Follobanen
New Double track Oslo – Ski

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Jernbaneverket

Railroad development projects in the Oslo region

Agenda

1. Follobanen
   Background and project overview
2. Detailed view about:
   - Tunell
   - TBM or drill & blast?
   - Slab track or ballasted track
3. The road ahead

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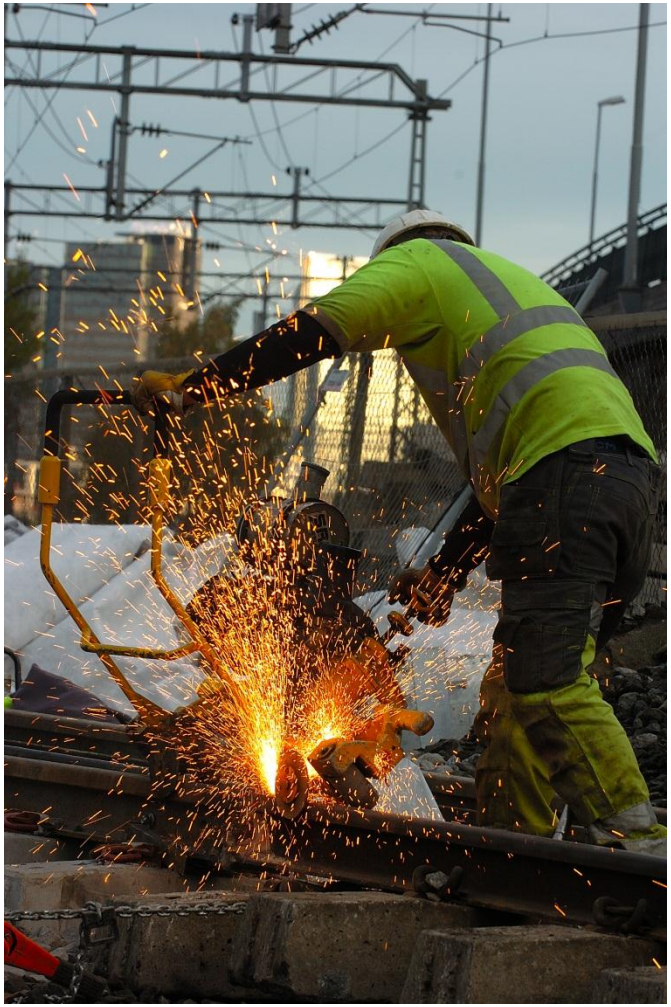
Our responsibility

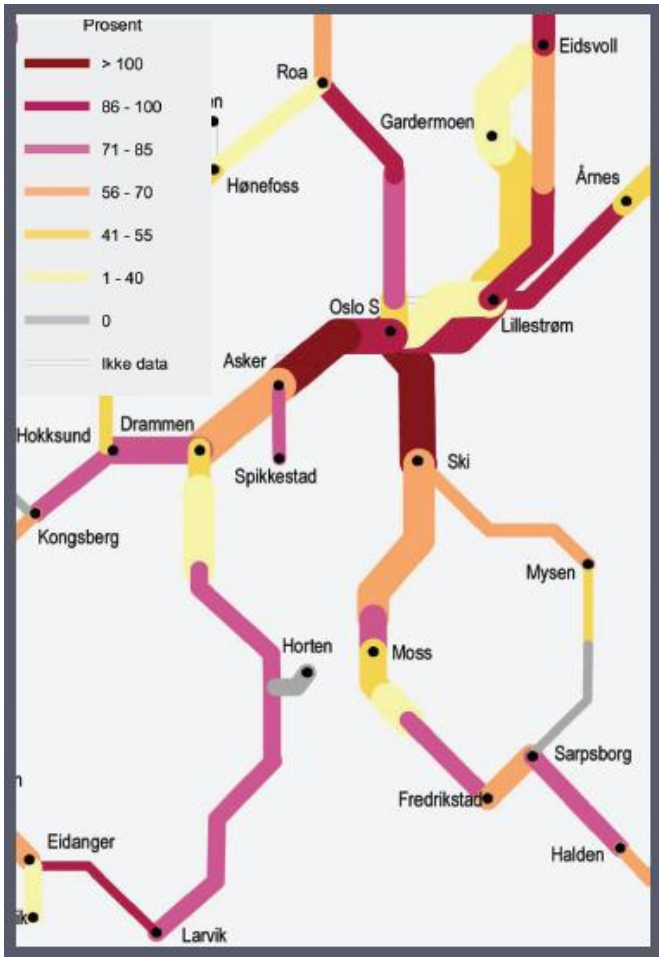


«The Norwegian Rail Administration works systematicly for continuous improvement of safety to avoid injury to people and the environment»

JA!
JEG TAR ANSVAR

Yes! I am responsible

Follobanen – Background

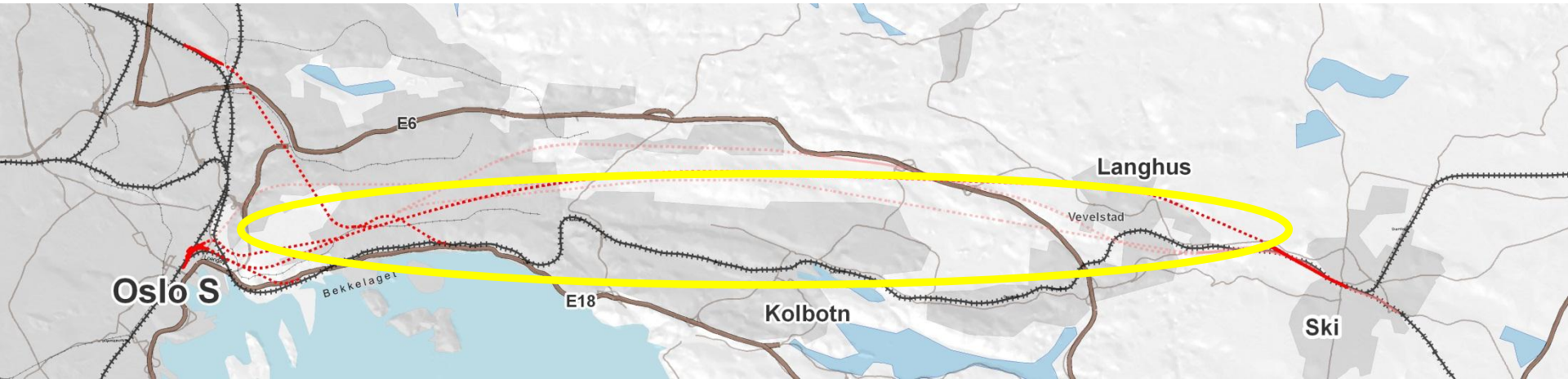


Follobanen will be built to meet the increased demand for rail capacity south of Oslo

