iMobility Lab

Hur kan förbättrad ramp metering minska köerna i Södra Länken?

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Motivation

Motorway congestion

- ↓ infrastructure capacity
- ↑ travel delay
- ↓ traffic safety
- ↑ environmental pollution

Control measures

- **Ramp metering** (direct impact on density → congestion)
- Link control (Variable Speed Limits, congestion warnings, etc.)
- Route guidance (VMS, etc.)
- Mainstream traffic control (mainline metering, work zones, bridges, etc.)

Ramp metering

Why ramp metering ?

- Congestion covering on- and off-ramps
- Incident response
- Safer merging

Where ?

- Localized bottlenecks
- Downstream bottlenecks
- Random-location bottlenecks

Metering strategies

Local:

- fixed-times,
- responsive strategies (e.g. ALINEA)

Coordinated:

- multiple bottlenecks,
- restricted storage space

Objective: Maximize throughput ↔ Minimize travel delays

Tunnel closures: Södra Länken

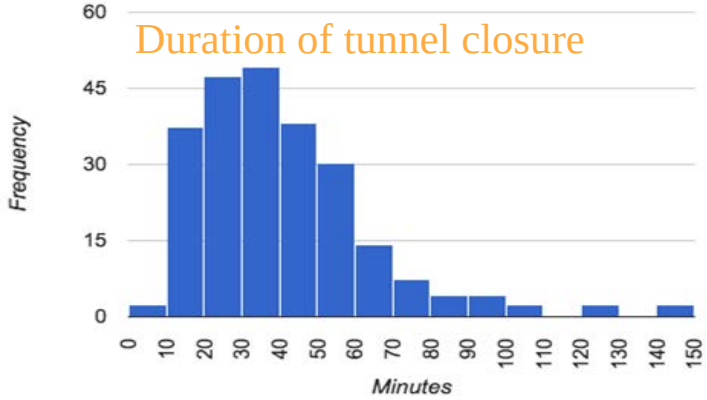


Foto: Christine Olsson

Previous research

