



# HIGH ROAD WEST

HYBRID PLANNING APPLICATION

## CROWD FLOW STUDY

PREPARED FOR LENDLEASE (HIGH ROAD WEST) LIMITED BY BURO HAPPOLD

MAY 2022

# **High Road West**

## **Crowd Flow Study**

**HRW-BHE-CF-00-RP-X-0001**

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# Contents

<b>1</b>	<b>Executive Summary</b>	<b>8</b>
<b>2</b>	<b>Introduction</b>	<b>9</b>
2.1	Buro Happold Crowd Flow expertise	9
2.2	Objectives and Key Questions	11
2.3	Masterplan Users	12
2.4	Crowd Flow Study Approach	13
2.5	Acceptance Criteria	15
2.6	Simulation software – Legion Space Works	17
2.7	Reference documents and data	17
<b>3</b>	<b>Incorporating the existing crowd management strategy</b>	<b>18</b>
<b>4</b>	<b>End-state Illustrative Masterplan</b>	<b>22</b>
<b>5</b>	<b>Defining the Key Crowd Flow Scenarios</b>	<b>24</b>
5.1	Input Parameters	25
5.2	Pedestrian Circulation routes	26
<b>6</b>	<b>Crowd flow analysis of HRW Masterplan</b>	<b>27</b>
6.1	HRW Masterplan Parameters and Illustrative Masterplan	27
6.2	Egress Modelling	28
6.3	Queue arrangement without funnelling	40
6.4	White Hart Lane Station – exit flows	45
6.5	Temporary Toilet locations	46
<b>7</b>	<b>Crowd flow during construction phasing</b>	<b>47</b>
7.1	Target parameters	51
7.2	Additional requirements	52
<b>8</b>	<b>Summary and Recommendations</b>	<b>53</b>
8.1	Spatial requirements for HRW Masterplan	53
8.2	Review of Existing Layout vs HRW Masterplan	54
8.3	Southbound queue lane	55

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8.4	Recommendations for HRW Masterplan	55
8.5	Next Steps	56
<b>Appendix A Detailed Crowd Flow data</b>		
A.1	Reference documents	57
A.2	Modal Split	58
A.3	Modal characteristics	59
A.4	THFC transport guide	63
<b>Appendix B Detailed Site visit Summary</b>		<b>64</b>
B.1	Whitehall Street and Love Lane	64
B.2	White Hart Lane	64
B.3	Queuing area available	65
B.4	Departure profile	65
B.5	Train timings and duration	66
B.6	Southbound platform users / queue on match days:	66
B.7	Northbound platform users / queue on match days:	67
B.8	Pedestrian Circulation routes	68
B.9	Security	68
B.10	Existing challenges and opportunities	69
<b>Appendix C Departure Profiles</b>		<b>70</b>
<b>Appendix D Platform Loading and Capacity</b>		<b>71</b>
D.1	Northbound:	71
D.2	Southbound:	71
<b>Appendix E High Level Review of HRW Masterplan</b>		<b>72</b>
E.1	Connectivity to Landscape and retail spaces	72
E.2	Walking distance	73
E.3	Visibility analysis	74
<b>Appendix F 0311-SEW-ZZ-ZZ-DR-T-001003 (Horizontal Limits of Deviations Plan)</b>		<b>75</b>
<b>Appendix G 0311-SEW-ZZ-00-DR-A-001100 (Illustrative Ground Floor GA)</b>		<b>76</b>

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<b>Appendix H 0311-SEW-ZZ-ZZ-SK-SK-001193 (Illustrative HRW Masterplan)</b>	<b>77</b>
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#### **Table of Tables**

<b>Table 2-1 Minimum separation between plot extents</b>	<b>14</b>
<b>Table 3-1 Summary of site observations</b>	<b>21</b>
<b>Table 5-1 Key Crowd Flow parameters</b>	<b>25</b>
<b>Table 6-1 Minimum separation between plot extents</b>	<b>27</b>
<b>Table 6-2 Summary of Sensitivity study, Southbound</b>	<b>36</b>
<b>Table 6-3 Summary of Sensitivity study, Northbound</b>	<b>38</b>
<b>Table 6-4 Comparison of queue layouts</b>	<b>44</b>
<b>Table 8-1 Summary of Southbound queue area</b>	<b>55</b>

#### **Table of Figures**

<b>Figure 2-1 Distribution of different users through the Masterplan</b>	<b>12</b>
<b>Figure 2-2 Proposed Masterplan</b>	<b>13</b>
<b>Figure 2-3 Acceptance Criteria – Fruin’s Level of Service</b>	<b>15</b>
<b>Figure 2-4 Illustration of Density applied in this study vs. previous studies</b>	<b>16</b>
<b>Figure 2-5 Illustration of Density captured through site survey</b>	<b>16</b>
<b>Figure 3-1 Existing crowd management strategy on existing site</b>	<b>19</b>
<b>Figure 4-1 Existing crowd management strategy mapped on to the Illustrative Masterplan and width at narrowest point</b>	<b>23</b>
<b>Figure 5-1 Road closures through HRW Masterplan, prepared by Buro Happold</b>	<b>26</b>
<b>Figure 6-1 Screen capture from Legion simulation for Typical Premier League Scenario</b>	<b>29</b>
<b>Figure 6-2 Queue build up for Southbound platform after final whistle</b>	<b>30</b>
<b>Figure 6-3 Density at Southbound queue lane for a typical Premier League match</b>	<b>32</b>
<b>Figure 6-4 Comparison of queue lengths for the Existing Layout and Illustrative Masterplan</b>	<b>33</b>
<b>Figure 6-6 Queueing area available on Illustrative Masterplan</b>	<b>35</b>
<b>Figure 6-7 Southbound summary, Boxing Event Day base case</b>	<b>37</b>
<b>Figure 6-8 Existing crowds moving from High Road on to White Hart Lane at a point where the route narrows.</b>	

<b>Figure 6-9 Existing pinchpoint from High Road to White Hart Lane</b>	<b>41</b>
<b>Figure 6-10 Existing crowds moving via Southbound lane towards White Hart Lane Station</b>	<b>41</b>
<b>Figure 6-11 Snake Queue</b>	<b>42</b>
<b>Figure 6-12 Disney style queue</b>	<b>42</b>
<b>Figure 6-13 Straight queue</b>	<b>43</b>
<b>Figure 1-14 Proposed exit routes from White Hart Lane Station during post-match flows</b>	<b>45</b>
<b>Figure 6-14 Footfall during the post-match egress</b>	<b>46</b>
<b>Figure 7-1 Crowd circulation route proposed during Q3 2022 to Q2 2023</b>	<b>47</b>
<b>Figure 7-2 Crowd circulation route proposed during Q2 2023 to Q2 2025</b>	<b>47</b>
<b>Figure 7-3 Crowd circulation route proposed during Q2 2025 to Q3 2028</b>	<b>48</b>
<b>Figure 7-4 Crowd circulation route proposed during Q3 2028 to Q4 2030</b>	<b>48</b>
<b>Figure 7-5 Crowd circulation route proposed during Q1 2029 to Q4 2029</b>	<b>49</b>
<b>Figure 7-6 Crowd circulation route proposed during Q4 2029 to End-State</b>	<b>49</b>
<b>Figure 7-7 Crowd circulation route proposed during End-State</b>	<b>50</b>
<b>Figure 7-8 Indicative crowd management during Plot D construction phasing</b>	<b>51</b>
<b>Figure 7-9 Indicative width of crowd management lanes during Plot D construction phasing</b>	<b>51</b>
<b>Figure 8-1 Recommendations on the Illustrative Masterplan</b>	<b>55</b>
<b>Figure B-1 Roads closed for Vehicular traffic, based NFL 2021 data</b>	<b>68</b>
<b>Figure B-2 Temporary barriers used for road closure, images captured during site visit</b>	<b>69</b>
<b>Figure D-1 Flow of spectators to Northbound platform</b>	<b>71</b>
<b>Figure D-2 Flow of spectators to Southbound platform</b>	<b>71</b>
<b>Figure E-1 Circulation routes and key decision points</b>	<b>72</b>
<b>Figure E-2 Planting and Open space</b>	<b>73</b>
<b>Figure E-3 Walking distance analysis</b>	<b>73</b>
<b>Figure E-4 Visibility analysis</b>	<b>74</b>

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# Glossary

Term	Definition
Footfall	The number of people entering or leaving the space in a given time
Density	The number of people in a given area or space

# Images disclaimer

Most images provided in this document are prepared by Buro Happold based on the proposed HRW Masterplan and information available. Figure names with a number superscript are based on data available in reference documents listed in Appendix A.

# 1 Executive Summary

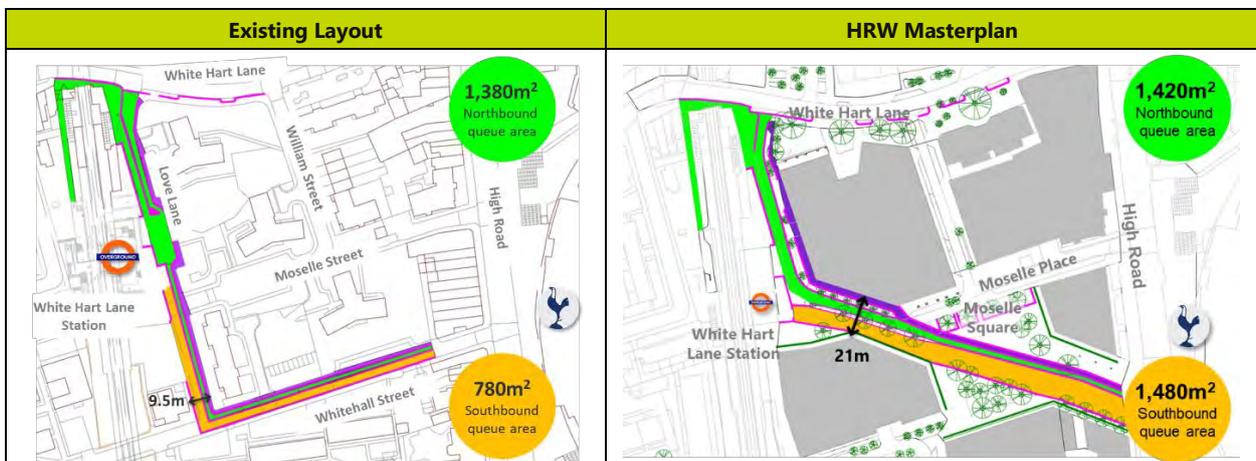
Buro Happold's Crowd Flow team has been appointed to review the High Road West (HRW) development Masterplan for crowd safety and management on major event days at Tottenham Hotspur Stadium and to facilitate efficient wayfinding throughout the site. Buro Happold's assessment has been based on the Masterplan Parameter plans and Illustrative Masterplan which has been prepared by Studio Egret West (SEW) and has been submitted as part of a hybrid planning application to the London Borough of Haringey (LBH).

The key assessment criteria for the Crowd Flow study is to ensure the HRW Masterplan provides at least equivalent areas and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days. Access for residents and a contraflow lane also need to be accommodated.

A high-level review of the minimum separation provided on main access routes / circulation areas shows that the Parameter plans would be able to meet the above assessment criteria, and accommodate the spatial requirements outlined in this report. A series of crowd flow dynamic modelling and sensitivity analysis is used to demonstrate how the crowd flow could work on event days within the Illustrative Masterplan and at the intermediate construction phases. These models and analysis are primarily to illustrate how the space could be operated, the ultimate acceptance criteria used is to ensure at least equivalent area and widths as the existing space are provided.

Overall, the HRW Masterplan will provide a better experience to all users and the provides following benefits compared to the existing site:

- ~55% to 90% increase in Southbound queue area on the illustrative layout compared to the existing site
- Illustrative Masterplan Northbound queue area is equivalent to the existing Northbound queue area
- 120% increase in width at narrowest point on Moselle Square compared to existing pinch point on Love Lane
- Flexibility to arrange queue lanes on Moselle Square or retain current queue configuration (i.e., Northbound queue along White Hart Lane)
- Space for additional through route to residences and retail, as well as contraflow lane
- Direct line of sight between Stadium and White Hart Lane Station
- Moselle Square provides flexibility i.e. can be used for queueing on event day and can used as a public realm on non-event days with retail provision around Moselle Square
- Built-In Security CCTV Estate management



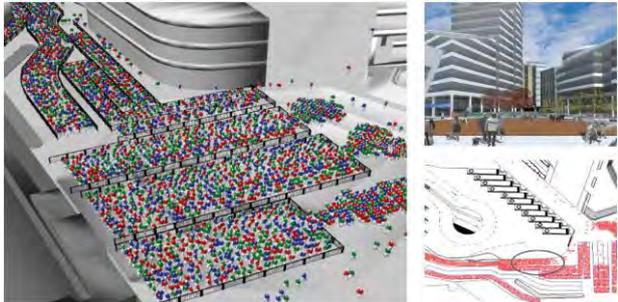
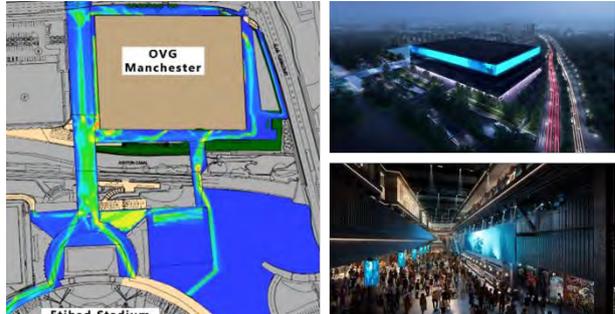
## 2 Introduction

Buro Happold's Crowd Flow team has been commissioned by Lendlease (High Road West) Ltd (Lendlease) to review the High Road West (HRW) Masterplan within the red line boundary.

Key to the success of the HRW Masterplan is ensuring that the design responds to the needs of the diverse users and provides a safe and comfortable experience to all. The HRW Masterplan presents opportunities to streamline post-match movements of spectators from Tottenham Hotspur Stadium and to provide an enhanced experience for day-to-day users of the site.

### 2.1 Buro Happold Crowd Flow expertise

Buro Happold's Crowd Flow team have wide-ranging expertise in public realm design: including demand forecasts, capacity planning, design optimisation and validation and operational planning. The 'people centred' and data driven design approach supports architects, developers, and clients during all stages of a project to design and manage urban venues so that they function optimally, through all crowd movement scenarios. Example case studies are provided below demonstrating the approach in a range of UK and international projects:

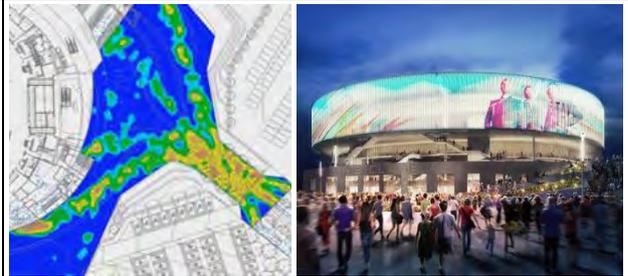
Cardiff Principality Stadium	OVG Manchester
	
<p>The objective of the Crowd Flow study was to optimise holistic pedestrian flows from the 74,000 capacity Principality Stadium to the Cardiff Central railway station, integrating with the bus station and vehicular and pedestrian access to the local area. Starting with crowd flow surveys of match day and non-match day scenarios and liaison with all key stakeholders, the study informed the Masterplan design as well as the wayfinding, signage and queue management during busy events, normal weekdays and construction phasing. The outputs from the study were used to optimise pedestrian crossing configurations, walkway widths (e.g. hoarding configuration during construction) and to ensure security bollards do not obstruct the safe egress of spectators from the stadium.</p>	<p>Buro Happold's Crowd Flow studies have influenced and optimised the design of the external spaces surrounding the arena. Located adjacent to Etihad Stadium and the Etihad Campus Metro stop, the detailed crowd flow modelling and analysis has helped unlocked the complex site to create positive visitor experiences for up to 24,000 fans. Crowd flow surveys and analysis of the existing peak spectator egress from the 55,000 capacity Etihad Stadium has been carried out to help inform the study. Detailed sensitivity analysis has been carried out to assess the impact of increased stadium capacity and different events proposed for the new arena on the public realm and metro queuing area.</p>

**Lord's Cricket Ground**



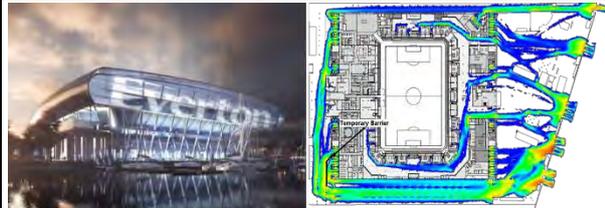
The study produced guidance for master planning as well as quantitative data used for detailed modelling of development at Lord's for safe, comfortable and efficient crowd circulation. Baseline crowd flow surveys were carried out to inform the detailed assessments for the new stands. Dynamic crowd flow modelling of the end-state and construction phases was carried out to ensure crowd safety during all operational phases.

**Bristol Arena**



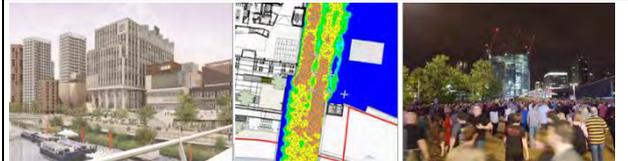
Buro Happold's Crowd Flow experts ensured that access routes to the arena are designed to avoid creating pinch points and bottlenecks that will hinder movement and negatively affect visitors' enjoyment of the venue. A detailed review of the connectivity of the plaza and exit routes to the city were carried out by the team utilising dynamic crowd flow modelling.

**Everton Stadium**



The Focus of the study was on the stadium building and plaza including an assessment of the street interface with the plaza, to inform the design and operation of the stadium with regards to spectator circulation and experience. High level static assessments of capacities for several normal operational scenarios and a detailed people flow simulations of the departure scenario was carried out to check for design compliance against guidance.

**Stratford Waterfront**



The study provided a day-in-life modelling of visitors through the public realm, integrated modelling of environment (daylight, noise, view), connectivity, placemaking and circulation capacities to optimise building massing and urban realm design. The study helped enhance the cultural, residential, and retail visitor experience within the Stratford Waterfront site by ensuring the design facilitates efficient circulation, creates comfortable dwelling spaces and maximises retail opportunities. The study also included detailed modelling and stress testing of the public realm for event days at the adjacent Olympic stadium, ensuring walkway widths and landscape configurations would deliver a safe environment for crowds at peak times.

**Al Bayt Stadium, Qatar**



Buro Happold's Crowd Flow experts provided a FIFA compliance review and a detailed crowd flow simulation to provide a world class experience for the spectators using the Al Bayt stadium. The stadium will be able to receive 70,000 spectators and to host some of the main matches of the 2022 FIFA World Cup™. The study took into consideration the operational requirements for fan segregation and showed how this could be achieved according to the stadium operational plan.

**Bronx Stadium, New York**



The Crowd Flow team helped optimise the design and operations of the site-wide masterplan, entrance security and queuing, circulation and concourse areas for various modes including matches and concerts. Using static analysis and detailed models of the various scenarios, the study helped optimise the circulation width, queuing system and maximise the use of the available space for the stadium.

## 2.2 Objectives and Key Questions

Buro Happold's Crowd Flow consultancy service aims to review and optimise the HRW Masterplan for crowd safety and management on major event days at Tottenham Hotspur Stadium and to facilitate efficient wayfinding throughout the site. In addition, the Crowd Flow team and the High Road West Design Team are working closely with Buro Happold's security consultants to ensure safety requirements are integrated within the HRW Masterplan.

A detailed Legion crowd flow modelling of the typical spectator egress after a Premier League match from Tottenham Hotspur Stadium has been carried out, to map the current queue strategy for White Hart Lane Station (WHLS) on the Illustrative Masterplan to demonstrate how this will potentially work in future. These simulations help to identify any potential bottlenecks as well as opportunities to enhance the experience of visitors and residents alike, and to refine the HRW Masterplan to respond to the following key requirements identified by the communities:

- Safety and security
- Public and green spaces
- Attractive and vibrant spaces for retail and local businesses
- Flexible spaces at 'Moselle Square' and 'Peacock Park' with community events in mind

This Crowd Flow study aims to answer the following key questions:

- Does the End-State Illustrative Masterplan and Construction phasing provide at least equivalent area and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days
  - Can the End-State Illustrative Masterplan and Construction phasing cater for the **current behaviour** and **footfall** of pedestrians around the site, and accommodate the current crowd management barrier system?
  - Do the layouts work well together and allow for seamless and **safe** movements of pedestrians through the site at peak times - particularly during post-match egress from Tottenham Hotspur Stadium?
  - How can the functions and spaces be laid out to deliver **intuitive wayfinding** and ability to **flexibly respond** to a range of scenarios / operations - including during peak arrivals and egress from Tottenham Hotspur Stadium?
-

## 2.3 Masterplan Users

The HRW End State Masterplan is likely to include a range of different users, including but not limited to:

- Local residents
- Work commuters
- Retail and Leisure visitors
- Heritage site visitors
- Tottenham Stadium visitors and spectators

The Masterplan needs to respond to the diverse needs of the users and various scenarios throughout the day, week and year including special events, matches and day-to-day life.

The distribution of different users through the Illustrative Masterplan (0311-SEW-ZZ-ZZ-SK-SK-001193 provided in Appendix H) is illustrated in the figure below. This is based on the Outline Design and Access Statement (DAS) prepared by Studio Egret West (SEW).

