West Silvertown
Docklands Light Railway station on London’s floodplain
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Colophon

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The content of this booklet is based on research and design carried out at the Delta Interventions Studio at the Delft University of Technology, Faculty of Architecture.

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Cover
Aerial view on West Silvertown

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Preface

London is shaped by the Thames, a dynamic relationship working in both directions that has and will continue to define the city’s development. This thesis summarises the research on these dynamics and proposes approaches on the scales of urban planning and architectural design. The study is initiated and completed within the framework of the Delta Interventions Studio, for the Architecture, Urbanism, and Building Technology Master of Science graduation at the Faculty of Architecture at the Delft University of Technology.

The thesis is divided in four main sections explaining the research and design at the foundation of this project. The first section, Origins, describes the historic development and ecological conditions of London’s floodplain and seeks the relationship between the two. The second section, Water & Growth, focuses on the current and future conditions of Greater London from the perspective of water risks and urban development. The last two sections, Urban Plan and West Silvertown Station, offer an interpretation of the results from the first two sections; a masterplan that describes the context for the architectural design of a station on the floodplain.
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Introduction

Context

London is the capital of the United Kingdom and the most populous metropolitan area in the European Union (Office for National Statistics, 2008). Due to its political characteristics, rich culture, influence in finance, and concentration of higher education, London has emerged as a leading global city (Sassen, 1991).

The city of London developed along the Thames River and its (now underground) tributaries for over two millennia. The river was once characterised by inherent floodplains accustomed to the threat of floods (Sheppard, 2000) and slowly transformed into an urbanised river city dealing with ecological threats from a protective perspective.

This tendency led to several interventions in water management against high tides and storm surges, minimising the risk of flooding until 2070 to 1 to 1000 (Environment Agency, 2010). In addition to protect the city, preliminary plans propose a 16 kilometre barrier across the Thames Estuary (Times Online, 2005).

The need for such plans is justified. Currently, reports estimate a continuing but steady population growth from the current 7.57 million inhabitants to approximately 8.5 million by 2026 (London Plan, 2008). Enabled by changes in economy, population, lifestyle and environment, city-scale and long-term development initiatives are of high importance for the vitality of the city.

Problem statement

The city of London faces two main challenges, inevitably connected to one another: the population growth of the coming decades and the flood-prone area of the Thames Floodplain. If not taken into account these can impinge the city's future. Generalised, one could state it is just one challenge: of finding a vital balance between ecological systems and urban development.

The substitution of the floodplain by urbanisation for over two millennia has led to an area in the city with a population of 1.5 million people, over eighty underground stops and three world heritage sites, all threatened by three spatial and ecological challenges involving water management. First the alluvial danger; the surroundings of the Thames River and its estuary are flood-prone by the influence of rising sea levels and storm surges. Secondly the rise of groundwater levels caused by the departure of industry that once subtracted large amounts of groundwater. Thirdly the hydrogeology of the Thames bank, characterised by a few water impermeable top layer of soil, any water on the floodplain must find its way to the Thames along the surface.

These three threats become a more severe problem when we look into near-future development expectations as written in the London Plan (2008). Numbers per neighbourhood envision a growth in population geographically east of the city centre with densification specifically on the most floodprone areas on the Thames floodplain.

Merging these threats and trends gives us the characteristics of a steadily growing dense river city, threatened by water issues inherent to its ecological system, with expanding problems due to future densification around its most threatened areas.
Aims

To address the issues defined in the problem statement, it is important to clarify that the population growth and problems that arise with the floodplain are more than a notional connection. All distinguishable layers in the urban fabric influence one another, and the aim of the project lies within these influences. Therefore, the general goal is to research the possibility of integration between ecological systems, urban development and architecture.

Within the framework of research, this will entail the following key-elements:
- To understand the historical ecological processes and characteristics.
- To define the current suppressed ecological processes in the city.
- To reveal how spatial development in London is influenced by ecological processes.
- To enquire data, types and municipal solutions on population growth.
- To expose compatibility between architectural and ecological features.
- To research local solutions for a large framework.

Within the boundaries of design, the following tangible aims are set out:
- To combine water management systems with natural processes.
- To design an urban plan with the potential to foster further similar integrated development in Greater London and offers a framework for an architectural design.
- To design a railway station integrated with and on the floodplain.
- To design a building that incorporates self-sufficiency in a local context.

Relevance

People have habituated delta regions for a long time due to their strategic positions and fertile land. Parallel to this, man started to control and later define the landscape to their specific needs. This interaction has predominantly been one-way, but with current knowledge and technology, a shift in thinking has to take place as to how a durable approach, which copes with the threats inhabitants and the ecology of urbanised delta cities face, can be developed.

The position of society is defining as it relies on the features of the delta, but deals with it as threats. There now is the possibility to re-evaluate this position towards the delta as an opportunity, encouraging a more balanced type of urban and architectural development in an ecological context. Hereby securing essential features as water supply, transport, safety, culture and leisure, all aspects that characterise what the Thames means for London as many other rivers mean for delta regions over the world.

Delta environments have been studied extensively on key-elements as water management, protection and ecology. A general knowledge is present on the complex effects of human interventions in ecological systems, thought necessary in order to develop. There is, however, a lack of knowledge on how ecological systems can prosper under the influence of urbanisation.

By developing a new approach for London, a global city partially urbanised on a floodplain, this project will contribute to adaptive strategies that mitigate environmental threats whilst maintaining a balance between urban and natural ecologies. On the architectural level, the research and design aim to address small-scaled local solutions that complement and clarify the wider urban framework.
Methodology

The research supporting the project’s background can not be easily identified as merely research. It is the interaction between research and design that lays a foundation for the overall products. Initially, the research orientation will focus on acquiring knowledge about the floodplain's characteristics and London's growth, preferably where they interact, like noted in Aims. As a starting point, literature review, mapping, and historical & future scenario data analysis, address both general and London-specific conditions. From here conclusions lead to locations and scenarios, which converges the research and opens up the possibility to start the design process in an abstract manner.

Once the location is defined and early steps in conceptual design have been made a site visit is important to get a sense of scale and identity, the current condition of the area, the characteristics of the location’s vicinity, a photographic report, test where possible if specific research outcomes actually concur with the site, and even possible measurements. A visit also gives the opportunity to talk with local experts, like involved architects and planners, the environmental agency and development corporations.

Research steers the conceptual phase of design, once this phase is mostly concluded it becomes the design that justifies or criticises earlier results, whilst it steers further research. For both the urban plan and architectural design references will play an important role in defining the direction of the project. Reference projects are chosen for a variety of qualities but never all combined; from its function to a conceptual idea or realisation and ending at a fine detail. The products made in the design phase offer constant feedback and will eventually lead to the results that will follow from here on out.
Origins

Since the founding of London in the 1 st century its economy revolved around this position. The port has been vital to London since the Romans and grew to be the busiest port in the world in the 18th and 19th century. London gradually transformed into an urbanised river city with currently over 7.5 million inhabitants (London Plan, 2008). Amidst these continuing developments London has expanded in all aspects and directions. Little by little the port moved downstream while other industries took over its central place in the economy. While the gravity of the city-centre started to lean to the east, the old docks, or London Docklands, became vacant. This wide area, where the Thames bends and curves most, tells the story of London’s urban development in relation to its natural origins best.

All docks have experienced strategic redevelopment in recent history, with some major projects still underway. Researching the location’s historic spatial development in relation to the natural conditions offers an in-depth view of how urban development affected and responded to threats and problems by water over time. As Docklands consists mostly out of reclaimed land and is one of the lowest parts in London, it is an issue now relevant for 1.5 million people living on the London floodplain.

To give shape to the historical research of the urban development on the London Floodplain in relation to the threats from water it is important to understand the natural conditions and systems that appeared prior to the urbanisation of the location. By combining a set of historic maps from London and its vicinity, still excluding land reclamation and port development, uncover the natural layer. In addition, general information on tidal rivers and their landscapes define the hydrological foundation of the area.

Secondly the development of London’s port has to be taken into account, what kind of usage defined the area over time, from the Plaistow Marshes to the scattered development of the Royal Docks. These developments were not randomly decided and weighed heavily on the position and qualities of the areas, all have impacted the future development and led to what characterises the area now. A combination of maps and literature offers insight on the development of the city, from the wooden quays to the first transition by land reclamation at the end of the 18th century, the opening of the West India Docks in 1802, to its transformation into the business district of Canary Wharf.

With the fundamentals of the natural system uncovered and the development distinguished the next step is to look into the dynamics between these two. Three questions offer the framework for the research into history and nature, and will be answered in this first chapter.

- How have the varying natural elements of the floodplain influenced development?
- How have man-made structures influenced the natural conditions?
- How did the natural origins and urban development interact over time?

The first two questions are answered by relating the choices in development, made over the course of two millennia, with the perspective of conditions distinguished in the first chapter. Specific analyses here are the geographical position of the city and its urban patterns against the floodplain, tides and the gradual advancement of the embankment.

As a conclusion of the former two questions, the last question is harder to answer, as natural conditions aren’t linear or cyclical like urbanisation. Weather and climate patterns vary greatly but a trend in change since the founding of London to now can be recognised. Combined with the impact of development on the natural systems it is possible to determine the dynamics of interaction between two hundred years of spatial development of the Docklands and the natural conditions of the floodplain, followed by a brief look in what could come.
1.1  **London floodplain**

1.1.1  **Thames River**

The Thames Valley, River and Estuary are very distinct from before the influence of human occupation and the dynamics of ever-changing landforms. On at least two occasions in history, during periods of low sea level in the ice ages (425,000–130,000 and 25,000–13,000 years ago) (Ross & Clark, 2008, p. 15), the relatively small Thames was diverted and intertwined with the Rhine, extending into the Channel River in what was to become the English Channel.

Throughout these unstable periods of time, the landscape experienced several major changes, from inhabitable and deserted to the moment water started flowing and the tundra slowly became suitable for life again.

Early human occupation gradually left behind its scars on the landscape, which over time had a tremendous effect on the character and usability of land. The appearance of the floodplain system altered, yet the fundamental dynamics were mostly discarded or hidden. These changed, now artificial, conditions led to a fragile system that became flood-prone, polluted and environmentally unaware. In relation to current knowledge on the Thames, the general theory of rivers offers relevant information to better comprehend the unique system of water and nature that established the foundation of London.

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Map 1.2  Tidal range over time projected on the Thames and Greater London
The Thames was and still is a tidal river, fed by the Thames river basin and over twenty tributaries it flows into the North Sea via the Thames estuary after travelling 346 kilometre with an average discharge around 65 m3/s. A minor river compared to the Rhine, with its 1,233 kilometres and 2,000 m3/s, yet the longest river of England.

