Flows Revalued

A future-oriented revaluation of the Strategy of the Two Networks

P5 Report

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Golden Gate Bridge, Source: (Author, 2018)

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AV
STOP

I want to thank,

my mentors for the knowledge and guidance throughout what has been a tough - but valuable experience.

my parents and sister, for being patient and endearing with me and always being there for support.

my friends, for the last minute support and for the fun last year as a student.

Part I: Project description

1 INTRODUCTION

Figure 1.1: Hill view on street grid, Source: (Author, 2018)

San Francisco is a city with unique urban and natural properties, given its topography and urban density. These unique properties express itself in the beautiful view on top of the hills, shaped by its elongated streets and skyscrapers in the Central Business District. In addition, San Francisco is historically a city of many cultural movements, like the hippie movement and gay communities, giving the city its unique cultural identity. Last years, the influx of a new population group has triggered a lot of attention - the so-called "Techies" - causing new shifts in the identity of San Francisco[1].

The presence of the Tech industry brings great capital investments to the city. But moreover, it makes San Francisco one of the pioneers for technical innovations in the United States[2]. The challenge is to direct this, in order to support new development in San Francisco.

1 https://www.theguardian.com/us-news/2015/jul/20/san-francisco-tenderloin-district-gentrification-tech-companies, accessed 2018-01-15
2 https://www.sfmta.com/projects/smart-city-challenge-2016, accessed 2018-01-15

The context of this thesis is provided by the Bay Area Resilient by Design Challenge[3], in collaboration with the University of Berkley. In its quest for an innovative approach to develop an adaptive plan to mitigate contingency. The personal fascination for innovative design for green-blue, driven by mobility networks is taken as a starting point.

Inspired by the Strategy of the Two Networks by Sybrand Tjallingii - originating from the Dutch planning tradition. This thesis accepts the challenge to investigate how urban renewal can be enabled by utilizing trends like future innovations in mobility and climate change. Within this context, this thesis explores explicitly how a strategy from the Dutch planning tradition can be deployed in an unknown context.

3 http://www.resilientbayarea.org/, accessed 18-01-15

2 MOTIVATION

In line with the framework the Delta Interventions studio offers, the personal motivation for this study is the interest for performative multifunctional designs, capable of responding to the dynamics of Delta cities. The integration and multidisciplinary approach of the studio informed by engineering and ecology, gives - from a personal conception - the ultimate meaning to the sustainable design of urban space.

The first steps for this approach where taken in the last semester of the first year of the Master track, where Smart Infrastructure and Mobility encouraged the interest for performative landscape infrastructures. Secondly, the Aquaterra course complemented this new interest with new insights in the technical aspects of the subsurface when designing performative infrastructures. At this moment in education, the Strategy of the Two Networks was also introduced for the first time.

Besides the academic motivation, the personal interest for the urban dynamics of high density cities is very important for the scope of this thesis. Inspired by stories about the thriving dynamics behind big metropolitan cities, by Edward Glaeser (2011) in his book the Triumph of the City. The challenge to explore San Francisco and to experience a big American city was quickly accepted.

3 PROBLEM DEFINITION

3.1 Problem field

Situated in the state of California, on the west side of the North American continent. San Francisco is the cultural and financial centre of Northern California. It is the smallest county of the state with about 860.000 inhabitants and it is the second dense city of the U.S. after New York.

San Francisco is located in the San Francisco Estuary Watershed, which serves as a source of runoff that provides drinking water to 25 million people. And while the San Francisco peninsula has changed dramatically over the past 200 years, the city still maintains a strong relationship with the regional landscape. Many streets offer panoramic views to water and green spaces (San Francisco Planning Department, 2014). Land reclamation in the 20th century has altered the relationship with the water drastically however and has been ignored to date (San Francisco Department of Public Health, 2016, p. 9). Areas along the coast and in the lower parts of the hilly area, are now prone to flood risk caused by future sea level rise and peak precipitation in storm events.

The 20th century is an era marked by an explosive increase in use of fossil fuelled vehicles. Causing the mobility network to grow very rapidly and causing urban fabric to disperse very quickly. Moreover, during the world wars, big investments where done in the infrastructural system to enable quick distribution of military goods. These developments in infrastructure did not develop in proportion with the sprawl of the built up (Bélanger, 2013, p. 27). With the consequence that the infrastructural footprint on the east side of San Francisco is much bigger than on the west side.

3.2 Problem analysis

Given its unique natural context and history of urbanisation, San Francisco has certain dynamics to respond to - in order to secure sustainable growth of the city. Much of the present problematics are embedded in the (urban) landscape and the topographical and geological setting of the San Francisco peninsula have appeared to be limiting factors in the historical expansions of the city. However, because of the attractive force of this ever growing peninsula, it did not took look before the current degree of urbanisation was achieved (Scott, 1985, pp. 4-41).

Aggressive urbanisation of the San Francisco peninsula has led to inundation caused by both the bay and ocean water. And inundation caused by peak precipitation in the lower lying areas of the hills. Moreover, where the traditional sewer system fails, the quality of the urban runoff is also at stake (San Francisco Department of Public Health, 2016).

Because the research for this thesis is done from the perspective of the Strategy of the Two Networks (S2N). The main focus of the problem analysis is on the trends in water management and mobility and the expected population growth of San Francisco. According to the S2N, the main carriers for urban development - and the activities supported in a specific area - are embedded in the change in hydrology and mobility (Nijhuis et al., 2015, pp. 69-70). Subsequently, these systems are under influence of innovations in technology and climate change.

The following part of this chapter describes the different dynamics conform the perspectives of the Ecological Conditions Strategy. From this investigation, it is possible to analyse on which problematics this research needs to focus. Ultimately, this problem analysis composes the fundamental base for the research and analysis done in this report, from here the conceptual building blocks in part II of this report.

Figure 3.1: Satellite image of the San Francisco Peninsula, Source: (Google maps, accessed 2018-01-15)

ENVIRONMENTAL CRISIS

Before San Francisco was substantially build up, many streams flowed from the higher lands into lakes or the bay and ocean. However, only a few of them can be seen today; the rest of the streams are cultivated and flow undergrounds (Sloan, 2006, p. 111). The occupancy and use of flood-plains is often based on the economic advantage of level ground, fertile soils and ease of access, without full consideration of flood risk. In the United States, many Federal, State and local government agencies are involved in flood-plain management and regulation, but often without sufficient coordinated authority and scope (Waananen, 1977). Resulting in hundred-million dollar investments in flood-prone areas, like Mission Bay for example. Fortunately, because of growing notice by media and governmental institutions like the Federal Emergency Management Agency. Awareness of water related problematics and climate change is of growing importance in the San Francisco Bay area.

Mainly because of its topography, San Francisco has two sets of water related problems: the first set of problems originate from precipitation, the second one originates from rising sea water levels. Storm water causes high volumes of urban runoff on sealed surfaces. Moreover, downhill runoff cause even bigger volumes of runoff in lower areas. Future storm events require better performances of conventional sewage systems, because water is too valuable to dump in the Bay and because the capacity of the sewage system is limited (Pötz, Bleuzé, Sjauw En Wa, & Baar, 2012).

The second water related problem is caused by storm events combined with future sea level rise. In these critical events, damage done to buildings and infrastructure have a huge impact on the accessibility of critical services like hospitals and jobs. Subsequently, this will mean huge financial consequences and a big societal impact.

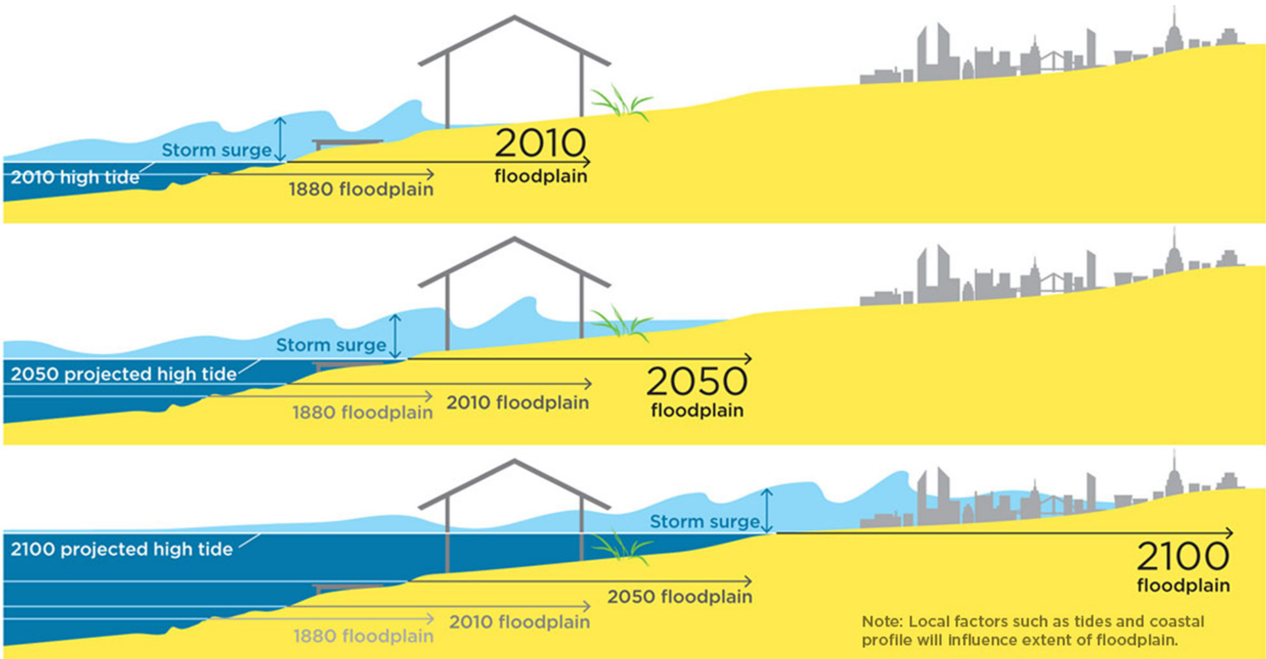


Figure 3.2: Storm surge and high tides magnify inundation, Source: http://www.ucsusa.org/sites/default/files/images/2015/08/gw-impacts-graphic-storm-surge-high-tides-magnify-sea-level-rise-risks.jpg, accessed 2018-01-15)

Inundation

There are three factors that affect the flow of water in San Francisco, respectively:

- Sea level rise caused by climate change;
- Inundation caused by temporary storm surge;
- Precipitation from extreme storms.

The three causes of inundation are interrelated, moreover precipitation and temporary storm surge are direct consequences of extreme storms and can cause both negative influence in the quality and quantity of water. As climate change increases the frequency and intensity of these storms. A 100-year extreme tide based our current conditions is estimated to be 104 centimeters above current daily high tide (San Francisco Department of Public Health, 2016, p. 9).

Although San Francisco has historically received an average of 135 centimeters of rainfall annually, Bay Area precipitation-levels fluctuate. In 1983, San Francisco received 110 centimeters of precipitation, while in 1977 precipitation levels did not exceed 22 centimeters. As a consequence, California is prone to both extremes: floods and droughts (San Francisco Department of Public Health, 2016, p. 10). Much of California's yearly precipitation (35% - 45%) is a result of atmospheric rivers or 'Pineapple Express' extreme storms, which can double the rainfall. Over the last half century, only about ten days per year have accounted for an average of 30% to 50% of annual California's precipitation. These extreme storms are more likely to be responsible for rainfall-related inundation in San Francisco than any other weather event and are responsible for 80% of California's flooding. On December 11, 2014, an atmospheric river event in San Francisco resulted in high winds, 45 centimeters of storm surge, and about 9 centimeters of rain. The storm downed trees and power lines, sent waves crashing over the Embarcadero, and flooded sewers, roadways, and storefronts (San Francisco Department of Public Health, 2016, p. 10).

San Francisco is one of the few West Coast cities with a combined sewer system (San Francisco Department of Public Health, 2016, p. 5). The storm water and wastewater are transported to one of three treatment facilities to be cleaned before being released into the Pacific Ocean or San Francisco Bay. During heavy storm events, up to 750 million liters of storm water and wastewater can be stored in large transport/storage structure around the city perimeter. However, during extreme rainfall, storm water and wastewater are discharged into the San Francisco Bay (San Francisco Department of Public Health, 2016, p. 7).

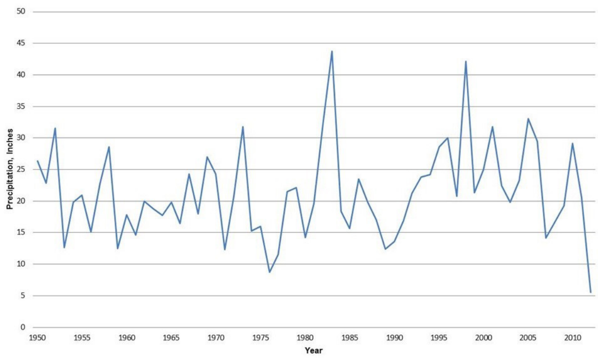


Figure 3.3: Annual precipitation in mm Source: (San Francisco Department of Public Health, 2016, p. 10)

Scenario of environmental crisis

Our past and present emission of carbon dioxide caused substantial future sea level rise and increase in precipitation. Although the greenhouse gasses in the atmosphere already ensures climate change, limiting greenhouse gasses might mitigate the acceleration of climate change. As the atmosphere warms up, both melting of the ice caps and thermal expansion of the oceans will cause global sea level rise. Based on the 2010 conditions, sea levels around the Bay are projected to rise between 20 and 40 centimeters by 2050, and between 70 and 120 centimeters by 2100 (San Francisco Department of Public Health, 2016, p. 12). As sea levels rise, extreme storms will become more frequent and intense. Extreme storms can cause flooding through both precipitation in the interior and storm surge along the coast. Most climate projections predict the average yearly precipitation-levels to remain stable or decrease. However, precipitation-levels are expected to become extreme dry or extreme wet.

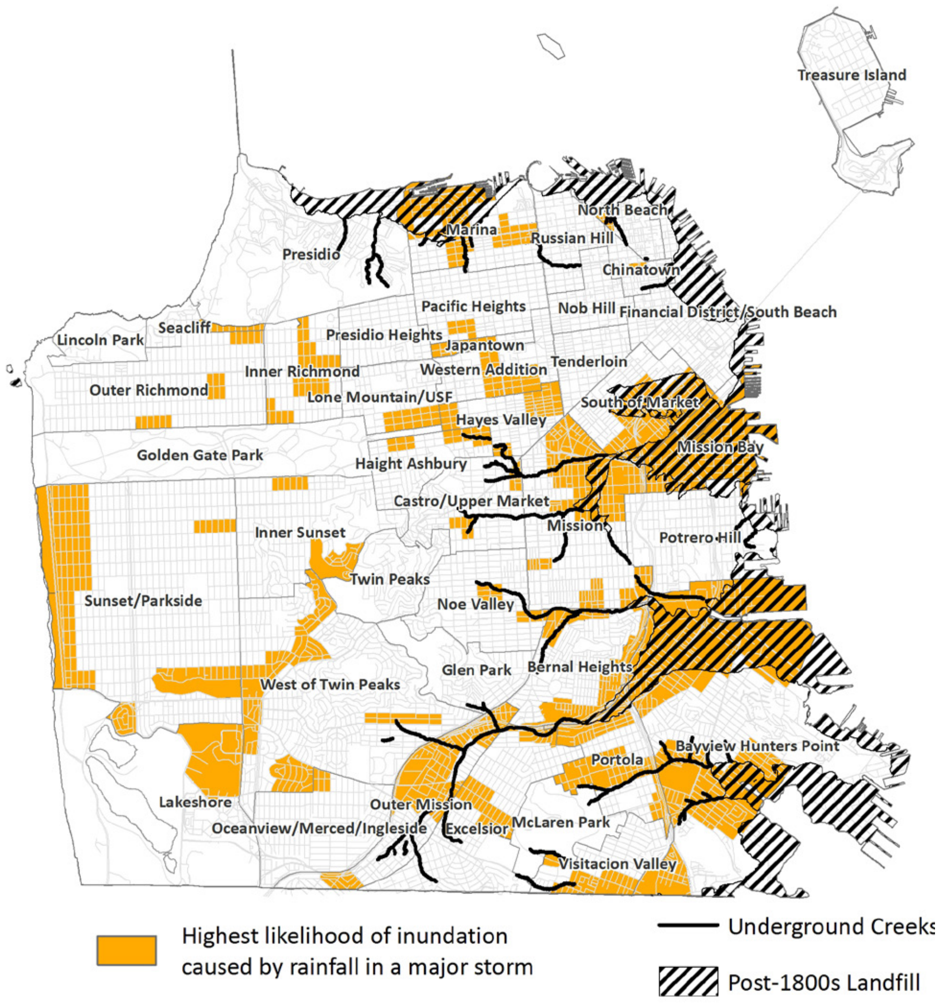


Figure 3.4: Highest likelihood of inundation caused by rainfall in a major storm, Source: (San Francisco Department of Public Health, 2016, p. 12).

During wet years, climatologists expect more atmospheric river events in the warmer spring and autumn months (San Francisco Department of Public Health, 2016, p. 12). Because the subsurface has a certain capacity to absorb water, more concentrated precipitation also translates into more runoff locally. These areas tend to correspond with the natural watershed, as water will drain downhill and discharge in natural drainage basins (San Francisco Department of Public Health, 2016, p. 12).

As storm surge will increase with sea level rise, a 100-year storm in 2100 is expected to add 90 centimeters on top of 70 to 120 centimeters sea level rise. The total inundation in such a scenario would be water levels almost 2 meters above current totals. Based on the San Francisco flood plains, a 2 meter increase in water levels would flood portions of South of Market, Mission Bay, and Bayview Hunters Point (San Francisco Department of Public Health, 2016, p. 13).

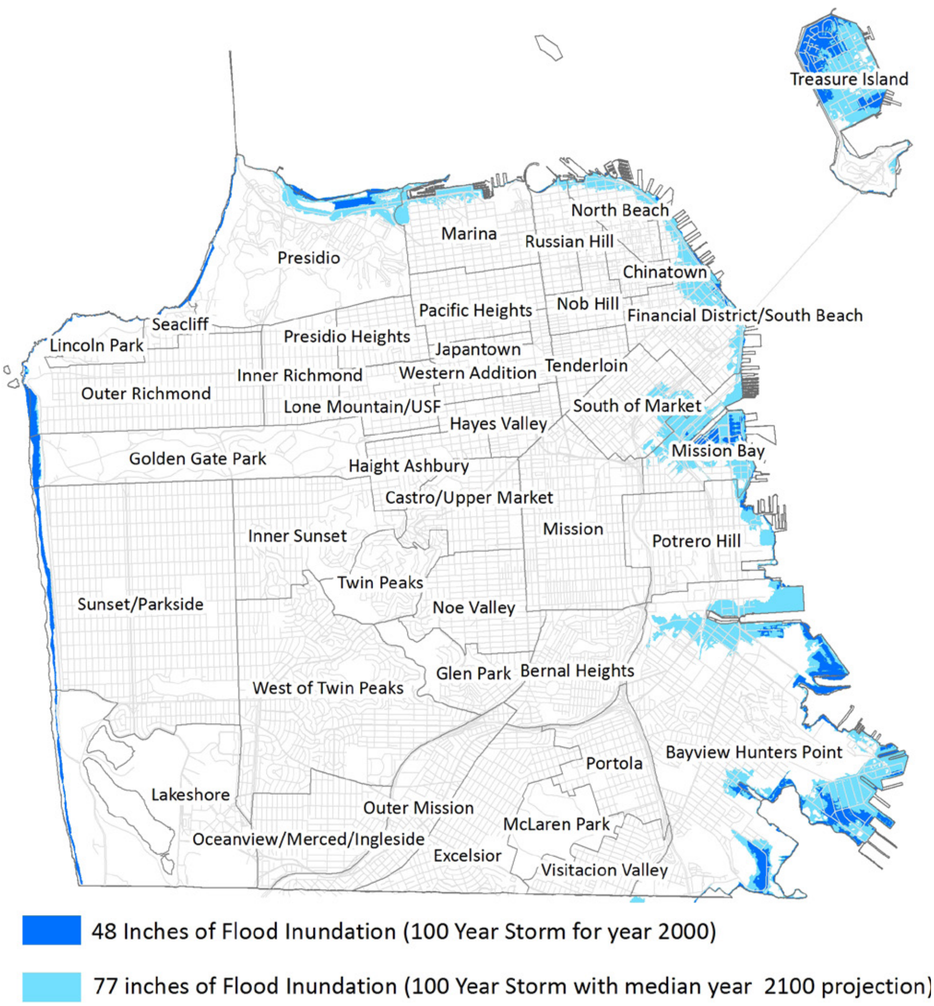


Figure 3.5: 100 year storms with median flood inundation projections for 2000 and 2100, Source: (San Francisco Department of Public Health, 2016, p. 13).

FUTURE MOBILITY

Figure 3.6: Impression of future mobility in society, Source: (https://combined-transport.eu/autonomous-vehicle-market, accessed 2018-01-15)

Because of its size and space, the United States became a very spread nation, adopting its car-infrastructure as a form of freedom. As a car-obsessed country, it build its mobility infrastructure around cars, a huge network of roads, parking structures, and other car-oriented facilities with a huge space occupation (Hung & Aquino, 2013, pp. 17-19). And while the demolition of the Embarcadero highway during the 80's opened up the urban environment, technological innovations in mobility might enable urban renewal in San Francisco yet again.

Changing role of infrastructure

The role of traditional infrastructure is changing and the requirements that the structures meet are increasingly important. The U.S. Interstate Highway System was initially developed for army purposes, but over the last 50 years, this road system has been made appropriate for civilians. At present, the system is responsible for 40% of highway traffic, 75% of heavy truck traffic and 90% of tourist traffic. Due to overcapacity and a lack of funding for improvements and maintenance, the infrastructure is in disrepair. Moreover, mobility flows are becoming more and more important. Increasing prosperity and individualization processes in living, working and leisure activities affect passenger transport (Tjallingii & Jonkhof, 2011).

Currently, aging population and the influx of new population is already affecting San Francisco and is expected to worsen. Under influence of growing globalization of the economy, freight demand and logistics are also increasing. Increased deliveries in San Francisco have caused safety conflicts and blocked road access. Additionally, travelling in San Francisco is very time-consuming and expensive (San Francisco Municipal Transportation Agency, 2016, p. 4). This situation requires the revaluation of the mobility system, in order to explore more (energy-)efficient forms of mobility and to retrofit the current infrastructures in order to meet for future demands (Hung & Aquino, 2013, p. 16).

Technical innovations in mobility

Fortunately, the Autonomous Vehicle (AV) is on the brink of entering the mobility market. The introduction of the AV and its affinity with ride sharing services, will force cities to confront uncertainties ranging from safety, ethics, and other regulatory challenges of widespread adoption of AV's. However, cities soon need to make complex decisions from the planning perspective; like the role of infrastructure, urban mobility, land use, and social equity and inclusion as people give up car ownership and take up ride sourcing and AV's. (Glus et al., 2017) An important assumption made concerning the effects of the shift from fossil to electric cars, is that the technology alone will have great benefits regarding safety, accessibility, affordability, availability and lastly sustainability (San Francisco Municipal Transportation Agency, 2016, p. 30). From the S2N - the main carriers for urban development are embedded in the change in hydrology and mobility. Therefore, this research analyses the effects and potentials of technological innovations in mobility *on the occupation of space, the health of the environment and the influence on hydrology.*

Technical innovations in mobility will cause a shift in future usage of big mobility infrastructures in the future. While automated vehicles could enhance road capacity by optimizing driving behaviour (Milakis et al., 2017, p. 66). If proper policies are not in place, cities may be left with large areas of empty parking spaces, and residents and businesses may move in large numbers to suburban and rural areas. On the other hand, cities that prepare for this technology can accumulate many benefits, such as the removal of big quantities of cars from the road, a more sustainable and healthy environment, increased mobility, efficiency and social equity, new employment opportunities for drivers and redevelopment of existing parking spaces. Public policy will play a decisive role in shaping automated vehicle technology and guiding its impact on cities, as it did during past technological revolutions involving the railroad and the automobile (Glus et al., 2017, p. 2). The

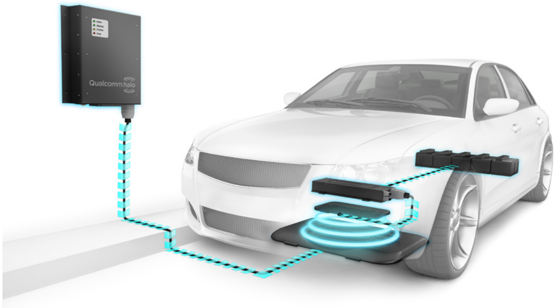


Figure 3.7: Inductive roads, Source: (https://www.theengineer.co.uk/issues/march-2013-online/your-questions-answered-inductive-charging-for-road-vehicles/, accessed 18-01-15)

Figure 3.8: AV's driving efficient in convoy, Source: (http://s.newsweek.com/sites/www.newsweek.com/files/2016/04/07/self-driving-truck-driverless-hgv-autonomous-convoy.jpg, accessed 18-01-15)

Figure 3.9: Slow speed electric vehicles, Source: (https://cnet3.cbsistatic.com/img/fyu61OWEmzpWN8stcrlhk3qLSNE=/fit-in/970x0/2016/07/28/2d1d8cf3-6697-4f66-bda7-87c069ad0d0f/mando-footloose-im-e-bike.jpg, accessed 18-01-15)

switch from fossil fuelled vehicles to electric vehicles can improve air quality and enable safer and healthier urban environments along the highway (Woodcock et al., 2009). Future innovations in mobility will create more liveable environments around infrastructures and will need a smaller land occupation. However, the spatial configuration of the grid will need to be reconsidered and soils need to be remediated. (Glus et al., 2017) Moreover, the negative effect of motorized vehicles on urban runoff will also be reduced significantly (Delang & Cheng, 2012).

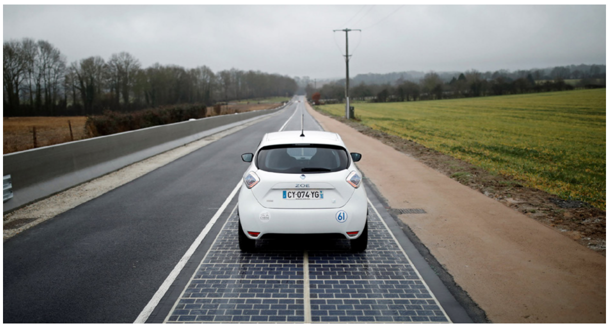


Figure 3.10: Solar roads, Source: (https://www.japantimes.co.jp/wp-content/uploads/2016/12/f-solarroad-a-20161224.jpg, accessed 18-01-15)

Scenario of future mobility

San Francisco is a pioneering community of creative thinkers, adapting the vision of future mobility, by adopting a path towards shared, electric, and AV's. And as the global capital of innovations in transportation and mobility, San Francisco is a test-bed for technical innovations (San Francisco Municipal Transportation Agency, 2016, pp. 5-6). Research on fully automated vehicles develops quite rapidly in the United States, moreover, California is one of four states with legislation allowing AV's on public roads. The main research teams in state are Caltrans and California Partners for Advanced Transit (CPAT) from the University of Berkley and Google. In 2014 Google claimed that they succeeded in 1,1 million kilometres of automated test drives without incidents (Wilmink, Malone, Soekroella, & Schuurman, 2014, pp. 45-48).

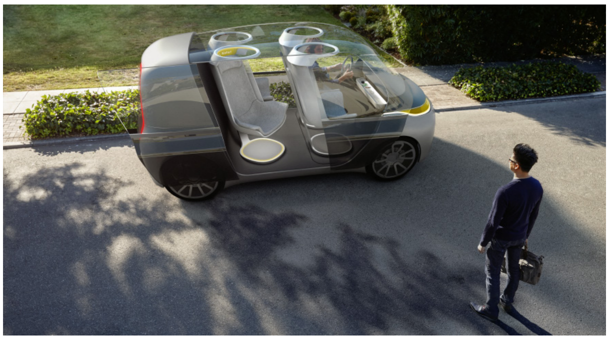


Figure 3.11: AV's and ridesharing, Source: (http://s3files.core77.com/blog/images/585605_66098_61933_6H5am4kyM.jpg, accessed 18-01-15)

This project takes the hypothesis, that assumes that both technology and policies of City and State government offer a positive context for the development of AV's. Moreover, the expectations in this context for highly automated vehicles are very positive. On the highway system, it is expected to launch from 2019, and in the urban context in 2025 (Milakis, Snelder, van Arem, van Wee, & Correia, 2015, pp. 5-12). While there is still al lot of research to be done on the technologies that drive future mobility, this research focusses on the potentials this technology enables, and the influence that it will have on the urban system.

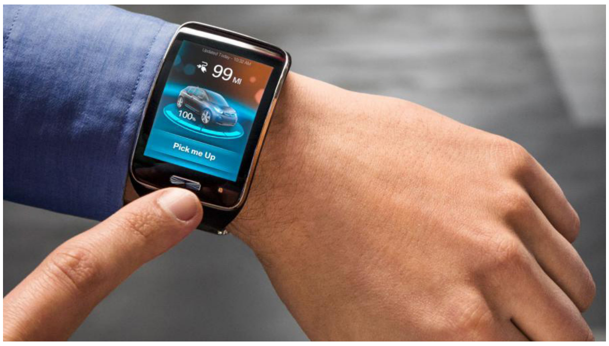


Figure 3.12: Autonomous parking, Source: (https://www.autocar.co.uk/sites/autocar.co.uk/files/styles/gallery_slide/public/Remote_Valet_Parking-012.jpg?itok=K4Z8cOJa, accessed 18-01-15)

POPULATION GROWTH

*Figure 3.13: Birds-eye view of Northeast San Francisco, Source: (*https://farm9.staticflickr.com/8855/17015344824_9c7ceef409_k.jpg, accessed 18-01-15)

As San Francisco is the second dense city of the United States, the stress on the current housing stock and its present inhabitants are very real. Tax breaks to attract the Tech-Industry brings in a significant amount of money for San Francisco city government's general fund, however housing for the lower and middle incomes in San Francisco becomes unaffordable because of these new inhabitants[1]. This problem is under influence of a lack of available space in San Francisco, in order to provide healthy living environments. Moreover, this pressure on available space is worsened by the fragmentation of green space. While the Golden State Park for example possesses great natural and ecological capital. It is isolated from the overall network of unsealed surfaces because of urbanization. This causes the network not able to utilize its maximum potential in supplying services to San Francisco and the residents cannot fully enjoy its amenities.

1 http://www.businessinsider.com/san-francisco-tech-tax-would-help-homelessness-2016-7?international=true&r=US&IR=T, accessed 18-01-15

Scenario of population growth

By 2040 the San Francisco Bay Area is projected to add 2.1 million people, increasing total regional population from 7.2 million to 9.3 million, an increase of 30 percent or roughly 1 percent per year. This growth means the Bay Area will continue to be California's second-largest population and economic center. To make an estimation of the population growth by 2040 in San Francisco, various sources are considered to justify a very uncertain prediction depending on different factors. The Association of Bay area governments and MTC Planning Committee (2013) estimated that a new sum of 92000 new units need to be realized by 2040, excluding units that are currently being constructed. Mayor Ed Lee proposed the construction of 30,000 housing units by 2020 in order to bring down, or at least stabilize the current housing costs[2] .

2 http://sfpublicpress.org/news/searise/2015-07/major-sf-bayfront-developments-advance-despite-sea-rise-warnings, accessed 18-01-15

Two major demographic changes shape the forecast of household and job growth: the increase in the senior population and the increase of minor populations (Association of Bay area governments & MTC Planning Committee, 2016). In an attempt to come up with strategies reliefing the pressure on the existing housing stok the Affordable Housing Bonus Program decided that constructors of new development are even allowed to add up to a maximum of two extra building levels. As long as 30% of the building can accommodate middle and low incomes (San Francisco Planning Department, 2014). The spatial implications of this kind of development will be far reaching and the occupation of space needs to be reassessed throughout. However, comprehensive strategy for densification in San Francisco is missing and challenges the possibilities for sustainable development.

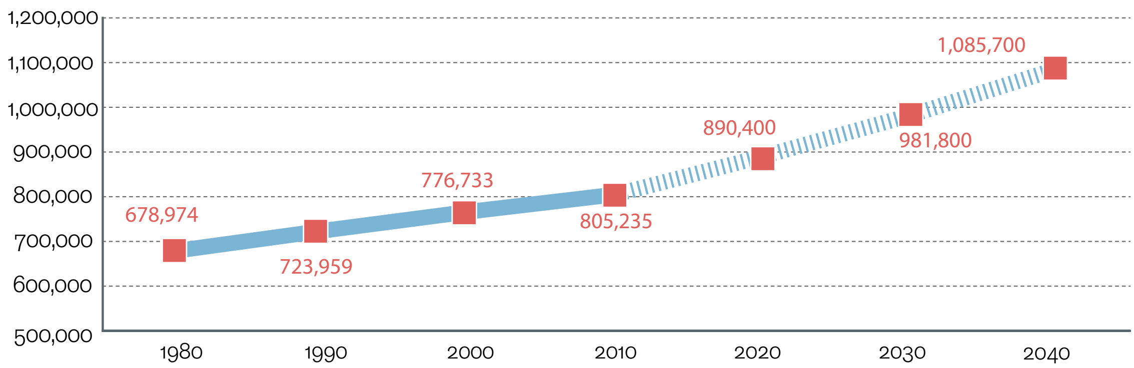


Figure 3.14: Projected population growth, Source: (San Francisco Department of Public Health, 2016, p. 15)

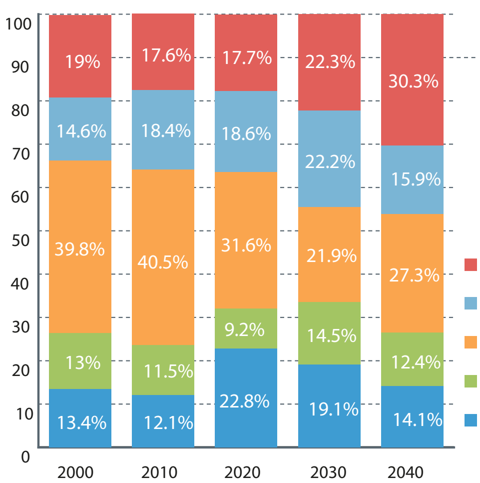


Figure 3.15: Projected population trends, Source: (San Francisco Department of Public Health, 2016, p. 15)

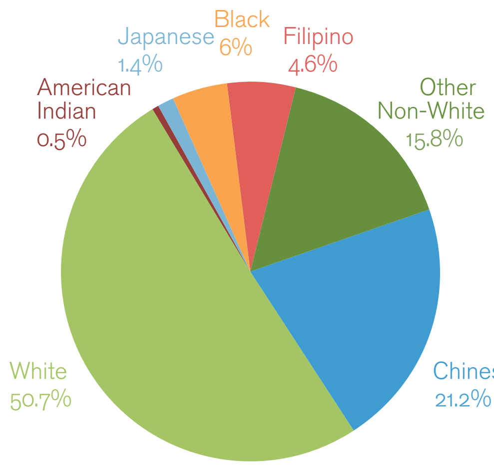


Figure 3.16: Projected ethnic composition, Source: (San Francisco Department of Public Health, 2016, p. 15)

Conclusion

Given its unique natural context and history of urbanisation, San Francisco has certain dynamics to respond to, in order to secure sustainable growth of the city. Much of the present problematics are embedded in the topographical and geological setting of the (urban) landscape.

San Francisco has two water related problems: the first is inundation caused by peak precipitation, the second one inundation caused by rising sea water levels. Because of climate change - sea levels are expected to rise perminantly by a maximum of 120 centimeters. As storm surge will increase with sea level rise, a 100-year storm in 2100 is expected to add another 90 centimeters on top of that. In the future heavy storm events will increase, and storm events peak precipitation causes high volumes of urban runoff on sealed surfaces. Moreover, downhill runoff cause even bigger volumes of runoff in lower areas. Subsequently, conventional sewage systems lack the capacity for future storm events (Pötz et al., 2012). In these critical events, damage done to buildings and infrastructure have a huge impact on the accessibility of critical services like hospitals and jobs.

While the changing role of mobility caused mobility infrastructures to grow beyond its intended capacity in the last 50 years (Hung & Aquino, 2013, pp. 17-19). Technical innovations in mobility will cause a new shift in future usage of big mobility infrastructures in the future. While automated vehicles could enhance road capacity by optimizing driving behaviour (Milakis et al., 2017, p. 66). The switch from fossil fuelled vehicles to electric vehicles can improve air quality and enable safer and healthier urban environments along the highway (Woodcock et al., 2009). Moreover, the negative effect of motorized vehicles on urban runoff will also be reduced significantly (Delang & Cheng, 2012).

As San Francisco is the second dense city of the United States, the stress on the current housing stock and its present inhabitants are very real. By 2040, The Association of Bay area governments and MTC Planning Committee (2013) estimated that a new sum of 92000 new units need to be realized by 2040.

The outlined problematics al come together in the territory of the I-101/U.S. Route 101 and I-280 highway, which are located in the lowest parts of the hilly east side of San Francisco, developed close to thousands of homes with disregard to its effects on public health.

3.3 Problem statement

San Francisco lies in a unique natural context and possesses great capital, which is of great value for the whole Bay Area. However, this capital is under pressure of future dynamics, caused by decades of human interference without acknowledging the natural conditions of the Bay. Making San Francisco an uncertain city for people to settle in the future.

The main problematics affecting San Francisco are caused by poor water management, obsolete mobility infrastructures and insufficient capacity for population growth. Study must prove if alternative and integrated forms of engineering and urban planning can mitigate environmental crisis in a scenario of opportunities offered by future technological innovations in mobility.

Figure 3.17: Satellite image of the San Francisco peninsula, Source: (Google maps, accessed 2018-01-15)

4 RESEARCH DEFINITION

4.1 Project aim

From the environmental point of view, future mobility (positive) and the change in the hydrological system (negative) are taken as trends from which the urban program needs to develop. This research starts with the conception that the Strategy of te Two Networks (S2N) internalizes a method that could help face the given challenges occurring both globally and as tested in San Francisco. The primary objective of this thesis, is to put this product of the Dutch planning tradition in another context and explore its potential in the San Francisco context. The theoretical foundation of the strategy for multifunctional Green-Blue infrastructures is driven by future mobility.

The test-case of this approach is located in San Francisco. San Francisco lies in a unique natural context and possesses great capital which is of great value for the whole Bay Area. However, this capital is under pressure of future dynamics, caused by decades of human interference without acknowledging the natural conditions of the Bay. This uncertainty makes San Francisco an unsustainable city to for people to settle in the future.

The aim of the project is to provide a method in which integrated engineering and urban planning and design will mitigate environmental crisis in a scenario of future technological interventions in mobility. Moreover, the aim is to revalue the S2N, in order to develop a conceptual framework that guides and structures this approach.

4.2 Research questions

Main research question:

How can a revalued strategy (**1**) of the two networks be utilized, in order to support urban renewal (**2**) in dealing with the environmental crisis and new modes of mobility (**3**)?

Sub research question **1***:*

What is the value of the original S2N in another context?

Sub research question **2***:*

How can the synergy of flows in the urban system be utilized in a methodological approach for urban renewal?

Sub research question **3***:*

How can new modes of mobility offer spatial solutions to deal with the environmental crisis?

4.3 Relevance

Societal

Half of the earths' inhabitants live in cities, and the rate of urbanisation is ever increasing. Our challenge is to keep our cities and planet liveable, safe and healthy. Due to climate change, increasing urbanisation and the depletion of fossil fuels, cities will need to undergo a gradual transition, away from exhausting the earth's natural sources in order to secure the needs of next generations. This thesis is driven by the belief that the integrated design and planning with environment guides this necessary transformation (Pötz et al., 2012, pp. 13-15).

Site specifically, this thesis is focussing on a case that is subjected by significant investments. These investments are under pressure of environmental crisis caused by precipitation and sea level rise. Preventing damage on private and public investments however, has less impact on society than fixing it. And while this thesis promotes low impact, natural and semi-natural approach in land use planning, engineering and urban design. These green infrastructures provide a lot of desirable co-benefits, like clean air and other services and amenities which society can enjoy.

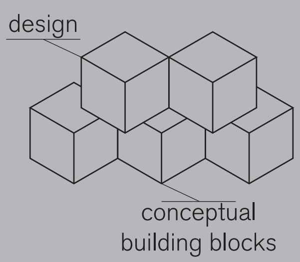
Scientific

From an urban planners' perspective, it is very interesting to see how individual alternative theories can form comprehensive strategies together. In this thesis this is done by the critical assimilation of different theories, in an attempt to revalue the Strategy of the Two Networks. The objective is to find out what the value of this product of the Dutch planning tradition is in a complex context.

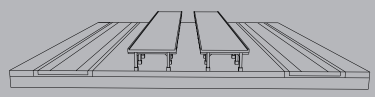
Ethical

This thesis responds to the status quo of urban development in a context where social, environmental and economical investments are not equal in projects. This condition is very existing when evaluating the present and history of American mobility infrastructures. Making the approach of this thesis, from the perspective of infrastructure, very controversial. However, when operating in fields of urban planning and engineering this balance needs to be consolidated and recovered when necessary. As prospective Urbanists, coming from wealthy and educated environments, it is our obligation to convert this privilege into equality.

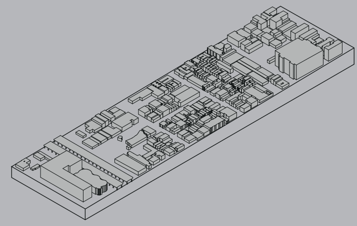
5 METHODOLOGY, INTRODUCTION OF THE BUILDING BLOCKS



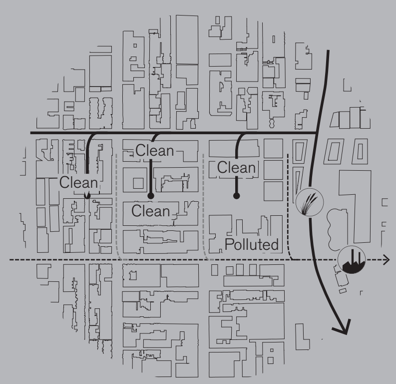
Conceptual building blocks: systematic simplifications of reality, which together form the foundation of the design.



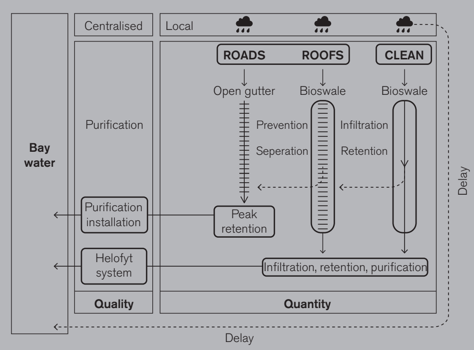
Mobility infrastructure prototype: one of the three building blocks; one prototype represents the physical appearance of a highway infrastructure.



Urban typology: one of the three building blocks; one urban typology is a representable sample of the physical environment.



Guiding principle: manifestation of the third building block, the Ecological Conditions Strategy; guiding principles formulate concrete themes for decision-making.



Guiding model: manifestation of the third building block, the Ecological Conditions Strategy; guiding models are solutions-in-principle for certain categories of plans.

Figure 5.1: Overview of main concepts, Source: (Author, 2018)

In the following chapter, the project methodology and approach of the research and design is made clear. As the structure of the report is a reflection of the process, the methodology is made insightful by dissecting the same structure. Subsequently, the structure is subdivided in four parts, respectively: *the project description*, *the conceptual building blocks*, *synthesis and design* and the *conclusions*. In order to provide a better insight in the method of this project, a methodology scheme on the next page illustrates the relation between the different parts of the research. Because this project deploys a distinct terminology, the page on the left introduces the key subjects of the terminology, used throughout this chapter.

Part I: Project description
The first part of the method relies on the problem definition in order to provide a context in which the conceptual building blocks can operate. Here, the future dynamics are explored and provide themes for further research.

Part II: Conceptual building block
The conceptual building blocks in this report are the fundamentals to research and design. It is a simplified representation of reality, which helps in understanding complex systems - like the test-case.

The first conceptual building block is the theoretical framework of Sybrand Tjallingii. *The Strategy of the Two Networks* (S2N) is an approach of the Ecological Conditions Strategy (ECS), which enables strategic planning and design. The ECS offers the *area*, *actors* and *flow perspective* as this projects framework, which restrains the research field and offers themes from which Part II and Part III can develop. (Tjallingii, 1996, pp. 180-266) As a method, this conceptual building block offers the guiding principles and guiding models, which are clear supports for research and design.

