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FAKULTA STAVEBNÍ

KATEDRA EKONOMIKY A ŘÍZENÍ STAVEB

RISK MANAGEMENT IN HISTORICAL RECONSTRUCTIONS

ŘÍZENÍ RIZIK HISTORICKÝCH REKONSTRUKCÍ

DIPLOMOVÁ PRÁCE

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STUDIJNÍ PROGRAM: STAVEBNÍ MANAGEMENT

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V Praze, 19.12.2014 podpis:

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ANOTATION

The task of this work is to provide some theoretical knowledge of risk management based mainly on information from sources such as PMBoK, academic articles or lectures from my university professors. The other half of this thesis will demonstrate risk management techniques on two reconstruction projects. Stakeholder identification, risk identification, risk assessment and risk control play the key role to achieve projects goals successfully and on time. Therefore, risk management plays very important role as well such as covering all organizational objectives and missions which are considered in operational projects of organizations. Thorough many discussions were made about risk management none of them I read considered risk management as a necessary part of the project management. Many discussions were made about the risk. However, they are mostly about risk in general. Only the minimum of works considers the risk in the construction projects. Therefore, this work is aimed on specific projects of residential house reconstruction and the handling of all risks the project might face in each phase of the project life cycle. The main aim of this work is to analyze relation and extent of risks in each stage of project so that we can achieve desirable results of the project by defining and implementing management processes of project risk.

Keywords: strategic management, project lifecycle, risk management, project management, risk management plan

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1. INTRODUCTION

Risk Management is a very important part of project planning in general. This applies in construction projects even more since it is usually big investment and there are many factors that can influence the project outcome.

As Sir Michael Latham said in 1994, (politician who wrote the influential joint government and industry report 'Constructing the Team' - known as the Latham Report)

‘No construction project is risk free. Risk can be managed, minimized, shared, transferred, or accepted. It cannot be ignored.‘

a quote that summarizes the whole risk management process during every project.

Therefore also the main outcome of this thesis should be how to deal with the risks that occur during the project, not how to avoid them. A good project manager should be able to analyze the risks, not to hide them from the owners. Identification of many risks at the beginning of the project realization doesn’t have to be necessarily perceived as a nonviable project. Moreover, according to well know saying ‘no risk no gain’ there is a big probability that the most viable projects are the ones most risky at the beginning. It always depends on how is each risk controlled and managed**.**

From my perspective, this is a part of project management that is usually a little bit neglected in the professional practice. Owners often push project managers to finish the project in a very short time, which is why planning phase is usually very brief and execution phase begins as soon as possible due to the deadline. The purpose of this thesis is to show the importance of Risk Management on a real construction projects and declare that longer planning phase could actually save owners’ inputs.

1.1. AIMS & OUTCOMES

The goal of this diploma thesis called “Risk Management in a Historical Reconstructions” can be divided into theoretical and practical part. In the theoretical part, I will introduce all the topics I have found and learned during my studies at the University of Sydney and Czech Technical University in Prague. The majority of the theoretical part will be based on Project Management Body of Knowledge 5th edition. The theoretical part will explain all the problems the risk management face during the project lifecycle. In the practical part of my diploma thesis, I will apply what I have learned about Risk Management on a two real project, both historical reconstructions, using different forms of Risk Analysis. Both projects can be seen in annex.

1.2. STATE OF THE ART

The purpose of this thesis is to summarize a theoretical knowledge that I achieved during my studies and by reading important articles related to this subject. These contributions are grouped into different sections, such as Project Lifecycle, Project Delivery Methods, Stakeholder Identification, Risk Identification, Risk Assessment or Risk Response Strategies. Furthermore, this knowledge is applied on two projects that I had the chance to collaborate on during my professional practice. Finally, some conclusions about the state of art of Project Risk Management are provided.

2. CONSTRUCTION PROJECTS

Projects are in general very complex organisms. To manage project success, it is often up to project manager's ability to manage stakeholder expectations and make trade-offs between key project dimensions. Every project Scope is defined by three constraints which are related to Time, Cost and Quality. Sometimes it is referred to as the 'Triple constraint'. Trade-offs between all four relationships is possible, but the outcome can never be 100% on all sides. This is a good framework to understand some basic rules about managing projects. It is also very convenient in difficult conversations with clients. By expressing their preferences in percentage of importance on each side, they can help to the project manager to focus on the most important part of the success in their eyes and to aim the whole risk analysis the right direction. *(Linton, 2014)*

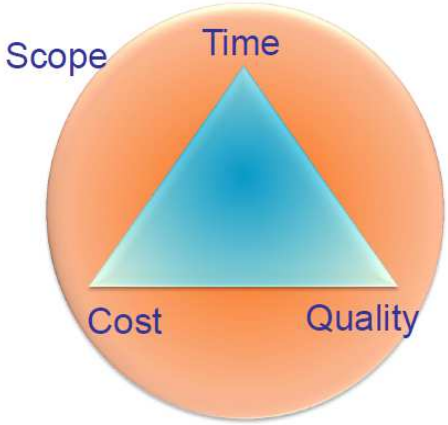


Image 1: Triple constraints

To understand the need of Risk Management in every construction project, it is very important to know the usual project development. Construction projects are usually very complicated. Every project is very unique and therefore managing such a project requires unique approach. Especially when speaking about huge projects, there are many examples from history that prove how shifty construction projects can be. For example iconic Opera House in Sydney in the end cost 15 times more than was originally planned. Usual mentioned causes could be divided into two categories. Internal risks are things that the project team can control or influence, such as planning and scheduling, construction process,

communication and information dissemination. The second group is called the external risks which are beyond the control of the project team. It could be market shifts, government actions but also weather or unexpected client changes. All in all, project overruns are quite common things but it doesn't necessarily have to be the rule. *(PMBoK, 2013)*

2.1. CONSTRUCTION PROJECT PHASES

To even start with such a complicated thing as Risk Management is, it is important to understand the project lifecycle and project phases. Risk identification is not a one-time event, it should be performed on a regular basis throughout the project. Construction project consist basically of several phases that are similar as in every other project. *(Griffin, 2010)*

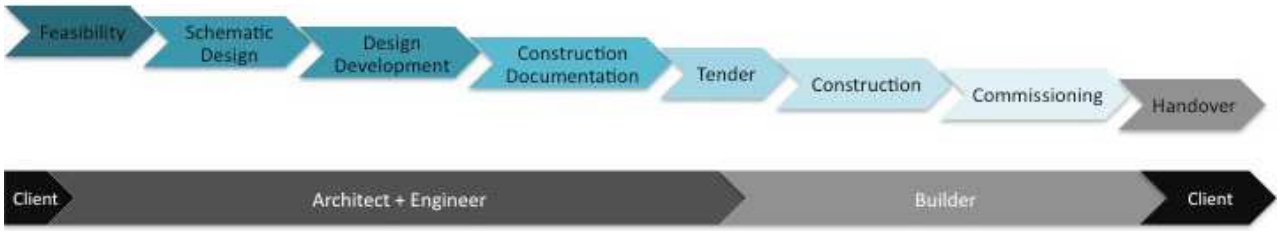


Image 2: CONSTRUCTION PROJECT PHASES

2.1.1. FEASIBILITY

It is the initial project phase. Client's requirements are defined. In terms of future development of the project, this is the key phase. Every client change is problematic due to waterfall typology of construction projects. Therefore it is necessary to clear all the definitions in client's eyes and give a good framework to eliminate waste (in terms of money and time). It is also the part when management team has to think of all the unique construction project management knowledge areas. The financial plan is closely connected with the feasibility study, as well as the safety and environmental plans, which are necessary for granting the permissions. Also claim prevention needs to be considered, to make the project success more achievable.

Speaking about Risk Management, in this project phase its main goal is to provide a risk-balanced decision to be made on whether to take the concept further or not. Key stakeholders determine their risk threshold for the idea and it's up to the project team to deliver a study that will ease their decision. Different owners have different risk tolerances, for example one organization may perceive an estimate that has 15 percent probability of overrunning as high risk, while another perceives it as low risk. *(Griffin, 2010)*

Crucial part of this pre-project phase is the project viability. A range of alternative options for project implementation should be considered and a relative risk assessment is undertaken for each of these options to determine which is the most likely to succeed.

2.1.2. DESIGN DEVELOPMENT

This is a very crucial phase of the project. In terms of future costs and functionality has this phase the biggest impact, as you can see from the chart below. As the phases proceed, the project costs increase whereas the ability to influence them decreases.

Main deliverables of this phase are all the planning outcomes such as Work Breakdown Structure (WBS), realistic estimates of time, cost and resource requirements and a project schedule is produced.

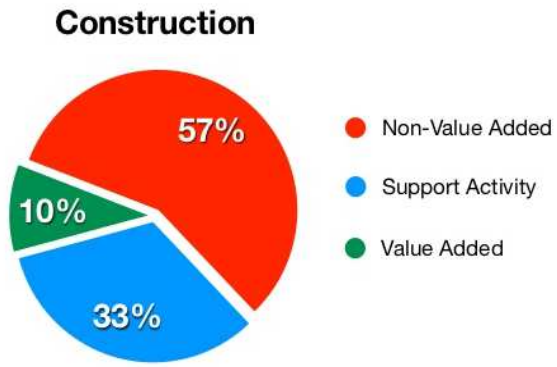


Image 3: PHASES DISTRIBUTION

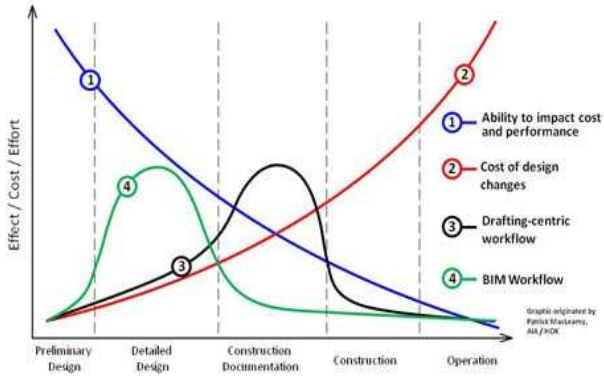


Image 4: INFLUENCE ON FINAL COST

Despite the huge importance of this phase it is a non-value added part of project process, which is kind of a pattern in all construction projects. As you can see from the chart in Image 2, only 10 percent of the whole project development is actually a value added activity.

Another very important thing is to make sure that the project design is practical and 'constructable'. Despite of experienced project management team and architect it is appropriate to work on early consultations with future constructor. This could be very easily solved by choosing the Design-Build type of contract. As the name implies, both actions are implemented through one contract. Contractor is also in charge of project design, which mainly saves time, since the construction works can begin even if the final design hasn't been completed yet.

In terms of Risk Managing this phase, this is the time when major risk assessment is undertaken. Project team identifies all the risks that are a threat to the project success, quantifies them in terms of possible financial impact, and determines actions and responses that are necessary to be made when risk occurs. Understanding risk exposure at this stage will allow the business to determine how the project should be run after its initiation in order to control the inbuilt risk, while remaining flexible to respond to other risks that may emerge during the project.

For this phase it is very important for the project manager to really undertake a full risk exposure of the project, that way the whole team will be aware of the overall level of risk of the project they are responsible for delivering. *(Griffin, 2010)*

2.1.3. CONSTRUCTION

It is a phase of actual executing the project. This is the most challenging part from project manager point of view. All the planning and design preparation is finally being executed and it is project manager's job to supervise the whole process of construction. PM is coordinating the subcontractors and makes sure the work is done in certain time and quality. And quality indeed is one of the biggest issues in construction performance. UK studies indicated that up to 30 percent of construction is rework and at least 10 percent of materials are wasted.

During the project execution, all the risk analyses are already made. The project manager's task in this phase is to provide risk updates for the key stakeholders and to control the risk development and its financial impact in accordance to deliver the project on time and budget. The frequency of application of risk management through the project execution phase depends on several parameters, the most obvious is the initial assessment of how risky the project is. Clearly a high – risk project is likely to require more frequent and detailed application of risk techniques than one with a lower risk. However the frequency usually matches the overall project reporting cycle (often monthly).

2.1.4. COMMISSIONING

Building commissioning is a very complex process of quality assurance and making sure that the building is prepared to operate and maintain in systems and equipment. It is a process of planning and delivering the project to work as intended, therefore is very closely related to initial phases of project, such as defining the requirements. The process focuses on verifying and documenting that the facility and all of its systems are planned, designed, installed and tested. It is also a phase when project manager need to communicate with the contractor about all defects that may have occur, which leads usually to claim management.

2.1.5. HANDOVER

From project management point of view, this is the maximizing value part of the project. It's also phase when the responsibility for the project is passed from contractor back to the owner (applies only to a traditional project delivery method, Design-Bid-Buid). This is executed by the handover plan, which is created usually by contractor. PM responsibility is then to review it and make sure that all handover requirements are addressed.

From a risk management point of view, the better risk analysis was elaborated at the beginning, the smoother this phase should be. All the major problems implemented in the risk analysis already occurred (if so), therefore project manager can focus on gathering the material and capturing the 'lessons learned'. This process is extremely helpful not only for the self-awareness of PM's mistakes and misunderstandings but also for the whole project team. Combined with a company risk register, it makes it easier in future projects to manage risks better. *(Griffin, 2010)*

2.2. PROJECT DELIVERY METHODS

As will be mentioned further on, one of the basic ways to deal with the risks during the project lifecycle is to transfer the responsibility for them to other stakeholders involved in the project. Therefore it is important to understand how can choosing a delivery method influence the possibilities of risk response strategies.

There are many ways and contractual arrangement how to deliver a project, I will provide a brief description of 3 most used methods in private investment sector.

2.2.1. DESIGN - BUILD (DB)

When DB is selected, owners sign only one contract and that is with the DB team. It is often a joint venture of general contractor and design team. This type of projects is usually performed upon a fixed price.

Once the design is discussed and all requirements are understood, the DB team is then responsible for the construction of the project and for the subcontractor coordination.

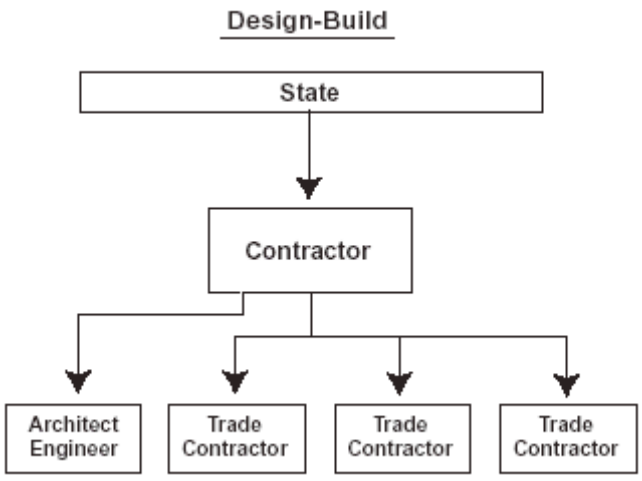


Image 5: Design-Build diagram

The biggest advantage of this method is that it is the fastest way how to achieve the project outcome. There is no extra time for bidding documentation and bidding overview as in the DBB system. Also due to the DB team collaboration, fast tracking is possible. This convenient method means that the project is delivered in series of packages of agreed design parts and therefore significantly saves overall time of project completion. *(Tomek, 2011)*

Another advantage is that usually it is the most cost effective method. Owner knows the budget, DB team knows the prices of the design, material and labor, which means they can design a building that suits the owner's needs. Traditional problem of DBB method is that architect designed a building above the owner's budget, which is discovered further during the contractor tendering process. In projects that require some kind of special knowledge or technology it can also happen that the project design is 'unbuildable'. Both of these problems cost the owner valuable time and money, which can be mitigated by this type of delivery method. *(Tomek, 2011)*

This is currently the most used project delivery method.

2.2.2. DESIGN - BID - BUILD (DBB)

In case of using the DBB system, the owner first engages the architect to create the design and other needed documentation. The whole design package is then presented in a tender to contractors to bid with the best offer, when the lowest price is selected usually. This means that the owner signs two contracts, which in the general contractor's point of view transfers the responsibility for the design to the owner.

This kind of project delivery method used to be the most commonly used, nowadays it is usually a matter of investors who focus on uniqueness of the building design. DBB process provides an extensive architectural support needed to produce the aesthetics. DBB system is typical for the amount of investor's control, since design team and contractor both report to the owner. This could be an advantage for very experienced investor who worked on many projects before, but a disadvantage for people with no professional experience at all. *(Tyson, 2005)*

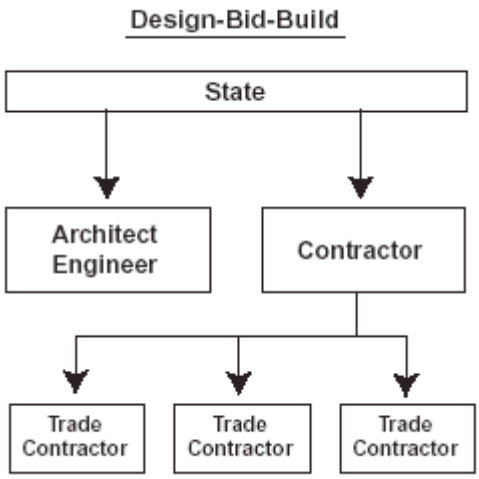


Image 6: Design-Bid-Build diagram

2.2.3. CONSTRUCTION MANAGEMENT

A construction manager provides services to the owner as necessary to extend or supplement owner's inexperience. The project manager acts on owner's behalf to provide professional advices concerning the project in exchange for usually a fixed management fee. This kind of payment also works well as a motivation for the CM to do his best. *(Tyson, 2005)*

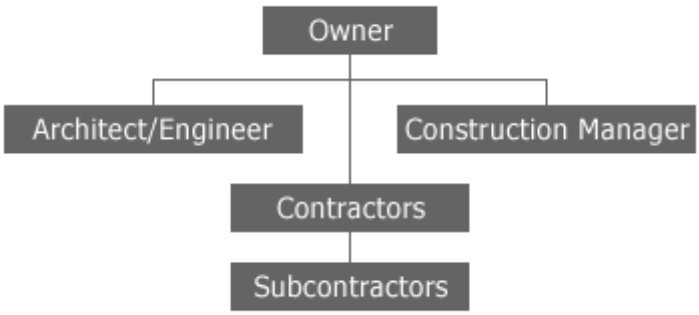


Image 7: Construction management diagram

The biggest advantage here is that CM represents the owner during the whole project, therefore investor can focus on other business or projects. Basically there is also no previous experience with construction investments needed. Whether DB or DBB system is selected, the construction manager can ensure the success of the project with minimal risk to you.

All in all, although CM delivery method in general point of view often means only relative comfort and minimized risk in exchange for little bit higher cost, construction manager can also save a lot of money because of his professional experiences and objectivity towards all of the stakeholders related to the project.

2.2.4. COMPARISON

According to the Construction Industry Institute, in 1985 only 6% of building construction used the DB Project Delivery System and only 12% used CM. Overtime, more and more companies have opted for the less risky DB method. In the very near future the construction percentages will be approximately DB 45%, DBB 45% and CM 10%.

When looking on three basic parameters according to which is usually construction projects evaluated, this is how each method thrives:

Unit Cost: Design-Build at least 45% less than Construction Management and 6% less than Design-Bid-Build.

Delivery Speed: Design-Build at least 23% faster than Construction Management and 33% faster than Design-Bid-Build.

Quality: Design-Build exceeded quality expectations at all levels. *(Tyson, 2005)*

3. PROJECT STAKEHOLDER IDENTIFICATION

Identification of project stakeholders is one of the first step of every successful project management plan and relates closely also to risk management process. In general, stakeholders are persons or organizations who are actively involved in the project or whose interests may be positively or negatively affected by the performance or completion of the project. Stakeholders may also exert influence over the project, its deliverables and the project team members. The internal project management team must identify both internal and external stakeholders in order to determine the project requirements and expectations of all parties involved. The Project Manager must manage the influence and expectations of the various stakeholders to ensure a successful project outcome.

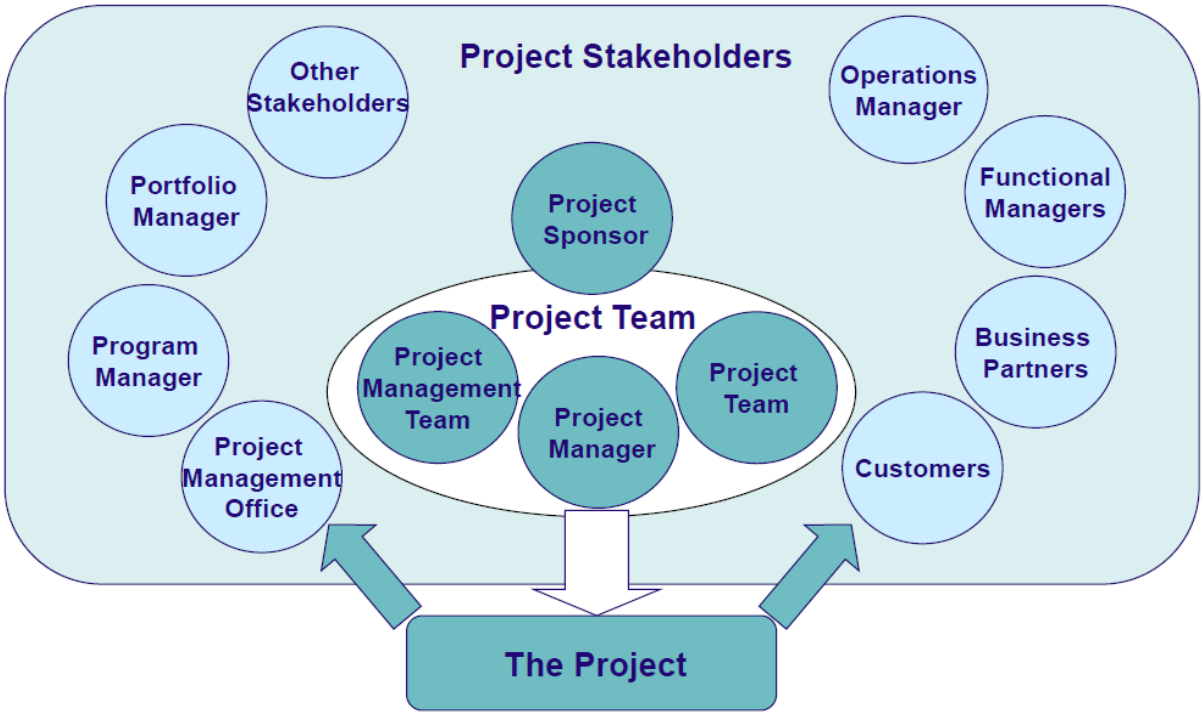


Image 8: Project Stakeholder Map

3.1. STAKEHOLDER IDENTIFICATION

Identifying stakeholders and understanding their relative influence on a project is critical. The thing is that it can be a very difficult task since not all of them may be obvious in the beginning of the project. Moreover, stakeholders can change over time and new ones can be identified during the project. Stakeholder expectations and power can also change during the project lifecycle. Those stakeholders identified later in the project process can severely disrupt the project, impacting the scope, timeframes or success measurement.

3.1.1 INPUTS TO IDENTIFY STAKEHOLDERS

Inputs for identification of stakeholders are as follows: *(PMBoK, 2013)*

- Project charter
- Procurement Documents and Contracts
- Enterprise Environmental Factors
    - Organization culture and structure
    - Government regulations
    - Industry standards
- Organizational Process Assets
    - Stakeholder register templates
    - Lessons learned from previous projects
    - Stakeholder registers from previous projects

3.1.2. TOOLS TO USE

A) STAKEHOLDER ANALYSIS

It is the process of systematical gathering and analyzing information to determine whose interests should be taken into account throughout the project. The goal is to identify each stakeholder's interests, expectations and influence. The project manager should always look at stakeholders with positive and negative feelings towards the project.

The whole analysis can be divided into three parts *(Linton, 2014):*

a) Identify all potential project stakeholders – this is the part, where the PM should try to understand their role and authority levels. The aim is to find out which stakeholders are the key ones. Those could be described as the decision–making part of the project governance and structure chart. They can be very useful also for identification of more stakeholders. Positive stakeholders then can be leveraged to enhance project success, negative ones need to be encouraged to support the project, or at least be neutral and tolerant.

b) Identify their power and impact – this is where the stakeholder management takes place. The goal is to classify stakeholders according to their power and interest and identify their communication requirements. Very useful tool here is to put all these requirements into so called Stakeholder Power & Interest Grid (see on Image no. 5)

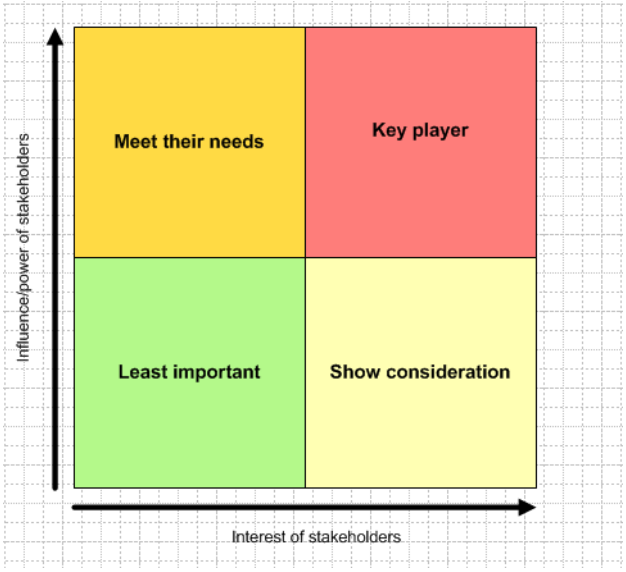


Image 9: Stakeholder map

c) Assess likely stakeholder reactions and plan to get support – in this part it is very important to identify each stakeholder's risk connected with the project together with the mitigation strategy to reduce negative impacts. In all probability, the bigger stakeholder's risk is, the more cautious the project manager should communicate.

B) EXPERT JUDGEMENT

Due to the fact that some of the stakeholders are normally uncovered throughout the project lifecycle, the list should be gradually expanded until all potential stakeholders are defined – e.g. staff or customers impacted by the project, third party suppliers, finance and legal departments. It not only takes a lot of experience for the PM to do that, also different external experts should be consulted. These are for example the key stakeholders as mentioned before, other project managers, various industry groups, professional associations and other subject matter experts.

3.1.3. OUTPUTS TO IDENTIFY STAKEHOLDERS

Outputs for identification of stakeholders are as follows: *(PMBoK, 2013)*

- Stakeholder Register
    - Identification information
    - Assessment information
    - Stakeholder classification
- Stakeholder Management Strategy
    - Defined approaches to increase support or decrease negative
- Stakeholder Analysis Matrix
    - Takes the results of the above and the Power and Interest assessment
    - Summarizes and organizes into a register or table
    - Includes potential strategies to gain support or reduce negative impacts

3.2. MANAGING STAKEHOLDER ENGAGEMENT

Managing stakeholder engagement is a process of communicating and working with each stakeholder to meet their needs and address issues as they arise. Stakeholder expectations are actively managed to increase the likelihood of project acceptance and success. Issues that have occurred are clarified and resolved, resulting in decisions, agreements and sometime change requests. This process is usually a responsibility of Project or Change Manager and typically occurs during the execution phase of the project. *(Linton, 2014)*

3.2.1. INPUTS TO MANAGE STAKEHOLDER ENGAGEMENT

Inputs for managing the stakeholder's engagement are as follows: *(PMBoK, 2013)*

- Stakeholder register
- Project communication plan
- Stakeholder management plan
- Project management plan
- Issue log – used to document resolution of issues
- Change log – used to document changes that occur during the project
- Organizational process assets
    - Communication policies and procedures
    - Issue management
    - Change control procedures
    - Lessons learned from previous projects

3.2.2. TOOLS TO USE

Below I am going to mention few skills that are useful not only for managing the stakeholders engagement, but also in general for managing the projects and their risks. *(Rabinowitz, 2012)*

A) COMMUNICATION METHODS

As mentioned before, good communication skills are one of the most important traits of all project managers. It is one of the primary ways to enhance skills for team members and to address skill gaps for current positions. It can be on-the-job style training or external courses, which are considerably more expensive.

B) INTERPERSONAL SKILLS

Alternative ways to fill skill gaps or to obtain new skills, includes mentoring and coaching, self study, secondments etc. Often overlooked in development plans as most team members tend to look for external training opportunities (which are much more costly).

C) MANAGEMENT SKILLS

Those can vary from a short kick of meeting for a project to off-site, to regular team drinks, to externally facilitated workshops. Critical in the early stages of team formation to ensure that the team can become productive and needs to continue throughout the project. Often includes setting of Ground Rules and common objectives, as well as mechanisms to discuss issues and to resolve conflict.

D) CONFLICT RESOLUTION SKILLS

Often there is a formal document developed at the inception of the project team that defines behaviors and expectations for team members – decreases misunderstandings and increases productivity. It needs to be consistent with the organizational culture.

E) NEGOTIATION SKILLS

Where possible it is a good idea to place all of the active project team members in the same work place. Greatly enhances team work but may not be possible due to distributed workforce, space limitations and virtual teaming.

3.2.3. OUTPUTS OF THIS PROCESS

Outputs for managing the stakeholder's engagement are as follows: (*PMBoK, 2013*)

- Change Requests
- Project Management Plan Updates
- Project Communication Plan Updates
- Stakeholder Management Plan Updates
- Stakeholder Register Updates
- Issue Log Updates
- Risk Log Updates
- Organizational Process Asset Updates
    - Lessons learned
    - Causes of issues
    - Reasoning behind corrective action

4. RISK IDENTIFICATION

After the initial step of a good risk management process – the stakeholder identification, the risk identification analysis itself comes to the line. In this phase we ask the questions 'What are the risks of this project?' or 'What sorts of risks are we likely to confront?'. Generally speaking, there are two basic levels of risks. Those that are project specific, for example changes in prices of input materials, contractor services, demand of the product the project will produce, price that people are willing to pay for the product, or contractor/sponsor collapse. Secondly, there are also some 'macro – economic' risks as well. It could be the market crash, recession, government shifts such as taxes or changes in law/standards.

The most important thing therefore is to know, what sort of risks are we likely to face. If we look closer to the project structure, there are different types of risks that fall into particular categories:

1. Completion Risks: is the project going to be finished on time, in budget and certain standard?
2. Operating Risks: such as market demand, throughput, pricing, customer access.
3. Political/Sovereign Risks: expropriation, legal changes, international intervention, conflicts.
4. Financial Risks: financial market dynamics, cost of debt, exchange rates. (*PMBoK 2013*)

Lastly, there are also all sorts of totally unexpected and unaffectable threats, including natural disasters such as earthquakes, floods, hurricanes and much more.

Considering all those risks, the analysis is always accomplished in a two way process. It is either identifying the causes-and-effects (which means find out what could happen and what will ensue) or effects-and-causes (what outcomes are to be avoided or encouraged and how each might occur). (*PMBoK, 2013*)

All in all, an unidentified risk is a danger to the project, lurking out to cause damage. And that is why the significance of the risk identification process cannot be explained enough.

4.1. INPUTS TO RISK IDENTIFICATION

It is important to understand, where to look for the information about potential project risks.

A lot of information is held in the management plans. All identification should start by going through the cost management plan, schedule management plan, quality management plan, if available. In early stages of the project should be sufficient also the cost and duration estimates.

Another useful source of information could be also the Work Breakdown Structure that can be used for recognizing risks on a different level of the WBS hierarchy.

Furthermore, the stakeholder identification which we should have already done by this point is also considered as a source of information. It provides a rich source of individuals and groups that should be consulted with and involved as part of identifying potential risk areas within the project.

However in my opinion one of the most important sources is the organizational assets, including the project files with all the information about previous failures and obstacles that were faced in the past. Also individual members of the project team may remember previous occurrences or assumptions. (*PMBoK, 2013*)

4.2. TOOLS AND TECHNIQUES FOR RISK IDENTIFICATION

Risk identification is crucial to risk management. If you fail to identify a risk, you will not be able to manage it. Having all these inputs is fine, but the key to the whole process is to identify the risks properly. The tools and techniques we use in this process are: *(VijayaKumar, 2013)*

a) Assumptions analysis - Assumptions in the project scope statement represent uncertainty. Assumptions are used to identify the risks. Assumptions analysis is the technique used to examine the validity of the assumptions and thereby to identify the risks resulting from the inaccuracies, inconsistencies, or incompleteness of each assumption. For example, supposing there is only one person in the organization that has a rare skill needed for the project. An obvious assumption would be that the person will not quit the organization before completing the Project. Ignoring this fact constitutes a potential risk.

b) Checklist analysis - carefully prepared checklists in any process are great no-brainer timesavers. Projects in the same organization will more often have similarities. As a result, it is possible to develop a risk identification checklist based on the information gathered from a similar set of projects previously performed. Also, if the risk breakdown structure (RBS) is developed in risk planning, the lowest level of the RBS can be used as a checklist.

c) Diagramming techniques - these techniques use diagrams to identify risks by exposing and exploring the risks' causes. Here are a few examples:

Cause-and-effect diagram - A cause-and-effect diagram illustrates how various factors (causes) can be linked to potential problems (effects).

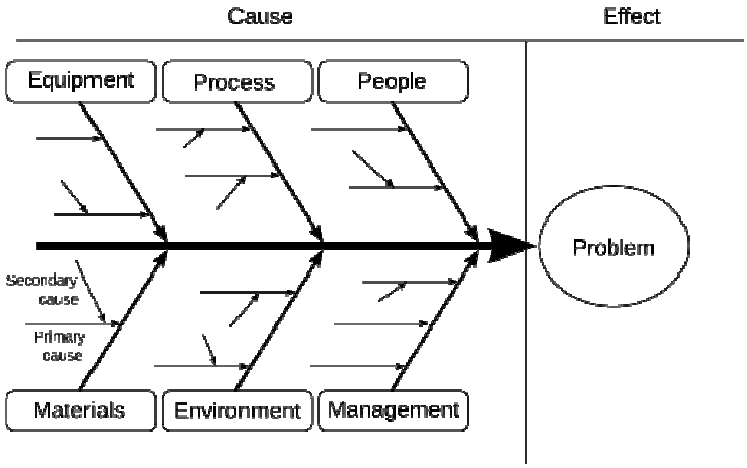


Image 10: A fishbone diagram or so called Ishikawa Diagram

Flowchart diagram - A flowchart depicts how the elements of a system are related to each other and shows the logical flow of a process. By examining the flowchart of a process, the risk management team can identify points of potential problems in the flowchart diagram.

Influence diagram - An influence diagram is a graphical representation of situations that shows relationships among various variables and outcomes, such as causal influences and time-ordering of events. By examining these diagrams, the risk management team can recognize potential problem areas and thereby identify risks.

d) Documentation reviews - A structured review of the relevant parts of input documents, such as the project scope statement and the project management plan, will definitely help in identifying risks. Furthermore, the knowledge base related to risk management from previous projects can also be used / reviewed.

e) Information-gathering techniques - To identify risks, it is necessary to gather risk related information. Following are some of the information gathering techniques used in risk identification: *(Linton, 2014)*

Brainstorming - The goal here is to get a comprehensive list of potential risks so that no risk goes unidentified. The project team, along with relevant experts from different disciplines, can participate in the brainstorming session. Brainstorming is better performed under the guidance of a facilitator or a moderator. It is possible to use the categories of risks or the RBS as a framework to keep the session focused on the issue.

