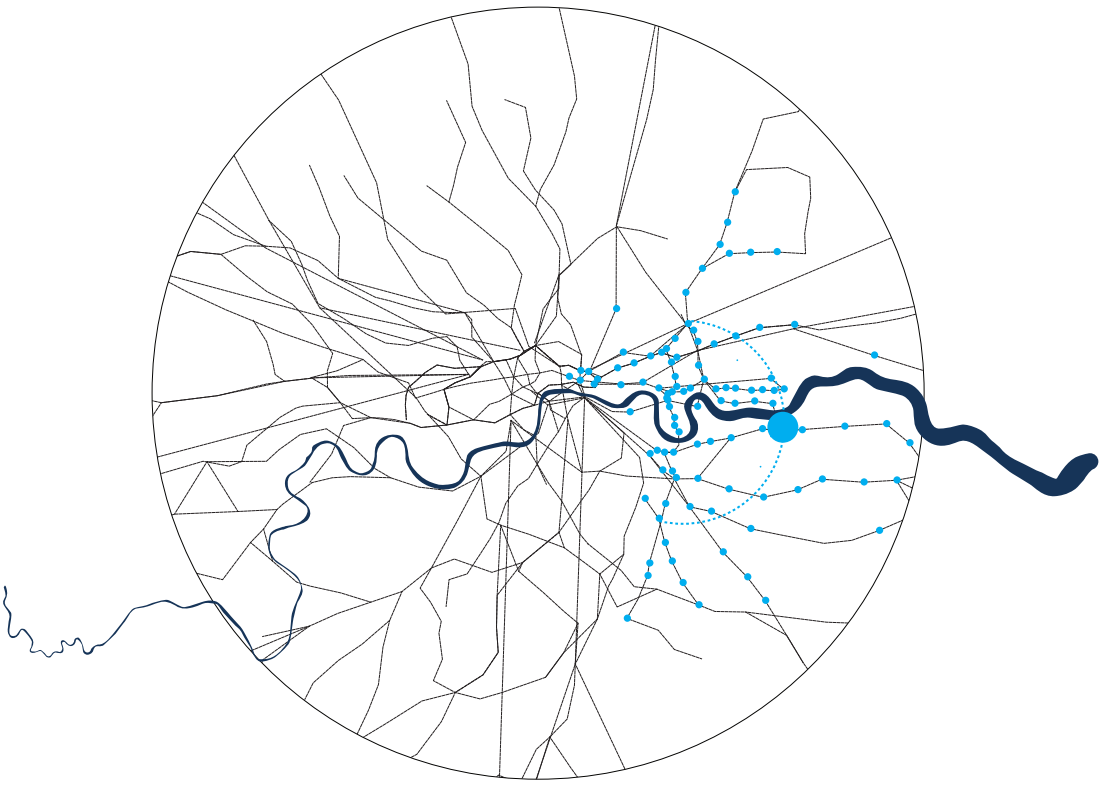

London 2041

challenging a region's mono-centric development paradigm

Daan Leenders

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challenging a region's mono-centric development paradigm

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Colofon

London 2041: challenging a region's mono-centric development paradigm

Master thesis
P5 Report

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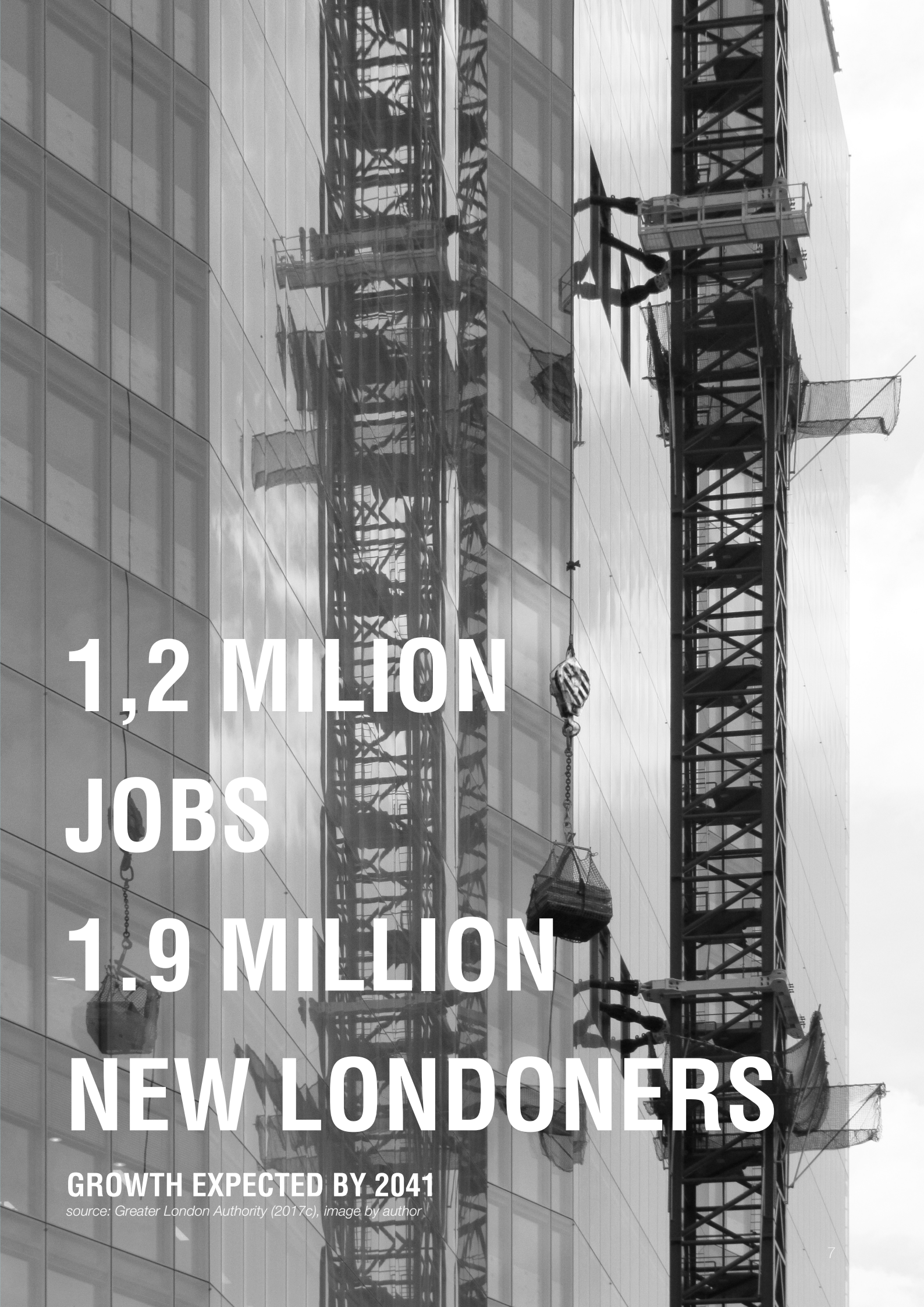
Executive summary



1,2 MILION JOBS

1.9 MILLION NEW LONDONERS

GROWTH EXPECTED BY 2041

source: Greater London Authority (2017c), image by author

2 WEEKS
14 DAYS
336 HOURS

SPENT COMMUTING BY THE AVERAGE LONDONER EVERY YEAR

source: Trade Union Congress (2017), image from Business Insider (2014)

This thesis proposes the development of Woolwich into a new centrality outside of Central London in order to combat the increasingly evident problems generated by London's mono-centric model of development. To do so this report first examines the causes for mono-centricity and the current attitude towards it, followed by a more in depth analysis of the issues it causes. In order to combat these issues several options for new centralities, and the transit networks needed to support them, are generated, optimized and evaluated based on a set of factors derived from a literature review. Subsequently Woolwich, the most fitting of the options reviewed, is further elaborated on with a development strategy comprising the local, regional and governance actions needed to guide its development into a centrality. Subsequently, it is assessed if the proposed development of Woolwich into a centrality contributes to solving the identified issues and reaching the goals set out.

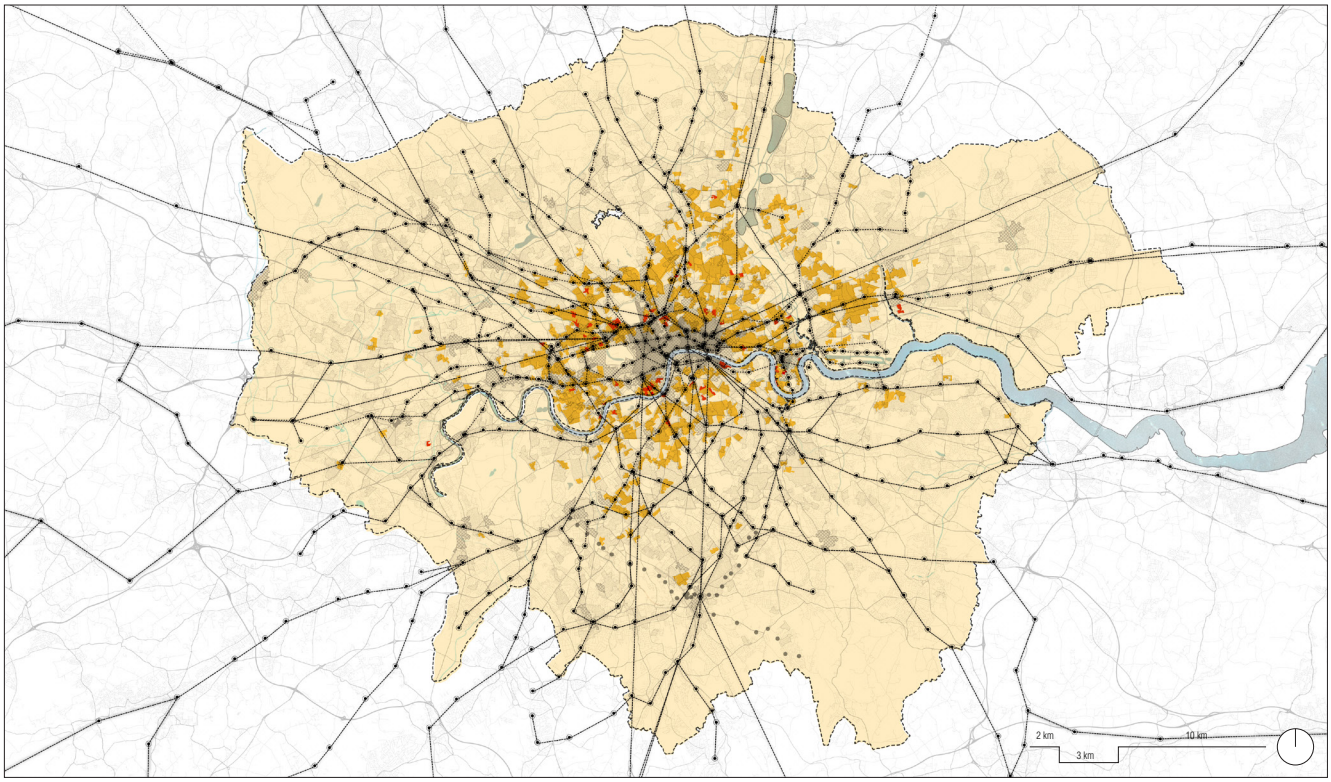
This summary will briefly examine each of these components. First a brief description of the identified problems is provided, followed by the problem statement, research questions, and goals. This is followed by the Centrality Development Framework which forms one of the main guides for the evaluation and strategy. Then the structure of the evaluation is briefly discussed, highlighting Woolwich, the variant selected. Finally, a brief overview is given of the development strategy followed by the outcomes of the assessment regarding the fulfilment of the project goals.

The issues of London's mono-centricity

London is projected to grow significantly with as many as 1,2 million additional jobs and 1.9 million new Londoners. However, this growth is not happening, and has not happened, in an equally distributed manner throughout the region. Instead, large discrepancies have come to exist within the region which features a highly productive core, where most employment is located, surrounded by a vast area consisting mostly of residential areas as seen in figures I and II. This difference naturally leads to long and intense everyday commutes of people going into the central area to work, only to flock back towards the rest of the region at the end of the day as seen in figure III.

This one-directional pattern not only makes inefficient use of transit infrastructure but has also lead to exorbitant commuting times for the region's inhabitants. In 2016 the average Londoner spent over an hour and twenty minutes travelling to work (Trade Union Congress, 2017). On a yearly basis this adds up to two full weeks spent commuting day and night.

However, the accessibility issues caused by London's mono-centric metropolitan functionality are not only expressed in long commutes, its costs are also monetary. An intense competition for the limited land in and around the central area, that does have good access to the services, amenities and jobs offered by the centre, has increased prices so much that many Londoners are forced to locate in Inner or Outer London. As such, the Londoners who cannot not afford the premiums as seen in figure IV. are forced into the long everyday commutes that define life in the region.



▪ Figure I. Population density

source: based on Greater London Authority (2018a)

1 - 70 people / ha

70 - 275 people / ha

275 - 685 people / ha

▪ Figure II. Employment density

source: based on Greater London Authority (2018a)

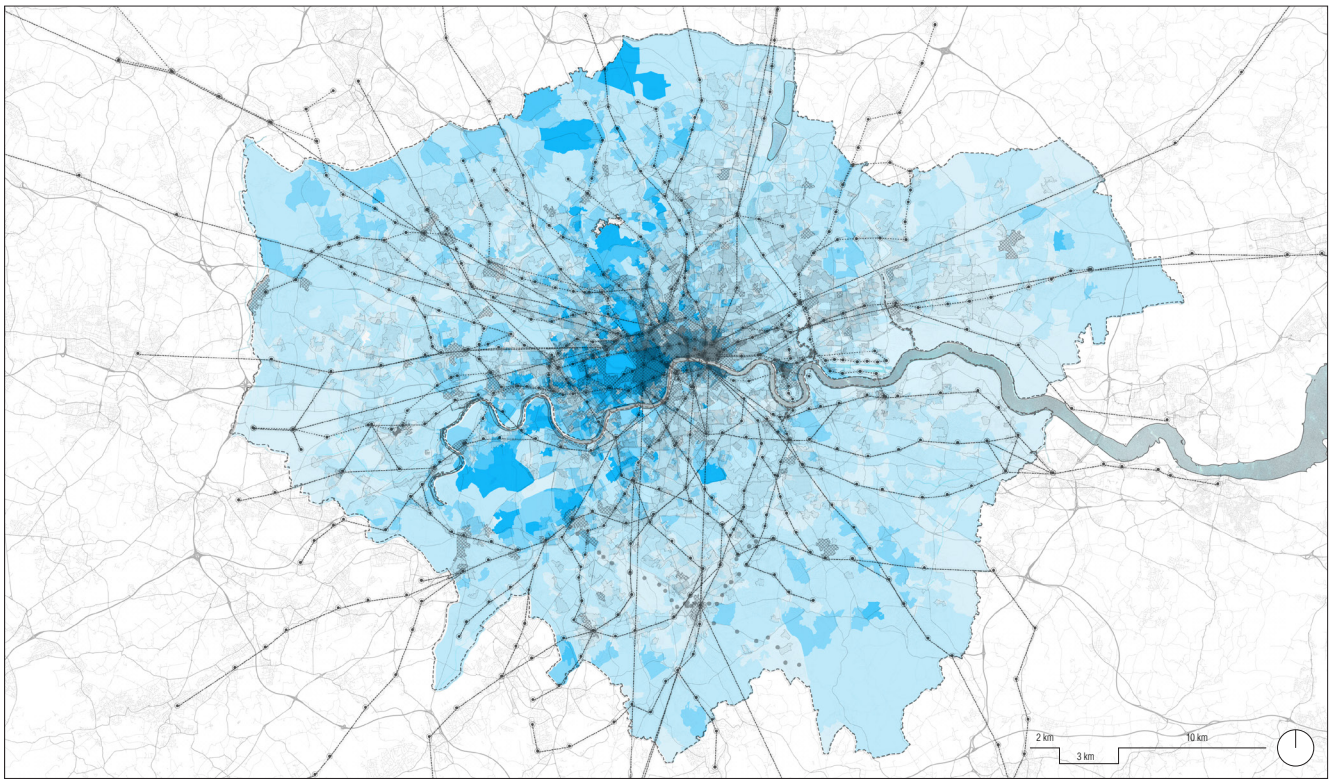
90.000 - 150.000 jobs / km^2

< 22.000 jobs / km^2

200.000 - 230.000 jobs / km^2

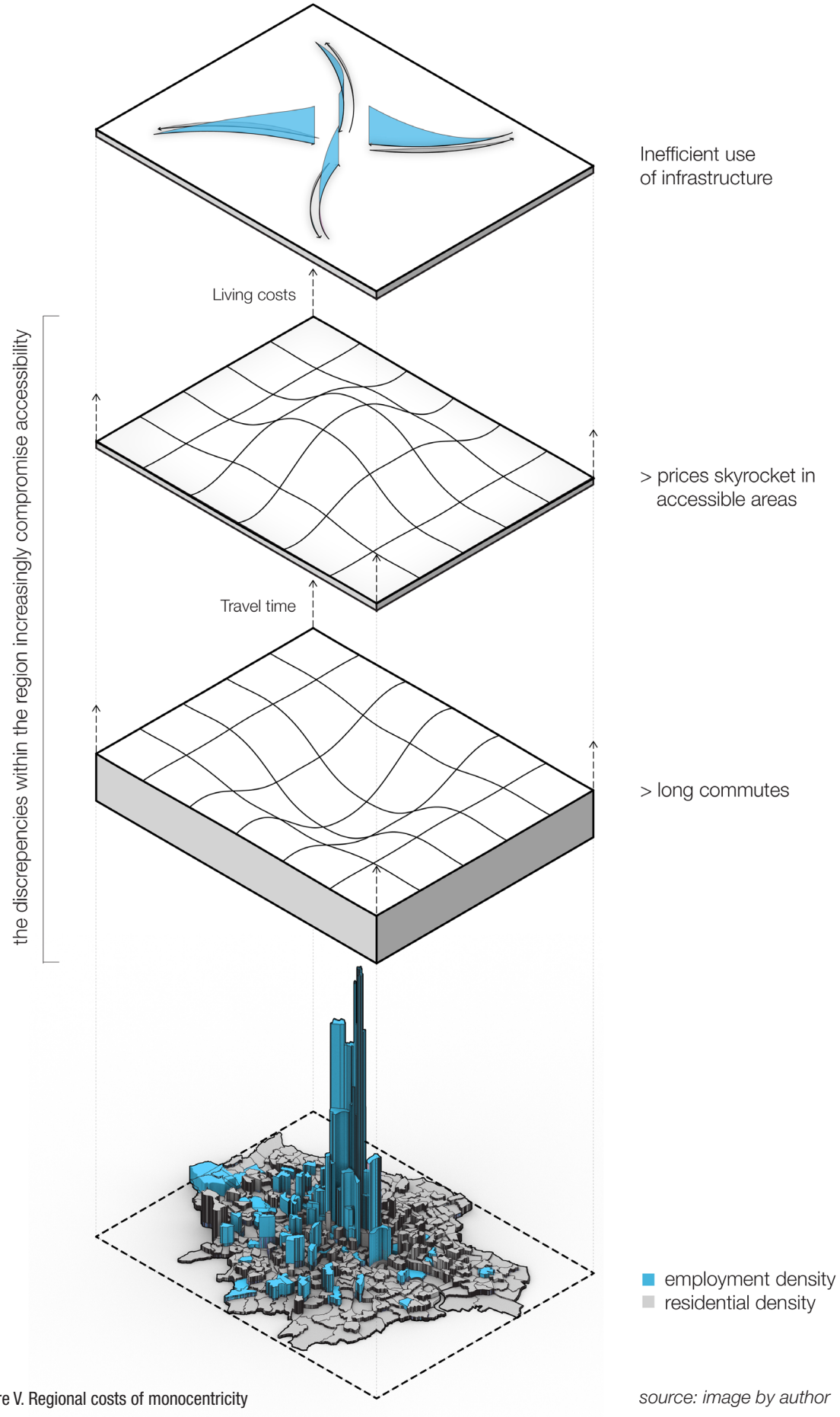
▪ Figure III. Percentage commuting to the CAZ *source: based on data from Office of National Statistics. Census Division et al. (2015)*

0% % employed in the CAZ 90%



▪ Figure IV. Housing affordability *source: based on Greater London Authority (2018a)*

< 5 houseprice / median household income > 29



▪ Figure V. Regional costs of monocentricity

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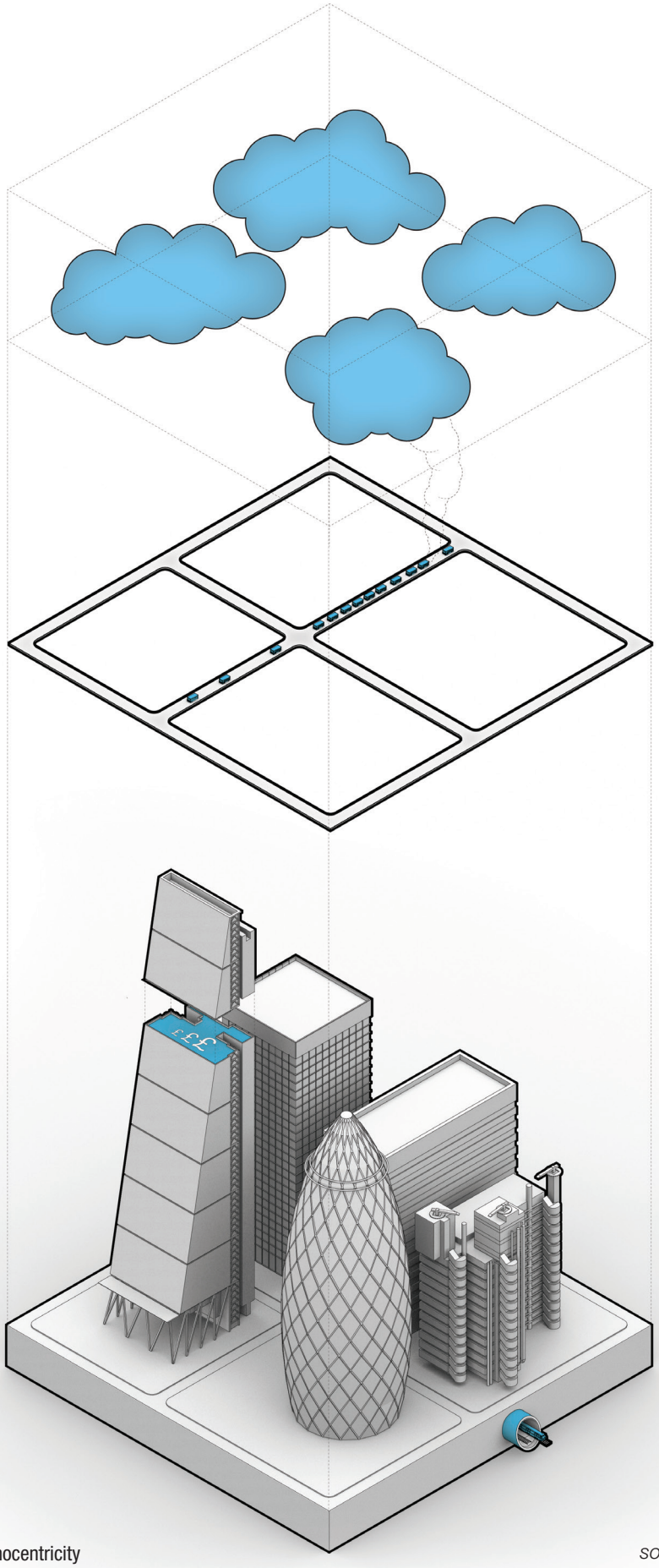


▪ Figure VI. Local costs of monocentricity

source: image by author

Research structure

The observed issues in London have lead to the following problem statement and associated research question:

The costs of Greater London's increasingly mono-centric metropolitan functionality are rising quickly. The large disparity between the region's productive core and surrounding residential areas are causing accessibility to employment, services, and amenities to become increasingly compromised. In light of projected growth, the time is now to critically consider an alternative to this model of development. While nurturing the competitive qualities that have made Greater London flourish as a region, a new balance must be struck that ensures better accessibility throughout the region, improving the daily lives of its inhabitants.

How can a better integration of land-use and mobility policy offer an alternative model of regional development for Greater London that improves territorial cohesion through the development of a new centrality outside the central area?

By improving territorial cohesion throughout Greater London and the development of a new centrality this thesis aims to achieve the following goals:

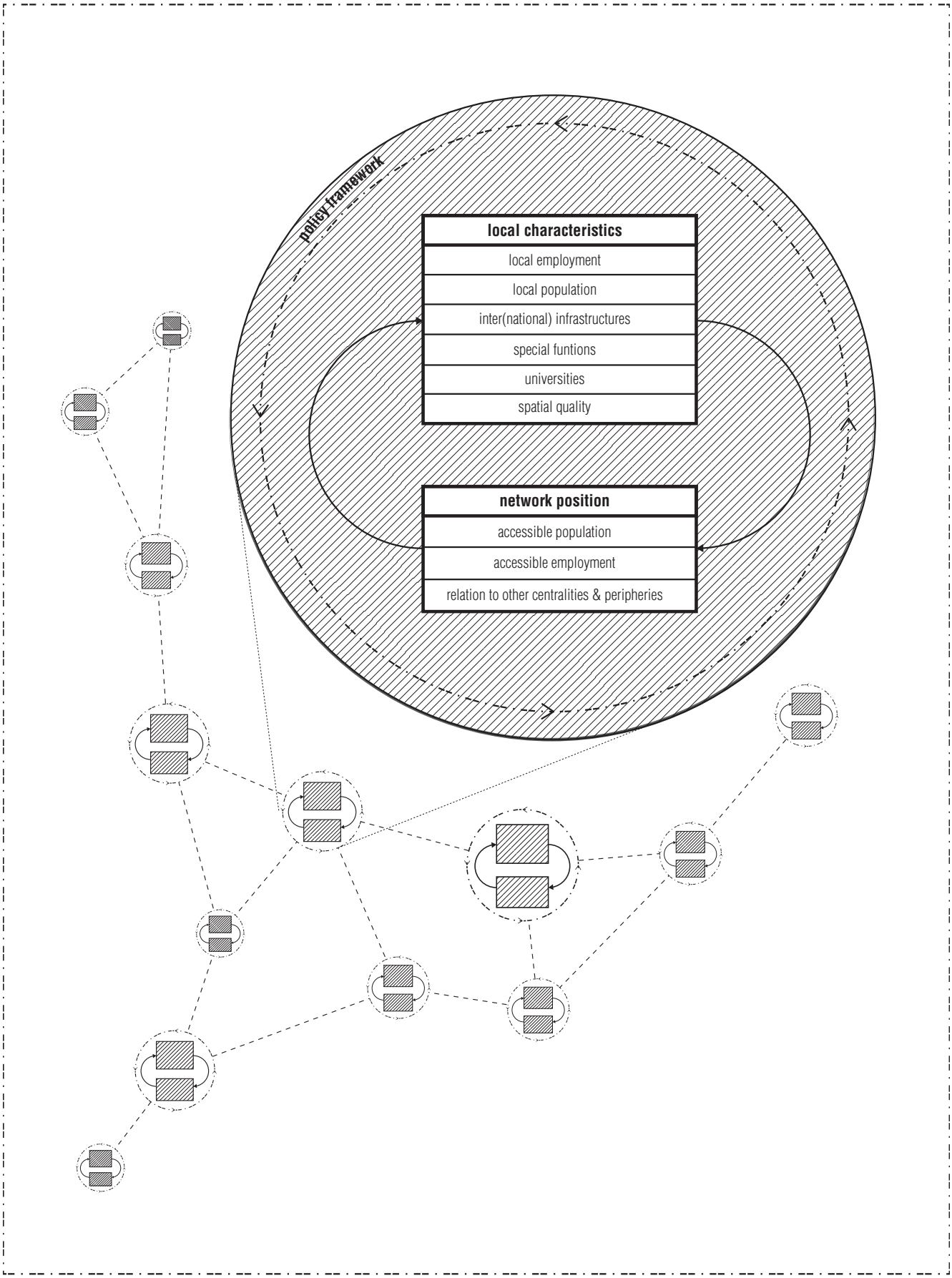
1. Create an accessible region in which services, amenities and jobs are a more common good and extreme commuting times are reduced.

2. Foster more sustainable and efficient travel patterns.

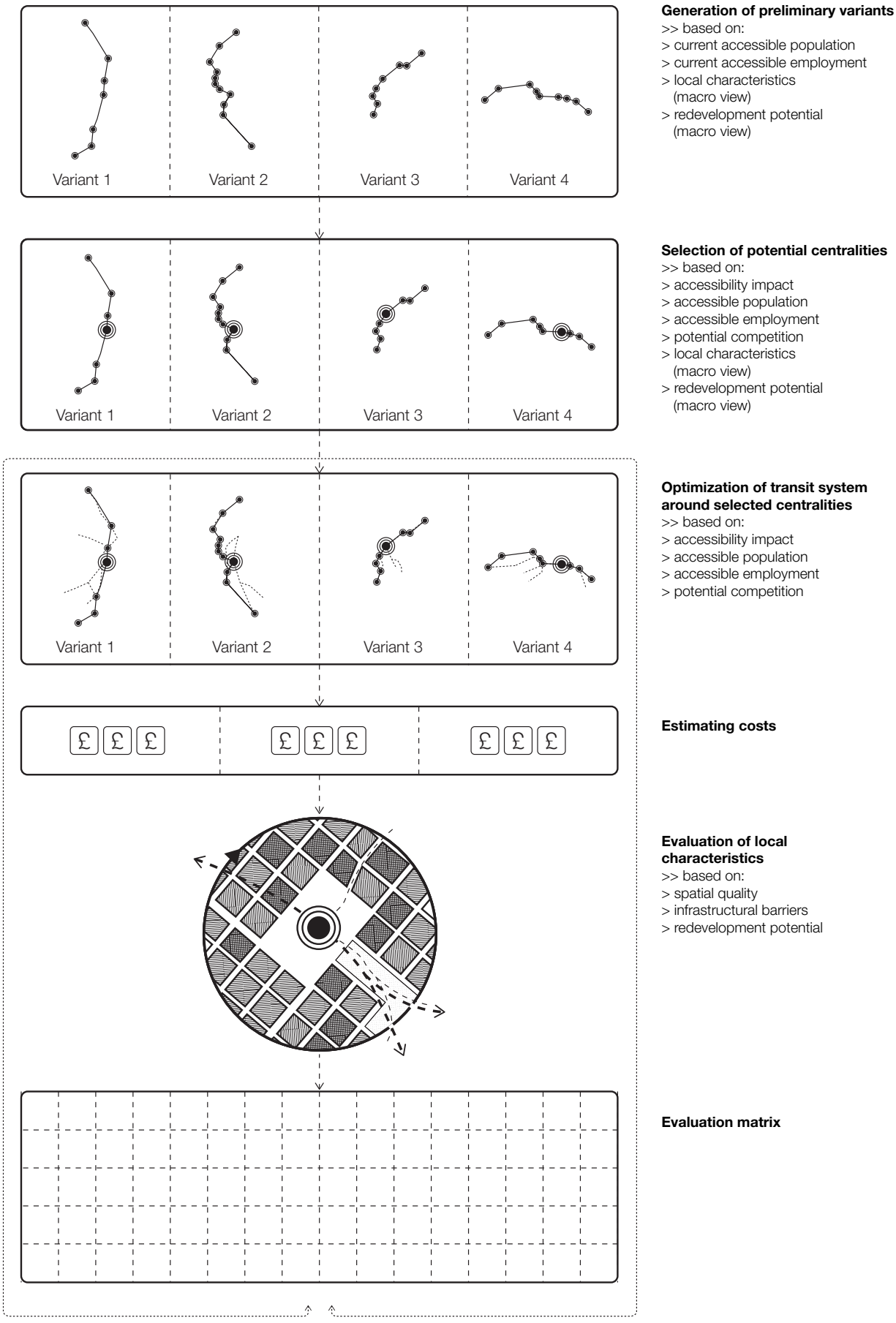
3. Accommodate London's growth in a more balanced manner throughout the region.

The Centrality Development Framework

In order to inform the approach taken in both the evaluation and development strategy a literature review has been carried out that has resulted in the Centrality Development Framework seen in figure VII. This framework offers an overview of the conditions that determine the formation of centralities. These conditions pertain to both the local characteristics and network position station areas and form a central element in the generation, evaluation and selection of options carried out in the thesis as well as the development strategy. The method by which the various options are generated, optimized, and evaluated is shown in figure VIII and leads to the selection of Woolwich as the location for a new centrality. Supporting Woolwich's network position is a new transit line in East London connecting Catford, Woolwich and Stratford as seen in figure IX. This line profoundly alters the structure of London's radial rail system that has facilitated much of its mono-centricity today by adding a north-south tangent.



▪ Figure VII. Centrality Development Framework *source: Image by author*



Generation of preliminary variants
>> based on:
> current accessible population
> current accessible employment
> local characteristics (macro view)
> redevelopment potential (macro view)

Selection of potential centralities
>> based on:
> accessibility impact
> accessible population
> accessible employment
> potential competition
> local characteristics (macro view)
> redevelopment potential (macro view)

Optimization of transit system around selected centralities
>> based on:
> accessibility impact
> accessible population
> accessible employment
> potential competition

Estimating costs

Evaluation of local characteristics
>> based on:
> spatial quality
> infrastructural barriers
> redevelopment potential

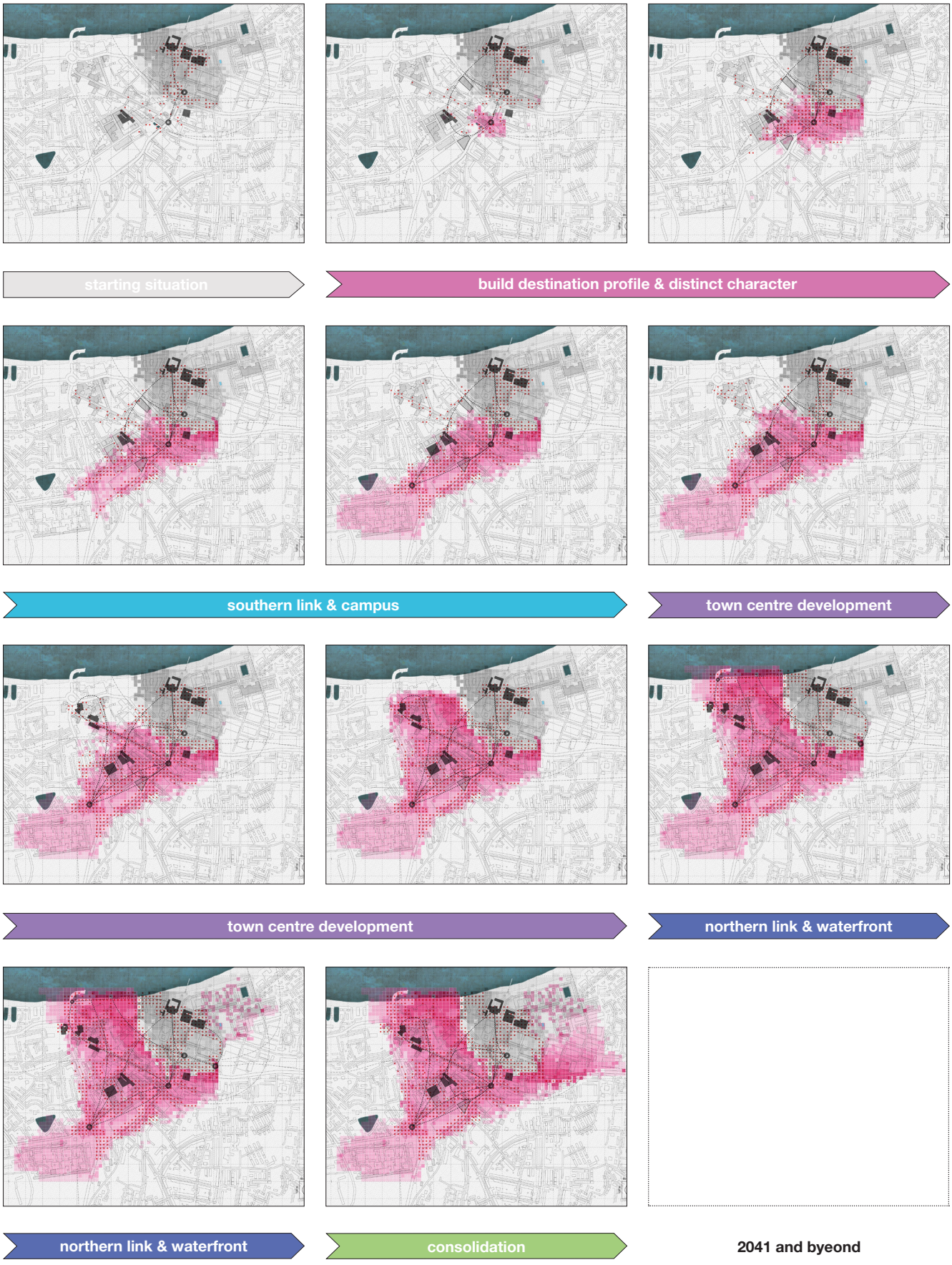
Evaluation matrix

▪ Figure VIII. Overview of evaluation steps and criteria used *source: Image by author*

Figure IX. Selected variant comprising a tangent through East London and a centrality at Woolwich *source: image by author*

A strategy for developing Woolwich

Due to the merits of its network position and local conditions such as its proximity to London City Airport, rich heritage, waterfront location, and diverse urban environment, Woolwich has been selected to be investigated further through a development strategy. This strategy comprises a range of interrelated actions on the local, regional, and governance scale levels that are phased through time and based on the insights from the theoretical framework, necessary supporting transit links, and local conditions. These actions mainly aim to guide the process of development by providing the necessary conditions rather than prescribing its exact shape and form. The development strategy is divided in six phases, as seen in figure X, that aim to make Woolwich a vibrant mix-use area that is home to knowledge and creative services. A central theme throughout these phases is to first create activity in the area that is subsequently leveraged into infrastructure investment. This infrastructure in turn, through the accessibility it provides, enables the next phase of development akin to the process described in the land use feedback cycle (Chorus, 2012). At the end of the development strategy as envisioned in this thesis, Woolwich should be home to roughly 149,000 jobs. This makes it a centrality of similar significance to current day Canary Wharf.



▪ Figure X. Overview of the development phasing

source: image by author

build destination profile & distinct character

town centre development

▪ Figure XI. Snapshots throughout the development process

town centre development

northern link & waterfront

source: images by author

Meeting the goals set out

With Woolwich offering roughly 149,000 jobs outside the central area, the proposal makes a significant contribution to balancing development throughout Greater London. However, the question remains how it influences the goals of making accessibility a more common good throughout the region, reducing commuting times, as well as fostering more efficient travel patterns. In order to determine the proposal's merits in regards to these goals two assessments are carried out. The first one determines the percentual increase in accessible employment within in twenty minutes, produced by the new transit line and 149,000 new jobs at Woolwich. The results, shown in figures XII and XIII, suggest that the proposal significantly improves accessibility to employment, especially in East London's more peripheral station areas. Hence it contributes to access becoming a more common good throughout the region. Its impacts regarding access to services and amenities requires follow up research however.

A rough assessment regarding the travel patterns a centrality at Woolwich would generate suggests that it could produce a passenger flow out from Central London of about 65,000 people. This would present a significant increase in bi-directional passenger flows, improving the efficiency of the transit system. Given that the proposals done in this thesis provide significant mass to help balance development throughout Greater London, improve the accessibility situation throughout East London, and foster more efficient travel patterns, it can be concluded that the proposals done respond well to the initial goals set out.

- Figure XII. Overview of increases in employment accessible in 20 minutes

0 - 20 %
20 - 40 %
40 - 60 %
60 - 80 %
80 - 100 %
100 - 300 %
> 300 %

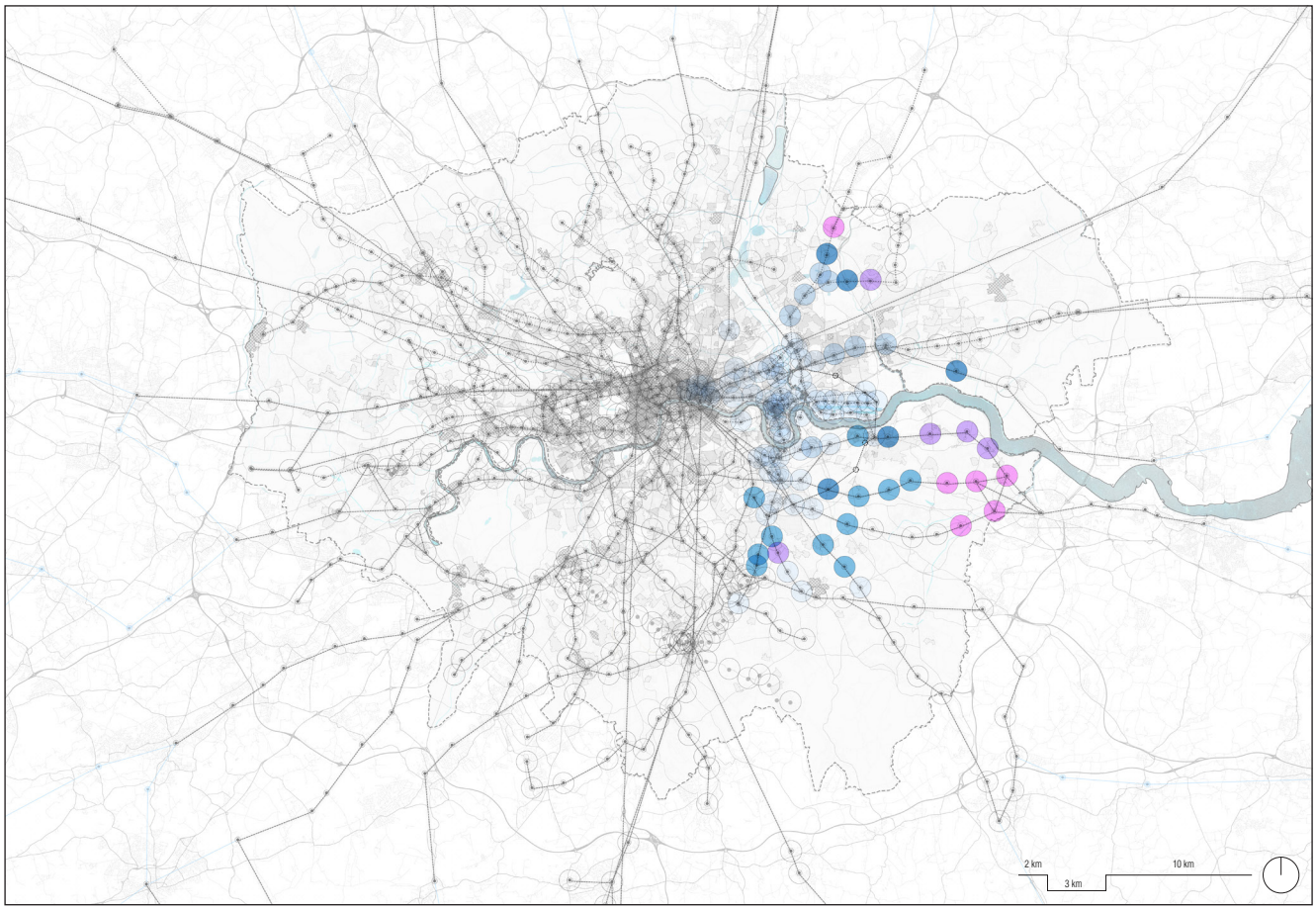
source: image by author

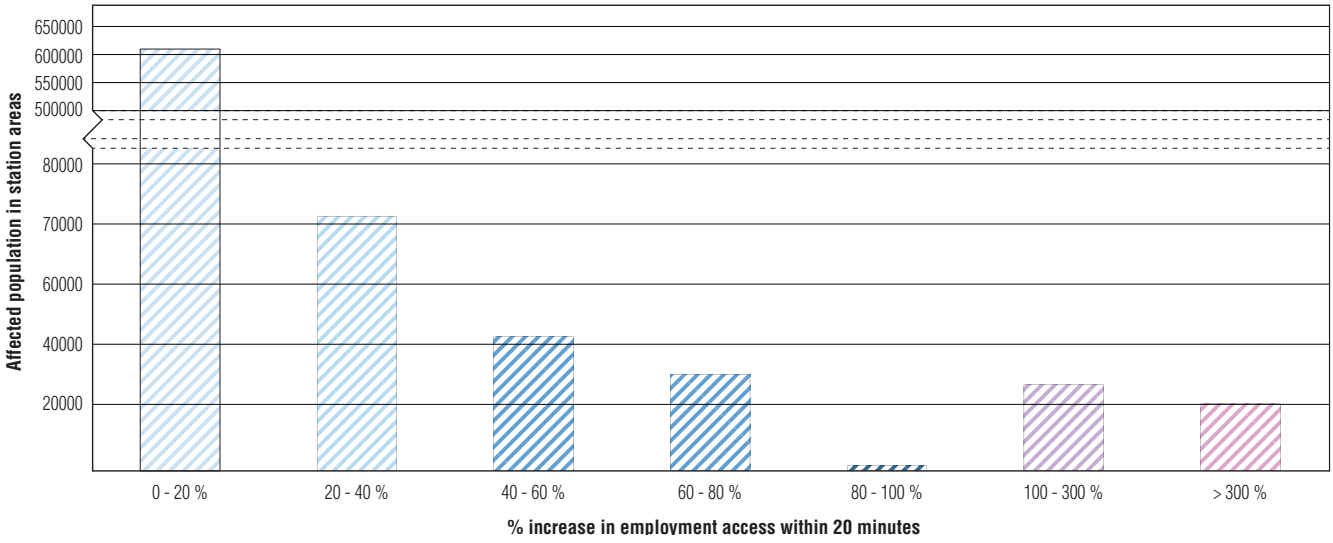
- Figure XIII. Number of people benefiting from increased employment access

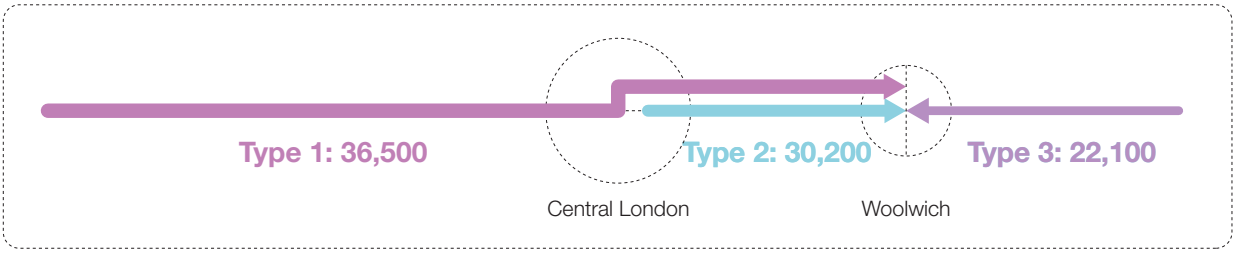
source: image by author

- Figure XIV. Estimation of generated passenger flows

source: image by author


2 km
3 km
10 km


650000
600000
550000
500000
80000
70000
60000
40000
20000
Affected population in station areas
0 - 20 %
20 - 40 %
40 - 60 %
60 - 80 %
80 - 100 %
100 - 300 %
> 300 %
% increase in employment access within 20 minutes


Type 1: 36,500
Type 2: 30,200
Type 3: 22,100
Central London
Woolwich

1. Introduction

+ the urban questions of today
+ emergence of the networked metropolis
+ contents of this report

The city is back. After a long period of suburbanization both in the UK and elsewhere in Europe, people are flocking back to cities and metropolitan regions. The largest and most successful of these regions have earned the moniker of World City as they have become focal points where the global networks increasingly driving national and international economies meet (Sassen, 2001).

The emergence of these World Cities has produced vibrant and cosmopolitan lifestyles, prosperity, diversity, innovation, and a host of other opportunities. However as with most things, negatives have also followed in its wake that raise their own pressing questions: How to handle the increasing, divisive spatial impacts of globalization? How do we allow citizens to participate in the city on fair terms? How to guide the increasingly privatized nature of development? Do we need to re-evaluate our car-dependency as congestion is bringing our cities to a grinding halt and the climate is changing?

Meanwhile, the way our cities function is evolving calling for new tools and approaches to answer these questions. It used to be for a long time that the city was a spatial continuum of places. However, especially in case of the large ones, this is often no longer so in the first place. With gains in mobility, proximity has become increasingly less important. More important are the networks that connect far-away places close together while skipping entirely over the places in between. This new reality necessitates a fresh approach that actively seeks to understand the nature of these networks and their configuration in order to properly address the challenges that await our cities in the years to come.

In light of these observations one would be hard pressed to find a more suitable subject to examine than Greater London. This metropolitan region is not only so interwoven with its main underlying transit system that has lovingly named it “the Tube”, but it is also facing many of the issues defining urban development today. It is projected to grow by 1,9 million new Londoners and 1,2 million new jobs by 2041, while dealing with shortages in even semi-affordable housing, congested roads and a transit system squeaking under its ever greater number of passengers (Greater London Authority, 2017c, The Guardian, 2014, TomTom, 2016). However, being a city facing great challenges, it has equally great ambitions, eying carbon neutrality by 2050 and an 80% modal share for walking cycling and public transit, all while further enhancing its position as a global economic leader. This combination between its great challenges and ambitions combined with the degree to which it is interwoven with its network make it a fascination object for examination in this thesis.

Contents of this report

This report forms the final step in a year-long graduation process. As such, it offers a comprehensive overview of the research undertaken, from the identification and framing of the issues at hand to the development and evaluation of their respective solutions.

Following this general introduction, the history of, current challenges, and policy directions for Greater London will first be discussed, providing context to the issues tackled. This is followed by a more in-depth analysis of London's issues relating to mono-centricity. Following discussion of the research question, scope, goals, and outcomes of this thesis, a theoretical framework will be introduced. This frames the approach taken within the aforementioned context of the networked metropolis. After a brief discussion on the resulting methodology, several variants featuring new centralities outside Central London are generated, evaluated, and optimized. The most fitting variant is elaborated through a comprehensive development strategy. Finally, it is evaluated if the outcomes of the development strategy meet the goals set out, and how they fit in the context of existing policy frameworks.

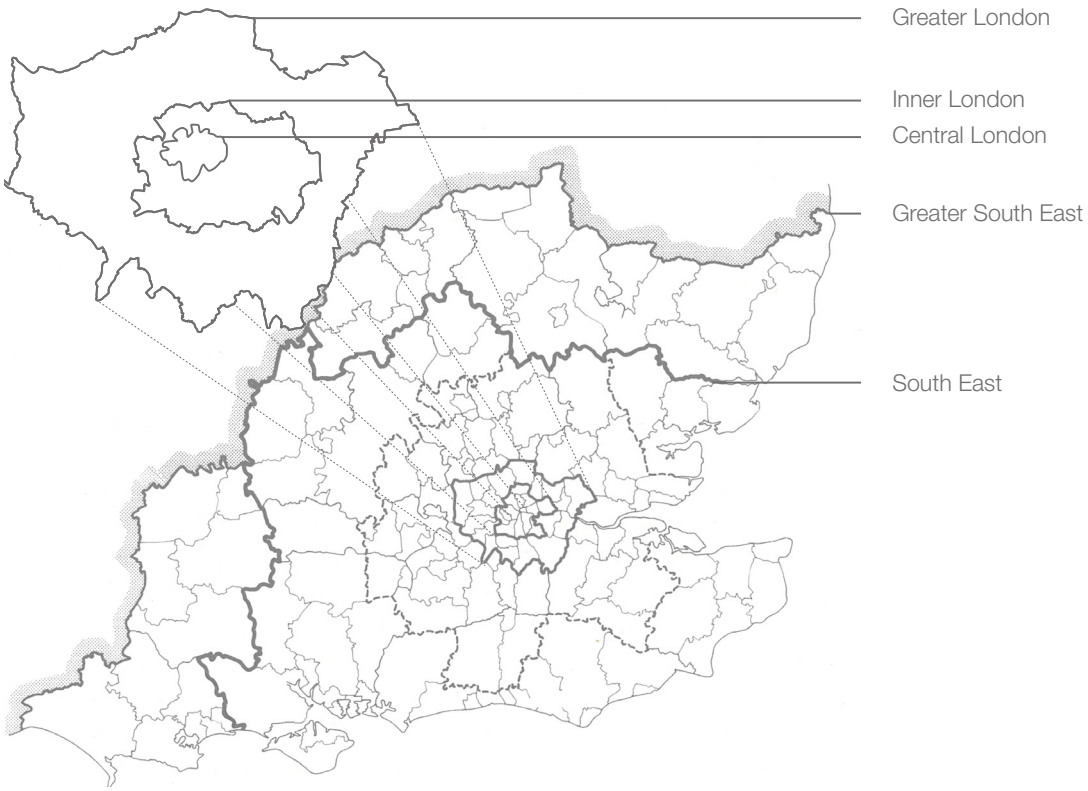
source: image by author

2. Introducing Greater London

+ mono-centricity and the transit network
+ private actors in London's development
+ challenge of growth
+ challenge of mobility
+ shortcomings of mono-centric policy

Before delving into the specific problems addressed in this thesis it is important to first achieve a basic understanding of its context; Greater London. Specifically, how it has come to be, the challenges it is facing and the way the government aims to handle them. To do so this chapter will first provide a brief overview of London's history, focussing on some of the main factors that have influenced its functioning as a region today. Subsequently, the current region's current state will be discussed with an emphasis on the challenges brought on by growth and the distribution of people's homes and workplaces. Finally, Greater London current policy framework The New London Plan will be discussed and critiqued.

In order to have these discussions it is important to know that London, throughout its history, a variety of plans, and studies, has been associated with a wide range of scale levels and territories. This are shown in figure 2.1. The first is the City which corresponds with the 677 acre ancient City of London, home to buildings old and new such as the St. Paul's Cathedral and the 2001 Gherkin. Around the City and stretching to the east lies the Central Area, roughly delimited by the Circle Metro line and including the Isle of Dogs. Beyond that lies Inner London which corresponds roughly to the London's Built-up area of 1914. Outside of that lies Outer London which together with Inner London forms the largest statutory delimitation today; Greater London. This area comprises a roughly 25 kilometre radius from the City and is the modern day area under the jurisdiction of the Greater London Authority (Greater London Authority, 2017c). However, to understand the history of London and its development plans it is essential to look beyond the borders of Greater London to those of the Wider South East Region, also referred to as the Greater South East in the past.



▪ Figure 2.1 Delimitations of London *source: adaption of Hall (1989)*

2.1 Historical development

For a large part of its history London remained relatively small, providing home to an estimated 200,000 inhabitants around 1600. It was at that time that London emerged as a global trade centre and its population boomed. In 1700 the population had risen to 550,000, then up to 1 million in 1801, quadrupling to 4,5 million by 1881 and 6,5 million by 1911 (Hall, 1989).

The limits of traveling by foot meant that London's population growth resulted in a compact, ever denser city up till halfway the 19th century.

Initially, this explosive population growth did not lead to a large spatial expansion of the city even though political stability offered it the luxury of expanding beyond its city walls. What kept London compact was the mobility of its people. As the vast majority of inhabitants had to travel to work by foot, London's population growth resulted in people packing increasingly close together. The limits of mobility meant that the explosive growth led to intense densification of the city (Hall, 1989).

This lasted until 1861 when the introduction of new means of transport started. New aboveground and the world's first underground railway were constructed, extending into the countryside as radial axis from Central London. These were supplemented by horse trams, -busses and carriageways. Freed from the confines of direct proximity, these new means of mobility allowed London to spread, first with middle- and upper-class suburbs such as Mayfair and Barnsbury followed by worker's estates such as Tottenham. This lead to a model of urbanization vastly different from the European Mainland. London grew with single family homes for people of all classes as opposed to the dense apartment blocks common on the other side of the Channel.

The introduction of radial railway lines and the new mobility this provided has allowed London's mono-centric model of a productive core surrounded by residential sprawl to be born.

However, it wasn't until the much faster electric rail replaced horse and steam powered carriages between 1890 and 1910 that urban sprawl really took over. Many new underground lines were constructed into the surrounding countryside funded through a model of land speculation: If we build it, the development will come. It worked. The residential developments along the railway lines allowed people to move away from their cramped accommodations in the productive central city in search of more comfortable confines. Industry largely remained in the centre where accessibility to workforce was highest due to the radial system transit lines (Hall, 1989). London's model of a productive central city surrounded by residential sprawl was born.

The 1944 Abercrombie Development Plan

The period after the Second World War introduced a distinct new chapter in London's and the Greater South East's development. Concerns began rising about London's economic dominance on a national scale, its ever increasing sprawl eating up valuable farmland and traditional farming villages, as well as the city's overcrowding, congestion, high land values and long journeys to work. Incidentally, with the exception of London's boundaries increasing, all issues that are again very much relevant today.

In the wake of Ebenezer Howards' Garden City movement came Abercrombie's Greater London Plan of 1944. In order to curb London's sprawl he pro-

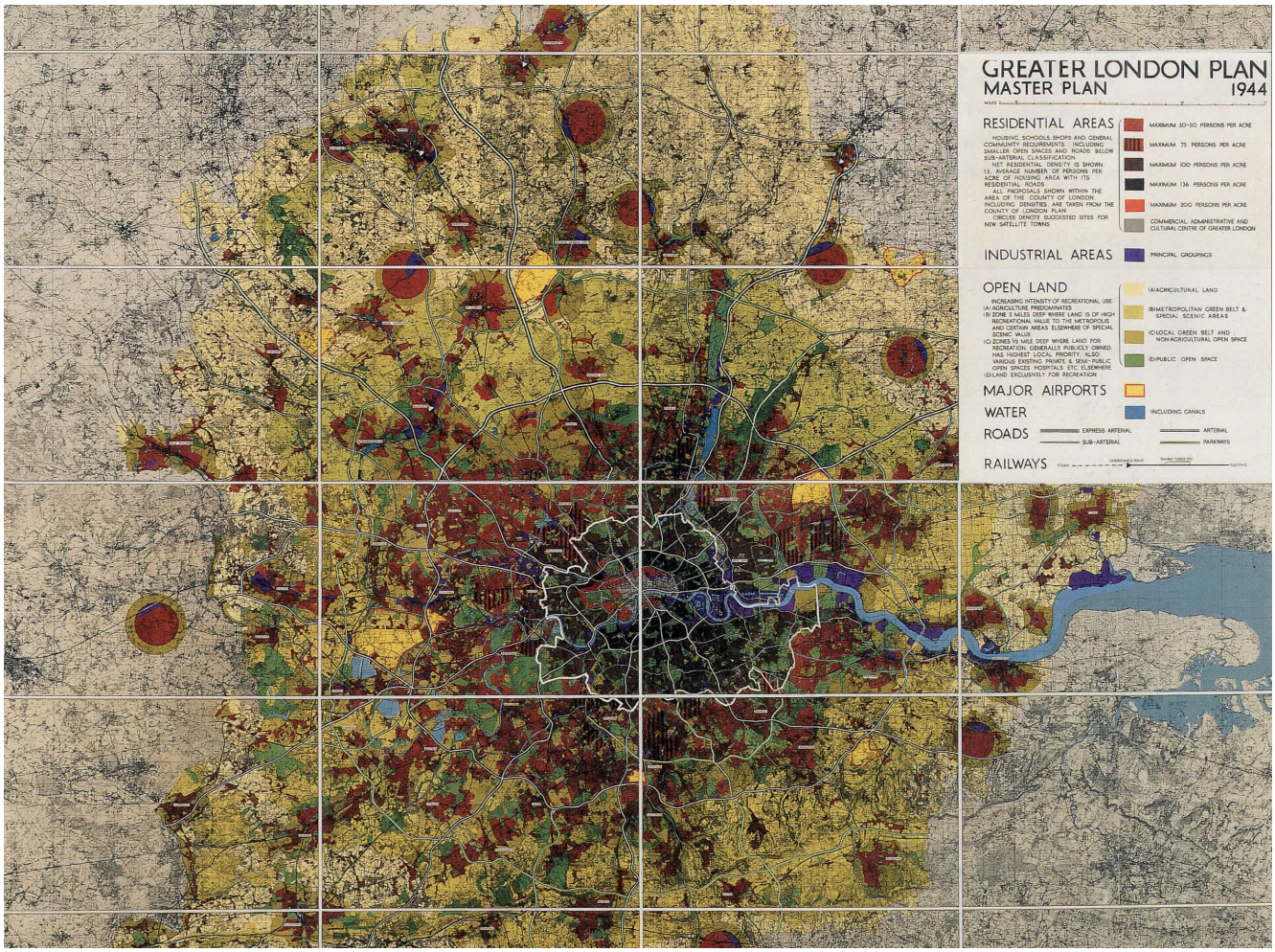


Figure 2.2 The Abercrombie Development Plan

source: van Roosmalen (1997)

posed a wide green belt around the city, put in place by the government in 1955. Outside the belt, Abercrombie proposed eight new towns surrounded by open country. Staying true to the ideals of the garden city these places where envisioned as self-contained towns for living and working. The measures for the implementation of this vision went far. A population advisor was set up that was tasked with controlling the migration of people in the region, determining the exact demographic and economic contents of certain areas. This went as far as subscribing jobs that would be best fit the gender composition of an area (Sudjic, 1992).

In order combat the negative externalities of London's concentration of activity, far-reaching top down instruments were put in place to promote polycentricity through the Wider South East.

His plans were taken to heart and followed up with the development of three larger new towns further out from London (van Roosmalen, 1997, Hall, 1989). However two things went wrong, job growth around London didn't stop and birth rates rose, both leading to a much larger population growth than anticipated. While the New Towns where the central topic during this development period they only offered home to 960,000 people up to 1986 whereas the rest of the South East saw a population growth of 3,725,00 people. Messy suburban development ensued (Hall, 1989).

The 1970 Strategic Plan for the South East

In reaction to the persistence of sprawl and unexpected growth, a new plan was made for the Greater South East region. This plan relied on the establishment of growth areas that could serve as counter-magnets to London in a polycentric system, alike to that of the Randstad. However, this time population growth ended up much lower than expected. At the same time London itself started to shrink drastically as its projected population for 1991 was reduced from 7,0 to 5,7 million. The people moving out of London partly offset the low overall population growth which allowed the designated growth areas to be developed anyway, albeit on a smaller scale than envisioned.

Towards London as a World City

The rapid decline of London, once the vibrant and prosperous heart of a nation and empire, turned heads. What resulted was a shift in the focus of planning policy. From this point on, the countryside would no longer be central but rather the increasingly dilapidated areas in the capital's central area that had been ravaged by the deindustrialization of the 70's and 80's. The 1977 White paper and 1978 Urban Areas Act brought an end to the new town programme in favour of inner-city revitalization policies. Under the new 1979 Thatcher regime, government involvement and public funding was reduced in favour of private enterprise. In line with this new direction, the Greater London Council (GLC) was disbanded, urban development corporations where set up, and so-called enterprise zones where designated. The urban development corporations would manage the necessary public expenditure in order to secure private capital while the enterprise zones offered further incentives for businesses in the form of property tax holidays and minimal planning regulations (Hall, 1989).

With Thatcher came a profound change in the instruments used for guiding urban development. The heavy top-down tools of Abercrombie were traded in for the stimulation of private enterprise from the local level.

Perhaps the most fitting example by which to illustrate this new chapter in London's development is Canary Wharf, a development emblematic for the transformation of London's identity as a city, the focus of planning, and the methods for achieving it. With the introduction of the shipping container the city of London, who had amassed much of it wealth in the past through shipping trade, lost its port as the Thames could not accommodate the draft of the large new vessels. When the last upstream port finally closed in 1981, the 25,000 dockers' jobs of 1960 had disappeared along with another 75,000 that depended on them (Sudjic, 1992). What was left was a derelict swath of land at the edge of London's central area.

In light of the new revitalization policies the London Dockland Development Corporation (LLDC) was founded with the aim of transforming the docklands into a location for low rise business parks and industrial sheds, the development of which would be stimulated by designating it as an enterprise zone. However, in reality, while the future identity of the Docklands would come to be defined by anonymous sheds, it certainly would not be low-rise ones. After a range of developers started specu-lating on the creation of a new financial hub, it was the Canadian firm Olympia & York that set out to make this vision a reality. Aiming to capitalize on the tax benefits and lax planning measures,

Figure 2.3 Construction at Canary Wharf continues today

source: image by author

they started construction on the Canary Wharf complex comprising ten million square feet in offices and half a million in retail space, all without a single residential unit. This composition was representative for the transformation of London's new economic motors. An area intended to provide blue-collar jobs to the poor surrounding communities came to accommodate white collar service jobs. Now home to several business banks and other international companies, the Isle of Dogs is representative for London's new era of prosperity. It is once again an international centre of trade, but this time not of goods delivered by ship but by the digital transfer of knowledge, money and stocks. In addition its conception, characteristic of Thatcher's new era of planning, showed that it was no longer the state but now the developer that shaped the city.

In its resurgence London has transitted to a mainly service driven economy with strong global ties.

A unified London within the Green Belt

With the radical changes discussed above London's population decline reversed and a steady growth started. While many continued to move out of London in search of affordable family homes, wealthier people started moving back into the city's revitalized centre. This growth was further supplemented by a steady flow of immigration from outside of the UK. London's shift from an industrial to service based economy continued with the business and fi-

nancial sectors blossoming and providing 40% of jobs in London. In 1995 the London Pride Prospectus was published, created by the private sector, this government-backed document aimed to ensure the development of London into Europe's only World City. Focussing primarily, as one would expect from a private lead endeavour, on the promotion of business and attraction of inward investment (Salet et al., 2003).

The year 1997 marked a significant shift in the policies underlying London's revival. After 18 years of conservative rule the Labour Party won the election and instituted both the new Greater London Authority (GLA) and an electable mayor. It was the first time since the GLC was disbanded under Thatcher that all of metropolitan London had a unified government. The GLA and mayor would provide strategic guidance for the entirety of London as demarcated by the Green Belt. Through the creation of Spatial Development strategies for the region as a whole, the GLA, which is still in place today, was tasked with ensuring comprehensive development throughout the region as a whole (Salet et al., 2003).

London's future

Since the turn of the century London has continued to develop as a World City. While this has undoubtedly brought much prosperity it has also lead to issues, some of which are discussed further in the next section. Therefore, in their latest Spatial Development Strategy, the 2018 New London Plan, the GLA has a particular focus on combatting the negative externalities of being a World City while aiming to maintain its position as one. This more balanced approach is indicative of the GLA's status as overseer the entire Greater London territory, a distinct departure from the period before the GLA when the competition between various boroughs resulted in a much more fragmented form of development.

With the (re)instatement of the GLA, there is once again a (planning) body that addresses the development of Greater London as a whole, something that disappeared with Thatcher. The instruments it employs are not nearly as far-reaching and prescriptive as those of Abercrombie however.

Major focal points for the future development of London are reduction of inequality, fostering economic participation and the reduction of the climate footprint. The goals the New London Plan lays out for the city's future and its means of achieving them are discussed further in the final section of this chapter.

Summary & discussion

In summary, London first developed as a compact city due to constraints of travelling by foot. This model changed when new means of mobility became available. The construction of radial transit links emanating from London's central area allowed people to move out of the cramped inner city causing the boundaries of the city to expand. Meanwhile the radial structure of the mobility system meant that the centre was the most accessible place, causing industry to remain there. It was so that the new underlying mobility network allowed for the mono-centric model of residential sprawl surrounding a productive core to be born.

As concern over sprawl and an overconcentration of activity in London

mounted, the green belt was instituted to limit London's expansion and combined with measures to divert growth to contained centres. Strict top-down measures were imposed in order to guide development in this pattern. As London's centre declined, the focus shifted to market driven inner city revitalization. This would lead to a period of profound change for London. It re-emerged as a world city driven by the service sector while the top-down government led development measures of Abercrombie were traded in for a market oriented system. This transformation led to the reappearance of a familiar functional model: a productive core surrounded by residential sprawl.

As will be discussed in the next section the issues of mono-centricity are once again gaining relevance. However a modern approach to them must must be vastly different from that of Abercrombie. A different set of tools is needed as the British planning system no longer lends itself for top down descriptive decision making. Nowadays private actors must be proactively engaged in order to realize (regional) planning goals.

Private actors must be proactively engaged to realize (regional) goals in the London of today.

2.2 Present-day London

London's demographic and economic growth have carried through to the present day. The Wider South East (WSE) is now home to 24,2 million people, 10,0 million households an 13,7 million jobs of which correspondingly 8,9 million, 10,0 million and 5,7 million are located in London (Greater London Authority, 2017).

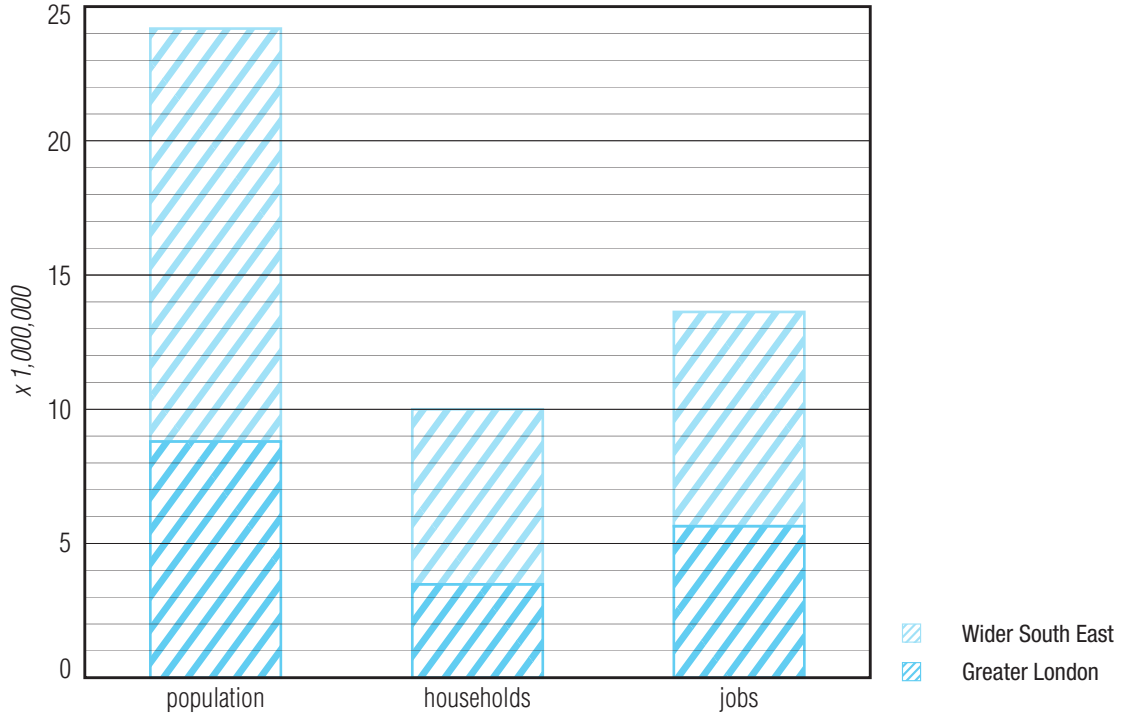


Figure 2.4 Demographic data for Greater London and the WSE

based on data from: Greater London Authority (2017c)

The Wider South East region still shows its inheritance from the 1940's to 1970's, consisting of multiple towns and cities networked by a set of radial and orbital connections with Greater London at their centre. However, as op-

▪ Figure 2.5 Population density

source: data from Greater London Authority (2018a)

275 - 685 people / ha
70 - 275 people / ha
1 - 70 people / ha

posed to the 1970's London is once again firmly established as the beating economic heart of the region and beyond. Authors such as Allen et al. (1998) even go as far as stating:

"The City of London is a dominant node, its connections with other regions and with other countries and continents far outweighing in significance its more local connections to the region in which it is locationally set. It is a place which is internationally embedded."

However, while businesses that act on a global level form some of the key drivers of London's economy today it still has a strong relation to its surroundings. As seen in figure 2.4 jobs are once again disproportionally concentrated in Greater London leading to large commutes from the wider region into the city every day.

Greater London is the undisputed heart of the Wider South East and Central London the undisputed heart of Greater London, both providing far more services, amenities and jobs than their surroundings

However, as discussed these discrepancies are not only apparent between Greater London and its surroundings but also within its own confines. As seen in figure 2.5 and 2.6 respectively, the distribution of jobs and population throughout Greater London is all but even. The City and Canary Wharf once again dominate London's employment market while homes are dispersed throughout the region at limited density. The productive inner and residential outer city are primarily connected by a network of radial railways, underground lines and roads. The sharp differentiation between the places where

Figure 2.6 Employment density

source: data from Greater London Authority (2018a)

people live and work leads to long and intense everyday commutes congregating towards the city centre in the morning, only to spread throughout Greater London again in the evening. People all over Greater London rely on the centre for many of their daily activities.

The housing challenge

The WSE is projected to grow faster than the rest of the country until 2041 with growth particularly concentrated in Greater London. Over the next 23 years the metropolitan area will offer room to an additional 1,9 million people and 1,2 million jobs (Greater London Authority, 2017c). Accommodating these additional people and jobs in an appropriate and affordable manner is one of London's major challenges and will require the construction of roughly 66,000 new homes every year.

Over the next 23 years London is projected to grow with 1,9 million people and 1,2 million jobs (Greater London Authority, 2017c)

London's resurgence has put a massive strain on the housing market as housing prices have skyrocketed. As income growth has not kept up affordability has increasingly been becoming an issue. Figure 2.7 and 2.8 compare housing affordability in London between 1995 and 2016 by measure of housing price relative to equalized median household income for the UK. The results are staggering, over the course of merely 21 years the relative cost of a home in some of Inner London's areas has multiplied by more than fifteen times. As a result the lower- and middle class are increasingly being priced

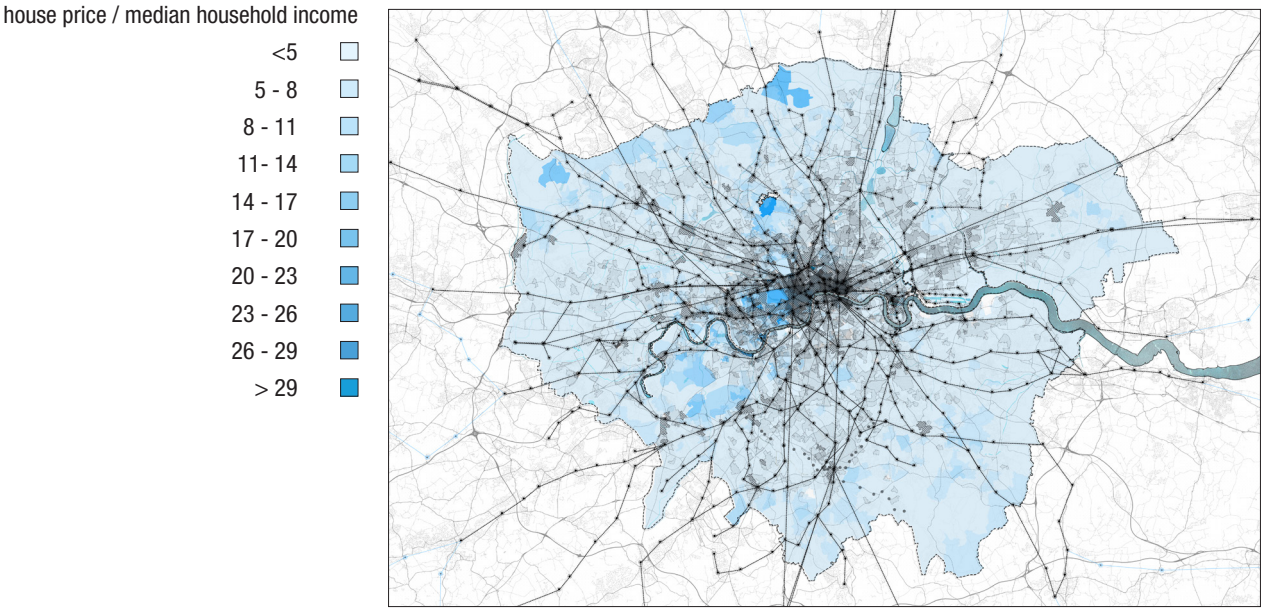


Figure 2.7 Housing affordability in 1995

source: data from Greater London Authority (2018a)

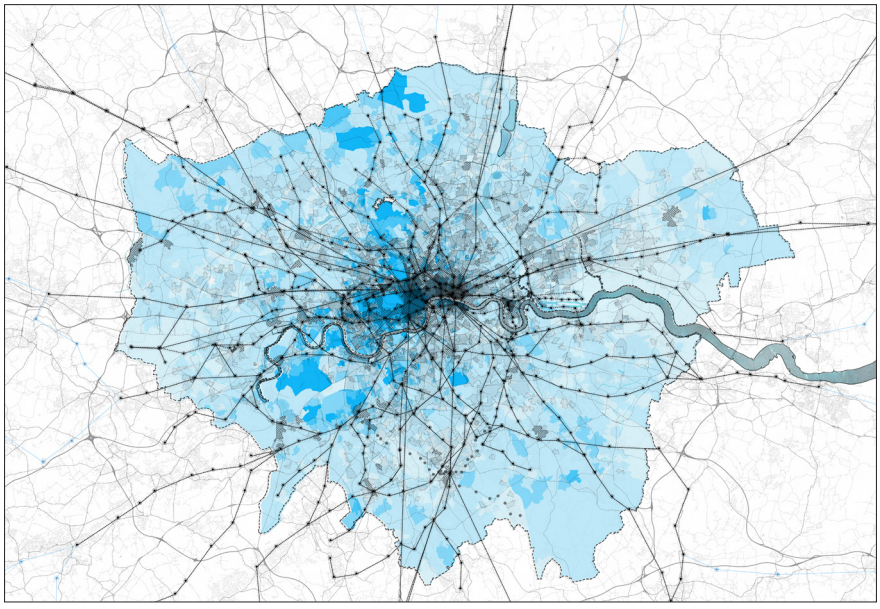


Figure 2.8 Housing affordability in 2016

source: data from Greater London Authority (2018a)

London's housing prices are sky rocketing, especially those nearby or in the centre close to the majority of services, jobs and amenities.

out of the city. While prices have risen throughout the entire region, increases in and around the central area have been highest, evocative of the discrepancy in local (or nearby) services, amenities and job opportunities.

It must however be noted that the surging housing prices are not solely due to London's population growth. A large part of this increase can be attributed to London's development in to a global city, reflected in the emergence of elite residential areas such as Belgravia that house London's new global citizens (Smith, 2003). There is also a lot of speculative foreign investment as illustrated by a new apartment tower at St. George's Wharf which is owned for more than 60% by foreign investors (The Guardian, 2016). However, while

the question of global capital distorting London's housing market is outside the scope of this thesis, it must be acknowledged that the provision of adequate housing will be one of the major challenges for London's future. This, combined with the space needed to accommodate the 1,2 million new jobs projected means that significant amounts of development will need to happen.

The mobility challenge

London's mono-centric functional model creates a high travel demand causing capacity issues for its mobility network.

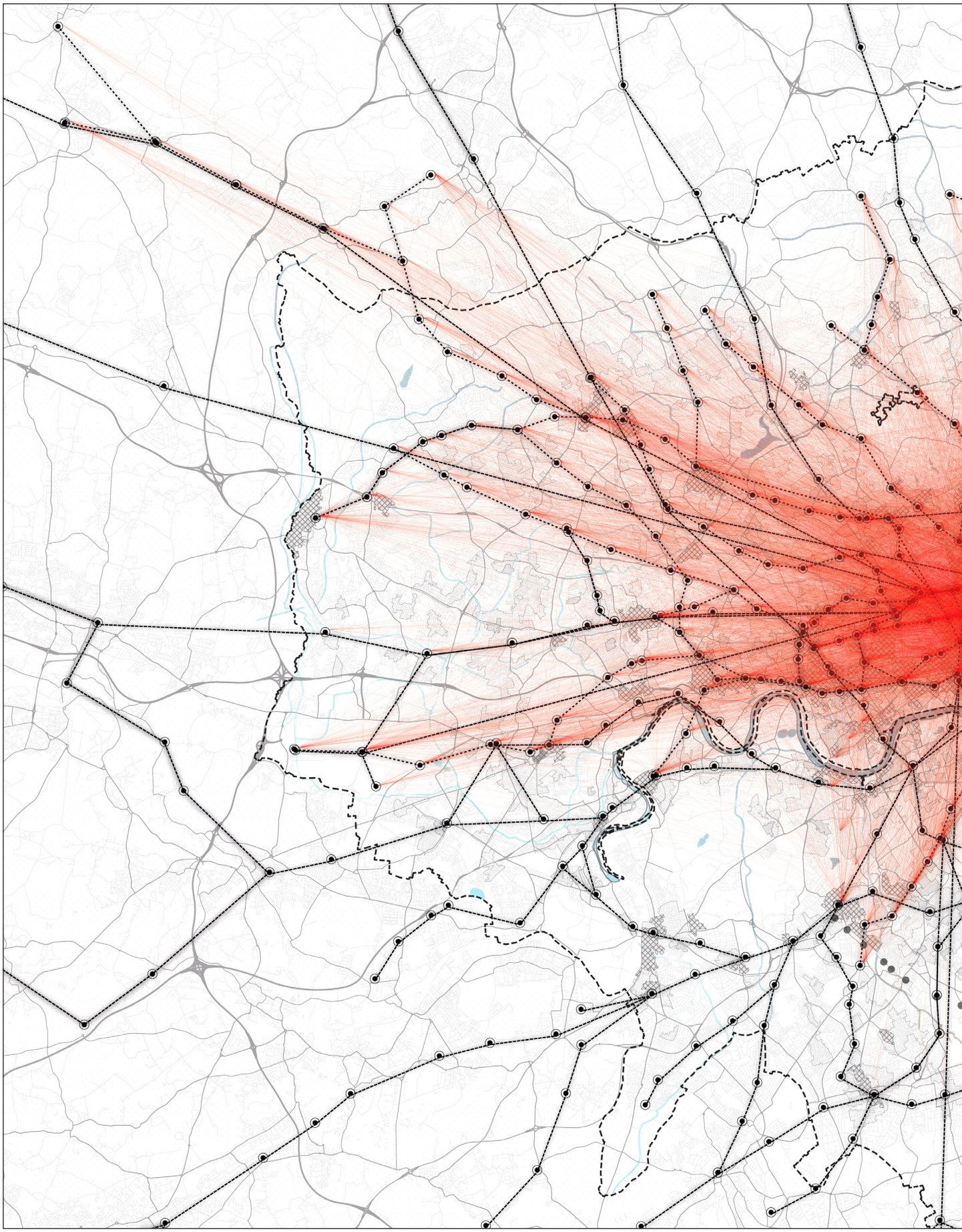
The challenge of London's growth is not solely finding the space to accommodate it. As increased mobility has freed living and working from the confines of direct proximity, the distances between the places where people live and work have increased drastically. London's high concentration of employment in its centre generates its characteristic radial commuting pattern as seen in figure 2.9. The capacity of the transit network is under significant pressure as more and more people have to travel to London's dense productive centre. In 2014 Sir Peter Hendy, London's transport commissioner publicly voiced his concern that without significant and continuous additions to public transport infrastructure people will simply not be able to access the city's transit network during peak hours (The Guardian, 2014). These candid remarks reflect the major challenges of increasing demand for transit.

The situation on London's roads is not much better. A 2016 study by TomTom has identified London as the most congested Western European metropolis with car trips taking up to 40% longer due to traffic (TomTom, 2016). In an attempt to combat road congestion and improve air quality a low emission zone has been established throughout Greater London supplemented by a Ultra Low Emission Zone and Congestion Charge in the central area (Transport for London, 2018b).

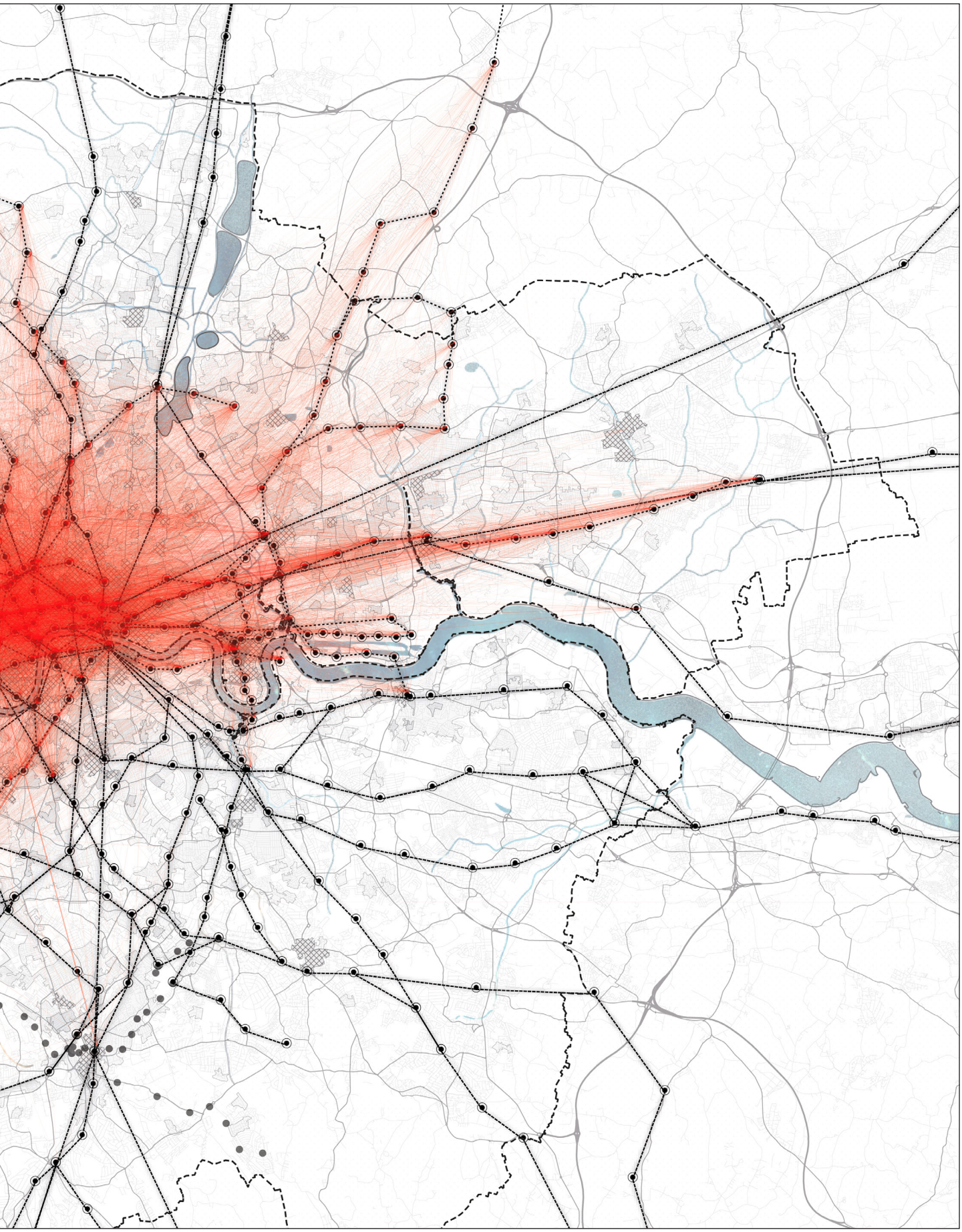
As Greater London keeps growing the capacity of an already challenged mobility system will come under increasing pressure. Hence, London's mobility challenge offers one of its most prominent questions for the future.

Summary

Over the last decades Greater London maintained its strong economic and demographic growth and has firmly established itself as a World City and the economic heart of the UK and WSE. However, while continued growth has brought much prosperity back to London it is also posing its own clear challenges such as accommodating this growth and providing space for 1.9 million new inhabitants and 1,2 million jobs. However, the distinct mono-centric pattern in which these functions are arranged is causing its own challenges as well. Housing prices have skyrocketed in places, close to jobs amenities and services of the central area. At the same time the mobility system is under pressure to transport the large number of people not living in this centre towards it to carry out their daily activities. These issues of accessibility stemming from London's mono-centricity are central to this thesis and will be further explored in the third chapter.



▪ Figure 2.9 Evening commute between 16.00 and 20.00 on all TfL rail infrastructure.



source: based on data from Greater London Authority (2018a)

2.3 The New London Plan

The New London Plan provides the framework to guide London's development until 2041.

