

Etihad Stadium Post-Implementation Ingress Review



Introduction

Manchester City Football Club (MCFC or ‘the Club’) had engaged Movement Strategies (MS) to provide a critical review of two key elements of the Etihad Stadium, namely: **Ingress into the stadium**, and **Food and Beverage (F&B) concessions** on level 1 and level 3 concourses.

The first phase of the study involved a review of the existing arrangements to identify possible issues and opportunities, and propose enhancement solutions. Findings and recommendations of the initial study are summarised in the following two reports that are referred to throughout this document:

- Ingress Review; ‘12581164 - MCFC Etihad Stadium - F&B Concessions Review_1.0.pdf’
- Concessions Review; ‘12581164 - MCFC Etihad Stadium – Ingress Review_1.0.pdf’

The Club made a number of changes to the ingress process and concessions based on the recommendations outlined in the two reports, and has asked MS to undertake a follow-up study (Phase 2) to:

- Assess the impact of these interventions on the performance of the processes.
- Provide further recommendations for improvement of the systems, if appropriate.
- Identify areas where a rollout to other parts of the stadium would be beneficial.

This document provides a summary of findings and recommendations to address issues related to the **Ingress Process**.

Executive Summary

The ingress system at the Y turnstiles has been reconfigured in accordance with the recommendations of Phase 1. The impact of the changes to the system have been assessed in the study with the intention to provide additional recommendations to further enhance the process.

The study has found that **the overall capacity of the ingress system has increased, making it more resilient to peaks in demand at matches with late arrival profiles.**

The analysis shows that:

- The security search rate has increased by 35%.
- Turnstile rate has increased by 7%.
- Overall delays have been lowered by 40% and queue footprint has been reduced.

There is scope to better distribute the spectators demand between entry lanes to further reduce queues/delays.

The balance of the ingress system (i.e., security vs turnstiles) has also been highlighted as a potential area for further investigation. A number of recommendations have been made to support further enhancements.

Phase 2 Recommendations:

1. Investigate the maximum search rate that meets the Club's security criteria, and subsequently train stewards in the search techniques required to achieve consistency across all entrances.
2. Ensure that the security search and turnstile provision is balanced to maximise capacity at each entrance and mitigate queues within the sterile area. Assuming an unchanged search rate, the analysis has identified the possible removal of 1 search lane and 1 bag lane to match the capacity of the Y turnstiles, or conversely, the addition of one turnstile at Y2, if available, to match security.
3. Stewards at the head of the security queues should direct people to less utilised lanes to spread demand more evenly.
4. Stewards should encourage spectators to use both sets of turnstiles at each bank to spread demand more evenly and reduce delays. Signage may also be used to reinforce messaging.
5. Ticketing errors should be investigated in more detail to optimise turnstile throughput.
6. Consider testing out arrangement at other entrances that can accommodate straight-line queues.
7. Reconfigure the X Entrance queue system to use the space between X and Y entrances

Study Objectives

This phase of the study focuses on the reconfiguration of the Y Entrance (see overleaf). N.B., site observations were also made for adjacent entrances.

The objectives of this study are to:

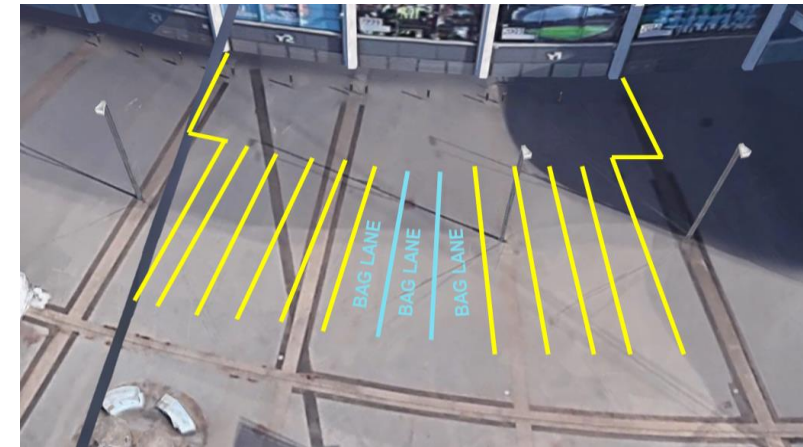
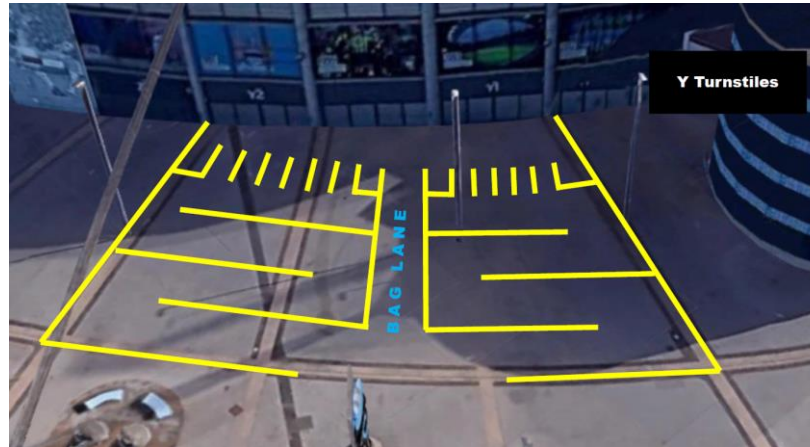
1. **Assess the impact the intervention has had on the performance of the entry system** – including the processing rates at security search and turnstiles, and the balance between the two.
2. **Identify possible further improvements** to minimise wait times and queue footprint, and enhance spectator perception of the process
3. **Propose additional areas that may benefit from intervention measures** – to be developed with the Club and tested in the next phase, if appropriate



Y Entrance reviewed by this study

Y entrance changes

Based on Phase 1's recommendations, the queue structure of the Y Entrance has been changed from a Disney queue to a series of straight line queues. The diagram below outlines the old and new queue layout. The table details the number of turnstiles and staff in use. An additional no.9 staff were allocated to the Y entrance.



