







Join us in Building The Stockholm bypasss Sweden's Largest Road and Tunnel Project

>> E4 The Stockholm bypass

22 In the next two years we need to procure Tunnels and Civil works to a total value of 2 billion euro, says Johan Brantmark, Project Director of The Stockholm bypass.

# >> E4 The Stockholm bypass

E4 The Stockholm bypass – Förbifart Stockholm – is a new route for the European highway (E4) past the Swedish capital. It connects the southern and northern parts of the Stockholm county, relieves the arterial roads and the inner city of traffic and reduces the vulnerability of the Stockholm traffic system.

The Stockholm bypass is one of the largest road projects run by the Swedish Transport Administration (STA). The new link will simplify everyday life and create opportunities for further development in a rapidly growing region.

To minimize the impact on sensitive natural and cultural environments, just over 18 km of the total of 21 km of the bypass link are in tunnels.

Two major interchanges will be built in conjunction with the existing E4 at Kungens Kurva and in Häggvik. In between these, the bypass will link up with the existing road network on the island of Lovön, at Bergslagsplan in Vinsta, and the E18 in Hjulsta. The building period is about ten years.

When the link opens for traffic it will be one of the longest road tunnels in the world. By 2035, the Swedish Transport Administration estimates that The Stockholm bypass will be used by approximately 140,000 vehicles per day.

# Join us in Building The Stockholm bypass

## Carrying out The Stockholm bypass

To execute The Stockholm bypass project around 50 contracts of varying sizes need to be procured. 15-20 of these are main civil contracts.

The contracts include the construction of rock tunnels, civil engineering, bridges, roads and electrical and mechanical installations.

The size of the main civil contracts varies between 50 and 300 million euro.

## Contracting tenders - preliminary plan

The contracts for The Stockholm bypass project will be procured in a way where some will be for the construction work only and some as design-build contracts.

- Six contracts for the main tunnel
- Six interchanges divided into several contracts
- E&M Contracts
- Preparatory work

## Up to date

The land aquisition plan is now adopted and approved by the government. The work on the project planning for building documentation is ongoing. The first tender documents have been sent out for quotation. We started the prequalification process for two of our main contracts in February 2014.

Contracts for establishing construction documents will be awarded in the years ahead, to be followed by tenders for contracting work.

The preparatory works have started and the amount of field work being performed is continually increasing. In the next two years we need to procure Tunnels and Civil works to a total value of 2 billion euro. The construction work for the main contracts is planned to start in the spring of 2016.



## The Stockholm bypass in brief

- Length: 21 km
- No. metres of main tunnel: 2x18 km
- Number of lanes: 3 lanes in each direction in two separate tunnel tubes
- Interchanges: 6
- Main highway bridge: 24 000 m<sup>2</sup>
- Total rock: 19 million tonnes
- Construction period: about 10 years
- Construction cost (2009 prices):
  3.1 billion euro

## **Rock Tunnels**

## The Rock tunnels

The E4 Stockholm bypass features one of the world's longest tunnels in an urban environment between Kungens kurva and Hjulsta. The tunnel is 16.5 km long. In addition there's a short tunnel, 1.8 km, beneath Järvafältet.

The Stockholm bypass passes Lovö in a tunnel with interchanges, two roundabouts and ramps, to Ekerövägen (road 261) at Edeby and Tillflykten.

On the stretch from Lovö to Lunda the bypass passes Lambarfjärden, Grimsta and Vinsta in a tunnel. A new interchange at Vinsta with two roundabouts on Bergslagsvägen will be built north of Bergslagsplan.

From the Vinsta interchange the Stockholm bypass runs in a tunnel to Hjulsta where it is located on the surface and onto a bridge over the Mälarbanan rail line, the creeks Bällstaån/Spångaån and the E18 Enköpingsvägen.

From Hästa klack the bypass returns underground in a tunnel, below Järvafältet, to a point by the junction of Finlandsgatan and Akallalänken.

The Stockholm bypass will be built with 3 lanes in each direction in two separate tunnel tubes. At its deepest point, the tunnel will be 60 m below the surface of Lake Mälaren and almost 100 m below ground level.

