CITYRINGEN
Branch off to Sydhavnen
SHG-SW
Scope of Works

Scope of Works

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COWI SYSTRA Joint Venture is Metroselskabet's Design Consultant for the project.

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Revision summary

Version	Date	Scope of revision	Change description
6.0	2017-12-15	Contract version	

1 Introduction

The purpose of this document is to present the Cityringen - Branch off to Sydhavnen project, and the scope of works for the contracts for this project.

Section 1 provides an overview of the Cityringen project including branch off to Nordhavnen and branch off to Sydhavnen.

Section 2 provides the Scope of Works for the Civil Works design and build contract CRSH1 and the Transportation System design and build contract CRSH4.

Section 3 provides the structure and content of the main interfacing contracts.

1.1 The Project

Cityringen - Branch off to Sydhavnen is an integrated part of Cityringen. Therefore the same principles and concepts used on Cityringen shall apply for the Branch off to Sydhavnen project. The system is to be operated as a single entity, and is to be constructed so that the works for the Branch off to Sydhavnen do not interrupt the operation of Cityringen unnecessary. The interfaces between Cityringen and the Branch off to Sydhavnen are incorporated in the contract packages for the Cityringen - Branch off to Sydhavnen.

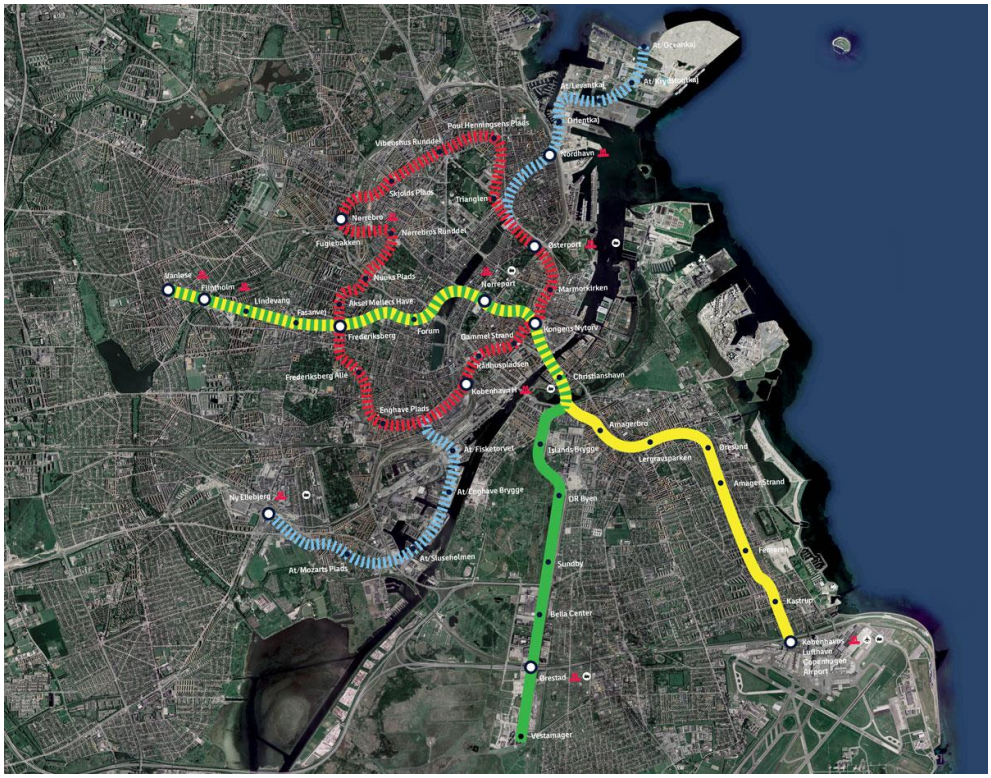

Figure 1 *Copenhagen Metro alignment. Metro in operation, M1(green) & M2 (yellow), Cityringen M3 (red) and the branch off to Nordhavnen and Sydhavnen M4 (blue)*

Cityringen consists of approximately 15 km double track in tunnel serving 17 deep and semi-shallow stations. Cityringen includes 3 shafts at Nørrebroparken, Sønder Boulevard and Øster Søgade. In order to support normal and fall back operation as well as maintenance activities the double track structure includes two diamond crossings in tunnel and one placed on the ramp at the entry to the Control and Maintenance Center (CMC).

The branch off to Nordhavnen consists of 2.5km double track, two stations (Nordhavn and Orientkaj), a shaft at Krauseparken and a diamond crossing at the ramp between Nordhavn and Orientkaj.

The branch off to Sydhavnen consists of 4.5 km double track, five stations (at/Fisketorvet (Fit), at/Enghave Brygge (Ebr), at/Sluseholmen (Slu), at/ Mozarts Plads (Mop) and Ny Ellebjerg (Nel)), two diamonds crossings one at H. C. Ørstedsværket (Øvk) just before at/Enghave Brygge station, and the other at Gåsebæk shaft (Gåb) before Ny Ellebjerg station. Refer to track schematic in SHG-CB 3.4.A.

The Cityringen railway infrastructure has been devised as a double track ring configuration, Figure 2. The passenger load is expected to be heaviest on the eastern part of the ring, i.e. between København H (Kh) – Kongens Nytorv (Kgn) – Østerport (Kk) and less heavy on the western part, i.e. Østerport (Kk) – Frederiksberg (Fb) – København H (Kh).

Cityringen is therefore envisaged to be serviced with a two-way ring-line called M3 where trains are running the full ring as well as a pendulum line called M4 serving only the eastern part from Ny Ellebjerg (Nel) through all Sydhavnen stations, to København H (Kh) through Kongens Nytorv (Kgn) and Østerport (Kk) to Nordhavnen and Orientkaj (Ork). The principle is shown in Figure 2 below:

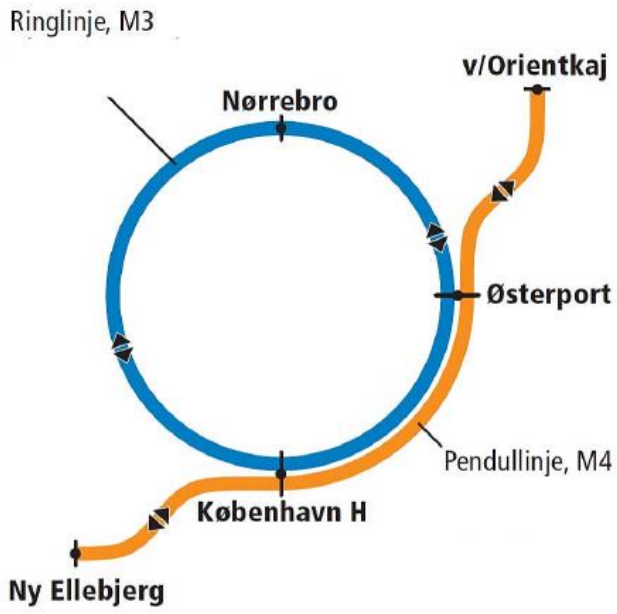

Figure 2 Illustration of operation showing pendulum (M4) and circular (M3) operation

Cityringen M3 and M4 passenger service will be 24 hours, 7 days a week. Expected headways (train intervals) on weekdays are as follows:

- Circular line M3:
  20 trains per hour leading to a 180 sec headway

- Pendulum line M4: (Ny Ellebjerg to Orientkaj station)
  20 trains per hour leading to a 180 sec headway.

Train headway (train interval) is defined as the time distance between two consecutive trains passing the same point. The basic requirement for Cityringen including branch off to Nordhavnen and Sydhavnen is that an operational headway of minimum 90 sec shall be possible. Furthermore the system shall be designed to allow down to 60 sec headway during fall back situations.

The overall target of service quality for Cityringen is defined as the service availability (SA) which expresses the ability of the transportation system (trains, infrastructure and operation & maintenance organisation) to meet the headway requirements. The SA target for Cityringen is 98% which means that monitored over an agreed period 98% of all trains must meet the headway requirements.

Passenger service will be fully automatic and driverless. The absence of a driver to run the trains does not mean that there is no staff to serve passengers. Stewards will be on board some (not all) trains and in stations according to a rotation scheme to assist passengers, take care of incidents and check tickets.

Passenger service will run under headway regulation which means that the automatic train control system (ATC) commands and adjust train departure in such a manner that the headway requirements are being fulfilled during the time periods of the day, cf. table example above.

Cityringen shall have transfer facilities to the existing metro stations at Kongens Nytorv and Frederiksberg. Further, transfer facilities will be provided connecting to the existing regional- and S-train railway stations at København H station, at Østerport station, at Nørrebro station, at Nordhavn station and at Ny Ellebjerg station.

Stations and vehicles will be equipped with state of the art passenger safety and information systems including dynamic passenger information displays, call-points and high quality live video surveillance systems.