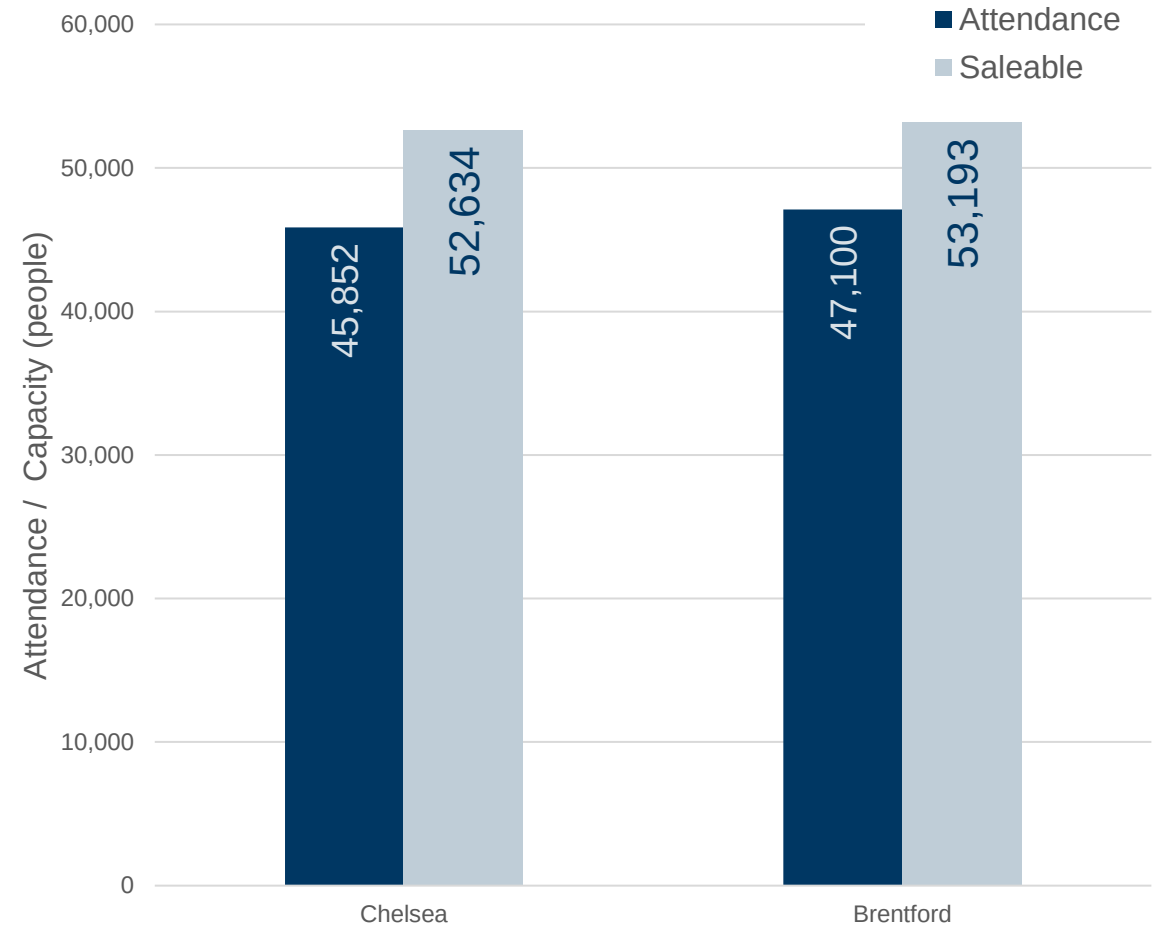
	2021/22 Season		2022/23 Season	
	Y1	Y2	Y1	Y2
Number of Turnstiles	4	4	4 (-)	5 (+1)
Number of Security Searchers	4	3	4 (-)	5 (+2)
Bag Lane	1 Shared Bag Lane		3 Shared Bag Lanes (+2)	
Number of Additional Staff	4 x Queue Management, 4 x Turnstile Steward		6 x Queue Management (+2), 5 x Turnstile Steward (+1)	
Total Staff	17		26 (+9)	

Match attendance and general fan behaviours

MS attended two match features to familiarise themselves with the updated stadium environment, discuss existing issues with key members of staff, conduct observations and collect photographic evidence of problem areas. Video footage was also collected through temporary CCTV cameras.

The two matches were:

1. **MCFC v Chelsea, 9th November 2022; 20:00 KO.** An evening mid-week EFL Cup match. The away section for this match was the entirety of the South stand on Level 3.
2. **MCFC v Brentford, 12th November 2022; 12:30 KO.** Seemingly a more typical lunchtime weekend match for the Premier League.



Match attendance figures (source: ticketing data)

Data sources

The review of the ingress process is based on the following data sources provided by MCFC or collected by MS.

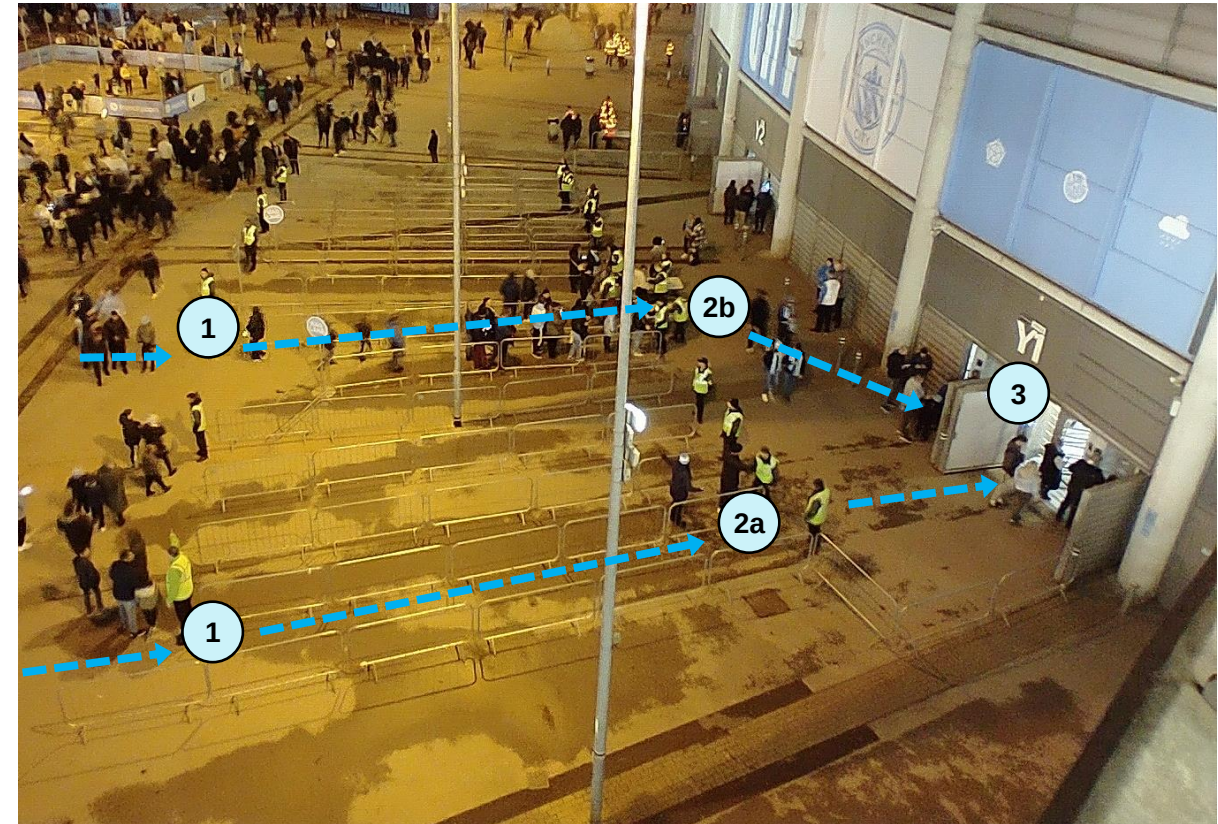


Data	Chelsea	Brentford
CCTV coverage and temporary camera footage	✓	✓
Security search rates (based on temporary camera footage)	✓	✓
Turnstile data	✓	✓
Spectator allocation to each entrance.	✓	✓