- 1,1 million residents in the Oslo region
- 30 % population increase by 2025
- 150 000 passengers every day
- Road traffic is increasing
- Currently no spare capacity on neither rail nor road.
- Great potential for increased freight traffic
- High speed train line towards Sweden and Europe are currently under evaluation

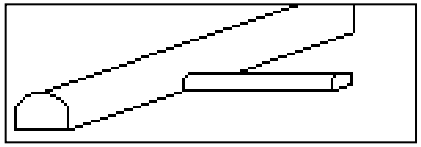
Follobanen: Facts and perspective

- The largest railway project In Norway - 22 km of new double-track railway line between Oslo S and Ski
- The longest railway tunnel in Norway - approximately 19,5 km
- Designed for at least 200 km/h or higher
- Two separate tubes with cross-passage every 500 meters
- No stop between Oslo and Ski
- Both Drill and Blast and TBM are considered
- Freight connection to Alnabru is considered, but not a part of the project



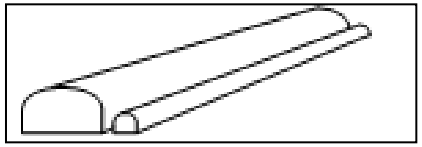
Tunnel concepts

Concept 1



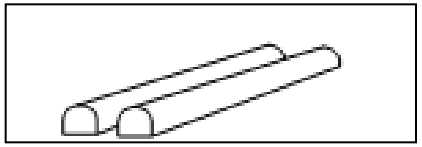
One double-track tunnel with exit to the surface every 1000 meter

Concept 2



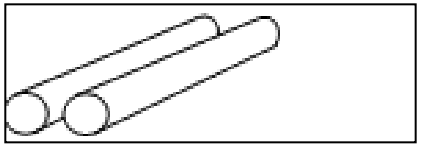
A double track tunnel with a parallel service tunnel and escape connections to service tunnel every 1000 meter