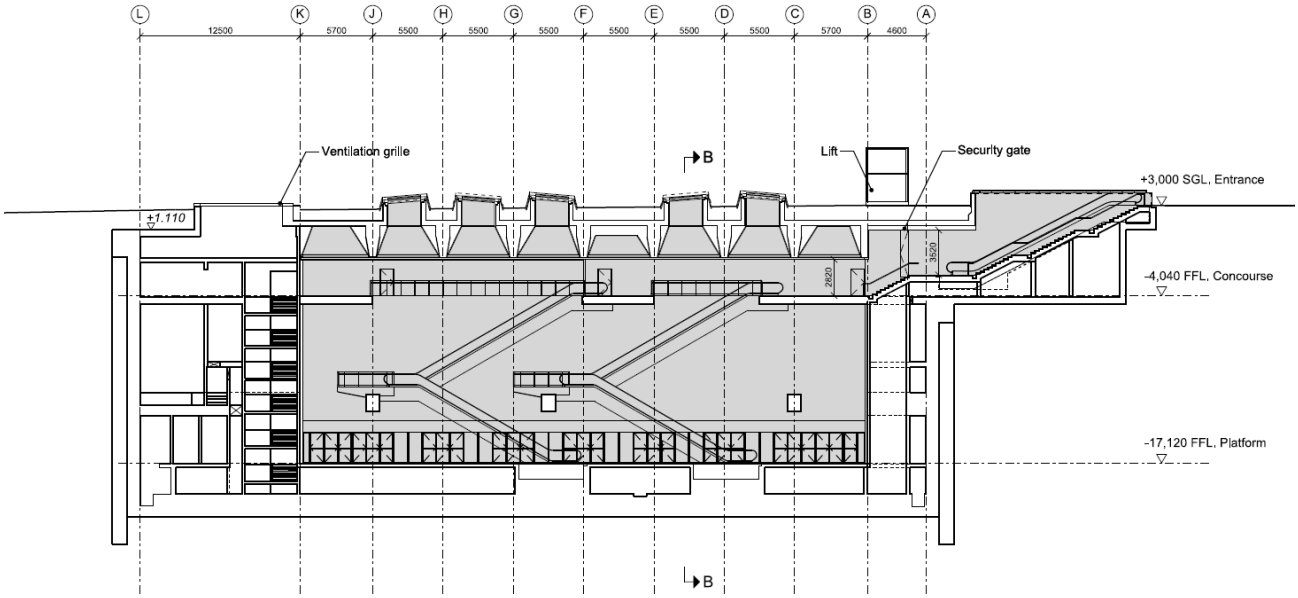

Figure 3 Cross-section of a typical deep station

The passenger vehicles consist of 3-car articulated trains of approximately 39 m in length, a width of 2.65 m and a floor height of 0.81 m. The trains will run on steel wheels on steel rails. The trains shall be comfortable with floors at platform level. Materials shall meet high qualitative and aesthetic requirements with high fire resistance and be suitable for the expected use.

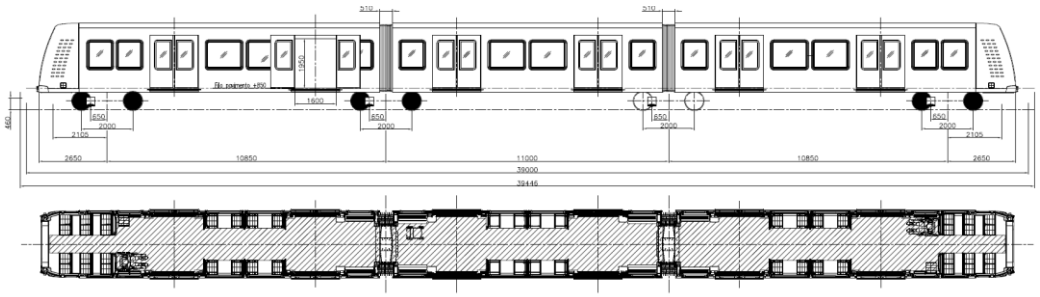

Figure 4 Passenger Vehicle lay out, (Drawing TL03P010038E, rev 0.6 provided by Ansaldo Breda

The Control and Maintenance Centre (CMC) will provide facilities for operation and maintenance, storage, administration and facilities for the staff for Cityringen including the branch off to Nordhavnen and Sydhavnen. Modern main control centre and emergency control centre shall provide a good working environment and facilities for train operation, surveillance and passenger service during normal and fall-back operation.

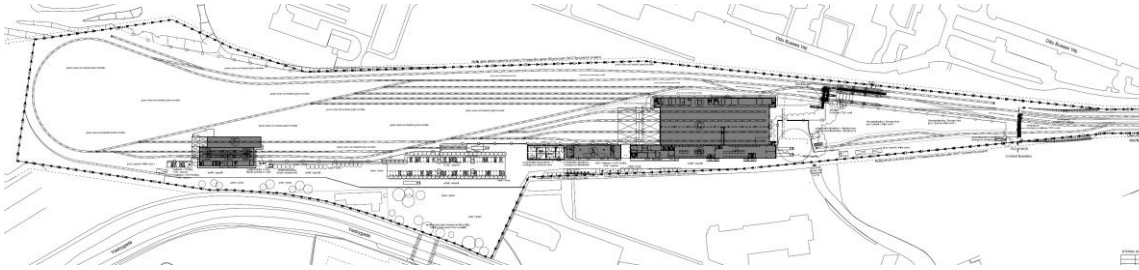

Figure 5 Cityringen control and maintenance centre (Drawing CR-ASTS-357001, rev 2) provided by Ansaldo STS

1.2 The mission for Cityringen

Cityringen shall provide an enhancement to Copenhagen's public transport system and shall sustain and reinforce the city's qualities as an environmentally friendly, modern city, playing its part as a major North-European capital.

The mission for Cityringen can be expressed by the following:

- It shall be a lightweight, fully-automated driverless metro system
- Trains shall run all day every day and thus provide a significant enhancement to public transport
- It shall operate with high level of reliability
- It shall be energy efficient, sustainable with low lifecycle cost
- It shall meet the best possible standards of passenger comfort and safety
- It shall offer a high level of customer service and passenger information
- It shall be based on both well-proven and modern technology
- There shall be a strong architectural identity, integrating all elements of Cityringen into a high quality holistic design
- There shall be close links to other urban transport systems
- It shall produce the least possible environmental impact during construction and operation
- There shall be a high quality working environment for all metro staff

1.3 The Employer

Metroselskabet is the Employer for all the Cityringen contracts.

Metroselskabet is owned by the Municipality of Copenhagen (approx. 50%), the Danish State (approx. 42%) and the Municipality of Frederiksberg (approx. 8%).

Metroselskabet shall, assisted by their consultants, manage the construction of Cityringen including the branch off to Nordhavnen and branch off to Sydhavnen.

1.4 The time schedules

1.4.1 Cityringen time schedule

Cityringen shall be constructed from 2010 and be tested, completed and opened as one entity in 2019.

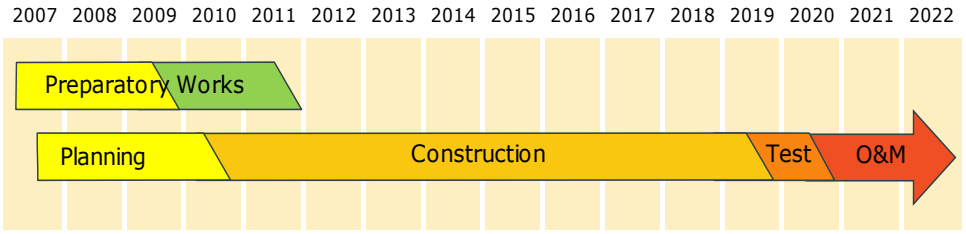

Figure 6 Cityringen time schedule

1.4.2 Sydhavnen time schedule

Cityringen - Branch off to Sydhavnen shall be constructed from 2017 and be tested, completed and opened in 2023.

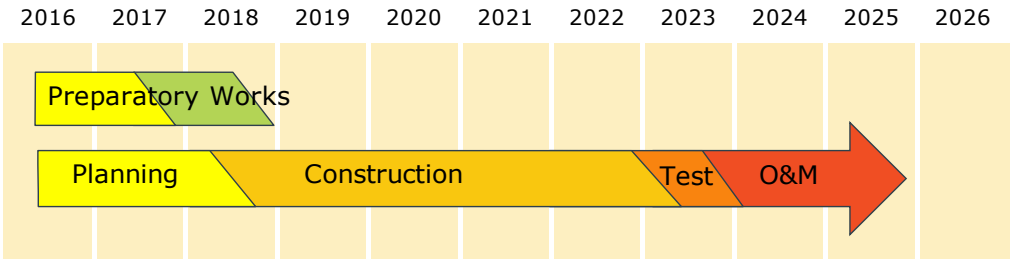

Figure 7 Sydhavnen time schedule

The overall time schedule for the Cityringen - Branch off to Sydhavnen project is contained in SHG-CB 4.12.A.2, with milestones as described in the SHG-CB 4.2 and SHG-AB/SB Attachment 1.