In order to guide development and address the significant challenges that London is facing the Greater London Authority released the draft of for the New London Plan (NLP) in December of 2017. The New London Plan is the statutory document providing the framework for Greater London's development until 2041. The principal purposes of the NLP are to further economic development and wealth creation, social development and improvement of the environment. Focussing on issues of strategic importance, the plan leaves issues of local dimensions to be addressed by the London Boroughs within the set framework provided by the NLP (Greater London Authority, 2017c).

In stark contrast to the post-war era, Greater London now strives to solve its issues within its own borders where possible. Trying to find the answer in the Wider South East is no longer an option as regional planning has been abolished nationwide with the 2011 Localism Act (Department for Communities and Local Government, 2015).

The New London Plan brings together a set of overall policy goals, a spatial development framework as well as the geographical and locational aspects of the Mayor's strategies concerning transport, environment, economy, housing, culture and health. This chapter of the report will focus on discussing the most relevant overall policy goals and the strategic development framework set in the Plan.

Good growth policy goals

The London Plan means to achieve a set of so-called Good Growth Policies meant to achieve sustainable growth. In total there are six different policy goals:

1. Building strong and inclusive communities
2. Making the best use of land
3. Creating a healthy city
4. Delivering the homes Londoners need
5. Growing a good economy
6. Increasing efficiency and resilience

Each of these overall policy goals is backed by a set of sub-policies. Some of the most notable are: promoting activity in London's town centres, diversifying the economy and sharing its benefits more equitably across London, achieving an 80% modal split for public transport, walking and cycling, and all while conserving and enhancing its global competitiveness and prosperity.

The spatial development patterns stipulated in the NLP provides a strategic framework for London's development and future challenges. Some of the changes the plan proposes are concrete transformative projects however a lot of the changes are expected to happen incrementally. The spatial development plan consists of three main layers: Growth Corridors, Opportunity Areas and the Town Centre Network.

Development will be organized in seven growth corridors situated along existing or planned infra-structure. The growth corridors extend in a radial fashion from central London connecting to the surrounding WSE as seen in figure 2.10. They are intended to improve accessibility both into and within London. The development of the growth corridors goes in unison with various major planned infrastructure works, most of which are designated as WSE Strategic Infrastructure Priority Projects. The first of these major works to be completed is the Elizabeth Line East, also referred to as Crossrail and will be operational towards the end of 2018. Other major projects are the new HS2 which is slated to be completed in 2026 and will provide high-speed railway access all the way from London to Birmingham and Crossrail 2 providing a North-South connection through Greater London.

Current policy organizes development around growth corridors following (new) transit lines, in which opportunity areas for development are designated.

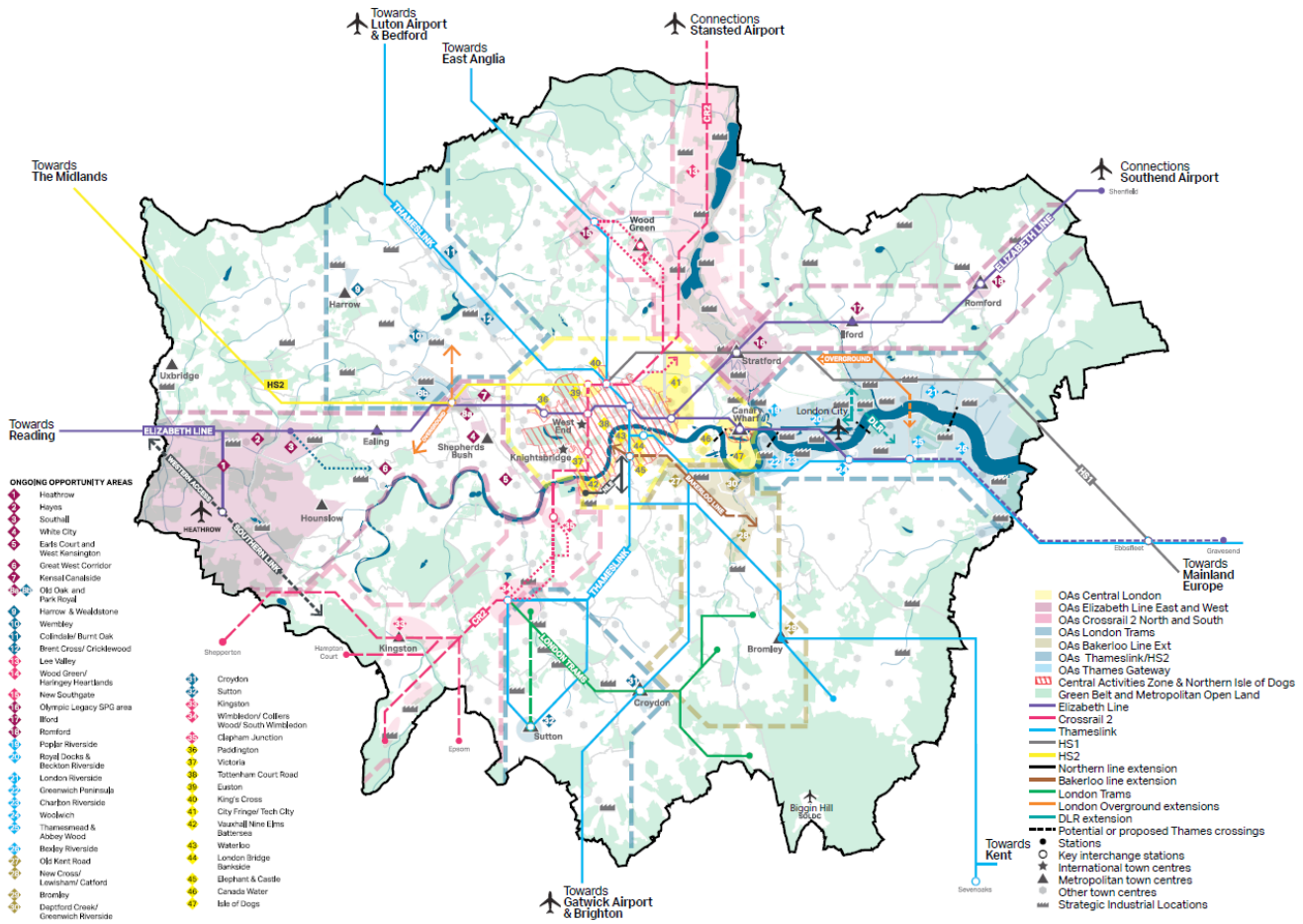


Figure 2.10 Housing affordability in 2016

source: Greater London Authority (2017c)

Within the growth corridors so-called Opportunity Areas form the core of the NLP's guidelines. These areas are designated for development and typically contain at least 5000 additional jobs, 2500 additional homes or a combination of the two. The plan outlines the type of development to take place in each of these areas and the present and future opportunities to capitalize on.

The Town Centre Network together with the Opportunity Areas are the means by which the government attempts to stimulate economic activity outside of London's central area. The town centres are supposed to provide a sense of identity for communities, a broad mix of uses such as shops and services and employment opportunities. Five classes of town centres have been designated ranging from neighbourhood to international centres depending on their typical floor space and accessibility levels. They are broadly distributed across London in an effort to promote local economies and more universal access to services and amenities. It must however be noted that there is no empirical method as to how these centres are selected (Masip-Tresserra et al., 2016).

Reflecting on the New London Plan

While advocating polycentricity many of the NLP's policies actually promote mono-centric development.

The proposed approach to achieving Sadiq Khan's Good Growth Policy Goals raises several question marks. These are mainly related to the metropolitan model promoted which, as discussed, is a major factor in London's challenges today. While the document hints at changing course, advocating the pursuit of a more polycentric metropolitan model, many of its concrete policies actually seem to promote an even greater level of mono-centricity.

The most obvious of these measures can be found in the policies specific to London's Central Activity Zone. As seen in the policy excerpt on the next page further densification through new office developments is actually promoted while residential developments are deterred. Meant to alleviate the overheated property market for office space that has resulted from the tightly packed agglomeration of workplaces in the central area, these policies are likely to further cement mono-centricity throughout the metropolitan region.

However the perpetuation of mono-centricity is not solely linked to CAZ specific policy. It is also apparent in the structure of the new rail-links planned. These once again form radial links out from Central London, essentially forming a continuation of the model introduced in the late 19th century where a dense productive is linked to the much less dense periphery.

The issue with this approach is the threat it poses to the NLP's goal of creating more economic activity in outer London. As these new lines improve access to London's Central Area, there is a significant chance that local activity in the newly connected areas will actually decline. As the inhabitants of these areas are likely to choose the higher service levels in the now better accessible centre, there is a good chance that some local businesses will disappear. This risk is derived from the better competitive position that the more central businesses have due to so-called agglomeration externalities. The process of agglomeration and its externalities will be further explained in the theoretical

Policy SD5 Offices, other strategic functions and residential development in the CAZ

A **New residential development should not compromise the strategic functions of the CAZ.**

B **Residential development is not appropriate in the commercial core of the City of London and Northern Isle of Dogs (detailed boundaries to be defined by boroughs in Development Plans).**

C **Offices and other CAZ strategic functions are to be given greater weight relative to new residential development in other core commercial areas of the CAZ including:**

- 1) other parts of the City of London and Northern Isle of Dogs (outside core areas in part B above)
- 2) the West End, Knightsbridge and other core commercial areas in the City of Westminster including Soho, Covent Garden, its Opportunity Areas and commercial parts of Marylebone and Fitzrovia
- 3) commercial core areas identified in the City Fringe/Tech City Opportunity Area Planning Framework
- 4) all other Opportunity Areas (except Vauxhall, Nine Elms, Battersea and Elephant & Castle)
- 5) identified clusters of specialist CAZ strategic functions, CAZ retail clusters and locally identified Special Policy Areas.

D Offices and other CAZ strategic functions are given equal weight relative to new residential in other parts of the CAZ not covered in parts B or C above including:

- 1) Vauxhall, Nine Elms, Battersea Opportunity Area
- 2) Elephant & Castle Opportunity Area
- 3) predominantly residential neighbourhoods or wholly residential streets (with exceptions in appropriate circumstances – for example clusters of specialist CAZ strategic functions, Special Policy Areas and CAZ retail clusters).

E In Development Plans, boroughs should develop local policies and define detailed boundaries for the areas in parts B, C and D above.

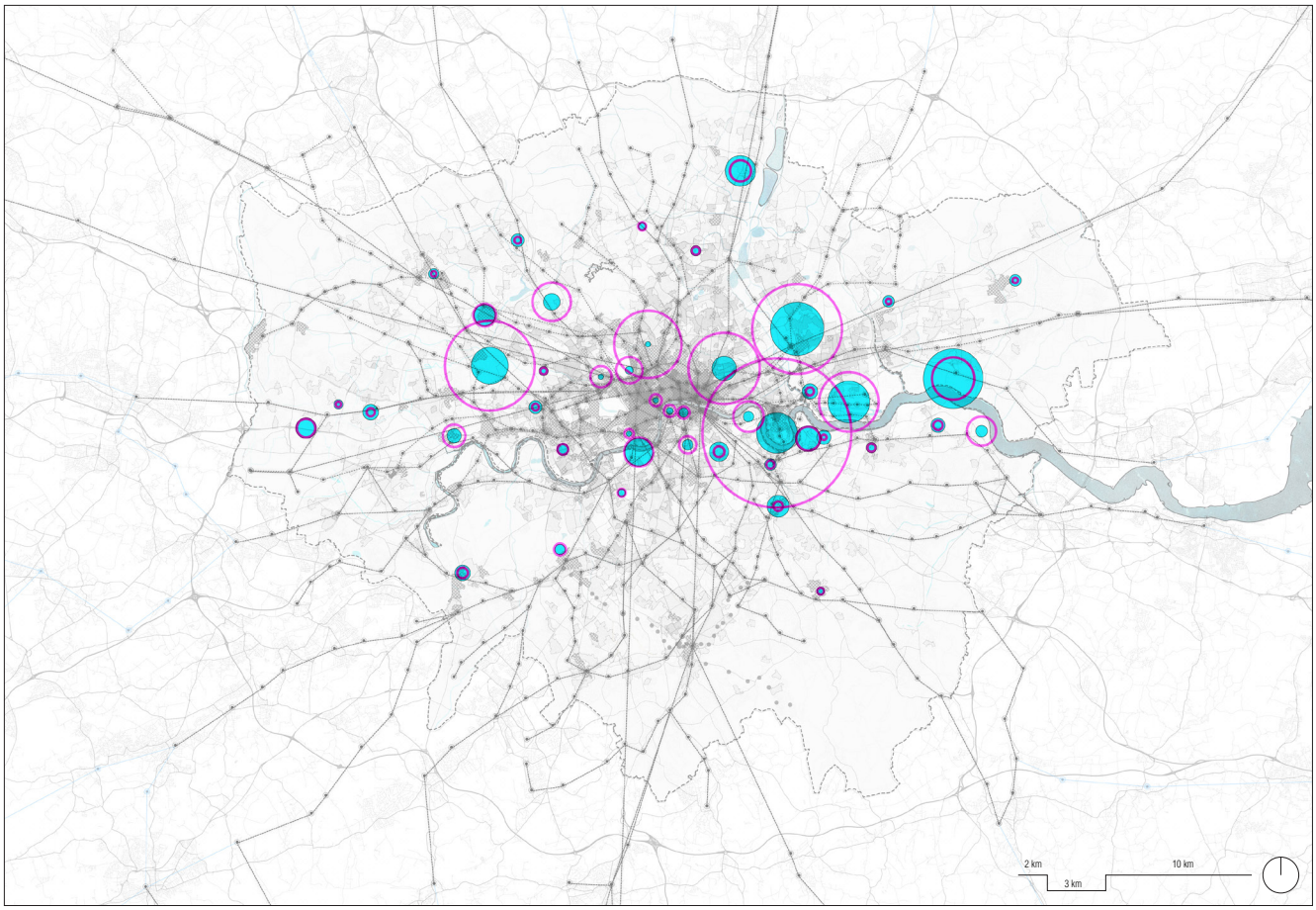
F **The Mayor will work with boroughs and support them to introduce Article 4 Directions to remove office to residential permitted development rights across the whole of the CAZ and the Northern Isle of Dogs (and those parts of Tech City and Kensington & Chelsea lying outside the CAZ).**

G Mixed-use office/residential proposals are supported in principle in areas defined in parts C and D above where there is an equivalent or net increase in office floorspace.

H **Residential development proposals should not lead to a loss of office floorspace in any part the CAZ unless there is no reasonable and demonstrable prospect of the site being used for offices and/or alternative provision is made for the provision of net additional office space near the development (including through swaps and credits – seepart I below).**

I Local approaches to mixed-use development of offices with housing should take into account the potential to use land use swaps, credits and off-site contributions to sustain strategically-important clusters of commercial activities such as those in the City of London, other parts of the commercial core of the CAZ and the Northern Isle of Dogs.

▪ Figure 2.11 Excerpt from the New London Plan's CAZ policies *source: adaption from Greater London Authority (2017c)*



▪ Figure 2.12 The NLP's proposed distribution of new homes and jobs *source: based on data from the Greater London Authority (2017c)*

● number of homes
○ number of jobs

framework in chapter 5. Experian (2017)'s studies on London's consumer goods market echoes the likelihood of further centralisation under current policy. It expects 76% of additional retail space to become concentrated in already established major shopping areas as well as a 60% decrease of retail space in smaller town centres. Again, this process of centralisation only enhances the disparities in the region and the reliance of its inhabitants on the centre.

This radial transit pattern along with the disparity in land use also causes inefficient use of infra-structural capacity. Studies such as that by Curtis (2006) show that only having a strong centrality at one end of a transit corridor leads to inefficient use due to peak hour as movements primarily take place into a single direction. This contributes to the capacity issues that London's mobility system is facing.

The NLP's seeks to further densify the productive functions in Central London and continues the construction of the radial railway links that have facilitated the development of mono-centricity throughout the region. Meanwhile it prescribes little significant employment development in Outer London.

The third issue that reflects the NLP's mono-centric ambitions is the proposed distribution of jobs and homes within the Opportunity Areas situated along the growth corridors. Whereas the NLP states that economic activity in Outer London should be promoted, the proposed distribution of additional jobs and homes paints a different picture. Figure 2.12 maps the proposed quantities with the size of the red circles corresponding to the amount of jobs and the blue ones to the amount of homes. It shows that the majority of

Opportunity Areas that provide a surplus of jobs are located in or near the city centre. The logarithmically scaled scatter plot in figure 2.13 maps the ratio of jobs to homes proposed in the various Opportunity Areas by their distance to the closest of the two main employment agglomerations, the City or Canary Wharf. Note that the most significant relative concentrations of jobs are all within a close distance of London's main employment agglomerations. The Opportunity Areas with a surplus of jobs in the 10 to 16 kilometre range are, with the exception of Wimbledon, all established industrial areas.

Based on these findings it can be argued that the proposed development distribution does not so much increase economic activity in Outer London but is rather an expansion of the productive centre. This has two main consequences for the usage of the transit corridors. Firstly having a negative employment deficit in new developments in Outer London means that more people in the future will have to travel to central London in order to work. Secondly the creation of new centres of employment close to Central London does little to promote more efficient bi-lateral usage of infrastructure.

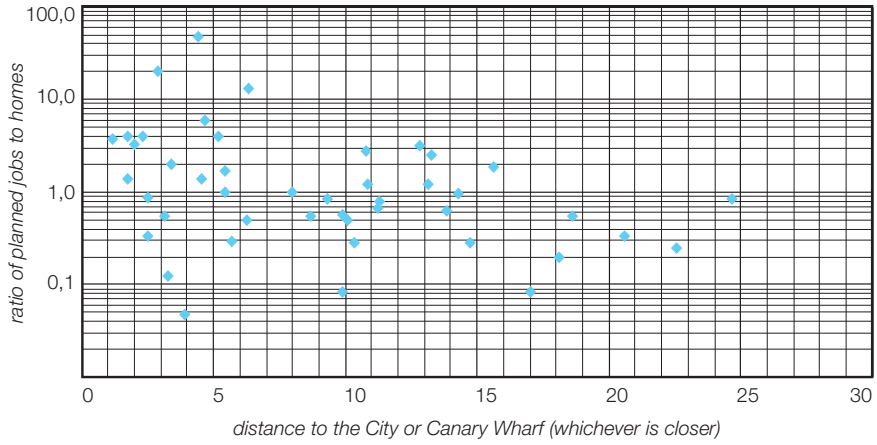


Figure 2.13 Ratio of jobs to homes for the designated Opportunity Areas

source: based on data from the Greater London Authority (2017c)

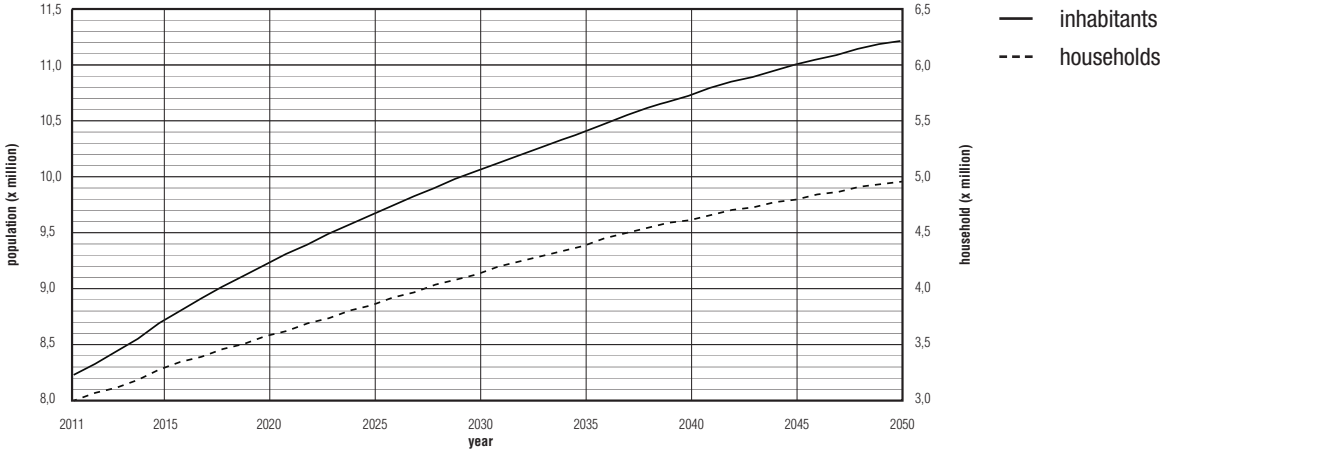
Summary

The New London Plan aims to provide a comprehensive answer to London's challenges with a particular focus on the promotion of social integration, local economies and sustainable transport modalities. However, it is questionable if its Good Growth Goals that promote a more balanced growth throughout the region will actually be achieved as many proposed measures perpetuate the current mono-centric functional model. The first example is the policy specific to CAZ which seeks to mitigate the costs of agglomeration while promoting further densification of productive activities in the area. Secondly, the radial development corridors emanating from central London not only stimulate an inefficient mobility pattern but they also risk reducing activity throughout the region due to competition effects. Finally, the population and employment densities proposed for the opportunity areas do little in term of stimulating activity outside Inner London. They are rather expansions to the employment in the central area than counterweights to it.

3. Problem analysis

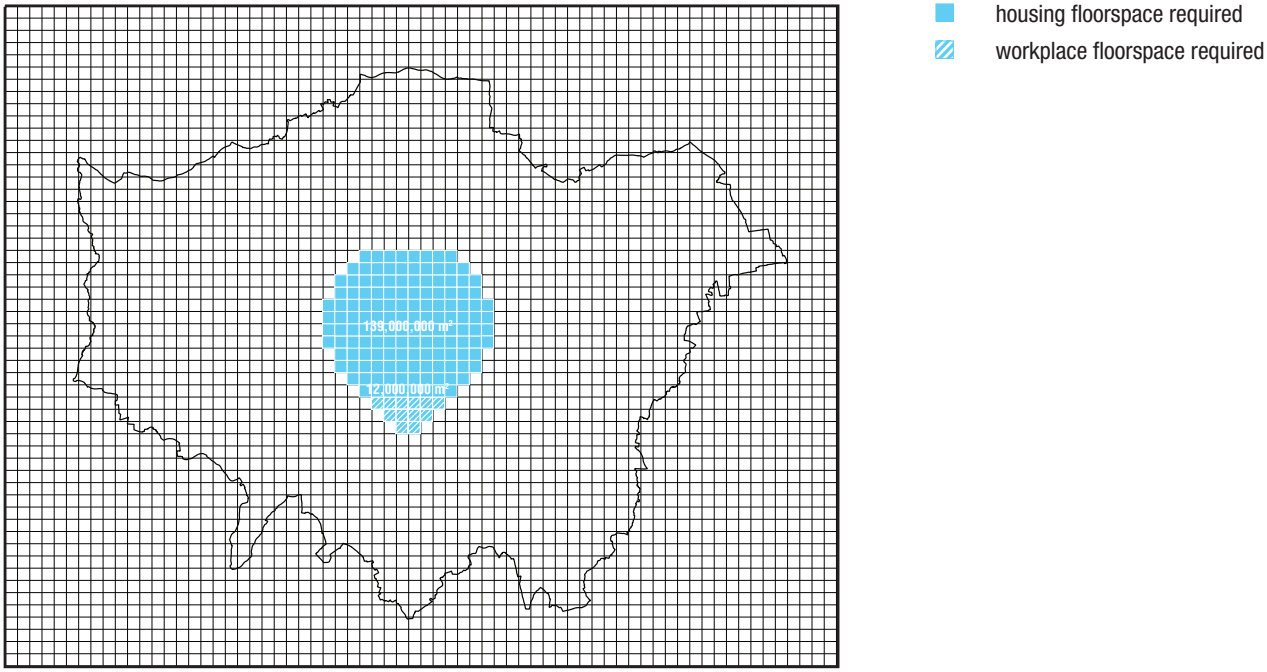
+ extreme commuting
+ costly accessibility
+ trending towards even greater mono-centricity
+ problem statement

As discussed, the Greater London region has developed in a very mono-centric fashion. As Greater London tries to accommodate its significant growth, projected at 1,9 million additional people and 1,2 million jobs over the next 23 years, the issues of this mono-centric model of development are becoming increasingly clear. While solely accommodating this growth will already require significant new floorspace as seen in figure 3.2, the specific case of London also raises its own questions on the topics of mobility and equity in the region. As briefly discussed in the previous chapter, these issues are closely related to the accessibility issues created by the region's aforementioned level of mono-centricity. This chapter aims to further specify these issues as well as the trends towards mono-centric development, finally concluding with the problem statement central to the rest of this thesis.



▪ Figure 3.1 Projected population growth

source: based on data from GLA Economics (2017)



▪ Figure 3.2 Floorspace needed to accomodate growth by 2041

source: based on data from GLA Economics (2017), Greater London Authority (2017b) and Greater London Authority (2017c)

3.1 Mono-Centricity and accessibility

As briefly discussed in the previous chapter, these issues are closely related to the problems regarding accessibility created by the region's aforementioned level of mono-centricity. These accessibility issues are expressed in various ways as will be discussed below, firstly in long travel times but also disparities throughout the region that create issues for many living outside the central area. These issues will be discussed first followed by relevant trends and policy approaches in regards to this mono-centric development model.

Commuting pattern & travel times

London's mono-centric structure necessitates long everyday commutes for many daily activities. The average Londoner spends 80 minutes commuting per day, two full weeks on a yearly basis.

The free market policies guiding London's revitalization have resulted in a strong division between its productive core and the vast residential areas surrounding it. This has naturally lead to long and intense everyday commutes of people towards and back from their workplaces in the centre of the region as seen in figure 3.3. This one-directional pattern not only makes inefficient use of transit infrastructure but is leading to exorbitant commuting times for its inhabitants. In 2016 average London commuters spent over an hour and twenty minutes per day on travelling to work (Trade Union Congress, 2017). On a yearly basis this adds up a full two weeks spend travelling back and forth to work. Very long commutes have also been in the rise as almost 800,000 commuters in London spend more than two hour on travel per day in 2014, an 68 % increase from 2004 (Trade Union Congress, 2015). The considerable time that needs to be spent travelling to accommodate Londoner's daily activities has a profound impact on their lives.

The cost of mono-centricity

Long commutes are not the only issue stemming from London's mono-centric model of development. Its costs are also monetary. As discussed in the previous chapter both inhabitants but also businesses pay a high premium for locations at the cities heart (Greater London Authority, 2017a, Greater London Authority, 2017b). A location in Central London has distinct advantages for both businesses and inhabitants. While businesses can gain a competitive edge from a central location, as discussed further in the theoretical framework, many people want to live close to the services, amenities and workplaces of which they (would like to) make use of in their daily lives.

Many Londoners are priced out of the central area that offers good accessibility, and into long commutes from the rest of the region.

However, space in the highly accessible central area is limited as it only offers space to a select few people as seen in figure 3.4. This results in an intense competition for space forcing the many who cannot afford the high prices in the centre, as seen in figure 3.5, to move to Inner or Outer London and into long commutes to accommodate their daily activities.

These, excessive commutes not only compromise liveability they also act as a barrier to find employment for lower income groups. Studies by (Transport for London, 2015) find that 40 % of lower income people report a lack of transport as detrimental to their access to employment while 25 % cites the high costs as a problem for attending job interviews.

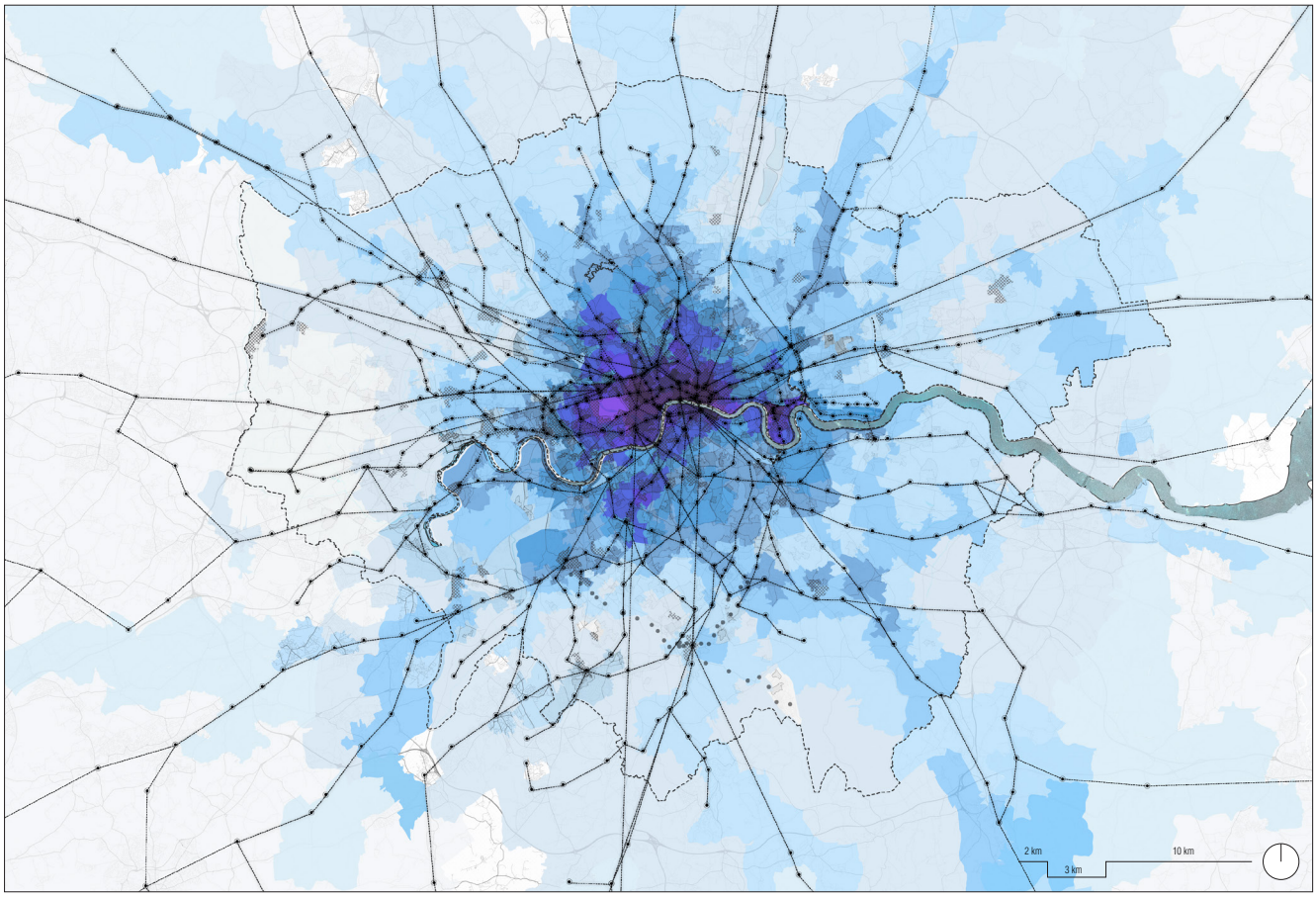
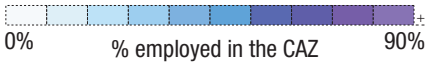


Figure 3.3 Percentage of people employed in the CAZ



source: based on data from Office of National Statistics. Census Division et al. (2015)

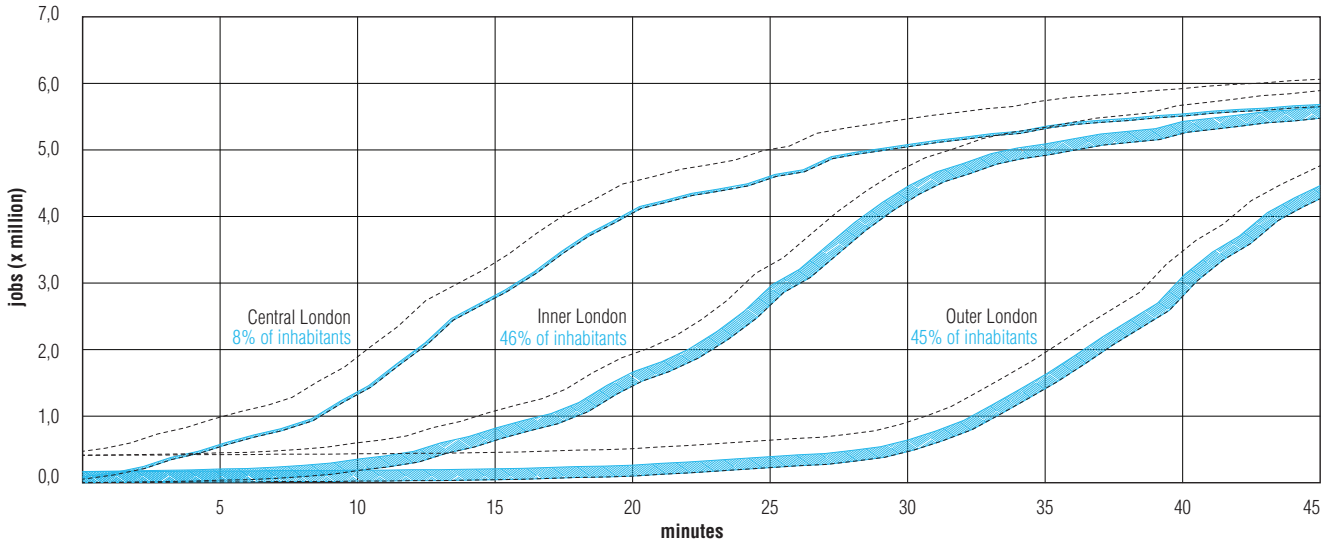


Figure 3.4 Accessible employment via rail transit and share of total London population living around stations for Central, Inner and Outer London

source: image by author

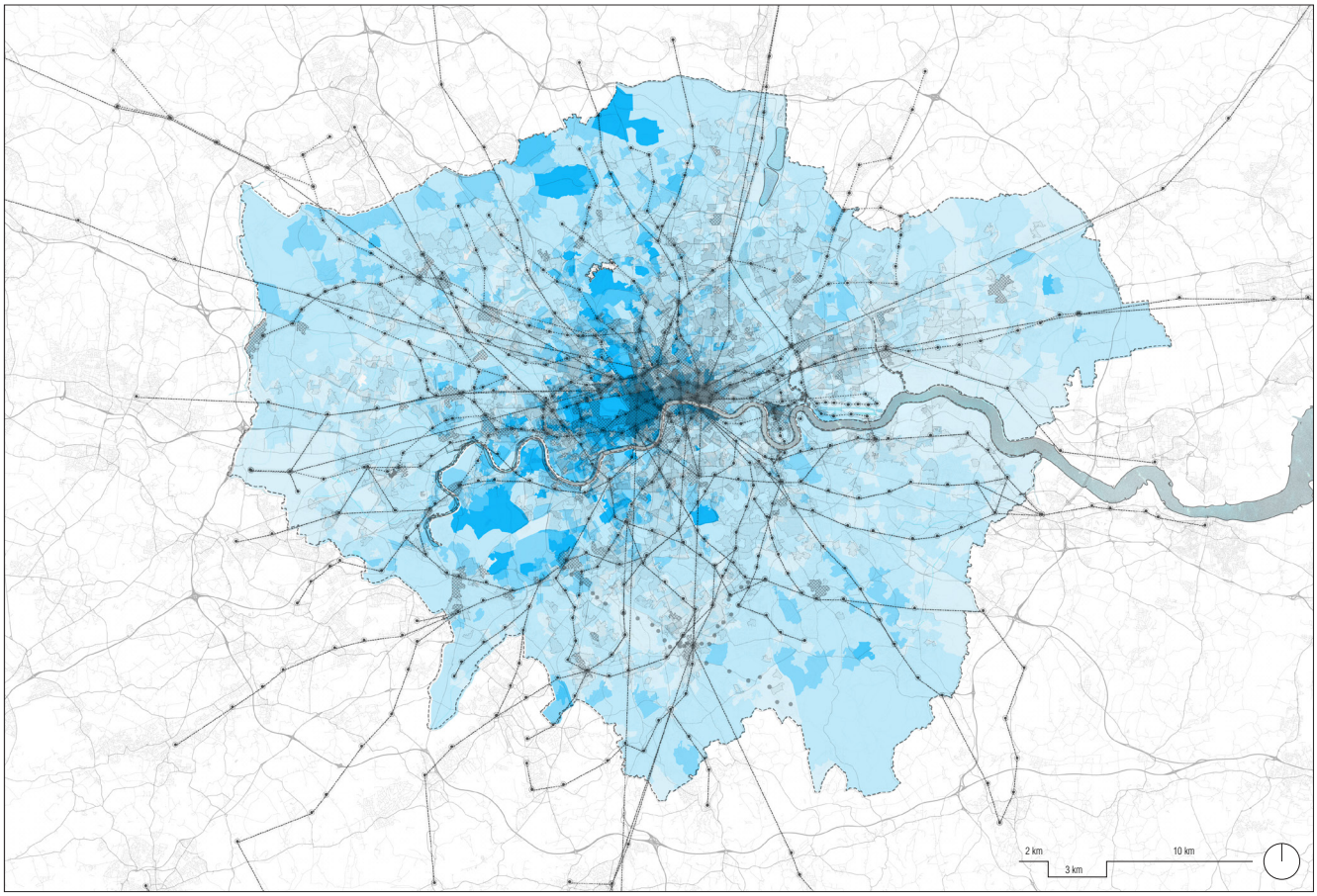


Figure 3.5 Affordability of housing in 2016

source: based on data from Office of National Statistics. Census Division et al. (2015)

house price / median household income

<5	17 - 20
5 - 8	20 - 23
8 - 11	23 - 26
11- 14	26 - 29
14 - 17	> 29

In conclusion, it can be seen that the costs of London's mono-centric model of development are increasingly compromising liveability for the region's inhabitants. People are forced into very long commutes and those living outside of the central area suffer from reduced access to employment, services and amenities. Meanwhile, the market demands a premium for the few places that are central and have good access to the affordances of the centre, a premium that most cannot afford. In light of the city's projected growth these problems are likely to escalate even further.

An even more monocentric future?

While the costs of London's mono-centricity are becoming increasingly pronounced little concrete is currently being done to challenge this trend. If anything the degree of mono-centricity seems to be increasing even further. Figure 3.6. details the economic sectors projected to for growth over the coming decades. Growth is primarily concentrated in service based industries, often reliant on office space. While office space has seen significant growth over recent years, it has also been centralizing rapidly as seen in figure 3.7. It is thus likely that Central London will come to accommodate many more jobs in the future.

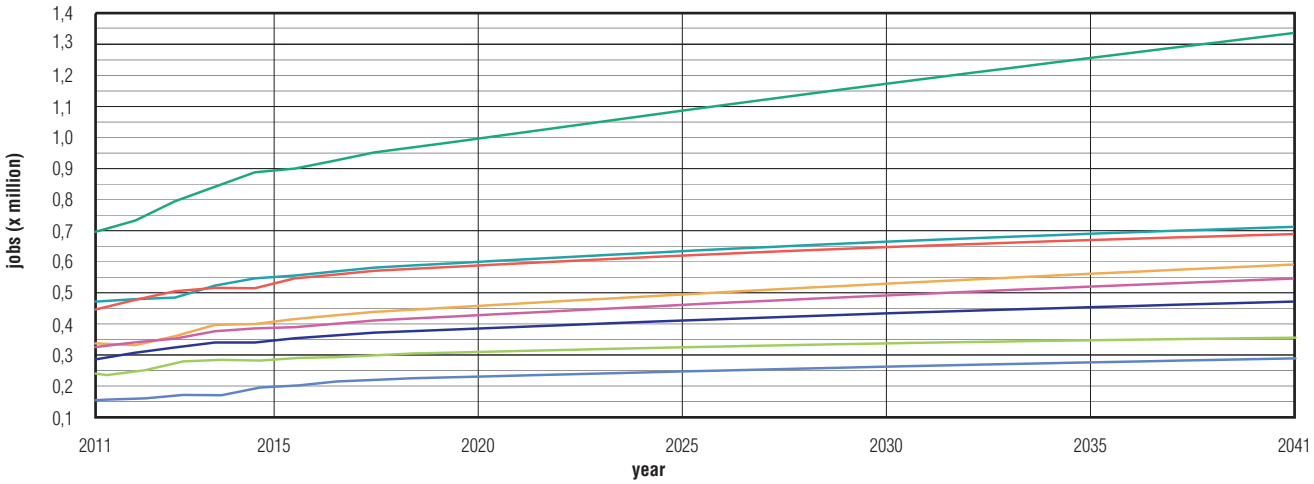


Figure 3.6 Industry sectors projected for growth

source: based on data from GLA Economics (2017)

- professional, real estate, scientific & technical activities
- administrative & support activities
- health
- arts, entertainment & recreation activities
- accomodation & food service activities
- education
- information & communication
- construction

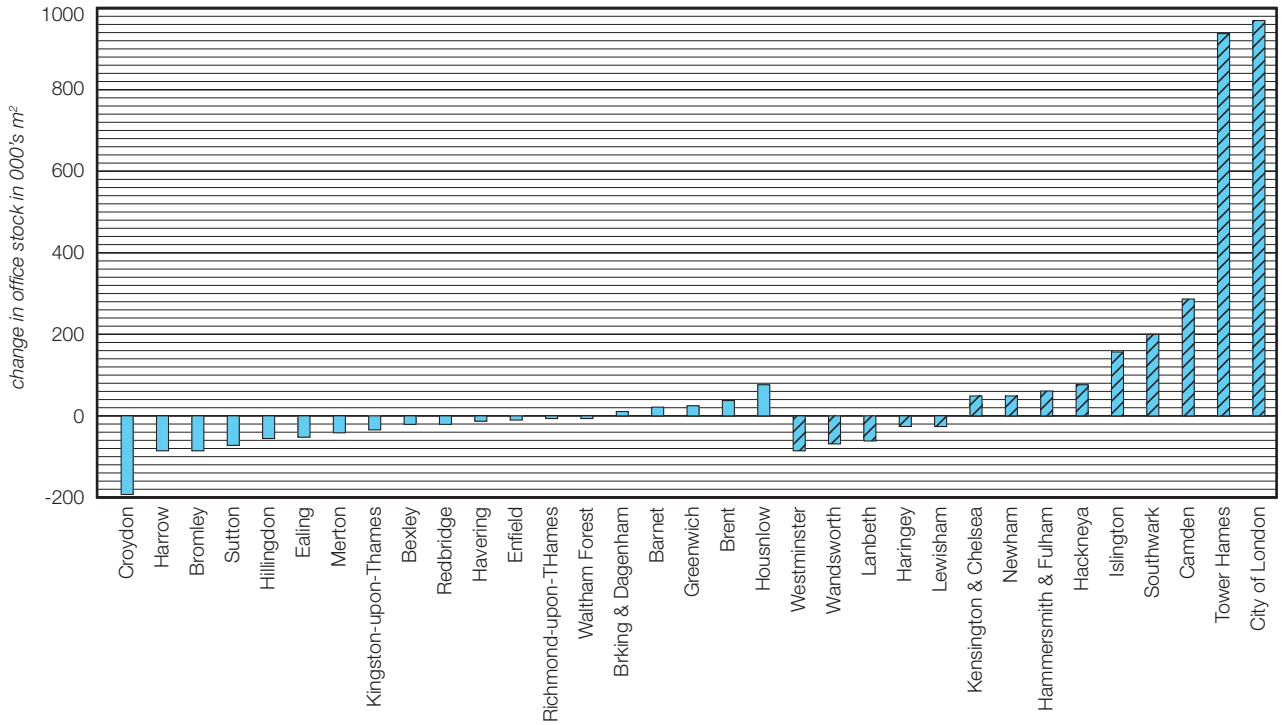


Figure 3.7 Office stock development 2000 - 2015

source: based on data from Greater London Authority (2017b)

- Outer London
- Inner & Central London

London's growth industries are increasingly centralised while the industries in Outer London are expected to decline. Hence, London's mono-centricity is likely to become even more pronounced and problematic.

While the sectors currently favouring the London's heart stand to grow, those who favour its outskirts are projected to decline. As seen in figures 3.8, 3.9, and 3.10 the manufacturing and logistics sectors, both primarily concentrated in outer London are projected to struggle, further weakening local employment in areas already lacking much of it. This trend combined with the centralization and office space and a growth in office jobs will mean that the divide between London's central area and periphery will quickly grow even more pronounced and problematic.

A lack of concrete policy

Current policy promotes further mono-centric development despite its significant issues.

The current policy set out in the New London Plan does not adequately address the issues brought on by the mono-centric model of development. While the issues of mobility, increased participation and the need for promoting activity in Outer London are cited as policy goals. the proposed Spatial Development Pattern further promotes the mono-centric structure of the region. Hence, it remains questionable if these goals will actually be achieved in light of the issues discussed.

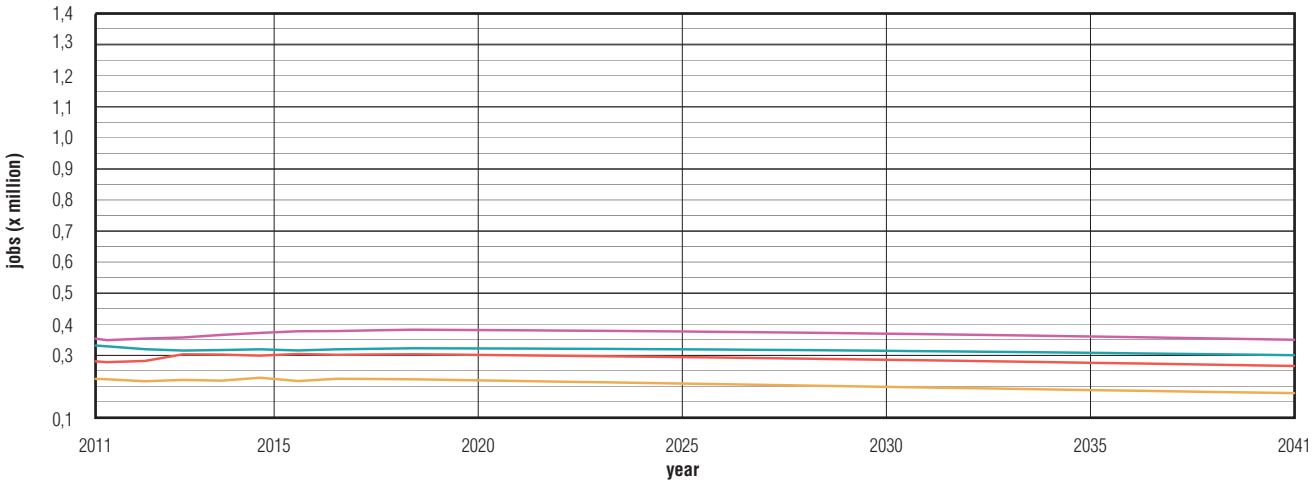


Figure 3.8 Industry sectors projected for decline

source: based on data from GLA Economics (2017)

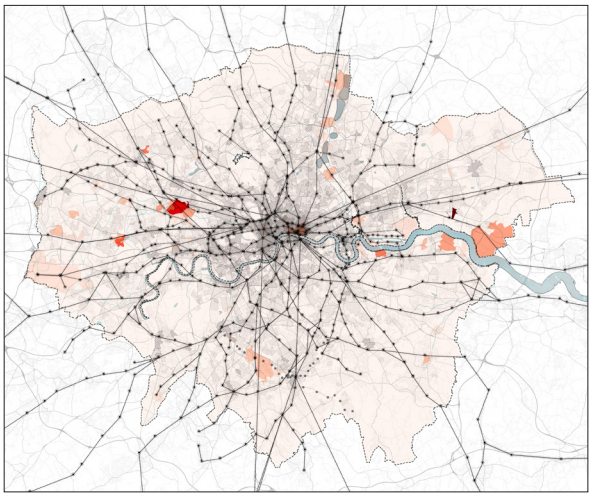


Figure 3.9 Employment in manufacturing

source: based on data from Greater London Authority (2018a)

Figure 3.10 Employment in logistics

source: based on data from Greater London Authority (2018a)

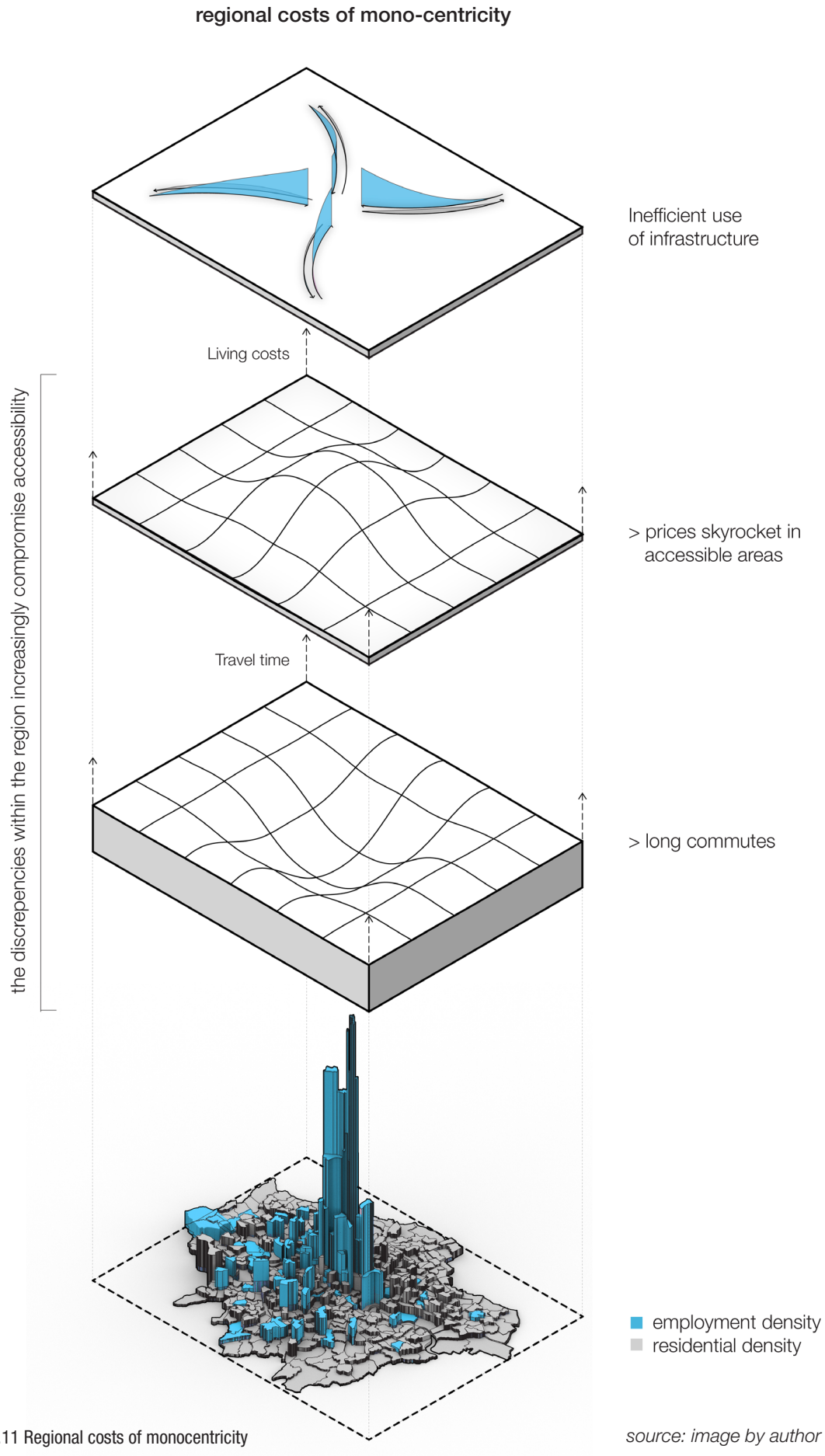
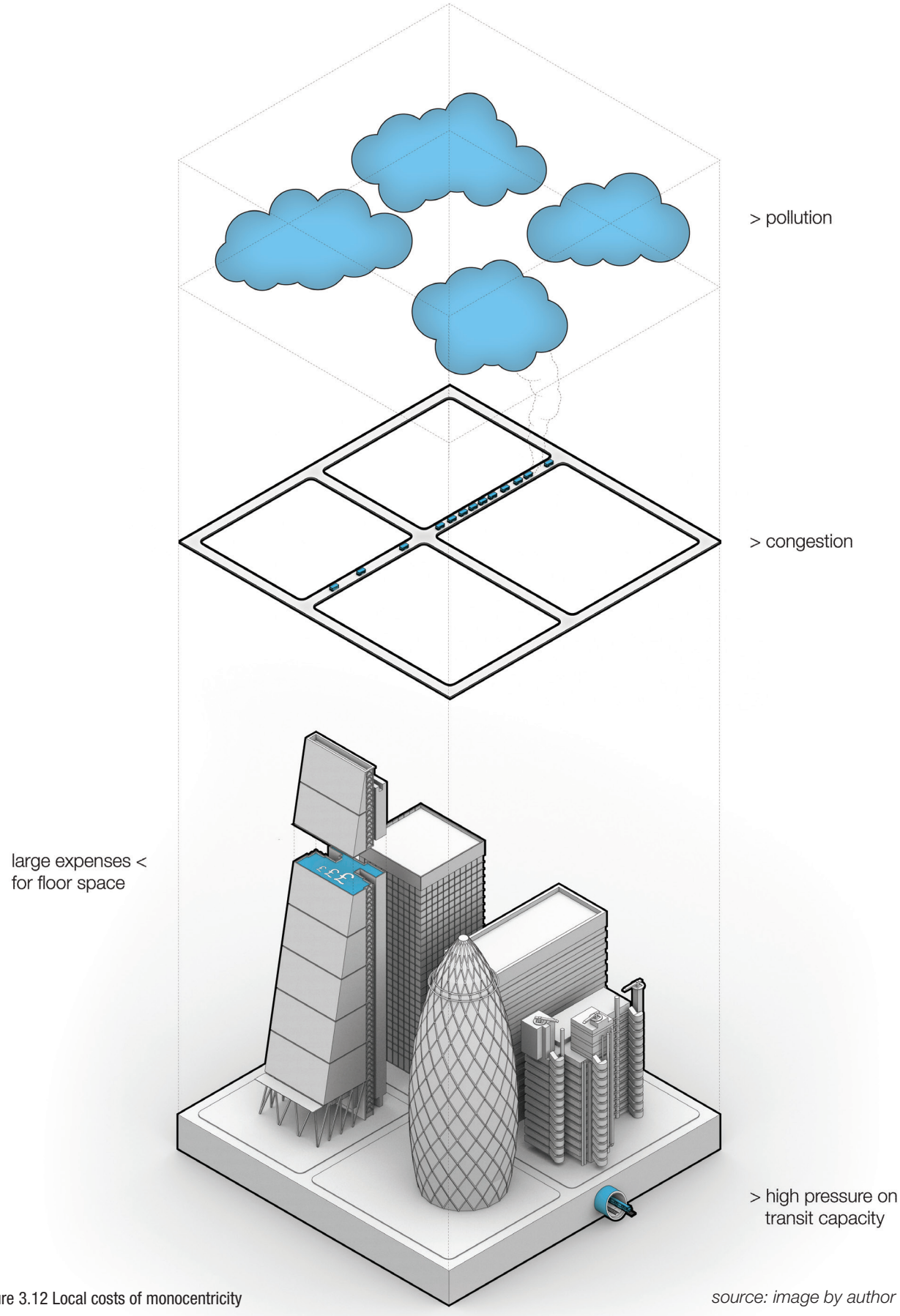


Figure 3.11 Regional costs of monocentricity

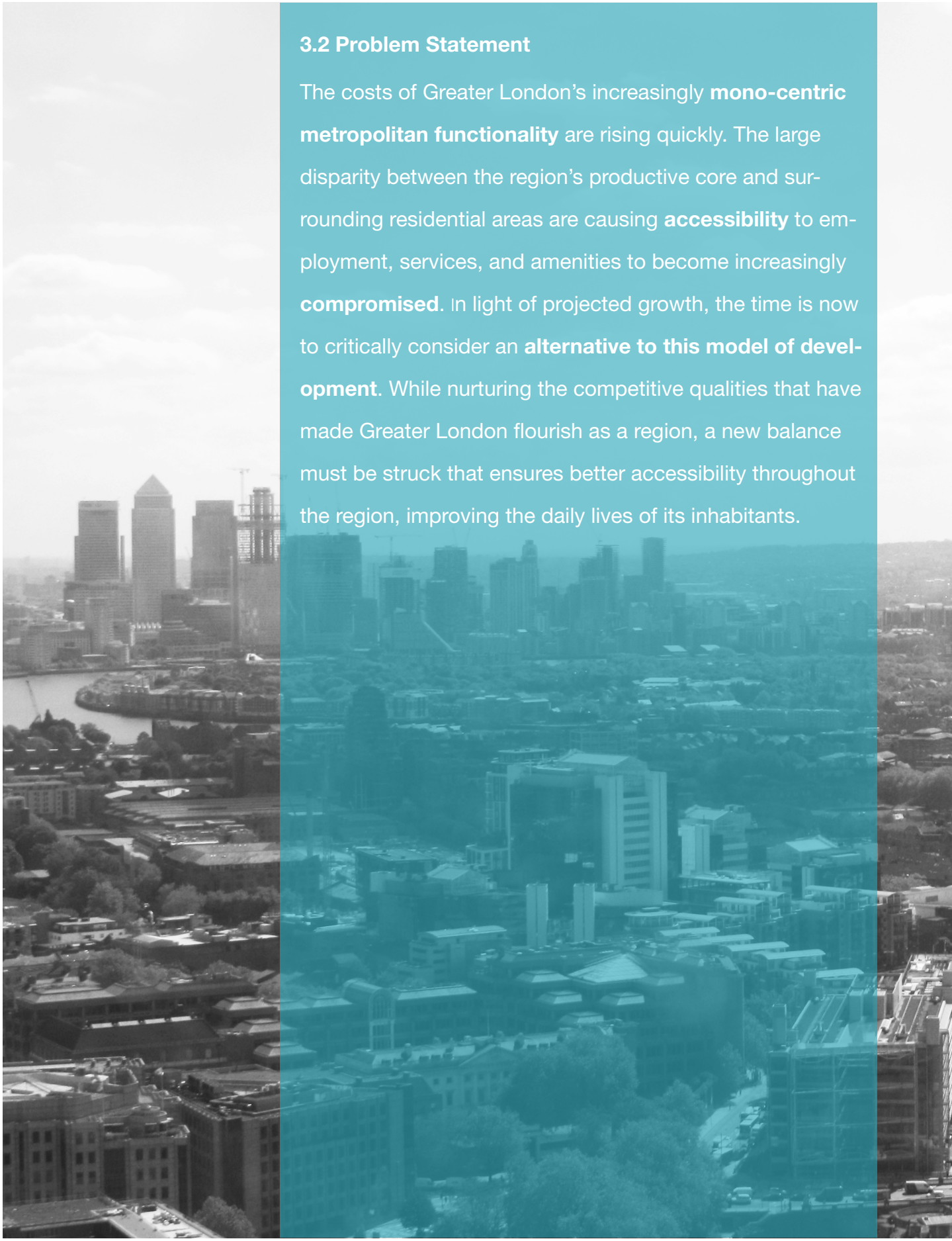
source: image by author

local costs of mono-centricity



▪ Figure 3.12 Local costs of monocentricity

source: image by author



3.2 Problem Statement

The costs of Greater London's increasingly **mono-centric metropolitan functionality** are rising quickly. The large disparity between the region's productive core and surrounding residential areas are causing **accessibility** to employment, services, and amenities to become increasingly **compromised**. In light of projected growth, the time is now to critically consider an **alternative to this model of development**. While nurturing the competitive qualities that have made Greater London flourish as a region, a new balance must be struck that ensures better accessibility throughout the region, improving the daily lives of its inhabitants.

source: image by author

4. Research structure

+ research questions
+ scope
+ goals
+ outcomes

Research questions

In order to tackle the issues of the issues identified in the problem statement this thesis will revolve around the following question:

How can a better integration of land-use and mobility policy offer an alternative model of regional development for Greater London that improves territorial cohesion through the development of a new centrality outside the central area?

Implicit to this question is the hypothesis that the issues of territorial cohesion throughout Greater London can be solved through the development of a new centrality outside of its established central area. This hypothesis is informed in part by the insights discussed in the theoretical framework but also by the recent regional strategies of other world cities such as the A Metropolis of Three Cities plan for Greater Sydney and the SDRIF 2030 plan for Île-de-France (Institut d'Aménagement et d'Urbanisme, 2018, Greater Sydney Comission, 2017). The latter of these two plans, along with the history leading up to its conception, are discussed in greater detail in a reference study found in the appendix.

In order to answer the main research question, several sub-questions are formulated:

1. What is territorial cohesion and why is it compromised in Greater London?

2. What variables influence the development of centralities?

3. What location is best fit for the development of a new centrality?

4. What interventions and frameworks need to be put in place to guide development and capitalize on its potentials?

5. To what extent does the development of this new centrality contribute to reaching the formulated goals for this thesis?

Goals

By improving territorial cohesion throughout Greater London and the development of a new centrality this thesis aims to achieve the following goals:

1. Create an accessible region in which services, amenities and jobs are a more common good and extreme commuting times are reduced.

2. Foster more sustainable and efficient travel patterns.

3. Accommodate London's growth in a more balanced manner throughout the region.

Scope

This thesis will focus on London's station areas as the rail system is a central part of life in London and one of the main reasons for its mono-centricity today.

In the vast complexity that makes up Greater London this thesis will focus specifically on the areas surrounding rail and tube stations. As identified, the structure of London's rail network has been key to guiding London's development into the mono-centric metropolis it is today. Furthermore, the well-developed rail network is central to the life of many Londoners and lauded as one of the chief reasons for its competitiveness and sustainability. Hence, it seems no less than fitting to focus on these areas.

Outcome

This thesis provides a comprehensive development strategy for a new centrality outside central London supported by a set of governance, regional and local actions.

The outcome of this thesis will be a comprehensive development strategy that explicitly shows both the regional and local potentials for a different model of development. Several locations will be evaluated for their potential to become a new centrality accompanied along with an inquiry into the new transit links needed to support such a transformation. For the most fitting of these locations a development strategy is devised offering a set of actions on the governance, regional and local scale levels that aim to guide development. In this special attention is paid to the process through time and the engagement of the private actors that are central to much of the development happening throughout the region today.

source: image by author

5. Theoretical framework

+ regions as networked systems
+ agglomeration, borrowing size & competition in urban systems
+ Transit Oriented Development
+ Greater London & territorial cohesion

As discussed in chapter 2, one of the most profound transformations that London has undergone throughout its history is closely connected to the introduction of its rail transit system which facilitated its transition from a compact city to a networked metropolitan region (Hall, 1989). As people's mobility was no longer confined by the limits of walking, activities became much more dispersed throughout the region linked together by the underlying networks. This transition has had a major impact on the way the city is used nowadays, and will be in the future. Hence, in order to construct a meaningful understanding of the current condition, and the way it can be transformed, it is key build a solid theoretical foundation addressing the structure of, processes in, and concrete tools for dealing with the network metropolis.

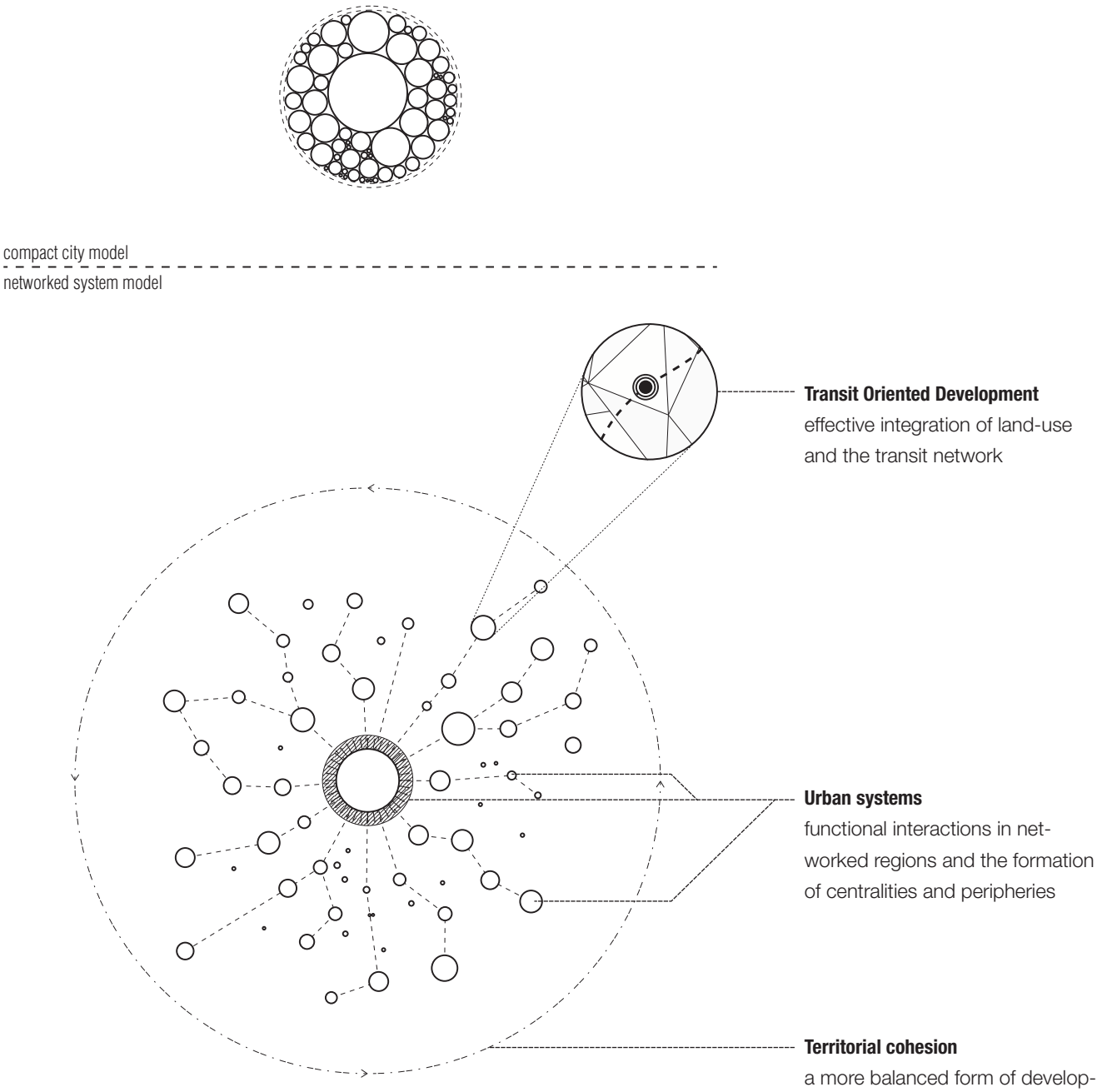


Figure 5.1 The compact city and networked system models and topics of discussion in the theoretical framework

source: image by author

In order to provide a structure for discussing networked regions and identify the most relevant factors for the development of centralities within said regions. To do so the following topics will be discussed:

1. Understanding the region as a networked urban system
   Introducing a formal structure for understanding the networked metropolis.

2. Agglomeration, borrowing size and competition within urban systems
   Understanding the processes behind the formation of centralities within urban systems

3. Transit Oriented Development
   A model for fostering a more effective relation between land use and transit networks

The insights from these three topics (and the reference study in the appendix) are synthesized into a comprehensive framework for the development of centralities. This framework will form the main guiding element informing the evaluation of various options and the development strategy in the chapters to follow.

Finally, this chapter will briefly discuss the topic of territorial cohesion in relation to Greater London. This term is used to frame the previously discussed issues regarding the distribution of housing and productive activities throughout the Greater London region.

5.1 Understanding the region as a networked urban system

The city has become a dispersed system of sources and destinations linked by networks.

As our cities have modernised, the spatial and social mobility of inhabitants has increased drastically reducing their confinement to particular areas within the city (Nio, 2000). The city has become a dispersed system of sources and destinations linked by networks, often functioning in a way that does not necessarily line up with its physical form.

Green (2007)'s framework is employed throughout this thesis, regarding the region as a system of nodes (station areas) and linkages (rail lines).

In order to have a clear discussion within the context of this reality, it is important to first establish a framework for understanding this condition. For this, Green (2007)'s model will be applied. This model, originating from the field of social network research, regards the metropolis as a system consisting on nodes and linkages. In the case of this research, nodes will refer to the areas surrounding London's heavy- and light rail stations. At times throughout the thesis the terms nodes and place (in the network) are used interchangeably, dependent on the context in which it is used.

Network position refers to a node's unique set of relations to each other node in the system

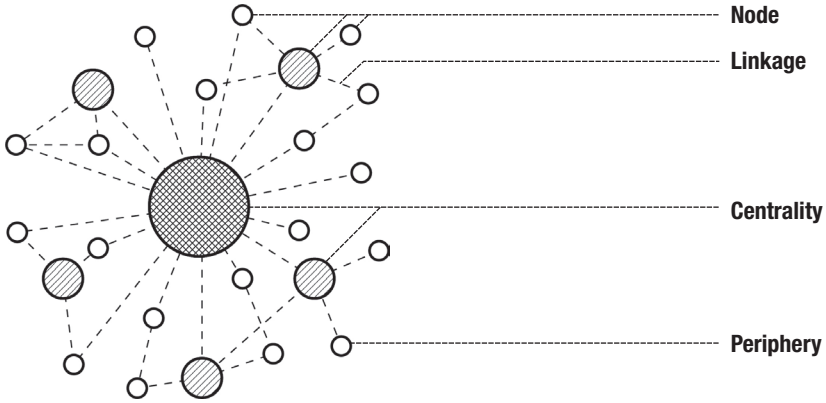
In regards to linkages this thesis focuses on mobility network which allows for movement and interaction between the various nodes or places in the city. Each node in urban system has its own particular set of links to other nodes, which is referred to as its network position. Again, this unique set of relations to other places does not necessarily line up with the spatial form of the region. To give a concrete example: it is much faster to travel from Paddington Station in Central London to Heathrow Airport than it is from Wimbledon,

even though in spatial terms it is actually slightly further away (Transport for London, 2018a).

Centralities & peripheries

It is also important to understand that the various nodes in the network are not necessarily equally important. Some nodes have a greater relative importance to others, which in turn rely on them (Burger and Meijers, 2011). The former will be referred to as centralities while the places that rely on them can be considered peripheries. This terminology is functional, a periphery can still be very much urban. The main determinant by which centralities are defined in this thesis is employment as it relates closely to problematic commuting patterns in the Greater London region.

Dominant nodes are referred to as centralities while the nodes reliant on them are referred to as peripheries.



▪ Figure 5.2 The networked system model applied in this thesis *source: image by author*

A concrete example of such a centrality would be Canary Wharf which provides many more jobs than it has inhabitants (Greater London Authority, 2018a). Thus, people from outside the area will travel to Canary wharf to work there, they are, to a certain extent, dependent on it. This means that Canary Wharf can be regarded as a centrality of employment within Greater London while the areas dependent on Canary wharf can be considered as peripheries.

Summary:

1. Life in the modern metropolis is increasingly dispersed, a situation facilitated by the underlying mobility network that links various places throughout the region.

2. This new reality can be understood as an (urban) system, consisting of nodes connected by functional linkages.

3. Network position refers a node's unique set of linkages connecting it to other places in the urban system.

4. Some nodes are more important relative to others, these can be regarded as centralities while the ones reliant on them can be regarded as peripheries.

5.2 Competition, agglomeration and borrowing size in urban systems

Agglomeration is a highly influential process in the formation of centralities.

As established, not every node in the urban system is of equal importance. In order to understand how the development of centralities can be stimulated, first the process of their formation must be understood. For this, the process of agglomeration will be discussed. This process is highly influential, with authors such as Venables (2007) going as far as stating it is the main economic basis for the very existence of cities. Hence, the concept of agglomeration has been highly influential on regional spatial planning practices, among which the New London Plan where it forms a key component (Greater London Authority, 2017c).

The following discussion will focus on the mechanics of agglomeration, its networked substitute borrowing size, and the resulting effects on the competitive position of nodes in the system. The discussion here is purely kept to understanding these mechanics and does not account for the allocating function of planning. The discussion here is kept succinct, for a more in-depth discussion of these topics please refer to the theory paper attached in the appendix.

The mechanics of agglomeration

Agglomeration benefits rely on the easy access provided by scale.

Agglomerations are high concentrations of firms and people that produce benefits for both groups due to the effects of economies of scale. For firms, this is most apparent in a productivity increase at no additional costs which makes them more competitive then peers who do no not profit from these benefits. Households on the other hand benefit from the larger variety of goods, services and amenities on offer (Johansson and Quigley, 2003, Bourdeau-Lepage and Huriot, 2005). These benefits are related the ease of access within agglomerations and can be related to four primary mechanics derived from scale:

1. Diversification of products

   Sizable consumer markets generate a strong and constant demand, allowing producers to diversify the products and services they offer. Because of the greater diversity on offer, firms can buy the specific products they need at lower costs while increasing the freedom of choice for inhabitants (Johansson & Quigley, 2003).

2. Reduction of transport costs

   As firms and/or consumers in agglomerations are located close to each other, transport costs are often reduced. This is especially relevant in regards to the time-savings for face-to-face interactions between high-wage employees (Bourdeau-Lepage and Huriot, 2005).

3. Knowledge spillovers

   As companies interact closely within agglomerations, they tend to learn from one another without having to pay for this knowledge (Johansson and Quigley, 2003).

4. Labour market pooling

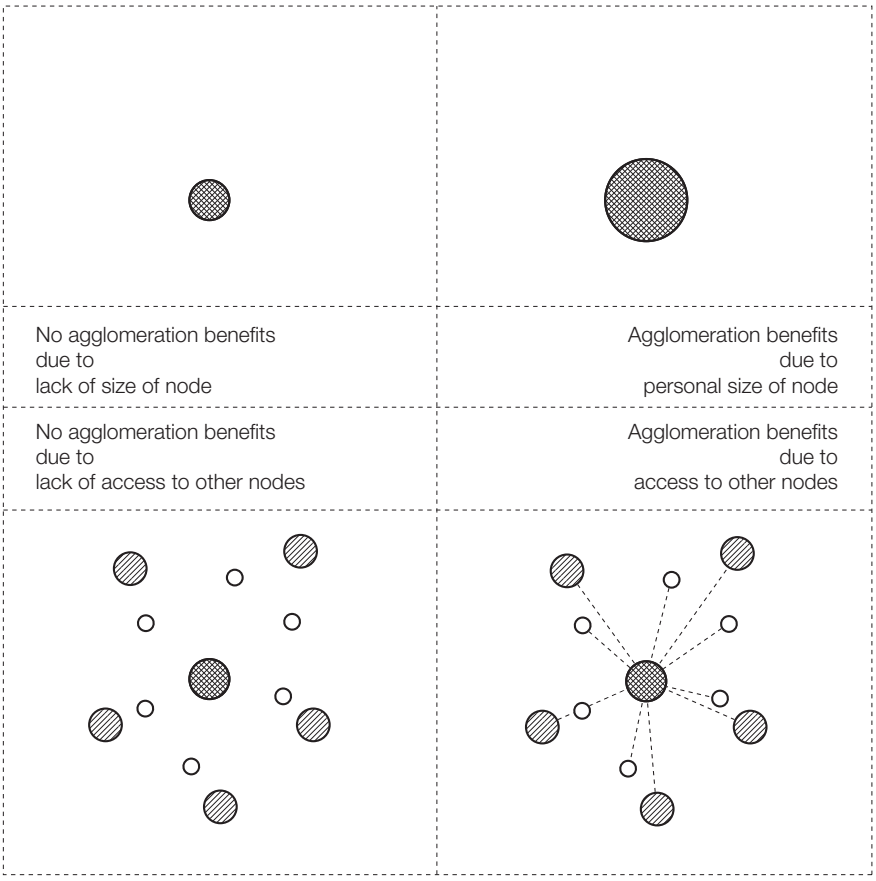
Due to the large population in an agglomeration it is easier for firms to find employees with fitting skills. Vice-versa the large quantity of firms offers fitting employment opportunities to said employees (Johansson and Quigley, 2003).

Borrowing size

In its traditional understanding agglomeration is directly tied to spatial proximity. However as established, the importance of proximity for the functioning of the metropolis has gradually declined with its transition towards a networked system. This paradigm shift has lead to a transition in the discussions on agglomeration (Meijers, 2007). An increasing number of authors now argue that effective networking can act as a substitute for critical mass in achieving the benefits of agglomeration (Burger et al., 2015, Meijers and Burger, 2015, Graham, 2007, Johansson and Quigley, 2003).

As discussed above, the mechanics of agglomeration economies are derived from the ease of interactions due to localized, high concentrations of activity. However, there is increasing evidence that the critical mass that agglomeration relies on can be sourced from other places in the urban system (Burger et al., 2014). As the linkages between nodes have made it easier to interact, places with a strong network position can borrow size from others in order to sustain functionalities and benefits they could not given their own particular size (Burger et al., 2015)

The critical mass that aglomerations rely on can be sourced from other nodes in a process called borrowing size.



▪ Figure 5.3 Sources of agglomeration benefits *source: image by author*

The costs of agglomeration

While agglomeration has its benefits it also incurs costs for both firms and inhabitants within it and its surroundings (Bourdeau-Lepage and Huriot, 2005, European Commission, 2008). Some of the most pronounced agglomeration costs are:

1. High land prices

2. Social exclusion

3. Congestion

4. Pollution

5. High levels of competition

Agglomeration not only provides benefits but also incurs costs, many of which are evident throughout Greater London.

As discussed in chapters 2 and 3 the dense agglomeration of productive activity at Greater London's heart incurring many of these costs. Due to an intense competition for space high land and property prices are commonplace especially in and around Central London, the region's main agglomeration. As discussed, these high prices lead to social exclusion as many are prized out of the Central Area and the have to travel far to make use of its opportunities. Congestion is also apparent in both the capacity issues of the transit system as well as on the roads. The latter of course brings pollution as well, something that is being combatted through a local emission charge for cars in Central London (Transport for London, 2018b)

Competition effects have also come to exist and as discussed could prove one of the main reasons that the transit corridors proposed in the new London Plan could actually reduce activity levels throughout Inner and Outer London rather than improve them. This mechanic can be explained by the occurrence of agglomeration shadows. As discussed, nodes can borrow size from other places to which they are connected in the urban network. However, not every node profits equally from a high level of embeddedness in the network. Some nodes, from which other borrow size, become subject to agglomeration shadows. This means that they support fewer functions than would be expected given their size (Burger et al., 2015). This can be explained by the competitive benefits generated by agglomeration economies. Nodes that benefit from agglomeration economies, be it due to their own size or their network position, are likely to outcompete firms located in places that experience no, or less, agglomeration benefits (Johansson and Quigley, 2003).

These mechanics provide reason to doubt that the radial transit corridors proposed in the New London Plan will stimulate activity in London in places other than the Central Area. Sizable agglomeration effects allow many Central London businesses to operate more efficiently and offer a greater variety of specialty products than their peers outside the Central Area. If new transit

corridors are created it is likely that many consumers will choose the more competitive pricing and greater variety offered by centrally located business over their local alternatives. This would in turn further enhance mono-centricity in the region along with the issues related to having such a dense centrality at the centre.

Networked competition effects and station area development paths

In light of doubts about the New London Plan's development scheme this thesis proposes four hypothetical development paths for nodes when new transit links are built through which to understand the dynamics of competition between nodes in urban systems. Explained in much greater detail in the theory paper in the appendix, these development paths originate from the understanding of a region as an urban system and that businesses in centralities are likely to outcompete those in the peripheries they are closely linked with due to agglomeration benefits. These agglomeration benefits are derived from either the personal size of a centrality or borrowed from nodes they are connected to.

As a new transit line and accompanying stations are built two things are likely to happen regarding network position: a node's access to centralities will increase or its accessibility to peripheries will increase. This leads to four possible scenarios: accessibility to centralities increases significantly while accessibility to peripheries does not (1), accessibility to both centralities and peripheries increases significantly (2), accessibility to centralities does not significantly increase while accessibility to peripheries does (3), or neither accessibility level changes significantly at all (4).

Assuming a generic station area of average density and a relatively self-contained functionality, these scenarios lead to four hypothetical development paths also seen in figure 5.4:

1. Externalisation of economic activity

For the first development path it is assumed that a station area's accessibility to centralities increases significantly while its access to peripheries does not. As these centralities can be assumed to be the beneficiary of agglomeration effects, either due to its size or network position. This means that its firms have a competitive advantage over those in the new station area, who do not benefit from agglomeration. As firms in the new station area are outcompeted, and consumers choose the higher variety of services in the centrality, local economic activity will decrease. The centrality will borrow size from the new station area, putting it in its agglomeration shadow. As a result a portion of the economic activity in the new station area will become externalized to the centrality.

2. Integration into a centrality

For the second development path, the assumption is taken that a new station increases its area's accessibility to both centralities and peripheries. As explained earlier, centralities can be assumed to benefit from agglomeration effects meaning they are also likely to suffer from its costs, such as high land prices. As the new station area provides strong access to the peripheries and their market, it offers a similar potential for agglomeration as the centrality it is connected to. However as it does not yet have the same level of development as the centrality, agglomeration costs will be lower. Therefore it is likely that firms from the centrality will move to the new station area in search of the same benefits at a lower cost. Through this process the new station area will become functionally integrated as the centrality expands into it.

3. Centralisation

For the third development path, the assumption is made that a new station increases its area's accessibility to the peripheries while having little impact on accessibility to the centrality. Due to the strong access to the peripheries, it will become able to borrow their size. If an area's network position allows for borrowing enough size, it has the potential to develop into a new centrality capable of competing with the existing ones.

4. Sustaining the status quo

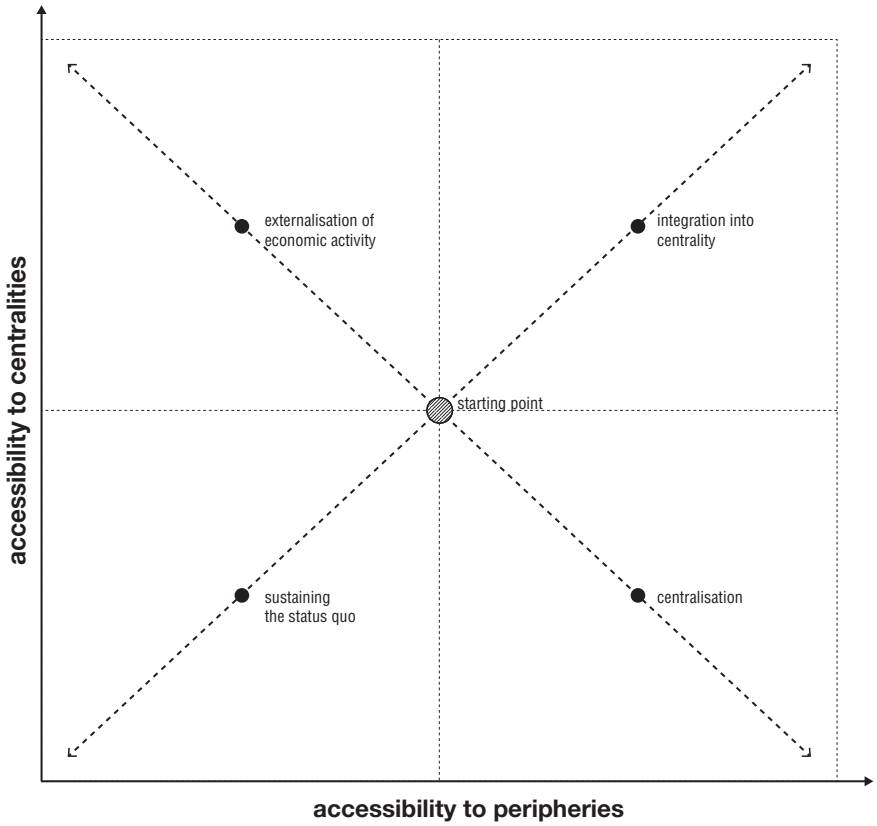
For the fourth and final development path, the assumption will be made that a new station does not significantly increase an area's accessibility to either the centralities or peripheries in an urban system. As little changes in regard to its position in the system it is likely that its functionality remains relatively self contained and no major changes in the amount or type of activity will occur.

In order for a node to develop a significant amount of economic activity it must have access to enough peripheries to not be outcompeted by existing centralities in the system.

It must be noted that the above mentioned changes in accessibility are all relative and certain thresholds are likely to exist that must be met before any of these development paths will occur. However, based on these hypothetical paths it can be argued that for a place to develop a significant amount of economic activity it needs access to enough peripheries to not be outcompeted by existing centralities in the system.

Complementarity in urban system

Interactions within urban systems however, do not always mean that places outcompete each other. Complementarities can also come to exist (Meijers, 2007). This can be attributed to the fact that different types of business benefit from, and are harmed by, the benefits and costs of agglomeration to a different degree (Bourdeau-Lepage and Huriot, 2005). High-Order services for example benefit greatly from ease of interactions in dense agglomeration, and can thus bear the high costs. Other sectors however, an obvious example being manufacturing, are likely to prefer cheaper out of centre locations as the benefits they derive from inner-city agglomeration effects are rather limited.



▪ Figure 5.4 Station area development paths *source: image by author*

Summary

1. Agglomeration is a key determinant for the development of centralities in urban systems and relies on the benefits of scale derived from a high concentration of activity in a given area.

2. Next to benefits, agglomeration also creates costs for firms and inhabitants. Different types of firms will profit or suffer from these benefits and costs in a different measure.

3. Nodes can substitute the critical mass needed to generate agglomeration effects by borrowing size from others that they are linked to. On the flipside, nodes whose size is borrowed, often exhibit reduced levels of activity as they are outcompeted by places that do benefit from agglomeration.

4. In order to benefit from networked agglomeration effects a node should have access to enough peripheries to prevent being outcompeted by the centralities in the system.

5. However there are not just winners and losers in this process, complementarities between places in urban systems can come to exist. This is closely related to the different balances of costs and benefits of agglomeration for different types of businesses.

5.3 Transit Oriented Development

The TOD model provides a way of redefining the relation between land use and the transit network.

As this thesis focusses on London's station areas, this section will discuss the model of Transit Oriented Development (TOD) a way of redefining the relation between land use and the transit network which has gained increasing traction over the last decades. First the goals of TOD will be discussed, followed by reflection on its regional dimensions and its lessons for the local dimensions of developing around transit nodes.

The Goals of TOD

As with urban systems theory, TOD is related to the observation that life in urban regions has become increasingly dispersed. However, in contrast to urban systems theory its main focal point is the transit hub as one of the few places where people from all over still converge en masse (Bertolini, 1999). As described by Cervero (2009), TOD involves "concentrating a mix of moderately dense and pedestrian-friendly development around transit stations to promote transit riding, increased walk and bicycle travel and other alternatives to the use of private cars" While Cervero solely points to the goal of achieving a shift towards more sustainable modes of transport, its increasing popularity in strategic plans can be attributed to a more varied set of reasons (Newman, 2009):

1. It assists cities in wealth creation

2. It reduces the external costs of car dependence

3. It saves time

4. It saves space

5. It creates spaces suitable for knowledge and service economies 6. It creates certainty for private investment

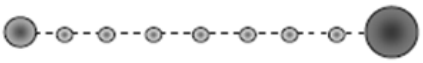
The reasons above refer to both local and regional dimensions. The discussion here will follow a similar structure. First, the regional aspects of TOD will be discussed briefly. First, TOD"s preference for a variety of centralities along transit lines will be explained followed by its understanding of how these come to be and the Node-place model as a tool for assessing the development potential of station areas. Subsequently TOD's local principles for the effective integration of land use and transit will be discussed briefly. Finally, the engagement of private stakeholders in the development process will be discussed briefly in relation to Transport Development Areas, the UK's policy approach to implementing the principles of TOD.

6.5.2 Regional dimension & the land use transport feedback cycle

On a regional level, TOD strategies usually advocate development along new or existing transit lines. Often they aim at creating multiple centralities spread out along the same line. The main reason for this is to promote more efficient

use of these lines. As seen in figure 5.5, spreading out centralities leads to more bi-directional travel patterns (Curtis, 2006). These bi-directional travel patterns make more efficient use of infrastructure as they require lower peak capacities than the mono-directional patterns that can be observed for example in London. As transit lines are used more efficiently, they become more affordable and hence making them a better alternative to car-based forms of mobility.

