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Daylight in Existing Buildings

A Comparative Study of Calculated Indicators for Daylight

Master's Thesis in the Master's Programme Structural Engineering and Building Technology

SARA ERIKSSON
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Cover:
Pictures of the residential buildings studied in this thesis.

Department of Civil and Environmental Engineering, Gothenburg, Sweden, 2016

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ABSTRACT

Daylight is an important part when designing a building. It is vital to have a good level of daylight in rooms where people stay for extended periods of time since it has been proven that a lack of daylight affects people's health and wellbeing in a negative way. Daylight in building is getting more and more important since densified cities and energy efficient buildings are likely to decrease the access of daylight in buildings. People also spends more time indoors in general.

This Master's Thesis is a pilot study to the extensive study "Moderniserad dagsljusstandard" that "Svenska Byggbranschens Utvecklingsfond" (SBUF) is financing. The purpose with the study is to renew the Swedish standard regarding daylight in buildings. This Master's Thesis aims to identify the daylight factor levels in existing buildings and evaluate different indicators for measuring daylight factor.

The studied buildings in this thesis consists of eight residential buildings, two student apartment buildings, two offices, two schools and two hospitals and all of them are located in the region of Gothenburg. The softwares used for modelling and simulations in this work are; AutoCAD, Rhinoceros, Grasshopper and Radiance in DIVA which is a plug-in to Rhino.

This Master's Thesis concludes that there are an extensive amount of rooms in the studied buildings that do not fulfill the demands of a daylight factor above 1%. The indicator used for calculating the daylight factor according to the current Swedish standard has a lot of weaknesses and difficulties and needs to be improved.

Key words: daylight, daylight factor, daylight level, indicators, Rhinoceros, DIVA, Radiance, Grasshopper

Dagsljus i befintliga byggnader
En jämförande studie av beräknade indikatorer för dagsljus

Examensarbete inom masterprogrammet Structural Engineering and Building Technology

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SAMMANFATTNING

Dagsljus är en viktig del i en byggnads utformning. Det är viktigt att ha en bra dagsljusnivå i stadigvarande vistelserum eftersom det bevisats att brist på dagsljus påverkar människors hälsa och välbefinnande på ett negativt sätt. Dagsljus i byggnader är ett begrepp som blir allt viktigare eftersom städer förtätas och det byggs alltmer energieffektiva byggnader. Människor spenderar i regel även alltmer tid inomhus.

Detta examensarbete är en förstudie till det omfattande arbetet ”Moderniserad dagsljusstandard” som ”Svenska Byggbranschens Utvecklingsfond” (SBUF) finansierar med syfte att förnya den svenska standarden gällande dagsljus i byggnader. Detta examensarbete syftar till att kartlägga vilka nivåer på dagsljusfaktorn som finns i befintliga byggnader samt utvärdera olika indikatorer för mätning av dagsljusfaktorn.

De studerade byggnaderna i detta examensarbete består av åtta flerbostadshus, två byggnader med studentlägenheter, två kontor, två skolor samt två sjukhus varav samtliga är belägna i Göteborgsregionen. De programvaror som använts i detta arbete för att skapa tredimensionella modeller och utföra dagsljussimuleringar är följande; AutoCAD, Rhinoceros, Grasshopper och Radiance i DIVA som är en plug-in till Rhino.

Detta examensarbete visar att det är en omfattande mängd rum i de studerade byggnaderna som inte uppfyller kravet på en dagsljusfaktor över 1%. Indikatorn som idag används i enlighet med den svenska standarden har många brister och behöver förbättras.

Nyckelord: dagsljus, dagsljusfaktor, dagsljusnivå, indikatorer, Rhinoceros, DIVA, Radiance, Grasshopper

CONTENTS

PREFACE

This Master's thesis has been carried out from January to June 2016 within the Master's Programme Structural Engineering and Building Technology at Chalmers University of Technology. The subject was introduced by Max Tillberg at Bengt Dahlgren AB which also has been the supervisor for this thesis together with Anna Larsson, Bengt Dahlgren AB, Angela Sasic Kalagasidis, professor at the Division of Building Technology, and Magnus Österbring, Industrial PhD student at the Division of Building Technology, from Chalmers University of Technology. The project has been carried out at Bengt Dahlgren's office in Mölndal.

This work would have been far more difficult without any guiding; therefore we would like to give special thanks to our supervisors, Max Tillberg, Anna Larsson, Angela Sasic Kalagasidis and Magnus Österbring. Your special knowledge and inputs helped guiding us in the right direction. Also, thank you Mats-Inge Olsson, Bengt Dahlgren AB, for providing us with the necessary drawing materials.

We would also like to thank our opponents, Ronja Arvidsson and Madeleine Fahlström, for good conversations and discussions during this semester.

Gothenburg, June 2016

Sara Eriksson
Lovisa Waldenström

NOTATIONS

Abbreviations and acronyms

BBR – ‘Boverkets ByggRegler’. Swedish building regulations.
SBUF – ‘Svenska Byggbranschens Utvecklingsfond’. The construction industry’s organization for research and development in Sweden.
SBN – ’Svensk Byggnorm’. Swedish building regulations used before BBR existed.
BABS – ‘Kungliga Byggnadsstyrelsens publikationer’. Swedish building regulations used before SBN existed.
SC – Sky Component
ERC – External Reflectance Component
IRC – Internal Reflectance Component
WFR - Window-to-Floor Ratio

Glossary

Cadastral reference – Fastighetsbeteckning
Daylight protractor – Dagsljusgradskiva
Obstruction angle – Avskärmningsvinkel
Sky view angle – Himmelsvinkel
Sky view factor – Himmelsfaktor
Sky exposure factor – “Himmelsexponeringsfaktor” (own translation)

1 INTRODUCTION

In this chapter, the background, purpose and limitations of this master thesis is presented together with a short description of the method.

1.1 Background

Daylight is an important part when designing a building. It is vital to have a good level of daylight in rooms where people stay for extended periods of time since it has been proven that a lack of daylight affects people's health and wellbeing in a negative way. Daylight in building is getting more and more important since densified cities and energy efficient buildings are likely to decrease the access of daylight in buildings. People also spend more time indoors.

The regulations regarding daylight have varied a lot throughout the years in Sweden. Currently, a daylight factor of 1% in rooms where people stay for an extended period of time is required [1]. The daylight factor is measured in a single point in the room and it is based on an old method using a daylight protractor. This method is outdated and therefore, other indicators for measuring the daylight factor are evaluated in this thesis. The requirement in "Boverkets Byggregler" (BBR) also refers to a simplified method called "AF-metoden" which also will be studied.

There is no documentation of which daylight factor levels that occur in existing buildings. Most people seem to be satisfied with the access of daylight they have today but there is no clear picture of what levels these are and in this thesis, a study is carried out in order to investigate the daylight factor levels in different buildings.

1.2 Purpose

This project is a pilot study to the extensive study "Moderniserad dagsljusstandard", in English "Modernized daylight standard", that "Svenska Byggbranschens Utvecklingsfond" (SBUF) is financing and different companies are involved in the project. The purpose with the study is to renew the Swedish standard regarding daylight in buildings. This Master's Thesis aims to identify the daylight factor levels in existing buildings in Gothenburg and evaluate different indicators for measuring daylight factor.

1.3 Limitations

In this master thesis, 16 buildings and 1205 rooms has been examined. When the daylight in buildings has been analyzed, the daylight factor is the indicator that has been evaluated thus no climate based indicators has been evaluated. Therefore only the quantity and not the quality of daylight have been studied.

1.4 Method

This master thesis has been carried out in five steps. A flow chart illustrating all steps is shown in *Figure 1*.

The first necessary step was to gather information and to collect data in the research area of daylight. Participation in a course held by Max Tillberg and Paul Rogers for Sweden Green Building Council (SGBC) [2] gave us important knowledge and input for this work.

Representative districts and buildings from different age periods were chosen and drawing materials for these buildings were collected.

When all the necessary information and material were gathered, the modelling and simulations began. The pieces of software used to generate floor plans in two- and three dimensional-models of the buildings are AutoCAD 2014 and Rhinoceros 5 respectively. Simulations are made in DIVA (plug-in for Rhino) and Radiance (included in DIVA). The software Grasshopper (version August-27, 2014), which also is a plug-in to Rhinoceros, has been used in order to calculate the sky view factor and the sky exposure factor.

In between modelling and simulating, a survey was distributed to the residents in three of the studied residential buildings. After the surveys were collected, the results were compiled and compared to the simulated results.

When all the simulations were made, they were compiled and evaluated. Analyzing the results and acknowledge different correlations were the fourth step in this thesis.

At last, these four steps led to the final step which resulted in a licensed Master's Thesis.

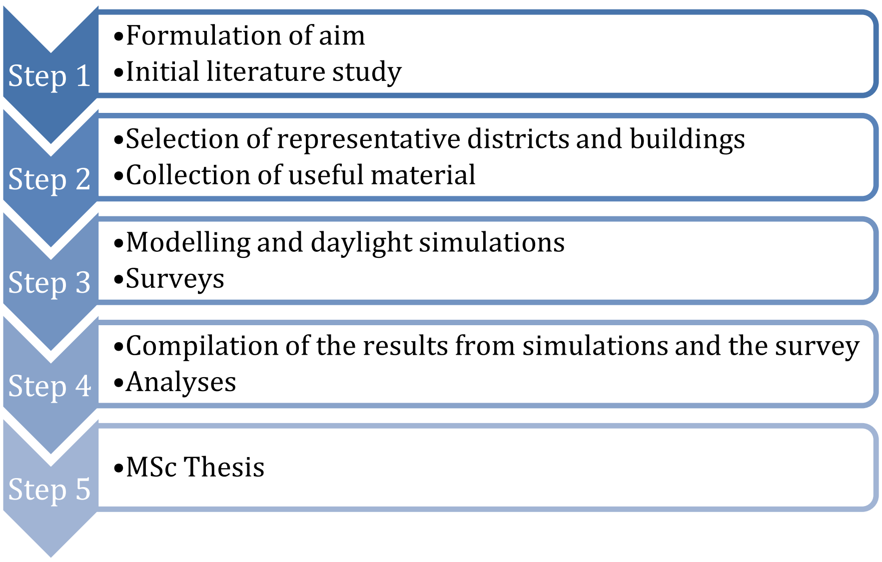

Figure 1 – Flow chart illustrating the method.

2 DAYLIGHT

This chapter explains the different properties of daylight, how it is measured, its impact on human's health and wellbeing and daylight regulations both in Sweden and in some other countries. A short description of different certification systems are also explained in this chapter.

2.1 Light

Light is electromagnetic radiation and the light a human eye perceives is just a fraction of the total energy. The light is visible in the frequency range of 380 and 750nm [3] which are shown in *Figure 2*. Daylight is the natural light during the bright part of the day and it is the combination of all the direct- and indirect sunlight.

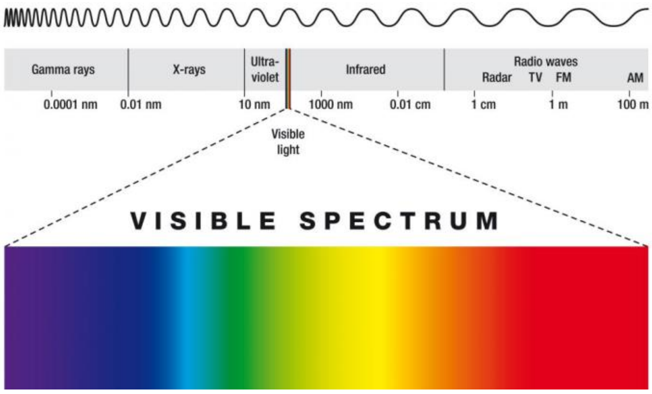

Figure 2 – Spectrum [P1] showing the part visible for the human eye.

2.1.1 Luminance and illuminance

When studying daylight there are some basic terms, such as luminance and illuminance that needs to be distinguished. Illuminance [2] is a measure of how much light that is transported towards a surface and it is measured in the unit lux. Illuminance is often mentioned when talking about daylight since the daylight factor is the relation between the illuminance inside and outside measured at the same time, which are further described in *Chapter 2.3.1*. The other term, luminance is also measured in lux but it is a measure of the amount of light that passes through a surface, or is being emitted, and then falls in a given angle, i.e. the amount of light an eye can perceive from different directions when looking in a specific angle. [2] Both these terms are illustrated in *Figure 3*.

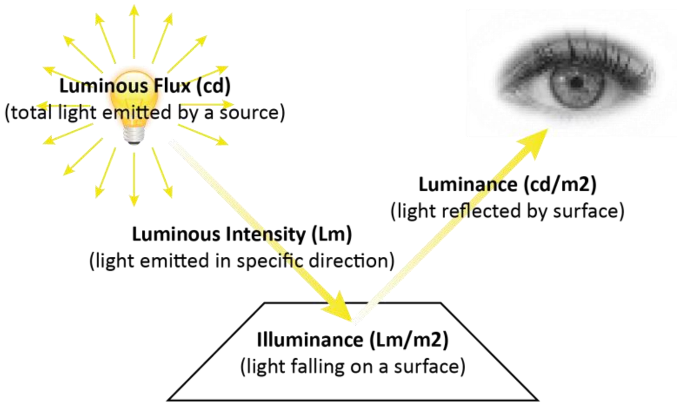

Figure 3 – Illuminance and luminance.

2.2 Impact on human's health and wellbeing

Science has shown [4] that a lack of daylight is affecting our wellbeing, both our psychological and physical health. It has been proven that our neural pathways in the brain are affected in three different ways in terms of our sight, circadian rhythm and the limbic system. Our circadian rhythm can be disturbed and this can lead to health problems in the long run such as an increased risk for having an accident, headache, fatigue, diabetes, depression, anxiety and other types of psychological health issues. However, it is not proven how much daylight that is required in order not to be affected in a negative way concerning our health and wellbeing. Electrical lighting does not contain the same spectra as the natural light and it has therefore not the same positive impact on humans' wellbeing.

2.3 Measuring daylight

The following subchapters explain different indicators for measuring daylight.

2.3.1 Daylight factor

Daylight factor (DF) is the ratio between the available illuminance indoors and the available illuminance outdoors at the same time under an overcast sky [4], see *Figure 4*. It is then multiplied with a factor 100 in order to get the daylight factor in percent, see *formula 1*. The sky has an illuminance level three times higher at the top compared to the sides.

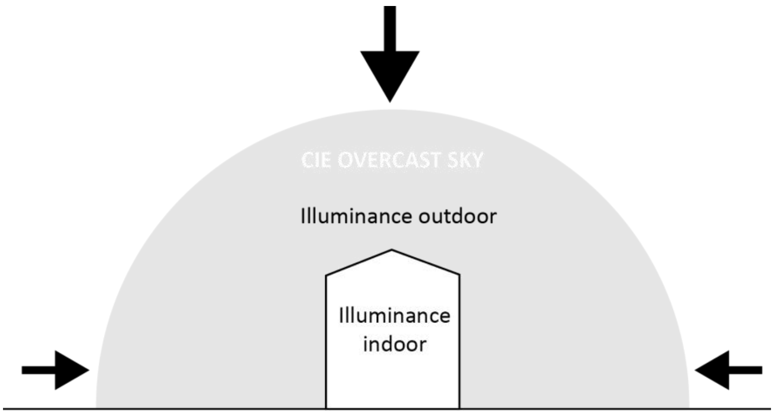

Figure 4 – Illustration of how daylight factor is measured.

$$DF = \frac{Illuminance\ indoor}{Illuminance\ outdoor} \times 100 \quad [\%] \quad (1)$$

The daylight factor in a room can be simulated for a specific point or over a surface. The daylight factor could also be measured in existing buildings using a light meter. The illuminance levels needs to be measured simultaneously inside the room in a specific point and outside under an unobstructed diffuse sky.

The illuminance level at the point considered is the sum of the sky component (SC), the external reflected component (ERC) and the internal reflected component (IRC) according to *formula 2*. The three components are illustrated in *Figure 5*.

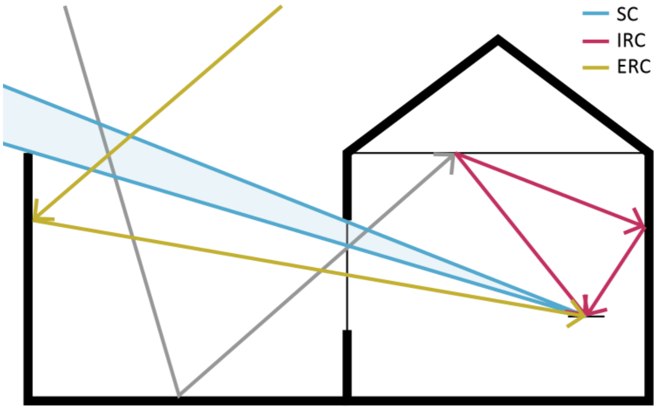

Figure 5 – Illustration of the three components; SC, ERC and IRC.

$$DF = SC + ERC + IRC \quad [\%] \quad (2)$$

The daylight factor is a static measure and the cardinal direction, location, season or sun has no impact. Hence it is independent of what time and place it is measured at. Some dynamic indicators are presented in the following subchapter.

2.3.2 Climate based indicators

There are a number of dynamic indicators for measuring daylight, often referred to as climate based indicators. These indicators do take the entire year into account when doing a calculation and they use climate files in order to simulate different sun- and sky conditions. As mentioned in the limitations, no climate based indicators are evaluated in this thesis. However, some of them are still shortly explained below in order to exemplify how daylight could be evaluated in the future if the daylight factor is to be replaced.

Daylight Autonomy (DA)

This indicator measures the percentage of annual daytime hours that is above a specified illumination level. The indicator also consider the occupation time [5]. It shows for example how long time an occupant can use the space without having to use any electrical lighting.

Continuous Daylight Autonomy (cDA)

cDA is a basic modification of DA. It works in the same way as DA but the continuous daylight autonomy credit values above the specified illumination level [6]. As an example; if there is a point that has a value varying below and above the specified illuminance level at least 50% of the time during a whole year, using the indicator DA would give it zero credit while cDA gives it credits for all the time when the point has an illuminance level above the boundary.

Useful Daylight Illuminance (UDI)
This indicator is also a modification of DA. There are three ranges of illuminance levels that are considered in this method. All points with a level between 100 and 2000 lux get full credit [7]. The horizontal illumination values above and below this range are not useful.

Daylight Saturation Percentage (DSP)
DSP is a modification of UDI. The only difference is that the limits are raised to 430 and 4300 lux respectively [8].

2.4 Daylight regulations

In Sweden, there are building regulations that need to be followed when planning and constructing a building. The authority that sets these rules is called "Boverket", in English "National Board", and they have a compendium called "Boverkets Byggregler" (BBR) which describes these rules. A summary of these rules and how they have varied through the history is presented in this chapter. Also some examples of daylight requirements in three other countries are presented.

2.4.1 Swedish present demands and in history

The Swedish demands regarding daylight have varied throughout the years. In the beginning of the 1900s [4] daylight was an important factor when designing a building although there were no specific requirements regarding daylight. The first indirect rule regarding daylight in buildings came from *Kungliga Byggnadsstyrelsens publikationer* (BABS) in 1960. However, this remark disappeared in the updated version in 1967. In conjunction with the 1973 oil crises in Sweden the demands concerning energy efficient buildings, were tightened in *Svensk Byggnorm* (SBN) 1975. For the first time in history, a demand of a daylight factor of 1% in a point in a room was mentioned. The daylight factor were to be calculated with help of a daylight protractor according to the method presented in the book "Dagsljus inomhus", in English "Daylight indoors", by B. Fritzell and H. A. Löfberg from 1970. Since this method was perceived as complicated and time consuming, a lot of people in the industry ignored these demands. Because of this, a simplified method was presented in 1980 called "AF-metoden", in English "Window-to-Floor area Ratio" (WFR). It is a ratio that shows the relation between the window glass area and the floor area.

When the financial crisis hit the Nordic countries in 1990 the requirements on the daylight factor was expanded to be applied for all rooms that are used for extended periods of time [4]. The formulation of the demand was also changed from "generous amount of daylight" to "good access to direct daylight". The simplified "AF-metoden" was used according to the standard SS 91 42 01. SBN was replaced by BBR in 1993 in order to simplify the building process. Only small adjustments of these regulations were made between 1993 and 2014.

The present requirements regarding daylight in buildings are described in BBR. The daylight factor should in residential buildings be 1% in all rooms where people stay for an extended period of time and it should be calculated at half the room depth, one meter from the darkest wall and 0.8 meter above the floor. An extract from BBR [1] is shown in *Figure 6* and a summary of the requirements in English are as follows;

Rooms or separable parts of rooms where people stay for an extended period of time should be designed in a way that good access to direct daylight is achieved. In student apartment buildings, it is sufficient to have access to indirect daylight in rooms intended for cooking and in common areas. The simplified "AF-metoden" can be used according to the Swedish standard SS 91 42 01. If the Swedish standard is fulfilled, a daylight factor of approximately 1% is achieved.

6:322 Dagsljus

Rum eller avskiljbara delar av rum där människor vistas mer än tillfälligt ska utformas och orienteras så att god tillgång till direkt dagsljus är möjlig, om detta inte är orimligt med hänsyn till rummets avsedda användning.

I studentbostäder räcker det dock med tillgång till indirekt dagsljus i rummet för matlagning och i gemensamma utrymmen för daglig samvaro, matlagning eller måltider. *(BFS 2014:3)*.

Allmänt råd

För beräkning av fönsterglasarean kan en förenklad metod enligt SS 91 42 01 användas. Metoden gäller för rumsstorlekar, fönsterglas, fönstermått, fönsterplacering och avskärmningsvinklar enligt standarden. Då bör ett schablonvärde för rummets fönsterglasarea vara minst 10 % av golvarean. Det innebär en dagsljusfaktor på cirka 1 % om standardens förutsättningar är uppfyllda. För rum med andra förutsättningar än de som anges i standarden kan fönsterglasarean beräknas för dagsljusfaktorn 1,0 % enligt standardens bilaga. *(BFS 2014:3)*.

Figure 6 – An extract from BBR showing the part regarding daylight regulations.

2.4.2 Demands in other countries

The requirements and guidelines regarding daylight in buildings vary a lot from country to country. One commonly used requirement is that a minimum daylight factor level is controlled by using a method that often compares the window glass area with the floor area. Another requirement that is common but do not exist in all countries are requirements on the view out. Parts of the requirements and guidelines regarding daylight in residential buildings in Great Britain, Denmark and Germany are presented as follows;

Great Britain

The British standard, “BS 8206-2:2008”, is a code of practice for daylighting. The demand for the minimum average daylight factor for bedrooms is 1%, for living rooms 1.5% and for kitchens 2% [9]. If there is a kitchen combined with a living room, the minimum average daylight factor is 2% as the highest demand always is selected.

Denmark

Denmark has higher demands in general regarding daylight than Sweden. For habitable rooms and kitchens, the daylight factor should be greater than 2% for half the room [10], i.e. the median value should be at least 2%.

Germany:

In Germany, the daylight factor in residential buildings is measured in rooms where people stay for extended periods of time. The daylight factor is measured in two points positioned at half the room depth, one meter from the side walls and 0.85 meter above the floor. The mean value of these points should be at least 0.9% [11] and the least favorable point should have a minimum daylight factor of 0.75%.

2.5 Certification systems

There are different kinds of certifications systems for buildings and these systems are used in different stages of the building process. In this chapter, a summary of the most essential requirements regarding daylight in four different certification systems are presented.

2.5.1 Miljöbyggnad

Miljöbyggnad is based on Swedish building regulations and construction practices. It covers energy, indoor environment and materials used in the building [12]. The system consists of 16 different indicators whereof daylight is one of them. The grading system consists of four different grades; CLASSIFIED BRONZE, SILVER and GOLD. The requirements for the daylight factor in a point for residential buildings are stated in *Table 1* and the table is translated to English by the authors since Miljöbyggnad only have these documents in Swedish.

Table 1 – The different requirements in Miljöbyggnad for different grades of the daylight factor

CLASSIFIED	BRONZE	SILVER	GOLD
DF < 1.0 %	DF ≥ 1.0 %	DF ≥ 1.2 %	DF ≥ 1.2 % showed with help of a data simulation and with passed results from the survey or self-declaration.

Apart from simulating the daylight factor, the simplified "AF-metoden" can be used in Miljöbyggnad. This method has some limitations and the criteria for using the method is described in *Chapter 3.3*. The requirements for this method in Miljöbyggnad for different grades are presented in *Table 2*. AF is calculated by dividing the glass area, A_{glass}, with the floor area, A_{floor}, as shown in *formula 3*.

$$AF = \frac{A_{glass}}{A_{floor}} * 100 \quad [\%] \quad (3)$$

Table 2 – Requirements for different grades for "AF" when using "AF-metoden"

CLASSIFIED	BRONZE	SILVER	GOLD
AF < 10 %	≥ 10 %	≥ 15 %	-

2.5.2 BREEAM

The Building Research Establishment Environmental Assessment Method is a certification system from Great Britain with local adaptions for several countries including Sweden. It consists of ten different categories which in turn consist of several indicators [13]. Daylight is an indicator that is a part of the category health and wellbeing. There are five possible grades; Pass, Good, Very Good, Excellent and Outstanding.

This certification system is not applicable for residential buildings thus only commercial buildings such as retail-, office- and industrial buildings can be certified. The daylight factor is measured as an average value and the grading scale depends on the position and height of the building. The daylight factor can also be measured in a point and it has different minimum levels compared to the average values.

2.5.3 LEED

The Leadership in Energy and Environmental Design from the United States has a grading scale containing four grades; Certified, Silver, Gold and Platinum [14]. Seven different indicators are evaluated where environmental quality is one example.

There are several methods that are approved according to this certification system for evaluating daylight. The first one is using daylight simulations and in this case 75% or more of all regularly occupied spaces should achieve illuminance levels in the range of 269 to 5382 lux. The sky condition should be clear and the calculation should be made September 21st at 9 a.m. and 3 p.m. Other approved methods for calculating the daylight is a simplified method, measurements or a combination of the different methods [15].

2.5.4 Svanen

Svanen is another certification system from Sweden. The national building code regarding the daylight factor has to be fulfilled in at least one room in every apartment where people stay for an extended period of time [16]. The daylight simulations should be made using approved software. Unlike Miljöbyggnad, the simplified method “AF-metoden”, is not accepted in this certification system.

3 EXPLANATION OF DIFFERENT STUDIED INDICATORS AND METHODS

There are many terms and concepts that are mentioned in this thesis. This chapter aims to explain some of the studied indicators and methods.

3.1 Obstruction Angle and Sky View Angle

The obstruction angle is shown in *Figure 7* and it is the angle between an imaginary horizontal plane through the middle of the window and the top of the object placed right in front of the window.

The sky view angle is the angle of which the vertical part of the sky is visible from a point in the middle of the window, see *Figure 7*.

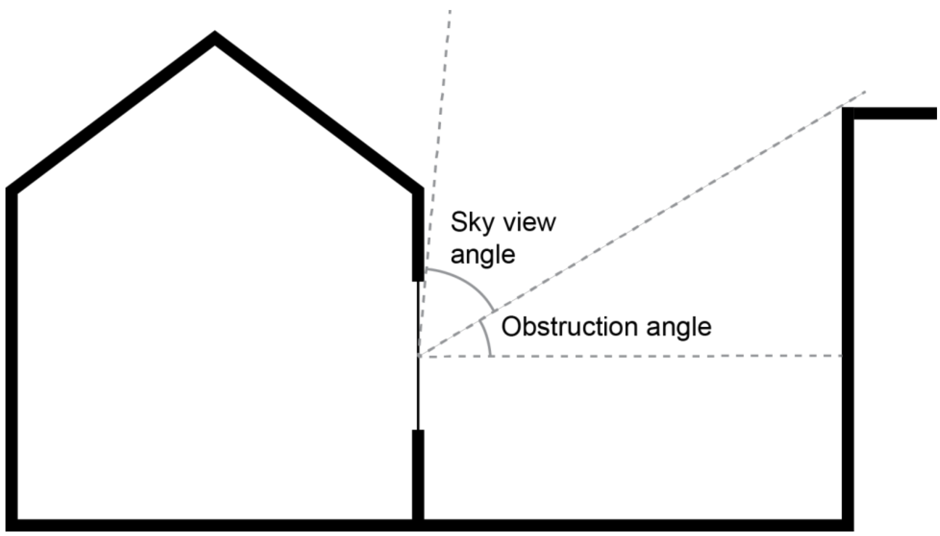

Figure 7 – Illustration of the sky view angle and the obstruction angle.

3.2 Sky View Factor and Sky Exposure Factor

The sky view factor (SVF) and sky exposure factor (SEF) is fairly similar to each other. The sky view factor expresses the percentage of the overlying hemispherical sky that is visible from a given surface while the sky exposure factor expresses the percentage in a single point instead. Another difference is that the sky exposure factor does not consider that the sky has three times as high illuminance level at the top compared to the sides, which the sky view factor does [17].

3.3 "AF-metoden"

"AF-metoden" is not the correct name for this method. The name "AF-metoden" was initiated since most people had problem remembering the real name; "SS 91 42 01, Building design – Daylight – Simplified method for checking required window glass area". However, in the continuation of this thesis the method will still be referred to as "AF-metoden". "AF-metoden" is used in order to evaluate whether the daylight is satisfactory in a room or not.

There are many conditions that have to be fulfilled in order to be able to use this method and these conditions [18], described in "Svensk Standard" version "SS 91 42 01", are presented as follows;

- The obstruction angle has to be in the range of $0 \leq \alpha \leq 30^\circ$
- The studied room must have room dimensions as follows:
    - 2.5 m ≤ width ≤ 6.0 m
    - 2.0 m ≤ depth ≤ 6.0 m
    - Height ≥ 2.1 m
- The windows must have clear glass with two or three panes. The windows are not allowed to be placed non-symmetrical. The glass surface that is placed lower than 0.8 meter above floor are excluded from the calculation and the windows must have dimensions as follows:
    - 0.6 m ≤ height ≤ 1.4 m
    - 0.9 m ≤ width ≤ 1.5 m
- The floor, walls and ceiling should be normally bright

If the conditions for using "AF-metoden" are fulfilled, the glass area in the room, A_{glass}, are compared to the floor area of the room, A_{floor}, times a factor f which is determined by the obstruction angle according to *Figure 8*. If there is a balcony or an access balcony outside the window, this area should be included in A_{floor}. In order to check if the daylight is satisfactory enough, *formula 4* is used.

$$A_{glass} \geq f * A_{floor} \qquad (4)$$

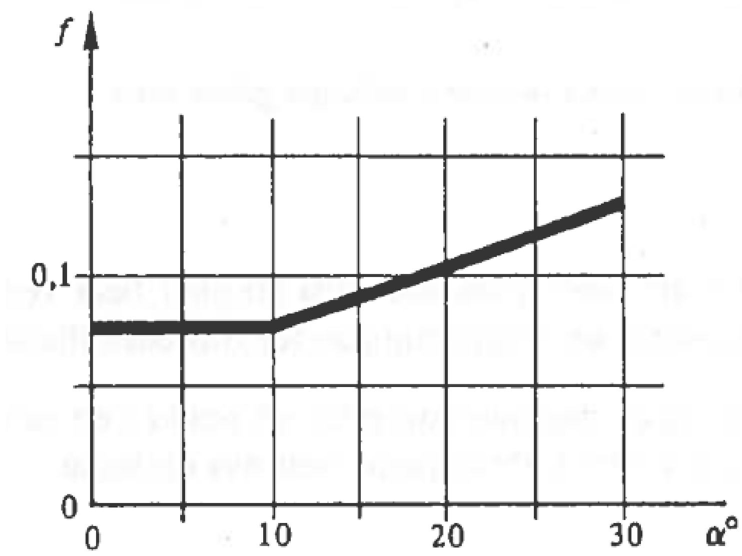

Figure 8 – Graph showing how the factor f is determined by the obstruction angle [P2].

3.4 Daylight protractor

A hand calculation method using a daylight protractor was used before the possibility of having a computer making daylight simulations.

When using this method, the daylight factor is calculated by summing up the contribution from the sky component (SC), the external reflectance component (ERC) and the internal reflectance component (IRC) [19] according to *formula 5*. SC and ERC can be approximated by using the daylight protractor while IRC can be estimated by using tables and formulas.

$$DF = SC + ERC + IRC \quad [\%] \quad (5)$$

A sectional drawing through every window and a floorplan is necessary when using this method. *Figure 9* demonstrates a part of how the daylight protractor is used when calculating the daylight factor in a point.

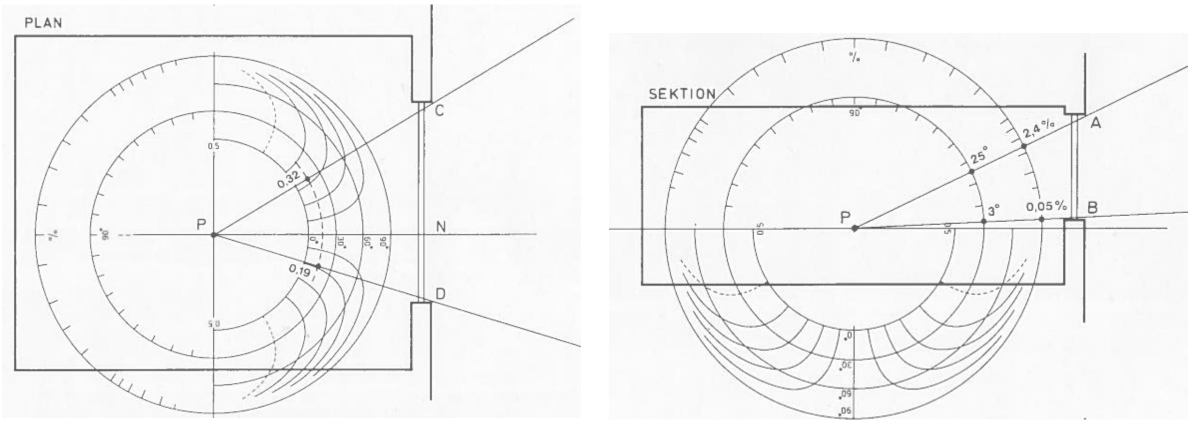

Figure 9 – Illustration of how the daylight protractor is used in floor plan and section [P3].

4 DESCRIPTION OF THE STUDIED BUILDINGS

The buildings that are studied in this thesis are described in this chapter. For most buildings, a representative floor plan or part of the floor plan is shown. All the used drawings can be found in *Appendix 3*.

In total, 16 buildings was selected and investigated and apart from eight residential buildings also two student apartment buildings, two offices, two hospitals and two schools have been studied. All buildings are named with a specific identification number. The first building has a building ID of 1, the next one 2, and so on until the last one that has a building identification number of 16. *Figure 10* shows the location and cadastral reference of all 16 buildings.

Since this project is a pilot study to the extensive study "Moderniserad dagsljusstandard", a list of proposed buildings that could be studied was handed to us by Paul Rogers, architect and daylight specialist at BAU, Byrån för Arkitektur och Urbanism, in English "The Office of Architecture and Urbanism". This list contained residential buildings built in different age periods, spread all over Sweden. Seven of those buildings were located in Gothenburg, whereof four of them were chosen to be studied in this thesis. The reason why three of the buildings located in Gothenburg were not chosen is because there was a lack of information about them or because the drawing material was too scant. Four additional residential buildings were also studied and was chosen after location and year of construction in order to get a wide spread of different buildings.

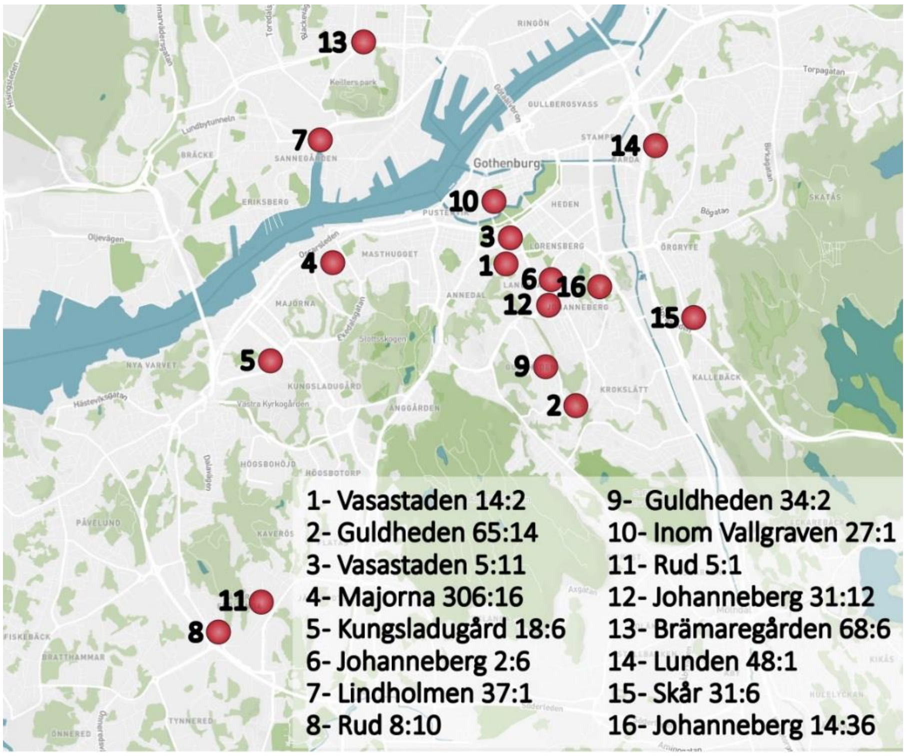

Figure 10 – The location of the studied buildings and their associated building ID and cadastral reference

Drawings of all buildings such as floor plans, façades and sections have been provided by *Stadsbyggnadskontoret* (City planning). Three dimensional models in AutoCAD of the surroundings containing the roof constructions of the surrounding buildings and the ground have been provided by Chalmers architectural database called “A-databasen”.

4.1 Residential buildings

Eight residential buildings have been studied in this thesis and a short description of all buildings is presented in this chapter.

Since the demands regarding daylight only applies for rooms where people stay for extended periods of time, there are four different room types in residential buildings that has been studied in this thesis; bedrooms, living rooms, kitchens and dining rooms.

Vasastaden 14:2

The first building is a housing association built in 1972 in the central part of Gothenburg. This was the first building to be study. A small part of this building was studied in order to find an appropriate method and learning how to simulate the buildings in the best and most effective way.

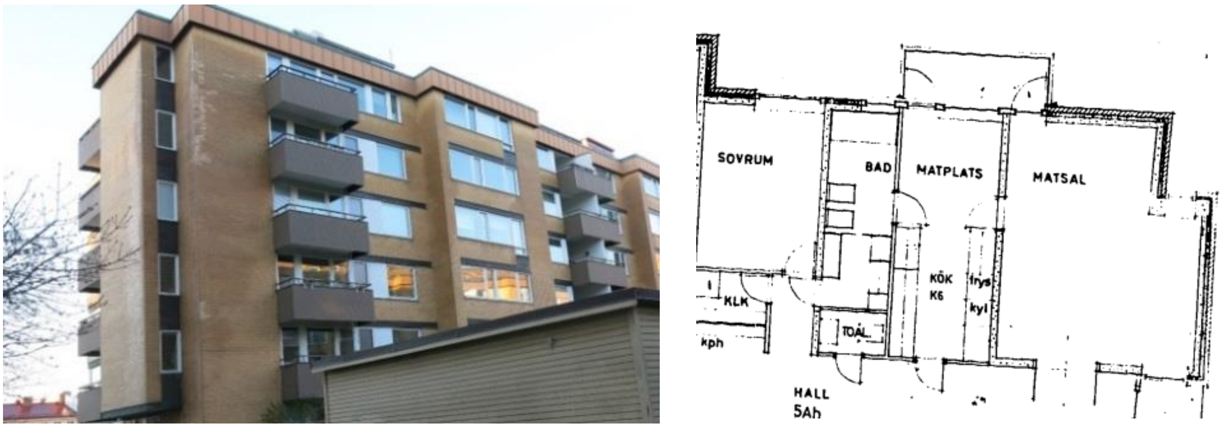

Figure 11 – Vasastaden 14:2

Guldheden 65:13

The second building, built in 1960 is situated in Guldheden. It is a "skivhus", so called block of flats in English and has 12 floors. There are several identical buildings placed in a row but angled in relation to each other and therefore, the buildings do not obstruct each other much. The perpendicular distance between the buildings are approximately 42 meters. All balconies are retracted in the façades.

Figure 12 – Guldheden 65:13

Vasastaden 5:11

This building was built in 1887 and it is the oldest residential building that has been studied in this thesis. It is located in central Gothenburg amongst other similar buildings of equal height. Most rooms are facing a small courtyard and the rest of the rooms are facing the street that is approximately 13 meters wide.

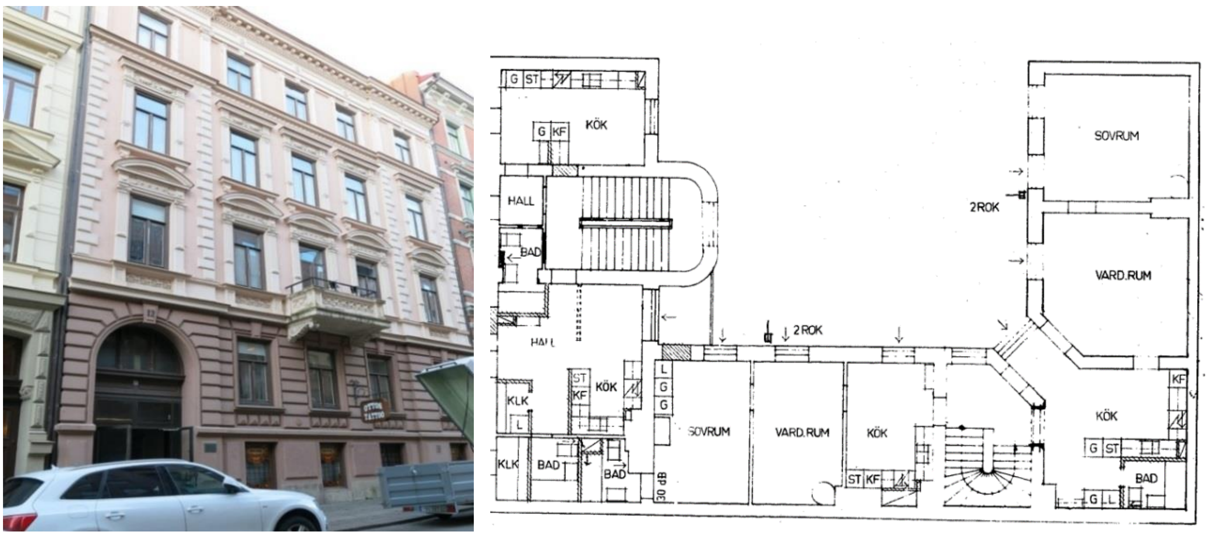

Figure 13 – Vasastaden 5:11

Majorna 306:16

Building number 4 is situated in Majorna and it is a typical "Landshövdingehus", so called Governor's house in English. It was built around 1897 and was renovated in the 1980's where attic apartments was added.

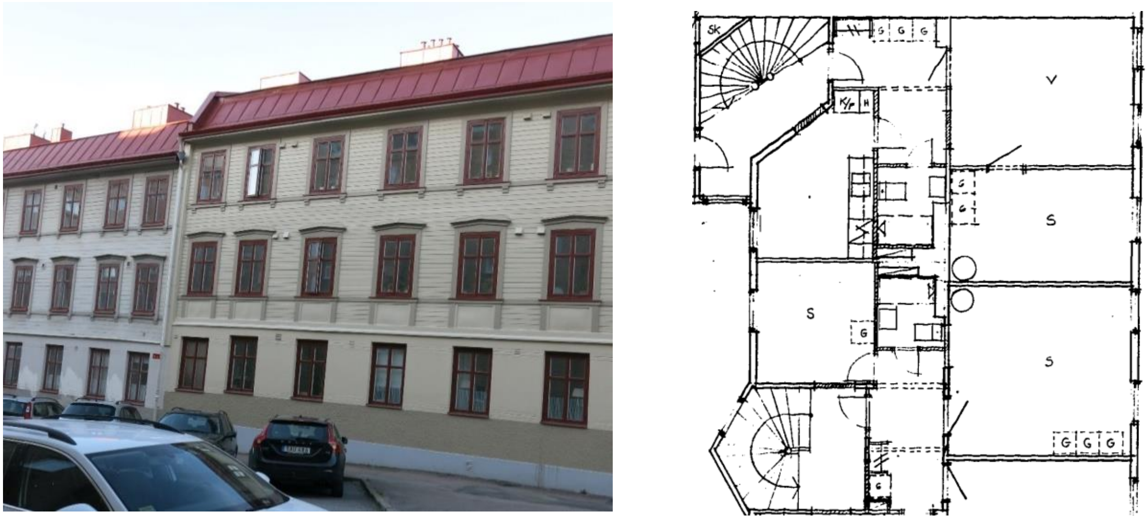

Figure 14 – Majorna 306:16

Kungsladugård 18:6

This building is also a "Landshövdingehus" and it was built in 1923. Characteristic for the floor plan is very narrow kitchens.

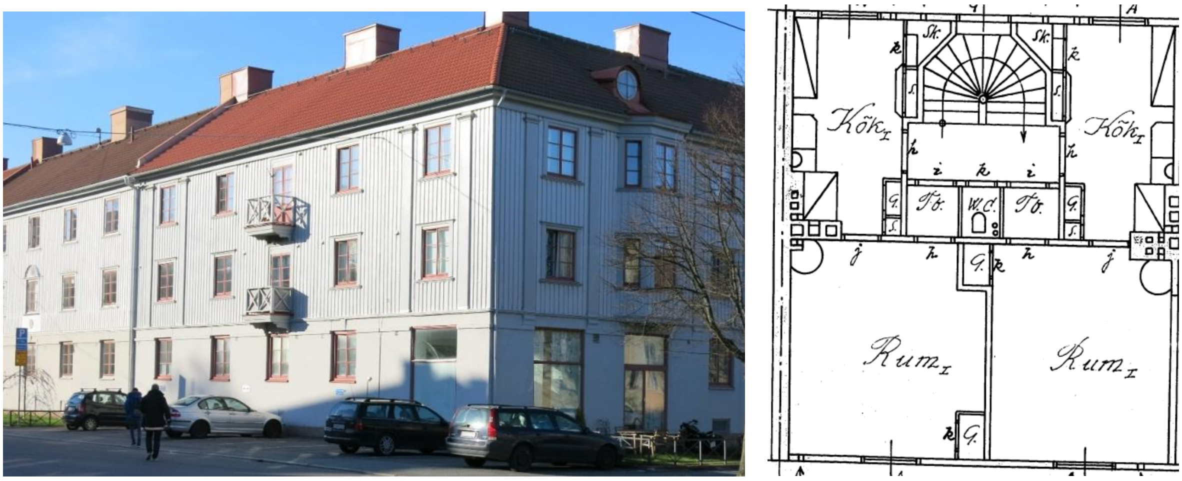

Figure 15 – Kungsladugård 18:6

Johanneberg 2:6

Building number 6 is situated in Johanneberg in the central part of Gothenburg and was built in 1928. Approximately 80% of the rooms has windows only facing the courtyard.

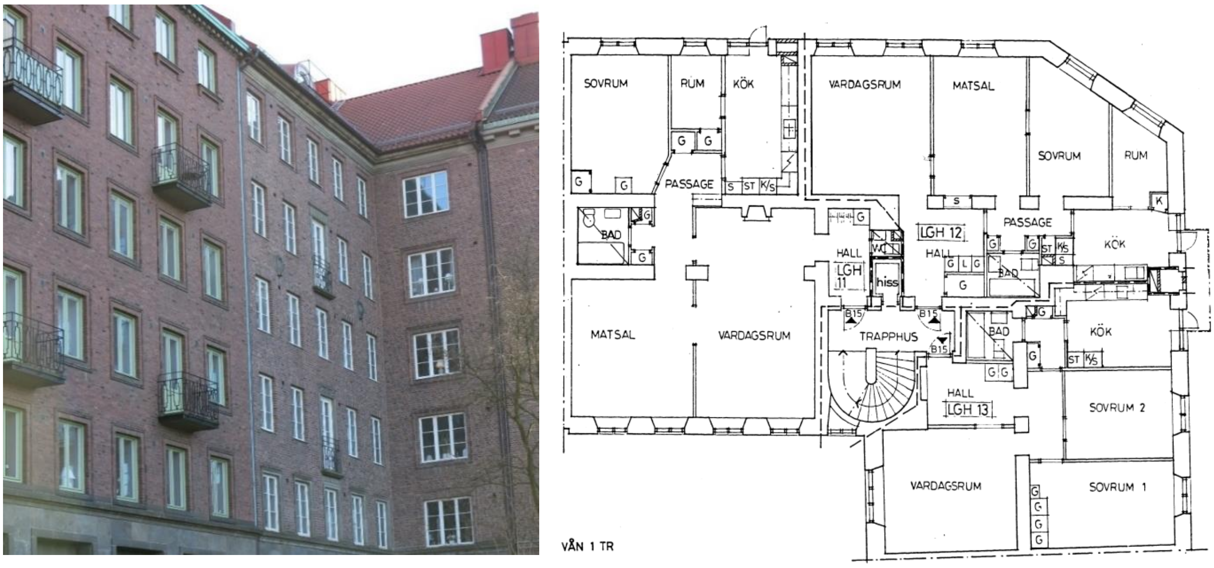

Figure 16 – Johanneberg 2:6

Lindholmen 37:1

This building was completed in 2013 and it is the most recently built building studied in this thesis. The building has two building bodies with different heights that are attached to each other. Just as many others newly built buildings, this building has an open floor plan with a combined kitchen and living room. It also has a lot of big balconies.

Figure 17 – Lindholmen 37:1

Rud 8:10

The last residential building that has been studied is a building situated in Frölunda, built in 1960. There are many identical buildings placed next to each other and they have a floor plan shaped like a star. This building consists of five apartments on each floor with the exact same floor plan for all floors.

Figure 18 – Rud 8:10

4.2 Student apartment buildings

A short explanation and some pictures of the two studied student apartment buildings are presented below.

Guldheden 34:2

The first student apartment building was built in 2004 and located in Guldheden. This building was burned down in 2012 and the façade was completely rebuilt. The apartments are mainly one bedroom apartments but a few two- and three bedroom apartments also exist. There is a glazed atrium in the middle of the building but no windows are facing the atrium. Characteristic for the floor plan is that the kitchens in the one bedroom apartments are placed in the hallway.


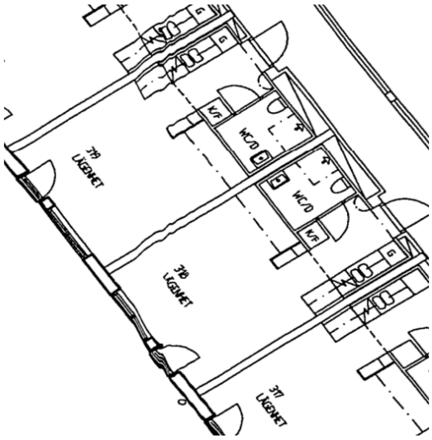

Figure 19 – Guldheden 34:2

Johanneberg 31:12

The second building is situated close to the first one but in Johanneberg, at the Chalmers campus area. This building was built in 2006 and the building consists of three building bodies that are attached, shaped like a "U". The bodies have different heights and only the highest one and the middle one is studied in this work. The highest one has 13 floors while the middle one has 5 floors. There are only one bedroom apartments in this building and the windows in the apartments are very narrow.


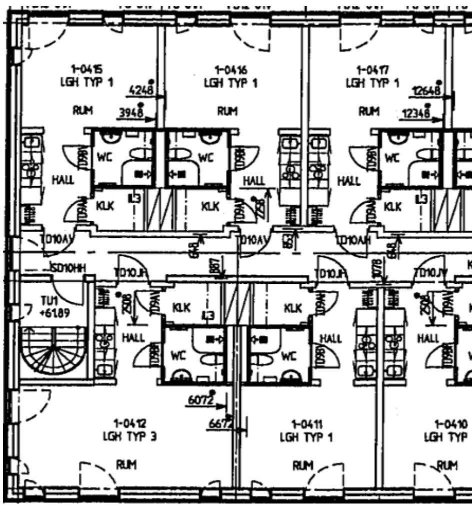

Figure 20 – Johanneberg 31:12

4.3 Offices

Both offices in this study consist of cell offices. Rooms such as conference rooms, meeting rooms etcetera has not been included.

Inom Vallgraven 27:1

The first office was built in 1863 and it is located in the city center of Gothenburg.

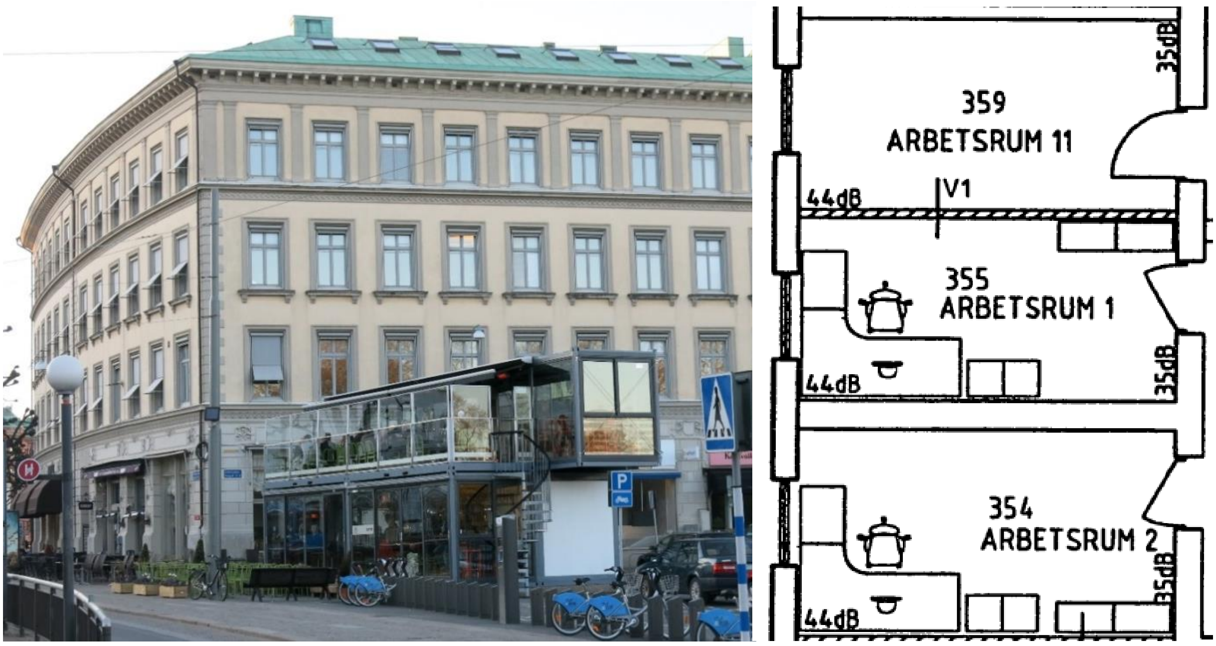

Figure 21 – Inom Vallgraven 27:1

Lunden 48:1

The second office was built in 2006 and it is situated in the eastern part of Gothenburg. This building was renovated in 2014 and an extension was constructed.

Figure 22 – Lunden 48:1

4.4 Hospitals

Two hospitals have been studied and the different room types that have been included in the study are; examination rooms, patient rooms and offices.

Brämaregården 68:6

The first hospital, Lundby hospital, is located in Hisingen and was constructed in 1966.

Figure 23 – Brämaregården 68:6

Johanneberg 14:36

The second hospital, Carlanderska hospital, was built in 1927 and is situated in Johanneberg.

Figure 24 – Johanneberg 14:36

4.5 Schools

For both schools in this thesis, classrooms are the only room type that has been studied since the teachers are assumed to spend most of the time in the classrooms teaching and do not spend a lot of time in their offices.

Rud 5:1

The first school, built in 1962, is located in the western part of Gothenburg. It was renovated in 1990 and an annex was constructed at that time.

Figure 25 – Rud 5:1

Skår 31:6

The second school was constructed in 2001 and it is situated in the eastern part of Gothenburg. This building was renovated in 2011 and an annex was constructed. The school consists of three different buildings that are surrounding the schoolyard.

Figure 26 – Skår 31:6

4.6 Summary of all the studied buildings

Figure 27 shows a timeline where all of the 16 studied buildings are arranged in chronological order by the year of construction. All residential buildings can be seen above the timeline while the other building types are placed below it.

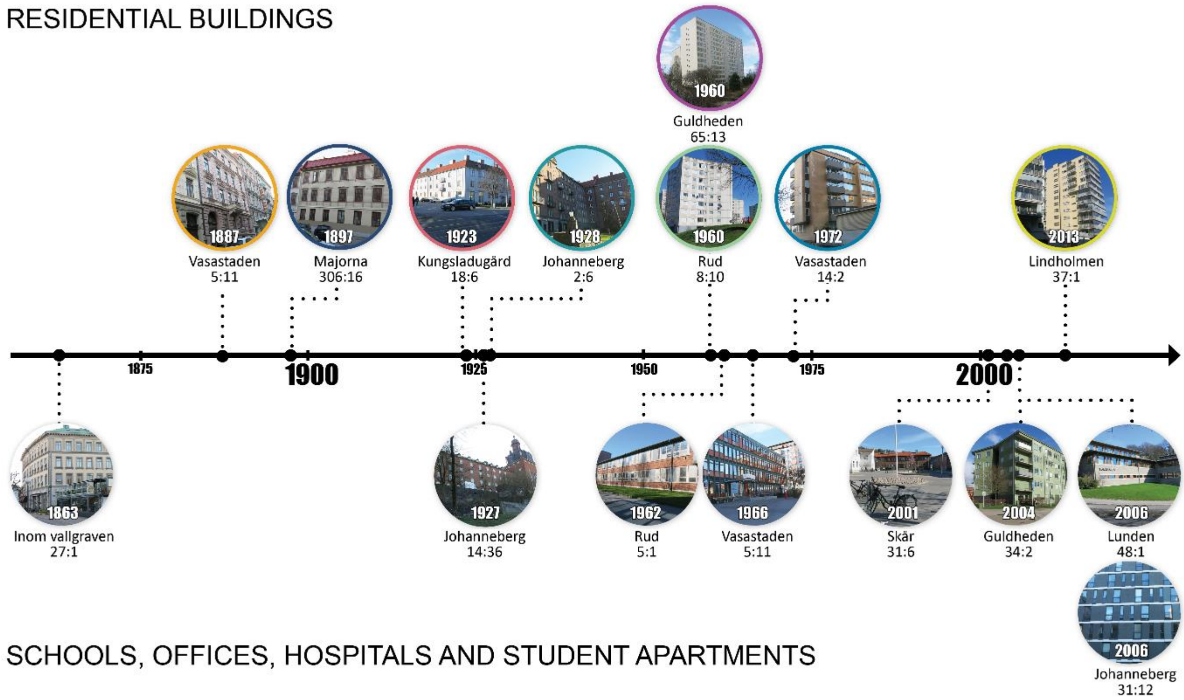

Figure 27 – Timeline containing all the studied buildings arranged in chronological order by the year of construction.

All rooms in the studied buildings have not been modeled and simulated, i.e. some parts of the buildings have been selected. Since the floor plans often looks the same for every floor, the limitation of only studying some floors still results in a representative image of how the levels in the entire building are.

All the studied buildings with corresponding cadastral reference and identification number together with other valuable information are presented in *Table 3*.

Table 3 – Compilation of the studied buildings

Building ID	Cadastral reference	Year of construction	Number of floorplans	Number of evaluated floorplans	Evaluated rooms
1	Vasastaden 14:2	1972	6	4	36
2	Guldheden 64:13	1960	12	8	200
3	Vasastaden 5:11	1887	4	4	42
4	Majorna 306:16	1897	4	3	140
5	Kungsladugård 18:6	1923	3	3	37
6	Johanneberg 2:6	1928	6	5	70
7	Lindholmen 37:1	2013	11	4	68
8	Rud 8:10	1960	10	4	100
9	Guldheden 34:2	2004	5	3	97
10	Inom Vallgraven 27:1	1863	5	4	47
11	Rud 5:1	1962	2	2	14
12	Johanneberg 31:12	2006	13	5	230
13	Brämaregården 68:6	1966	4	4	38
14	Lunden 48:1	2006	3	3	36
15	Skår 31:6	2001	2	2	30
16	Johanneberg 14:36	1927	4	3	52

5 METHODOLOGY

This chapter explains the method used for performing computational daylight simulations and calculations of the sky view factor and sky exposure factor as well as the methodology of the survey.

5.1 Computational daylight simulations

This chapter describes the different steps to create three dimensional models of the buildings and to simulate and evaluate daylight in the buildings that has been utilized in this thesis. A more detailed description of the different steps can be found in *Appendix 1*.

5.1.1 Modelling

In order to be able to make daylight calculations, a three dimensional model of the building has to be generated. The project started out with collecting drawing materials for all the studied buildings and since almost all drawing material for the chosen buildings is scanned drawings, drawings in AutoCAD 2014 were made by having the scanned drawings as templates. Within the scanned drawings, there were drawings of the buildings from different age periods. The newest drawings were always chosen but if there were some information missing, the older ones have covered up the shortcomings in the drawing material.

The drawings made in AutoCAD was then imported into Rhinoceros 5 and a three dimensional model was created. The process can be seen in *Figure 28* and *Figure 29* shows how one of the buildings looks in reality and as a three dimensional model.

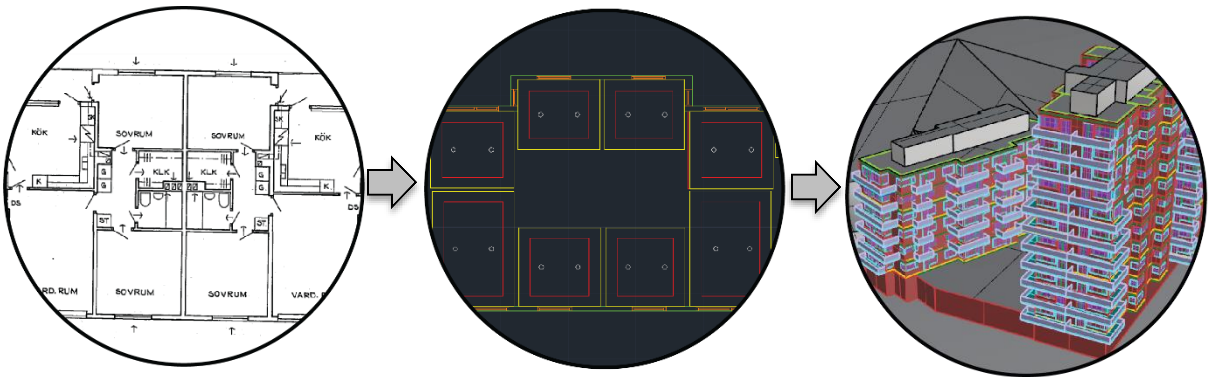

Figure 28 –Showing the process in making the three dimensional models from the scanned drawings.

The surroundings has also been modeled since it can have a big impact on the daylight in the buildings and in order to model the surrounding, a three dimensional CAD-file containing roof constructions and the ground floor has been used.

A detailed description of what the models are supposed to contain and how different objects such as window frames, balconies etcetera should be modeled can be found in *Appendix 1*.

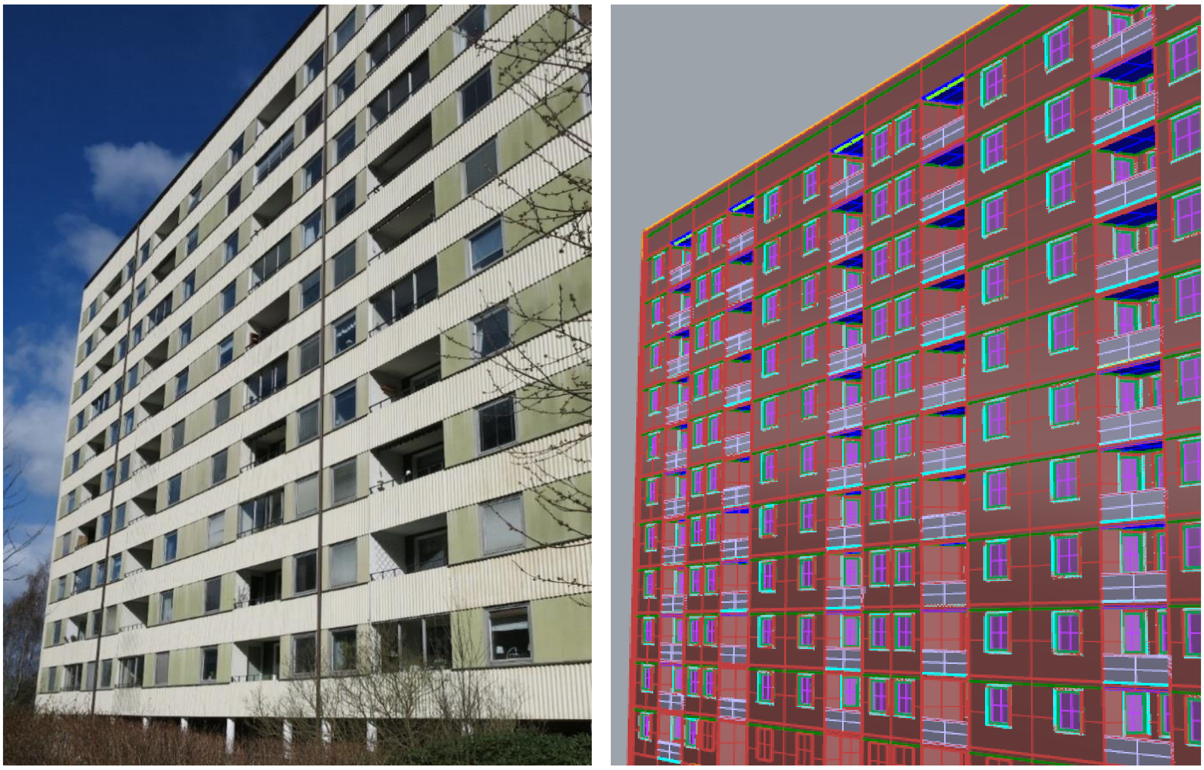

Figure 29 – (a) The real building and (b) the three dimensional model in Rhino.

5.1.2 Optical properties and settings

The aim is to show the accessibility of daylight and not the exact level in current buildings. For this reason, idealized optical properties have been assumed and internal geometric objects such as furniture have been neglected.

Since there are no standardized values for reflectance and transmittance for different objects, the optical properties that has been used in this thesis has been developed in consultation with experts in the field and is shown in *Table 4*. The same values will be used in the project "Moderniserad dagsljusstandard".

The properties for the balcony railing can vary a lot for different buildings. Therefore the value for reflectance or transmittance will vary between zero and one. If it is completely opaque it is assumed to have the same optical properties as the external façades, otherwise a value for the transparency has been assumed and the value used for the different buildings can be found in the result files.

Table 4 – Compilation of the reflectance and transmittance for different objects used in this study

Outside ground	0.2
External façades	0.3
Surrounding buildings and objects	0.2
Floor	0.3
Walls	0.7
Ceiling	0.8
Window frame	0.8
Side of window	0.5
Balcony	0.3
Balcony bottom	0.7
Balcony railing	x
Water	0.5
Roof	0.3

When making a grid-based daylight factor simulation in Radiance, five settings are important to take into consideration. The first one is the number of ambient bounces (-ab), the second one is the ambient divisions (-ad), the third one is the ambient super-samples (-as), the fourth one is the ambient resolution (-ar) and the last one is the ambient accuracy (-aa). The main settings that have been used in Radiance are: [-ab 7 -ad 2048 -as 512 -ar 256 -aa 0.1].

5.1.3 Computational grids and calculation points

Two different types of computational grids have been used for calculation of the median- and average values for the daylight factor over a surface. The first one covers the whole floor area of the room while the other one is retracted 0.5 meter from each wall. All grids have a distance of 0.3 meters between the calculation points and they are placed 0.8 meter (the height of a working desk) above the floor. The points used when calculating the daylight factor in a point are placed at half room depth and one meter from the darkest wall. *Figure 30* shows an illustration of the calculation point and the two different calculation grids.

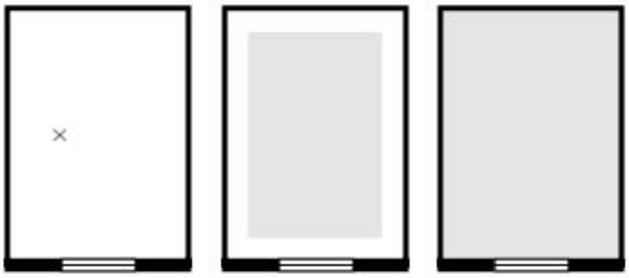

Figure 30 – Illustration of the location of the calculation point and distribution of the different calculation grids.

All the calculation points and calculation grids were also created in the two dimensional model which later on made it a lot easier when creating the computational grids in the three dimensional models. An example of this can be seen in *Figure 31* where the two different kinds of calculation grids and the calculation points are visible.

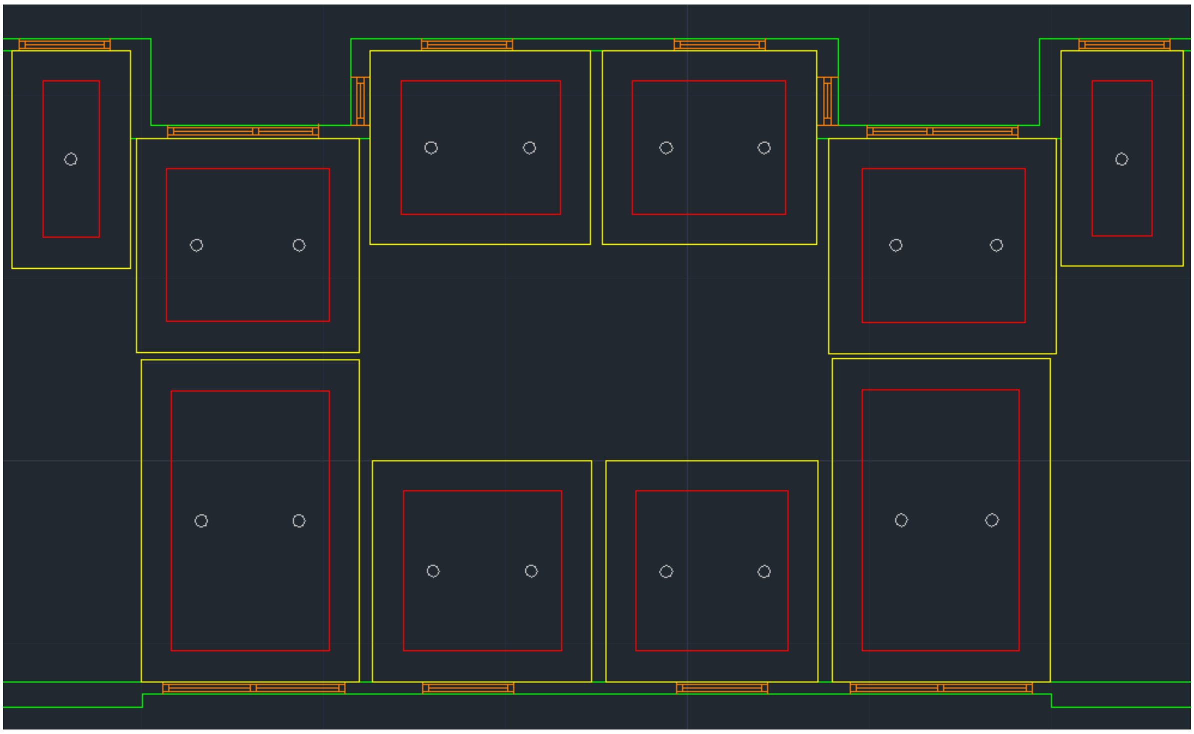

Figure 31 – An example of a two dimensional model made in AutoCAD

A calculation grid has also been placed 0.05 meters outside the windows, showed in *Figure 32*, in order to see the available daylight outside the windows. The same distance between the calculation points has been used as for the other grids.

For each window an average value has been calculated and if a room has several windows an average value of all windows in the room has been calculated (not area-weighted).

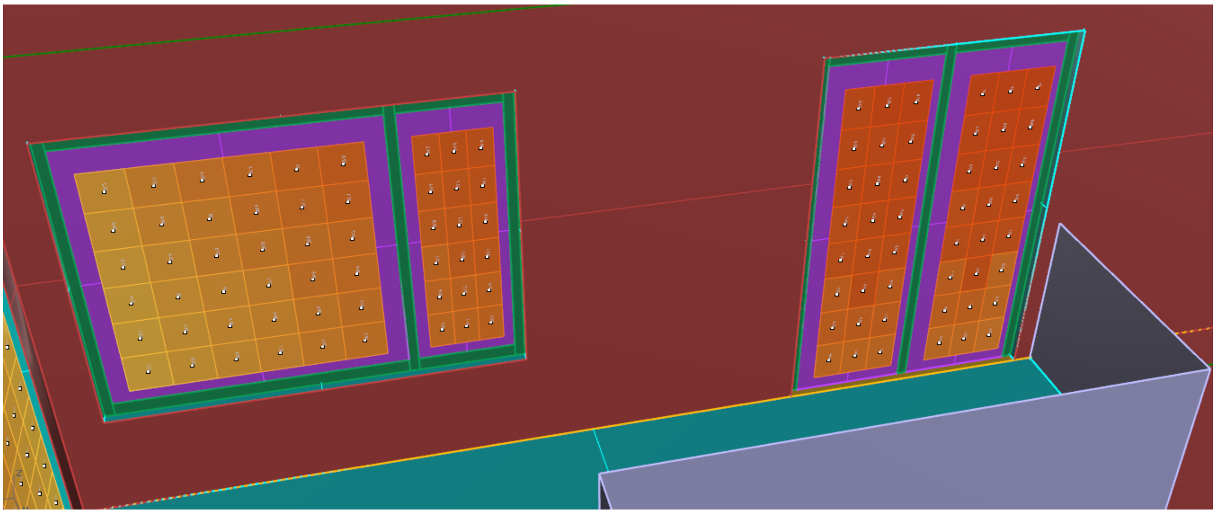

Figure 32 – The distribution of the calculation points in the grids outside the windows in Rhino.

5.2 Sky View Factor and Sky Exposure Factor

The Sky View Factor (SVF) and Sky Exposure Factor (SEF) have been calculated for all residential buildings. This has been done using the software Grasshopper (version August-27, 2014) which is a plug-in to Rhinoceros. SVF and SEF have been calculated using the same grid as for calculating the daylight factor outside the windows. *Figure 33* shows an image of a calculation of the sky view factor in Grasshopper.

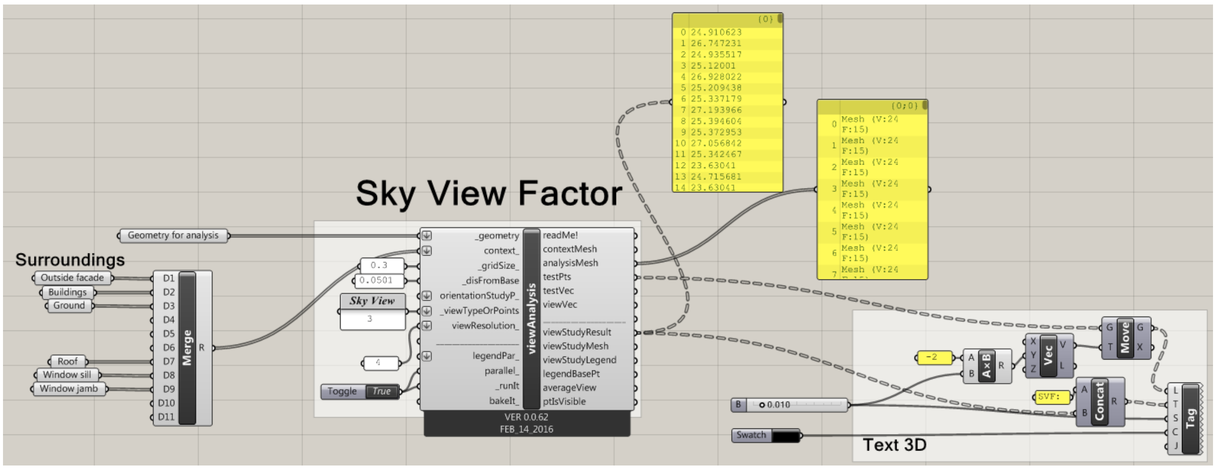

Figure 33 – Calculation of the sky view factor in Grasshopper.

5.3 Survey

A survey on the resident's perceived satisfaction with daylight in their apartments has been done during this work and it has been distributed to the residents in three of the studied buildings, more exact in the buildings 2, 6 and 7. The survey consists of 9 questions and is divided into three parts; "daylight", "sunlight and sun shading" and "view out". The first part, "daylight", covers questions regarding how the residents perceive the amount of daylight in their apartments. The questions in part two and three does not directly include daylight but was included in the survey in order to verify if the respondent understood the questions about daylight and for example did not mix it up with the definition of direct sunlight. The survey can be found in *Appendix 2*.

In order to compile the result in an easy way and knowing which apartments that had answered the survey, every survey were marked with an identification number and the floor plan of that specific apartment was printed on their survey. This made it possible to compare the answers for each specific room with the simulated results.

6 RESULTS AND ANALYSES

The results from the daylight simulations are compiled into two Excel documents. The first document, *Building level*, describes parameters that concerns the entire building and the second one, *Room level*, describes parameters that concerns the individual rooms. The *Building level* sheet can be found in *Appendix 4*. The *Room level* document cannot be found in appendix since the size of the document is too big (it contains 1651 rows and 48 columns). From the results, analyses have been made and they are presented and discussed in this chapter.

As a first step, the current daylight factor levels (calculated in a point in a room) in the studied buildings are presented, both for different buildings and for different room types. Since the daylight factor should be calculated in a single point according to BBR, the value of the daylight factor in a point is presented. Thereafter, a discussion of the difficulties with defining the rooms and most of all the difficulties where to place the points for calculation can be found. A comparison between the point-, median- and average values for the rooms then follows and the manual method with a daylight protractor and the simplified “AF-metoden” is evaluated. Finally, a study to evaluate the available daylight outside the façade and make conclusions about the daylight factor inside is presented in this chapter.

6.1 Residential buildings

The results and analyses for the residential buildings have been compiled in this chapter. It contains results and analyses for different buildings and different room types.

6.1.1 Daylight factor in different buildings

The daylight factor has been calculated in a point according to the regulations in BBR. The distribution of the level of daylight factor in all residential buildings is shown in *Figure 34*. The dashed line marks the daylight factor of 1%. The daylight factor in all studied rooms (N=42) in building number 3 is below 1% which means that no rooms in this building met the requirement of a daylight factor above 1%. As can be seen in *Figure 34*, there are many rooms, 36% of all studied rooms that do not meet the demands. None of the buildings meets the requirement in all of the studied rooms, not even the building constructed in 2013 (building 7). Worth noticing is that all residential buildings except one were built before 1975 when the requirement of a daylight factor above 1% was introduced.

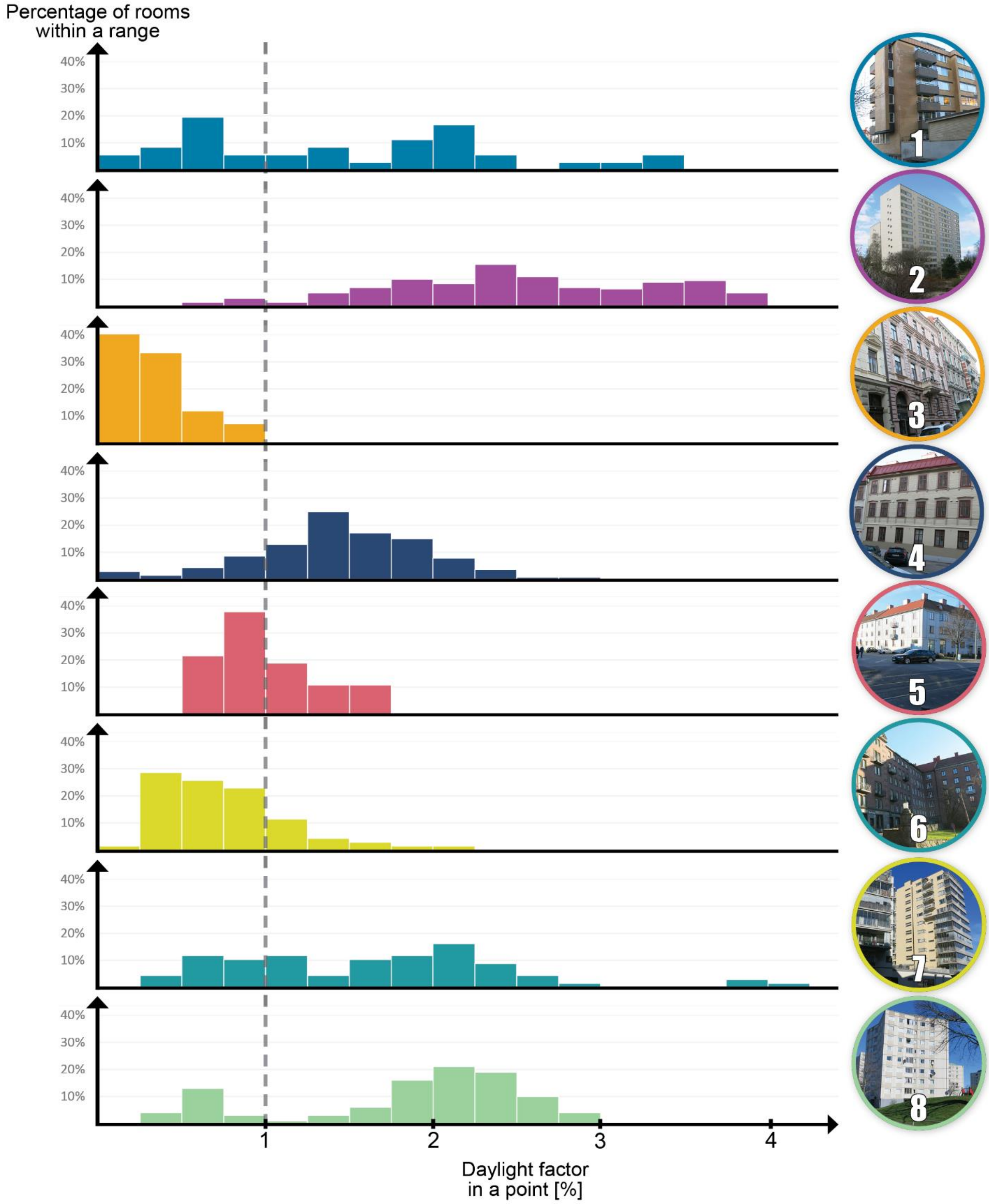

Figure 34 – The results of the daylight factor calculated in a point for all residential buildings.

All the residential buildings are listed in *Table 5* together with the percentage of all the rooms that has a daylight factor greater than 1%. The total average daylight factor (weighted after the number of rooms) for each of those buildings has also been calculated.