The Ingress process

Ingress into the stadium is conducted into three main steps at each entrance, namely:

1. **Soft Ticket/Bag Check** – Stewards ensure spectators join the correct queue for their allocated entrance and direct them to the bag check line, if they have a bag.
2. **Security Check**
 - a. **Security Wanding** – Queue threads lead spectators to stewards with magnetic security wands.
 - b. **Bag Check** – Spectators' bags are searched at a table while a second steward wands them.
3. **Turnstiles** – Paperless tickets are scanned electronically at the turnstiles and the spectator enters the stadium through the concourse.



Ingress process into the stadium

Spectator arrival

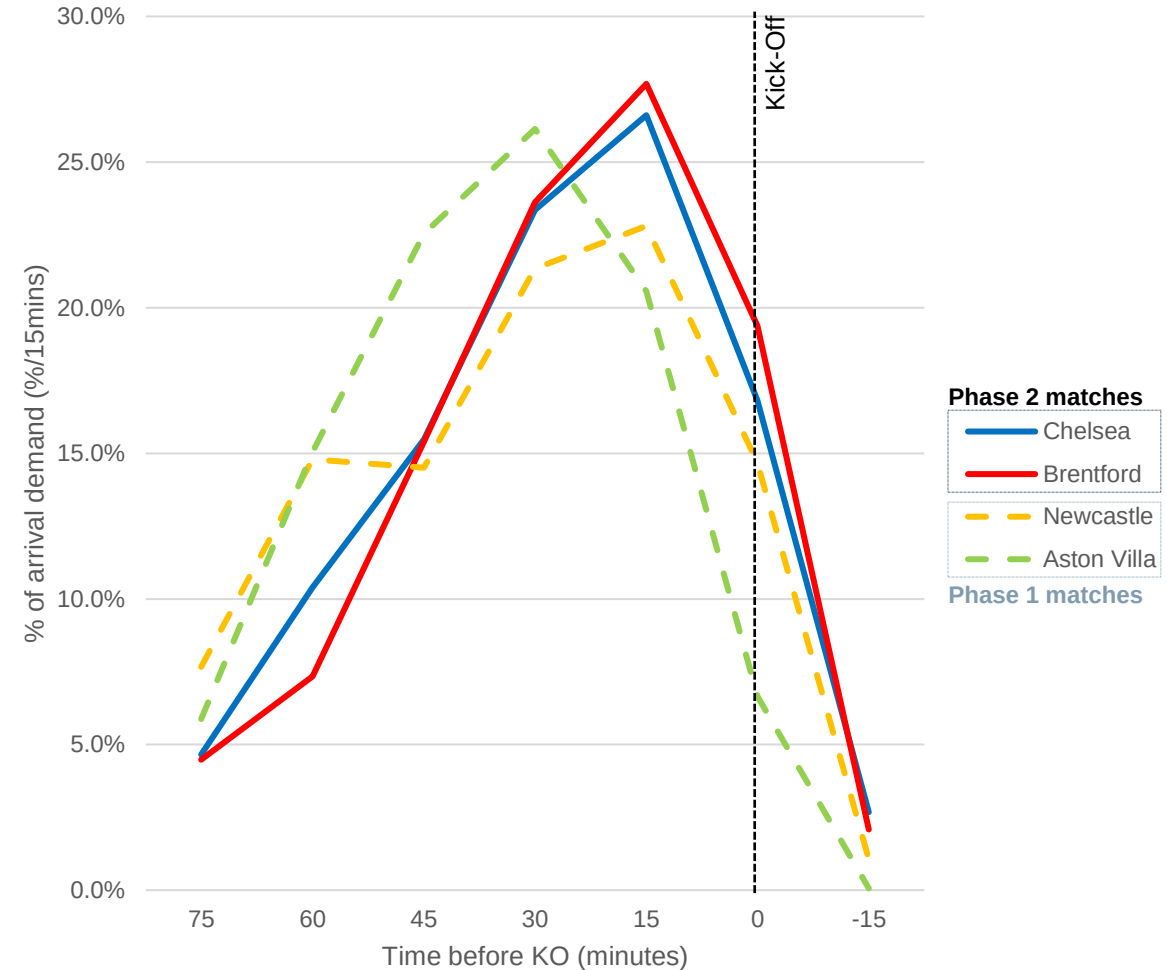
The arrival of spectators was collected from video footage at the point fans join their allocated entrance queue. The data shows a truer representation of the arrival profile than the turnstiles since it is not constrained by the turnstiles or the security process.

Data shows that the peak for the Phase 2 matches occur 30 to 15 minutes before kick-off. The peak 15 minute periods for the **Phase 2 matches occurred later than the Phase 1 matches and had a slightly higher proportion of the demand.**

The KO times of the Phase 2 matches could explain why people were less likely to arrive to the match early. For the Chelsea match (20:30 KO), people may have been arriving after work and for the Brentford match (12:30 KO), spectators may have arrived after an early weekend journey. N.B. Both Phase 1 matches were mid-afternoon on a weekend.

The 15-minute peaks in demand (25-30%) are relatively high compared to other similar stadiums (generally around 20%). This increases the pressure on the ingress system.

This means that the matches studied for Phase 2 are a reasonable stress-test for the remodelled ingress system.