TOD often advocates a multitude of centralities spread out along a transit line to foster more efficient bi-directional travel patterns

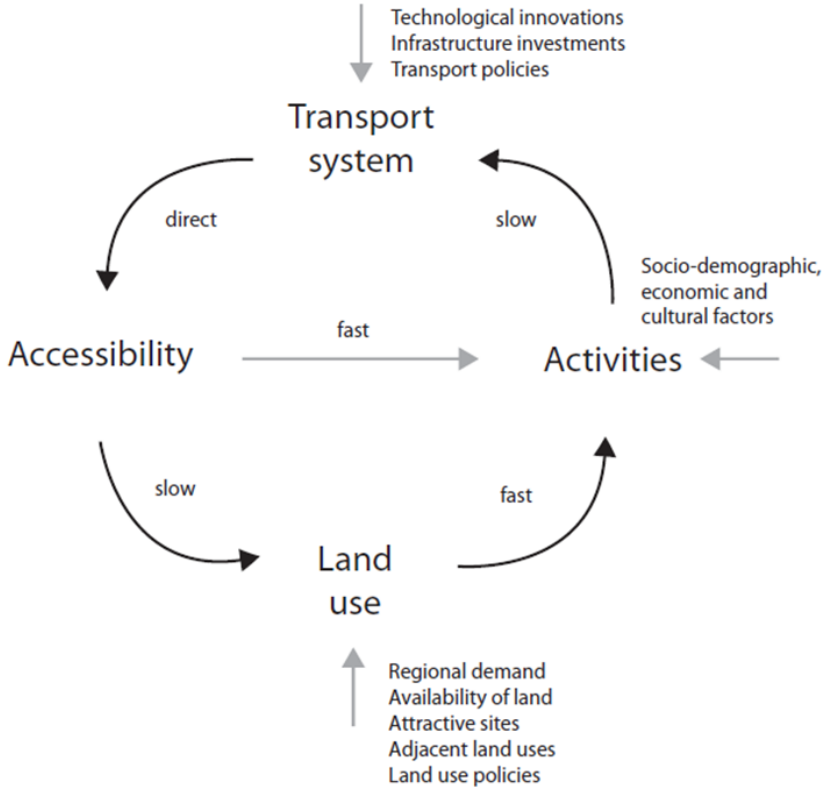
Scenario	Density (dw/ha gross)	Maximum efficiency of bus use (at current 6% mode share)	
		East (CBD) bound (%)	West bound (%)
Current urban structure	8.5	145	4
Current urban structure with 12% mode share	8.4	289	8
Ultimate density if Town Planning Schemes implemented	25.5	429	12
Scenario 1:	14	100	100
Strong centres at corridor ends, very small centres of equal size between			
Scenario 2:	9.6	100	51
 Centre at one corridor end half attractiveness of other corridor end, all other centres small and equal to each other			
Scenario 3:	13.6	99	61
Centre at one corridor end largest, two other large centres (equal to each other) at mid-point and other corridor end, all other centres small and equal to each other			
Scenario 4:	12	99	52
Hierarchy of centres: one corridor end largest, other corridor end next largest, mid-point centre next largest, 25th quartile and 75th quartile next largest, rest minor			
Scenario 5:	13	96	47
One corridor end largest centre, mid-point centre large, other corridor end mid-sized, rest minor			

▪ Figure 5.5 Relation of travel flows and distribution of centralities along transit corridors *source: Curtis (2006)*

However as discussed in the previous section, these newly planned centralities don't just come to exist. When planning them regional competitive processes must be taken into account. TOD's central argument for the economic potential of transit nodes over other places is that activity can be supported by the critical mass of commuters passing through (Cervero, 2009). This insight is further expanded in the land-use transport feedback cycle as seen in figure 5.6. This cycle shows the interrelation of transport and land use patterns. The latter influence the location of activities, while transport is

The Land Use Feedback Cycle explains the cyclic relation between transport infrastructure and activities. The former provides access stimulating the latter, while the latter creates more demand for the former.

needed to overcome the distance between them. These new transportation services, transform the level of accessibility which is in itself again a co-determinant for the location of certain activities (Chorus, 2012).



▪ Figure 5.6 The Land Use Feedback Cycle *source: adaption by Chorus (2012)*

In reality however, the causality of the Land Use Feedback Cycle is not as clear. Firstly, there is an aspect of slowness in the reaction times of the cycle's different components. While activity patterns can transform relatively quickly, the physical realm of land use and especially infrastructure are much slower to adapt. Secondly, accessibility, land-use and activity are not in engaged in a mutually exclusive relationship, many more factors are at work as identified by (Chorus, 2012):

Land use patterns:

1. Availability of land
2. Local land use policy
3. Regional demand for development
4. Attractiveness of the location
5. Appropriateness of adjacent land uses

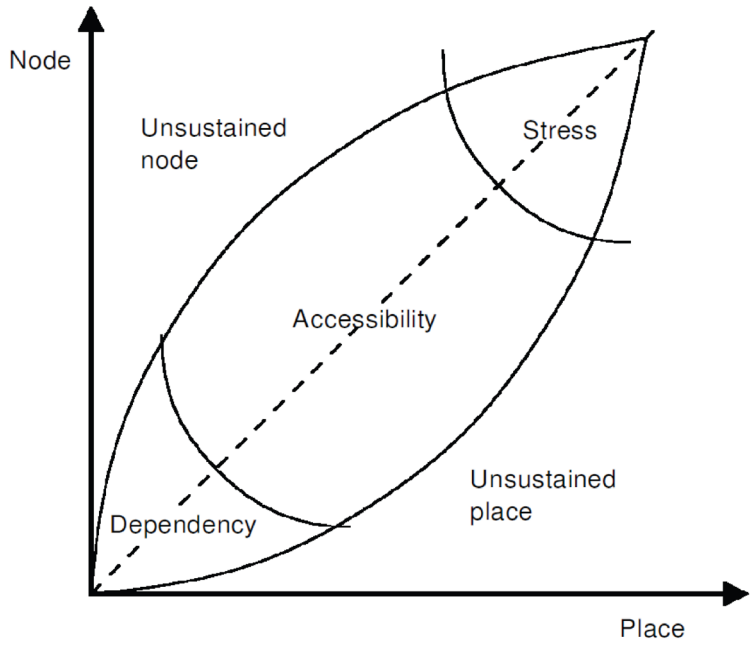
Travel behaviour:

1. Attitudinal characteristics
2. Lifestyle characteristics
3. Socio-economic characteristics

Because of the multitude of factors and feedback slowness of the dynamic between land use and transport the LUTF-Cycle should be taken as a tool for understanding rather than a proverbial law of nature. However, in order to formulate a regional TOD strategy it is necessary to gain a more concrete insight into the potential of stations to form new centralities. For this the Node-Place Model, discussed next, has become a central tool.

Reflecting on the Node-Place Model

The Node-Place Model assesses a station area's development potential by comparing its value as both a node and a place. The place-value represents the activities surrounding the station area and is conceived through the amount and mix of jobs and residences in proximity of the station. The node-value represents the network position of a station area and is determined by measures of its connectivity such as the number of railways, bus stops and parking spaces (Bertolini, 1999). These values are indexed for all stations in a particular sample as seen in figure 5.7. If stations are close to the mean their node- and place-values are in balance while the anything else would indicate that they are unsustainable. Unsustainable in this context refers to a station area either hosting more activities than its network position should be able to provide for, or that there is an overcapacity in connectivity in regard to the activities taking place. If there are no external factors such as subsidies at work, it must be expected that these station areas will move towards the mean through a regional process of competition affecting the node- or place-values (Bertolini, 1999). In regard to this move, Chorus (2012) argues justly that this shift will most likely take place through an increase of either connectivity or activity levels as a decrease would mean sizable losses of investment. However, multiple critiques can be had on the Node-Place model.



Node-Index components:

1. Train: directions served
2. Train: daily frequency of services
3. Train: Stations within 45 minutes travel distance
4. Other transit: number of directions
5. Other transit: daily frequency
6. Car: distance to closest highway exit
7. Car: parking capacity
8. Bicycle: number of bicycle paths
9. Bicycle: parking capacity

Place-Index components

1. Number of residents
2. Number of workers in the four main economic clusters
3. Degree of functional mix

▪ Figure 5.7 The Node-Place Model *source: Bertolini (1999)*

The first of these critiques concerns the three states Bertolini identifies along the mean line: dependency, stress and accessibility. Dependency means that levels of connectivity and activity are so low that there must be another reason for keeping the station in operation. Stress refers to an overheated situation in which it will be difficult to develop further due to the large amounts of traffic and the high levels of activity. The third and ideal state is, rather arbitrarily, called accessibility and refers to an envisioned state of equilibrium. Here both levels of connectivity and activity are in balance.

Bertolini (1999) argues that stressed station areas are difficult to develop further. However, reality seems to argue otherwise. First off, the relations described are relative, meaning that it cannot be assumed that tstations in the stress zone of the “football” are abnormally busy in absolute terms. Secondly the stakes for development are often highest at the stressed stations, offering incentive to develop them further as can be seen by examples new developments around very busy transit hubs such as Utrecht Centraal in the Netherlands or King’s Cross in London.

The definition of states however is not the most fundamental critique to be had on the Node-Place Model as explained in detail in the theory paper found in the appendix. This regards its method for evaluating node-value or network position. To do this the node-place model simply considers the number of connections a station has, however this does not do justice to the importance of accessibility in facilitating agglomeration effects. In order to properly assess the node-value of station areas an alternative way must be found to more accurately describe its accessibility relations to other nodes than merely counting the number of links to other stations. One such method, as applied throughout this thesis, is explained in the chapter on methodology.

Local integration of transit and land-use

TOD provides several principles for the successful design of station areas that promote integration of land-use and transit.

While some of TOD’s approaches to regional questions seem underdeveloped, a lot remains to be learned from the principles it proposes regarding the local integration of transit nodes. These usually pertain the direct surroundings of a transit node. Calthorpe (1993)’s work on New Urbanism, an early application of TOD concepts, sets the maximum radius at 2000 feet or around 600 metres as from a transit station. In practice today, the radii used are in general anywhere between 400 and 800 metres (Ribeiro, 2014). Within these areas the integration land use and transit relies on three main principles (Tan, 2013):

1. Sufficient density

2. Mixing of functions

3. Promotion of slow modes of transport

Sufficient density, combined with the promotion of slow transport modes, is key to establishing the consumer base needed to sustain a transit node. By concentrating regional population around transit nodes, the overall share of

ridership can also be improved (Perry. and Lew., 2009). Secondly, by mixing functions around transit nodes, the surrounding communities have a relatively large amount of amenities easily accessible by foot or bike reducing the overall need for mobility. It is as such that the transit hub itself becomes a place of activity offering its own range of functions and street life rather than solely performing the utilitarian function of providing transport. Such transit environments that promote easy interactions are also thought to be key to stimulating the economies of creative and knowledge services (Newman, 2009).

TDA, the British approach to implementation

The majority of TOD principles discussed here are well established in British planning policy under the guise of Transport Development Areas (TDA's). Policy regarding TDA's pays special attention to its implementation, in particular to the assembly of partnerships for area development that engage private actors, and the monitoring of development (RICS, 2002). One way, advocated for the most complex TDA projects, is setting up development corporations. These corporations unite private and public partners to deliver the project. TDA, or TOD, projects are particularly interesting to private parties, as the long lifespan of rail infrastructure gives investors security regarding accessibility gains. This increases willingness to engage in the PPT constructions that are increasingly important in light of neoliberal policy and shrinking government budgets. An example from outside the UK, Hong Kong's MTR, is one of the most striking examples of this approach's success, featuring a model combining transit and property development that is fully self-sufficient and even profitable (Leong, 2016).

TDA refers to the British planning policy looking to implement TOD principles. Special attention is paid to the implementation, advocating measures such as development corporations that aim to engage private actors.

Summary

1. TOD aims for a variety of goals, both on a local and regional scale level, ranging from improving transit ridership to providing the interaction environments needed for knowledge industries.

2. TOD's reasoning behind the economic potential of transit nodes comes from the relationship between access and activity as described in the LUTF-Cycle. This argument is applied in the Node-Place Model but using overly simple connectivity variables to determine accessibility.

3. TOD provides concrete principles for the local integration of transit nodes and their surrounding areas. The primary components are: promoting slow modes of transport, creating sufficient density and mixing functions. This aims to create accessible communities and the interaction environments vital to the knowledge economy.

4. TOD is integrated in British planning policy under the guise of TDA. This primarily focuses on implementation, advocating measures such as development corporations.

5.4 Synthesis: Framework for centrality development

The Centrality Development Framework proposed here forms a guiding element throughout the evaluation of options and the development strategy

Based on the insights from both the perspectives of urban systems and TOD, as well as the reference study in the appendix, this section will provide a comprehensive framework for the development of centralities around transit nodes. This framework, as seen in figure 5.8, will form a guiding element informing both the evaluation and generation of options, and the development strategy in the chapters to follow.

Structure of the framework

The framework proposed here finds its origin in the Node-Place Model's understanding of the dual nature of station areas: their potential is defined by both their local characteristics and their network position (Bertolini, 1999). However, in the understanding of these two phenomena the framework proposed here will depart from the Node-Place Model.

The Centrality Development Framework provides both local and network characteristics that play part in determining a node's potential to develop into a centrality.

Following the argumentation provided in the theory paper attached to this report, a station's network position will not be defined through notions of connectivity. Instead the notion of accessibility is used, specifically access to labour markets, other firms, and its relation to other centralities and peripheries in the system. Furthermore, the characteristics of the station area will not solely be described using quantities of population and jobs. While important, as we have seen they are a major determinant for agglomeration benefits, there are also other factors that must be taken in to account. The first is the spatial quality of a place, which can have pronounced impacts on the location decision of firms and inhabitants (Bourdeau-Lepage and Huriot, 2005). In addition to this unique functions such as stadiums, concert halls as well as (inter)national infrastructures are taken into account. These can function as anchors for development. Especially airports, who do not only offer a gateway to the rest of the world but which due to their importance, are also likely to secure infrastructure investment in the future (Graham, 2002).

Additional components

However, to solely identifying the physical conditions of a place and its place in the transit network is not enough assess if a transit node can be developed into a centrality. Various authors argue that, in developed countries, infrastructure investment on its own does not equate economic growth for a (Meijers et al., 2012, OECD, 2002, Banister and Berechman, 2001). A more comprehensive approach to development is needed. As argued by Banister and Berechman (2001) there are three additional components needed for economic development around transport infrastructure to happen:

1. Favourable economic conditions
   Infrastructure has a primarily redistributive effect on economic growth, therefore the potential of developing new centralities is largely dependent on overall economic conditions in a region. In regards to Greater London and its growth projections, conditions seem favourable.

2. Securing Investment
If there is no investment, nothing will happen. However as discussed above, the model of TOD offers ample opportunity for mobilizing private funds.

3. Supportive policy
An organizational framework is needed, supportive of local development and growth over that in other places.

Planning for desirable outcomes

Whereas the mechanics relating to the location choices of businesses and development of centralities discussed up to this point are primarily based on market mechanics, the third component mentioned by Banister and Berechman (2001) hints at the role of planning in these processes.

Most mechanics relating the location choices of businesses and the development of centralities presented in this theoretical framework are based on market mechanics, the third additional component, supportive policy, presented by, hints at the role of planning in guiding these processes. Planning policy, should provide a framework that guides these mechanics in order to produce desirable outcomes that the market itself might not account for. A clear example in the case of London would be solving the accessibility issues, and the ethical concerns regarding equality of opportunity this brings, that are negative externalities to London's mono-centric approach to development.

In my personal opinion, the word "guide" is key in a planning approach to such issues. Instead of forcing all manner of location decision in a top down prescriptive manner, planning policy should seek to accommodate the processes of urban formation in such a way that desirable outcomes are stimulated. Such an approach would ideally regulate and stimulate certain decisions by individual actors where needed without overly limiting their flexibility, ingenuity and entrepreneurship by being overly prescriptive.

This thesis advocates a role for planning that guides the processes transforming our cities towards desirable outcomes without being overly prescriptive.

However, for such an approach to work, and know what to stimulate and regulate, such an approach requires an understanding of why the private actors pushing urban development make the decisions they make. There are limits to which developers and other private actors can be forced to make the decisions necessary to achieve proposed planning goals, especially in a market-oriented system like that of the UK. This exactly is where the Centrality Development Framework seen in figure 5.8 comes in. It provides an overview of local and network characteristics relevant to mechanics driving centrality development. As such, it provides a set of criteria for selecting a possible location for the development of a new centrality and a set of factors on which to improve to provide a viable alternative to other places in the urban system.

In order to successfully guide these processes they must be understood, this is the use of the Centrality Development Framework.

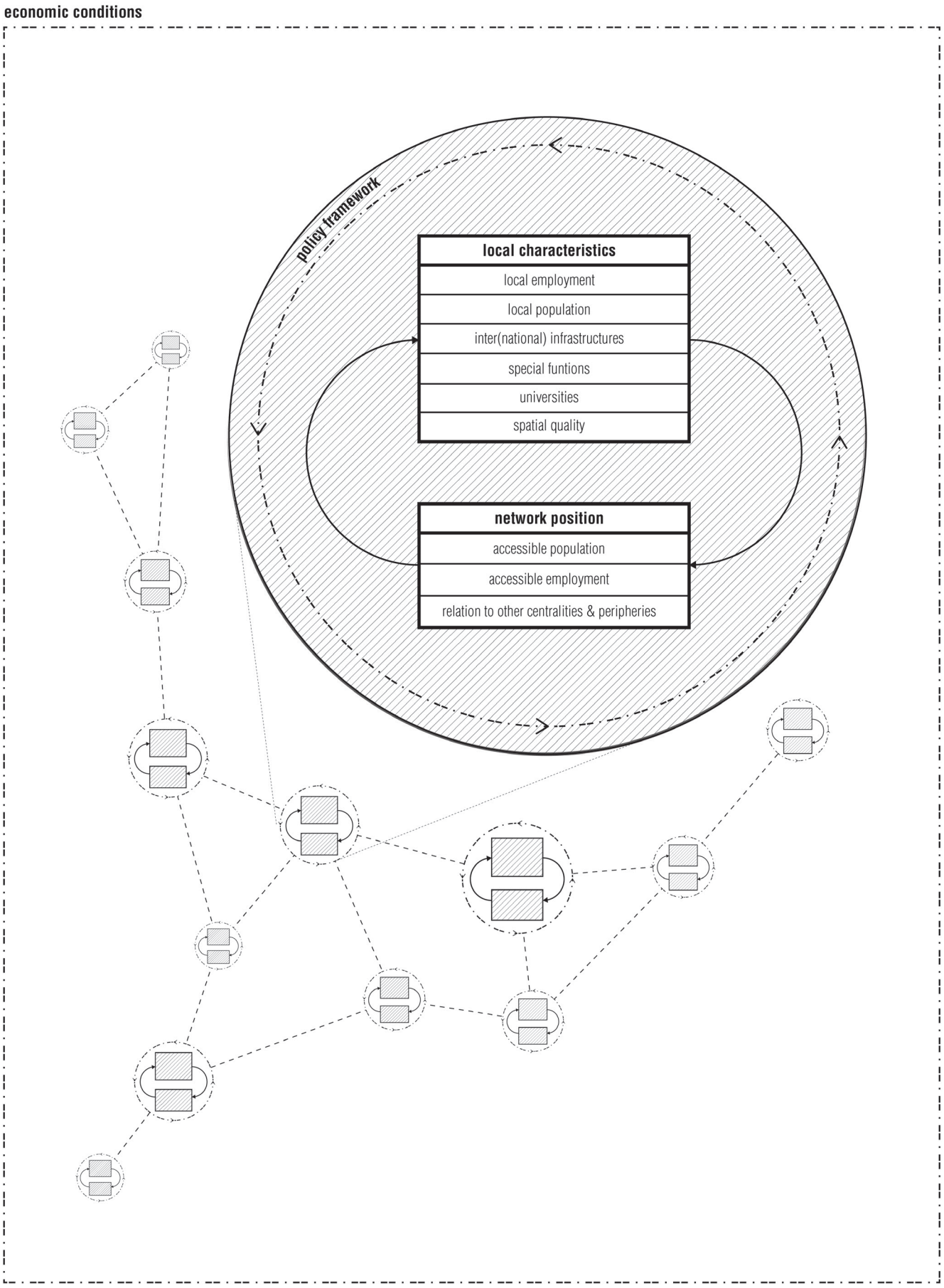


Figure 5.8 Centrality Development Framework

source: Image by author

5.5 Fostering territorial cohesion in metropolitan regions

As stated in the research question, this thesis aims to improve territorial cohesion throughout London, but the question remains: What does territorial cohesion entail and why does it need to be improved upon?

The concept of territorial cohesion aims to build bridges between the economic effectiveness of, and social cohesion and ecological balance within territories, aiming for a sustainable mode of development that promotes cooperation between authorities and stakeholders (European Commission, 2008). In this particular attention is paid to the distribution of activities throughout territories. Current discussions and applications of the EU territorial cohesion policy primarily concern cross-border cooperation between member states and the balancing of economic growth throughout the EU as an entirety (ESPON, 2013). However, in its original debate the concept was also projected to the scale of metropolitan regions. While debate on a EU level has departed from this scale level following sentiments of encroached sovereignty from member states (Faludi, 2009), the concept itself remains relevant for large metropolitan regions.

Territorial cohesion aims for a more sustainable form of development combining economic effectiveness, social cohesion and ecological balance with an emphasis on the distribution of activity throughout territories.

The concept of territorial cohesion is especially relevant for the case of Greater London as one of its primary concerns is the distribution of (economic) activity in order to avoid or mitigate the negative externalities produced by large agglomerations (European Commission, 2008). As has already been discussed in great detail, many of London's inhabitants suffer from these externalities be it in the form of long commutes, being prized out of the central areas or otherwise.

However, as discussed agglomerations not only produce negatives but also positives through facilitating highly specialized and productive economies. Territorial cohesion policy aims to maximize the positives and minimize the negatives of agglomeration. Through an effective distribution of development throughout a territory and the avoidance of excessive concentrations of growth it is thought that access the increasing returns of agglomeration can be made more universal (European Commission, 2008).

Territorial cohesion argues that an effective distribution, and avoidance of excessive concentrations, can mitigate the negatives of agglomeration while fostering the positives.

Some of the core notions underlying territorial cohesion policy are central to this thesis, particularly the aim of combining both economic effectiveness and social cohesion as well as achieving this through ha more balanced distribution of development. The latter is of course evident in the thesis's principle means, developing a new centrality outside of Central London. The former notion is central in both the thesis' goal as well as its approach to planning which seeks to offer a viable alternative outside of the Central Area for economic activity to locate to.

The concept of territorial cohesion is relevant for London as its mono-centric distribution of activities is causing profound negative externalities throughout the region. Hence, its core notions are evident throughout this thesis.

6. Methodology

+ a guide to the process
+ three insights fundamental to the approach taken
+ a model for assessing network position

Having established the foundations of this thesis through the problems, questions, goals and theoretical framework discussed previously, this chapter will further clarify the relations between the various parts of these thesis, before moving on the proposals done in the next chapters. This first section of this chapter will function as a roadmap, providing an overview of the most important lessons learned throughout the various chapters, and the way they inform the approaches and decisions that follow. This chapter refrains from summing up a set of tools used throughout the thesis, for where they are not self-explanatory, they are discussed on application. There is but one exception to this, the network analysis. This tool is discussed separately due to the complexity of mechanics and considerations in involved.

6.1 A reader's guide to the process

When addressing a problem in the urban domain, there are often nearly as many directions in which to seek a solution as there are proverbial roads leading to Rome. The same goes for the accessibility issues resulting from London's mono-centricity tackled in this thesis. The New London Plan proposes one such solution, even if this thesis casts doubt on its merits. With so many possible approaches to the problem it is key to understand how the observations made in thesis have informed the path taken. To do so, this section will describe the various stages of the project emphasizing three fundamental insights that have guided the thesis, the first derived from the examination of London's development history, the second from the discussed theory and gaps regarding its practical implementation, and finally a personal belief in what the role of planning should be.

1. Contextualization

Primarily taking place in chapter 2. the contextualization first identifies the issues stemming from London's mono-centricity and their relevance in light of projected growth. In addition to identifying the issues this thesis deals with it also offers the first insight fundamental to the approach taken. This insight regards the innate connection between London's radial transit system and its mono-centric metropolitan model, the former essentially enabling the development and perpetuation of the latter. This diagnosis resonates through several aspects of the thesis, from the critique on the current policy to the transit system becoming a central vehicle for the creation a new centrality as explored in the theoretical framework and applied in the chapters to come.

The observation of the innate connection between London's mono-centricity and its radial transit system has been fundamental to the approach in this thesis.

2. Problem analysis

The problem analysis further specifies the issues of mono-centricity identified in the contextualization. It not only further examines the accessibility related costs generated by mono-centricity but it also analysis a series of trends that show that current policy and market dynamics only seem to enhance these trends. Hence, it shows the need to act.

3. Theoretical framing

Following the identification of problems, a literature review is carried out which forms the foundations of the steps taken throughout the rest of the thesis. Dealing with issues of mono-centricity, theory on urban systems and agglomeration forms a logical first subject for this review. However, given the innate connection identified between London's transit system and its metropolitan functionality the topic of TOD also forms a key part of this discussion. While the insights and approaches of both fields prove to be quite compatible, the more detailed insights on centrality development from urban systems theory highlight the lack of effective tools for assessing the redevelopment potential of station areas based on network position. This second fundamental insight leads to this thesis producing a network analysis model capable of describing network position not based on connectivity values but accessibility; its capacity for facilitating interactions. This network analysis model, as described in the final section to this chapter, has become a central and indispensable tool throughout the thesis. It is not only central in the evaluation carried out in the next chapter, but it is also used devise directives to housing policy in the development strategy and is key to finally measuring the impacts of the proposals done. Without this tool, much of the work presented throughout the following chapters could not be done, or at least not with the same rigour.

The second fundamental insight concerns the need for a tool describing network position not based on connectivity but on accessibility.

In addition, the theoretical framework provides a set of variables relevant to the development of centralities by proposing the Centrality Development Framework. This framework forms the foundation of both the evaluation of options carried out in the next chapter as well as the development strategy.

4. Planning for desirable outcomes

The final fundamental insight is rather a personal belief that I have of the ideal planning's ideal role as discussed in section four of the theoretical framework. This view, that planning should provide a guiding role, stimulating the processes that shape our city to produce desirable outcomes, is essential in the way the Centrality Development Framework is applied throughout the next chapters. The factors identified are regarded as conditions that enable development, which are sought to be optimized making a place attractive for development and as such mobilizing relevant actors to take action. This conscious approach of creating conditions stimulating stakeholders to act is in stark contrast to a hard, prescriptive, top-down approach to development.

The third fundamental insight concerns the guiding role that planning should take.

5. Exploration, evaluation & optimization

The exploration, evaluation and optimization of options carried out in the next chapter is the first point where the three fundamental insights regarding the innate connection between London's transit system and metropolitan functionality, the need for concrete tools to evaluate network position, and the need for providing optimal conditions for development, truly come together for the first time. Firstly, each variant proposed adds a tangent to London's transit network fundamentally altering its radial structure that has enabled much of its mono-centric development up to this point. Secondly, it seeks

During the step of exploring, evaluating and optimizing various options for a new out of centre centrality these three fundamental insights first come together.

to identify the most fit location for a new centrality and supporting networks based on the factors identified in the Centrality Development Framework in order to provide an attractive alternative for businesses to settle. Finally, it utilizes the network analysis model proposed in a variety of ways as to accurately assess the relevant network characteristics examined. The exact steps taken in this process are explained in detail in the next chapter.

6. Achieving conditions for growth

Following the selection of a location and identification of supporting networks, the next step is achieving development. What must be done through time, to achieve the conditions necessary for growth to take place? The answer is given through a comprehensive development strategy comprising set of actions on the regional, local and governance levels that aim to improve upon the factors defined in the Centrality Development Framework. The actions aim to stimulate and guide development while maintaining flexibility offering a process oriented approach, instead of prescriptive, top-down one.

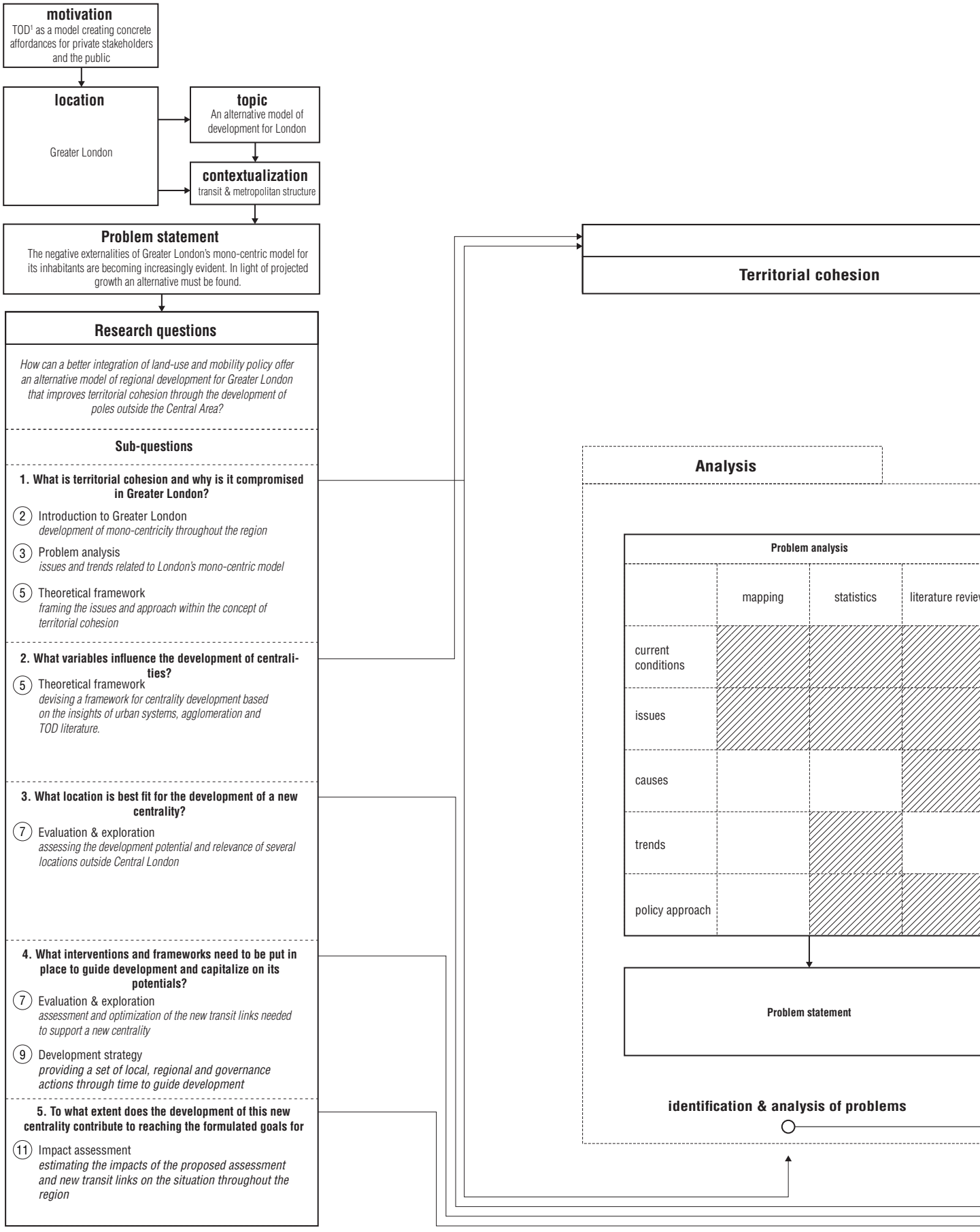
The development strategy draws on key features of the theoretical framework such as the centrality development framework, land use feedback cycle as well as the approach of planning for desirable outcomes.

The actions proposed are based both on the context and surroundings of the selected locations, the industries the developments seeks to attract, as well as several key concepts related to TOD. One such concept is the land-use feedback cycle. This cycle is evident in the cyclical nature of development and accessibility improvements within the development strategy, where development builds leverage for new infrastructure investment, which in turn enables the next stage of development.

7. Evaluating the outcomes

As a final step this thesis seeks to assess whether the final proposals actually fit the project goals, and the extent to which they fit in existing policy frameworks. The first, concerning accessibility and travel patterns, once again makes use network analysis. The latter is done through a brief review of and reflection on current planning documents.

The chart presented on the next page provides a overview of the steps taken throughout this thesis. In addition presents the chapters relevant to the research's various sub-questions.

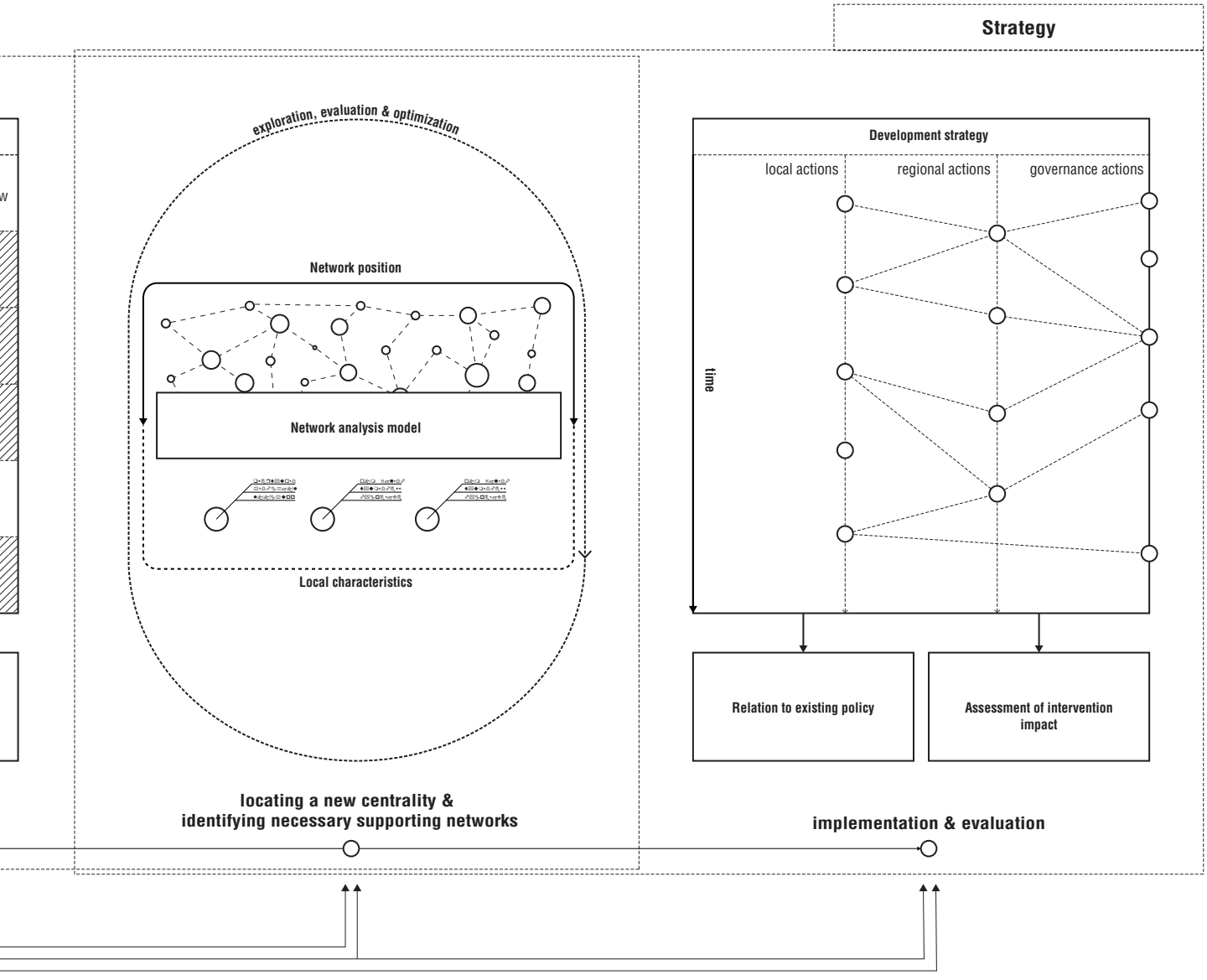


▪ Figure 6.1 Methodology chart

Theoretical framework		
Urban systems	Competition, agglomeration & borrowing size within urban systems	Transit Oriented Development

Centrality development framework

Strategy



source: Image by author

6.2 Constructing a model for assessing network position: considerations, inner workings and limitations

In addition to providing a roadmap of considerations underlying the research carried out, this chapter will zoom in on of the more unique tools applied in this thesis; a network analysis model. Already briefly mentioned in the previous section, this model has been essential to many of the steps taken throughout the following chapters.

"the first law of geography: everything is related to everything else, but near things are more related than distant things" (Tobler, 1970)

Framework of the model

As discussed in the theoretical framework, the networked relations between places in the urban system are of great importance for the development of centralities. In order to achieve a concrete understanding of London's web of roughly 600 interconnected stations, a network analysis model is used throughout this thesis. The following paragraphs will detail its inner workings, the considerations that have been made, as well as the limitations to the approach.

In order to assess network position via accessibility, a network analysis model is set up using the Python programming language. The model consists of London's station areas and the rail links between them.

The analytical model proposed here is based on Green (2007)'s approach of modelling urban systems through the idea of networks, consisting of nodes and linkages. As the focus is on the (re)development potential of station areas, all rail stations within Greater London will be regarded as nodes, and all the light and heavy rail connections between them as linkages. Together these form a network that is evaluated using the Networkx extension to the Python programming language.

The model aims to model accessibility based on the time it takes to travel between different station areas.

As explained in the theoretical framework, the focus should be on the functional nature of these transit links: providing access to other nodes in the urban system. Here, access can be considered as: the possibility of someone to travel somewhere to do something at an acceptable cost (OECD, 2002). The cost central to evaluation in this thesis is time, something of which not enough is left after enduring the average London commute. Hence, the model aims examine accessibility via the time it takes to travel between stations.

In order to model accessibility, each link is assigned a travel time, based on the time it takes to travel from the node at its one end to the node at its other. These travel times have been determined using the online journey planners of London's various public transit companies (Transport for London, 2018a, Trainline, 2018). However, in reality public transit links do not solely link two stations, instead they form continues lines linking a series of them. This means that while it takes no extra time to travel between stations on the same line, it does take extra time to transfer from one line to another. In the model these transfer times are simulated by flat rate of six minutes, added every time a transfer is made. As opposed to the live departure times used in the route scheduling apps many use on their phones, this approach takes scheduling out of the equation. Considering this thesis pertains a long term

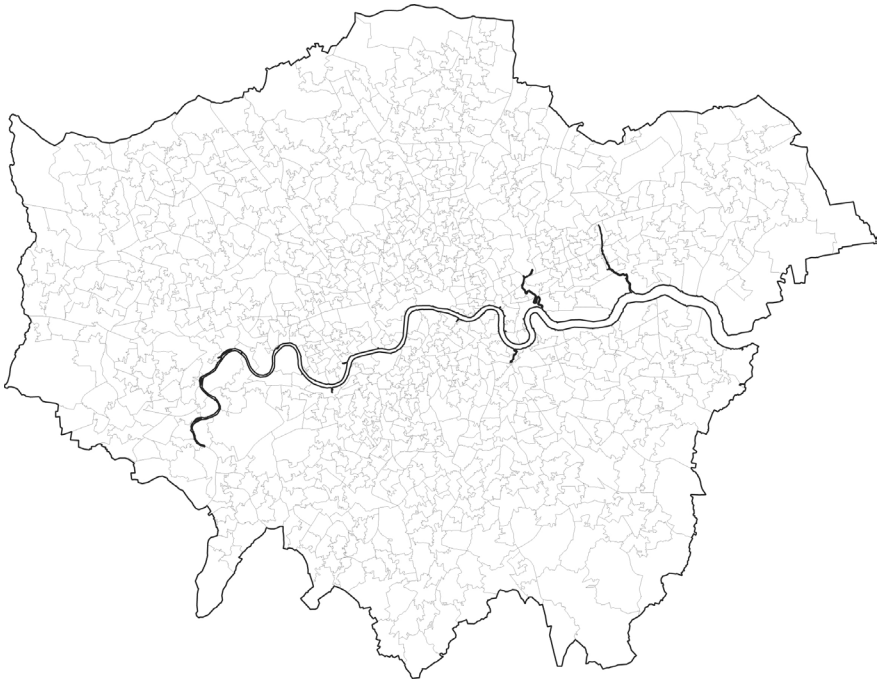
strategy this approach seems more suitable as it focuses on the network properties rather than more flexible operational aspects.

As discussed, it is not so much the access to a station itself that is of interest, it is rather the extent of access to activities and people around these stations. Therefore a set of relevant variables, such as the number of jobs and population, has to be determined for all the areas surrounding stations in Greater London.

For each station area the surrounding population and number of jobs are determined. These can subsequently be matched with the travel times between the various stations.

In TOD assessments this is often done by projecting a circle around a station of which the demographic contents are determined. In general the radius used is between 400 and 800 metres (Ribeiro, 2014). However, simply projecting a circle around a station does not do justice to the oft cited aspects of pedestrian-friendliness often associated with TOD (Tan, 2013, Curtis et al., 2009, Calthorpe, 1993).

In order to better address this issue of local integration this analysis will substitute these perfect circles with so-called isochrones. An isochrones is an area that is reachable from a certain point, by a certain mode of transport, within a certain time. The isochrones are generated via Openrouteservice which generates them based on OpenStreetMap, an open source online mapping project of remarkable accuracy (OpenRouteService, 2018). Plotted with Greater London's stations at their centres, the isochrones are generated for walking distance of seven minutes. Assuming a walking speed of 6,5 kilometres per hour or 108,5 metres per minute, The chosen travel time of seven minutes fits well within the aforementioned 400 to 800m range typically used in TOD assessments.



▪ Figure 6.2 LSOA 2011 demarcations

source: based on Greater London Authority (2014)

These isochrones areas are subsequently overlaid on various geo-located datasets for Greater London using geographic information systems (GIS) software. In order to provide a high level of accuracy the LSOA2011 area demarcation, dividing Greater London into areas with an average of 1722 inhabitants, is used (Greater London Authority, 2014).

The area demarcations of both the LSOA2011 can be seen in figure 6.2. A diagrammatic overview of the model framework as a whole can be seen in figure 6.3.

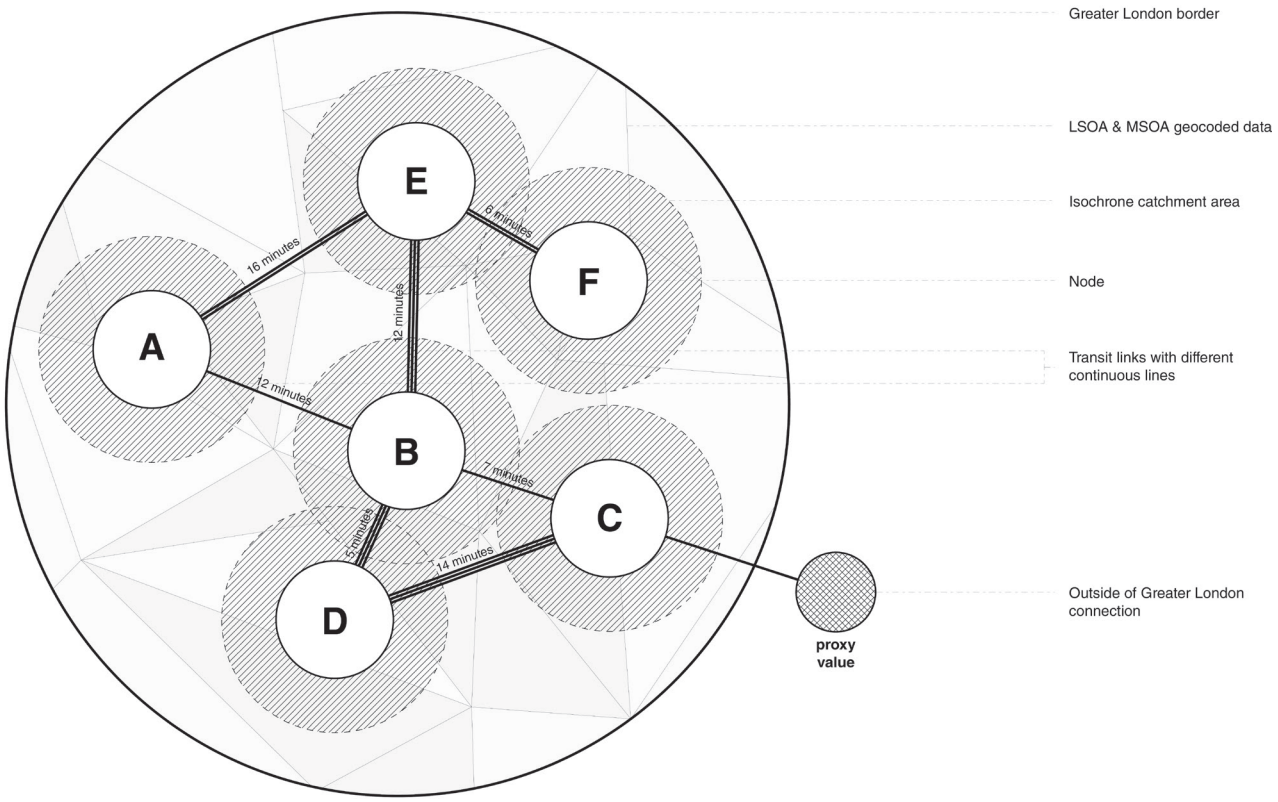
Obviously, the transit networks of London are not confined to its borders. In reality they form the main focal point of the entire national rail system (Sudjic, 1992). However, modelling the entirety of the UK, as done for Greater London in this study, is an insurmountable task. The problem is however, that if these links would be disregarded, Central London would have an unfair advantage over the nodes towards the edge. Therefore the links leaving Greater London will be represented by proxy values: a set of nodes each at the end of an outgoing line, representing the entirety of incoming commuters by public transit. These values are sourced from Office for National Statistics. Census Division et al. (2015). Employment beyond London's borders is not taken into account due to the difficulty of data collection and the relatively small number of people commuting out from London.

Evaluating the model

The model produces three main outputs: total accessible population and employment, a minute by minute aggregate of accessible station areas and associated values, and a matrix showing the travel times between all stations.

Now that the structure of the model has been explained, it is time to discuss the different ways it is used for evaluating a node's network position. Three outputs are produced: total accessible population and employment, a minute by minute aggregate of accessible stations and associated values, and finally a matrix showing the shortest travel times between all stations. All these measures are based on the travel time from a source node to every other node in the system. These travel times are determined by the shortest possible path between these nodes, taking into account the travel times associated with the different links as well as the time associated with transfers. To produce the outputs related to accessible population and employment, the resulting travel times are matched with the station area characteristics of their respective nodes. In case station catchment areas overlap with one another, the overlapping area is awarded to the station closest to the source node. This avoids double counting.

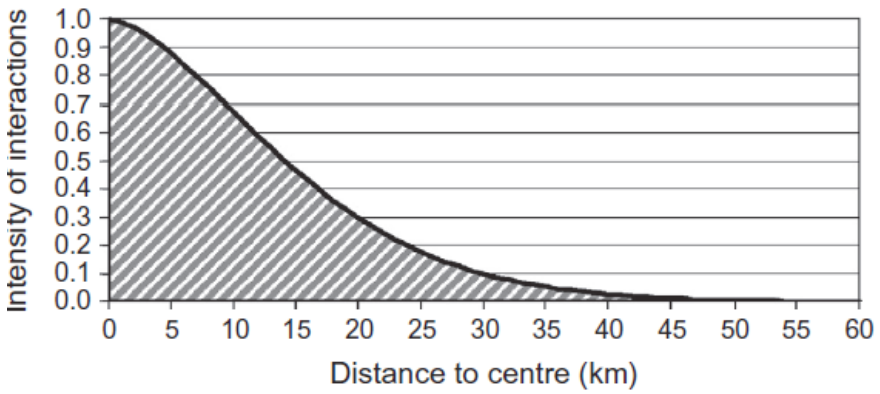
An important determinant for the labour market a node has access to, is the time that people are willing to spend commuting. In assessing the labour market of a place, studies often make use of distance- or time-decay functions (Mamun et al., 2013). A typical example of such a curve can be seen in figure 6.4. These functions indicate the proportion of people willing to commute to or from work given a certain travel time. However as travel attitudes are very much dependent on local culture and lifestyles (Chorus, 2012), these functions cannot simply be translated from one place to another. As the



▪ Figure 6.3 LSOA 2011 demarcations *source: image by author*

scope of this thesis, and a lack of available data, do not lend themselves to determining such a function for Greater London, an alternative measure must be used to give an estimate of acceptable commuting times.

In order to establish an estimate two different datasets have been combined, one featuring the main modes of transport for all commuting within and into Greater London, and the other outlining the average travel times for various modes of transport in the UK. Combining these two datasets gives an impression of the proportion of people willing to commute for a certain amount of time. Based on these proportions weights are assigned representing the percentage of people willing to commute for several time brackets as seen in figure 6.5. These estimated proportions follow a roughly similar pattern as



▪ Figure 6.4 LSOA 2011 demarcations *source: Halás, Klapka & Kladivo (2014)*

Travel Time	0 - 5 min	5 - 10 min	10 - 15 min	15 - 20 min	20 - 25 min	25 - 30 min	30 - 35 min	35 - 40 min	40 - 45 min	45 - 50 min	50 - 55 min	55 - 60 min	60 - 65 min	65 - 70 min	70 - 75 min	75 - 80 min
Weight	100 %	100 %	100 %	98%	95%	90%	70%	36%	34%	33%	27%	22%	16%	13%	10%	5%

▪ Figure 6.5 Weights representing willingness to commute for a given timeframe *source: image by author*

seen in the typical time-decay function in figure 6.4.

Based on the estimate above accessible population, as relevant to labour markets, and accessible employment are calculated using the following formula:

$$Pot_{source} = N_{source} + \sum (N_{destination} * F_{destination\ travel\ time})$$

Pot_{source} = Potential labour or employment market for source node
N_{source} = Characteristics of the area surrounding source node
$N_{destination}$ = Characteristics of the area surrounding destination node
$F_{destination\ travel\ time}$ = Factor for willingness to commute dependent on the travel time to the destination node

Overview per minute

While the abovementioned functionalities provide comprehensive functional measures for network position, it could be very useful to also get an insight into raw properties of a node's network position. For this, a minute by minute aggregate is generated on the basis of accessible station areas and their contents or other categorizations. The exact application of this method will be explained in more detail in the next chapter.

Limitations

Several limitations apply, the most important being that the model exclusively examines the rail system, ignoring other modalities.

Of course, as with any model, the one explained here has its limitations. Most importantly it must be noted that only rail travel, as a means of regional transport, is accounted for. In reality, the car still plays an important role in getting around at longer distances. Furthermore the model solely represents accessibility based on network structure. Capacities and scheduling play no role in the assessment. In regards to capacity it must also be noted that all rail station types, train, tube and tram, are all treated equally in regards to their catchment areas. In reality, the differences in speed and capacity offered are likely to command different catchment areas (Mamun et al., 2013). Finally it must be noted that the flat rate penalty now used for transfers might be overly simplistic, as it assumes that changing between modalities takes the same amount of time as changing within a single modality, However the impacts of this on the assessment are likely to be minimal.

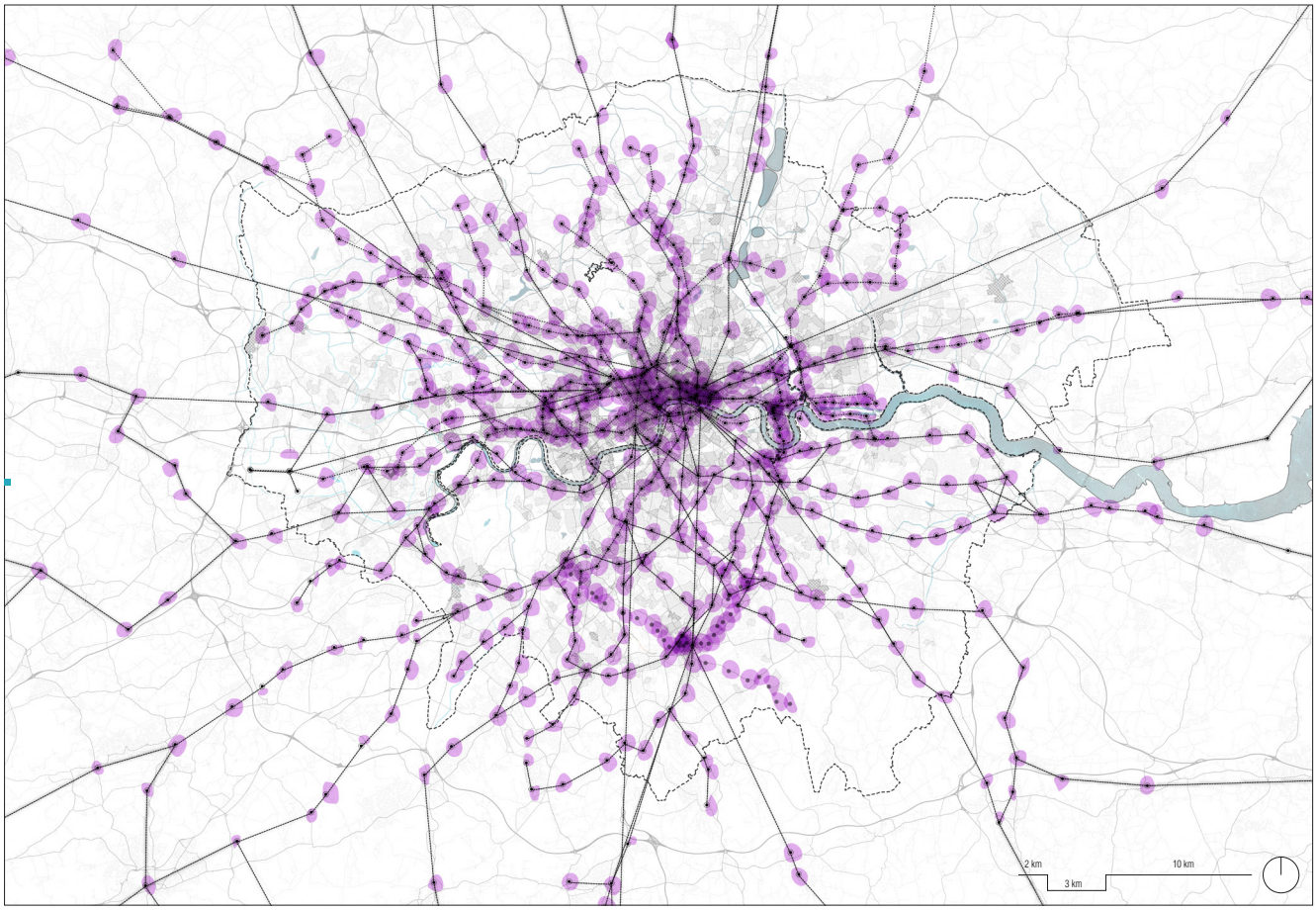


Figure 6.6 Station catchment areas *source: Image by author*

7. Evaluation of options

+ generating
+ optimizing
+ selecting

Having identified the relevant problems, scope and approach for this thesis the following chapters will investigate where and how a new centrality developed. This first chapter will primarily deal with the question of where but will also seek to identify what alterations to the transit network are needed on a regional scale. This is done by evaluating and optimizing a series of different options. The next following section will first explain the overall structure of this process after which the relevant variables will be discussed as well as the way they are assessed. After this the actual evaluation and optimization will be carried out after which a single option is selected.

7.1 Assessment methodology

As identified in the Centrality Development Framework a station areas potential to develop into a centrality is determined by both its local characteristics and its network position. This chapter seeks to identify the station area could be developed in order to improve territorial cohesion. For this current local characteristics are evaluated as well as network position and the new transit connections needed to improve this. This is done, in part, based on the criteria identified in the Centrality Development Framework, something which is explained in greater detail in the next section. However, due to the great number of transit stations in London it is simply impossible to evaluate every single one. Hence, in order to select a station are for further investigation, several steps of sub-selection and refinement are taken:

Due to the great number of transit stations in Greater London, several steps of sub-selection and refinement are taken in order to identify a station area that could be developed into a centrality.

1. Generation of preliminary variants

As a first step, four preliminary variants are generated current network properties, a macro view local characteristics and the varying potentials for redevelopment throughout the region.

2. Selection of potential centralities

For the second step the various station areas affected by these variants are evaluated for their potential to develop into a centrality. In this labour and employment access are used as the first selection criteria, followed an overview of their impacts, competitive position, and a macro view of redevelopment potential and local characteristics.

3. Optimization of transit system around selected centralities

Following the selection the identification of the station area with most potential for each variant, a step of optimization is taken. By arranging the networks around a station area, rather then selecting a station are on a line as done in the 2nd step, a more optimal arrangement can be reached. The optimization carried out firstly seeks to enhance impact on accessibility and access to labour, employment and supporting functions. Secondly, it seeks to locate “feeder” lines along areas with a high redevelopment potential which could the funding of said interventions easier. Finally, the optimization of course seeks to minimize the amount of new connections necessary. Based on these qualities three out of four variants are selected to continue to the next

steps where their costs are assessed and local characteristics are examined in further detail.

4. Estimating costs

After having determined the most optimal networks to support the selected centralities their costs will be estimated. These are summarized in this chapter, further info and assumptions taken can be found in the appendix.

5. Evaluation of local characteristics

As a final step the selected centralities are assessed on their local qualities namely: spatial quality, local infrastructural barriers and potential for redevelopment.

6. Evaluation matrix

Finally the insights from the previous steps are combined a comprehensive matrix which provides the basis for selecting one variant to be detailed further through a development strategy.

7.2 Evaluation criteria

The evaluation and optimization process is based on four main criteria: accessibility impact, network potential, local potential and redevelopment potential.

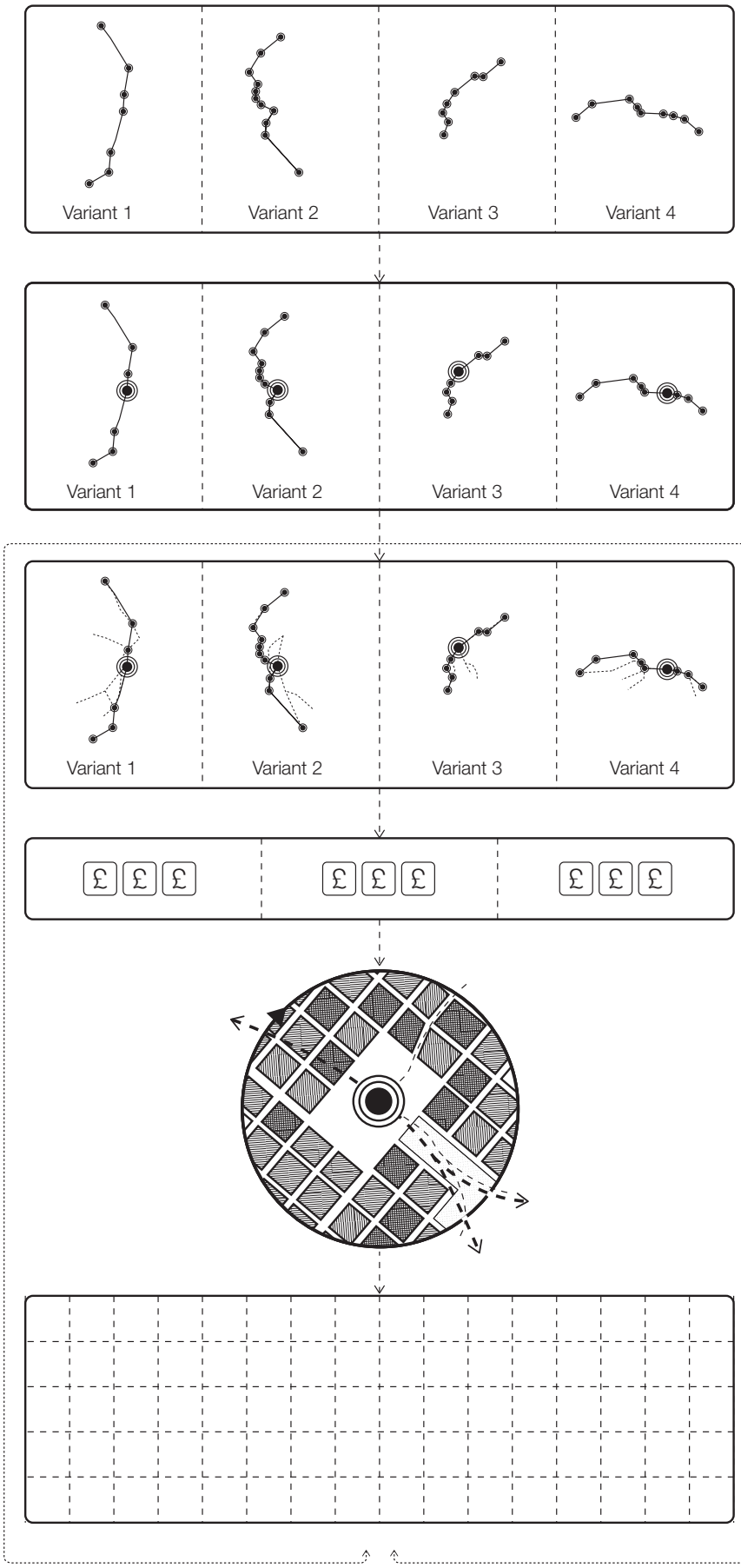
As has already been mentioned briefly, the evaluation and optimization in this chapter is done through a series of criteria. This section will explain what these criteria entail and why they are selected followed by the way they are assessed. The criteria used are as follows:

1. Accessibility impact

The development of a new centrality is in itself not the goal of this thesis. Rather it is the means to an end: Mitigating the costs associated to agglomeration, in particular improving on the compromised levels of accessibility throughout the region generated by the current mono-centric model of development. Hence, any assessment must concretely address the impacts of the proposed interventions on the accessibility situation throughout the region.

2. Network potential

In addition to local characteristics the Centrality Development Framework also addresses the importance of a place's network position in the greater urban networks. Here three main variables are taken into account: First is the accessible population, representing the labour and consumer markets key agglomeration. Second is accessible employment, representing access to other firms, businesses and economic activities also a major determinant for agglomeration. The third factor taken into account are the relations to the various centralities and peripheries in London's urban system. As established, for a place to develop into a centrality itself it must have adequate access to peripheries to prevent being outcompeted by other centralities.



Generation of preliminary variants
>> based on:
> current accessible population
> current accessible employment
> local characteristics (macro view)
> redevelopment potential (macro view)

Selection of potential centralities
>> based on:
> accessibility impact
> accessible population
> accessible employment
> potential competition
> local characteristics (macro view)
> redevelopment potential (macro view)

Optimization of transit system around selected centralities
>> based on:
> accessibility impact
> accessible population
> accessible employment
> potential competition

Estimating costs

Evaluation of local characteristics
>> based on:
> spatial quality
> infrastructural barriers
> redevelopment potential

Evaluation matrix

▪ Figure 7.1 Overview of evaluation steps and criteria used

source: Image by author

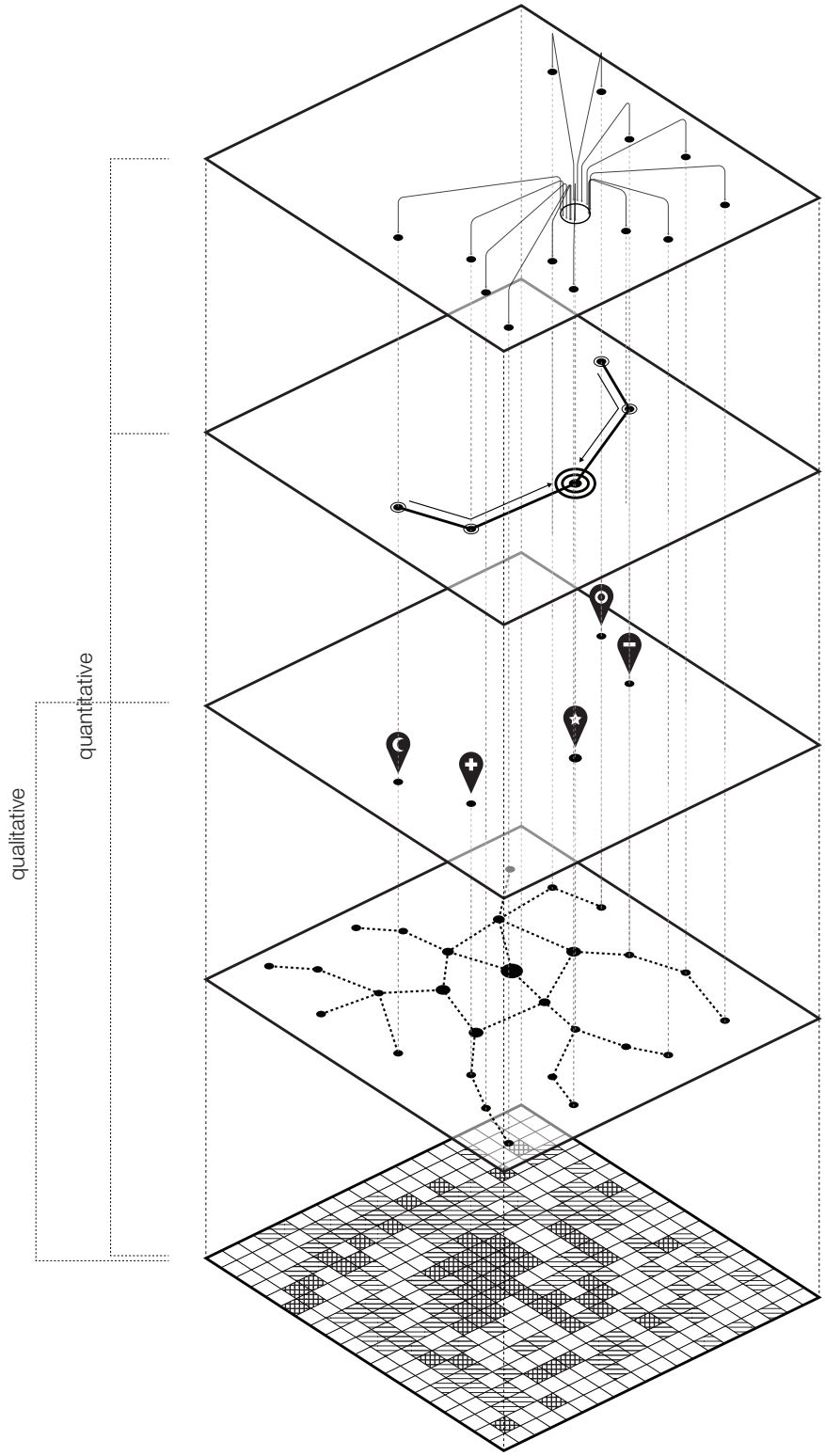
3. Local potential

As identified in the Centrality Development Framework constructed in the Theoretical Frame-work several local characteristics are key in supporting the development of centralities. The first three steps do this based on local characteristics that can be mapped on a regional scale namely: unique landscape features such as the Thames, (inter)national infrastructure hubs, universities, and unique functions such as stadiums, large conference halls and music venues. The fourth step takes a different approach, having a more in-depth look at the conditions for the three station areas then selected. Further details on this can be found in that respective section.

4. Redevelopment potential

The fourth and final criteria pertains to the fact that most of Greater London's territory has al-ready been developed in one way or another. While development is bound to happen consid-ering London's projected growth, there are places where this will be easier than in others. This can of course positively influence the feasibility of the proposed interventions. As with criteria three step four will provide a more in-depth look into local conditions while the first three provide a regional perspective.

The first two criteria are assessed in a quantitative manner using the network analysis method explained in the previous chapter. These will be discussed next, followed by the local potential which utilizes qualitative methods and finally redevelopment potential which combines both qualitative and quantitative aspects.



Accessibility impact

Network potential
> accessible population
> accessible employment
> relation to centralities & peripheries

Local potential
> unique landscape qualities
> (inter)national infrastructure hubs
> universities
> unique functions

Current situation

Redevelopment potential
> brownfields
> heritage
> intensity of use
> green space
> airspace obstacle restrictions

▪ Figure 7.2 Criteria used in step one through three

source: Image by author

7.3 Accessibility impact

Accessibility impact is determined by comparing the access potential centralities have to other station areas categorized by their accessible employment and population.

The first criteria that will be discussed is the accessibility impact of the different evaluated variants. The method for doing so is devised in such way that it is easily repeatable throughout the various evaluations done in this chapter. A more in-depth impact assessment for the final variant and development strategy is done in chapter 11. The assessment in this chapter uses two main variables representative of the impact that accessibility improvement can have. All Greater London station areas are categorized through these variables and subsequently aggregated by the time in which they are accessible from the node being assessed. Comparing the number of station areas in each category at a certain time for different stations is used to give an impression of the accessibility impact that the development of a particular station are would have. The two main variables used in the categorization are:

1) Accessible employment
   In order to improve the discrepancies concerning accessibility in the region the focus must be put on those areas suffering from poor accessibility levels.

2) Population
   As the population is not distributed equally over the various station areas the varying densities must be taken into account. If two areas have a similar level of accessibility but one is densely populated and the other sparsely it stands to reason that the improving that of the former will have a more profound impact as it affects more people.

Based on these two variables London three categories are devised. Station areas with an above median level of accessible employment are omitted as accessibility is not a pressing issue in these areas. The other areas divided as seen in figures 7.3, 7.4 and 7.5, as well as listed below :

1) Type A
   - Below median level of accessible employment
   - Relatively high number of inhabitants relative to its accessible employment

2) Type B
   - Below median level of accessible employment
   - Moderate number of inhabitants relative to its accessible employment

3) Type C
   - Below median level of accessible employment
   - Low number of inhabitants relative to its accessible employment

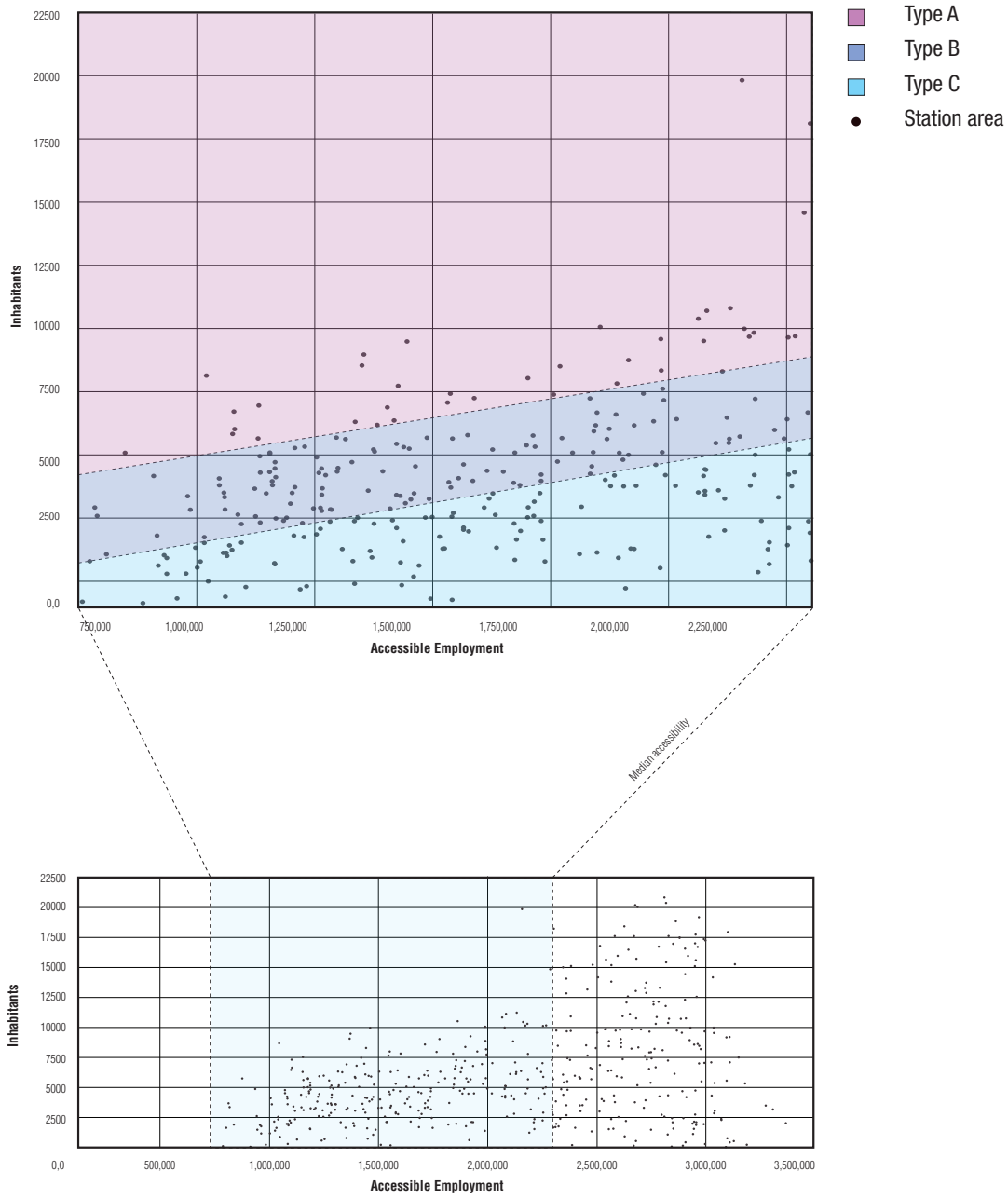


Figure 7.3 Categorization of station areas into target areas *source: Image by author*

Type A > High population density relative to access to employment

> Example:
Colindale
> Population:
9011 people
> Accessible Employment:
1,778,137 jobs

Type B > Medium density relative to accessible employement

> Example:
Enfield Lock
> Population:
5395 people
> Accessible Employment:
1,772,911 jobs

Type C > Low density relative to accessible employment

> Example:
Stanmore
> Population:
1886 people
> Accessible Employment:
1,818,710 jobs

Figure 7.4 Examples of target areas

source: overview by author
photos from Google Maps (2018)

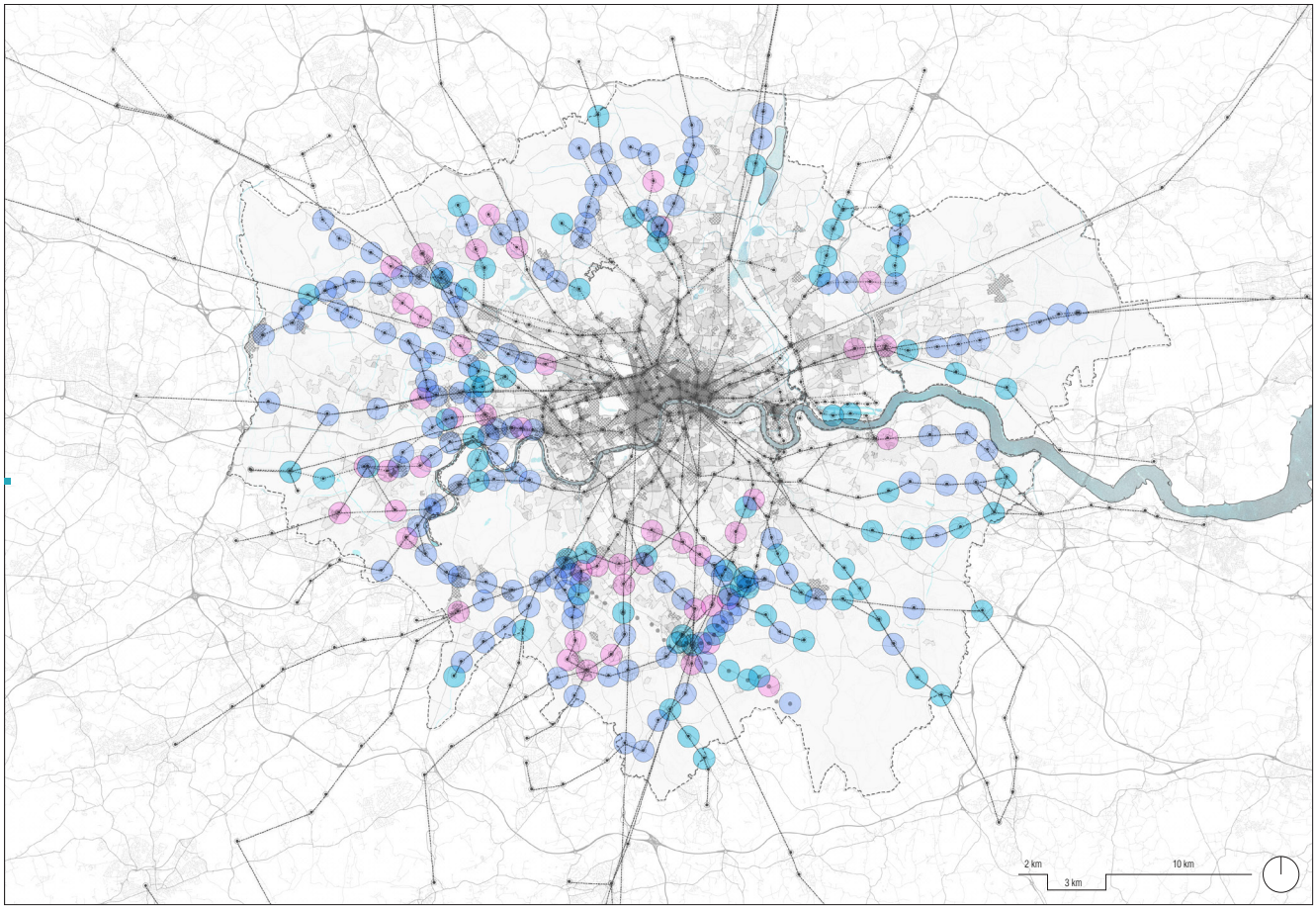


Figure 7.5 Distribution of target areas throughout Greater London *source: Image by author*

type A
type B
type C

7.4 Network potential

Network potential is examined through determining accessible population, accessible employment and relations to centralities and peripheries.

The second criteria being assessed quantitatively is the network potential of a station area examined through accessible population, accessible employment, and relations to centralities and peripheries.

Accessible population and employment

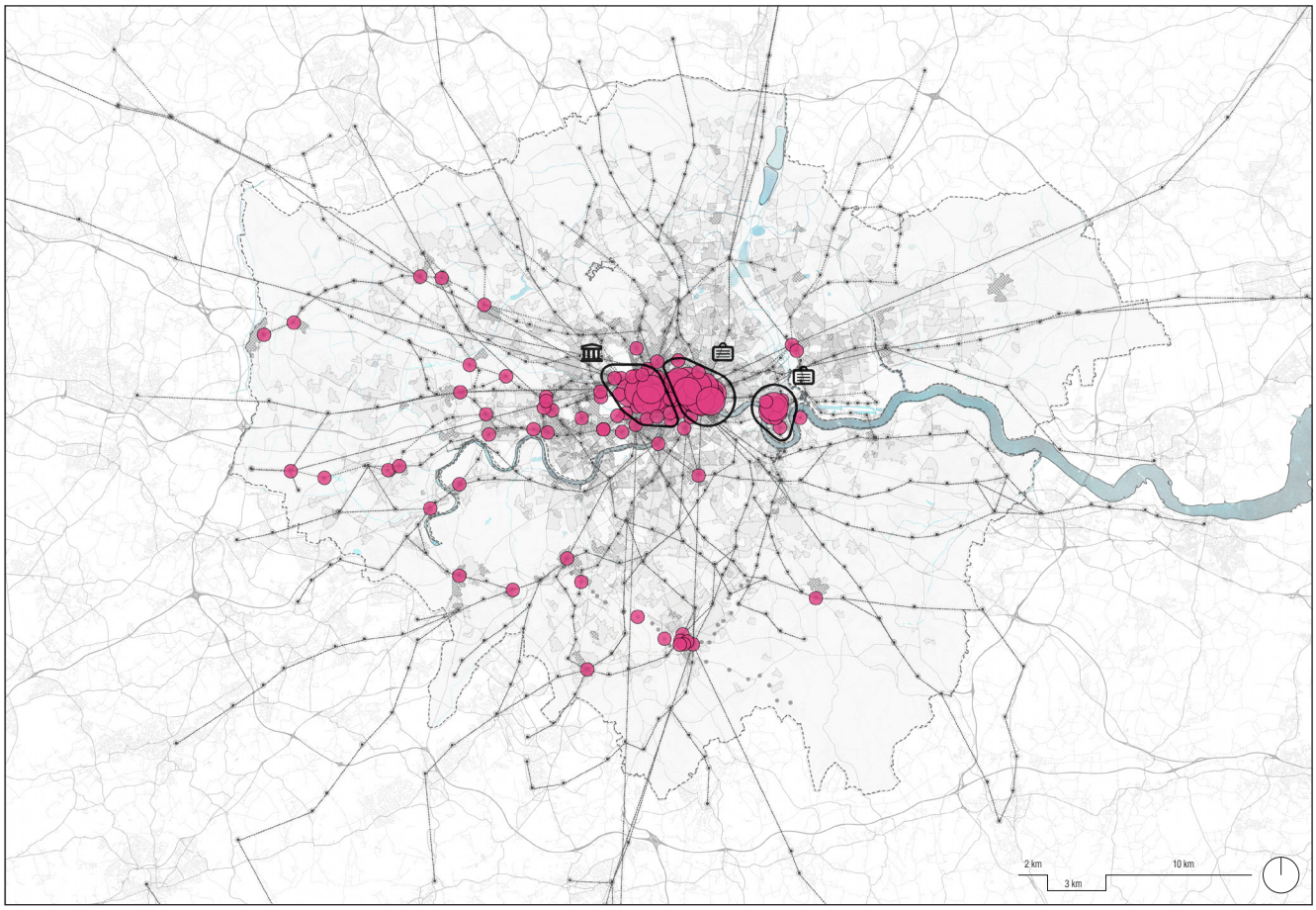
When regarding access to population and employment, willingness to travel is key. In order take this into account the method for assessing labour and employment markets introduced in the previous chapter are utilized. This takes into account not only the amount of people and jobs that can be reached from a node but also the time it takes to reach them and the associated willingness to travel.

Centrality-Periphery relations

Tier 1 centrality	> top 5 percentile rank for surplus employment
> Example: Bank **> Employment surplus:** 224179 jobs	
Tier 2 centrality	> top 20 percentile rank for surplus employment
> Example: King's Cross **> Employment surplus:** 23765 jobs	
Periphery	> bottom 80 percentile rank for surplus employment
> Examples: Leyton Holloway Road Sydenham Hill **> Employment surplus:** - 8315 - 8766 - 2846	

Figure 7.6 Categorization and examples of centralities and peripheries

source: overview by author photos from Google Maps (2018)



▪ Figure 7.7 Distribution of Centralities throughout Greater London *source: image by author*

In order to assess the number of centralities and peripheries a node has access to in a given time a similar method will be used to that for the accessibility impact. However of course, a different categorization method is used. The following formula by Burger & Meijers (2011) serves as the basis for the categorization proposed here:

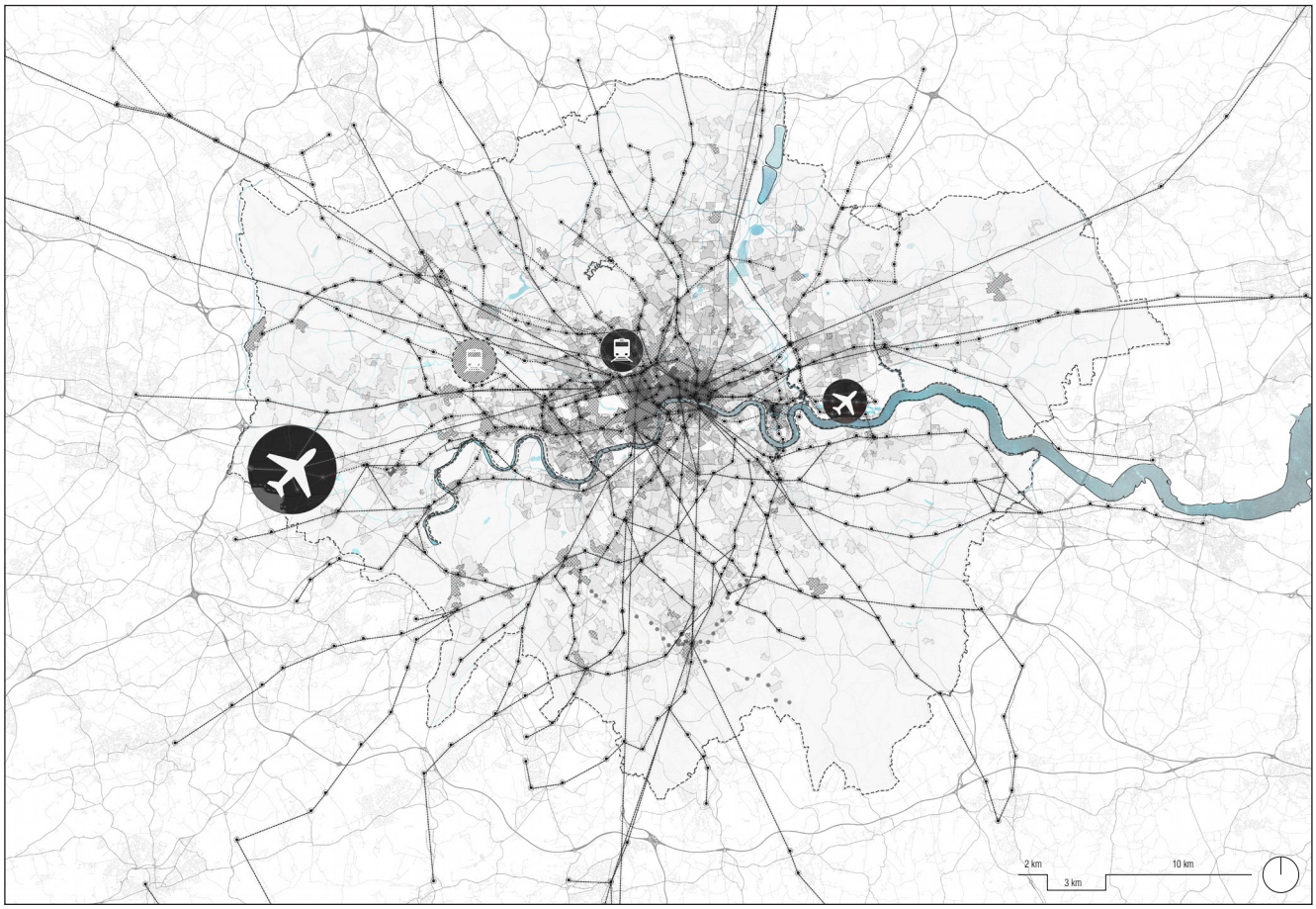
- Tier 1 centrality
- Tier 2 centrality
- Cluster
- Professional service focus
- Public service focus

$$Cc = Nc - Lc$$

Cc = Centrality Nc = Absolute importance based on incoming flows
Lc = Local importance based on internal flows

However, the categorization propsed here differs slightly in its variables. Given the complexity of flow data and the fact its latest iteration is almost a decade old, this assessment uses employment surplus as a measure of centrality. Based a station areas percentile rank in employment surplus three categories have been defined as seen in figure 7.6. These are again aggregated by the time in which they are accessible providing an overview of the relations for each node at a given time. While there is no set-in-stone minimum proportion for the number of peripheries to centralities to prevent a nod from being outcompeted, comparing relative amounts provides at least some sense of the risk of competition.

Centrality - Periphery relations are determined by comparing the access potential centralities have to other station areas categorized by their employment surplus into 1st and 2nd tier centralities and peripheries.