Table 5 – Compilation of all buildings showing the percentage of rooms with a daylight factor greater than 1% and the average daylight factor in a point

Building ID	Percentage of all rooms with a DF > 1%	Total average daylight factor in a point for different buildings
1	61 %	1.47 %
2	96 %	2.50 %
3	0 %	0.31 %
4	83 %	1.45 %
5	41 %	1.01 %
6	21 %	0.74 %
7	74 %	1.65 %
8	80 %	1.85 %
Total	71 %	1.67 %

Different number of rooms have been simulated in the different buildings, for example have 36 rooms been simulated in building 1 while 200 rooms have been simulated in building 2. When summing up all buildings and looking at the total distribution of the daylight factor in a point, some buildings will influence the distribution more than others. To avoid bias based on the size of buildings, the compiled graph in *Figure 35* does not show the percentage of simulated rooms that has a daylight factor within a range but instead shows the distribution of the daylight factor where the contribution from all 8 buildings are equally weighted.

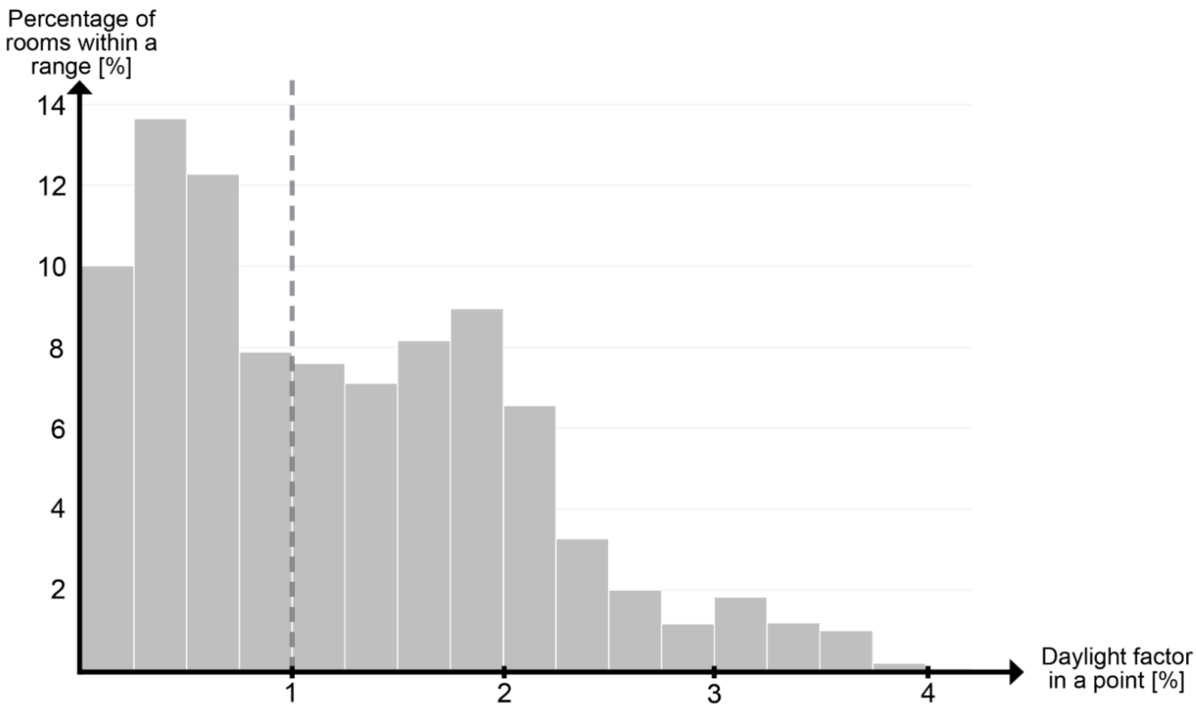

Figure 35 – Distribution of the daylight factor for all residential buildings equally weighted.

Worth noticing is that this distribution will look very different depending on which buildings are included. As mention before, this is a pilot study to a more extensive project and eventually more buildings will be studied. This will give a more representative image of the general daylight factor levels that occurs in existing buildings.

6.1.2 Daylight factor in different room types

Only the rooms where people stay for an extended period of time (bedrooms, kitchens, living rooms and dining rooms) are covered by the requirements of daylight in residential buildings. Therefore, these are the only room types that have been simulated in the residential buildings.

Because there are many different types of rooms, they have all been categorized into four main room types, see *Table 6*. The rooms that are a combination of living room and kitchen have not been divided into two rooms in the simulations. These rooms belong to two room types; living room and kitchen.

Table 6 – Shows all the different studied room types divided into the four main categories

Bedroom	**Living room**	**Kitchen**	**Dining room**
Bedroom	Living room	Kitchen	Dining room
Small room	Family room	Divided kitchen	Divided dining
	Living room / Bedroom	Divided kitchenette	
	Living room / Kitchen	Living room / Kitchen	

Figure 36 shows the distribution of the daylight factor for the four different room types. It is clearly shown that the kitchen is the room type that has the least amount of daylight in general. A reasonably explanation for this is that the kitchen often is placed further into the building and sometimes behind other rooms.

304 bedrooms, 191 living rooms, 179 kitchens and 43 dining rooms has been a part of this study. The graph in the bottom is a bit sprawling, merely because there were only 43 rooms that belonged to the room type dining room. Most apartments (136 out of 179) do not have a separate dining room, instead the dining table is part of the kitchen.

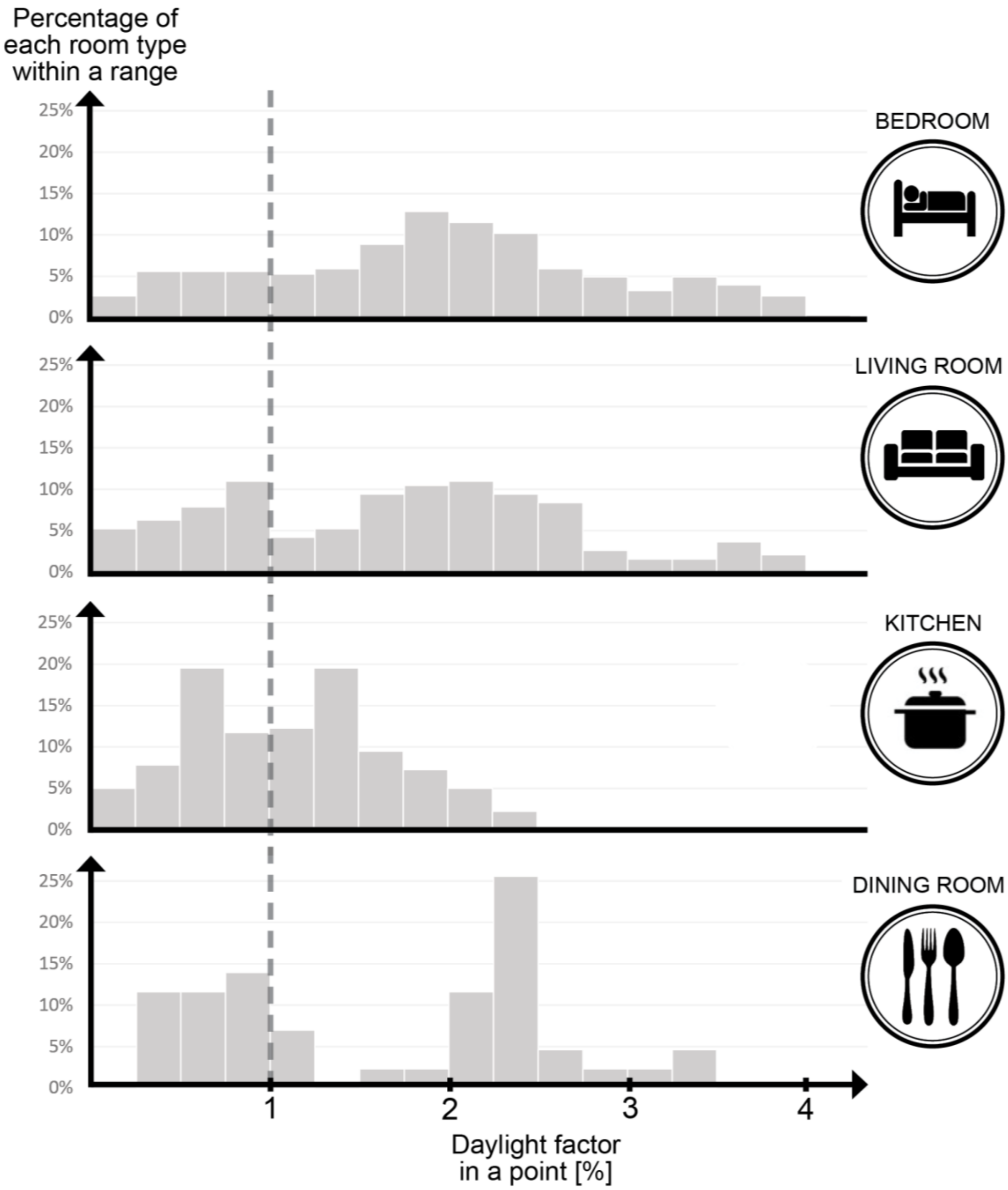

Figure 36 – Distribution of the daylight factor for all studied rooms divided into the four main categories.

6.2 Student apartment buildings

The requirements regarding daylight for student apartment buildings are not the same as for residential buildings. As mentioned in *Chapter 2.4.1*, it is sufficient to have access to indirect daylight in rooms intended for cooking in student apartment buildings. However, the kitchenettes have also been included in this study in order to evaluate the daylight in these rooms as well.

The distribution of the daylight factor for both buildings can be seen in *Figure 37*. The bars in dark grey represents the kitchenettes and the light grey bars respresents the other rooms consisting of bedrooms, living rooms and rooms that is a combination of bedroom and living room. As can be seen, all kitchenettes have a daylight factor less than 0.75%. In building 9, the daylight factor for 97% of the kitchenettes falls below 0.25%. The reason why the daylight factor is considerably lower in the kitchenettes is becacuse they are placed furher into the building, behind other rooms and only receive indirect daylight.

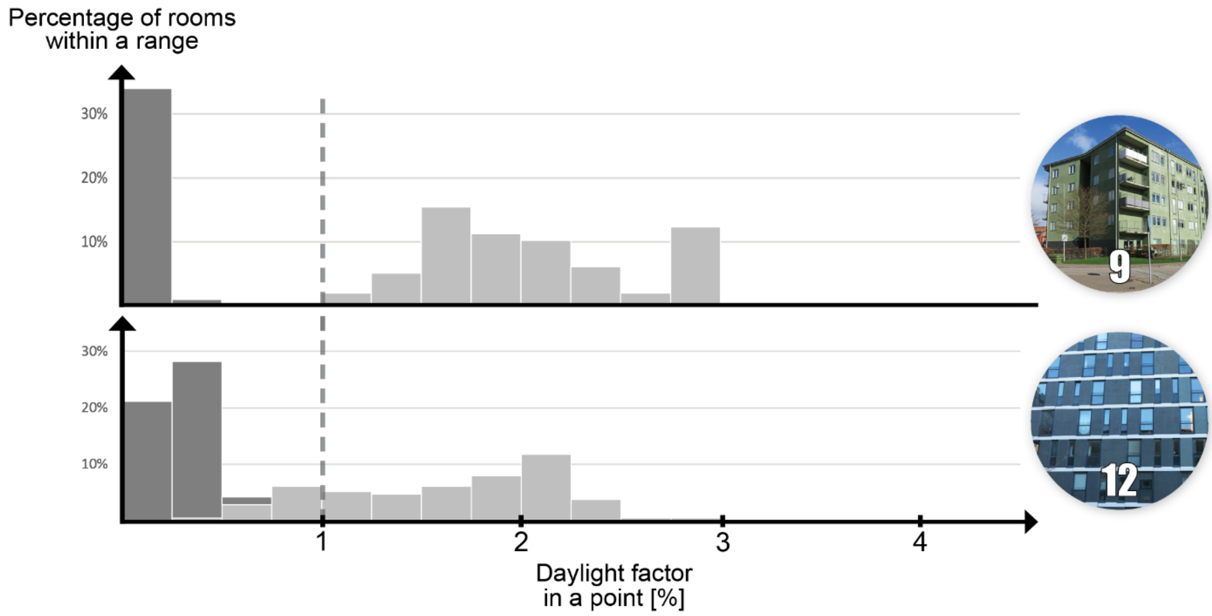

Figure 37 – The distribution of the daylight factor for the studied student apartment buildings. The kitchenettes are marked in dark grey and all other rooms in light grey.

6.3 Offices

All studied rooms in the office buildings consist of cell offices. *Figure 38* shows the simulated daylight factor for all rooms in both office buildings. As can be seen, a lot of rooms have a rather high daylight factor. For example, in building 14, 63% of all rooms have a daylight factor above 3%. A reasonable explanation for this is that cell offices normally are relatively small and since the daylight factor is greatly affected by the room depth, small rooms normally have a higher daylight factor but also that the window-to-floor area ratio normally becomes larger. Another explanation is that the obstructions are relatively small around these studied buildings.

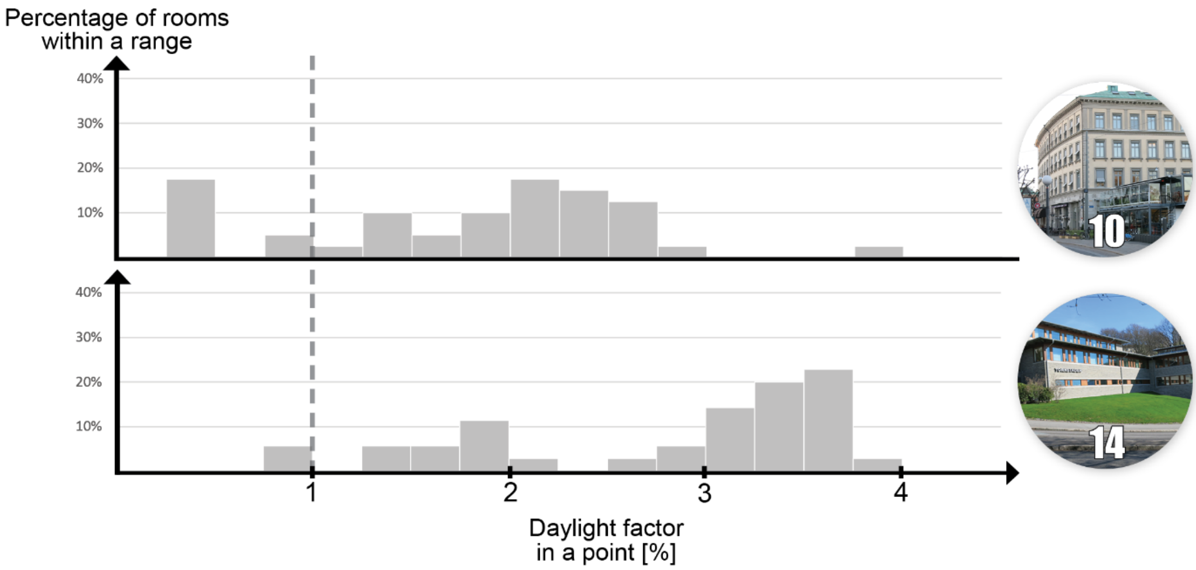

Figure 38 - The distribution of the daylight factor for the studied offices.

6.4 Hospitals

The rooms that have been included in the study for hospitals are; examination rooms, patient rooms and offices. *Figure 39* shows the percentage distribution of rooms with a daylight factor within a range.

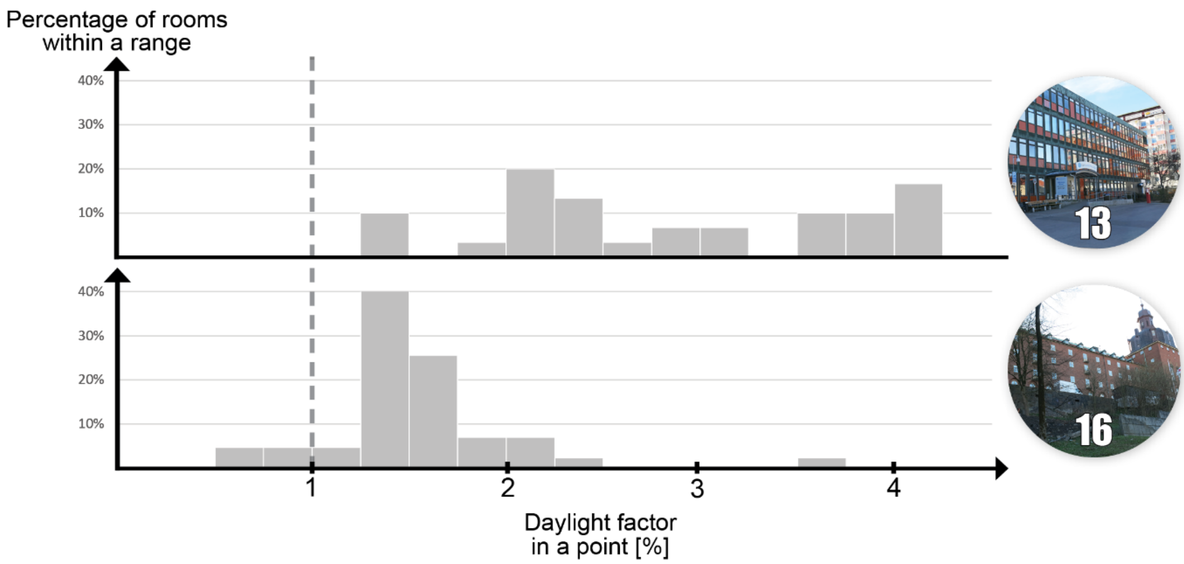

Figure 39 - The distribution of the daylight factor for the studied hospitals.

6.5 Schools

In both schools, only the classrooms have been studied. The distribution of the daylight factor calculated in a single point is shown in *Figure 40* for both buildings. In building 11, the average daylight factor in a point is around 2% while in building 15, the average daylight factor in a point is a bit lower in general, around 1%.

In contrast to the student apartment buildings, offices and hospitals none of the rooms in the schools have a daylight factor above 2.5%. A reasonable explanation for this is that the depths of the classrooms generally are greater in comparison to other room types and therefore the point where the daylight factor is measured is placed further into the buildings but also that the classrooms often are lit from one side. This is however usually compensated by a bigger room height and highly placed windows.

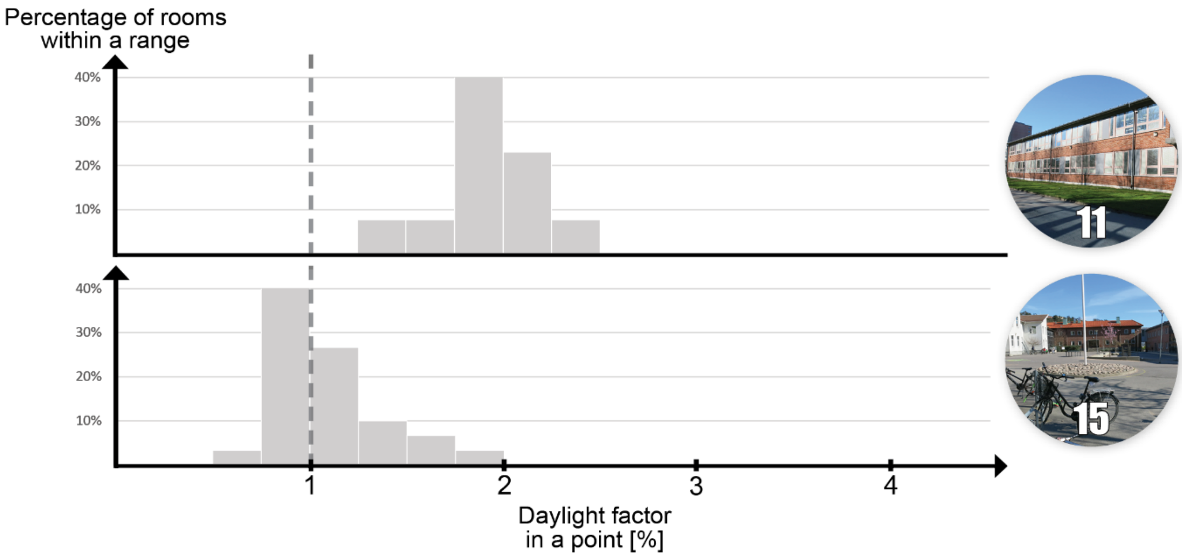

Figure 40 - The distribution of the daylight factor for the studied schools.

6.6 Difficulties with defining the point and distribution of grid

Defining the room and the point where the daylight factor should be calculated is not always simple. During this work, these problems have been encountered many times. To highlight these issues, some examples are studied and exemplified in this chapter.

6.6.1 Defining the room

Open floor plans are frequently used in apartments in Sweden, especially in newly constructed buildings. The kitchen and dining room are often combined into one room. This makes it difficult to define these rooms in order to make daylight calculations. The first example, shown in *Figure 41,* has no wall between the kitchen and the dining room. Should the calculation be made for the kitchen and dining room as single rooms or should they be divided into two rooms? In this thesis, the dining room and kitchen has been divided into two separate rooms. *Figure 41(a)* shows how the floor plan of the room looks like and *Figure 41(b)* demonstrations how the computational grids are distributed.

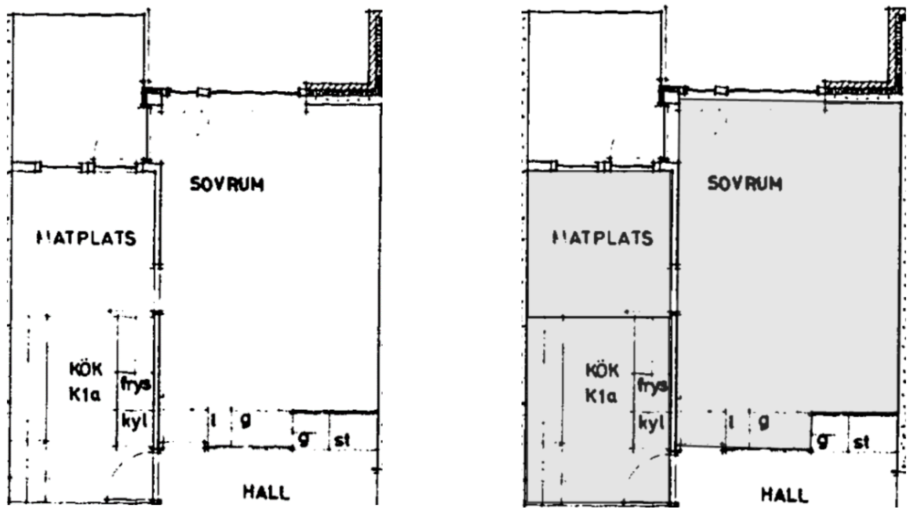

Figure 41 – Shows (a) the original floorplan and (b) how the rooms are defined in the calculations made.

In student apartment buildings kitchenette, living room and alcove are often combined into one big room. How should these rooms be divided when making calculations? *Figure 42* shows an apartment situated in one of the studied student apartment buildings. *Figure 42(a)* shows the original floor plan and *Figure 42(b)* shows the area, marked in grey that has been used when calculating the daylight factor in this thesis.

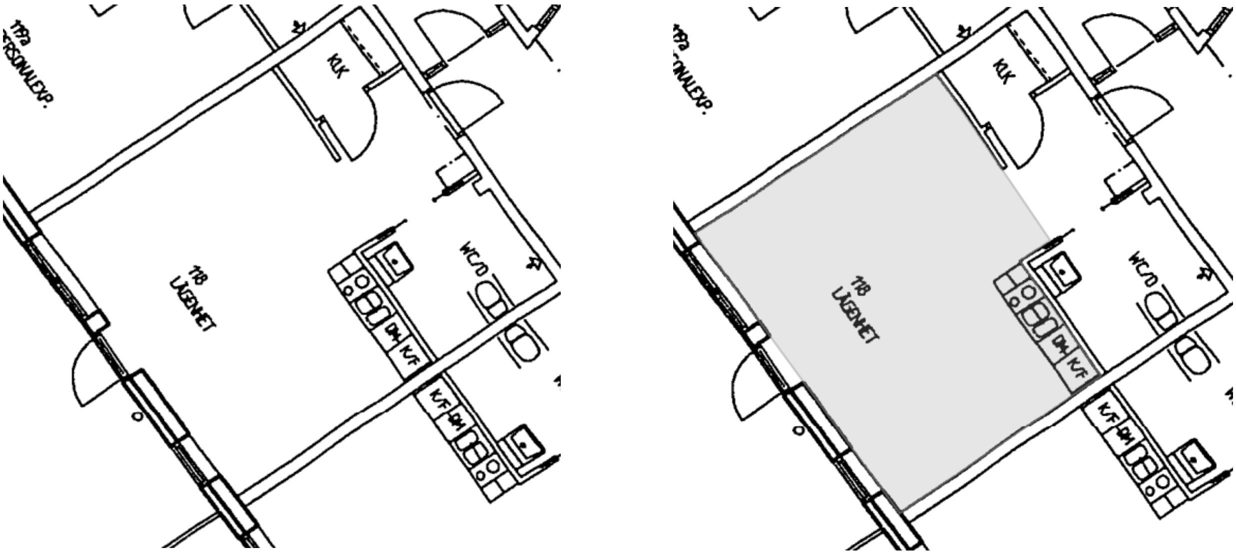

Figure 42 – Shows (a) the original floorplan and (b) the calculation zone.

6.6.2 Defining the point

For some rooms, the room is well defined but the position of the calculation point is not. Several examples of this problem are hereby exemplified.

The point should be placed at half room depth, one meter from the darkest inner wall and 0.8 meter above the floor. For rectangular rooms there are no uncertainties where this point should be placed but for rooms with another shape it becomes a problem. First of all, how shall half room depth is defined? *Figure 43(a)* shows an example of a room where the direction of the room depth is unclear and *Figure 43(b)* illustrates an example of a room where the direction of the room depth is clear but the room depth varies. In this thesis, an average distance has been calculated when the room depth varies in the room.

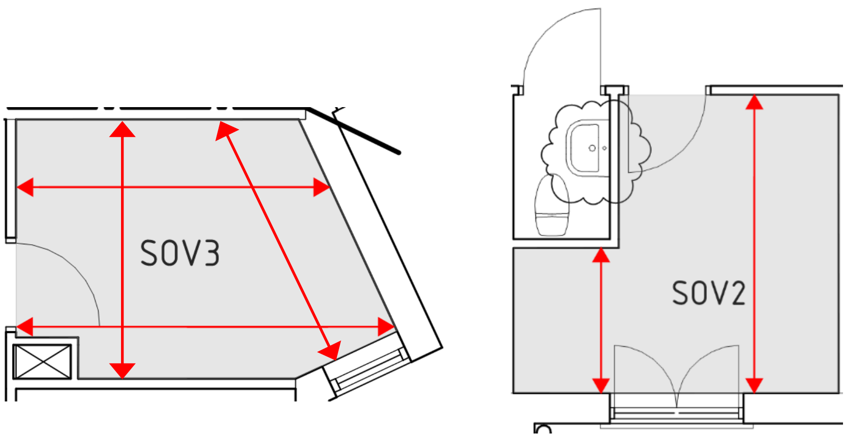

Figure 43 – Shows different definitions of the room depth in a room, (a) several room depths in different directions and (b) two different room depths in one direction.

All three rooms in *Figure 44* (marked in grey) have a combined kitchen and living room. The rooms have a complex shape and it is unclear where the calculation point should be placed in these rooms. In this thesis, several points were placed at positions that seemed to fit the requirement of where to place the point and after simulating the daylight factor, the point with the lowest daylight factor was chosen. *Figure 44* shows the studied points (red circles) and the points with the lowest daylight factor (red dots).

Figure 44 – Shows the floorplan of three rooms that has a combined kitchen and living room.

The kitchen in the next example, shown in *Figure 45(a)*, is very well defined since there are walls surrounding the whole room. The shape of the room is however very irregular which leads to difficulties when defining the calculation point, see *Figure 45(b)*.

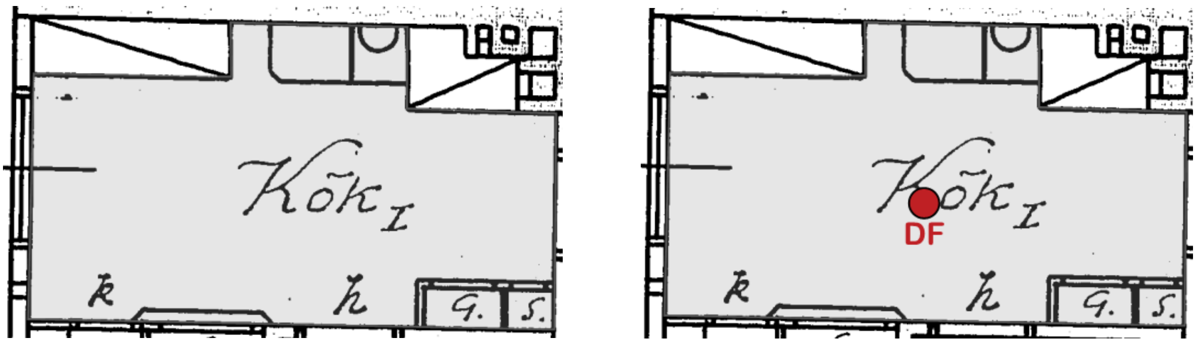

Figure 45 – Shows (a) a non-rectangular kitchen and (b) the position of the calculation point.

6.7 Different indicators for measuring daylight factor

In *Chapter 6.1*, the current daylight factor levels in different residential buildings and different room types were shown, calculated for a single point in the room. As described in *Chapter 5.1.3*, the daylight factor has also been calculated using four other indicators and in this chapter, the correlations between these indicators are evaluated.

Figure 46 shows a comparison between the simulated daylight factor in a point and the other four indicators. All rooms in this study, excluding the rooms where the position of the calculation point was considered to be unclear (1043 rooms out of 1205) have been used when making this comparison.

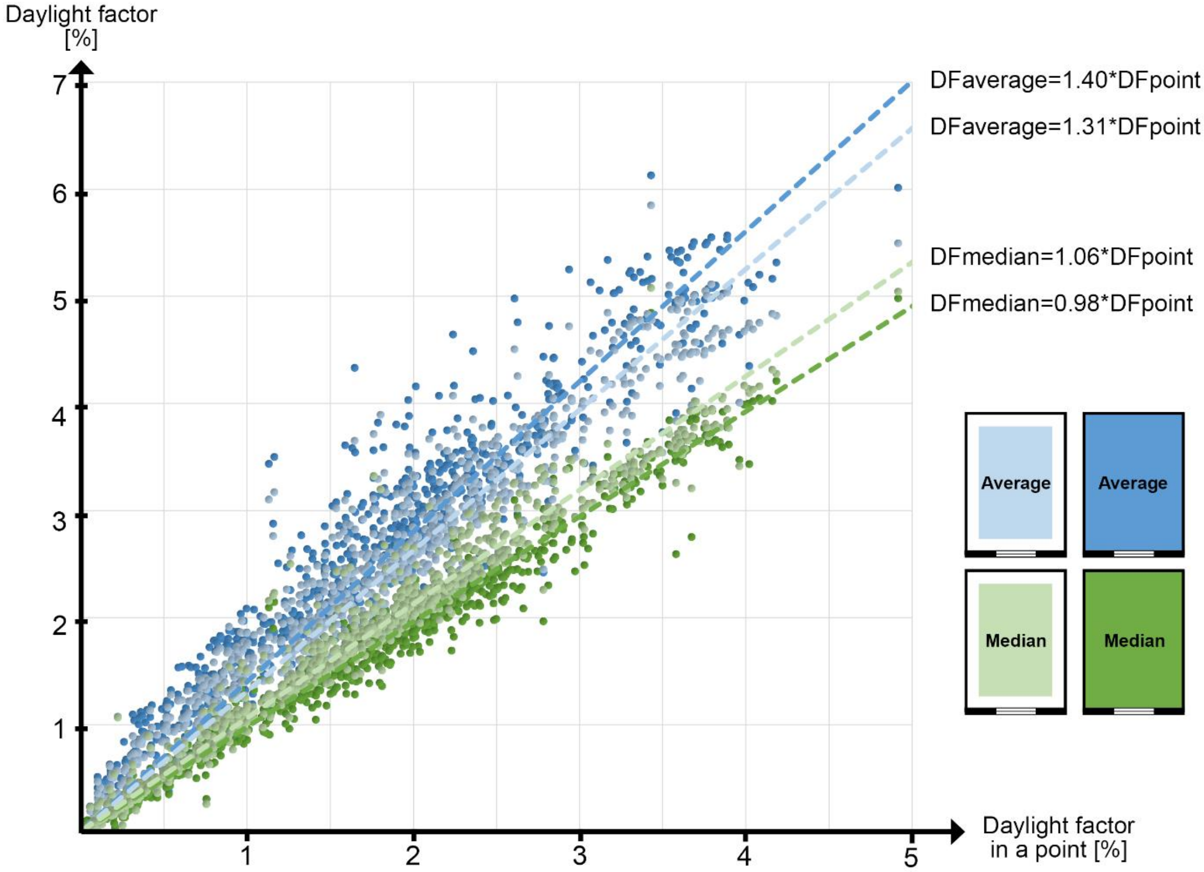

Figure 46 – Comparison between the simulated daylight factor in a point and the other studied indicators.

As shown in *Figure 46*, the daylight factor calculated as median- and point values nearly correlates 1:1 with each other while the average values in general becomes larger. When reducing the grid size by retracting the grid 0.5 meter from the walls the simulated result changes. The median values generally increases while the average values generally decreases. An explanation for this is illustrated in *Figure 47*. It shows a typical room of rectangular shape with windows in one wall. The area that is excluded when reducing the grid size is shown in *Figure 47(c)* and as can be seen, a greater part of the values below the median value than above the median value is removed and for that reason the median values increases.

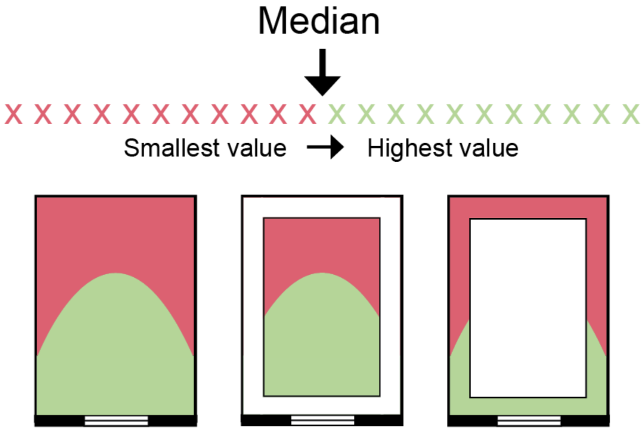

Figure 47 – Illustration of (a) a room with a grid covering the entire area, (b) a room with a grid covering an area retracted 0.5 meters from the inner walls and (c) the area in the room that is excluded when reducing the size of the grid. The green zone represents the area in the room were the daylight factor is above the median value while the red zone represent the area in the room were the daylight factor is below the median value.

Of course the same values are excluded when calculating the average value as for the median value when reducing the grid but still, the value decreases and to be able to understand why, one has to look at the magnitude of the daylight factor for all points in the room. This has been done for four different rooms, see *Figure 48*. The dots in the graphs shows the size of the daylight factor for each calculation point, arranged after size of daylight factor. As can be seen, some calculation points in the rooms have a daylight factor with significantly higher values than the rest of the points. Obviously these points are the ones placed right in front of the windows. Reducing the grid size and therefore excluding these points leads to a decreased average value even though a greater number of the lower values, as explained before, are being removed.

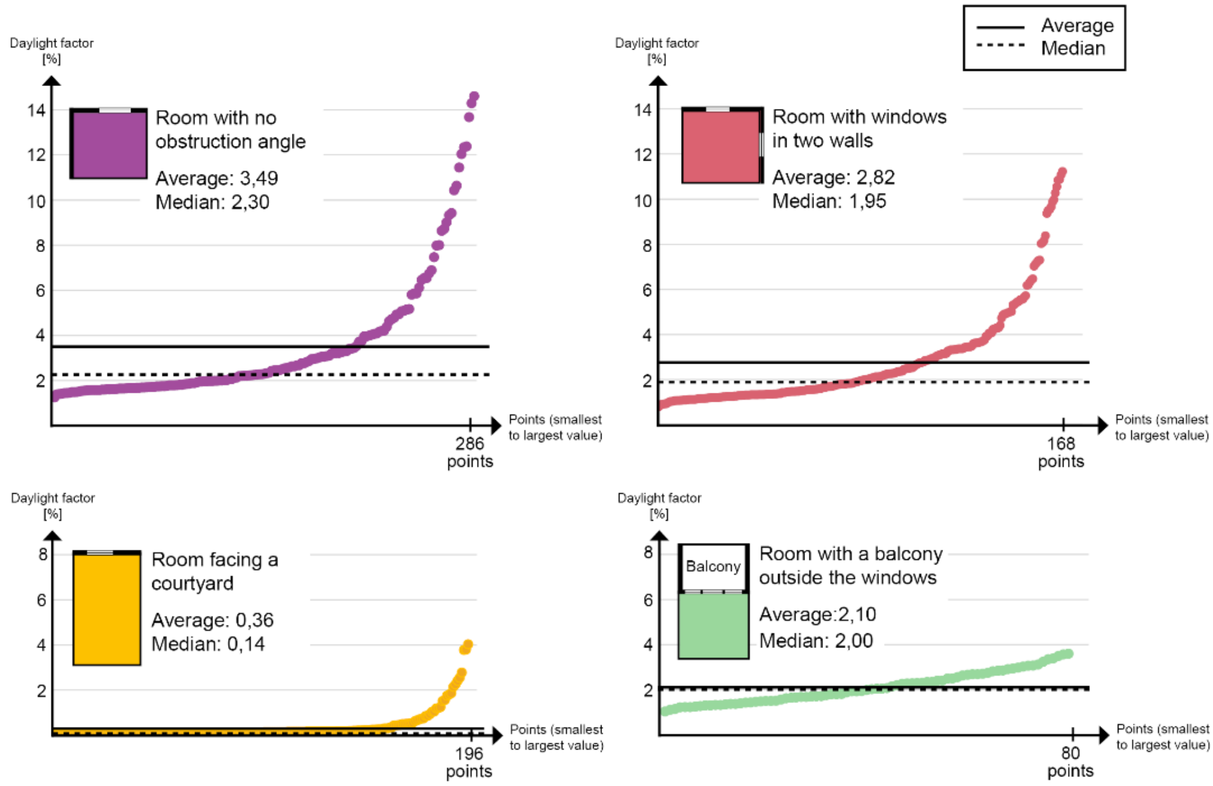

Figure 48 – Graphs expressing the daylight factor for all calculation points in four different rooms. Also, the resulting median- and average values can be seen. Purple – building 2 room 42, yellow – building 3 room 5, red – building 5 room 23 and green – building 8 room 4.

As can be seen in *Figure 48* the shape of the graphs, in other words how the daylight is distributed in the room, varies a lot from room to room.

Depending on which indicator; median- or average value that is used in the requirements for daylight factor, some rooms will be favored more than others, in other words it will be easier to meet the required daylight factor. An example of a room that probably will be favored when using a median value is the room marked in green in *Figure 48*. The average value is although 5% larger than the median value for this room but as illustrated in *Figure 46*, the average values are generally more than 5% larger than the median values and therefore the requirement when using an average value should be more than 5% larger.

6.8 "AF-metoden"

The applicability and accuracy of "AF-metoden" have been tested for all eight residential buildings.

6.8.1 Applicability

The applicability demonstrates the percentage of rooms that "AF-metoden" can be applied on, i.e. the percentage of all rooms that meets all of the criteria, described in *Chapter 3.3*. As can be seen in *Figure 49*, 61 % of all studied rooms met these criteria and those rooms have been used to evaluate the accuracy of the method, which is presented in C*hapter 6.7.2*.

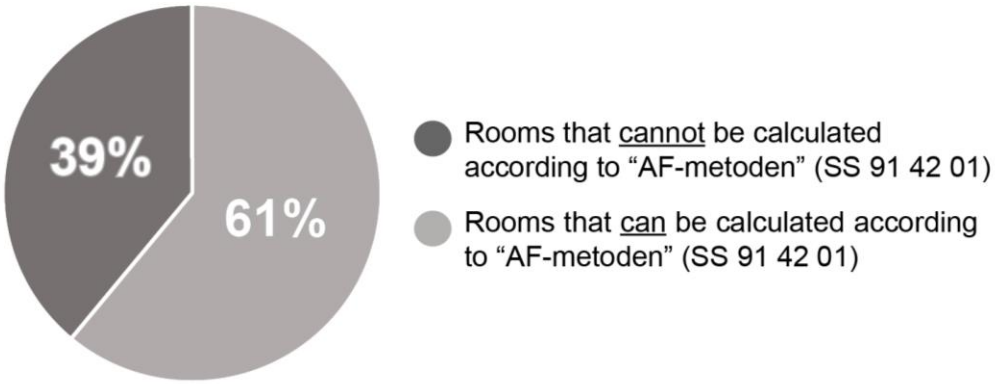

Figure 49 – Percentage of the studied rooms that "AF-metoden" are applicable for.

The "AF-method" will probably be less applicable for new buildings as cities are being densified which leads to larger obstruction angles. In addition, the new buildings often have an open floor plan with irregular rooms and windows placed at different heights and in different cardinal directions.

6.8.2 Accuracy

"AF-metoden" does not state that a daylight factor greater than 1% is guaranteed if the condition of the glass area is met, shown in *formula 6*. It says that it probably would give a daylight factor bigger than 1%. The accuracy of this method has been evaluated. For 78% of all rooms that met the criteria, the method gave the right indication while the method turned out to give the wrong indication for 22% of the rooms, as illustrated in *Figure 50*.

$$A_{glass} \geq f * A_{floor} \qquad (6)$$

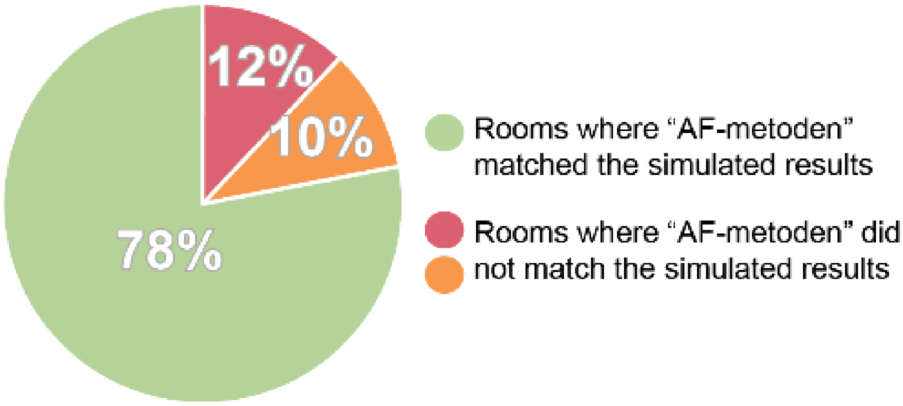

Figure 50 – Percentage of the studied rooms where "AF-metoden" matched or did not match the simulated results.

Figure 51 shows a matrix where the green part, 78%, represents the rooms where "AF-metoden" gave the right indication compared to the simulated results while the red and orange part, 22%, shows the rooms where "AF-metoden" gave the wrong indications. The red part, 12%, should according to the simplified method have a daylight factor above 1% but the simulated result showed that the daylight factor in fact was lower than 1%, i.e. the method overestimated the daylight factor. The part marked in orange, 10%, should according to "AF-metoden" have a daylight factor below 1% but the simulated result showed that the daylight factor actually were above 1%.

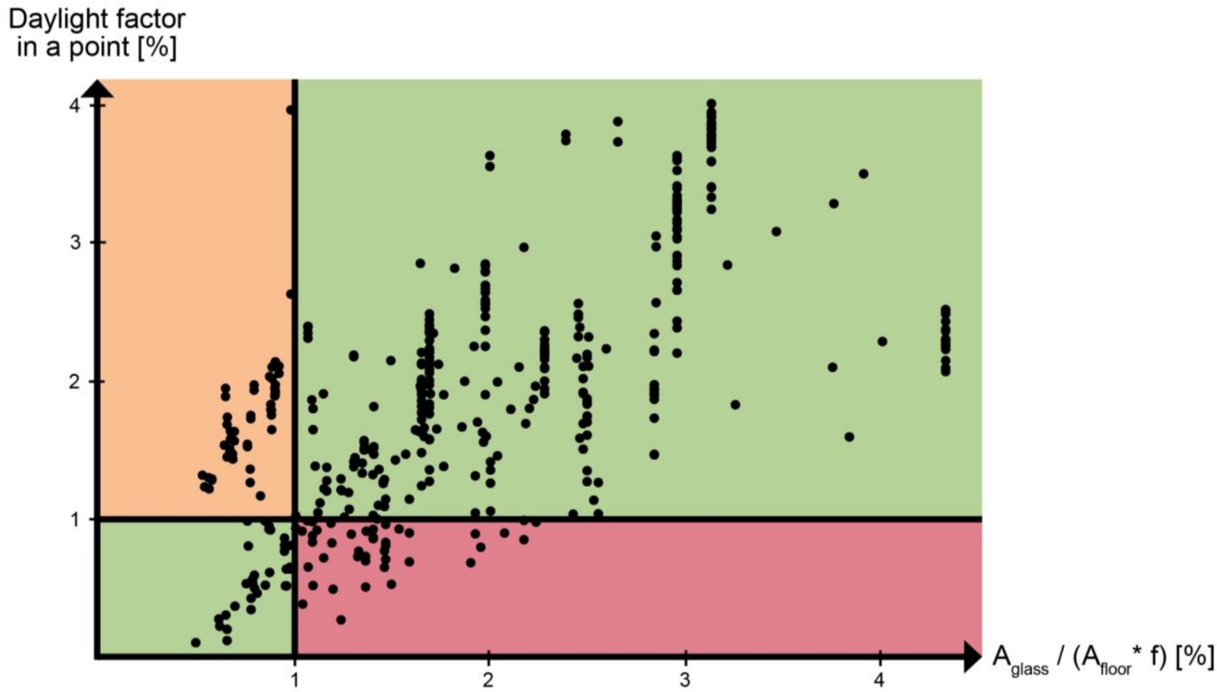

*Figure 51 – Graph showing the simulated daylight factor in a point and the fraction of A_{glass} and A_{floor}*f for all rooms that met the requirements for use of "AF-metoden".*

6.8.3 Limitations

Even though “AF-metoden” is denoted as a simplified method it has a lot of limitations. The obstruction angle can be difficult and time consuming to find and a sectional drawing with surroundings through the specific window is needed which does not always exist.

The method is very simplified, it only works in two dimensions and it does not take the variation laterally into account. *Figure 52* illustrates three different situations where the obstruction angle is the same in all three cases, but in reality the amount of daylight inside the room will vary a lot.

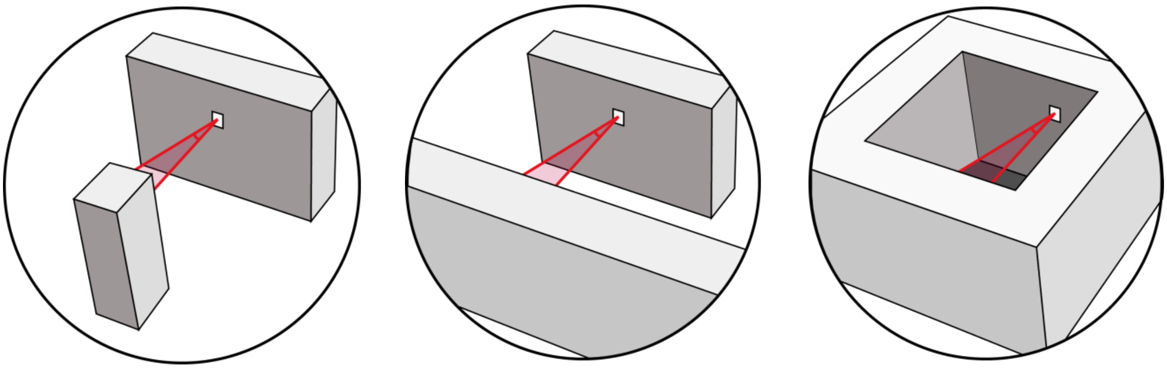

Figure 52 – Illustration of three different cases where the obstruction angle is the same for each case but the daylight factor varies inside the room.

6.9 Daylight protractor

In this thesis, the daylight factor in a point has been calculated manually for 28 rooms in three different buildings. Six different types of rooms have been investigated for several floors.

6.9.1 Comparison between the daylight factor calculated using a daylight protractor and simulations made in DIVA

In *Figure 53*, the results from the daylight protractor method is compared to results from the daylight simulations made in DIVA.

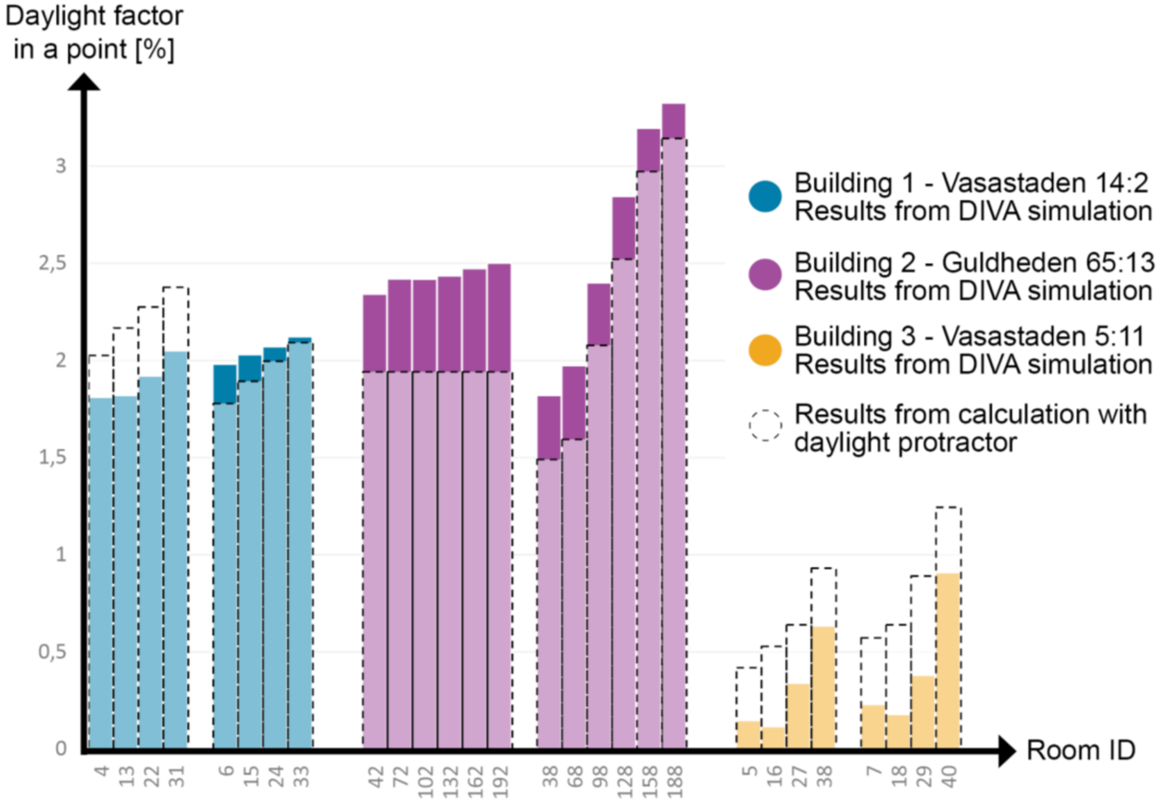

Figure 53 – A comparison between the results using a daylight protractor and the simulated results.

The only parameter from the surrounding buildings and landscape when using the method with the daylight protractor is the angle from the middle of the window to the building or landscape right in front of the window. This limitation was also discussed in the previous chapter with "AF-metoden" and illustrated in *Figure 52*. Because of this limitation, the method overestimates the daylight factor for some rooms and underestimates the daylight factor for others. This is what happens for rooms in building 2 (purple), where the obstruction angle is zero but there are other buildings next to it and it can also be seen for the rooms in building 3 (yellow), which has windows facing the courtyard.

6.9.2 SC, ERC and IRC

When calculating the daylight factor manually, the contributions from each of the three components; SC, ERC and IRC are calculated separately and then summed up. The contribution from each component to the daylight factor is unknown when making a computer simulation in DIVA. As can be seen in *Figure 54*, the contribution from the ERC is relatively small compared to the other two components, however this is not always the case. SC can be zero if the surroundings are very dense which means that ERC in that case can be very important. Understanding how the light from outside reaches a point indoors will give a good understanding of how to build three dimensional models in a simple way that reflects the reality as good as possible.

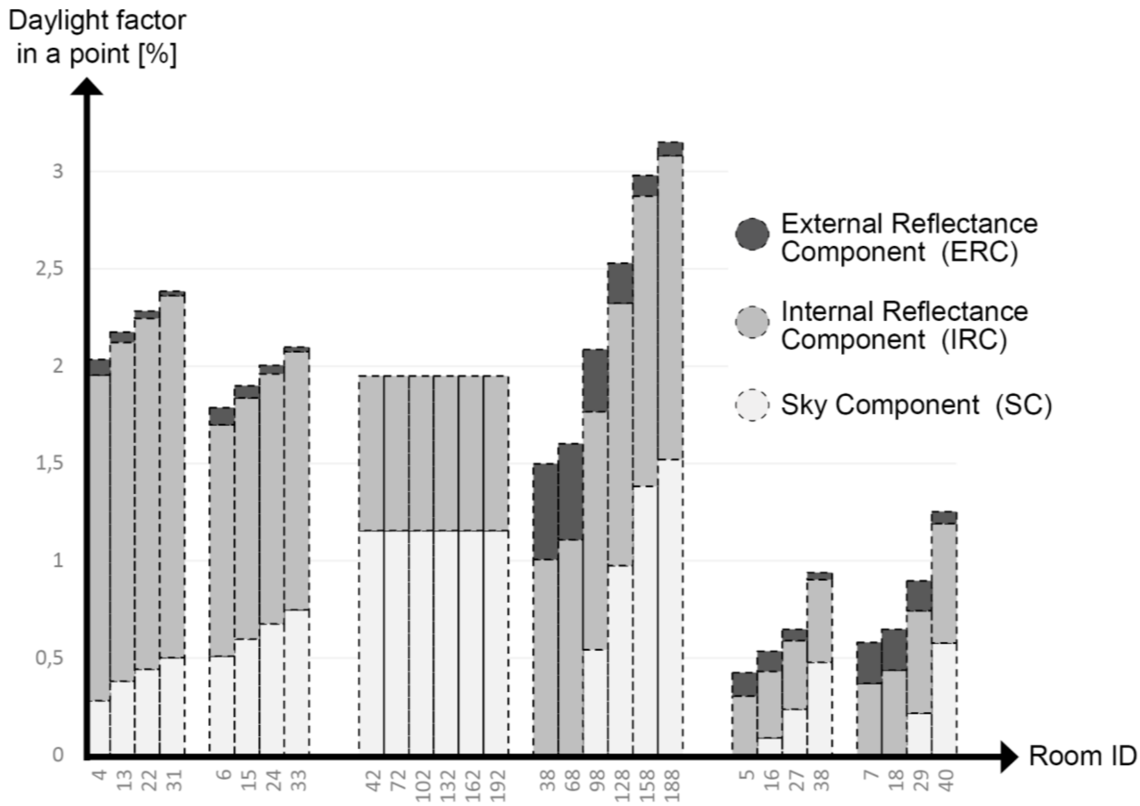

Figure 54 – Contribution from the three components ERC, IRC and SC.

6.9.3 Limitations

This manual method is very time consuming and a section through each window is required. Because of the number of factors influencing the amount of daylight reaching a point in a room and since the amount of light varies greatly across the room, many parameters needs to be included in order to calculate the daylight factor with reasonable accuracy. Since there are a lot of steps using this method, there is also a higher risk for errors.

6.10 Daylight factor outside window, SVF and SEF

So far, only the daylight inside the buildings has been analyzed. In this chapter, in contrast to previous chapters, the exterior of the buildings has been examined. This has been done in order to investigate whether it is possible to make predictions of which values for the daylight factor that can be expected inside the buildings by examining the exterior of the building.

6.10.1 Available daylight factor outside window

The daylight factor has been calculated as an average value of the windows 0.05 meters outside the windows for all studied buildings. The simulated results varied between 7% and 49% and three examples are presented in *Figure 55*. The first example, building number 2 has a daylight factor of 46% outside one of the windows on the top floor. The second example is building number 3 which is located in central Gothenburg. The street in front of the building is narrow and there are buildings with the same height across the street. The resulting daylight factor for one of the windows on the first floor is 22%. This building has a small courtyard on the other side of the building and the lowest simulated daylight factor for the windows facing the courtyard was 11%. The last example is a room on the fourth floor in building number 6 and the daylight factor outside the window is 33%. As previously mentioned, there are rooms that have a daylight factor as low as 7% outside the windows. These rooms all have balconies placed outside the windows.

Figure 55 – Examples of different daylight factors outside some windows in buildings 2, 3 and 6.

6.10.2 Correlation between the daylight factor outside the windows and the daylight factor in a room

There are no direct connection between the available daylight factor outside the façade and the daylight factor in a room and in order to find a correlation, it is necessary to include the window-to-floor area ratio.

The daylight factor outside the windows has been multiplied by the area of the windows and the daylight factor in a room has been multiplied with the floor area of the room. In this way, one could say that the first product expresses the inlet of daylight and the other product the total amount of daylight in the room. These two products are compared to each other in *Figure 56* where the daylight factor inside the room has been calculated in a point, as a median value and as an average value respectively. The rooms with a daylight factor outside the windows times the window area larger than 300 %m^2 are not included in these diagrams since there only were a few of them which could lead to the wrong indication regarding the linearity of the graphs. Despite the limited amount of parameters, the relationships between these factors are rather linear.

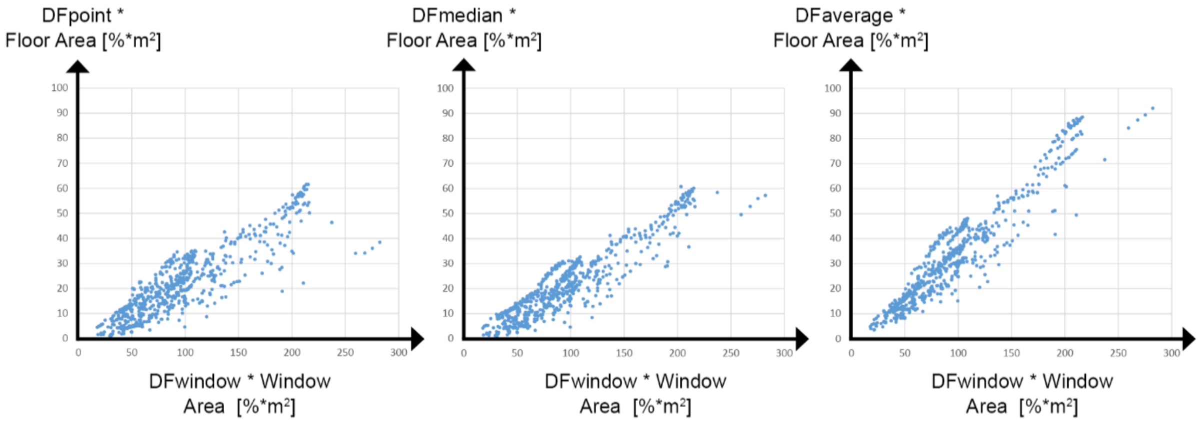

Figure 56 – Daylight factor measured outside the windows multiplied with the window area compared with the simulated daylight factor, for three indicators, multiplied with the floor area.

6.10.3 Suggested "DFW-method"

In this subchapter, a suggested method for controlling if the daylight will be sufficient in a room is presented. It is called the "DFW-method" (DaylightFactorWindow-Method) and it is a method that is further developed from "AF-metoden". One of the limitations when using "AF-metoden" is that the obstruction angle only works in two dimensions and it does not take the lateral variations into account and therefore this parameter has been replaced by the daylight factor outside the window. The daylight factor in a point has also been replaced by an average daylight factor for a computational grid covering the entire floor area. Since the daylight factor calculated as an average value compared to a daylight factor calculated in a single point in the room generally is higher, the value that is desired is changed from 1% to 1.4% since this was the found correlation between these two indicators, see *Figure 46*.

Formula 7 expresses how the suggested "DFW-method" works and if the condition in this formula is fulfilled, the average daylight factor should with a high probability exceed 1.4%.

$$DF_{window} \times \frac{A_{glass}}{A_{floor}} \geq 5.0 \qquad (7)$$

Figure 57 shows the simulated daylight factor for all rooms in the residential buildings that has at least one window and the corresponding window-to-floor area ratio multiplied with the daylight factor outside the window.

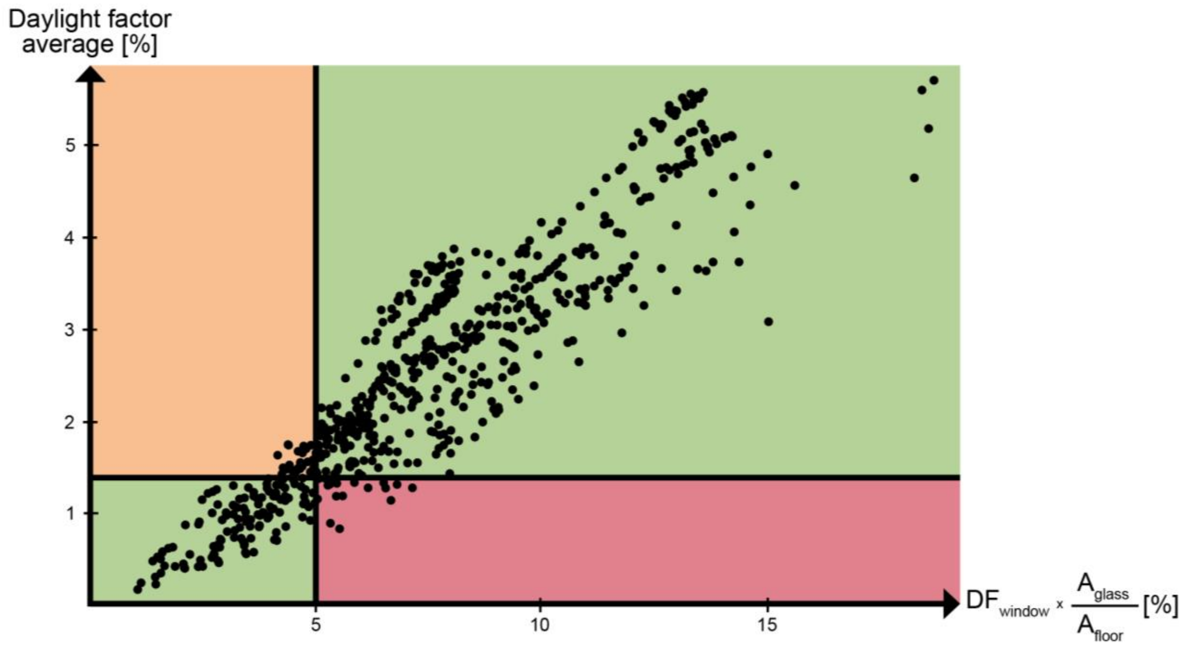

*Figure 57 - Graph showing the simulated daylight factor in a point and the fraction of A_{glass}*DF_{window} and A_{floor} for all rooms with windows.*

A desire was that this suggested method should be applicable for a larger percentage of rooms than "AF-metoden" and still get a better accuracy. A comparison between the applicability and accuracy for the two different methods is presented as follows.

Applicability

There are a lot of conditions that needs to be fulfilled in order to be able to use “AF-metoden” but the only condition that needs to be fulfilled for use of the “DFW-method” is that the room should have at least one window. 5% of the studied rooms in the residential buildings was placed behind other rooms and had therefore no windows. The applicability for both methods is shown in *Figure 58*.

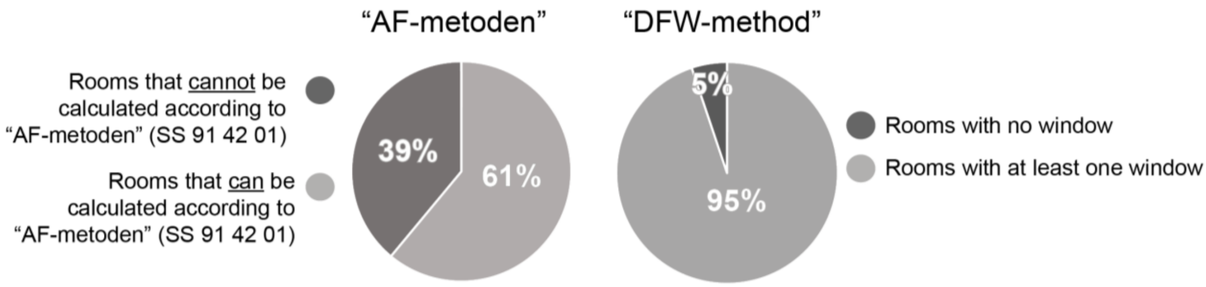

Figure 58 – Applicability for “AF-metoden” and the “DFW-method”.

Accuracy

The accuracy of both methods is shown in *Figure 59* and as can be seen, the accuracy of the “DFW-method” is 93% compared to “AF-metoden” where the accuracy is 78%.

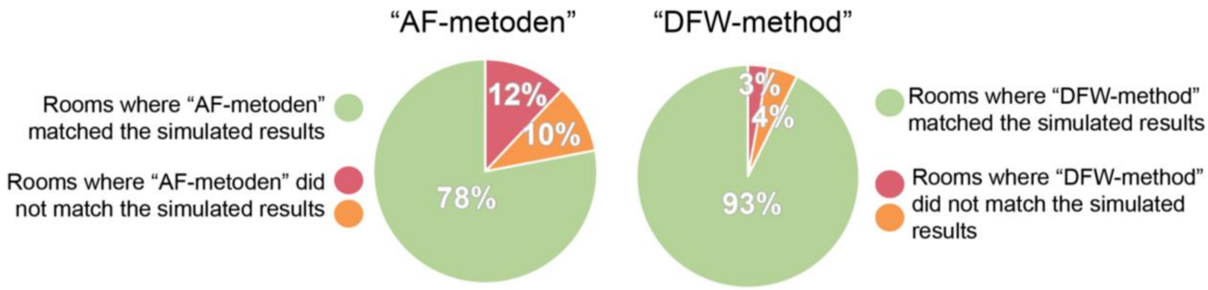

Figure 59 - Accuracy for “AF-metoden” and the “DFW-method”.

Further development

Some suggestions for further developments and adjustments of this method are listed as follows;

- The “DFW-method” that has been developed in this thesis has been adapted from the results to give a high accuracy but more buildings needs to be studied in order to evaluate if the accuracy of the method in general is as high as shown in this thesis.
- Depending on which indicator that is used for calculation of daylight factor and also which minimum level for the daylight factor that is required, the formula used in this method can be adjusted.
- The method can be further evaluated in order to see if other additional types of room should be excluded.
- In order to simplify this method further, a study to evaluate whether the daylight factor outside the window can be replaced by SVF or SEF can be executed.
- The daylight factor outside the windows for a room has not been area-weighted when merging the values for all windows into one value for the room. The results may be even better if the windows are area-weighted.

6.10.4 Comparison between the daylight factor outside window, SVF and SEF

When calculating the daylight factor in a room, there are three components contributing; the sky component, the externally reflected component and the internally reflected component, illustrated in *Figure 5*. These three components are reduced to two components when calculating the daylight factor outside the windows since there is no internal reflectance. As shown in *Chapter 6.8.2*, the contribution from the external reflectance component is often relatively small compared to the sky component. When there are a lot of surrounding buildings, this factor can however give a considerable contribution. When calculating SVF and SEF, this component is excluded.

Figure 60 shows a comparison between the daylight factor (DF_{window}), SVF and SEF all measured outside the windows for buildings number 1, 2 and 3. The values are organized after the size of the daylight factor and as can be seen these three indicators result in nearly the same values. In the lower range the difference in percentage between DF_{window} and the other two indicators is higher and the reason for that is that external reflections from the surroundings are taken into account when calculating DF_{window}. In the higher range, all three indicators almost coincide since there are nearly no external reflections.

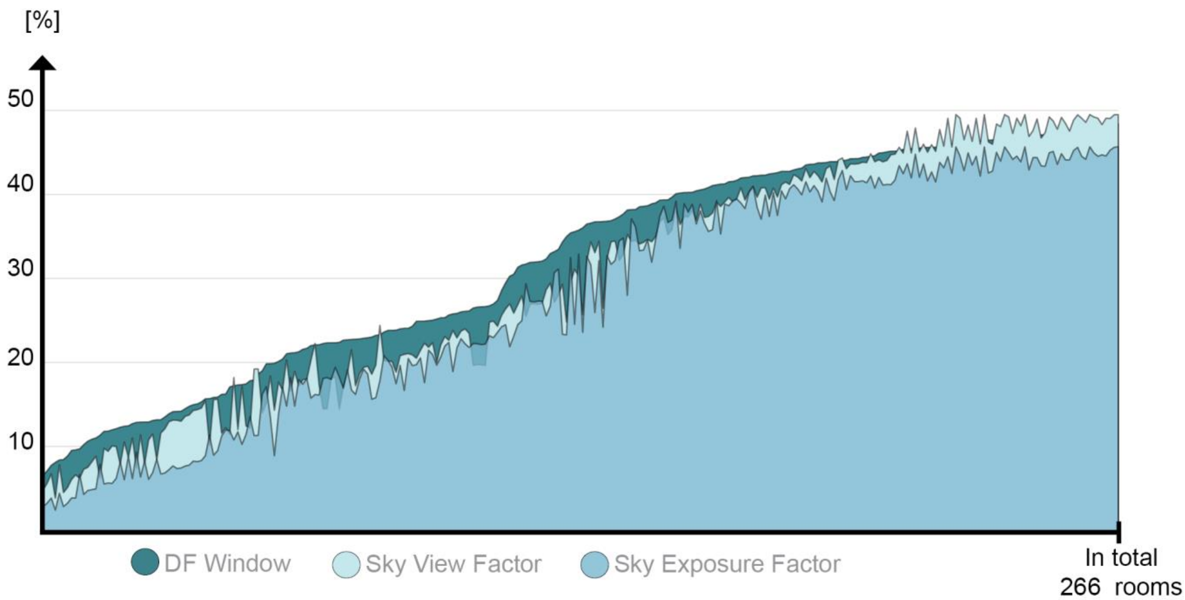

Figure 60 – Daylight factor, sky view factor and sky exposure factor measured outside the windows. The values are organized after the size of the daylight factor.

6.11 Survey

For building number 2, 6 and 7 surveys were distributed for which the total achieved response rate was 67%. The response rates for all three buildings are shown in *Table 7*. 45 out of 67 apartments answered the survey which corresponds to 124 rooms.

Table 7 – Number of distributed and collected surveys for all three buildings

Building ID	Number of distributed surveys	Number of collected surveys	Response rate
2	36	24	67 %
6	15	8	53 %
7	16	13	81 %
All	67	45	67 %

All questions (shortened) are listed below and the entire survey can be found in *Appendix 2*.

Q1. How do you perceive the access to daylight in the following rooms?
Q2. Would you request for more or less access to daylight in the following rooms?
Q3. Which room type do you think is the most important room to have the greatest access to daylight?
Q4. Do you normally use electrical lighting daytime in the following rooms?
Q5. Do you have access to direct sunlight in the following rooms?
Q6. Do you often use curtains, blinds or other sun shadings in the following rooms?
Q7. If use of sun shading, why it is used?
Q8. Do you consider the view out to be interesting in the following rooms? (Quantity)
Q9. Do you consider the view out to be enough in the following rooms? (Quality)

Question number 1, 2, 4, 5, 6, 8 and 9 all contained question about a specific room and when the survey had been collected, all answers from these questions were compared to the simulated daylight factor in that specific room. The grey dots in in *Figure 61* represent the simulated daylight factor in all rooms, organized after the size of daylight factor. Above all grey dots, the answers from question number 1 for that specific room is shown as a green dot. From these sets of points, a polynomial trend line was created and it can be seen as a dashed green line. The trend line indicates the general tendency of the answers.

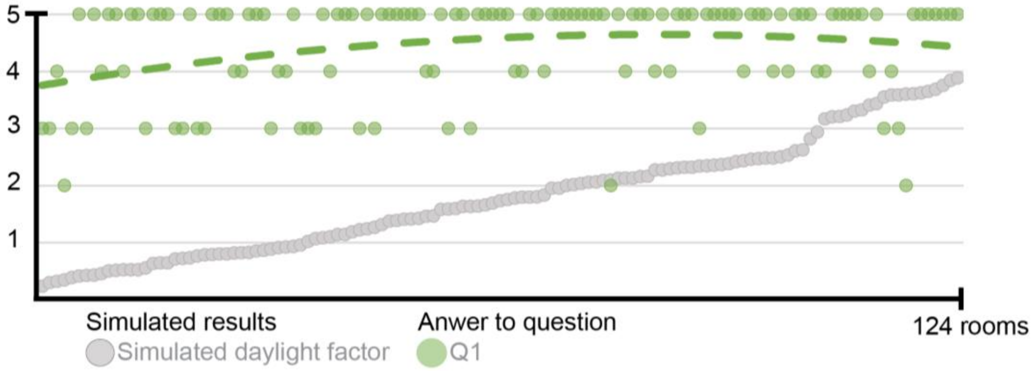

Figure 61 – Simulated daylight factor in a point and the answers to question number 1.

The same procedure as for question number 1 has also been done for question number 2, 4, 5, 6, 8 and 9 and the results can be seen in *Figure 62*.

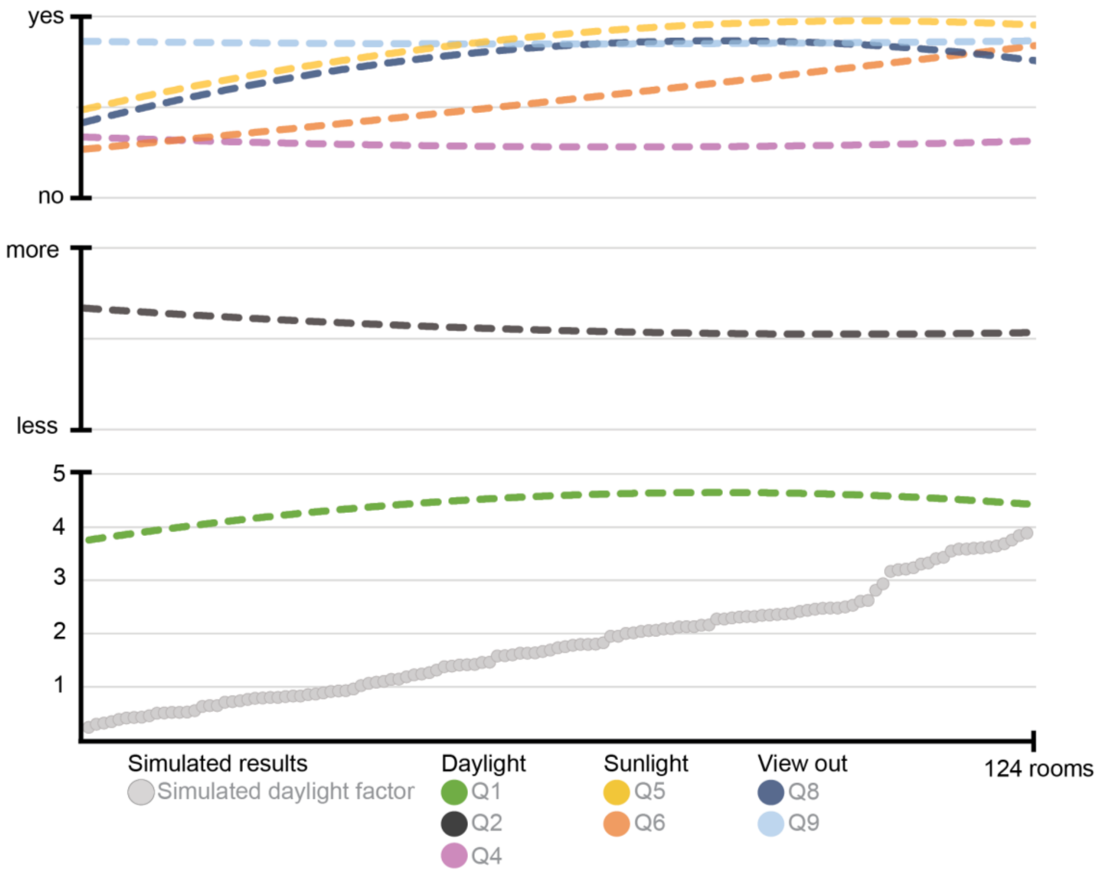

Figure 62 – Compilation of the answers gathered from the survey.

As can be seen in *Figure 62*, people seem to perceive the access of daylight as greater the higher the simulated access to daylight is. The access of direct sunlight also increases the higher the simulated daylight level is and therefore a reasonable conclusion is that some people think the access of daylight is greater than it is because the sun is shining in, making it brighter. It may also be because rooms with a lot of daylight also have more sunlight in general because they have less surrounding buildings and other shading objects.

In order to see if the residents were content with the current access of daylight in their apartment, the tenant were asked if they wished for more access to daylight in the different rooms. As can be seen in the *Figure 63* most people, 79% were pleased with the current levels.

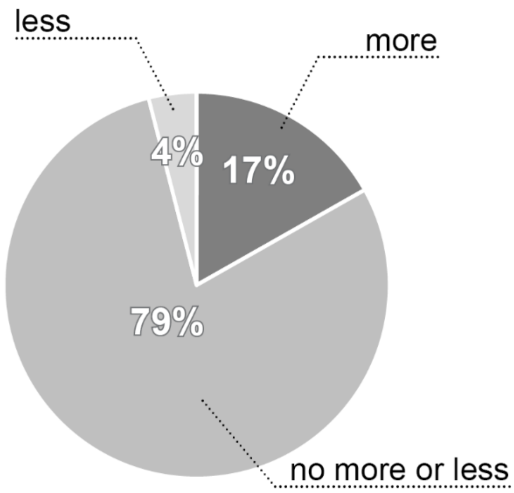

Figure 63 – Diagram showing how the residents felt about the current daylighting levels in their apartments.

Question number 3 concerned which room type that the residents prioritize to have access to more daylight. The four different room types were ranked (1-4) where 1 was the most important room. An average was calculated and the results can be seen in *Figure 64*. As can be seen most people thought that the kitchen is the most important room. Unfortunately the kitchens normally have the least access to daylight which was shown in *Chapter 6.1*. 40 out of 45 tenants (89 %) thought that the bedroom was the least important room to have much access to daylight in.

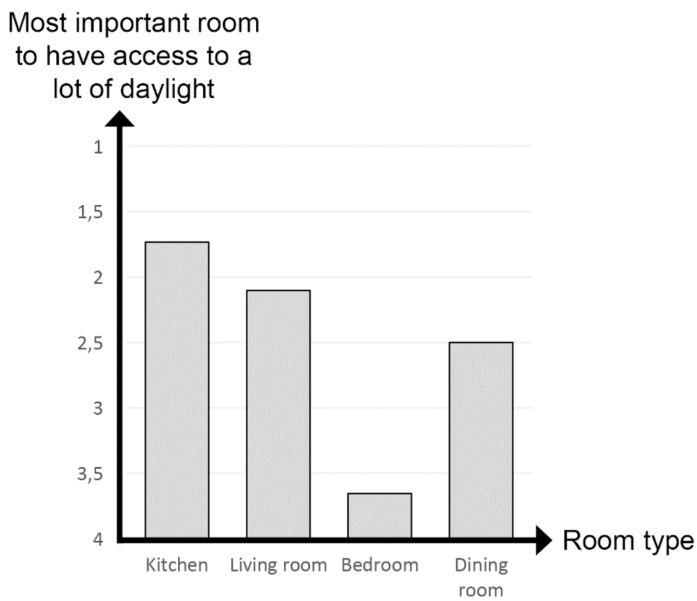

Figure 64 – Diagram showing which room the residents thought was the most important room to have much access to daylight in (where 1 is the most important room).

The result from the surveys alone are not enough in order to make reliable conclusions about how the residents perceive the daylight in their home, it can however indicate what people in general desire. Question number 7 is a supplementary question to question 6 and since question number 6 did not give any valuable information, the answers from question number 7 has not been analyzed.

7 CONCLUSIONS

There are many indicators and methods that has been evaluated and analyzed in this thesis and here follows a summary of our main conclusions.

This Master’s Thesis concludes that there are an extensive amount of rooms that do not fulfill the demands of a daylight factor above 1%. In the studied residential buildings, the room type that has the lowest daylight factor overall were the kitchens and in contrast to the simulated results, the survey indicated that most people desired to have the greatest amount of daylight in their kitchens compared to other rooms.

The indicator used for calculating the daylight factor according to the current Swedish standard has a lot of limitations and difficulties. For daylight simulations, it is very hard to know where the calculation points should be positioned in rooms that are not of rectangular shape. “AF-metoden” has been proven inapplicable for an extensive amount of rooms and in addition, the method is too simplified in order to give sufficient accurate indications.

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All drawing material such as floor plans, façades and sections have been provided by *Stadsbyggnadskontoret* (City planning). Three dimensional models in AutoCAD of the surroundings containing the roofs of the surrounding buildings and the ground have been provided by Chalmers architectural database called “A-databasen”.

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9 APPENDICES

Appendix 1 – Daylight Simulations – Description of method

Daylight Simulations
Description of method

This document describes the different steps to model, simulate and evaluate daylight in existing and newly built buildings. The aim with this method, described in this document, is to show the accessibility of direct daylight and not the exact level in current buildings. For this reason, it is assumed idealized optical properties and internal geometric objects such as furniture is neglected. This document is primarily designed to be used by the CAD tool Rhinoceros, daylight calculation program Radiance and some form of graphical interface between these programs, such as Grasshopper / Ladybug or DIVA.

This document is divided in 7 different parts:

Part 1, Modelling
Part 2, Optical properties
Part 3, Computational grid and calculation points
Part 4, Calculation of daylight factor
Part 5, Input, results and basis
Part 6, Surveys
Part 7, License information

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PART 1, MODELLING

The most time consuming and most important part when doing a daylight calculation is to create a three-dimensional model of the current rooms and their surroundings. It is therefore important that it is carried out in a well-structured and correct way.
A daylight model is a three-dimensional CAD-file which contains all of the geometry needed to calculate the daylight in one or more rooms or calculation points. For this to be possible the CAD-file needs to be modeled in such a way that it can be assigned optical properties as reflectance and transparency, to be interpreted by daylight calculation programs such as Radiance and connected to computational grids. Some CAD software is also capable of reading results from daylight calculations.

Geometric demarcation

The geometric boundary may not affect the outcome. This for example means that an overriding object cannot be neglected just because it is far away if it affects the daylight. Another example is the interior glass surfaces. These are often designed to send the light further into a building. When studying a room against a bright courtyard, it is important to take all glass surfaces from the atrium into account as they have very low reflectance.

The use of existing geometry

Reusing existing models saves time but means a great risk since they may contain information that cannot be interpreted by the calculation program correctly. They are also very rarely intended for daylight calculations and often contains too much information and details. If imported existing objects is used in the model they have to the greatest possible extent be simplified and quality assured. However, we recommend that the imported items are used only as three-dimensional surfaces to create shading areas.