1.5 Contract Structure

The organisation and contracts of the Cityringen - Branch off to Sydhavnen project is shown in the figure below.

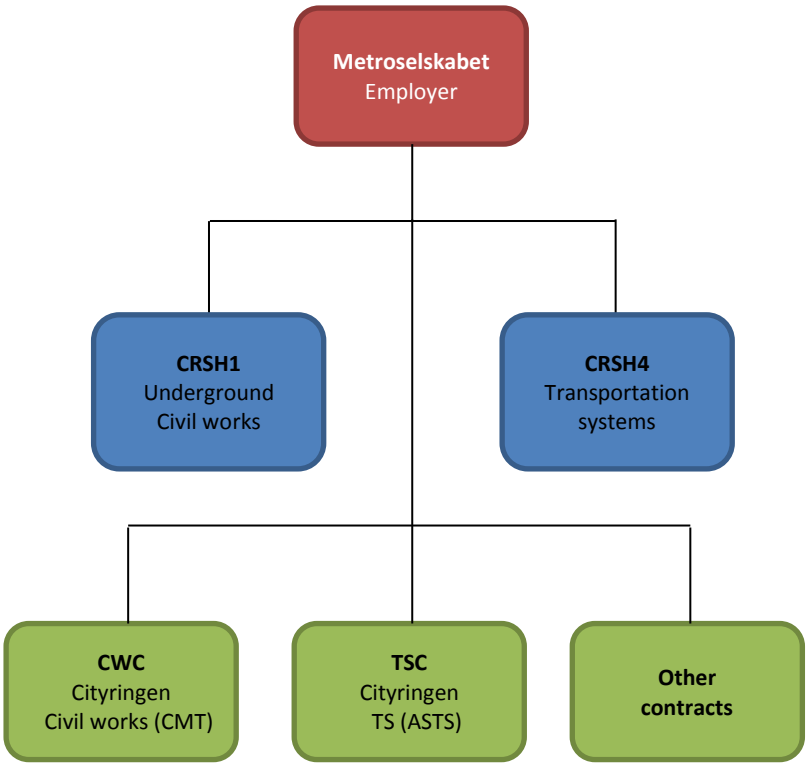

Figure 8 Overall contract structure for Cityringen - Branch off to Sydhavnen

Referring to this figure, the roles and responsibilities of the different entities are briefly described in the following:

- **Metroselskabet**
  Metroselskabet (MS) carries the overall responsibility for the development of Cityringen. MS is overall responsible for the tendering, contracting and implementation of the contracts for Cityringen and branch off to Nordhavnen and Sydhavnen including responsibility for financial and cost control, public relations and reporting to Authorities.

- **CRSH1 Underground Civil Works**
  This contract covers all underground works:

  - Bored tunnels, incl. pump sumps and cross passages in low points and all associated preparatory works.
  - Works at Havneholmen shaft.
  - Underground station civil works for five stations (at/Fisketorvet, at/Enghave Brygge, at/Sluseholmen and at/Mozarts Plads and Ny Ellebjerg).

- H. C. Ørstedsværket cross-over cut and cover structure.
- Gåsebæk shaft cross-over cut and cover structure.
- Stop end tracks structures at Ny Ellebjerg
- M&E works to the stations, tunnels and cut and cover structures.
- Architectural works to the underground stations and shafts.
- Art works to the underground stations

- **CRSH4 Transportation System Works**
  This contract covers the following parts of the transportation system:

  - Permanent Way
  - Traction Power
  - Power Supply
  - Local SCADA

The existing contractors on Cityringen Transportation Systems Contractor (TSC) and Civil Works Contractor (CWC) will construct the following works at CRSH or interfacing with CRSH:

- **TSC Cityringen Transportation System Works**
  This contract covers the following parts of the transportation system:
  - Automatic Train Control System
  - Platform Screen Door System (PSDS)
  - Passenger Security and Information Systems (PSIS)
  - SCADA System
  - Control Centre
  - Transmission System
  - Radio Communication System
  - Intrusion Detection and Access Control System
  - Rolling Stock (Passenger Vehicles, Service Vehicles, Rescue Trolleys)

  This contract shall also provide cable routes and install cables for Ticketing, Rejsekort and Passenger counting provided by the Employer.

- **CWC Cityringen Civil Works**
  This contract includes the Cityringen Civil Works including
  - Bifurcation structure at Havneholmen shaft

  Finally there are a number of other contracts in the area of Sydhavnen falling into the group of “Other Contracts”:

- **Other Contractors**
  Other contractors are responsible for minor parts and deliveries for Cityringen - Branch off to Sydhavnen as well as demolition and preparatory works and station areas works.

  Utility diversions and public road traffic management around Sydhavnen stations will be started in 2016.

At Ny Ellebjerg the following other contracts are foreseen:

- CRSH-NEL-RB1 Interim extension of Ringbanen platform.
- CRSH-NEL-RB2 Temporary relocation of Ringbanen station.
- CRSH-NEL-RB3 Permanent relocation of Ringbanen station.
- CRSH5 Transfer works below the KØR tracks.
- CRSH6 Concourse Hall works.
- Future buildings above Ny Ellebjerg station.

1.6 Environmental Impact Study

The Employer has performed an Environmental Impact Study for the project. The Environmental Impact Study forms the basis and conditions for the authority approval of the project. Information on the EIA-report “Metro til Sydhavnen, VVM-redegørelse” can be found at:

http://soap.plansystem.dk/pdfarchive/12_3013230_1440145210397.pdf

A supplement to the EIA is being prepared by the Employer in spring 2017 to cover the environmental impact of the works at pump sumps and at the Gåsebæk shaft.

2 Cityringen - Branch off to Sydhavnen Contracts

2.1 General

2.1.1 Introduction

This section provides the Scope of Work for the 2 design and build main contracts covering the work for the Cityringen - Branch off to Sydhavnen Project: CRSH1 and CRSH4.

2.1.2 Project Management and Administration

The Contractor shall be responsible for the comprehensive and effective management, planning and design of all work within his scope.

The Contractor's project management shall be conducted in accordance with sound management and engineering concepts throughout all phases of the Project. It shall in particular follow the specifications and requirements defined in SHG-CB 2.1 and SHG-CB 4.1.

The planning and design works shall follow the overall requirements and processes stated in the SHG-CB 4.2 and SHG-CB 4.12 as well as all the other processes and design stated in the contract documents.

The Contractor shall develop and maintain (throughout the Contract) all the required plans and schedules including but not limited to:

- Working Schedules
- Project Implementation plan
- Quality plans, including Inspection and Testing plans
- Non-conformance reporting and Remedial plans
- Authority approval plans
- Safety plans
- Safety Case plans
- Monitoring and Measurement plans
- Interface Management plans
- Environmental Action plans
- Occupational Health and Safety (OHS) plans
- Test plans
- Reliability, Availability and Maintainability (RAM) plans
- Configuration Management plans.
- Mobilisation plans.
- Employment plans.
- Training plans.
- and all other necessary planning and reporting

2.1.3 Documentation

The Contractor shall for his entire supply chain and for the individual Subsystems:

- Prepare and supply all documentation including training documentation required to operate and maintain the facilities.

- For all systems and subsystems work out Design documentation, Construction documentation, test documentation, “as built documentation” and meet and fulfil all the requirements stated in the specification documents, and in the SHG-CB documents.
- Prepare and supply all specification of service and maintenance procedures including documentation as to how the system supports 24/7 operation.

2.1.4 Work Sites

The Contractor shall include all necessary establishments to support the work including mobilisation, operation and demobilisation of all worksites as specified in the SHG-CB 4.13 and SHG-MW-7.

2.1.5 Work Site Areas and Existing Utilities

The work sites will be handed over to the Contractors according to the drawings, the Contract Programme and the Contract Milestones.

Utilities and services will have been relocated within the yellow footprint when the Contractor is given access to the work sites, except where specifically stated. Live utilities left in place are to be protected so that they are not damaged or affected by the works. Where roads are to be reinstated or traffic management schemes implemented to suit the progress of the works, the Contractor shall coordinate with all stakeholders and authorities as necessary to maintain safe passage for all vehicles, bicycles, and the public, and to prevent environmental damage or nuisance.

2.1.6 Contract Interface Coordination

The Contractor is fully responsible for contract interface coordination, with the timely delivery of information, timely requesting of information needs, and attendance by senior managerial staff at all necessary coordination meetings as specified in the SHG-CB 4.3. The Contractor shall develop, complete and resolve all interface issues including but not limited to requirements for contract interfaces that are specified in SHG-CB 4.3.A.

2.2 CRSH1 Underground Civil Works

The CRSH1 Underground Civil Works contract covers all underground works required for the Cityringen - Branch off to Sydhavnen, including the underground civil, structural and building works, mechanical and electrical installations as well as all architectural works.