The range of the tidal section varied greatly over time, before the Teddington Lock was installed the tide would come in as far as Staines, 115 kilometres upstream. Depending on the time of year and the location, the river tides rise and fall in the range of 7 metres and due to its tidal nature, the river’s vicinity is vulnerable to flooding by storm surges.

I.I.I Tributaries

Thames’ most interesting tributaries can be found in the larger metropolitan area of London. Also called ‘the lost rivers of London’, - which describes the evolution of the rivers perfectly – they were once features on the landscape and became underground streams flowing anonymously under the city. In the past they have formed boundaries, dictated the course of roads and influenced the location of industry, contributing to the history and development of London. Now the tributaries are tamed, many have become part of London’s sewer system while some still remain in the open for recreational use. Similar to the non-tidal section of the Thames River, the tributaries, if not forgotten, are controlled by locks and sluices. (Barton, 1996)
1.1.1 Floodplain

Before the feats of human engineering the Thames used to be wide and slow, surrounded by a floodplain. Although not visible now, this flood prone area still exists, yet is contained, discarded and built on.

The floodplain is a nearly flat land adjacent to the river, stretching from the riverbanks to the base of the enclosing Thames valley and was subjected to flooding on a regular basis during periods of high discharge and storm surges, which has now become a threat rather than attribute. The moving flow of water caused the river to meander, eroding the outer banks and widening its valley while going downstream. This phenomenon results in several other, for London relevant, features.

First of these features is the oxbow lake, a U-shaped body of water formed when a wide meander is cut off from the main river. This process occurs when a meander becomes so curved its neck touches the opposite site of the river and eventually breaches through. An example of an oxbow in the making is visible at the

Map 1.4 Thames Floodplain projected on Greater London
Isle of Dogs, with its already distinctive curved shape. Behind these curved shapes is the second feature; the backswamps, low-lying, swampy areas on the floodplain where deposits settle after a flood. This section of the floodplain is most prone to flooding, yet is protected by natural levees.

Traditionally the Thames Floodplain would partially flood several times a year, besides the more rare but major flood events. Without human intervention, each flood allowed the river to deposit its suspended sediment on the riverbanks, leaving behind natural protection that followed the Thames’ path. Both a high river discharge and tidal-related floods can bring in sediments, respectively fine sands, silts and muds, and coastal silts and muds. Natural levees can be breached, for instance when an oxbow lake is being formed, or overtopped, which doesn’t damage the levee and has fewer consequences for future flooding, though it does leave behind sediment over the whole of the floodplain, a natural ability to tackle the settling of soil. Together, these river dynamics laid the foundation of a flourishing ecosystem; from the flora on the floodplain and in its brackish tideway, to the fish, birds and mammals, including humans.
1.1.2 Cultivation to capitol

The first appearance of humans in the Thames Valley occurred around 40,000 BC. Due to the last glacial period it took approximately another 27,000 years before humans were permanently present, as the London area was a barren polar desert where temperatures were around 16–17 degrees lower than today. At this time, sea levels were around 100 metres lower, with a land bridge between what we would now geographically call the southern parts of the British Isles and mainland Europe. (Ross & Clark, 2008, p. 15, 18)

Settling close to rivers, lakes and springs, groups of hunter-gatherers slowly colonised the area in small temporary camps. Under the influence of a changing climate the area became more habitable and around 6,500 BC rising sea levels finally transformed the land into a group of islands. River levels rose simultaneous to the sea and soon low-lying areas around the Thames were submerged. (Ross & Clark, 2008, p. 19)

Along the floodplain of the Thames and its tributaries, traces of human occupation can be found, but it wasn’t until 2,000 BC that land use drastically changed. Farming started to replace a semi-nomadic lifestyle and as the population increased, so did the pressure on the land. Under a growing demand, even parts of the floodplain were being cultivated.

Further away from the river, extensive field systems were laid out and the area thrived under the success of agriculture. Although trade of bronze already existed, long-distance trade flourished parallel to the agricultural productivity, as tin and copper – amongst other commodities – became more important. (Ross & Clark, 2008, p. 22)

Change was coming for the south and east of Britain. Tribal communities, mainly focussed on farming came under growing Roman influence after several expeditions around 50 BC. Trade increased and within a century troops landed and southeast Britain was under Roman control. A connection between two Roman towns (now known as St. Albans and Canterbury) had to cross the Thames, thus the location for early London was soon established. Within several years Londinium had a population that may have reached 10,000 people. Meanwhile the appearance of merchants and goods stimulated the development of provisional quays, which in turn led to shops, workshops and housing. (Ross & Clark, 2008, p. 24–29) Times were turbulent and as the whole of Britain wasn’t conquered a thriving Londinium soon fell prey to tribes. Although completely burned down, the city resurrected a decade later and before the turn of the century (100 AD) Londinium had grown to be the largest city in Britain. This was most noticeable along the Thames, now traversable by bridge and characterised by almost a kilometre of quays with behind them warehouses, together forming the port of the city. (Ross & Clark, 2008, p. 30)
By the middle of the 2nd century, Londinium became the base from which the whole Roman province was managed. A network of roads, where along settlements sprang up, united the hinterland. The port of Londinium played a pivotal role in the success of serving this vast area. It thrived under the import and export from and to all corners of the empire.

During the 4th century the city started a decline as commercial and administrative centre, partially due to the division of Britain into two provinces and a change in location of commercial activity. Although Britain revived after the civil wars in the 3rd century, London did not. After a second division into four provinces the end of Londinium slowly began. By the beginning of the 5th century the British provinces ceased to exist and within a generation the city was abandoned and with exception of the Roman walls enclosing the city, there was hardly a legacy left. (Ross & Clark, 2008, p. 26, 32, 36, 37, 48, 49)
1.1.3 Medieval London

The city walls of Londinium stood empty for a long period of time. Christian missionaries arrived in an Anglo-Saxon occupied east Britain and settled west of the former Roman site. As a trading town, the city benefited from the surviving network of Roman roads whilst the moderately sloped riverbank replaced the ruined embankment of old Londinium. It wasn’t until the 9th century – after Lundenwic was sacked by the Vikings – that new streets were laid out within the old Roman walls. Now called Lundenwic and later Lundenburh, the city functioned as a stronghold for over two centuries. New wharfs brought trade and wealth but also a long-stretching war. Under Danish rule, the 11th century introduced a multitude of cultures into the city as its population grew. Meanwhile the national government separated itself from Lundenwic in re-founded Westminster. With the political and royal centre west of the trading commercial centre they were renewed neighbours, a spatial distinction still noticeable today. Over the following centuries the cities slowly merged, but it was first and foremost a trading city with a secondary role as royal capital. (Ross & Clark, 2008, p. 50, 55, 56, 59)

By 1300 London’s population had grown to over 80,000 people while its cultural and economic dominance grew. London’s trade with other English towns formed the foundation of its success in medieval international trade. With supplies in abundance and a solid infrastructure trade made London England’s greatest port for both import and export. Although famous for its wealth, it was only shared by few people. The influx of new immigrants, from the countryside and overseas, was continuous as the city’s birth rates were exceeded by its death rates. Now the largest and wealthiest city in medieval England, London entered a century in which it was continuously tested by disastrous events as famines, a war with France, the Black Death and civil disturbances. The population was reduced by half and would not recover for 150 years. Economic and social conditions were in disorder, but with the population reduced London soon flourished again as trade and industry revived and wealth was concentrated in fewer hands. (Ross & Clark, 2008, p. 66, 67, 68, 75, 76, 80)
Early and later medieval London’s waterfront reflected the city’s dependence on river traffic and trade. Over time, the Thames waterfront became mainly occupied with wharfs, warehouses and even cranes. Embanking the Thames waterfront was a necessity to this development but wooden revetments quickly dilapidated by exposure to the tides. It became easier to replace and fortify in front of the old embankment, hereby steadily advancing into the Thames. This resulted in gaining up to 100 metres of land until river walls of masonry became the norm in the 15th century. (Ross & Clark, 2008, p. 78, 79)

London’s social and economic power influenced much of southern and midland England. This power however, came to dominate the surrounding region to the extent that independent urban development in the vicinity of the capital was discouraged. Northwest and south of the Thames – the area now called Greater London – didn’t hold more than very few small settlements and scattered farms, while all that remains now are their names. (Ross & Clark, 2008, p. 82)
1.2 Historical development

1.2.1 Trade & industry

The Tudor period (1485-1603) drastically altered the face of London; reformation, political turbulence, but most of all the dissolution of monasteries led the way into a new era. Religious precincts were claimed for secular use, large amounts of land became available on the property market while London attracted thousands of immigrants from the 1540s. New private owners and an ever-growing workforce led the way in the expanding city. (Ross & Clark, 2008, p. 84, 86, 90)

At the beginning of this period, near the end of the 15th century, London's port was still dominated by the London Bridge, built around the remnants of the Roman piled bridge between 1176 and 1209, over 270 metres long and surmounted by houses, shops and gates. A drawbridge allowed larger vessels to pass but powerful and dangerous tidal flows made it hard to navigate. The size of ships grew to the scale they could not pass the London Bridge anymore, confining them to the area east of the bridge, which would later be called 'Pool of London'. The city would have to wait until 1750 before a second bridge at Westminster crossed the Thames. (Foxell, 2007, p. 34)

While the size of the ships grew there was also a change in trade as the northern European trade stagnated. Meanwhile, international markets became more accessible due to the uprising of trading companies that allowed merchants to trade directly with foreign traders. The profits were then invested in British colonies, which monopolised the trade and defined new trade networks and markets for London. New shipyards and wet docks were opened and the city flourished under the influence of global trade and the inherently growing amount of vessels. Which in turn led to a change in domestic trade too, as locally produced and sourced products opened opportunities for new industries. (Ross & Clark, 2008, p. 79, 90, 91)

London started growing eastwards from the beginning of the 17th century and within a hundred years a previously arable area was occupied by a mass of houses and work places, the first developments that would later form the East End. The growth started with the extension of the wharfs along the riverside which supported the growing maritime activity, both trade and military. A backbone for building, servicing and supplying ships arose, soon followed by other essential industries including ones not welcome within the city. A warren of dense streets and poor housing became a hive of labour and poverty, more than a century before the industrial revolution. (Whitfield, 2006, p. 81)
Near the end of the 17th century, after overcoming a royal shift in power, a civil war, the Great Plague and the Great Fire of 1666 which destroyed most of the city, London was by far the biggest city in Europe, with nearly 600,000 inhabitants in its extended urban area. (Ross & Clark, 2008, p. 90, 91) In between the segregated political West End and labour-focused East End lay the ancient nucleus of London, strategically positioned in the centre, providing much of the finance which supported both districts. (Whitfield, 2006, p. 81) (Sheppard, 1998, 273)