7.5 Local potentials

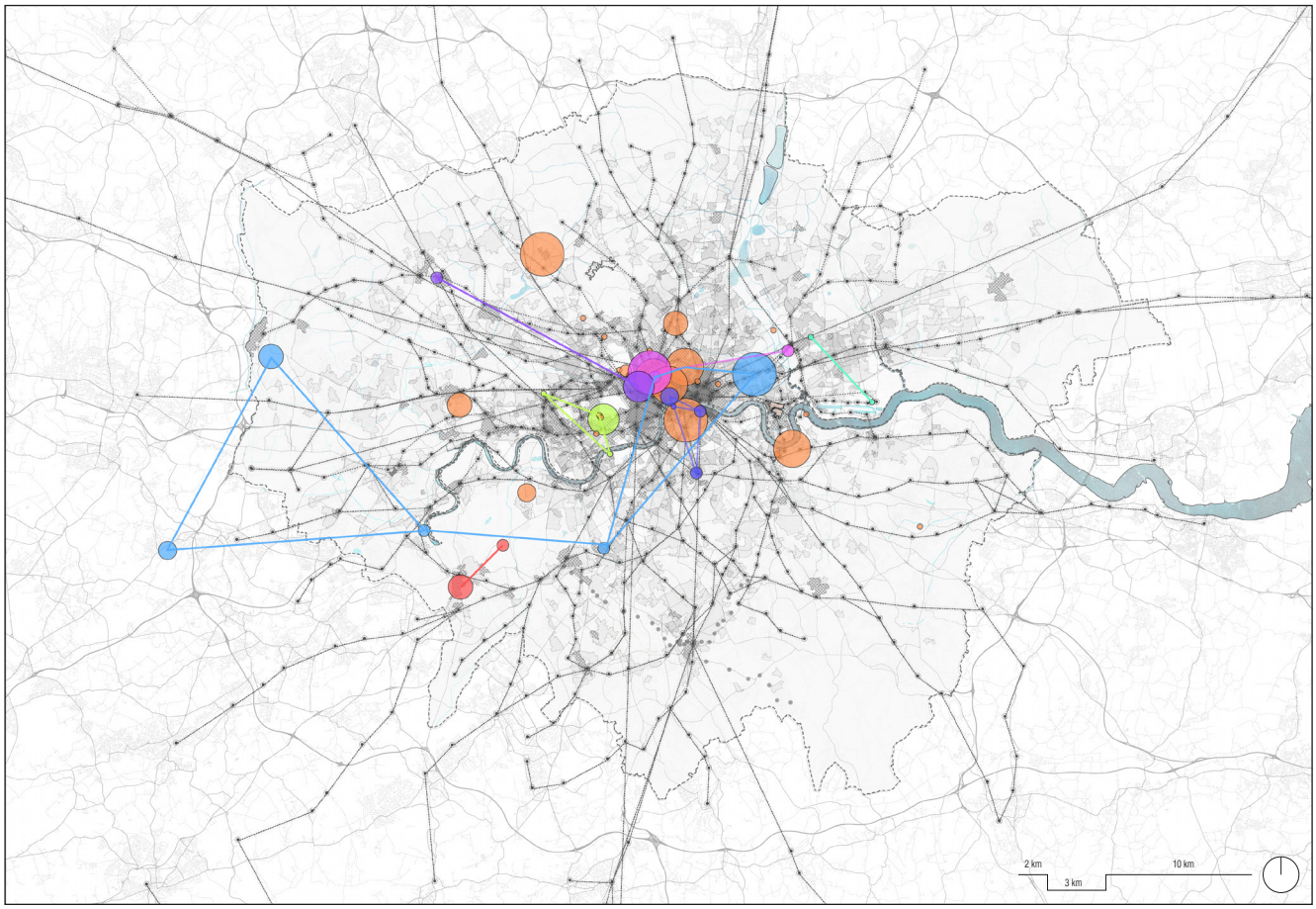
The examination of local potential is done via mapping. Figures 7.8, 7.9 and 7.10 give an overview of the region's (inter)national infrastructure hubs, universities and unique functions respectively. These locations are taken into account while devising the various options.

- Figure 7.8 (Inter)national infrastructure hubs
  - High speed rail station
  - Planned high speed rail station
  - Airport

- Figure 7.9 University locations
  - type A
  - type B
  - type C

- Figure 7.10 Unique functions
  - Music venues
  - Stadiums
  - Museums
  - Conference venues
  - Venue size
  - Clusters

source: images by author


2 km
3 km
10 km

2 km
3 km
10 km

7.6 Redevelopment potential

A macro assessment of redevelopment potential throughout the region is done based on a weighted aggregate score for a variety of variables.

As the majority of London already consists of built-up area, and expansion into the Green Belt is off the table, it is necessary to gain an understanding of where it will be harder or easier to develop. This is done on the basis of various indicators as seen in figure 7.12. These indicators are aggregated in a 100x100 grid overlaid on Greater London to make their various data types compatible. Subsequently they have been assigned different weights, some positive and some negative as indicated in the figure. These together lead to an overall redevelopment potential score as seen in figure 7.11. The lighter colours in this map indicate that development will be easier, black however does not mean that development is impossible.

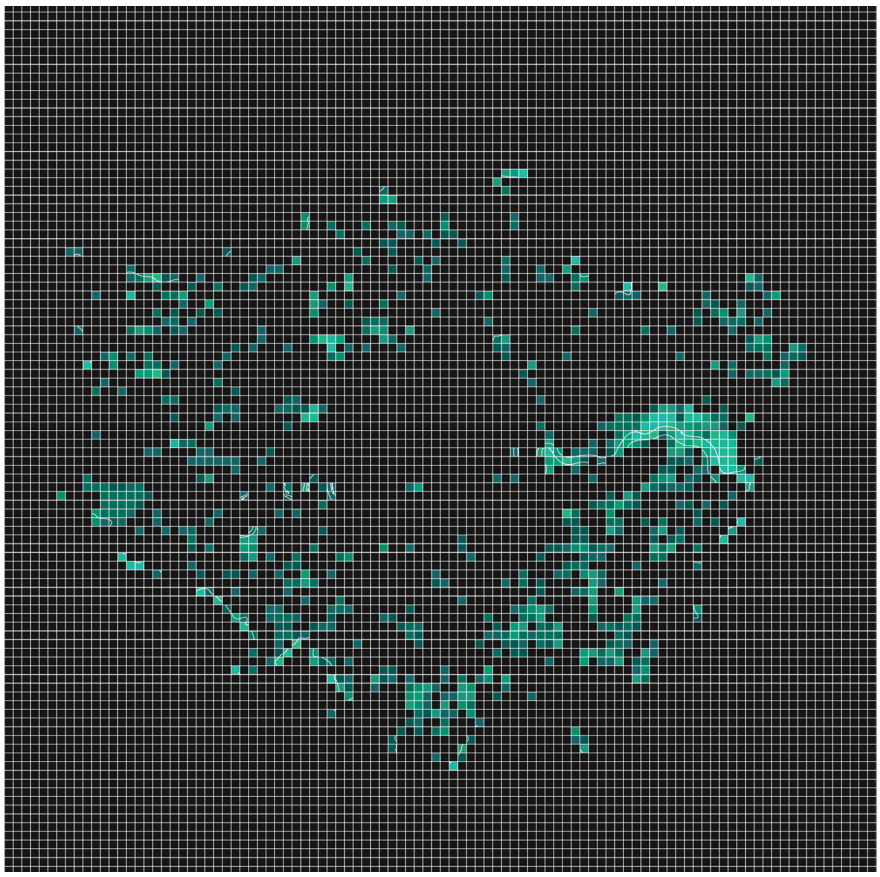
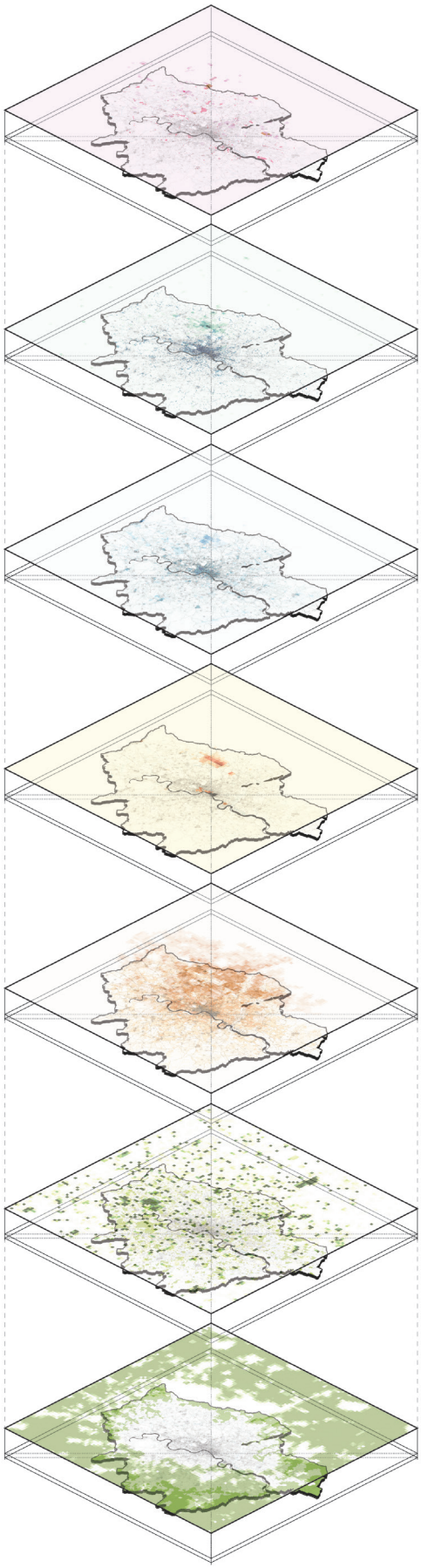


Figure 7.11 Estimation of redevelopment potential throughout Greater London *source: image by author*



Available land ⊕⊕
> indicator: brownfield surface
> data type: polygons

Heritage ⊖
> indicator: listed buildings
> data type: points

Declining Industries ⊕
> indicator: employment in affected sectors

Urban Intensity ⊕ ∨density∧ ⊖
> indicator: employment density
> data type: geolocated statistics

Urban Intensity ⊕ ∨density∧ ⊖
> indicator: population density
> data type: geolocated statistics

Parks & Recreation ⊖
> indicator: green space
> data type: polygons

Green Belt ⊖⊖
> indicator: green belt demarcations
> data type: polygons

source: based on data from Greater London Authority (2018a), OpenStreetMap (2018) and Ordnance Survey (2018)

▪ Figure 7.12 Variables used for estimating redevelopment potential

▪ Figure 7.13 Restrictions imposed by the Green Belt and Airports *source: image by author*

Restricted Areas

Airport obstacle boundaries

Airspace obstacle restrictions

As the development of a new centrality will likely comprise at least several tall buildings London's airspace restriction need to be accounted for. Figure 7.13. shows these constraints along with those of the Green Belt. The lines around London City Airport indicate the space in which consultation is needed if indicated heights are exceeded (Aerodrome Standards Department and Authority, 2004). The circle around Heathrow Airport indicates its own safeguarded area, however its precise restrictions are not public. Nonetheless, given the larger size of aircraft and more frequent flight movements it can be expected that they are significantly more strict than those of London City Airport.

source: image by author

7.7 Step 1: Generation of preliminary variants

Four preliminary variants are generated, all comprising an added tangent to the railway system, fundamentally altering its radial structure.

As the first step to the evaluation carried out in this chapter four preliminary variants are generated. As seen in figure 7.14 each of these variants comprises a new tangent that's added to London's railway system. This way each variants signifies a distinct departure from the radial transit pattern that has facilitated London's mono-centric development and is further advocated in the New London Plan. Instead of better connecting station areas with Central London, these tangents aim to better connect the station areas in different with one another. This is assumed to do more for their network position without significantly increasing risk of being outcompeted by Central London.

The four variants aim to connect stations with relatively good accessibility, and situate lines near favourable local conditions and redevelopment potential.

The four preliminary variants presented here aim to connect stations throughout the various radial lines that already have reasonably good access to population and employment so they can further profit from each other's strong positions. In addition, attention is paid to the situate them near favourable local conditions and redevelopment potential as discussed in the previous sections.

One might have noted that none of the options features extensive new linkages in South London. This is due to two main reasons. First is the fragmented nature of public transport operation in the south where a variety of companies provide services in addition to those of TfL which would make implementation significantly more complex. Secondly, the subsurface, consisting mostly of Lambeth and Thanet Sands as opposed to the clay north of the Thames, is less suitable for deep (May, 2017) tunnelling. Based on the considerations discussed above, the four preliminary variants chosen are as follows:

Variant 1

This variant features are north-south tangent crossing the east bounds of London City Airport. Not only could the airport provide a significant catalyst for development, the new line also crosses the Thames which could provide a valuable waterfront location.

Variant 2

This variant features a north-south tangent in the western part of Greater London, linking Wembley and Wimbledon. Again, the Thames could provide a valuable waterfront location especially as the macro level redevelopment potential seems to indicate ample room for development along its banks.

Variant 3

Variant three features a tangent emanating from Wembley, linking Wembley Central and Wembley Park and emanating to the south and north-east respectively. In between Wembley Central and Wembley Park lies the Wembley sports and entertainment cluster which could provide a significant anchor for future development.

Figure 7.14 Preliminary variants that will be evaluated *source: image by author*

Variant 4

This fourth and final variant features an east-west tangent emanating from Totteham Hale. This is another location where a major soccer station could provide an effective anchor for development.

Variant 1
Variant 2
Variant 3
Variant 4

7.8 Step 2: Selection of potential centralities

Each of the four new lines proposed comprises a number of different station areas. In order to identify which of these warrant further investigation into their potential to become a new centrality their network potential is evaluated. Figure 7.15. shows the various affected station areas and highlights the ones selected.

For these four variants the most fit stations are selected.

Each of the preliminary variants of course comprises many different station areas. As a first step as sub-selection is made based on their network position characteristics seen in the figure 7.15. Figure 7.16 provides an overview of these station areas including a macro view of redevelopment potential and local characteristics. Based on this the centrality chosen to investigate variant one is Woolwich Arsenal. Variant 2 will focus on Turnham Green as both Wembley Central and Wembley Park act perform better in Variant 3, which due to their proximity looks at these two together. Variant four will focus on Tottenham Hale having more favourable local conditions such as the Tottenham Hotspur stadium. It must however be noted that variant four seems to lack serious impact on accessibility.

Variant	Station	Target Areas						Labour Market	Employment Market	Centralities		Peripheries	Centralities		Peripheries
		Type A - 15	Type B - 15	Type C - 15	Type A - 35	Type B - 35	Type C - 35			1st tier - 15 mins	2nd tier - 15 mins	15 mins	1st tier - 35 mins	2nd tier - 35 mins	35 mins
1	Gallions Reach	4	3	7	8	29	37	1911844.303	2701722.765	4	9	49	23	52	180
1	Woolwich Arsenal	2	17	23	11	47	61	1815659.625	2582398.854	3	7	61	23	49	179
2B	Turnham Green	4	16	8	23	77	27	1754536.047	2361248.363	0	11	22	12	58	146
2B	Wembley Central	8	12	7	15	63	27	1882580.161	2632160.98	0	5	26	17	58	145
2B	Wembley Park	8	14	8	15	64	33	1838299.664	2591241.228	0	4	33	18	62	151
3	Wembley Central	5	15	9	17	70	24	1898885.869	2623900.074	0	7	27	17	55	155
3	Wembley Park	6	18	8	16	72	32	1865818.159	2591622.572	0	5	35	18	59	163
4	Tottenham Hale	0	8	4	4	37	29	1856486.61	2685442.264	1	3	23	20	46	148

Figure 7.15 Network characteristics for each station in the four preliminary variants *source: image by author*

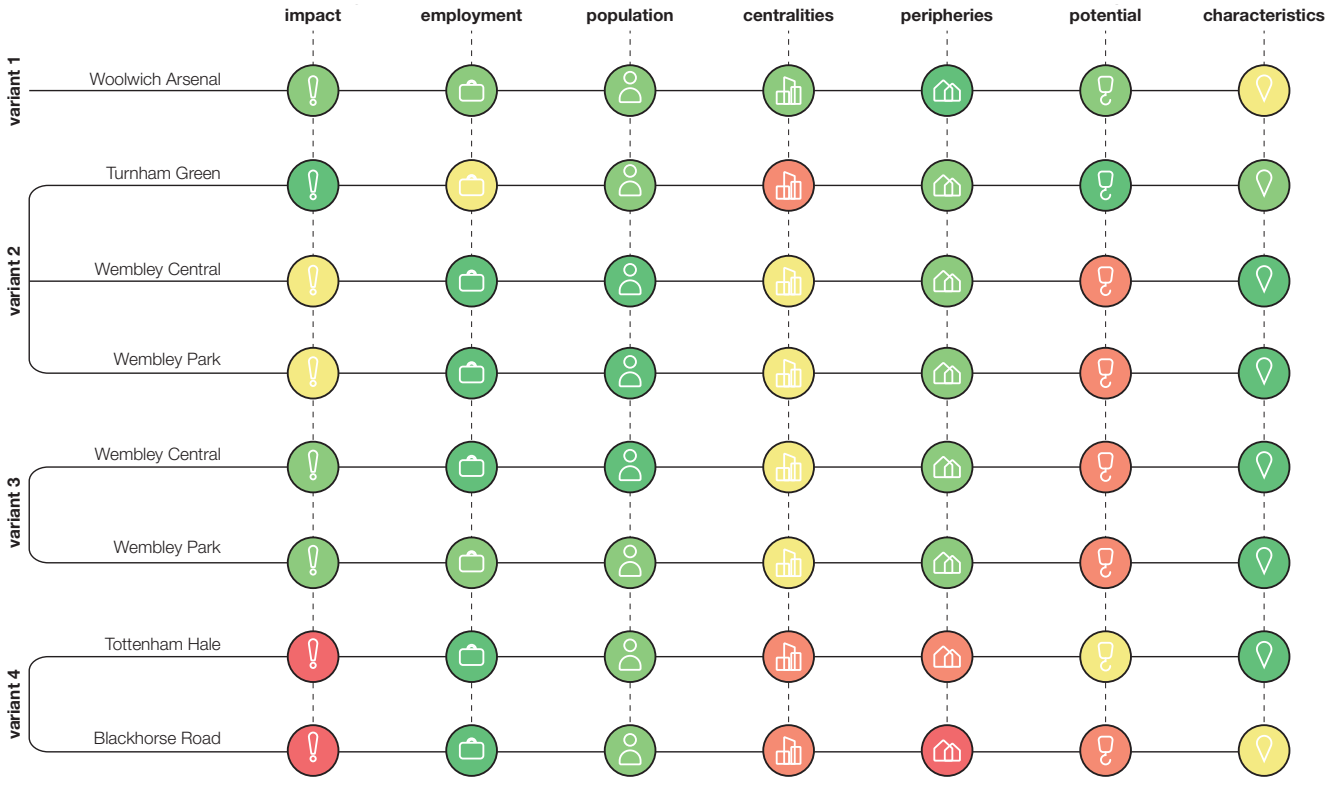


Figure 7.16 Overview of properties for a sub-selection of station areas *source: image by author*

7.9 Step 3: Optimization of transit system around selected centralities

96 Unique configurations have been assessed on a trial-and-error basis to create optimal network conditions around the selected stations, reduce the length of additional lines and locating them near places with high redevelopment potential.

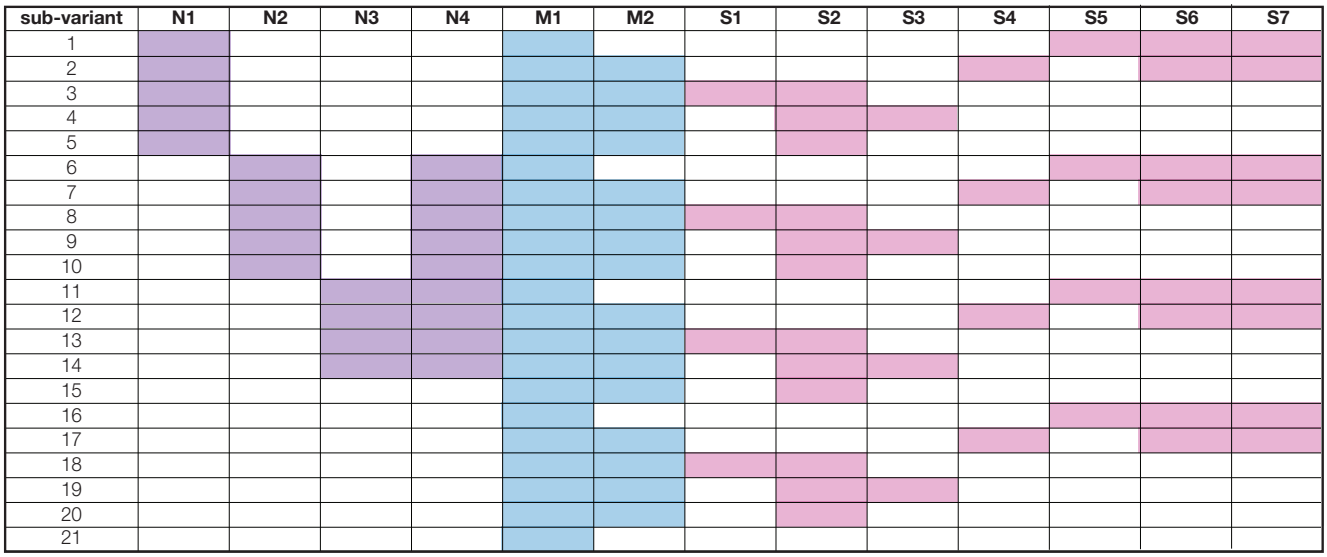
Having identified the locations to be investigated further, the next step is to optimize the configuration of transit links supporting them. During this optimization 96 unique configurations have been assessed on a trial-and-error basis. The first aim in this process is improving network potential by maximizing accessibility impact, accessible population, accessible employment while providing enough access to peripheries to offset that to centralities. Secondly it is seeking to locate “feeding” lines along areas with high redevelopment potential, providing the potential revenue needed for funding said interventions. Finally, the amount of new connections is minimized, in respect to the aforementioned factors, in order reduce the total investment necessary. The following pages give an overview of the assessed configurations and their respective network potential, followed by the selection of a single variant whose network characteristics are shown in greater detail.

Source: image by author

Variant 1 – Woolwich Arsenal

For Woolwich Arsenal sub-variant 3 is selected.

Based on the outcomes of the network analysis sub-variant 3 is selected. While it lags slightly behind sub-variants 7 to 15 in terms of all-around performance it needs a lot less new rail, giving it the best balance between performance and feasibility.



▪ Figure 7.17 Evaluated configurations *source: image by author*

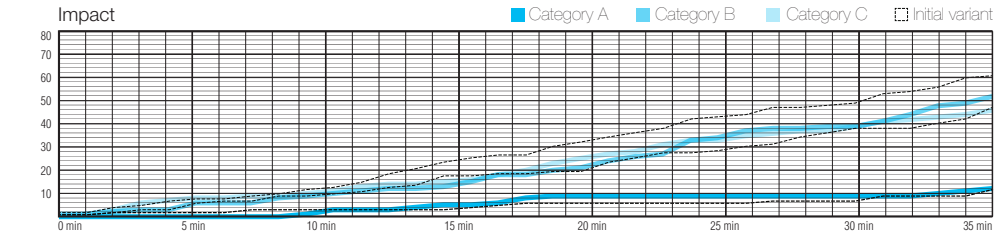
sub-variants	target areas						accessible employment	accessible employment	centralities		peripheries	centralities		peripheries
	type A 15 mins	type B 15 mins	type C 15 mins	type A 35 mins	type B 35 mins	type C 35 mins			1st tier 15 mins	2nd tier 15 mins	15 mins	1st tier 35 mins	2nd tier 35 mins	35 mins
1	1	14	19	8	38	48	1707649	2501225	4	2	57	25	28	164
2	1	14	20	8	38	48	1710881	2545711	4	2	56	25	28	164
3	1	14	17	9	44	51	1735133	2554590	4	3	60	25	28	171
4	1	14	19	8	36	46	1702317	2540600	4	3	59	25	28	160
5	1	14	17	8	36	46	1701653	2540397	4	3	57	25	28	160
6	1	14	19	8	38	48	1707635	2501210	4	2	56	25	28	164
7	2	16	22	8	38	50	1748379	2537451	4	2	64	25	28	171
8	2	16	19	9	44	52	1772631	2546331	4	2	64	25	28	178
9	2	16	21	8	36	48	1739816	2532341	4	2	63	25	28	167
10	2	16	19	8	36	48	1739152	2532137	4	2	61	25	28	167
11	1	14	19	8	38	48	1707635	2501210	4	2	56	25	28	164
12	2	15	21	8	38	50	1746751	2536785	4	2	62	25	28	171
13	2	15	18	9	44	52	1771003	2545665	4	2	62	25	28	178
14	2	15	20	8	36	48	1738188	2531674	4	2	61	25	28	167
15	2	15	17	8	36	48	1737413	2531411	4	2	58	25	28	167
16	1	14	19	8	38	48	1707635	2501210	4	2	56	25	28	164
17	1	14	20	8	38	48	1711044	2522945	4	2	59	25	28	164
18	1	14	17	9	44	51	1735296	2531824	4	2	59	25	28	171
19	1	14	16	8	36	46	1701506	2517521	4	2	55	25	28	160
20	1	14	15	8	36	46	1698399	2495162	4	2	52	25	28	160
21	1	14	16	8	36	46	1701506	2517521	4	2	55	25	28	160

▪ Figure 7.18 Woolwich Arsenal's network characteristics for the evaluated configurations *source: image by author*

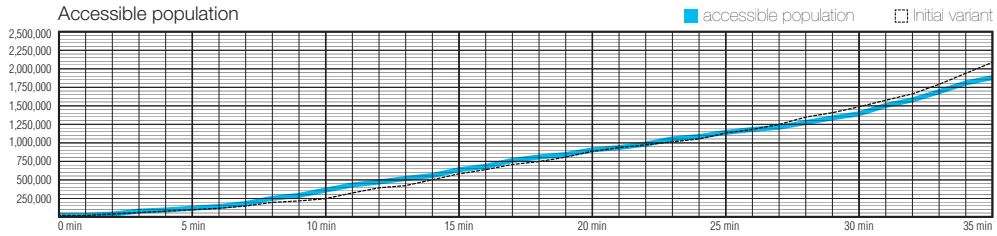
▪ Figure 7.19 Overview of evaluated configurations *source: image by author*

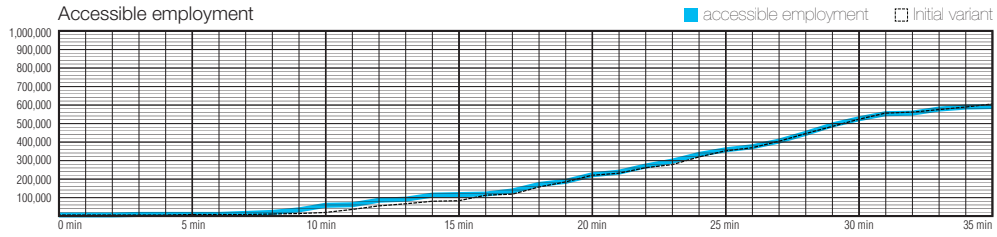
▪ Figure 7.20 Selected configuration supporting Woolwich Arsenal for variant 1 *source: image by author*

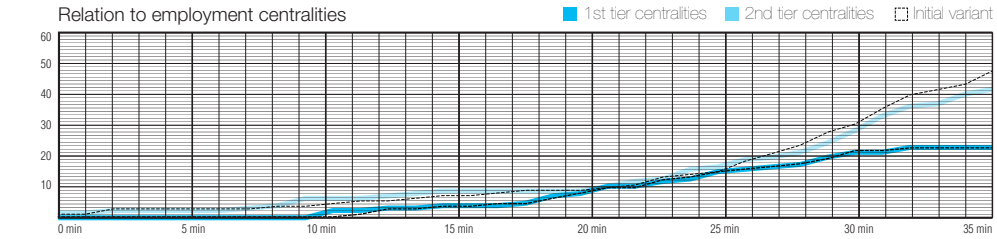
Impact



Network Position







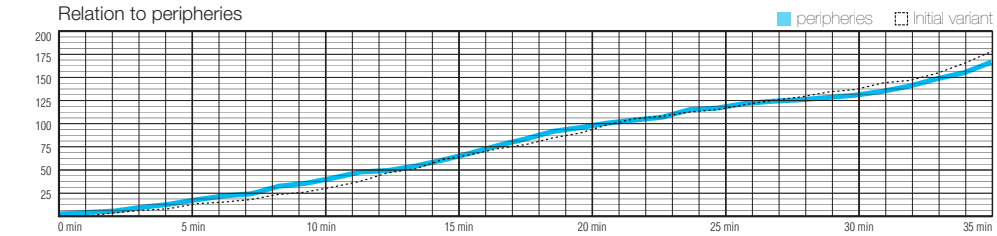
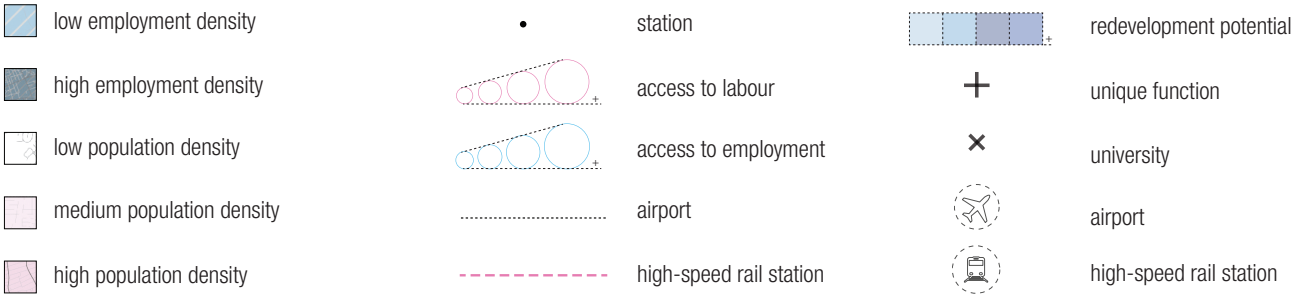


Figure 7.21 Accessibility per minute

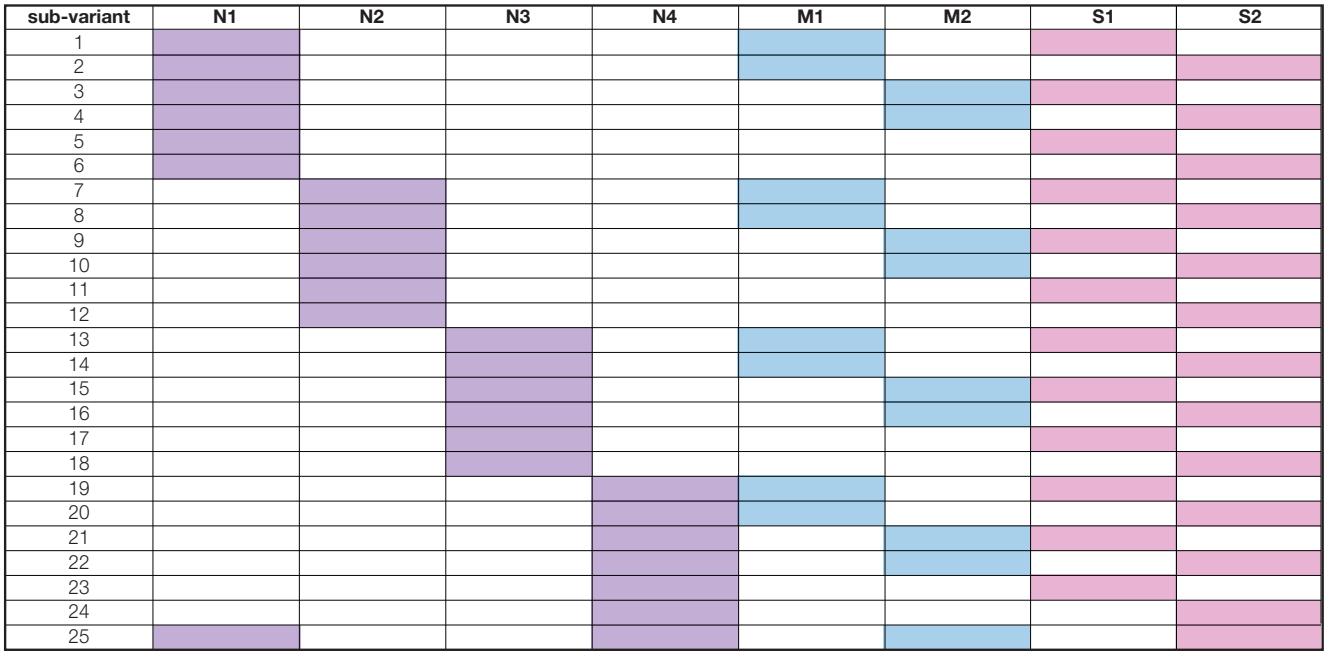
source: image by author



Variant 2 – Turnham Green

For Woolwich Arsenal sub-variant 25 is selected.

Based on the performance of the various sub-variants, the decision was made to add an additional version combining both link N1 and N4. This sub-variant, nr. 25, scores very well on most performance criteria while requiring relatively limited new links. However, as it uses extensive stretches of existing rail, their capacity is likely to need upgrading in order to run continuous trains.



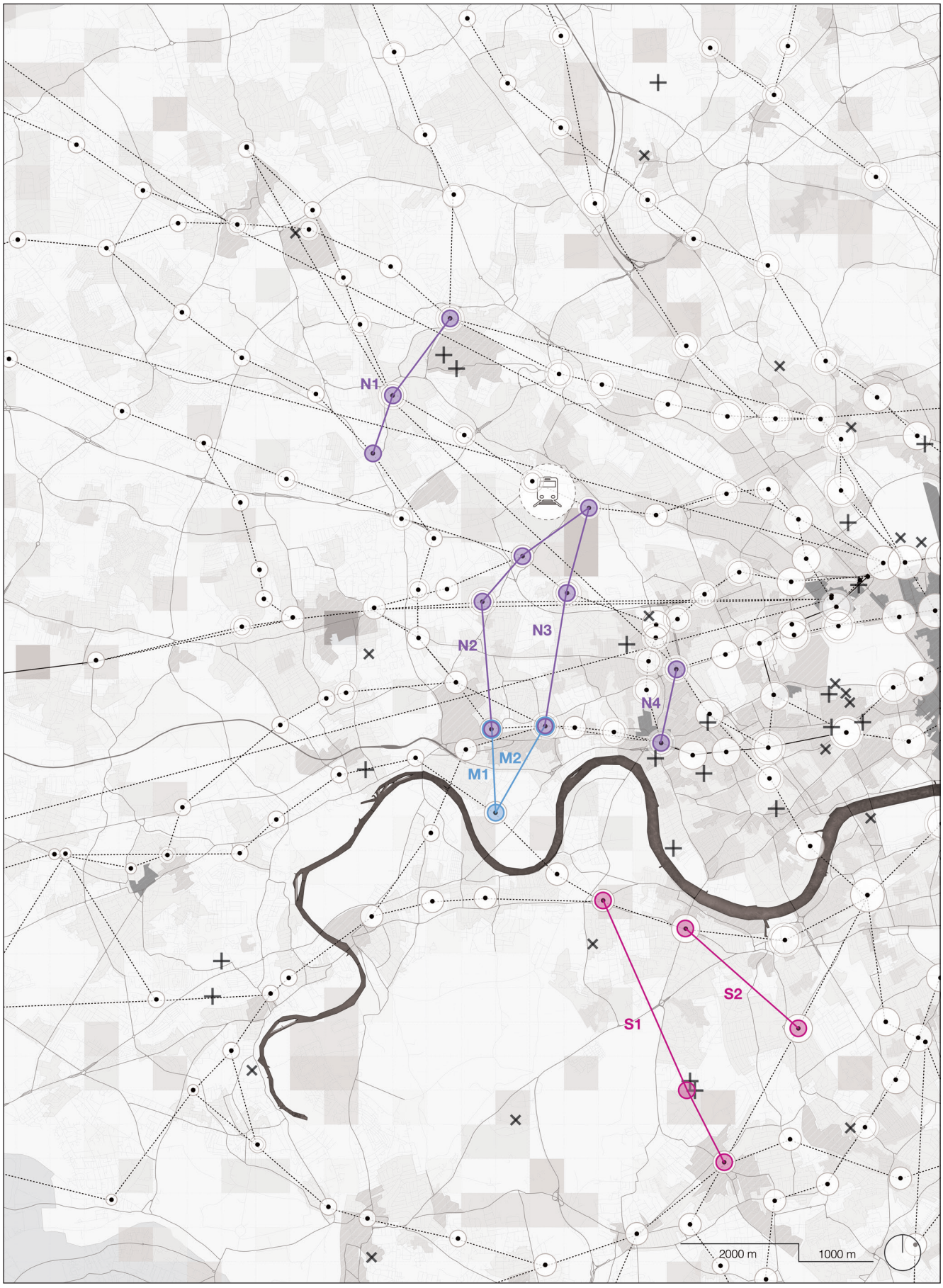
▪ Figure 7.24 Evaluated configurations

source: image by author

sub-variants	target areas						accessible employment	accessible employment	centralities		peripheries	centralities		peripheries
	type A 15 mins	type B 15 mins	type C 15 mins	type A 35 mins	type B 35 mins	type C 35 mins			1st tier 15 mins	2nd tier 15 mins	15 mins	1st tier 35 mins	2nd tier 35 mins	35 mins
1	4	12	6	18	64	24	1661605	2322018	0	1	27	13	26	153
2	4	15	7	20	74	25	1714929	2346061	0	1	31	13	26	169
3	4	15	7	20	74	25	1714929	2346061	0	1	31	13	26	169
4	4	15	7	18	69	24	1689611	2335724	0	1	31	13	26	160
5	4	11	6	18	58	22	1635768	2306082	0	1	26	13	26	144
6	4	11	6	18	57	22	1631196	2301279	0	1	26	13	26	143
7	4	13	6	14	62	19	1591277	2293586	0	1	28	13	26	137
8	4	13	6	14	57	17	1576283	2282870	0	1	28	13	26	129
9	4	16	7	16	72	20	1644601	2317628	0	1	32	13	26	153
10	4	16	7	14	67	19	1619284	2307292	0	1	32	13	26	144
11	4	12	6	14	55	17	1560868	2272847	0	1	27	13	26	127
12	4	12	6	14	55	17	1565440	2277650	0	1	27	13	26	128
13	5	15	8	15	62	20	1627963	2272609	0	1	34	13	26	141
14	5	15	8	15	57	18	1612969	2261894	0	1	34	13	26	133
15	5	18	9	17	72	21	1681287	2296652	0	1	38	13	26	157
16	5	18	9	15	67	20	1655969	2286315	0	1	38	13	26	148
17	5	14	8	15	55	18	1597554	2251870	0	1	33	13	26	131
18	5	14	8	15	55	18	1597554	2251870	0	1	33	13	26	131
19	4	12	6	14	54	19	1574282	2397703	0	1	29	15	26	132
20	4	12	6	14	49	17	1561157	2387475	0	1	29	15	26	124
21	4	15	7	16	64	20	1615119	2418493	0	1	33	15	26	146
22	4	15	7	14	59	19	1589801	2408157	0	1	33	15	26	137
23	4	11	6	14	48	17	1552551	2382936	0	1	28	15	26	123
24	4	11	6	14	47	17	1548649	2379223	0	1	28	15	26	122
25	4	15	8	18	69	24	1695844	2450490	0	1	34	15	26	160

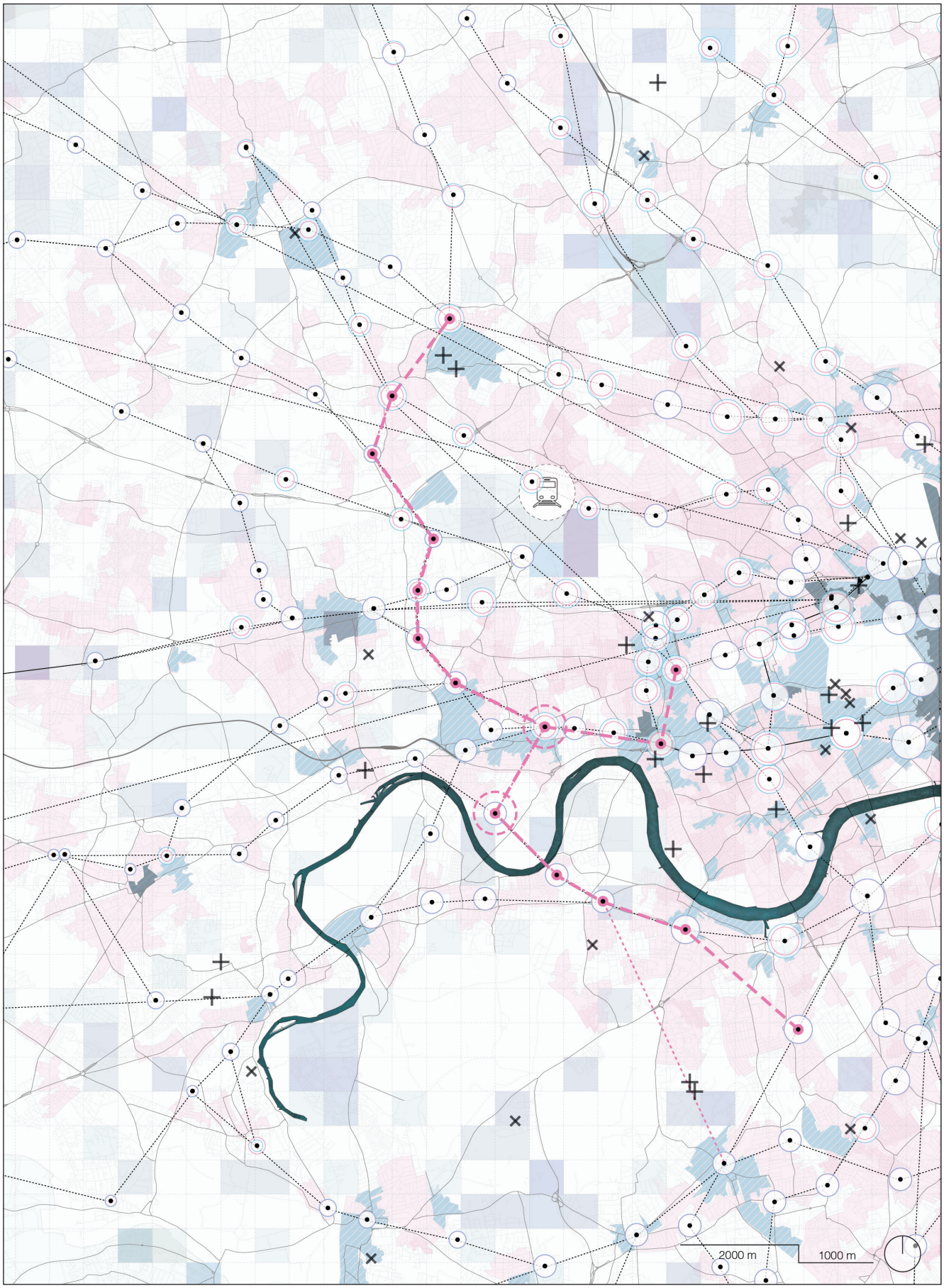
▪ Figure 7.25 Woolwich Arsenal's network characteristics for the evaluated configurations

source: image by author



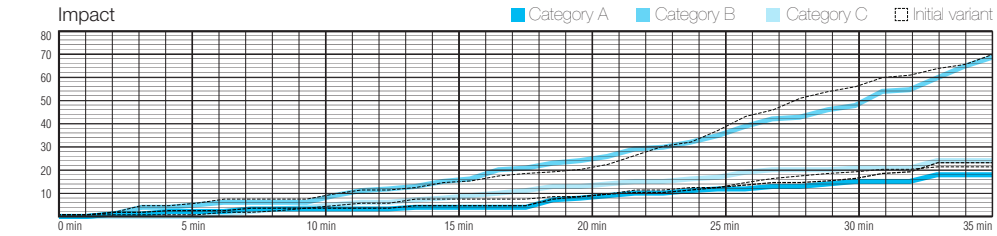
▪ Figure 7.26 Overview of evaluated configurations

source: image by author

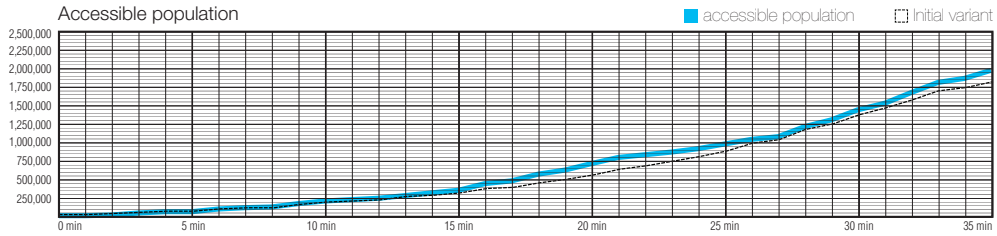


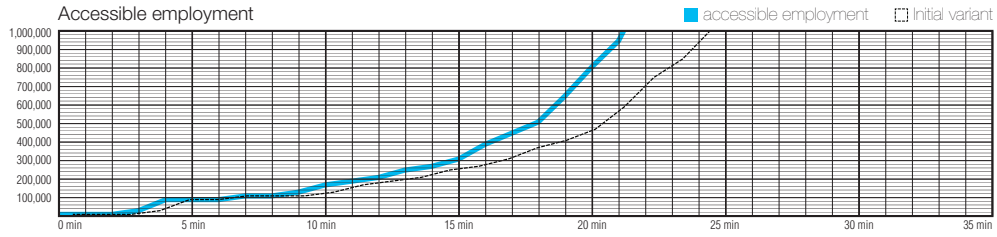
▪ Figure 7.30 Selected configuration supporting Woolwich Arsenal for variant 1 *source: image by author*

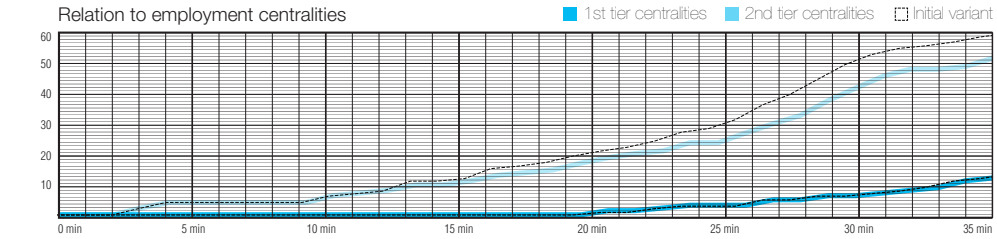
Impact



Network Position







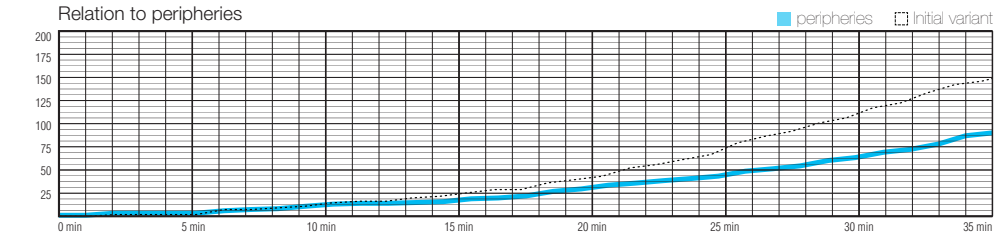


Figure 7.31 Accessibility per minute

low employment density
high employment density
low population density
medium population density
high population density

station
access to labour
access to employment
airport
high-speed rail station

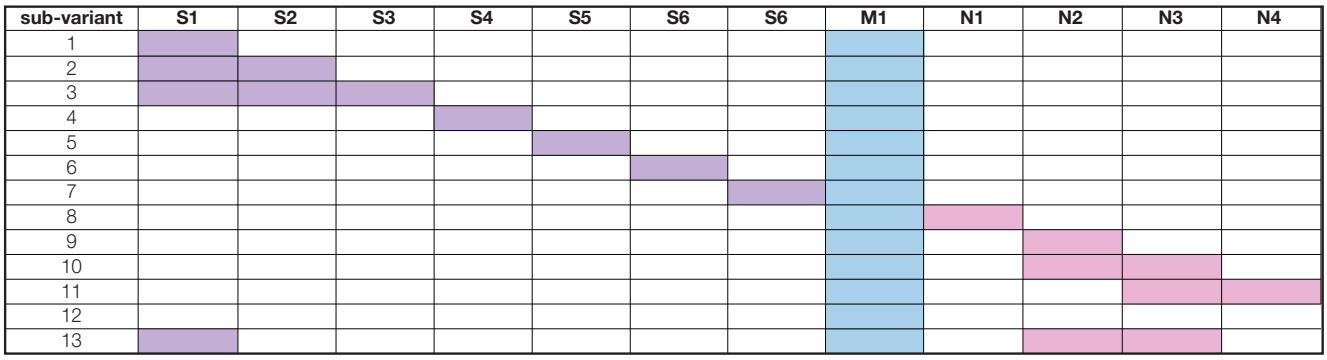
redevelopment potential
unique function
university
airport
high-speed rail station

Variant 3 – Wembley Park / Central

For Wembley sub-variant 13 is selected.

Due to the large number of possible combinations of links in this variant, a slightly different approach is taken. Each possible link is evaluated on its own after which the most promising are combined in a single sub-variant, nr. 13. This variant, performs well on all accounts while requiring a very limited set of new links.

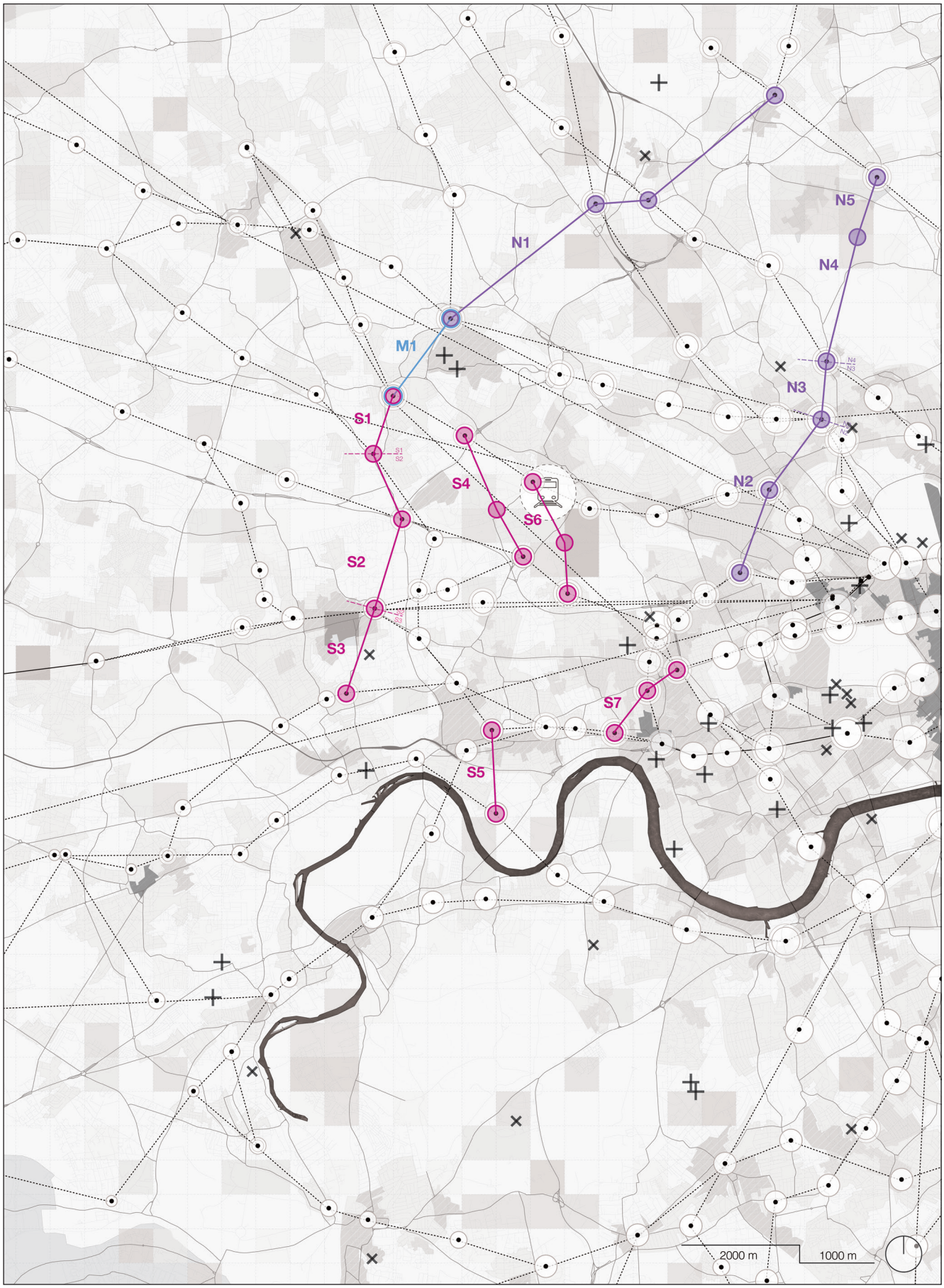
The links N2 and N3 selected for this variant are in themselves also evocative of the insights gained using network analysis as they don't feed directly into Wembley but rather into other stations that have good access to it.



▪ Figure 7.34 Evaluated configurations *source: image by author*

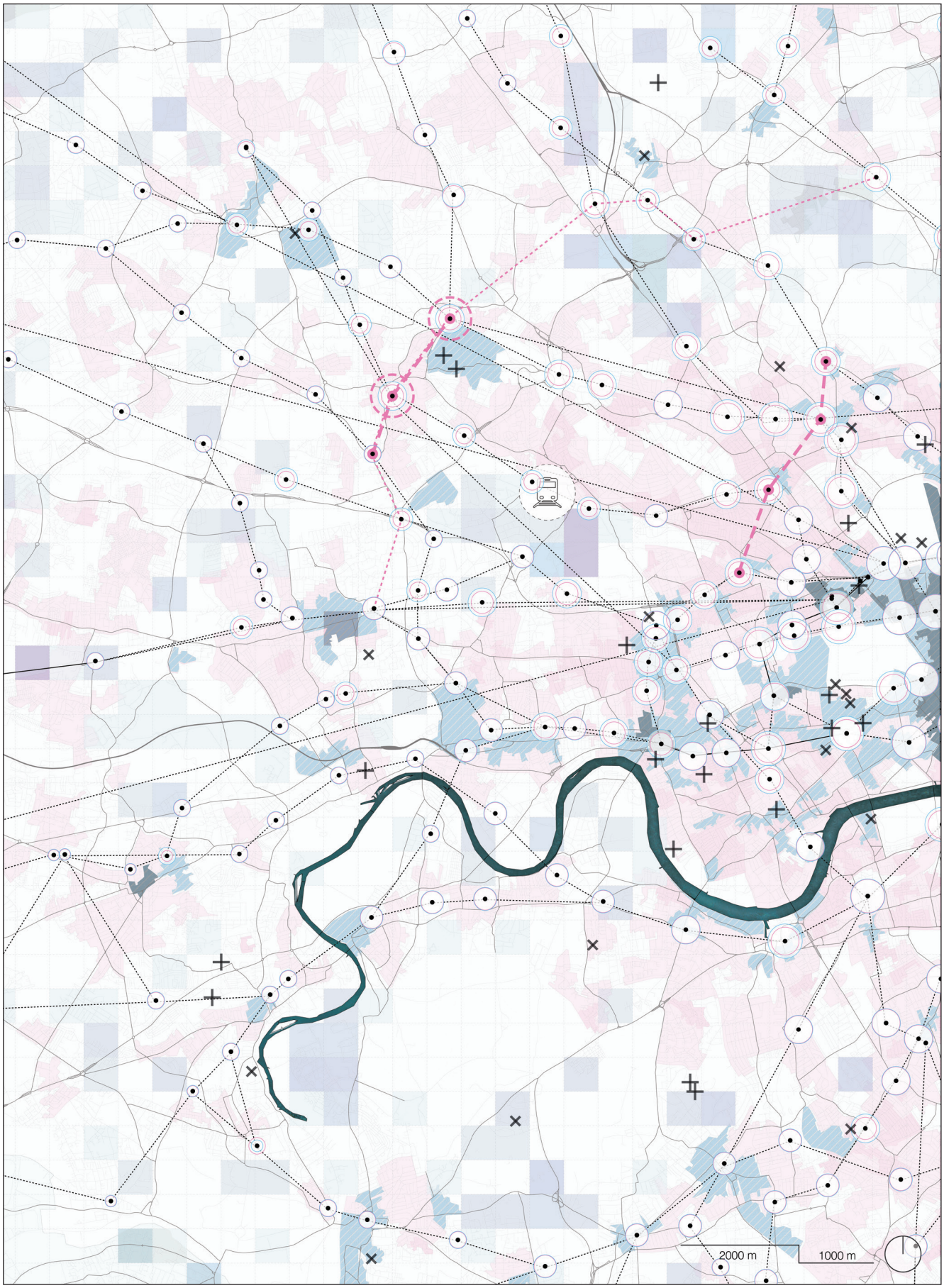
sub-variants	target areas						accessible employment	accessible employment	centralities		peripheries	centralities		peripheries
	type A 15 mins	type B 15 mins	type C 15 mins	type A 35 mins	type B 35 mins	type C 35 mins			1st tier 15 mins	2nd tier 15 mins	15 mins	1st tier 35 mins	2nd tier 35 mins	35 mins
1	7	15	7	12	55	22	1769804	2587071	0	1	23	18	30	139
2	8	18	10	15	63	24	1872828	2638533	0	1	40	18	30	171
3	8	19	11	15	63	25	1873944	2640002	0	1	42	18	30	172
4	3	8	6	10	52	18	1757937	2527587	0	1	21	18	29	149
5	3	8	5	8	40	17	1716059	2500726	0	1	20	18	29	134
6	8	18	10	15	63	24	1735624	2513945	0	1	21	18	29	140
7	3	8	5	9	44	18	1748025	2526897	0	1	20	18	29	140
8	3	10	6	10	47	18	1759666	2521876	0	1	23	18	29	144
9	3	8	5	8	42	18	1734183	2509040	0	1	20	18	29	137
10	3	8	5	8	42	18	1744711	2529265	0	1	20	18	29	137
11	3	8	5	8	41	18	1720490	2503501	0	1	20	18	29	135
12	3	8	5	8	40	17	1716027	2500719	0	1	20	18	29	134
13	8	13	7	15	59	23	1862932	2628827	0	1	32	18	30	165

▪ Figure 7.35 Wembley Central's network characteristics for the evaluated configurations *source: image by author*



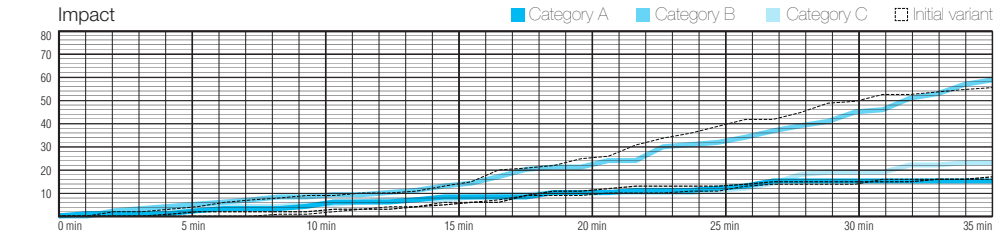
▪ Figure 7.36 Overview of evaluated configurations

source: image by author

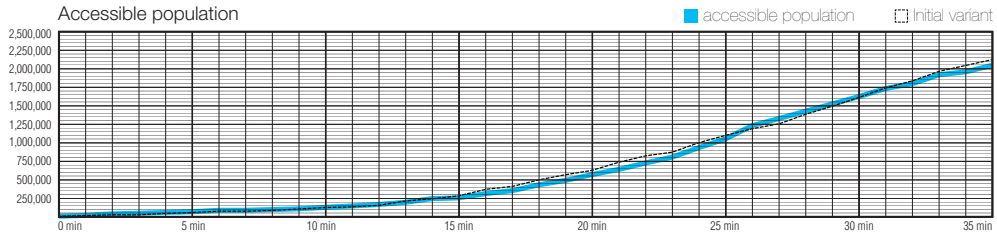


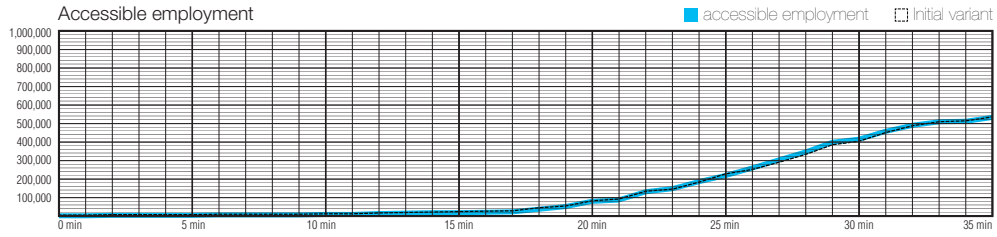
▪ Figure 7.37 Selected configuration supporting Wembley Central for variant 3 *source: image by author*

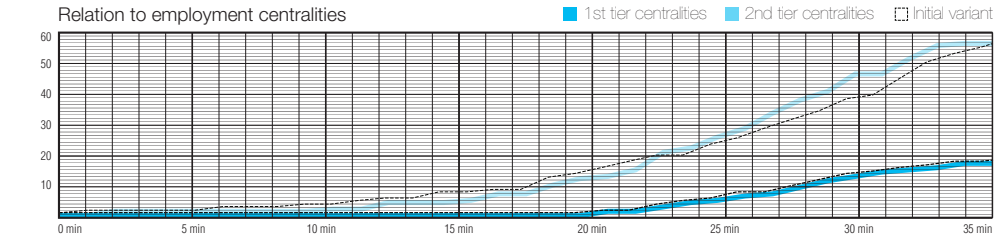
Impact



Network Position







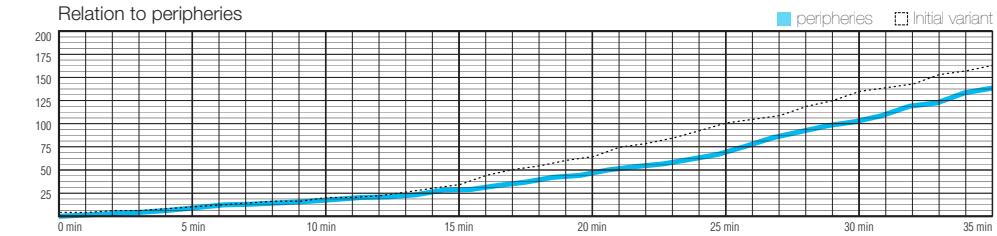
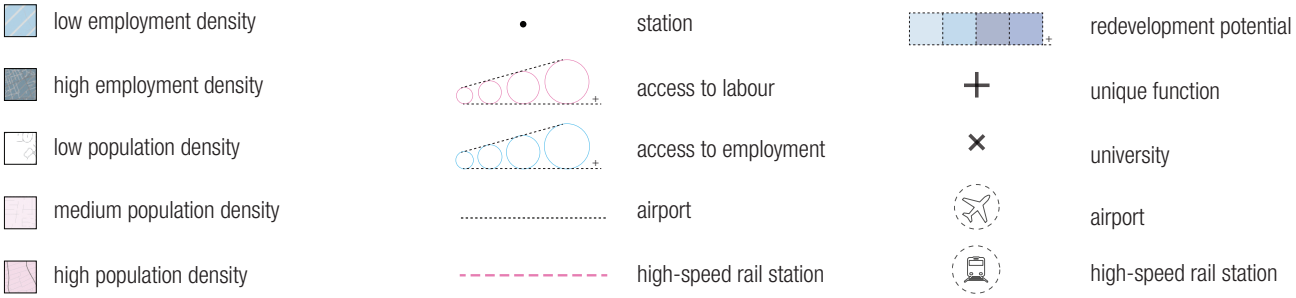


Figure 7.38 Accessibility per minute

source: image by author



Variant 4 - Tottenham Hale

For Tottenham Hale sub-variant nr. 4 is selected. However, it still performs very poorly in terms of accessibility impact.

For variant four, sub-variant nr. 4 has been selected. The main reason being that it offers the highest impact on accessibility of all evaluated sub-variants, which mentioned is one of variant four's main shortcomings. However, even after selection of this variant it still performs considerably worse in this department than the others.

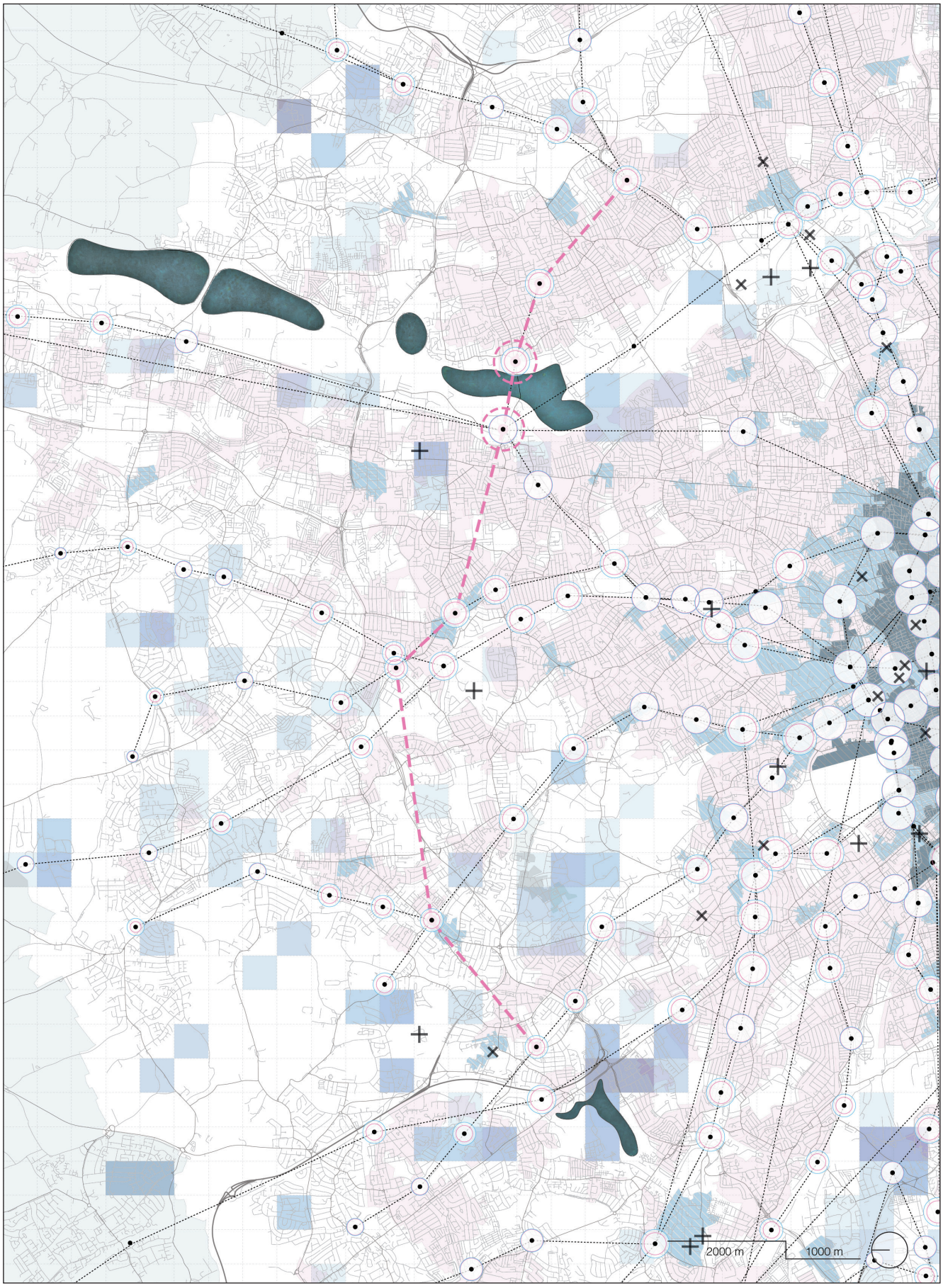
sub-variant	W1	W2	W3	W4	M1	E1	E2
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

▪ Figure 7.39 Evaluated configurations *source: image by author*

sub-variants	target areas						accessible employment	accessible employment	centralities		peripheries	centralities		peripheries
	type A 15 mins	type B 15 mins	type C 15 mins	type A 35 mins	type B 35 mins	type C 35 mins			1st tier 15 mins	2nd tier 15 mins	15 mins	1st tier 35 mins	2nd tier 35 mins	35 mins
1	0	7	3	4	36	31	1861352	2710231	1	3	22	23	30	166
2	0	7	3	4	35	29	1844567	2680188	1	3	22	22	30	161
3	0	6	3	3	30	23	1791964	2663843	1	3	21	22	30	146
4	0	7	3	5	38	32	1859297	2708710	1	3	22	23	30	166
5	0	7	3	4	35	29	1842512	2678667	1	3	22	22	30	161
6	0	6	3	3	30	23	1789909	2662322	1	3	21	22	30	146
7	0	8	4	4	38	31	1875251	2716014	1	3	24	23	30	168
8	0	8	4	4	37	29	1858466	2685971	1	3	24	22	30	163
9	0	7	4	3	32	23	1805863	2669627	1	3	24	23	30	168
10	0	6	3	3	30	23	1861352	2710231	1	3	22	23	30	166
11	0	7	3	4	35	29	1844567	2680188	1	3	22	22	30	161
12	0	6	3	3	34	25	1791964	2663843	1	3	21	22	30	146
13	0	7	3	4	33	30	1849777	2703844	1	3	22	23	30	162
14	0	7	3	4	32	28	1832992	2673801	1	3	22	22	30	157
15	0	6	3	3	27	22	1780390	2657457	1	3	21	22	30	142

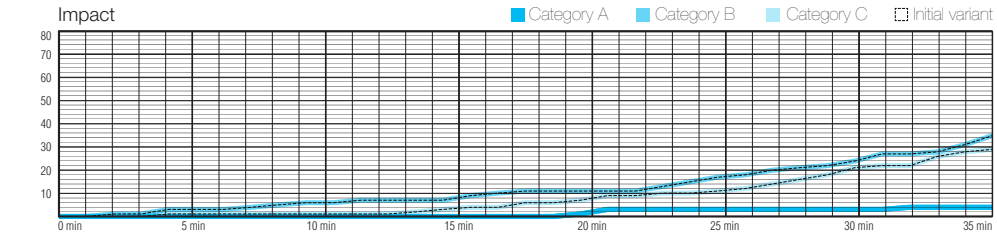
▪ Figure 7.40 Tottenham Hale's network characteristics for the evaluated configurations *source: image by author*

▪ Figure 7.41 Overview of evaluated configurations *source: image by author*

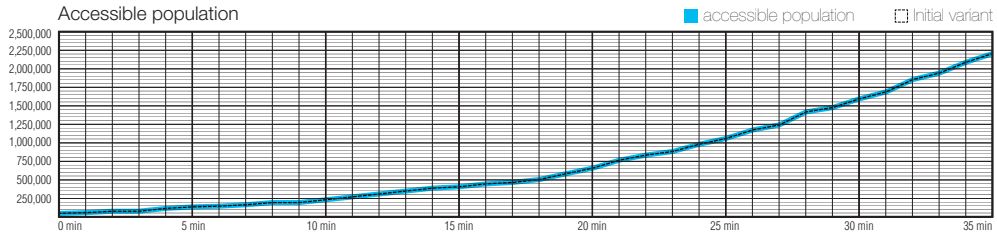


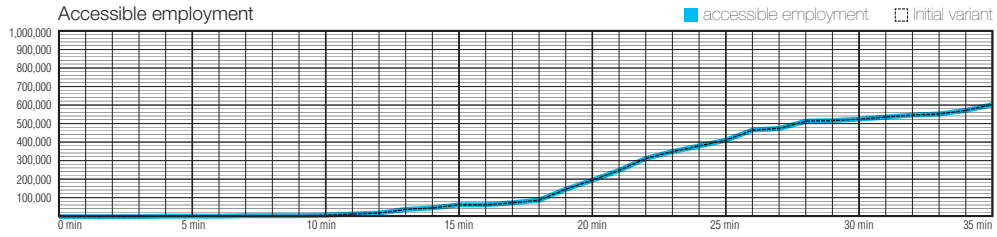
▪ Figure 7.42 Selected configuration supporting Tottenham Hale for variant 4 *source: image by author*

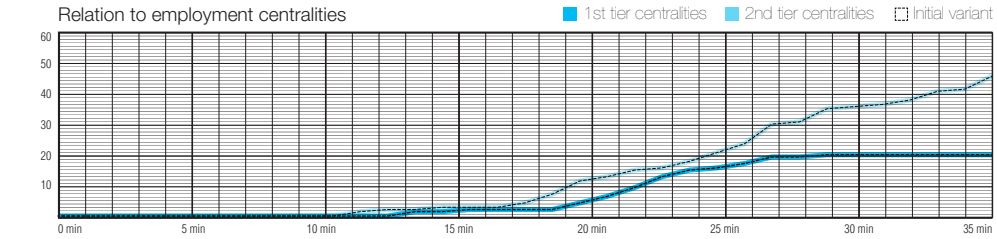
Impact



Network Position







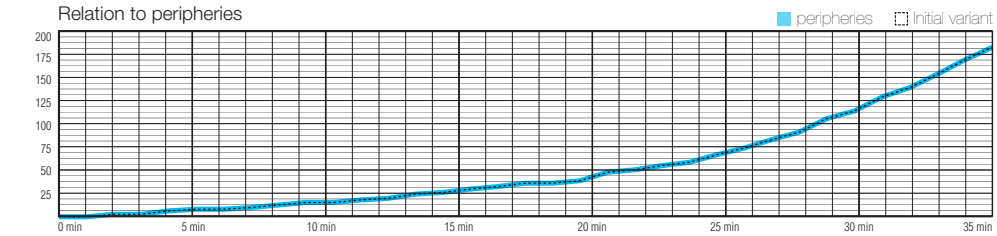
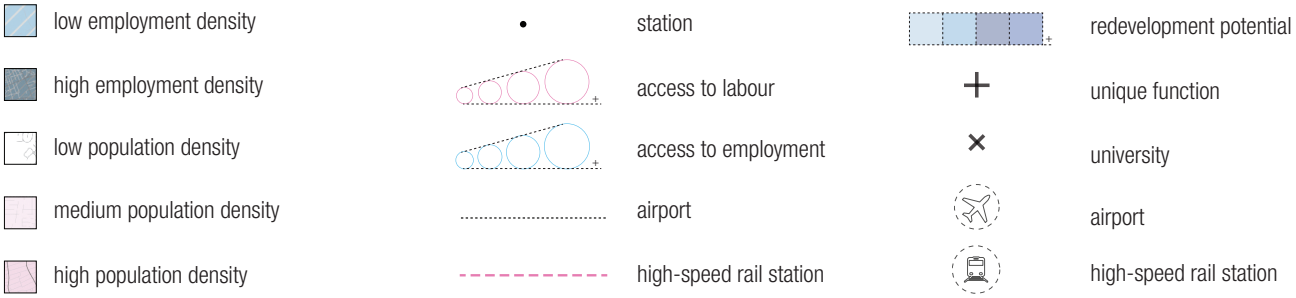


Figure 7.43 Accessibility per minute

source: image by author



Next steps

At this point the four potential locations for centralities have been selected along with the networks needed to support them: Woolwich Arsenal (1) across the river Thames from City Airport, Turnham Green (2) bordering one of the bends of the same river, Wembley (3) which is already an established hub for entertainment, and finally Tottenham Hale (4) also home to a sizable stadium.

Before these options are compared two more steps will be carried out. First the costs of the selected supporting networks are assessed followed by a step providing a more in-depth analysis of the local characteristics in and around these areas.

7.10 Step 4: Estimating costs

The following pages will offer a cost estimate for the supporting transit networks proposed in step four. This is based on several variables:

1. Length of new surface rail
   For each variant the amount of rail that could reasonably be realized on the surface has been determined.

2. Length of new subsurface rail
   For each variant the amount of rail that is best constructed below the surface has been determined. Next to incurring costs itself, the combined length of new surface and subsurface rail is also used to determine systems and indirect costs.

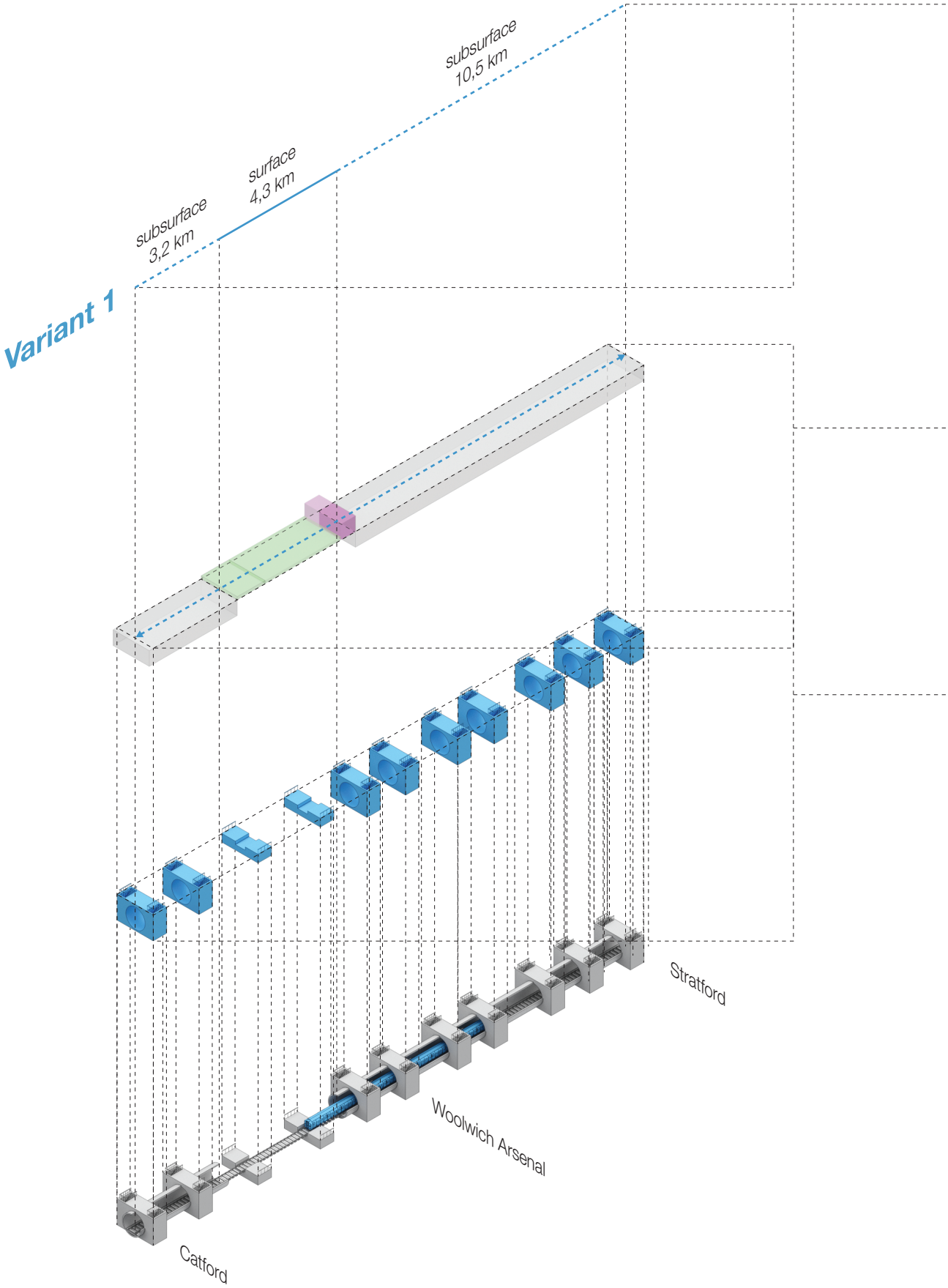
3. Length of rail connections part of the new line
   As the new lines proposed in both variants two and three make use of existing lines it is likely that capacity increases will be necessary for a new autonomous route to operate. The costs associated with these upgrades is assumed to be 40% of the unit costs for surface rail per kilometre. This estimate takes into account that capacity increases are unlikely to be needed everywhere but that extra costs will be incurred as by the delays that engineering works are likely to cause. Furthermore, the total length of the new line including new and existing sections are used to determine the costs of the new trains also called rolling stock.

4. Land acquisition costs for the surface sections
   Of course, the land on which new surface rail is to be built has to be acquired. The UK government can acquire land for the value it could reasonably be expected to realize if sold on the open market (Valuation Office Agency, 2018). To determine this value this assessment takes into account the amount of land that needs to be acquired as well as its respective uses and locations. The latter accounts for the widely different land and property values throughout London. While subsurface rights will need to be acquired they are not accounted for in this estimate, due to the insignificant costs associated (Crossrail Limited, 2008, Thames Tideway Tunnel, 2014).

5. Number of new surface station stops
   The number of new stations or new stops at stations that need to be realized and can be located on the surface. Stops along the existing stretches of variants two and three are not taken into account.

6. Number of new subsurface station stops
   The number of new stations or new stops at stations that need to be realized and need to be underground. Stops along the existing stretches of variants two and three are not taken into account.

The unit prices used to translate these variables to costs are based primarily on PwC (2014)'s adaption of MottMcDonald's initial cost estimate for Crossrail 2's metro option. This should provide a reasonably reliable estimation of the current construction costs for rail infrastructure in the UK. Further detail on these unit prices and the way land acquisition costs have been calculated can be found in the appendix. The costs associated with the various are shown over the next pages.



▪ Figure 7.44 Cost estimate for variant 1

source: image by author

Cost of links

> surface rail:	4,3 km	63,8 million £
> subsurface rail:	13,7 km	813,5 million £
	+	
other costs:		
> systems	18,0 km	647,9 million £
> indirects	18,0 km	416,8 million £
> capacity upgrade of existing lines	– km	– million £
> rolling stock (frequency of 40 trains per hour)	18,0 km	1030,2 million £

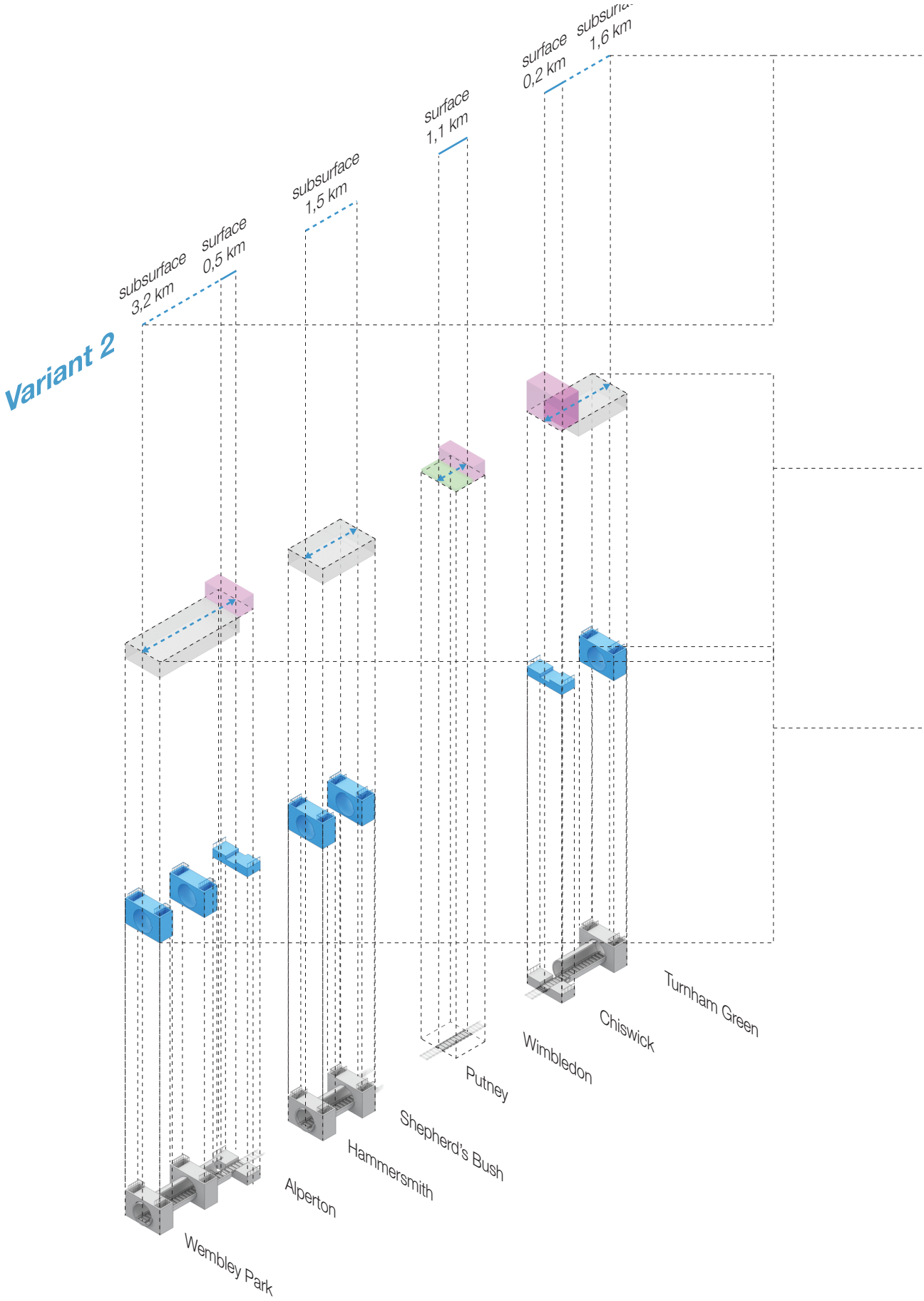
Land acquisition

> open space [government owned]	1,1 km	– million £
> open space [other ownership]	2,7 km	103.6 million £
> residential [low density]	0,5 km	17,2 million £
> residential [medium density]	– km	– million £
> industrial [low density]	0,1km	0,7 million £

Stations

surface stations	2 stations	205,1 million £
subsurface stations	9 stations	3691,4 million £

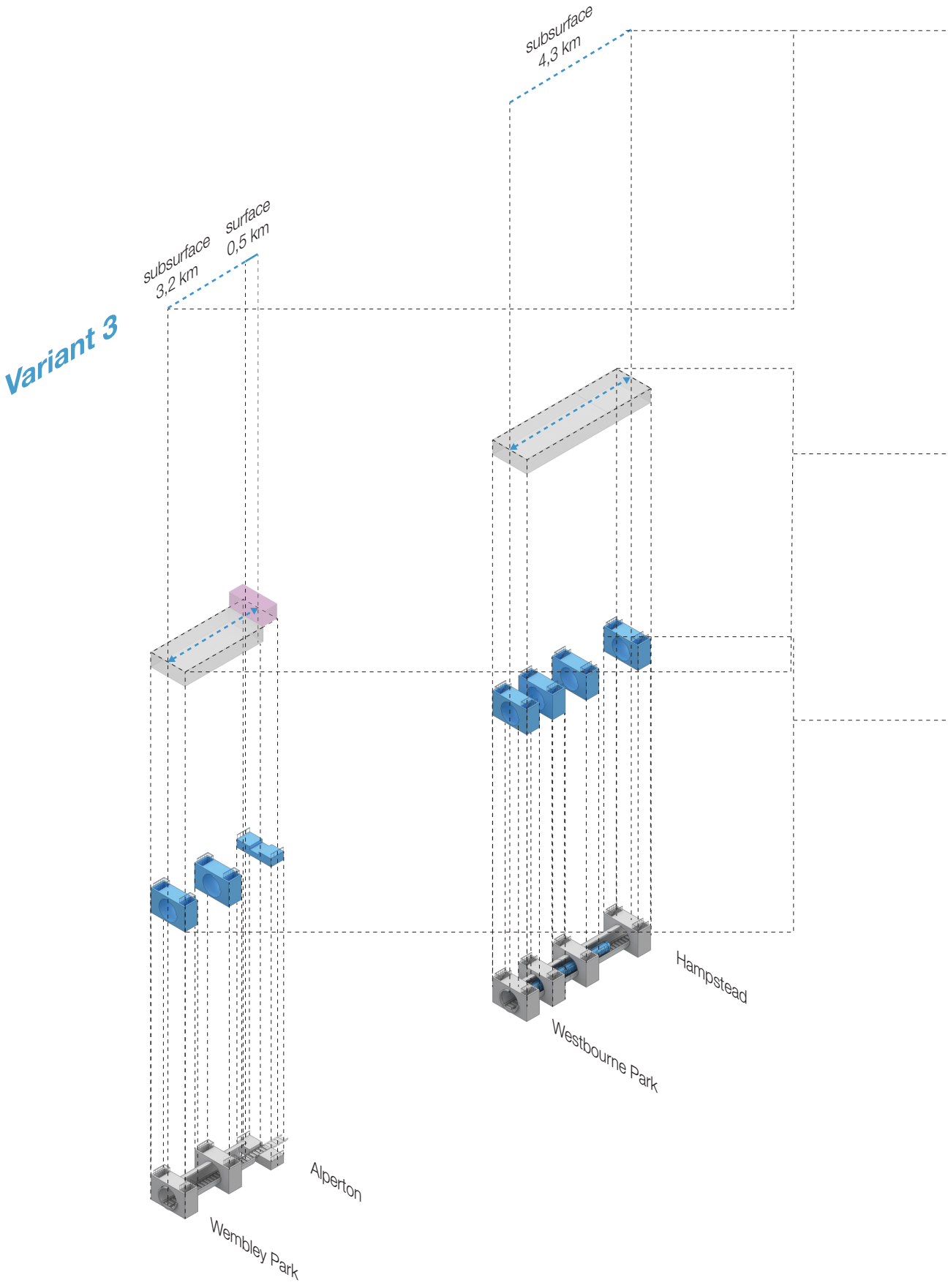
contingency (66% of subtotal):	4631,4 million £
estimated costs:	**11649 million £**



▪ Figure 7.45 Cost estimate for variant 2

source: image by author

Cost of links		
> surface rail:	1,8 km	26,7 million £
> subsurface rail:	6,3 km	374,1 million £
	+	
other costs:		
> systems	8,1 km	303,7 million £
> indirects	8,1 km	187,6 million £
> capacity upgrade of existing lines	14,9 km	– million £
> rolling stock (frequency of 40 trains per hour)	23,0 km	1,316,4 million £
Land acquisition		
> open space [government owned]	– km	– million £
> open space [other ownership]	1,2 km	36,8 million £
> residential [low density]	0,5 km	32,7 million £
> residential [medium density]	0,2 km	12,8 million £
> industrial [low density]	0,5 km	19,4 million £
Stations		
surface stations	2 stations	205,1 million £
subsurface stations	5 stations	2050,8 million £
	contingency (66% of subtotal):	3535,7 million £
	estimated costs:	**8893 million £**



▪ Figure 7.46 Cost estimate for variant 3 *source: image by author*

Cost of links

> surface rail:	0,5 km	63,8 million £
> subsurface rail:	7,5 km	813,5 million £
	+	
other costs:		
> systems	8,0 km	647,9 million £
> indirects	8,0 km	416,8 million £
> capacity upgrade of existing lines	7,1 km	– million £
> rolling stock (frequency of 40 trains per hour)	15,1 km	1030,2 million £

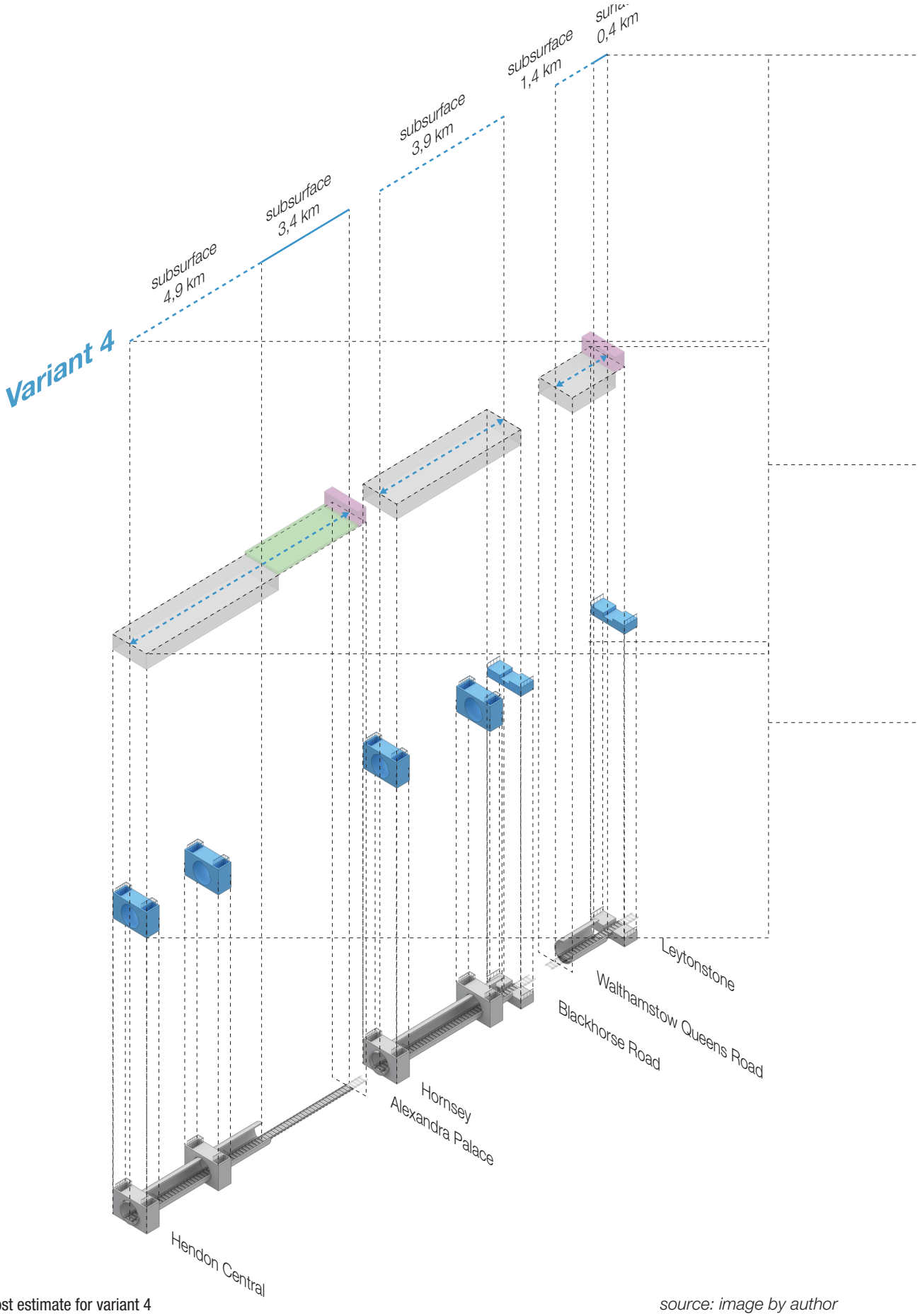
Land acquisition

> open space [government owned]	– km	– million £
> open space [other ownership]	0,5 km	103.6 million £
> residential [low density]	– km	17,2 million £
> residential [medium density]	– km	– million £
> industrial [low density]	– km	0,7 million £

Stations

surface stations	1 stations	102,5 million £
subsurface stations	6 stations	2460,9 million £

contingency (66% of subtotal):	3142,95 million £
estimated costs:	**7905 million £**



▪ Figure 7.47 Cost estimate for variant 4

source: image by author

Cost of links

> surface rail:	3,8 km	56,4 million £
> subsurface rail:	10,2 km	605,7 million £
	+	
other costs:		
> systems	14,0 km	534,9 million £
> indirects	14,0 km	324,2 million £
> capacity upgrade of existing lines	3,1 km	164,6 million £
> rolling stock (frequency of 40 trains per hour)	17,1 km	978,7 million £

Land acquisition

> open space [government owned]	– km	– million £
> open space [other ownership]	3,1 km	121,7 million £
> residential [low density]	0,3 km	16,0 million £
> residential [medium density]	0,3 km	21,7 million £
> industrial [low density]	– km	– million £

Stations

surface stations	2 stations	205,1 million £
subsurface stations	4 stations	1640,6 million £

contingency (66% of subtotal):	3075,3 million £
estimated costs:	**7735 million £**

Summary

Based on the cost estimate carried out it can be concluded that variant 1 is likely the most expensive.

