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Dutch Coastlines Design

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Coastal protection along the Dutch coast: weak links

The Netherlands, with 70% of its GDP being produced in areas below sea level, has to be constantly alert on safety against flooding. Studies in 2003 revealed that the Dutch North Sea coastline with extensive stretches of dunes and dikes needed further strengthening in order to maintain the desired protection levels. A protection level with the ambition to withstand a superstorm as extreme as once in 10.000 years!
Strengthening is required as the force from the sea is becoming stronger due to sea level rise, higher waves and longer storm duration. Climate is changing, hence we need to adept and make our coastline more climate resilience.

As such the Dutch government started the reinforcement of the coastal protection in the so called coastal Weak Links. By now these projects are completed, and ARCADIS was heavily involved in those projects. Projects not only designed for protection against high water levels. Projects with a second objective: improve spatial quality at the same time!

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ARCADIS COASTAL WATERFRONTS

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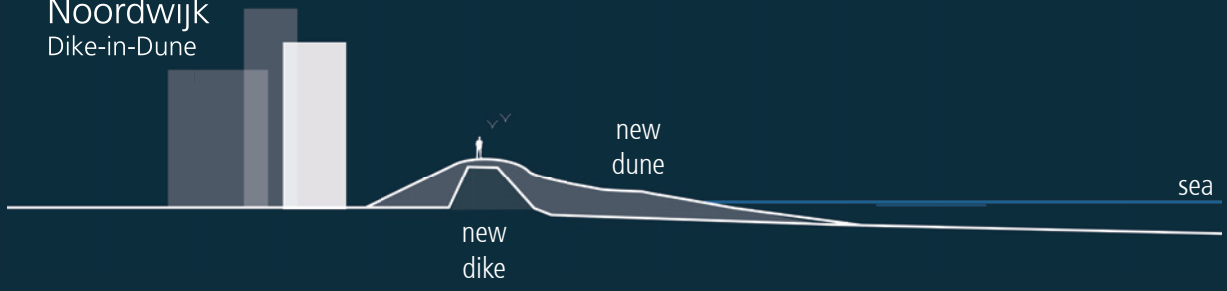
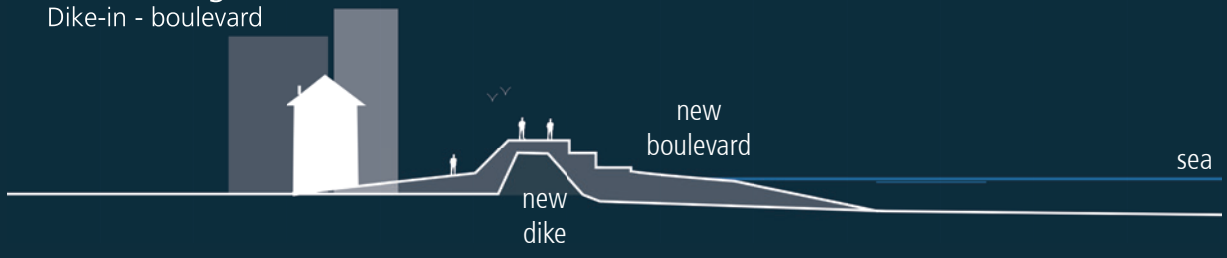


Katwijk
Dike-in-dune + carpark

Scheveningen
Dike-in - boulevard



Two objectives:

Coastal protection ànd spatial quality

The Dutch government realised very well that the need for reinforcement could also be turned into an opportunity. By have two objectives every project was challenged to seek for win-win situations, for co-creation with other stakeholders, and seek for partnerships to achieve full potential.

Improving spatial quality : in a highly metropolitan situation (like Scheveningen – The Hague), with 15 million tourists every year, tremendous economic interests and the wish to give a boost to the boulevard. Or in originally a fisherman's village (Katwijk), more a family type of beach resort, with the wish to build an underground car park. Or further north in a much more rural setting with Nature2000 areas (Dunes of North-Holland), with the wish to keep it as natural as possible.

Every specific location demands tailor made solutions. Solutions incorporating the site specific conditions, and site specific interests and ambitions !

Engineering challenge:

combination of hard and soft solutions = hybrid solutions

Coastal reinforcement can be done in many ways, and depending on the site specific conditions ànd ambitions, the hydraulic engineering challenge is framed. Should we go for a heavy sea wall, made of concrete? Or do we reinforce the dunes with more sand? Or are we going for a more Building-with-Nature approach? Or can we combine Do we add more sand in front of an existing structure? Or can we combine the advantages of hard and soft solutions, and as such come up with hybrid solutions?

That is what we did…

Optimising the balance between wider and higher dunes, and lower and more compact structures. Results are a dike-in-dune, where the sand is the first line of protection, but in a severe worse case a very robust dike will provide the ultimate protection. Or a dike-in-boulevard, with substantial expansion of the beach, sufficient sand underneath the boulevard, and as ultimate protection a dike embedded in the boulevard! Or what to think of extra sand shaped as dunes and lagunes in front of an existing sea wall?

