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Immersed Tunnel Sepaku River Ibu Kota Negara (IKN)

Inovasi Untuk Solusi

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Inovasi Untuk Solusi

TRANS SUMATERA

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Outline

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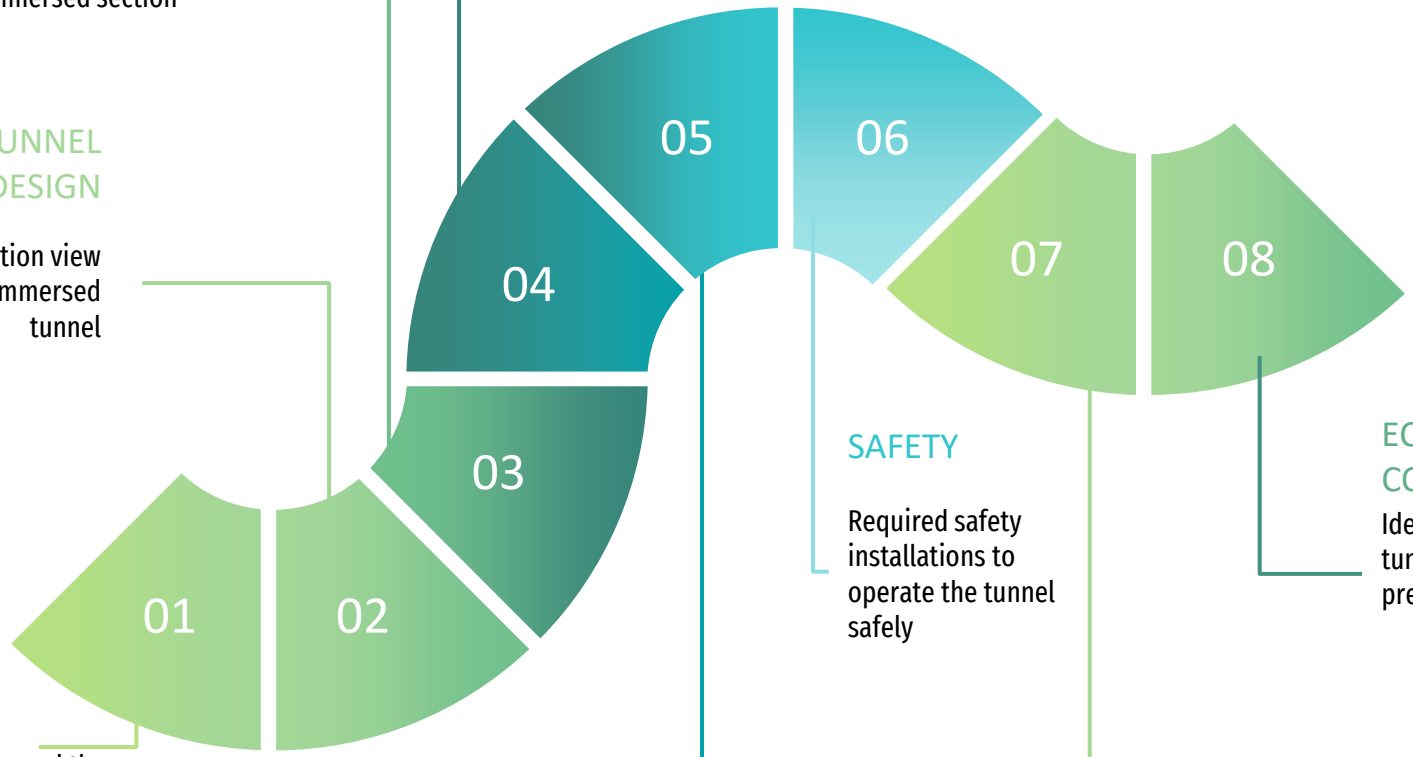


PROJECT BACKGROUND

Description of the problem and the solution that the project provide

IMMERSED TUNNEL DESIGN

Plan view, cross section view and 3D view of the immersed tunnel

DESIGN OF THE IMMERSED SECTION

Technical consideration of the Immersed section

ENVIROMENTAL CONDITION

Various environmental condition that need to be consider for during and after the construction

MATERIALS

Materials specification for construction

SAFETY

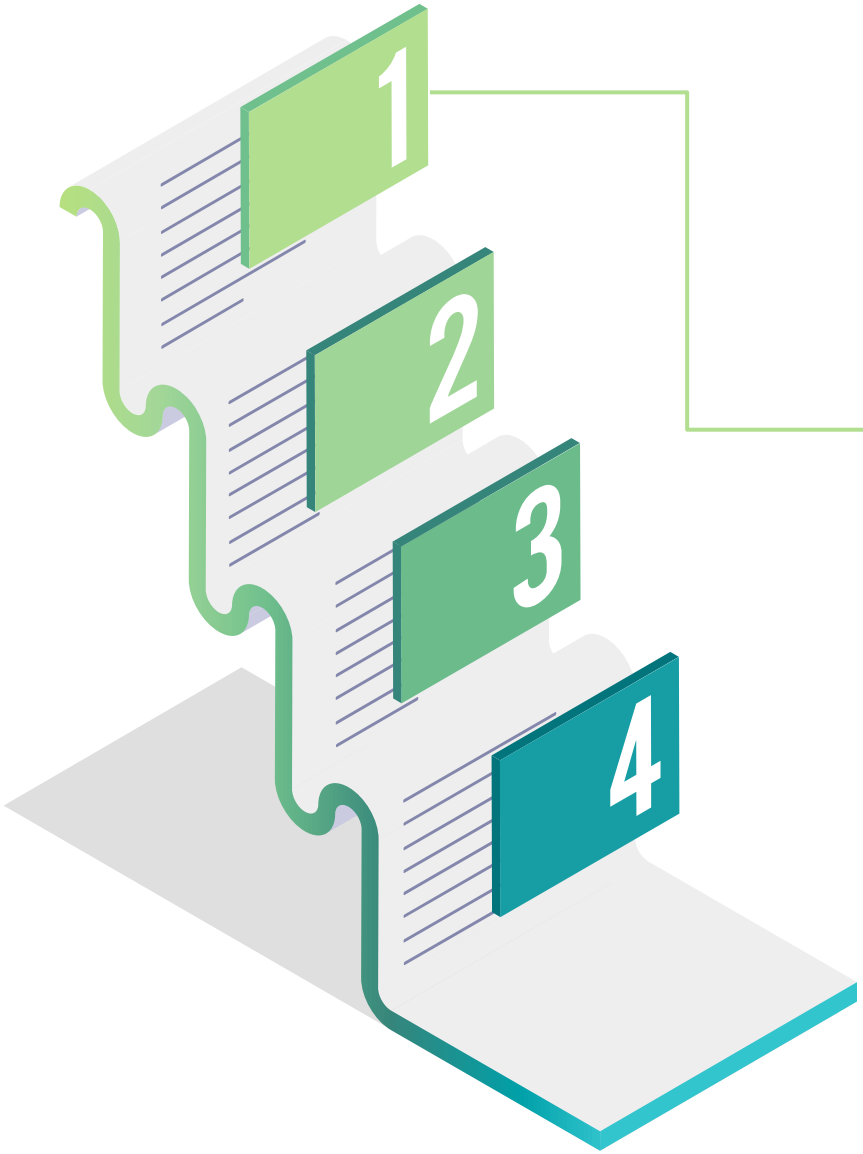
Required safety installations to operate the tunnel safely

