

# BeMo – Tunnelling is our Business



Junction Structure Kriegsbergstraße, Tunnel Bad Cannstatt, Stuttgart - Germany



# BeMo Tunnelling

BeMo = Beton- und Monierbau

- Underground Construction & Tunnelling
- Refurbishment & Renovation
- Civils, Industrial & Steel Construction
- Heavy Civil Works



Crossrail C510, London - UK



# BeMo Tunnelling

## Underground Construction & Tunnelling

- Major European contractor
- Specialized on underground works
- Execution of all kinds of underground structures in joint ventures and as a single contractor
- Main markets: Austria, Germany, England
- Design & Structural Engineering
- Mechanical Engineering
- Survey & Geotechnical Monitoring
- Technical Services for tunnel contractors worldwide

Stuttgart 21, Lot 3, Bad Cannstatt Tunnels,  
Stuttgart - Germany







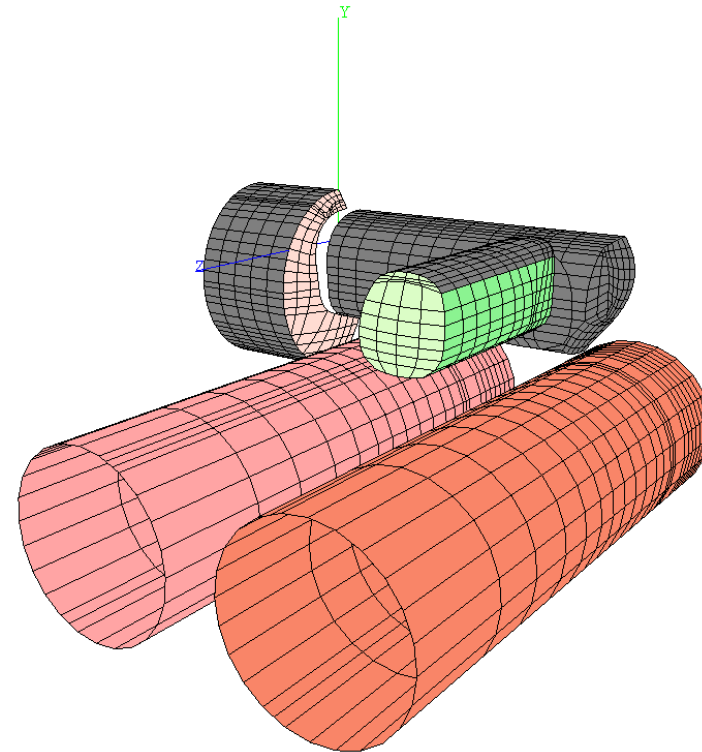
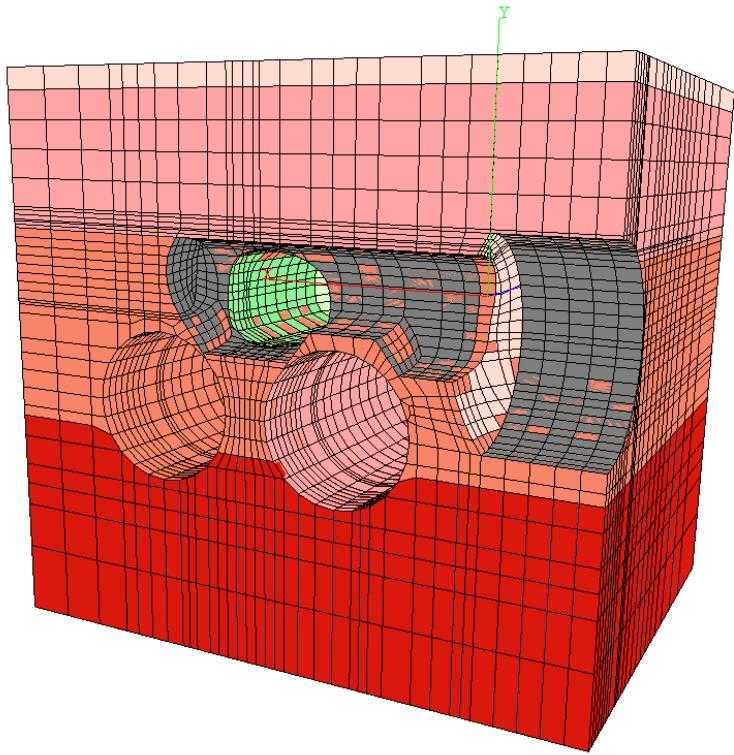
# BeMo Tunnelling

- **Founded: 1964**
- **Headquarters: Innsbruck, Austria**
- **Parent Group: Metrostav, Czech Republic**
- **Turnover (BeMo): appr. 200 Mio Euro / Year**
- **> 600 employees**
- **Major Infrastructure projects incl. tunnels and stations for roads, rail, light-rail, metro, subways, airports**
- **Tunnels & facilities for the water, sewer, energy and utility sector (e.g. powerstations)**
- **All types of underground works**
  - **TBM (Hard rock, open-/closed-type, EPB-/slurry-/hydro shield)**
  - **NATM / SEM/ SCL (e.g. drill & blast, excavator, compressed air, shotcrete)**
  - **Scandinavian Tunnelling Method**