### 1.2.2 London Port

18th century London continued the dynamics of the previous decades. Unprecedented in its size and diversity the city grew to become the largest city in the world with over a million inhabitants. The socio-economic roots of this growth were Protestantism and capitalism, catalysed by the free market. The built-up area of London saw a dramatic expansion during this Georgian period. Two building booms (ending in 1730 and 1760) changed the city’s map as London spread into the surrounding countryside due to improved roads to the north and bridges to the south. (Ross & Clark, 2008, p. 124, 130)

The urban expansion was supported by London’s growth as a manufacturing centre, which soon became the largest of Britain. The city had a critical advantage with its varied and large workforce, biggest port and largest consumer market. Its industrial dominance would only decrease near the end of the century, as new independent centres arose outside London’s reach. (Ross & Clark, 2008, p. 133, 134)

Where at the end of the 14th century London saw an average of 7 vessels a day (Ross & Clark, 2008, p. 79) this number grew to 2000 ships in 1727. Most of the ships would anchor in the Pool, deep water down from the London Bridge where ships would have to wait up to three months for their cargo to be processed. The medieval quays were increasingly unable to cope with this volume of shipping and the congested port was in crisis. (Whitfield, 2006, p. 127) Ownership of the quays was fragmented, making it harder to tackle the port’s problems with an overall solution. Entangled private interest, from the East India Company to mooring chains, hindered strategic development while the riverside area staid virtually unchanged since the medieval period.
Exasperated by the state of the port, the city’s merchants started campaigning for improvements. The government set up a series of committees aimed to enquire into the conditions of the port. In 1796, a Parliamentary commission reported on the congestion of London’s port. As a result, several ambitious plans were put forward for new docks to be excavated where ships could moor, increasing capacity and keeping the river free. Further investigation led to the West India Dock Act of 1799, opening the way for long-desired redevelopment of the port. (Ross & Clark, 2008, p. 138, 139) (Whitfield, 2006, p. 127)

### 1.2.3 The Dock Boom

From 1800 to 1830 London’s map was redrawn. The West India Dock act radically changed the riverside landscape to the east and south east of the city’s centre. Plans were initially focussed on an area densely occupied by housing which led to a shift in attention by the West Indies lobby towards the low-lying area north of the Isle of Dogs, now known as Canary Wharf. Funded by private companies excavation on two large, but exclusive, docks began in 1800. The main port of London remained overcrowded and in the same year another act was passed: London Dock Act, which enabled further development.

Although the dock boom was now in full force and development would be underway for the following thirty years, the London Dock had to overcome financial difficulties within its first year. Opposition from the City Corporation (municipal governing body already founded during Anglo-Saxon times) and those with commercial interest, the French war (resulting in a drop of trade), and a lack of capital (surpassing three times the original estimates) troubled the development from the start. (Ross & Clark, 2008, p. 176) (Whitfield, 2006, p. 127)

The West India Docks (1802) and London Docks (1805) were soon highly successful. Import and export quays, entry locks and basins all contributed to the port’s newfound efficiency. This initial success prompted the East India Company to review its facilities and in 1806 the new East India Dock was opened. Adaptations were made though, it had less warehouses than its predecessors as all the goods were immediately transported to the city over newly constructed private toll roads. (Ross & Clark, 2008, p. 177) (Whitfield, 2006, p. 127)
Dock development south of the Thames took a different course. Although several schemes and plans for canals and dock basins were under consideration in the 1790s, it took until 1802 before the Grand Surrey Canal Company started its work, solely on a canal that would link the Thames with Portsmouth. Meanwhile competitors bought up land around the canal, which eventually led to a patchwork of eight docks owned by three different companies in the 1820s.

St. Katherine Dock concluded the first phase of London’s dock building. Where all the other docks during the boom were developed on virgin land, meadow or marsh, St. Katherine’s was built on the small area of land between the Tower of London and the London Dock. The main attraction would be the proximity to the city, overthrowing the argument of costs following the demolition of houses in the densely packed area. The dock was completed in 1828 but from the start too small to use as larger, steam-powered vessels started to dominate trade. Trade diminished within five years, concluding the dock boom. (Ross & Clark, 2008, p. 177) (Whitfield, 2006, p. 129)

1.2.4 Plaistow Marshes

By the middle of the 19th century London was the most powerful nation of the industrial age. The metropolis was expanding and doubled from 1.6 million in 1831 to 3.2 million in 1871, which in turn led to overcrowded endemic areas. Change came when the small administrative districts lost the favour to new citywide authorities, sponsored by the national government. The city could now start with improving roads, buildings and sanitation. (Ross & Clark, 2008, p. 186)

While the city expanded eastwards in the beginning of the 19th century, it did not reach the current metropolitan borders by far. More so, the area east of the city and docks provided a place to escape from London, acting as a pleasure ground and leisure area for working Londoners from the East End, travelling along the Thames to piers and promenades along the riverbank. This area, including the Thames Gateway (the area of land on both sides of the River Thames and the Thames Estuary), was mostly man-made. Dutch drained the area to bring in their livestock, giving the area the characterising drainage field patterns. (Farrell, 2010, p. 87)
Amid this area were the Plaistow Marshes, part of the extensive alluvial marshes of the Thames. These were mostly uninhabited, yet the settlement of Plaistow in West Ham can be traced back to the 13th century. Contrary to the growth of London, the town held mere 150 houses near the end of the 18th century. Plaistow was eventually relieved from its isolation as a road extended from the East India Dock and crossed the Plaistow Marshes.

The town, however, did not immediately profit from this new connection; industry developed considerably more in the northern parts of West Ham. The south lingered until the 1840s, when much of the Plaistow marshes were bought and developed. Intended for the transport of coal, the railway from North Woolwich to Stratford gave rise to manufacturing industries, including a shipyard. Driven by the railway and hydraulic power and financed by a group of entrepreneurs, work on the Victoria Dock, the first of the Royal Docks, started quickly. The Royal Victoria Dock opened in 1855 and the urban expansion resulted in several new townships. Canning Town, Plaistow New Town and Hallsville soon merged into Canning Town whilst development along the Thames bank started to spring up. In the vicinity of London’s royal dockyards, set up by Henry VIII in 1513, the construction of a new urban pattern was well underway. (Powell, 1973)

1.2.5 Royal Docks

The growth of suburban London showed a high degree of continuity from the 17th to the 20th century. London’s population increased to four million inhabitants in the 1890s, and with improved transport and infrastructure, the working and lower middle-class retreated to the fast growing suburbs on a massive scale. Building became London’s biggest industry and the city was now a place for the poorest and wealthiest. (Sheppard, 1998, p. 273-279)
With the city in constant need for new supplies, London’s port kept expanding, which resulted in a fierce competition between the different dock companies. When the Royal Victoria Dock opened in 1855, it profited from the railway like the East India Dock did from its toll road. Now the grandest dock of London’s port, it quickly drew trade away from its rivals.

Under the pressure of decreasing profits, the older dock companies began combining and building new docks. South of the West India Docks, the East and West India Dock Company built the Millwall Dock in 1868, and two years later the South West India Dock was positioned in between. Meanwhile the London and St. Katharine Dock Company responded with the Royal Albert Dock in 1880, east of the Royal Victoria Dock. (Ross & Clark, 2008, p. 262) Hitherto, a whole sequence of docks was built, learning from its predecessors, increasing in size, yet fragmented and unsystematic. With the two Royal docks built further downstream, operating by scale like inland seas, the East and West India Company in return built a new dock more than fifteen kilometres downstream at Tilbury in 1886. (Farrell, 2010, p. 63)

What followed was more than a decade of problems. At the height of Britain’s imperial power its port fell into a financial crisis. Poor management led to problems with accessibility as many docks lacked access to railways, dock entrances were too small for steamships, and existing warehouses were inefficient. Dock companies went into receivership, the Great Dock Strike of 1889 occurred and in 1900, a royal commission identified a lack of coordination as the root problem. (Ross & Clark, 2008, p. 262)

In 1908, the government set up one single organisation to manage all the port’s affairs; the Port of London Authority (PLA). They soon began an ambitious process of improvement but were held back by financial restrictions. The first priority was dredging the Thames from the estuary to the docks, but this soon changed as the demands for better facilities at the docks grew. Increased import led the PLA to shift their attention towards the Royal Docks. Central to these improvements was the King George V Dock, complementing the Royal Docks on the south, after delays by the Great War (WWI) it was opened in 1921. Now, a whole city district was uniquely created by a sequence of engineered and designed elements, gates, locks, quays, enclosed security walls, cranes and a mass of warehouses. (Farrell, 2010, p. 67)

By 1939, the PLA added 32 hectares of dock basin and 10 kilometres of quayside to the port’s facilities, besides dredging 80 kilometres of river channel to allow passage of modern ships. The improvements were so successful that the volume of trade between 1920 and 1930 increased from three million to eight million tons. Farrell (2010) describes the magnitude of the area best:

“Eventually, so holistic was the blanketed new urban pattern that the entire sub-region of several square miles, with over 404 hectares of enclosed water, became known simply as ‘The Docklands’, and it still is.”

London’s port transformed the map of London. The gradual development of the docks reinforced and extended the historic character of the East End and stimulated the siting of industries along the riverside. (Whitfield, 2006, p. 129)
1.2.6 Docklands

The success of the docks attracted unwelcome attention during World War II. The Luftwaffe raided London and the docks were a primary target, with devastating effects. Winston Churchill said ‘London is the greatest target in the world, a kind of tremendous fat, valuable cow, tied up to attract the beasts of prey’. Between September and December 1940, the dock facilities had been destructed and local communities suffered badly, and the V-bomb attacks at the end of the war were said to be even worse. The physical destructions of the war initiated a new era of planned development, not only in the catastrophic east, but also throughout the whole metropolitan area. (Ross & Clark, 2008, p. 263) (Whitfield, 2006, p. 174, 193)

Planning had already begun before the end of the war, as a post-war London had to deal with a half ruined city and a decline in population from 8.6 to 6.7 million people. Catastrophe was turned into something positive; London could be rebuilt according to new guidelines. Abercrombie’s Greater London Plan, commissioned by the municipality, envisaged a neater and more rational city, tackling the four ‘major defects’ of London; traffic congestion, depressed housing, inadequacy and maldistribution of open spaces and the indeterminate zoning of houses and industry. At the heart of the plan was decentralisation, London’s sprawl had to be put to a halt by rearranging population and industry. The vision was at the basis of many reconstruction projects in the 1950s and although London lost its street markets along the way, it gained green spaces. (Ross & Clark, 2008, p. 278)

Abercrombie’s plan however, was only the beginning. Modernism, with its utopian answers, was on the rise in Britain and centuries old building restrictions in the city centre were soon abandoned while new architectural styles were embraced. This led to a boom in development, a process that spread throughout London and led to the rebuilding of the shattered East End in a form that was cold and featureless. In the twenty years to come, London’s skyline was transformed by endless rows of cloned concrete towers. (Whitfield, 2006, p. 175, 197)

Parallel to development, the economy took a downturn as the manufacturing industry collapsed. Trading privileges with Commonwealth countries were lost, the oil crisis and competition from the Far East affected all industries and jobs, along with people, vanished.