Concept 3a



Two single track tunnels with escape connections every 500 meter

Concept 3b



Two single track tunnels with escape connections every 500 meter

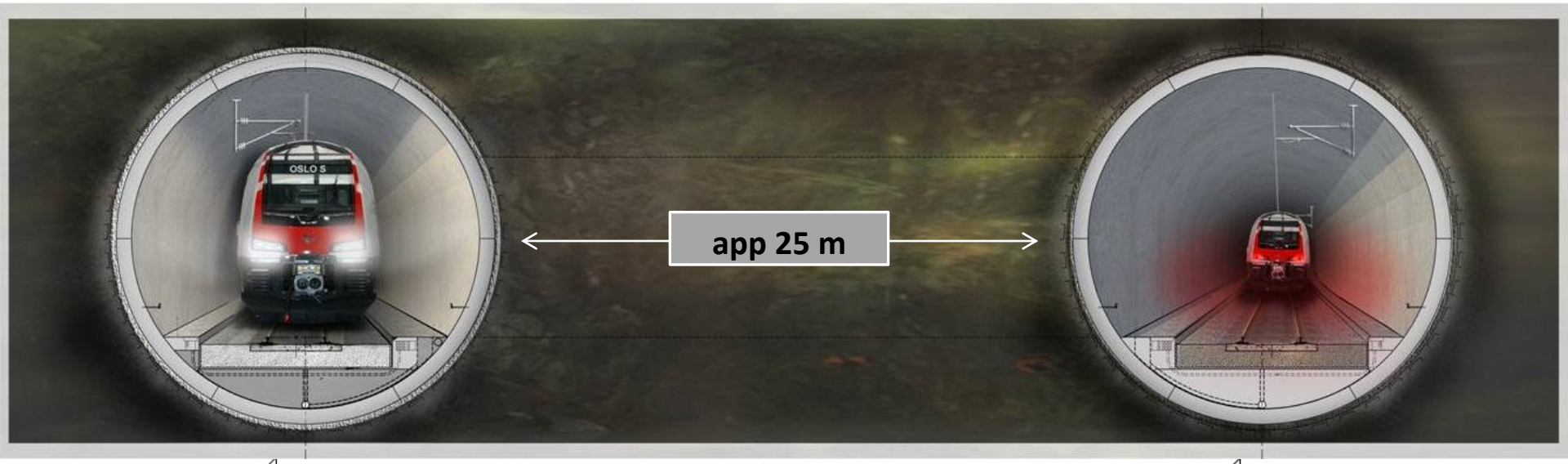
Conclusion

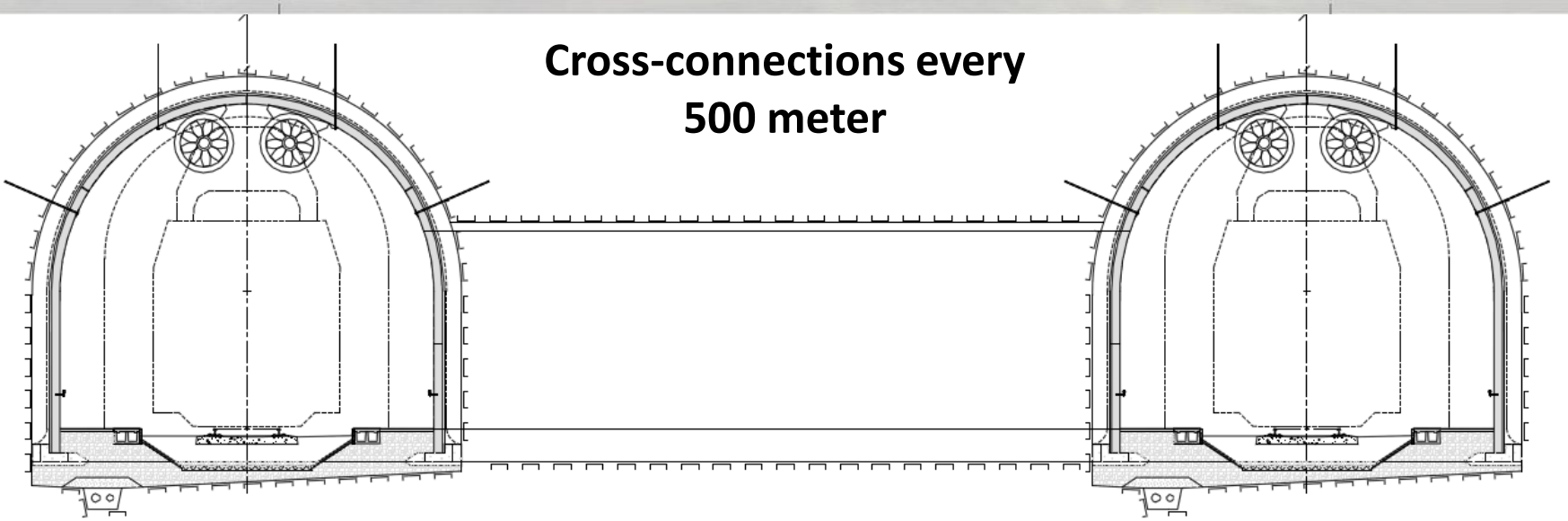
Concept 1 and 2: Only drill and blast are suitable

Concept 3: Both drill and blast and TBM are suitable

Decisions about two separate tubes and both methods are to be considered

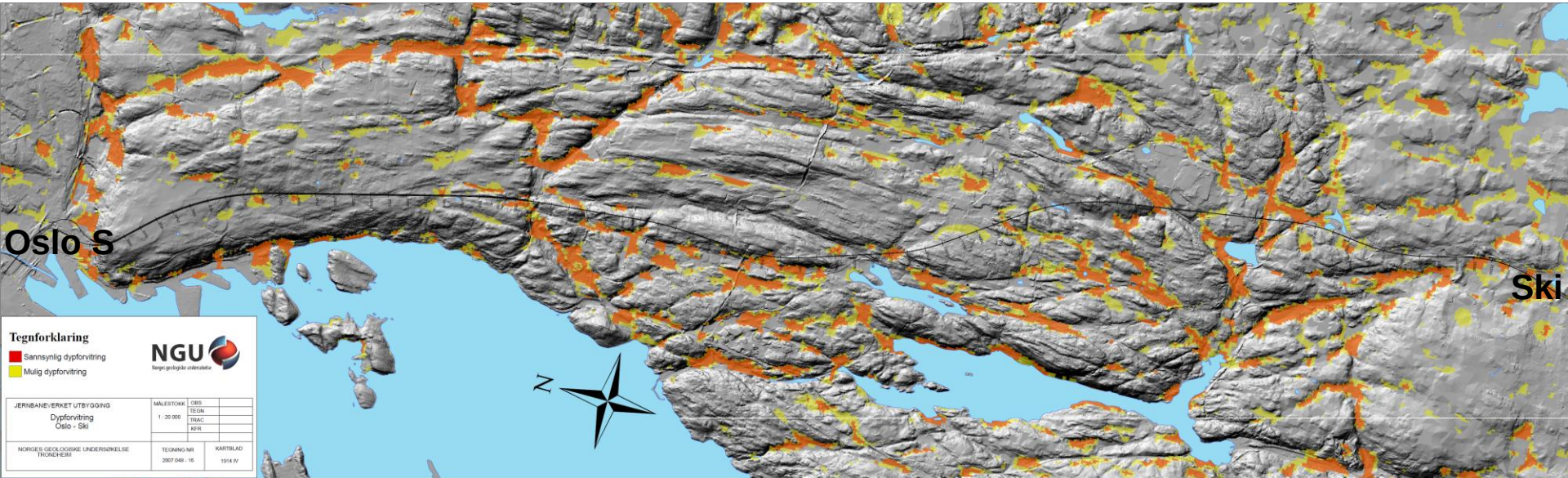
Tunnel with two separate tubes





Geology

- Gneiss with fractured zones and intrusions
- Borability, DRI: 27 - 52 and CLI: 4 - 14
- Degree of fracturing: 1- 2
- Stability of the rock mass is considered to be good, except for some faults and fractured zones
- Hydrogeology: water leaking is expected in some areas mainly in fractured zones and intrusions



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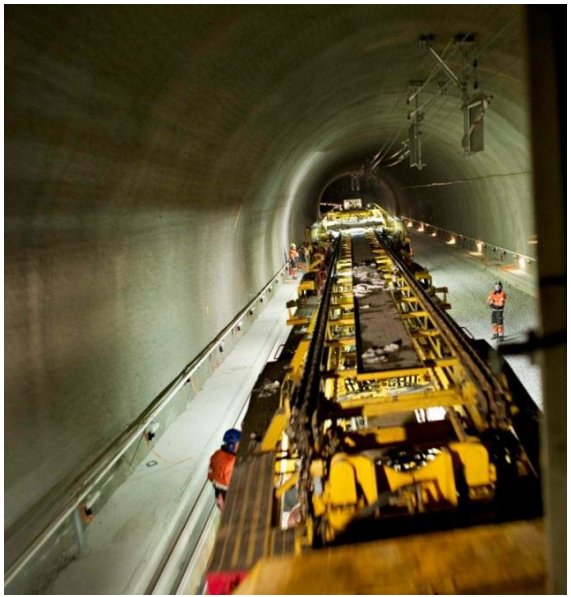
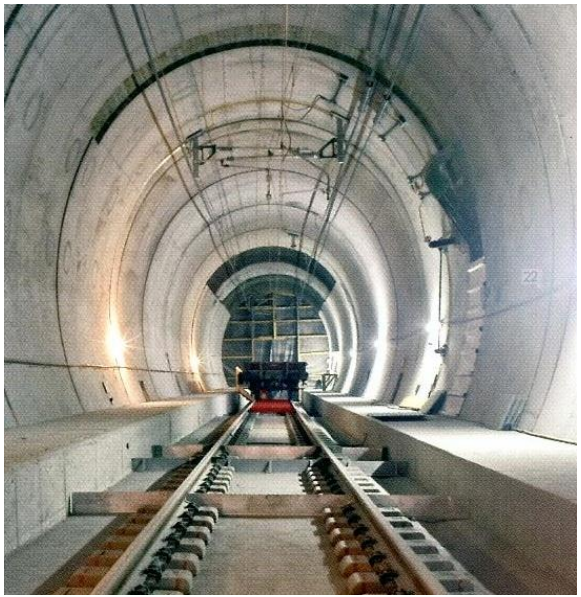
Why TBM at Follobanen?

