CHALMERS

Next stop, Haga

A traffic safety investigation of the new train station in Haga, along the future railway tunnel Västlänken

Master of Science Thesis in the Master's Programme Geo and Water Engineering

LARS STRÖMQVIST
CECILIA WIDEMAN

Department of Civil and Environmental Engineering
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CHALMERS UNIVERSITY OF TECHNOLOGY
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Department of Civil and Environmental Engineering
Division of GeoEngineering
Road and Traffic Research Group
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
Vasagatan, Lars Strömqvist

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ABSTRACT

The future railway tunnel Västlänken is a major infrastructural project that will enhance commuting possibilities to, from and through Göteborg. The tunnel is a part of the project K2020, which is a long-range traffic political cooperation between different public organizations in Sweden. Västlänken is planned to be in service in the year of 2028. After the construction of Västlänken, the Haga station will become a large public transport junction. Consequently, there will be larger flows of pedestrians and bicyclists compared to the present state and therefore an increased risk of accidents.

In 1997, the Swedish government adopted the Vision Zero. The aim of this vision is that there should not be any traffic accidents with fatal or severe injuries as an outcome. In 2009 a milestone was decided that the number of fatalities should decrease with 50 % and severe injuries should decrease with 25 % from 2007 to 2020.

The aim of this master thesis is to analyze the traffic situation around the future site of the Haga station today and the situation when Västlänken is built. Furthermore, the intention is to illustrate how the number of injured persons, in the studied area, can be reduced with 50 %. This has been compared between the present state and the future scenario, when the traffic volume has increased as a result of the Haga station. This goal was reached by evaluating changes in traffic flows and changes in the design of the intersections and streets, as well as new speed limits. The changes in traffic flows will increase the number of injuries with approximately 5.7 % while the design and speed measures will decrease the number of injuries with each 46.0 % and 10.0 %. This will lead to a total decrease of 50.1 % of the number of injuries.

Key words: traffic safety, pedestrian, bicycle, motor vehicle, accident, injury, street, intersection, traffic flow, design, speed, station, measures

Haga nästa
En trafiksäkerhetsutredning av den nya tågstationen i Haga längs den framtida järnvägstunneln Västlänken

Master of Science Thesis in the Master's Programme Geo and Water Engineering

LARS STRÖMQVIST
CECILIA WIDEMAN
Department of Civil and Environmental Engineering
Division of GeoEngineering
Road and Traffic Research *Group*
Chalmers University of Technology

SAMMANDRAG

Den framtida järnvägstunneln Västlänken är ett stort infrastrukturprojekt som kommer att förbättra pendlingsmöjligheterna till, från och genom Göteborg. Tunneln är en del av projektet K2020, som är ett långsiktigt trafikpolitiskt samarbete mellan olika offentliga organisationer i Sverige. Västlänken planeras vara i drift år 2028. Efter Västlänkens färdigställande kommer Hagastationen att bli en stor knutpunkt. Detta kommer att leda till större flöden av fotgängare och cyklister jämfört med nuläget och därmed en ökad risk för olyckor.

År 1997 antog den svenska regeringen Nollvisionen. Syftet med denna vision är att det inte skall finnas några trafikolyckor som resulterar i dödligt eller svårt skadade. Under 2009 beslutades det om ett delmål att antalet dödade i trafiken skall minska med 50 % och antalet svårt skadade skall minska med 25 %, från 2007 till 2020.

Syftet med detta examensarbete är att analysera trafiksituationen kring den framtida platsen för Hagastationen idag och situationen när Västlänken är byggd. Dessutom är avsikten att åskådliggöra hur antalet skadade, i det undersökta området, kan reduceras med 50 %. Detta jämförs mellan den nuvarande situationen och det framtida scenariot, när trafikmängden ökar som en följd av Hagastationen. Detta mål nås genom att utvärdera förändringar i trafikflödet, i utformningen av korsningar och gator samt av nya hastighetsgränser. Förändringen av trafikflödet kommer att öka antalet skador med cirka 5,7 % medan design- och hastighetsåtgärder kommer att minska antalet skador med vardera 46,0 % och 10,0 %. Detta ger en total minskning av antalet skadade med 50,1 %.

Nyckel ord: trafiksäkerhet, fotgängare, cyklister, motorfordon, trafikolyckor, skada, trafikflöden, utformning, hastighet, station, åtgärder

Contents

Preface

The Master of Science Thesis has been carried out from December 2010 to June 2011, as a part of the Master's Program Geo and Water Engineering at the department of GeoEngineering, Road and Traffic Research Group, Chalmers University of Technology, Sweden. The project has been carried out at the Traffic group at Sweco in Göteborg, on behalf of the Traffic and Public Transport Authority of Göteborg.

The thesis had not been possible without the help from several people. Therefore, we want to thank the following people:

- Roger Johansson, our supervisor at Sweco
- Gunnar Lannér, examiner at Chalmers University of Technology
- Our reference group consisting of :
    - Bertil Hallman, Trafikverket
    - Tomas Bergbom, Trafikverket
    - Suzanne Andersson, Trafikkontoret
    - Anna Berlin, Trafikkontoret
    - Margareta Lindeberg, Västtrafik
- Stefan Andersson at Sweco for his help with the simulation
- Wolfgang Liepack for the study visit at the City Tunnel in Malmö
- Our opponents Emma Fritzell, Ylva Höglund and Maria Lindelöf

Finally, we want to thank the Traffic group at Sweco and Martin Röcklinger for the support and enjoyable coffee breaks. And of course, a thanks to our supporting families.

Göteborg, June 2011

Lars Strömqvist and Cecilia Wideman

1 Introduction

The future railway tunnel Västlänken is a major infrastructural project that will enhance commuting possibilities to, from and through Göteborg. But how will the new stations affect the traffic safety around the stations? This report will try to give an answer to that question for one of the stations.

1.1 Background

The population of the world is constantly growing, especially in the urban areas, both by concentration and by geographic expansion. The latter one means that more people commute from suburbs to a larger city. During the recent years, the population growth in Göteborg has been lower than the two other large cities in Sweden, Stockholm and Malmö, see diagram 1.1. To be able to increase the growth from geographic expansion, the public transport system has to be developed to obtain a faster and more attractive transport system. This has resulted in the project K2020, which is a long-range traffic political cooperation between the Region Västra Götaland (Västra Götalandsregionen), the Göteborg Region Association of Local Authorities (Göteborgsregionens kommunalförbund), the city of Göteborg, the Swedish Transport Administration (Trafikverket) and the public transportation company Västtrafik.

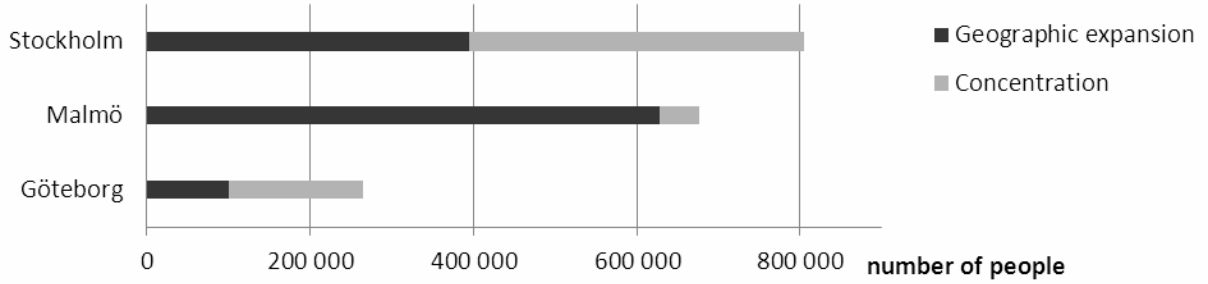


Diagram 1.1. Population growth in the three largest cities in Sweden between 1970 and 2005. (Source (edited): Västra Götalandsregionen, p.3, 2007)

An important part of K2020 is the construction of the railway tunnel Västlänken beneath Göteborg, which is estimated to be completed in the year of 2028 (Trafikverket, 2011c). It is important since the Central station in Göteborg has a low capacity due to the fact that it is a terminus, which is a station where all railway tracks end. One of the three new stations that will be built along Västlänken is the Haga station, see figure 1.1. The two other stops, the Central station and Korsvägen, are, unlike Haga, already large public transport junctions operated by several buses, express buses, trams and trains (only for the Central station). After the construction of Västlänken, the Haga station will also become a large junction. Therefore, there will be larger flows of commuters compared to the present state. Consequently, with the increased flow of commuters there is a risk that there will be more situations that could lead to traffic accidents between pedestrians, cyclists and motor vehicles.

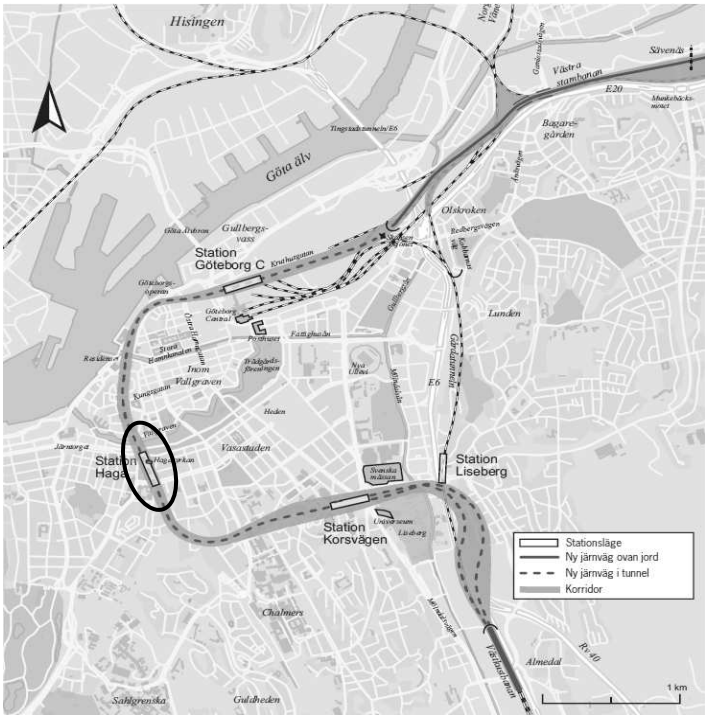


Figure 1.1. The proposed route of Västlänken. The ellipse shows where the Haga station will be located. (Source (edited): Trafikverket, 2010b)

The increased risk has to be decreased by traffic safety measures. This is something many countries have been working with, for example with the help of guidelines. In 1997, the Swedish government adopted the Vision Zero. The aim of this vision is that there should not be any traffic accidents with fatal or severe injuries. The philosophy behind the Vision Zero is different than the normal view on traffic safety. In the Vision Zero it is stated that humans are not perfect, they make mistakes, and therefore the responsibility for traffic safety should lie between system and design and not by individually responsibility. It is also based on that saving lives is not expensive; it is cheap (Vision Zero Initiative, n.d.).

Due to this different view on traffic safety, Sweden is one of the leading countries in traffic safety in the world (NTF, 2011). In 2009, a milestone was decided that the number of fatalities should be decreased with 50 % and severe injuries should be decreased with 25 %, from 2007 to 2020 (Trafikverket, 2010a).

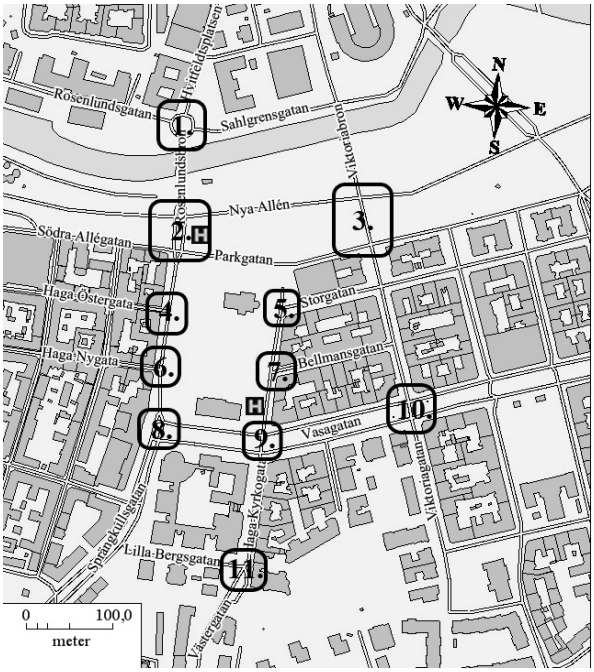
1.2 Purpose

The aim of this master thesis is to illustrate how the number of injuries in the investigated intersections and streets can be decreased with 50 %. This at the same time as the traffic volume increases as a result of the Haga station. This goal is reached by evaluating the changes in traffic flows, changes in the design of the intersections and streets as well as how new speed limits may affect the situation.

1.3 Method

Necessary information has been gathered by performing literature studies. This has been an ongoing process throughout the major part of the project. Furthermore, several site investigations have been performed. This has been done in the different intersections and streets in connection to the exits from the underground station at Haga, see figure 1.2. To obtain data about traffic flows, manual counting has been

performed. Data concerning motorized traffic flows are derived from the Traffic & Public Transport Authority of Göteborg (Trafikkontoret). Prediction of future pedestrian flows has been done in the simulation program VISUM. Moreover STRADA (Swedish Traffic Accident Data Acquisition) is used to analyze what kind and how many accidents that have occurred in the investigated area. Moreover, consultation meetings with a reference group have been carried out. This group consists of personnel from Västtrafik, the Swedish Transport Administration, Traffic & Public Transport Authority of Göteborg and Chalmers University of Technology, who are all well acquainted in the subject.



1. Rosenlundsbron – Sahlgrensgatan

2. Sprängkullsgatan – The Alléstråket

3. Viktoriagatan – The Alléstråket

4. Sprängkullsgatan – Haga Östergata

5. Haga Kyrkogata – Storgatan

6. Sprängkullsgatan – Haga Nygata

7. Haga Kyrkogata – Bellmansgatan

8. Sprängkullsgatan – Vasagatan

9. Haga Kyrkogata – Vasagatan

10. Viktoriagatan – Vasagatan

11. Haga Kyrkogata – Lilla Bergsgatan

Figure 1.2. Studied intersections and streets. (Source: Göteborg Stad, n.d.)

1.4 Delimitation

Accidents that have occurred in the investigated area, from 1999-01-01 until 2010-12-31, which has been reported to STRADA, have been analyzed. Furthermore, unlike the Vision Zero, this thesis also considers minor injuries. This since a minor injury could lead to a lifelong suffering.

When considering the future scenario, traffic safety has been prioritized. Therefore, mobility has been a subordinated parameter in some cases. Analyzes that are made in this report are from pedestrians' and bicyclists' points of view, motor vehicles are viewed as a secondary road user. Furthermore, the thesis does not consider the measures from an economical perspective.

2 Similar Projects

There are several projects that are ongoing, soon to start or finished, that are similar to Västlänken. Two such projects in Sweden are the City tunnel in Malmö and the Stockholm City Line.

2.1 The City Tunnel, Malmö

The City Tunnel in Malmö is similar to Västlänken since Malmö Central station is, as well as Göteborg Central station, a terminus which has reached its capacity. Furthermore, Malmö has no history of any subway or railway tunnel underneath the central parts of the city.

The City Tunnel was built to develop the Öresund region, which consists of the southernmost part of Sweden and the island Zealand in Denmark. The 4.5 km long tunnel links Malmö Central station to the Öresund Bridge and Copenhagen as well as Ystad and Trelleborg in Skåne, see figure 2.1 (Trafikverket, 2011a). Along the tunnel has three new stations been built, two underground stations at Malmö C and Triangeln and one station at the surface shortly after the southern tunnel exit, Hyllie. The tunnel has its exits in conjunction to the stations Malmö C and Hyllie.