CAD-files

The geometric basis for daylight calculations shall be modeled as follows:
- All geometries will be drawn in the Rhinoceros 5 or be easily imported to Rhino 5.
- The drawing unit must be in meters.
- All surfaces must be meshes or surfaces. Solids should not be used.
- Normal direction should preferably be perpendicular towards the rooms for opaque surfaces and outwardly for window openings.
- The models should not contain more than the most necessary information.
- There should be no more than one surface in the same plane. The exception are the surfaces used to generate the computational grids.
- Simulation softwares have difficulties handling curved surfaces which means that all curved surfaces should be made into triangular ones before being simulated.
- The models should not contain undefined layers that are not used in the calculation program.
- A surface to generate computational grids should be placed on the floor. This should be a surface with the normal direction pointing upwards. The surface should have a distribution which is the same as the calculation grid.
- Files cannot contain any blank spaces.

- Surfaces should be placed in layers which indicate their type and optical properties. The following layers shall be used.

Table 1, Layer name and layer color that should be used to different objects

Object	Name of the layer	Color
Outside ground	OutsideGround_0.2	
Surrounding buildings and objects	Buildings_0.2	
External facades	OutsideFacade_0.3	
Floor	Floor_0.3	
Walls	Wall_0.7	
Ceiling	Ceiling_0.8	
Balcony	Balcony_0.3	
Balcony bottom	BalconyBottom_0.7	
Balcony railing	BalconyRailing_xx	
Window frame and glazing bars	WindowJamb_0.8	
Side of window	WindowSill_0.5	
Glass	Glazing_xx	
Open water	Water_0.5	
Roof	Roof_0.3	
Distribution of computational grid	GridGeneration	

Where xx is replaced with reflectance or transmittance respectively. If further layers are needed they should be documented.

Ground
The ground floor will be modeled at least 30 meters from the external facades to include luminous reflectance of the ground. The ground plane should be placed slightly above the z=0 since many modeling program automatically adds a ground plane at z=0. The ground floor should not be unnecessarily large, since this can affect the calculation accuracy negatively.

Water
Reflections in the water can have a major impact on the daylight and should therefore be modeled when necessary. The water should be modeled as a flat surface with an area that is large enough for the account of reflected light, at least 50 meters from the facade of the investigated rooms.

Trees and vegetation
Trees and vegetation in the immediate area of the buildings should not be modeled, although they may have a big shadowing impact.

Surrounding buildings and other shading items
All objects that can reduce the daylight should be taken into consideration. This includes for example adjacent buildings which can have an extremely large impact on daylight in rooms nearby. Surrounding buildings can be modeled quite rough, the most important thing is that the obstruction of the sky is correct. Other geometry is handled by having low reflectance. Adjacent buildings can be described as homogeneous and you do not have to distinguish e.g. windows in different layers.

Windows

Windows consists not only of glass opening but also of the frame, window sash and possible some kind of glazing bars. These are dense and can have a major impact on the daylight calculation. Although, the hole of the window is considered as part of the window. In the first instance, the window is modeled as geometrically accurate as possible and shall consist of the following elements:

- Glass opening
- Frame and sash
- Side of window

In the calculation programs, it is important to describe the glass as a single surface without any thickness, although the glass in reality consists of several layers. The representative glass surface should be placed in the same position as the outermost glass, see *Figure 1*.

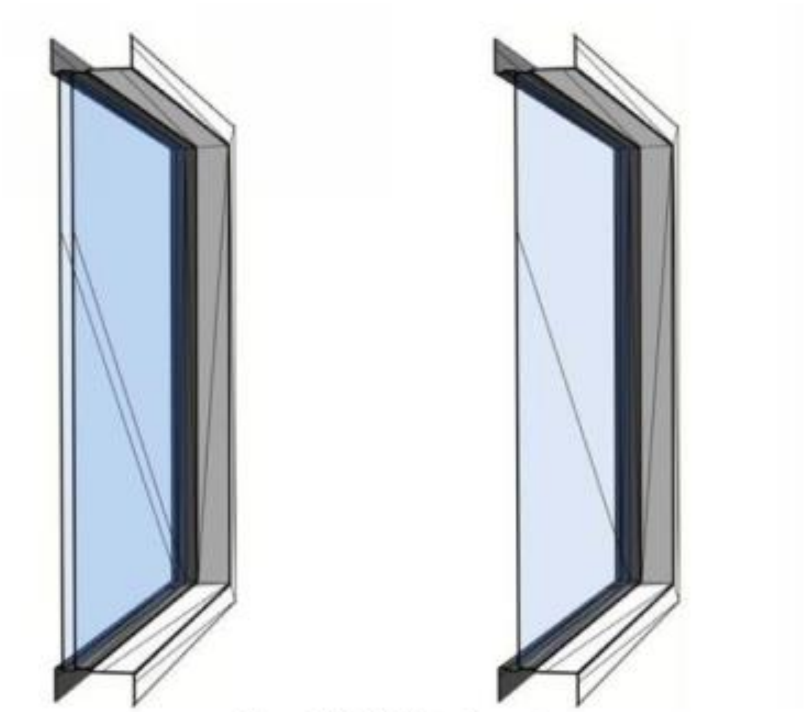


Figure 1, Model of the glass opening

Frame and sash may be described as one unit and simplified into a rectangular box, see *Figure 2*. If the size of the frame is unknown, it shall be presumed to 20% of the window's external frame dimensions.

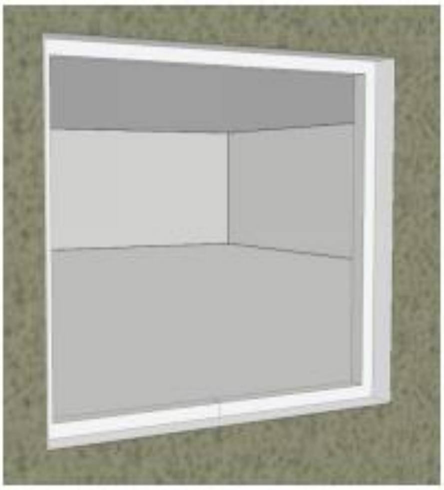


Figure 2, Model of the frame and sash

Figure 3 shows the side of the window (light green and red) and the window sash (turquoise). The inclination of these surfaces will be accurate because they have a great impact on the daylight. This especially concerns skylights.

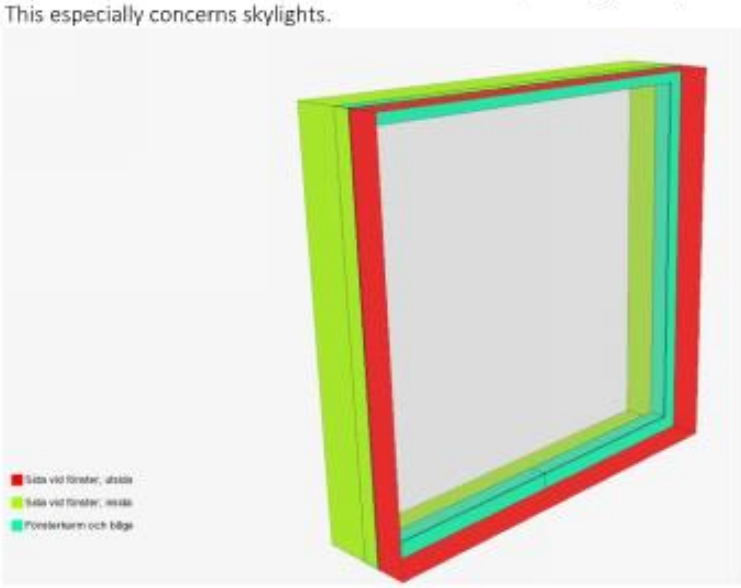


Figure 3, Model of the side of the window

Glazing bars should be modeled as a geometric object if it is thicker than 5 cm, see *Figure 4*. Narrow glazing bars can be modeled as a proportional reduction of the glass opening's light transmittance. If this is performed, this must be stated in xx.

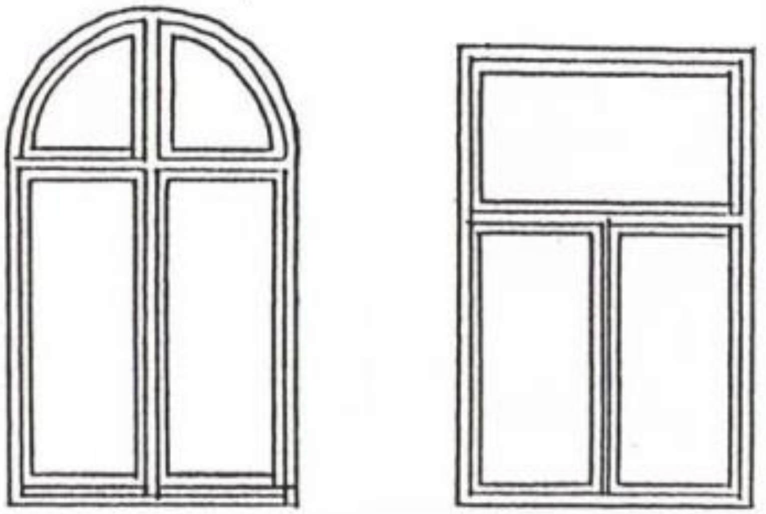


Figure 4, Example of glazing bars that are so large that they should be modeled geometrically

Window-bench

Window-benches can have a mayor influence of the daylight but should not be modeled.

Doors

All doors will be modeled as a closed, opaque and with the same optical properties as the wall they are placed in. Doors may have different optical properties on the front- and back side and should therefore be modeled as two flat surfaces.

Openings

Openings between rooms should be modeled with the real thickness and with the same optical properties as the wall they are placed in. Openings should not be neglected as they swallow light.

Interior glass surfaces

If you choose to model a single room with interior glass surfaces, these glass surfaces should be described as a surface with a reflectance set to 1 - the glass' luminous transmittance in order not to overestimate the reflectance.

Ceiling

Ceilings should be modeled but may be simplified to homogenous flat surfaces. No account of technical installations in the ceiling should be made.

Floor

Floors should be modeled as a homogeneous material. No consideration needs to be taken to the doorsteps or minor geometric objects.

Furnishing

Furniture, kitchen equipment, benches, hoods, movable screens and portable closets should not be modeled and the surface where they are expected to stand are to be modeled as a normal interior wall, floor or ceiling. Fixed wardrobes should be modeled, and the floor space they occupy should not be included in the analyzed floor area.

Balconies

Balconies have a great impact on the daylight, and will be modeled as precise as possible. Clear-view balcony railings can either be modeled with a smooth transparent surface with a transparency corresponding to the actual light transmittance or as geometric objects. They should have the proper height. If the transparency is unknown, it is assumed to be 20%.

Sunscreen

Moving sunscreens should not be modeled if they can be removed and in that way do not affect the daylight negatively. Fixed sun protections should be modeled.

PART 2, OPTICAL PROPERTIES

All non-transparent surfaces should be modeled as plastics, glazed building elements such as windows should be modeled as glass materials. Partially transparent surfaces such as vegetation can be modeled as trans-materials or glass materials. According to the calculation conditions 1, the following reflectance should be used:

Table 2, Values for reflectance for different building elements

	IES LM-83-12	SBI	DIVA	BRE	Values
Outside ground	0.1	0.1	0.1-0.2		0.2
External facades					0.3
Surrounding buildings and objects	0.2 (vegetation)	0.3	0.3		0.2
Floor	0.2	0.1	0.2-0.35		0.3
Walls	0.5	0.4	0.5		0.7
Ceiling	0.7	0.7	0.7-0.8		0.8
Window frame	-	0.8	-		0.8
Side of window	0.5	0.7	-		0.5
Balcony	-	-	-		0.3
Balcony bottom	-	-	-	-	0.7
Balcony railing	-	-	-	-	x
Water	-	-	-	-	0.5
Furniture	0.5	-	0.5		-
Roof	-	-	-	-	0.3

In all the examples above the specularity and roughness is set to 0, which also will be made in the calculation conditions 1.
According to the first calculation conditions, the light transmittance of the glazed parts in windows should be set to 0.7 if the light transmittance is unknown.
The transmissivity which is used to describe the light transmittance of the glass material in Radiance may be approximated to 1.09 x luminous transmittance. The light transmittance of the glass shall be determined in accordance with EN 410 and are usually named LT or τ_v. Note that this is not the same as energy transmittance T_{uv} or ST / DET/ T-value.
If other calculation conditions than these are used, they should be presented in another description. This should include e.g. differing reflectance, transmittance or calculation settings.

Snow, rain and dirt

No account of snow, rain and dirt should be made. All the surfaces will be assumed to have optical properties similar to a dry surface. Consideration should be given to the contamination of the external surfaces. This is assumed to have been made in the use of standardized optical properties. Windows and interior surfaces are assumed to be perfectly clean since this description is intended to show the availability of daylight.

PART 3, COMPUTATIONAL GRIDS AND CALCULATION POINTS

Computational grids should be placed 0.8 meter above the finished floor. Two types of grid are used where the first one covers the whole floor area in the room and the other one is withdrawn 0.5 meter from all walls. The measuring points shall be placed in a grid, evenly spread, in both directions with a distance of 0.3 meters between them. When making grids for the windows, the calculation points are placed 5 centimeters outside the glazing with the same distance between the points as for the rest of the calculation grids.

Representative points will be added in the middle of the rooms, 1 meter from the darkest inner wall 0.8 m above the floor.

Computational grids and representative points will be added in all the rooms where there is a demand of daylight. This includes bedrooms, living rooms and kitchens in dwellings. Alcoves, closets, corridors and toilets / bathrooms are not covered by daylight requirements. If there are rooms or parts of rooms where it is uncertain whether they are subject to daylight requirements it should be documented in a separate document, see the chapter of documentation requirements. The same applies if it is not possible to determine where the representative point will be added. A CAD-model can contain one or more computational grids.

PART 4, CALCULATION OF DAYLIGHT FACTOR

The daylight factor shall be calculated using a calculation program verified by CIE 171: 2006 Test Cases. Examples of such programs are Velux Daylight Visualizer and Radiance. Split flux method should not be used.

The daylight factor is defined as the ratio of the illuminance at a point inside and one unshaded point outdoor with a standard sky known as the CIE overcast sky, see *Figure 5*. If Radiance is used for the simulations, the sky type 16 should be used. For the other programs sky type 1 should be used. The difference between these skies can be big for horizontal surfaces.

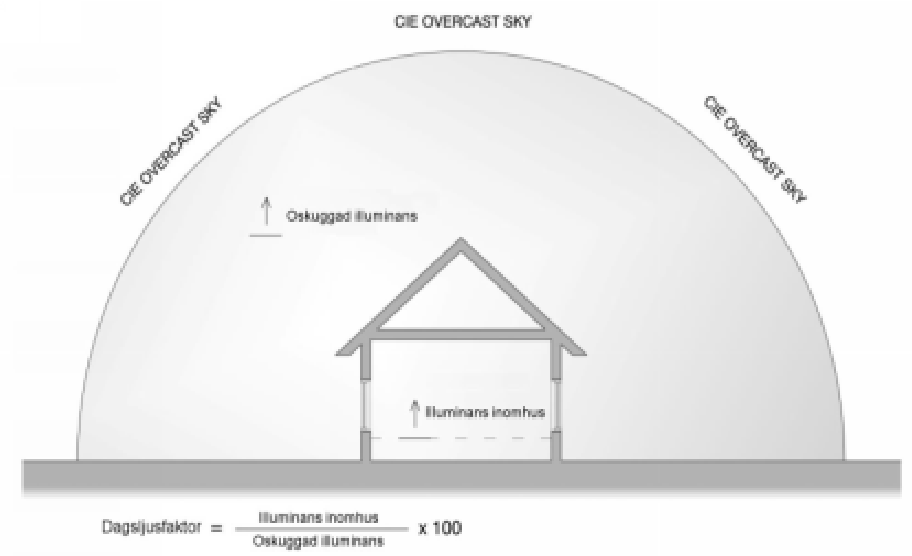


Figure 5, Definition of daylight factor

The average daylight factor in a room, DF_{av}, is calculated as the average daylight factor in a particular computational grid with n number of points according DFM = (DF1 + DF2 + ... + DFN) / n.

The median value of the daylight factor in a room, DF_{med}, is the value that separates the higher half of daylight factors in a particular computational grid with n number of points from the lower half.

Many programs have automated programs to determine the DF_{av} while the median must be generated manually or by a specially written tool.

The settings that should be used in the Radiance are mainly the following:

-ab 7 -ad 2048 -as 512 -ar 256 -aa 0.1

PART 5, INPUT, RESULTS AND BASES

Representative conditions and results in the form of various indicators are stored in a common database. Currently this is two Excel files named BuildingLevel.xls and RoomLevel.xls placed on sharepoint.bdabgbg.se. An invitation is required in order to get access to the file. The first file contains an overview of the studied buildings and the second one presents the evaluated rooms and all the results, see the following explanations for more information. If the input does not exist or is hard to define, "NaN" (not a number), should be used. The following inputs should be declared:

BUILDING LEVEL

buildingID (xx): A serial number which identifies the building.
buildingType (student housing, small houses, multifamily building, office, hotel, care building, school): Type of building, mainly based on the ownership.
cadastralReference (xxxx:xx): Used to easily identify the property.
address
postalCode
country
yearBuilt (xxxx): The year the building was ready to use.
yearOfRenovation (xxxx): The year when a renovation was made.
renovationMeasures: Which renovation measures that were made.
nFloors (xx): The attic will be counted as a floor if it is going to be furnished as a part of an apartment or working premises and if the building height is more than 0.7 meters higher than the top side of the attic floor. A basement counts as a floor if the top side of the floor immediately above the basement is more than 1.5 m above ground level (medium level) next to the building.
nEvaluatesFloors: The number of evaluated floors.
nEvaluatedRooms: The number of evaluated rooms.
roomsDFp>1%: The percentage of rooms that have an daylight factor (in the specific point) higher than 1%.

ROOM LEVEL

ID
buildingID (xx): A serial number which identifies the building
dwellingID (xx): A serial number which identifies which dwelling the room belongs to. If it is not a dwelling, "NaN" should be used.
floor (xx): For a floor level of a building, that is not a sloping house, the floor 0 is the floor that has the entrance in ground level and is accessed without stairs. The floors below are numbered -1, -2, etc. The floors above are numbered 1, 2, 3, 4, etc. For sloping houses, floor 0 is the top entrance level.
roomID (xx): A serial number which identifies the room in the current building.
simulationType: Calculation conditions. A sequence number indicating the assumed conditions. These conditions include optical properties such as reflectance and transmittance, settings for calculation program, ambient bounces and size of computational grids. If the

conditions that are described in this document is used choose "1". If other settings are used, describe the changed parameters in a document entitled SimulationType_xx.txt where xx is a sequential number.

Dwelling

dwellingSize (xx): The number of rooms in the current dwelling. A room is defined as a space in the building that is accessible and confined on all sides of the floor, walls and ceiling with a floor area of at least 7 m^2.
roomType (bedroom, kitchen, living room, cell office, shared office, classroom, patient room): Room type in the current building.

Room dimensions

floorArea_m2 (square meter with one decimal): The size of the current room.
externalWallArea_m2 (meter with one decimal): The area of the external wall(s).
rectangularRoom (0, 1): If the room is rectangular, choose "1", otherwise "0".
roomDepth_m (meter with one decimal): Average distance between the dominant exterior wall and opposite interior wall.
roomWidth_m (meter with one decimal): Average distance between the two walls perpendicular to the dominant exterior wall.
roomHeight_m (meter with one decimal): Distance between finished floor and the underside of the ceiling or floor structure if the ceiling is missing.

Balconies

balconyDepth_m (0, meter with one decimal): The depth of any balcony or access balcony located outside one or several windows.
balconyArea_m2 (square meter with one decimal): Area of the balcony located outside one or several windows.
balconyGlazing (0, 1): If the balcony is glazed choose "1", otherwise "0".
balconyRailingTransparency: If the balcony is dense choose "1" otherwise, if it has a transparency, put the estimated value as a fraction, e.g. transparency of 70%, choose "0.7".

Windows

windowNWalls (xx): The number of the encircling outer walls that has at least one windows or a glazed door. Even roof with skylights must be included.
nWindows (xx): Total numbers of windows in the room. Even glazed doors should be included.
windowArea_m2 (square meter with one decimal): The total window opening area where the frame is included.
windowArea914201_m2 (square meter with one decimal): The total window opening area where the frame is included. The area below 0.8 meters above floor should be excluded.
windowFrameFactor (0.xx): The total dense area such as frame, sash and glazing bars divided by the total window opening in the current room.
windowTopHeight_m (meter with one decimal): Distance top edge of window to floor. If different windows have various distances, an average value should be reported.
nWindowSouth: The number of windows and glazed doors facing south.

nWindowWest: The number of windows and glazed doors facing west.
nWindowNorth: The number of windows and glazed doors facing north.
nWindowEast: The number of windows and glazed doors facing east.

Measured indicators

ObstructionAngle_deg: The angle between an imaginary horizontal line placed in the middle of the window and the top of the object placed perpendicular to the current window see *Figure 6*. Note that the obstruction angle does not account for varying angles in plan. If different windows have different obstruction angles, an average value should be reported.

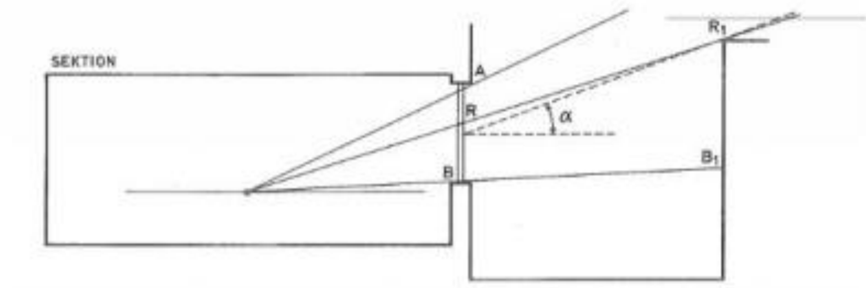


Figure 6, Obstruction angle, α

SVA_deg (Sky View Angle): The angle of the vertical part of the sky that can be seen from a point in the middle of the window, *Figure 7*. If different windows have different angles, an average value should be reported.

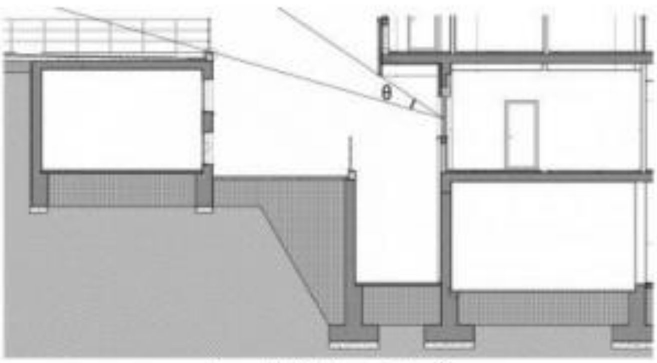


Figure 7, Sky View Angle, ϑ

SVF_x (Sky View Factor): The ratio of the overlying hemispherical sky that is directly visible from a given surface.

DFpManual: Daylight factor in a point located in the middle of the room, one meter from the darkest inner wall calculated manually according to the old method, using a "dagsljusgradskiva".
DFwindow: Average vertical daylight factor on the outside of the window. If the room has several windows, an average should be used (not weighted area).

Daylight factor
DFav0 (% with one decimal): Average daylight factor in the room for a computational grid covering the entire room.
DFmed0 (% with one decimal): Median daylight factor in the room for a computational grid covering the entire room.
DFav0.5 (% with one decimal): Average daylight factor in the room for a computational grid 0.5 meters from the interior walls
DFmed0.5 (% with one decimal): Median daylight factor in the room for a computational grid 0.5 meters from the interior walls.
DFp (% with one decimal): Daylight factor in a point located a half the room depth, one meter from the darkest inner wall.
DFworkplace (% with one decimal): Daylight factor at the darkest fixed workplace.
DF>1% (%): Share of the room with a daylight factor greater than 1%.
DF>2% (%): Share of the room with a daylight factor greater than 2%.

Defined conditions
wellDefinedConditions (0, 1): If the reported circumstances are relevant and well defined choose "1", otherwise "0". Examples of undefined places are those in which one or more of the measured indicators or room characteristics are not relevant because of the complexity of the room.
wellDefinedRoom (0, 1): If the room is well defined choose "1", otherwise "0". Well defined means that it is clear if it is really a room, that the room is subjected by daylight requirements and that the room distribution is unambiguous.
wellDefinedPoint (0, 1): If the calculation point is well defined choose "1", otherwise "0". The point is considered to be well defined if it is possible to identify the point directly or through an analysis of several points.

Additional information
modeled (signature): The person(s) that modeled /set the thermal properties.
calculated (signature): The person(s) that calculated the indicators.
reviewed (signature): The person(s) that examined the quality.
comments: Other relevant information.

Requirements for the report

The requirements for the report is listed below and should be uploaded in to three different folders; *buildings*, *documentation* and *results*. The structure of the folders and a proposal of the naming (in italics) of the files can be seen further down.

- Text documents describing the building and relevant information, e.g. source of surrounding 3D geometry and drawings.
- CAD file and/or calculation file with all the information to carry out the daylight calculation. The file should contain the shading surroundings, geometry for current rooms and computational grids. The files should be entitled "buildingID_simulationType_typeOfGrid", e.g. "1_st1_0mGrid". Where the different types of grids are: 0mGrid, 0.5mGrid, Point and Window.
- Results in the form of one or more CSV-files with identification in order to be able to connect it to the computational grids.
- Plans which should contain roomID, calculation points, distribution of computational grids (only the grid covering the entire room) and potential workplaces.
- Facade drawings and sections

BUILDINGS

Building 1 (*BuildingID_cadastralReference, e.g. 1_Vasastaden 14.2*)
    Document describing the building (*BuildingID_description*)
    Drawings and material
        Plans *(BuildingID_simulationType_plan+floor, e.g. 1_st1_plan1)*
        Facades *(BuildingID_facade_cardinalDirection, e.g. 1_facade_south)*
        Sections *(BuildingID_section+cut, e.g. 1_sectionA-A)*
        Possible 2D-model (e.g. Autocad)
    Post processing (processing of results)
    Simulation
        3D-model with computational grids and points
        (BuildingID_simulationType_typeOfGrid, e.g. 1_st1_0mGrid)
        Result files *(Res_BuildingID_simulationTyoe_typeOfGrid, e.g. Res_1_st1_Point)*
Building 2
...

DOCUMENTATION

Description of method (Simulation type 1)
Simulation type 2
Simulation type 3
...

RESULTS

Results_BuildingLevel (excel file with information and results regarding the buildings)
Results_RoomLevel (excel file with information and results regarding the rooms)

PART 6, SURVEYS

If the room is perceived to have good access to direct daylight
If you often use curtains, blinds or other types of sun protection (yes, no)
Why the residents use sunscreens (transparency, too hot, too bright, because of plants, ...)
If the outlook is interesting
If you have access to direct sunlight in the dwelling
...

PART 7, LICENSE INFORMATION

Appendix 2 – Survey in Swedish and in English

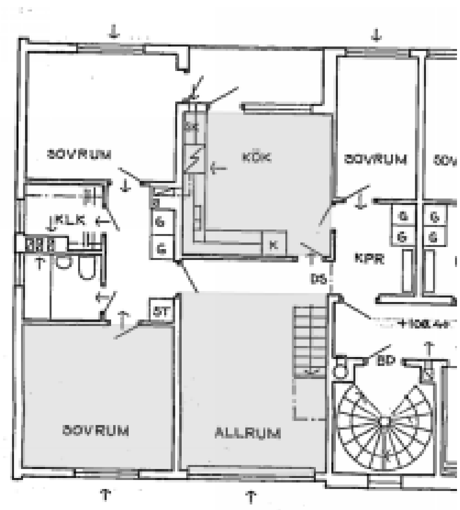
CHALMERS
UNIVERSITY OF TECHNOLOGY

ENKÄTUNDERSÖKNING - DAGSLJUS

Hej!
Vi är två studenter från Chalmers som skriver examensarbete inom området dagsljus. En del i vårt arbete är att undersöka hur ni som boende upplever tillgången till dagsljus i er lägenhet. Vi vore ytterst tacksamma om ni ville ta er tid och svara på 9 korta frågor som följer på nästkommande sida! Det hade hjälpt oss otroligt mycket i vårt fortsatta arbete!

Tack på förhand!

Med Vänlig Hälsning
Sara Eriksson
Lovisa Waldenström



Källa: Stadsbyggnadskontoret

DAGSLJUS **är inte direkt solljus utan det naturliga ljuset från solen som vi får en mulen dag eller genom att byggnader skymmer solen.**

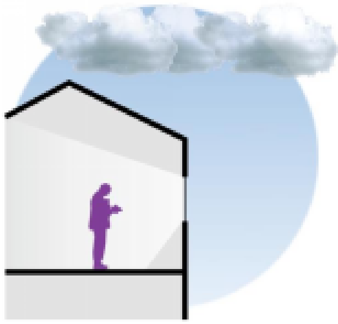
1. Hur upplever ni att tillgången på dagsljus är i följande rum och i din bostad i stort? (ringa in en **siffra**)

Kök	Dålig	1	2	3	4	5	God
Matrum	Dålig	1	2	3	4	5	God
Vardagsrum	Dålig	1	2	3	4	5	God
Sovrum (markerat)	Dålig	1	2	3	4	5	God
Bostaden i stort	Dålig	1	2	3	4	5	God

2. Skulle ni önska att du hade mer eller mindre tillgång till dagsljus i något av följande rum?

Kök	☐ Mer	☐ Mindre	☐ Varken mer eller mindre
Matrum	☐ Mer	☐ Mindre	☐ Varken mer eller mindre
Vardagsrum	☐ Mer	☐ Mindre	☐ Varken mer eller mindre
Sovrum (markerat)	☐ Mer	☐ Mindre	☐ Varken mer eller mindre

3. I vilket rum anser ni att det är viktigast att få in mycket dagsljus? (rangordna, där 1 är viktigaste rummet och 4 det minst viktiga rummet)
   ___ Kök
   ___ Matrum
   ___ Vardagsrum
   ___ Sovrum (markerat)



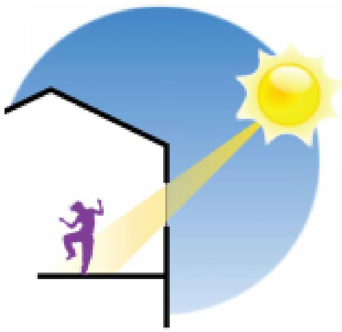
4. Använder ni ofta elektrisk belysning dagtid i följande rum?

Kök	☐ Ja	☐ Nej
Matrum	☐ Ja	☐ Nej
Vardagsrum	☐ Ja	☐ Nej
Sovrum (markerat)	☐ Ja	☐ Nej

SOLLJUS OCH SOLSKYDD **Solljus är det direkta solljuset som strålar in i bostaden genom fönsterna.**

5. Har ni tillgång till direkt solljus i följande rum?

Kök	☐ Ja	☐ Nej
Matrum	☐ Ja	☐ Nej
Vardagsrum	☐ Ja	☐ Nej
Sovrum (markerat)	☐ Ja	☐ Nej



6. Använder ni ofta gardin, persienn eller annat solskydd i följande rum?

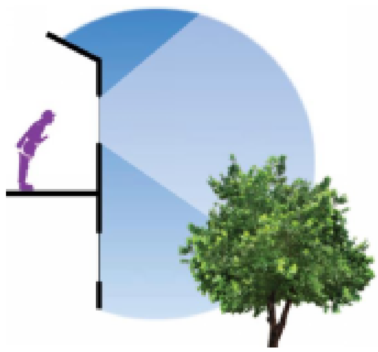
Kök	☐ Ja	☐ Nej
Matrum	☐ Ja	☐ Nej
Vardagsrum	☐ Ja	☐ Nej
Sovrum (markerat)	☐ Ja	☐ Nej

7. Om solskydd används, varför använder ni dem? (flera kryss är möjligt)
   ☐ För att förhindra insyn ☐ För varmt
   ☐ På grund av växter ☐ Bländning
   ☐ Annat (vad i sådana fall?) ________________________________

UTBLICK **är det man kan se ut genom fönsterna.**

8. Anser ni att utblicken är intressant i följande rum? (kvalitet)

Kök	☐ Ja	☐ Nej
Matrum	☐ Ja	☐ Nej
Vardagsrum	☐ Ja	☐ Nej
Sovrum (markerat)	☐ Ja	☐ Nej



9. Anser ni att utblicken är tillräcklig i följande rum? (kvantitet)

Kök	☐ Ja	☐ Nej
Matrum	☐ Ja	☐ Nej
Vardagsrum	☐ Ja	☐ Nej
Sovrum (markerat)	☐ Ja	☐ Nej

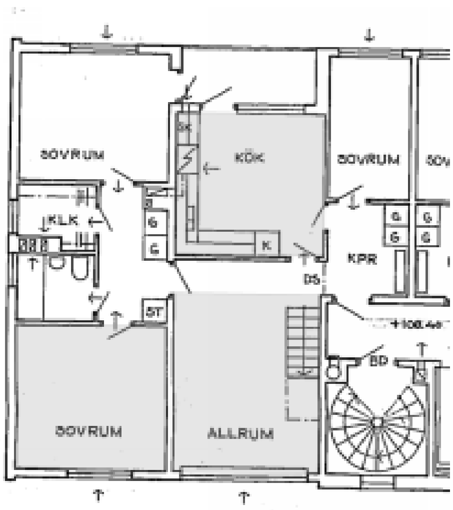
CHALMERS
UNIVERSITY OF TECHNOLOGY

SURVEY - DAYLIGHT

Hello!
We are two student from Chalmers writing our Master Thesis within the field of daylight. Part of our work is to examine how you as residents perceive the access to daylight in your apartment. We would be very thankful if you could take your time to answer 9 short questions that follows on the next page. It would help us a lot in our future work.

Thanks in advance!

Sincerely,
Sara Eriksson
Lovisa Waldenström



Source: Stadsbyggnadskontoret

DAYLIGHT

is not direct sunlight but the natural light from the sun that we get a cloudy day or by buildings obscuring the sun.

1. How do you perceive the access to daylight in the following rooms and in your apartment in general? (circle a number)

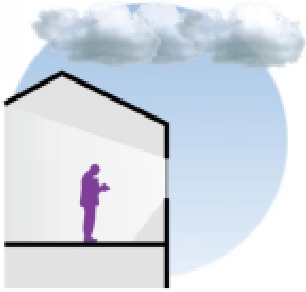
Kitchen	Bad	1	2	3	4	5	Good
Dining room	Bad	1	2	3	4	5	Good
Living room	Bad	1	2	3	4	5	Good
Bedroom (marked)	Bad	1	2	3	4	5	Good
The apartment in general	Bad	1	2	3	4	5	Good

2. Would you request for more or less access to daylight in the following rooms?

Kitchen	☐ More	☐ Less	☐ No more or less
Dining room	☐ More	☐ Less	☐ No more or less
Living room	☐ More	☐ Less	☐ No more or less
Bedroom (marked)	☐ More	☐ Less	☐ No more or less

3. Which room type do you think is the most important room to have the greatest access to **daylight**? (rank, where 1 is the most and 4 the least important room)

   ___ Kitchen
   ___ Dining room
   ___ Living room
   ___ Bedroom (marked)



4. Do you normally use electrical lighting daytime in the following rooms?

Kitchen	☐ Yes	☐ No
Dining room	☐ Yes	☐ No
Living room	☐ Yes	☐ No
Bedroom (marked)	☐ Yes	☐ No

SUNLIGHT AND SUN SHADING

Sunlight is the direct sunlight shining into the home through the windows.

5. Do you have access to direct sunlight in the following rooms?

Kitchen	☐ Yes	☐ No
Dining room	☐ Yes	☐ No
Living room	☐ Yes	☐ No
Bedroom (marked)	☐ Yes	☐ No

6. Do you often use curtains, blinds or other sun shadings in the following rooms?

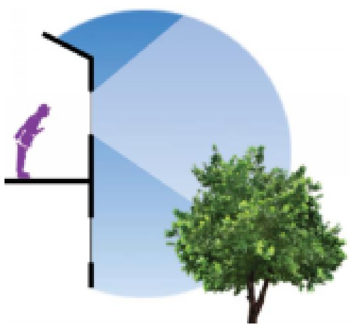
Kitchen	☐ Yes	☐ No
Dining room	☐ Yes	☐ No
Living room	☐ Yes	☐ No
Bedroom (marked)	☐ Yes	☐ No

7. If use of sun shading, why it is used? (multiple choices possible)

   ☐ To prevent insight ☐ Too hot
   ☐ Due to plants ☐ Glare
   ☐ Other (What in such cases?) ____

VIEW OUT

is what you can see through the windows.



8. Do you consider the view out to be interesting in the following rooms? (Quantity)

Kitchen	☐ Yes	☐ No
Dining room	☐ Yes	☐ No
Living room	☐ Yes	☐ No
Bedroom (marked)	☐ Yes	☐ No

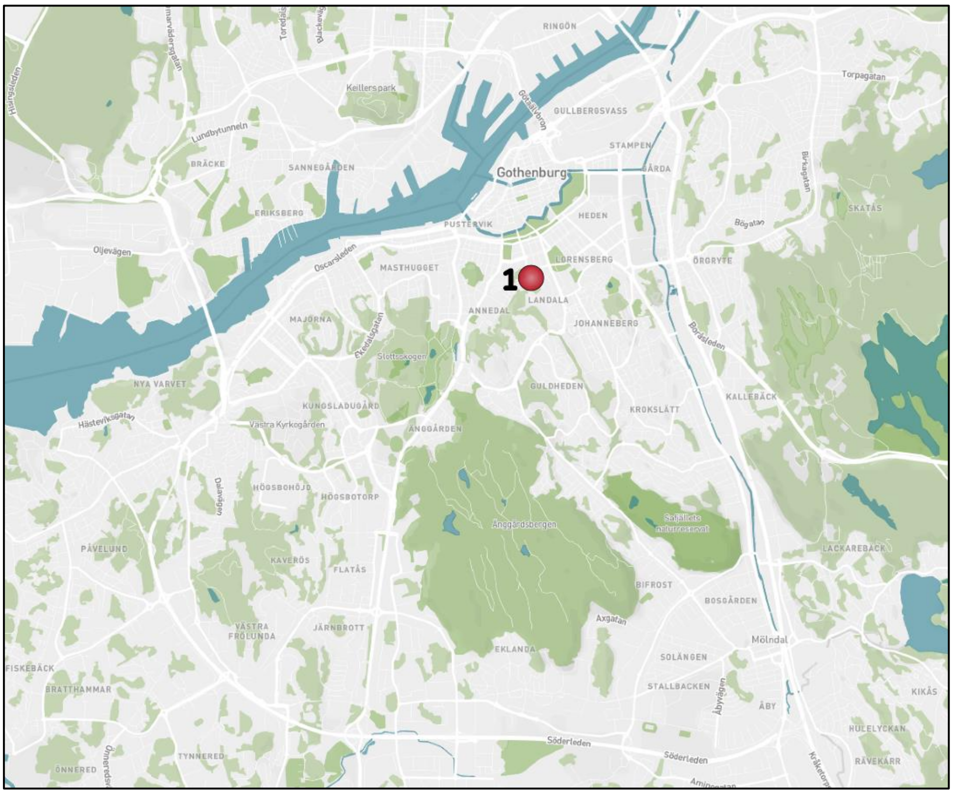
9. Do you consider the view out to be enough in the following rooms? (Quality)

Kitchen	☐ Yes	☐ No
Dining room	☐ Yes	☐ No
Living room	☐ Yes	☐ No
Bedroom (marked)	☐ Yes	☐ No

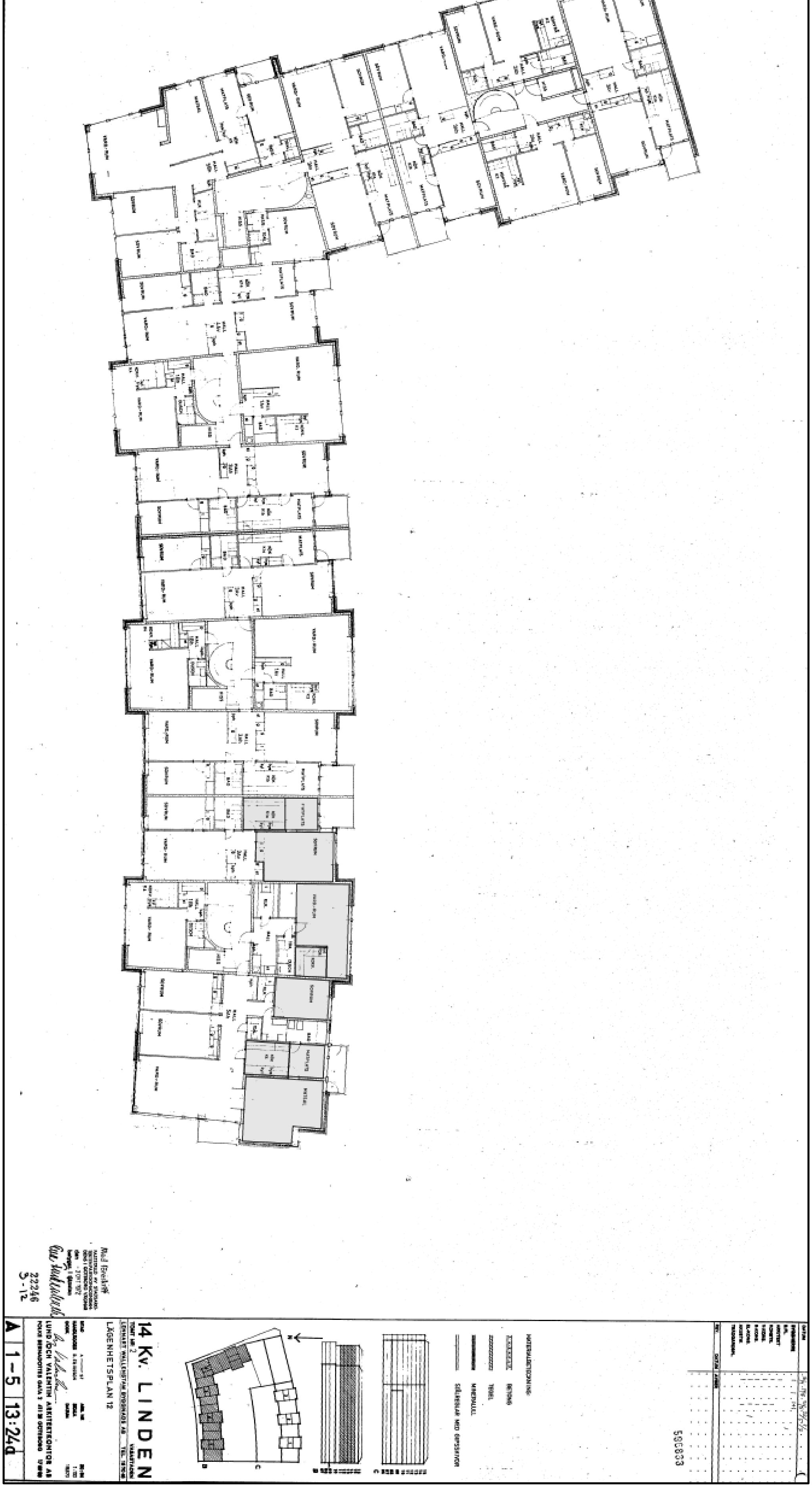
Appendix 3 – Drawing material of the studied buildings

The drawing material used to model all the buildings are attached in this appendix. A map of where the specific building is placed in Gothenburg and another one where the specific building is marked in red are presented for all the buildings. Studied floorplans and necessary facades and sections are also shown.

Appendix 3A – 1_Vasastaden 14:2

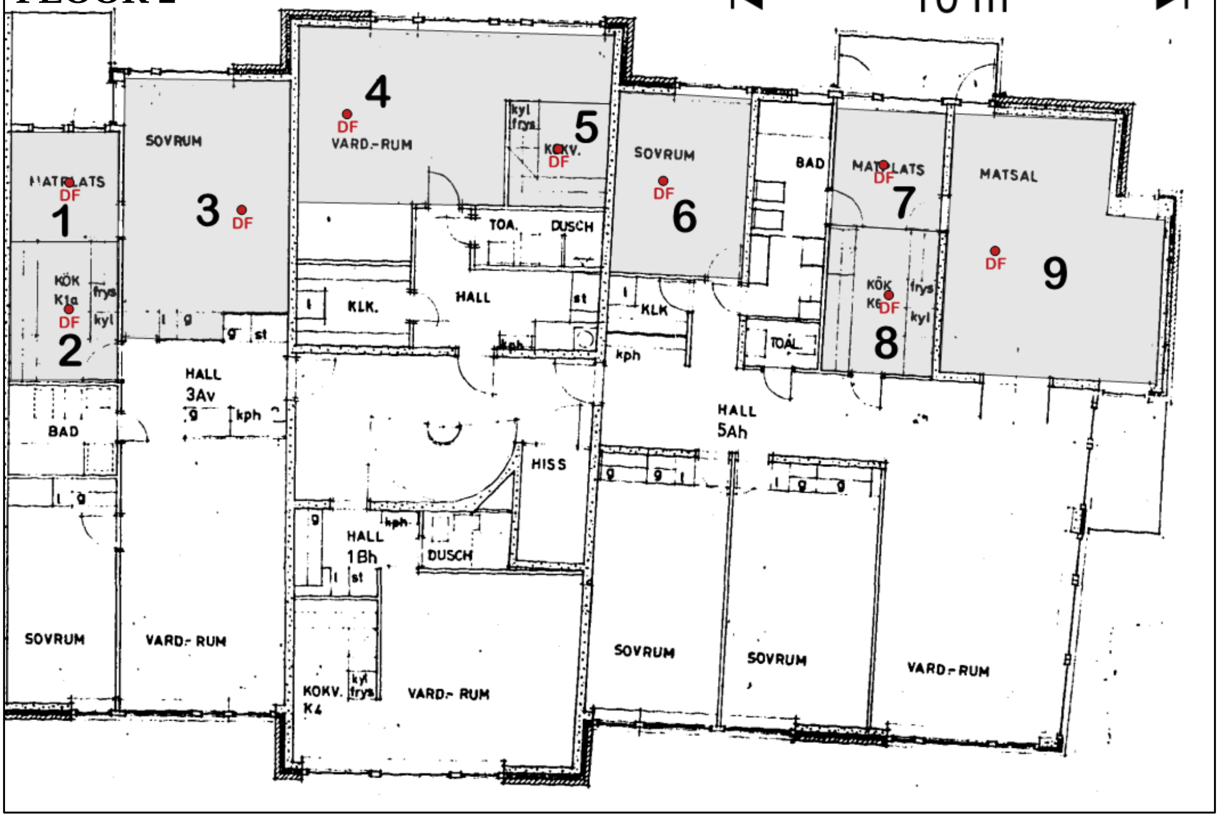


FLOORPLAN

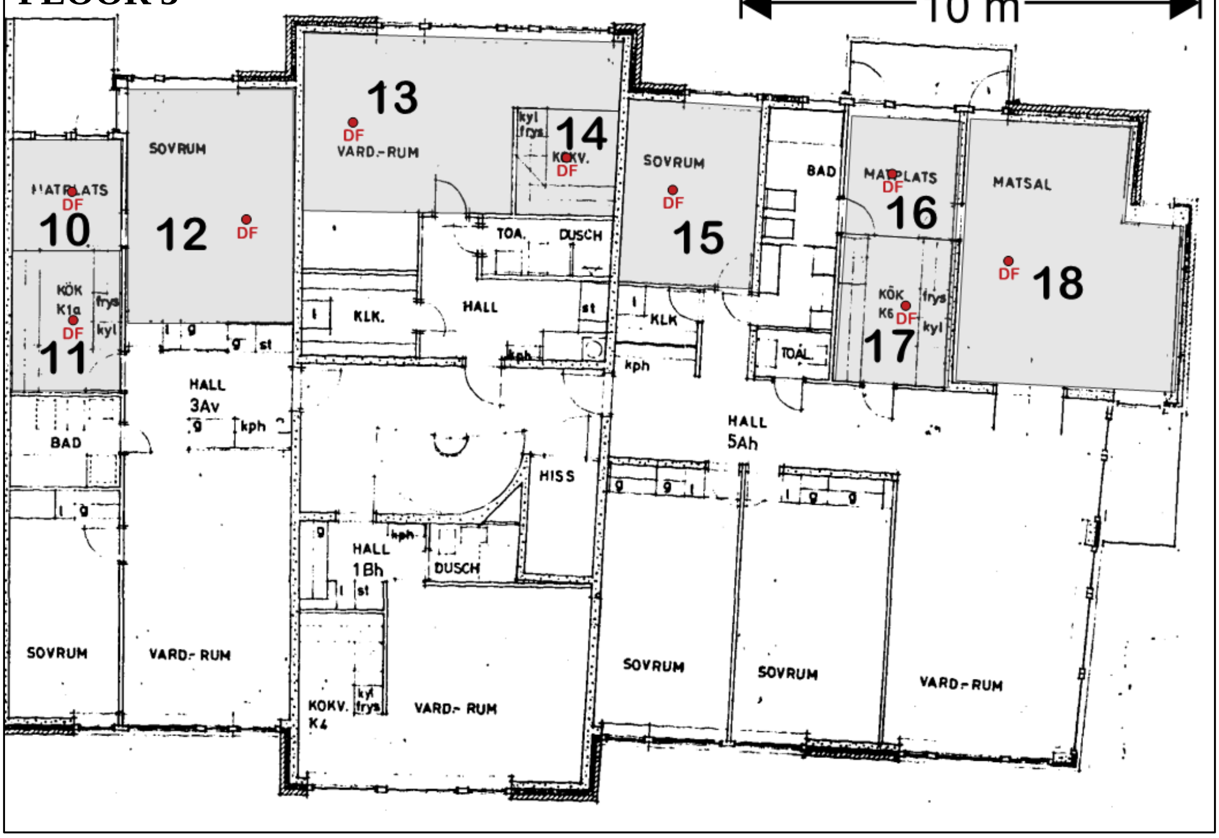


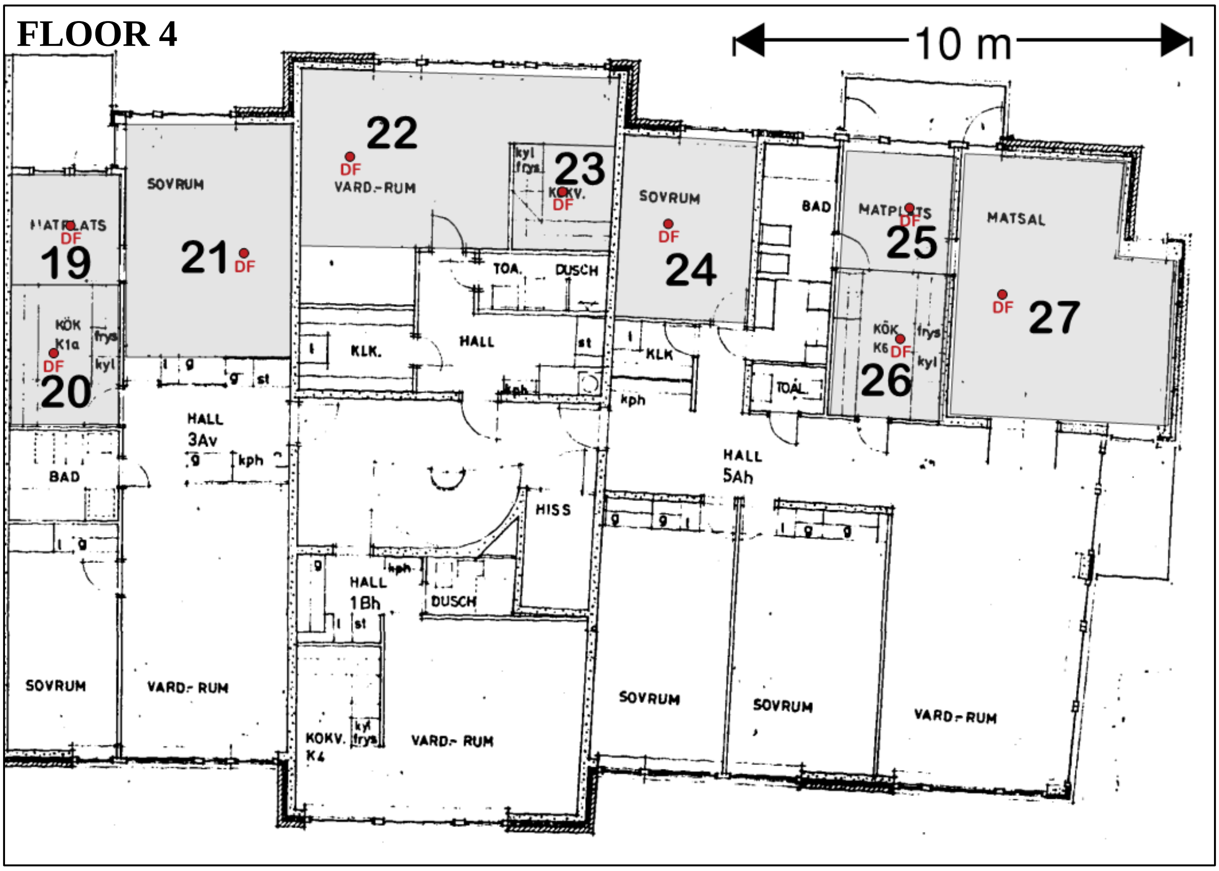
SIMULATION TYPE 1

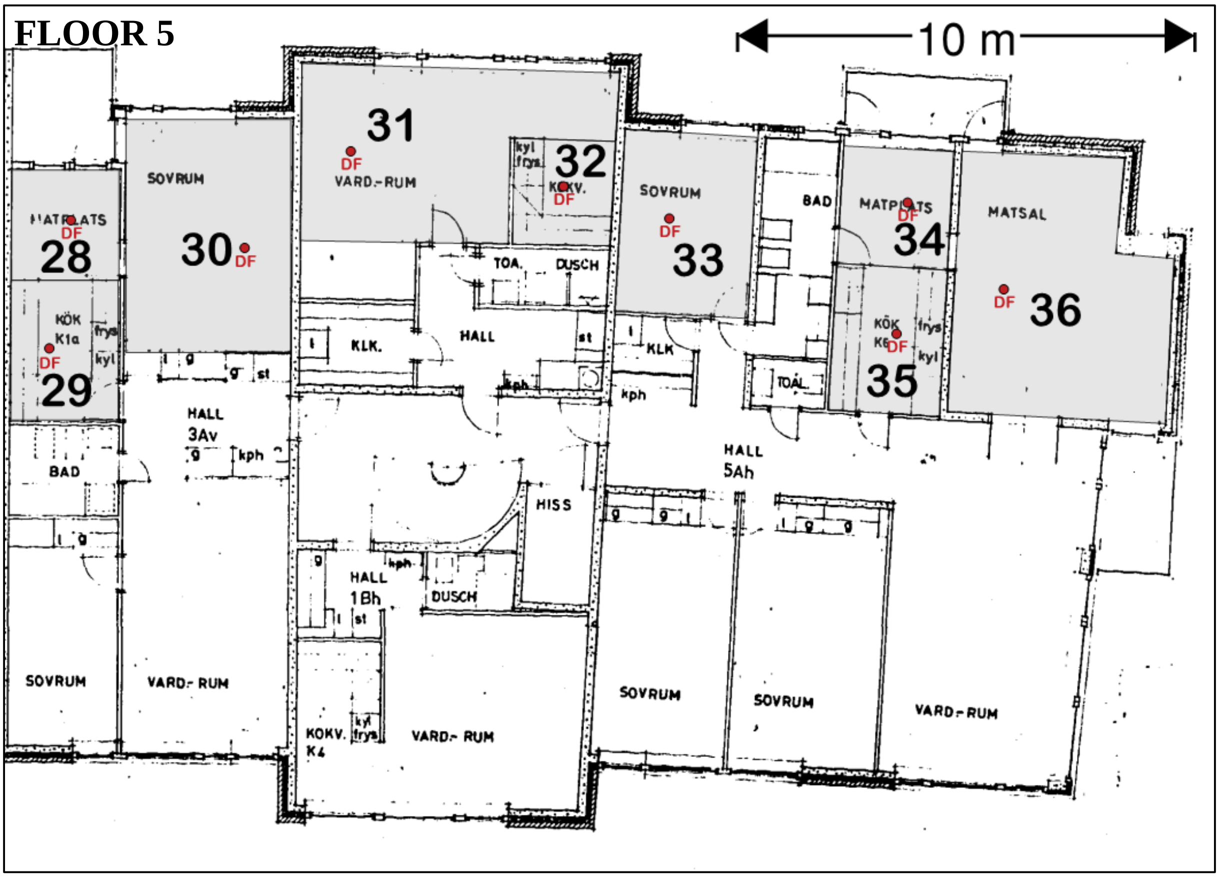
FLOOR 2



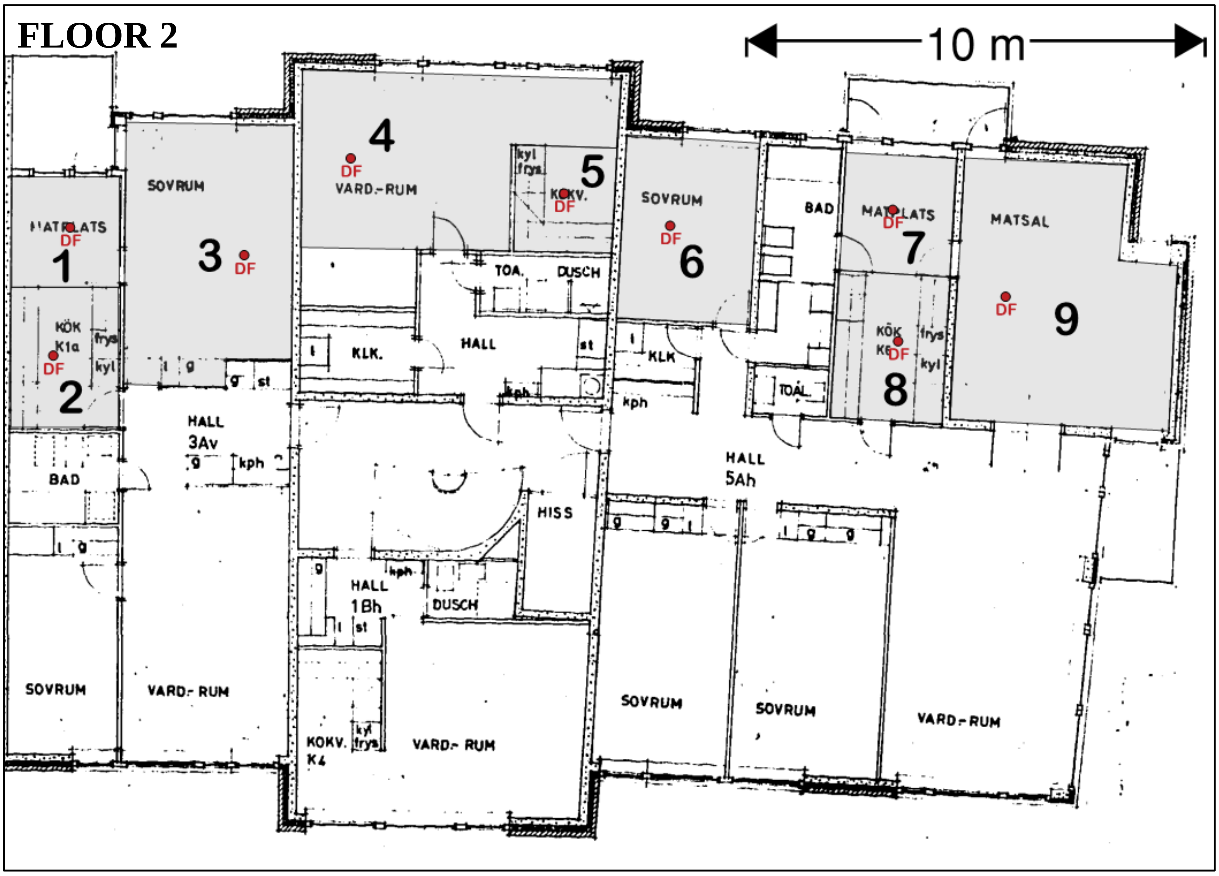
FLOOR 3

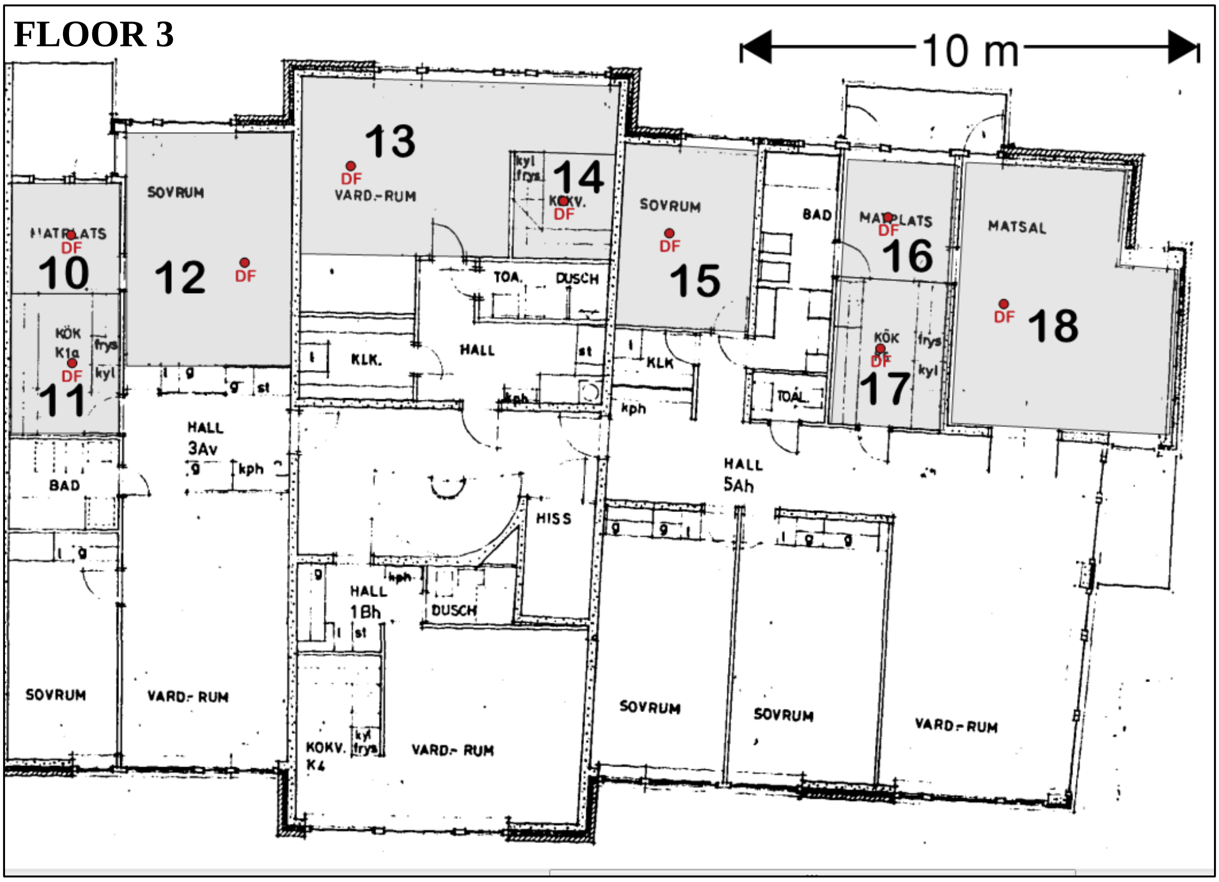


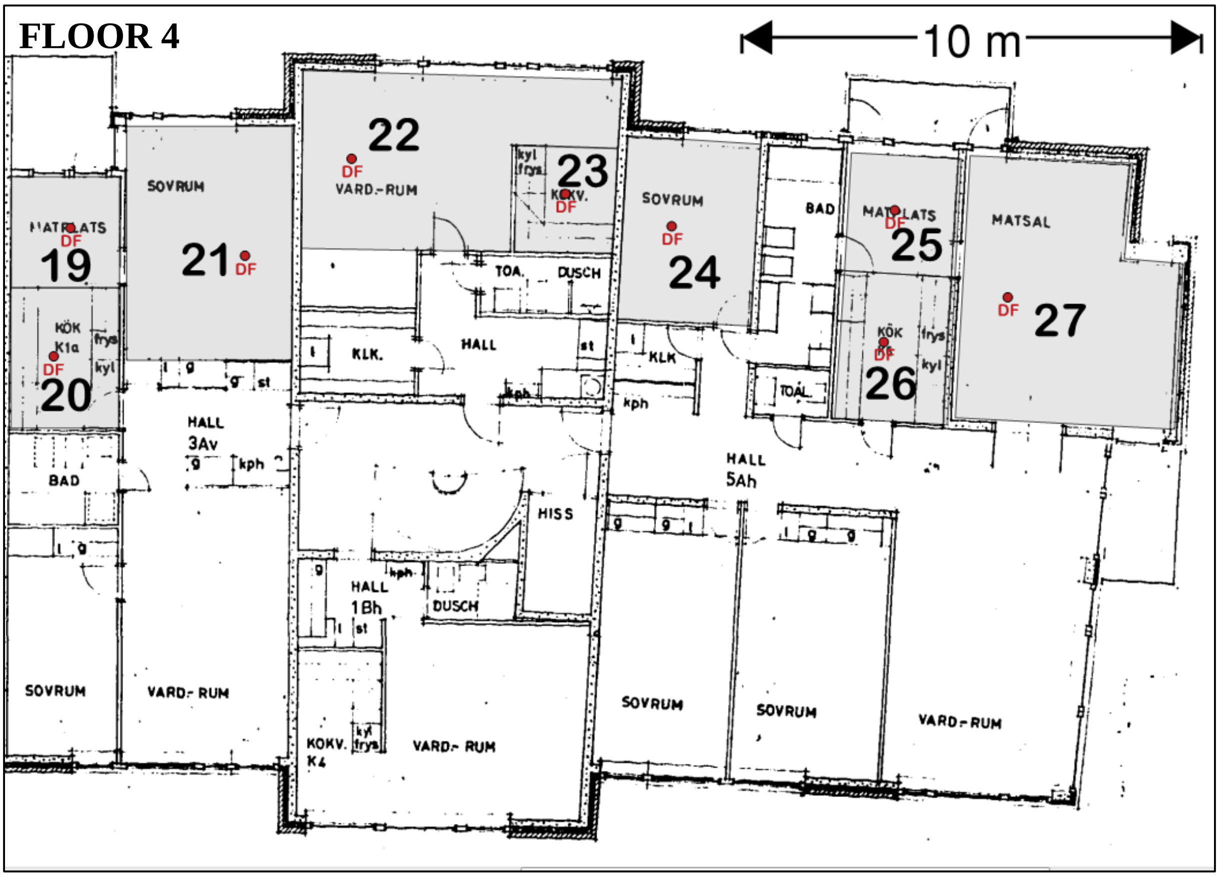

FLOOR 4
10 m
22
DF
VARD.-RUM
kyl
frys
23
KOKV.
DF
SOVRUM
21
DF
MATPLATS
DF
19
KÖK
K1a
frys
kyl
DF
20
SOVRUM
DF
24
BAD
MATPLATS
DF
25
MATSAL
DF
27
KÖK
K6
DF
frys
kyl
26
TOA.
DUSCH
HALL
KLK.
st
kph
KLK
TOAL
HALL
3Av
kph
BAD
HALL
5Ah
HISS
HALL
1Bh
kph
DUSCH
st
SOVRUM
VARD.-RUM
KOKV.
K4
kyl
frys
VARD.-RUM
SOVRUM
SOVRUM
VARD.-RUM


FLOOR 5
10 m
31
DF
VARD.-RUM
kyl
frys
32
KOKV.
DF
SOVRUM
30
DF
MATPLATS
DF
28
KÖK
K1a
frys
kyl
DF
29
SOVRUM
DF
33
BAD
MATPLATS
DF
34
MATSAL
DF
36
KÖK
K6
DF
frys
kyl
35
TOA.
DUSCH
HALL
KLK.
st
kph
KLK
TOAL
HALL
3Av
kph
BAD
HALL
5Ah
HISS
HALL
1Bh
kph
DUSCH
st
SOVRUM
VARD.-RUM
KOKV.
K4
kyl
frys
VARD.-RUM
SOVRUM
SOVRUM
VARD.-RUM

SIMULATION TYPE 2






FLOOR 4
10 m
22
23
19
20
21
24
25
26
27
DF
VARD.-RUM
SOVRUM
KÖK
K1a
frys
kyl
KOKV.
BAD
MATSAL
TOA.
DUSCH
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KLK.
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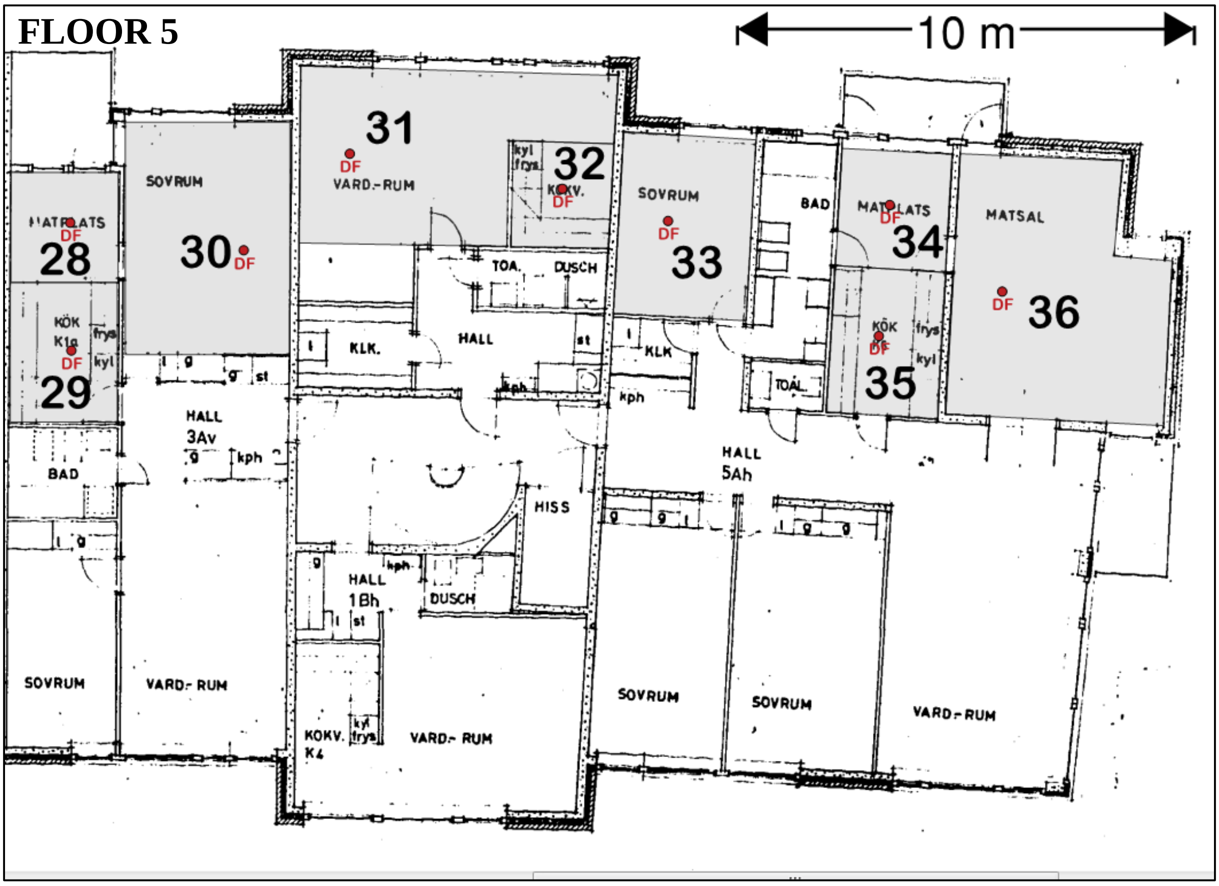
1Bh
HALL
5Ah
TOAL
KOKV.
K4
VARD.- RUM


FLOOR 5
10 m
31
32
28
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30
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35
36
DF
VARD.-RUM
SOVRUM
KÖK
K1a
frys
kyl
KOKV.
BAD
MATSAL
TOA.
DUSCH
HALL
KLK.
KLK
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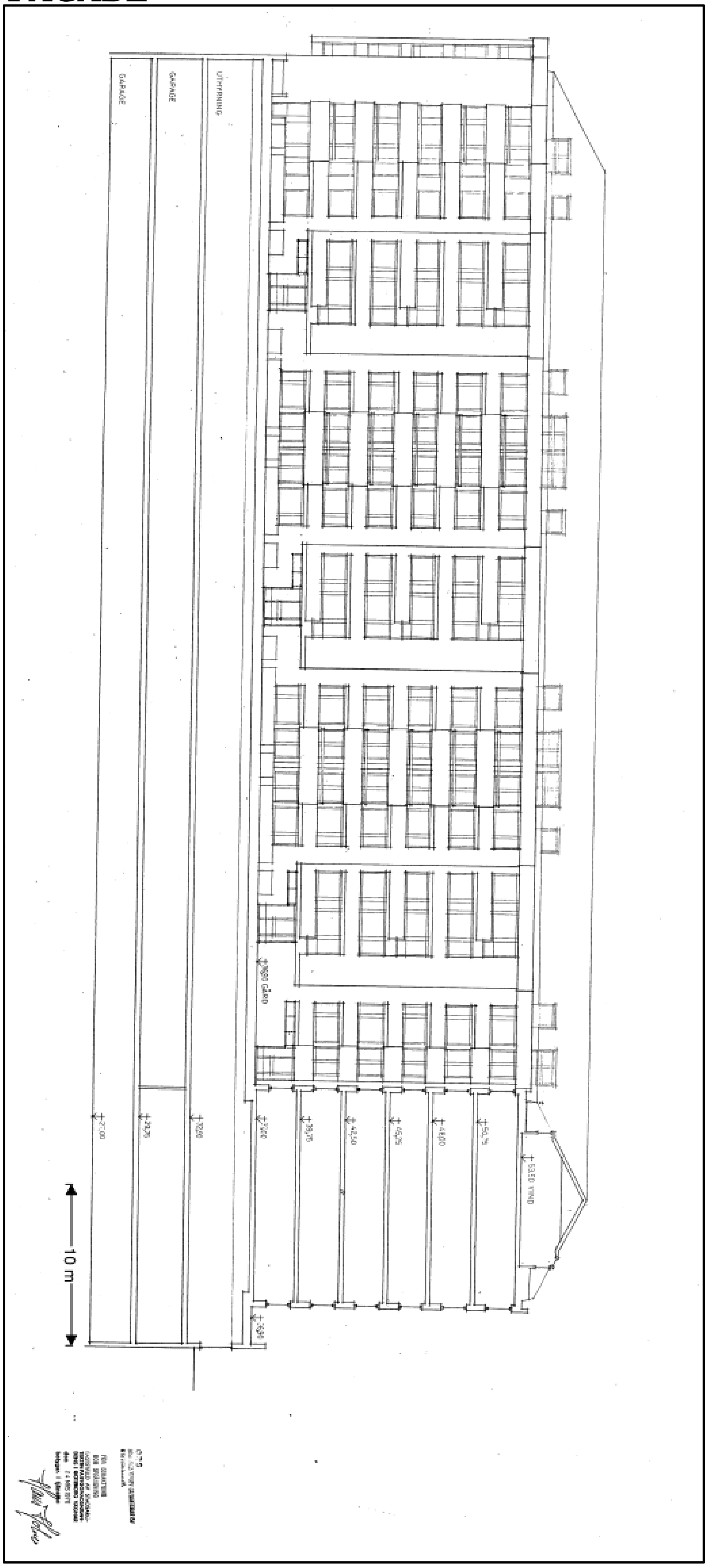
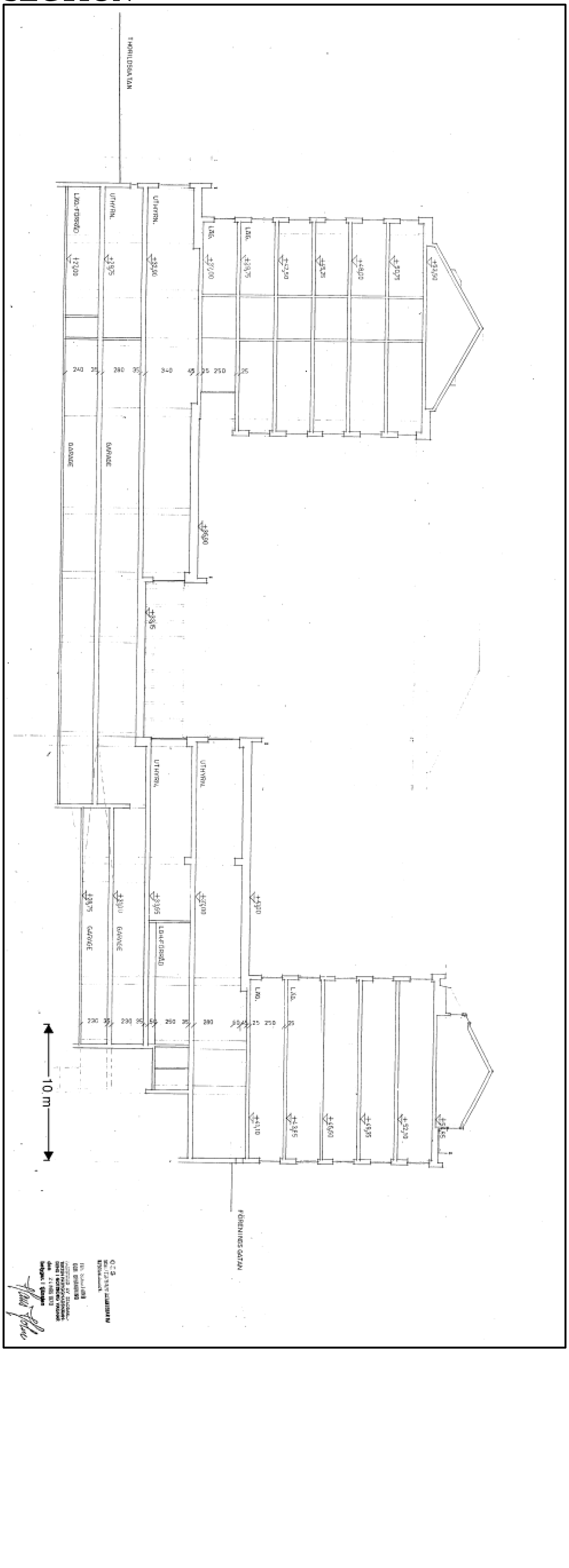
3Av
HISS
HALL
1Bh
HALL
5Ah
TOAL
KOKV.
K4
VARD.- RUM