- TBM is considered to be competitive regarding both price and time
- The circular profile of TBM is suitable for railway
- Full lining might be an advantage on railways designed for high speed and heavy traffic
- A bored tunnel can give less disturbance to the external environment (access tunnels and ground vibration) during the excavation phase





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Types of TBM

Open machine

- ”Simple” machine
- Relatively low price
- Good progress in hard rock formations
- Sensitive to soft rock and fault zones
- Open front, pregrouting and water/frost protection is needed
- Rock support and water/frost protection behind the machine

Double shield machine

- Good performance and more independent of ground conditions
- Boring and simultaneous segment installation
- Permanent rock support trough segment lining
- Traditional ground support, pregrouting and water/frost protection is limited
- Water protection by either ”Single shell ” or ”Double shell” lining

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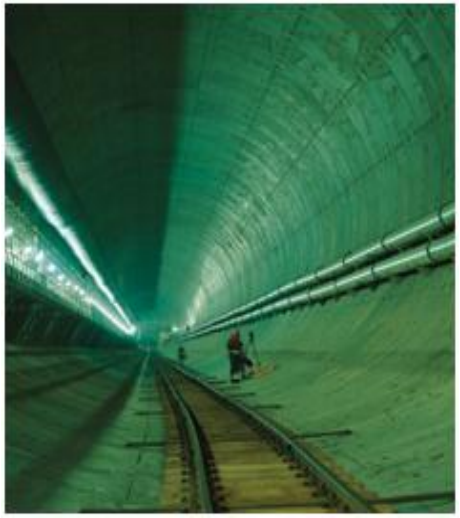
Recommended type of TBM

Double shield, a predictable solution

Solutions for water and frost protection



Drill and blast

- Drained solution with cast in place concrete lining – Pregrouting is required in sensitive areas

TBM

Single or double shell lining?

- Single shell lining: Concrete segments with gaskets is water tight
- Double shell lining is usually drained

Requirements

- Water / frost protection
- Rock support
- Progress

Conclusion

Single shell lining is recommended

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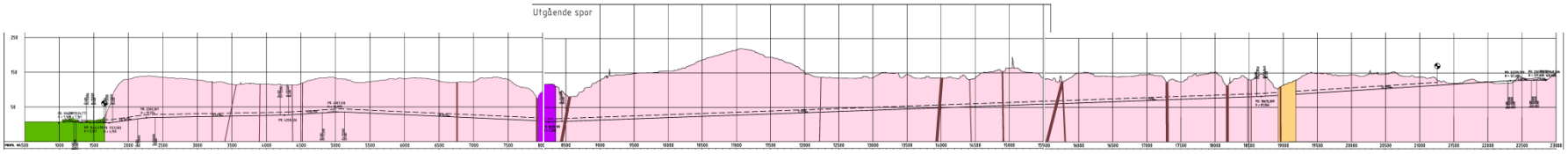
Drill and blast