METHOD OF CONSTRUCTION

Construction method of the immersed section

ECOLOGICAL CONSIDERATIONS

Identify impact of immersed tunnel and its measures to prevent / reduce it



PROJECT BACKGROUND

Description of the problem and the solution that the project provide

Project Background

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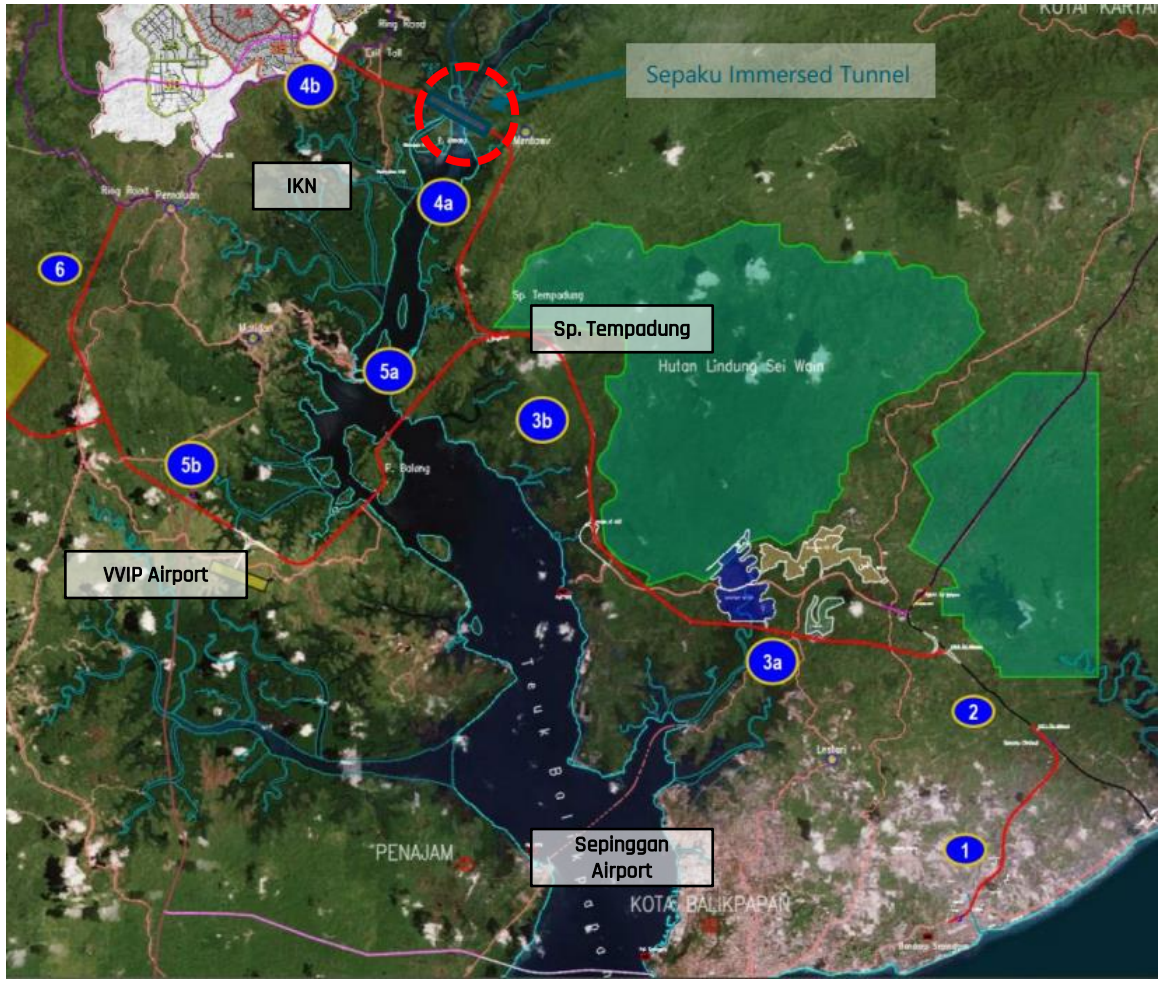
The construction of the Nusantara Capital (IKN) in East Kalimantan has entered the construction stage, including the IKN Access Toll Road. The section 1, 2, 3a and 3b are under construction, meanwhile the Sepaku Immersed Tunnel (Sepaku IMT) is planned as **part of segment 4b**.



Problem

The Tempadung – Government Center toll road trajectory plan **passes through mangrove forest.** Therefore, it is not possible to conduct massive land acquisition in the area, that will make large impact to the forest ecological.

Solution

The Government **plans to build an Immersed Tunnel or underwater tunnel through Balikpapan Bay** that have relatively small ecological impact compared to other solutions like bridge.

IMMERSED TUNNEL DESIGN

Plan view, cross section view and 3D view of the immersed tunnel

Immersed Tunnel Design & Design Criteria

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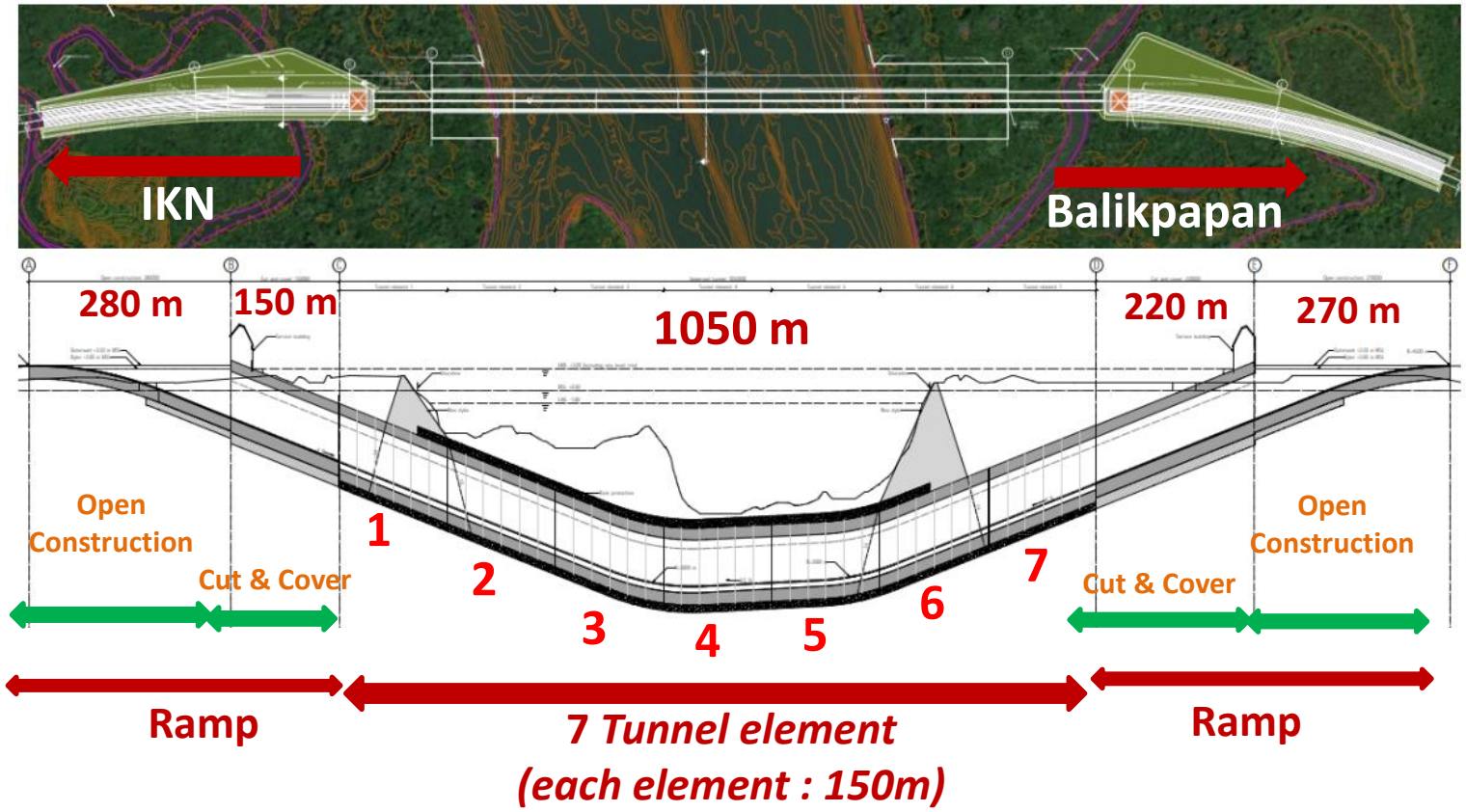
The total length of the tunnel structure amounts **1,970 m**. It consists of open and closed ramp sections on both sides connected with a 1,050 m immersed section **consisting of 7 tunnel elements**. The ramp sections are surrounded with elevated land to prevent the tunnel from flooding and look like two island rising above the existing surface level



