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Accessibility and Viability of Rotterdam Central District

More priority to cyclists and pedestrians in the Delftseplein and the Conradstraat

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Bachelor thesis report

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Preface

This thesis is submitted in partial fulfilment of the requirements for a Bachelor's Degree in Civil engineering for the author. The reasons for selecting Rotterdam are the close proximity of the author living in Delft, using the Central Station weekly and the fact that the station building is now one of the architectural icons of Rotterdam. The literature of this thesis is based on earlier studies and articles included with references to assumptions that are made.

This study report provides a solution to the current and future traffic problems in the Delftseplein and the Conradstraat. It results a redesign of these streets with an improved accessibility, combining functions and a mix of living and environment. This thesis is in interest to city planners, city-centre managers and all those involved or fascinated in the redevelopment of the area around the Central Station of Rotterdam.

I would like to thank Ir. R. Koster and Dr. Ir. Y. Yuan for their time and support during the fulfilment of my thesis. Their advice and critical reflection on my earlier assumptions stimulated me in my progress and gave a positive boost to my achievements during my report study.

Delft, June 2018

Lise Andringa

Summary

Access to services, information, goods and people are the source of economic development in cities. The more efficient this access, the better the economic benefits and the higher the networking advantages. How cities facilitate accessibility through their infrastructure and urban environment impacts directly on other measures of human development and well-being. The issue on how to achieve an accessible and viable city centre is a familiar problem for several cities.

Rotterdam is interesting to provide research on, due to its just renovated Central Station, international gateway and well-knowns as a bicycle city. The report focuses on the area Rotterdam Central District, particularly the Delftseplein and the Conradstraat. Streets that are adjacent to the railway station terminal, situated in the south side area of the Central Station of Rotterdam. There are several reasons for this report focus. Firstly, the station area being particularly limited while the intensity of use is extremely high. Secondly, the attractive location of these streets, being next to the just renovated Central Station. As a result, there are plans of constructing new buildings in the streets. Consisting of the purpose of housing new companies and residents. (Gemeente Rotterdam, 2017) In the current situation the public transport systems are dominating and there is also an extreme lack of parking places for cyclists in the Delftseplein and the Conradstraat.

The following research question is central to this report: *Which measures can be taken to improve the accessibility and viability of Rotterdam Central District?* Mainly focussing on: *How can we redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians and give them more priority.* Therefore, the stakeholders that are concerned in the report study area, the statement of requirements stated by the municipality of Rotterdam and reference projects are taken into consideration. This to ensure that improvements are made within awareness of all the relevant information.

Consequently, three alternatives are established by testing against the following seven criteria. First, for places to be well-used and loved they must be safe, comfortable, varied and attractive. Second, the new development should enrich the qualities of existing urban places. Thirdly, places need to be easy to get to and visually with their surroundings. Fourth, the natural and manmade environment and utilise each site's intrinsic resources. Fifth, stimulating and convenient places meet a variety of demands from a wide range of users and social groups. Sixth, to be developable and well cared for it must be economically viable, well managed and maintained. Lastly, new development needs to be adaptable to future changes in use.

Accordingly, the assessment of the three designs shows that design 3, using different levels for traffic, provides the highest final score. Especially in the criteria of places for people, enrich of the existing and mix of uses and forms. It introduces a partly underground bicycle lane that is connected to the existing and new bicycle parking garage beneath the Central Station of Rotterdam. An underground bicycle roundabout beneath the Central Station provides a connection between the Delftseplein, the Conradstraat and the north side of the Central Station. In the Delftseplein the car lanes, kiss & ride places and taxi stands are moved to one level below the ground. The bus station in the Conradstraat is moved to one level above the ground. As a result, an expansion and improvement of the boulevards and a liveable area in both the streets is created.

However, design 1, the use of underground bicycle lanes, delivers also an high final score. Particularly interesting are the criteria scores of manage the investment. To provide the most suitable solution to the report problem it is essential to pay some attention to this. Besides this, design 3 already consist partly of components of design 1, the underground bicycle lanes and roundabout. It is not attractive to use more elements of design 1 or 2 in the final result of this report, since this will bring disadvantages to other criteria.

To conclude, taking all the interpretations that are stated above in consideration, it is recommend to choose alternative 3 as redesign for the existing situation and solution to this report study. This result prevents Rotterdam Central District from infrastructure and traffic problems in the future. Especially when looking to the future increase of the cyclists and pedestrian flow in the Delftseplein and the Conradstraat. In addition, moving the bus station to one level above the ground gives the opportunity to make it a landmark or eye catcher next to the international gateway of Rotterdam.

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1. Introduction

The infrastructure and the urban environment is essential for a city centre. The quality of a city centre depends for an important part on the quality of the transport planning. A well thought-out planning provides new viewpoints and reflective frameworks to help city organisers, designers and city residents that form the city's future. From economic point of view, strengthening the inner city interaction environment, the communication and reacting of people to each other, is the most important mobility issue. Looking to the inner city, excellent accommodation quality for both housing residents as companies and optimal accessibility and viability is crucial.

The city of Rotterdam is besides its international gateway also a recognised bicycle city. Because the number of cyclist has risen spectacularly and still is. (Rotterdam Gemeente , 2016) The south side of the area around the Central Station in Rotterdam is also known as Rotterdam Central District. This is a dynamic and attractive entrance from the Central Station to the city centre of Rotterdam. Station areas are exceptionally interesting to city organisers and designers. Due to the fact that the space is particularly limited, while the intensity of use is extremely high. The conflict between mobility and the quality of life is a familiar problem for several cities. This issue on how to achieve an accessible and viable city centre can be tackled by improving connections, air quality, safety, beauty, noise and sustainability.

This report focuses on Rotterdam Central District, especially the Delftseplein and the Conradstraat. These are streets adjacent to the station terminal and form an important entrance route to the Central Station. Due to the attractive location near the just renovated Central Station, new buildings determined for housing companies and residents will be constructed in these streets. (Gemeente Rotterdam [1], 2017) This results in problems, because currently the public transport system is dominating and the number of travellers to the Central Station is already increasing. The future traffic flow in Rotterdam Central District is even expected to triplet in less than 10 years. (Besselink J., 2016). The purpose of this report is to find a solution to this problem, with the research question: *Which measures can be taken to improve the accessibility and viability in Rotterdam Central District?*

To realise this, it is necessary to create more consistency in the streets for both cyclists as pedestrians. Currently, the tram and car are dominating in the Delftseplein and the bus in the Conradstraat. On top of that, there is also an extreme lack of parking places for cyclist. Accordingly, the user-friendliness of these streets need to improve. For these reasons, this report mainly focusses on: *Redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians and give them more priority.* During the report a social-geography approximation method is used to approach the design. This method contains a number of steps based on design dilemmas. As a result, the outcome can be optimally tailored to its main function. To generate a design that requires the most accurate solution to the report problem, three designs are created and tested by several criteria.

The report is divided into seven sections. Following this introduction, the second section defines the analysis that is approximately for this report. The third section introduces the design approach, the method that is used to investigate the research problem. The fourth section consist of the results, the solution for the research problem, where knowledge insight and practices comes together. The fifth section provides the evaluation of the designs by criteria. The sixth section discusses the design process used in this report. The seventh section presents some concluding remarks of the report and consist some recommendations for the municipality of Rotterdam.

It is important to know why certain design decisions and methods are used in the report. This to ensure that improvements are made with awareness of all the relevant information. For this reason, the Annexes provide further information about the Mixone project, the Stakeholders, Reference projects, Statement of Requirements, the Public transport system of Rotterdam Central District, the future pedestrian flows during the day, the Urban Design Compendium, the Cross Sections of the existing and three redesigns and the extensive explanation of the performance level for each criteria of each design can be found.

2. Analysis

This chapter elaborates the analysis of the report study. Firstly, the area is described to elaborate the motivation of the report. The second section introduces the research focus. In the third section the research problem is defined. Finally, the fifth section describes the objectives of the report.

2.1 Area description

Rotterdam is the Netherlands' second largest city and well known by its international gateway for users of the public transport network. The city centre is relatively young, most of the inner city was lost when it was bombed in 1940 during the war. Over the last 10 years, the number of cyclists in Rotterdam has risen spectacularly, while car traffic from and to the city centre is decreasing. This results in bottlenecks in the network for cyclists and pedestrians. (Rotterdam Gemeente , 2016) Currently, 110,000 travellers go through the Central Station every day by HSL, train, metro, tram, bus, taxi and bicycle. A figure that is set to increase to 320,000 by 2030. (Besselink J., 2016).

The space in station areas are particularly limited, while the intensity of use is higher than other parts of the city. That is why station area development is extremely crucial for the municipality of Rotterdam. The south side of the station area of Rotterdam is also called, Rotterdam Central District (RCD). (Kruit C. 2017) The location of the RCD is shown with the red lines in figure 2.1.

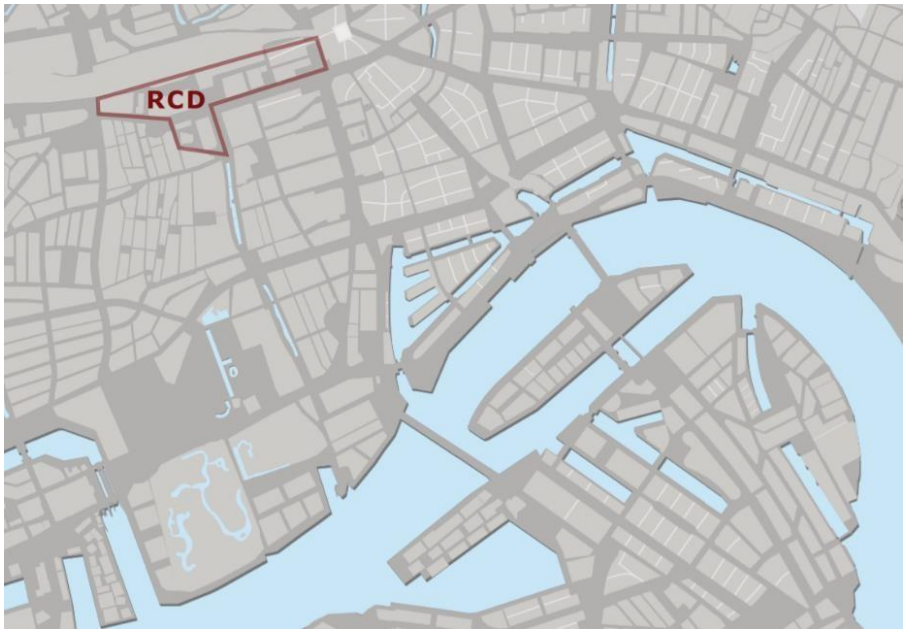

Figure 2.1: Location Rotterdam Central District (RCD) in the city of Rotterdam (Coppens C. , 2017)

The RCD is a dynamic and attractive entrance for the city centre of Rotterdam. In figure 2 the most important streets of the RCD are shown. So far there has been renovated, transformed and invested in the Central station and the outdoor space. To increase the accessibility and viability of the RCD, a few projects are already complete. For example, the renovation of the public transport system around the Central Station, also known as the Weena Global District. But also, the Kruispleingarage, the new bicycle parking garage underneath the Central Station . (Rotterdam Gemeente [2], 2017). It is now crucial to give more attention to the accessibility and viability of the streets around the Weena, in the area Rotterdam Central District.

The world around us is changed and that also affects the next step required for Rotterdam Central District. The economy flows again and there is a lot of interest in Rotterdam. (Rotterdam Gemeente [2], 2017) It has been 10 years since the first redevelopment plan of the RDC, consisting mainly of improving the area around the Weena, the so called Weena Glocal District. The outdoor space is almost completed.

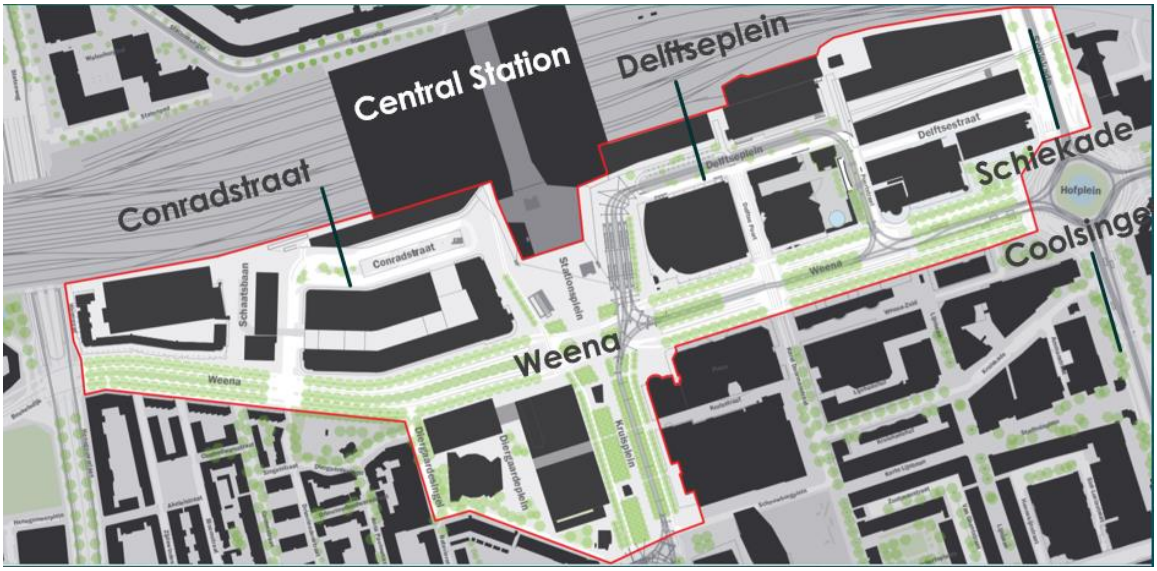

Figure 2.2: Rotterdam Central District with the most important streets (Rotterdam Gemeente , 2010)

The design of the Delftseplein and the Conradstraat are still temporary facilities, due to the fact that they are planning to construct two new buildings in this area. This building project is also called 'Mixone', further elaborated in Annex A. The purpose of these buildings is housing new companies and residents. The high potential for housing new companies and residents in these streets has several reasons. The attractive location next to the Central Station. On top of that, the improved area around the Central Station resulted in an pleasant living environment.

2.2 Research focus

The research focus in Rotterdam Central District will be on the Delftseplein and the Conradstraat, shown in figure 2.2. These streets are adjacent to the station terminal and parallel to the important main traffic street, the Weena. Besides the Weena, these streets are important urban entrance routes to the Central Station.

There are several reasons for the focus being on particular these two streets. Firstly, as stated before in Section 2.1 , over the years, the number of travellers in the area RCD will increase. Therefore the access to the Central Station should expand. Currently, the Weena is the central connection to the Central Station for cyclists and pedestrians. Because the public transport systems are dominating in the Delftseplein and the Conradstraat. On top of that, there is an extreme lack of parking places for cars and cyclists. Consequently, to develop the access of the Central station, it is necessary to improve the approachability of the Delftseplein and the Conradstraat.

Secondly, as stated before in Section 2.1, these streets has an high potential of housing new companies and residents. Consequently, these new buildings will bring a new dimension and increase the use.

2.3 Problem definition

Access to services, information, goods and people are the source of economic development in cities. The more efficient this access, the better the economic benefits and the higher the networking advantages. How cities facilitate accessibility through their infrastructure and urban environment impacts directly on other measures of human development and well-being.

The issue on how to achieve an accessible and viable city centre is a well-known problem for several cities. Accessibility can be defined as 'the opportunity for interaction, the ease with which people can reach distant but necessary services, the ability of people to reach destinations at which they can carry out a given activity. (Van Nes R., 2016). The way in which cities facilitate accessibility through their transport system directly impacts in higher levels of productivity.

Consequently, this also impacts directly on other measures of well-being and human development. Viability can be defined by the ability to continue to exist or develop'. Crucial themes are; air quality, sound, social and community participation, movement, recreation and safety.

An important task to take into consideration, is to find a balance in the use of transport systems. This consists of shaping more continuity in the streets for cyclists and pedestrians, but not losing sight of the car, the tram or the bus. At the moment the tram, the bus and the car are dominating in these streets and there is an extreme lack of parking places for cyclist. This results in the following research question;

Research question: *Which measures can be taken to improve the accessibility and viability in Rotterdam Central District?*

2.4 Objectives

To find a solution to the research question as stated in Section 2.3, the following aims need to be taken into consideration:

-Provide a better cohesion between the different traffic flows in the street.

> Currently, the tram, bus and car are dominating in these streets. The balance between the public transport traffic flow and the bicycle and pedestrian flows need to be improved. This to create more user-friendlier area for the bicycles and pedestrians.

-Create more parking places for bicycle.

> At the moment, there is an extreme lack of parking places for cyclist.

-Improve the public accessible environment of the area.

> This can be done by generating a fitting mix of living and environment. The realization of a public accessible environment consists of an attractive residential. An improvement of the vitality in the area is required.

To find an answer to the research question, specific actions are considered. Due to the aims stated above the following objectives can be defined:

-How can we combine the different traffic flows?

-What are the most suitable locations to create more parking places for bicycles?

-How can we create a more attractive and liveable environment?

The objectives guide the specific report actions. This consists of achieving more attractive streets and higher quality of use. The challenge lies to redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians, so that the quality of stay improves. The overall objective results in the main focus of the study:

Main focus of the report: *Redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians and give them more priority.*

3. Design Approach

The design process forms the way through which new knowledge, insight and practices comes together. The purpose of the design is to improve the accessibility and viability in the area Rotterdam Central District. The focus will be on the Delftseplein and the Conradstraat, due to the important urban entrance routes to the Central Station and high potential for housing new companies as stated in Section 2.2.

To find a solution to the research question stated in Section 2.3, '*Which measures can be taken to improve the accessibility and viability in Rotterdam Central District*?', a more sustainable and liveable environment needs to be created. The design should consist of an high approachability, combining functions and a mix of living and environment. As stated in Section 2.4 the main focus of the report consist of '*Redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians and give them more priority*'.

During the design approach both the Stakeholders that are concerned in this project; specified in Annex B as the Statement of Requirements; defined in Annex C, are taken into consideration. Because it is important to know why certain design decisions and methods are used in the design process. This to ensure that the improvements are made within awareness of all the relevant information.

This chapter is divided into three sections. First, the existing design is analysed. The second section describes the general approach of the report. Finally, the third section describes the design criteria. This is important, since the different alternatives need to be evaluated and compared further in the report study.

3.1 Design Analysis

As stated before in Section 2.1, the existing network will encounter some changes. There are plans to construct two new buildings, one in the Delftseplein and another one in the Conradstraat. With a purpose of housing new companies and residents. (Rotterdam Gemeente [1], 2017) . This building project is further elaborate in Annex A, the so called 'Mixone project'. For this reason, it is important to define the impact that the adjustment of the buildings will bring to the existing network of the Delftseplein and the Conradstraat.

The existing network and the changes that it will encounter in the future need to be analysed. This is done for both the Delftseplein as well as the Conradstraat. Secondly, a map of the total study area is figured. After this, a street map is provided of the current situation. Subsequently, an analyse of the future pedestrian flow and the future bicycle flow are made. This will be done by using the future functional analysis of the area around the Central Station in Rotterdam. Based on the available space and volume of the transport system. While improving the present design, it can be valuable to re-use existing elements of the transport system.

3.1.1 The Delftseplein

Firstly, the existing network is analysed. The Delftseplein forms an important link between the pedestrian flows coming from and to the eastern exit of Rotterdam Central on the north side. On the other side the Delftseplein connects the Coolsingel and Schiekade, shown in figure 2.2, to the Central Station. These are important city boulevards and long traffic lines through the city of Rotterdam that connects directly to the urban entrance routes. On top of that, the trams runs across the Delftseplein and stops east of the station terminal. There are also Kiss & Ride places for cars located in this street.

The function of the tram system in the Delftseplein needs to be retained. As stated in Section 2.1, the tram system is just redeveloped in 2016. Due to this fact, in this report study the existing horizontal alignment, location of the tram stop and the intersection of the existing public tram system of Rotterdam Central District will be re-used. This tram system contains two rails in both direction, further illustration of the public transport system in Rotterdam Central District can be found in Annex E. (RET, 2017)

Besides the fact that the Delftseplein already is the most important connection between the Central Station of Rotterdam and the Schiekadeblok. The Delftseplein will also become a destination, due to the adjoining

buildings. As a result, the street will turn out to be more lively by the increase and diverse of users. With the new building also a new underground carparking garage will be included to the street. Further information about the precise location of the parking garage can be found in Annex A, (Rotterdam Gemeente [1] , 2017)

3.1.2 The Conradstraat

In the existing network, the Conradstraat is located besides the western exit of Rotterdam Central on the south side. But also the bus station and the bicycle tunnel that runs through the Central station from north to south are positioned in this street. The location of the bicycle tunnel beneath the Central Station is shown in pink in figure 3.1. (Philippe Samyn and Partners ,2003)

Secondly, the impact that the buildings brings to the street is analysed. The Conradstraat occupies a position of its own due to the domination of the bus station, this needs to be retained. As stated in Section 2.1, also the bus station is just redeveloped in 2016. Due to this fact, in this report study the existing bus system will be re-used. The bus station that is currently located in the Conradstraat consist of eight different bus stops. (RET, 2017) This will be retained, by applying the existing public transport system in Rotterdam Central District, illustrated in Annex E.

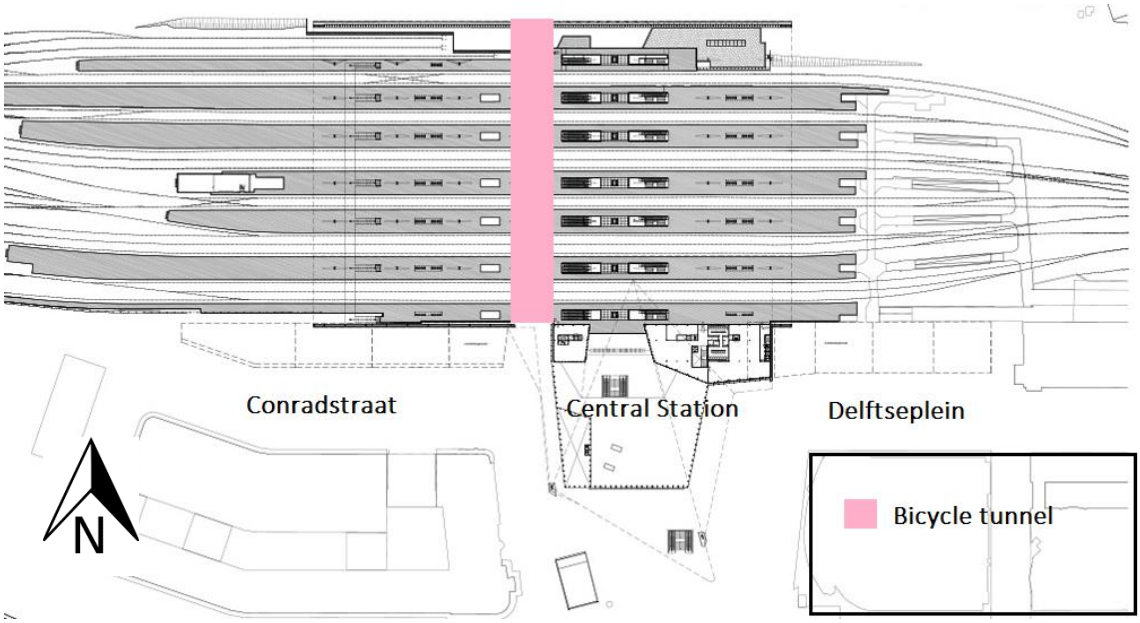

Figure 3.1: The Conradstraat and the Delftseplein that are located in the south side of the Central Station are illustrated. The location of the bicycle tunnel that goes beneath the Central Station of Rotterdam, connecting the north and south side, is shown in pink. (Philippe Samyn and Partners ,2003)

The new building in the Conradstraat will ensure that the passengers of the bus station can use the same type of functions as can be found in the station. However, it will also become a destination for many visitors. On top of that, it will also introduce an new entrance of the underground parking garage for bicycles, that is located beneath the new building. Further information about the precise location of the parking garage can be found in Annex A, (Rotterdam Gemeente [1] , 2017)

3.1.3 Map of the report area

To get a more realistic view of the different road users in the report area several cross sections in both the Delftseplein as the Conradstraat are created for each design that is established in Chapter 4. The locations of the cross sections that are used during the visualisation of the solutions are shown in a map. The wide for each cross section is included in the map. The report focus area consist of the Delftseplein and the Conradstraat. Figure 3.2 contains the map of the Delftseplein. Figure 3.3 shows the map of the Conradstraat. A map overview of both the Delftseplein as well as the Conradstraat can be found in Annex G.

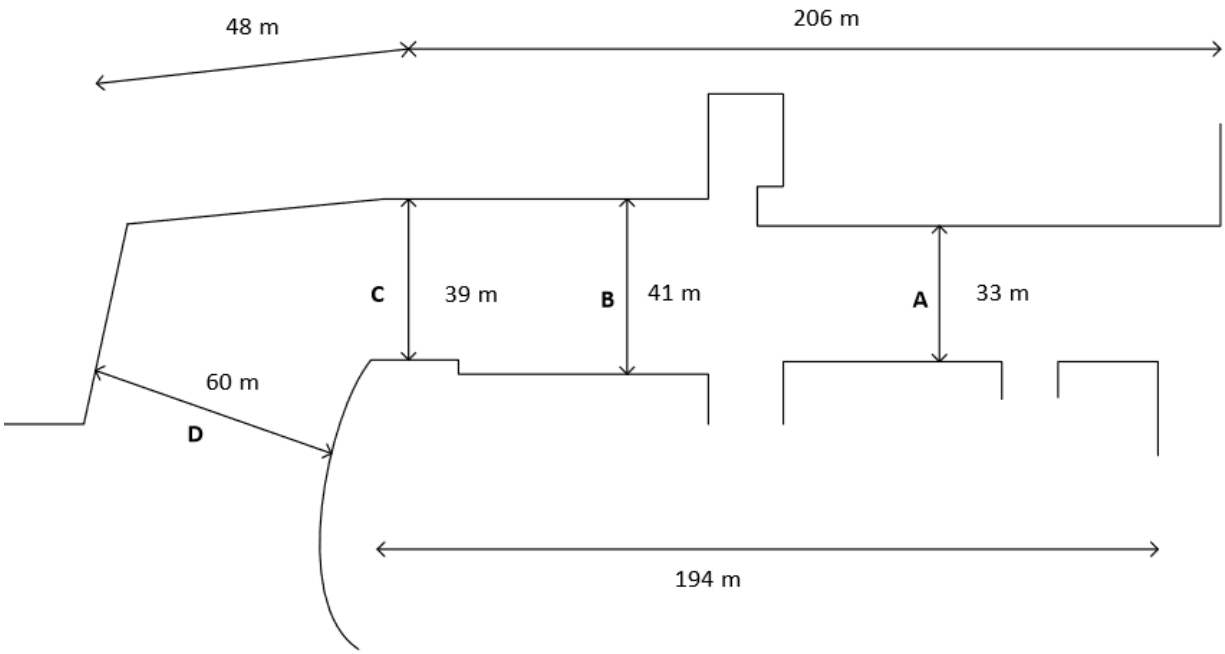

Figure 3.2: Map of the Delftseplein. The different cross sections are shown with A, B, C, D including the wide for each cross section.

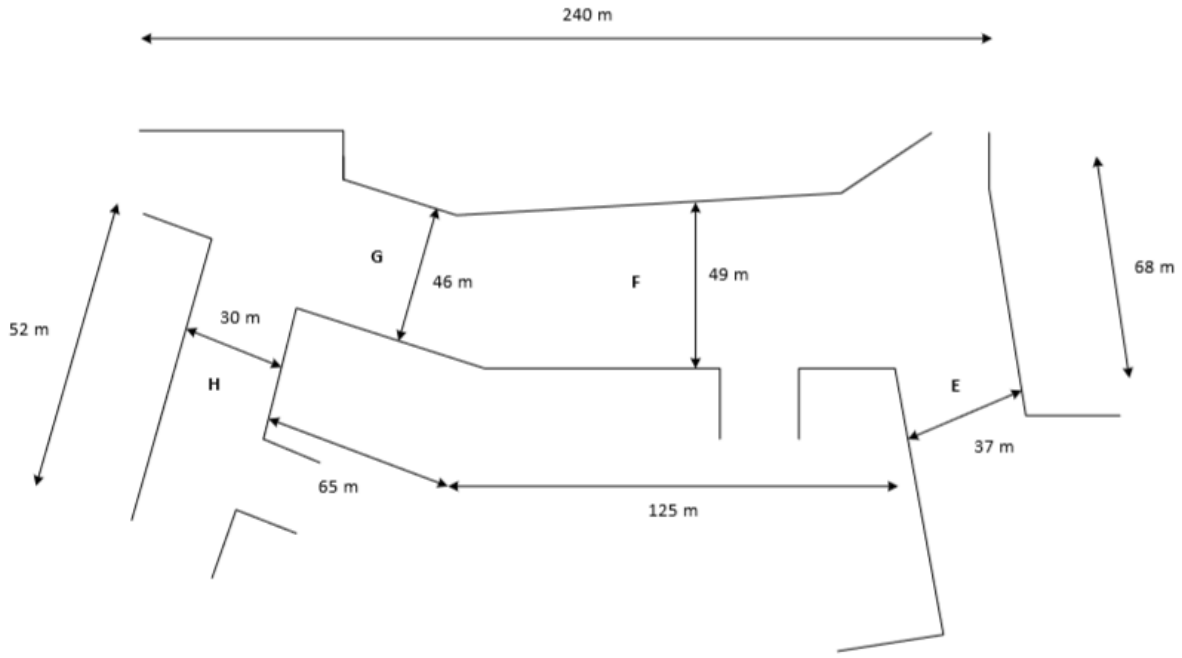

Figure 3.3: Map of the Conradstraat. The different cross sections are shown with E, F, G, H including the wide for each cross section.