Building the Stockholm bypass implies that about 19 million tonnes of rock from the rock tunnels have to be transported and disposed of in an efficient and environmentally appropriate manner. In order not to overload the road network with heavy transports, three temporary jetties will be built from where 50 percent of the rock mass will be transported: one

#### **ROCK TUNNELS IN BRIEF:**

No. metres of main tunnel: 2x18 km

Total rock: 19 million tonnes

No. metres ramp tunnel: approx. 14 km

No. metres transverse tunnels: approx. 3.9 km

Jetties: 3

Normal section main tunnel: 3 lanes 125 m<sup>2</sup>

Normal section ramp tunnel: 1 lane 80 m<sup>2</sup>

Working tunnels: 6 with a total length of 2.7 km

Boring method: Drill and blast

at Sätra boatyard and two on the island of Lovö, at Malmviken and at the northern part of Lovö. The rock mass will be transported between the working tunnel and the temporary jettie on conveyors. From there the rock mass will be transported by sea to temporary reception points.

#### Design

Construction document planning will be carried out in extended collaboration with planning consultants with the objective of developing the industry, partly by focussing on the function, ease of construction and final cost of the finished bypass.

We use BIM, Building Information Models, in the project planning.

Controlled core drilling has been carried out along the tunnel route where it is passed by Lake Mälaren to reduce uncertainty regarding the quality of the rock.



### Building

For the rock work, 6 contracts are planned for the main tunnels. Each contract will have a link via a working tunnel or a link via one of the permanent access ramps. For three of the contracts, rock will be transported via a conveyor to the temporary jetty.

The rock contracts also include evacuation tunnels between the main tunnels and the ramp tunnels at the connecting interchanges.

The Stockholm bypass mainly runs through good quality rock. The tunnel will be excavated using traditional drill and blast technology. All tunnels will be grouted. The road surface will be built in concrete.

The construction of the Stockholm bypass is characterised by paying major attention to the environment and local residents. At the same time effective operation with high productivity is crucial to keeping on schedule. Our ambition is therefore to work with functional requirements and conditions as far as possible.

#### Programme

The design works are ongoing as well as the procurement process. We have sent out the first tender documents for quotation, and the prequalification process for the main contracts have started.

## Preliminary plan for the contracts for the rock tunnel works:

FSE 209 - Main tunnel Skärholmen.

Production starts in the beginning of 2017, finishes 2022.

**FSE 210 -** Access tunnels (Skärholmen & Sätra) and temporary jetty, Skärholmen.

Production starts in the beginning of 2015, finishes 2016. Awarded.

**FSE 302 -** Main tunnel, access tunnel and temporary jetty, Norra Lovö.

Production starts in the beginning of 2016, finishes 2022.

**FSE 308 -** Main tunnel, access tunnel and temporary jetty, Södra Lovö.

Production starts in the beginning of 2016, finishes 2022.

FSE 403 - Main tunnel, Johannelund.

Production starts in autumn 2015, finishes 2021. Ongoing prequalification process.

**FSE 410 - Main tunnel and access tunnel , Lunda.** Production starts in the end of 2016, finishes 2021.

**FSE 607 - Access tunnel , Akalla.** Production starts in the end of 2015, finishes 2017.

**FSE 613 - Main tunnel, Akalla.** Production starts in the summer of 2017, finishes 2020.

## Contact us:

Project Managers:

Lasse Wilson Telephone: +46 (0)10-124 29 64 lasse.wilson@trafikverket.se

Roland Ekenberg Telephone: +46 (0)10-123 86 24 roland.ekenberg@trafikverket.se

Niklas Lindkvist Telephone: +46 (0)10- 123 91 30 niclas.lindkvist@trafikverket.se

#### **Design Coordinators:**

Nils Outters Telephone: +46 (0)10-123 88 40 nils.outters@trafikverket.se

Beatrice Lindström Telephone: +46 (0)10-123 87 68 beatrice.lindstrom@trafikverket.se

#### Procurement:

Lars Malthe Telephone: +46 (0)10-123 91 07 lars.malthe@trafikverket.se

## Kungens kurva Interchange



Kungens kurva viewed from the south. The existing Kungens kurva interchange will be rebuilt and will gain direct ramps in towards Stockholm. The interchanges Lindvreten södra and the Lindvreten norra consist of grade separated roundabout overpasses.

## Kungens kurva

From Vårby backe in the south to the Bredäng junction in the north, on a stretch about 5 kilometres long, we are building the on and off ramps for The Stockholm bypass (Förbifart Stockholm). The stretch will also have three interchanges: two already exist (Lindvreten south and Kungens Kurva), and a new one will be built (Lindvreten north). The conditions in the area are complicated by deep layers of clay and varying rock conditions.

