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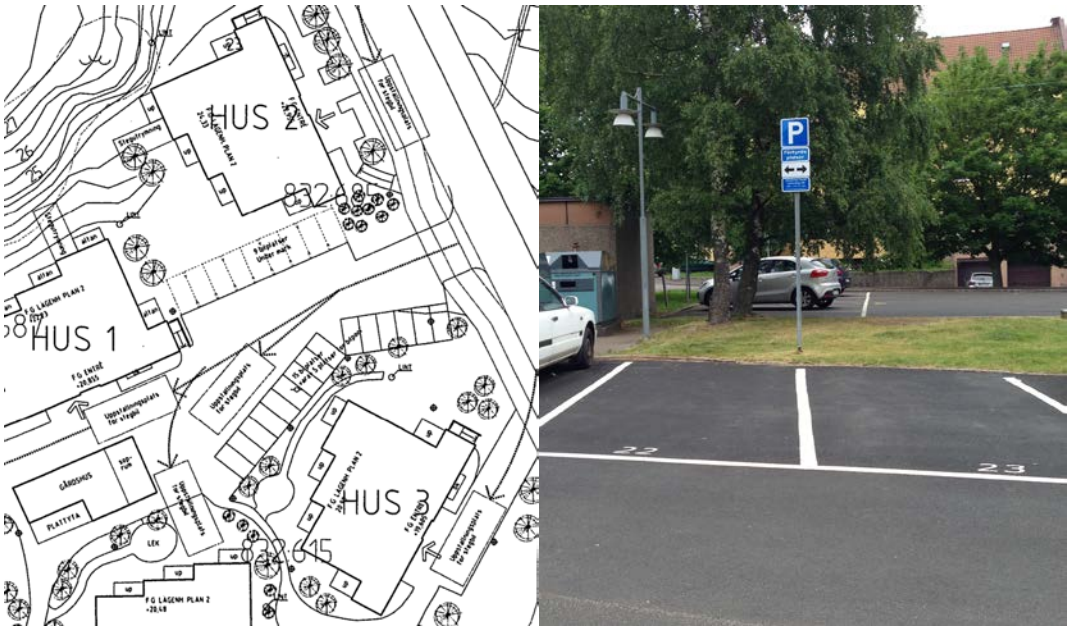

The parking standard in Gothenburg

A comparison between theory and reality

Master of Science Thesis in the Master's Programme Infrastructure and Environmental Engineering

KRISTIAN GILLMÉN
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CHALMERS UNIVERSITY OF TECHNOLOGY
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Master's Thesis 2014:52

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Cover:
Left figure: Building permit for residential buildings in Gothenburg
Right figure: Parking space in Gothenburg

Department of Civil and Environmental Engineering Göteborg, Sweden 2014

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ABSTRACT

Before constructing a residential or commercial building in a city, a number of demands have to be fulfilled. These demands do not only include the size, design and purpose of the building but also the number of parking spaces that needs to be built on the property. The regulations regarding parking is governed by Gothenburg's parking standard and are stated in the detailed development plans and are requirements to get a building permit approved. The existing parking standard was introduced in 2011 and is based on Gothenburg's parking policy where one of the goals is to reduce the number of parking spaces in public areas and instead be provided on the development site. The aim of this thesis is to analyze the guidelines regarding parking when planning and constructing residential houses and preschools in Gothenburg and to investigate the consequences that these guidelines have both now and in the near future. Both the existing and the previous parking standard will be described and case studies will be conducted at five different locations, including both residential areas and preschools, to see in which extent the parking standard is implemented when planning and building an area and to see how it may affect the car ownership in a residential area or the traffic safety at a preschool. One of the results from the study shows that the number of parking spaces that gets built on the development site is not sufficient to cover the demand which leads to a continuing demand of alternative parking outside the site, which in turn counteracts the goal of the parking policy.

Key words: Parking standard, parking ratio, parking space, parking policy, detailed development plan, building permit, preschool, Lundby, Gårda, Bergsjön, Göteborg

Parkeringstalen i Göteborg

En jämförelse mellan teori och verklighet

Examensarbete inom Infrastructure and Environmental Engineering

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SAMMANFATTNING

Det är många kriterier och krav som måste uppfyllas innan byggstart av en kommersiell eller kommunal byggnad. Dessa krav inkluderas inte endast av storlek, design och ändamål utan också av antalet parkeringar som måste byggas på fastigheten. Dessa förordningar gällande parkering regleras i Göteborgs parkeringsstandard, även kallad parkeringstal, de är angivna i detaljplanen och är krav som måste vara uppfyllda när bygglov godkänns. Den nuvarande parkeringsstandarden togs fram år 2011 och bygger på Göteborgs parkeringspolicy där ett av målen är att reducera antalet parkeringar på gatumark. Istället ska den parkering som behövs i staden erbjudas på kvartersmark. Syftet med denna rapport är att analysera de riklinjer som finns angående anläggning av parkering vid planering och byggnation av bostadshus och förskolor i Göteborg samt att undersöka konsekvenserna dessa riklinjer kan få både nu och i framtiden. Både den nuvarande och föregående parkeringsstandarden kommer att beskrivas och fallstudier kommer att genomföras på fem olika platser i Göteborg, både i bostadsområden och vid förskolor, för att se i vilken utsträckning parkeringsstandarden implementeras när ett område planeras och bebyggs. Detta görs för att undersöka hur antalet parkeringar påverkar bilägandet i ett bostadsområde eller trafiksäkerheten vid en förskola. Ett av resultatet från studien visar att antalet parkeringsplatser som byggs på kvartersmark inte täcker det behovet av parkering som finns, vilket leder till en fortsatt efterfrågan av alternativ parkering, vilket i sin tur motverkar målet med Göteborgs parkeringspolicy.

Nyckelord: Parkeringstal, parkeringspolicy, parkeringsstandard, parkeringsnorm bygglov, detaljplan, Bergsjön Gårda, Göteborg, Lundby

Contents

Preface

This master thesis has been conducted at the request of the department of traffic (DOT) in Gothenburg and is the final step of the Master's Programme Infrastructure and Environmental Engineering at Chalmers University of Technology. It represents 30 credits and was written in Gothenburg from February 2014 to June 2014.

The thesis has been carried out by Kristian Gillmén and Hugo Gräsberg and has been performed at the DOT in Gothenburg. Supervisors have been Sebastian Svedgren, traffic planner at the DOT and Jan Englund at Chalmers University of Technology. University professor Lars O Eriksson has been the examiner.

We would like to thank our supervisors as well as all the knowledgeable personnel at the DOT for the support, input and interest throughout the writing of this thesis.

Göteborg June 2014

Kristian Gillmén & Hugo Gräsberg

Glossary

Administrator – *Handläggare* – The person that handles building permits

City executive office – *Stadsledningskontoret*

Department of city planning – *Stadsbyggnadskontoret*

Department of traffic (DOT) – *Trafikkontoret*

Development site – *Kvartersmark*

Household – *Hushåll* – An apartment or detached house with one or several residents

Premises office – *Lokalsekretariatet*

Parking ratio – *Parkeringstal*

Regular parking – *Markparkering*

Rental apartment – *Hyresrätt*

Small statistical area – *Basområde*

Tenant-owned apartment – *Bostadsrätt*

Tenant-owner association – *Bostadsrättsförening*

Visitor parking at preschool – *Besöksparkering* – Parking reserved for dropping of and picking up children

1 Introduction

This initial chapter presents the background, purpose and method of the report. The necessary limitations needed to be able to write the report are also presented.

1.1 Background

Before constructing a residential or commercial building in a city, a number of demands have to be fulfilled. These demands do not only include the size, design, purpose, etcetera but also the number of parking spaces that needs to be built on the property.

The guidelines regarding the number of car and bicycle parking spaces in the city of Gothenburg are stated in the detailed development plans and are requirements to get a building permit approved. These guidelines are set to regulate the number of parking spaces that needs to be built when a new residential, commercial or public building is constructed. The number of parking spaces is presented either as an amount of cars per apartment/detached house or an amount of cars per 1000 m^2. This is called parking ratio and is based on the number of residents and visitors, forecasts of future car ownership and the accessibility to public transportation.

The parking ratio is not only a way to ensure that enough parking spaces are available in the city, it is also used as a control measure to reduce the use of cars in the city and encourage the population to use alternative ways of transport e.g. bicycle and public transportation. However the city of Gothenburg does see a problem here and the guidelines does not seem to correspond to the reality and even though the travel with public transport has increased the number of cars per inhabitant is not decreasing in the same rate.

Recommendations regarding preschools in general and parking spaces for pick up and drop of in particular, were introduced for the first time in the new guidelines for parking ratios issued in 2011. Only recommendations regarding parking for employees at schools in general were included in the old parking standards. The number of parking spaces dedicated to dropping of and picking up children at preschools was then estimated and varied from case to case. The new parking ratios give clear guidelines and are more standardized regarding the total number of parking spaces, however, no real follow up of the results of this has been made. The department of traffic (DOT) has therefore requested that the parking situation of preschools should be observed.

The department of city planning is responsible for the development of detailed development plans and the issuing of building permits. However, a complaint regarding the parking situation in an area after construction ends up at the DOT and the end result and consequences of the construction might never reach those responsible for planning at the department of city planning.

1.2 Aim

The aim of this thesis is to analyze the guidelines regarding parking when planning and constructing residential houses and preschools in Gothenburg and to investigate the effect that these guidelines have both now and in the near future.

1.3 Objectives

Based on the aim the following issues have been formulated to be answered inside the boundaries of the report.

- What are the guidelines for parking ratio today?
- To what extent are the guidelines regarding parking followed when planning and constructing new buildings?
- What are the results of the new parking standard for preschools?
- In what extent does the number of parking spaces affect the car ownership?

1.4 Limitations

The investigations of how the guidelines for parking ratios are corresponding to reality are limited to the city of Gothenburg and are focusing on a five special cases. Three residential areas have been analyzed, two located in the city district of Lundby and one in the city district of Gårda. Two newly built preschools have been studied, one in the city district of Bergsjön and one in the city district of Lundby.

1.5 Method

The initial stage of the project were spent by studying existing literature and report and by gathering information to be able to get a deeper understanding of the subject. Experts have been interviewed and consulted to get an insight into how the department of traffic in Gothenburg is working with these questions and their experience of how the reality differs from the guidelines on the parking ratio. Five special cases have been studied, statistics on residences and car ownership have been analyzed and field investigations were carried out to gather more information about the current situation regarding parking ratios in Gothenburg.

2 Theory

The first part of this chapter describes the current and future situation in Gothenburg regarding population, car ownership and parking. The second part present the laws, guidelines and tools used to control the development of an urban environment, focusing on parking ratio.

2.1 The future challenges in Gothenburg

The city of Gothenburg is facing major changes and numerous challenges. The city becomes more densified, the land is used more efficiently and the urban environment planning is heading towards a more sustainable approach (Stadsbyggnadskontoret et al., 2009). The ambition is that Gothenburg shall be both attractive and accessible. By year 2035 it is calculated that Gothenburg will have 150 000 new residents, 80 000 new jobs and will be the core in the regions labor market consisting of 1.7 million people (Trafikkontoret, 2014). The growth of the region leads to a continuous increase of commuters as well as the distance travelled. A large proportion will still travel by car which increases the demand of parking spaces.

2.2 Car ownership in Gothenburg

By the end of year 2012 there were a total of 186 000, registered and deregistered, cars in Gothenburg that was owned by persons and personal companies (Statistiska Centralbyrån, 2013). This can be seen in relation with the amount of households in Gothenburg, 260 000, and the amount of inhabitants, 526 000. The ratio of cars per households is 0.71 and the ratio of cars per inhabitants is 0.35. The areas with the highest car ownership in Gothenburg are located on Hisingen and the western part of the city (Trafikkontoret, 2008). This section presents the factors that affect the car ownership in Gothenburg as well as the changes over the past ten years.

2.2.1 Variables that affect the car ownership

A report with focus on the parking guidelines called “Riktlinjer för parkering”, published in 2008, was written to serve as a basis for assessment of parking needs and to develop a model to predict future car ownership in different parts of Gothenburg. Different variables that affect the car ownership and could be compared with each other were put together. When looking at Gothenburg in general the variable that showed the strongest correlation with car ownership is the number of persons per household. However, the variable that affects the car ownership the most differs depending on which part of the city that is studied. Gothenburg is therefore divided into four geographical regions, Hisingen, Nordost, Centrum and Väster, since car ownership and the socio-economic structure differs in the different parts of the city. The division is shown in Figure 1. The factors that seem to affect the car ownership is the size of the apartment, the distance to Brunnsparken, persons per household and percentage of detached houses in the area (Trafikkontoret, 2008).

Figure 1: The four different regions that reflect car ownership in Gothenburg.

In the sector Väster the apartment's size, measured in number of rooms, has a stronger correlation than the number of persons per household. The size is a strong variable in the sector Centrum as well. The proportion of detached houses is the variable that has the highest correlation to the car ownership in the sector Nordost. In the sector Hisingen it is a combination of the number of persons per household and the proportion of detached houses. The distance from the residence to Brunnsparken also has a connection, however not as strong as the other variables, to the number of cars per household in all four sectors. Furthermore the variables that describe economic conditions such as income, unemployment and average age in the area are also linked to the number of cars per household (Trafikkontoret, 2008).

2.2.2 Statistics for Gothenburg

Statistics from the Swedish statistical agency (Statistiska Centralbyrån, SCB), provided by the city executive office, was examined to be able to study the change in car ownership in Gothenburg between year 2004 and 2012. The city is divided into small statistical areas and the statistics include both registered and deregistered cars for professional and personal use, owned by individuals and personal enterprises. The statistics are based on which statistical area the owner of the car is registered and it is not certain that the owner parks the car in that area. Certain statistics are missing within the range, e.g. no statistics on the number of households from 2010, however it is considered to give a fairly good view of the development.

A different division of Gothenburg than in the previous section is used to illustrate the car ownership. This division is retrieved from Gothenburg's parking policy, further described in section 2.2 and divides Gothenburg into four parts, shown in Figure 2. The first part is called zone A and contains the area inside of the moat, zone B consist of the central parts of Gothenburg and zone C includes parts of Hisingen, Majorna, Gamlestaden and Krokslätt. The remaining parts of Gothenburg is called zone D. Zone A is not included in the statistics for zone B, zone B is not included in zone C, etc. The area, called zone A, in Figure 2 is relatively small and the statistical uncertainty is therefore higher.

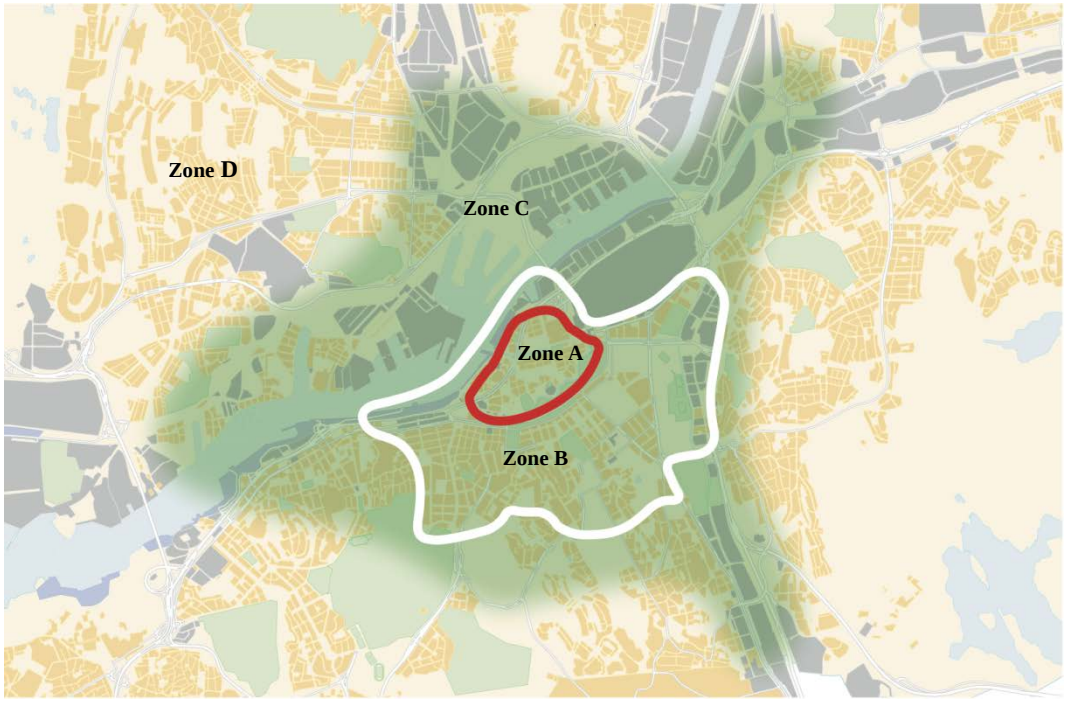


Figure 2: Geographical limits according to the parking policy (Stadsbyggnadskontoret et al., 2009)

The number of households in Gothenburg is steadily increasing. Between year 2004 and 2012 the increase were 6% and the change in the number of households over the years is shown in Table 1. The largest increase can be seen in zone A (20%) and zone C (17%). The number of households in zone B and zone D has increased with 6% and 3% respectively (Statistiska Centralbyrån, 2013).