Interviewing - This is one of the common methods used for information gathering for risk identification. You interview the appropriate stakeholders and subject-matter experts to gather information that will help identify risks for the project at hand.

Root cause identification - A powerful way to identify risk is to look for anything in the project that might generate a risk. In other words, if a potential cause for risks is defined, it's simple to identify the risks resulting from that cause. Furthermore, if the cause of a risk is known, it helps to plan an effective response. It is also possible to

look for risks at the opposite side of causes that is, impacts. It is often visualized as well as fishbone diagram.

SWOT analysis - While root cause identification techniques look into the causes of risks to identify risks, a SWOT analysis looks at the potential impacts of risks to identify risks. While examining the strengths, weaknesses, opportunities, and threats (SWOT) of a given project, you will be exposing the risks involved. Strength is an opportunity, a weakness is a threat, and opportunities and threats are posed by risks. This helps broaden the spectrum of risks considered. For example, strength of a particular project might be that most of its parts are well understood from previously executed similar projects. Therefore, the risks involved in those parts will be easy to identify. A weakness of a project might be that one of the parts involves new technology that is not well-tested. So, this is a source of unknown risks. An opportunity might be that an organization will be the first one to take this product to market. An example of a threat might be that the government is considering a bill that, if it becomes a law, will have profound implications for this project.

Image 11: SWOT Analysis summary

4.3. THE OUTPUT OF RISK IDENTIFICATION

The main outcome of risk identification is the Risk register. The risk register is a document that contains the output of the risk identification process. The risk register will be constantly updated with a lot of information from other risk management processes. To begin, you store the following information from the risk identification process in the risk register *(PMBoK, 2013):*

List of identified risks - These are the risks that you identified in the risk identification process. These risks should be described in reasonable detail, which may include the following:
The risks - The definition and nature of each risk and the causes that will give rise to the risk.

List of the root causes of the risks - This is a list of events or conditions that might give rise to the identified risks.

Updates to risk categories - Risks categories were originally identified in the risk management planning process. However, in the process of identifying risks, you might discover new categories or modify existing categories. The updated risk categories must be included in the risk register.

Risks symptoms – Risk symptoms, so called triggers, are indirect manifestations of actual risks events.

List of potential responses - Risk response planning is a separate process that is performed after risk analysis. However, during risk identification, you might identify potential risk responses that you must document in the risk register. These responses can be further examined and planned in the risk response planning process.

The results of the risk identification process usually lead to qualitative risk analysis. However, depending upon the project and the experience of the risk management team, risk identification might lead directly to quantitative risk analysis and even to risk response planning.

5. QUALITATIVE RISK ANALYSIS

Qualitative risk assessment is frequently the most useful part of the risk management process and it lays the foundation for all the following up stages in that process, such as quantitative analysis that are usually required to define budgets and timescales. Therefore at the beginning it is quite important to understand the actual difference between those two phases of risk management process. Qualitative analysis is the application of methods for ranking the identified risks according to their potential impact on project objectives. This process prioritizes risks according to their potential effect on project objectives and determines the importance of addressing specific risks responses. This is implemented by assigning each of the risks by *probability* and *impact*. Quantitative phase on the other hand is a further analysis which quantifies the possible outcomes for the project and assesses the probability of achieving specific project objectives. In other words, it creates a realistic and achievable cost, schedule or scope targets. *(Fremouw, 2011)*

QUALITATIVE	**QUANTITATIVE**
Risk - level	Project – level
Subjective evaluation of probability and impact	Probabilistic estimates of time and cost
Quick and easy to perform	Time consuming
No special software or tools required	May require specialized tools

Table 1: Summary of differences between the qualitative and quantitative part of risk management

The quantitative analysis usually uses a pre-defined rating scale and should be of course reviewed throughout the project lifecycle and updated to stay current with changes in project.

From time to time, no further analysis needs to be done. Applying weighting factors to the qualitative assessment provides a quasi-quantitative form of analysis. This way it can lead straight to risk response planning.

5.1. INPUTS TO QUALITATIVE RISK ANALYSIS

- Risk register - this is the source of all of the known risks that are to be analyzed.
- Risk management plan - because this is in affect a risk management strategy document for the project, it will clarify the overall approach that needs to be taken to risk management on this particular project as well as stating how much risk is acceptable and who should be involved in carrying out the qualitative risk analysis of the project risks.
- Project scope statement - this key document describes both the project and product deliverables along with the objectives of the project and to the requirements, along with the constraints and assumptions. When it was first created within the define scope process, it also included all the identified risks known at that time, and these will be used along with the other information within this document for qualitative risk analysis.
- Organizational process assets - these will include aspects such as tools to help carry out qualitative risk analysis, policies, procedures and guidelines for risk management, and historical information including lessons learned from previous similar projects.

5.2. TOOLS AND TECHNIQUES FOR QUALITATIVE RISK ANALYSIS

5.2.1. RISK PROBABILITY AND IMPACT ASSESSMENT

Risk probability assessment investigates the likelihood that each specific risk will occur, whereas risk impact assessment ivestigates the potential effect on a project objective such as schedule, cost, quality or performance. These may have either a negative effect (threat) or a positive effect (opportunity). Important thing to realise is that those two dimensions of risk are applied to specific risks, not to the overall project. That way the whole analysis is much detailed and flexible. *(Al Khalil, 2010)*

Both the likelihood and impact are evaluated by a score according to the definitions stated in the risk management plan and these can be considered together to provide a risk score. The assessmnet is usually held in a form of meetings or interviews with participants who include

area of risk experts and the project management team members. All the details justifying the assessment should be documented and kept for later updates and revisions.

Below is a table of an example of such an assessment.

Project Objective	Very Low .05	Low .1	Moderate .2	High .4	Very High .8
Cost	Insignificant Cost Increase	<5% Cost Increase	5-10% Cost Increase	10-20% Cost Increase	>20% Cost Increase
Schedule	Insignificant Schedule Slippage	Schedule Slippage <5%	Overall Project Slippage 5-10%	Overall Project Slippage 10-20%	Overall Project Schedule Slips >20%
Scope	Scope Decrease Barely Noticeable	Minor Areas of Scope Are Affected	Major Areas of Scope Are Affected	Scope Reduction Unacceptable to the Client	Project End Item Is Effectively Useless
Quality	Quality Degradation Barely Noticeable	Only Very Demanding Applications Are Affected	Quality Reduction Requires Client Approval	Quality Reduction Unacceptable to the Client	Project End Item is Effectively Unusable

Table 2: Evaluating Impact of a Risk on Major Project Objectives, (Al Khalil, 2010)

5.2.2. PROBABILITY / IMPACT RISK RATING MATRIX

A risk matrix may be constructed that assigns risk ratings (low, moderate, high) to risks based on combining probability and impact scales of a risk on a project objective. *(Al Khalil, 2010)*

It is the project management team responsibility to determine which combinations of probability and impact results in a high risk classification (red condition), moderate risk (yellow condition), and low risk (green condition). Each category then has a specific risk response planned afterwards. Risks within the red boxes are likely to require further analysis, including quantification and aggressive risk management (both threats and opportunities). Lower risks require less emphasis and it usually it is enough to include them in a watch list for monitoring.

It is also possible to rate risks separately in terms of their impact on cost, time, scope and quality. In addition, it can lead to determining one overall rating for the risk. An overall rating scheme can be developed to reflect the organization's preference for one objective over another and using those preferences to develop an assessment of the risks that are addressed by certain objective.

Below is an example of rating matrix.

		Threats					Opportunities				
Probability	0.90	0.05	0.09	0.18	0.36	0.72	0.72	0.36	0.18	0.09	0.05
	0.70	0.04	0.07	0.14	0.28	0.56	0.56	0.28	0.14	0.07	0.04
	0.50	0.03	0.05	0.10	0.20	0.40	0.40	0.20	0.10	0.05	0.03
	0.30	0.02	0.03	0.06	0.12	0.24	0.24	0.12	0.06	0.03	0.02
	0.10	0.01	0.01	0.02	0.04	0.08	0.08	0.04	0.02	0.01	0.01
		0.05	0.10	0.20	0.40	0.80	0.80	0.40	0.20	0.10	0.05
		Impact									

Image 12: Probability – Impact Matrix

5.2.3. DELPHI TECHNIQUE

It is a well used technique for predicting and estimating the likelihood and outcome of future events that could happen during the project. Either positive or negative event, there is always a great amount of uncertainty. Therefore this technique uses a group of experts that individually give estimates and assumptions to a facilitator who reviews the data and issues a summary report. Management team reviews the report individually and updates the forecast so that the experts can create a second report. Although the experts have full records of what forecasts other experts have made, they don't know who made which - the key thing here is the anonymity that allows the experts to express their opinions without any constraints and let them express even the unpopular ideas. This process repeats till all the participants reach some kind of consensus. The aim is to clarify and expand on issues and identify areas of agreement or disagreement. *(Piraveenan, 2014)*

5.2.4. RISK DATA QUALITY ASSESSMENT

It is necessary to use an accurate data for a reliable qualitative risk analysis. The assessment includes examining of the extent of understanding the risk, data availability and reliability. The use of low precision data, for example when the risk is not well understood, may lead to a qualitative risk analysis that can confuse the project manager. Therefore it is critical to obtain a good quality data, only that way the analysis can be actually useful.

5.2.5. RISK URGENCY ASSESSMENT

Risks that are likely to occur in near future require more urgent attention than those that may occur later on the project. Therefore urgent risks need urgent responses. Urgency can be addressed by including time of response as an indicator of priority. Other indicators may include symptoms and warning signs, as well as the risk rating. In some qualitative analyses the assessment of risk urgency can be combined with the risk ranking determined from the probability and impact matrix to give a final seriousness rating.

5.3. OUTPUTS TO QUALITATIVE RISK ANALYSIS

The output of qualitative analysis is update of project documents, mainly the risk register. The risk register can be updated with the following information. *(Al Khalil, 2010)*

Relative ranking or priority list of project risks - the probability and impact matrix can be used to classify risks according to their individual significance. Risks may be listed by priority separately for schedule, cost, and performance since organizations may value one objective over another. The project manager can then use the prioritized list of risks to focus attention on those items of high significance to the most important objectives.

Risks grouped by categories - this can point to common underlying causes of risk, which may in turn suggest a holistic approach to dealing with them. Discovering concentrations of risk may also improve the effectiveness of risk responses.

List of risks requiring response in the near-term – includes those risks that require an urgent response and those that can be handled at a later date may be put into different groups.

List of risks for additional analysis and response - some risks might warrant more analysis, including Quantitative Risk Analysis, as well as response action.

Watch lists of low-priority risks - those that are not assessed as important in this process and can be placed on a watch list for continued monitoring.

6. QUANTITATIVE RISK ANALYSIS

A quantitative risk analysis is a further analysis following up after qualitative part of risk management. Usually it is applied to the higher priority risks during which a numerical or quantitative rating is assigned in order to develop a probabilistic analysis of the project.

A quantitative analysis provides a quantitative approach to making decisions when there is uncertainty and creates realistic and achievable cost, schedule and scope targets.

Crucial thing while performing quantitative analysis is to have a high-quality data and a prioritized list of project risks (usually from the qualitative risk analysis).

While performing quantitative risk analyses, it is important to realize following number of factors *(PMBoK, 2013)*:

- Opportunities and threats can interact in unanticipated ways (schedule delays may force consideration of a new strategy that reduces overall project duration).
- A single risk event can cause multiple effects, as when late delivery of a key component produces cost overruns, schedule delays, penalty payments, and a lower-quality product.
- Opportunities for one stakeholder (reduced cost) may be threats to another (reduced profits).
- The mathematical techniques used can create a false impression of precision and reliability.

6.1. INPUTS TO RISK QUANTIFICATION

Besides the classic inputs for each part of the risk management such as the risk management plan, schedule management plan and cost management plan, there are few important documents to start with quantitative risk analysis.

Risk register – in this phase it should contain all the identified risks so far on the project including the qualitative data analyzed in the previous part. That means that each identified risk should have assigned a score expressing the probability of occurrence, impact it could cause to the project objectives and urgency stating required time to respond. This way we perform the quantitative analysis just on those categories of risks, that are the biggest threats / opportunities for the overall project outcome.

Stakeholder risk tolerances – different organizations and different individuals have different thresholds for risk. Examples from *PMBoK*:

- A highly profitable company may be willing to spend $500,000 to write a proposal for a $1 billion contract, while a company operating at break-even is not.
- One organization may perceive an estimate that has a 15 percent probability of overrunning as high risk, while another perceives it as a low risk.

6.2. TOOLS AND TECHNIQUES TO RISK QUANTIFICATION

6.2.1. FINANCIAL ANALYSIS

Financial analysis includes techniques such as Lifecycle Costing, Return on Investment (ROI), Internal Rate of Return (IRR), Net Present Value (NPV) and Cash Flow Analysis. *(Harré, 2014)*

NPV – Net Present Value is a tool to decide how much a project's cash flows are 'worth' in today's money. Mathematically it is basically a difference between the present value of cash inflows and the present value of cash outflows.

The following is the formula for calculating NPV: *(Investopedia, 2014)*

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

Where:

C_t = net cash inflow during the period

C_o = initial investment

r = discount rate

t = number of time periods

NPV is a basic tool in discounted cash flow analysis and is standard method for using the time value of money to appraise long-term projects.

At risk analysis, NPV is used as a decision making tool, an indicator of how much value can be assigned to each threat/opportunity, therefore what is the possible impact on the project outcome.

IRR – Internal Rate of Return is a way of evaluating what interest rate will result in an NPV=0 for the project cash flows. At this point a project's cash flows are equal to the project's costs. In decision making process, IRR is a tool that is used to determine the so called hurdle rate. It is the minimum rate of return a company will accept for a project. *(Harré, 2014)*

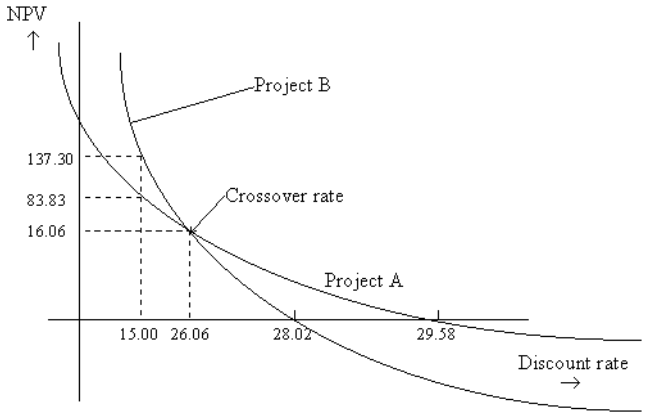


Image 13: Chart of the relationship between IRR and NPV

6.2.2. EXPECTED MONETARY VALUE AND DECISION TREES

Decision Trees is a graphical technique, which helps in risk prioritization and impact analysis through constructing a chain of risk events and calculating the Expected Value given risk scenario based on the likelihood of each risk event and the impact cost of the scenario outcome.

Decision trees provide a highly effective structure within which it is possible to lay out options and investigate the possible outcomes of choosing those options. *(Linton, 2014)*

Expected Value is calculated by multiplying the *impact cost* of a risk scenario outcome by the product of successive risk *probabilities* in the chain of risk events making up the scenario.

One potential alternative how to calculate EMV, when probabilities are known or can be estimated, is also during the risk analysis. In this case it is called The Value at Risk (VaR), which describes the amount of money that will be gained or lost with some probability, typically worst-case scenario for each identified risk. *(Piraveenan, 2014)*

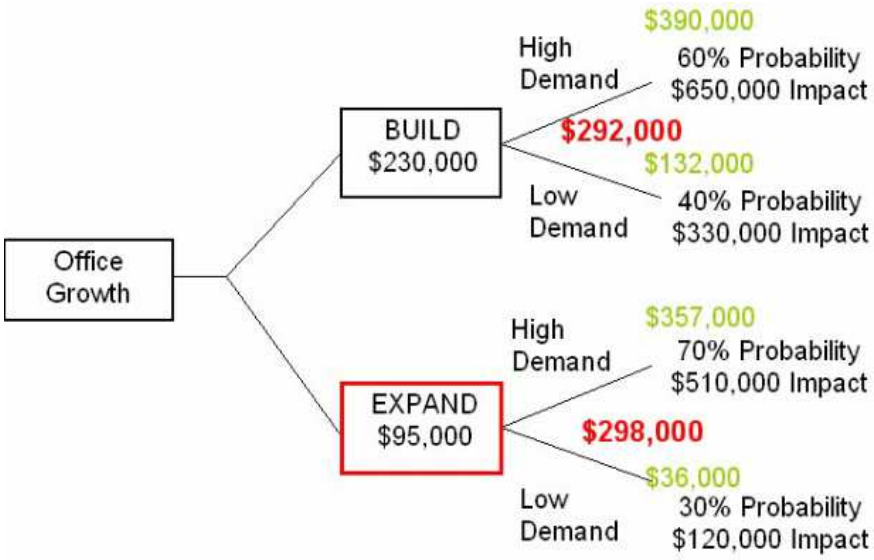


Image 14: EMV analysis used on an example

6.2.3. UTILITY THEORY

Utility theory accounts for the observed behavior where rational decisions about risk do not align with the predictions based on the highest Expected Monetary Value. The model takes into account the risk appetite in relation to the risk reward ratio.

In other words, utility is a measure of relative satisfaction. Utility theory uses the utility function, which measures an individual's relative preference for an outcome such as increase in wealth and is defined based on two assumptions *(Piraveenan, 2014):*

- Non-satiation: increasing wealth is always desirable and utility increases with wealth (i.e. more wealth if preferable to less wealth)
- Risk-aversion: utility of additional units of wealth (marginal utility) decreases with wealth

Therefore the principle of expected utility maximization states that rational investor will select an investment option which maximizes expected utility of his decision.

Example 1

Initial wealth = $5

For a $4 investment assume a 50/50 chance of making $4 or losing the investment

EMV of not investing (risk free option) is $5 with an expected utility of $\sqrt{\$5} = 2.24$

EMV of investing (risky option) = 0.5 x ($5+$4) + 0.5 x ($5-$4) = $5

The expected utility of investing is 0.5 x $\sqrt{\$9} + 0.5 \times \sqrt{\$1} = 0.5 \times 3 + 0.5 \times 1 = 2$

Since expected utility of investing is less than that of not investing the decision is not to invest

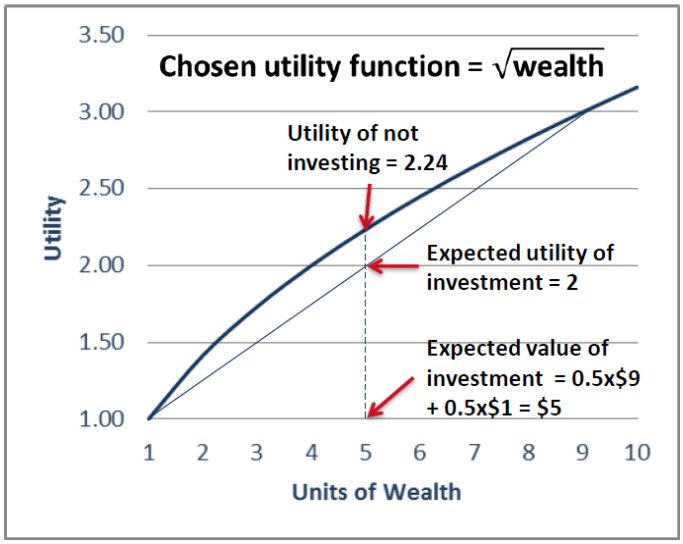


Image 15: Example of Utility Theory use

6.2.4. MONTE CARLO ANALYSIS

Monte Carlo analysis is a simulation method, which uses random sampling to determine the impact of risk on the likelihood of a particular outcome – in this case risk impact and probability of occurrence. The values of each factor are defined in terms of a probability distribution function. The simulation is usually run multiple times using volatility and correlation estimates chosen by the project manager. Each time the simulation randomly chooses activity impact based on their probability distribution functions and calculating the risk overall assessment. The results are then statistically analyzed into categories according to their assessment. *(Piraveenan, 2014)*

Usually the outcome of the analysis states a percentage of risks with the same probability to occur. Monte Carlo simulation is often used also in schedule duration estimates.

This method is very realistic, therefore more likely to estimate risk assessment accurately. However, its implementation requires computers and it also takes longer time to perform this calculation. *(Choudhry, 2006)*

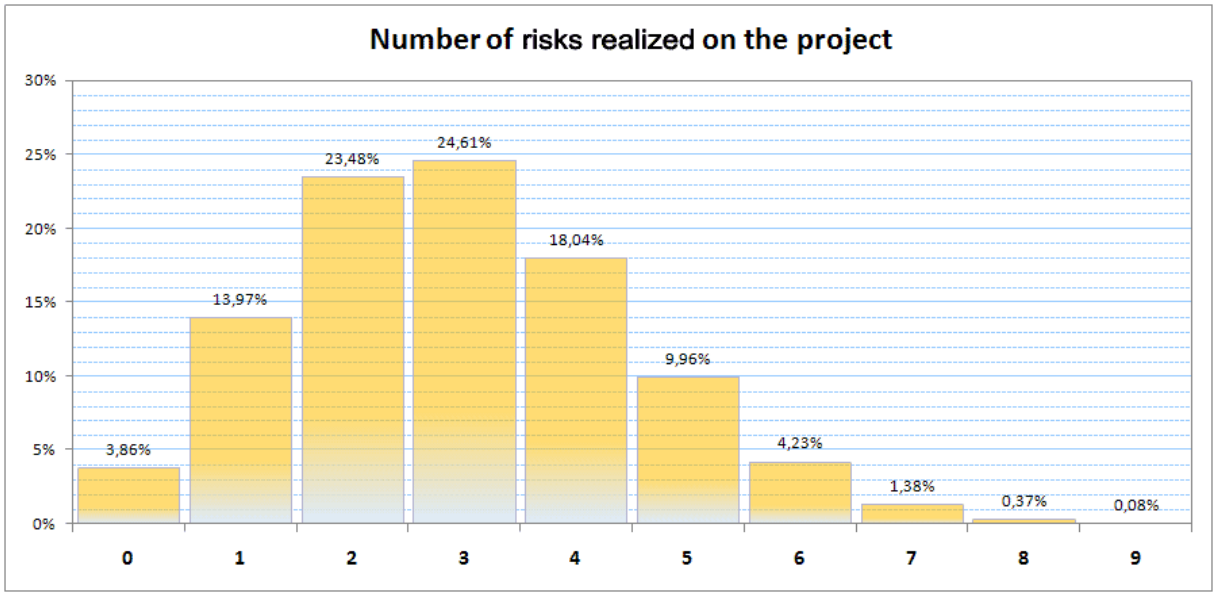


Image 16: Example of Monte Carlo Analysis used in Risk Management

6.3. OUTPUTS FROM RISK QUANTIFICATION

Outputs from this part of risk analysis are as follows: *(PMBoK, 2013)*

List of opportunities to pursue, threats to respond to – the major output from risk quantification is a list of opportunities that should be pursued and threats that require attention.

List of opportunities to ignore, threats to accept – the risk quantification process should also document those sources of risk events that the project management team has consciously decided to accept or ignore and who made the decision to do so

7. RISK RESPONSE STRATEGIES

The objective of Risk Response Planning is to determine how risks and opportunities will be dealt with.

7.1. RISK RESPONSE CATEGORIES

7.1.1. ACCEPTING

This strategy is used for risks that are most suitable to just accept the consequences. Acceptance can be active, which involves preparation to deal with the consequences of the risk occurring (e.g. by developing a contingency plan to execute should the risk occur). And allocation of contingency itself is the typical pattern in this response strategy. *(PMBoK, 2013)*

Passive acceptance means simply not doing anything to address the risk and is not recommended (e.g. by accepting a lower profit if some activities overrun).

Types of contingency include schedule contingency (additional time allocated in the schedule to deal with the impact of risks on project duration), budget contingency (additional budget allocated to deal with the impact of risk on project cost) and risk response alternatives (enables the project to progress in the event that selected risk response strategies fail to reduce risk impact and/or likelihood). *(Piraveenan, 2014)*

7.1.2. REDUCING

Reducing expected monetary value of a risk event by reducing the probability of occurrence (e.g. using proven technology to lessen the probability that the product of the project will not work), reducing the risk event value (e.g. buying insurance), or both. The degree by which the likelihood and impact will be reduced, known as residual risk, needs to be

determined. The effectiveness of risk reduction measures is recorded by updating residual risk values. *(Piraveenan, 2014)*

Examples of risk mitigation:

Implementing a new course of action that will reduce the problem, e.g. adopting less complex processes, conducting more seismic or engineering tests, or choosing a more stable supplier.

Changing conditions so that the probability of the risk occurring is reduced, e.g. adding resources or time to the schedule.

Prototype development to reduce the risk of scaling up from a bench scale model.

Where it is not possible to reduce probability, a mitigation response might address the risk impact by targeting linkages that determine the impact severity. For example, designing redundancy into a subsystem may reduce the impact that results from a failure of the original component. *(Al Khalil, 2010)*

7.1.3. TRANSFERING

It is the process of shifting the impact of the risk to another parties (e.g. by some contractual agreements, insurance, partnership/joint venture). The responsibility for the impact is transferred to another bearer. Another example of risk transfer is currency hedging in risks involving shifts in exchange rates. This type of response does not change the likelihood of the risk, it can be only associated with a significant cost by introducing a number of secondary risks depending on the approach chosen.

Examples of risk transfer:

The use of insurance, performance bonds, warranties and guarantees.

Contracts may be used to transfer liability for specified risks to another party.

Use of a fixed price contract may transfer risk to the seller if the project's design is stable. A cost reimbursable contract leaves more of the risk with the buyer, but it may help reduce cost if there are midproject changes. *(Al Khalil, 2010)*

7.1.4. ELIMINATING

Eliminating a specific threat, usually by eliminating the cause or not undertaking the activities which may trigger the risk event to occur. The project management team can never eliminate all risks, but specific risk events can often be treated in a way of elimination. When choosing this treatment strategy it is important to consider:

What will happen if the activities are not undertaken?

Does the benefit of avoiding the risk outweigh the impact of not undertaking the activities?

Is the cost of alternative treatment strategies higher than the benefit of undertaking the activities?

Does the impact of the risk event occurring justify not undertaking the activities?

Is the likelihood of the risk high enough to justify not undertaking the activities? *(Piraveenan, 2014)*

Examples of risk elimination: add resources of time, adopt a familiar approach instead of an innovative one, avoid an unfamiliar subcontractor, clarify requirements, improve communication, obtain information, acquire expertise, reduce the scope to avoid high-risk activities. *(Al Khalil, 2010)*

7.2. STRATEGIES TO RESPOND TO POSITIVE RISKS (OPPORTUNITIES)

There are also some positive risks to discover during the previous risk analysis. These are called opportunities and it is also very important to find response strategies to such events to maximize their positive impact. *(Al Khalil, 2010)*

a) Exploit the opportunity – it means to make sure that the risk event happens by eliminating the uncertainty, such as assigning qualified personnel, select an appropriate project delivery method or provide better quality.

b) Share the opportunity – that means allocating the ownership to a third party who has a better chance of achieving the required results, such as joint ventures, partnerships, rewards.

c) Enhance the opportunity – it means to increase the likelihood of occurrence or the impact of the event, for example by improving chances for the event to happen so the opportunity becomes more certain, considering how the impact can be increased and choose a course of action that will multiply the opportunity impact.

7.3. INPUTS TO RISK RESPONSE PLANNING

From previous analysis we will have the following lists: *(PMBoK, 2013)*

List of opportunities to pursue, risks to respond to – the major output from risk quantification is a list of opportunities that should be pursued and threats that require attention.

List of opportunities to ignore, threats to accept – the risk quantification process should also document those sources of risk events that the project management team has consciously decided to accept or ignore and who made the decision to do so

7.4. TOOLS AND TECHNIQUES TO RISK RESPONSE PLANNING

Usual way to deal with identified risks is to involve the risk responsibility somehow in a contract. Contracts are in general a way how to transfer a responsibility for some kind of risk impact, therefore by agreeing on certain conditions most of the risks identified can be easily mitigated to another parties.

Also insurance or insurance-like agreements such as bonding (usually part of the contracts as well) is often available to deal with some categories of risk. The type of coverage available and the cost of coverage vary by application area. *(PMBoK, 2013)*

7.4.1. COST/BENEFIT ANALYSIS

It is an important tool in the selection of risk reduction strategies. When the cost of implementing the risk response is included in the comparison, it can show the net effect of the response on the project cost. The response can then be judged in terms of whether its net effect is to increase cost and whether that increase can be justified by the time it saves. Assessing risk mitigation strategies makes it possible to fully understand their effects. Therefore the main idea of this technique is that the benefit of treating the risk should always outweigh the cost of treatment. *(Piraveenan, 2014)*

7.4.2. PROCUREMENT

Procurement is the process of acquiring the goods and services from outside the immediate project organization. Very often it becomes an appropriate response to some types of risks. For example, risk associated with using a particular technology may be mitigated by contracting with an organization that has experience with that technology.

Procurement often includes exchanging one risk for another. For example mitigating cost risk with a fixed price contract may create schedule risk if the seller is unable to perform on time. Also every risk responsibility has of course its own price, which could lead to another

example such as trying to transfer all technical risk to the seller, which may result in an unacceptably high proposal. *(PMBoK, 2013)*

7.4.3. CONTINGENCY PLANNING

Contingency planning involves defining action steps to be taken if an identified risk event should occur. *(PMBoK, 2013)*

Usually contingency planning involves creating the Plan B due to unexpected changes that will disable the project manager team to use the original management plan. Important thing is to not plan too much. Contingency planning needs a careful balance between over-preparing for something that may never happen, and adequate preparation, so that project management team can respond quickly and effectively to a crisis situation when it occurs. On the other hand due to a low probability of a crisis occurring, people often don't see contingency planning as an urgent activity. Unfortunately this sometimes means that the task never gets done.

7.5. OUTPUTS TO RISK RESPONSE PLANNING

The outputs from planning risk responses are generally updates to already existing documents, such as Project Management Plan.

Risk Register - will be updated with the risk response activities. Risk Management plan should include who is responsible for managing various areas of risk, what kind of activity should the responsible stakeholder undertake.

Contingency plans – are pre-defined actions to be taken if an identified risk event occur.

Contractual agreements – may be entered into for insurance, services, and other items as appropriate in order to avoid or mitigate threats. *(PMBoK, 2013)*

8. RISK MONITORING AND CONTROL

As the project continues to further phases, it is very important to control and monitor numerous assumptions and estimates made at the planning phase. It is also time for evaluation risk plan effectiveness in reducing risks. Risk monitoring is then important to keep track of the identified risks (including the watch list) and trigger conditions for contingencies. This phase is also about identifying new risks arising during the project execution. *(Al Khalil, 2010)*

8.1. INPUTS TO PROJECT RISK MONITORING AND CONTROL

Risk Register – part of the Risk Management Plan, contains outputs from previous processes: identified risks & owners, risk responses and triggers.

Approved Change Requests – all modifications made throughout the project lifecycle, further being updated. Also includes additional risk identification, which is necessary as project proceeds. *(Al Khalil, 2010)*

Actual risk events – list of risks that actually occurred needed so that the response developed can be implemented. *(PMBoK, 2013)*

8.2. TOOLS AND TECHNIQUES FOR RISK RESPONSE CONTROL

8.2.1. RISK REASSESSMENT

Key technique used in monitoring and controlling phase. Risk rating and prioritization may change during the life of the project and changes may require additional qualitative and quantitative analysis. Reassessments should be performed regularly throughout the project lifecycle, e.g. at coordination team meetings, major reviews should be then taken at major

project milestones. This process includes also some kind of risk audits, when effectiveness of risk response planning is controlled. *(Al Khalil, 2010)*

8.2.2. WORKAROUNDS

Workarounds are unplanned responses to negative risk events. Workarounds are unplanned only in the sense that the response was not defined in advance of the risk event occurring. Workarounds must be properly documented and incorporated into the project plan and risk response plan. *(PMBoK, 2013)*

8.2.2. RESERVE ANALYSIS

Reserve analysis compares available reserves with amount of risk remaining at the time and determines whether reserves are sufficient. Commonly used tool is the Earned Value, which is expressed in monetary terms which makes it easier to communicate with stakeholders not familiar with other methods. It can be used for analyzing costs spent for risk treatment as well as to analyze overall project budget. Similarly to the Risk Reassessment, this analysis is performed regularly throughout the project, indicating possible cost overruns caused by inadequate risk impact analysis.

This method works on the principle of comparing:

Planned Value (PV) – what was planned. It is the authorized budget assigned to a risk or other activity used in a relation to the overall project budget.

Earned Value (EV) – what was achieved. It is the value of completed work expressed in terms of the proportion of the project budget assigned to a risk or other activity, which is calculated as the percent complete.

