Castlefield Corridor
Congested Infrastructure Report

Capacity Analysis – System Operator

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Abbreviations	
Acronym	**Meaning**
CLC	Cheshire Lines Committee route
CTP	Concept Train Plan
DSG	Delivery Steering Group
ECS	Empty Coaching Stock
ITSS	Indicative Train Service Specification
ROC	Rail Operating Centre
SPAD	Signal Passed At Danger
SRT	Sectional Run Time
Tph	Trains Per Hour
TPRs	Timetable Planning Rules
WCML	West Coast Mainline

Contents

Part A: **Executive Summary**

This report identifies the constraints and limitations in the Manchester area that are contributing to the poor performance of trains running through the Castlefield Corridor in Manchester, as well as identifying some high-level possible solutions to the issues identified. This is the first of two reports required by the Congested Infrastructure Code of Practice; the second, due for publication in Spring 2020, will consider a capacity enhancement plan, giving specific options to alleviate the constraints identified in this document.

In 2018, capacity analysis was undertaken to attempt to identify if an optimised train service plan would alleviate the train performance issues experienced in this area. This included retiming and altering the routing of services. The analysis also identified limitations imposed by the current operating procedures in the area and of the infrastructure.

For the purposes of this analysis an industry-agreed Train Service Specification (TSS) was created, incorporating current services and additional committed services; this is attached in Appendix A – Train Service Specification (TSS). This TSS differed from the current (May 2019) working timetable (WTT); it was based on the May 2018 WTT, with additional services required as part of franchise commitments overlaid on this, or existing services amended to reflect planned changes in the next couple of years. It was assumed that services which currently run through Victoria could be split there and re-paired to provide more operationally convenient (from a timetabling perspective) services if this proved desirable. Station calls at Deansgate and intermediate stations on the route to Manchester Airport were omitted to speed-up the analysis; this does not mean that calls at these stations could not be accommodated, and these can be considered during any future analysis.

As such, the TSS gives an indication of the maximum number of services that can be robustly timetabled through the central Manchester area and what the key constraints are, rather than being limited to the current timetable structure.

The analysis identified that the two Concept Train Plans (CTP) developed from the TSS cannot be robustly accommodated on the May 2018 Manchester area infrastructure. A combination of infrastructure, timetable and/or train service interventions are required to enable a robust service to operate in and around Central Manchester. Without an infrastructure intervention, 13tph is the maximum number of services which can be dependably operated through the Castlefield Corridor (of which two terminate at Manchester Oxford Road). This is approximately 85% of the theoretical capacity of the Castlefield Corridor which is acknowledged as the threshold for reliable performance (International Union of Railways, UIC Code 406 report).

A common theme throughout the analysis is that there are either too many trains and/or not enough infrastructure in certain areas and that if no additional infrastructure is provided, the number of trains should be reduced in order to run a better performing timetable. There may also be cases where a reduction in the train service could be combined with infrastructure interventions to deliver a better performing timetable.

A.01 Areas of consideration

A.01.01 Infrastructure

This analysis has been based on the infrastructure in May 2018 timetable, with one exception (a centre turnback having been assumed at Oxford Road). This report has highlighted throughout the limitations imposed by the infrastructure, particularly with regards to the number of flat junctions in the Central Manchester area and the number of conflicting moves this introduces. Within the Corridor itself it has been identified that there is no scope for running additional trains without the provision of extra infrastructure.

The analysis assumed present day infrastructure remained in place (with the exception of a centre turnback being assumed at Oxford Road). However, the analysis has identified infrastructure interventions that would be beneficial from a timetabling perspective. These are being considered by a cross-industry project which is looking at the constraints in this area.

See Sections B.03.02, and C.04 for more on infrastructure.

A.01.02 Operating procedures

The railway in the area considered is complex, with a number of different routes (each with different service mixes and headways) funnelling into the Corridor – see Figure 1.