Table 1: the number of apartments and detached houses in different parts of Gothenburg and the percentage change between 2004 and 2012

	Households				
	Zone A	Zone B	Zone C	Zone D	Entire Gothenburg
2004	2085	27692	42 758	172 141	244 676
2006	2155	27871	45 123	173 543	248 692
2008	2255	28045	46 368	174 305	250 973
2010	-	-	-	-	-
2011	2383	29480	49 422	177 050	258 335
2012	2491	29422	50 067	178 354	260 334
Percentage change	19%	6%	17%	4%	6%

The number of inhabitants in Gothenburg has increased as well. Between year 2004 and 2012 the total population of Gothenburg increased with 9%, the change in the number of inhabitants over the years is shown in table 2. However, when the population is not increasing in the same extent as the number of households when locking at zone A, only a 7% increase in population compared to a 19% increase in residences. Other than that there is a 9% increase in zone B, a 15% increase in zone C and a 9% increase in zone D (Statistiska Centralbyrån, 2013).

Table 2: the population in different parts of Gothenburg and the percentage change between 2004 and 2012

Inhabitants					
	Zone A	Zone B	Zone C	Zone D	Entire Gothenburg
2004	3 652	46 231	72 002	359 525	481 410
2006	3 629	46 265	73 865	365 998	489 757
2008	3 733	47 142	76 455	372 867	500 197
2010	3 827	48 877	80 315	380 732	513 751
2011	3 846	49 814	81 441	385 273	520 374
2012	3 916	50 286	82 550	389 337	526 089
Percentage change	7%	9%	15%	8%	9%

The total amount of cars in Gothenburg has increased with 14% between year 2004 and 2012, the change in the amount of cars over the years is shown in table 3. In zone A, where the increase of population and residences were the highest in percentage terms, the amount of cars is practically unchanged. In zone B has the number of cars increased with 19%, which in turn is significantly higher than the increase in population and residences (Statistiska Centralbyrån, 2013).

Table 3: the number of cars in different parts of Gothenburg and the percentage change between 2004 and 2012

Cars					
	Zone A	Zone B	Zone C	Zone D	Entire Gothenburg
2004	1 062	12 891	20 442	128 216	162 611
2006	998	13 001	21 305	131 690	166 994
2008	1 075	13 922	21 513	136 296	172 806
2010	1 101	14 646	22 333	141 074	179 154
2011	1 107	14 935	22 708	144 616	183 366
2012	1 060	15 462	22 961	146 033	185 516
Percentage change	0%	20%	12%	14%	14%

When comparing the statistics on the change in population and number of households with the car ownership, displayed in table 4 and table 5, a decrease can be noticed in zone A and zone C. While a slight increase can be seen in zone B and remaining Gothenburg. When looking at entire Gothenburg the increase in the number of cars per household is 7% and the increase in the number of cars per 1000 inhabitants is 4% (Statistiska Centralbyrån, 2013).

Table 4: the number of cars per household in different parts of Gothenburg and the percentage change between 2004 and 2012

Cars per Household					
	Zone A	Zone B	Zone C	Zone D	Entire Gothenburg
2004	0,51	0,47	0,48	0,74	0,66
2006	0,46	0,47	0,47	0,76	0,67
2008	0,48	0,50	0,46	0,78	0,69
2010	-	-	-	-	-
2011	0,46	0,51	0,46	0,82	0,71
2012	0,43	0,53	0,46	0,82	0,71
Percentage change	-16%	13%	-4%	10%	7%

Table 5: the number of cars per person in different parts of Gothenburg and the percentage change between 2004 and 2012

Cars per person					
	Zone A	Zone B	Zone C	Zone D	Entire Gothenburg
2004	0,291	0,279	0,284	0,357	0,338
2006	0,275	0,281	0,288	0,360	0,341
2008	0,288	0,295	0,281	0,366	0,345
2010	0,288	0,300	0,278	0,371	0,349
2011	0,288	0,300	0,279	0,375	0,352
2012	0,271	0,307	0,278	0,375	0,353
Percentage change	-7%	10%	-2%	5%	4%

2.3 Parking and the parking policy in Gothenburg

As described previously in this chapter, a lot is changing in Gothenburg. An increasing number of cars in the city and a densification of urban areas have lead to a growing competition of the land with development potential used for other purposes than residential or commercial buildings. Meanwhile, focus has shifted towards a more sustainable development where availability and environmental aspects are central. This meant that the guidelines regarding parking from 1996 became outdated and a parking policy that takes the changing conditions into account and encourage travel by public transport and bicycle was requested (Stadsbyggnadskontoret et al., 2009).

The current parking policy for Gothenburg city was passed by the city council in 2009 and it includes guidelines for both car and bicycle parking in the city. (Stadsbyggnadskontoret et al., 2009). The parking policy is focusing on certain strategic areas. A summary of these are;

- Modify the current parking spaces in the central parts of the city
- Plan for an unchanged accessibility of the Gothenburg event area
- Encourage the use of car sharing
- Use parking fees and time limits as tools for achieving the goals
- Prioritize short and half-day parking
- Parking for residents shall be provided on the property land
- Prioritize an attractive urban environment instead of car parking spaces
- Adapt the parking facilities to the cityscape
- Replace regular parking with shared parking facilities
- Build safe, secure and attractive
- Car free zones

The parking policy provides different approaches for parking in the different parts of the city and Gothenburg is therefore divided, as described in the previous section, into zone A, B, C and D as shown in figure 2 (Stadsbyggnadskontoret et al., 2009).

A large part of the squares, courtyards, streets etc in the central parts of the city is occupied by parking spaces. As a mean to reduce this, several of the streets in the city centre have been converted into streets where cars are allowed but at a low speed. The pedestrians are prioritized and the parking along these kinds of streets has been removed. However, the total number of parking spaces in the city center has remained largely unchanged the last couple of years (Stadsbyggnadskontoret et al., 2009).

Parking facilities have generally been constructed as regular ground parking spaces at a low cost but with a low efficient use of land. Therefore it has been relatively cheap to park in the city which means that the fee for parking does not reflect the potential market value of the land (Stadsbyggnadskontoret et al., 2009).

2.3.1 Costs for constructing parking facilities

The construction cost varies a lot depending on the type of parking facility. The cheapest is to construct a regular ground parking and the most expensive is to build an underground parking garage. The factors that mainly affect the costs are the ground properties, the complexity of the building and to use the land efficient. To make the construction waterproof when building below surface level drives up the cost regardless of the conditions of the subgrade. The large loads generated in the terrace slab or the combination with other businesses in the same building gives unfavorable conditions for a rational parking solution. The space required for one parking space with driveways varies from 20 to 35 m^2 depending on how well the solution is optimized (Bergqvist, 2013). The construction cost in thousand SEK per parking space is presented in Table 6 below.

Table 6: Cost for constructing parking facilities (Bergqvist, 2013).

Type of facility	Cost in kSEK/space
Ground parking	15-30
Basic parking deck (2 floors)	60-80
Basic parking deck (3 floors)	80-150
Parking garage (4-5 floors) ≤ 500 spaces	150-250
Parking garage (5-7 floors) > 600 spaces	200-400
Underground parking garage (1 floor)	300-450
Underground parking garage (2 floor)	450-750

These costs are isolated for the construction of the parking facility. Other costs such as purchasing the property and demolish previous buildings or facilities are not included.

The market price for one parking space in the central parts of Gothenburg is of today roughly 1500 – 2000 SEK per month. The lower level is applied to the parking spaces supplied by Gothenburg parking company. This parking fee is too low for newly produced parking facilities with a construction cost that lies above 250 000 SEK per parking space to be able to give cost coverage. This could be a burden for the company's overall profitability and could lead to difficulties on a short term basis (Bergqvist, 2013).

2.3.2 Objectives and targets for car and bicycle parking

The objective of the parking policy is to contribute to a city that should be accessible by everyone. The city shall be attractive and beautiful with a sustainable urban development – socially, economically and ecologically. The parking policy shall encourage a larger part of the population to choose public transportation or bikes instead of cars (Stadsbyggnadskontoret et al., 2009).

The aim of the policy is that the central parts of the city should have approximately the same amount of car parking spaces in the future as it has today. The parking spaces may need to be relocated to make way for alternative transportation routes and new buildings or be rebuilt as more space efficient parking facilities. However, as the access to public transport is improved the number of parking spaces may be reduced in the future (Trafikkontoret, 2014).

The number of organized bicycle parking spaces should be expanded in central Gothenburg, within comfortable walking distance to key destinations. Bicycle parking spaces shall also be provided at commuter parking and all major public transport stops. Bicycle parking at residences and workplaces shall be provided on the development site. The parking areas must be secure, of good quality, have weather protection and provide the possibility to safely store the bike (Trafikkontoret, 2014).

2.4 Planning and developing urban environments

Certain guidelines, tools and regulations are essential when a municipality is planning for the type of growth Gothenburg is facing. This part of the chapter will describe the means to develop urban environments.

2.4.1 Planning and building act

The planning and building act controls how construction and the use of land and water are planned in Sweden. It aims to promote societal progress and good living conditions together with a long term sustainable environment for future generations as well as today's society. The act states that every municipality is responsible for their own physical planning and that the municipalities need to have a comprehensive plan. The act also contains regulations for building permits and detailed development plans (Boverket, 2006).

2.4.2 Comprehensive plan

As stated in previous section all municipalities in Sweden should according to the planning and building act have a comprehensive plan that covers the entire municipal area. The comprehensive plan is the municipality's way to describe the physical environment. The plan should present in which extent the municipality is planning to cater for national interests and environmental quality standards. The plan could also include the municipality's vision for the area and be the strategic document for the future development (Boverket, 2011).

The comprehensive plan is indicative when it comes to designing detailed development plans and area regulations as well as issuing building permits according to the planning and building act but also when municipalities or other authorities are making decisions regarding land and water exploitation. The comprehensive plan is not legally binding (Boverket, 2011).

2.4.3 Detailed development plan

A detailed development plan is a legally binding settlement between the municipality and the property owner. The plan explains what can and cannot be done inside a specific area. The municipality implements with political decisions how land and water should be used and how buildings specifications and dimensions should look like with the development plan. The detailed development plan appears as a specific area on the map over the building site. The plan also contains a site description which explains the purpose and content of the plan. An illustration of the area and an environmental impact assessment are two other documents that are commonly enclosed in the detailed development plan. It is only the municipality that decides whether a development plan should be formed and adopted. The municipality is also responsible for the interpretation of the existing detailed development plans (Boverket, 2012).

2.4.4 Building permits

Before anything is built the municipality needs to review the building permit application and compare it to the detailed development plans. Consideration to design and if the project satisfy the general requirements according to the planning and building act are made before the municipality issuing building permits (Göteborg Stad, 2006). Building permits are required when constructing new buildings, adding structures or making alterations to an existing building (Boverket, 2013).

2.5 The new parking standard

The new parking standard is based on the parking policy for the city of Gothenburg and is a replacement for the previous parking standards that was issued 1996.

The new parking standard includes guidelines for car and bicycle parking spaces at:

- residential buildings
- businesses
- office buildings
- industries
- schools/preschools
- hospitals/health center
- retirement home
- hotels

The parking standard is a guideline to be able to assess an appropriate number of parking spaces when issuing detailed development plans and building permits. The standard is a local application of the rules regarding parking in the planning and building act and does not have a direct legal effect. It is the local building committee that will have to decide if the appropriate number of parking spaces for each specific case is met in a reasonable extent. Because of the different conditions in every single building project the issue of parking should be analyzed regarding these specifics. The parking standards should work as guidelines for the committee to ease the process and to judge similar projects in a similar way (Stadsbyggnadskontoret, et al., 2011).

2.5.1 Parking ratio in the detailed development plan

The parking standard is implemented in the detailed development plan and it includes the recommended ratio between the number of parking spaces per 1000 m^2 or per household that the plan should permit. The detailed development plan basically states the development rights for parking and the municipality can insist that the developer should allocate a minimum amount of the permitted building area for parking spaces. The municipality should, when the detailed development plan is designed, ensure an appropriate space for car and bicycle parking and if necessary regulate the design of the parking space, e.g. parking garage (Stadsbyggnadskontoret, et al., 2011).

The recommended amount of parking spaces, in the stage where the detailed development plan is designed, conforms relatively well with today's demand. Residential areas with high access to public transport have a recommended level that lies below today's demand. This limited possibility to park the car close to the residence is used in the purpose to lower the car ownership (Stadsbyggnadskontoret, et al., 2011).

When planning for businesses located in areas with high access to public transportation a maximum level for parking spaces is applied. The levels are lower than the current demand for parking and this limited possibility to park the car at the work place intends to lower the commuting by car (Stadsbyggnadskontoret, et al., 2011).

2.5.2 Parking ratio in building permits

In the stage where the building permits are issued, the parking ratios states the minimum number of car and bicycle parking spaces that the property owner has to provide. These minimum levels basically represent 80 percent of the detailed development plan recommended levels. The remaining 20 percent should work as a backup for future demands or as flexibility based on the claims of the building permits applicant. In conjunction with the issuing of building permits the municipality should verify if the design of the area makes it possible to, in the future, achieve the number of parking spaces recommended in the detailed development plan (Stadsbyggnadskontoret, et al., 2011).

It is based on the documents in the building permits that the municipality can decide if appropriate space for parking in a project is met. The permitted building area in the detailed development plan should be generous enough for the minimum number of parking that the municipality demands, always should fit inside the boundaries of the area (Stadsbyggnadskontoret, et al., 2011).

2.5.3 Exceptions from the parking standard

In some cases the parking standard have to be adapted based on specific conditions or focuses in individual projects. For example residential buildings where car sharing are available in a large extent, student housing or residential building targeting persons with higher or lower car ownership. These types of exceptions should primarily be done in the stage where the building permits are issued.

Exceptions from the parking standard should be based on a special parking investigation and can be approved if:

- The building has other purposes than to the ones that are mentioned in the parking standard.
- The project has a focus that causes the demand for parking not to correlate to the number of parking spaces recommended in the standard.
- The local building committee finds is necessary.

The parking ratios should always originate from a long term and sustainable level. The developer should be able to present how the special focus of the project is contributing in a sustainable way, in order to get a special adaption for the parking ratios (Stadsbyggnadskontoret, et al., 2011).

2.5.4 Shared use

Car and bicycle parking that can be used for different purposes at different times is a more efficient use of land, compared to parking that is reserved for a specific purpose or individual. If land that is used for parking is claimed by detailed development plans or building permits, it should be evaluated if the entire or parts of the parking area should be replaced based on the two principles on shared use and available capacity that is listed below (Stadsbyggnadskontoret, et al., 2011).

Shared use could be possible between different purpose within or outside the target area if:

- The demand for the parking spaces in question occurs at different times for different purposes.
- The parking spaces are not reserved for one specific user.

The parking policy states that residents should be able to park their car anytime, day and night, which makes the shared use for parking at residences inappropriate. Experience shows however that parking spaces at residential houses rarely are used more than 80 percent of the time. Therefore shared use of parking could be implemented with a maximum of 20 percent, if it is important to minimize the amount of parking spaces (Stadsbyggnadskontoret, et al., 2011).

Examples where shared parking arrangements can be implemented is an area with a mixture of residences and businesses or mixture of businesses with different opening-hours and therefore solely are using the parking during daytime or nighttime/weekends. The daytime uses could include administrative offices, schools and municipal offices. Nighttime and weekend uses could include restaurants, theaters and buildings dedicated for religious activities (Stadsbyggnadskontoret, 1996).

2.6 The difference between the old and the new parking standard

The parking standard from 1996 was based on forecasts for future car density and usage. The amount of parking spaces was decided depending on the size of the facility, number of apartments and the number of employees. The forecast for car density extends to the year 2020 and it is showing a steady increase of the amount of cars. The new standard is based on a forecast that states that the car ownership and usage will remain at the same level as today (Stadsbyggnadskontoret, et al., 2011).

The geographical boundaries in the old parking standard differ from the new when it comes to classifying the different parts of the city. A big difference is that the central parts of Hisingen and Gamlestaden are included in zone C in the new standard while the old classified them to zone D (Stadsbyggnadskontoret, et al., 2011).

The parking standards from 1996 were using the center of the city as starting point for assessing the need for parking at residential buildings. The further away from the city center the more parking were estimated to be needed per apartment or per 1000 m^2. Figure 3 shows the distance in km from the city center (Stadsbyggnadskontoret, et al., 2011).

When it comes to guidelines regarding parking for residential buildings, the old parking standard stated the parking ratio as the number of parking spaces per apartment for both detailed development plans and building permits. The new standard states the parking ratio as the number of parking spaces per 1000 m^2 for the detailed development plan and as the number of parking spaces per apartment for the building permits (Stadsbyggnadskontoret, et al., 2011).