3.1.4 Street map of the current situation

Before the designs are further elaborate in Chapter 4, it is necessary to understand the existing situation. For that reason, the street map of the existing situation of both the Delftseplein as the Conradstraat is visualised in figure 3.4. To get a better view of the Delftseplein cross section C is provided in figure 3.5. The cross section of the Conradstraat is shown in figure 3.6. In Annex I all the cross sections of the current design of both the Delftseplein as the Conradstraat can be found.

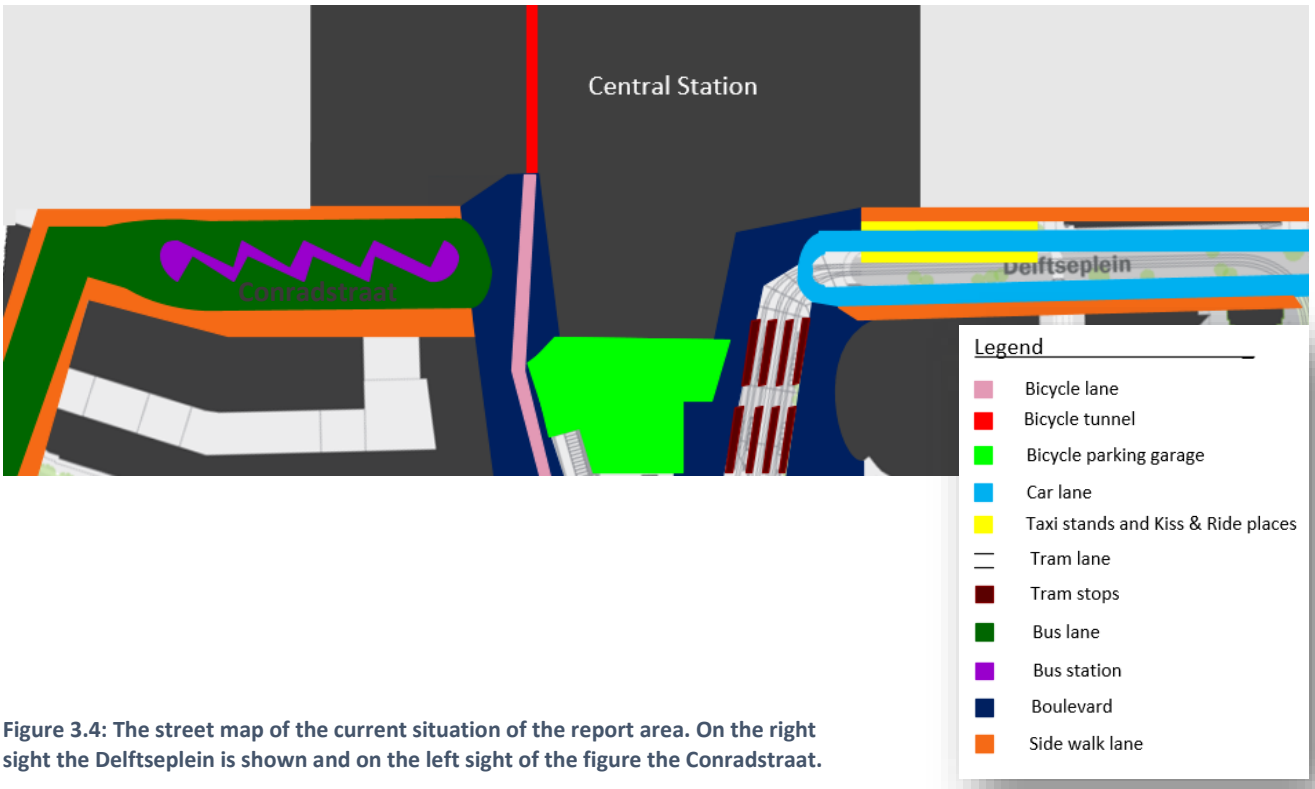

Figure 3.4: The street map of the current situation of the report area. On the right sight the Delftseplein is shown and on the left sight of the figure the Conradstraat.

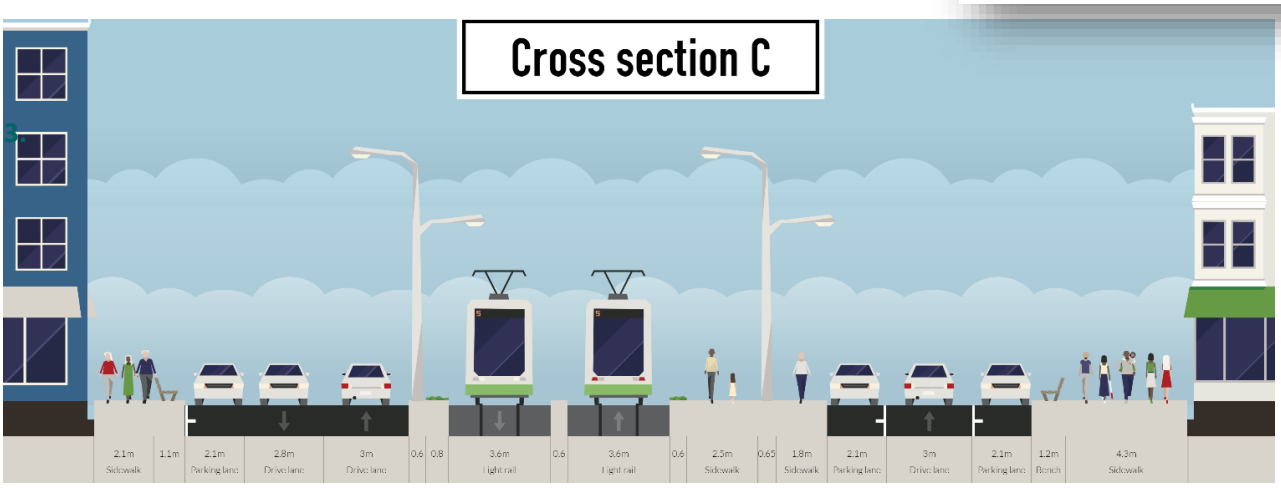

Figure 3.5. Cross section C. The width of this part of the Delftseplein contains 39 m.

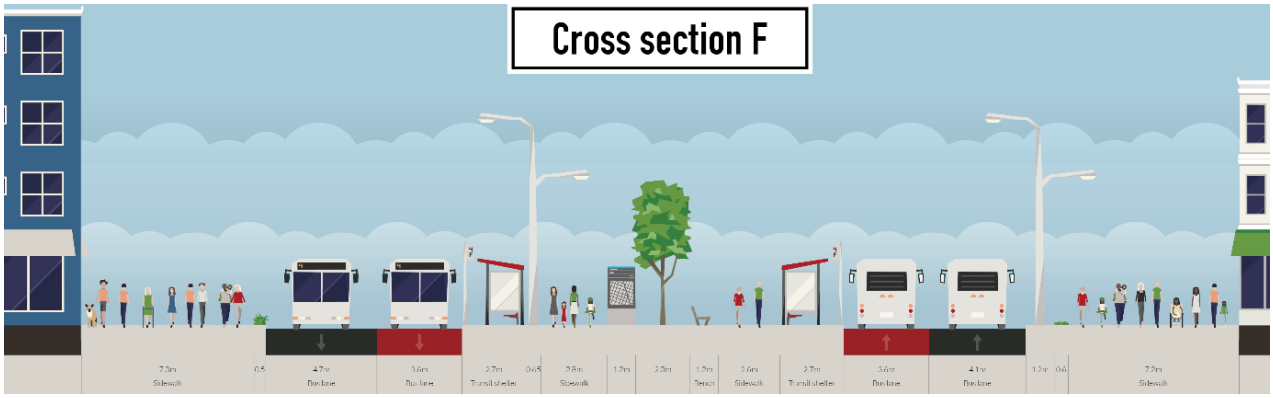

Figure 3.6. Cross section F. The width of this part of the Conradstraat contains 49 m.

3.1.5 The pedestrian flow in the area around the Central Station

To get a view of the volume of the pedestrians that uses the Delftseplein and the Conradstraat, the pedestrian flow in 2025 in the area around the Delftseplein and the Conradstraat is illustrated in figure 3.7. (Van Oorschot K. , 2017) Further information about the future pedestrian flow for the future in this area, during the day can be found in Annex E.

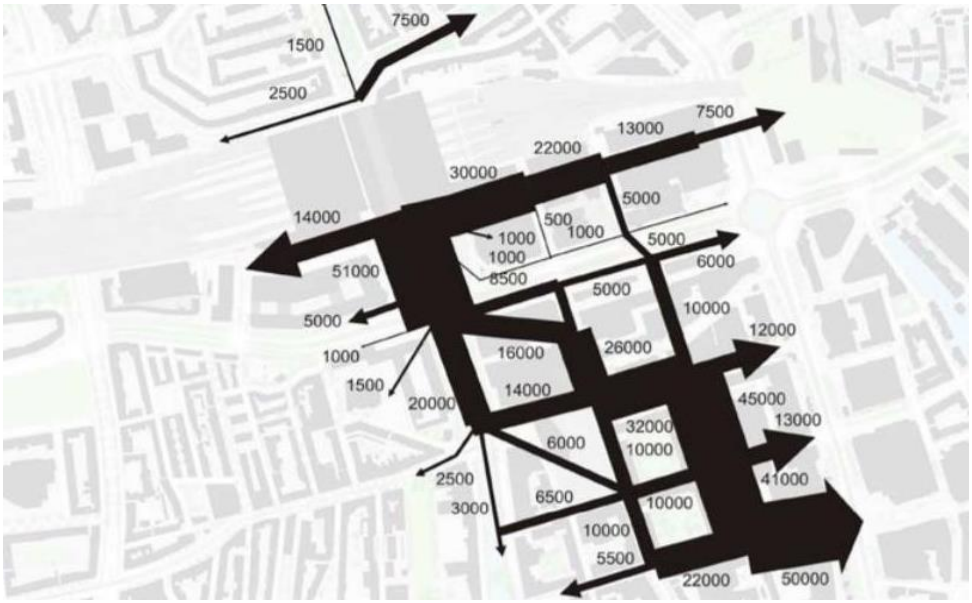

Figure 3.7: Predicted pedestrian flow for the year 2025 during a normal work day in the area around the Central Station of Rotterdam. (Van Oorschot K. , 2017)

3.1.6 The bicycle flow in the area around the Central Station

During the design of the bicycle lane in both the Delftseplein as well as the Conradstraat a reference project about the north side redevelopment of the Central Station in Rotterdam is used (Bicycle Dutch [2], 2017) This reference project is further elaborate in Annex D. In the north side they created a bi-directional bicycle lane of 3.5 metre wide. It is important to take this project as reference, due to the bicycle tunnel that connects the north and south side of the Central Station of Rotterdam, shown in figure 3.1. As a result, the bicycle lanes that are introduced to the south side also consist of a bi-directional bicycle lane of 3.5 metre wide. This increases the quality of the area and results, by improving the structure.

Currently the Weena is the main and only entrance to the Central Station for bicycles. For that reason it is an important point to take into consideration when looking to the bicycle flow in Rotterdam Central District. On a weekday, through the Weena 8,247 people pass by on a bicycle. (Bicycle Dutch [1], 2017) As stated in Section 2.1, this amount of cyclists will triple by 2030. For this reason it is crucial to divide the bicycle flow over the Delftseplein, the Conradstraat and the Weena.

3.2 General Approach

Accessibility can be studied both by traffic engineering methods as well as the social- geography concept. In this report the social- geography approximation is used to find a solution to the research problem. (Van Nes R., 2016) This method contains a number of steps based on design dilemmas, that are followed in sequence.

This method provides a design that can be optimally tailored to its main function. Particularly in this report study, the focus on giving more priority to cyclists and pedestrians. Eventually, at a later stage of the design process, it is possible to combine different functions.

1. Purpose of the report study:

-Which measures can be taken to improve the accessibility and viability in the Delftseplein and the Conradstraat?

2. What is stationary?

-The way the housing of residents and companies are divided over the streets.

-Already existing underground parking facilities.

-The accessibility of the public areas in the station must be guaranteed.

-The function of the public transport system needs to be retained.

3. What is adjustable?

-The location of the public transport systems and stops.

-Population distribution.

-Spatial behaviour.

-Parking places for bicycles.

-Parking places for cars.

4. Orientation of the report study:

Giving the cyclists and pedestrians more priority, by designing the street in point of view of the cyclists and pedestrians. Currently the tram, bus and cars are dominating in these streets.

5. Redesign process:

In Chapter 4 three designs of the Delftseplein the Conradstraat are created. All the results are included with a report of explanations of the choices made during the design process. Each design consist of the following results:

1. Street map

   During the design process the program Microsoft Visio 2016, a drafting software application, is used to provide the map view of both the Delftseplein as the Conradstraat. The position of the transport systems are presented in this street map.

2. Cross sections

   The location of the different cross sections in the Delftseplein are shown in figure 3.2, the same for the Conradstraat in figure 3.3. The cross sections are visualised with the program 'Streetmix' (Streetmix, 2018).

3. Plausibility check

   A reasonableness check for the design is made. This is done by using the design guidelines confirmed by (CROW, 2013), (CROW, 2014) and (CROW, 2017).

3.3 Design Criteria

The challenge in the redevelopment of the streets lies in finding a design that meets all objectives as well as possible. Several designs will be established, to make the decision process more efficient. This section consist of two steps, first the explanation of the methodology that is used during this report study. Secondly the design criteria's are further elaborate. Finally in Chapter 5 a schematic evaluation criteria table will be determined that includes the levelling of the different criteria.

For the purpose of this report study, the evaluation criteria need to consist of mobility, environmental and social-economic aspects of urban planning. The main focus will be on giving more priority to cyclists and pedestrians. However, also the public space and the urban plan are extremely important in the design, due to its great encouragement on the future growth of the city. (Hillier, 1996) To establish an appropriate public space quality evaluation method, different methodologies are used to compare with. Its difficulty lies in guaranteeing the link between a suitable design vision and a successful result. (Gil J. & Pinto Duarte J. , 2008)

For that reason, during this report study the design guidelines of 'Urban Design Compendium' (Yeang, 2000) are used. This guidance provides how to achieve and assess the highest quality of the urban design. The design criteria used in the 'Urban Design Compendium' are provided with reference to other design documents. Further information about the 'Urban Design Compendium' and the establishment can be found in Annex H.

Secondly, the evaluation consist of a table that gives a schematic overview of the evaluation criteria that are used during the report study. (Sousa P., 2011). In accordance with the 'Urban Design Compendium' the different criteria are divided with the same weightings. Besides that, each criterion has different levels to assign an adequate score for each criterion. (Yeang, 2000) The different performance levels consist of the following score range: failed (0-20%), sufficient (21-40%), adequate (41-60%), good (61-80%), excellent (81-100%). The highest final grade results in the design that gives the solution to the research question of this report study. This evaluation process and the levelling of each criteria will be further elaborate in Chapter 5.

To provide a clear view of the requirements of each criterion some questions are formed. As a result an more appropriate percentage of the performance level can be generated. The questions are as follows:

Places for People:

-How much is the user-friendly of the area improved?

-How is the approachability of the public area?

-In what way is the viability improved as much as mandatory?

-How is the social security guaranteed in the area?

-What can be concluded about the attractiveness of the atmosphere of the boulevards?

Enrich the Existing:

-How much priority is there provided to the cyclists and pedestrians?

-In what way is function of the transport system retained as much as obligated?

-What can be concluded about the availability of the public places that are located in the station?

-How generous and inviting are the created bicycles parking places?

Make Connections:

-How well is the transition between the different transport systems managed?

-How much is the accessibility in the area improved?

-What can be determined about the locations that are used for bicycle parking?

-In what way are the new residents of the building able to load and unload in the street?

Work with the Landscape:

-On what level is the environment more attractive and liveable?

-What can be concluded about the amount of vegetation offered in the area?

Mix Uses and Forms:

-How much continuity in there created in both the streets?

-What are the abilities of use in the evening hours?

-In what way are the users and functions reinforcing each other?

-How significant are the different public transport systems well- combined?

Manage the Investment:

-How much is the cost estimation of the solution?

-What can be said about the economically viability of the design?

-What are the consequences for the area during the construction phase?

Design for Change:

-What are the possibilities for further development?

-What can be concluded about the environmentally conscious, consisting of energy and resource efficiency in the design.

4. Results

In this chapter three redesigns of the combination of the Delftseplein and the Conradstraat are created . The designs consist of high approachability, combining functions and a mix of living and environment. All the results will be included with explanation of the choices made during the design process.

Each design consist of the following results. First, a street map of the area that the report focusses on. Secondly, the cross sections on several positions in both the Delftseplein as the Conradstraat. The locations of the cross sections are illustrated in figure 3.2 and 3.3 of Section 3.1. Finally, a plausibility check will be done by using the design guidelines confirmed by (CROW, 2013), (CROW, 2014) and (CROW, 2017). In Chapter 5, the final design will be evaluate with the design criteria provided for this report study.

The existing situation and some important facts needs to be taken into consideration during the design phase. The street map of the current situation is shown in figure 3.4. The cross sections of the current situation of both the Delftseplein and the Conradstraat can be found in Annex I. In both the existing designs of the streets there are no bicycle lanes and an extreme lack of parking places for cars and bicycles. As a result, beneath the new buildings in the Delftseplein and the Conradstraat a bicycle and car parking garage will be managed. In addition, due to the new buildings that will be located in the Conradstraat, the streets will become a destination instead of only an entrance to the Central Station.

The Delftseplein is an access road that contains many transport systems. The tram system is just redeveloped in 2016. (RET, 2017) In this report study the existing horizontal alignment, location of the tram stop and the intersection of the existing public tram system of Rotterdam Central District will be retained in all the three designs. On top of that, the location near the Central Station and in the middle of the street results in the minimum walking distance for pedestrians from the Central Station and equally accessibility from both sides of the road. The Delftseplein is further analysed in Section 3.1.1.

The main function of the Conradstraat is the already located bus station, therefore the bus is dominating in this street. It is not possible to change enormous things about the dimension of the bus station, because it is too frequently used and important to the city. Further analyse of the Conradstraat can be found in Section 3.1.2

Before the three designs will be further elaborate, a table is established that gives a short summary of the key elements used in each design. The three solutions provided as a list are shown in table 4.1.

Table 4.1: Brief summary of the three designs. This is provided with a list that consist of every key element used in the design.

Brief summary of the results			
Design	1. Underground Bicycle Lanes	2. Shared Spaces	3. Split Levels
Key elements	-New bicycle lanes, partly underground in both the streets. -Bicycle roundabout located under the Central Station	-Shared bicycle/ bus lane. -Shared bicycle/ car lane.	-New bicycle lanes, only underground beneath the Central Station. -Bicycle roundabout located under the Central Station.
	-Tram system retained on ground level.	-Tram system retained on ground level.	-Tram system retained on ground level.
	-Bus station retained on ground level.	-Bus station retained on ground level.	-Bus station on one level above the ground.
	-Car lane retained on ground level. - Kiss & ride stands retained on ground level. - Taxi stands retained on ground Level.	-Shared car/ bicycle lane. -Kiss & ride stands retained on ground level. -Taxi stands retained on ground level.	-Car lane on one level below the ground, connected to parking garage. -Kiss & ride places on one level below the ground . -Taxi stands on one level below the ground.

4.1 Design 1: Underground Bicycle lanes

The first design consist of an expansion of the already existing bicycle tunnel beneath the Central Station. The street map of this solution is shown in figure 4.1. The cross sections of Design 1 can be found in Annex J. It provides underground bicycle lanes with access to the Delftseplein, the Conradstraat, the existing and new underground bicycle parking facilities beneath the Central Station of Rotterdam and the north side area of the Central Station. This is done, due to the main focus of the report study, giving more priority to cyclist and pedestrians.

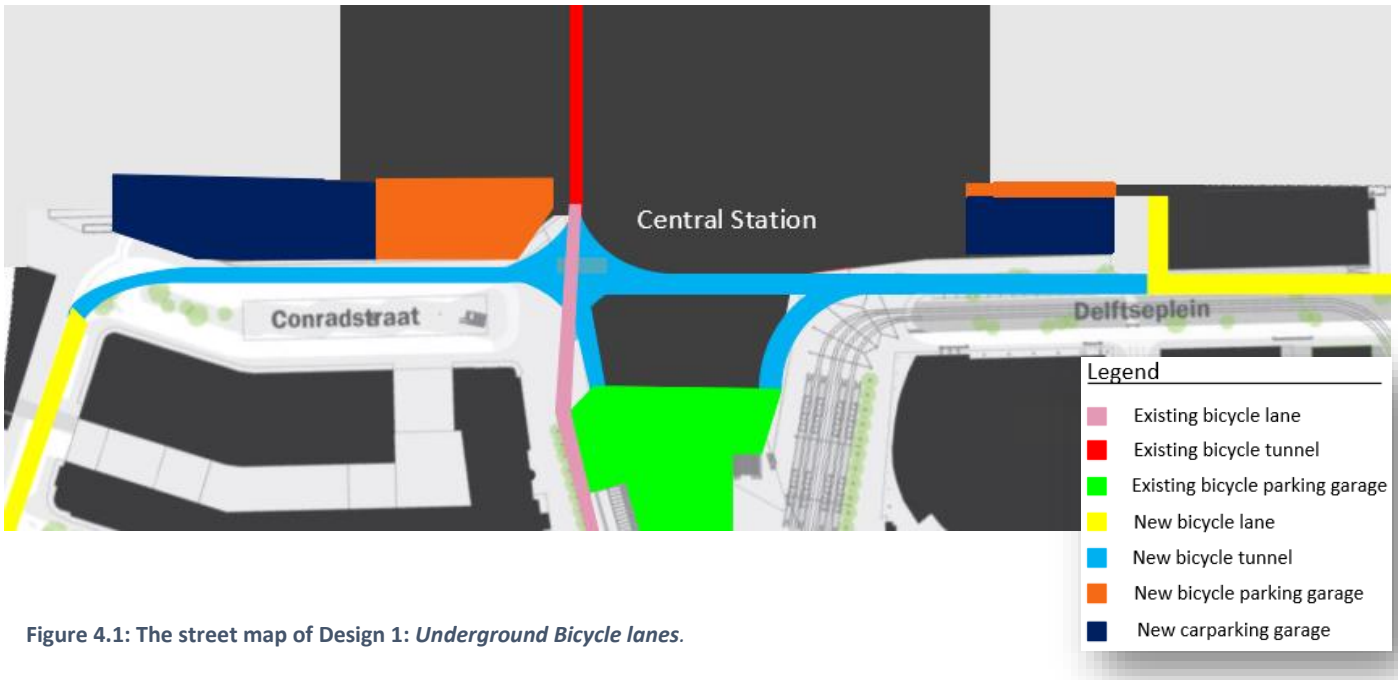

Figure 4.1: The street map of Design 1: *Underground Bicycle lanes*.

It is possible to construct the underground bicycle lane at that exact location beneath the Central Station, because it is next to the already existing underground metro system and bicycle parking facilities. The current hall of the Central Station on ground level will be located on top of it. As a result, the underground bicycle lane can be connected to the existing bicycle tunnel, that already is located under the Central Station. To realise this connection between the existing and new bicycle tunnel, an underground bicycle roundabout is used. As indication, the bicycle roundabout located on the Wilhelminakade/ Prinsesseweg in Groningen is used as reference. (Gemeente Groningen, 2017) The berms in the inner corner force cyclists to already follow the cycle path. This to make a safer crossing possible. Further information about this reference project can be found in Annex D.

The Delftseplein

This design provides an underground bicycle lane with access to the existing and new underground parking facilities that are located beneath the Central Station. As a result, the access to the Central Station for cyclists is extremely improved. Because the Central Station and parking facilities are approachable from all directions.

Not only the cyclist have better access to the Central Station, there is also more space for the pedestrians. On top of that, due to the extra area, a more attractive boulevard is created. The tram system, the Kiss & Ride places, car lanes and carparking facilities that already were located in the street will retain their location. As a result, during the realisation phase of the redesign, there will be less hindrance for these transport systems in the Delftseplein. The tram and cars have divided lanes, due to the fact that the tram system is to frequently used. To improve the charming atmosphere in the area, the tram system is surrounded with trees.

When becoming a destination, it is also crucial that the street is accessible from both directions. This was not possible in the existing design. To make this feasible, a bicycle lane on the right side of figure 4.1 that goes over in a bicycle tunnel is provided . Due to the underground bicycle lane in front of the building, there is also created more space. The new residents and employees will be able to reach their destination by all the different transport systems.

Finally, the plausibility check need to be done for the Delftseplein. Because of the new introduced bicycle lanes in the street, partly underground, the increased number of cyclists in the future is taken into account. The bicycle lanes will be bi-directional with a width of 3,5 metre. An example of how the bicycle lane is provided in the street is shown with the cross section in the Delftseplein in figure 4.2. The position of the cross section in the Delftseplein is further illustrated in figure 3.3.

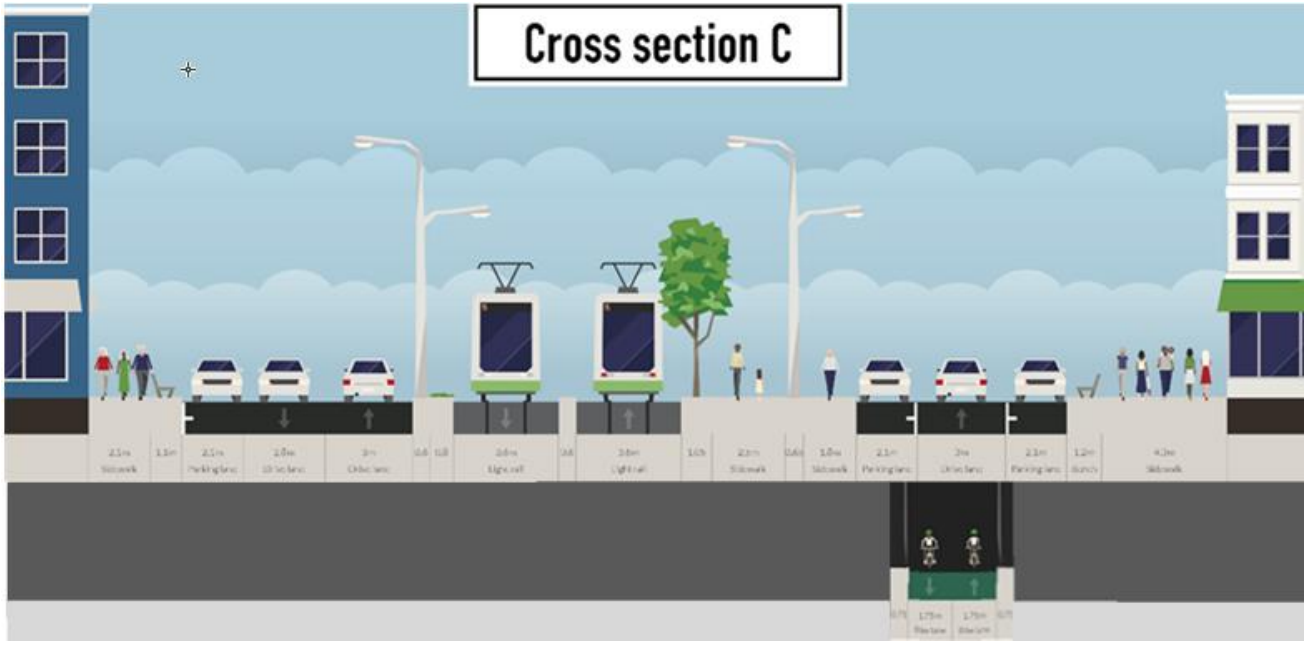

Figure 4.2. Cross section C. The width of this part of the Delftseplein contains 39 m.

There could be conflicts between the tram, cars, taxis, pedestrians and partly also cyclists. The tram and cars/taxis have separate lanes. As a result, there is less interaction between these two transport systems. Also the car/taxis and cyclist have less interaction, because at the location of the Kiss & Ride places the bicycle lane has already turned into a tunnel. The same for the interaction between the tram and the cyclists. The tram system, the Kiss & Ride places and car lanes will be retained. As a result, no check is needed for these transport systems.

The Conradstraat

To provide more priority to cyclist in this street, the design introduces an underground bicycle lane. Accordingly, the access to the Central station, the existing and new underground parking facilities for cyclists will be improved. The two road users are both able to reach their destination and have priority without hinderance of each other. They are all approachable from all directions from the city centre. Thus, also from the Conradstraat. Not only the cyclist have better access to the Central Station, there is also more space for the pedestrians. This results in a more attractive boulevard in the Conradstraat.

The location of the new building is approachable, due to the new bicycle lane on the left side of figure 4.1 that turns into an bicycle tunnel further in the street. As a result, cyclists are able to access the building and the new bicycle parking garage beneath it, from both directions. Accordingly the redesign results in more space in front of the new building. Therefore, the new residents and employees are able to reach 'their destination' when using the main entrance. .

Finally, the plausibility check need to be done for the redesign of the Conradstraat. Due to the new introduced bicycle lanes in the street, partly underground, the increased number of cyclists in the future is taken into account. The bicycle lanes will be bi-directional and 3,5 metre width. There is also an interaction between the bus, cars, pedestrians and partly also cyclists. At the location of the bus station there is a car free zone and an underground bicycle lane. This results in less interaction between these road users at the most active part of the street. The bus station and car lanes will be retained, so no check is needed for these transport systems. The bus station will stay in the middle of the street, therefore equal accessible from both sides of the street. And the location will remain near the Central Station, this reduces the walking distance for pedestrians from the Central Station.