Once into the Central Manchester area, trains travel at low speed; line speed is mostly 20 – 30 mph, but services generally travel more slowly than this, due to operating on restrictive (i.e. Yellow or Double-Yellow) aspects. TOC/FOC driving policies in part dictate slow approaches to such signals, which causes the train service to operate more slowly than it theoretically could do. In short this means that trains take longer to clear junctions than is assumed. This links to issues observed regarding the Timetable Planning Rules (TPRs), which are not fully reflective of how services operate through this area.

See sections C.01 and C.03 for more on operational constraints.

Signalling operations across the Greater Manchester area and the feeder routes towards the Castlefield Corridor are characterised by a complicated set up of different locations (ten separate locations working in isolation within three miles) and a mix of technologies, including a mix of lever frame, NX and VDU signalling.

Routes from the north, south, east and west converge in the Castlefield Corridor, where trains pass to and from areas controlled by Manchester Piccadilly SCC and Manchester

ROC, and vice versa. Trains from the north and south are signalled towards the Castlefield Corridor by Manchester Piccadilly, are then signalled within the central core by Manchester ROC before again coming under the control of Manchester Piccadilly (or another fringe location depending upon end destination).

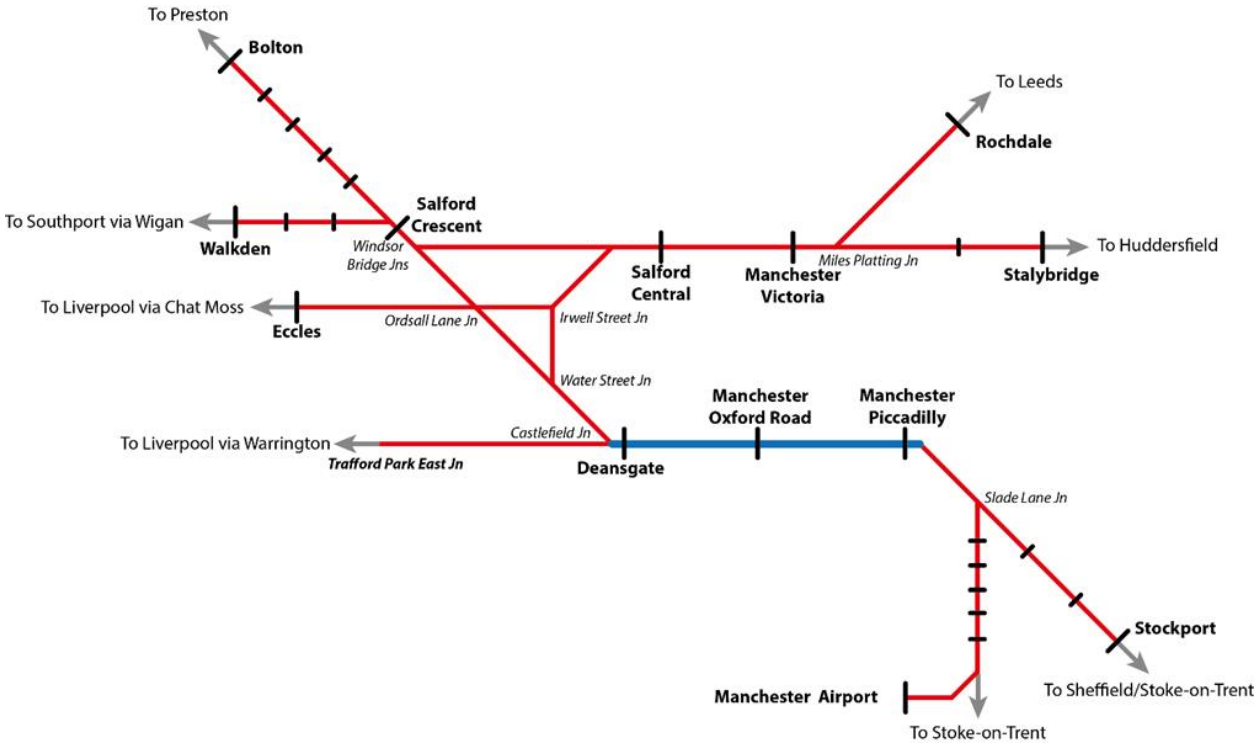

Figure 1: Routes (red) feeding the Castlefield Corridor (blue).