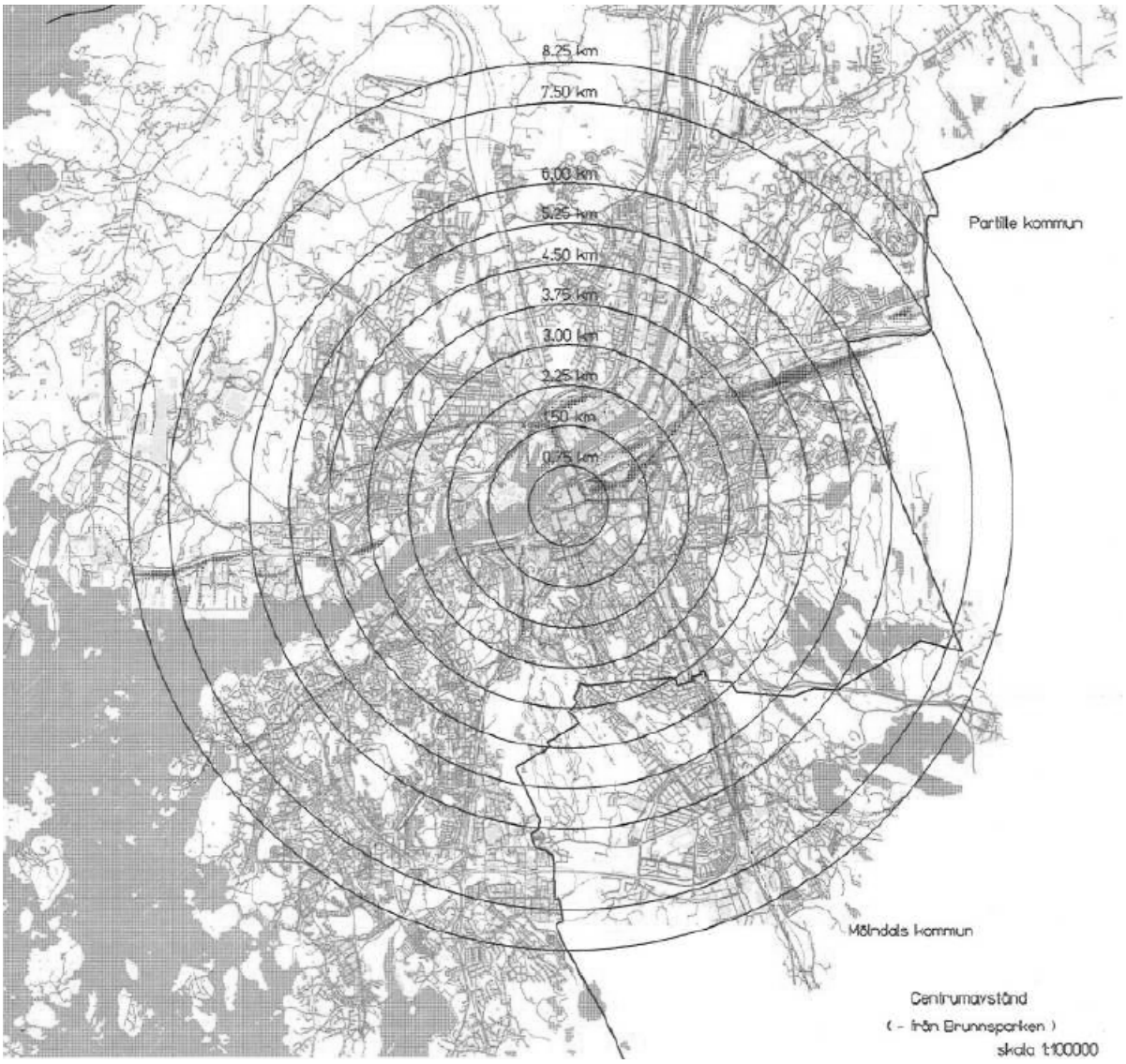


Figure 3: The parking standards from 1996 used the distance from the city center to assess the number of parking spaces needed at a residential building.

The parking standard from 1996 only includes recommendations regarding parking for the employees at preschools. Guidelines regarding parking spaces for pick up and drop of were introduced for the first time in the new parking standard. The number of parking spaces dedicated to dropping of and picking up children at preschools was estimated and varied from case to case in the old standard while the new parking standard give clear guidelines and are more standardized regarding the total number of parking spaces (Stadsbyggnadskontoret, et al., 2011).

3 The case studies

This chapter describes how the case studies have been conducted. How building documents and statistics have been analyzed, how parking ratios have been calculated and how the current situation in each area has been assessed.

3.1 Background to the investigation

The case studies have been performed to investigate whether the parking ratio and parking standard for residential areas and preschools, set by the department of city planning in Gothenburg, are followed or not. Five different cases have been studied, three residential areas and two preschools. The case studies purpose it to analyze the process from detailed development plan to finished building. Detailed development plans, building permits and statistics for the areas will be studied and the parking situation today will be investigated.

The residential areas that will be studied closer were selected in consultation with key personal at the department of traffic and are interesting because they are newly built and have some special conditions and parking requirements. Two of the investigated residential areas are located in the city district of Lundby and one in the city district of Gårda.

Recommendations regarding parking spaces for pick up and drop off at preschools were introduced for the first time in the new guidelines for parking ratios issued in 2011. Only recommendations regarding parking for employees at the preschool were included in the old parking standards. The number of parking spaces dedicated to dropping of and picking up children at preschools was then estimated and varied from case to case. The new parking ratios give clear guidelines and are more standardized regarding the total number of parking spaces. The results of the new guidelines have however only been followed up in a few cases. The DOT has therefore requested that the parking situation at two preschools should be observed. They were chosen in consultation with one of the building permit administrators and are located in the city districts of Lundby and Bergsjön.

3.2 Planning and building documents

Building documents, such as detailed development plans, implementation descriptions and building permits, was collected for all the investigated neighborhoods. All the documents regarding the detailed development plans were obtained from the records of the department of traffic in Gothenburg and the building permits were collected from the archives in the department of city planning.

3.2.1 Analyzing the detailed development plans

The estimated number of parking are stated in the detailed development plan and is based either on the old or the new parking standard, depending on when the development plan was designed. It is usually presented as the number of parking per household. The number of apartments and households are at this point only estimations based on the requirements from the different stakeholders, such as the

developer and the municipality. The development plan also specifies if there are any special conditions and requirements for parking in the area.

The accessibility to public transports is described in the development plans such as the distance to the nearest stop, which type of transport that is available and the frequency of departures. Pedestrian walkways and bicycling streets close to the target neighborhood are also presented in the plan along with potential new routes connecting the already existing ones.

The local supply of businesses, services and schools close to the site area are listed, as well as if the planned building could cause disruption on the existing traffic and road network and to nearby businesses. All these requirements are factors in deciding the parking ratio in the detailed development plans.

3.2.2 Analyzing the building permits

The building permits usually consist of the final drawings of the development site. These documents were studied to be able to see how many parking spaces the developer was authorized to build. The building permits were also used in the study of the parking situation in the area and when comparing the blueprints to the actual number of parking that was built.

3.3 Calculation of the parking ratio according to the new parking standard

The parking requirements for the residential buildings are set according to the old parking standard. A calculation of the parking ratio according to the new standard will therefore be performed as a comparison. This sub-chapter will present the statistics that forms the basis for the parking ratio and explain how to calculate the ratio for residential buildings and preschools.

3.3.1 Parking ratios for residential houses

The parking standard's objective is to ensure that the residents should have access to parking spaces around-the-clock and not being forced to move the car or use it to travel to work just because there is a lack of parking spaces in the daytime. The parking ratio is not the same all over Gothenburg and is depending on population and residential statistics and access to public transportation (Stadsbyggnadskontoret, et al., 2011).

3.3.1.1 Residential statistics

The number of persons in each household varies, especially between detached houses and apartment buildings. The size and location of the residence is also an important factor.

Table 7 shows the density of persons in each household. In this case a small apartment is not larger than a two bedroom apartment.

Table 7: Number of persons per household in different residential types

Residential type	Person/household
Apartment, Apartment building, Zone A and Zone B	1,6
Apartment, Apartment building, Zone C	1,7
Apartment, Apartment building, Zone D	1,8
Apartment, Apartment building, Entire Gothenburg	1,8
Small Apartment, Apartment building, Zone A and Zone B	1,4
Small Apartment, Apartment building, Zone C	1,5
Small Apartment, Apartment building, Zone D	1,4
Small Apartment, Apartment building, Entire Gothenburg	1,4
Small detached houses, Entire Gothenburg	3,0

3.3.1.2 Car ownership

The parking ratios are based on that the future level of car ownership will continue steady as it did in the forecasts made in the report about the demand for parking called "Riktlinjer för parkering – underlag för bedömning av parkeringsbehov" by Trafikkontoret 2008.

Table 8 shows the number of cars per person in different residential types.

Table 8: Car ownership per person in different residential type

Residential type	Cars/person
Apartment, Apartment building, Zone A and Zone B	0,31
Apartment, Apartment building, Zone C	0,32
Apartment, Apartment building, Zone D	0,36
Small Apartment, Apartment building, Zone A and Zone B	0,24
Small Apartment, Apartment building, Zone C	0,28
Small Apartment, Apartment building, Zone D	0,33
Small detached houses, Entire Gothenburg	0,55

3.3.1.3 Apartment estimations

In the detailed development plan each apartment is estimated to be 90 m^2 which is slightly less than the average apartment (100 m^2). This will decrease the risk to go below the recommended levels in the detailed development plan when issuing the building permits. In the stage where the permits are designed the parking ratio is based on the actual number of apartments in the different parts of Gothenburg (Stadsbyggnadskontoret, et al., 2011).

The numbers of visitor parking spaces have been estimated in comparison with other municipalities in Sweden and the Nordic countries. The numbers can be seen in

Table 9 below.

Table 9: Visitor parking in Gothenburg

Residential type, visit	Detailed development plan Parking/1000 m²	Building Permit Parking/household
Apartment, Zone A, Zone B and Zone C	0,6	0,05
Apartment, Zone D	1	0,07
Detached houses	0,2 per house	0,2

3.3.1.4 Public transportation

The access to public transport in Gothenburg can be seen in figure 4. The accessibility is defined as the time it takes to reach more than half of Gothenburg's working places from the target area. High accessibility means that it takes less than 30 minutes, fairly high means less than 45 minutes and low stands for more than 45 minutes. For example, it is possible for a person who lives in an area with high accessibility to travel to work within 30 minutes. The travel time is calculated based on the time spent in a vehicle, transfer time as well as the time it takes to walk between transfers. The walking time from the starting point and the walking time from the last stop to the target point are excluded (Stadsbyggnadskontoret, et al., 2011).

When calculating the parking ratio for an area with high access to public transport, the ratio will be lowered with 10%. No alterations are made if the area has fair or low access (Stadsbyggnadskontoret, et al., 2011).

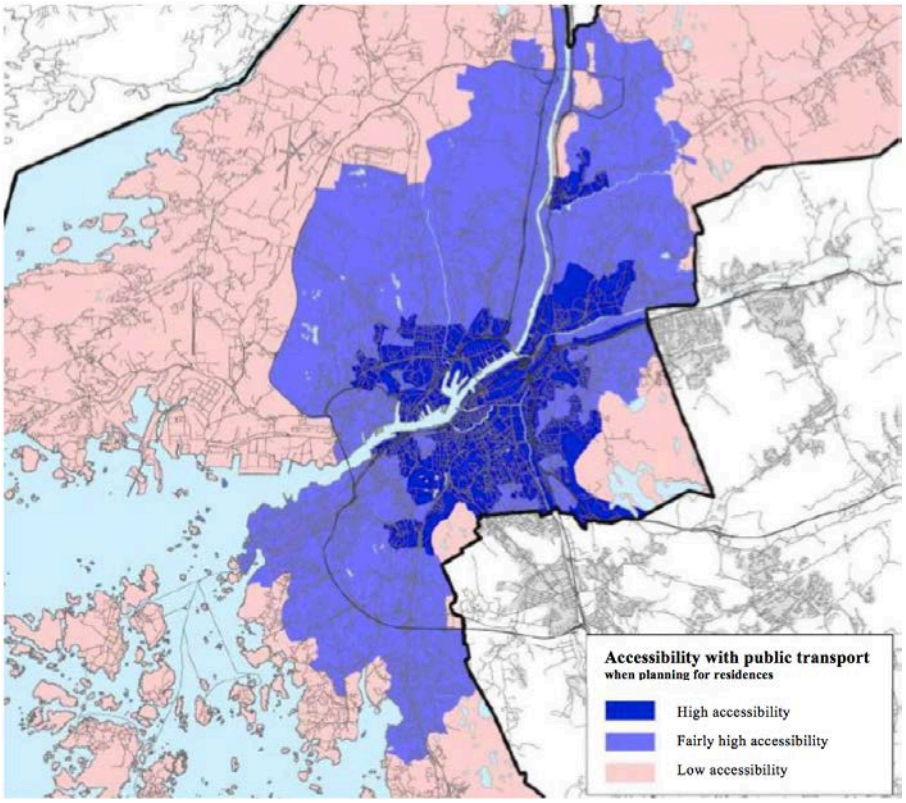


Figure 4: Access to public transport in Gothenburg. Based on a model for public transport from Västtrafik, according to 2006-2007 timetables (Stadsbyggnadskontoret, et al., 2011).

3.3.1.5 Calculation example for residential buildings

Example of how to calculate parking ratio for residential buildings and the difference between the detailed development plan and building permits can be seen in the textbox below.

Detailed development plan
Parking ratio for residential buildings = residential parking spaces + visitor parking – 10% if high access to public transport

Residential parking spaces = number of person/household * car/person * 1000 m^2 / estimated apartment area – 10% if high access to public transport

Ex. Apartment, Apartment building, Zone D
1.8 person/household
0.36 car/person
90 m^2/household

Residential parking:	1.8 * 0.36 * 1000/90 = 7.2 parking spaces/1000 m^2
Visitor parking:	1 parking space/1000 m^2
Total:	7.2 + 1 = 8.2 parking spaces/1000 m^2

Building Permits
Parking ratio for residential buildings = residential parking spaces + visitor parking – 10% if high access to public transport

Residential parking spaces = number of person/household * car/person – 10% if high access to public transport

Ex. Apartment, Apartment building, Zone D
1.8 person/household
0.36 car/person

Residential parking:	1.8 * 0.36 = 0.65 parking/household
Visitor parking:	0.07 parking/household
Total:	0.65 + 0.07 = 0.72 parking/household

3.3.2 Parking ratios for preschools

The parking ratios for preschools consist of both recommendations for visitors and employees. The ratio for employees is based on the location of the preschools and its accessibility to public transport. The visitor parking at preschools should preferably be designed to be a safe environment for children to be picked-up and dropped-off.

3.3.2.1 Parking ratio for employees

The access to public transport for business in Gothenburg can be seen in figure 5. The accessibility is defined as the time it takes for each inhabitant in Gothenburg, Partille, the western part of Härryda and the northern part of Mölndal to reach more than half of Gothenburg's working places. High accessibility means that it takes less than 30 minutes, fairly high means less than 40 minutes, low stands for between 40 and 50 minutes and poor accessibility is more than 50 minutes.

The travel time is calculated based on the time spent in a vehicle, transfer time as well as the time it takes to walk between transfers. The walking time from the starting point and the walking time from the last stop to the target point are excluded (Stadsbyggnadskontoret, et al., 2011).

According to this definition the access to public transport for businesses is high for basically the entire zone A and B and parts of zone. The access to public transport is fairly high in almost all of the populated areas in the municipality. When the public transport system is expanding, so will the areas with high and fairly high accessibility.

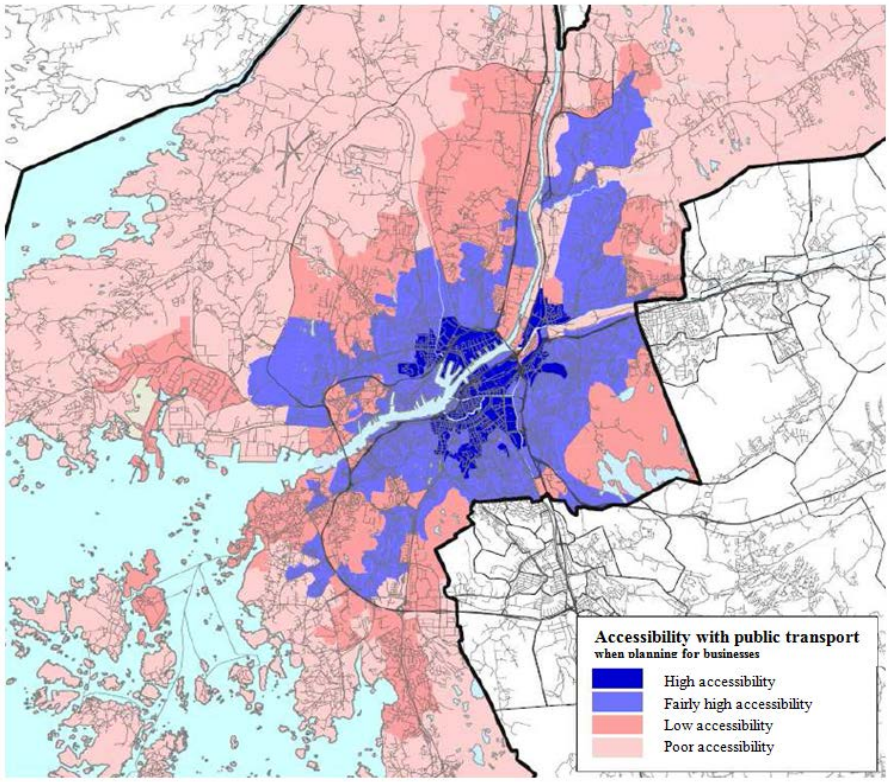


Figure 5: Access to public transport when planning for businesses in Gothenburg. Based on a model for public transport from Västtrafiks, according to 2006-2007 timetables (Stadsbyggnadskontoret, et al., 2011).

The parking ratios for employees are based on:

- High accessibility: car stands for maximum 15% of all commuter traffic
- Fairly high accessibility: car stands for max. 25% of all commuter traffic
- Low accessibility: car stands for max. 50% of all commuter traffic
- Poor accessibility: cars stands for 60% of all commuter traffic

If the property owner fails to meet the parking requirement, set in the detailed development plan and later approved in the building permits for the development site, the property owner is obliged to provide parking spaces elsewhere – in a reasonable proximity. The parking policy states that reasonable distance to parking is compared to the walking distance from public transportation. A walking distance of 400 meters from the parking area should be accepted. Waiting spaces and parking reserved for disabled should however be close to the entrances (Stadsbyggnadskontoret, et al., 2011).

The Swedish department of education has, together with the premises office in Gothenburg, estimated the number of employees in a preschool to 17 per 1000 m^2 (Stadsbyggnadskontoret, et al., 2011). The parking ratios for employees can then be calculated and the results are shown in Table 10.

Table 10: Parking ratios for employees in preschools.