4.2 *Design 2: Shared Spaces*

This design consist of the Shared Space concept and will be used in both the Delftseplein as the Conradstraat. The street map of the shared space solution is shown in figure 4.3. It consist of a mix between different traffic systems, instead of every system having their own space. The reference project that is used for this design consist of the Shared Space concept used in the north side redevelopment of the Central Station of Rotterdam. (Bicycle Dutch [2], 2017) In this reference the taxis are allowed to cross the bicycle lane wherever they want, so there is no need of a designated crossing. This concept is also used in this design by introducing a shared bus and bicycle lane on the left side of figure 4.3. The shared car and bicycle lane is shown on the right and partly also on the left side of figure 4.3. Further information from the reference can be found in Annex D. The cross sections of Design 2 can be found in Annex K.

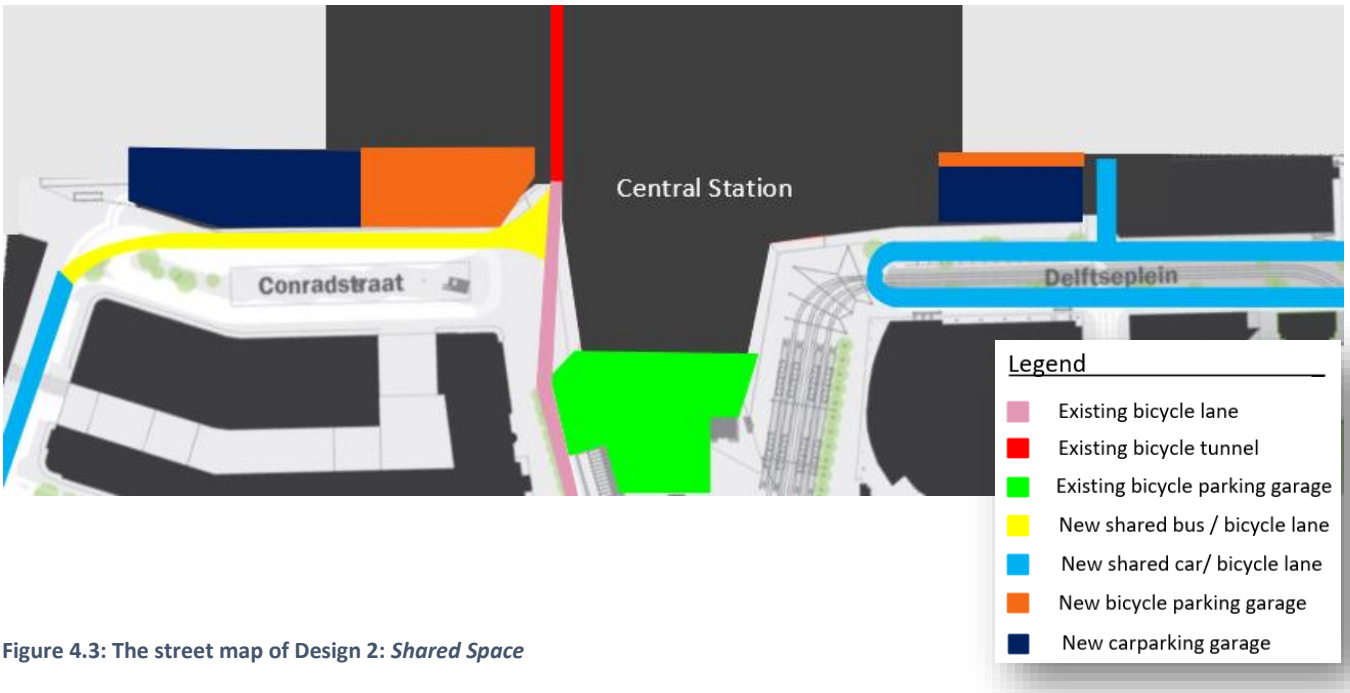

Figure 4.3: The street map of Design 2: *Shared Space*

The Delftseplein

This design consist of the solution of not giving every transport system their own space. As a result, the cyclist will have better access to the Central Station and the existing and new bicycle parking facilities. The shared space concept that will be realised in the Delftseplein consist of the car/taxis and cyclists sharing their lane. To increase the safety, a one directional lane is used for both the car/taxis as well as the cyclists. The tram system, the Kiss & Ride places, car lanes and carparking facilities that already were located in the street are retained in location. Further information about the existing situation can be found in Annex I.

Consequently, during the realisation phase of the redesign, there will be less hindrance for these transport systems in the Delftseplein. The cars/taxis and tram have divided lanes, due to the fact that the tram system is to frequently used to share with. To improve the charming atmosphere in the area, the tram system is surrounded with trees.

When the street becomes a destination, it is crucial that the street and the new building is achievable from all directions by all kind of road users. There are no car parking facilities in the street, only the Kiss & Ride places and taxi stands. In spite of this, there are a lot of underground carparking facilities, as a result the building and street is good achievable as destination by car. Because of the already existing car parking facilities it was not an attractive solution to choose a car free zone in the area around the Central Station.

In addition, the redesign should provide an increase in the approachable of the new building by both the cyclist as the pedestrians. The cyclist are only able to achieve the building from one direction. Due to the one directional shared lane in the street. On the other hand, the extra space that is created with the one directional shared lane, results in more priority to the pedestrians in the street. This also creates a more attractive boulevard and gives the new residents and employees the possibility to reach 'their destination'.

Finally, a plausibility check need to be done for the Delftseplein. Within this solution the increased number of cyclists in the future is taken into account. The interaction with the different users need to be tested, due to the various different road users in the street. There could be interaction between the tram, cars, taxis, pedestrians and cyclists. The tram and cars/taxis have separate lanes. This results in less interaction between these different transport systems. No check is needed for the tram system and the kiss & ride places, because they will be remained. The shared space concept will bring more interaction between the car/taxis and cyclists, because they are sharing there lane. The enhanced interaction should not immediately result in a disadvantage. Because, due to the one-directional shared lane the safety of the cyclists is required.

The Conradstraat

To provide more priority to cyclist in this street, this solution introduces a shared bicycle lane. Accordingly, the access to the Central station, the existing and new underground parking facilities for cyclists will be improved with this redesign. Not only the cyclist will have better access to the Central Station, there is also more space for the pedestrians. Due to the sharing concept, not giving every transport system their own space, the sidewalks can be improved. As a result, more priority will be given to the pedestrians in the street by creating more attractive boulevards. With the shared bus and bicycle lane the two road users are both able to reach their destination, but not by using their own space.

With the shared bicycle lane, both the new building as the new bicycle parking garage beneath it will be accessible by cyclists. The shared bicycle/car lane is provided to give the residents and employees of the new building the possibility to reach the new car parking garage beneath the new building. It will also be the only parking facility in this street, because the other part of the street will be a car free zone. Accordingly due to the redesign bringing more space in front of the new building. The residents and employees of the new building are able to reach 'their destination' in a more generous way when using the main entrance.

Finally, also a plausibility check need to be done for the redesign of the Conradstraat. There could be interaction between the bus, cars, pedestrians and cyclists. At the location of the bus station is a car free zone, so there will be less interaction between these two transport systems at the most active part of the street. Due to the shared bicycle and bus lane there will be interaction between these road users in this part of the street. The enhanced interaction should not immediately result in a disadvantage. Because, the shared bicycle lane will be bi-directional with a width of 7 m. The bus lane is one-directional, so the shared bicycle/ bus lane will only be located in front of the new building. This shared bicycle/ bus lane that is provided in the Conradstraat is shown with cross section F. The location of the cross section in the Conradstraat is further illustrated in figure 3.3.

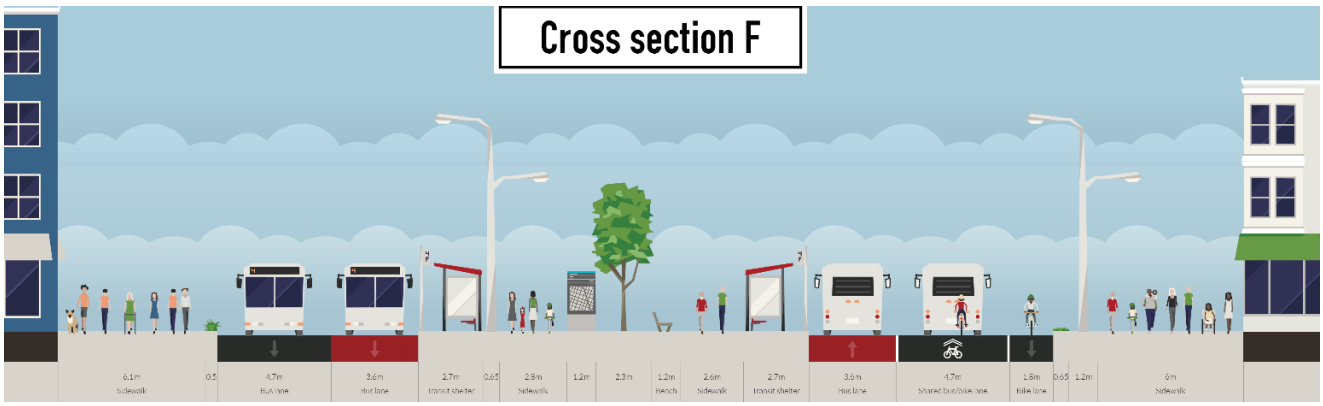

Figure 4.4. Cross section F of Design 2: *Shared Spaces*. The width of this part of the Conradstraat contains 49 m.

The bus station will be retained in the middle of the street and near the Central Station. Because this reduces the walking distance for pedestrians from the central station and other sides of the street. On the left side of figure 4.3, the bicycles will share their lane with the cars. This will not result in that much interaction, because the cars will only use the car lane to reach their destination. The destination is the car parking garage beneath the new building, because this is the only car parking facility in the street.

4.3 Design 3: Split levels

In the third design the solution of different levels to separate the traffic systems is used. The redesign approach is done by dividing the 'slow' and 'fast' traffic. The slow traffic consist of pedestrians and cyclist. The fast traffic contains of the bus, metro, tram and cars. The street map of this split levels concept for bicycle lanes is shown in figure 4.5. The redesign by using split levels for the public transport systems is shown in figure 4.6. The cross sections of Design 3 can be found in Annex L.

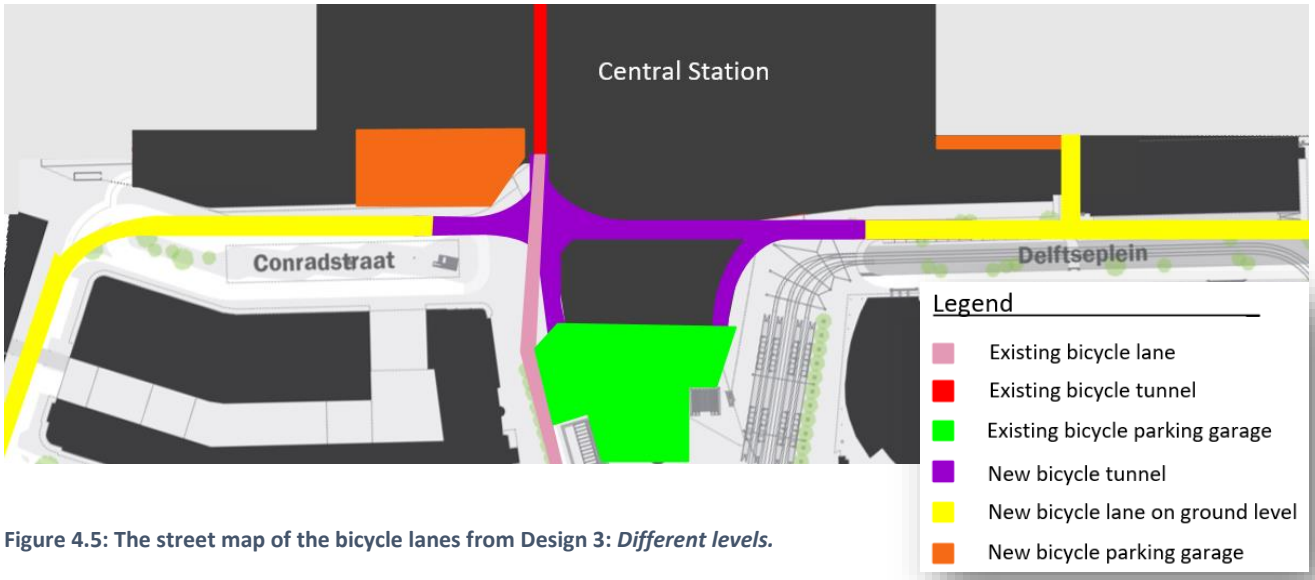

Figure 4.5: The street map of the bicycle lanes from Design 3: *Different levels.*

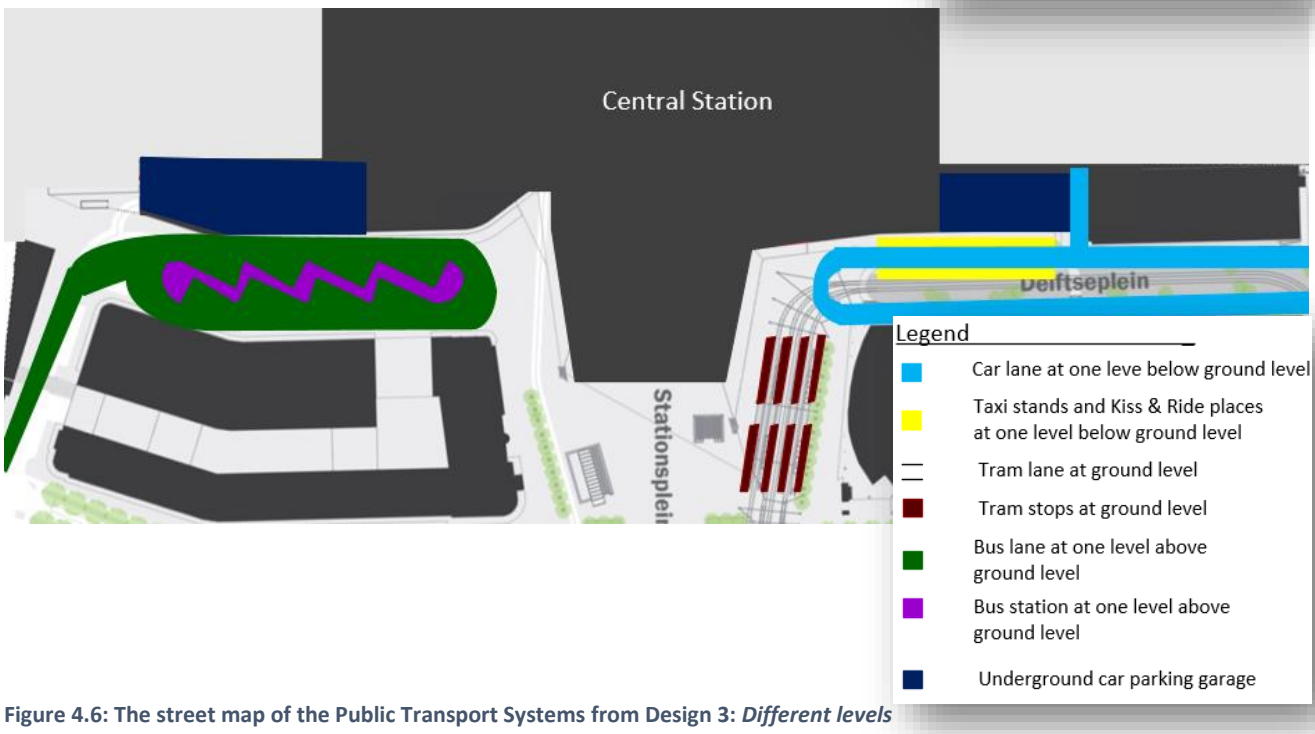

Figure 4.6: The street map of the Public Transport Systems from Design 3: *Different levels*

The reference project that is used for this solution is the public transport system of the Central Station in Amsterdam. The buses are placed one level higher behind the station, while the car traffic passes underneath the Central Station. (CROW, 2016) Further information from the reference be found in Annex D. Also again the use of an underground bicycle roundabout beneath the Central Station is used in this design. This is done, due to the main focus of the report study, giving more priority to cyclist and pedestrians. Both the new parking facilities for bicycles and the existing underground parking facilities beneath the Central Station will be approachable from all the different directions of the city centre. To realise the connection between the existing and new bicycle tunnel, an underground bicycle roundabout is used. As indication, the bicycle roundabout located on the Wilhelminakade/ Prinsesseweg in Groningen is used as reference. (Gemeente Groningen, 2017) Further information about the reference projects used as indication for this design can be found in Annex D.

The Delftseplein

This design provides a bicycle lane that is partly on ground level and partly underground. This to give access to the new and existing underground parking facilities for bicycles. On top of that, the access for cyclists to the Central station and the parking garage located beneath it is extremely improved. Because the Central Station and parking facilities are approachable from all directions.

The use of different levels will also be applied in the Delftseplein by moving the car lanes, kiss & ride places and taxi stands to one level below the ground. An example of what the street view will look like is given in figure 4.7. This is done with the cross section B positioned in the Delftseplein. The position of the cross section in the Delftseplein is further illustrated in figure 3.2. This solution results in attractive boulevards and the expansion of the available space for both the cyclists as the pedestrians. Consequently, this redesign provides more priority to cyclists and pedestrians. The tram system will retain their location. As a result, during the realisation phase of the redesign, there will be less hindrance for this transport systems in the Delftseplein. To improve the charming atmosphere in the area, the tram system is surrounded with trees.

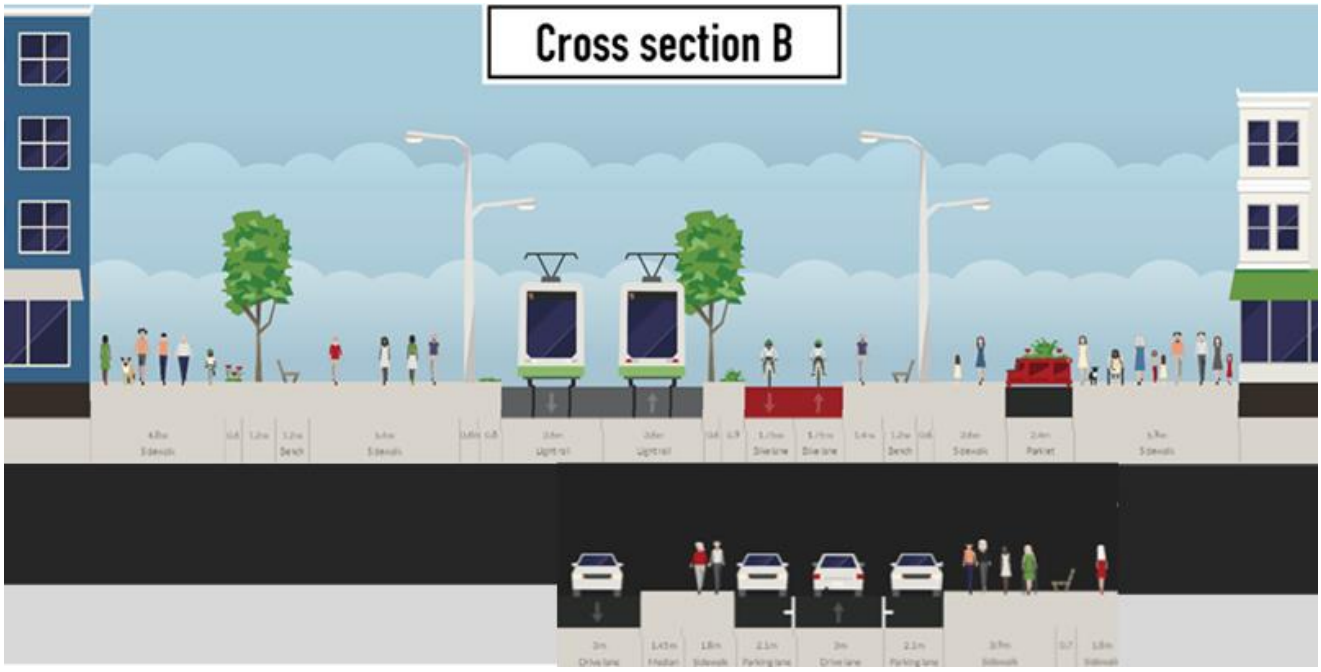

Figure 4.7. Cross section B. The width of this part of the Delftseplein contains 41 m.

The transition of the location of the car lanes, kiss & ride places and taxi stands will provide huge hinderance for the other transport systems that are located in the Delftseplein. However, the solution of different levels is still more attractive than the expansion of the car free zone. Due to the fact that there are currently several car parking garages located in the Delftseplein.

The underground car/taxi lanes, the bicycle lane and an expansion of the sidewalks results in an improvement of the accessibility of the new building in the street. Because there will be much more space in front of the building. The residents and employees will be able to reach ‘their destination’ when using the main entrance.

Lastly, the plausibility check need to be done for the Delftseplein. Because of the introduced bicycle lanes in the street, partly underground, the increased number of cyclists in the future is taken into account. The bicycle lanes will be bi-directional with a width of 3,5 metre. There could be interaction between the tram, cars, taxis, pedestrians and cyclists. The tram system will be retained, so no check is needed for this transport system. On top of that it currently uses separate lanes, what already resulted in less interaction with other transport systems. The car/taxi lanes will be moved to one level below ground level. Therefore there will be no interaction with other transport systems. However, the accessibility from the Central Station and the Delftseplein to these transport systems beneath level will decrease.

The Conradstraat

To provide more priority to cyclist in this street, the redesign introduces a bicycle lane that is partly on ground level and partly underground. Accordingly, the access to the Central station, the existing and new underground parking facilities for cyclists will be improved for the Conradstraat. All being approachable from all the different directions from the city centre. Not only the cyclist have better access to the Central Station, there is also more space for the pedestrians. This results in a more attractive boulevard in the Conradstraat.

The use of different levels will also be applied in the Conradstraat by moving the bus station to one level above ground level. A street view of this is visualised in figure 4.8 with cross section F located in the Conradstraat. The position of the cross section in the Conradstraat is further illustrated in figure 3.3. This will change the dominating position of the bus in the street. Consequently, this redesign provides priority to cyclists and pedestrians in the Conradstraat. Attractive boulevards and expansion of the available space for both cyclists as pedestrians will be realised.

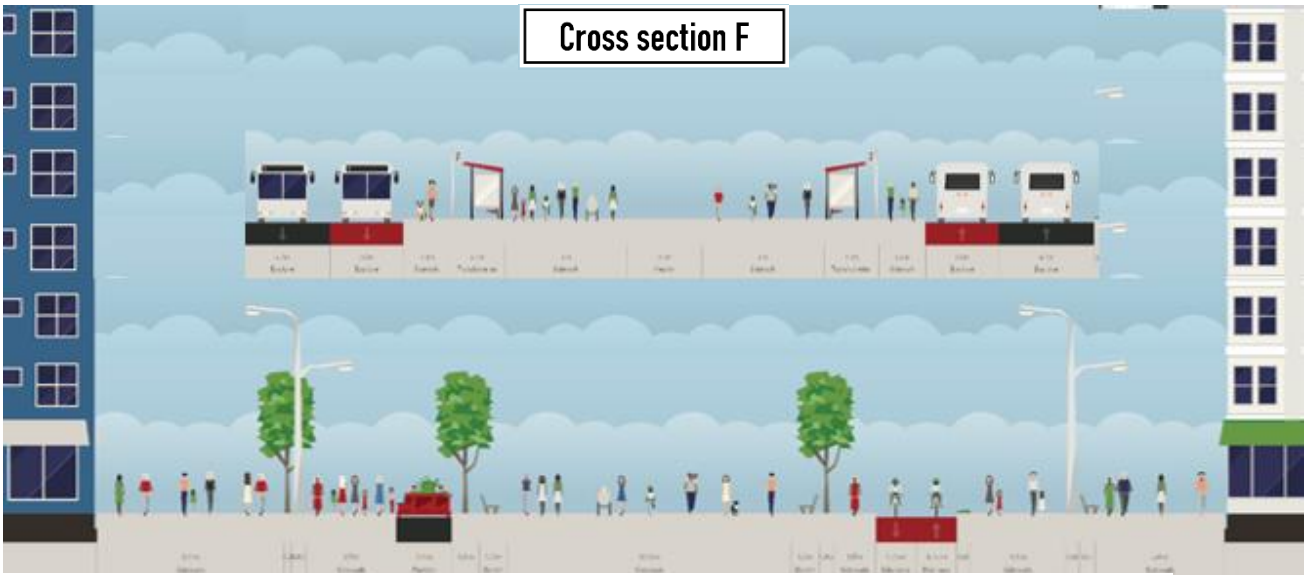

Figure 4.8 Cross section F. The width of this part of the Conradstraat contains 49 m.

The approachability of the new building for the residents and employees of the new building will be applied by bringing more space in the front. The main entrance will be reachable for both pedestrians as cyclists. For the cyclist a new parking facility beneath the new building will be constructed. On top of that, the car lane will receive access to the new underground parking garage beneath the new building. The other part of the street will retain a car free zone.

Finally, also a plausibility check need to be done for this redesign of the Conradstraat. Due to the introduced bicycle lanes in the street, partly underground, the increased number of cyclists in the future is taken into account. The bicycle lanes will be bi-directional and separated from the side walk with a width of 3,5 metre. There could be interaction between the bus, cars, pedestrians and cyclists. The bus station will be replaced to one level above ground level. This results in no interaction with other transport systems, but the accessibility from the Central Station and the Conradstraat to these transport system above level will decrease.

5. Comparison of designs

This chapter consist of the decision process to obtain a solution to the research question. This is done by evaluating the three designs by different criteria. The evaluation process consists of three steps for each design. First a short description of each possible solution included with a summarised explanation of some interesting performance of that design. Secondly, a brief summary of this explanation of the performance level for each criterion. Lastly, a schematic evaluation criteria table is determined that includes the grading of the different criteria. The criteria used during the evaluation are further elaborate in Section 3.3. The criteria are determined with reference to other design documents, additional information can be found in Annex H.

Design 1: Underground Bicycle Lanes

The first design consist of an expansion of the already existing bicycle tunnel beneath the Central Station. Remarkable is the improved public area, by creating more space on ground level. The area is not as cropped compared with the existing situation and more liveable by increasing the amount of planting in the area. However, the public transport systems are still dominating in the streets. Consequently, there is not given full attention to the main focus of the report; more priority to cyclists and pedestrians. On the other hand, the created bicycle parking places are better approachable, inviting and the public transport systems are entirely able to retain their function. Also the further development of the area and future increase of pedestrian and cyclists in the streets are taken into account. The capital spending of the bicycle tunnel is adaptable, as the total cost estimation for this solution estimated in table 5.1 is €7.072.000. (Smidth Wegenbouw,2018). This is a less expensive solution compared with removing other transport systems beneath ground level. The consequences of the construction are manageable, since the public transport systems in the area will not magnitude huge hinderance during.

Table 5.1: Cost estimation of Design 1: Underground Bicycle Lanes (x €1.000) (Smidth Wegenbouw,2018)

Post	Explanation	Direct costs	Direct costs specified later	Indirect costs
Estimated building costs				
Excavation	Total 5900 m3 €106 per m3 thus €625.400, labour costs €63.700 and logistic costs €66.230.	625,4	63,7	66,2
Construction underground bicycle lanes	Material €160 euro per m2 asphalt and construction thus €1.818.000, with transport and logistic cost of 10% thus €181.840 and labour costs €192.420.	1.818	181,8	192,4
Subtotal Construction costs		**2.443**	**245,5**	**293,6**
Technicalities	5% of total building costs	671,4		
Engineering costs	10,20% of total building costs	1.348		
Subtotal Engineering costs		**2.019**		
Risk Mitigation	5% of construction costs	1.586		
Subtotal Other costs		**1.586**		
Total Investment costs by category		6.038	245,5	293,6
Total Estimated building costs		**6.577**		
Estimated lifecycle costs				
Maintenance bicycle lanes	Preventive and corrective (50% Pro Rail, 50% Municipality of Amsterdam)			450
Subtotal maintenance				450
Total Estimated lifecycle costs		**450**		
Total Cost estimation: 7.072				

Design 2: Shared Spaces

The second design introduces the Shared Space concept. A mix between the different traffic systems, instead of every system having their own space. The shared space concept will result in more interaction between the different road users. As a result, this is not the most desirable solution for cyclists. Because there is not given full priority to the cyclists and pedestrians, since the public transport systems are still dominating in the streets. On top of that, the main entrance of the new building is not maximally approachable. The traffic systems are

still located in front of the building, what results in a cropped and not liveable area. However, the public transport systems are still well combined, because they are located on the same level. There are also no huge construction and maintenance costs needed or hinderance to traffic in the streets during the construction phase. The cost estimation of this design estimated in table 5.2 is €1.581.000. (Smidth Wegenbouw,2018). In spite of this, the possibilities for further development of the area are not as much as required. The future pedestrian and cyclists flow is not fully taken into consideration.