After the war, the docks had enjoyed a fifteen-year boom before going into a sudden decline. Planning authorities had not foreseen technical changes in cargo handling and labour issues, from late 1960s trade began to move away from the old docks, leading to the first closure in 1967, the East India Docks. By the 1980s most heavy traffic already halted at Tilbury while the Thames and the docks lay mostly empty. (Whitfield, 2006, p. 201) (Ross & Clark, 2008, p. 290, 296)

The Royal Docks were the last to close from commercial traffic in 1980. London’s Docklands was now a derelict and vacant area of 22 square kilometres in the heart of East London with little prospect. While the fate of the whole dock system had been obvious for a long time, no plan for the region’s future emerged. Everyone was involved but no one was in charge, the opportunities of rebuilding the area weren’t foreseen and the dock closures led to high unemployment and social deprivation in the surrounding areas.

Docklands was designated as an enterprise zone in 1981, governed by a development corporation empowered to override normal planning procedures. The London Docklands Development Corporation’s (LDDC) heart of the strategy was to bring in private investors to regenerate the area. Accessibility improved with the construction of the Docklands Light Railway (DLR), connecting all the north bank docks with the centre, and with the extension of the Jubilee line, connecting the former Surrey Docks with the rest of Docklands.
From the late 1980s, banks and other companies began to move from the city to the new Canary Wharf centre. With growing economic confidence in the late 1990s, more joined and London’s economic centre of gravity shifted east. The former industrial site was transforming into an attractive place to live and work, but Docklands juxtaposed. From the Isle of Dog to the Royal Docks, outside Canary Wharf the development was scattered and disunified.

In typical London fashion, the city rethinks and learns from its past experiences, and with the partially huge commercial success of the model of urban regeneration, there was appetite for a new project: the Thames Gateway. Of even a bigger scale, this plan envisions more houses, new jobs, bridges and transport infrastructure on both sides of the river. The Thames Gateway underlines the focus of the city to shift its gravity eastwards, supported by a new transport hub at Stratford and the 2012 Olympics in the Lower Lea Valley. (Ross & Clark, 2008, p. 310, 334) (Whitfield, 2006, p. 201) (Farrell, 2010, p. 70)
1.3 Urban Interaction

1.3.1 Position

London’s geographical position, as previously discussed, originates from the Roman influence. There is no evidence for existence of tribal centres on the site of Londinium before its founding, and this lack of presence may have contributed to the localisation. For the Romans, as mentioned in 2.2, most important was the necessity to cross the Thames River. Thus Londinium was built there where the Thames was narrow enough to be bridged and had sufficient high ground on either side of the river. The location of the city held two significant advantages; sea transport connected it to the rest of the empire, and as it was in the centre of Roman Britain, all roads radiated from Londinium to the other major towns. The city’s position made it ideal to manage the whole province, thereby gaining more importance. Although deserted after the fall of the Roman Empire, the vicinity staid inhabited. Over time, London grew to once again become the centre of Britain; its position, roads and waters proved a time-withstanding beneficial formula.

At the end of the 18th century, a grander and much more complex city than ever before revolved around the Roman’s ‘Square Mile’. The city’s limits were often tested and under growing pressure and London’s port was the first artefact of the city to take an eastward course. Opposed to the relatively safe high ground of early Londinium, low-lying and marshy areas now became a part of the city, all for the advantage of a port further downstream.

1.3.2 Floodplain & tides

Before the founding of Londinium, the wetland area surrounding the Thames was already in use. As the sea levels were rising so was the Thames, thus becoming more of a liability as valuable fields used for farming now risked flooding. With the tidal limit shifting and the river increasing in size, local communities started building wooden constructions like bridges and piers, dating back until mid-2nd millennium BC. Pressure on land and resources increased as the population grew and arable land shrunk, leading to attempts to bring low-lying islands in the floodplain under cultivation. Wooden track ways were built but would eventually succumb to the river’s path.

At the end of the following three millennia the floodplain had only seen minor changes on a local scale. The Thames however gained a whole different character; the tides enabled large cross-Channel ships to sail up-river, enforcing the position of newly found Londinium. In the next millennium, the city’s waterfront would expand rapidly as the population increased, the port grew and industries arose, all depending on the river.

The state of the river however was very poor. At the turn to the 19th century, there was no waste management; instead all waste flowed or was deposited in the Thames. This eventually led to an increased sedimentation, which in turn led to the appearance of shoals, wrecking ships and making the port inaccessible at low tide due to a shortage of deep water.
Despite all human interventions, the dynamics of the floodplain and river were severely restricted, not stopped. The embankment, which will be further discussed in 4.3, countering inundation and reclaiming land, also steered development. The river’s current scoured out a deep channel on the outer curves, initiating growth of local communities, as the boats could dock independent from the tidal level.

The opposite bank however, became a place of lower value. Here, at the inner curves, the water moves more slowly; sediments settle and mudflats grow. Although these areas later merged with the city, the patterns are still visible as the river has more bends at Docklands than anywhere else, leading to imbalanced utilisation of the banks.

1.3.3 Embankment

Shallow shores characterised the Thames riverbank, but as Londinium and its waterfront expanded rapidly, they became increasingly uneasy to use. Wooden fortifications were built at the river to make the warehouses accessible from the quays. Thames’s first embankment was short-lived as the flat-bottomed ships during the Saxon-period could moor more easily at the moderate slopes of the natural riverside.

By then, the Roman waterfront was long ruined. Collapsed stonewalls and decaying wooden wharves made the area unsafe. Weak embankments led to the process described in 2.3, where new embankments were placed in front of the old, narrowing the river, creating faster and deeper water, thus disabling natural levees and deposition.

The first embankments, other than the Roman wooden fortifications, were most likely made from brushwood with clay and gravel on top and reinforced at the riverside with structural posts and planks. Shipbuilding and harbour construction developed parallel, and over time, larger ships led to taller and stronger waterfronts. After the introduction of masonry embankments in the 15th century the embankments wouldn’t advance any more.

Only after the second half of the 19th century did the borders of the riverside change. The Thames Embankment was developed when it became clear that action had to be taken against the exposure of mud, debris and sewage at low tide. The project reclaimed nine hectares of marshland between the city-centre and the river, giving the Thames an even narrower appearance.
1.3.4 Dynamics

Over the course of two millennia of urban development, climate change was and still is the most influential factor on growth and advancement in London. Rising river levels once flooding marsh- and woodlands would now affect a floodplain with approximately 1.5 million inhabitants. A resilient human population managed to convert these natural dynamics into a place where they could thrive, unconsciously becoming part of the system that is being fought. Now the urban patterns tell the history of the area, one where the urban development is interwoven with its pre-existing natural conditions and made to something new, yet never finished.

Rising water levels, subject to extraordinarily high tides, London managed to use these aspects to its advantage and has the possibility to keep doing this, the Docklands wouldn’t have existed without them, nor would Canary Wharf. Although it led to an introverted area in the middle of a city, urban planners like Abercrombie already acknowledged the potential of water as a quality, as public space, far before the area deemed unnecessary.

Of course the area’s maritime heritage, history and environment are highly marketable, yet the risk of flooding is still tangible. The Thames Barrier and the numerous locks and weirs at the tributaries and the non-tidal section are a testament to this, next to the floods that occurred after the 1928 Thames Flood*. The available research, experience and knowledge on London and other river-cities, can open a new time for the city. For in the past, despite being dictated, the Thames has shaped London’s development, a role that will only increase in a time where climate change is higher on the agenda than ever before.

The Docklands, different than the Thames completely man-made has more potential than is acknowledged. Its waterscapes are slowly being transformed from private utility to public amenity, just like the raised riverside structures east of the city, once necessary to cross the tidal flats, becoming an attraction on its own.

More local, yet influencing the city as a whole, the east would be enhanced by the introduction of a bridge; the urban condition is at its prime when communities have a physical connection between both sides of the river, something which has already been essential in the development of London’s city-centre and would enable the Docklands to become part of its expansion, completing the shift eastwards.

2.1 Comparison: Thames & Rhine

As an addition to the historic context and floodplain complexities of the Thames river a comparison with the Rhine delta is drafted. The graduation studio Delta Interventions’ framework focused mainly on the Dutch delta, and as most readers are Dutch, a brief comparison offers more insight to the threats, risks and current situation of the London floodplain.

The Thames river is, just like the Rhine, a tidal river and under threat of rising sea-levels, making the surrounding land flood prone. Risks of flooding due to seasonal increased river discharge are more likely in the Dutch delta, however this is more inland. The Thames’ tributaries are relatively nearer to the estuary, as the river is smaller in scale, and therefore surround the city of London. The Netherlands’ low-lying areas under threat are more vast than the floodplain of the Thames and demand a different type of protection.

Where the land around the Rhine Delta is protected by a complex network of so-called dike-rings – an area of land surrounded by a structure of dikes – the Thames river is enfolded by 337 kilometres of embankment and supported by locks and weirs to manage the fluvial threats of the tributaries.
Dike-ring 14 is the largest single area in the Rhine Delta, with a flood risk of 1:10,000 and housing around 3 million people, the area generates around 65% of the Dutch gross national product. The difference in scale and approach becomes clear when we compare this to the Thames' floodplain, where 1.5 million people live, on a much denser scale, with an estimated property of 200 billion euro and a flood risk of 1:1,000.

Both rivers have a ‘masterpiece’ at their disposal to reduce threats. For the Thames, this is the Thames Barrier, the world’s second largest movable flood barrier, positioned at Silvertown and protecting the city from high tides and storm surges. The Maeslantkering, located near the port of Rotterdam at Hoek van Holland, is a storm surge barrier part of a network of barriers in the Rhine Delta. Since completion in 1982, the Thames Barrier has been closed for tidal and fluvial threats 119 times, a stark contrast compared to the 1 closing of the Maeslantkering, completed in 1997. It must be added that the Thames Barrier closes monthly for testing purposes, the Maeslantkering yearly, only the latter’s testing has been included in the table.