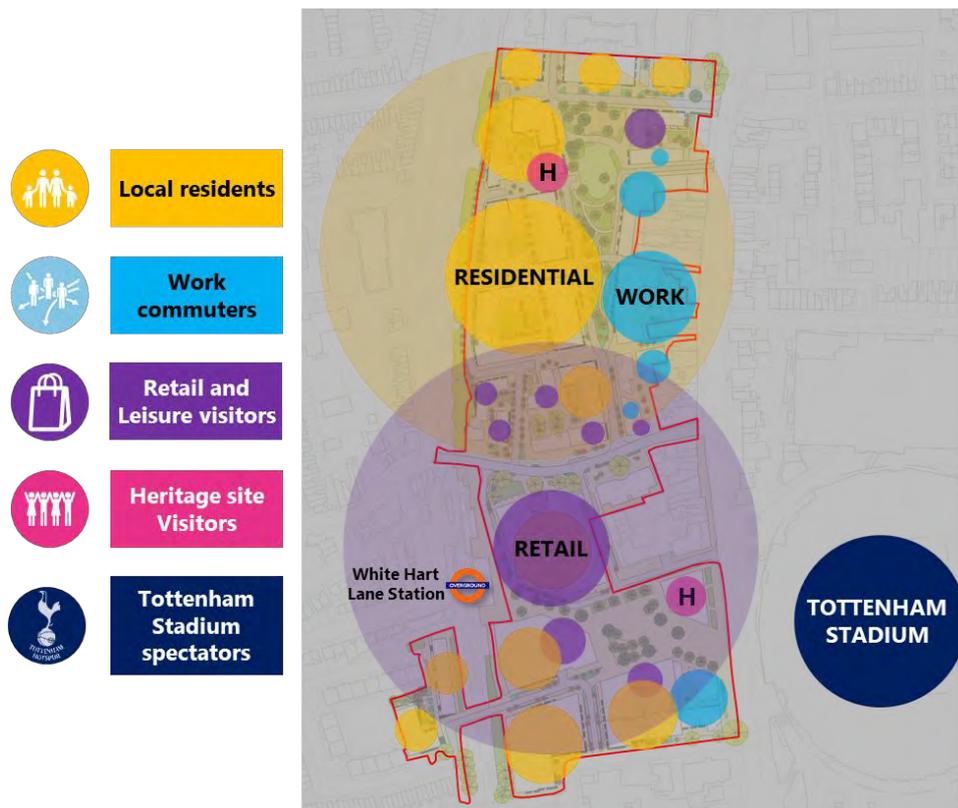


Figure 2-1 Distribution of different users through the Masterplan

## 2.4 Crowd Flow Study Approach

White Hart Lane splits High Road West into two parts:

1. Northern Part - which includes the Peacock Industrial Estate
2. Southern Part - which includes the Love Lane Estate

The adjacency of the Southern part of the Masterplan to White Hart Lane Station and Tottenham Hotspur Stadium results in high footfall through the Southern part of the Masterplan during Pre-event arrivals and Post-event departures. Different types of events are hosted in the stadium including Premier League football matches, NFL matches, Boxing event, Concerts etc.

Egress after an event is considered the most critical period for crowd flows as arrivals tend to be more distributed over a longer duration, in comparison egress can be more condensed and queues for White Hart Lane Station are likely to form. The area for queueing at White Hart Lane Station post-event is a critical parameter and is the focus of this Crowd Flow Study – ensuring that at least equivalent area and widths as the existing space for queues to White Hart Lane Station on event days are provided.

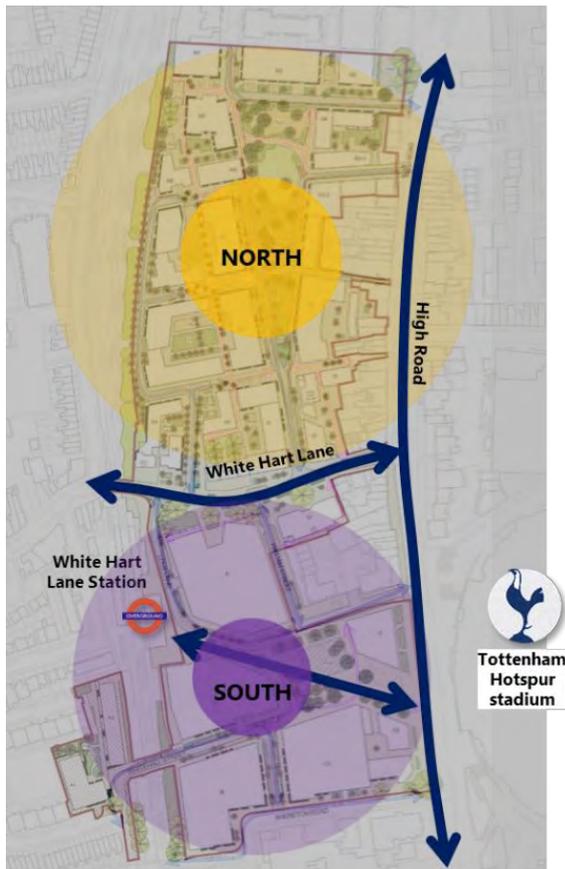


Figure 2-2 Proposed Masterplan

As above, the movement of crowds is primarily focussed within the southern half of HRW Masterplan where the direct route between White Hart Lane Station and the Stadium is proposed. Within the Parameter Plans the minimum separation differences are shown between individual plots for main access routes / circulation areas. Parameter Plan Ref: 0311-SEW-ZZ-ZZ-DR-T-001003 (Horizontal Limits of Deviations Plan) is included in Appendix C.

**Table 2-1 Minimum separation between plot extents**

Block	Block	Minimum Separation (metres)	Illustrative Masterplan
C	E	21m	34m (at ground floor)
C	F	66m	70m
D	E	64m	64m
D	F	21m	21m
I1	I2	12m	15m

The minimum separation distances listed above have been incorporated within the Illustrative Masterplan including the minimum 21 metres separation distance required between Plot D and Plot F – which is a key location for Crowd Flow. The Crowd Flow Study has therefore been based on the minimum separation distances shown within the Parameter Plans, which are also reflected for these purposes within the Illustrative Masterplan. In practice, the detail of the routes and distances will be approved as part of the Reserved Matters Application process which will include the minimum distances set out above.

The approach for this Crowd Flow Study is as outlined below:

1. **Understand the existing space provision on event days** – Site visits and review of existing site drawings to understand queue configurations, areas and widths currently deployed on event days for the stadium
2. **Ensure at least equivalent area and widths are provided in the HRW Masterplan** – Review and markup of drawings to demonstrate the areas and widths available for Northbound and Southbound queues for White Hart Lane Station within the red line boundary, compared to the existing provision
3. **Review how the site could operate under different scenarios** - Exploration of different queue configurations to adapt for different event types, use of dynamic modelling and sensitivity analysis to compare existing and proposed site for a range of scenarios, including:
  - a. Premier League and NFL football matches – which are frequent events and typically have higher attendance compared to some other events,
  - b. Boxing Event and a stress test for the Premier League (e.g. Cup game) which are rare but have more condensed departure profiles,
4. **Ensure at least equivalent area and widths can be provided during construction phasing** - Review and markup of drawings to demonstrate the areas and widths available for Northbound and Southbound queues for White Hart Lane Station within the red line boundary, compared to the existing provision

## 2.5 Acceptance Criteria

The key assessment criteria for the Crowd Flow study during End-State Illustrative Masterplan and interim construction phasing is to ensure:

- At least equivalent area and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days is provided within the red line boundary.
- Access for residents and a contraflow lane are accommodated.
- Sufficient space to map the existing crowd management barrier system, to include access to Southbound travellers via the Whitehall Street/ Moselle Square and access to Northbound entrance via White Hart Lane is provided.

A series of crowd flow dynamic modelling and sensitivity analysis is used to demonstrate how the crowd flow could work on event days within the Illustrative Masterplan and at the construction phases. These models and analysis are primarily to illustrate how the space could be operated, the ultimate acceptance criteria used is to ensure at least equivalent area and widths as the existing queue spaces are provided

Fruin's Levels of Service (LoS) are used in pedestrian planning as an accepted industry practise for assessing performance of spaces in terms of pedestrian comfort and safety. Fruin's LoS have previously been used in other Crowd Flow studies of the area and Stadium. They provide a quantitative way of categorising spaces, with six levels of service (A to F) and associated metrics of pedestrian density and achievable flow rates, corresponding to the crowding conditions.

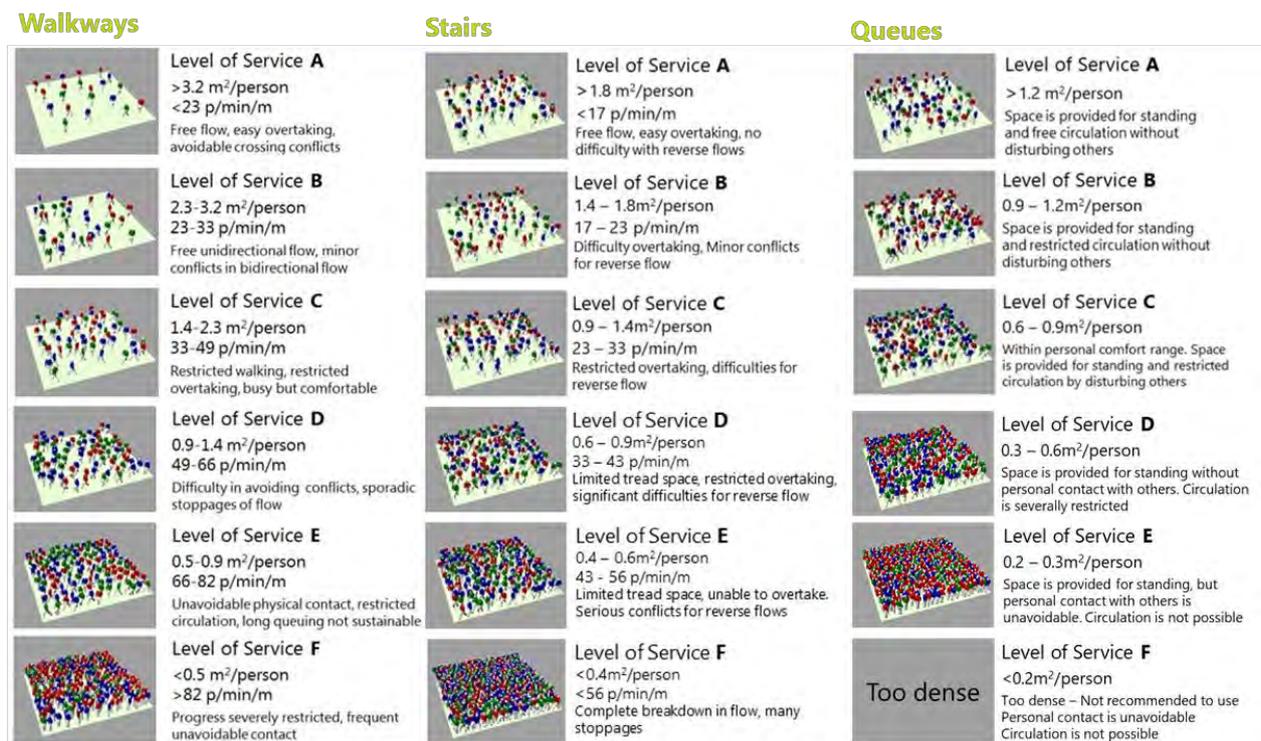


Figure 2-3 Acceptance Criteria – Fruin's Level of Service

Typically, LoS C is considered comfortable for queue spaces in public realm, while a density of up to mid LoS D,  $0.4\text{m}^2$  per person (2.5 persons per  $\text{m}^2$ ), is considered acceptable for projects of this scale and nature.

To illustrate the queueing outside the White Hart Lane Station for Southbound and Northbound travellers, Fruin's LoS C/D i.e.  $0.65\text{m}^2/\text{person}$  (1.5 persons per  $\text{m}^2$ ) is applied in this study. This is considered safe and comfortable for queueing within barriers in front of a train station.

It is noted that a density of Fruin's LoS D/E i.e.,  $0.3\text{m}^2/\text{person}$  (3 persons per  $\text{m}^2$ ) is used by Tim Spencer and Co<sup>14</sup> and a density of  $0.5\text{m}^2/\text{person}$  (2 persons per  $\text{m}^2$ ) is used by Movement Strategies<sup>8</sup> for the queueing area calculation. These densities are higher than those applied in this study. Review of the outputs in this report should therefore take into account the variance between the densities considered.

Illustrations of these densities are provided below.

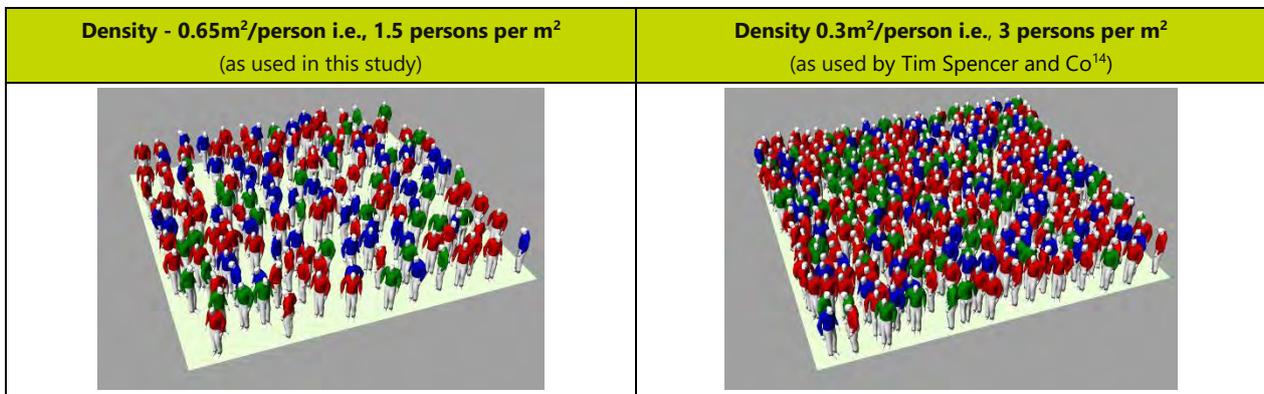


Figure 2-4 Illustration of Density applied in this study vs. previous studies

The current site has been observed to experience densities of  $\sim 0.5\text{m}^2$  per person although it is noted that this can vary for different events, duration of queue and position within the queue.

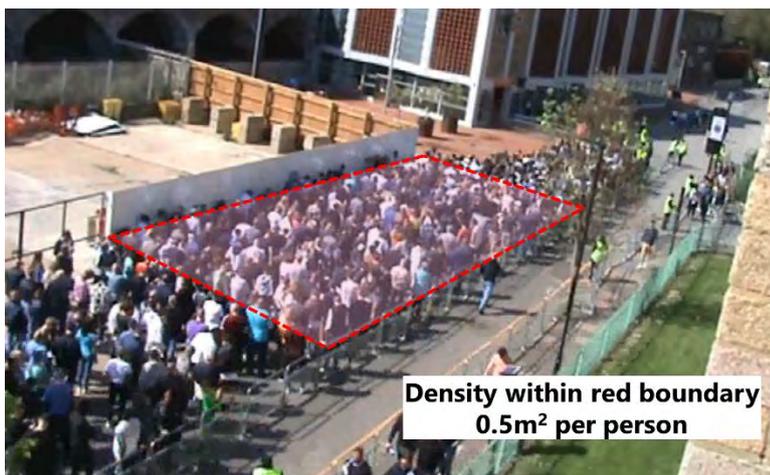


Figure 2-5 Illustration of Density captured through site survey

## 2.6 Simulation software – Legion Space Works

**Legion Space Works** is the industry-leading tool for detailed pedestrian simulation. It allows precise modelling and analysis of how a space will perform under different scenarios. The level of detail and insight offered by Legion makes it the ideal tool to be used to validate design proposals and options.

Legion uses microscopic multi-agent simulation, where each pedestrian is simulated individually. Each virtual pedestrian (entity) has their own characteristics, preferences and objectives that influence how they move and interact with other entities. The underlying movement model is based on the principle of least effort, where entities will seek to minimise a cost function, balancing their desires to make progress towards their objective, maintain personal space and move at a preferred speed. Advanced navigation algorithms are used to model the different routes that people take through a station.

Legion provides extensive outputs relating to density, flow-rates, speeds, occupancy, queuing, waiting and journey time. These outputs are presented visually through animations, heat maps and traces as well as numerically for charting and further statistical analysis.

## 2.7 Reference documents and data

The inputs and assumptions provided in this document are based on the reference documents provided to date by Lendlease, information available on London Borough of Haringey Council's planning portal and data collected through post-match site observations carried out by the Crowd Flow team. Input parameters taken from available data are referenced using a number superscript, where the number corresponds to the reference documents. A full list of reference documents is provided in Appendix A.

The parameters used in the study are based on the publicly available data and documentation at time of writing. The analysis within this report can be updated to reflect any updated data, should this be made available and provide additional information than what is currently accessible. Sensitivity analysis is also conducted to test the impact on the performance of the site with respect to a number of crowd flow parameters.

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### 3 Incorporating the existing crowd management strategy

The aim of this Crowd Flow study is to demonstrate how the HRW Masterplan can safely accommodate the existing crowd management and queue strategy, areas and widths developed by THFC during peak egress from the stadium.

In order to understand the existing strategy and crowd behaviours, post-match site observations were carried out by the Crowd Flow team on the following days – a summary of the observations is provided in Table 3-1:

- Thursday 2<sup>nd</sup> December 2021, 7:30pm kick-off
- Sunday 5<sup>th</sup> December 2021, 2:00pm kick-off
- Saturday 16<sup>th</sup> April 2022 (Easter weekend) 12:30pm kick-off
- Sunday 1<sup>st</sup> May 2022 (Bank holiday Weekend), 2pm kick-off
- Thursday 12<sup>th</sup> May 2022 , 7:45pm kick-off

The existing crowd management plan during post-match egress provides 3-lane barrier system along Whitehall Street and Love Lane to allow spectators to access the White Hart Lane Station and Love Lane estate. The lanes allow for

- Queue for Southbound platform, area 780m<sup>2</sup>, minimum width 3.6m on Whitehall Street,
- Queue for Northbound platform, area 1,380m<sup>2</sup> including primary queue along Love Lane (turning back towards White Hart Lane) and access along Whitehall Street. Minimum width 1.5m on Whitehall Street and Love Lane,
- Contraflow (primarily for Southbound platform users who arrived from White Hart Lane), minimum width 1.4m
- Route along White Hart Lane between Love Lane and William Street is used for access to both Northbound queue and contraflow and therefore is not included in Northbound queue area

The key assessment criteria for the Crowd Flow study is to ensure the Illustrative Masterplan and construction phasing layouts provides at least the above mentioned area and widths for Northbound and Southbound queue to White Hart Lane Station on event days. Access for residents and a contraflow lane also need to be accommodated.

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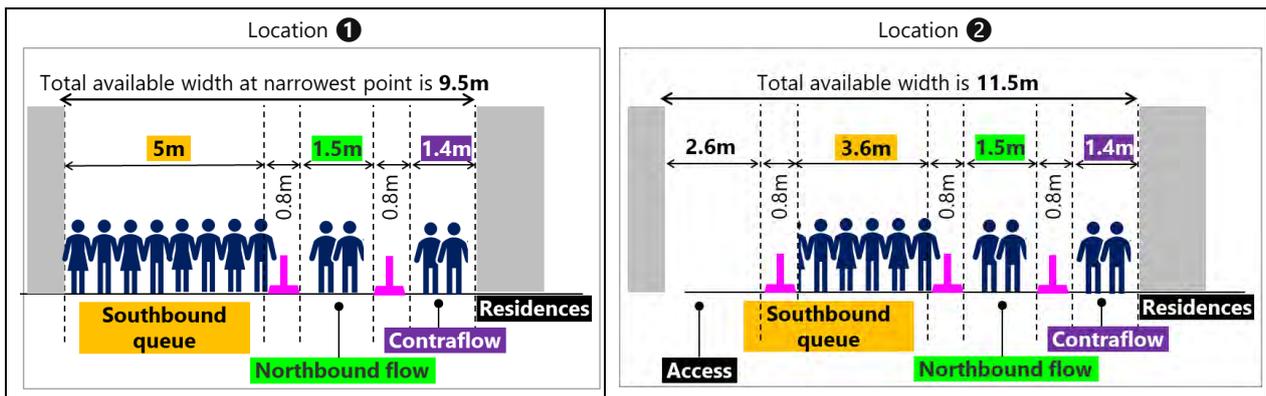
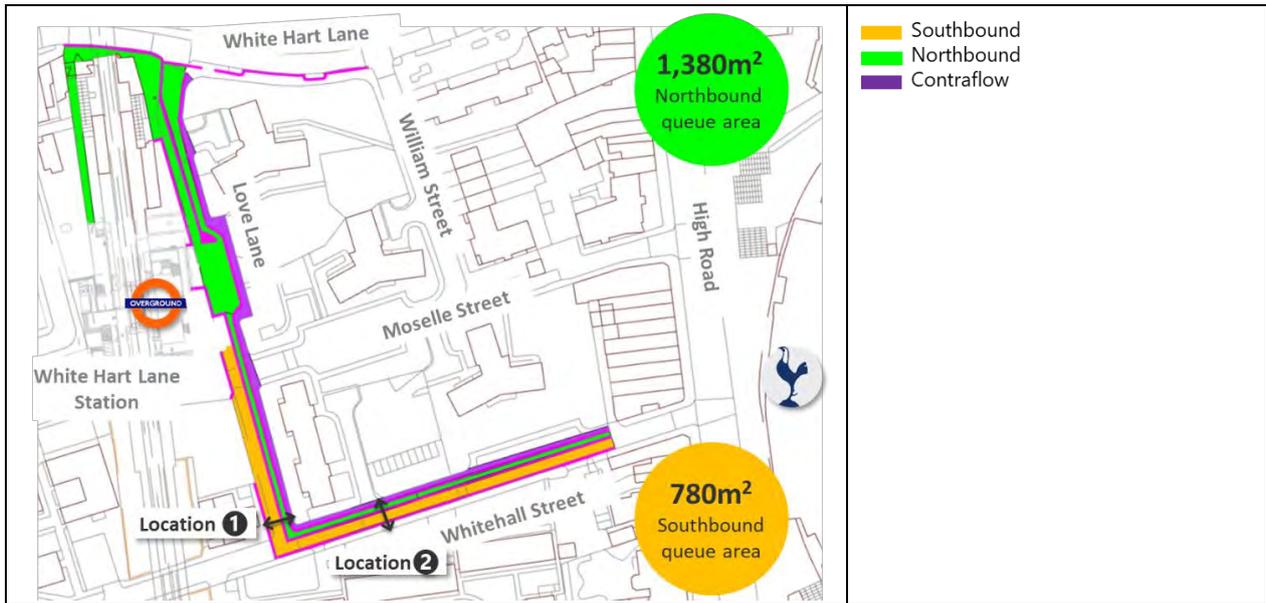


Figure 3-1 Existing crowd management strategy on existing site

The site observations also helped provide an understanding of the crowd dynamics of spectators leaving the Tottenham Hotspur Stadium and queuing at White Hart Lane Station for different days of the week i.e., Mid-week vs Weekend, for varying Kick-off / Final whistle times, for train cancellations / reduced services and for varying demographics of spectators i.e. non-London spectators (Norwich) vs London spectators (Brentford / Arsenal) in addition to season ticket holders.