Top and Side View

Design Criteria

1	Speed	: 80 km/h
2	Total lane	: 2 x 3
3	Lane width	: 3,6 m
4	Inner shoulder	: 1m
5	Outer shoulder	: 0,8 m
6	Vertical clearence	: 5,1 m
7	Max gradient	: 4.0 %
8	Convex curvature	: 4,500 m
9	Concave curvature	: 3,000 m
10	Pavement	: Flexible

Immersed Tunnel Design

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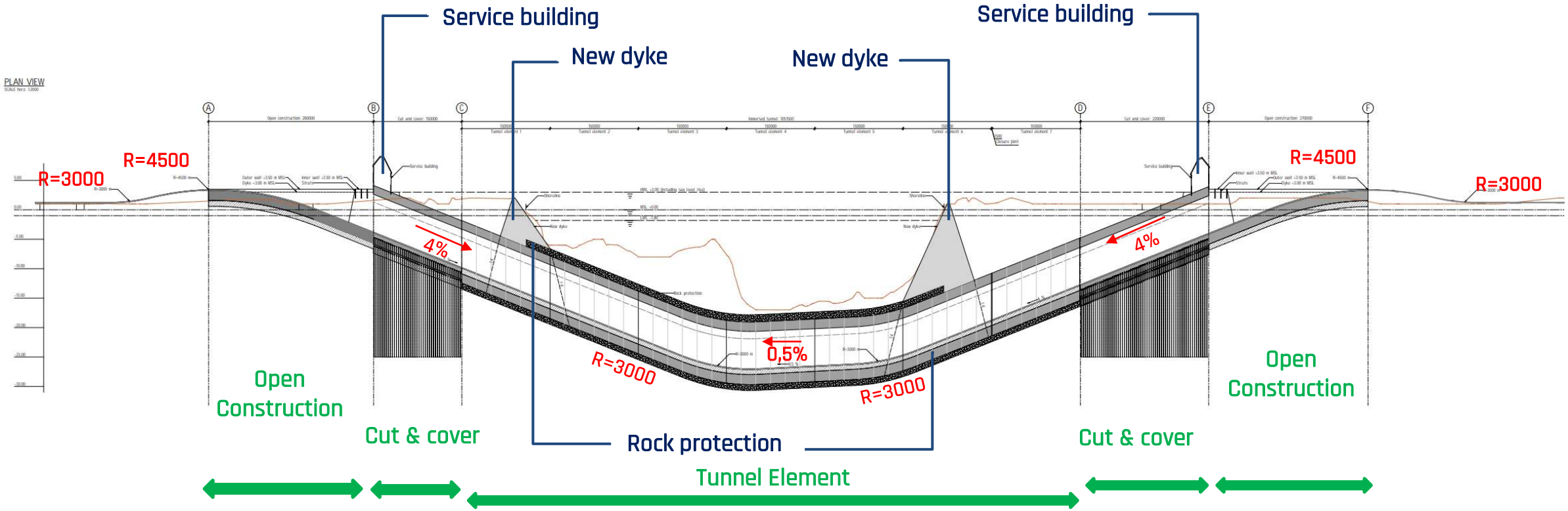
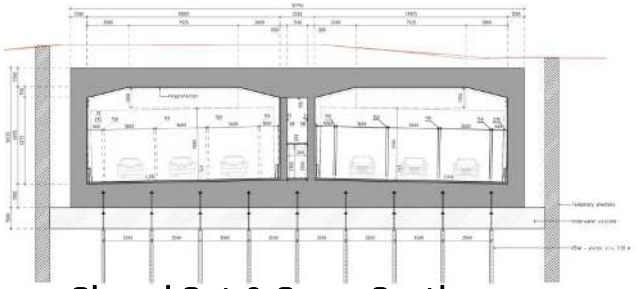
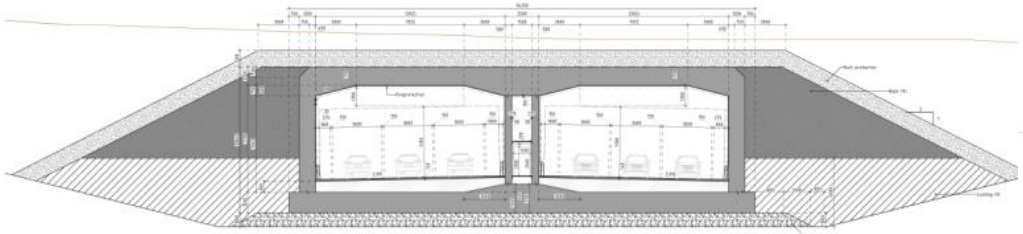