Closure

Metering

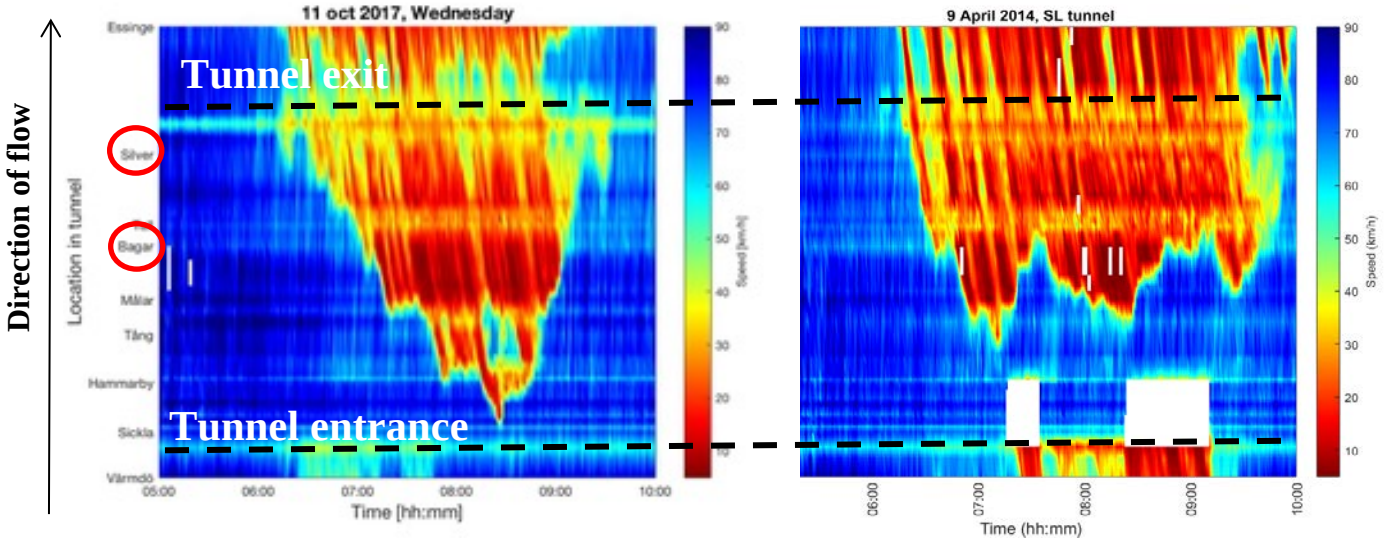
Combinations of metering and closures

- Effective control strategy depends on underlying causes of congestion
- Metering is the most promising strategy

Bottleneck analysis

Congestion patterns:

- Södra Länken - weaving bottlenecks (2014, 2017)
- Essingeleden bottlenecks and weaving bottlenecks (2014)



- MCS speeds, counts (April 2014, October 2017)
- Morning peak:

  5 – 10 am

Study objectives

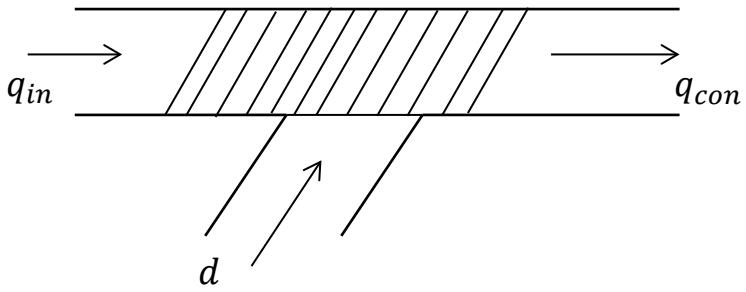
Identify suitable metering strategies to alleviate congestion

- **Critical bottlenecks**
- **Critical ramps** where metering is feasible and beneficial
- **Adequate metering strategies**, and their requirements
- Implementation and evaluation through **traffic simulation**

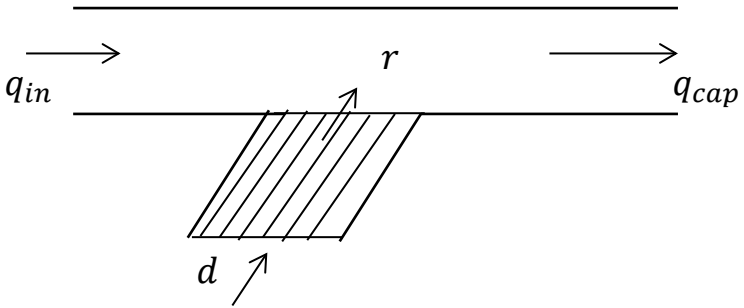
Control methods

Metering strategies:

- Fixed-time: historical traffic measurements (demand)
- Responsive strategies: real-time measurements (occupancy, density)
  - ALINEA (Papageorgiou et al., 1991)