Actual Cost (AC) – what was spent. It is the cost actually incurred in completing the work/activity corresponding to the accrued Earned Value. *(Piraveenan, 2014)*

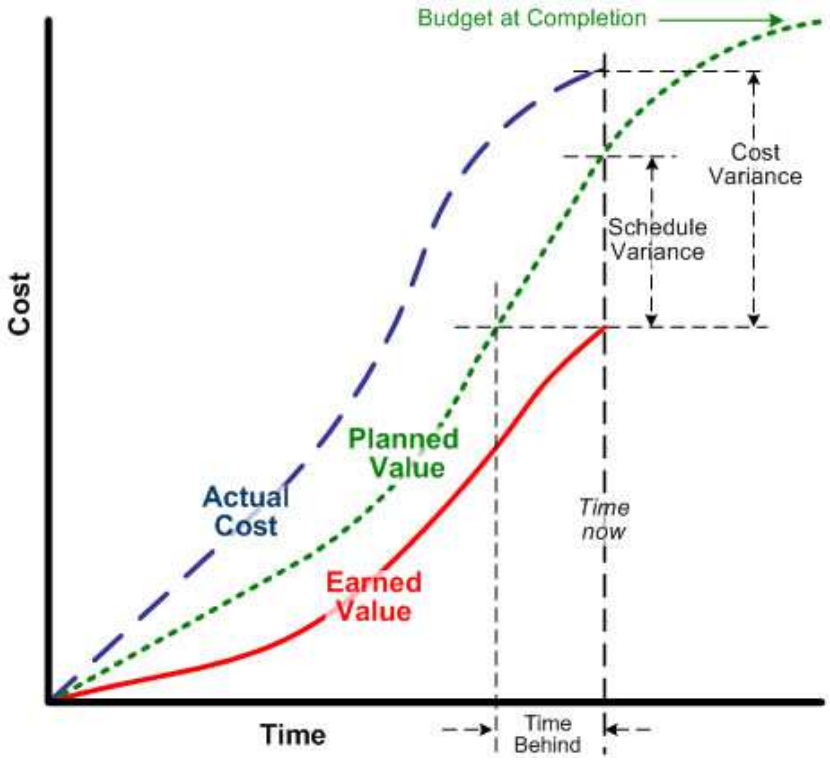


Image 17: Earned Value Analysis chart

EARNED VALUE VARIANCES	
COST VARIANCE (CV) = Earned Value (EV) – Actual Cost (AC)	> 0 means under budget < 0 means over budget
SCHEDULE VARIANCE (SV) = Earned Value (EV) – Planned Value (PV)	> 0 means ahead of schedule < 0 means behind schedule

Table 3: Evaluation of the Earned Value analysis

8.3. OUTPUTS TO PROJECT RISK MONITORING AND CONTROL

There are two main outcomes from risk monitoring project phase.

a) Corrective action – it consists primarily of performing the planned risk response (e.g., implementing contingency plans or workarounds). *(PMBoK, 2013)*

b) Updates to risk management plan – as anticipated risk events occur or fail to occur, and as actual risk event effects are evaluated, estimates of probabilities and value should be updated. *(PMBoK, 2013)*

c) Project change requests – implementing contingency plans or workarounds frequently results in a requirement to change the project plan to respond to risks. The result is issuance of an updated Project Management Plan that is managed by overall change control. *(Al Khalil, 2010)*

9. RISK MANAGEMENT PERFORMED ON REAL PROJECTS

9.1. PROJECT No. 1 – DRTINOVA 22

The first project I am going to use for the purpose to show how to use risk management in practice is reconstruction of a historical building located at Smíchov, Prague. This building was built in 19th century and in 2001 was bought by a developer group called Medusa s.r.o. The purpose was to renovate all 14 units for sale. Old tenants were paid off and two year reconstruction was ready to begin. Estimated cost of the renovation was 50 million CZK.

Nowadays, the reconstruction is nearly finished and units are slowly been sold. There has been many problems and also cost and time overruns during the project lifecycle. For the purpose of this thesis I will go back in time and try to perform a risk analysis, which could help eliminate these problems. With this first project I will use very detailed but maybe a little bit lengthy form of analysis. This kind of analysis would be probably performed for academic purposes (as for this thesis) or with bigger projects, where risk management is a standalone discipline performed with team of specialists (in this case it would probably go even deeper and more detailed).

Image 18: Refurbished building on Drtinova 22, Prague 5

9.1.1. PROJECT CONTEXT

A typical Project Risk Management Strategy includes the following processes *(PMI, 2013):*

a) Identification of Stakeholders – it is a process of identifying people, groups and organizations that could impact or be impacted by decisions, activities or outcomes of the project. The process also analyses and documents relevant information regarding each stakeholder interests, involvement, interdependencies, influence and potential impact on project success.

b) Identify Risks – the process of determining which risks may affect the project and documenting their characteristics. A prime characteristic of a risk would be the impact (or effect) of an event relating to that risk when occurs.

c) Perform Risk Analysis (Qualitative & Quantitative) – Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and the impact the risk would cause.

d) Plan Risk Responses (or Risk Management Strategy) – the process of developing options and actions to reduce threats to project objectives.

e) Control Risk (or Risk Treatment Plan and Controls) – the process of implementing risk response plans, cracking identified risks, monitoring residual risks (from treated risks), identifying new risks and evaluating risk process effectiveness throughout the project.

9.1.2. IDENTIFICATION OF STAKEHOLDERS

In the table below you can find stakeholders and their responsibilities towards the project.

STAKEHOLDER	DESCRIPTION	RESPONSIBILITIES
Owner	Medusa s.r.o.	Manages financing of the project
Project Manager	Project Manager CBRE s.r.o.	Manage all aspects of the project, represents the owner's interests
Project Management Team	Project team CBRE s.r.o.	Provides support to PM
Design team	Designing studio CEDE s.r.o.	Provides technical documentation and controls whether the project is constructed according to the design
Contractor Company	STROVAL s.r.o.	Guarantees delivery of the project in certain time and quality
Contractor Project Team	Project team STROVAL s.r.o.	Manages all aspects of the project from the contractor's perspective
Subcontractors	Subcontractors of Construction Company	Perform works in certain time and quality
Suppliers	Suppliers of Construction Company	Deliver goods in certain time and quality
Construction Authority	Czech Construction Authority in Prague	Checks whether the design and technical features of the project fulfill Czech Construction Law
Antiquities Authority	Czech Antiquities Authority in Prague	Controls whether the construction fulfill the Antiquities laws and standards
Environment Authority	Czech Environment Authority in Prague	Controls whether the construction fulfill the Environment laws and standards
Hygiene Authority	Czech Hygiene Authority in Prague	Controls whether the construction fulfill the Hygiene laws and standards
Fire protection Authority	Czech Fire Protection Authority in Prague	Controls whether the construction fulfill the Fire Protection laws and standards
Safety Authority	Czech Safety Authority	Controls whether the construction fulfill the Czech Safety standards
Owners of neighboring plots	Owners of neighboring properties	Agree or disagree with the project
Owners of existing flats	Inhabitants of the reconstructed building	Agree or disagree with the project

Table 4: Stakeholder identification

9.1.3. RISK IDENTIFICATION

The table below contains risks that should be considered before, during and after the project has finished. For purposes of this thesis I used the risk categorization according to Miller and Lessard. *(Klemetti, 2006)*

ID	RISK	RISK BEARER	DESCRIPTION
ENVIRONMENTAL RISKS			
1	Environmental analysis incomplete	CBRE, Czech Environmental Authority in Prague	CEA in Prague is not able to hand out needed permissions
2	Availability of project data and mapping at the beginning of the environmental study is insufficient	CBRE, Czech Environmental Authority in Prague	CEA in Prague is not able to hand out needed permissions
3	New alternatives required to avoid, mitigate or minimize impact	CBRE, Czech Environmental Authority in Prague	Alternatives have to be thought through and their effect on environment has to be mitigated
4	Design changes require additional Environmental analysis	CEDE studio	In order to legalize the project, new proposal needs to be submitted to CEA in Prague
5	Environmental regulations change	Czech Environmental Authority in Prague	Project delay, possible project scope changes
6	Unanticipated noise impacts	STROVAL	Loud works need to be mitigated or done in certain day periods
EXTERNAL RISKS			
7	Flat owners unwilling to sell	Inhabitants of existing flats	Due to negotiation with the owners the project can become enormously delayed
8	Local communities pose objections	Owners of neighboring plots	Building permits could never be released
9	Unreasonably high expectations from stakeholders	MEDUSA	Stresses the whole project organization, project will not meet the objectives
10	Stakeholders request late changes	MEDUSA	Project scope changes, probably will cause project delay
11	New stakeholders emerge and request changes	Greater forces	Project scope changes, probably will cause project delay
12	Threat of lawsuits towards owners	Inhabitant of existing flats, owners of neighboring plots,	Project delay, additional cost

		STROVAL	
13	Increase in material cost due to market forces	Greater forces	Project cost increases
14	New permits or additional information required	Czech Authorities	Project delay
15	Permits or agency actions delayed or take longer than expected	Czech Authorities	Project delay
16	Pressure to deliver project on an accelerated schedule	MEDUSA	Stresses the whole project organization, project will not meet the objectives
17	Unsuitable weather conditions	Greater forces	Project delay
18	Low demand of new apartments in the area	MEDUSA	Revenues lower than expected
19	Bad connection to the public transport, parking possibilities	MEDUSA	Low demand for the renovated apartments
DESIGN RISKS			
20	Design incomplete	CEDE studio	Execution phase cannot start
21	Inaccurate assumptions on technical issues in planning stage	CEDE studio	Defects will be discovered during the construction works
22	Surveys incomplete	CEDE studio	Project design cannot be completed
23	Unresolved constructability items	CEDE studio	Need of more information, expert judgment, project delay
24	Complex hydraulic features	CEDE studio	Complex design of the substructure, project delay
25	Incomplete quantity estimates	CEDE studio	Extra works, resources = extra cost
26	Insufficient bearing capacity of the existing foundations	CEDE studio, STROVAL	Expensive renovation procedures, project delay
27	Insufficient bearing capacity of the load-carrying elements (walls, lintels)	CEDE studio, STROVAL	Expensive renovation procedures, project delay
28	New or revised design standard	Czech Authorities	Changes in project documentation, project delay
CONSTRUCTION RISKS			
29	Inaccurate construction time estimates	CBRE, STROVAL	Project delays, fines
30	Permit work window time is insufficient	CBRE	Execution phase is delayed
31	Change requests due to differing site conditions	STROVAL	Contract adjustment
32	Construction or pile driving noise and vibration impacting adjacent businesses or residents	STROVAL	Construction works could be paused by the Authorities

33	Street or ramp closures not coordinated with local community	STROVAL, Czech Authorities	Complication with waste moving, delivery of resources
34	Insufficient or limited construction or staging areas	STROVAL, Czech Authorities	Complication with waste moving, delivery of resources
35	Changes during construction require additional coordination with resource agencies	CBRE, Czech Authorities	Due to the review periods it could cause a project delay
36	Long lead time for utilities caused by design and manufacture of special components (e.g. special pipe)	Subcontractors	Project delay, extra cost
37	Unexpected extra works	STROVAL, CEDE studio	Extra works, resources = extra cost
38	Poor work quality according to Czech construction law	STROVAL, Subcontractors	Defects reparation on contractor's cost, project delay
39	Unexpected occurrence of wiring	STROVAL, CEDE studio	Extra works, resources = extra cost
40	Big amount of unremoved defects	STROVAL, Subcontractors	Defects reparation on contractor's cost, project delay
41	Problems in achieving planned certifications for the building	CEDE studio, STROVAL	Fines, defects reparations
42	Problems with subcontractors coordination	STROVAL, CBRE	Fines for the contractor
43	Insufficient onsite safety	STROVAL	Fines for the contractor
PROJECT MANAGEMENT RISKS			
44	Insufficient time for project preparation	MEDUSA, CBRE	Inaccurate estimation, poor planning
45	Project scope definition is incomplete	CBRE	Project might not meet its objectives
46	Project scope, schedule, objectives, cost, and deliverables are not clearly defined or understood	MEDUSA, CBRE	Project might not meet its objectives in time and expected quality
47	Estimating and/or scheduling errors	CBRE	Project might not meet its objectives in time
48	Lack of coordination/communication	CBRE	Could cause more problems
49	Underestimated support resources or overly optimistic delivery schedule	CBRE, STROVAL	Project might not meet its objectives in time
50	Scope creep	CBRE, MEDUSA	Project might not meet its objectives in time
51	Unresolved project conflicts not escalated in a timely manner	CBRE	Conflicts could grow bigger, trustworthy of PM in owner's point of view

52	Delay in earlier project phases jeopardizes ability to meet programmed delivery commitment	CBRE	Project delay
53	Inconsistent cost, time, scope, and quality objectives	CBRE	Difficulties meeting project's objectives
54	Type of the contract (DB, DBB, CM)	MEDUSA	Different responsibility and risk mitigation
55	Contract conditions (fines, due dates)	CBRE	Protection of the owner
56	Former experiences with the contractor	CBRE	Critical factor during the tendering process
57	Amount of the retention bond	CBRE	Protection of the owner in case of significant amount of defects
ORGANIZATIONAL RISKS			
58	Inexperienced staff assigned	CBRE	Mistakes that would not appear usually
59	Length of warranty	STROVAL	Protection of the owner
60	Invoice payments periods	MEDUSA	Could cause extra cost when owner is not able to pay on time
61	Unanticipated project manager workload	CBRE	Unforced mistakes, poor planning
62	Funding changes for fiscal year	MEDUSA	Insufficient funds for the project
63	Labor shortage or strike	STROVAL	Project delay, financial impact to the contractor
64	Losing critical staff at crucial point of the project	CBRE, STROVAL	Risk of transferring responsibilities to another person
65	Financial situation of the contractor	STROVAL	Critical factor during the tendering process
66	The height of the bank warranty	STROVAL	Critical factor during the tendering process
67	Contractor leaves the project early (unfinished project)	STROVAL	Contractor is in insolvency
68	Insurance of the construction company	STROVAL	Critical factor during the tendering process
69	Insurance of the designer	CEDE studio	Critical factor during the tendering process

Table 5: Risks Identification

9.1.4. RISK QUALITATIVE ASSESSMENT

For qualitative risk assessment I used the Risk Matrix – Risk Likelihood vs. Impact. Likelihood of the risk occurrence is divided into categories of unlikely, likely and very likely. Risk impact is divided into categories of minor, moderate and major. According to these two factors the overall assessment has been divided into following categories: very low, low, medium, high and extreme.

Descriptions of each category are stated below: *(Clark, 2009)*

Impact levels:

Minor – should the event occur there would be minor interruption to operations e.g. temporary loss of data without which the business could continue to function, and/or minor cost, and/or minor amounts of confidential information falling into the wrong hands.

Moderate - should the event occur there would be significant interruption to business operations e.g. permanent loss of data with which the business could continue to function, and/or significant cost, and/or considerable amounts of confidential information falling into the wrong hands.

Major - Should the event occur there would be major interruption to business operations e.g. permanent loss of data with which the business could not continue to function, and/or major cost, and/or significant amounts of confidential information falling into the wrong hands.

Likelihood levels:

Unlikely – it is unlikely that the event could occur

Likely – it is likely that the event could occur

Very likely – it is very likely that the event could occur

Assessment levels:

Low – risks that will cause minimal impact to the project

Medium – risks that will cause moderate damage to the project

High – risks that will impact the project heavily but may not end the project

Extreme – risks that will greatly impact the project with a possibility to end the project

ID	RISK	LIKELIHOOD	IMPACT	OVERALL RISK ASSESSMENT
ENVIRONMENTAL RISKS				
1	Environmental analysis incomplete	Likely	Minor	Low
2	Availability of project data and mapping at the beginning of the environmental study is insufficient	Unlikely	Minor	Very low
3	New alternatives required to avoid, mitigate or minimize impact	Unlikely	Moderate	Low
4	Design changes require additional Environmental analysis	Likely	Major	High
5	Environmental regulations change	Unlikely	Moderate	Low
6	Unanticipated noise impacts	Very likely	Moderate	High
EXTERNAL RISKS				
7	Flat owners unwilling to sell	Likely	Major	High
8	Local communities pose objections	Unlikely	Moderate	Low
9	Unreasonably high expectations from stakeholders	Unlikely	Moderate	Low
10	Stakeholders request late changes	Likely	Moderate	Medium
11	New stakeholders emerge	Unlikely	Minor	Very low

	and request changes			
12	Threat of lawsuits towards owners	Unlikely	Major	Medium
13	Increase in material cost due to market forces	Likely	Major	Extreme
14	New permits or additional information required	Unlikely	Major	Medium
15	Permits or agency actions delayed or take longer than expected	Likely	Moderate	Medium
16	Pressure to deliver project on an accelerated schedule	Likely	Major	High
17	Unsuitable weather conditions	Very likely	Moderate	High
18	Low demand of new apartments in the area	Unlikely	Major	Medium
19	Bad connection to the public transport, parking possibilities	Unlikely	Minor	Very low
DESIGN RISKS				
20	Design incomplete	Likely	Moderate	Medium
21	Inaccurate assumptions on technical issues in planning stage	Very likely	Major	Extreme
22	Surveys incomplete	Unlikely	Moderate	Low
23	Unresolved constructability items	Unlikely	Moderate	Low
24	Complex hydraulic features	Very likely	Moderate	High
25	Incomplete quantity estimates	Likely	Moderate	Medium
26	Insufficient bearing capacity of the existing foundations	Unlikely	Major	Medium
27	Insufficient bearing capacity of the load-carrying elements (walls, lintels)	Likely	Major	High
28	New or revised design standard	Unlikely	Minor	Very low
CONSTRUCTION RISKS				
29	Inaccurate construction time estimates	Likely	Moderate	Medium
30	Permit work window time is insufficient	Likely	Minor	Low
31	Change requests due to differing site conditions	Unlikely	Minor	Very low

32	Construction or pile driving noise and vibration impacting adjacent businesses or residents	Likely	Minor	Low
33	Street or ramp closures not coordinated with local community	Unlikely	Minor	Very low
34	Insufficient or limited construction or staging areas	Unlikely	Minor	Very low
35	Changes during construction require additional coordination with resource agencies	Likely	Moderate	Medium
36	Long lead time for utilities caused by design and manufacture of special components (e.g. special pipe)	Likely	Moderate	Medium
37	Unexpected extra works	Very likely	Moderate	High
38	Poor work quality according to Czech construction law	Likely	Moderate	Medium
39	Unexpected occurrence of wiring	Likely	Minor	Low
40	Big amount of unremoved defects	Very likely	Moderate	High
41	Problems in achieving planned certifications for the building	Unlikely	Moderate	Low
42	Problems with subcontractors coordination	Very likely	Major	Extreme
43	Insufficient onsite safety	Likely	Major	High
PROJECT MANAGEMENT RISKS				
44	Insufficient time for project preparation	Likely	Moderate	Medium
45	Project scope definition is incomplete	Unlikely	Moderate	Low
46	Project scope, schedule, objectives, cost, and deliverables are not clearly defined or understood	Likely	Moderate	Medium
47	Estimating and/or scheduling errors	Likely	Moderate	Medium
48	Lack of coordination/communication	Likely	Minor	Low

49	Underestimated support resources or overly optimistic delivery schedule	Unlikely	Major	Medium
50	Scope creep	Very likely	Major	Extreme
51	Unresolved project conflicts not escalated in a timely manner	Likely	Minor	Low
52	Delay in earlier project phases jeopardizes ability to meet programmed delivery commitment	Likely	Major	High
53	Inconsistent cost, time, scope, and quality objectives	Likely	Moderate	Medium
54	Type of the contract (DB, DBB, CM)	Unlikely	Moderate	Low
55	Inaccurate contract conditions (fines, due dates..)	Likely	Major	High
56	Former experiences with the contractor	Likely	Moderate	Medium
57	Amount of the retention bond	Unlikely	Moderate	Low
ORGANIZATIONAL RISKS				
58	Inexperienced staff assigned	Unlikely	Moderate	Low
59	Length of warranty	Unlikely	Minor	Very low
60	Invoice payments periods	Unlikely	Minor	Very low
61	Unanticipated project manager workload	Likely	Moderate	Medium
62	Funding changes for fiscal year	Unlikely	Minor	Very low
63	Labor shortage or strike	Unlikely	Major	Medium
64	Losing critical staff at crucial point of the project	Likely	Major	High
65	Financial situation of the contractor	Likely	Major	High
66	The height of the bank warranty	Unlikely	Moderate	Low
67	Contractor leaves the project early (unfinished project)	Very likely	Major	Extreme
68	Insurance of the construction company	Likely	Moderate	Medium
69	Insurance of the designer	Likely	Moderate	Medium

Table 6: Qualitative Risk Analysis

9.1.5. RISK QUANTITATIVE ASSESSMENT

As mentioned before, for the purposes of this risk analysis we will proceed with the quantitative assessment only with identified risks that we qualified to have great impact on the project outcome in case of occurrence. As a tool I will use the Expected Monetary Value technique (closely described in paragraph 5.2.2.).

The assessment will be performed in 3 steps: *(Hulett, 2010)*

a) Determining a risk impact – key part of the quantitative assessment. Different kind of risks has different kind of impact on the project. Determining the risk impact cost is one of the most difficult parts of risk analysis and requires a lot of experiences. Due to my lack of experience and confidence to perform this part of risk analysis I sought for help from my supervisor at work, Ing. Josef Hruška, PhD. Also I used some of our company contract conditions due to the fines used in real construction projects. Based on this information I conducted this assessment, usually related to the overall project cost.

b) Determining likelihood of risk occurrence – from previous part of risk analysis, the qualitative assessment, we already know that occurrence of all these risks is relatively high. In this part we will use a 0 to 1 assessment which is basically a percentage scale.

c) Determining the Expected Monetary Value of the risk occurrence – in this step we will simply multiply the risk cost with the percentage likelihood of occurrence by which we will gain the total of the weighted payoffs as predicted outcomes related to the risk occurrence.

ID	RISK	IMPACT (CZK)	LIKELIHOOD (0 – 1)	EXPECTED MONETARY VALUE (CZK)
1	Design changes require additional Environmental analysis	50 000 CZK	0,60	30 000 CZK
2	Unanticipated noise impacts	100 000 CZK	0,70	70 000 CZK
3	Flat owners unwilling to sell	1 500 000 CZK	0,30	450 000 CZK
4	Increase in material cost due to market forces	200 000 CZK	0,40	80 000 CZK
5	Unsuitable weather conditions	10 000 CZK/day	0,80	8 000 CZK/day
6	Inaccurate assumptions on technical issues in planning stage	5 000 000 CZK	0,15	750 000 CZK
7	Complex hydraulic features	1 500 000 CZK	0,30	450 000 CZK
8	Insufficient bearing capacity of the load-carrying elements (walls, lintels)	750 000 CZK	0,20	150 000 CZK
9	Unexpected extra works	2 500 000 CZK	0,60	1 500 000 CZK
11	Big amount of unremoved defects	10 000 CZK/defect	0,50	5 000 CZK/defect
12	Problems with subcontractors coordination	250 000 CZK	0,60	150 000 CZK
13	Insufficient onsite safety	1 500 000 CZK	0,50	750 000 CZK
14	Scope creep	500 000 CZK	0,50	250 000 CZK
15	Delay in earlier project phases jeopardizes ability to meet programmed delivery commitment	10 000 CZK/day	0,70	7 000 CZK/day
16	Inaccurate contract conditions (fines, due dates..)	750 000 CZK	0,30	225 000 CZK
17	Losing critical staff at crucial point of the project	100 000 CZK	0,20	20 000 CZK
18	Contractor leaves the project early (unfinished project)	7 500 000 CZK	0,15	1 125 000 CZK

Table 7: Quantitative Risk Analysis - EMV

9.1.6. RISK RESPONSE STRATEGIES AND CONTROL

Similarly as in previous part of this analysis, risk response strategies and risk control will be closely described only for risks with greater impact to the project outcomes. We will assume that all other risks will be observed, controlled and reevaluated during the whole project lifecycle. Which means that once the likelihood of their occurrence increases to the 'higher security' category, the project management team will perform more detailed analysis straight away.

ID	RISK	RISK RESPONSE STRATEGIES AND CONTROL
1	Design changes require additional Environmental analysis	ACCEPT: changes in stakeholders requirements are common thing, that way we should be prepared and have some extra time in the planning phase of the project to react and not to cause a project delay. REDUCE: we can reduce the likelihood and impact of additional design changes by organizing more coordination meetings with the stakeholders and also hiring a renowned design studio that can better understand the owner's needs.
2	Unanticipated noise impacts	TRANSFER: noisy works are part of the construction process, complaints can be mitigated by: notice to the neighbors about ongoing construction works, contract with the contractor including high fines for performing noisy works out of agreed hours of the day.
3	Flat owners unwilling to sell	REDUCE: occurrence of this risk would probably lead to protracted litigations (and also project delay), therefore better strategy would be to offer the owners a bigger purchase price.
4	Increase in material cost due to market forces	TRANSFER: the best way how to mitigate this risk is to transfer the responsibility to the general contractor, who will transfer the risk to other subcontractors and suppliers.
5	Unsuitable weather conditions	TRANSFER: unsuitable weather conditions should be specified in detail in the contract. The fines for project delay do not apply in case of project delay due to unsuitable weather conditions.
6	Inaccurate assumptions on technical issues in planning stage	REDUCE: due to the huge impact on the project, additional surveys and calculations should be made. Advisable are also extra consultations with experts from the field. TRANSFER: because of the high inscrutability in reconstruction projects, it is advisable to hire design studio with great

		insurance in case of unexpected defects.
7	Complex hydraulic features	REDUCE: due to the huge impact on the project, additional surveys and calculations should be made. Advisable are also extra consultations with experts from the field. TRANSFER: because of the high inscrutability in reconstruction projects, it is advisable to hire design studio with great insurance in case of unexpected defects.
8	Insufficient bearing capacity of the load-carrying elements (walls, lintels)	REDUCE: due to the huge impact on the project, additional surveys and calculations should be made. Advisable are also extra consultations with experts from the field. TRANSFER: because of the high inscrutability in reconstruction projects, it is advisable to hire design studio with great insurance in case of unexpected defects.
9	Unexpected extra works	REDUCE: extra works arise during the construction phase due to the unpredictability of the site, therefore the best way how to reduce their amount is to hire an experienced designer, provide him enough time for onsite exploration, provide available designs and documentation or perform enough surveys.
11	Big amount of unremoved defects	TRANSFER: defects are responsibility of the contractor, therefore there should be some fines for project delays and huge amount of defects in the contract. Also it is necessary to check for the defect throughout the construction phase so there are not so many defects detected during the hand over.
12	Problems with subcontractors coordination	TRANSFER: this risk is transferred to the contractor. It is completely up to the general contractor how many subcontractors will be used as long as the coordination is well managed. In case of project delay fines can apply.
13	Insufficient onsite safety	TRANSFER: onsite safety is the responsibility of the contractor. From project manager's point of view it is advisable to hire a safety inspector (BOZP) to keep an eye on following the safety procedures mentioned in the contract. In case of any safety breach high fines may apply. Special attention should be paid to training of all employees which will be present on the construction site. The contractor must have signed document from all employees that they were trained. Also, the contractor should prevent entrance of unauthorized people to the construction site.
14	Scope creep	REDUCE: scope creeps are usually a result of poor communication between stakeholders and project management team. We can reduce the likelihood and impact of additional design changes by organizing more coordination meetings with the stakeholders and also creating a well experienced project management team.
15	Delay in earlier project phases jeopardizes ability to	REDUCE: project management team should be prepared for unexpected changes causing delays in each project phase by

	meet programmed delivery commitment	creating reserves in time estimations. This way the whole project should not be delayed. Time estimation has to include all the waiting periods from Czech Authorities, technological breaks, delivery periods of material and resources of the contractor. On the other hand it takes a lot of experiences to do so.
16	Inaccurate contract conditions (fines, due dates..)	ELIMINATE: There are fines for breach of contract from both sides (owner/contractor). Fines for non-performance of contract etc. The fines are necessary part of the contract and they protect both sides. Also due dates stated in the contract should be agreed based on some kind of estimates and discussions between both signing parts.
17	Losing critical staff at crucial point of the project	REDUCE: the consequences of losing a critical member of the team during the project can be reduced by focusing on team work rather than individual work. Information and knowledge is better shared, therefore anyone can be more easily replaced. It is also advisable to record all the changes, requirements and procedures in construction journal and intern documents.
18	Contractor leaves the project early (unfinished project)	TRANSFER: for not finishing the project there are heavy fines for contractor in every kind of contract.

Table 8: Risk Response Strategies and Control

9.2. PROJECT No. 2 – ARBESOVA REZIDENCE

The second project I am going to use is also a reconstruction of historical building located at Smíchov, Prague. This building was built in 19th century as well and in 2005 was bought by a developer group called Hampshire s.r.o. The purpose was to renovate all 20 units for sale. This project took place at more or less same time as the Drtinova 22 reconstruction. Estimated cost of the renovation was 85 million CZK.

Nowadays, similarly to project no. 1, the reconstruction is nearly finished and units are being sold. There have also been some problems during the project lifecycle which is why I chose this project for the purposes of this thesis. In order to show also other ways how to perform a risk analysis, this time I will use a much briefer form. This kind of analysis consists of table of a few most important risks forming a well-arranged method which is very easy to control and reanalyze. Similar kind of analysis is usually performed while managing real projects, where risk management is part of the project management plan and there is not enough time to focus on risks and threats closely.

Image 19: Refurbished building Arbesova Residence, Prague 5

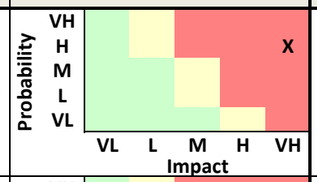
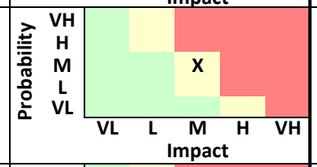
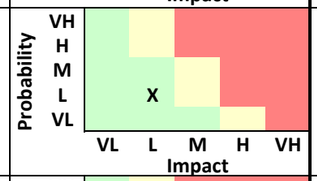
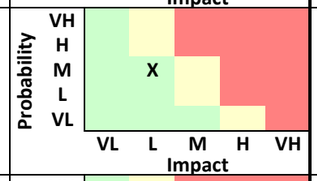
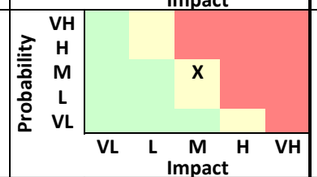
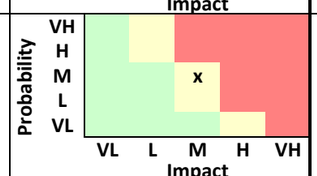
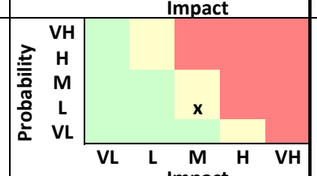
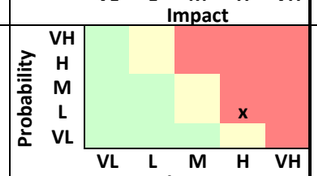
Risk Identification								Qualitative Risk Assessment			Risk Response Plan		Monitoring and Control		
#	Status	Risk Category	Risk Event	Cause	Effect	Threat or Opportunity	Primary Objective	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsibile Entity	Interval or Milestone Check	Status: Date and Review Comments
1	Active	External	Project not fully funded	Budget Constraints- allocation in doubt or subject to change	Project delayed	Threat	Time	High	Very High		Reduce	Project may be divided into 2or 3 phases with options in the contract	Project Manager	Monthly	
2	Active	Design	Inaccurate quantity estimate	Insufficient onsite exploration, design errors	Insufficient resources estimated	Threat	Cost	Medium	Medium		Transfer	Contract terms. It is designer's responsibility to make as many surveys as possible.	Designer	At completion of design proposal	
3	Active	Construction	Unidentified utility impacts	Unidentified utilities	Project cost increases	Threat	Cost	Low	Low		Transfer	Contingency plan. Contractor is responsible for coordination.	Utility Engineer	Monthly	
4	Active	External	Permit delays	Permits expire. Permits or agency actions are delayed or take longer then expected.	Fines, penalties and project delays	Threat	Time	Medium	Low		Transfer	Consultant reponsible for coordinating permits and identifying permit requirements.	Project Manager	Monthly	
5	Active	Construction	Differing site conditions	Unexpected geotechnical issues. Natural or manmade obstructions.	Increased project costs	Threat	Cost	Medium	Medium		Reduce	Thorough geotechnical investigations performed	Geotechnical Engineer	At completion of subsurface exploration	
6	Active	Project Management	Scope Creep	Unexpected change in project scope	Project cost and schedule affected	Threat	Scope	Medium	Medium		Reduce	More frequent stakeholders meeting	Project Manager	Monthly	
7	Active	Organization	Resource conflicts with other projects	Too many project running at one time	Not enough resources, project delays	Threat	Time	Low	Medium		Reduce	Contingency plan for insufficient resources	General Contractor	Monthly	
8	Active	Design	Inaccurate assumptions during the planning phase	Unidentified site conditions	Extra works, extra cost	Threat	Cost	Low	High		Eliminate	Extra survey performed during the planning phase	Designer	At completion of design proposal	

Table 9: Risk Management Register - Arbesova Rezidence

10. SUMMARY AND CONCLUSION

This Diploma thesis is about Risk Management in Historical Reconstructions. The purpose of this thesis was to prove the importance of performing risk analysis in construction industry.

The goal was to provide some theoretical knowledge and afterwards perform risk management on projects, which have been almost finished by this time. This way we are able to find out what would happen if planning, especially risk management plan, would be more detailed.

First eight chapters were focused on theoretical knowledge necessary to perform such an analysis.

First chapter, which is a general introduction to the issues covered in this paper, is followed by commenting on current situation in construction business in general.

Second chapter is focused on construction projects and their specific features. The basic theory of what defines a project, Triple constraint, is presented. Following is a description of each project phase that occurs in a typical construction project. It is the Feasibility, Design development, Construction, Commissioning and Handover. Mentioned are typical tasks and issues handled during each phase. Third part of this chapter is a description of most used project delivery methods. Mentioned are Design-Build (DB), Design-Bid-Build (DBB) and Construction Management (CM). Each method is also compared with others by advantages and disadvantages commenting on three basic constraints in project – time, cost, scope.

Following six chapters describe six steps of project analysis as I learned during my studies at University of Sydney. They are similar to division mentioned in PMBoK and I used the same structure also for the risk analysis of the first project.

First of them, the third chapter of this thesis, is about Stakeholder Identification. As possible tools and techniques to use are stated the Stakeholder Analysis, including identifying stakeholders impact and power, and Expert Judgement, which is used in less clear situations. The output should be a Stakeholder Register. Second part of this chapter is dedicated to Stakeholder Engagement Management, which is an important part of the stakeholder

analysis. It includes the ways how to communicate with each stakeholder to achieve the best possible understanding and trust, which is a key part of the relationship between project manager and stakeholder.

Fourth chapter is focused on Risk Identification. At the beginning there is description of how can be risks categorized according to multiple factors. There are also multiple tools and techniques how can be risks identified such as Assumption analysis, Diagramming techniques, Brainstorming or SWOT analysis. The output should be the Risk Register.

Following is the fifth chapter, Qualitative Risk Analysis. At the beginning there is a comparison of qualitative and quantitative technique, to prevent from any misunderstandings. Another important note is that there are not only threats to analyze but also opportunities to enhance. Among tools mentioned there is Risk Probability and Impact Assessment, Probability/Impact Risk Rating Matrix, Delphi Technique, Risk Quality Assessment and Risk Urgency Assessment. The output is either risk register simply updated by relative ranking of each risk or reshuffling risks according to their priority.

Sixth chapter is Quantitative analysis. There are multiple techniques to use, as an example I would mention various Financial tools such as Net Present Value (NPV) or Internal Rate of Return (IRR), Expected Monetary Value and Utility Theory. The output of this part should be list of risks and opportunities evaluated by either monetary values or some other scales.

Seventh chapter is focused on the Risk Response Strategies. In case of threats, there are usually four types of reaction to distinguish. Risks can be either accepted, reduced (mitigated), transferred or eliminated. On the other hand opportunities can be either exploited, shared or enhanced. Among tools to discover the right type of reaction I mentioned the Cost/Benefit Analysis, Procurement (which is an extra discipline by itself) and Contingency Planning. In the end of this phase each risk should have its response strategy assigned.

Last theoretical chapter, the Risk Monitoring and Control, describes how important it is to keep all the risks identified on track and control their development throughout the whole project lifecycle. Tools to use are Risk Reassessment, Workarounds and Reserve Analysis (Earned Value technique).

Finally I performed a complete Risk Analysis on two different projects, reconstructions of historical buildings in Prague City Centre. Both of these projects were delivered by Construction Management method.