Sand - in-front-of-sand

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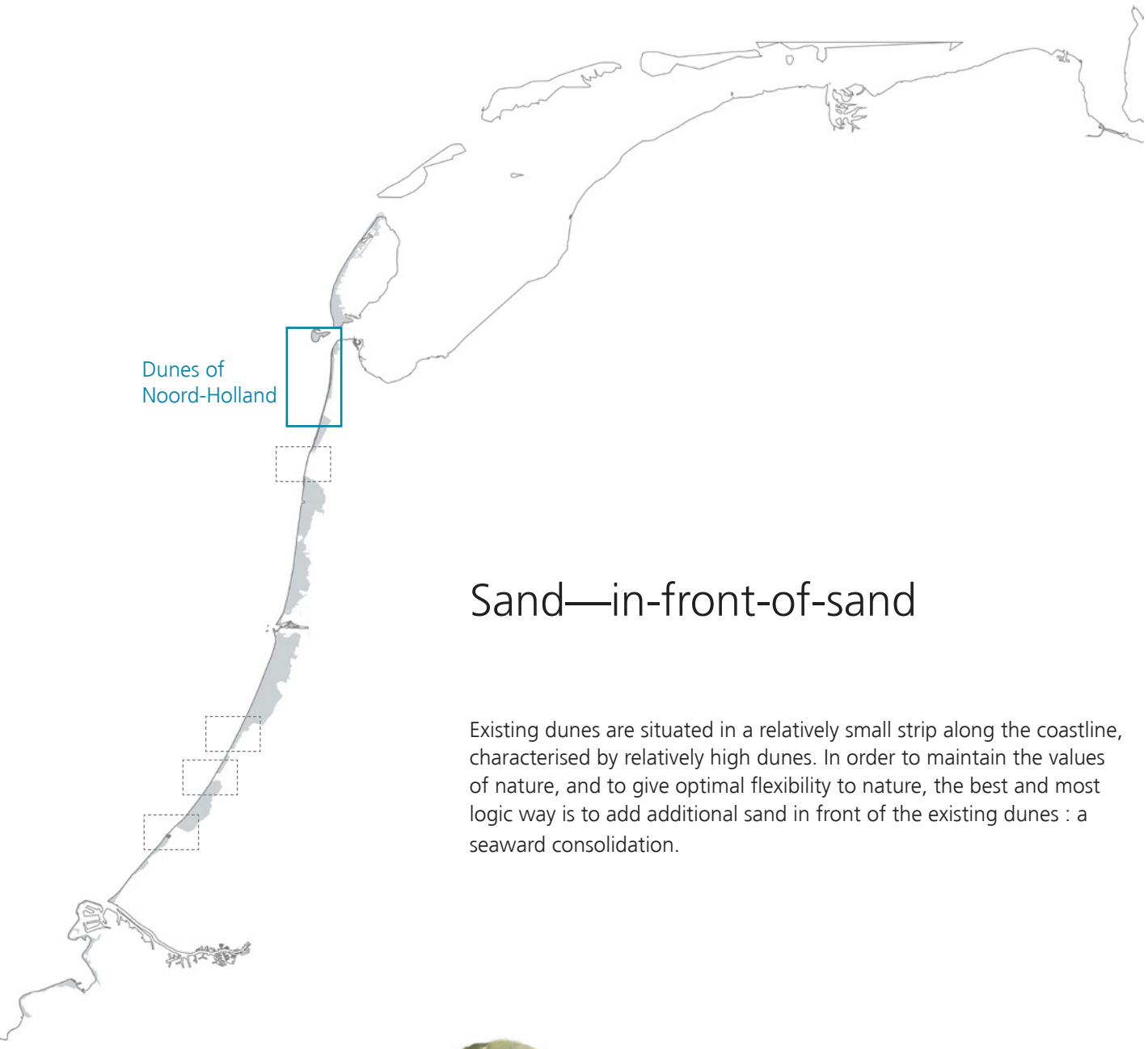
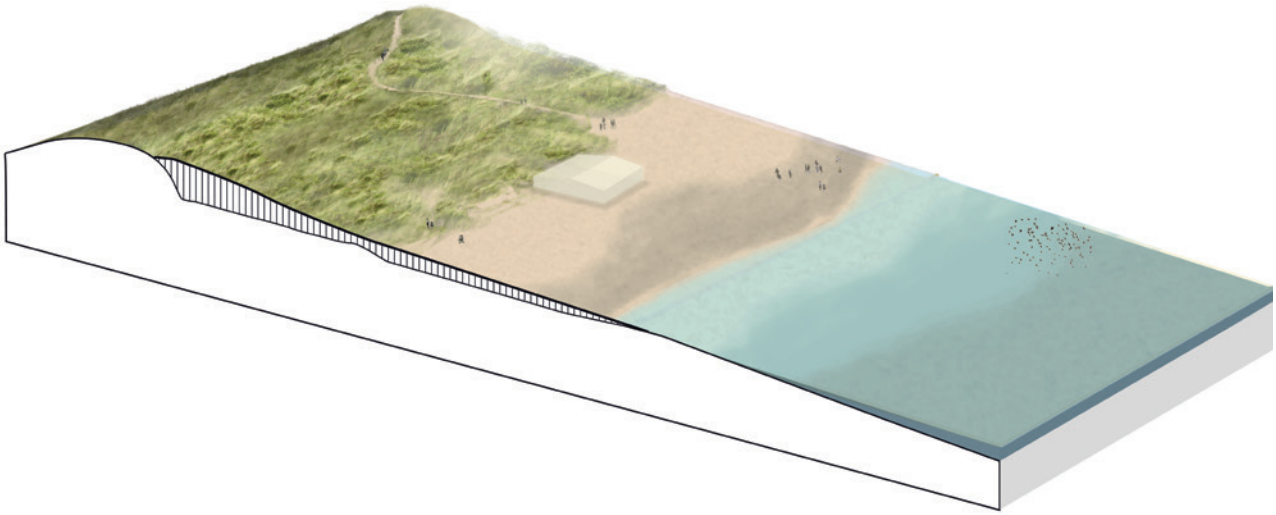
Dunes of North Holland

Situated in the extreme north of the province of North-Holland, the dunes of the 'Kop van Noord-Holland' needed additional strengthening. The area is characterized by its wide views over extensive rural areas, with large agricultural fields directly behind the dunes, in combination with all kind of recreational locations such a holiday bungalow resorts, camping sites and Nature2000 projected areas. The challenge was to strengthen the coastline, increase natural values, and provide a boost to the recreational activities.