Rig areas / access tunnels

9 access tunnels using drill & blast



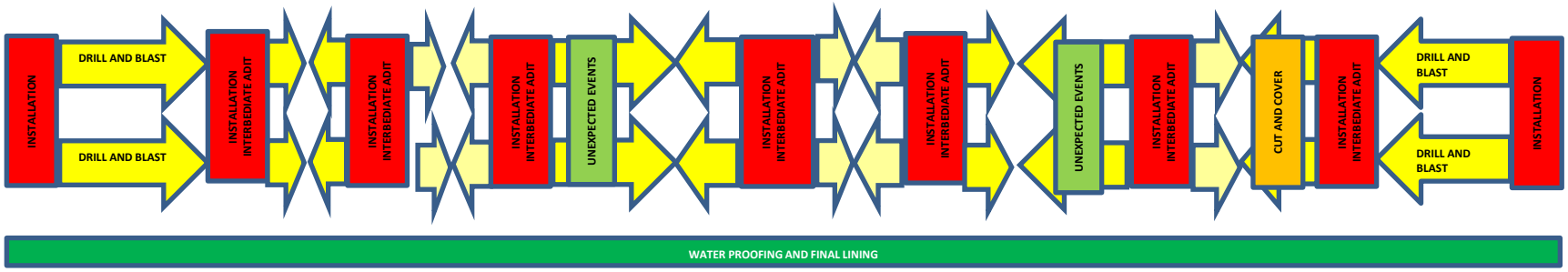
Oslo

Sprengning

Ski

Step 1

Step 2



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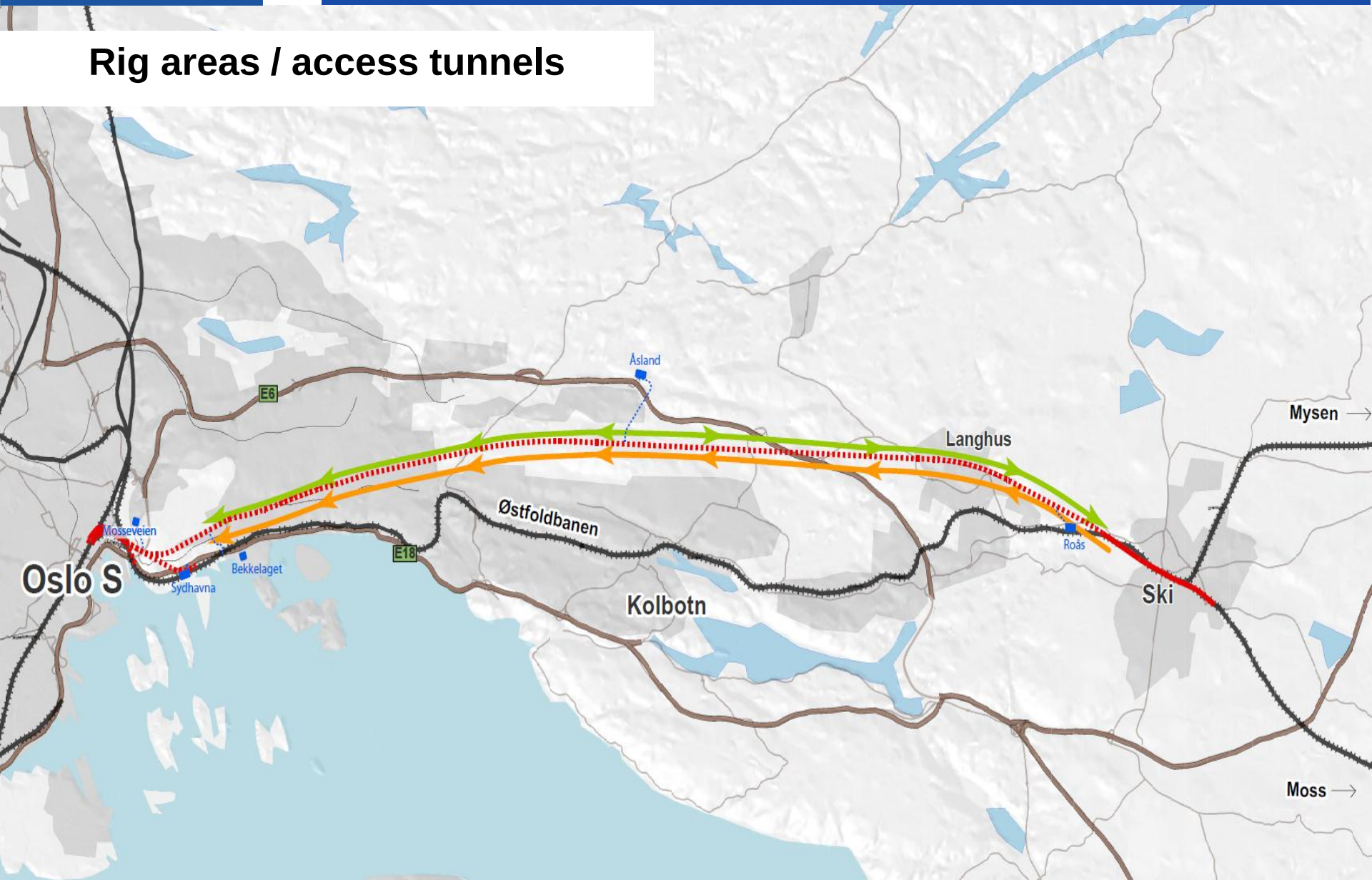
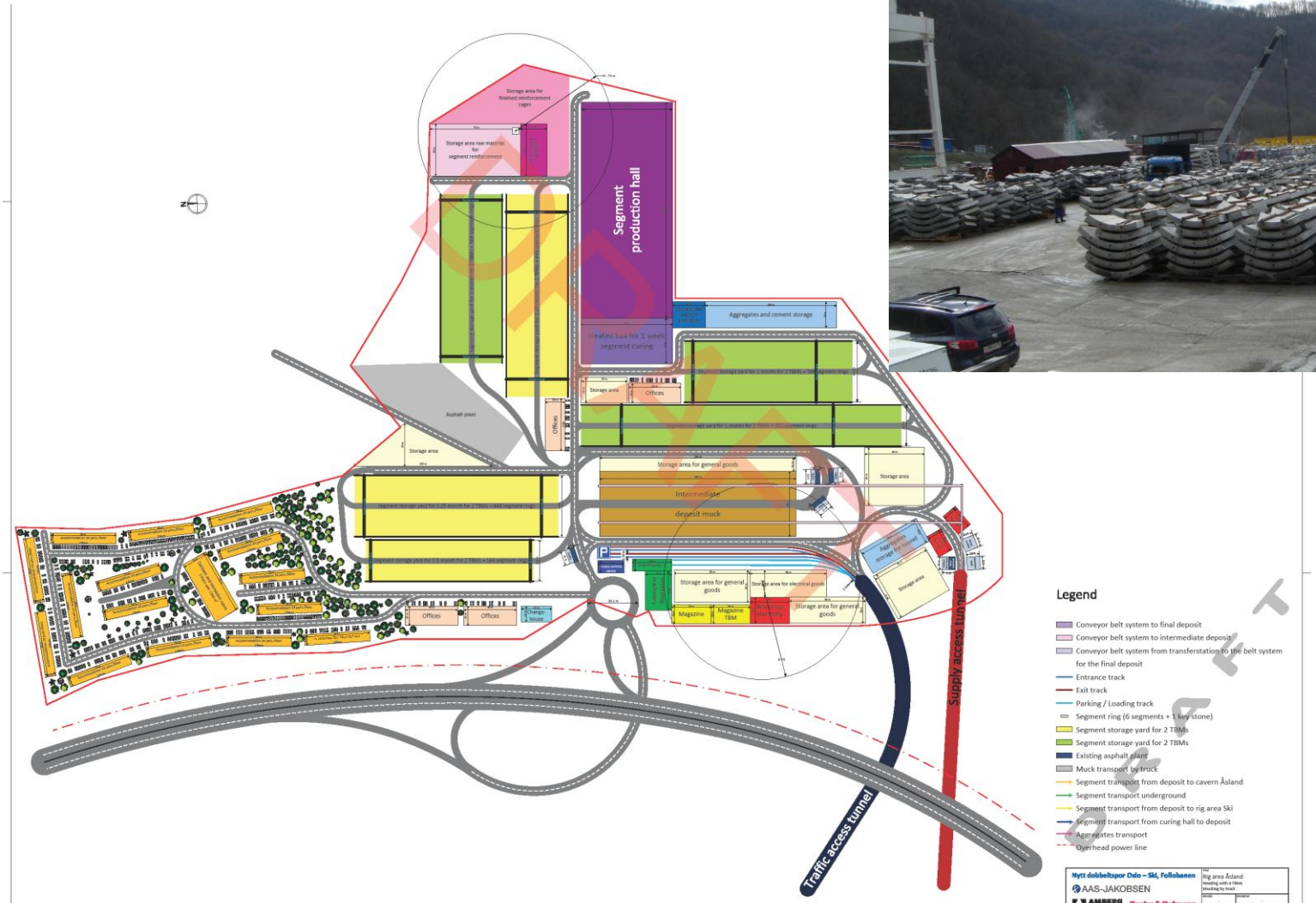
TBM