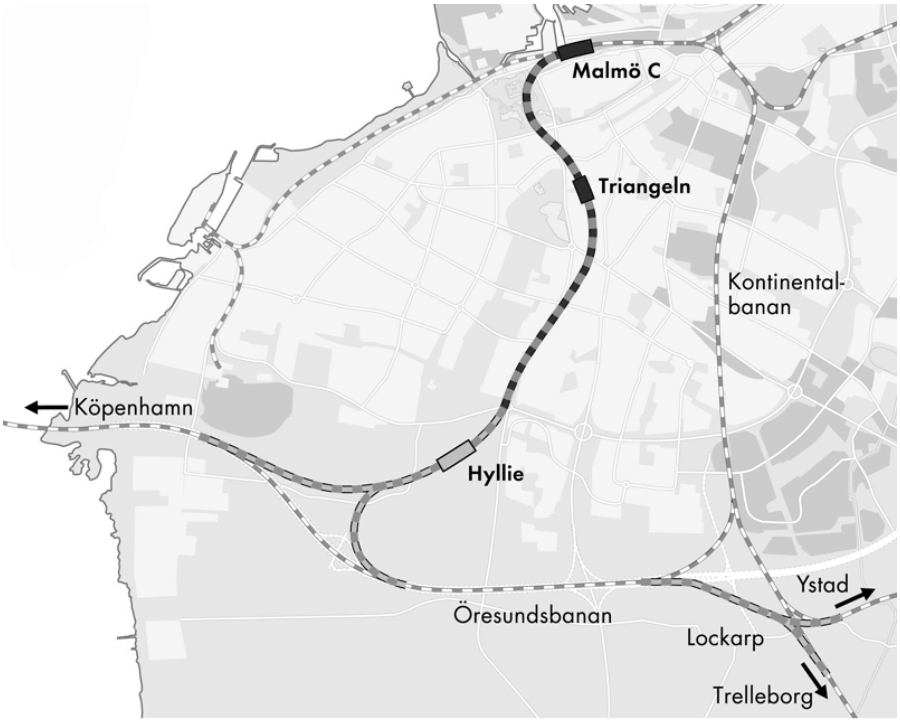


Figure 2.1. The route of the City Tunnel. (Source: Trafikverket, 2011a)

Another similar aspect to Västlänken is the station Triangeln. It is located in the central parts of the city and was not a large junction before the start of the project, just like the situation with the planned Haga station. The station has two entrances, they are located northwest of the S:t Johannes church and one further south next to the Dental School. The entrance next to the Dental School has one main exit and two smaller exits on each side, in the station building. In a few years the buses that operate in central Malmö along a street east of Triangeln will be moved to a street that passes just west of the northern entrance to the station with a bus stop close to the entrance (Liepack, W, 2011).

Measures have been made to create a safer environment around the entrances by constructing collision protections, see figure 2.2. This has been done to prevent larger vehicles from driving into the station or a crowd of people.

Figure 2.2. Collision protection at one of the entrances to the station Triangeln. The area around the entrance is under construction. (Photo: Cecilia Wideman)

A difference between the Triangeln station and the Haga station is the surroundings. The Triangeln station is built in a quite calm area without high levels of traffic volumes, while the Haga station is planned to be built in an area with some of central Göteborg's most busy streets, the Alléstråket. Although the station Triangeln is built, the area around it is still a construction site. A new mall and square is being constructed in the proximity to the station.

2.2 The Stockholm City Line

The reason that the Stockholm City Line is going to be built is since the capacity on the two tracks south of Stockholm has reached its limit. The City Line will double the track capacity in Stockholm. The City line is a 6 km long tunnel where only commuter trains will operate. There will be two stations; Stockholm City and Stockholm Odenplan. It is planned to be opened in 2017 (Trafikverket, 2 011b).

The City Line in Stockholm is somewhat different from the other two cities' projects since the different stations already are large junctions. Furthermore, Stockholm already has an existing network of railway tunnels, the metro.

3 The Present Situation

The Haga station will be located on the border between two city districts, Haga and Vasastaden, beneath the Haga Park. Both districts are among the older of Göteborg's city districts, with a 19th century-atmosphere. However, the two districts are quite different from each other. Haga is an old working class neighbourhood renowned for its picturesque wooden houses and narrow streets, while Vasastaden is a district consisting of stone buildings with wide streets. Nowadays, both districts are popular places to visit by tourists. Among the tourist attractions in the area there are several that distinguish themselves from the others, such as the street Haga Nygata, with its small shops and cafés, see figure 3.1, the redoubt Skansen Kronan, the spa Hagabadet and the large fish-market, Feskekôrka. More mundane locations in the area are the many schools, like Handelshögskolan, Pedagogen and Schillerska and the emergency hospital Axcessakuten.

Figure 3.1. Haga Nygata. (Photo: Lars Strömqvist)

At present, there are three bus and tram stops in the area, Hagakyrkan, Vasa Viktoriagatan and Handelshögskolan. They are operated by several buses and tram lines. At the stop Hagakyrkan it has been observed that, today, at peak hours it has reached its capacity due to that it is often queue in to the tram and bus stop.

3.1 Traffic flows

The area is dominated by three larger passages Vasagatan, Sprängkullsgatan and the Alléstråket, which consists of Parkgatan, Södra Allegatan, Norra Allégatan and Nya Allén. For specific values of the traffic flows, see appendix 1.

3.1.1 Pedestrians

Manual counting of pedestrian flows has been done in March during rush hour between 7-9 am and 3.30-5.30 pm to get the maximum flow. The counting was recorded in 5-minutes interval. The maximal flow in 15 minutes has been multiplied by 4 to get the flow in a maximum hour.

The pedestrians are primarily using Vasagatan when travelling in the area, see figure 3.2. Furthermore, there are also large volumes in conjunction to intersection 2 where the tram and bus stop Hagakyrkan is located. However, the number of users on Parkgatan might be exaggerated, this since the stop is located at beginning of Parkgatan.

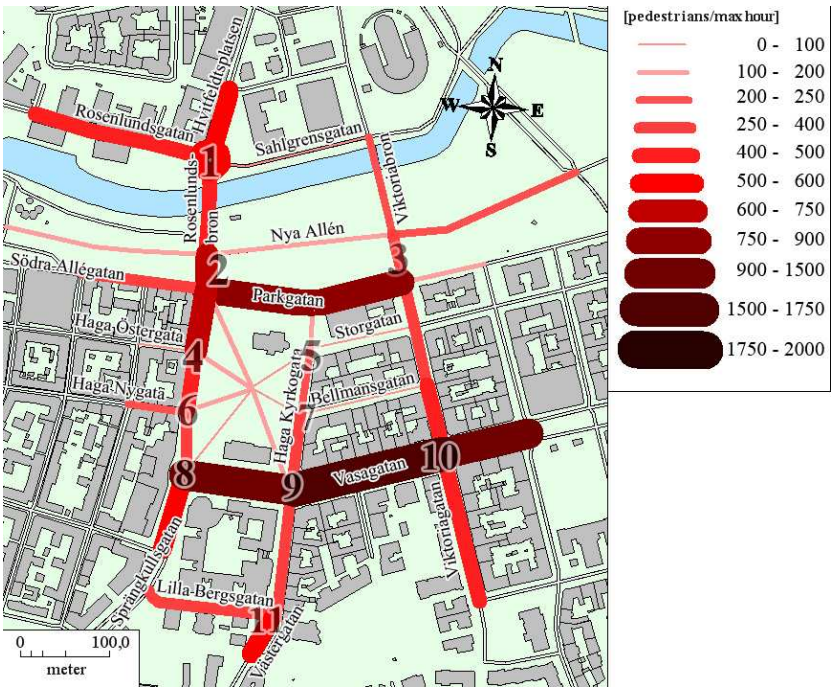


Figure 3.2. Present flows of pedestrians in the investigated area.

3.1.2 Bicyclists

Bicyclists have been manually counted in the same way as the pedestrians to get the maximal flow in one hour. In a year there are large variations of the bicyclist flows, as shown in figure 3.3 for the street Dag Hammarskjöldsleden in Göteborg. Counting of bicyclists flow has been done in March. Therefore, it has been recalculated into 85-percentile of the quarter 2 and 3, where there are larger flows. It is assumed that the variation in Dag Hammarskjöldsleden vary the same as in the studied area in the report. The bicyclists travel generally through the area along one of the three major passages, see figure 3.4.

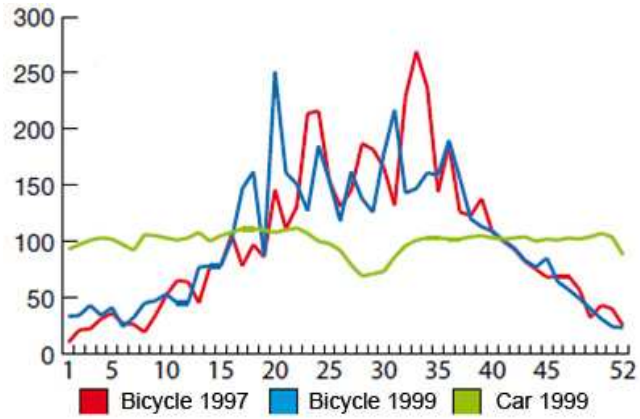


Figure 3.3. The difference in bicycle volumes for two years, 1997 and 1999 and for motor vehicles in 1999. (Source (edited): Göteborg Stad, 2011).

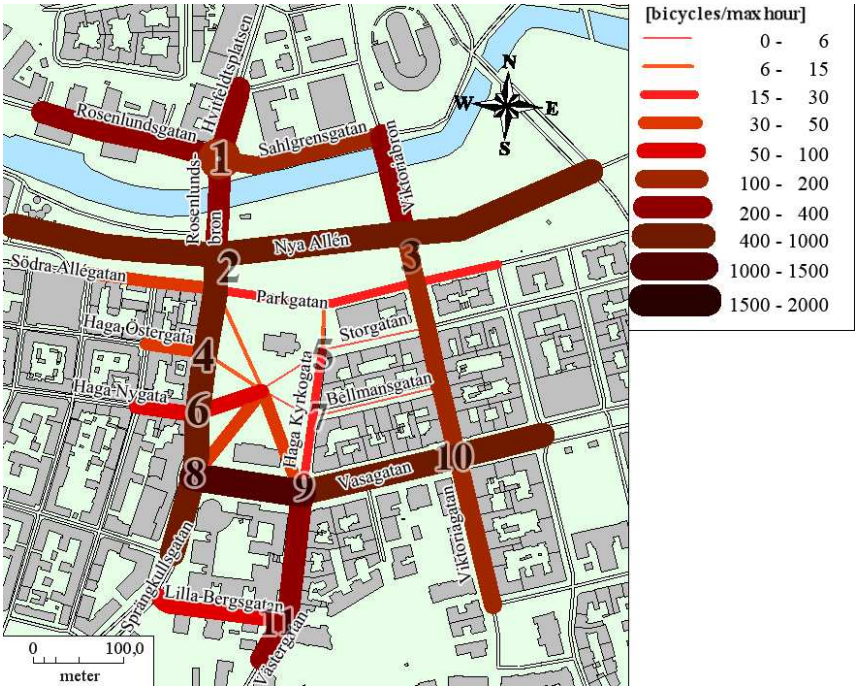


Figure 3.4. Present flows of bicycles in the investigated area.

3.1.3 Motor vehicles

Motor vehicles have, like the bicyclists, the largest flows in the three major passages, see figure 3.5. The data have been acquired from the Traffic & Public Transport Authority of Göteborg (Göteborg Stad, n.d.). Two streets were missing data, Haga Östergata and Haga Nygata, therefore have the flows on those two streets been manually counted. Observe that only the Alléstråket has been divided in each direction due to that they are one-way streets. Therefore, it looks like there is a higher flow on Sprängkullsgatan compared to the Alléstråket.

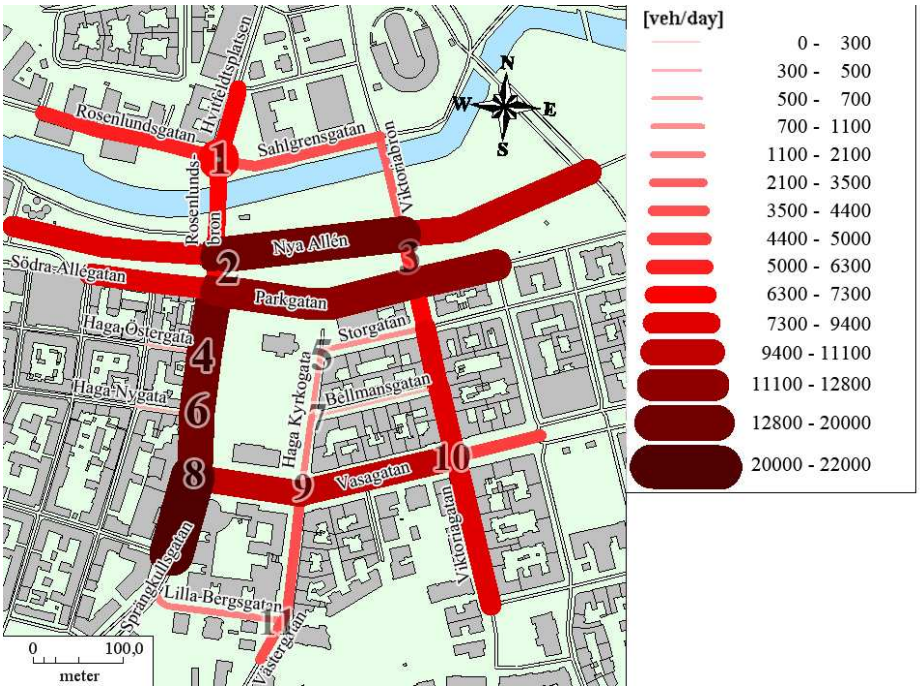


Figure 3.5. Present flows of motor vehicles in the investigated area. (Source: Göteborg Stad, n.d.)

3.2 Design

Design is an important aspect when considering traffic safety. There are several parameters of the design to take into account. Among the more important are speed reduction measures. The text is divided; first it presents the design of the streets and afterwards the design of the intersections.

3.2.1 Streets

The type of streets in the studied area differs a lot. Here it is presented the type of street, what traffic rules that there are, number of lanes, if there is parking along the street, if there is any kind of speed reduction measure, if there are sidewalks, zebra crossing and bicycle lane/path. A bicycle path is when the bicyclists travel on a separate path while a bicycle lane is when the bicyclists travel in separated lane in the carriageway together with the motor vehicles.

3.2.1.1 Rosenlundsgatan/Sahlgrensgatan

The streets are both two-ways with one lane in each direction. The streets have sidewalks on each side of the road. It is allowed to park along Rosenlundsgatan while Sahlgrensgatan have marked angle parking spaces along the whole south side and along approximately half the north side.

3.2.1.2 Nya Allén

Nya Allén is a one-way street going east to west with three lanes, but after the intersection 2 it becomes a two-lane street. The street is a main road through the whole area. The middle lane before intersection 2 is an emergency route.

A bicycle path is located on the south side of Nya Allén along the street with trees separating it from the street. On the north side along the street is a pedestrian path located, also separated with trees.

3.2.1.3 Södra Allégatan/Parkgatan

Both Södra Allégatan and Parkgatan are main roads that have two lanes; one of the lanes is shared with trams and buses. It is only allowed to travel west-east direction along the streets. East of intersection 3, Parkgatan get three lanes instead, this since the buses and trams have turned in the intersection.

Along Parkgatan, east of intersection 3, it is not allowed to park, and during rush hour (7.00-9.00 and 15.00-18.00) it is not allowed to stop. The same applies for Södra Allégatan west of intersection 2. However, between intersection 2 and 3, it is never allowed to park or stop on Parkgatan.

There are sidewalks along the south side of the streets. Along Parkgatan, between intersection 2 and 3, is the sidewalk partly separated with a fence from the street. However, the fence is not complete, see figure 3.6. Between intersection 2 and 3 is a zebra crossing to the tram and bus stop. From analyzes of the accidents and from ocular observation along the street it can be evaluated that accidents happens due do that persons take a shortcut over the streets to reach the buss and tram stop at Haga instead of using the zebra crossing. There are no bicycle lanes along the streets. However, it has been observed that bicyclists use the carriageway.

Figure 3.6. The sidewalk south of Parkgatan. (Photo: Cecilia Wideman)

3.2.1.4 Haga Östergata

Haga Östergata is an one-way street, east-west direction, and it is not permitted to park along the side of the street. The street is narrow and has sidewalks on both sides consisting of setts.

3.2.1.5 Storgatan

Storgatan is a two-way street and has sidewalks on both sides. There are angle parking spaces located along the north side and along the southern side it is permitted to stop and park.

3.2.1.6 Haga Nygata

Haga Nygata is a living street, a street where the traffic is on the pedestrians' terms. Both bicycle and motor vehicles have to travel at pedestrian speed and give way for pedestrians. Moreover, coming from a living street out to a larger street, one has to give away for intersecting traffic.

3.2.1.7 Bellmansgatan

The street is a one-way street going west. It has sidewalks on both sides and it is permitted to park along the north side of the road.

3.2.1.8 Vasagatan

Vasagatan is a two-way street with an alley in the middle that separates the two directions. In the middle of the alley there are both a pedestrian path and a bicycle path that are separated with setts in the pavement. There are sidewalks on both sides of the street and it is allowed to park along the major part of the street. Vasagatan, in the direction towards Sprängkullsgatan, gets two lanes 35 meters before intersection 8. Just before that it is an elevated zebra crossing, passing Vasagatan. Before that there are parking spaces along the street. In the direction from Sprängkullsgatan, after the intersection 8 it is a parking space for physically impaired and space to stop but it is not allowed to park.

Vasagatan is operated with trams, except in the beginning between Haga Kyrkogata and Sprängkullsgatan. A tram and bus stop is located to the east of intersection 10.