Arrival profile of fans at Y Entrance (source: video count data)

Achieved turnstile rates

The turnstile data shows that turnstiles reach a maximum rate of 420 – 570 people/hour/turnstile. The average turnstile throughput in the peak 30 minute period is 450 people/hour/turnstile. **This is a 7% increase in throughput compared to Phase 1.**

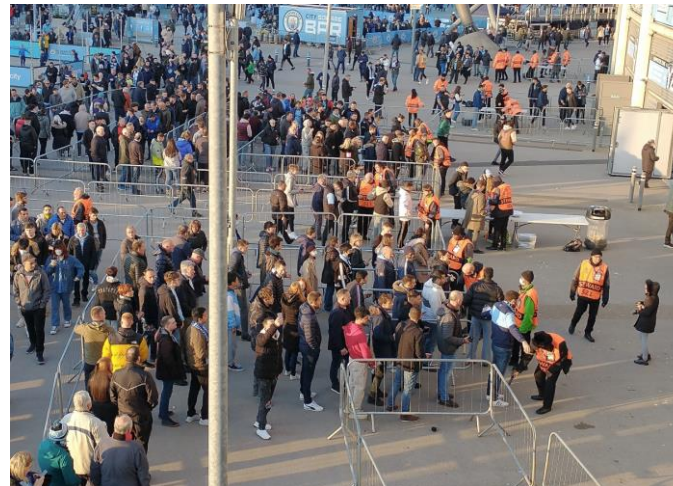
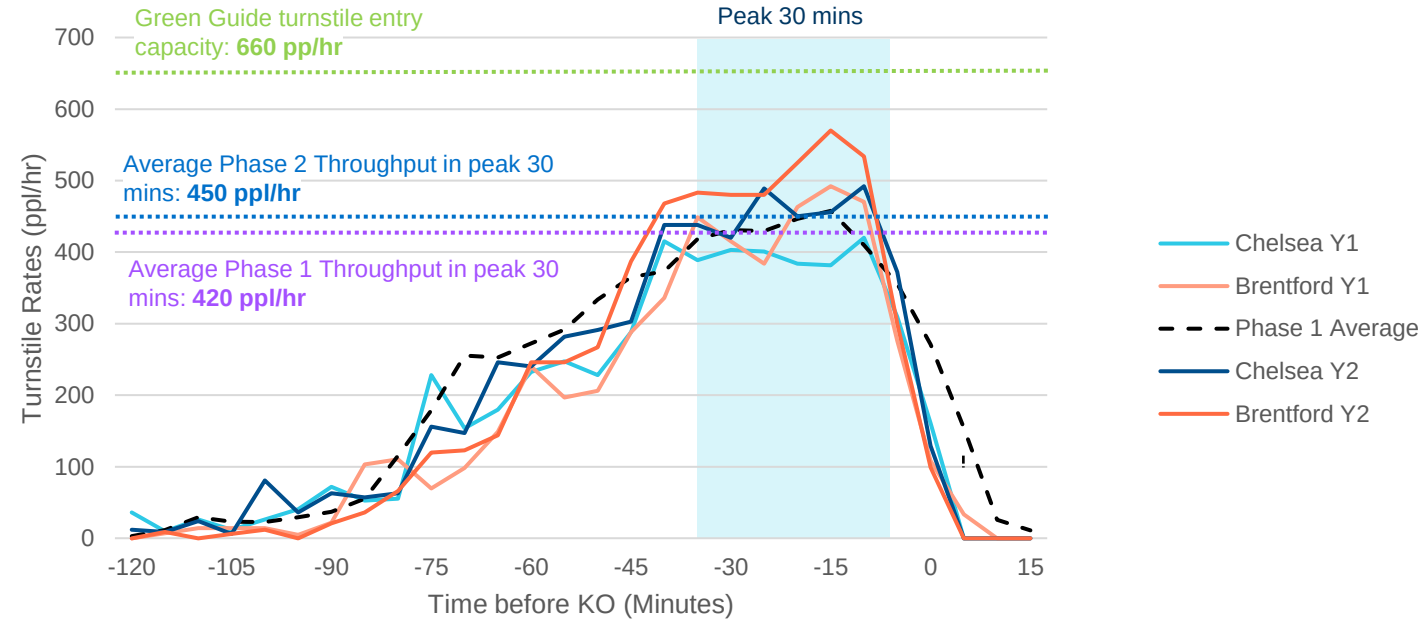
N.B. This is still below the entry capacity of 660 people/hour/turnstile suggested by the Guide to Safety at Sports Ground ('Green Guide').

In Phase 1 the security rates constrained the achievable turnstile rates and queues only formed at the security search.

In Phase 2, queues form at both the security search and the turnstiles. This shows that **the balance between the security search and the turnstiles has changed**. This is investigated in later slides.

*source: Guide to Safety at Sports Grounds (Green Guide)

Phase 2 Turnstile Rates as compared to Phase 1 Average at the Y Entrance (source: turnstile data for Chelsea, Brentford and Phase 1 Matches)



Phase 1: Queueing at the security search only



Phase 2: Queueing at the security search and the turnstiles

Spectator arrival vs turnstile entry profile

delays in the entry system

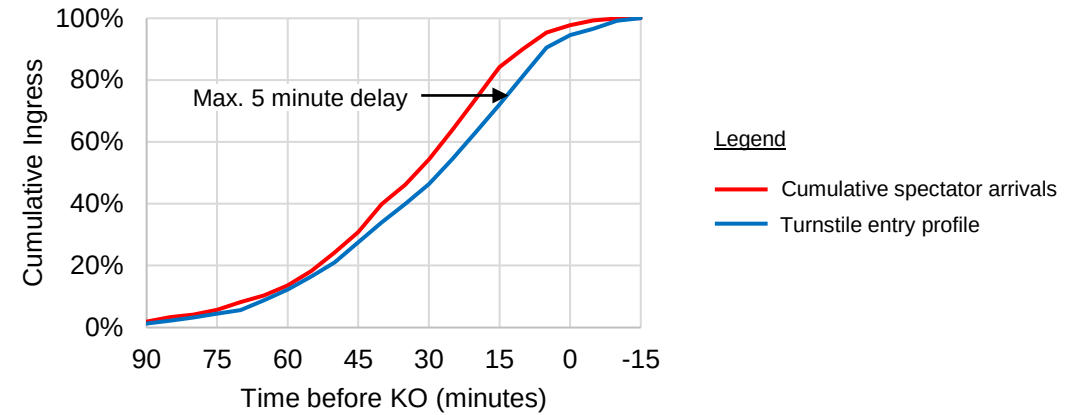
Comparing the cumulative spectator arrivals against the turnstiles entry profile shows the delay incurred in the entry system.

The delay in the system has been reduced from Phase 1 to Phase 2 for similar arrival profiles. In the MCFC v Newcastle, the maximum delay shown was 5 minutes.