Sand—in-front-of-sand

Existing dunes are situated in a relatively small strip along the coastline, characterised by relatively high dunes. In order to maintain the values of nature, and to give optimal flexibility to nature, the best and most logic way is to add additional sand in front of the existing dunes : a seaward consolidation.



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Dune-in-front-of-dike

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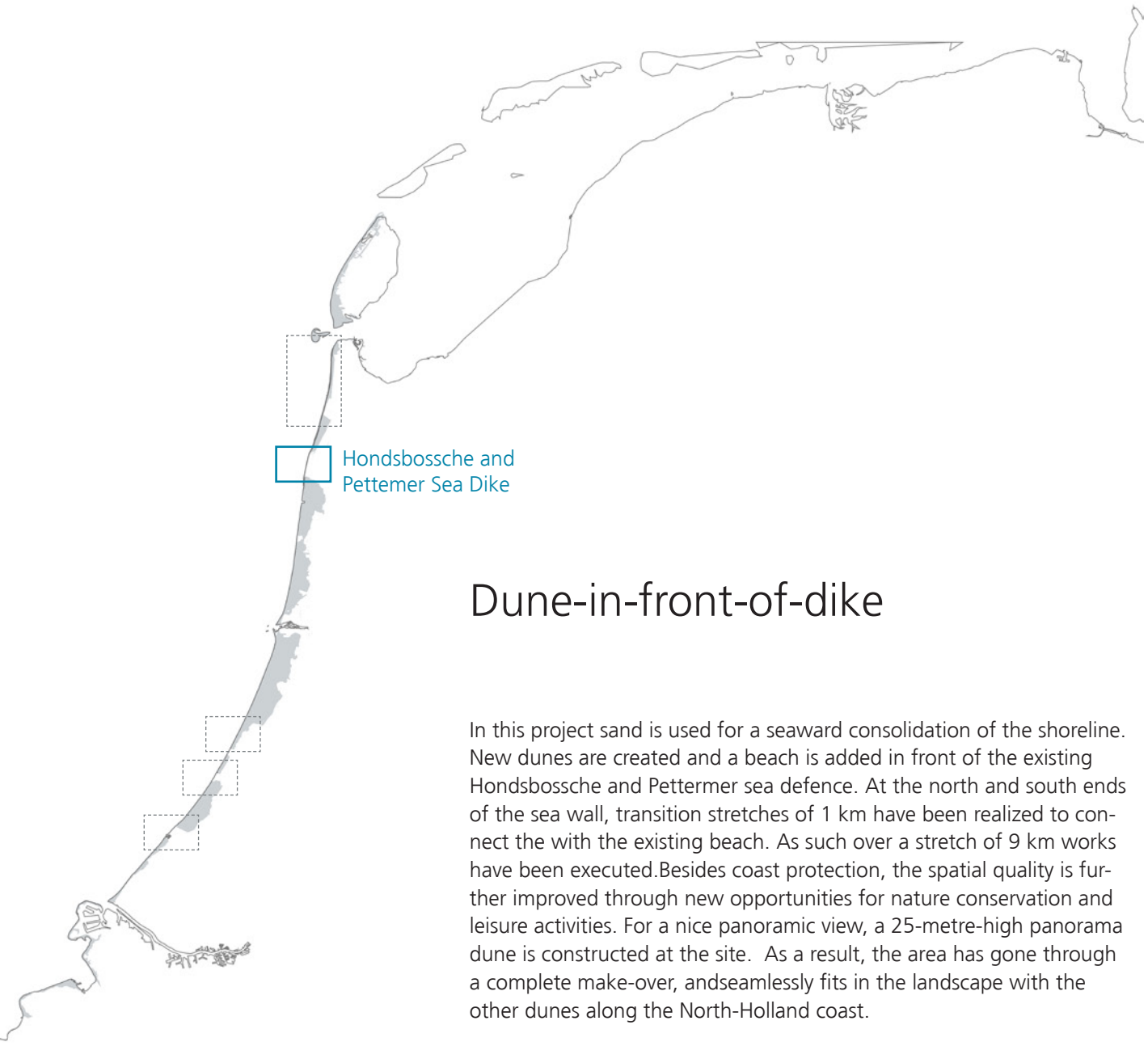
Hondsbossche and Pettemer Sea Dike