3.2.1.9 Lilla Bergsgatan

Lilla Bergsgatan is a one-way street in the west, but after an exit from a building it becomes a two-way street. It is allowed to park along the north side of the street.

3.2.1.10 Hvitfeldtsplatsen/Rosenlundsbron

The recommended speed at Rosenlundsbron is 30 km/h and it is not allowed to park along it. At Hvitfeldtsplatsen it is allowed to park on the west side but not on the east side. Along Rosenlundsbron there are bicyclist lanes on each side that are one-way. Although it has been observed that bicyclists travel in the wrong direction going south to north on the west side. This is probably due to the lack of bicycle lane/path along the east side of Sprängkullsgatan and therefore has to cross Rosenlundsbron at the north part of intersection 2. To wait for green light takes time, therefore they choose to go against the traffic on the bicycle way and later pass Rosenlundsbron. There has been put up one-way sign in the southern end of the street. However, it does obviously not prevent them going in the wrong direction.

3.2.1.11 Sprängkullsgatan

Sprängkullsgatan is an emergency route. The street has, along the major part, two traffic lanes. In the direction heading north the street has only one lane between the intersections 8 and 6. In the southern direction the street has only one lane between the intersections 2 and 6.

Sprängkullsgatan is a main road and therefore not permitted to park along. There is one parking lot for physically impaired after intersection 8 going south. Afterwards, there is also a smaller loading zone. 70 meters south of the intersection 8 there is an elevated zebra crossing.

There are sidewalks along both sides of the street. Bicyclist paths are located on the west side and on the east side on the south part of Sprängkullsgatan before intersection 8. After the intersection 8 it has been observed that some bicyclists that travel on the east side of Sprängkullsgatan at the street towards intersection 2.

3.2.1.12 Haga Kyrkogata (north part)

The north part of Haga Kyrkogata is a one-way street going south. However, it is observed that bicyclists travel on the road in both directions. On the east side of Haga Kyrkogata is a sidewalk where it is allowed to park along. On the west side there are angled parking lots. Behind these parking lots is the Haga Park located with a playground, see figure 3.7.

Figure 3.7. Haga Kyrkogata with the angle parking, park and playground, to the left. (Photo: Cecilia Wideman)

3.2.1.13 Haga Kyrkogata (south part)/Västergatan

Both streets are two-way streets that tram operates along. Motor vehicles drive in the same lane as the trams. Tram stops are located on the south and north side of the intersection 11. There are street parking spaces along both sides in both the streets, except where the tram stops are located.

The streets have side-walks on both sides. Bicyclists travel on the street. It is marked a few meters long bicycle lane on the right side of the tram stop when coming from south on Västergatan.

3.2.1.14 Viktoriabron/Viktoriagatan

Viktoriagatan and Viktoriabron are two-way streets with one lane in each direction shared with trams. In the south direction along Viktoriagatan, between intersection 3a and 3b is a bus lane.

Along Viktoriagatan south of intersection 3 there is street parking on both sides of the road. It is not allowed to park along Viktoriagatan north of the intersection 3 as well as on Viktoriabron.

On both sides there are sidewalks. North of intersection 3 there are one-way bicycle lanes on each side of the road. There is an unmarked one-way bicycle lane next to the bus lane, with traffic lights for the bicyclists.

3.2.2 Intersections

As well as the streets in the studied area, the intersections do also differ a lot. Here are the types of intersections presented, what traffic rules that are applied, number of lanes, if there are any kind of speed reduction measures, sidewalks, zebra crossings, bicycle lane/path and bicycle crossing.

3.2.2.1 Intersection 1: Rosenlundsbron – Sahlgrensgatan

This intersection is an elevated roundabout with four streets leading in to it. There are no marked zebra crossings in or around the intersection, see figure 3.8. There is a

bicycle lane marked with setts in the roundabout. However, it is not that clearly highlighted, it might be missed by motor vehicles. The directions of the bicycle lanes are marked in the pavement with painted arrows.

Figure 3.8. Intersection 1. (Source: Transportstyrelsen, n.d.)

3.2.2.2 Intersection 2: Sprängkullsgatan – The Alléstråket

The intersection is divided into two intersections: 2a; the northern one, and 2b; the southern one. This is due to that the directions are separated with an about 25 meters wide green area, see figure 3.9. Moreover, the traffic flows are larger in comparison to the other studied streets. Both intersections are regulated by traffic lights.

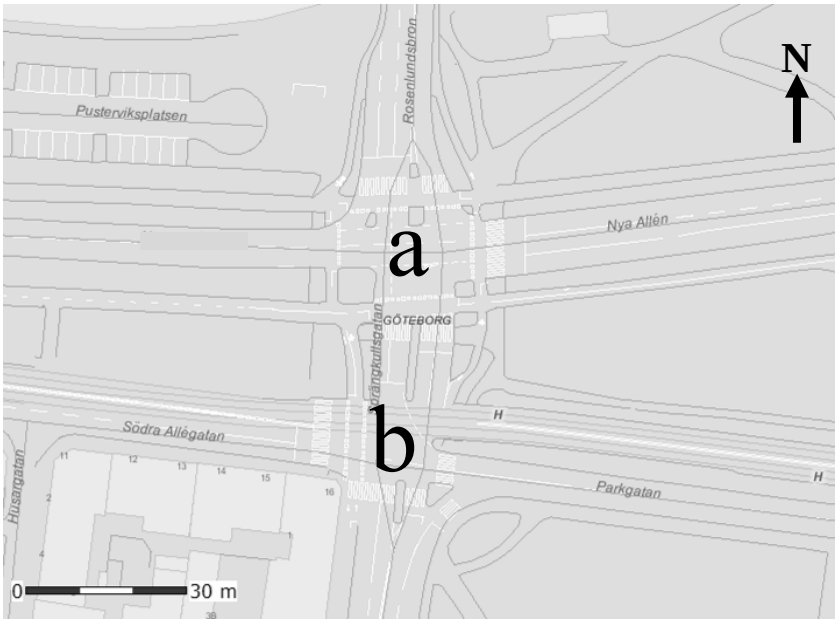


Figure 3.9. Intersection 2. (Source: Transportstyrelsen, n.d.)

3.2.2.2.1 Intersection 2a: Sprängkullsgatan – Nya Allén

There are zebra crossings on all intersecting streets and traffic islands in the middle of Sprängkullsgatan, at both the south and north part.

To alert motor vehicle users that are turning left from Nya Allén a warning sign that lights up when bicyclists have green light, has been installed.

3.2.2.2.2 Intersection 2b: Sprängkullsgatan – Södra Allégatan/Parkgatan

Motor vehicles coming from west at Södra Allégatan are not permitted to turn left. Coming from north on Sprängkullsgatan it is not allowed to turn left during rush hour in the afternoon (16.00-18.00). There are zebra crossings on each intersecting street. On the south part of the intersection there are two traffic islands; one separating the two directions and one dividing the two lanes, the right turning and the one going straight. The latter traffic island is formed as a triangle and is not very large, see figure 3.10.

Figure 3.10. The triangle shaped traffic island in the south-east part of intersection 2b. (Photo: Cecilia Wideman)

3.2.2.3 Intersection 3: Viktoriagatan – The Alléstråket

Intersection 3 is, like intersection 2, divided into two intersections: 3a; the north one, and 3b; the south one. This is due to that the directions are separated with an about 40 meters wide green area, see figure 3.11. The intersection is regulated by traffic light signals.

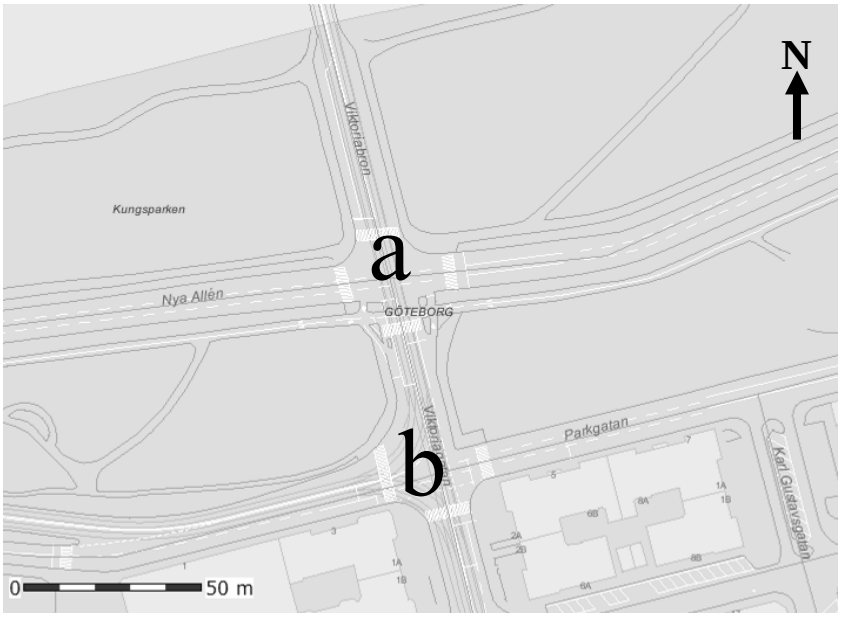


Figure 3.11. Intersection 3. (Source: Transportstyrelsen, n.d.)

3.2.2.3.1 Intersection 3a: Viktoriagatan – Nya Allén

Viktoriagatan in the south direction going from the intersection is a bus lane and therefore, it is not allowed to turn left from Nya Allén. Although, it has been observed that cars drive there anyway, see figure 3.12. This causes a traffic safety problem. There are zebra crossings on all intersecting streets. When turning right, going north to west, there is space for one car in a new lane.

Figure 3.12. The car in the middle is standing in the bus lane. (Photo: Cecilia Wideman)

3.2.2.3.2 Intersection 3b: Viktoriagatan – Parkgatan

Trams operate north-west as well as south-west in the intersection. There are zebra crossings on all intersecting streets. At the zebra crossing over the street in west there is a problem due to that the pedestrians have green light at the same time as the trams have green light to turn south-west and the pedestrians have to give way. To warn the pedestrians that a tram is approaching, a sign has been put up, see figure 3.13. However, this sign is difficult to see for pedestrians. Moreover, this sign is supplemented with a flashing sign warning for trams.

Figure 3.13. The sign says: Watch out! Trams from both directions. (Photo: Cecilia Wideman)

3.2.2.4 Intersection 4: Sprängkullsgatan – Haga Östergata

The intersection is a T-intersection where Sprängkullsgatan is a main street. In the extension of Haga Östergata is an elevated zebra crossing located. Approximately in the middle of the zebra crossing is a traffic island located. The zebra crossing is longer on the east part of the traffic island than on the west side. This is due to two lanes instead of one lane as it is one the east side, see figure 3.14. Furthermore, it is only the motor vehicles traveling on Sprängkullsgatan in south direction that are allowed to turn in to Haga Östergata.

Figure 3.14. Intersection 4. (Source: Transportstyrelsen, n.d.)

3.2.2.5 Intersection 5: Haga Kyrkogata – Storgatan

The intersection is an L-intersection, but with pedestrians and bicyclists entering from all four directions. There is a parking lot just north of the intersection which enters Storgatan to the east, just before the intersection, see figure 3.15.

Figure 3.15. Intersection 5. (Source: Transportstyrelsen, n.d.)

3.2.2.6 Intersection 6: Sprängkullsgatan – Haga Nygata

The intersection is a T-intersection where Sprängkullsgatan is a main street. In the extension of Haga Nygata is an elevated zebra crossing located. Approximately in the middle of the zebra crossing is a traffic island located, see figure 3.16. It is only permitted to turn right out from Haga Nygata to Sprängkullsgatan, and turn right coming north from Sprängkullsgatan to Haga Nygata.

Figure 3.16. Intersection 6. (Source: Transportstyrelsen, n.d.)

3.2.2.7 Intersection 7: Haga Kyrkogata – Bellmansgatan

The intersection is a T-intersection with connecting pedestrian path from the Haga Park in the west. Both of the streets are one-way streets, Haga Kyrkogata goes north-south and Bellmansgatan goes east-west. There are no zebra crossings in the intersection, see figure 3.17.

Figure 3.17. Intersection 7. (Source: Transportstyrelsen, n.d.)

3.2.2.8 Intersection 8: Sprängkullsgatan – Vasagatan

The intersection is a T-intersection that is regulated by traffic lights. There is one zebra crossing in the middle of the intersection that crosses Sprängkullsgatan as an extension of the Alley in the middle of Vasagatan. It is elevated although there is a great extent of settlements, and therefore it might not be considered as elevated anymore. There are zebra crossings also at the east part of the intersection across Vasagatan, see figure 3.18.

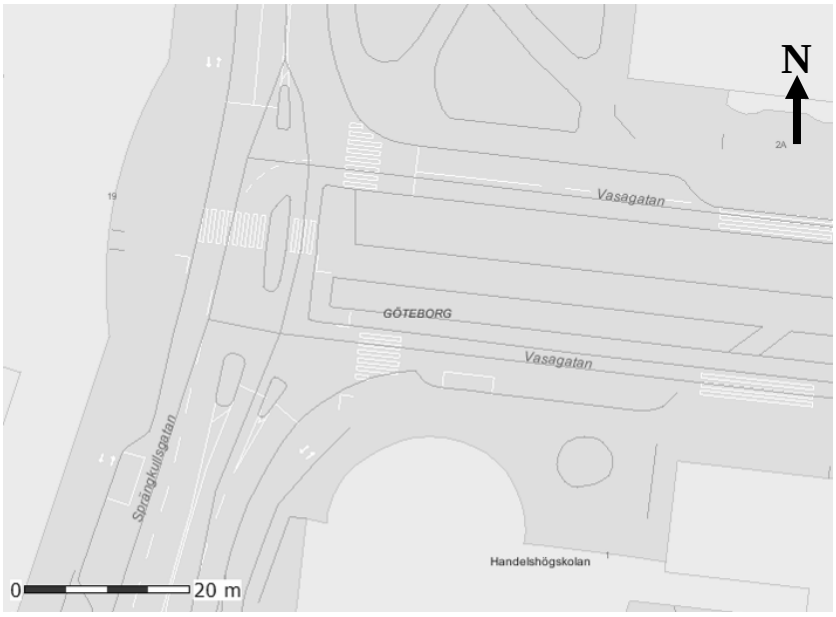


Figure 3.18. Intersection 8. (Source: Transportstyrelsen, n.d.)

3.2.2.9 Intersection 9: Haga Kyrkogata – Vasagatan

Trams operate this intersection in south-east direction. Motor vehicles from Haga Kyrkogata have to give way for those traveling on Vasagatan. However, trams are always given priority. There are flashing warning signs that warns the motor vehicles when trams are approaching. In the middle of the intersection there is a traffic island. There are zebra crossings on all sides of the intersection. In the west-east direction passing the traffic island in the middle, is a zebra crossing together with bicycle crossing, see figure 3.19.

A fence by the southwest zebra crossing has been made longer and ends just before the zebra crossing. This to make the width clear so that the drivers do not think that there is space for two vehicles over the zebra crossing.

Figure 3.19. Intersection 9. (Source: Transportstyrelsen, n.d.)

3.2.2.10 Intersection 10: Viktoriagatan – Vasagatan

Trams operate the intersection north-east, north-west and east-west direction. There are street parking spaces along the sides of both intersecting streets. There are zebra crossings on all sides of the intersection. In the middle in the west-east direction is a zebra crossing together with bicycle crossing, see figure 3.20. When coming from west, just before the intersection, after parking places along the street, starts a new lane for vehicles that turns right, see figure 3.21.

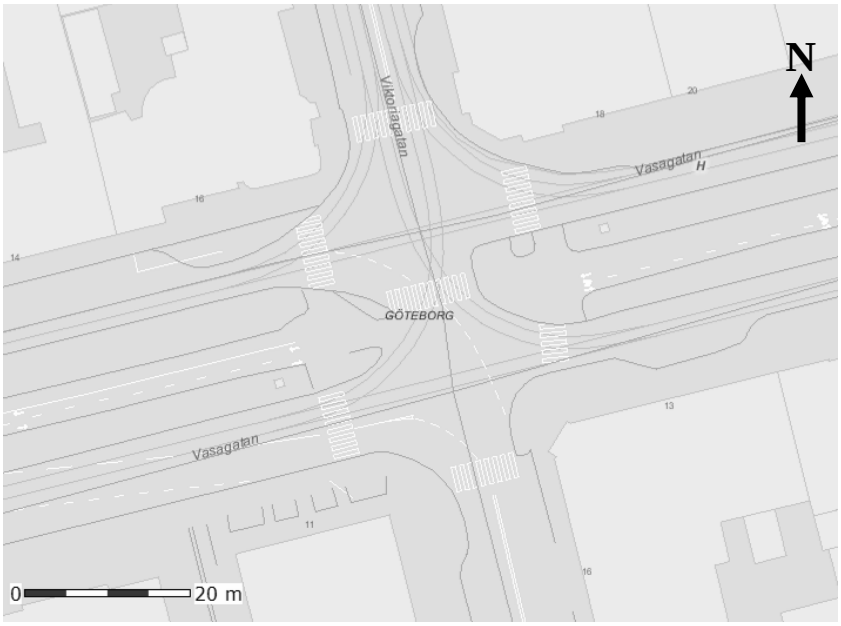


Figure 3.20. Intersection 10. (Source: Transportstyrelsen, n.d.)