The protection against very high flood levels with a return period of 1,000 years is estimated to suffice until 2030, though after that officially within acceptable limits, proposals are developed for a barrier at the estuary, increasing protection and including a larger area of the floodplain.
2.2 Water

From the perspective of water protection the situation on London’s floodplain is now established. Next to the generic characteristics and historic development of London discussed in chapter 1, there are three under-exposed aspects, which are the groundwater level, urban runoff, and the tides.

2.2.1 Groundwater

At the core of the industrial revolutions was the creation of the factory. London, in the centre of this development was perfectly positioned. The industry, positioned at the riverbanks, used groundwater for a variety of purposes. When the industry slowly left London in the 60s of the 20th century, the decreased groundwater levels, stabilised and in the mid 70s started increasing. This trend became alarming near the end of the 90s when the water table reached critical levels for the city’s urbanisation. It was decided to control the depth by pumping water north into basins in the Lea Valley. There are several opportunities in local management of the groundwater, utilise heat pumps for energy, improve nutrition and quality in dock water and local use of the water.

2.2.2 Urban runoff

Until 1300, London was built on nutrient acidic soil, in the beginning of the 19th century the city expanded towards wet and floodprone areas. Now, the majority of London was built on clay, a wet soil that combined with precipitation causes urban runoff, soil inundation, pollution and jeopardises groundwater management. The high level of urbanisation demands for open spaces where water has the possibility to reach the aquifers under the city, rather than become a menace for the city.
2.2.3  Tides

As stated before, the Thames is a tidal river. The tide comes in as far as Teddington Lock, a complex of three locks and a weird, where the tideway officially stops. The fluctuation of the tidal range over the course of a year is great and varies strongly per measured location.

The Port of London Authority gathers data and offers expectations on the tidal range for seven locations, which are outlined in the cross section underneath, it shows the average and maximum range. The tidal range varies most and is also highest at North Woolwich, Silvertown, near the Thames barrier, where it can vary 7 metres. This is due to the meandering of the river, an aspect that not only affects the height of the tides upstream, but also its duration, the tide takes longer to flow out than to flow in.

Map 2.3  Thames tidal ranges

Image 2.1  Thames maximum and minimum tidal range in cross section along the river
London has been growing over the course of two millennia, during this period small settlements in the city’s vicinity merged like towns are now absorbed by the expanding metropolitan area. This type of growth influenced and still influences the spatial composition and quality of the city, one of an ever-increasing network of local centres with a high amount of in-between zones and parks.

Currently, growth is marked by an eastward trend, resulting in several recent development initiatives as the London City Airport (1986) in the Royal Docks, the introduction of the Docklands Light Railway in 1987 to serve the new business district of Canary Wharf, followed by the nearby housing estate Britannia Village, the O2 arena, which quickly became a landmark of the city on the Greenwich Peninsula, and two major functional additions in the beginning of the new millennium; the ExCel exhibition and convention centre and the University of East London, concluded by the 2012 Olympic Games in Stratford.
The foundation of this eastward trend can be derived from the London Plan (2008), which anticipates structural growth in both employment and population, leading to increased housing demands, for the coming two decades. The publication separates the main areas of growth into two corridors; the Stansted-Cambridge corridor, densifying and directing the city to the north; and the Thames Gateway corridor, with densification and addition to the east along the Thames.

The two corridors intersect there where most growth is expected, the boroughs Hackney, Tower Hamlets, Barking and Dagenham, and in the middle, Newham. This follows the trend made visible on the previous page, where the gravity of Greater London is slowly moving east.

Notable in this development is the location of growth, over half the area of the four boroughs lies within the limits of the floodplain, seriously increasing the possible effects of a potential flood.
2.4 Visions & perspectives

Like other cities, London has gathered a wide array of plans and policies over the course of its existence. This part will highlight several key-elements of plans and their intentions for London. Abercrombie’s Plan for London, the municipal London Plan, and Thames Hub vision will offer insight into the city’s possible improvements in the past, present and future.

At the start of World War II, London suffered greatly from the Blitz as more than one million houses were destroyed, and as can be found in chapter one, the Docks were a primary target. The vacant spaces left behind led to the UK government to commission Abercrombie, who in 1943 already outlined provisions for the development and improvement of Greater London. Before the war ended, the Greater London Plan was drafted, but never fully realised.

The main intention was to control the expanding population in London by the creation of new towns and expansion of existing towns and establish rural environments within the borders of the city to improve the quality of life. This park system would have introduced new standards for open spaces and hierarchically linked parks, attempting to restrict the development of new infrastructure and housing. With local centres and a green belt at the core of the plan, Abercrombie also defined the Thames as the largest single open space in London, advocating to increase the accessibility to the waterfront.
More than six decades later, the mayor of London in collaboration with the Greater London Authority published the London Plan (2004-2008), a spatial development strategy for the Greater London area with objectives as accommodating economical and population growth, improve living qualities and mitigating and adapting to climate change.

Possibly referring to Abercrombie, next to a green city, it also aims to recognise water as a public space by introducing the Blue Ribbon Network. All waterways and water bodies are to be connected in this new system where water becomes part of the public realm, contributing to the open space network.

Lastly, a possible preview of the future. One where the Thames Barrier is replaced for the benefit of a detailed transportation masterplan for the Thames estuary developed by Foster + Partners in collaboration with consulting firms Halcrow and Volterra. The masterplan envisions an integrated infrastructure network, build on existing transportation lines and proposes a new barrier and crossing that increases London’s protection from floods towards the 22nd century, whilst opening up new possible sites for development and harnessing tidal power.
Urban Plan

3.1 Location

With the pivotal points in history of London’s development in relation to water exposed, the characteristics of the floodplain’s water management issues analysed, the locations and issues of the growth corridors defined, and a framework by prior, present and future plans described, a location for the urban plan can be specified. Newham is at the intersection of the two growth corridors, connects with the Thames and is the centre of recent development initiatives that catalyse the city’s expansion to the east, it is time to zoom in.

Adjacent to the Royal Docks lies an industrial district called Silvertown. The transformation of this area already started with the London City Airport, Britannia Village, and the Thames Barrier Park, and is ought to continue with the redevelopment of the 20 hectare Silvertown Quays in 2014.

According to the London Plan, the growth of the area will mostly rely on housing, as to the west is the Isle of Dogs, where Canary Wharf – a pillar of employment – is positioned, and the revitalisation of Stratford in the Lower Lea Valley due to the Olympic Games’ heritage will foster its own demands.

West Silvertown, south of the Royal Victoria Dock and at the Thames’ waterfront is a 52 hectare strip of industrial and vacant land that, if transformed, would complete the redevelopment of Silvertown and add to the goals of the London Plan, making it a tangible location. The site’s position on the floodplain however, is risky, as it is one of the lower lying areas of the floodplain – especially compared to its vicinity - due to its position as a former point bar right before the oxbow of the Thames that shapes Greenwich Peninsula and the Isle of Dogs.
3.2 Concept

In the concept of the urban plan, a close relation is sought between architecture and urbanism. The current directional structures of the site’s topography and occupation, which can be seen on the image to the right, serve as guidelines for the landscape design.

These guidelines are all perpendicular to the Thames’ embankment and so the direction of the landscape will point towards the waterfront. Meanwhile, the infrastructure of the plan is parallel to the waterfront, crossing the directional axes of the landscape, together forming a foundation for the urban plan and architectural design, with at its core the connection towards the water.

The axes of the landscape provide a foundation for a division of levees. Rather than one big levee, the idea is that the levees are segmented and variable, yet interconnected elements. This segmentation leads to a variety of height levels on and around the levee, and also allows the river into the plan under the influence of the Thames’ tides.

The railway functions as the main element interwoven through the plan and is also a backbone for pedestrians, connecting all areas by being able to walk over the raised railway. In collaboration with the levees it defines the position on the rest of the masterplan’s programme, which is mainly housing and some mixed use, following the recommendations from the London Plan.
3.3 Levee system

Without considering the building masses of the current occupants, the high waterfront in West Silvertown blocks any possible connection from the city to the Thames. The embankment’s topography has steadily increased in height over time as a result of several floods and the high fluctuation in tidal range, specifically around Silvertown. Unlike the embankment, the site itself is slowly submerging.

These characteristics are used in the plan to improve the quality of the area, by following Abercrombie’s ideals of approaching water as part of the public realm and integrating it with the guidelines of the London Plan’s Blue Ribbon Network.

The levees, as stated in the concept, are segmented and although connected, each have different topographies. They vary from a normal width levee to the concept of an extra wide levee, which minimises the obstacle a levee can become and maximises the connection the site can make with the water.

On the utmost west and east, water is a permanent attribute to the plan. In between these areas, water from the Thames flows through the landscape, depending on the height of the tide. This difference can be seen on the next page, where the top image shows the levees and floodplain during low and normal tide, and the bottom image is an impression of the levee system during high tide.

The divisions between the different segments of the continuing levee are concrete slabs. They are present on both the waterfront side and the protected area behind the levee and stem from the railway that flows through the landscape.
3.4 Building Typology

The design brief for Newham and specifically the area of West Silvertown is clear; the area needs to provide in housing for a growing population in East London. Research defines demands for the Royal Docks as 22 homes per hectare, or more specifically for West Silvertown around 1200 on 52 hectare. The plan however provides in 1800 to 2000 homes, taking into account there are less opportunities for densification and expansion due to the airport. The integration with water in the urban plan demands a different approach for the types of buildings. To facilitate a range of different needs the choice was made to define six different types of typologies.

Permanent water areas will house the already existing and typical narrow boats and barges that come in a wide variety of sizes. Houseboats will be added near the border of the plan, hereby offering three different ways of living on the water. At the edge of the permanent water areas levee houses are included. These have the possibility to partially submerge at the lowest level during spring tide – under the condition the Thames Barrier isn’t closed – as their shape follows the levee down.