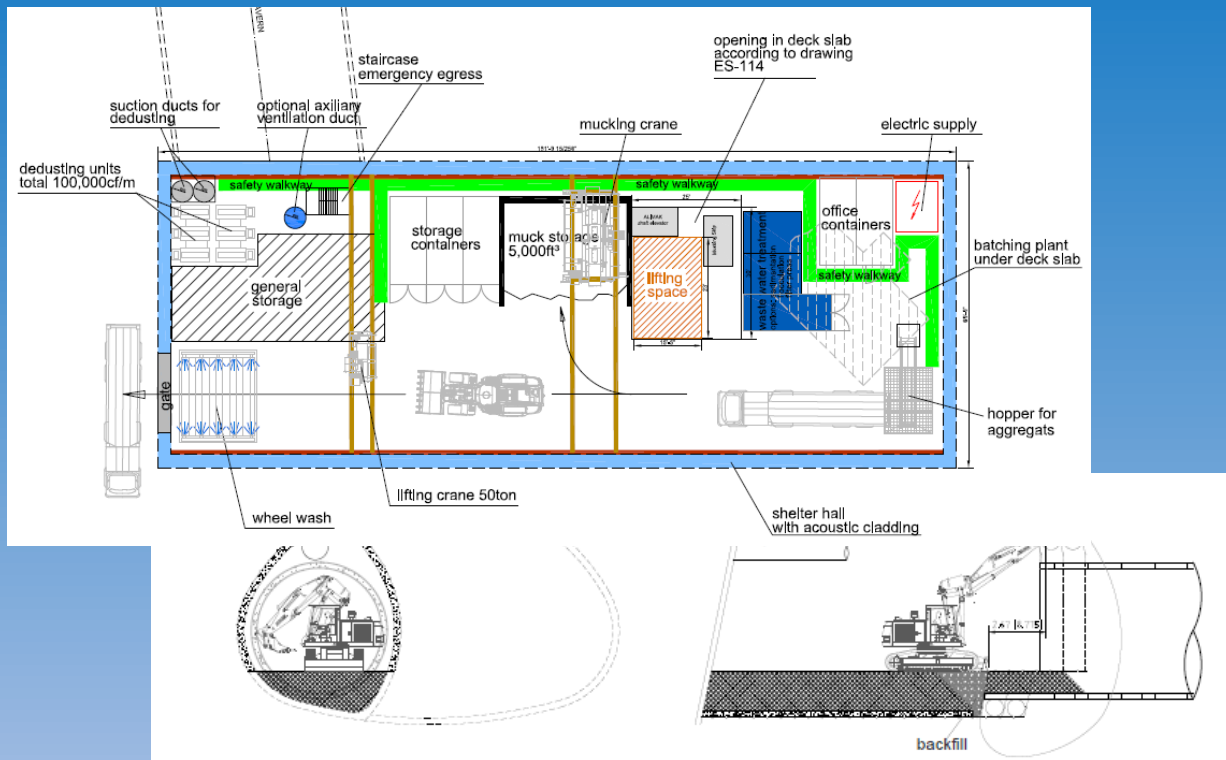
# BeMo Design Department:

capability to deliver complex 3D-Models and Analysis for underground structures





# BeMo Mechanical Department:



- Geometry studies
- Ventilation calculations
- Equipment selection
- Equipment cost estimates
- Site lay out incl. drawings
- Formwork selection
- Rent out equipment



# BeMo Survey Department:

- Internal and external tunnel survey
- Complex geotechnical monitoring
- Basenet creation
- Training & support of local surveyors