Figure 3.21. When coming from west into the intersection there are two lanes, one for those who turns right, and one for those who turns left or goes straight. (Photo: Cecilia Wideman)

3.2.2.11 Intersection 11: Haga Kyrkogata – Lilla Bergsgatan

The intersection is a T-intersection with trams operating in south-north direction on Haga Kyrkogata and Västergatan. The intersection has no marked zebra crossing, see figure 3.22. It has been observed that pedestrian pass the streets in several different points in the intersection and that they normally watch out before they pass the street.

Figure 3.22. Intersection 11. (Source: Transportstyrelsen, n.d.)

3.3 Actual speed

The speed of vehicles in a city affects several factors of how the city is experienced. Streets with high speed can create a barrier effect and divide parts of the city. To feel safe is another factor that higher speed has a negative effect upon. High speed also creates a higher noise level and an increase of pollutants. And finally, it has a negative impact on the most important subject in this thesis, the traffic safety.

It is generally known that high speed of vehicles kills people due to kinetic energy. Already at 30 km/h the risk of pedestrians being killed increases, see diagram 3.1. However, at streets with 30 km/h as speed limit no accidents with fatal outcome have occurred in Göteborg. Even if 50km/h is not regarded as a high speed, 55 % of all fatal accidents happens at streets where that is the speed limit (Göteborg Stad, p. 65, 2009a).

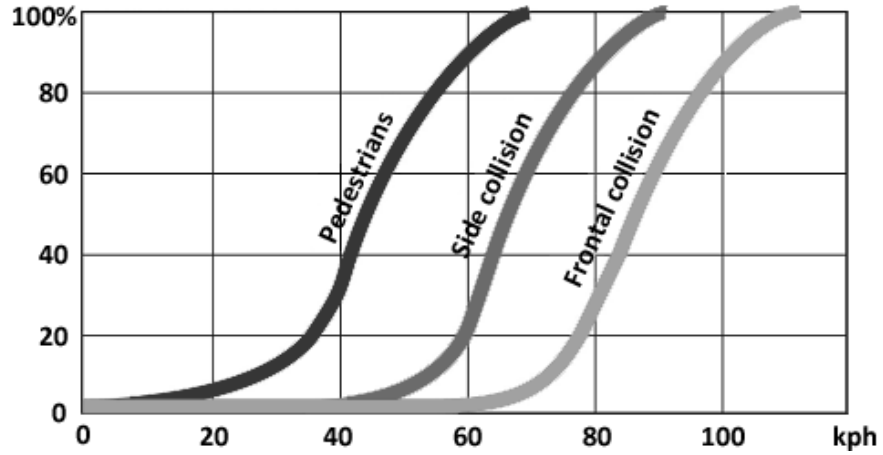


Diagram 3.1 The risk of being killed increases with speed for accidents with pedestrians, side collision and frontal collision. (Source (edited): Svenska Kommunförbundet, p. 22, 1998)

Speed limits are not always kept, therefore have controls of the actual speed, of the vehicles, been carried out in the area. The results can be seen together with the speed limit in table 3.1 for each street and in table 3.2 for the intersections.

Table 3.1. Measured speed along the streets.

Street/Streets	Speed limit	Measured speed (85-percentile)
Rosenlundsgatan/Sahlgrensgatan	50	30 / 40
Nya Allén	50	48
Södra Allégatan/Parkgatan	50	48
Haga Östergata	50	26
Storgatan	50	22
Haga Nygata	*	10
Bellmansgatan	50	25
Vasagatan	50	40
Lilla Bergsgatan	50	33
Hvitfeldtsplatsen/Rosenlundsbron	50	36 / 34
Sprängkullsgatan	50	43 (South part) / 33 (North part)
Haga Kyrkogata (North part)	50	26
Haga Kyrkogata (South part) / Västergatan	50	38
Viktoriabron/Viktoriagatan	50	40

* The street is a living street. Therefore, the speed is limited to walking speed.

Table 3.2. Measured speed in to the intersections.

Intersection	Speed limit	Measured speed (85-percentile)
1	50	40
2a	50	48
2b	50	48
3a	50	48
3b	50	48
4	50	33
5	50	26
6	50	33
7	50	26
8	50	43
9	50	40
10	50	40
11	50	38

3.4 Accidents

Information about accidents that have occurred in the area is derived from STRADA - Swedish Traffic Accident Data Acquisition. It is a national data base, gathering data of injuries and accidents in the entire road transport system. There are two sources contributing with reports: police and hospitals. The Swedish Transport Agency (Tranportstyrelsen) is the authority responsible for STRADA. 1996 started the work with STRADA and since 2003; the reporting is done in almost the whole nation. In Göteborg police and hospitals have been reporting accidents to STRADA since 1999.

Due to STRADA has two sources, both police and hospitals; they can supplement each other and give more information. The police usually have better information concerning how the accident happened and where, while hospitals give a better diagnose on how severe the injury is. However, not all accidents are reported into STRADA. These are accidents where the injured person has not sought out the hospital and the police have not been on the accident location. The unreported injuries are often outcomes from either pedestrian fall accidents or single accidents with bicycles.

The diagnoses made at the hospitals are given in the classification system ISS, which has a scale from 1 to 75. The ISS system describes how life threatening injuries, on up to three body parts, are. The police have a different scale than the hospital. To be able to compare the severity, a table to translate the different grades is illustrated in table 3.3.

Table 3.3. Translation from ISS-values to the police assessment. (Source: Transportstyrelsen, p. 20, 2010)

ISS-grading (hospital)	**Severity of injury (police)**	**Severity of accident (police)**
0	Uninjured	No bodily injured accident
1-8	Minor injury	Minor accident
9-	Severe injury	Severe accident
Deceased	Fatal injury	Fatal accident

Unlike the Vision Zero, this report considers accidents where the outcome is a minor injury. There are three main reasons why considering minor injuries too. Firstly, a minor accident could have, under different circumstances, lead to a severe injury. Secondly, some injuries, like whiplash, might leads to a lifelong suffering. Lastly, a larger number of accidents provide a larger basis when analyzing the causes of accidents. Furthermore, this report also considers accidents caused by persons under the influence of alcohol. The accidents analyzed in this report have occurred between January 1999 and January 2011. They are distributed in the area as seen in figure 3.23.

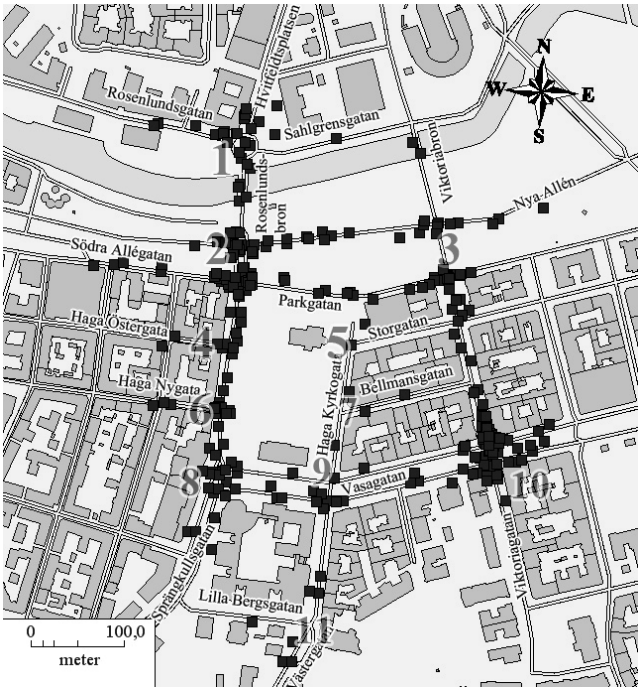


Figure 3.23. Accidents that have occurred in the investigated area (Source: Transportstyrelsen, n.d.).

The accidents are categorized into pedestrian, bicycle and motor vehicle accidents, where for example accidents between bicyclists and motor vehicles are categorized under bicycle accidents, since the bicyclist is more likely to become injured. Table 3.4 and 3.5 illustrate which streets and intersections that are most hazardous for each transport mode. The intersections are defined individually based on the size and the accidents adjacent to it. Consequently, the accidents along the streets are the remainder of the accidents.

Table 3.4. Number of accidents that resulted in injuries and number of injured per street/streets.

Street/Streets	Pedestrians		Bicycle		Motor vehicle	
	Accidents	Injured	Accidents	Injured	Accidents	Injured
Rosenlundsgatan/Sahlgrensgatan	1	1	1	1	1	1
Nya Allén	0	0	1	1	8	15
Södra Allégatan/Parkgatan	9	9	0	0	5	7
Haga Östergata	1	1	1	1	0	0
Storgatan	1	1	0	0	0	0
Haga Nygata	2	2	1	1	0	0
Bellmansgatan	2	2	0	0	0	0
Vasagatan	7	7	8	8	1	1
Lilla Bergsgatan	1	1	0	0	0	0
Hvitfeldtsplatsen/Rosenlundsbron	6	6	0	0	1	1
Sprängkullsgatan	1	1	1	1	4	7
Haga Kyrkogata (north part)	1	2	0	0	0	0
Haga Kyrkogata (south part)/ Västergatan	2	2	4	4	0	0
Viktoriabron/Viktoriagatan	3	3	9	9	2	2
Sum	37	38	26	26	22	34

Table 3.5. Number of accidents that resulted in injuries and number of injured per intersection.

Intersection	Pedestrians		Bicycle		Motor vehicle	
	Accidents	Injured	Accidents	Injured	Accidents	Injured
1	9	9	1	1	3	3
2a	1	1	12	12	11	15
2b	15	17	1	1	9	13
3a	2	2	2	2	5	6
3b	4	4	0	0	13	28
4	3	3	4	5	1	2
5	1	1	0	0	0	0
6	7	7	5	5	0	0
7	0	0	0	0	0	0
8	1	1	4	4	7	12
9	2	2	6	6	1	1
10	13	13	31	31	8	13
11	0	0	0	0	0	0
Sum	58	60	66	67	58	93

3.4.1 Accidents along streets

The number of injured people in accidents along the streets is lower than in the intersections. This is since there are less conflict situations between pedestrian, bicyclists and motor vehicles; the traffic is more divided along the streets. This results in that the types of accident with the highest number of injuries are those with only one mode of transport involved, see diagram 3.2.

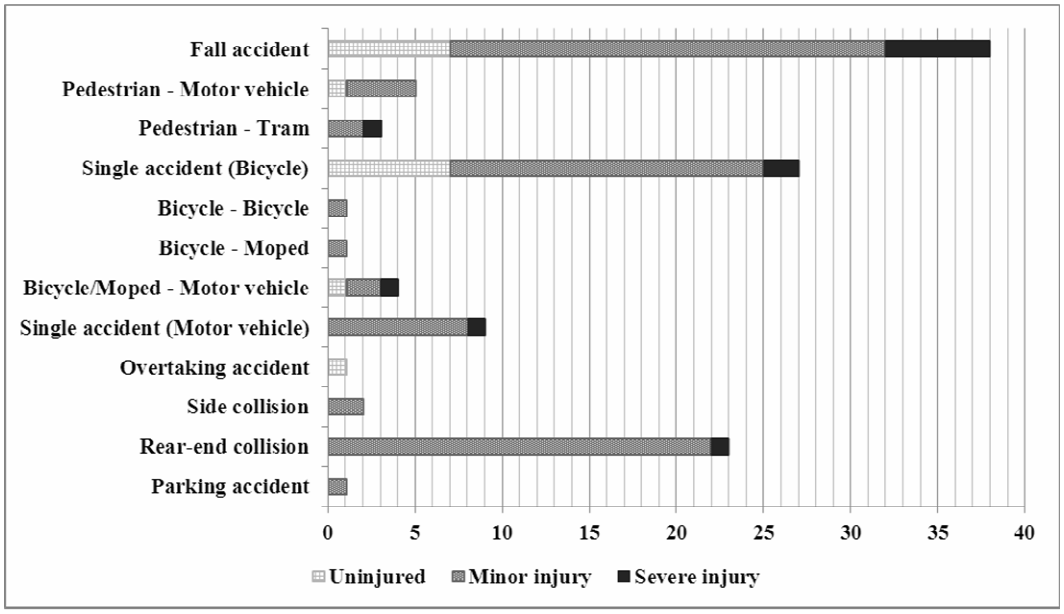


Diagram 3.2. Type of accident and the severity of the injury (Source: Transportstyrelsen, n.d.).

The most hazardous street in the area depends on which mode of transport the injured person was using. For bicyclists are Viktoriagatan and Vasagatan the two most hazardous streets, see figure 3.24. Many of these accidents are caused in the same way as those that occurred in the intersection between Viktoriagatan and Vasagatan, the bicyclist has steered into the tram tracks and falls. Furthermore, Nya Allén is the street that is most hazardous for motor vehicles with many rear-end collisions due to queue situations during rush hours. With less conflict situation with other transport modes, fall accidents are the most common accident for pedestrians and they are fairly equally distributed throughout the different streets.

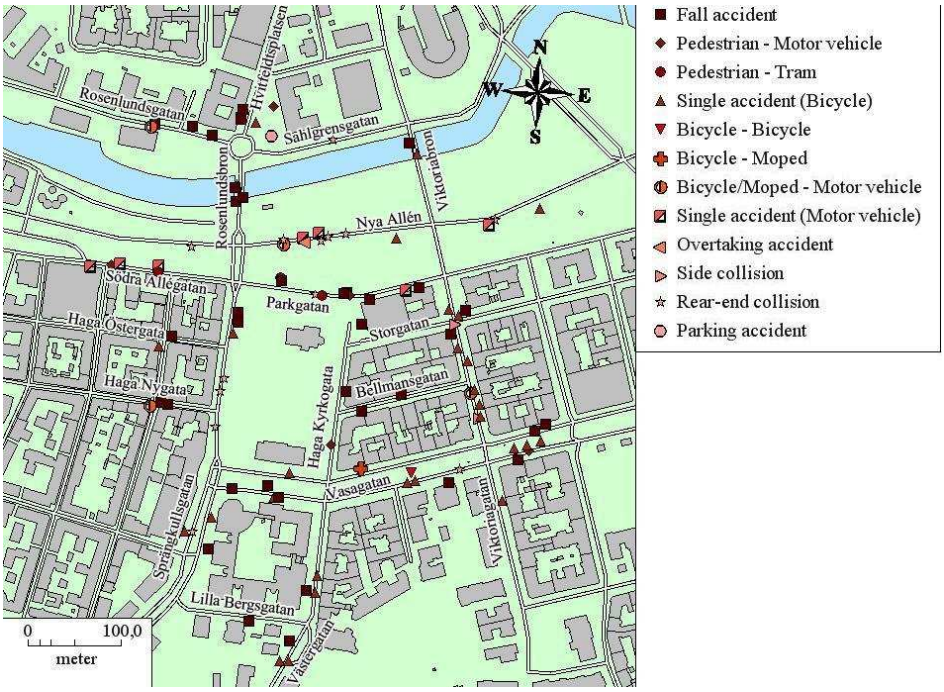


Figure 3.24. Type of accident and where they have occurred along the street (Source: Transportstyrelsen, n.d.)s.

3.4.2 Pedestrian accidents in intersections

One of the major causes for an injured pedestrian are accidents where the pedestrian stumbles on uneven surfaces or slips on ice or wet leaves and falls, see diagram 3.3. Those who become severely injured from this type of accident are usually more than 65 years old.

According to research from the Traffic & Public Transport Authority of Göteborg, areas around stops for public transport systems are more hazardous for pedestrian. 29 % of all accidents where pedestrians were hit by vehicles occurred there (Göteborg Stad, p. 87, 2009a). As can be seen, pedestrians in conflict with trams, is the accident type with highest percentage of severely injured.