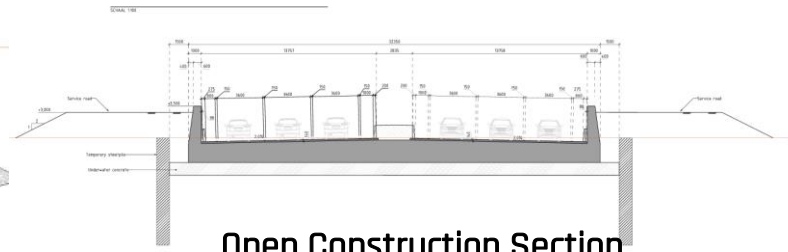
CROSS SECTION



Closed Cut & Cover Section



Immersed Section



Open Construction Section

Immersed Tunnel Design

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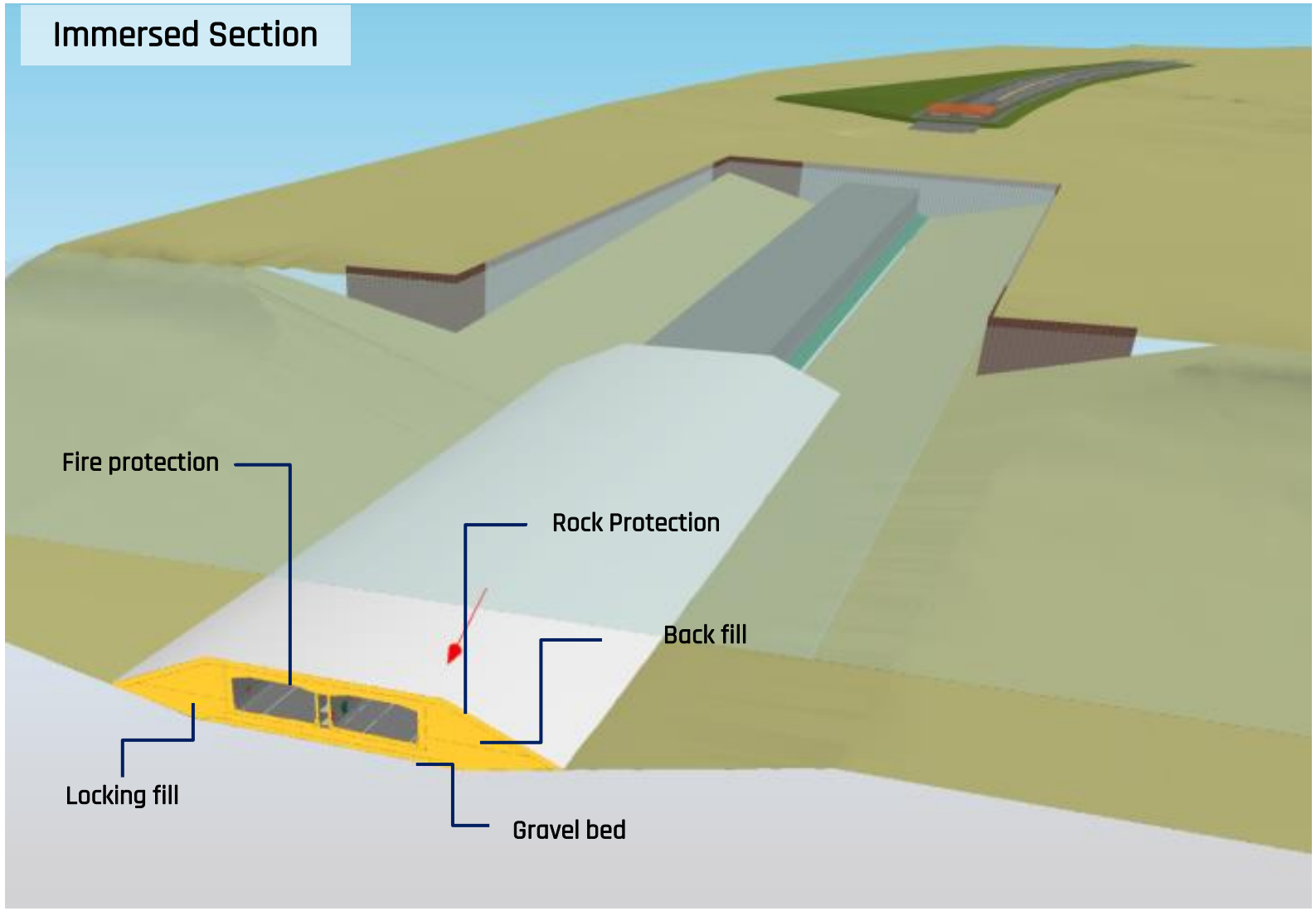
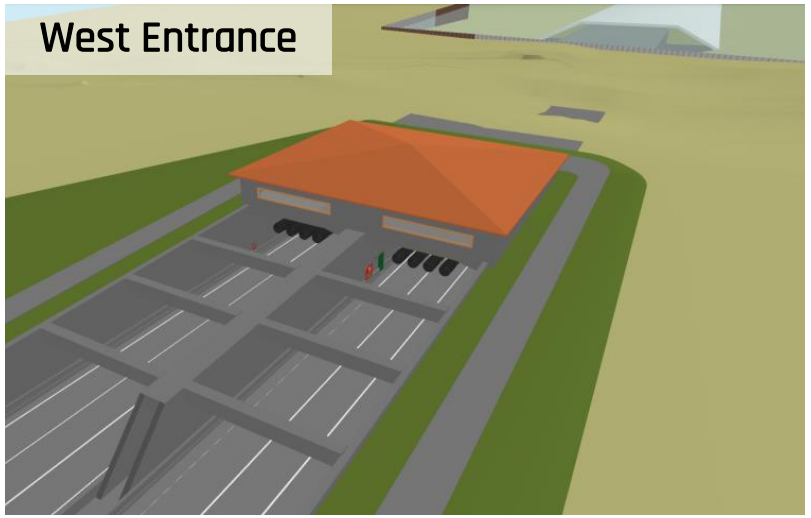
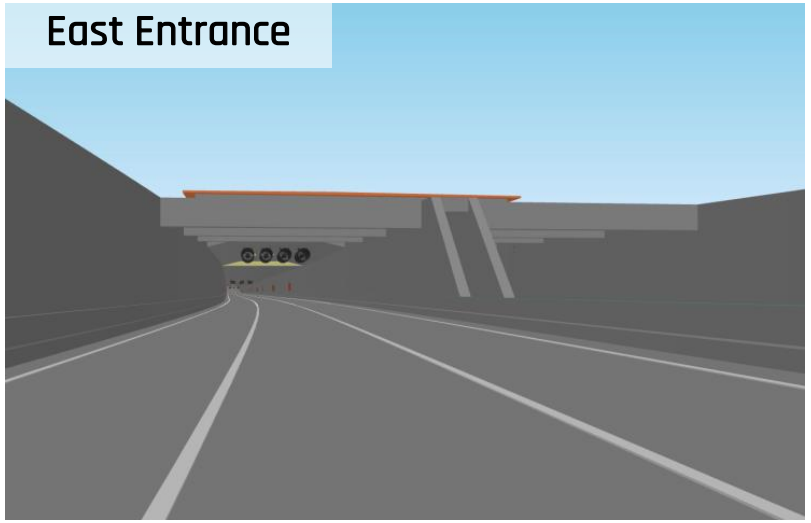
Immersed Section



West Entrance



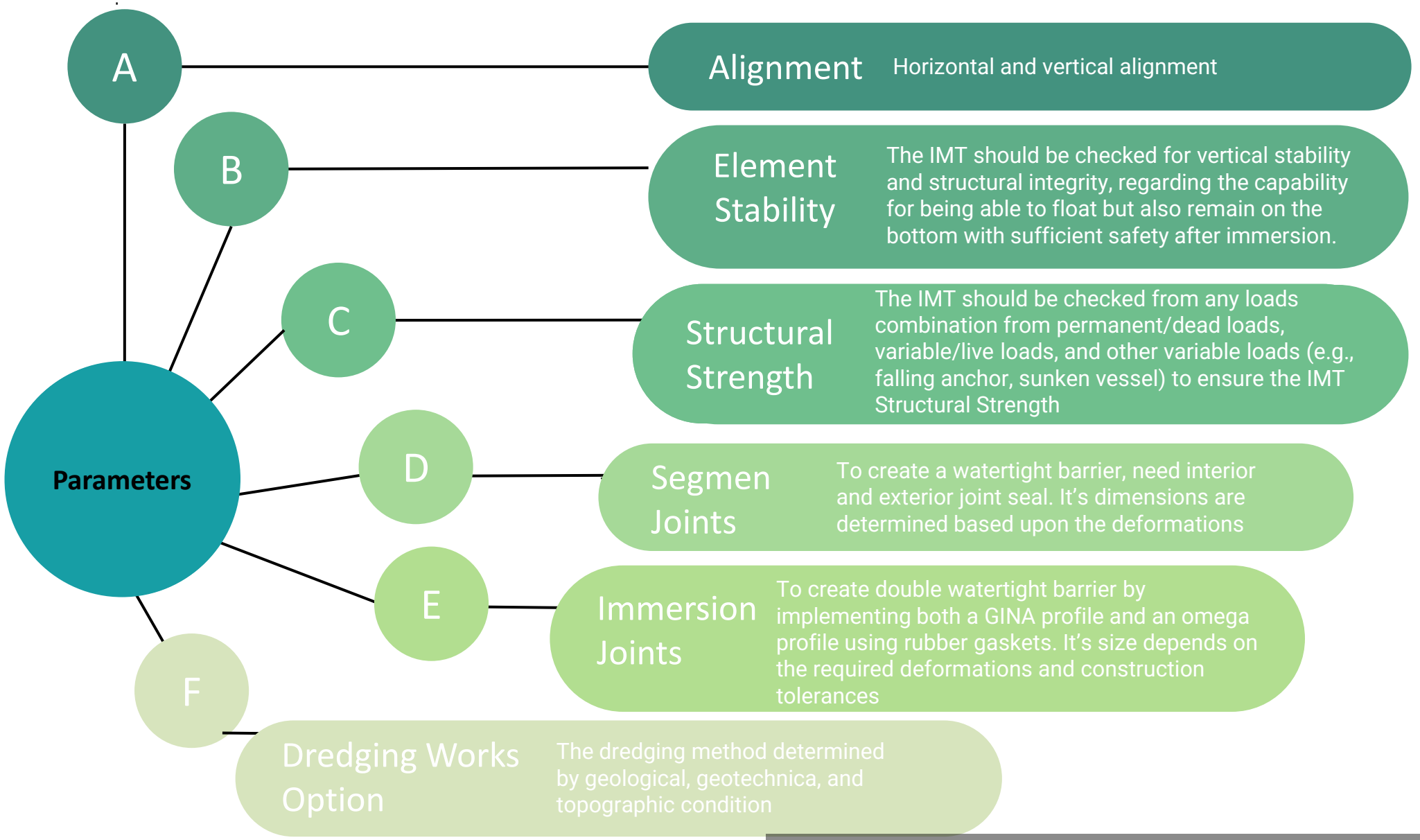
East Entrance



DESIGN OF THE IMMERSED SECTION

Technical consideration of the Immersed section

Design Of The Immersed Section



Design Of The Immersed Section –Segment Joints & Immersion Joints

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Immersion Join

Immersion joint is located between the elements and consists of a large rubber gasket which can accommodate the elongation and compression of the joint. These are both rubber gaskets. The size of the gaskets depends on the required deformations and construction tolerances.