Preschool, employees	Detailed development plan Parking/1000 m²	Building permit Parking/1000 m²
High access	2,5 (max)	2
Fairly high access	4 (max)	3
Low access	8	6
poor access	10	8

3.3.2.2 Parking ratio for visitors

The visitor parking at preschools should preferably be designed to be a safe environment for children to be picked-up and dropped-off. The parking ratio for visitor parking is based on the location of the preschool and the number of parking spaces per 1000 m^2 can be seen in Table 11.

Table 11: Parking ratios for visitors in preschools.

Preschool, visit	Detailed development plan Parking/1000 m²	Building permit Parking/1000 m²
Zone A and Zone B	3	2,5
Zone C	5	4
Zone D	7	5,5

The estimated space per unit required for a preschool is based on the comparison with other municipalities, data from the premises office and the department of education. It is said to be 200 m^2 for each preschool unit, including kitchen and staffrooms (Stadsbyggnadskontoret, et al., 2011). The resulting parking ratio per unit is listed below.

- Zone A/Zone B: 0.6 parking/unit
- Zone C: 1 parking/unit
- Zone D: 1.5 parking/unit

3.3.2.3 Calculation example for preschools

Example of how to calculate the amount of parking places for a preschool and the difference between the detailed development plans and building permits can be seen in the textbox below.

Detailed development plan

Parking ratio for preschool = Parking for employees + parking for visitors

Parking for employees = Number of units * 200 m^2 * Table 10 value / 1000 m^2

Parking for visitors = Number of units * 200 m^2 * Table 11 value / 1000 m^2

Ex. Preschool with six units, Zone D, low access to public transportation

Parking for employees = 6 * 200 * 8 / 1000 = 9.6 parking spaces

Parking for visitors = 6 * 200 * 7 / 1000 = 8.4 parking spaces

Parking ratio for preschool = 9.6 + 8.4 = **18 parking spaces**

Building permits

Parking ratio for preschool = Parking for employees + parking for visitors

Parking for employees = Number of units * 200 m^2 * Table 10 value / 1000 m^2

Parking for visitors = Number of units * 200 m^2 * Table 11 value / 1000 m^2

Ex. Preschool with six units, Zone D, low access to public transportation

Parking for employees = 6 * 200 * 6 / 1000 = 7.2 parking spaces

Parking for visitors = 6 * 200 * 5.5 / 1000 = 6.6 parking spaces

Parking ratio for preschool = 7.2 + 6.6 = 13.8 parking spaces ~ **14 parking spaces**

3.4 Statistics

Statistics from SCB compiled 2012-12-31 regarding the number of cars, inhabitants and households. The statistics are divided into the multiple small statistical areas that Gothenburg contains of and was provided by the city executive office. The statistics are based on which of the statistical area the inhabitant or owner of the car is registered in, however it is not certain that the owner parks the car in that area. The statistics include both registered and deregistered cars for professional and personal use owned by persons and personal enterprises. To get a good overview of the situation in the specific cases the statistics were compiled by looking at the statistical area that the property is located in and also nearby areas with the same building type.

3.5 Investigation of the current situation

The parking investigations in the field were carried out when all the necessary information for all the target areas was gathered. This was done to get a feel of how the theory behind the parking standard was corresponding to the reality and if what was stated in the building permits were actually built. The study was performed by either study the situation at the site or by contacting the persons responsible for managing the parking facilities or a combination of the two.

The parking studies that were carried out at the residential buildings in the city district of Lundby consisted of investigation of the occupancy rate on the adjacent streets as well as the situation on the development site. The easiest way to do these investigations was to walk around in the area and by hand calculate, estimate and observe the total amount of available parking spaces at three different occasions; weekday morning, weekday evening and Sunday afternoon. The tenant-owner associations or companies that managed the parking facilities were contacted to assess the situation in the parking garages belonging to the residential buildings.

All parking belonging to the residential buildings in the city district of Gårda are located in underground garage only accessible by the tenants. The observations in Gårda are therefore carried out by contacting the companies and tenant-owner associations responsible for managing the parking. This is also done for one of the residential buildings in the city district of Lundby.

The investigations at the two preschools were performed by standing outside the parking area and observe the morning drop-offs. The preschool administrators had been contacted before the study was carried out to be sure in which time peak traffic occurred. The interesting part was to see if there were any problems or traffic chaos and if the number of parking spaces was enough to handle peak traffic.

4 Results

The results of the case study are presented in this chapter. All the locations of the investigated areas are shown in Figure 6.

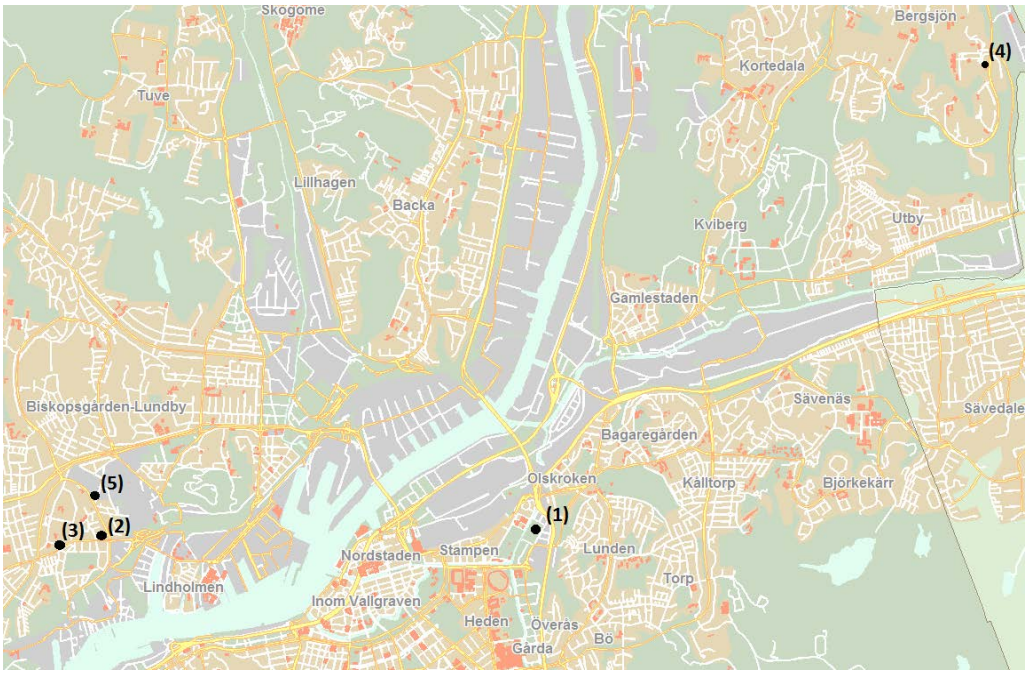


Figure 6: (1) Kvarteret Venus, Gårda, (2) Trekantsgatan, Lundby, (3) Brf. Byabacken, Lundby, (4) Saturnusgatan, Bergsjön, (5) Prästvägen, Lundby

4.1 Investigation of residential buildings

The parking situations in three different residential complexes, one located in the city district of Gårda and two located in the city district of Lundby have been investigated and the results are presented in this section. These areas are located in different zones, consist of both rented and tenant-owned apartments and stand out in some way regarding parking.

4.1.1 Kvarteret Venus, Gårda

The planning started in 2002 for a development site in the northern parts the city district of Gårda, marked with (1) in Figure 6, confined by Anders Perssonsgatan, J Sigfried Edströms gata, Vestgatan and Gullbergsån, see Figure 7. This area is henceforth referred to as kv Venus. The detailed development plan contained two blocks with several apartment buildings divided in the middle by the street Sixten Camps gata. The block north of the street, marked with (a) in Figure 7, consists of tenant-owned apartments while the block south of the street, marked with (b) in Figure 7, consists of rental apartments (Stadsbyggnadskontoret, 2005). The construction was finished and the tenants had moved in by the end of April 2012, a total of 652 apartments were built, 316 in the southern block and 336 in the northern block.

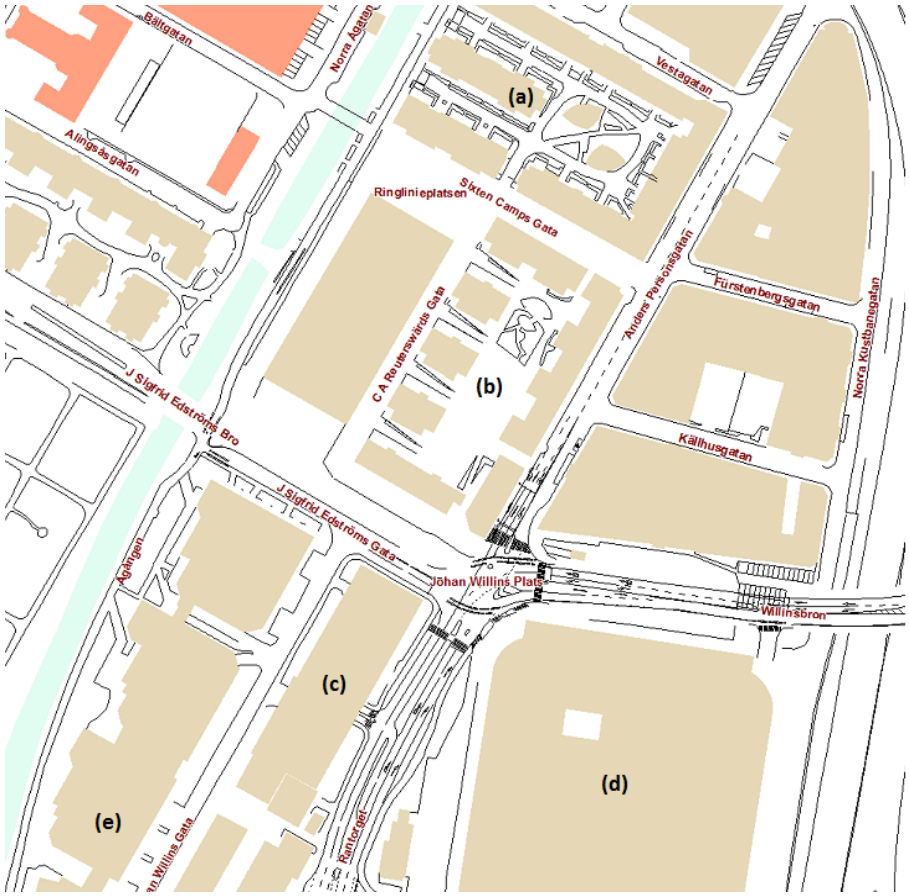


Figure 7 Apartment buildings and parking facilities adjacent to kv Venus. (a) Northern block, (b) Southern block, (c), (d) and (e) Nearby parking facilities

4.1.1.1 Commercial and public services at kv Venus

Kv Venus is situated in an area with high access to public transport. The nearest bus stop is located about 200 meters from the property. A bus towards the central parts of Gothenburg departs every 5 minutes in peak traffic. The bus/tram stop at Svingeln is located about 400 meters from kv Venus. A wide range of trams and busses to most parts of the city depart from svingeln, including a couple express busses towards the outskirts of the Gothenburg region (Stadsbyggnadskontoret, 2005).

A small convenience store and some restaurants are located in kv Venus. A larger grocery store, pharmacy and numerous restaurants are located on Friggagatan, about 700 meters from the property. The distance between kv Venus and the city center is about 2 kilometers. There are not many schools and preschools are available in the area. It is about 500 meters to the nearest preschool and about 1.7 kilometer to the nearest elementary school (Stadsbyggnadskontoret, 2005).

4.1.1.2 Parking requirements for kv Venus

Car parking spaces for the residents shall primarily be provided on the development site. The parking ratio given in the detailed development plan is 0.65 parking spaces per apartment. These parking spaces shall be built in underground parking garages, under the apartment blocks. When the detailed development plan was issued the planned amount of apartments were 350 in the northern block and 400 in the southern block. To fulfill the parking ratio set in the detailed development plan, 224 parking

spaces under the northern block and 260 parking spaces under the southern block needs to be built. If the full amount of parking spaces cannot be provided in parking garages on the property the detailed development plan allows the developer to rent space in nearby parking facilities (Stadsbyggnadskontoret, 2005).

The developers got approved building permits for constructing a total of 327 apartments and 214 parking spaces in the northern block, see Appendix 1, and a total of 432 apartments and 163 parking spaces in the southern block, see Appendix 2. The resulting parking ratio is 0.65 in the northern block and 0.38 in the southern block. A 25 year lease for 97 parking spaces in a nearby parking facility, marked with (c) in Figure 7, has been signed to compensate for the lower amount of parking spaces in the southern block. When summing up the parking spaces in the southern block the parking ratio is 0.60.

When calculating the parking ratio according to the new parking standard, following the method described in section 3.4 and more specific in the textbox below, the parking ratio is 4.77 parking spaces per 1000 m^2 in the detailed development plan and 0.42 parking spaces per apartment in the building permit. The result is generated by assuming that half of the apartments are classified as small apartments and the other half are classified as regular apartments.

Parking ratio in the Detailed Development Plan for kv Venus
50% Apartment, 50% Small apartment, Apartment building, Zone B
1.5 person/household
0.28 car/person
90 m^2/household

Residential parking:	1.5 * 0.28 * 1000/90 – 10% = 4.23 parking space/1000 m^2
Visitor parking:	0.6 – 10% = 0.54 parking space/1000 m^2
Total:	4.23 + 0.54 = 4.77 parking space/1000 m^2

Parking ratio in the Building Permits for kv Venus
50% Apartment, 50% Small apartment, Apartment building, Zone B
1.5 person/household
0.28 car/person

Residential parking:	1.5 * 0.28 – 10% = 0.378 parking/household
Visitor parking:	0.05 – 10% = 0.045 parking/household
Total:	0.378 + 0.045 = 0.423 parking/household

4.1.1.3 The current parking situation at kv Venus

The statistical area 11758, that kv Venus belongs to, contain no other residential buildings than the ones constructed in kv Venus. The statistics on car ownership is therefore retrieved from that area alone. According to the statistics from SCB the average number of inhabitants per household in the area is 1.9 and the average number of cars per household is 0.52, see Appendix 4.

The final amount of apartments in kv Venus is, as mentioned before, 652. The amount differs from both the detailed development plan and the building permits, mainly because of a reduction in the number of floors, from 33 to 13, in a high-rise building in the southern block. The northern block consist of four houses with a total of 336 apartments, 214 parking spaces in an underground garage were built underneath these houses, resulting in a parking ratio of 0.64. The southern block also consist of four houses with a total of 316 apartments, 164 parking spaces were constructed in the underground garage but because of the reduction of apartments, the lease for 97 parking spaces in the nearby parking facility have been reduced to 30 parking spaces. This results in a parking ratio of 0.61 in the southern block. Parking spaces in the northern block cannot be leased by the tenants in the southern block, and vice verse, the resulting parking ratio for the entire plan area is therefore not considered.

The 214 parking spaces in the northern block is divided between and managed by the six tenant-owner associations in the buildings, the associations manage between 31 and 42 parking spaces each, corresponding to 0.6 to 0.67 parking spaces per apartment. When the parking study was carried out in mid April 2014 all spaces where leased and 43 persons stood in queue for a parking, according to the chairmen or person in charge for parking spaces in the tenant-owner associations. The length of the queue varies between the associations, from 15 persons in queue for 35 spaces in one association down to no queue at all for one association.

The property company Poseidon manages all 194 parking spaces that belong to the apartments in the southern block. The demand for parking spaces is not as high in this block as in the northern block. Five parking spaces are vacant in the underground garage on the property and only 15 of the 30 parking spaces in the nearby parking facility are leased.

Two more parking facilities, marked with (d) and (e) in Figure 7, are available in the area besides the parking facility that Poseidon is leasing spaces in. Parking spaces along the roads Anders Persongatan and Venusgatan are available for a time based fee.

4.1.2 Trekantsgatan, Lundby

A design contest for a site on Trekantsgatan in the southeastern parts of Lundby, marked with (2) in Figure 6, the site is marked with a circle in Figure 8. The theme for the contest was building for sustainable development, and it was announced by the Gothenburg real estate committee during year 2005 (Stadsbyggnadskontoret, 2007). The winning contribution contained five apartment buildings, with a total of 105 rental apartments, that were constructed in 2010-2011 and the tenants moved in during the second half of year 2011. This property is henceforth referred to as Trekantsgatan.