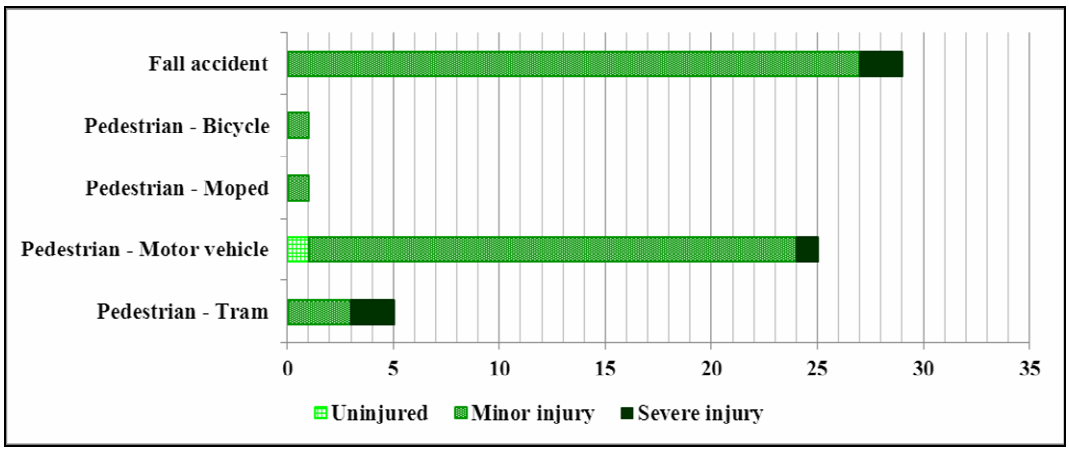


Diagram 3.3. Type of pedestrian accident and the severity of the injury.

The most hazardous intersection for pedestrians according to the number of occurred accidents, not counting fall accidents, is intersection 2, see figure 3.25. The intersection has high traffic flows of both pedestrians and motor vehicles. This, together with the presence of busses and trams create a situation that is complex and difficult to get an overview of.

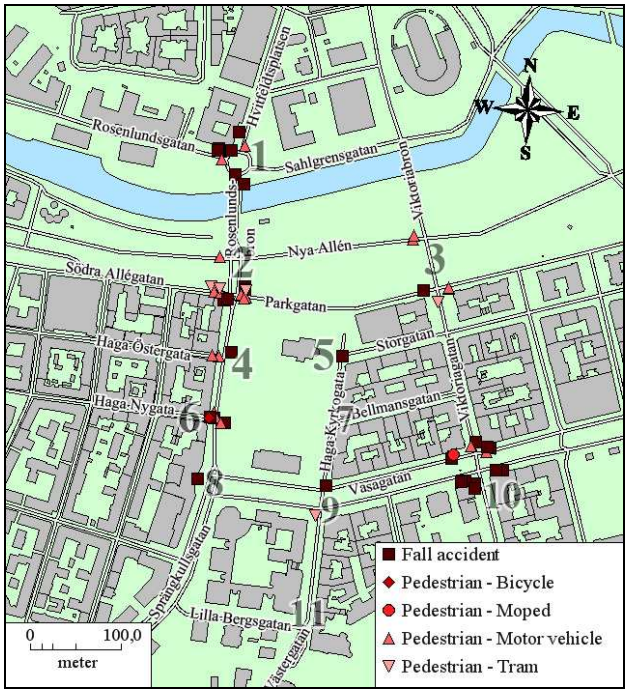


Figure 3.25. Type of pedestrian accidents and where they have occurred (Source: Transportstyrelsen, n.d.).

3.4.3 Bicycle accidents in intersections

The main cause of injuries among bicyclists is single accidents, see diagram 3.4. Many of these accidents happen when the bicyclist is inattentive and steers into the tram tracks and falls. These accidents happen especially in intersection 10, where the tram tracks are turning, see figure 3.26.

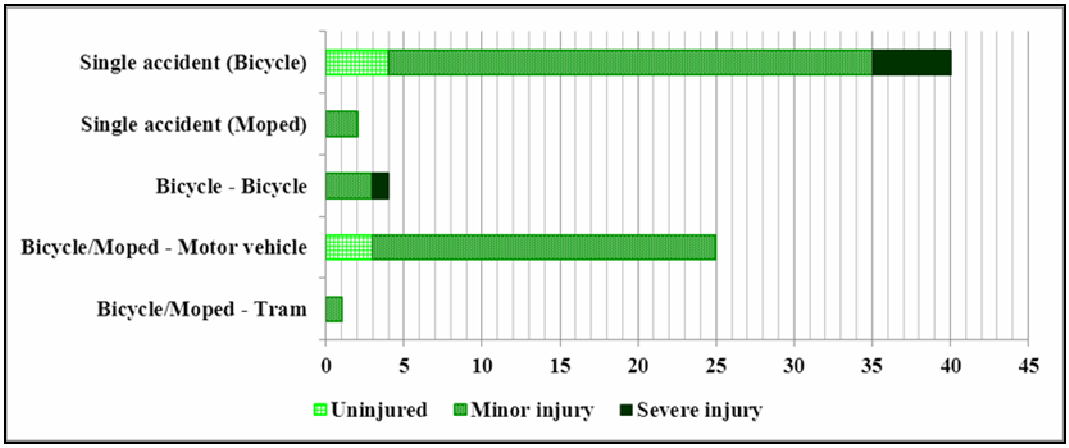


Diagram 3.4. Type of bicycle accident and the severity of the injury.

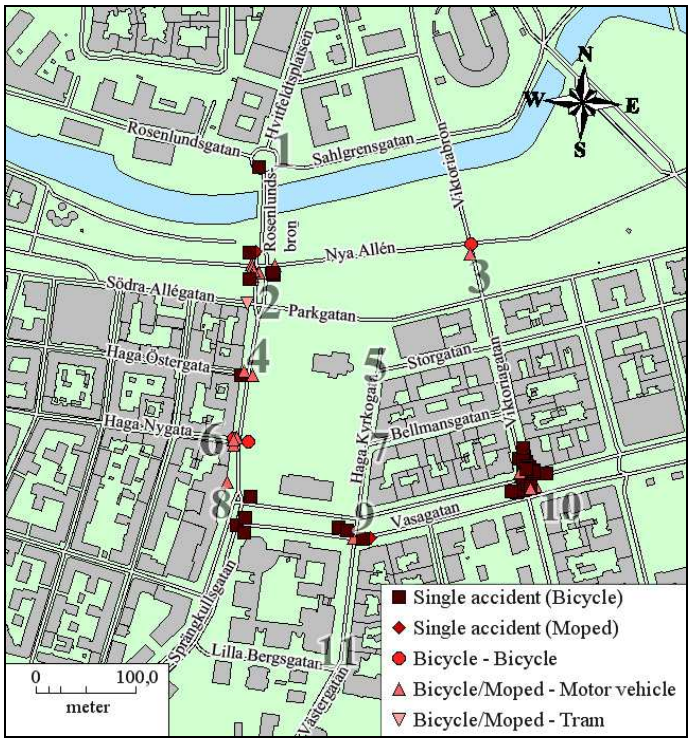


Figure 3.26. Type of bicycle accidents and where they have occurred (Source: Transportstyrelsen, n.d.) .

3.4.4 Motor vehicle accidents in intersections

One of the two most common accidents for motor vehicles is when one vehicle drives into the rear of another, see diagram 3.5. These accidents do often occur during rush hours due to queues at the traffic lights. However, the risk of becoming severely injured in a rear-end collision is less than in an accident where one vehicle has driven in to the side of another. This kind of accident does often occur when one part has run a red light and crashes into another vehicle. The higher speed increases the risk for a more severe injury.

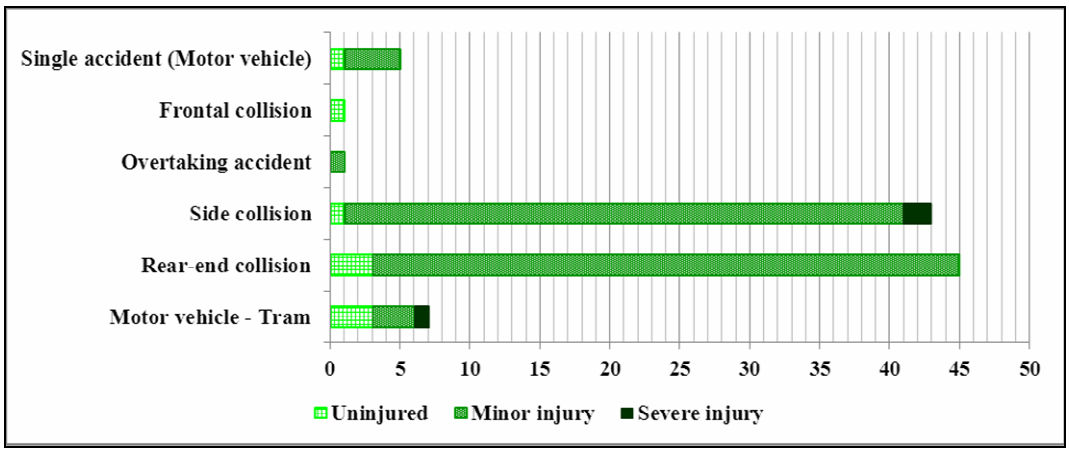


Diagram 3.5 Type of motor vehicle accident and the severity of the injury.

The most hazardous intersections for people travelling with motor vehicles, according to the number of previous accidents, are intersection 2, see figure 3.27. This can partly be explained by the high volumes of traffic during rush hours and the possibility to have a high speed when there is less traffic.

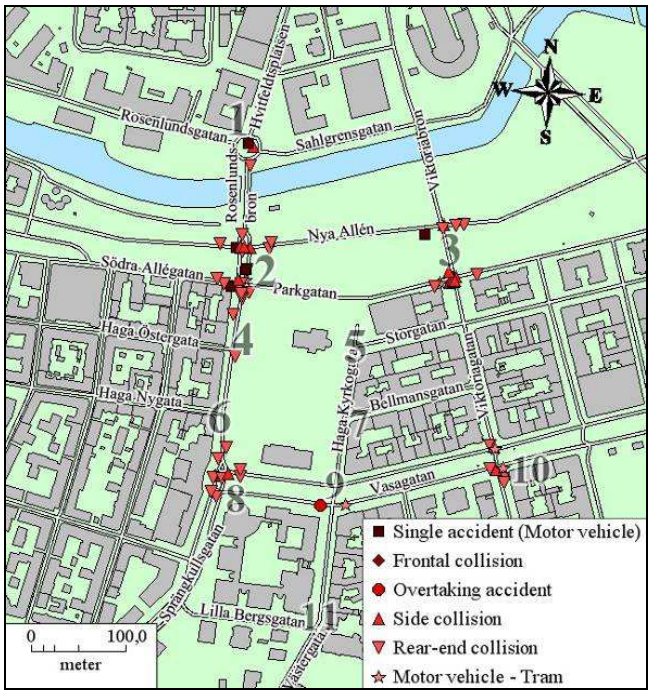


Figure 3.27. Type of motor vehicle accidents and where they have occurred (Source: Transportstyrelsen, n.d.).

4 Future Scenario, 2028

Haga will already at the year of 2013 become an important junction. The proposed suggestion is that there will be two express lines, which will operate along Sprängkullsgatan in a bus lane (Västtrafik, 2010).

Congestion fees will start to be used in Göteborg the first of January 2013. The fees will be taken between 6.00-18.30 and cost 8, 13 or 18 SEK/passage (Regeringskansliet, 2010). The purpose is to get co-financing for infrastructure project, such as Västlänken, and to decrease the congestion at the roads. To be able to take care of increased number of commuters that will travel with public transport, the bus line network must be changed to be able to handle it. Furthermore, the parking policy of Göteborg states that the distance to the closest public transport stop should be less or equal to the distance to the closest parking place (Göteborg Stad, p. 19, 2009b). This might attract more people to the public transport system.

The planning process of Västlänken will begin during 2011. When the planning process is completed, approximately in 2018, the building process will begin and take nine to ten years. The cost of the project is calculated to 20 billion SEK according to the price level of 2009 (Trafikverket, 2011c).

The location of the station will be underneath the Haga Park, with several entrances. The main entrance will be located east of the intersection 2, in the Alléstråket, from where bus and trams will operate. There will be a mezzanine plane from where several smaller exits will be located, so that people can pass underneath intersection 2 to get to the destination without crossing the intersection and in that way get less exposure to the traffic. A second large exit will be located in the south-east corner of the Haga Park, between intersection 7 and 9, see figure 4.1.

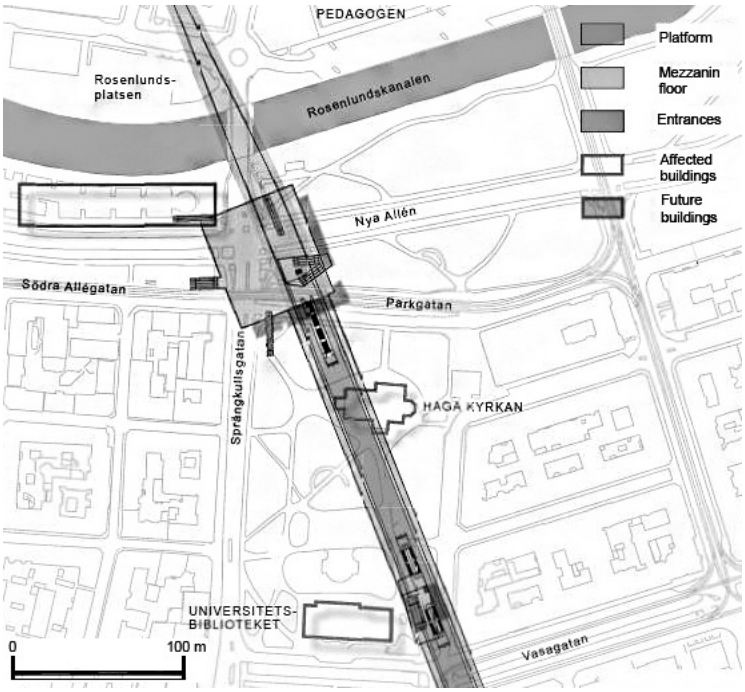


Figure 4.1. Blueprint over the Haga station. (Source (edited): Banverket, p. 50, 2006b)

Skeppsbron, north-west of the studied area, along the Göta älv, will have gone through a major change. It is planned to be 4-5 new blocks with both apartments and different businesses. The reason to the project is to connect the city center, together with the river and make the area to a popular meeting place (Älvstranden utveckling, n.d.).

In a more distance future there are plans of possible extensions connected to Västlänken. This is done to connect Hisingen in the north and Askim and Särö in the south (Banverket, p. 22, 2006c).

4.1 Prognosis of traffic flows

In the future, when the Västlänken is built, the flows of pedestrians, bicyclists and vehicles will be different from today. A change in flows will lead to a changed risk of traffic accidents. Therefore, a prognosis of future traffic flows has been done for the different transport modes. For specific values, see appendix 1.

4.1.1 Pedestrians

To make a prognosis of future flows of pedestrians, a simulation in VISUM has been carried out. VISUM is a software system for transportation planning, travel demand modeling and network data management on macro level. It is assumed that people are prepared to walk 600 meters to reach a train station, see figure 4.2 (Hartoft-Nielsen, p. 35, 2002). Between the two future stations at Västlänken, Haga station and Göteborg's central station is it about 1300 meters. Therefore, 600 meters in radius is considered as a good estimation of catchment-area, since the central station might have some more attraction.

Figure 4.2. The circles symbolize 600 meters distance from the two planned entrances. The shaded areas with dashed border lines are the relevant base areas.

Haga station is going to be used by about 30,000 passengers per day, where every second passenger will continue their journey with bus or tram (Banverket, p.32, 2006a). It is assumed that these commuters either originat from the area or have their destination in the area, see figure 4.3.

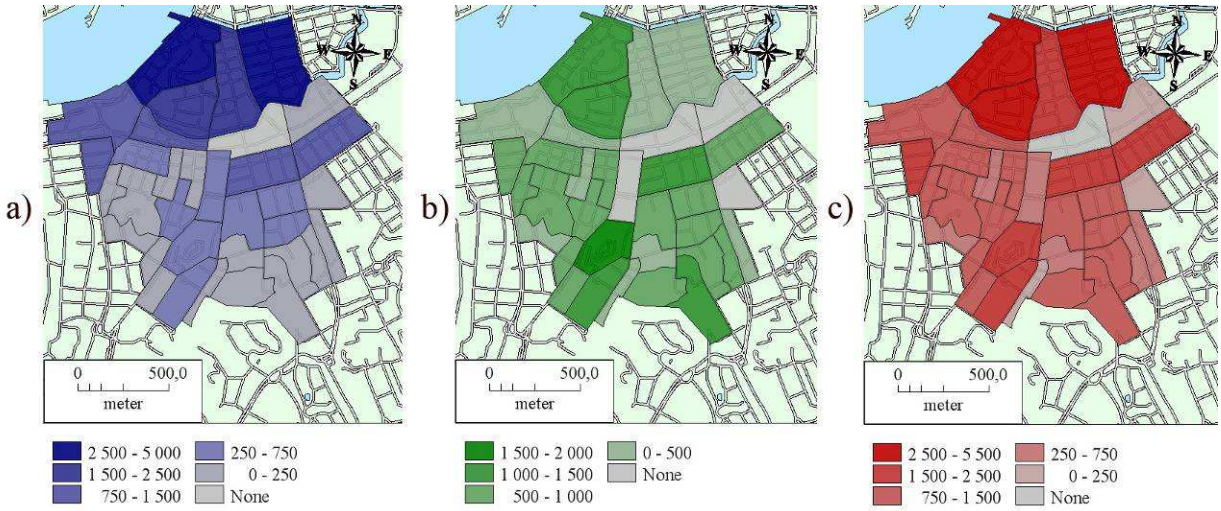


Figure 4.3. a) Number of people working in the area. b) Number of people living in the area. c) Total number of people working and living in the area.