Table 5.2: Cost estimation of Design 2: Shared Spaces (x €1.000) (Smidth Wegenbouw,2018)

Post	Explanation	Direct costs	Direct costs specified later	Indirect costs
Estimated building costs				
Excavation	Total 11700 m3 €106 per m3 thus €620.100, labour costs €61.300 and logistic costs €68.200	620,1	61,3	68,2
Construction shared lanes	Material €60 euro per m2 asphalt thus €208.000, with transport and logistic cost of 10% thus €21.560 and labour costs €28.320.	351	36,2	38,5
Subtotal Construction costs		**971,1**	**97,5**	**106,7**
Technicalities	5% of total building costs	51,3		
Engineering costs	10,20% of total building costs	98,2		
Subtotal Engineering costs		**149,5**		
Risk Mitigation	5% of construction costs	116,3		
Subtotal Other costs		**116,3**		
Total Investment costs by category		1.237	97,5	106,7
Total Estimated building costs	**1.441**			
Estimated lifecycle costs				
Maintenance shared lanes	Preventive and corrective (50% Pro Rail, 50% Municipality of Amsterdam)			140
Subtotal maintenance				140
Total Estimated lifecycle costs	**140**			
Total Cost estimation: 1.581				

Design 3: Split levels

In the third design the model of different levels is used to separate the different transport functions. The created public area has become a pleasant place to stay, due to the attractive atmosphere that is created. Furthermore, the approachable of the streets are extremely improved, due to the extra space that can be used. Every transport system has its own space. This results in almost no interaction between the different traffic flows. Due to the different levels, there is also more space to expand the sidewalks and boulevards. Consequently, this design is giving full priority cyclists and pedestrians. Both the streets are made in point of view of the cyclists and pedestrians. On top of that, also the functions of the public transport systems are retained. However, the bus station that will be constructed one level above the ground will result in a less attractive view for the area. On the contrary, there lays potential to make this as attractive as possible and create a landmark next to the just renovated Central Station. On top of that, the area on ground level will be improved. Especially an expansion of the green areas, by introducing more trees and plants in the environment. The public transport systems are less combined, since they are not retained on same level. But, the different transport systems are divided, what results in more continuity in the streets. The use of different levels will result in an huge increase of the amount of capital spending. Due to the high construction and maintenance costs of this solution. Also the other transport systems that are positioned in the area will undermine huge hinderance during the construction phase. As a result, there are consequences, but they are manageable. Subsequently, the design is economically viable, because it is able to secure financing while having a positive impact on both the environment as the society. The cost estimation of this solution estimated in table 5.3 is €72.700.000. (T. Hilgers & J. Beelen, 2017) There are several possibilities for further development of the area. Due to the introduced bicycle lanes and expansion of the boulevards in the streets, the increasing number of cyclists and pedestrians in the future are taken into account.

Table 5.3: Cost estimation of Design 3: Split Levels (x €1.000) (T. Hilgers & J. Beelen, 2017)

Post	Explanation	Direct costs	Direct costs specified later	Indirect costs
Estimated building costs				
Excavation bus station	Total 6740 m3 €106 per m3 thus €714.000, labour costs €72.644 and logistic costs €64.240	714	72,6	64,2
Construction bus station	Material €25.860.000, with transport and logistic cost of 10% thus €2.586.000 and labour costs €2.3450.000	25.860	2.586	2.345
Excavation car lanes, taxi stands and kiss & ride places	Total 29100 m3 €106 per m3 thus €3.084.600, logistic costs €308.460 and labour costs €270.300	3.084	308	270
Construction car lanes, taxi stands and kiss & ride places	Material €20.450.000 , with transport and logistic cost of 10% thus €2.065.00 and labour costs €2.450.000.	20.450	2.065	2.450
Excavation partly bicycle lanes	Total 2800 m3 €106 per m3 thus €148.400, labour costs €27.244 and logistic costs €29.430	296,8	27,2	29,4
Construction bicycle lanes	Material €160 euro per m2 asphalt and construction thus €208.000, with transport and logistic cost of 10% thus €21.560 and labour costs €28.320.	208	21,6	28,3
Subtotal Construction costs		**50.613**	**5.080**	**5.187**
Technicalities	5% of total building costs	2.780		
Engineering costs	10,20% of total building costs	5.560		
Subtotal Engineering costs		**8.340**		
Risk Mitigation	5% of construction costs	3.480		
Subtotal Other costs		**3.480**		
Total Investment costs by category		62.433	5.080	5.187
Total Estimated building costs	**72.700**			
Estimated lifecycle costs				
Maintenance bus station	Preventive and corrective (50% ProRail, 50% Municipality of Amsterdam)			210
Maintenance car lanes, taxi stands and kiss & ride places	Preventive and corrective (50% ProRail, 50% Municipality of Amsterdam)			450
Maintenance bicycle lanes	Preventive and corrective (50% ProRail, 50% Municipality of Amsterdam)			150
Subtotal Maintenance				810
Total Estimated lifecycle costs	**810**			
Total Cost estimation: 73.510				

In table 5.4 a short list with key elements of the evaluation process is established. This provides a brief overview of the performance levelling of the criteria for each design. Further explanation of the performance level scores can be found in Annex L. The performance for each key element is formed by using the following possible levels: failed (--), sufficient (-), adequate (+-), good (+) and excellent (++).

Consequently, the brief summary of the performance can be further determined by using different gradings. A schematic overview of the performance level for each criteria provided with grading is established in table 5.5. The gradings are provided by giving a value to the different levels of the brief summary presented in table 5.4. The key elements that result in an higher weighting in the grading of the three designs are shown in bold. This to give a better view of how the scores are established. The performance levels consist of the following grading range: failed (0-20%), sufficient (21-40%), adequate (41-60%), good (61-80%), excellent (81-100%). As a result, every criteria can have a diverse percentage to assign an adequate score for each design. The highest final grade results in the design that gives the most appropriate solution to the research question of this report.

Table 5.4: Brief summary of the performance levelling of the criteria for all the three designs. This is provided with a list that consist of every key element used in the design. The short-term of the performance for each key element consist of the following possible levels: failed (--), sufficient (-), adequate (+-), good (+) and excellent (++).

Brief summary of the performance levelling			
Criteria	**Design 1:** **Underground Bicycle Lanes**	**Design 2:** **Shared Spaces**	**Design 3** **Split Levels**
1. Places for People -	**+ Public area** + Viability +- Social safety **+ Traffic safety** +- Distinctive, offer variety	**+- Public area** +- Viability + Social safety **+- Traffic safety** +- Distinctive, offer variety	**++ Public area** + Viability +- Social safety **+ Traffic safety** +- Distinctive, offer variety
2. Enrich the Existing	**+ Main focus of the report** + Function public transport systems **+- Availability public places**	**+- Main focus of the report** + Function public transport systems **- Availability public places**	**++ Main focus of the report** + Function public transport system **++ Availability public places**
3. Make Connections	+ Transition transport functions **+ Accessibility** + Ability residents new building	+ Transition transport functions **+- Accessibility** +- Ability residents new building	- Transition transport functions **++ Accessibility** ++ Ability residents new building
4 .Work with the Landscape	+ Liveable environment **+ Attractive atmosphere** +- Durability	- Liveable environment **+- Attractive atmosphere** + Durability	+ Liveable environment **++ Attractive atmosphere** +- Durability
5. Mix Uses and Forms	+-Continuity in the streets + Road users reinforcing each other **+ Combining of transport systems**	- Continuity in the streets +- Road users reinforcing each other **+ Combining of transport systems**	+ Continuity in the streets + Road users reinforcing each other **++ Combining of transport systems**
6. Manage the Investment	**+ Economically viable** + Hinderance during construction	**+ Economically viable** + Hinderance during construction	**+ Economically viable** +- Hinderance during construction
7. Design for Change	**+ Possibility further development** +- Flexibility in use + Environmental conscious	**+- Possibility further development** +- Flexibility in use +- Environmental conscious	**++ Possibility further development** + Flexibility in use +- Environmental conscious

Table 5.5: Schematic evaluation of the criteria for all the three designs. This is established by giving a grade for the performance level of each criteria.

Schematic evaluation of the criteria's			
Evaluation criteria's	Performance level		
	Design 1 **Underground bicycle lanes**	**Design 2** **Shared Spaces**	**Design 3** **Split levels**
1. Places for People	77%	68%	83%
2. Enrich the Existing	83%	71%	95%
3. Make Connections	75%	67%	80%
4. Work with the Landscape	73%	65%	83%
5. Mix Uses and Forms	76%	70%	88%
6. Manage the Investment	86%	84%	80%
7. Design for Change	73%	65%	84%
Total score:	77.6%	70%	84.7%

Accordingly, the assessment of the three designs to the criteria shows that design 3, using different levels for the traffic systems in the area, provides the highest final score. Especially in the criteria of places for people, by improving the places by creating a more safe, comfortable, varied and attractive area. Secondly, this design also exceedingly enriches the qualities of the existing urban places. The mix of uses is also expand, by stimulating enjoyable convenient places that meet a variety of demands from the widest possible range of users and social groups. Lastly, the new development needs are adaptable to future changes in use. On the other hand, the cost estimation is considerable higher compared with the other designs. Although, the solution is economically viable, while looking to the positive impact on both the environment as the society. Last of all, design 3 is the only design that provides full priority to the cyclists and pedestrians in both the streets, the main focus of this report study.

The concept of shared spaces, design 2, has the lowest final grade. However, the score of how to manage the investment is higher compared with design 3. Then again, this design scores particularly lower in the other criteria, for example the possibilities for further development and the accessibility of the area. Also when looking to the criteria of work with the landscape, consisting of the natural and manmade environment and utilisation of resources. Compared with other designs, the public area is cropped, less liveable and attractive.

However, design 1, the use of underground bicycle lanes also provides a considerable final score. To provide the most suitable solution to the report problem it is essential to pay some attention to this. Also in this design particularly interesting is the score of manage the investment. This consist of the economic viability, manageability and maintainability of the solution. It scores higher compared with design 3, due to the less hinderance during the construction phase and the lower cost estimation. Less space is needed when moving only the bicycle lanes to one level beneath the ground. This results in lower construction and maintenance costs. On the other hand, the possible further development of the area could be enhanced when looking to the increase of the cyclists and pedestrian flow in the future. Furthermore, design 3 already consist of elements of design 1, the underground bicycle lanes and bicycle roundabout. It is not possible to use more elements from this design in the final result, because that will bring disadvantages and a lower score for other criteria.

To conclude, taking all the interpretations that are stated above in consideration, ensures that alternative 3 is the most suitable solution to this report study. This solution is an huge investment, but on the other hand, the infrastructure and the urban environment are essential for a city centre. The quality of a city centre depends for an important part on the quality of the transport planning. On top of that, this design provides a permanent solution that is adaptable for several years. If that isn't enough the bus station also brings the possibility to introduce a new eye catcher to the international gateway of Rotterdam.

To give a better view of the final result of this report study, design 3, an enhanced imagination of some cross sections is presented. In figure 5.1 and 5.2 a visualisation of the cross sections located in the Delftseplein are created. The cross sections that are located in the Conradstraat of this solution are shown in figure 5.3 and 5.4. The pictures provide an interpretation of the expansion and improvement of the boulevards. There is created a liveable area and both the cyclists and pedestrians is given priority, by moving the public transport systems.

Figure 5.1: Visualisation of cross section A located in the Delftseplein.

Figure 5.2: Visualisation of cross section C located in the Delftseplein.

Figure 5.3: Visualisation of cross section F located in the Conradstraat.

Figure 5.4 Visualisation of cross section H located in the Conradstraat.

6. Discussion

This chapter provides the discussion of the research method used in the report study. This is necessary since an essential part of any research consist of being critical about the approximation that is managed to find a solution to the research question. (Wieringa R. & Maiden N. & Rolland C, 2006) First a short introduction of the research question and method is provided. Followed by the explanation of the results, included with an interpretation of why they are important. Next, the relation of the results to similar studies is determined. Afterwards the consideration of alternative explanations of the findings. Followed by the acknowledge of the report study's limitations, subsequently with suggestions for further research. Lastly, critical notes about the results are explained.

To find an answer to the report problem, a social-geography approximation method is used. In this report study three promising designs are compared by several criteria. The design that results in the most suitable solution consist of the split levels concept. This is applied in the Delftseplein by moving the car lanes, kiss & ride places and taxi stands to one level below the ground. The bus station in the Conradstraat is moved one level above the ground. As a result, an expansion and improvement of the boulevards and a liveable area for residents of the new building is created in both the Delftseplein and the Conradstraat. It also establishes a partly underground bicycle lane that is connected to the existing and new bicycle parking garages. On top of that, an underground bicycle roundabout will provide a connection between the Delftseplein, the Conradstraat and the north side area of the Central Station of Rotterdam.

Moreover, as indication for similar research to this report, reference projects are used to compare with. Orientation of the redevelopment of the area around the Central Station of Amsterdam was significant for this report study, since station areas are particularly limited while the intensity of use is extremely high. This solution also consist of the use of split levels for the different traffic systems in the area (CROW, 2016) However, in this design they were not allowed to use the underground levels. This is in line with the unfavourable underground that is located beneath the Central Station of Amsterdam.

Another important reference for this report consisted of the north side area redevelopment of the Central Station of Rotterdam. This is crucial, because they are connected with a bicycle tunnel beneath the Central Station. As a result, cohesion between the north and south area demanded. In spite of this, this cohesion is not completely managed. Due to the fact that the north side redevelopment consist of a shared space solution. While the provided redesign of the south side area consist of the use of split levels. An alternative explanation of this could be that the south side area involves much more traffic systems compared with the north side. Especially, when giving more priority to cyclists and pedestrians. To create an improved area for people as much as feasible, the use of different levels resulted in the most suitable solution for both the Delftseplein and the Conradstraat.

Additionally, the result provided in design 3 also consist of a underground bicycle roundabout. As reference, the bicycle roundabout located on the Wilhelminakade/ Prinsesseweg in Groningen is used. (Gemeente Groningen, 2017) This to ensure that the design consist of realistic solution for the research question. Although, this bicycle roundabout is not positioned beneath ground level. Consequently, this makes the reference less valuable, but the principles used in the design of a bicycle roundabout stay similar.

Furthermore, during the design approach both the Stakeholders that are concerned in this project; specified in Annex B as the Statement of Requirements; defined in Annex C, are taken into consideration. Because it is important to know why certain design decisions and methods are used in the design process. This to ensure that the improvements are made within awareness of all the relevant information. However, the report study also acknowledge some limitations. For instance, accessibility can be studied by both traffic engineering methods as social-geography methods. In this report the social- geography approximation is used. However, using the traffic engineering estimation provides findings that are better controllable. Due to the fact that a larger and enhanced referable amount of data can be used. But its advantages also lays in the fact that the approach provide dynamic and real-time traffic information. On the other hand, it is far more difficult to

interpret and translate this into design decisions. As a result, also in line with the short period of time that was viable for this report study, the use of more extensive data was not manageable. The approximation used in this report study consist of a simplified abstraction of the results, translated in diagrams and maps. Consequently, the results were immediately usable in the further design process without extended intervention for further analysis.

It is also important to take into consideration that design models aren't similar to analytical models. Design models consist of an illustrative representation of the conventions. They are complex in their way of detailed geometry, non-hierarchical and contain of independent elements. While analytical models are generated by multifaceted processes and based on interconnected information and usually easy to understand in terms of geometry. The same for the difference between analysis and evaluation. Analytical results consist of just numbers and the positive or negative interpretation depends on the context. On the other hand, evaluation requires an interpretation of the analytical results as it tests them against criteria. The criteria could consist of the assurance of quality, sustainability and development goals. This to ensure that the design should consist of an high approachability, combining functions and a mix of living and environment. There can be concluded that besides the functionality and the way the different models interface, an important dissimilarity between design and analytical models lays in the elements they use.

The design criteria of the 'Urban Design Compendium', used in the evaluation of the three designs are provided with reference to other design documents . Besides this, suggestions for further research could be based on improving the consideration of dissimilar desires from a particular surrounding when using the evaluation criteria. There are also possibilities to give more value to the cost estimation of the different alternatives. In the current evaluation, the economic viability and consequences for the area during the construction phase are taken into account with the criteria of manage the investment. It can also be challenging to give a value to the economically viability. Since there could be dissimilarities in the positive impact on both the environment as the society of a solution. Or the hesitation about if the cost estimation is worth the investment.

Looking to the final result, there could be doubts about the advantages and opportunities of alternative 3. First, the underground bicycle lane that is located beneath the Central Station. Besides the already located metro system and bicycle parking garage beneath the Central Station it is possible to construct the bicycle lane next to this. But, it is essential to pay attention to the hinderance and decrease in social safety that the construction phase will bring to the just renovated Central Station. Additionally, removing the car lanes, kiss & ride places and taxi stands in the Delftseplein to one level below the ground could bring some sceptics. However, the solution of different levels is still more attractive than for example the expansion of the car free zone or shared lane concept. Due to the fact that there are currently several car parking garages located in the Delftseplein and the car parking places in the area are already too short. On top of that, in moving the bus station in the Conradstraat to one level above the ground lays potential to create a landmark or eye catcher. Important to take into account that it should provide a positive contribution to the Central Station instead of blocking its view.

The hesitation for both the travellers as the municipality of Rotterdam could mainly consist of the doubts if the redevelopment is worth the investment and hinderance during the construction phase. But also about the fact if there is even the need to expand the boulevards and bicycle lanes. Taking all the explanations and specifications as stated above in consideration. In the end the fact that the solution is permanent and prevents Rotterdam Central District from infrastructure and traffic problems in the future is crucial. Consequently, it provides more possibilities for further development of the Delftseplein and the Conradstraat and subsequently also for the city of Rotterdam. Especially when looking to the future increase of the cyclists and pedestrian flow. The solution of this report offers the opportunity to expand the sidewalks, boulevards and bicycle lanes and as a result improve the accessibility and viability of Rotterdam Central District. This is in line with the main focus of the report study; giving more priority to cyclists and pedestrians in the Delftseplein and the Conradstraat.

7. Conclusion

The report study has provided a recommendation that gives the solution to the main focus of the report, *redesign the Delftseplein and the Conradstraat in the point of view of cyclists and pedestrians by giving them more priority.* The design uses the concept of split levels for the different traffic systems in the area. The recommended design introduces the following key elements to the Delftseplein and the Conradstraat:

- A partly underground bicycle lane that is connected to the existing and new bicycle parking garage beneath the Central Station of Rotterdam.
- Underground bicycle roundabout beneath the Central Station provides a connection between the Delftseplein, the Conradstraat and the north side of the Central Station.
- The car lanes, kiss & ride places and taxi stands in the Delftseplein are placed one level below the ground.
- The tram system in the Delftseplein is retained.
- The bus station in the Conradstraat is positioned one level above the ground.
- An expansion and improvement of the boulevards.
- Realisation of a liveable area for both the pedestrian as the residents and employers of the new building.

The final result prevents Rotterdam Central District from infrastructure and traffic problems in the future. Especially when looking to the future increase of the cyclists and pedestrian flow in this area. Besides this, moving the bus station to one level above the ground gives the opportunity to make it a landmark or eye catcher next to the international gateway of Rotterdam.

A critical note could consist of scepticism about if the redevelopment is worth the investment and hinderance during the construction phase. Suggestion for further research is based on improving the consideration of the desires from a particular surrounding when using the evaluation criteria.

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Annex A: Mixone project

In this annex the project 'Mixone' is further elaborate. Mixone stands for the spatial development of the Rotterdam Central District. The location of the four new buildings they are planning to build is shown in figure A.1. The purpose consists of housing new companies and residents. It stimulates the liveliness in the public space. (Rotterdam Gemeente [1], 2017)

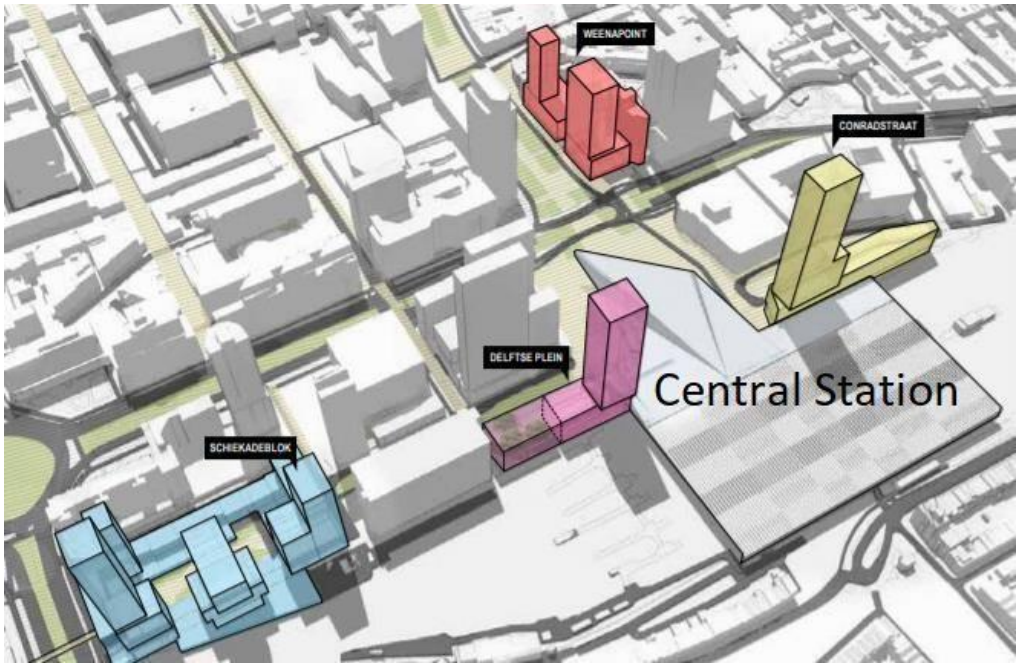


Figure A.1: Redevelopment locations in Rotterdam Central District. (Rotterdam Gemeente [1], 2017)

Rotterdam Central District is the beating heart of the city of Rotterdam and essential for events, trade, meetings and the culture of the city. The Central Station is the blooming entrance of the city centre. With the renovated station area, a new standard for internationally oriented working and living environment is born. Everything comes together from shopping until education. This results in an attractive location with high potential for housing new companies and residents. For these reasons stated above, a so called 'Mixone' building project is created for the Delftseplein and the Conradstraat.

Due to the study of this report, it is important to get a clear vision about the construction plans of the Delftseplein and the Conradstraat. This to get a clear view about the value that the new buildings will bring to these streets. As a result, this inspiration can be used during the research, while redesigning the streets.

The economy flows again and the amount of existing houses that are being sold has risen sharply. As a result, increasing shortage in houses leads to a strong raise in the housing prices. Also extremely rising in popularity is living in the city of Rotterdam. For these reason, housing for residents is also desirable in Rotterdam Central District. This results in a better balance and more liveliness in the streets, even in the evening hours.

Especially, the Delftseplein and the Conradstraat are locations in which the intended area concept must be expressed. Streets that are adjacent to the station terminal and form an important entrance route to the Central Station. The impact that the new buildings will give to the streets are shown in figure A.2; the Delftseplein, and in figure A.3; the Conradstraat. In both the figures the green area illustrate the entrance of the new carparking garage. For figure A.3, the pink circle demonstrate the entrance of the parking garage for bicycles. Figure A.4 shows the entrances and exits of underground parking garage in the Delftseplein. The new underground carparking garage is shown with the red circle.

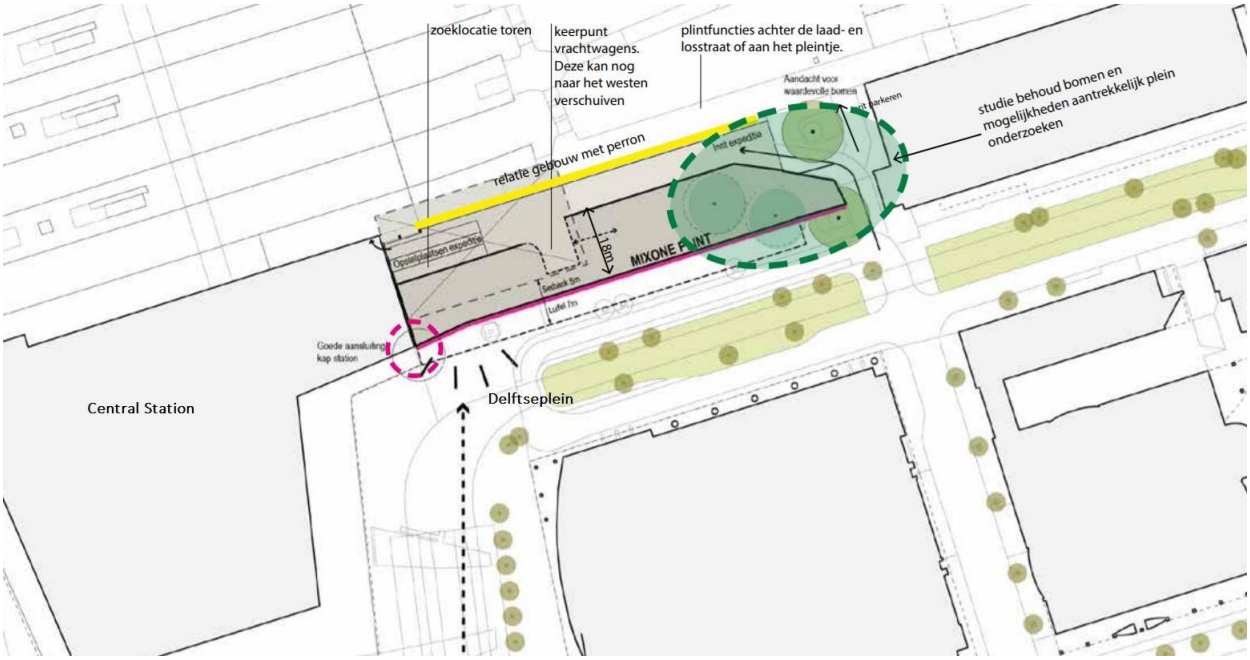


Figure A.2: The impression that the new building brings to the Delftseplein (Rotterdam Gemeente [1], 2017)

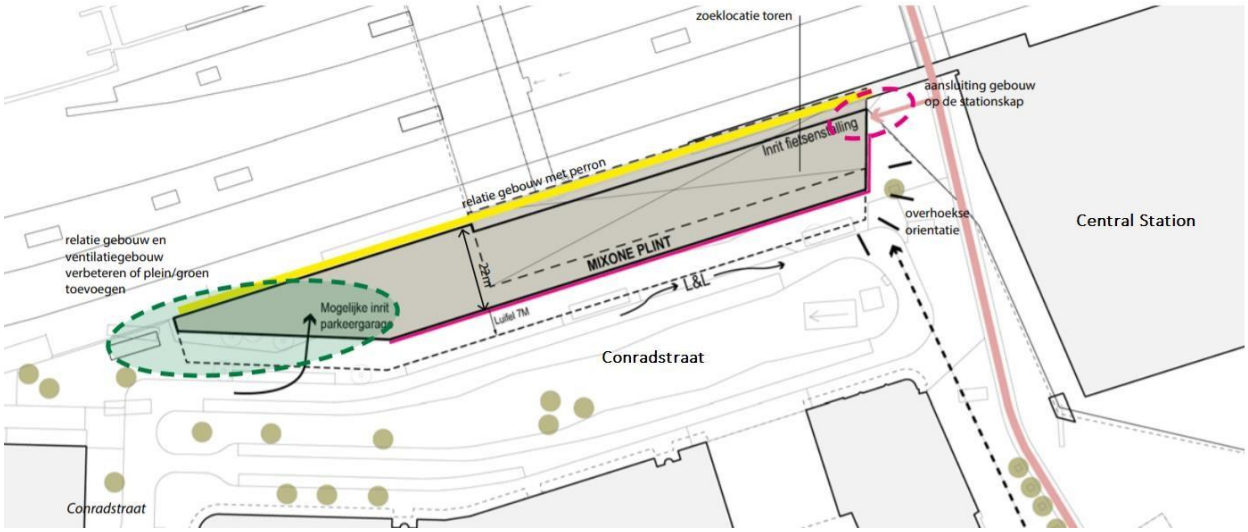


Figure A.3 The impression that the new building brings to the Conradstraat (Rotterdam Gemeente [1], 2017)

Figure A.4: Entrances and exits of parking garages in the Delftseplein (Rotterdam Gemeente [1] , 2017)

Due to the new underground carparking garage, also the car flow will encounter some changes. The car routing of the Delftseplein is illustrated with the red path in figure A.5. The green area demonstrates the location of the new underground carparking garage. This gives a view of the coherency of the parking garage with the auto routing in the street. The underground carparking garages and car routing are important to take into consideration, because these are stationary during the design process.

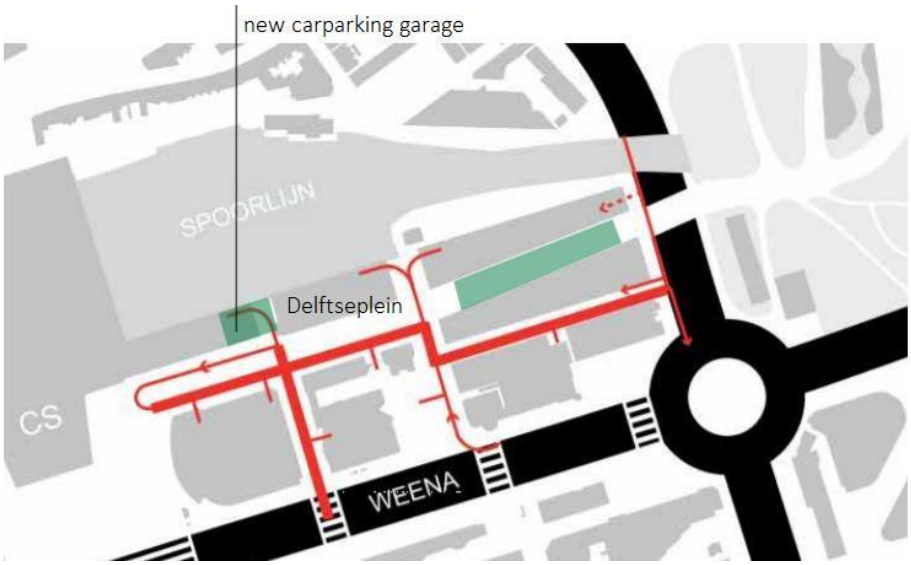


Figure A.5: Car routing of the Delftseplein illustrated with the red path (Rotterdam Gemeente [1] , 2017)

The new building in the Conradstraat will ensure that the passengers of the bus station can use the same type of functions as can be found in the station. However, it will also become a destination for many visitors. On top of that, it will also introduce an new entrance of the underground parking garage for bicycles, that is located beneath the new building.. The car routing of the Conradstraat is illustrated with the red path in figure A.6. The green area demonstrates the location of the new underground carparking garage. This gives a view of the coherency of the parking garage with the auto routing in the street.