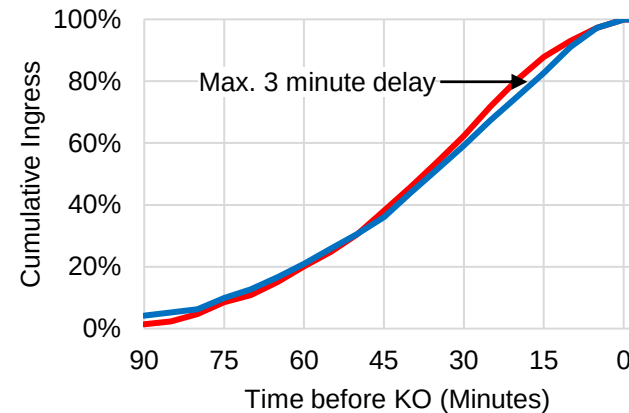
For the Phase 2 matches, the **maximum delay for the ingress process was 3 minutes.**

On average, it is **40% faster to enter the stadium with the new system.**

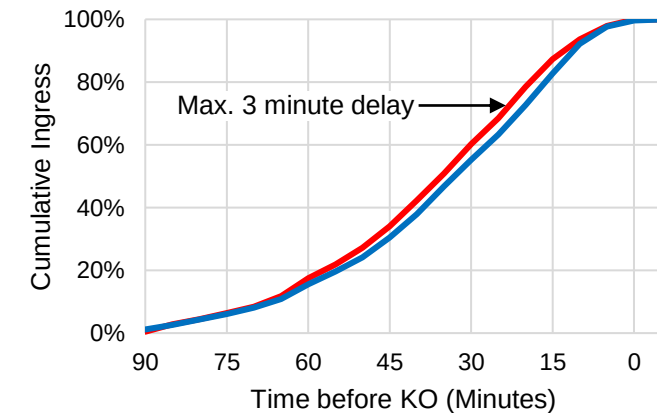
The system provides more capacity is more resilient to peaks in demand at matches with late arrival profiles.



Phase 1: MCFC v Newcastle arrival demand and turnstile ingress



Phase 2: MCFC v Chelsea arrival demand and turnstile ingress



Phase 2: MCFC v Brentford arrival demand and turnstile ingress

(source: video and turnstile data for Newcastle, Chelsea and Brentford matches)

Reduced queue lengths

The ingress system in Phase 2 experiences smaller queues compared to Phase 1.

Anecdotal observations suggest that, in this season, the queues have not extended into the wider circulation space as they used to in Phase 1.

This is corroborated by the reduced delay in the ingress process shown on the previous pages.



Phase 1 Peak Queues



Phase 2 Peak Queues

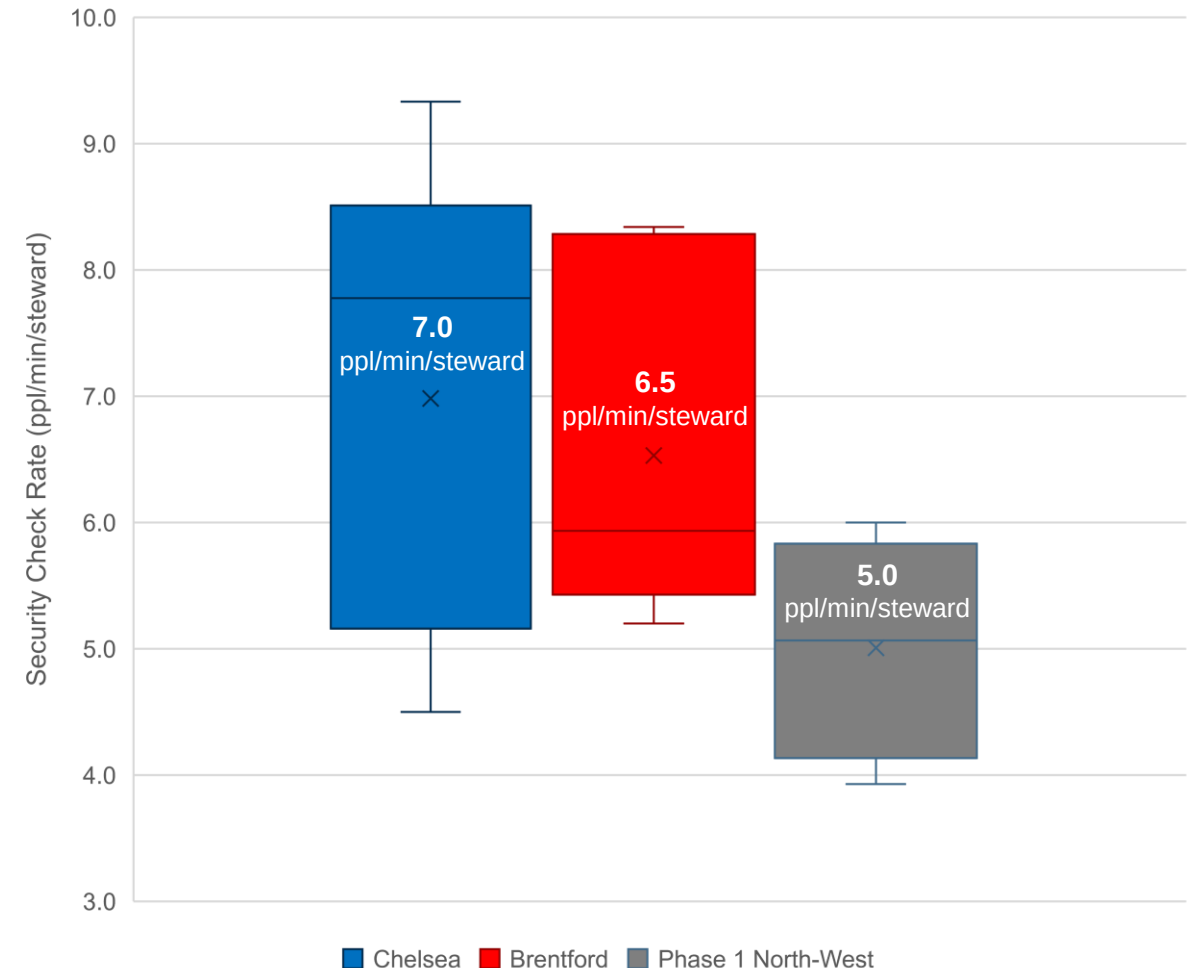
Security search rates

Video data analysis of security checks during periods of constant use can measure security check rates. **The average security search rate has increased by 35%, but the variance in rates has also increased.**

The faster search rates have contributed to the reduction in delay experienced by spectators.

The video footage shows that there are a range of techniques being used for the search. The stewards with higher search rates were observed only wandering the top half of spectators. The stewards with lower search rates were observed checking pockets and intermittently pausing to talk to spectators.

Therefore, **it is recommended that the Club investigates the maximum search rate that meets its security criteria**, and subsequently trains stewards in the search techniques required to achieve consistency across all entrances.