The results from the manual counting are added to the result from the simulation as background flow. The added result is illustrated in figure 4.4.

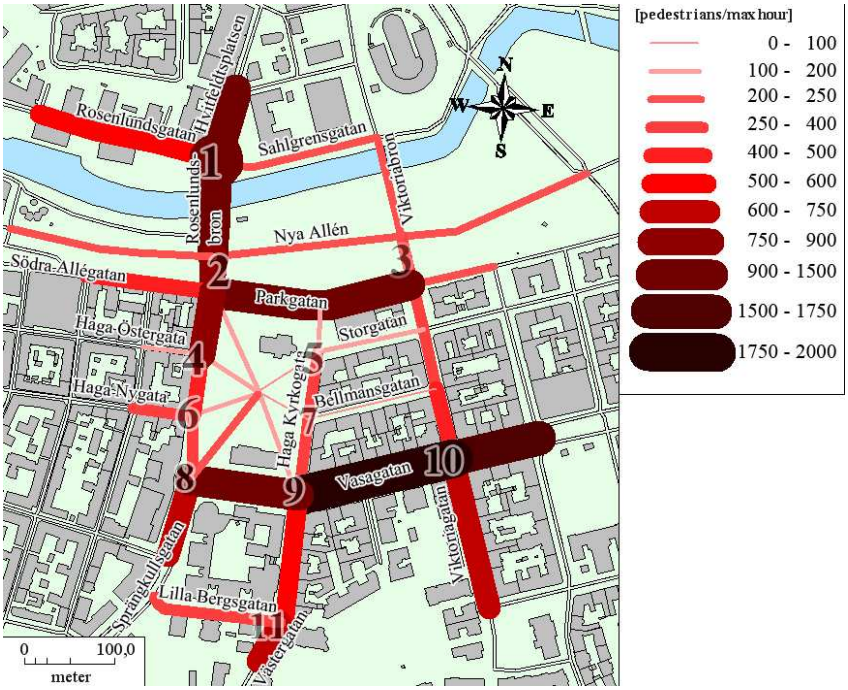


Figure 4.4. Future pedestrian flow.

4.1.2 Bicyclists

In 1999, a goal was stated that the amount of bicyclists in Göteborg should increase from 120,000, a mean value for the years 1994-96, to 180,000 year 2012 (Göteborg Stad, p. 36. 1999). However, the amount of bicyclists has instead decreased. In 2009 the number of bicyclists per weekday was only 100,000 (Göteborg Stad, p. 3. 2011b). Therefore, it is assumed that the original aim, an increase of 50 %, is going to be fulfilled in the year 2028. This applies on all streets in the investigated area, see figure 4.5.

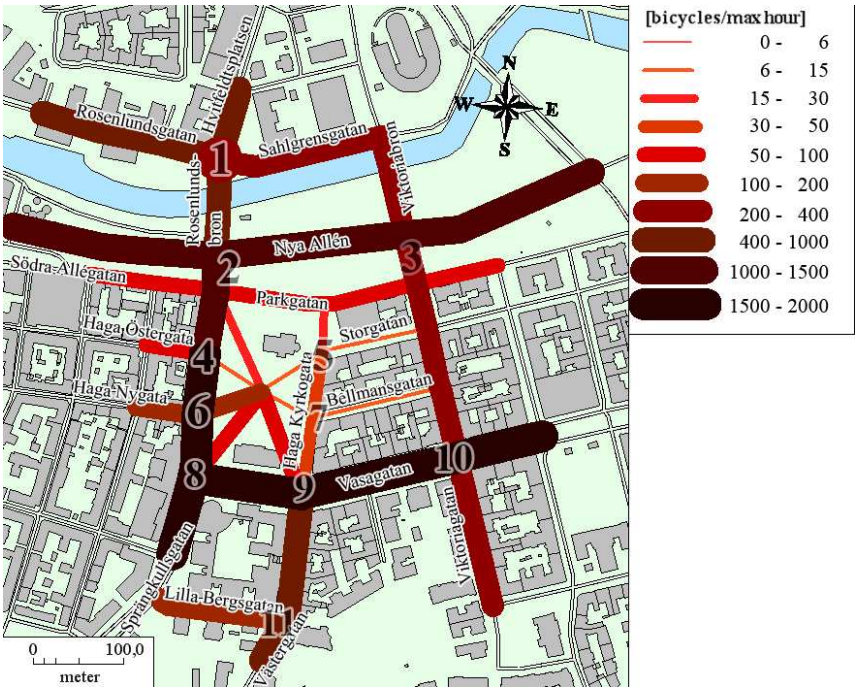


Figure 4.5. Future bicycle flow.

4.1.3 Motor vehicles

From the Swedish Transport administration's model system Sampers 2.5.4, data is collected with effect from the congestion fee which leads to a decreased flow of motor vehicles (Trafikverket, n.d.). The alternative for the suggested modified tax area is used. There is only data for the streets Sprängkullsgatan, the Alléstråket, Vasagatan and Hvitfeldtsplatsen/Rosenlundsbron. Therefore, a mean value has been calculated to use for the rest of the streets that were missing such data. The decrease of flow is between 6-22 % at the streets.

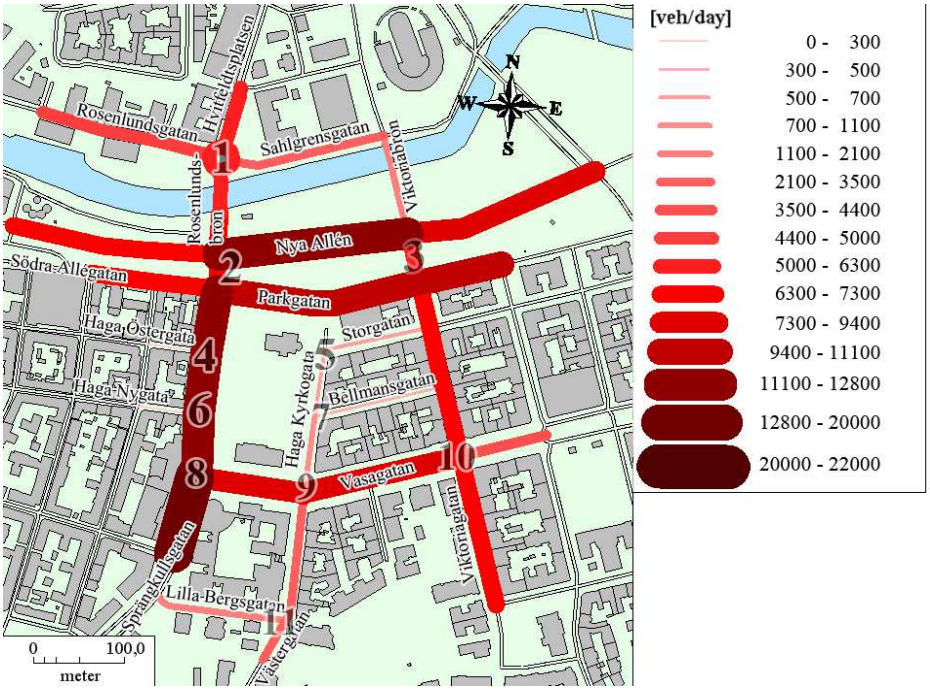


Figure 4.6. Future motor vehicle flow.

4.2 Design of the streets and intersections around the Haga station

To make the streets safer, the designs of the streets and intersections have to be improved. Here are suggestion on how that can be done presented.

4.2.1 Streets

Create more green waves for pedestrians and bicycles along the streets. It was observed that it was green wave for the cars in the Alléstråket, but exactly when bicyclists came to the next intersection had the lights just turned over to red.

To prevent bicyclists from running red lights when there is low traffic, detectors should be used 20-40 meters in front of the intersection to detect them and if possible give them green light. This should be used to increase the mobility for bicyclists. Moreover they do not need to stop at red light and push a button if there would be that kind of detector instead.

There should be zebra crossings over bicycle lanes for pedestrians, see figure 4.7. This would make it more clearly for the bicyclists that are crossing pedestrians, which they have to give way for. Furthermore, it will make the pedestrians aware of the bicyclists.

Figure 4.7. Zebra crossing over the bicycle lane. (Source: Sveriges Kommuner och Landsting, p.107, 2010)

It has been observed from the previous accidents that many of the single accidents have happened due to uneven surface on the streets. Therefore, routine maintenance in all streets and intersections should be better. To prevent settlements and cracks, around pedestrian crossings over tram tracks, another less fragile material than asphalt or setts should be used. This might decrease the number of fall accidents in conjunction to tram tracks.

4.2.1.1 Rosenlundsgatan/Sahlgrensgatan

To prevent accidents between cars and bicyclists one measure is to make bicycle lanes along these streets. It would decrease the total number of accidents with 30 % (Sveriges Kommuner och Landsting, p. 9, 2009). It has been observed at other places in Göteborg, where there are arcades and bicycle paths/lanes that pedestrians tend to use the bicycle path/lane instead of the sidewalk, see figure 4.8. To prevent this from happening, the sidewalk should be made wider, so that a part of the sidewalk is outside the arcades.

Figure 4.8. Pedestrians are using the bicycle path at Östra Larmgatan. (Photo: Lars Strömqvist)

These bicycle lanes should connect to the already existing bicycle lanes and paths at Järntorgsgatan in the west and Rosenlundsbron in the south, as well as the new area in north-west; Skeppsbron. This will also make the area around Feskekôrka more attractive.

To make room for the bicycle lanes and extended side walk on Rosenlundsgatan, a suggestion is to use the area where the parking place along the north side of the street is located today. The removing of the parking spaces along Rosenlundsgatan will decrease the total number of accidents with approximately 20 % (Elvik et al, part 2.3.15, 2007).

However, if removing the parking spaces along Rosenlundsgatan it might become more alluring to have a higher speed along the street. To prevent this, a measure is to build speed bumps along the street to ensure that the motor vehicles still drive at 30 km/h. This should also be done along Sahlgrensgatan to reduce the speed to 30 km/h.

4.2.1.2 Nya Allén

The lane to the left should be a bus only lane to increase the mobility for the public transport. This lane could also be used as an emergency route instead of the one in the middle. This can prevent accidents, between motor vehicles and emergency vehicles, from happening.

There are several measures to use to decrease the number of rear-end collisions between two motor vehicles. It has been observed that some of these accidents have happened since motor vehicles have stopped to drop off passengers and then become hit by another vehicle. To prevent this from happening, a sign that prohibits stops should be put up shortly after the intersection. A disembarkation zone close to the station should be made to facilitate swift drop offs.

There should be signs along the bicycle path in the middle of the alley that says dictated bicycle traffic. Furthermore, there should be a sign along the pedestrian path on the north side of the alley that says dictated pedestrian traffic. These two measures should be done to emphasize where each transport mode should go to avoid conflicts between them. Moreover, the bicycle path in the middle of the alley should be divided with marking on the path. This is done to separate the directions into two different lanes, see figure 4.9.

Figure 4.9. Divided direction on bicycle path. (Sveriges Kommuner och Landsting, p. 78, 2010)

4.2.1.3 Södra Allégatan/Parkgatan

To create a safer environment close to the station and at Parkgatan, the fence should be fixed to divide the street from the sidewalk. If the fence is built from the zebra crossing at the east side of the bus and tram stop until intersection 3, the number of pedestrian accidents could be lowered with approximately 33 % and the number of accidents with motor vehicles could decrease with 50 % (Sveriges Kommuner och Landsting, p 18, 2009). Today many people run over the street to get to the tram and bus stop from the east side. When building the Haga station this possibility, to take a shortcut, must be prevented by the design. It should be more attractive and easier, when coming from east, to pass the road over the zebra crossing in the intersection 3b, Parkgatan-Viktoriagatan.

Today it is prohibited to stop along Södra Allégatan and Parkgatan certain times during the day. However, to reduce the risk of rear-end collisions; this prohibition should apply for the whole day.

4.2.1.4 Haga Östergata

There have not occurred any accidents that can be prevented by design. Therefore, there are no suggested measures for Haga Östergata.

4.2.1.5 Storgatan

Since Storgatan and the surrounding streets are very close to the Haga station, and located between the stops Hagakyrkan, Vasa Viktoriagatan and Handelshögskolan, many people will probably walk on this street. To decrease speed in this area, the streets Storgatan; between Haga Kyrkogata and Viktoriagatan, Haga Kyrkogata; between Storgatan and Vasagatan, and Bellmansgatan should be converted to living streets, to make it on the pedestrians' terms. The parking area and open space outside the Smyrna church is uneven and should be better maintained. With cafés and shops in the area it would be a pleasant place for people to stay at, while they wait for a train or as a meeting point with good public connections to it. It would be like extension the Haga Park, instead of a wall with parking lots and traffic along the street as it is today.

The removal of parking places along Storgatan will give a 20 % reduction of accidents (Elvik et al, part 2.3.15, 2007). Some marked parking lots should still be located on the streets, especially reserved for physically impaired.

4.2.1.6 Haga Nygata

Due to that there have not occurred any accidents that can be prevented by design. Therefore, there are no suggested measures for Haga Nygata.

4.2.1.7 Bellmansgatan

Bellmansgatan should be turned into living street, see 4.2.1.5. Some short period parking spaces and loading zone should be located on Bellmansgatan. This should be done to compensate the parking spaces that have been taken away from Viktoriagatan (see 4.2.1.14).

4.2.1.8 Vasagatan

To prevent bicyclists coming from Nedre Fogelbergsgatan, which enters Vasagatan from south between intersection 9 and 10, to go on the street at Vasagatan, a small ramp should be constructed up to the bicycle path in the middle of the alley. To make sure that the bicyclists are alert when crossing Vasagatan, either a speed bump or rumble strips should be built before the intersection.

4.2.1.9 Lilla Bergsgatan

To decrease the speed along Lilla Bergsgatan, speed bumps should be constructed and the street should be made narrower.

4.2.1.10 Hvitfeldtsplatsen/Rosenlundsbron

The problem with bicyclists going in the wrong direction on the street Rosenlundsbron will be prevented by measures at Sprängkullsgatan, see 4.2.1.11. The bicyclist lanes should continue on Hvitfeldtsplatsen to create a safer environment for all transport modes. This measure will decrease the total number of accidents with 30 % (Sveriges Kommuner och Landsting, p. 9, 2009).

4.2.1.11 Sprängkullsgatan

To prevent bicyclists going on the one-way bicycle lane at Rosenlundsbron, it should be a bicycle lane along the east part of Sprängkullsgatan where it is missing. He new bicycle lane would connect the bicycle lane that ends in intersection 8 and starts again in intersection 2. This measure will decrease the total number of accidents with approximately 30 % (Sveriges Kommuner och Landsting, p. 9, 2009). Another measure is to highlight the separation between pedestrians and bicyclists with gutters on the west side, which will decrease the number of conflicts between the two transport modes.

4.2.1.12 Haga Kyrkogata (north part)

Haga Kyrkogata should be turned into living street, see 4.2.1.5.

4.2.1.13 Haga Kyrkogata (south part)/Västergatan

To make these streets safer for bicyclist with the tram tracks as a hazardous event, especially through the narrow passage by the tram stop, a bicycle lane should be marked on the street to show where it is safe to cycle.

The tram stop on the west side needs to be rebuilt so that it is possible to have a bicycle path passing on the western side of the tram stop. The weather protection at the tram stop should be moved a bit closer to the road to make space for the bicycle path. The distance between the weather protection and road today is pretty large and there will be enough space after this measure has been done. There should be a bicycle lane from intersection 9, behind the parking place, until after the tram stop, before the intersection 11, where the bicycle path should be lead to a bicycle lane at the road.

On the east side there should be a bicycle lane and the parking places should be taken away to make space, due to lack of space for both. This measure should decrease the accidents with 30 % due to the bicycle lane (Sveriges Kommuner och Landsting, p.9, 2009) and 20 % due to removal of parking places along the street (Elvik et al, part 2.3.15, 2007). At the same time, the sidewalk should be made wider.

4.2.1.14 Viktoriabron/Viktoriagatan

On Viktoriagatan there are many accidents where bicyclists fall due to that they steer into the tram tracks. Therefore, the suggested measure is to remove the parking spaces along Viktoriagatan to make room for the bicycle lane. These measures would decrease the total number of accidents with 20 % (Elvik et al, part 2.3.15, 2007) due to the removal of parking places and 30 % due to constructing bicycle lane along the street. A short period parking and a loading zone should be built at the intersecting Bellmansgatan to compensate for the removed parking spaces along Viktoriagatan. Due to these measures, it will be possible to make the sidewalk wider and give space for the restaurants and cafés to have larger terraces outside at the sidewalk.