More than 100,000 vehicles per day will be passing close by the worksites for The Stockholm bypass,

which will be located in the middle of what is currently the E4. During many of the construction stages, the traffic will be diverted through temporary solutions.

The largest commercial area in Scandinavia is located in this area, with Kungens Kurva on one side and the Skärholmen centre on the other, which together have over 30 million visitors each year. In total, the area will be affected by the construction of the Stockholm bypass for about ten years.

## Contact us:

#### **Project Manager:** Anders Liwendahl Telephone: +46(0)10-123 87 72 anders.liwendahl@trafikverket.se

#### Assistant Project Manager Per Lunde Telephone: +46(0)10-123 87

Telephone: +46(0)10-123 87 80 per.lunde@trafikverket.se

#### **Procurement:** Lars Malthe Telephone: +46 (0)10-123 91 07 lars.malthe@trafikverket.se

### Implementation

The stretch is divided over four contracts. Preliminary plan of the contracts for Kungens kurva interchanges:

### FSE 101:

**Roads and Bridges Vårby Backe** is at the far south end. This contract includes widening the road as well as demolishing the existing bicycle and pedestrian bridge and constructing a new one. The existing bridge across the E4 at Lindvreten junction will be rebuilt as an overhead roundabout. This stretch of road is 1.5 km long. Construction time is approx. 3 years.

**Preliminary schedule:** planning and production starts in the beginning of 2018, finishes 2021.

#### Estimated quantities FSE 101:

Excavated rock	40 000 m <sup>3</sup>
Excavated soil	130 000 m <sup>3</sup>
Concrete	10 000 m <sup>3</sup>
Soil reinforcement	3 000 m <sup>2</sup>

#### FSE 105:

**Concrete Tunnel Kungens Kurva** is the most significant contract, and contains the on and off ramps to the Stockholm bypass coming from the south. The contract also includes a new overhead roundabout, a concrete trough, a concrete tunnel, 20 metres of rock tunnel, an air exhaust station and a footpath between Skärholmen and Kungens Kurva on a level with IKEA. This stretch of road is approx. 1.5 km long. Construction time is approx. 6 years.

**Preliminary schedule:** planning and production starts summer 2015, finishes 2021.

Estimated	quantities	FSE 105:
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Excavated rock	300 000 m <sup>3</sup>
Excavated soil	$500000m^3$
Concrete	80 000 m <sup>3</sup>
Soil reinforcement	11 000 m <sup>2</sup>
Concrete tunnel incl. trough	300+300 m
Rock tunnel	20 m

Preliminary plan for the contracts for the interchange in Kungens kurva:

- FSE 101 Roads and Bridges Vårby Backe
- FSE 105 Concrete Tunnel Kungens Kurva
- FSE 117 Pedestrian and Bicycle Bridge Kungens Kurva
- FSE 215 Concrete Tunnels Skärholmen

#### FSE 117:

**Pedestrian and Bicycle Bridge Kungens Kurva** will be built across E4/E20 on a level with Heron city. The bridge will contain central heating pipes etc. The bridge is c. eight metres wide, 150 metres long, and connects to Skärholmsvägen and Månskärsvägen behind Heron city. Construction time will be a little over 1.5 years.

**Preliminary schedule:** planning and production has started, finishes in the beginning of 2017.

#### FSE 215:

**Concrete Tunnels Skärholmen** is the contract for the northern part of Kungens Kurva. The northernmost contract. Includes the on and off ramps for the Stockholm bypass coming from the north. The contract involves widening the existing road, two concrete troughs, two concrete tunnels (one on each side of the E20) and a 2x20 metre rock tunnel. Due to the soil conditions, the contract also includes a great deal of ground reinforcement. The stretch is approx. 2 kilometres long. Time of construction is approx. 5 years.

**Preliminary schedule:** planning and production starts in the end of 2016, finishes 2021.

#### **Estimated quantities FSE 215:**

Excavated rock	70 000 m <sup>3</sup>
Excavated soil	30 000 m <sup>3</sup>
Concrete	20 000 m <sup>3</sup>
Soil reinforcement	30 000 m <sup>2</sup>

## Lovö, Vinsta and Hjulsta Interchanges

Two major interchanges will be built in conjunction with the existing E4 at Kungens Kurva and Häggvik. In between these, the bypass will link up with the existing road network on the island of Lovön, at Bergslagsplan in Vinsta, and the E18 in Hjulsta.