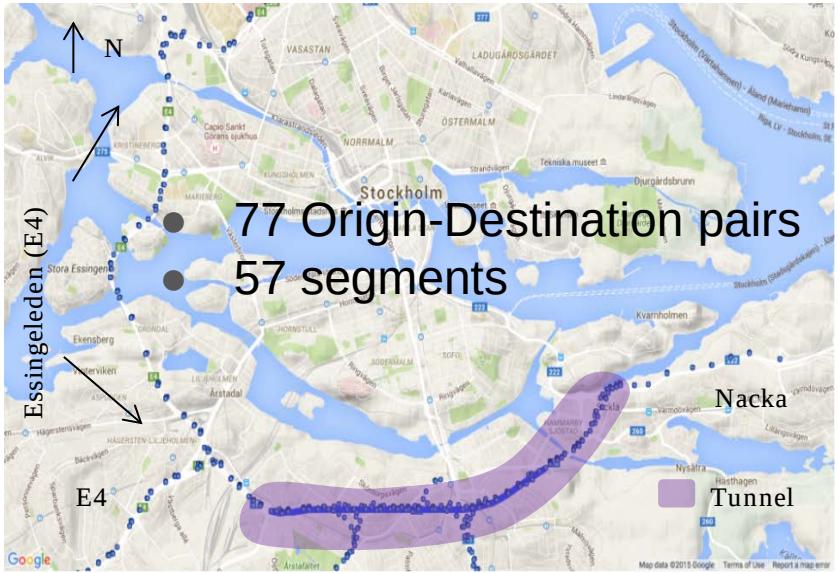


No control

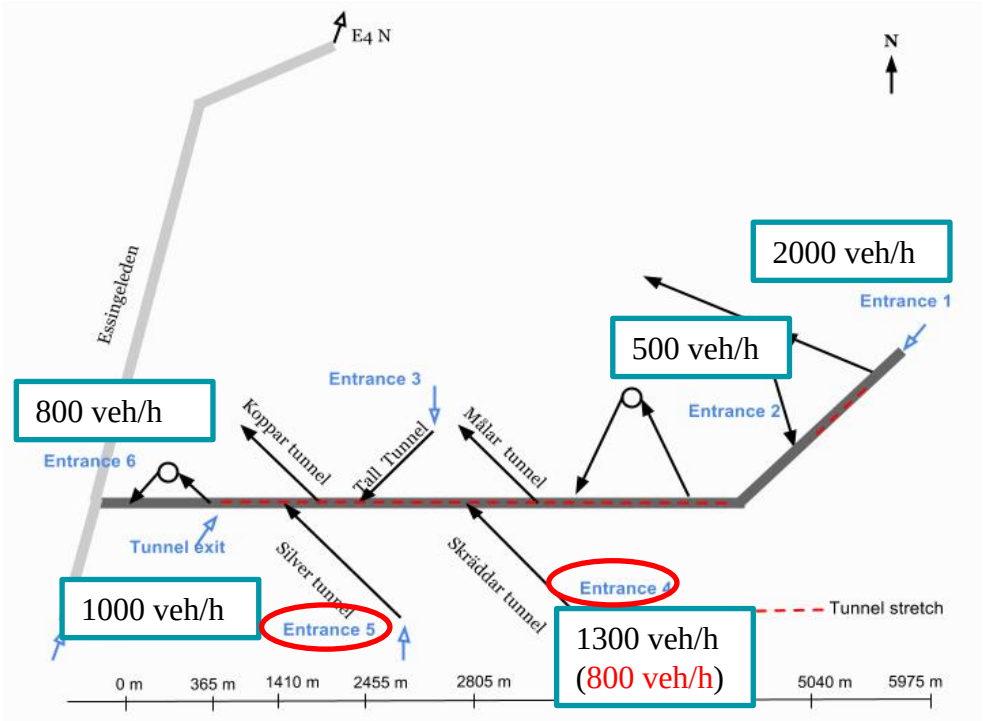


Metering

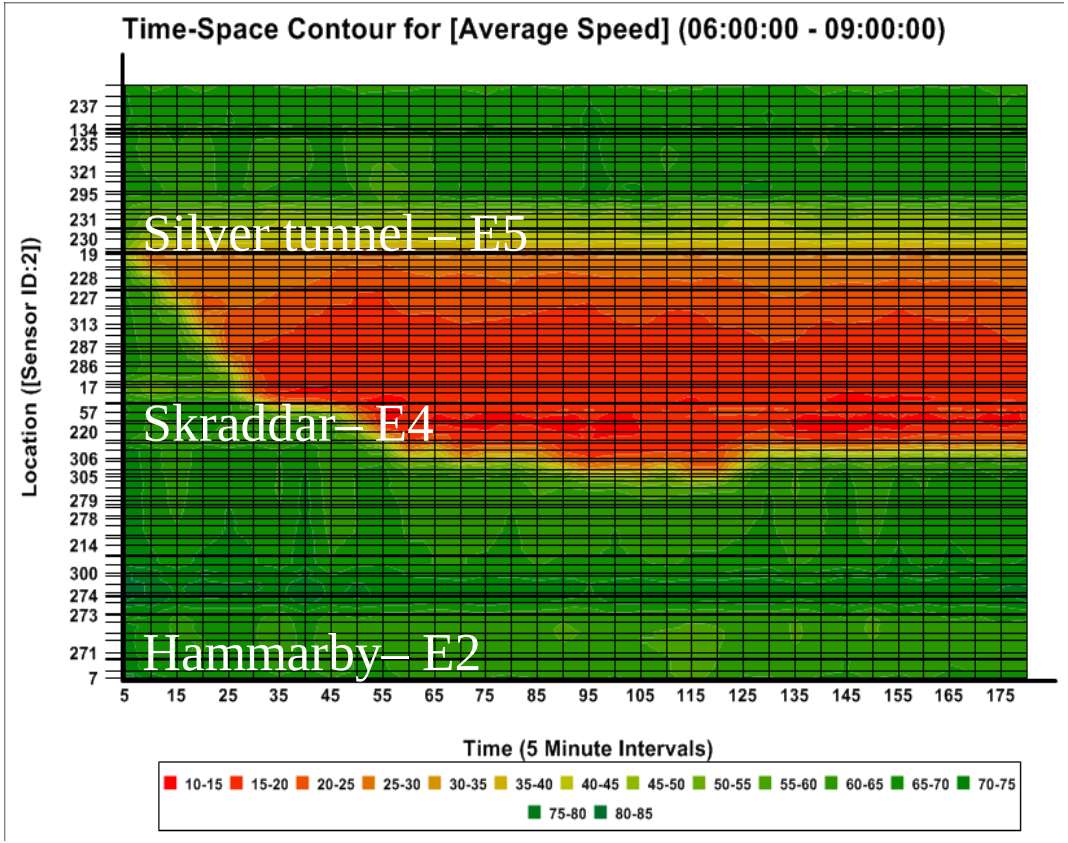
Study network



Microscopic simulation - TransModeler 4.0



Results – No control