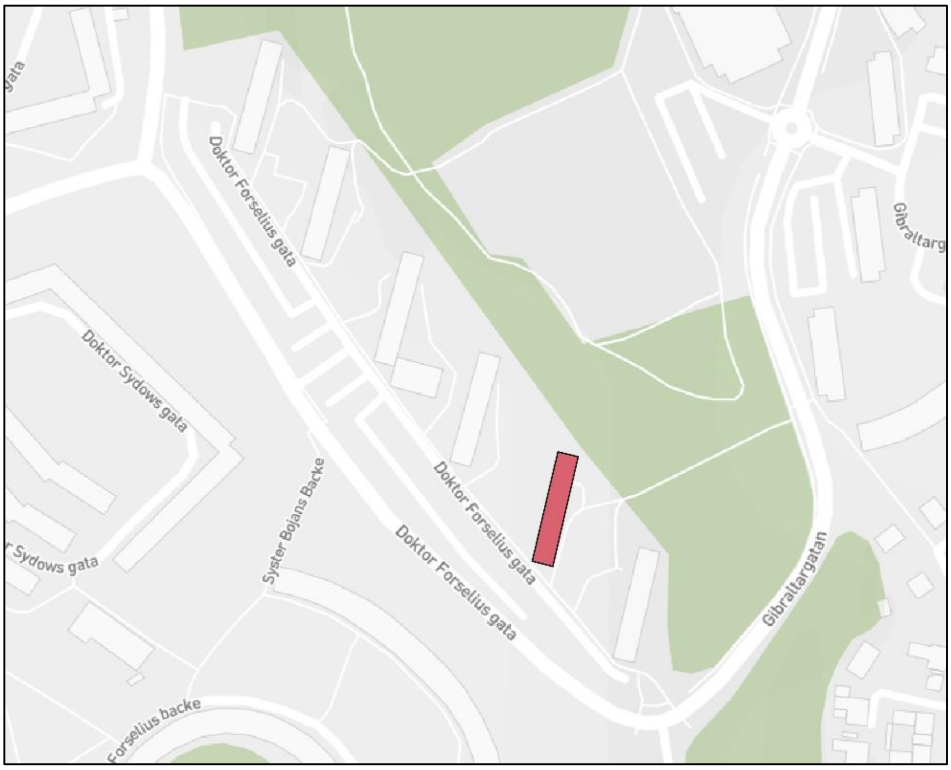
FACADE



SECTION

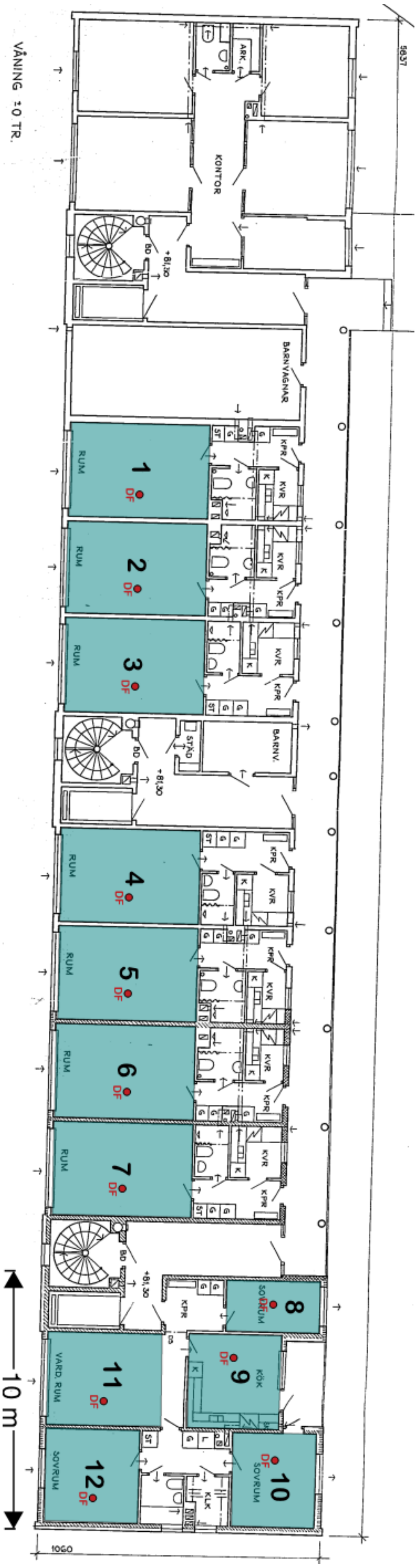


Appendix 3B – 2_Guldheden 65:13

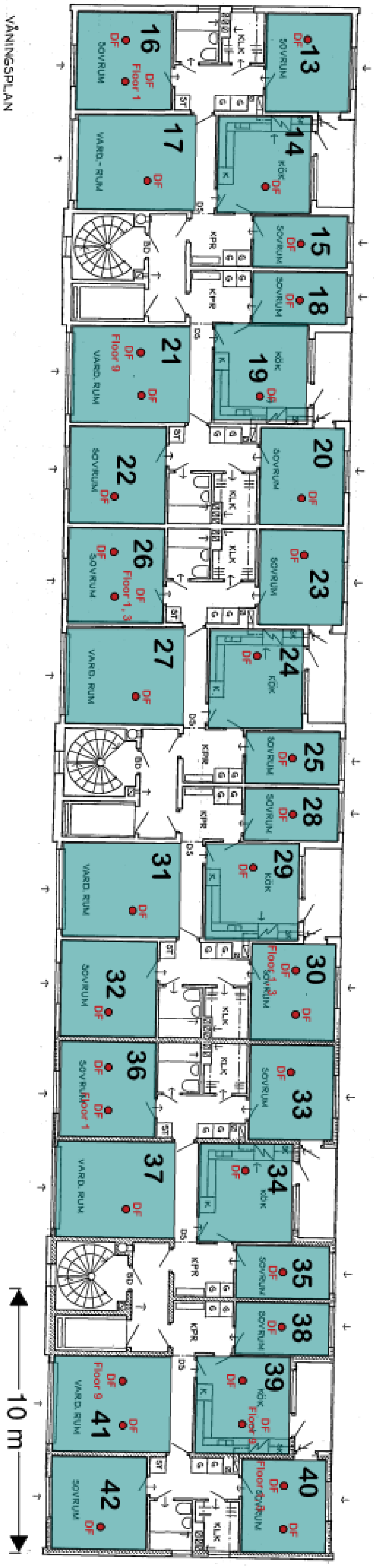


SIMULATION TYPE 1

FLOOR 0

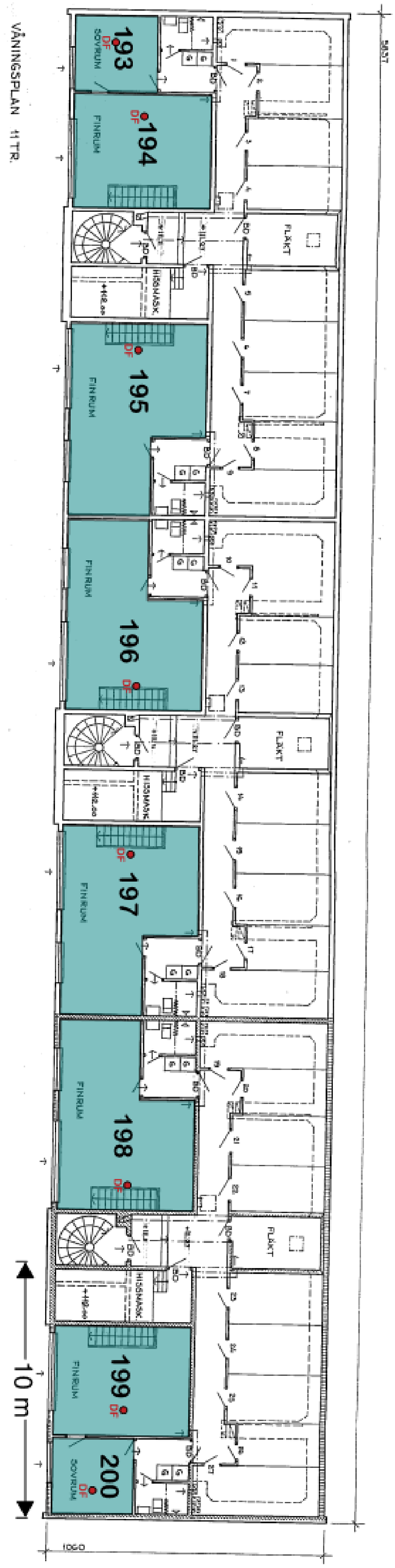


FLOOR 1-9



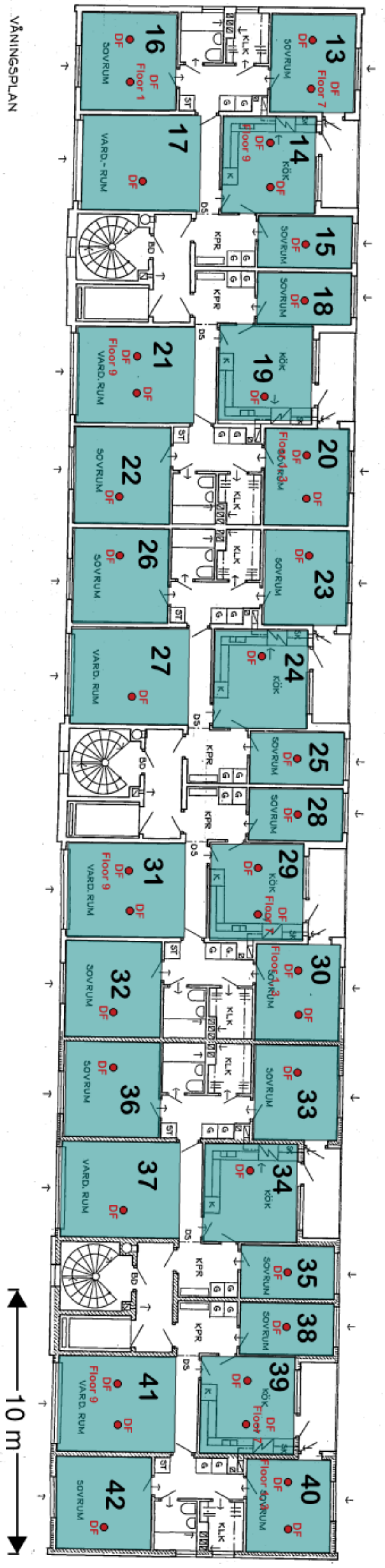
FLOOR 10

FLOOR 11

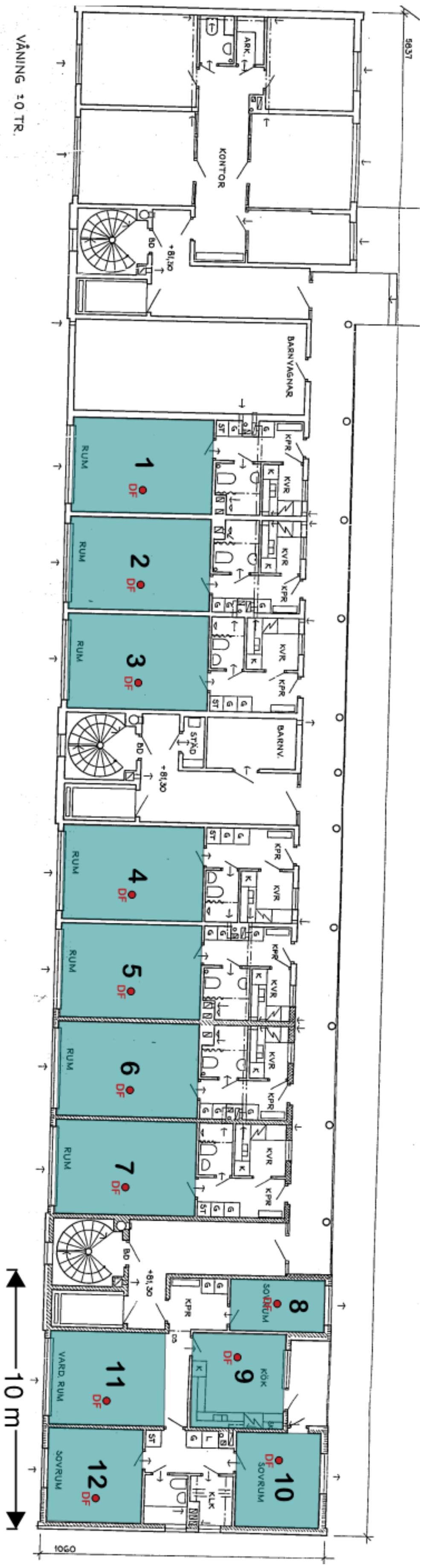


SIMULATION TYPE 2

FLOOR 0

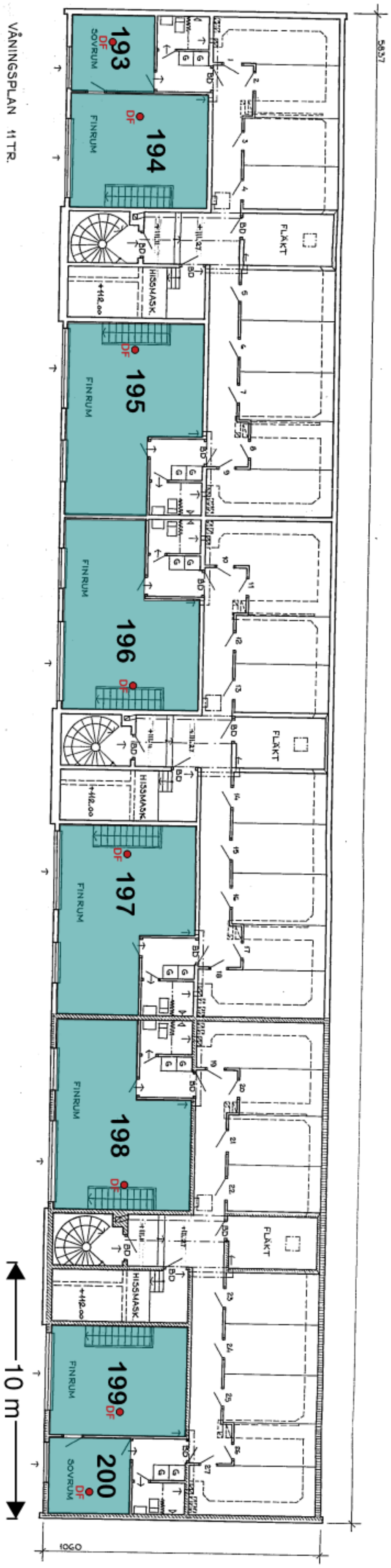


FLOOR 1-9

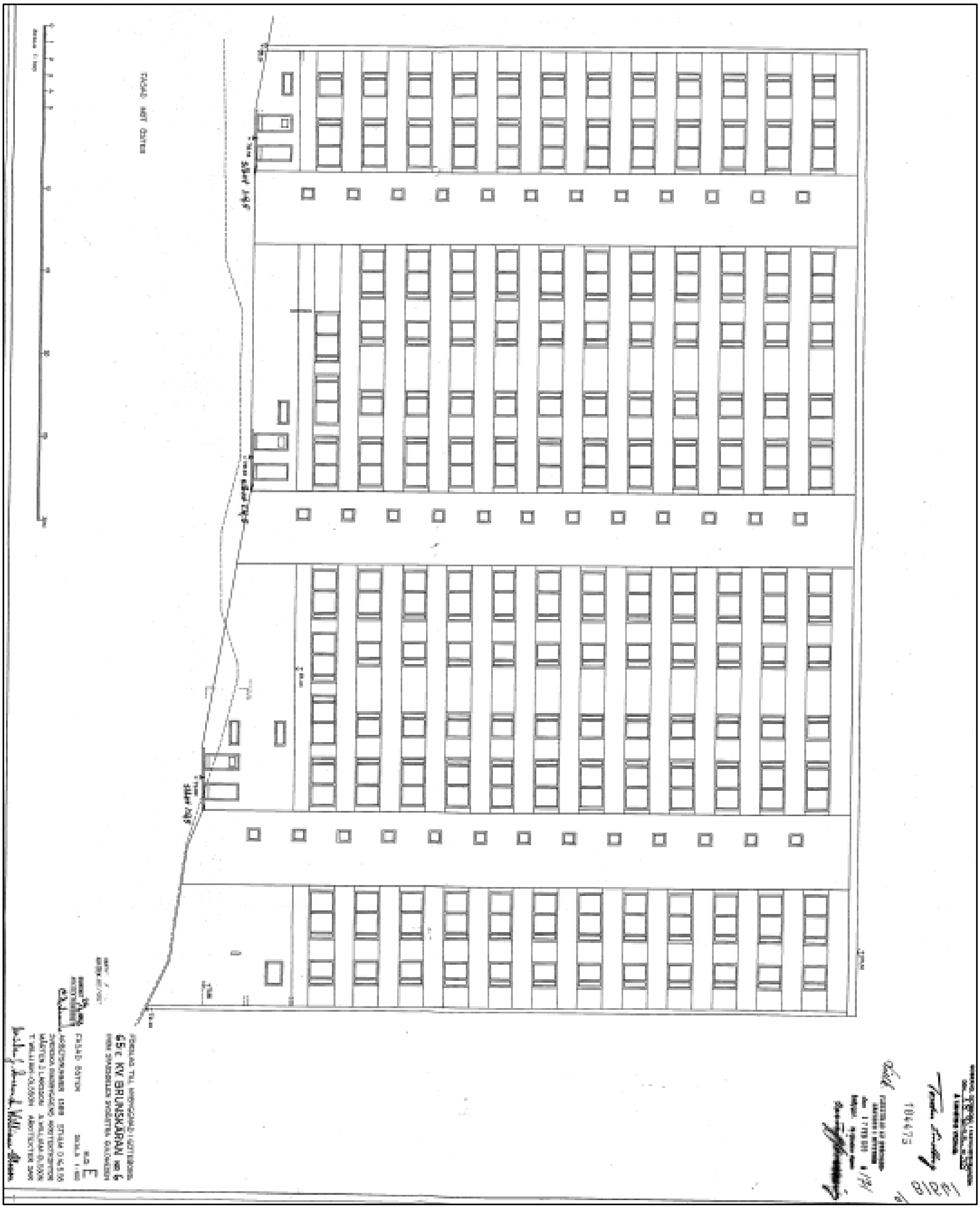


FLOOR 10

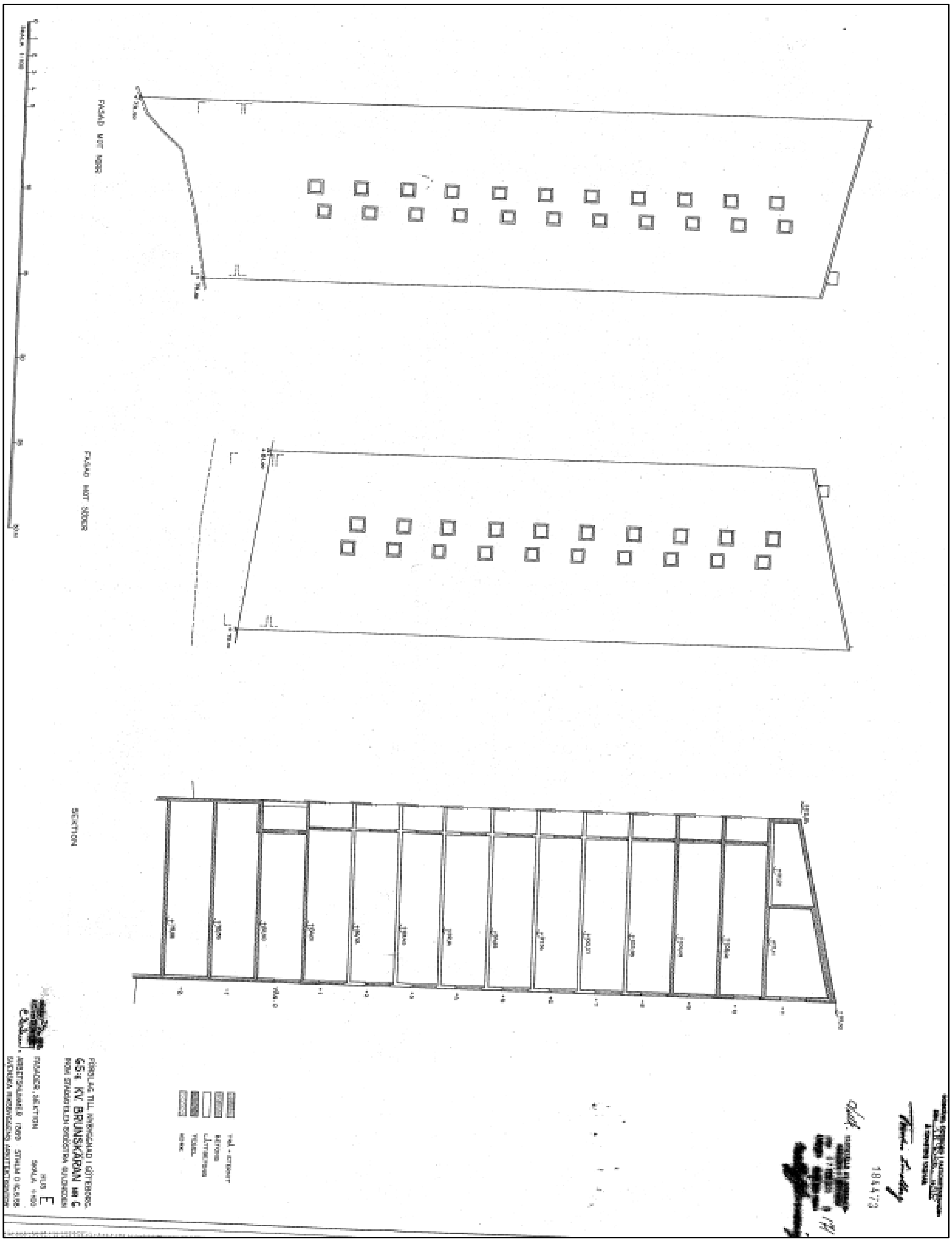
FLOOR 11



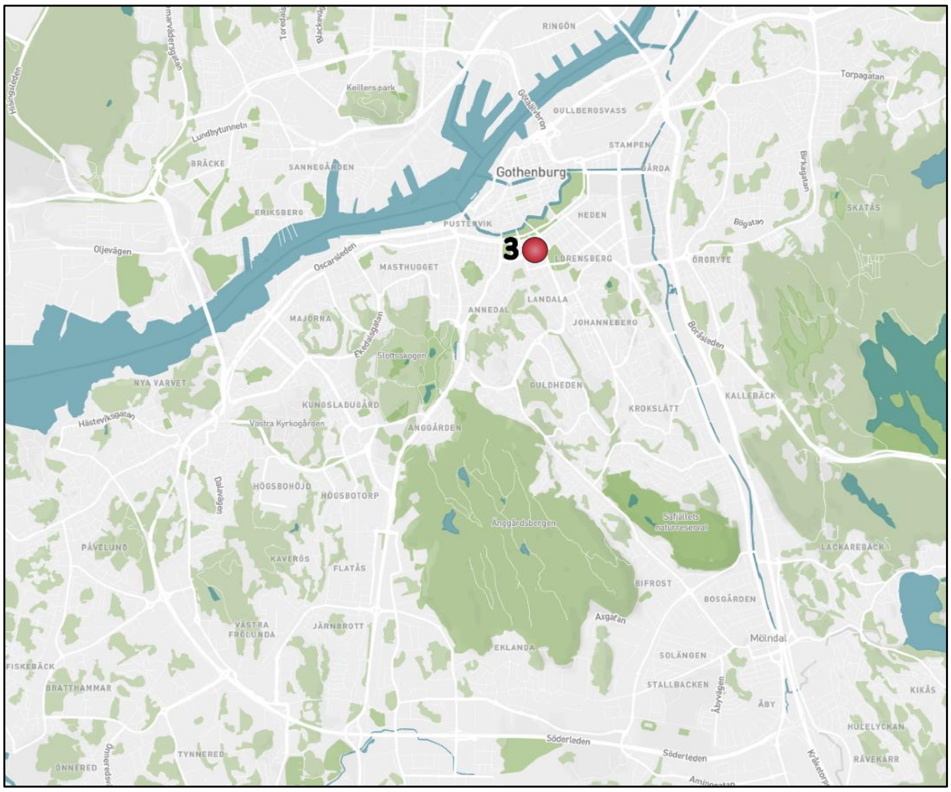
FACADE



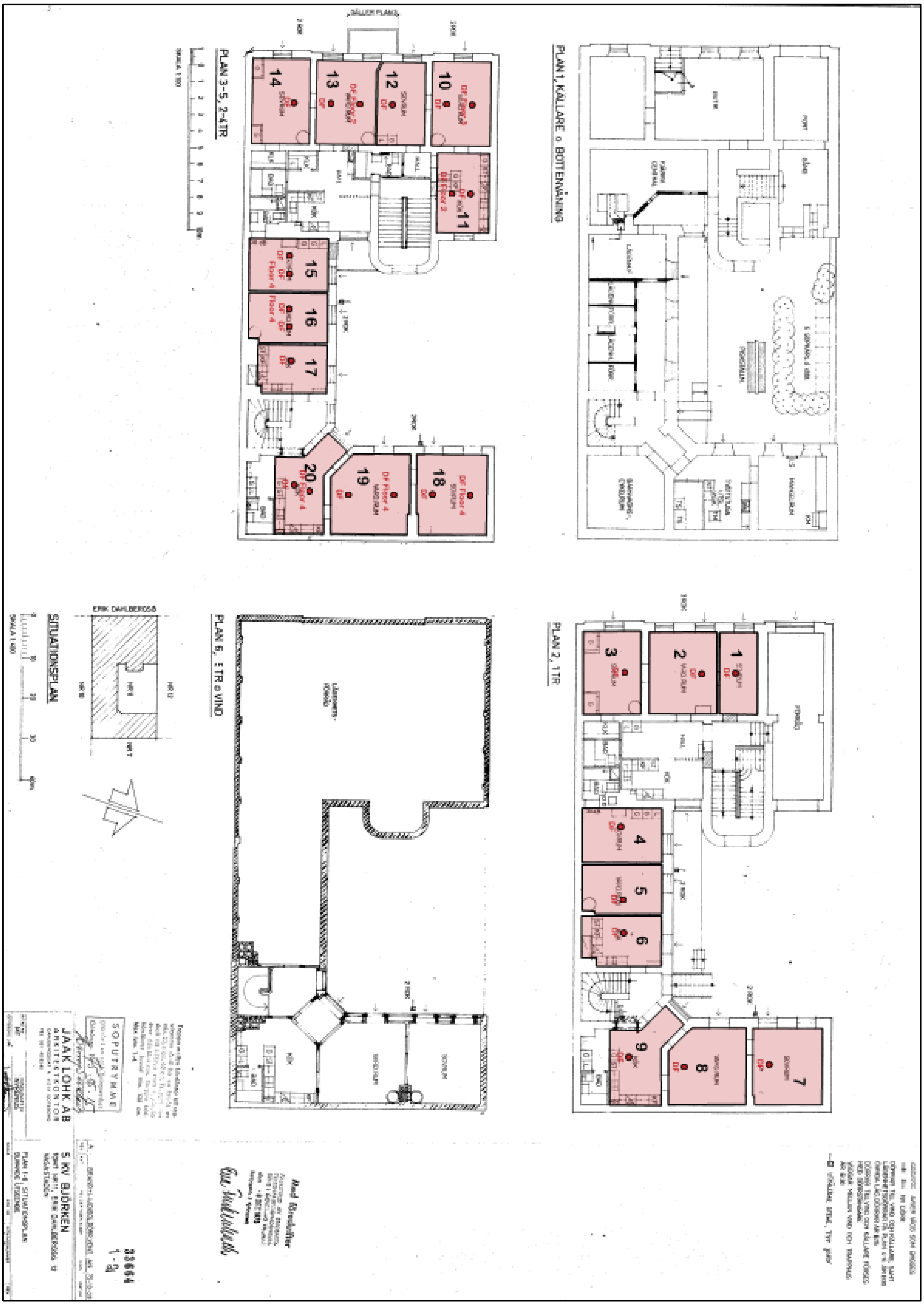
FACADES AND SECTION



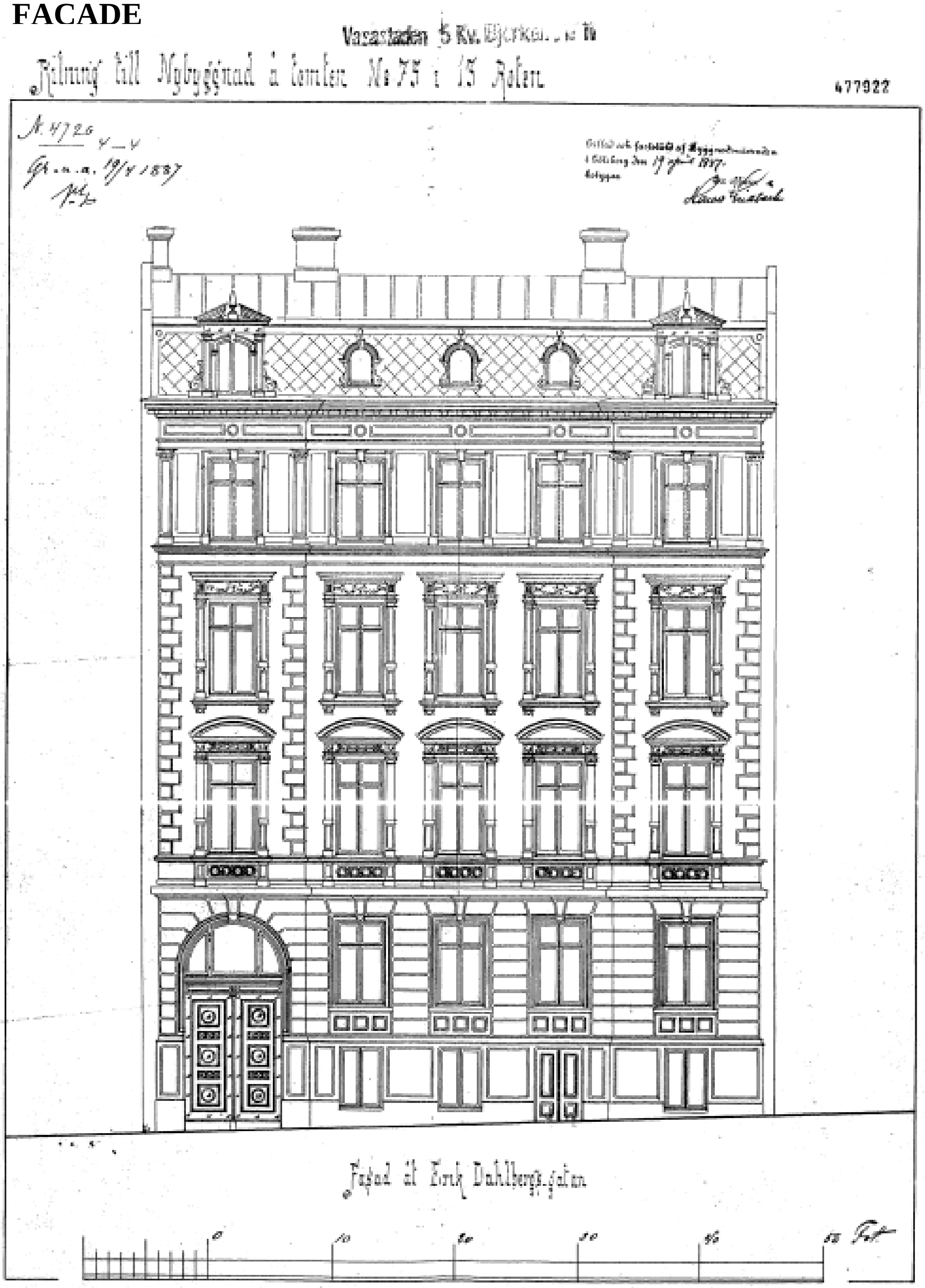
Appendix 3C – 3_Vasastaden 5:11



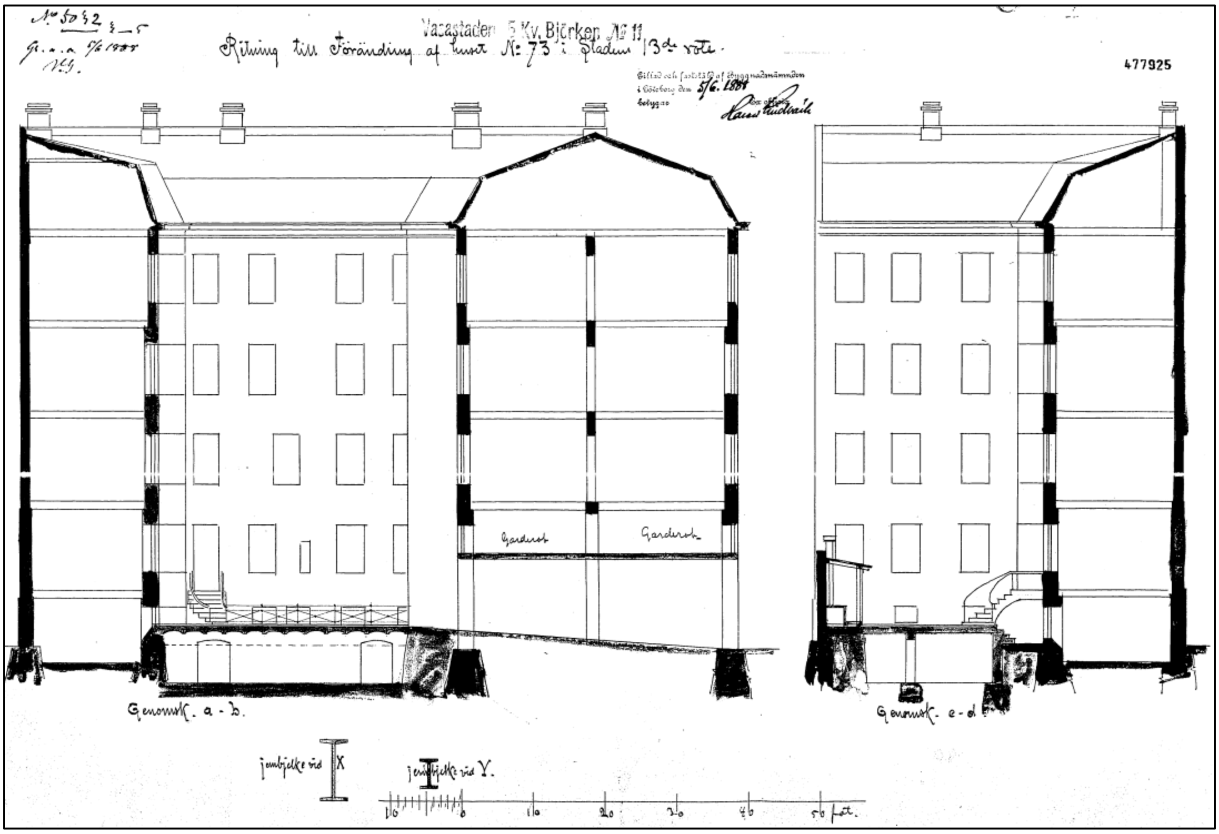
FLOORPLANS

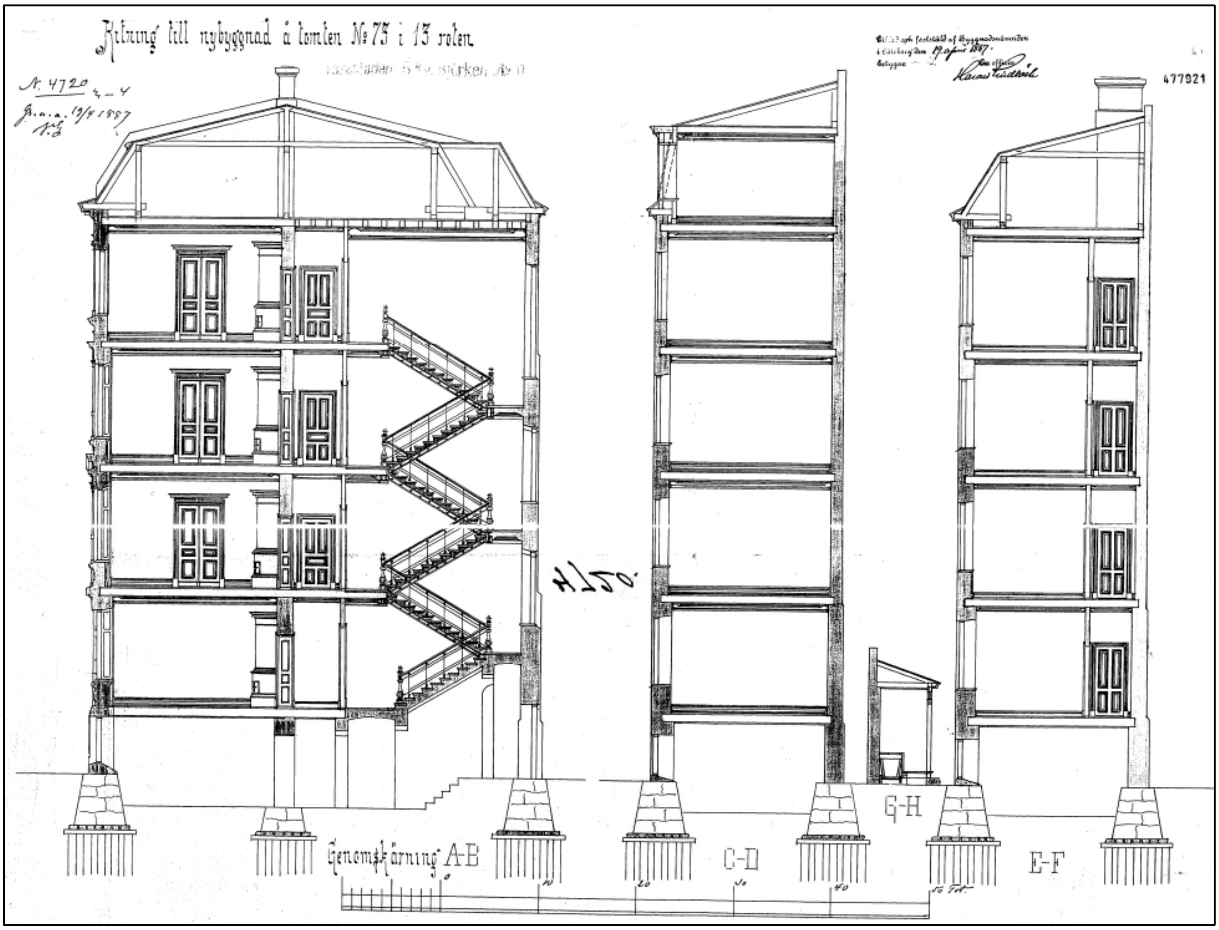

PLAN 3-5, 2-4 TR
PLAN 1, KÄLLARE o BOTTENVÅNING
PLAN 2, 1 TR
PLAN 6, 5 TR o VIND
SITUATIONSPLAN
ERIK DAHLBERGSG
JAAK LOHK AB
ARKITEKTKONTOR
5 KV BJÖRKEN

FACADE

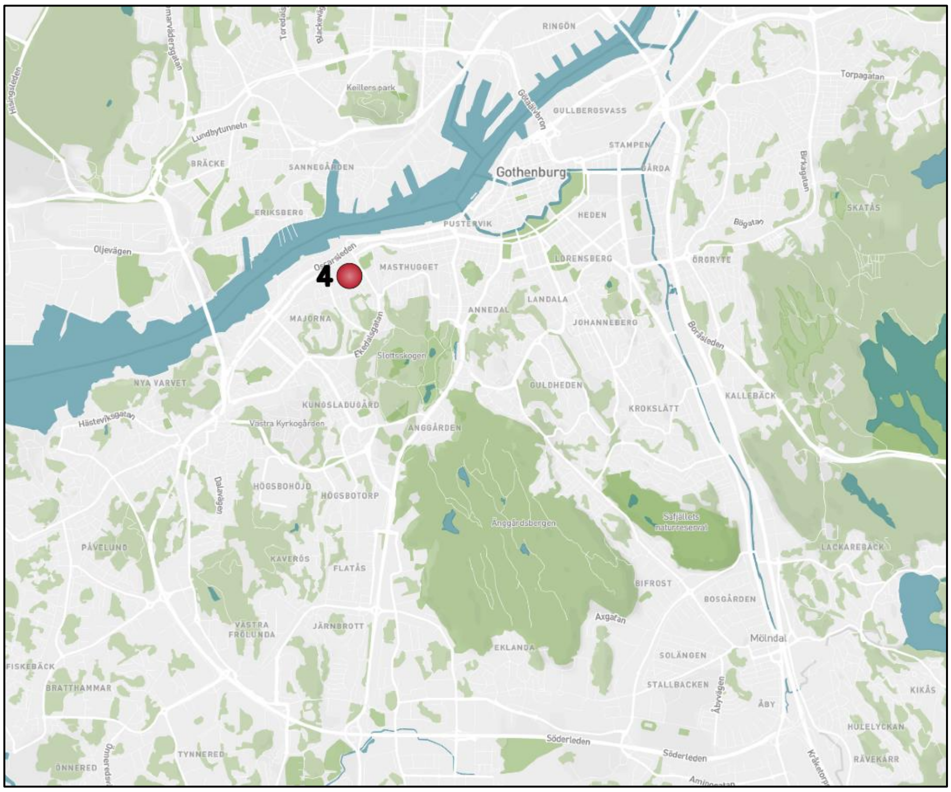

Vasastaden 5 Kv. Björken
Ritning till Nybyggnad å tomten No 75 i 15 Roten
477922
Fasad åt Erik Dahlbergsgatan
0
10
20
30
40
50 Fot

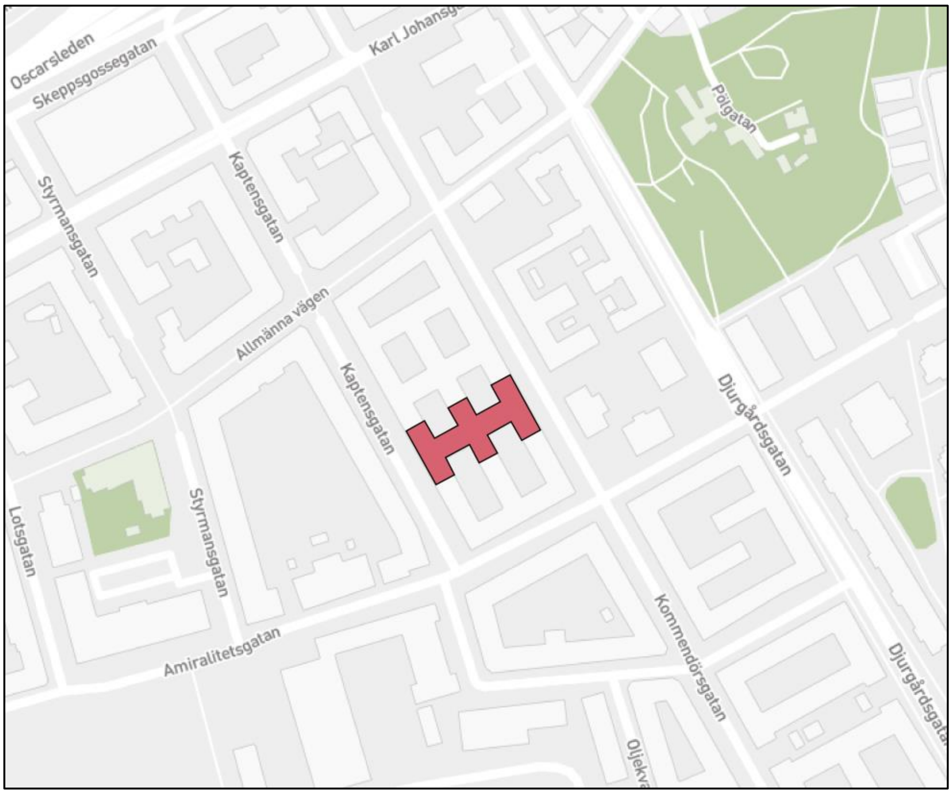
SECTIONS


Vasastaden 5 Kv. Björken № 11
Ritning till Förändring af huset N:o 73 i Staden 13de rote.
477925
Garderob
Garderob
Genomsk. a - b.
Genomsk. c - d.

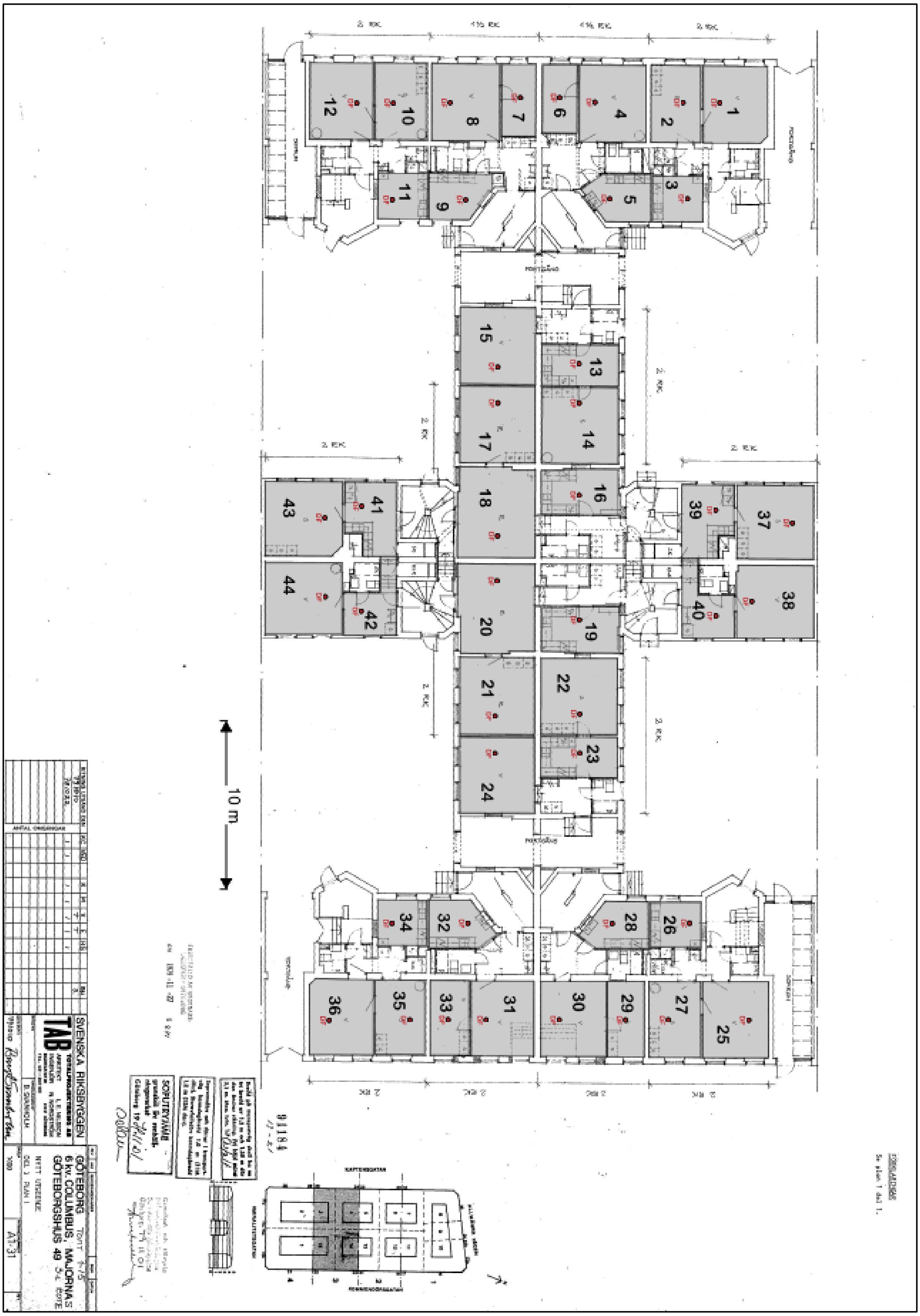

Ritning till nybyggnad å tomten № 73 i 13 roten
Vasastaden 5 Kv. Björken № 11
477921
Genomskärning A-B
C-D
E-F
G-H

Appendix 3D – 4_Majorna 306:16

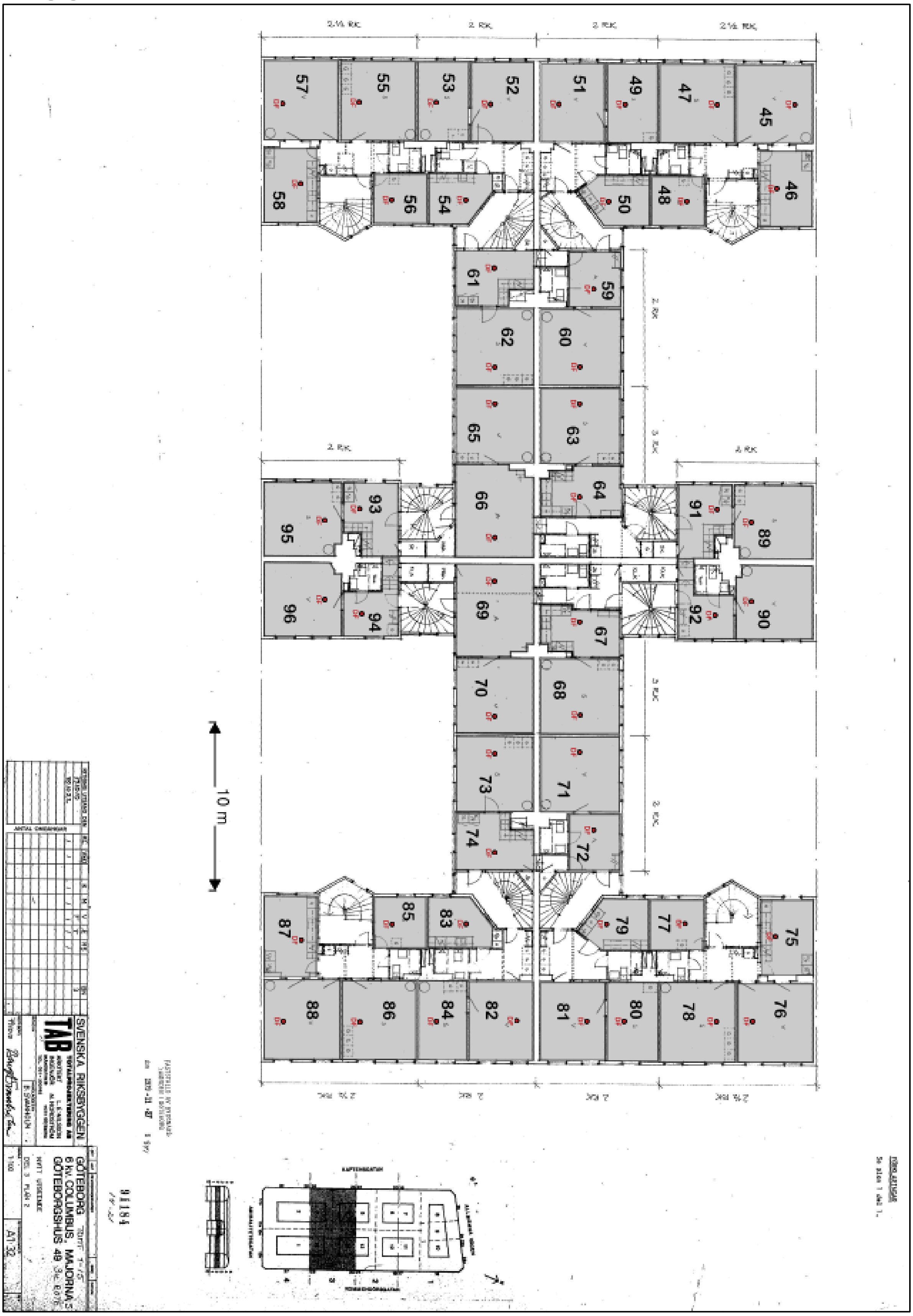




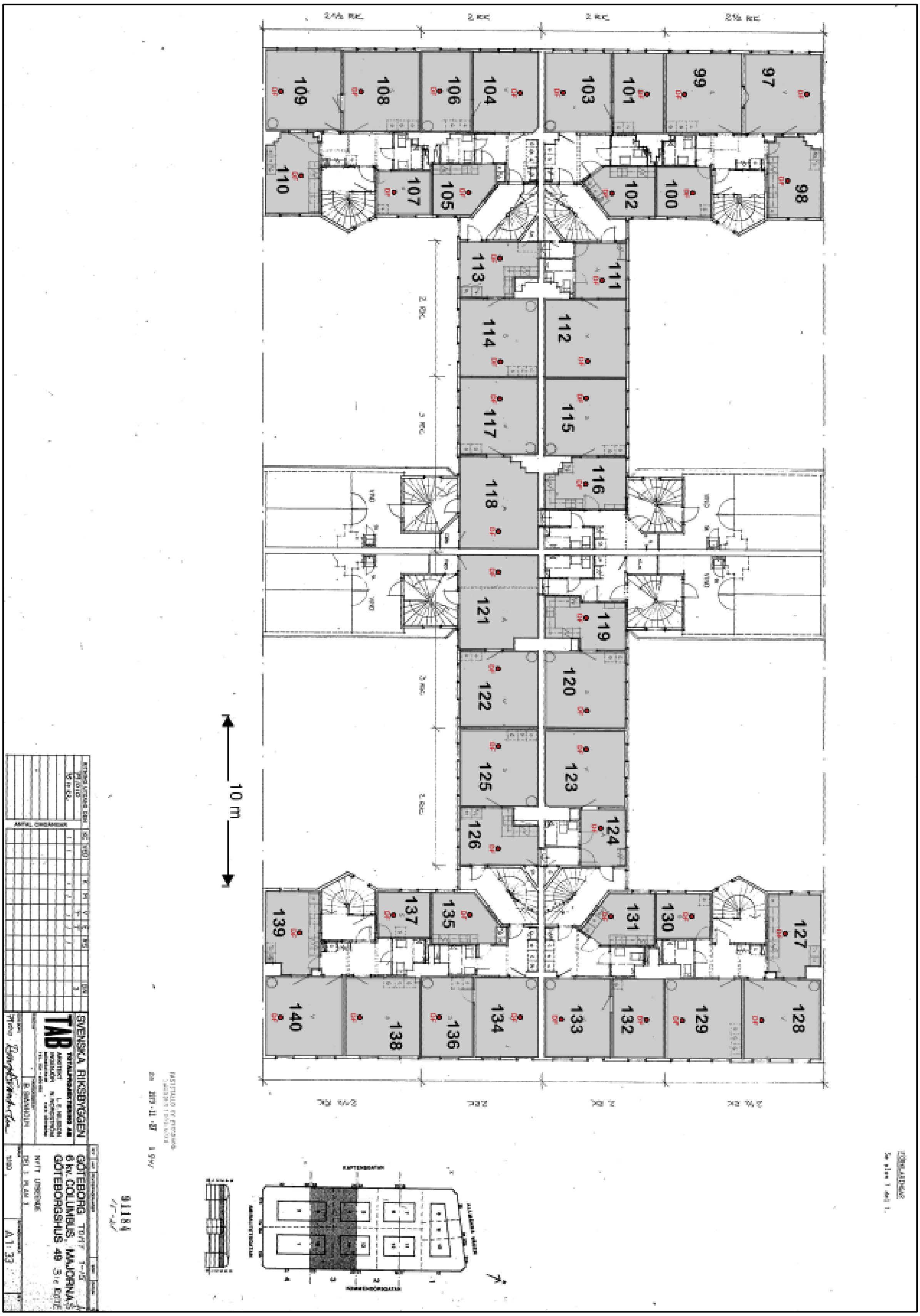
FLOOR 1



FLOOR 2



FLOOR 3



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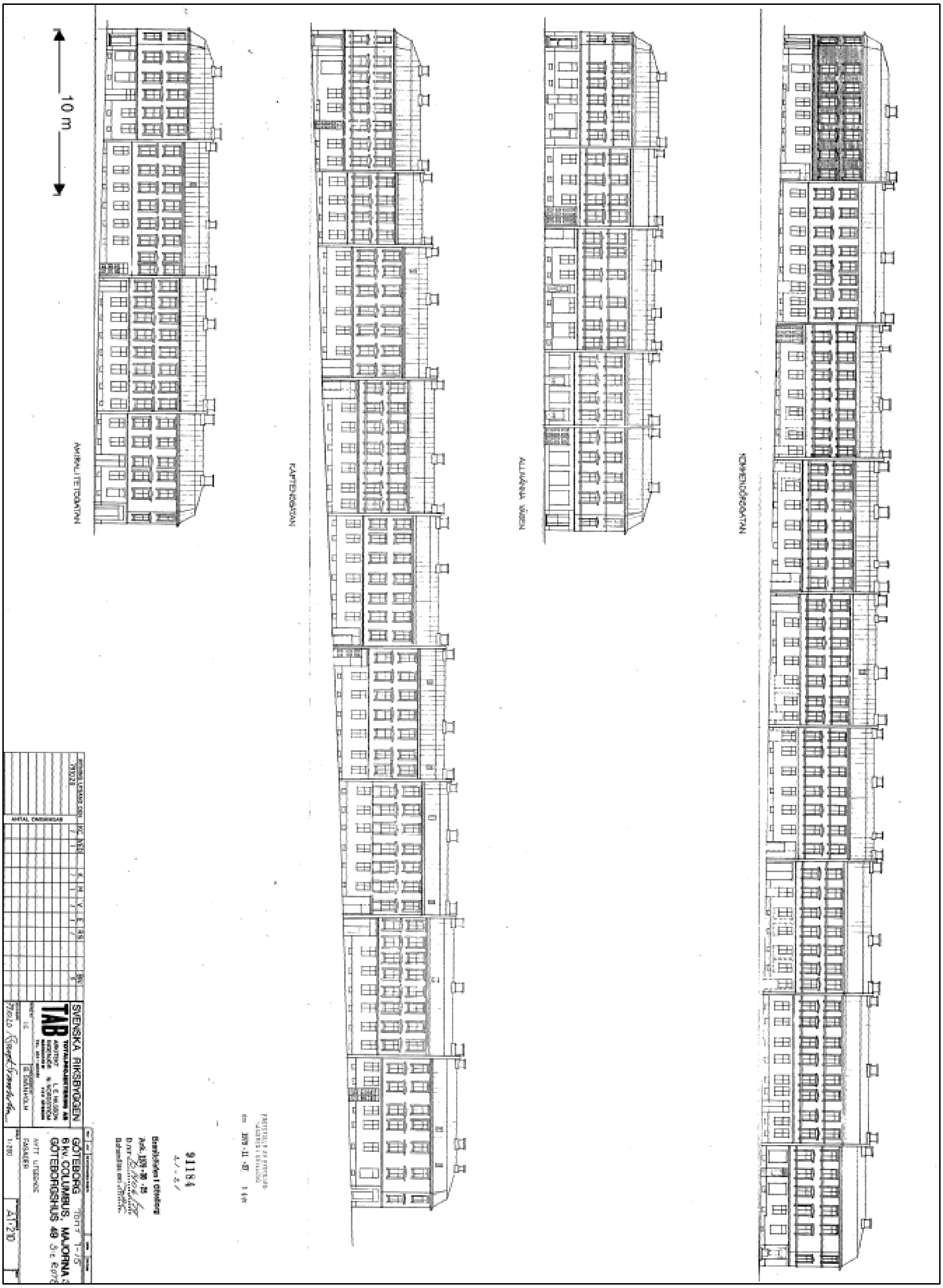
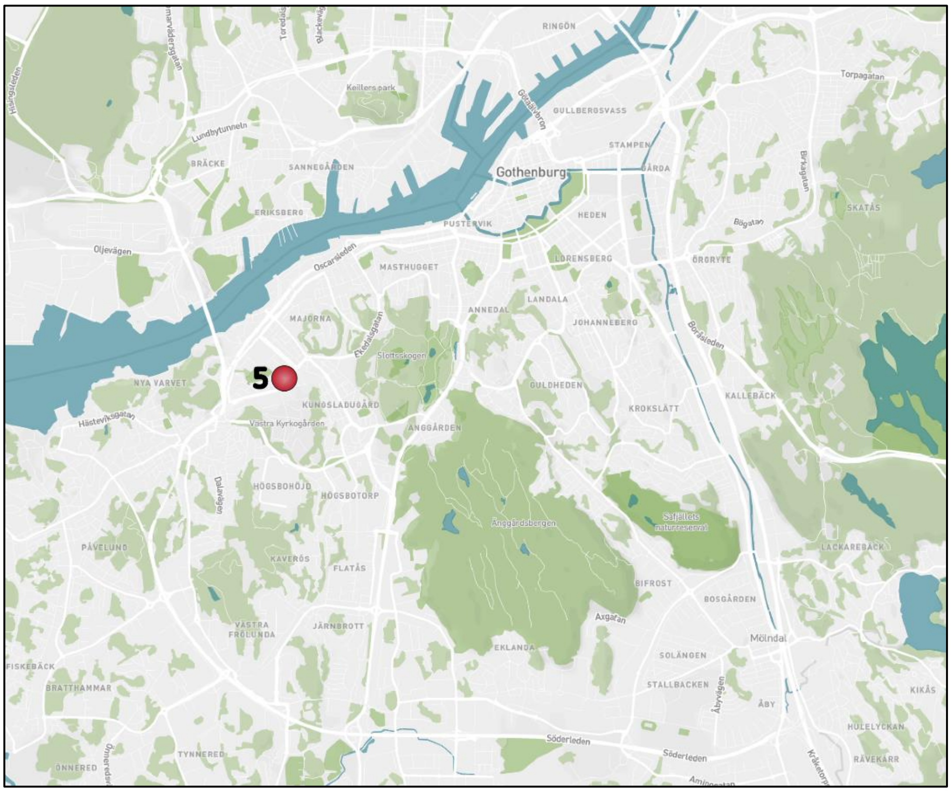
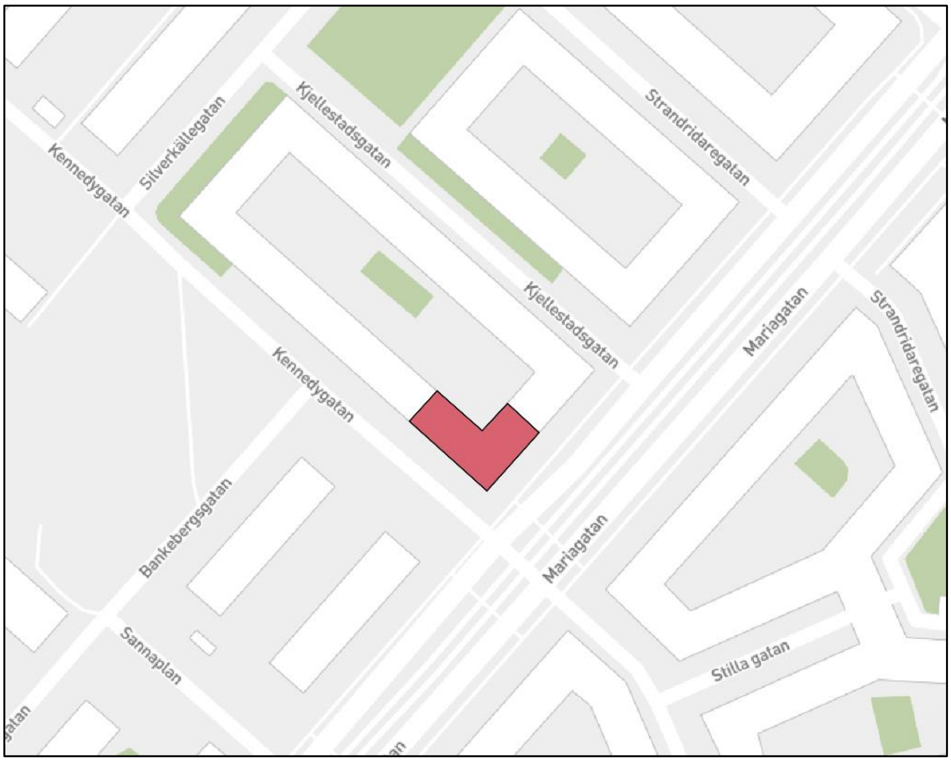
10 m

FACADES


10 m
AMIRALITETSGATAN
KAPTENSGATAN
ALLMÄNNA VÄGEN
KOMMENDÖRSGATAN
SVENSKA RIKSBYGGEN
TAB
91184

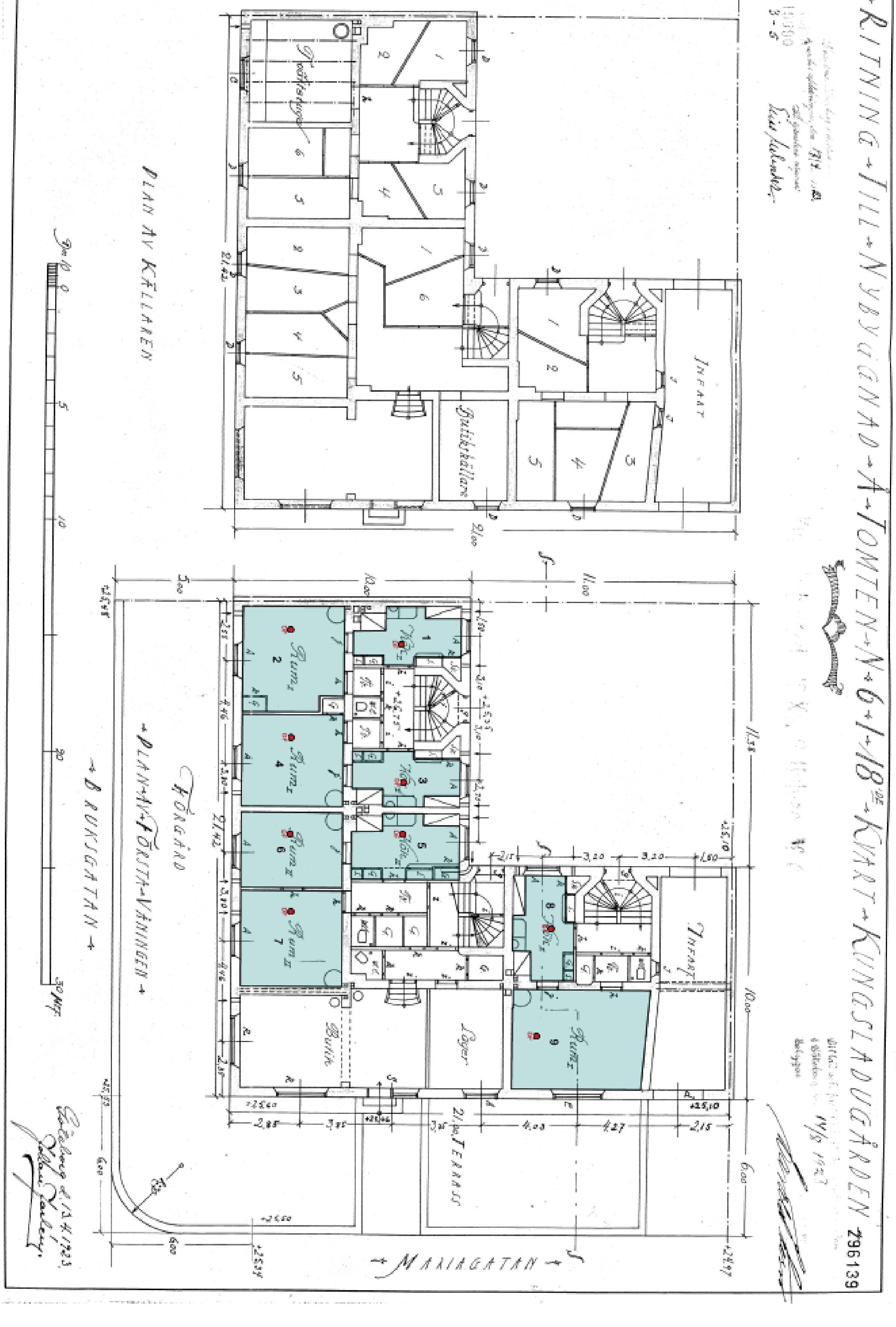
Appendix 3E – 5_Kungsladugård 18:6





SIMULATION TYPE 1

FLOORPLANS



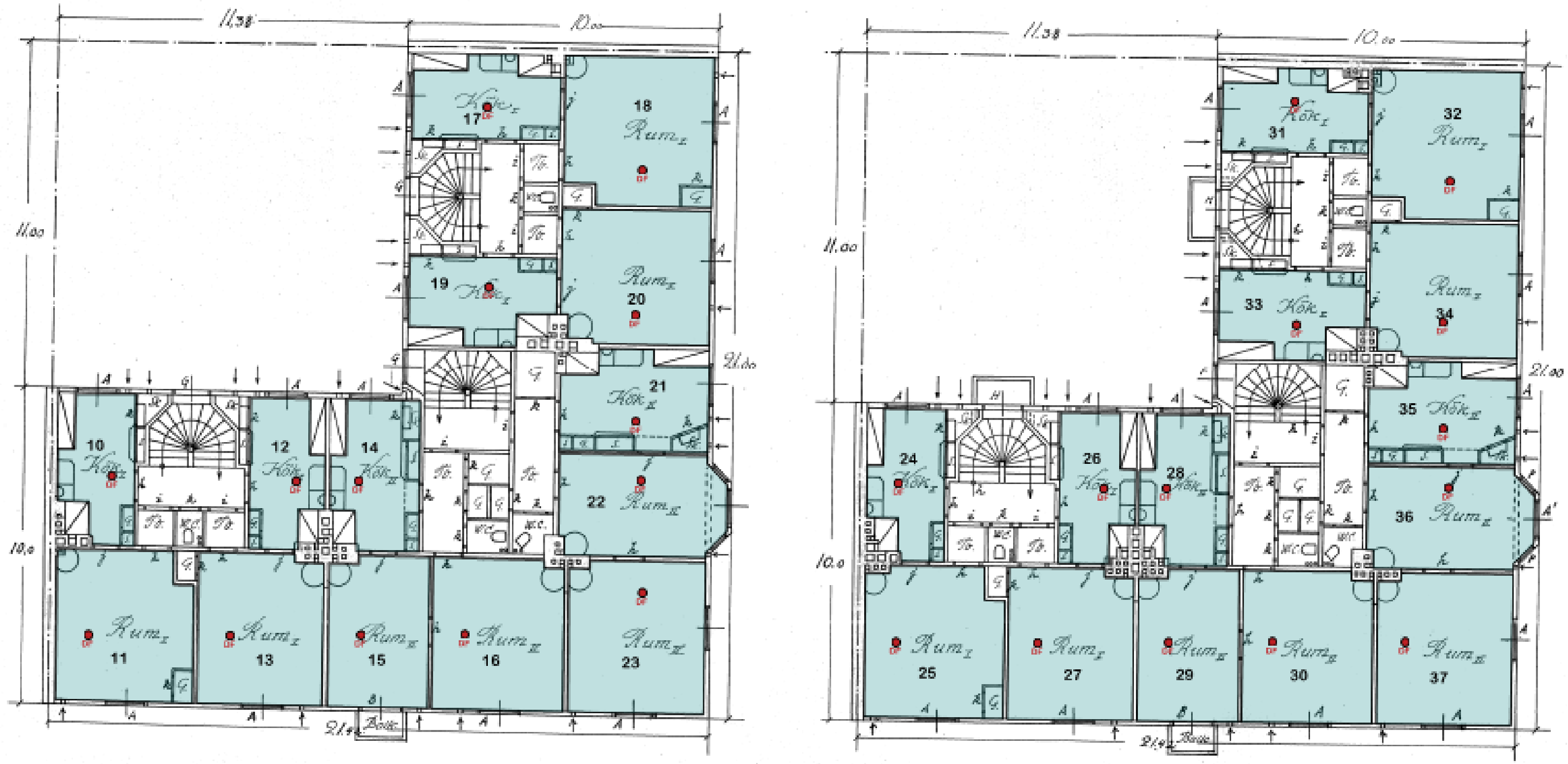
RITNING TILL NYBYGGNAD Å TOMTEN № 61 18DE KVART KUNGSLADUGÅRDEN

296140

Göteborg d. 17/4 23.
Elias Åhlander

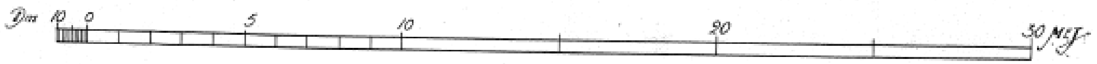
19090
4 - 5

Göteborg den 17/5 1923



PLAN AV ANDRA VÅNINGEN

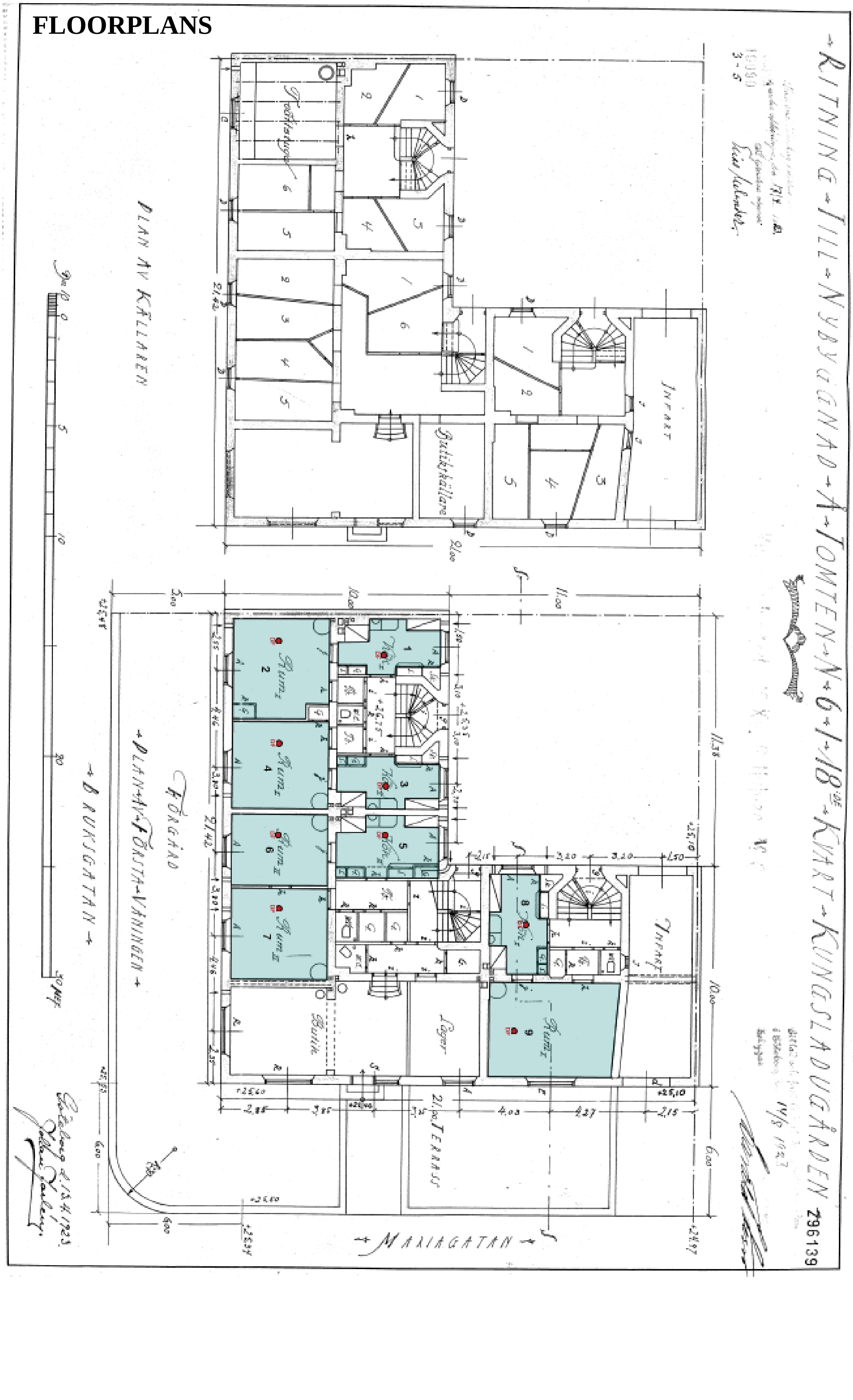
PLAN AV TREDJE VÅNINGEN



Göteborg d. 13. 4. 1923.
Johan Jarlén

SIMULATION TYPE 2

FLOORPLANS



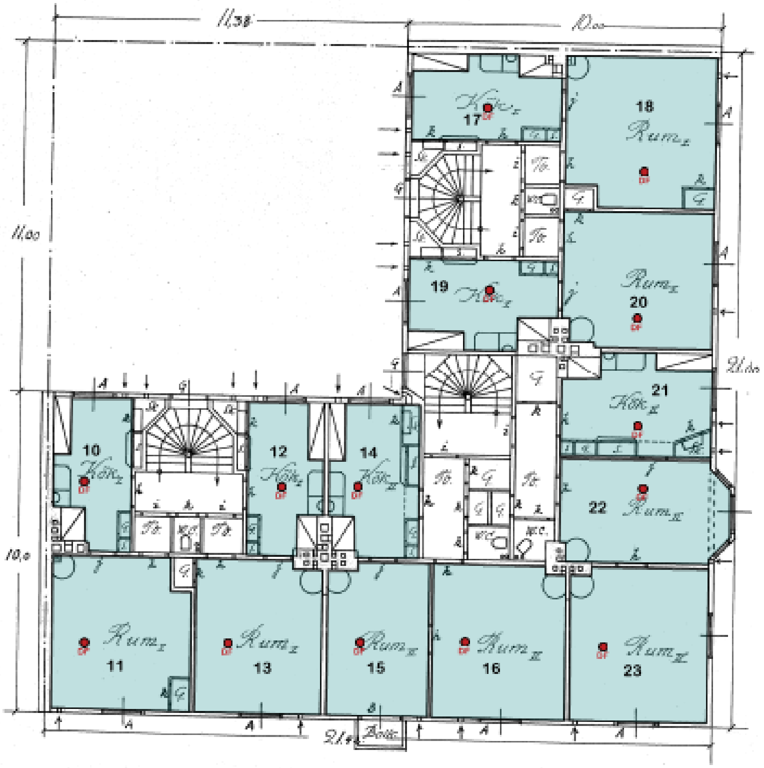
RITNING TILL NYBYGGNAD Å TOMTEN № 61 18:DE KVART KUNGSLADUGÅRDEN

296140

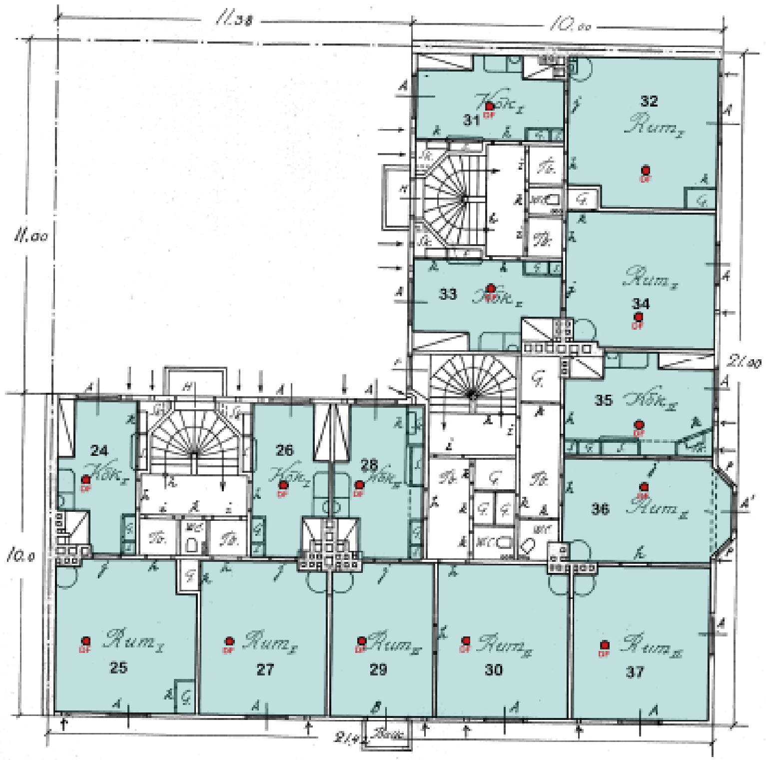
19990
4 - 5

Eriks Ahlander

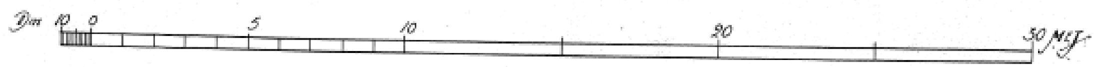
Göteborg 17/8 1923



PLAN AV ANDRA VÅNINGEN

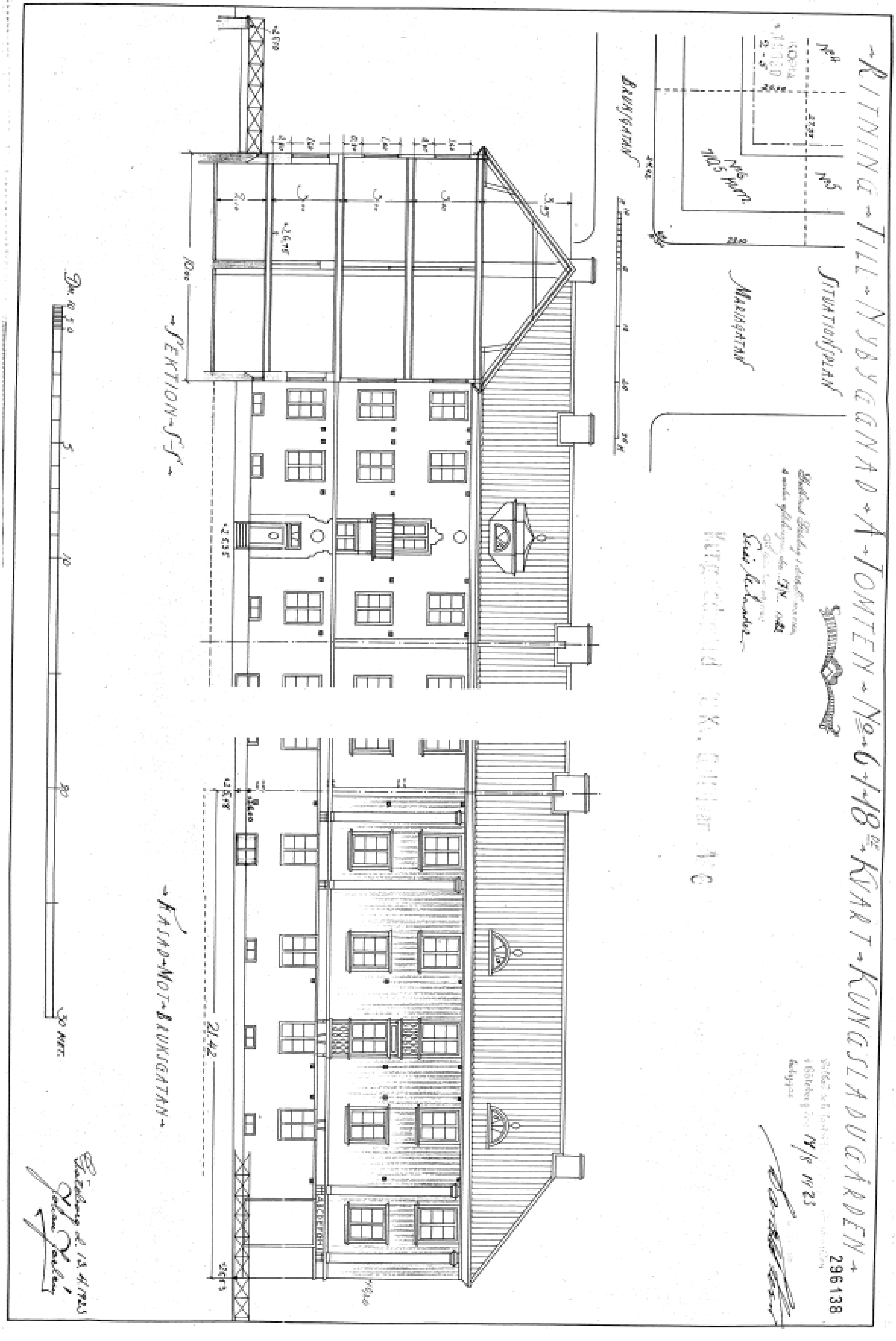


PLAN AV TREDJE VÅNINGEN

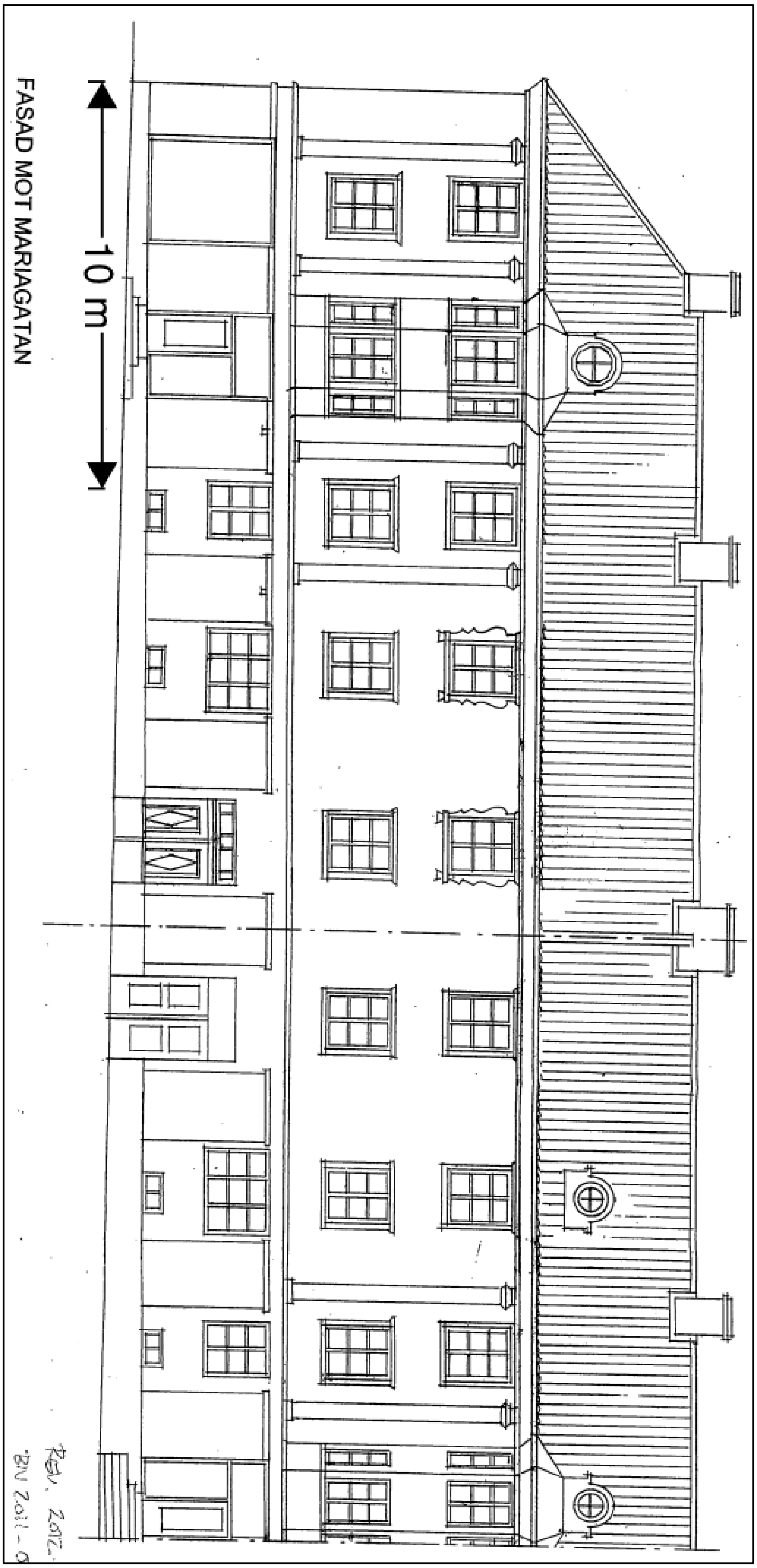


Göteborg d. 13.4.1923.
Johan Garlén

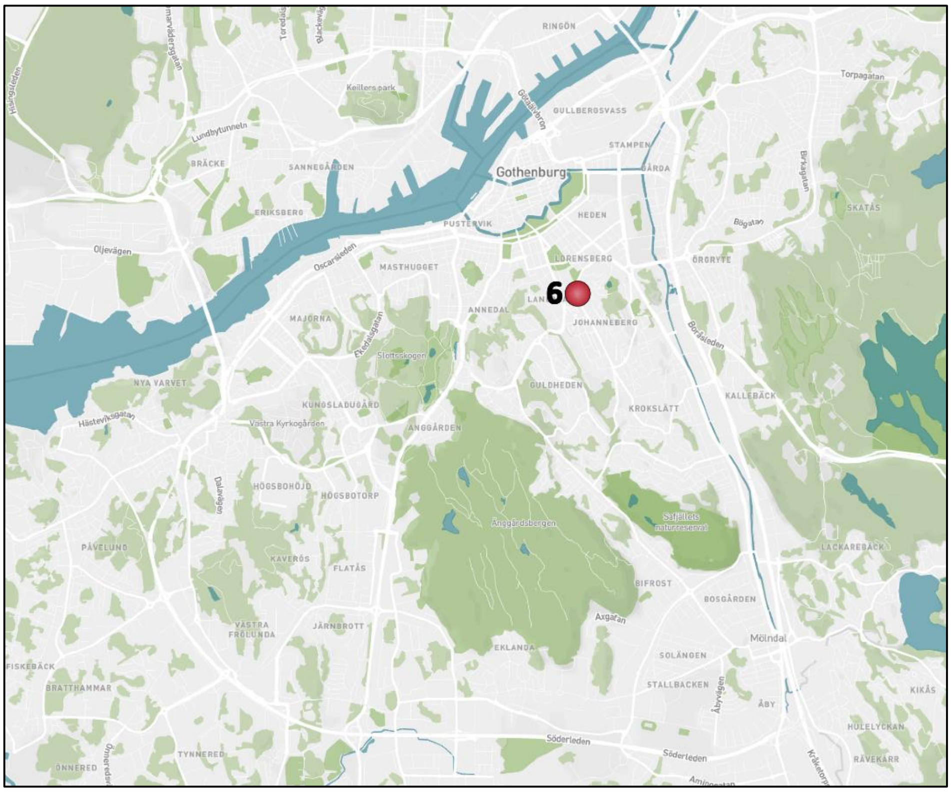
FACADE AND SECTION

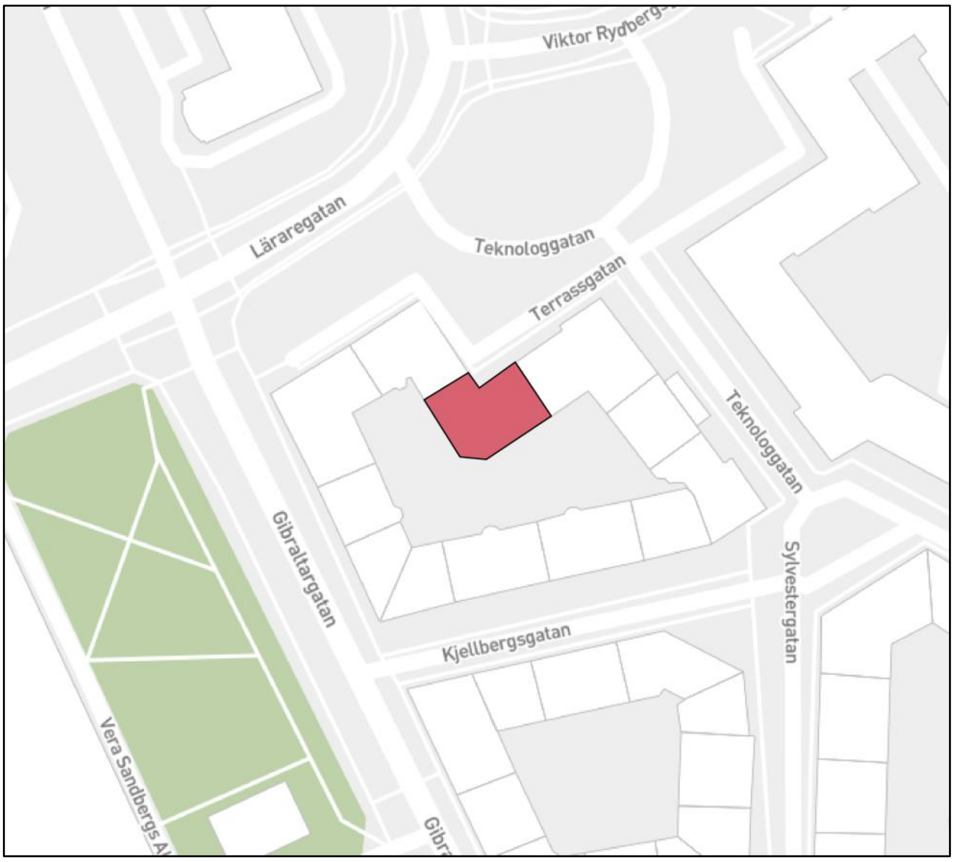


FACADE



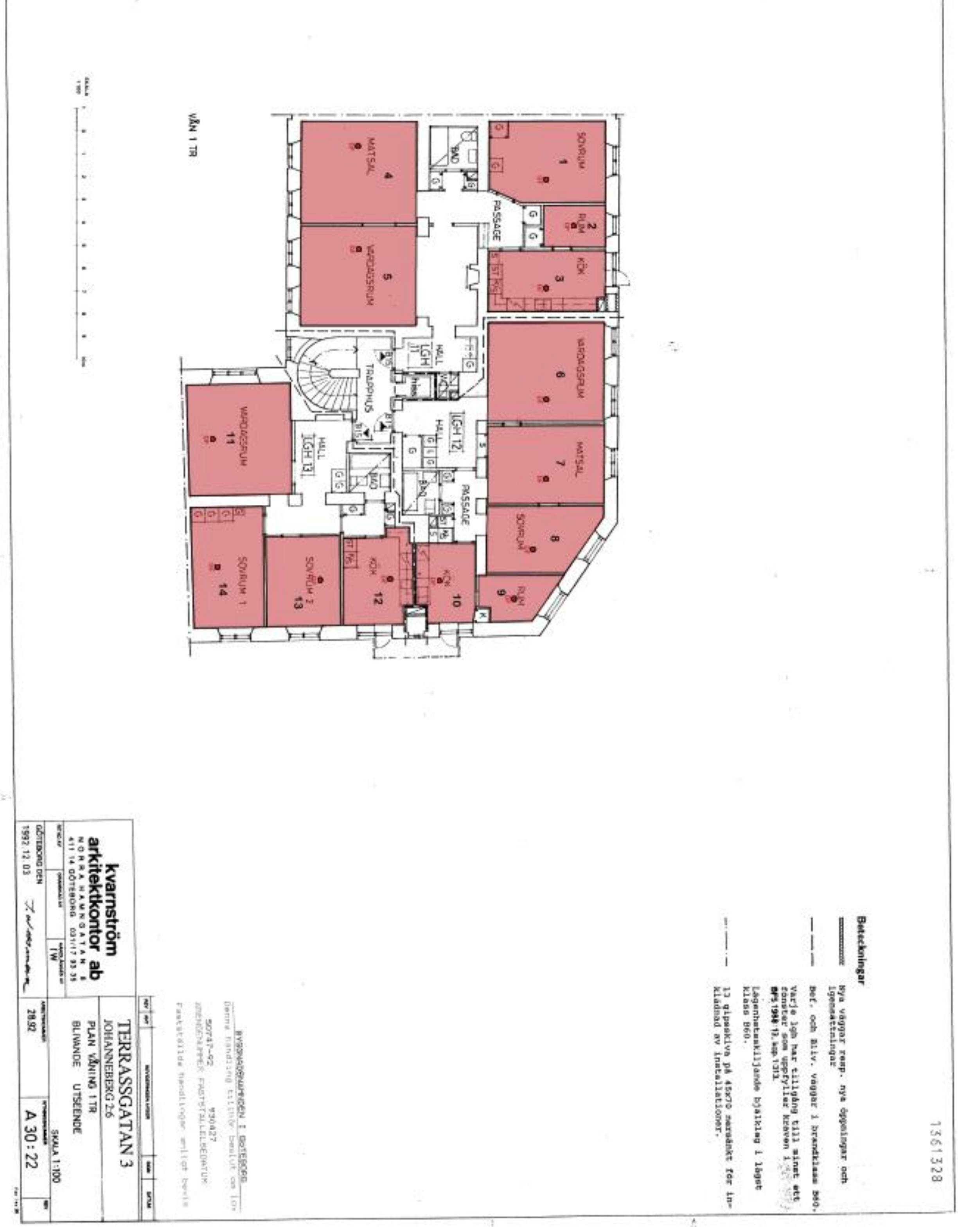
Appendix 3F – 6_Johanneberg 2:6





SIMULATION TYPE 1

FLOORPLANS



1361329

Beteckningar

	Nya väggar resp. nya öppningar och igensättningar
	Bef. och Bliv. väggar i brandklass B60.
	Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:12, kap. 1:313.
	Lägenhetsskiljande bjälklag i lägst klass B60.
	13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov
90747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM
Fastställda handlingar enligt bevis

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35
HANDLÄGGARE AV: DW
GÖTEBORG DEN 1992.12.03

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 2 TR
BLIVANDE UTSEENDE
SKALA 1:100
ARBETSNUMMER 28,92
RITNINGSNUMMER A 30: 23

1361330

Beteckningar

Nya väggar resp. nya öppningar och igensättningar

Bef. och Bliv. väggar i brandklass B60.

Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:13, kap.1:313.

Lägenhetsskiljande bjälklag i lägst klass B60.

13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

SKALA 1:100

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov

50747-92 930427
ARENDENUMMER FASTSTÄLLELSEDATUM

Fastställda handlingar enligt bevis

REV	ANT	REVIDERINGEN AVSER	SIGN	DATUM

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

HANDLÄGGES AV: I.W

GÖTEBORG DEN 1992.12.03 T. Wessman

TERRASSGATAN 3
JOHANNEBERG 2:6

PLAN VÅNING 3 TR
BLIVANDE UTSEENDE

SKALA 1:100

28,92

A 30:24

1361331

Beteckningar

- (hatched line) Nya väggar resp. nya öppningar och igensättningar
- — — — Bef. och Bliv. väggar i brandklass B60.
- Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:13, kap. 1:313.
- Lägenhetsskiljande bjälklag i lägst klass B60.
- —·—·— 13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov

50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM

Fastställda handlingar enligt bevis

REV	ANT	REVIDERINGEN AVSER	SIGN	DATUM
A		LUCKA I BALK- BJÄLKLAG	AHN	92.12.10

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

RITAD AV | GRANSKAD AV | HANDLÄGGES AV: I.W

GÖTEBORG DEN 1992.12.03 J. Wessman

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 4TR
BLIVANDE UTSEENDE

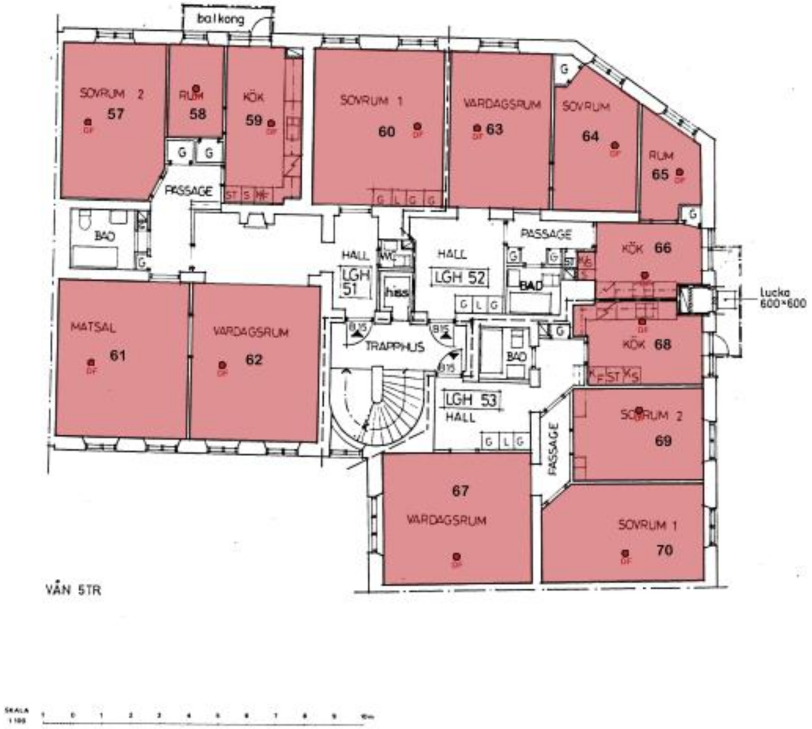
SKALA 1:100

ARBETSNUMMER: 28,92 | RITNINGSNUMMER: A 30:25 | REV: A

1361332

Beteckningar

(hatched line)	Nya väggar resp. nya öppningar och igensättningar
(dashed line)	Bef. och Bliv. väggar i brandklass B60.
	Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:13, kap 1:313.
	Lägenhetsskiljande bjälklag i lägst klass B60.
(dash-dot line)	13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.



BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov

50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM

Fastställda handlingar enligt bevis

REV	ANT	REVIDERINGEN AVSER	SIGN	DATUM
A		LUCKA I BALK-BJÄLKLAG	AHN	92.12.10

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

RITAD AV | GRANSKAD AV | HANDLÄGGES AV: LW

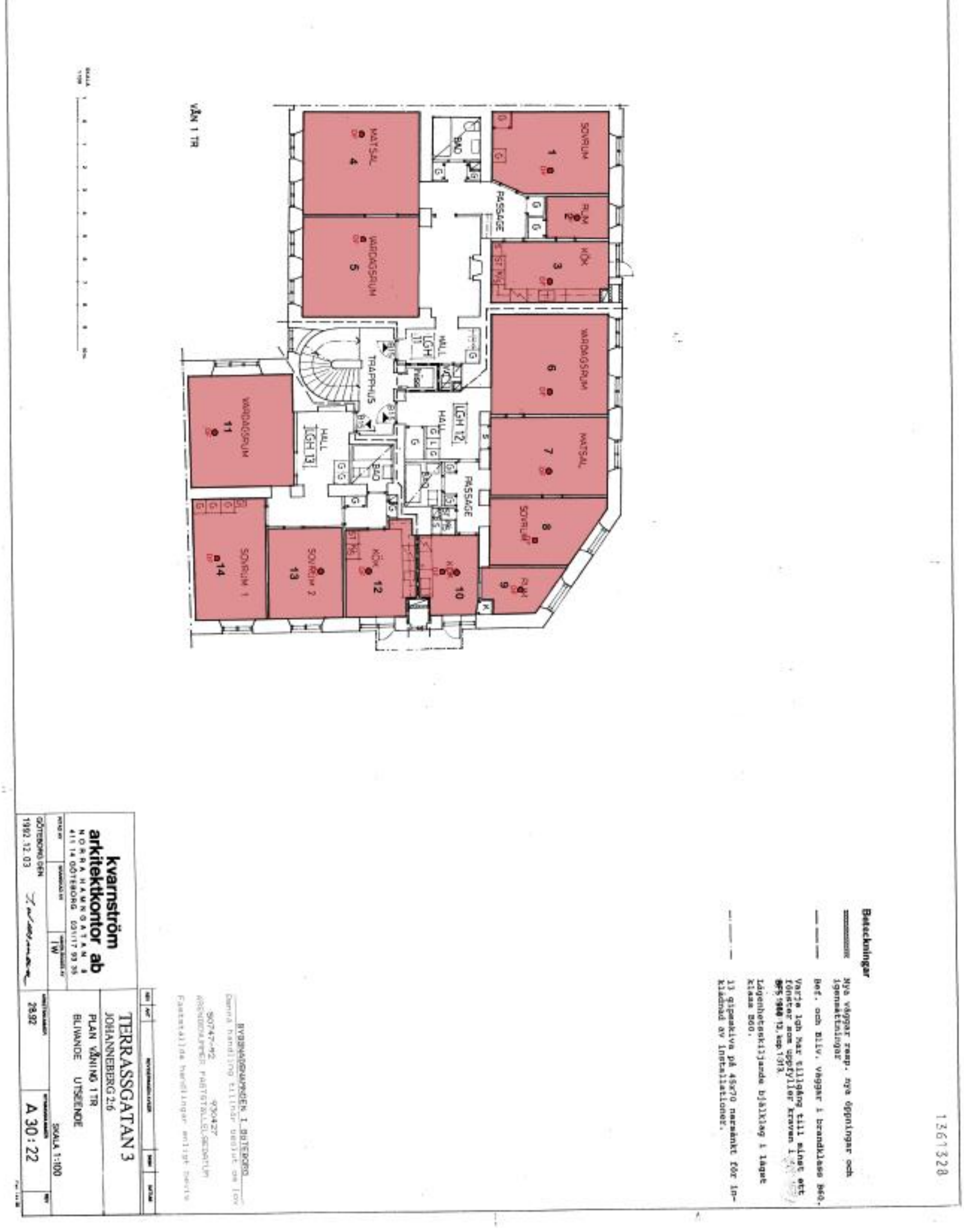
GÖTEBORG DEN 1992.12.03 T. Nessman

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 5 TR
BLIVANDE UTSEENDE
SKALA 1:100

ARBETSNUMMER: 28.92
RITNINGSNUMMER: A 30:26
REV: A

SIMULATION TYPE 2

FLOORPLANS



1361329

Beteckningar

- Nya väggar resp. nya öppningar och igensättningar
- Bef. och Bliv. väggar i brandklass B60.
- Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:13, kap 1:313
- Lägenhetsskiljande bjälklag i lägst klass B60.
- 13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov
50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM
Fastställda handlingar enligt beslut

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 83 35

IW

GÖTEBORG DEN 1992.12.03

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 2 TR
BLIVANDE UTSEENDE
SKALA 1:100

28,92

A 30: 23

1361330

Beteckningar

(hatched line)	Nya väggar resp. nya öppningar och igensättningar
— — —	Bef. och Bliv. väggar i brandklass B60.
	Varje lgh har tillgång till minst ett fönster som uppfyller kraven i [illegible] BFS [illegible], kap.1:313.
	Lägenhetsskiljande bjälklag i lägst klass B60.
–·–·–	13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

VÅN 3 TR

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

HANDLÄGGARE: I.W

GÖTEBORG DEN 1992.12.03

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 3 TR
BLIVANDE UTSEENDE

SKALA 1:100

2892

A 30:24

1361331

Beteckningar

Nya väggar resp. nya öppningar och igensättningar

Bef. och Bliv. väggar i brandklass B60.

Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:18, kap.1:313.

Lägenhetsskiljande bjälklag i lägst klass B60.

13 gipsskiva på 45x70 nersänkt för inklädnad av installationer.

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov

50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM

Fastställda handlingar enligt bevis

REV	ART	REVIDERINGEN AVSER	SIGN	DATUM
A		LUCKA I BALK-BJÄLKLAG	AHN	92.12.10

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

HANDLÄGGES AV: I.W
GÖTEBORG DEN 1992.12.03

TERRASSGATAN 3
JOHANNEBERG 2:6

PLAN VÅNING 4 TR
BLIVANDE UTSEENDE

SKALA 1:100

ARBETSNUMMER: 2892
RITNINGSNUMMER: A 30 : 25
REV: A

1361332

Beteckningar

Nya väggar resp. nya öppningar och igensättningar

Bef. och Bliv. väggar i brandklass B60.

Varje lgh har tillgång till minst ett fönster som uppfyller kraven i BFS 1988:13, kap 1:313.

Lägenhetsskiljande bjälklag i lägst klass B60.

13 gipsskiva på 45x70 nersänkt för inkladnad av installationer.

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov
50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM
Fastställda handlingar enligt bevis

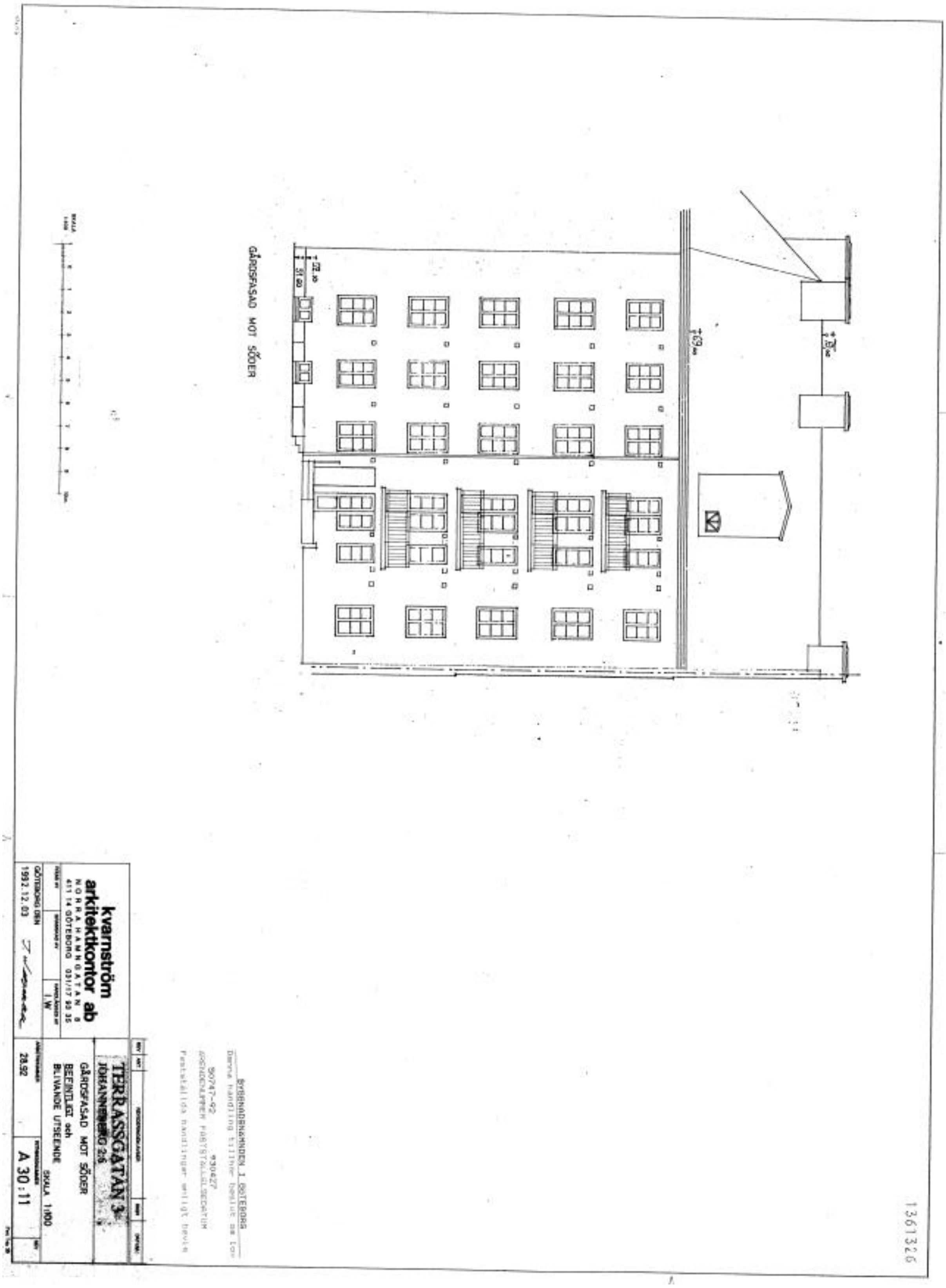
A	LUCKA I BALK-BJÄLKLAG	AHN	92.12.10

kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

HANDLÄGGARE AV: I.W
GÖTEBORG DEN 1992.12.03

TERRASSGATAN 3
JOHANNEBERG 2:6
PLAN VÅNING 5 TR
BLIVANDE UTSEENDE
SKALA 1:100
2892
A 30:26
A

FACADES


GÅRDSFASAD MOT SÖDER
kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG
1992.12.03
TERRASSGATAN 3
JOHANNEBERG 2:6
GÅRDSFASAD MOT SÖDER
BEFINTLIGT och BLIVANDE UTSEENDE
SKALA 1:100
28.92
A 30:11
1361326

1361325

GÅRDSFASAD MOT VÄSTER

GÅRDSFASAD MOT SYDVÄST

BYGGNADSNÄMNDEN I GÖTEBORG
Denna handling tillhör beslut om lov
50747-92 930427
ÄRENDENUMMER FASTSTÄLLELSEDATUM
Fastställda handlingar enligt bevis

A	STEGE FÖR NÖDUTRYMN	AHN	92.12.10

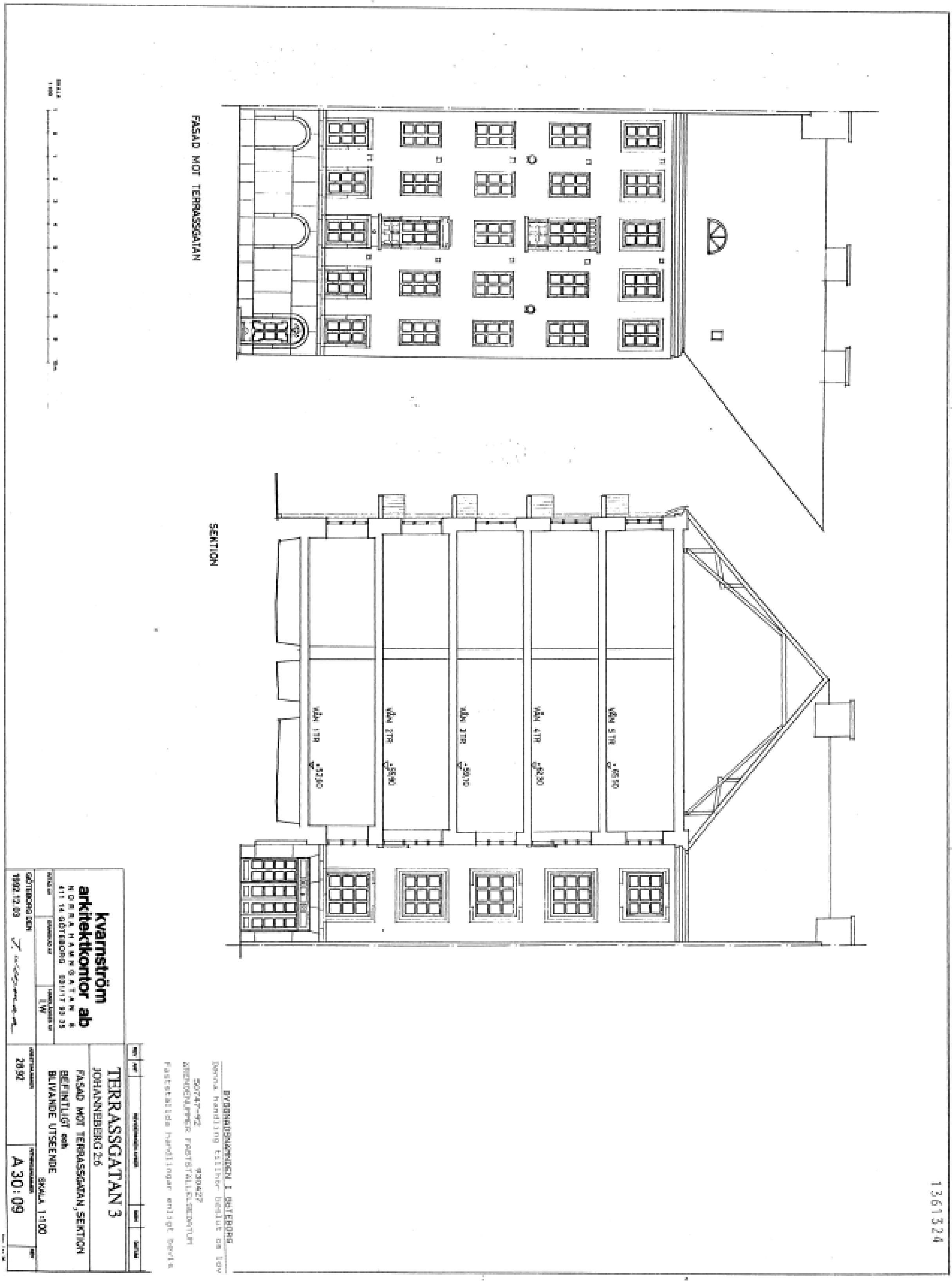
kvarnström arkitektkontor ab
NORRA HAMNGATAN 8
411 14 GÖTEBORG 031/17 93 35

HANDLÄGGARE: I.W
GÖTEBORG DEN 1992.12.03

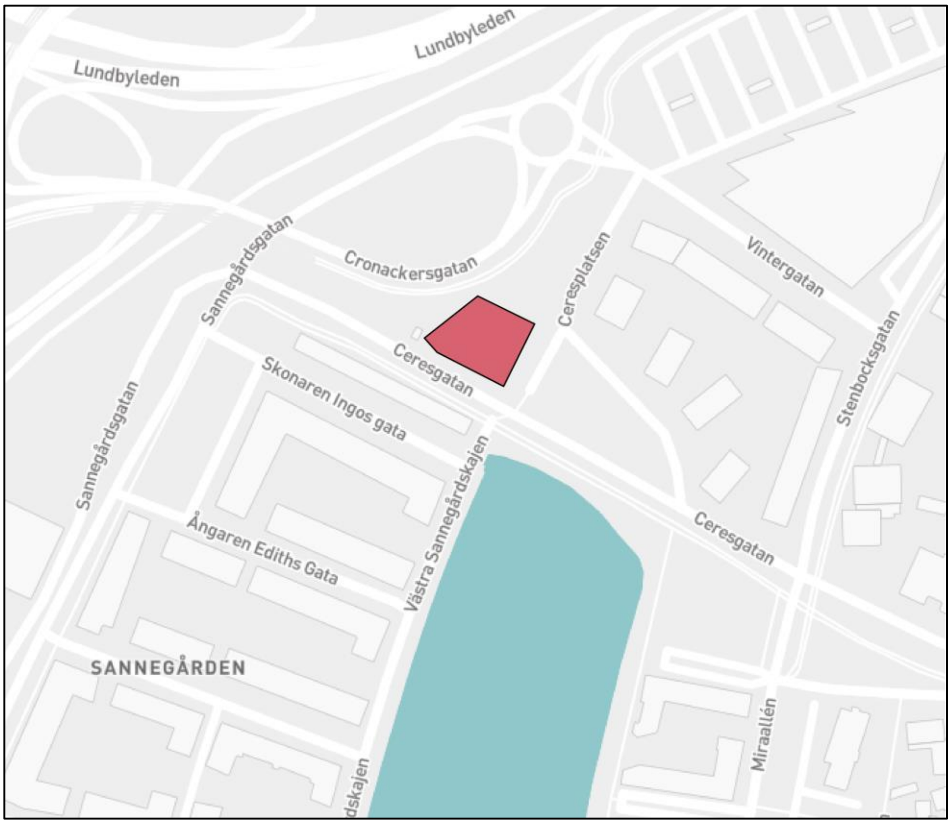
TERRASSGATAN 3
JOHANNEBERG 2:6
GÅRDSFASAD MOT VÄSTER o. SYD VÄST
BEFINTLIGT och
BLIVANDE UTSEENDE
SKALA 1:100

2892 A 30:10 A

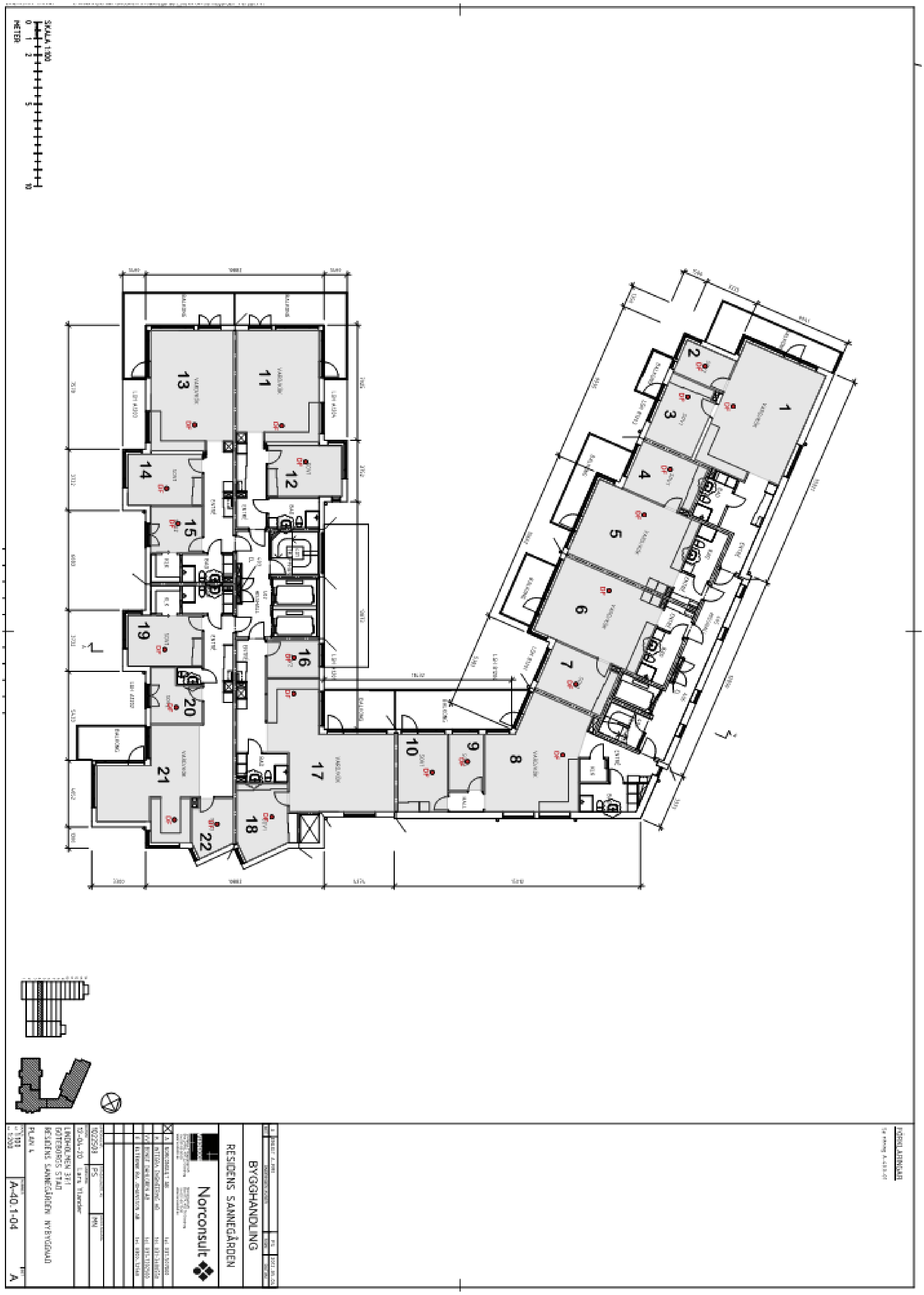
FACADE AND SECTION

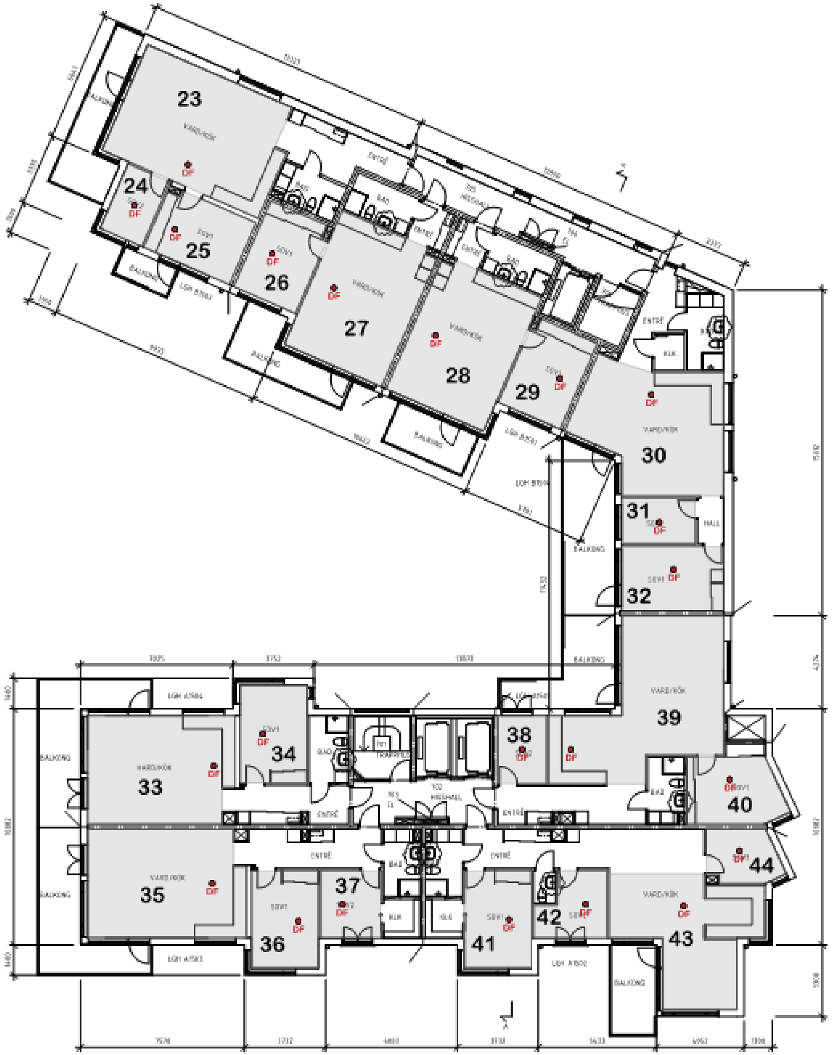


Appendix 3G – 7_Lindholmen 37:1

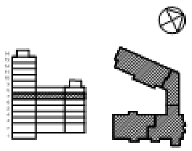


FLOORPLANS





SKALA 1:100
0 1 2 5 10
METER



FÖRKLARINGAR

Se ritning A-40.0-01

BYGGHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A	NORCONSULT AB	tel. 031-501000
K	INTEGRA ENGINEERING AB	tel. 031-5408550
VVS	BENGT DAHLGREN AB	tel. 031-7202500
E	ELTEKNIK OA JOHANSSON AB	tel. 0300-72560

1022508 PS MN

12-04-20 Lars Ylander

LINDHOLMEN 37:1

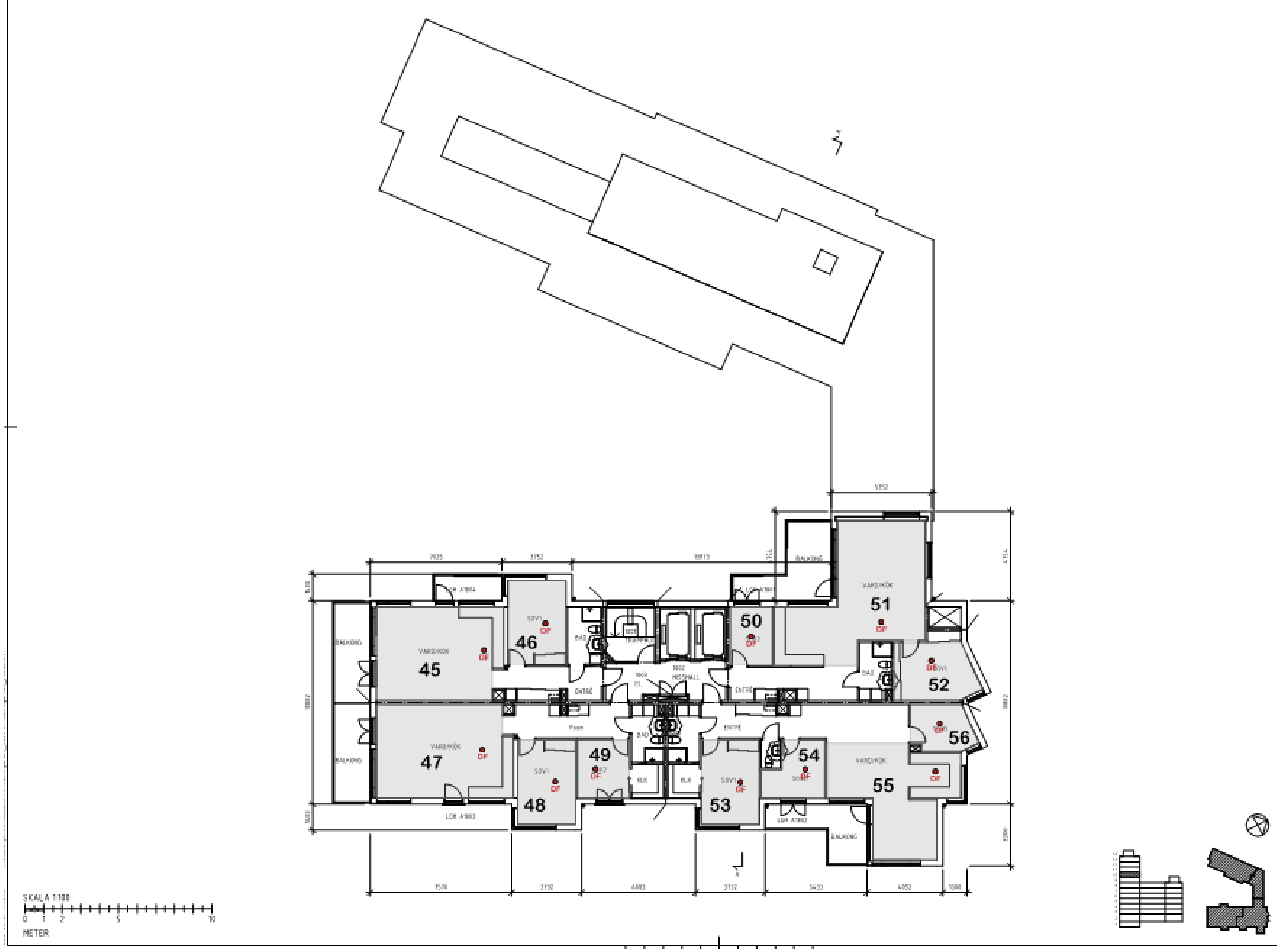
GÖTEBORGS STAD

RESIDENS SANNEGÅRDEN NYBYGGNAD

PLAN 1

1:100 1:200

A-40.1-07 A



FÖRKLARINGAR

Se ritning A-40.0-01

A	ENLIGT A-PM1	PS	2012-05-04

BYGGHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A	NORCONSULT AB	tel. 031-50 7000
K	INTEGRA ENGINEERING AB	tel. 031-3690550
VS	BENGT DAHLGREN AB	tel. 031-7297500
E	ELTEKNIK BA JOHANSSON AB	tel. 0304-17540

1022508 PS MN

12-06-20 Lars Ylander

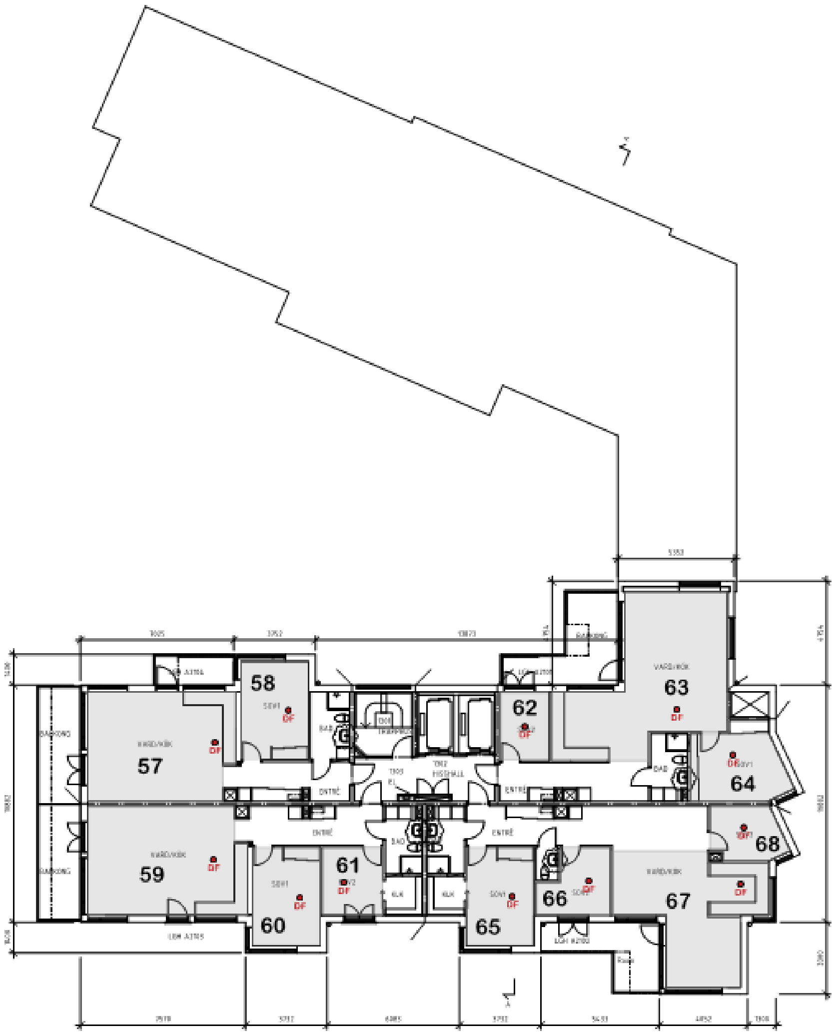
LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

PLAN 10

A1 1:100 A3 1:200 A-40.1-10 A

FÖRKLARINGAR

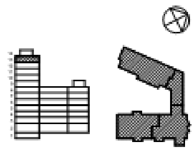
Se ritning A-40.0-01



SKALA 1:100

0 1 2 5 10

METER



A	ÄNDRING	PS	2012-05-04

BYGGHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A	NORCONSULT AB	tel. 031-507000
K	INTEGRA ENGINEERING AB	tel. 031-3400550
VVS	BENGT DAHLGREN AB	tel. 031-7202500
E	ELTEKNIK NA JOHANSSON AB	tel. 0980-17560

1022508 | PS | MN

12-04-20 | Lars Ylander

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

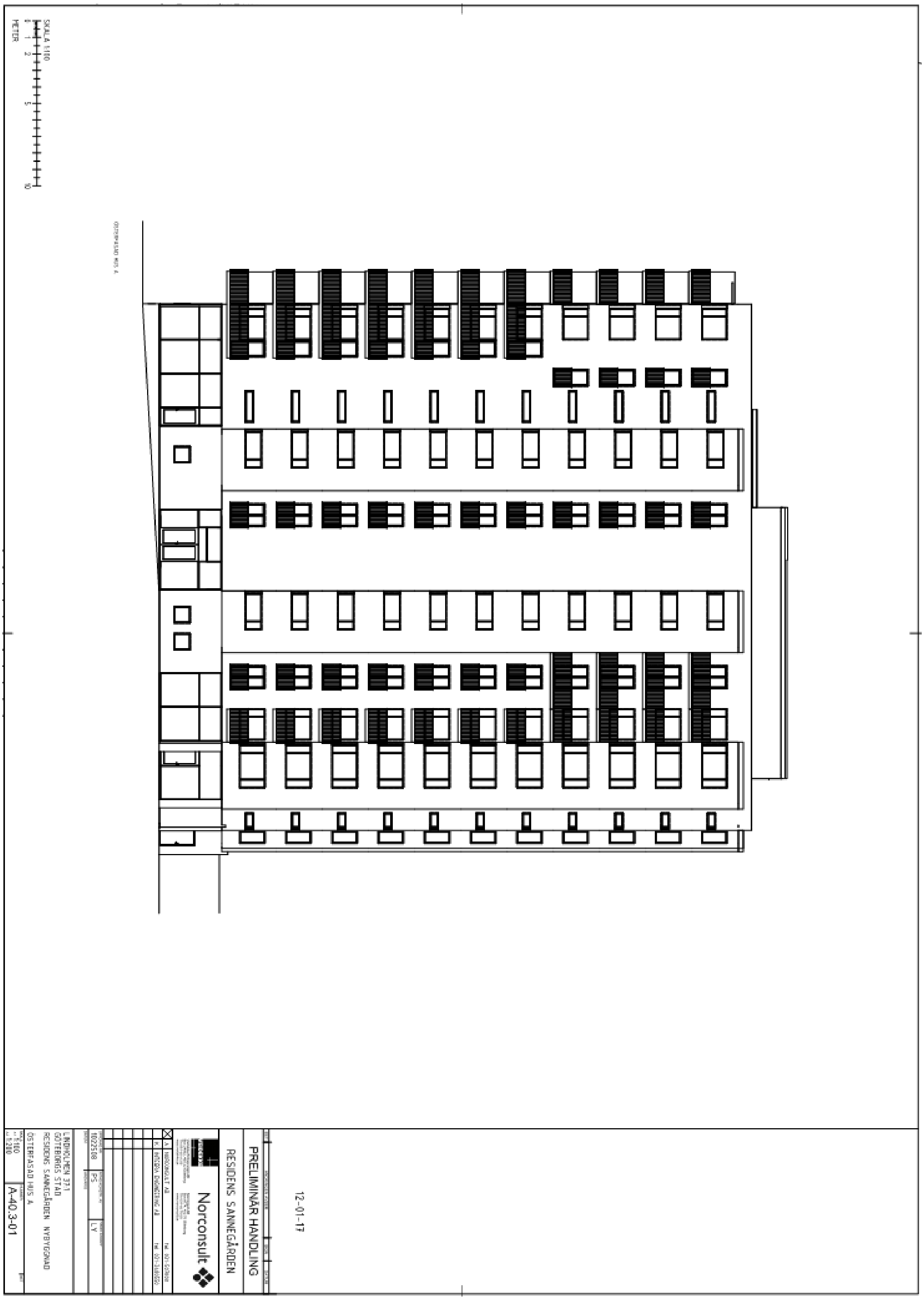
PLAN 13

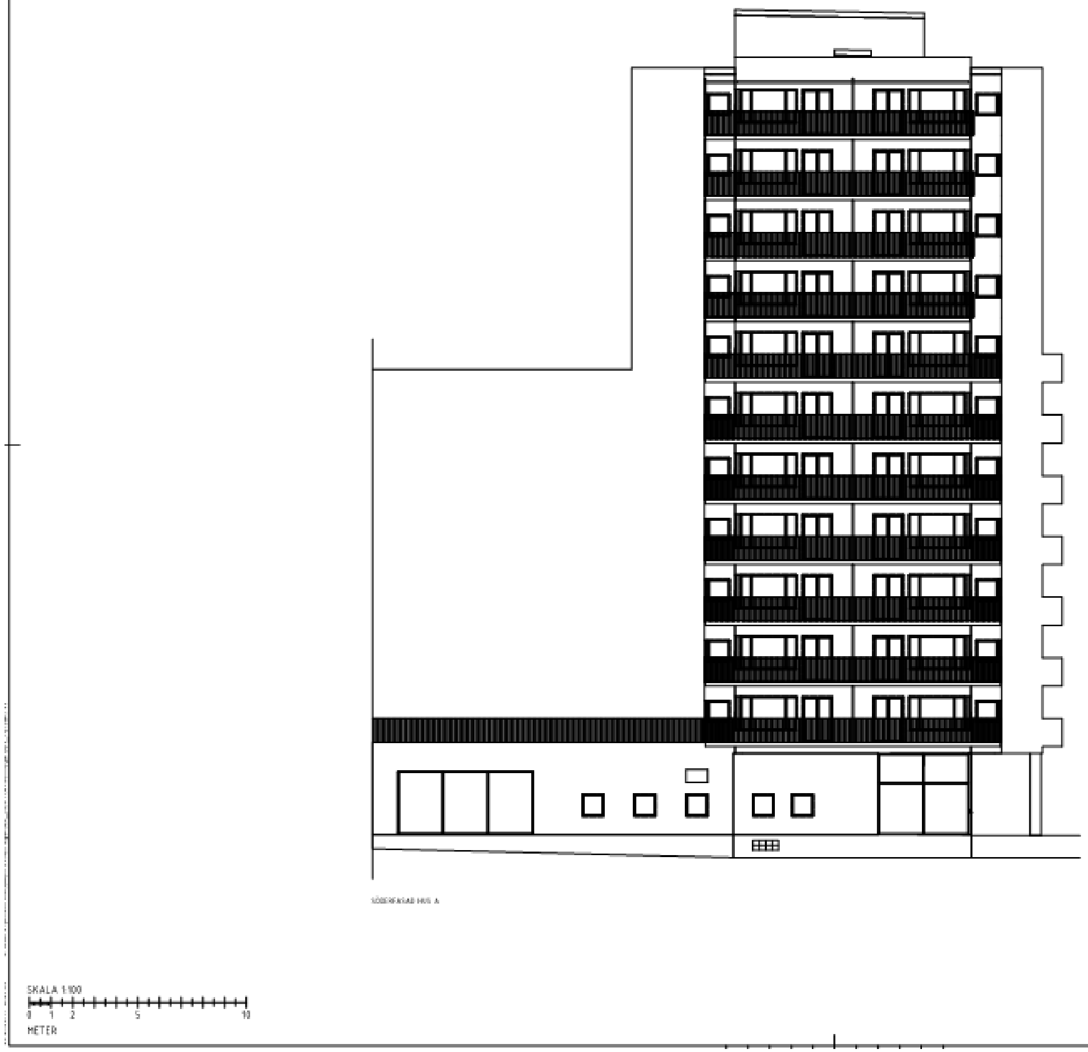
A1 1:100
A3 1:200

A-40.1-13

A

FACADES


PRELIMINÄR HANDLING
RESIDENS SANNEGÅRDEN
Norconsult
12-01-17
A-40.3-01



12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A NORCONSULT AB

K INTEGRA ENGINEERING AB

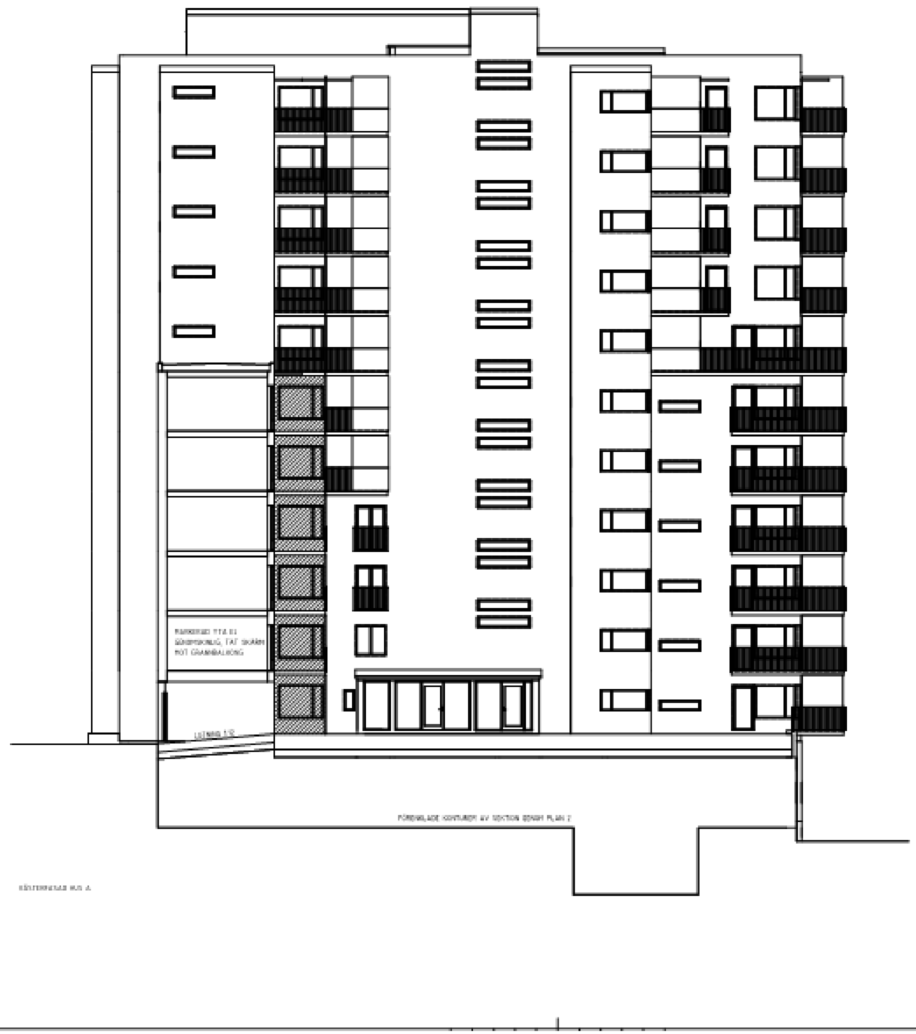
1022588 | PS | LY

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

SÖDERFASAD HUS A

A1 1:100
A3 1:200

A-40.3-02



12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A	NORCONSULT AB	
B	INTEGRA ENGINEERING AB	

1022508	PS	LY

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

VÄSTERFASAD HUS A

A1 1:100
A3 1:200

A-40.3-03

SÖDERFASAD HUS B

SÖDERFASAD HUS A MOT GÅRD

SKALA 1:100
0 1 2 5 10
METER

12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A NORCONSULT AB

K INTEGRA ENGINEERING AB

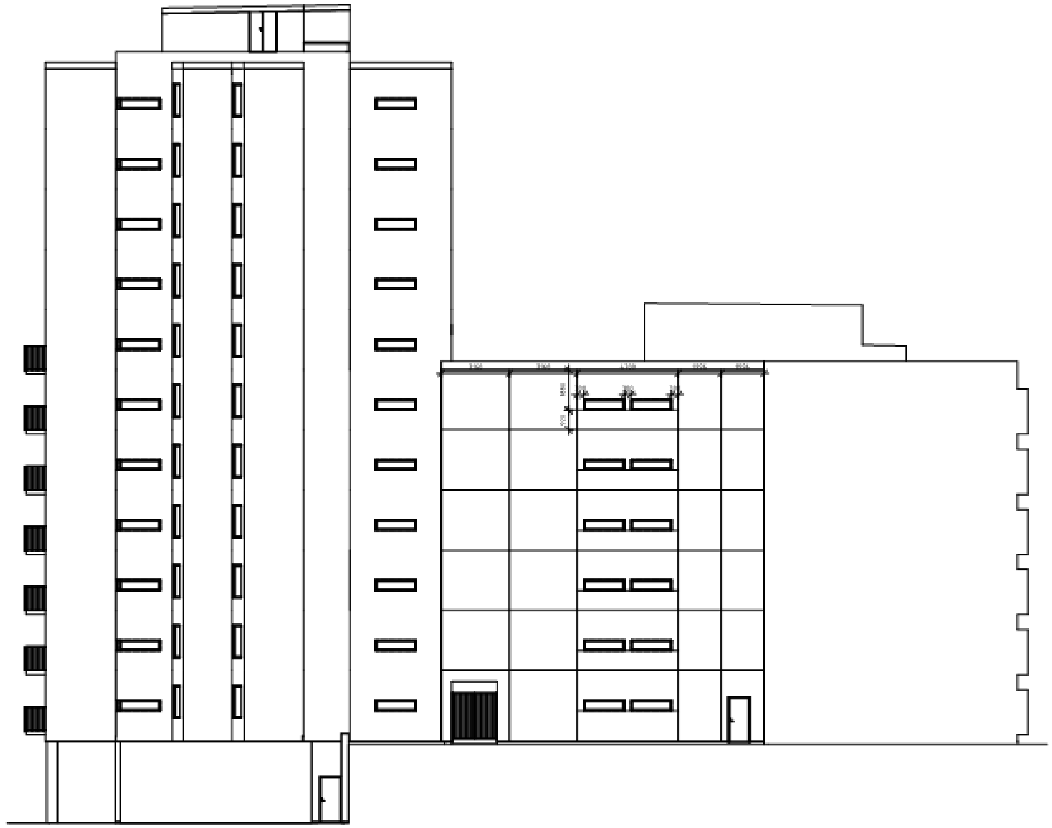
1022508 | PS | LY

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

SÖDERFASADER HUS B SAMT A MOT GÅRD

1:50
1:100

A-40.3-04



NORRFASAD

SKALA 1:100
0 1 2 5 10
METER

12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A NORCONSULT AB tel. 031-50 70 00
K INTEGRA ENGINEERING AB tel. 031-14 58 50

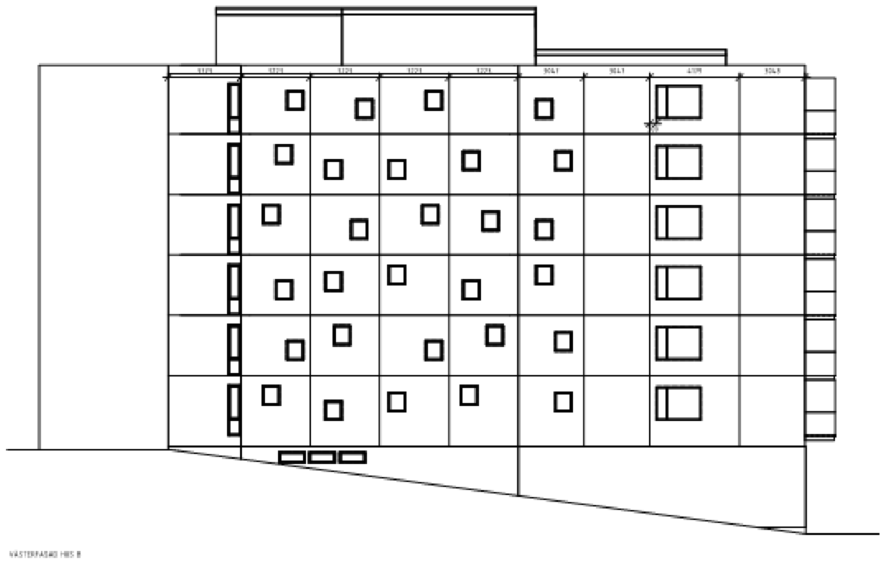
1022508	PS	LY

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

NORRFASAD

A1 1:100
A3 1:200

A-40.3-07



SKALA 1:100
0 1 2 5 10
METER

12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A NORCONSULT AB
K INTEGRA ENGINEERING AB

1022508
PS
LY

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

VÄSTERFASAD HUS B

1:50
1:100

A-40.3-06

SKALA 1:100
0 1 2 5 10
METER

12-01-17

PRELIMINÄRHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A NORCONSULT AB
K INTEGRA ENGINEERING AB

1022508 | PS | LY

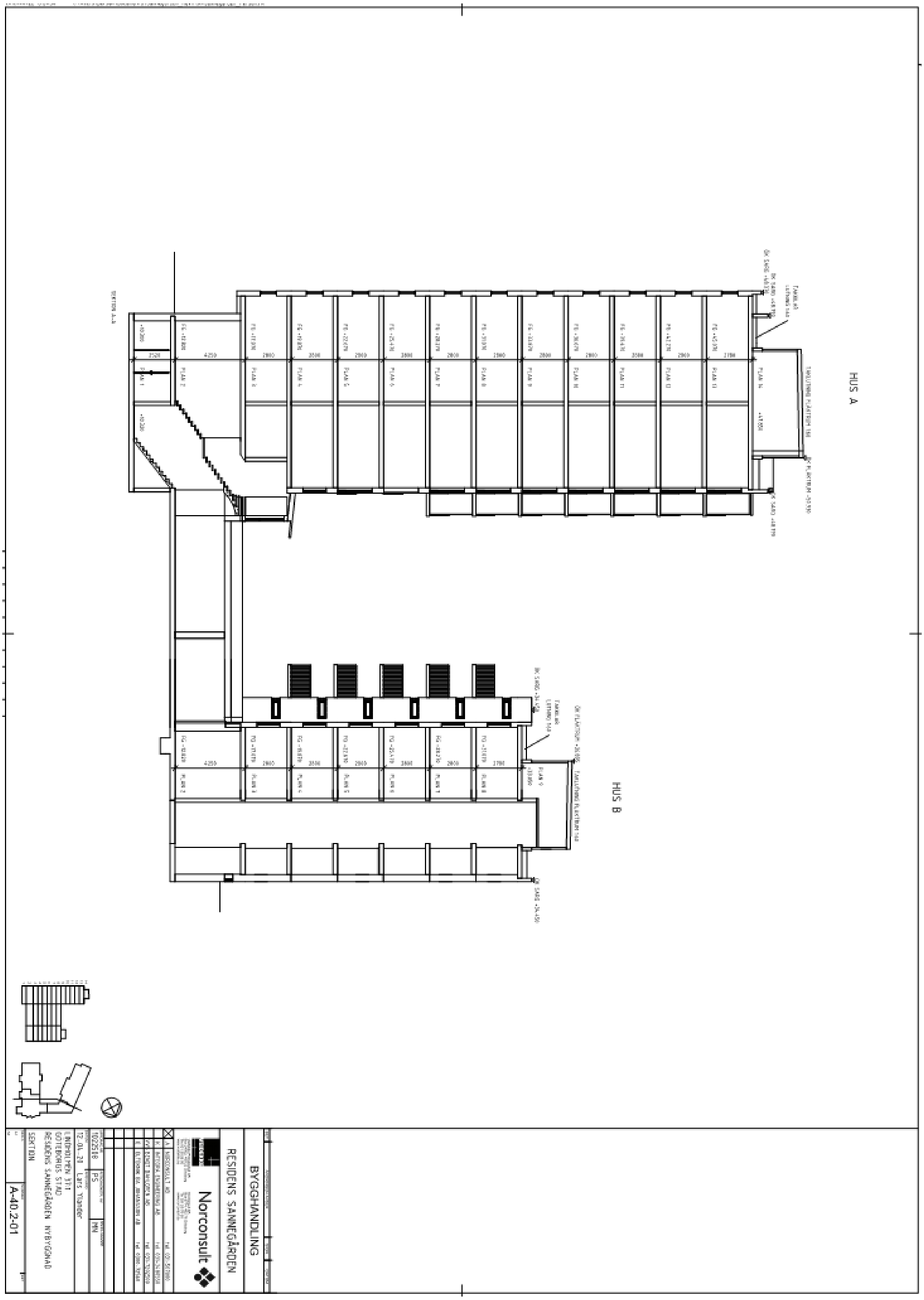
LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

ÖSTERFASAD HUS B

A1 1:100
A3 1:200

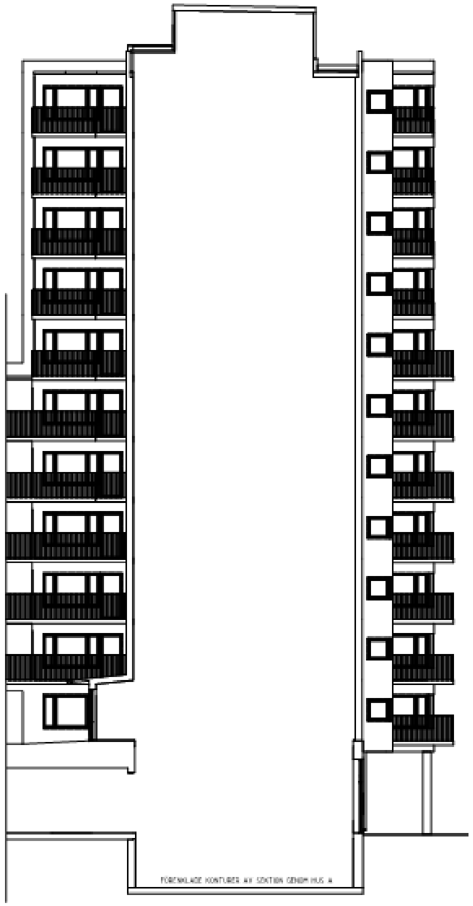
A-40.3-05

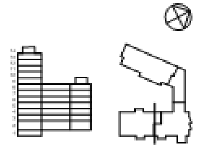
SECTIONS


HUS A
HUS B
BYGGHANDLING
RESIDENS SANNEGÅRDEN
Norconsult
A-40.2-01

FÖRKLARINGAR

Se ritning A-40.0-01





BYGGHANDLING

RESIDENS SANNEGÅRDEN

Norconsult

A	NORCONSULT AB	
K	INTEGRA ENGINEERING AB	
VVS	BENGT DAHLGREN AB	
E	ELTEKNIK BA JOHANSSON AB	

1022508 | PS | MN

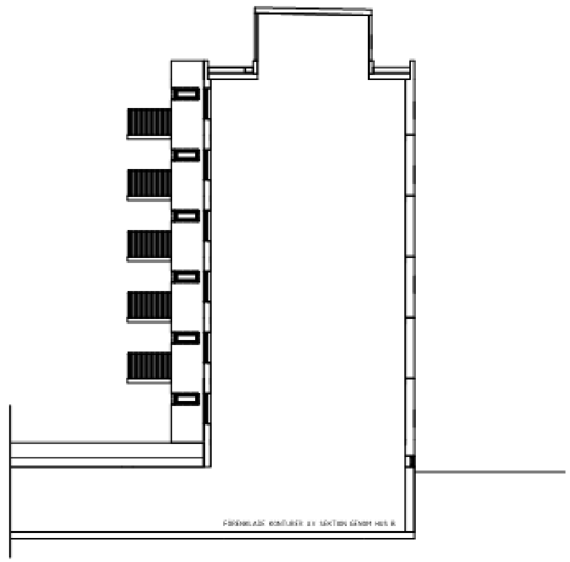
12-05-04 Lars Ylander

LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

SÖDERFASAD HUS A - 02

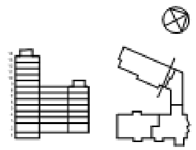
1:50
1:100

A-40.3-09



FÖRKLARINGAR

Se ritning A-40.0-M



BYGGHANDLING	
RESIDENS SANNEGÅRDEN	
Norconsult	
A	NORCONSULT AB
K	INTEGRA ENGINEERING AB
VVS	BENGT DAHLGREN AB
E	E-TEKNIK BA JOHANSSON AB
1022508	PS	MN
12-05-04	Lars Ylander	

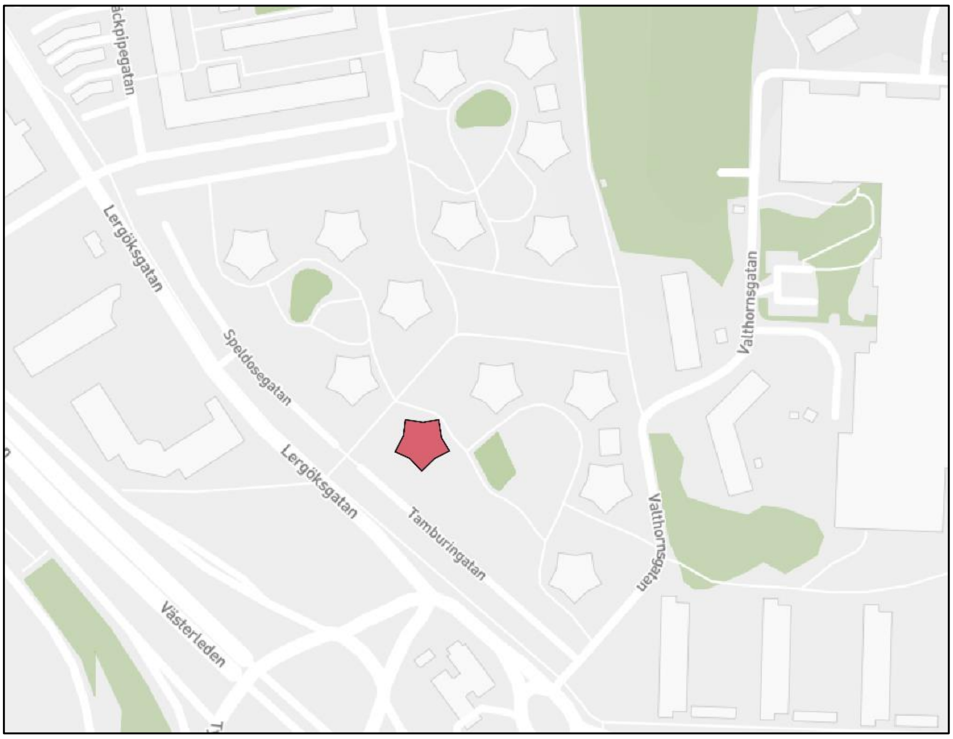
LINDHOLMEN 37:1
GÖTEBORGS STAD
RESIDENS SANNEGÅRDEN NYBYGGNAD

NORRFASAD HUS B

A1 1:100
A3 1:200

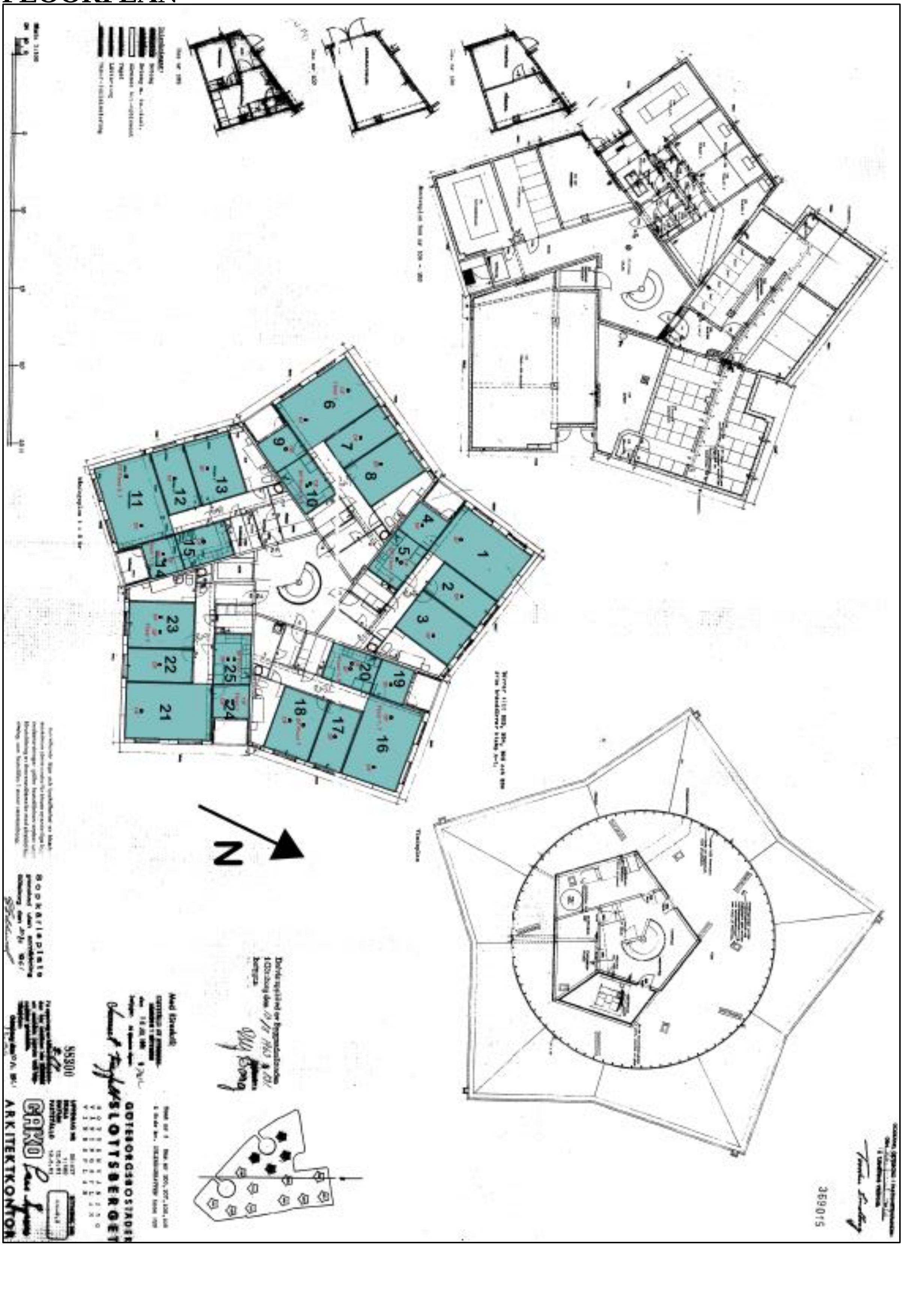
A-40.3-08

Appendix 3H – 8_Rud 8:10



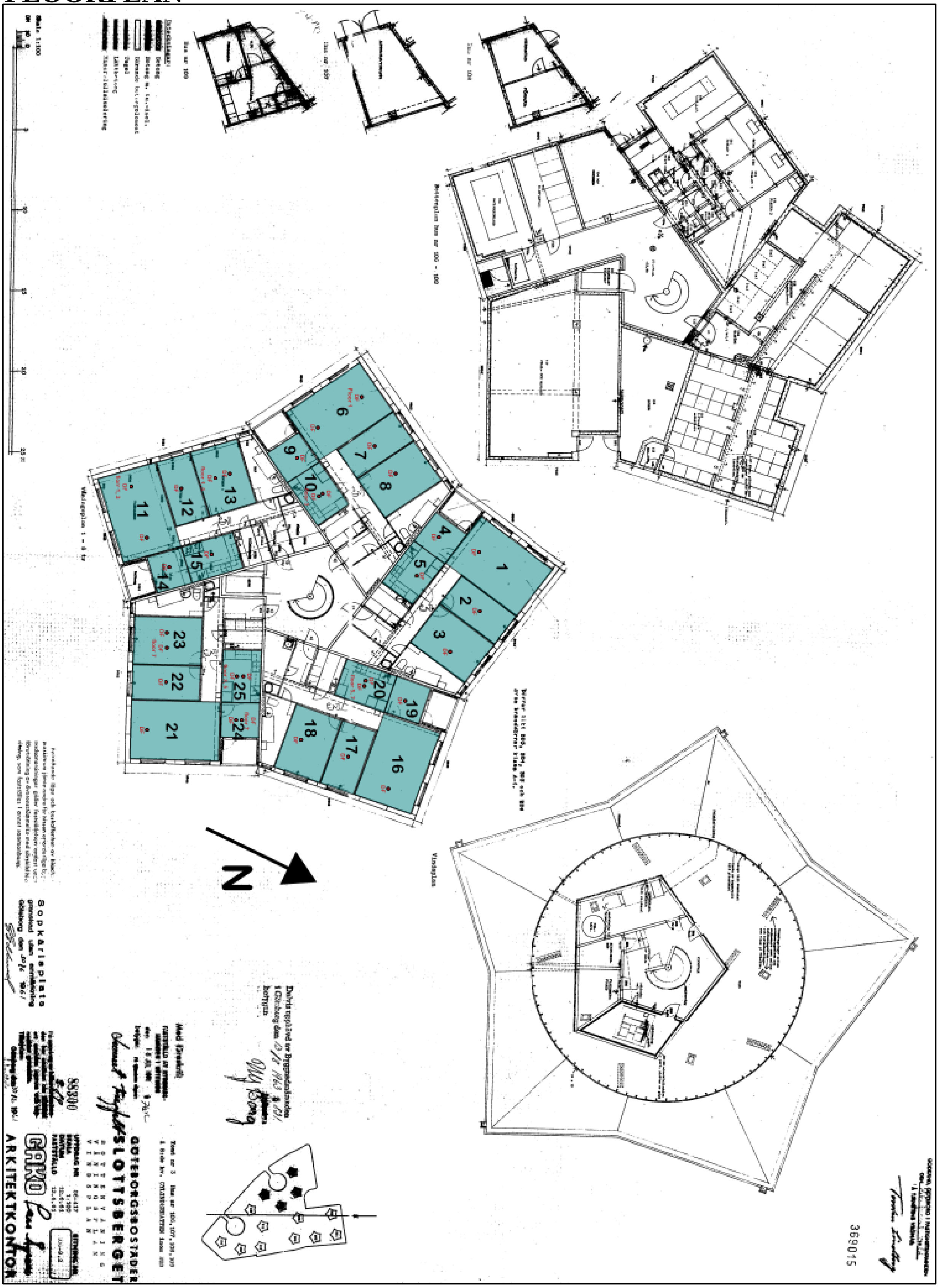
SIMULATION TYPE 1

FLOORPLAN

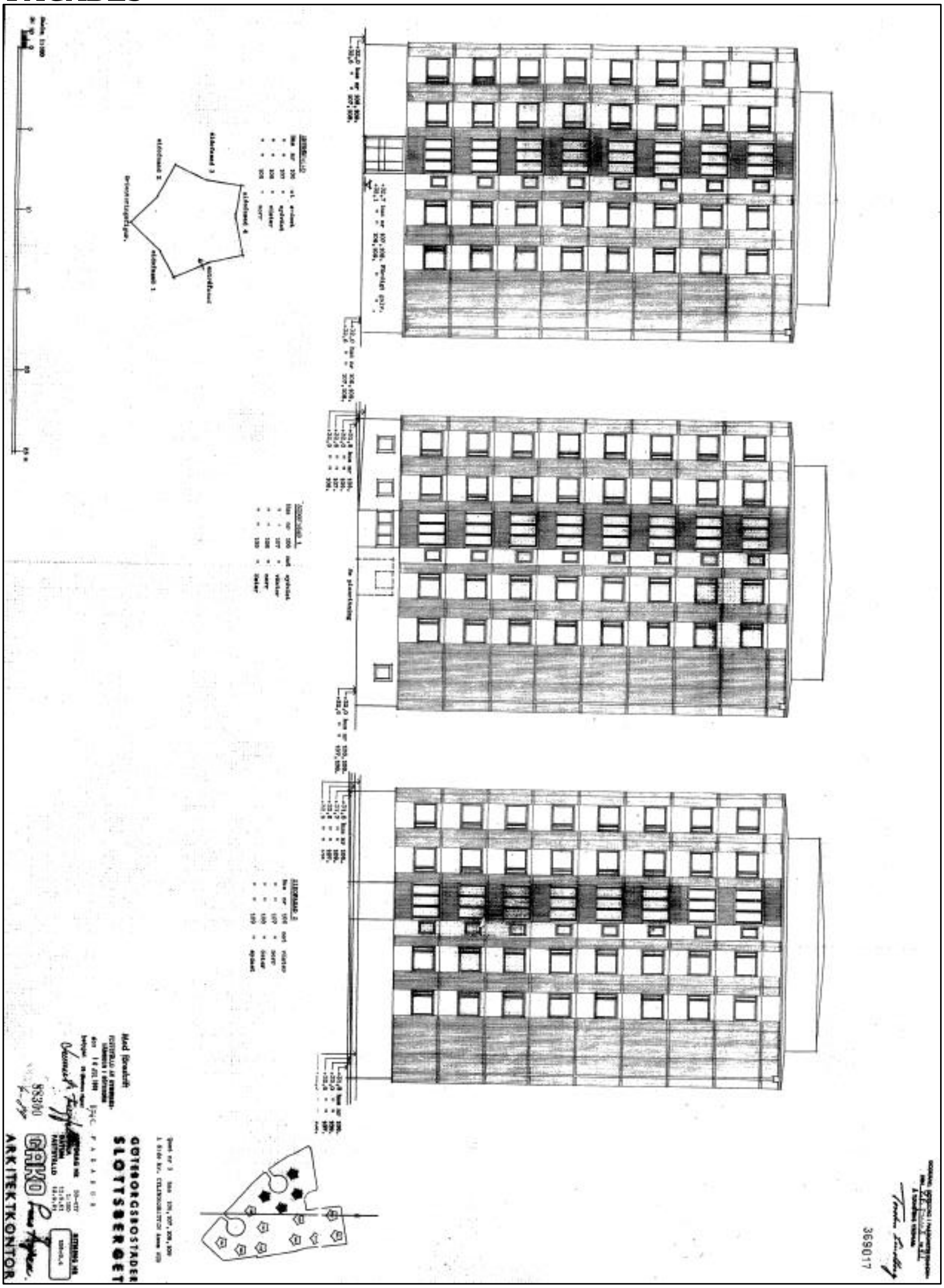


SIMULATION TYPE 2

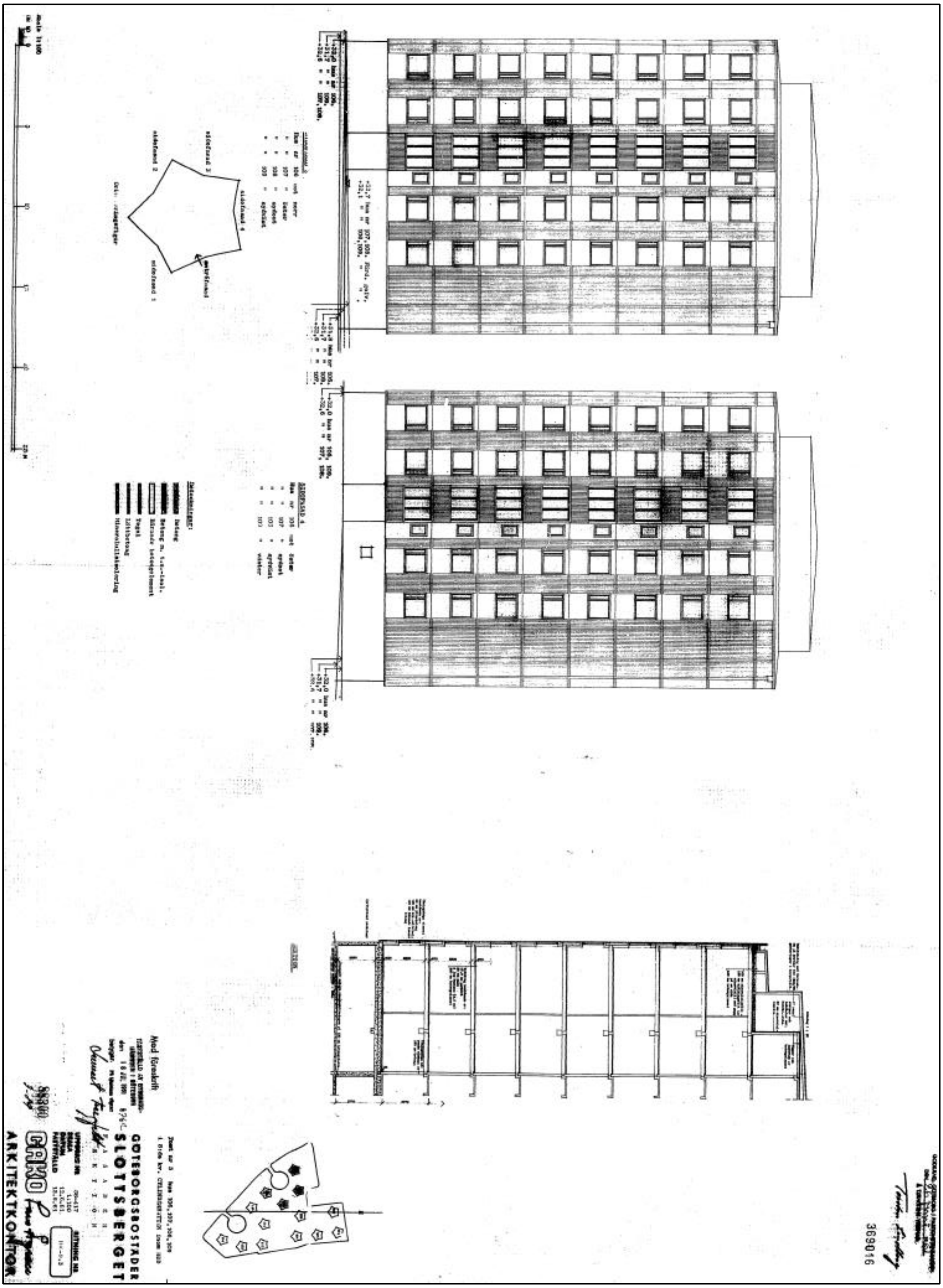
FLOORPLAN



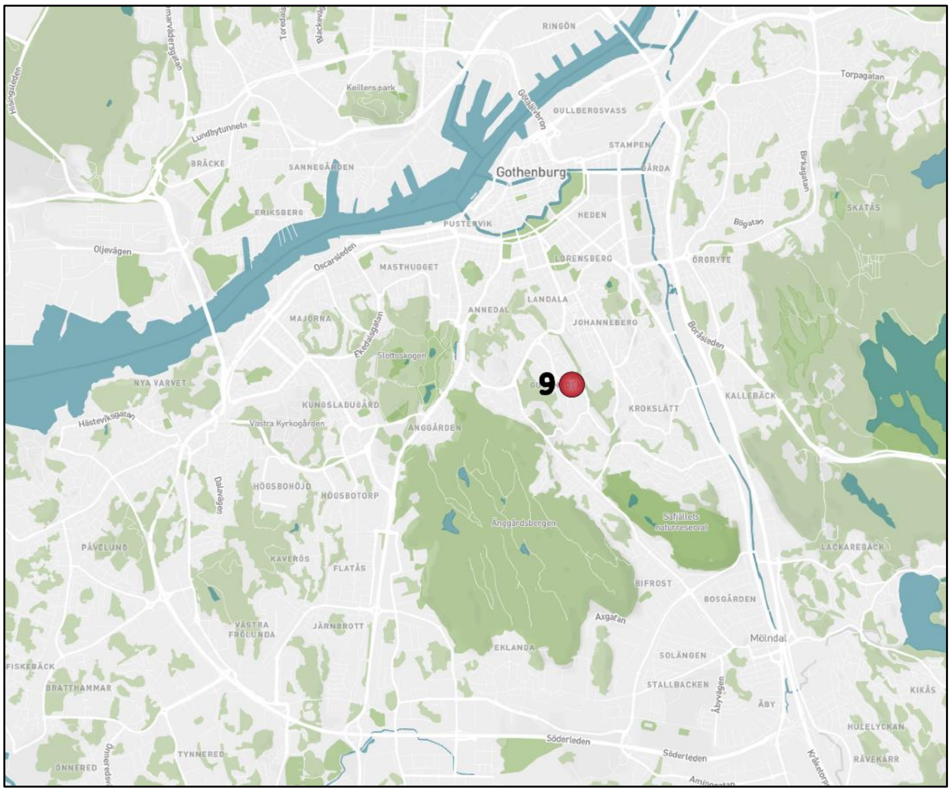
FACADES



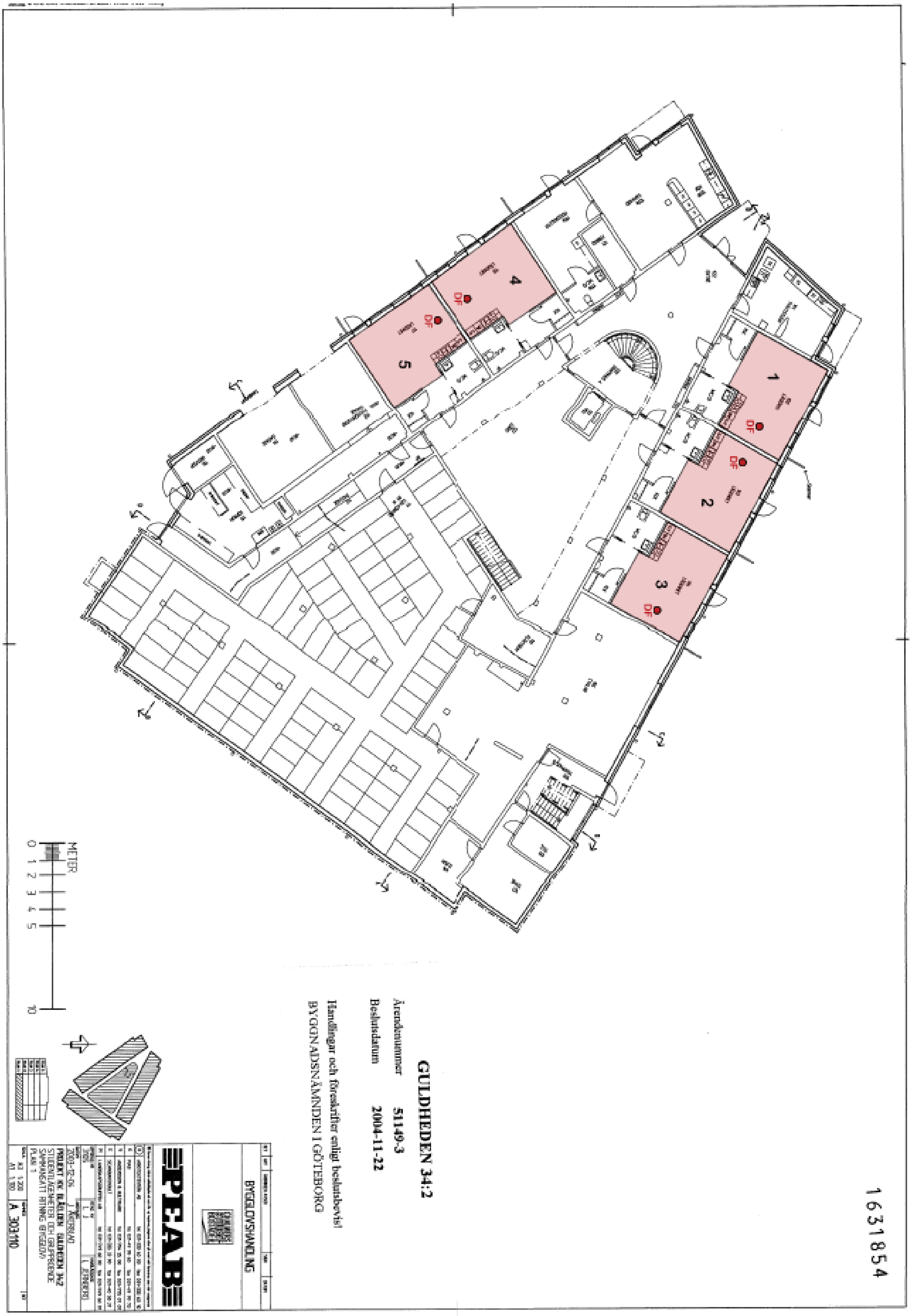
FACADES AND SECTION



Appendix 3I – 9_Guldheden 34:2



FLOORPLANS



1
2
3
4
5
DF
METER
0 1 2 3 4 5 10
GULDHEDEN 34:2
Ärendenummer 51149-3
Beslutsdatum 2004-11-22
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
1631854
BYGGLOVSHANDLING
PEAB
A 303110