However, as Marshall (2012) states that urban research needs a critical attitude towards the application of theory. A systematic verification and critical assimilation of scientific knowledge is done to consolidate a revalued S2N. Supplemental to the conceptual building block the revalued S2N represents, there are two more building blocks supporting the representation of the physical context. Based on the West8 prototypes, spatial representation of mobility infrastructures are made. In addition, the Spacemate is used in order to make a representation of the urban system.

Moreover, the original S2N is a product of the Dutch planning tradition, embedded in the Dutch (urban) landscape. In order to apply the S2N on the complex case of San Francisco, it is important to reflect on the values of the S2N in another context. In order to relate the S2N with the physical context of San Francisco, a categorization and assessment is made of the mobility infrastructures and the urban system in its trajectory. The project method is based on the Resilient Infrastructure and Environment research done by Hooimeijer et al. (2017) and similar steps are taken in order to clarify the research domain.

The second conceptual building block is the categorization and simplified representation of highway infrastructures in the trajectory of the I-80/U.S. Route 101 and I-280 highway. This project takes the mobility prototypes by West8 in their research on the healthy relation between city and highway. The assessment of the mobility infrastructure prototypes is done in consideration of the assessment criteria of West8. And are combined with the project specific dynamics of the test case.

Secondly, in order to investigate the influence of the prototypes on the urban system, representative samples of the urban system are taken along the highway, resulting in the urban typologies. In order to link the research to a more technical perspective, urban samples are taken inspired by the Spacemate by Berghauser Pont & Haupt (2010). Topics of density are researched together with historical events, zoning and location in the water course.

Part III Synthesis and design

The result of the categorization of the physical context, is the combination of 5 urban typologies and 3 mobility prototypes. Moreover, the S2N offers guiding models and principles, which guide the design process. The first step towards the application of the method on design, is a revaluation of the original guiding principles and guiding models into revalued guiding principles for the test-case. These guiding principles and models originate from the information obtained from the research on the conceptual building blocks. And are exposed to an iterative process of adjustments during the design process.

The revalued guiding principles and models offer strategical aims on urban renewal and the urban program. However, additional improvements in the method needs to be made in order to provide enough inspiration for a contemporary design. Because of the complexity of the case the method needs additional adjustments in order to generate a design. In the Landscape Urbanism discourse that is emanating from the United States, the natural system is put forward as leading operational logic and landscape architecture is granted the ability to make urban structures more durable and sustainable. It seems to be a possible solution for enabling the ecological system as leading and guiding in urban renewal urban renewal. (Hooimeijer, 2017b) While the guiding principles and guiding models makes it possible to locate specific living environments in relation to the carrying flows and actors; embedded in an ecological framework, which is supported by Landscape Urbanism.

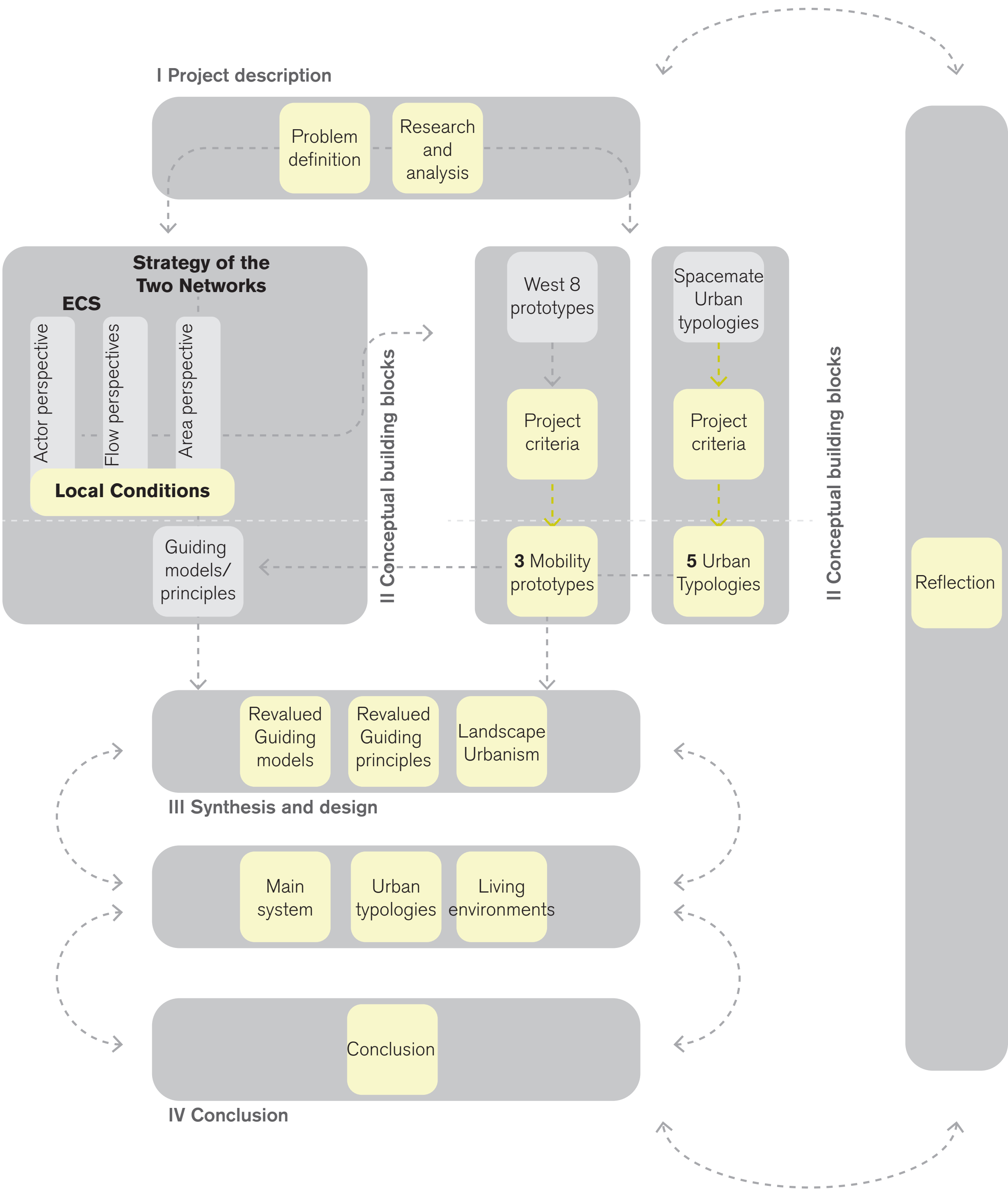


Figure 5.2: Scheme of methodology, Source: (Author, 2018)

Part II: Conceptual building blocks

6 THEORETICAL FRAMEWORK

The first conceptual building block is the theoretical framework of Sybrand Tjallingii (1996). The Strategy of the Two Networks (S2N) is an approach of the Ecological Conditions Strategy (ECS), which enables strategic planning and design. The ECS offers the area, actors and flow perspective as this projects framework (Tjallingii, 1996, pp. 180-266) The S2N utilizes the water and mobility network as carriers for spatial development. The water network facilitates ecology, the water system and recreation. Subsequently, the mobility network facilitates commerce, services and more intensive recreation. The living environments are positioned in the center and as a result of this, a zoning is formed from clean and tranquil living environments to polluted and dynamic zones. From a methodological perspective, the S2N offers a research method on which this research is based, however it also creates an ecological framework which is applied to the project test-case.

6.1 Strategy of the Two Networks

The S2N origins from the early 1990's, when discourse over the emerging concept of sustainable urban development changed the role of ecology, from creating limiting conditions to carrying conditions. This integrated approach however, is not unfamiliar to planners and designers. Frederick Law Olmsted was a pioneer in this approach, with his plan for the Boston Emerald Necklace Park System in 1887. In his plan, he showed how urban development can benefit from a design, that incorporates natural valleys that act as both drainage and water retention systems as an urban area. (Pötz et al., 2012)

Elaborating on the basic principles of the "casco concept", or "frame concept" in English, the S2N is a guiding model that utilizes the idea of creating a framework which highly depends on the relationship between hydrology and nature (Tjallingii, 1995, pp. 23-45). It also created conditions for agriculture - based on open spaces in the frame, in order to conserve and create habitat between urbanized areas. Moreover, the S2N includes urban development and takes the mobility network as a second carrying structure for agricultural and industrial activities, these activities require good conditions for transportation as a result of the dynamics of technology and economy (Nijhuis et al., 2015, p. 62).

From the perspective of San Francisco, there is a big pressure to divide spaces into monofunctional areas for profitable activities. Rising land prices and the necessity for closed land development even increases this pressure more. At the same time, market uncertainties are often high. The approach of the S2N facilitates a robust framework of sustainable carriers which offers flexible implementation within the framework. This can provide an answer to the uncertainties of spatial activities. On the other hand, this framework also supports multifunctional green-blue zones, which are essential for long-term safety, health and well-being, which also contribute to the livability and business climate. (Tjallingii & Jonkhof, 2011, pp. 75-79)

6.2 The Ecological conditions strategy

The S2N is one of the conceptual tools of the Ecological Conditions Strategy (ECS). Tjallingii (1996, pp. 181-195) states that in the urban landscape three core values exist, that require synergy between activities in need for carrying structures. From an area perspective, the aim is to create amenities for a habitable environment for residents. Secondly, from a flow perspective, the aim is to generate activities that have internalized the responsibility for flows. And lastly, from the actors' perspective the strategic aim is to create conditions for a shared involvement in ecological and hydrological.

The S2N takes the area perspective as its starting point. As a guiding model that should be able to cope with the problems of urbanization, the approach adopted the carrying structures of water (slow) and the mobility system (fast) (Tjallingii, 1996, p. 266). The slow lane is the ecology driven flow manager, making use of the local landscape where water safety and quality are combined. The water network based on the drainage pattern is the carrier. The fast lane, on the other hand, supports the productivity of commercial and logistical activities. From a planning perspective, the slow lane environment requires for strategies of co-operation and key involvement from non-profit organizations, both private and public. In the fast lane, strategies for competition are the driving force. (Nijhuis et al., 2015, pp. 58-78)

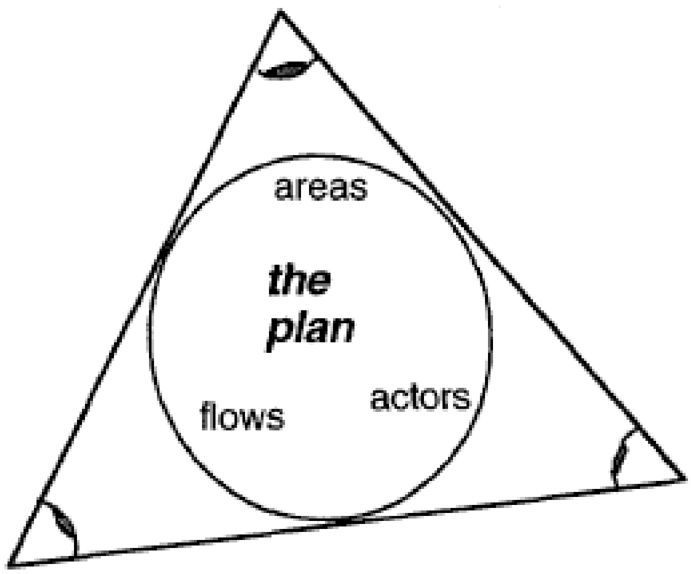


Figure 6.1: Decision fields, (Tjallingii, 1996, p. 183)

6.3 Flow perspectives

There is a fundamental ecological reason for differentiation of areas and flows. This is illustrated by the "ecodevice", which is an ecosystem model representing the interaction between flows and areas by van Wirdum and van Leeuwen (1982). The model shows the input (supply from a source, push) and output (discharge to a sink, pull) which characterizes all open systems. An ecosystem cannot function without the input of solar energy, water and minerals, the discharge of heat and certain substances is also essential. In addition to in and out, the system also has the capacity to resist (the concave side) and to retain (the convex side). Protection against flooding by dikes is a form of resistance and the insulation of building is a way to retain the heat. Storage of food, water, energy and recycling of materials are examples of retention that reduces the need for supply. (Tjallingii, 1996, p. 175)

The aim for the decision making on flow management, is to generate activities that have internalized the responsibility for flows. This means that activities do not rub off their environmental problems to other users. The aim is on the mutual synergy between the different perspectives. From the flow perspective, we can distinguish 4 important flows that need to be in synergy: *energy, food, water and mobility flows* (Tjallingii, 1995, p. 39). The S2N addresses central issues of the water and mobility flows. These are the flows with most spatial implications for the plan (Nijhuis et al., 2015, p. 66). Subsequently, most of the problems that occur in the urban habitat tend to be a result of the large extra supply and discharge of flows.

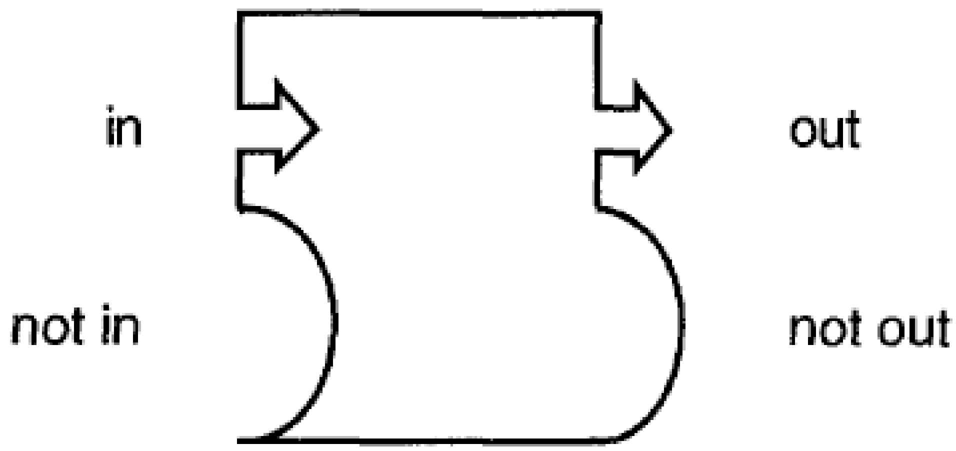


Figure 6.2: Ecodevice model, (Tjallingii, 1996, p. 183)

Water flows

Climate adaptation from the water flow perspective focusses on space for water quantity and quality. From the quantity perspective, the implication is that the infiltration and drainage networks can play an important role as spatially organizing structures: the infiltration zones, small rivers and valleys, rivers and floodplains, wetlands and lakes (Tjallingii, 1996, pp. 196-213). However, infiltration is sometimes impossible when peak storms exceed the capacity of the soil or when the surface is completely sealed. In these scenarios, retention should be preferred over discharging the water elsewhere (Nijhuis et al., 2015). From the area perspective, suitable spaces for retention and infiltration need to be localized. Bioswales - green linear infiltration surfaces - are highly suitable for this and form an important part of the green structure (Tjallingii & Berendsen, 2007, p. 14).

Urban areas are considered to be the source of poor water quality. However, intensively cultivated farmlands and high intensity activities are responsible for pollution and nutrient rich water. When connecting urban development with water flows, it is very important that the water runs from clean to polluted. Due to the availability of space and fluctuation of the water level, the water is often located at the city edges (Nijhuis et al., 2015).

Mobility flows

Traffic can act as a vehicle for various flows, for example materials or people. However, it can also be approached as a flow in its own right, with its characteristic networks and retention demand, like in car parking (Tjallingii & Jonkhof, 2011, pp. 63-65). Accessibility is one of the main decisive factors for the spatial layout, and so does the traffic network become a spatial carrier that enables and attracts dynamic activities (Tjallingii & Jonkhof, 2011). Many cities developed on the waterside for example, at a time that shipping was the most important mode for transport. As a result, businesses set up along the water and big roads were built there to serve them. Shipping is still important for some goods, but the seaport activities have moved seaward to deeper waters and river harbors have developed outside the city centers, many roads are still there however. From the traffic flow perspective, watersides are more attractive for slow lane activities and these are not compatible with fast lane dynamics. In accordance to the S2N, quiet and green zones are often relieved from heavy traffic (Nijhuis et al., 2015, pp. 69-70).

The physical occupation of mobility infrastructures in San Francisco is from a totally different degree than that usually occurs in the Netherlands. Moreover, locating the big infrastructures in the United States is done more controversially, often conflicting with its surrounding (Scott, 1985, pp. 109-239). Since the theory of this report was already acknowledged in the 1990's by the Dutch national Spatial Planning agency (Nijhuis et al., 2015, p. 63). It is also safe to say that the relating traffic and water flows to living environments is more adopted in the Netherlands, and will prove a bigger challenge in San Francisco.

Energy flows

In climate adaptation, the focus is mainly on the capacity of green-blue networks to manage water quantity and quality. However, these networks contribute to the development of energy flows in urban areas (Tjallingii, 1995, p. 46-56). As an alternative to ending resources, green-blue networks are able to mitigate heat stress in cities that accumulate excessive heat. During hot summers, cooler and humid air can penetrate into the heart of the city through these structures. Moreover, green-blue networks with a large surface and a circular hydrological system, can act as a source for seasonal heat-cold storage. Between the different seasons, heat can be exchanged with its surrounding buildings.

The management of green-blue areas is now mainly a big expanse. From the actors perspective, there may be an opportunity in managing the residual flows caused by maintenance of the green-blue structures. Pruning waste for example can provide a source for the decentralized production of heat and electricity. The green residual streams are no longer waste but raw material or fuel. The former expenses will subsequently be the cost carrier for green area management (Tjallingii & Jonkhof, 2011, p. 15).

Food flows

The food in our supermarkets originates from all parts of the world. The relation between food and time and space is increasingly fading because of this, influencing the flows of foods in our cities heavily (Tjallingii, 1995, pp. 36-39). All year long fruits and vegetables are available, regardless of the season and its origin. This is possible because of innovations in conservation techniques and logistics. Moreover, in order to stay competitive, companies constantly look for the cheapest possible production techniques of as large as possible amounts of food.

Over the last century, the world's population has grown by six times however, while food productions increased by seven times. The production of vegetable products however, still has to double by 2050 to meet the growing demand of the world population. Of the present world population, one billion people suffer from food shortage, while the same number suffers from overweight. From the total food produced globally, 30% is wasted, and in the USA this is even 50% (Tjallingii & Jonkhof, 2011, pp. 60-63). The solutions to this disorder in food flows seems to hide in the decentralization of the production systems - and locate it closer to the cities. By integrating agriculture in the periphery and the green spaces in the cities, more adaptive and sustainable flows of food can settle. Moreover, these interventions can contribute as cost carriers in the multifunctional landscape of water management and climate control of the city (Tjallingii & Jonkhof, 2011, pp. 60-63).

5.4 Area perspective

From the area perspective, the city needs to provide a healthy and diverse habitat. The goal is to use local potential in the area for functional value, perceptional value and future value for different types of people, plants and animals (Tjallingii, 1995, p. 33). This is enabled by the spatial synergy of the landscape sub layers with the layers of networks and occupation, and the cohesion of the networks and activities that intertwine in this space (Tjallingii & Jonkhof, 2011, p. 42).

In urban development, the abiotic basic conditions are created in house building, road building and water building. These conditions are not created by decorating a dead city with greenery. Reconnecting fragmented voids with routes for plants and animals, for example, can often be combined excellently with footpaths and cycle tracks and with water courses (Tjallingii, 1995, p. 36). Through integrated design of local potentials, synergy in flows, healthy and diverse habitat and defragmentation of habitat, there may be a sustainable basis for the Living city.

6.5 Actor perspective

The problems of alienation and non-participation in the social process manifest themselves in all levels of society. Vandalism and ignorance to environmental problems are part of the general problems of individualization and the enlarging differences between different groups of society. However, part of the solution can be peoples' involvement in the organization of the daily environment within the framework of social and environmental innovation (Tjallingii, 1995, p. 37).

From the actor perspective, the driving factor is the cooperation of people, groups, organizations and companies that play a part in planning, implementing and managing of urban plans and projects. This is not only involvement in the planning process, but also the role that residents play in a waste plan, the role that road users play in a traffic plan (Tjallingii & Jonkhof, 2011, p. 42). The goal is to increase involvement for the responsibility of flows in the area. But involvement in the processes of nature is also seen by many as a goal itself. Many of the 'urban ecological projects' have been set up with this goal in mind. Participation in the contact with nature can also enrich urban life (Tjallingii, 1995, p. 37).

6.6 Guiding principles and guiding models

In order to optimize the synergy between flows, it is of great importance to start planning early in the plan making process. If the planning process advances to fast to the formation of strict goals, it is possible to miss the opportunity to interlink the different flows. Thereupon are the guiding models and guiding principles intended (Tjallingii & Jonkhof, 2011, p. 41).

The guiding principles formulate concrete themes for decision-making like traffic and water planning, urban structure, green areas, or the division of tasks in waste water treatment. These principles hold intermediate positions between the main strategic aims and more concrete planning proposals. The guiding principles are closely linked to guiding models, they are solutions-in-principle for certain categories of plans, ranging from a model for energy saving in houses to a model for regional urbanization. The guiding models provide the relevant information about intentionally consistent and empirically researched combinations. They represent hypothetical constructs about the optimal organization of space and processes in well-defined categories of situations. Context is an essential part of this evaluative research (Tjallingii, 1996, pp. 177-181).

FLOW	GUIDING PRINCIPLE	GUIDING MODELS
WATER	Retain and keep clean	Delay model
	Utilizing local hydrology	Circulation model
	Water synergy	Infiltration model
ENERGY	Residual flows	Bio cogeneration heath model
		Heating network city model
	Cool island	Green ventilation model
FOOD	Green edge	City edge living model
	Stimulate bike use	Green bike route model
	Functionally separate + spatially bundling	Corridor model
MOBILITY	Green edge	City edge living model
		ABC-cluster model
	Stimulate bike use	Green bike route model
	Functionally separate + spatially bundling	Corridor model

Table 6.1: Overview of guiding models, (Tjallingii & Jonkhof, 2011)

PERSPECTIVE	GUIDING PRINCIPLE
AREAS	**The slow-lane and fast-lane principle** The guiding principle for effective space use is an ecological zoning of dynamic and peaceful areas, carried by the networks of traffic and water.
	The sublayer principle The design for this principle is controlled by the sublayer, formed by nature and culture of the existing landscape (work with nature). In this context, special attention is paid to biodiversity.
	The space for synergy principle The plan creates spatial conditions for sustainable flow management and involvement of the actors by making ecological relationships visible.
FLOWS	**The economical use principle** Create conditions for economical use ('reduce, reuse, recycle'). Storage of excess or as a shortage reserve is a key factor.
	The sustainable source principle Make use of local or regional sustainable, environmentally friendly processes and resources (work with nature).
	The synergy with areas and actor's principle Creating conditions for synergy of activities in an area and the interests of actors. Prevent nuisance and pollution, make flow management visible.
ACTORS	**The first fitting than measuring principle** For effective division of tasks and cooperation in planning processes. Ensure continuity from planning to the stage of use and management.
	The making visible principle Work with visible flow management and involvement in natural processes in the landscape. Make use of visible pilot projects of pioneers who are already working innovatively in the area.
	The planning as learning principle In a learning process of practice and theory, find the synergy of interests and activities in the perspective of innovative developments.

Table 6.2: Overview of guiding principles, (Tjallingii & Jonkhof, 2011)

6.7 Application of the Strategy of the Two Networks

As a result from the first conceptual building block, the ECS offers a variety of guiding models and guiding principles. These are important thematic restrictions that guide the design. Subsequently, the S2N offers a strategical perspective on the relation between the different perspectives, which the models and principles internalize. This results in the following selection:

Guiding principles:
Areas: Slow- and Fast-lane principle
Flows: The synergy with areas and actor's principle
Actors: The making visible principle

Guiding models:
Water: Delay model
Mobility: ABC-cluster model

Regardless of the selection of main guiding principles and models, the residual models and principles from page 38/39 needs to be kept in mind. Moreover, the original models and principles are linked to unique properties of the Dutch urban landscape. In an iterative process of research and analysis of the case area - done in the conceptual building blocks - the guiding principles and models are thoroughly reflected on, in order to discover its value for its application in a new context.

Comparisation

When comparing the Dutch case to the test-case; From the flow perspective, the Dutch water system is characterized by its poldersystem. The Dutch landscape is located below sea level, protected by levee's for coastal flooding. Inlands, the water needs to be mechanically pumped up to higher levels of surface water in order to prevent inundation caused by (peak) precipitation. In contrast, San Francisco possesses a hilly landscape in which gravity can be used to divert the water downhill more naturally. Additionally, measures must be taken to prevent inundation downhill under influence of uphill precipitation.

Secondly, there is a mismatch when applying the original S2N in a scenario of future dynamics. The original S2N was developed in the early 90's when there was an other perspective on future mobility and water management. Not only are the scale and impact of the change in these networks different from the Dutch context, but the theory does not consider a scenario where innovations in the mobility network can contribute to innovative water management and living environments.

Lastly - from the area perspective - the S2N is developed in a spatial context where there is a lot of open space in between urban areas. Application in an extremely urbanised case as San Francisco needs revaluation of the use of space - when exploring potentials for bioswales for example. Moreover, the degree of surface sealing and car occupancy of the test case is mostly unprecedented in the Netherlands. Traditionally the Netherlands possesses one of the most progressive forms of policy in relation to water management and spatial planning (Dijk, 2008, p. 11). However, this kind of policy is not familiar in San Francisco. Where spatial planning is historically more car-oriented and focussed on mobility infrastructures (Scott, 1985).

Ultimately, understanding the traditional concept of the S2N and subsequent application of the guiding principles and models - on the test case of San Francisco - must prove the value of the S2N. However, as a conceptual building block, the method of the S2N comes short in criteria on which the guiding principles and models can be reviewed in a contemporary case. In order to develop the S2N further, criteria co-developed in the third conceptual building block (the urban typology) are used in order to reflect on the value of the guiding principles and models. The urban dynamics are composed by: *the zoning policy, the hydrological system, the geological and topographical setting, the artificial drainage system and the relation to the highway.*

Slow- and Fast-lane principle
The guiding principle for the sustainable use of space is the ecological separation of a dynamic zone and a tranquil zone, carried by the networks of traffic and water. This means looking for the integration of water and green, when creating conditions for urban vitality. The integrated design between water and commercial functions is the carrier for the dynamic zone. The ideal place for a living environment is ideally in between the fast-and slow-oriented zone (Tjallingii & Jonkhof, 2011, p. 43).

The synergy with areas and actor's principle
Creating conditions for the relation between activities in an area and the interests of local actors. Preventing nuisance and pollution and make flow management visible. In order to secure the quality of sources of urban runoff for example, it is important to relate slow and non-polluting activities to water flows. Fast and polluting activities can be related to the mobility flows (Tjallingii & Jonkhof, 2011, p. 43).

The making visible principle
Work with visible flow management and involvement in natural processes in the landscape. Make use of visible pilot projects. In order to make the green-blue interventions work, it is important to involve local actors in the maintenance process of the interventions. Moreover, it is important to trigger their interest by initiating private green plots for example, which actors need to maintain themselves instead of local government (Tjallingii & Jonkhof, 2011, p. 43).

Delay model
In this guiding model from the area perspective, the principle of purifying and retaining is applied with the help of technical and spatial measures. The urban runoff is delayed from the source and disconnected from the sewer system. The rainwater on roofs, in parks and other basins is being retained on step lower in the water course (Tjallingii & Berendsen, 2007, p. 15).

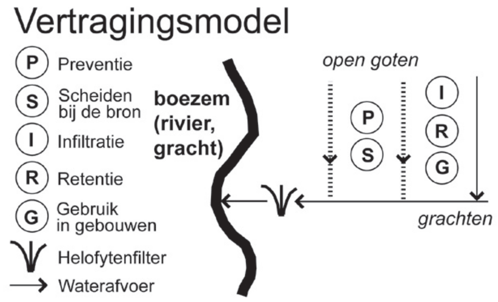


Figure 6.3: Delay model, (Tjallingii & Berendsen, 2007)

ABC-cluster model
To prevent clutter zones of commercial activity and logistics to cause nuisance to living environments and quality of the water system, companies need to be clustered as efficients as possible. The ABC-cluster model creates conditions for the attractive quality of green borders: no roads between housing and greenery and clustering of companies, so that the residential areas remain peaceful and green (Tjallingii & Berendsen, 2007, p. 19).

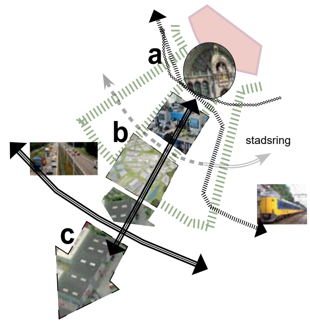


Figure 6.4: ABC cluster model, (Tjallingii & Jonkhof, 2011)

Guiding model for the area perspective, S2N model
In order to give the guiding models from the flow perspectives direction, it is important to implement a guiding model from which de right areas develop. The guiding model for areas aims to create a framework of spatial carriers for urban development and chooses the spatial networks of traffic and water as a starting point. (Tjallingii & Berendsen, 2007, p. 15)

Residual models

As mentioned before, residual models need to be considered in the back-mind. In light of local urban dynamics and future dynamics. Special attention is given to the *infiltration model and the corridor model.* In addition to measures at building and street level, the infiltration model focuses on infiltrating runoff into the subsurface. Often it consists of sand, and in any case the groundwater level should be low. On the neighborhood scale, the model argues for rainwater infiltration in ditches that are usually dry but after heavy precipitation the water can retain several days, after which it slowly infiltrates into the ground. (Tjallingii & Berendsen, 2007, p. 14).

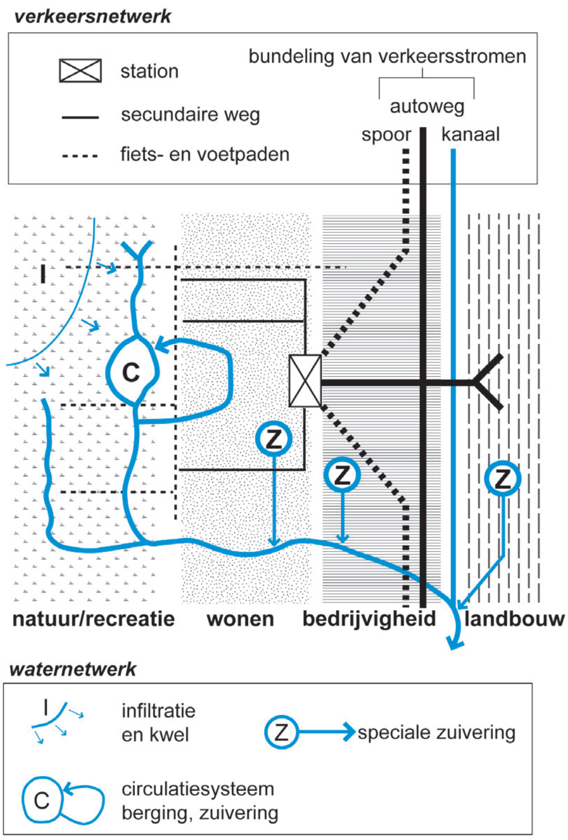


Figure 6.5: Guiding model areas, (Tjallingii & Berendsen, 2007)

The corridor model improves the flow of car traffic through its spatial bundling of parallel roads. In addition, investments are also done in bridges and tunnels, as a result of which the traffic forms fewer barriers to green structures, so that water and cool air can flow more easily. It is precisely this model that give direction to the linking of mobility infrastructures with the role of blue-green structures in order to secure sustainable plans.

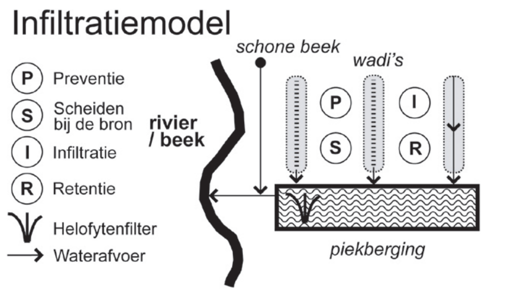


Figure 6.6: Infiltration model, (Tjallingii & Berendsen, 2007)

Conclusion

The S2N is developed in the early 90's and because of contemporary challenges like climate change and future mobility, the S2N is not up to date. Evidently, the S2N is not adapted to AV's and does not anticipate on other topographical settings. According to the revaluation of the guiding principles and models and by applying the revalued guiding principles and models - the value of the original S2N in another context is still embedded in the core principles the original S2N offers.

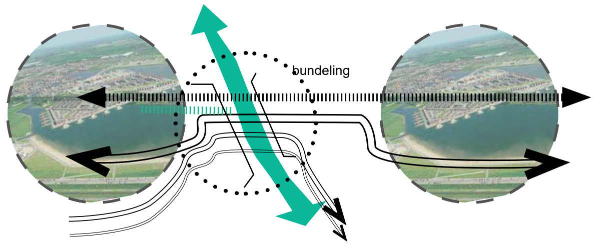


Figure 6.7: Corridor model, (Tjallingii & Jonkhof, 2011)

7 MOBILITY INFRASTRUCTURE PROTOTYPES

Figure 7.1: Impression of the I-101 Highway, Source: (Author, 2018)

While the changing role of mobility caused mobility infrastructures to grow beyond its intended capacity in the last 50 years (Hung & Aquino, 2013, pp. 17-19). A revaluation of present mobility infrastructures needs to be made in order to predict a new future.

the entrance of AV's on the mobility market could induce many positive effects - like a more efficient use of urban space by optimizing driving behaviour and autonomous parking (Milakis et al., 2017, p. 66). The switch from fossil to electric vehicles will enable safer and healthier urban environments along the highway (Woodcock et al., 2009). Moreover, the reduced negative effect of motorized vehicles on urban runoff will enable more sustainable water management (Delang & Cheng, 2012).

Considering the position of the I-80/U.S. Route 101 and I-280 highway in the water course - close to residential living environments. Potentials of innovations in mobility will have to be used in order to adapt to future dynamics. Climate change will require better performances in water management. And population growth and growing pressure on urban space, will make an integrated design for the highway extra significant.

From the methodological point of view, the second conceptual building block is the categorization and simplified representation of highway structures in San Francisco. The goal of the next part of analysis is to research the different spatial appearances of the highway. Subsequently, it explores the potentials of the highway and how it can be deployed for spatial quality and water management.

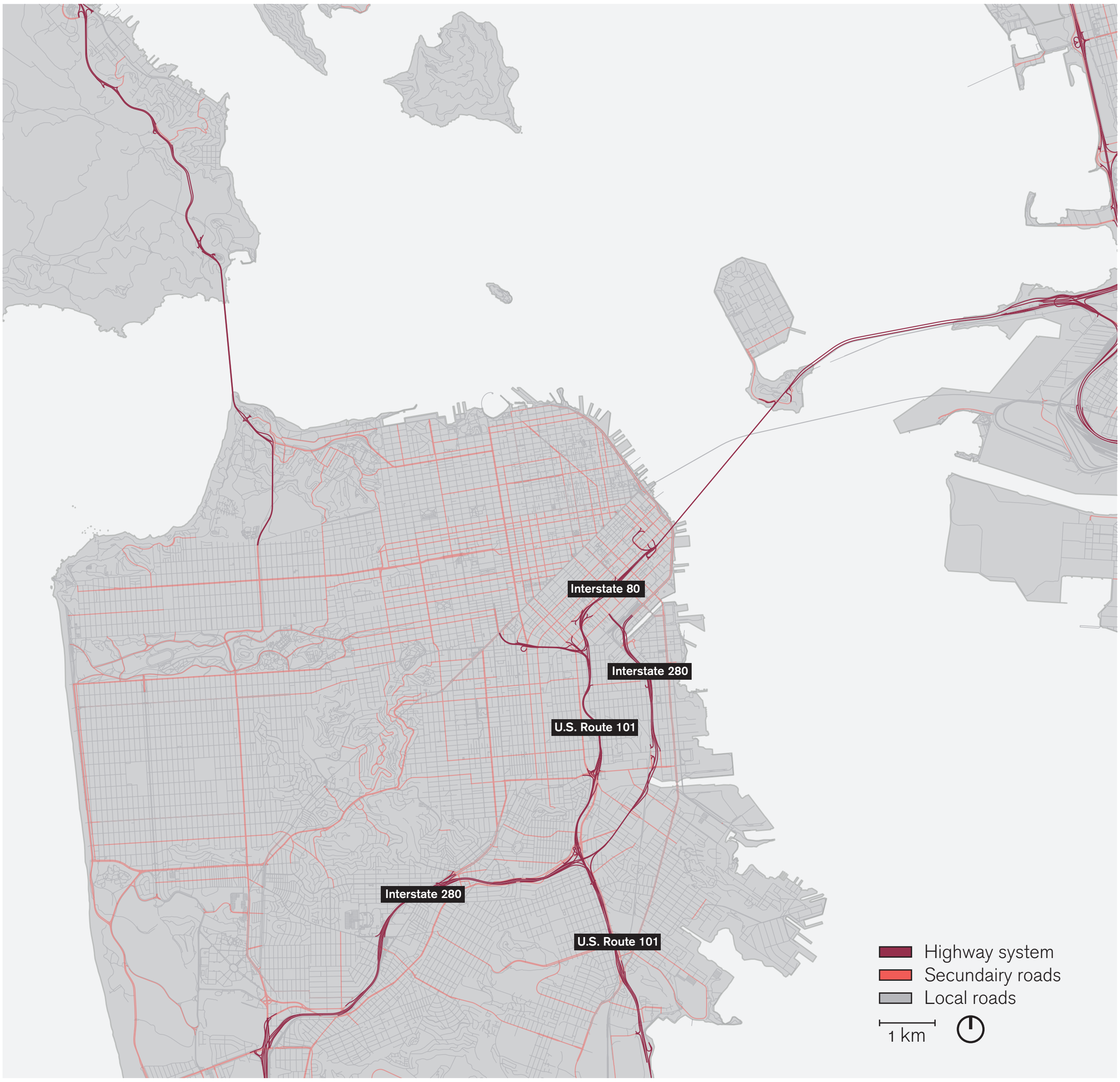


Figure 7.2: Mobility network San Francisco, Source: (Author, 2018)

7.1 West8 prototypes

The analysis of the mobility infrastructures in San Francisco elaborates on the method of the mobility prototypes by West8 and Atelier Rijksbouwmeester (2013). In their research on the healthy relation between city and highway (Gezonde relatie tussen stad en snelweg) a reflection is made on the spatial appearances of local mobility infrastructures in different Dutch cities. Conform the method provided by West8, this part of research categorizes and assesses the different spatial appearances of mobility infrastructures in the test-case. Result is a set of simplified representations of mobility infrastructure, which supplement the guiding models and guiding principles.

In the explorative research on the relationship between infrastructures and the spatial quality of cities, West8 has made an inventory and categorization of highway prototypes throughout the Netherlands. The result was a series of 11 different prototypes, which thereafter where studied and compared in terms of: cost, connections, visual impact, noise and air pollution, and environmental quality. In the exploration the focus is limited to the spatial appearance of highways and the potentials for transformations. (West8 & Atelier Rijksbouwmeester, 2013, pp. 5-9)

7.2 Categorization of mobility infrastructure prototypes

The categorized mobility infrastructure prototypes in this research are originating from the trajectory of the I-80/U.S. Route 101 and I-280 highways. Categorization is done based on the spatial appearance of the mobility infrastructures and is done by inspecting the entire highway infrastructure. The results of this precise inspection is a set of three mobility infrastructure prototypes: *the Flyover highway prototype, the Gutter highway prototype and the Staged highway prototype*. The mobility infrastructure prototypes are located in different parts of the trajectory of the highways and are made insightful on the next pages.

The assessment of the test-case mobility infrastructure prototypes is done in consideration of the assessment criteria of West8 on the influence of the highway on spatial quality. The West8 prototypes are assessed in cost, connections, visual impact, noise and air pollution, and lastly environmental quality. However, in order to connect the method of West8 with the project specific dynamics. The categorization in this research is done, based on the relation of the mobility infrastructure prototypes on the future dynamics as established in the problem analysis. In order to make structured and clear criteria, the future dynamics are adapted to fit the 3 perspectives of the ECS, namely the mobility flow perspective, hydrology flow perspective and the area and actor perspective.

From the **mobility flow perspective**: Connectivity and permeability; The extent to which highway prototypes are accessible from secondary roads and to which extend it permits crossing traffic.

From the **hydrology flow perspective:** Composition and materialization; How does the physical occurrence of the prototype influence the flow of runoff and does it prevent retention and infiltration?

From the **area and actor perspective:** Societal impact and well being; To which extend can the prototype be a positive influence on the living environment, and how liveable is the prototype itself.

	CONNECTIVITY AND PERMEABILITY	COMPOSITION AND MATERIALIZATION	SOCIETAL IMPACT
FLYOVER PROTOTYPE	Low connectivity because of difficulty to construct connections, high permeability because of elevation.	The prototype itself does not influence the flow of runoff. Parking facilities under the prototype prevent infiltration and retention.	Anonymous parking areas under the prototype, however easy to cross. Moderate air and noise pollution because of elevation difference with street.
GUTTER PROTOTYPE	Moderate connectivity and permeability: connections and crossings can be built on top.	The sloped embankments prevent infiltration and retention. The slope itself accelerates the velocity of the runoff.	Embankments are not in use, the prototype itself acts as a barrier. Air and noise pollution is high.
STAGED PROTOTYPE	Low connectivity because of difficulty to construct connections, permeability also low because of soil base.	The multi-stage construction causes dirty runoff to end in environment. Prototype does not support infiltration or retention.	Multi-stage construction acts as a barrier. Moderate air and noise pollution.

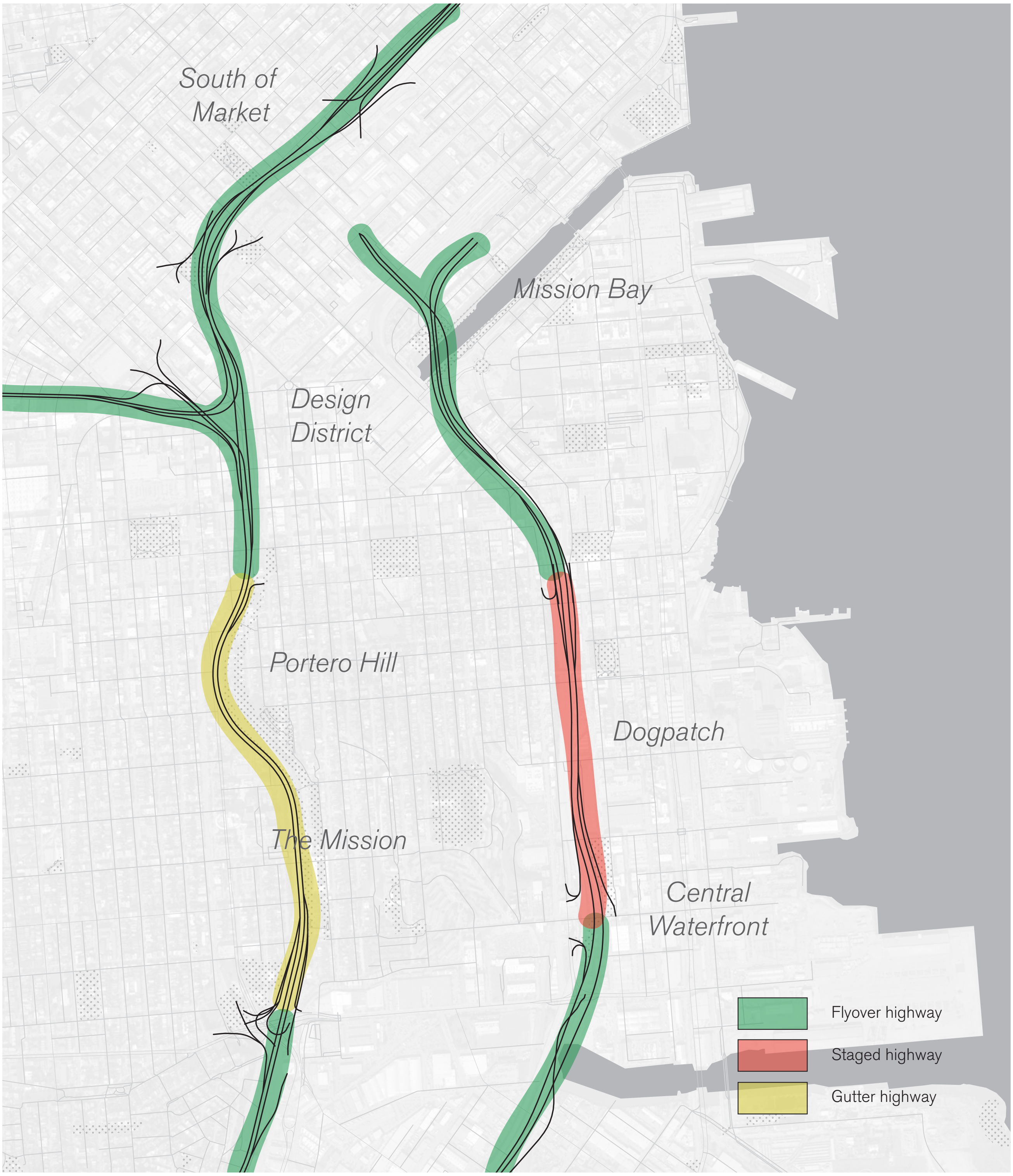
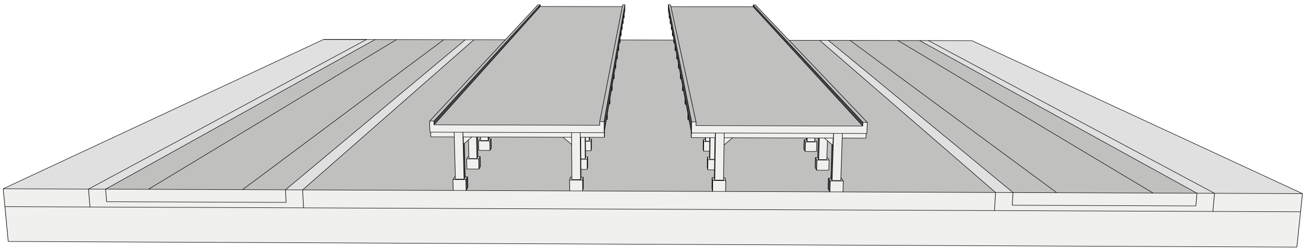


Figure 7.3: Locations of mobility infrastructure prototypes, Source: (Author, 2018)

FLYOVER HIGHWAY PROTOTYPE



CHARACTERISTICS

Low connectivity because of difficulty to construct connections, high permeability because of elevation.