Scenario 1:

One-car-per-green metering at entrance 5 (Silver) (6:00 – 8:00 am):

- Cycle 4 sec, rate: 900 veh/h
- Cycle 6 sec, rate: 600 veh/h
- Cycle 7 sec, rate: 500 veh/h

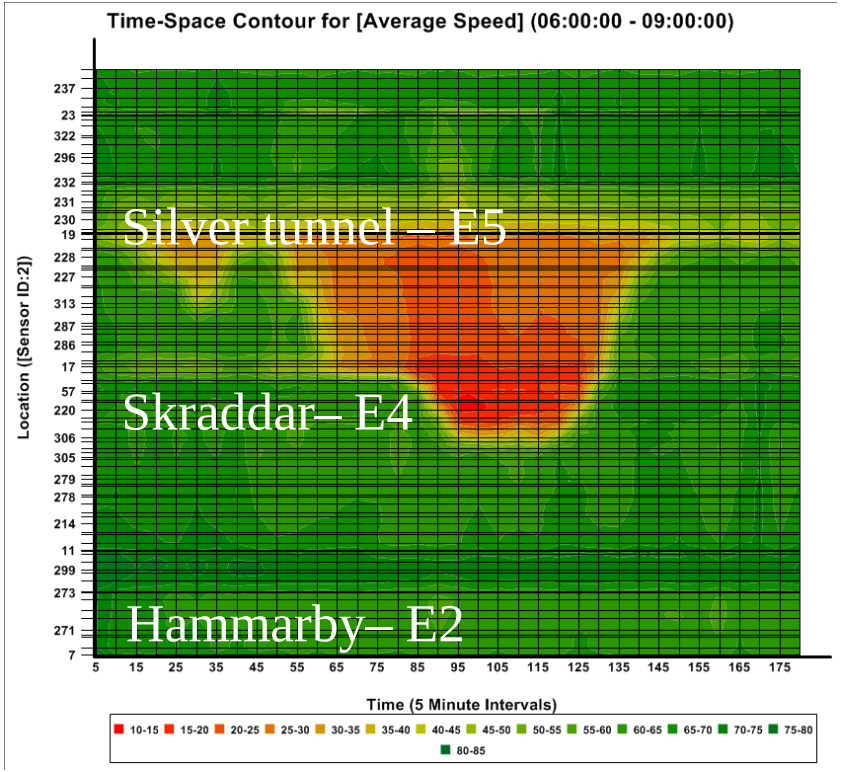
Scenario 2:

Metering at entrance 5 (Silver) (6:00 – 8:00 am): rate 500 veh/h

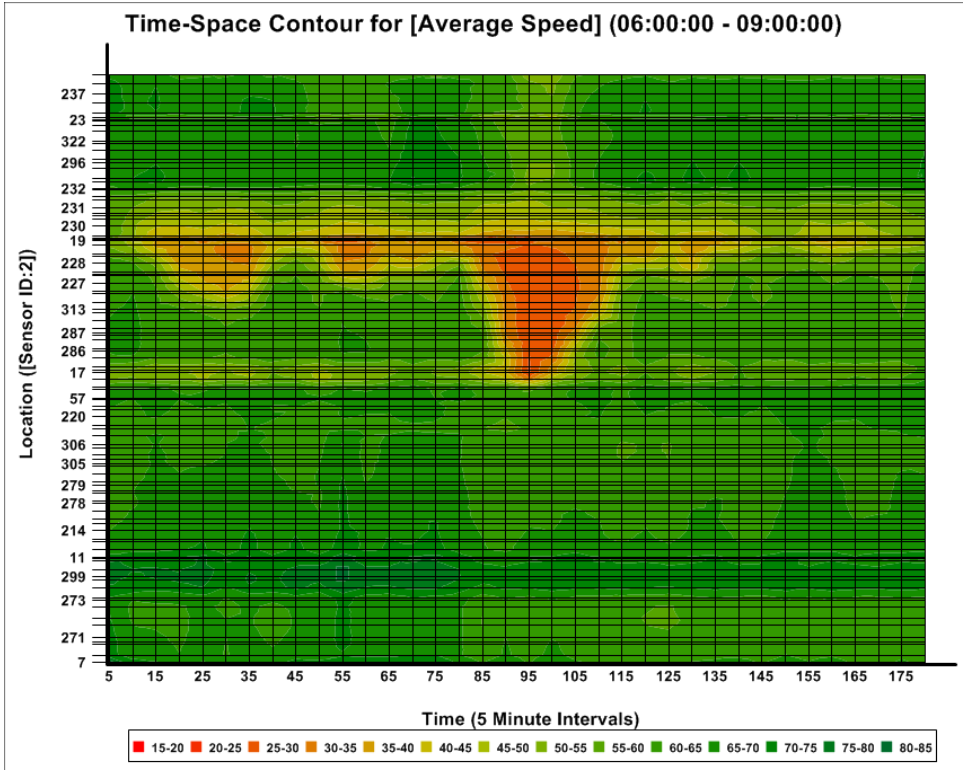
Metering at entrance 1 (Sickla) (7:00 – 7:30 am): rate 900 veh/h