Rig areas / access tunnels



Rig area with 4 TBM machines

Size of area: App 130 000 m²



Progress with TBM / drill & blast

TBM:

- 15 m/day - 90 m/week
- App. 300 working days (144 h/week) pr. year

Drill & blast (incl. frontinjeksjon)

- 4-5 m/day - 15-28,5 m/week (depending on level of frontinjeksjon)
- 101 t/week and 46 weeks/year

Criteria for evaluation

- The differences between TBM (three variables) and drill & blast are, relatively speaking, small.
- Choise of methods are depending on the criterea that are chosen.

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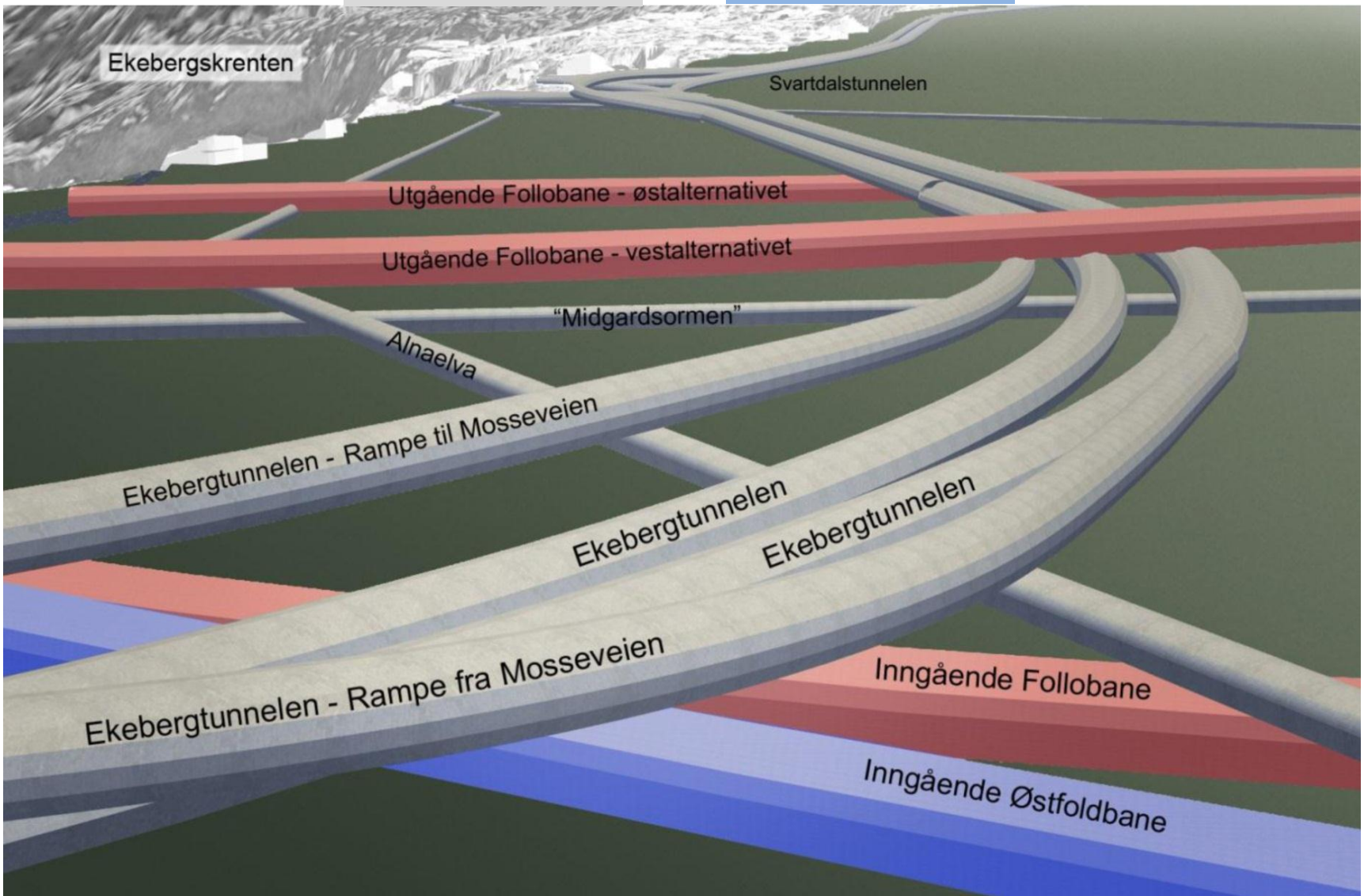
Possible conflicts with existing facilities

Existing tunnels

New tunnels



TBM muck (rock chips)

App 4.5 million m^3 total volume rock
= App 7.2 million m^3 excavated muck

The volume of the Cheops Pyramid
= 2.6 mill. m^3

1.7 / 2.8 Cheops pyramids that goes to disposal site....