# Examples for successful projects (current examples)

- Metro City Tunnel, Karlsruhe, Germany



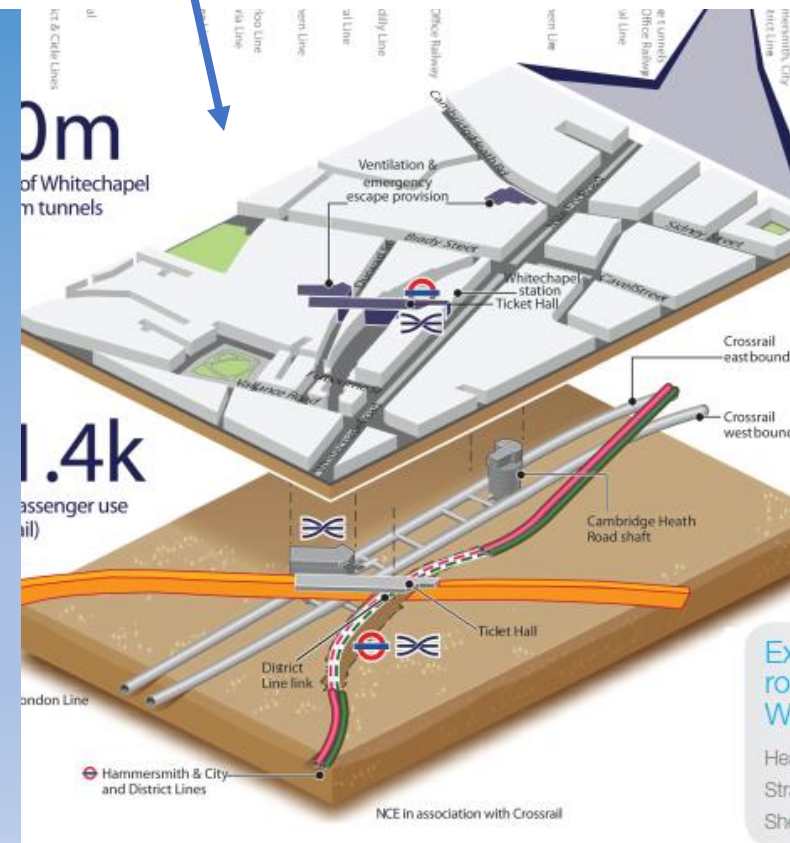
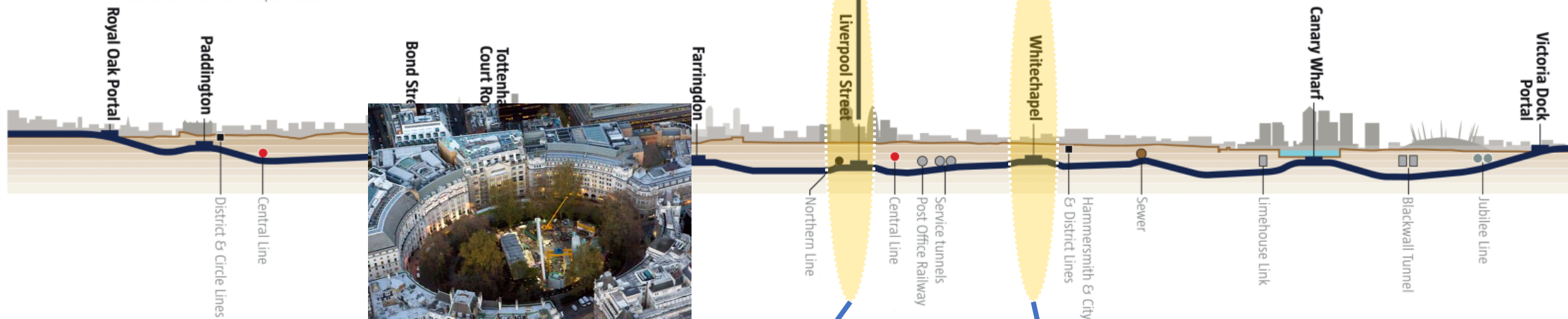


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# Examples for successful projects (current examples)