Figure A.6: Car routing of the Conradstraat illustrated with the red path (Rotterdam Gemeente [1] , 2017)

The Mixone is critically about adding more office spaces. This because the vacancy of a lot of existing office spaces. For these reasons, important is the mix of different function of housing types. Flexibility need to be included in the concept to guarantee the future value of the streets. The realisation of this cohesion between the different functions in the buildings is shown in figure A.7 the Delftseplein, and in figure A.7; the Conradstraat. Depending on the functions in both buildings there will be looked to what is needed.

The priority of the building lays in making optimal use of the public area. To stimulate the area, there is an unlimited share of provisions allowed. However, Rotterdam Central District is not trying to compete with the shopping area of the city of Rotterdam. Also the roof top participates in the attractiveness and vibrancy of the area. With as main function a nice place to stay. The view over the platforms is an added value for the social safety and liveliness of the station and the building itself.

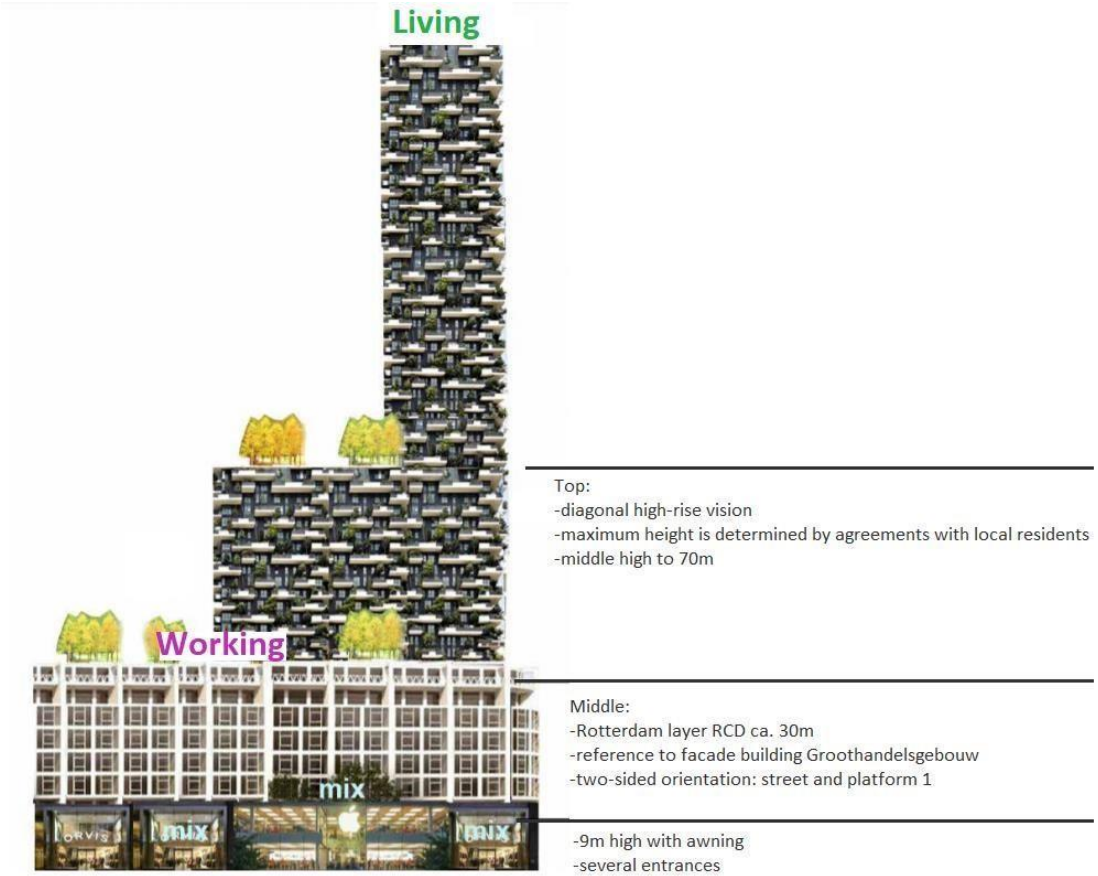


Figure A.7: Division of the functions inside the new buildings on the Delftseplein. (Rotterdam Gemeente [1] , 2017)

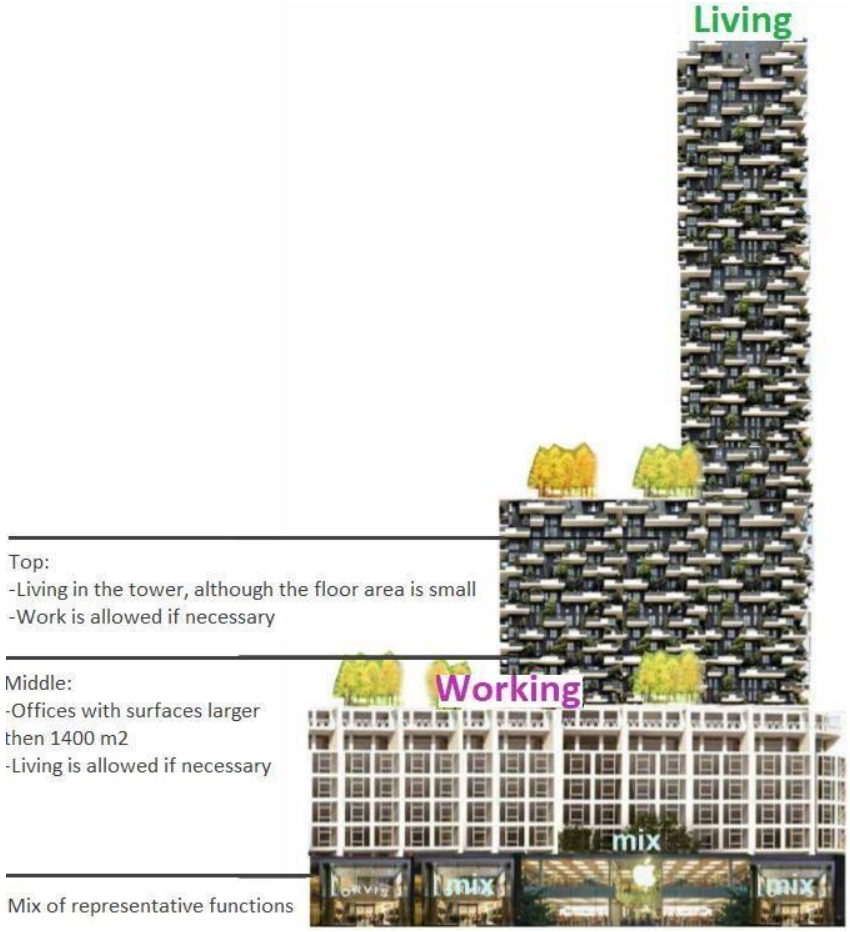


Figure A.8: Division of the functions inside the new buildings on the Delftseplein. (Rotterdam Gemeente [1] , 2017)

Annex B: Stakeholder Analysis

Due to the importance of the Rotterdam Central District to the city of Rotterdam, there are a lot of stakeholders that need to be taken into consideration. The stakeholders can be divided in different groups. First are mentioned the stakeholders that have the highest interest in the research study of the redesign of the Delftseplein and the Conradstraat. The concerned stakeholders are divided by the by the amount of interest, influence and power.

Inhabitants of the area:

The main stakeholders in this report are the inhabitants of the area. Due to the location being the centre of the city. But also because they are the main focus of this report study, as stated in Section 2.3. It consist of a powerful party, thus a moderate level of contact is required to keep them satisfied. Their goal is to have an as nice as possible living environment. Due to amount of inhabitants in the city centre their combined voice could cause obstacles. For this reason, it is important to keep them in consideration during the evaluation criteria, described in Chapter 3.

Vereniging Rotterdam Central District:

The Vereniging Rotterdam Central District is also a main stakeholder to this report. It consist of municipality, building owners and users of the street. They are the client and commissioning parties of the area. The Vereniging Rotterdam Central District is created with the idea to join forces and share expertise and knowledge between an entrepreneur and an investor for the area Rotterdam Central District. This to make sure that the promising location of Rotterdam Central District will be used maximum. The goal of the Vereniging Rotterdam Central District is the development of the area, the profiling outside and the community. (Vereniging Rotterdam Central District, 2017).

For these reasons, the interest and power position are extremely high. Also when looking to the main focus of the report, as stated in Section 2.3.

Municipality of Rotterdam:

The municipality of Rotterdam has much interest in the redesign of the project that is located in the Delftseplein and the Conradstraat. Because, the completion of the business project will have influence on the city of Rotterdam. On top of that, they are one of the investors in the project.

On the other hand, the municipality of Rotterdam has also a lot of authorities when statement of requirements, elaborated in Annex B and the evaluation criteria, described in Chapter 3, come into play.

Government:

The overseeing government does not have much of a vested interest with the research, but is the one that determined the underlying legislature and laws. Hence it is important to always keep the government satisfied and keep them into consideration during the statements of requirements, elaborated in Annex B, and the evaluation criteria, described in Chapter 3.

Rotterdam Central Station:

Rotterdam Central Station is also an stakeholder to the research study, due to the fact that the access to the Central Station should expand. This is also a crucial reason for the focus on the Delftseplein and the Conradstraat. A moderate level of contact in order to keep them satisfied is necessary.

Annex C: Statement of Requirements

In this annex the statement of requirements are further explained. This is done separately for both the Delftseplein as the Conradstraat. First of all, after a short description of the street, the functional requirements are described. This is necessary to define what the solution should consist of at least to be permissible. Secondly, the preconditions are explained. Those are imposed by the environment and consist of things that needs to be taken into account during the search for a solution. Thirdly, the wishes are defined. A wish is something to be reckoned with, but has a lower priority than the requirements. However, if a wish is taken into consideration, this is greatly appreciated by the parties that are involved. Finally, there are some assumptions that need to be made to create a solution. Assumptions are crucial to verify further missing data that are relevant during the research of the report.

The requirements are defined by the Municipality of Rotterdam. (Rotterdam Gemeente [1], 2017*)*. On top of that, some requirements are defined by taking the stakeholders, stated in Annex B, into account.

C.1 Delftseplein:

C.1.1 Functional requirements

- The public transport system that is located in the streets needs to retain its function.
- The street is not accessible for freight traffic with a trailer.
- The street must be designed in such a way that freight traffic (maximum length of 12m) in the opposite direction can pass each other.
- Create both physically as programmatically a clear link between the bus lane and the station square.
- There must be a possibility for the new residents and shop owners to be able to load and unload in the street at places indicated for that purpose.
- A total concept is created with different target groups, users and functions reinforcing each other.
- The parking concept is in line with the target group.

C.1.2 Preconditions

- There are several options for preserving the existing trees.

C.1.3 Wishes

- The boulevards in the Delftseplein must have an attractive atmosphere, a pleasant place to stay.
- More priority should be given to cyclists and pedestrians.
- (Bicycle) parking must be inviting.
- Contributing to the vitality in the area through the realization of the public-accessible environment.
- Attention to the ability of use in the evening hours.
- There is a mix of different function of the building and housing types. Flexibility need to be included in the area to guarantee the future value of the streets.

C.1.4 Assumptions

- On the Delftseplein, several entrances and exits of parking garages are located. When creating the new design, they must be located out of sight.
- If possible, no parking places in the street, unless it concerns electric shared cars. Then parking is out of sight, situated underground. With the exception of a possible solution where parking in the plinth of the station is solved, where now businesses are located.

C.2 Conradstraat:

C.2.1 Functional requirements

- The public transport system that is located in the streets needs to retain its function.
- The accessibility of the public areas in the station under platform 1 must be guaranteed.
- In the street an extension of the public bicycle parking is necessary, because it is close to the bicycle tunnel. A public parking facility for 4000 to 4500 bicycles has to be realized in the street, under the new building. An entrance is located at the eastern head of the new building.
- There must be a possibility for the new residents to be able to load and unload in the street at places indicated for that purpose.
- The street has an open view over the bicycle tunnel and the entrance to the bicycle parking place beneath the Central Station. This is necessary due to the social security of this place.
- A total concept is created with different target groups, users and functions reinforcing each other.
- The parking concept is in line with the target group.

C.2.2 Preconditions

- There are several options for preserving the existing trees.

C.2.3 Wishes

- The boulevards in the Conradstraat must have an attractive atmosphere, a pleasant place to stay.
- (Bicycle) parking must be inviting.
- More priority should be given to cyclists and pedestrians.
- There is a mix of different function of housing types. Flexibility need to be included in the concept to guarantee the future value of the streets.
- Contributing to the vitality in the area through the realization of the public-accessible environment.
- Attention to the ability of use in the evening hours.

C.2.4 Assumptions

- The corner of the Conradstraat and the Central Station should have a better connection.
- The connection between the various utilitarian elements that are present in the corner of the Conradstraat and the Central Station should be improved.
- The transition between the street and the bicycle tunnel must be well designed.
- If possible, no parking places in the street, unless it concerns electric shared cars. Then parking is out of sight, situated underground. With the exception of a possible solution where parking in the plinth of the station is solved, where now businesses are located.

Annex D: Reference Projects

This annex consist of several reference projects that are used as indication during the report study of the Delftseplein and the Conradstraat. They were relevant to keep in mind, while redesigning these streets. The reference projects can be comparable due to similar ambition, complexity, size or location.

Spoor zone Delft:

The reference project Spoorzone Delft is relevant to compare with, because of its similar ambition. The high priority that is given to cyclists and pedestrians. First of all, they created a lot of new bicycle places in the area beneath and around the Station. Secondly, they also constructed new routes for bicycles to get better access. The process is realised in different phases, consisting of creating new parking facilities before removing the old facilities. They have designed an underground bicycle parking with 5,000 places, direct access to the new underground station. In addition, the parking places above ground will be expanded to 1,400 places. Consequently, this results in a total of more than 8,700 bicycle parking spaces in the station area. (Spoorzone Delft, 2017)

Amsterdam Central Station

The area around the Central Station in Amsterdam can be used as reference, due to the different level device they have recently realised the project in 2017. Figure D.1. gives a total view of the public transport system around the Central Station. (GVB, 2018) The buses are placed one level higher behind the station, shown in figure D.2 . The car traffic will pass underneath the central station. (CROW, 2016)

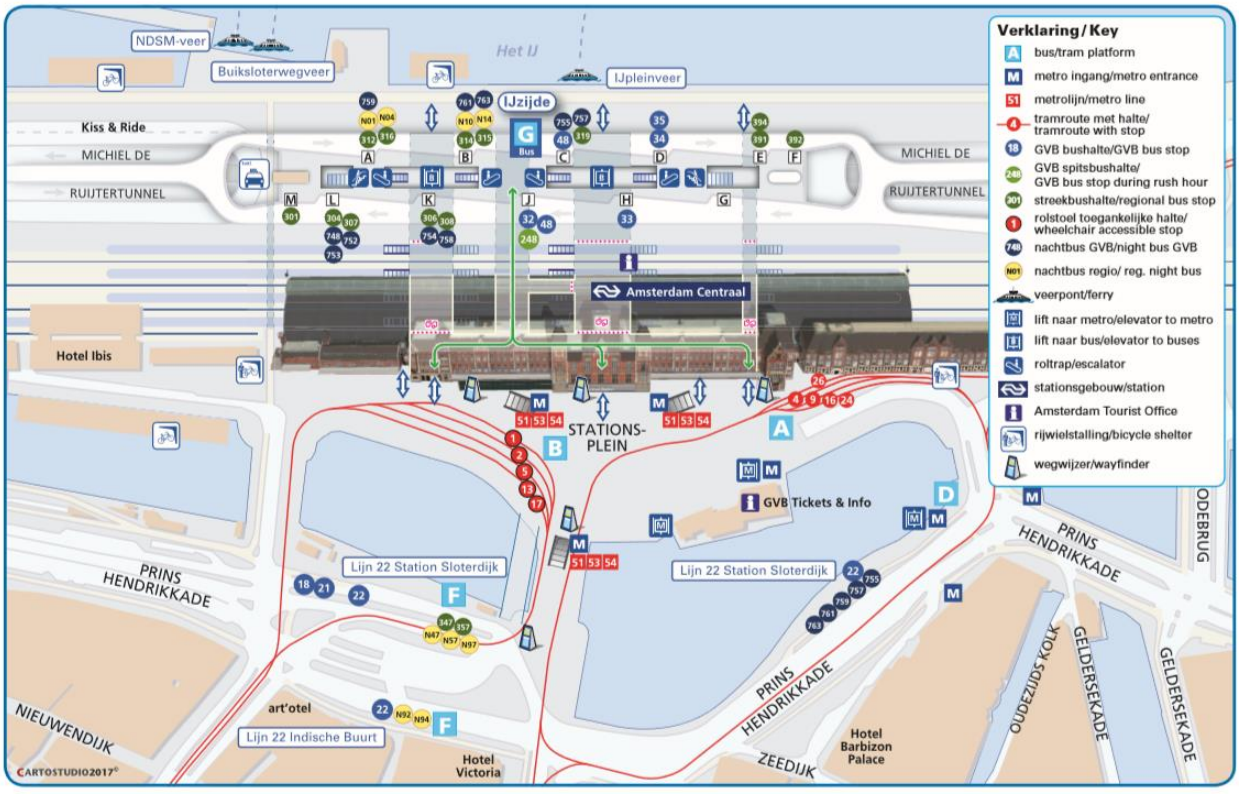


Figure D.1: The public transport system in the area around the Central Station in Rotterdam. (GVB, 2018)

Figure D.2: The bus station at the Central Station in Amsterdam. The buses are placed one level higher behind the Central Station. (CROW, 2016)

A2 Maastricht:

A2 Maastricht can be used as reference, because its similar potential for housing botch new companies as well as residents. The area development is also called the 'Groene Loper', located above the tunnel that is created under the ground. There is room for 1,100 new homes and 30,000 m^2 of new companies (A2 Maastricht, 2016). The new real estate in the area ensures a natural transition to the existing buildings. Besides this, it also adds value to the current surrounding. In addition, this also results in a connection between the different neighbourhoods in the area. In this project they have chosen a varied range of rental properties in different price ranges. This to create a more variable area. Because of this diversity there is something for everyone.

The north side redevelopment of the Central Station in Rotterdam

It is important to take this project as reference, because it is crucial to have a cohesion between the north and south side areas around the Rotterdam Central Station. Some of the design features that are used in the north side can also be used while redesigning parts of the south side. This increases the quality of the area and results in an improved organisation. Especially in case of the bicycle lanes, because they are connected with a bicycle tunnel beneath the Central Station. (Philippe Samyn and Partners ,2003)

On top of that, the Shared Space concept that has evolved in also giving a function to the total spatial development started as a traffic solution. (Rotterdam Gemeente, 2016) It consist of a mix between the different traffic systems, instead of every system having their own space. Due to the fact that it has a positive influence to the economic effects of the area, the solution could be suitable for the Delftseplein and the Conradstraat.

Before the redevelopment, the main problem of the north side consisted of the lack in continuity between the different transport function in the area. The redesign resulted in more priority to cyclists. Due to the fact that the they created a bi-directional bicycle lane of 3.5 metre wide, instead of the old on-street cycle lanes. The taxis are allowed to cross the bicycle lane wherever they want, due to the reason that in this case there is no need for a designated crossing. Of course, there is a crossing location with lower curbs for carriages and wheel chairs. The created bicycle lane is visualised in figure D.3. (Bicycle Dutch [2], 2017)

Figure D.3: The redesigned bi-directional bicycle lane of 3.5 metre wide in the north side area of the Central Station of Rotterdam. In the left side the taxis stands are located, they are allowed to cross the bicycle lane wherever they want. (Bicycle Dutch [2], 2017)

Bicycle roundabout Wilhelminakade/ Prinsesseweg in Groningen

The crossing Wilhelminkade/ Prinsesseweg in Groningen used to be a well-known disaster for cyclists. As a result a generous bicycle roundabout is created to make this crossing safer. The provided bicycle roundabout is shown in figure D.4 This can be used as a reference project, due to the priority that is given to the cyclists. The berms in the inner corner force cyclist to already follow the cycle path. This to prevent dangerous situations. (Gemeente Groningen, 2017)

Figure D.4: The bicycle roundabout Wilhelminakade/ Prinsesseweg in Groningen. (Gemeente Groningen, 2017)

Annex E: Public transport system of Rotterdam Central District

This Annex elaborates the public transport system that is located in de area around the Central Station in Rotterdam, Rotterdam Central District. Figure E.1 shows the in 2016 finished renovation of the public traffic system of Central Station, also called the Weena Central District. (Rotterdam Gemeente, 2016) The tram system is located in the Delftseplein and consist two rails in both direction. In the Conradstraat the bus station is positioned with eight different bus stop locations at the bus station. Further information about the public transport system since the 4th of July in 2016 can be found in figure E.2. (RET, 2017)

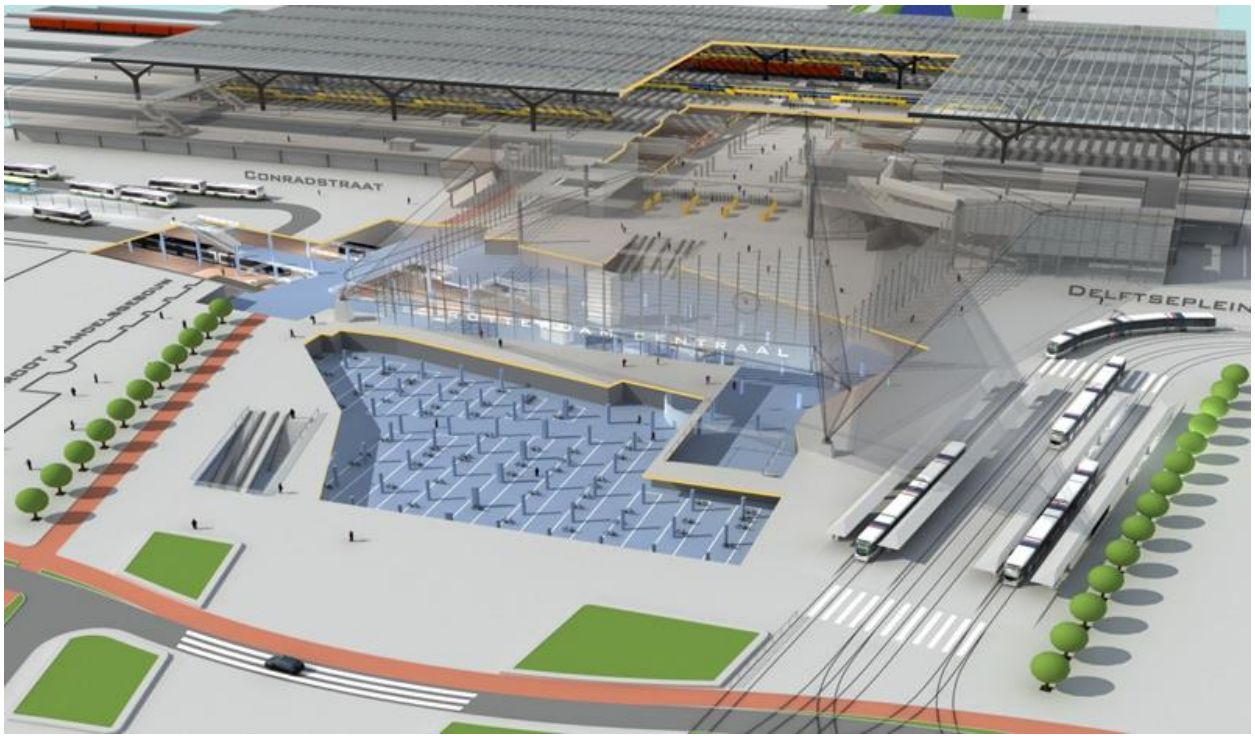


Figure E.1. The Weena Global District, finished in 2016. (Rotterdam Gemeente, 2016)

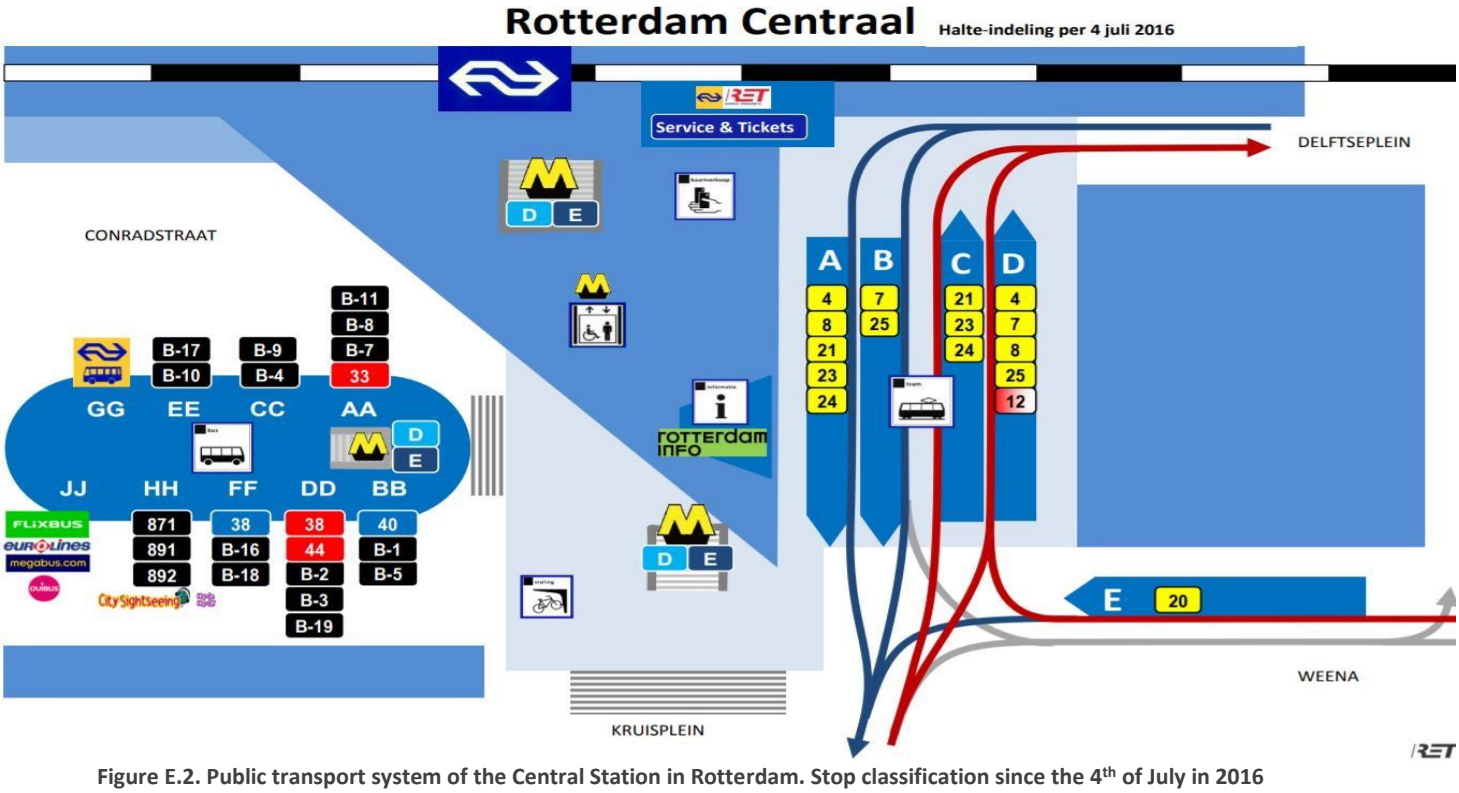


Figure E.2. Public transport system of the Central Station in Rotterdam. Stop classification since the 4th of July in 2016 (RET, 2017)

Annex F: Future pedestrian flows during the day

The network of Rotterdam Central District is dynamic and changes several times during the day. This results in different time windows that are translated in different map images. In this annex the future pedestrian flows during the day is described. Shown in figure E.1 during the morning, figure E.2 during the afternoon, figure E.3 during the evening and in figure E.4 during the night. Below a legend is provided to divide the different function of the pedestrian flows. The figures can be used to illustrate the main loops through the area. (Coppens C. ,2017)

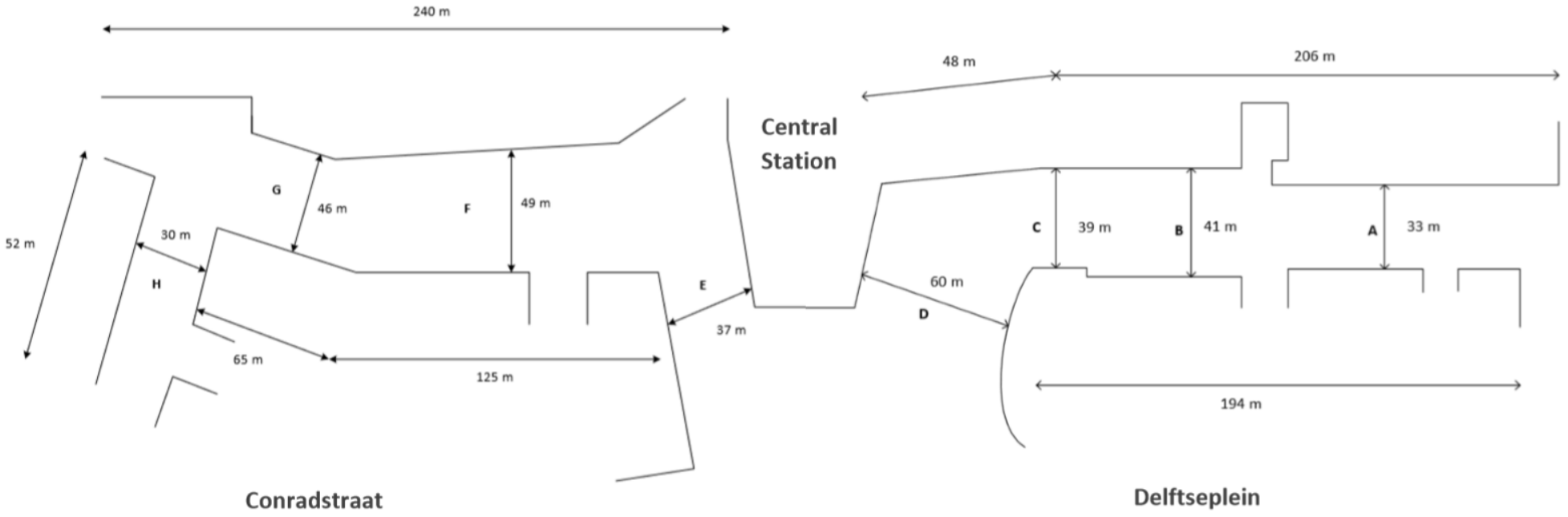
Figure E.1: pedestrian flow during the morning

Figure E.2: pedestrian flow during the afternoon

Figure E.3: pedestrian flow during the evening

Figure E.4: pedestrian flow during the night

This annex provide the map of the study report area, consisting of the Delftseplein and the Conradstraat. The different cross sections are shown with A, B, C, D in the Delftseplein and E, F, G, H in the Conradstraat. All including the wide for each cross section.