First analysis followed the structure described in theoretical part of this thesis. At the beginning I identified 16 stakeholders involved in this project. After that I identified 69 risks which I qualified according to their likelihood of occurrence and impact into categories of Very low, Low, Medium, High and Extreme overall risk assessment. During the Quantitative part I narrowed the list up to risks with High or Extreme assessment and performed the Expected Monetary Value analysis. This step turned out to be tricky, it was very difficult for me to estimate possible risk impacts in monetary value, therefore I used professional experiences of my supervisor at CBRE, who kindly consulted this part with me. The outcome of this part is that the biggest threats for this particular project are unexpected extra works and early leaving of the general contractor. In the next step I determined a risk strategy with a particular actions to undertake for each of these risks. In reality, every risk would be furthermore continuously reassessed at regular meeting throughout the project and risk responses would be updated according to the actual development of the project.

For the second case study I used totally different form of risk analysis, the one I am used to use at work. It is very tabular and easy-to-orientate way of risk analysis. The analyses consisted of the same steps as described before, with the difference that there are only risks identified with great impact on the project.

If I had to compare assumptions towards the reality, there have been many problems during the execution phase of both projects. Both projects ended up costing more money and with a schedule delay. Mostly the problems originated from the planning and design preparation phase, when inaccurate estimates were made (such as quantity estimates of resources, construction work time estimates). Also during the construction, many issues were discovered onsite and new processes needed to be established, which means extra works and increased cost. Moreover, general contractor of the first project resigned before the project was finished. This issue continues up to this day, when lengthy lawsuit is being held. No one knows how significant is impact of this trial according to the cost estimates made in advance. From this point of view, it is more than obvious that more detailed risk analysis

would help to at least be prepared for such an incident (usually the second type of risk analysis counts only with risks seen in previous projects).

In conclusion, historical reconstructions are a specific field, where all stakeholders need to be cautious from the very beginning. As in other types of projects, crucial part is quality design including all the works necessary to undertake. Second crucial step is choosing a trustful general contractor, who is able to finish the construction in time and certain quality. From a project manager point of view, stakeholders should allow the project management team enough time for detailed planning, mainly to include the Risk Analysis in it, which is in my previous experiences often a significant problem. Risks are part of every project, not only historical reconstructions. Therefore we should always pay more attention to risk prevention rather than establish actions when risks occur.

11. BIBLIOGRAPHY

11.1. LIST OF LITERATURE

PMI Standards Committee, W. R. Duncan, 2013, *A Guide to the Project Management Body of Knowledge,* Automated Graphic Systems, USA

Frederik Pretorius, Paul Lejot, Arthur McInnis, Douglas Arner, Berry Fong-Chung Hsu, 2008, *Project Finance for Constructions and Infrastructure : Principles and Case Studies,* Blackwell Publishing Ltd, USA

Nigel J. Smith, Tony Merna, Paul Jobling, 2006, *Managing Risks In Construction Projects*, 2nd Edition, Blackwell Publishing Ltd, USA

Moorad Choudhry, 2006, *An Introduction To Value-at-Risk*, 4th Edition, John Wiley & Sons Ltd, England

Mahendra Piraveenan, 2014, *Lectures of Data Analytics for Project Management*, University of Sydney

Therese Linton, 2014, *Lectures of Critical Thinking and Systems Assessment*, University of Sydney

Michael Harré, 2014, *Lectures of Introduction to Project Finance,* University of Sydney

ONLINE SOURCES:

Danny Griffin, 2010, *Project Phases in the Construction Industry*, [ONLINE]

http://www.aiu.edu/publications/student/english/Project%20Management.html

Phil Rabinowitz, 2012, *Identifying and Analyzing Stakeholders and Their Interests*, [ONLINE]

http://ctb.ku.edu/en/table-of-contents/participation/encouraging-involvement/identify-stakeholders/main

Belinda Fremouw, 2011, *Qualitative Risk Analysis vs. Quantitative Risk Analysis (PMP Concept)*, [VIDEO]

https://www.youtube.com/watch?v=hx-r0sdp2wk

Mohammed Al Khalil, 2010, *Lectures of Project Risk Management*, [ONLINE]

http://faculty.kfupm.edu.sa/CEM/alkhalil/cem_516.htm

Lionel Galway, 2004, *Quantitative Risk Analysis for Project Management,* [ONLINE]

http://www.rand.org/content/dam/rand/pubs/working_papers/2004/RAND_WR112.pdf

Anna Klemetti, 2006, *Risk Management in Construction Project Networks*, [ONLINE]

http://lib.tkk.fi/Reports/2006/isbn9512281473.pdf

David Hulett, 2010, *Integrated Cost – Schedule Risk Analysis*, [ONLINE]

http://www.gowerpublishing.com/pdf/SamplePages/Integrated-Cost-Schedule-Risk-Analysis-CH1.pdf

Tyson Building Corporation, 2005, *Design-Build, Design-Bid-Build and Construction Management*, [ONLINE]

http://www.tysonbuilding.com/images/SelectingProjectDelivery.pdf

Aleš Tomek, 2011, *Základní charakteristiky smluv typu Design Build*, [ONLINE]

http://k126.fsv.cvut.cz/predmety/126mgt/mgt_design-build-doc.-tomek-.pdf

Anand VijayaKumar, 2013, *Identifying Risks*, [ONLINE]

http://getpmpcertified.blogspot.cz/2011/06/chapter-51-identifying-risks.html

Adrian Smith, 2011, Earned Value Management, [ONLINE]

http://www.chambers.com.au/glossary/earned_value_management.php

11.2. LIST OF IMAGES

Image 1: Therese Linton, 2014, Lecture of *Critical Thinking and System Assessment*, University of Sydney, [PDF SNAPSHOT]

Image 2: Image made by the author, 2014, Construction project phases

Image 3: Adrian Smith, 2011, Comparing Agile and Waterfall methods of Project Management, [ONLINE]

http://ennova.com.au/blog/2011/09/agile-lean-compared-applied-construction

Image 4: Daniel Davis, 2011, Discussions – Beyond tool making, [ONLINE]

http://www.danieldavis.com/thesis-ch8/

Image 5: Legislative Analyst's Office, 2003, Use of Design-Build for K-12 School Construction, [ONLINE]

http://www.lao.ca.gov/2003/design_build/102403_design_build.aspx

Image 6: Legislative Analyst's Office, 2003, Use of Design-Build for K-12 School Construction, [ONLINE]

http://www.lao.ca.gov/2003/design_build/102403_design_build.aspx

Image 7: Horne Construction, 2005, Construction Management, [ONLINE]

http://www.horneconst.com/services/constructionman.htm

Image 8: PMI Standards Committee, W. R. Duncan, 1996, *A Guide to the Project Management Body of Knowledge*

Image 9: J. Bryson, 1995, *Strategic Planning for Public and Nonprofit Organizations*, [ONLINE]

http://stakeholdermap.com/stakeholder-analysis.html

Image 10: COMINDWORK, 2014, *Work Productivity Tricks – Fishbone Diagram*, [ONLINE]

http://www.comindwork.com/weekly/2014-07-28/productivity/fishbone-diagram-Ishikawa

Image 11: Parkhurst Consulting CPA PC, 2012, *SWOT Analysis*, [ONLINE]

http://www.parkhurst-consulting.com/swot-analysis/

Image 12: Hugh Wycombe, 2007, Probability – impact assessment, [ONLINE]

http://www.praxisframework.org/library/probability-impact-assessment

Image 13: Kaplan Financial Knowledge Bank, 2013, *Discounted Cash Flow Techniques*, [ONLINE]

http://kfknowledgebank.kaplan.co.uk/KFKB/Wiki%20Pages/Discount%20cash%20flow%20techniques.aspx

Image 14: Anand VijayaKumar, 2013, *Decision Tree Analysis*, [ONLINE]

http://getpmpcertified.blogspot.com.es/2013/02/decision-tree-analysis.html

Image 15: Mahendra Piraveenan, 2014, Lectures of *Data Analytics for Project Management*, University of Sydney, [PDF SNAPSHOT]

Image 16: StatScorer, 2014, Risk and decision analysis using Monte Carlo simulations, [ONLINE]

http://www.statscorer.com/Examples/risk-project.php

Image 17: Adrian Smith, 2011, Earned Value Management, [ONLINE]

http://www.chambers.com.au/glossary/earned_value_management.php

Image 18: CBRE's archive, Reconstruction of Drtinova 22, Prague 5

Image 19: CBRE's archive, Reconstruction of Arbesova residence, Prague 5

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Table 9: Risk Management Register – Arbesova Rezidence, [MADE BY THE AUTHOR]

11.4. LIST OF SHORTCUTS

PM – Project Manager

PMBoK – Project Management Body of Knowledge

DB – Design Build

DBB – Design Bid Build

CM – Construction Management

ROI – Return on Investment

IRR – Internal Rate of Return

NPV – Net Present Value

PV – Planned Value

EV – Earned Value

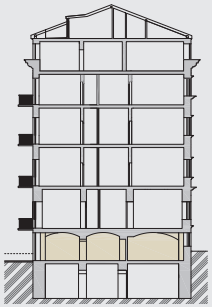
AC – Actual Cost

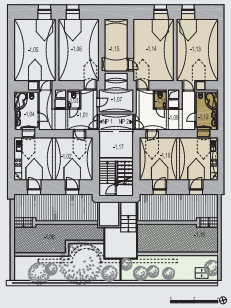
PMI – Project Management Institute

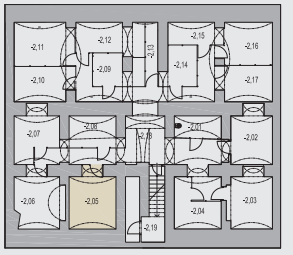
12. ANNEX

PART I. MARKETING PLANS OF DRTINOVA 22

Commercial Space 602



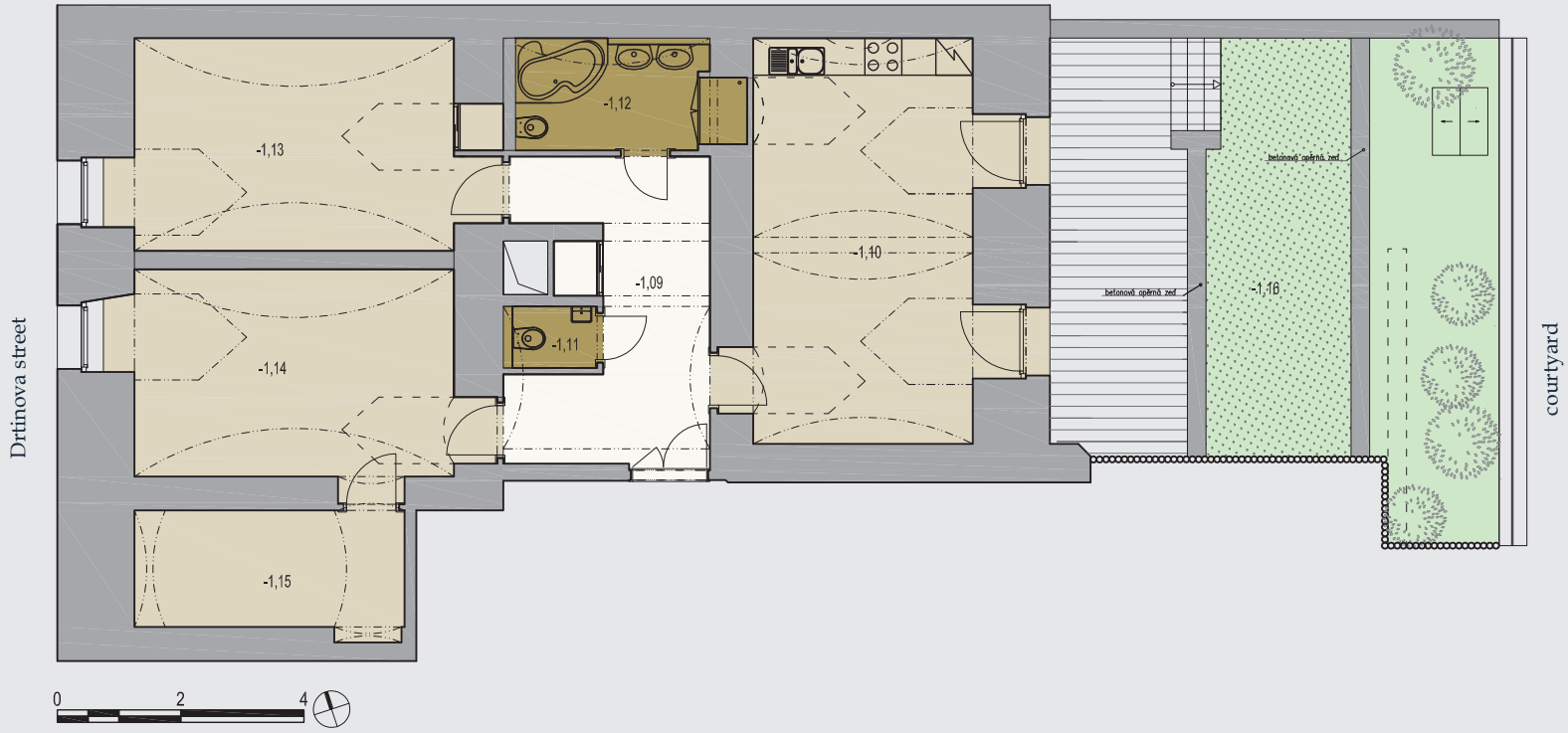




1st basement 3+k 104,90sqm

1.01	corridor	13,60sqm
1.02	office with kitchen	26,30sqm
1.03	WC	1,35sqm
1.04	bathroom	6,20sqm
1.05	office	18,45sqm
1.06	office	18,75sqm
1.07	storage	8,55sqm
2.05	cellar	11,70sqm
1.08	garden	51,90sqm

* Garden area is not included in the total area of units.

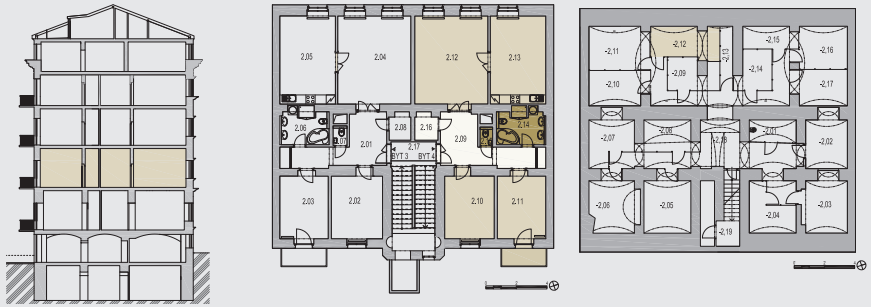


www.drtinova22.cz

Areas of individual rooms are to reference only.

CBRE s.r.o., nám,. Republiky 1a · 110 00 Praha 1 · **HOT-LINE 774 470 097** · info@drtinova22.cz · www.cbre.cz

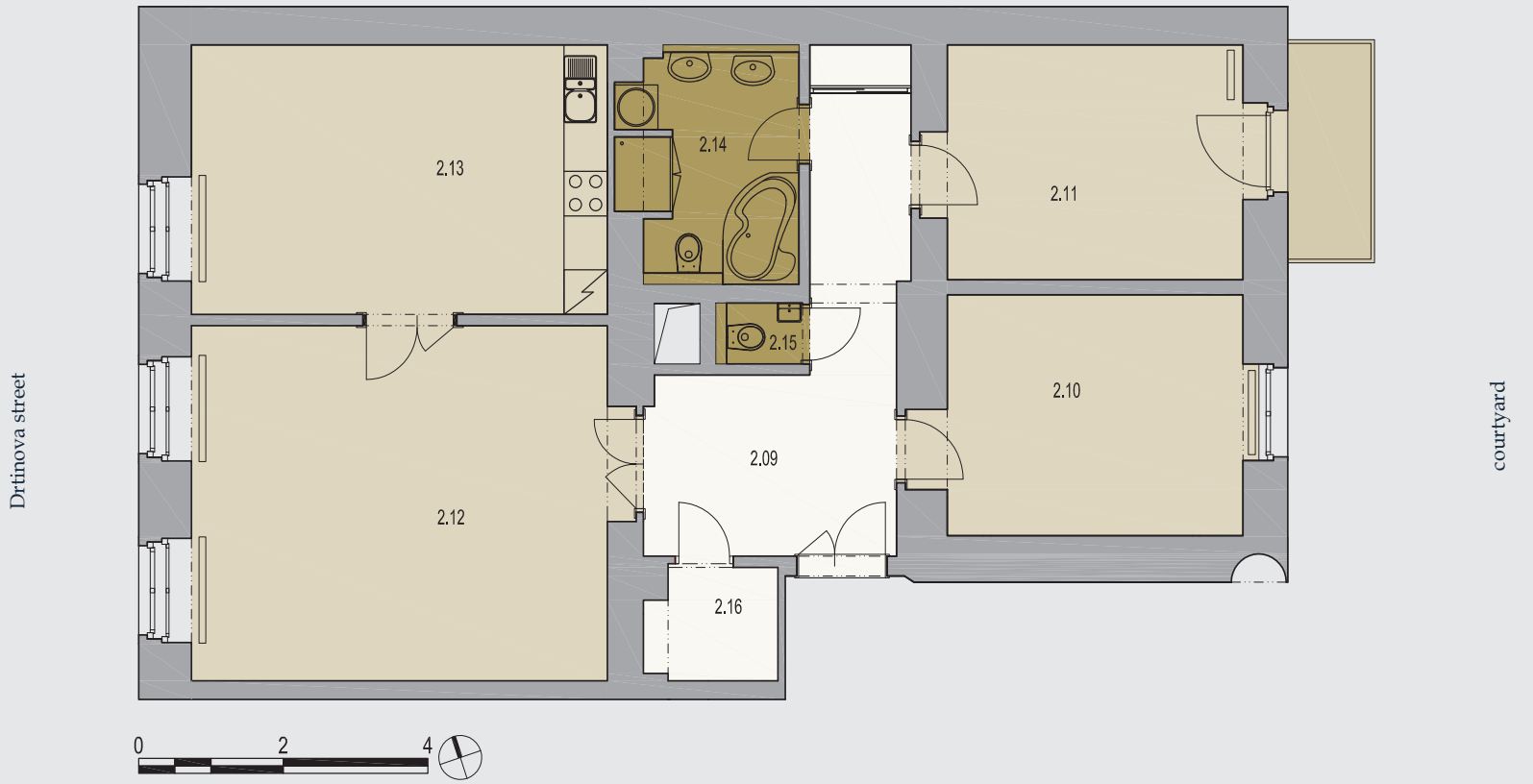
Apartment 204



2nd floor 3+1 110,15sqm

2.09	corridor	14,35sqm
2.10	room	13,85sqm
2.11	room	13,80sqm
2.12	room	28,10sqm
2.13	kitchen	20,85sqm
2.14	bathroom	7,10sqm
2.15	WC	0,85sqm
2.16	pantry	2,65sqm
2.12	cellar	8,60sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.

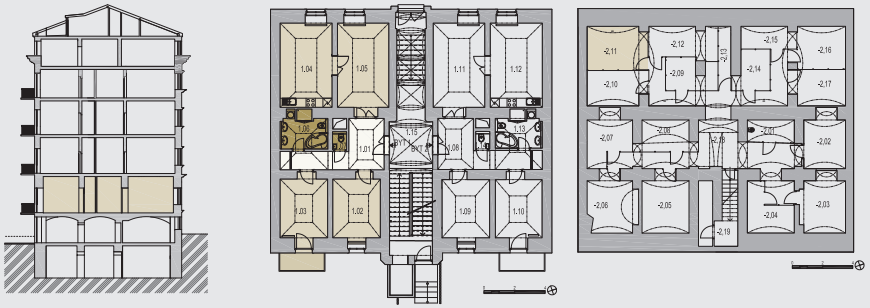


www.drtinova22.cz

Areas of individual rooms are to reference only.

CBRE s.r.o., nám,. Republiky 1a · 110 00 Praha 1 · **HOT-LINE 774 470 097** · info@drtinova22.cz · www.cbre.cz

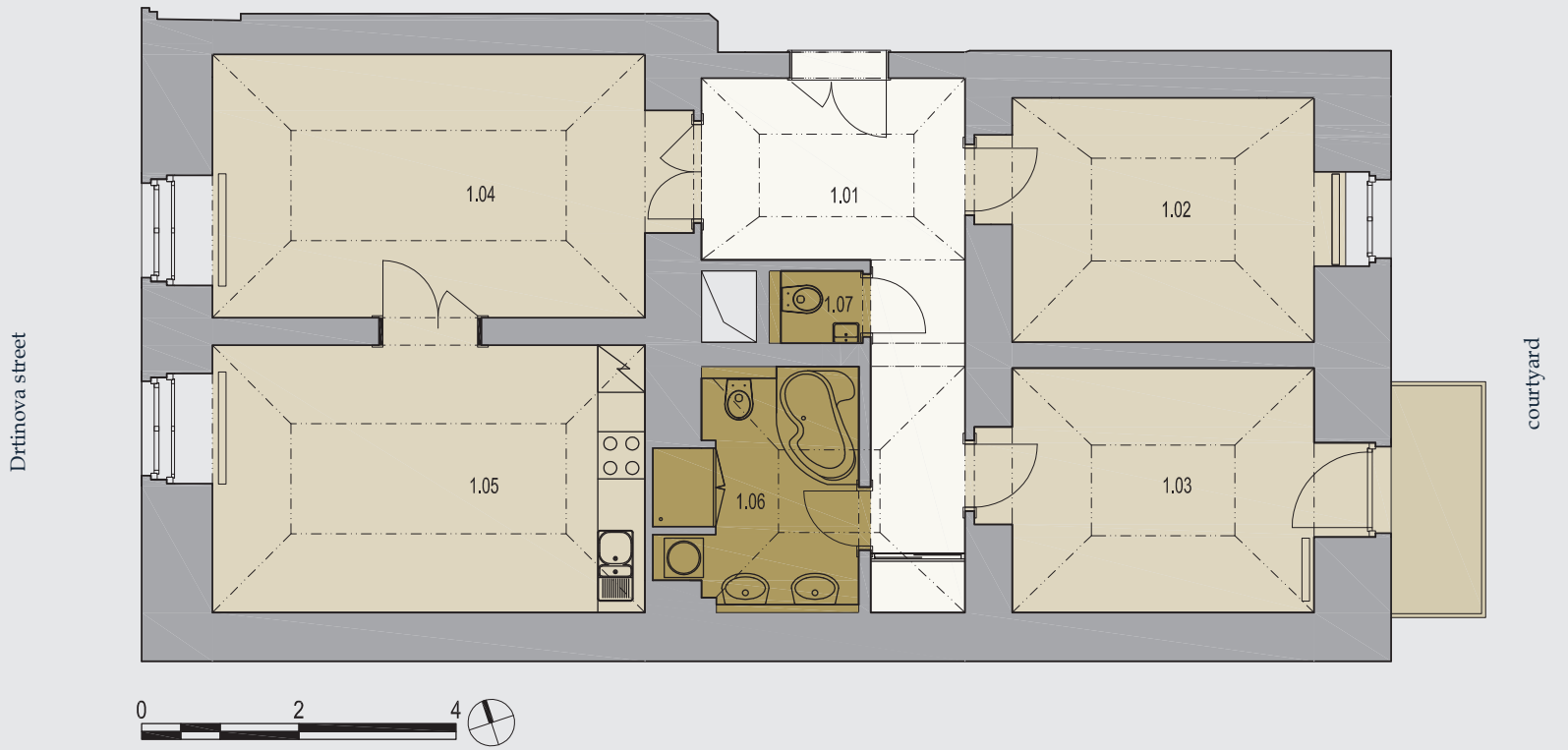
Apartment 101



1st floor 3+1 95,90sqm

1.01	corridor	13,00sqm
1.02	room	12,60sqm
1.03	room	13,30sqm
1.04	room	19,40sqm
1.05	kitchen	18,70sqm
1.06	bathroom	6,75sqm
1.07	WC	0,95sqm
2.11	cellar	11,20sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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Areas of individual rooms are to reference only.

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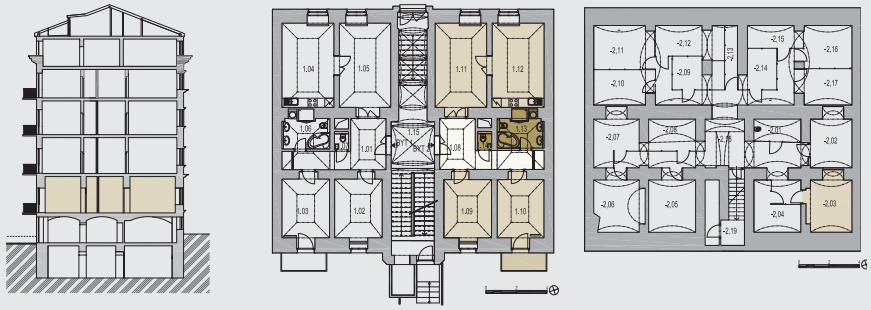
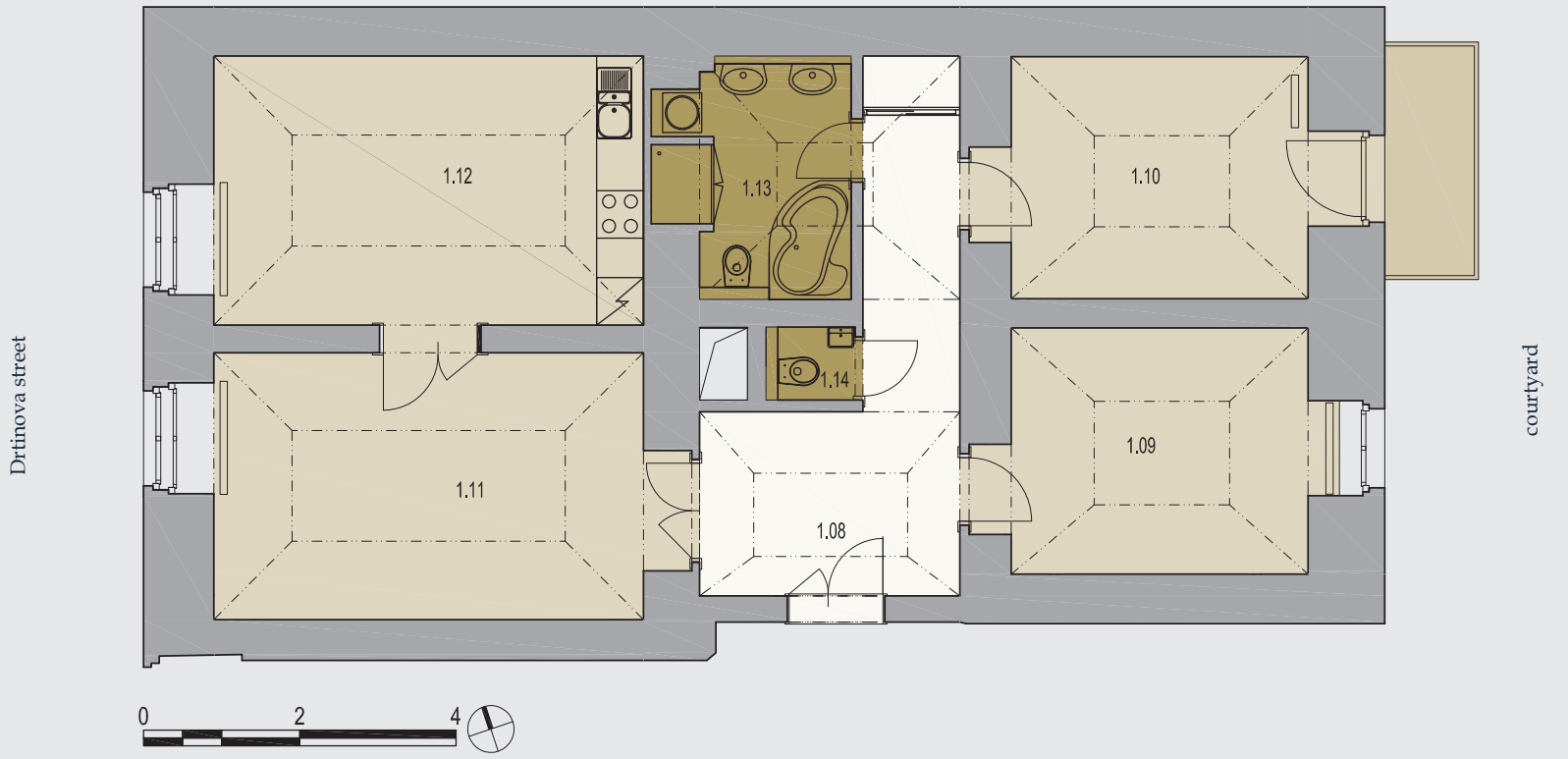
Apartment 102



1st floor 3+1 96,70sqm

1.08	corridor	13,30sqm
1.09	room	12,50sqm
1.10	room	13,10sqm
1.11	room	20,00sqm
1.12	kitchen	19,00sqm
1.13	bathroom	6,50sqm
1.14	WC	0,90sqm
2.03	cellar	11,40sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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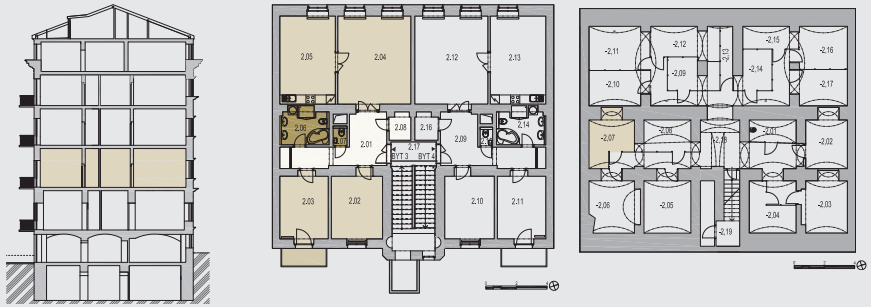
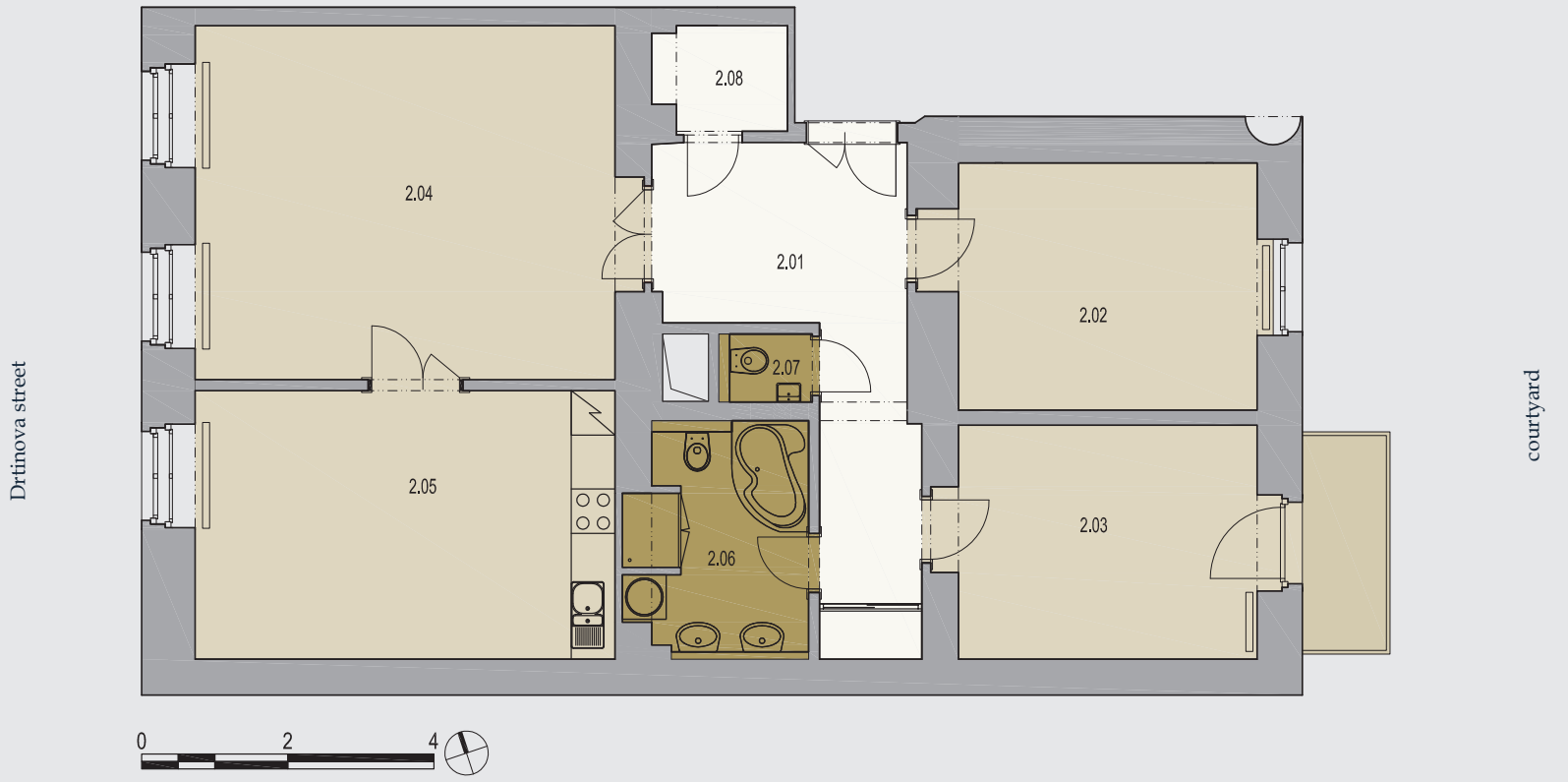
Apartment 203