Based on the rough estimate of costs carried out in this section it becomes clear that variant 2, 3 and 4 bring reasonably similar costs varying between about 7,5 and 9,0 billion pounds. Variant 1 is significantly more expensive with a cost of roughly 11,5 billion pounds. While this option comprises the most new rail to be constructed, the difference can mostly be attributed to the fact that it includes the construction of 11 new stops as opposed to 7, 7, and 6 for variants 2 through 4. These three variants take the assumption that no large investments are needed into stops along the existing stretches of their lines. However, if it turns out such investments are needed the overall costs could be a lot more similar.

Tottenham Hale is omitted from the rest of this evaluation due to its problematically low accessibility impact which is not offset by significantly lower costs.

Finally, it must be noted that variant 4, supporting the development of Tottenham Hale, is not significantly cheaper than the other options. This, combined with its lack of impact identified in step 3, has lead to omit this variant from further consideration evaluation.

7.11 Step 5: Evaluation of local characteristics

The local characteristics of the three selected variants are examined in greater detail.

Following the optimization and cost estimation of the networks needed to support the potential centralities it is now time to take a more in-depth look into the local characteristics of Woolwich Arsenal (1), Turnham Green (2), and Wembley Central (3). In order to do this several things are evaluated:

1. Barriers hindering local integration
   First, the large pieces of infrastructure and waterways that could act as barriers are identified. These barriers could prove problematic for the integration of a new centrality into its local surroundings.

2. Redevelopment potential
   Secondly, the redevelopment potential is once again examined. Here the various brownfield sites, industrial lots which could be transformed and pieces of heritage are inventoried. This should provide a more accurate insight into redevelopment opportunities than the aggregated regional assessment used in step 1 through 3.

3. Spatial quality & functional mix
   Finally, the spatial quality and functional mix will be examined for all relevant characteristic areas surrounding the selected stations. This is done on the basis of selected criteria from the Value of Good Urban Design report by CABE and DETR (2001). The most relevant area for each variant is discussed in this chapter, the full evaluation can be found in the appendix. The criteria examined are in this evaluation are:

   1. Character
   The presence and potential for a distinct character generated by locally distinctive patterns of development and culture.

   2. Continuity and enclosure
   The continuity of street frontages and enclosure of space by development which clearly delimits private and public areas.

   3. Quality of the public realm
   Public spaces that are attractive, safe, uncluttered and work efficiently.

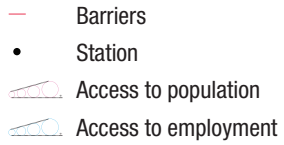
   4. Ease of movement
   Space and layout that promotes accessibility and local permeability which are easy to move through.

The following pages will examine these three points for each variant.

Variant 1 Woolwich - Barriers hindering local integration

As opposed to the other two locations, Woolwich suffers little from heavy infrastructure as the rail lines intersecting the area are mostly buried underground. The Thames forms both a barrier and a connection as it provides a stop for the ferries going up and down the Thames. There are however also multiple connections across it in the form of a submerged foot tunnel, ferry and the DLR.

Figure 7.48 Barriers hindering local integration around Woolwich arsenal



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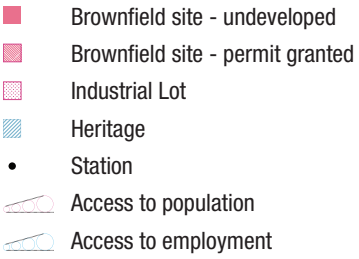
Variant 1 Woolwich - Redevelopment potential

Woolwich has a wide variety of development opportunities, however they are relatively scattered. One location of particular interest are the sizable Royal Artillery Barracks which the MOD has decided to sell for development (Dunne, 2016). Compared to the other two locations, the closed block structures of Woolwich could prove more suitable for infill developments.

Figure 7.49 Redevelopment potential around Woolwich Arsenal



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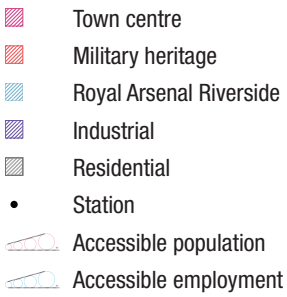
Variant 1 Woolwich - Spatial quality & functional mix

Woolwich is the most diverse of the areas examined. At its heart, oriented towards the Thames lies the Arsenal, a former military site featuring many historic buildings supplemented by denser often historicizing developments. The public spaces are wide, well kept and pedestrian oriented, but as of now do lack life. Outside the arsenal Woolwich features a historical London with well defined blocks and open facades. However post-war infill and demolition without redevelopment has in many places infringed on its historical character. Outside these areas of historic nature Woolwich features much residential development mostly consisting of monofunctional detached apartment blocks and an industrial area.

Figure 7.50 General overview of functions around Woolwich arsenal

Figure 7.51 Relevant characteristic areas around Woolwich Arsenal



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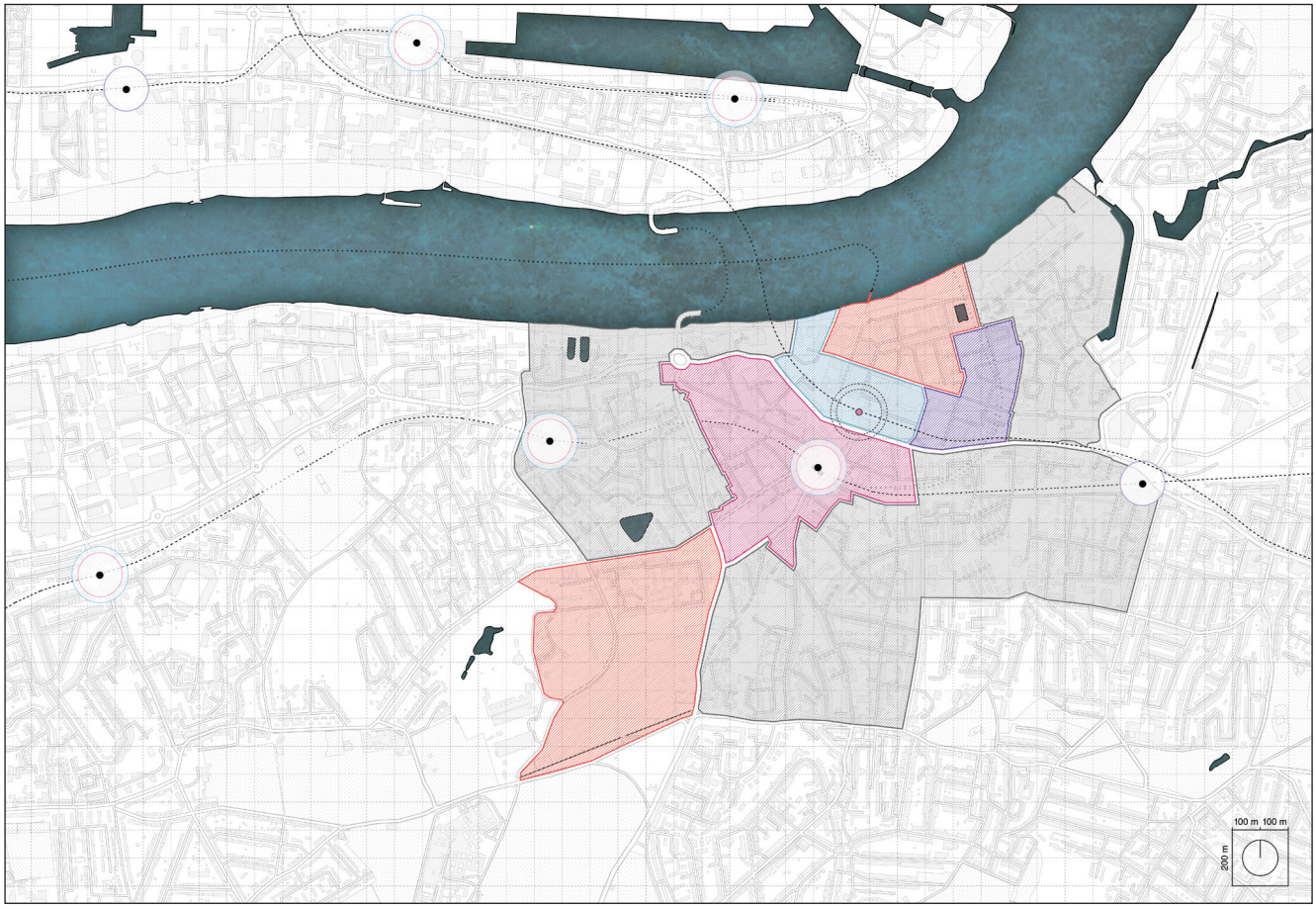
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Figure 7.52 Woolwich Town Centre *source: image by author*

Character

Woolwich features a town centre with a clear historical character. However there are numerous instances where post-war infill development infringe on this identity. At its centre are two squares, one of which is used as a market. These squares are surrounded by various narrow shopping streets.

Continuity & enclosure

Woolwich has well defined urban spaces, featuring a clear street pattern delimited by closed buildings blocks. Most streets feature open facades on the ground floor offering space for a variety of retail and hospitality activities. There are however several derelict sites located throughout the area that break up the otherwise clear urban pattern.

Quality of public space

In recent years, attention has clearly been paid to the area's public spaces, offering ample greenery and various opportunities to reside.

Ease of movement

Most areas in the Woolwich Town Centre are car free as traffic is directed around it, resulting in a pedestrian friendly enviroment. The only real hindrance to pedestrian flows are the busy roads at the edge of the town centre and arsenal as well as in front of the western DLR entrance.

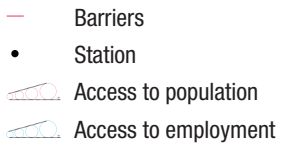
▪ Figure 7.53 Views around Woolwich Town Centre

source: Google Maps (2018)

Variant 2 Turnham Green - Barriers

The area between Turnham Green and Chiswick is heavily fragmented by heavy pieces of infrastructure, consisting of both rail lines and urban highways. This, combined with the distance between Turnham Green and the thames make it difficult to envision a comprehensive development here.

Figure 7.54 Barriers hindering local integration around Turnham Green

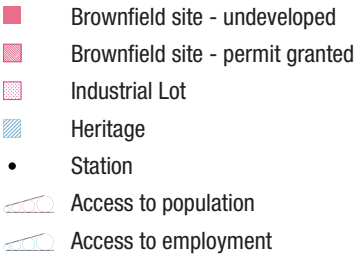


source: image by author

Variant 2 Turnham Green - Redevelopment potential

The number of brownfield sites in the area is relatively limited. The only brownfield site of significant size is located on the south side of the Thames, poorly connected to the Turnham Green and Chiswick stations. This is in stark contrast with the findings from the regional redevelopment potential analysis used in steps one through three. This contrast can be attributed to the fact that the sports facilities, registered as very low density development instead of something worth maintaining.

Figure 7.55 Redevelopment potential around Turnham Green



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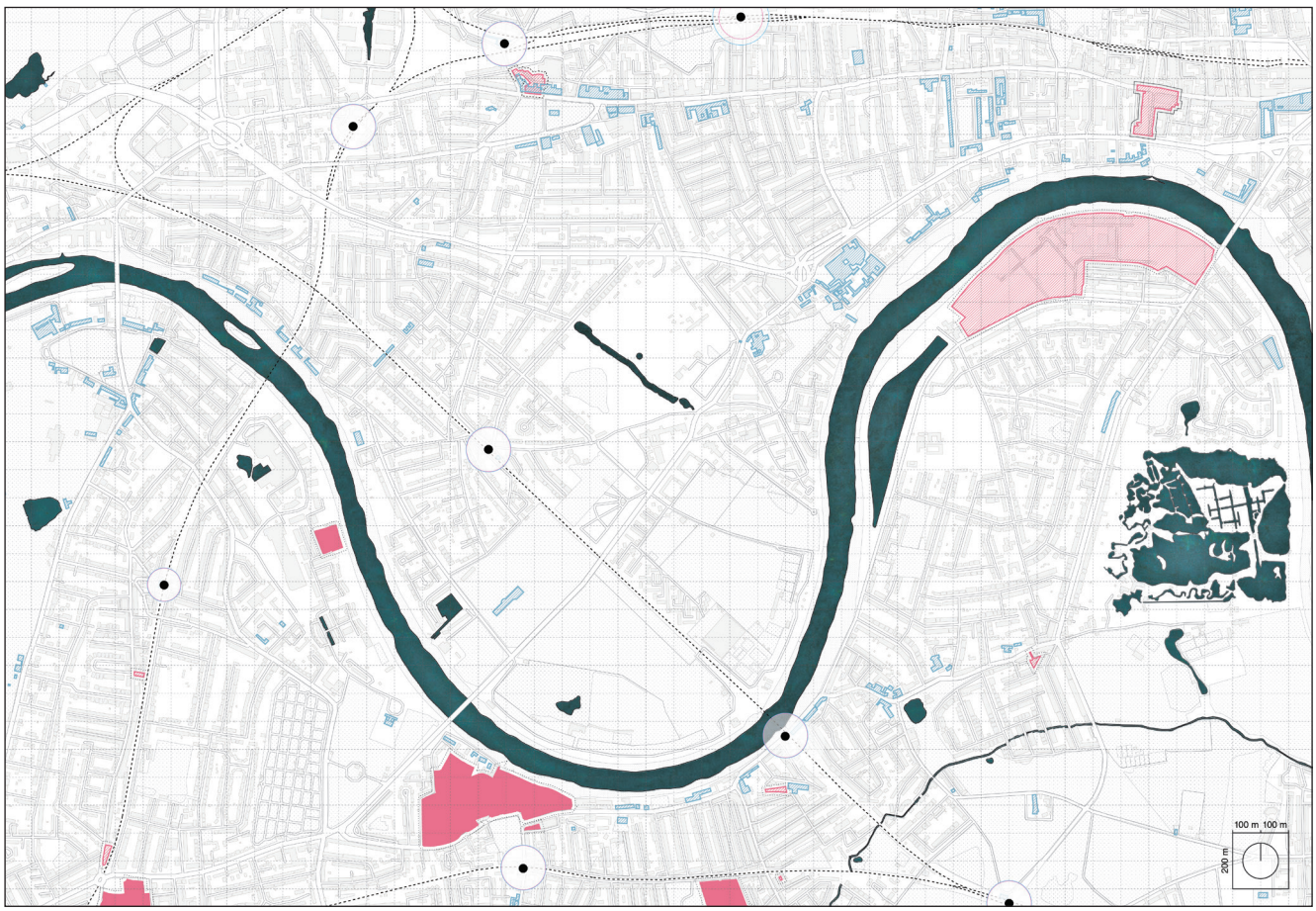
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Variant 2 Turnham Green - Spatial quality & functional mix

Woolwich is the most diverse of the areas examined. At its heart, oriented towards the Thames lies the Arsenal, a former military site featuring many historic buildings supplemented by denser often historicizing developments. The public spaces are wide, well kept and pedestrian oriented, but as of now do lack life. Outside the arsenal Woolwich features a historical London with well defined blocks and open facades. However post-war infill and demolition without redevelopment has in many places infringed on its historical character. Outside these areas of historic nature Woolwich features much residential development mostly consisting of monofunctional detached apartment blocks and an industrial area.

▪ Figure 7.56 General overview of functions around Turnham Green

source: image by author

▪ Figure 7.57 Relevant characteristic areas around Turnham Green

source: image by author

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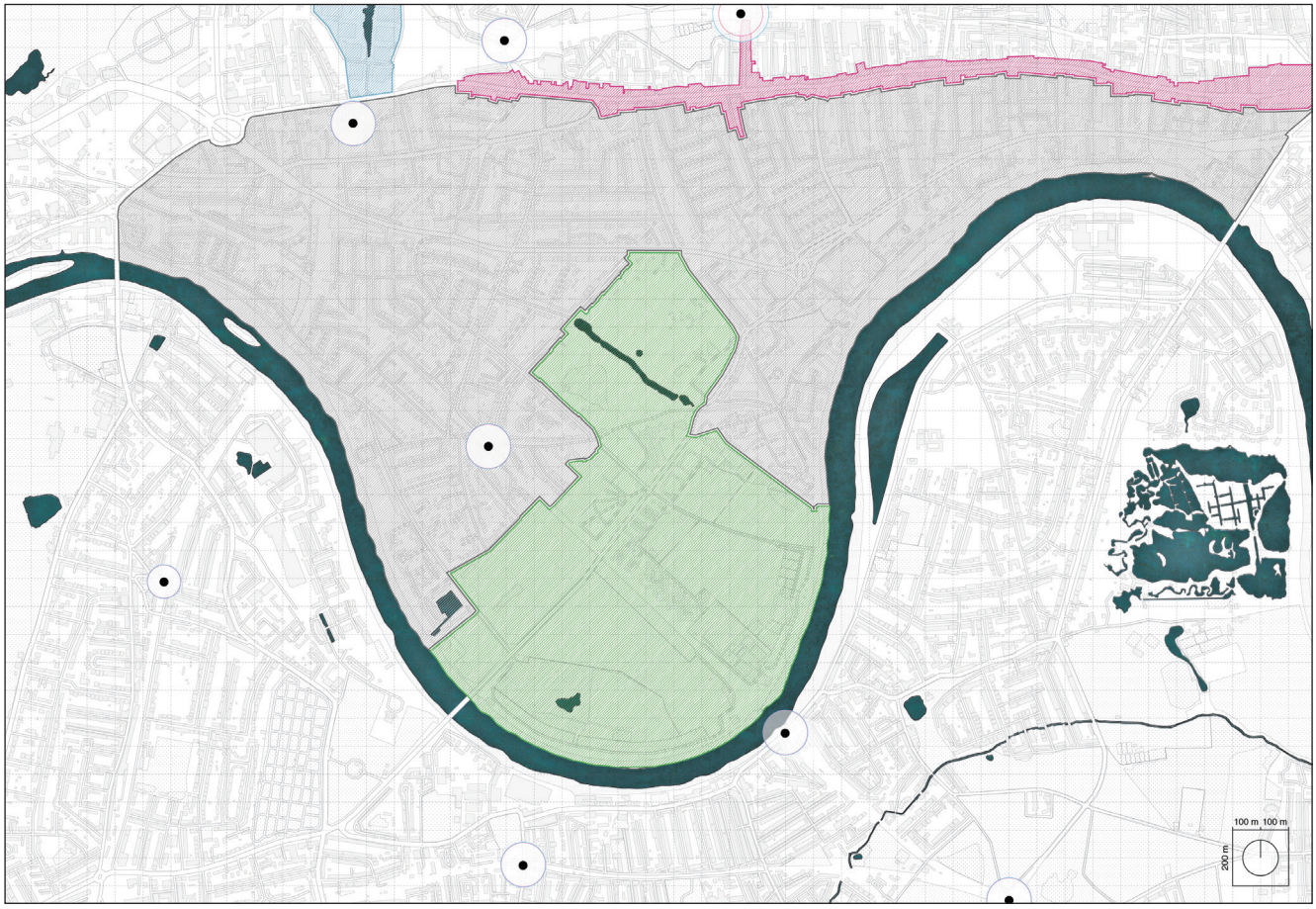
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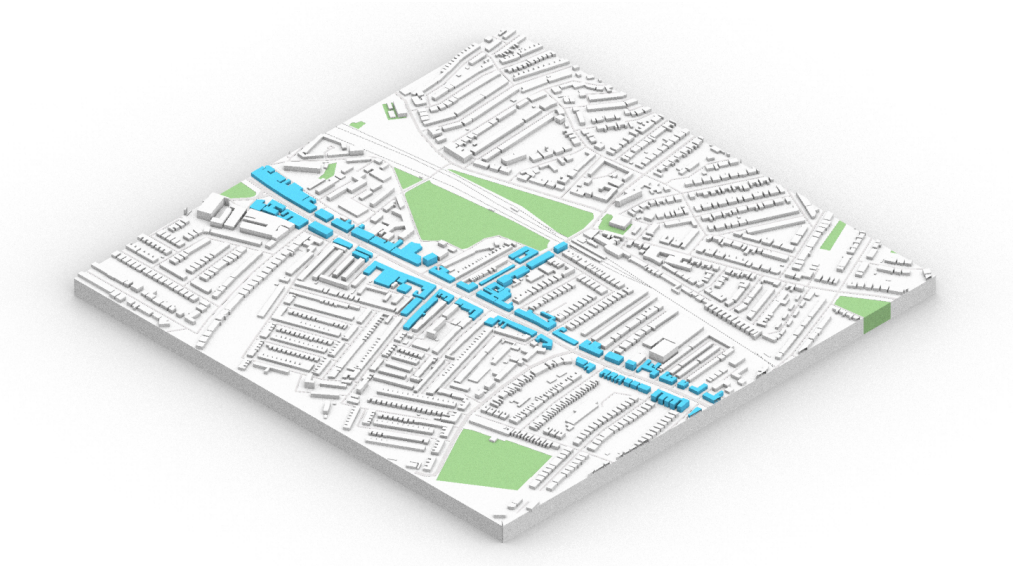


Figure 7.58 Chiswick High Street *source: image by author*

Character

The Chiswick High Road at Turnham Green is a typical London high street with a strong historical character.

Continuity & enclosure

The high street has a well-defined linear structure flanked on both sides by storefronts. Outside of this linear strip activity levels and densities quickly drop. On its western end the high-street culminates in a small park while it carries all the way to Hammersmith Town Centre on its other end.

Quality of public space

The high street features wide pavements that offer ample room for pedestrians while also accommodating small seating areas for the hospitality establishments lining the street. Large trees irregularly line the street on both sides giving it a lush green character throughout most of the year.

Ease of movement

The wide sidewalks make it easy to navigate along the street. While suffering from traffic, ample crossings are available in the form of both zebras and traffic lights.

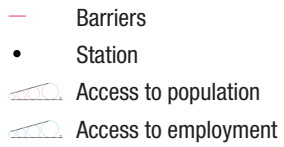
Figure 7.59 Views around Chiswick High Street

source: Google Maps (2018)

Variant 3 Wembley - Barriers

The area between Turnham Green and Chiswick is heavily fragmented by heavy pieces of infrastructure, consisting of both rail lines and urban highways. This, combined with the distance between Turnham Green and the thames make it difficult to envision a comprehensive development here.

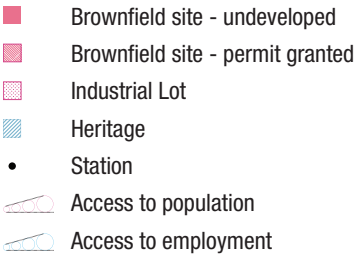
Figure 7.60 Barriers hindering local integration around Wembley



Variant 3 Wembley - Redevelopment potential

The number of brownfield sites in the area is relatively limited. The only brownfield site of significant size is located on the south side of the Thames, poorly connected to the Turnham Green and Chiswick stations. This is in stark contrast with the findings from the regional redevelopment potential analysis used in steps one through three. This contrast can be attributed to the fact that the sports facilities, registered as very low density development instead of something worth maintaining.

Figure 7.61 Redevelopment potential around Wembley



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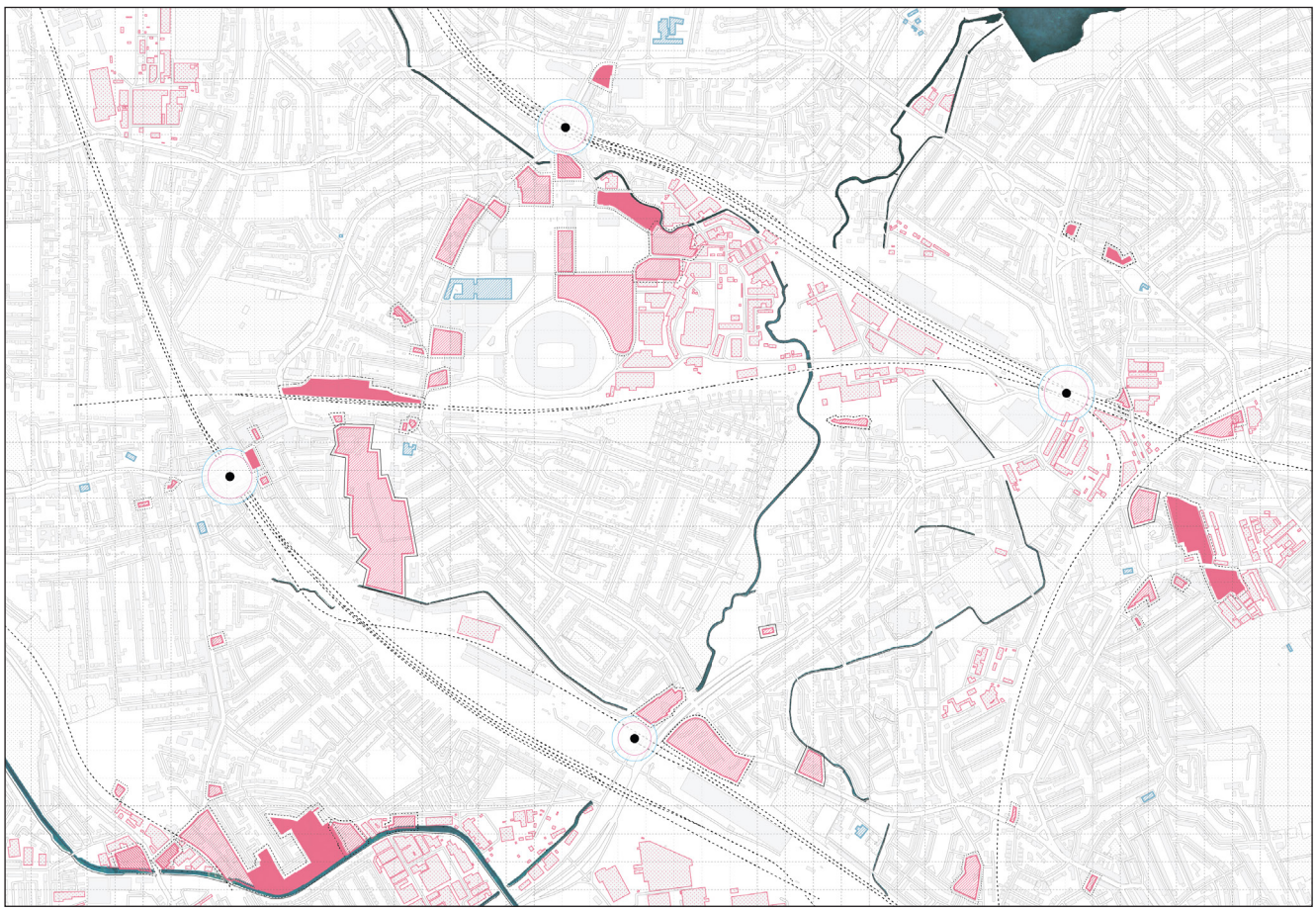
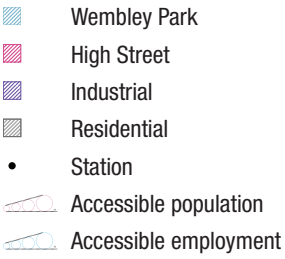


Variant 3 Wembley - Spatial quality & functional mix

Turnham Green and the Chiswick area in which it is located have a strong historical char-acter featuring a stately London high road featuring with generous pedestrian spaces and a mixture of hospitality and retail uses. However, towards the direction of the Thames to its south, the location originally envisioned for development, this dramatically changes. The clear definition of space seen in the high street gives way to historic suburban developments. Featuring mostly semi-detached housing much of the definition and continuity in the street pattern is lost here, making it difficult to envision development into much more than a residential neighbourhood. The area closest to the Thames is characterized by a large range of sports facilities, which in an urban area like London are best left untouched.

▪ Figure 7.62 General overview of functions around Wembley

▪ Figure 7.63 Characteristic areas in Wembley



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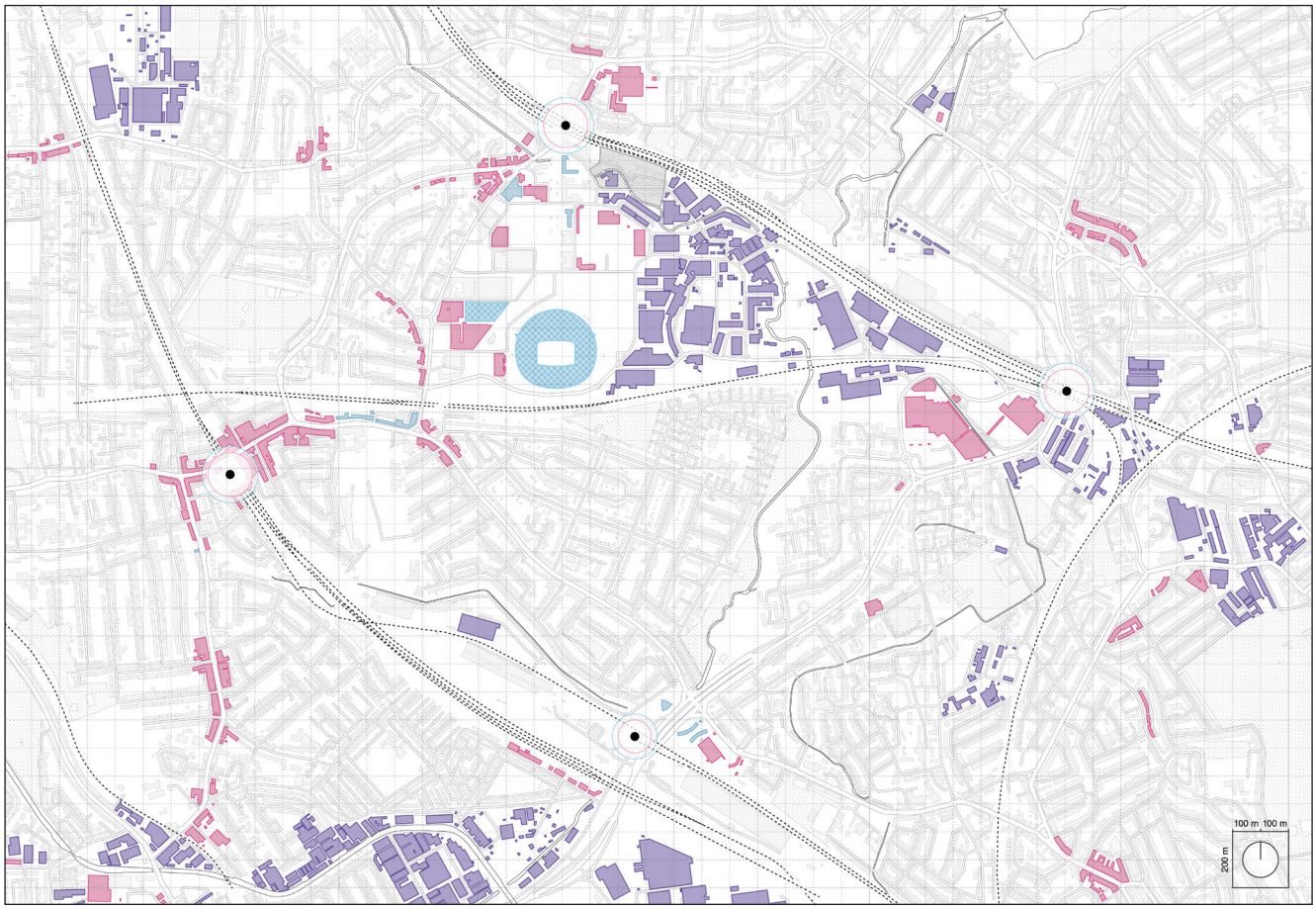
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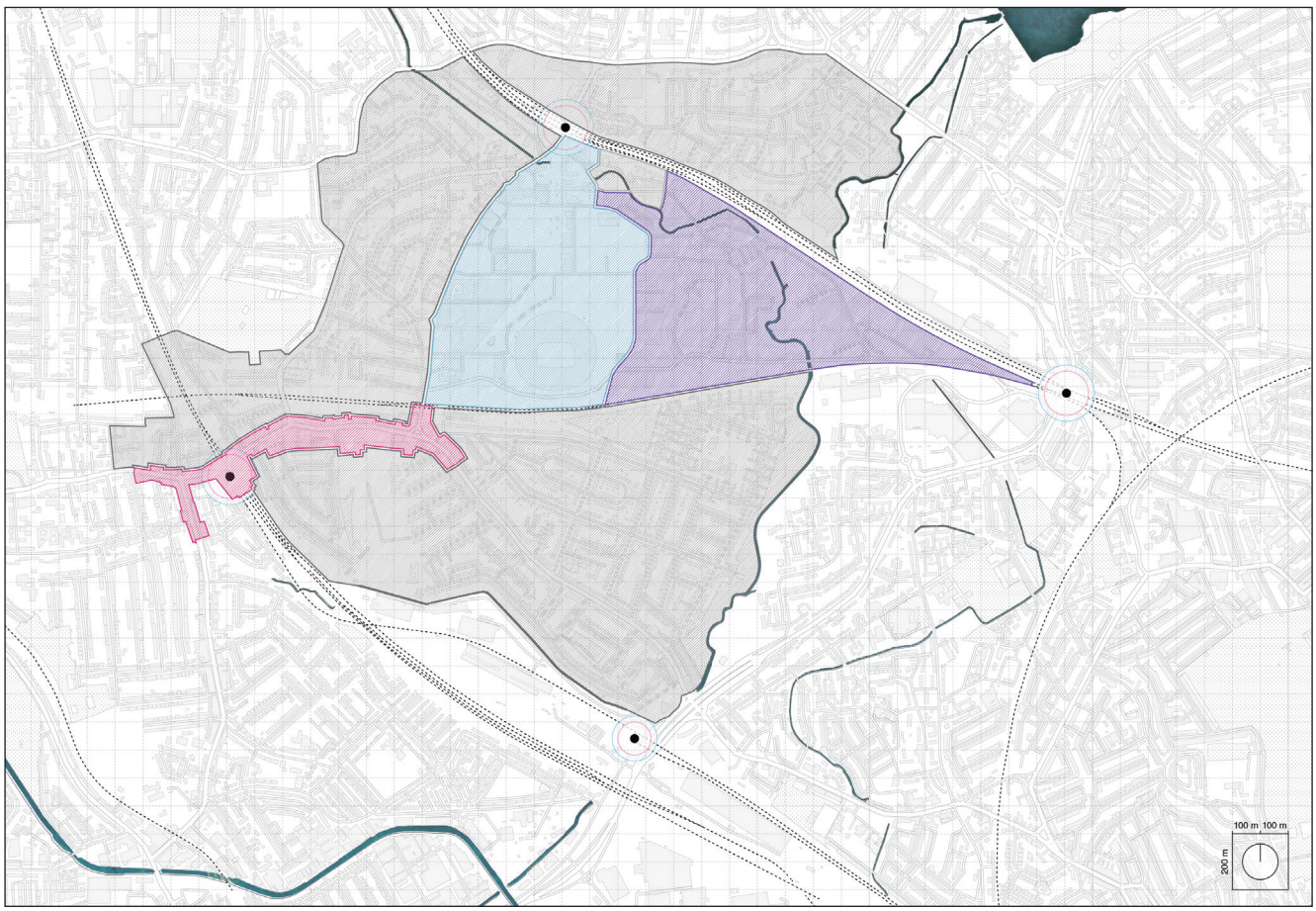
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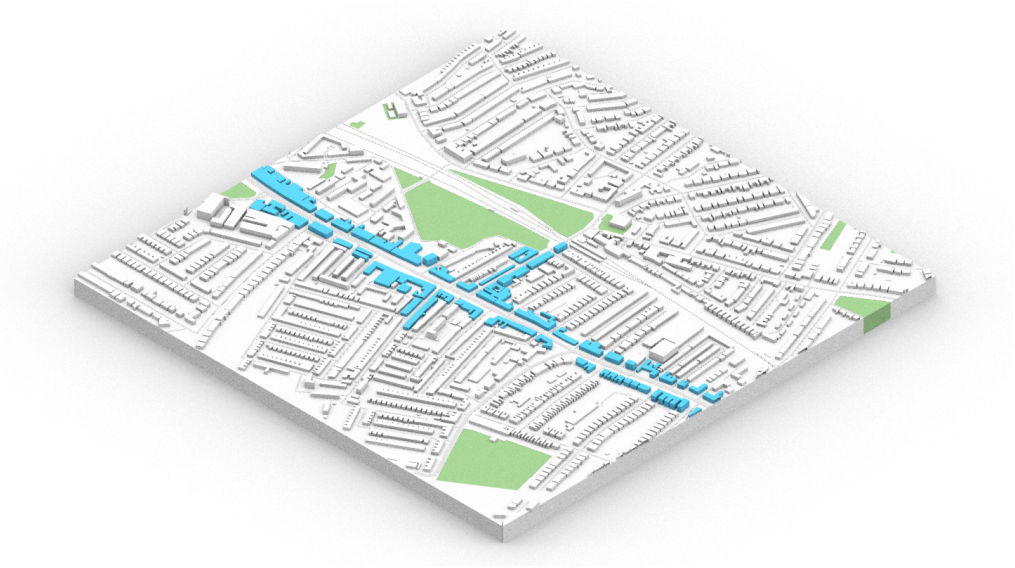


Figure 7.64 Chiswick High Street *source: image by author*

Character

The Chiswick High Road at Turnham Green is a typical London high street with a strong historical character.

Continuity & enclosure

The high street has a well-defined linear structure flanked on both sides by storefronts. Outside of this linear strip activity levels and densities quickly drop. On its western end the high-street culminates in a small park while it carries all the way to Hammersmith Town Centre on its other end.

Quality of public space

The high street features wide pavements that offer ample room for pedestrians while also accommodating small seating areas for the hospitality establishments lining the street. Large trees irregularly line the street on both sides giving it a lush green character throughout most of the year.

Ease of movement

The wide sidewalks make it easy to navigate along the street. While suffering from traffic, ample crossings are available in the form of both zebras and traffic lights.

Figure 7.65 Views around Wembley Park

source: images by author

7.12 Assessment matrix

The observations made in this chapter are collected in an assessment matrix that serves as the basis for selecting a variant to be developed further.

The assessment matrix seen on the next spread forms the basis for the selection of a variant to be developed further and collects all the observations regarding network and local characteristics made in this chapter. A single variable is added to both access to employment and population that shows accessibility at 15 minutes, providing extra context to the aggregated amount in regards to reducing travel times. Following the various steps of sub-selection and optimization, all three variants perform relatively well in regards to their network potential. Based on these measures Wembley can be considered the most all-round candidate. While both Woolwich Arsenal and Chiswick perform well they have their relative weaknesses. The former lags slightly behind in terms of impact and has a slight, but not alarming, risk of being outcompeted. It is however the best in terms of accessible population, a field where Turnham Green is lacking.

After optimization all variants score relatively well in terms of network potential with Wembley proving the most all-round candidate.

Turnham Green's poor local characteristics push it out of consideration.

While Turnham Green performed well in terms of overall network potential, its local characteristics push it out of consideration due to its distance from the Thames and lack of other unique features, overly suburban surroundings, fragmentation from heavy infrastructure and limited availability of brownfield land.

In terms of local characteristics it is Woolwich that excels. It offers unique features with its waterfront location, historical heritage and proximity to London City Airport that could prove a catalyst for development. It is also the most spatially diverse and has a clear urban block structure that is much less prevalent in the other two variants and likely easier transformed into a different type of urban environment. Furthermore, it offers plenty and unique, in the case of the Royal Artillery Barracks, opportunities for redevelopment albeit somewhat scattered. It does feature the highest costs of the variants evaluated by a significant margin, however this might partly be offset by the many opportunities for redevelopment surrounding its supporting transit networks.

Woolwich's local characteristics seem to offer more potential than Wembley's.

Wembley also does relatively well in terms of local characteristics with its large entertainment facilities presenting a unique selling point. However, this cluster has its downsides. Being the most interesting for redevelopment, compared to neighbouring areas, it forms an isolated patch surrounded by heavy infrastructure. Internally, while well kept, its public spaces are made to accommodate the large crowds coming in and out of its entertainment venues, an environment that might not be conducive to a lively urban setting throughout the whole day. While there are significant opportunities for redevelopment of brownfields and industry on Wembley's patch, its suburban surrounding offer little of such potential. It is however accompanied by the smallest price tag for its supporting networks.

Conclusion

Based on the assessed criteria Woolwich is selected for further elaboration. While not the best performer in terms of network potential it definitely holds its own and its local characteristics push it ahead of Wembley. This is mainly due

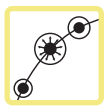
to Woolwich's diverse environment and more human scaled environment. While Woolwich's is by far the most costly of the variants evaluated, it offers the most opportunities for new development around its line which should partly offset this difference and warrants its further investigation.

Finally, Woolwich is selected for further exploration. While its more expensive and its network characteristics are slightly worse than those of Wembley its local characteristics make it the preferred option.

▪ Figure 7.66 View from a sky garden in the City towards Canary Wharf *source: images by author*

Variant	Woolwich Arsenal					
impact on accessibility			A	B	C	
		15 minutes	1	14	17	15 minute
		35 minutes	9	44	51	35 minute
access to population		overall	1,735,133			overall
		15 minutes	625,000			15 minute
access to employment		Overall	2,554,590			Overall
		15 minutes	110,000			15 minute
risk of competition			Tier-1 Centrality	Tier-2 Centrality	Periphery	
		15 minutes	4	3	60	15 minute
		35 minutes	25	28	171	35 minute
unique characteristics		- In close proximity to London City Airport - Historical home of the British Military armaments - Waterfront location				- Waterfro
spatial quality		- Diverse area - Unique historical character - Well defined block structures				- Well artic - Otherwis - Thames
local integration		- Little fragmentation due to heavy infrastructure, part of a major rail artery already underground				- The area infrastruct - Both Tur removed f
local redevelopment potential		- Many brownfield and industrial locations, however they are relatively scattered - The Royal Artillery Barracks stands to be sold by the MOD - Closed block typologies are relatively suitable for infill development				- Limited av ment oppor
surrounding redevelopment potential		- Many opportuntiies for future redevelopment in nearby areas and locations along closely connected transit lines				- Limited op areas and l
amount of new rail	£	11649 million £				£

▪ Figure 7.67 Assessment matrix

Turnham Green					Wembley			
	A	B	C			A	B	C
es	4	15	18		15 minutes	8	13	7
es	18	69	24		35 minutes	15	59	23
	1,695,844				overall	1,862,932		
es	260,000				15 minutes	260,000		
	2,450,490				Overall	2,628,827		
es	180,000				15 minutes	80,000		
	Tier-1 Centrality	Tier-2 Centrality	Periphery			Tier-1 Centrality	Tier-2 Centrality	Periphery
s	0	1	34		15 minutes	0	1	32
s	15	26	160		35 minutes	18	30	165
nt location					- Wembley Entertainment Cluster			
culated high street near Turnham Green Station se the area is of mostly suburban structure waterfront is far away from Turnham Green Station					- Care has been taken in the urban design of Wembley Park, however the large introverted buildings and heavy car infrastructure might not make for a succesful environment for other uses - Lively high-street is surrounded by vast sub-urban neighbourhoods			
is heavily fragmented by both heavy rail and road ure nham Green and Chiswick station are relatively far rom one another (1,8 km)					- A vast array of railway and road arteries largely cross through the area, creating an isolated patch around Wembley Stadium			
vailability of brownfield land and other redevelop- tunities					- Many opportunities to redevelop brownfields and industrial locations on the patch surrounding Wembley Stadium - The freestanding housing outside of this patch might be relatively difficult to redevelop.			
pportuntiies for future redevelopment in nearby ocations along closely connected transit lines					- Limited opportuntiies for future redevelopment in nearby areas and locations along closely connected transit lines			
8893 million £					7905 million £			

source: images by author

8. A new centrality for London: Woolwich

+ decline & regeneration
+ redevelopment potential
+ integration of transit stations

Now that the choice has been made for Woolwich as the location of London's new centrality, the next step is to determine how its development can actually be achieved. In order to provide a basis for the development strategy, this chapter will first examine Woolwich further, examining its history and recent activity in the area, followed by a more detailed look at the redevelopment potential in the area as well as the integration and catchment areas of the Arsenal DLR and Crossrail stations.

Woolwich's military history

While not as known today, the area of Woolwich has long played a pivotal role in the expansion and protection of the British Empire, as the leading location of arms production and home to a Royal Naval Dockyard. This dockyard was established in 1512, however it wasn't until the late 17th century that military presence really developed with the establishment of an artillery battery to counter the Dutch Invasion over the Thames. Following this, the army acquired a large part of the waterfront for storage and the production of armaments (Guillery, 2012). A considerable local workforce became employed in the testing, development and production of new munitions and weapons at a site that would quickly become the leading such facility in the country. The Royal Woolwich Arsenal would even become the birthplace of the Royal Military Academy later moved to Woolwich Common, close to the Artillery Barracks erected in 1802.

Woolwich was once a vibrant industrial town revolving around the Royal Arsenal, however with its disappearance much activity has left the area.

The area kept flourishing until after the First World war, during which it employed roughly 80,000 people in a facility stretching from Woolwich to Plumstead (BBC, 2014a). However, after the war the level of activity in the facility quickly declined. The introduction of alternative industries in an effort to maintain local employment largely failed and employment dwindled from 24,000 to 6000 between 1919 and 1922 (Guillery, 2012). While employment naturally rose again during the Second World War it never it never managed to recover to its previous levels. Following the war, talk about closing down the Royal Arsenal facility became increasingly frequent, culminating in the decision to close down production facilities in 1963. The impact on Woolwich was significant. In the words of Charles Pannel, Labour MP for Leeds West: "Woolwich Arsenal probably means more to Woolwich, and has meant more to Woolwich, than almost any other factory has meant o the constituency in the country" (Guillery, 2012). Charles Pannel's words have rung true as the disappearance of its industrial backbone has left its mark on Woolwich which until recently was seen by many as "run-down" and whose Arsenal site is only home to 170 jobs today (Morrison, 2018, Greater London Authority, 2018a).

Traces of Woolwich's history can still be seen in throughout the area today.

However, while the jobs have mostly disappeared the area still resonates its military past as historical buildings line its streets, often aptly named such as General Gordon Square at the heart of the town centre. While clear imprints of its history remain little is left of the Royal Naval Dockyards that first established the military presence in the area following its demolition in favour of a housing estate in the 1970's (Guillery, 2012). This loss is evocative for the situation in Woolwich where heritage is often side-by-side with poor quality post-war developments that do little to enhance the area's unique character.

Regeneration

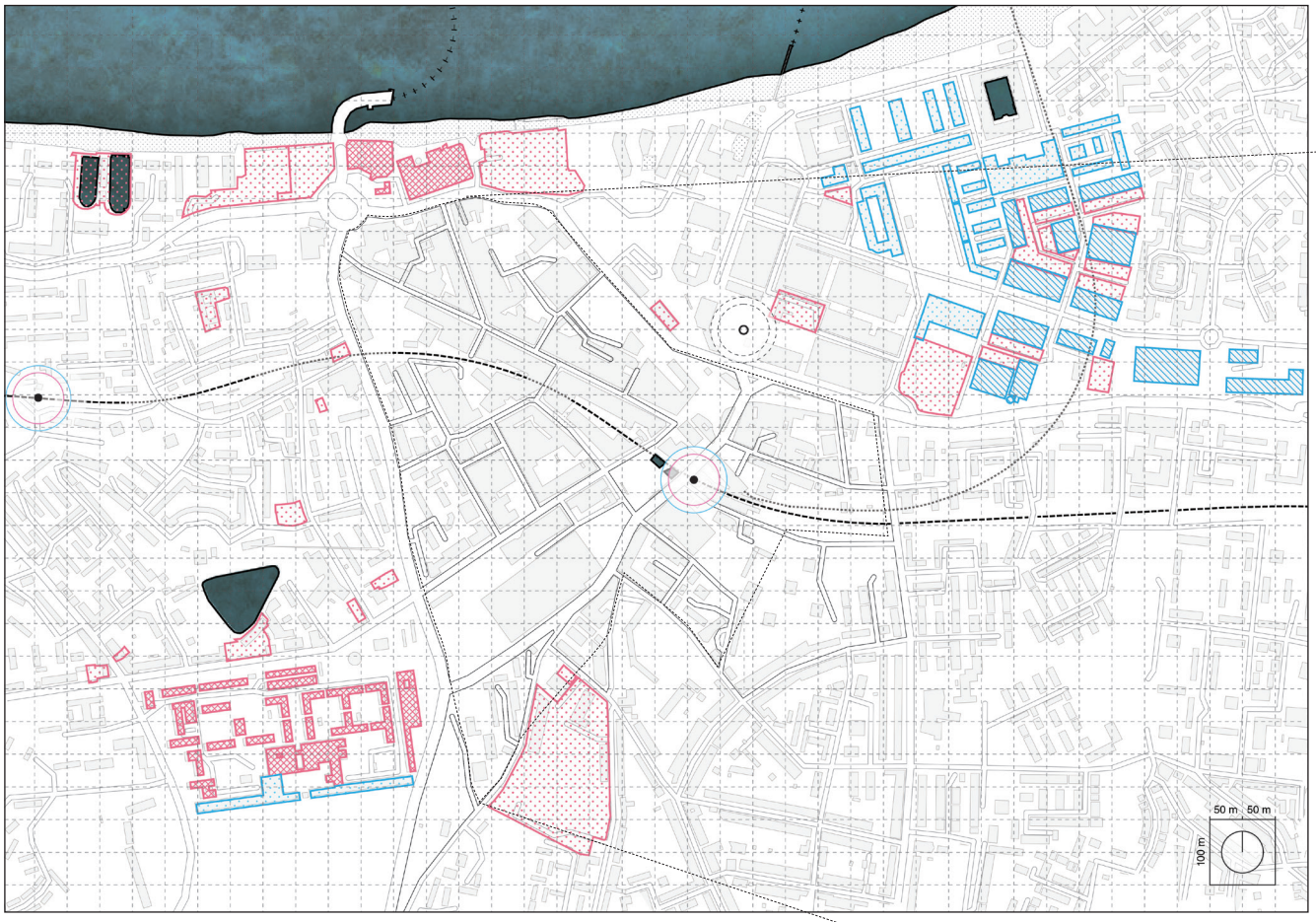
Over recent years, regeneration has started throughout Woolwich in advance of Crossrail's arrival. Several new developments are also underway such as a large Cultural Quarter at the Arsenal and the sale of the sizable Royal Artillery Barracks.

In recent years the "run-down" reputation Woolwich has acquired over the past decades is becoming increasingly challenged as its plentiful heritage is being brought back to life and many new developments are springing as Crossrail is bound to arrive. The most notable of these development is the Berkeley Group's Royal Arsenal Riverside project. While starting out as a transformation project of selected buildings on the eastern end of the Arsenal site, it has since started the development of several high-end high-rise residential buildings. While opposed at first, Berkeley's willingness to finance the Crossrail station's above-ground construction has provided the base for a welcome compromise (Guillery, 2012).

Since then, many new developments have started. Amongst which a recently approved cultural centre that is set to rival the size of the Southbank Centre (Morrison, 2018). Major private investments have also been made into the high-street and Town Centre (British Land, 2018). These new developments have given an influx to Woolwich and turned it into an up-an coming area in the region. This upturn could be further solidified by the MOD's planned sale of the sizable Royal Artillery Barracks at Woolwich Common (Dunne, 2016). However, Woolwich's new Tesco Superstore, the 2014 Carbuncle Cup winner for worst building in Britain, is an example of what might be in the future if no care is taken to enhance that which has made Woolwich unique to this day (Booth, 2014).

Figure 8.1 Woolwich Arsenal Gatehouse around 1911, WW1 and today (top to bottom)

source: Old UK Photos (2019), BBC (2014b) & Google Maps (2018)



▪ Figure 8.2 Redevelopment potential at Woolwich

source: image by author

Brownfield & parking
Demolition
Industrial lot
Transformation

Woolwich features ample space for redevelopment. Especially in its town centre where there are many empty spaces and poor quality buildings that could be redeveloped.

Development potential

While Woolwich's development potential has already been examined in the previous chapter, it was done in a rather coarse fashion. In order to provide a proper basis for the development strategy in the next chapter figures 8.2 and 8.3. do so in greater detail. The first figure shows the greater surroundings, inventorying designated brownfield sites, industrial lots, buildings that could be demolished as well as buildings with significant value for transformation. Figure 8.3 zooms in on the town centre, and indicates open space that could offer room for infill development, buildings enhancing historical character that should be preserved as well as buildings that could be demolished if so required. As can be seen, the town centres characteristic buildings are mostly concentrated at its centre while sizable open spaces, consisting primarily of parking lots and brownfield sites, offer ample space for redevelopment.

As Woolwich is located along the banks the Thames, and in light of climate change and rising water levels, flood risk requires consideration in assessing development potential as well. However as seen in figure 8.4, flooding provides no significant threat as opposed to areas such as Canary Wharf which is located entirely in a flood risk zone. From the perspective of flood risk Woolwich is actually one of the safest places to develop along the Thames due to its location at the run-up to Shooter's Hill.

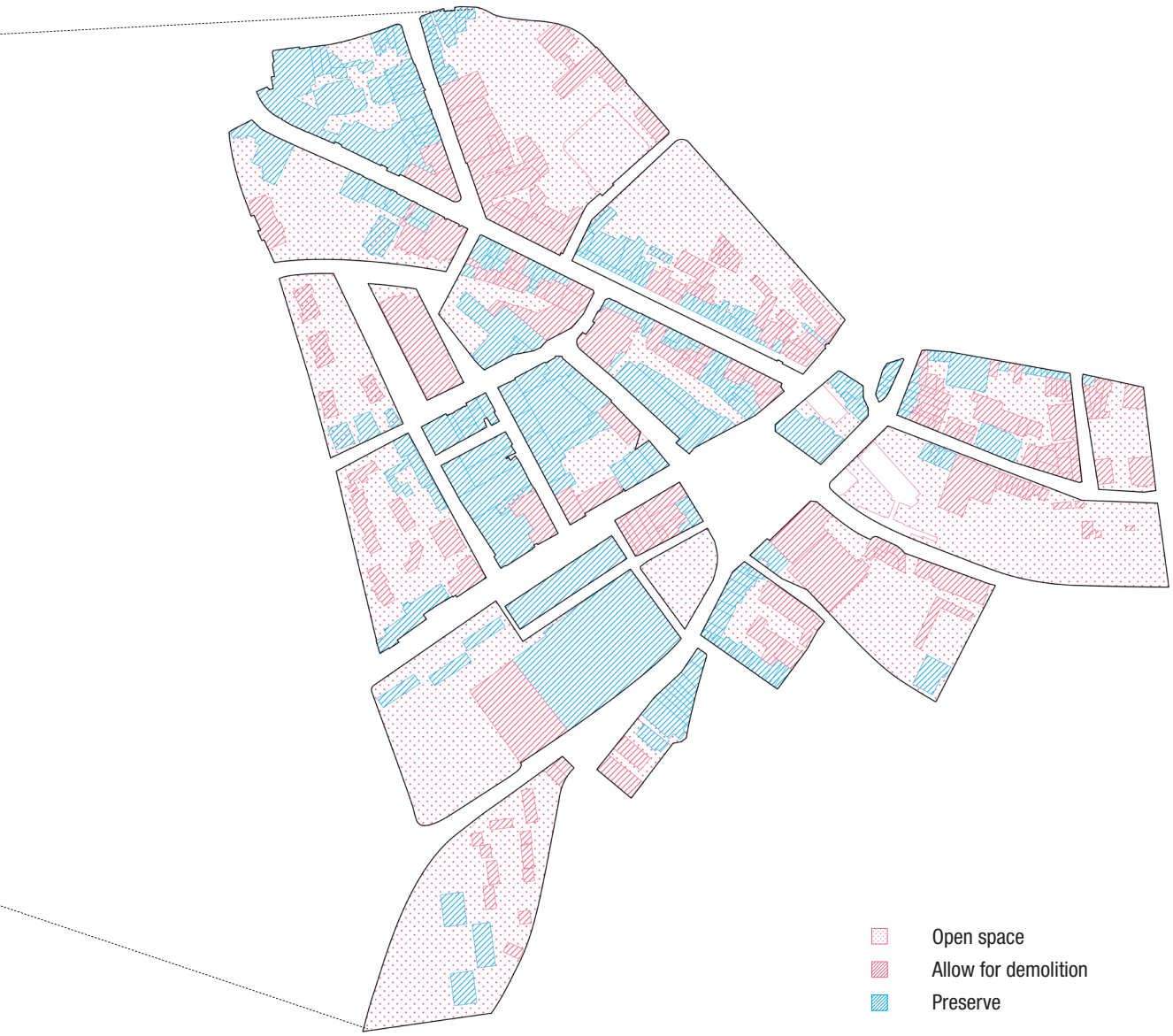


Figure 8.3 Redevelopment potential at Woolwich Town Centre

source: image by author

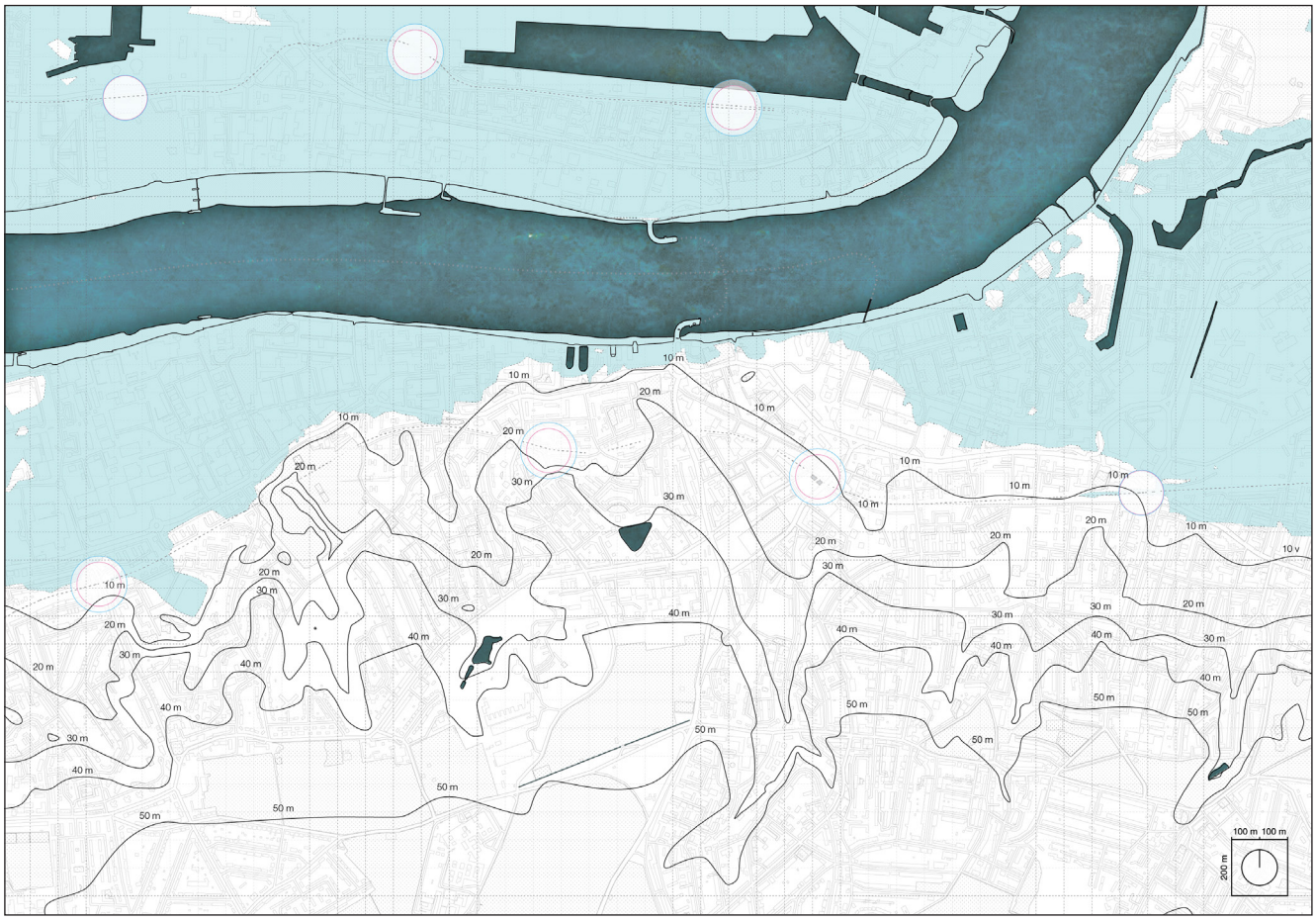


Figure 8.4 Flood risk

source: image by author

Flood risk zones

Contour lines

Figure 8.5 Reachability of stations and integration of street network

source: image by author

Station's sphere of influence

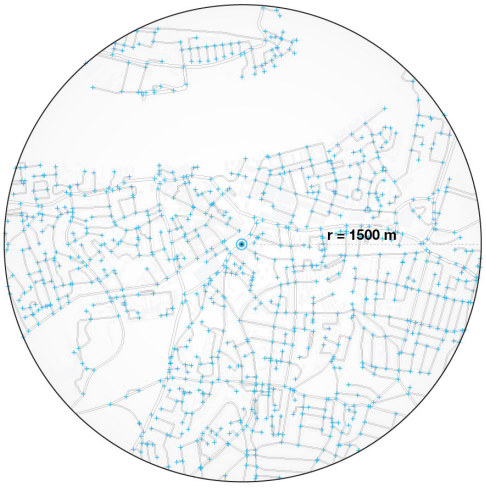
Throughout this thesis Woolwich's development potential has been identified on the basis of both its local characteristics as well as its potential position in the wider urban system. Hence, it is essential if the development strategy is to capitalize on these potentials, to understand how Woolwich Arsenal station is integrated into the surrounding urban fabric. After all, the station is the element connecting Woolwich to the rest the region.

In order to do so a two-fold analysis is carried out to understand both its reachability and level of integration in the street network. The process is explained in the figure on the next page. As a first step the 10 minute walking ranges of relevant stations are calculated making use of the OpenRouteService (2018). The second step is to estimate the integration level of these various streets in regards to foot traffic coming to and from the station by determining the number of overlapping routes plotted.

The results of this analysis are shown in figure 8.5. Concerning integration two major axis can be defined. One running north to south, past the town centre's two central squares and one running east to west, past the arsenal towards the waterfront. Figure 8.7 gives a more easily interpretable view of the stations' reachability through time. What becomes clear is that the areas

< 1 minute walking
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
Intensity of use

The north-south axis through the area, being the most easily accessible from the stations, could form an effective starting point for development.

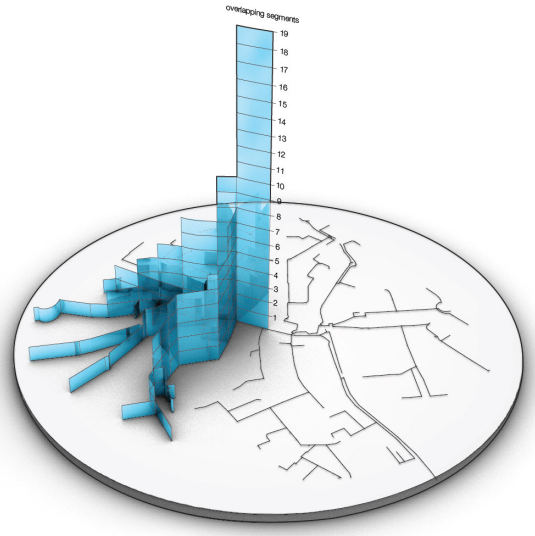


Extract all endpoints and intersection of the roads surrounding the station

Walking paths will be generated between every of these points and the station to be assessed

Optimal routes are generated through OpenRouteService©

Select all routes that take less than 10 minutes to complete



Count overlapping sections to deduct itensity of use

▪ Figure 8.6 Methodology for assessing reachability & integration

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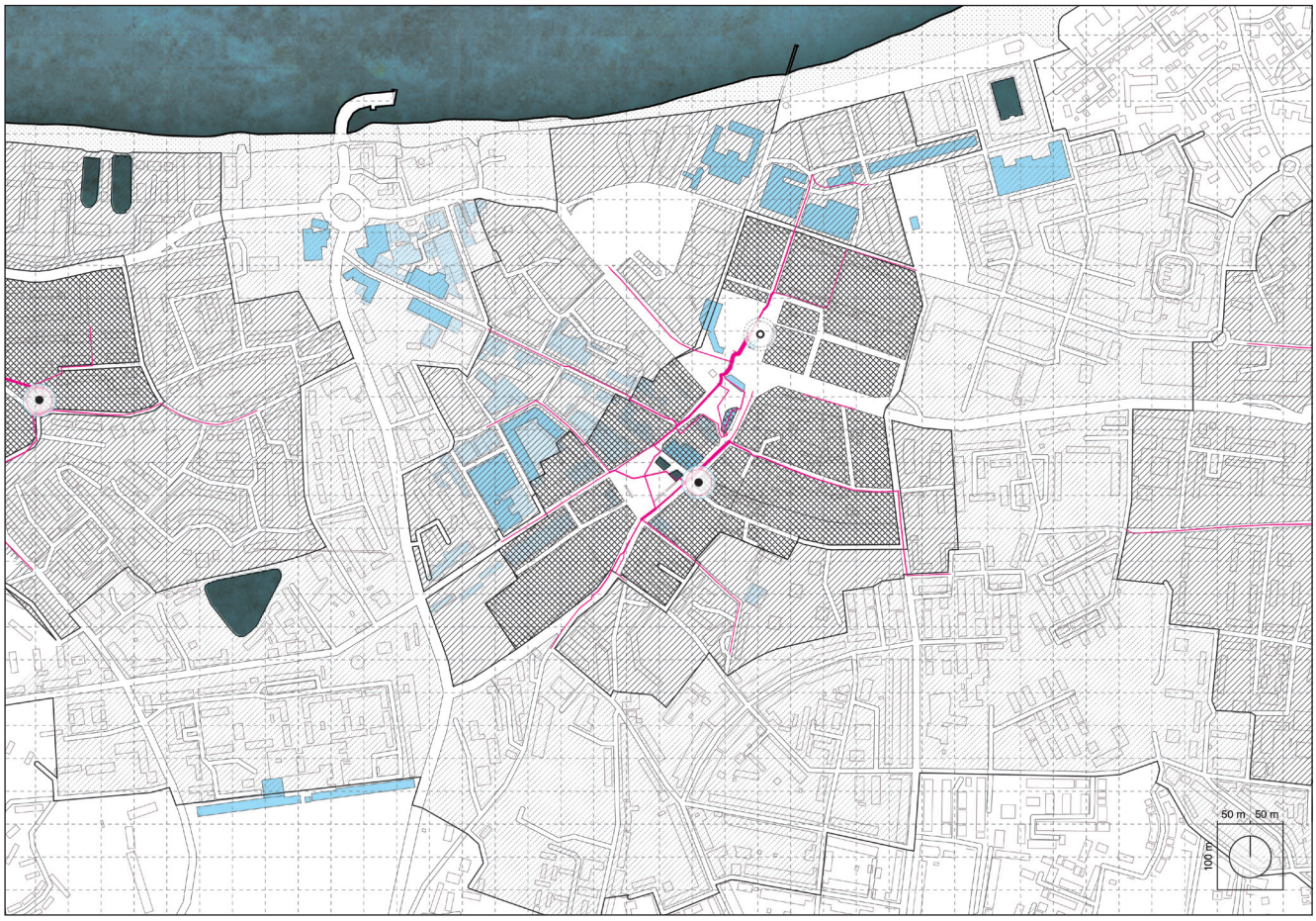


Figure 8.7 Reachability of stations

source: image by author

around the north-south axis are most easily reached, and could thus provide an effective starting point for development.

Conclusion

After decades of decline Woolwich is on the rise again. Its rich heritage is being restored and transformed and new developments including a large cultural centre are underway in light of Crossrail's arrival. Whilst preserving Woolwich's characteristic historical structures there is plenty of room for new development in and around the town centre. Starting around the squares on its north-south axis, most reachable from the station a development strategy should be able to capitalize on the newfound activity in the area and the availability of redevelopment opportunities to foster significant new development at Woolwich.

9. Development Strategy

+ industries targeted
+ interrelated actions through time
+ interrelated actions in space

As discussed over the previous chapters Woolwich offers clear opportunities but also has its own specific challenges. However, without proper action opportunities are likely to remain opportunities. Hence, the question remains: What needs to be done to capitalize on these opportunities and deal with challenges at hand, in order to develop Woolwich into a new centrality for London? This chapter aims to answer this question by providing a development strategy detailed through a set of interrelated actions phased through time. First, the considerations regarding which industries the development will aim to attract are discussed briefly together with base principles for creating a fitting environment. This is followed by a timeline that offers a comprehensive overview of the various actions, and their interrelations, that need to be undertaken for development. Subsequently, this phasing is further elaborated through a time-series of maps showing how development is likely to proceed and which actions are undertaken at certain points in time.

9.1 Industries targeted

In order to determine which industries are targeted to locate to Woolwich, two main things are taken into account: growth projections and local qualities. While London's economy is projected to produce as many as 1,2 million additional jobs by 2041 it is key to understand that this growth is not distributed equally across the different industrial sectors (GLA Economics, 2017). The bulk of growth is located in what could be defined as knowledge and creative services, hence these would present fitting industries to target.

However, beyond the general factors identified in chapter 8. that make Woolwich an attractive place for industries to settle, there are also specific condition making Woolwich a good fit for knowledge and creative services. Firstly, large cultural amenities planned, such as the Cultural Quarter, and existing ones such as the Millennium Performing Arts College could provide unique opportunities for creative industries. Moreover, if Crossrail is extended to Ebbsfleet, as is currently being discussed, Woolwich would become the first major stop in London from the cluster of high-tech logistics and manufacturing being planned for the Thames' Inner Estuary (Thames Estuary 2050 Growth Commission, 2018). This again gives Woolwich unique leverage regarding related knowledge or creative services such as product design. More information on the relation between Woolwich and the envisioned development of the Thames Estuary can be found in chapter 12.

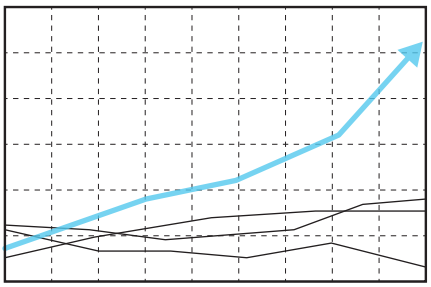
The development aims to attract knowledge and creative services, as they are projected to grow significantly and fit to Woolwich's unique characteristics.

While literature offers little in conclusive rules for designing an environment fit for the targeted industries, two main things seem to be important: an environment that promotes interactions, facilitating knowledge exchange, and a sense of "social buzz", excitement surrounding a unique up-and-coming area (Murphy et al., 2015, van der Hee and Romein, 2015). The development at Woolwich aims to cultivate these aspects, promoting interaction by offering a rich variety of hospitality, retail and residential uses in addition to office space, as well as promot-ing walkability and a spaces of human scale. In an effort to enhance local character, the development will seek to enhance its historical heritage. These various approaches are integrated in the set of actions presented in the following sections and the strategic guidebook.

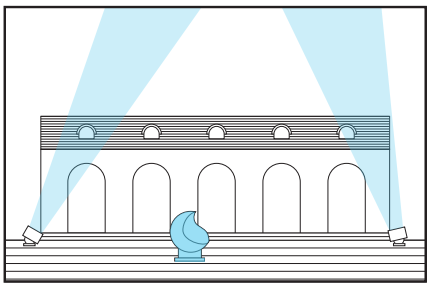
The development aims to provide a fitting environment for these industries by promoting interactions and a sense of social buzz.

Creative & knowledge services

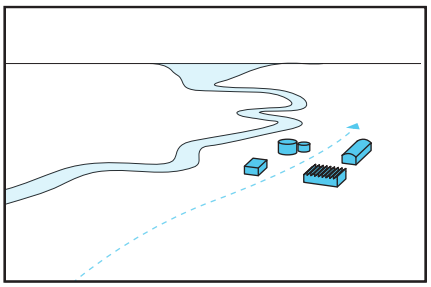
why?



Sectors projected for signficant growth (GLA Economics, 2016)

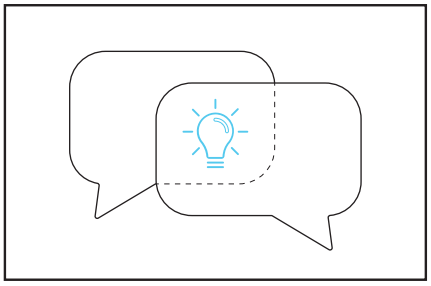


Build on existing and planned cultural amenities



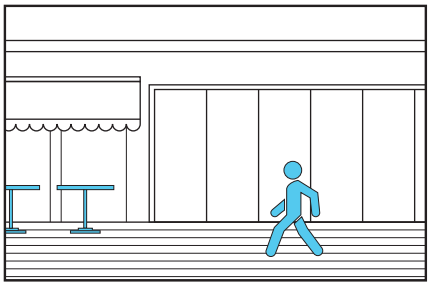
Potential for complementary relationship to new high-tech manufacturing & logistics in Thames Estuary (see chap. 11)

how?

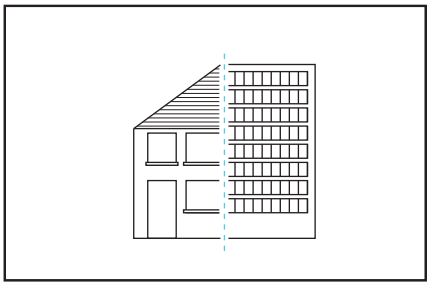


promote interaction environments facilitating knowledge exchange

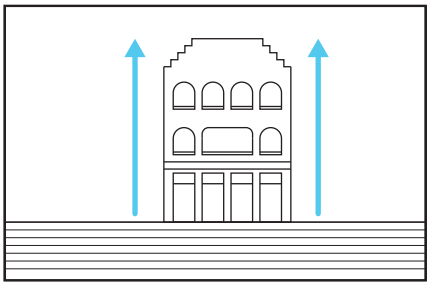
promote a unique identity for and “buzz” around the area



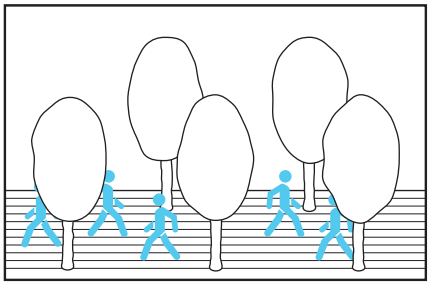
stimulate a rich offer of hospitality and retail supporting activy through-out Woolwich’s streets



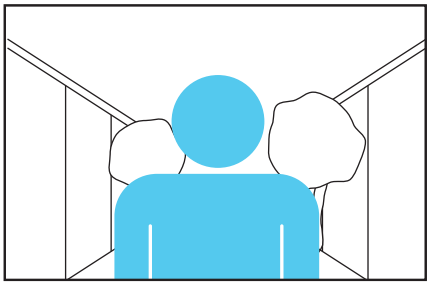
mix residential and commercial uses promoting activity throughout the entire day and week



enhance Woolwich’s historical heritage and character it generates



promote walkability throughout the area



promote human scale throughout the development

▪ Figure 9.1 Considerations regarding the attraction of creative and knowledge services

source: image by author

9.2 Timeline

Having identified the issues and opportunities, potential for redevelopment, and industries to target, the following sections will provide a comprehensive overview of the various actions that need to be undertaken to guide development. This is done via a timeline, as seen on the next page, showing how the different actions are interrelated and phased through time.

The actions taken are built on the insights of the theoretical framework, necessary supporting transit links, and local conditions. A first categorization is made by scale level where actions are classified as belonging to local, regional or governance scale levels. A second categorization is made based on the actions' main goal by which they are divided into various categories derived from the centrality development framework. To this a final category, "development", is added, relating not the creation of conditions, but rather to the actual deliverance of floorspace.

The timeline provides a comprehensive overview of the phasing and interrelation of local, regional and governance actions needed to guide development.

Apart from the Centrality Development framework another concept discussed in the theoretical framework takes a central role: the land-use feedback cycle. Briefly put this cycle explains that activity is stimulated by the accessibility that transport infrastructure provides, while vice-versa activity generates travel demand that necessitates or justifies the development of additional infrastructure (Chorus, 2012). This concept has been central to the phasing as seen in figure 9.2. The first phase stimulates activity throughout the area and creates leverage for the first significant infrastructure investment; creating the southern section of the new transit tangent. The creation of this tangent subsequently enables the development of the town centre and a business or university campus at the Royal Artillery Barracks. These developments again create leverage for the investments in the northern leg of the new transit tangent. The additional accessibility generated by this tangent, again, unlocks the next stage in the development of new floorspace.

The phasing makes use of the insights from the land-use feedback cycle by seeking to build critical mass as leverage for infrastructure investment that enables the next step in development throughout its various phases.

While much deliberation has gone into the phasing and interrelation of actions presented in this timeline it should not be understood as a blueprint. Given the long timespan of this strategy it must be expected that conditions change in ways unforeseen and the impacts or success of actions might differ from initial expectations. Hence, it is essential to maintain a critical and flexible attitude throughout the process in regards to the timeline presented in order to safeguard the goals set out for Woolwich's development.