Annex H: Urban Design Compendium

This annex provide further information about the 'Urban Design Compenidum' . A guidance on how to achieve and assess the highest quality of the urban design. This to help all those that are involved during the design evaluation process. Due to the importance of quality design, it is crucial to have some guidance on what urban designs work well and why. There is even stated that quality of design is the most important criteria for public funding. (Yeang, 2000)

The design criteria's that are used during the evaluation criteria of this report study are provided with reference to other design documents. Due to the similarities between the different design criteria methods, a conclusion of the key aspects of urban design could be find. The key aspects of urban design that are established by the Urban Design Compendium method are described in table H.1.

Table H.1: Evaluation criteria's for redesign of an inner city (Yeang, 2000)

Places for People
For places to be well-used and well-loved, they must be safe, comfortable, varied and attractive. They also need to be distinctive, and offer variety, choice and fun. Vibrant places offer opportunities for meeting people, playing in the street and watching the world go by.
Enrich the Existing
New development should enrich the qualities of existing urban places. This means encouraging a distinctive response that arises from and complements its setting. This applies at every scale - the region, the city, the town, the neigbourhood, and the street.
Make Connections
Places need to be easy to get to and be integrated physically and visually with their surroundings. This requires attention to how to get around by foot, bicycle, public transport and the car - and in that order.
Work with the Landscape
Places that strike a balance between the natural and man made environment and utilise each site's intrinsic resources - the climate, landform, landscape and ecology - to maximise energy conservation and amenity.
Mix Uses and Forms
Stimulating, enjoyable and convenient places meet a variety of demands from the widest possible range of users, amenities and social groups. They also weave together different building forms, uses, tenures and densities.
Manage the Investment
For projects to be developable and well cared for they must be economically viable, well managed and maintained. This means understanding the market considerations of developers, ensuring long term commitment from the community and the local authority, defining appropriate delivery mechanisms and seeing this as part of the design process.
Design for Change
New development needs to be flexible enough to respond to future changes in use, lifestyle and demography. This means designing for energy and resource efficiency; creating flexibility in the use of property, public spaces and the service infrastructure and introducing new approaches to transportation, traffic management and parking.

The design criteria's stated above are provided with reference to other design documents . The following evaluation approaches are used as orientation; 'By Design Principles of urban design' (DETR and CABE, 2000) , (Princes Foundation Design and theory principles, 2007) , 'Responsive Environment' (Bentley I. , 1985), 'PPS1 Principles of good design' (Chiaradia A. , 2008). The result of the comparison between the different design criteria methods are shown in table H.2. As a result, a more simplified model is created that can be used during the urban design criteria evaluation.

Table H.2: Key aspects of urban design, established by using reference of different design criteria approaches. (Yeang, 2000)

UDC1 Key aspects of urban design	By Design Principles of urban design	Princes Foundation Design and theory principles	Responsive Environments	PPS1 Principles of good design
Places for people	Quality of the public realm Continuity and Enclosure	Make Places	Robustness	create an environment where everyone can access and benefit from the full range of opportunities available to members of society
Enrich the existing	Character	Build beautifully	Visual appropriateness Richness	be integrated into the existing urban form and the natural and built environments
Make connections	Ease of Movement	Allow movement logically and legibly	Permeability	be integrated into the existing urban form and the natural and built environments
	Legibility		Legibility	address the connections between people and places by considering the needs of people to access jobs and key services
Work with the landscape		Design using natural harmonics		consider the direct and indirect impacts on the natural environment.
Mix uses and form	Diversity	Engender social interaction	Variety	address the connections between people and places by considering the needs of people to access jobs and key services
Manage the investment		Sustain land value		
Design for change	Adaptability		Personalisation	create an environment where everyone can access and benefit from the full range of opportunities available to members of society

Annex I: Cross sections of existing situation

This annex consist of the cross sections of the existing situation of both the Delftseplein as the Conradstraat.

Delftseplein:

The Delftseplein is imagined with the following cross sections; cross sections A, B, C and D are shown in figure I.1, figure I.2, figure I.3 and figure I.4.

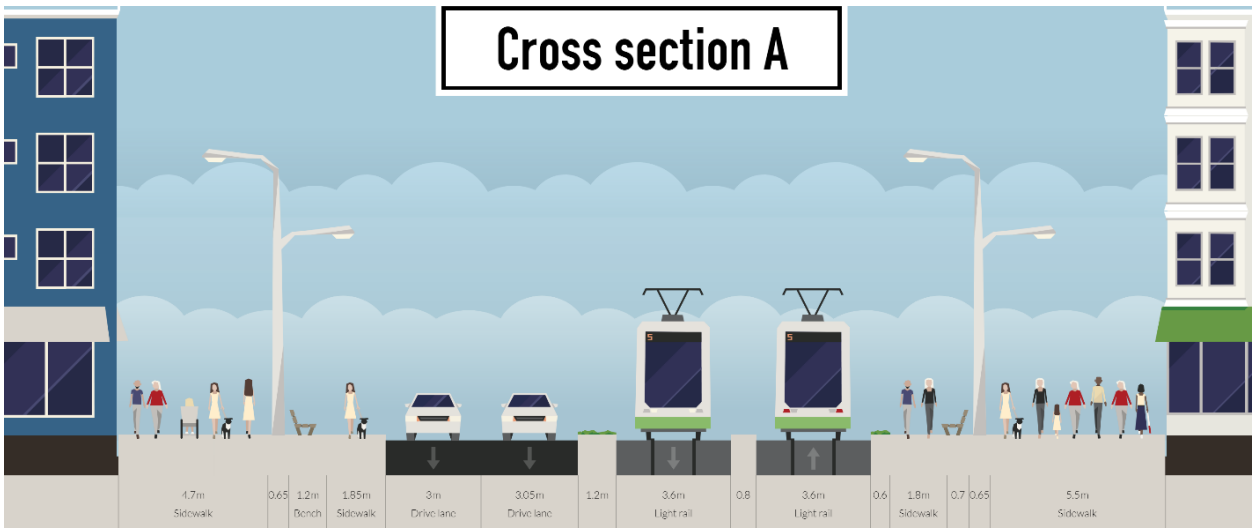


Figure I.1. Cross section of Street A. The width of this part of the Delftseplein contains 33 m.

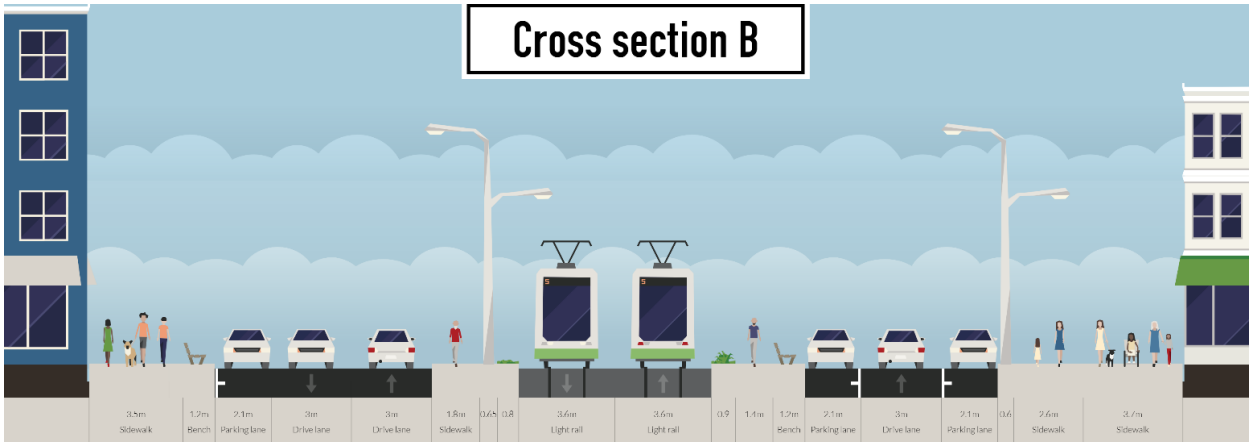


Figure I.2. Cross section B. The width of this part of the Delftseplein contains 41 m.

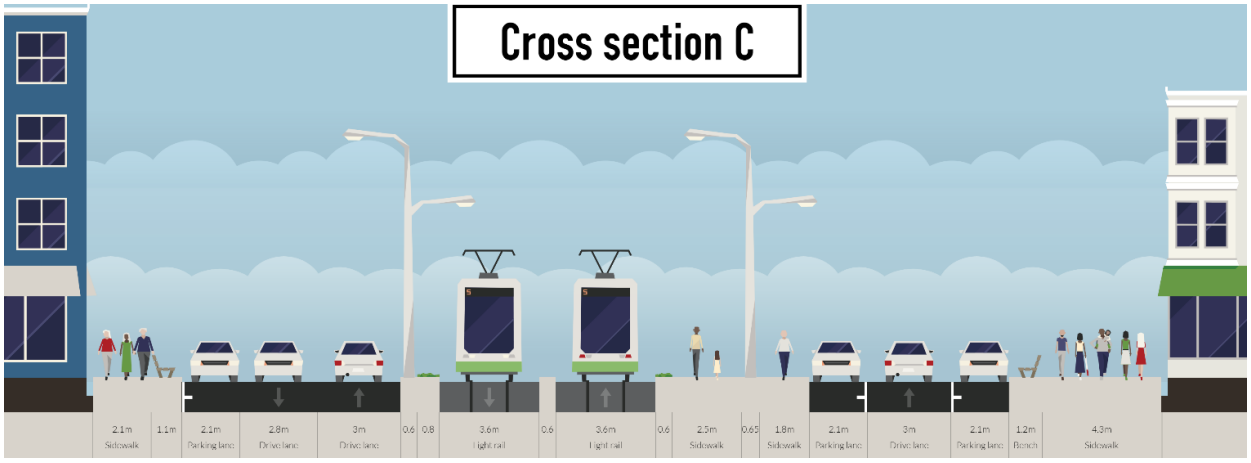


Figure I.3. Cross section C. The width of this part of the Delftseplein contains 39 m.

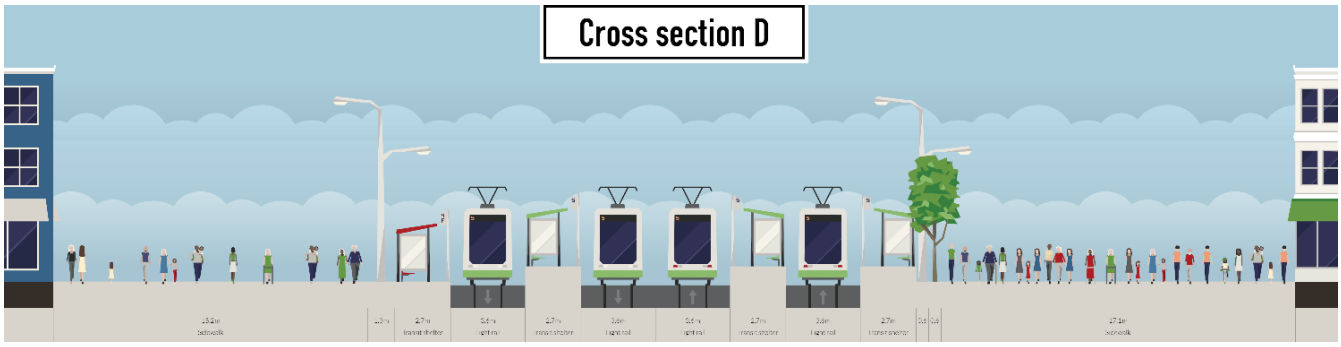


Figure I.4. Cross section D. The width of this part of the Delftseplein contains 60 m.

Conradstraat:

The Conradstraat is imagined with the following cross sections; cross sections E, F, G and H are shown in figure I.5, figure I.6, figure I.7 and figure I.8

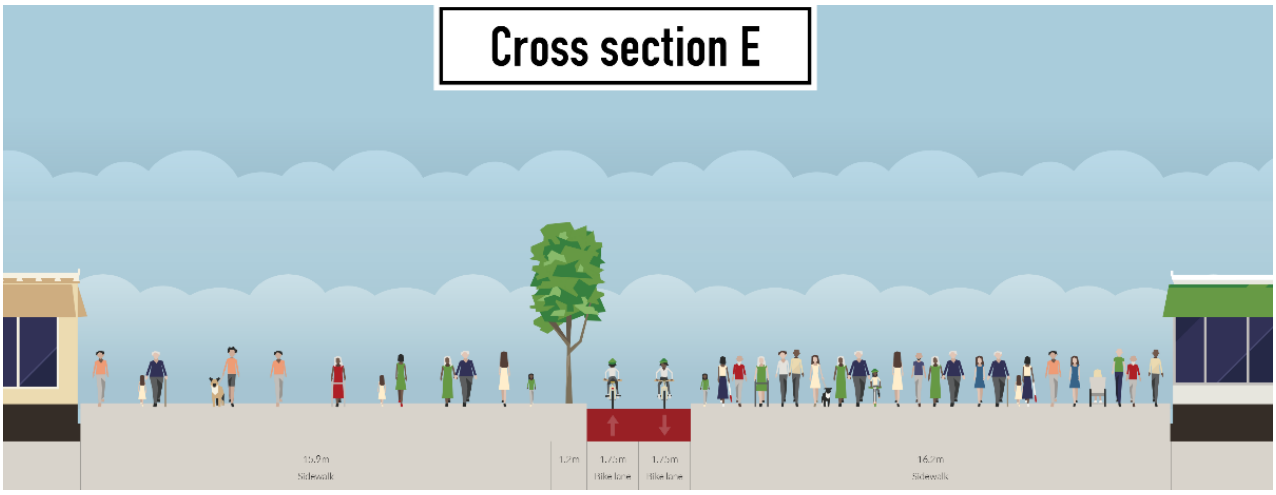


Figure I.5. Cross section E. The width of this part of the Conradstraat contains 37 m.

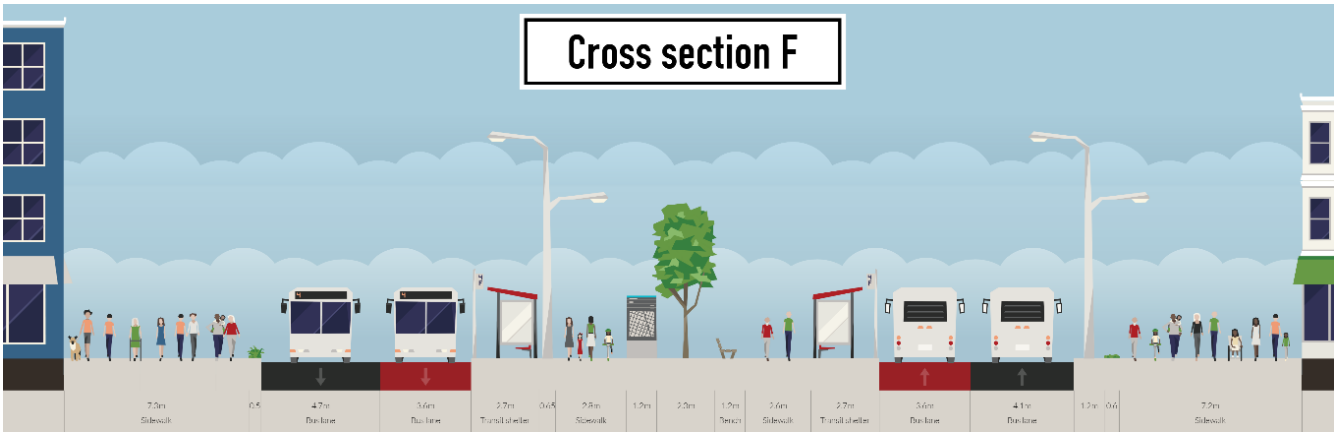


Figure I.6. Cross section F. The width of this part of the Conradstraat contains 49 m.

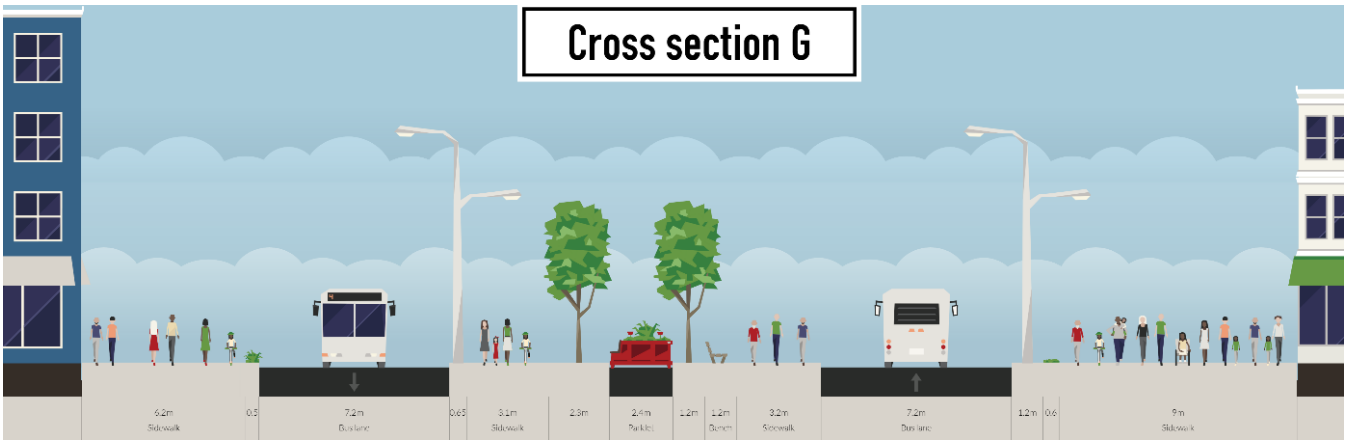


Figure I.7. Cross section G. The width of this part of the Conradstraat contains 46 m.

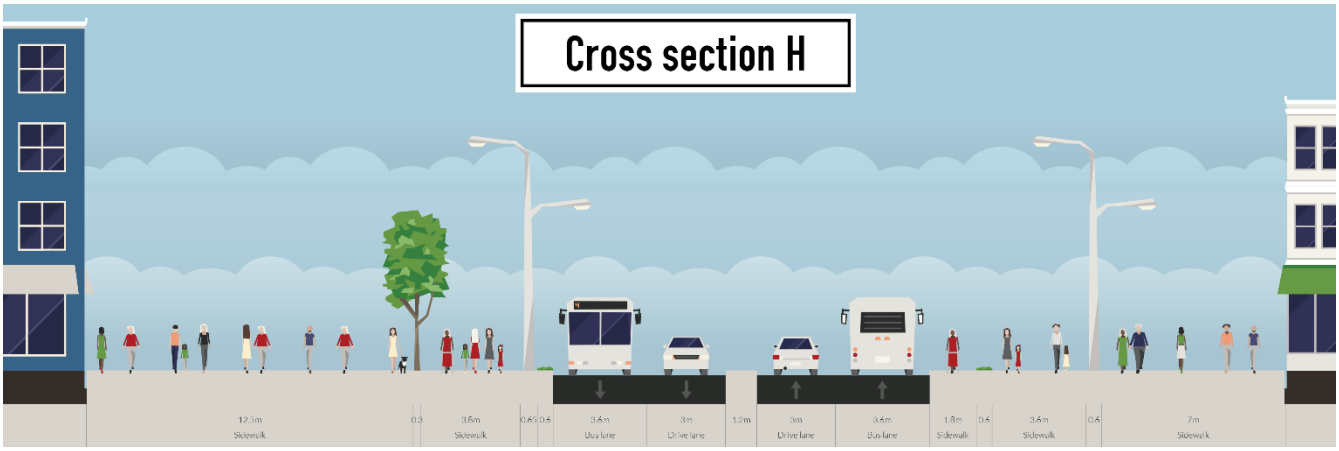


Figure I.8. Cross section H. The width of this part of the Conradstraat contains 30 m.

Annex J: Cross sections of Design 1: *Underground Bicycle lanes*

This annex consist of the cross sections of Design 1. In this design an underground bicycle lane is used to provide a solution to the report study and give more priority to the cyclists and pedestrians.

Delftseplein:

The Delftseplein is imagined with the following cross sections; cross sections A, B, C and D are shown in figure J.1, figure J.2, figure J.3 and figure J.4.

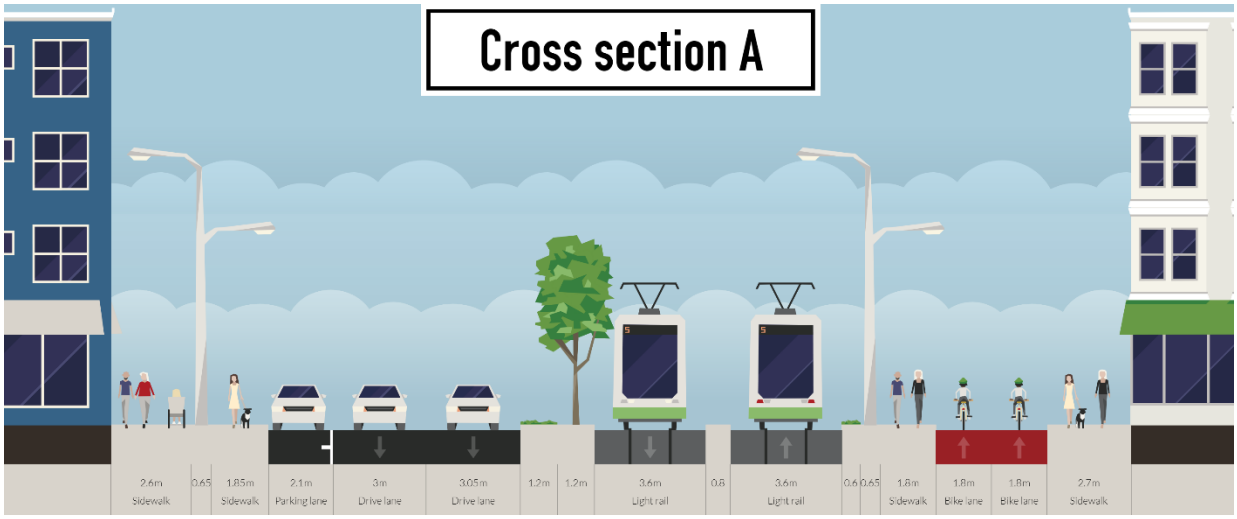


Figure J.1. Cross section of Street A. The width of this part of the Delftseplein contains 33 m.

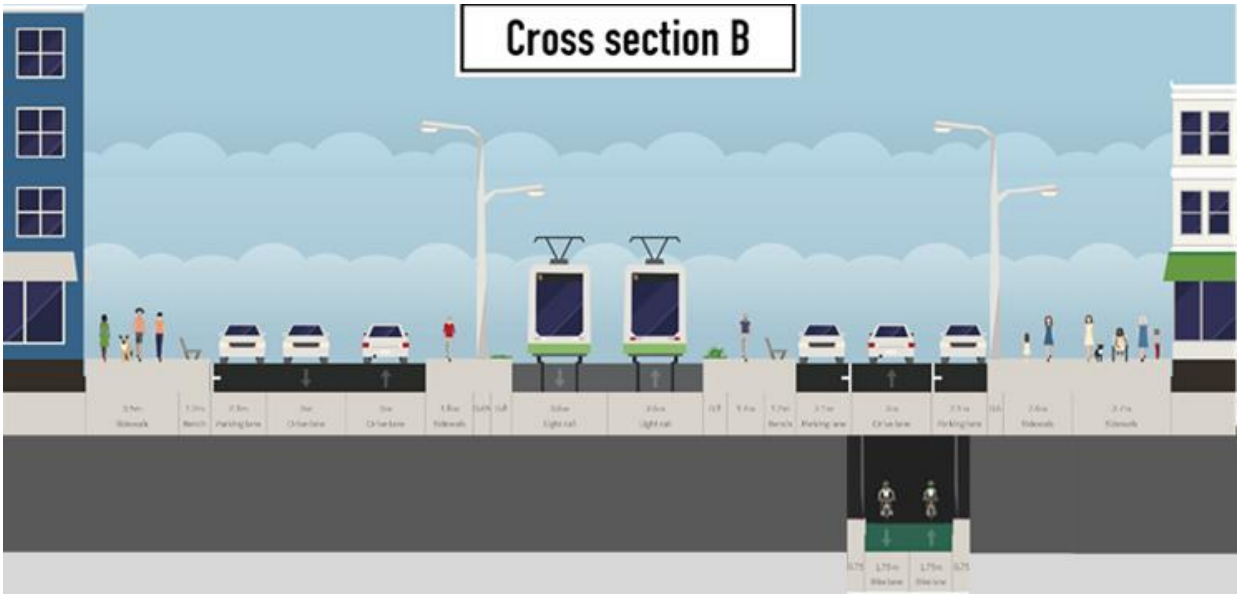


Figure J.2. Cross section B. The width of this part of the Delftseplein contains 41 m.

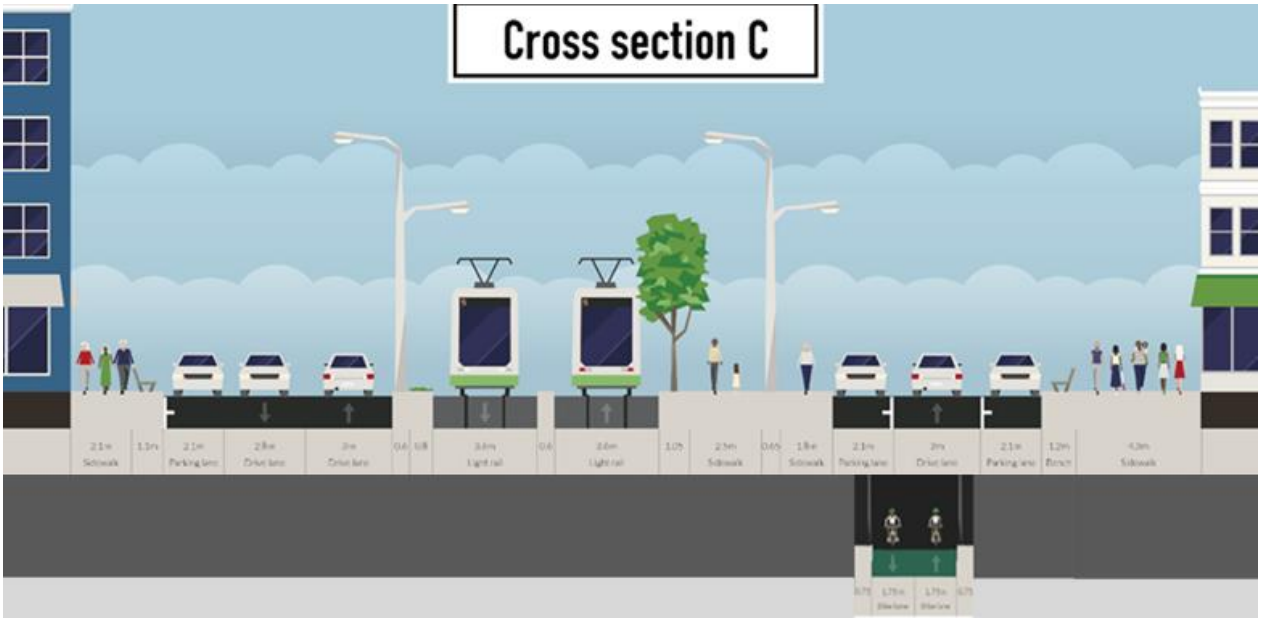


Figure J.3. Cross section C. The width of this part of the Delftseplein contains 39 m.