The scope of work for CRSH1 comprises the following works:

- Bored tunnels, incl. pump sumps and cross passages in low points and all associated preparatory works
- Works at Havneholmen shaft
- Station civil works for five underground stations
- H. C. Ørstedsværket cross-over structure
- Gåsebæk shaft cross-over structure
- Stop end track structures at Ny Ellebjerg

- M&E works to the stations, shafts and tunnels
- Architectural works to the stations and shafts.
- Art works to the underground stations

The CRSH1 Contractor shall design, coordinate all design and construction interfaces with works by others, and construct all works within the contract scope.

The CRSH1 contract has major design and construction interfaces to the following separate contracts:

- CRSH4 Transportation System contract (TS)
- TSC Cityringen Transportation Systems Contract

In the following subsections the scope of work is described and illustrated.

2.2.1 Bored tunnel

The works cover the tunnels from Havneholmen shaft to Ny Ellebjerg station and includes approximately 4,000 m of twin bored tunnels with pre-cast segmental lining plus two cross passages with pump sumps established at tunnel low points by the use of sprayed concrete lining (SCL) between the bored tunnels.

The tunnel work site will be at Enghave Brygge and it is envisaged that TBMs will have to be launched from Ørstedværket shaft first towards Havneholmen shaft from which location the TBMs will be transported back to Ørstedværket shaft where they will be launched again towards Ny Ellebjerg station. All material supplies and tunnel muck shall be handled at Ørstedværket shaft.

The tunnel construction will be through the Copenhagen Limestone (mainly Upper Copenhagen Limestone), or the Bryozene Limestone. Between Enghave Brygge station and Sluseholmen station the TBMs will have to cross the Carlsberg Fault which also represents the shift in geology from Copenhagen Limestone, north and east of the fault, to Bryozene Limestone, south and west of the fault. The quaternary layers of till and meltwater deposits above the limestone typically have a thickness of 5 to 10 m and the groundwater table is typically located 2 to 5 m below the ground surface. The tunnel depth varies from approximately 12 m to 30 m below ground surface.

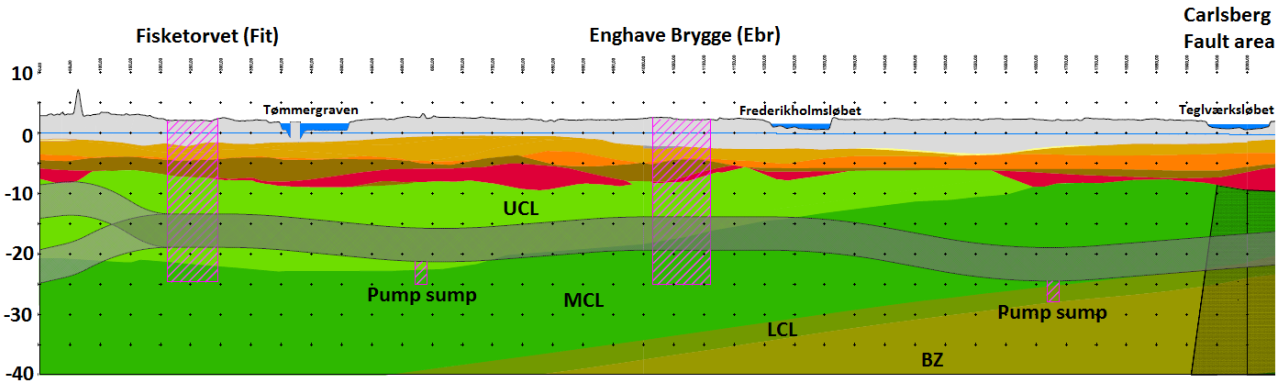

Figure 9 Sydhavnen Metro, indicative example of geological profile

Between Fisketorvet and Sluseholmen stations the tunnels will pass below a new town development area with buildings of up to generally 9 stories height which typically are founded on piles extending down to the top of the limestone or a few meters into the limestone. Some buildings will exceed 9 stories in height. After Sluseholmen station the tunnel passes below Sydhavnsgade railway tunnel owned by Sund & Bælt A/S.

The Contractors' attention is drawn to the need to minimize ground movements and lowering the ground water table during tunnelling and station construction, to avoid any damage to buildings, infrastructure or utilities, and also to (i) avoid any migration of polluted areas of groundwater and (ii) avoid negative impacts on the groundwater resource.

The tunnel shall have a minimum internal clear diameter of 4.90 m and a maximum outer diameter not conflicting with the physical dimensions of the underground stations and receiving chambers.

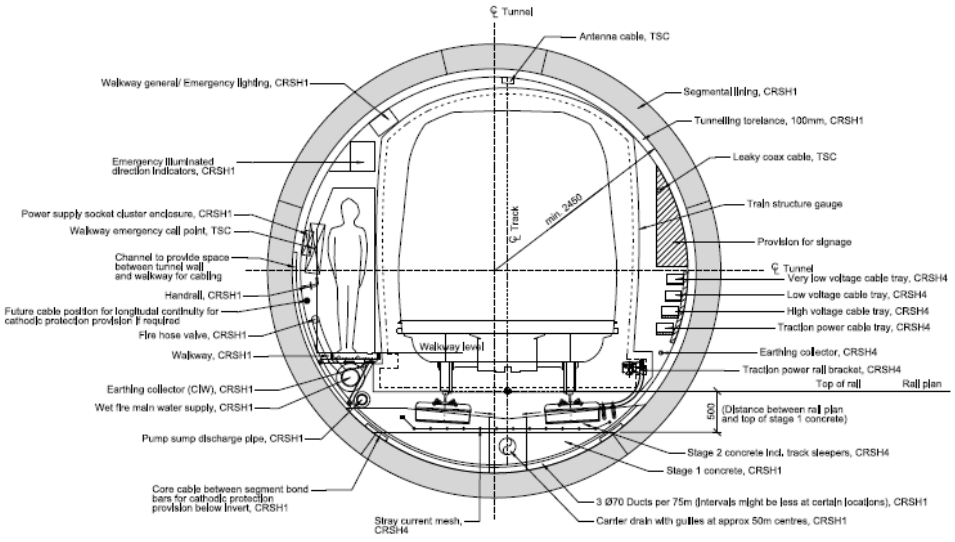

Figure 10 Bored tunnel, Typical Cross Section

The tunnel works also cover the pre-treatment grouting, monitoring and control of groundwater needed to complete the excavated tunnels, with first stage concrete, tunnel drainage and walkways installed in the tunnels. Ground treatment shall be carried out as required to support the contractor's methods and equipment at the launching and extraction at station and shaft locations and elsewhere as required.

2.2.2 Underground stations

The CRSH1 Contractor shall design, coordinate and construct five underground stations located at:

- Fisketorvet shopping mall
- Enghave Brygge just north of Frederiksholmsløbet canal
- Sluseholmen between Sydhavnsgade and Fordgraven
- Mozarts Plads
- Ny Ellebjerg.

Four of the stations will be deep underground stations with the platform located app. 19 m below surface level, and one station (Mozarts Plads) will be a semi shallow station with the platform located app. 14 m below surface level. The station boxes are typical 64 m long and 20 m wide with shallow extensions for stairs etc. The semi shallow station will have a large underground extension to one side housing technical installations.

Fisketorvet station shall be a deep underground station. In the main solution for the station the neighbouring Fisketorvet shopping mall will be extended to the northernmost secant pile wall of the station. The station shall be designed to allow for the loads from this building.

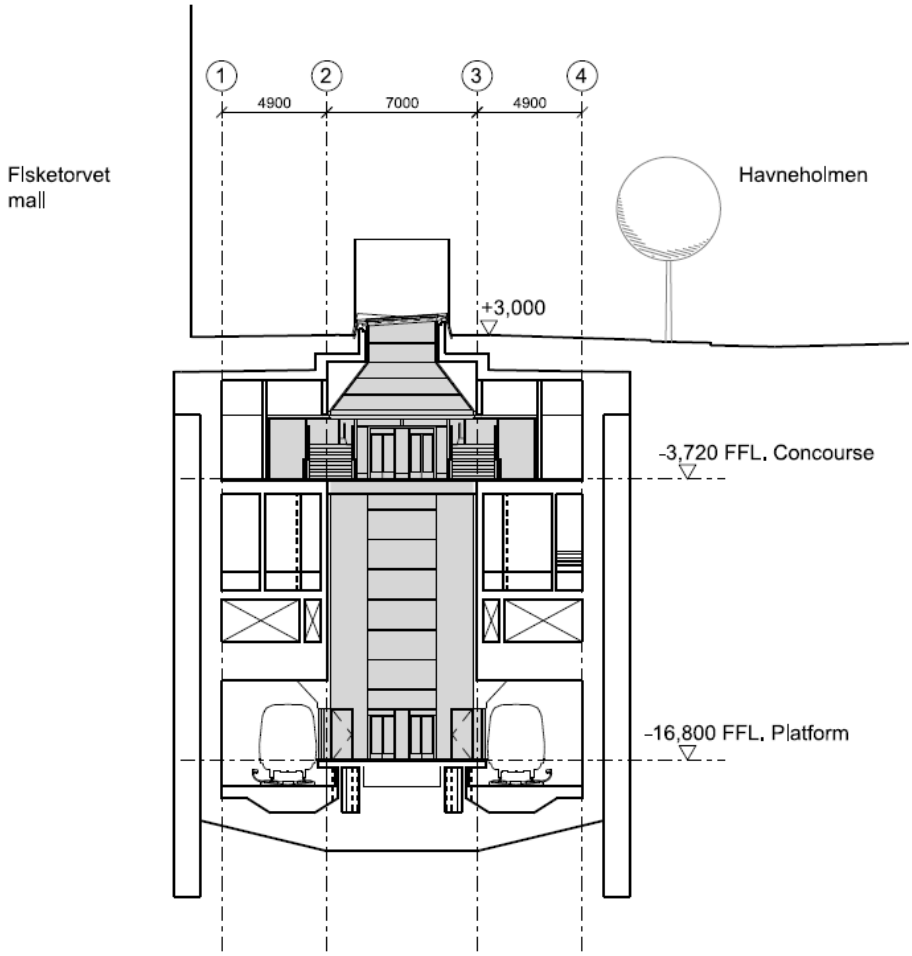

Figure 11 Fisketorvet, deep underground station, Typical Cross section

Optionally the CRSH1 Contractor shall include works for the expansion of the neighbouring Fisketorvet Shopping Mall. The optional works are defined in two options:

Option 1) Preparation for a mall expansion covering the full width of the station to the southernmost secant pile wall of the station, i.e. an expansion above the metro station. In this option the station shall be designed to allow for the loads from the building both in the line of the northernmost and the southernmost secant pile walls. Further, the station shall be raised, skylights shall be omitted and consequently the station shall be equipped with mechanical smoke ventilation. The option is described in SH1-OP-1.1 and SH1-OP-1.2 (drawings).

Option 2) Design and construction of the underground structures for a direct access from the metro concourse to the Mall ground floor. This option is described in SH1-OP-2.

Enghave Brygge station, Sluseholmen station and Ny Ellebjerg station shall be deep underground stations.

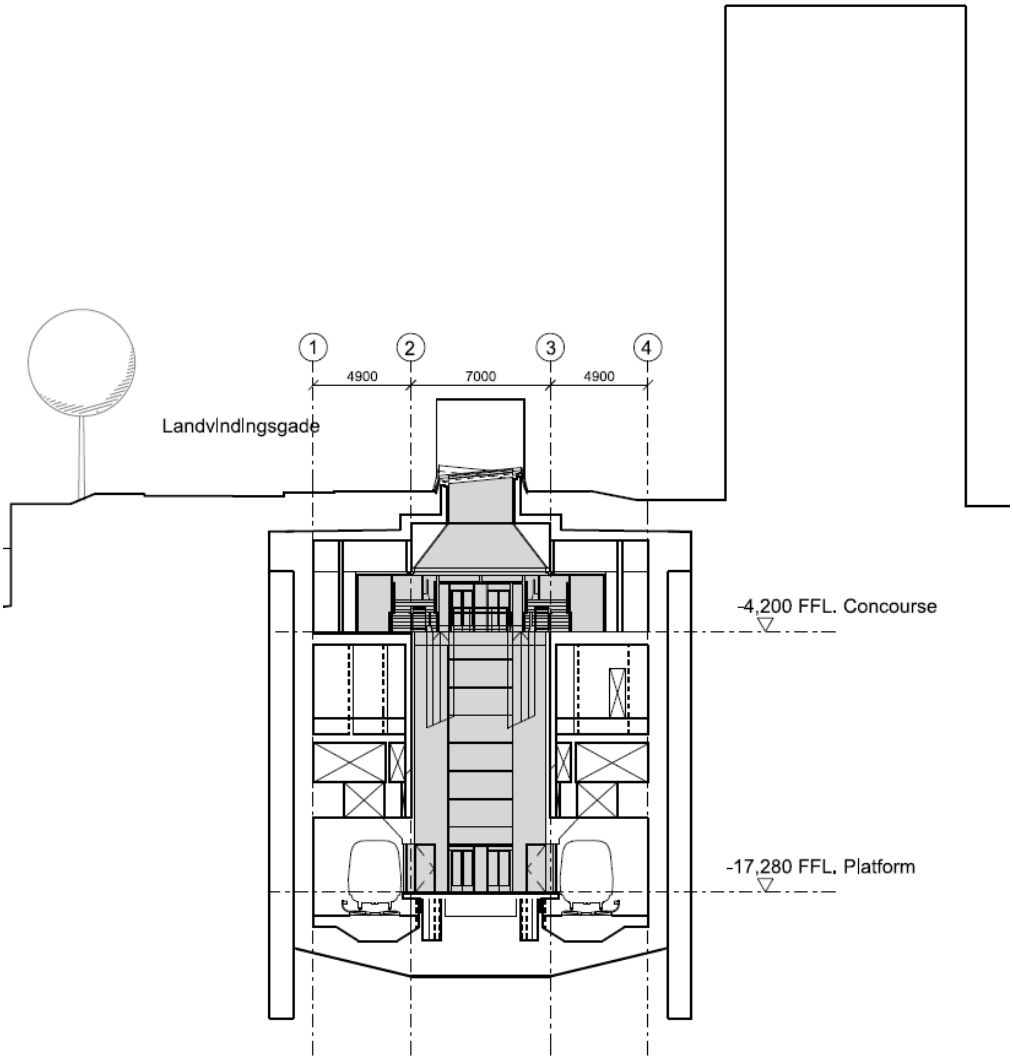

Figure 12 Enghave Brygge, deep underground station, Typical Cross section

As part of the agreement for an underground metro station at Ny Ellebjerg it has been agreed that the area around and above Ny Ellebjerg station will be developed in the future. The future development is foreseen to include one or more new buildings covering the area for railway and metro. It is foreseen that a station concourse hall and transfer works below the KØR tracks will be constructed by others in contract CRSH5 and CRSH6.

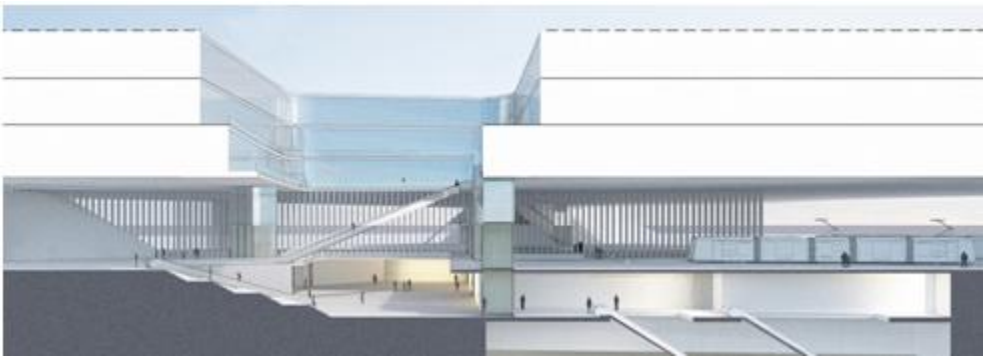

Figure 13 Architectural visualization of a concourse hall with connections to Metro, other railway lines and to future buildings above.

At Ny Ellebjerg station the CRSH1 scope is to construct the station box, the stop end tracks and secondary stair, whereas the main stair will be part of the concourse hall works and constructed in a separate contract, CRSH6.

The future building or buildings at Ny Ellebjerg station is planned to be built above the station and stop end track structures and the structures shall be designed to allow for the loads from this/these buildings.

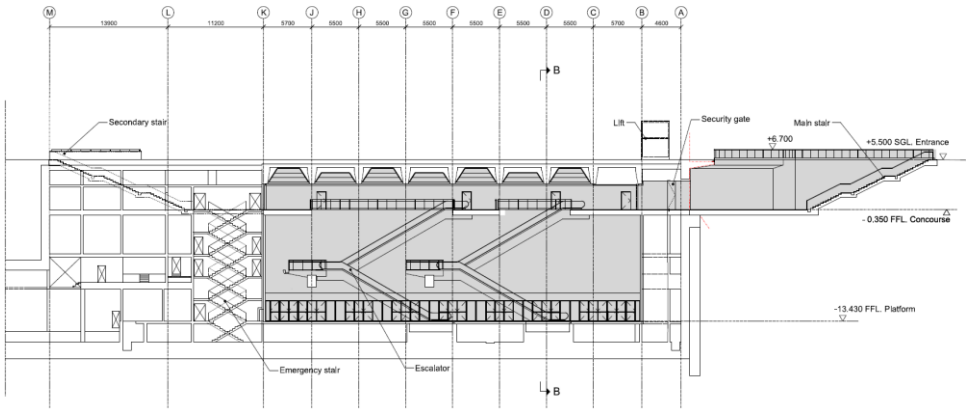

Figure 14 Ny Ellebjerg, deep underground station, Typical Cross section

The contract limit to the concourse hall, contract CRSH6, is shown with a red line in the figure below. The layout of the concourse hall, the main stair and transfer tunnel is indicative and may change.