The prototype itself does not influence the flow of runoff. Parking facilities under the prototype prevent infiltration and retention.

Anonymous parking areas under the prototype, however easy to cross. Moderate air and noise pollution because of elevation difference with street.

Figure 7.4: Flyover prototype, Source: (Author, 2018)

SITUATIONS

< 5

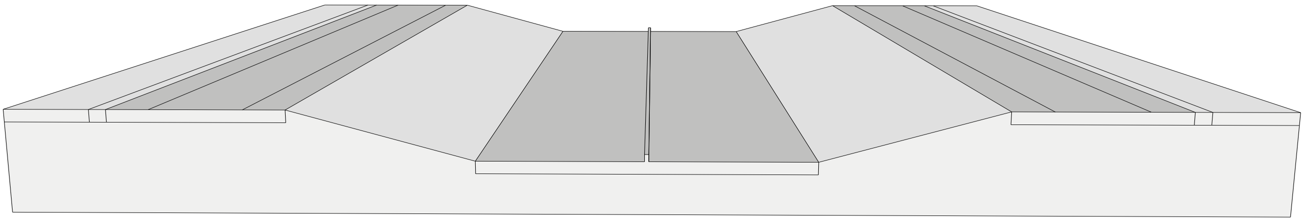
<10

< 20

<30

<50

GUTTER HIGHWAY PROTOTYPE



CHARACTERISTICS

Moderate connectivity and permeability: connections and crossings can be built on top.

The sloped embankments prevent infiltration and retention. The slope itself accelerates the velocity of the runoff.

Embankments are not in use, the prototype itself acts as a barrier. Air and noise pollution is high.

Figure 7.5: Gutter prototype, Source: (Author, 2018)

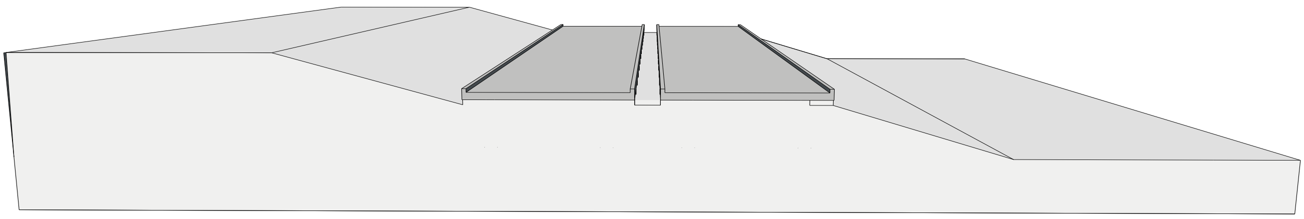
SITUATIONS

< 10

<20

< 30

STAGED HIGHWAY PROTOTYPE



CHARACTERISTICS

Low connectivity because of difficulty to construct connections, permeability also low because of soil base.

The multi-stage construction causes dirty runoff to end in environment. Prototype does not support infiltration or retention.

Multi-stage construction acts as a barrier. Moderate air and noise pollution.

Figure 7.6: Staged prototype, Source: (Google maps, accessed 2018-01-15)

SITUATIONS

<10

< 20

DYNAMICS OF THE HIGHWAY

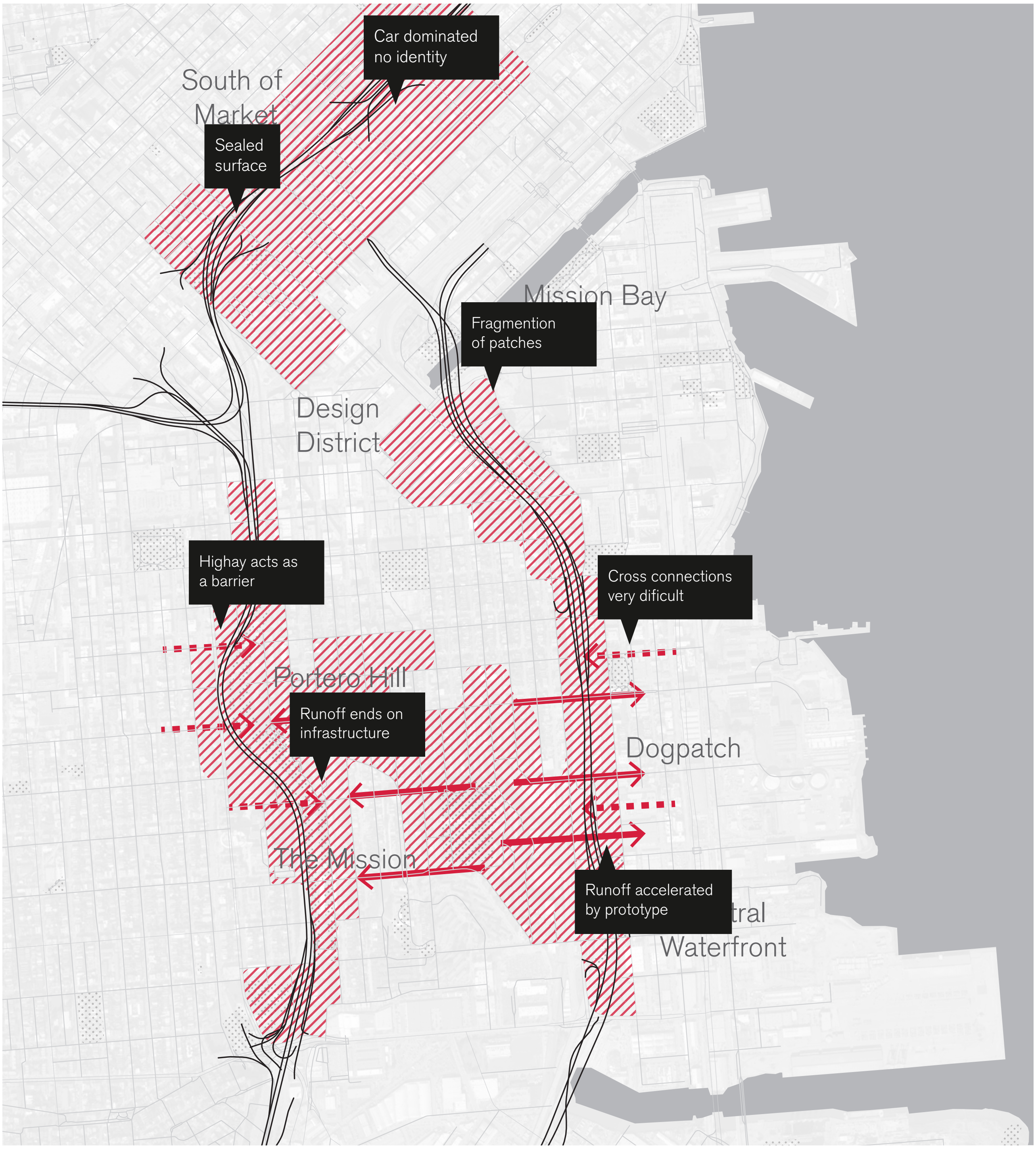


Figure 7.7: Dynamics posting threats to prototypes, source: (Author, 2018)

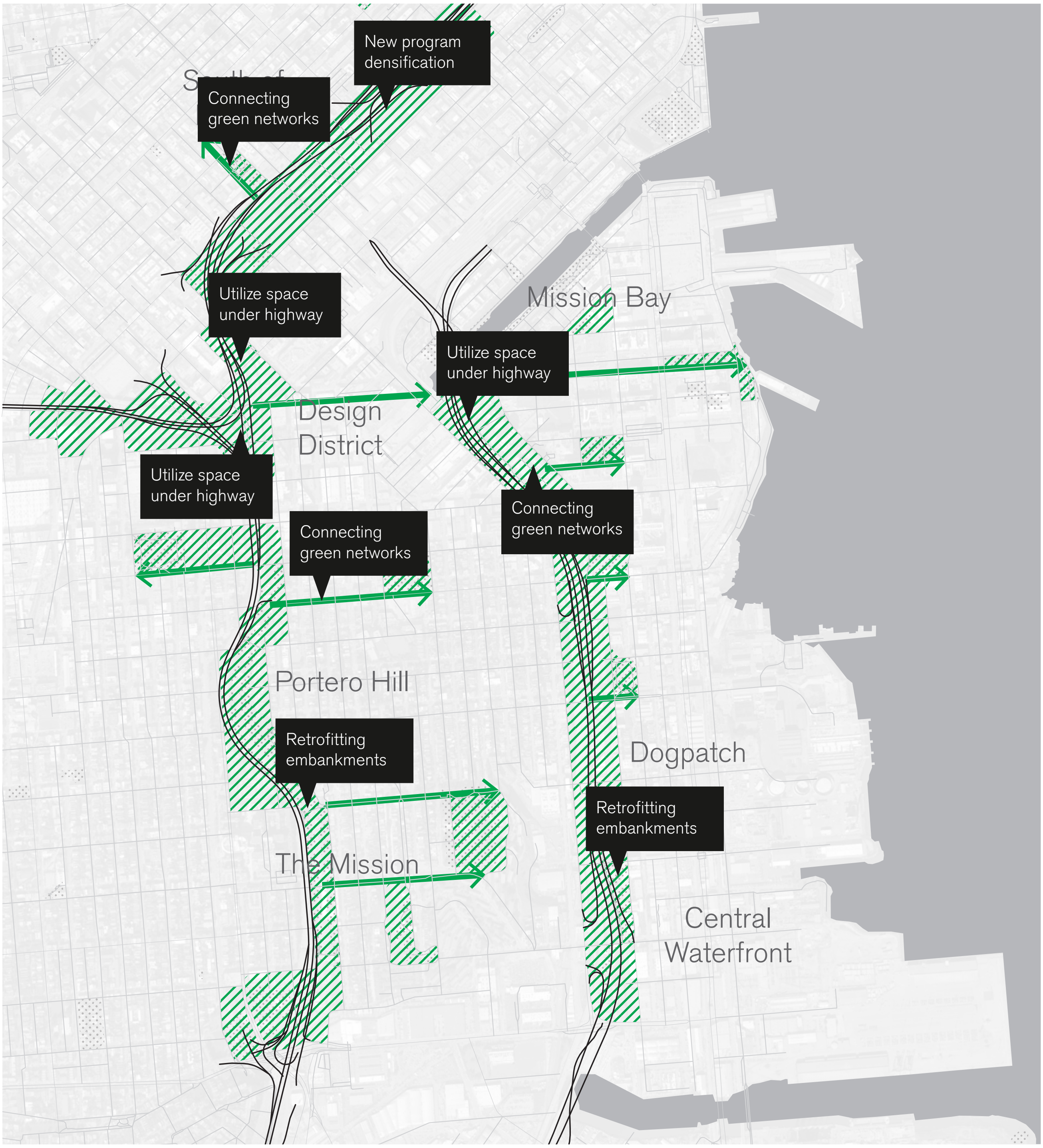


Figure 7.8: Potentials to improve prototypes, source: (Author, 2018)

7.4 Conclusions

Characterizing and assessing the properties of the mobility infrastructure prototypes, resulted in the first conceptual building blocks. Subsequently, It is the first step towards a methodological approach for design for the test-case and an improved S2N. Next step is the construction of a conceptual building block, capable of representing the urban system, in order to research the influence of the highway on the urban system.

The previous research of the second conceptual building block elaborated further on the West8 prototypes and used its research method to categorize and assess the spatial appearances of the highway. In light of future dynamics and the perspectives of the ECS, the performances of the mobility infrastructure in the fields of connectivity and permeability, composition and materialization and societal impact where explored. From the assessment of the I-80/U.S. Route 101 and I-280 highway, three mobility infrastructures prototypes where categorized: the *flyover prototype*, *gutter prototype* and the *staged prototype*. Moreover, this research showed that - in order to meet future requirements of the urban system - the biggest threats to tackle are respectively: the socially and ecologically disconnected character of the prototypes, the paved and car oriented character of the prototypes and lastly the unlivability of the prototypes caused by its pollution and a lack of spacial quality. The following potentials resulted from the assessment of the mobility infrastructure prototypes:

- *Utilizing the space above and below the prototypes*: when vehicles prove to be less harmful for its surrounding, the physical build of the prototype can accommodate new building programs.

- *Improvements to the constructions and materialization of the prototypes*: in order to improve its properties in flow management, the capability of the prototype to accommodate future mobility and water flows need to be secured. Therefore, improvements to the construction and materialisation have to be done in order to mitigate their negative effects.

- *Matching the right programs to the agenda of the prototype*: since innovation in mobility, will have a positive effect on the spatial quality around highways. Revalued prototypes need to be guided to accommodate the right types of activities and programming.

CONCEPTUAL BUILDING BLOCKS

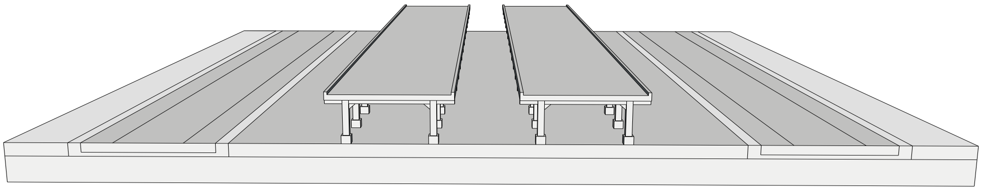


Figure 7.9: Flyover highway prototype, source: (Author, 2018)

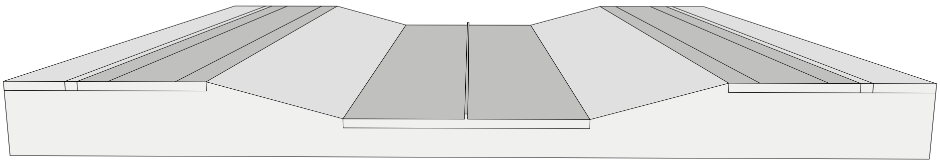


Figure 7.10: Gutter highway prototype, source: (Author, 2018)

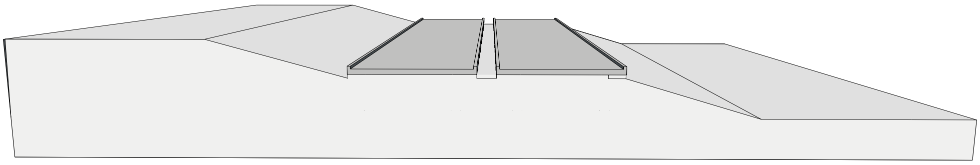


Figure 7.11: Staged highway prototype, source: (Author, 2018)

8 URBAN TYPOLOGIES

In the previous chapter a systematic investigation was done on the different prototypical physical appearances of the highway, concluding with local threats and potentials. This chapter researches the local urban dynamics that influence the interaction between the urban fabric and highway. As the conceptual building blocks for the S2N and the mobility infrastructure prototypes are simplified representation of reality - this chapters conceptual building block will make a representations of urban systems.

In order to categorize and simplify local sets of dynamics, a systematic study is done on the different urban typologies that occur in the zone of influence of the highways. The result of the study is the distinction of five different urban typologies, with unique socio-spatial properties. Subsequently, to analyze the urban properties from an integral perspective, topics from the layer approach are chosen as inspiration for the assessment criteria.

The layer approach is an analytical scheme that simplifies the urban dynamics in three interrelated layers: the occupation layer, the network layer and the subsurface layer. Because the S2N plays an intermediate role in the balance between activities from the occupation layer and the ecological basis formed by the network and subsurface layer (Nijhuis et al., 2015, pp. 65-66). The urban properties are assessed from the ecological perspective. However, in order to connect these themes from a more technical perspective, knowledge have been drawn from the Spacemate by Berghauser Berghauser Pont & Haupt (2010). From the method of the Spacemate the relationship between types of urban environment and data such as building intensity and other properties are taken as a tool for the categorization of urban typologies.

In this research the different living environments are categorized and assessed, the periods of development of the urban typologies are investigated in order to explain what dynamics have been important to the structuring of the urban environment and the over time (Berghauser Pont & Haupt, 2010, pp. 168-197). This is done by historical analysis of building age and the urban spread of San Francisco. Next, the intensity of human activities is related to the natural layers by studying the zoning maps of San Francisco and connecting this to the subsurface data and position in the water course. Ultimately a selection of urban typologies is made by categorization of the data, and the physical data is made insightful by calculations of the density conform the Spacemate.

Figure 8.1: Scheme of layer approach, Source: (http://www.ruimtexmilieu.nl/uploads/images/afbeelding%20lagenbenadering.gif, accessed 18-01-16)

8.1 Spacemate: space, density and urban form

One method to describe the performances of the city, is to quantify its density and build up intensity. By observation of the building intensity (FSI), coverage (GSI), spaciousness (OSR) and average number of storeys, the concept of density can be made clear. However, so far density can only represent a vague number, and doesn't provide enough clarity to describe the qualities of the living environment. Therefore, it is firstly important to understand what dynamics structured and constrained the build environment (Berghauser Pont & Haupt, 2010, pp. 168-197). The following part is going to focus on the historical trends that left clear patterns of urbanization in San Francisco. This is done by analyzing the urban spread throughout history, the building years of current buildings, and the development of the grid. By doing so, a deeper understanding can be made of the historical base of the urban fabric and can act as a base on which the urban typologies can develop. Lastly - when selecting the urban typologies - the data from this part can be related to the numbers of density, in order to provide concrete information for the design.

Density developments of San Francisco

San Francisco knew some profound developments throughout history, not only under influence of the natural dynamics - when the first settlers anchored at Market Street and today's environmental crisis. But also by the cultures that came and settled during the gold rush, the second world war and the tech boom. The presence of the different counter cultures meant a strong opposition in city planning, which ultimately makes San Francisco a unique and resilient city. Moreover, its historical development as a city depending on its port activity - and yet today a tech and office oriented city– caused a lot of shifts in the city. When combining the data of population growth and the historical development of urbanization, building years and the San Francisco grid. The traces these historical dynamics leave in the urban fabric become visible, and a relation and distinction of the construction of the urban typologies and its specific period in time can be made.

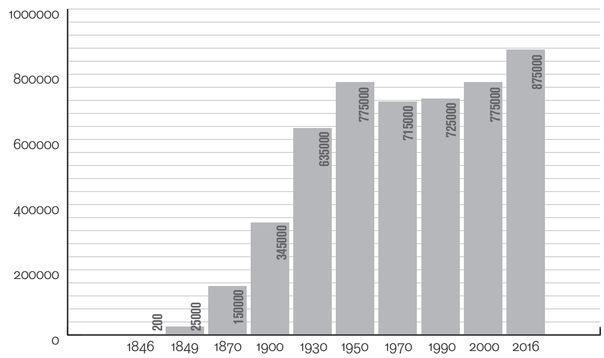


Figure 8.2: Development of population, Source: (http://www.sfgenealogy.com/sf/history/hgpop.htm, accessed 18-01-16)

Historical events

First European settlement, pre gold rush

The first anchorage on San Francisco soil was established at an inlet on the north-east end of the peninsula in 1769, what is now called Market Street. The small settlement that developed nearby was named Yerba Buena (Sloan, 2006, p. 111). In 1846, Yerba Buena doubled in population when about 240 Mormon pioneers arrived. During the 1846 Mexican-American War, Yerba Buena was claimed by America and one year later its name changed to San Francisco. Because of its location at the tip of a peninsula without water or wood, San Francisco lacked most of the facilities to support a 19th-century settlement. These natural disadvantages required the town's residents to bring resources to the site, therefore being very dependent on port activities. The large city that came to be known as San Francisco eventually, knew a slow start as a sleepy village. (Scott, 1985, pp. 23-26)

Post gold rush (1848-1880)

The California gold rush started in 1848 and led to a large boom in population. Between January 1848 and December 1849, the arrival of the "forty-niners" increased the city's population from 1,000 to 25,000 inhabitants. The population boom included many workers from China who came to settle permanently and work in the gold mines and later on the Transcontinental Railroad. Causing San Francisco's harbour to be filled with abandoned ships. Many of the vessels were used as raw material for the city's harborside expansion. The rapid growth continued through the 1850's and complicated city planning efforts heavily. In order to standardize the development of the land, a grid structure was projected on the available land which is active to date. (Scott, 1985, pp. 26-56)

Earthquake reconstruction (1906-1930)

In 1906, San Francisco was hit by a devastating earthquake. Water mains ruptured throughout San Francisco and the fires that followed burned out of control for days, destroying approximately 80% of the city, including almost all of the downtown core. Immediately after the quake re-planning and reconstruction plans were initiated to quickly rebuild the city. One of the ambitious reconstruction plans - proposed before the fire – came from urban planner Daniel Burnham. And while the original street grid was restored, many of Burnham's proposals such as wider streets, a subway under Market Street and a more people friendly Fisherman's Wharf, where realized. (Scott, 1985, pp. 109-239)

World War II

During World War II, San Francisco was the major mainland supply point and port of embarkation for the war in the Pacific. It also saw Japantown completely empty out as a result of an order, that forced all Japanese of birth or descent to be interned. By 1943 many large sections of the neighborhood remained vacant due to the forced internment. The void was quickly filled by thousands of African Americans who sought wartime industrial jobs. Many also settled in the Fillmore District and most notably near the Bayview-Hunters Point shipyards, working in the dry-docks there. (Scott, 1985, p. 239)

Freeway revolt

After World War II many military personnel settled in the city, causing the total build out of San Francisco. During this period, Caltrans commenced an aggressive freeway construction program in the Bay Area. However, strong resistance - because of the city's high population density meant the displacement of a large number of people - resulted in the "freeway revolt". Subsequently, Caltrans tried to minimize displacement by building double-decker freeways, which became an eyesore in the city and ultimately turned out to be seismically unsafe. (Henderson, 2013, pp. 54-86) the 1960's also ended the significance of the port of San Francisco as a major marine terminal. As it had no room for expansion, a large quantity of port activity shifted to the cross-bay port of Oakland. (Scott, 1985, pp. 109-239)

Manhattization and the Dot-com boom

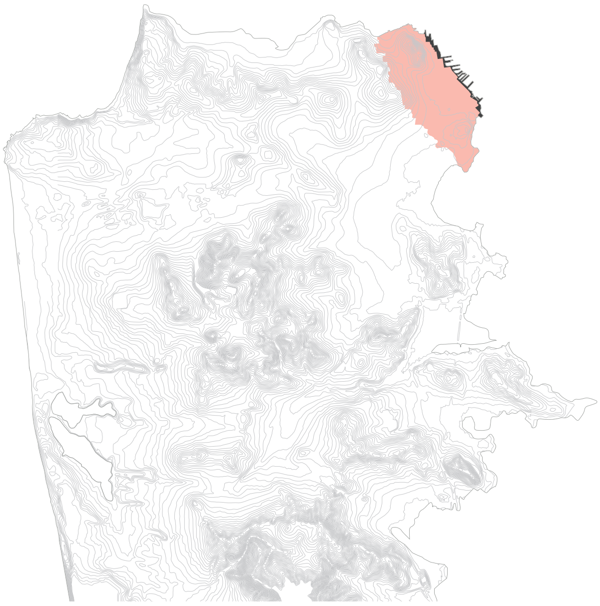
Between the late 70's and 80's, a development boom referred to as "Manhattanization" took place. Many large skyscrapers were built - primarily in the Financial District - including high-rise condominiums in residential neighborhoods. Similar to the freeway revolt, the 'skyscraper revolt' forced the city to initiate height restrictions in the planning code. (Graham & Guy, 2002, pp. 369-382) For years, this slowed down construction of new skyscrapers. A decade later, the demolition of the quake damaged Embarcadero resulted in restoration of the waterfront. And in 1996, the development of the new Mission Bay neighborhood was initiated. During the dot-com boom of the late 90's, large numbers of entrepreneurs and computer software professionals moved into the city, and changed the social landscape as once poorer neighborhoods became gentrified. The rising rents forced many people and businesses to leave. (Centner, 2008)

Postmillennial San Francisco

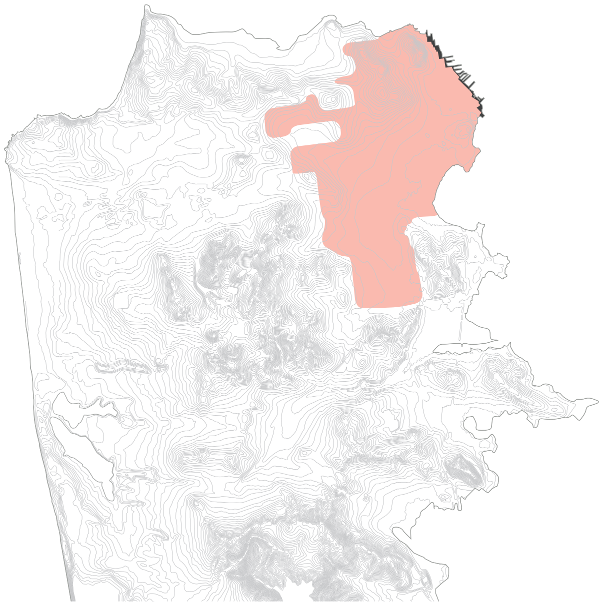
In 2001, the markets crashed, the dot-com boom ended, and many left San Francisco. South of Market - where many dot-com companies were located - was a virtual wasteland of empty. By 2003 however, the city's economy had recovered from the dot-com crash, thanks to the tourist industry and the Web 2.0. (Centner, 2008) Residential demand as well as rents rose again and as a result, city officials eased building height restrictions and zoning codes, in order to construct residential condominiums in South of Market. The early 2000's and 2010's saw the redevelopment of the Mission Bay neighborhood. Originally an industrial district, it was stimulated by the construction of the University of California, San Francisco Mission Bay campus and its UCSF Medical Center, currently it's an up and coming neighborhood. (San Francisco Bay Area Planning and Urban Research Association, 2016, pp. 5-15)

HISTORICAL PATTERNS OF URBANISATION

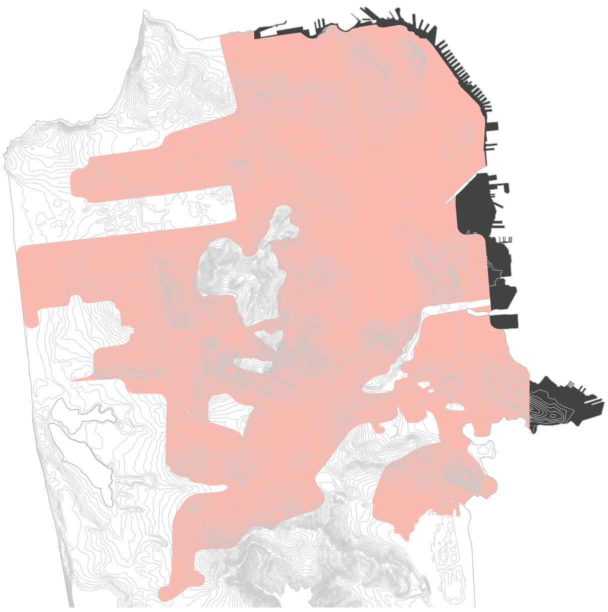
First European settlement



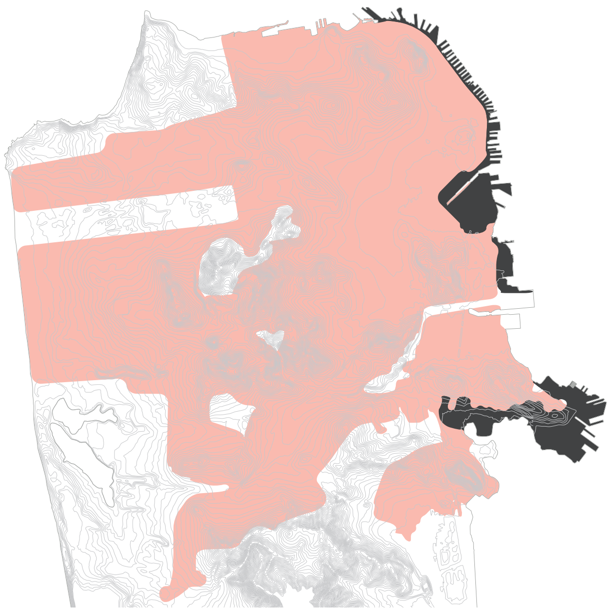
Gold rush



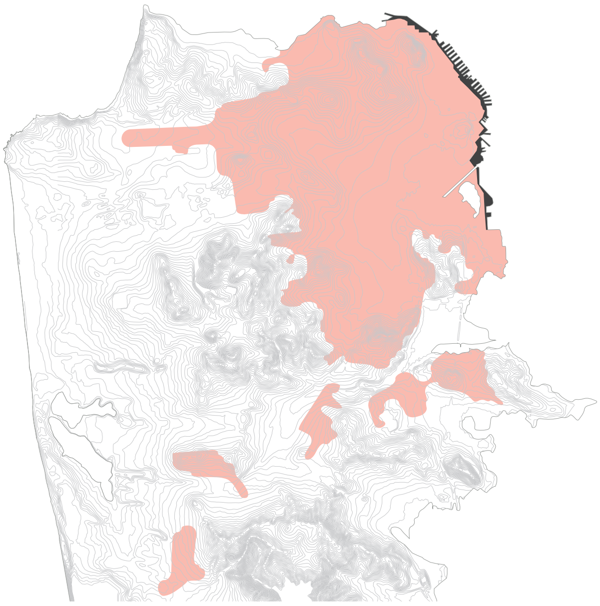
World War II



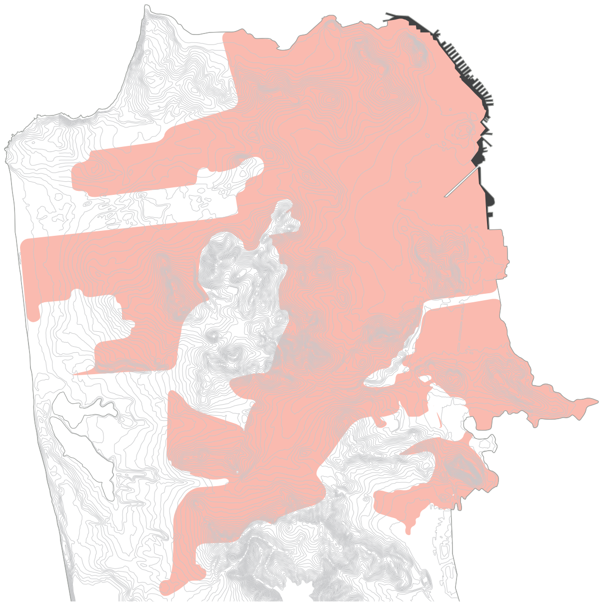
Post-World War II



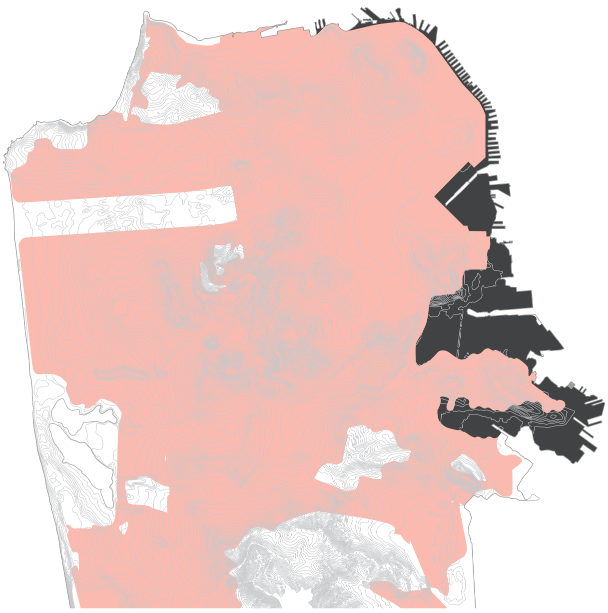
1890



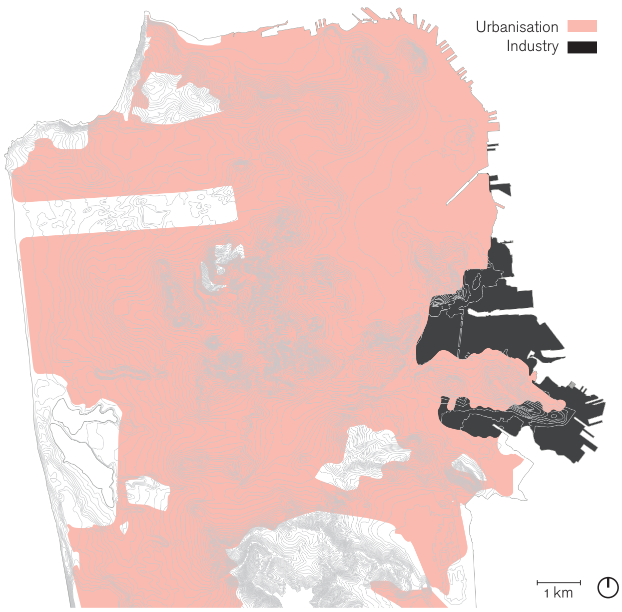
Earthquake reconstruction



Manhattization and Dot-com boom

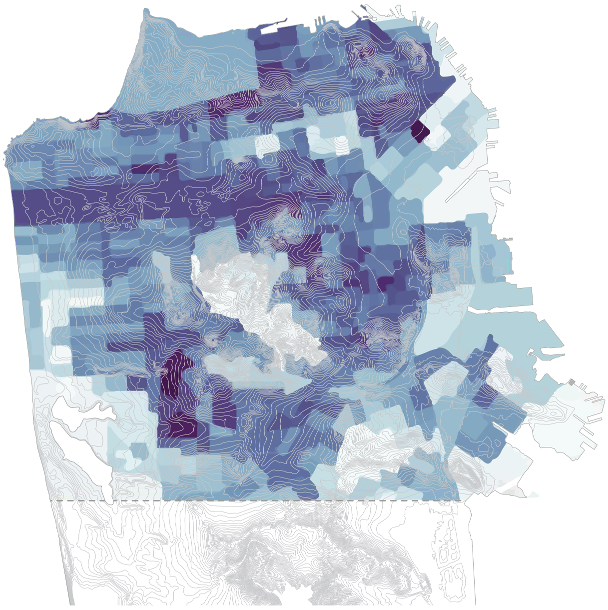


Postmillennial San Francisco

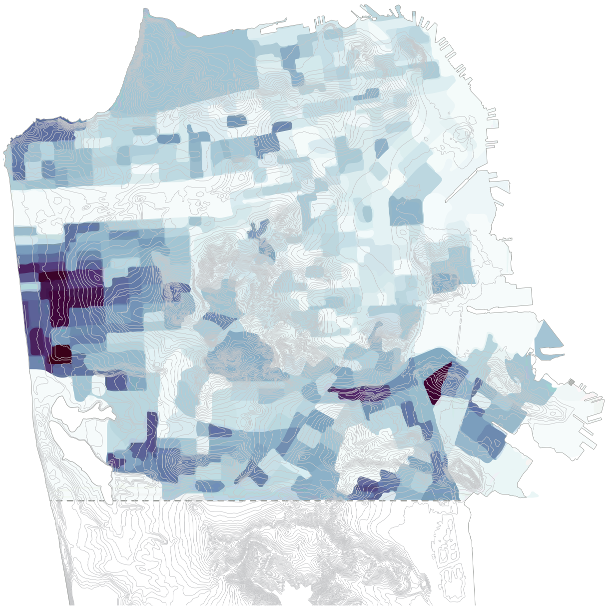


BUILDING YEARS

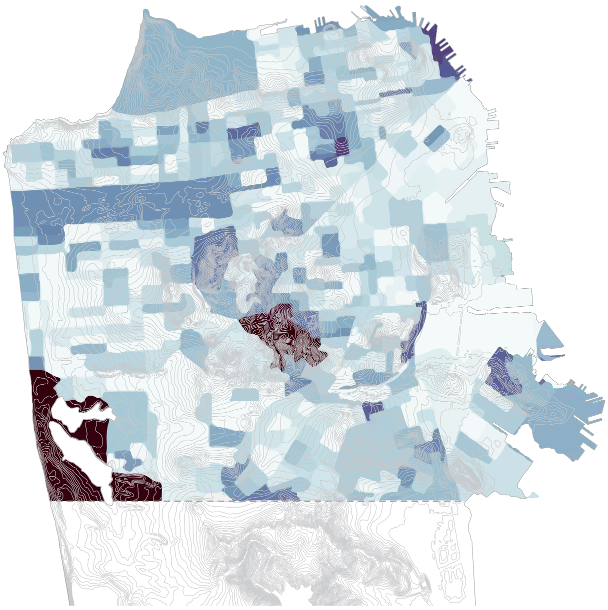
< 1939



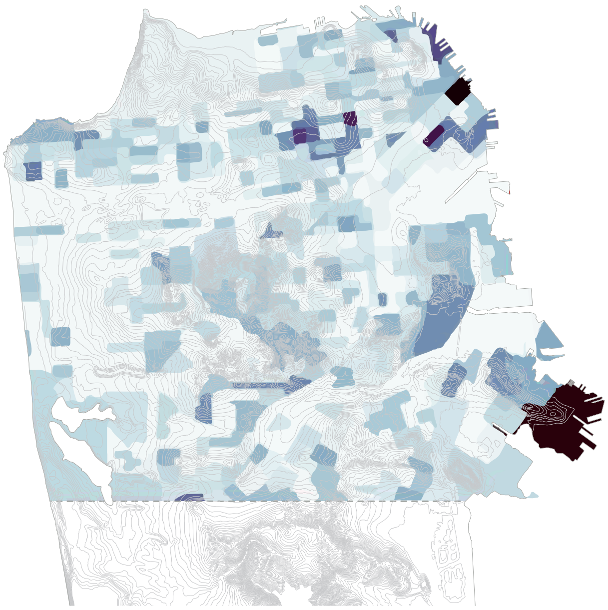
1940 - 1949



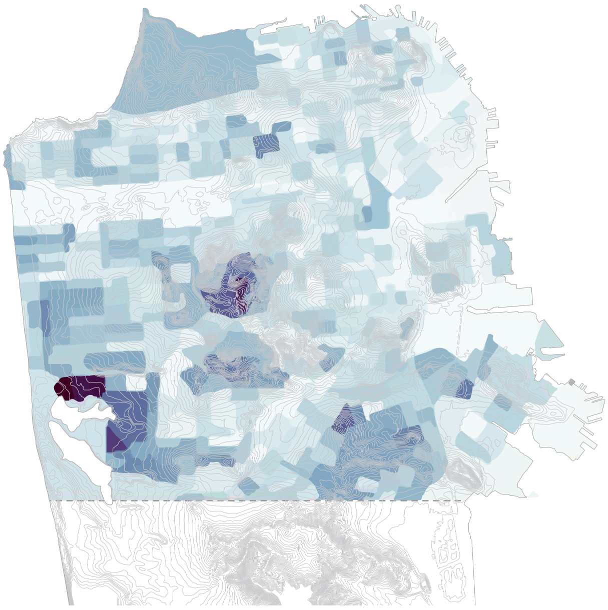
1970 - 1979



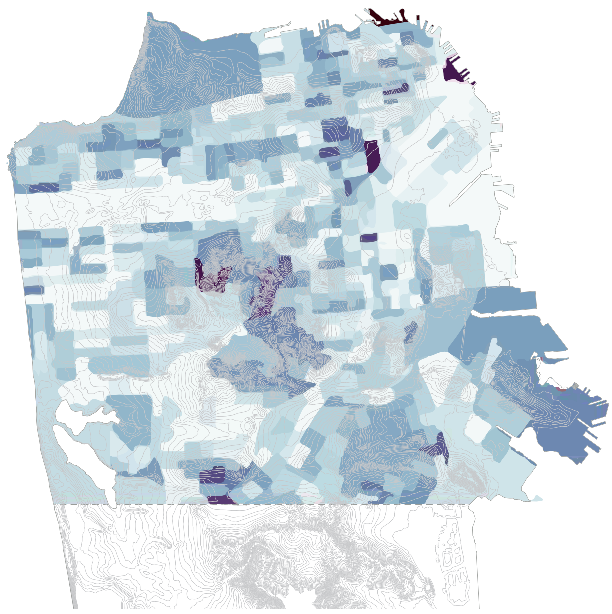
1980 - 1989



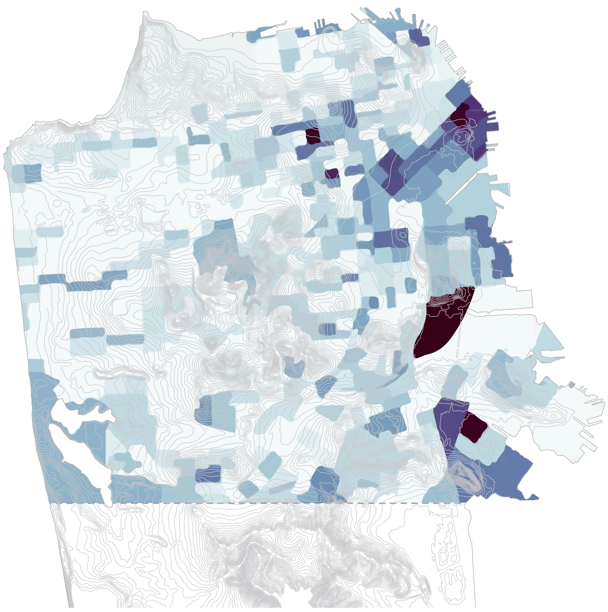
1950 - 1959



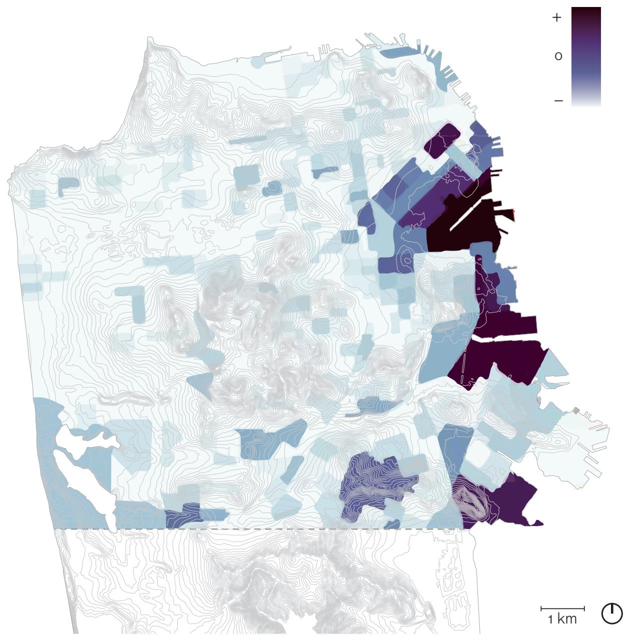
1960 - 1969



1990 - 1999



2000 >



8.2 The San Francisco grid

Grid systems possess significant potentials for high-density cities to meet future demands (Busquets, 2013). The examination of the history of the grid system offers valuable insights. The grid is a matrix for innovation within urban development, allowing the creation of sustainable compact cities and performative urban infrastructures, forming new networks and innovative city systems. (Busquets, 2013)

San Francisco is an example of an accumulative city, where different grids are developed in patches over time. Different grids are juxtaposed over time. This type of grid layout has been applied frequently on cities throughout history. Having separate and distinct sectors in which the grids have been added together to form coherent, well-organized wholes (Busquets, 2013).

From the patterns in the grid system it is easy to discern the different grid systems, which reflects back on the previous historical events in urbanisation. Apart from the linear grid - over time urbanisation had also spread to the difficult to cultivate hills (Sloan, 2006). Making the topography easy to discern from the grid patterns.