2nd floor 3+1 110,75sqm

2.01	corridor	14,45sqm
2.02	room	14,35sqm
2.03	room	13,80sqm
2.04	room	28,10sqm
2.05	kitchen	20,85sqm
2.06	bathroom	7,00sqm
2.07	WC	1,05sqm
2.08	pantry	2,50sqm
2.07	cellar	8,65sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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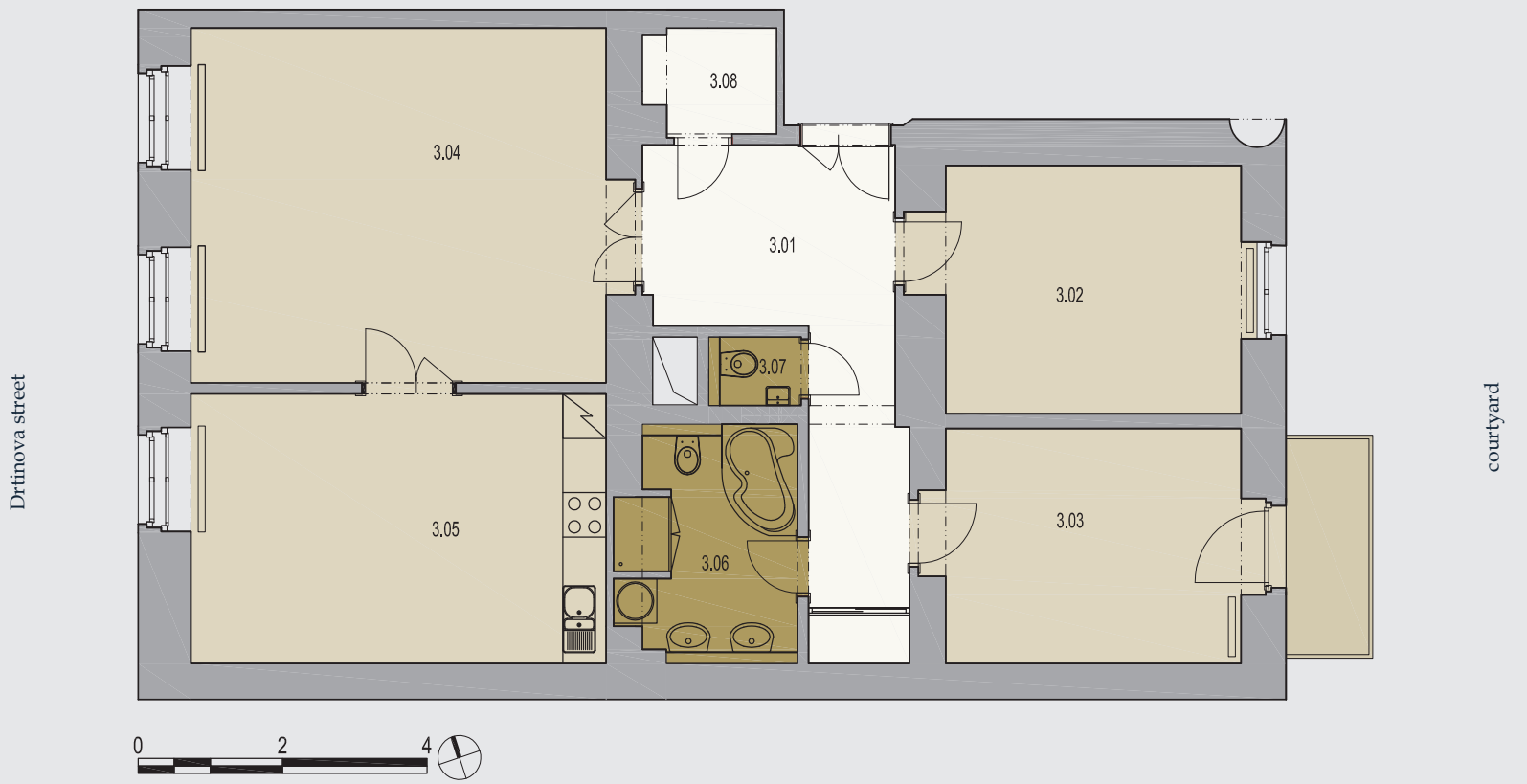
Apartment 305

3rd floor 3+1 110,65sqm

3.01	corridor	14,45sqm
3.02	room	14,35sqm
3.03	room	13,80sqm
3.04	room	28,10sqm
3.05	kitchen	20,85sqm
3.06	bathroom	7,00sqm
3.07	WC	1,05sqm
3.08	pantry	2,40sqm
2.10	cellar	8,65sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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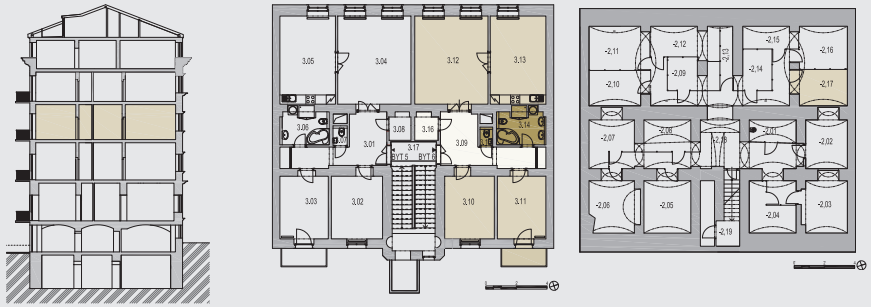
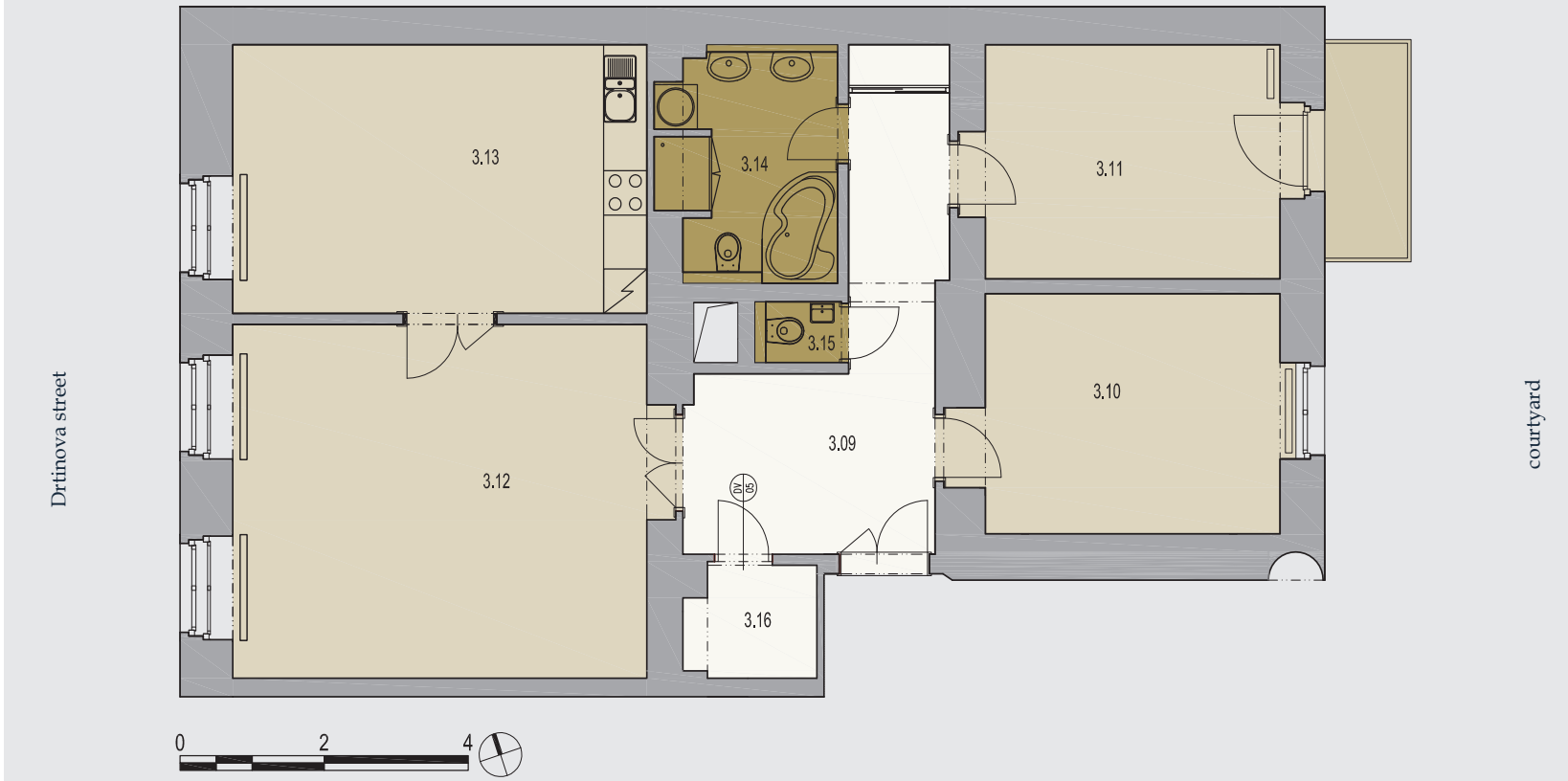
Apartment 306



3rd floor 3+1 110,00sqm

3.09	corridor	14,35sqm
3.10	room	13,90sqm
3.11	room	13,80sqm
3.12	room	28,10sqm
3.13	kitchen	20,85sqm
3.14	bathroom	7,10sqm
3.15	WC	0,85sqm
3.16	pantry	2,55sqm
2.17	cellar	8,50sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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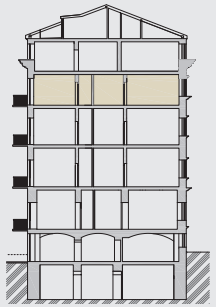
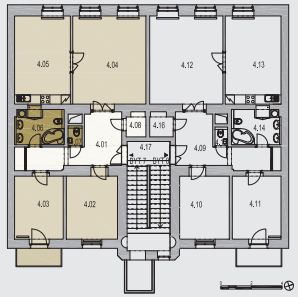
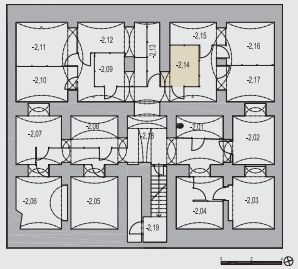
Apartment 407



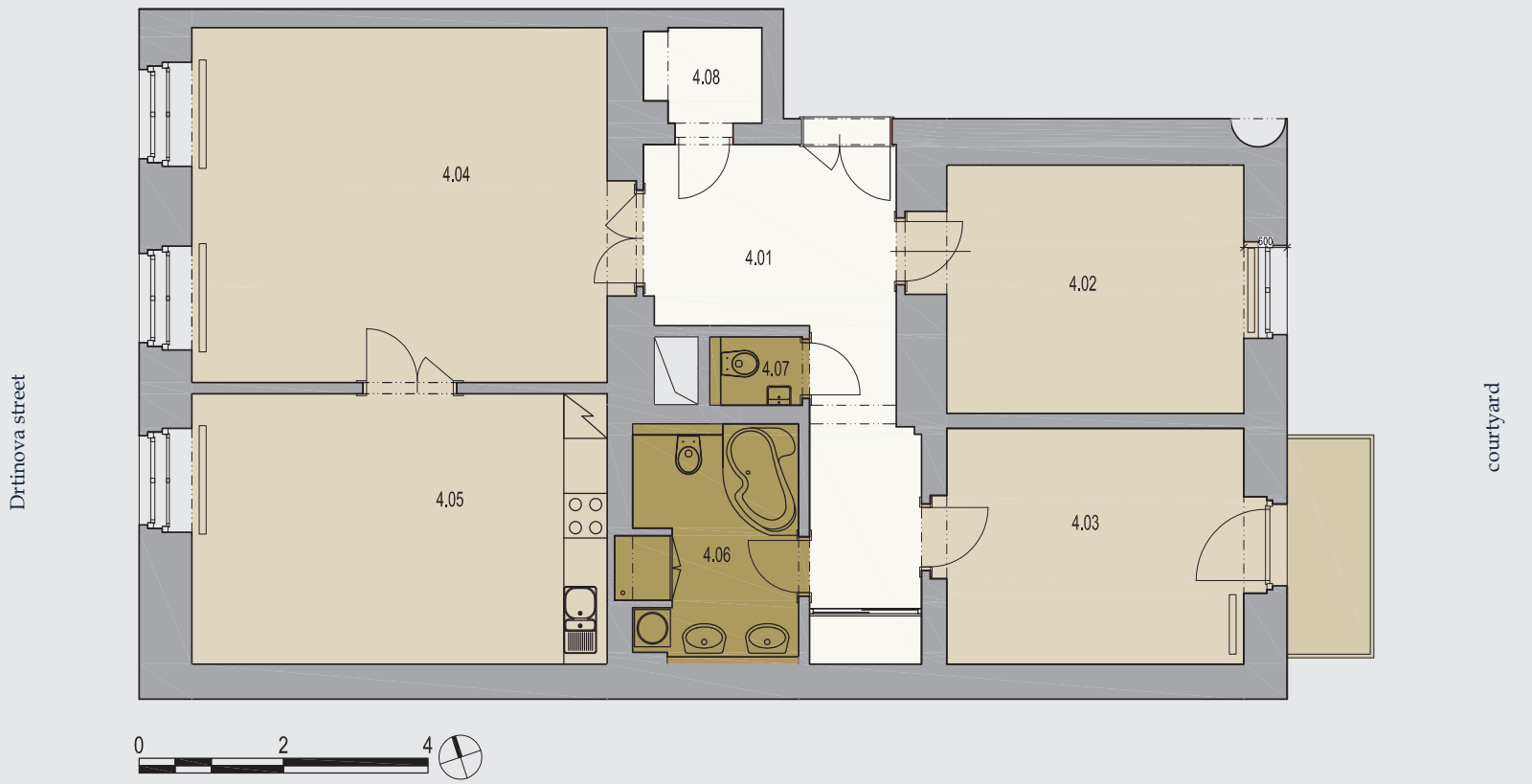




4th floor 3+1 108,00sqm

4.01	corridor	14,95sqm
4.02	room	14,35sqm
4.03	room	13,70sqm
4.04	room	28,30sqm
4.05	kitchen	20,95sqm
4.06	bathroom	7,10sqm
4.07	WC	1,05sqm
4.08	pantry	2,10sqm
2.14	cellar	5,50sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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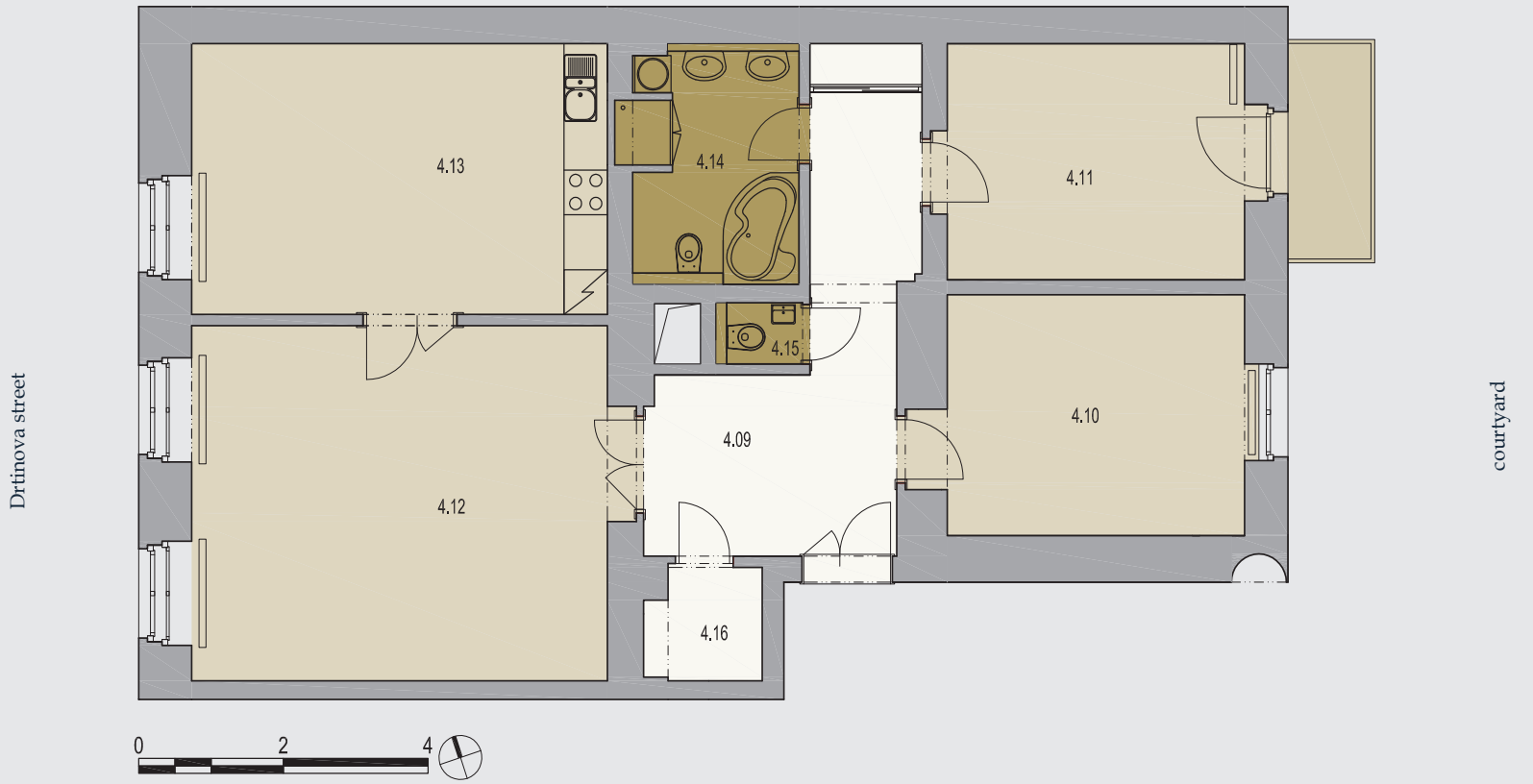
Apartment 408

4th floor 3+1 108,62sqm

4.09	corridor	15,67sqm
4.10	room	13,95sqm
4.11	room	13,70sqm
4.12	room	28,10sqm
4.13	kitchen	20,90sqm
4.14	bathroom	7,10sqm
4.15	WC	0,90sqm
4.16	pantry	2,40sqm
2.09	cellar	5,90sqm
*	balcony	2,60sqm

* Balcony area is not included in the total area of units.



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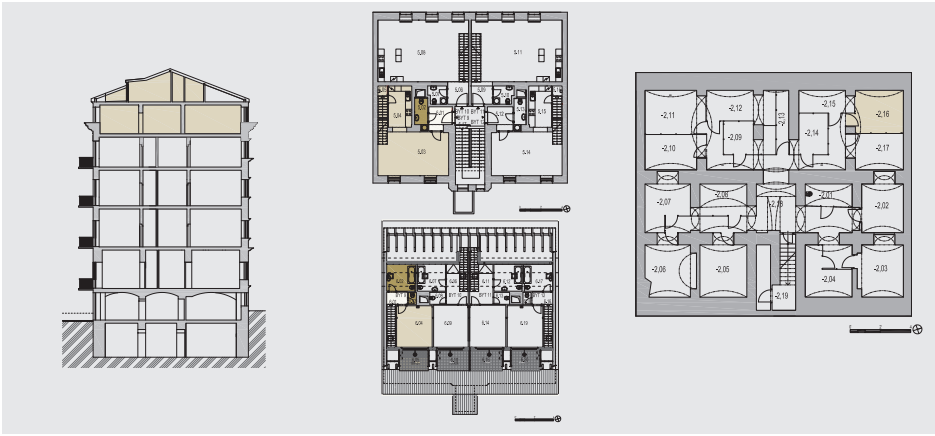
Apartment 509



Maisonette 2+k 87,60sqm

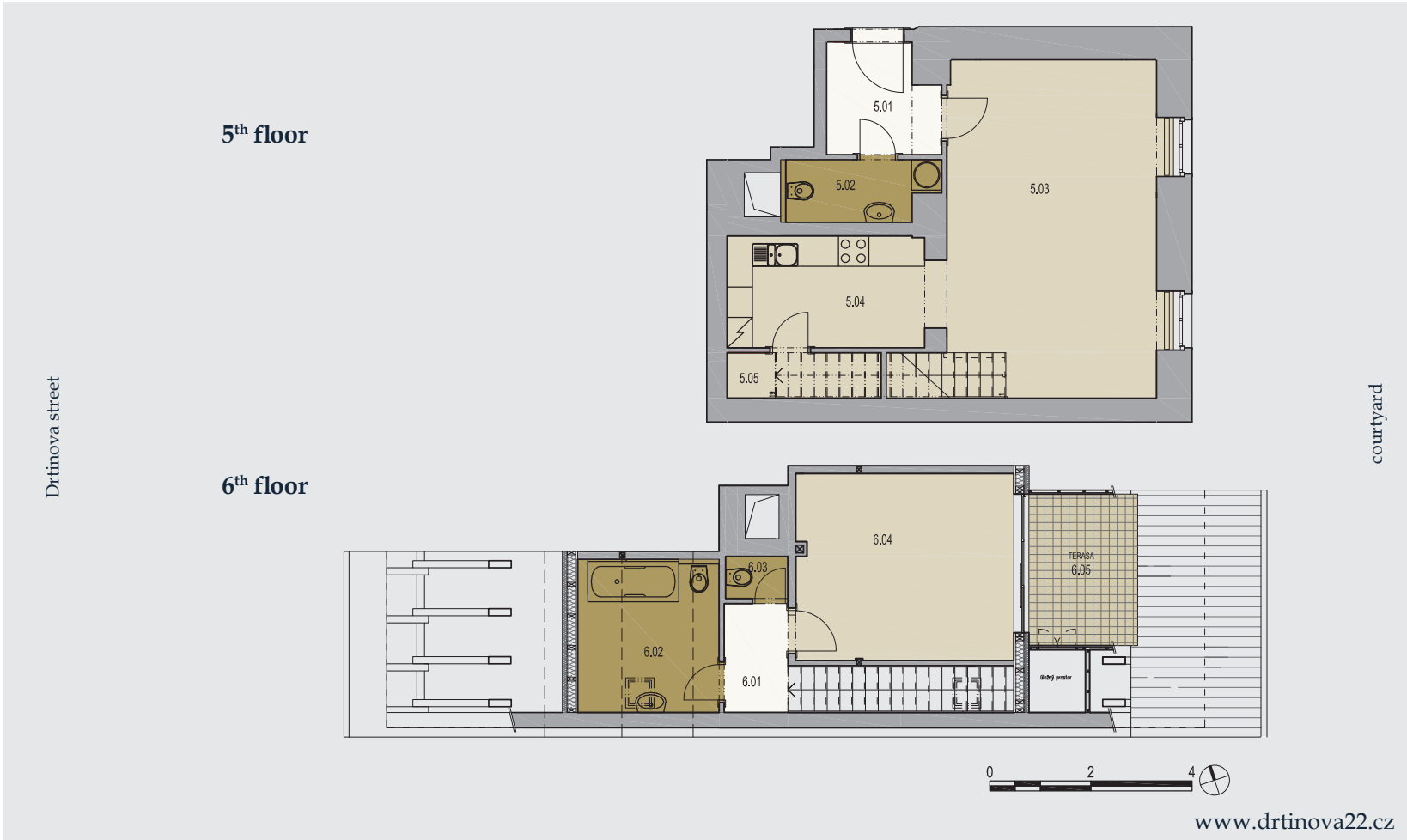
5th floor

5.01	corridor	4,60sqm
5.02	WC	3,35sqm
5.03	room	26,70sqm
5.04	kitchen	9,20sqm
5.05	pantry	2,70sqm

6th floor

6.01	corridor + staircase	6,60sqm
6.02	kitchen	8,40sqm
6.03	WC	1,05sqm
6.04	room	15,80sqm
2.16	cellar	9,20sqm
6.05	*terrace	6,45sqm

* Terrace area is not included in the total area of units.



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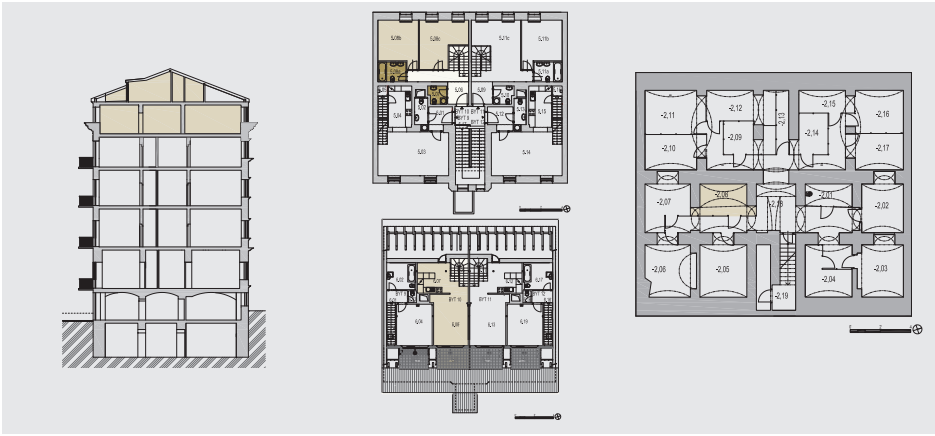
Apartment 510



Maisonette 3+k 101,09sqm

5th floor

5.06	corridor	14,96sqm
5.07	WC	2,86sqm
5.08a	bathroom	4,96sqm
5.08b	room	15,65sqm
5.08c	room	17,27sqm

6th floor

6.06	staircase	4,91sqm
6.07	kitchen	12,65sqm
6.08	room	15,20sqm
6.10	*terrace	7,48sqm
2.08	cellar	6,80sqm

* Terrace area is not included in the total area of units.

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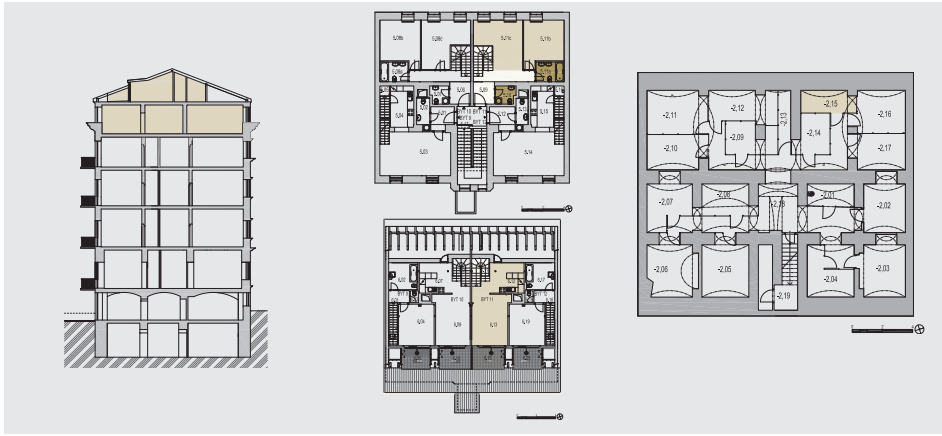
Apartment 511



Maisonette 3+k 101,78sqm

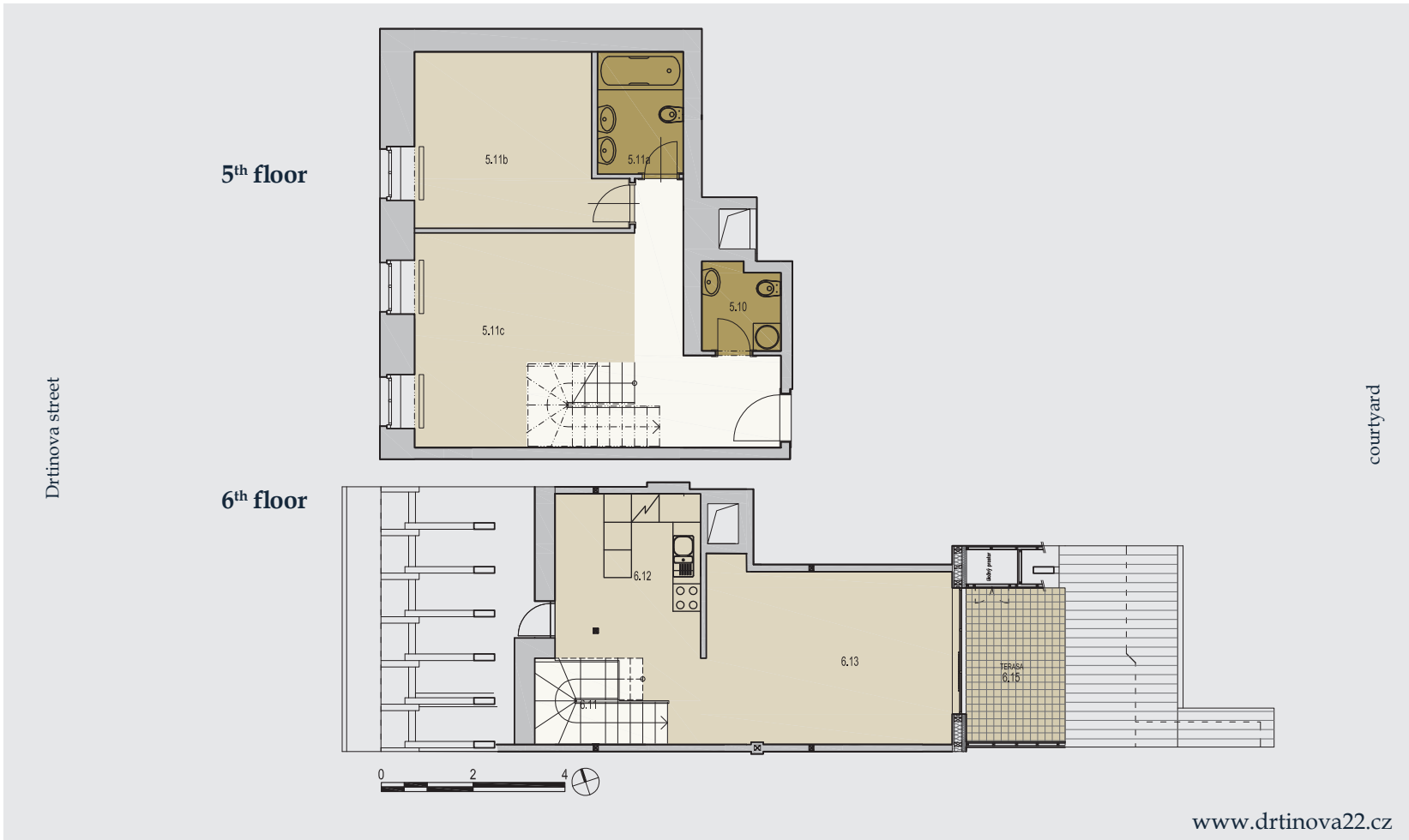
5th floor

5.09	corridor	14,96sqm
5.10	WC	2,86sqm
5.11a	bathroom	4,95sqm
5.11b	room	15,65sqm
5.11c	room	17,96sqm

6th floor

6.11	staircase	4,91sqm
6.12	kitchen	12,65sqm
6.13	room	20,36sqm
6.15	*terrace	7,48sqm
2.15	cellar	4,90sqm

* Terrace area is not included in the total area of units.



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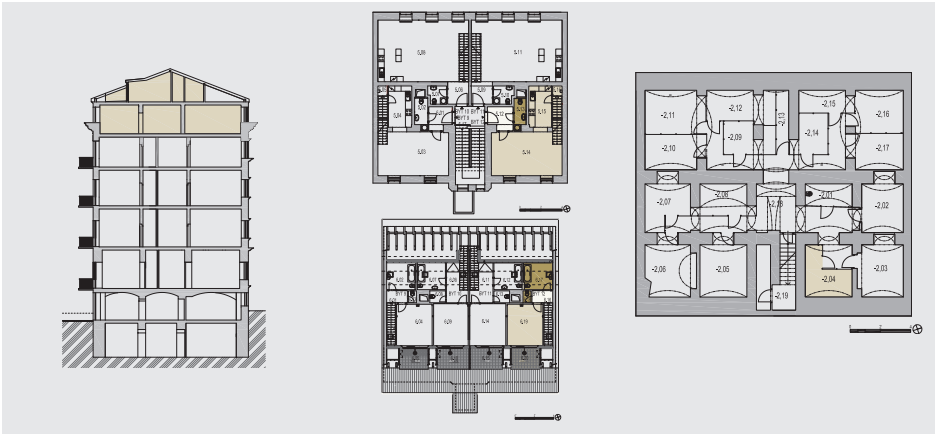
Apartment 512



Maisonette 2+k 85,65sqm

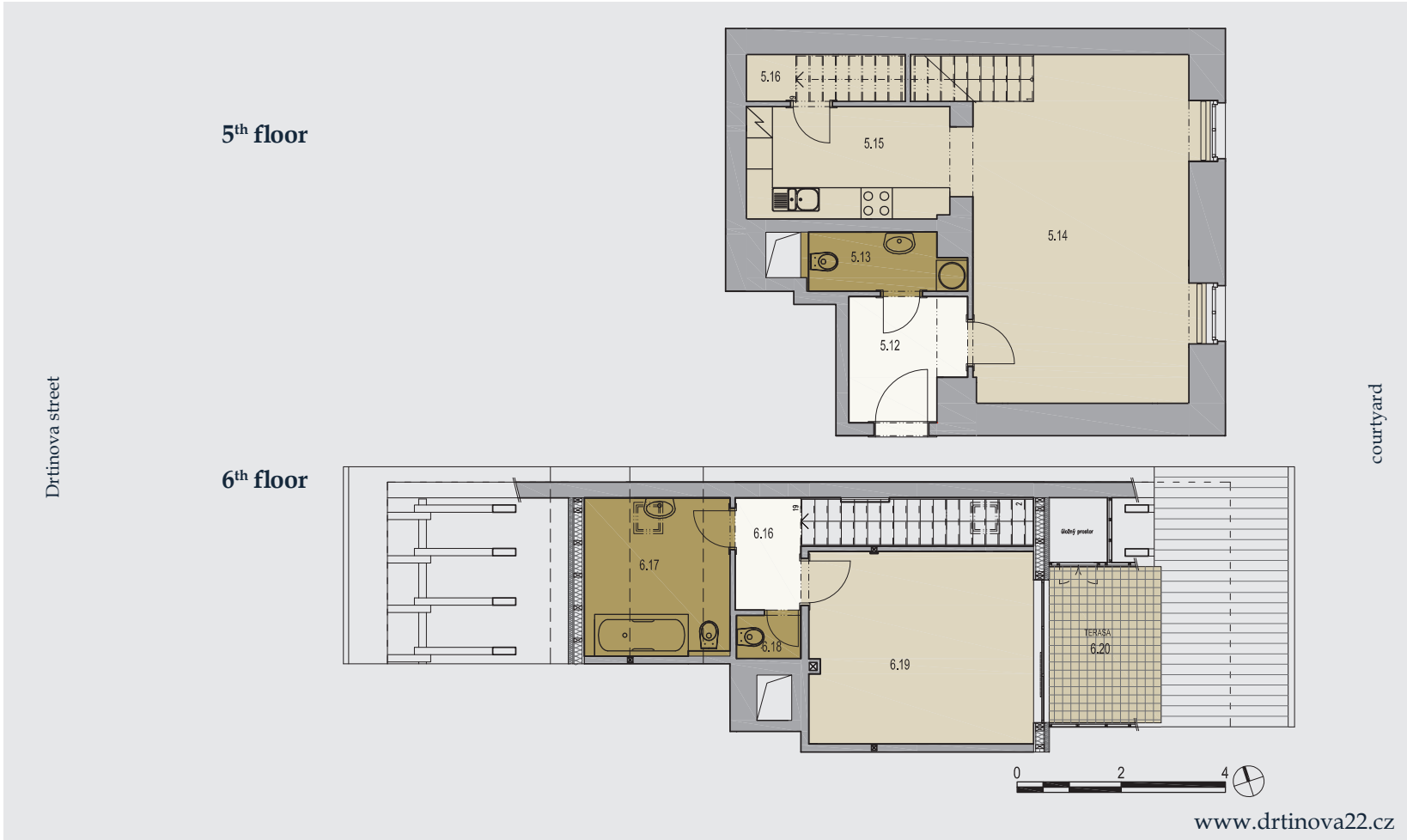
5th floor

5.12	corridor	5,00sqm
5.13	WC	3,10sqm
5.14	room	26,70sqm
5.15	kitchen	9,00sqm
5.16	pantry	2,70sqm

6th floor

6.16	corridor	6,70sqm
6.17	kitchen	8,40sqm
6.18	WC	1,05sqm
6.19	room	15,70sqm
2.04	cellar	7,30sqm
6.20	*terrace	6,45sqm

* Terrace area is not included in the total area of units.