It is acknowledged that there are a wide range of match types and other event types that take place at the stadium which result in variations of crowd behaviour. Dynamic Crowd Flow modelling (based on the minimum separation distances shown within the Parameter Plans, which are also reflected for these purposes within the Illustrative Masterplan) is used to demonstrate how the Illustrative Masterplan could operate under a selection of these scenarios – with a focus on the more regular Premier League Match scenario. In addition to detailed modelling of the post-match Premier League egress scenario, sensitivity analysis is also conducted with the aim of reviewing the performance of Illustrative Masterplan under a wider range of scenarios.

The site observations carried out in December were primarily focused on determining the current queue strategy used on the site during the egress after a match at the stadium. A summary of our observation is provided in the table below, details are provided in the Appendix.

Key points noted regarding crowd dynamics from the site observations are:

- Spectators are responsive to announcements and information provided by THFC and Stewards. For example for the match held on the 1<sup>st</sup> of May – Sunday, THFC were aware in advance of disrupted train services and announcements were made inside the stadium to advise spectators to walk to alternative stations. A proportion of spectators walked to alternative modes instead of waiting in front of White Hart Lane Station.
  - Northbound spectators arrive from both Whitehall Street or White Hart Lane to reach the Station entrance leading to Northbound platform
  - Contraflow lane is mainly used by Southbound spectators who arrive via White Hart Lane
  - Queues for Southbound are always contained within the barriers provided
  - Background flow of residences were noted on Whitehall Street, moving towards Love Lane estate or High Road
  - Queues for Southbound disappear within 45 minutes after the final whistle. Queue for Northbound platform are typically minimal and contained within the station boundary unless there is severe rail disruption reducing train frequency to 2 trains or less per hour.
-

Table 3-1 Summary of site observations

	2 <sup>nd</sup> December 2021 (Thursday) Tottenham vs Brentford	5 <sup>th</sup> December 2021 (Sunday) Tottenham vs Norwich City	16 <sup>th</sup> April 2022 (Saturday) Tottenham vs Brighton	1 <sup>st</sup> May 2022 (Sunday) Tottenham vs Leicester	12 <sup>th</sup> May (Thursday) Tottenham vs Arsenal
<b>Kick-off</b>	7.30pm	2.00pm	12.30pm	2.00pm	7.45pm
<b>Full Time</b>	21.22pm	3.53pm	2.25pm	3.52pm	9.36pm
<b>Total attendees</b>	54,202 spectators	57,088 spectators	58,685 spectators	59,482 spectators	62,027 spectators
<b>WHLS demand</b>	Not measured*	Not measured*	13.2%	7%	10.7%
<b>Southbound vs. Northbound demand</b>	Much higher demand for Southbound	Much higher demand for Southbound	64% for Southbound and 36% for Northbound	55% for Southbound and 45% for Northbound	58% for Southbound and 42% for Northbound
<b>Rate at which people enter Southbound doors</b>	Not measured*	Not measured*	Peak: 90 people/min/door	Not measured*	Peak: 153 people/min/door
<b>Rate at which people enter Northbound gate</b>	Not measured*	Not measured*	Peak: 108 people / minute	Peak: 117 people / minute	Peak: 122 people / minute
<b>Number of trains during peak hour of egress</b>	4 trains per hour per platform (No cancellations or delays more than 1 minute)	4 trains per hour per platform (No cancellations or delays more than 1 minute)	5 NB trains per hour 6 SB trains per hour (1 NB train cancelled)	3 trains per hour per platform (1 train per direction cancelled per hour)	4 NB trains per hour 5 SB trains per hour (No cancellations or delays more than 1 minute)
<b>Maximum extent of Southbound queue</b>	~50m length	~180m length	~80-100m	Less than 70m	~140m length
<b>Southbound observations</b>	Southbound queue needed to be stopped on small number of occasions when platform was full.	Southbound queue often stopped for several minutes to allow platform to clear.	Stewards let Southbound travellers (~8.7%) cut across lanes in front of WHLS Southbound entrance when there wasn't a queue for Southbound or when this queue was very small	Spectators were diverted to Seven Sisters when information was provided about WHLS train cancellation. Spectators cut lanes on Love Lane to join queue (did not walk down Whitehall Street)	Southbound queue lane on Whitehall Street was narrower than the Northbound queue. This led to a large queue that extended onto Whitehall Street
<b>Northbound observations</b>	Mostly free flow towards Northbound platform	Mostly free flow towards Northbound platform	Mostly free flow towards Northbound platform, short queues formed within station boundary	Queue spills outside the Northbound entrance gate for ~6 minutes, and was contained within White Hart Lane	Mostly free flow towards Northbound platform. Short queues formed within station boundary
<b>Background/Contraflow</b>	Moderate usage of contraflow lane to access Southbound queue (e.g. from White Hart Lane)	Lower usage of contraflow lane to access Southbound queue (e.g. from White Hart Lane)	28% of people entering Southbound Entrance used the Southbound contraflow lane.	Moderate usage of contraflow lane	26% of people entering Southbound Entrance used the Southbound counterflow lane.

\*Not all data were measured for all events due to event type, lighting and visibility of areas of the site

## 4 End-state Illustrative Masterplan

The Illustrative Masterplan has sufficient space to accommodate the existing 3-lane barrier crowd management plan along Moselle Square to allow spectators to access the White Hart Lane Station and local residences during post-match egress. The lanes are:

### **Lane 1 - Southbound flow from Stadium to White Hart Lane station:**

- An area of ~1,480m<sup>2</sup> can be provided for Southbound queue area in the Illustrative Masterplan, which is a significant increase (90%) compared to the existing Southbound queue area of 780m<sup>2</sup>.
- High Road provides contingency space to accommodate Southbound spectator queue during busy events for example Boxing events, or events with a hard finish.
- There is flexibility to consider different queue lane configurations in the Illustrative Masterplan (Please see 6.3.)

### **Lane 2 - Northbound flow from Stadium to White Hart Lane station:**

- A total area of ~1,420m<sup>2</sup> can be achieved in the Illustrative Masterplan compared to the existing Northbound queue area of 1,380m<sup>2</sup>.
- Northbound queue can be operated as it is currently (i.e. primary queue extends along White Hart Lane). It also has the flexibility to queue along Moselle Square.
- A 1.5m wide lane would be provided parallel to Southbound lane on Moselle Square to allow access for any Northbound travellers entering via Moselle Square.

### **Lane 3 – Contraflow:**

- A 1.4m wide contraflow lane would be provided between Moselle Square to White Hart Lane

### **Narrowest point:**

- The narrowest point in the HRW Masterplan is 21m, which is a 120% increase compared to the narrowest point in existing site (9.5m on Love Lane).
  - This provides sufficient width to accommodate the 3-lane barrier crowd management plan (Southbound queue, access to Northbound queue and Contraflow lane), retail frontage and landscape features in the Illustrative Masterplan.
-

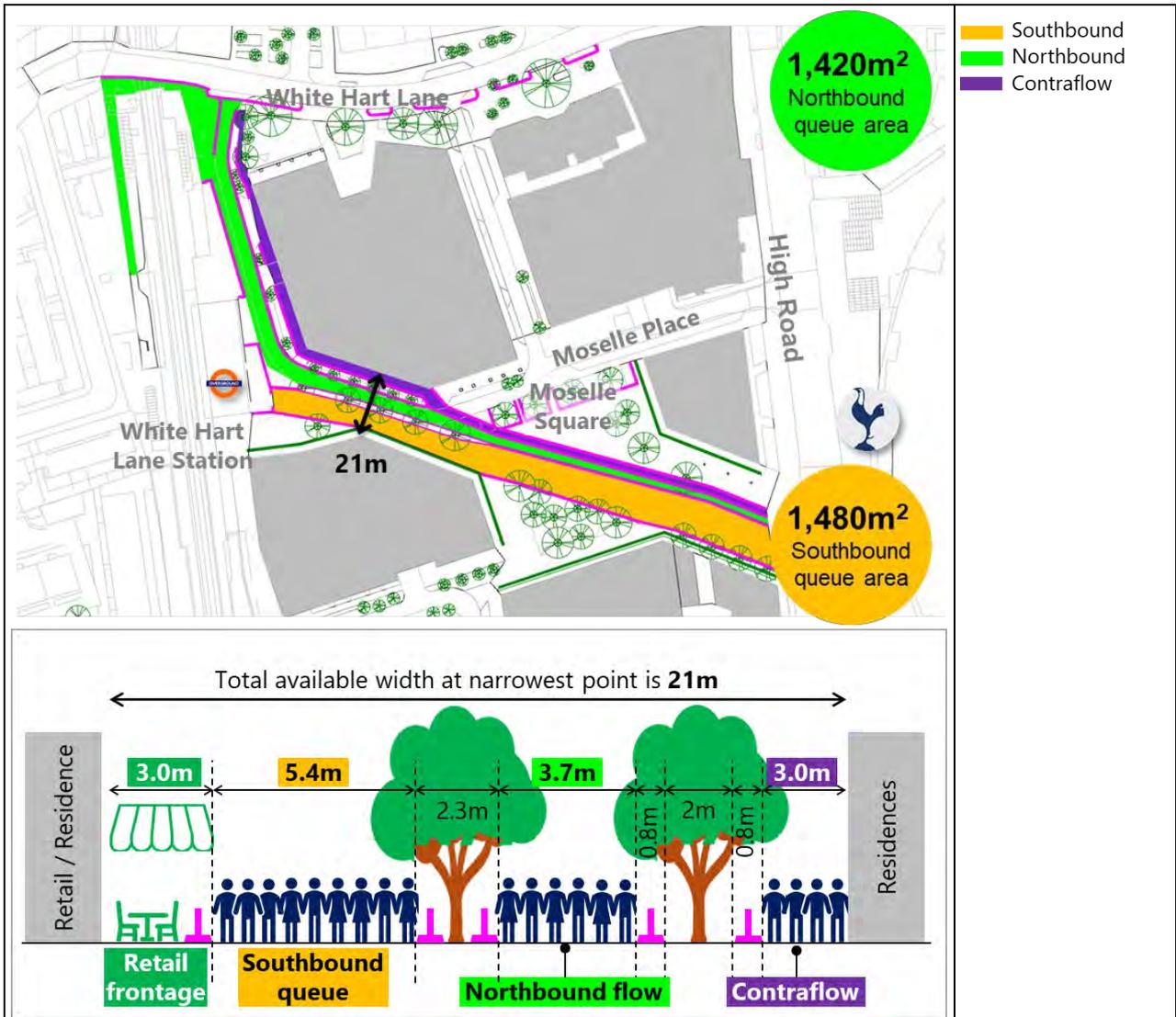


Figure 4-1 Existing crowd management strategy mapped on to the Illustrative Masterplan and width at narrowest point

## 5 Defining the Key Crowd Flow Scenarios

As shown in the previous section, the End State Illustrative Masterplan (which reflects the minimum separation distances shown within the Parameter Plans) provides at least an equivalent amount of queue space compared to the existing space. The following section outlines a series of crowd flow scenarios used to build a dynamic crowd flow model and various sensitivity analysis of the Illustrative Masterplan to demonstrate how it could operate.

There are a range of events planned at Tottenham Hotspur Stadium every year which will generate spectators moving to and from the White Hart Lane Station (WHLS) via Moselle Square. Post-match movement after the following critical movement scenarios are used to demonstrate how the Illustrative Masterplan could operate for crowd safety and comfort.

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## 5.1 Input Parameters

These scenarios have been developed with key stakeholders incorporating the data from the previous Crowd Flow studies. They represent more onerous conditions compared to the observations from recent matches. They show a higher proportion of spectators using White Hart Lane Station and a faster departure profile (i.e. quicker arrival to the station resulting in larger queue build up). They illustrate a range of scenarios to review how the crowd flow could work within the Illustrative Masterplan which are all acceptable.

**Table 5-1 Key Crowd Flow parameters**

	Premier League	NFL	Boxing Event	Cup Game (Stress Test)
<b>Tottenham Stadium spectators</b>	62,850 spectators (Including 3,000 away fans)	62,850 spectators	67,000 spectators <sup>6</sup>	62,850 spectators
<b>Retained in Stadium</b>	0% <sup>5</sup>	20% <sup>5</sup>	0%	0%
<b>Peak 15 minutes demand</b>	44.4% <sup>11</sup>	25.4% <sup>12</sup>	80% <sup>19</sup>	80% <sup>19</sup>
<b>Proportion dwelling local area post-match</b>	30% of Home fans, 5% of away fans <sup>9</sup>	20% of spectators <sup>9</sup>	Minimal because they have to catch last train <sup>19</sup>	Minimal because they have to catch last train <sup>19</sup>
<b>WHLS usage</b>	20.3% <sup>9</sup>	19% <sup>9</sup>	14% <sup>6</sup>	23% <sup>19</sup>
<b>Southbound:Northbound</b>	70:30 <sup>15</sup>	80:20 <sup>10</sup>	70:30 <sup>6</sup>	80:20 <sup>19</sup>
<b>WHLS Train Frequency</b>	Northbound and Southbound: 6 trains per hour for each platform			
<b>WHLS Southbound train capacity / loading</b>	<ul style="list-style-type: none"> <li>Trains operated as 8-car capacity – 1,161 people per train<sup>20</sup></li> <li>Loading of train is considered at 90% of its capacity i.e., 1,045 people</li> </ul>			
<b>WHLS Northbound train capacity / loading</b>	<ul style="list-style-type: none"> <li>Trains operated as 8-car capacity – 1,161 people per train<sup>20</sup></li> <li>Loading of train is considered at 80% of its capacity i.e., 929 people</li> </ul>			
<b>Southbound platform capacity/ loading</b>	<ul style="list-style-type: none"> <li>Platform capacity is assumed to be limited to train's loading capacity i.e., 1,045 people per minute. Excess queue will wait outside the station</li> <li>Platform is assumed to be filled based on the flow through the stairs i.e., 182 people per minute (Refer Appendix D for details)</li> </ul>			
<b>Northbound platform capacity/ loading</b>	<ul style="list-style-type: none"> <li>Platform capacity is assumed to be limited to a full train load i.e., 1,161 people. Excess queue will wait outside the station</li> <li>Platform is assumed to be filled on the flow through the 2m walkway i.e., 98 people per minute (Refer Appendix D for details)</li> </ul>			
<b>Queue management and barrier layout</b>	<ul style="list-style-type: none"> <li>3-lane barrier system along Moselle Square to allow Southbound platform flow, Northbound platform flow and for any contra flow (for spectators arriving from White Hart Lane or Residential area). Refer Figure 4-1</li> <li>Barriers along White Hart Lane allow circulation to Northbound platform, Southbound platform, residential area and further West</li> <li>Limited access to Moselle Place and William Street (i.e., residents only)</li> <li>Southbound travellers enter WHLS via the East entrance, spectator queue towards Moselle Square</li> <li>Northbound travellers enter WHLS via the North entrance, spectator queue along White Hart Lane, Love Lane and Moselle Square</li> </ul>			

## 5.2 Pedestrian Circulation routes

The "Blue Book"<sup>3</sup> is a document providing guidance for local residents and businesses for Event days at THFC Stadium, with input from various stakeholders and includes information on travel modes and road closures.

Based on Blue Book data<sup>3</sup> and mapping the existing crowd management strategy (observed through site visit) to the Illustrative Masterplan, it is assumed that key routes through the Masterplan including High Road, White Hart Lane, Love Lane, William Street and Moselle Place are pedestrian only 15-minutes prior to final whistle and for 60-minutes during post-match egress for Premier League and NFL matches. William Street and Moselle Place provide pedestrian access to residents only.



Figure 5-1 Road closures through HRW Masterplan, prepared by Buro Happold

## 6 Crowd flow analysis of HRW Masterplan

### 6.1 HRW Masterplan Parameters and Illustrative Masterplan

The movement of crowds has been focussed within the southern half of HRW Masterplan where the direct route between White Hart Lane Station and the Stadium is proposed. Within the Parameter Plans the minimum separation differences are shown between individual plots for main access routes / circulation areas. Parameter Plan Ref: 0311-SEW-ZZ-ZZ-DR-T-001003 (Horizontal Limits of Deviations Plan) is included in Appendix C.

**Table 6-1 Minimum separation between plot extents**

Block	Block	Minimum Separation (metres)	Illustrative Masterplan
C	E	21m	34m (at ground floor)
C	F	66m	70m
D	E	64m	64m
D	F	21m	21m
I1	I2	12m	15m

The minimum separation distances listed above have been incorporated within the Illustrative Masterplan including the minimum 21 metres separation distance required between Plot D and Plot F – which is a key location for Crowd Flow. Crowd flow modelling has therefore been based on the minimum separation distances shown within the Parameter Plans, which are also reflected for these purposes within the Illustrative Masterplan. In practice, the detail of the routes and distances will be approved as part of the Reserved Matters Application process which will include the minimum distances set out above.

## 6.2 Egress Modelling

Dynamic crowd flow modelling has been carried out in Legion to visualise the performance of the Existing site compared to the Illustrative Masterplan during spectator egress from Tottenham Hotspur Stadium during the following scenarios:

- Spectator egress after a Typical Premier League match.
- Stress test, for example Spectator egress after a Cup Game with extra time and penalties

The aim of the model is to illustrate how the queues for White Hart Lane Station form during the egress period, and visualise the area occupied by spectators in the queue – comparing at which point the queue reaches for the existing vs. the Illustrative Masterplan.

### 6.2.1 Legion Model inputs

Key inputs considered for the Legion model are summarised in Table 5-1 Key Crowd Flow parameters, considering the Premier League and Cup Game scenarios.

Additional inputs to the Legion model are as follows:

- Final Whistle is considered at 16:50
- Train frequency considered is a train arriving every 10 mins, starting from 16:45.
- The model starts from the Stadium site and considers spectator flows towards White Hart Lane and other transport nodes to the North, South and West

	Existing	Illustrative Masterplan
<b>Access to Southbound Platform queue</b>	70% via Whitehall Street directly 30% via White Hart Lane then contraflow lane to join end of Southbound queue	100% Via Moselle Square*
<b>Access to Northbound Platform queue</b>	60% via White Hart Lane 40% via Whitehall Street	60% via White Hart Lane 40% via Moselle Square

\*This provides the shorter route to the Southbound queue and hence tests a more onerous scenario compared to routing some spectators along White Hart Lane and the contra-flow lane

## 6.2.2 Typical Premier League Scenario

The Legion modelling outputs show the desire lines of spectators moving away from the Stadium, the extent of the queues, and crowd density levels. The purpose is to compare the Illustrative Masterplan with the existing to demonstrate how the crowd flows could operate on a typical Premier League Scenario.

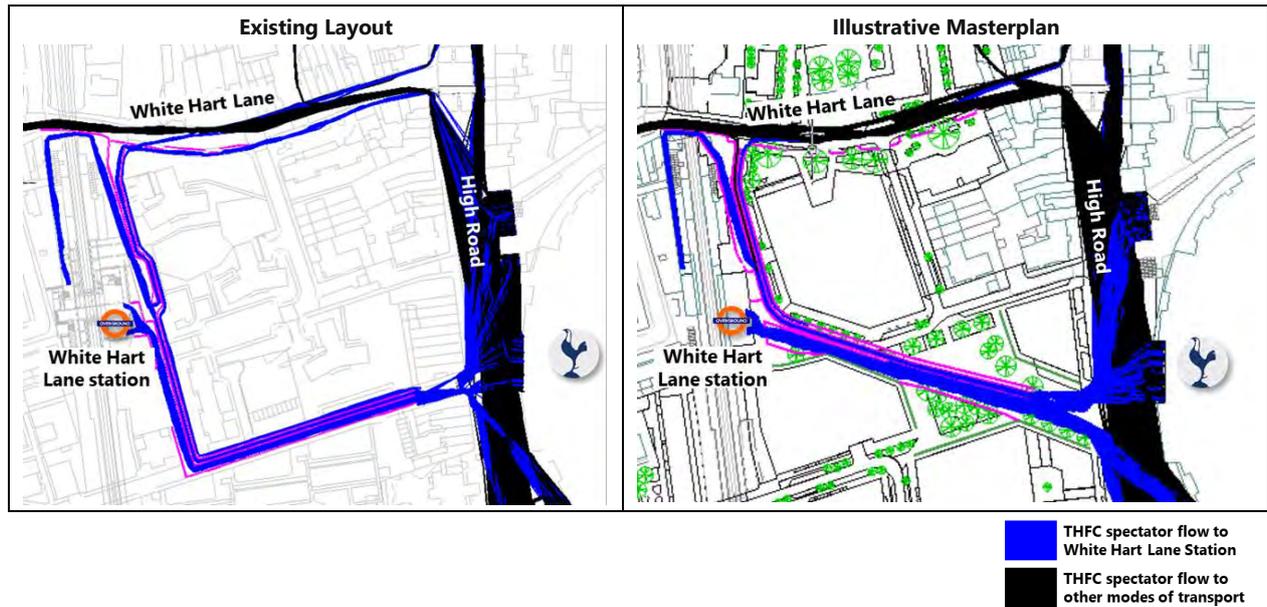


Figure 6-1 Screen capture from Legion simulation for Typical Premier League Scenario

### Queue length – Typical Premier League

The still images below from the modelling show the extent of the queue build up for the Southbound platform in the existing site vs. the Illustrative Masterplan after a Typical Premier League match. The queue spills out of the barriers in the existing site while the Illustrative Masterplan can accommodate the peak queue for the typical Premier League egress scenario – which potentially reaches as far as the East of Moselle Square. Minimal queuing was observed for Northbound platform (please refer to Sensitivity analysis section for further analysis of Northbound queues).