1631856

GULDHEDEN 34:2

Ärendenummer **51149-3**

Beslutsdatum **2004-11-22**

Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG

BYGGLOVSHANLDING

PEAB

3105 L J L JERNBERG

2003-12-04 J ÅKERBLAD

PROJEKT KV. BLÅELDEN GULDHEDEN 34:2
STUDENTLÄGENHETER OCH GRUPPBOENDE
SAMMANSATT RITNING (BYGGLOV)
PLAN 3

A3 1:200
A1 1:100

A 303:130

1631858

GULDHEDEN 34:2

Ärendenummer **51149-3**
Beslutsdatum **2004-11-22**

Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG

BYGGLOVSHANDLING

CHALMERS STUDENTBOSTÄDER

PEAB

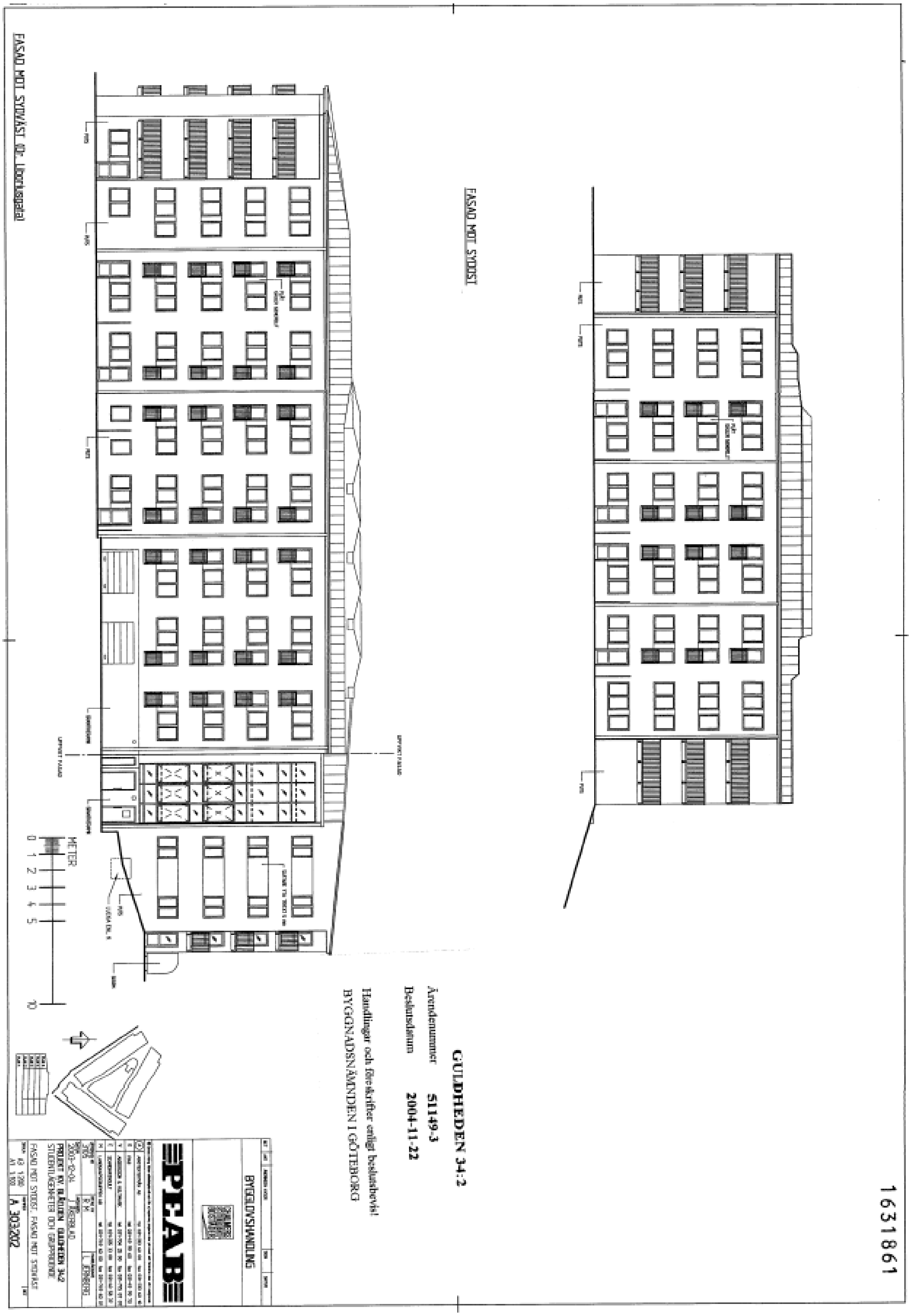
UPPDRAG NR 3105	RITAD AV L J
HANDLÄGGARE	L JERNBERG
DATUM 2003-12-04	ANSVARIG J ÅKERBLAD

PROJEKT KV. BLÅELDEN GULDHEDEN 34:2
STUDENTLÄGENHETER OCH GRUPPBOENDE
SAMMANSATT RITNING (BYGGLOV)
PLAN 5

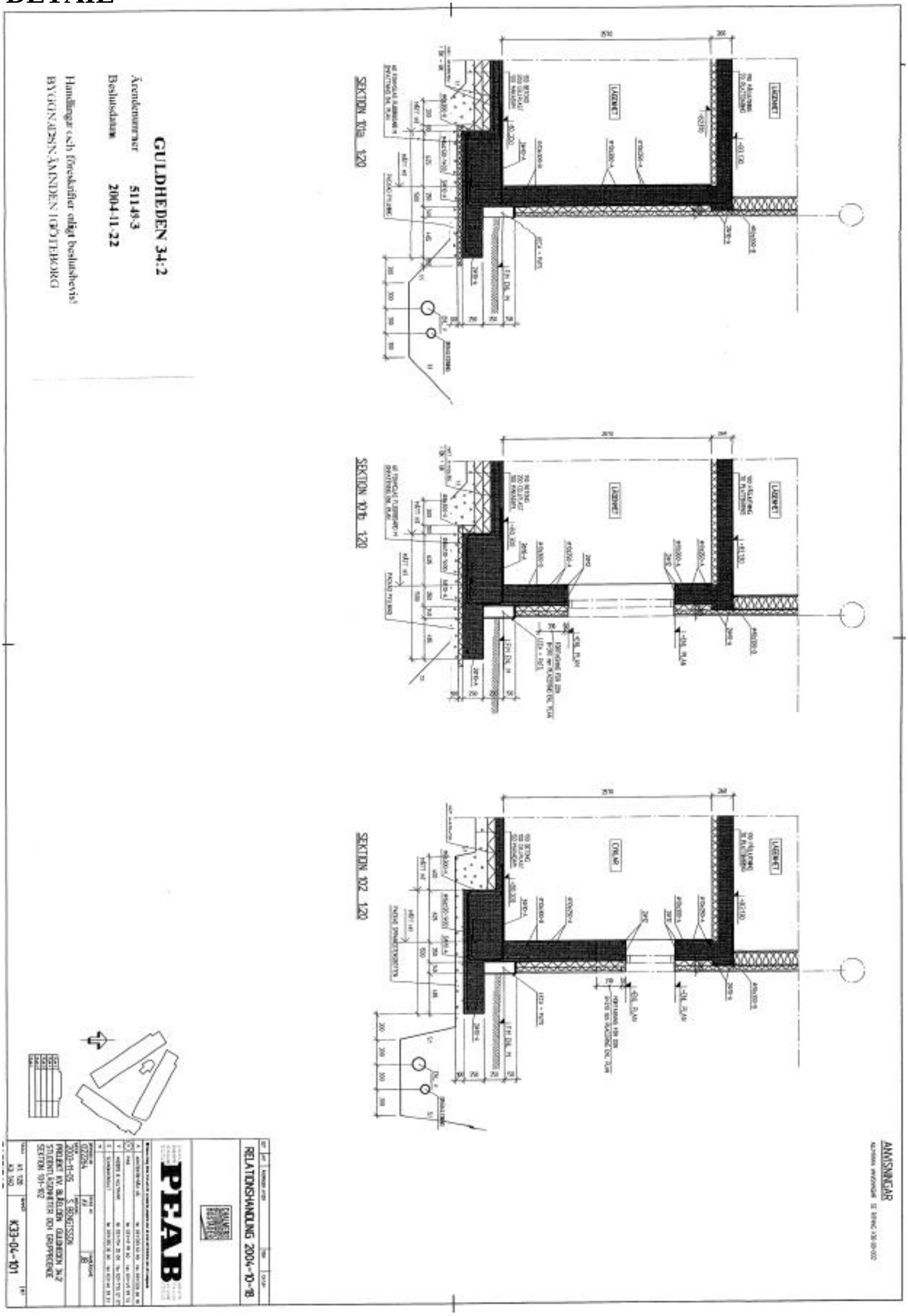
A3 1:200
A1 1:100

A 303:150

FACADES

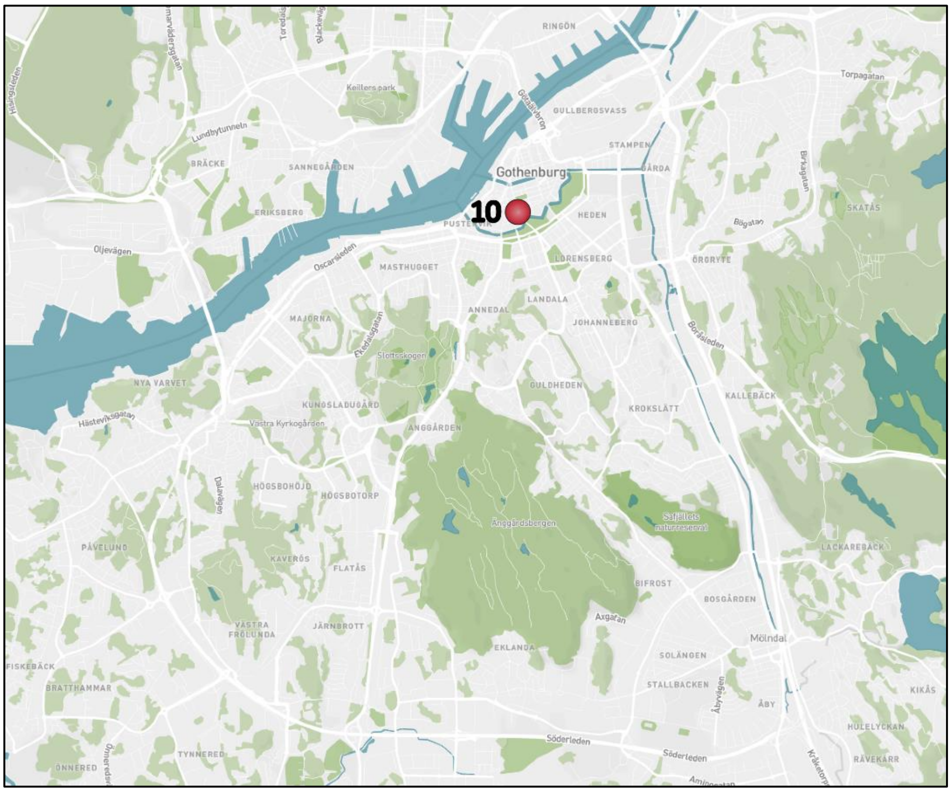

FASAD MOT SYDOST
GULDHEDEN 34:2
Ärendenummer 51149-3
Beslutsdatum 2004-11-22
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
1631861
BYGGLOVSHANDLING
PEAB
METER
0 1 2 3 4 5 10
A 303202

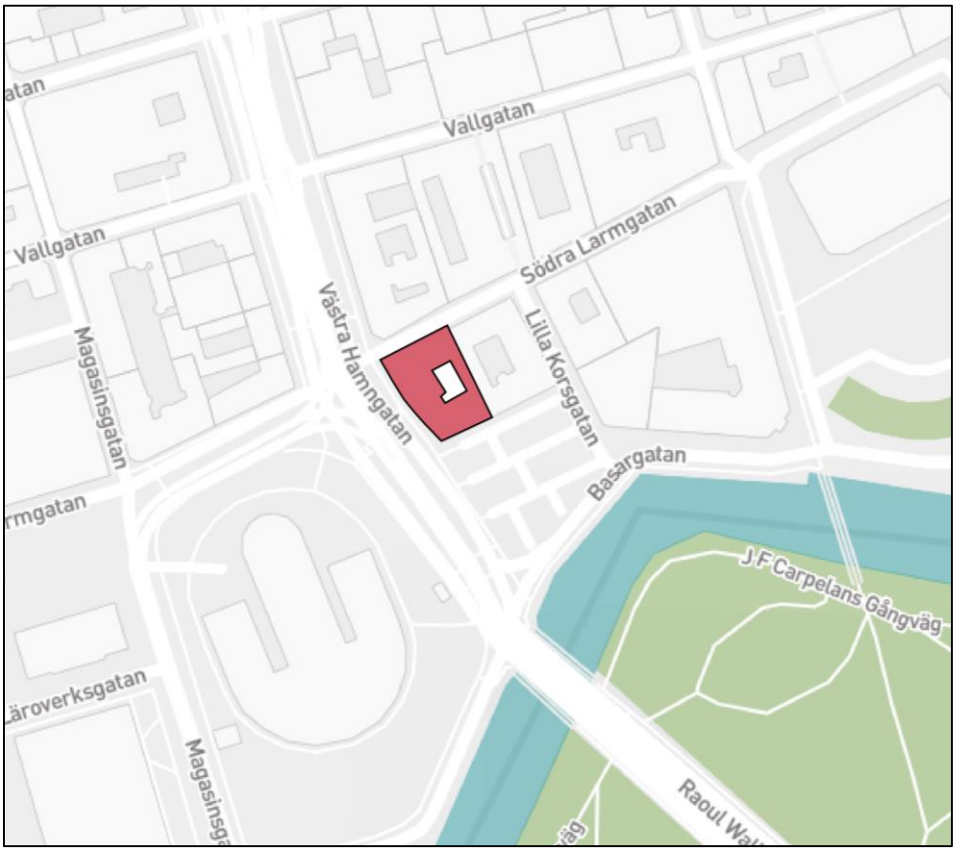
DETAIL



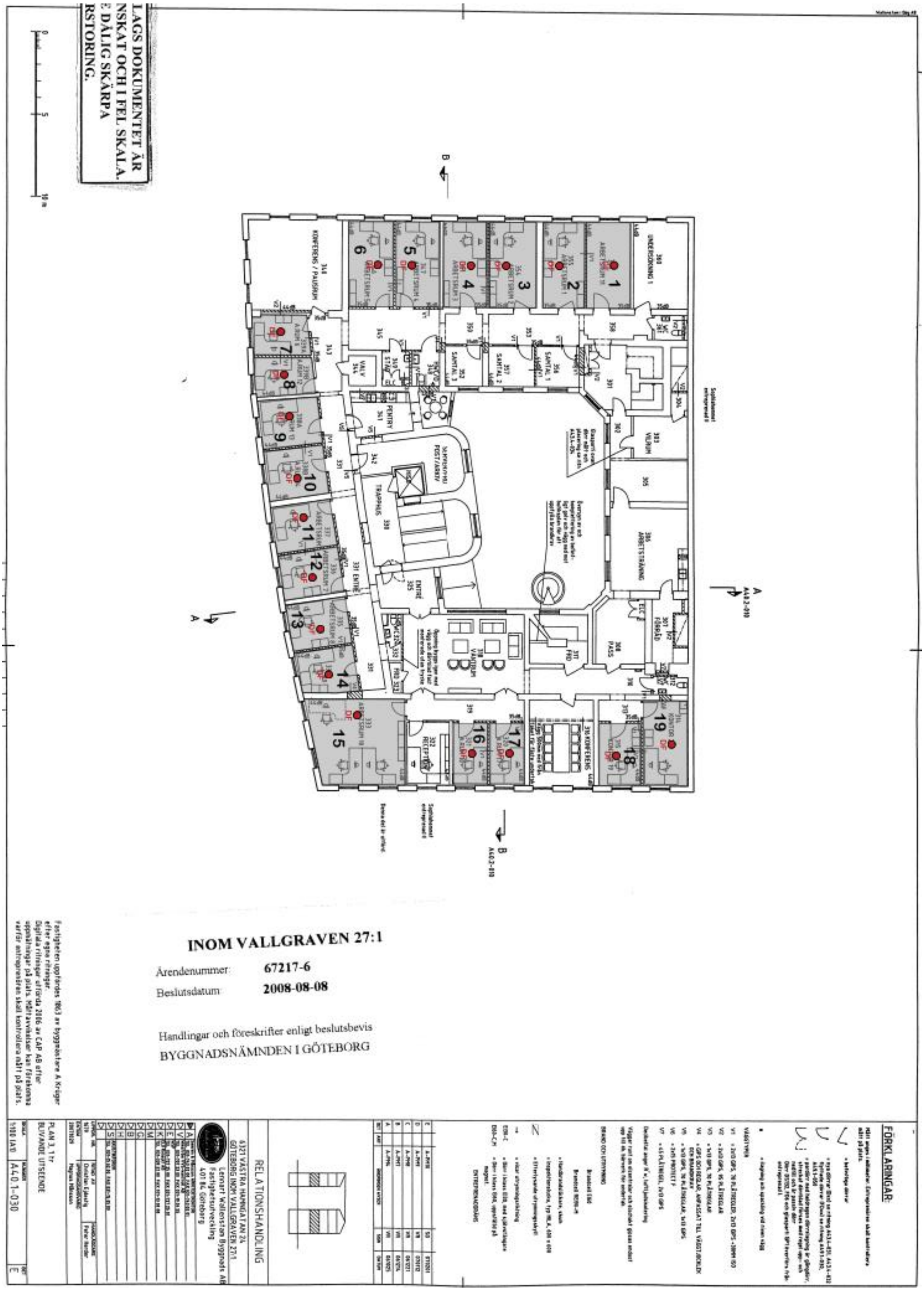
GULDHEDEN 34:2
Ärendenummer 51148-3
Beslutsdatum 2004-11-22
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
SEKTION 101a 1:20
SEKTION 101b 1:20
SEKTION 102 1:20
ANVISNINGAR
RELATIONSHANDLING 2004-10-18
PEAB
K33-04-101

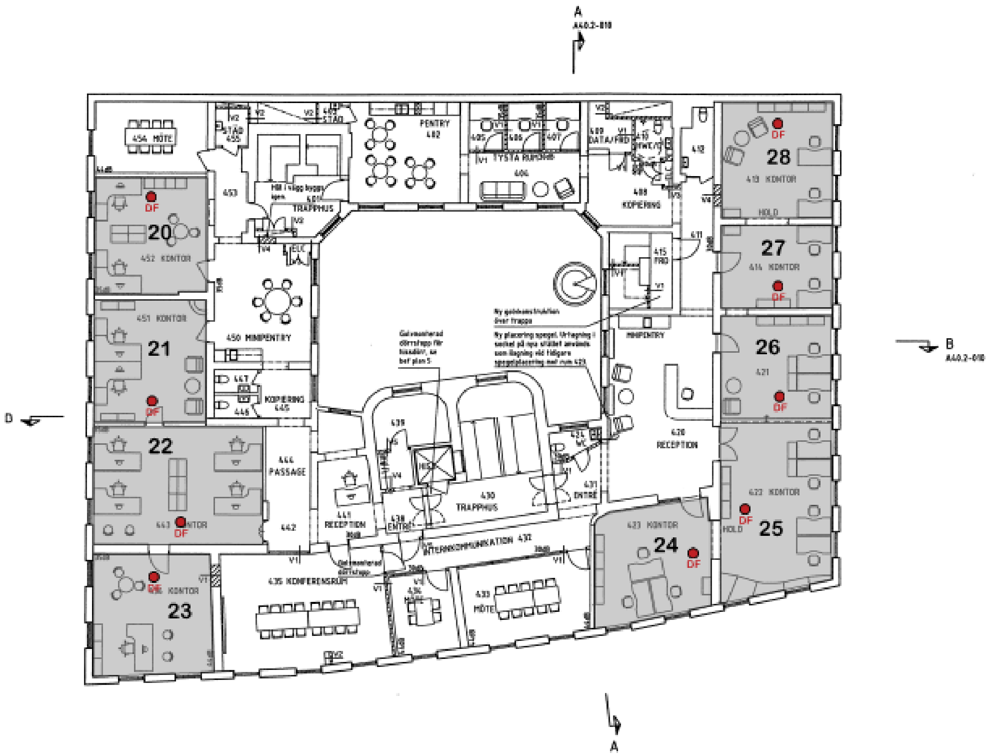
Appendix 3J – 10_Inom vallgraven 27:1





FLOORPLANS


INOM VALLGRAVEN 27:1
Ärendenummer 67217-6
Beslutsdatum 2008-08-08
Handlingar och föreskrifter enligt beslutsbevis
BYGGNADSNÄMNDEN I GÖTEBORG



LAGS DOKUMENTET ÄR
NSKAT OCH I FEL SKALA.
E DÅLIG SKÄRPA
RSTORING.

0 5 10 m

INOM VALLGRAVEN 27:1

Ärendenummer: **67217-6**

Beslutsdatum: **2008-08-08**

Handlingar och föreskrifter enligt beslutsbevis
BYGGNADSNÄMNDEN I GÖTEBORG

Fastigheten uppfördes 1863 av byggmästare A Krüger efter egna ritningar.
Digitala ritningar utförda 2006 av CAP AB efter uppmätningar på plats. Måttavvikelser kan förekomma varför entreprenören skall kontrollera mått på plats.

FÖRKLARINGAR:

Mått anges i millimeter. Entreprenören skall kontrollera mått på plats.

= befintliga dörrar

= nya dörrar (Dxx) se ritning A43.4-(015-015) och fyllfade (FDxx)

= pardörr med heldragen dörrslagning är gångdörr, streckat dörrblad förses med regel upp- och nedtill och är passiv dörr

= lagning och spackling vid riven vägg

VÄGGTYPER

V1 = 2x13 GIPS, 70 PLÅTREGLER, 2x13 GIPS + 30MM ISO VÄGGEN SKALL HÅLLA EN LJUDKLASS PÅ 44dB

V2 = 2x13 GIPS, 95 PLÅTREGLAR

V3 = 1x13 GIPS, 70 PLÅTREGLER

V4 = GIPS OCH REGLAR, ANPASSAT TILL VÄGGTJOCKLEK OCH BRANDKRAV

V5 = 1x13 GIPS, 70 PLÅTREGLER, 1x13 GIPS

Decibeltal anger R'w, luftljudsisolering

Väggar runt om elcentraler och elschakt gipsas endast upp till ök. bärverk för undertak.

BRAND OCH UTRYMNING

Brandcell EI60

Brandcell REI90-M

= Handbrandsläckare, skum

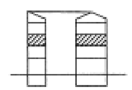
= Efterlysande utrymningsskylt

= visar utrymningsriktning

EI30-C = Dörr i klass EI30, med självstängare

EI60-C,M = Dörr i klass EI60, uppställd på magnet.

A	A-PM4	VR	081025
BET	ANT	ÄNDRINGEN AVSER	SIGN	DATUM



RELATIONSRITNING

6321 VÄSTRA HAMNGATAN 24
GÖTEBORG INOM VALLGRAVEN 27:1

Lennart Wallenstam Byggnads AB
Fastighetsutveckling
401 84 Göteborg

A	
V	
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K	
M	
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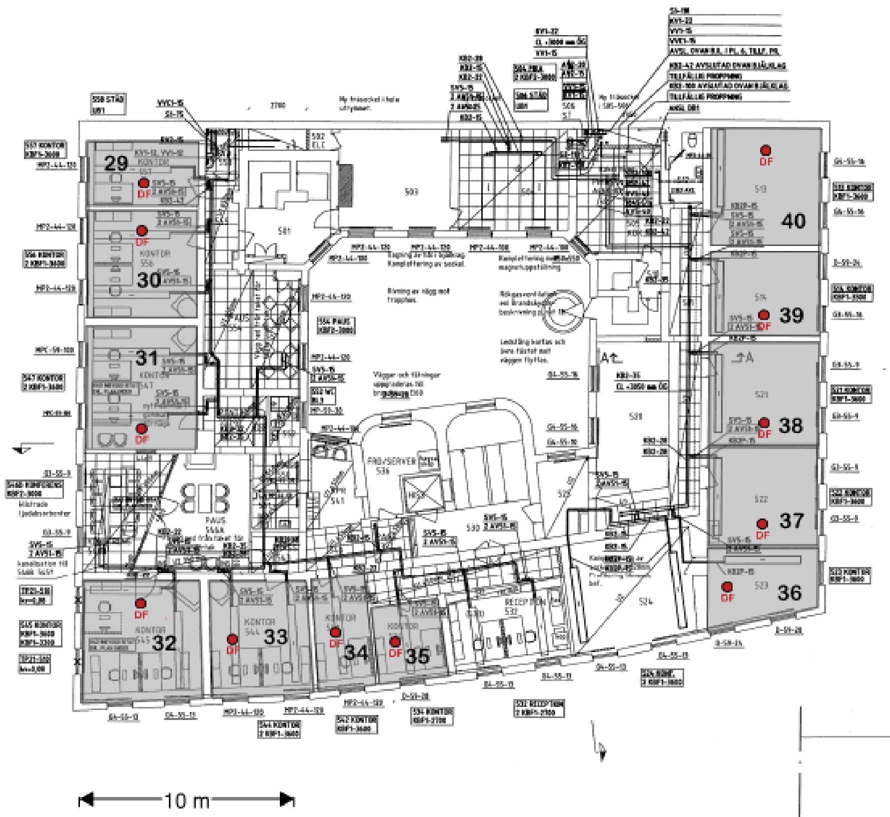
B	
H	
S	

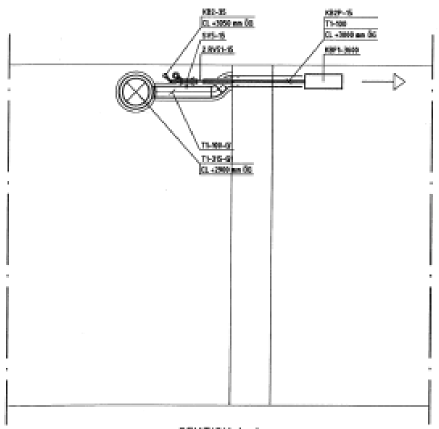
UPPDR. NR.	RITAD AV	HANDLÄGGARE
1671	Christian Cjöselig	Peter Herder
DATUM	UPPDRAGSANSVARIG	
20071029	Magnus Månsson	

PLAN 4, 2 tr
BLIVANDE UTSEENDE

SKALA	NUMMER	BET
1:100 (A1)	A40.1-040	A



1749242



SEKTION A–A
SKALA(A1) 1:20

FÖRKLARINGAR

SYSTEM

S1	SPILLVATTEN
KV1	KALLVATTEN
VV1	VARMVATTEN
VVC	VARMVATTEN CIRKULATION
VS1	VÄRME SÄKUNDÄR
KB1	KÖLDBÄRARE 7/12 °C (GLYKOL)
KB2	KÖLDBÄRARE 14/17 °C

KOMPONENTER

AVS	AVSTÄNGNINGSVENTIL, KYLA
SVS	STYRVENTIL, KYLA
RVS	INJUSTERINGSVENTIL, KYLA
AVS1	TRIMVENTIL
KB2	KÖLDBÄRARE
KBF1	KYLBAFFEL, FRIHÄNGANDE
KBF2	KYLBAFFEL, INFÄLLD
FLK1	FANCOIL

INJUSTERING KÖLDBÄRARE

FÖR STAD-VENTILER ANGES FLÖDET DIREKT VID VENTILEN.

KYLBAFFLAR

INJUSTERING AV FLÖDET SKER VIA SVS-15 ENLIGT NEDAN. TRIMVENTILER ÄR ENDAST FÖR AVSTÄNGNING OCH SKALL VARA FULLT ÖPPNA.

BETJÄNAR	SVS-15 Kvs	VARV	BER FLÖDE
KBF1-2400	0,3	0,8	108 l/h
KBF1-3300	0,6	1,1	176 l/h
KBF1-3600	0,6	1,1	187 l/h
2 KBF1-3600 (PARALL.KOPPL.)	1,1	1,5	374 l/h
2 KBF2-3000 (PARALL.KOPPL.)	1,1	1,5	346 l/h

FLÄKTLUFTKYLARE

INJUSTERING AV FLÖDET SKER VIA EN AV TRIMVENTILERNA (DEN ANDRA SKALL VARA FULLT ÖPPEN). TRIMVENTILERNA STÄNGS HELT OCH ÖPPNAS FÖRESKRIVET ANTAL VARV ENLIGT NEDAN.

BETJÄNAR	AV 51	VARV	BER FLÖDE
FLK1-25	DN15	2,5	162 l/h
FLK1-33	DN15	3,0	191 l/h

RELATIONSRITNING 07-12-28

6321 VÄSTRA HAMNGATAN 24-26
GÖTEBORG INOM VALLGRAVEN 27:1

Lennart Wallenstam Byggnads AB
Fastighetsutveckling
401 84 Göteborg

A	
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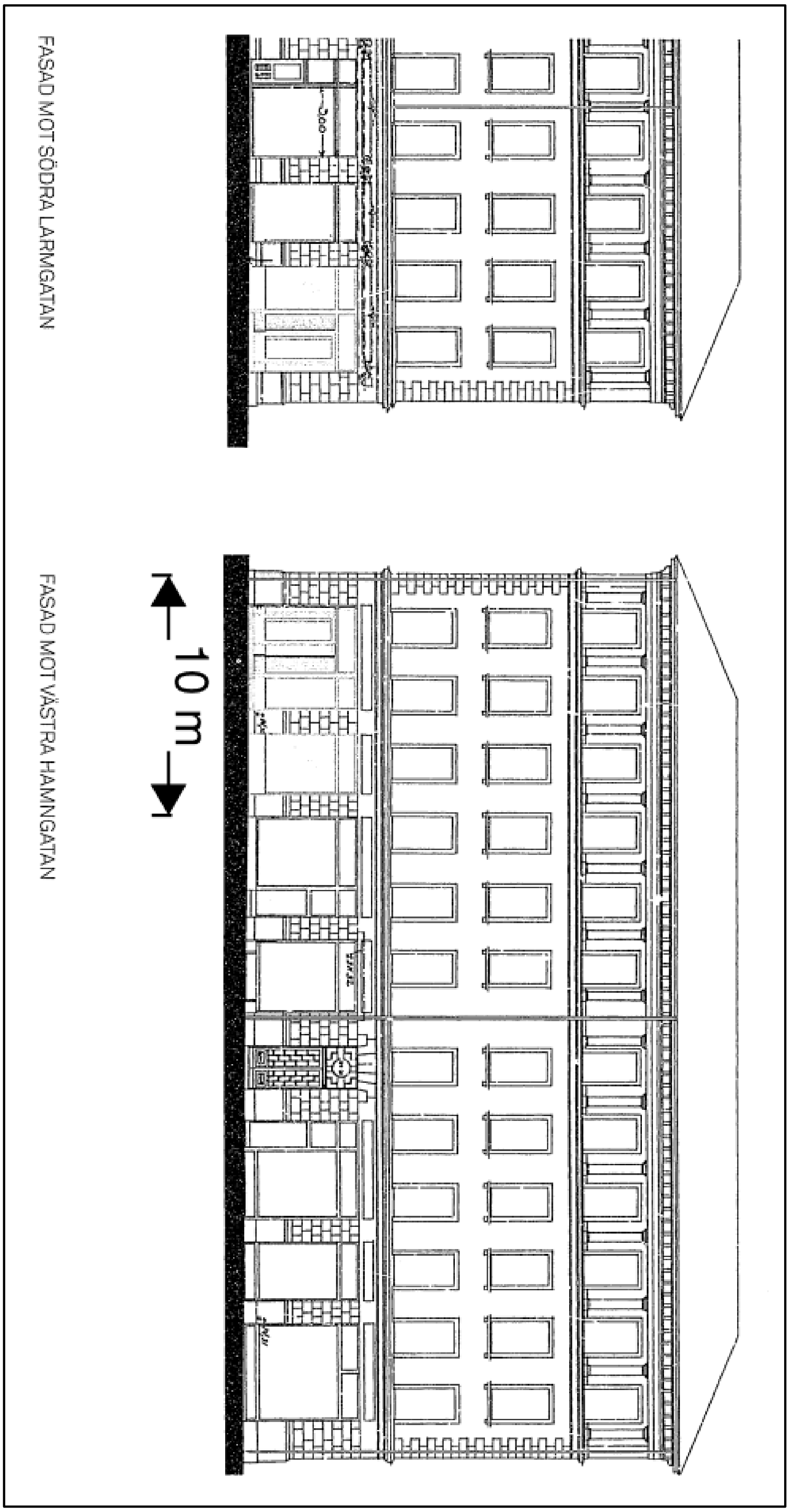
S	

UPPDRAG NR	RITAD AV	HANDLÄGGARE
050593	Matte Askeroth	Samuel Freiholtz
DATUM 2006-08-30	Samuel Freiholtz	

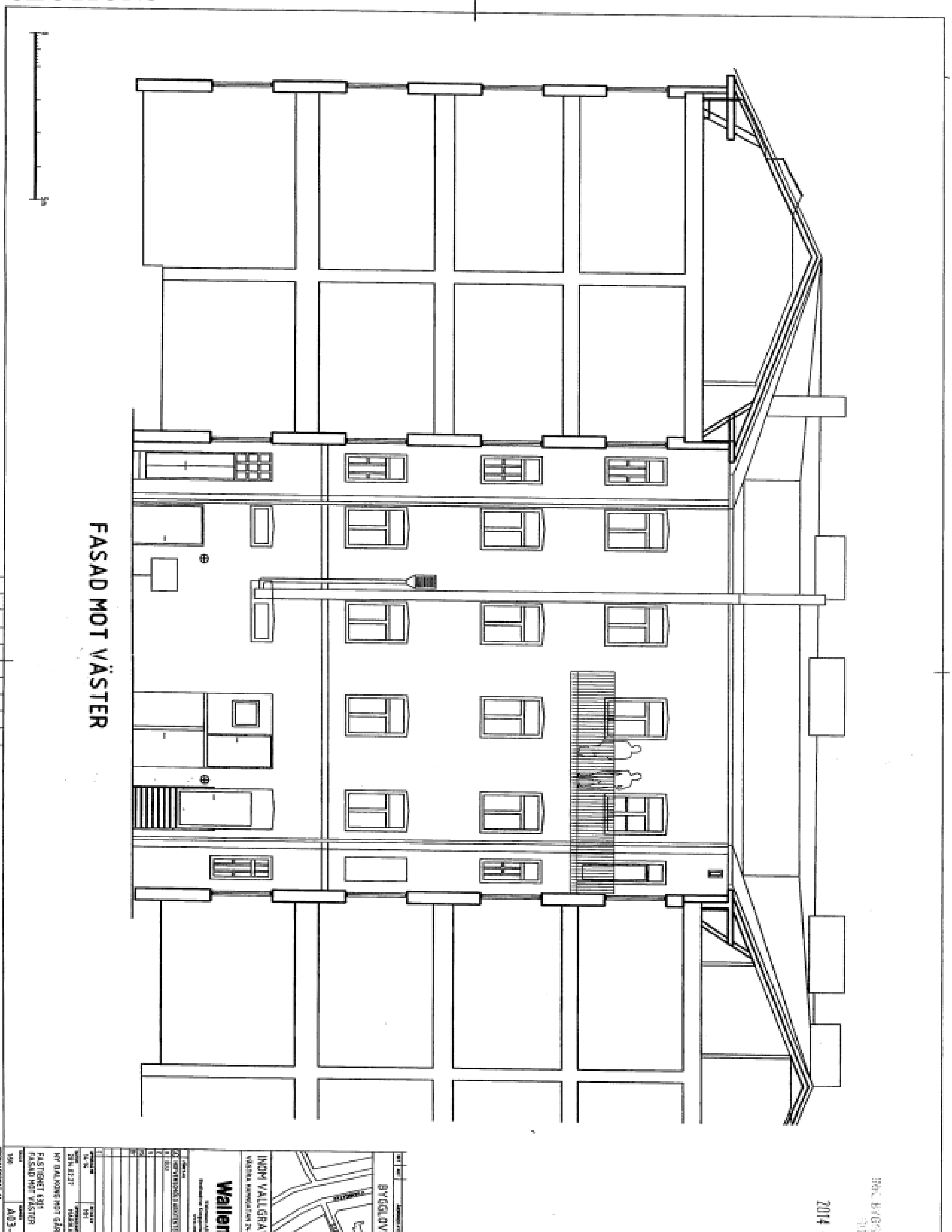
OMBYGGNAD AV KONTOR
PLAN 5, 3 tr
RÖRINSTALLATION

SKALA	NUMMER	REV
1:100 (A1)	V50.1-050	

FACADES



SECTIONS

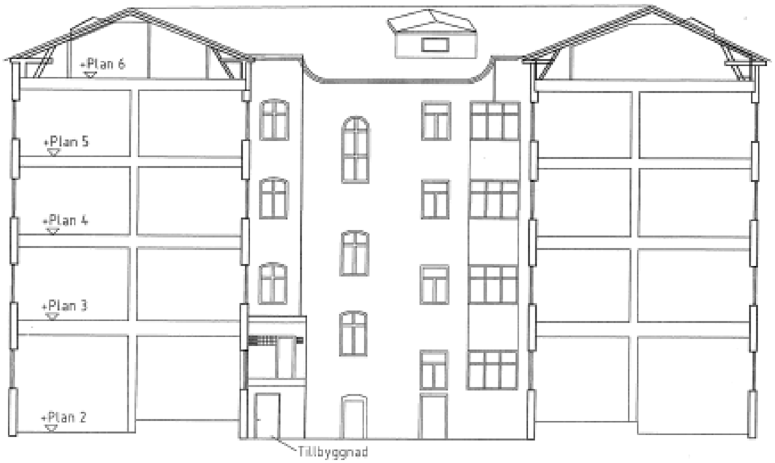


INOM VALLGRAVEN 27:1

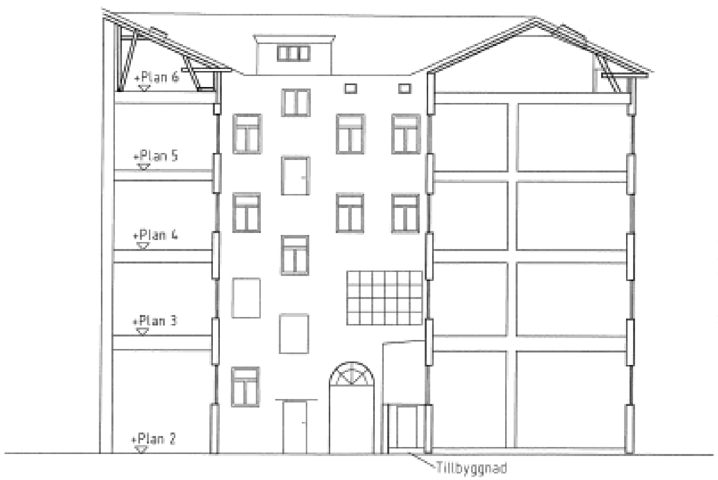
Ärendenummer:BN 2014-001443
Beslutsdatum: 2014-03-14

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

1707525



FASAD MOT GÅRD / SEKTION B-B

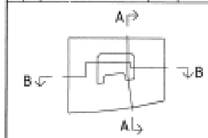


FASAD MOT GÅRD / SEKTION A-A

0 5 10 m

INOM VALLGRAVEN 27:1
Ärendenummer 68126-7
Beslutsdatum 2007-05-15

Fastigheten uppfördes 1863 av byggmästare A Kräger efter egna ritningar.
Digitala ritningar utförda 2006 av CAP AB efter uppmätningar på plats. Måttavvikelser kan förekomma varför entreprenören skall kontrollera mått på plats.



BYGGLOVSHANDLING

6321 VÄSTRA HAMNGATAN 24
GÖTEBORG INOM VALLGRAVEN 27:1

Lennart Wallenstam Byggnads AB
Fastighetsutveckling
401 84 Göteborg

A
V
E
K
M
G
B
H
S

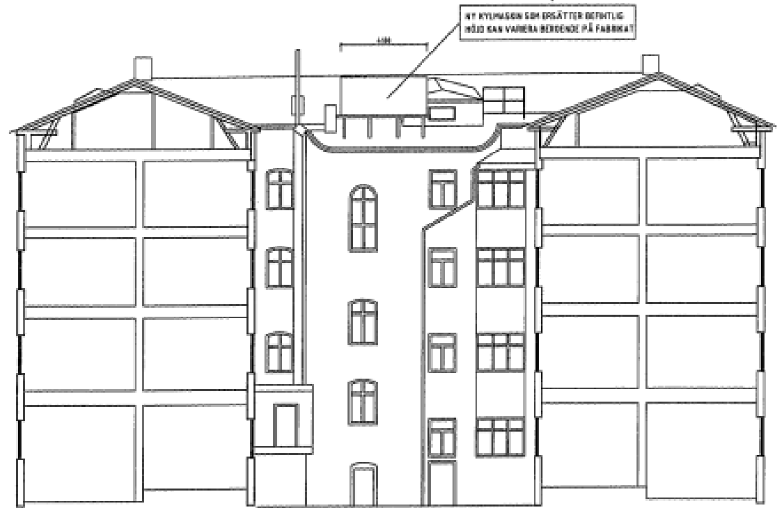
Ritad av Helena Eliasson
Sophie Befve
Magnus Håkansson

SEKTIONER
BLIVANDE UTSEENDE

1:100 (A1)
A40.2-011

FÖRKLARINGAR:

1680994



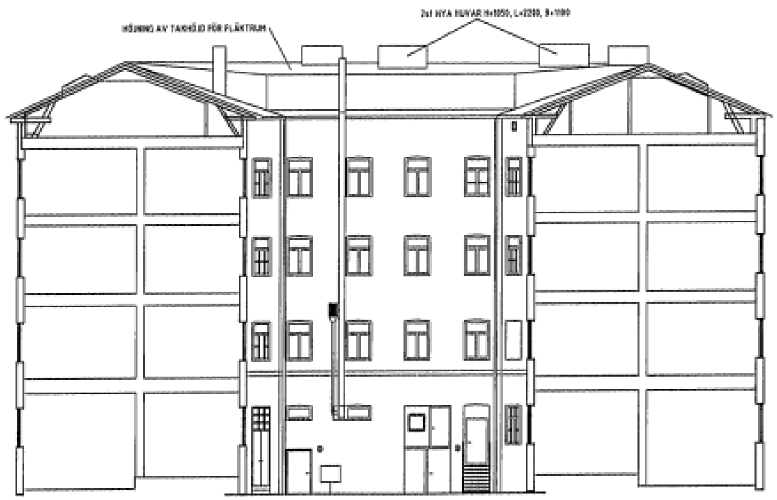
BLIVANDE FASAD MOT ÖSTER

INOM VALLGRAVEN 27:1

Ärendenummer **67286-6**

Beslutsdatum **2006-07-14**

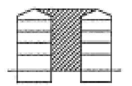
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG



BLIVANDE FASAD MOT VÄSTER

0 5 10 m

Fastigheten uppfördes 1853 av byggmästare A.Krüger efter egna ritningar.
Digitala ritningar utförda 2006 av CAP AB efter uppmätningar på plats. Måttavvikelser kan förekomma varför entreprenören skall kontrollera mått på plats.



BYGGLOVSHANDLING

6321 VÄSTRA HAMNGATAN 24
GÖTEBORG INOM VALLGRAVEN 27:1

Lennart Wallenstam Byggnads AB
Fastighetsutveckling
401 84 Göteborg

A		
V		
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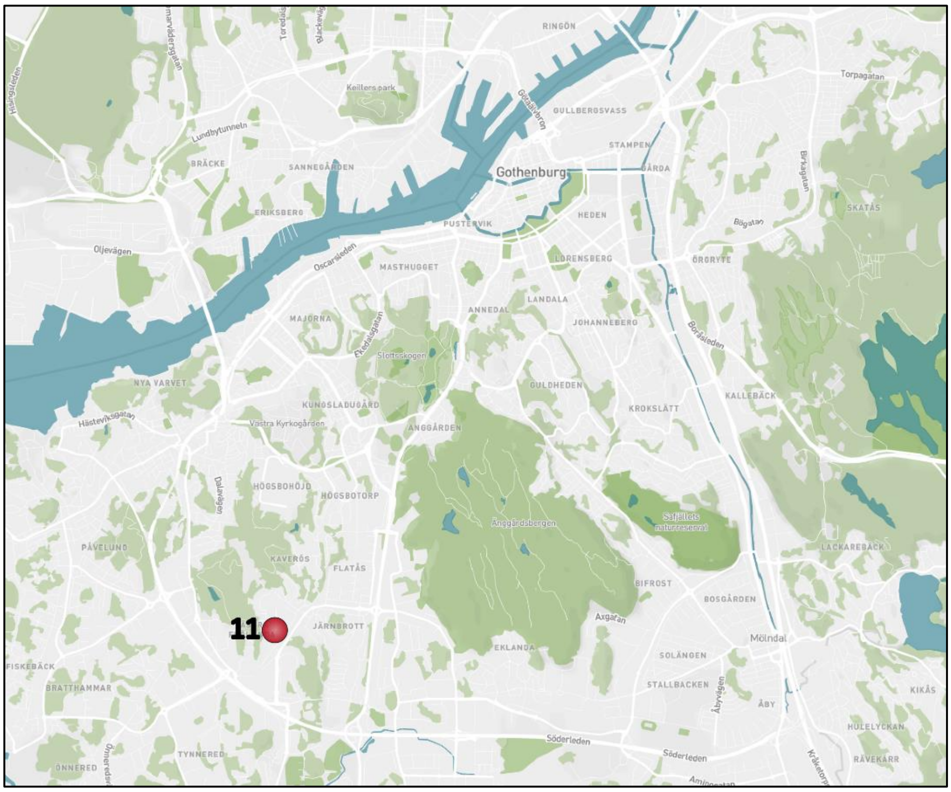
B		
H		
S		

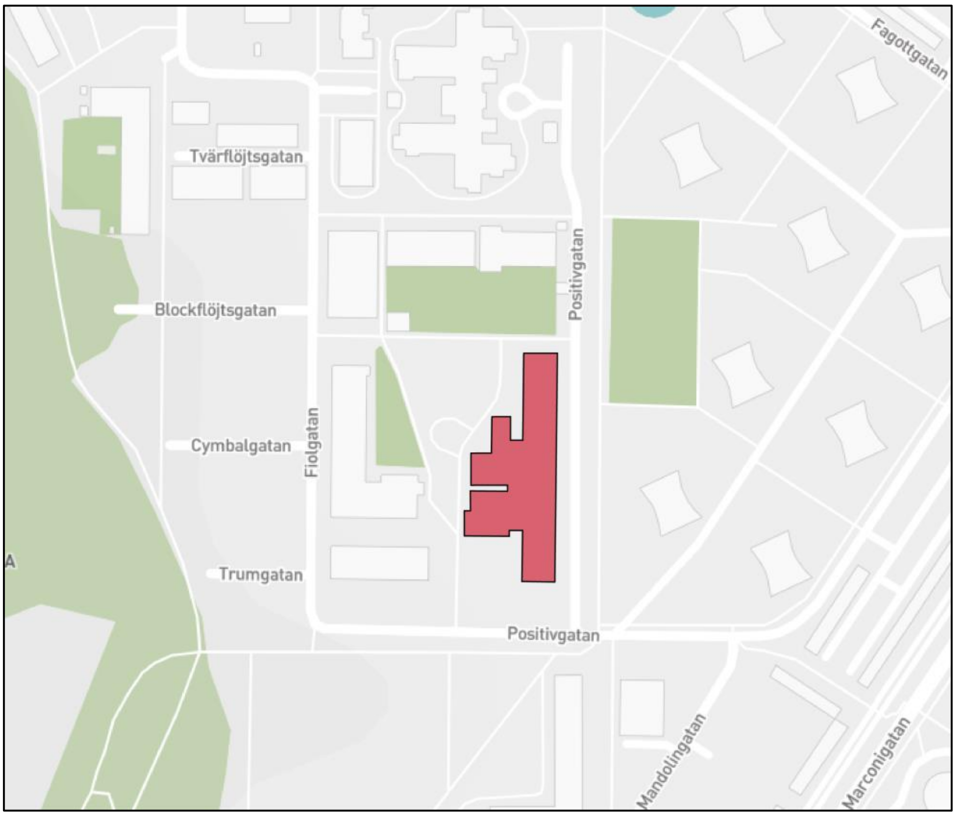
1619	Christian Sjöberg	Verena Rösberg
20060629	Magnus Hansson	

NYTT UTSEENDE GÅRDSFASADER

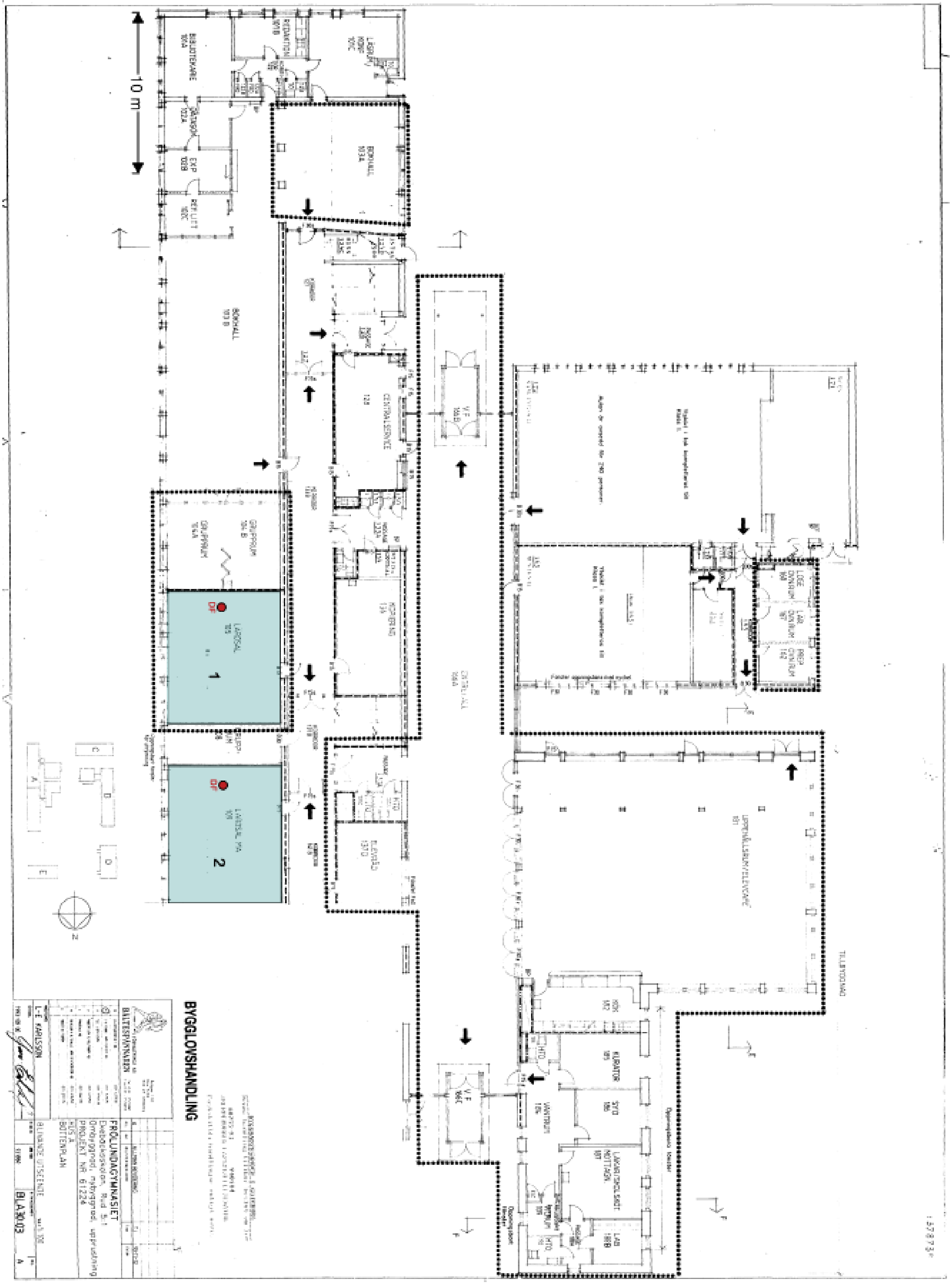
1/100 (A1)	A48.2-020	

Appendix 3K – 11_Rud 5:1





FLOORPLANS



BYGGLOVSHANDLING

BÅLTESPÄNNAREN

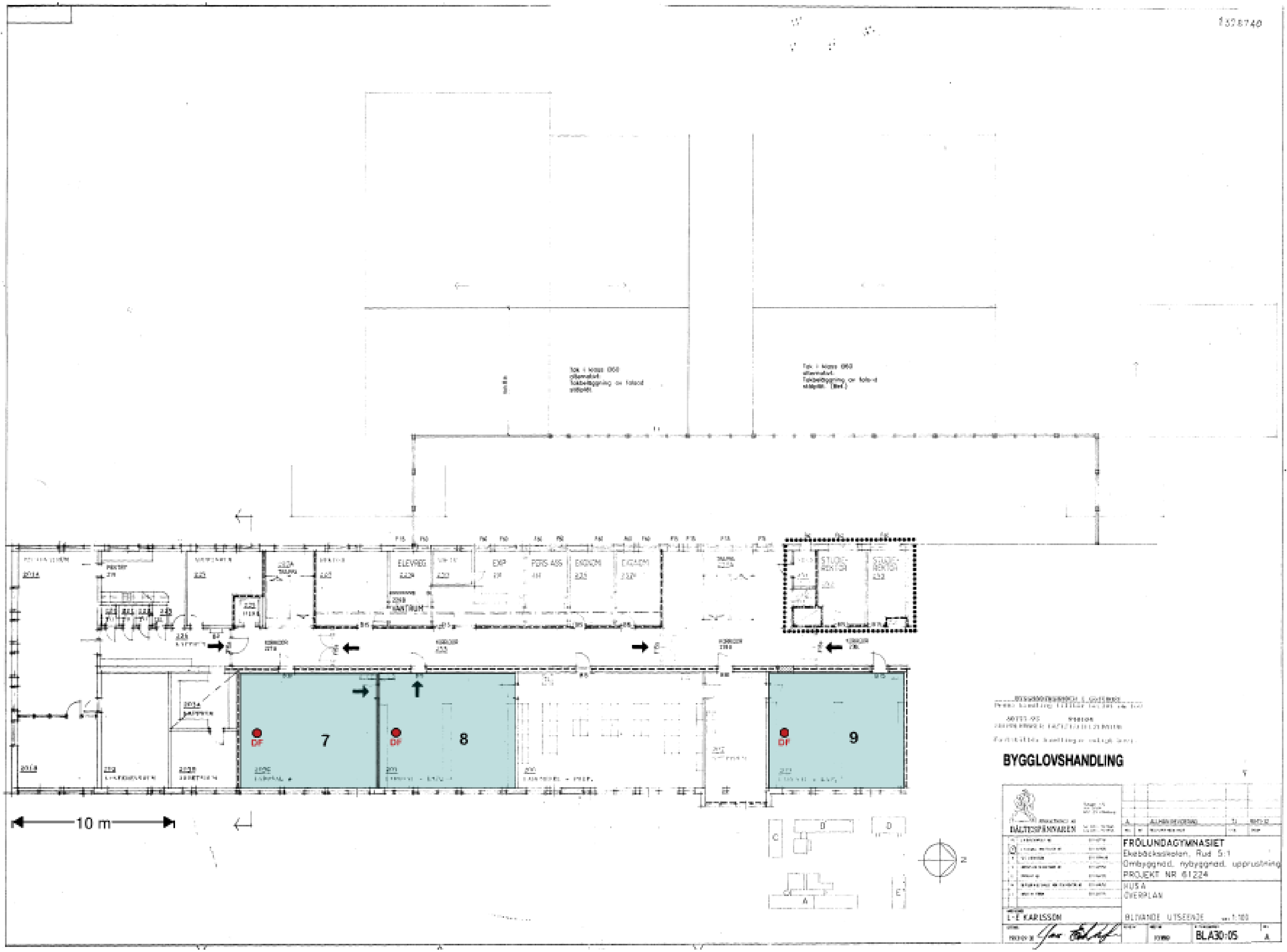
FRÖLUNDAGYMNASIET
Ekebäckskolan, Rud 5:1
Ombyggnad, nybyggnad, upprustning
PROJEKT NR 61224

HUS A
BOTTEN- OCH ÖVERPLAN

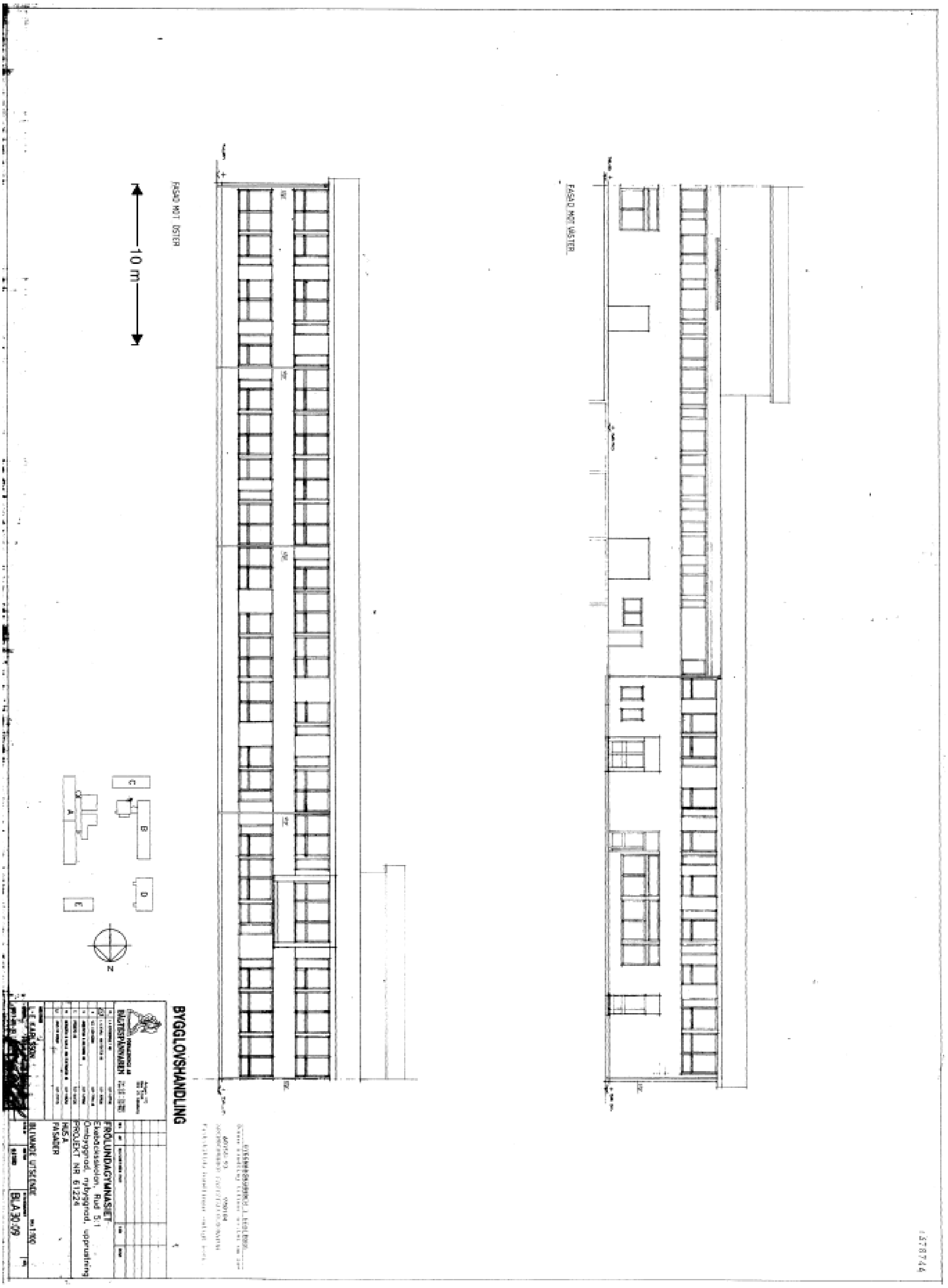
BLIVANDE UTSEENDE 1:100

L-E KARLSSON

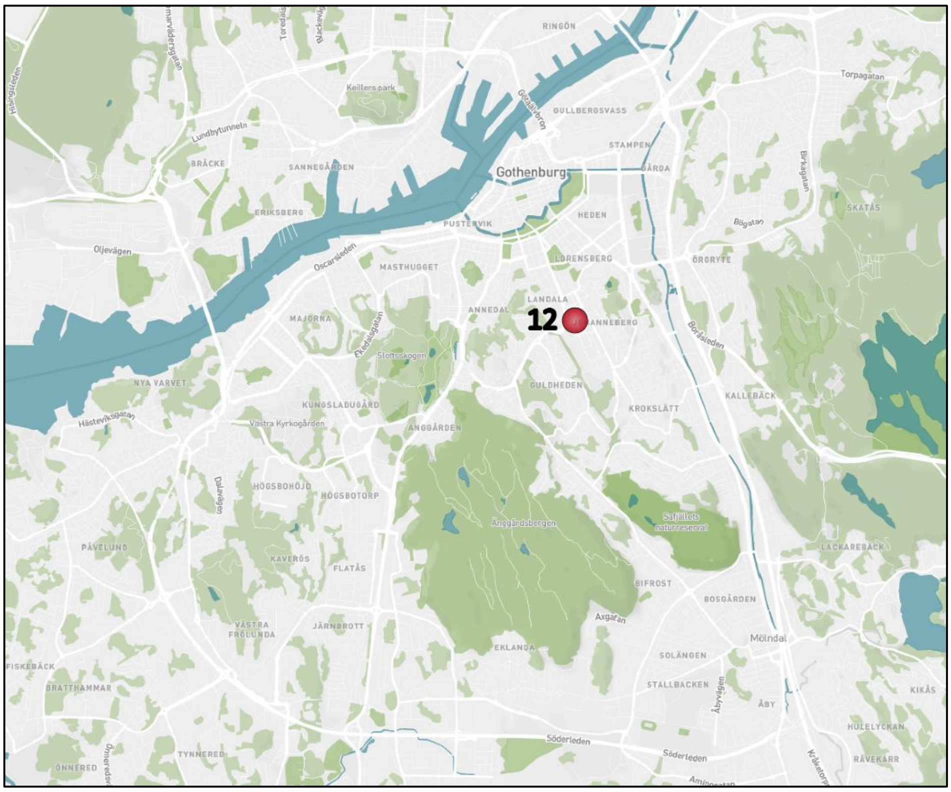
BLA30:04 A

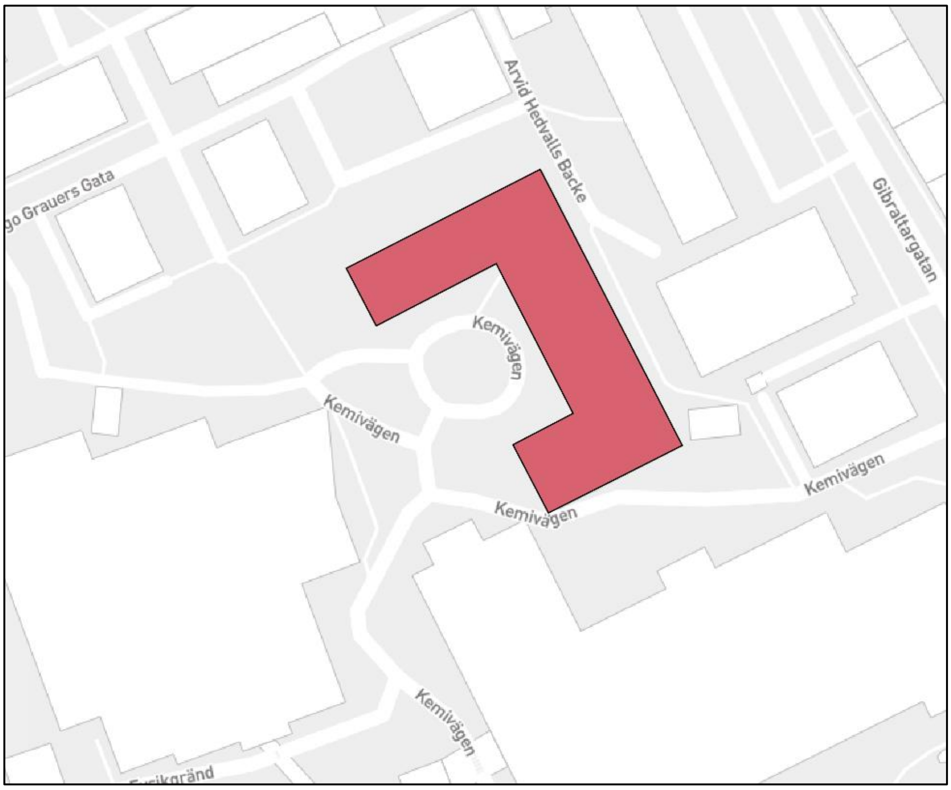

1328740
ELEVREG
EXP
PERS ASS
STUDIE-REKTOR
PENTRUM
7
8
9
DF
DF
DF
10 m
BYGGLOVSHANDLING
DALTCSPÄNNAREN
FRÖLUNDAGYMNASIET
Ekebäcksskolan, Rud 5:1
Ombyggnad, nybyggnad, upprustning
PROJEKT NR 61224
HUS A
ÖVERPLAN
L-E KARLSSON
BLA30:05
A

FACADES

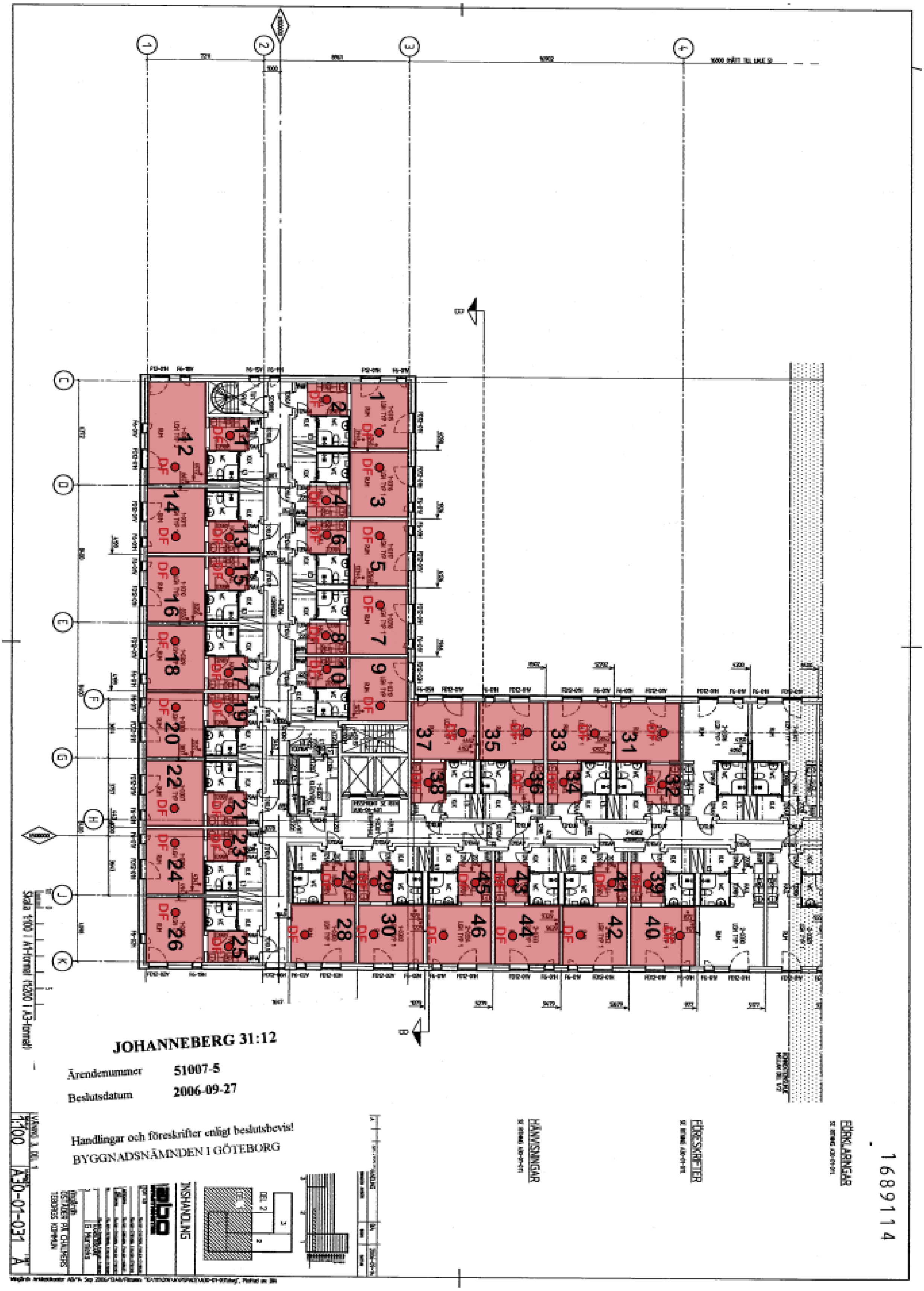

FASAD MOT ÖSTER
FASAD MOT VÄSTER
10 m
BYGGLOVSHANDLING
FRÖLUNDAGYMNASIET
PROJEKT NR 61224
HUS A
FASADER
BLA30.09

Appendix 3L – 12_Johanneberg 31:12



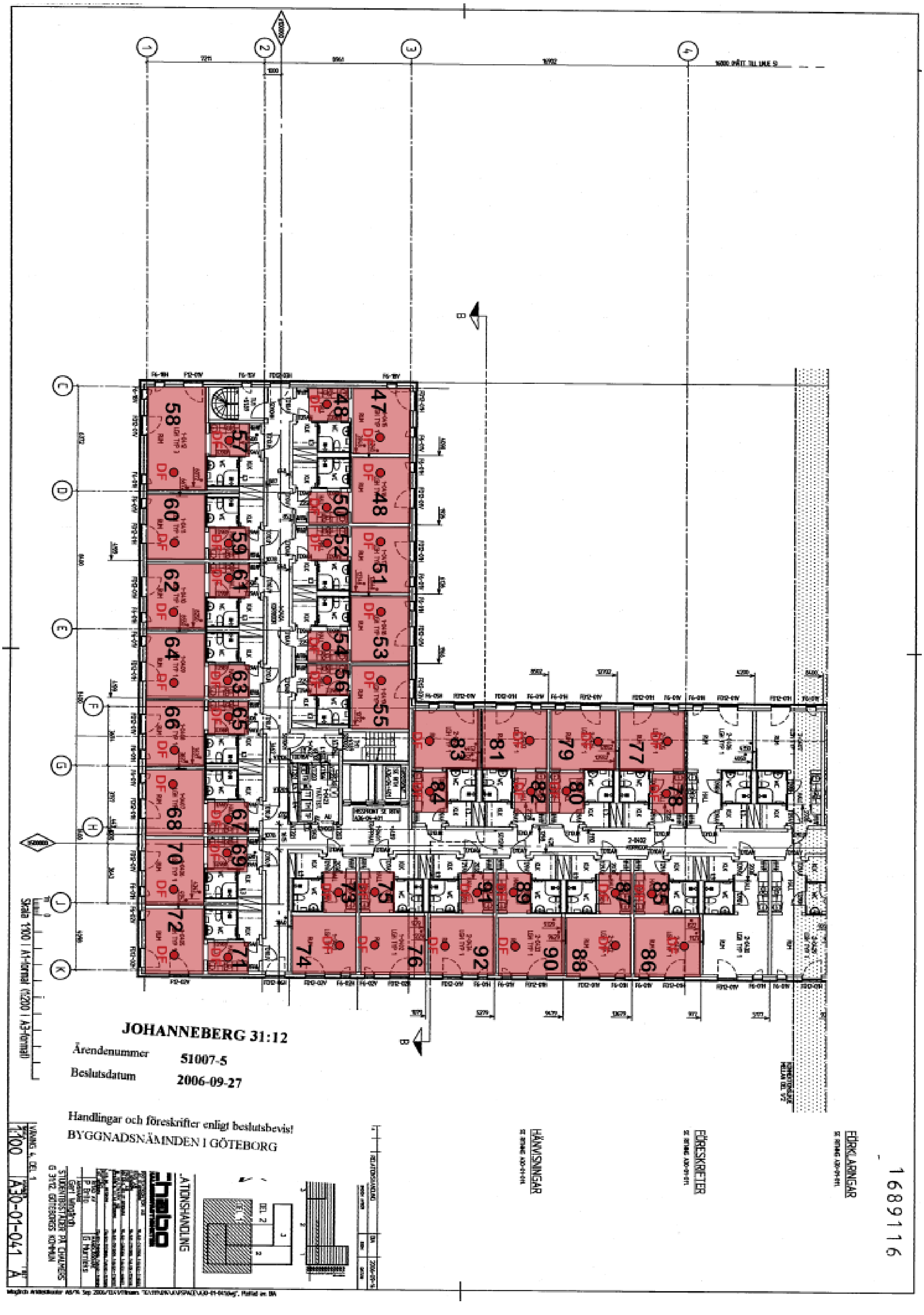


FLOOR 3



JOHANNEBERG 31:12
Ärendenummer 51007-5
Beslutsdatum 2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG

FLOOR 4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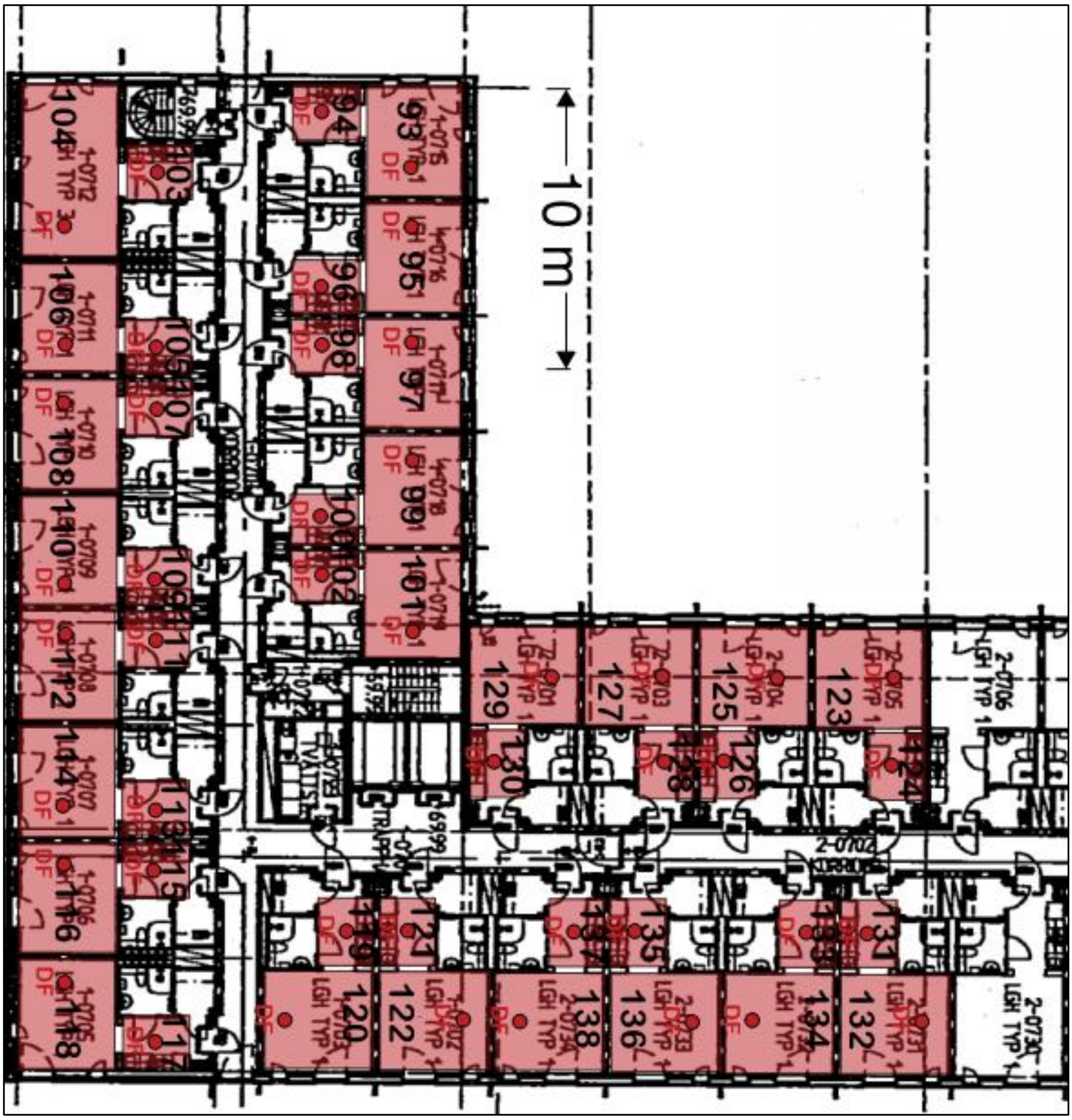
Ärendenummer 51007-5
Beslutsdatum 2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
1689116

FLOOR 7



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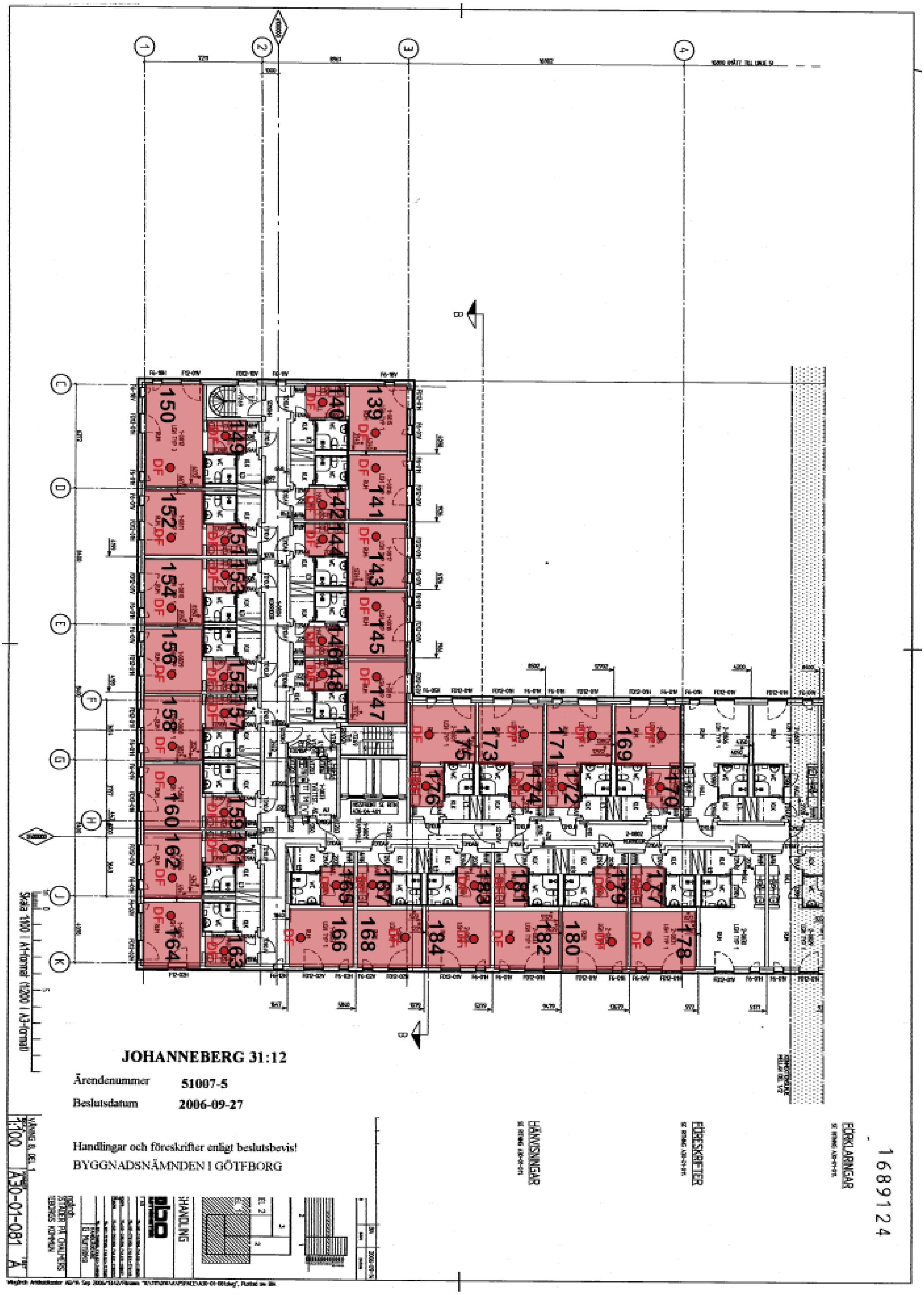
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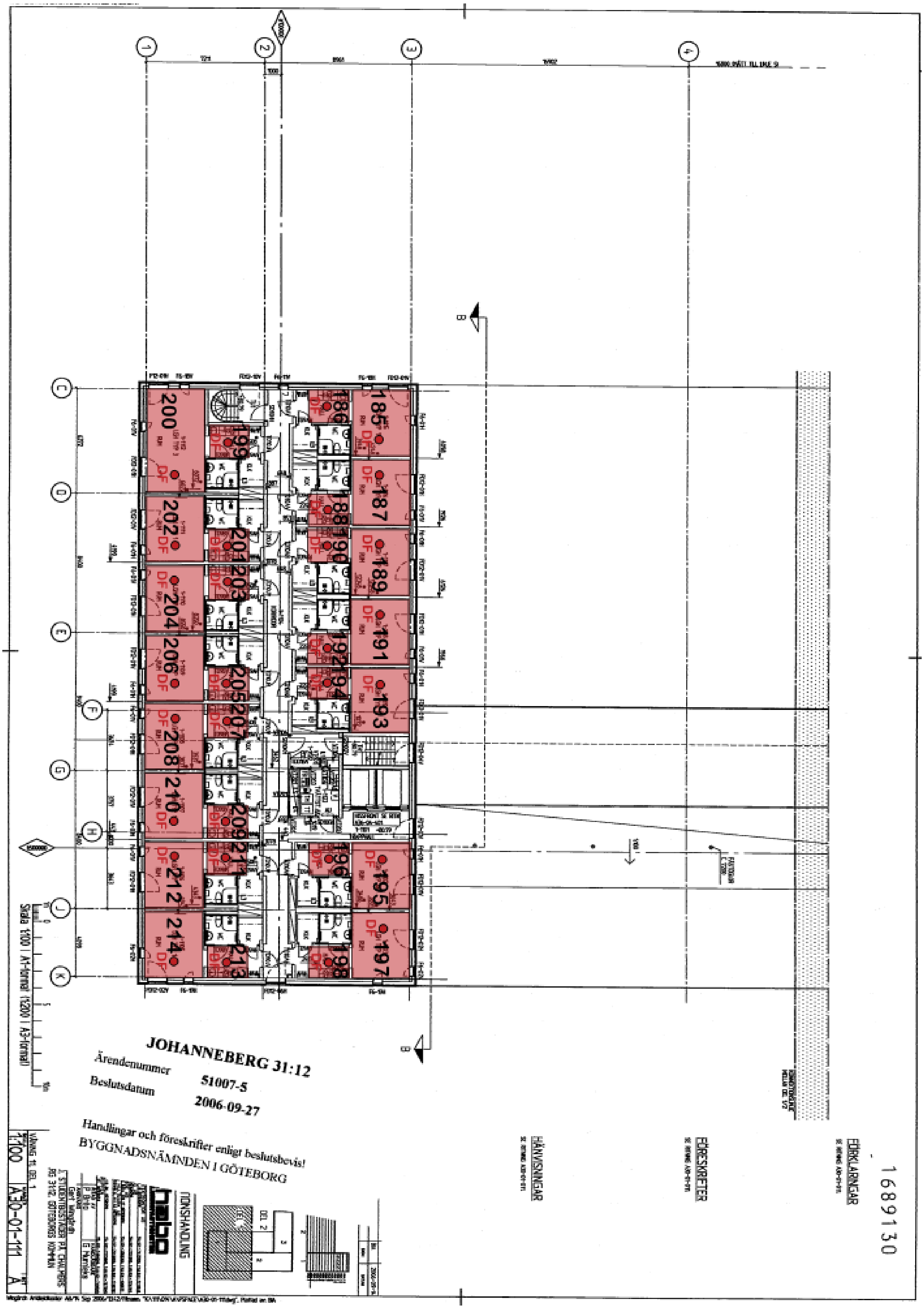
Ärendenummer 51007-5
Beslutsdatum 2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
1689124

FLOOR 11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JOHANNEBERG 31:12
Ärendenummer
51007-5
Beslutsdatum
2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
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FÖRESKRIFTER
FÖRKLARINGAR
1689130
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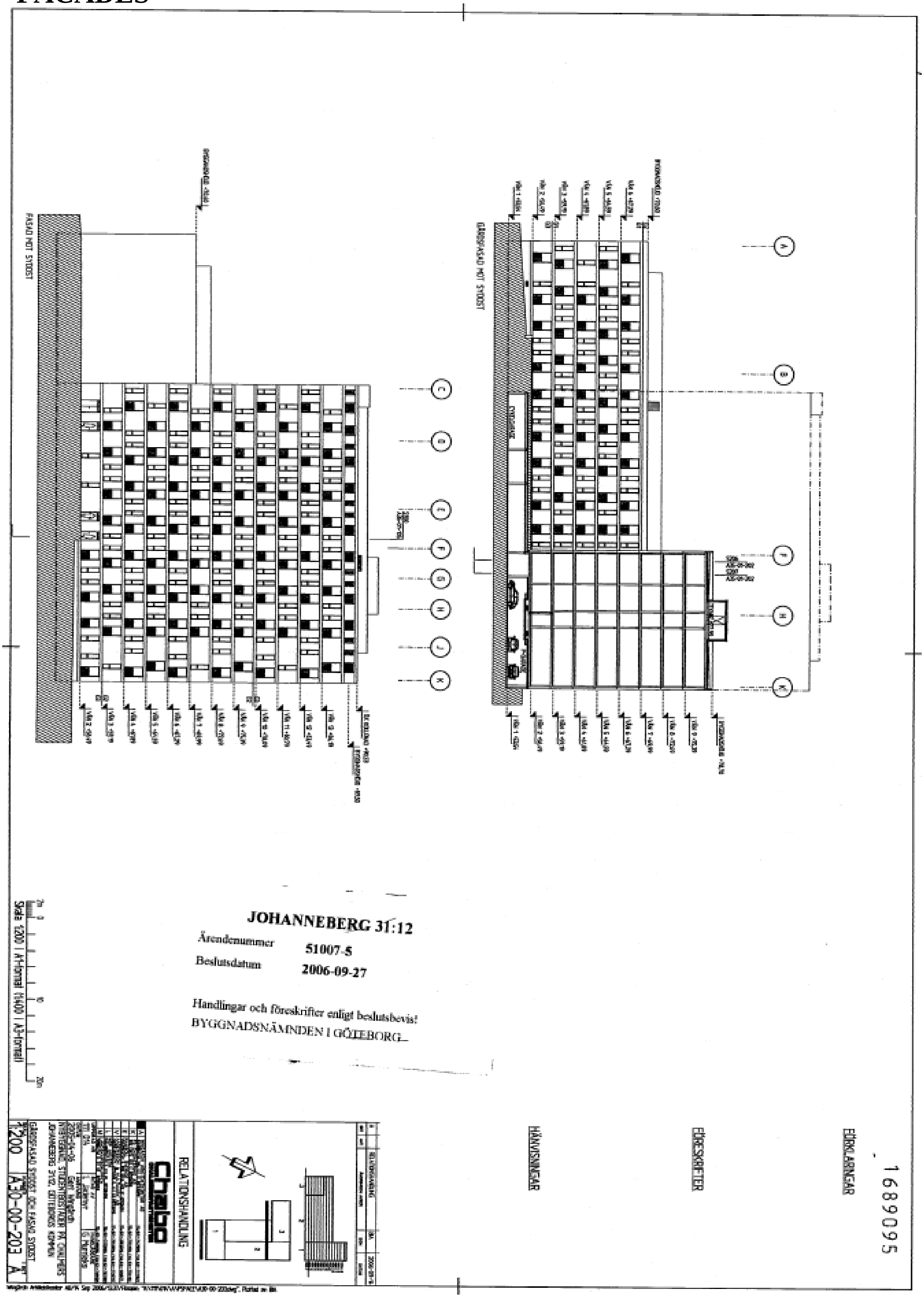
A30-01-111

FACADES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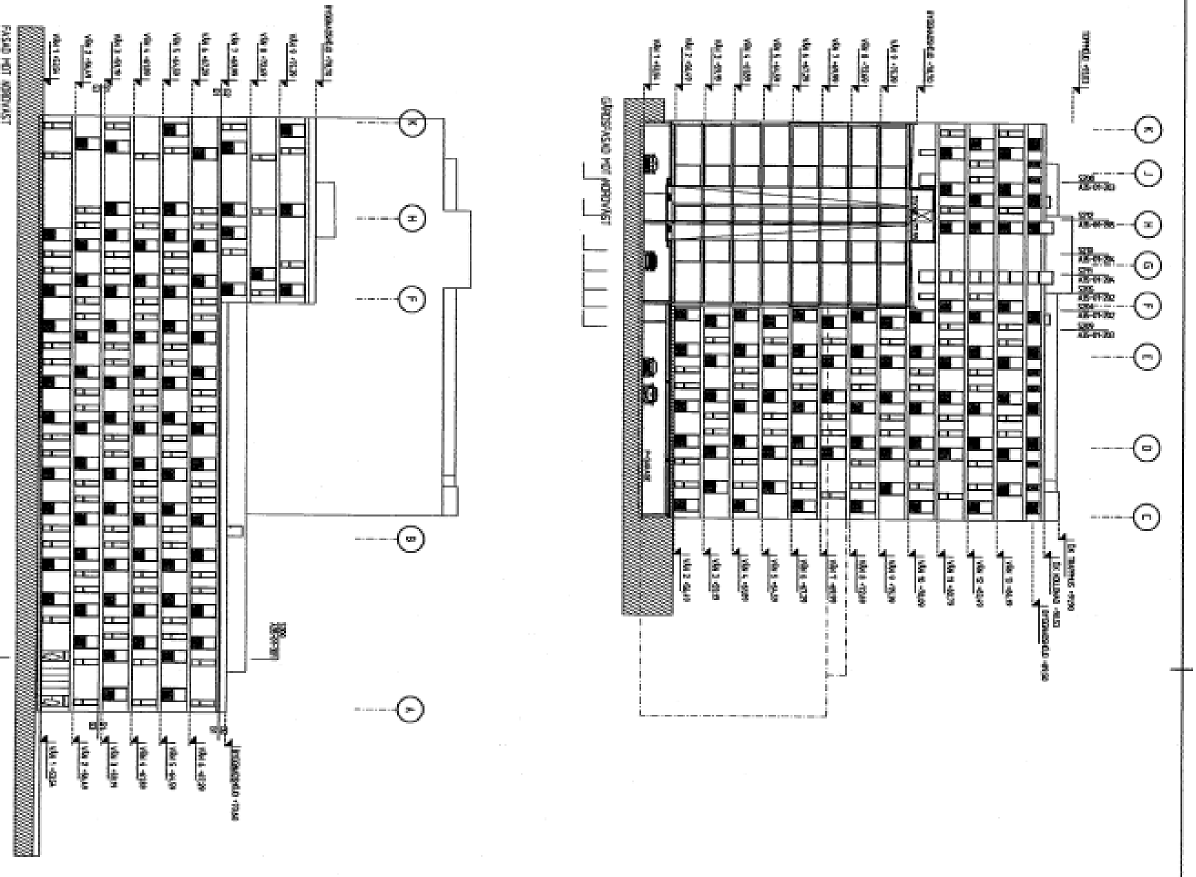
Ärendenummer 51007-5
Beslutsdatum 2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
HÄNVISNINGAR
FÖRESKRIFTER
FÖRKLARINGAR
1689095
RELATIONSHANDLING
GÅRDSFASAD MOT SYDOST
FASAD MOT SYDOST
1:200
A30-00-203 A



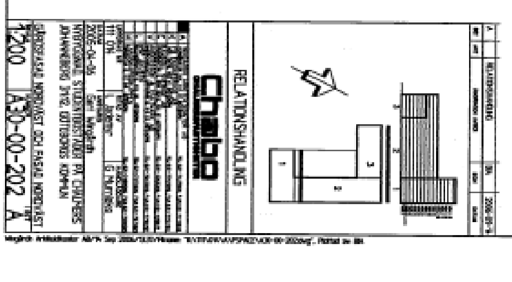
JOHANNEBERG 31:12

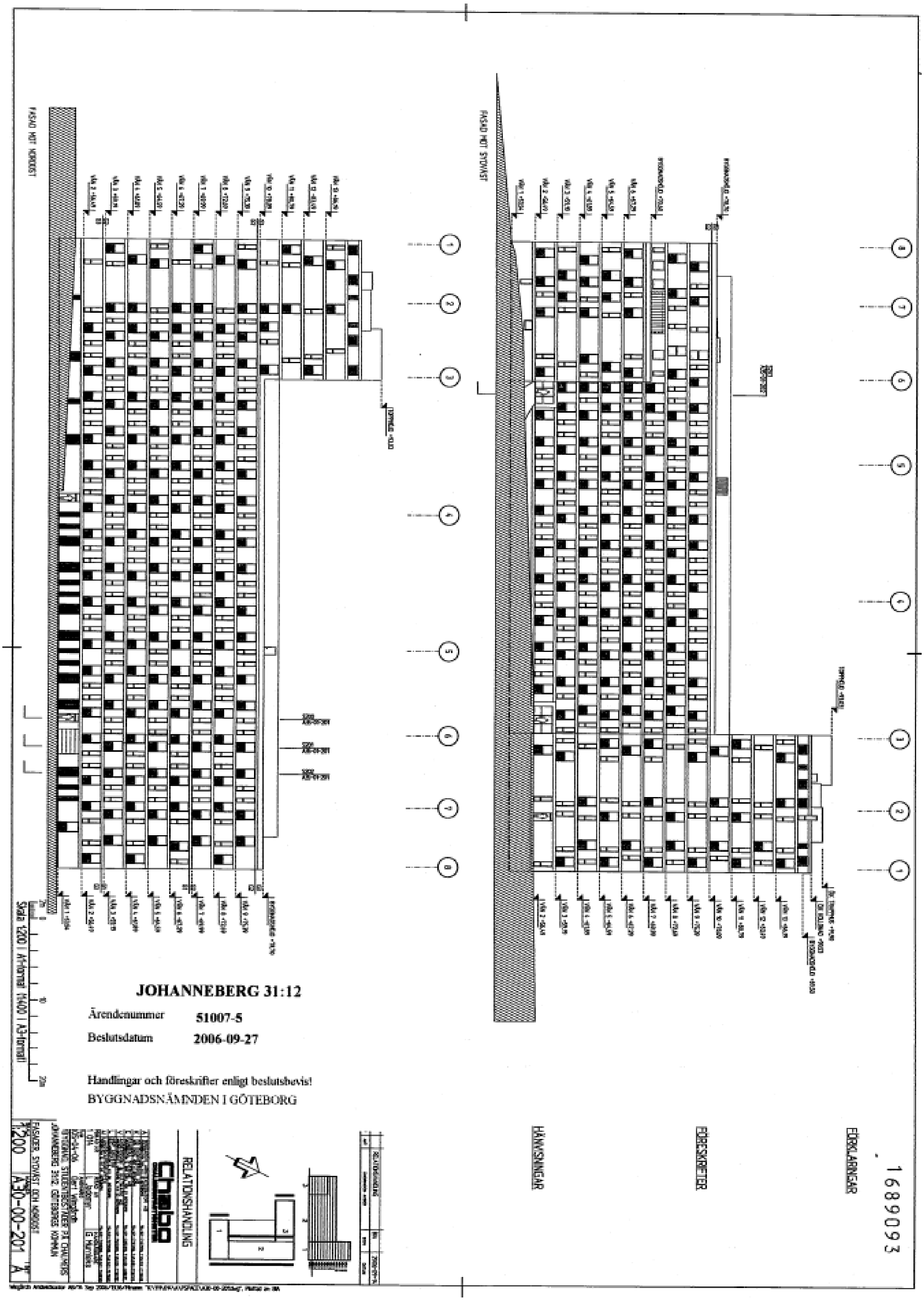
Ärendenummer **51007-5**

Beslutsdatum **2006-09-27**

Handlingar och föreskrifter enligt beslutsbevis!

BYGGNADSNÄMNDEN I GÖTEBORG





JOHANNEBERG 31:12

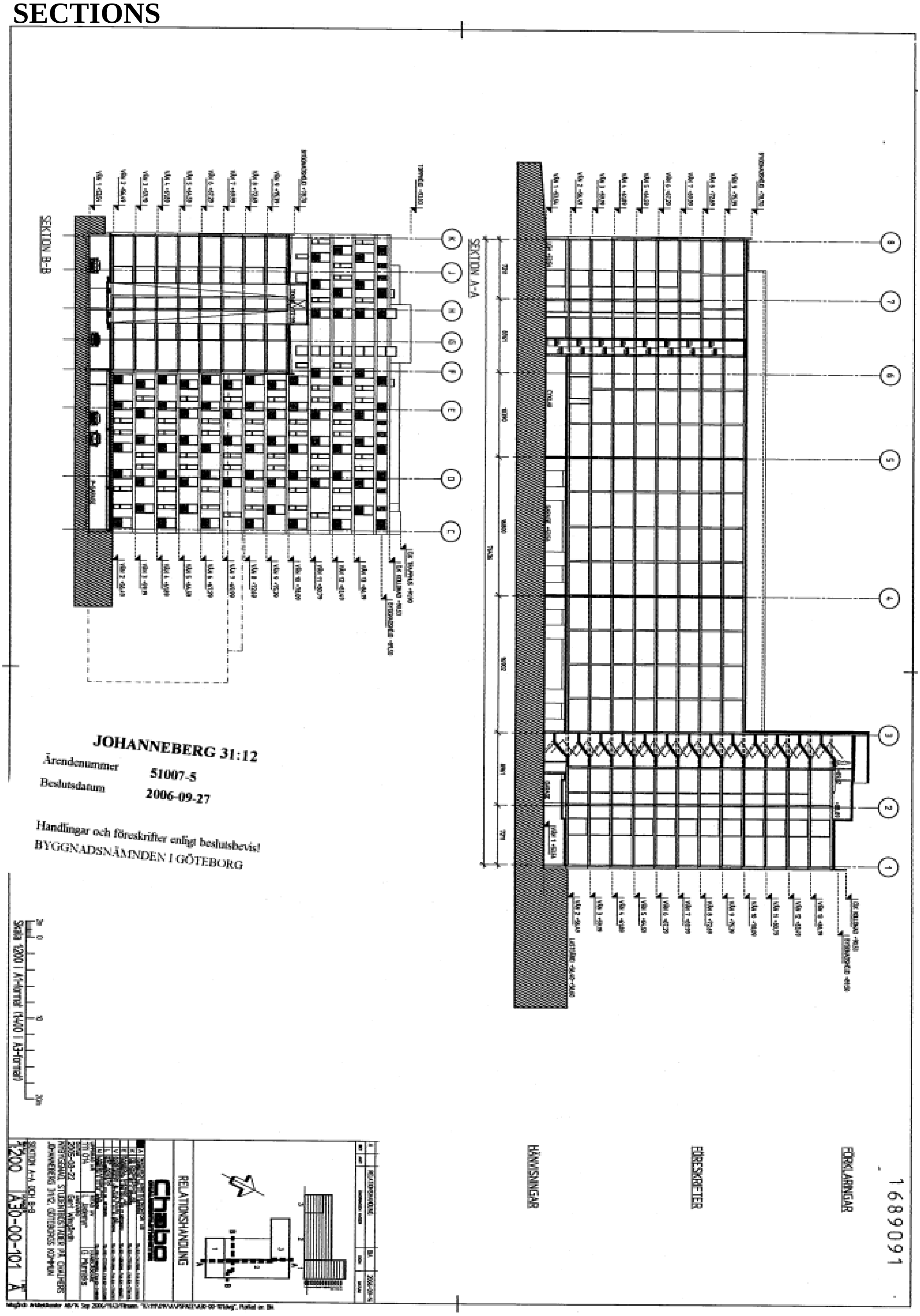
Ärendenummer 51007-5

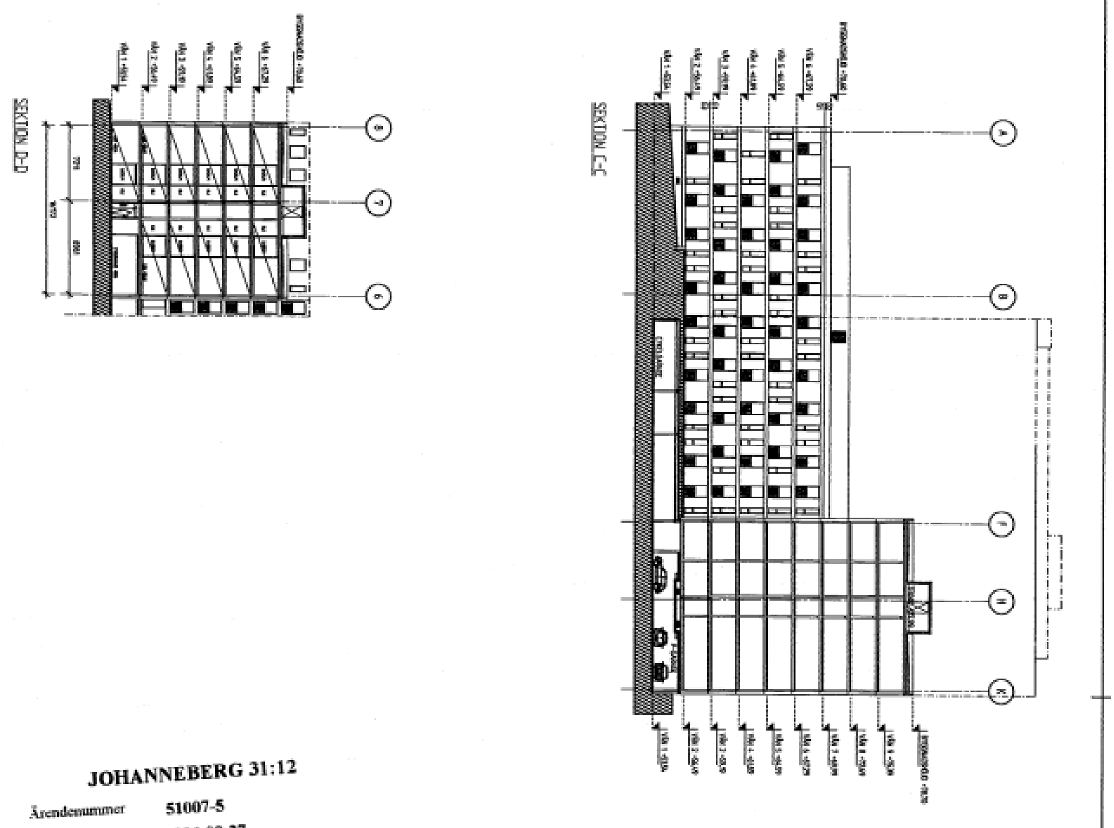
Beslutsdatum 2006-09-27

Handlingar och föreskrifter enligt beslutsbevis!

BYGGNADSNÄMNDEN I GÖTEBORG

SECTIONS


JOHANNEBERG 31:12
Ärendenummer 51007-5
Beslutsdatum 2006-09-27
Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG
SEKTION A-A
SEKTION B-B
HÄNVISNINGAR
FÖRESKRIFTER
FÖRKLARINGAR
RELATIONSHANDLING
1689091
1:200 A30-00-101 A



JOHANNEBERG 31:12

Ärendenummer 51007-5

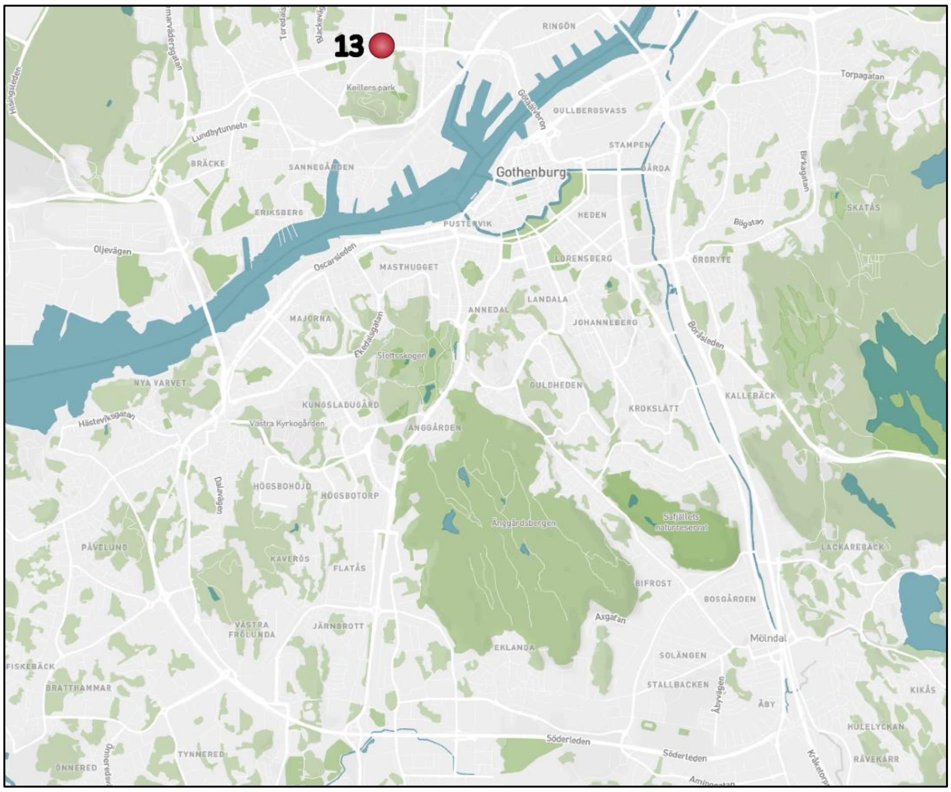
Beslutsdatum 2006-09-27

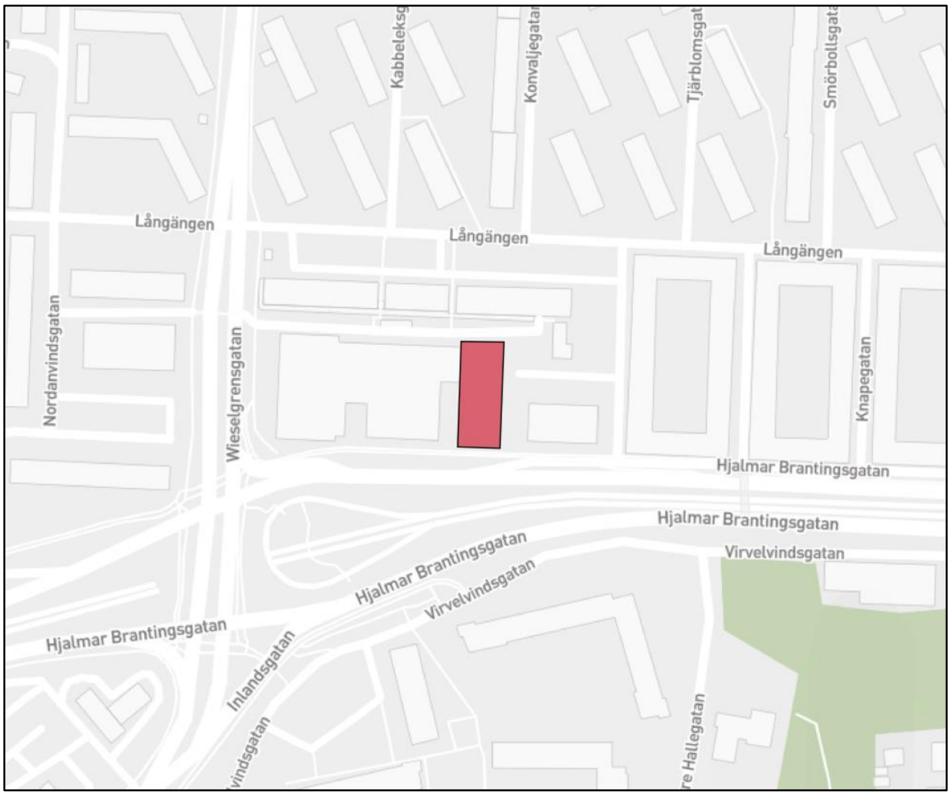
Handlingar och föreskrifter enligt beslutsbevis!

BYGGNADSNÄMNDEN I GÖTEBORG

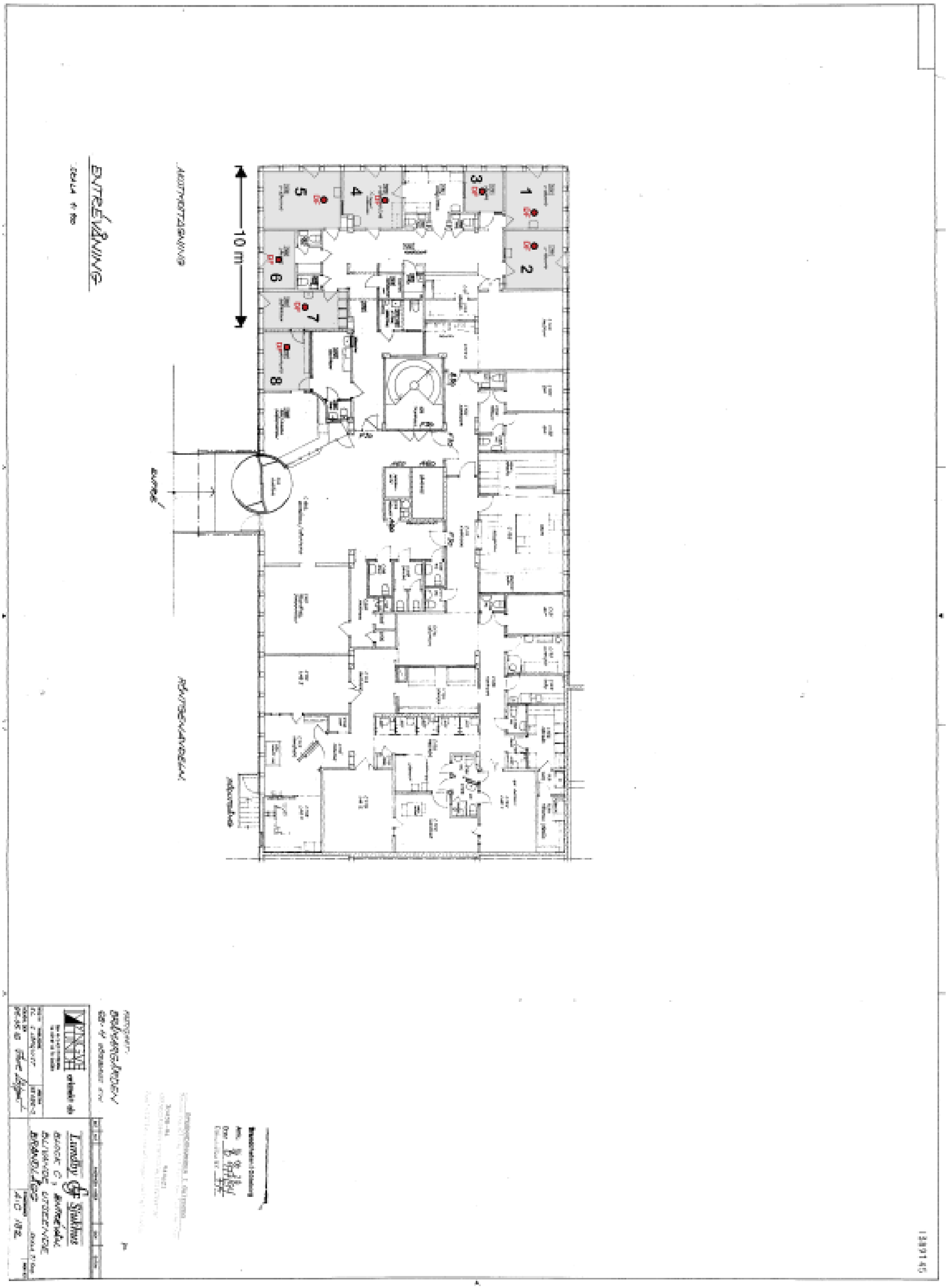
1689092

Appendix 3M – 13_Brämaregården 68:6





FLOORPLANS



VÅNING 1 TR

SKALA 1:100

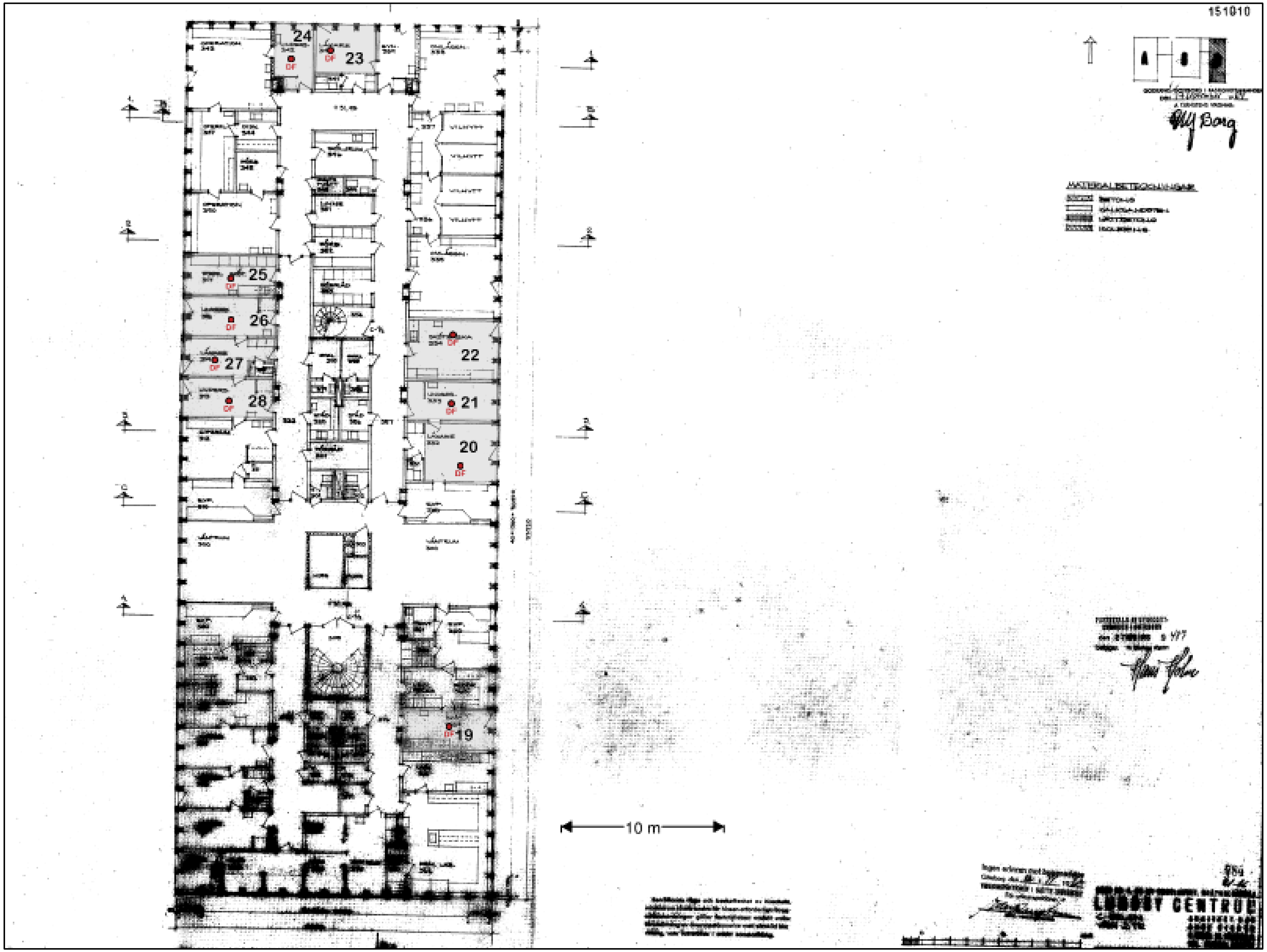
Brandchefen i Göteborg

FASTIGHET:
BRÄMARGÅRDEN

YNGVE LINDE arkitekt ab

Lundby Sjukhus
BLOCK C, VÅNING 1 TR
BLIVANDE UTSEENDE
BRANDLÄGG
SKALA 1:100
A:C 232

1389146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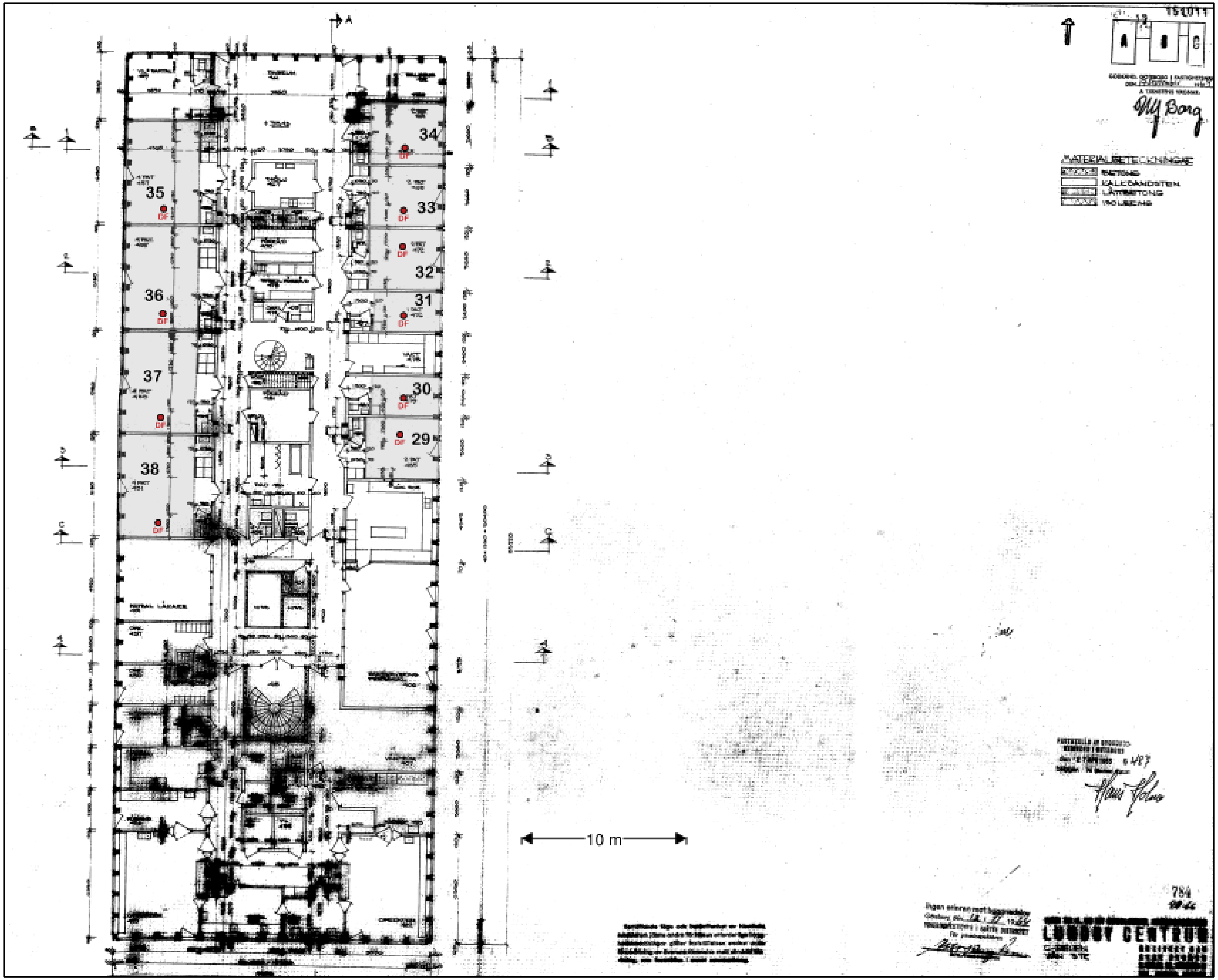
LUNDBY CENTRUM



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DF
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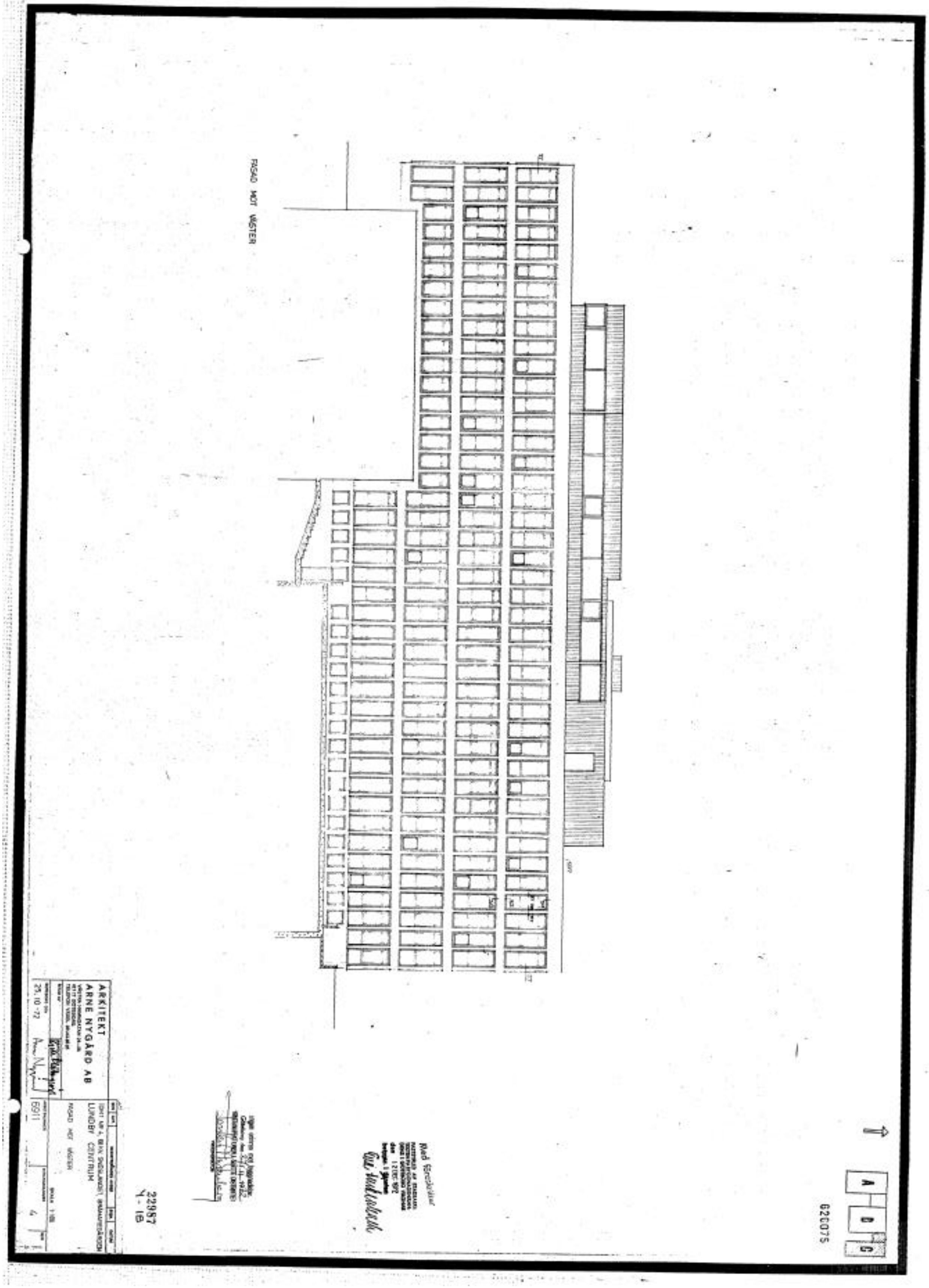
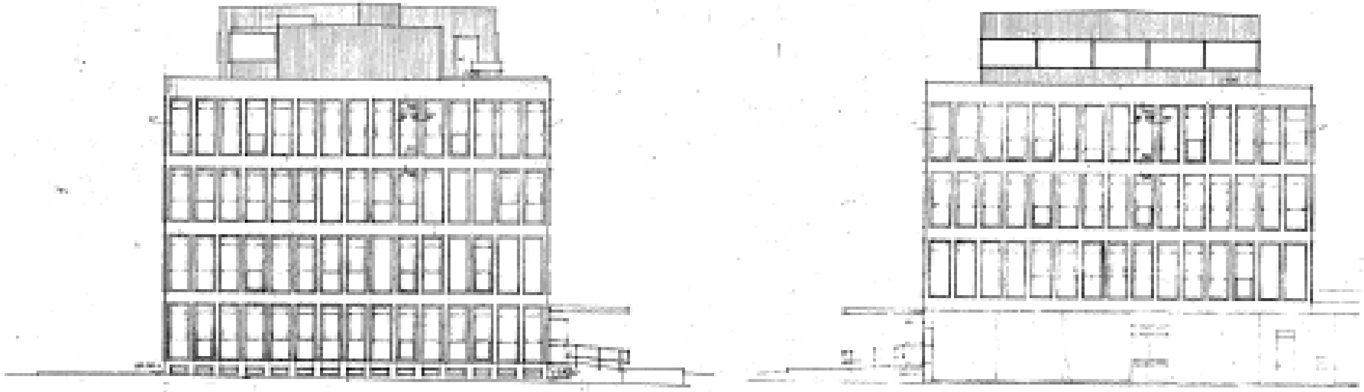
MATERIALBETECKNINGAR
BETONG
KALKSANDSTEN
LÄTTBETONG
ISOLERING
LUNDBY CENTRUM
784

FACADES


FASAD MOT VÄSTER
ARKITEKT
ARNE NYGÅRD AB
LUNDBY CENTRUM
22987



FASAD MOT SÖDER

FASAD MOT NORR

A B C

G24876

33987
3 - 15

ARKITEKT
ARNE MYGÅRD AB

LUNDBY CENTRUM

FASADER MOT SÖDER OCH NORR

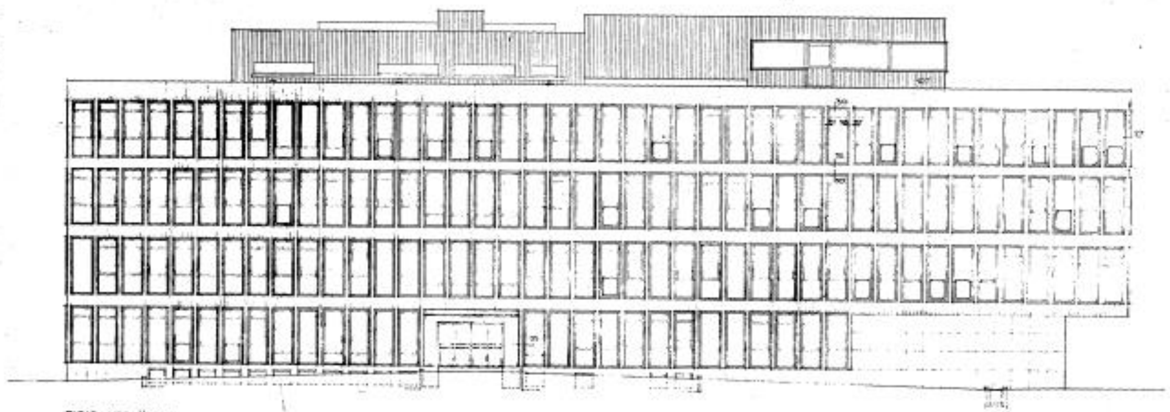
SKALA 1:100

25.10.72

9

A B C

620074



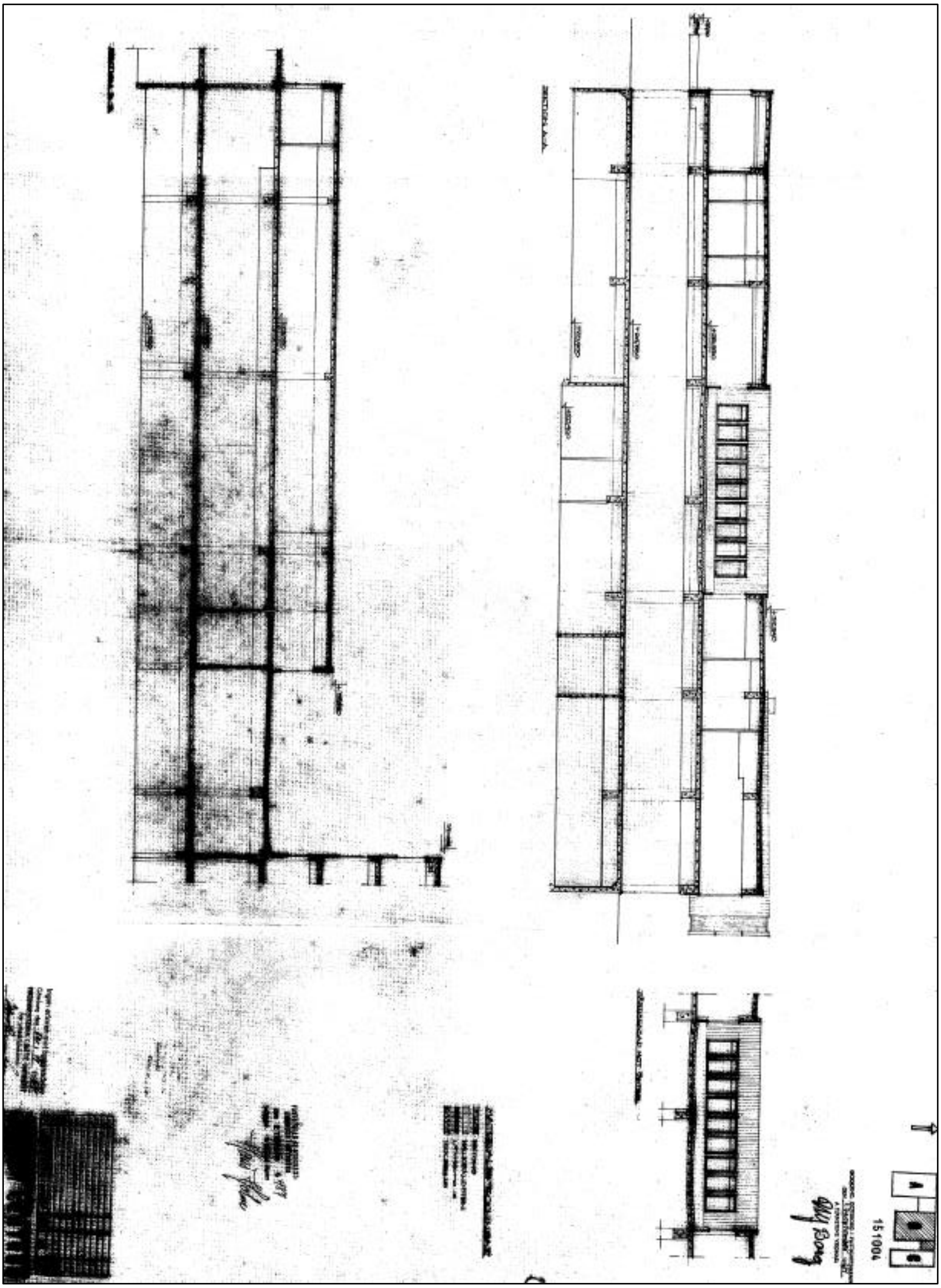
FASAD MOT ÖSTER

Med Stadshus
den 1 2 DEC 1972

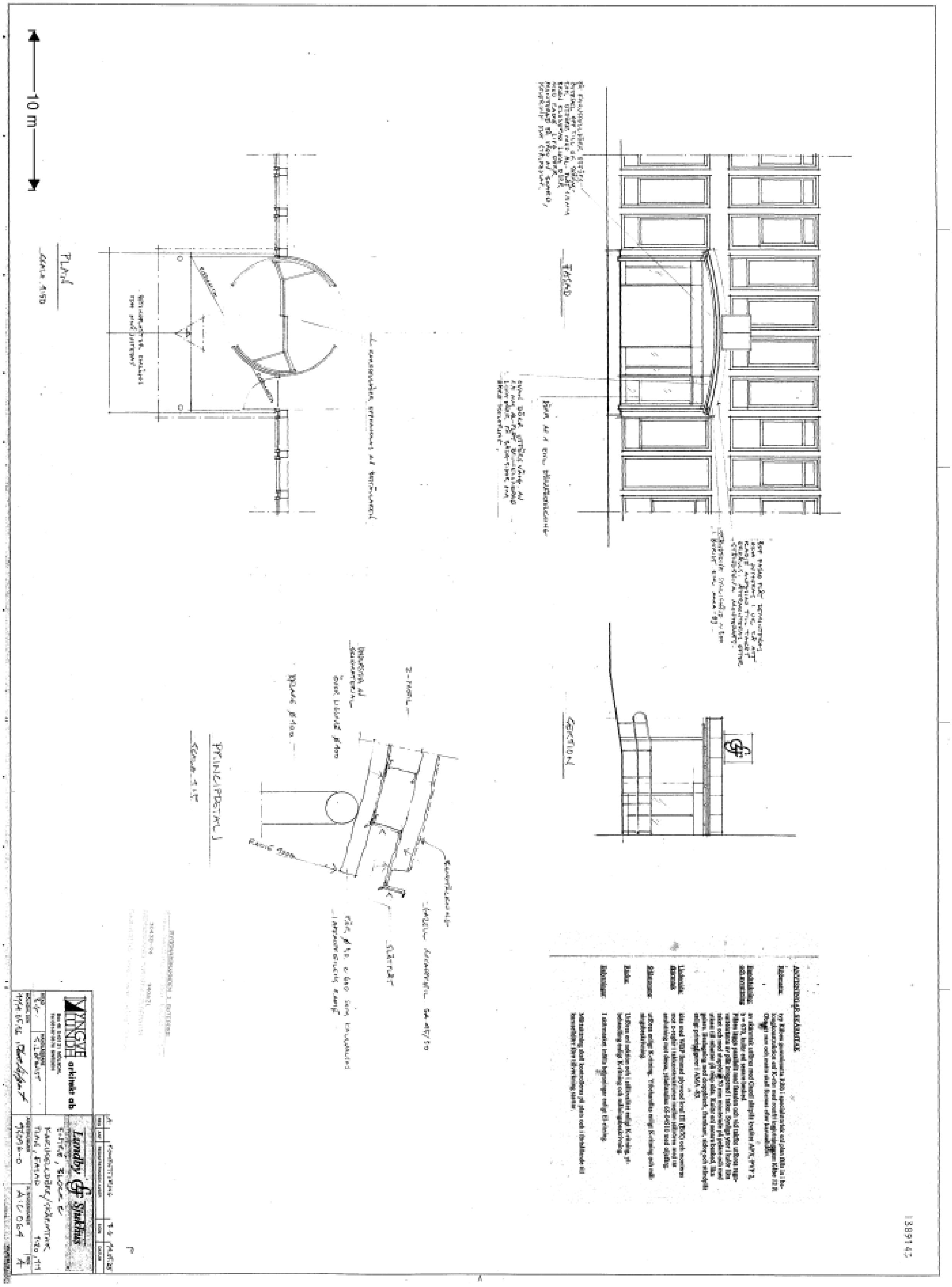
22987
3-18

ARKITEKT ARNE NYGÅRD AB	LUNDBY CENTRUM FASAD MOT ÖSTER
	SKALA 1:100
25.10-72	6911 — 3

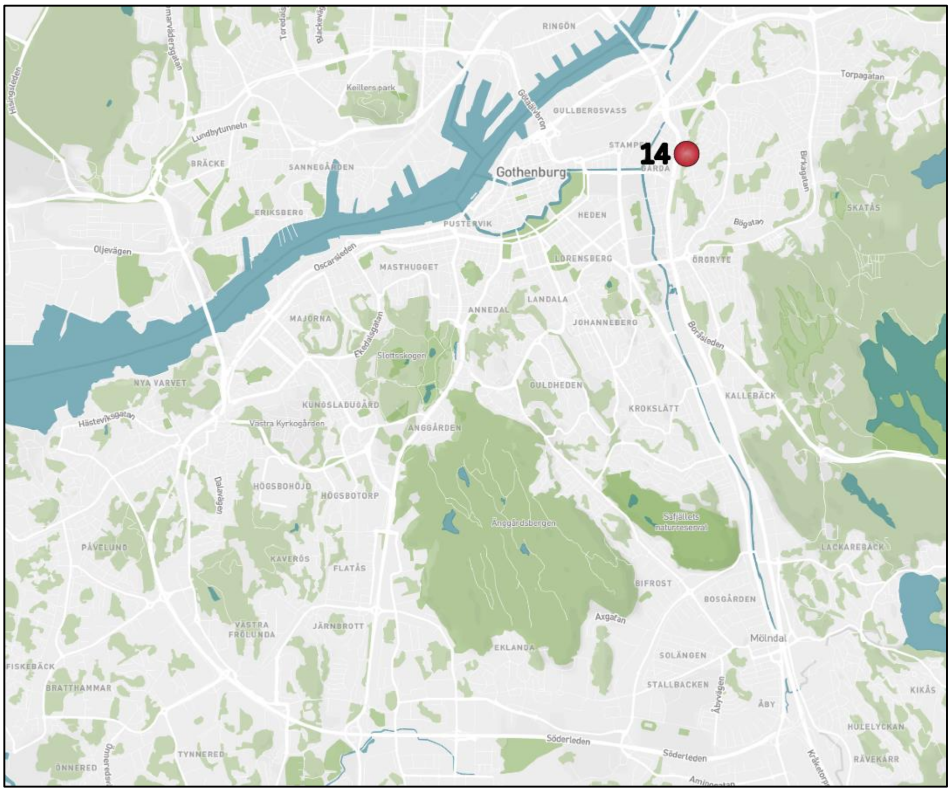
SECTIONS

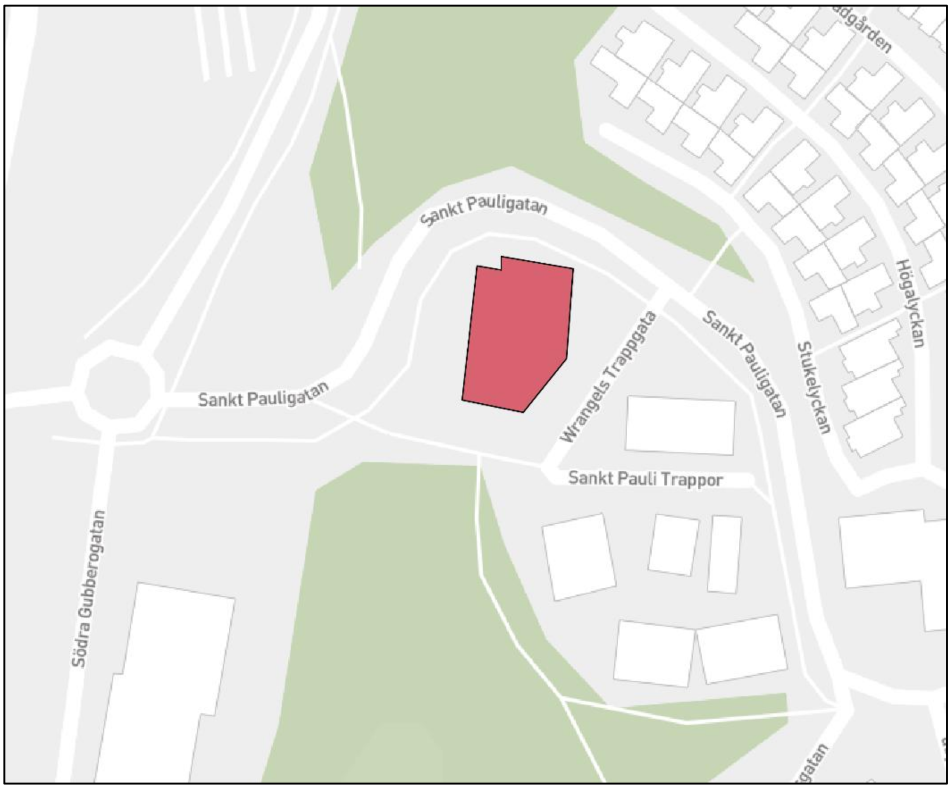


DETAIL

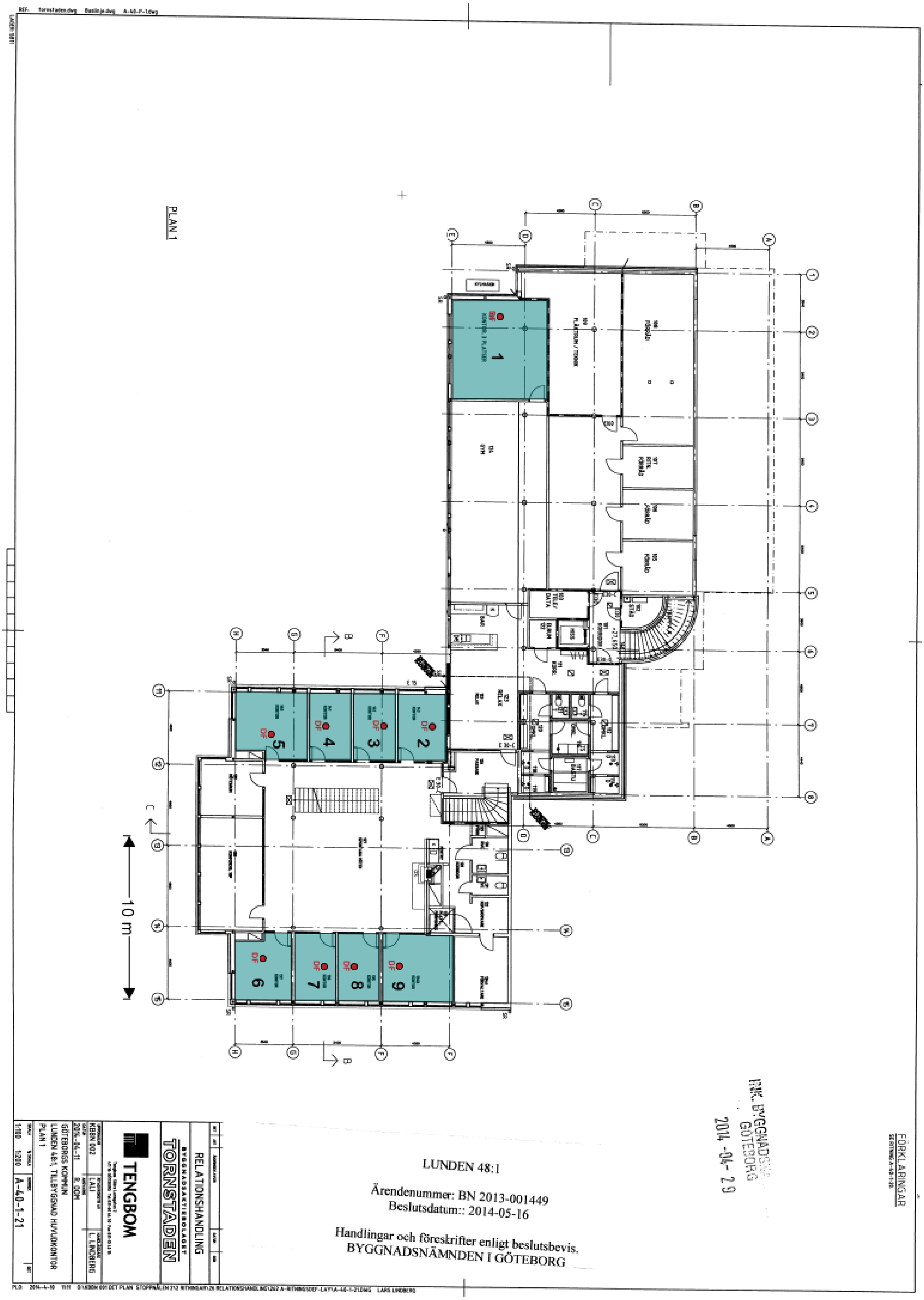


Appendix 3N – 14_Lunden 48:1





FLOORPLANS



PLAN 1
10 m
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DF
TENGBOM
TORNSTADEN
RELATIONSHANDLING
GÖTEBORGS KOMMUN
LUNDEN 48:1, TILLBYGGNAD HUVUDKONTOR
PLAN 1
A-40-1-21
LUNDEN 48:1
Ärendenummer: BN 2013-001449
Beslutsdatum:: 2014-05-16
Handlingar och föreskrifter enligt beslutsbevis,
BYGGNADSNÄMNDEN I GÖTEBORG
2014-04-29
FÖRKLARINGAR

PLAN 2

FÖRKLARINGAR

INK. BYGGNADS... GÖTEBORG 2014-04-29

LUNDEN 48:1

Ärendenumrner: BN 2013-001449
Beslutsdatum:: 2014-05-16

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

RELATIONSHANDLING

BYGGNADSAKTIEBOLAGET TORNSTADEN

TENGBOM

GÖTEBORGS KOMMUN
LUNDEN 48:1, TILLBYGGNAD HUVUDKONTOR
PLAN 2, ENTRÉPLAN

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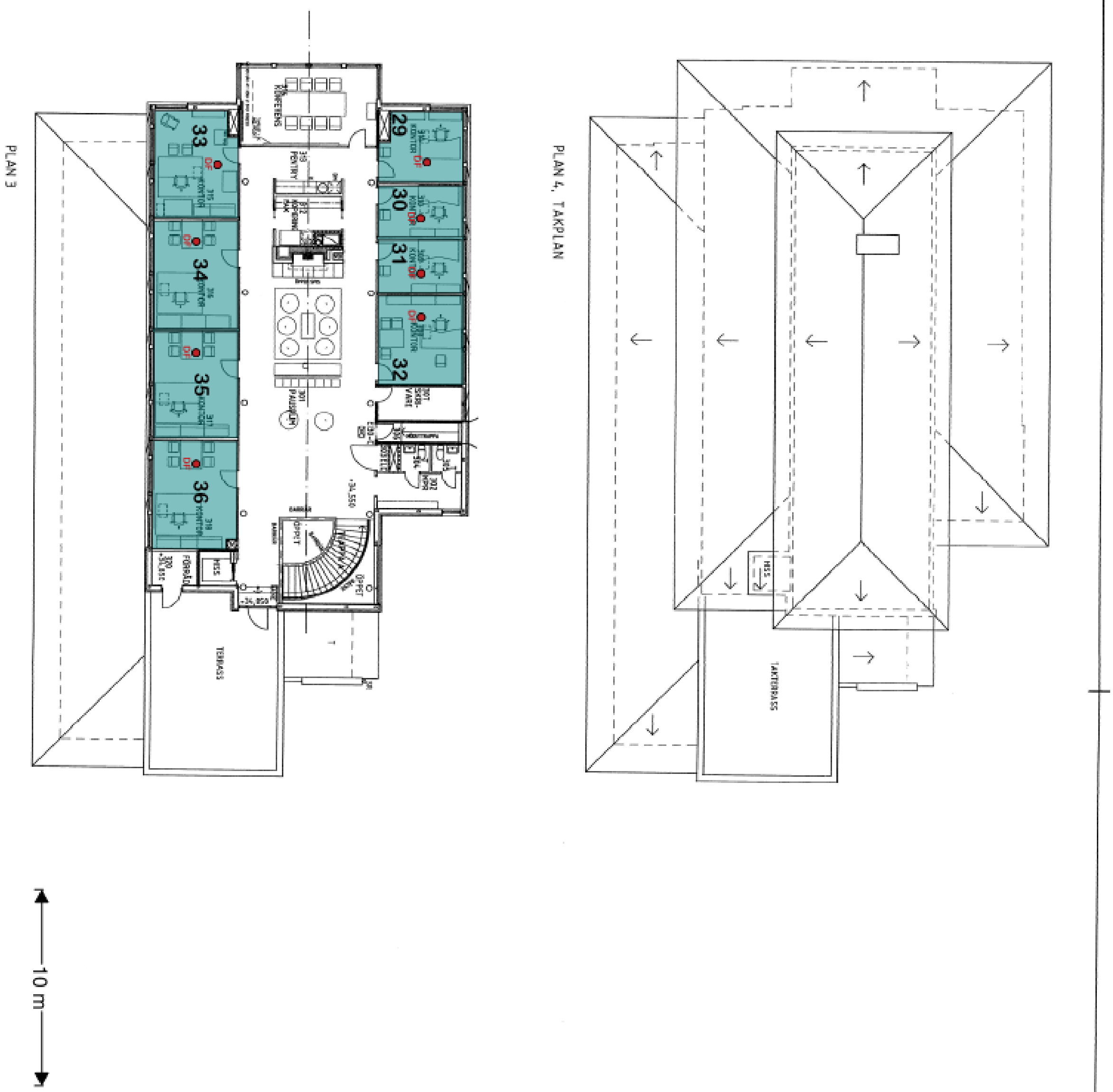


LUNDEN 48:1

Ärendenummer 52077-5

Beslutsdatum 2007-10-02

Handlingar och föreskrifter enligt beslutsbevis!