A concept for housing blocks makes it possible to build and live in the submerging zone. Closed blocks with an inner courtyard are protected from water on the outside at the lowest level, keeping water out during high tide yet living on the floodplain. The housing blocks are situated in three groups, making them easily accessible when the water is at its highest via raised boardwalks. Also connected to these boardwalks are the pier houses, stacked and longitudinal homes that are permanently raised above the alluvial land.
The sixth building type will be that of a higher density tower, as the intention was to keep the open space ratio high, leaving a large amount of open space per total floor area. Instead of choosing high-rise, the concept of the horizontal skyscraper by Steven Holl was opted. This design is raised above its footprint, thereby opening the possibility to be protected from water, whilst offering both a highly quantitative amount of floor space with the potential of good quality and the scale of the building makes it more feasible to offer a mixed use programme.
3.6 Phasing

West Silvertown is positioned amidst an area with several regeneration projects recently completed or soon to be started. To shed a realistic light on the design, a phasing schedule is developed which includes the regeneration projects, a replacement of the Thames Barrier further downstream and places the West Silvertown urban project and the topic of the next chapter and main design, West Silvertown Station in a time frame.

The phasing diagram is divided in the realisation of the levee, the built environment, infrastructure, usage of renewable energy and water resources and finally the lifespan of the current Thames Barrier and the proposed Thames Hub Barrier.
During the development of Silvertown Quays, planned between 2014 and 2018, the development corporations can already start with shifting land ownership and clearing the site before starting work on the levees. Once the western levee system is finished, infrastructural works and building development on the fluvial land can take off and gradually continue to the eastern part of the plan.

Work on the levees is finalised before the minimum need for an upgrade of the Thames Barrier in 2030, keeping West Silvertown safe from floods until 2070, when the Thames Barrier is expected to become insufficient. Before that happens, the project development of the Thames Hub Barrier should be finalised, on the condition that the government agrees with proposed plans in the coming fifteen years.

Due to the interdependency of partial projects, the development of the commercial centre relies on the station as they are adjacent and integrated. Once the station is completed the rainwater and solar harvesting can be initiated while West Silvertown is safe from water and connected to London.
West Silvertown Station

In the centre of the urban plan is the new West Silvertown Docklands Light Railway station. The choice to design a station was made relatively early, during the research process, when the geographical locations of all stations and lines of the London Underground were superimposed over a map of the London floodplain with the aim to get an indication of the effects of a flood on transportation. This map is shown below, and directly makes you aware of the magnitude of a serious flood when it is concluded that over 80 underground stations are positioned on the floodplain. The interesting aspect is that a local solution for a station can offer generic methods of tackling a problem that occurs in a vast area.

This chapter will first cover a set of architectural references studied that have certain elements and qualities that influenced the final design. Followed by a description of the programme, or design brief, and its organisation. From the development of the concept behind the building, we move on to the actual design, the set of principles used for more specific decisions, the characteristics of materials and finally the technical aspects. Hereby giving a complete view of the design and how the station safely supports and improves West Silvertown’s position in the eastward extension of London.
4.1 References

Compared to the West Silvertown Station, the following five references differ in both scale and function. Instead, they are depicted to highlight aspects in ideas, approaches, and realisation that have contributed to the design of the station.

4.1.1 OMA - Les Halles

This competition entry by OMA for a former market area in Paris attempts to redefine a modern cityscape for the city as a self-reported environmentally-conscious masterplan. The design aspect highlighted for this thesis is its quality to invigorate interaction with other urban artefacts, as its multi-layered buildup aims to acknowledge the relation between underground and surface by emerging buildings from and penetrating buildings into the ground.

Although location specific - according to OMA the site suffers from schizophrenia - the methods used to approach its aims are useful in the way that this plan recognises the possibility for both architecture and urbanism to expose the broad variety of layers that can be found on a site but are too often hidden or disregarded, yet have the potential to contribute strongly to a design by merely including it. Accomplished specifically in this plan by weaving all layers into a fabric, rather than stacking them.
4.1.2 FOA - Yokohama International Passenger Terminal

The Yokohama International Passenger Terminal is a transportation hub that is a link rather than a boundary between city and sea. Depending on the direction of travel there are two circulation principles combined in one building. When one arrives from the city, the building is a waterfront plaza with vistas to the bay, welcoming the traveller to the waterfront, whereas coming from the sea the traveller arrives in a part of the building with a closed character and an almost underground appearance, moving towards the exit one gradually reaches the surface, arriving at the city.

The terminal’s surface topography of public space is not just a recognisable aspect of the building, each segment of circulation in the routing associates in one way or another with the topography, making it the link between two worlds. In this ambiguous space, the surface and spatial qualities lead the visitor without forcing them in a specific direction to discover that every step is very literally a new dimension.
4.1.3 CERVER Design Studio - Lakefront Station

A transportation hub for a railway and bus station can be interpreted in an infinite amount of ways. In this competition entry for this specific location, the highway adjacent to the hub was a barrier between major parts of Cleveland and its waterfront. Extending the roof in the design to pass over the highway offered solace as a connector between the city and the waterfront.

In this design, landscape becomes an interface between architectural and urban conditions, re-activating the flow of the waterfront by creating a cohesive link to the site.

4.1.4 Benthem & Crouwel - Rotterdam Centraal Station

Rotterdam Centraal Station is another transportation hub, though on a bigger scale, and selected for different purposes. The roof design incorporates a multifunctional roof on a visually light structural design. Of the 30,000 square metre glass roof, 10% is integrated with photovoltaic cells, generating 500 kilowatt peak. There where PV-cells are not part of the roof, similar shaped surface patterns have been included to generate an optimal inside climate.
4.1.5 Grimshaw Architects - Bijlmer Arena Station

Another station in the Netherlands, Amsterdam to be specific, highlights two final elements that are of added value to the design. Providing services for both the train and underground, the building’s railway is raised from its plot, sharing a similarity with the Docklands Light Railway. Although raised, the space below is of light atmosphere due to the openings in the roof and the width between the rails. The border of the passenger concourse starts at the lower level and can be closed, but isn’t interrupted by hard physical borders instead it uses glass walls.

Next to the raised railways is the roof structure, the structural design incorporates a gentle angle which has a directional effect parallel to the axis of the trains, extending the space of the station outside its parameters. This is enforced by the choice of materials, wooden slats perpendicular to the direction of the cantilevered structure accentuate the course and supported by a segmenting steel frame that increases the perception of perspective.
4.2 Programme & organisation

The design brief can be divided in two main clusters, the first being the actual station, and the second a local centre for commercial space, serving the West Silvertown community. The main aspect taken into account for the organisation of these elements is the separation between publicly accessible space and passenger areas. Where the commercial space is available for all, the passenger concourse for instance is only partially accessible without a ticket. In between these two areas the public domain serves as a connector, interwoven in the urban plan.

The commercial spaces exist of a kiosk, a supermarket, post office, a café, and the likes. The station cluster requires the typical spaces needed to serve passengers like ticket offices and machines, an information desk with a paid and unpaid concourse leading to the platform, but also an area for staff only. In the image below an abstract representation of the distribution of the programme in the building is given. The main programmatic elements are distributed over two floors, the commercial spaces on ground level, and the raised underground platform on the level of the levee. A more detailed view of the programme and its connectivity is given at the section of floorplans.
### West Silvertown Station

<table>
<thead>
<tr>
<th>Commercial Space</th>
<th>6150 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesco Express</td>
<td>300 m²</td>
</tr>
<tr>
<td>Shop / Counter / Staff / Stock</td>
<td></td>
</tr>
<tr>
<td>Boots</td>
<td>800 m²</td>
</tr>
<tr>
<td>Shop / Counter / Staff / Stock</td>
<td></td>
</tr>
<tr>
<td>Sainsbury’s</td>
<td>2000 m²</td>
</tr>
<tr>
<td>Shop / Counter / Staff / Stock</td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td>1600 m²</td>
</tr>
<tr>
<td>Dining / Bar / Kitchen / Restrooms / Stock / Staff</td>
<td></td>
</tr>
<tr>
<td>Bar &amp; Café</td>
<td>1000 m²</td>
</tr>
<tr>
<td>Bar &amp; Seating / Counter / Restrooms / Small kitchen / Stock / Staff</td>
<td></td>
</tr>
<tr>
<td>Florist</td>
<td>100 m²</td>
</tr>
<tr>
<td>Post Office</td>
<td>100 m²</td>
</tr>
<tr>
<td>Hair Salon</td>
<td>150 m²</td>
</tr>
<tr>
<td>Kiosk</td>
<td>100 m²</td>
</tr>
<tr>
<td>Station</td>
<td>2210 m²</td>
</tr>
<tr>
<td>Passenger Concourse</td>
<td>550 m²</td>
</tr>
<tr>
<td>Check-in / Traffic</td>
<td></td>
</tr>
<tr>
<td>Platform</td>
<td>1400 m²</td>
</tr>
<tr>
<td>Arrival / Departure</td>
<td></td>
</tr>
<tr>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>Corridor</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>150 m²</td>
</tr>
<tr>
<td>Ticket Machines</td>
<td>30 m²</td>
</tr>
<tr>
<td>Passenger Services</td>
<td>40 m²</td>
</tr>
<tr>
<td>Public Toilets</td>
<td>40 m²</td>
</tr>
<tr>
<td>Other</td>
<td>25200 m²</td>
</tr>
<tr>
<td>Dispatch</td>
<td>500 m²</td>
</tr>
<tr>
<td>Supply / Storage</td>
<td></td>
</tr>
<tr>
<td>Building Services</td>
<td>200 m²</td>
</tr>
<tr>
<td>HVAC / Energy / Water</td>
<td></td>
</tr>
<tr>
<td>Parking</td>
<td>20000 m²</td>
</tr>
</tbody>
</table>

Image 4.7  Programme brief
Combined, the station and the commercial centre provide services for two communities, the urban plan explained in the previous part and Britannia Village, the first of two regeneration plans, second being Silvertown Quays. Britannia Village lies between West Silvertown and the Royal Victoria Dock and was completed in 2000 offering 1100 homes. Including the 1800-2000 homes of the West Silvertown plan, the DLR station will serve around 3000 homes on a catchment area of 67 hectare.

The DLR, which currently runs every 10 minutes in each direction and is not at full capacity as the area is still under development. Each train normally has two cars with a total seating capacity of 140 passengers and a maximum of over 500 places. The train needs less than twenty minutes from West Silvertown to arrive in the centre of London, which has the potential to make it a popular location as commuting from other directions within Greater London can take over 45 minutes.

---

**Frequency of Docklands Light Railway**

<table>
<thead>
<tr>
<th>Type</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>10 min</td>
</tr>
<tr>
<td>Peak hours</td>
<td>8 min</td>
</tr>
</tbody>
</table>

**Travel Times**

- Canning Town (transfer node): 3 min
- Bank (central London): 18 min

---

Map 4.2 London Underground superimposed on Greater London including floodplain and growth with connectivity

---

West Silvertown Station
4.3 Concept

At the foundation of the design’s conceptual intentions were for the building to operate within the layers of both urbanism and architecture; connecting with the city via the public domain and views; and approaching the water whilst offering connectivity to the London metropolitan area.