Crossrail C510, Whitechapel and Liverpool Street Station Tunnels, London, UK





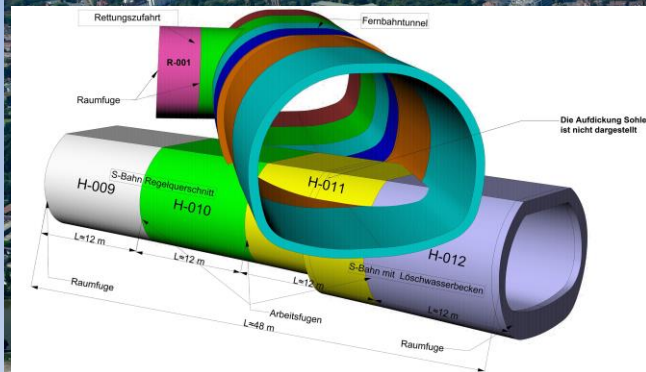
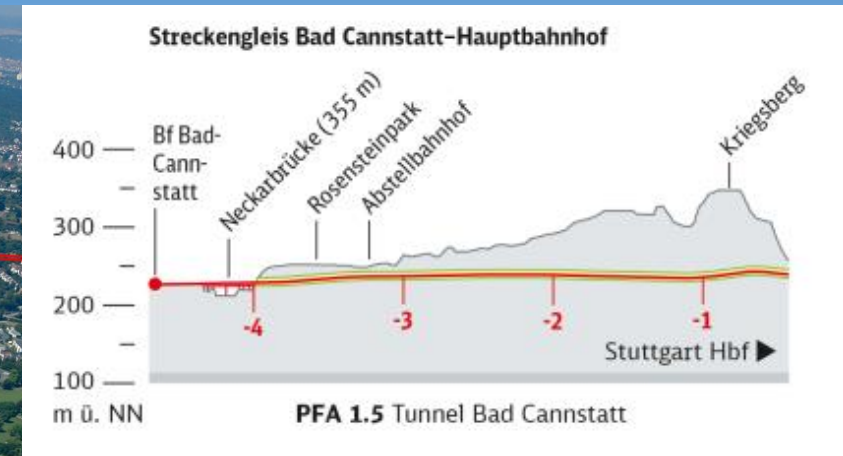
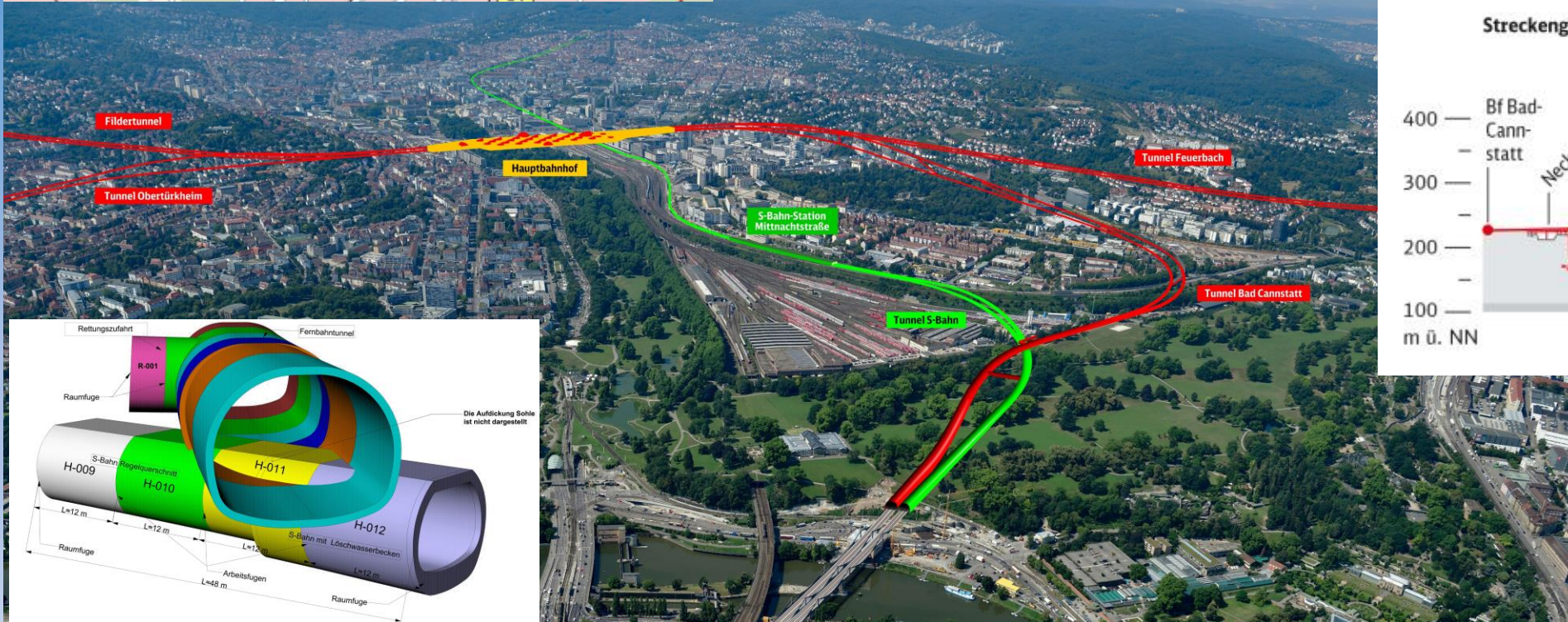
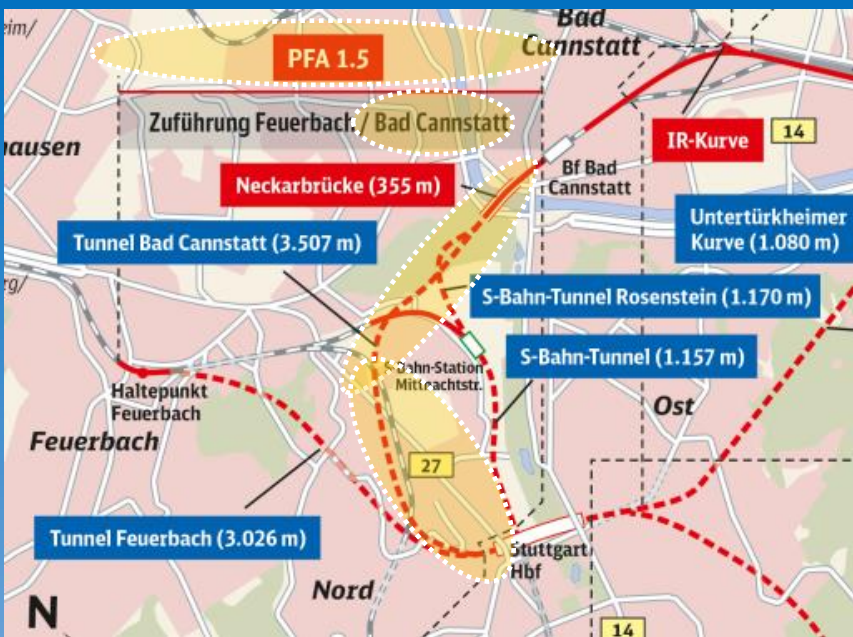
# Examples for successful projects (current examples)