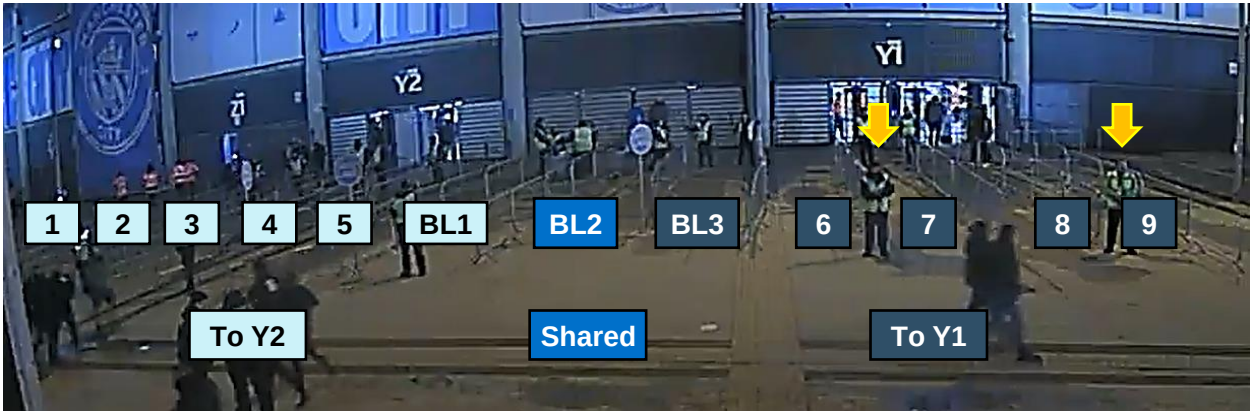
Security search rates (source: video data for Chelsea and Brentford matches)

Turnstile demand

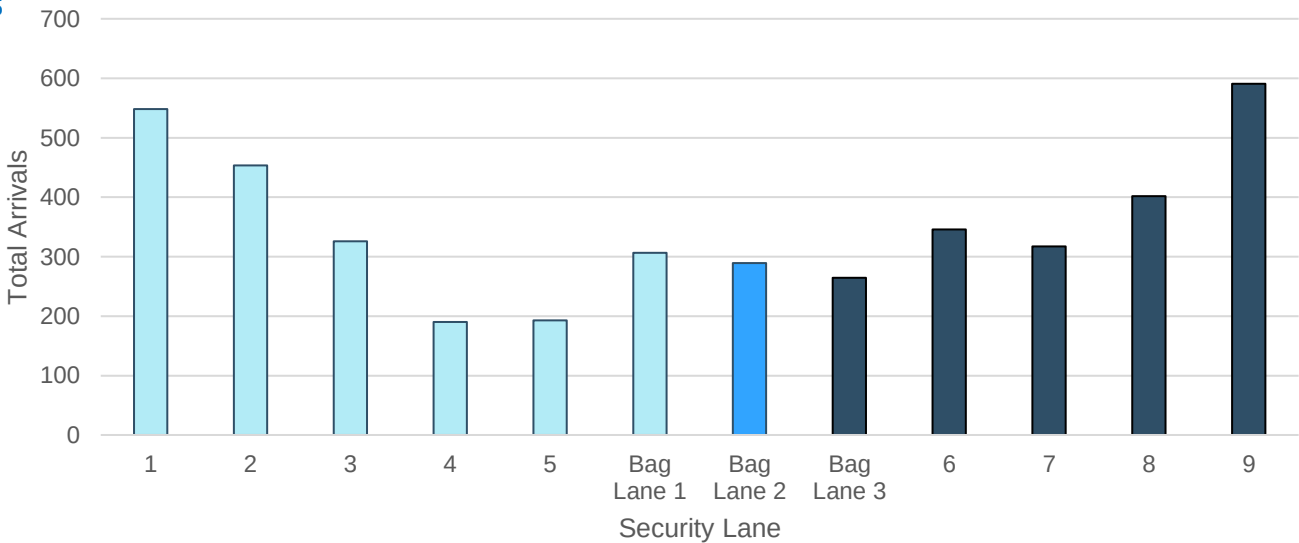
The spectator demand is not distributed evenly between the turnstiles. This is due to:

Allocation to search lanes – The stewards at the head of the queue do not necessarily direct spectators to the lane with the fewest people. As they are the first lane spectators see from the two approaches, the outer lanes had a higher demand in the peak 30 minutes, as shown in the graph opposite. There were large disparities in queue lengths during the peak 5 minutes.

It is recommended that stewards at the head of the queue direct people to less used lanes to spread demand more evenly across the different lanes.



Security Check Lanes



Phase 2 average unconstrained demand to the security check lanes (source: video data for Chelsea and Brentford matches)



MCFC v Brentford; 12:16
Steward at head of queue not directing arrivals to less busy queue

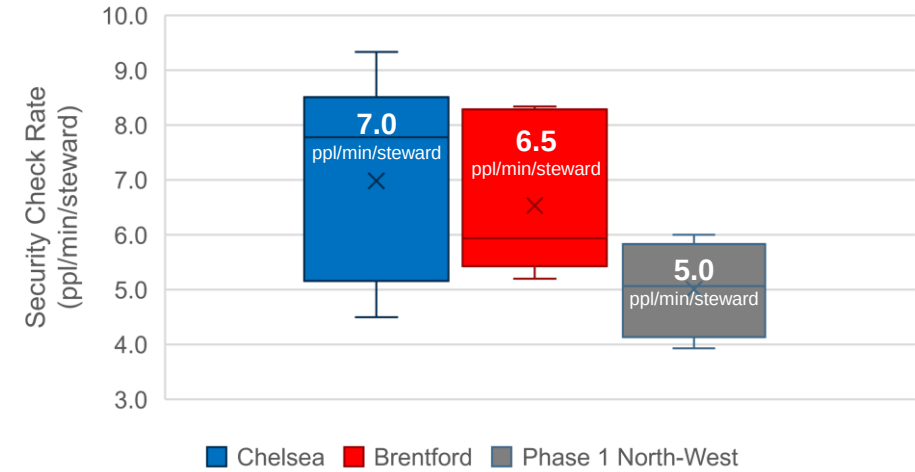
Turnstile Demand

The variability in security rates – The range in security search rates means that demand is fed to the turnstiles differently for each lane. The fastest steward was more than twice as quick as the slowest steward.

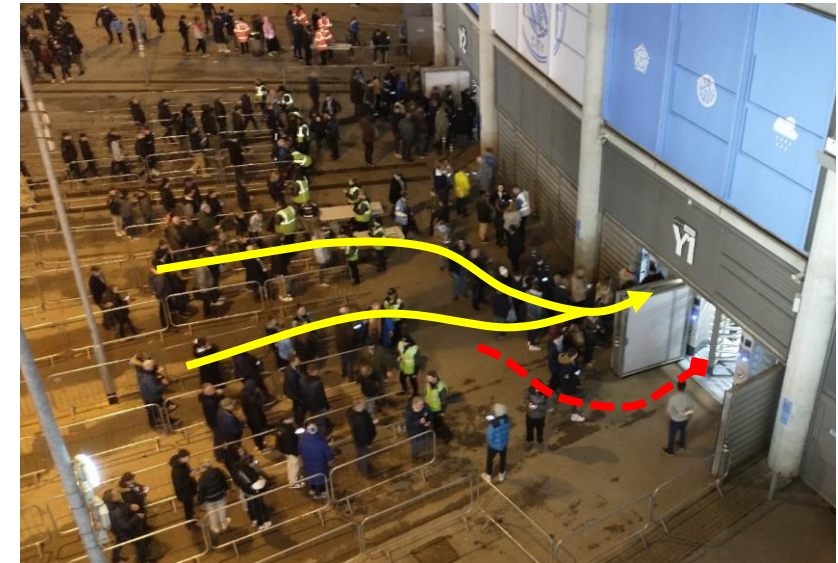
The structure of the queue – The lane structure feeds the inner turnstiles more than the outer turnstiles. This is amplified by the fact that the bag check lanes are in the centre and the folded doors of the turnstiles obstruct visibility of the outer turnstiles. This means the inner turnstiles experience a higher demand than the outer.