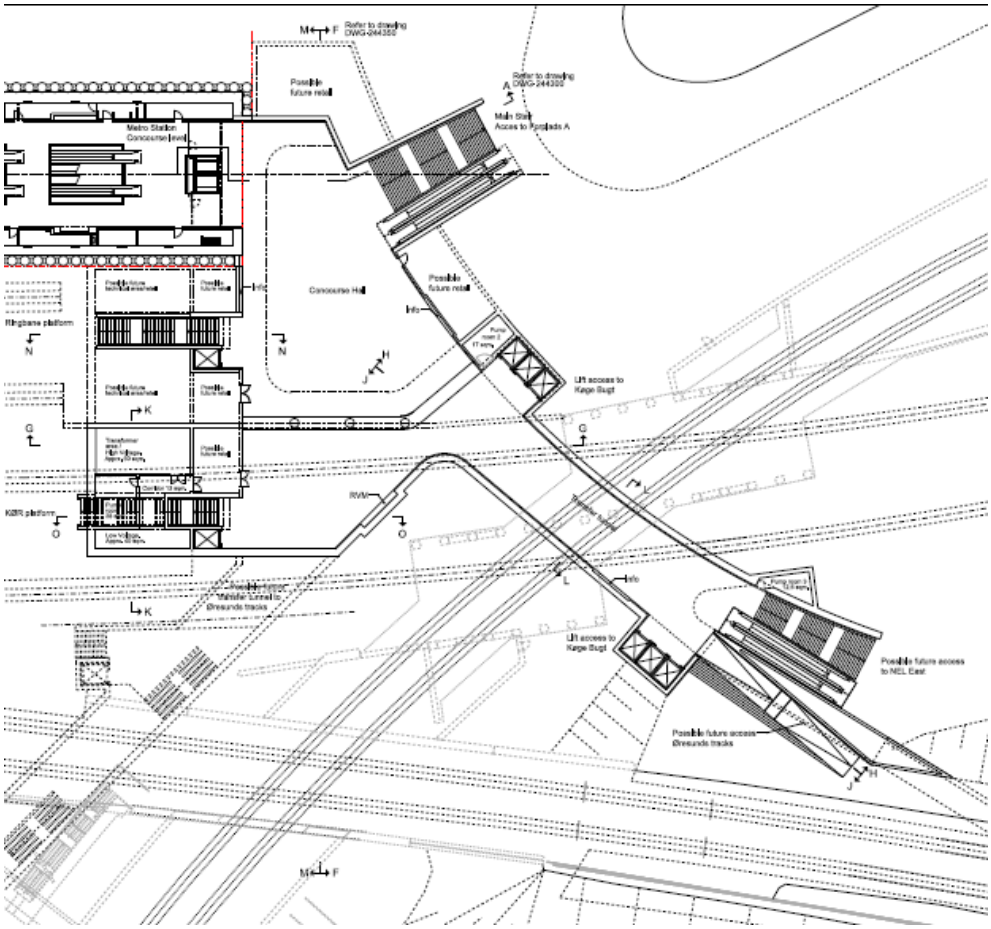

Figure 15 Ny Ellebjerg station, Plan showing layout of station, concourse hall, main stair and transfer tunnel.

Mozarts Plads shall be a semi shallow underground station. Compared to the deep underground station, the majority of technical rooms are located outside the station box in an underground appendix to the station.

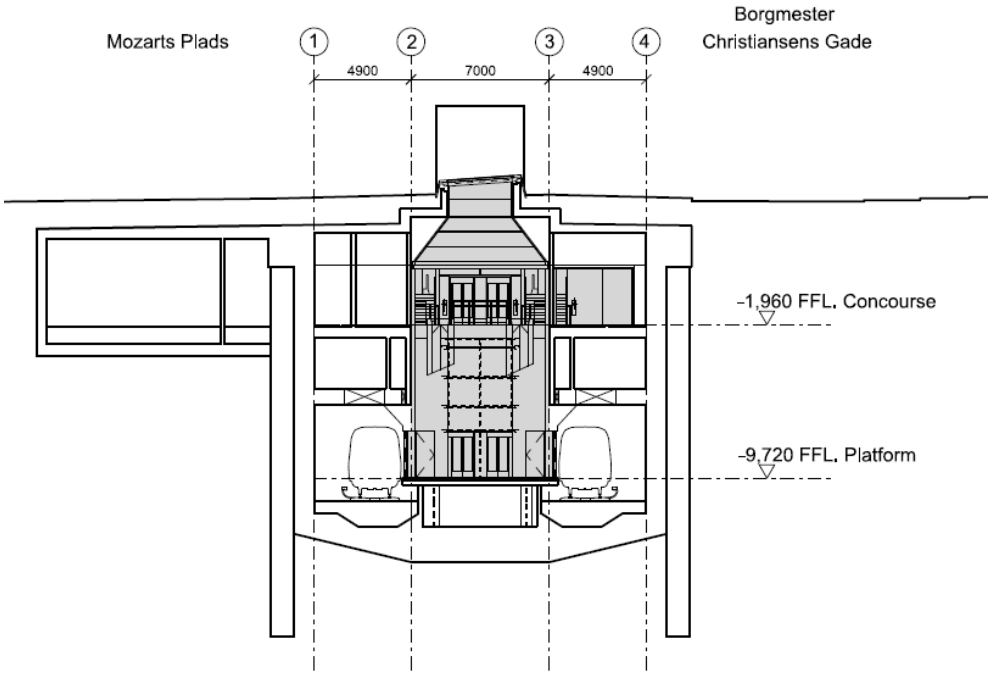

Figure 16 Mozarts Plads, semi shallow station, Typical Cross Section

At Mozarts Plads and at Fisketorvet stations flood gates shall be installed at the four tunnel eyes located towards the harbor/canals crossings. For this reason these two stations are extended in length.

2.2.3 Works at Havneholmen shaft

The Havneholmen shaft has been constructed by the Cityringen Civil Works Contractor (CWC) as part of the works for Cityringen.

The works by CRSH1 include tunnel connections into the shaft inner lining wall in Havneholmen shaft as well as other works on/in the shaft. The detail of the works is described in section 3.1.

2.2.4 H. C. Ørstedsværket cross-over

At Ørstedsværket, just north of Enghave Brygge station an underground cross over shall be constructed with an approximately length of 117 m as a cut and cover structure.

During the tunnel construction the cross over structure shall be used as access shaft for the tunnelling works. TBMs shall be assembled and launched from here, first in the direction of Havneholmen shaft and later towards Ny Ellebjerg station. All material supplies and tunnel muck shall be handled through the H. C. Ørstedsværket shaft.

The Øvk structure shall be combined with the station box of Enghave Brygge and shall above tunnel level house technical rooms and a secondary access to the station. The area above the track level shall further be planned to be used for car parking in two levels. The CRSH1 Contractor shall fulfil the geometrical requirements for the future car park.

A future residential building is planned to be built partly above the box structure and the structure shall be designed to allow for the loads from this building.

2.2.5 Gåsebæk Shaft Cross-over

At Gåsebæk shaft, east of Ny Ellebjerg station, an underground cross over shall be constructed with an approximately length of 89 m as a cut and cover structure.

The Gåsebæk structure shall have a combined passenger emergency exit and access shaft for the rescue services. Above the tunnel level the structure shall house technical rooms in the north-western end.

Future residential or office buildings may be built partly or fully above the box structure and the structure shall be designed to allow for the loads from such buildings.

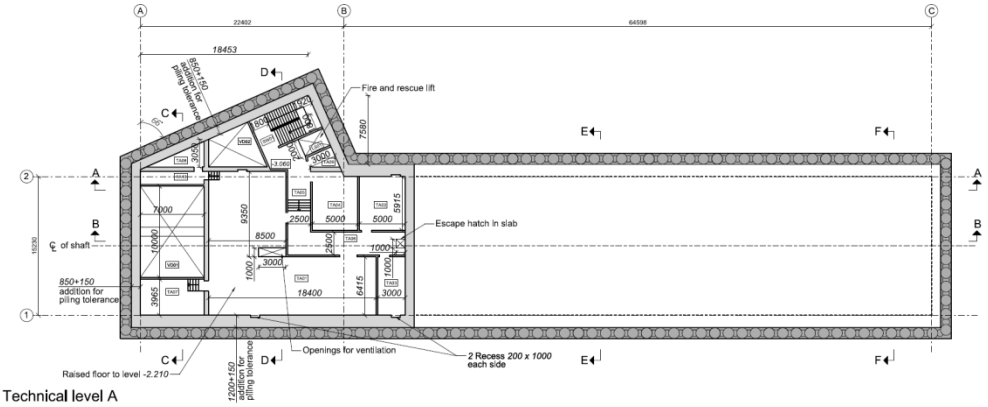

Figure 17 Gåsebæk shaft cross-over, technical level plan

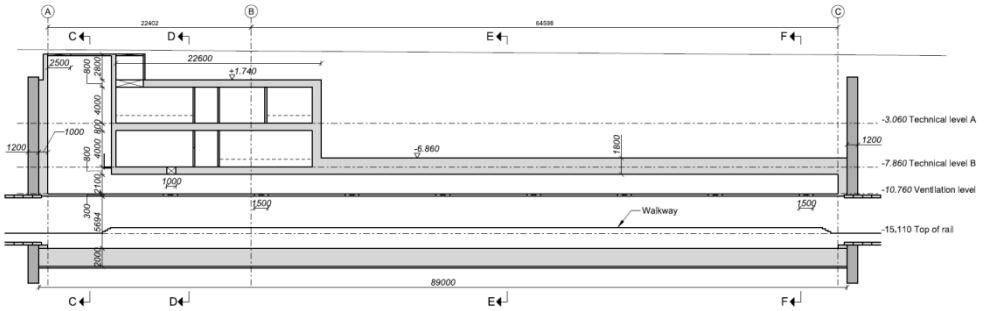

Figure 18 Gåsebæk shaft cross-over, Longitudinal section

2.2.6 Mechanical and Electrical Installations

CRSH1 Contractor shall design and supply M&E installations for all underground works including all stations, tunnels and shafts, to provide:

- Safety and comfort for the passengers and O&M personnel.
- Reliable and long life installations
- Pressurized staircases for safe egress and fire-fighting access consistent with the Fire Safety Strategy developed for Cityringen and agreed with the regulatory authorities.

The M&E installations comprise but are not limited to:

- Low voltage distributing boards
- Lighting and small power sockets
- Cable support for M&E installations and for TSC at concourse level
- Lifts and escalators
- Ventilation
- Technical room air conditioning
- Earthing
- Pumps
- Fire fighting
- Flood gates at tunnel eyes at Fisketorvet and at Mozarts Plads stations
- Flood doors at Fisketorvet
- Local SCADA to control M&E installations and its connection to the Central SCADA provided by TSC.

2.2.7 Architectural Works

Architectural works at the five underground stations and shafts is included in the scope of work for CRSH1. The design of the Architectural works is subject to specific constraints on materials, geometry, form and level of quality and functionality as defined by the Employer.

The CRSH1 Contractor shall manage the design and construction interface of architectural works and M&E systems with the two Transportation System contractors CRSH4 and TSC, who will install all transportation systems including PSDS at the underground stations.

The scope of the Architectural works includes but is not limited to:

- Floor finishes in public areas, tactile paths and interfaces with PSDS
- Cladding and info walls in public areas, partitions
- Ceilings in public areas, including skylights
- Staircases, handrails and balustrades
- Doors in public areas
- Static signage
- Art works to underground stations

2.3 CRSH4 – Transportation System Works

2.3.1 General

The scope of work for CRSH4 comprises the following elements of the transportation system:

- Permanent way
- Traction power
- Power supply
- Local SCADA

The CRSH4 contract has major design and construction interfaces to the following separate contracts:

- CRSH1 Underground Civil Works
- TSC Cityringen Transportation Systems Contract

The CRSH4 contract will cover works in all tunnels, stations, shafts, cross overs and stop tracks.

In the following subsections the scope of work is described.

2.3.2 Permanent way

The Permanent Way shall include all track super structures for the branch off to Sydhavnen.

All tracks shall be slab track. The scope of work encompasses all works and deliverables required to establish the complete Permanent Way installation.

The detailed work scope for Permanent Way is described in SH4-PW. Design and construction to achieve noise and vibration performance requirements are the responsibility of the CRSH4 Contractor.

2.3.3 Traction power

The Traction Power shall encompass all installations needed for converting AC power to 750VDC traction power and to distribute the power throughout Cityringen - Branch off to Sydhavnen to supply all Rolling Stock with electrical power. An underside contact 3rd rail system provides the distribution of traction power to the Rolling Stock.

The CRSH4 scope of work encompasses all works and deliverables required to establish the complete Traction Power system for the Cityringen – Branch off to Sydhavnen.

The detailed work scope for Traction Power is described in SH4-TP.

2.3.4 Power supply

The Power Supply shall include all 10kV and 230/400V installations necessary to convey safe and reliable electrical power to the Project's Transportation System as well as the Civil Work installations.

Uninterrupted power supply (UPS) shall provide for essential consumers in the transportation system such as ATC, SCADA, Transmission, Radio, PSIS, PSDS, PCS, ACS/IDS (part of TSC supply) as well as control voltage for TP and PS.

The scope of work includes all works and deliverable required to establish the complete low voltage and 10kV Power Supply installations for the Sydhavnen branch off.

It also includes the raised floor in CRSH4, corridor, and TSC rooms of stations technical level, and the main cables supports along the tracks and in stations/Shafts for both CRSH4 and TSC

The detailed work scope for Power Supply is described in the SH4-PS.

2.3.5 Local SCADA

Supervisory Control and Data Acquisition (SCADA) is for supervision and control of auxiliary systems with the main task of the operator being able to watch alarms generated in Cityringen including branch off to Nordhavnen and Sydhavnen installations and rolling stock and to determine what action is needed due to such an alarm.

For each contract there will be a local SCADA system for collecting input and distribute outputs to the central SCADA.

The CRSH4 TS local SCADA includes local control of 10kV, Traction and main 400V equipment, and the connection to the central main SCADA which is to be installed by Cityringen Transportation System Contractor (TSC). It shall be equipped with a remote access capability to allow field operators to perform remote diagnostics and repairs.

3 Interfaces

This section provides an overview of the main interfaces to CRSH1 and CRSH4 contracts.

3.1 Cityringen existing structure

3.1.1 General

The branch off to Sydhavnen shall connect to Cityringen at Havneholmen shaft (Hah), which is designed and constructed by the Cityringen Civil Works Contractor (CWC) and will be in operation when Cityringen – Branch off to Sydhavnen will be constructed.

Hah shall be prepared for receiving Sydhavnen connection and a temporary wall will separate Sydhavnen part of the shaft from the operated part as shown in the plan and cross section below:

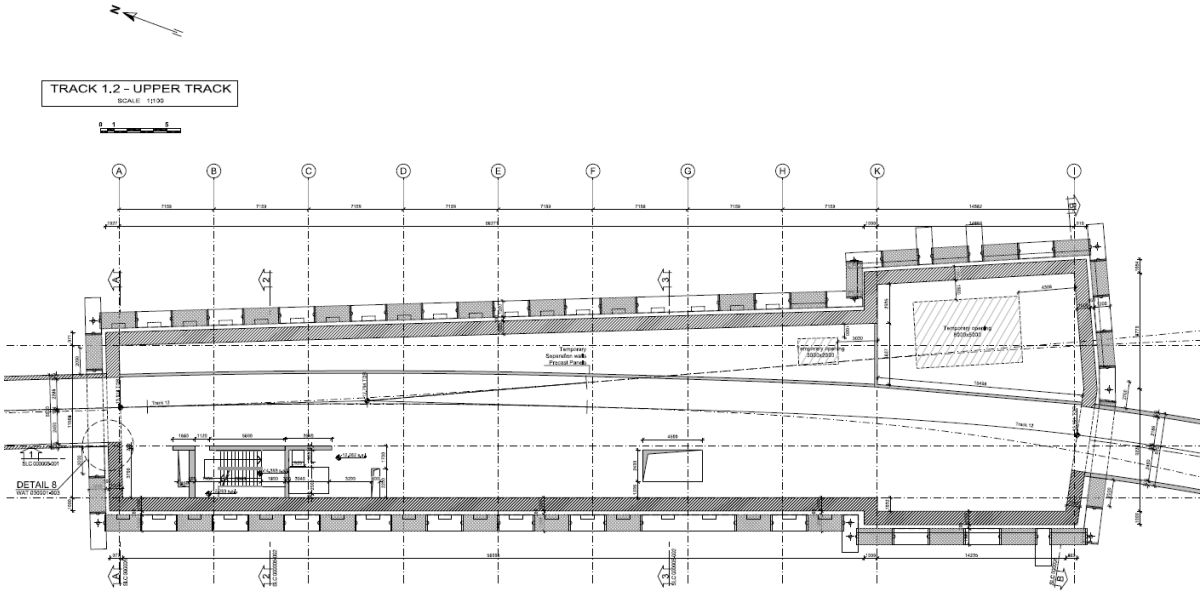

Figure 19 Havneholmen reception shaft, Plan

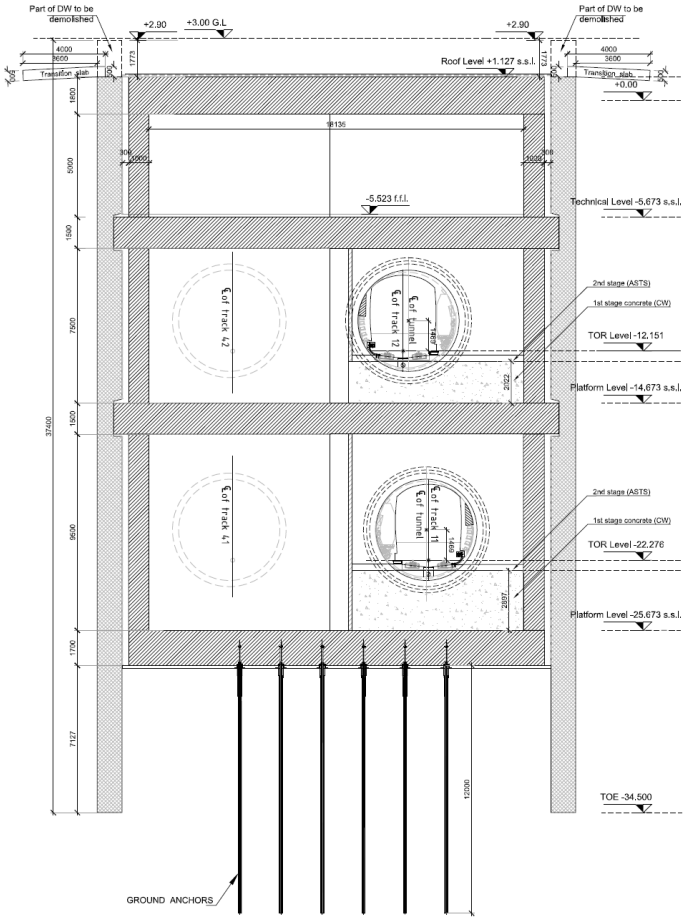

Figure 20 Havneholmen reception shaft, Typical Cross Section

For more details the Contractor shall refer to the drawings listed in SHG-PBA-7.

3.1.2 CRSH1 scope

At Hah CRSH1 scope includes:

- Preparatory works, including worksite, ground treatment and groundwater control required for the TBM reception
- Connection of the tunnel to the shaft inner lining wall
- Tunnel services into the Sydhavnen part of the shaft including walkways, hand rails, drainage, lighting, and connection to the existing services
- Earthing connecting plates before entering Hah shaft
- Tunnel ventilation equipment including controls and connections to existing switchboards.

3.1.3 CRSH4 scope

At Hah CRSH4 scope includes:

- Permanent Way into the Sydhavnen part of the shaft
- Connection of the HV 10kV cables to the existing HV switchboard'
- Earthing and stray current connecting plates before entering Hah shaft.

3.2 Cityringen Transportation System Contract

This section covers the Cityringen Transportation System and Operation & Maintenance works on Cityringen, TSC. These works are outside the scope of the CRSH4 contract but will have interfaces to the CRSH1 and CRSH4 contracts.

3.2.1 Cityringen Transportation System supplies

The Transportation System and Operation & Maintenance contract on Cityringen (TSC) comprises all transportation supplies on Cityringen and the following supplies at the branch off to Sydhavnen:

- Railway Infrastructure elements which are not included in CRSH4:
  - Automatic Train Control (ATC)
  - Platform Screen Door System (PSDS)
  - Passenger Security and Information System (PSIS)
  - Supervisory Control and Data Acquisition (SCADA)
  - Control Centre (CC)
  - Transmission System (TRS)
  - Radio Communication System (RCS)
  - Intrusion Detection and Access Control System (IDS/ACS)
- Rolling Stock: Passenger vehicles as well as service vehicles
- Cabling for MS equipment

The TSC contract includes planning, design, implementation and construction, installation, testing, commissioning and certification of all the above subsystems and integration testing, trial run and operation and maintenance of the entire Cityringen including the branch off to Sydhavnen, including Civil Works, CRSH4 works as well as Employer and third party supplied items.

3.2.2 Operation & Maintenance

The Operation & Maintenance system and mobilisation includes planning, design, implementation, installation, testing and commissioning of O&M system and mobilisation and certification of the O&M organisation, procedures and preparation for start of revenue operation.

This includes among other things the following:

- Administration and management system
- Furniture and equipment for the CMC, tools and movables
- Operation and maintenance procedures
- Staff recruitment and training
- Certification for revenue operation

Operation & Maintenance includes trial runs and the operation and maintenance of all structures and systems in Cityringen including Civil Works, Employers supply and third party supplied items for a period of five years (from start of Cityringen) with an option for extension of the Operation & Maintenance contract period for a further three years. These activities apply for Cityringen as well as for the branch off to Sydhavnen.

3.3 Other contracts

The Employer will enter into separate contracts for the following works:

3.3.1 Preparatory works

- Archaeology investigations
  Separate work by others includes archaeology investigations at all relevant work sites. The Contractor shall assume that archaeological investigations may be required during construction work according to conditions specified in SHG-AB/SB.

- Utility Relocation
  Separate work by others includes relocation of some utilities at all worksites. It is planned that these works are completed to an extent that any remaining activities under these contracts will not impact on the CRSH Contractors work after access for the Contractor has been provided to the work sites.

- Road Diversion
  Separate work by others includes temporary diversion of roads at some worksites. It is planned that these works are completed to an extent that any remaining activities under these contracts will not impact on the CRSH Contractors work after access has been provided to the work sites.

- Neighbouring Buildings
  Separate work by others includes necessary modifications to buildings and properties necessary to ensure the safe fire egress, and access for garbage handling etc. as agreed with third parties.

- Temporary relocation of Ringbanen Ny Ellebjerg station

This contract covers the works listed below:

- The new temporary station.
- The new temporary technical building.
- All necessary changes to existing railway structures.
- All necessary changes to existing railway systems.
  The removal of existing railways structures and systems abandoned.

3.3.2 CRSH5 Ny Ellebjerg Transfer Works below KØR tracks

This contract covers the works listed below:

- All structures for transfer works below existing KØR Banedanmark structures including temporary lifts, all cast-in items and box-outs.
- Temporary architectural works.
- All systems to operate the above (power supply, lighting, sockets, pumps).
- All necessary changes to existing railway structures for establishing the transfer works.

3.3.3 CRSH6 Ny Ellebjerg Concourse Hall Works

This contract covers the works listed below:

- All structures for Concourse Hall between the Metro station, the permanent Ringbane station and the transfer works below KØR tracks, including permanent lifts and escalators, all cast-in items and box-outs.
- Architectural works also covering the transfer works below KØR tracks.
- All systems to operate the above (power supply, lighting, sockets, pumps, signals).

3.3.4 CRSH-NEL-RB-3 Permanent relocation of Ringbanen Ny Ellebjerg station

This contract covers the works listed below:

- The new permanent station.
- The new permanent technical building.
- All necessary changes to railway structures.
- All necessary changes to railway systems.
- The removal of railways structures and systems abandoned.

3.3.5 Future Buildings above Ny Ellebjerg station

As part of the Metroselskabet's´ Owners agreement for an underground station at Ny Ellebjerg it has been agreed to develop the area at Ny Ellebjerg with a future building above the metro station and railways.

The development of the area will be planned and scheduled in parallel with the implementation of the Cityringen – Branch of to Sydhavnen construction.

3.3.6 Station Area Works

Station area works will be covered by separate contracts.

3.3.7 Other works in the Sydhavnen Area

Other works as part of Cityringen - Branch off to Sydhavnen where the CRSH Contractors shall have an interface responsibility are:

- Mobile phone equipment
  This contract includes supply of equipment for mobile phone coverage in Cityringen. The equipment consists of antennas and amplification equipment in the tunnels and in stations. Equipment in the tunnels and stations shall be installed, tested, operated and maintained by Cityringen TS Contractor, TSC. The central units are operated and maintained by the mobile phone companies.

- Ticketing system equipment
  This contract includes supply, installation and maintenance of ticketing vending and validation equipment at the stations. The equipment consists of smart card validators, reload vending machines (RVM), networks and routers on stations.

- Heart defibrillators
  Heart defibrillators will be supplied and installed in stations at platform levels by others.

- Litter bins
  Litter bins at stations will be supplied by the Employer and installed by CRSH1.

- Clocks
  Clocks at stations will be supplied by the Employer and installed by TSC.

- Rest bars
  Rest bars at stations will be supplied by the Employer and installed by CRSH1.

3.4 External Contracts

3.4.1 Frederiksholmsløbet Bridge Contractor

The Copenhagen Municipality will construct a bridge across the Frederiksholmsløbet. The construction works is expected to overlap with the construction of the Cityringen – Branch off to Sydhavnen.

The CRSH1 Contractor shall coordinate the works with the bridge contractor as defined in the interface schedule in SHG-CB 4.3.

3.4.2 Fisketorvet Mall Contractor

The Fisketorvet Mall have plan for extension of the shopping mall. They operate with two possible solutions. One for extending the mall to the northern secant pile wall of the Fisketorvet station box, as shown in the drawing in the SHG-CB 3.4.A and a solution for extending the mall across the station box to location of the southern secant pile wall as described in SH1-OP-1.1.

The CRSH1 Contractor shall coordinate the works with the Fisketorvet Mall contractor(s) for the mall extension as defined in the option document SH1-OP-1.1, and interface schedules in SHG-CB 4.3.