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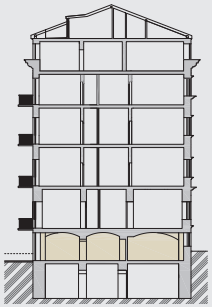
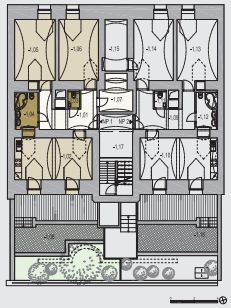
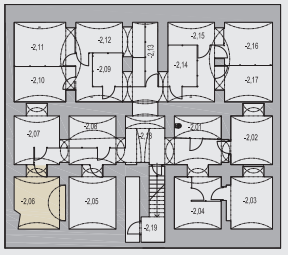
Commercial Space 601



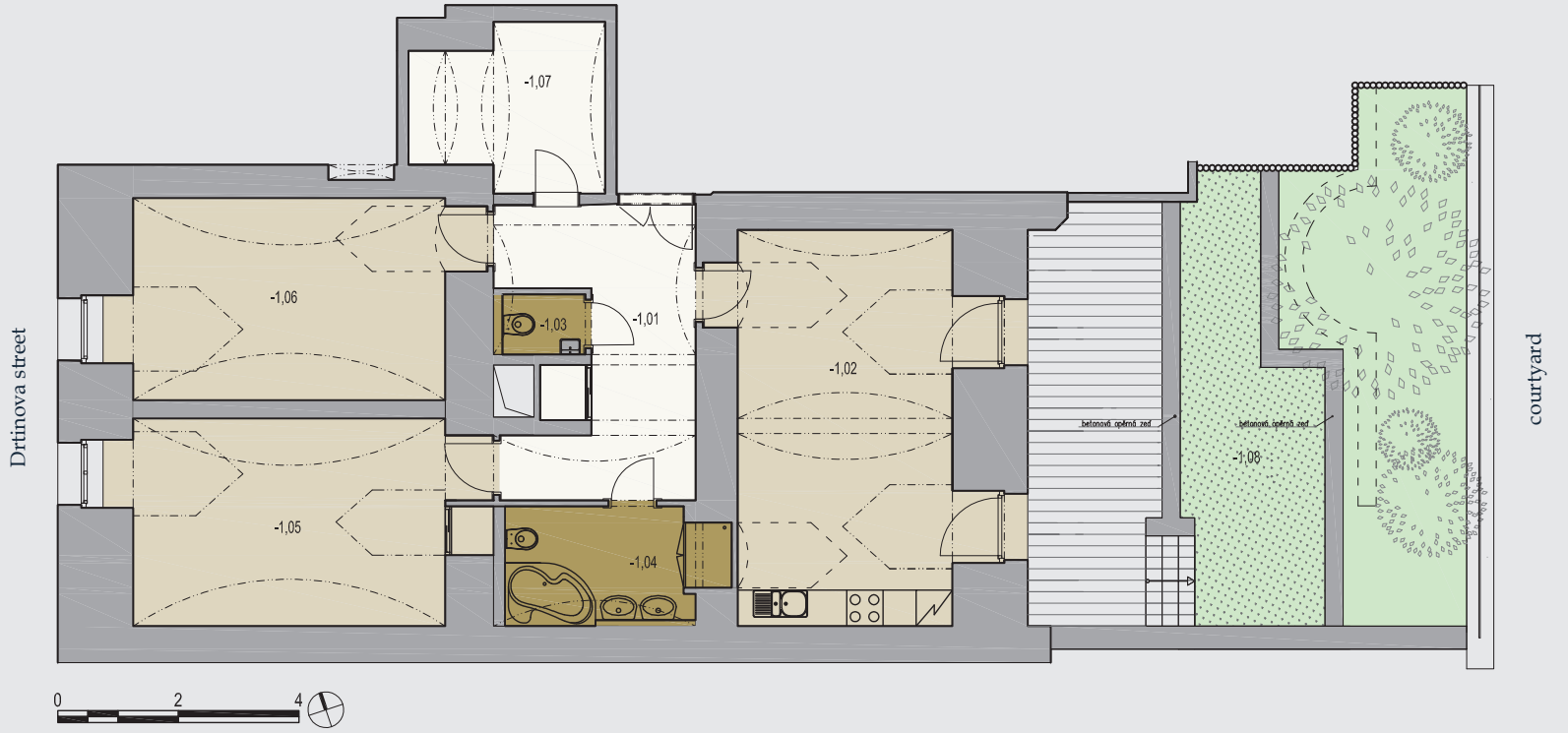




1st basement 3+k 103,97sqm

1.01	corridor	13,20sqm
1.02	office with kitchen	25,75sqm
1.03	WC	1,37sqm
1.04	bathroom	6,70sqm
1.05	office	18,45sqm
1.06	office	18,70sqm
1.07	storage	7,90sqm
2.06	cellar	11,90sqm
1.08	garden	55,80sqm

* Garden area is not included in the total area of units



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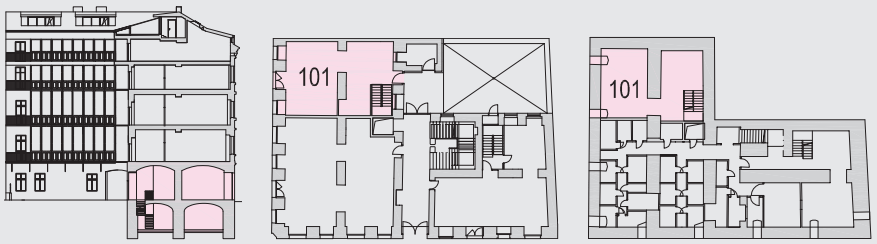
PART II. MARKETING PLANS OF ARBESOVA REZIDENCE

ARBESOVA REZIDENCE

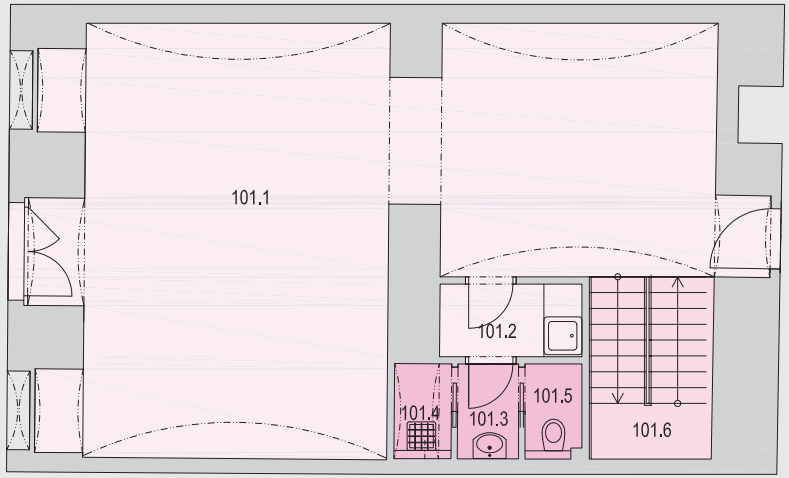
commercial space 101



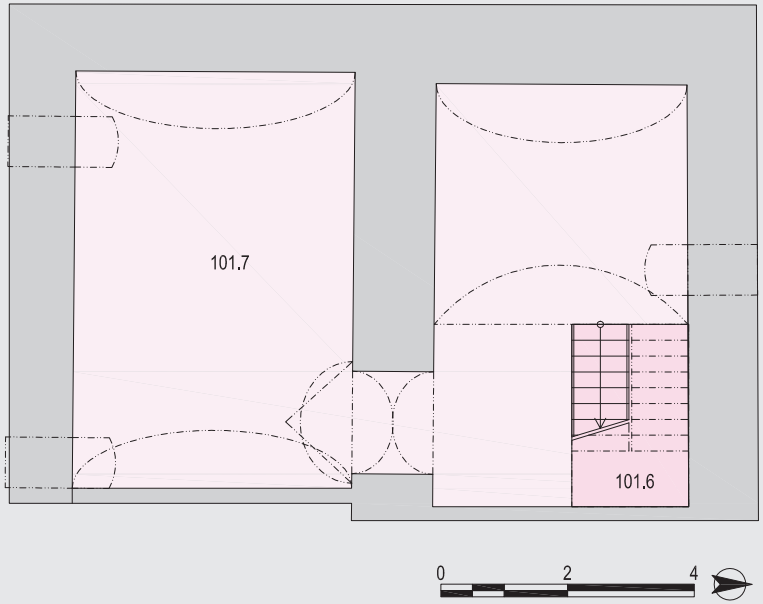
1st basement+1st floor/126,8sqm

101.1	commercial space	56,8sqm
101.2	kitchen	2,6sqm
101.3	hall	1,4sqm
101.4	utility room	1,3sqm
101.5	WC	1,3sqm
101.6	staircase	5,6sqm
101.7	commercial space in 1st basement	57,8sqm

1st floor



1st basement



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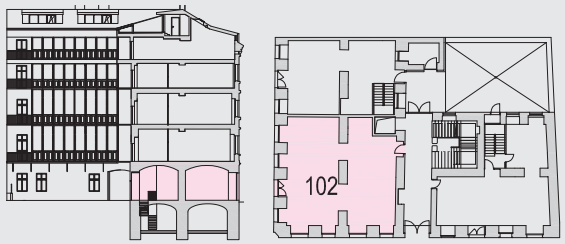
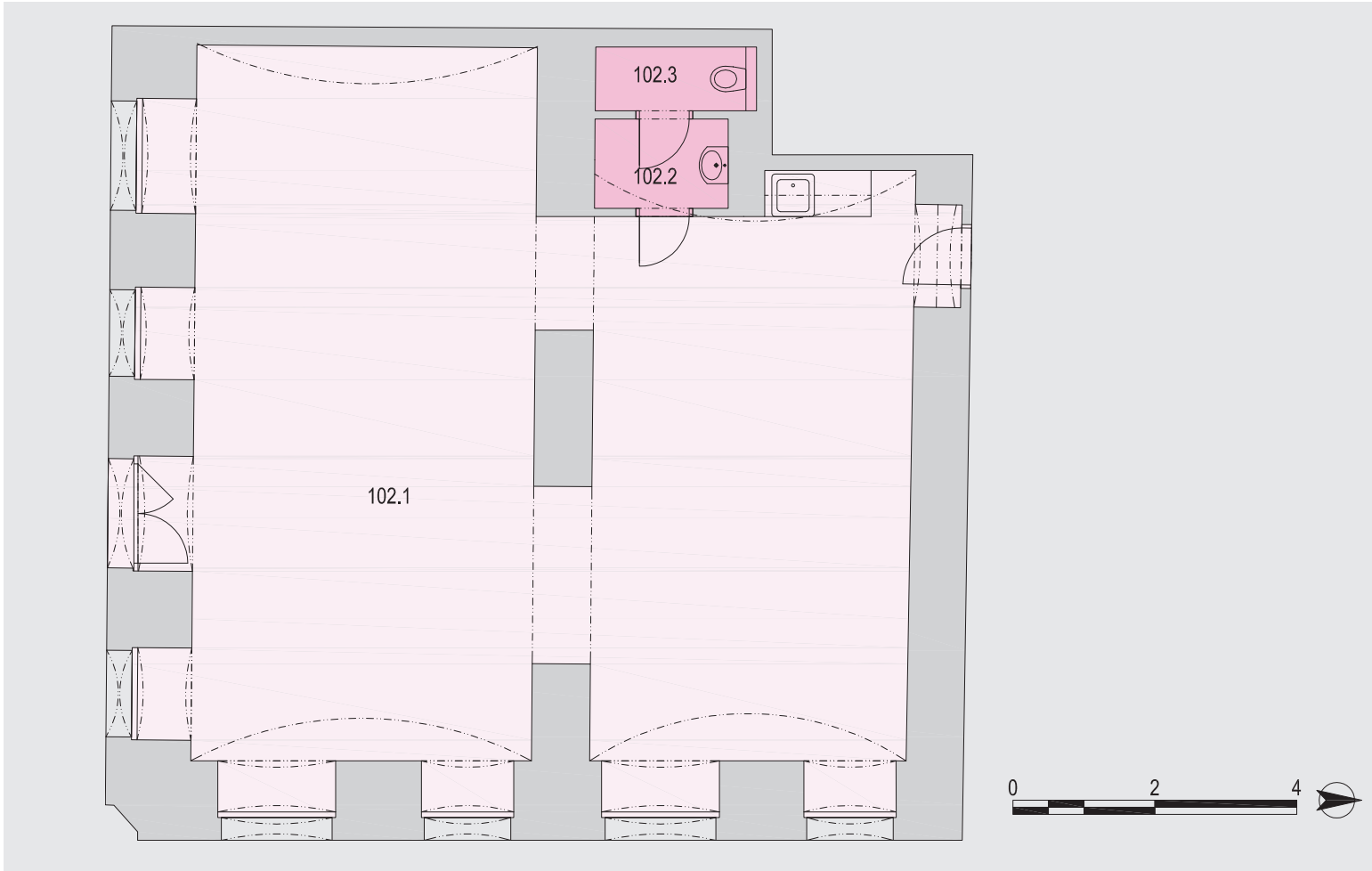
ARBESOVA REZIDENCE

commercial space 102



1st floor/101,6sqm

102.1	commercial space	97,2sqm
102.2	hall	2,4sqm
102.3	WC	2,0sqm



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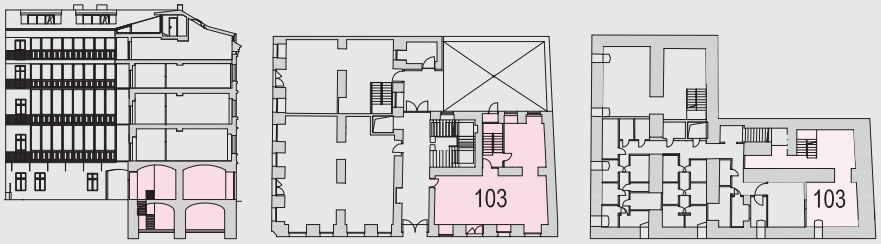
ARBESOVA REZIDENCE

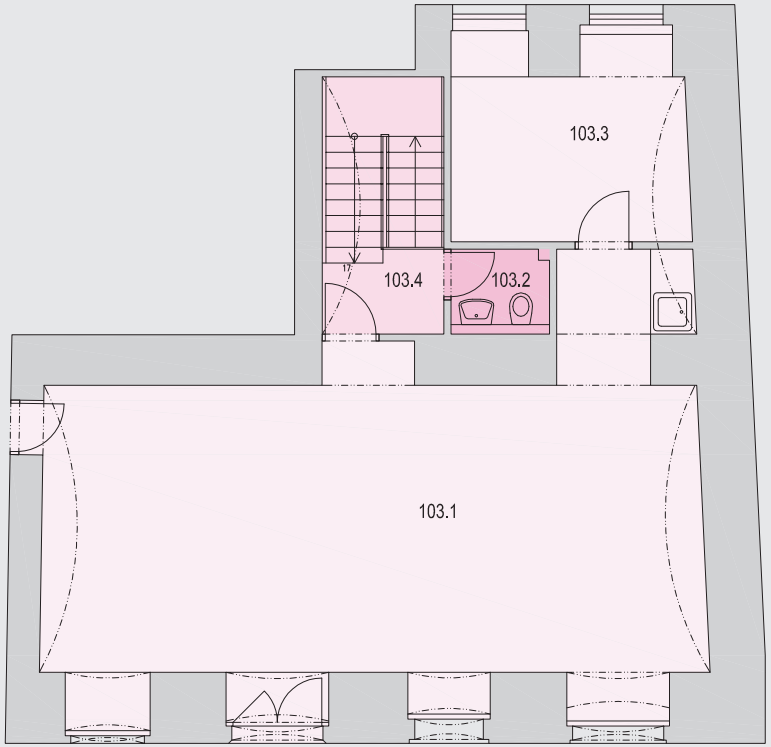
commercial space 103



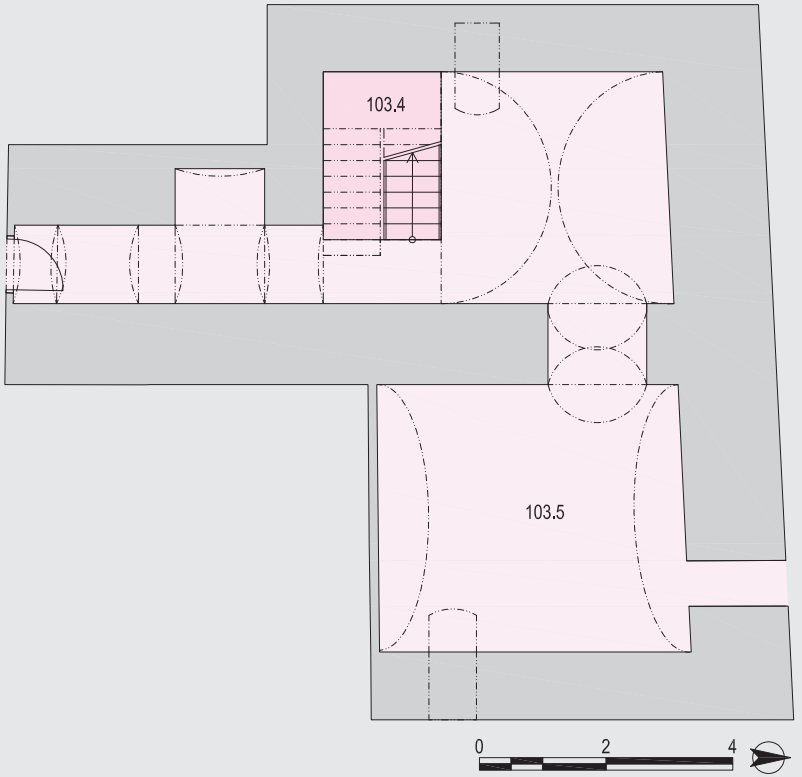
1st basement+1st floor/127,7sqm

103.1	commercial space	57,4sqm
103.2	WC	2,1sqm
103.3	office	10,7sqm
103.4	staircase	7,8sqm
103.5	commercial space	49,7sqm

1st basement



1st floor



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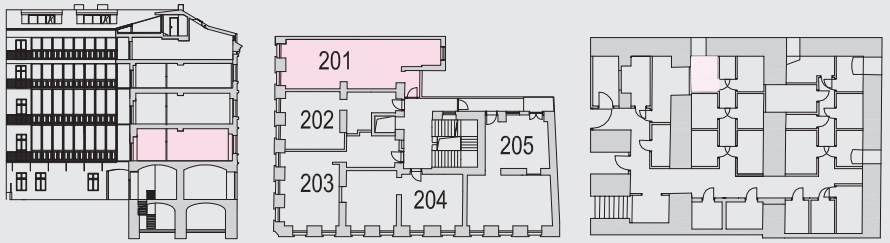
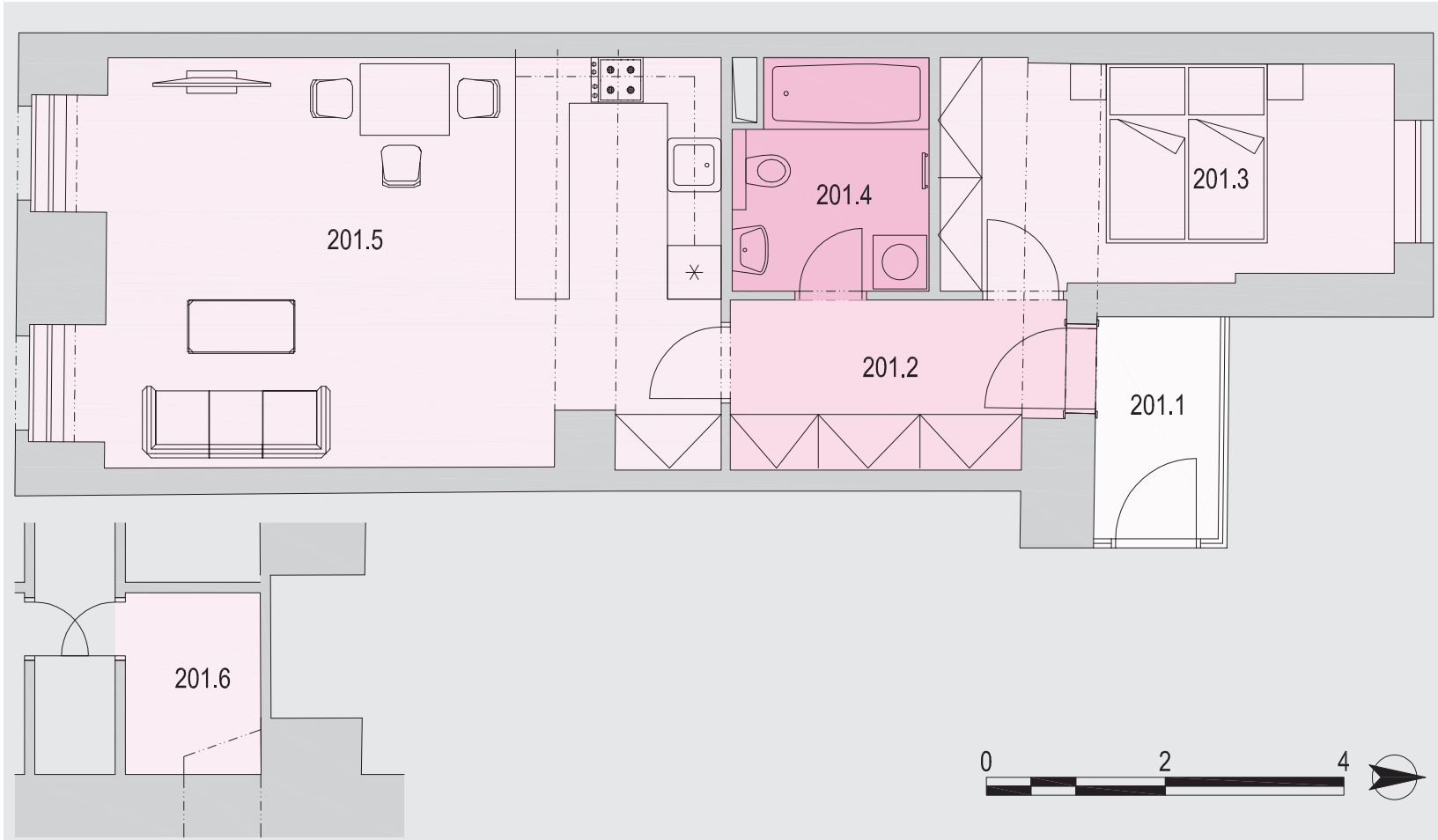
ARBESOVA REZIDENCE

apartment 201



2nd floor/2+k/63,6sqm

201.1	glazed balcony	3,4sqm
201.2	corridor	6,8sqm
201.3	room	12,4sqm
201.4	bathroom	5,5sqm
201.5	living room +kitchen	32,3sqm
201.6	cellar	3,1sqm



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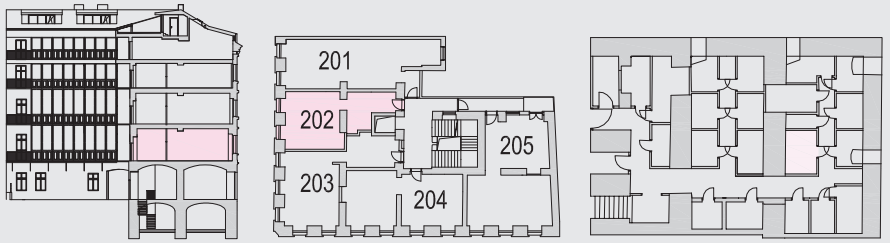
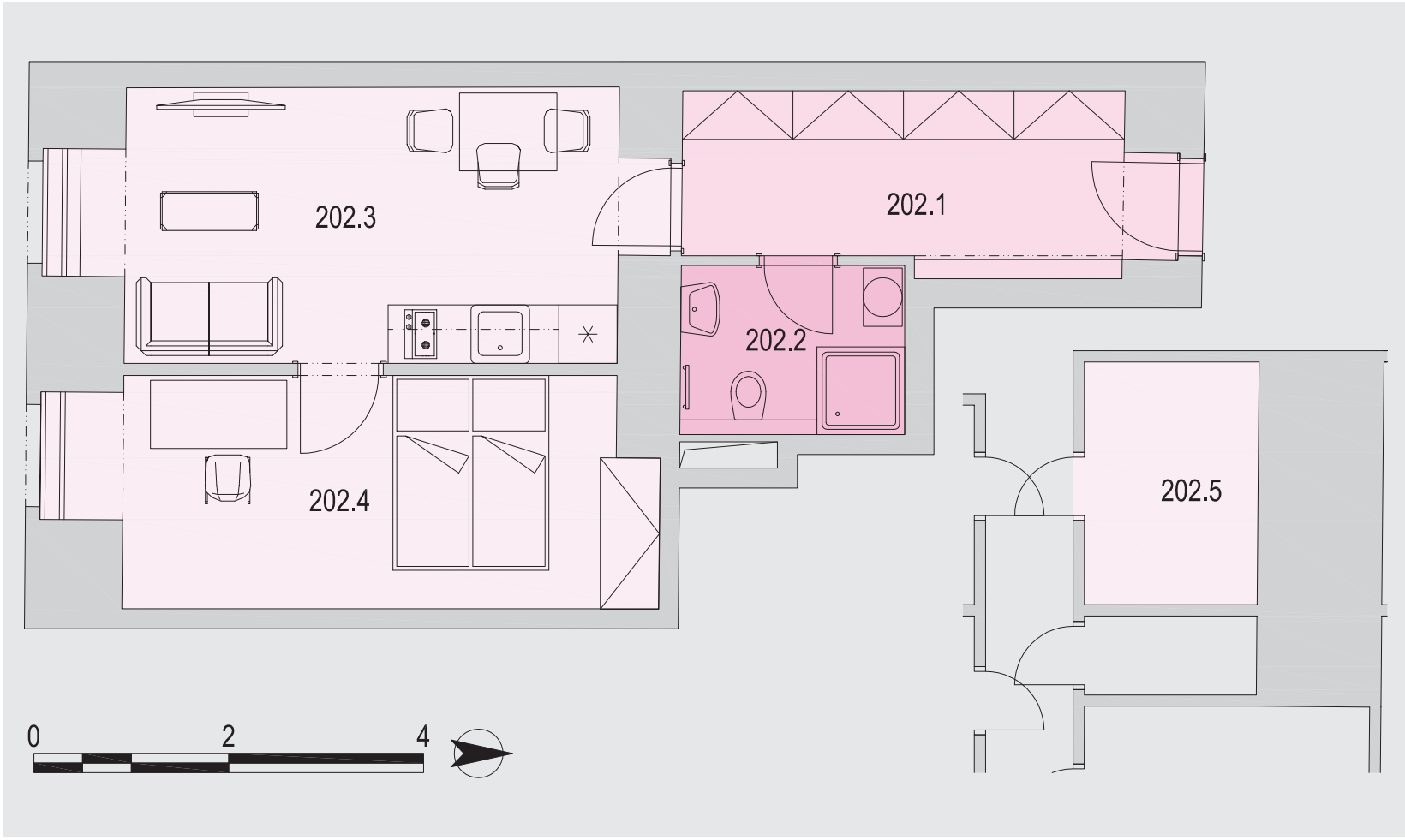
ARBESOVA REZIDENCE

apartment 202



2nd floor/2+k/46,1sqm

202.1	corridor	8,8sqm
202.2	bathroom	4,0sqm
202.3	living room +kitchen	15,5sqm
202.4	room	13,4sqm
202.5	cellar	4,4sqm



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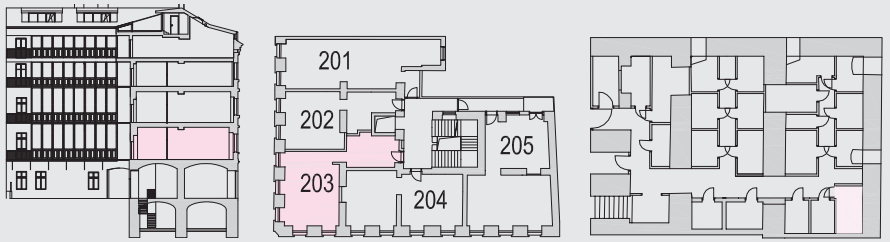
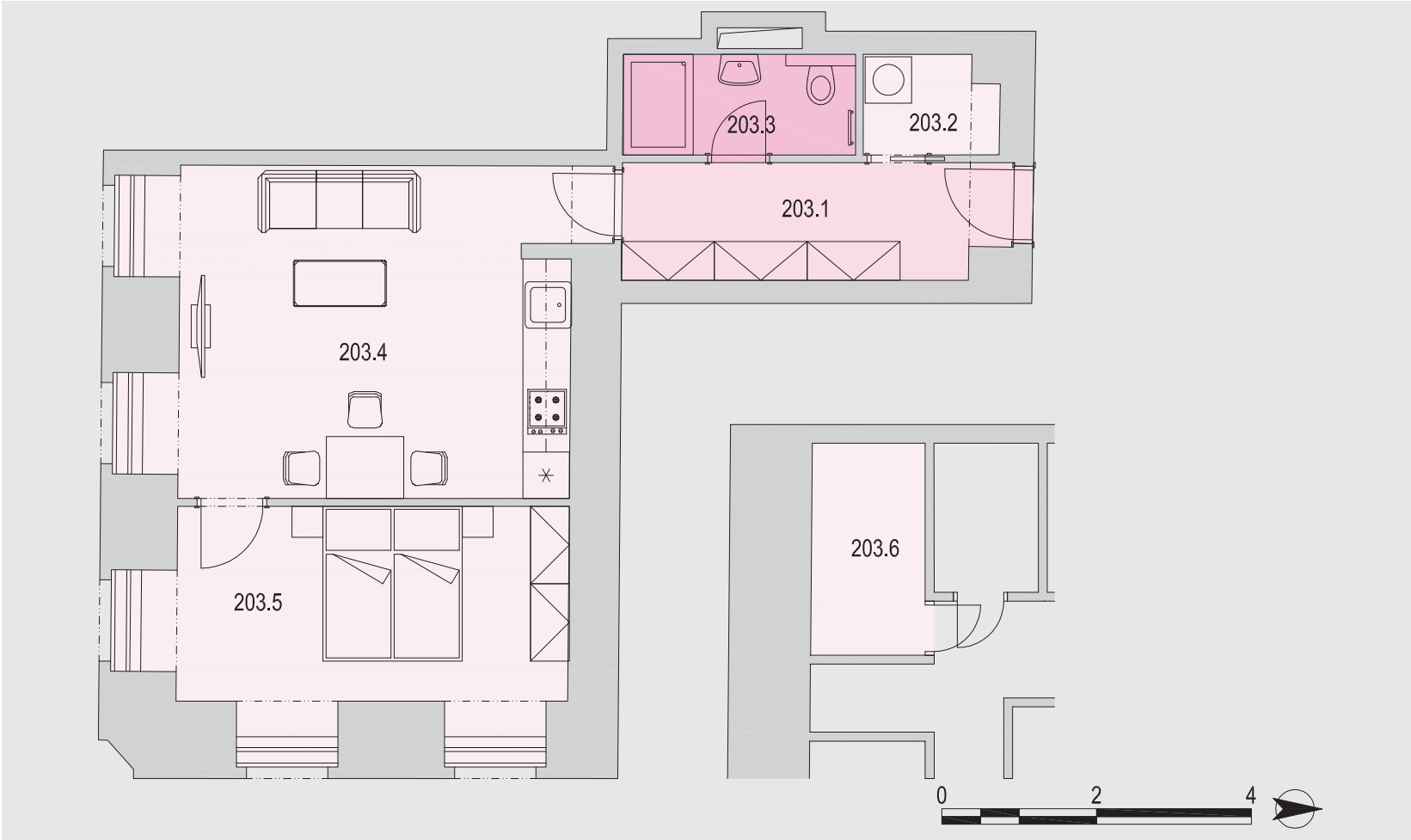
apartment 203



2nd floor/2+k/55,9sqm

203.1	corridor	7,4sqm
203.2	pantry	2,2sqm
203.3	bathroom	3,9sqm
203.4	living room +kitchen	23,4sqm
203.5	room	14,6sqm
203.6	cellar	4,4sqm