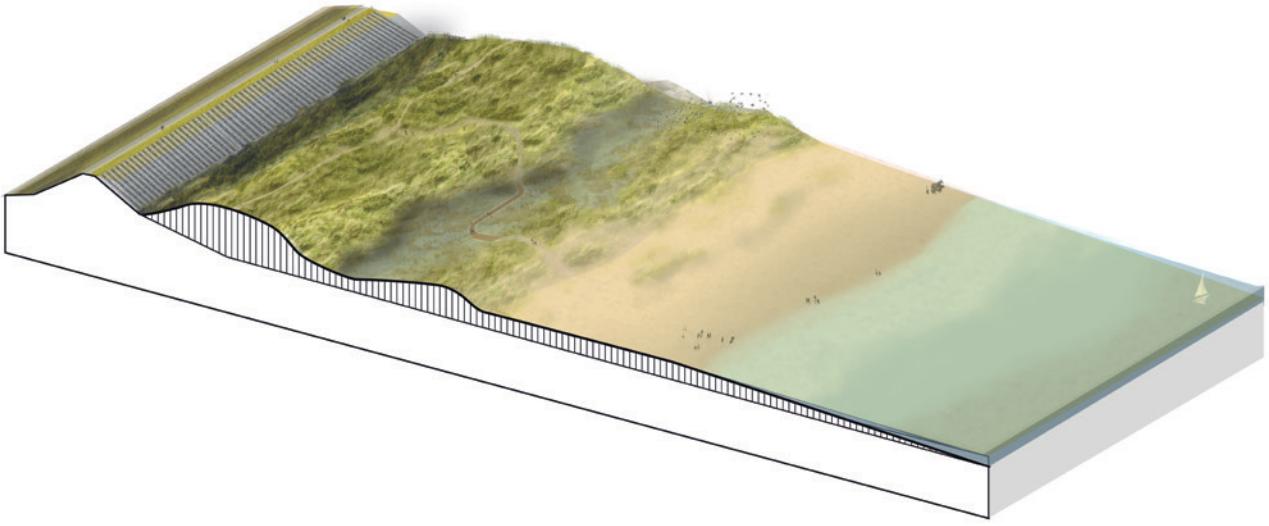
Strengthening was necessary for the total stretch (around 6km) of the embankment Hondsbossche and Pettemer Zeewering (Sea Dike), located in the province of North-Holland. The embankment is surrounded by nature reserves and valuable landscape, with some of the historic polders in the hinterland being reclaimed up to 400 years ago.

Based on a landscape analysis of the area, alternative solutions were developed, ranging from raising the existing dike to longitudinal sand replenishment, and allowing for more overtopping of the dike. Design proposals for improving spatial quality were elaborated with an emphasis on landscape and cultural heritage, recreation and tourism, liveability and nature development. Cultural heritage in this case dominantly determined by the existing Sea Dike: a historical piece of coastal protection!



Dune-in-front-of-dike

In this project sand is used for a seaward consolidation of the shoreline. New dunes are created and a beach is added in front of the existing Hondsbossche and Pettermer sea defence. At the north and south ends of the sea wall, transition stretches of 1 km have been realized to connect the with the existing beach. As such over a stretch of 9 km works have been executed.Besides coast protection, the spatial quality is further improved through new opportunities for nature conservation and leisure activities. For a nice panoramic view, a 25-metre-high panorama dune is constructed at the site. As a result, the area has gone through a complete make-over, andseamlessly fits in the landscape with the other dunes along the North-Holland coast.



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Taking an integrated approach, strengthening the defences using sand replenishment was the obvious preferred solution as it offers a flexible, robust and eco-system friendly approach to coastal protection. It offers many other benefits as well: nature development, improved accessibility and attractiveness for recreation and tourism, while protecting the cultural heritage in the polders behind. This robust and sustainable solution is in keeping with the current approach for the Dutch coast and can count on local support.

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Dike-in-Dune

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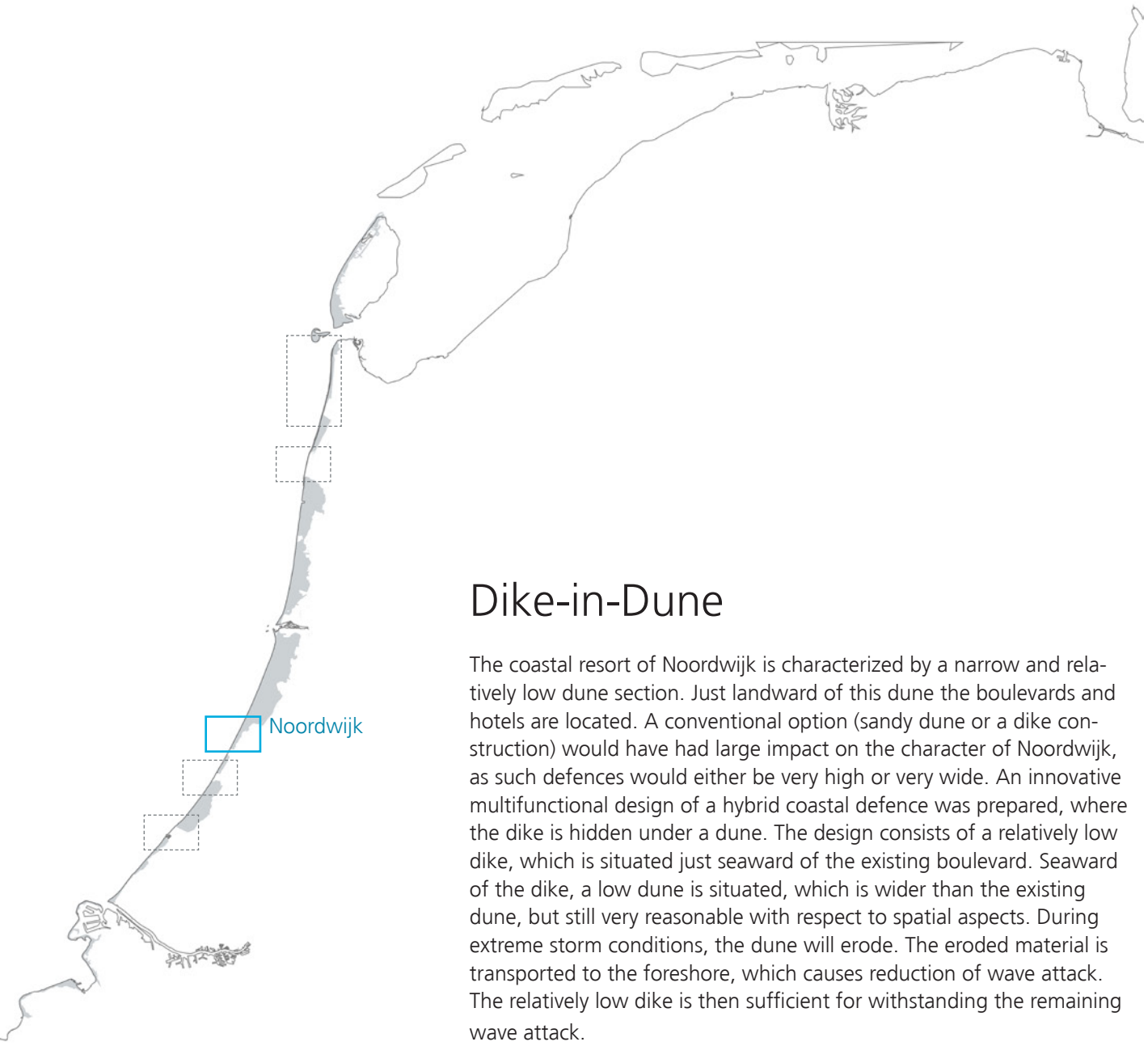
Noordwijk