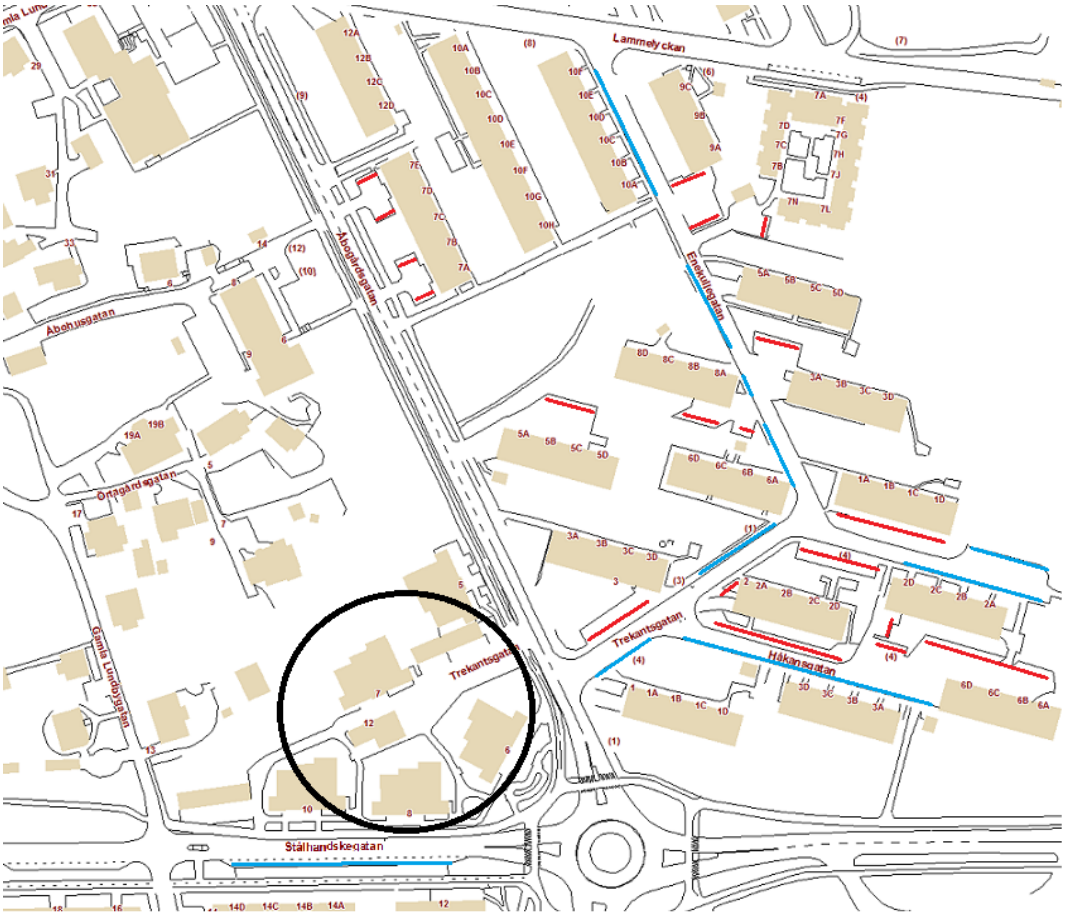


Figure 8 The investigated area adjacent to Trekantsgatan. Red lines symbolize parking spaces for rent and blue lines symbolize street parking.

4.1.2.1 Commercial and public services at Trekantsgatan

Trekantsgatan is located in an area with high access to public transportation and the closest bus stop is located less than 200 meters from the property. A trunk bus towards downtown Gothenburg and other key-areas in Gothenburg depart every 10 minutes and in peak traffic as frequent as every 5 minutes. A local bus departs every 30 minutes and reaches, among other, the range of services offered at Wieselgrensplatsen (Stadsbyggnadskontoret, 2007).

A shopping center is located about 200 meters from Trekantsgatan, with a well-stocked grocery store, liquor store and a store for consumer electronics and appliances. The local square Kyrkbytorget is located about 700 meters from Trekantsgatan. It has a banking office, post office, pharmacy, library, restaurants, grocery store and a few smaller stores. Both schools and preschools are available in the surrounding area, about 500 meters to the nearest preschool and about 1 kilometer to the nearest school (Stadsbyggnadskontoret, 2007).

4.1.2.2 Parking requirements for Trekantsgatan

Car parking spaces for the residents shall be provided on the development site. The parking ratio given in the detailed development plan is 0.66 parking spaces per apartment (Stadsbyggnadskontoret, 2007). This means that a total of 69 parking spaces, where of a maximum of 18 parking spaces is allowed above ground, shall be constructed if 105 apartments are built.

An exception from the parking ratio has been granted during a trial period on Trekantsgatan, this is done as a means to reduce the resident's need to own a car and instead encourage the use of car sharing. The exception from the parking ratio means that the number of parking spaces per apartment can be reduced to 0.30 if an additional amount of 25% car sharing spaces are constructed. This means that a minimum of 32 parking spaces and an additional 8 car sharing spaces shall be constructed if 105 apartments are built. The trial period is set to five years and a follow up shall be conducted when the trial period ends to evaluate the parking situation. As a condition for the trial to take place the space needed to construct the full amount of parking spaces, i.e. 69 parking spaces, shall be available on the property (Stadsbyggnadskontoret, 2007).

The developer got an approved building permit, see Appendix 5, for constructing five houses with 105 apartments and a total of 34 parking spaces. Where 18 parking spaces are in garages partly underground and 11 parking spaces are above ground and 5 spaces that are reserved for car sharing. Which corresponds to a parking ratio of 0.28 and an additional 17% car sharing spaces have been approved.

When calculating the parking ratio according to the new parking standard, according to the method described in section 3.4 and more specific in the textbox below, the parking ratio is 6.13 parking spaces per 1000 m^2 in the detailed development plan and 0.53 parking spaces per apartment in the building permit

Parking ratio in the Detailed Development Plan for Trekantsgatan
Small apartment, Apartment building, Zone D
1.4 person/household
0.33 car/person
90 m^2/household

Residential parking:	1.4 * 0.33 * 1000/90 = 5.13 parking space/1000 m^2
Visitor parking:	1 parking space/1000 m^2
Total:	5.13 + 1 = 6.13 parking space/1000 m^2

Parking ratio in the Building Permits for Trekantsgatan
Small apartment, Apartment building, Zone D
1.4 person/household
0.33 car/person

Residential parking:	1.4 * 0.33 = 0.462 parking/household
Visitor parking:	0.07 parking/household
Total:	0.462 + 0.07 = 0.532 parking/household

4.1.2.3 The current parking situation at Trekantsgatan

The area around Trekantsgatan, i.e. the statistical areas 41402, 41403 and 41405, contains a majority of apartment houses and only a few detached houses. 41404 where the new buildings are located mostly consist of small detached houses and will therefore not contribute to an accurate picture of the situation, see Appendix 6. According to statistics from SCB the average number of inhabitants per household in the area is 1.52 and the average number of cars per household is 0.47, see Appendix 4.

The five newly built houses on Trekantsgatan consist of 105 one and two bedroom apartments. A total of 36 parking spaces have been built, 18 in garages, 17 above ground and only one additional marked as a car sharing space. This means that the final parking ratio on Trekantsgatan is 0.33 with an additional 3% car sharing spaces.

The 35 rentable parking spaces are only available to the tenants in the five houses. All spaces were rented in the middle of April and 16 persons were standing in queue for a parking space according to the company that owns the apartment buildings.

A study of the parking situation in area around Trekantsgatan was performed, in 2009, before the construction of the new apartment buildings. This was done as a part of the trial with reducing the number of parking spaces on Trekantsgatan. The occupancy rate of the parking spaces on the surrounding streets was measured, the streets that where included in the study was: Håkansgatan, Enkullegatan, Trekantsgatan, Åbogårdsgatan between Stålhandskegatan and Lammelyckan and lastly Stålhandskegatan between Lundbygatan and Säterigatan. Both free parking along the streets, marked with blue lines in Figure 8, and private parking spaces for rent, marked with red lines in Figure 8, were included in the study. The study was conducted during three occasions: a weekday morning, a weekday evening and on a Sunday afternoon. A follow up of this study was performed in the same way in March 2014 where the same streets were studied to see if the occupancy rate had changed since the construction of Trekantsgatan.

The result from the study show that the parking situation in the area has changed over the last five years. The number of parking spaces for rent in the area has increased, from 81 to 112 spaces, the newly built spaces on Trekantsgatan is not included. The number of free parking spaces along the streets remains unchanged at 65 spaces. The study shows that the occupancy rate has increased, slightly for the private parking spaces and more drastically for the free parking spaces, this is shown in Table 12. Even though the increase in occupancy rate for the private parking spaces is minor in percentage terms, there was an average increase of 13 cars per observation.

Table 12: Occupancy rate for the parking spaces in the area

	Parking for rent		**Free parking**	
	2009	2014	2009	2014
Morning	33%	33%	51%	56%
Evening	42%	43%	69%	91%
Sunday	38%	41%	74%	80%

4.1.3 Brf. Byabacken, Lundby

An old heating station, north of Östra Bräckevägen in Lundby, marked with (3) in Figure 6, with an external parking garage is according to the development plan to be demolished to make space for two apartment buildings in the shape of tower blocks and with 7 floors. The site is marked with a circle in Figure 9. The plan was given legal effect in the end of 2010 and states that 45 apartments should be divided in the two houses with parking partially beneath surface level (Stadsbyggnadskontoret, 2009). The total number of apartments was however increased to 54 in the building permits and the construction started in the third quarter of 2011. The tenant-owners were able to start the occupancy in the first half of 2013. This property is henceforth referred to as Byabacken.

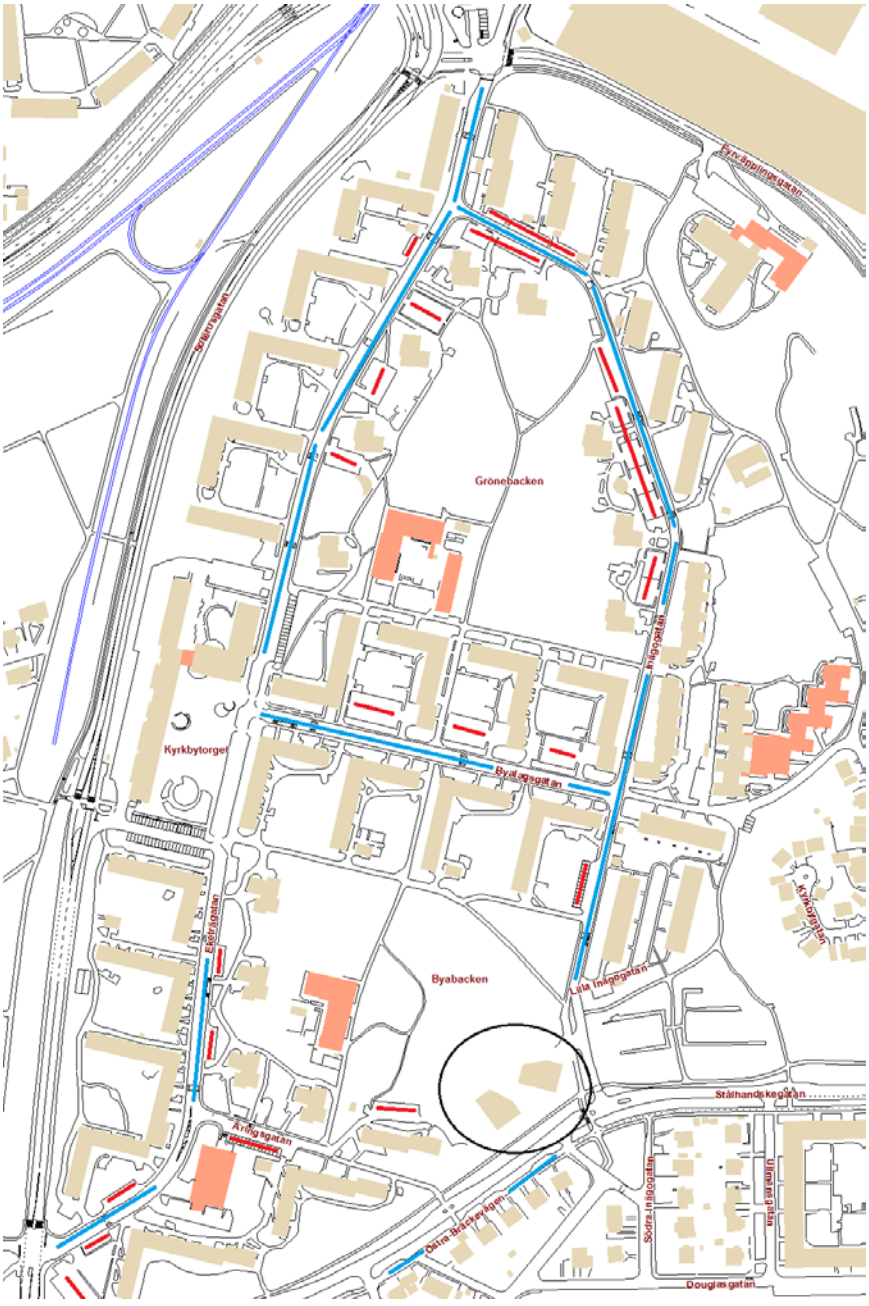


Figure 9: The investigated area adjacent to Byabacken. Red lines symbolize parking spaces for rent and blue lines symbolize street parking.

4.1.3.1 Commercial and public services at Byabacken

Byabacken is located in an area with fairly high access to public transport with 400 meters to the nearest bus stop, Kyrkbytorget. The interchange stop, Eketrägatan, with three tram lines and one trunk bus line, lies 700 meters from the site. Kyrkbytorget is the local square situated about 400 meters from Byabacken. It has a banking office, post office, pharmacy, library, restaurants, grocery store and a few smaller stores. Eriksberg shopping center is situated 550 meter from Byabacken and supplies a well-stocked grocery store, liquor store and a store for consumer electronics and appliances. Both schools and preschools are available in the surrounding area, about 200 meters to the preschool and about 900 meters to the nearest school.

4.1.3.2 Parking requirements for Byabacken

The development site is a part of the program to raise the development density in the city district of Lundby. The program highlights the demand of larger apartments, new types of accommodations and the problems with the parking situation in the district. According to the detailed development plan the newly built housing area will be assigned with 0.8 parking spaces per apartment, which will be located in a parking deck below the buildings. The ratio includes visitor parking and should cover the future demands. The parking ratio was calculated according to the old parking standards (Stadsbyggnadskontoret, 2009).

The property owner, Bostadsbolaget AB, for the apartment houses in the vicinity has announced a demand of 15 new parking spaces inside the site area for the residents in the adjacent buildings, as a compensation for the previously existing parking deck. The detailed development plan states that approximately ten new ground parking spaces will be disposed west of the new buildings. The plan also states that some parking spaces in the parking deck could be reserved for residents in adjacent buildings and may be used for car sharing. Visitor parking and parking for disabled should be located together with the proposed ground parking west of the buildings (Stadsbyggnadskontoret, 2009). The number of parking on the development site should be 43, according to the detailed development plan, and an additional 15 places for compensation for the old parking deck. This means that a total number of 58 parking spaces are required.

The developer got an approved building permit, see Appendix 7, for constructing two tower blocks with 54 apartments and a total of 51 parking spaces. Where 40 parking spaces are in garages underground and eleven parking spaces are above ground whereof one is dedicated for disabled, which results in a parking ratio of 0.94. If 15 of these 51 parking spaces are dedicated to the neighboring houses than the parking ratio for Byabacken will result in 0.67 parking per apartment.

When calculating the parking ratio according to the new parking standard, according to the method described in section 3.4 and more specific in the textbox below, the parking ratio is 7.13 parking spaces per 1000 m^2 in the detailed development plan and 0.62 parking spaces per apartment in the building permit. The result is generated by assuming that half of the apartments are classified as small apartments and the other half are classified as regular apartments.

Parking ratio in the Detailed Development Plan for Byabacken
50% Apartment, 50% Small apartment, Apartment building, Zone D
1.6 person/household
0.345 car/person
90 m^2/household

Residential parking:	1.6 * 0.345 * 1000/90 = 6.13 parking space/1000 m^2
Visitor parking:	1 parking space/1000 m^2
Total:	6.13 + 1 = 7.13 parking space/1000 m^2

Parking ratio in the Building Permits for Byabacken
50% Apartment, 50% Small apartment, Apartment building, Zone D
1.6 person/household
0.345 car/person

Residential parking:	1.6 * 0.345 = 0.552 parking/household
Visitor parking:	0.07 parking/household
Total:	0.552 + 0.07 = 0.622 parking/household

4.1.3.3 The current parking situation at Byabacken

According to the statistics from the Swedish Statistical Agency (SCB 2012) the small statistical area where Byabacken is located, only contains apartment houses, see Appendix 6. When the surrounding statistical areas are included, i.e. 41412-41416, the average inhabitant per household quota is 1.41 and the average number of cars per household is 0.41, see Appendix 4.

According to the developer, Egnahemsbolaget, 40 parking spaces were built in the parking deck. The parking study shows that eleven parking spaces were built above ground on the development site. One is dedicated for disabled and two are dedicated for visitors to the tenants in Byabacken. The eight remaining are the compensation for the previous, now demolished parking deck, and are manage by Parkeringbolaget. These parking spaces are rented by the adjacent apartment buildings and the final parking ratio for the tenants at Byabacken is calculated to 0.80 spaces per apartment. All the 40 places in the parking deck are leased by the tenants in Byabacken and according to the tenant-owning association there are a few persons in queue. How many of the remaining eight parking spaces above ground that are leased are unknown. The occupancy rate of these parking spaces was at the most 63%.

To be able to get an overview of the parking situation in the area close to Byabacken and to see if the situation still is as problematic as stated in the detailed development plan, a parking study was performed. The study was carried out in a similar fashion as the follow-up study at Trekantsgatan, described in section 4.1.2.3, with three different assessment occasions: weekday morning, weekday evening and Sunday afternoon. The observed streets are shown in Figure 9. The red lines are symbolized as parking spaces for rent and the blue lines as street parking spaces or free parking spaces. The amount of available parking spaces for rent was a total of 356 places on the streets Äringsgatan, Eketrägatan, Byalagsgatan and Inägogatan. The amount of free parking spaces was estimated to 184 places along the streets Äringsgatan, Eketrägatan, Byalagsgatan, Inägogatan and Östra Bräckevägen. The occupancy rate was measured at three occasions and the results are presented in Table 13.

Table 13: Occupancy rate for the parking spaces in the area

	Parking for rent	Free parking
Morning	51%	66%
Evening	69%	98%
Sunday	60%	85%

The occupancy rate for the free parking spaces is very high on all the streets in the area. The total amount of available parking spaces, rentable and free, in the area is estimated to 540. When this amount is compared to the statistics from SCB regarding the amount of households in the area, a ratio of 0.41 parking spaces per household is obtained. The general impression of the parking situation at the adjacent neighborhoods to Byabacken is that there is a great demand for owning a car and to be able to park it at a low cost, but not necessarily close to the apartment. According to the property owners in the area, who manage the rentable parking spaces, there is still about 10% unrented spaces.