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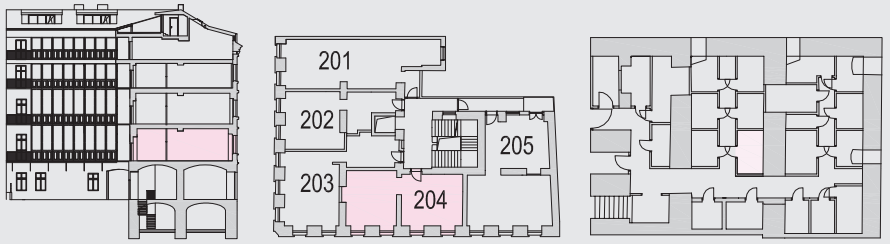
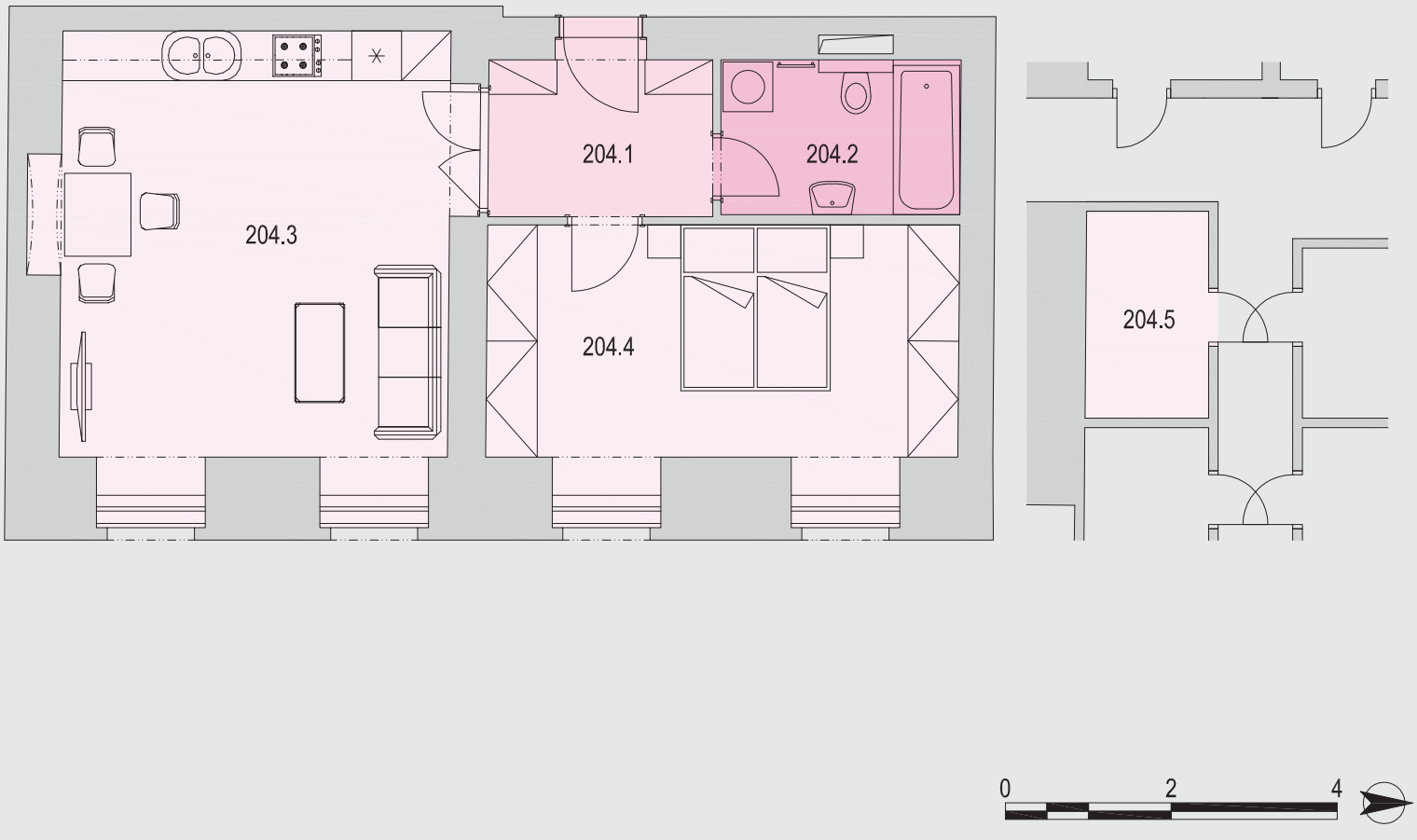
apartment 204



2nd floor/2+k/58,3sqm

204.1	corridor	5,2sqm
204.2	bathroom	5,4sqm
204.3	living room +kitchen	26,9sqm
204.4	room	17, 1sqm
204.5	cellar	3,7sqm



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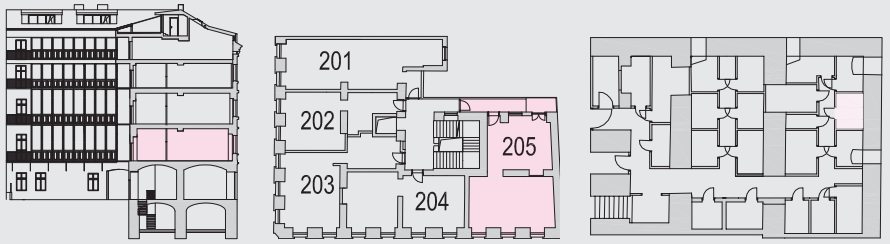
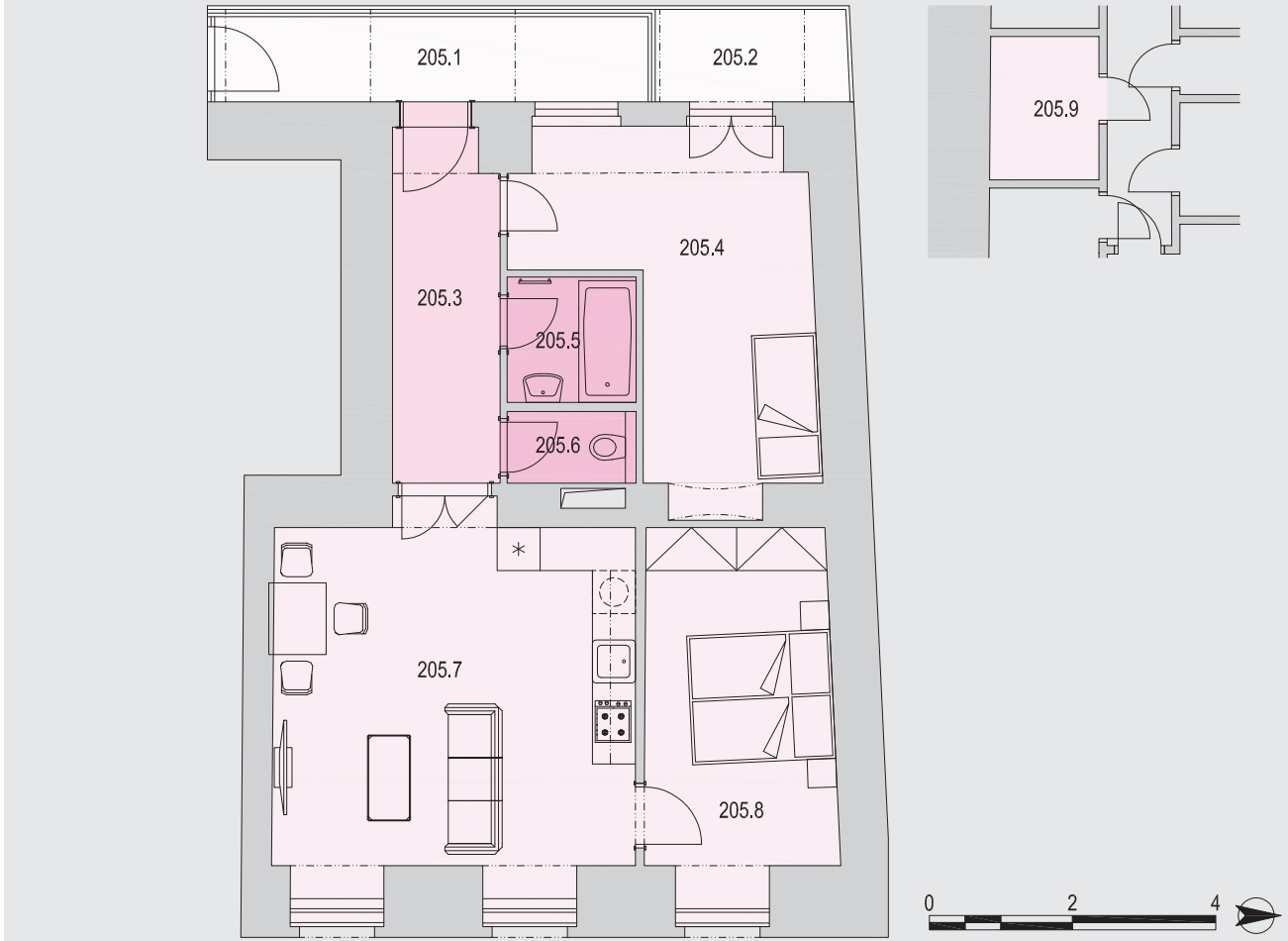
apartment 205



2nd floor/3+k/77,1sqm

205.1	glazed balcony	7,5sqm
205.3	corridor	7,4sqm
205.4	room	15,6sqm
205.5	bathroom	3,2sqm
205.6	WC	1,8sqm
205.7	living room +kitchen	25,7sqm
205.8	room	12,9sqm
205.9	cellar	3,0sqm
***205.2**	balcony	3,2sqm

* it is not included in the total area of the units



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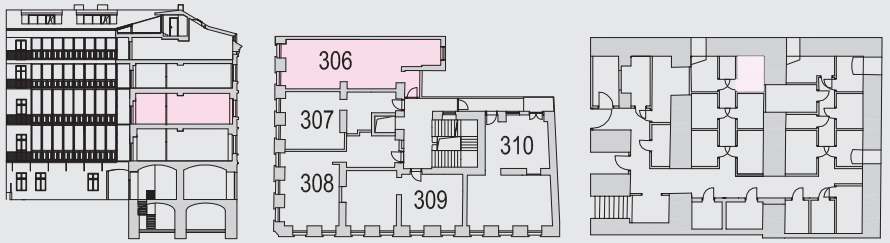
apartment 306



3rd floor/2+k/63,7sqm

306.1	glazed balcony	3,4sqm
306.2	corridor	6,9sqm
306.3	room	12,4sqm
306.4	bathroom	5,5sqm
306.5	living room +kitchen	32,4sqm
306.6	cellar	3,1sqm

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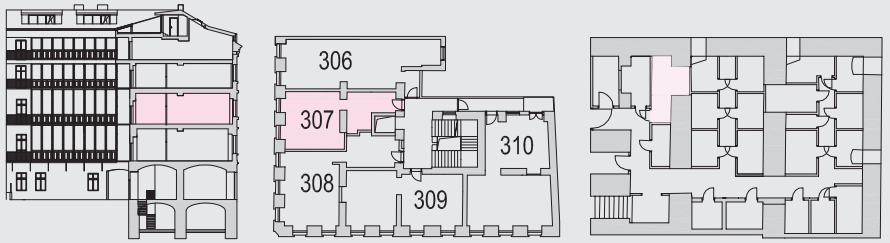
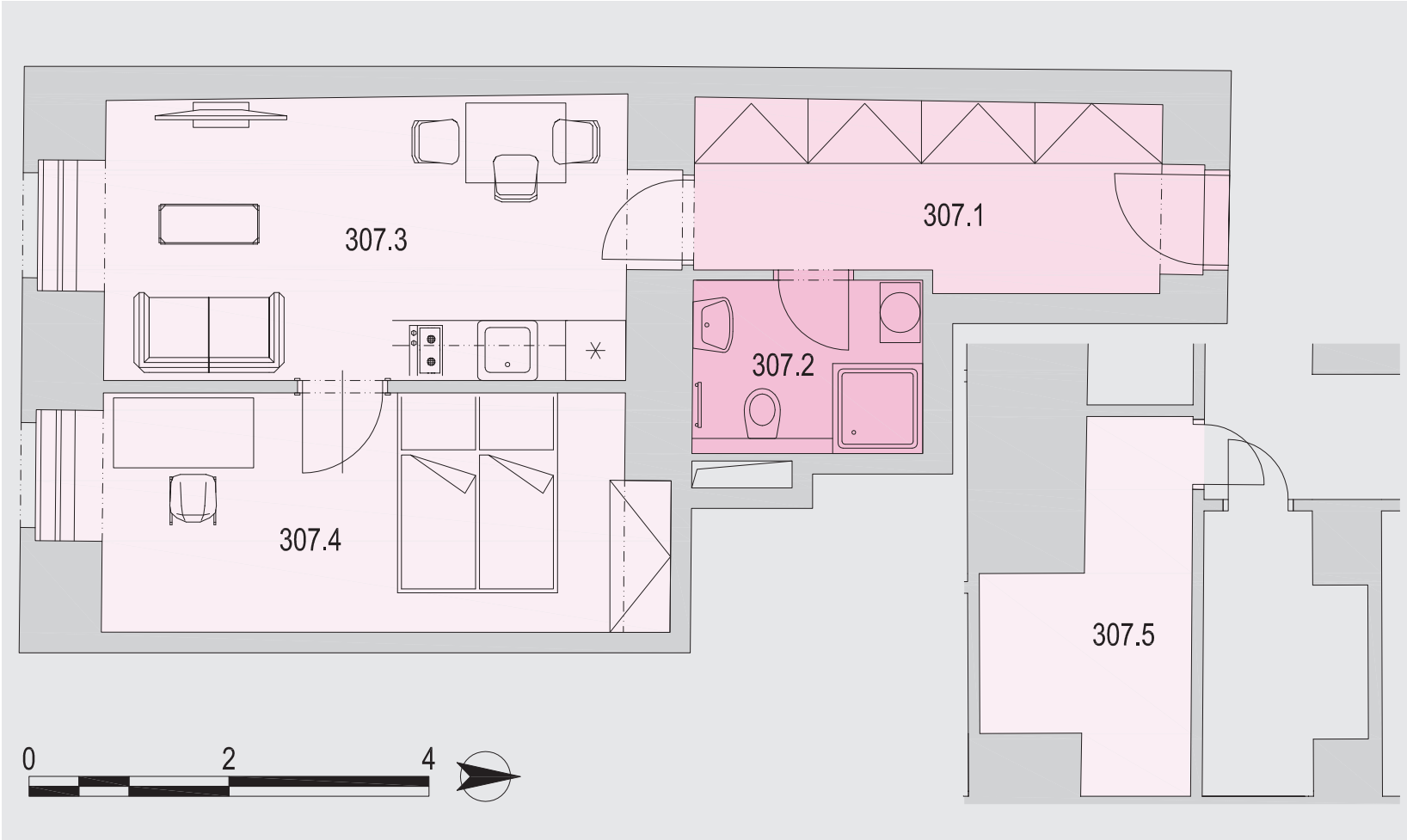
apartment 307



3rd floor/2+k/48,0sqm

307.1	corridor	8,9sqm
307.2	bathroom	4,0sqm
307.3	living room +kitchen	15,7sqm
307.4	room	13,6sqm
307.5	cellar	5,8sqm



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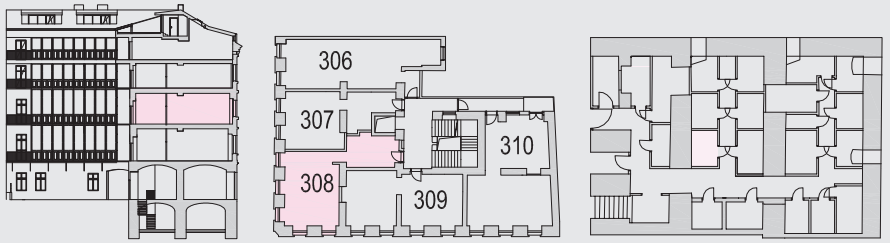
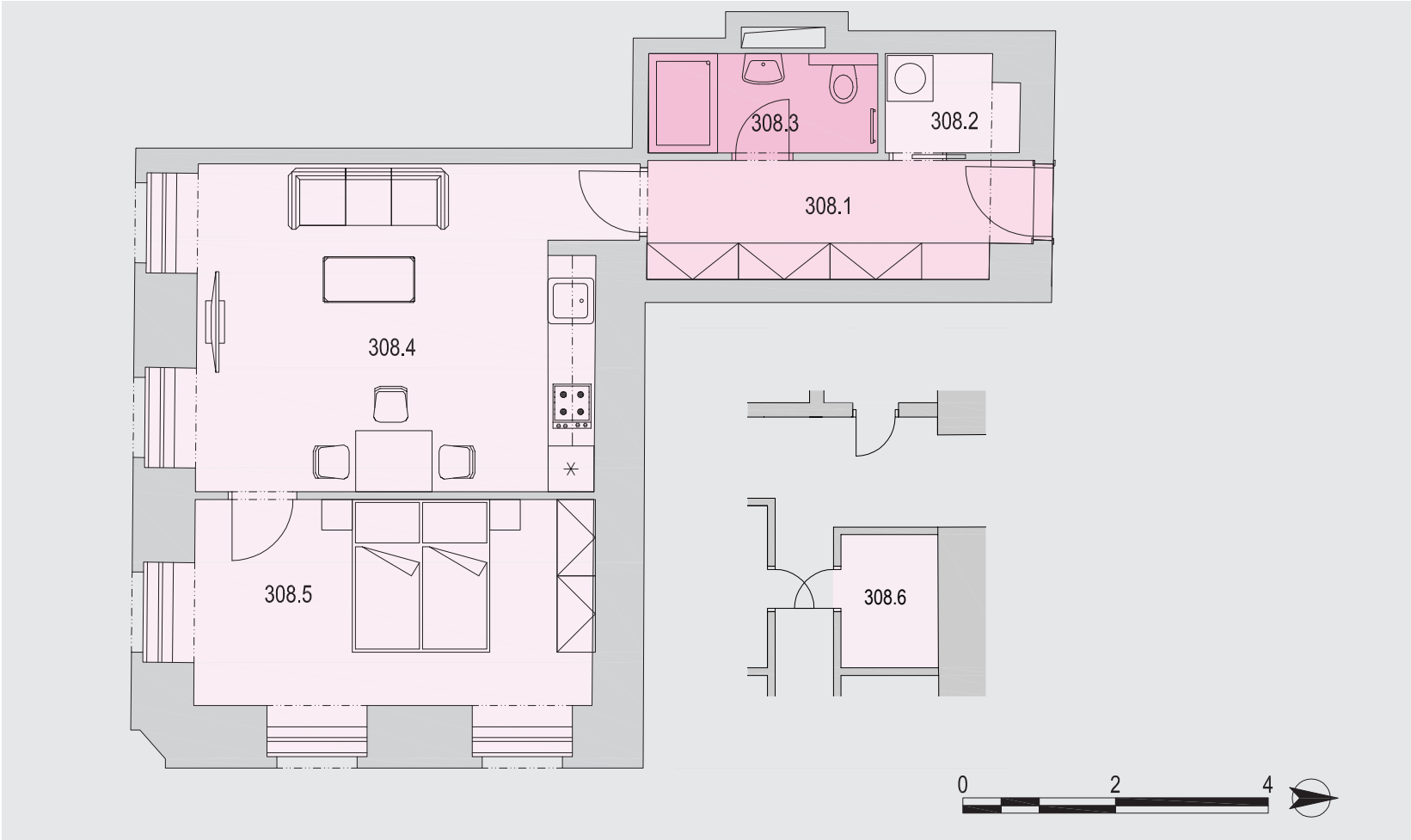
apartment 308



3rd floor/2+kk/55,7sqm

308.1	corridor	7,6 sqm
308.2	pantry	2,2 sqm
308.3	bathroom	3,9 sqm
308.4	living room +kitchen	23,7 sqm
308.5	room	15,2 sqm
308.6	cellar	3,1 sqm



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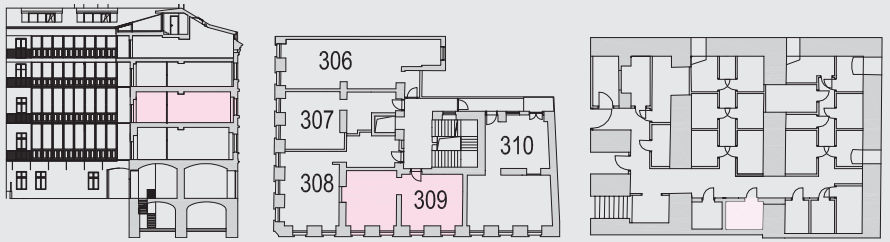
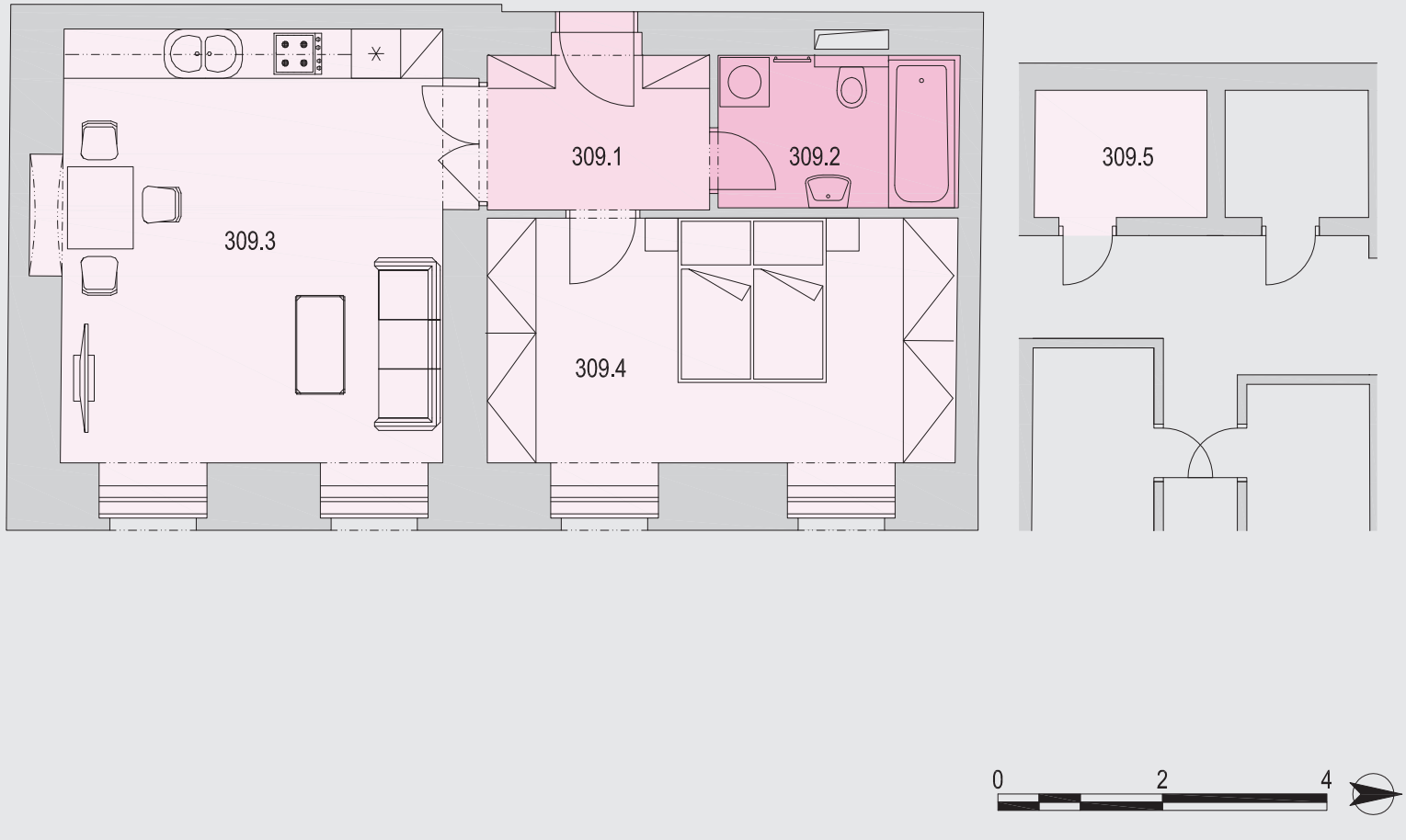
apartment 309



3rd floor/2+k/58,7sqm

309.1	corridor	5,4sqm
309.2	bathroom	5,4sqm
309.3	living room +kitchen	26,9sqm
309.4	room	17,7sqm
309.5	cellar	3,2sqm



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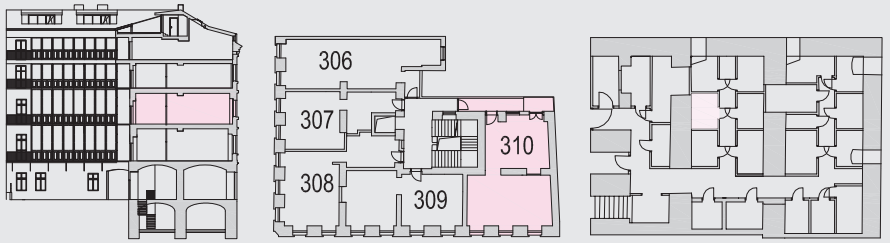
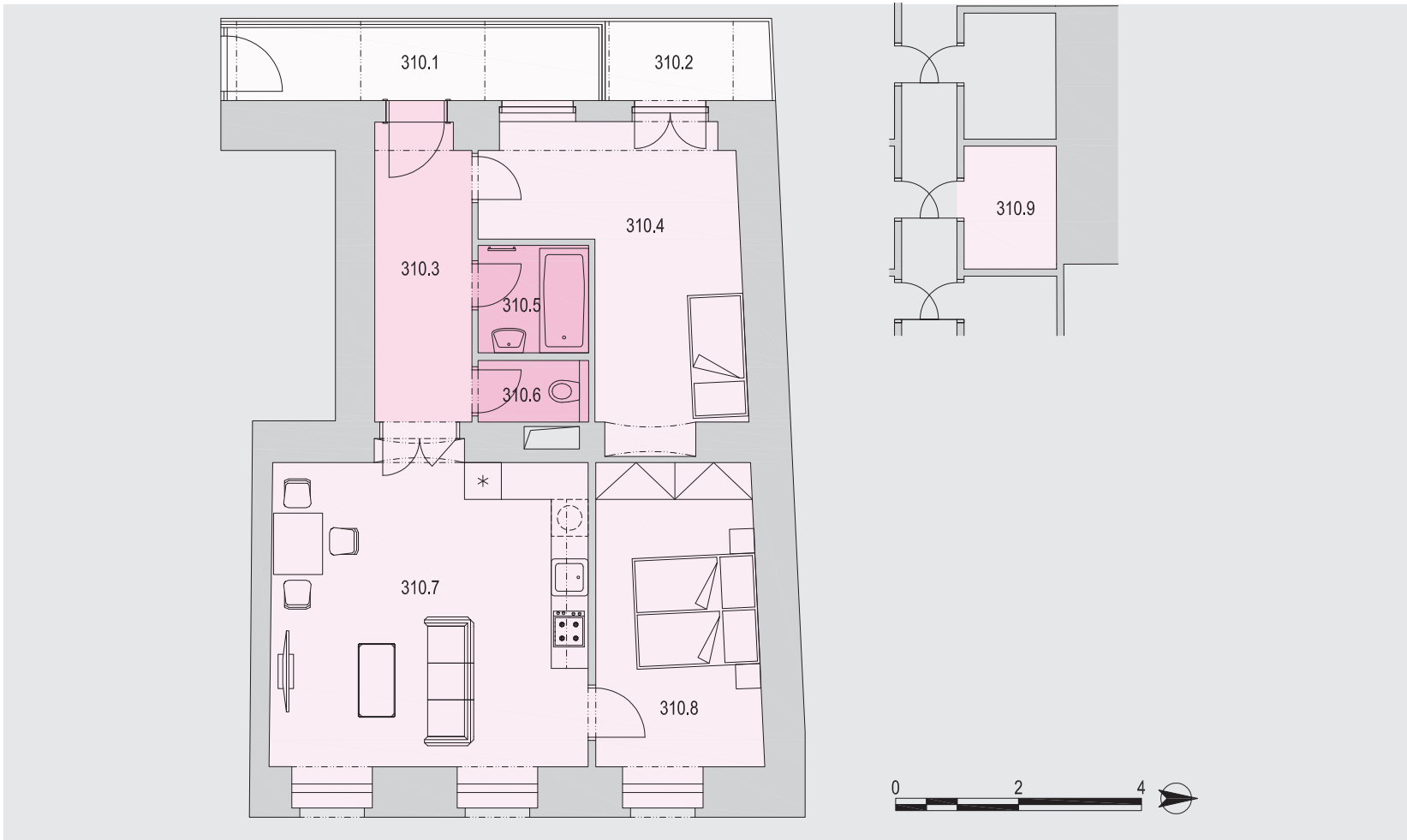
apartment 310



3rd floor/3+k/79,2sqm

310.1	glazed balcony	7,5sqm
310.3	corridor	7,6sqm
310.4	room	15,9sqm
310.5	bathroom	3,2sqm
310.6	WC	1,8sqm
310.7	living room +kitchen	26,8sqm
310.8	room	13,4sqm
310.9	cellar	3,0sqm
***310.2**	balcony	3,2sqm

* it is not included in the total area of the units



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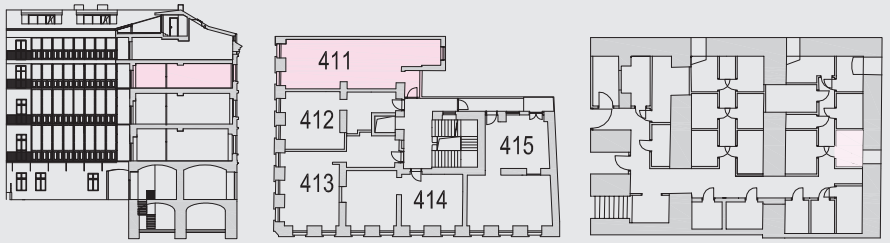
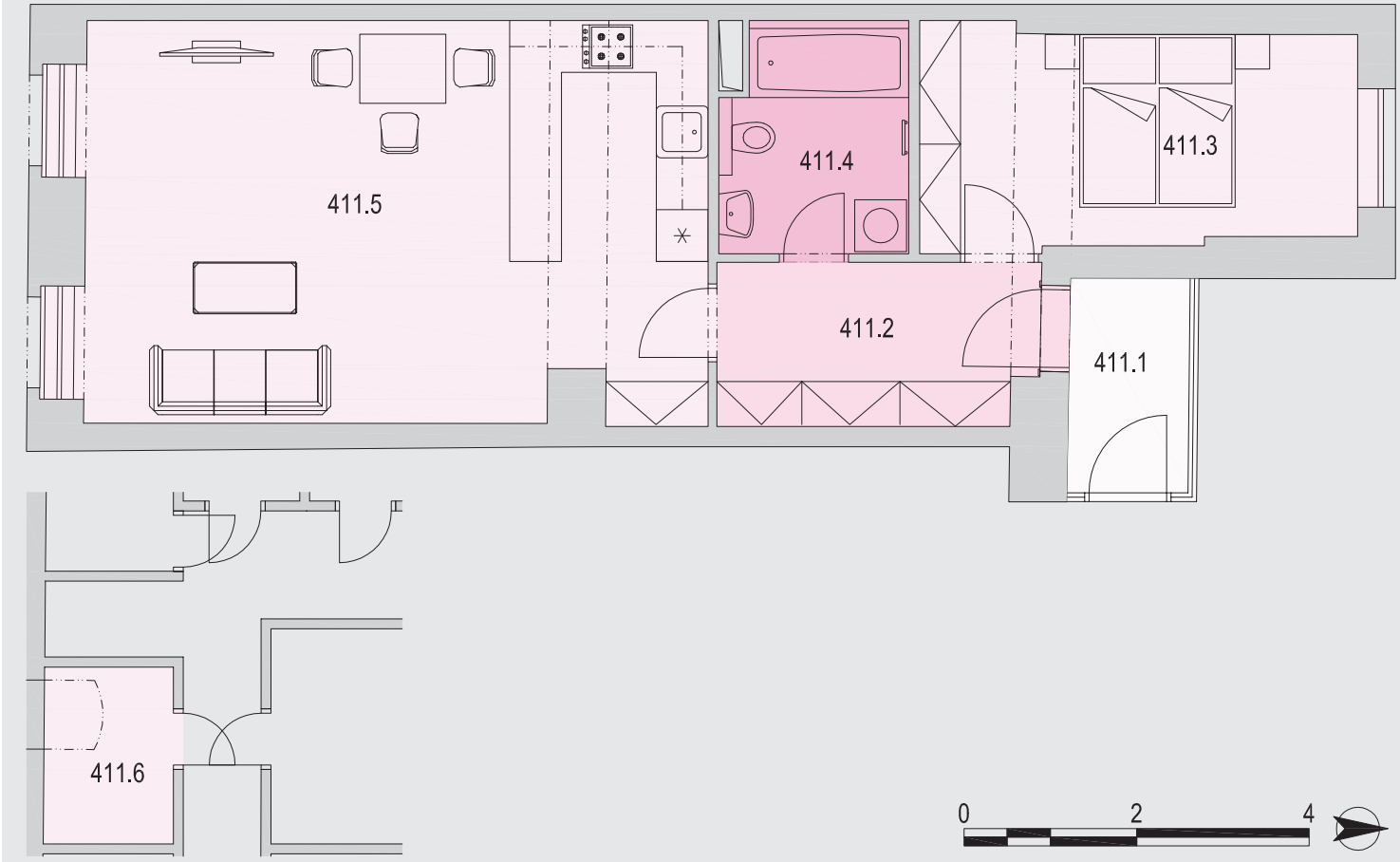
apartment 411



4th floor/2+k/65,2sqm

411.1	glazed balcony	3,4sqm
411.2	corridor	6,9sqm
411.3	room	12,6sqm
411.4	bathroom	5,6sqm
411.5	living room +kitchen	33,6sqm
411.6	cellar	3,1sqm



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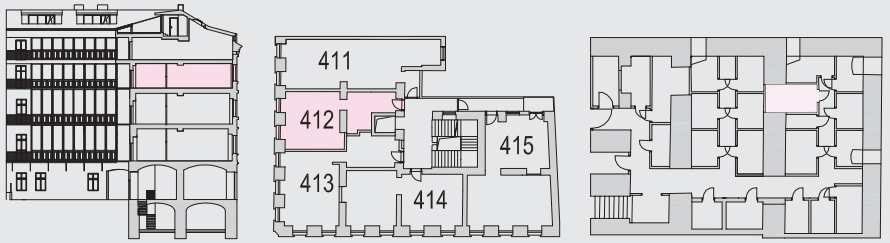
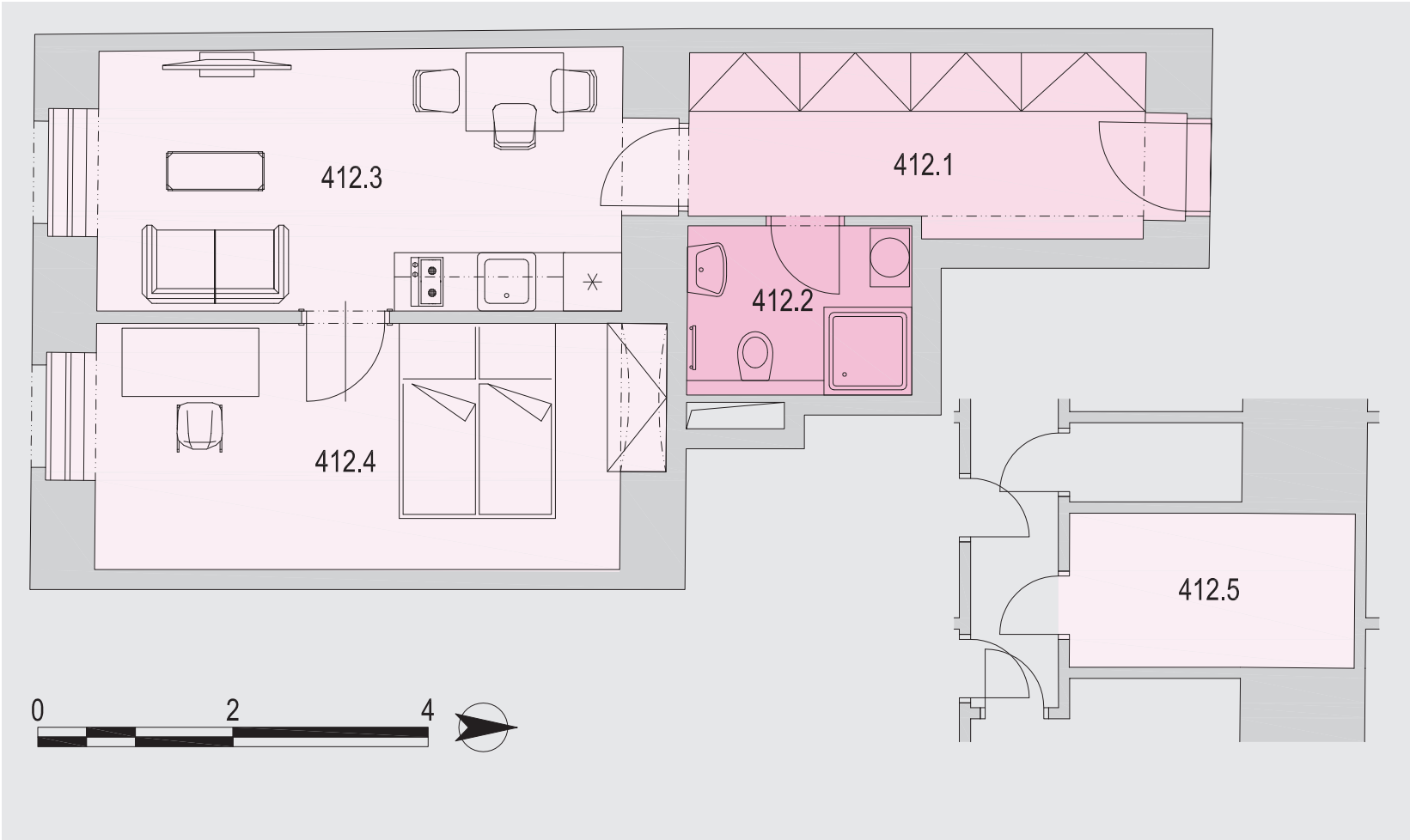
apartment 412



