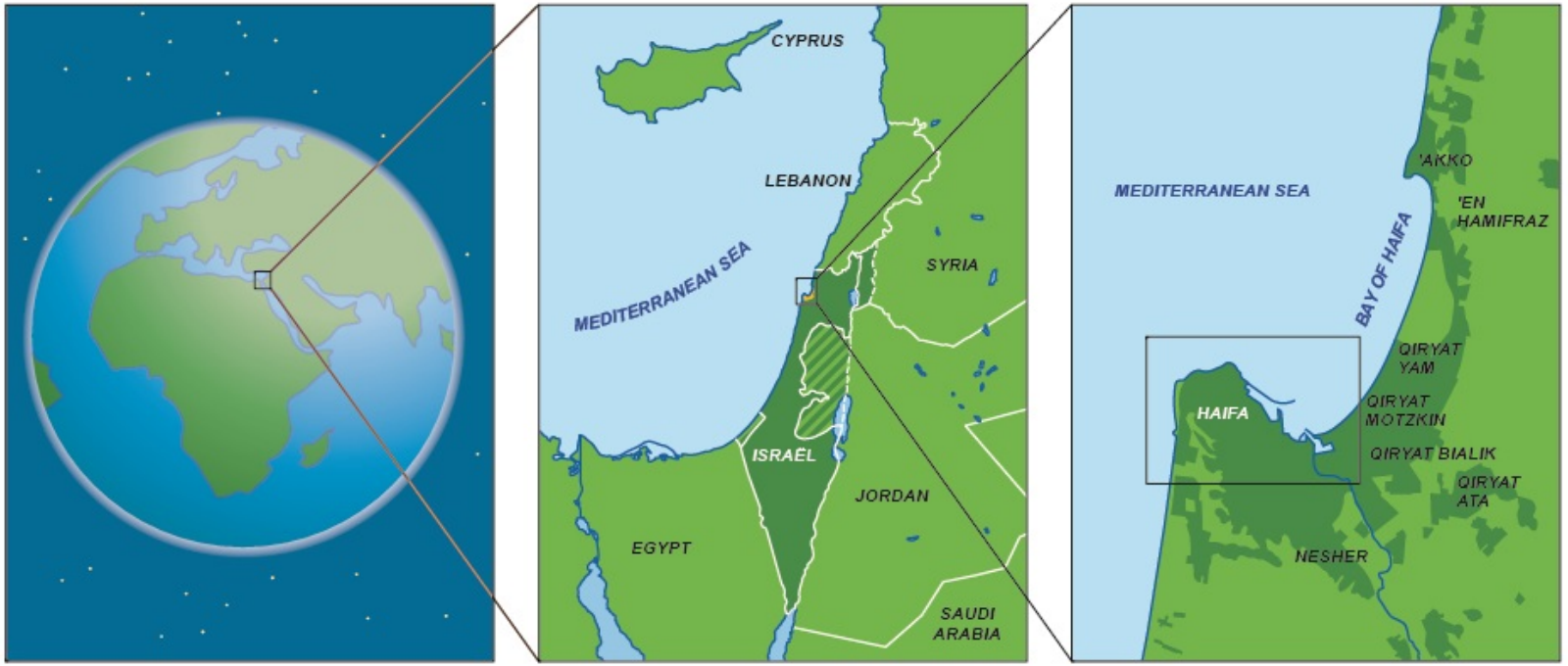
Tel Aviv


TEL AVIV LAND RECLAMATION PROJECT BERM BREAKWATER
CROSS SECTION PROFILE A
calm water area
45 ton cubes
rock
+2.00
+2.00
-3.00
-7.00
-16.20
rock
sea
sand
quarry run
sand
subsoil
80 m
240 m
320 m

Hadera

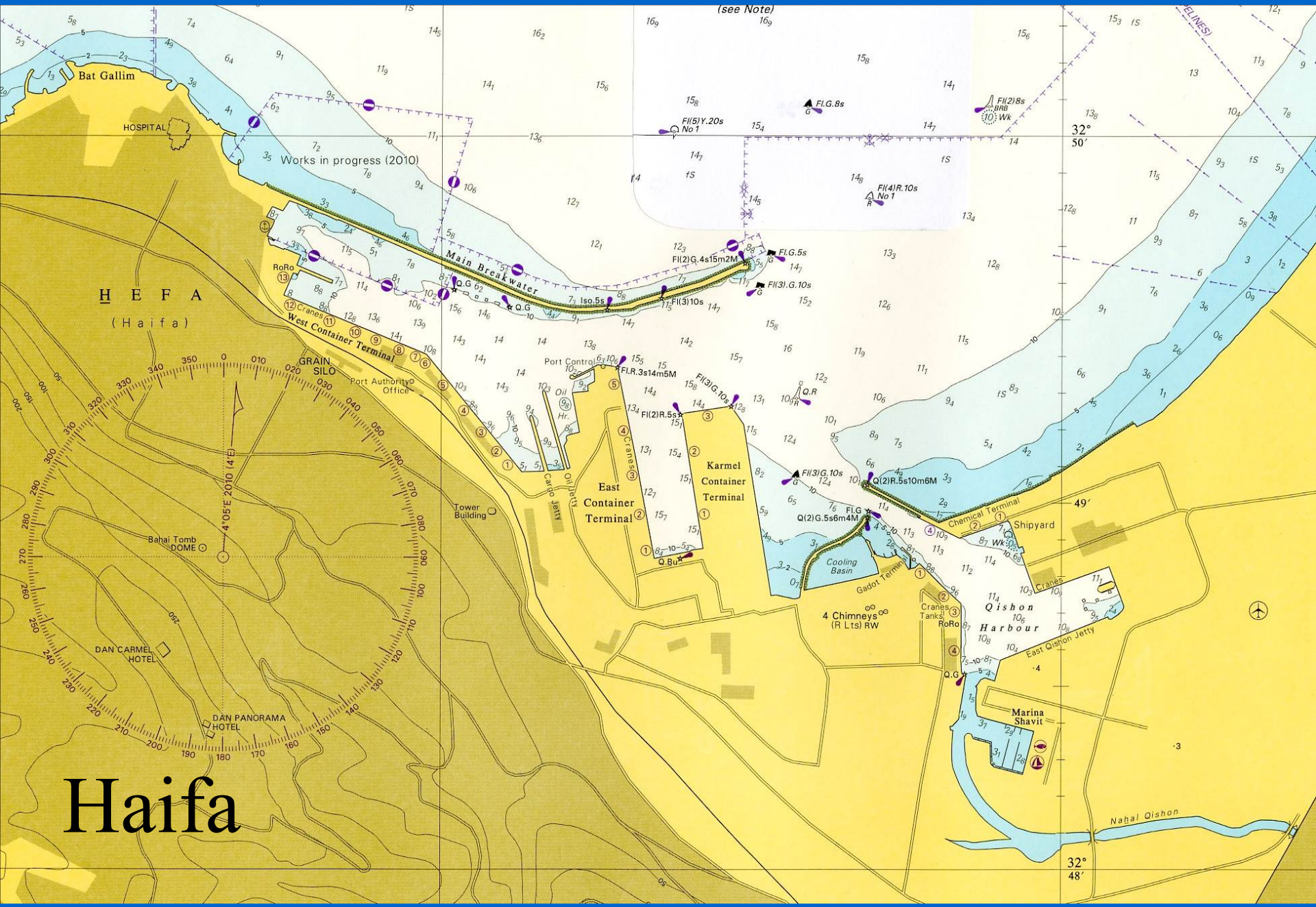

Fl.5s
Oil (see Note)
Fl.5s
(see Note)
Nussani
Fl.G.2s9m3M
Fl.R.5s9m2M
CHIMNEY
(300) (Fl.RW Lts)
Coal Jetty
Power Station
CHIMNEY
(254) (Fl.RW Lts)
CHIMNEY
(254) (Fl.RW Lts)
Fl(3)23s
Q(2)
Nahal Hadera
A
HADERA