Results – Metering

Scenario 1: Metering entrances 5

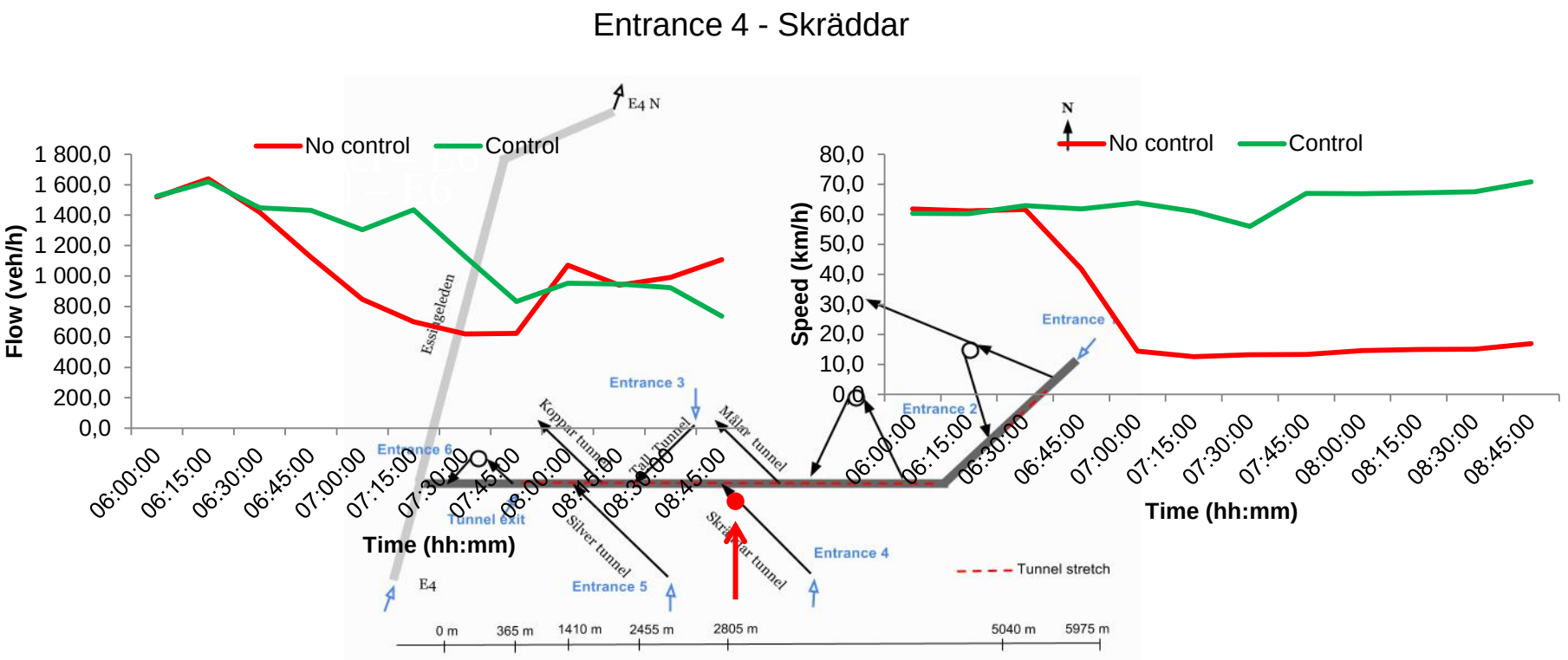


Scenario 2: Metering entrances 5 + 1



Results – Metering

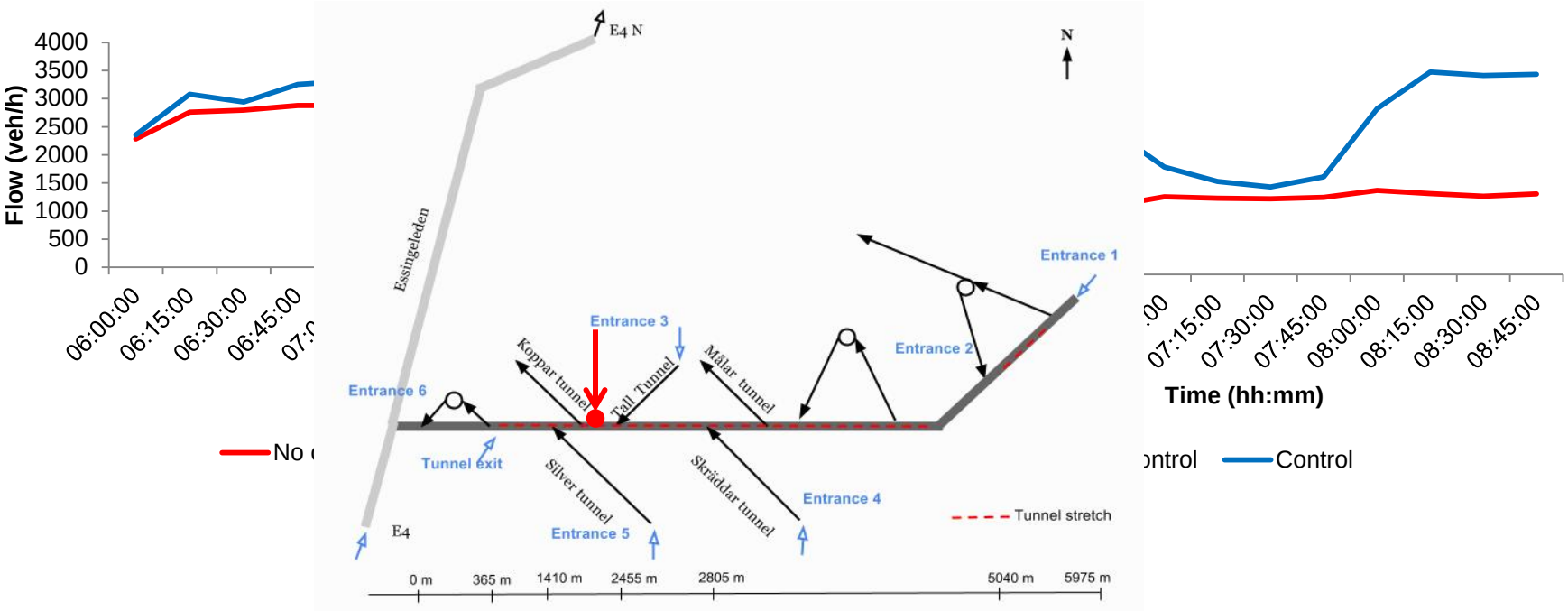
Scenario 1: Metering entrances 5



Results – Metering

Scenario 1: Metering entrances 5

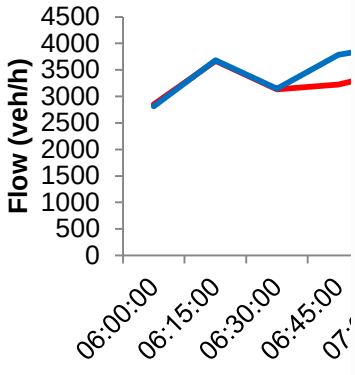
Upstream entrance 5 – mainstream

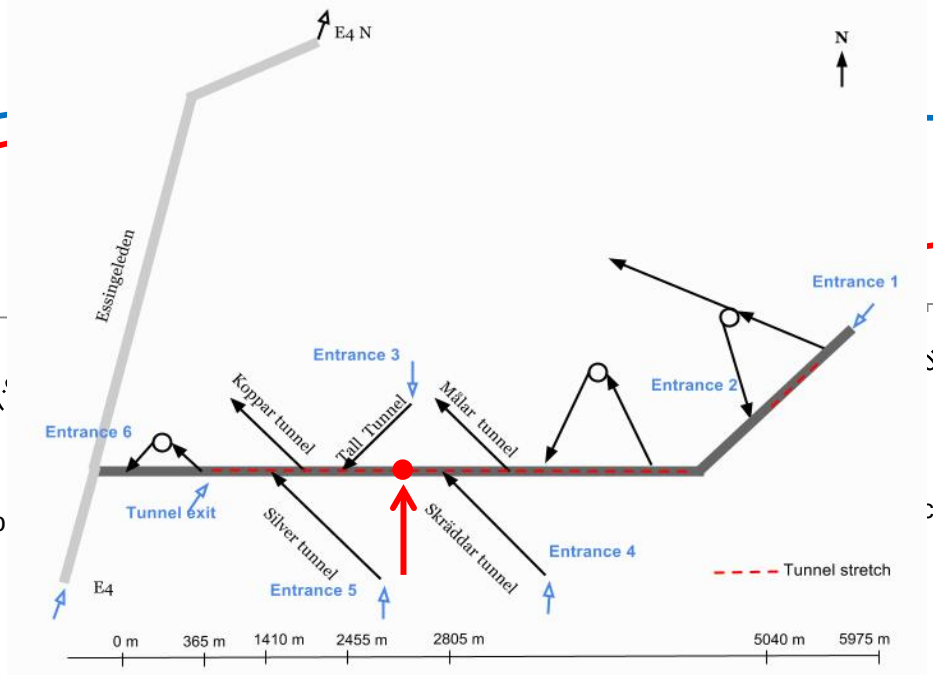