4th floor/2+k/47,0sqm

412.1	corridor	8,8sqm
412.2	bathroom	4,0sqm
412.3	living room +kitchen	15,2sqm
412.4	room	14,4sqm
412.5	cellar	4,6sqm



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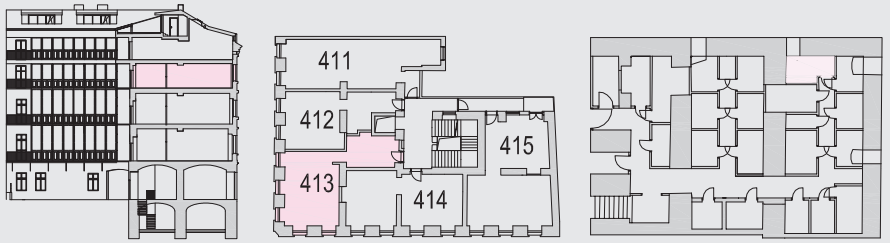
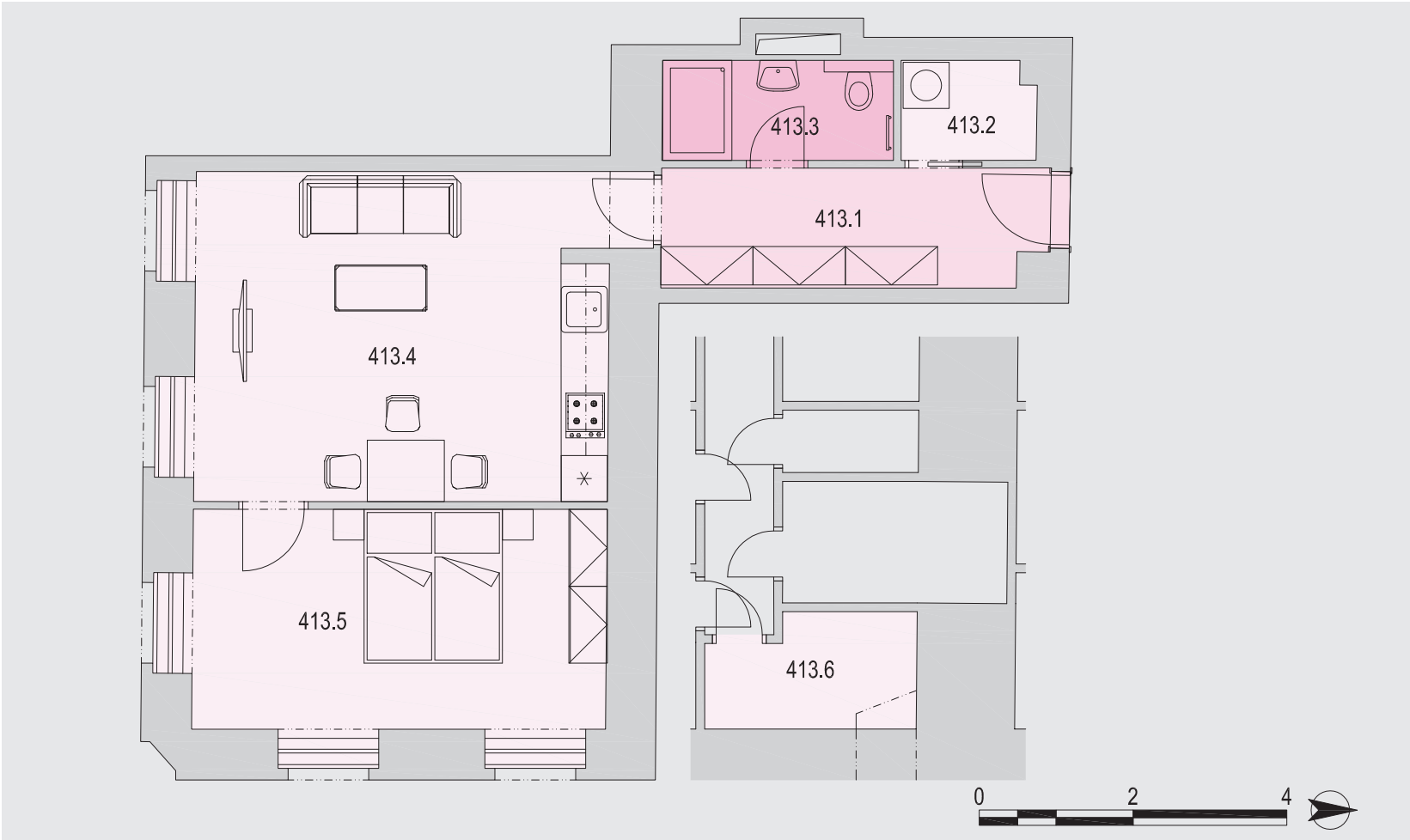
apartment 413



4th floor/2+k/57,5sqm

413.1	corridor	7,7sqm
413.2	pantry	2,2sqm
413.3	bathroom	3,9sqm
413.4	living room +kitchen	24,0sqm
413.5	room	15,9sqm
413.6	cellar	3,8sqm



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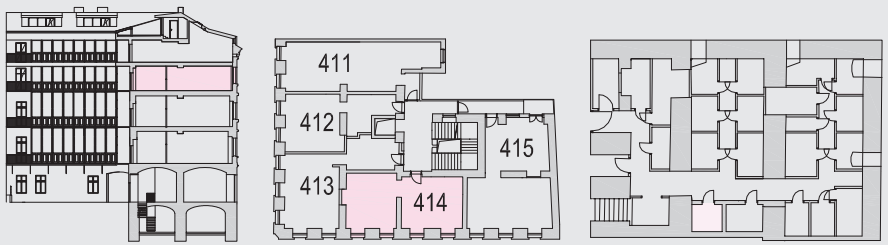
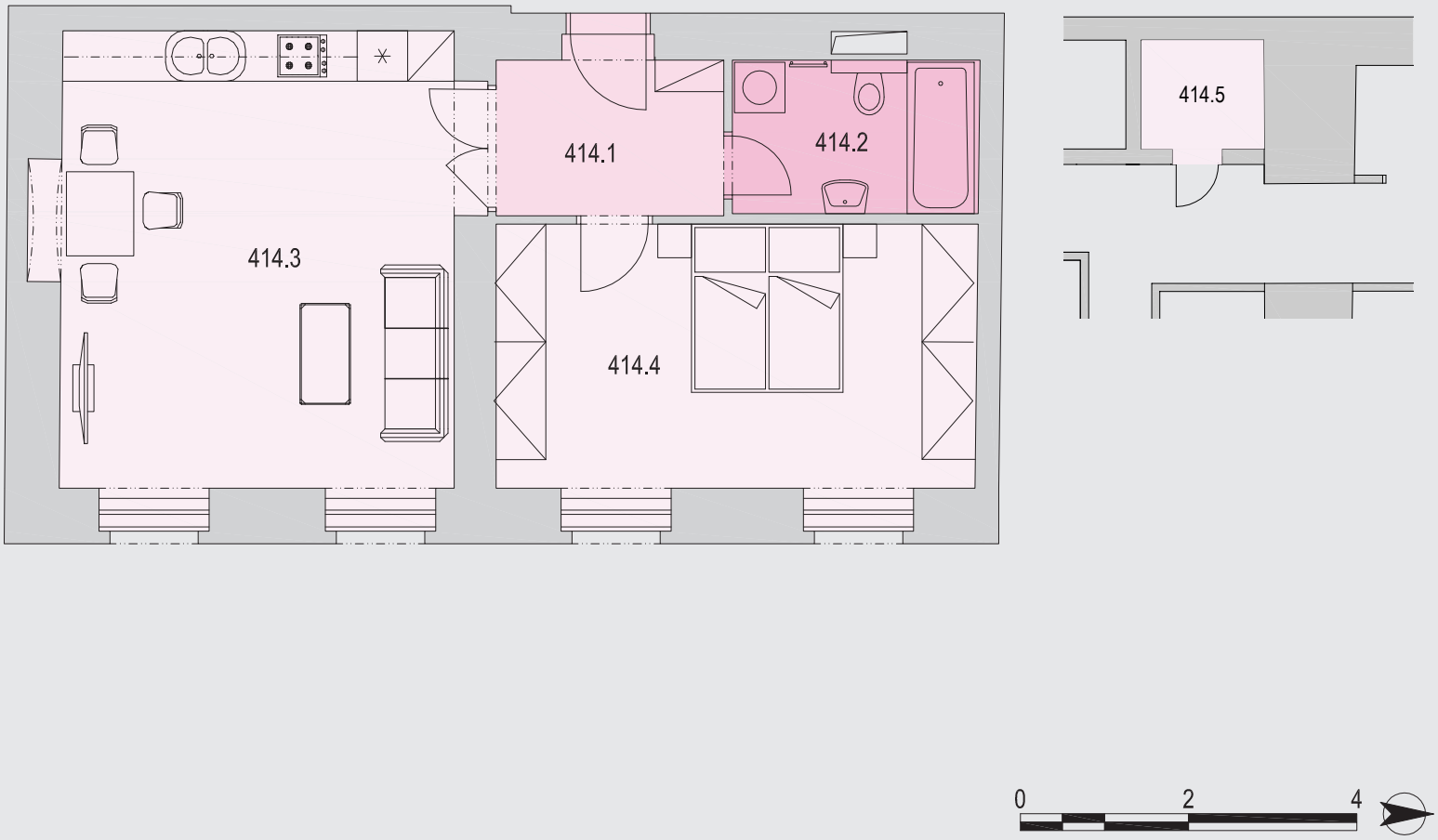
apartment 414



4th floor/2+kk/58,5 sqm

414.1	corridor	5,3 sqm
414.2	bathroom	5,4 sqm
414.3	living room +kitchen	26,9 sqm
414.4	room	18,2 sqm
414.5	cellar	2,7 sqm



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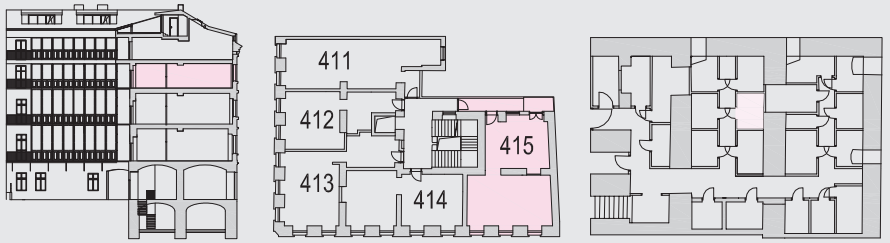
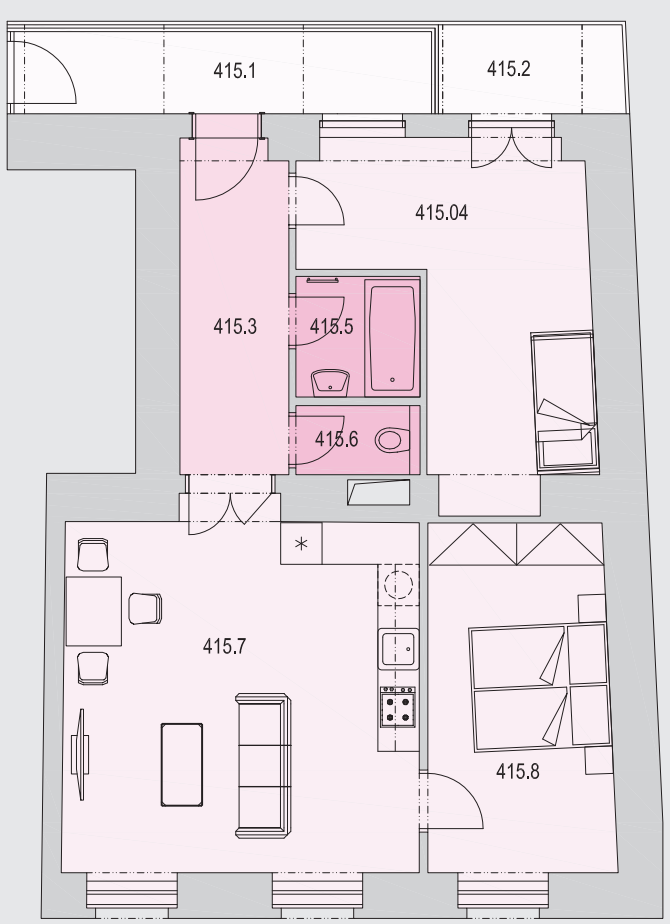
apartment 415

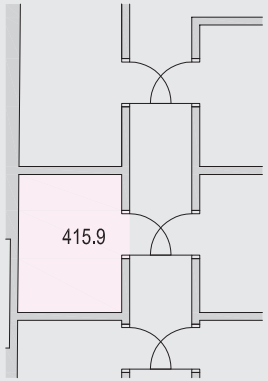


4th floor/3+k/79,8sqm

415.1	glazed balcony	7,5sqm
415.3	corridor	7,6sqm
415.4	room	16,0sqm
415.5	bathroom	3,2sqm
415.6	WC	1,8sqm
415.7	living room +kitchen	27,2sqm
415.8	room	13,5sqm
415.9	cellar	3,0sqm
***415.2**	balcony	3,2sqm

* it is not included in the total area of the units





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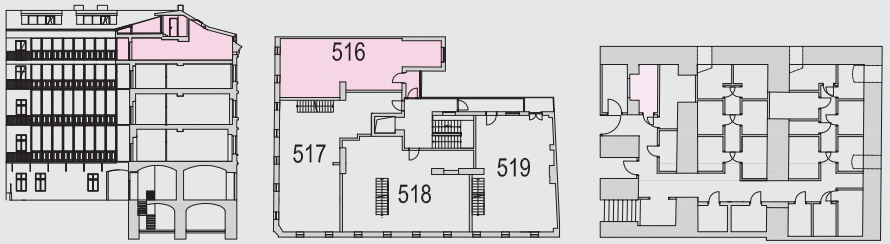
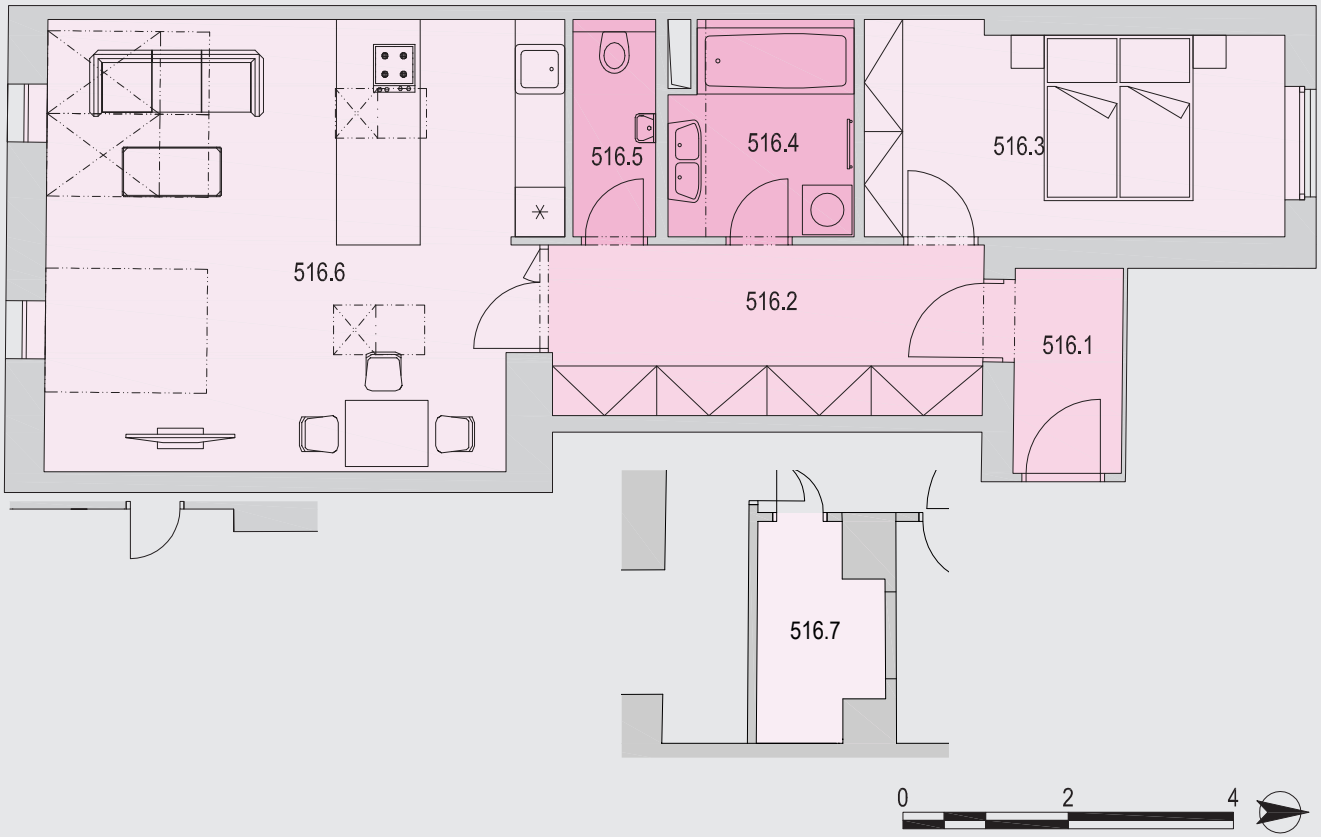
apartment 516



5th floor/2+kk/71,8 sqm

516.1	hall	3,3 sqm
516.2	corridor	10,8 sqm
516.3	room	12,7 sqm
516.4	bathroom	5,6 sqm
516.5	laundry	2,6 sqm
516.6	living room +kitchen	32,8 sqm
516.7	cellar	4,0 sqm



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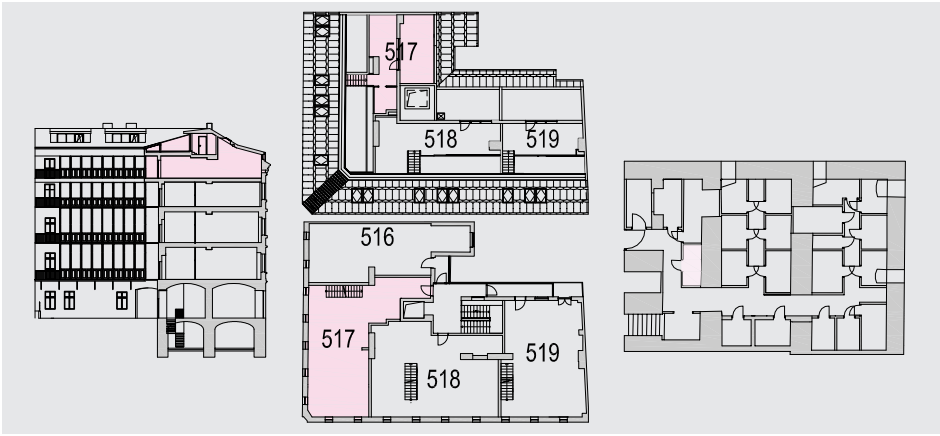
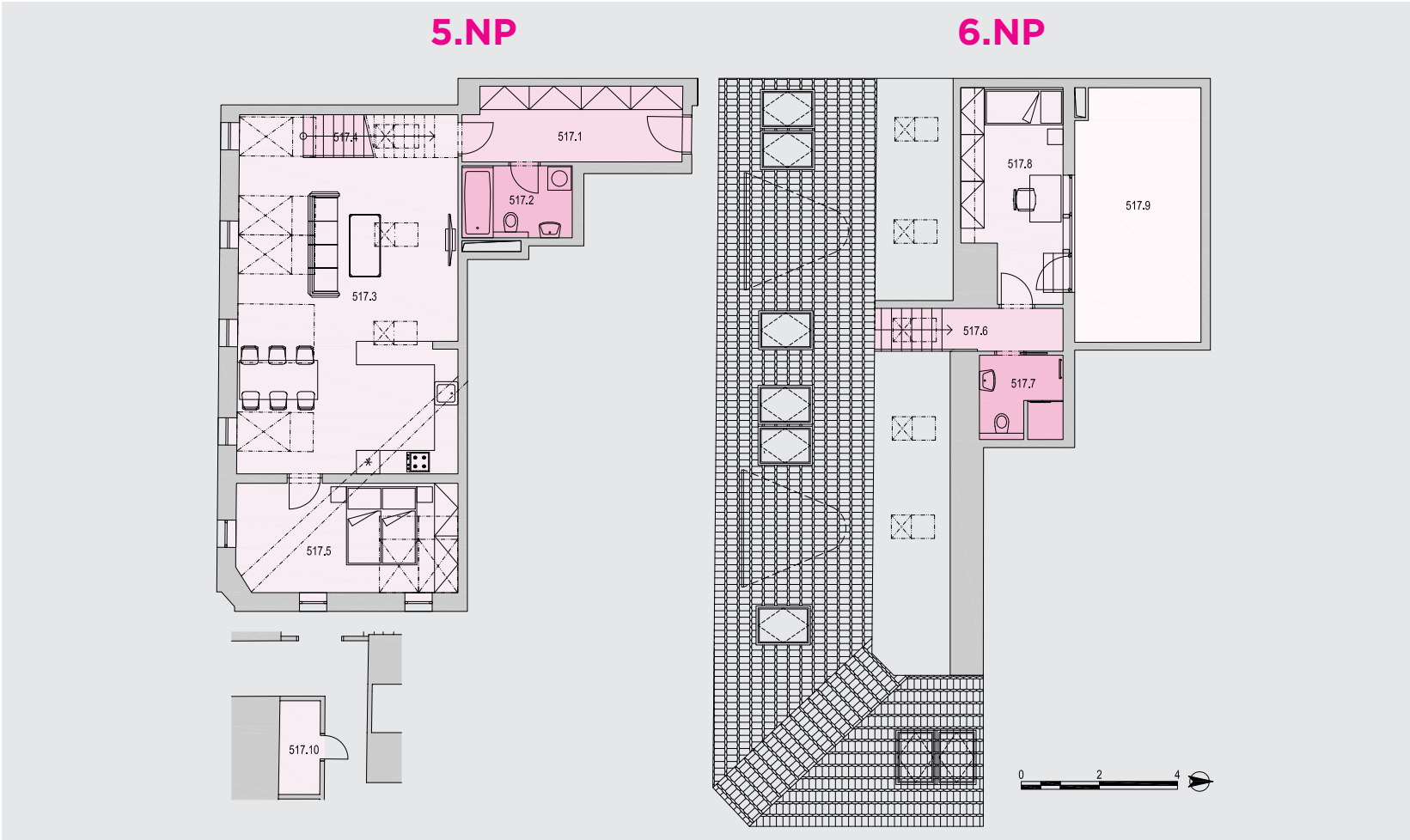
byt 517



5.NP+6.NP/106,5m² MEZONET 3+kk

517.1	chodba	10,6m²
517.2	koupelna	5,2m²
517.3	obývací pokoj+kk	49,7m²
517.4	schodiště	2,1m²
517.5	pokoj	15,8m²
517.6	chodba	3,1m²
517.7	koupelna	4,5m²
517.8	pokoj	13,0m²
517.10	sklep	2,5m²
*517.9	terasa	21,2m²

* nezapočítává se do celkové plochy bytové jednotky



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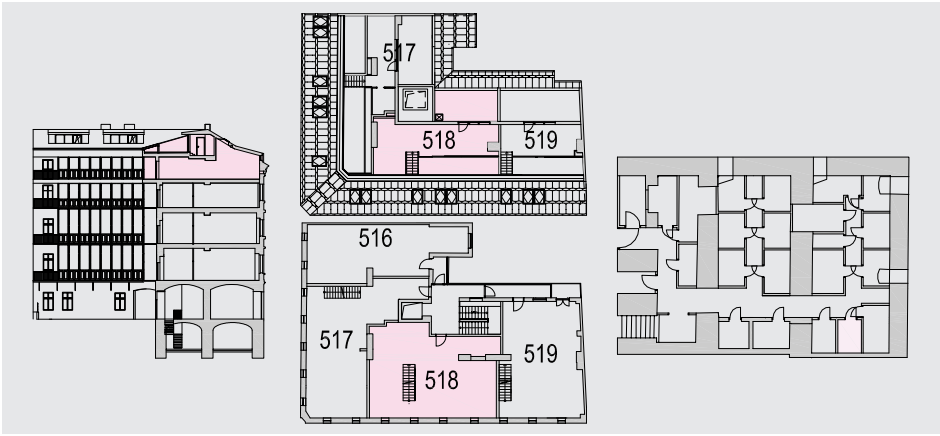
apartment 518

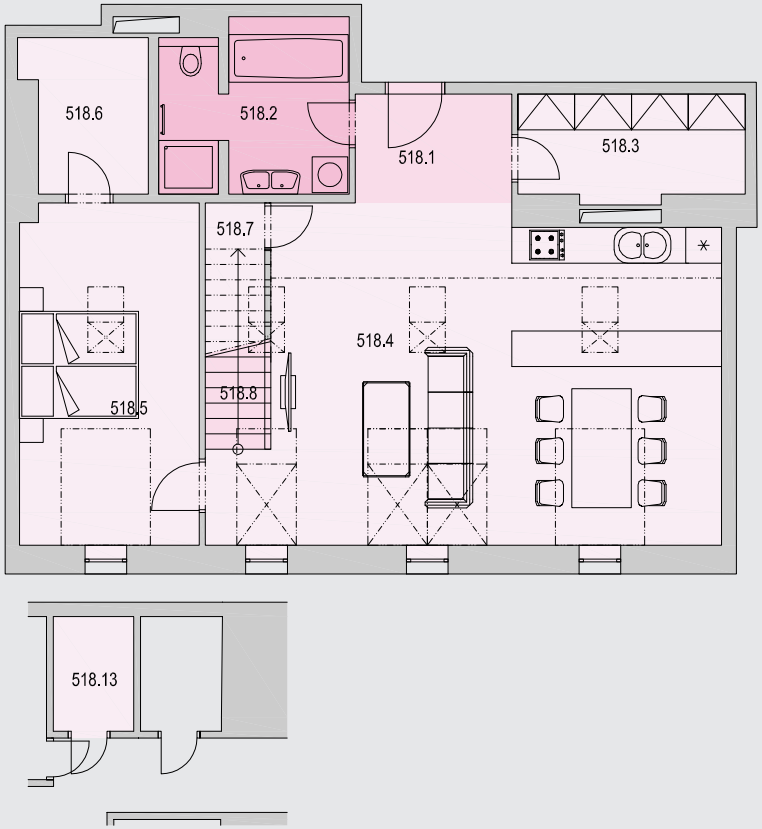


5th floor+6th floor/135,2sqm MAISONETTE 3+k

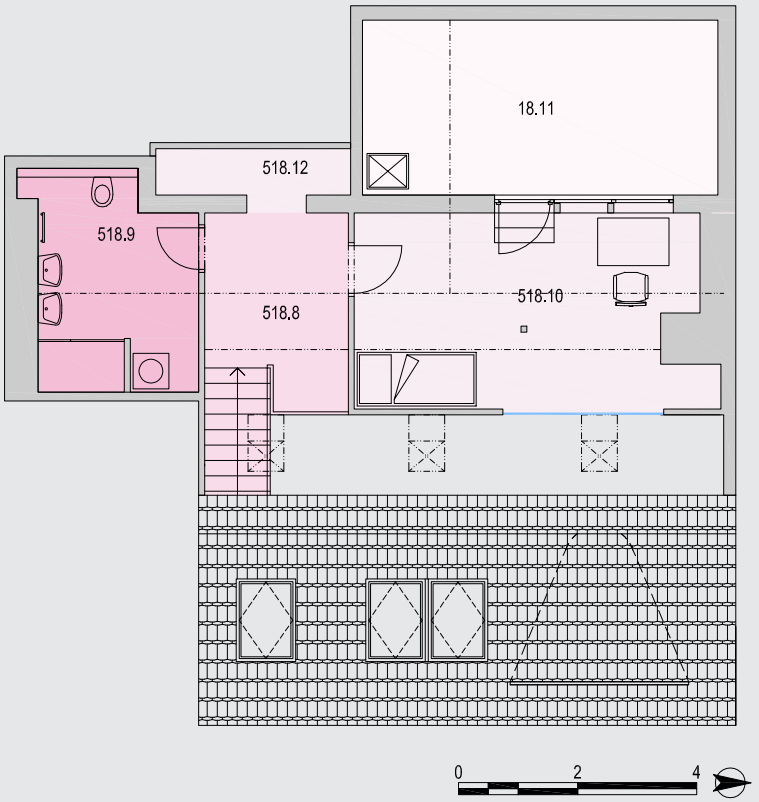
518.1	corridor	4,8sqm
518.2	bathroom	8,8sqm
518.3	dressing room	6,7sqm
518.4	living room +kitchen	43,9sqm
518.5	room	17,2sqm
518.6	dressing room	5,1sqm
518.7	pantry	2,3sqm
518.8	corridor	11,6sqm
518.9	bathroom	9,6sqm
518.10	room	19,6sqm
518.12	pantry	2,9sqm
518.13	cellar	2,7sqm
*518.11	terrace	17,9sqm

* it is not included in the total area of the units

5th floor



6th floor



Areas of the individual rooms are for reference only. Interior equipment shown on the floor plan is not included.

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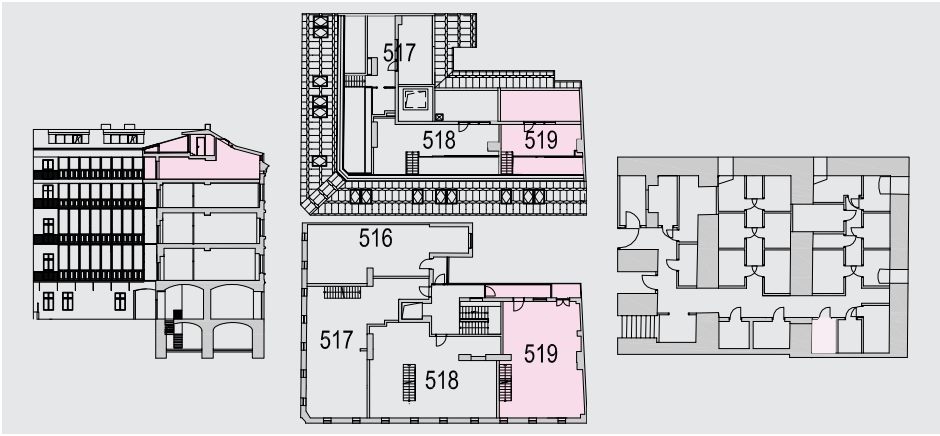
ARBESOVA REZIDENCE

apartment 519

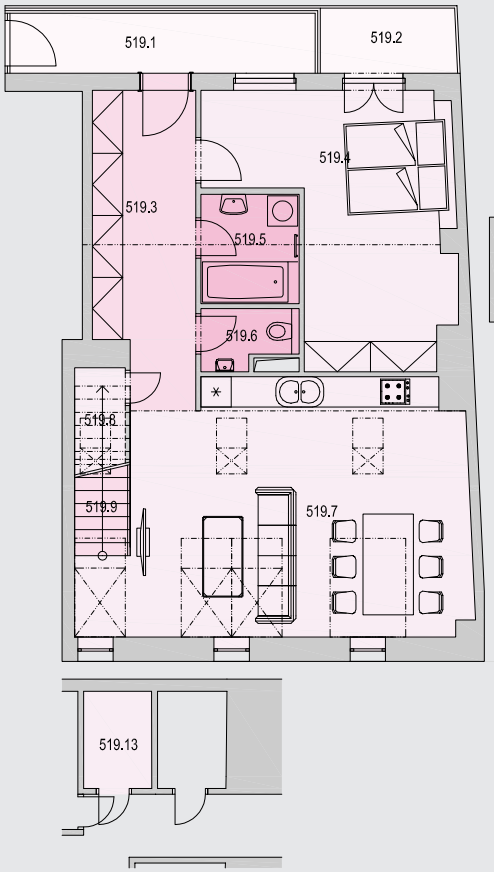


5th floor+6th floor/111,4sqm MAISONETTE 3+k

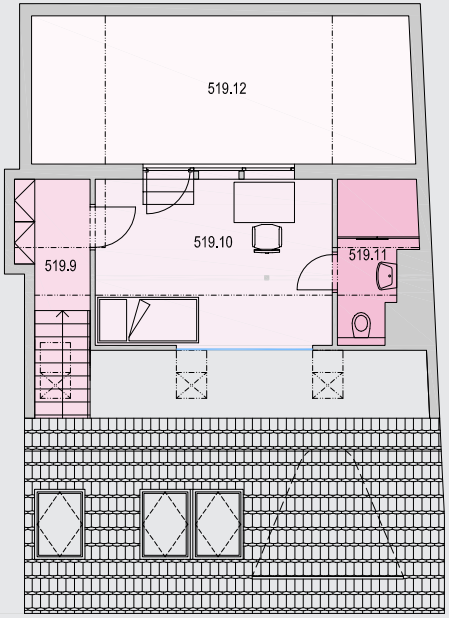
519.1	glazed balcony	7,5sqm
519.3	corridor	12,0sqm
519.4	room	20,3sqm
519.5	bathroom	4,2sqm
519.6	WC	2,1sqm
519.7	living room +kitchen	35,1sqm
519.8	pantry	1,8sqm
519.9	corridor	7,8sqm
519.10	room	16,3sqm
519.11	bathroom	4,3sqm
519.13	cellar	2,6sqm
*519.2	balcony	3,7sqm
*519.12	terrace	22,6sqm

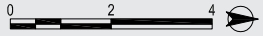
* it is not included in the total area of the units

5th floor



6th floor





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