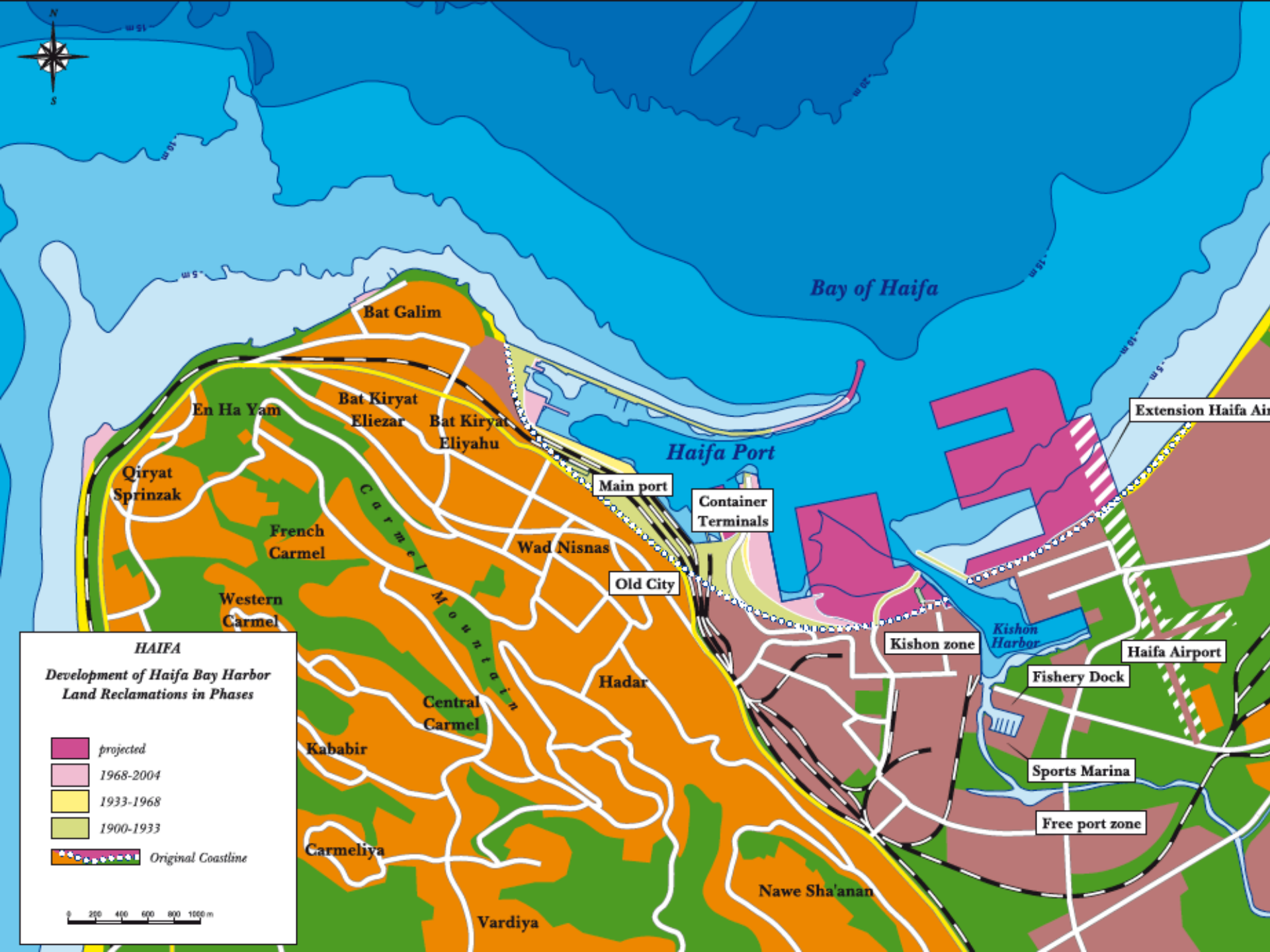

CYPRUS
LEBANON
MEDITERRANEAN SEA
SYRIA
ISRAËL
JORDAN
EGYPT
SAUDI ARABIA
MEDITERRANEAN SEA
'AKKO
'EN HAMIFRAZ
BAY OF HAIFA
QIRYAT YAM
HAIFA
QIRYAT MOTZKIN
QIRYAT BIALIK
QIRYAT ATA
NESHER