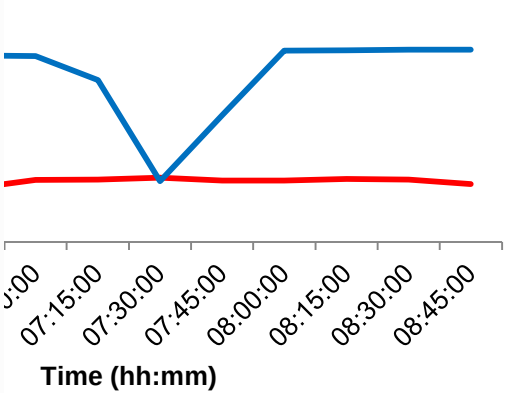
Results – Metering

Scenario 1: Metering entrances 5

Downstream entrance 4 – mainstream

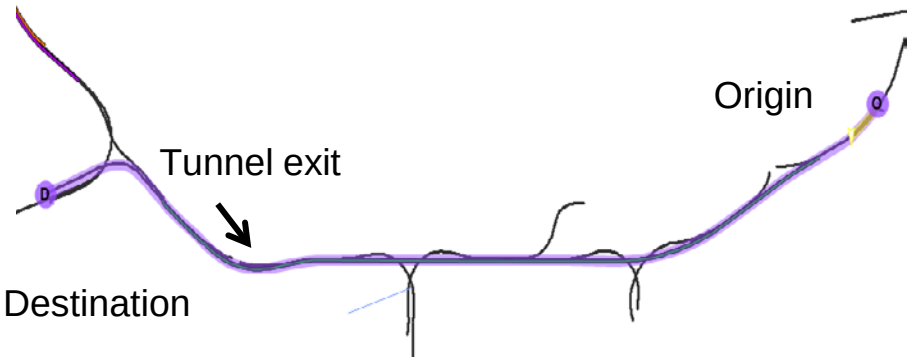


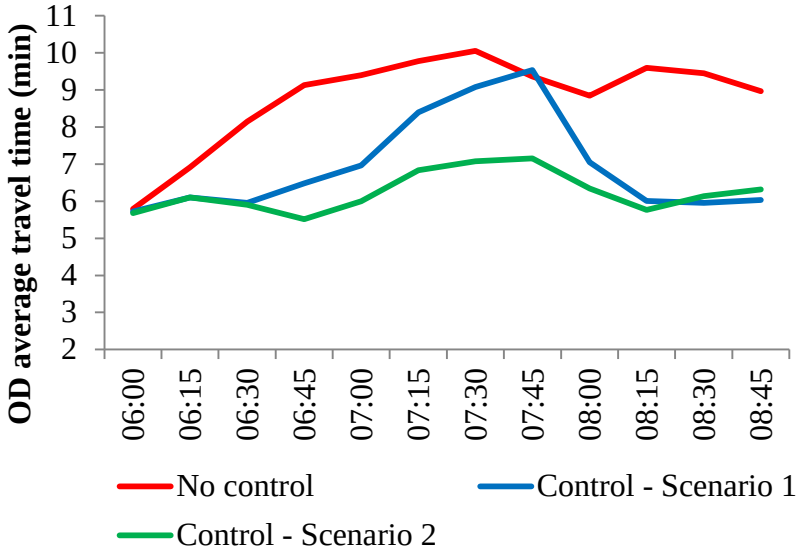




Results – Travel time

Travel times are for select OD pair (6 km)





Conclusions

- Metering helps mitigate congestion and reduce travel times
- Control is critical for some on-ramps
- Control strategy that considers distant bottlenecks

Future work

- Sensitivity analysis for different
    - Demand levels
    - Metering activation time
    - Combination of metered on-ramps
- Integration of different traffic management strategies
- Extended ALINEA (PI-controller) for distant bottlenecks
- Impact of metering on local network – drivers' routing behavior

Thank you!