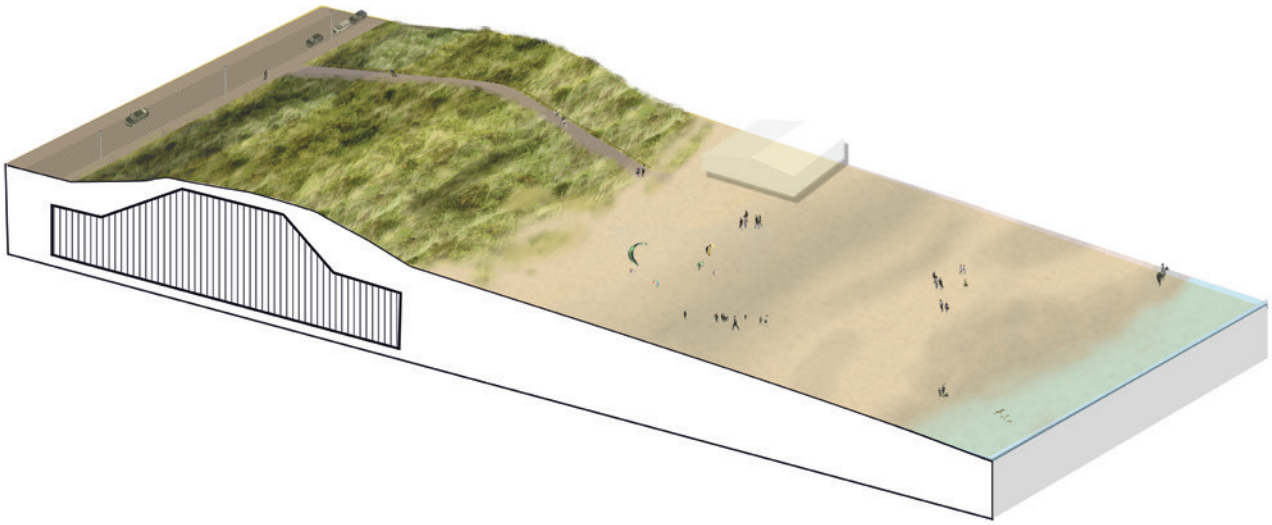
This coastal resort, famous for its beach and its large and exclusive hotels along and partly in an attractive natural dune, is characterised by a relatively low boulevard and dune area. Houses and hotels are located just landward of this boulevard, which means that there is only a limited space for strengthening the coastline. Secondly, the coastal defences should be such that the natural character of the town and its dune area (which exists for centuries) remains.

The following aspects were considered crucial:
Main source of income of this coastal resort is tourism. In order to avoid economic damage, the character of the town, after implementation of the coastal defence works, should remain more or less the same;



Dike-in-Dune

The coastal resort of Noordwijk is characterized by a narrow and relatively low dune section. Just landward of this dune the boulevards and hotels are located. A conventional option (sandy dune or a dike construction) would have had large impact on the character of Noordwijk, as such defences would either be very high or very wide. An innovative multifunctional design of a hybrid coastal defence was prepared, where the dike is hidden under a dune. The design consists of a relatively low dike, which is situated just seaward of the existing boulevard. Seaward of the dike, a low dune is situated, which is wider than the existing dune, but still very reasonable with respect to spatial aspects. During extreme storm conditions, the dune will erode. The eroded material is transported to the foreshore, which causes reduction of wave attack. The relatively low dike is then sufficient for withstanding the remaining wave attack.