4.2 Investigation of preschools

The investigations of the parking situation at two preschools, located at Saturnusgatan and Prästvägen marked with (4) and (5) in Figure 6, are presented in this section. Various complaints have been reported to the department of traffic regarding issues like safety, lack of parking spaces etc.

4.2.1 The preschool at Prästvägen, Lundby

The city district of Lundby is, as mentioned before, part of a program to raise the development density in the area. The old schoolhouse at Prästvägen was not large enough to handle the increasing amount of preschoolers in the area therefore a pavilion had to be built next to the existing house. The old schoolhouse has however undergone some large renovations to meet the increasing demand one example is a new parking slot in connection with the road Prästvägen.

The closest bus stop, Lundbys Gamla Kyrka, is located only 100 meters from the school and is served by the trunk bus 16. The interchange stop, Eketrägatan, is located approximately 500 meters from the preschool, see Figure 10. The access to public transportation is considered to be fairly high for employees in the area.

Figure 10: (a) The pavilion, (b) the old school house, (c) the closest bus stop, Lundbys Gamla Kyrka, (d) the interchange stop, Eketrägatan.

The new preschool is not included in the development plans for the area because of the temporary nature of the pavilion. The preschool on Prästvägen consists however of a total of 9 units divided into the two buildings, which correspond to 1800 m^2 total, according to the parking ratios in Gothenburg (see chapter 3, particularly section 3.3.2.2).

According to the recommendations for the parking ratio in a detailed development plan (see chapter 3, particular section 3.3.2 and more specific in the textbox below) the minimum allowed amount of parking spaces for a preschool with 9 units should 20 for both employees and visitors. The parking ratio for a preschool of that size and location should be five places for employees and ten for visitors according to the recommendations for building permits, which sums up to a total of fifteen parking places.

Number of parking spaces in the detailed development plan

Preschool with nine units, Zone D, fairly high access to public transportation

Parking for employees = 9 * 200 * 4 / 1000 = 7.2 parking spaces

Parking for visitors = 9 * 200 * 7 / 1000 = 12.6 parking spaces

Parking ratio for preschool = 7.2 + 12.6 = **19.8 parking spaces**

Number of parking spaces in the building permits

Preschool with nine units, Zone D, fairly high access to public transportation

Parking for employees = 9 * 200 * 3 / 1000 = 5.4 parking spaces

Parking for visitors = 9 * 200 * 5.5 / 1000 = 9.9 parking spaces

Parking ratio for preschool = 5.4 + 9.9 = **15.3 parking spaces**

The actual building permits state that seven regular parking is to be built on the development site outside the pavilion in a parallel parking lot, in connection with the road Fyrväpplingsgatan. Building permits for the renovations of the old school building states that approximately seven cars would be able to fit inside the new parallel parking lot, which can be seen in Appendix 8. According to the administrator for preschools, at the department of traffic, parking spaces for employees are not included.

4.2.1.1 The current situation at Prästvägen

The parking study was carried out between 07:15 and 08:30 on Thursday the 10th of April and the peak traffic occurred between 07:50 and 08:00. Total amount of available parking spaces was estimated to seven spaces outside the pavilion, in connection to the road Fyrväpplingsgatan. Seven parking spaces were estimated to be located outside the old school building, in connection to the road Prästvägen. These 14 parking spaces were observed to be dedicated for pick-ups and drop-offs only. According to the preschool administrator the employees does not have any reserved spaces on the development site, the street parking in the adjacent neighborhood was used instead.

At peak traffic six out of seven parking spaces were occupied outside the pavilion and seven out of seven outside the old school building. The occupation rate was high but only at a short period of time. No traffic chaos or problems with lack of parking spaces was observed. It could however be a problem with the garbage disposal, when the garbage truck does its garbage route close to peak traffic time, as it did during the observation.

4.2.2 The preschool at Saturnusgatan, Bergsjön

Saturnusgatan 20 is a newly built preschool located in the city district of Bergsjön. The last unit was finished in November 2013 and the preschool now consists of 6 units. The preschool is built on a hill overlooking the square Rymdtorget and the inclination of the road leading up to the preschool is steep, about 8%, see Appendix 9. If the road were not crooked the inclination is assessed to have been too high for a person pushing a stroller up the hill. The preschool is located close to the interchange stop Rymdtorget that consists of a bus stop, marked with (c) in Figure 11 and a tram stop, marked with (d) in Figure 11 approximately 300 meters apart from each other. However, the classification of the accessibility to public transportation is considered to be low in the area.

Figure 11: (a) The preschool Saturnusgatan 20, (b) The parking area, (c) Rymdtorget bus stop, (d) Rymdtorget tram stop

4.2.2.1 The number of parking spaces at Saturnusgatan

The site of the preschool is part of an area that belong to a detailed development plan that is issued in 1964, no recommendations regarding parking is stated in the plan. In the building permit for the preschool it is stated that 13 regular parking spaces and one space for disabled persons should be constructed on the development site. No information on the distribution between parking for employees and parking for visitors is given in the permit shown in Appendix 9.

The number of parking spaces at the preschool is therefore calculated with the method described in chapter 3, section 3.3.2, according to the new parking standard. This results in that the minimum allowed amount of parking spaces for the preschool should be 18 spaces, 10 for employees and 8 visitors, in the detailed development plan. The calculation for the number of parking spaces in the building permit results in 14 parking spaces in total, 7 for employees and 7 for visitors. The calculations are shown in the textbox below.

Number of parking spaces in the detailed development plan

Preschool with six units, Zone D, low access to public transportation

Parking for employees = 6 * 200 * 8 / 1000 = 9.6 parking spaces

Parking for visitors = 6 * 200 * 7 / 1000 = 8.4 parking spaces

Parking ratio for preschool = 9.6 + 8.4 = **18.0 parking spaces**

Number of parking spaces in the building permits

Preschool with nine units, Zone D, fairly high access to public transportation

Parking for employees = 6 * 200 * 6 / 1000 = 7.2 parking spaces

Parking for visitors = 6 * 200 * 5.5 / 1000 = 6.6 parking spaces

Parking ratio for preschool = 7.2 + 6.6 = **13.8 parking spaces**

4.2.2.2 The current situations at Saturnusgatan

The parking study was carried out between 07:30 to 09:00 on Friday the 11th of April. The peak traffic occurred somewhere between 08:40 and 08:50. According to one of the employees most of the children at this preschool are scheduled only between 09:00 and 14:00, hence the late peak traffic. The total amount of available parking spaces is 13 regular parking and 1 parking space for disabled. During the observations it was clear that these 13 parking spaces only were used by the employees. At most 10 out of the 13 where occupied. The drop-offs occurred at the large turning zone, approximately 16 meters wide and 18 meter long, located between the building and the parking area, see Figure 11. At peak traffic there were four cars dropping of their children at the same time and two to three cars during the remaining part of the observation. During the observation the garbage truck came and picked up the garbage from the preschool. The turning zone was large enough to handle the garbage truck and two parked cars at the same time. No traffic chaos or problems related to the lack of parking spaces was observed.

5 Discussion

The methodology and the results of the case studies as well as the theory behind it are discussed in this chapter.

5.1 Statistics of car ownership and households

No clear pattern can be seen in the relationship between the number of households, the number of inhabitants and the car ownership between 2004 and 2012. An example of this is in zone A where the number of households increased with 19%, the number of inhabitants increased with 7% and the number of cars is practically the same as in 2004. Another example is in zone B where the number of households increased with 6%, the number of inhabitants increased with 9% and the number of cars has increased with as much as 20%. This means that there is a 16% decrease in the number of cars per household in zone A while there is a 13% increase in the number of cars per household in zone B.

The large difference between the number of new households and the number of new cars per household might depend on a variety of factors. One reason can be that the newly built houses in zone A have been designed with exceptions from the parking standard, e.g. student housing, test project with reduces parking needs, etc. Another explanation for the variations might be uncertainties in the statistics, e.g. different sources of information throughout the years. No obvious factor have however been found related to the large increase in car ownership in zone B.

The result is that we cannot see a clear correlation between the number of residences that get built, the number of persons that moves in and the number of cars in the city which makes it more difficult to estimate the future car ownership.

5.2 Shared use

One of the greatest challenges when it comes to parking is to use the area as efficient as possible. By implementing shared use of the parking facility the degree of efficiency can be raised. We think that this should be a central part when planning new areas in the city. By building both residential and office buildings in the same area a parking facility could be built at a strategic point and then in some extent be used by businesses during daytime and by households during nighttime and weekends. This means that fewer parking spaces need to be constructed, which will reduce the overall construction cost and in turn might lead to that more apartments are built.

A form of shared use of parking was implemented at the preschool Prästvägen. There were no dedicated parking spaces for the employees on the development site so they had to park their car on the streets of the adjacent neighborhoods. It was not clear to us in which extent this was deliberate in a shared use point of view but it was working and the total amount of parking spaces at the preschool could be reduced.

One thing that needs to be considered when planning for shared use of a parking facility is that not everyone use their car every day, this makes it more difficult to know on forehand the number of parking spaces that can be shared.

5.3 Special parking investigation

From our study we conclude that the possibility to adjust the number of parking spaces depending on the type of project is good. Projects where we see it fit to adjust the parking ratio are e.g. in student housing or projects with a special focus on low car dependency. This can reduce the construction cost for the project and in turn raise the rate of construction in the city. However, these special conditions need to be stated and communicated in a clear way to the future tenants or owners of the apartments.

Due to the result from the investigation at Trekantsgatan, discussed further later in this chapter, we do not see it suitable to reduce the number of parking spaces in projects with the goal to reduce the car dependency by offering e.g. car sharing, if the routines regarding follow-up is not improved. This is mainly because it is difficult to estimate the demand or the desire to use car sharing instead of having a privately owned car.

5.4 Alternative parking solutions

The car dependency will always exist to some extent, no matter how good the alternative means of transportation are in a city. With the municipality's demand on developers to provide parking on the development site the most common solution, when the size of the land is limited, is to build an underground parking garage. It could also be stated as a demand in the detailed development plan that a limited amount of regular parking is allow on the development site. This is a very costly solution that makes it more difficult for the developer to get cost coverage for the project and it might lead to that fewer residences are being built which in turn leads to a continuing shortage of accommodation in Gothenburg. However, parking still needs to be provided and an alternative to constructing parking facilities in connection to every building can be to construct parking facilities centrally located in each neighborhood, shared by the residents living in the area. The suitable location can be determined in the same way as the location for a bus or tram stop, where the number of inhabitants and the walking distance are taken into account. This is a more cost effective alternative since the construction cost per parking space for a 4-5 floor parking garage is half that of a 1st floor underground parking garage and as little as one third of the cost for a 2nd floor parking garage. A detached parking facility will claim more developable land that could be used for commercial and residential building but have a higher capacity and are cheaper per parking space than an underground parking facility.

One problem that could arise is the distribution of parking spaces between the involved parties, who will manage the facility and how will the distribution of spaces be governed.

5.5 How the case study was performed

The idea to perform a case study was formed in discussion with key personnel at the department of traffic. There were few previous studies to consult so the method used was developed together with our supervisor. The general plan was to first review all the important building documents and relevant statistics and then perform a parking study to be able to compare theory to practice.

5.5.1 Building documents

All vital building documents were retrieved from the register and archive, these documents have provided us with most of the important information and the administrators on the specific cases have been consulted on occasion to clarify where it is needed. However, since the process from the creation of a detailed development plan until the construction can start, involves a lot of parties and the decisions are in many cases discussed verbally, which can lead to that some of the statements and motivations behind the decisions never reach the register or archive. This has been most noticeable when the building permits have been studied and the motivations behind the adoption of the statements in the detailed development plan are not documented. This means that some of the assumptions we have made regarding, e.g. the division between the parking for the residents in Byabacken the parking provided for residents in adjacent buildings, can be somewhat vague.

5.5.2 Statistics for the target areas

The statistics regarding cars per household and persons per household were divided into small statistical areas. When collecting the statistics for the specific cases we had to find the statistical area where the residential building is located. To get a better view of the situation the adjacent areas with similar types of buildings had to be selected. This creates some uncertainty in the results since the type and size of the apartments in the adjacent area may differ from those in the newly built houses. It has however been considered to give an adequate picture of the situation in the area.

5.5.3 The parking ratio according to the new parking standard

The calculation of the parking ratio according to the new standard was performed to be able to compare the parking ratio from the old standard that is used in the projects with what it could have been today. Our calculations are made according to the examples provided in the new parking standard without taking other factors into account, factors that an administrator with experience from creating detailed development plans and approving building permits would consider.

When it comes to guidelines regarding parking for residential buildings, the old parking standard stated the parking ratio as the number of parking spaces per apartment for both detailed development plans and building permits. The new standard states the parking ratio as the number of parking spaces per 1000 m^2 for the detailed development plan and as the number of parking spaces per apartment for the building permits. This means that only parking ratio for the building permits can be compared.

5.5.4 Parking investigation

The main objective with the parking investigations in the field was to get a feel of how the theory behind the parking standard was corresponding to the reality and if what was stated in the building permits were actually built. By talking to the company or person responsible for the parking facilities and observing the situation in the field we could form a good opinion on the parking situation. The observations of the parking situation on the adjacent street as well as the observations at the preschools were performed at too few times to be statistically reliable but give a fair enough picture of the situation.

5.6 Residential buildings

All the investigated residential areas have given some interesting results, such as the difference between tenant-owned apartments and rental apartments, persons behaviors when there is free parking available and the impact of implementing car sharing. These results will be discussed further in the following section.

5.6.1 Kv Venus

An interesting observation from kv Venus is the difference in car ownership between the tenant-owned apartments in the northern block and the rented apartments in the southern block. The number of parking spaces that are built correlates fairly well with the number of parking spaces stated in the building permit. 0.64 parking spaces per apartment were built in the northern block, which can be compared with the 0.65 stated in the building permit and 0.61 parking spaces per apartment were built in the southern block, which can be compared with the 0.60 stated in the building permit. Even though there are more parking spaces available per apartment in the northern block than in the southern block there is still a shortage of parking and a queue in the northern block while there is unrented parking spaces in the southern block.

One possible reason for this difference can be the fact that the northern block consist of tenant-owned apartments and the southern block consists of rental apartments. The apartments in both blocks are similar in size and both are relatively expensive to live in. However, tenant-owned apartments are usually not the first choice for someone who is getting their first apartment instead it attracts persons with relatively high monetary assets who to a large extent own a car. It might also be a large proportion of older inhabitants that might have moved back into the city from a detached house in the suburbs and could still own one or more cars.

Our calculated parking ratio for building permits according to the new parking standard is 0.42, which is significantly lower than the parking ratio set in the actual building permits. This would result in 73 fewer spaces in the northern block and 61 fewer spaces in the southern block. Since there already is a shortage of parking in the northern block, 43 persons in queue, this would add to that situation. The lower parking ratio would affect the situation and probably create a shortage of parking in the southern block as well, since they only have 20 unrented spaces in their facilities today.

5.6.2 Trekantsgatan

The investigation at Trekantsgatan shows that what was built differs from what was stated in the detailed development plan and the building permits regarding parking. 34 parking spaces were approved in the building permits and 36 were constructed. However five parking spaces should have been reserved for car sharing according to the building permits while only one has been provided in reality. This might depend on a variety of factors e.g. the demand for car sharing was low and therefore the car sharing company, who is profit driven, reduced the number of cars at Trekantsgatan. It could also be as simple as the property owner did not supply more than one parking space for car sharing.

The result is that 16 persons are standing in queue for the 35 rentable parking spaces belonging to the property and the occupancy rate on the free parking on the adjacent streets has risen. It is difficult to predict how the situation would be if five parking spaces were reserved for car sharing but with even fewer parking spaces for the tenants the queue would probably not be shorter.

If all the 69 parking spaces were built, as stated in the detailed development plan, there would probably be an excess of parking spaces. Based on that the average number of cars per household is 0.47 in the area and that there is 51 persons in total that have a parking space or standing in queue for one. The parking ratio according to the new parking standard generates 56 parking spaces, which still is high but more in line with the demand than the parking ratio in the detailed development plan.

5.6.3 Byabacken

At Byabacken the reality does not differ much from what was stated in the building documents. The previous, now demolished, parking deck had about 35 parking spaces and the development plan stated that some compensation would be assigned on the property because of the already high parking demand in the area. The parking ratio of 0.80 is complied if we look to the fact that eight of the parking spaces on the development site were intended for the residents in adjacent buildings. The parking ratio for Byabacken was calculated using the standards from 1996 but 0.80 parking spaces per apartment is still a high ratio. When calculating the ratio using the new standards the results was 0.62 spaces per apartment.

Because of the fact that no study has been conducted regarding the parking situation in the neighborhood before Byabacken was built, as it was at Trekantsgatan, the parking study that was performed could only state the current parking situation after the construction of Byabacken, the impact of the demolished parking deck and the loss of all those parking spaces where therefore difficult to measure. According to the gathered statistics over the area, Byabacken excluded, a ratio of 0.41 cars per household was obtained. It is the same ratio as the number of parking spaces per household. It could be a coincident but it is more likely that the number of cars have converged to the number of available parking spaces in the area over time.

It is therefore interesting to discuss why the car ownership is so much higher at the property of Byabacken. One explanation could be that it is a tenant-owned apartment complex and with the same argument as in kv Venus the tendency to own a car is higher in this type of resident. It could also be that the surrounding area has a low ratio of cars per household which makes the ratio at Byabacken to stand out.

Another interesting result that can be extracted from this study is that persons in the area are rather parking for free and taking the chance not to find any parking space close to home or at all, than to pay for their own spot close to the apartment.