Rubber Gasket


Shear Keys


Shear Keys in Segment Joint

Segment Joints

A segment joint is situated between the segments of an element and consists of a rubber profile to accommodate elongation of the joint. To create a watertight barrier an internal joint seal and an exterior joint seal are implemented

Design Of The Immersed Section- Dredging Works Option

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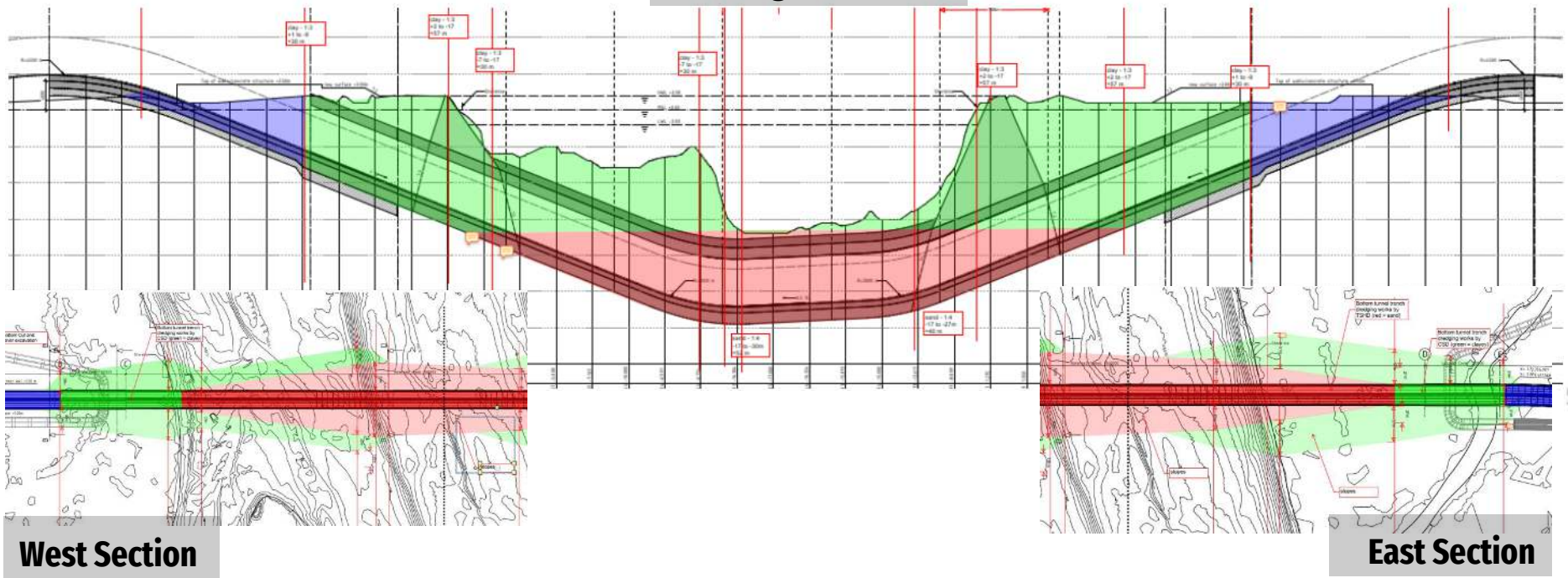
Long Section

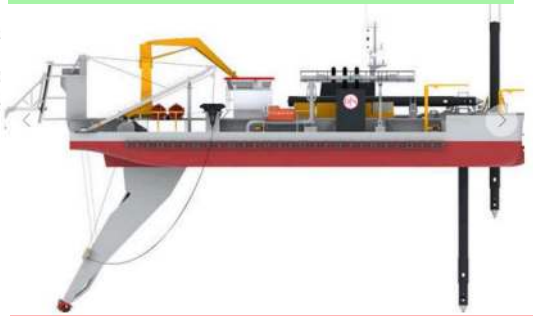


West Section

East Section

	CSD Dredging
	TSHD Dredging
	Cut and Cover

Cutter Suction Dredging (CSD)



Trailing Suction Hopper Dredger (TSHD)

CONSIDERATIONS :

1. The sections near the shore **(green hatch)** mainly consist of clay layers up to a level of -17m up to +2 m. **A CSD which suitable for operating in shallow water can dredge material in front of the cutter head, especially clay layer and does not have minimum draft requirements**
2. The deeper sand layers from -17,0 m to -30,0 m **(red hatch)** difficult to dredge with a CSD (max 18m depth). **The clamshells's grab will struggle to penetrate in the dense sand layer, because it will stay on the sand layer. A small TSHD would be suitable to dredge that layer.**
3. To limit the amount of dredging and the damage to the mangrove forest as well, temporary sheet piles are used at the shore limiting the width of the trench.

ENVIRONMENTAL CONDITIONS

Various environmental condition that considered for during and after the construction

Environmental Conditions

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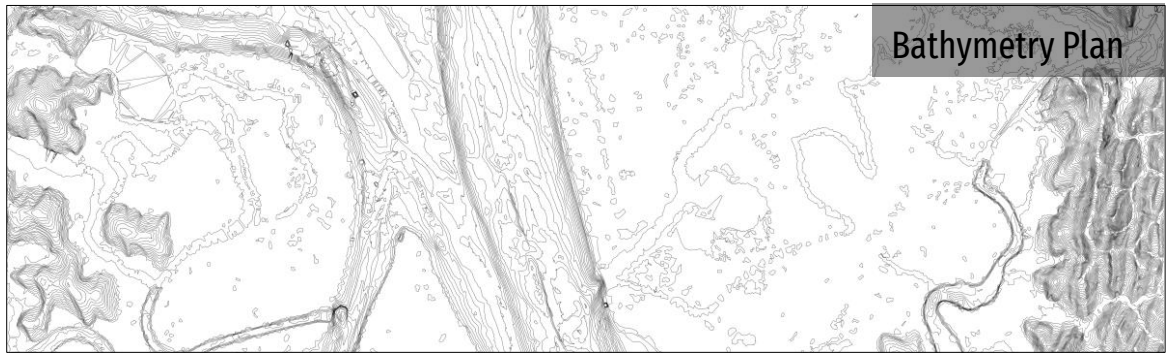
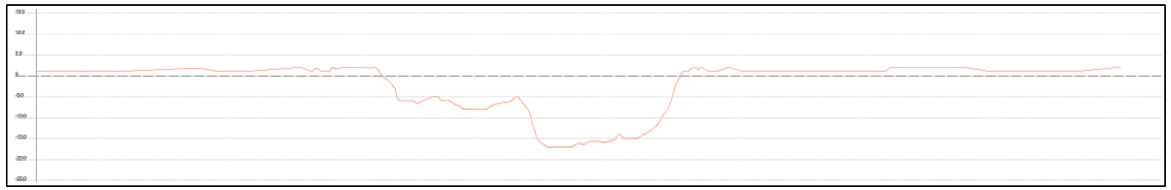
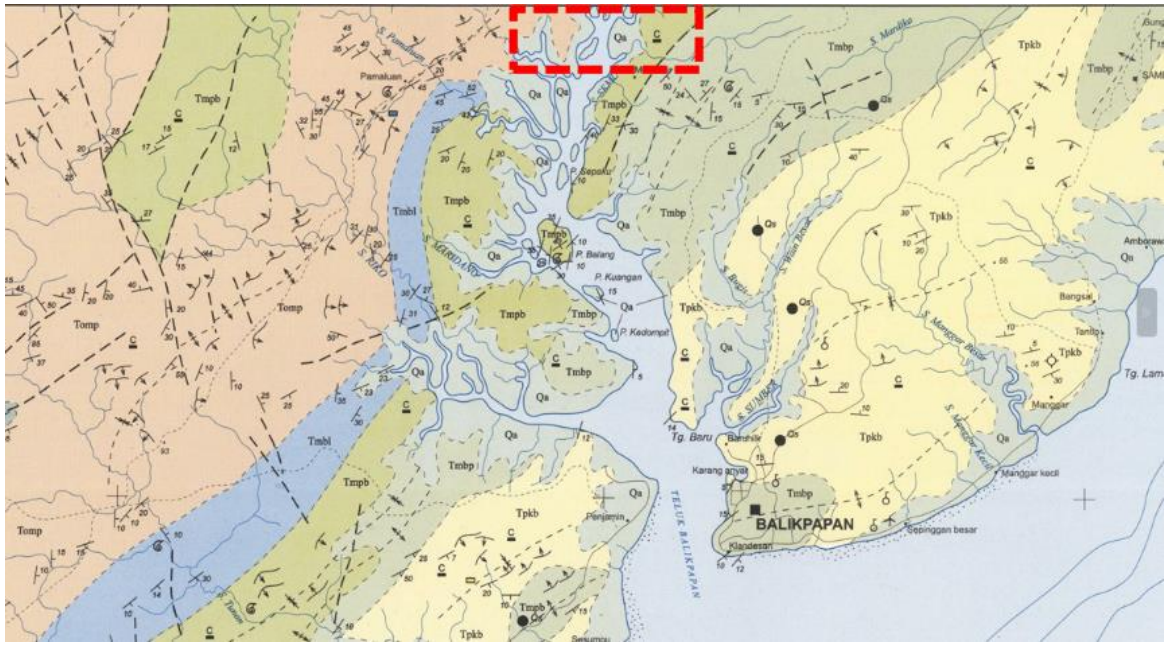
Bathymetry and Topography

The deepest part of the river is at -17.00 m MSL. On the East side the river is deepest, and the shoreline is steep. The West side is shallow with an average riverbed level of -7.00 m MSL.
The surface level at the shore is between +1.00 m MSL and +2.00 m MSL.