Figure 6-2 Queue build up for Southbound platform after final whistle

### **Cumulative Mean Density – Typical Premier League**

The still images below show the cumulative mean density captured every 10 minutes (based on train timings) for the peak period of the simulation along the Southbound queue after a Typical Premier League match. Fruin's Level of Service for Queue spaces is applied here (see Acceptance Criteria section for details).



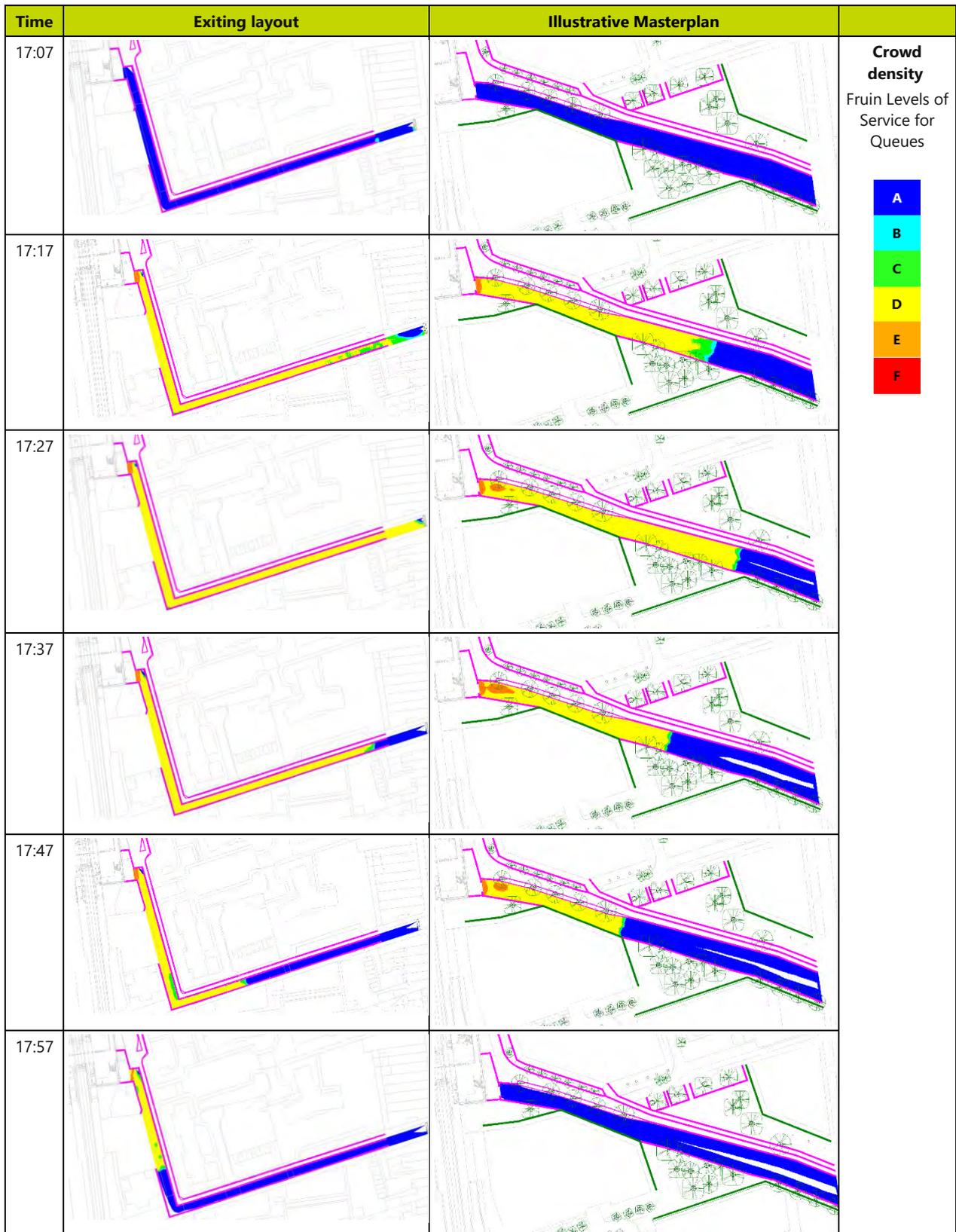


Figure 6-3 Density at Southbound queue lane for a typical Premier League match

### 6.2.3 Stress Test Scenario

The Stress Test scenario represents rare occurrences whereby spectators leave the Stadium more quickly compared to a typical Premier League Match, for example Spectator egress after a Cup Game with extra time and penalties.

Under such a scenario, it is assumed that contingency planning would be in place, therefore the model outputs below are to demonstrate how the Illustrative Masterplan compares to the Existing site in terms of the rate at which the Southbound queue reaches its capacity. From this point, spectators would spill into the area on High Road, and, as observed in the current scenario, it is possible that a proportion of these spectators would choose to walk to other transport nodes.

The still images below from the modelling show the extent of the queue build up for the Southbound platform in the existing site vs the Illustrative Masterplan for the Stress Test scenario. The queue spills out of the barriers and on to High Road in both the existing site and the Illustrative Masterplan. It is noted that the area of High Road occupied by this contingency queue is much larger for the existing layout compared to the Illustrative Masterplan due to the larger Southbound queue area. Minimal queueing was observed for Northbound platform (please refer to Sensitivity analysis section for further analysis of Northbound queues).

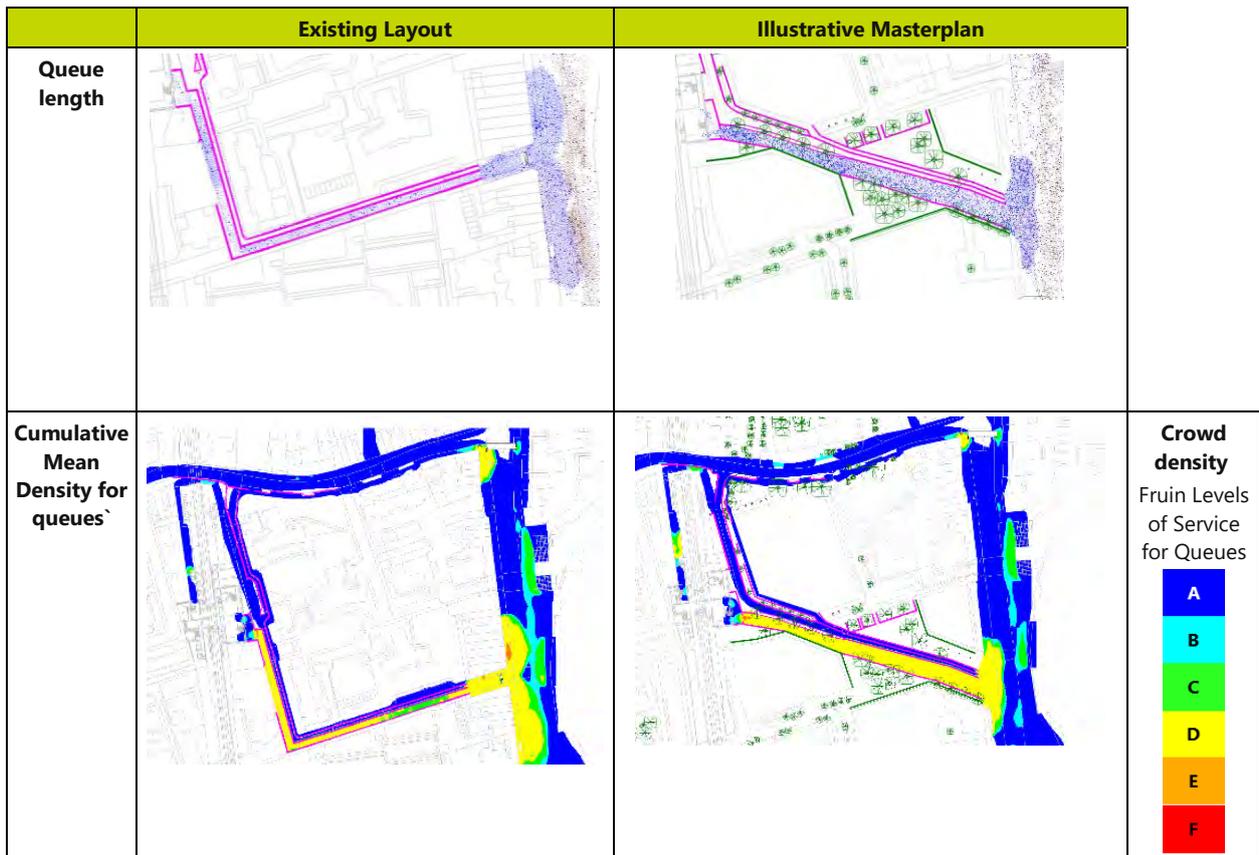


Figure 6-4 Comparison of queue lengths for the Existing Layout and Illustrative Masterplan

#### **6.2.4 Egress Modelling Summary:**

The modelling outputs demonstrate how the crowd flows for a typical Premier League match and a Cup Match (Stress Test scenario) could be operated within the Illustrative Masterplan in comparison to how these scenarios would perform within the existing site.

The purpose of the exercise is to demonstrate the potential improvements provided by the HRW Masterplan compared to the existing site. The Event management and Contingency planning for special events with late finishes, rail disruptions etc., would remain the responsibility of THFC.

##### **Typical Premier League**

- For the scenario analysed, the Illustrative Masterplan has sufficient space to contain the maximum queue length for both Northbound and Southbound. In comparison, applying the same scenario to the existing layout, the queues spill out of the barrier area for a duration of 5 minutes
- Southbound queue: The queue reaches its maximum length 30 minutes after the final whistle. The queue levels are based on spectator arrival rates and train timing. The queue spills out of the barriers in the existing site while the Illustrative Masterplan can accommodate the peak queue for the typical Premier League egress scenario – which potentially reaches as far as the East of Moselle Square.
- Northbound queue: Minimal queueing was observed for Northbound platform (please refer to Sensitivity analysis section for further analysis of Northbound queues).

##### **Stress test**

- Southbound queue: For both existing and Illustrative Masterplan the Southbound queue spills outside the barrier area. Due to the higher queue capacity of the Illustrative Masterplan – the queue spilling out into High Road occupies 912m<sup>2</sup> compared to 1,493m<sup>2</sup> in the existing layout (a 40% reduction in the area of High Road occupied by queue overspill).
  - High Road West provides contingency space for events similar to the Stress Test scenario modelled, including boxing events, concert events where a late or hard finish is likely to happen.
  - Northbound queue: For the Stress test scenario the Northbound demand is reduced to 20% and therefore the queue is contained within the barriers for both Existing and Proposed layout.
  - As is currently adopted in the existing scenario, it is assumed stewards would be available on site to direct and manage the crowd of spectators.
  - It is assumed appropriate crowd management measures would be provided by THFC and relevant stakeholders as deployed in the current scenario, for example to inform spectators of the likely duration of queues and delays at the White Hart Lane Station and encourage Southbound spectators to walk to alternative train stations including Seven Sisters, Tottenham Hale.
  - As noted from the site observation on 1st May, spectators travel plans can be influenced by the information provided by THFC and stewards on the ground. During scenarios where large queues form, spectators might choose to walk to an alternative train station (for example Seven Sisters) which would have a shorter journey time compared to the queueing at White Hart Lane Station.
-

### 6.2.5 Sensitivity Study – Southbound and Northbound Queue length

As demonstrated in the previous section, the Illustrative Masterplan provides at least equivalent area and widths for the Northbound and Southbound queues at White Hart Lane as in the existing scenario. The following analysis calculates the area of queue space that fans could occupy under different scenarios as well as the maximum queue time.

From the information available, it is noted that the demand for the Southbound services from White Hart Lane varies for different days of the week and different match types. Additionally, matches at Tottenham Hotspur Stadium would have varying kick off times as well as non-London spectators (e.g., Norwich) vs London spectators (Arsenal /Brentford) in addition to season ticket holders. The sensitivity study below captures a range of variation for the White Hart Lane Station users for the Southbound and Northbound travel.

The resulting queuing area taken up by spectators under these scenarios is calculated based on Fruin’s LoS C/D i.e. 0.65m<sup>2</sup>/person (1.5 persons per m<sup>2</sup>). This is considered as comfortable density for pedestrians and comparable to the density observed through site surveys.

Queuing areas available for Southbound and Northbound platforms are shown in the image below.

- Southbound queueing area available is 1,480m<sup>2</sup>
- Northbound queueing area available is 1,420m<sup>2</sup>



Figure 6-5 Queueing area available on Illustrative Masterplan

The tables below summarise the queue length, duration and area occupied for the various s events when parameters such as White Hart Lane Station (WHLS) usage, Southbound or Northbound demand would vary from the base case assumptions. A range of train timings relative to Final Whistle have been assessed and the worst case reported for each scenario. The results are coloured based on the following criteria:

	Sufficient queue area in Illustrative Masterplan to accommodate the demand
	Queue is likely to spill outside the barrier area for a short duration. However, the queues can be accommodated within the Masterplan without spilling into High Road
	Queues would spill into High Road and spectators could be directed to walk to alternative stations where possible

Table 6-2 Summary of Sensitivity study, Southbound

	Premier League	NFL	Boxing Event	Cup Game (Stress Test)
<b>Default parameter:</b>				
<b>Demand</b>	62,850 spectators	62,850 spectators	67,000 spectators	62,850 spectators
<b>Peak 15-minutes demand</b>	44.4%	25.4%	80%	80%
<b>WHLS usage</b>	20.3%	15.2%	14%	23%
<b>Southbound</b>	70%	68%	70%	80%
<b>Train frequency</b>	6 trains per hour per platform	6 trains per hour per platform	6 trains per hour per platform	6 trains per hour per platform
<b>Base case: using above parameters</b>	Queue Length: 2,431 spectators Queue Duration: 54 minutes Area Occupied: 1,580 m <sup>2</sup>	Queue Length: 330 spectators Queue Duration: 8 minutes Area Occupied: 215 m <sup>2</sup>	Queue Length: 3,660 spectators Queue Duration: 65 minutes Area Occupied: 2,380 m <sup>2</sup>	Queue Length: 7,704 spectators Queue Duration: 112 minutes Area Occupied: 5,010 m <sup>2</sup>
<b>WHLS usage: 7% decrease (based on site observation)</b>	Queue Length: 1,031 spectators Queue Duration: 27 minutes Area Occupied: 670m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA Area Occupied: NA m <sup>2</sup>	Queue Length: 1,055 spectators Queue Duration: 26 minutes Area Occupied: 686 m <sup>2</sup>	Queue Length: 4,844 spectators Queue Duration: 76 minutes Area Occupied: 3,150 m <sup>2</sup>
<b>WHLS usage: 2% increase</b>	Queue Length: 2,880 spectators Queue Duration: 57 minutes Area Occupied: 1,870 m <sup>2</sup>	Queue Length: 705 spectators Queue Duration: 36 minutes Area Occupied: 458 m <sup>2</sup>	Queue Length: 4,410 spectators Queue Duration: 73 minutes Area Occupied: 2,870 m <sup>2</sup>	Queue Length: 8,550 spectators Queue Duration: 116 minutes Area Occupied: 5,560 m <sup>2</sup>
<b>WHLS usage: 4% increase</b>	Queue Length: 3,320 spectators Queue Duration: 65 minutes Area Occupied: 2,160 m <sup>2</sup>	Queue Length: 1,165 spectators Queue Duration: 47 minutes Area Occupied: 757 m <sup>2</sup>	Queue Length: 5,160 spectators Queue Duration: 82 minutes Area Occupied: 3,350 m <sup>2</sup>	Queue Length: 9,410 spectators Queue Duration: 116 minutes Area Occupied: 6,115 m <sup>2</sup>
<b>Southbound: 5% increase</b>	Queue Length: 2,760 spectators Queue Duration: 56 minutes Area Occupied: 1,790 m <sup>2</sup>	Queue Length: 515 spectators Queue Duration: 28 minutes Area Occupied: 335 m <sup>2</sup>	Queue Length: 4,030 spectators Queue Duration: 66 minutes Area Occupied: 2,620 m <sup>2</sup>	Queue Length: 8,310 spectators Queue Duration: 116 minutes Area Occupied: 5,400 m <sup>2</sup>
<b>Southbound: 10% increase</b>	Queue Length: 3,060 spectators Queue Duration: 59 minutes Area Occupied: 1,990 m <sup>2</sup>	Queue Length: 765 spectators Queue Duration: 36 minutes Area Occupied: 497 m <sup>2</sup>	Queue Length: 4,410 spectators Queue Duration: 73 minutes Area Occupied: 2,870 m <sup>2</sup>	Queue Length: 8,930 spectators Queue Duration: 116 minutes Area Occupied: 5,805 m <sup>2</sup>

An example of the calculation details is provided below for the Boxing event. This approach is considered for all other queue length calculations:

- Stadium capacity: 67,000 spectators <sup>6</sup>
- WHLS usage: 14%<sup>6</sup>, of which 70%<sup>6</sup> are Southbound users (i.e., 6,566 people) and remaining are Northbound passengers (i.e., 2,814 people)
- Departure profile assumed from Stadium to Station – 80% leave in first 15 minutes, remaining 20% leave uniformly in the next 30 minutes. To assess a peak scenario, it is assumed that a minimal number of spectators dwell in local area after the event as they would have to catch their last train
- The maximum queue length is likely to be 3,660 people, requiring a queue area of 2,380m<sup>2</sup> at Fruin’s LoS C/D i.e. 0.65m<sup>2</sup>/person (1.5 persons per m<sup>2</sup>). This queue would spill out to the High Road West for the peak period. This study assumes the following (refer graph in Figure 6-6):
  - Total demand for Southbound trains = 6,566 people
  - Demand in first 15 minutes is 80% = 5,253 people
  - Flow of spectators on to the platform is restricted by the stairs. Peak minute flow is assumed as 182p/minute (Refer Appendix for details). It would take 5 to 6 minutes to load the platform to capacity considered (i.e., 1,045 people) following which the stewards stop spectators outside the station till the next train has passed.
  - The first train comes at 3 minutes past the final whistle and takes 546 people away within two minutes
  - Second train comes at 13 minutes past the final whistle and takes 1 full train load i.e., 1,045 people away within two minutes.
  - People waiting on the platform after the second train has left is 182 people (at 15 minutes past)
  - Hence by 15 minutes when 80% spectators have arrived, the above train capacity (546+1,045 total 1,591 people) have left resulting in 3,660 people queuing outside the station

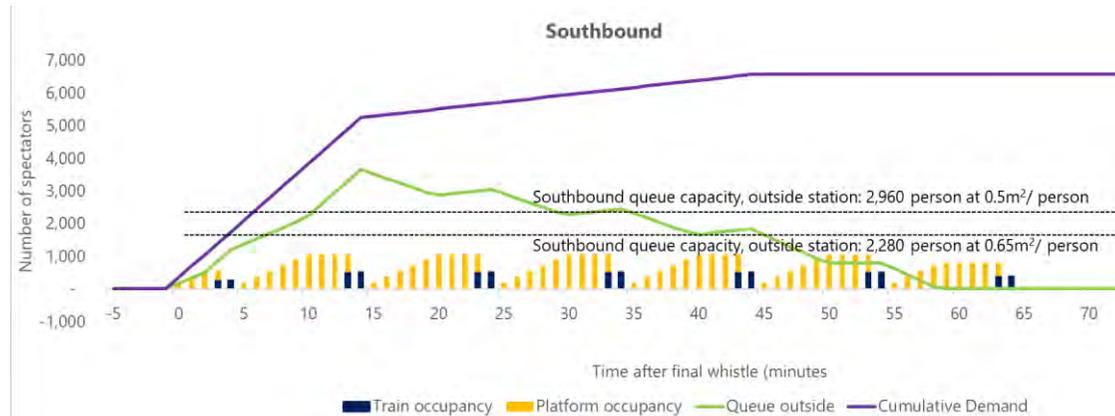


Figure 6-6 Southbound summary, Boxing Event Day base case

**Table 6-3 Summary of Sensitivity study, Northbound**

	Premier League	NFL	Boxing Event	Cup Game (Stress Test)
<b>Default parameter:</b>				
<b>Demand</b>	62,850 spectators	62,850 spectators	67,000 spectators	62,850 spectators
<b>Peak 15-minutes demand</b>	44.4%	25.4%	80%	80%
<b>WHLS usage</b>	20.3%	15.2%	14%	23%
<b>Northbound</b>	30%	32%	30%	20%
<b>Train frequency</b>	6 trains per hour per platform	6 trains per hour per platform	6 trains per hour per platform	6 trains per hour per platform
<b>Base case: using above parameters</b>	Queue Length: 446 spectators Queue Duration: 21 minutes Area Occupied: 290 m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA minutes Area Occupied: NA m <sup>2</sup>	Queue Length: 795 spectators Queue Duration: 24 minutes Area Occupied: 517 m <sup>2</sup>	Queue Length: 855 spectators Queue Duration: 24 minutes Area Occupied: 556 m <sup>2</sup>
<b>WHLS usage: 2% increase</b>	Queue Length: 637 spectators Queue Duration: 25 minutes Area Occupied: 414 m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA minutes Area Occupied: NA m <sup>2</sup>	Queue Length: 1,110 spectators Queue Duration: 28 minutes Area Occupied: 722 m <sup>2</sup>	Queue Length: 1,065 spectators Queue Duration: 27 minutes Area Occupied: 692 m <sup>2</sup>
<b>WHLS usage: 4% increase</b>	Queue Length: 814 spectators Queue Duration: 30 minutes Area Occupied: 529 m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA minutes Area Occupied: NA m <sup>2</sup>	Queue Length: 1,440 spectators Queue Duration: 31 minutes Area Occupied: 936 m <sup>2</sup>	Queue Length: 1,260 spectators Queue Duration: 30 minutes Area Occupied: 819 m <sup>2</sup>
<b>Northbound: 5% increase</b>	Queue Length: 750 spectators Queue Duration: 28 minutes Area Occupied: 488 m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA minutes Area Occupied: NA m <sup>2</sup>	Queue Length: 1,170 spectators Queue Duration: 29 minutes Area Occupied: 761 m <sup>2</sup>	Queue Length: 1,440 spectators Queue Duration: 31 minutes Area Occupied: 936 m <sup>2</sup>
<b>Northbound:10% increase</b>	Queue Length: 1,060 spectators Queue Duration: 36 minutes Area Occupied: 688 m <sup>2</sup>	Queue Length: 0 spectators Queue Duration: NA minutes Area Occupied: NA m <sup>2</sup>	Queue Length: 1,545 spectators Queue Duration: 34 minutes Area Occupied: 1,004 m <sup>2</sup>	Queue Length: 2,010 spectators Queue Duration: 44 minutes Area Occupied: 1,307 m <sup>2</sup>

It is noted that two routes can be considered for Northbound trains, one to Enfield and one to Chestnut. The above assessment assumed that 50% people can take any train and 25% specifically require an Enfield train and 25% specifically require an Hartfield train. However, it is possible that a higher percentage of people might wait on the platform for the next available train to their destination. A sensitivity study was carried out to review the queue level when 50% spectators will be waiting on the platform for second train. The queue level calculation shows that in all cases the minimum separation distances within the Parameter Plans as modelled within the Illustrative Masterplan has sufficient space to accommodate queues safely and comfortably for the above scenarios.