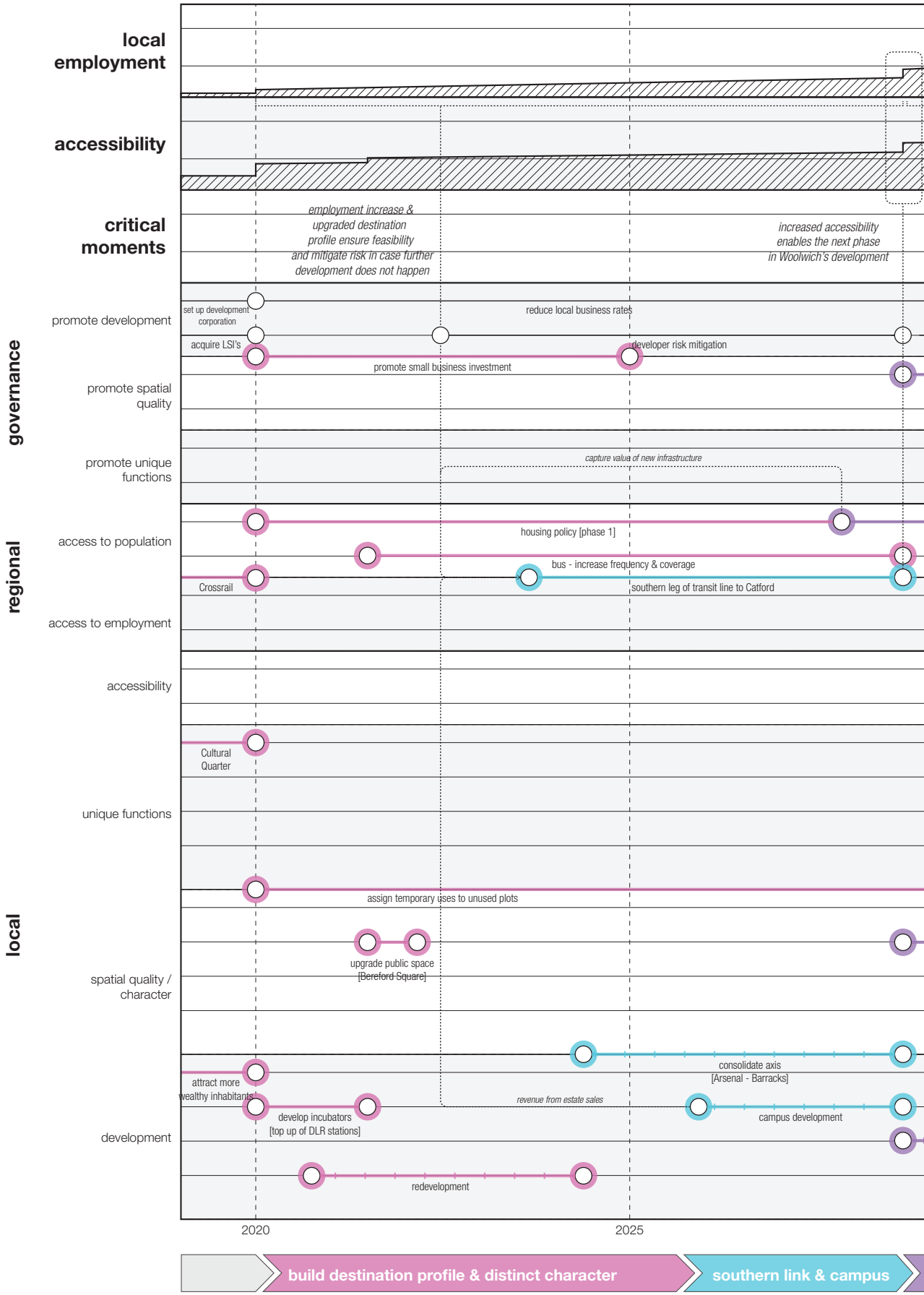
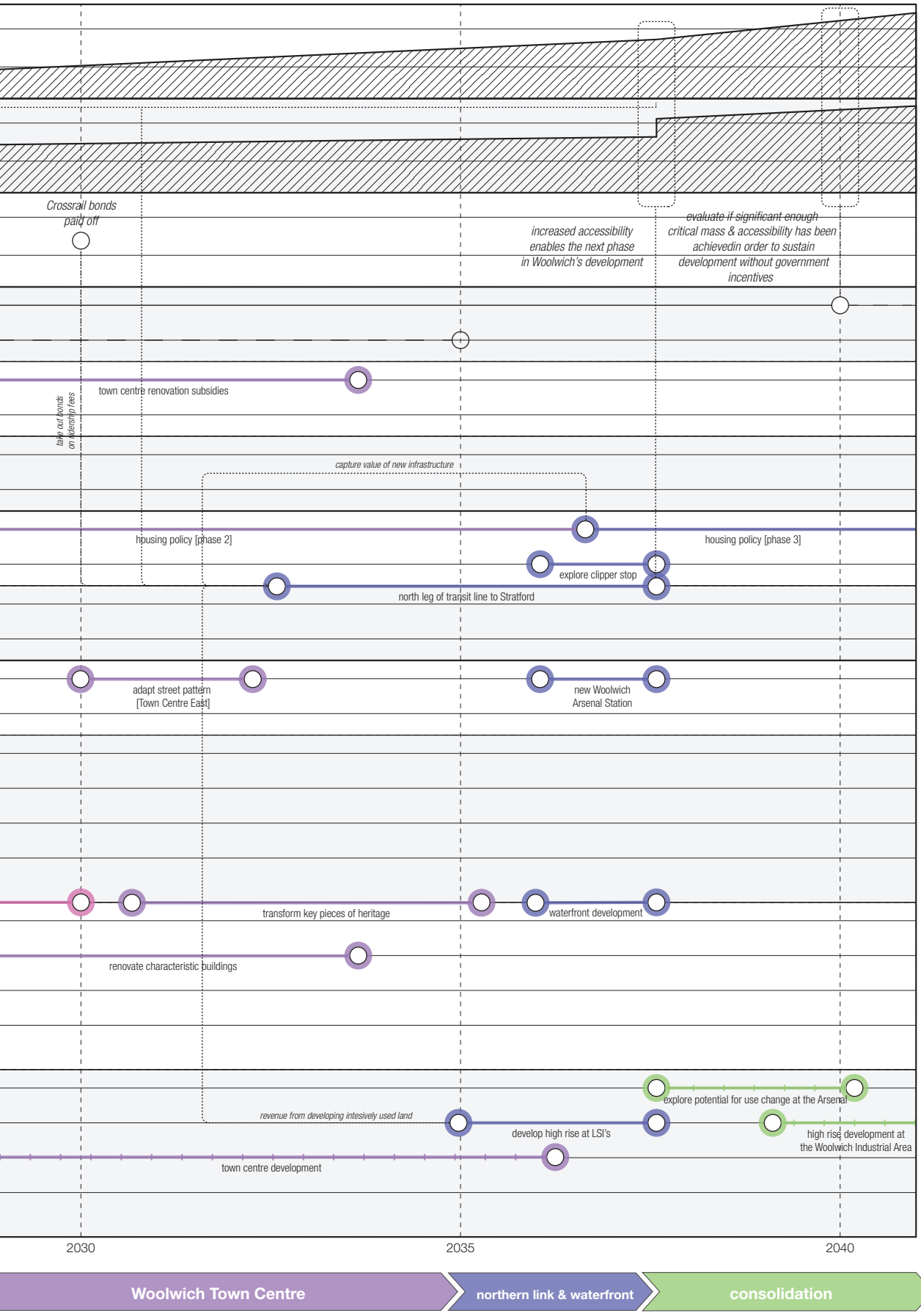


Figure 9.2 Timeline

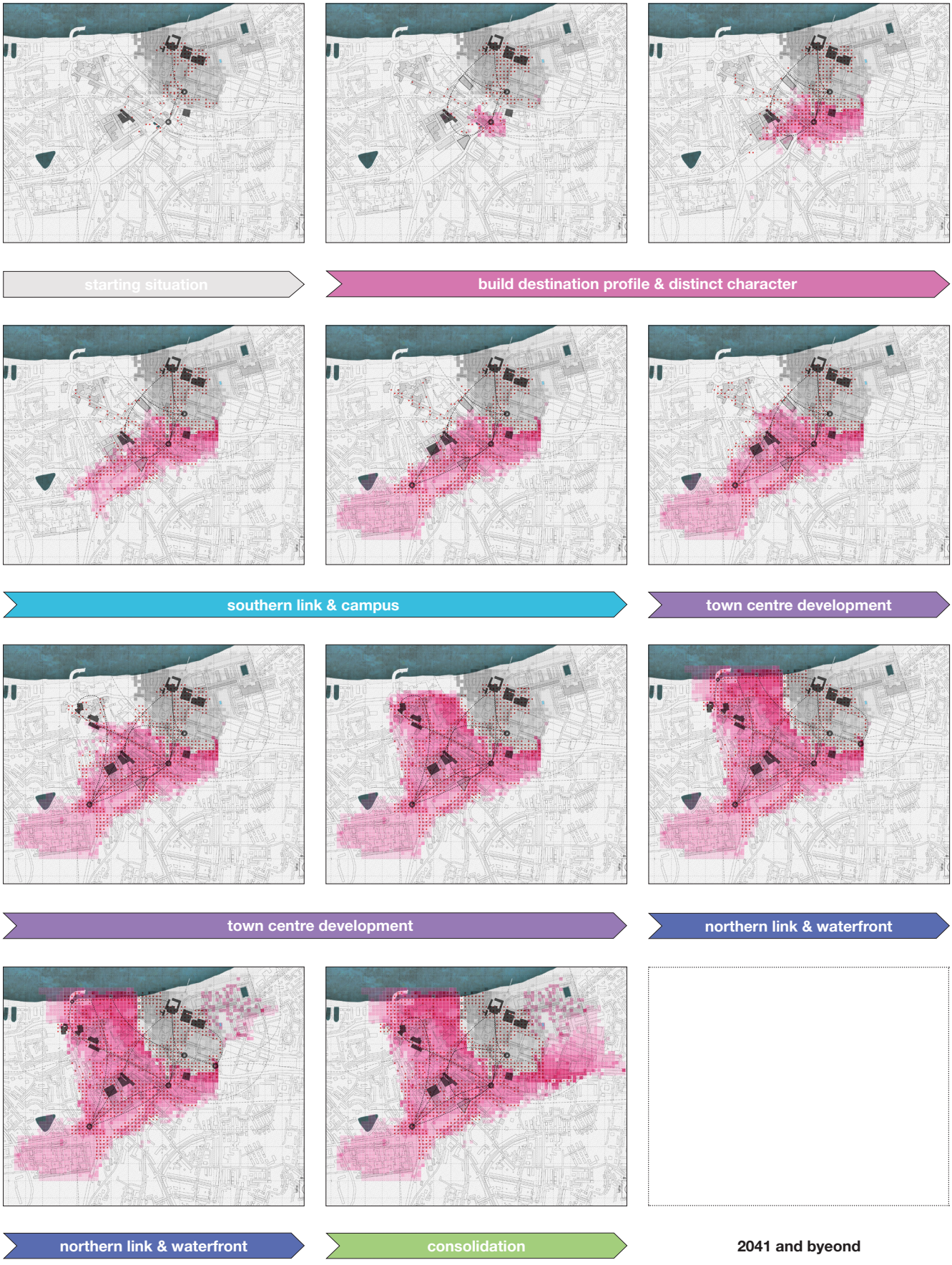


source: image by author

9.3 Phasing

Having established the general phases of development, the actions taken, as well as their interrelations, this section will describe the manifestation of the strategy in space. This is done through a timeseries of maps highlighting the specific actions underway at particular times. The most relevant of these actions are explained in further detail in the strategic guide in the next chapter. These can be recognized by the black circle besides their name, the first letter indicating their scale level (L, R, or G) followed by a number referencing their position in the strategic guide.

Throughout the maps presented here no hard definition is given to the specific plots being developed. Given the guiding role of planning advocated in this thesis, this approach is preferable, focussing on the conditions and frameworks around which development can take place in a flexible fashion rather than providing a blueprint for development.



▪ Figure 9.3 Overview of the development phasing

source: image by author

At the beginning of the project, the seeds for kickstarting development are already there. Crossrail will have arrived boosting accessibility, Berkeley's Royal Arsenal Riverside development will have brought inhabitants with increased spending capacities into the area providing an uplift for local business and with the creation of the planned Cultural Quarter Woolwich will feature a unique set of cultural institutions. While the Arsenal is indicated on the maps, due to the important conditions it provides to support development, new developments will primarily take outside this area rather than in it. While little active interventions are done in the area, incremental changes in the Arsenal are of course to be expected as its surroundings transform dramatically.

> Royal Arsenal Riverside

> Woolwich Creative District

> Woolwich Public Market

> Millennium Performing Arts College

supporting actions

> set up development corporation G1

> acquire locations of strategic interest G2

> set up development monitoring system G3

In order to start development the existing DLR stations will be topped up with incubators offering upcoming businesses a chance to capitalize on the opportunities of an upcoming area. Attractivity is further stimulated by a reduction of local business rates. Various derelict sites will be given temporary functions enhancing leisure opportunities and small business investment will be stimulated in order to stimulate retail and hospitality offer and the interaction environment they can help generate.

- Arsenal
- Mix-Use Development
- Enhanced retail & hospitality
- Special functions
- Station

> temporary uses for derelict sites L1

> promote local business investment

> develop incubators by topping up DLR stations L2

supporting actions

> Increase bus frequency & coverage R1

> Housing policy directives [phase 1] R4

> Reduce local business rates

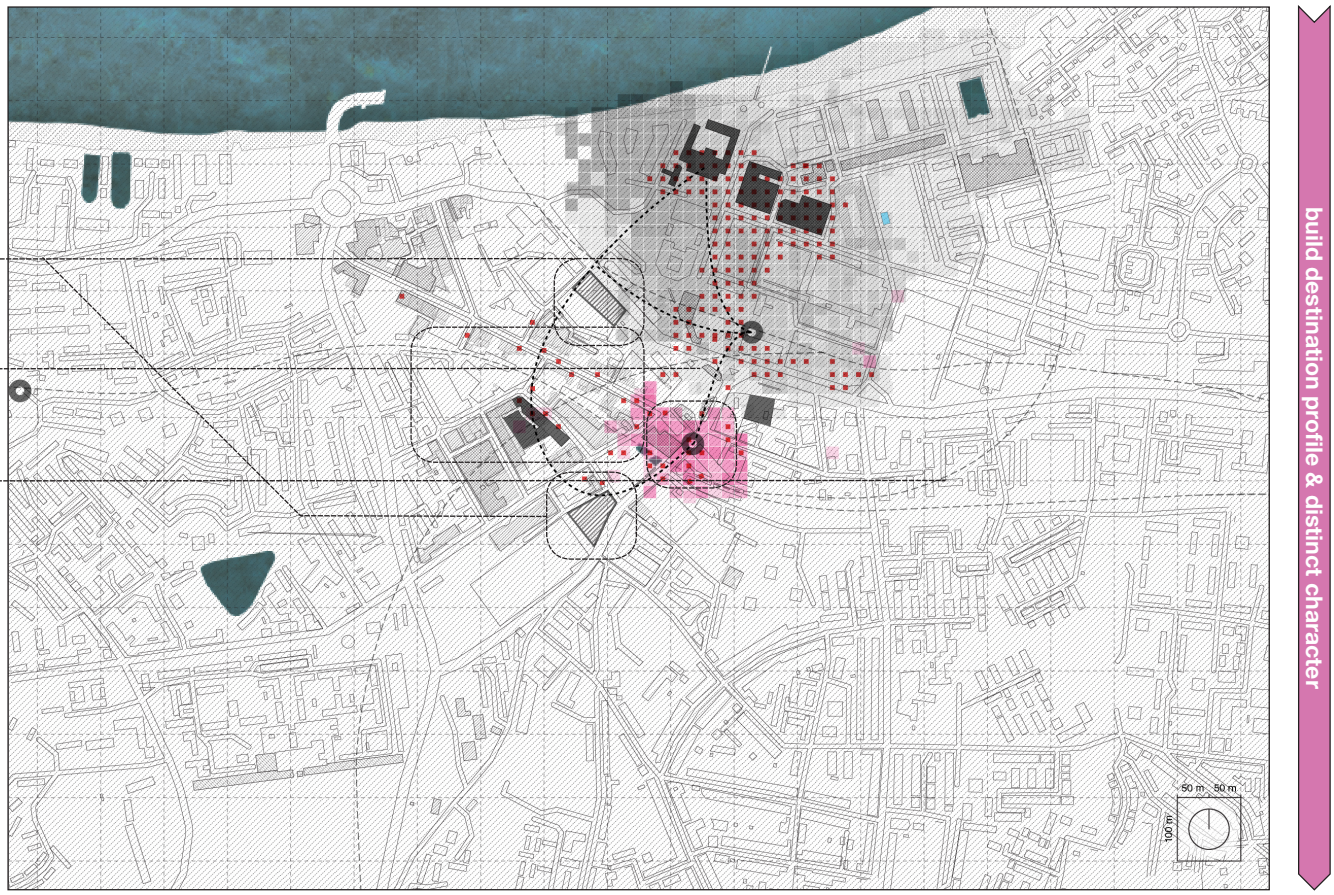


Figure 9.4 & 9.5 Starting situation and first development step

source: image by author

The first new mix-use developments are focussed on the area around Bereford Square as this is the most reachable from both stations. In order to support these employment functions the frequency and coverage of bus services will be increased as a relatively inexpensive way of increasing accessibility during the early phases of development. Finally, efforts are undertaken to improve the public spaces at Bereford Square strengthening the connection between the Arsenal and Town Centre aimed at enhancing the ease of pedestrian traffic. This will further integration and synergy of the Arsenal's transformed heritage and the new developments taking place.

> public space improvement

> redevelop town centre blocks L3

supporting actions

> Increase bus frequency & coverage R1
> Housing policy directives [phase 1] R4
> Reduce local business rates

Now that the connection between the arsenal and the town centre squares are improved, efforts are undertaken to further consolidate the axis toward the Royal Artillery Barracks. Special care is taken to fill gaps in the surrounding urban fabric better delimiting space and promoting active uses on ground floors.

> consolidate axis L4

> redevelop poor quality building stock

supporting actions

> Increase bus frequency & coverage R1
> Housing policy directives [phase 1] R4
> Reduce local business rates

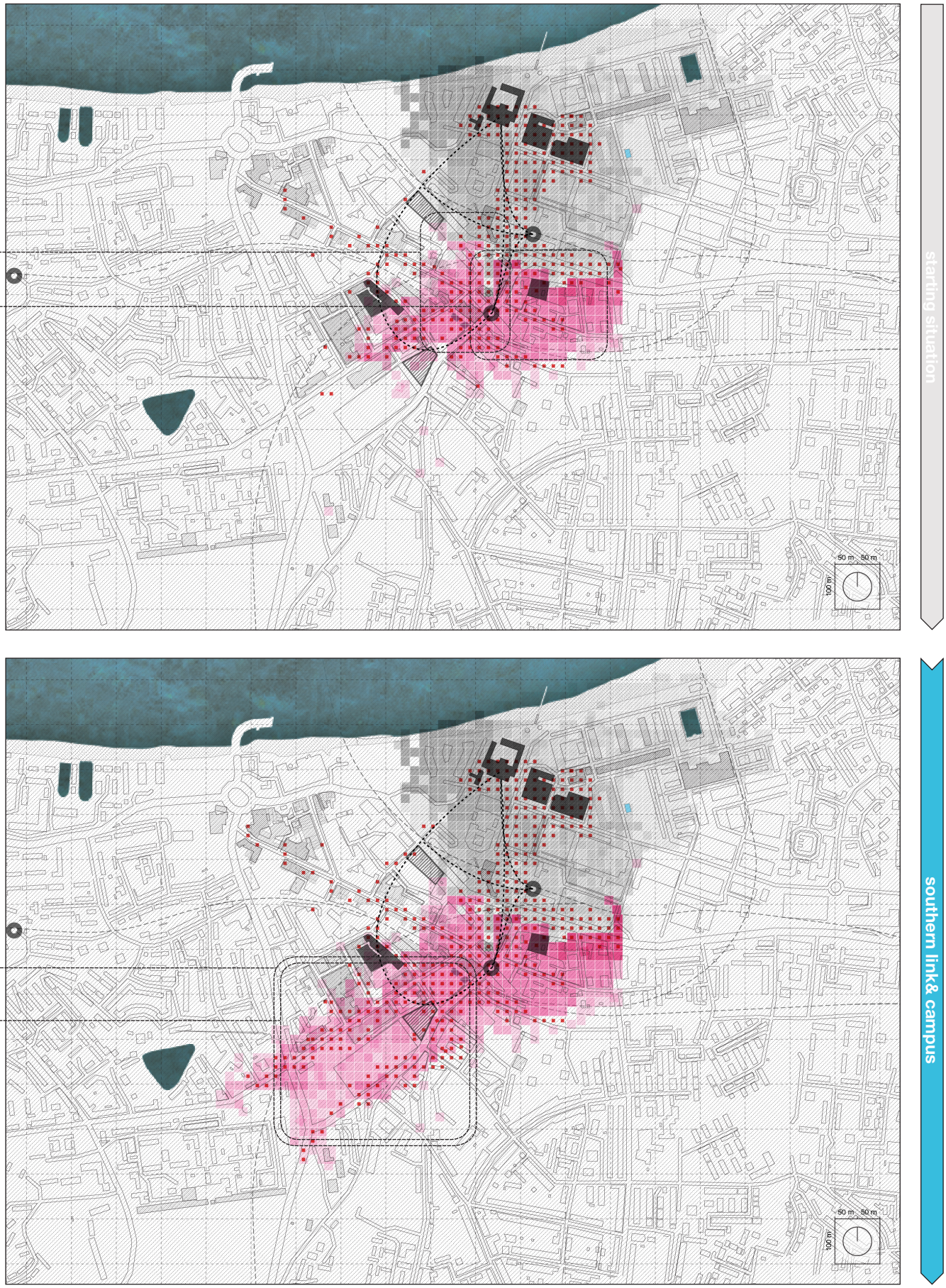


Figure 9.6 & 9.7 Overviews from the development phasing

source: image by author

As development at Woolwich has reached sufficient critical mass, it provides sufficient critical mass to warrant the construction of the southern leg of the new transit tangent. The opening of this new line enables the transformation of the Royal Artillery Barracks into a university or business campus. With the opening of this campus the north-south axis running through the area now has strong attractors at both ends, with the transformed Royal Barracks at its south and the Arsenal at its north end. Meanwhile, key pieces of heritage north of this axis will be transformed as a way of drawing this newfound activity deeper into the town centre.

supporting actions

> Housing policy directives [phase 2] R4
> Reduce local business rates

> transform key pieces of heritage L6

> opening of Royal Barracks Station & southern leg of the new transit tangent R2

> convert of Royal Artillery Barracks to business or university campus

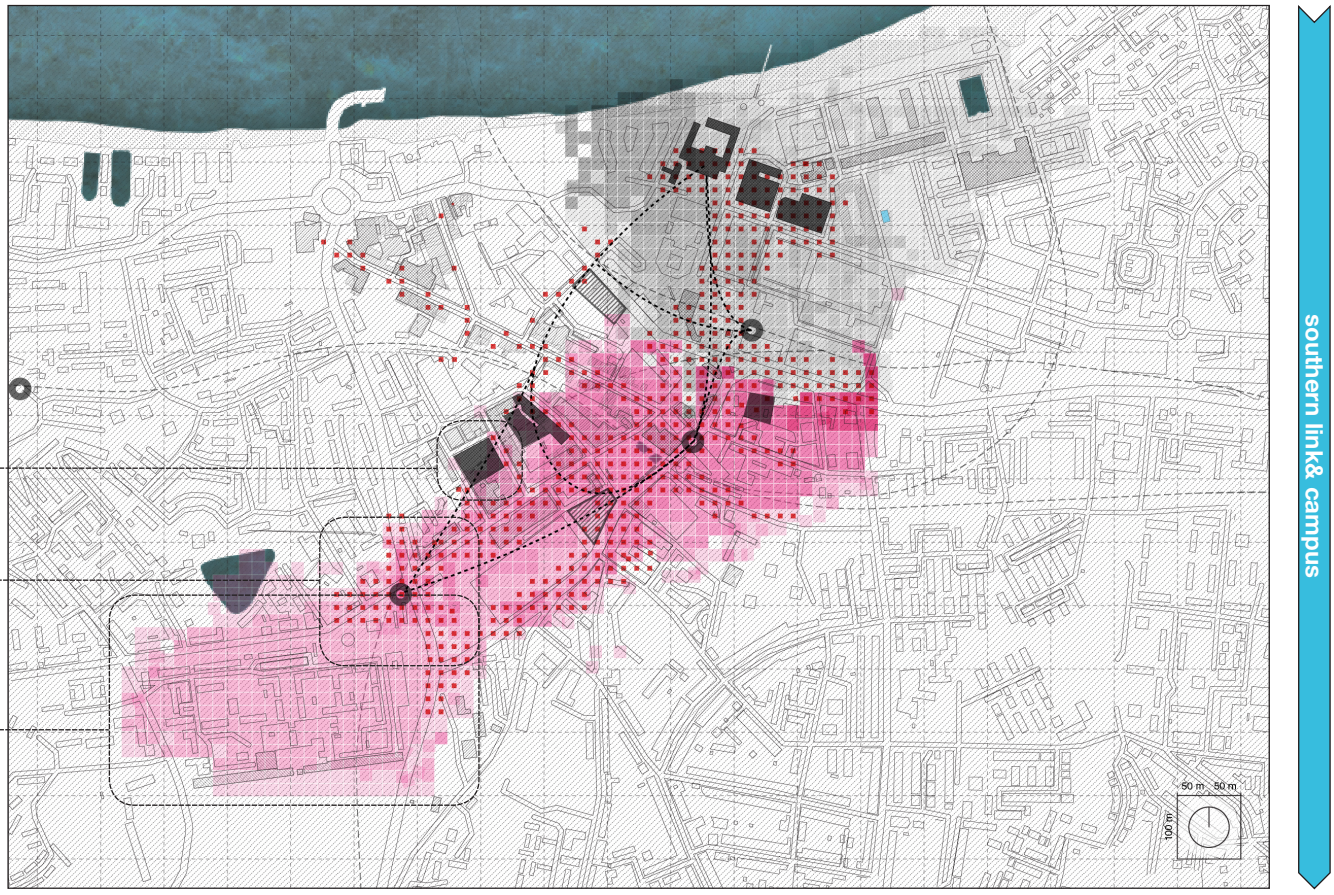
Redevelopment of the town centre blocks start while subsidies are given out to improve the characteristic buildings already there.

> redevelop blocks L3

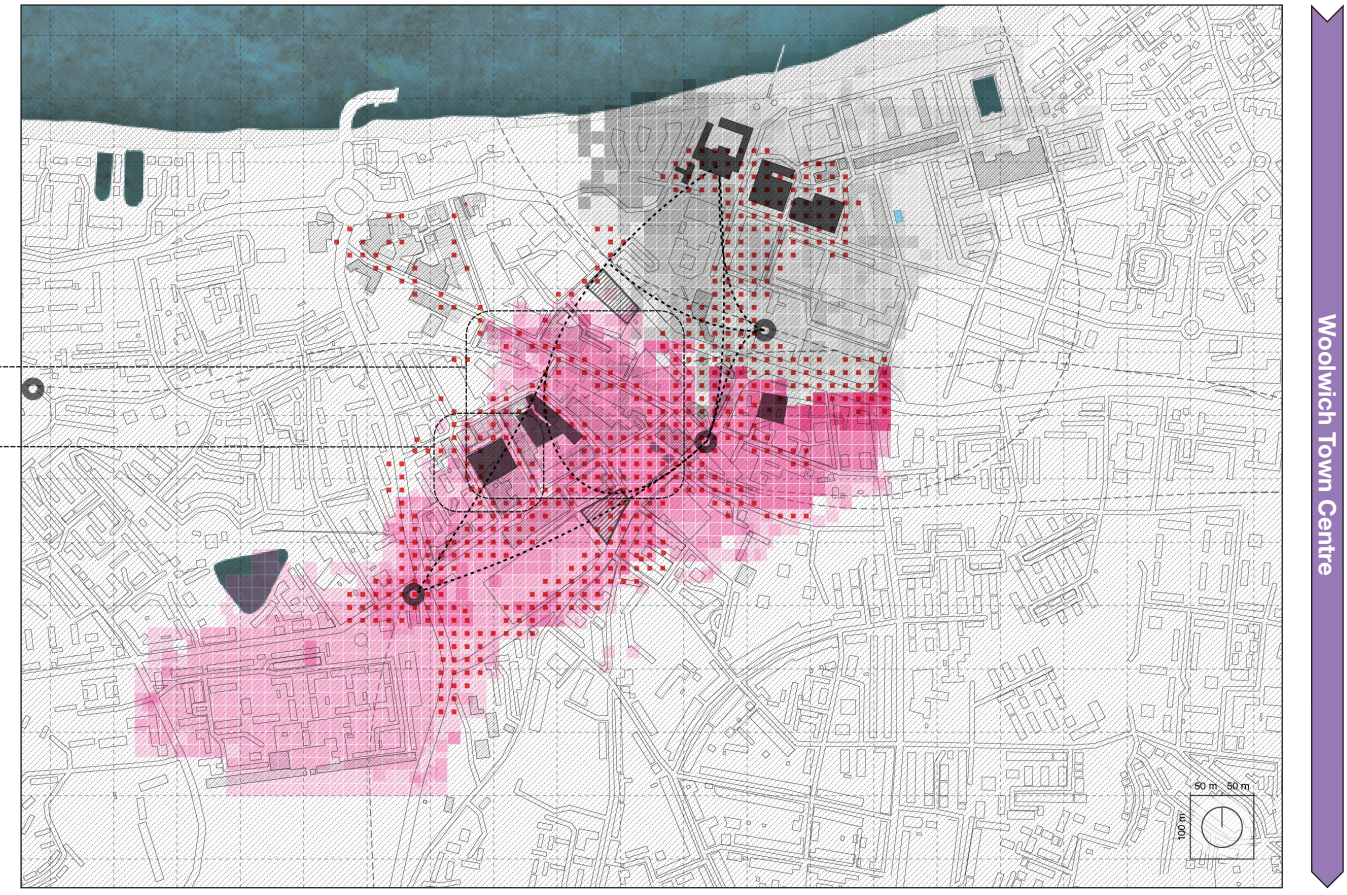
> transform key pieces of heritage L6

supporting actions

> Housing policy directives [phase 2] R4
> Reduce local business rates
> Town centre renovation subsidies



southern link& campus



Woolwich Town Centre

Figure 9.8 & 9.8 Overviews from the development phasing

source: image by author

As town-centre development continues, more key pieces of heritage will be transformed towards the north end of the town centre's main street. This will aid the street, which as seen in the previous chapter is well integrated into the stations' catchment areas, to become a lively backbone for further development.

supporting actions

> Housing policy directives [phase 2] R4
> Reduce local business rates [reassess]

> transform key pieces of heritage L6

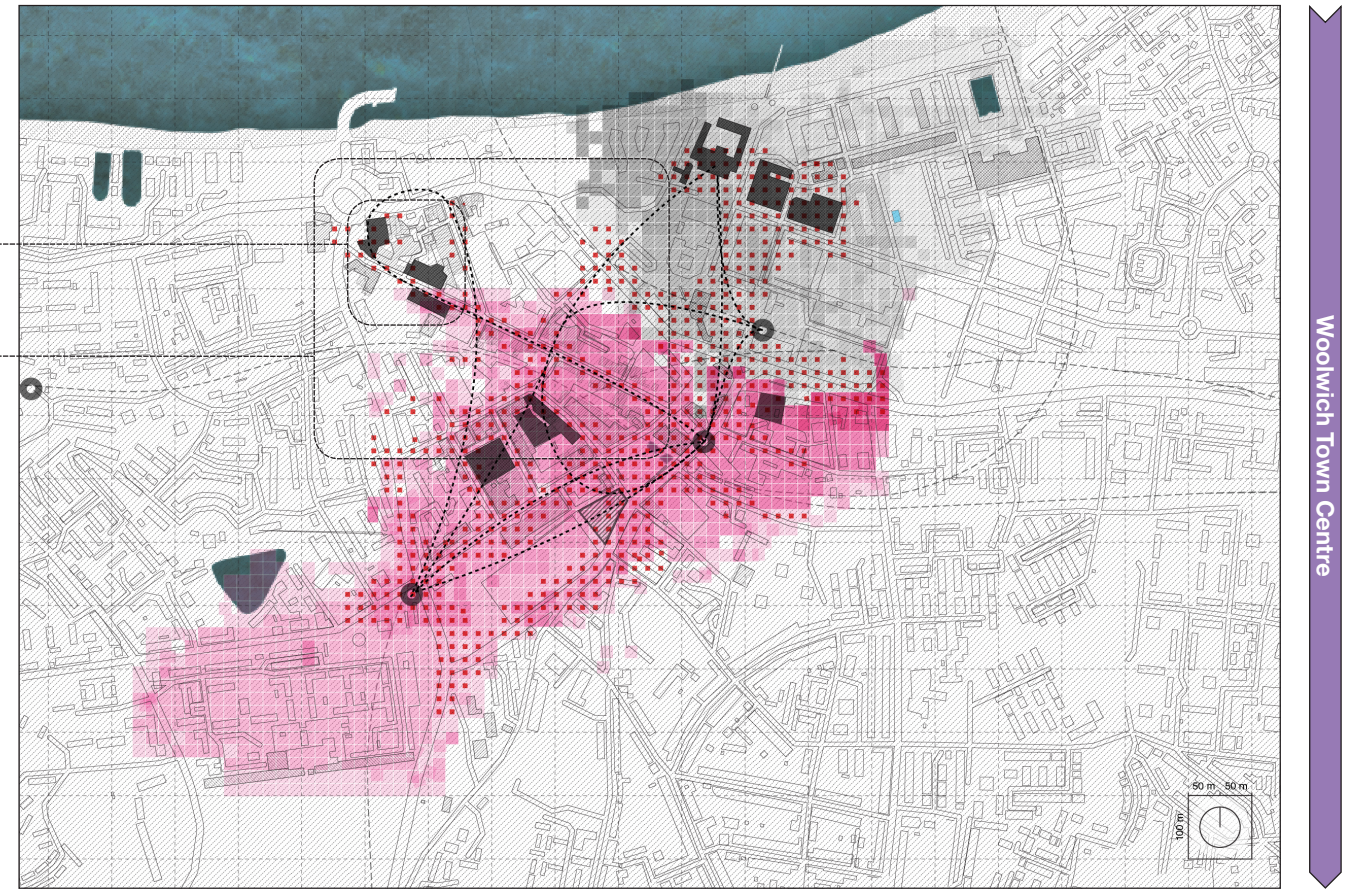
> redevelop blocks L3

Redevelopment of the town centre completes and the derelict sites with temporary uses are redeveloped as the offer of hospitality and leisure amenities throughout the area has increased significantly.

> redevelop blocks L3

supporting actions

> Housing policy directives [phase 2] R4
> Reduce local business rates



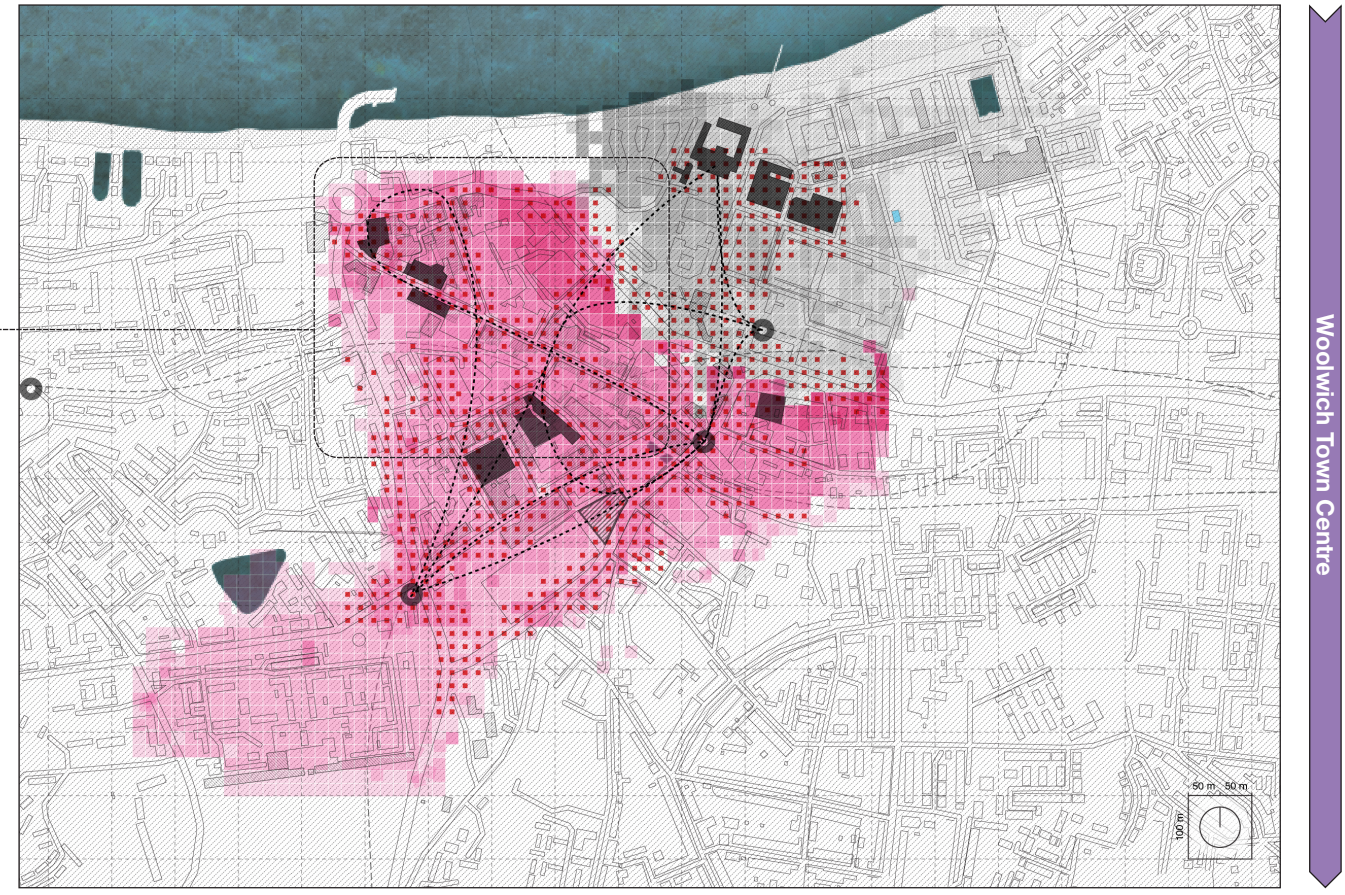


Figure 9.10 & 9.11 Overviews from the development phasing

source: image by author

At this point the critical mass of employment, and revitalization of the Arsenal and town centre have made Woolwich a true destination in the region. Enabled by the high travel demand, this position will be strengthened further by the opening of the northern section of the new transit tangent. In combination with this extension a new station will be opened, befitting of the Woolwich's new position in the region.

> **explore new Thames Clipper stop**

> **develop waterfront** L7

At the previously acquired Locations of Strategic Interest new high rise commercial buildings are erected. This sizable investment is now possible as the area is now developed enough as a commercial centre to mitigate the risks involved as well as due to the improved network position derived from the metro extension to Stratford. Oriented towards the waterfront, he high-rise developments will be linked back to the Arsenal side with a new waterfront promenade. Along the promenade the potential for a new Thames Clipper stop will be explored. This could help mitigate the fact that it is relatively far, roughly a six to eight minute walk, from the closest station. However, even if a new stop is deemed unfeasible or ineffective the character and life of the newly developed mix-use area between the station and waterfront should make for an attractive walk not posing significant issues.

> **develop high rise commercial space at previously acquired locations of strategic interest** G2

> **opening of northern leg of the Arsenal Line & creation of a new station** R3 L8

supporting actions

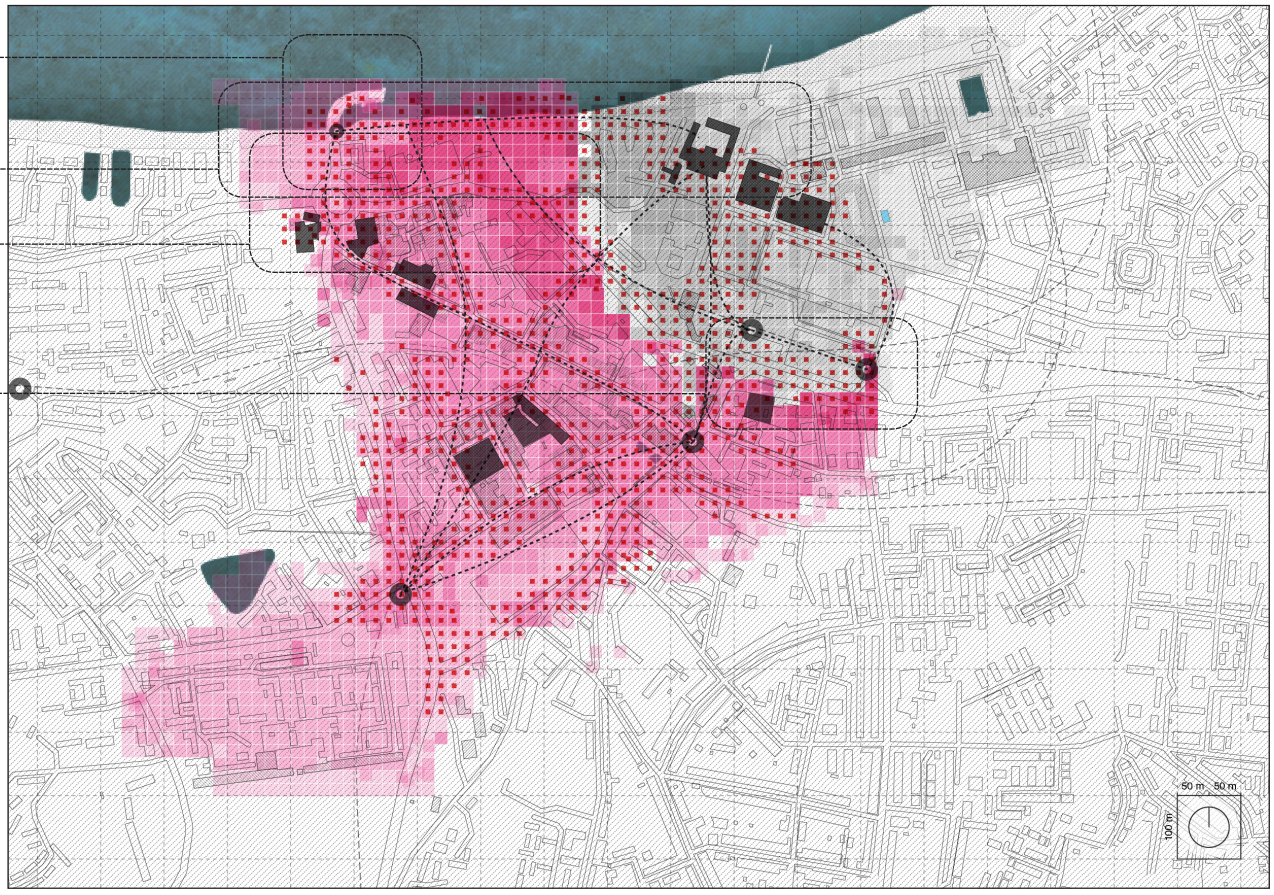
> **Housing policy directives [phase 3]** R4
> **Reduce local business rates**

With the ongoing development of Woolwich the creative businesses that kickstarted its develop-ment are likely under increasing pressure to move out from larger more profitable enterprises. In order to maintain the creatives that have been so essential into making the area into what it is, the possibility for use changes within the Arsenal will be explored actively. Currently offering mostly residential spaces, the smaller spaces in these subdivided buildings could prove more suitable to small start-up business than the larger companies that continue to move into Woolwich. This would provide the creatives a new home at the heart of the area's heritage.

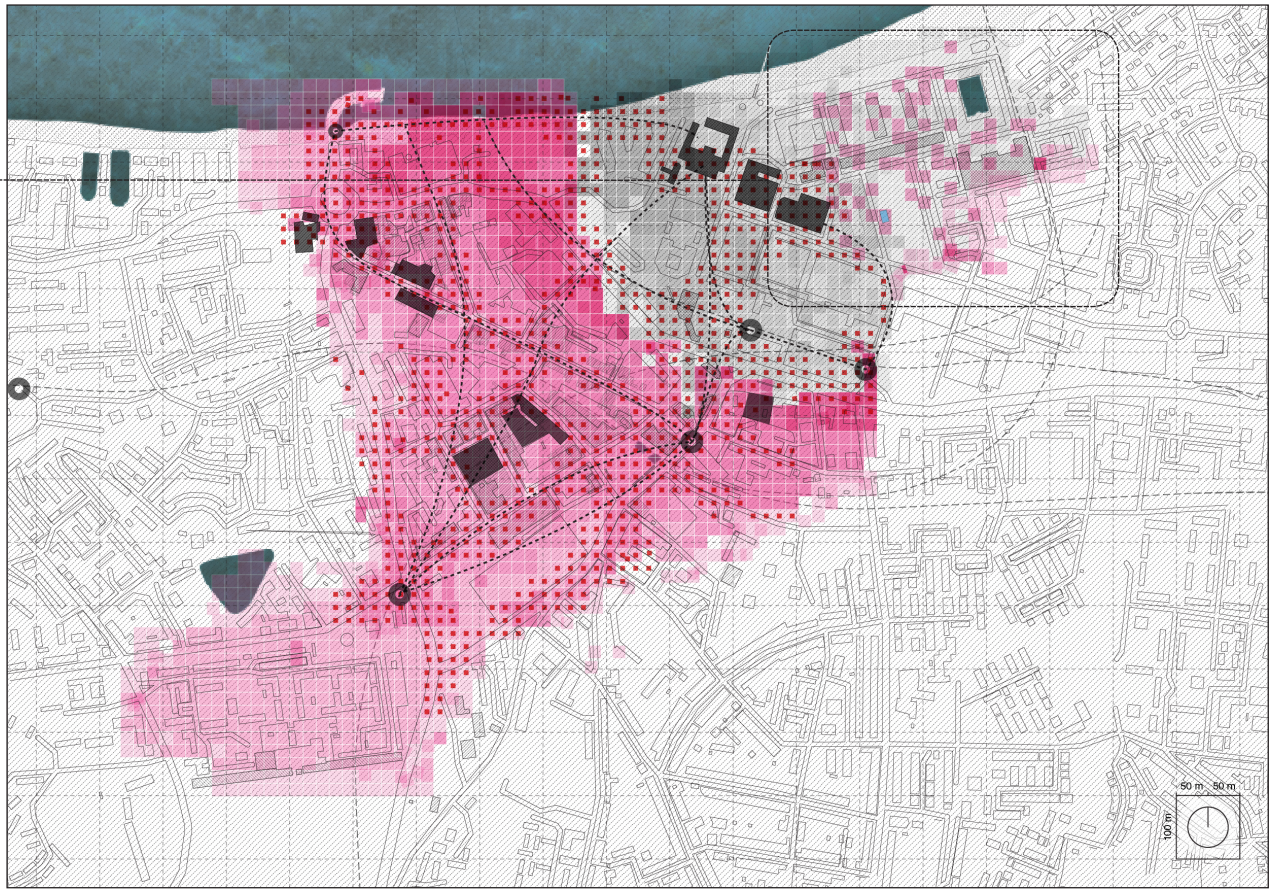
> **explore potential for use change at the Arsenal** L9

supporting actions

> **Housing policy directives [phase 3]** R4
> **Reduce local business rates**



northern link & waterfront



consolidation

▪ Figure 9.12 & 9.13 Overviews from the development phasing

source: image by author

As a final step, assuming persistent demand, the Woolwich industrial estate will be transformed into an office location linked to the arsenal and the east-west axis running through the area consolidating Woolwich's position as a significant new centrality within Greater London.

Following the overview, interrelation and phasing of actions presented in this chapter, the next chapter will offer further detail into the most relevant actions undertaken.

> redevelopment of the Woolwich Industrial Estate

supporting actions

> Housing policy directives [phase 3] R4
> Reduce local business rates [reassess]

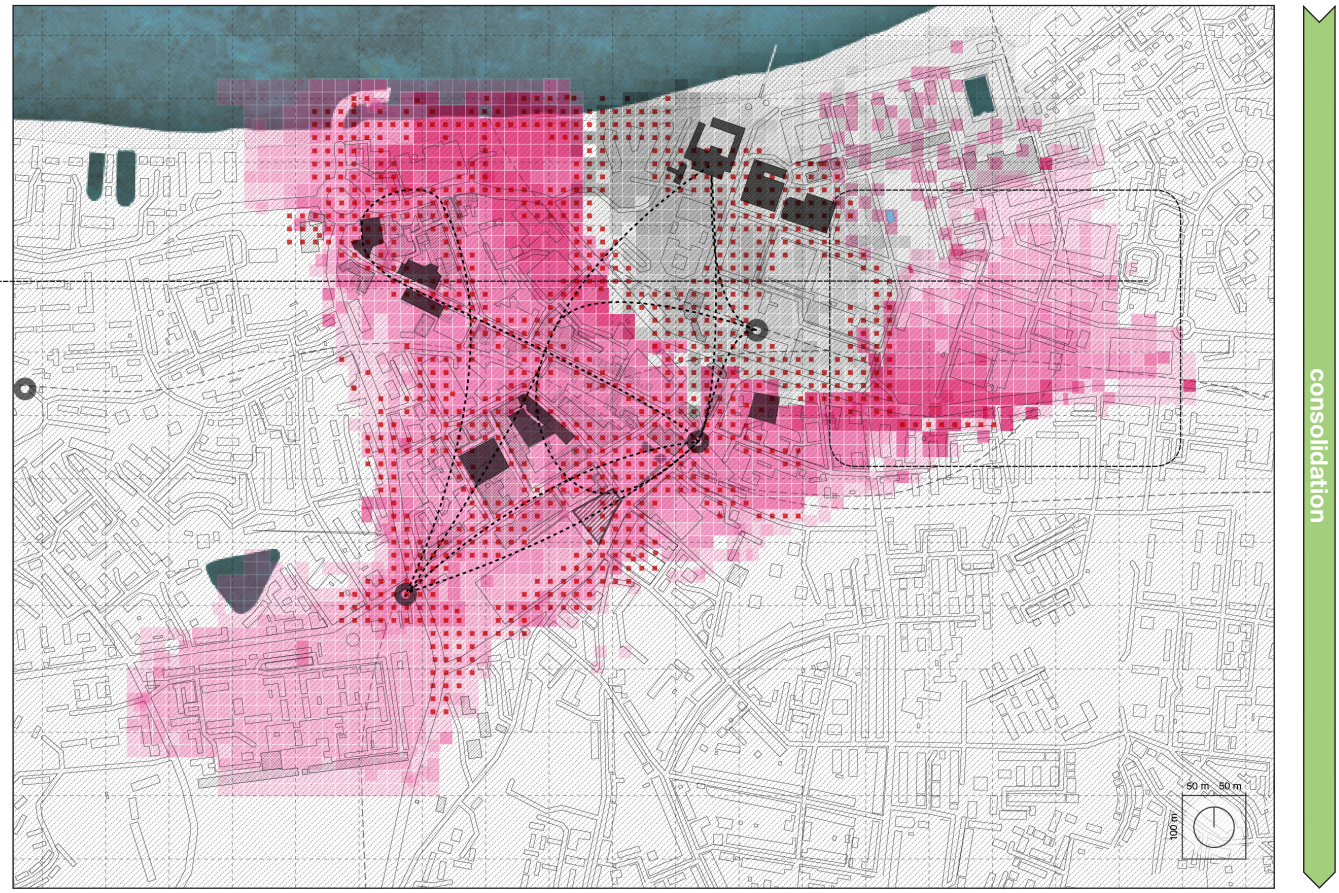
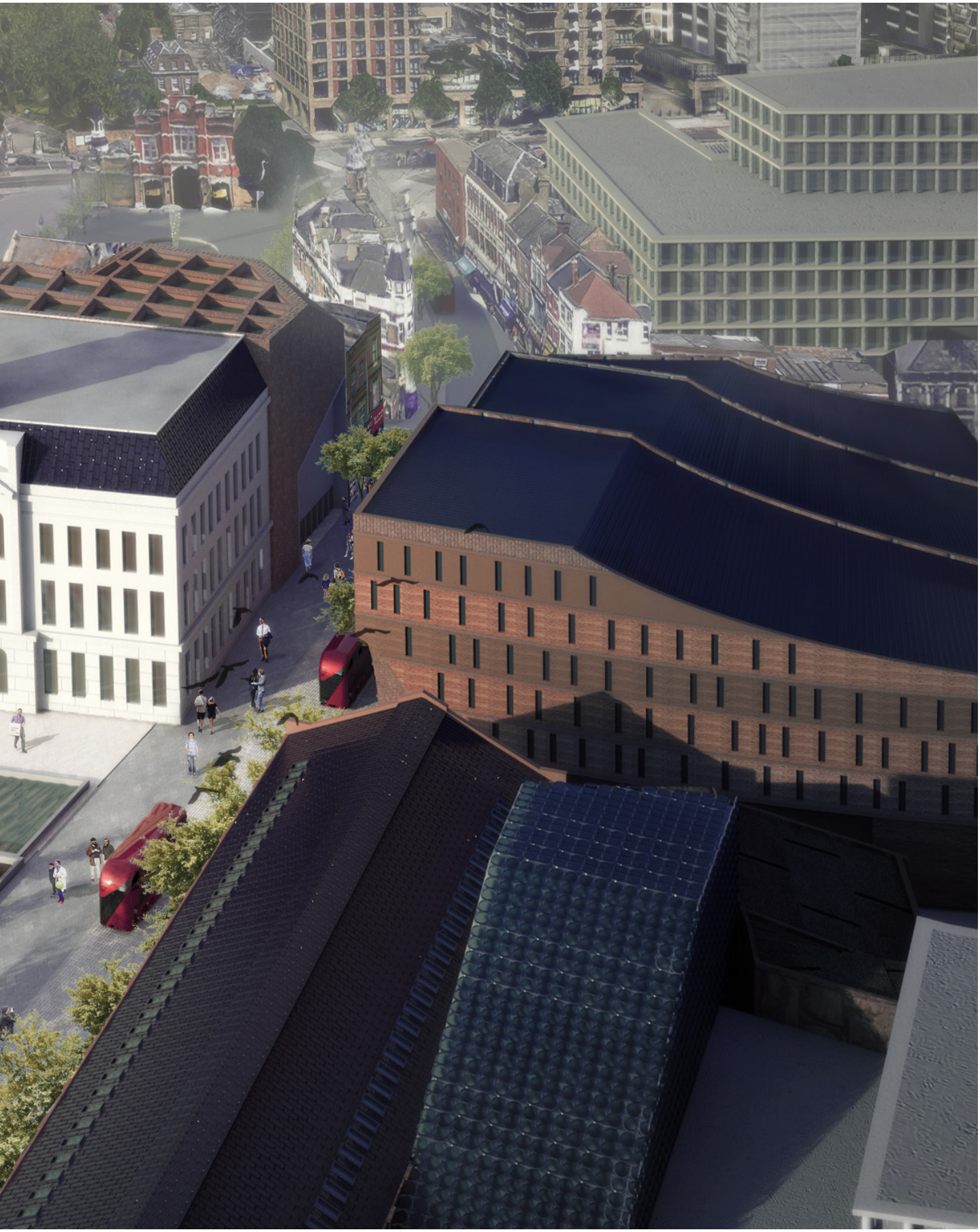


Figure 9.14 Final step of the development phasing

source: image by author

▪ Figure 9.15 View of Bereford Square towards the end of the development strategy



source: image by author

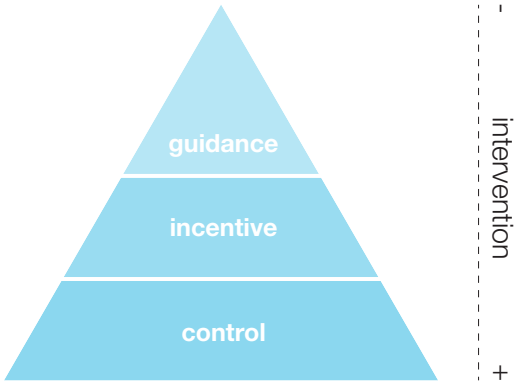
10. Strategic guide

+ local actions
+ regional actions
+ governance actions

This chapter will examine the in the development strategy's most relevant actions in greater detail. The following pages will offer an overview of first the local actions, followed by the regional actions and ending with an overview of governance actions.

Throughout the thesis, and especially the development strategy, there has been a conscious effort to guide development without being overly prescriptive. This approach is of course also reflected throughout the various actions described in this chapter. The regional and governance actions provide a set of frameworks to guide and organize development as well as interventions that help create the conditions needed to support it. The local actions related to design are conceived using Carmona (2016)'s tools for design governance. By situating the actions taking within these tools, they become a framework through which things can happen rather than simply a description of what should happen. This is not only befitting of the style of planning advocated in this thesis but also to the British approach which is still strongly influenced by the neoliberal legacy of Thatcher.

The local actions within this chapter are framed in Carmona (2016)'s formal tools for design governance. By doing so they become a framework in which things can happen rather than merely a description of what should. This allows for greater flexibility and sensitivity to unaccounted for conditions during implementation and fits well the British style of planning.



▪ Figure 10.1 Formal tools of design governance *source: adapted from Carmona (2016)*

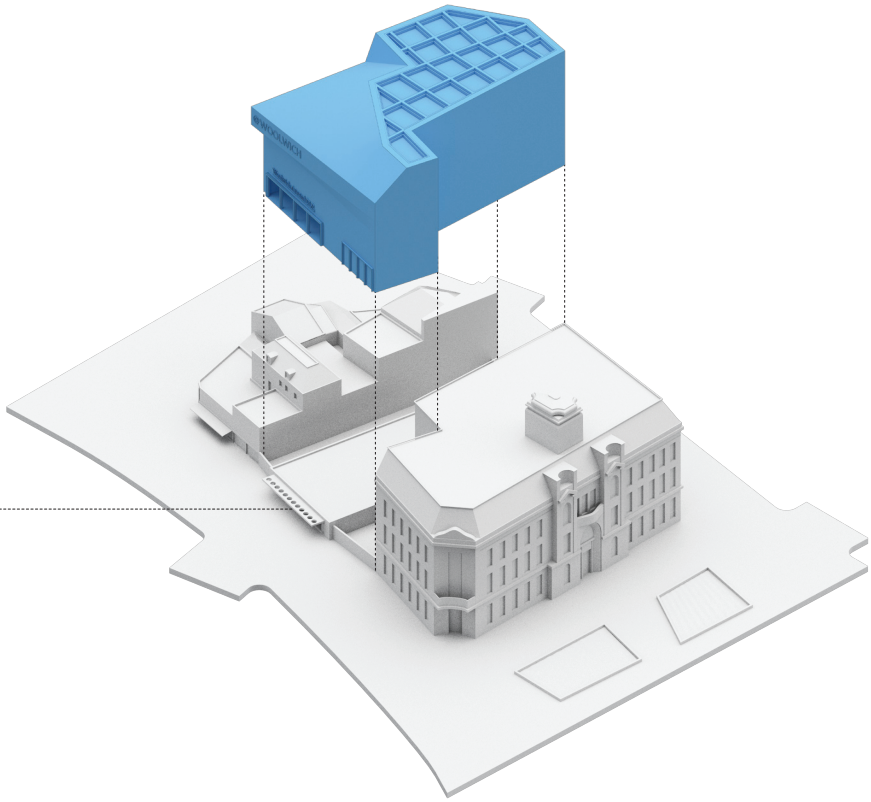
The tools for design governance can be categorized in formal and informal (Carmona, 2016). Due to their more direct and tangible impact, the local actions presented here are framed within the formal tools. These tools can be categorized by their level of intervention as seen in the figure above. In order to maintain flexibility and allow stakeholders more freedom in finding optimal solutions, the actions proposed try to make use of guidance and incentive where possible using control only as a last resort.

Local 1 | Temporary uses for derelict sites

Figure 10.2 Derelict sites are activated by temporary functions *source: image by author*

Local 2 | Develop business incubators

>> incentive
> cheap transfer of government owned land to developers can reduces the investment necessary, lowering the threshold for the first developing the first significant commercial spaces at Woolwich
tool: land-right transfer / lease
actor: Royal Borough of Greenwich / Transport for London



>> guidance
> clearly define urban space by filling in gaps in the built fabric [see “Consolidate Axis”]
tool: development strategy
actor: Woolwich Development Corporation

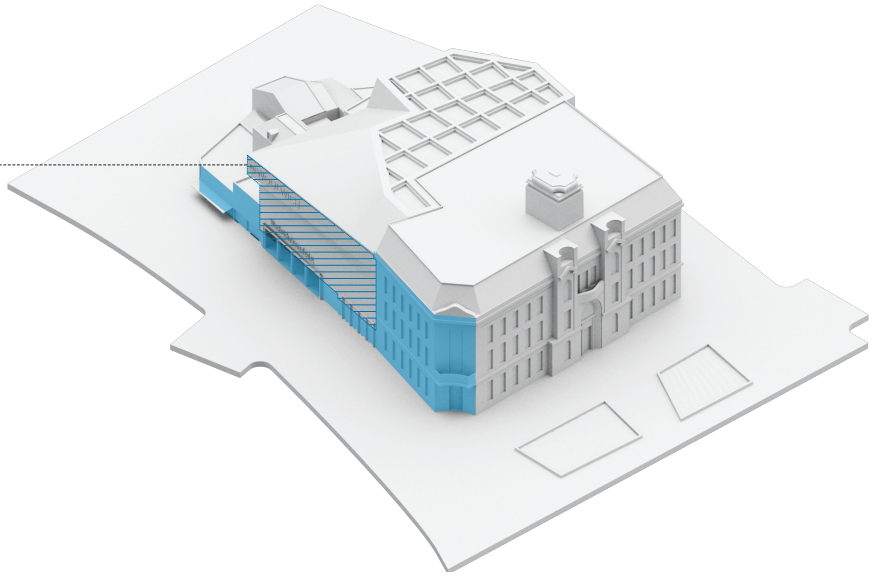
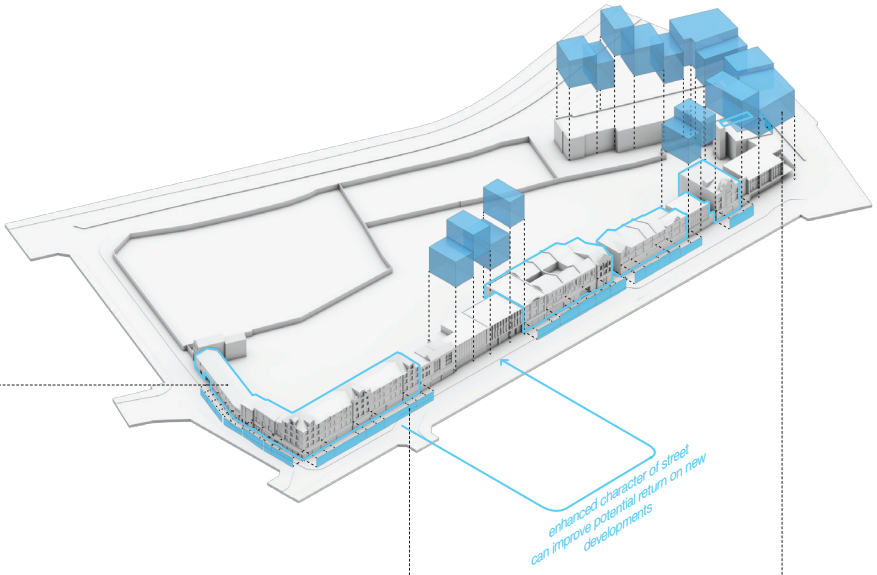


Figure 10.3 Topping up of DLR statios with business incubators

source: image by author

Local 3 | Develop town centre blocks



>> guidance [preferred]
> identify characteristic buildings
tool: development strategy
actor: Woolwich Development Corporation

>> control [last resort]
> preserve characteristic buildings
tool: granting planning permission
actor: Woolwich Development Corporation

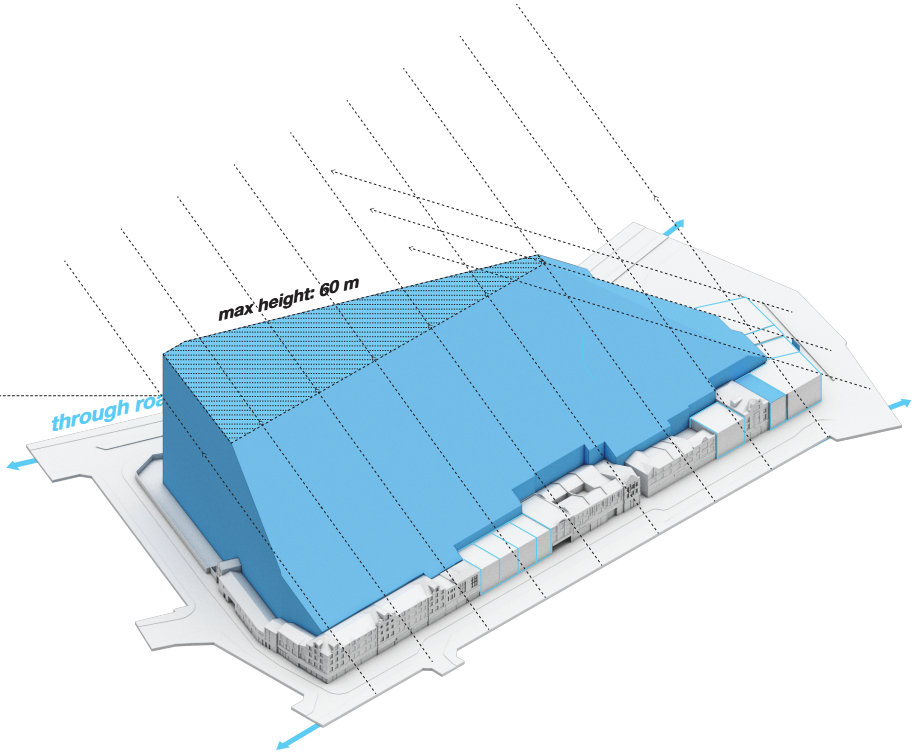
>> incentive
> restoration & improvement of characteristic buildings' shopfronts
tool: granting planning permission
actor: WDC

>> guidance
> enhance character through redevelopment of low quality stock
tool: design guidelines
actor: Woolwich Development Corporation

▪ Figure 10.4 Framework for redeveloping the town centre blocks

Local 3 | Develop town centre blocks

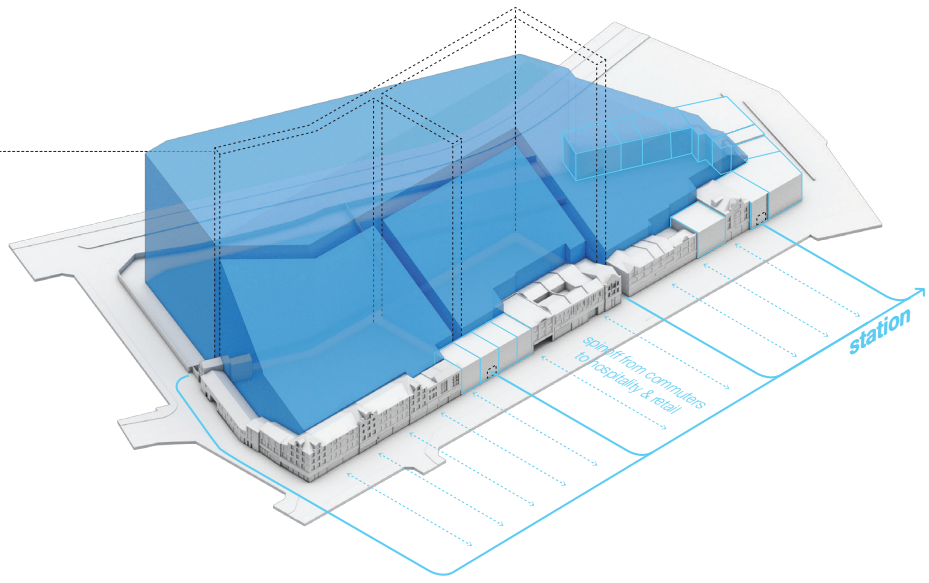
>> control
> maximum building height dependent on sightlines from town centre streets
tool: granting planning permission
actor: Woolwich Development Corporation



indirect incentive

Due to height restrictions potential Gross Floor Area is lower towards the town centre streets. This area is less costly to give up for ciculation

>> guidance
> orienting internal circulation towards highly integrated town centre streets (if dimensions require)
tool: development strategy
actor: Woolwich Development Corporation



source: image by author

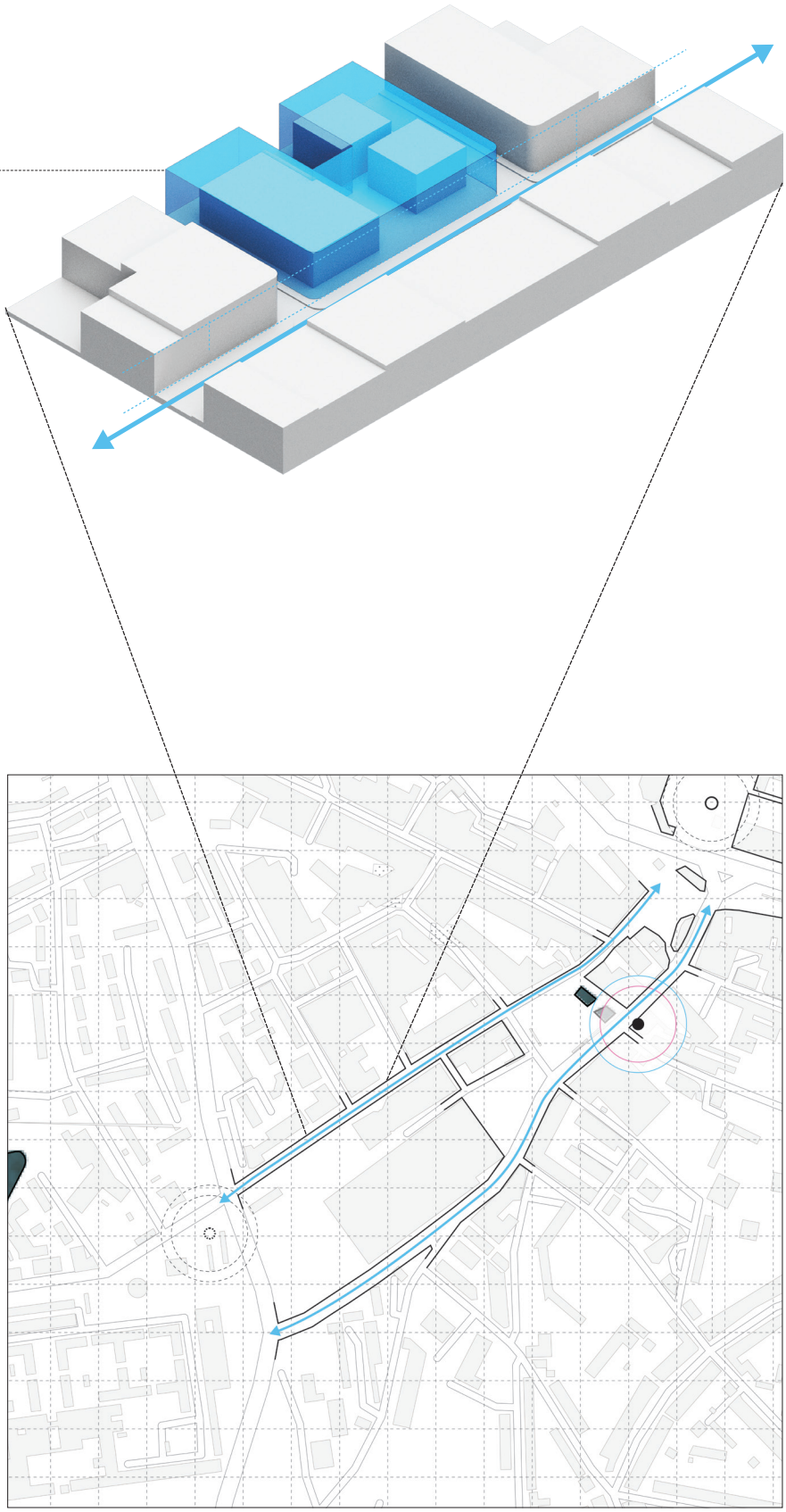
Local 3 | Develop town centre blocks

▪ Figure 10.5 Leaving work in the town centre

source: image by author

Local 4 | Consolidate north-south axis

>> guidance
> improve delimitation of the axis towards the Royal Artillery Barracks through filling voids in the surrounding built fabric
tool: development strategy
actor: WDC

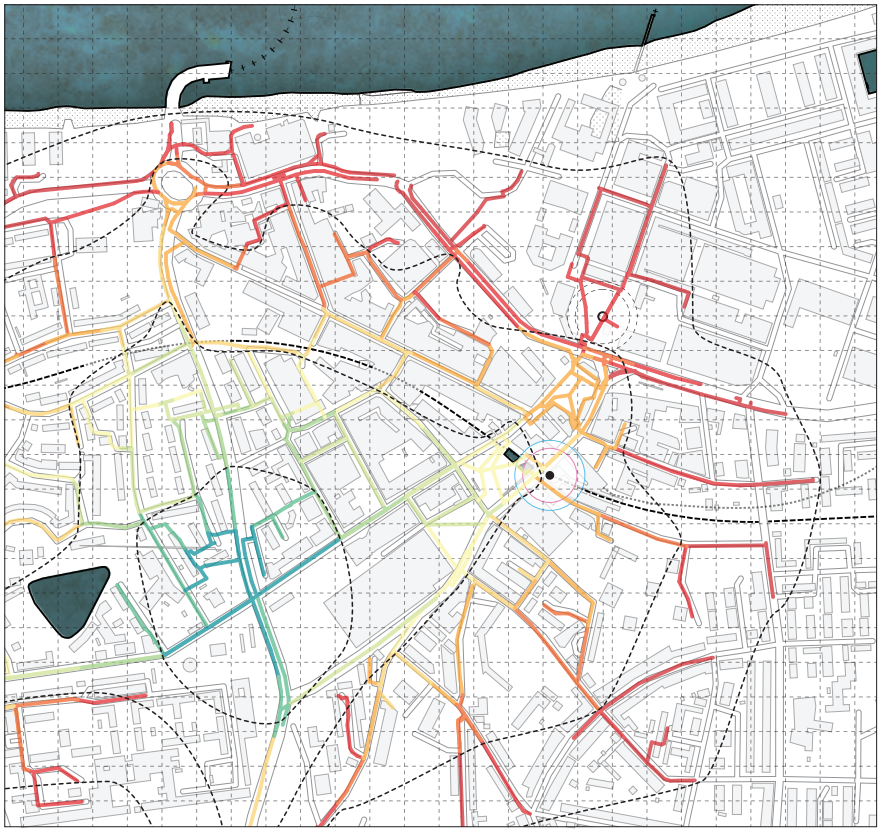


▪ Figure 10.6 Principles for consolidating axis

source: image by author

Local 5 | Adapt street pattern

>> before



>> after

- < 1 min walking
- 1- 3 mins
- 3 - 6 mins
- 6 - 9 mins

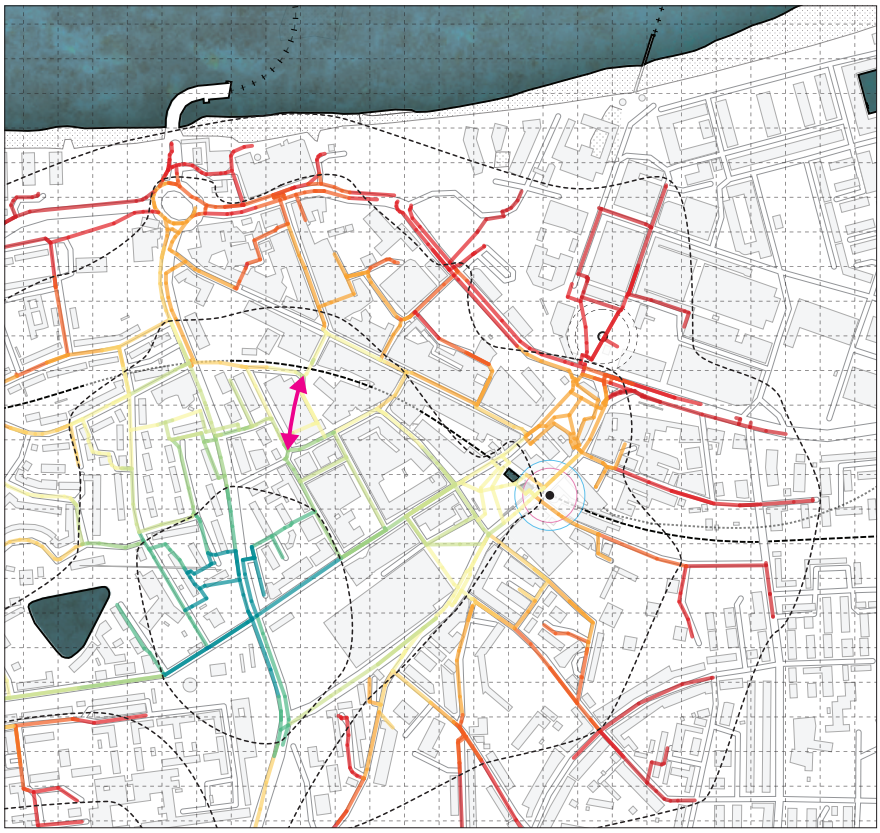


Figure 10.7 Adaption of street pattern *source: image by author*

Local 6 | Transform key pieces of heritage

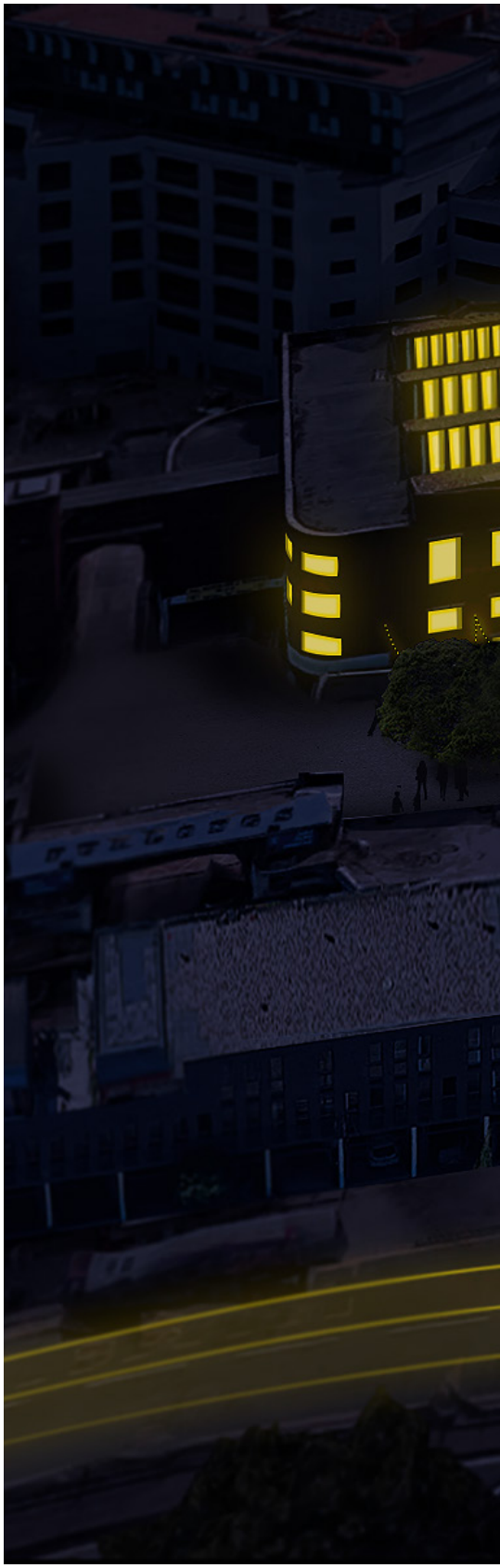


Figure 10.8 Transformation of key heritage

source: image by author

Local 7 | Waterfront development

>> guidance
> increase in scale towards water-front [continuation of Royal Riverside precedent]
tool: design guidelines
actor: Woolwich Development Corporation

>> control
> Inquiry with city airport on maximum building heights
tool: Safeguarded and Obstacle Limitation Surfaces
actor: London City Airport

>> guidance
> Riverside prominade links back to the Arsenal
tool: development strategy
actor: Woolwich Development Corporation

>> guidance
> variation between small alleyways walking streets with active facades creates a pluriform environment oriented towards the river
tool: development strategy
actor: Woolwich Development Corporation

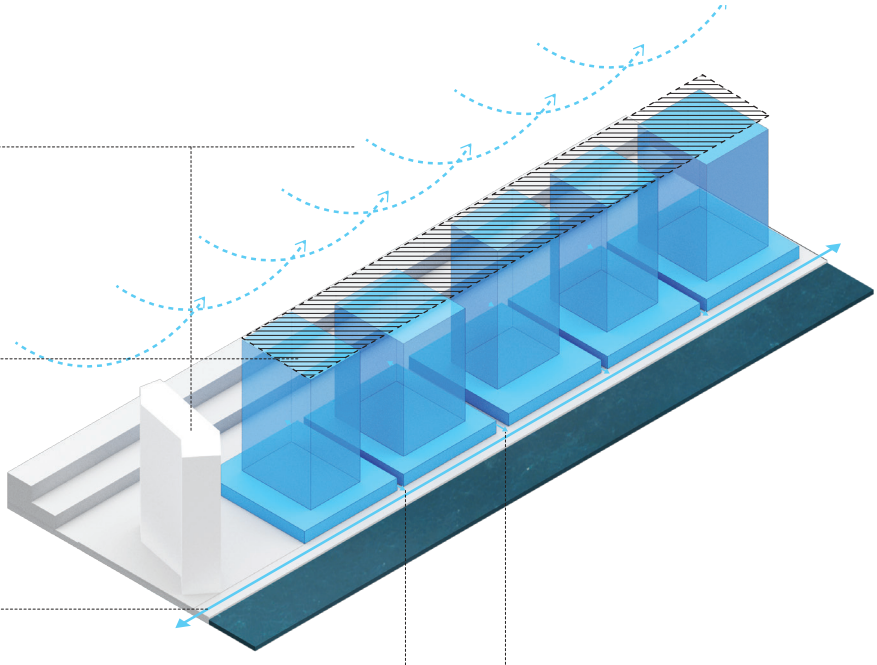


Figure 10.9 Framework for waterfront development

source: image by author

▪ Figure 10.10 View from an alleyway towards the waterfront *source: image by author*

Local 7 | Waterfront development

Figure 10.11 Departing from Woolwich

Local 7 | Waterfront development

source: image by author

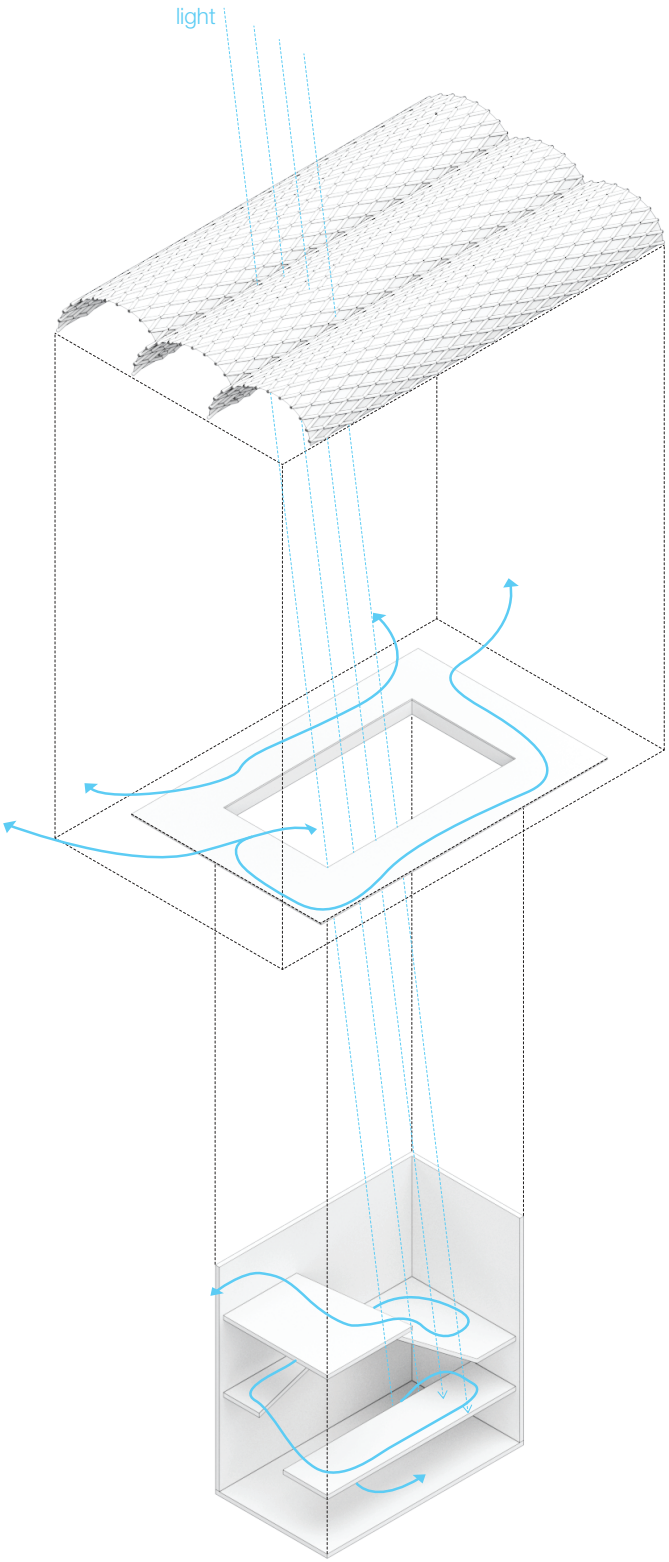
Local 8 | New Woolwich Arsenal Station

Design concepts for successful underground station design
selection from: van der Hoeven and Juchnevic (2016)

>> guidance
>> canopy
> create a seamless transition between inside & outside
> allow daylight to filter into the station
tool: coordination with architect & engineers
actor: Transport for London

>> guidance
>> proximity
> integration of urban functions under canopy and in station box
tool: coordination with architect & engineers
actor: Transport for London

>> guidance
>> open station box & architectural light
> create an open & layered transition down into the station box to allow for overview and play of light filtering down
tool: coordination with architect & engineers
actor: Transport for London



▪ Figure 10.12 Design concepts for successful station design

source: based on van der Hoeven and Juchnevic (2016)

Figure 10.13 Left to right, top to bottom: Canary Wharf Station , King's Cross Station, Liverpool Street Station, Crossrail Place, Southwark Station, Canary Wharf Station

source: image 1,3,4 from Flickr (2019), image 5 from The Times (2017), image 2 and 6 by author

Local 9 | Use changes at the Arsenal

>> guidance
> remove partition floors to improve quality
tool: occupier demand study
actor: developer

>> incentive
> simplify application process for residential - commercial conversion
tool: development strategy
actor: Woolwich Development Corporation

>> guidance
> the smaller subdivided spaces in the Arsenal's transformed buildings is better suited for smaller (often creative) businesses
tool: development strategy
actor: Woolwich Development Corporation

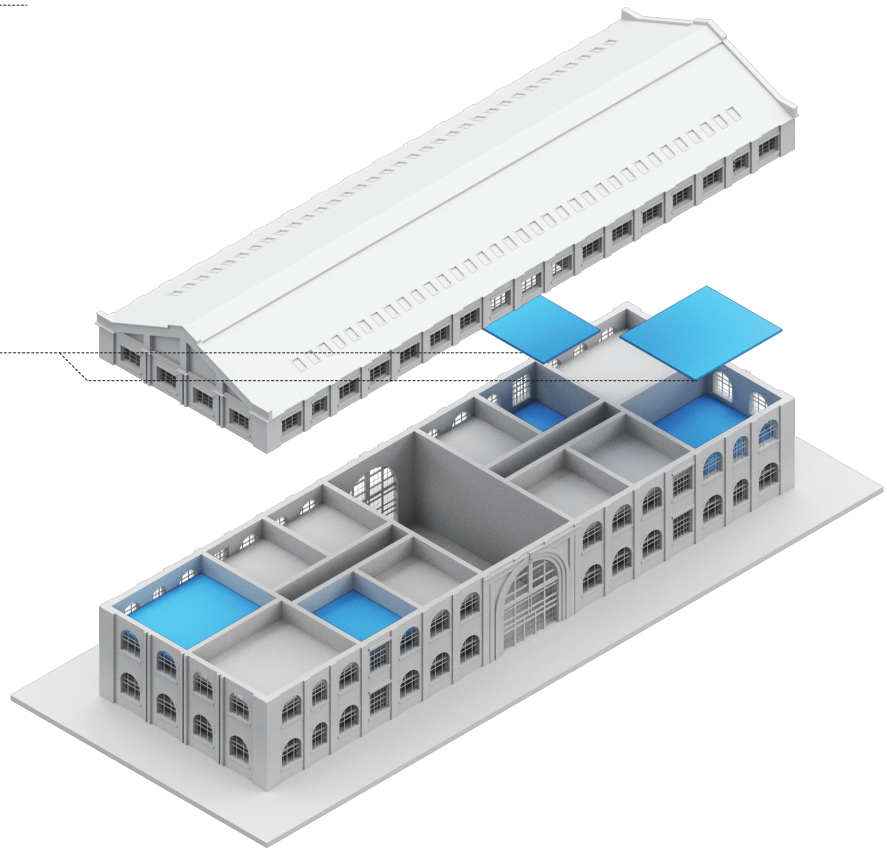


Figure 10.14 Use change at the Arsenal

source: image by author

Figure 10.15 Overview of and directives for adapting the bus network supporting Woolwich

source: based on Greater London Authority (2018a)

In the early stages of Woolwich's development it is key to find a cheaper alternative to the expensive rail transit upgrades already examined in detail. One way of doing so is im-proving the coverage of its bus services. As seen in figure 10.15, Woolwich already forms a central point where many services come together. However, taking into account frequencies, it becomes clear that services are primarily oriented towards Central London. Exploring the possibility of increasing frequencies and coverage towards the other areas surrounding Woolwich could provide a viable way of further improving its accessibility.