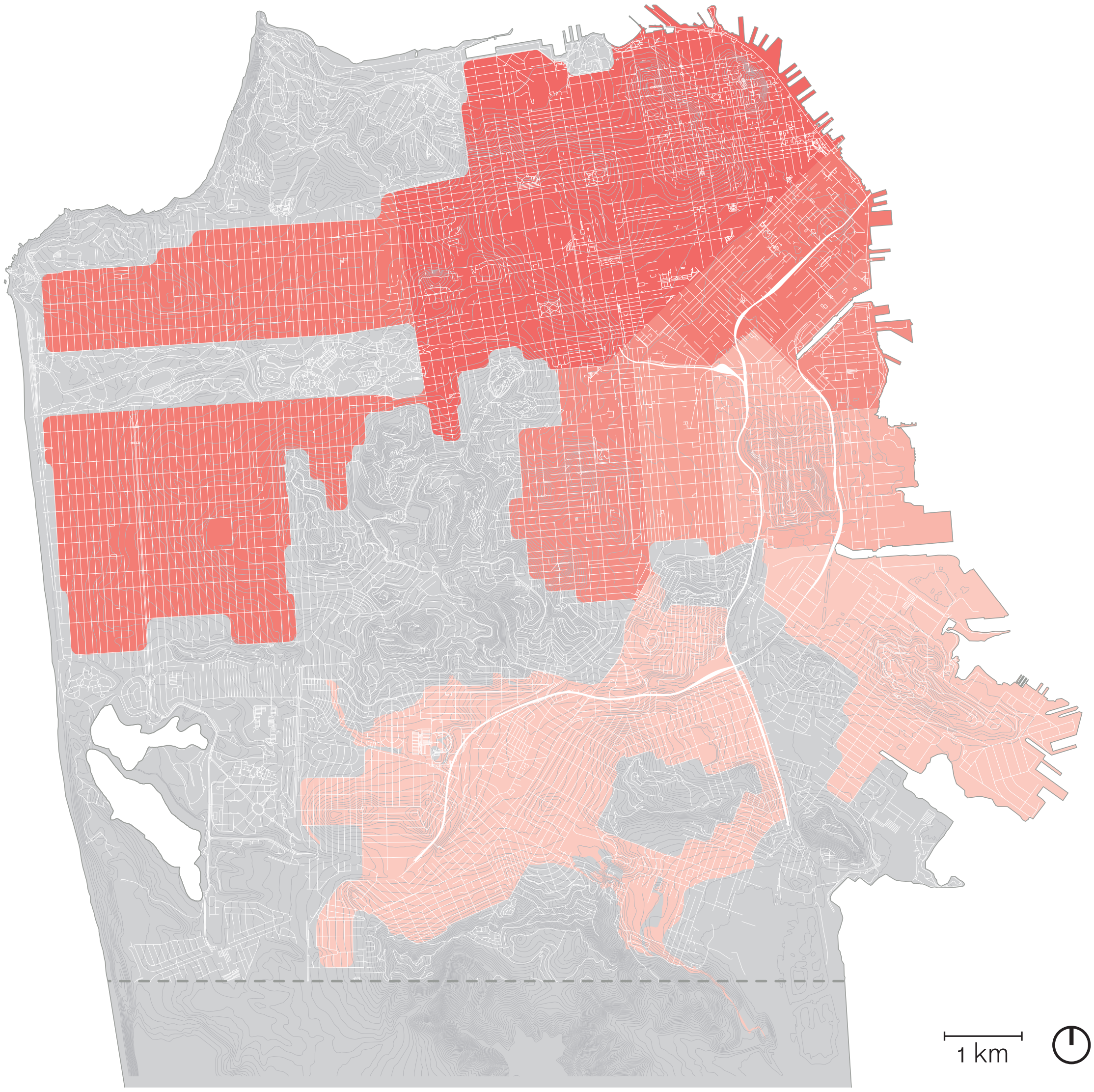


Figure 8.3: The accumulative grid system of San Francisco, Source: (Author, 2018)

8.3 Zoning of San Francisco

In order to discern different living environments in San Francisco, information has been obtained from the zoning map of the San Francisco planning department. The zoning map shows different patterns in land use and combined with the historical data on urban development, the characteristic living environment can be placed within a specific context. Moreover, together with the quantification of the density and building intensity, a more precise image of the urban system can be drawn.

When overlaying the patterns of the historical urban spread, patterns in the accumulative grid system and patterns of land use. It its possible to identify distinct areas, which form the base of categorization and assessing of the third conceptual building block. Next, based on the hydrological, geological and topographical setting, further categorization and assessment will take place in order to define urban typologies.

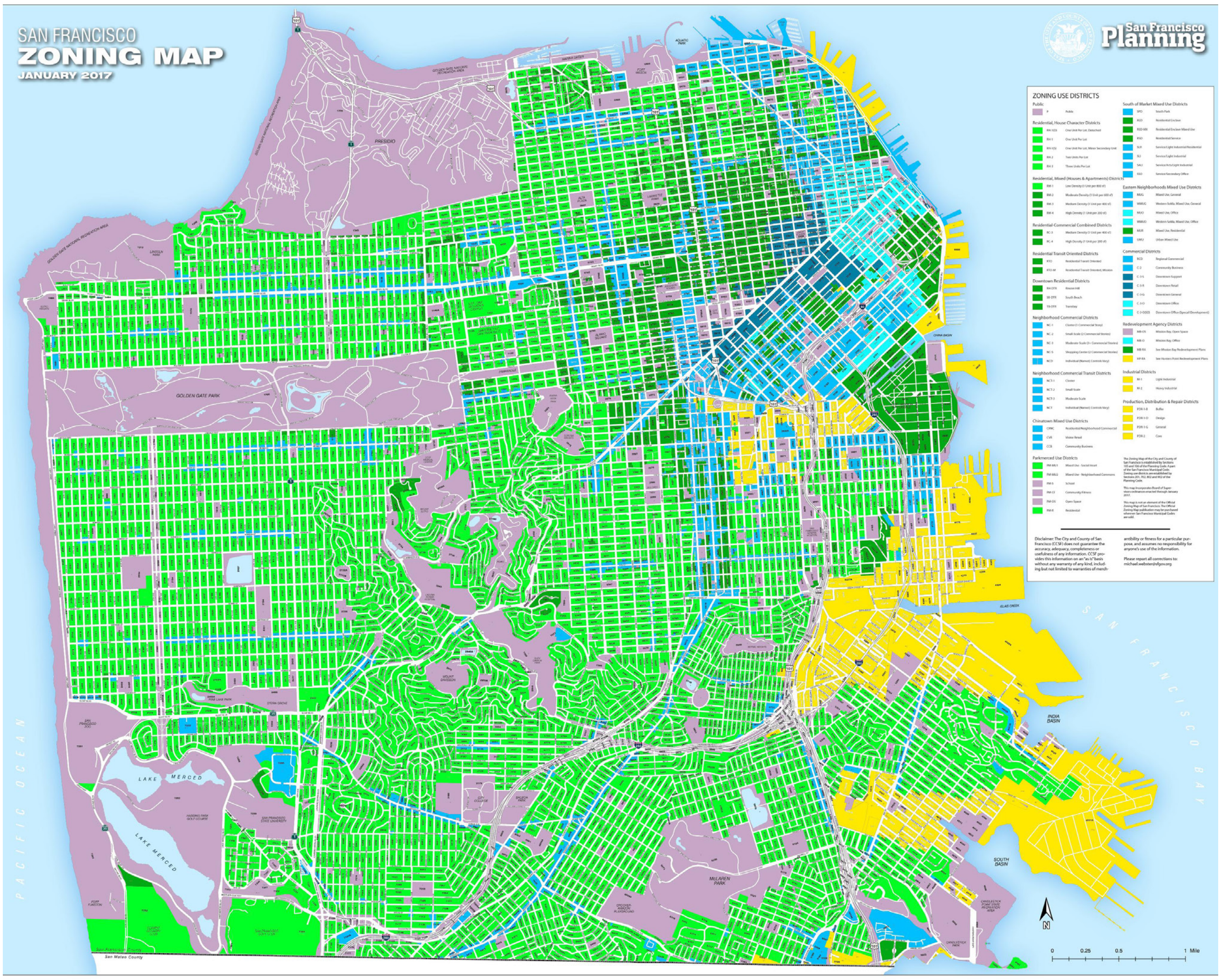


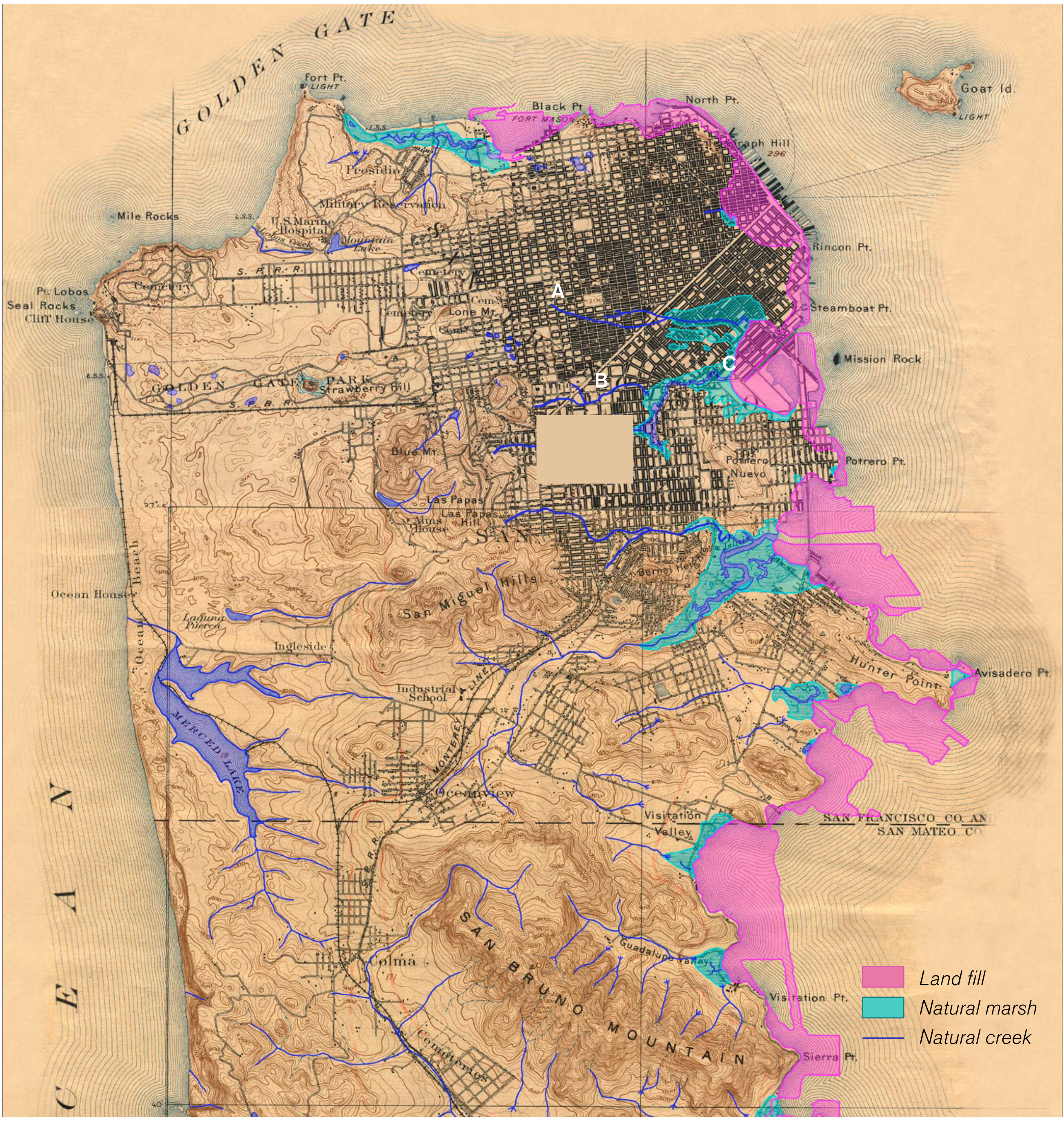
Figure 8.4: Zoning map of San Francsico, Source: http://sf-planning.org/zoning-maps, accessed 18-01-16)

8.3 Location in the water course

As a peninsula, the future of San Francisco is very dependent of its waterfront. South of Mission and Mission Bay are located at the eastern coastline and border the coastline of San Francisco Bay. Much of the land that now covers San Francisco's Bay waterfront is not natural. Before the city was built up, many streams flowed from the highlands into the lakes or to the bay and ocean. Only a few of them can be seen today; the rest are filled and flow only underground. Hayes creek (a) and Mission creek (b) naturally flowed through the present South of Market area to an extensive marsh at the edge of the bay (c) .(Sloan, 2006, p. 116)

As the City developed, the Bay was filled in for additional housing, commerce, and infrastructure. This landfill consists of dredged mud and sand from the bottom of the bay, wood from sunken merchant vessels, and rubble from the 1906 earthquake. The neighborhoods built on landfill are built at low elevation, and located at the bottom of a watershed in a natural drainage basin. In addition to many neighborhoods being partly built on landfill, development now covers most of San Francisco's natural streams and creeks. Historically, San Francisco was home to Mission Creek, Islais Creek, Yosemite Creek, and other waterways that transported rainfall from the hills to the Pacific Ocean or San Francisco Bay. These creeks are still active, but now flow through sewer pipes. During heavy precipitation events, storm water runoff from impervious surfaces will pool along these natural drainage channels and may flood the roads, homes, and businesses. (Sloan, 2006, p. 116)

Figure 8.5: Natural landscape of San Francisco projected on a 1895 map, Source: (http://explore.museumca.org/creeks/SFTopoCreeks.html##Oakland, accessed 18-01-15)


GOLDEN GATE
Fort Pt.
Black Pt.
North Pt.
Goat Id.
Presidio
Mile Rocks
Pt. Lobos
Seal Rocks
Cliff House
Rincon Pt.
Steamboat Pt.
Mission Rock
GOLDEN GATE PARK
A
B
C
Blue Mt.
Potrero Pt.
San Miguel Hills
Ocean House
Ingleside
Industrial School
Hunter Point
Avisadero Pt.
MERCED LAKE
Oceanview
Visitation Valley
SAN FRANCISCO CO.
SAN MATEO CO.
SAN BRUNO MOUNTAIN
Colma
Visitation Pt.
Sierra Pt.
Land fill
Natural marsh
Natural creek

Geologic setting San Francisco

The geologic landscape in San Francisco can be divided into two distinct categories: bedrock and unconsolidated sediments. Bedrock in San Francisco consists of consolidated rocks of the Franciscan Complex of the Late Jurassic and Cretaceous age. Outcrops of bedrock in the hilly areas account for about 24 percent of the land surface in San Francisco. (Sloan, 2006, pp. 110-131)

Lying on top of the volcanic and sedimentary rocks are the younger sediments, deposited in the past 1.8 million years, the quaternary period, which constitute the groundwater basins. The Bay areas valleys are filled with eroded out of the rising hills, and creek deposits form the sloping alluvial plain that surround the bay (Sloan, 2006, p. 74). At the edges of the San Francisco bay are thick deposits of sediment carried in by rivers and creeks. Sand and mud have accumulated in the valleys of the San Francisco Bay for the past half a million to a million years. In most flat areas unconsolidated sediments are present, that constitute the groundwater basins (see figure 8.6). These unconsolidated soils, are mainly composed of artificial fill (af), dune sands (Qhs) and alluvium deposits (Qoa). Penetrating the top sediments are the serpentine melangé bedrocks in the hilly areas of east San Francisco (br). (Sloan, 2006, pp. 110-131)

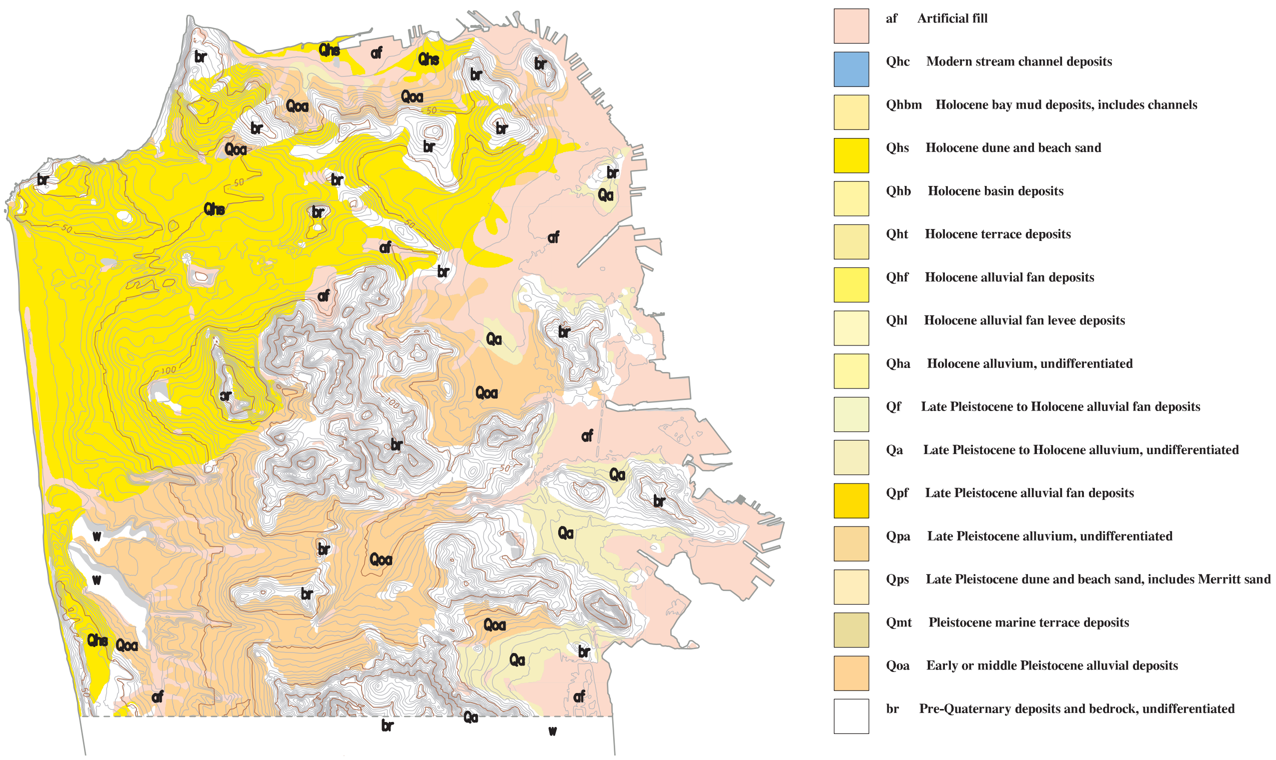


Figure 8.6: Quarternary soils San Fransico, Source: (http://funnel.sfsu.edu/courses/gm309/F05/problems/LivingOnTheEdge/geomaps/mapportions/SFGeo.jpg, accessed 18-01-16)

Groundwater Basins

In San Francisco a groundwater basin is defined as a continuous body of unconsolidated sediments and the surrounding surface drainage area. The eastern part of San Francisco is divided into five basins on the basis of bedrock ridges exposed at the land surface. The Downtown Basin, is the largest of the eastern basins at 7512 acres and is the basin responsible for the focus area. (Phillips, Hamlin, & Yates, pp. 6-7)

All basins are open to the Pacific Ocean or San Francisco Bay. The landward parts of the groundwater basins generally are bounded horizontally and vertically by bedrock, which is assumed to be more impermeable than unconsolidated alluvium. Groundwater flow may occur between basins where the bedrock ridge constituting the boundary is subterranean. Groundwater levels on the east side of the City generally are closer to the land surface than those on the west side. Groundwater basins on the east side are thinner and smaller in volume than those on the west side (Phillips et al., 1993).

Groundwater recharge

Groundwater recharge to the groundwater basin occurs from infiltration of rainfall, and leakage of water and sewer pipes. Recharge to the Downtown San Francisco groundwater basin was estimated to be 5,900 ac-ft per year. Recharge due to leakage from municipal water and sewer pipes accounted for about half of the total recharge of groundwater in the San Francisco area. Recharge of San Francisco's groundwater basins is hindered not only by the vast extent of impervious surfaces in the city, but also by the historic channelization of nearly all surface water drainages into the combined sewer system (Phillips et al., 1993).

The primary water-bearing formations are comprised of unconsolidated sediments and include alluvial fan deposits, beach and dune sands, undifferentiated alluvium and artificial fill. The oldest of these sediments are Pleistocene in age. Water-bearing formations are thickest beneath the central and northeaster portion of the basin (between Interstate 80 and Chinatown) where bedrock is encountered at less than 300 feet below ground surface. In much of the basin bedrock is encountered at less than 200 feet below ground surface (Phillips et.al. 1993).

Groundwater within the Downtown basin is subject to high concentrations of nitrates and elevated chloride, boron and total dissolved solids concentrations. High nitrate levels and are attributed to groundwater recharge from sewer pipe leakage and possibly to fertilizer introduced by irrigation return flows. (San Francisco Water Department, 2004)

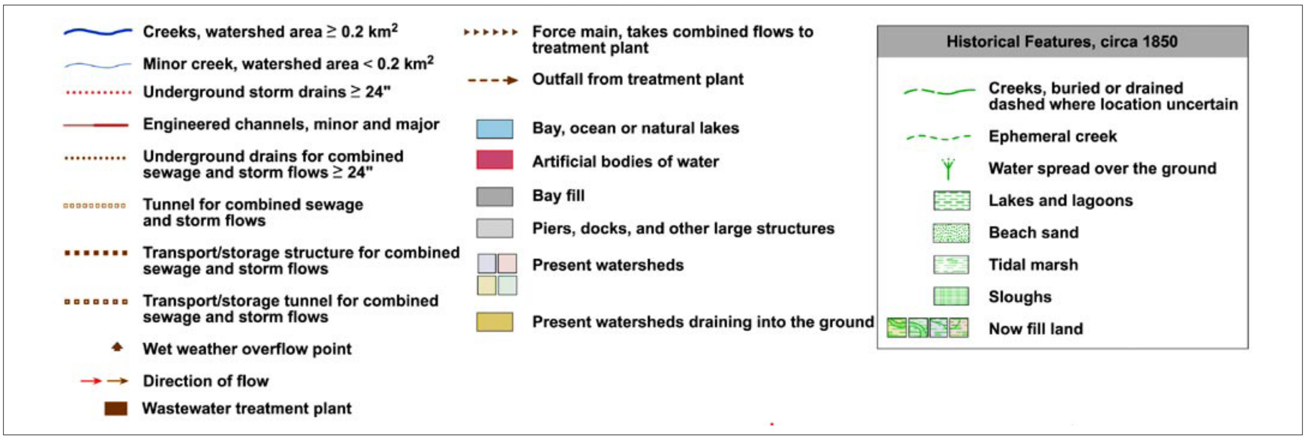
Current drainage system

San Francisco is the only coastal city in California with a combined sewer system that collects and treats both wastewater and storm water in the same networks. Water flows through most of the sewers using gravity. The drainage system utilizes the topography, reducing the energy and maintenance costs associated with mechanical pumping. Storm water enters the combined sewer system through building roof drains and catch basins along the street and gets treated at purification plants, just like the wastewater that goes down the domestic drains.[1]

Designated storm drains direct the storm water directly to the Bay or Ocean with minimal treatment. Storm drains require greater public awareness due to the potential for pollutants, such as motor oil, pesticides, and trash, to be washed into the Bay. As of June, 2016 six storm drains in the San Francisco Mission Bay neighborhood have been adorned with special educational murals created by a local artist, drawing awareness to the impact pollutants can have on the environment. (San Francisco Water Department, 2004)

Studies of sewer flow indicate that infiltration of groundwater predominantly occurs on the east side, where the water table commonly is above the sewer lines. Many underground structures in this area, such as the Powell Street Bay Area Rapid Transit (BART) station and the basement at the old Opera House, require sump pumps to remove infiltrating ground water. Historically, groundwater pumping coupled with small storage volumes resulted in water levels that declined below sea level in the downtown area (Phillips et al., 1993, pp. 6-7).

Legend



1 *http://sfwater.org/index.aspx?page=398*

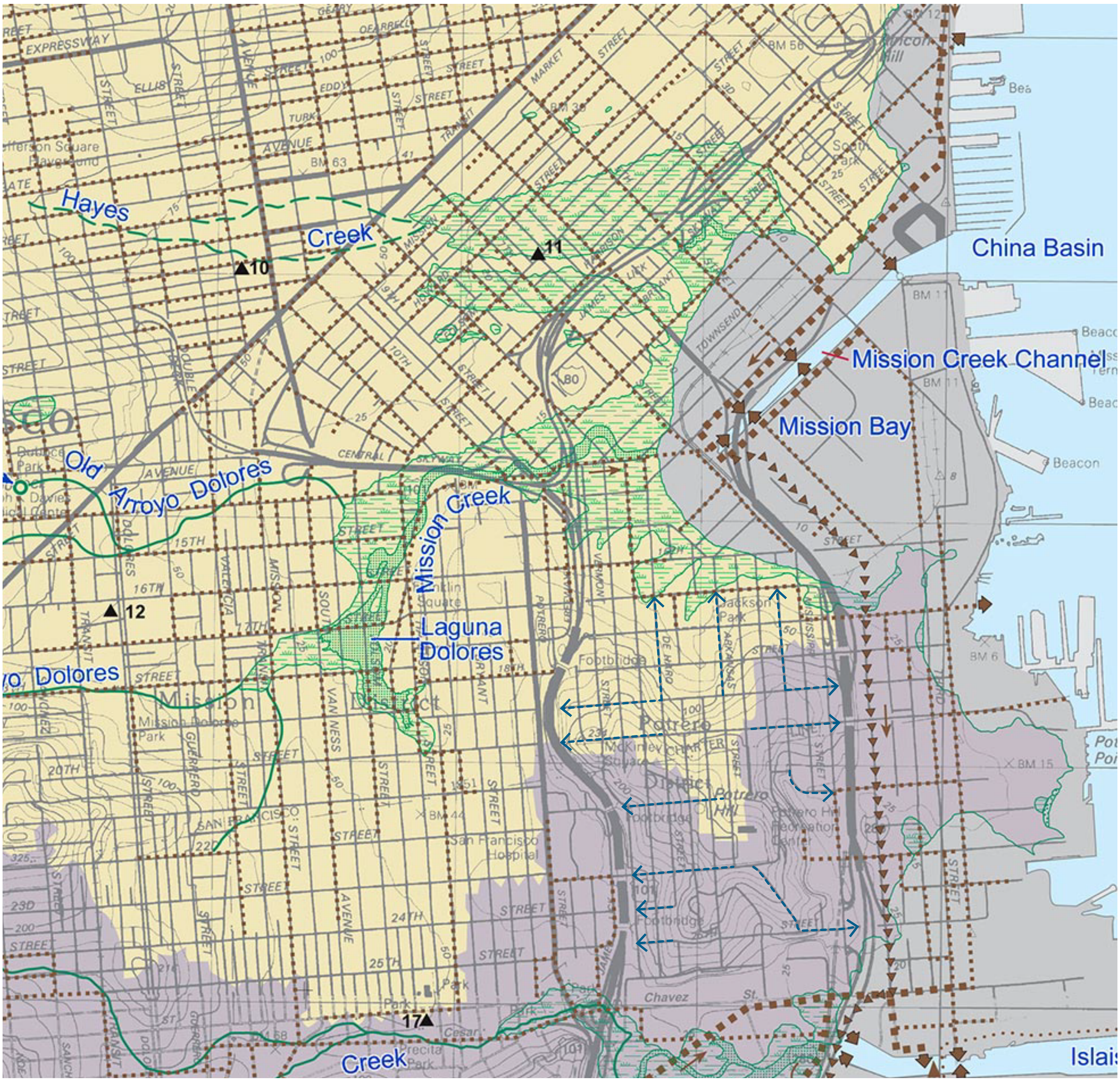


Figure 8.7: Mission creek watershed and artificial discharge, Source: (http://explore.museumca.org/creeks/1640-ResMission.html#, accessed 18-01-16)

8.4 Relation to highway

From a mobility perspective, the (in-)direct connections with the mobility infrastructure prototypes are assessed when distinguishing the different urban typologies. Data from chapter 7 is used.

8.5 Selection of San Francisco typologies

The previous research on the urban fabric resulted in five different typologies: the Downtown typology, Commercial typology, Mixed-use typology, Residential typology and Industrial typology. The typologies are visually represented by tiles

	DOWNTOWN TYPOLOGY	COMMERCIAL TYPOLOGY	MIXED-USE TYPOLOGY	RESIDENTIAL TYPOLOGY	FORMER INDUSTRIAL TYPOLOGY
NEIGHBORHOOD	South of Market	Design district	Mission Bay	Mission district	Dogpatch
PROTOTYPE	Flyover prototype	Flyover prototype	Flyover prototype	Gutter prototype	Staged prototype
DENSITY AND SPACE	FSI: 1,53 GSI: 0,47 OSR: 0,34 L: 3,23	FSI: 1,77 GSI: 0,39 OSR: 0,38 L: 2,56	FSI: 3,73 GSI: 0,25 OSR: 0,44 L: 10,8	FSI: 1,20 GSI: 0,35 OSR: 0,94 L: 3,01	FSI: 1,65 GSI: 0,43 OSR: 0,62 L: 3,56
FUNCTION	Downtown retail, regional commercial, residential, mixed use-residential	Commercial design, urban mixed use	Mixed-use residential, high density residential, knowledge industry.	Low density residential, medium density residental	Urban mixed-use, Mixed-use residential, former heavy industry
HISTORIC SETTING	Gold rush, building age <1939	Gold rush, building age < 2000	World war II, building age 2000 >	Earthquake reconstruction, building age <1939	World war II, building age <2000
SUBSURFACE	Artificial fill and sand	Artificial fill	Artificial fill	Alluvium deposits and bedrock	Artificial fill and bedrock
POSITION IN Water course	Midstream, located at underground creek. High risk of inundation caused by rainfall and floods.	Downstream, lowest point. High risk of inundation caused by rainfall.	Downstream, lowest point. High risk of inundation caused by rainfall and floods.	Upstream, highest point. High risk of inundation caused by rainfall.	Downstream, lowest point. Medium risk of inundation caused by rainfall and floods.

Figure 8.8: Locations of urban typologies, Source: (Author, 2018)

URBAN TYPOLOGY 1: DOWNTOWN TYPOLOGY

Figure 8.9: Setting of Downtown typology, Source: (Google maps, accessed 2018-01-16)

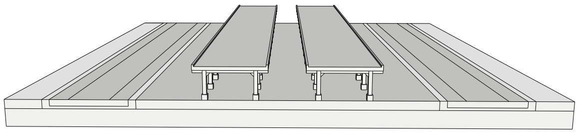


Figure 8.10: Flyover mobility prototype, Source: (Author, 2018)

The Downtown typology location is bounded by Market Street to the Northwest, Financial District to the northeast, the I-80 California Interstate highway to the southeast and the US-101 highway to the southwest. The base of the old Yerba Buena settlement was located here, making it one of the eldest parts of the city. (Scott, 1985, p. 24)

Because of its roads connecting to Market Street, high traffic pressure is coming from perpendicular direction. Moreover, because of the continuing streets, the livability is a stake. Fortunately, the City acknowledged this problem in 2006, making it eligible for extra funding in order to make the streets more livable (San Francisco Planning Department, 2016, pp. 50-52). Besides apartments, the neighborhood consists of technology companies, warehouses and auto repair shops, making some places very anonymous.

The Downtown typology in particular is one influenced by many counter cultures throughout history. During the waterfront redevelopment of the Embarcadero highway in the 1950's the gay community was relocated to this area. Causing various sex clubs and bars to settle here, making it the sexual center of San Francisco. This community had been actively resisting the city's redevelopment plans for the area throughout the 1970's. However, as the AIDS epidemic spread in the 1980's, the power of this community to stand up to the City Hall was dramatically weakened. (Brook, Carlsson, & Peters, 1998, p. 261)

Beginning in the 1990's, older housing stock has been joined by loft-style apartments. Many of these were live-work space, in an attempt to maintain ther arts community in San Francisco. However, during the late 1990's - as the dot-com boom progressed - live-work apartment lofts where often occupied by employees from the tech-business. Because South of Market became a local center of the dot-com boom space for housing development, where readily converted into offices. (Centner, 2008)

Figure 8.11: Impression of Downtown typology, Source: (Author, 2018)

Figure 8.13: Impression of Downtown typology, Source: (Author, 2018)

Figure 8.12: Impression of Downtown typology, Source: (Google maps, accessed 18-01-16)

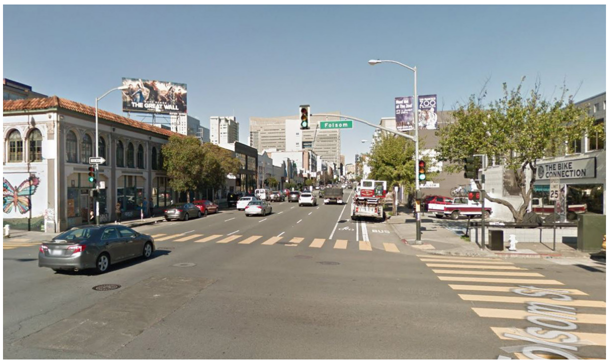
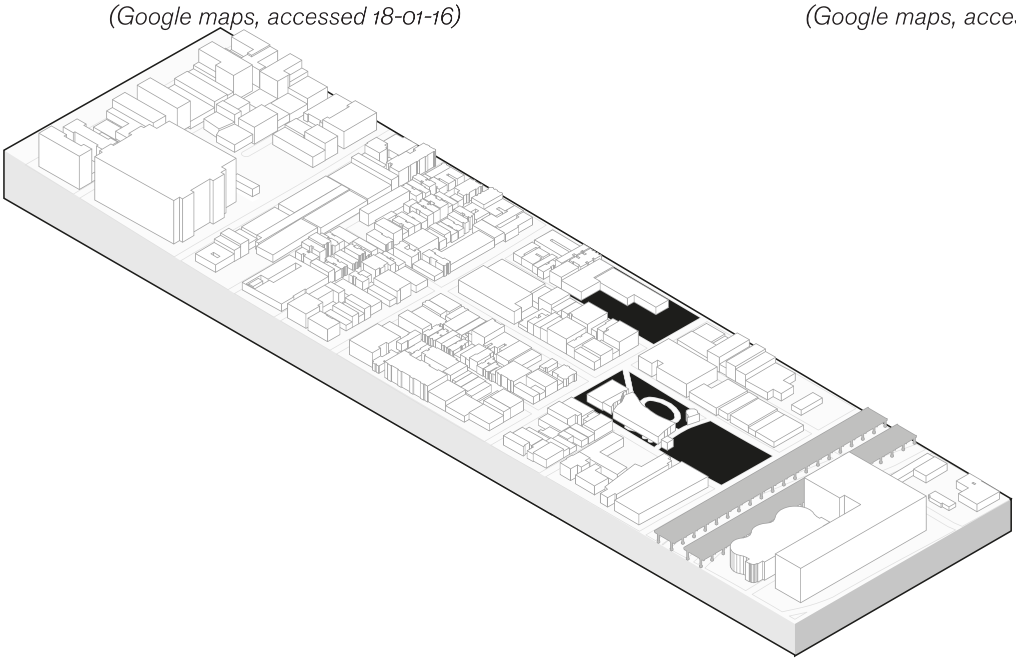


Figure 8.14: Impression of Downtown typology, Source: (Google maps, accessed 18-01-16)



URBAN TYPOLOGY 2: COMMERCIAL TYPOLOGY

Figure 8.15: Setting of Commercial typology, Source: (Google maps, accessed 2018-01-16)

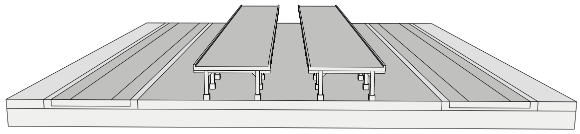


Figure 8.16: Flyover mobility prototype, Source: (Author, 2018)

The Commercial typology is located in a car dominated area directly below the U.S. Route-101 and the I-80 California Interstate junction. It is a mixed industrial-office-retail area, with a high concentration of commercial showrooms, as well as the campus of the California College of the Arts. This combination of functions, makes the Design district rather anonymous in certain areas past office hours.

However, an influx of new residential housing and tech businesses over the past year has livened up this neighborhood considerably, and shopkeepers and restaurant owners have taken notice by expanding hours beyond weekdays. (Centner, 2008)

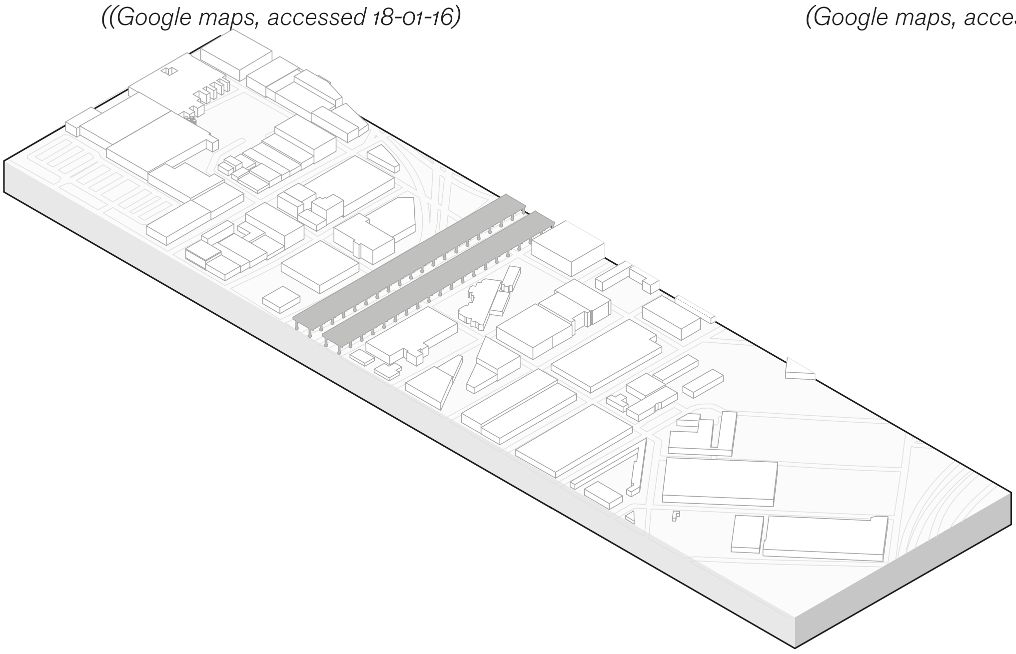
The low-lying Commercial typology is located in the artificially filled Mission creek - a natural valley - making this area very susceptible for inundation caused by rainfall in a major storm event (Sloan, 2006, p. 116). Moreover, runoff from the heavily paved parking spaces under the highway junction, causes heavily polluted runoff water to put the sewer systems under extreme stress, during storm events.

Figure 8.17: Impression of Commercial typology, Source: (Google maps, accessed 18-01-16)

Figure 8.19: Impression of Commercial typology, Source: (Google maps, accessed 18-01-16)

Figure 8.18: Impression of Commercial typology, Source: ((Google maps, accessed 18-01-16)

Figure 8.20: Impression of Commercial typology, Source: (Google maps, accessed 18-01-16)



URBAN TYPOLOGY 3: MIXED-USE TYPOLOGY

Figure 8.21: Setting of Downtown typology, Source: (Google maps, accessed 2018-01-16)

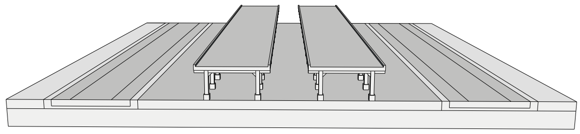


Figure 8.22: Flyover mobility prototype, Source: (Author, 2018)

Mission Bay is a neighborhood located on the east side of the city, on the edge of Downtown San Francisco and adjacent to the bay water. Mission Bay is limited by the neighborhoods around China Basin to the north and the area limited by the Bay water in the east, the I-280 Interstate highway to the west and Dogpatch to the south.

Before urbanization, Mission Bay was located in a marsh and a dynamic lagoon with tidal waters (Sloan, 2006, pp. 111-117). Starting from the Gold rush until the late 1870's, shipbuilding and repair were the main industries, while the waters continued to yield a healthy supply of oysters and clams. Causing butchers to settle their slaughterhouses around the Mission Creek marshes aside the industrial zones. (San Francisco Bay Area Planning and Urban Research Association, 2016, pp. 5-15)

Mission Bay was used as a convenient place to deposit rubble from building projects and debris from the 1906 earthquake. As the marsh quickly stabilized with the weight of the fill, the area quickly became an industrial district (Sloan, 2006). And with the addition of the railroads, Mission Bay became the home to shipyards, canneries, a sugar refinery and various warehouses. (San Francisco Bay Area Planning and Urban Research Association, 2016, pp. 5-15)

In the late 1990's, a master plan to revive Mission Bay into a new living environment was developed by the city. This plan was known as the Mission Bay Project and is the largest urban development plan initiated by San Francisco since the construction of Golden Gate Park in the late 1800's. Fuelled by the construction of the UCSF Mission Bay campus, the area continues to attract new residents and industry, making Mission Bay an up and coming neighborhood with luxurious apartments. (San Francisco Bay Area Planning and Urban Research Association, 2016, pp. 5-15)

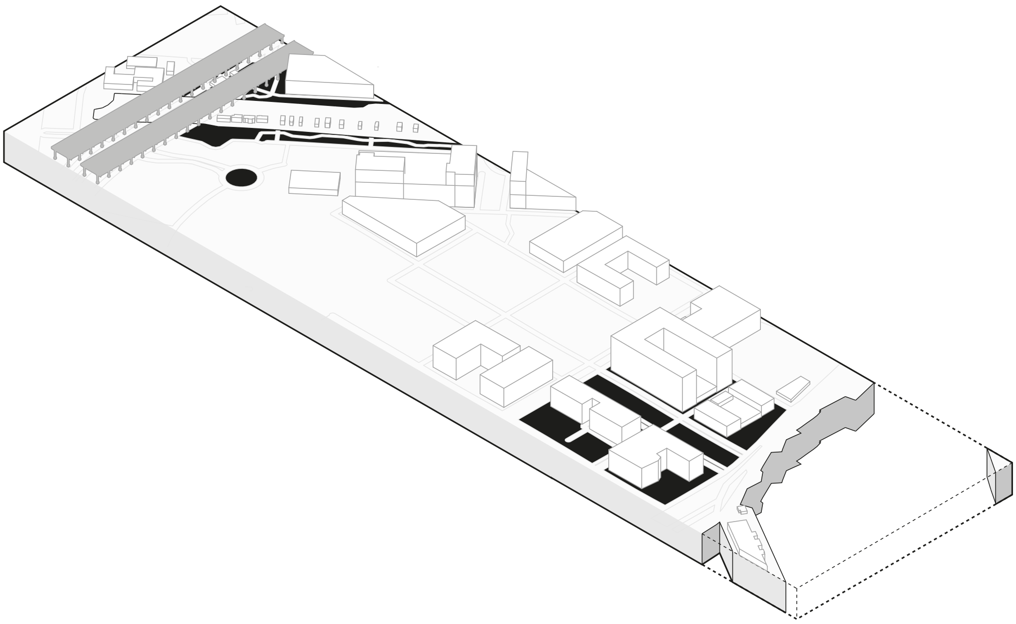
However, even as the current development might seem a step in the right direction, coastal development is still under heavy pressure of industry and offices. Causing the coast to be inaccessible because of the ship industry and because of parking facilities. And moreover, new development is done without acknowledgement of climate change.

Figure 8.23: Impression of Mixed-use typology, Source: (Author, 2018)

Figure 8.25: Impression of Mixed-use typology, Source: (Author, 2018)

Figure 8.24: Impression of Mixed-use typology, Source: (Author, 2018)

Figure 8.26: Impression of Mixed-use typology, Source: (Author, 2018)



URBAN TYPOLOGY 4: RESIDENTIAL TYPOLOGY

Figure 8.27: Setting of Residential typology, Source: (Google maps, accessed 2018-01-16)

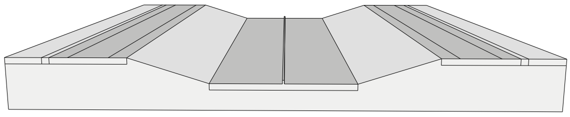


Figure 8.28: Gutter mobility prototype, Source: (Author, 2018)

The typology that is primarily characterized by residential functions, is located in the hills of east San Francisco and is formed by the neighborhoods Mission District to the left of the U.S. Route 101 and Potrero Hill right from the U.S. Route 101.