Crossrail C510,  
Whitechapel and Liverpool  
Street Station Tunnels,  
London, UK



# Examples for successful projects (current examples)

- Stuttgart 21, PFA 1.5, Lot 3, Bad Cannstatt Tunnels, Stuttgart, Germany







# Examples for successful projects (current examples)

Stuttgart 21, PFA 1.5, Lot 3,  
Bad Cannstatt Tunnels, Stuttgart, Germany





# Technical Services - from contractor to contractor

## Pre – award phase:

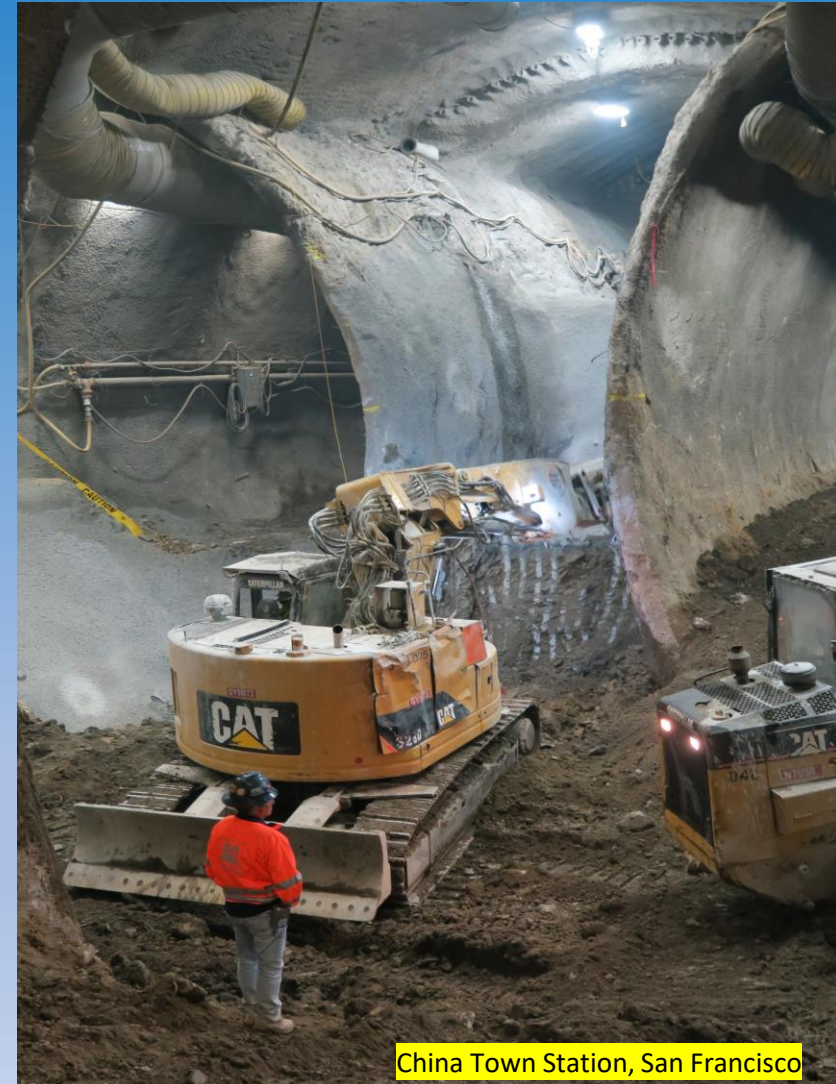
- Development of optimization potential in close cooperation with the project
- Design review with respect to constructability and optimization
- Support with equipment selection
- Geometry studies with goal to find the right equipment
- Ventilation calculations based on local H&S regulations
- Schedule development
- Support during estimation
  - Cycle time analysis
  - Quantity survey – Bill of quantities
  - Develop basis for second estimate for QA/QC-purposes
  - ...