4.2.2 Intersections

Rumble strips in bicycle paths should be made generally before intersections. This measure will not decrease the bicyclists speed. However, it will increase the bicyclists' attention and therefore it might prevent them from either running a red light or getting hit by a turning motor vehicle turning (Sveriges Kommuner och Landsting, p.16 2009).

4.2.2.1 Intersection 1: Rosenlundsbron – Sahlgrensgatan

As it is today, the intersection is designed as an elevated roundabout with no zebra crossings. However, the gradient does not decrease the speed of the motor vehicles to a satisfactory level. To be able to fulfill the required decrease of accident, the gradient has to be made steeper. To emphasize that pedestrian are using the intersection, warning for pedestrian signs should be put up in all entrances to the roundabout in combination with a recommended speed limit of 20 km/h.

Furthermore, the bicycle lane in the roundabout should be made more obvious so that the motor vehicle users notice it. Today's lane is not satisfactory highlighted and can be considered as non-marked. If it is properly marked, the number of accidents will decrease with approximately 14 % (Schoon & von Minnen, 1994 cited in Hallberg & Nowak, p.12 2003).

4.2.2.2 Intersection 2: Spängkullsgatan – Parkgatan/Nya Allén

To decrease the number of conflicts in the intersections, the traffic signals should be programmed so that each transport mode and direction has their own green period.

This measure will decrease the total number of accidents with approximately 75 % (Elvik et al, part 2.3.9, 2007).

The zebra crossings should be elevated to make sure that motor vehicles decrease their speed when passing the zebra crossings. This measure will ensure that the motor vehicles reduce their speed to 30 km/h when entering the intersection. A bicycle lane should be made along the whole east side, see 4.2.2.2.2.

4.2.2.2.1 Intersection2a: Sprängkullsgatan – Nya Allén

The direction signs above the street should be located earlier along Nya Allén. This measure should be done to avoid late lane changes that might cause rear-end collisions or side collisions.

4.2.2.2.2 Intersection 2b: Sprängkullsgatan – Södra Allégatan/Parkgatan

The number of lanes that motor vehicles are allowed to use on Södra Allégatan should be reduced from two to one. The middle lane, used by both motor vehicles, trams and buses today, should be turned to public transport lane only. This measure should be made to be able to build an elevated zebra crossing where motor vehicles travel and ensure their speed reduction without effecting the buses and trams.

As it is today, the pedestrian passages over the tram tracks in conjunction to the tram stop have sound signals and red light when a tram or bus is approaching. The red light should be replaced with flashing light signals, which is commonly used in Göteborg when passing tram tracks. The flashing light will increase the pedestrians' attention to an approaching bus or tram.

The lane going north, into the intersection, there is no bicycle lane. However, as mentioned, it has been observed that bicyclist do travel there. To make it safer for bicyclists and to prevent bicyclists from going in the wrong direction along Rosenlundsgatan there should be a bicycle lane with a bicycle box, see figure 4.10. The bicycle box will decrease the number of accidents involving bicyclists with 35 % (Sveriges Kommuner och Landsting, p. 35, 2009).

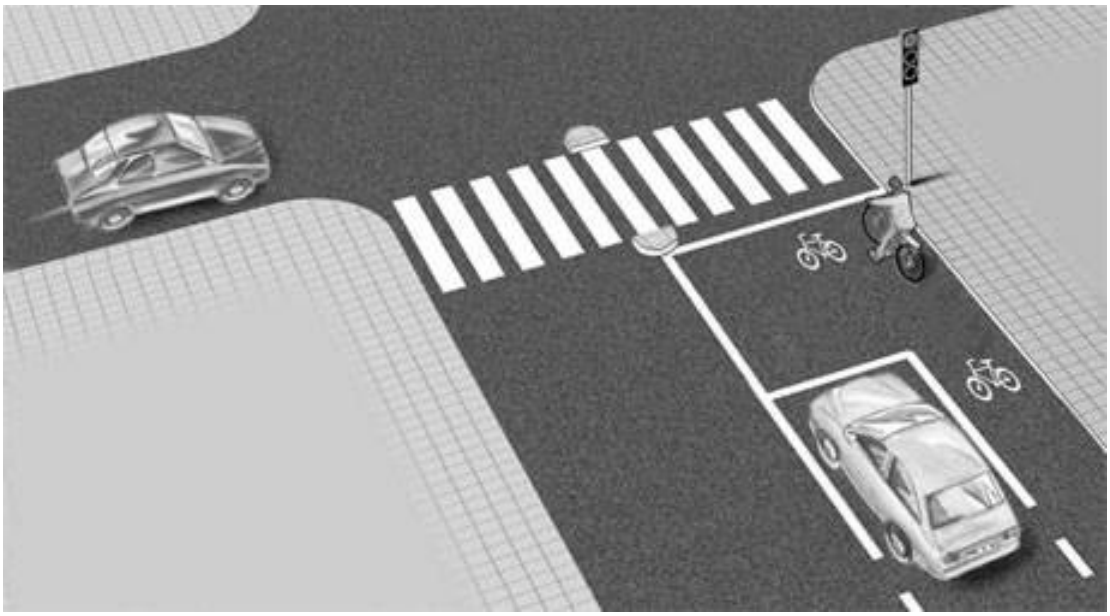


Figure 4.10. Bicycle box. (Source: Stockholm Stad, 2011)

4.2.2.3 Intersection 3: Viktoriagatan – Parkgatan/Nya Allén

To decrease the number of conflicts in the intersections, the traffic signals should be programmed so that each transport mode and direction has their own green period. This measure will decrease the total number of accidents with approximately 75 % (Elvik et al, part 2.3.9, 2007).

The bicycle lane on the west side should be highlighted. Furthermore, there should be created a bicycle lane on the east side of the intersection as it is on the west side. This measure will decrease the number of accidents with approximately 30% (Sveriges Kommuner och Landsting, p. 9, 2009). This will combine the suggested bicycle lane along Viktoriagatan and the existing lane north of intersection 3.

Rumble strips in the motor vehicle lane will alert the drivers and make them reduce their speed in the intersection. This measure will reduce the total number of accidents with approximately 33 % (Elvik et al, part 2.3.12, 2007).

4.2.2.3.1 Intersection 3a: Viktoriagatan – Nya Allén

To clarify that it is prohibited to turn left from Nya Allén to Viktoriagatan a new sign should be put up that says that turning left is prohibited. In addition to this, there should be an additional sign below that says: "Do not apply to buses".

Moreover, the direction signs above the street should be located earlier along Nya Allén. This measure should be done to avoid late lane changes that might cause rear-end collisions or side collisions.

4.2.2.3.2 Intersection 3b: Viktoriagatan – Parkgatan

A more obvious traffic light, which hangs down from the wires above the street, is recommended to be installed. This since there has been a lot of accidents in the intersection where one part has run a red light. As it is today, there are only two traffic lights for motor vehicles for each intersecting street.

4.2.2.4 Intersection 4: Sprängkullsgatan – Haga Östergata

The traffic island should be made at least 2.25 meter wide, which is required width, so that the pedestrians have a larger "waiting zone" when passing the street (Sveriges Kommuner och Landsting, p.97, 2010). The wider traffic island is also needed when the bus traffic along Sprängkullsgatan will begin in 2013 with a bus lane on each side of the traffic island.

To reduce the speed at the zebra crossing passing Sprängkullsgatan is the suggestion to make the speed bump steeper, with an inclination of 1:10. This is done to ensure that the motor vehicles do not exceed the speed limit of 30 km/h (Sveriges Kommuner och Landsting, p. 83, 2009). However, to facilitate for the future bus traffic along Sprängkullsgatan, the bump should be constructed like an H with less inclination on the outer ramps. This can be done since a bus have a larger axel width than a car.

A warning sign about crossing bicyclists should be put up for right turning motor vehicles going south on Sprängkullsgatan.

4.2.2.5 Intersection 5: Haga Kyrkogata – Storgatan

These intersecting streets should be turned into living street, see 4.2.1.5.

4.2.2.6 Intersection 6: Sprängkullsgatan – Haga Nygata

See 4.2.2.4 for measures since the intersections are similar.

4.2.2.7 Intersection 7: Haga Kyrkogata – Bellmansgatan

These intersecting streets should be turned into living street, see 4.2. 1.5.

4.2.2.8 Intersection 8: Sprängkullsgatan – Vasagatan

Make the speed bump steeper to make sure that motor vehicles decrease their speed when passing the zebra crossings. Furthermore, there should also be speed bumps when entering the intersection from Sprängkullsgatan.

4.2.2.9 Intersection 9: Haga Kyrkogata – Vasagatan

Reduce the exposure by making the width of the zebra crossing (in north-east) smaller and make the sidewalk wider. The width of the zebra crossing can be reduced to about a half of its present width. This measure will decrease the number of accidents with approximately 5 % for both pedestrians and motor vehicles (Vägverket, p. 23, 1998).

The reduced speed in the intersections for trams, which is 30 km/h in the intersection, should be further reduced to 20 km/h. Due to that the trams turn in the intersection, sounding warning signs should be put up to alert the pedestrians and bicyclists that a tram is approaching and that they have to give away.

The concrete pillars in the section are recommended to be more clearly marked, so that the bicyclists are observant of them.

The intersecting Haga Kyrkogata in the north part should be turned into a living street.

4.2.2.10 Intersection 10: Viktoriagatan – Vasagatan

Shorten the zebra crossings, in south-west, over the road like in the intersection 9. This measure will decrease the number of accidents with approximately 5 % for both pedestrians and motor vehicles (Vägverket, p. 23, 1998). The lane for turning right when going west-south will then be taken away. Then the risk of people parking to close to the intersection is decreased. The removal of parking places at Viktoriagatan, north of the intersection, will reduce the risk for accident with approximately 20 % for all transport modes (Elvik et al, part 2.3.15, 2207).

Rumble strips should be made to alert the motor vehicle drivers of the coming intersection. This measure will decrease the total number of accidents with approximately 33 % (Elvik et al, part 2.3.12, 2007).

Create a bicycle lane through the intersection's northeast part; from the alley in the east to the street in north. This is done to clarify where the bicyclists should go. This measure might decrease the total number of accidents with approximately 30 % (Sveriges Kommuner och Landsting, p.9, 2009). The large number of accidents, where bicyclists fall, might be reduced with a sign that warns them for the tram tracks when coming from the alley.

The concrete pillars in the section are recommended to be more clearly marked, so that the bicyclists are observant of them.

4.2.2.11 Intersection 11: Haga Kyrkogata – Lilla Bergsgatan

The measure in this intersection is to have a bicycle lane, described in 4.2.1.13. Due to the fact that there is no zebra crossing in the intersection and that it has not been any accident, it makes people more attentive when passing, but there is still good accessibility due to that there is not a high vehicle flow. Therefore, the solution that exists seems to work.

4.3 Speed

To decrease the risk of road users being injured, speed limits can be lowered. A reduction of speed does not give significant time loss in comparison to the increase of traffic safety. To evaluate the traffic safety effect when the speed is decreased, the Power Model is used. It is a formula which takes kinetic energy into account, as well as the number of accidents and how many injured persons it resulted in. See the formula below (Nilsson, p. 8, 2000).

$$z_1 = \left(\frac{v_1}{v_0}\right)^2 y_0 + \left(\frac{v_1}{v_0}\right)^4 (z_0 - y_0)$$

z_1 = future number of injured persons
v_0 = speed today
v_1 = the estimated new speed
y_0 = number of accidents at present state for the studied time period
z_0 = number of injured persons at present state for the studied time period

The value for the speed today, is the 85-percentile used from the measured speed to get a representative value. The accidents and injuries used in the formula are only those where motor vehicles have been at least one of the parts, see table 4.1.

Speed bumps along both Rosenlundsgatan and Sahlgrensgatan will ensure that the motor vehicles drive at 30 km/h. This will result in a decrease of approximately 10 km/h for Sahlgrensgatan and a preservation of the speed along Rosenlundsgatan. The elevated roundabout is estimated to decrease the speed from 40 km/h to 30 km/h.

The measures proposed in intersection 2, elevated zebra crossings, will decrease the speed of motor vehicles entering the intersection, from 48 km/h to 30 km/h.

Lilla Bergsgatan with the recommended speed bumps will get an average speed of 30 km/h, a reduction with 3 km/h from today's 85-percentile. However, since there have not occurred any accidents along Lilla Bergsgatan, the speed reduction will not have any effect on the calculations. Nevertheless, an accident can occur even if there has not been anyone before. Therefore, the proposed measures might have effect.

At Sprängkullsgatan with the steeper bumps proposed in the future design, will the average speed be 30 km/h according to Sveriges Kommuner och Landsting, 2009, which will lead to a reduction of 3-13 km/h. The speed reduction will lead to up to 1.3 injuries less, depending on which street segment. This speed reduction does also apply for intersection 6 and 8 where it will result in a decrease of up to 7.9 injuries.

For Haga Kyrkogata, Bellmansgatan and Storgatan the suggestion is to make them into a living street. Due to that Haga Nygata today is a living street and had a measured speed of 10 km/h, an assumption is made that the speed on the three streets would be reduced to 10 km/h from today's value of 22-26 km/h.

Table 4.1. Input data and results for the Power Model in the intersections and streets where it has been used. Number of accidents and injuries with motor vehicles involved after design measures.

Intersection/Street	No. Accidents	No. Injured	Speed (85-percentile)	Future speed	Future no. Injuries
1	5	5	40	30	2.8
2a	4.75	5.75	48	30	2.0
2b	5	6	48	30	2.1
4	6	8	33	30	6.3
5	0	0	26	10	0
6	6	6	33	30	5.0
7	0	0	26	10	0
8	8	13	43	30	5.1
Sahlgrensgatan 1-east	1	1	40	30	0.6
Storgatan 5-east	0	0	22	10	0
Bellmansgatan 7-east	0	0	25	10	0
Lilla Bergsgatan	0	0	33	30	0
Sprängkullsgatan 2b-4	0	0	33	30	0
Sprängkullsgatan 4-6	1.4	2.8	33	30	2.1
Sprängkullsgatan 6-8	0.7	0.7	33	30	0.6
Sprängkullsgatan 8-south	1	2	43	30	0.7
Haga Kyrkogata 5-7	0	0	26	10	0
Haga Kyrkogata 7-9	0.8	1.6	26	10	0.1
Sum	39.7	51.9			27.4

At non-signalized intersections vehicles have duty to give way for pedestrians. According to Sveriges kommuner och Landsting 2010 results this into more accessibility but not more safety the pedestrians. Therefore, should vehicles speed be limited to 30 km/h into the intersection.

5 Evaluation of the Future Scenario

To calculate how many accidents there will be in the future scenario, an Excel-model has been used, see appendix 2. The first input into the model is the number of previous occurred accidents and the number of injuries that these have resulted in. However, pedestrian fall accidents and certain bicycle single accidents have not been considered in the model. It is assumed that these accidents depend on the lack of maintenance. The number of injuries that had occurred during the investigated time frame was 244 and this number has to be decreased with 50 % to reach the aim of this report.

A quota between the number of accidents and the number of injuries has been calculated for each intersection and street from previous occurred accidents in the area. This is done to convert the different measures that are suggested from a decrease of accidents to how many injuries they represent. This applies for all input except the result from the power model, which gives the result in decrease of number of injured.

After the input of the accidents and injuries, the change of traffic flows is added to the model. This is shown as the difference in number of accidents in percent between the present state and the future scenario, see figure 5.1. The increase in pedestrian flow will only affect the pedestrian accidents while the increase of bicycle flow will affect both pedestrian and bicyclist accidents. However, the decrease of motor vehicle flow will affect all transport modes. The number of injuries will increase with approximately 8.6 % when considering the changes in traffic volumes.