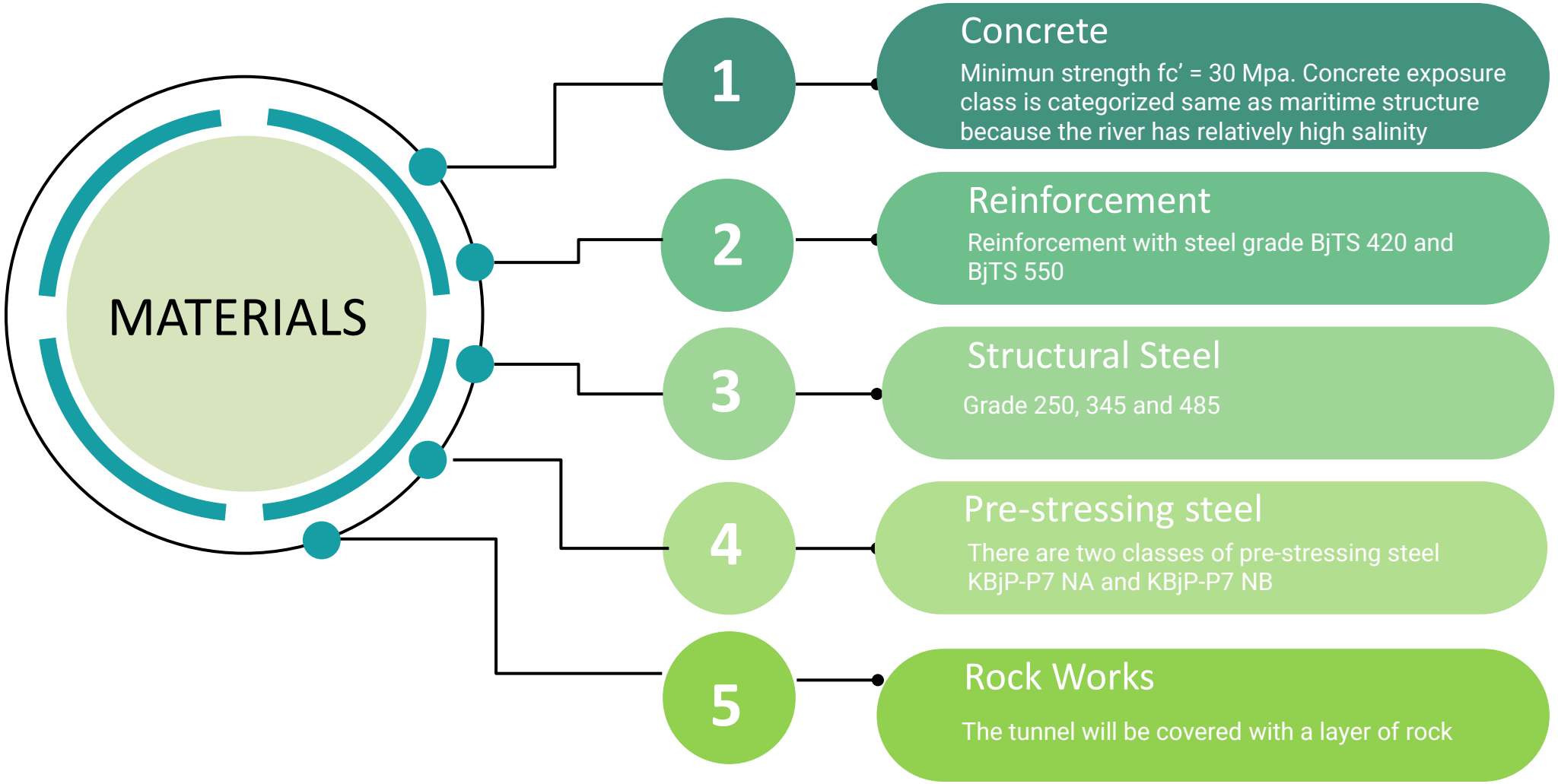
Geology

The alluvial type contains large particle such as cobbles and pebbles although also mixed with clay, that also seen in the soil investigation data. Below the alluvium layer is a Balikpapan formation, lithology of quartz sandstone and claystone.

MATERIALS

Materials specification for construction

Materials


MATERIALS
1
Concrete
Minimun strength fc' = 30 Mpa. Concrete exposure class is categorized same as maritime structure because the river has relatively high salinity
2
Reinforcement
Reinforcement with steel grade BjTS 420 and BjTS 550
3
Structural Steel
Grade 250, 345 and 485
4
Pre-stressing steel
There are two classes of pre-stressing steel KBjP-P7 NA and KBjP-P7 NB
5
Rock Works
The tunnel will be covered with a layer of rock

SAFETY

Required safety installations to operate the tunnel safely

Safety

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Fire Protection Boards

To prevent or postpone structural damage to the tunnel construction, fire resisting panels will be applied to the tunnel ceiling and walls. The provision of the fire resisting panels is sufficient to protect the construction for fire during 2 hours according to the Rijkswaterstaat (RWS) fire curve

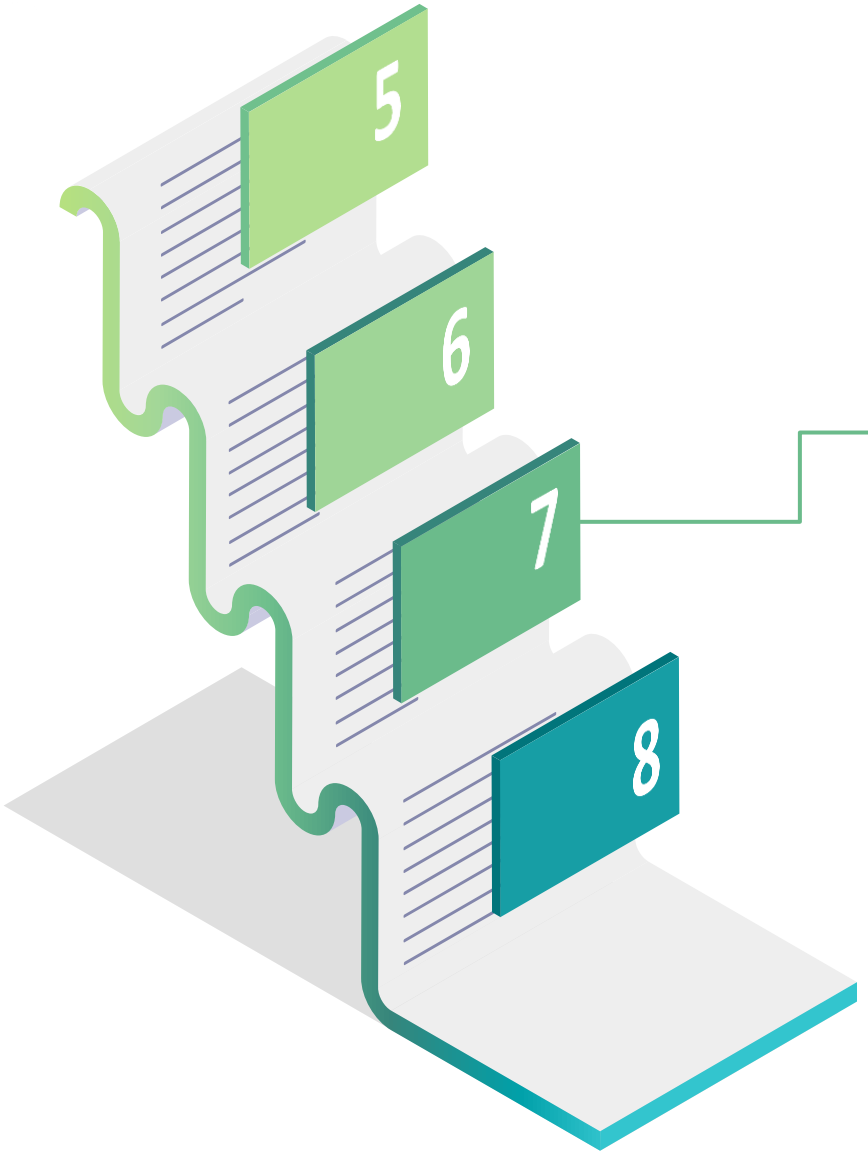
Evacuation Plan

In case of an emergency in one of the road tubes, the possibility exists that the occupants must get out of the tube and into a safe environment. Therefore, several services are available that combined form an evacuation plan. These services are :