Excavation & Support				
Cross Over Cavern Center Drift Top heading, l=3,33 feet (1,0 m)				
excavator: ITC312				
wall shotcrete system				
track loader				
	input	intermediate result	calculated time (min)	Remark
Cross section (drift top heading theoretical: 20' x 12')	25,74			
Overbreak (15cm) x 20' x	1,28			
Abbruchtagelänge	1,00			3 feet = 4 inches = 3,33 feet
Grabenbohlelänge: 28 ft	8,53			
Grabenbohlebohlebohle	0,00			
grouted pipe splices Abbruchtag	0,00			bol box only
Drill length grouted pipe splices	0,00			bol box only
Drill: 10' x 10' x 10' x 10'	0,00			
Probe holes (1 pc. x 10 feet every 3rd round)	0,30			
Drill length probe holes per stick	3,05			
m3 feet Ausbruch		27,02		
m3 excavation per round loose (factor 1,3)		45,94		
m3 shotcrete (theor. face 20' x 12', lining 28 feet)	1,76			2'
m3 shotcrete lining (theor. face 20' x 12', lining 28 feet)	2,17			10'
m3 shotcrete invert (theor. face 20' x 12', lining 28 feet)	1,01			10'
m3 shotcrete face 1,30		2,28		
m3 shotcrete lining fact. 1,30		3,90		30% for rebound, overprofile and waste
m3 shotcrete invert fact. 1,30		1,31		
Wahl: 10' x 10' x 10' x 10'	0,00			
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Excavation m3/hr	20,00			ITC 312
Mucking m3 loose/hr	35,00			Track loader
in minutes:				
Prozess zum Baggern	15,00		15,00	4,2%
excavation time total		81,07	81,07	22,6%
time for switching tools at excavator		60,00	60,00	16,7%
Time: 10' x 10' x 10' x 10'	0,00		0,00	0,0%
Set up for mucking	30,00		30,00	8,4%
Mucking	0,00		0,00	0,0%
Set up time for shotcreting (2' x 20 min)	40,00		40,00	11,2%
Shotcrete	17,10		17,10	4,8%
Wahl: 10' x 10' x 10' x 10'	0,00		0,00	0,0%
put up below glider	60,00		60,00	16,7%
Shotcrete lining	23,41		23,41	6,5%
Shotcrete invert (10' between side walls)	7,85		7,85	2,2%
Wahl: 10' x 10' x 10' x 10'	0,00		0,00	0,0%
set up drill rig for splices and probeholes	20,00		20,00	5,6%
Drilling splices	0,00		0,00	0,0%
Set up Mtl pump	0,00		0,00	0,0%
Installation splices	0,00		0,00	0,0%
Drilling probeholes (0.8min, 1 boom)	3,81		3,81	1,1%
total minutes/cycle:				
			363,25	
total hours/cycle:				
			5,97	
number of possible cycles in 24 hours:				
			4,02	
real working time: 2x11 hours				
			3,68	(safety meetings, shift change, ...)
possible progress in m/day:				
			3,68	(m/day)
"performance" factor				
	0,70		2,58	m/Tag
Zyklus in Stunden:				
Prozess zum Baggern	0,25			
excavation time total	1,35			
time for switching tools at excavator	1,00			
Set up for mucking	0,50			
Mucking	0,00			
Set up time for shotcreting (2' x 20 min)	0,67			
Shotcrete	0,29			
put up below glider	1,00			
Shotcrete lining	0,39			
Shotcrete invert	0,13			
probe holes	0,40			
Gesamter Zyklus in STUNDEN:				
	5,97	363,25	(control sum)	

# Technical Services - from contractor to contractor

## Post – award phase:

- Development of optimization potential
- Feasibility studies/ Value Engineering Proposals
- Shotcrete conception
- Equipment selection
- Support with temporary ventilation issues
- Survey:
  - Base net creation
  - Support with software selection
  - On site training – survey & geotechnical measurements
- Provision of on-site key personell:
  - Site managers
  - Superintendents/ operating superintendents
- Equipment rental



China Town Station, San Francisco



# Examples for successful projects / current and past

- SEM Cross over cavern, Metro Los Angeles, CA, USA
- Plymouth Tunnel, MD, USA
- Quarters Tunnel, Edmonton, AB, CAN
- Chinatown Station, San Francisco, USA
- John Hart GSR, Campbell River, CAN
- SEM-Tunnel Tysons Corner, VA, USA
- Beacon Hill Station, Seattle Light Rail, Seattle, WA, USA
- Metro Puente Alto, Santiago de Chile