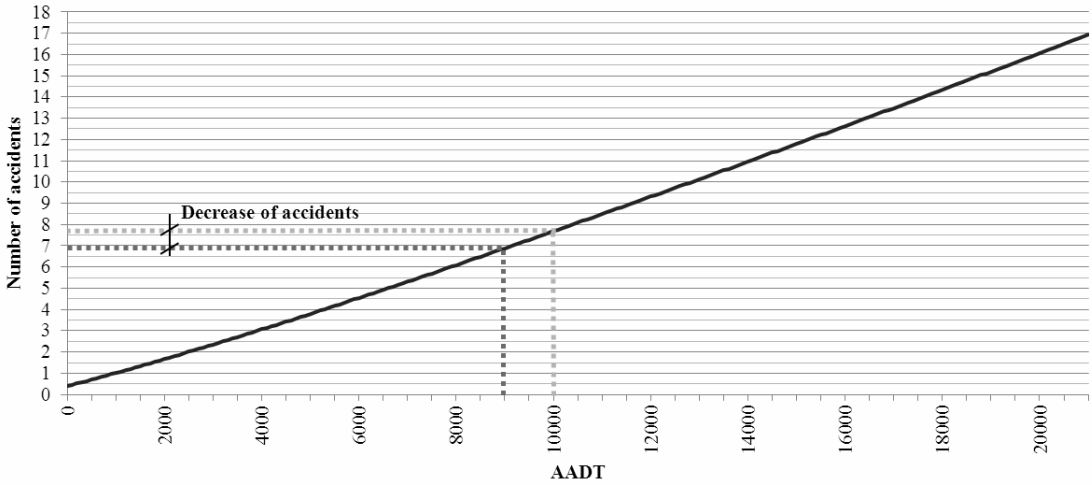


Figure 5.1. Relation between traffic volume and number of accidents with injuries as an outcome. (Source (edited): Elvik et. al, part 1.3, 2007)

Thirdly, the design measures are added into the model. However, it is only those measures that give a value in percent that are used in the model. It is difficult to evaluate which effect other measures might have on the traffic safety. The different design measures will decrease the number of injuries with approximately 46.0 %.

Lastly, the result from the Power Model gives a decrease of 10.0 % of the total number of injuries. When weighting the input data together the number of injuries is decreased with 47.4 %. However, this is still not enough since the aim is 50 %. To reach this, some more changes have to be done. The new bicycle lane on the east side of Sprängkullsgatan will decrease the number of bicyclists going on the west bicycle

path. It is assumed that this decrease is approximately one third. This modification of the model gives the percentage of 50.1 %, slightly above the goal.

6 Discussion and Conclusion

Measures for certain single accidents, such as persons that have fallen due to an icy pavement, gravel or leaves, have not been evaluated in the result. These accidents do not usually result in a severe injury, but they are quite many. The accident type is overrepresented by elderly people, who also often receive more severe injuries. The recommendation we give is to have a higher level of routine maintenance. Especially in streets where many people walk should have an extra level of routine maintenance.

Some accidents are hard to assess whether they are caused by a person under the influence of alcohol or if they are a suicide attempt. Both of these are not accounted for in the Vision Zero. However, there can still be measures done to reduce the risk for those kinds of accidents, or to reduce the effect of the accident.

The ISS system describes how severe the injury on a person is. The severity is based on how life threating the injury is. However, it does not take the consequences of the injury into account. For example is whiplash not classified as a severe injury, even though it can lead to severe suffer and affect the quality of life.

As could be seen, there where almost no accidents between pedestrians and bicyclists. This might seem strange, since it is observed that bicyclists sometimes use the pedestrian path and vice versa. The low number can have several explanations; one is that those accidents not are reported into STRADA at all. This could be explained by that there were no police at the accident scene or if the injured one has not sought out a hospital. Another reason could be that both pedestrians and bicyclists are aware that there can be others in their path and therefore be more alert in those situations.

Several of the suggested measures will decrease the number of parking places. However, there are possibilities to build parking places in connection to Västlänken. Although, special needs must be fulfilled, such as parking spaces for physically impaired closer to the destination such as shops. We believe that in the city it is not necessary to have the car just outside the door; it is ok to walk the same distance or longer as to a bus or tram stop, just like the parking policy for Göteborg declares. This will also make it easier to choose a more sustainable mean of travel, with public transport or bicycle.

The mezzanine floor at the north entrance could be used as a parking garage for commuters and residents from the surrounding area. Furthermore, this floor could also be used as a multi-level crossing by leading down bicyclists and pedestrians travelling through the area. This would lead to fewer conflicts between motor vehicles and therefore, fewer accidents.

To have several exits in the same entrance building like at Triangeln makes people choose direction inside the building, instead of outside, in the traffic environment. This could be applied to the southern entrance to reduce the risk of accidents. Another good example from Triangeln to apply at the Haga station is collision protections around the entrance buildings.

The two main entrances could be complemented with more entrances further away, like one at Järntorget, Grönsakstorget and Vasaplatsen. This would distribute the flows of commuters and therefore decrease the risk of accidents. Furthermore, if the future plans of extensions to Askim and Hisingen become real, more entrances would be a way to handle the increased flow of commuters at the Haga station.

There are several sources of error that might affect the result. The predicted number of users of the Haga station, 30,000, could be too high or, as well, too low. Moreover, the increase of bicycle traffic flows is a rough estimation. If the vision, of 180,000 bicyclists per day, from 1999 is reached by 2028, the number of accidents will probably increase. However, if there is an increase of traffic flows the different transport modes might become more aware of each other. Therefore, there could actually be a decrease of accidents when there is an increase of traffic volumes.

Consequently, the traffic safety can be increased to a satisfactory level with relative small measures in the design and speed limits. However, there are always sources of error to consider when performing this kind of investigation. Therefore, a continued study of the project might solve the different question marks that still exist.

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APPENDIX 1: TRAFFIC FLOWS

Street	Motor vehicle flow, present	Year of measurement	Motor vehicle flow, after congestion fees	Pedestrian flow, present	Pedestrian flow, 2028	Bicycle flow, present	Bicycle flow, 2028
Bellmansgatan	400	1983	369	52	52	5	9
Haga Kyrkogata, between intersection 9 & 11	3700	2011	3416	368	527	241	434
Haga Kyrkogata, between intersection 7 & 9	1100	1983	1016	272	272	19	34
Haga Kyrkogata, between intersection 5 & 7	700	1983	646	204	255	24	43
Haga Nygata	300	2011	277	212	292	77	138
Haga Östergata	300	2011	277	72	136	33	60
Hvitfeldsplatsen	6300	2005	5900	508	1075	167	300
Hvitfeldtsplatsen	6300	2005	5900	572	922	380	684
Lilla Bergsgatan	1300	2011	1200	360	393	83	150
Nya Allén, between intersection 2a & 3a	13200	2009	11400	188	201	797	1434
Nya Allén, from intersection 2a	8700	2010	6700	172	223	815	1468
Nya Allén, from intersection 3a	10500	2010	8700	248	249	676	1218
Parkgatan, between intersection 2b & 3b	11100	2010	9400	868	931	28	50
Parkgatan, from intersection 3b	11800	2010	10100	192	242	28	50
Rosenlundsbron	7200	2010	6100	404	961	278	500
Rosenlundsgatan	5000	2008	4616	464	544	241	434
Rosenlundsplatsen, Intersection 1	6300	2005	5900	508	1075	167	300
Sahlgrensgatan	3500	2008	3231	88	235	130	233
Sprängkullsgatan, between intersection 4 & 6	12800	2010	11700	432	432	899	1618
Sprängkullsgatan, between intersection 6 & 8	12800	2010	11700	376	376	991	1785
Sprängkullsgatan, between intersection 2a & 2b	7200	2010	6647	652	892	723	1301
Sprängkullsgatan, between intersection 2b & 4	12800	2010	11700	702	766	718	1293
Sprängkullsgatan, from intersection 8	20800	2010	19200	520	628	991	1785
Storgatan	700	1983	646	84	129	5	9
Södra Allégatan	8700	2010	7100	328	438	46	83
The Haga Park	-	-	-	196	196	10	17
The Haga Park	-	-	-	44	96	5	9
The Haga Park	-	-	-	48	48	5	9
The Haga Park	-	-	-	110	110	7	13
The Haga Park	-	-	-	104	184	57	103
The Haga Park	-	-	-	168	168	46	83
The Haga Park	-	-	-	87	227	49	88
The Haga Park	-	-	-	140	140	12	21
Vasagatan, between intersection 8 & 9	9400	2010	8500	932	932	1038	1868
Vasagatan, between intersection 9 & 10	9400	2010	8500	1556	1943	954	1718
Vasagatan, from intersection 10	4400	1983	3900	1476	1644	843	1518
Viktoriabron	2100	2010	1939	248	248	204	367
Viktoriagatan, from intersection 10	7300	2010	6740	488	616	158	284
Viktoriagatan, , between intersection 3a & 3b	5900	1984	5447	352	352	148	267
Viktoriagatan, between intersection 3b & 10	7300	1983	6740	412	412	111	200
Västergatan	3500	2011	3231	536	620	241	434

	Injuries				Accidents			Injuries/Accident			Flow			Design					Speed			Future no. accidents
	before				before						increase/decrease			affecting type of accidents					before	after	The power model	
intersection/road	total	pedestrian	bicycle	vehicle	pedestrian	bicycle	vehicle	pedestrian	bicycle	vehicle	pedestrian	bicycle	vehicle	all	all 2	pedestrian	bicycle	vehicle	speed	speed	decrease of accidents	
1	5	2	0	3	2	0	3	1,00	0,00	1,00	2,12	1,36	0,94	100%	100%	100%	86%	100%	40	30	2,2	6,03
2a	26	1	10	15	1	10	11	1,00	1,00	1,36	1,55	1,54	0,82	100%	25%	100%	100%	100%	48	30	3,7	2,99
2b	27	13	1	13	11	1	9	1,18	1,00	1,44	1,05	1,50	0,86	100%	25%	100%	65%	100%	48	30	3,9	3,51
3a	10	2	2	6	2	2	5	1,00	1,00	1,20	1,01	1,52	0,85	67%	25%	100%	100%	100%	48	48	0,0	1,72
3b	31	3	0	28	3	0	13	1,00	0,00	2,15	1,17	1,36	0,86	67%	25%	100%	70%	100%	48	48	0,0	4,73
4	8	2	4	2	2	4	1	1,00	1,00	2,00	1,15	1,00	0,91	100%	100%	100%	100%	100%	33	30	1,7	5,90
5	0	0	0	0	0	0	0	0,00	0,00	0,00	1,15	1,10	0,68	100%	100%	100%	100%	100%	34	10	0,0	0,00
6	9	4	5	0	4	5	0	1,00	1,00	0,00	1,16	1,00	0,91	100%	100%	100%	100%	100%	33	30	1,0	7,77
7	0	0	0	0	0	0	0	0,00	0,00	0,00	1,15	1,14	0,52	100%	100%	100%	100%	100%	34	10	0,0	0,00
8	16	0	4	12	0	4	7	0,00	1,00	1,71	1,17	1,54	0,91	100%	100%	100%	100%	100%	43	30	7,9	8,57
9	7	1	5	1	1	5	1	1,00	1,00	1,00	1,15	1,53	0,87	67%	100%	99%	100%	99%	40	40	0,0	6,05
10	44	3	28	13	3	28	8	1,00	1,00	1,63	1,20	1,53	0,91	67%	100%	99%	70%	99%	40	40	0,0	29,31
11	0	0	0	0	0	0	0	0,00	0,00	0,00	1,20	1,42	0,93	100%	100%	100%	100%	100%	38	38	0,0	0,00
1-west	1	0	1	0	0	1	0	0,00	1,00	0,00	1,13	1,41	0,93	70%	80%	100%	100%	100%	30	30	0,0	0,73
1-east	1	0	0	1	0	0	1	0,00	0,00	1,00	1,47	1,33	0,93	100%	100%	100%	100%	100%	40	30	0,4	0,49
1-north	2	1	0	1	1	0	1	1,00	0,00	1,00	1,11	1,46	0,94	70%	100%	100%	100%	100%	36	36	0,0	1,72
1-2	0	0	0	0	0	0	0	0,00	0,00	0,00	1,15	1,43	0,85	100%	100%	100%	100%	100%	34	34	0,0	0,00
2a-west	2	0	0	2	0	0	1	0,00	0,00	2,00	1,31	1,52	0,76	100%	100%	100%	100%	100%	48	48	0,0	1,53
2b-west	5	1	0	4	1	0	3	1,00	0,00	1,33	1,18	1,19	0,81	100%	100%	67%	100%	50%	48	48	0,0	2,39
2b-4	0	0	0	0	0	0	0	0,00	0,00	0,00	1,10	1,48	0,91	70%	100%	100%	100%	100%	33	30	0,0	0,00
2a-3a	9	0	0	9	0	0	5	0,00	0,00	1,80	1,29	1,52	0,86	100%	100%	100%	100%	100%	48	48	0,0	7,71
2b-3b	6	3	0	3	3	0	3	1,00	0,00	1,00	1,07	1,13	0,84	100%	100%	67%	100%	50%	48	48	0,0	3,31
3a-east	4	0	0	4	0	0	2	0,00	0,00	2,00	1,23	1,51	0,82	100%	100%	100%	100%	100%	48	48	0,0	3,29
3b-east	0	0	0	0	0	0	0	0,00	0,00	0,00	1,28	1,13	0,85	100%	100%	100%	100%	100%	48	48	0,0	0,00
3a-north	1	0	1	0	0	1	0	0,00	1,00	0,00	1,23	1,39	0,94	100%	100%	100%	100%	100%	39	39	0,0	1,30
3b-10	9	0	7	2	0	7	2	0,00	1,00	1,00	1,15	1,35	0,92	70%	80%	100%	100%	100%	40	40	0,0	5,90
4-west	0	0	0	0	0	0	0	0,00	0,00	0,00	1,52	1,15	0,98	100%	100%	100%	100%	100%	26	26	0,0	0,00
4-6	4	0	0	4	0	0	2	0,00	0,00	2,00	1,14	1,50	0,91	70%	100%	100%	100%	100%	33	30	0,7	1,86
6-west	1	0	1	0	0	1	0	0,00	1,00	0,00	1,26	1,26	0,98	100%	100%	100%	100%	100%	10	10	0,0	1,23
6-8	1	0	0	1	0	0	1	0,00	0,00	1,00	1,16	1,51	0,91	70%	100%	100%	100%	100%	33	30	0,1	0,52
8-south	3	0	1	2	0	1	1	0,00	1,00	2,00	1,12	1,53	0,92	100%	100%	100%	100%	100%	43	30	1,3	1,96
8-9	0	0	0	0	0	0	0	0,00	0,00	0,00	1,07	1,53	0,90	100%	100%	100%	100%	100%	40	40	0,0	0,00
5-east	0	0	0	0	0	0	0	0,00	0,00	0,00	1,48	1,03	0,68	100%	100%	100%	100%	100%	22	10	0,0	0,00
5-7	0	0	0	0	0	0	0	0,00	0,00	0,00	1,27	1,12	0,68	100%	100%	100%	100%	100%	34	10	0,0	0,00
7-east	0	0	0	0	0	0	0	0,00	0,00	0,00	1,60	1,03	0,88	100%	100%	100%	100%	100%	25	10	0,0	0,00
7-9	2	2	0	0	1	0	0	2,00	0,00	0,00	1,21	1,10	0,95	80%	100%	100%	100%	100%	26	10	1,5	0,56
9-10	5	0	4	1	0	4	1	0,00	1,00	1,00	1,04	1,53	0,90	100%	100%	100%	100%	100%	40	40	0,0	6,40
9-11	2	0	2	0	0	2	0	0,00	1,00	0,00	1,17	1,41	0,93	80%	70%	100%	100%	100%	38	38	0,0	1,47
11-west	0	0	0	0	0	0	0	0,00	0,00	0,00	1,17	1,27	0,95	100%	100%	100%	100%	100%	33	30	0,0	0,00
11-south	2	0	2	0	0	2	0	0,00	1,00	0,00	1,12	1,41	0,93	80%	70%	100%	100%	100%	38	38	0,0	1,47
10-south	0	0	0	0	0	0	0	0,00	0,00	0,00	1,13	1,36	0,92	100%	100%	100%	100%	100%	39	39	0,0	0,00
10-east	1	1	0	0	1	0	0	1,00	0,00	0,00	1,04	1,52	0,89	100%	100%	100%	100%	100%	40	40	0,0	1,42
Injuries before	**244**																				total:	121,83
																					goal:	122
																					difference %	50,07%

APPENDIX 2: EXCEL-MODEL

$$FNI = \left(D_v \cdot A_v \cdot IA_v + D_b \cdot A_b \cdot IA_b \cdot F_b + D_p \cdot A_p \cdot IA_p \cdot F_p \cdot F_b\right) \cdot D_{a1} \cdot D_{a2} \cdot F_v - PM$$

FNI – Future number of injuries

D_v – Design measures, motor vehicles
D_b – Design measures, bicycles
D_p – Design measures, pedestrians
D_{a1} – Design measures, all transport modes
D_{a2} – Design measures, all transport modes

A_v – Number of accidents, motor vehicles
A_b – Number of accidents, bicycles
A_p – Number of accidents, pedestrians

IA_v – Quota between number of injuries and number of accidents, motor vehicles
IA_b – Quota between number of injuries and number of accidents, bicycles
IA_p – Quota between number of injuries and number of accidents, pedestrians

F_v – Traffic flow, motor vehicles
F_b – Traffic flow, bicycles
F_p – Traffic flow, pedestrians

PM – Result from the Power Model