Transport

Closed convey or belt:

- No conflicts with road traffic
- Environmentally friendly
- Temporary construction - vulnerable nature resources is a challenge

With car:

- Heavy traffic
- Dust
- Noise

With train:

- Evironmentally friendly soulution
- Lack of spare capacity on railroad is challenging

Mass usage

Suitable land fillings for masses is being considered. Depending of method and production facilities, some of the mass may be re-used

Conventional driven tunnel:

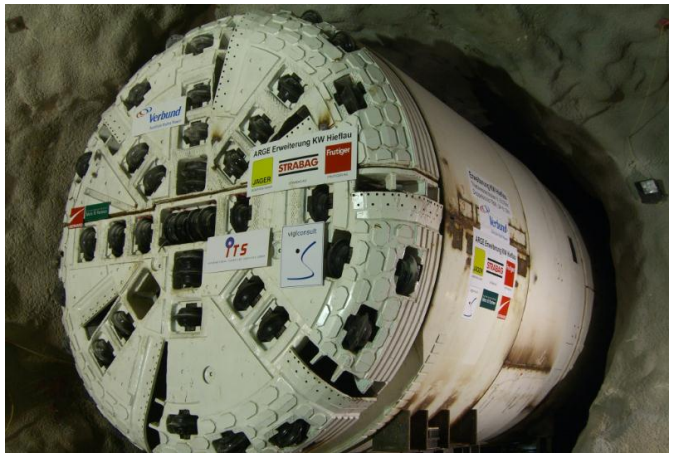
- Some of the material can be re-used for bat filling and balasted track

  → Need for transportation of mass from several locations to production area/ storage

TBM:

- Mass used for production of concrete

  → Reduced need for transport



Comparison to other projects

Two separate tubes on Follobanen

- → Main reason for differences to other comparable projects.
- → May lead to possible lack of space with 52m^2 diameter tubes

The following points are to be evaluated:

- Track system – Slab track or balasted track?
- Catenary system – S25 are used today
- Signaling system – Conventional or ERMTS?
- Technical installations

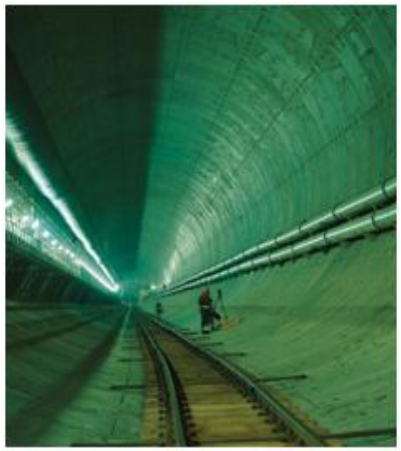
The road ahead

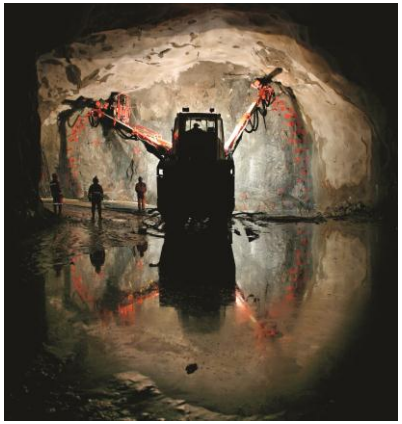
4 possible solutions:

1. Drill and blast
2. TBM
3. Combination - drill and blast and TBM
4. Both alternative methods will be prepared for tender

- Based on preliminary results both methods are still to be considered.
- A desicion will be reached within the next 6 months

Follobanen – made for the future



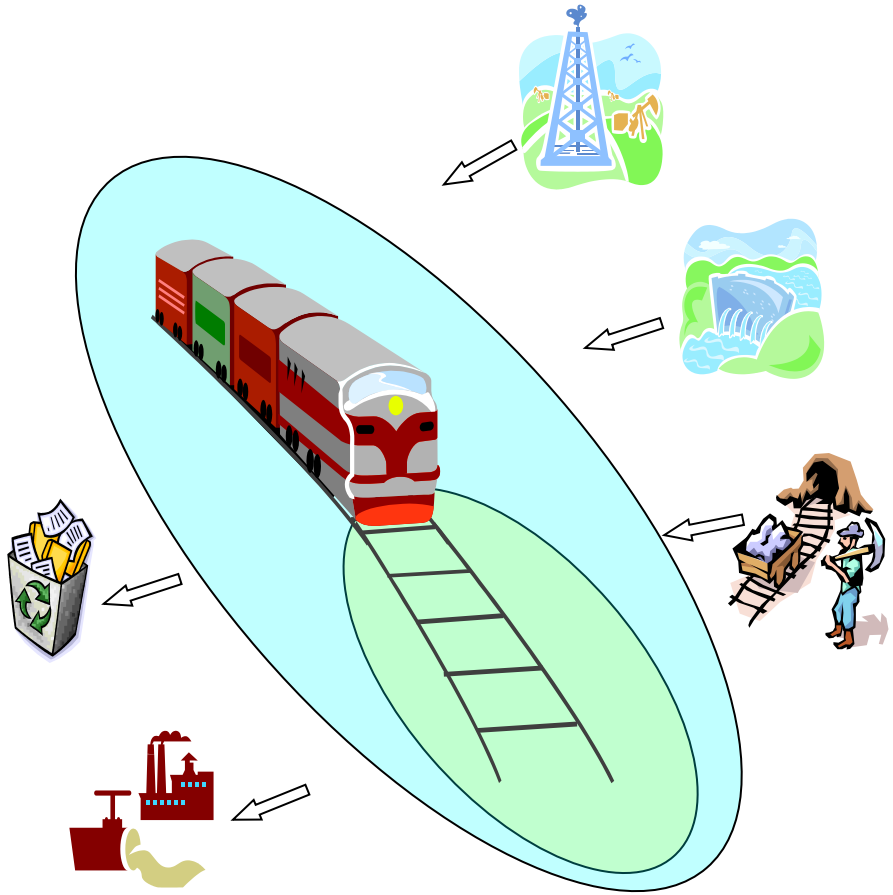


Criteria:

- Cost
- Time
- LCC
- Environmental conditions

Regardless of the choise of methods, this will be a great challenge for the Norwegian Rail Administration, external consultants and contractors taking part in the project ☺

Environmental budget (LCA)



Design plan

- Documentation of lifetime impacts regarding material use, construction work, material transport and operation

Construction plan

- Eco procurement, buying green
- Improvement through better environmental solutions and products

Construction

- Demanding “Environmental product declaration” EPD of the most important materials
- Environmental accounting