The three interchanges, Lovö, Vinsta and Hjulsta are all part of the same Stockholm bypass sub-project but all differ in nature. On the island of Lovö construction will be in virtually untouched countryside, while in Vinsta the building work will be in an urban environment with many local residents. In Hjulsta the interchange is a large-scale infrastructure project where the bypass will run over a bridge above the Mälarbanan rail line and the E18 and in a concrete tunnel below Järvafältet.

## Future construction document planning

Construction document planning for the Lovö and Vinsta interchanges will be carried out in extended collaboration with planning consultants with the objective of developing the industry, partly by focusing on the function, ease of construction and final cost of the finished bypass.

We actively use BIM, Building Information Models, in the project planning.

Preliminary plan for the contracts for the interchanges at Lovö, Vinsta och Hjulsta:

FSE309 - Interchange Lovö, including Lindö tunnel

- FSE401 Interchange Vinsta
- FSE501 Interchange Hjulsta södra
- FSE502 Interchange Hjulsta norra



The stretch of the Stockholm bypass at the three interchanges of Lovö, Vinsta and Hjulsta

## Programme

For the Lovö interchange the construction document planning is expected to be put out to tender in the end of 2015. Planning and production starts spring/ summer 2017.

For the Vinsta interchange the contract will be put out for tender in the beginning of 2016. Planning and production starts summer of 2018.

The construction document planning is ongoing for the Hjulsta interchange and start for the construction work on the first contracts is expected to start for the south part (FSE 501) in the beginning of 2017, and for the northern part (FSE 502) summer 2016.

## Contact us:

### Project Manager:

Pia Andersson Telephone: +46 (0)10-123 85 63 pia.andersson@trafikverket.se

## Design Coordinators:

Astrid Rahlén Telephone: +46 (0)10-123 62 21 astrid.rahlen@trafikverket.se

Ove Malmberg Telephone: +46 (0)10-123 87 91 ove.malmberg@trafikverket.se Karl Wallroth Telephone: +46 (0)10-124 42 76 karl.wallroth@trafikverket.se

## Procurement:

Lars Malthe Telephone: +46 (0)10-123 91 07 lars.malthe@trafikverket.se

## Lovö Interchange



Interchanges by Edeby and Tillflykten on the Lovö island seen from the north.

## The Lovö island

The Stockholm bypass passes Lovö in a tunnel with interchanges, two roundabouts and ramps, to Ekerövägen (road 261) at Edeby and Tillflykten.

The Lovö interchange consists of two roundabouts on Ekerövägen. Ramps run north and south from the roundabouts. The ramp tunnels are north-west of Ekerövägen to achieve sufficient rock cover. Ekerövägen will be widened from three lanes to four between the roundabouts.

On the stretch towards Tappström an additional tunnel will be added to the existing Lindö tunnel.

South of the roundabouts at Edeby a bus stop will be built for passengers for buses using the Stockholm bypass and Ekerövägen. The bus stop will also be served by a pedestrian and cycle underpass under Ekerövägen. Two existing underpasses will be widened to comply with the new road.

#### Planning

The construction document planning for the Lovö interchange will be carried out as a design-build contract in client-contractor collaboration. Planning covers the above ground parts of the interchange.

#### Implementation

The island of Lovö enjoys a unique natural and cultural landscape which demands great care, particularly during the construction phase. It will be important to work with various active stakeholders to minimise disruption to the surroundings and make it easier for Ekerö traffic to pass through the area.

#### LOVÖ IN BRIEF:

**No. metres (2+2 lanes) new/reconstructed road:** approx. 3.9 km

#### Of this total no. metres of road

- concrete tunnel: approx. 100 m
- rock tunnel: approx. 175 m
- on bridge: 3 pedestrian/cycle underpass under road 261, Ekerövägen

## **No. metres of lime cement columns:** approx. 100 000 m

No. metres new/reconstructed pedestrian/cycle path: approx. 2.6 km

**Pedestrian/cycle bridges:** 1 Various re-laying of water pipes and cables

## Vinsta Interchange



Vinsta interchange seen from a new interchange on Skattegårdsvägen towards Johannelund and Berslagsplan.