Haifa

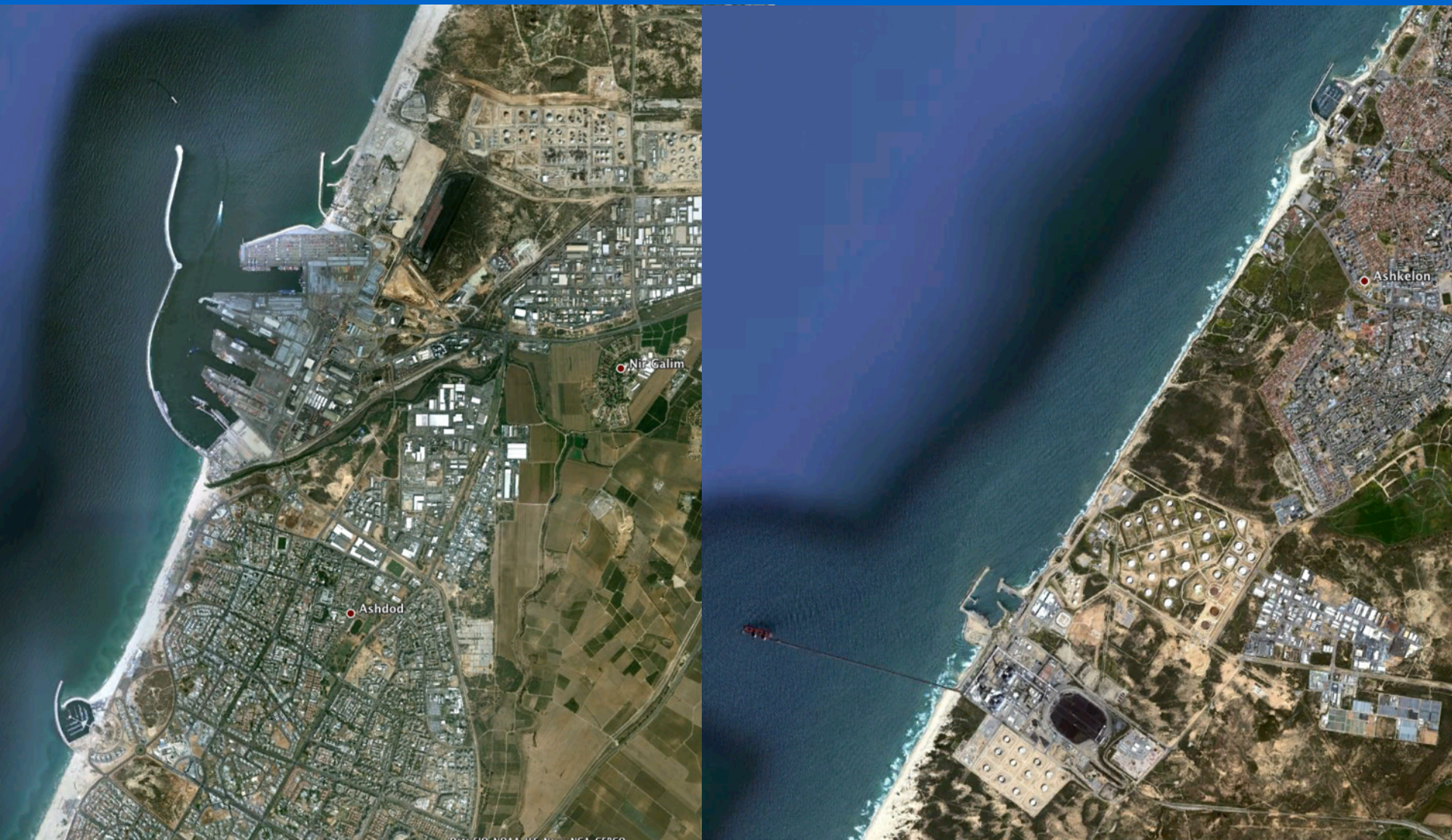

Haifa
Haifa


Bat Gallim
HOSPITAL
Works in progress (2010)
Main Breakwater
RoRo
H E F A
(Haifa)
West Container Terminal
GRAIN SILO
Port Authority Office
Port Control
Oil Jetty
Cargo Jetty
East Container Terminal
Karmel Container Terminal
Tower Building
Bahai Tomb DOME
DAN CARMEL HOTEL
DAN PANORAMA HOTEL
4°05'E 2010 (4'E)
Fl.R.3s14m5M
Fl(2)R.5s
Fl(3)G.10s
Q.R
Fl(2)G.4s15m2M
Fl.G.5s
Fl(3).G.10s
Fl(3)10s
Iso.5s
Q.G
Fl.G.8s
Fl(5)Y.20s No 1
Fl(2)8s BRB Wk
Fl(4)R.10s No 1
Q(2)R.5s10m6M
Fl(3)G.10s
Fl.G
Q(2)G.5s6m4M
Q.Bu
Chemical Terminal
Shipyard
Cooling Basin
Gadot Terminal
4 Chimneys (R Lts) RW
Cranes
Tanks
RoRo
Qishon Harbour
East Qishon Jetty
Marina Shavit
Nahal Qishon
32° 50′
32° 48′
49′

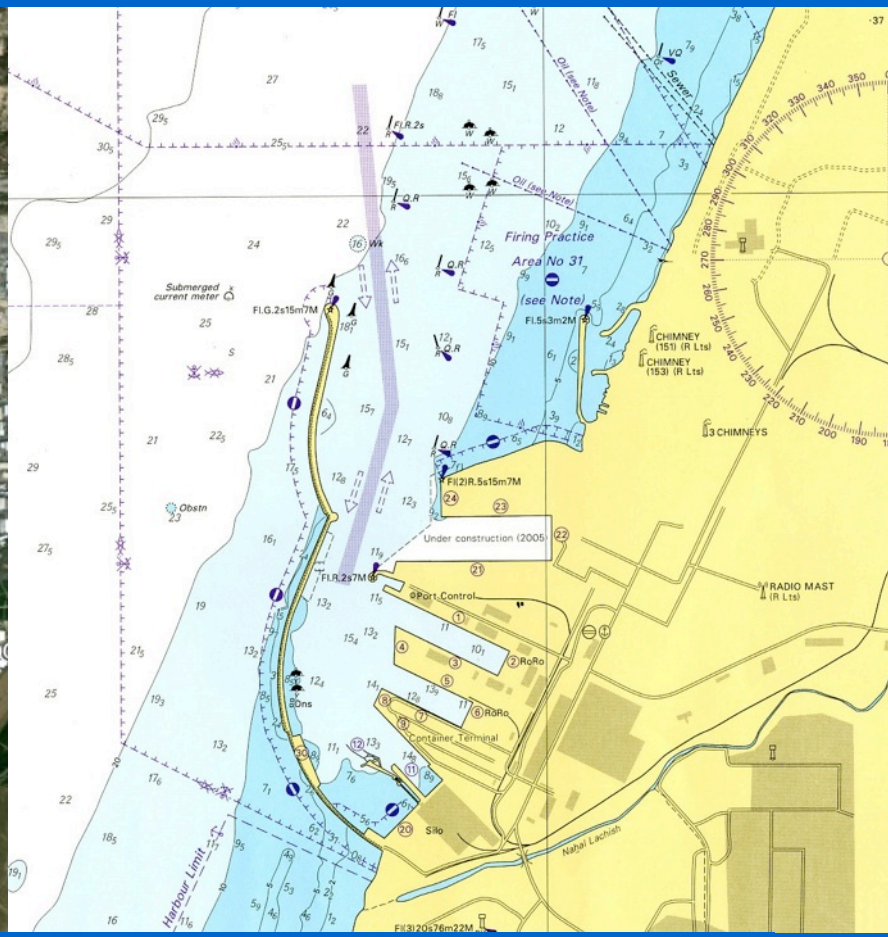
Haifa

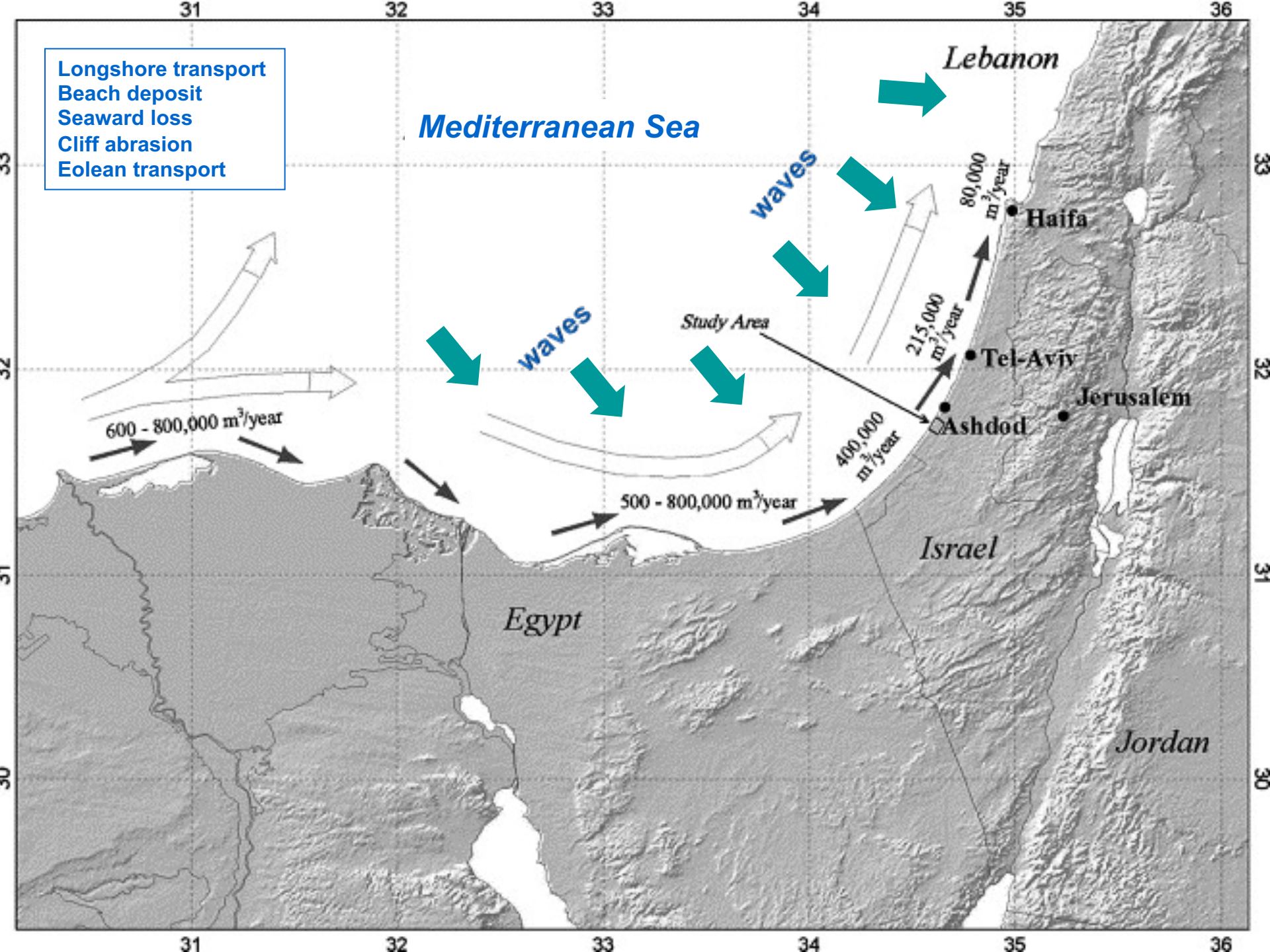

N
S
15 m
-15 m
-20 m
-5 m
Bay of Haifa
Bat Galim
En Ha Yam
Bat Kiryat Eliezar
Bat Kiryat Eliyahu
Haifa Port
Qiryat Sprinzak
Main port
Container Terminals
Extension Haifa Air
French Carmel
Carmel Mountain
Wad Nisnas
Old City
Western Carmel
Kishon zone
Kishon Harbor
Haifa Airport
Fishery Dock
Hadar
Central Carmel
Kababir
Sports Marina
Free port zone
Carmeliya
Nawe Sha'anan
Vardiya
HAIFA
Development of Haifa Bay Harbor
Land Reclamations in Phases
projected
1968-2004
1933-1968
1900-1933
Original Coastline
0 200 400 600 800 1000 m