In the decades after the Gold Rush, the city of San Francisco quickly expanded, and the Mission was developed and subdivided into housing plots for working-class immigrants, largely German, Irish, and Italian, and also for industrial uses. During the 1940-1960's, a large number of Mexican immigrants moved into the area - displaced in order to create the western landing of the Bay Bridge - causing white population to abandon the area, giving the Mission a Latin-American character for what it is known today. During the 1960s, Central American immigration has contributed to a Central American presence that outnumbers Mexicans since the 1960s. (Scott, 1985)

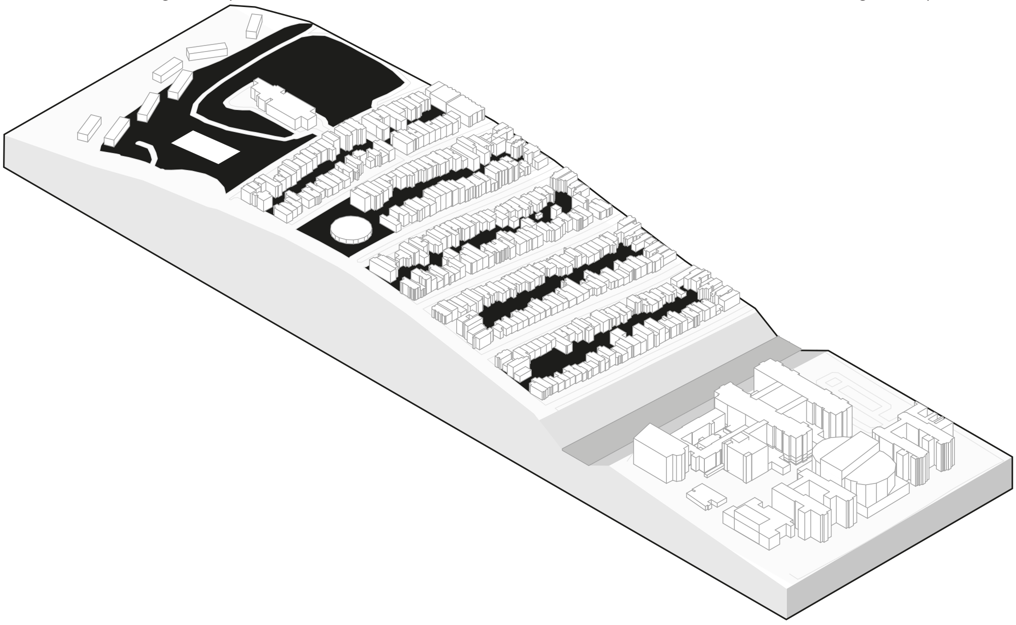
The Mission has a unique micro-climate and can even be warmer and sunnier than other parts of San Francisco. The micro-climates of San Francisco create a system by which each neighborhood can have different weather at any given time, although this phenomenon tends to be less pronounced during the winter months. The Mission's geographical location isolate it from the fog and wind from the west. (Sloan, 2006, p. 116)

Figure 8.29: Impression of Residential typology, Source: (Author, 2018)

Figure 8.31: Impression of Residential typology, Source: (Author, 2018)

Figure 8.30: Impression of Residential typology, Source: (Google maps, accessed 18-01-16)

Figure 8.32: Impression of Residential typology, Source: (Google maps, accessed 18-01-16)



URBAN TYPOLOGY 5: FORMER INDUSTRIAL TYPOLOGY

Figure 8.33: Setting of Former industrial typology, Source: (Google maps, accessed 2018-01-16)

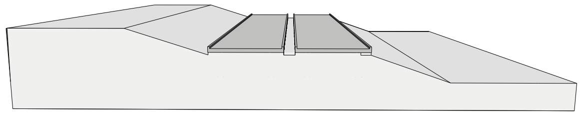


Figure 8.34: Staged mobility prototype, Source: (Author, 2018)

Dogpatch is located on the eastern side of the city, adjacent to the waterfront of the San Francisco Bay, and to the east of Potrero Hill. Its boundaries are Mariposa Street to the north, I-280 to the west, Cesar Chavez to the south, and the waterfront to the east. It contains housing, some remaining heavy industry, more recent light industry, and a new but growing arts district.[1]

Because it survived the 1906 earthquake and fire relatively unharmed - and because it had not been redeveloped until recently - Dogpatch has some of the oldest houses dating back from the 1860's (Scott, 1985). Between the 1860's and 1880's, the marshes at the edge of the bay were filled, and the area was connected to the main part of the city (Sloan, 2006).

The United States' decision to enter World War II created an industrial boom in Dogpatch, led by the shipyards that constructed navy ships. Dogpatch experienced a significant increase in population (but not housing). In the 1960's, I-280 highway was constructed, under much controversy. To obtain the necessary land for the freeways, some residents were forced to vacate their homes in exchange for significantly below-market price paid by the government. I-280 sliced through Potrero Nuevo, and the area east of the freeway began to form a unique identity (Scott, 1985, pp. 239-249). Dogpatch began to shed its gritty, working-class roots during the dot-com era in the 1990's, when its demographic began to change due to the transformation of Mission Bay into a biotechnology and healthcare hub further gentrified Dogpatch.[2]

1 http://www.nytimes.com/2009/03/29/travel/29surfacing.html, accessed 18-01-23

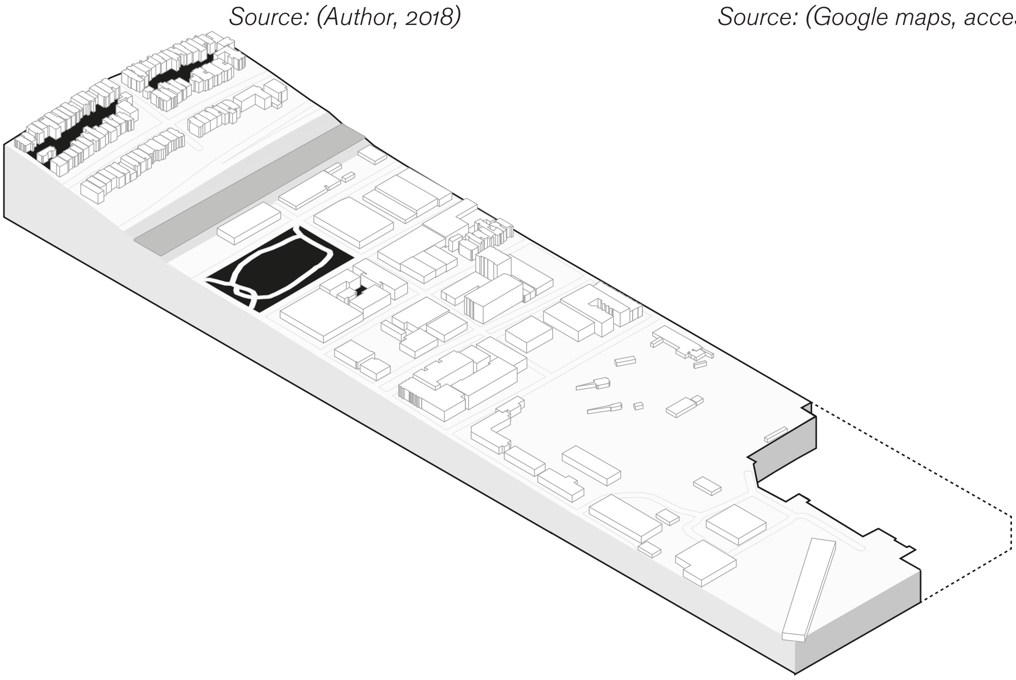
2 http://www.spur.org/publications/urbanist-article/2001-07-01/2000-census-tract, accessed 18-01-23

Figure 8.35: Impression of Former industrial typology, Source: (Google maps, accessed 18-01-16)

Figure 8.37: Impression of Former industrial typology, Source: (Author, 2018)

Figure 8.36: Impression of Former industrial typology, Source: (Author, 2018)

Figure 8.38: Impression of Former industrial typology, Source: (Google maps, accessed 18-01-16)



CHARACTERISTICS

	DOWNTOWN TYPOLOGY	COMMERCIAL TYPOLOGY
CONCEPTS	Downtown residential area.	Predominantly commercial area with luxury housing.
CAR INFRASTRUCTURE	Ongoing traffic because of location between Market Street and I-80. High accessibility, high intensity roads. Parking exclusively on street.	Car infrastructure is extremely dominant. Big car parks and road side parking.
HOUSING (BLOCKS)	Low variety of housing types. Medium density building types, stacked 3-5 units. No family houses and high variety in building years.	Little variety in housing, predominantly middle-high income apartments.
PUBLIC SPACE	Little public space with staying quality. Disconnected green patches. Public space is very monotonous, strengthened by the repetitive grid layout.	No public space or space with considerable staying quality in the street scape.
SUBSURFACE	Surface is almost completely sealed, subsurface is permeable. Some areas are built on landfill. Combined sewer, which overflow is discharged in the Bay.	Surface is almost completely sealed. Subsurface is permeable quaternary muds and quaternary sands.
ENERGY INFRASTRUCTURE / POTENTIAL	Overhead electricity lines. Redefine public space to generate energy.	Overhead electricity lines. Redefine parking space to generate energy.
WATER POTENTIAL	Space for natural cleaning and infiltrating gray water. New discharge system, disconnected from traditional sewer.	Recover car territory in order to clean and retain water.
SOCIO-SPATIAL ISSUES / POTENTIALS	Buffer zone of I-80 is very anonymous. Car is dominating the streets.	Territory dominated by mobility is very anonymous.
UTILITIES	Medium to high services, high accessibility to Market Street.	Low in daily services, dependent on the car. High in luxury services.
DESIGN MOTIVES	Reprogramming road hierarchy for improved living environment. Adding new high-density building types. Addition of (semi-) public space, breaking the grid with more complex structures.	Reprogramming the car dominated territory. Use the development of green-blue projects to build new affordable housing.

MIXED-USE TYPOLOGY	RESIDENTIAL TYPOLOGY	FORMER INDUSTRIAL TYPOLOGY
Currently in redevelopment, high density building.	Low density residential area.	Product of gentrification. Half industrial and half residential.
Clear hierarchy of car infrastructure. High accessibility, car dominance on streets is medium. Street parking is dominant, many big car parks.	Oversized ongoing roads, low intensity. High accessibility.	Clear hierarchy of car infrastructure, low intensity. Variety in parking: new blocks provide inside parking, roadside parking throughout and parking in private garages.
Variety of luxurious housing in high density. No ground bound housing.	Ground-bound houses, mostly family houses with garages and backyards.	Upper middle-class working neighborhood. Mix of traditional ground bound houses and more luxurious apartments.
Streets are wide and spacious, dynamic design of street scape. Relatively many green parks, medium-high in staying quality. Nor private of semi-public space.	Little public space with staying quality. Disconnected green patches.	The new developed area offers a variety in public, semi-public and private green space. The staying quality of the public space is high.
Streets possess a high degree of sealed surface. Subsurface is composed of landfill.	High concentration of sealed surfaces, subsurface is permeable. Private gardens which can be utilized.	Subsurface is composed of quaternary sand stone and mudstone. East of 3rd street is landfill.
Underground electricity lines. A lot of unbuild plots that can be used for the generation of energy.	Overhead electricity lines. High variety in building age, retrofitting of existing buildings necessary. On grid parking on private parking lots.	Overhead electricity lines. On grid parking on private parking lots.
Space for local treatment of water. Connecting green patches, to create green-blue networks.	Space for natural cleaning and infiltrating gray water. New discharge system, disconnected from traditional sewer. Delaying the uphill runoff.	Connecting green surfaces, to create green-blue networks, in order to facilitate a disconnected system.
Low degree of appropriation of space.	Residential area feels very anonymous due to the domination of the car.	The area is very isolated and detached from the water.
Medium daily services, high upper regional services.	Low services, though in the perimeter of the Zuckerburg San Francisco General Hospital. There is no sewer system.	Low in daily services, dependent on car.
Use of green-blue structures to guide new development. Flexible programming.	Reprogramming road hierarchy for improved living environment. Retrofitting old building stock. Actors involvement around topics of sustainability.	Adding more affordable housing.

8.6 Conclusion

This chapter analysed the local urban dynamics that influence the interaction between the urban system and the highway. In order to categorize and simplify local sets of dynamics, a systematic study was done on the different urban typologies that occur in the trajectory of the highways. The urban properties are assessed from the ecological perspective. However, in order to connect these themes to a more technical perspective, the Spacemate is used from a methodological perspective to categorise the different urban systems. From this study, five urban typologies were distinguished and assessed in light of *historic development, functions, build intensity, relation to the highway and properties in water management*. The result was the differentiation of a *Downtown typology, Commercial typology, Mixed-use typology, Residential typology and former-Industrial typology*.

Because the different typologies are set in different local contexts, there are potentially five different scenarios in which future mobility affects the urban system. However, from the perspective of the S2N, there is a misplaced relationship between the flows. Therefore, there is a lack in spatial quality and amenities for healthy living environments. This is caused by water flows that are totally replaced by artificial systems. Overflowing of these systems can cause damage to property and nature, and these sealed systems do not draw any qualities for living environments. Moreover, the mobility system that this sealed system supports, is overdimensioned and too dominant.

CONCEPTUAL BUILDING BLOCKS

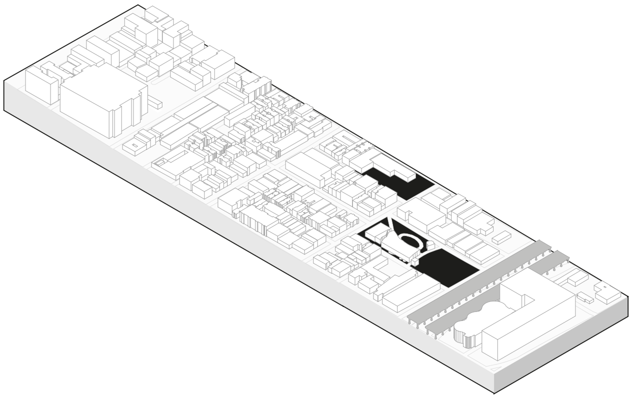


Figure 8.39: Downtown typology, source: (Author, 2018)

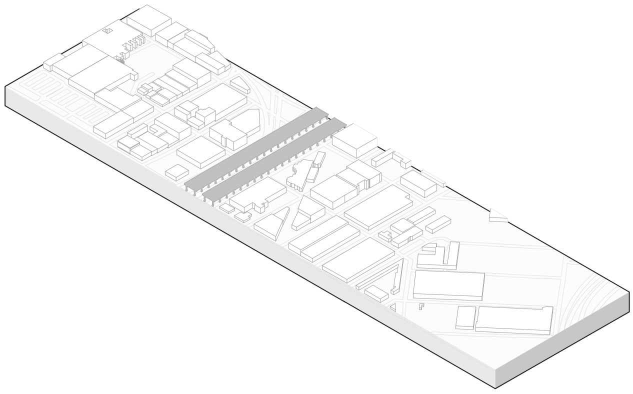


Figure 8.42: Commercial typology, source: (Author, 2018)

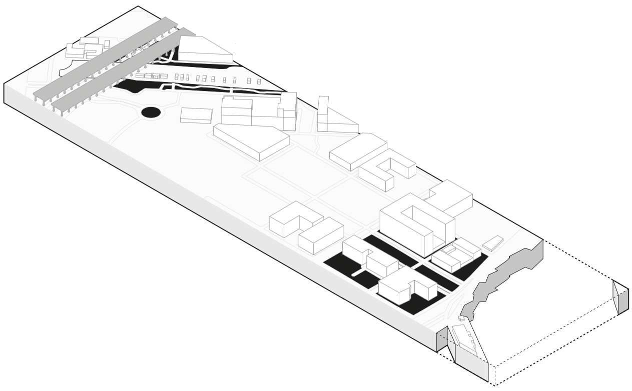


Figure 8.40: Mixed-use typology, source: (Author, 2018)

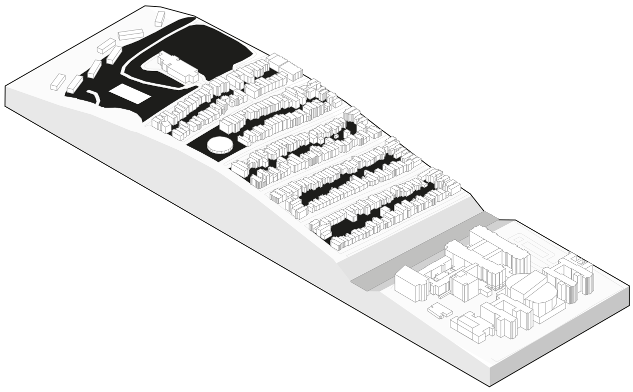


Figure 8.43: Residential typology, source: (Author, 2018)

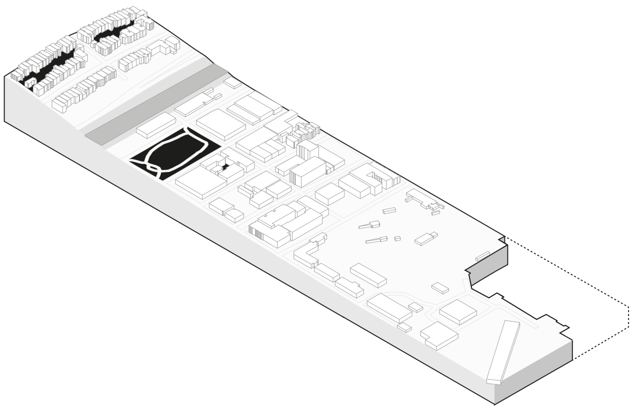


Figure 8.41: Former-industrial typology, source: (Author, 2018)

Part III: Synthesis and design

9 DESIGN INSTRUMENTS

Application and synthesis of the conceptual building blocks, the selection of guiding models and guiding principles are revalued in light of the urban dynamics composed by: *the zoning policy, the hydrological system, the geological and topographical setting, the artificial drainage system and the relation to the highway.* Moreover, reflection through the conceptual building blocks gave insight in the values of the Strategy of the Two Networks (S2N), that remain of importance.

9.1 Revised guiding principles

The original guiding principles are concrete themes for decision making on different scales. These are closely related to the guiding models, however in the original S2N, the guiding principles lack a visual representation. In the following section, the design and concept of the revalued guiding principles are constructed. Each revalued guiding principle possess a new graphic representation of the concept.

Slow-and fast-lane principle | Area perspective

The concept for the slow-and fast-lane principle is still based on the ecological separation of a *slow/clean* oriented zone and a *fast/polluted oriented zone*. Water storage and space for water systems require integration of ecologically sound activities with nature and water management. These are the low-dynamic activities that reinforce each other in the slow-lane. On the other hand, a living environment also benefits from the proximity of commercial functions for daily needs and above regional functions for pleasure, which are located in the fast-lane. In the traditional principle for the slow- and fast-lane, residential functions are located in-between the two zones.

Because of a lack of space for a designated ecological area - it is decided to make a gradual transition between the two areas and to appoint a zoning of slow and fast areas in the existing context. In the revalued principle special adapted living environments are located in both the slow area and the fast area instead, in contrast to the original principle. Chapter 10 elaborates on the possible living environments, developed from this zoning.

In the **slow zone** special living environments focussing on water management and slow mobility, need to secure its functioning from the ecological perspective. Water (flow) management in the slow zone is characterized by local measures, enabling efficient management of water quality because of treatment close to the source. Mobility (flow) management is focussed on restrictions of motorized vehicles and stimulation of slow vehicles. Living environments are focussed on sustainable awareness and unique ecological living environments.

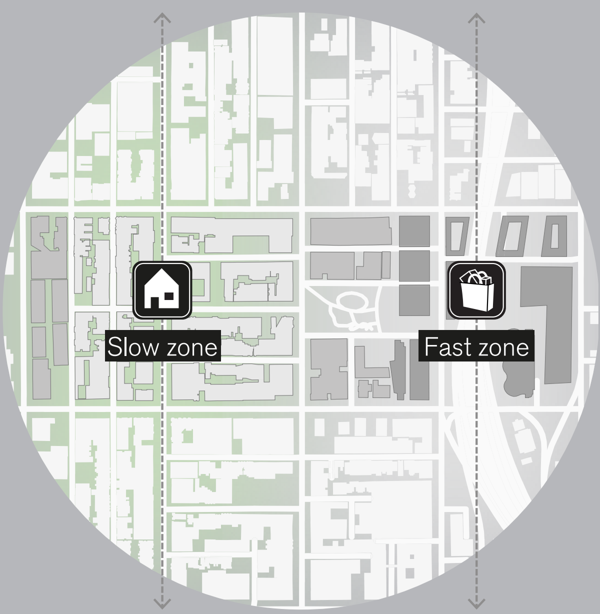


Figure 9.1: Revalued Slow-and fast-lane principle, Source: (Author, 2018)

The **fast zone** is characterized by highly urban living environments, supported by mobility systems and a high offer of services. The fast zone is located in the highway territory, to prevent unwanted traffic in the slow zone for logistical and residential purposes. Automated vehicles from both fast and slow zones are parked here. From the water flow perspective, the fast zone is characterized by centralized and artificial measures, because of potential pollution.

This integration of residential activities in both the fast zone and slow zone is mainly enabled by technical innovations in mobility. Autonomous vehicles will prove to be less polluting and will be more efficient in space. Moreover, this makes a strict separation of the two zones less important. The new space will be responsible for the generation of new operational living environments.

Synergy with areas and actors | Flow perspective
This guiding principle creates conditions for the synergy of activities in the project area, strongly related to the carrying flows. The principle illustrates how the flows flow from clean to polluted - local measures to centralized measured. Focus of the principle is to prevent pollution of the flows caused by the activities of the mobility network. The difference between the synergy with areas and actors principle and the fast- and slow-lane principle, is that this principle elaborates on the qualities of the flows, instead of the areas. The principle ranks the activities from clean to polluting and focusses on the separation of it.

The flows are directed from clean to polluted. In contrast to the original principle, the revalued principle is very much dependant on topography, because of its dominance in flow direction. This means that uphill living environments are associated with clean activities and downhill living environments with polluting activities. From the mobility flow perspective, this principle also links to the present mobility system of the test-case, where the biggest mobility flows bundle in the lowest lying areas.

Upstream is the clean source of runoff, where runoff is being treated at an early stage. These places need to be car-free in order to secure the water quality. Living environments are characterized by activities that do not pollute and take advantage of resident involvement.

De middle zone is the transition zone, local treatment of water is not the main focus, however separation of polluted sources is important. This is the zone were sports fields can be located, and thus bigger surfaces, local involvement is not necessary.

The polluted zone, where mobility flow is the main carrier. This area is where mobility flows are bundled and where commercial activities, logistics and parking services take place. The focus of this area is to separate the flows, and focus the mobility flows locally so that mobility flows do not pollute the upstream living environments.

Figure 9.2: Revalued Synergy with areas and actors principle, Source: (Author, 2018)

The making visible principle | Actor perspective

The making visible principle encourages visible flow management and involvement of natural processes in the urban landscape. It is intended to make use of visible pilot projects, in order to create awareness and involvement of actors. (Tjallingii & Jonkhof, 2011, p. 43). In the ecological zone, this can be done by utilizing vegetated bioswales and floodable fields. In the dynamic zones, open gutters and fountains using rainwater can be used to raise awareness.

In certain urban environments it can be difficult to involve actors in pilot projects, because they might not feel connected to the public space. Families with playing children are stronger connected to the public space and therefore easier to involve in these projects (van der Wilk, 2016). Especially in urbanised cases - like the Downtown typology for instance - it is key to reconsider the involvement of actors. In the ecological zone, people can own their own rain gardens. In the dynamic zone, where people live in apartments, it is difficult to expect the same involvement. Therefore, centralized and artificial solutions need to be considered there.

9.2 Revised guiding models

The original guiding models are concrete themes for decision making on different scales, they represent hypothetical concepts of the organization of space. When designing a plan, it can be difficult to take the interrelated quality of water flows and mobility flows in account. The revised guiding models need to secure the quality of the flows and at the same time guide the structuring nature of the flows.

Guiding model hydrology

The revalued guiding model for hydrology is a combination of the original infiltration model and the delay model. It seeks to guide the runoff water from roof to the bay water, enabled by technical and spatial measures in order to secure its quality. The urban runoff is delayed

Figure 9.3: Revalued The making visible principle, Source: (Author, 2018)

as much as possible to prevent downhill inundation and is disconnected from the traditional sewer. Rainwater is discharged via open gutters from the local system, to the central system where the water is purified. Given the topography of San Francisco, there is a big potential for discharge of urban runoff through bioswales and open gutters. While, conventional sewer systems use pumps to transport the water, this system can rely on gravity. Moreover, the grid system makes it possible to integrate linear discharge systems as part of the urban system. In addition to the secured discharge through bioswales and open gutters, the model also focuses on infiltration of rainwater in the subsurface. This is possible where sand soils are located. (Tjallingii & Berendsen, 2007, p. 15).

Guiding model mobility

The guiding model for mobility is based on both the ABC-cluster model and the corridor model. The guiding model aims to prevent unnecessary mobility by the clustering of commercial activity and logistics. However, because

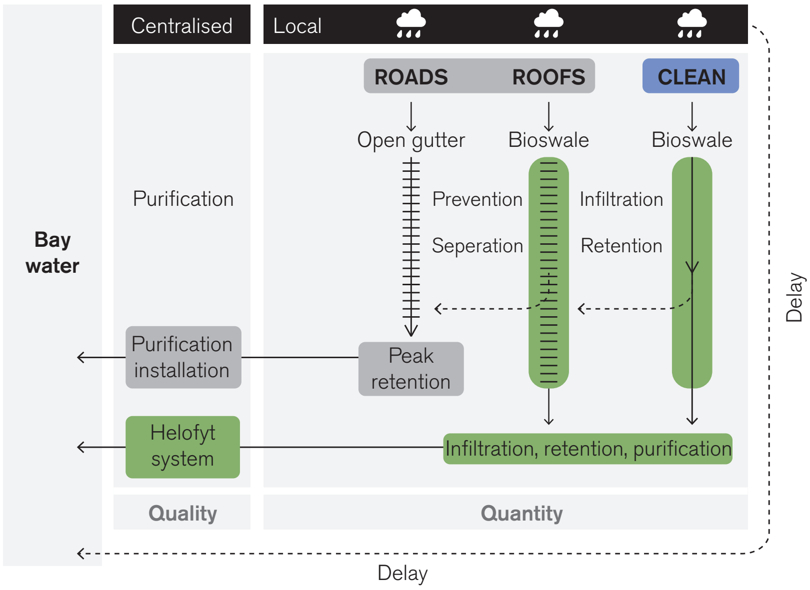


Figure 9.4: Revalued guiding model for hydrology, Source: (Author, 2018)

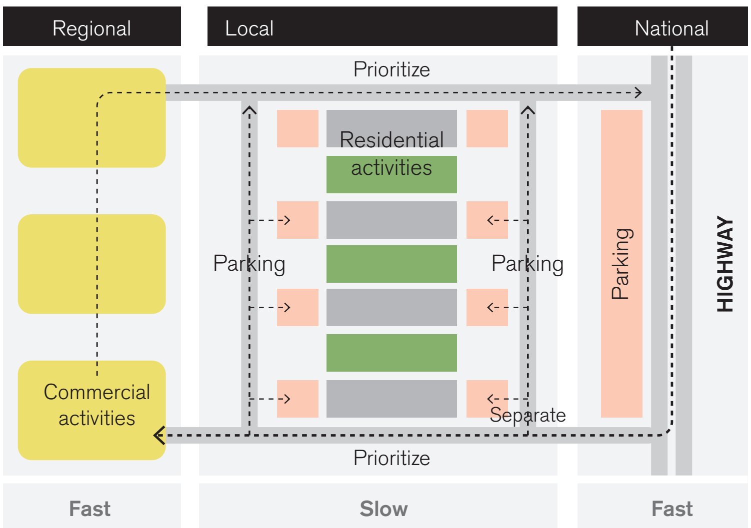


Figure 9.5: Revalued guiding model for mobility, Source: (Author, 2018)

of the potential of future mobility, the corridor model can be revalued because integration of both mobility and hydrology flows will be made possible under influence of the potentials of innovations in the mobility system.

Conclusion
From the process of application of the guiding models and guiding principles on the test-case, it became apparent that the S2N is still useful, yet in need of a revaluation. The S2N is developed in the early 90's and because of contemporary challenges like climate change and technical innovations in mobility, the S2N is not up to date. Evidently, the S2N is not adapted to AV's and does not anticipate on other topographical settings. However, this does not limits the usefulness of the S2N for research and design.

According to the revaluation of the guiding principles and models and by applying the revalued guiding principles and models in design - the value of the original S2N in another context is still embedded in the core principles the original S2N offers.

The value of the S2N lies in the ecological framework of interrelated flows and relation with the actors that it offers. Regardless of whether you change the context or period in time, the relationship remains the same. Even though future mobility reduces the negative effects of mobility (fast) on the water (slow) system. It remains undesirable to link the fast and slow flows, because the areas carried by the flows do not match the actors, nor activities. For example, a high dynamic mobility flow does not contribute to a quiet and green living environment for families, but does better for a high service zone - which can benefit from its connectivity. Moreover, the responsibility that families carry for their living environment is lost in an commercial area.

As a method, the value of the S2N lies in the fact that it offers simplified principles of complex systems - the guiding principles and models - which are the first steps to design. However, additional improvements to the method needs to be made. In order to consolidate the method of the S2N, additional conceptual building blocks need to be constructed, that help to simplify the urban system.

Figure 9.6: Guiding principles and models mapped, Source: (Author, 2018)


Buildings
Green-Blue connection
Mobility priority connection
High intensity development zone
Low intensity development zone
Mobility HUB
Slow lane
living environment
Fast lane
living environment
500 m

10 SYNTHESIS AND DESIGN

Because of the scale and complexity of the project, the design consists of three different plans - which do not necessarily have different scale levels. The plans are best understood as a tree; The main system is the tree trunk, the urban typologies are the branches and the living environments are the leafs. Each has his own operational system in cooperation with the others. By reflecting these plans on the concepts of the revised guiding models and guiding principles. Each intervention in the project is related to themes and perspectives from the Ecological Conditions Strategy (ECS).

From the re-evaluation of the mobility infrastructures, the first design is the new concept for the highway system. This shows the new role of the highway from both the mobility flow perspective as the hydrology flow perspective, and illustrates what kind of actors and activities are related to this. In order to illustrate how the system functions, different critical sections have been made. The second design is on the typological scale, and shows how flows are managed in perspective of future dynamics. The integrated design of these flows result in propositions for new living environments, which internalize the synergy between the flows. The last level of design focusses on the Downtown typology, and elaborates on the operation of the different perspectives of the ECS. Together, the combination of interventions generate a plan that reduces flood risk and at the same create the conditions for sustainable living environments. By making this design, it becomes clear that all interventions are interconnected, through all types of abstractions and levels of elaboration.

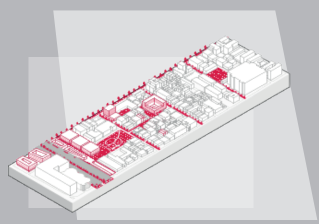
DESIGN INSTRUMENTS

RESTRAINTS FOR DESIGN

SYSTEM

MAIN SYSTEM

URBAN TYPOLOGY



GENERAL DESIGN SOLUTIONS

LIVING ENVIRONMENT

UNIQUE LIVING ENVIRONMENTS

NEW VISION FOR HIGHWAY

- Discharge system
- Mobility system
- Program of highway
- Techniques

TYPOLOGICAL DESIGN

- General applicable design solutions
- Broader range of application
- Part of system

LOCAL DESIGN

- Unique design solutions
- Materialisation
- Techniques
- Elaboration on possible living environment in a typology

Figure 10.1: Rainwater discharge outlet in bay water, Source: (Author, 2018)

Figure 10.2: Car domination, Source: (Author, 2018)

10.1 System concept

The I-101 and I-280 highways are located in the lower parts of Potrero Hill. There are no measures for runoff originating from the uphill areas. Downhill sewer inlets are designed to protect the local neighborhoods from flood risk. However, because of climate change and lack of uphill measures, the I-101 and I-280 highways and downhill neighborhoods have experienced serious flood issues.[1]

The following section is a result of a quest for future interventions, capable of expanding the capacity of the current systems. The new design for the highways envisions to repair the current water system and bringing it closer to its natural functionality. By doing so, the potentials of the future highway are utilized to increase the spatial quality of local neighborhoods.

Conform the design thinking of landscape urbanism (Hooimeijer, et al., 2017b), the plan seeks to reintroduce critical connections with the hidden natural system. This is done by adapting local intervention for water management to the underlying landscape. It enables a more efficient and multifunctional system for water management. The relation between the operation of the system and the spacial quality it borrows to its surrounding, is guided by the slow- and fast-lane principle. On a technical scale, the design is guided by the models for mobility and water.

In order to understand the functionality of this system, different section drawings are made to illustrate how the spaces around the highway can be enabled for improved water flow management and mobility flow management. Moreover, zoomed-in sections are made of critical points, in order to show what techniques are used to operate the system.

Figure 10.3: Setting of the highways in the landscape, Source: (Author, 2018)

1 http://www.sfgate.com/bayarea/article/Highway-101-in-S-F-prone-to-flooding-5017807.php


I-280
Portero Hill
I-101

Discharge system
The main concept of the discharge system is to create sufficient multifunctional room, that guarantees a synergy between the mobility and hydrology flows and by doing so creating quality under and around the highway.

From the water flow perspective, the discharge system is a system that catches the water uphill and seeks to buffer and purify the water as efficiently as possible before reaching the bay water. Essentially, it aims to approach the natural discharge system of San Francisco. However, there are a few points of notion to the system. Certain subsurface soils require protective measures for the infiltration of water. Additionally the local position of the intervention in the water course requires different properties in its ability to *remove pollutants, reduce the runoff volume and reduction of peak flows*.

In its course, the water gets purified and filtered through different technical innovations in the landscape. Buffering and infiltration of precipitation is done in retention basins, that double as public parks with different characters. At the end of the discharge system, the water is - through separation and local purification - clean enough to discharge in the bay water. The design of the concept is performed conform the overflow guiding model. So that the system can overflow and at the same time, secure the water quality by separating the water from polluted sources.

Coastal Protection
In the areas affected by flooding caused by sea level rise and storm surge, measures are taken that also contribute to the discharge system. Along the bay shore, a new coastal project is initiated. That what currently is occupied by parking and obsolete space, is designed as a raised park measuring a maximum of 120 centimeters high. By doing so the relation with the bay water is reinforced. However, in order to mitigate the additional 90 centimeters of storm flood, 3rd street needs to be raised to prevent storm flooding spreading all the way to South of Market. The space in between will be made flood proof and dynamic landscape, providing green parks for recreation and offering green infrastructures for the new and existing buildings to discharge.

Figure 10.4: Concept for water flows, Source: (Author, 2018)


Detention basin
retain
Detention basin/swale
4
retain
Flood proof disconnected plains
Floodable retrofits
Green water square
Buffer park
1
2
retain
retain
retain
Raised infrastructure
Detention basin/swale
Detention basin
retain
Bioretention terrace
delay
Flood proof disconnected plains
Bioretention terrace
3
delay
retain
500 m

Mobility system

Whilst the functionality of the water system depends on separation of clean and polluted sources. The new relation between the system of mobility and hydrology is not necessarily dependant on separation of the main network of flows. Moreover, a smart selection and location of key programs within the re-evaluation of the highway is the key for a sustainable synergy between flows. Therefore, the water and mobility flows can operate side-by-side.

The new concept for the mobility system does not change in the way it supports the mobility flows. The routes of the highway do not change, and most interventions are done from the conclusions of chapter 7. Potentials to retrofit the highway proved to be the *utilization of the space above and under the mobility infrastructures, improvements to the construction and materialization of the mobility infrastructure* and lastly *matching the right programs to the agenda of the prototype* (which is dependant of the urban typology).

Qualities and amenities

Since the design is done from the perspective of the Strategy of the Two Networks (S2N). The combination of the water flows and the mobility flows need to result in unique living environments. The technical innovations enabling the management of the water flows, provide the amenities for new development. However, future mobility creates the conditions for new development, by enabling smart parking and connections with the new forms of residential building. Subsequently, the next drawing illustrates the key interventions executed on the highway.

The following part of this section takes the flows of water and mobility and illustrates in different critical sections, what kind of living environments can result from design. Moreover, the second - zoomed in - sections shows how the interventions in the mobility prototypes can facilitate the water flows.

Figure 10.5: Concept for mobility flows, Source: (Author, 2018)


Direct connect new buildings
Building under the highway
Only elevated and floodproof roads
Building under the highway
Direct connect new buildings
Raised infrastructure
Only elevated and floodproof roads
Building on top of highway
Direct connect new buildings
1
2
3
4
500 m

Section 1: Reclaiming no-man' s land

The first result of the re-evaluation of the highway, is a redesign of the no-man's land under the U.S. Route 101 highway junction. Subtraction of the parking spaces in this area result in new place for urban development . Since this area is located in the lowest point in the water course, this is where all the flows come together. From a water flow perspective, the network of bioswales join here and discharge the runoff in to the bioswales and retention park. This offers the opportunity for a new building ensemble amidst a green dynamic landscape. Which from time to time overflows in storm events. Although this is a place where water is buffered, infiltration in the subsoil is to be prevented. In filtration crates that allow vegetation to grow are utilized to buffer the water.

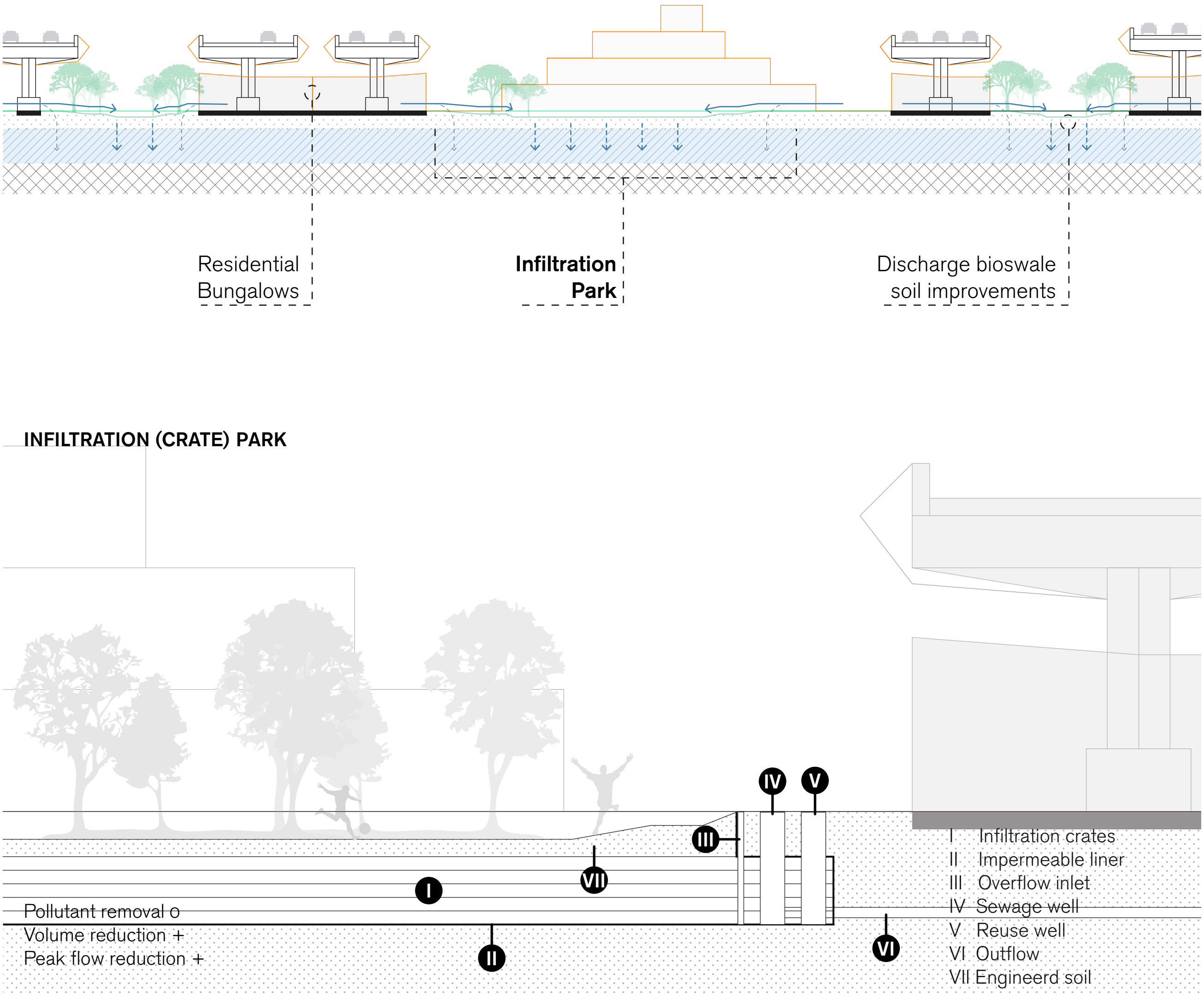
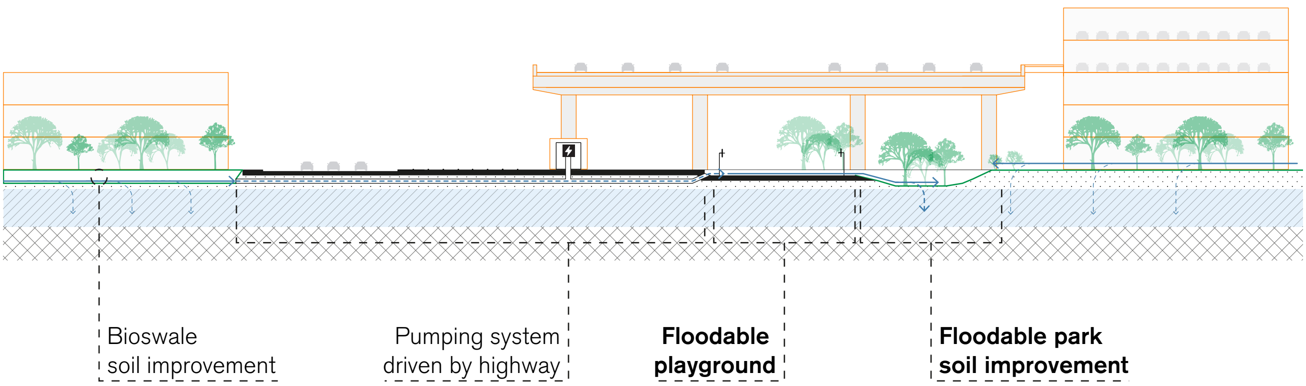


Figure 10.6 a+b: Urban sections in no-man's land, Source: (Author, 2018)

Section 2: Crossing tracks

One of the most critical locations in the discharge system, is the area under the I-280 highway at the height of Mission Bay. Here, the water has to cross the tracks safely. Therefore, the water is pumped through pipes from detention basins west of the tracks to the main discharge systems on the east. Since the ground is polluted and located in the lower lying area of the water course. It is chosen to aim entirely on its capacity to discharge the water in the Bay. Moreover, in order to relate activities that guarantee the protected status of the discharge system. The space under the highway is focussed on flexible and non-polluting activities like living and exercising. The design of the new crossing makes this area more pleasant to pass through by bike or by foot.