On the stretch from Lovö to Vinsta the bypass passes Lambarfjärden, Grimsta and Vinsta in a tunnel. North of Bergslagsplan in Vinsta a new interchange will be built with two roundabouts on Bergslagsvägen with entrance and exit ramps for northbound and southbound traffic. The roundabouts are linked by Bergslagsvägen which will be widened over a stretch of approximately 500 metres between the roundabouts and will also have a lane for public transport.

The pedestrian and cycle path network around the two roundabouts will be rebuilt and an entirely new pedestrian path will be created serving the metro station. Stops for changing between busses on the Stockholm bypass and busses running on Bergslagsvägen are planned between the roundabouts. There will also be a pedestrian and cycle underpass at these stops running under Bergslagsvägen. Two new bridges will also be built for pedestrian and cycle traffic.

#### Planning

The construction document planning for the Vinsta interchange will be carried out as a design-build contract in a client-contractor collaboration. The construction document planning covers the above ground parts of the interchange, i.e. two roundabouts, roadworks, two pedestrian and cycle bridges, rebuilding pedestrian and cycle paths, noise protection measures and temporary roads.

#### Implementation

Vinsta is an area with a large number of residents, who will be affected over a long construction period. Therefore an early start on noise prevention measures is a priority. Re-laying pipes will also take place at an early stage. For many years rock mass from the rock excavation work will be removed via the interchange's ramps, which will demand coordination at the construction site. A temporary road will have to be built for the rebuilding work on Bergslagsvägen.

#### **VINSTA IN BRIEF:**

**No. metres new/reconstructed road:** approx. 1.5 km Of this total no. metres of road - on bridge: 1 pedestrian/cyclepassunder Bergslagsvägen

**No. metres new/reconstructed pedestrian/cycle path:** approx. 2 km

#### Pedestrian/cycle bridges: 2

**No. metres of lime cement columns:** approx. 50 000 m Sheet piling

Plus various re-laying of water pipes and cables and noise prevention measures.

## Hjulsta Interchange

From the Vinsta interchange the Stockholm bypass runs in a tunnel to Lunda where it comes up to the surface and onto a bridge over the Mälarbanan rail line, the creeks Bällstaån/Spångaån and the E18 Enköpingsvägen. At the Hjulsta interchange the two major European motorways, the E4 Stockholm bypass and the E18 Enköpingsvägen, meet.

After passing above the Hjulsta interchange, the Stockholm bypass runs on a bridge to the hill in the north at Hjulsta storhage. The road passes the hill section in a cutting and then continues over a bridge over the pedestrian and cycle path on the northern edge of the hill. The road then runs in a cutting towards the start of the concrete tunnel at the southern edge of Hästa klack.

#### Planning

We are working on the construction document planning for the Hjulsta junction. The consulting assignment includes to establish the tender documents for the design/build contracts which describes the concrete tunnels, bridges, road including ramps and temporary diversion of Akallalänken.

#### Implementation

Hjulsta interchange is an area which will see a number of associated projects. The reconstruction of the E18 with a new roundabout at Hjulsta is now complete. The work with The Stockholm bypass will put high demands in terms of a safe working environment, particularly since there is heavy traffic in the area. However, there are no plans for the rock mass from boring the tunnel to be removed via the Hjulsta interchange. Ground reinforcement will be necessary using lime cement columns and excavation with sheet piling.



Hjulsta interchange seen from the E18 to the south by Hjulsta.

#### HJULSTA IN BRIEF:

No. metres (3+3 lanes) new/reconstructed road: approx. 1.8 km Of this total no. metres of road - in concrete tunnel: approx. 550 m - concrete trench: approx. 150 m - on bridges: approx. 700 m

No. metres new/reconstructed road for ramps and local road with 1 to 2 lanes: approx. 2.5 km Of which total no. metres of road - on bridges: approx. 550 m **No. metres of lime cement columns:** approx. 100 000 m of columns

**No. metres new/reconstructed pedestrian/cycle path:** approx. 500 m

Plus various re-laying of water pipes and cables and noise prevention measures.

Piling and Sheet piling

## Akalla and Häggvik Interchanges

## Akalla - Häggvik

The Akalla-Häggvik interchanges consists of the two northernmost junctions of the bypass as well as connections between the two. From Hästa klack the bypass runs in a 1.8 km tunnel below Järvafältet, to a point by the junction of Finlandsgatan and Akallalänken in Akalla.