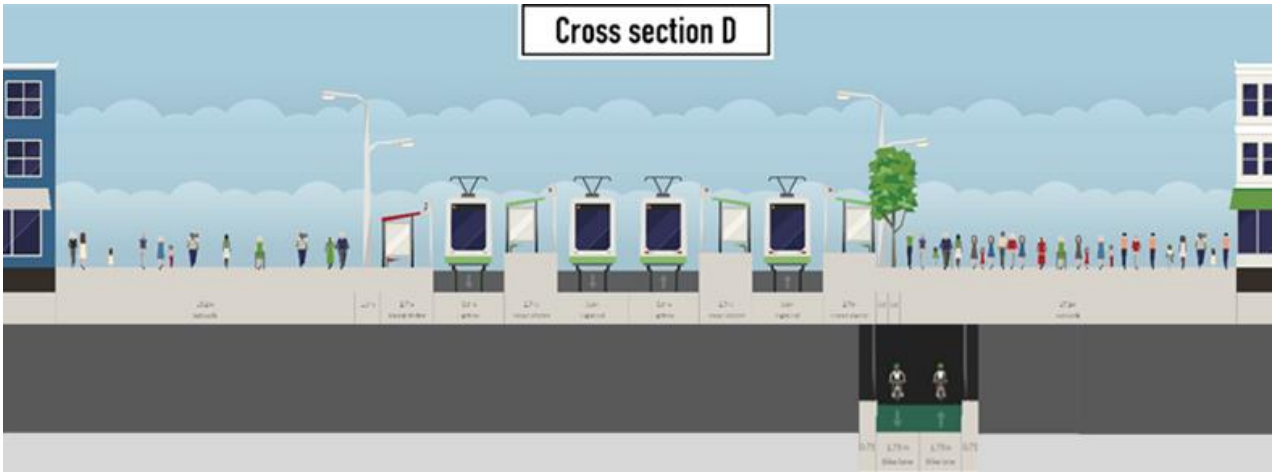


Figure J.4. Cross section D. The width of this part of the Delftseplein contains 60 m.

Conradstraat:

The Conradstraat is imagined with the following cross sections; cross sections E, F, G and H are shown in figure J.5, figure J.6, figure J.7 and figure J.8

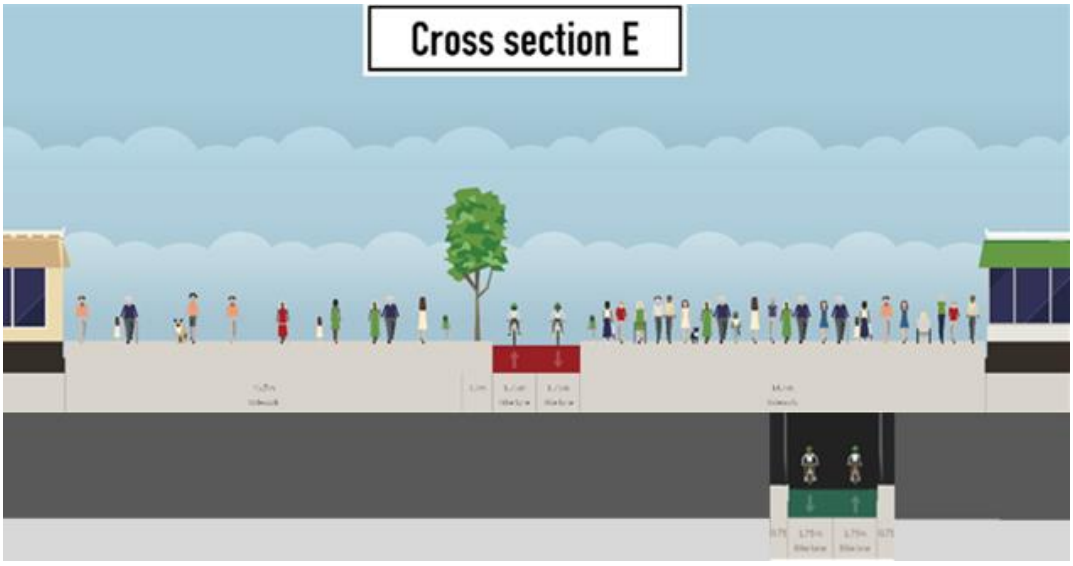


Figure J.5. Cross section E. The width of this part of the Conradstraat contains 37 m.

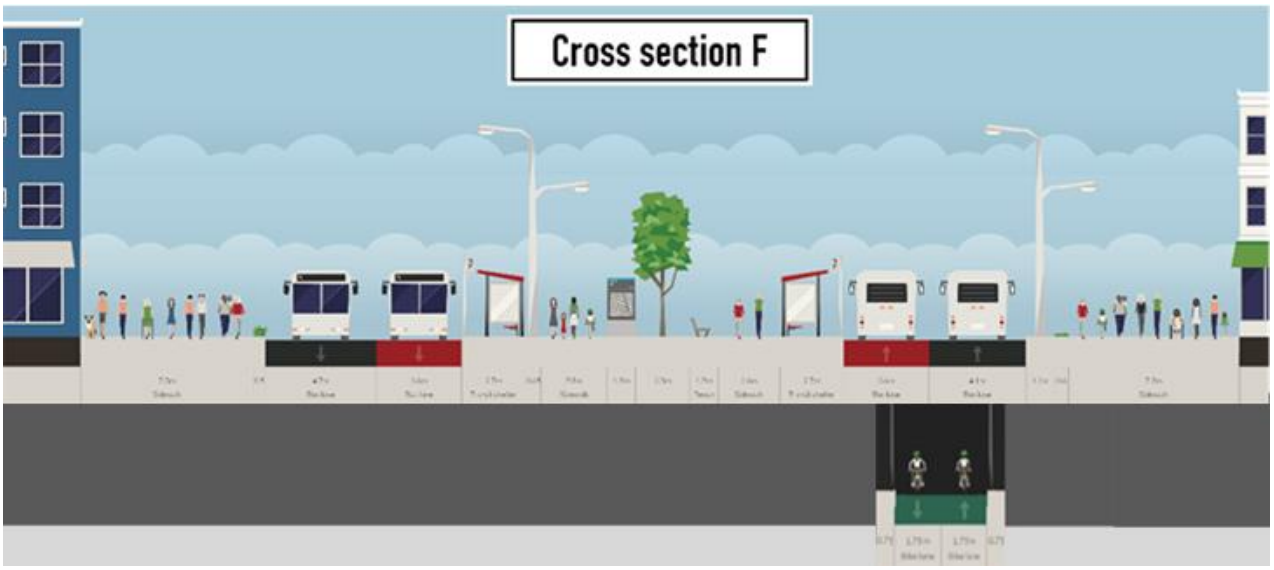


Figure J.6. Cross section F. The width of this part of the Conradstraat contains 49 m.

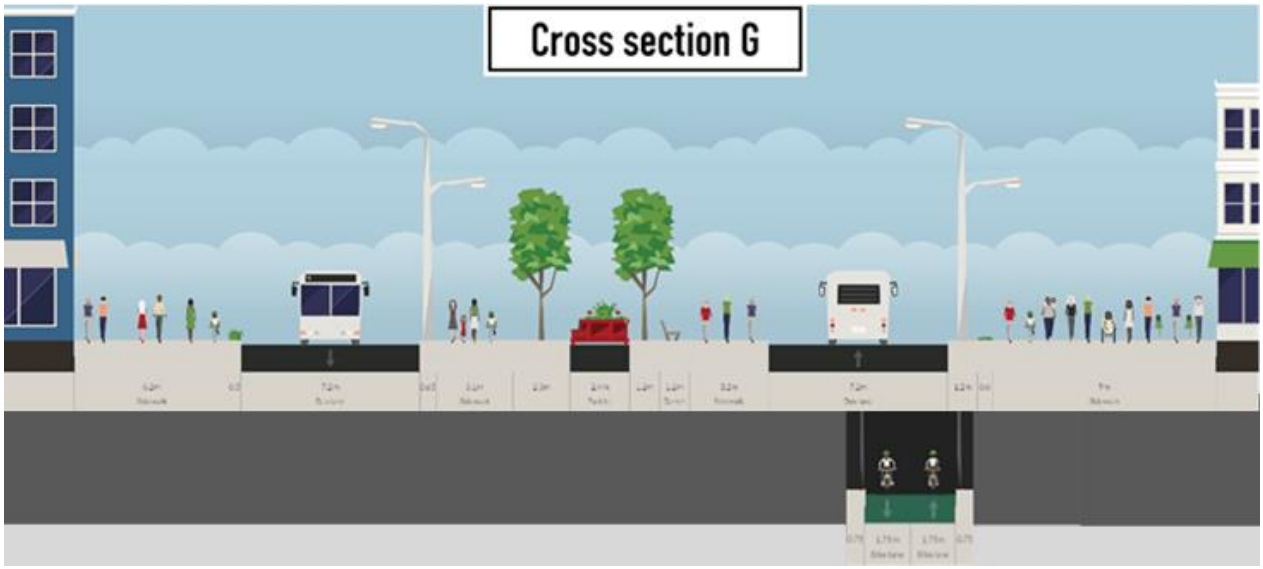


Figure J.7. Cross section G. The width of this part of the Conradstraat contains 46 m.

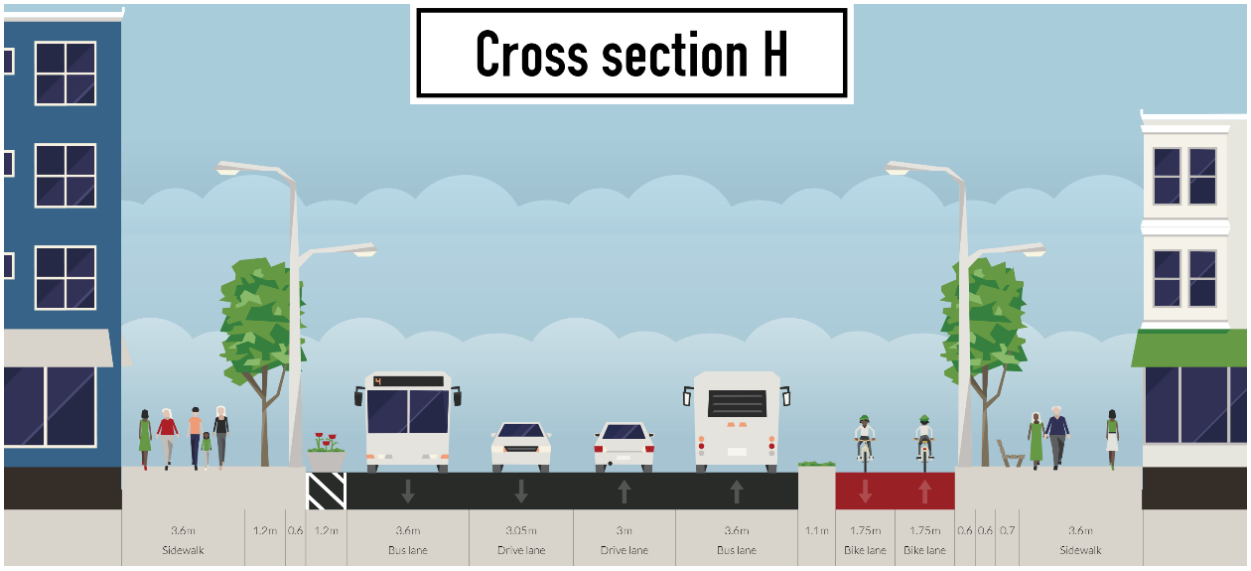


Figure J.8. Cross section H. The width of this part of the Conradstraat contains 30 m.

Annex K: Cross sections of Design 2: *Shared Spaces*

This annex consist of the cross sections of Design 2.

Delftseplein:

The Delftseplein is imagined with the following cross sections; cross sections A, B, C and D are shown in figure K.1, figure K.2, figure K.3 and figure K.4.

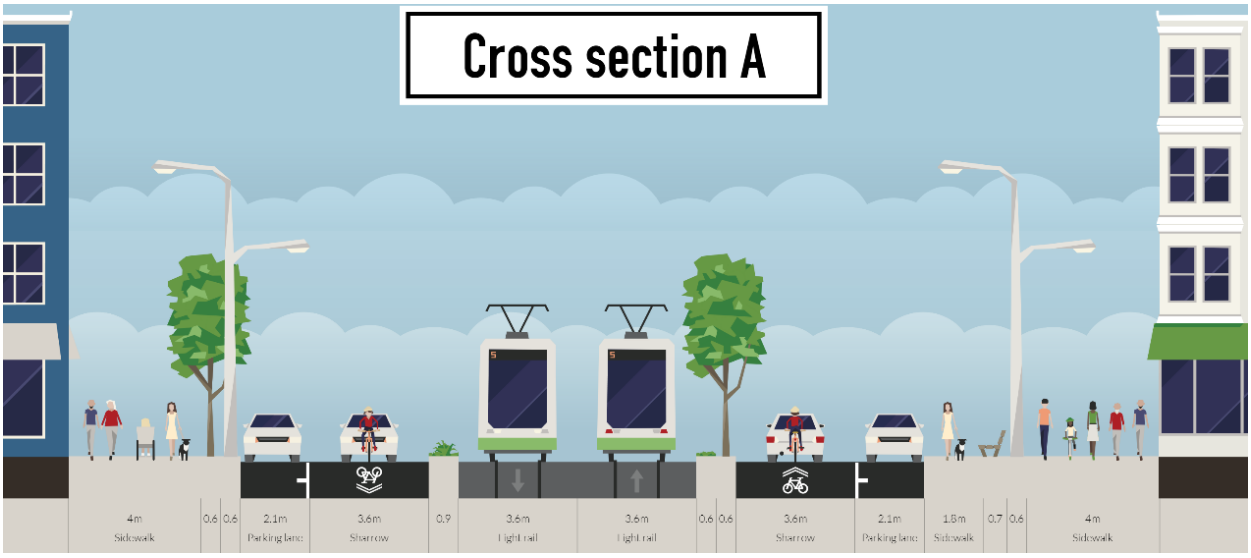


Figure K.1. Cross section of Street A. The width of this part of the Delftseplein contains 33 m.

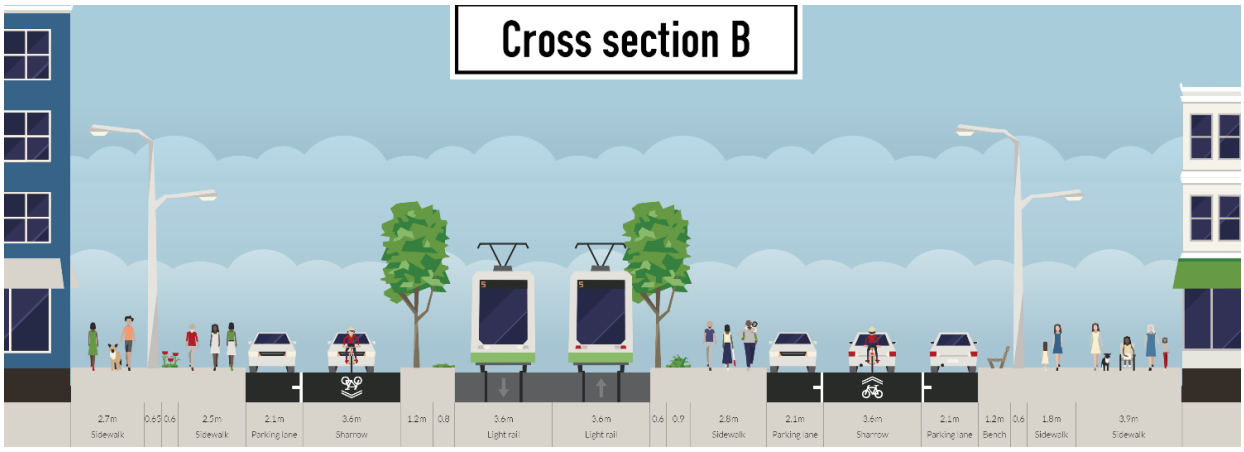


Figure K.2. Cross section B. The width of this part of the Delftseplein contains 41 m.

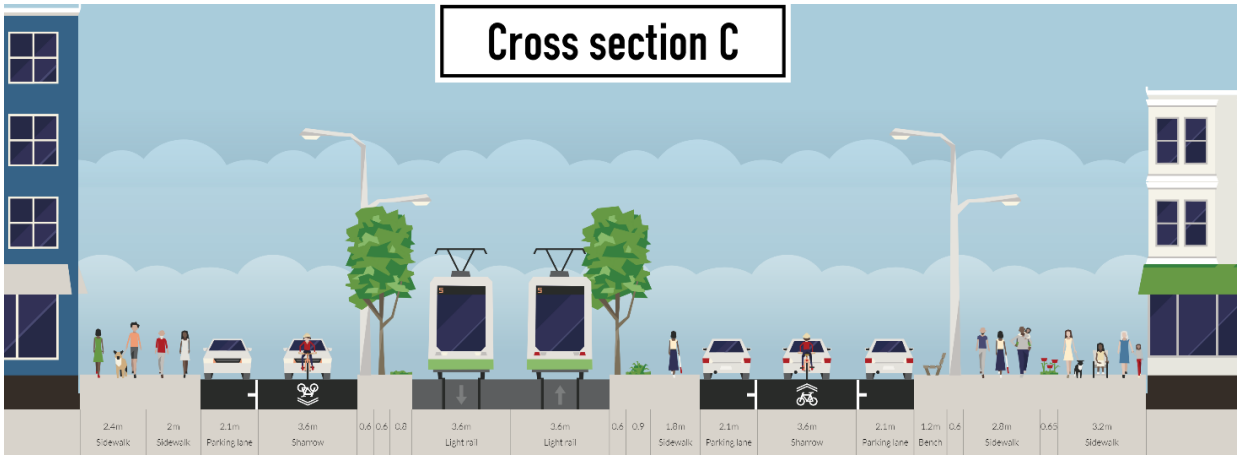


Figure K.3. Cross section C. The width of this part of the Delftseplein contains 39 m.

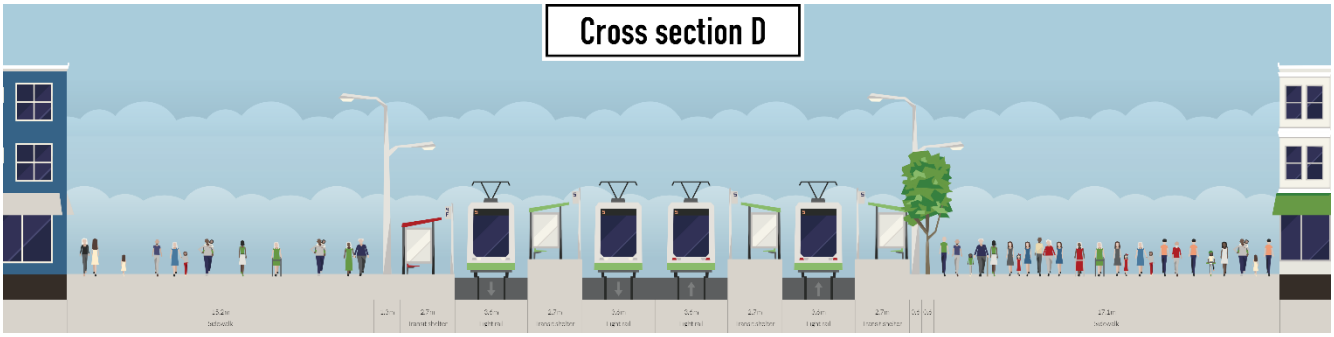


Figure K.4. Cross section D. The width of this part of the Delftseplein contains 60 m.

Conradstraat:

The Conradstraat is imagined with the following cross sections; cross sections E, F, G and H are shown in figure K.5, figure K.6, figure K.7 and figure K.8

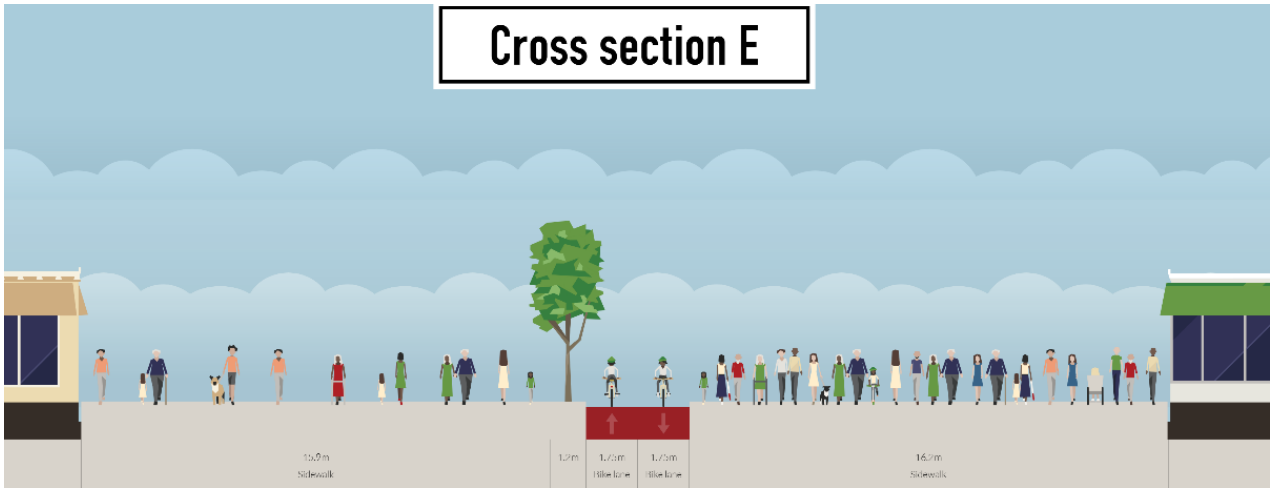


Figure K.5. Cross section E. The width of this part of the Conradstraat contains 37 m.

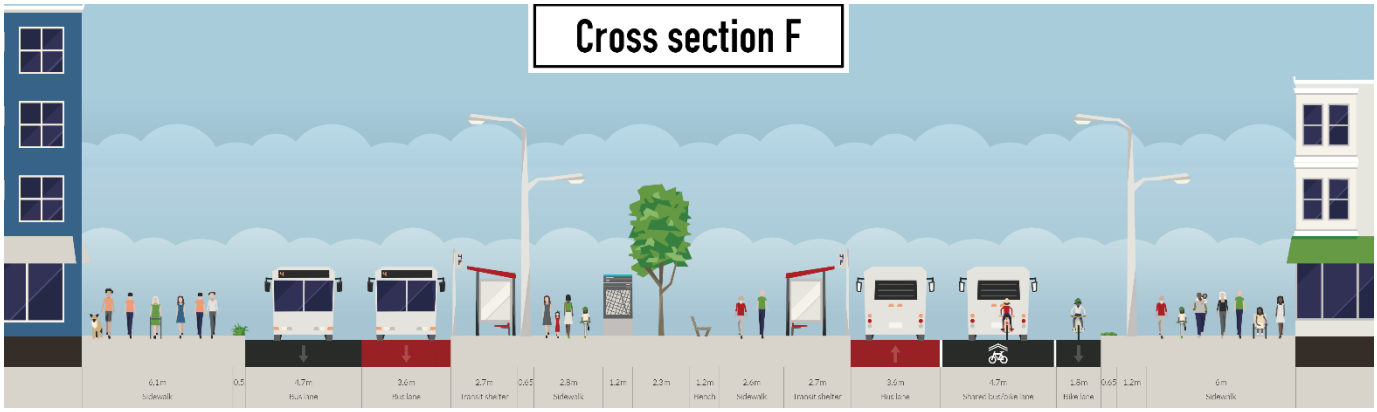


Figure K.6. Cross section F. The width of this part of the Conradstraat contains 49 m.

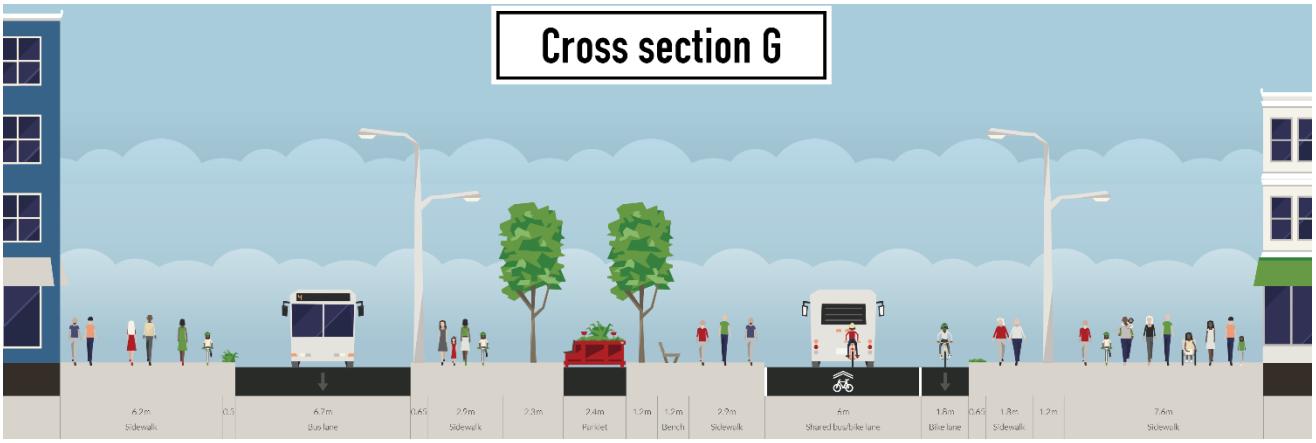


Figure K.7. Cross section G. The width of this part of the Conradstraat contains 46 m.

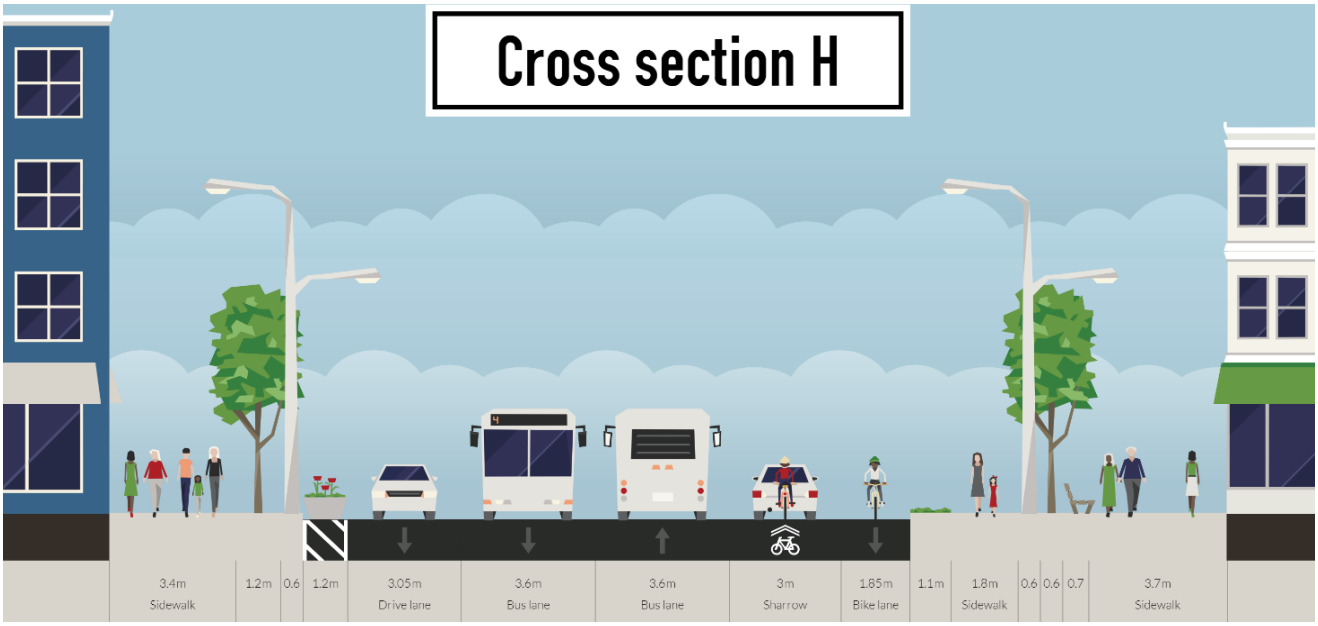


Figure K.8. Cross section H. The width of this part of the Conradstraat contains 30 m.

Annex L: Cross sections of Design 3: *Different levels*

This annex consist of the cross sections of Design 3.

Delftseplein:

The Delftseplein is imagined with the following cross sections; cross sections A, B, C and D are shown in figure L.1, figure L.2, figure L.3 and figure L.4.