Ashdod - Ashkelon



Ashdod - Ashkelon




Longshore transport
Beach deposit
Seaward loss
Cliff abrasion
Eolean transport
Mediterranean Sea
Lebanon
waves
waves
Study Area
80,000 m³/year
Haifa
215,000 m³/year
Tel-Aviv
Jerusalem
Ashdod
400,000 m³/year
600 - 800,000 m³/year
500 - 800,000 m³/year
Israel
Egypt
Jordan
31
32
33
34
35
36

G. Almagor - D. Gill - I. Perath

D. Rosen

Importance of E.I.A.

Fig. 5-3a: Hermit crab, *Diogenes pugilator*

Fig. 5-3b: Snail Changeable nassa, *Sphaeronassa mutabilis*

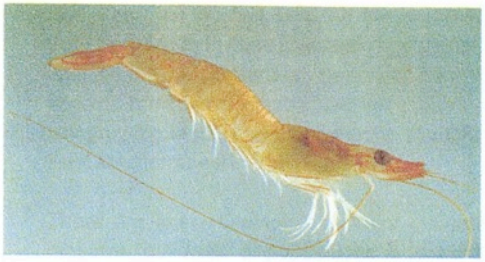


Fig. 5-3g: Pink Shrimp (Gamba), *Parapenaeus longirostris*

Fig. 5-3h: Crab, *Galathea Intermedia*

Fig. 5-3c: White shrimp, *Trachypenaeus Curvirostris*

Fig. 5-3d: Pebble crab, *Myra fugax*

Fig. 5-3i: Peacock worm, *Sabella pavonina*

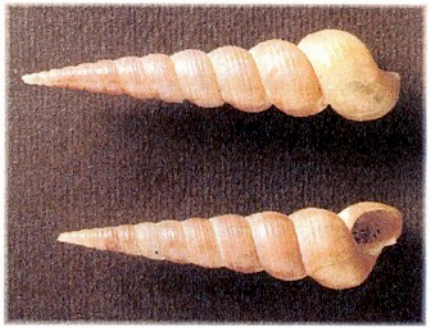


Fig. 5-3j: Snail, *Turritella communis*

Fig. 5-3e: Heart urchin, *Brissopsis lyrifera*

Fig. 5-3f:Mediterranean feather star, *Antedon mediterranea*

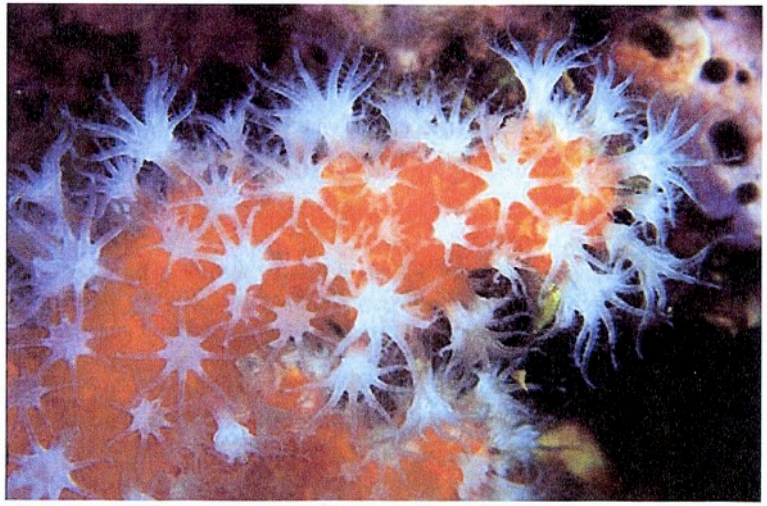
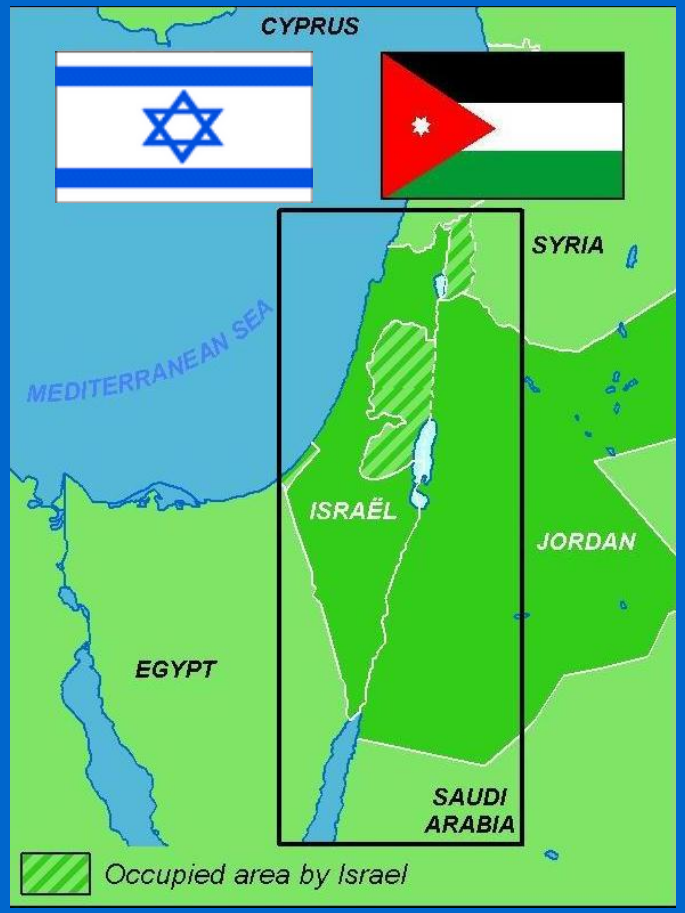
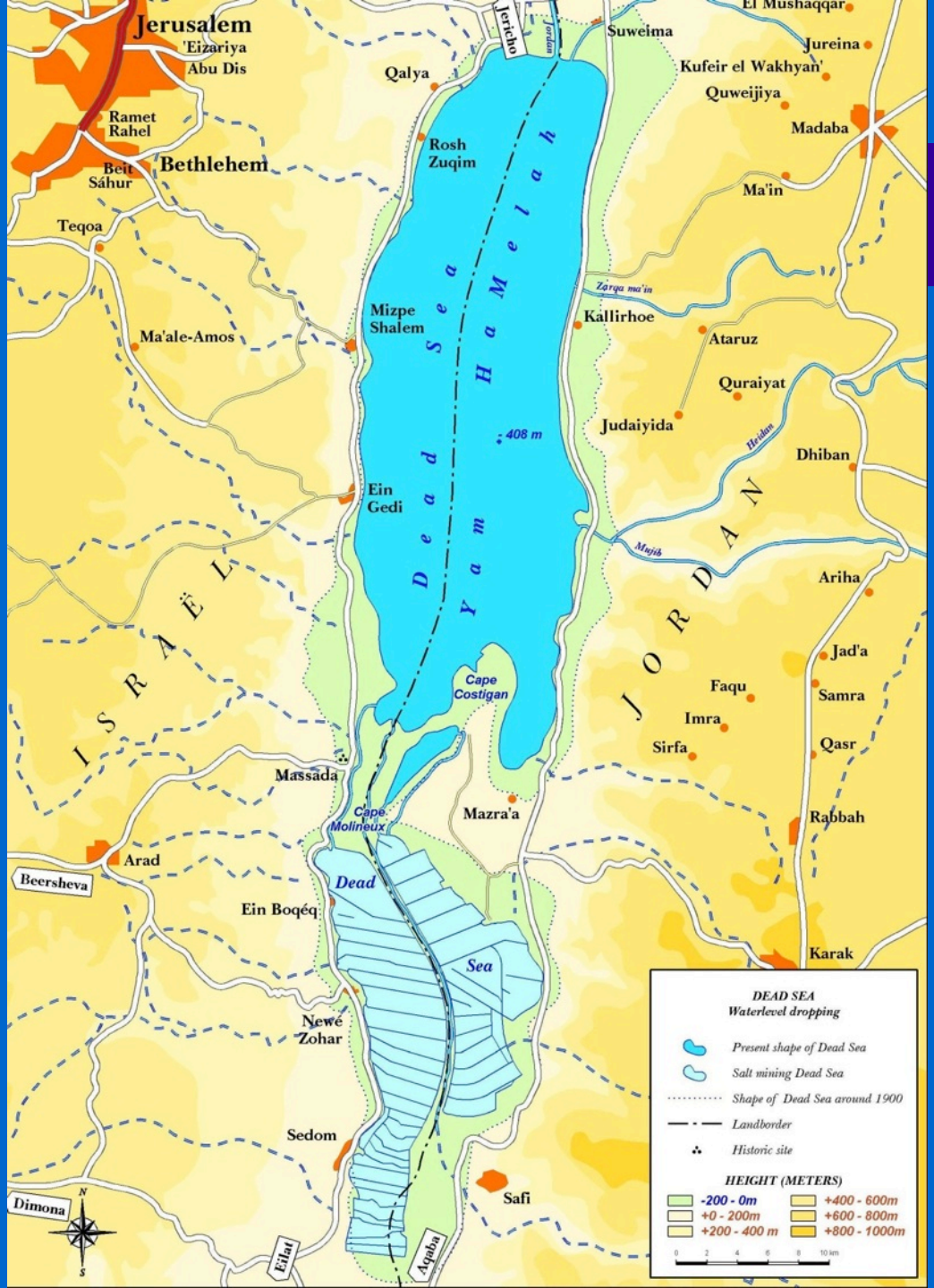