BYGGNADSNÄMNDEN I GÖTEBORG

RELATIONSHANDLING

TORNSTADEN

NYBYGGNAD AV KONTORSHUS

BYGGNADSAKTIEBOLAGET TORNSTADEN

2006-12-11

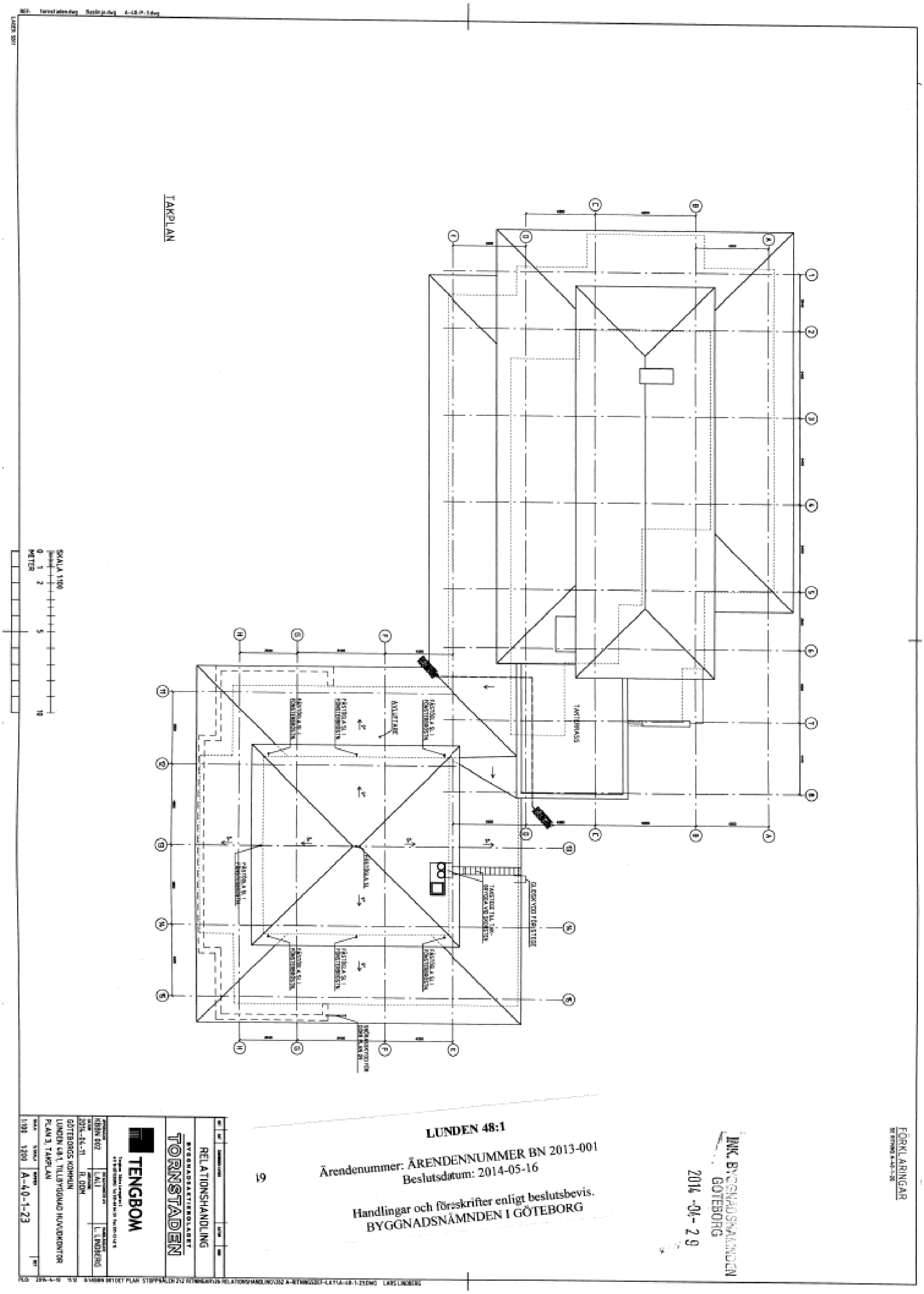
GÖTEBORGS KOMMUN

PLAN 3

PLAN 4, TAKPLAN

A-40.0-02

1723927



LUNDEN 48:1

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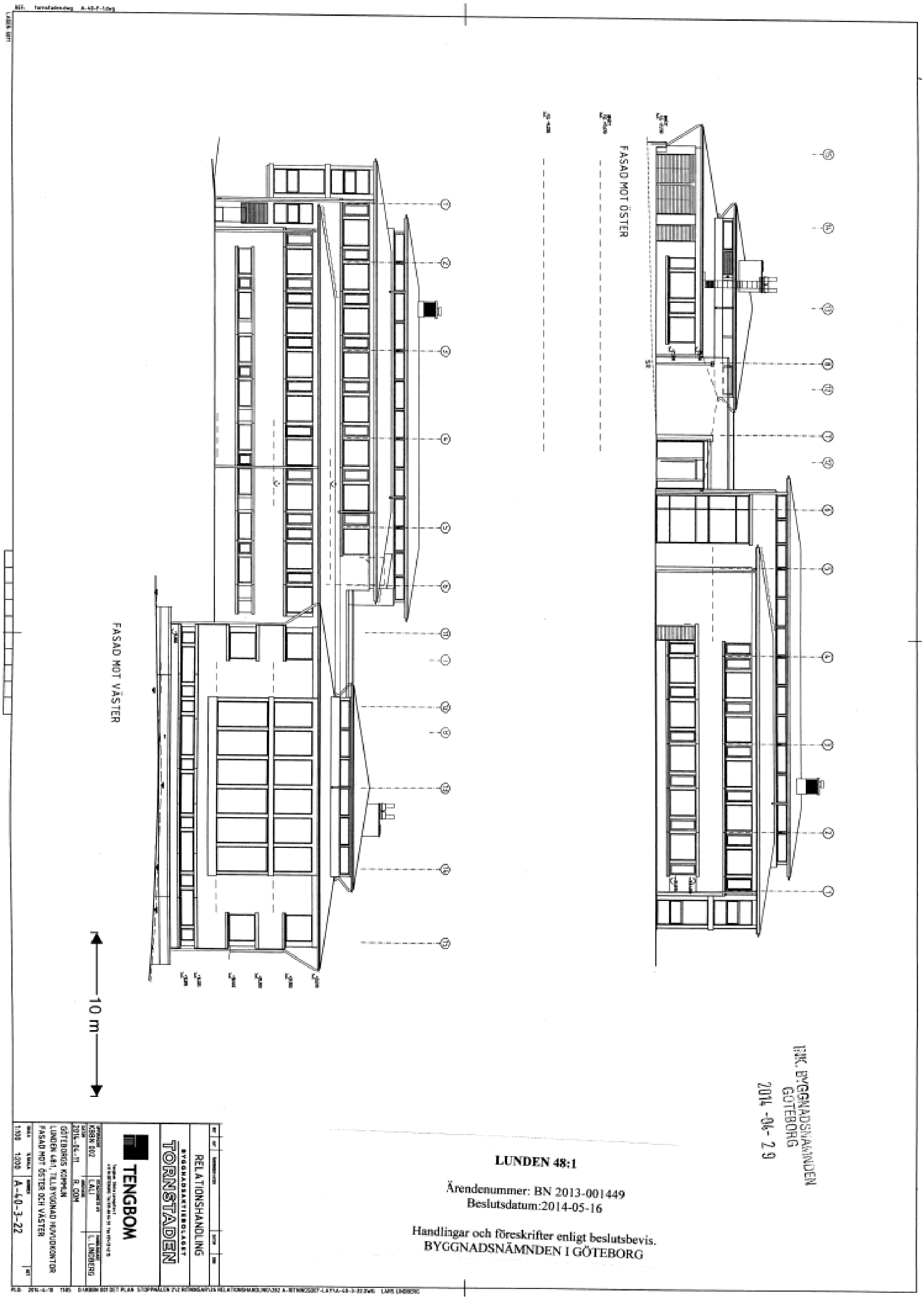
Ärendenummer: ÄRENDENNUMMER BN 2013-001
Beslutsdatum: 2014-05-16

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

INK. BYGGNADSNÄMNDEN
GÖTEBORG
2014 -04- 29

FACADES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FASAD MOT VÄSTER
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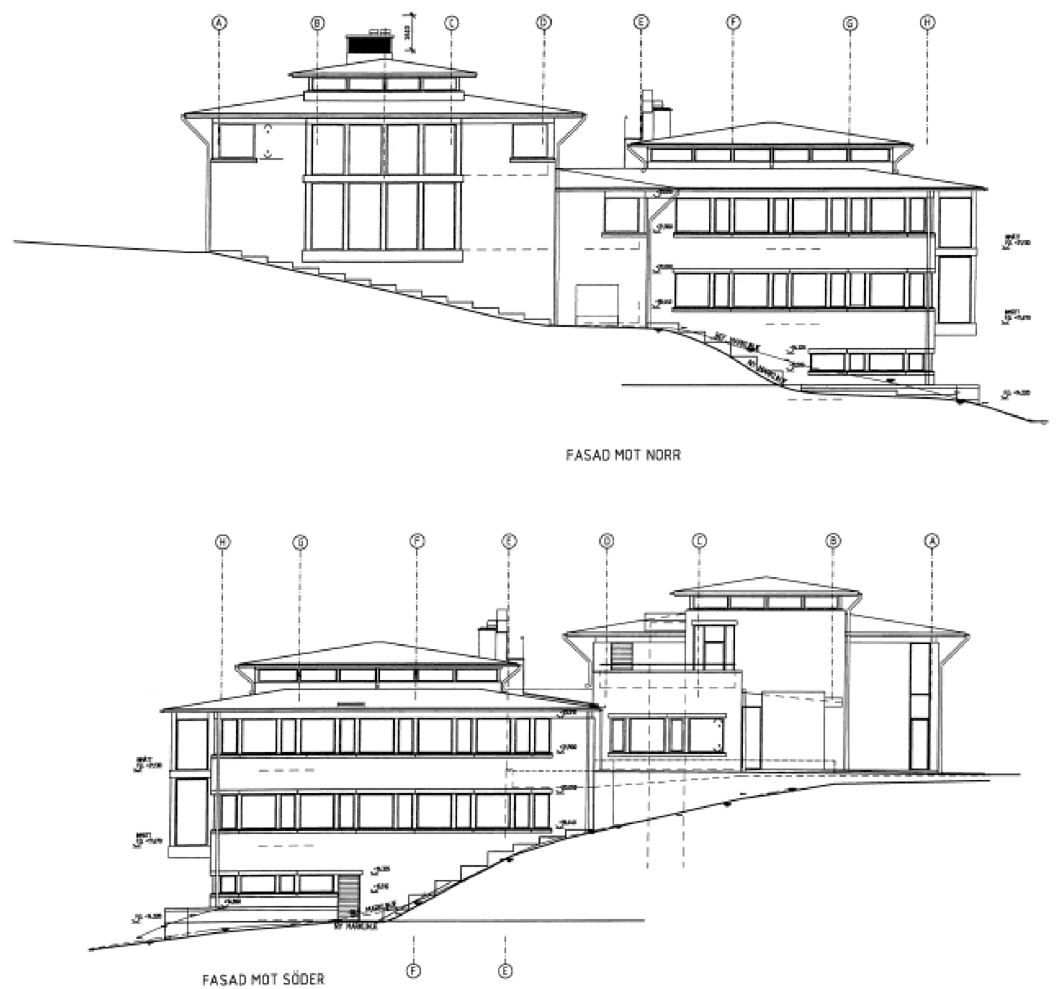
RELATIONSHANDLING
TORNSTADEN
TENGBOM
GÖTEBORGS KOMMUN
LUNDEN 48:1, TILLBYGGNAD HUVUDKONTOR
FASAD MOT ÖSTER OCH VÄSTER
A-40-3-22
INK. BYGGNADSNÄMNDEN
GÖTEBORG
2014 -06- 29
LUNDEN 48:1
Ärendenummer: BN 2013-001449
Beslutsdatum:2014-05-16
Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG



10 m

INK. BYGGNADSNÄMNDEN GÖTEBORG
2014 -04- 29

LUNDEN 48:1

Ärendenummer: BN 2013-001449
Beslutsdatum: 2014-05-16

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

RELATIONSHANDLING

BYGGNADSAKTIEBOLAGET
TORNSTADEN

TENGBOM

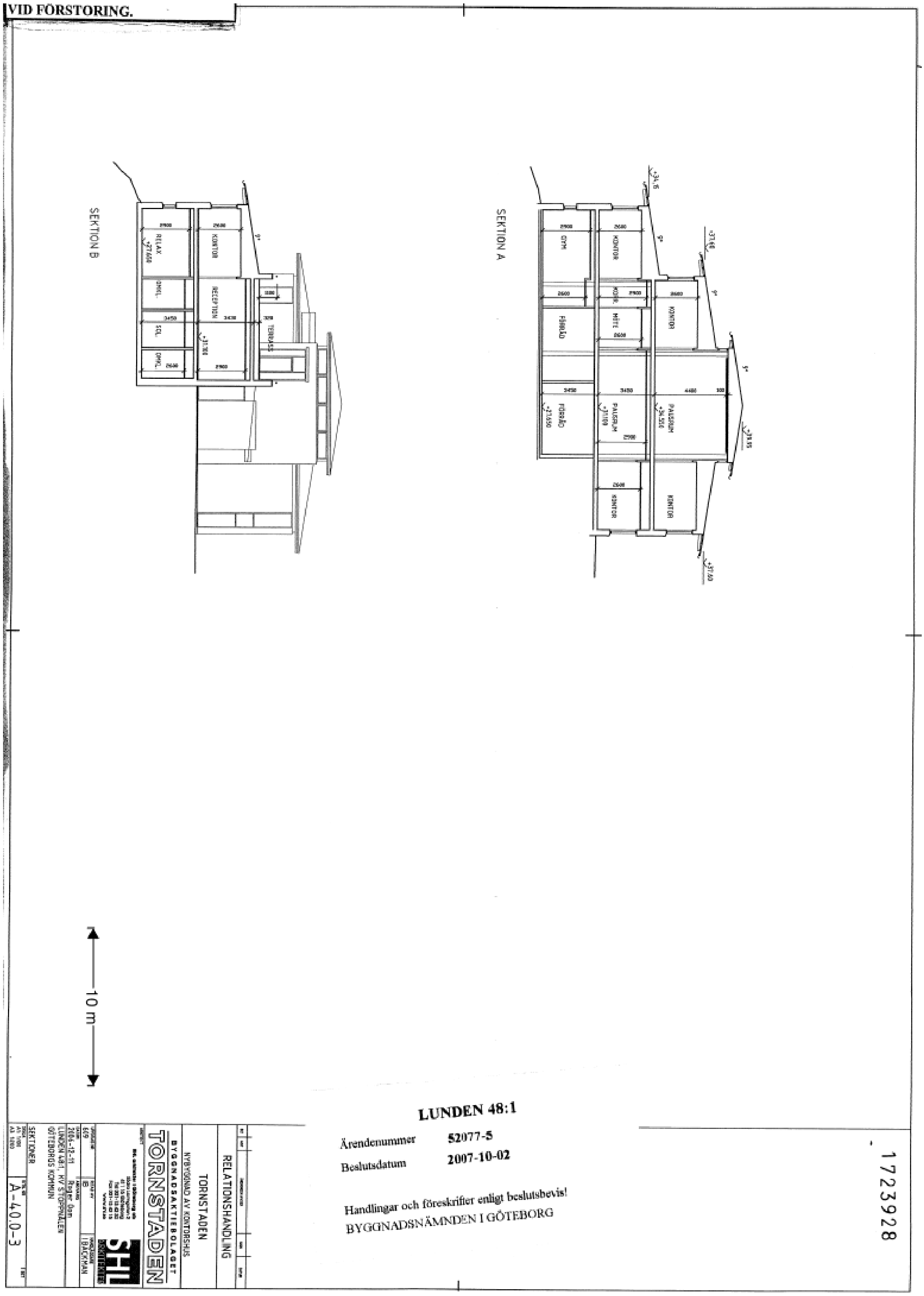
KBBN 002	LALI	L. LINDBERG
2011-04-11	R. ODM	

GÖTEBORGS KOMMUN
LUNDEN 48:1, TILLBYGGNAD HUVUDKONTOR
FASAD MOT NORR OCH SÖDER

1:100 1:200 A-40-3-21

SECTIONS

VID FÖRSTORING.



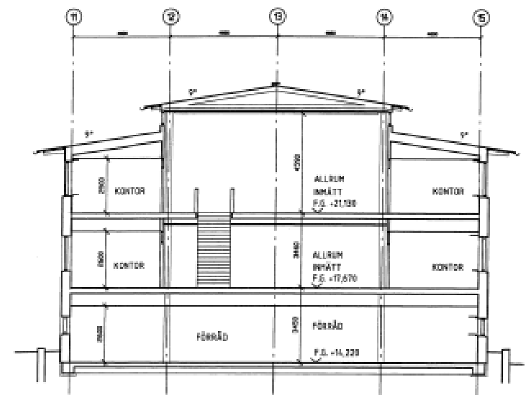
LUNDEN 48:1

Ärendenummer 52077-5

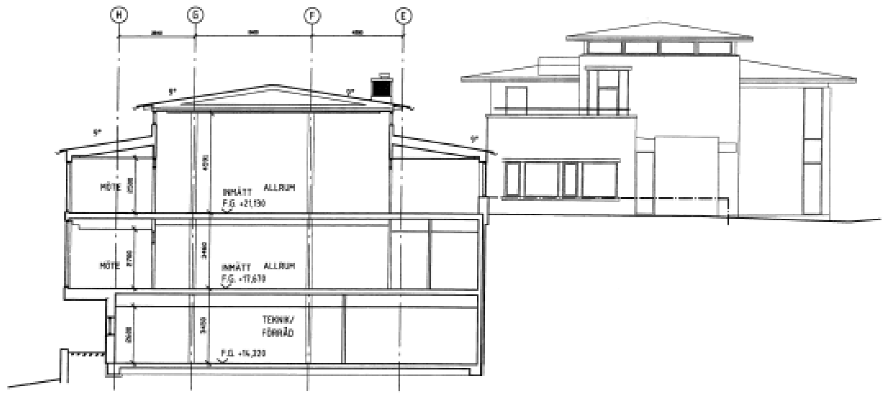
Beslutsdatum 2007-10-02

Handlingar och föreskrifter enligt beslutsbevis!

BYGGNADSNÄMNDEN I GÖTEBORG



SEKTION BB, TILLBYGGNAD



SEKTION CC, TILLBYGGNAD

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INK. BYGGNADSNÄMNDEN
GÖTEBORG
2014 -04- 29

LUNDEN 48:1
Ärendenummer: BN 2013-001449
Beslutsdatum: 2014-05-16

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

RELATIONSHANDLING

BYGGNADSAKTIEBOLAGET
TORNSTADEN

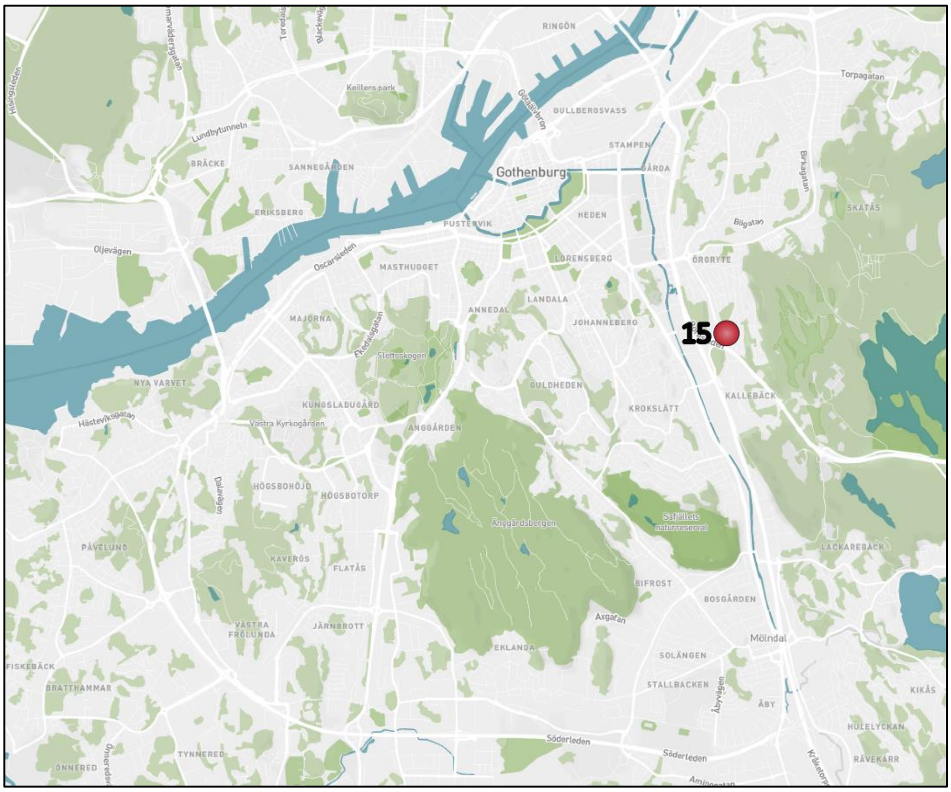
TENGBOM

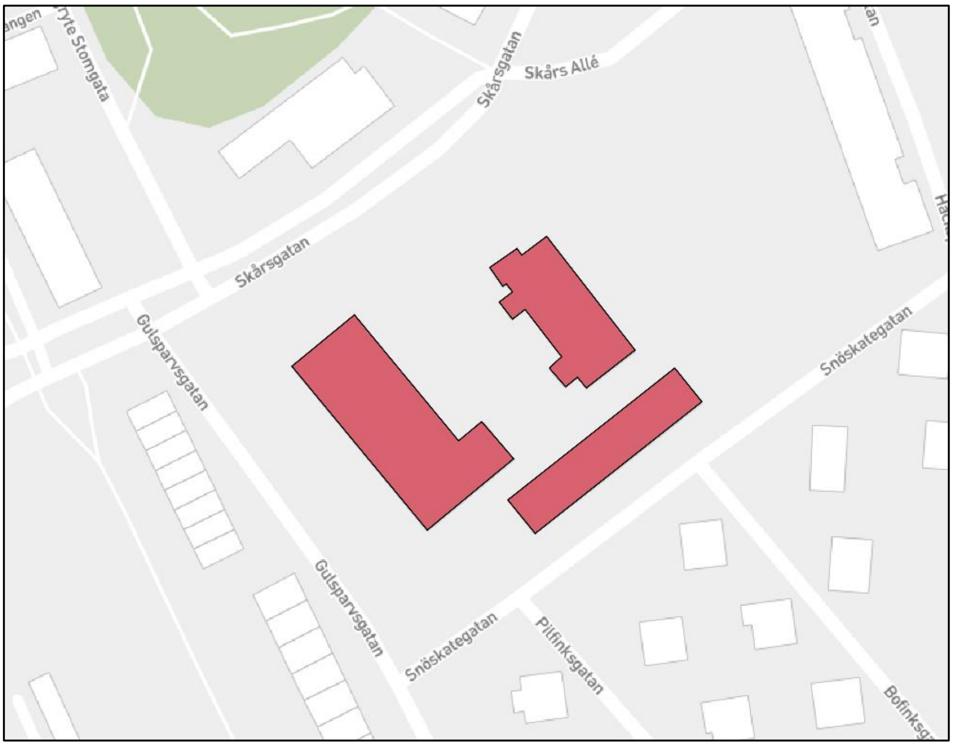
KBBN 002	LALI	L. LINDBERG
2014-04-11	R. OOM	

GÖTEBORGS KOMMUN
LUNDEN 48:1, TILLBYGGNAD HUVUDKONTOR
SEKTION B-B OCH C-C

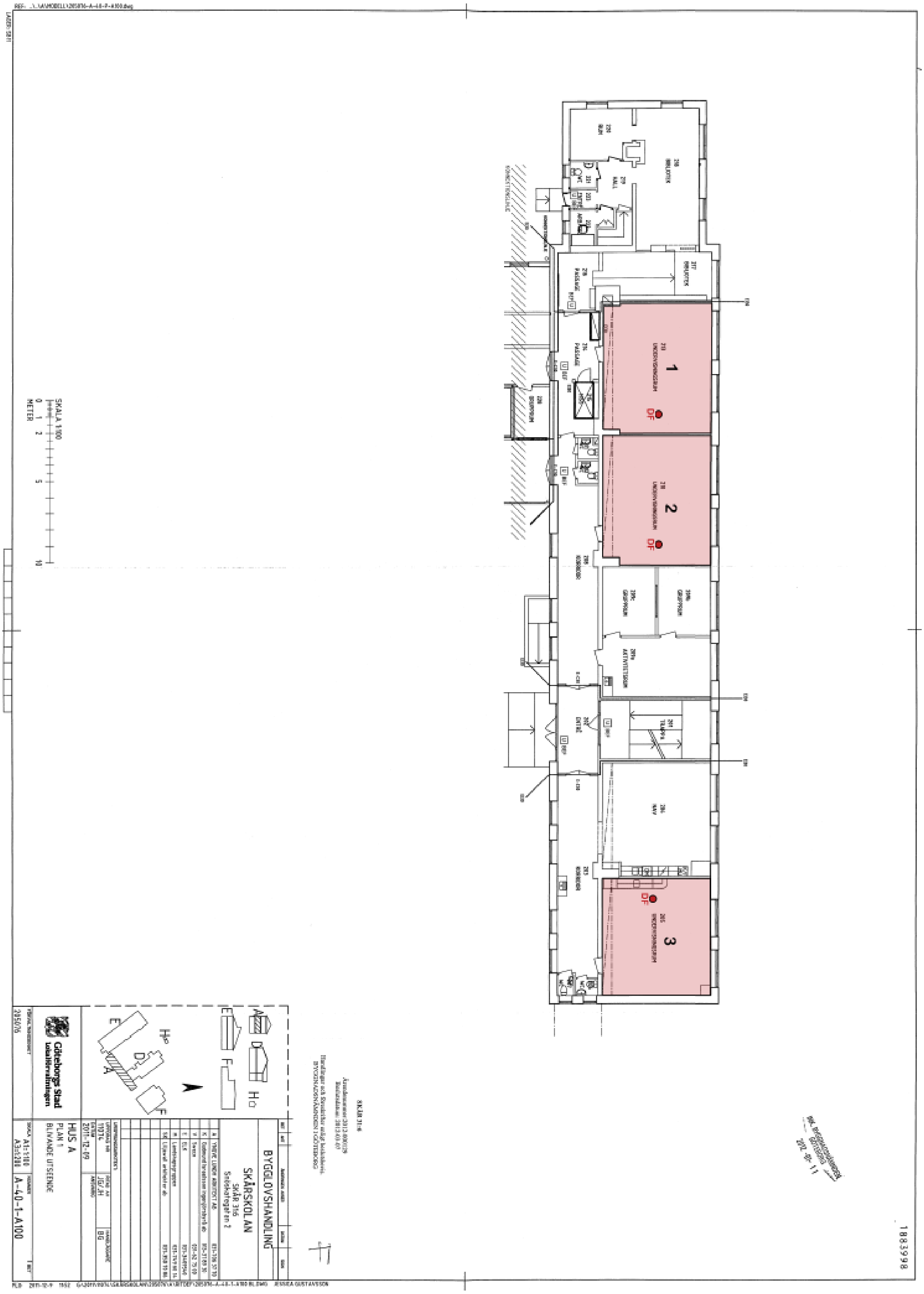
1:100	1:200	A-40-2-21

Appendix 3O – 15_Skår 31:6



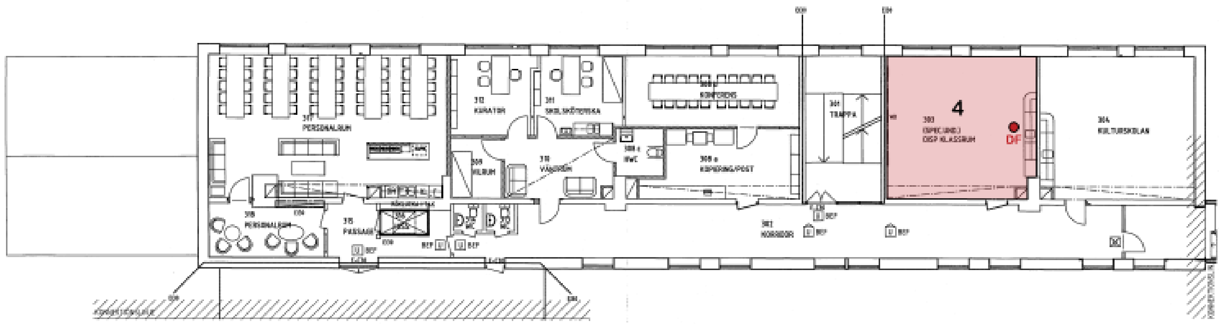


FLOORPLANS – HOUSE A



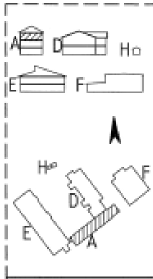
1883999

INK. BYGGNADSNÄMNDEN GÖTEBORG 2012 -01- 11



SKÅR 31:6
Ärendenummer: 2012-000129
Beslutsdatum: 2012-03-07

Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG



BYGGLOVSHANDLING

SKÅRSKOLAN
SKÅR 31:6
Snöskatogatan 2

A YNGVE LUNDH ARKITEKT AB	031-766 37 70
K Gudmund Israelsson ingenjörsbyrå ab	031-31 89 30
V Sweco	031-62 75 00
E ELK	031-36 085 40
M Landskapsgruppen	031-74 9 60 94
SK Liljewall arkitekter ab	031-350 70 96

UPPDRAG NR	RITAD AV	HANDLÄGGARE
11074	JG/JH	BG
DATUM 2011-12-09	ANSVARIG	

Göteborgs Stad Lokalförvaltningen

HUS A
PLAN 2
BLIVANDE UTSEENDE

FÖRVALTNINGSENHET 205076 · SKALA A1=1:100 A3=1:200 · NUMMER A-40-1-A200

SKALA 1:100
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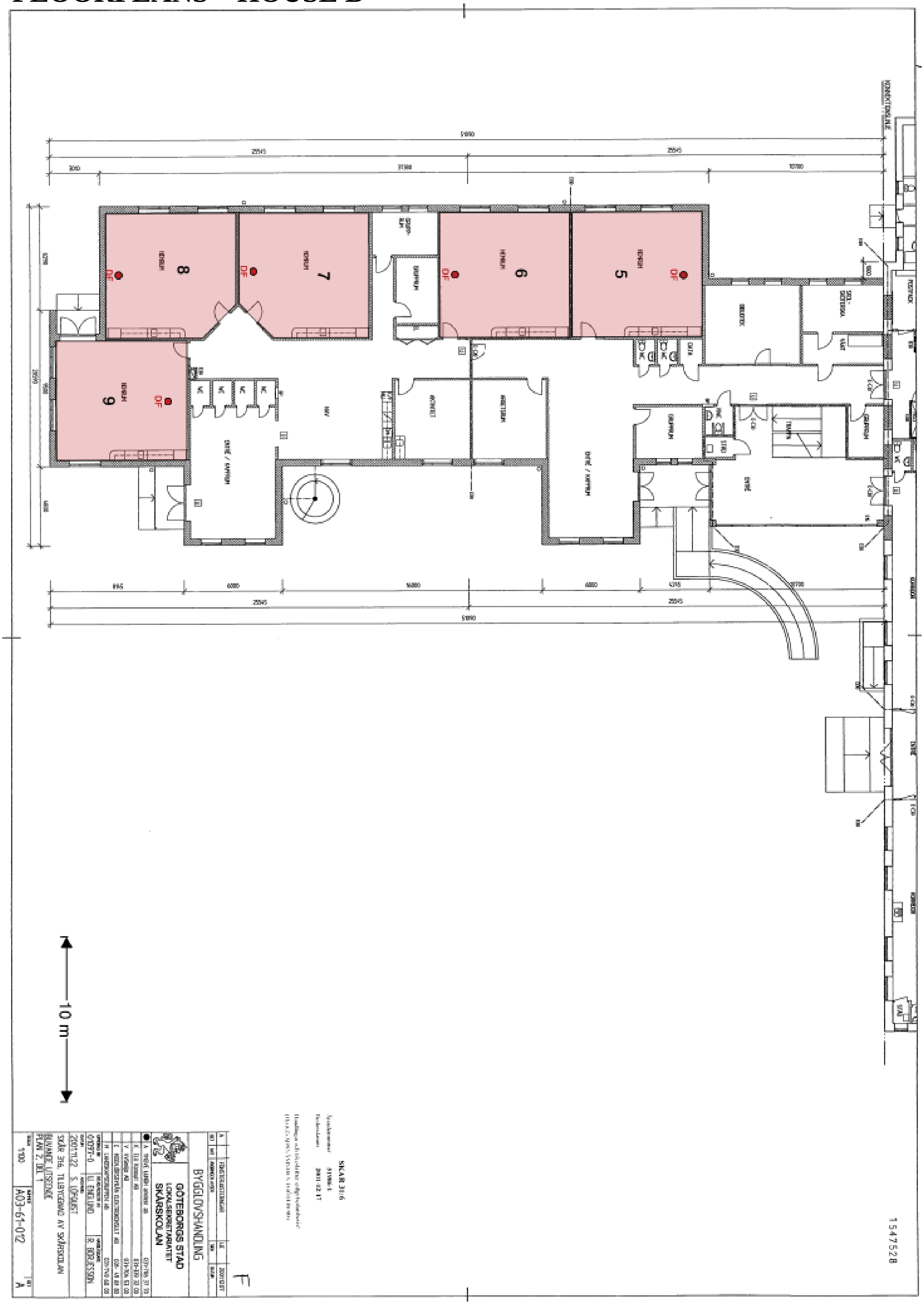
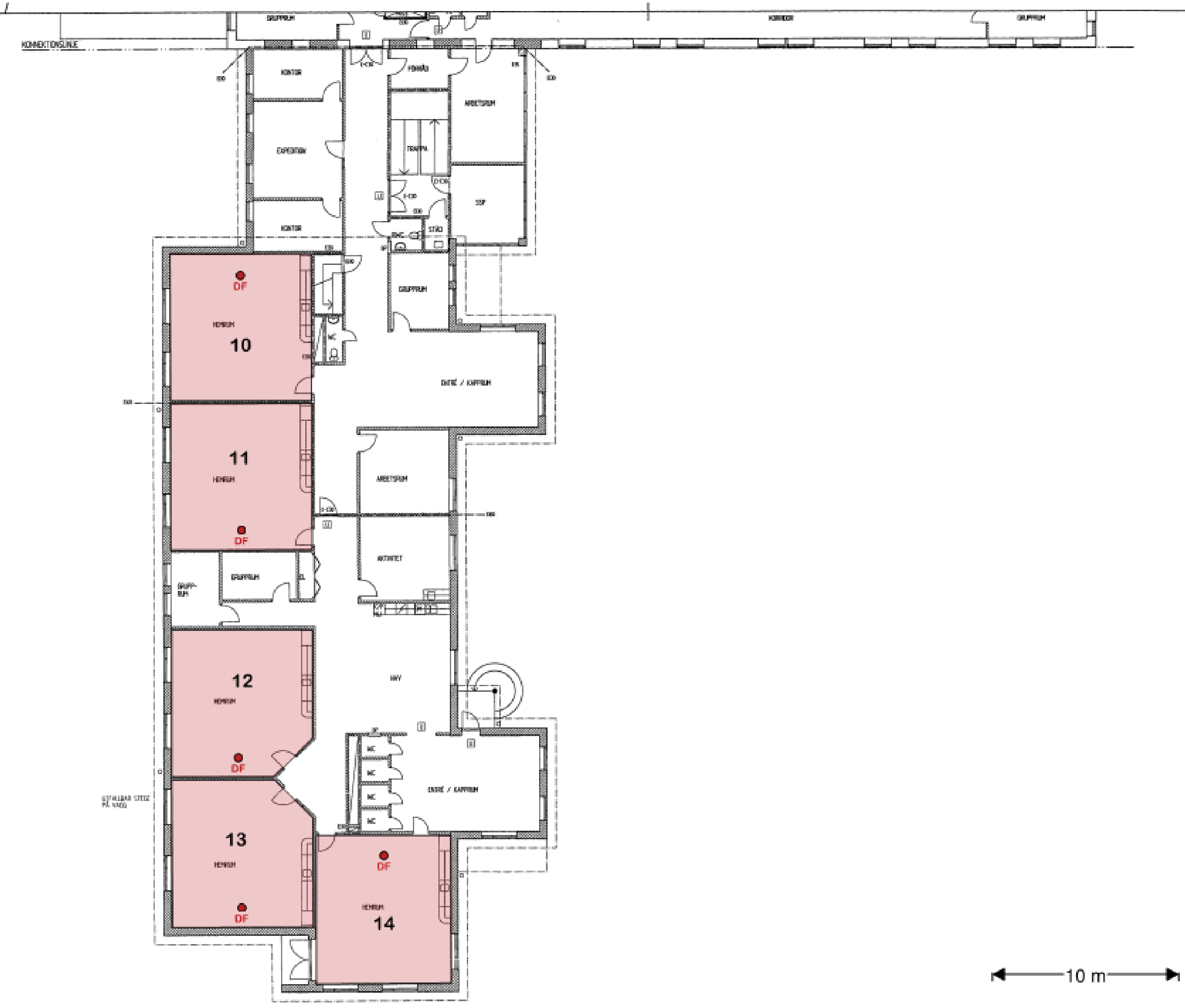
METER

FLOORPLANS – HOUSE D





SKAR 31:6

Ärendenummer 81096-1

Beslutsdatum 2001-12-17

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BET	ANT	ÄNDRINGEN AVSER	SIGN	DATUM

BYGGLOVSHANDLING

GÖTEBORGS STAD
LOKALSEKRETARIATET
SKÅRSKOLAN

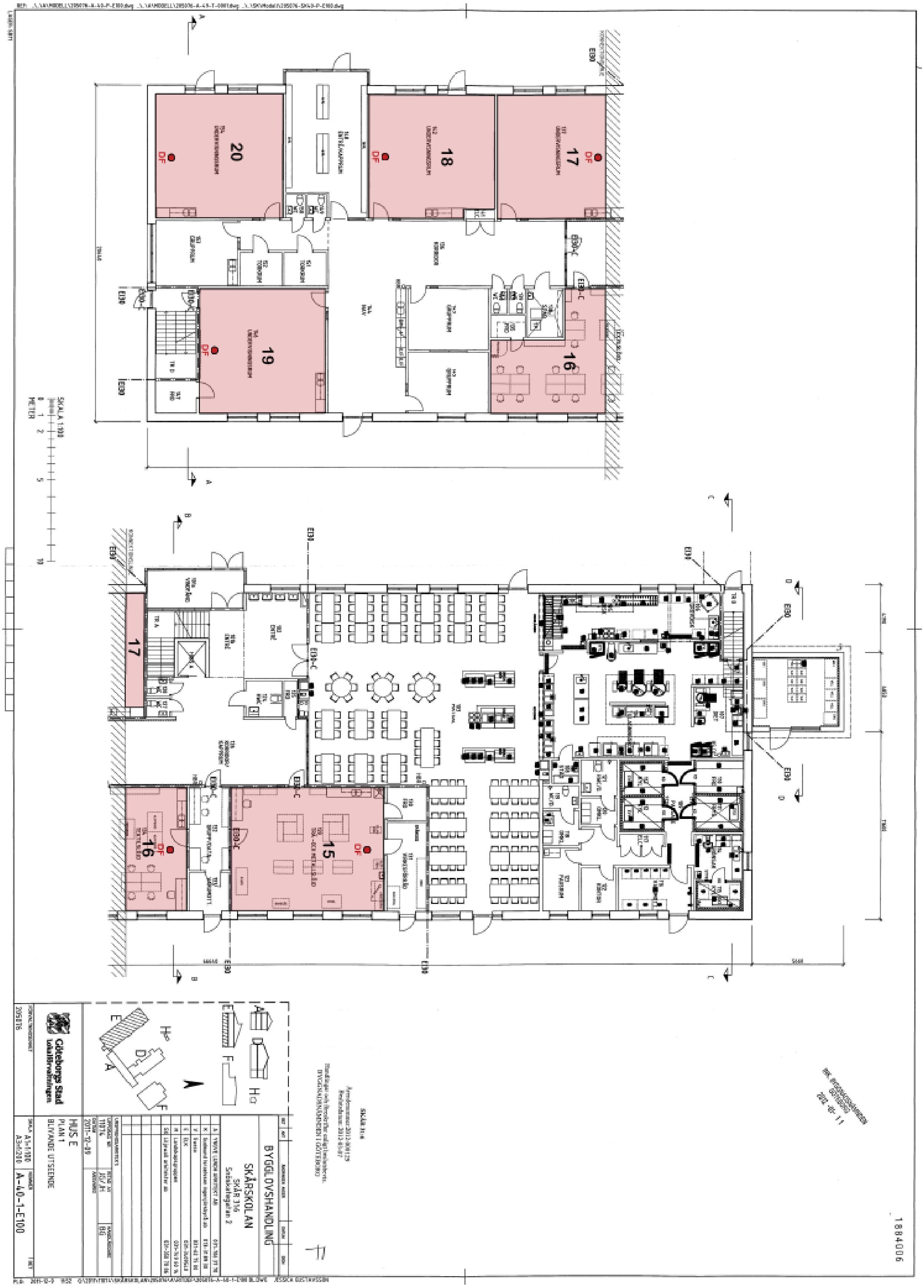
●	A YNGVE LUNDH arkitekt ab	031-706 37 10
	K ELU Konsult AB	031-339 32 00
	V VVSkraft AB	031-704 53 00
	E INGENJÖRSBYRÅN ELEKTROKONSULT AB	031- 49 81 80
	M LANDSKAPSGRUPPEN AB	031-719 60 00

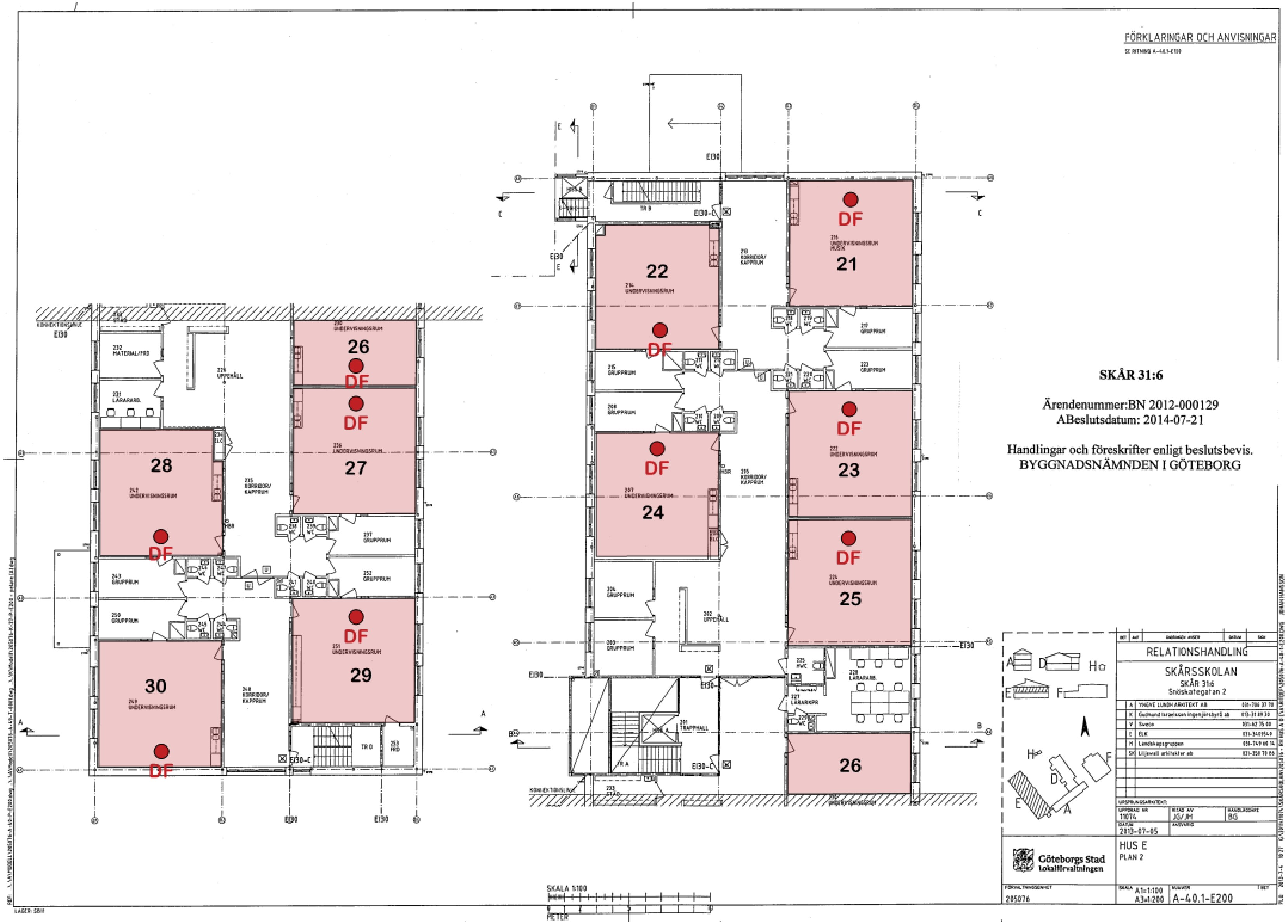
UPPDRAG NR	ANSVARIG	HANDLÄGGARE
01097-0	U. ENGLUND	R. BÖRJESSON
DATUM	RITAD AV	
20011122	S. LÖFQUIST	

SKÅR 31:6, TILLBYGGNAD AV SKÅRSKOLAN
BEFINTLIGT UTSEENDE
PLAN 3, DEL 1

SKALA	RITNR	REV
1:100	A03-61-014	A

FLOORPLANS – HOUSE E





SKÄR 31:6

Ärendenummer:BN 2012-000129
ABeslutsdatum: 2014-07-21

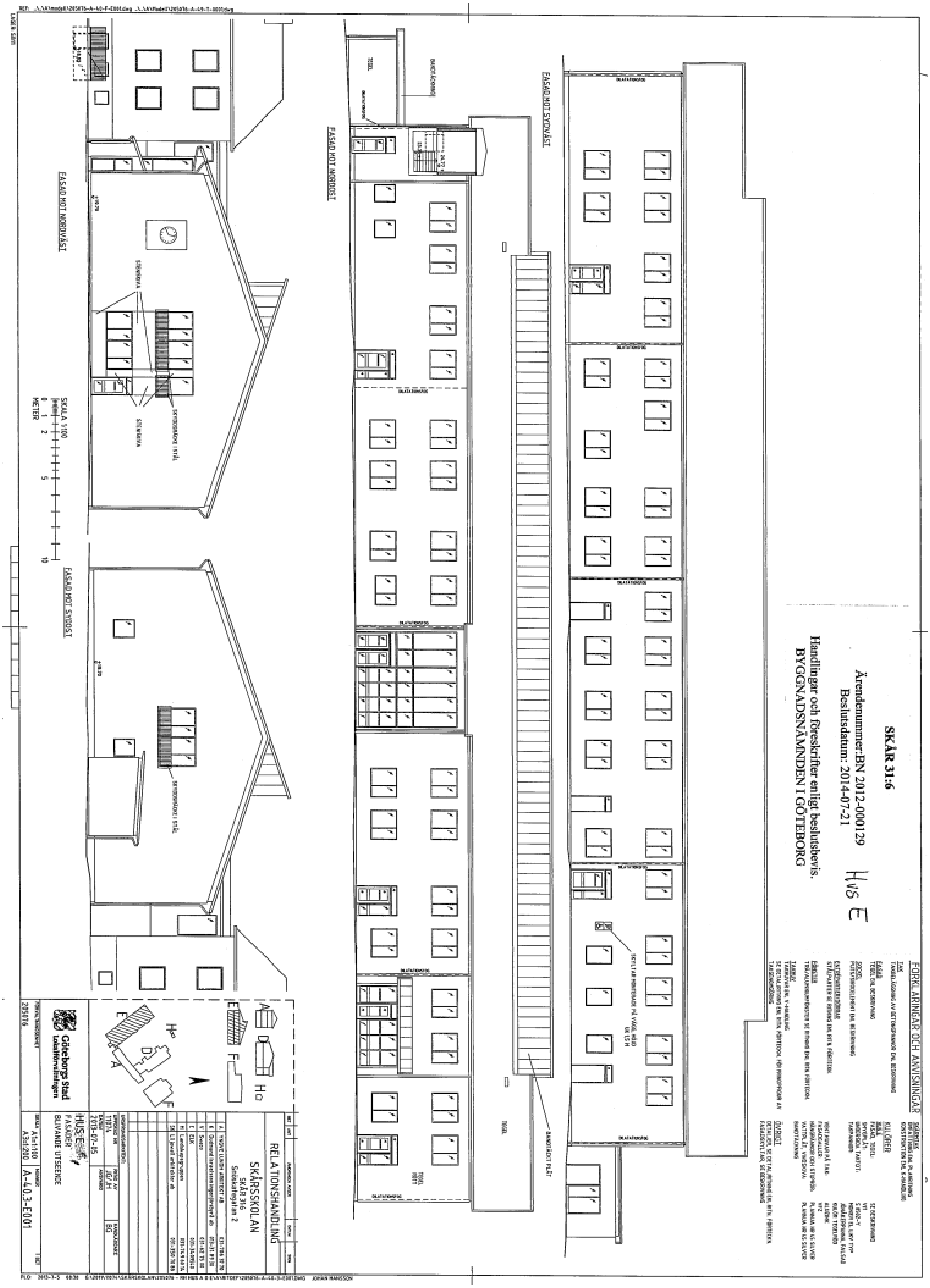
Handlingar och föreskrifter enligt beslutsbevis.
BYGGNADSNÄMNDEN I GÖTEBORG

RELATIONSHANDLING
SKÅRSSKOLAN
SKÅR 316
Snöskategatan 2

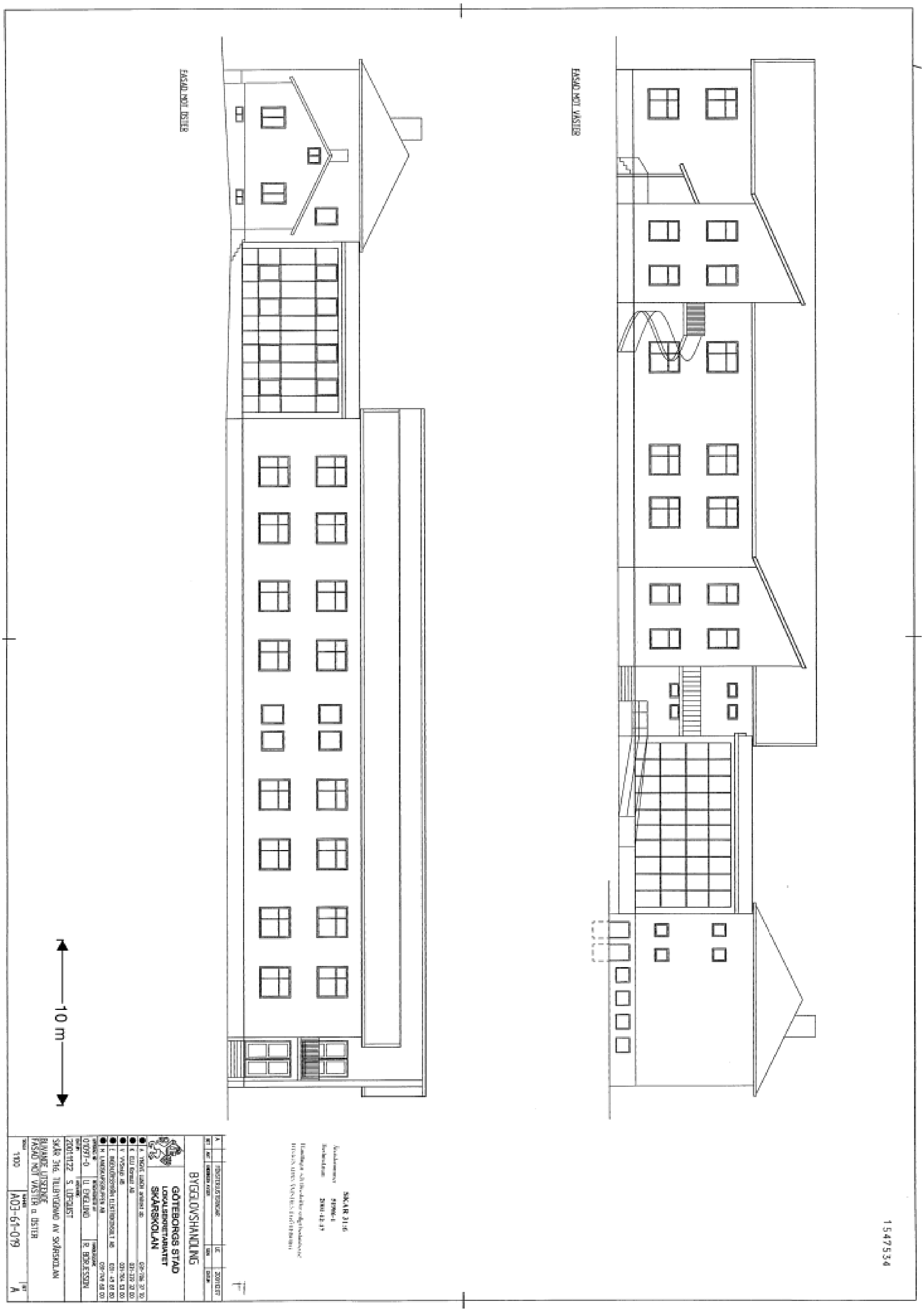
Göteborgs Stad
Lokalförvaltningen

HUS E
PLAN 2
2013-07-05
A1=1:100
A3=1:200
A-40.1-E200

FACADES – HOUSE E



FACADES


FASAD MOT ÖSTER
FASAD MOT VÄSTER
10 m
BYGGLOVSHANDLING
GÖTEBORGS STAD
LOKALSEKRETARIATET
SKÄRSKOLAN
1547534

1586614

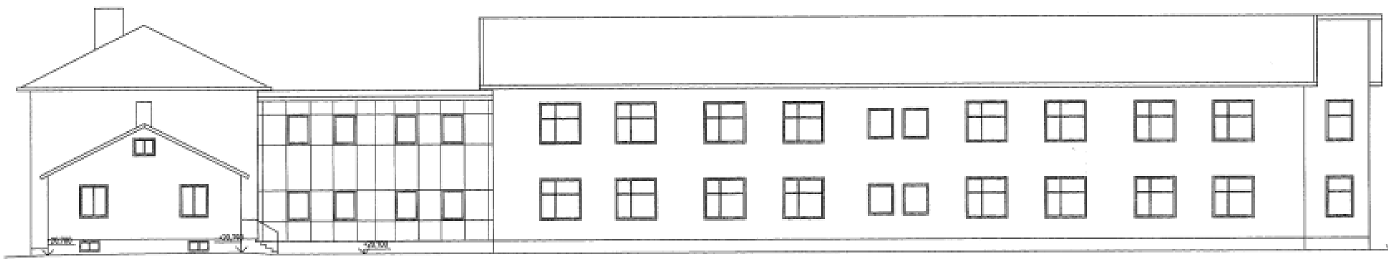
SKÅR 31:6

Ärendenummer 51986-1

Beslutsdatum 2003-04-08

Handlingar och föreskrifter enligt beslutsbevis!
BYGGNADSNÄMNDEN I GÖTEBORG

FASAD MOT SYDVÄST



FASAD MOT NORDOST

10 m

REV	ÄNDRINGEN AVSER	SIGN	DATUM
B	RELATIONSHANDLING	UE	2002.05.17
A	MARKNIVÅER, RAMP	UE	2002.02.12

RELATIONSHANDLING

GÖTEBORGS STAD
LOKALSEKRETARIATET
SKÄRSKOLAN

A	YNGVE LUNDH arkitekt ab	031-706 37 78
K	GUJ Konsult AB	031-339 37 08
V	VVSmiljö AB	031-704 53 08
E	INGENJÖRSBYRÅN ELEKTROKONSULT AB	031- 49 81 88
M	LANDSKAPSGRUPPEN AB	031-749 60 08

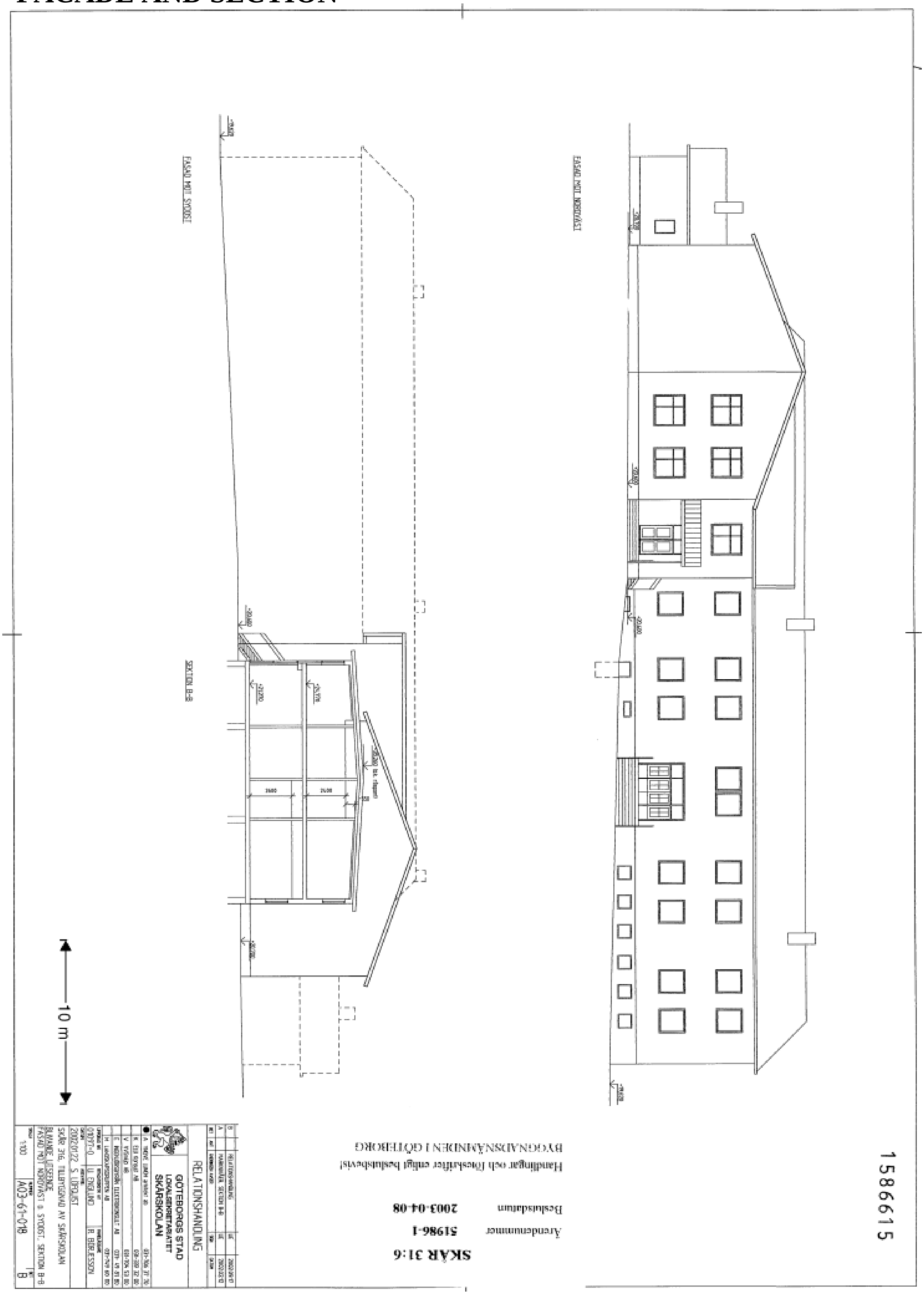
01097-0 U. ENGLUND R. BÖRJESSON

2002.01.22 S. LÖFQUIST

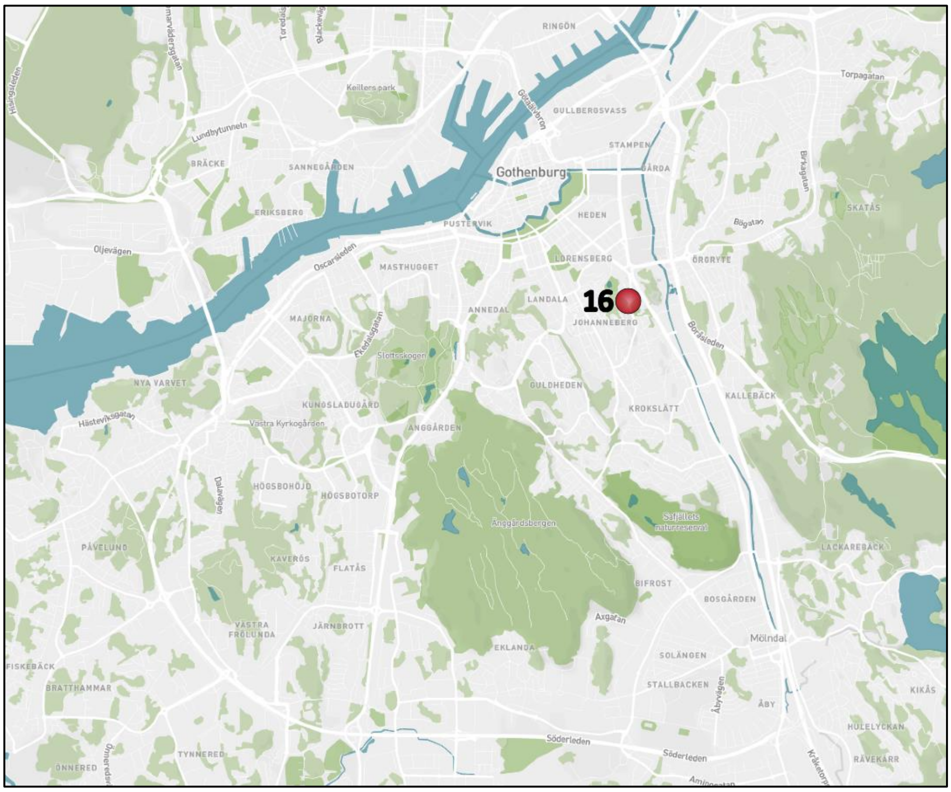
SKÅR 31:6, TILLBYGGNAD AV SKÄRSKOLAN
BLIVANDE UTSEENDE
FASAD MOT SYDVÄST o. NORDOST

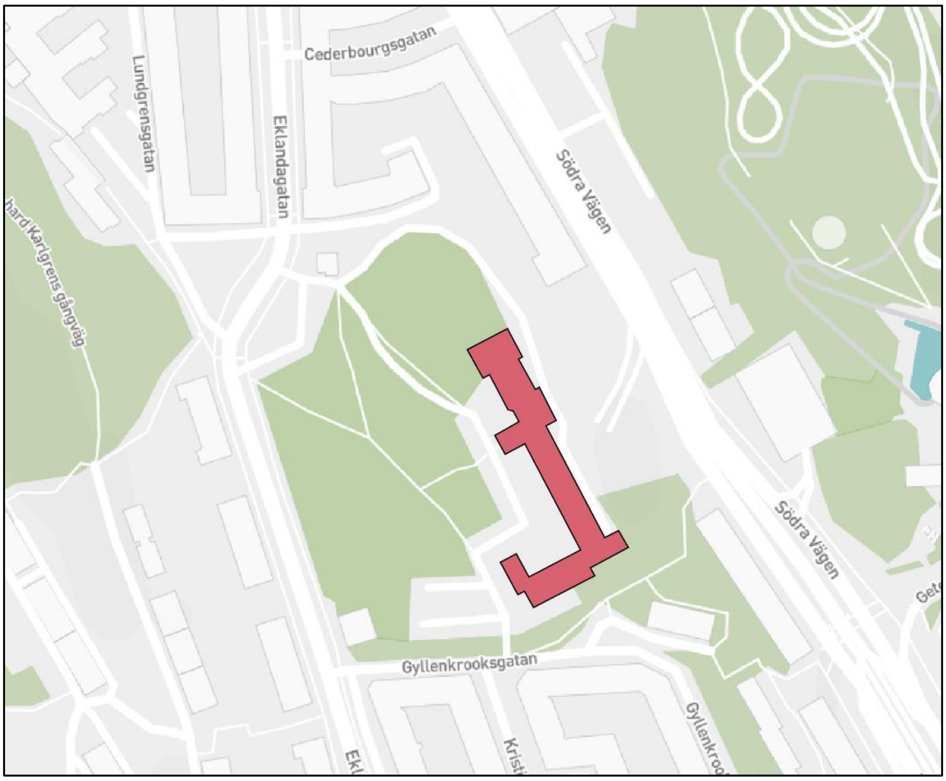
1:100 A03-61-019 B

FACADE AND SECTION



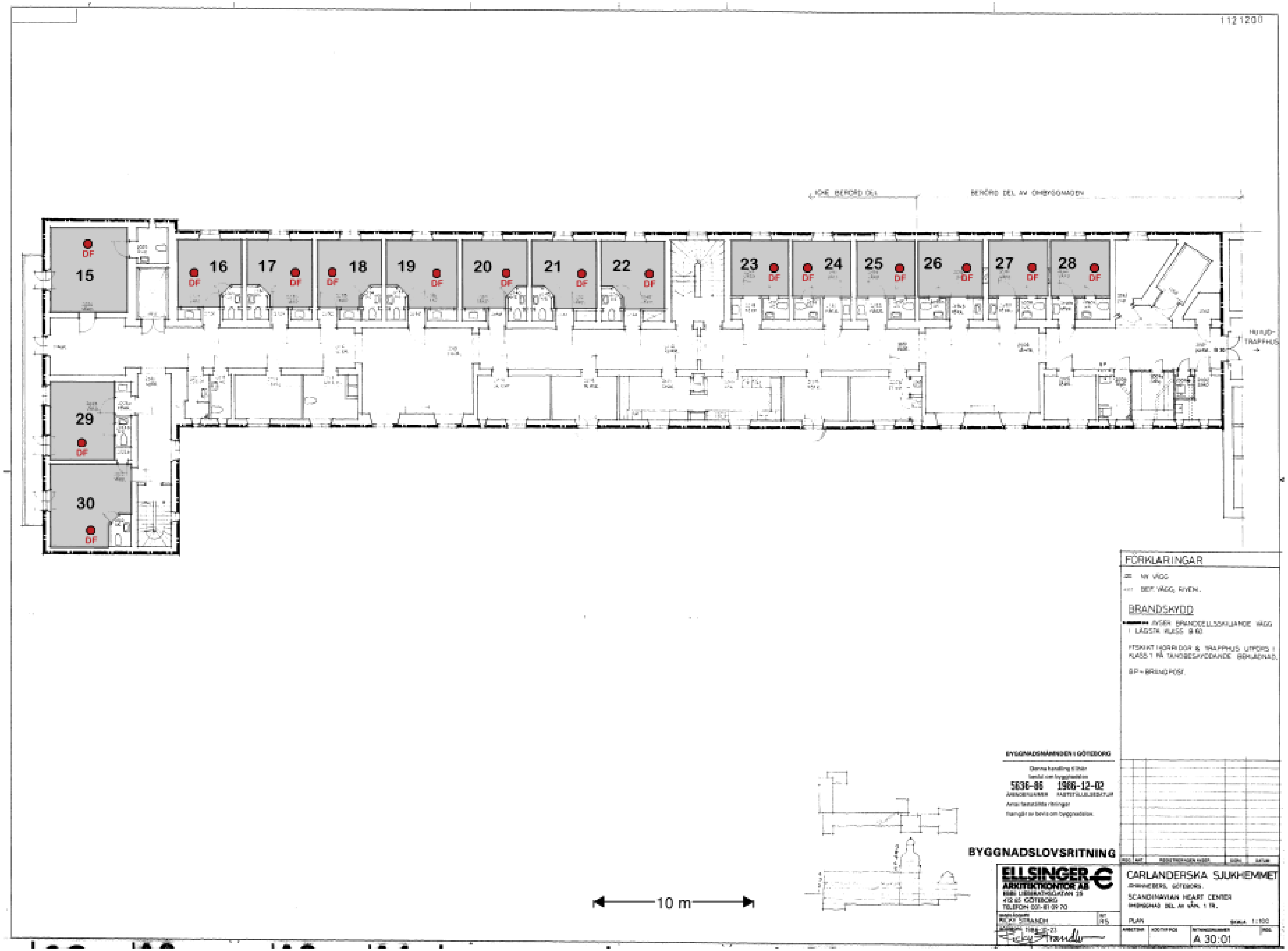
Appendix 3P – 16_Johanneberg 14:36

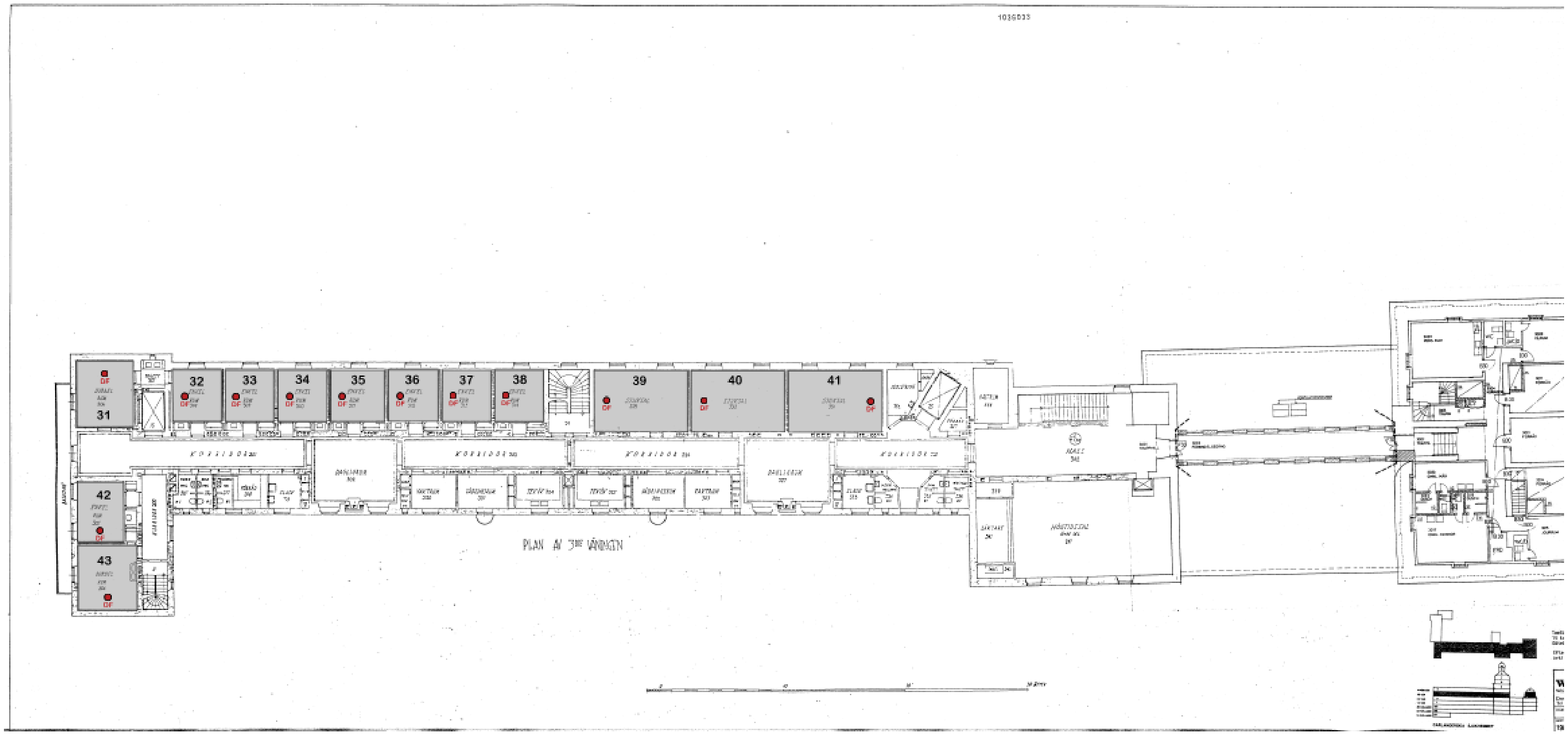




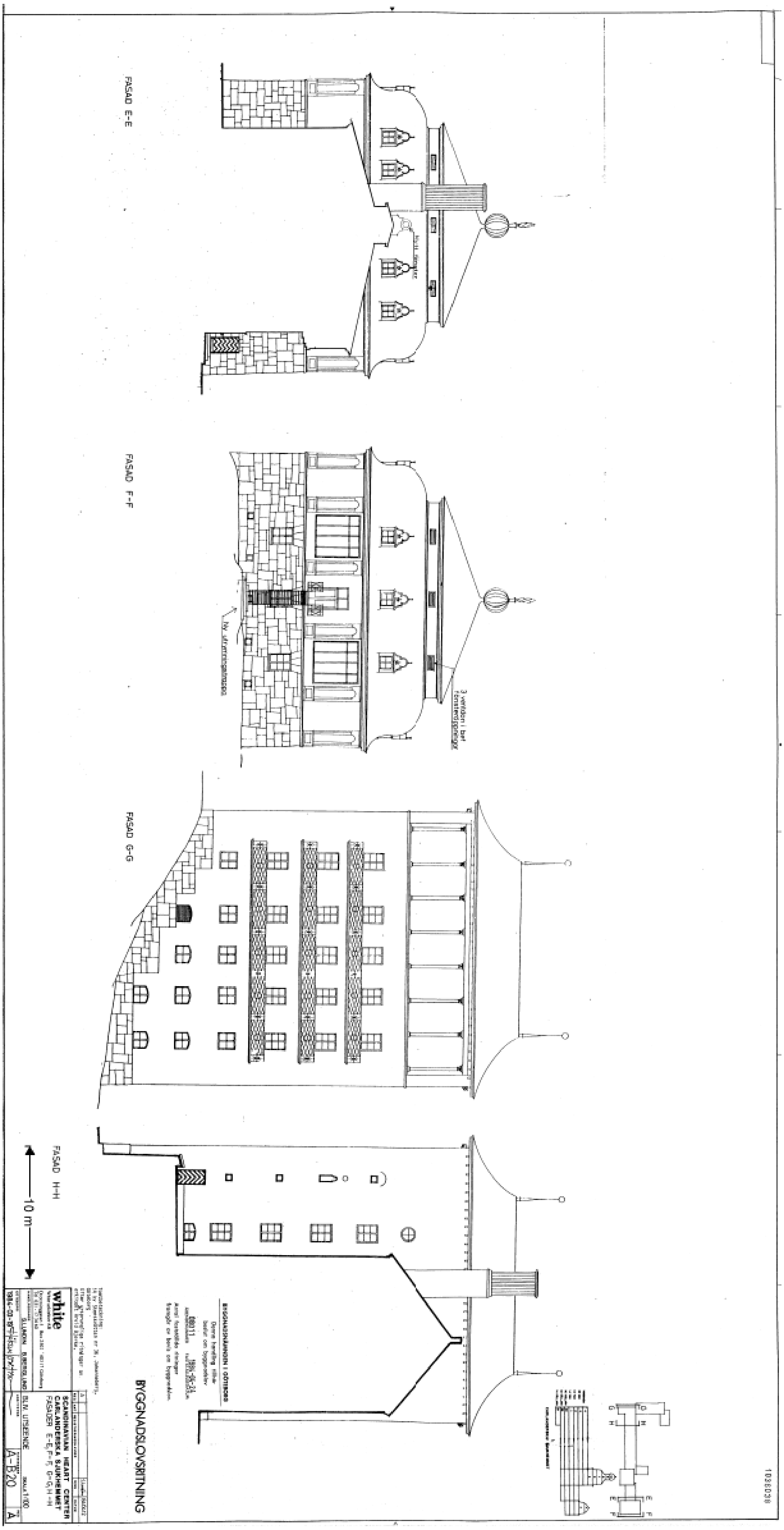
FLOORPLANS

PLAN 1
PLAN 2
SITUATIONSPLAN
BYGGLOVSHANDLING
SCANDINAVIAN HEART CENTER
10 m
1
2
3
4
5
6
7
8
9
10
11
12
13
14

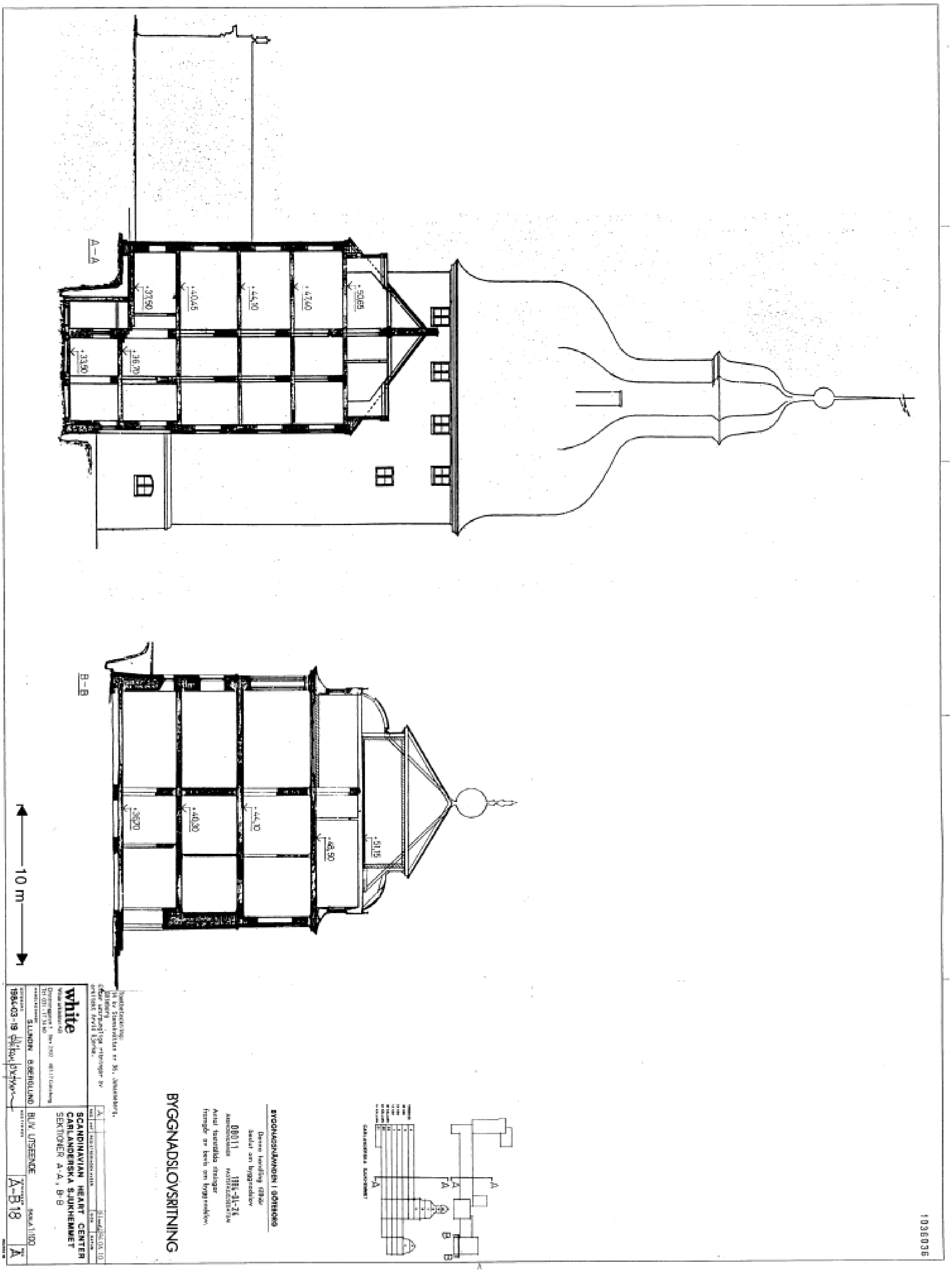

15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
DF
BERÖRD DEL AV OMBYGGNADEN
10 m
FÖRKLARINGAR
BRANDSKYDD
BP = BRANDPOST
BYGGNADSLOVSRITNING
5636-86
1986-12-02
ELLSINGER
ARKITEKTKONTOR AB
412 65 GÖTEBORG
RICKY STRANDH
CARLANDERSKA SJUKHEMMET
SCANDINAVIAN HEART CENTER
PLAN
1:100
A 30:01


1036033
31
32
33
34
35
36
37
38
39
40
41
42
43
DF
PLAN AV 3:DJE VÅNINGEN

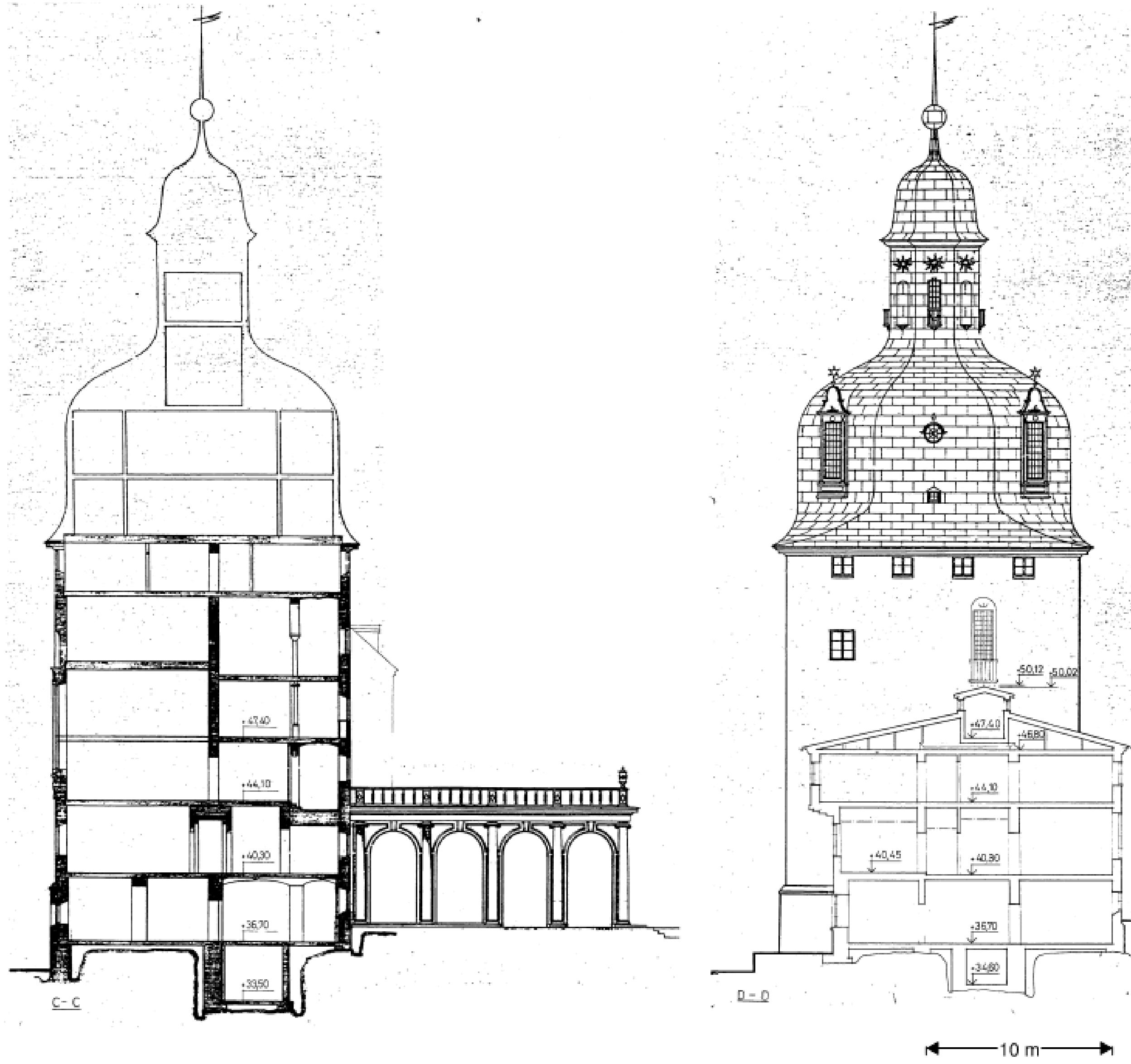
FACADES

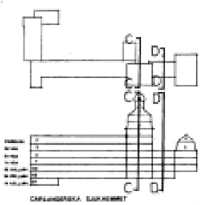

FASAD E-E
FASAD F-F
FASAD G-G
FASAD H-H
10 m
BYGGNADSLOVSRITNING
white

SECTIONS


A–A
B–B
10 m
white
SCANDINAVIAN HEART CENTER
CARLANDERSKA SJUKHEMMET
SEKTIONER A-A, B-B
BYGGNADSLOVSRITNING
1036036

1036037





BYGGNADSNÄMNDEN I GÖTEBORG

Denna handling tillhör beslut om byggnadslov

08311 1984-06-26

Avrial fastställda ritningar framgår av bevis om byggnadslov.

BYGGNADSLOVSRITNING

Tomtbeteckning:
14 kv Stapelbädden nr 36, Johanneberg,
Göteborg.

Efter ursprungliga ritningar av arkitekt Arvid Bjerke.

white White arkitekter AB Drottninggatan 5 Box 2502 403 17 Göteborg Tel 031 - 17 54 80	**SCANDINAVIAN HEART CENTER** **CARLANDERSKA SJUKHEMMET** SEKTIONER C-C, D-D
S.LUNDIN B.BERGLUND	BLIV. UTSEENDE SKALA 1:100
1984-03-19	A-B19 A

Appendix 4 – Results – Building level

buildingID	buildingType	cadastralReference	address	postalCode	country	yearBuilt
1	Residential	Vasastaden 14:2	Thorildsgatan (30)	411 25 Göteborg	Sweden	1972
2	Residential	Guldheden 64:13	Doktor Forselius Gata 26-30	413 26 Göteborg	Sweden	1960
3	Residential	Vasastaden 5:11	Erik Dahlbergsgatan 12	411 26 Göteborg	Sweden	1887
4	Residential	Majorna 306:16	Allmänna vägen, Kaptensgatan, Amiralitetsgatan och Kommendörsgatan	414 59 Göteborg	Sweden	1897
5	Residential	Kungsladugård 18:6	Mariagatan, Kennedygatan	414 73 Göteborg	Sweden	1923
6	Residential	Johanneberg 2:6	Terrassgatan 3	411 33 Göteborg	Sweden	1928
7	Residential	Lindholmen 37:1	Ceresplatsen 1-5	417 58 Göteborg	Sweden	2013
8	Residential	Rud 8:10	Tamburingatan 9	421 51 Västra Frölunda	Sweden	1960
9	Student apartments	Guldheden 34:2	Doktor Wigardhs Gata 2	413 23 Göteborg	Sweden	2004
10	Office	Inom vallgraven 27:1	Södra larmgatan, Västra hamngatan	411 17 Göteborg	Sweden	1863
11	School	Rud 5:1	Positivgatan 3	421 51 Västra Frölunda	Sweden	1962
12	Student apartments	Johanneberg 31:12	Kemivägen (5)	412 58 Göteborg	Sweden	2006
13	Hospital	Brämaregården 68:6	Wieselgrensplatsen 2	417 17 Göteborg	Sweden	1966
14	Office	Lunden 48:1	Wrangels Trappgata 1	416 60 Göteborg	Sweden	2006
15	School	Skår 31:6	Snöskategatan 2	412 70 Göteborg	Sweden	2001
16	Hospital	Johanneberg 14:36	Carlandersplatsen	412 55 Göteborg	Sweden	1927

yearOfRenovation	renovationMeasures	nFloors	nEvaluatedFloors	nEvaluatedRooms	roomsDFp>1%
NaN	NaN	6	4	36	61%
NaN	NaN	12	8	200	96%
NaN	NaN	4	4	42	0%
1981-1982	Attic-apartments	4	3	140	83%
NaN	NaN	3	3	37	41%
NaN	NaN	6	5	70	21%
NaN	NaN	11	4	68	74%
NaN	NaN	10	4	100	80%
2012	New facade	5	3	97	65%
NaN	NaN	5	4	47	80%
1990	Extension	2	2	14	100%
NaN	NaN	13	5	230	38%
NaN	NaN	4	4	38	100%
2014	Extension	3	3	36	94%
2011-2013	Extension	2	2	30	43%
2014-2016	Extension	4	3	52	88%