5.7 Preschools

The study at the two preschools was performed at only one occasion each. That is probably not enough to get a correct statistical overview but the purpose for us was more to get a feeling about the parking situation at peak traffic and to observe if there was any problems at that time. We made the decision that it would not change much in our results to do more field studies. The only thing that we think would make a difference is to observe the traffic at different seasons. The studies were carried out in the second week of April. At this time more persons are starting to use the bicycle instead of car which can lead to fewer problems in the parking situation. An earlier observation this year would have been preferred to get a more interesting result.

5.7.1 Prästvägen

The estimated number of parking spaces during the study for the two buildings was 14 spaces divided into two parking lots along the street. This is a little bit less than what our calculations for building permits from the new parking standard would have granted. The calculations states that 15 spaces should be built for both visitors and employees, 10 for visitors and 5 for employees. During the observation onsite we saw that the 14 spaces that were built only were used by visitors and not by any employees. At peak traffic almost all of the 14 parking spaces were occupied by visitors at the same time, which means that if the parking standard would have been followed in this specific case and only 10 spaces would have been built, the amount of parking spaces would not have been sufficient.

There is no loading zone on the property so every truck with an errand at the preschool need to use the same parking lot as everyone else. During the observation we noticed that the waste management had scheduled the garbage route very close to peak traffic. They actually had to stop the truck on the road and block one lane when performing the waste disposal routine because of the lack of parking spaces. Cars could still pass in the other lane beside the truck but the perceived safety was reduced drastically. Errands that are delivered by truck should therefore be rearranged to times other than during peak traffic.

5.7.2 Saturnusgatan

It is stated in building permit that a minimum of 14 parking spaces should be built, this is in line with the new parking standard and that is also the amount that has been built. However, the study shows that a larger portion, than estimated, of the employees takes their car to work and the employees occupy spaces intended for visitors. There is no problem with the parking situation at the preschool today but if the turning zone, between the preschool building and the parking, not had been designed as a zone for pick up and drop off there would not have been a sufficient amount of parking spaces.

5.8 Further discussion

In some cases there is a difference between owning a car and using it every day. Even though the alternative means of transportation is getting better some persons might still own a car only out of convenience; e.g. use it when shopping for groceries or occasional longer trips, and not only because they are dependent on a car for every day travel to and from work etc. A way to reduce this behaviour, to some extent, is to raise the price for parking. However, the risk is that the matter of owning a car or not will become a class issue and in the end only the wealthy in Gothenburg will be able to afford a car.

6 Conclusions

This thesis has been performed at the department of traffic in Gothenburg with the aim to investigate the parking standard and the difference between theory and reality when planning and constructing residential, commercial and public buildings. Five cases have been analyzed and several interesting issues regarding parking have been identified and are summarized below.

- The parking ratio can functions as a control measure and regulate the car ownership in an area. However this only works if there is no alternative parking available in that area or if the parking that is available is too expensive. If there is alternative parking available in the area, which is the case in most parts of the city, the car ownership will most likely converge to the total amount of parking spaces and not to the parking ratio.

- The study shows a difference regarding car ownership between tenant-owned apartments and rental apartments and therefore a difference in demand for parking. Hence, the apartment type should be a factor when calculating the parking ratio. A lower ratio for rental apartments means that construction costs can be lowered which in turn can increase the construction rate of rental apartment buildings.

- The investigations at the preschools show that the number of parking spaces recommended in the new parking standard is set to low. If the recommendations in the parking standard had been followed when planning for the preschools the amount of parking spaces would not be sufficient.

- The result shows that the number of parking spaces on the development site is not sufficient to cover the demand which leads to a continuing demand of alternative parking outside the site, which in turn counteracts the goal of the parking policy.

7 Proposal for further studies

Throughout this master thesis many different factors related to the parking situation in Gothenburg have been investigated. The results are an addition to the already debated and delicate topic regarding the parking situation in Gothenburg. However, these factors could be studied more thoroughly and the most relevant ones are summarized in this chapter.

First and foremost the subject needs to be revisited when the new parking standard have been implemented in a larger extent. So that the outcome of the, in many cases, lower amount of parking spaces per household can be reviewed.

Further studies should be made to investigate the difference in car ownership between tenant owned and rental apartments to see if the apartment type could be a factor when calculating the parking ratio.

A study of the behaviour when it comes to selling or keeping a personal car when there is a lack of parking in an area or the parking that is available is expensive would be of interest. Peoples attitude towards car sharing and alternative means of transport could also be studied.

8 References

Bergqvist, D. (2013). *Vad Kostar det?* Göteborg: Trafikkontoret.

Boverket. (2013, January 18). *Bygga & förvalta; Bygglov och anmälan; När du måste ha bygglov: Boverket*. Retrieved March 10, 2014, from Boverket-website: http://www.boverket.se/Bygga--forvalta/Bygglov-och-anmalan/Nar-du-maste-ha-bygglov/

Boverket. (2012, February 03). *Planera; Kommunal planering; Detaljplanering: Boverket*. Retrieved March 10, 2014, from Boverket-Website: http://www.boverket.se/Planera/Kommunal-planering/Detaljplanering/

Boverket. (2011, September 02). *Planera; Kommunal planering; Översiktsplanering: Boverket*. Retrieved March 10, 2014, from Boverket-website: http://www.boverket.se/Planera/Kommunal-planering/Oversiktsplanering/

Boverket. (2006). *Planning building act.* Karlskrona: Boverket.

Gatubolaget. (2009). *Bostäder Sydöst Lundby Kyrkby.* Göteborg.

Göteborg Stad. (2006, October 12). *Bygga & Bo; Bygga, riva och förändra; Bygglov: Göteborg Stad*. Retrieved March 10, 2014, from Göteborg Stad-webbplats: http://goteborg.se/wps/portal?uri=gbglnk:gbg.page.2e5fd2f3-60f5-46b6-bcac-036400091602

Stadsbyggnadskontoret. (2009). *Detailjplan för Bostäder norr om Östra Bräckevägen, (Kyrkbyn 94:2) inom stadsdelen Lundby i Göteborg.* Göteborg: Göteborgs Stad.

Stadsbyggnadskontoret. (2007). *Detaljplan för Bostäder sydost om Lundby Kyrkby inom stadsdelarna Kyrkbyn och Rambergsstaden i Göteborg.* Göteborg: Göteborgs Stad.

Stadsbyggnadskontoret. (2005). *Detaljplan för kv Venus inom stadsdelen Gårda i Göteborg.* Göteborg: Göteborgs Stad.

Stadsbyggnadskontoret et al. (2009). *Parkeringspolicy för Göteborgs stad.* Göteborg: Göteborgs Stad.

Stadsbyggnadskontoret. (1996). *Parkeringsnormer för Göteborg 1996.* Göteborg: Stadsbyggnadskontoret.

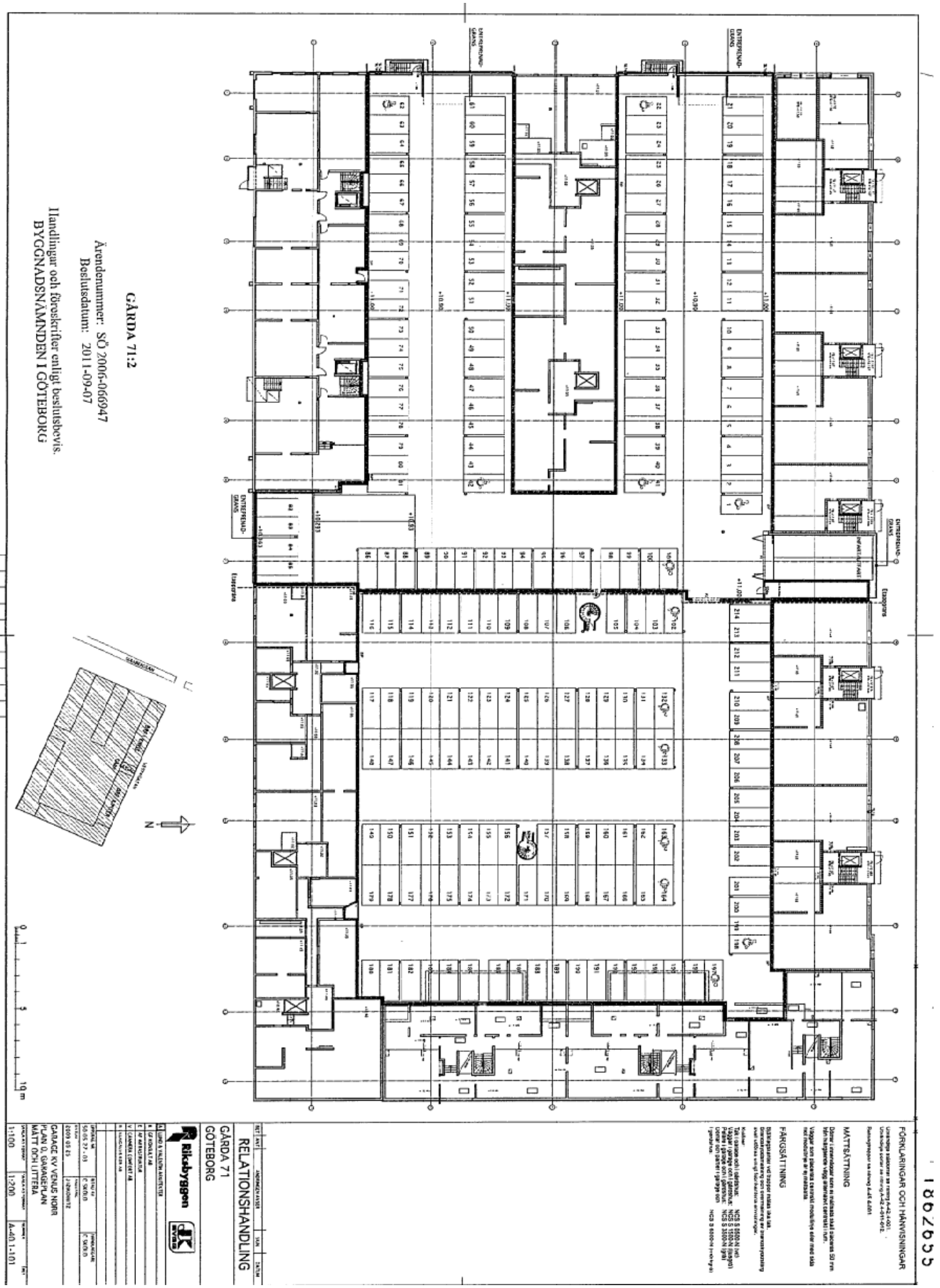
Stadsbyggnadskontoret, et al. (2011). *Vägledning till parkeringstal vid detaljplaner och bygglov 2011.* Göteborg: Stadsbyggnadskontoret.

Statistiska Centralbyrån. (2013). *Folkmängd, antal bostäder samt antal personbilar i Göteborg per basområde 2004-2012.* Stockholm: Statistiska Centralbyrån.

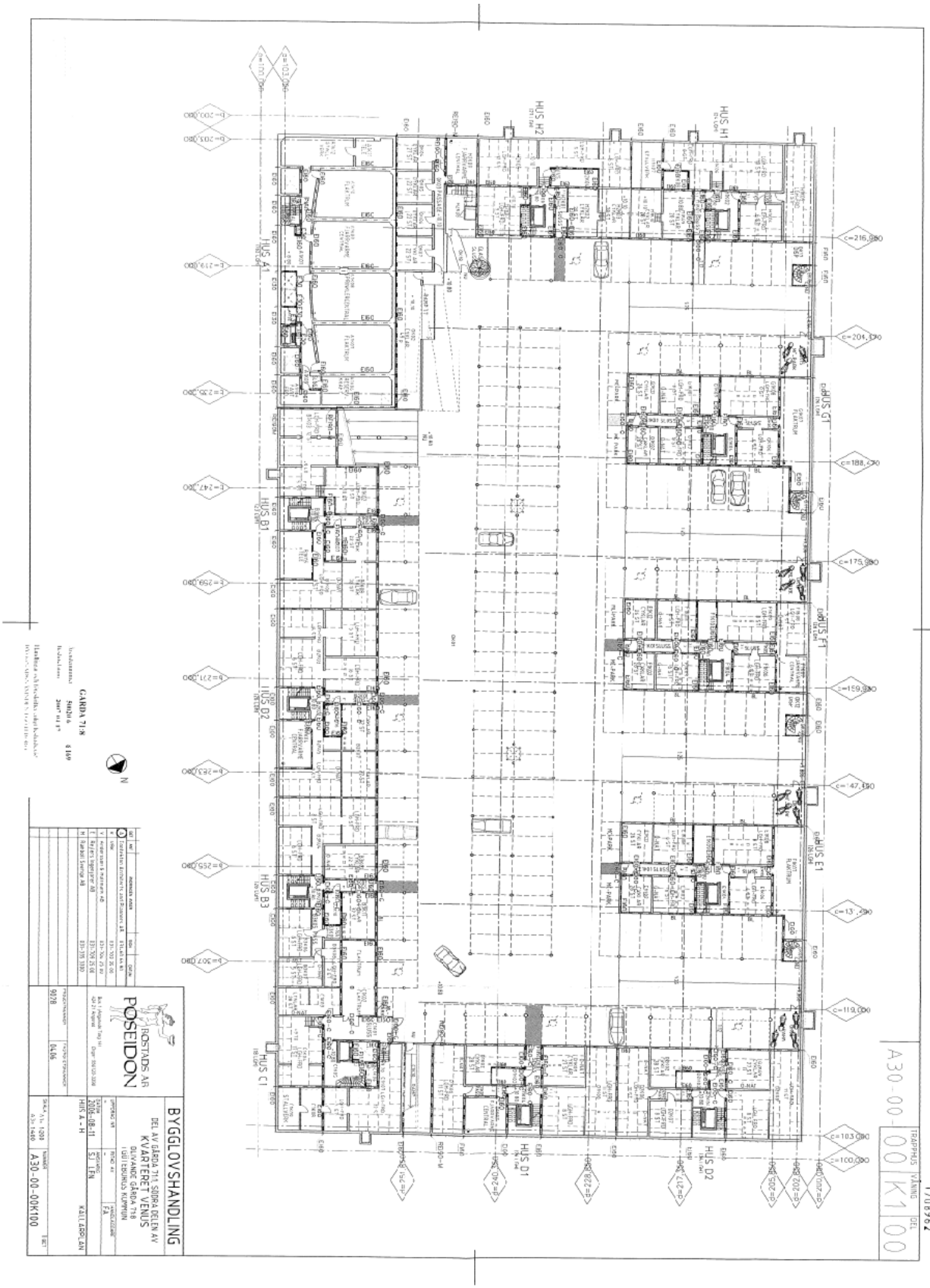
Trafikkontoret. (2014). *Göteborg 2035 - Trafikstrategi för en nära storstad.* Göteborg.

Trafikkontoret. (2008). *Riktlinjer för parkering - underlag för bedömning av parkeringsbehov.* Göteborg: Trafikkontoret.

Appendix 1 – building permit kv Venus (northern block)



Appendix 2 – building permit kv Venus (southern block)



Appendix 3 – small statistical areas surrounding kv Venus

Appendix 4 - statistics

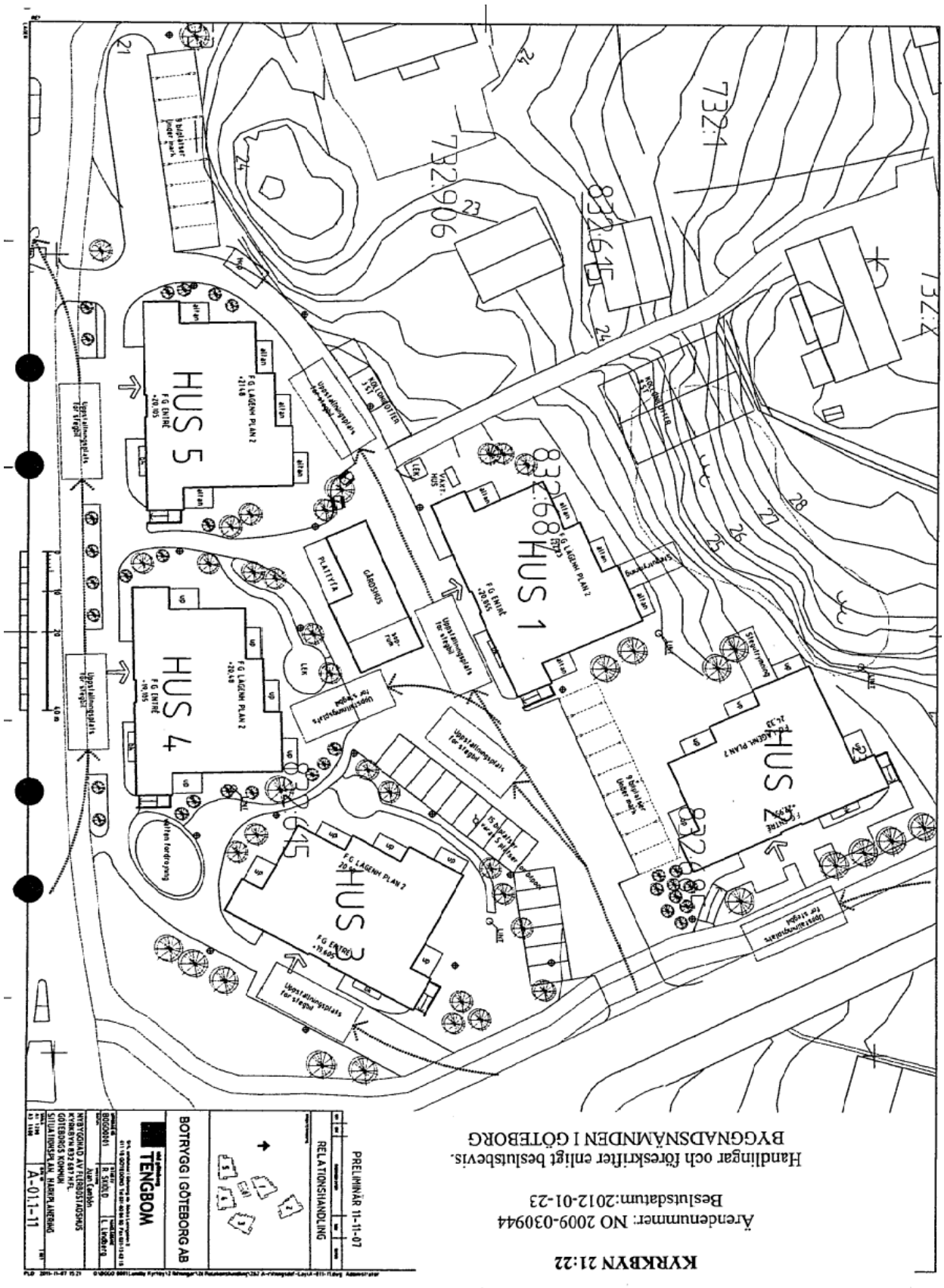
	Statistical area	Population	Residences		2012							
					Cars							
					Registered				Deregistered			
			Detached houses	Apartments	Individual		Personal enterprises		Fysisk person		Personal enterprises	
					Professional	Personal	Professional	Personal	Professional	Personal	Professional	Personal
Kv Venus	11758	1237	0	652	0	280	4	32	0	20	0	4
Trekantsgatan	41402	272	1	194	0	62	0	4	0	12	0	1
	41403	394	0	264	0	85	0	9	0	45	0	0
	41404	325	31	144	0	106	0	13	0	4	0	2
	41405	738	1	466	0	177	1	10	0	29	0	4
Brf Byabacken	41412	313	0	240	0	67	0	4	0	10	0	0
	41413	408	0	230	0	88	0	2	0	20	0	0
	41414	398	0	296	0	98	0	5	0	12	0	2
	41415	396	0	306	0	106	1	5	0	19	0	1
	41416	355	0	252	0	86	0	3	0	16	0	1