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HOTELS
ORANJE

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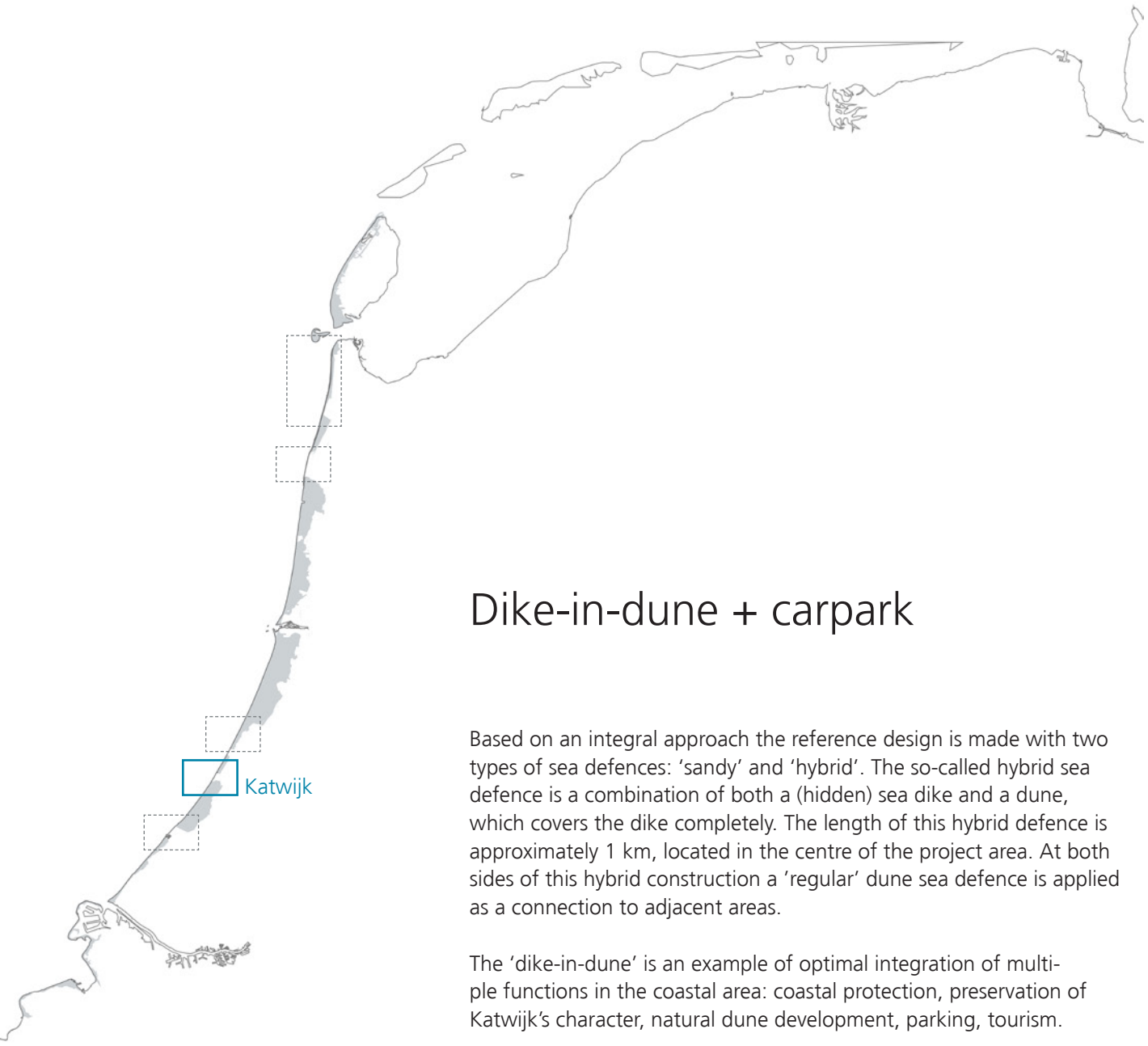
Katwijk

Katwijk is a coastal town characterised by its strong history of a fisherman's community. Katwijk is also a typical family oriented beach resort: not so mondaine as for instance Schevingen and Noordwijk, but a strong tradition as a typical family based recreational beach. It has a nice, relatively simple boulevard along the beach. Houses and hotels are located just landward of this boulevard, which means that there is only limited space for developing coastal defence works. The coastal defences should be such that the character of the town remains, and the strong 'connection' between boulevard and beach-area is maintained for tourists and residents.

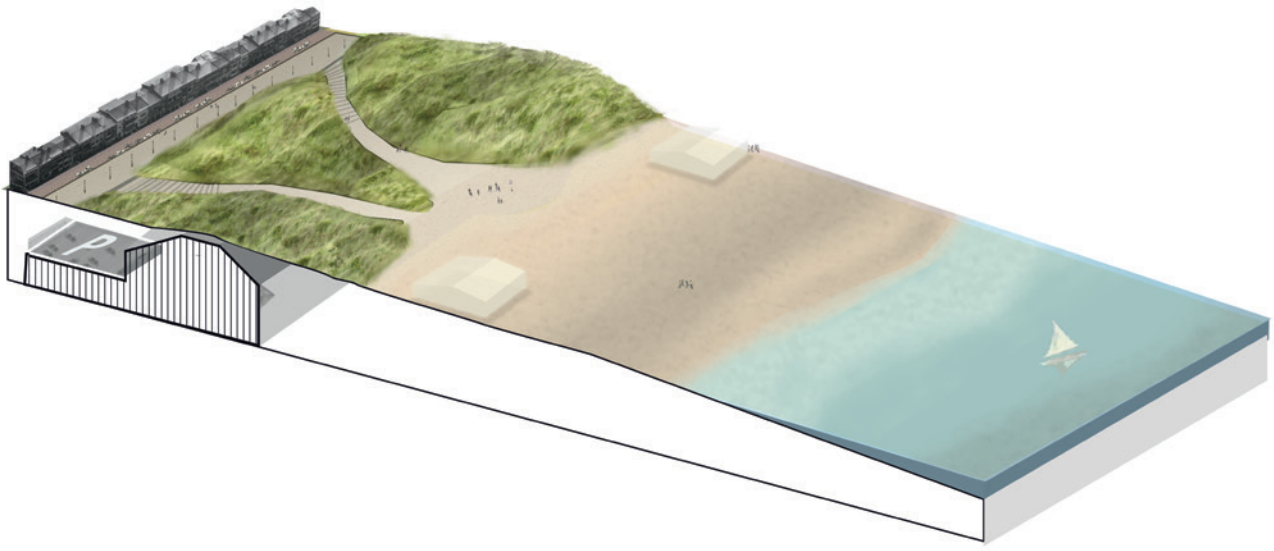
Dike-in-dune + carpark



Dike-in-dune + carpark

Based on an integral approach the reference design is made with two types of sea defences: 'sandy' and 'hybrid'. The so-called hybrid sea defence is a combination of both a (hidden) sea dike and a dune, which covers the dike completely. The length of this hybrid defence is approximately 1 km, located in the centre of the project area. At both sides of this hybrid construction a 'regular' dune sea defence is applied as a connection to adjacent areas.