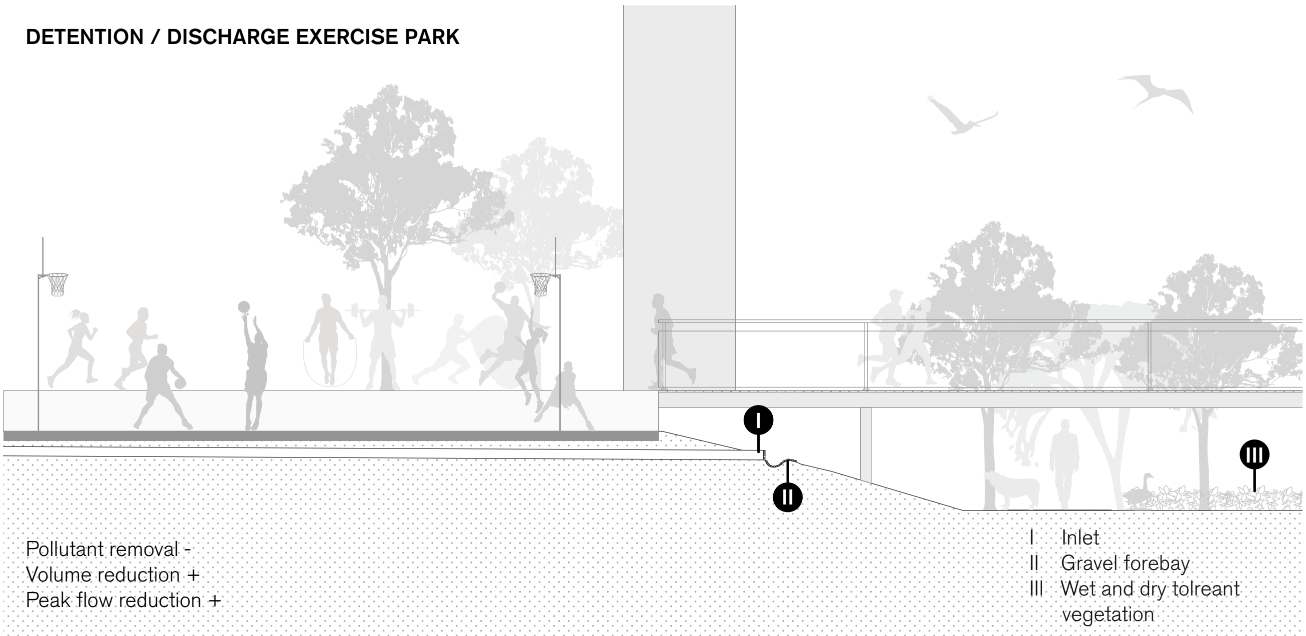
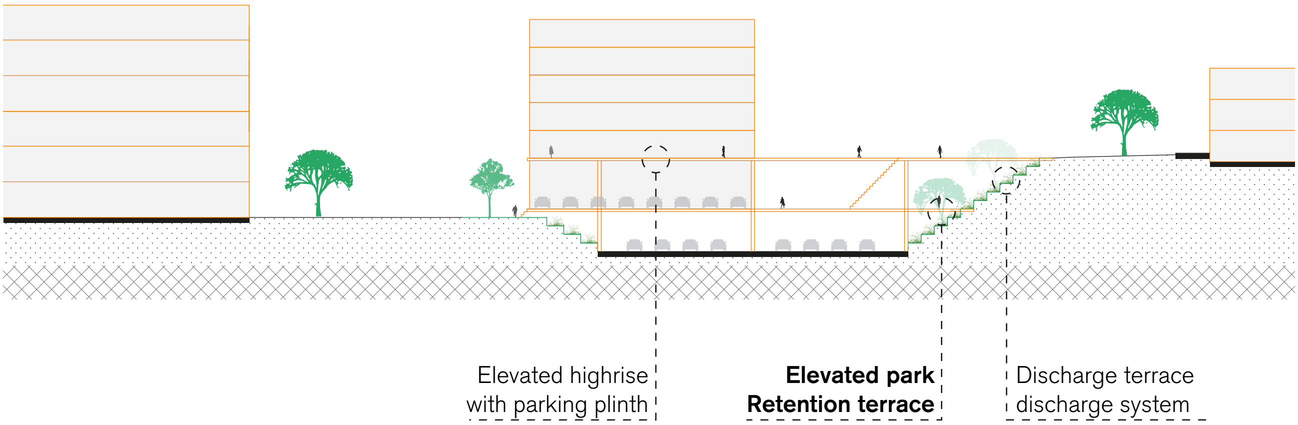


Figure 10.7 a+b: Urban sections at train crossing, Source: (Author, 2018)

Section 3: New program above highway

As electric vehicles emit less noise and air pollution, new living environments can be created on top of the highways. The image below, shows how a new form of living can erect above the highway, allowing people to enter their houses immediately from their cars. The construction utilizes the height differences of the gutter highway in order to create a multiple level park, which connects both sides of the highway. Moreover, it borrows its qualities from the vegetation growing on top of the bioretention terrace. The bioretention terrace relies on vegetation and native or engineered soils to buffer, infiltrate, transpire, and remove pollutants from runoff, reducing peak flow and improving storm water quality. Because the bedrock does not allow sufficient infiltration, this technique relies less on reducing storm water volume.



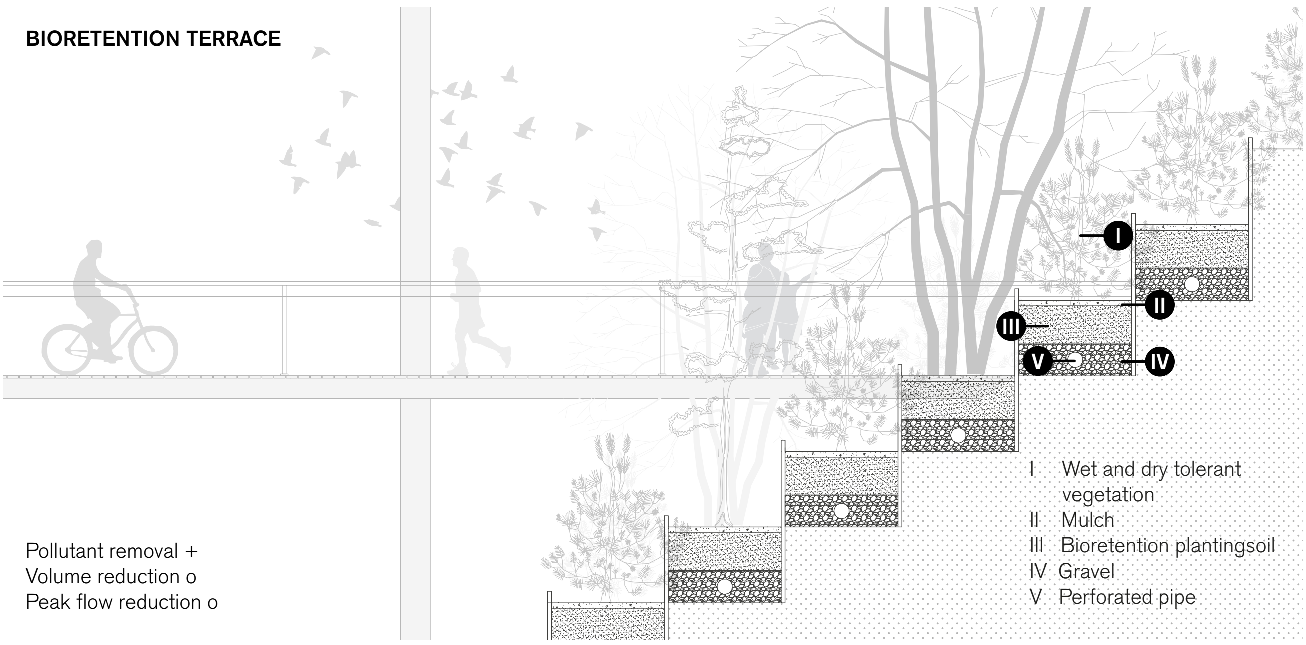
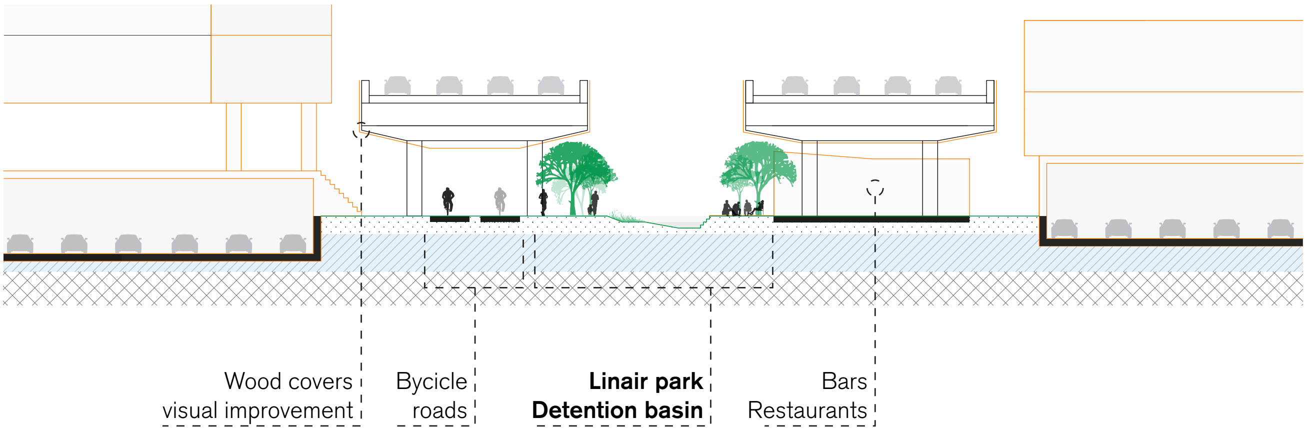


Figure 10.8 a+b: Urban sections gutter highway, Source: (Author, 2018)

Section 4: New program under highway

In the downtown area, the redevelopment of the highway results in new commercial activity under the highway. Bars and restaurants can settle on this unique place. The linear discharge system can be used as a backyard where customers can enjoy their food and beverages. In order to secure the quality of the runoff water, commercial activity needs to be kept on a moderate level.



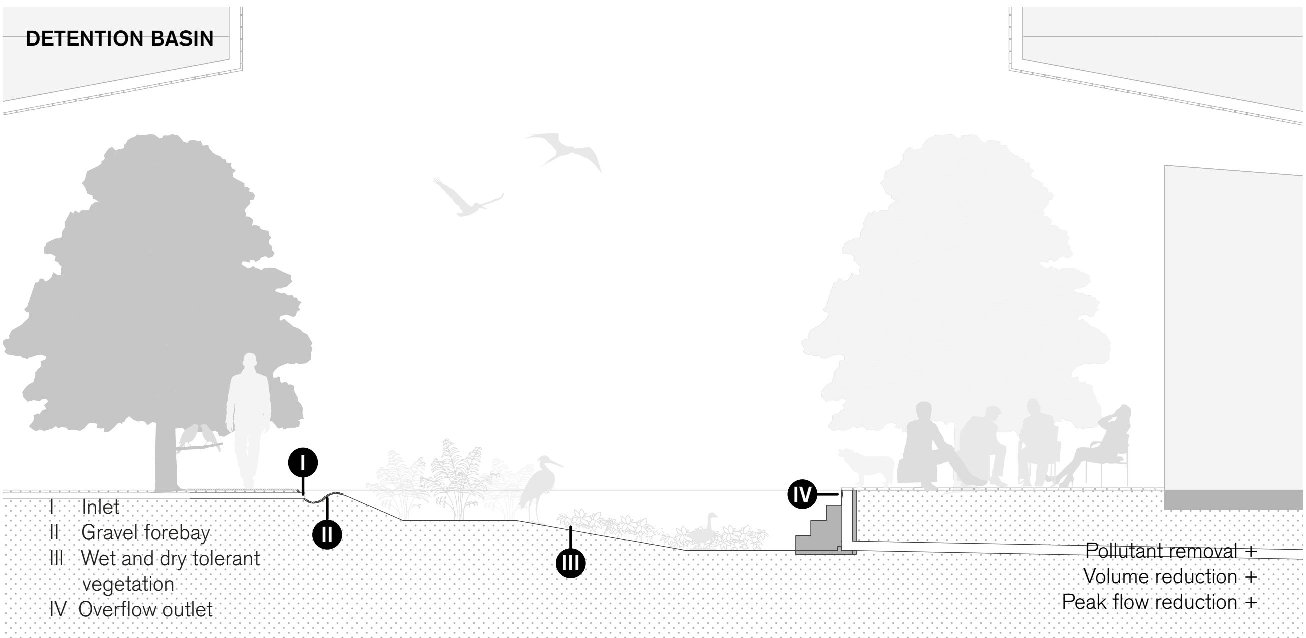


Figure 10.9 a+b: Urban sections flyover highway, Source: (Author, 2018)

10.2 Typological design

In the previous section of this chapter, the design of the overall system was illustrated. This showed how the bigger system works from a flow perspective and by showing the details of the system, a first suggestion was made about possible new program near the highway. The next section of the report however, is focussing on the socio-spatial samples that links to this system and focusses more on the unique living environments that derive from it.

Firstly, an inventarisation scheme of the urban typologies, the mobility infrastructure prototypes and revised guiding principles and models is made. This inventarisation scheme act as a scheme of graphic guidelines for the design, making it easier to maintain focus through the scales. With the inspiration drawn from the conceptual building blocks, concepts of the design interventions on the scale level of urban typologies can be made for each urban typology. Thereafter, each urban typology is highlighted individually and a typical living environment originating from this typology is illustrated.

New urban typologies

When combining the information gained from the conceptual building blocks; the guiding principles and models, mobility infrastructure prototypes and urban typologies. Enough inspiration can be drawn in order to make conceptual designs for all the different urban typologies, in perspective of future dynamics.

The urban typologies are representative samples, the purpose is that the new urban typologies illustrate design solutions that belong to areas associated to this typology. The urban typologies mutually relate differently to topics of mobility and socio-spatial issues. Subsequently, the next section illustrates the integrated design for each typology. From the perspectives of ECS the typical concepts of hydrology, mobility, food and energy and redevelopment of the highway is illustrated.

New living environments

This section also explores what kind of living environments can derive from the assemblage of local functions, urban density, relation to mobility infrastructures and properties in water management, from the perspective of future dynamics. As a result of this, collages of living environments are intended to show the qualities that can derive form the synergy of flows. Moreover, the collages show what kind of urban setting can result and are intended to show what program can exist. The page on the right shows the locations of the different living environments and the urban typologies.

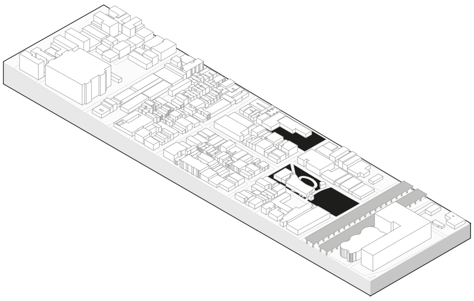
Figure 10.10: Location of urban typologies and living environments, Source: (Author, 2018)

I DOWNTOWN TYPOLOGY
GREEN COURT A
C FLOOD-BLOCK
III MIXED-USE TYPOLOGY
ECO-VILLAGE B
II COMMERCIAL TYPOLOGY
V FORMER INDUSTRIAL TYPOLOGY
IV RESIDENTIAL TYPOLOGY
E MOBILITY HUB
D NEIGHBORHOOD
Typology
Living environment
500 m

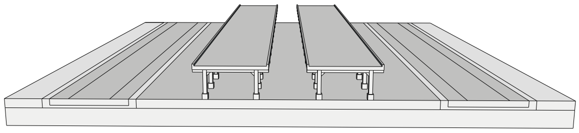
OVERVIEW OF CONCEPTUAL BUILDING BLOCKS

URBAN TYPOLOGY | **MOBILITY PROTOTYPE**

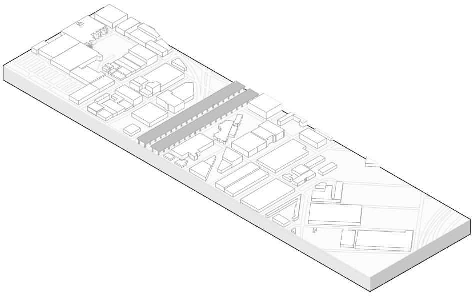
DOWNTOWN TYPOLOGY



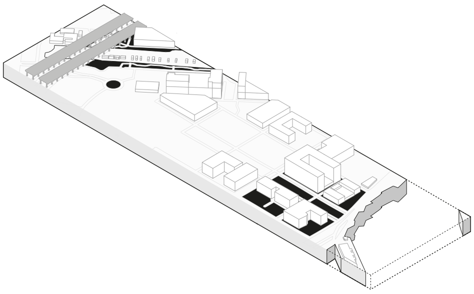
FLYOVER HIGHWAY



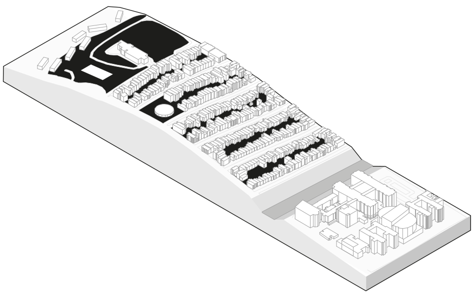
COMMERCIAL YPOLOGY



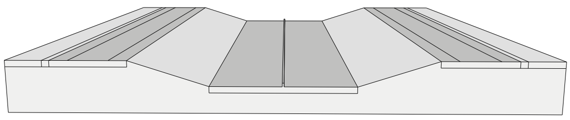
MIXED-USE TYPOLOGY



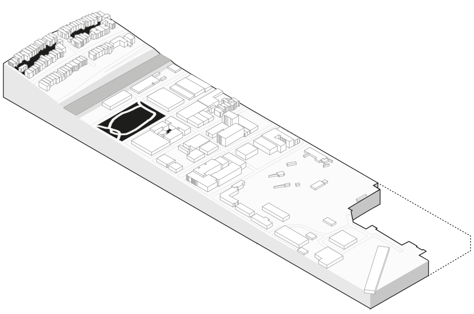
RESIDENTIAL TYPOLOGY



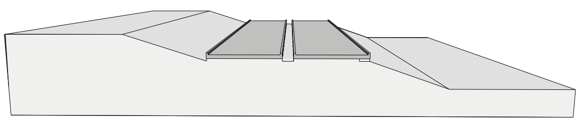
GUTTER HIGHWAY



FORMER INDUSTRIAL TYPOLGY



STAGED HIGHWAY

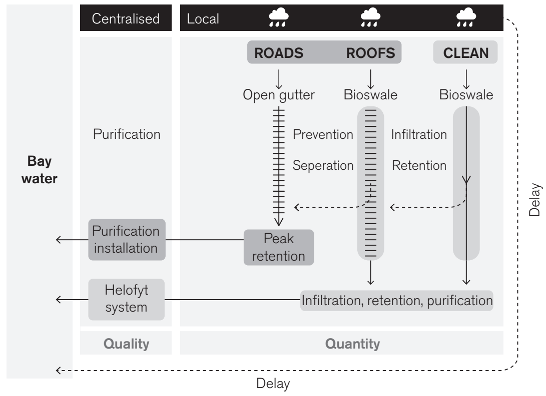


REVISED GUIDING PRINCIPLE

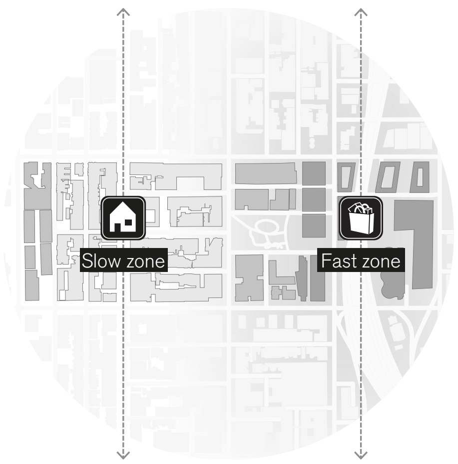
REVISED GUIDING MODEL

ACTOR PERSPECTIVE

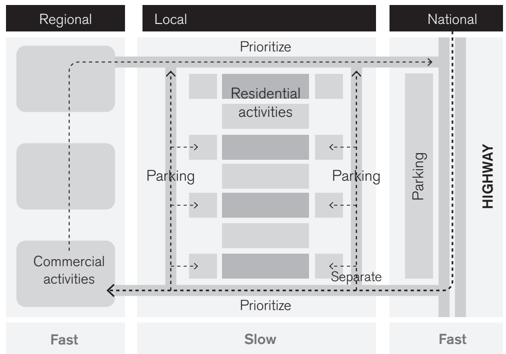
WATER FLOW



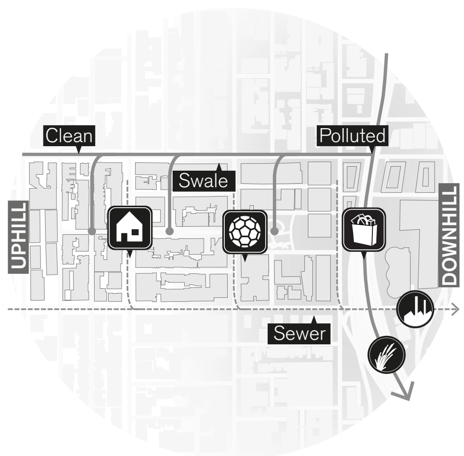
AREA PERSPECTIVE



TRAFFIC FLOW



FLOW PERSPECTIVE

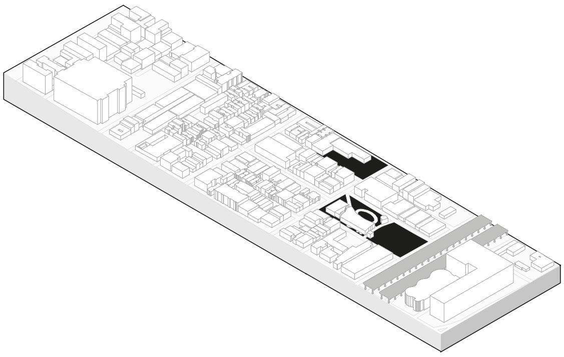


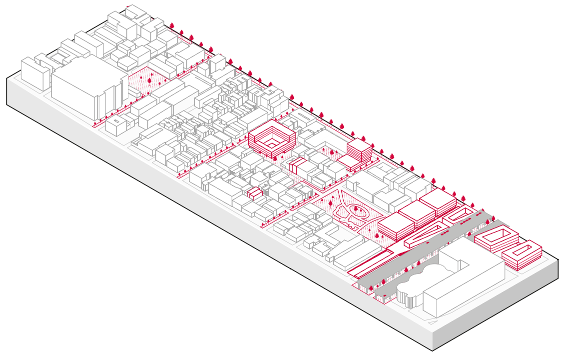
COMPARISATION

EXISTING SITUATION

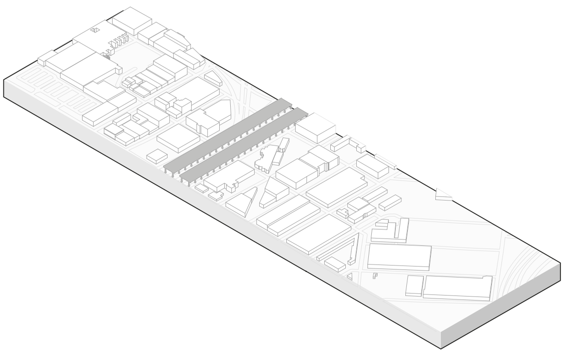
FUTURE SITUATION

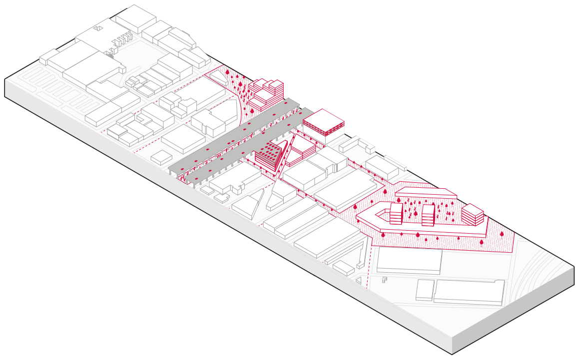
DOWNTOWN TYPOLOGY



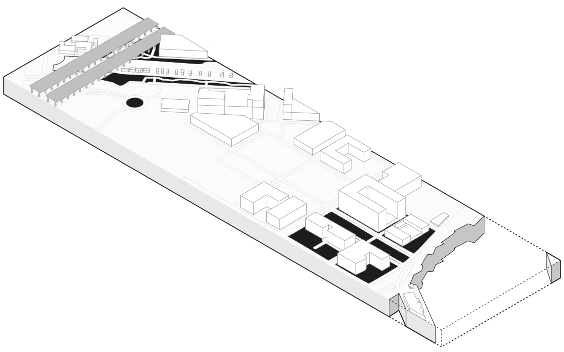


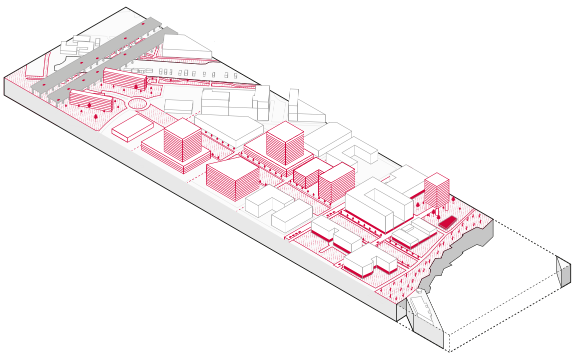
COMMERCIAL YPOLOGY





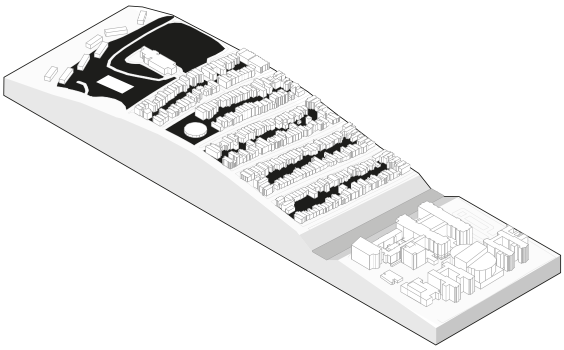
MIXED-USE TYPOLOGY

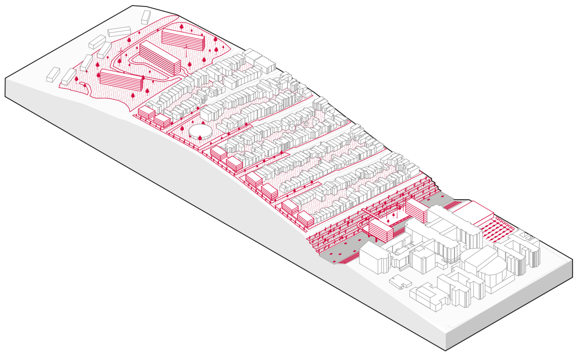




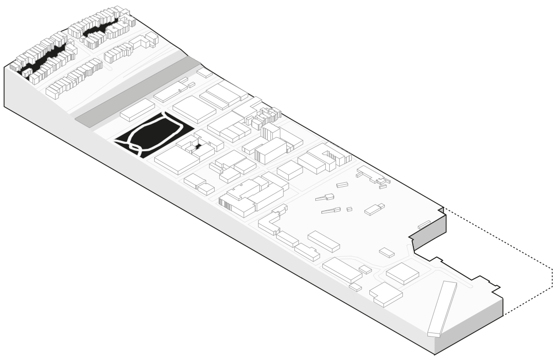
EXISTING SITUATION | FUTURE SITUATION

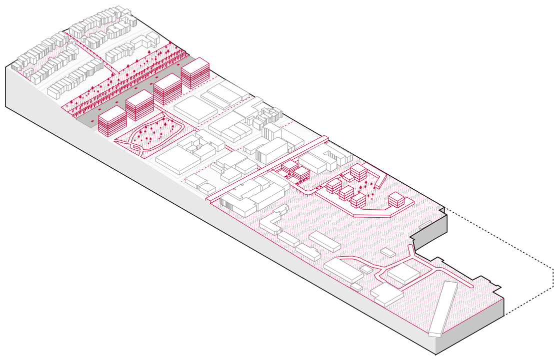
RESIDENTIAL TYPOLOGY





FORMER INDUSTRIAL TYPOLOGY

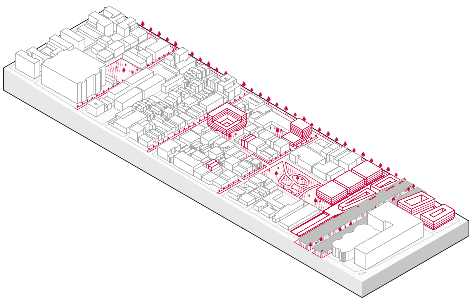




CONCEPTS OF NEW TYPOLOGIES

URBAN TYPOLOGY | HYDROLOGY | MOBILITY

DOWNTOWN TYPOLOGY



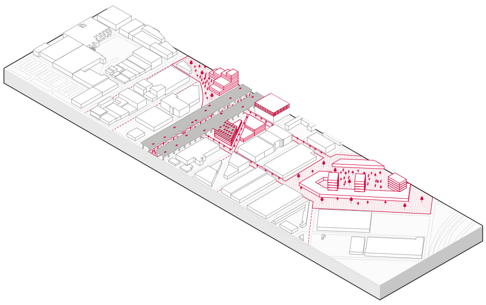
Hydrology

- New network of bioswales
- Local treatment of runoff in residential area
- Small scale, private interventions in building guidelines
- Allowing infiltration where sand-soil is located
- Preventing infiltration where artificial fill is located

Mobility

- Integration of highway in new building block
- Closing streets in the slow lane
- Extraction of on-street parking
- Parking concentrated in fast lane
- New hierarchy in road network

COMMERCIAL YPOLOGY



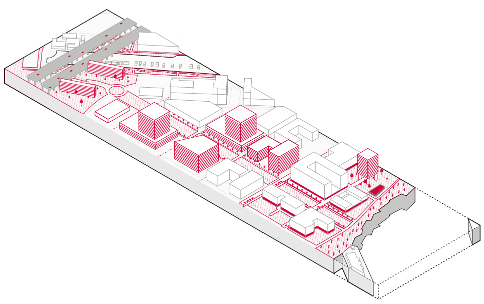
Hydrology

- Streets retrofitted for peak discharge system
- Local centralized treatment of runoff in residential areas
- Big scale interventions, actors working together
- Soil improvements for water purification
- Infiltration crates to increase buffer capacity

Mobility

- Integration of parking in blocks buffer zone
- Closing streets in the main discharge streets
- Extraction of on-street parking
- Parking concentrated in fast lane

MIXED-USE TYPOLOGY



Hydrology

- Green axis for peak discharge
- Big scale interventions, centralized solutions
- Soil improvements for water purification
- Floodable coastal zone
- Elevated coastal park
- Elevated infrastructure as flood barrier

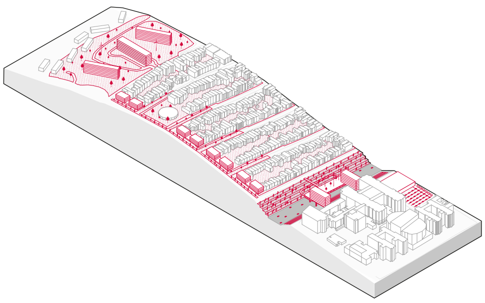
Mobility

- Integration of parking in plinths
- Extraction of on-street parking
- Elevated flood proof roads

FOOD & ENERGY	URBAN RENEWAL	REDEVELOPMENT OF HIGHWAY
▪ Solar roads, connected to buildings in the buffer area ▪ Medium intensity vertical agri-culture in buffer ▪ Small scale, private interven-tions in building guidelines	▪ Intensification of the fast lane, new high density buildings in buffer zone highway ▪ New living environment in the slow lane	▪ New building program under highway ▪ New connections to the highway ▪ New development in the buffer area
▪ Solar roads, connected to buildings in the buffer area ▪ Big scale, private interventions in building	▪ Intensification of the fast lane, new high density buildings in buffer zone highway ▪ New slow lane oriented living environment, high density	▪ New building program under highway ▪ New connections to the highway ▪ New development in the buffer area
▪ Solar roads, connected to buildings in the buffer area ▪ Big scale, private interventions in building	▪ Intensification of the fast lane, new high density buildings in buffer zone highway ▪ New slow lane oriented living environment, high density	▪ New building program under highway ▪ New connections to the highway ▪ New development in the buffer area

URBAN TYPOLOGY | **HYDROLOGY** | **MOBILITY**

RESIDENTIAL TYPOLOGY



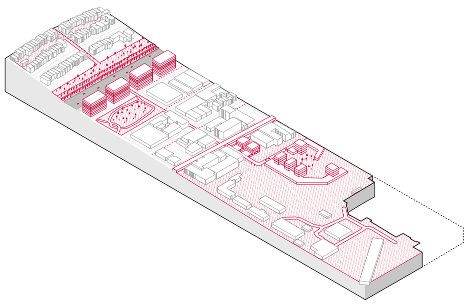
HYDROLOGY

- Improvements to delay and buffer precipitation
- New network of bioswales
- Local treatment of runoff in residential area
- Small scale, private interventions in building guidelines

MOBILITY

- Integration of parking in plinths
- Extraction of on-street parking

FORMER INDUSTRIAL TYPOLOGY



HYDROLOGY

- Green axis for peak discharge
- Big scale interventions, centralizied solutions for buffering
- Soil improvements for water purification
- Floodable coast area
- Elevated coastal zone
- Elevated infrastructure as flood barrier

MOBILITY

- Integration of parking in buildings
- Extraction of on-street parking
- Elevated flood proof roads
- Parking inside new buildings

FOOD & ENERGY	URBAN RENEWAL	REDEVELOPMENT OF HIGHWAY
▪ Solar roads, connected to buildings in the buffer area ▪ Small scale, private interventions in building ▪ Energy efficiency rules for new building projects	▪ Intensification of the fast lane, new high buildings in buffer zone highway ▪ Improvements of slow lane public space ▪ High density building replacement	▪ New building program above highway ▪ New connections over the highway ▪ Improvements on embankments of the highway
▪ Solar roads, connected to buildings in the buffer area ▪ Big scale, private interventions in building	▪ Intensification of the fast lane, new high density buildings in buffer zone highway ▪ New slow lane oriented living environment, high density building ▪ High density building ensembles in the slow lane ▪ Replacement of single homes for apartments blocks (max 4 levels high)	▪ New building program in buffer zone ▪ New connections to the highway and over the highway

URBAN TYPOLOGY 2: COMMERCIAL TYPE

This typology has the largest mobility infrastructure footprint and falls short as a living environment, because it lacks identity and because of grave soil contamination.

▪ *Hydrology:* The Commercial typology is located downhill in the water course in the artificially filled Mission creek - a natural valley. Aim is to improve the soil, and to prevent infiltration into the polluted artificial fill. The system focus is mainly to buffer and secure clean discharge to the bay. Therefore, this typology needs to posses as much as possible buffer capacity. The treatment of water is done in central facilities, integrated into the new living environments.

▪ *Mobility:* Disconnection of the living environments and water buffering locations, in order to secure the quality of the water. Extraction of on-street parking spots, by replacing parking inside buildings.

▪ *Food & energy:* Solar roads can generate energy, which can be utilised to charge AV's in the building in the buffer zone of the highway. Vertical farms can be build in the buffer zone and utilize energy from the roads.

▪ *Urban renewal:* Obsolete plots can be renewed into residential housing ensembles. Big blocks, with inside parks can differentiate new private and semi-private public space. Because of the necessity of buffer space, new buildings will be build in high density (with small footprints). The parking space in the proximity of the highway junction can be developed for new living environments. Old warehouses can be replaced for new housing.

▪ *Redevelopment of the highway:* New buildings in the buffer zone of the highway are directly connected to the highway.

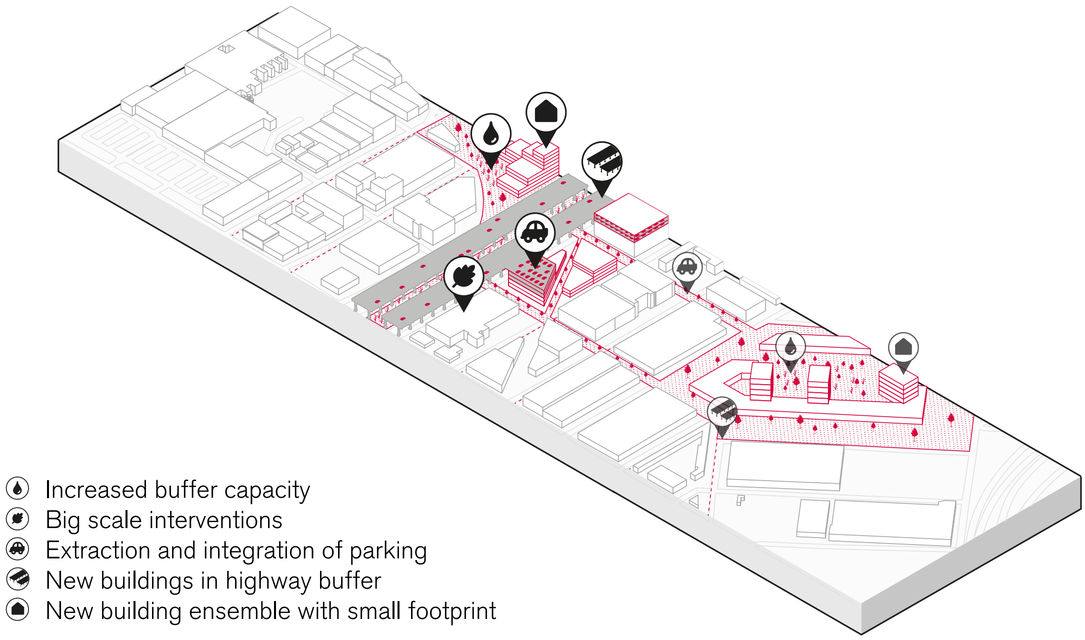


Figure 10.11: Impression of new living environment, Source: (Author, 2018)

Eco-village

What was once a no-man's land of car parking and zigzagging highway structures. Isolated in a district primarily focussed on commercial activities, will offers an intrinsic green lifestyle, that utilizes the isolated location in order to create a village type of lifestyle. New residential housing is developed under the mobility infrastructures, a new apartment building is developed in a multifunctional park setting.

The eco-village elaborates on San Francisco's history as a support for counter cultures and is a place for open minded people - that appreciate unconventional forms of living. The "eco-geeks" share the green space and do maintenance on the bioswale as if it is their own garden. In periods of peak precipitation, the park acts as a storm water buffer. However, during summers it is the perfect place to have barbecues and meet neighbors and friends.

Figure 10.12: Present situation, Source: (Google maps, accessed 18-01-16)

This location is an important area in the discharge system, in order to guarantee its quality as a clean source of runoff. This project focusses on slow activities and clean mobility like cycling and ridesharing AV's. Key for the project development is the involvement of responsible residents, that accommodate in the bungalows under the highway.

URBAN TYPOLOGY 3: MIXED-USE TYPE

As a former harbour area, Mission Bay is now in its second redevelopment phase. Entering the post-fossile era, notion of environmental crisis and the potentials of future mobility have caused to turn the development plans of Mission Bay by 180 degrees.

▪ *Hydrology*: With flood risk coming from both inland as from the bay, the future of Mission Bay is dependant on its performances in water management. However, this challenge offers big opportunities for Mission Bay to provide a unique and sustainable living environment. Local runoff, originating from clean sources is separated and collected in the linear park. In order to mitigate the 90 centimeters storm flood, in addition to 120 centimeters sea level rise by 2100. 3rd street needs to be raised to prevent flooding to spread until South of Market.

▪ *Mobility:* Critical infrastructure is elevated and building blocks are directly connected to it. Public space is design so that it is floodable. Existing building ground floors are made flood proof.

▪ *Urban renewal:* Obsolete parking spaces can be utilized to enable urban renewal. Already initiated new development is revalued conform the values of the guiding principles and models. New apartments blocks are build with small as possible footprints and a minimum of 10 levels and up.

▪ *Redevelopment of the highway*: Extraction of paved areas under the mobility infrastructure, this can be used to facilitate the discharge system. New buildings in the buffer zone of the highway, which are directly connected to the highway.

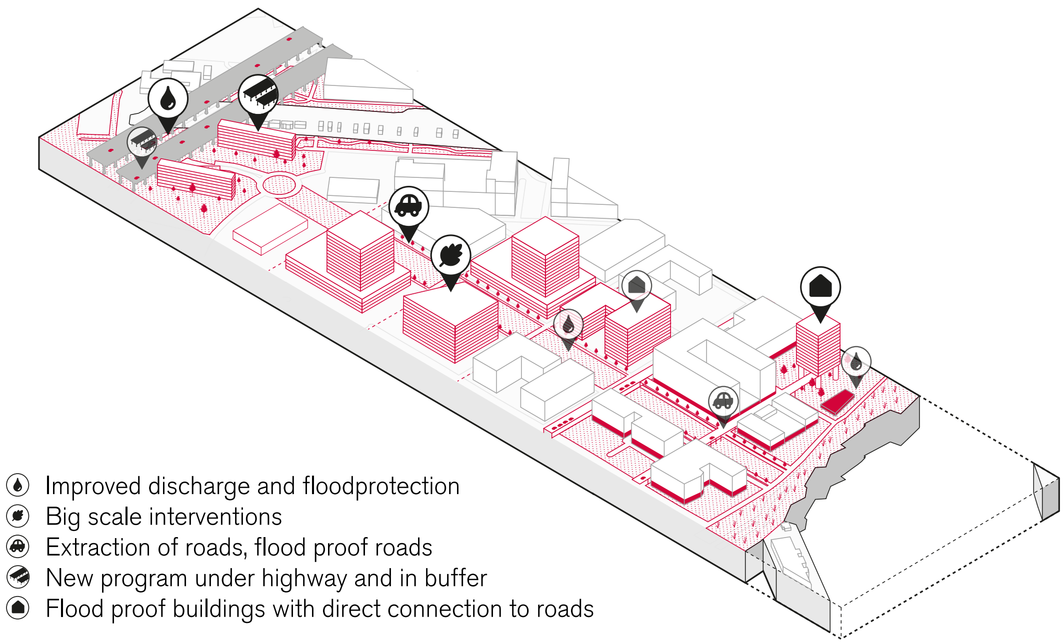


Figure 10.13: Impression of new living environment, Source: (Author, 2018)

Flood-proof living

With the critical interventions done in Mission Bay, a totally new context is created. What was once a place swallowed up by the overdimensioned parking spots of AT&T park, is now a green area connecting to the water front.

The area has a green and organic appearance, in order to express its dynamic character, raising the awareness of people. In storm events, the area can flood until the raised level of 3rd street. In dry seasons the public space can be used to recreate and the green can be utilized for relieving urban heat.

The elevated roads connecting the new raised building blocks also interact with the existing buildings in the area, in order to create new places. Under the elevated road, a gallery arises, which offers sheltered walking routes through the neighborhood when the weather is bad. As a result, new meeting places arise along this line and HUB's for public transport can bundle here.

Figure 10.14: Present situation, Source: (Google maps, accessed 18-01-16)

Disconnected from fast mobility flows, slow flows get the opportunity to develop to the fullest in this area. Since the landscape of Mission Bay is very flat, a new concealed bicycle fast way can make bicycling a very convenient mode of transport.

URBAN TYPOLOGY 4: RESIDENTIAL TYPE

This is the main typology, planned for residential use. The challenge is to improve the current living environment and generate an integrated system that can buffer the discharge locally, in order to prevent downhill flooding. Located in the hills between U.S. Route 101 and Interstate 280, this typology has some challenges concerning mobility and hydrology. The residential build up of the typology is characterised by low density building and an aging building stock.

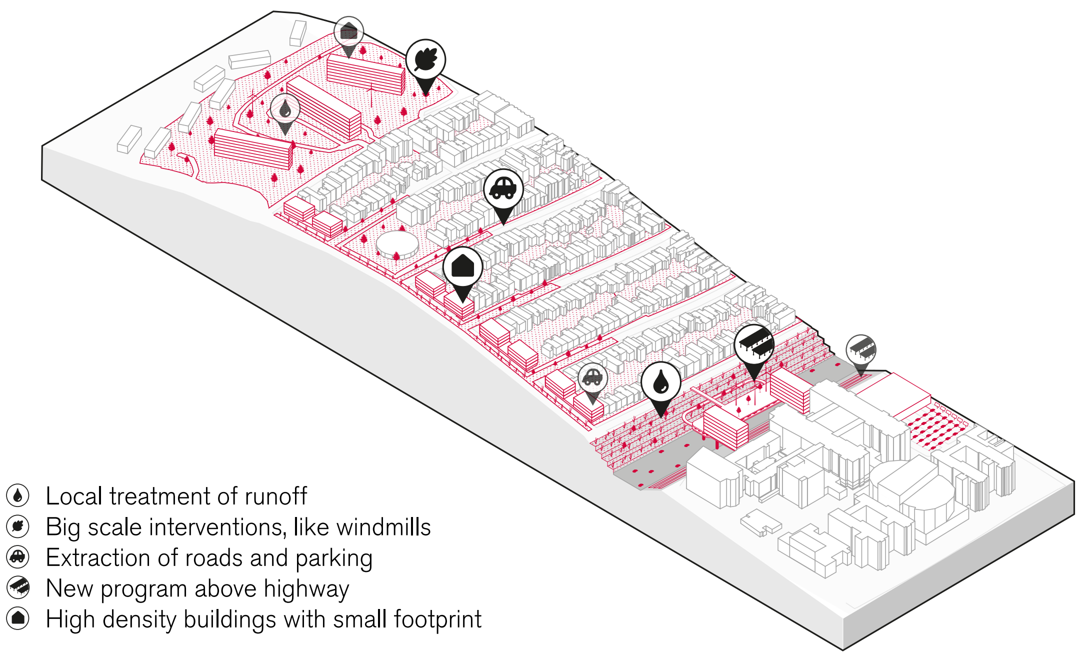
▪ *Hydrology*: As the continuing streets cause the runoff to discharge in high velocities and volumes down the hills, new improvements aim to delay and buffer precipitation, beginning from the roof. This is done by both small scale interventions (flow through planters and rain gardens), as big scale interventions (retention systems and parks).