### 6.2.6 Sensitivity analysis summary

- The sensitivity analysis is used to demonstrate potential queue lengths and durations under a range of scenarios.
  - Under some conditions the number of people queueing may exceed the area available within the Illustrative Masterplan – however, it is noted, that as the areas provided in the Illustrative Masterplan are equivalent to or greater than the existing site the same overspill (or worse) would be expected in the existing site for these cases.
  - Under such conditions the space on High Road would be available as a contingency queue space.
  - It is also noted, that at the point the queue for the Southbound platform has been exceeded (i.e. a queue of ~2,280 people), people joining the back of this queue could be waiting up to 30 minutes (if operating at 6 trains per hour) or up to 45 minutes if operating at 4 trains per hour. Given these long waits, some spectators may prefer to walk to an alternative station to reduce their overall journey time.
  - Increasing the train frequency to 8 trains per hour would decrease the queue area occupied by spectators. A reduction to 4 trains per hour (or less due to cancellations etc.) would potentially increase the queue area occupied by spectators, however, from the observations of the existing site it is noted that under such conditions the proportion of spectators that use White Hart Lane tends to be lower than applied in this sensitivity analysis.
  - Additional variations of train timing and other parameters would also slightly impact the overall queue demands. This exercise is intended to provide an example of how a selection of variables can impact the potential queue demand, however as stated above – the Illustrative Masterplan provides equivalent to or greater queue area than the existing scenario.
-

### 6.3 Queue arrangement without funnelling

The current queue arrangement deployed by THFC aims to avoid “funnelling” (narrowing in width of the queue).

It is noted that the existing arrangement does have a number of locations where funnelling occurs, for example at the locations highlighted below, including the pinchpoint from High Road on to White Hart Lane, from High Road on to Whitehall Street and within the Northbound queue itself.

This section demonstrates how the HRW Masterplan has the flexibility to implement different queue configurations and adapt as the crowd flow strategy is developed with stakeholders. Examples are provided only to illustrate this potential rather than to provide a recommended queue layout or design.



Figure 6-7 Existing crowds moving from High Road on to White Hart Lane at a point where the route narrows.



Figure 6-8 Existing pinchpoint from High Road to White Hart Lane

Funnelling was also noted at the head of the Southbound queue lane, shown in images below.

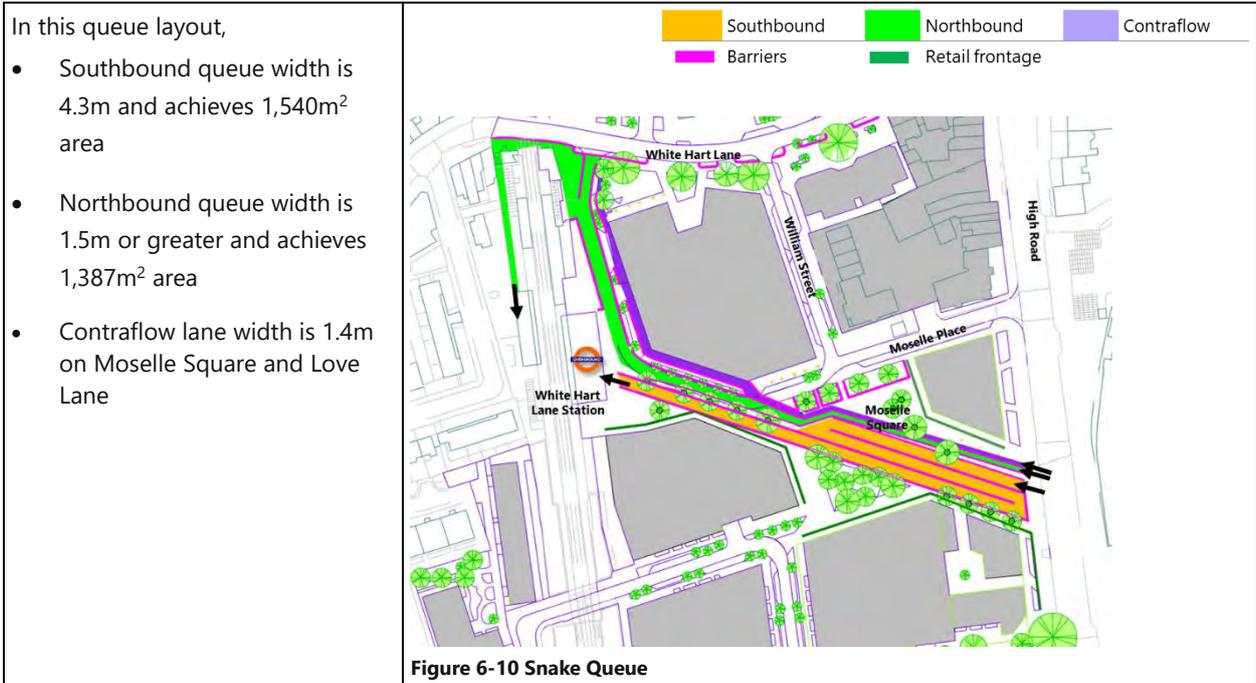


Figure 6-9 Existing crowds moving via Southbound lane towards White Hart Lane Station

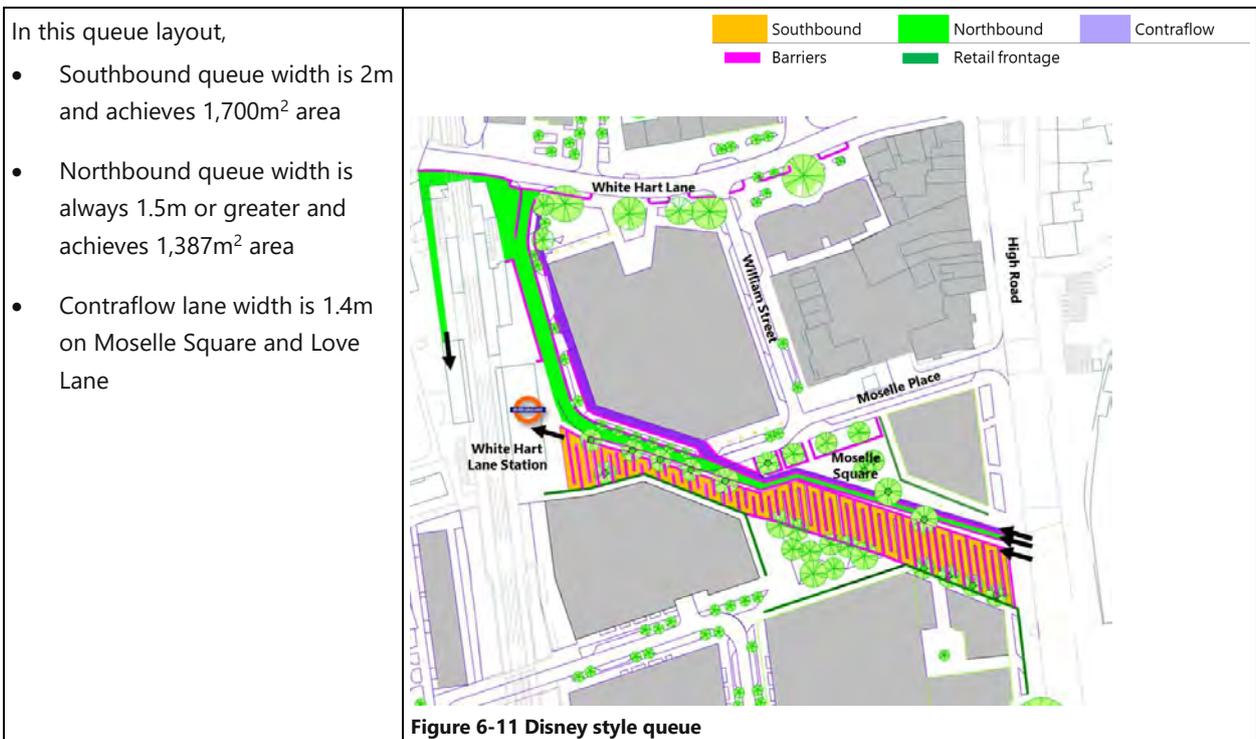
As the crowd is moving slowly within the queue barriers, some level of narrowing around pinchpoints is not considered a safety issue in this context, in particular as the crowd is heavily monitored and managed by stewards. However, provided below are alternative queue layout options within the Illustrative Masterplan which provide at least the equivalent amount of queue space as the existing scenario, and which avoid funnelling. A summary of the

advantages and disadvantages of these layouts are also provided below and demonstrate the ability of the Masterplan to be flexible and adapt as the crowd flow strategy is developed with stakeholders.

### 6.3.1 Option 1 – Snake queue



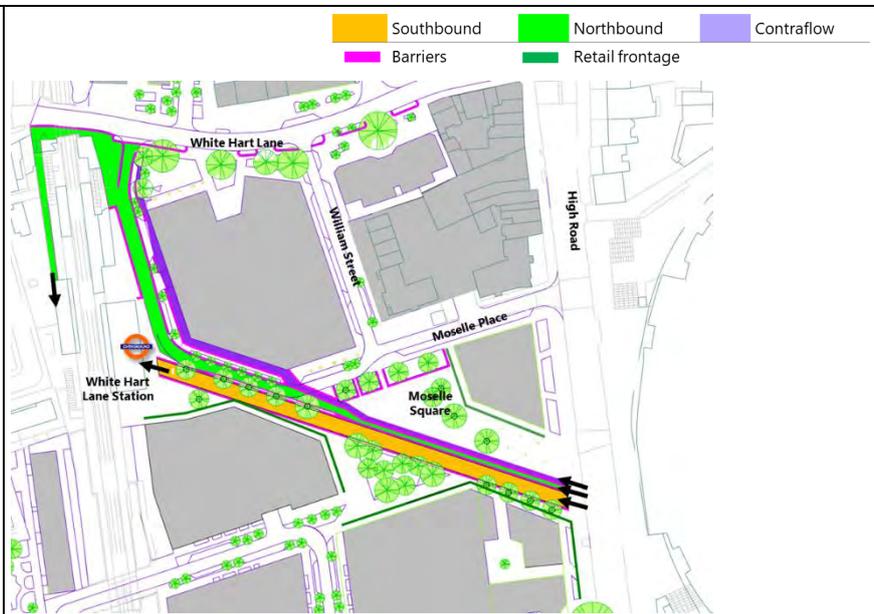
### 6.3.2 Option 2 – Disney style queue



### 6.3.3 Option 3 – Straight queue

In this queue layout,

- Southbound queue width is 5.8m and achieves 1,018m<sup>2</sup> area
- Northbound queue width is 1.5m or greater and achieves 1,396m<sup>2</sup> area
- Contraflow lane width is always 1.4m or greater



### 6.3.4 Summary of Queue arrangement options

The Illustrative Masterplan provides flexibility to allow queue area of variable size to accommodate spectators for various events. For example, the straight queue can be considered for a typical post-match egress while Disney style queue could be considered during the worst-case scenario such as a late finish after a cup game etc, though this would require more management. Overall, the increase in total available space allows for a range of options to be explored and agreed to provide the best solution for Residents and Stadium visitors.

The table below provides a high-level summary of the different queue layout options with no-funnelling. A few minor landscape changes (i.e., relocated trees) would be required in the Illustrative Masterplan to make these options work

**Table 6-4 Comparison of queue layouts**

	<b>Option 1 – Snake queue</b>	<b>Option 2 - Disney style</b>	<b>Option 3 – Straight queue</b>
Southbound area	1,540 m <sup>2</sup>	1,700 m <sup>2</sup>	1,018 m <sup>2</sup>
Northbound area	1,387 m <sup>2</sup>	1,387 m <sup>2</sup>	1,396 m <sup>2</sup>
Pros	Southbound queue can operate dynamically – i.e., the snake end is only required for peak period	Maximum area for Southbound - flexibility to increase further	<ul style="list-style-type: none"> <li>• Straight line access i.e., no angle change</li> <li>• More open space on Moselle Square</li> </ul>
Cons	<ul style="list-style-type: none"> <li>• Narrow point for Northbound on Love Lane (as existing)</li> <li>• Angle change on approach to all lanes</li> <li>• Reduced open space on Moselle Square</li> <li>• Up to 85m of queue length in the direction away from the station</li> </ul>	<ul style="list-style-type: none"> <li>• Lot of barriers for Southbound Lane – harder to dynamically manage and therefore the first and last spectators will need to walk around all the barriers</li> </ul>	<ul style="list-style-type: none"> <li>• Lower Southbound queue area compared to other options (but comparable to current provision)</li> <li>• Plot F frontage used by Contraflow</li> </ul>

#### 6.4 White Hart Lane Station – exit flows

During the site visit it was noted that there is minimal exit flow from White Hart Lane Station to the local area during the post-match egress period, particularly when spectators queue to enter the station. This exit flow is directed through the West facing exit of the station (Penshurst Road) by stewards and security present in the station.

In addition to the existing exit flow route mentioned above, the image below provides suggested indicative exit routes for people leaving White Hart Lane Station into the local area, to access their residences, retail facilities etc. during egress of spectators from Tottenham Stadium.. Stewards and directional signing would be needed to guide the spectators through the queue management system, particularly through the retail frontage of Plot D and through the barrier layout on Love Lane. Each plot will update this as it comes forward in Reserved Matters Applications.

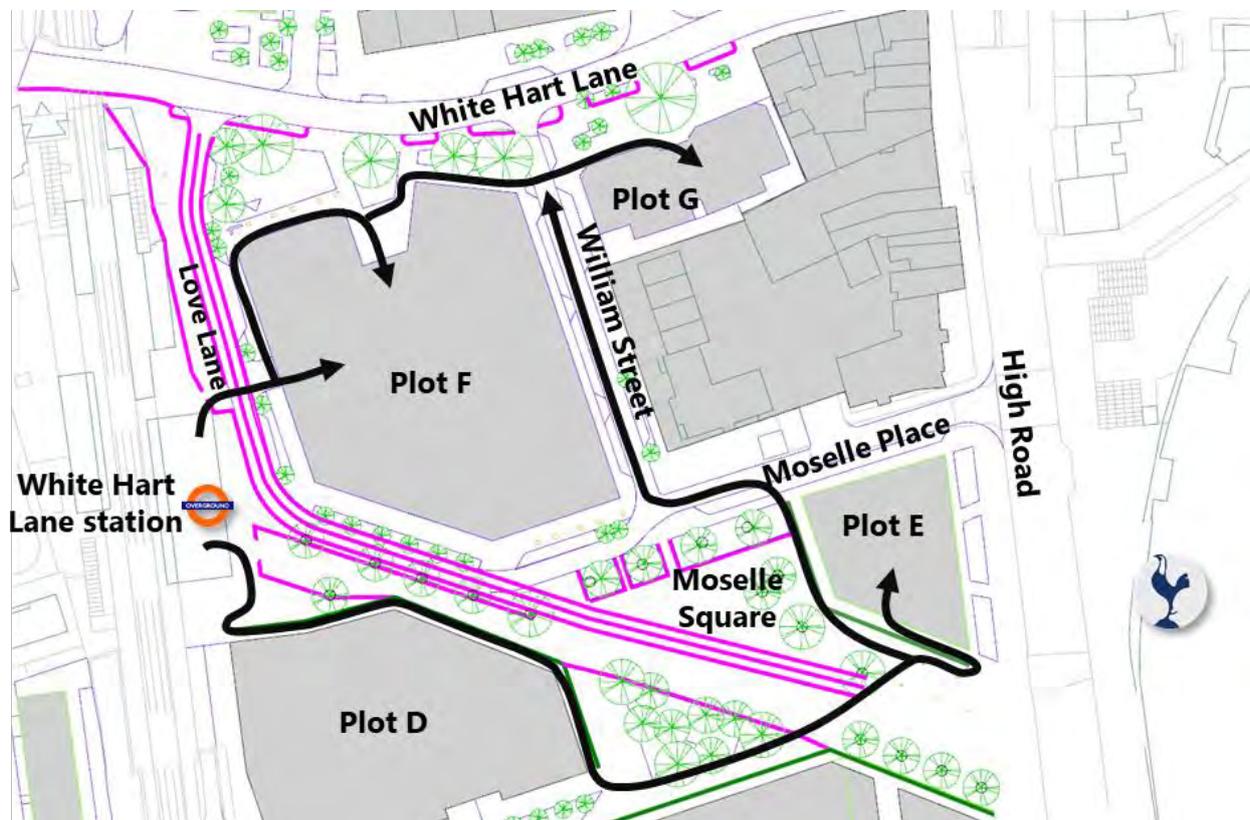


Figure 6-13 Proposed exit routes from White Hart Lane Station during post-match flows

## 6.5 Temporary Toilet locations

Any temporary toilets should be provided at locations which do not obstruct Tottenham Stadium spectator flow and queues to the White Hart Lane Station as well as circulation to adjacent residences. It will also help if the toilets are in a visible location. The heatmap below visualises the footfall during the post-match egress scenario considered.