Bus lines
Frequency

Regional 2 | Southern transit tangent

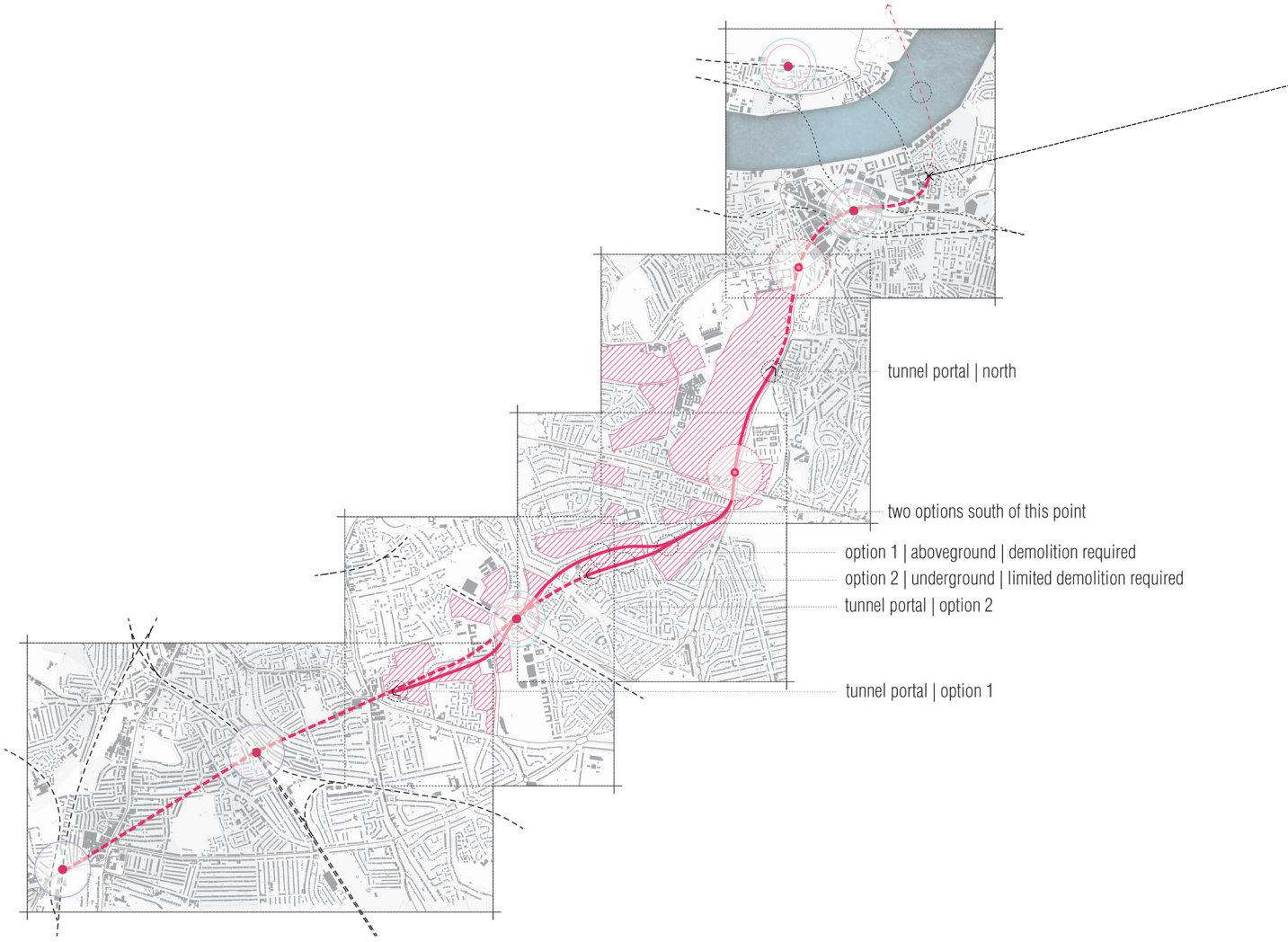


Figure 10.16 Options for construction of the southern leg of the proposed transit line *source: image by author*

- Existing station
- Exploration area for new station
- Tunnel portal
- TBM extraction portal
- Surface rail
- Subsurface rail
- Open space

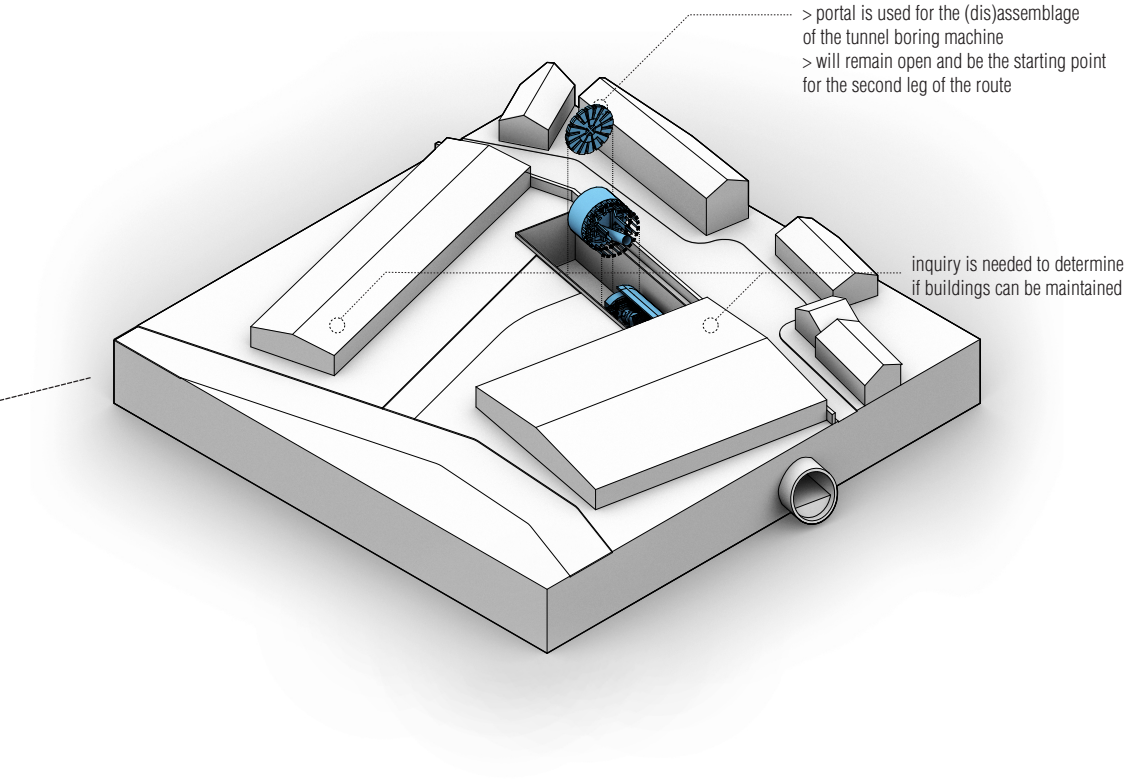


Figure 10.17 Pit from which construction can be continued *source: image by author*

Construction of the new transit tangent supporting Woolwich's development will start with its southern stretch connecting Catford Bridge Station, Hither Green Station, Kidbrooke Station, Woolwich Common Station (new), Royal Barracks Station (new) and terminating at Woolwich Arsenal. Even though its impact on Woolwich's accessibility is lower than that of the future northern section there are two main reasons for constructing it first: it enables the sizable Royal Artillery Barracks' transformation and will in all likelihood be significantly easier to fund.

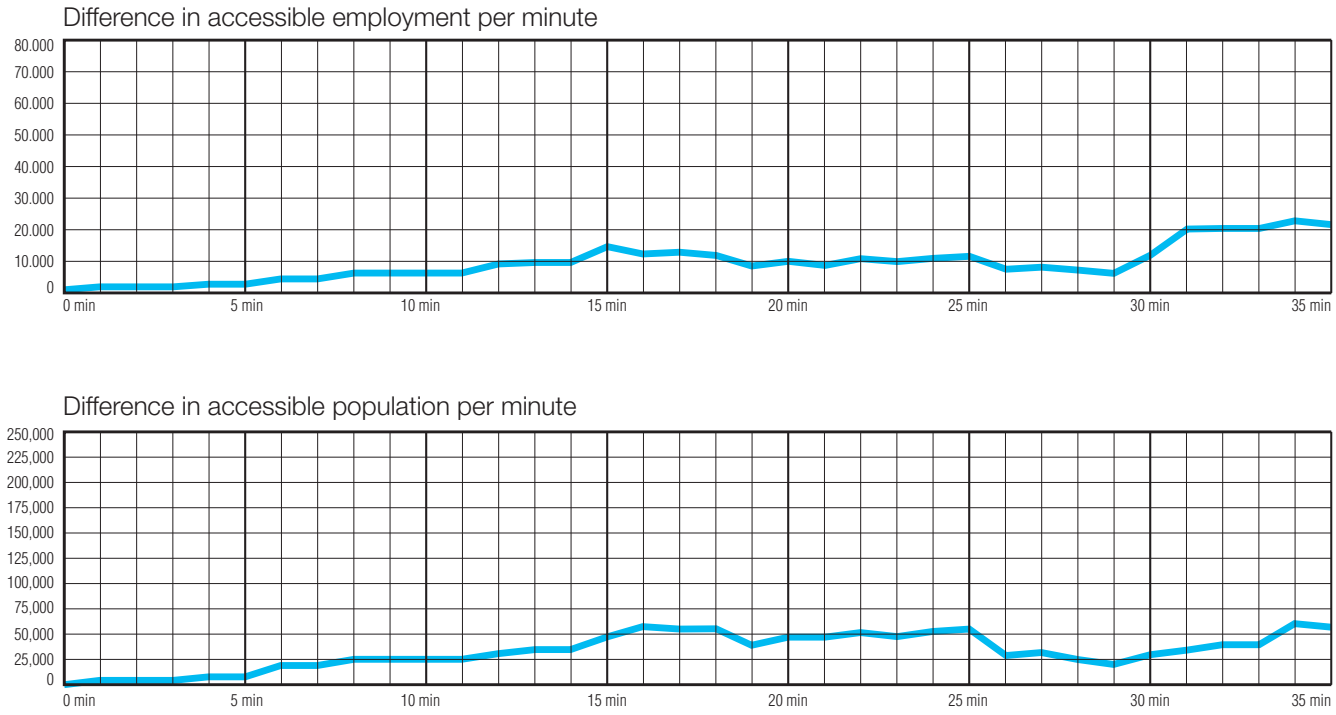
The southern leg of the transit tangent is constructed first due to easier funding and the risk of competition associated with creating the northern leg to early.

The first reason funding is likely to be easier is because the cost of the line itself will simply be lower as it does not cross under the Thames and a significant stretch can be realized above ground and over government owned land as seen in the image to the right. It is also likely to be easier to catch the value it generates. Not only are there sizable development opportunities along its various stations, it also features two stations (at the Royal Barracks and Woolwich Common) of which the surrounding land is owned by the state. This negates the need for excessively complex constructions to capture land value rises or infrastructure levies.

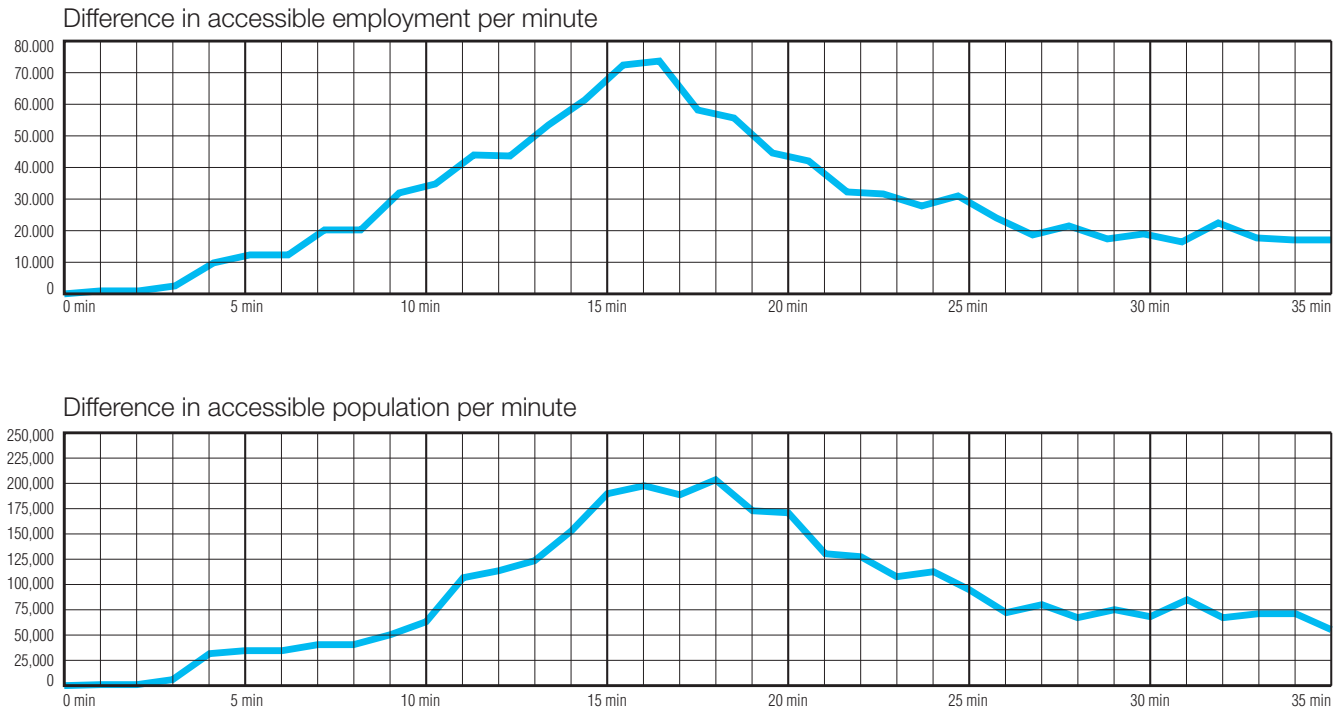
During construction of the line it will be extended slightly north of the arsenal station towards an entry/exit portal to be constructed at the Woolwich Industrial Estate. This pit can be left open and make it easier to continue construction on the Northern Leg later.

Regional 2 | Southern transit tangent

Impact of southern line [= situation with southern line - base situation]



Impact of northern line [= situation with northern line - situation with southern line]



▪ Figure 10.18 Comparison of accessibility gains from the northern and southern sections of the new transit line *source: image by author*

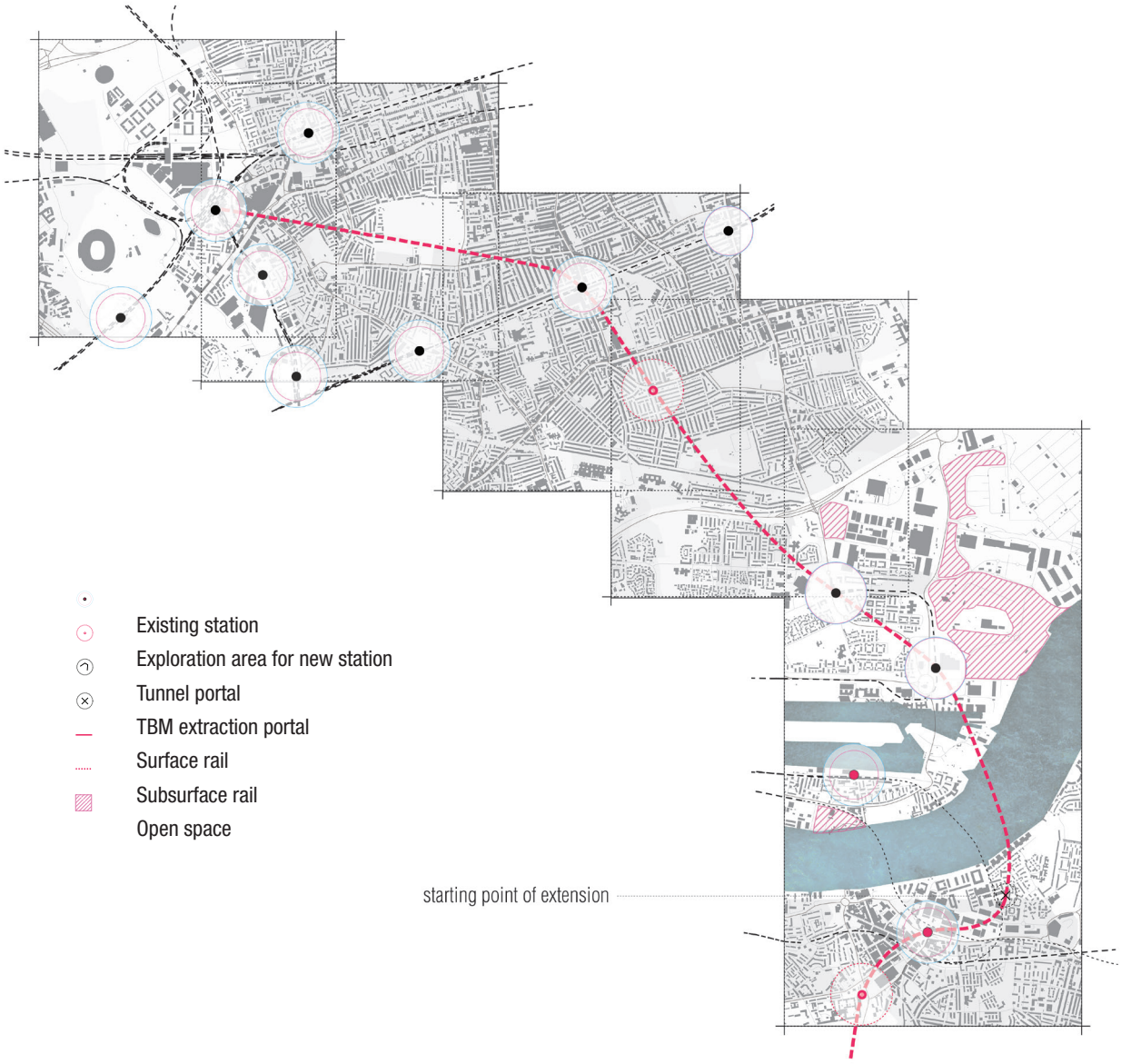


Figure 10.19 Path of the northern leg of the proposed transit line

source: image by author

After a critical mass has been reached at Woolwich the northern leg of the transit tangent will be constructed. This leg significantly boosts Woolwich's accessibility enabling its development into a significant centrality. Even though the accessibility boost from the northern leg is much more significant than that of the southern leg it not solely because funding that it is better constructed last. As discussed in the theoretical framework there is a real risk that Woolwich will be outcompeted and activities will externalize if it gains accessibility to other dominant centralities too early. Hence, realizing the northern leg to early could prove troublesome in realizing the project goals.

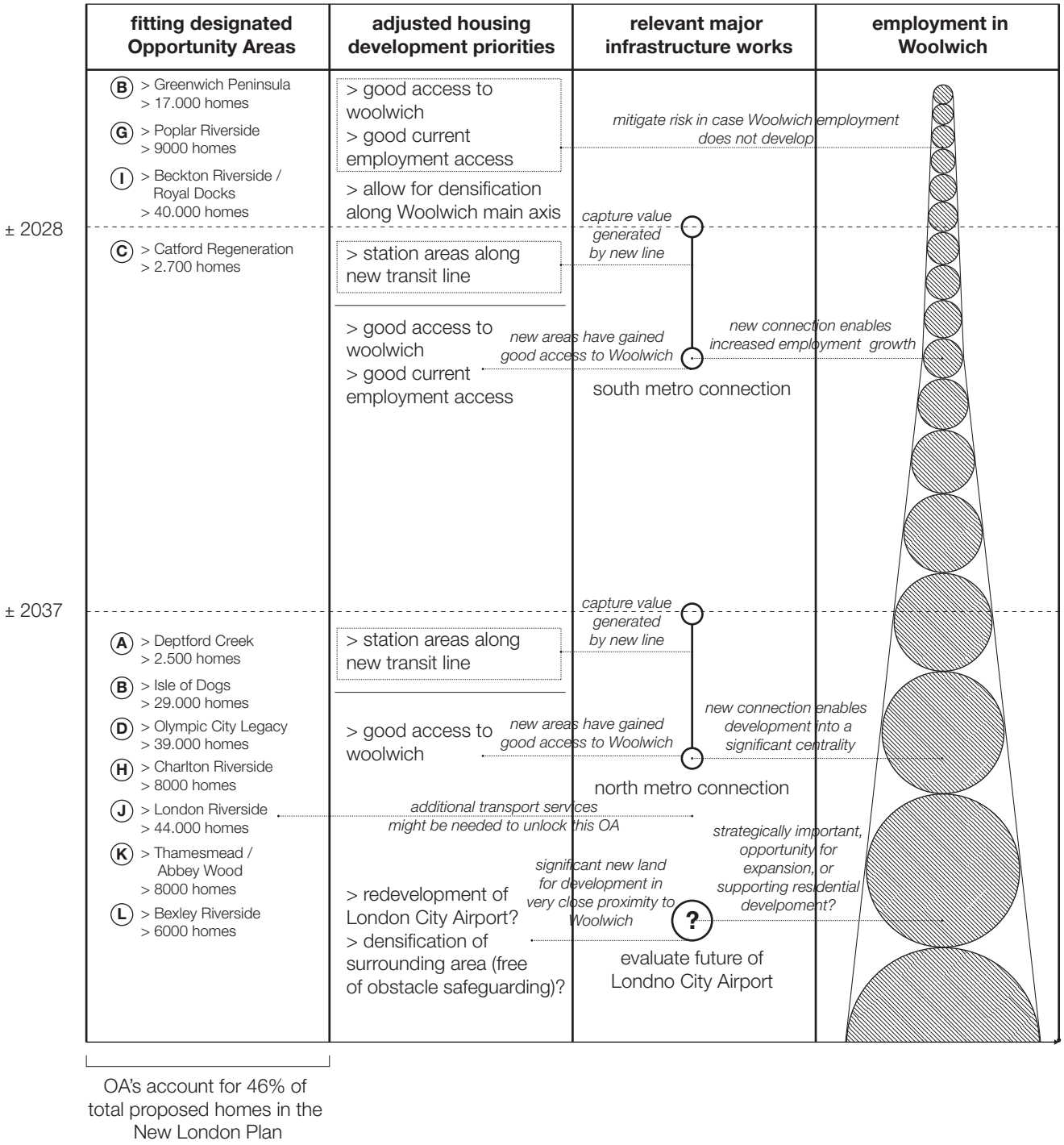
Existing station
Exploration area for new station
Tunnel portal
TBM extraction portal
Surface rail
Subsurface rail
Open space

Regional 4 | Housing policy directives

As accessibility concerns a system of sources and destinations directives are set out supporting housing development in areas well connected to Woolwich that help improve its network position.

As accessibility is determined by a network of sources and destinations improving accessibility to Woolwich is not solely achieved by creating new connections. Instead it is important to tailor housing policy and promote residential development in places with good access to Woolwich. However, through time different approaches are needed to fit the different stages of Woolwich's development. The first phase of Woolwich's development is marred with the greatest uncertainties regarding the ability to attract new jobs to the area. Therefore during this early phase, regional housing policy should prioritize locations with good access to both Woolwich and the existing employment concentrations in the CAZ. This way, the risk of developing houses in places with poor employment access is reduced in case Woolwich's development proves unsuccessful. As the new southern transit leg is developed focus should switch to the affected station areas in order to capitalize on the value generated by this new infrastructure. Finally, when Woolwich has truly established itself as a significant centrality, attention in policy can also shift to locations that solely have good access to Woolwich. It must be noted that, while these directives present focal points for housing policy they do not represent any immense alterations as 46 % of homes proposed in the New London Plan are located within fifteen minutes from Woolwich come phase three.

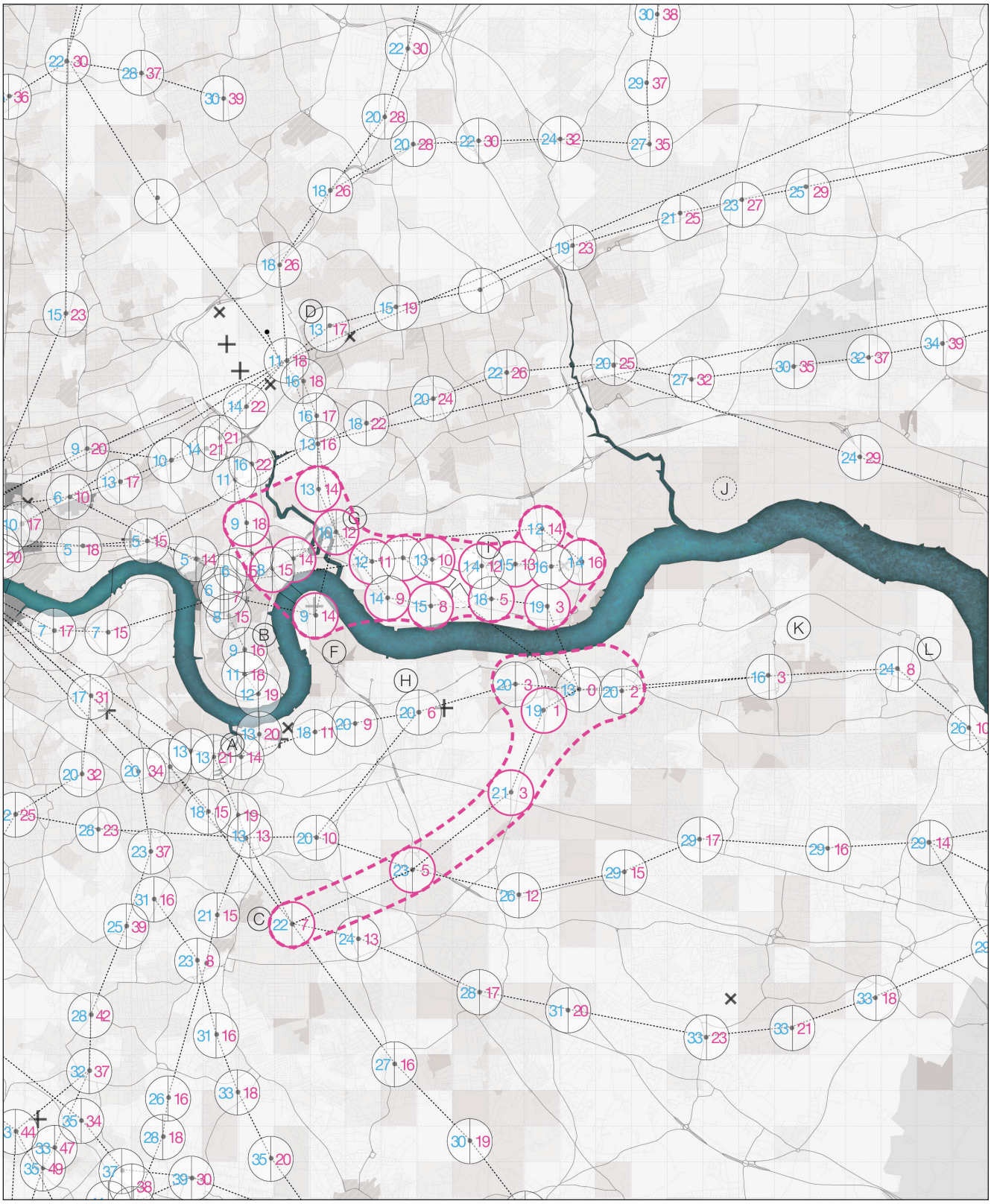
Housing policy directives



▪ Figure 10.20 Overview of housing policy directives

source: image by author

Regional 4 | Housing policy directives



▪ Figure 10.21 Focus areas for phase 1 *source: image by author*

- Station
- Average travel time to CAZ
- Travel time to Woolwich Arsenal
- Focus station
- General focus area

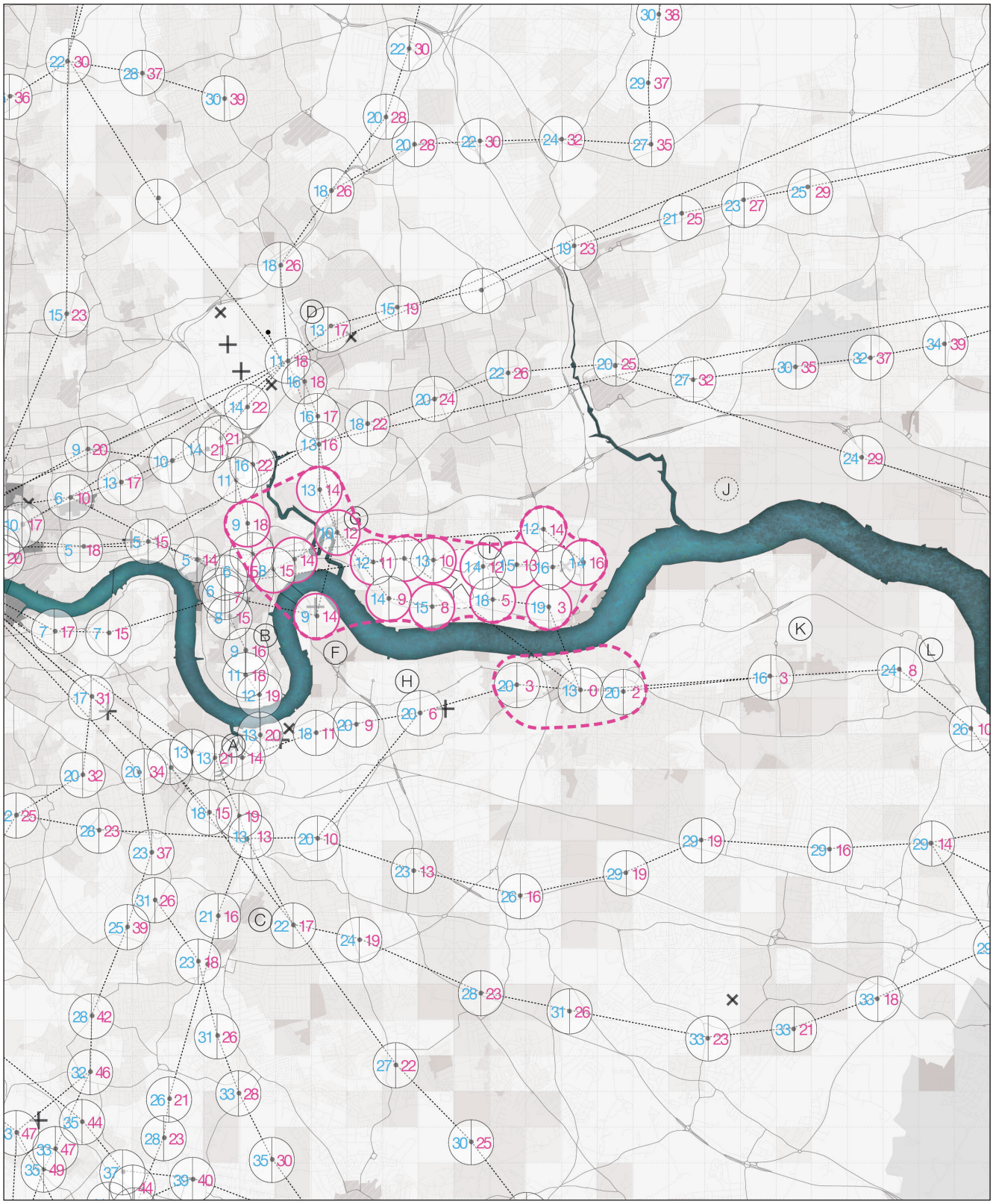
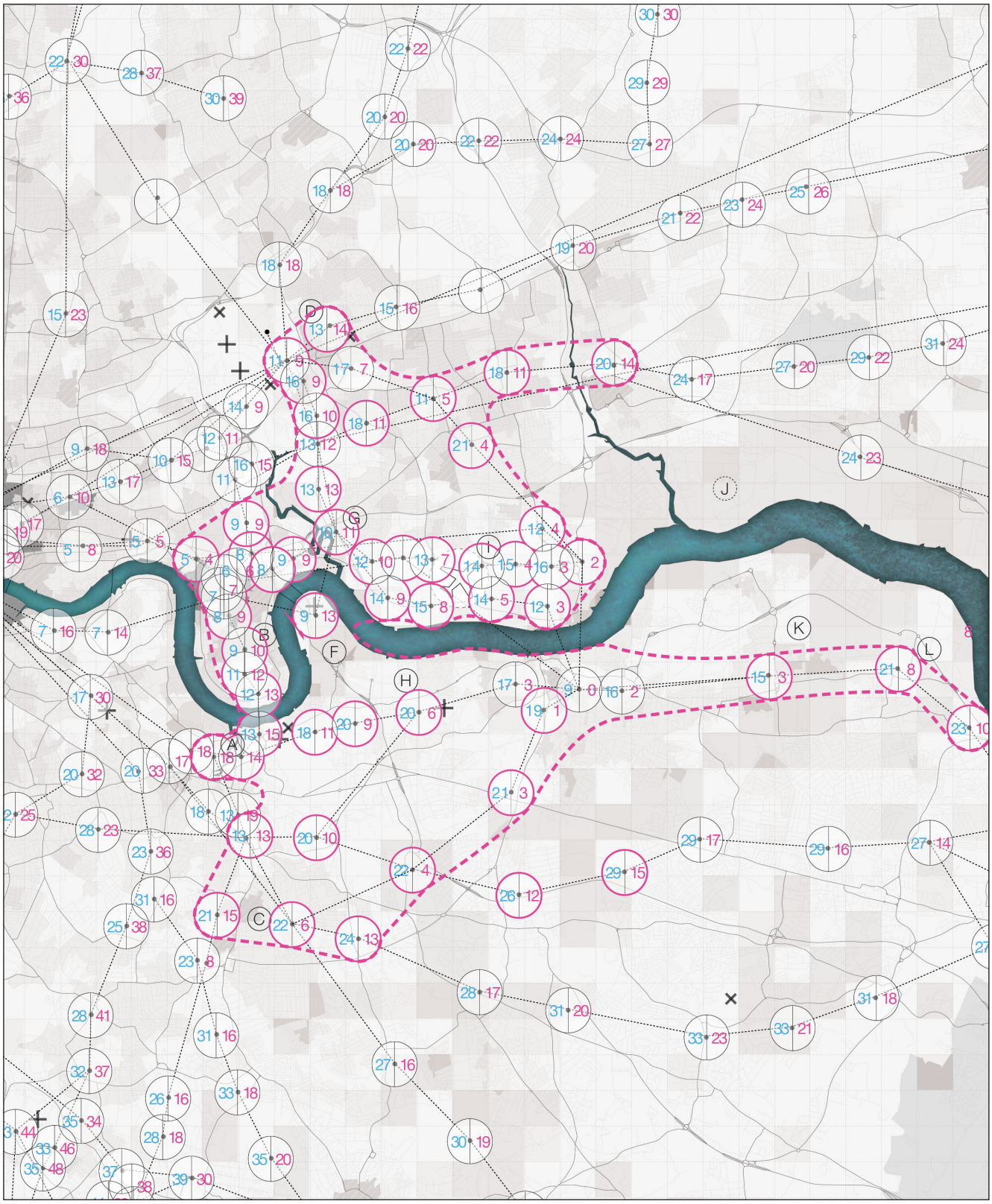


Figure 10.22 Focus areas for phase 2 *source: image by author*

- Station
- Average travel time to CAZ
- Travel time to Woolwich Arsenal
- Focus station
- General focus area

Regional 4 | Housing policy directives



▪ Figure 10.23 Focus areas for phase 3 *source: image by author*

- Station
- Average travel time to CAZ
- Travel time to Woolwich Arsenal
- Focus station
- General focus area

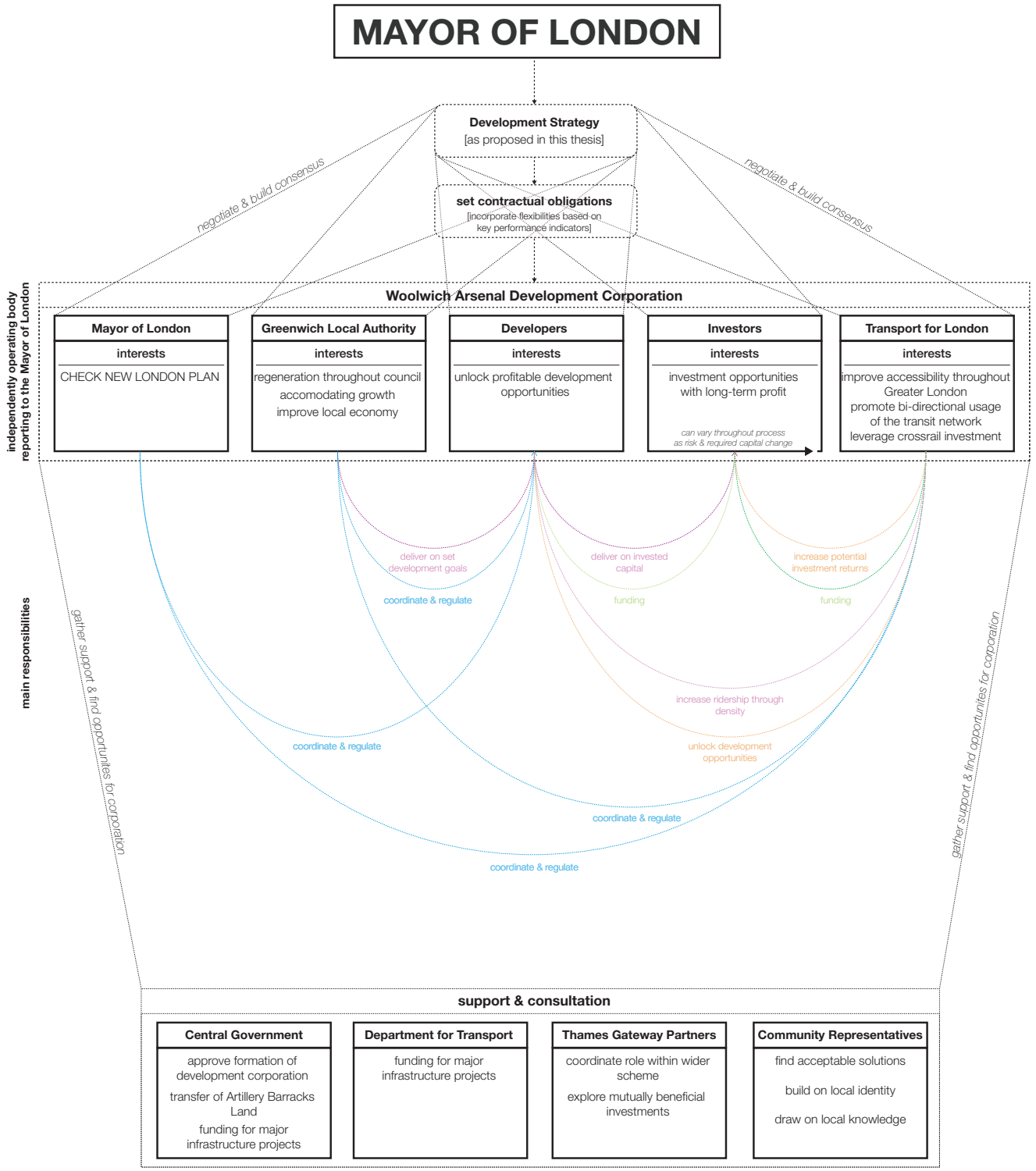
Figure 10.24 View of London's railways *source: image by author*

Governance 1 | Development corporation

To effectively organize the wide range of actors involved in the proposal and to shield it from political turmoil a mayoral development corporation is set up to oversee development.

In order to successfully develop Woolwich, an organization model must be found that effectively engages the wide range of actors involved and is able to weather the various cycles of government that will emerge during the projects time frame. One such model, the establishment of a development corporation, has become an important tool in British planning policy, specifically in highly complex TDA locations (RICS, 2002). Effective coordination between actors could smooth the transition between steps relating to building leverage for, and the creation of new transit infrastructure, effectively reducing the slowness of the land use feedback cycle cited by Chorus (2012).

The application of such development corporations has been expanded with the 2011 eleven localism act which has allowed the Mayor of London to set up Mayoral Development Corporations. So far two have been established the London Legacy Development Corporation (LLDC) supervising the development in and around the Olympic park and the Old Oak and Royal Park Development Corporation (OPDC) who are to regenerate a vast industrial site surrounding an HS2 station (LLDC, 2018, OPDC, 2018). These independently operated bodies take over various planning powers in designated areas and are chaired by representatives from relevant bodies, both public and private. Considering the fact the development corporations have been increasingly used for major development projects within London and have been lauded for their ability to manage complex multi-stakeholder projects makes them a fitting model to be applied in Woolwich's development.



▪ Figure 10.25 Functioning of mayoral development corporations

source: image by author

Governance 2 I Acquire LSI's

In order for Woolwich to turn into a centrality of note, construction of a number of high-rise commercial developments will be necessary. However, not all locations in the area are fit for such density and the sites that are also attractive to residential development. In order to make sure they are not turned into homes early, when uncertainties are still to high for the development of commercial high-rises, the development corporation must acquire these locations of strategic interest (LSI's). They can then keep them unbuilt, while possibly assigning temporary uses, until the development process is along far enough for commercial high-rise development to become attractive.

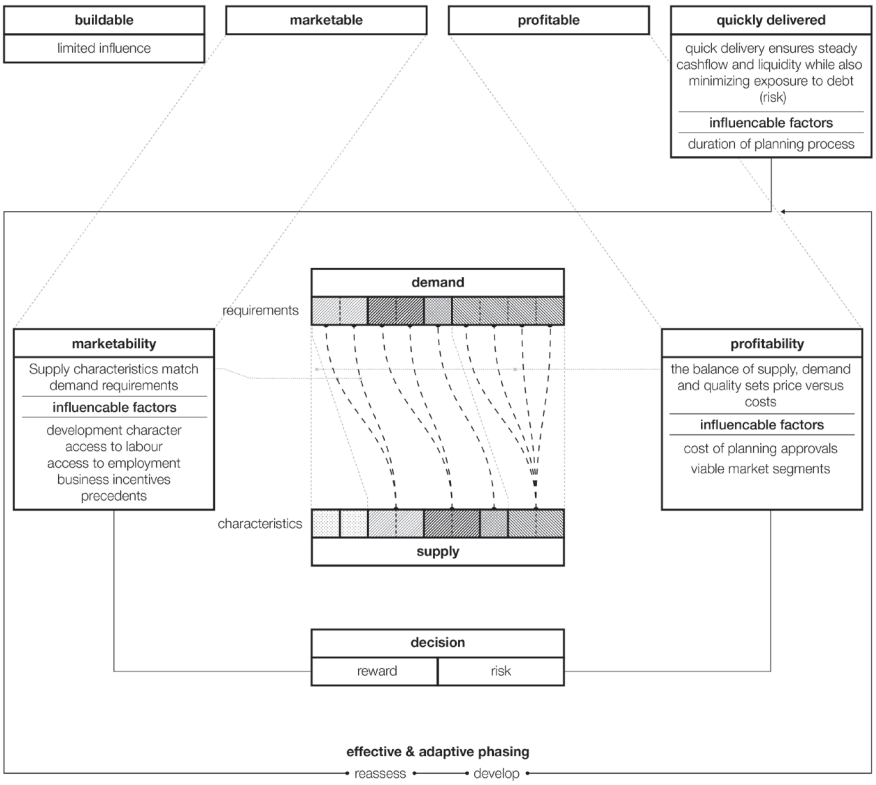
▪ Figure 10.26 Locations of strategic interest to be acquired

source: image by author

In order to safeguard development from changing and unforeseen conditions and unexpected results from actions, it is important to monitor key performance indicators and take action accordingly.

Any long term development is marred with uncertainties. It is for that very reason that the RICS (2002) emphasizes the need for active urban management. As conditions change in unforeseen ways, it is necessary to adapt. A key indicator to monitor in order to safeguard the intentions of the Woolwich development project is the amount of local jobs created. This indicator is most closely related to the core goals of the project; developing Woolwich into an centrality outside London's central area.

If goals relating the number of jobs are not being met, and unfavourable economic conditions throughout the region are not the cause, there are likely issues regarding either occupancy or the amount of commercial floorspace being delivered as seen in figure 10.28. Issues in the first department are likely to mean that the space on offer is not marketable enough, and thus not attractive enough to potential customers. Issues in the second department indicate that developers are likely perceiving issues regarding marketability or profitability that discourage them from developing new space. The dynamics regarding developer decisions are shown in figure 10.27. In order to get development back on track towards meeting the goals set out, it is key to identify where the issues in marketability or profitability come from and take actions to mitigate them.



▪ Figure 10.27 Property developer considerations

source: image by author based in part on CABE & DETR (2001)

Governance 3 | Set up monitoring system

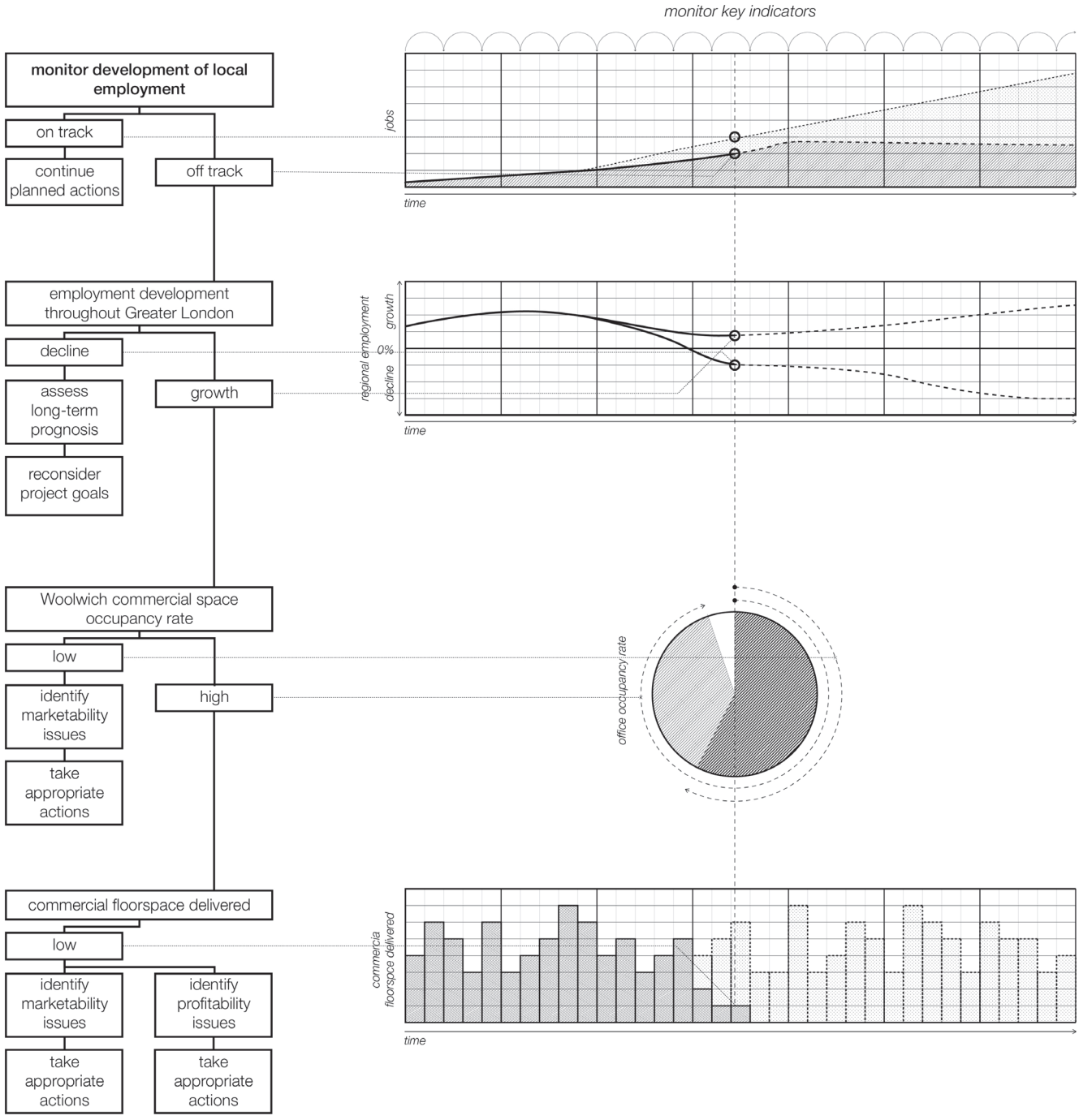


Figure 10.28 Monitoring of key performance indicators

source: image by author

Figure 10.29 Afternoon break between the glass and steel towers of the City *source: image by author*

11. Impact assessment

+ employment potential
+ accessibility improvement
+ influence on travel patterns

Having determined where a new centrality can best be realized, what supporting transit networks are needed, and what actions need to be taken through time in order to realize development, one questions remains: does the proposal fulfil the goals it intended to realize?

As discussed in chapter five, this thesis hopes to achieve three main goals associated with the development of a centrality outside the central area:

1. Create an accessible region in which services, amenities and jobs are a more common good and extreme commuting times are reduced.

2. Foster more sustainable and efficient travel patterns.

3. Accommodate London's growth in a more balanced manner throughout the region.

The extent to which the development of Woolwich meets these goals is examined in this chapter via three assessments. The first assessment corresponds to the third goal and examines the employment potential, the number of jobs that could be realized, at Woolwich if development takes place as described in chapters nine and ten. The second assessment corresponds to the first goal, examining the impact a new centrality at Woolwich would have on accessibility throughout the region. The third and final assessment corresponds to the second goal and aims to provide insight into the proposal's impact on regional travel patterns.

11.1 Employment potential

The first assessment in this chapter aims to estimate the total amount of jobs that Woolwich could provide for at the end of the proposed development strategy. The method used for estimation is seen in figure 11.2, and consists of three main components that together determine the total employment potential:

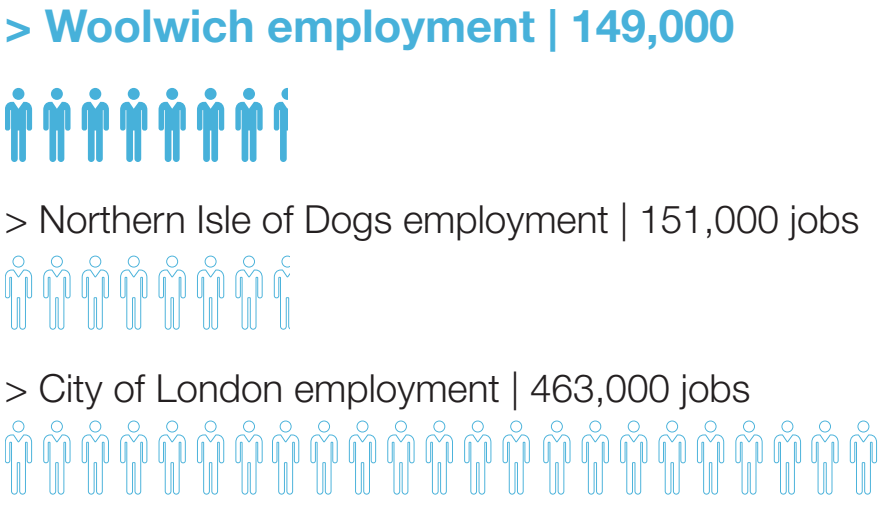
1. Developable gross floor area
   An estimation of the total amount of floorspace available for residential or commercial use at the end of the development strategy.

2. Ratio of commercial to residential floorspace
   As discussed, Woolwich is not envisioned as a monofunctional office park but rather as a vibrant city district mixing both commercial and residential uses. In order to determine a probable mix of commercial and residential floorspace three other mix-use areas in London are examined: Hammersmith, Croydon and King's Cross.

3. Floorspace per workplace
   The average floorspace per workplace is based on the industries that Woolwich aims to attract. To provide a proper fit to space demands of the targeted industries 11,9 m2 / workplace is assumed higher than the London average of 10,0 m2 / workplace commonly used for London office space (British Council for Offices, 2013, Greater London Authority, 2017b).

Having the capacity to provide for roughly 149,000 jobs Woolwich can be considered a centrality of significance outside Central London. Hence, it forms a substantial contribution to the goal of more balanced developed throughout the region.

Using the method presented here, it is estimated that Woolwich could offer space to as much as 149,000 jobs. While obviously not accounting for the entire 1,2 million additional jobs projected for 2041, it certainly forms an out of centre centrality of significance in comparison to that of Canary Wharf as seen in figure 11.1. Hence, it can be said that the proposals done contribute to a more balanced growth throughout the region, especially given its relation to new residential developments in East London as discussed in the directives to housing policy in chapter 10.



▪ Figure 11.1 Comparison of Woolwich, Canary Wharf and the City *source: image by author*

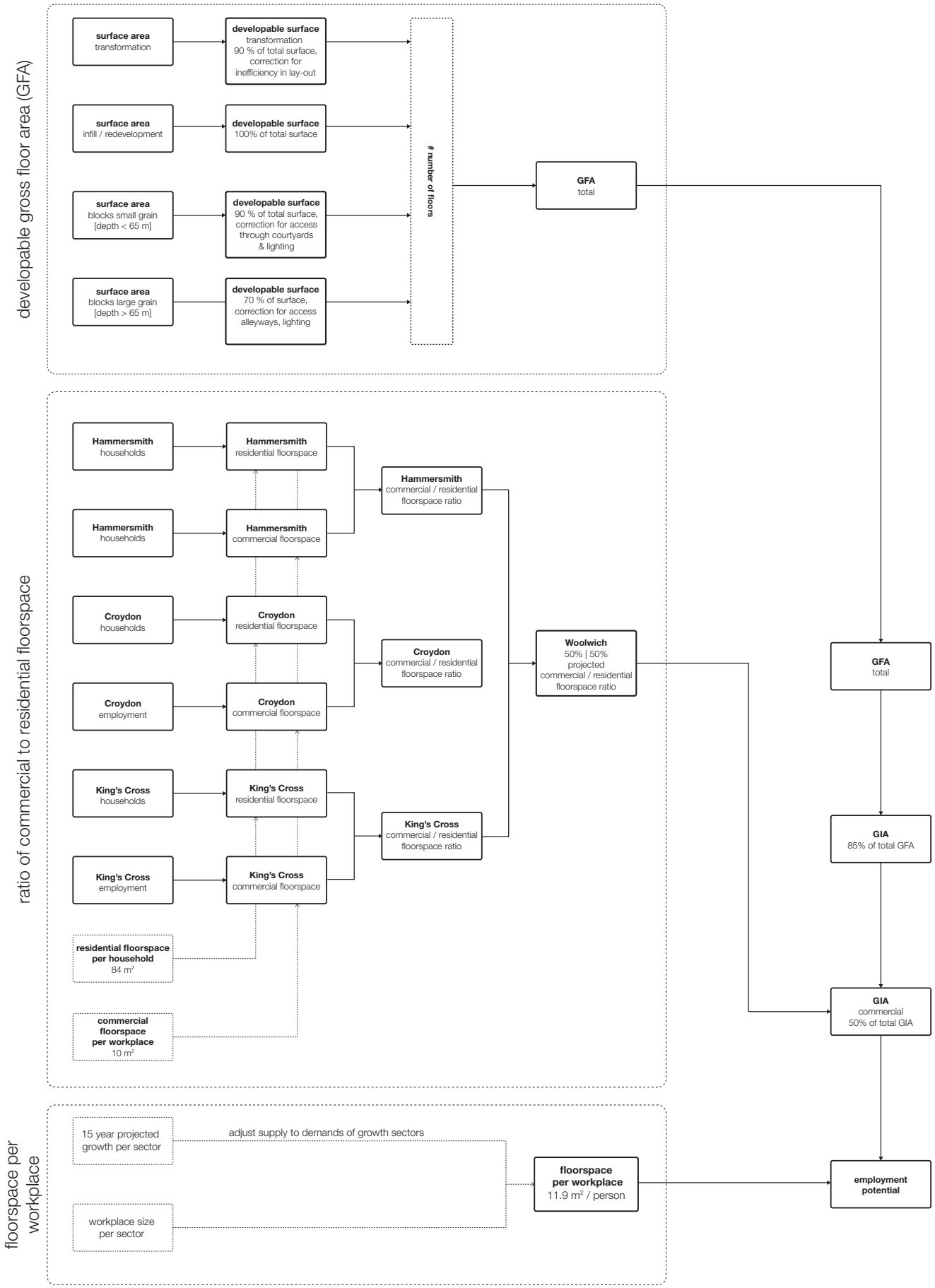


Figure 11.2 Method for comparing employment potential

source: image by author

11.2 Impact on accessibility

The second assessment concerns the goal of creating an accessible region in which services, amenities and jobs are a more common good and extreme commuting times are reduced. While Woolwich is envisioned as a mixed area home to jobs, amenities and services, the main focus throughout this thesis has been on employment. Hence, this assessment will focus on the impact of the proposal on employment accessibility since it can be examined most concretely.

As the proposals done here aim to reduce commuting times the assessment will concentrate on accessible employment within twenty minutes, considerably less than current average commuting times. The outcomes of this assessment shown in figures 11.2 and 11.3, show the difference in the employment accessible within twenty minutes, generated by the new transit link and 149,000 additional jobs at Woolwich, compared to the current situation. The assessment does not account for other increases in employment or population throughout the region.

The creation of a centrality at Woolwich proves effective in contributing to an increase of easily accessible employment for non-central parts of Greater London.

As seen in figure 11.3 the accessibility impacts of Woolwich are, as to be expected, mostly confined to East London. Here the relative increase for areas close to Central London is rather limited (0-10%) as their current accessibility to employment is already rather high. However, the percentual increase rises rapidly further away from Central London, up to as much as roughly 430 % in the most peripheral areas. It can thus be concluded that the developing a centrality at Woolwich proves to be an effective way of providing better accessibility to employment at shorter commuting times throughout the region. Moreover as the amount of people benefitting from an increase of more than 20% as seen in figure 11.4 is bound to increase significantly given current housing policy, further enhancing the proposal's impact.

While Woolwich aims to provide more than just employment, these impacts are, giving the work carried out in this thesis, significantly more difficult to assess. Hence, providing a conclusive verdict on the proposal's impact regarding improved access to services and amenities would require follow-up research.

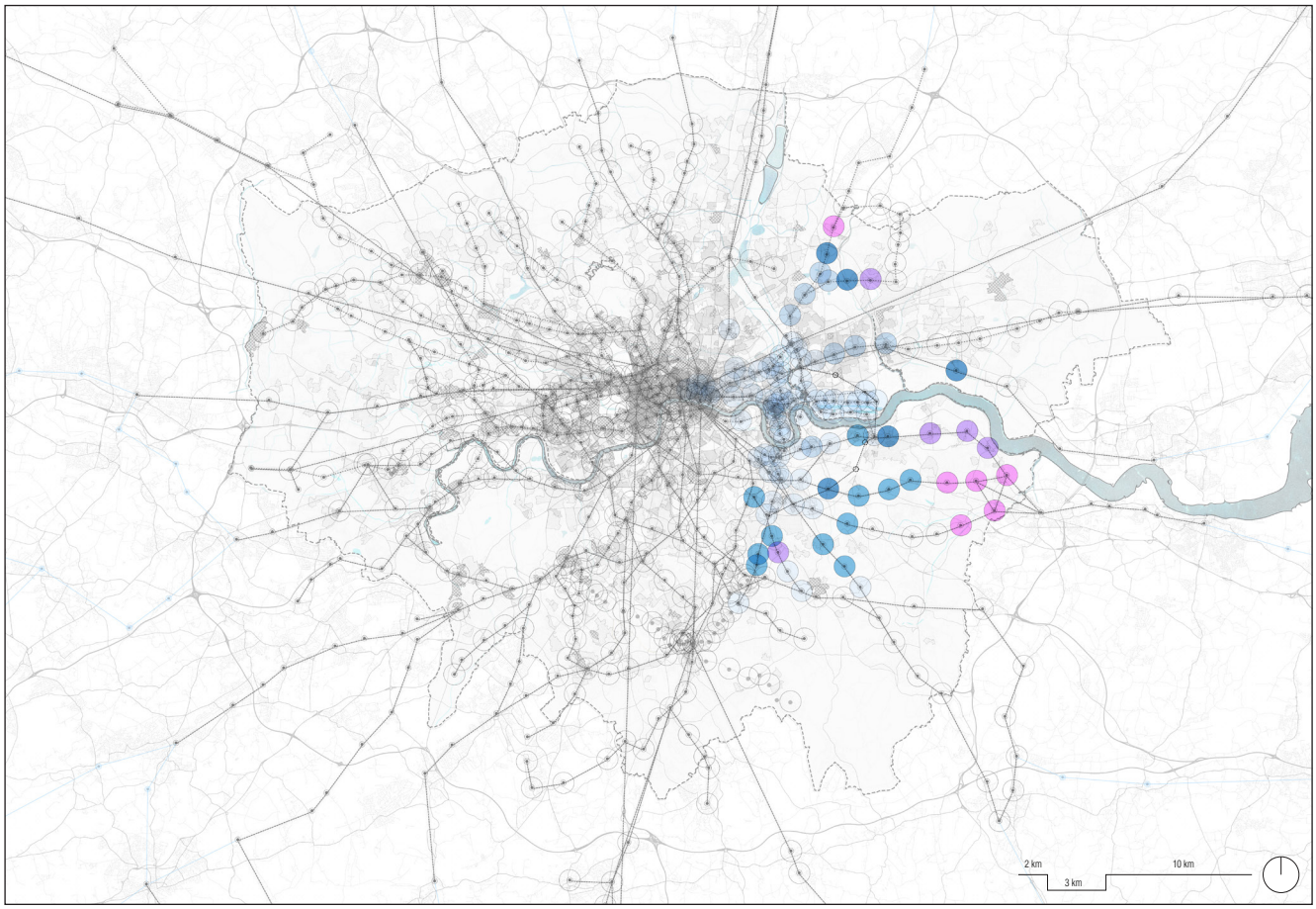


Figure 11.3 Overview of increases in employment accessible in 20 minutes *source: image by author*

- 0 - 20 %
- 20 - 40 %
- 40 - 60 %
- 60 - 80 %
- 80 - 100 %
- 100 - 300 %
- > 300 %

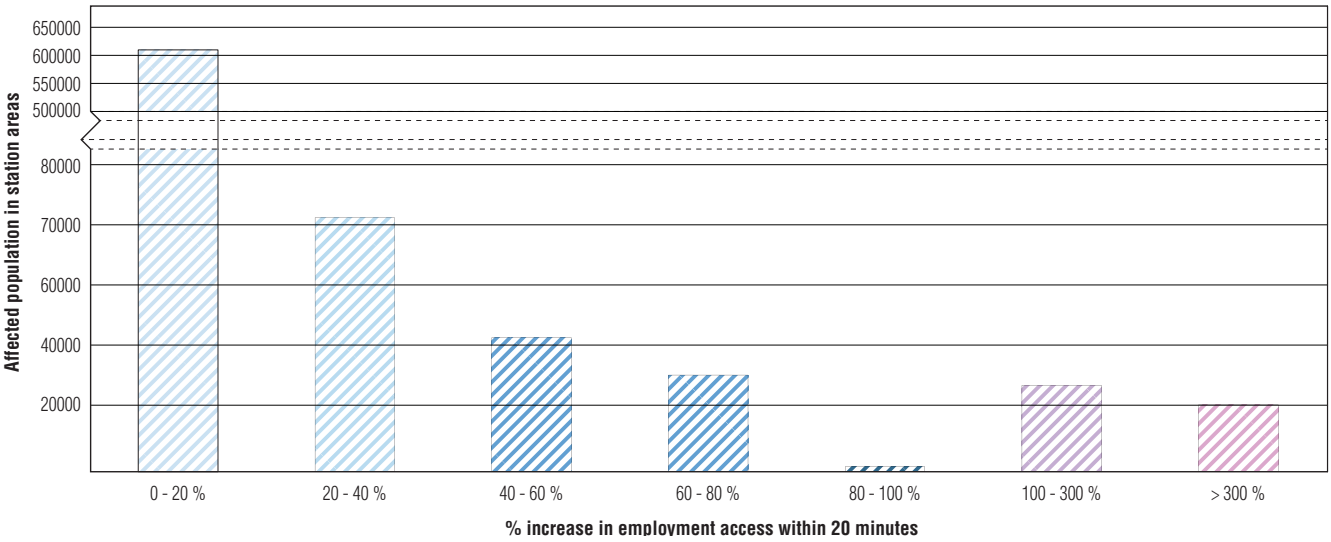
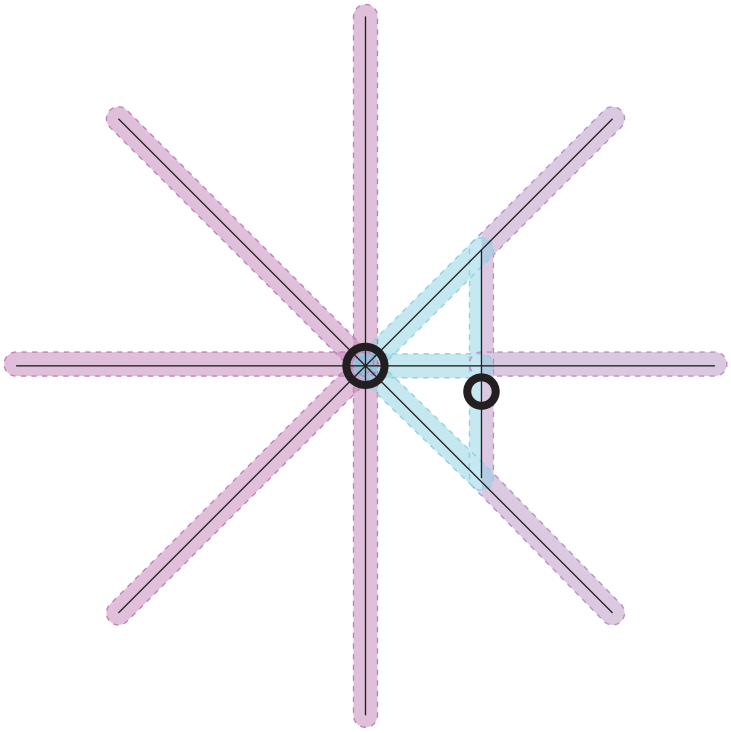


Figure 11.4 Number of people benefiting from increased employment access *source: image by author*

11.3 Impact on travel patterns

The final assessments deals with the goal to foster more sustainable and efficient travel patterns. This goal primarily concerns the mono-directionality of London's current commutes which cause the need for high peak capacities that are otherwise underutilized. The assessment carried out here aims to provide some base understanding of the impacts the proposal and if it would introduce more bi-directional passenger flows.

It must be noted that the assessment carried does not aim to achieve anything beyond a base understanding of impacts. This is due to simplified nature of the method applied which for example does not account for things such as demographic characteristics in matching inhabitants throughout the region with the jobs on offer at Woolwich. It also only accounts for rail travel and not for other modes of transport.



▪ Figure 11.5 Typical commuting patterns to Woolwich

source: image by author

The analysis carried out here consists of three main components also seen in figure 11.5:

1. Amount of commuters traveling to Woolwich

2. Commuters to Woolwich by station of origin
   In order to determine the stations where Woolwich employees commute from several steps are taken. First the total commuters coming into Woolwich are divided by the times they spend commuting based on the commuting weights discussed in chapter 6. Methodology. While the travel

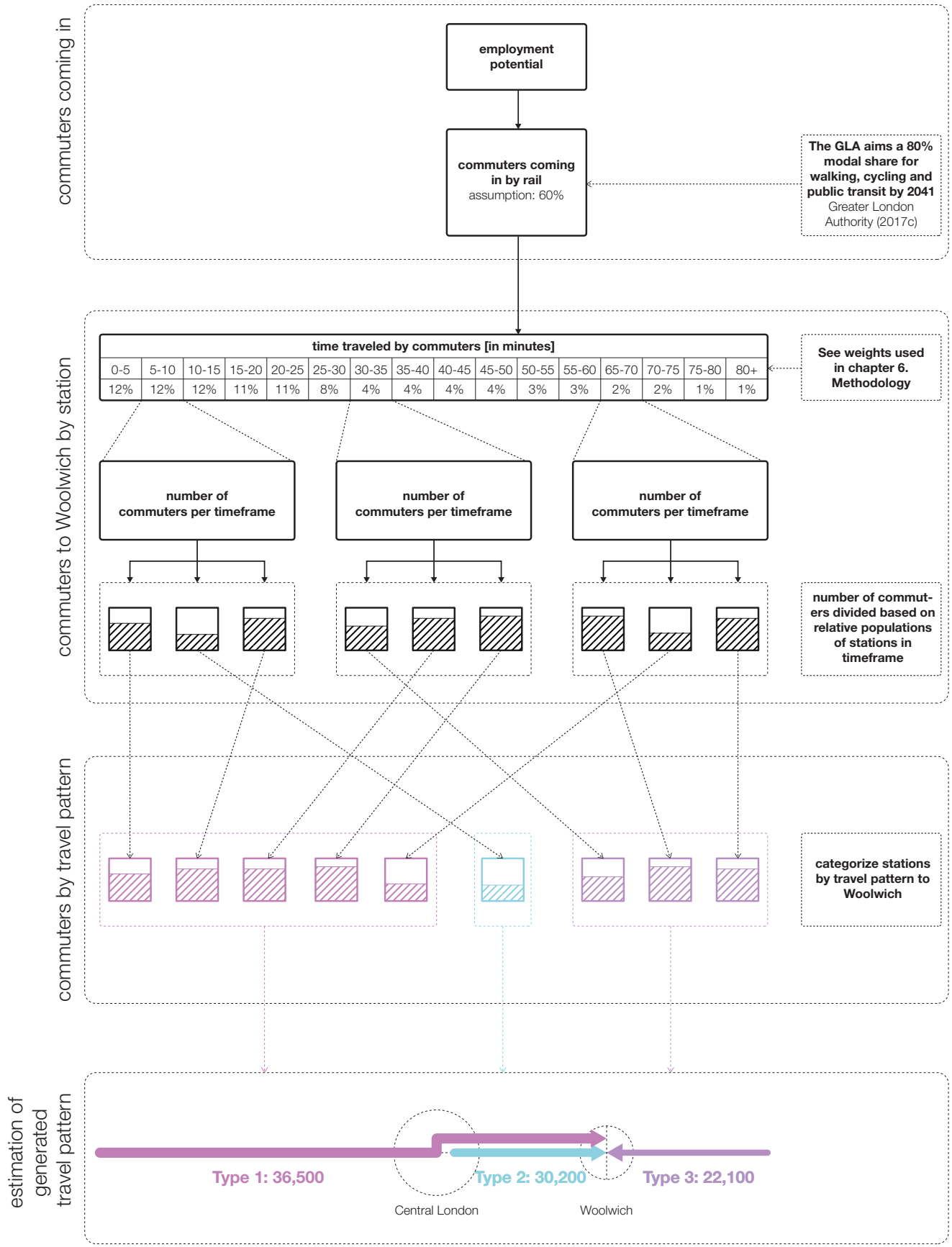


Figure 11.6 Method for estimating generated travel patterns

source: image by author

times here are higher than the proposal hopes to achieve, they offer a solid foundation to work from. The total amount of commuters per timeframe is subsequently divided based over the stations in that same time frame, relative to the population in their surrounding station areas.

3. Number of commuters by travel pattern
   The various stations are categorized into three typical commuting patterns to Woolwich as seen in figure 11.6:

   Type 1: Commuters first travel into Central London after which they commute out from the central area towards Woolwich

   Type 2: Commuters travel away from the Central Area towards Woolwich

   Type 3: Commuters travel towards the Central London at first but change directions to Woolwich, avoiding the most congested central sections of the network.

The total number of commuters per station category, as mapped in figure 11.7, is added up resulting in the total number of commuters per typical commuting pattern.

The assessment done here suggests that the proposal would add roughly 65,000 people travelling out from Central London. This presents a significant addition to bi-directional passenger flows and the efficiency of transit system operations.

As seen in figure 11.5 this assessment suggests that roughly 65,000 people will commute away from Central London and into Woolwich, of whom roughly 35,000 travel into the central area first. While these 35,000 people provide extra pressure to the network they can hardly be avoided. At the same time the roughly 65,000 people travelling out from Central London introduce a significant amount of bi-directionality to the network given that a metro line has a capacity of roughly 30,000 passengers / hour in a single direction (House of Commons - Transport Committee, 2005). This should help improve the efficiency of London's transit network.

11.4 Conclusion

In conclusion, based on the assessments carried out in this chapter, the proposals done in this thesis seem to respond well to the initial goals set out. The development of Woolwich could offer home to roughly 149,000 jobs, roughly as many as Canary Wharf, making it a new centrality outside of Central London of legitimate significance. Hence, it forms a substantial contribution towards accommodating London's growth in a more balanced manner throughout the region. Furthermore, this new centrality significantly increases nearby accessible employment for many of East London's more peripheral station areas making accessibility a more common good throughout the region. However, its impacts regarding access to amenities and services warrant further investigation. Finally, the coarse estimation of generated travel patterns suggests that this new centrality should increase amount of bi-directional passenger flows on transit lines improving the efficiency with which transit system operates.

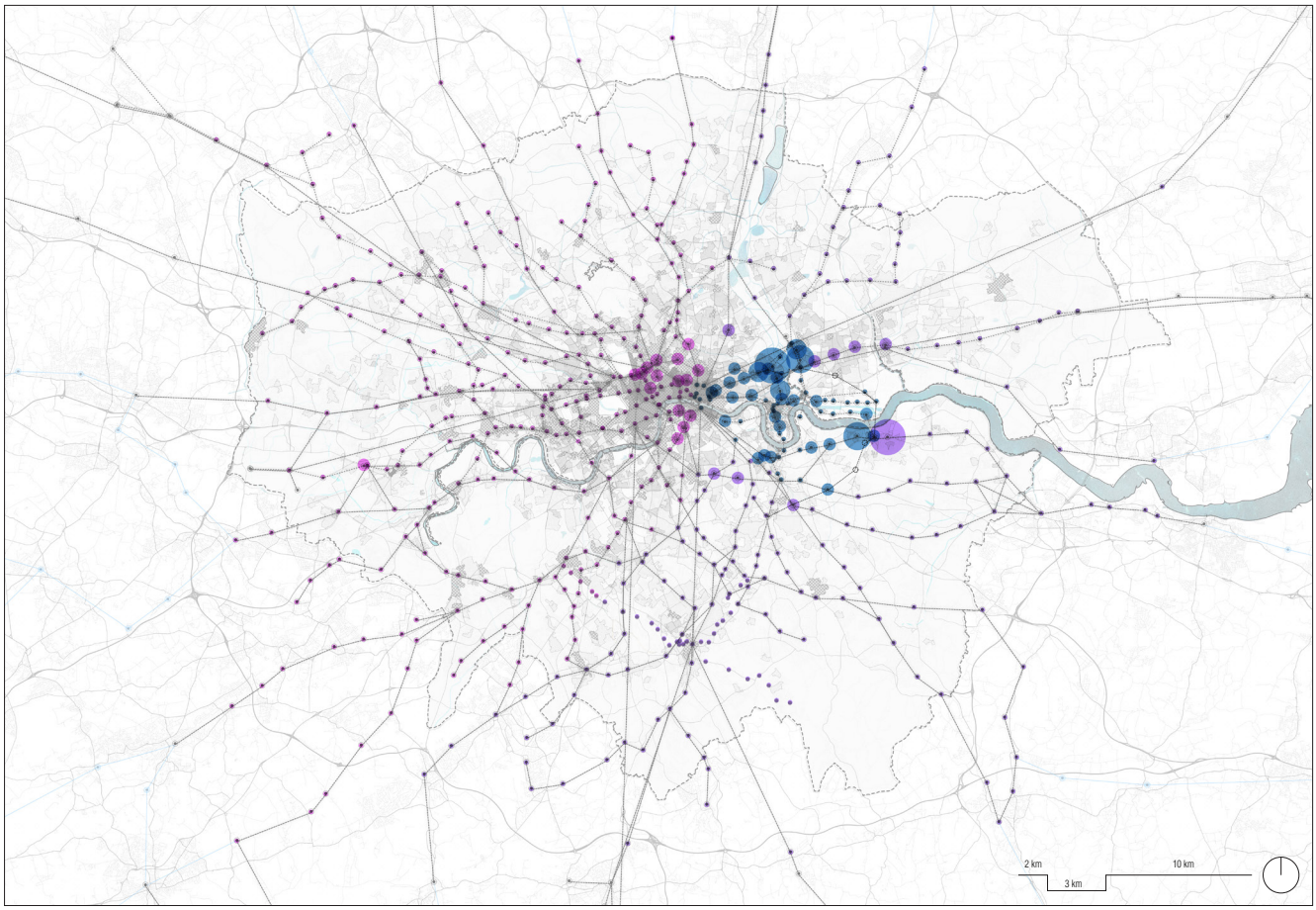
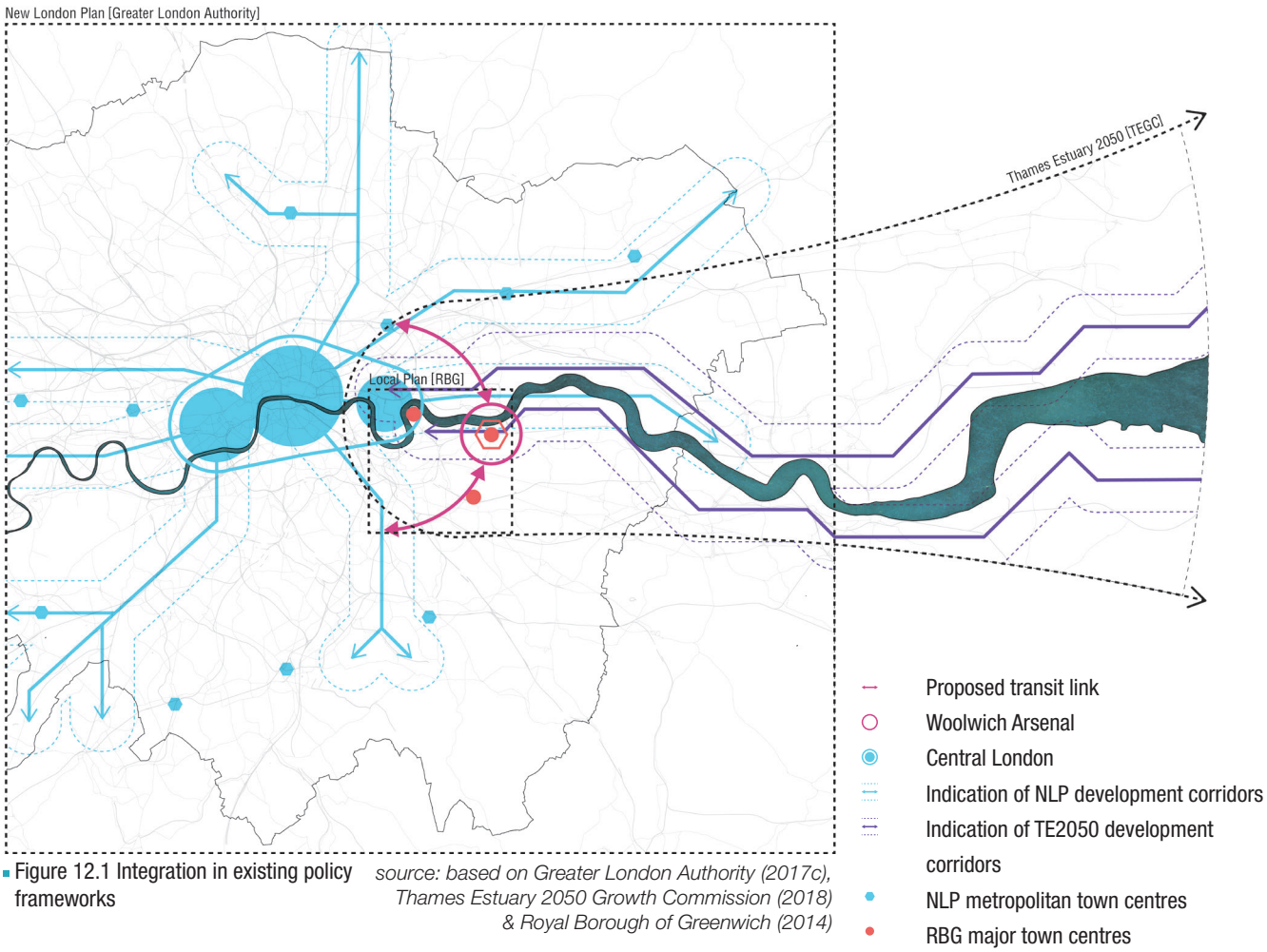


Figure 11.7 Stations categorized by travel pattern generated and number of commuters to Woolwich *source: image by author*

12. Relation to existing policy

+ achieving the goals of the New London Plan
+ building the Thames Estuary
+ expanding local ambitions beyond borders



▪ Figure 12.1 Integration in existing policy frameworks

source: based on Greater London Authority (2017c), Thames Estuary 2050 Growth Commission (2018) & Royal Borough of Greenwich (2014)

Having examined the extent to which the proposals in this thesis match the goals set out, this chapter will now examine its relation to and compatibility with existing policy. For this three policy documents are examined briefly over the following pages:

The New London Plan

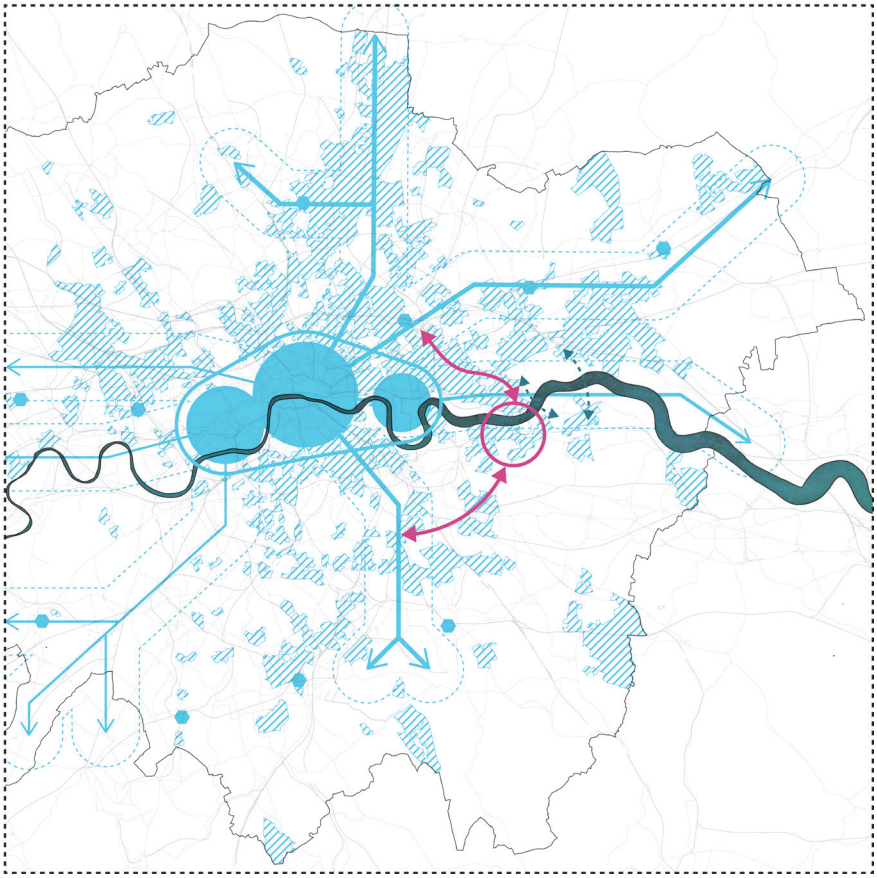
The primary policy framework guiding development throughout the entirety of Greater London until 2041. This framework focusses on issues of strategic importance while leaving those of local dimensions to be determined locally (Greater London Authority, 2017c).

The Thames Estuary 2050 Vision

The follow up to the Thames Gateway Programme, this document aims to help realise the potentials for development and improvement throughout the Thames Estuary. As opposed to the New London Plan, this document does not have any statutory bearings in itself (Thames Estuary 2050 Growth Commission, 2018).

The Royal Borough of Greenwich Local Plan

This document concerns the lowest scale level of the three documents examined here. It sets out a set of goals and policies that aim to guide the development of the Borough until 2028 and is based on the previous iteration of the London Plan (Royal Borough of Greenwich, 2014).



Proposed transit link
Woolwich Arsenal
Central London
Indication of NLP development corridors
NLP metropolitan town centres
Strategic Regeneration Areas

Figure 12.2 Integration into the New London Plan *source: based on Greater London Authority (2017c)*

Relation to the New London Plan

Of all the policy documents here the proposal's relation to the New London Plan have already been discussed in the greatest detail. The main discussion so far has been on the proposal of a new centrality at Woolwich, supported by adding a tangent to the radial transit system that currently facilitates London's mono-centricity. Doing so should provide a more effective answer to cited policy goals such as sharing the benefits of London's economy more equitably across London and promoting activity outside the central area. However, the proposals in this thesis have more compatibilities with the New London Plan.

The proposals done in this thesis should help solidify returns on the large Crossrail investments by improving its catchment area.

Firstly, the new tangent links three of London's transit corridors with one another, among which that of the new Crossrail. By linking into Crossrail from the south, the tangent should improve its catchment area, further solidifying the returns on the sizable investment Crossrail has been.

The proposals also contribute to the regeneration efforts undertaken throughout East London over the past years.

Secondly, this tangent also crosses through and links various of Eat London's Strategic Areas for Regeneration as set out in the New London Plan. The increased levels of accessibility, development around new stops and the provision of significant employment in nearby Woolwich has the potential to significantly aid the regeneration of these areas. Hence, it is a logical follow up to the sizable efforts to regenerate East London as started with the Olympic

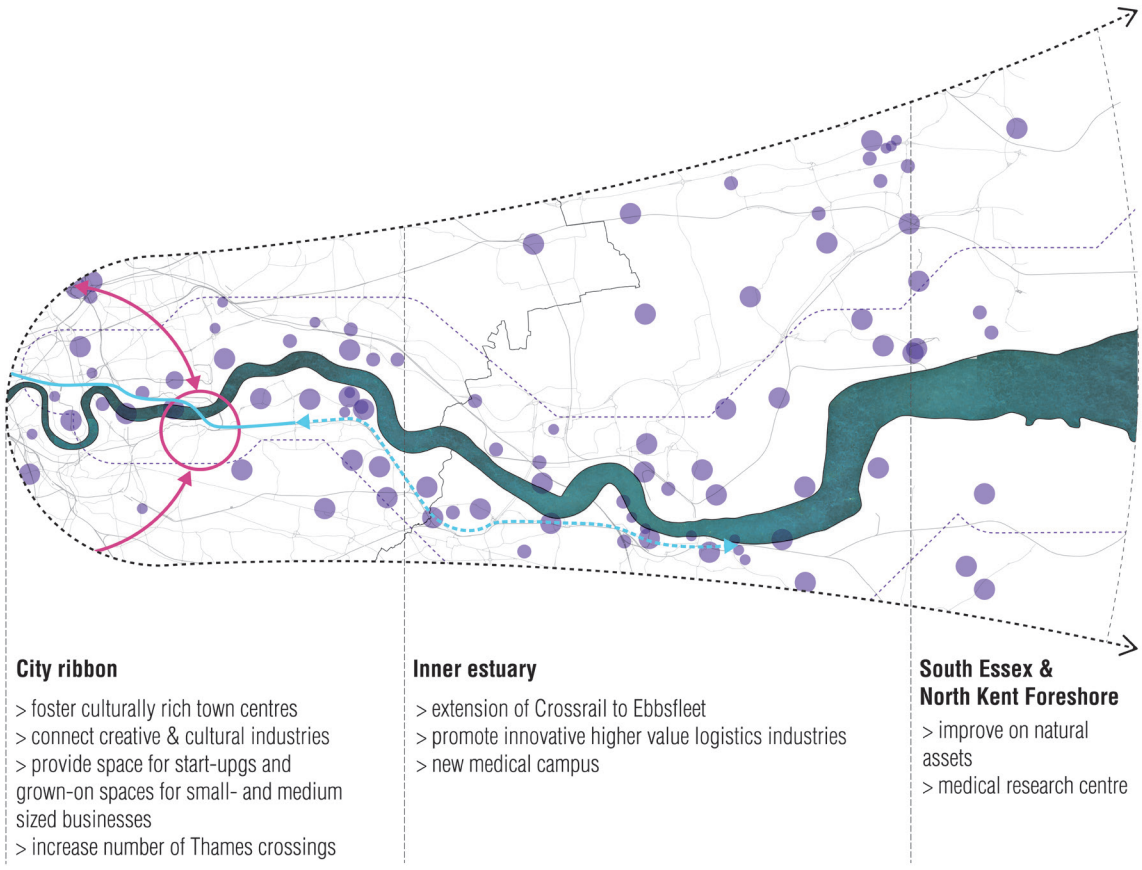


Figure 12.3 Integration into the Thames Estuary 2050 Vision

source: based on Thames Estuary Growth Commission (2018)

Park, located at the north end of the tangent.

Finally, the new tangent functions as a substitute for two Thames crossings currently explored featuring extensions to the DLR and London Overground. These explorations are evocative of both the need for a crossing and a willingness to spend on it. This willingness, combined with the other benefits provided by the selected variant could help justify its higher costs compared to the other variants evaluated.

- Proposed transit link
- Woolwich Arsenal
- Indication of TE2050 development corridors
- Crossrail
- Crossrail extension to Ebbsfleet
- TE2050 related projects

Relation tot the Thames Estuary 2050 vision

The Thames Estuary 2050 (TE2050) vision follows up the Thames Gateway programme, seeking to realize the potential of the estuary by promoting its local potentials generating a patchwork of successful places (Thames Estuary 2050 Growth Commission, 2018). This vision divides the Estuary into five different zones the first two being most relevant to the proposals in this thesis: The City Ribbon and the Inner Estuary.

The City Ribbon comprises most of the Thames within Greater London, east from Canary Wharf. In this zone it seeks to create culturally vibrant Town Centres, and locations for businesses to develop. In this light, the proposed centrality at Woolwich can be viewed as an effort fulfil the ambitious development goals for the Estuary. However its synergies with the TE2050 vision go further.

The proposals add specification to the aims for the City Ribbon set out in the TE2050 vision.

Figure 12.4 Integration into the Greenwich Local Plan *source: based on Greater London Authority (2017c)*

Woolwich would form the first major stop in Greater London from the proposed high tech logistics and manufacturing in the Estuary. This could provide effective synergies for both.