Fig. 5-3k: Soft coral, *Alcyonium palmatum*

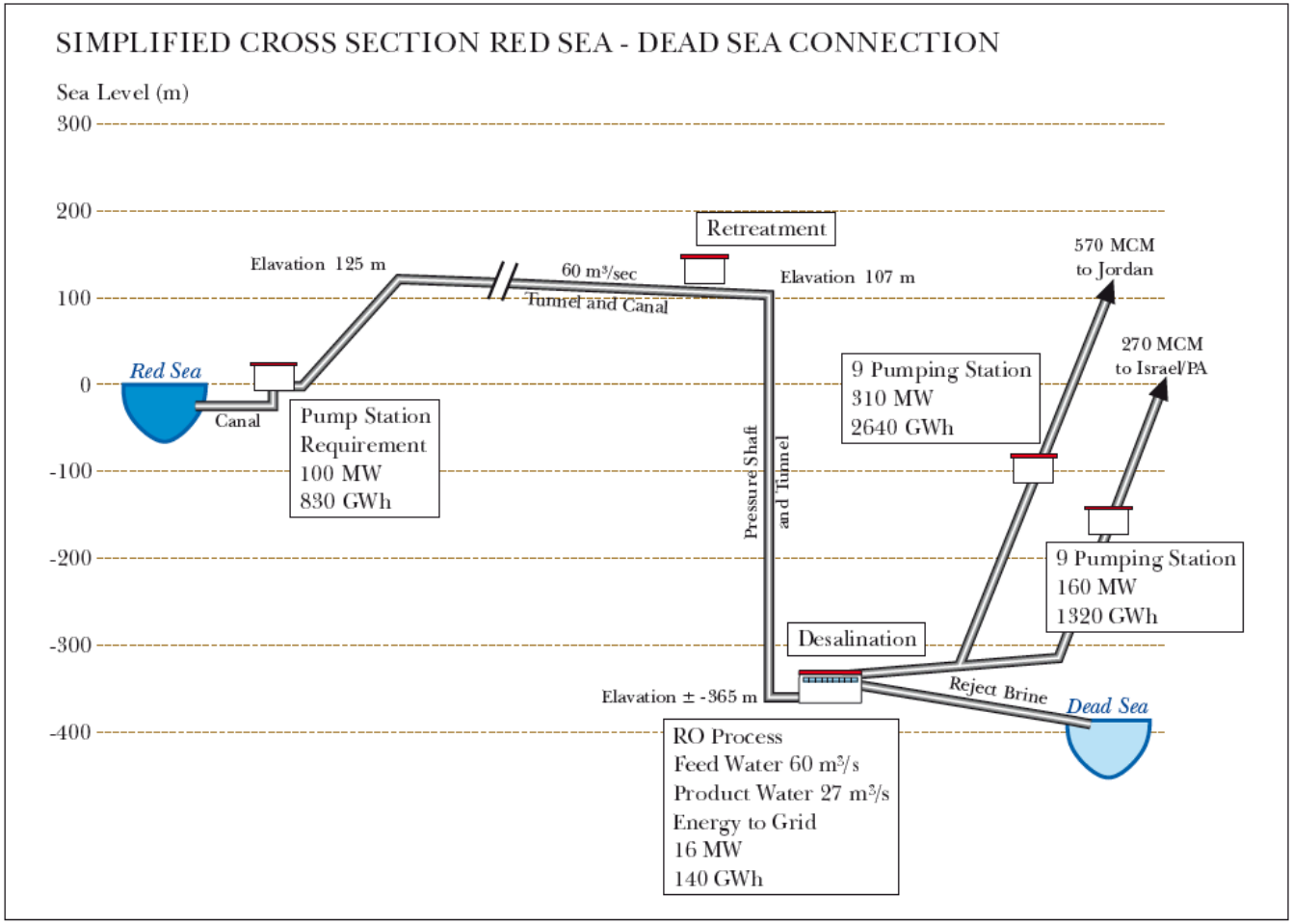
BUILDING WITH NATURE



Israël, Jordan


Jerusalem
'Eizariya
Abu Dis
Ramet Rahel
Beit Sáhur
Bethlehem
Teqoa
Ma'ale-Amos
Jericho
Jordan
Qalya
Rosh Zuqim
Mizpe Shalem
Dead Sea Yam HaMelah
408 m
Ein Gedi
Cape Costigan
Cape Molineux
Massada
Mazra'a
Arad
Beersheva
Ein Boqéq
Dead Sea
Newé Zohar
Sedom
Safi
Dimona
Eilat
Aqaba
ISRAËL
JORDAN
Suweima
El Mushaqqar
Jureina
Kufeir el Wakhyan
Quweijiya
Madaba
Ma'in
Zarqa ma'in
Kallirhoe
Ataruz
Quraiyat
Judaiyida
Heidan
Dhiban
Mujib
Ariha
Jad'a
Faqu
Samra
Imra
Sirfa
Qasr
Rabbah
Karak
DEAD SEA
Waterlevel dropping
Present shape of Dead Sea
Salt mining Dead Sea
Shape of Dead Sea around 1900
Landborder
Historic site
HEIGHT (METERS)
-200 - 0m
+0 - 200m
+200 - 400 m
+400 - 600m
+600 - 800m
+800 - 1000m
0 2 4 6 8 10 km
N
S