- Arrows to point occupants to the right side of the road
- Icon on the walls to inform occupant to nearest emergency exit
- Special lamination emergency exit in poor visibility
- ETC

Emergency Egress

Every 100 m an emergency door is placed in the inner wall. In case of fire occupants can enter the safe escape gallery through the emergency door. Once occupants enter the emergency gallery, they are safe and can walk to the exit of the tunnel or wait for further rescue.



METHOD OF CONSTRUCTION

Construction method of the immersed section

Method Of Construction

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1. *Immersed tunnel elements construction*
2. *Dredging*
3. *Elements lifting and installation*
4. *Back filling*
5. *Tunnel Ramp Construction*

Method Of Construction

Immersed Tunnel Elements Construction

The immersed tunnel elements shall most likely be constructed in a tailer made casting. The location of the casting basin can be along the entire Sepaku river as long as sufficient water depth is available for the tunnel element to be transported

Casting basin just before inundation (left) and casting basin after inundation with one tunnel element floating (right)- case study : The Coatzacoalcos tunnel in Mexico

Method Of Construction

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Trench Dredging

For the dredging, generally it can be done with mechanical dredging techniques.
Depending on soil conditions, soil improvement may be required if there is very soft soil at the tunnel bottom.
The use of dredged products as embankment material must also be based on the results of soil properties tests and compliance with applicable specifications.

Grab dredger, Kahmari 2 with 16 m^3 Horizontal Profiling Grab + split hopper barge, case study : The Marieholm tunnel in Sweden

Method Of Construction

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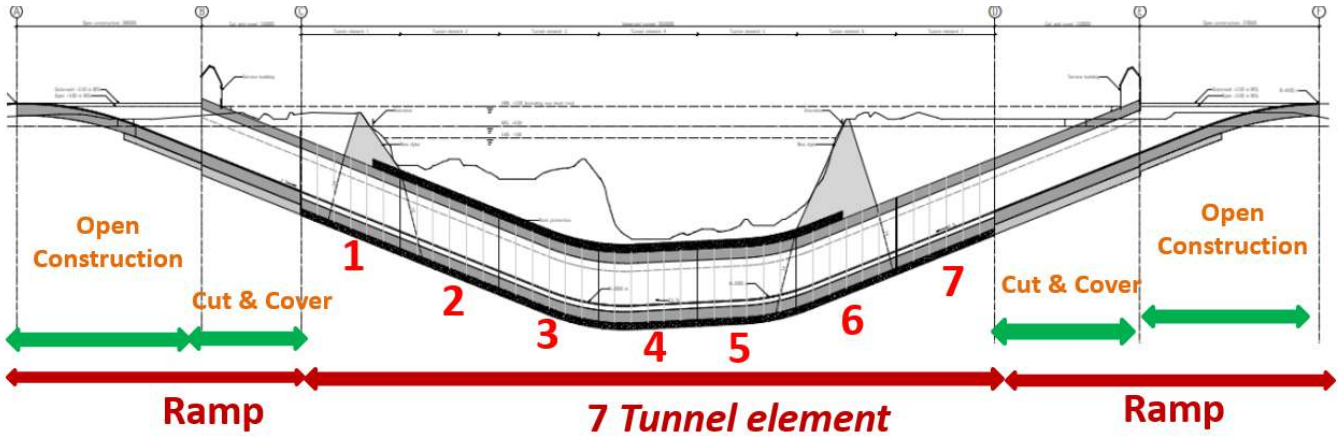
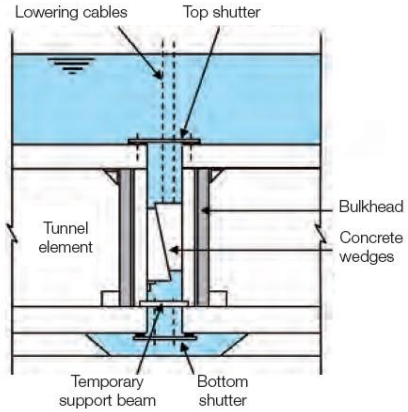
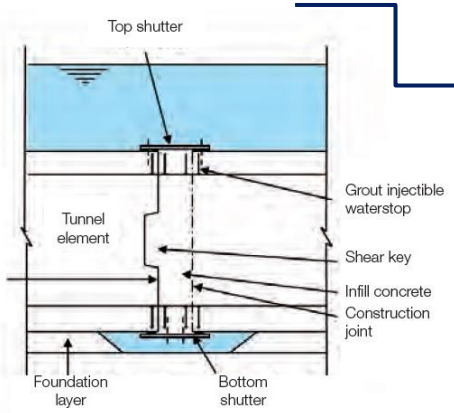
Immersed Tunnel Elements Installation



Case in-situ closure Joint concept





In the current design **it is assumed that elements 1 to 6** are connected to each other **starting from the West**

Between elements 6 and 7 an approximately 1.50 m gap will remain. This final part is called the **closure joint** and **shall be constructed in-situ**

When the formwork is installed **the water is drained and a dry working environment is created.**

Tunnel element 7 will be immersed against the Eastern cut & cover section.

After immersing of the last element, form work is installed with divers on the outside of the floor, walls and roof.