▪ *Mobility:* Closing the continuing streets will create a far more liveable area. As the downhill streets create dangerous situations in traffic, closing the streets will provide better spatial quality. To protect the water quality of the buffer courts, parking is done inside the buildings on the head ends of the streets.

▪ *Food & energy:* Windmills uphill will compose a good combination with the big open buffer spaces. Moreover, there is potential to retrofit the building stock to the new energetic standards and energetic rules for new buildings.

▪ *Urban renewal:* Potential to development apartments instead of single housing. The wide design of the streets makes it possible to increase the building heights by two extra levels, making the average building height 4. High density development in the uphill buffer parks.

▪ *Redevelopment of the highway*: New building program above highway. Improving the embankments of the highway with bioretention terraces.



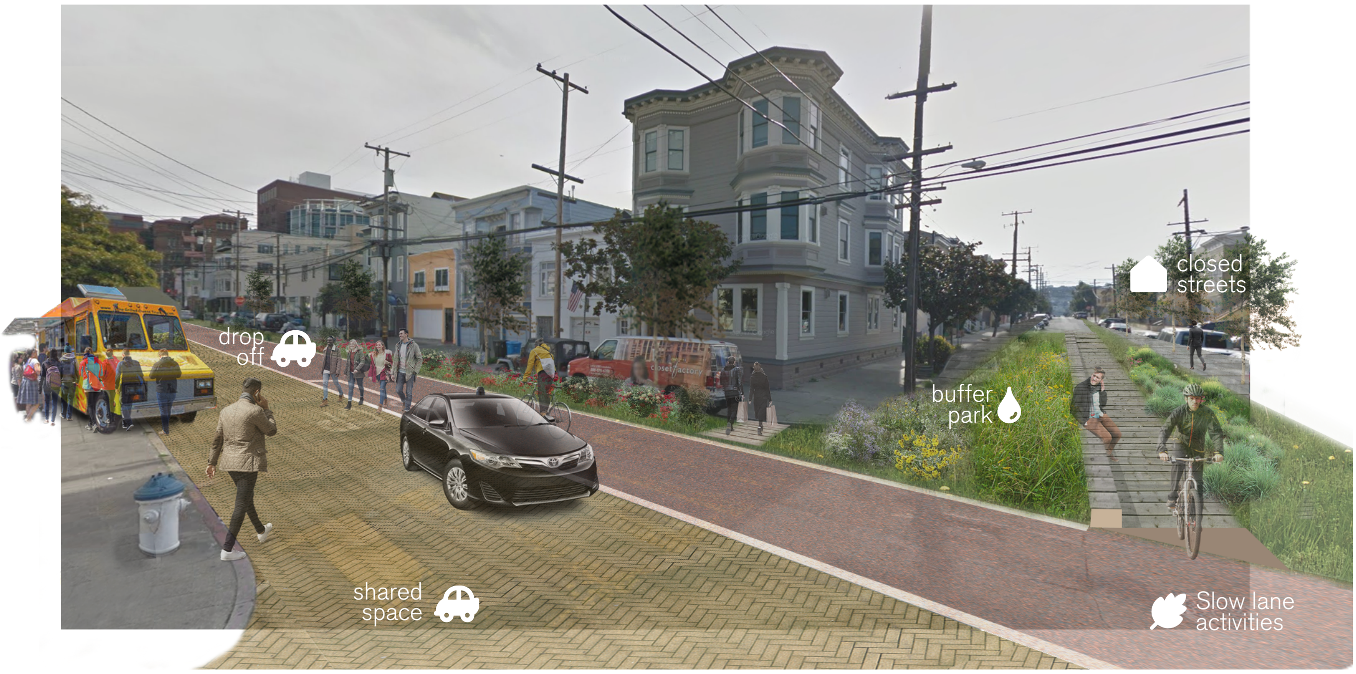


Figure 10.15: Impression of new living environment, Source: (Author, 2018)

The neighborhood

What is now an uninspiring and car-dominated network of over dimensioned hilly streets, is to be a future place for families. Integrated design in mobility and water management can improve this uphill neighborhood into a lively residential living environment.

The abstraction of paved streets and parking spaces, make it possible to turn roads into shared spaces. Cars are only allowed to drop off and park in new collective parking buildings. Enabling both new public space to arise and also provide for a clean source of runoff water.

Because most sewer facilities are focussed downhill, there are no uphill pre measures. However, new innovative improvements can both mitigate downhill flooding and improve uphill public space. Water management is primarily focussed on delaying the uphill precipitation and water is treated and retained locally in green basins.

Figure 10.16: Present situation, Source: (Google maps, accessed 18-01-16)

URBAN TYPOLOGY 5: FORMER INDUSTRIAL TYPE

This type is a comparable to the mixed-use type. However, the redevelopment of the industrial sites is less advances and is more oriented on residential use. From the perspective of water management, it has similar challenges, however less discharge to cope with. The challenge here is to secure the quality of the runoff.

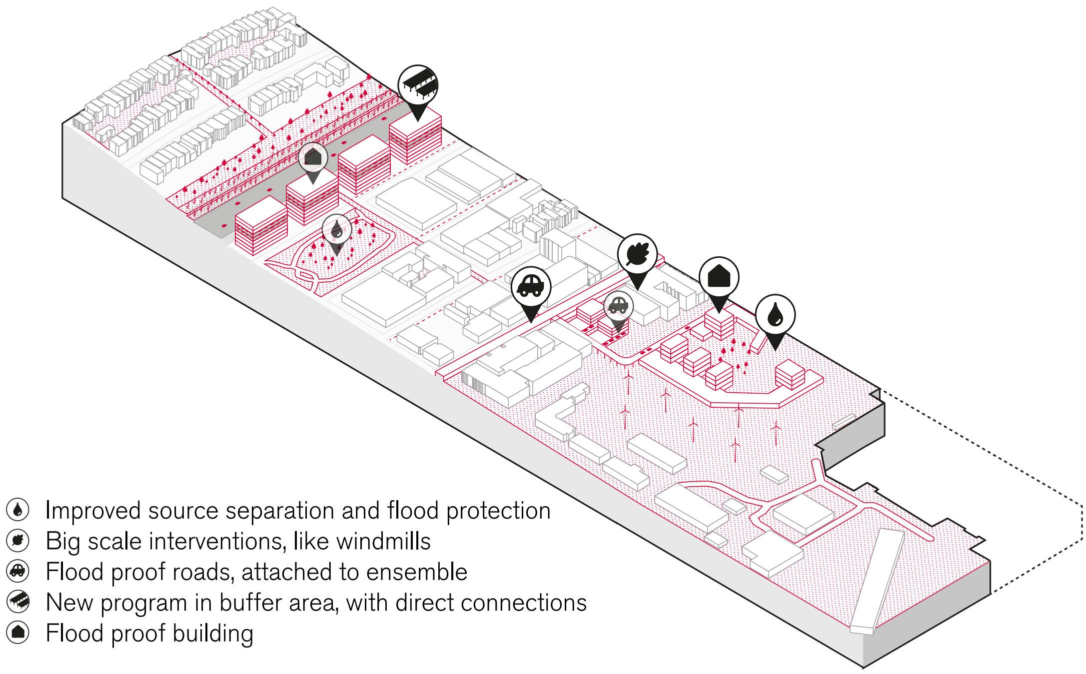
▪ *Hydrology*: Because of soil quality, water management is mainly focused on separation and discharge of precipitation. In the flood prone area and elevated coastal zone and elevated infrastructure as flood barrier (3rd street coming from Mission Bay).

▪ *Mobility:* In the fast lane, strict separation of clean sources, by connecting the new buildings with the highway. Parking is integrated in the buildings to prevent unnecessary mobility flows.

▪ *Food & energy:* Solar roads can generate energy, which can be utilised to charge AV's in the building in the buffer zone of the highway. Subsequently, vertical farms can be build in the buffer zone and utilize energy from the roads.

▪ *Urban renewal:* Redevelopment of old storage facilities in the fast lane, into high density building (8 levels). New slow lane oriented living environment, with medium density building ensembles (4 levels) in order to secure the quality of the water.

▪ *Redevelopment of the highway*: New building program in buffer zone. New connections to the highway and over the highway



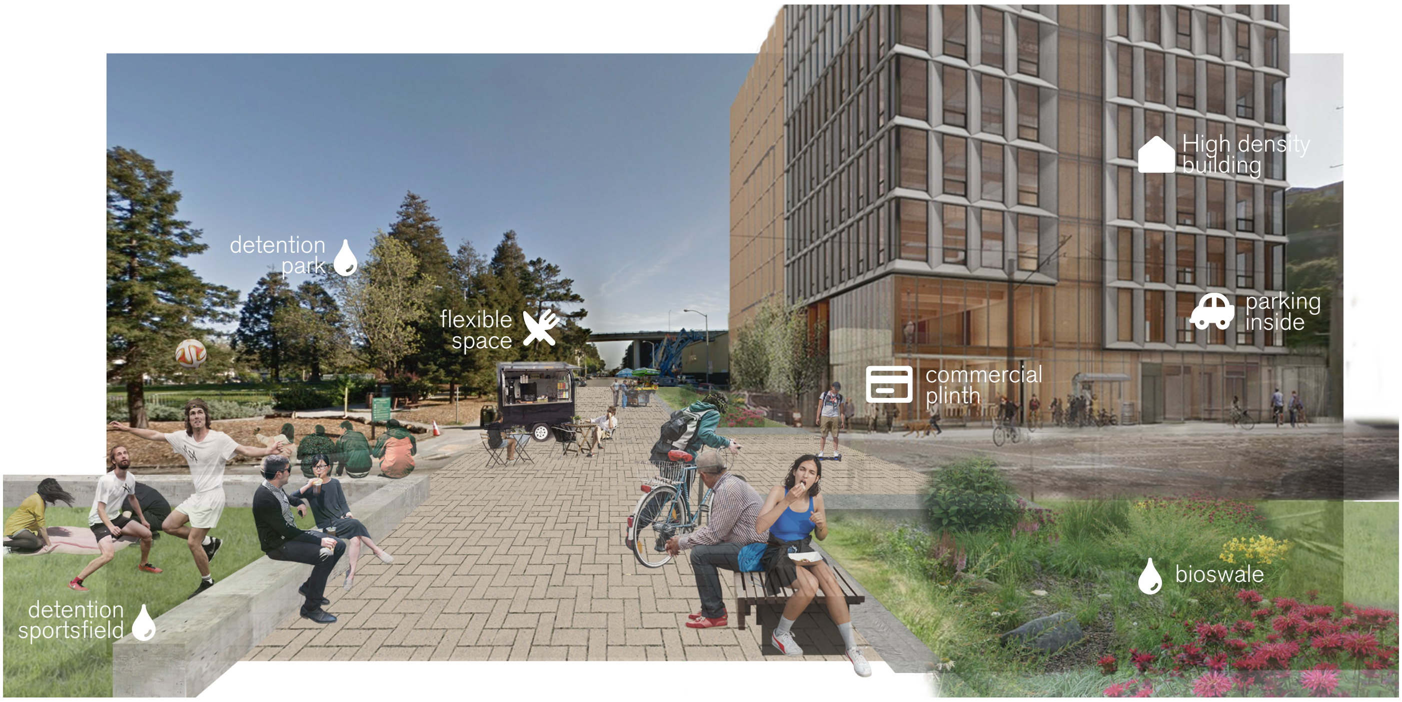


Figure 10.17 Impression of new living environment, Source: (Author, 2018)

Mobility HUB

Located along the highway in the Dogpatch neighborhood, vacated industrial space can be used[1] to develop new living environments around tall buildings that have a direct relation to the highway.

The new mobility HUB is key in a commercial area and offers apartments in the top levels and a commercial plinth. The middle layers of the building are connected to the highway and offer parking and logistic facilities.

Since the ground is contaminated, water management is mainly focussed on separation and retention of water. In order to delay runoff, so that the discharge bioswales get less load in events of peak precipitation.

Figure 10.18: Present situation, Source: (Google maps, accessed 18-01-16)

The network of vegetated bioswales offer a green car-free commercial area. And the concrete edges of the retention basins can act as seating for resting and eating visitors.

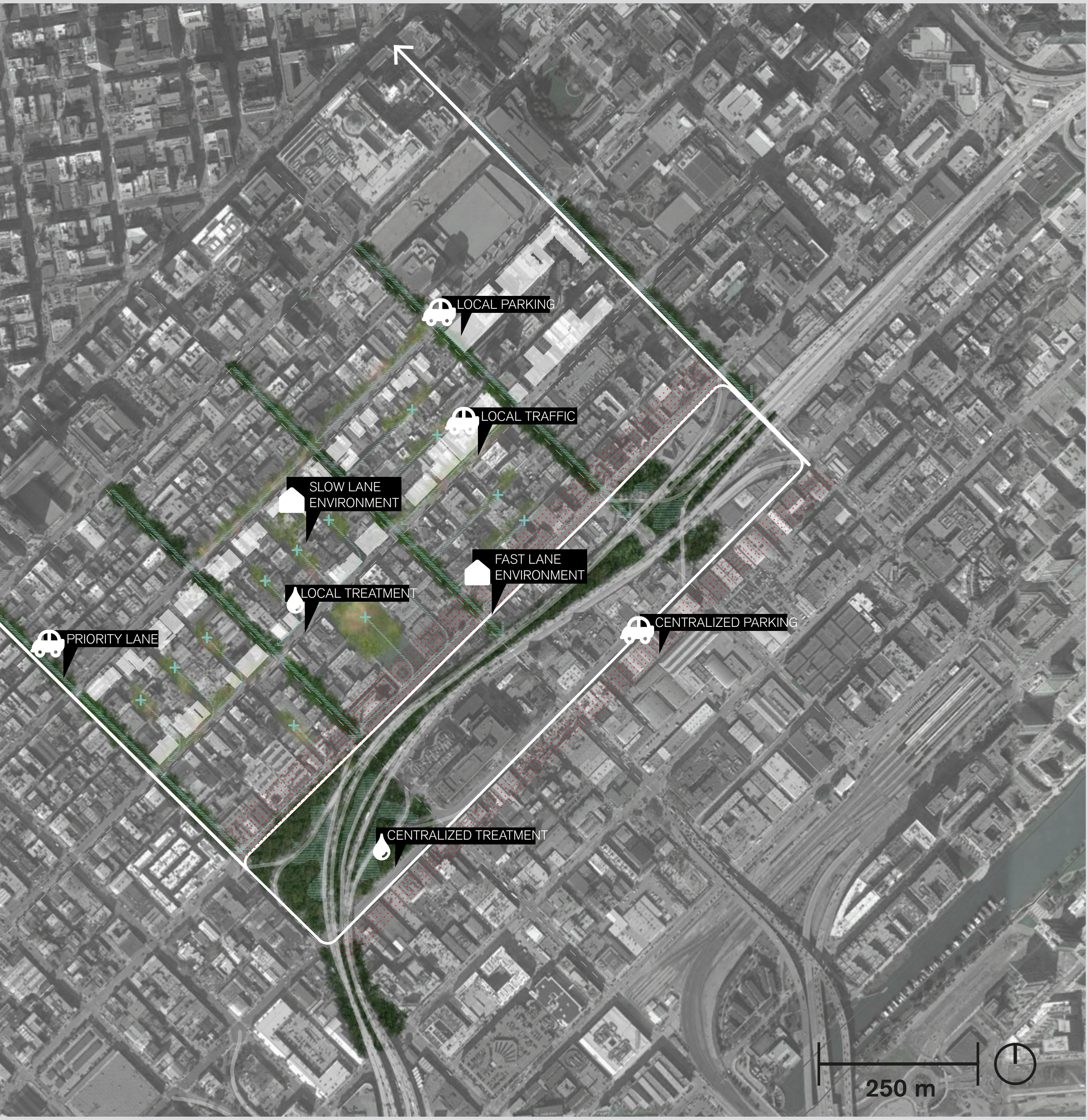
1 https://www.usatoday.com/story/tech/columnist/shinal/2015/09/23/tech-economy-lands-dogpatch-thud/72578468/, accessed 18-01-17

10.3 Elaboration on Downtown typology

Because the Downtown type is located in one of the most build-up areas of the city. The design of this typology is going to illustrate how a synergy in flows can support an innovative living environment in a heavily urbanised context.

In order to illustrate how the S2N operates in a new context, this part of the project is focussing on the elaboration of the Downtown type. The first part of this section explains how the branch system connects with the main system and what kind of fast and slow zone living environments can result from this. Subsequently, schemes illustrate how the typology works from the different perspectives of the ECS. The operation of flows are shown in order to understand the system on the scale of the street. Finally, the project building guidelines documents illustrate how the S2N can be implemented.

Figure 10.19: Title, (Author, 2018)


LOCAL PARKING
LOCAL TRAFFIC
SLOW LANE ENVIRONMENT
FAST LANE ENVIRONMENT
LOCAL TREATMENT
PRIORITY LANE
CENTRALIZED PARKING
CENTRALIZED TREATMENT
250 m

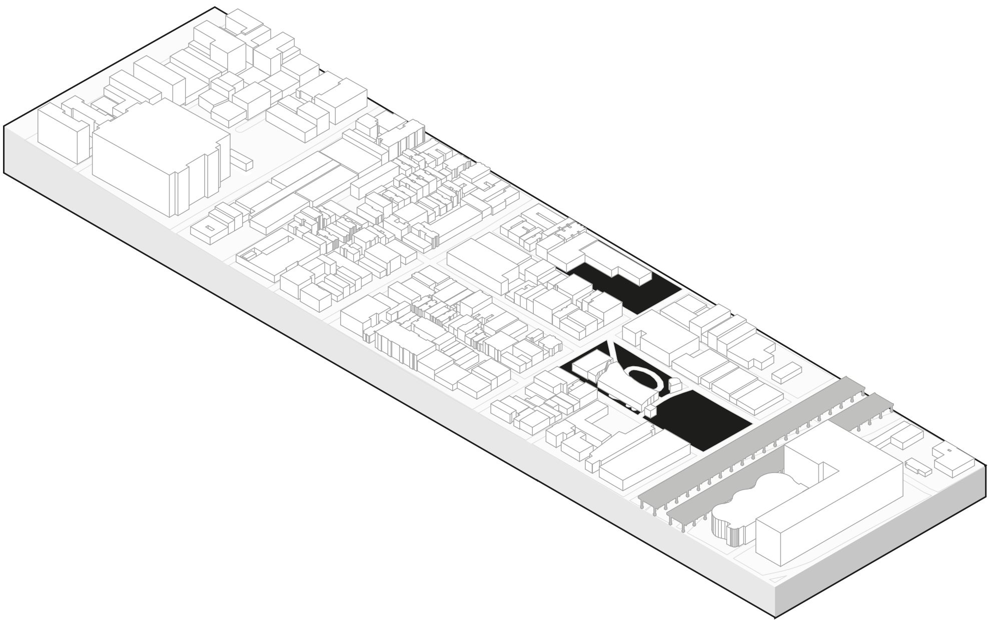
URBAN TYPOLOGY 1: DOWNTOWN TYPE

Figure 10.20: Present situation, Source: (Author, 2018)

Figure 10.22: Present situation, Source: (Google maps, accessed 18-01-16)

Figure 10.21: Present situation, Source: (Author, 2018)

Figure 10.23: Present situation, Source: (Author, 2018)



Because of its location close to Market Street and the Central Business District, the ongoing roads in this typology tend to be over dimensioned, resulting in a pressure on livable space. Subsequently, the mobility infrastructure prototype has a high space occupation, because of the many on-street parking spaces and mobility related functions. Causing a lot of very anonymous places.

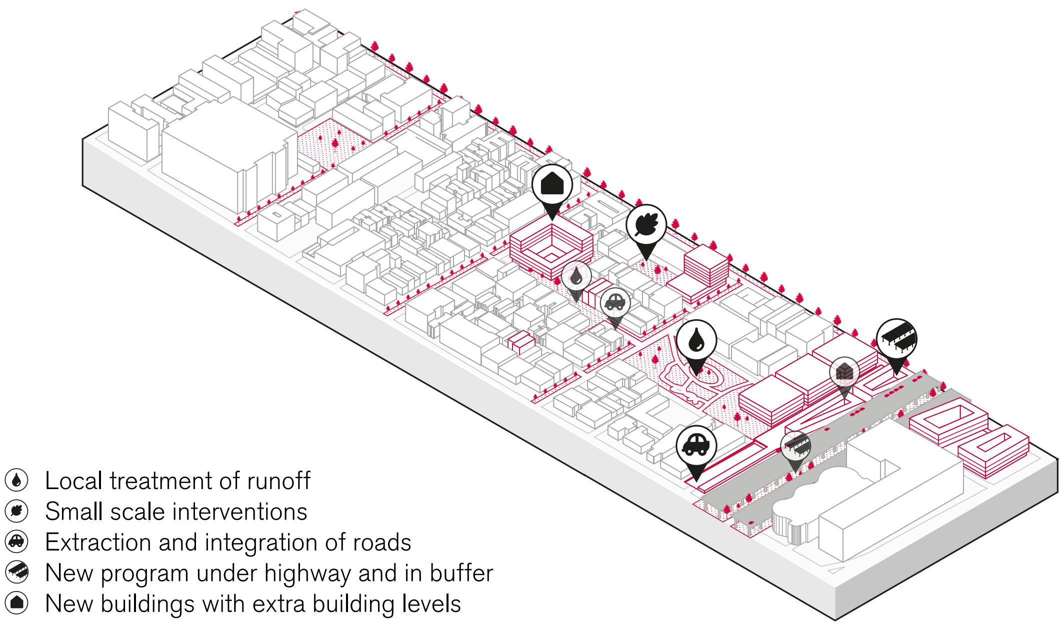
▪ *Hydrology:* Located in the midstream area of the water course, and the subsoil mainly consisting of beach sands. It makes it very suitable to treat the water locally. In the downtown typology, interventions are focussing on local buffering and infiltration of precipitation, in order to prevent high volumes of precipitation downstream. New small scale local treatment areas are assigned inside the streets and are connected through a system of bioswales.

▪ *Mobility:* In order to mitigate the dominance of the car, on-street parking is removed and replaced by parking in buildings. Continuing streets are closed, in order to create courts.

▪ *Energy & Food:* Solar roads can generate energy, which can be utilised to charge AV's in the buildings in the buffer zone. People can rent plots to grow their own food on a small scale, for both consumption and education

▪ *Urban renewal:* As this typology possess one of the oldest groups of buildings. There is a big opportunity in replacing single building units for units with additional building layers. Re-evaluation of the buffer zone enables potentials for high density building and new building program is also possible under the highway.

- *Redevelopment of the highway:* The main potential in this Downtown typology is extraction of the roads and parking spaces. And replacing this by multifunctional programs under the mobility infrastructure.



PERSPECTIVES OF THE STRATEGY OF THE TWO NETWORKS

Mobility flow perspective
Interventions in the road hierarchy will create more liveable streets, innovative parking and automated vehicles will enable smarter use of available space.

The highway has a new connection to the typology, with the parallel road integrate in the plinths of the buildings in the buffer zone. Based on the ABC-cluster model, the aim is to connect commercial functions to this zone, in order to prevent unnecessary traffic through the slow lane.

Water flow perspective
The guiding principle for efficient use of space is the ecological separation of a dynamic, high service zone and a quiet living zone. Carried by the networks of water and mobility. Interconnected design through all the project levels ensures the quality and quantity of the water flows.

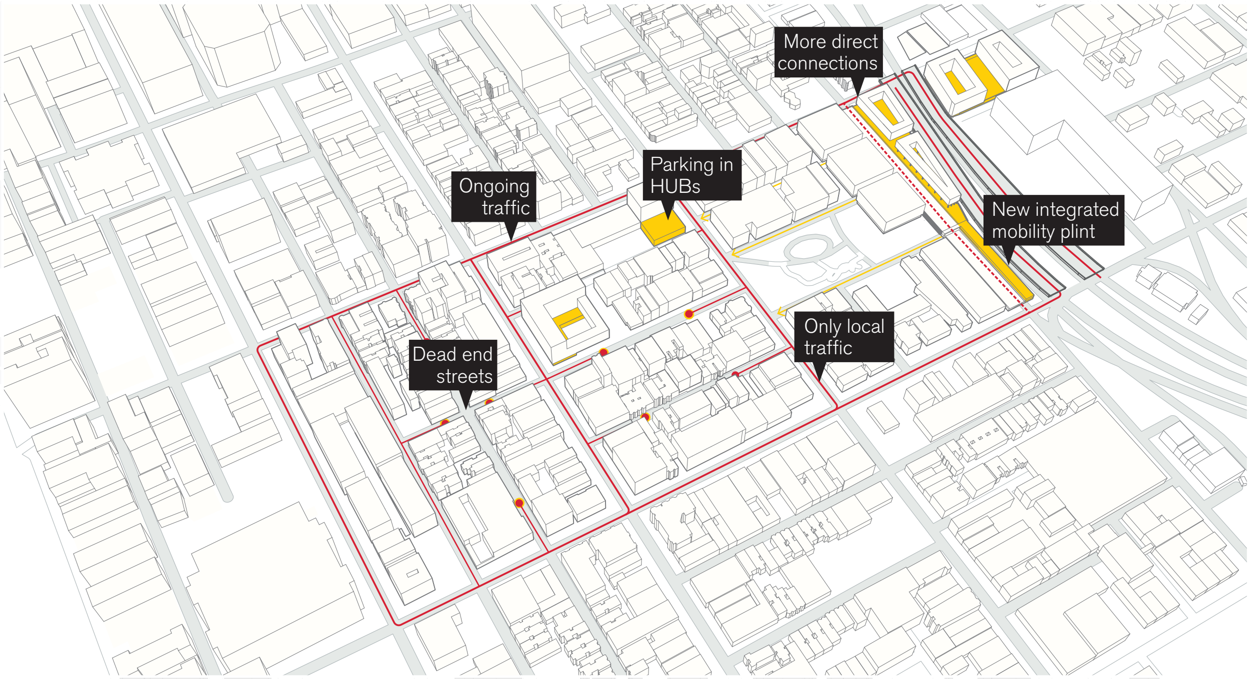


Figure 10.24: Title, (Author, 2018)

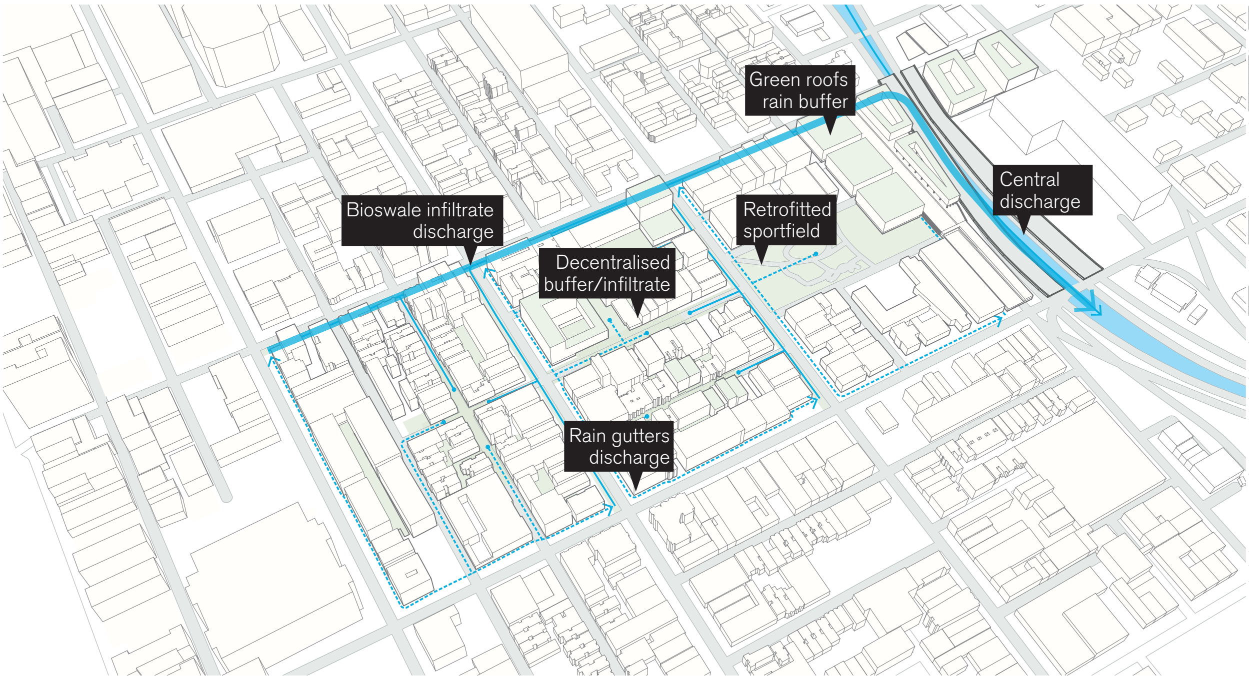


Figure 10.25: Title, (Author, 2018)

Area perspective

From the area perspective, the synergy between the different flows needs can creat new green spaces, with different type of atmospheres.

Actor perspective

From the actors perspective it is very important to formulate building rules in relation to the public space, in order to create synergy between flows and actors. The program of the new spaces are in accordance with the residents in order to create involvement.

Figure 10.26: Title, (Author, 2018)

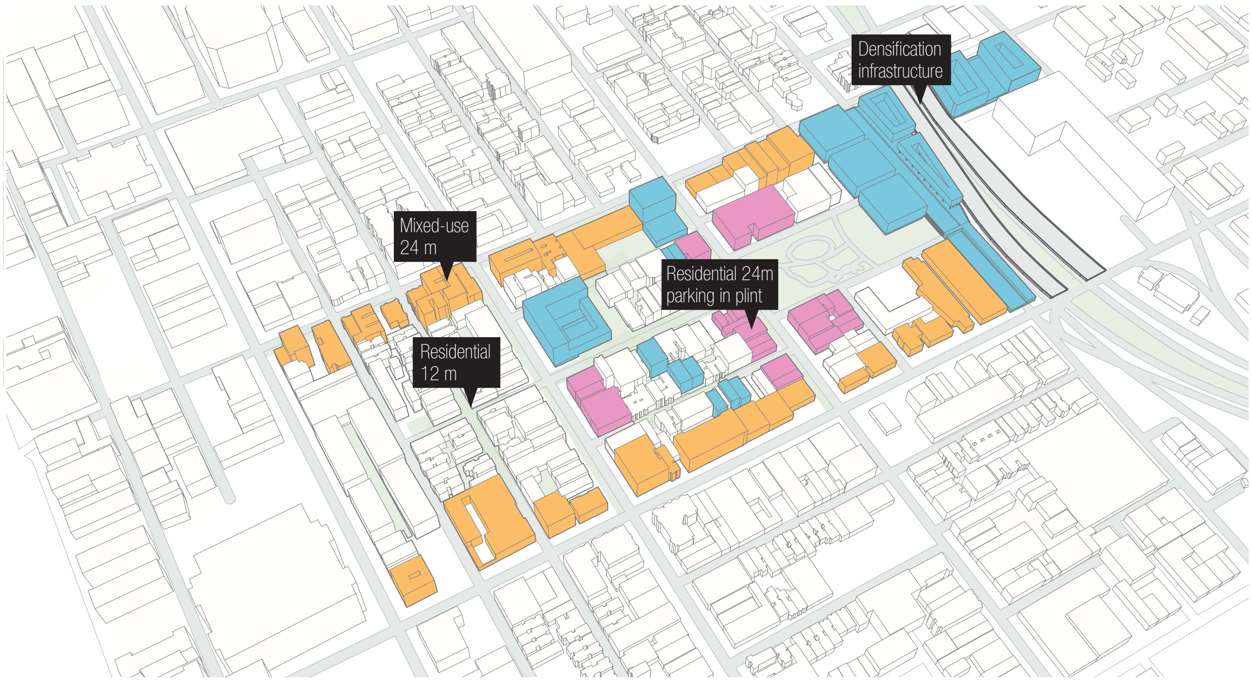


Figure 10.27: Title, (Author, 2018)

SLOW LANE LIVING ENVIRONMENT

Figure 10.28: Impression of slow lane living environment, Source: (Author, 2018)

The green court
Before the technology boom transformed San Francisco and sent housing prices through the roof, the city was alive with children and families. However, in 2017, San Francisco shows extremely hostile with families[1]. The green court neighborhood is located near Market street, the commercial center of shopping in San Francisco and is intended to become a residential oasis in Downtown San Francisco.

What once was an anonymous street - with no spatial quality whatsoever - dominated by parking and ongoing traffic, is now a lively street with space for children to play and residents to recreate. Residents keep their own garden plots which also function as rain buffers. The bioswales on each side of the street are connected to the greater network of discharge in case of storm events. The insides of the building blocks in the slow zone, will be predominantly occupied by residential functions and new building types are introduced. As the quality of the inside will increase, new building blocks will face towards the inside with new balconies increasing social cohesion.

1 https://www.nytimes.com/2017/01/21/us/san-francisco-children.html

Figure 10.29: Impression of slow lane living environment during storm event, Source: (Author, 2018)

From an area perspective, the green court is a place designed for slow activities and acts as a clean source of runoff water. Local activities are adapted to secure the quality of the water, space is made for playing children and residential gardens. However, polluting activities like parking or storage of polluting substances are forbidden. The perpendicular road to the green court is only accessible for local traffic and is only allowed to drop residents off. As the water and traffic systems run parallel to each other, measures are taken to prevent the flow of polluted to clean sources by utilizing the local topography. Water is buffered and treated on higher ground. In storm events, measures are focussed on mitigating the volume of runoff and buffering the runoff as much as possible.

Operation of runoff system in slow lane

(1) Precipitation lands on a vegetated roof, which are fixed in new building regulations. Vegetated roofs can buffer only small volumes of water, however it can prevent pollution from roofs to end up in the runoff.

(2) The runoff from the roofs flow from the drain pipe into a private infiltration garden. New buildings are obligated to reserve 1.2 meters plot from the facade of the house, in order to infiltrate their own water.

(3) Water that overflows this system, is collected in a public, communal dry basin.

(4) Water overflowing this system, then exits the clean source area via vegetated bioswales.

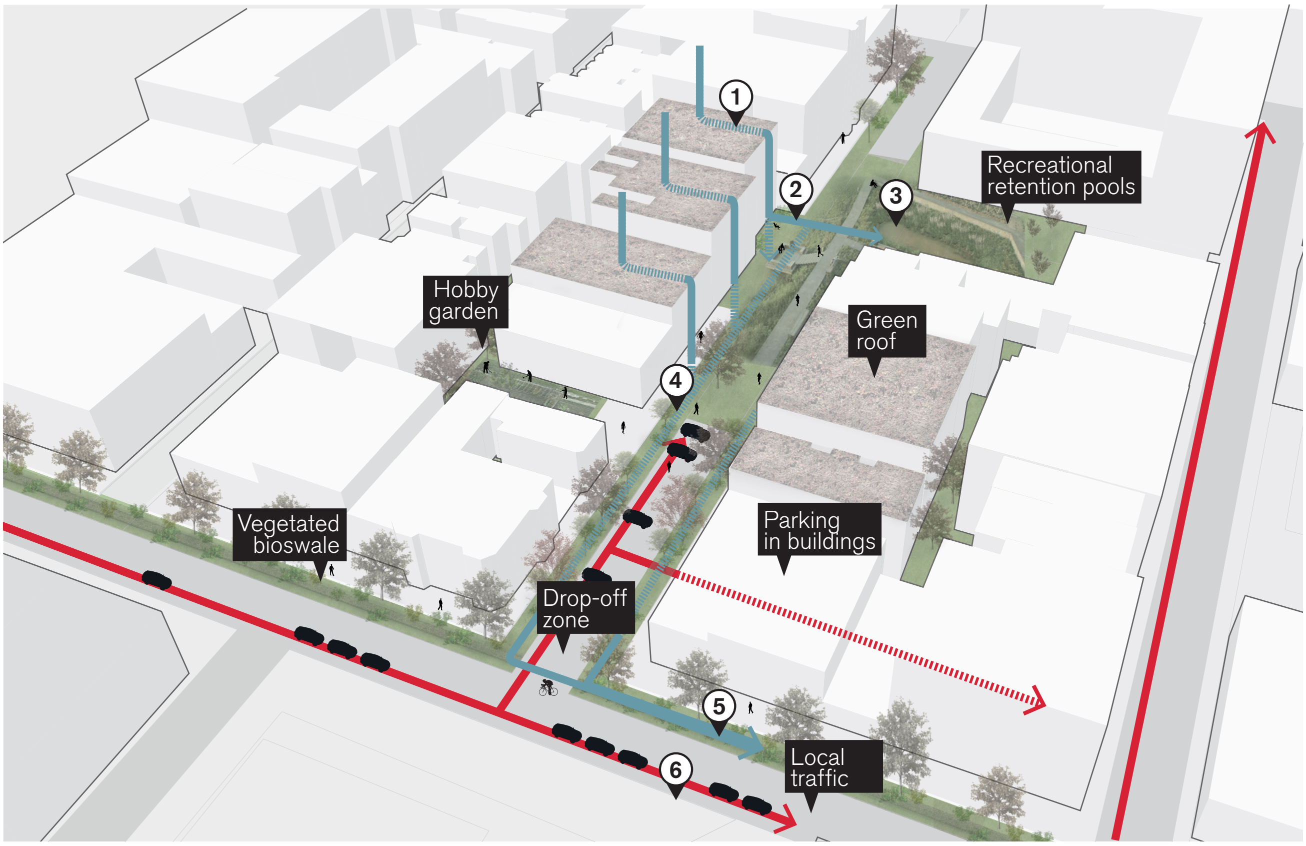
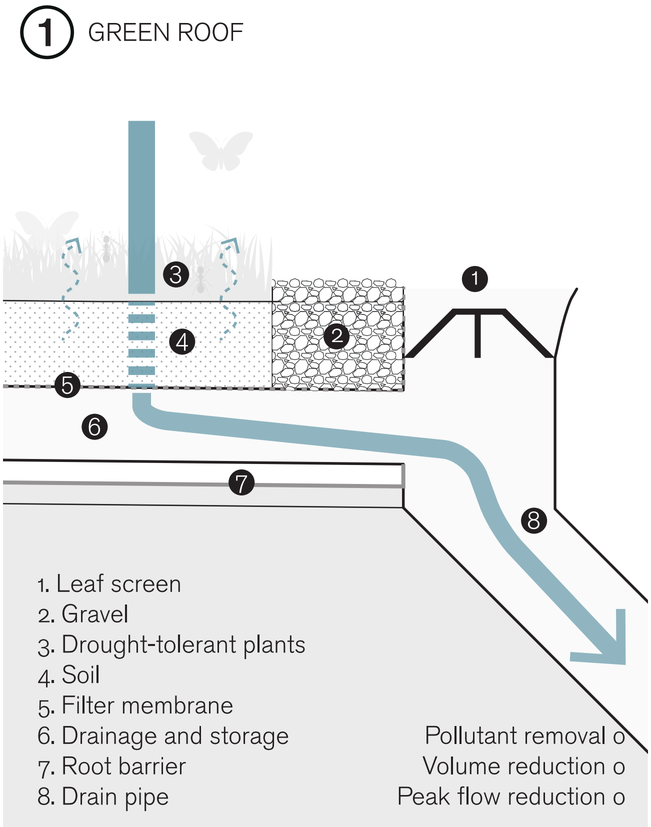


Figure 10.30: Flows of slow lane living environment, (Author, 2018)



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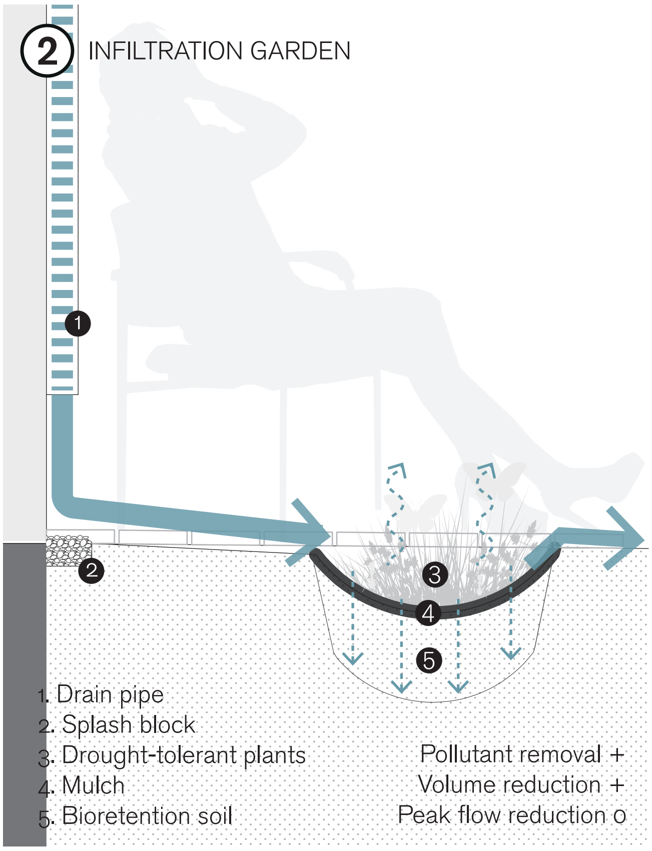

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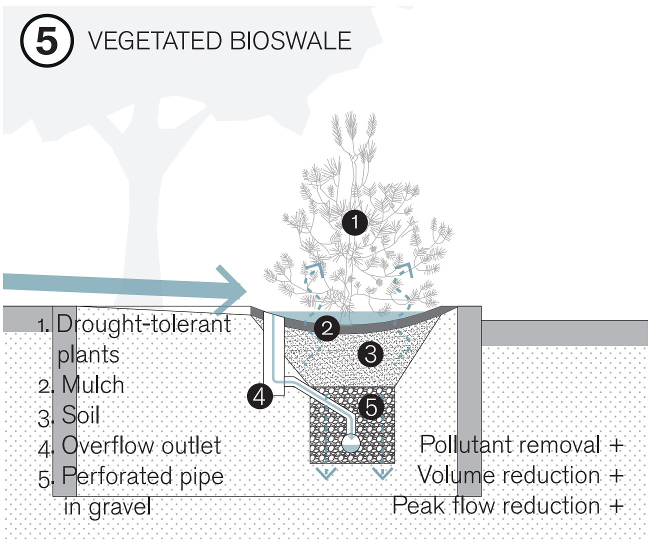

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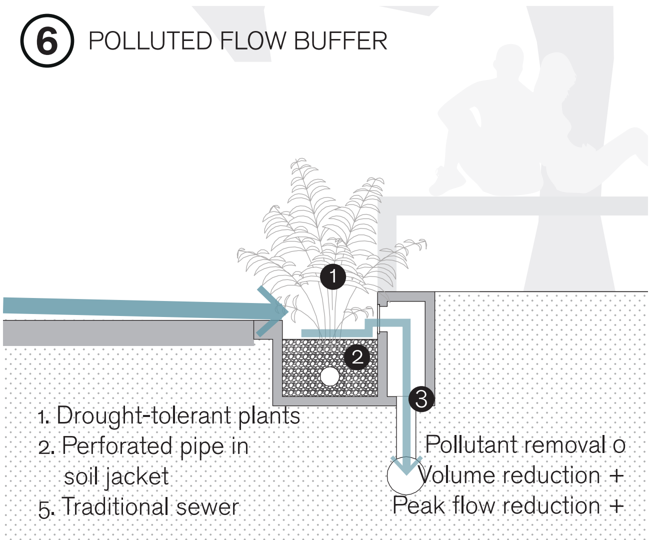

Figure 10.34: Title, (Author, 2018)

FAST LANE LIVING ENVIRONMENT

Figure 10.35: Impression of fast lane living environment, Source: (Author, 2018)

The Boulevard

In the present day situation, the boulevard is a parallel road to the I-80 highway, occupied by car repair shops and other car related services. During the day, space under the highway is mainly occupied car parking, at night the space is completely abandoned however. In the post-fuel era, this area will make a drastic change, as the car related services will become unnecessary and technical innovations will offer better alternatives than on-street parking.

The Boulevard will become a new mobility HUB in the fast-lane, which is envisioned to become a major mode for mobility. The living environment it offers, is characterised by a dynamic living environment with high apartment buildings and offers many commercial services. The former parallel road is integrated in the building and connects directly with the highway. Because of its situation in the fast-lane, from the perspective of water management, the runoff originating from this area is directly connected to the artificial system. During pea precipitation its possible to store water in tanks in the construction.

Figure 10.36: Impression of fast lane living environment during storm event, Source: (Author, 2018)

Located in the lower part of the local water course - the fast-lane is where cars are active and fast oriented activities take place. The fast-lane is a source for polluted runoff and the focus is on buffering and separation of runoff. Overflow from the sewer and runoff from the road has to be prevented as much as possible. The different types of runoff flow parallel, however clean runoff in the bioswales are located at higher ground and polluted water on lower ground and undergrounds.