The 'dike-in-dune' is an example of optimal integration of multiple functions in the coastal area: coastal protection, preservation of Katwijk's character, natural dune development, parking, tourism.



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Due to the innovative, so-called 'dike-in-dune', design for the primary sea defences a significant area just landward of the dike (but seaward of the boulevard) becomes available. In this area an entirely new underground parking garage is realised. Moreover, the fact that both the sea dike and the parking garage are hidden inside the new dunes, the 'natural appearance' of the coastal zone is not affected (or even improved).

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Scheveningen

The boulevard of Scheveningen is a very popular tourist destination. Scheveningen, as part of the city of The Hague, is the only major city at the Dutch coast. Almost 14 million people a year visit the boulevard.

The challenge is to provide a technical solution, but also provide a significant improvemen of the economic and recreational quality of the boulevard: a boulevard was centred so far only around the 'Pier' and 'Kurhaus'. A new boulevard designed to connect this area with the more historical centre of Scheveningen, being originally a fisherman's community. But also a boulevard that should attract more tourists, should allow tourists to walk around safely. Hence separate lanes for pedestrians, bicycles and motorized traffic was desired. And historically, it would be nice to have the original curves in the coastline back in the new design.

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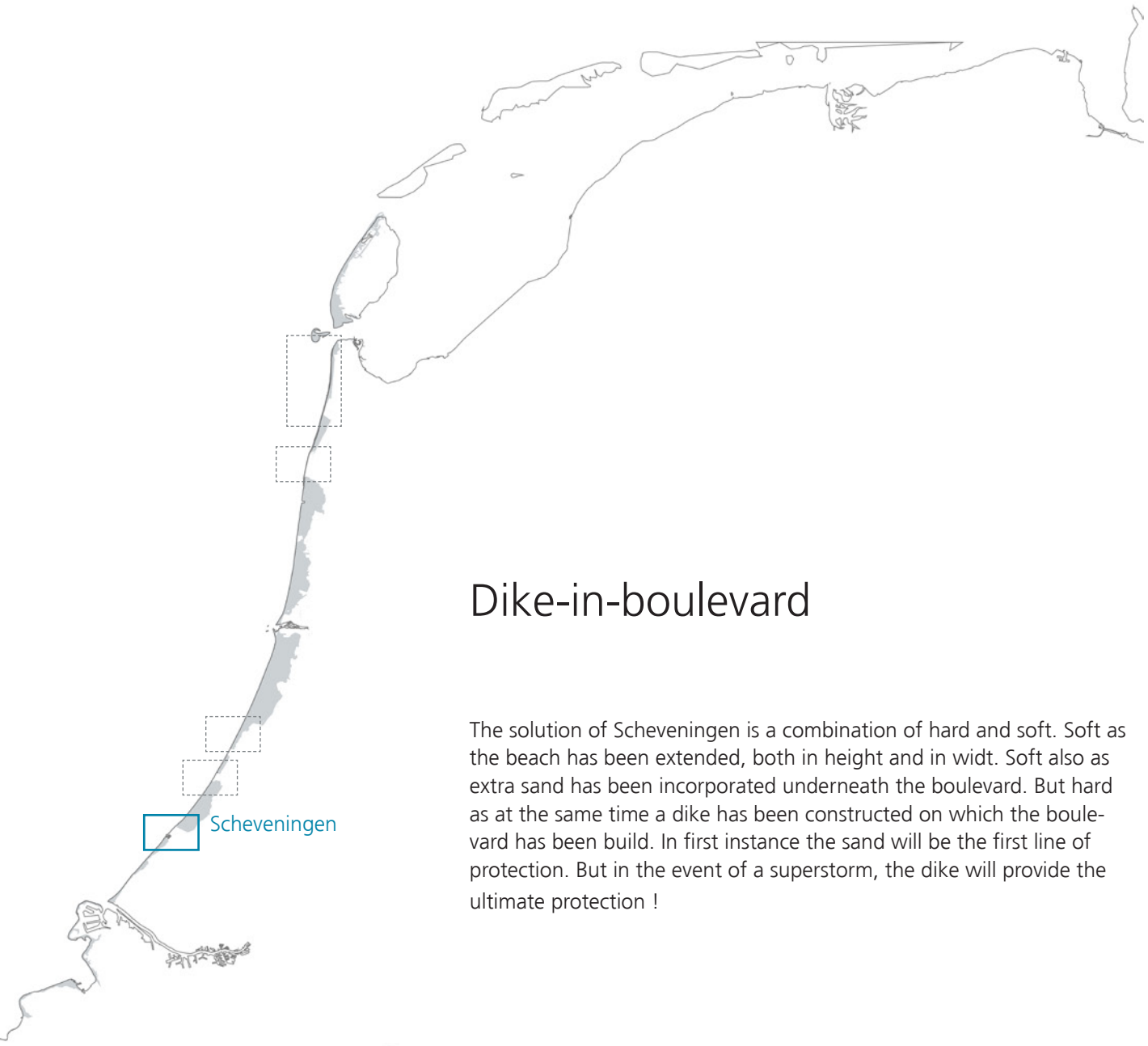
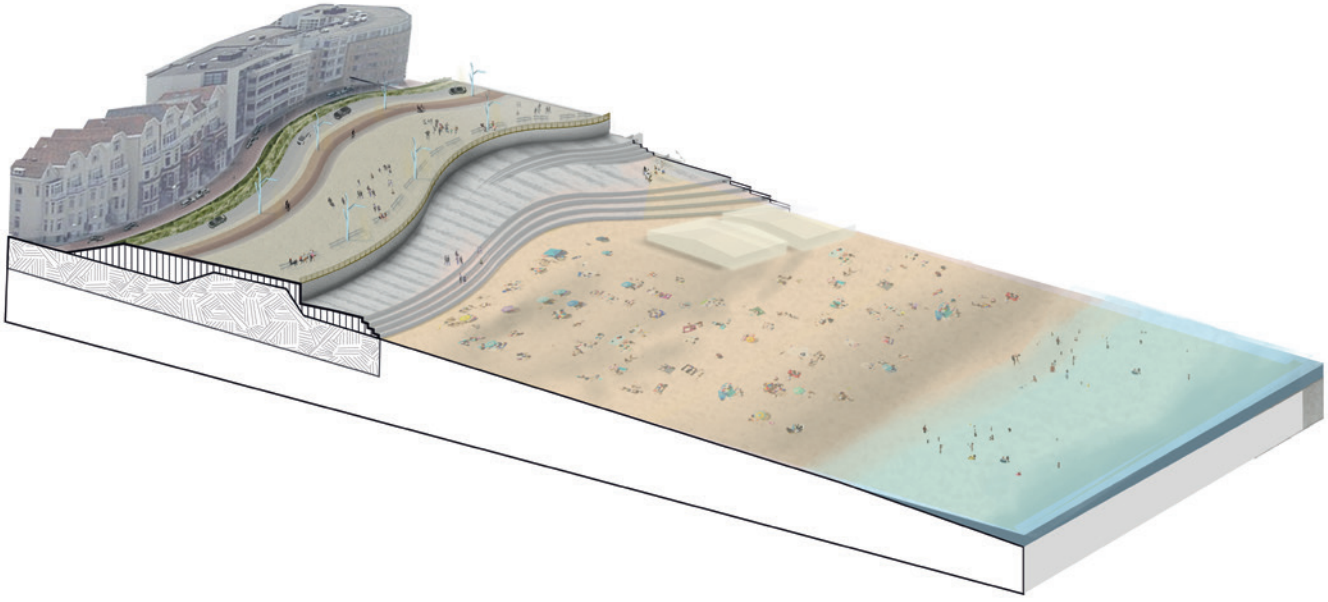
Dike - in - boulevard