Initially referring to a – for the area – high-rise building, the concept was to expose the variety of layers over the vertical axis. As the conceptualisation progressed and became more integrated with the urban plan for West Silvertown, this was soon disregarded as the flows of people, water, and landscape were all horizontally oriented, leading to a different angle.

Integration with the levee system and approaching the railway not only as a long distance connector but as a local backbone led to the change to integrate the design with the topography of the landscape. The position of the building and its masses were now able to expose the layers and flows, they did not merely follow the programme, there was now potential for the design to make an addition to the public domain.

As research and design progressed, pollination between the urban plan and architectural concept became more distinct. A cantilevered roof emerging from the railway and parallel to the levee system was introduced to define the connection between the design’s programme and the public domain. Lastly, where the roof and square meet the levee, a wide set of stairs appears, leading the visitor towards and over the levee, setting the foundation for a cohesive interaction between the architecture and urban planning.
4.4 Design

The concept led to the design already seen from above in the chapter Urban Plan, and made visible in the abstract isometric projection in the programme section and below. Instead of expanding on the overall design, features and principles of the building will be explained in the next subchapter, using the image below to highlight the specific area it entails, visualisations of the spatial qualities is focused on in the subchapter Materials.

Briefly explained, the design can be summarised as the Docklands Light Railway flowing over the landscape of levees, that on their turn continue into an element with the affiliate program of commercial spaces, positioned next to the public square, covered by the roof that hovers above the platform of the railway.
4.5 Design principles

At the foundation of the design are a set of ideas and principles derived from research and design. These principles are applied to support the building’s concept, improve its logistics and functionality, and aesthetic appeal.

4.5.1 Tube

The railway is wrapped by a façade to decrease the amount of noise disturbance in the urban plan, which makes the railway into an object with mass. This mass, as stated under the subchapter Concept is on the one hand a connector for the urban plan, yet could become an obstacle (Spek, 2003) for the link between the public space and the water as a public domain.

The top image left shows the current situation, where the waterfront typology actually is the disconnector, solely changing the levee or integrating the levee with the wrapped railway changes the situation, but not to the extent that it improves the connection. A wider levee in physical combination with the railway provides an interconnection without obstacles between the levee, the river Thames, and the railway.

In this last alternative, the column structure under the railway is of the utmost importance, a wrong choice will lead to a loss of openness and transparency. For this reason, a small study was completed to visualise the direct effects of different structures in perspective. Starting with a regular approach of rounded columns, this led to several alternatives like continuing slabs that follow the direction of the roof, a set of random pillars and different angles and positions of columns, eventually a combination between wide columns following the roof structure and angles of the railway led to the final result, shown in the last image.
4.5.2 Platform

The choice of platform layout arrangement mostly relied on the amount of space available, lesser is needed for an island platform which optimises the space usage of the building as a whole, as the railway crosses the building. Besides this aspect, the safety issues that can be prevented with a side platform when a station is overcrowded won’t be applicable. West Silvertown isn’t a transfer node nor a relatively busy station. The DLR is specifically designed to deal with tight curves, making the effect of diverging tracks a nonproblem. An added benefit is the decrease in amount of separate stairs.

4.5.3 Stairs

The platform is accessible from two directions, two sets of stairs leading from the top of the railway connect the station to both sides of the urban plan and stairs going down from the platform to the public square offers travellers the option to visit the commercial spaces or walk to Britannia Village and the Royal Docks, opposite of West Silvertown.

A main set of stairs under the cantilevered roof connect the square to the levee and the Thames. This diverging element spatially relates to both the orthogonal direction of the local levees and the railway, which is under a 30 degree angle. Like the levees, the stairs boundaries are concrete slabs, and have an incorporated railing and light that illuminates the stroke.
4.5.4 Roof

In spatial terms the roof functions as a canopy and connecting element, besides this function photovoltaic cells are also integrated in the glass, with a total surface of 4800 square metres it has the potential to harvest 800 kilowatts-peak in energy. The gentle slope of the glass leads to four of the five main beams, where rainwater is harvested and directed to the building services space to be stored and re-used as grey water for the building.

4.5.5 Levee opening

The building is integrated in an extension of the levee and opens up on the waterfront towards the Thames, creating a visual and physical connection between the interior of the building and the river.

4.5.6 Parking

A split level layout was chosen for the spatial arrangement of parking. The benefit of this arrangement correlates with the physical appearance outside the building, as the facade’s slab of the mid level rooftop continues into the exterior and can be combined with the floor construction of the second level of parking. At the same time the arrangement has the benefit it doesn’t demand as much floor area for ramps as with equal floors, increasing the amount of parking spaces available for visitors of the centre and park area, commuters and nearby house owners.
4.6 Plans

Now that the concept, programme, and design principles are clear, it is time to move forward to the final design. In this part, the plans and sections of the building are shown. They are supported by an isometric projection of the three main levels with a differentiation of the main programmatic aspects and the routing towards these. Though originally presented in a scale of 1:500, due to the booklet’s format the drawings are scaled to 1:2000.

The routing is distinguished in three main flows, first the flows to approach the station in yellow, second the routing through and around the commercial centre in red, and third the building services route, supplying the centre, in grey. The latter one is only reached via the main road northwest of the building, whilst the commercial centre and station are also connected via the levee. The station has one extra connection on the top level, by the tube wrapped around the railway. The station is hereby quickly accessible via three different levels, serving nearby West Silvertown via the levees, the rest of the urban plan by the railway and Britannia Village via the road northwest.
4.7 Materials

4.7.1 Wooden cladding

The wooden cladding of the beams is made from pine wood, an easily processed wood and widely available in the United Kingdom. The Pinus sylvestris is cut in separate slats and treated with a lasur coating to give it a lighter appearance and preparing it for decolourisation, which is of lower maintenance in the long term.

The cladding elements are vertically positioned for two reasons, the first being the prevention of deflection in a later stage, due to possible the length and the nature of wood, secondly for appearance, the beams appear to have more depth in perspective when segmented.
4.7.2 Photovoltaic roof panels

The roof elements of laminated glass have integrated photovoltaic cells with PVB-foil for additional strength. The Optisol Sky is delivered with a module width of 950 mm and variable lengths. It is positioned parallel to the railway—a thirty degree difference with the direction of the beams— with the purpose to accentuate the connection between the different scales and layers that come together at the building.

A total of 6000 square metres of glass covers the public square, with an effective area of 4800 square metres the roof has the potential to harvest 800 kilowatts-peak under optimal conditions.
4.7.3 Levee & square

A gradual transition from the levee to the square is accomplished by using a tiling system with three main elements, grass tiles, concrete slab pavement similar to the concrete facade and several water features. They are all in the same dimensions and positioned in a predefined random pattern. This effect has the purpose to make the transition from one element to the other more smooth and ambiguous, creating a higher integration between the public square, levee, and building.
4.7.4 Wooden slats

The wooden slats are, like the cladding, made from pine wood and treated in the same way, with the difference that due to their lengths, they are laminated to counter possible warping. They measure 50 mm by 400 mm and have variable heights, depending on the location. A steel T frame connects the slats to the precast concrete structure above and underneath, the frames are later covered by a second layer of in situ concrete to finish the facade.
4.7.3 Concrete slabs

Concrete is a returning material in the whole plan, and therefore defining for the building as well. It can be found back not only on the facade but also on the wrapping of the railway and the slabs separating the levees in the masterplan. The latter have integrated lighting, as can be seen below, this makes the structure of the plan more prominent and in combination with water, especially during high tides, reflection adds an extra dimension of aesthetics to the plan.

The concrete on the facades is poured in situ to create a surface with as much continuation as possible. An extra treatment method is included; formliner sheets add a light vertical stripe texture to the facade, accentuating the scale and depth of the material. The concrete is purposely influenced by weather over time, adding a natural texture and colouration which complements the greying of the wood.
4.7.4 **Store identity**

Though the outside of the building is relatively closed due to the vertical blinds, the inside corridor is a transparent whole with glazing up to the ceiling. This transparency opens up the possibility to tune the character of all different commercial occupation. All businesses have their own strong identity inside, which in this design will be highly visible from the outside too.

Similarly, the stores' logos will retain their typography and identity, except for colouration, which will be adjusted to the overall rule which can be seen on the left, supported by reference images of Leiden Centraal Station, where a comparable approach is used.
4.8 Construction & details

4.8.1 Structure

The structural visualisation shows the construction principles behind the building. It starts at the bottom with the foundation and hollow core slabs for the ground floor. Above the foundation is the construction of concrete columns and beams, which varies in height and amount of levels along the length of the design. On top of the beams the slabs of the other floors and roof are laid out.

The construction of the railway, which runs through the building is separate from the commercial centre, as can also be seen in the following pages focused on details. The tube’s construction consists of adjoined precast concrete elements and steel beams in the roof. Integrated in the tube is the roof above the square, which consists of five steel frameworks cladded with wood.