1994-Treaty-Line



Pipeline approx. 180 km length
Volume 200 million m³ / year from Red Sea
of which:
approx. 100 million m³ / year desalinated water
approx. 100 million m³ / year residual water into Dead Sea
Environmental concerns

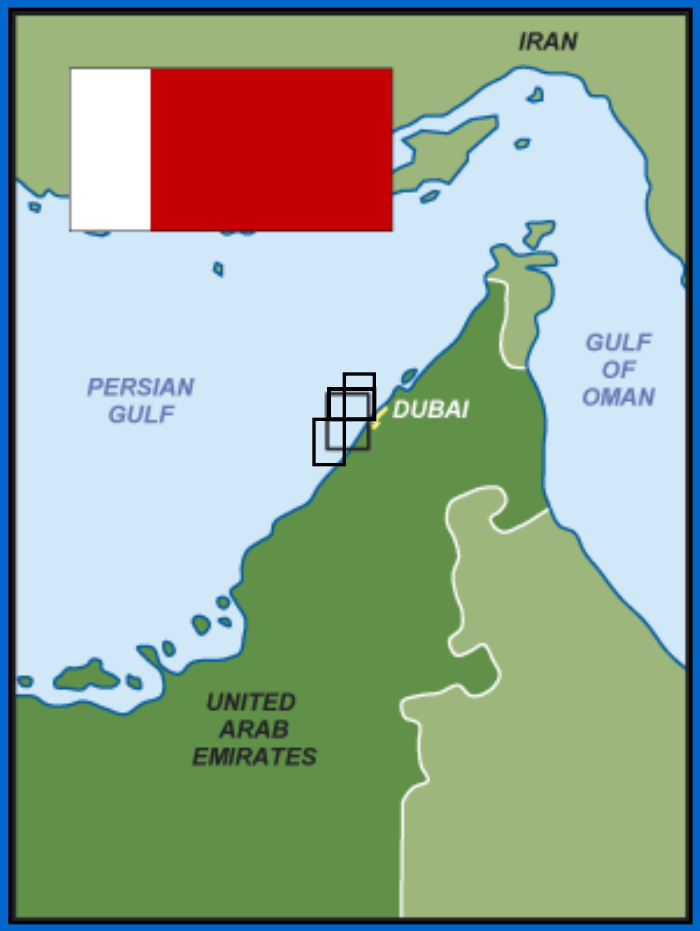
Eilat - Aqaba


Eilat
Airport
Arcadia
Marina of Eilat
ISRAËL
JORDAN
Red Sea Star
Underwater Observatory
Fish Farms
Aqaba
Military Port
Phosphate Terminal
Hotel
Pollution Control
Japanese Gardens
Japanese Gardens
EGYPT
Underwater Observatory
Gulf of Aqaba
Hotel
Caves
Taba
Gulf of Aqaba
Land Reclamations & Internal Lagoon Creation
Eilat & Aqaba
Projected reclamation
Industry
Original Coastline

BUILDING WITH NATURE

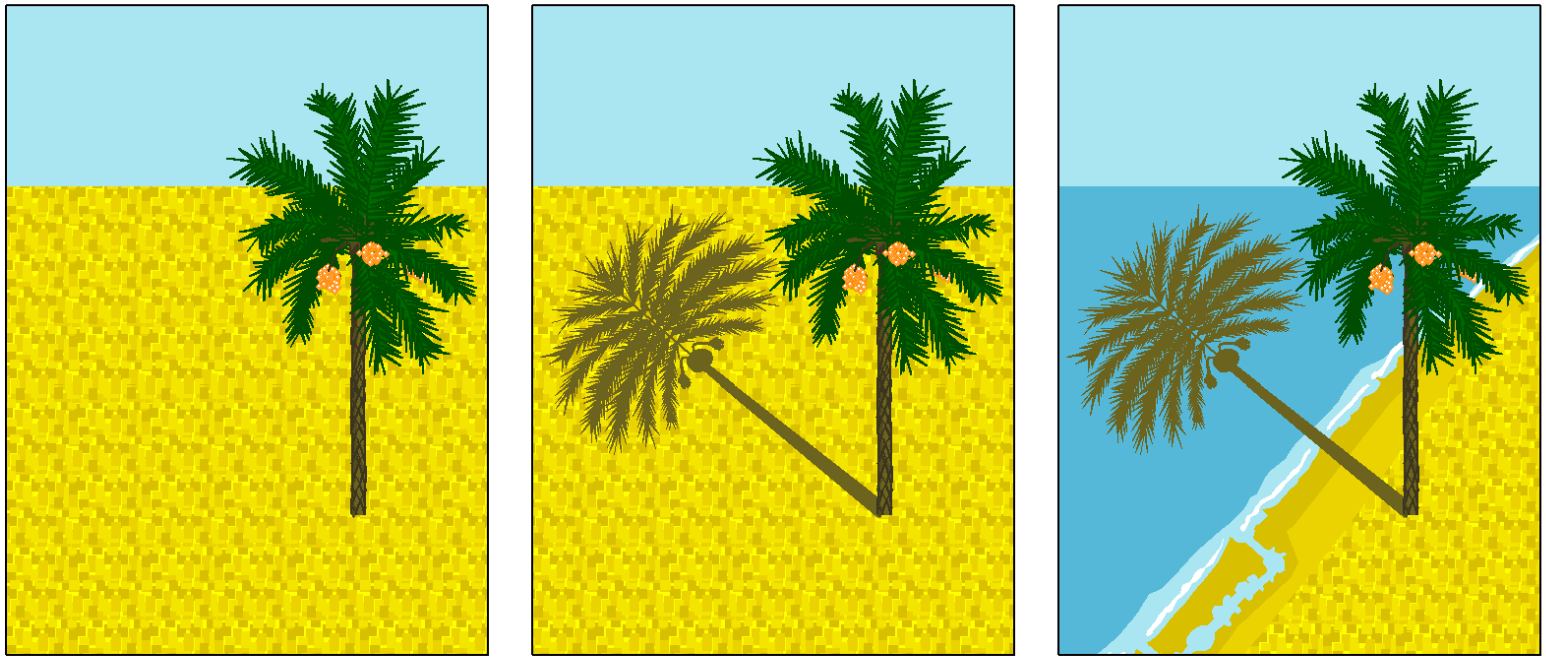
Middle East U.A.E.