Method Of Construction

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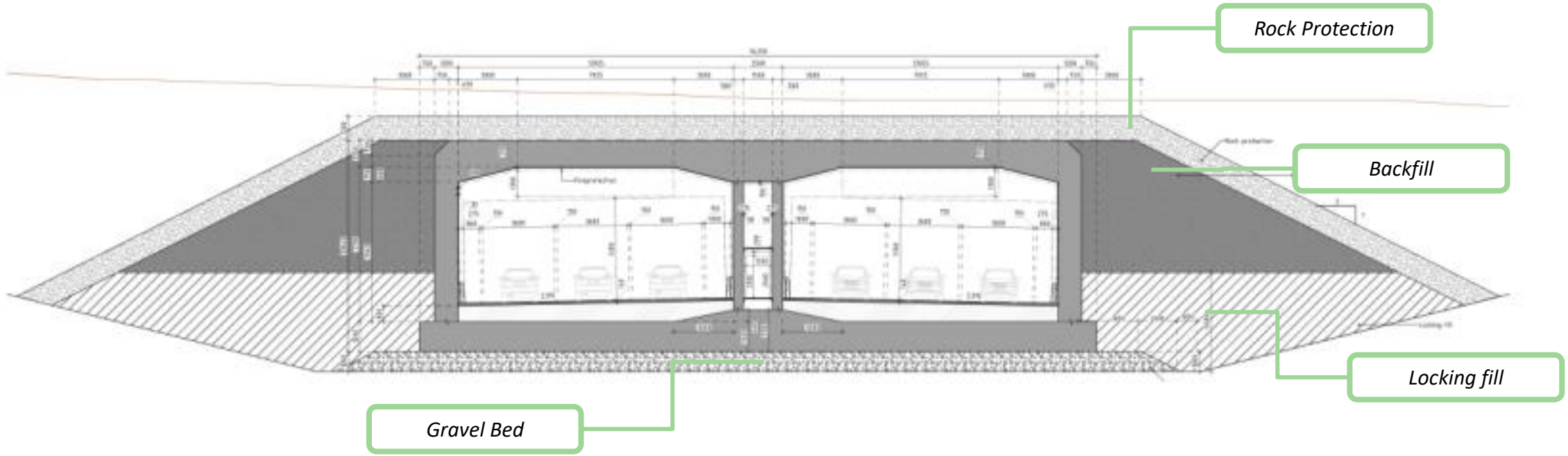
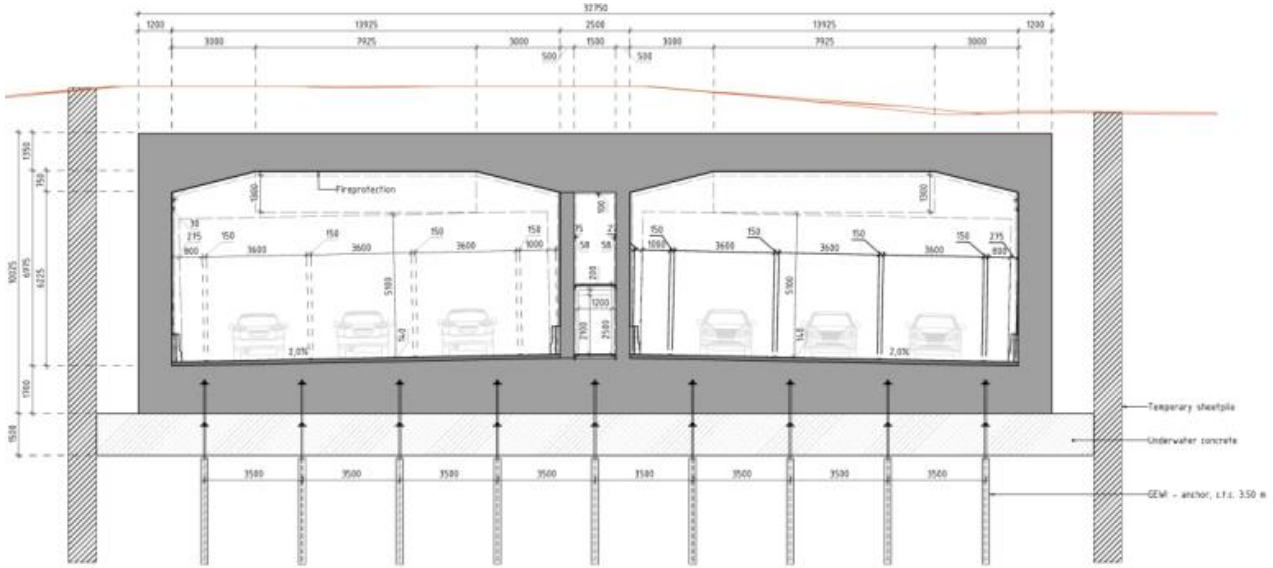
Backfilling

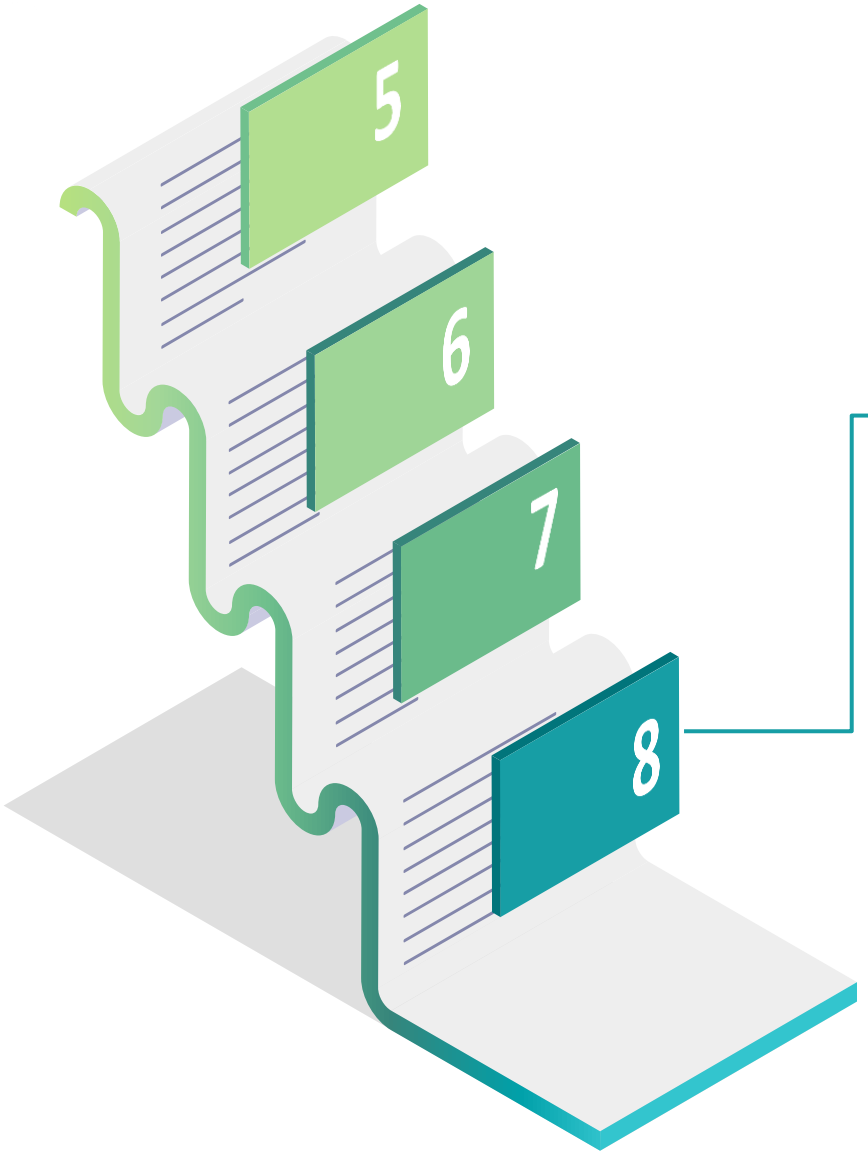


Method Of Construction



The Cut & Cover Construction Method

- The Tunnel Ramp sections exist of **open and closed sections**
- For the current design, it is assumed that temporary sheets piles are used from where the soil is excavated.
- The water will remain in the construction pit to limit the forces on the sheet piles.
- An underwater concrete floor is poured and is anchored in the soil with tension anchors to prevent uplift once the construction pit is dewatered.
- After dewatering of the construction pit the permanent reinforced concrete floor and walls and roof can be constructed.
- Once the permanent structure is finished the tunnel can be backfilled and the sheet piles can be removed.



ECOLOGICAL CONSIDERATIONS

Identify impact of immersed tunnel and its measures to prevent / reduce it

Ecological Considerations

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Current Ecosystem

The project area **is situated in the heart of a vast mangrove forest**. It is connected to a delta river system, with river arms spanning up to 50 km. The pristine forest area has a surface area of more than 500 ha. The highway and tunnel are planned 30 km upstream, deep in the forest.

Consequences

1. Permanent loss of mangrove areas
2. Forest degradation from disturbed waterflows
3. Negative effects offshore, if dredged material is dumped offshore
4. Permanent fragmentation of forest, blocking migration routes and splitting populations
5. High disturbance (noise) of pristine forest, forcing populations to migrate deeper into the forest
6. Emissions from Deforestation and Forest Degradation

Ecological Considerations

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Fundamental Design Changes

By using Immersed tunnel, the footprint of the project during the operation phase will be reduced. A larger mangrove area will be able to recover, and a larger migration corridor will be established.

Limiting The Effect of Development

Tunnel

- Design adaptation by minimize impact on waterflow, migration ruites and noise disturbance
- Dredging and disposal by mimicking natural condition and reuse the material in other project
- Backfilling after construction naturally or use stored or new material
- Recolonisation of mangroves naturaly also speed it up by using small measures or planting the mangroves
- Preventive measures by limiting footprint of tunnel and construction site also storage area of dredged material

Highway

- Design adaptation by including opening for water flows, allow small scale migration (ecoduct, tunnel), minimizing noise (sound barriers and also include fencing to reduce road kill
- Preventive measures by limiting footprint of tunnel and construction site also storage area of dredged material
- Conservation and education by formalize protective status of mangrove area around project

TERIMA KASIH