- Moselle Square has space to accommodate dwelling people and toilets. This needs to be developed in detail with Haringey Council and Tottenham Stadium alongside Lendlease to ensure this works for all users and creates the best places.
- William Street and Moselle Street are closed off to spectators from Tottenham Hotspur Stadium as in the current scenario, while access is maintained for residential users.
- The highest footfall is along the approach to the Southbound platform of White Hart Lane Station, and this route should be dedicated for queueing and access only during post-match egress period (i.e. no additional street furniture along the route)

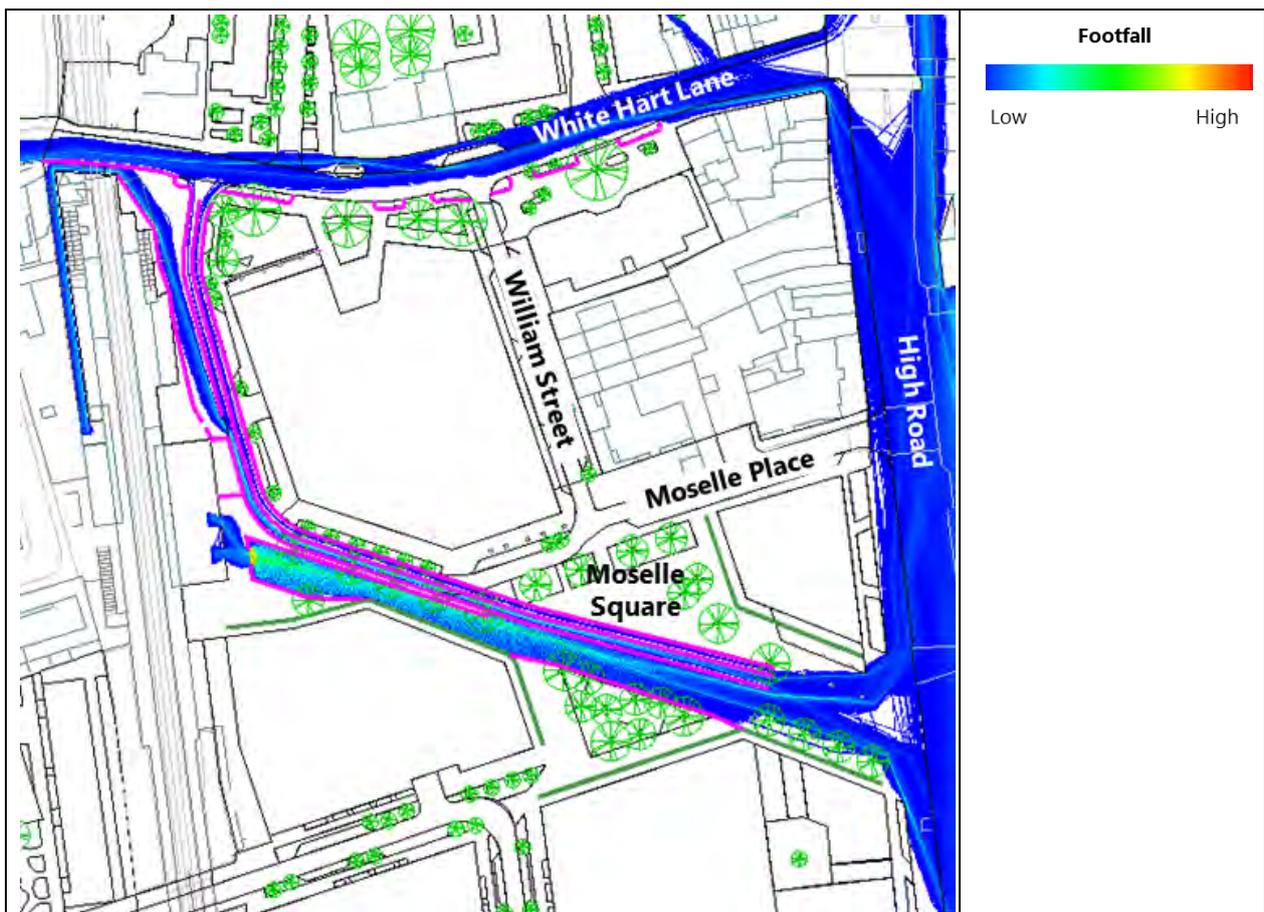


Figure 6-14 Footfall during the post-match egress

## 7 Crowd flow during construction phasing

The Crowd Flow team has carried out a high-level review of the construction phasing scenarios to examine the overall parameters to be targeted throughout the construction life-cycle of HRW. The indicative key southern phasing routes considered for the different construction phases is provided in images below. These Crowd Flow routes will be reviewed and updated with Lendlease and other stakeholders, as part of the Reserved Matters Application (RMA) process as well as in consultation with the Safety Advisory Group (SAG) at each key route change. The applicant has included more detailed phasing in the Construction Environmental Management Plans (CEMP) within the submission.

### Q3 2022 to Q2 2023

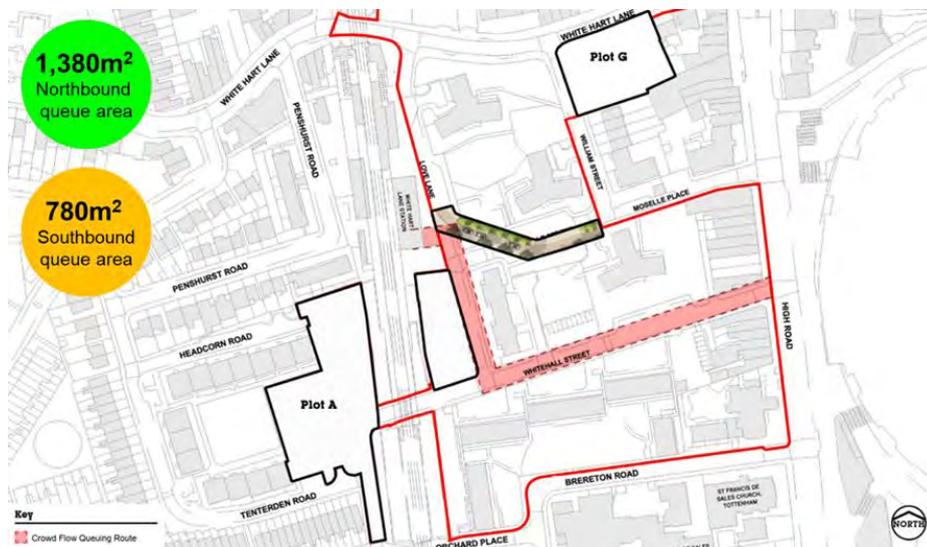


Figure 7-1 Crowd circulation route proposed during Q3 2022 to Q2 2023

### Q2 2023 to Q2 2025

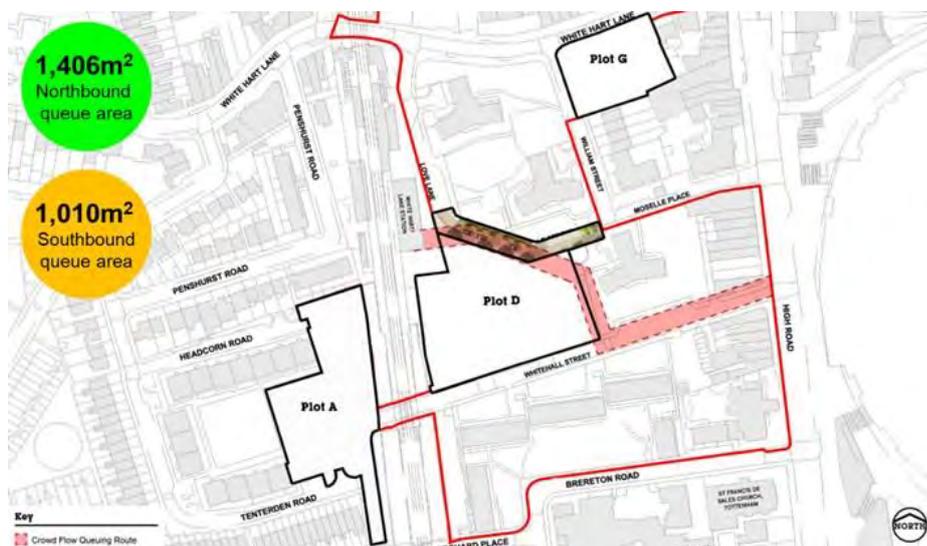


Figure 7-2 Crowd circulation route proposed during Q2 2023 to Q2 2025

Q2 2025 to Q3 2028



Figure 7-3 Crowd circulation route proposed during Q2 2025 to Q3 2028

Q3 2028 to Q1 2029



Figure 7-4 Crowd circulation route proposed during Q3 2028 to Q4 2030

**Q1 2029 to Q4 2029**



**Figure 7-5 Crowd circulation route proposed during Q1 2029 to Q4 2029**

**Q4 2029 to End-State**



**Figure 7-6 Crowd circulation route proposed during Q4 2029 to End-State**

## End-State



Figure 7-7 Crowd circulation route proposed during End-State

The effective width measured for the different lanes along Whitehall Street in the existing site are as follows:

- Southbound lane is 3.5 to 5m effective width, total 780m<sup>2</sup> area
- Northbound lane is ~1.5m effective width, total 1,380m<sup>2</sup> area
- Contraflow lane is ~1.4m effective width

## 7.1 Target parameters

The target considered for construction phasing is to provide at least the equivalent area and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days. These targets will be reviewed in detail in agreement with Lendlease and other stakeholders, as part of the Reserved Matters Application process. Provided below is an example of the construction phase for the Commencement of Plot D construction

- Southbound queue lane on Whitehall Street is maintained as per the existing provision, and a minimum width of 5m would be provided for the remaining length of Southbound queue lane up to White Hart Lane station. A minimum area of 780m<sup>2</sup> would be provided for Southbound queue to match the existing queue space available.
- Northbound queue lane on the approach to the station, on Love Lane and access from White Hart Lane is maintained as per the existing provision. A minimum area of 1,380m<sup>2</sup> would be provided for Northbound queue to match the existing queue space available. Additionally, a 1.5m wide lane would be provided alongside the Southbound Lane to accommodate Northbound travellers entering via Whitehall Street
- Similarly, a 1.4m wide contraflow lane would also be provided alongside the Southbound Lane.

The below figures demonstrate how the above parameters could be applied within the Plot D Construction Phasing, these would be reviewed at RMA and developed in consultation with the SAG.



Figure 7-8 Indicative crowd management during Plot D construction phasing

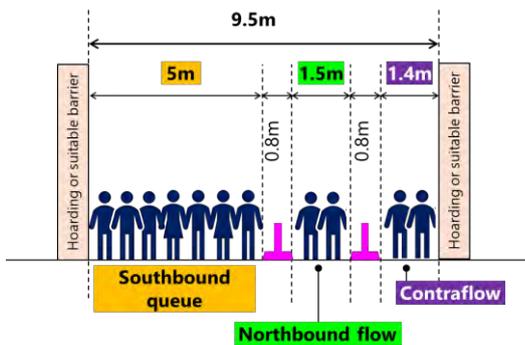


Figure 7-9 Indicative width of crowd management lanes during Plot D construction phasing

## **7.2 Additional requirements**

### **7.2.1 Circulation area**

The following changes would be required within the queue space indicated:

- Removal of landscape features including fences/ boundary walls, trees, signposts, lamp posts etc. which can potentially obstruct crowd flow and queue
- All circulation area should be made safe and accessible for crowd movements and queuing i.e. flat ground with minimum level difference, step-free access, free from trip hazard and should be anti-slippery material
- Sufficient lighting would be required along the circulation routes and queue spaces particularly for winter months when daylight is reduced
- Signs and stewards would be needed on High Road and the new-temporary queue arrangement to direct spectators to the right location. If digital signage is possible – live updates of rail facilities would help spectators make decisions and walk to adjacent station if queue times are longer than walking distance to adjacent station
- Appropriate road closures and parking suspension is required during pre-match arrivals and post-match departure period to make it safe for crowd movement and queuing.
- Passing places should be provided to allow two wheelchair users to pass each other. Passing places should also be provided at junctions (e.g. corners) along an access route. A passing place should be 2m long and 1.8m wide and located within direct sight of another passing place, or at a maximum distance of 25m from another, whichever is the closer (according to BS8300)

### **7.2.2 Contingency spaces**

- The existing Southbound queue lane area of 780m<sup>2</sup> can hold spectators queuing after a typical Football match at the Tottenham Stadium
  - In scenarios where spectators are expected to spill out of the queuing area provided e.g., for after a Boxing Event or Cup Game, High Road should be considered as Contingency area. THFC should plan for these within their Event Management plans
-

## 8 Summary and Recommendations

Buro Happold's Crowd Flow team has been appointed to review the High Road West (HRW) development Masterplan for crowd safety and management on major event days at Tottenham Hotspur Stadium and to facilitate efficient wayfinding throughout the site. Buro Happold's assessment has been based on the Masterplan Parameter plans and Illustrative Masterplan which has been prepared by Studio Egret West (SEW) and has been submitted as part of a hybrid planning application to the London Borough of Haringey (LBH).

The key assessment criteria for the Crowd Flow study is to ensure the HRW Masterplan provides at least equivalent areas and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days. Access for residents and a contraflow lane also need to be accommodated.

A high-level review of the minimum separation provided on main access routes / circulation areas in the Parameter plans shows that the Illustrative Masterplans would be able to meet the above assessment criteria, and accommodate the spatial requirements outlined in this report. A series of crowd flow dynamic modelling and sensitivity analysis is used to demonstrate how the crowd flow could work on event days within the Illustrative Masterplan and at the intermediate construction phases. These models and analysis are primarily to illustrate how the space could be operated, the ultimate acceptance criteria used is to ensure at least equivalent area and widths as the existing space are provided.

Overall, the proposed Masterplan will provide a better experience to all users and the provides following benefits compared to the existing site:

- ~55% to 90% increase in Southbound queue area on the illustrative layout compared to the existing site
- Illustrative Masterplan Northbound queue area is equivalent to the existing Northbound queue area
- 120% increase in width at narrowest point on Moselle Square compared to existing pinch point on Love Lane
- Flexibility to arrange queue lanes on Moselle Square or retain current queue configuration (i.e., Northbound queue along White Hart Lane)
- Space for additional through route to residences and retail, as well as contraflow lane
- Direct line of sight between Stadium and White Hart Lane Station
- Moselle Square provides flexibility i.e. can be used for queueing on event day and can used as a public realm on non-event days with retail provision around Moselle Square
- Built-In Security CCTV Estate management

### 8.1 Spatial requirements for HRW Masterplan

The following spatial requirements can be provided within the HRW Masterplan.

During the typical egress of Tottenham Stadium spectators, the following are recommended:

- High Road and White Hart Lane should be maintained closed to vehicular traffic to ensure safety of Tottenham Stadium spectators leaving the stadium.
  - The aim of the HRW Masterplan is to provide at least equivalent area and widths as the existing space for Northbound and Southbound queues to White Hart Lane Station on event days in the End-State Masterplan and Construction phasing:
-

- **Southbound:** Minimum area 780m<sup>2</sup>, minimum width 3.6m
- **Northbound flow:** Minimum area 1,380m<sup>2</sup>, minimum width 1.5m
- **Contraflow:** Minimum width 1.4m
- Passing places should be provided to allow two wheelchair users to pass each other.
- Access for emergency services and stewards should also be considered

## 8.2 Review of Existing Layout vs HRW Masterplan

The table below summarises the crowd flow review of the Existing and HRW Masterplan

	Existing Layout	HRW Masterplan
<b>THFC Queue management</b>	Observations of the site have highlighted that the Tottenham Stadium crowds are managed efficiently and safely on match days, however, there are potential opportunities to further enhance the crowd flow such as the bottleneck at the corner of White Hart Lane, whilst also maximising benefits for residents and users from the local community	The HRW Masterplan provides sufficient widths and flexibility to manage the Tottenham Stadium crowds using the existing queue management strategy but also creates greater safety and comfort for individuals, while allowing additional through-routes for access to retail for residents and wider community
<b>Circulation routes</b>	Pavement widths on White Hart Lane are restricted at certain places causing pinch points	Pinch points along WHL can be mitigated as Northbound platform users can be directed to White Hart Lane Station (WHLS) via Moselle Square
<b>Flexibility</b>	Existing site presents several challenges to crowd flow on match day <ul style="list-style-type: none"> <li>• Available pavement and road width on White Hart Lane and Whitehall Street are used for queuing</li> <li>• Spectators are not able to dwell on streets leading to White Hart Lane Station</li> <li>• Residential roads need to be closed off to traffic which disrupts the lives of residents during match time</li> </ul>	HRW Masterplan provides sufficient widths and flexibility <ul style="list-style-type: none"> <li>• Opportunity for the Northbound queue to be provided within Moselle Square next to the southbound queue or retain current queue configuration</li> <li>• Moselle Square provides a flexible space where people can dwell and interact on non-match days (activated by surrounding retail) but also can be adapted as an area to manage and direct crowds and queues on match day.</li> </ul>
<b>Wayfinding</b>	Tottenham Stadium is not visible from White Hart Lane Station (and vice versa). Some areas are poorly lit leading to a sense of insecurity	The route from Tottenham Stadium to White Hart Lane Station has a direct line of site – creating an impressive and welcoming experience for people arriving to the area and supporting wayfinding. Moselle Square provides a good opportunity for wayfinding and a large open space for stewards to assist people in joining the correct lane
<b>Security</b>	Pedestrian – Vehicular interface is reduced due to road closure, which enables pedestrians to freely flow the otherwise busy High Road and WHL. Temporary barriers are used to prevent vehicular traffic on closed roads	Existing road closure measures should be in place to ensure safety of all spectators. Bollards and other security measures would be incorporated into the layout to ensure safety of crowd within the Moselle Square and queueing area
<b>Retail</b>	White Hart Lane Station entrances and queuing area are not directly visible from retail spaces provided on High Road and White Hart Lane	Retail provision around Moselle Square provides improved opportunity for place activation due to its high visibility and proximity to high footfall routes
<b>Toilets</b>	Temporary Toilets are provided along Whitehall Street and can be easily accessed by Southbound travellers. However, these provisions are not directly visible or accessible for Northbound spectators using White Hart Lane	Moselle Square has space to accommodate a wider strategy which can create comfort for White Hart Lane Station users and others. Location for toilets can be reviewed in detail later, in coordination with stakeholders to ensure best place is created for all users as well as existing residents

### 8.3 Southbound queue lane

In summary, the Illustrative Masterplan (which reflects the Parameter Plans) provides a greater queue area and width for Southbound queue compared to the current site (see table below) and options are provided for different queue arrangements within the Illustrative Masterplan (Refer 6.3).

**Table 8-1 Summary of Southbound queue area**

	Area for Southbound queue	Capacity (0.65m <sup>2</sup> / person)	Capacity (0.5m <sup>2</sup> / person)
Existing queue provision	780 m <sup>2</sup>	1,200 people	1,560 people
Proposed	1,480 m <sup>2</sup>	2,280 people	2,960 people
Proposed Option 1 (Snake)	1,540 m <sup>2</sup>	2,370 people	3,080 people
Proposed Option 2 (Disney)	1,700 m <sup>2</sup>	2,615 people	3,400 people
Proposed Option 3 (Straight)	1,018 m <sup>2</sup>	1,565 people	2,035 people

### 8.4 Recommendations for HRW Masterplan

The recommendations for the post-event crowd management for HRW Masterplan are as follows. This is to be developed and agreed with London Borough of Haringey Council in consultation with THFC through the Reserved Matters Applications stage in relation to the part of the Masterplan which has been submitted for outline planning permission.

- 1 Access to William St and Moselle Place could be restricted to local residents only. This will help channel spectators to the 3-queue lanes via Moselle Square
- 2 Comfort areas and other facilities for spectators, including directional signing and information, can be placed in Moselle Square which would be visible to all White Hart Lane Station users. This can be reviewed in detail later, in coordination with stakeholders to ensure best place is created for all stakeholders
- 3 Barriers to be maintained around all planting (including rain garden planting) to protect them



**Figure 8-1 Recommendations on the Illustrative Masterplan**

## 8.5 Next Steps

- The Crowd Flow team is happy to work with London Borough of Haringey, THFC and Lendlease to develop the HRW Masterplan requirements for crowd safety and better experience and to provide intuitive wayfinding.
  - The parameters used in the study are based on the publicly available data and documentation at time of writing. The analysis within this report can be updated to reflect any updated data, should this be made available and provide additional information than what is currently accessible. Sensitivity analysis is also conducted to demonstrate the impact on the performance of the site with respect to a number of crowd flow parameters.
  - A detailed review of the crowd flow through the Masterplan for the different construction phases will be carried out, with agreement with Lendlease and other stakeholders, as part of the Reserved Matters Application process.
  - A detailed review of the parameter plans with landscape details (if different to the Illustrative Masterplan) is recommended to finalise the crowd flow requirements and operational strategy as the design develops within the framework of the application and delivery of HRW, and Reserved Matters Applications are submitted.
-

# Appendix A Detailed Crowd Flow data

## A.1 Reference documents

The following documents have been referred to in this study:

- 1 HGY/2016/2573 – Committee report for 10-10-2016 meeting (accessed from Haringey planning portal - link)
  - 2 A review of a Crowd Safety Options Appraisal; Dr Dickie.J.K; October 9th 2015 (accessed from Haringey planning portal - link)
  - 3 Blue-book (provided by Lendlease)
  - 4 Jim Dickie Crowd Movement Moselle Square and Tottenham Hotspur Stadium (provided by Lendlease)
  - 5 TA Report (major event day) – 2015 (accessed from Haringey planning portal - link)
  - 6 SM\_THFC\_BOXING\_LAMP\_13.09.21\_V10.0 - FINAL-compressed (provided by Lendlease)
  - 7 Transport Plan for AJ Final Report 130921 (provided by Lendlease)
  - 8 Design Parameters Station-Stadium Link 1.1 July 2016 (provided by Lendlease)
  - 9 Matchday Demand Forecast Assumptions Data Book, Movement Strategies (accessed from Haringey planning portal – link)
  - 10 NFL Scenario – Assumptions Data Book, Movement Strategies (accessed from Haringey planning portal – link)
  - 11 THFC New Stadium Rail Capacity Analysis, Movement Strategies (accessed from Haringey planning portal – link)
  - 12 THFC New Stadium – NFL scenario Rail Capacity Analysis, Movement Strategies (accessed from Haringey planning portal – link)
  - 13 Indicative Station Crowd Management assessments at WHL, NP, TH and SS stations, Tim Spencer & Co. (accessed from Haringey planning portal – link)
  - 14 TA Station Queue Visualisations 2015, Tim Spencer & Co. (accessed from Haringey planning portal – link)
  - 15 Meeting with Tim Spencer, THFC, Haringey Council dated 29 November 2021
  - 16 [2021 NFL London Games at Tottenham Hotspur Stadium](#)
  - 17 Ground floor plan and Platform plan – New Station building Ref: HGY/2016/2573 (accessed from Haringey planning portal – link)
  - 18 Meeting with Haringey Council dated 02 February 2022
  - 19 Meeting with Tim Spencer, THFC, Haringey Council dated 11 February 2022
  - 20 Email from Steer dated 03022022
-

## A.2 Modal Split

Modal split for Premier League and NFL matches from Reference document 9 - Matchday Demand Forecast Assumptions Data Book by Movement Strategies and Reference document 5 - TA Report (major event day) by Tim Spencer & Co. is summarised below

### A.2.1 Premier League

Table Appendix A - 1 Modal split on departures after Premier League matches <sup>9</sup>