BUILDING WITH NATURE

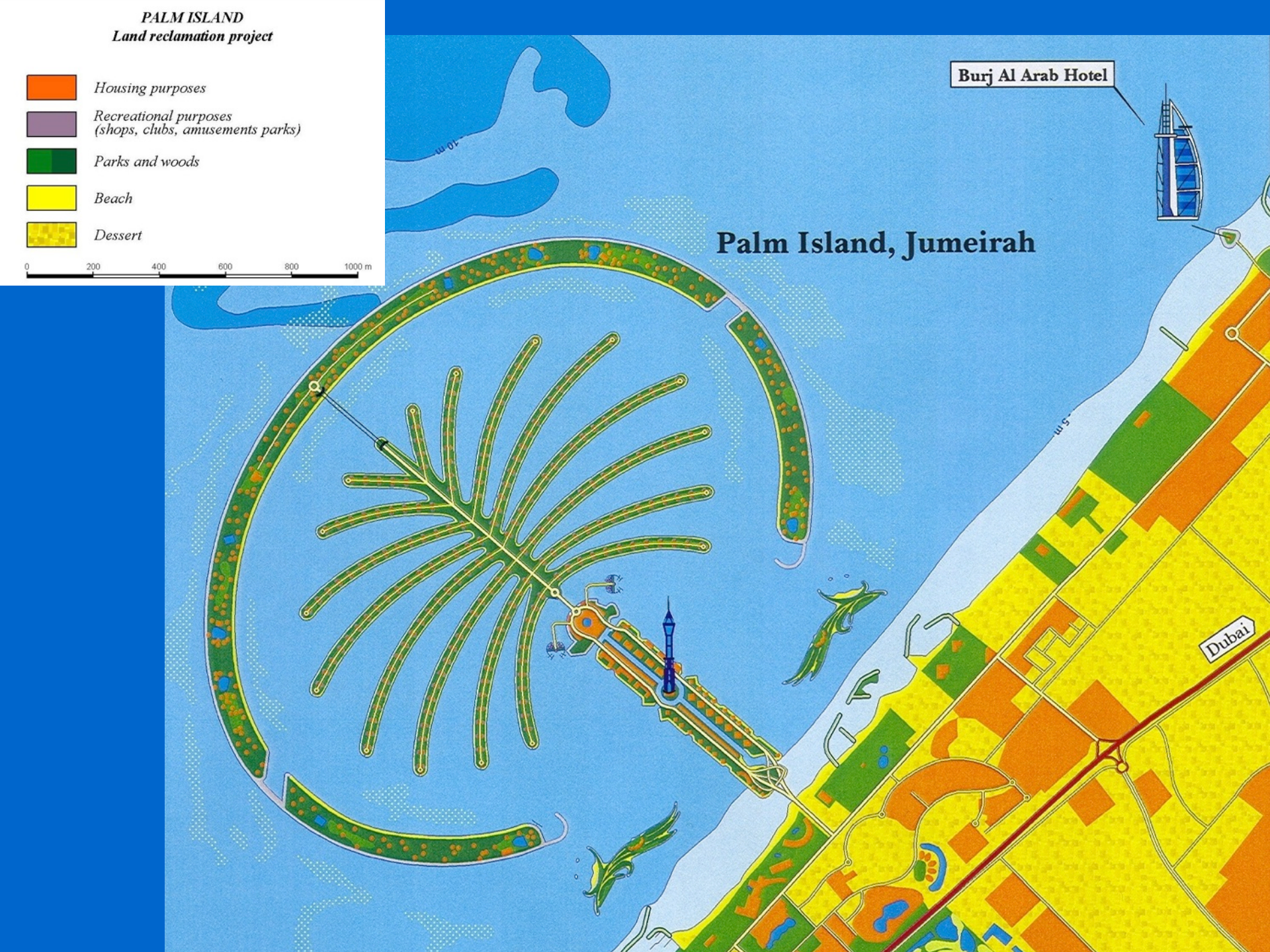


U.A.E.
Dubai

BUILDING WITH NATURE



U.A.E.
Dubai


PALM ISLAND
Land reclamation project
Housing purposes
Recreational purposes
(shops, clubs, amusements parks)
Parks and woods
Beach
Dessert
0
200
400
600
800
1000 m
Burj Al Arab Hotel
Palm Island, Jumeirah
Dubai