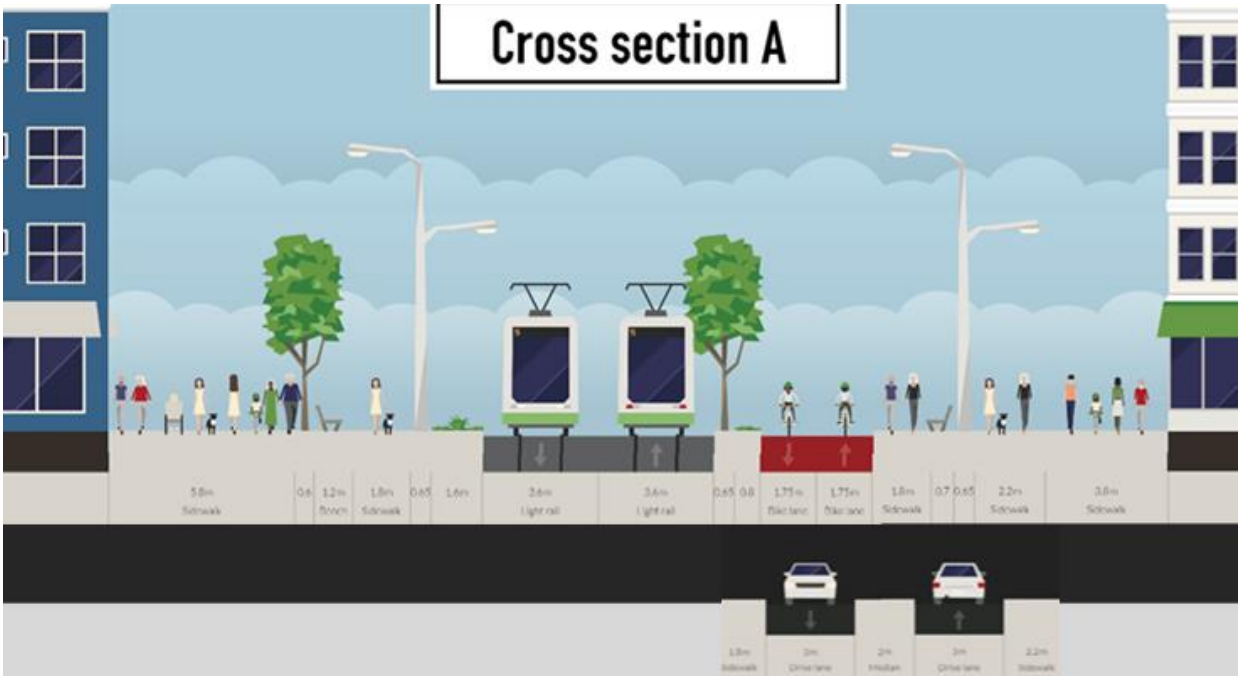


Figure L.1. Cross section of Street A. The width of this part of the Delftseplein contains 33 m.

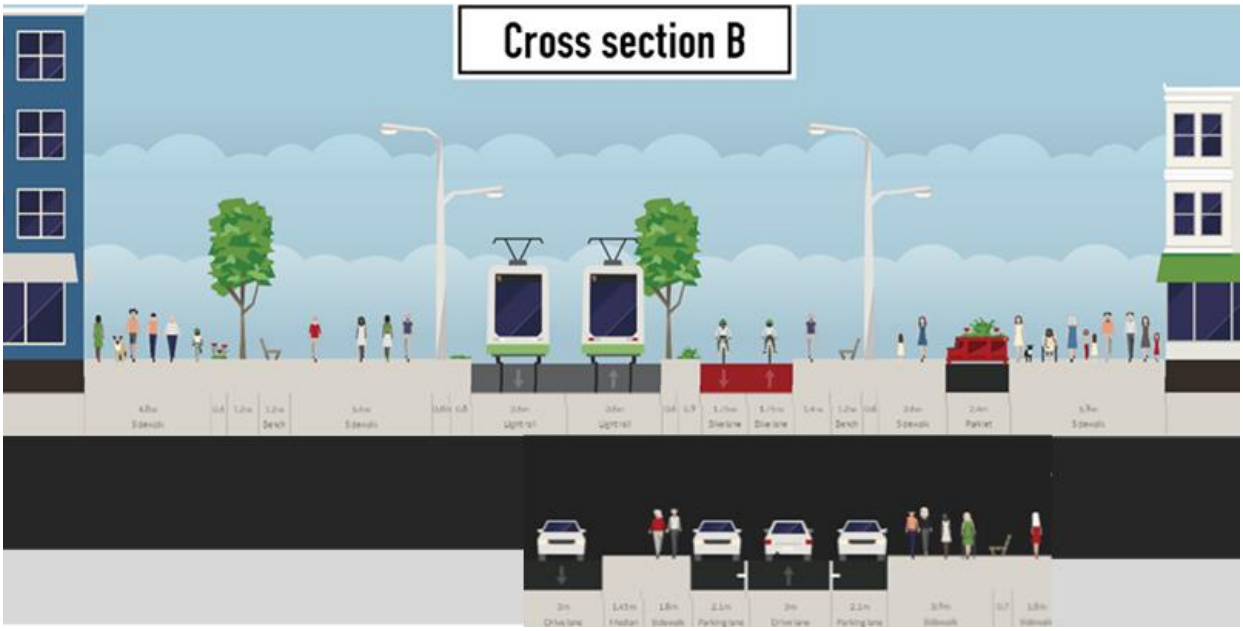


Figure L.2. Cross section B. The width of this part of the Delftseplein contains 41 m.

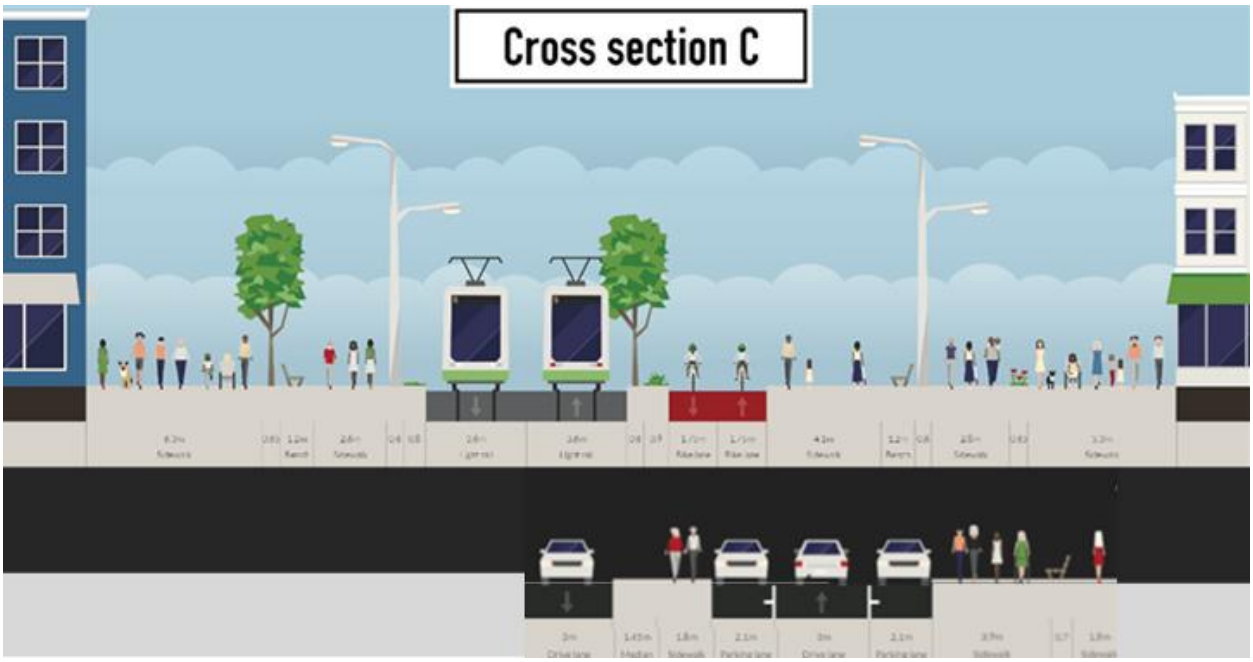


Figure L.3. Cross section C. The width of this part of the Delftseplein contains 39 m.

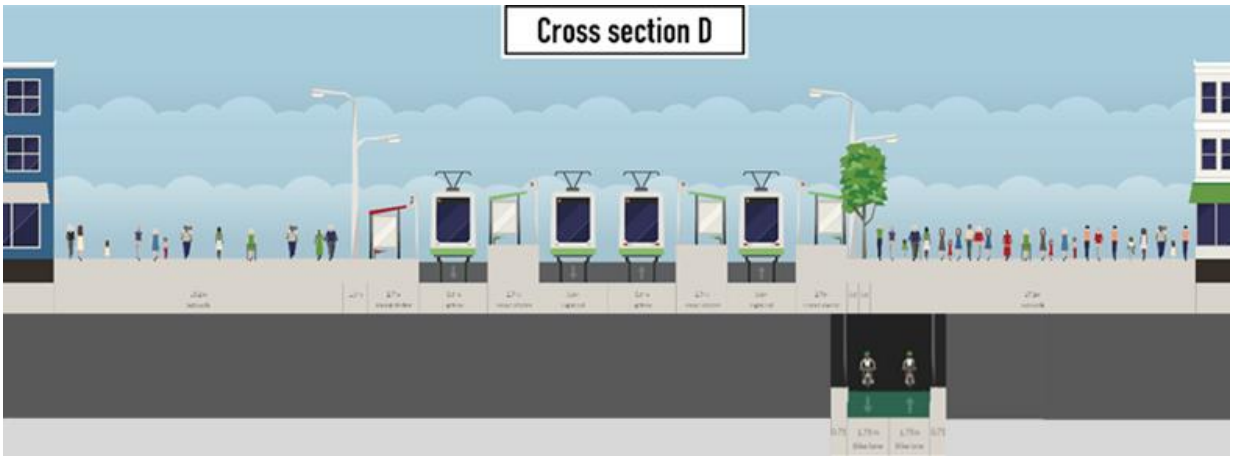


Figure L.4. Cross section D. The width of this part of the Delftseplein contains 60 m.

Conradstraat:

The Conradstraat is imagined with the following cross sections; cross sections E, F, G and H are shown in figure L.5, figure L.6, figure L.7 and figure L.8

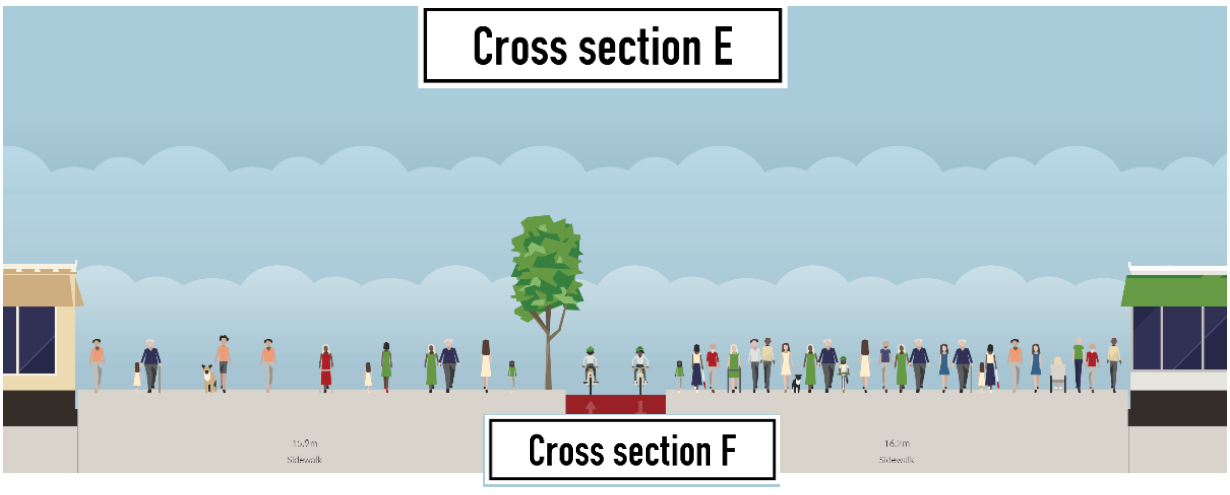


Figure L.5. Cross section E. The width of this part of the Conradstraat contains 37 m.

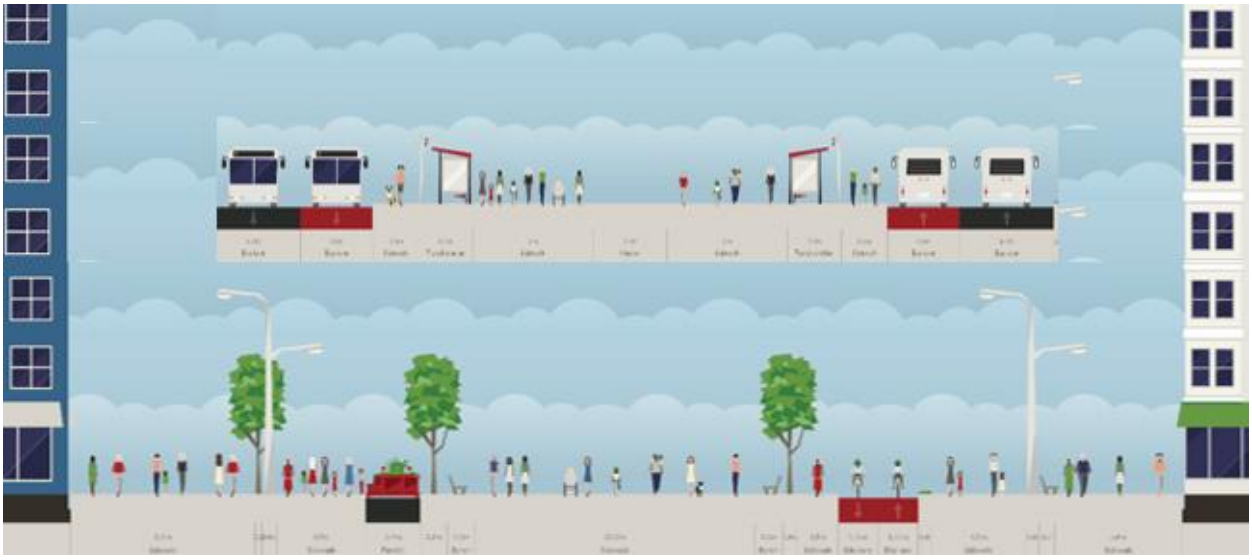


Figure L.6. Cross section F. The width of this part of the Conradstraat contains 49 m.

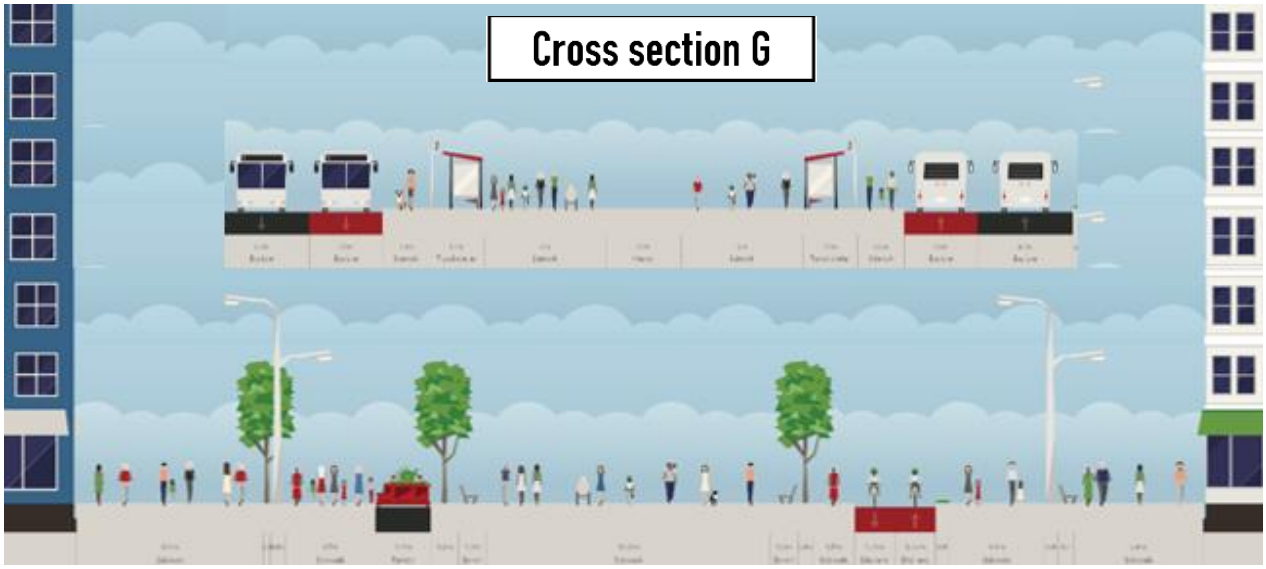


Figure L.7. Cross section G. The width of this part of the Conradstraat contains 46 m.

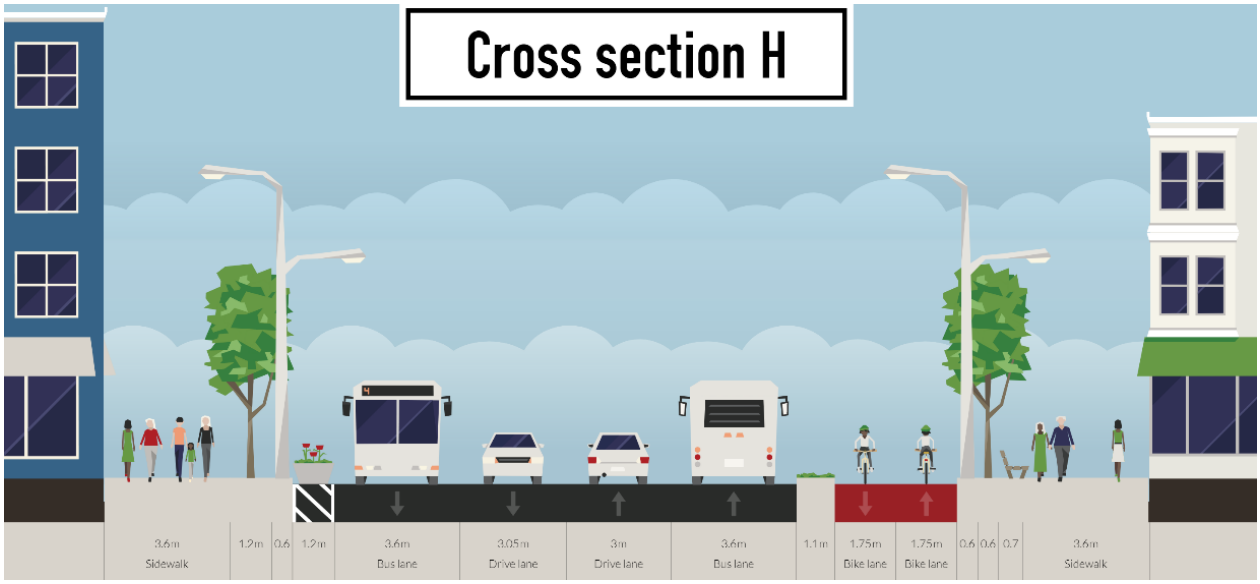


Figure L.8. Cross section H. The width of this part of the Conradstraat contains 30 m.

Annex M: Performance level for each criteria Design 1: *Underground Bicycle lanes*

This annex provide the explanation of the performance level for each criteria of the second design created as possible solution for the research question. The first design consist of an expansion of the already existing bicycle tunnel beneath the Central Station.

Places for People:

More space for the boulevards is created, due to the underground bicycle lanes. This results in an increased user-friendliness and improved approachability for pedestrians and other transport systems in the area. The streets has become a pleasant place to stay. On the other hand, the bicycle tunnel will have negative influence to the social safety for cyclists. Of course this can be decreased as much as possible by good lightening and other security measurements. Conversely, the traffic safety will increase, due to less interaction between other traffic flows that will be attendant on ground level. Also the viability between the different transport systems in the streets will be enhanced, as a result of the decreased interaction between the road users. However, this could have been done even more by removing more transport systems to different levels and giving each transport system their own space.

Enrich the Existing:

In the existing design there were no bicycle lanes and an extreme lack of parking places. This is improved by introducing the underground bicycle lanes in both the Delftseplein as the Conradstraat. Certainly, this is not the most desirable solution for cyclists, but it increases the accessibility of the area. The public places in the Central Station will also retain available. However, the public transport systems are still dominating in the streets. Accordingly, in contrast with the main focus of the report, as stated in Section 2.4, there is not given full priority to the cyclists in both the streets. On the other hand, the created bicycles parking places are better approachable, inviting and the public transport systems are entirely able to retain their function.

Make Connections:

The accessibility of the Delftseplein and the Conradstraat are both improved. Especially for cyclists, because the existing bicycle tunnel and the new and existing underground parking facilities beneath the Central Station will be approachable by bicycle from all the different directions from the city centre. (Philippe Samyn and Partners ,2003) Also the most suitable locations for bicycle parking are used in this design. The transition of the different public transport systems will be retained properly. (RET, 2017) However, the approachability of the main entrance of the new building could have been better. There is for example not much space to load or unload in the streets for residents and the companies housing in the new building. (Gemeente Rotterdam [1], 2017) The public transport system will be still attendant in front of the buildings.

Work with the Landscape:

The environment is more attractive, because the cyclists are removed to one level below the ground. As a result, there is more space and the area is less cropped compared with the existing situation. Although, the public transport system is still dominating in the Delftseplein and the Conradstraat. (RET, 2017) To create an environment as liveable as possible, looking to the available space, more trees and green areas is included into the area. This will improve the liveability and attractiveness of the environment.

Mix Uses and Forms:

More continuity in the streets is created by including separated bicycle lanes in the streets. As a result, the different target groups, users and functions are reinforcing each. The ability of use in the evening was needed to take into consideration by the expansion of the public area. This needed to be done due to the new buildings that will be introduced to the streets. (Gemeente Rotterdam [1], 2017) The public transport systems are still well combined, because they retain located on the same level. (RET, 2017) This results in less walking distance between the different transport systems.

Manage the Investment:

The bicycle tunnel is an investment, but it is economically viable, because it is able to secure financing while having a positive impact on both the environment as the society. Another fact to take into consideration, the capital spending of a bicycle tunnel will be not that much compared with removing other transport systems. This has several reasons, first less space is needed beneath the ground, that results in lower construction and maintenance costs. Secondly, it will cause less hinderance to the cyclists and other road users when constructing the bicycle tunnels. Due to the fact that, at this moment, there are no bicycle lanes available in the streets. However, there will be consequences for the area, but they could be manageable. The public transport systems located in the area will not magnitude huge negative effects during the construction.

Design for Change:

There is space for a possible further development of the area. Because of the new introduced bicycle lanes in the street, partly underground, the increased number of cyclists in the future is taken into account. (Besselink J., 2016). The bicycle lanes will be bi-directional with a width of 3,5 metre. Also the future pedestrian flow to the Central Station that is still increasing is taken into account. (Van Oorschot K. , 2017) This is done by the enhanced sidewalks and the expansion of the boulevards.

Annex N: Performance level for each criteria Design 2: *Shared Space*

This annex provide the explanation of the performance level for each criteria of the second design created as possible solution for the research question. The design consist of the Shared Spaces concept, a mix between the different traffic systems, instead of every system having their own space.

Places for People:

In the existing design there were no bicycle lanes. As a result, by including shared lanes to the design, the cyclists will have better access to the Central Station and both the existing and new parking facilities. The shared space concept will also result in more interaction between the different road users. However, it will also include a negative effect to the social security. To increase the safety, one directional lanes will be used to prevent too much interaction between the different road users. The viability and user-friendliness of the area will be less than in the other designs, but it is still improved compared with the existing situation.

Enrich the Existing:

There are currently no bicycle lanes in the streets. On top of that, there is also an extreme lack of parking places for both cars as bicycles. This is improved by introducing new parking places and the shared space device for cyclists. Of course the shared space lanes are not the most desirable solution for cyclists, because it still results in a lot of interaction with the other road users. (Bicycle Dutch [1], 2017) On top of that, the public transport systems are still dominating in the area, so there is still not given full priority to cyclists. In spite of this, the Central Station and the new and existing parking places are better accessible by bicycle.

Make Connections:

The accessibility for both the Delftseplein as the Conradstraat is improved. The new and existing parking facilities for bicycles and the Central Station are approachable from all the different directions of the city centre. As a result, this design also contains the most suitable locations for bicycle parking, looking to the shared space device. The transition of the different public transport systems are retained properly. (RET, 2017) However, the main entrance of the new building will be not maximally approachable. Due to the public transport systems that will be located in front of the new buildings in both the streets, there is not much space to load or unload in the streets for residents and the companies that will be housing in the new building. (Gemeente Rotterdam [1], 2017) Also the shops that will be located on ground level will have an less attractive appearance.

Work with the Landscape:

The environment is decreased in attractiveness, due to the even busier area that is created by including the shared lanes. Due to the fact that the transport system is still dominating in the street, this result in a cropped area. Accordingly, not a nice place you want to stay. There is also not much room to preserve as much trees as needed to provide more cohesion between the different traffic flows in the street.

Mix Uses and Forms:

The public transport systems are still well combined, because they are located on the same level. This results in the smallest possible walking distance from the public transport systems around the Central Station. Due to the new buildings that will be introduced in both the streets, the ability of use in the evening needed to take into consideration. (Gemeente Rotterdam [1], 2017) This is done by keeping everything close together, what result in a more liveable environment during the evening hours. There is no huge expansion of the public area possible, but it is improved in contrast with the existing design.

Manage the Investment:

The design is economically viable, due to the fact that there are no huge construction costs needed during the realisation phase of the design. The capital spending will be much less than in the other designs. However, the road users will provide some hinderances during the construction phase for a short period of time. On top of that, the less space that is available in front of the new buildings in the streets will have a negative influence to the sale of houses that will be introduced to the streets. (Gemeente Rotterdam [1],

2017) Because the crowded area results in a less attractive environment to live in. Consequently, the building will be less attractive for residents, companies and shops.

Design for Change:

The increasing number of cyclists in the future is partly taken into account, due to the introduced shared bicycle lane. (Besselink J., 2016). The shared bicycle lanes will expand the bicycle entrances to the Central Station, but they will not be an attractive entrance for cyclists to the Central Station. Because a shared lane results in more interaction between the different road users. (Bicycle Dutch [1], 2017) Subsequently, the shared bicycle lane in the street will mostly be used by cyclists that need to reach their destination in the street. As a result, the growing number of cyclists to the Central Station will not be prevent. Also, the future pedestrian flow that is growing is not totally taken into consideration. (Van Oorschot K. , 2017) The enhanced sidewalks and expansion of the boulevards are not that much as needed. On top of that, there are also not that much possibilities for further development of the area.

Annex O: Performance level for each criteria Design 3: Split levels

This annex provide the explanation of the performance level for each criteria of the third design created as potential solution for the research question. The design consist of the use of split levels to separate the different transport functions.

Places for People:

The created public area has become a pleasant place to stay, due to the attractive atmosphere that is created. Furthermore, the approachable of the streets are extremely improved, due to the extra space that can be used. Every transport system has its own space. (RET, 2017) This results in almost no interaction between the different traffic flows. This has a positive influence on the traffic safety in both the streets. On top of that, the existing bicycle tunnel and the new and existing parking places are better accessible. (Philippe Samyn and Partners ,2003) The user-friendliness of the public transport systems are maybe not that much as in the other designs, because they are placed on different levels. This results in longer walking distances. On the other hand, the viability of the area is advanced, due to the fact that the area will be less crowded. The bicycle lane underground, the kiss & ride places, taxi stands and car lanes that are positioned underground have a negative influence on the social safety of the road users. (RET, 2017) But this can be decreased as much as possible by good lightening, security and safety measures.

Enrich the Existing:

In the existing design there were no bicycle lanes and an extreme lack of parking places. This is improved by introducing bicycle lanes on ground level. Similar for the existing bicycle tunnel and the new and existing parking places for both bicycles and cars. Due to the different levels, there is also more space for the expansion of sidewalks and boulevards. Consequently, this design is made in the point of view of the cyclists and the pedestrians. Both is given full priority in the streets. On top of that, also the functions of the public transport systems are retained. (RET, 2017)

Make Connections:

The accessibility of the Delftseplein and the Conradstraat are both extremely improved. Especially for cyclists, because the new parking facilities for bicycles as well as the existing underground parking facilities beneath the Central Station will be approachable from all the different directions of the city centre. (Philippe Samyn and Partners ,2003) In this design the most suitable locations for bicycle parking are used. However, the transition of the different public transport systems will be less attractive, due to the longer walking distances and as a result longer traffic time. Nevertheless, the new buildings will be much better approachable. (Gemeente Rotterdam [1], 2017) Due to the fact that the public transport system are removed. In this design there will be more space for the residents and show owners to attend 'their destination'. For example, there will be space to load and unload your cars.

Work with the Landscape:

The environment is partly more attractive. Of course the bus station that will be constructed one level above the ground will result in a less attractive view for the area. But there is potential to make this as attractive as possible. On the contrary, the area on ground level will be improved. Especially the expansion of the green areas, by introducing more trees and plants in the environment.

Mix Uses and Forms:

The different target groups, users and function are reinforcing each other. Due to the new buildings in the area, the ability of use in the evening was needed to take into consideration. (Gemeente Rotterdam [1], 2017) This is done enormously by the expansion of the public area and creating a more liveable environment. The public transport systems are less combined, because they are not retained on same level. (RET, 2017) However, the different transport systems are divided, what results in more continuity in the streets.

Manage the Investment:

The use of different levels will result in an increase in the amount of capital spending. Due to the high construction and maintenance costs of this solution. Also the other transport systems that are positioned in the area will undermine huge hinderance during the construction phase. As a result, there are consequences, but they could be manageable. Subsequently, the design is economically viable, because it is able to secure financing while having a positive impact on both the environment as the society. In spite of this, it is an enormous investment. On the other hand, due to the extra space that is created in front of the new buildings, the area has become more attractive to live in. (Gemeente Rotterdam [1], 2017) This will also have a positive influence to the sale of houses and shops that will be introduced into the streets.

Design for Change:

There are several possibilities for further development of the area. Due to the new introduced bicycle lanes in the street, the increased number of cyclists in the future is taken into account. (Besselink J., 2016) The bicycle lanes will be bi-directional with a width of 3,5 metre. Also the future pedestrian flow to the Central Station that is increasing extremely is taken into account. (Van Oorschot K. , 2017) This is done by enhanced sidewalks and the expansion of the boulevards. But it will be difficult to remove the public transport systems once they are placed on a different level. (RET, 2017)