These factors mean that the turnstiles do not efficiently process the demand, and therefore do not consistently maintain their maximum throughput.

Instances were observed where there were queues at the inner turnstiles while the outer turnstiles were available. **Stewards should also encourage spectators to use both sets of turnstiles at each bank to spread demand more evenly and reduce delays. Signage may also be used to reinforce messaging.**



Range of Security Check Rates
(source: video data for Brentford and Chelsea matches)



Available outer turnstiles while there is queueing at the inner turnstiles. Bag check and standard lane demand merging to create queue at outer turnstile

Balance in the entry system

In this phase of the study, queues formed at both the security search and the turnstiles. This suggests the balance of throughputs of the security search and turnstiles has changed compared to Phase 1.

The **throughput of the security search has increased** from Phase 1 to Phase 2 due to:

1. **Search rate** – The average search rate has increased from 5 ppl/min/steward to 6.5 – 7.0 ppl/min/steward. The bag lane search rate was measured at 4.2ppl/min/steward.
2. **Number of Lanes** – There are 3 more security lanes in the Phase 2 structure (2x Bag Lanes, 1x Standard) compared to Phase 1.
3. **Queue Structure** – Stewards experience fewer periods of inactivity with the straight line queueing compared to the Disney queue system. This is because the straight line queues considerably reduce the time taken for the next person to approach the steward.



Queueing at the security search and the turnstiles

Balance in the entry system

Balancing the entry system is largely dependent on the service rates achieved by security and turnstile processes, and their respective provision.

The diagram opposite outlines the provision and calculated throughput of the security and turnstiles processes using the following rates:

- Security Search Rate of 7.0 people/minute/steward (420 people/hour/steward)
- Bag Search Rate of 4.2 people/minute/table (252 people/hour/table)
- Average peak turnstile rates for each turnstile unit

This is assuming that the throughput of the bag checks is split evenly between Y1 and Y2.

The **security search has a higher throughput than the turnstiles which leads to queues in the sterile well**. These queues forced the security search to stop intermittently to allow the build-up of spectators to be processed by the turnstiles.

Note that Y1 has 5 turnstiles and 4 lanes of stewards but Y2 has 4 turnstiles but 5 lanes of stewards. Y2 experiences more queueing than Y1, this is because there is a larger imbalance between the throughput of security searchers and turnstiles.



		Y2		Y1	
		No of Units	Throughput (ppl/hour)	No of Units	Throughput (ppl/hour)
Existing	Security Searchers	5 Standard + 1.5 Bag Check	2,478	4 Standard + 1.5 Bag Check	2,058
	Turnstiles	4	1,856	5	2,000
	Difference	-	-622	-	-58

Calculated throughput of the existing security search and turnstile configuration (source: video data for Brentford and Chelsea matches)

Balancing the entry system | Stewarding

Phase 2 experience smaller queues at the security search, this provides an opportunity to remove stewards if necessary.

Based on the assumed rates and to more evenly balance the throughput, **a trial could be conducted with search lane removed at Y2 and a shared bag check lane also removed**. The impact of this is included in the table opposite.

This configuration means that the turnstiles have more capacity than the security search, so queues should not form as consistently in the sterile well.



		Y2		Y1	
		No of Units	Throughput (ppl/hour)	No of Units	Throughput (ppl/hour)
Existing	Security Searchers	5 Standard + 1.5 Bag Check	2,478	4 Standard + 1.5 Bag Check	2,058
	Turnstiles	4	1,939	5	2,105
	Difference	-	-539	-	47
Proposed	Security Searchers	4 Standard + 1 Bag Check	1,932	4 Standard + 1 Bag Check	1,932
	Turnstiles	4	1,939	5	2,105
	Difference	-	7	-	173

Calculated throughput of the proposed security search and turnstiles configuration as compared to the existing

Balancing the entry system | Turnstiles

Conversely, instead of reducing the number of stewards, the number of turnstiles could be increased (if available) to reduce the queues forming in the sterile well.

Using the same assumed rates as before, **using an additional turnstile at Y2 would improve the balance of the capacities of the security and the turnstiles more evenly.** The impact this would have on ingress throughputs is included in the table opposite. **This configuration could be trialled, if an additional turnstile is available at Y2.**

The security search would still have more capacity than the turnstiles at Y2 so queues may still form in the sterile well.

The overall capacity of the ingress system would increase with this proposed configuration, thereby reducing delays.



		Y2		Y1	
		No of Units	Throughput (ppl/hour)	No of Units	Throughput (ppl/hour)
Existing	Security Searchers	5 Standard + 1.5 Bag Check	2,478	4 Standard + 1.5 Bag Check	2,058
	Turnstiles	4	1,939	5	2,105
	Difference	-	-539	-	47
Proposed	Security Searchers	5 Standard + 1.5 Bag Check	2,478	4 Standard + 1.5 Bag Check	2,058
	Turnstiles	5 (+1)	2,424	5 (-)	2,105
	Difference	-	-54	-	47

Calculated throughput of the proposed security search and turnstiles configuration as compared to the existing

Ticketing Errors

Ticketing errors reduce the throughput of the turnstiles, making them less efficient. This is believed to be the main reason behind the wide range of turnstile rates recorded during the peak even though they are at capacity.

The throughput of the ingress system has increased, both at security and at the turnstiles. This means any ticketing errors at the turnstiles cause queues to form more quickly than in Phase 1.

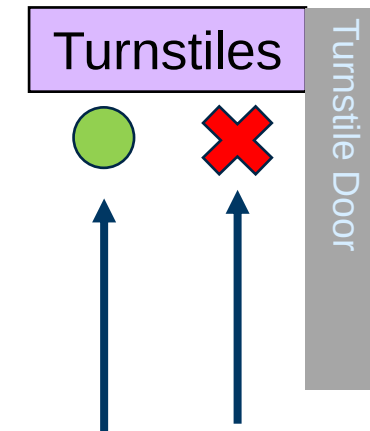
It is unclear from our observations what causes errors to occur. **It is recommended that the Club investigates further to minimise impact on the turnstile capacity.**

Stewards should also encourage spectators with a ticketing error to exit the system to resolve their issue in order to not block people behind.

However, it should be noted that the queue of spectators behind the person with the error prevents them from moving aside as easily. This is made worse in some situations by the large turnstile doors, blocking movement in either way.