Operation of runoff system in slow lane

5. Polluted water from the road flow into the buffers in front of the traditional sewer. When the water overflows because of peak precipitation, it overflows into the artificial sewer inlet.

6. Water from the clean source flows through the vegetated bioswales. Water that overflows from this system, would potentially overflow on the road, into the polluted water buffer.

7. Once arrived in the fast lane, sealing of the pavement is allowed because of the polluted artificial fill. The water is then buffered in special underground basins.

8. Water from the basins can be reused or utilized as fountains, when the peak precipitation ended.

9. Through the different zones, the runoff ends in the central discharge system. The water here is of less quality, because it is further away of the source. Subsequently, moderate commercial activities are also allowed.

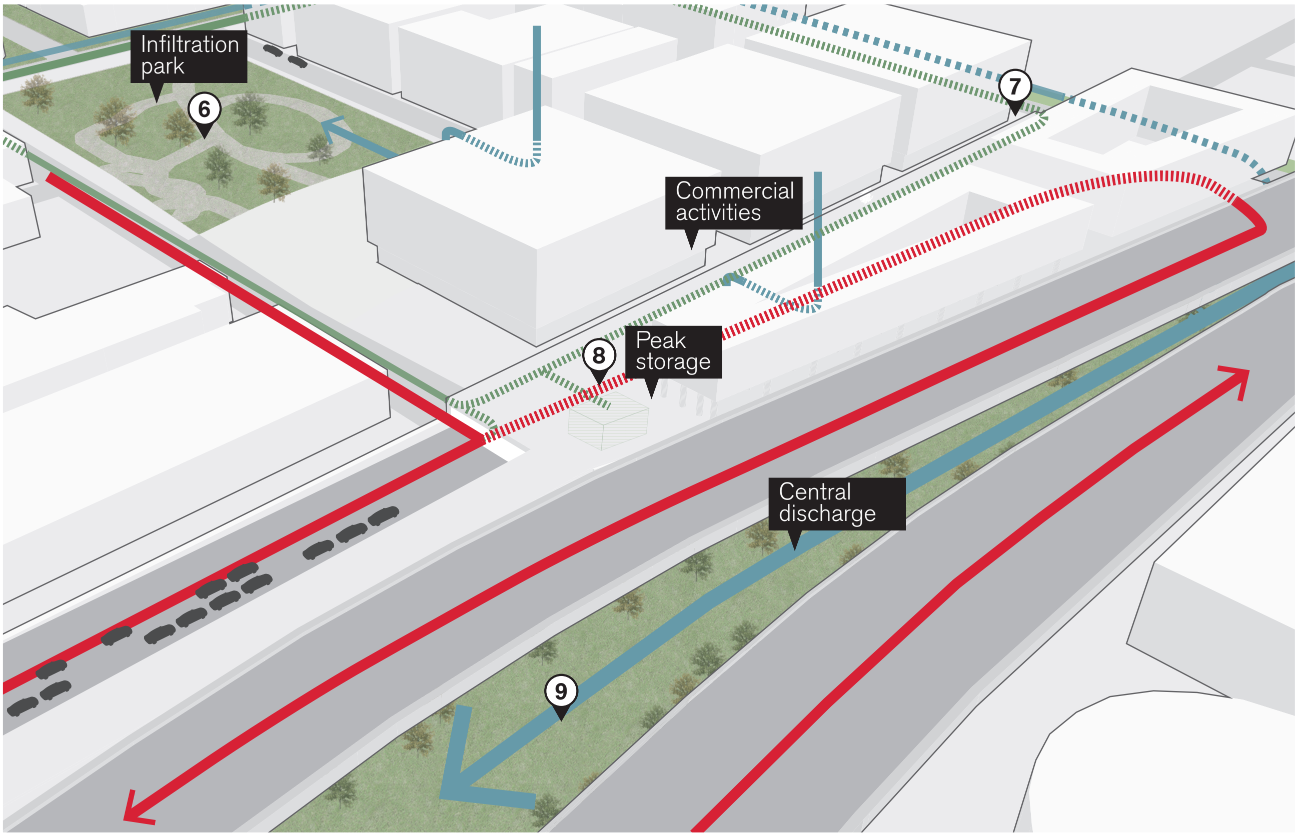

Figure 10.37: Flow of fast lane living environment, (Author, 2018)

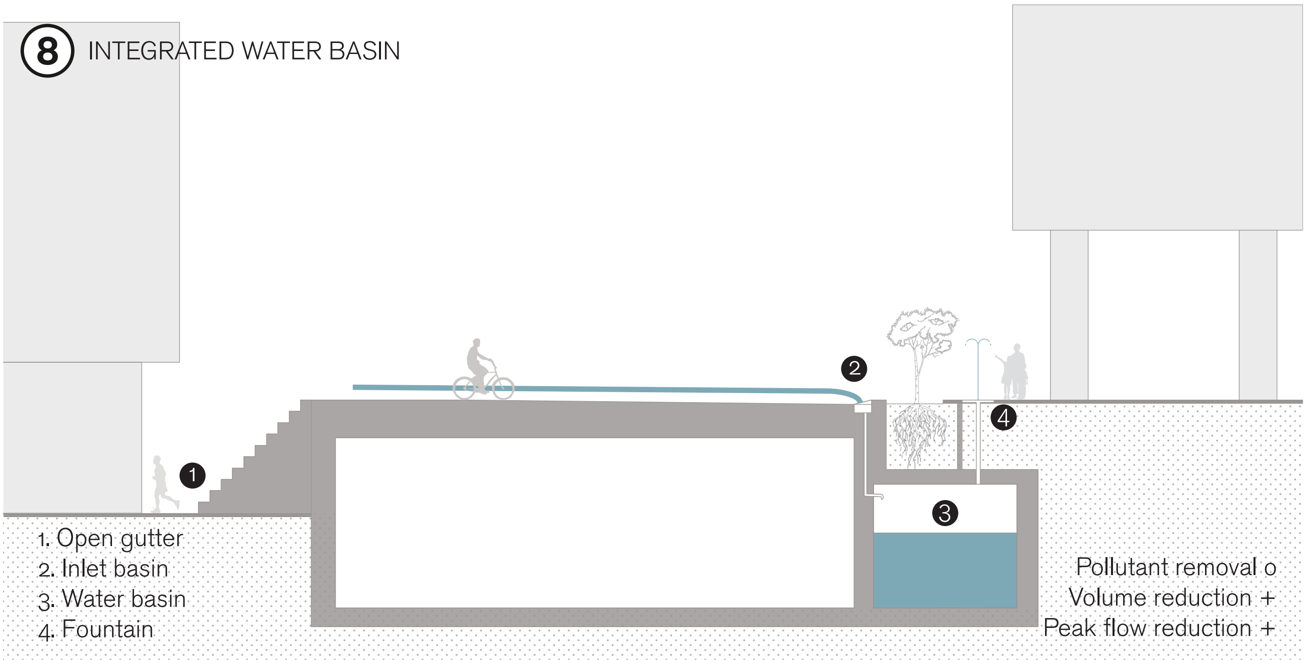

Figure 10.38: Flow of fast lane living environment, (Author, 2018)

NEW DEVELOPMENT GUIDELINES

In order to ensure the key principles of the design, guidelines for new building development of the Downtown type are the exact construction fields fixed for new buildings. The following main issues have been fixed in this document:

- Parking is done in the plinth of new apartment buildings.
- The streets are dead end, motorized vehicles can only enter for drop off purpose.
- New buildings need to reserve an infiltration plot measuring a minimum of 1,2 meters from the building boundary.

Building rules and building envelopes
The following housing types can be distinguished within the subdivision of the building zones A, B and C:

A. Apartment blocks with commercial functions in the ground floor, up to 5 levels max.
B. Apartment blocks with parking in the ground floor, up to 5 levels max
C. Small-scale residential apartment buildings, up to 4 levels max.

People can buy an additional plot of green in the private area. The buyers of the plots will form an association of owners. This association of owners will be responsible for the management and maintenance of the green plots. The reference buildings in the map on the side, illustrate how the new building footprints can be planned. Additional green space may be used for activities, that do not leave nutricions or polluting substances - like non organic waste and fertilizer.

Traffic and parking
In order to prevent unnecessary traffic inside of the neighborhood the streets are closed and only accessible for electric vehicles to drop people and goods off. Since traffic flow on 6th and 7th street (towards Market Street) needs to maintain undisturbed, parking spaces are situated along Howard street and Folsom street. E-Bike parking facilities are located in the paved zone of the green court and offer charging and locking stations.

Water management
For the water management around and below the residential buildings, a drainage system must be installed by the project developer, connected to the public facilities, so that the groundwater level remains at a level where no flooding or damage occurs.

Precipitation is buffered on a neighborhood scale for as long as possible. When new buildings are realized, space for an infiltration plot measuring 1,2 meters from the building boundary needs to be reserved. At the front of the houses, rainwater is transported above ground to the public space in the green court. Residents must ensure proper drainage of the backyard. Pruning waste from public and private green is collected collectively.

Target residents
Zone A is intended for professionals (programmers, artists, owners of small businesses) that want to combine living and working and that demand a more urban lifestyle.

Zone B is intended for a higher income group, people with and without families that have a private car and want to store in the parking facilities in the building block.

Zone C is exclusively intended for young couples and families with children. So that the activities that are intended in the public space on court are combined with the right target group.

- - - - building boundary
intended private green
intended public green
▲ parking entrance

Reference building
A Mixed-use
B Building blocks w. parking
C Family housing

100 meter

Figure 10.39: New development guidelines, (Author, 2018)

Building guidelines

In order to secure a sustainable relationship between the buildings and the public space; in relation to light, permeable ground and the ability to facilitate outdoor activities. Guiding rules have been made about use of the building plot and physical dimensions of the buildings. The following illustrations constitute a summary of these rules.

Building Zone A

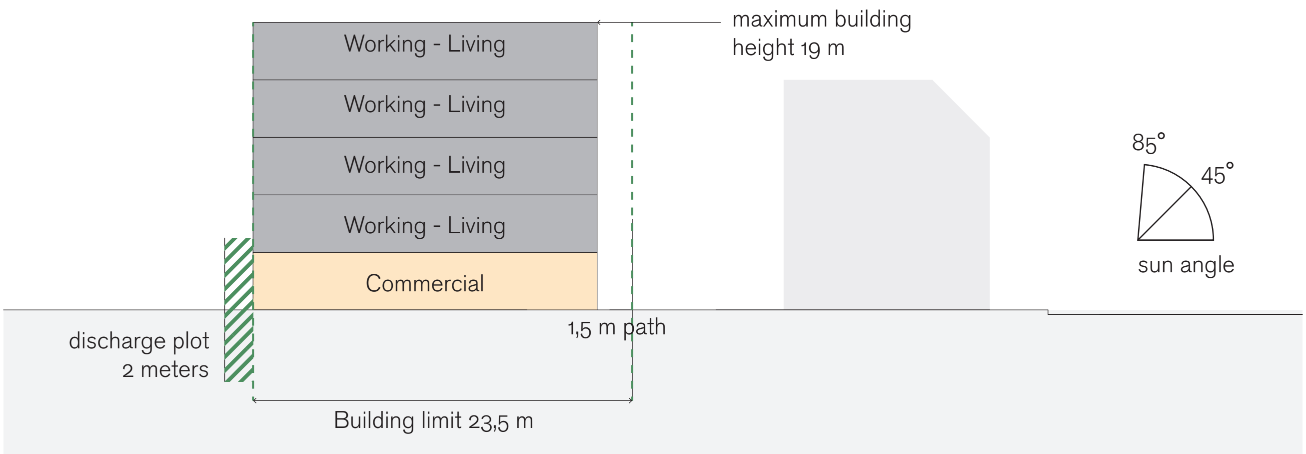

Figure 10.1: Title, (Author, 2018)

Building Zone B

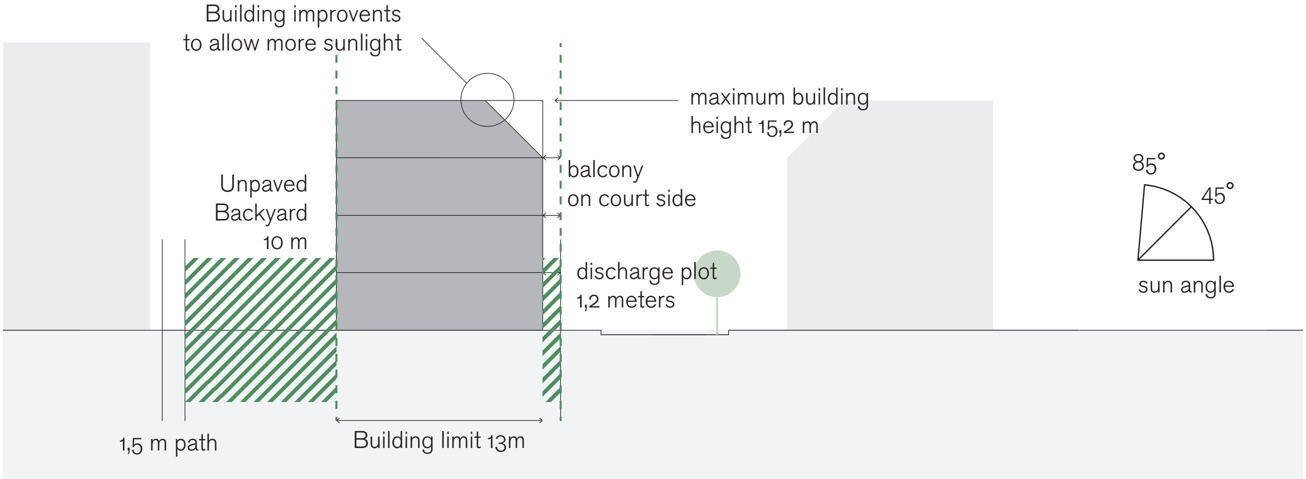

Figure 10.1: Title, (Author, 2018)

Building Zone C

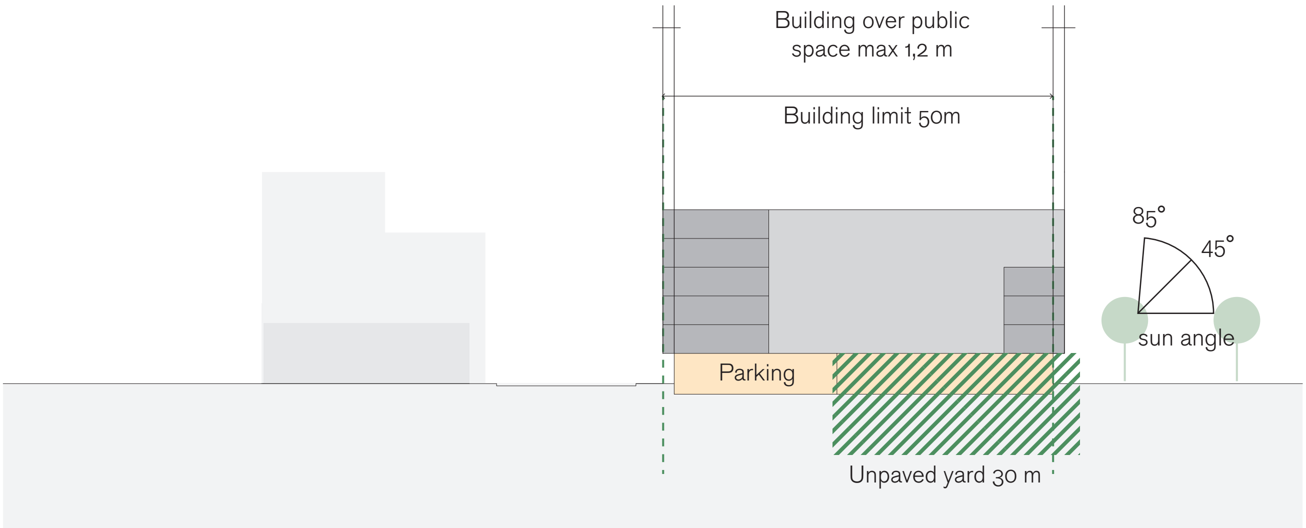

Figure 10.1: Title, (Author, 2018)

Part IV: Conclusions

11 CONCLUSIONS

Figure 11.1: Impression of future mobility, Source: (Author, 2018)

Main research question:
How can a revalued Strategy (**1**) of the Two Networks be utilized, in order to support urban renewal (**2**) in dealing with the environmental crisis and new modes of mobility (**3**)?

Sub research question **1**:
What is the value of the original S2N in another context?

Sub research question **2**:
How can the synergy of flows in the urban system be utilized in a methodological approach for urban renewal?

Sub research question **3**:
Can new modes of mobility offer spatial solutions to deal effectively with the environmental crisis?

The aim of the project is to provide an approach in which integrated engineering and urban planning and design will mitigate environmental crisis in a scenario of technological innovations in mobility. Moreover, the aim is to revalue the Strategy of the Two Networks (S2N), to develop a conceptual framework that guides and structures this approach. This is done in a systematic way of simplifying the urban dynamics These so called *conceptual building blocks* are consecutively *the revalued S2N*, *mobility infrastructure prototypes* and *urban typologies*.

The test-case for this approach is located in San Francisco. San Francisco lies in a unique natural context and possesses great capital which is of great value for the whole bay area. However, this capital is under pressure of future dynamics, caused by decades of human interference without acknowledging the natural conditions of the Bay. This uncertainty makes San Francisco an unsustainable city for people to settle in the future.

The main problematic affecting San Francisco are caused by poor water management, obsolete mobility infrastructures and insufficient capacity for population growth. However, future mobility enables potentials like efficient use of space, healthier urban environments and reduced negative effect on the water system. Located in critical places in the water course of the Mission creek watershed - the structures of the I-101 and I-280 highway have a significant effect on its environment and is therefore the test-case of the project.

In response to the trends affecting the test-case, this research starts with the conception that the S2N internalizes a method that could help face the challenges occurring both globally and as tested in San Francisco. However, as Marshall (2012) states that urban research needs a critical attitude towards the application of theory. A systematic verification and critical assimilation of scientific knowledge should consolidate a revalued S2N. Because the S2N does not provide an actual design method, this project focuses on developing a design method based on a revalued S2N for a complex case.

(1) The S2N is developed in the early 90's and because of contemporary challenges like climate change and technical innovations in mobility, the S2N is not up to date. Evidently, the S2N is not adapted to AV's and does not anticipate on other topographical settings.

According to the revaluation of the guiding principles and models and by applying the revalued guiding principles and models in design - *the value of the original S2N in another context* is still embedded in the core principles of the original S2N. The value of the S2N lies in the ecological framework of interrelated flows and relation with the actors that it offers. Regardless of whether you change the context or period in time, the relationship remains the same. As a method, the value of the S2N lies in the fact that it offers simplified principles of complex systems - the guiding principles and models - which are the first steps to design. However, additional improvements to the method need to be made, in order to consolidate the method of the S2N. Therefore, this research constructed additional conceptual building blocks that help to simplify the urban system.

(2) Supplemental to the conceptual building block the revalued S2N represents, there are two more building blocks supporting the representation of the physical context. Based on the West8 prototypes, spatial representation of mobility infrastructures are made. In addition, the Spacemate is used in order to make a representation of the urban system.

Combining the information from the conceptual building blocks with contemporary insights from the theory of Landscape Urbanism make it possible to generate concrete ideas for a design for urban renewal. The revalued guiding principles and models offer strategical aims on urban renewal and the urban program. This makes it possible to locate specific living environments in relation to the carrying flows and actors; embedded in an ecological framework, which is supported by Landscape Urbanism. In the project, the guiding models and guiding principles enabled a synergy between the flows in different plans of design.

(3) As a consequence, the vision for the spatial solution to the environmental crisis was delivered from the (urban) landscape of San Francisco. By integrated design of landscape, urban typologies and mobility infrastructure prototypes it became possible to redevelop the current highway into a multifunctional infrastructure, enabled by future modes of mobility. By retrofitting mobility infrastructures, future mobility issues can be combined with water management and urban renewal. By utilizing the space above and below the constructed infrastructure, improving the construction and materialization of the mobility infrastructure and matching the right programs locally to the mobility infrastructure.

By answering the sub questions, answer can be given to the main research question: *How can a revalued Strategy of the Two Networks be utilized, in order to support urban renewal in dealing with the environmental crisis and new modes of mobility*?

As both a method and a strategy, the S2N is of significant value for the application in another context. As a strategy, the value of the S2N lies in the ecological framework of flows and actors that it offers to the project. As a method, the value of the S2N lies in the fact that it offers simplified design principles of complex systems. The revalued guiding principles and models make it possible to generate and locate specific living environments in relation to the local carrying flows and actors; embedded in an ecological framework, which is shaped by Landscape Urbanism.

The revalued guiding models and guiding principles, showed useful in the construction of a synergy in flows in a context of future dynamics in an unknown urban system. The vision for the spatial solution to the environmental crisis was delivered from integrated design of landscape, urban typology and mobility infrastructure prototype. Subsequently, the alternative to the present highway system is an actual multifunctional infrastructure embedded in an ecological structured framework of slow and fast flows, enabled by the potentials of future modes of mobility on the one hand and critical consideration of the natural landscape on the other hand.

11.1 Reflection

The next part of this reports conclusion chapter will shed light on the process and results of research and design in the graduation project. The aim of the reflection is to look back on the development of the project and elaborate on the project approach. Subsequently, the choice of method and argumentation which preceded the research is going to be reflected on and answer the question of how and why the approach did or did not work and to what extent.

The relationship between research and design

Looking back at the project, it can be concluded that the process and the design are very much influenced by multiple loops of backward and forward research. Each conceptual building block was a new loop of research, and switching between the building blocks, resulted in valuable interconnections between the building blocks. The research method however, is also very much influenced by design. The research done on the conceptual building blocks, resulted in products that where already closely related to design: the guiding models and guiding principles, the mobility infrastructure prototypes and the urban typologies. The combination of these building blocks turned out to be a very clear foundation for the design. However, in the process of developing this report, the structure was not always as clear. Especially in earlier stages of design, this disturbed the switch between research in design.

As this project is built up from existing theories, this theoretical foundation influenced the process both positively and negatively. By focussing on the given perspectives and the systematic research method, a clear frame was provided and thematic focus throughout all aspects of the research was present. Also in the process of synthesis and design it offered very clear conceptual building blocks. However, at times it also caused distraction from the core values of the project, which sometimes resulted in unnecessary research. Subsequently, as a result from the research and design process, it can be concluded that this project tends to be a method of design research. During the project, it was an ongoing process of searching for an appropriate method that can complement the systematic approach of the Strategy of the Two Networks. Building this clear framework, was as demanding and labour-intensive as the research and design itself. Luckily, in the end the combination of the three building blocks proved to be a complete and insightful method.

The relationship between the theme of the graduation lab and the subject/case study chosen by the student within this framework (location/object).

This project is conducted under the theme of the Delta Urbanism studio, which focusses on the integrated approach of the design and planning of urbanized delta areas. The studio reflects on new interdependencies between natural processes and societal practices for the delivery of water resilient urbanized areas, landscapes and regions. Although the case area of this thesis is not located in a delta, San Francisco naturally had a very dynamic landscape of hills and floodplanes very much comparable to a delta landscape. The urbanisation of San Francisco - without acknowledging the natural conditions of the landscape - resulted in a project in which products of human activity that disturb the natural functionality of the landscape, were extensively researched. Subsequently, the integrated approach of the studio is one of the key elements of the project. And the Strategy of the Two Networks - on which this graduation project is based - is an integrated approach that looks for synergy in the natural and human processes.

The relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework.

As the studio focusses on the integrated approach of new interdependencies between natural processes and societal practices for the delivery of water resilient urbanized areas. One of the main approaches was to explore the landscape from the 3x3x3 analysis, which is an analytical method in which different layers of the landscape are analysed from three different time perspectives and three different scales. The designated method of this thesis, a revised Strategy of the Two Networks, is a manifestation of this approach. And positions itself by relating the natural processes with societal practices. This project attempted to improve the traditional approach by linking the conventional themes to future mobility and climate change. This was done by a systematic assessment of mobility infrastructure and urban typologies, linking flow management to human activities.

The relationship between the project and the wider social context.

Environmental crisis is already occurring, and policy makers cannot ignore this anymore in order to prevent unnecessary damage to the economy and the population health. Integrated design and engineering of urban areas, from the environmental point of view is not a question anymore. In a scenario of explosive population growth, this more efficient approach of the available space, is unavoidable. Moreover, this projects not only has attempted to explore a scenario in which the change in hydrology is occuring, but also integrated the future development of mobility infrastructures. Generating alternative measures to manage future dynamics.

11.2 Urban theory paper

Perspectives on innovative green-blue urban design

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Abstract – More and more cities are looking for new, more complete implementation of green space in the city. Besides recreational purpose and aesthetics, improving air quality, increasing property value and better health are some co-benefits (van der Heide & Ruijs, 2010, pp. 3-4). Decentralised models for urban development were already conceived early in the 20th century. The urban development concepts were attempts to improve the inefficiency of our cities. And while the petroleum era, caused a period of still stand. New discussions in the 21st century woke up the discussion about the integrated design of green-blue networks with more conventional forms of networks and infrastructures. During the review of this research topic, the focus is set on two different approaches for urban development which seek for a synergism of different flows and networks. These concepts will be the more traditional Dutch strategy of the two networks and the landscape oriented urban landscape infrastructures. This research will explore and compare the perspectives on integrated and multidisciplinary approaches in the design and strategy of green-blue networks in order to guide urban development. Moreover, this research needs to give a more concrete definition of urban landscape infrastructures and green-blue networks.

Key words – green-blue networks, mobility, hydrology, landscape infrastructures, two network strategy.

1 Introduction

More and more cities are looking for new, more complete implementation of green space in the city. Besides recreational purpose and aesthetics, improving air quality, increasing property value and better health are some co-benefits (van der Heide & Ruijs, 2010, pp. 3-4). Moreover, climate change and the growing pressure on available space in and outside cities require better performances in its capability to keep the ecology and water cycle in balance.

The objective of water management in urban areas is to ensure that no damage is caused during peak periods of precipitation in the city and that prolonged periods of drought do not cause problems in the city, nor the countryside. It ensures that cities are supplied with sources of clean drinking water and proper treatment of wastewater. On the other hand, various factors in the urban water balance, form a very fragile balance. However, this vulnerable balance of the urban water cycle is under pressure of the effects of climate change and growing urbanization. Green-blue cities aim to recreate a naturally oriented water cycle while contributing amenities to the city by bringing water management and green infrastructure together (Pötz, Bleuzé, Sjauw En Wa, & Baar, 2012, p. 49).

1.1 Development of green and blue

However, the theory will prove, that green-blue development is very much depending on mobility networks and its capability to adapt to ecological and hydrological networks. Moreover, degradation of the water- and ecosystems are very much caused by mobility structures (Walsh, Fletcher, & Burns, 2012, pp. 1-3). In an attempt to comprehend the complexity of urban development in the context of ever going contingency, key theories in the field of green-blue networks are explored. Innovative and integrated forms of engineering and urban planning are ought to battle environmental crisis in a scenario of future technological innovations.

From the environmental point of view, mobility and the change in the hydrological system are taken as trends from which the urban program needs to adapt. This research paper will explore multifunctional infrastructures driven by mobility as integrated design guidelines with water management. In the first part of this paper the history and current state of green-blue development will be explored. Next the strategy of the two networks and the concept of design of urban landscape infrastructures and different aspects of the integration of multifunctional infrastructures will be made explicit. Lastly, the conclusion will compare the two principles of integrated design.

2 History of green-blue development

Decentralized models for urban development were already conceived early in the 20th century. The urban development concepts were attempts to improve the inefficiency of our cities. Decentralized concepts for productive green areas and reuse of urban waste were developed. This was not only a response to the urban pressure of cities, but also to food shortages by the great depression and World War 1 (Pötz et al., 2012, pp. 28-30).

2.1 Visionary predecessors

One of the key concepts are the Garden City by Ebenezer Howard and Lebrechts Migge's socialised Kolonialparken and garden city concepts. Howard's idea of a garden city presented an alternative perspective to the urban pressure caused by expanding cities. His model represented a central city linked to a series of satellite cities which provided agriculture, urban waste processing and water purification. The green areas in Howard's city model were very productive, offering a high level of self-sufficiency. Ebenezer Howard was one of the first to identify the inefficiency of long transport lines (Pötz et al., 2012, pp. 28-31).

German garden and landscape architect Lebrecht Migge developed ideas for socialising urban vegetation. He transformed representative green areas into Kolonialparken and allotment areas centred around commons. Additionally, Migge worked on models for increased efficiency of his gardens and Kolonialparken, reusing organic urban waste and integrated water purification in the green areas. Similarly, Le Corbusier's concept of 'Ville Contemporaire' still presents self-sufficiency, agriculture and allotments as self-evident elements. And Frank Lloyd Wright's Broadcare City concept, the residents own kitchen gardens or live on small farms (Pötz et al., 2012, pp. 28-31).

2.1 Beginning of the petroleum era

After the Depression of the 1930s, the developments of new concepts came to a standstill. Following World War 2, only few continued the development of new concepts. Urban agriculture and the concept of cycles became less important to urban developers; the use of petroleum products for artificial fertilisers, pesticides, transport and cooling. Moreover, waste water purification and processing and organic waste processing where not linked to the production anymore. Rendering the integrated approach of green and blue idle (Pötz et al., 2012, pp. 28-31).

3 Contemporary green-blue development

Decades of increasing urbanization has reversed urban and natural proportions. Whereas urbanized islands where previously embedded in agricultural or natural landscapes because of food production. Nowadays in heavily urbanized areas around the world, green zones only occur between the urbanized areas. Causing inner urban areas to lack certain ecological and hydrological services. In the international urban development discussion, structuring function are assigned to those green areas between the diffuse and expanding urban areas. Which means that in future scenarios, it is no longer the built-up urban area that serves as a structuring element, but rather green areas that serve various functions (Pötz et al., 2012, pp. 23-35).

The integrated design of green-blue networks with more conventional forms of networks and infrastructures become a medium to a more natural approach to urban storm water management. Through the use of natural outflow or buffering, more use of onsite infiltration into the soil and improved urban planning, will be more cost effective and efficient compared to centralized water management (Pötz et al., 2012, pp. 49-59).

4 The strategy of the two networks

Inspired by the discourse over spatial configuration of agricultural and more natural zones between urbanized areas. The strategy of the two networks is a guiding model that expanded the idea of creating a frame as a carrying structure based on the synergy of hydrology and nature. It also created conditions for agriculture based on the spaces opened by the frame, in order to conserve and create habitat between urbanized areas. The strategy of the two networks included urban development and took the traffic network as a second carrying structure for agricultural and industrial activities, these activities require transport conditions as a result of the dynamics of technology and economy (Nijhuis, Jauslin, & van der Hoeven, 2015, p. 62).

4.1 Area, flow and actor perspective

Tjallingii (1996, pp. 181-195) states that in the urban landscape three core values exist that require synergy between activities in need for carrying structures. From an area perspective, the aim is to create amenities for a habitable environment for human users. Secondly, from a flow perspective, the aim is to generate activities that have internalized the responsibility for flows. And lastly, form the actors' perspective the strategic aim is to create conditions for a shared involvement in ecological and hydrological.

4.2 Synergism of mobility and hydrology

The strategy of the two networks takes the area perspective as its starting point. As a guiding model that should be able to cope with the persistent problems of urbanization, the approach adopted the carrying structures of water (slow) and the traffic system (fast) (Tjallingii, 1996, p. 266). The slow lane is the ecology driven flow manager, making use of the local landscape where water safety and quality are combined. The water network based on the drainage pattern is the carrier. The fast lane, on the other hand, supports the efficient productivity of activities. This includes the industrial ecology of recycling, waste treatment and waste prevention strategies. From a planning perspective the slow lane environment requires for strategies of co-operation and key involvement from non-profit organizations, both private and public. In the fast lane, strategies for competition are the driving force (Nijhuis et al., 2015, pp. 58-78).

5 Design of urban landscape infrastructures

The next type of synergy explored, is the design concept of urban landscape infrastructures. This concept seeks to redefine infrastructure beyond its strictly utilitarian definition. This more contemporary design concept is capable of forming a frame for urban development and facilitates functional, social and ecological interactions. By approaching infrastructural design as an interdisciplinary effort to establish a local identity through tangible relationships to a place or region. The design of these practical landscape infrastructures is a crosscutting field that involves multiple disciplines in which the role of designers is essential (Nijhuis et al., 2015, p. 14).

5.1 The new engineering

Bélanger (2013, pp. 8-9) states that as ecology becomes the new engineering, the project of landscape infrastructure is proposed here. The approach of landscape infrastructure surpasses the more historic tendencies of the practice of (landscape) architecture and embraces urbanization as a predominant process in the contemporary spatial transformation. Moreover it attempts to fix the centralized conditions of the 19th century urban form and of the industrial city.

Landscape infrastructure is driven by civil engineering and advocate of multifunctional urban infrastructure. Predominant challenges facing urban regions today are addressed, including changing climates, resource flows, and population mobilities. Responding to the slowness of land use zoning and the overexertion of technological systems at the end of the 20th century the concept of landscape infrastructures argues for the strategic design of infrastructural ecologies, a synthetic landscape of living, biophysical systems that operate as an urban infrastructures to shape and direct the future of urban economies into the 21st century (Bélanger, 2013).

5.2 Synergism of mobility and ecology

The integration of the infrastructural system within the landscape framework requires the redefinition of the old system with a new set of requirements. Requirements that are more aligned to natural systems of ecology and green space. The contingency of today's infrastructure necessitates the system to be designed for flexibility and adaptability. Secondly, traditional infrastructure was conceived as a centralized, mono-functional system. Today's trend however, is for the infrastructure system to become decentralized, where the need to address for instance, storm water runoff, energy, farming, or transportation dealt with at a local level. Aside from performing its intended functions, the multifunctional variations of these vital systems can be a catalyst for urban development (Ying & Infrastructure Research Initiative at S. W. A., 2011, p. 17).

Landscape infrastructures require mobility infrastructures to perform multiple functions: they must fulfil the requirements of public space and must be connected to other functioning urban systems. The multifunctional aspect of infrastructure also speaks to the importance of diversification as a general principle in city-making, leading to an optimized condition in which the city and its infrastructure are one and the same, where infrastructure informs how the city is organized and built. In addition to the temporal, decentralized, and multifunctional characteristics that define landscape infrastructure, landscape infrastructure is further comprised of a set of attributes relating to form, function, and time, outlined below, all of which have a cumulative effect benefiting the greater whole. A landscape infrastructure project may contain all of the attributes described, with one more dominant than another given varying degrees of scale, scope, and influence (Ying & Infrastructure Research Initiative at S. W. A., 2011, p. 17).

6 Conclusions

Reviewing the perspectives on integrated and multidisciplinary approaches in the design and strategy of green-blue networks in order to guide urban development. One can conclude that the two approaches originate from the same body of thought, historically and conceptionally. Though they are fundamentally different in the way mobility structures are adapted and objectified.

Decentralized models for urban development were already conceived in the 20th century. Green-blue development was driven by agriculture and innovations where made for the cause of productivity using green and blue. Visionary predecessors in the field of the design of garden cities where Ebenezer Howard and Lebrecht Migge. However, after the Depression of the 1930s, urban agriculture and the concept of cycles became less important to urban developers. Luckily, in the international urban development discussion, structuring function where assigned to the green areas again, which are located between the expanding urban areas.

The common concept embraced by both the strategy of the two networks and the concept of urban landscape infrastructures, lies very much in the hybridization of the mobility and hydrology network in order to anticipate on new requirements caused by contingency. And subsequently moving from a centralized system, to a decentralized and local system. Also, do the two approached very much focus on the amenities created for residential habitat, the responsibility to accommodate flows and the creation of the conditions from the involved perspective of the user. More than from the perspective of landscape infrastructures, the strategic aim in the strategy of the two networks requires more direct social involvement.

However, the approach of landscape infrastructures is a more contemporary one. Focusing more on energy and present problems in the infrastructural system. And where landscape infrastructures objectify and really hybridizes the infrastructural system. The strategy of the two networks creates more of a frameworks in which the whole of flows of fast and slows are facilitated. Giving it more potential to act as a guiding model for urban development, driven by changes in the hydrology and ecology.

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11.3 Graduation orientation

For the graduation orientation, a workshop is done with Jeremy Bricker. Jeremy is a hydraulic engineer from the faculty of engineering, who studies hydraulic and coastal engineering focused on the application of fluid mechanics to engineering design. At the Stanford University, he studied wave-current interaction and sediment transport in the San Francsico Bay. In addition he investigated wastewater outfall and river plume dilution in Osaka. Because of his experience as a civil engineer, originating from the Stanford University in San Francisco, we are very interested in his input on our works as Delta Urbanism students.

The workshop is a round the table interview with Jeremy in which we present our own plans and Jeremy thereafter gives his opinion from his expertise. The initial theme of the interview was subsoil and the public utilities in San Francisco. Although the workshop we had was prepared, and the main focus was discussed. The workshop should act as sort of a dialogue, to stimulate unexpected input from de interviewee. The interview helps us get an insight into different technological aspects of our subjects, as well as providing a different opinion from the perspective of a civil engineer. We each prepared questions, on ground water and soil quality, sediment, governance and underground storage and then interviewed him for an hour.

Since this thesis is very much focussing on urban development enabled by environmental crisis, caused by urban runoff. and innovations in mobility, Intensive research has to be done about public utilities in and above the subsurface. Also, integrated and multidisciplinary design asks cross-discipline involvement. Someone originating from the Bay Area can tell more about the proposed implications of hydrological systems. The following part of the text summarizes the interview with Jeremy.

Jeremy: Jeremy summarizes his research on sedimentation and erosion in the San Francisco Bay area and his experience as a consultant engineer in a firm for hydraulic engineering. Here he focussed on drainage, dam construction and removal, dykes and water supply. Then he worked for 8 years in Japan to work on environmental crisis caused by tsunami's. Now he working on storm surge and infrastructures and buildings in the Netherlands.

Peter: Peter introduces his research by stating that his thesis takes the changes in hydrology and technical innovations in mobility as driving forces for new development in San Francisco. The trajectory of the 280 and 101 Freeways are the main focus of the thesis and Mission Bay is the location of design. Subsequently, this case is influenced by flooding caused by precipitation from the west and flooding caused by sea level rise on the east. As a possible solution Peter proposes two networks based on the Strategy of the Two Networks, a fast mobily network and a slow network for hydrology. Jeremy responds that infiltration might not be possible because the area is not higher than the sea level, however a living breakwater system along the coast might mitigate tip-over. For similar projects, there is the New York rebuild by design competition that have entries with living breakwater systems. Ground water storage might not work in Mission Bay and the coast is already used, so those are two problems. Also he warns that in addition to the freeways there is also a railroad running through there.

Lisanne: Lisanne focusses on flexible interactive rainwater storage for Amsterdam Buiksloterham area, sustainable awareness through urban participation. Lisanne introduced her case in Amsterdam, however Jeremy Bricker immediately mentioned his inexperience in this location. He suggested for her to absorb information from the other cases and ask questions that adress her individual case during the discussions of the other cases.

Max: Max focusses on the Petaluma marshland restoration and sedimentation control by the means of building with nature; using natural processes to prevent future floods. Jeremy elaborates on the relation between upstream sedimentation by pluvial flows and downstream sediments that come from bay water movement. He related future sedimentation to past human alterations of the bay. Aquatic mining from 1840 onwards influenced the amount of sediment in the bay area because rock and stone structures under the water were drilled or dug into smaller pieces. Marshland adaptation to agricultural fields and later salt retention ponds has created less space where sediment is gathered, therefore caused an increase in coastal sediment flow. However, these alterations have not appeared since 1920 and a sedimentary equilibrium could be expected. This all means that upstream sedimentation will soon be the dominant flow and Max should focus on this pattern during the remainder of his research project.

After the sedimentation equation had been settled, the discussion continued on flood control for the Petaluma area. Max suggested that the flood risk is very high with sea level rise, mainly because of the collection of sedimentation in and around the city. Jeremy proposed to think of ways to collect sediment at desired locations, by creating bodies of shallow water, where sand could be collected. The speed of water flows could be controlled by creating dams or natural breakwaters, to optimise sedimentation packing. A bypass before the city limits, ending in a large shallow lake, could be an ideal solution to future problems regarding sediment and floods.

Jeroen: Jeroen discusses pluvial flood water retention by the means of green urban transformation and network development. Jeremy responded by explaining that infiltrated pluvial water could not be used immediately as a resource. Filtration and treatment is necessary before consumption is possible. Jeroen replies by asking if this water could be stored and used as grey water in households. Jeremy acknowledged this would be a sustainable possibility, however the plumbing of the houses needs to be adapted before this collected water could be used. While individual households might obtain certain transformations because they have money to invest and wish to live more sustainable, this could not be applied as a structural urban plan. It might be rewarding to research possibilities of rainwater storage and reuse in a public situation. Due to seasonal rain, irrigation might not be a proper function for stored rainwater.

Benefits of infiltrating pluvial water into the soil include prevention of drainage flooding; which means the municipality of San Francisco prevents federal fines they receive after each overflow. This benefit may be a large enough driving factor to stimulate green urban transformation. Since a lot of surface currently is covered by impervious materials, development of these layers might be most beneficial.

From the interview with Jeremy I got good input as in the reference of living breakwater systems as a system for purification and mitigation of top over in events of storm. Also new insights on the relationship between the history of San Francisco and the technical aspects of topography, landfill and environmental crisis gave new insights. Moreover, his feedback on the technological aspects of Mission Bay where very important to re-consider certain solutions, like infiltration systems in Mission Bay.

However, the discourse of the other group members was also very valuable. For example, Max's case is more related to the natural context, of which San Francisco is originating from. And the natural properties of the marshes are also very much relatable to my own project. Moreover, the aspect of time that where discussed was very interesting to implement in my own project. Jeremy subsequently stated that the natural conditions of Petaluma will change because of settlement of the marshlands.

All in all, the round the table workshop was very usefull. The discourse that emerged was very constructive and went very naturally. Though the workshop wasn't exactly as planned, the workshop went very well and organized. The only point of criticism was the fact that th workshop exceeded the hour limited by a little bit. Which meant that the interviewee had to top at a certain point without really wrapping up the workshop. Jeremy stated however that we where always welcome to contact him.

11.4 Graduation Plan

Personal Information	
Name	Peter Steehouder
Student number	4018117
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E-mail address	petersteehouder@gmail.com / p.steehouder@student.tudelft.nl
Graduation Studio	
Name / Theme	Delta Interventions / Delta Urbanism
Teachers	Fransje Hooimeijer (1st), Wil Zonneveld (2nd)
Argumentation of choice of studio	Interested in integrated design of performative networks
Graduation Project	
Title of the graduation project	Green-Blue-Gray Networks
Goal	
Location	Mission Bay, San Francisco. California, USA
The posed problem	San Francisco lies in a unique natural context and possesses great capital, which is of great value for the whole Bay Area. However, this capital is under pressure of future uncertainties, caused by decades of human interference without acknowledging the natural conditions of the Bay. The main problematics are caused by poor water management in relation to the natural landscape, conflict over habitat and the monofunctionality of mobility infrastructures.
Research Question	"How can innovative and integrated engineering, urban planning and design create conditions for urban renewal, anticipating on environmental crisis and future mobility?"
Design assignment	From the environmental point of view, future mobility (positive) and the change in the hydrological system (negative) are taken as trends from which the urban program needs to unfold. Basically, this is an application of the Strategy of the Two Networks by Sybrand Tjallingii. The primary objective of this thesis, is to put this product of the Dutch planning tradition in an unfamiliar context and explore its potential for an appropriate theory in the San Francisco context.
Process	
Method description	The methodology of this research is very much driven by the thematic domains framing the possible research perspectives. The methodology used in this project is sub divided in four essential segments.

Problem analysis segment is founded on personal motivation and fascination and is based on personal supported theories. Moreover, a visit to the site and research done in history and present trends, shapes the relation between the theory and the site. The 3 theoretical domains are a result of clarifying and deducing the problem analysis and is a combination of theory and local trends.

Moreover, the insights done are validated by doing 3x3x3 and a SWOT analysis. The final result of this segment or phase is a research question.

Theoretical framework segment is the second segment is a consequence of the main research question. The reduction of this main research question led to the sub research questions, according to the three domains of environment, habitat and mobility. The actual theoretical framework, is composed of a review paper exploring important subjects for the framework of this research.

The Analysis segment is done through the scales and also conform the three domains. The macro, meso and micro scale are analysed from the perspective of environment, habitat and mobility. The combination of the three domains through the different scales is an important tool to explore local potentials and motivation for the design.

After the analysis part, the design and strategy follows. The design is also done on a macro, meso and micro scale and is supported by the conclusions of the analysis segment. Again, this design of the strategy is according to the three domains, however the design and strategy is aimed to be a assemble of the different domains in order to create a integrated whole. On the Macro scale, a strategy for new development will be developed conform the thematic domains.

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