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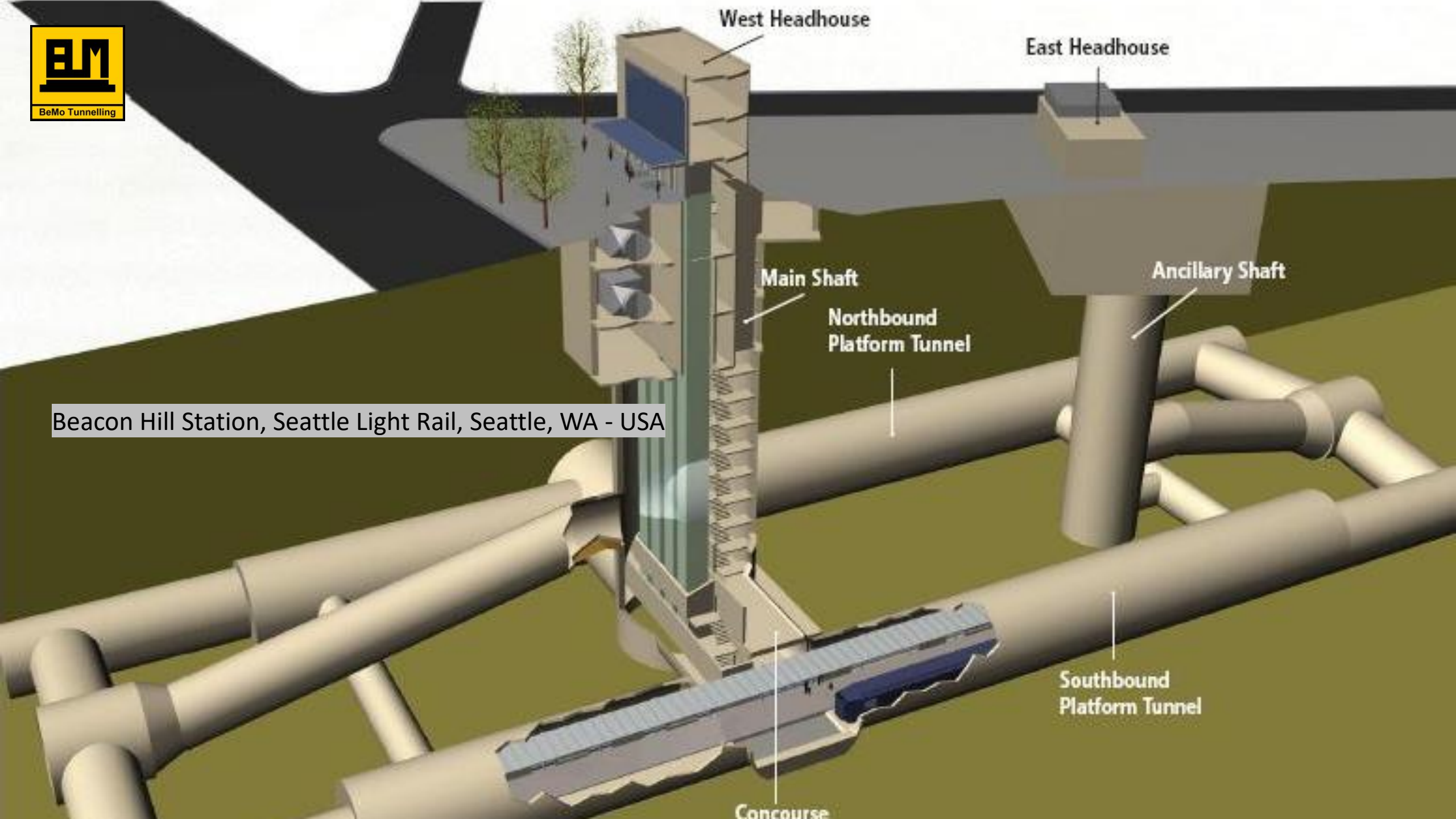


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Beacon Hill Station, Seattle Light Rail, Seattle, WA - USA