4.8.2 Installation

As told previously, the roof catches rainwater to be re-used by the commercial centre as grey water. This flows via the tube into the space for building services seen underneath. From this point, water, ventilation, heating, electricity, e.g. run via an underground corridor across the length of the building. From this shaft the services go perpendicular via the foundation to connect with the different programmatic elements. The service shaft stops at the beginning of the parking area, for the elevators and lighting.
Roof construction
- Growing medium
  - 10 mm filter sheet
  - 80 mm drainage layer
  - Concrete curb
  - Protection mat
  - Root barrier
  - Bituminous layer
  - 50 mm top floor
  - 260 mm hollow-core slab
  - 20 mm bearing layer
  - 320 mm precast concrete supporting beam
  - 100 mm mineral wool thermal insulation
  - 18 mm pine wood ceiling

Double glazing
- 8 mm toughened glass
- 12 mm cavity
- 2 x 8 mm laminated safety glass
- 80 mm steel I-beam

Levee wall
- 200 mm precast concrete wall
- Bituminous undercoat
- 600 mm reinforced precast load-bearing concrete wall
  - 10 mm cavity
  - 100 mm foamed-glass insulation
  - 100 mm in situ concrete wall

Floor construction
- 20 mm troweled concrete floor
- 50 mm top floor
- Sealing layer
- 80 mm mineral-fibre impact sound insulation
- 260 mm hollow-core slab
- 20 mm bearing layer
- 320 mm precast concrete supporting beam
- 100 mm wool thermal insulation
- 18 mm pine wood ceiling

Foundation
- 20 mm troweled concrete floor
- 50 mm top floor
- Sealing layer
- 40 mm impact sound insulation
- 200 mm in situ concrete foundation

Concrete curb
- Gravel

Structural Design

83 West Silvertown Station
4.8.3 Facade details

1. Roof construction
   Growing medium
   10 mm filter sheet
   80 mm drainage layer
   Concrete curb
   Protection mat
   Root barrier
   Bituminous layer
   50 mm top floor
   260 mm hollow-core slab
   20 mm bearing layer
   320 mm precast concrete supporting beam
   100 mm mineral wool thermal insulation
   18 mm pine wood ceiling

2. Slab
   200 mm in situ concrete facade
   600 mm precast reinforced concrete slab
   200 mm in situ concrete facade
   facade cast with formliners
   - vertical line surface profile

3. Slats
   400 mm * 50 mm laminated pine
   200 mm steel T-frame

4. Floor construction
   20 mm troweled concrete floor
   30 mm top floor
   sealing layer
   80 mm mineral-fibre impact sound insulation
   260 mm hollow-core slab
   20 mm bearing layer
   320 mm precast concrete supporting beam
   100 mm wood thermal insulation
   18 mm pine wood ceiling

5. Foundation
   20 mm troweled concrete floor
   30 mm top floor
   sealing layer
   40 mm impact sound insulation
   200 mm in situ concrete foundation

6. Concrete curb
   Rafter
   Gravel.
9 Roof construction
- 800 x 800 mm concrete paving slabs
- Neoprene bearing layer
- Bituminous layer
- 40 mm mineral fibre impact sound insulation
- Bituminous layer
- 260 mm hollow-core slab
- Installation cavity
- Plasterboard

10 Wall construction
- 200 mm in situ concrete facade
- Facade cast with formliners
- Vertical line surface profile
- 600 mm load-bearing wall
- Installation cavity
- Raster

11 Ceiling light
- IPE 180 steel I-beam
- 8 mm toughened glass in steel frame
The elevated railway has three distinct spatial places, shown below. On top of the railway is a pedestrian path that continues to both ends of the plan, serving as a connector for inhabitants to reach the station. It has the distinct concrete slabs also incorporated in the design of the rest of the building. The pavement consists of tiles made from the same concrete as the facade, creating a monolithic element hovering over the plan.

The platform area of the station uses these same tiles, while the walls are clad with rasters from galvanised steel. The rasters add depth to the interior space, maintain an open connection through the outside via the station's name, and offer an extra place for tubing and installations. The lighting is fixed in between the columns and runs parallel to the rails.

Underneath the station is the open space that crosses the whole square. As the trains are not visible from each direction, a lighting fixture was designed spanning the width of the ceiling. When a train arrives the lights will increase in intensity and start rolling in the direction the train will go, alerting passengers who want to take the DLR.
Reflection

Studio & Approach

The framework offered by the Delta Interventions graduation studio entails a multi-disciplinary approach that results in research and design over a variety of scales with the common ground of delta regions. In this structure, cross-pollination between different disciplines was stimulated. Both architecture and urbanism students collaborated on the mutual research of the Dutch delta during the MSc3 track. Small-scaled studio specific lectures from landscape architects to civil engineers were offered, and in combination with an excursion to Hamburg and presenting the studio at the Floating Pavilion in Rotterdam, the studio aimed to teach the finer specifics of the delta theme and connect with a variety of disciplines to generate a solid foundation for the research of the project.

Despite the studio’s focus on the Dutch delta, the choice of subject was not location-bound per se. Although the majority of the students continued on the Dutch delta with their projects, it was not so much the physical location that related to the studio, rather the type. From coastlines, to inland river areas, and floodplains to flood defences, the material derived from the collaborative research performed by the studio was applicable to the wide variety of possible projects. The eventual masterplan for West Silvertown and the DLR-station integrated in a levee on the floodplain all touch upon the often generically applicable tools and methods gained from the studio.

Within the framework of the studio it was stimulated to investigate and share individual, project-specific elements of research, which in turn could be used by other students. The approach to analyse the ecological systems of the London floodplain in relation to the city’s growth proved a correct method as they further defined and specified the direction of the project. Due to the results from the initial research, this process almost became intuitive as research progressed, specifically when deciding on location and object, stemming strongly from the conclusions.

The research also offered an extended scope for the project’s timeline and surroundings, as other plans in the vicinity of the location from the past and the present and for the future were analysed and eventually included in the storyline, creating a solid underlying basis for the further development of the masterplan and station.

Research & Design

As can be concluded from the previous part, research played a very significant role in the design, which is of course expected from a study in a scientific framework. The beauty of research and design is the interaction between the two, more specific, research by design and design by
research. A researcher and designer can never be fully objective and, possibly subconsciously, steers the research in a certain direction towards the design, or the design towards the research. As an example; in one of the first phases of research a map of the geographical position of the London Underground was superimposed on the London floodplain, initially out of interest, this indirectly contributed to the decision to design a DLR-station, part of the underground system.

Another feat to acknowledge is the opposite of the intuitive aspect, design plays a significant role for the research in a later phase. When the conducted research has defined the boundaries of the project, in order for the design to become more comprehensive, new research topics appear and research already carried out has to be further specified. On the one hand this criticises the already performed research, yet is an essential part to continue with the project.

Another correlation that I found is a more literal interpretation of the relationship between research and design. Research is designed and design is researched. The methods and framework laid out as descriptive research, correlational research, and literature review were designed to serve the project, just like the design of the project is researched in its own way to reflect, make changes, or further specify certain elements.

Relevance

The project’s context is a viable one, the risks the area has to deal with are very real and applicable to locations worldwide. Although delta areas have been studied extensively, this project is a contribution to this expanding body of knowledge as it integrates layers from a range of scales that are usually separated, in a type of area with qualities that are too often disregarded.

Despite efforts, the city of London still hasn’t been able to unlock the full potential of its position at the Thames. West Silvertown’s plan and station aim to do so and serve, protect and facilitate the (new) people of the area for a prolonged period of time in an idealistic yet realistic way. The generic qualities of the project can be transformed into tools for areas with comparable conditions, revitalising the connection between the layers of landscape, urban planning and architecture. Although this project is a small step, it is of the utmost importance to continue a fresh approach of adaptive strategies on architectural and urban scale that mitigate environmental pressure in urbanised river cities whilst improving the balance with its ecological systems.
Map Statement

Map 1.0  British Isles and London project on
dymaxion map
Wikimedia Commons

Map 1.1  Great Britain, Thames River Basin,
Greater London
Environment Agency (Crown Copyright)
Wikimedia Commons

Map 1.2  Tidal range over time projected on
River Thames and Greater London
Ross & Clark, 2008, pp. 23
Wikimedia Commons
Google Maps

Map 1.3  Tributaries of the Thames
Barton, 1996, pp. 14
Wikimedia Commons

Map 1.4  Thames Floodplain projected on
Greater London
Greater London Authority
Environment Agency
Wikimedia Commons

Map 1.5  Road from St Albans to Canterbury
(left to right)
Environment Agency (Crown Copyright)
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Google Maps

Map 1.6  Site of Londinium before founding
Map 1.7  Londinium 10 years after founding
Map 1.8  Londinium rebuilt
Sheppard, 1998, pp. 20, 22, 25

Image 1.1  General section of floodplain with
specified features
Pearson Prentice Hall, Inc
(not by author)

Image 1.2  London embankment development
over 100 metres in 2000 years
Sheppard, 1998, pp. 26, 27
Ross & Clark, 2008, pp. 37

Map 1.x  Underlayer
Farrell, 2010, 87
Wikimedia Commons
Google Maps

Map 1.9  London & Thames around 1680 -
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Foxell, 2007, pp. 29

Map 1.10 London, Thames & Docks after
1805 - result of West India Dock Act
Foxell, 2007, pp. 37

Map 1.11  London, Thames & Docks after
1832 - End of Dock Boom
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Map 1.12 London, Thames & Docks after
1855 - Eastern Counties and Thames Junction
Railway & Royal Victoria Dock
Foxell, 2007, pp. 133

Map 1.13 London, Thames & Docks after
1921 - Last additions to Docklands
Foxell, 2007, pp. 151

Map 1.14 London, Thames & Docks pres-
ently - Former docks partially filled in
Ross & Clark, 2008, pp. 310, 311

Map 2.1/2.2 Thames & Rhine Comparison
wikimedia commons
bosatlases
environment agency

Map 2.3  Thames Tidal ranges
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Map 2.4  Composition by centres
Map 2.5  Recent development

Map 2.6/2.7/2.8 Growth & Employment
London Plan 2008

Map 3.1  Urban Plan location
Map 3.2  Growth conclusion

Map 3.3  Projected growth per area
London Plan 2008
Map 3.4 West Silvertown

Map 4.1 London Underground on floodplain
Wikimedia Commons

Table 2.1/2.2 Barrier Closures
Environment Agency

Table 2.3/2.4 Groundwater levels
walbrookriver.org

Image 2.1 Thames Tidal range section
Port of London Authority

Image 2.2/2.3/2.4 Greater London Plan
Plan for London

Image 2.5 Blue Ribbon Network
London Plan 2008

Image 2.6/2.7 Thames Hub
designboom.com

Image 3.X
all by author

Images 4.1 Les Halles
OMA.eu

Images 4.2 Yokohama Terminal
FOA

Image 4.3 Lakefront Station
archdaily.com

Images 4.4 Rotterdam Centraal Station
Benthem & Crouwel

Images 4.5 Bijlmer Arena Station
flickr.com

Images 4.6-onward
By author

All maps and illustrations for the Origins section are products of the author unless stated differently. They are combinations of a great range of maps and written information, found in literature, lectures, and online. The wide variety of sources, new and dated maps and different scales made accuracy difficult though it is strived after.

To maintain order in the thesis, the choice was made to structure the mapping in different scales. This is done by category, leading to the following arrangement:

Scale 1 Britain
Show London and Thames in context and clarify its position

Scale 2 Greater London & Thames Estuary
Visualise Thames attributes of floodplain, tides and tributaries

Scale 3 Historic
Transformation of early Londinium

Scale 4 London & Thames
Visualise growth of London and extension of docks in relation to Thames

Side note: Near the end of the 19th century London expanded to a size not possible to completely include in the maps, therefore the choice was made to illustrate the last two maps (1921 and presently) differently.

Cover Illustration
Waterside Park
Barrier Park East
(edited by author)

Alternative Cover Illustration (next page)
Postcards from the Future
London as Venice
Image: Robert Graves & Didier Madoc-Jones
Photography: Jason Hawkes
Museum of London – 2010
(not by author)
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