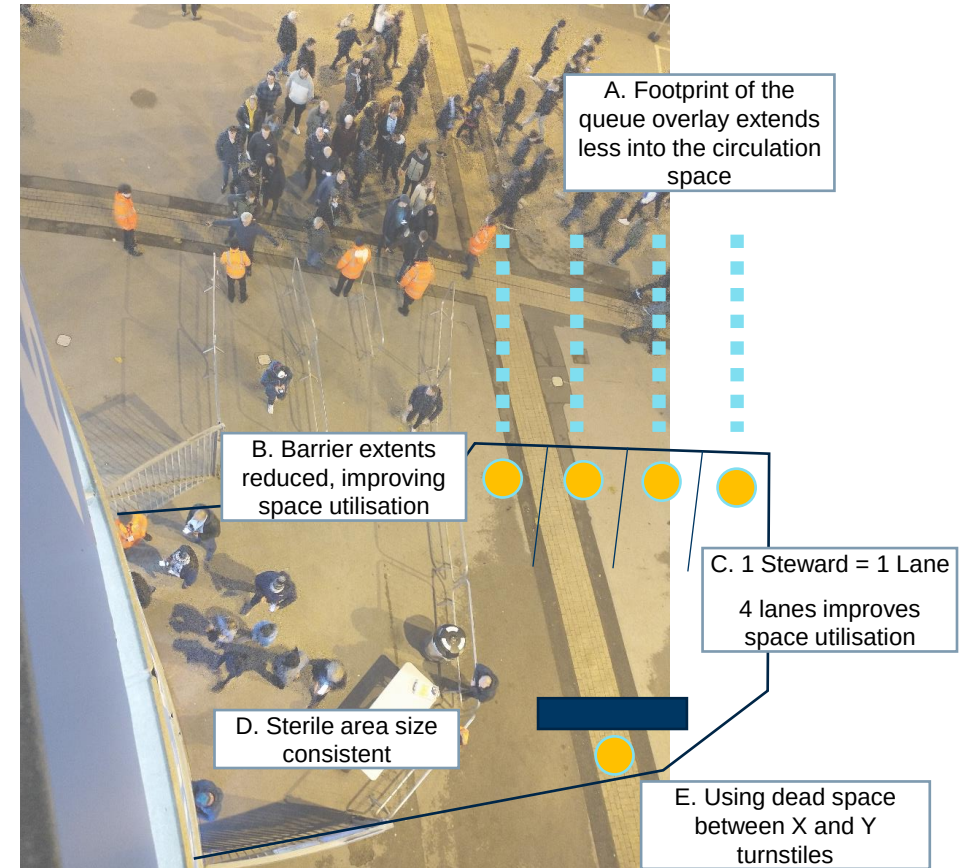
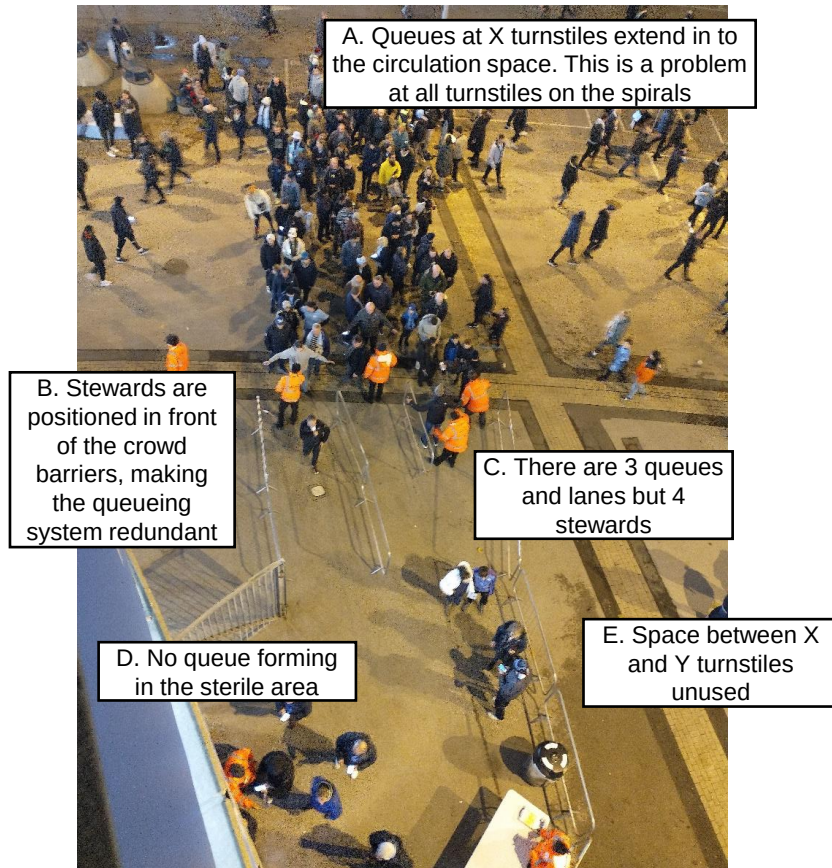
Queue of 8 people caused by spectator ticket error, causing blockage for 1 minute 20 seconds



Existing Turnstile Arrangement

X Entrance Considerations

In both Phase 1 and 2, large queues have been observed at the X Entrance extending well into the circulation area. The diagram below suggests considerations for the queue structure that may facilitate ingress into turnstiles that lead to spiral ramps.



Summary of recommendations

Overall, the throughput of the ingress system at the Y entrances has improved compared to Phase 1, especially the throughput of the security check stage. The following interventions are recommended to enhance the entry system, particularly in terms of balancing capacity and demands.

1. Investigate the maximum search rate that meets the Club's security criteria, and subsequently trains stewards in the search techniques required to achieve consistency across all entrances.
2. Ensure that the security search and turnstile provision is balanced to maximise capacity at each entrance and mitigate queues within the sterile area. Assuming an unchanged search rate, the analysis has identified the possible removal of 1 search lane and 1 bag lane to match the capacity of the Y turnstiles, or conversely, the addition of one turnstile at Y2, if available, to match security.
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4. Steward should also encourage spectators to use both sets of turnstiles at each bank to spread demand more evenly and reduce delays. Signage may also be used to reinforce messaging.
5. Ticketing errors should be investigated in more detail to optimise turnstile throughput. Stewards should also encourage spectators with a ticketing error to exit the system to resolve their issue in order to not block people behind.
6. Consider testing out arrangement at other entrances that can accommodate straight-line queues.
7. Reconfigure the X Entrance queue system to use the space between X and Y entrances

Metadata

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This document has been prepared by Movement Strategies, a Gutteridge Haskins & Davey Limited company ("MS") for the sole benefit, use and information of City Football Group Limited ("the Client") for the purpose agreed between MS and the Client set out in the related proposal.

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