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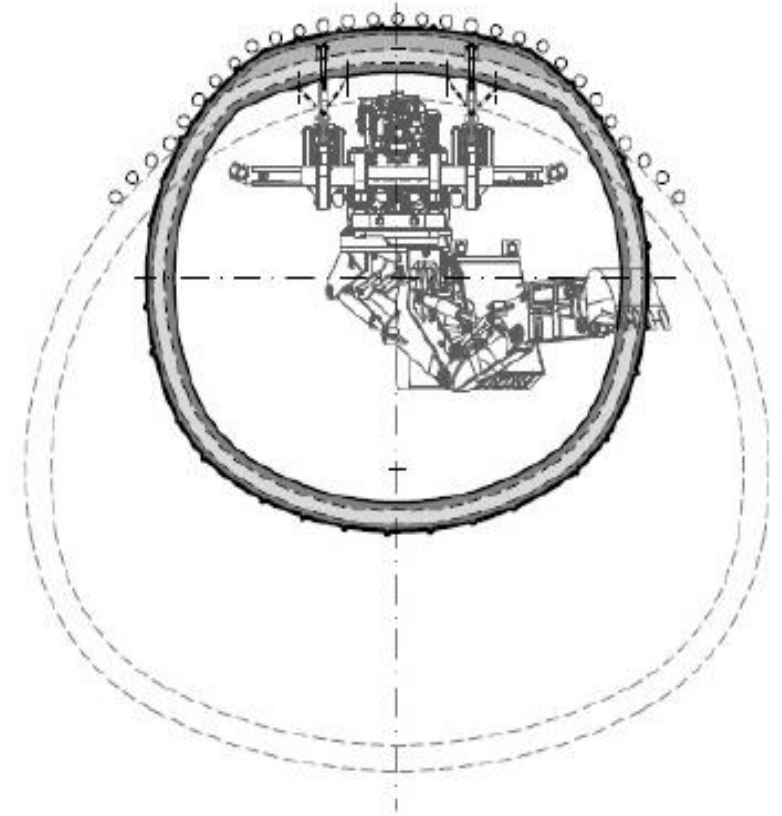
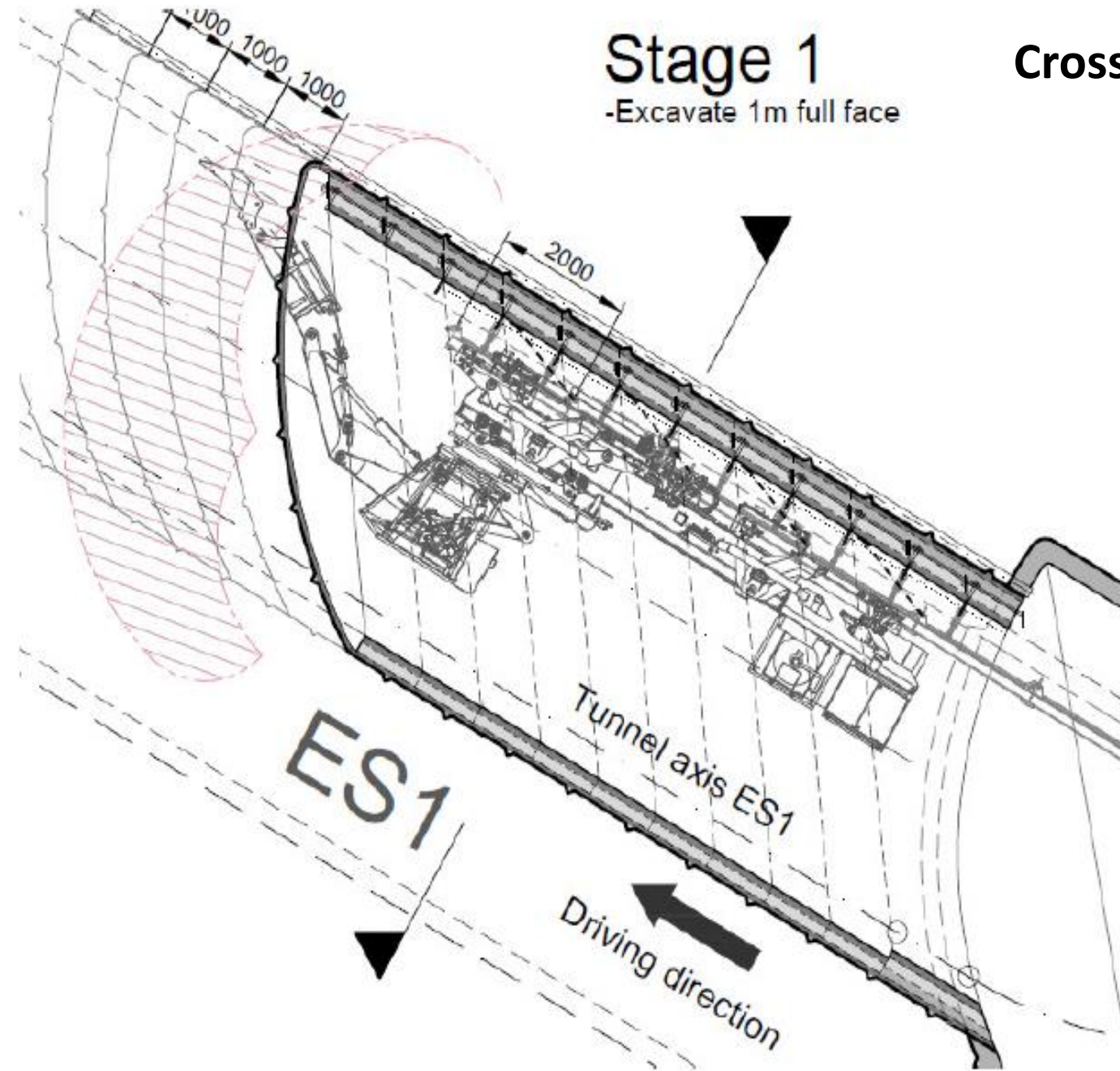
# There is always potential for innovations ...

- Uphill excavator – London Crossrail
  - Developed by BeMo/ GTA and suitable for steep escalator staircases which have to be excavated from below
- Shotcrete inner linings – sprayed on PVC membrane
  - Russia Wharf Tunnel, Boston, Massachusetts (2003) – value engineering proposal
  - Plymouth Tunnel, Silver Spring, Maryland (2019)



## Cross Rail London – Uphill excavator

**Stage 1**  
-Excavate 1m full face







Uphill excavator – Crossrail, C510, London - UK



# Shotcrete on PVC membrane = shotcrete final lining example: Russia Wharf Tunnel in Boston, USA (2003)





# Shotcrete on PVC membrane = shotcrete final lining example: Plymouth Tunnel in Silver Spring, Maryland (2019)





# Thank You

King's Cross Station Redevelopment – Tunnelling Works, London - UK