Dike-in-boulevard

The solution of Scheveningen is a combination of hard and soft. Soft as the beach has been extended, both in height and in widt. Soft also as extra sand has been incorporated underneath the boulevard. But hard as at the same time a dike has been constructed on which the boulevard has been build. In first instance the sand will be the first line of protection. But in the event of a superstorm, the dike will provide the ultimate protection !



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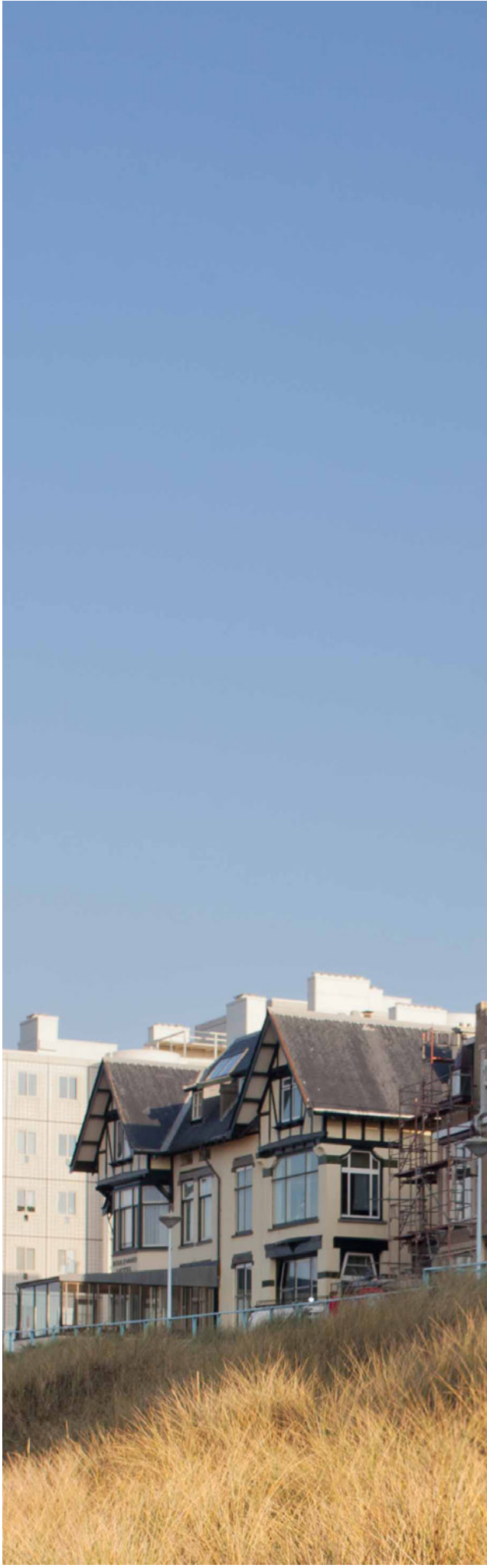

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