Beyond the City Ribbon lies the Inner Estuary, whose development focusses on the promotion of innovative logistics and associated industries as well as further developments of its town centres. The bulk of associated projects, as seen in the figure 12.3, located on the Thames' south bank, just like Woolwich. As plans to extend Crossrail's southern leg from Abbey Wood to Ebbsfleet are gaining increasing traction within politics, the private sector and government bodies, Woolwich could become the first major stop in Greater London connecting to this new innovative area of production (C2E Campaign, 2018, Kent Online, 2018, BBC, 2018). Hence, the development of Woolwich should not only be seen as valuable to the aims of the TE2050 vision. The reverse is also true, the proposals of TE2050 could be of significant added value to the development of Woolwich as well, resulting in a strong synergy between the two.

Relation to the Royal Borough of Greenwich Local Plan

The proposals build on current ambitions from the RBG to develop Woolwich into a metropolitan town centre.

The most recent Local Plan for the Royal Borough of Greenwich set out its aims and general means for development until 2028 and is based on the previous iteration of the London Plan (Royal Borough of Greenwich, 2014). One of the key features of the local plan is its ambition to develop Woolwich into a Metropolitan Town Centre, the highest possible town centre qualification as per the New London Plan and its predecessor.

While, this does not come close to entailing the level of development proposed in this thesis, it entail a commitment from the Greenwich council to supporting the development of new office, retail and leisure places. Particular emphasis is put, as it is in this thesis, on creating a dynamic interaction envi-

ronment capitalizing on the areas cultural heritage and the identity it brings.

In addition, several strategic development locations are situated in close proximity to Woolwich, promoting densification in its immediate surroundings. One of these locations is located at Kidbrooke, which will be one of the stops along the new transit line, further facilitating development in this area. Subsequently this line moves on, out of the Borough towards Catford, another major town centre in the neighbouring Borough of Lewisham. Here, the arrival of the new line can also provide major reinforcement to local regeneration efforts.

Conclusion

While this thesis advocates a significant paradigm shift in the approach to Greater London's development, its proposals fit remarkably well within the framework of current policy. Moving away from mono-centric development towards the development of a new centrality, not only provides and alternative answer towards delivering on goals questionable to be reached under current policy. It also finds synergies in other areas. Firstly, it provides specification intentions laid out in current policy, such as the development of the City Ribbon and Thames Estuary as found in the TE2050 Vision and New London Plan. Secondly it reinforces and is reinforced by other major projects that are planned or underway such as the regeneration of East London, expansion of London City Airport, and the developments planned along Crossrail's extension to Ebbsfleet. Finally, it expands on the ambitions set out on a local scale level, such as Woolwich becoming a metropolitan town centre, by positioning its development within a set of larger scale objectives such as those set out in this project as well as those of the projects above.

While presenting a profound paradigm shift regarding a development approach for greater london, the proposals done fit remarkably well within current policy frameworks.

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Appendix

A Reference study: Île-de-France

B Theory paper

C Cost estimate tables

D Spatial quality assessment

E Employment potential tables

Mono-centricity is not the only option for large metropolitan regions, there are alterantives. One such alternative can be found in Île-de-France, home to Paris. This region has developed in a more polycentric pattern, thus given its size and stature, it makes an interesting case for the examination of the tools and motivations behind this pattern of development as will be done in this chapter.

Introduction to the Île-de-France region

The roughly 12,000 square kilometre area of Île-de-France is one of France's eighteen administrative regions. It is home to the Greater Paris agglomeration and roughly equals its functional area. Île-de-France is strongly fragmented containing eight departments and over 1200 municipalities. Of these municipalities Paris is by far the largest, forming what some call a state within a state. Where Île-de-France dominates France, Paris dominates Île-de-France. Due to its dominant position as capital region France's central government has retained control over important policy sectors such as transport and regional planning (Salet et al., 2003).

At the heart of the Paris agglomeration lies the central area characterised by Hausman's iconic design. Surrounding this core lies a ring of highways, extending into the sprawl surrounding the central city. The public transit system also features a set of radial lines, with termini stations in the inner city, that extend into France, forming the main focal point for the national railway system in similar fashion to London (Sudjic, 1992). The various radials are linked by a circular line at the edge of the central city.

Île-de-France can be characterised as region with multiple centralities of different importance (Bourdeau-Lepage and Huriot, 2005). It's high-order functions are concentrated in the central area of la Défense but there are other significant employment clusters, often with their own specialization. Most are located around its outer ring such as the R&D focussed Saclay Plateau (Desjardins, 2018).

Development of the Île-de-France region

Île-de-France has a long history of regional development plans called Schéma Direcion (SD), which date back to 1965 after which they have been renewed every ten years. However, while a focal point in planners the implementation of these plans has lacked some of Hausman's forcefulness. Time and time again their outcomes been convoluted due to lacking cooperation and conflict between the region's 1200 municipalities. These constant conflicts have left the Île-de-France a fragmented whole even after 50 years of comprehensive regional planning (Salet et al., 2003).

The first 1965 plan, as seen in figure A.1, intended for decentralized population growth in the form of new towns and the creation of la Défence, the new out of centre business district (Elinbaum and Galland, 2016). By building this district outside of the city centre, France could have its worldwide business district without having its glass monoliths disrupting the uniform historic char-

acter of Hausman's inner city.

In similar fashion to London, and much of Western Europe, the period from 1975 to 1995 saw sig-nificant trends of deindustrialization and decentralization of both economic activity and population growth (Elinbaum and Galland, 2016). Many functions moved towards Paris's outer ring where they once again clustered together into various new centralities as seen in figure A.2. At the same time most high-order functions remained in the centre and La Defence areas (Bourdeau-Lepage and Huriot, 2005).

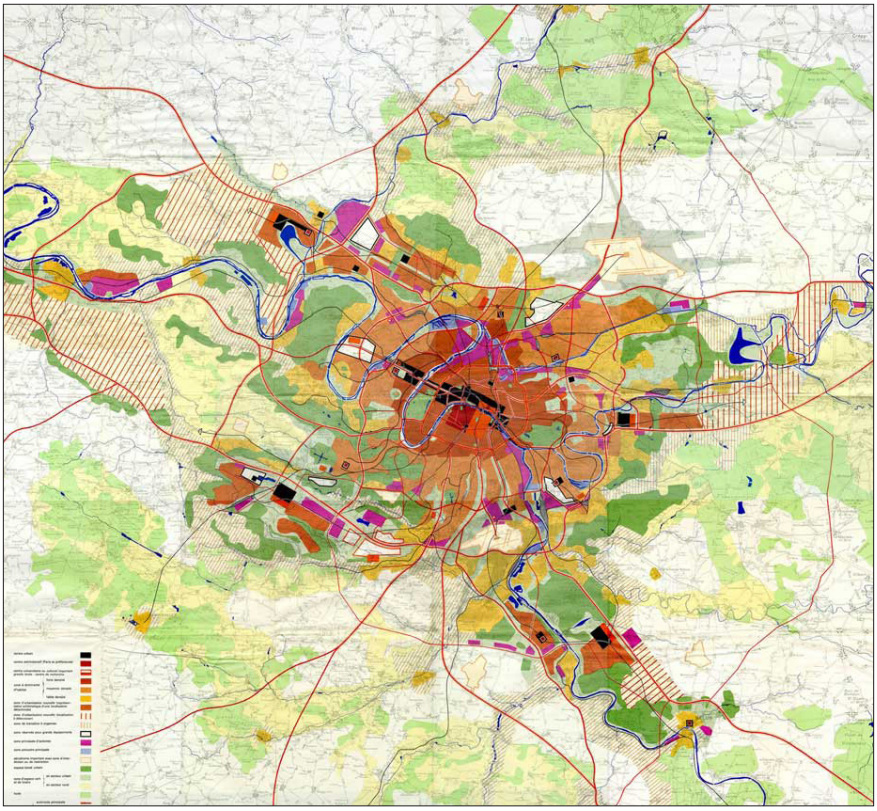


Figure A.1 The 1965 Schéma Direcion for the Paris region *source: SDAURP (1965)*

However it must be noted that the new towns planned for Paris are of very different nature than those Abercrombie had in mind for London. Paris' new towns were rather extensions of the city than the self-contained garden cities in the legacy of Ebenezer Howard. The core principles behind the planning of Paris and its periphery were maintained in the 1976 plan, albeit on a reduced scale.

While employment decentralized, the central city population remained steady, leading to more efficient bi-directional commuter flows along the city's radial axes (Aguiléra et al., 2009). However, interaction between the suburbs also increased creating a pattern that the centrally focussed infrastructure could not accommodate effectively, resulting in widespread transport issues (Salet et al., 2003). This was further compounded by the dominance of the car in the policy debate. Even though the amount of tarmac in the city steadily increased, it could not curb congestion as Paris came to a grinding halt

(Halpern and Galès, 2016). The 1994 SDRIF regional strategy sought to curb urban sprawl and its associated transport issues however, once again, inter-municipal communication, or the lack thereof continued to cause issues.

In order to counter these issues of cooperation the Ministry of the Capital Region, was created in order to carry out the SDRIF 2008 strategy which had access to stronger legally binding instruments. This new Schéma Direcion proposed a Compact City policy guided by three main themes: investment in sustainable transport, reducing segregation and maintaining Paris' position in the world economy (Elinbaum and Galland, 2016).

In 2016 the latest SDRIF 2030 strategy was launched in unison with the formation of the Greater Metropolitan Authority meant to promote inter-municipal communication. This strategy and the formation of a metropolitan authority have signified a major break from the past situation where the Paris and its suburbs barely cooperated. It departs from the compact city model in favour of promoting the multi-polar situation better in line with Greater Paris' actual functional structure. In conjunction with this departure the focus has shifted from car-based mobility to public transport resulting in modernisation and extension of the existing transit network, densification around stations and the creation of the Grand Paris Express (Desjardins, 2018). This second project will comprise long circular lines around connecting the various dominant poles, finally offering the infrastructure now lacking for these places to interact effectively (see fig A.2).

Table 1: Spatial distribution of employment in the Ile-de-France region, 1978–1997

	Paris	Inner ring	Outer ring	Total
Total employment change	(–18%)	(+5%)	(+40%)	(+4%)
Percentage employment 1978	41.14	35.54	23.32	100.00
Percentage employment 1997	32.40	36.13	31.47	100.00

Sources: INSEE; Boiteux-Orain and Guillain, 2002.

Figure A.2 Decentralisation of employment in Greater Paris *source: Bourdeau-Lepage and Huriot (2005)*

Motivations for the development of new poles

As is fitting for a city of constant conflict, the rationales and motivations that have informed the development stages of new poles in and around Greater Paris have been incredibly diverse, from conservation to embracing modernity, from revitalizing deprived communities to grandiose pet projects, and from orienting urban form towards the car to justifying investment into public transport.

The most outspoken example of the development of a new pole in Paris is of course that of La Défense. The conception of General de Gaulle and later continued by Giscard d'Estaing, la Défense had to become the European counterweight to Manhattan, a symbol for France's resurgence as a global force after the devastation of the Second World War (Sudjic, 1992). However as France looked at the future, it held its past in high regard. In an effort to preserve Hausman's historic city, buildings higher than seven stories where prohibited in the central area after the completion of the Tour Montparnasse,

further solidifying la Défense's position as a commercial heart for Paris.

Paris' widespread suburbanization, following the ideals of new town policy, lead to a staggering increase in car-use in the second half of the twentieth century. While more asphalt was the answer to congestion for most of this period things changed in the early 1990's. As air pollution spiked to dangerous levels, citizen groups and political leaders united to reduce car emissions (Halpern and Galès, 2016). However, as with most things in France, a policy shift towards public transit remained contentious. In order to convince the municipalities outside Paris to come to a comprehensive regional solution, the new lines proposed were accompanied by a revitalization strategy for the poor neighbourhoods on Paris fringe. This process eventually led to the approval of a nine kilometre tramway across three of Paris' Arrondissements in 2000, along with the economic developments promised (Halpern and Galès, 2016)).

More recently, with the new SDRIF 2030 strategy has offered a different reasoning for out of centre development. In this strategy polycentricity has become the central element in the regional approach of Île-de-France. Supported by an immense new circular railway connecting the various sub-centres, this strategy takes a regional view and is founded on goals of enhancing sustainability, livability and economic position. While these goals are partly informed by the increasingly evident consequences of the neglect of Paris' Balieu's, much attention is also paid towards further integrating Paris' land market as a boost for its competitiveness as a World City (Schafran, 2017).

Tools for stimulating the development of new poles

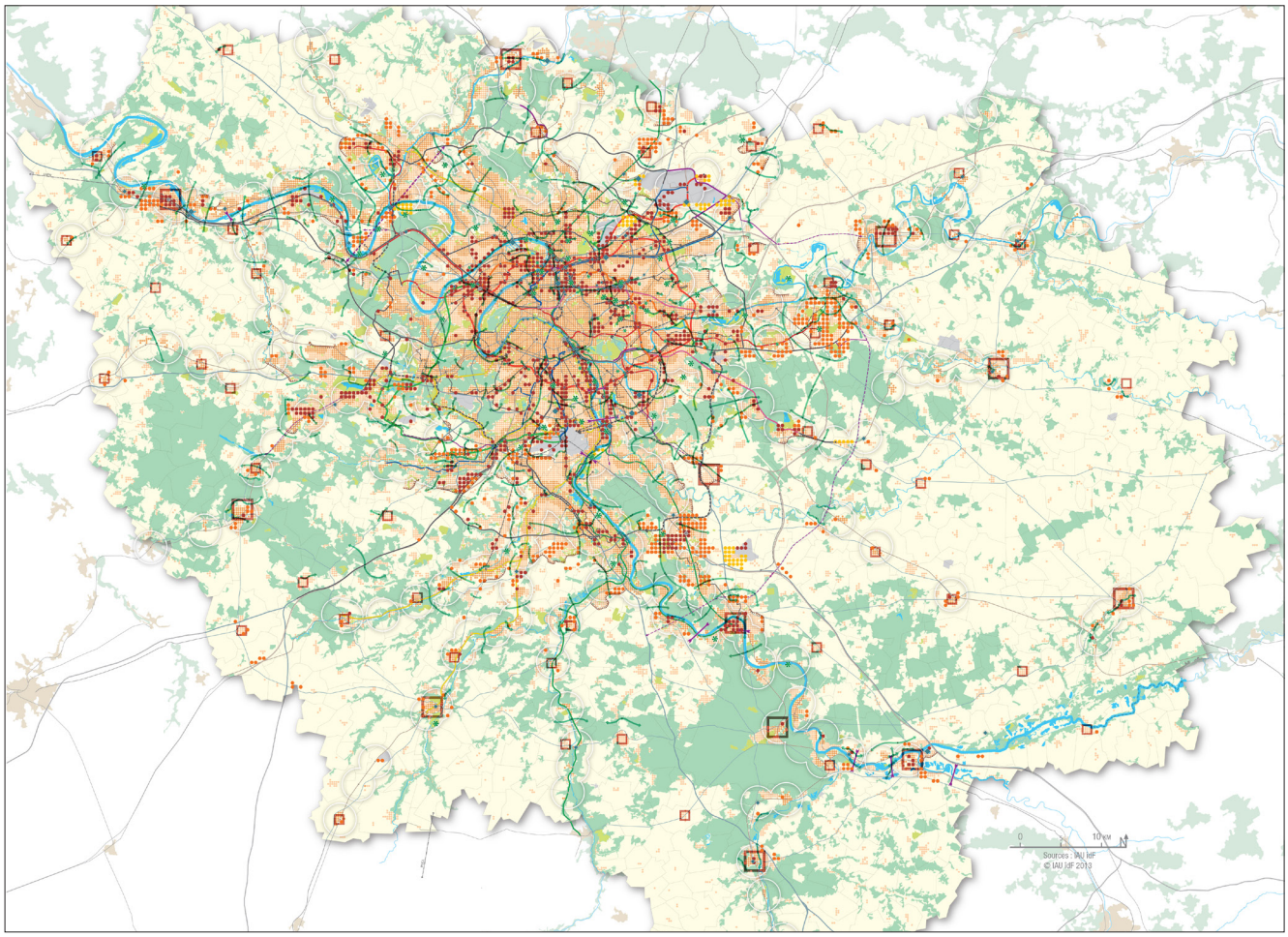
As discussed, indecision and conflicts in governance have often hampered Paris' intended development. The more radical developments that have happened in Paris have often been the result of the great legislative power of the French presidency. In the words of Sudjic (1992): "as far as decision making about development is concerned, Paris is still closer to Louis XIV and Napolean III than the milk and water expediency that passes for modern planning elsewhere."

Since Hausman, this has nowhere been more evident than in the development of la Défence. Being the pet project of presidents de Gaulle and d'Estaing, vast public funds and legislative powers where mobilized in order create it. In order to ensure rapid and uncontested development the EPAD development corporation was found and placed under direct control of the presidency, granting it access to the national treasury. Now that funds were ensured, tenancy was next up. In a tour de force almost unimaginable in most western countries today, companies were forced to settle in the area. If they wouldn't be tempted by the a wide range of financial incentives, they would simply be denied office permits to settle anywhere else in Paris (Sudjic, 1992).

However while one might not expect it upon first viewing la Défence's anonymous glass towers, its development was not solely a financial and legislative undertaking but also very much a placemaking one. This approach was

pivotal for asserting the importance of this new commercial heart for Paris. First is its symbolic placement in Hausman's constellation of boulevards. While it is located outside the old city, it crowns the Paris most famous axis, the Champs-Élysées, connecting it to the Louvre and Arc de Triomphe. The latter relation is punctuated even further by la Défense's very own arc, commis-sioned by Mitterand in 1982 (Sudjic, 1992).

In order to provide a structure for discussing networked regions and identify the most relevant factors for the development of centralities within said But la Défence does not only derive its identity from its relation to the rest of the city. Even before its development it had a symbolic meaning, being home to the la Défense de Paris memorial, commemorating the soldiers of the Franco-Prussion War, from which it lends its name.



▪ Figure A.3 The SDRIF 2030 development plan

source: Institut d'Aménagement et d'Urbanisme (2018)

SDRIF 2030

The tools proposed in the SDRIF 2030 to develop Greater Paris' outer poles might be less evocative than those of la Défense, but they are at least as grand. The development relies primarily on two aspects: a massive regional transit project and a restructuring of regional governance. It must be noted that the new transit ring proposed throughout Paris suburbs is not merely a tool for improving mobility. Rather, it links together the various suburban cores

of Île-de-France, allowing for further integration and intensification of land use throughout the metropolitan region with compact, and mixed used development around its stations (Guironnet, 2018, Schafran, 2017). With these measures, the region embraces the polycentric structure that has evolved over the last decades which the transit system up till now has not yet adequately supported (Lemoine and Prédali, 2009). This new regional approach is supported by the reform of governance structures in an effort to impose a new order on the political squabbles that have hindered the development of the region for so long (Halpern and Galès, 2016).

Conclusion

In conclusion there are range of different motivations for polycentric development throughout Paris's recent history as well as a wide range of tools applied to achieve it as seen in figure A.5. While not all of these are relevant to the case of London, such as the extreme legislative pressure employed to move businesses to la Défense, others are. Some of the most important motivations relevant to London are increasing liveability in the region as a whole, improving its competitiveness and packaging transit reforms with revitalization strategies. In terms of tools financial incentives could prove useful in balancing the attractiveness of locations (as has already been done at Canary Wharf), furthermore a certain character or point of recognition for the location of a new centrality could be important as well as its improving embeddedness in the greater mobility network.

Relevant to London:

Not relevant to London:

motivations for polycentric development
asserting paris as a World City
preserving the historical identity of the inner city
packaging transport reforms with revitalization strategies
better supporting existing functional structure of the region
increasing liveability in the metropolis as a whole
integrating more territory in the overall land market

Figure A.4 Motivations for polycentric development *source: image by author*

tools employed for polycentric development
public funding of real estate development
financial incentives
legislative pressure
symbolic embedding within the historical city
improving the embeddedness in mobility networks
governmental reform to foster a regional vision

Figure A.5 Tools employed for polycentric development *source: image by author*

Impacts of networked agglomeration economies on station area development

Abstract

Transit Oriented Development (TOD)'s model of transit network and land use integration is becoming increasingly established both in academic discourse and in practice. Central to formulating a successful TOD strategy is the proper assessment of the (re)development potential of station areas for which the Node-Place Model has become a central tool. This model employs generic indicators for the connectivity and activity levels of station areas to model interactions between them. This approach seems overly simple in light of the discourse on networked urban systems. This paper aims to expand on the generic connectivity-activity relation of the Node-Place Model by evaluating the impacts of agglomeration on the economic development of station areas. It does this from an urban system perspective using accessibility rather than connectivity to better address the interactions between different station areas. Four different development paths are hypothesized based on changed levels of accessibility to the centres and peripheries in the urban system. These development paths indicate that a broader approach is needed to properly assess the (re)development potential of station areas by highlighting the importance of the regional structure of centralities and peripheries, the transit links between them and the position of a station area in this network.

Keywords: Transit Oriented development; urban systems; agglomeration economies; Node-Place Model; accessibility;

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1. Introduction

Since the year 2000 issues such as sprawl, congestion, and climate change have motivated planners and academics alike to revise one of spatial planning's most central issues: the relation between land use and mobility (Curtis et al., 2009). One of the most applied and researched planning concepts resulting from this exploration is Transit Oriented Development (TOD). This concept as broadly described by Cervero involves 'concentrating a mix of moderately dense and pedestrian-friendly development around transit stations to promote transit riding, increased walk and bicycle travel and other alternatives to the use of private cars' (Curtis et al., 2009).

While much has been written on TOD over recent years its relation to the emergent understanding of urban regions as networked systems remains underexplored. Current literature focuses primarily on tools for implementation, case studies, and isolated performance indicators for transit use and intensity of land-use. This becomes readily apparent from the titles of some of the fields most cited works, for example see Scopus (2018): "Transit Oriented Development: Making it happen", "Hedonic price effects of pedestrian- and transit-oriented development" and "The impact of transit-oriented development on housing prices in San Diego, CA". These studies often treat TODs as isolated instances with generic levels of connectivity and thus fail to concretely address the impacts of functional interactions between networked places in urban systems as described by authors such as Burger and Meijers (2011) and Green (2007). A clear example of this is the Node-Place Model, a tool for assessing the (re)development potential for station areas which employs isolated indicators for connectivity and activity. This approach seems overly simplistic in light of studies on urban systems.

In order to expand on the generic relations of the Node-Place Model this paper aims to explore how Transit Oriented Developments are affected by agglomeration, an influential process for economic development in urban regions. Four hypothetical development paths for TOD areas are suggested dependant on the region's original structure, the morphology of the transit network, and the position of the developed area within said network.

In order to construct this argument, first of all the concept of TOD will be introduced, along with the Node-Place Model. Subsequently the understanding and functioning of regions as networked urban systems will be discussed. Afterwards these two concepts will be intersected. For this discussion the concept of accessibility will be suggested as a more appropriate term for describing the interaction in networked urban systems than the generic notions of connectivity currently applied in the Node-Place Model. After providing the initial base for discussion the mechanics of agglomeration and its underlying variables will be explained. Originally a concept based on spatial proximity, agglomeration economies will then be discussed in the context of networked urban systems. Finally, based on the intersection of the Node-Place Model, urban systems, and the mechanics of agglomeration in networks, four hypothetical development paths for station areas will be proposed. These development paths offer an expanded insight into the generic relation between density and connectivity used in the Node-Place Model.

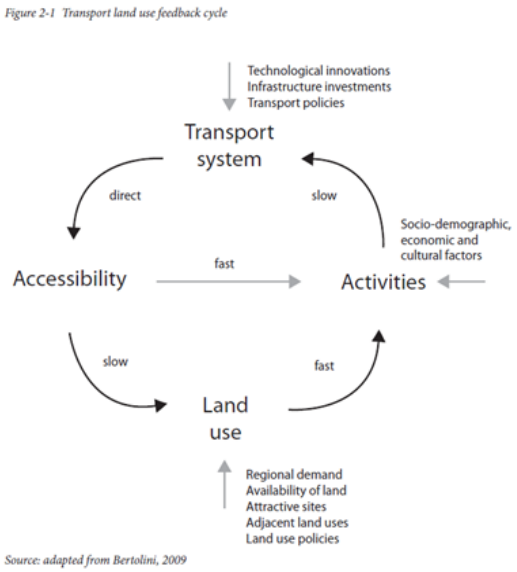
2. Transit Oriented Development and the Node-Place Model

In order to provide the base for our discussion, there will first be a brief introduction to Transit Oriented Development, its associated concepts, and models. The model of TOD has been gaining traction as a new approach for relating land-use and transport (Curtis et al., 2009). It's emergence is a reaction to the increasingly dispersed and open nature of the contemporary urban system, in which people live in one place, while working and recreating in another. Due to the associated increase in mobility, the places in a region where people come together have become focalized around transportation hubs. It is this new organisation of movement patterns that Transit Oriented Development aims to embrace and capitalize on (Bertolini, 1999). The overall manner in which the TOD development model approaches this new reality is probably best summed up by Tan (2013): "TOD refers to mixed-used residential and commercial developments with sufficient density, preferably graduated, oriented towards and in proximity (walkable) distance to a public transportation node in opposition to a car-dominated and sprawlish urban form".

As can be deducted from the abovementioned definition, TOD has become touted as a viable alternative to car-based mobility and its associated land-use patterns. It is not only suggested as a means of reducing reliance on automotive transport and its negative externalities, but also as a means reducing travel time, saving space, engaging private stakeholders, generating wealth and creating a favourable environment for knowledge economy activities (Curtis et al., 2009, Chorus, 2012). In this broad range of subjects, paper will focus on TOD's potential to foster economic growth in its surrounding station areas.

To understand TOD's potential for fostering economic growth, it is key to understand the interrelation between accessibility and activity. This interrelation is most clearly described by the so-called Land-Use Feedback Cycle as seen in figure 1. (Chorus, 2012, Bertolini, 2009). The land-use patterns in a city are an important determinant for the location of activities. These activities generate a travel demand, which needs to be accommodated through new infrastructure. This new infrastructure transforms the level of accessibility of a place, which is in turn an important determinant for the location-decision of landlords, households, investors and firms. In short, accessibility partly determines the activities that come to take place in an area. As these new activities emerge they will, once again, generate their own new travel demand. The cycle starts over.

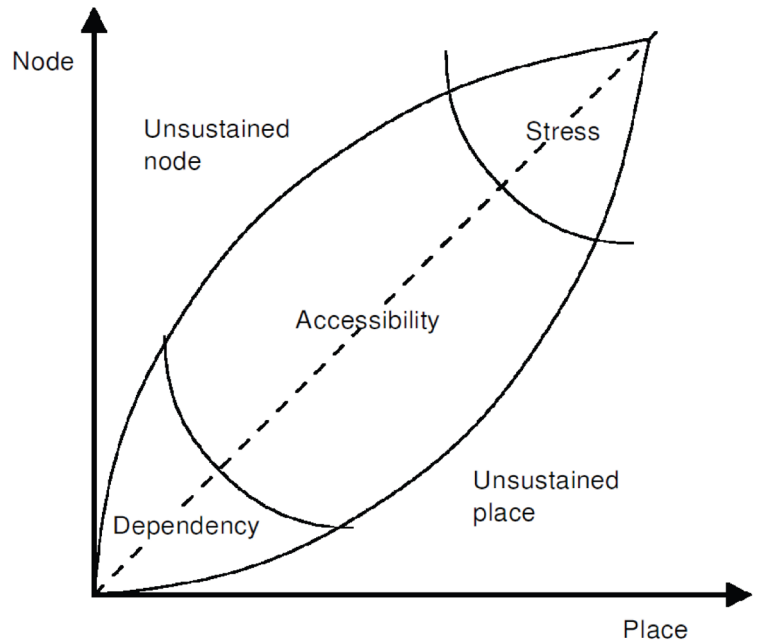
In order to formulate a successful TOD strategy the understandings of the Land-Use Feedback Cycle need to be translated into a method for evaluating the (re)development potential of station areas. For this, the Node-Place Model has become a central tool (Curtis et al., 2009, Bertolini, 2008, Bertolini, 1999, Chorus, 2012, Reusser et al., 2008). This model is based on the aforementioned notion that the transit hub is the most pronounced manifestation of accessibility in the modern dispersed city. It is the place where different people can come and perform a variety of different activities (Bertolini, 1999). Therefore, these transportation hubs can be regarded as both nodes and places, part of the network of flows of city users and spaces of activity. As explained in the Land-Use Feedback Cycle, these aspects are intertwined. Spatial distribution creates the need for mobility whereas increased accessibility can be a determinant for land-use location decisions. This interdependency, combined with a process of competition between the various station areas in a system, form the essence of the Node-Place Model (Bertolini, 1999, Chorus, 2012)



▪ Figure 11.8 Integration in existing policy

source: adaption by Chorus (2012)

This abstract notion is translated into a workable model as seen in figure 2. A set of station areas is evaluated by their so-called node and place indexes mapped on the y and x axis respectively. The node-value is composed of a set of generic measures for connectivity, and the place-value by a set of generic measures for density and diversity of activities. When observing the chart the mean line, and states of unsustained node and place are most relevant to the discussion in this paper. The mean line indicates an equilibrium in which node- and place-value are in balance. An unsustained node means that a station area's connectivity is relatively much higher than the level of activity and vice versa for the unsustained place. These situations can be regarded as inefficient, either connectivity is much higher than needed to fit local demand or the amount of activities exceeds that which the level of connectivity can maintain. As the different station areas in a system compete with one another, outside funding or exceptional locational quali-



Node-Index components:

1. Train: directions served
2. Train: daily frequency of services
3. Train: Stations within 45 minutes travel distance
4. Other transit: number of directions
5. Other transit: daily frequency
6. Car: distance to closest highway exit
7. Car: parking capacity
8. Bicycle: number of bicycle paths
9. Bicycle: parking capacity

Place-Index components

1. Number of residents
2. Number of workers in the four main economic clusters
3. Degree of functional mix

▪ Figure 5.9 The Node-Place Model

source: Bertolini (1999)

ties will be needed to sustain these inefficient nodes or places. Without this, station areas will tend to move towards a state of equilibrium through changes to the either the level of connectivity or activity (Bertolini, 1999). Conclusively, it can be said that the Node-Place Model attempts to describe interactions within a networked system of station areas by comparing levels of connectivity and activity for every station area, expecting them to balance out through a blind process of competition. However, modelling interactions in networked systems by solely comparing isolated indicators for different station areas seems to be an overtly simple approach in light of recent advances in the field of networked urban systems. The theory behind such networked urban systems will be discussed in the next section.

3. Understanding urban regions as networked systems

In order to progress towards an understanding of station area development more specific than the blind competition suggested in the Node-Place Model, it is crucial to first establish an understanding of urban regions as networked systems. This concept, in similar fashion to TOD, originates from the increasingly open and dispersed nature of the contemporary city. However, as opposed to TOD its primary focus is not on the increased movements of people resulting from this new reality. Instead it focuses on the interactions between places that determine the functioning of urban regions as a whole. As a theoretical construct, it explains urban regions as networked systems of sources and destinations that interact in a way that does not necessarily line up with their physical form (Nio, 2000). Over time, this abstract notion has become increasingly formalized as an aspatial model for understanding processes within urban regions, combining both network theory and economic geography.

To understand the workings of networked urban systems its building blocks must first be discussed briefly. The urban systems model finds its origin in network theory. It understands urban regions as networks comprised of nodes and linkages (Green, 2007). Nodes can be all sorts of different things from cities to people, firms or web servers. It is important to note that each of these nodes is a separate instance in itself, often having its own unique characteristics. Linkages are the things that connect the different nodes in a system. These can again, depending on the type of nodes, take many forms from commuter flows to friendships, financial transactions, or email traffic. In short, a system is a set of nodes that are networked with one another through the linkages between them.

When exploring processes in urban systems, it is important to note that the linkages are functional in nature, meaning that they allow for interaction between different nodes. They in fact consists of flows, be it people, money, or something else (Green, 2007, Burger and Meijers, 2011). The magnitude and scale of these linkages is often not evenly distributed over a system, making certain nodes more important relative to others. These nodes can be regarded as centralities in their system. This situation can most concisely be described by the following expression from Burger and Meijers (2011), in which a higher value for Cc indicates a higher relative importance in its system:

$$C_c = Nc - Lc$$

$$C_c = \text{Centrality}$$

$$N_c = \text{Absolute importance based on incoming flows}$$

$$L_c = \text{Local importance based on internal flows}$$

A clear example to illustrate this would be the level of centrality for employment in particular area of a region. In this case, the total employment in an area would be the Nc value as this is equal to the amount of workers coming in. Subsequently, Lc would be the amount of people both living and working in this same area. The centrality value Cc would then indicate the amount of workers commuting to the area from the other nodes, and with that its relative importance for providing employment throughout the networked region.

The logical result of the existence of centralities, is the existence of the opposite. Coming back to the previous exam-

ple: If there are places in a system that provide a disproportionally high amount of employment, there will be others that provide a disproportionally small amount. In the context of this paper, these will be referred to as peripheries. Again this term is functional not morphological, peripheries can in fact be urban.

In order to discuss how insights into urban systems can contribute to TOD's central Node-Place Model, it is necessary to first determine a way of intersecting these two models. As discussed, there is a great variety of nodes and linkages through which urban systems can be examined. In the context of TOD, the Node-Place Model already identifies two appropriate measures: station areas as nodes and public transit connections as linkages. However, as urban systems theory concerns interactions the measurement of these transit links must be redefined. The focus must shift from their physical properties to their functional capacities, as will be discussed in the next section.

4. Accessibility as an alternative to connectivity

As previously discussed, both studies into TOD and networked urban systems have a similar origin, the dispersed nature of the contemporary urban region. However, in their approach to this situation they have departed from each other. TOD has become focussed on transit hubs as the new focal points in the dispersed city. The generic values for connectivity employed in the Node-Place Model, such as the number of rail and bus connections, are exemplary of this approach. They indicate the importance of a place as a transit hub and with that its relative importance in the urban region. Urban systems research on the other hand, builds on the interactions between different places in this dispersed region. It focuses on functional relations. In order to apply the insights from urban systems research to the Node-Place Model it is necessary to not just look at the quantity and type of infrastructure supporting a transit hub, but rather at the interactions it can facilitate. Therefore the notion of accessibility will be used as a more appropriate alternative to that of connectivity.

As opposed to connectivity, accessibility does not merely indicate the amount of connections but rather what these connections allow to be reached. Accessibility as explained by the OECD (2002) considers the possibility of someone to travel somewhere to do something which can be exploited. In short, it links both the means of transport with a certain travel purpose. It indicates what can be reached from a certain place, or by a certain person, against an acceptable cost, be that money, travel time, or something else. Accessibility allows for interaction and is thus indicative for the potential to engage in functional relations with other places.

Replacing the Node-Place Model's variables related to connectivity with ones related to accessibility allows for more specific discussion of the interactions between networked station areas, as opposed to simply assuming anonymous competition. These variables open the door for new insights into the potential development paths of station areas, going beyond the more generic connectivity-accessibility relationship described in the Node-Place Model. In order to describe these relations, relevant accessibility variables for economic development in urban regions first be identified.

5. Agglomeration in urban systems

Now that accessibility has been established as a way of describing node-value better able to address the interactions between station areas, it is time to discuss the type of interactions that can occur as well as their related variables. As there are a great many interactions happening within urban systems the following discussion will limit itself to agglomeration being one of the main drivers of economic development in urban regions (Venables, 2007). For clarity in this discussion, urban systems will be regarded as if they are confined to their own region even though most, in this day and age, have national and international ties as well (Burger and Meijers, 2011, Burger et al., 2015).

Agglomerations are high concentrations of firms and population that develop due to the pursuit of benefits from economies of scale in the relation between producers of services and products, and households (Johansson and Quigley, 2003, Bourdeau-Lepage and Huriot, 2005). The benefits from such agglomeration economies are derived from four main mechanics. The first is the most complex and comes to exist due to the large markets that agglom-

erations provide. These provide a strong an constant demand that firms can rely on as there are many consumers, in the form of both households and companies, that purchase goods and services. Due to this constant and strong demand, companies can start to offer more specialized products better tailored to certain sub-groups in the market. This creates more variety in the marketplace allowing firms to buy the specific products they need at a lower cost while also offering a wider range of consumer goods which in turn promotes the well-being of inhabitants (Johansson and Quigley, 2003).

The second benefit is the reduction of interaction costs due to proximity. As firms and/or consumers are closer to each other transport cost will be reduced. This makes it cheaper to make use of each other's services, improving overall efficiency. The third benefit is the increased likelihood of knowledge spillovers due to the close proximity of firms in an agglomeration. As firms interact closely, they often learn from each other without paying anything for this knowledge. This again has the potential to boost productivity without any additional cost. The final benefit of agglomeration is labour market pooling. Due to the large population in an agglomeration, firms have better access to the high-skilled people that they need. Vice-versa the large quantity of firms offers employment opportunities to said people (Johansson and Quigley, 2003).

However, agglomeration does not solely have benefits for firms and households, it also has downsides. Some of the most pronounced are increased competition and the high prices of land and floor space (Bourdeau-Lepage and Huriot, 2005). The first speaks for itself while the second is a direct result of agglomeration's reliance on proximity. As the benefits of agglomeration are derived from high concentrations of activity in a small area, the limited available space will become increasingly expensive. Therefore, only those functions for which the benefits of agglomeration exceed the costs will be found there.

Conclusively agglomeration economies lead to increases in productivity, cost reduction, and variety in offered consumer goods. The underlying mechanics are dependent on scale, and with that variables such as access to a wide variety of firms, and sizable consumer and labour markets. However due to their reliance on proximity, agglomerations also have negative effects for firms and consumers due to the high levels of competition and land prices.

6. Networking as a substitute for scale in agglomeration

The benefits of agglomeration economies are said to be derived from the spatial proximity of people and firms, and thus seem to be spatially constrained. However as established previously, the modern urban region is becoming increasingly aspatial and functions in a way that does not necessarily adhere to its physical form anymore. This brings the necessity of proximity, for achieving the benefits of agglomeration, into question. In this light, authors such as Johansson and Quigley (2003) argue that the linkages tying urban systems together could provide a substitute for proximity. These linkages can provide the high levels of accessibility that agglomeration economies rely on without the strong spatial constraints. These findings are confirmed by Graham (2007) whose research finds that UK firms exhibit the productivity boosts associated with agglomeration as their accessibility to employment increases, regardless of spatial proximity. Studies by Meijers and Burger (2015) find similar interactions they dub "borrowing size", where cities in urban systems provide functions they should not be able to given their individual size.

The functioning of this borrowed size effect can be explained by the variables underlying agglomeration economies, such as access to a wide variety of firms and, sizable consumer and labour markets. As places become gain better access to each other, the spatial range in which firms, consumer and labour markets can easily interact increases. Due to this increase, the scale necessary for the benefits of agglomeration can be sourced from other places in the urban system making it possible to achieve a disconnection between the size and functionality of a place (Meijers and Burger, 2015).

However this process of borrowing size can be a double edged sword, because of competition effects. As places borrow size from others in the region, they often cast an agglomeration shadow. This means that consumers will

be lead away from local amenities due to the high service level available in places benefitting from this networked agglomeration (Burger et al., 2015). Some places in urban systems have a better network position than others, this allows them access to a larger proportion of the regional market and its associated agglomeration benefits. This results in an uneven competition, as can be explained by the nature of these benefits identified earlier by Johansson and Quigley (2003). Firms benefitting from agglomeration economies tend to be more efficient and offer a wider, and thus more desirable, range of consumer goods. This gives them a distinct advantage over firms that do not benefit from such effects due to a less favourable network position. This makes it likely for places that benefit from agglomeration to outcompete places that do not.

The processes of borrowing size and the associated agglomeration shadows lead to the development of centralities and functionally peripheral places within urban systems. As discussed in section three, centralities are places of relative importance in a system on which other peripheral places rely. As firms in places benefitting from agglomeration outcompete those in places that do not, a reliance is created. The places where firms are outcompeted become more reliant on the winner, thus creating centrality – periphery relations within the system. Therefore, it seems that network position is an important factor for the development path of a place as it impacts development as centrality or periphery based on its access to the regional market.

Conclusively the benefits of agglomeration can be attained either through individual size or access to other places, which allows for the borrowing of size. As the benefits of agglomeration impact the competitive balance in urban systems, both size and network position factor into the development of centralities and peripheral places in urban regions. Building on these insights, it is now time to discuss how this can bring further nuance to the connectivity-activity relationship identified in the Node-Place Model.

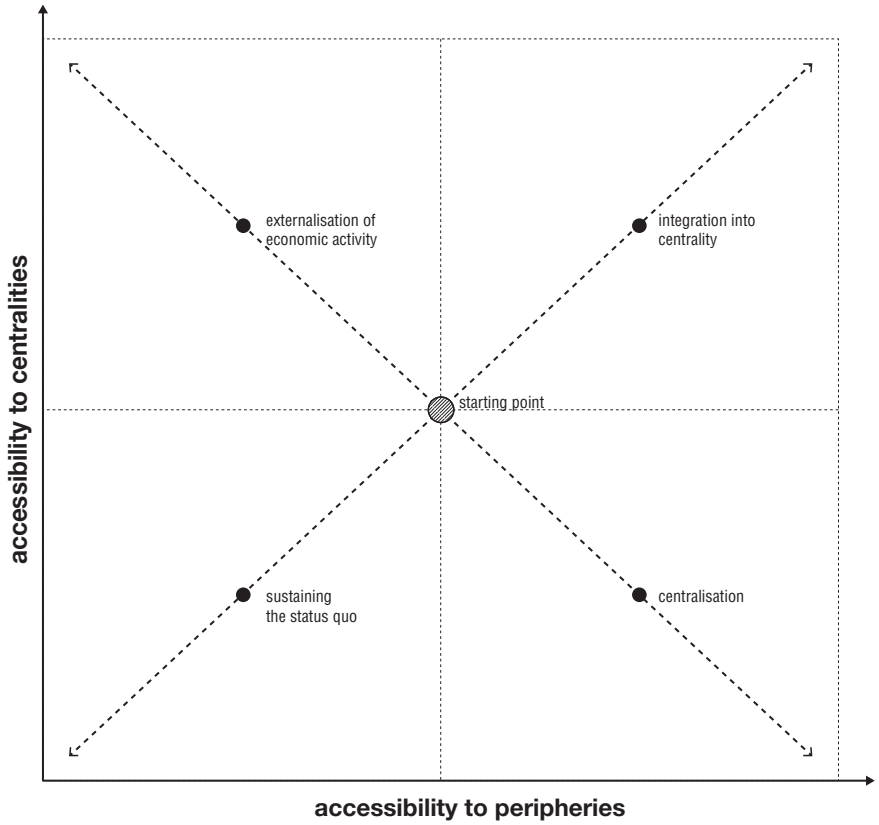


Figure 5.10 Station area development paths *source: image by author*

7. Four hypothetical development paths for TOD's

The next and final step for the discussion in this paper is to assess how the aforementioned insights can help expand on the more generic connectivity-activity relation proposed in the Node-Place Model. As established, urban regions can be regarded as systems consisting of nodes with unique characteristics, networked through a set of linkages between them. The development of centralities and peripheries in such systems, is in part influenced by the benefits of agglomeration economies. These benefits emerge from the access to sizable markets and can be achieved through either a high concentration of activity in a node itself, or by borrowing size from other nodes it has access to.

To apply these insights to TOD and the Node-Place Model, station areas will be regarded as nodes, and transit lines as the linkages that allow for access between them. To guide the discussion, the base assumption will be that a new station is built in an existing area that does not yet have one, is of average density, and has a reasonably self-contained functionality. This area is located in a region that already boasts a transit network and already features a system of centralities and peripheries, derived from the size and network position of its nodes.

As the new station is built, two things are likely to happen regarding its network position: its accessibility to centralities changes and/or its accessibility to peripheries changes. This leads to four possible scenarios: accessibility to the centrality increases while accessibility to the periphery does not (7.1), both accessibility to the centrality and periphery increase (7.2), accessibility to the centrality does not increase while accessibility to the periphery does (7.3) or neither accessibility level changes much at all (7.4). This leads to four hypothetical development paths as seen in figure 3. and discussed per scenario below.

7.1 Externalisation of economic activity

For the first development path, the assumption is taken that a new station increases its area's accessibility to a centrality while having little impact on access to the peripheries. The centrality can be assumed to be the beneficiary of agglomeration effects, either due to its size or network position. This means that its firms have a competitive advantage over those in the new station area, who do not benefit from agglomeration. As firms in the new station area are outcompeted, and consumers choose the higher variety of services in the centrality, local economic activity will decrease. The centrality will borrow size from the new station area, putting it in its agglomeration shadow. As a result a portion of the economic activity in the new station area will become externalized to the centrality.

7.2 Integration into centrality

For the second development path, the assumption is taken that a new station increases its area's accessibility to both a centrality and the peripheries. As explained earlier, the centrality can be assumed to benefit from agglomeration effects meaning that it is also likely to suffer from its costs, such as high land prices. As the new station area provides strong access to the peripheries and their market, it offers a similar potential for agglomeration as the centrality it is connected to. However as it does not yet have the same level of development as the centrality, agglomeration costs will be lower. Therefore it is likely that firms from the centrality will move to the new station area in search of the same benefits at a lower cost. Through this process the new station area will become functionally integrated as the centrality expands into it.

7.3 Centralisation

For the third development path, the assumption is made that a new station increases its area's accessibility to the peripheries while having little impact on accessibility to the centrality. Due to the strong access to the peripheries, it will become possible to borrow their size. If an area's network position allows for borrowing enough size, it has the potential to develop into a new centrality capable of competing with the existing ones.

7.4 Sustaining the status quo

For the fourth and final development path, the assumption will be made that a new station does not significantly increase an area's accessibility to either the centralities or peripheries in an urban system. As little changes in regard to its position in the system it is likely that its functionality remains relatively self contained and no major changes in the amount or type of activity will occur.

The four development paths suggested here are not solely limited to the development of new station areas but could also serve to evaluate the consequences of accessibility impacts from new links in a system. However, it must be noted that the above mentioned changes in accessibility are all relative relative and that certain thresholds are likely to exist, which must be met before any of these development paths occur. Possibly, these thresholds could be affected by the individual size of the evaluated station area. However, further empirical studies are needed to confirm the occurrence of these development paths and the conditions that need to be met for them to happen.

Conclusively, these four development paths show that the type of places a station area gains access to, is important for the kind of development that will occur. This goes beyond the more generic relation between connectivity and activity proposed in the Node-Place Model. Following this approach three additional variables are needed in order to assess the (re)development of station areas. First is the original structure of the region with its centralities and peripheries. Second is the morphology of the transit network that links these places and allows for interaction between them. Third is the position of the station area in the network and with that its relation to the various centralities and peripheries.

9. Conclusion

As we have seen, Transit Oriented Development has become an increasingly popular concept both in theory and practice. Essential to formulating successful TOD strategies is the assessment of the (re)development potential of station areas, for this the Node-Place Model has become a central tool. However, this only uses isolated indicators for connectivity and activity in order to model interactions within a system of stations, an approach that seems overly simplistic in light of recent studies into networked urban systems. These systems model urban regions as networked entities consisting of nodes and the functional linkages between them in order to describe their internal processes. In order to put the (re)development potential of station areas in the context of this discourse a shift in focus is needed from the physical characteristics of transit links to their functional capacity of providing accessibility.

Accessibility is essential to agglomeration as being one of the central processes shaping economic development in urban systems. Firms benefiting from agglomeration exhibit increased efficiency and are capable of offering a higher variety of goods to consumers, giving them a competitive advantage over places that do not. Therefore it is likely that such firms will outcompete ones in the same market that do not benefit from such benefits. This leads to the development of centralities and reliant peripheries in the urban system. The economics underlying the benefits of agglomeration are derived from the access to sizable markets and can be achieved either through the individual size of a place or its access to others which allows it to borrow size from them.

In the context of TOD these processes suggest that the network position of a station area in regards to the various centralities and peripheries in a system, can provide significant insights into the (re)development potential of these areas. As new stations or transit links are developed, areas are likely to achieve increased accessibility to either centralities or peripheries. Dependant on the balance between these two accessibility measures four development paths can be expected: externalisation of economic activity, expansion of a centrality, the emergence of a new centrality, or a continuation of the status quo. These insights expand on the more generic connectivity-activity relation of the Node-Place Model showing that the regional structure of centralities and peripheries, the transit links between them, and the position of a station area within this network are essential to the type of development that can take place.

However, the findings in this paper should not yet be taken as rules that are 'set in stone' for the development of

station areas. Rather they serve as a starting point for a broader discussion on the determinants for station area development as one paper cannot address the associated complexities fully. For example, the discussion in this paper assumes that uneven competition will lead to the creation of centralities and peripheries. However, reality is significantly more diverse. As different places in networked urban systems compete there is not always a clear winner and loser, instead complementarities can come to exist (Burger et al., 2014). This can partly be explained due to the different balances that different economic sectors have for the costs and benefits of agglomeration (Bourdeau-Lepage and Huriot, 2005). Finally, it must also be noted that while the term accessibility already does a better job in addressing the economic growth opportunities around station areas than connectivity, it is not the determining factor. Other factors such as overall economic conditions, land use, and policy frameworks (OECD, 2002, Banister and Berechman, 2001) are at least as important in determining the (re)development potential of station areas.

Cost estimate								
	Quantities				Costs			
	Var 1	Var 2	Var 3	Var 4	Var 1	Var 2	Var 3	Var 4
Cost of Links								
Surface rail	4.3	1.8	0.5	3.8	63.8	26.7	7.42	56.4
Subsurface rail	13.7	6.3	7.5	10.2	813.5	374.1	445.37	605.7
systems	18.0	8.1	8.0	14.0	674.9	303.7	299.97	524.9
indirects	18.0	8.1	8.0	14.0	416.8	187.6	185.24	324.2
capacity upgrade	-	14.9	7.1	3.1	-	791.1	376.96	164.6
rolling stock	18.0	23.0	15.1	17.1	1,030.2	1,316.4	864.26	978.7
Land acquisition								
subsurface rights	13.7	6.3	7.5	10.2	-	-	-	-
open space (gov)	1.1	-	-	-	-	-	-	-
open space (other)	2.8	1.2	0.5	3.1	103.6	36.8	-	121.7
residential (LD)	0.4	0.5	-	0.3	17.2	32.7	-	16.0
residential (MD)	-	0.2	-	0.3	-	12.8	-	21.7
industrial	0.1	0.5	-	-	0.7	19.4	19.37	-
Stations								
surface stations	2.0	2.0	1.0	2.0	205.1	205.1	102.54	205.1
subsurface stations	9.0	5.0	6.0	4.0	3,691.4	2,050.8	2,460.92	1,640.6
Contingency (66%)					4,631.4	3,535.7	3,142.95	3,075.3
Total					**11,648.7**	**8,893**	**7,905**	**7,735**

Unit prices					
	CR2 Quantity	CR 2 Cost	Proj Cost		Note
Cost of Links					
Surface rail			14.85	million £ / km	25 % of underground rail[1]
Subsurface rail	30.75 km	1826 million £	59.38	million £ / km	Total costs / line length
systems	30.75 km	1153 million £	37.50	million £ / km	Total costs / line length
rolling stock	30.75 km	1760 million £	57.24	million £ / km	Total costs / line length
indirects	30.75 km	712 million £	23.15	million £ / km	Total costs / line length
capacity upgrade			53.09	million £ / km	40% of costs above for surface rail[2]
Land acquisition					
subsurface rights	-	-		-	Borough specific, see Land acquisition price
open space (gov)	-	-		-	Borough specific, see Land acquisition price
open space (other)	-	-		-	Borough specific, see Land acquisition price
residential (LD)	-	-		-	Borough specific, see Land acquisition price
residential (MD)	-	-		-	Borough specific, see Land acquisition price
Industrial (LD)	-	-		-	Borough specific, see Land acquisition price
Industrial (MD)	-	-		-	Borough specific, see Land acquisition price
Stations					
surface stations			102.54	million £ / station	25 % of underground station[1]
subsurface stations	13 km	5332 million £	410.15	million £ / station	Total costs / number of stations

▪ Figure A.6 Cost estimate

source: calculations by author

Land acquisition prices					
Type	**Units / ha plot**	**median House Price[4]**	**acquisition price / ha**	**Price / km (assuming railway occupies a 25m wide strip)**	**Note**
Variant 1					
Residential (LD)	40	430,000 £	17,200,000 £ / ha	43.0 million £ / km	2018 median house price Borough of Lewisham
Residential (MD)	65	430,000 £	27,950,000 £ / ha	69.9 million £ / km	2018 median house price Borough of Lewisham
Industrial			2,905,405 £ / ha	7.3 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			14,800,000 £ / ha	37.0 million £ / km	2018 residential Land value Borough of Lewisham
Variant 2					
North					
Residential (LD)	40	499,950 £	19,998,000 £ / ha	50.0 million £ / km	2018 median house price Borough of Brent
Residential (MD)	65	499,950 £	32,496,750 £ / ha	81.2 million £ / km	2018 median house price Borough of Brent
Industrial			15,498,450 £ / ha	38.7 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			8,000,000 £ / ha	20.0 million £ / km	2018 residential Land value Borough of Brent
Mid					
Residential (LD)	40	395,000 £	15,800,000 £ / ha	39.5 million £ / km	2018 median house price Borough of Hounslow
Residential (MD)	65	395,000 £	25,675,000 £ / ha	64.2 million £ / km	2018 median house price Borough of Hounslow
Industrial			8,797,727 £ / ha	22.0 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			8,800,000 £ / ha	22.0 million £ / km	2018 residential Land value Borough of Lewisham
South					
Residential (LD)	40	654,000 £	26,160,000 £ / ha	65.4 million £ / km	2018 median house price Borough of Wandsworth
Residential (MD)	65	654,000 £	42,510,000 £ / ha	106.3 million £ / km	2018 median house price Borough of Wandsworth
Industrial			6,620,082 £ / ha	16.6 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			24,500,000 £ / ha	61.3 million £ / km	2018 residential Land value Borough of Wandsworth
Variant 3					
Residential (LD)	40	499,950 £	19,998,000 £ / ha	50.0 million £ / km	2018 median house price Borough of Brent
Residential (MD)	65	499,950 £	32,496,750 £ / ha	81.2 million £ / km	2018 median house price Borough of Brent
Industrial			15,498,450 £ / ha	38.7 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			8,000,000 £ / ha	20.0 million £ / km	2018 residential Land value Borough of Brent
Variant 4					
East					
Residential (LD)	40	533,500 £	21,340,000 £ / ha	53.4 million £ / km	2018 median house price Borough of Barnet
Residential (MD)	65	533,500 £	34,677,500 £ / ha	86.7 million £ / km	2018 median house price Borough of Barnet
Industrial			5,029,172 £ / ha	12.6 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			15,700,000 £ / ha	39.3 million £ / km	2018 residential Land value Borough of Barnet
West					
Residential (LD)	40	445,000 £	17,800,000 £ / ha	44.5 million £ / km	2018 median house price Borough of Waltham Forest
Residential (MD)	65	445,000 £	28,925,000 £ / ha	72.3 million £ / km	2018 median house price Borough of Waltham Forest
Industrial			4,734,043 £ / ha	11.8 million £ / km	Residential (LD) / ratio of residential to industrial land value
Open Space			9,400,000 £ / ha	23.5 million £ / km	2018 residential Land value Borough of Waltham Forest

Land prices per Borough[3]			
Borough	**Residential**	**Industrial**	**Ratio**
Lewisham	14,800,000	2,500,000	5.9
Brent	8,000,000	6,200,000	1.3
Hounslow	8,800,000	4,900,000	1.8
Wandsworth	24,500,000	6,200,000	4.0
Barnet	15,700,000	3,700,000	4.2
Waltham Forest	9,400,000	2,500,000	3.8

1. Flyvbjerg et al (2008)

2. Estimation considering capacity upgrades are unlikely to be needed everywhere but will incurr costs by disrupting regular operations

3. GLA Economics (2016)

4. Greater London Authority (2018a)

Land acquisition costs					
Type	**Quantity**	**Price**		**Cost**	
Variant 1					
Residential (LD)	0.4 km	43.0	m. £ / km	17.2	m. £
Residential (MD)	-	69.9	m. £ / km	-	m. £
Industrial	0.1 km	7.3	m. £ / km	0.7	m. £
Open Space	2.8 km	37.0	m. £ / km	103.6	m. £
Total				**121.5**	**m. £**
Variant 2					
North					
Residential (LD)		0 50.0	m. £ / km	0	m. £
Residential (MD)		0 81.2	m. £ / km	0	m. £
Industrial	0.5 km	38.7	m. £ / km	19.37306	m. £
Open Space		0 20.0	m. £ / km	0	m. £
Mid					
Residential (LD)		0 39.5	m. £ / km	0	m. £
Residential (MD)	0.2 km	64.2	m. £ / km	12.8375	m. £
Industrial		0 22.0	m. £ / km	0	m. £
Open Space		0 22.0	m. £ / km	0	m. £
South					
Residential (LD)	0.5 km	65.4	m. £ / km	32.7	m. £
Residential (MD)		0106.3	m. £ / km	0	m. £
Industrial		0 16.6	m. £ / km	0	m. £
Open Space	0.6 km	61.3	m. £ / km	36.75	m. £
Total				**101.7**	**m. £**
Variant 3					
Residential (LD)		0 50.0	m. £ / km	-	m. £
Residential (MD)		0 81.2	m. £ / km	-	m. £
Industrial	0.5 km	38.7	m. £ / km	19.4	m. £
Open Space		0 20.0	m. £ / km	-	m. £
Total				**19.4**	**m. £**
Variant 4					
East					
Residential (LD)	0.3 km	53.4	m. £ / km	16.005	m. £
Residential (MD)		0 86.7	m. £ / km	0	m. £
Industrial		0 12.6	m. £ / km	0	m. £
Open Space	3.1 km	39.3	m. £ / km	121.675	m. £
West					
Residential (LD)		0 44.5	m. £ / km	0	m. £
Residential (MD)	0.3 kml	72.3	m. £ / km	21.69375	m. £
Industrial		0 11.8	m. £ / km	0	m. £
Open Space		0 23.5	m. £ / km	0	m. £
Total				**159.4**	**m. £**

▪ Figure A.7 Cost estimate *source: calculations by author*

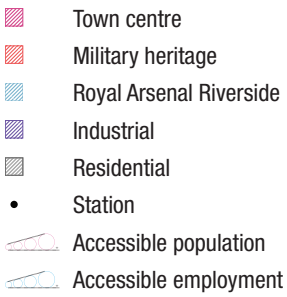
Variant 1 Woolwich - Spatial quality & functional mix

Woolwich is the most diverse of the areas examined. At its heart, oriented towards the Thames lies the Arsenal, a former military site featuring many historic buildings supplemented by denser often historicizing developments. The public spaces are wide, well kept and pedestrian oriented, but as of now do lack life. Outside the arsenal Woolwich features a historical London with well defined blocks and open facades. However post-war infill and demolition without redevelopment has in many places infringed on its historical character. Outside these areas of historic nature Woolwich features much residential development mostly consisting of monofunctional detached apartment blocks and an industrial area.

Figure A.8 General overview of functions around Woolwich arsenal

source: image by author

Figure A.9 Relevant characteristic areas around Woolwich Arsenal



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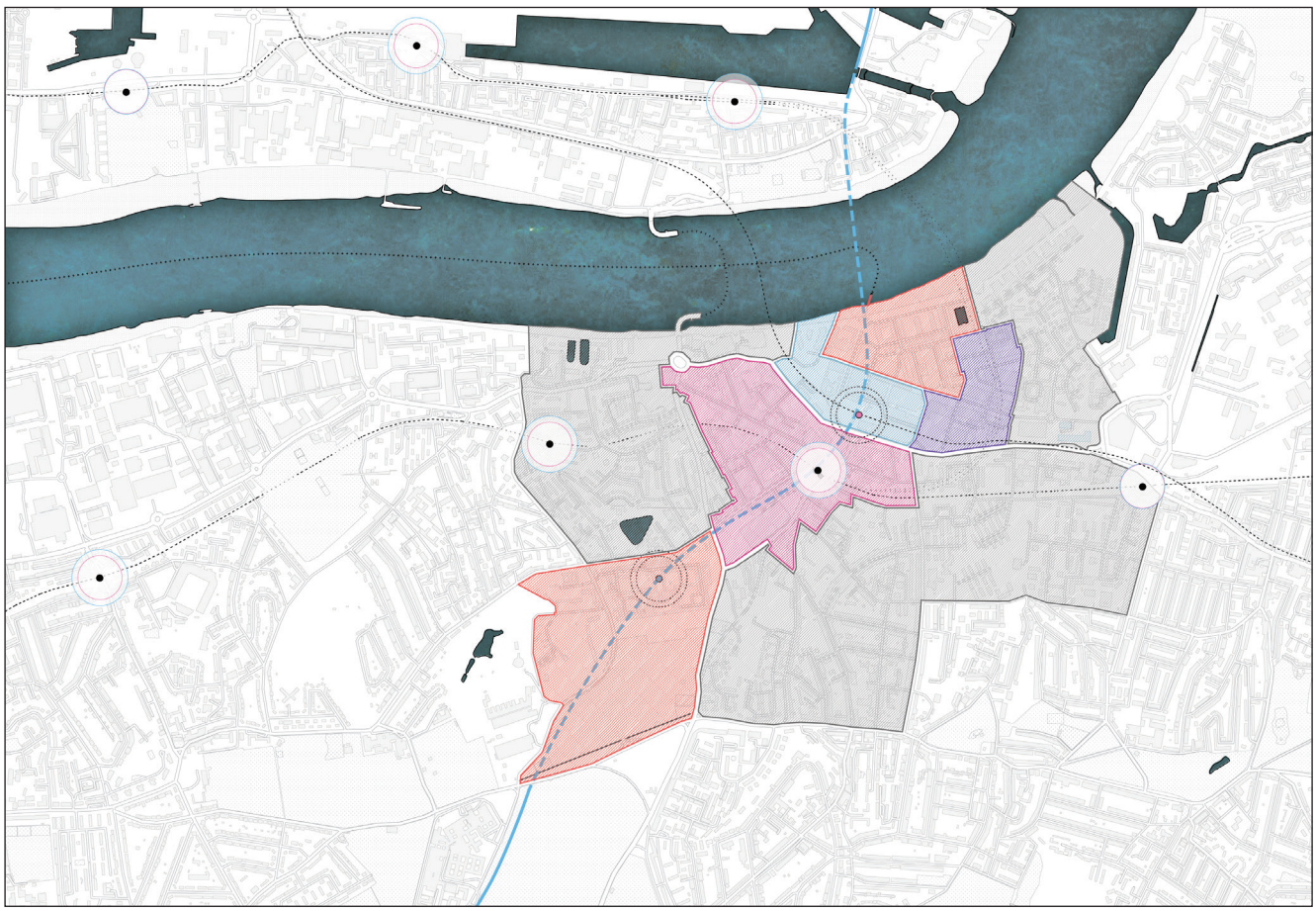

Figure A.10 Woolwich Town Centre *source: image by author*

Character

Woolwich features a town centre with a clear historical character. However there are numerous instances where post-war infill development infringe on this identity. At its centre are two squares, one of which is used as a market. These squares are surrounded by various narrow shopping streets.

Continuity & enclosure

Woolwich has well defined urban spaces, featuring a clear street pattern delimited by closed buildings blocks. Most streets feature open facades on the ground floor offering space for a variety of retail and hospitality activities. There are however several derelict sites located throughout the area that break up the otherwise clear urban pattern.

Quality of public space

In recent years, attention has clearly been paid to the area's public spaces, offering ample greenery and various opportunities to reside.

Ease of movement

Most areas in the Woolwich Town Centre are car free as traffic is directed around it, resulting in a pedestrian friendly enviroment. The only real hindrance to pedestrian flows are the busy roads at the edge of the town centre and arsenal as well as in front of the western DLR entrance.

Figure A.11 Views around Woolwich Town Centre

source: Google Maps (2018)

Figure A.12 Woolwich Arsenal *source: image by author*

Character

An area with a strong historical character that can be traced back to its days as the main armaments production site of Great Britain. The mostly low-rise historical buildings on the site are complemented by several higher, more modern additions are often of a historicizing character allthough some of the latest additions feature a more contemporary up-market image.

Continuity & enclosure

The variety of building typologies offer a wide assortment of public space varying from small squares between buildings, to inner courtyards and well defined streets. However, throughout the area most facades are closed towards the pavements housing residential and other introverted uses.

Quality of public space

The urban spaces in the arsenal are varied, well-kept, and adorned by greenery and historical elements such as old cannons. While pleasurable to pass through, the Arsenal's public spaces offer little opportunity such as seating to promote residing in these areas.

Ease of movement

While mostly car accessible, the area is primarily pedestrian oriented with wide pavements and shared road surfaces. It must however be noted that parts of the area to the north are currently inaccessible to the public an act as a gated community.

▪ Figure A.13 Views around Woolwich Arsenal

source: Google Maps (2018)

▪ Figure A.14 Woolwich residential areas *source: image by author*

Character
Residential area featuring mostly low- to mid-rise appartment buildings.
Continuity & enclosure
WIth swirling roads, dead ends and loose blocks there is public space is poorly defined.
Quality of public space
While there is ample green space, it is of little quality. It offers little value as a place to stay other than a patch of grass for childeren to play on.
Ease of movement
Due to the many pedestrian paths going through and between the various streets te area is very porous making it easy to move around. However due to the lack of active frontages and the signficant dispersion of routes night-time safety could be questionable.

▪ Figure A.15 Views around Woolwich's residential areas *source: Google Maps (2018)*

Figure A.16 Woolwich Industrial Area *source: image by author*

Character
A typical industrial area, with large accessible plots hosting a variety of businesses in shared buildings.
Continuity & enclosure
The plots act as self-contained units and there is little definition of space.
Quality of public space
There is little in terms of quality of space.
Ease of movement
While sidewalks are available, the area is mostly geared towards motorized transport.

▪ Figure A.17 Views around Woolwich's industrial area *source: Google Maps (2018)*

Variant 2 Turnham Green - Spatial quality & functional mix

Woolwich is the most diverse of the areas examined. At its heart, oriented towards the Thames lies the Arsenal, a former military site featuring many historic buildings supplemented by denser often historicizing developments. The public spaces are wide, well kept and pedestrian oriented, but as of now do lack life. Outside the arsenal Woolwich features a historical London with well defined blocks and open facades. However post-war infill and demolition without redevelopment has in many places infringed on its historical character. Outside these areas of historic nature Woolwich features much residential development mostly consisting of monofunctional detached apartment blocks and an industrial area.

Figure A.18 General overview of functions around Turnham Green

source: image by author

Figure A.19 Relevant characteristic areas around Turnham Green

source: image by author

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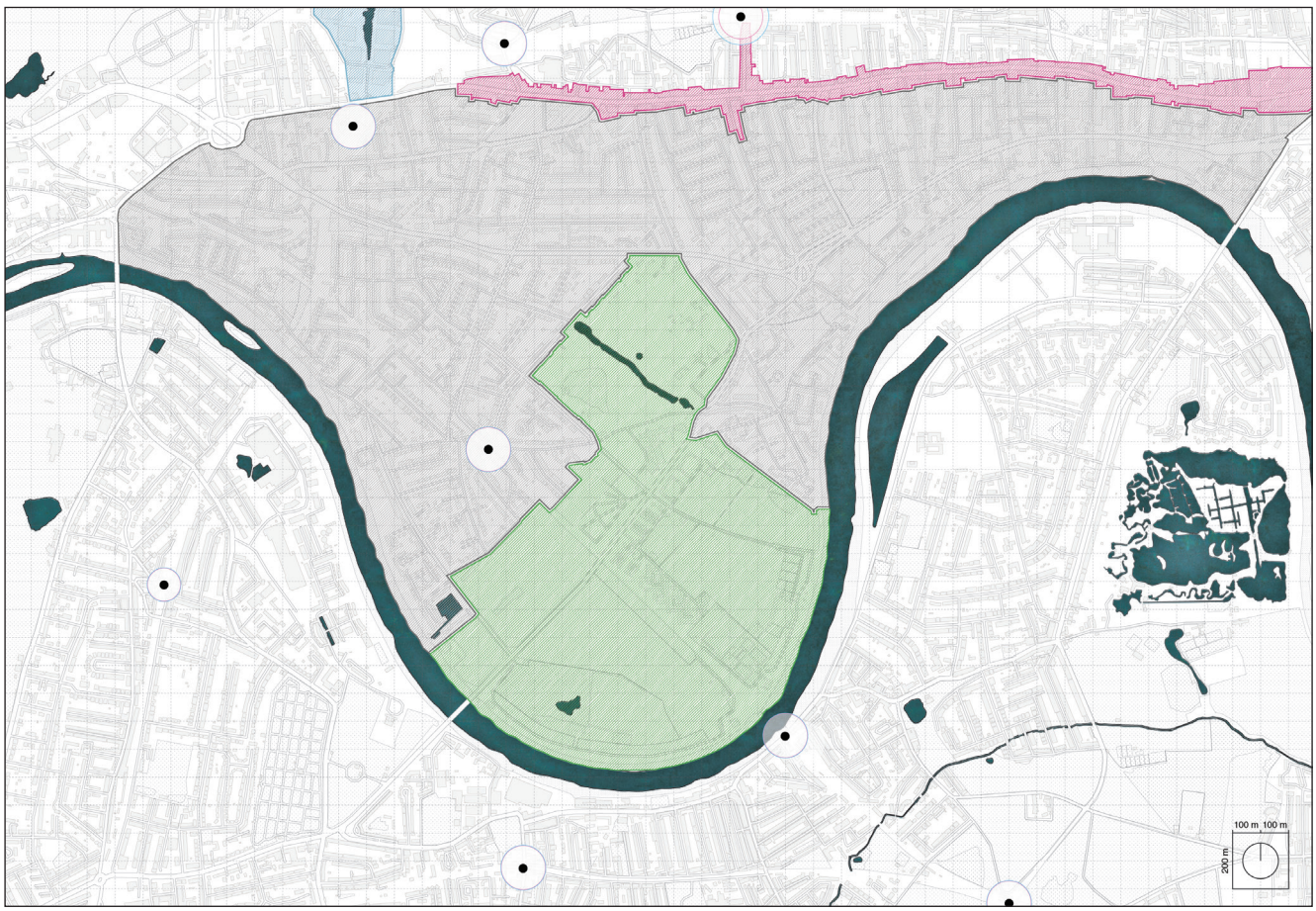
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Figure A.20 Turnham Green High Road *source: image by author*

Character

The Chiswick High Road at Turnham Green is a typical London high street with a strong historical character.

Continuity & enclosure

The high street has a well-defined linear structure flanked on both sides by storefronts. Outside of this linear strip activity levels and densities quickly drop. On its western end the high-street culminates in a small park while it carries all the way to Hammersmith Town Centre on its other end.

Quality of public space

The high street features wide pavements that offer ample room for pedestrians while also accommodating small seating areas for the hospitality establishments lining the street. Large trees irregularly line the street on both sides giving it a lush green character throughout most of the year.

Ease of movement

The wide sidewalks make it easy to navigate along the street. While suffering from traffic, ample crossings are available in the form of both zebras and traffic lights.

Figure A.21 Turnham Green High Road

source: Google Maps (2018)

Figure A.22 Turnham Green residential areas *source: image by author*

Character

The residential areas of Chiswick primarily feature historical semi-detached and row houses arranged in an irregular but interconnected street pattern.

Continuity & enclosure

As most homes are set back with either front yards or car parking spots the streets lack a clear sense of definition

Quality of public space

With exception of several (small) public parks, little attention is paid to the public space. The character of the streets, typically consisting of a 2-way road adjoined by pavements, is primarily defined by the porches in front of the houses.

Ease of movement

While low traffic intensity and sidewalks make it easy for pedestrians to navigate these areas, the swirling roads and monofunctional nature of these areas make for long walking distances to amenities.

▪ Figure A.23 Residential areas around Turnham Green *source: Google Maps (2018)*

Figure A.24 Turnham Green parks & recreation *source: image by author*

Character
A green enclave in the city, hosting a wide range of sports facilities.
Continuity & enclosure
A very non-urban setting comprised of large lots connected by tree lined lanes.
Quality of public space
While the area is very green, there is little in terms of space for public use. The public area is intended for transport.
Ease of movement
The area is mostly geared towards car traffic as a lack of pedestrian infrastructure and long distances between the entry points of plots make walking unattractive.

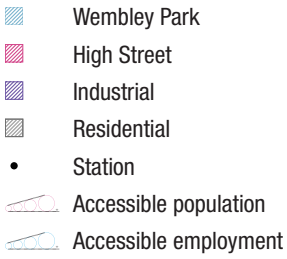
▪ Figure A.25 Sports fields and parks south of Turnham Green *source: Google Maps (2018)*

Variant 3 Wembley - Spatial quality & functional mix

Turnham Green and the Chiswick area in which it is located have a strong historical char-acter featuring a stately London high road featuring with generous pedestrian spaces and a mixture of hospitality and retail uses. However, towards the direction of the Thames to its south, the location originally envisioned for development, this dramatically changes. The clear definition of space seen in the high street gives way to historic suburban developments. Featuring mostly semi-detached housing much of the definition and continuity in the street pattern is lost here, making it difficult to envision development into much more than a residential neighbourhood. The area closest to the Thames is characterized by a large range of sports facilities, which in an urban area like London are best left untouched.

Figure A.26 General overview of functions around Wembley

Figure A.27 Characteristic areas in Wembley



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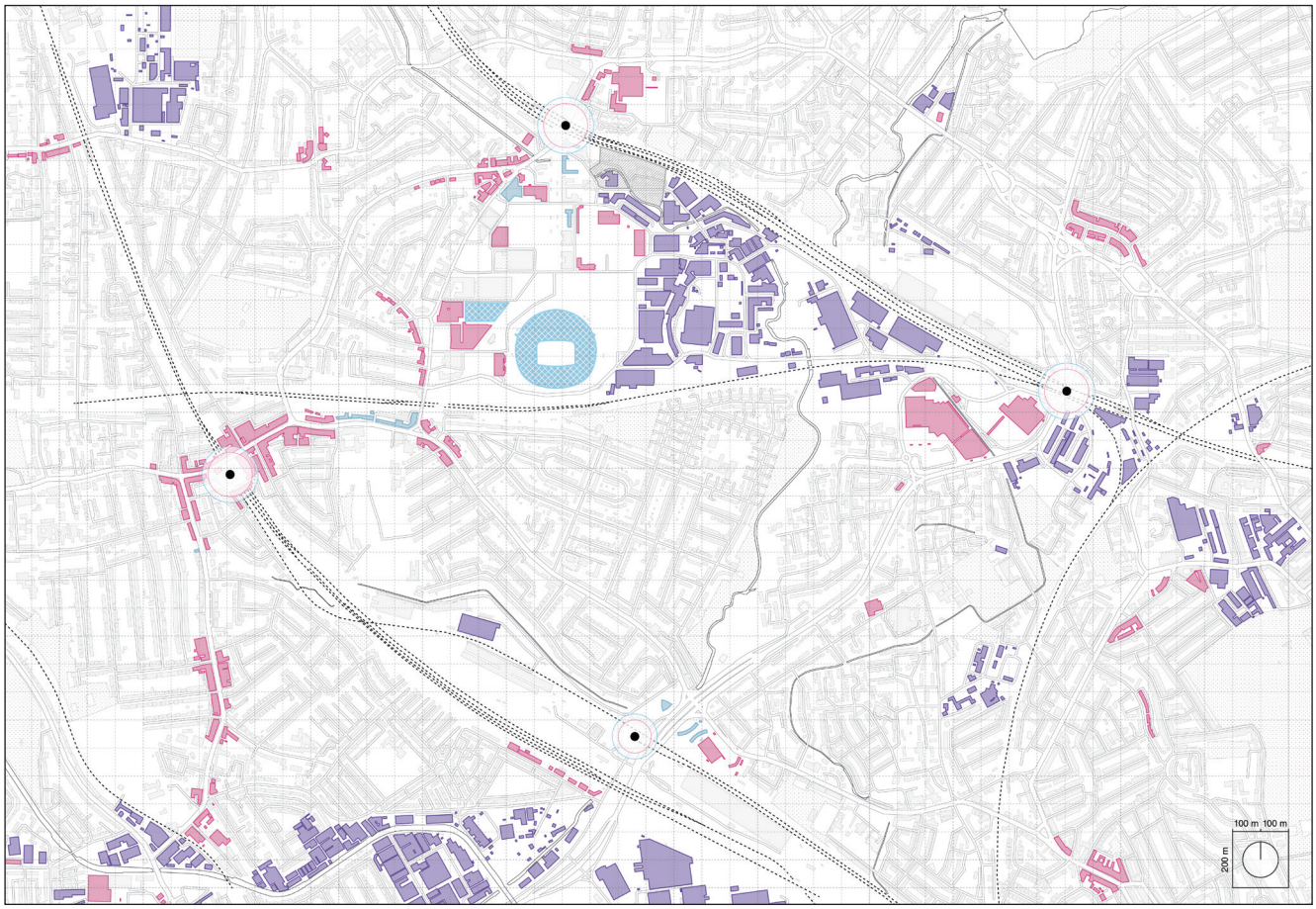
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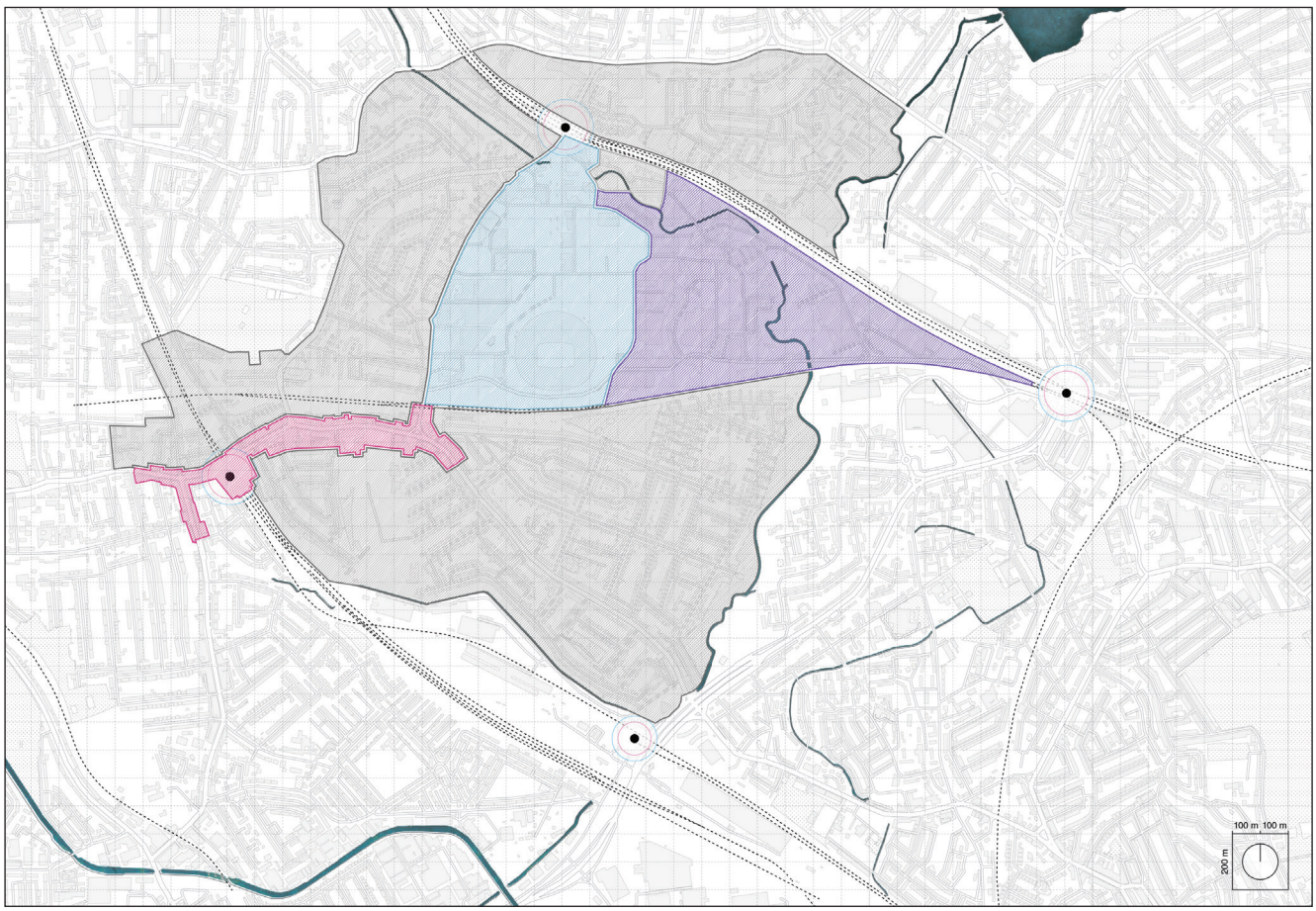
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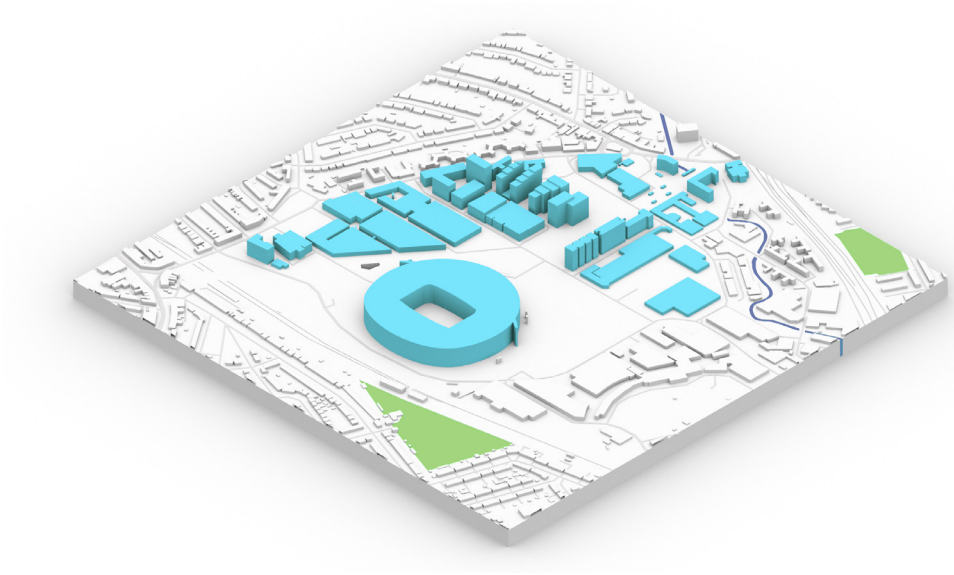

Figure A.28 Wembley Park

source: image by author

Character

The area is strongly focussed around Wembley Stadium which lays at the end of a long axis. This axis is surrounded by big blocks of high-rise residential development much of which is rather generic in its appearance.

Continuity & enclosure

There is a clearly defined axis towards Wembley stadium. However off this axis space becomes less defined with introverted office towards and prominent car infrastructure. There are open facades accommodating retail usage around the stations but most floor space is provided in enclosed mall typologies.

Quality of public space

Much attention has been paid to public space design directly around the station. These spaces are generously proportioned to accommodate the crowds associated with local events. However when no such event is under way the space can easily feel overproportioned.

Ease of movement

As noted in the “barriers” section of this chapter, the Wembley Park area is cut off from much of its surroundings by heavy infrastructure. Within the area itself the spatial composition of the area revolves around the central axis from Wembley Park Station to the stadium at its end, allowing for large crowds to easilily move between station and stadium. However the abundance of car-infrastructure makes other movements more difficult.

▪ Figure A.29 Wembley Park

source: images by author

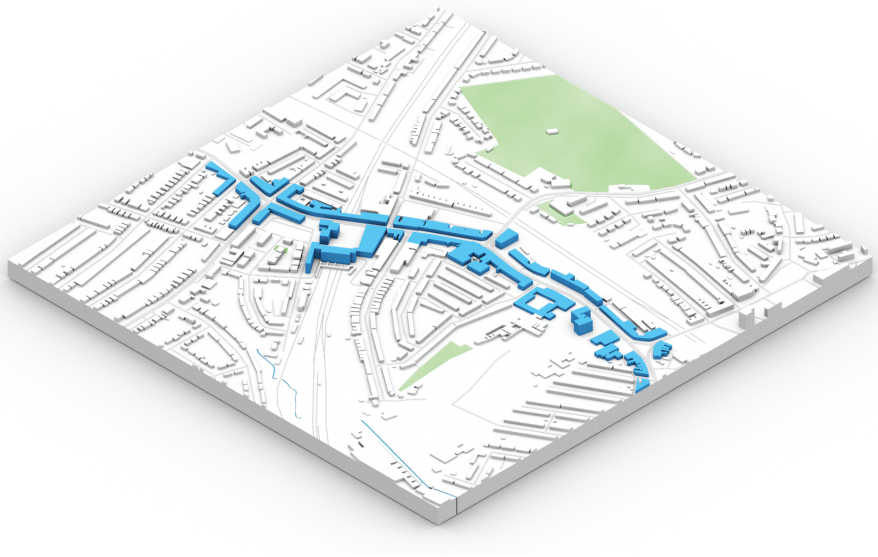

Figure A.30 Wembley High Road *source: image by author*

Character

Lively London high street with an eclectic mix of low-rise buildings. At the midpoint of the high-street lies Wembley Central Station which, in contrast to its surroundings, is characterised by a 1960's shopping mall and apartment blocks.

Continuity & enclosure

The high street has a well-defined linear structure flanked on both sides by storefronts. Outside of this linear strip activity levels and densities quickly drop. Both ends of the high street are poorly defined, with little definition signalling to its connection to Wembley Park.

Quality of public space

While the public space throughout the high street offers little in special in terms of public space design, the open storefronts and occasional market stall on the curb improve the liveliness of the street.

Ease of movement

It is easy to move along the high-street. However due to heavy traffic crossing the street is kept to dedicated junctions with traffic lights.

▪ Figure A.31 Wembley High Road

source: images by author

Figure A.32 Wembley Industrial Estate *source: image by author*

Character

A typical industrial area comprised of large lots with sheds and open space for productive activities.

Continuity & enclosure

As the area consists of large fenced of lots, that are not fully built up there is little well-articulated space. The area in the lots serves a purely logistical purpose.

Quality of public space

There is little in terms of quality of space.

Ease of movement

While sidewalks are available, the area is mostly geared towards motorized transport.

▪ Figure A.33 Wembley Industrial Estate *source: Google Maps (2018)*

Figure A.34 Wembley residential areas *source: image by author*

Character

The residential areas around Wembley have a suburban character and consists primarily of inter-war semi-detached housing.

Continuity & enclosure

The streets follow a swirling pattern with many dead ends. As most homes are set back with either front yards or car parking spots the streets lack the clear definition.

Quality of public space

With exception of several (small) public parks, little attention is paid to the public space. The character of the streets, typically consisting of a 2-way road adjoined by pavements, is primarily defined by the porches in front of the houses.

Ease of movement

While low traffic intensity and sidewalks make it easy for pedestrians to navigate these areas, the swirling roads and monofunctional nature of these areas make for long walking distances to amenities.

Figure A.35 Wembley's residential area

source: Google Maps (2018)

Developable GFA		
Type	Total Surface Area incl. height	Developable Surface incl. height
Transformation	430,047 m²	387,041 m²
Infill / Redevelopment	212,544 m²	212,544 m²
Blocks [small grain]	930,525 m²	837,472.50 m²
Blocks [large grain]	3,896,399 m²	2,727,479.30 m²
GFA Total		**4,164,537.79 m²**

Space use reference		
m2 / household:	84 m²	(Greater London Authority, 2017a)
m2 / workplace:	10 m²	(Greater London Authority, 2017b)

Ratio of commercial to residenitla floorspace					
Location	Households	Jobs	Residential floorspace	Commercial floorspace	% Commercial
Hammersmith	4442	38210	373128 m²	382100 m²	51%
Croydon	5830	37390	489720 m²	373900 m²	43%
King's Cross	6135	41913	515340 m²	419130 m²	45%

Space use reference		
m2 / household:	84 m²	(Greater London Authority, 2017a)
m2 / workplace:	10 m²	(Greater London Authority, 2017b)

Woolwich Employment potential		
GFA Total	4164537 m²	
GIA Total	3539857 m²	GFA * 85% (Space Management Group, 2006)
Commercial / residential ratio	0.5	
GIA Commercial	1769928 m²	GIA Total * Commercial / Residential ratio
m2 / workplace:	11.9 m²	(British Council for Offices, 2013)
Employment potential	**148,733**	

▪ Figure A.36 Estimation of employment potential *source: calculations by author*