Result: - More environmental friendly railroads

Building for the future

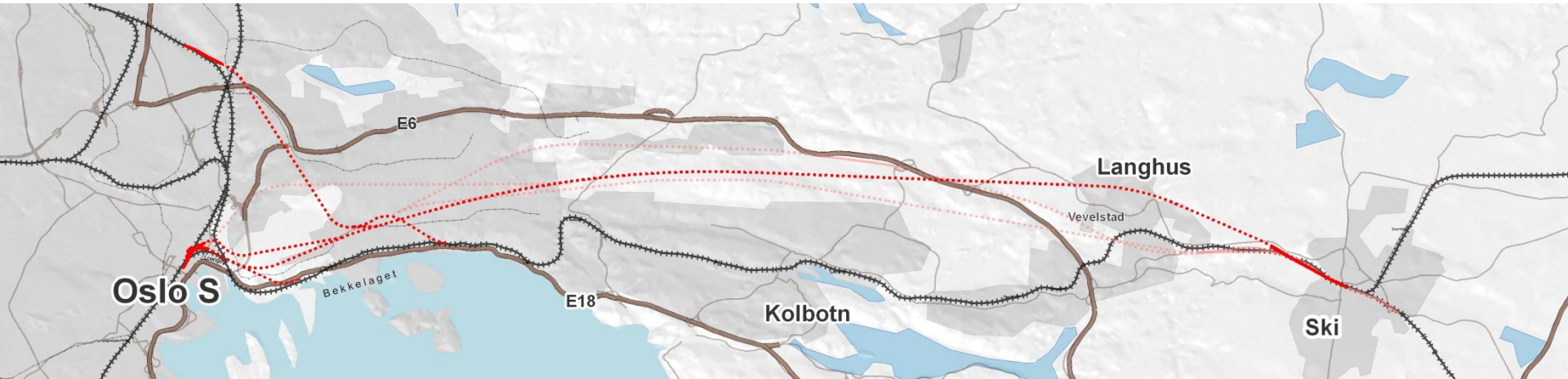
Follobanen must satisfy tomorrow's requirements for:

- Safety
- Reliability
- Maintainability

Solutions must last for a lifetime

Rail as environmentally friendly transportation:

- An environmental account will document the environmental effect of the construction phase



Time schedule

2011

Main planning

Impact assessment - Approved

2012

Area development plan for public scrutiny

Detail planning

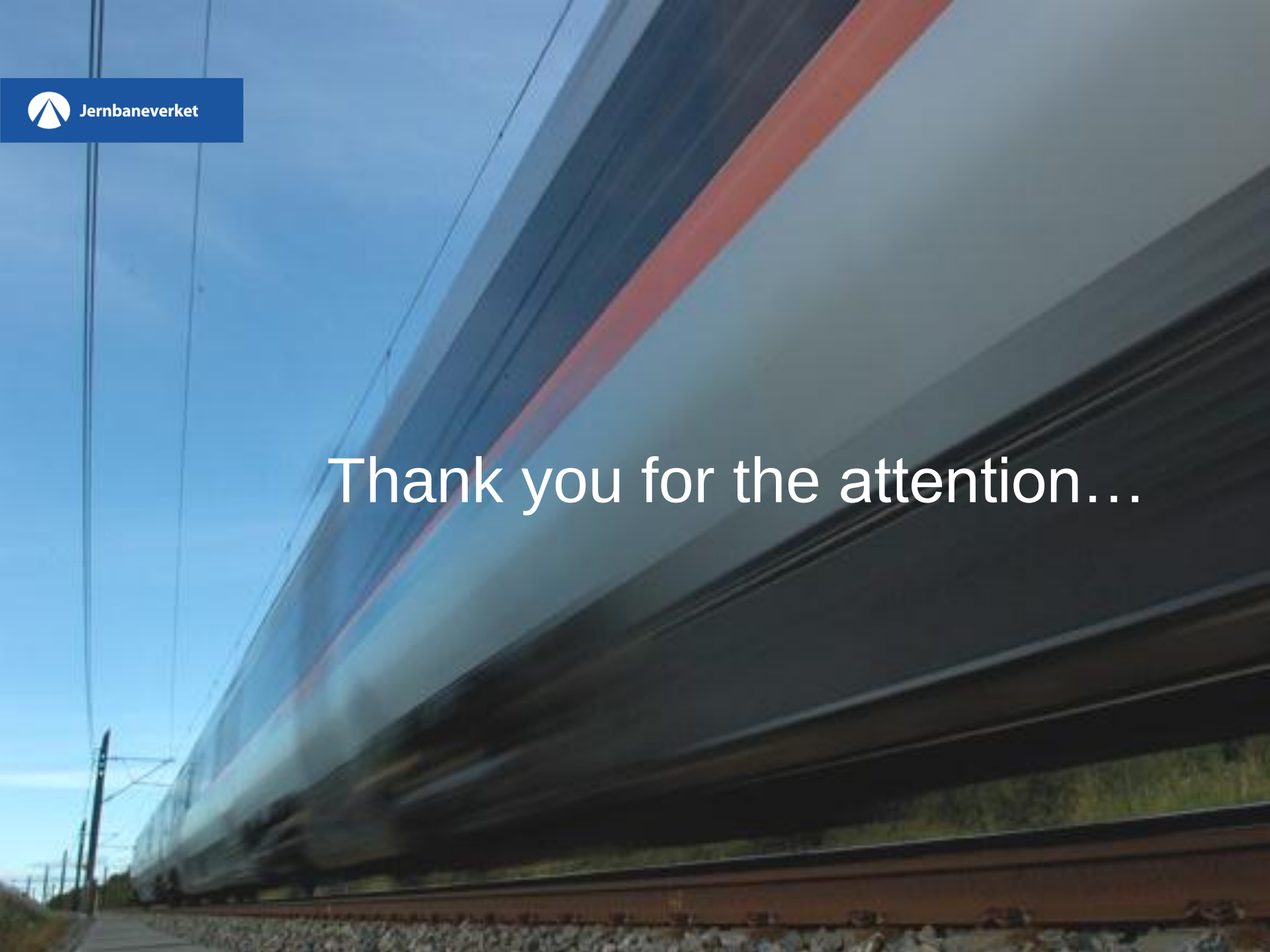
Permission from the Ministry of Transportation and Communications to start the constructions work

2013

Ski station: Carry out the first construction phase in 2012 and 2013

The rest of the project: Most of the contracts will probably be agreed on between 2013 and 2016

Our target: Finalized in 2018 - 19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Thank you for the attention…