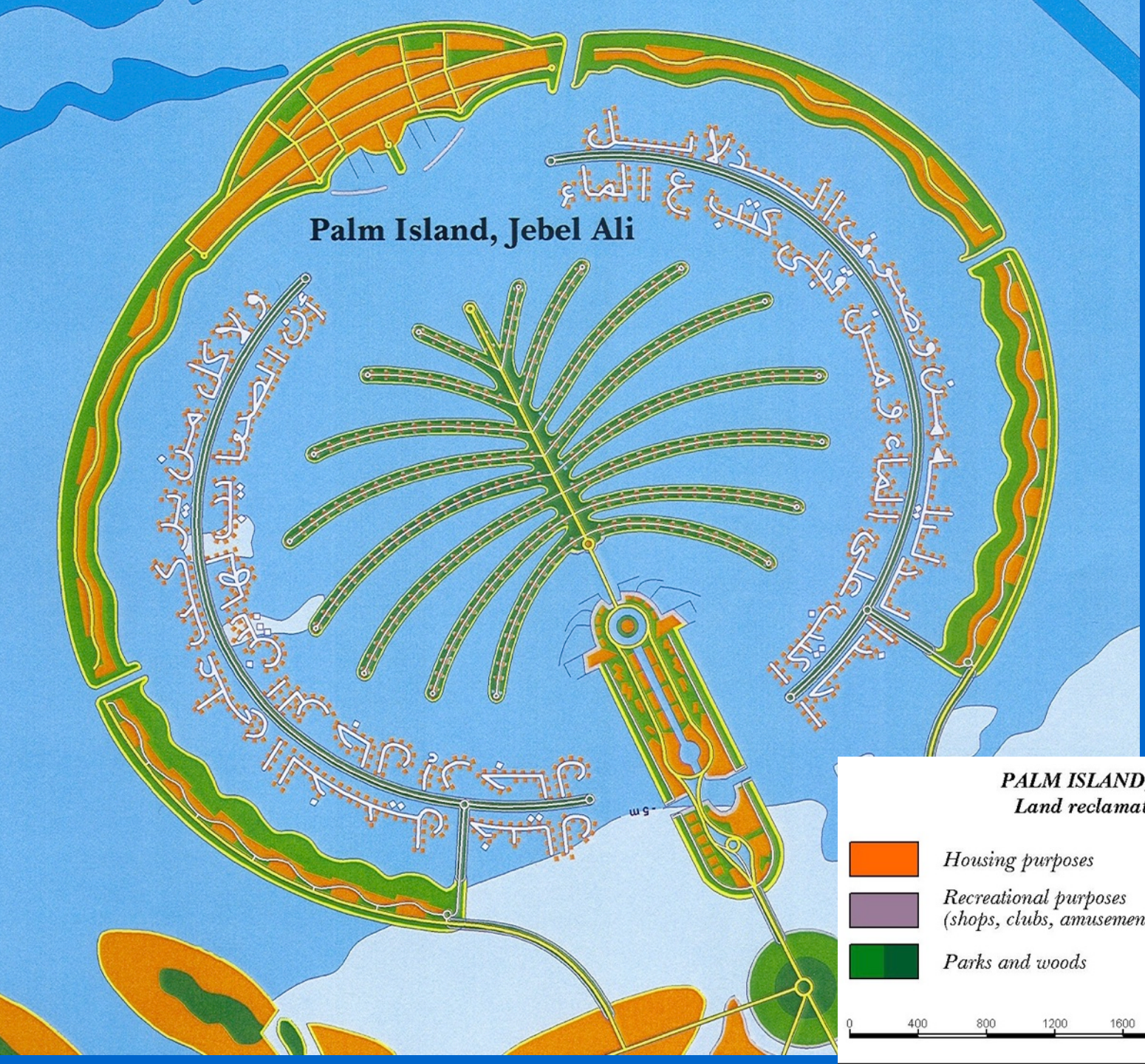
Palm Island Jumeirah - Dubai

april 2002

september 2002

mei 2003

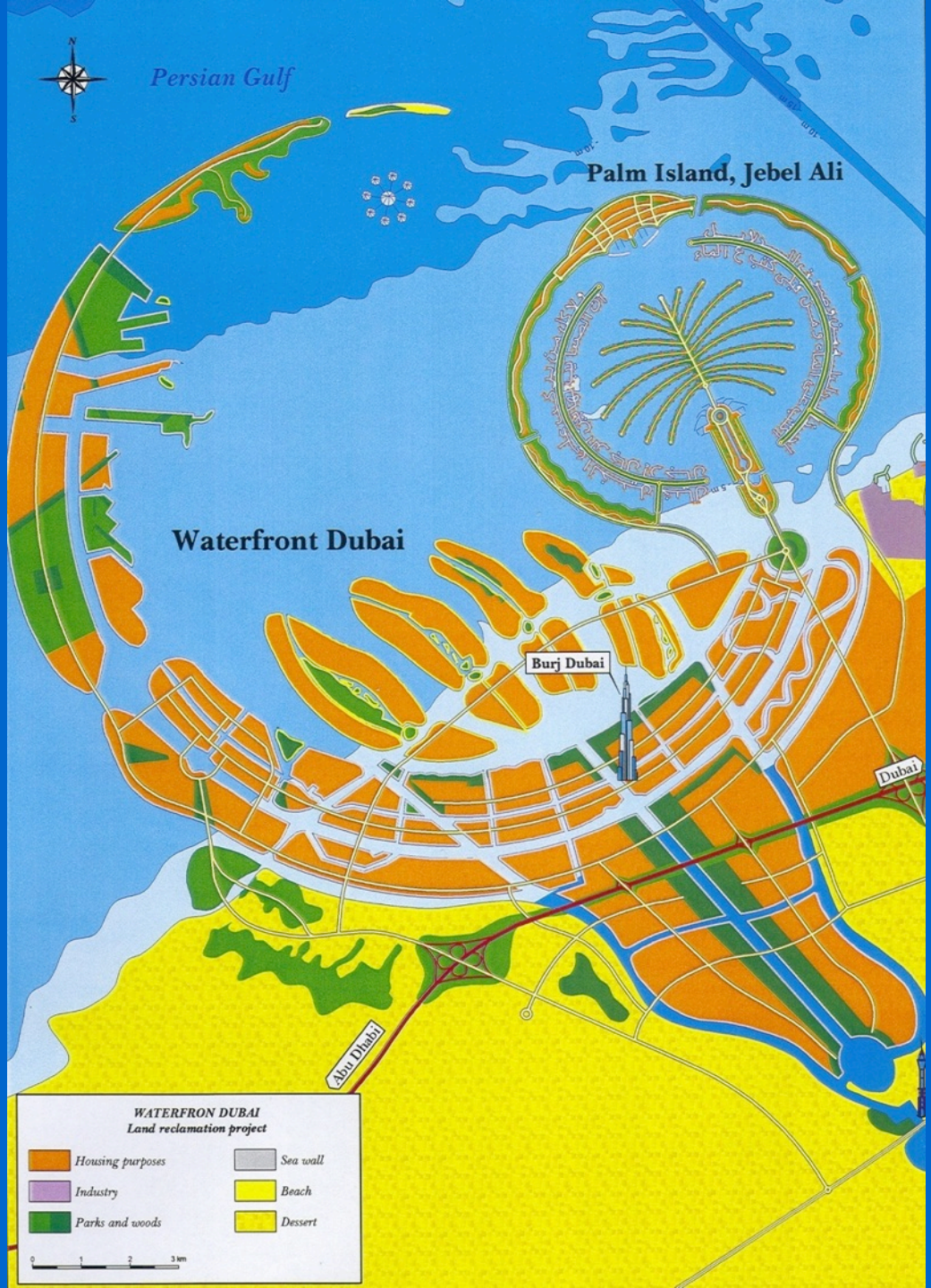
2012

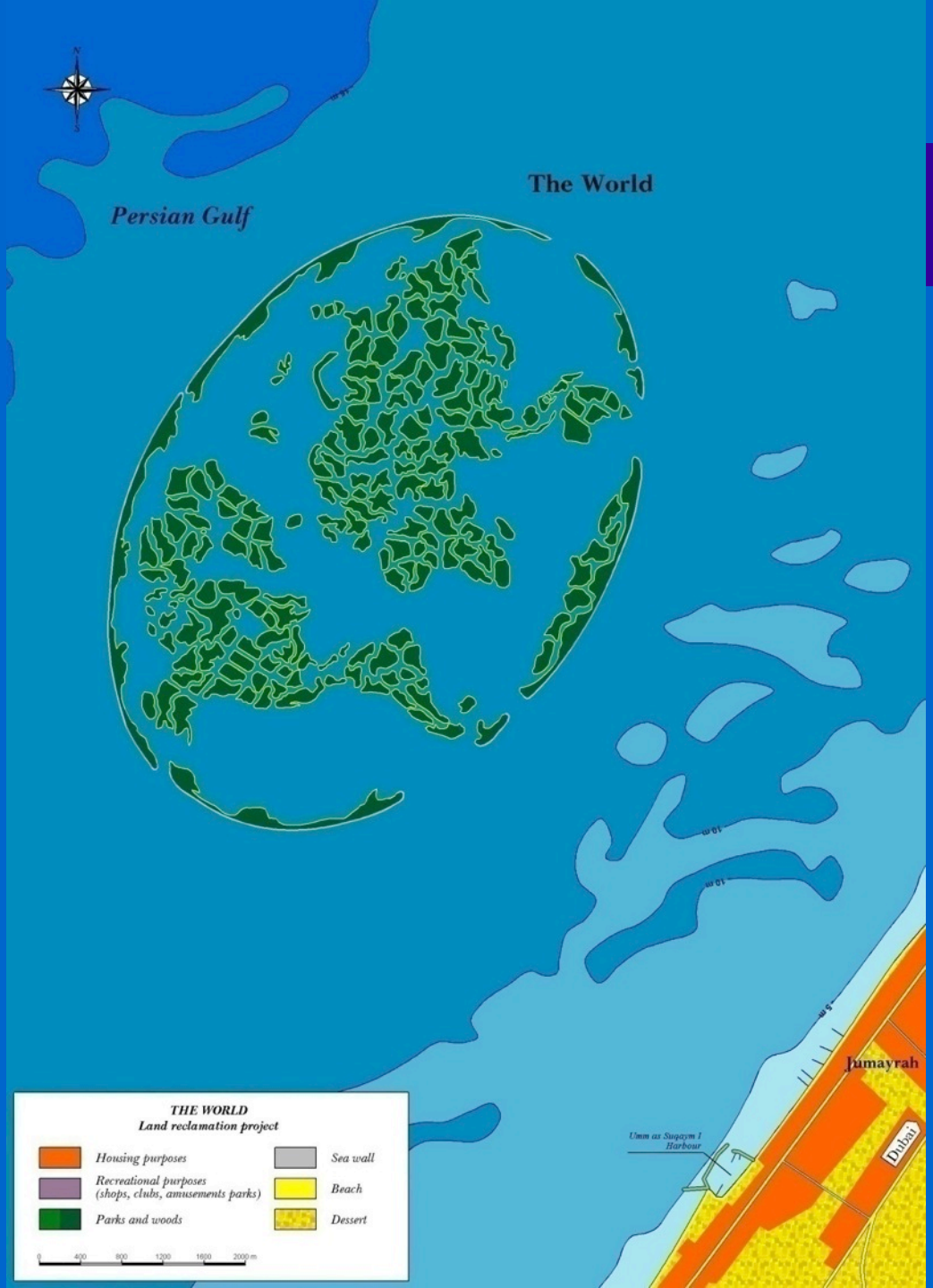


PALM ISLAND, JEBEL ALI
Land reclamation project

Housing purposes	*Sea wall*
Recreational purposes (shops, clubs, amusements parks)	*Beach*
Parks and woods	*Dessert*

0 400 800 1200 1600 2000 m


Persian Gulf
Palm Island, Jebel Ali
Waterfront Dubai
Burj Dubai
Dubai
Abu Dhabi
WATERFRON DUBAI
Land reclamation project
Housing purposes
Industry
Parks and woods
Sea wall
Beach
Dessert
0 1 2 3 km



The World

approx. 9 km x 6 km
5 km off the coast
of Dubai

ca. 300 Islands

325 million m^3 sand

32 million ton stones

The Palm, Deira

approx. 14.3 km x 8.5 km

surface area 80 km²

41 palm leaves

1.3 billion m³ sand

length of outher rim
berm break water
ca. 21 km


RECLAMATION PROJECTS OVERVIEW
Land reclamation project
Housing purposes
Harbor, industry
Parks and woods
Sea wall
Beach
Dessert
Persian Gulf
The Palm, Deira
The World
height: 321 m
Palm Island, Jumeirah
Dubai Waterfront
Palm Island, Jebel Ali
Dubay
Barr Dubay
Jumeirah
Umm as Suqaym
United Arab Emirates
height approximately 750 meter
1 Jumeirah Lake Towers
2 Jumeirah Islands
3 The Gardens
4 Gardens Shopping Mall
5 Burj Al Arab Hotel
6 Jebel Ali Harbor
7 Burj Arab
8 Jebel Ali International Airport

QATAR

THE PEARL