	Midweek			Weekend		
	Home fans (95.08%)	Away fans (4.92%)	Total	Home fans (94.84%)	Away fans (5.16%)	Total
Coach	1.5%	16.0%	2.2%	1.9%	15.9%	2.6%
Local Bus	8.0%	13.0%	8.2%	7.7%	13.2%	8.0%
Taxi	1.5%	0.0%	1.4%	1.5%	0.0%	1.4%
Walk	3.0%	0.0%	2.9%	3.0%	0.0%	2.8%
Cycle	1.0%	0.0%	1.0%	1.0%	0.0%	0.9%
Rail from WHL	20.0%	26.5%	20.3%	19.4%	26.5%	19.8%
Rail from NP	14.0%	8.5%	13.7%	13.9%	8.5%	13.6%
Walk to SS	10.5%	22.5%	11.1%	10.9%	22.4%	11.5%
Walk to TH	9.5%	2.5%	9.2%	9.9%	2.5%	9.6%
Car	23.0%	11.0%	22.4%	22.4%	11.0%	21.8%
Motorcycle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shuttle Bus	8.0%	0.0%	7.6%	8.4%	0.0%	8.0%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

### A.2.2 NFL

Table Appendix A - 2 Modal split on departures after NFL matches <sup>9</sup>

	Leaves directly	Stays in Local area	Total
Cycle	0.80%	0.20%	1.0%
Walk	1.20%	0.30%	1.5%
Walk to SS Tube	11.20%	2.80%	14.0%
Bus to SS Tube	2.4%	0.6%	3.0%
Rail from WHL	15.20%	3.80%	19.0%
Rail from NP	13.60%	3.40%	17.0%
Car	12.00%	3.00%	15.0%
Bus	1.6%	0.4%	2.0%
Coach	4.00%	1.00%	5.0%
Taxi	1.20%	0.30%	1.5%
AP Shuttle Bus	4.00%	1.00%	5.0%
TH Shuttle Bus	2.69%	0.34%	3.03%

Walk to TH tube	9.60%	2.40%	12.0%
<b>Total</b>	<b>79.5%</b>	<b>19.5%</b>	<b>99.03%</b>

### A.3 Modal characteristics

Modal characteristics for Premier League and NFL spectators during post-match egress based on Reference document 9 - Matchday Demand Forecast Assumptions Data Book, Movement Strategies is summarised below

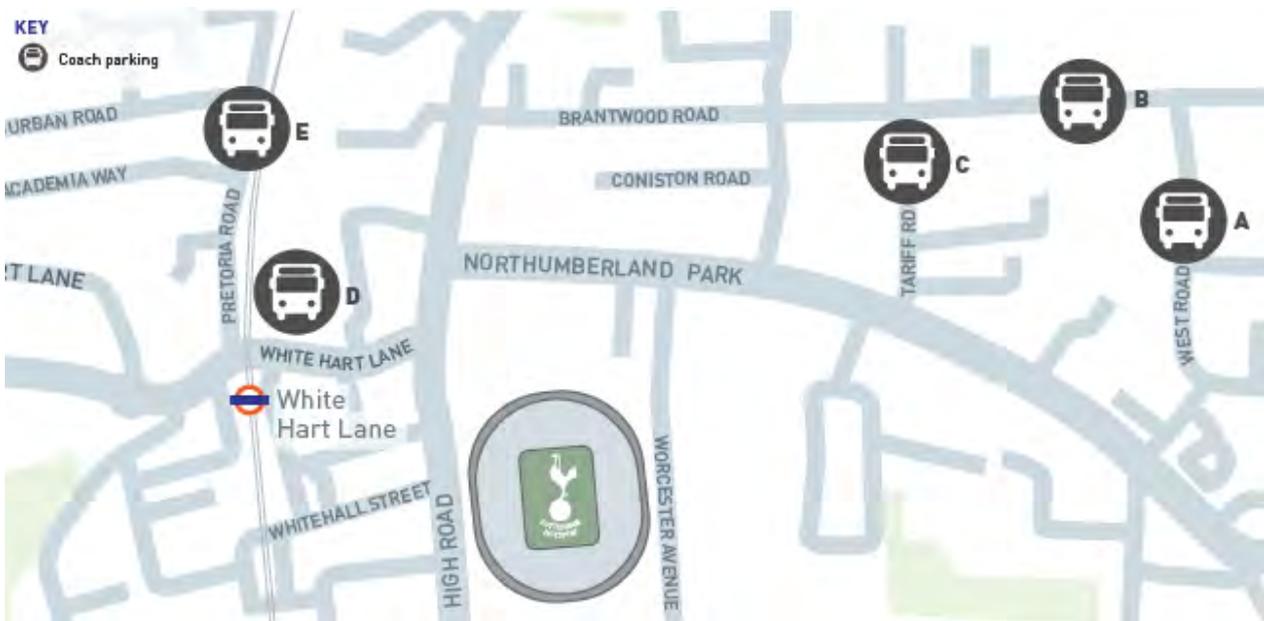
#### A.3.1 Coach users

Reference document number 3: Blue-book mentions that Coach Park in Zone E will likely only be used when over 40 coaches are expected. Zone D is also a temporary location for the first season and is subject to change.

Based on the above information, the following Coach Demand is assumed for spectators wanting to use coaches after a match at the THFC stadium. Coach stops D and E are considered for NFL only since the coach demand is higher for NFL matches compared to Premier League matches

**Table Appendix A - 3 Coach demand during post-match egress**

	Premier League	NFL
Coach stops A, B, C – NE side of Stadium	100% spectators	80% spectators
Coach stops D, E - West		20% spectators



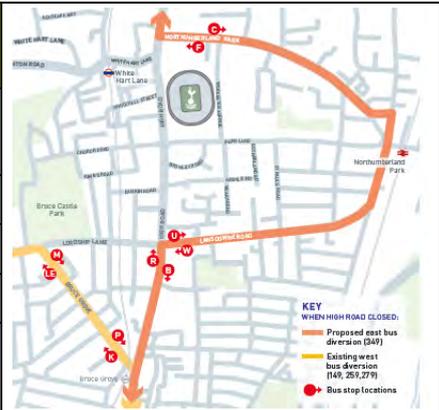
**Figure Appendix A - 1 Coach Park locations based on reference document number 3: Blue-book**

### A.3.2 Local Bus users

Following proportion of Local Bus demand attributed to each stop is considered during post-match egress after a Premier League or NFL match <sup>9</sup>

Table Appendix A - 4 Local Bus demand during post-match egress

Bus Route	Bus Stop	Proportion of Demand	Direction of travel assumed in HRW Masterplan study
149, 259, 279, 349	R, V	55.2%	South
W3	T, U	10.5%	South
318, 341, 476	E, F	13.2%	North
123, 243, W4	J, H	15.8%	South
34, 444	North circular	5.3%	North



### A.3.3 Taxi

According to reference document number 3: Blue-book, a secured a new, temporary, event day black taxi rank at Scotland Green, which will operate during event day hours. This means spectators would have to walk South after a match at the THFC stadium

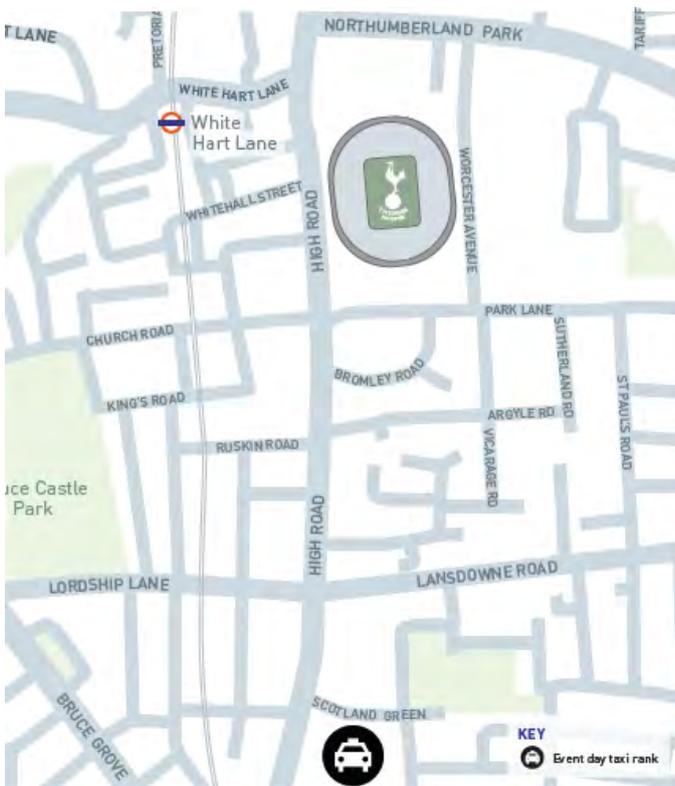


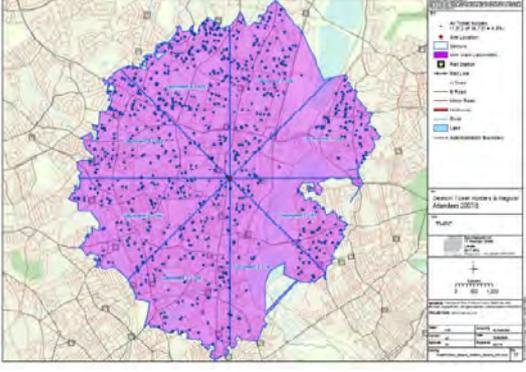
Figure Appendix A - 2 Event day taxi rank location, based on reference document number 3: Blue-book

### A.3.4 Walk

The following proportion of Walk Demand is attributed to each sector is considered during post-match egress after Premier League and NFL matches <sup>9</sup>

**Table Appendix A - 5 Walk demand during post-match egress**

Sector	Proportion of Demand	Direction of travel assumed in HRW Masterplan study
NNE	14.4%	North
ENE	11.4%	East
ESE	5.0%	South
SSE	4.2%	South
SSW	12.3%	South
WSW	10.8%	South
WNW	18.3%	West
NNW	23.6%	50-50 West - North



From the above table it is summarised that for spectators who walk after a match at the THFC stadium

- 30.1% depart via West
- 26.2% depart via North
- 11.4% depart via East
- 32.3% depart via South

### A.3.5 Car users

Following proportion of Car demand attributed to each zone is considered during post-match egress after a Premier League and NFL matches <sup>9</sup>

**Table Appendix A - 6 Car demand during post-match egress**

Sector	Proportion of Demand	Direction of travel assumed in HRW Masterplan study
Zone 1	15.3%	West
Zone 2	26.4%	North
Zone 3	7.8%	East
Zone 4	12.5%	South
Zone 5	26.7%	South
Zone 6	5.5%	South
Zone 7	1.8%	South
Zone 8	3.5%	South
Zone 9	0.5%	South



From the above table it is summarised that for spectators who walk after a match at the THFC stadium

- 15.3% depart via West
- 26.4% depart via North
- 7.8% depart via East
- 50.5% depart via South

### A.3.6 Shuttle Bus users

For spectators travelling by shuttle bus service after a Premier League or NFL match at the THFC stadium, the following proportion split is assumed <sup>9</sup>

- 40% arrive/depart via Tottenham Hale
- 60% arrive/depart via Alexandra Park

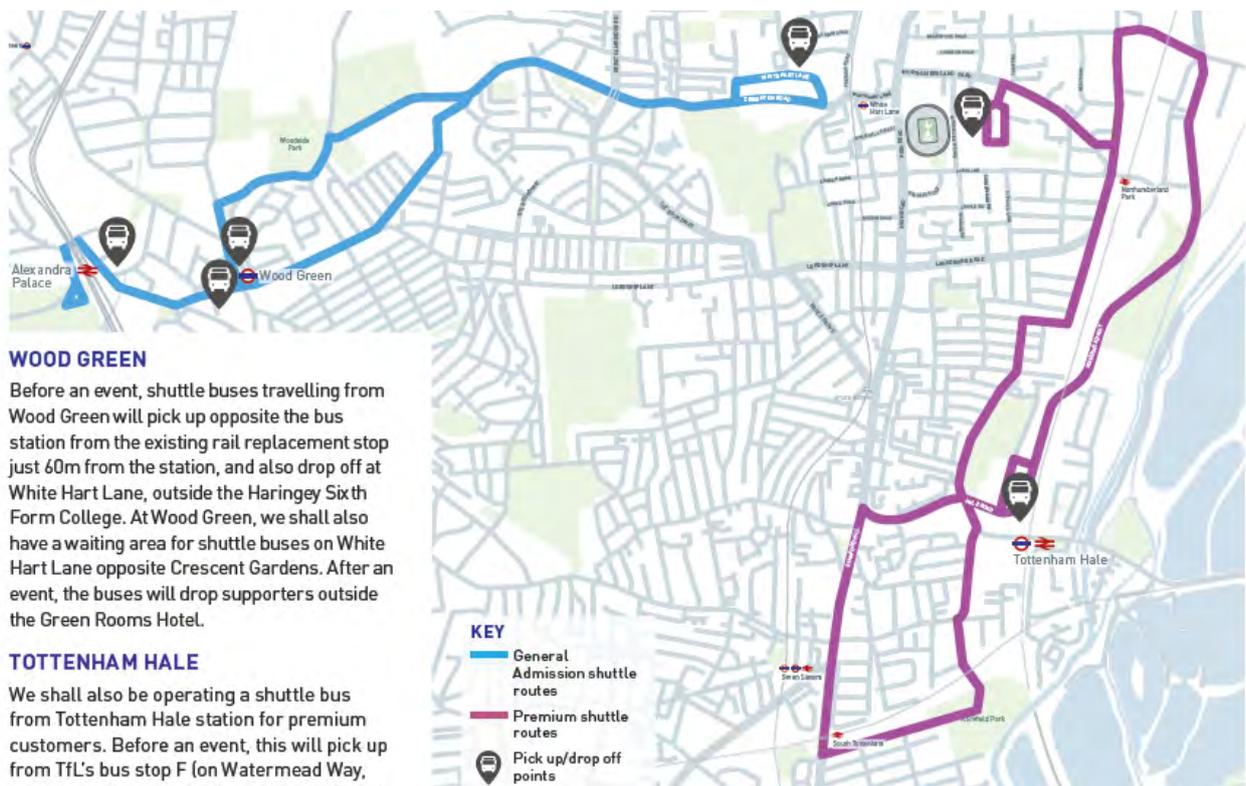


Figure Appendix A - 3 Shuttle bus routes based on reference document number 3: Blue-book

## A.4 THFC transport guide

Following image provides a holistic view of the locations for the different modes of transport including overground and underground stations, local bus stops, shuttle bus location, coach park locations and main walking routes from THFC stadium. Image taken from website: SM\_THFC\_HighLevelOverview\_gatenumbers\_LIGHT\_1.10.18 - FINAL (tottenhamhotspur.com)



Figure Appendix A - 4 THFC transport guide

## Appendix B Detailed Site visit Summary

### B.1 Whitehall Street and Love Lane

- 3- separate lanes were noted on Whitehall Street – Southbound queue lane, Northbound queue lane and a lane to facilitate contraflow on all site survey days
- The width of the north bound queue varied from 1.8m to 3.5m. Lower footfall was seen through this lane.
- Southbound queue width was max. 5.2m. This allowed 10 -12 persons wide queues within the barriers. Funnelling was noted at the head of the Southbound lane (closer to the East Entrance of White Hart Lane Station)
- Southbound queue occupied Love Lane and Whitehall Street and extended up to the locations indicated below

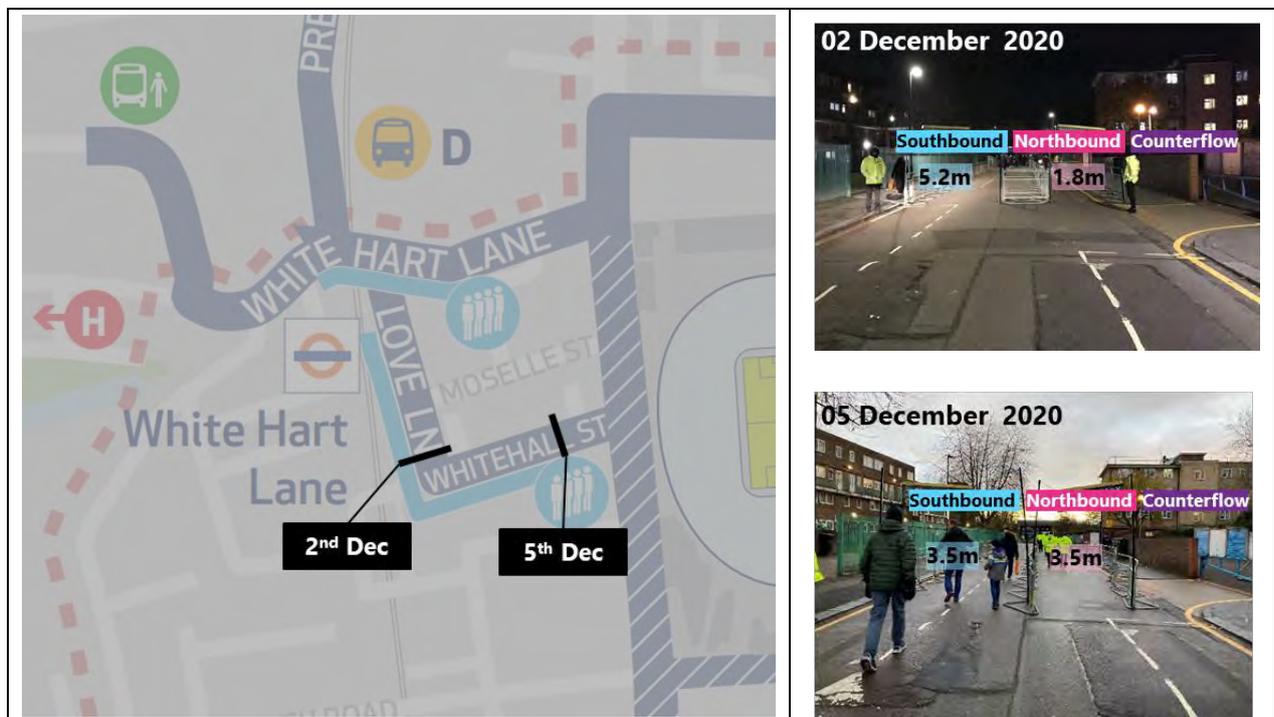


Figure Appendix A - 5 Extent of queue observed on Whitehall Street during site visit

### B.2 White Hart Lane

- Flow of Tottenham Hotspur Stadium spectators towards Northbound platform arrive from White Hart Lane. The barriers along White Hart Lane allow towards Northbound platform and Whitehall Street / Love Lane estate
- 2- separate lanes were noted on White Hart Lane – North / Southbound queue lane. White Hart Lane was used by spectators travelling further West. Road was pedestrianised 10 minutes before final whistle.

- The width of the North / Southbound queue was 1.8m. Very low footfall was observed for fans using the Southbound queue.

### B.3 Queuing area available

Southbound queuing area available is ~780m<sup>2</sup>; Northbound queuing area available is ~1,380m<sup>2</sup>

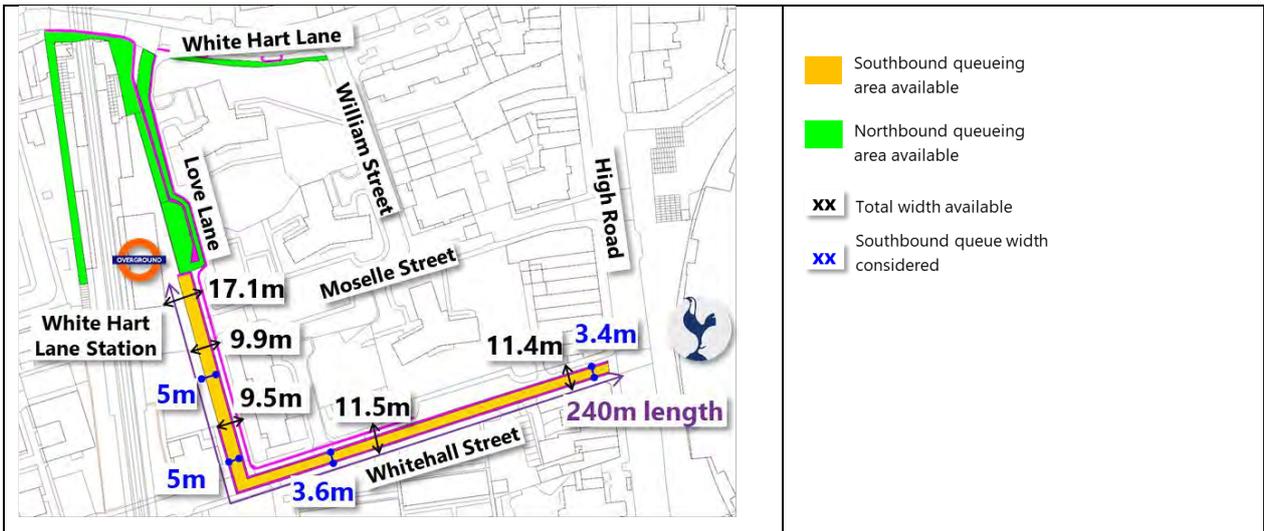
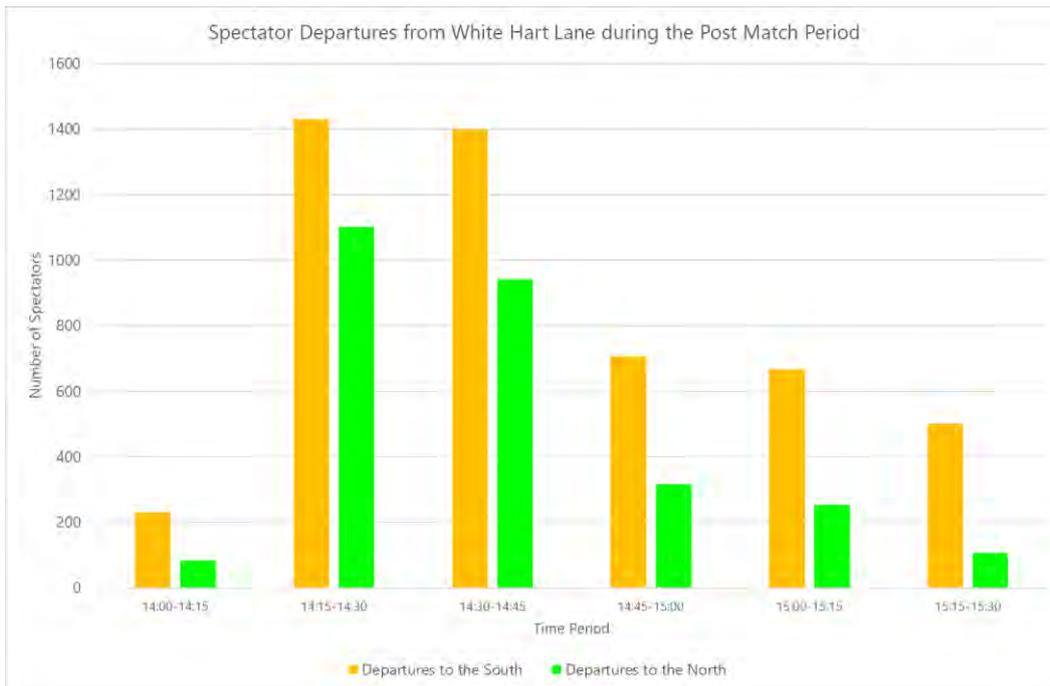


Figure Appendix A - 6 Total width available on existing site (based on site observations)

### B.4 Departure profile

The graph below shows the rate at which people join the Southbound queue lane on Whitehall Street and Northbound entrance on White Hart Lane, captured on 16<sup>th</sup> April 2022, Full time at 14:25.