After Akalla the bypass runs lowered to the Häggvik interchange where The Stockholm bypass is connected to the current E4 Uppsalavägen, Norrortsleden and the local road network. Everybody in northern Järva will get a quick and convenient link with the southern parts of the county via the E4 Förbifart Stockholm.

## Planning

The building documentation is project planned in extended collaboration with the project planning consultants, ÅF/URS, and has the target of developing the sector, for example by focusing on the function, constructability, and final cost of the completed bypass. We use BIM, Building Information Models, in the project planning.



The Stockholm bypass runs in a deep trench north of Akalla. Thereafter it continues northwards under the Akalla interchange towards Häggvik. The Akalla interchange links to the Hanstaleden thoroughfare.



The Häggvik interchange is a major and complicated interchange, where Förbifart Stockholm connects with the current E4 Uppsalavägen thoroughfare, the Norrortsleden thoroughfare, and the local road network. Even so, it will be possible to build and operate the interchange without making any significant inroads into the Hansta nature reserve or the Fyndet forest.

### Implementation

The interchanges Akalla and Häggvik are preliminarily planned to be carried out in two large design-build contracts, FSE61 in Akalla and FSE62 in Häggvik. There will also be four contracts for the preparatory works.

### Contract for FSE61 Akalla interchange

Förbifart Stockholm connects from the rock tunnel under the Järvafältet head towards Akalla with a short concrete tunnel and a trench. The tunnel and trench are built in an area with a great depth of clay, where the clay is also soft. At Akalla, a grade-separated interchange will be built in the form of an elliptic roundabout above the Stockholm bypass.

The roundabout and its ramps will probably be built on a piled deck. The works for the tunnel and trench will be carried out within deep sheet pilings, around 450 m long, with considerable demands on impermeability and anchoring.

The continuation towards Häggvik is located in a deep rock excavation along the Hansta nature reserve.

**Preliminary time schedule FSE61:** production starts in spring 2016, completed in the year of 2021.

Estimated quantities FSE61 Akalla:		
Sealed surface	15 000 m <sup>2</sup>	
Excavated rock	$300000m^3$	
Excavated soil	120 000 m <sup>3</sup>	
Sheet piling	10 000 m <sup>2</sup>	
Concrete	$35000m^3$	

#### TOTAL ESTIMATED QUANTITIES IN AKALLA OCH HÄGGVIK:

#### Major construction elements:

2.5 km new motorway

6 concrete bridges, totalling 500 m in length, the longest bridge 230 m

3 concrete tunnels, total length 550 m, 1 concrete trench of 300 m

Supporting walls, total length 1500 m

Flat slabs 2 500  $m^2$ 

#### Contract for FSE62 Häggvik interchange

The continuation towards Häggvik is located in a deep rock excavation along the Hansta nature reserve. In Häggvik, the new motorway is connected to the existing E4 and the connection includes new bridges and extension to existing bridges, concrete tunnels and supporting walls. In the most intense cross-section, around 20 traffic lanes will share the space. The works will be carried out in an extremely difficult traffic environment, where passage for traffic must always be maintained. On an average weekday, just over 100 000 vehicles pass through.

**Preliminary time schedule FSE62:** production starts in spring 2016, completed in the year of 2021.

stimated	quantities	FSE62 Häggvik:	
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Sealed surface	160 000 m <sup>2</sup>
Excavated rock	500 000 m <sup>3</sup>
Excavated soil	900 000 m <sup>3</sup>
Sheet piling	15 000 m <sup>2</sup>
Concrete	40 000 m <sup>3</sup>

## Contact us:

#### **Project Manager:**

Alexandra Stassais Söderblom Telephone: +46 (0)10-123 88 89 alexandra.stassais-soderblom@ trafikverket.se

#### Contract Manager Akalla:

Stefan Wennerström Telephone: +46 (0)10-123 89 22 stefan.wennerstrom@trafikverket.se

#### Contract Manager Häggvik:

Fredrik Övermo Telephone: +46 (0)70 206 65 38 fredrik.overmo@trafikverket.se

#### Procurement:

Lars Malthe Telephone: +46 (0)10-123 91 07 lars.malthe@trafikverket.se





Swedish Transport Administration SE-171 54 Solna, Sweden • Visiting address: Solna Strandväg 98 www.trafikverket.se • stockholm@trafikverket.se Telephone: +46 (0)771-921 921