Kv Venus	
Persons / Residence	1,90
Cars / Person	0,27
Cars / Residence	0,52

Trekantsgatan	
Persons / Residence	1,57
Cars / Person	0,33
Cars / Residence	0,51

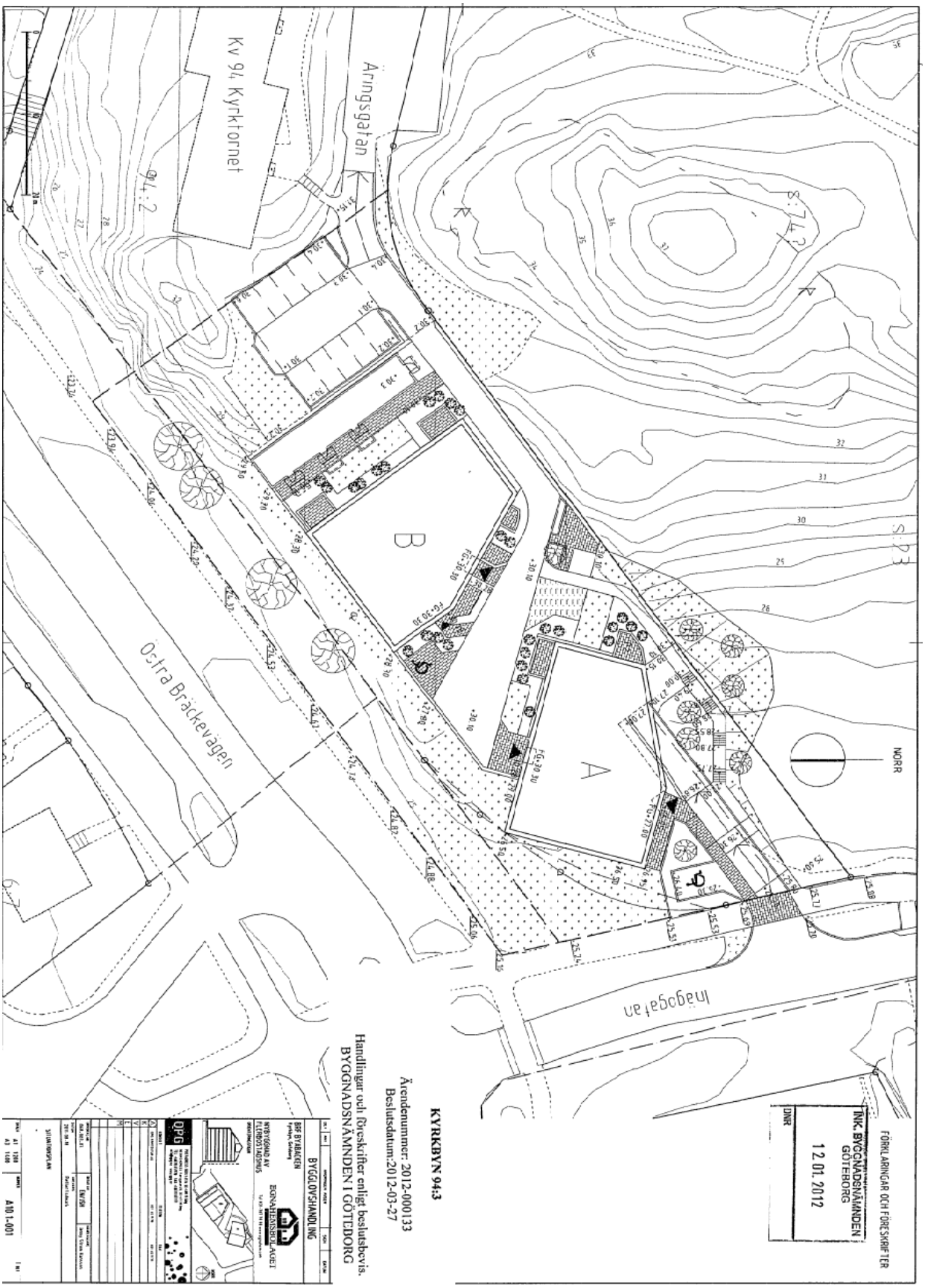
Brf Byabacken	
Persons / Residence	1,41
Cars / Person	0,29
Cars / Residence	0,41

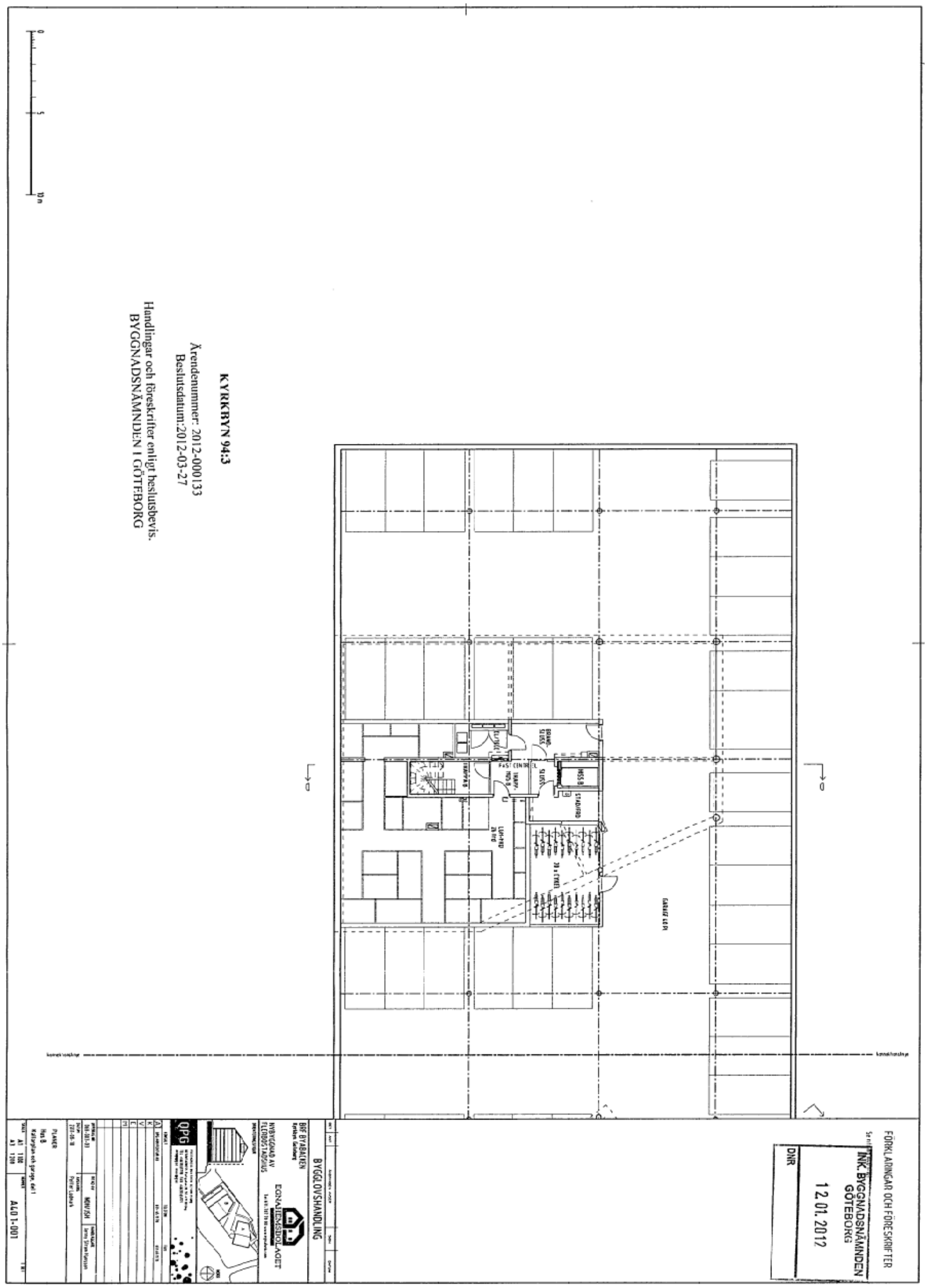
Appendix 5 – building permit Trekantsgatan



Appendix 6 – Small statistical areas surrounding Trekantsgatan and Byabacken

Appendix 7 – building permits Byabacken

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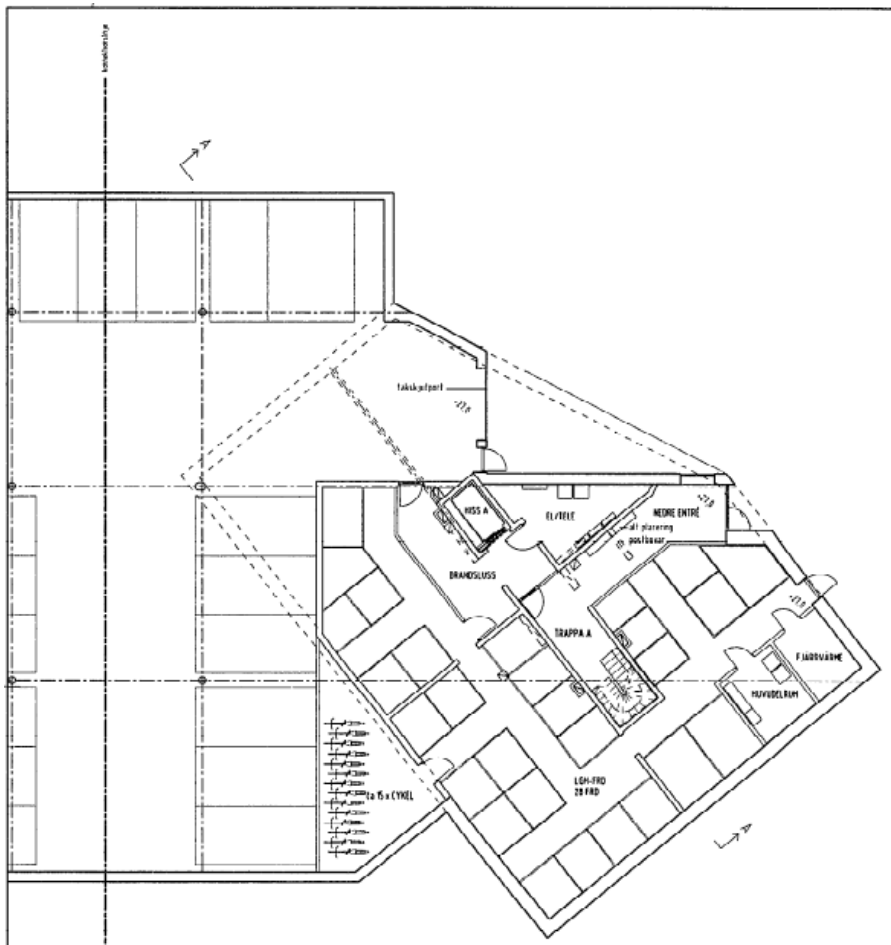
Beslutsdatum: 2012-03-27
Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG
FÖRKLARINGAR OCH FÖRESKRIFTER
INK. BYGGNADSNÄMNDEN GÖTEBORG
12.01.2012
DNR
BYGGLOVSHANDLING
BRF BYABACKEN
EGNAHEMSBOLAGET
A40.1-001



FÖRKLARINGAR OCH FÖRESKRIFTER

KYRKBYN 94:3

Ärendenummer: 2012-000133
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Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

BYGGLOVSHANDLING

BRF BYABACKEN
Kyrkbyn, Göteborg

EGNAHEMSBOLAGET

NYBYGGNAD AV
FLERBOSTADSHUS

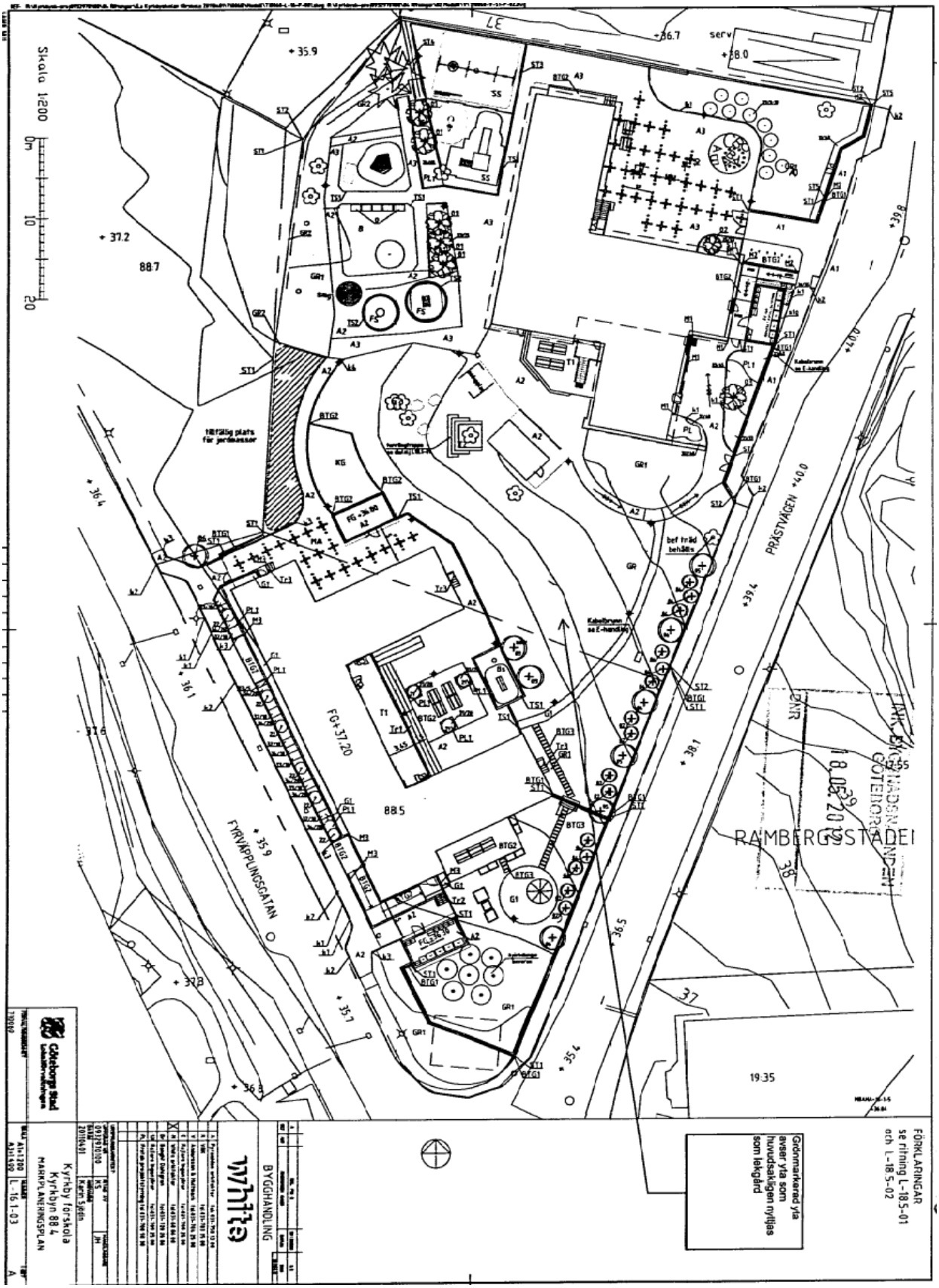
QPG

PLANER
Hus A
Källarplan och garage, del 2

A1 1:100
A3 1:200

A401-002

Appendix 8 – building permit document Prästvägen



Appendix 9 – building permit Saturnusgatan