- Total Southbound users – 4,936 (8.4%)
- Total Northbound users – 2,803 (4.8%)



**Figure Appendix A - 7 Departure profile captured on 16<sup>th</sup> April**

### **B.5 Train timings and duration**

- There were roughly 4 to 5 trains per hour per platform
- Average dwell time of trains:
  - On Northbound platform is 60 to 90 seconds, except for a train that dwell longer (approximately 4 minutes) as it was waiting for the arrival of a Southbound train on the adjacent platform
  - On Southbound platform is 90 to 120 seconds, within a range of 75 to 195 seconds
- Intervals between trains:
  - Shortest interval between Northbound trains was ~4 minutes and longest interval was ~26 minutes. Most trains arrived every 15 minutes
  - Shortest interval between Southbound trains was ~6 minutes and longest interval was ~16 minutes. Most trains arrived every 15 minutes

### **B.6 Southbound platform users / queue on match days:**

- Frequency of southbound Overground trains and the station platform have limited capacity to accommodate the demand of Premier League spectators leaving the stadium after a match, hence people queued outside the station
- Spectators for the Southbound platform queue along Love Lane and Whitehall Street, to enter the station from the East entrance.

- Stewards use red / green signs to indicate when people can enter the station, the flow is stopped once the platform is full and the crowd is held back until the platform is cleared.



Figure Appendix A - 8 Queue and stewards outside White Hart Lane Station - East Entrance, Images captured during site visit

### B.7 Northbound platform users / queue on match days:

- It was observed that demand for northbound Overground trains after a Premier League match at the stadium is lower than the demand for southbound Overground trains. This demand can usually be accommodated within the frequency of northbound trains and the station platform capacity, with minimal queueing outside the station.
- Northbound passengers move along White Hart Lane towards the West side of White Hart Lane Station and enter the station from North facing entrance.
- The club deploys crowd management along White Hart Lane that allows queuing on West side of the station and back along White Hart Lane. Road is closed for vehicular traffic 10 minutes before final whistle and for 60 minutes after the final whistle.



Figure Appendix A - 9 Flow on White Hart Lane towards Northbound platform, Images captured during site visit

## B.8 Pedestrian Circulation routes

Key routes through the Masterplan including High Road, Whitehall Street, White Hart Lane, Love Lane are pedestrian only 15-minutes prior to final whistle and for 60 to 90-minutes during post-match egress. Temporary Vehicle barriers are deployed and staffed by stewards.

Image here is taken for the weblink: [2021 NFL London Games at Tottenham Hotspur Stadium](#)<sup>16</sup>



Figure B-1 Roads closed for Vehicular traffic, based NFL 2021 data

## B.9 Security

Temporary barriers are used for road closure on High Road, White Hart Lane, Whitehall Street and Moselle Place. Stewards manage the area to divert vehicles and pedestrians. Permanent fixtures are not provided since these roads are used on non-match days to access local streets.

A detailed assessment of the security requirements and threat levels has been carried out by Buro Happold's security team for the HRW Masterplan.





Figure B-2 Temporary barriers used for road closure, images captured during site visit

## B.10 Existing challenges and opportunities

Layout of the existing site presents several challenges to pedestrian movement in particular crowd flow on match day.

- Residential roads need to be closed off to traffic which disrupts the lives of residents during match time
- The crowd management strategy on match day directs Northbound and Southbound spectators for White Hart Lane Station to queue along available pavement and road width on White Hart Lane and Whitehall Street respectively. Stewards and barrier layout enables efficient and safe management of the crowd
- Long Southbound queue was noted for the weekend match, though the Stadium was not at full capacity, and the current environs is not particularly pleasant to queue in
- The current widths available mean the queue system needs to occupy the entire width of Whitehall Street. It is therefore challenging for Spectators to dwell on the streets leading to White Hart Lane Station post-match (e.g. meeting friends) as it is likely to obstruct circulation and queuing areas
- Pavement widths on White Hart Lane are restricted at certain places causing pinch points
- The stadium is not visible from the station (and vice versa) and some areas are poorly lit leading to a sense of insecurity. The design team can work together with the THFC team to improve the existing situation
- There is a lack of visibility of the White Hart Lane Station entrance from the main roads and back of queue in particular for Northbound passengers
- Retail spaces are provided on High Road and White Hart Lane. There is no direct visibility to the queueing area and White Hart Lane Station entrances from retail spaces
- Temporary Toilets are provided along Whitehall Street and can be easily accessed by Southbound travellers. However, this is not directly visible or accessible for Northbound spectators using White Hart Lane

# Appendix C Departure Profiles

Details of the departure profiles considered for the different events are as follows



# Appendix D Platform Loading and Capacity

## D.1 Northbound:

Platform capacity is limited to a full train load i.e., 1,161 people. Excess queue will wait outside the station. Northbound platform loading rate is assumed as follows:

- Walkway – All Northbound spectators pass through a 2m wide walkway<sup>17</sup>. Considering flow rate of LoS C/D = 49p/m/min, number of people passing the walkway would be 98 people per minute
- Stairs – 2 stairs of 2.3m and 2.9m width. Considering flow rate of 35p/m/min (based of London Underground criteria for one-way flow on stair), number of people entering the platform would be 182 people per minute
- The above flow rates show that the rate at which the Northbound platform will be filled will be based on the flow through the 2m walkway i.e., 98 people per minute

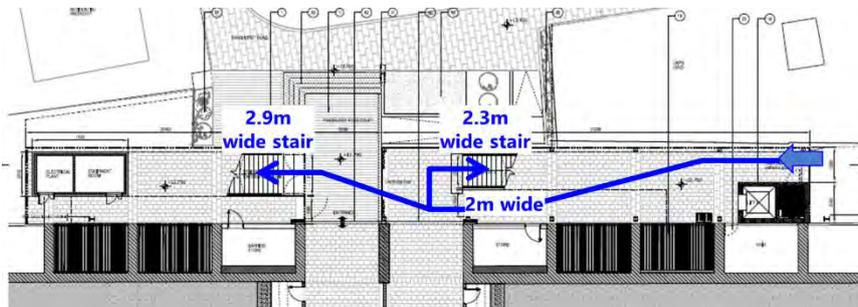


Figure D-1 Flow of spectators to Northbound platform

## D.2 Southbound:

Platform capacity is limited to train's loading capacity i.e., 1,045 people per minute. Excess queue will wait outside the station. Southbound Platform loading rate is assumed as follows:

- Entrance – 2 doors of 2.3m width each <sup>17</sup>. Considering flow rate of LoS C/D = 49p/m/min, number of people entering the station would be 225 people per minute
- Stairs – 2 stairs of 2.3m and 2.9m width. Considering flow rate of 35p/m/min (based of London Underground criteria for one-way flow on stair), number of people entering the platform would be 182 people per minute
- The above flow rates show that the rate at which the Southbound platform will be filled, will be based on the flow through the stairs i.e., 182 people per minute

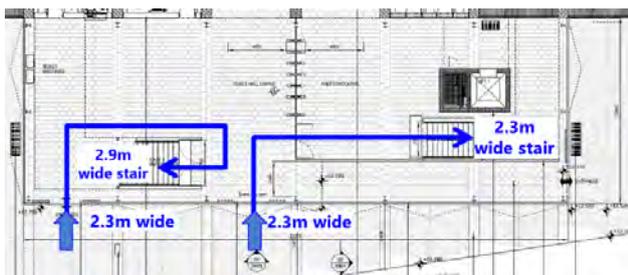


Figure D-2 Flow of spectators to Southbound platform

# Appendix E High Level Review of HRW Masterplan

## E.1 Circulation routes and decision points

- The Masterplan has primary and secondary circulation routes, providing good permeability and flexibility to circulate
- High Road and White Hart Lane provide the primary movement routes for vehicles and pedestrians, and Moselle Square is a primary pedestrian route
- The proposed Masterplan, particularly the Southern part provides good connectivity between the residences, retail, White Hart Lane Station and bus stops.
- The route from White Hart Lane Station to the Tottenham Hotspur Stadium provides a direct link between these two key elements.
- Wayfinding cues including signing should be provided at key decision points to direct users to the key destinations.

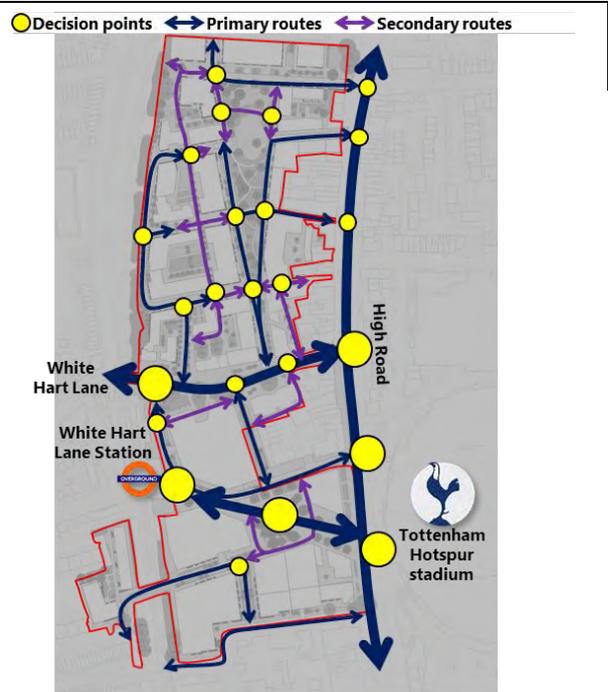


Figure E-1 Circulation routes and key decision points

## E.2 Connectivity to Landscape and retail spaces

- Existing and new planting spread across the Masterplan helps the local community to connect with nature. Crowd flow analysis shown previously in this report has taken in to account the illustrative planting and ensures the effective widths provided are sufficient for safe movement and comfortable queuing.
- Two major open spaces, one each at the North and South of White Hart Lane helps with placemaking and makes a lively and healthy destination for local community and visitors. The use of the spaces can be customised as per local community needs e.g. Moselle Square can be a park/ food court during typical days while used as a through route/ queuing area for match days.
- Retail spaces are mainly proposed near Moselle Square and White Hart Lane Station – two busy spots in the Masterplan particularly during match days at Tottenham Hotspur Stadium. These provide opportunities to increase retail visitation.

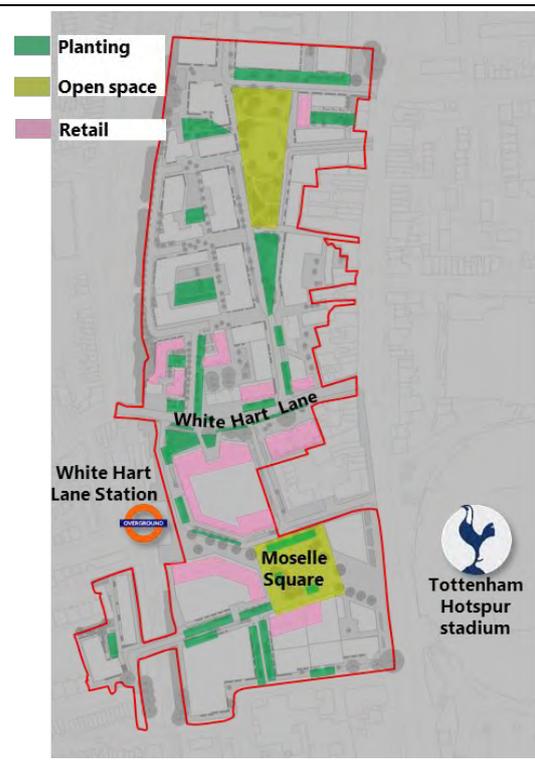


Figure E-2 Planting and Open space

### E.3 Walking distance

All locations within the Masterplan are accessible within 10 minutes from WHLS and from Tottenham Stadium. The spread of retail allows people to reach a retail location within 5 minutes from their residences, stadium or WHLS.

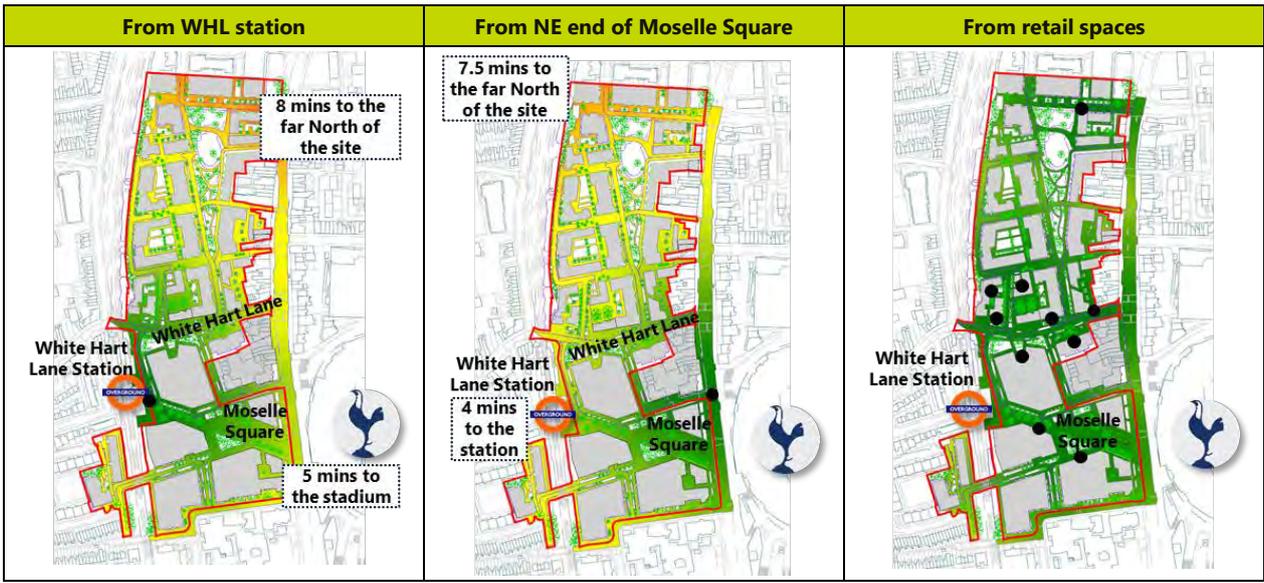


Figure E-3 Walking distance analysis

## E.4 Visibility analysis

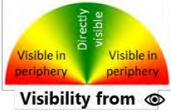
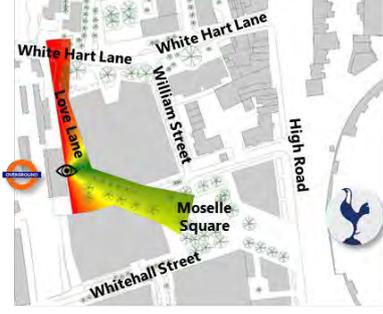
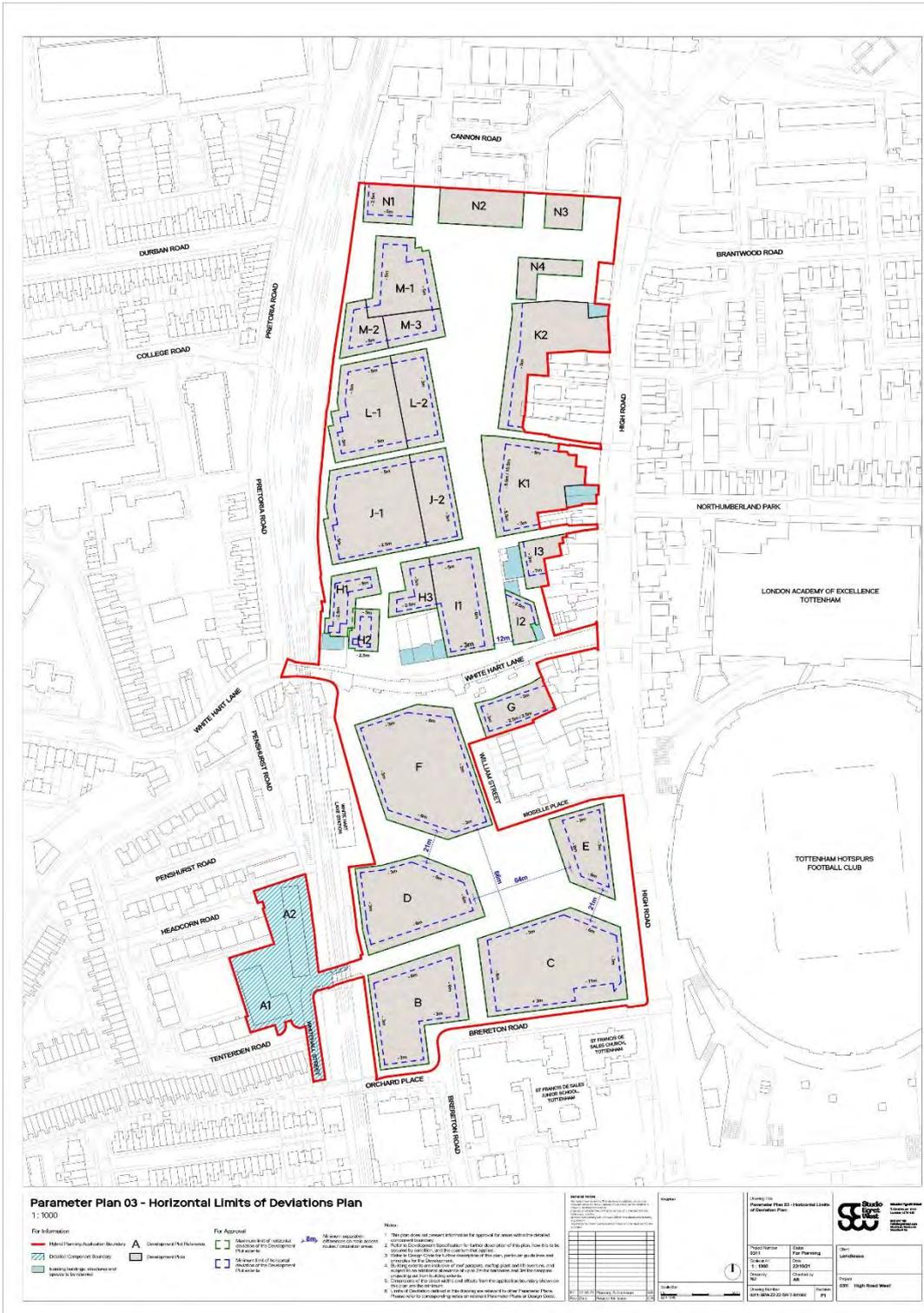
<p>In the existing layout, the Stadium is not visible from the Station (and vice versa). To illustrate the improvements in the Masterplan, the images below show what visitors and spectators can see from each location</p>		
<p><b>From White Hart Lane Station</b></p>	<p><b>From SE end of Moselle Square</b></p>	<p><b>From White Hart Lane</b></p>
		
<p>Good visibility from White Hart Lane Station exits towards Moselle Square and towards Tottenham Stadium. This helps with intuitive wayfinding, for people to follow the routing within Moselle Square</p>	<p>Good visibility from SE end of Moselle Square towards White Hart Lane Station. Signing and stewards would be required to direct spectators to the barrier system on Moselle Square.</p>	<p>As in the existing situation, the approach to White Hart Lane Station is visible as spectators reach the junction between Love Lane and White Hart Lane. Existing wayfinding strategy using signing and stewards is required in the proposed Masterplan to direct people to Love Lane and WHLS from White Hart Lane.</p>

Figure E-4 Visibility analysis

# Appendix F 0311-SEW-ZZ-ZZ-DR-T-001003 (Horizontal Limits of Deviations Plan)





# Appendix H 0311-SEW-ZZ-ZZ-SK-SK-001193 (Illustrative HRW Masterplan)



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