This complicated situation means that strategically managing services through the central Manchester area and beyond is not possible for signallers in the Greater Manchester area, and trains are invariably dealt with on a 'first come, first served' basis. Efforts by both signallers and Train Running Controllers to manage the service are compounded and limited by lack of regulating points heading towards central Manchester and also lack of flexibility at Manchester Oxford Road due to shared overlaps at the platform ends.

A.01.03 Nature of the different services operating

Services in the Central Manchester area are mixed; many are local commuter services, but there are also freight and long-distance passenger services as well. These may have travelled long distances (e.g. across the Pennines from York, or down the WCML from Glasgow), with an increased potential to pick up delay on-route and import it into the Corridor.

Freight services arriving and departing from Trafford Park terminal just to the west of the Corridor provide an additional complicating factor for managing the train service, as additional time is required to allow for moves in and out of that location.

Due to their differing natures, services are comprised of varying rolling stock types, that bring with it a variety of performance characteristics, lengths and door configurations (all of which affects the speed to station calls). These are due to change further with the upcoming introduction of new trains into service on some of the routes into Central Manchester.

See Appendix A for a list of the services and rolling stock types assumed for this analysis,

A.01.04 Rerouting services

The 2018 analysis investigated opportunities for improving the train service by splitting current through services at Victoria. Work is ongoing to explore what benefits a reworking of the train plan would bring.

Some services which would benefit from minor rerouting are the Transport for Wales services which do reverse moves in the Corridor, or terminate in Manchester Piccadilly platform 14 and then reverse to run as ECS to Mayfield loop or Longsight Excursion platform, where they recess before returning to platform 13 to commence another journey. Moving these reversals out of the Corridor and into the train shed at Manchester Piccadilly station would be advantageous from a performance perspective.

See section C.02 for more on the routing of services.

A.01.05 Retiming services

The analysis sought to accommodate an overall quantum of services in the timetable, rather than accommodating certain trains at certain times. As such, all services were re-timed from today to try and achieve the most robust timetable possible.

A.01.06 Speed alterations

As mentioned above, the lines peed is mostly 20 – 30 mph through the Castlefield Corridor and the routes immediately leading into it. Line speed improvements were not considered as part of this analysis, as the distance between stations and junctions in this area would prevent any tangible benefit being gained from this.

A.02 Summary of Constraints

The analysis identified constraints that are ranked on their impact as High, Medium and Low. These are not quantifiable and are only an indication of the difficulty the constraint had on the ability to timetable these areas. There is no guarantee that the potential resolutions listed would solve the problems that are currently prevalent in the Manchester area and further analysis would need to be carried out on potential designs to check whether the interventions taken forward do deliver a reliable timetable.

Constraint level	Issue	Potential Resolution	Timescales
High	TPRs through the Castlefield Corridor do not accurately represent the operational running of the railway, allowing insufficient time for certain movements to take place	Review and amend TPR values	Short term
High	Insufficient infrastructure/too many trains through the Castlefield Corridor	Reduce total number of trains in the Corridor	Medium – long term
High	Too many conflicting train movements across the area analysed	Remove/divert services to reduce conflicts	Short term
Medium	Junction layouts at Salford Crescent create too many conflicting moves	Redesign station and junction to reduce conflicts	Medium – long term
Medium	Lack of flexibility (ability to re-order services) on routes feeding into Manchester	Provide overtaking capability on feeder routes	Medium – long term
Medium	Irwell Street & Deal Street junctions have a shortage of parallel moves	Redesign junctions to enable more parallel moves	Medium – long term
Medium	Insufficient platform capacity at Manchester Victoria station	Mid-platform signals to reduce platform reoccupation time	Medium – long term

Low	Shortage of platform capacity at Manchester Airport station	Provide more/longer platforms	Medium – long term
Low	Single line sections between Bolton & Blackburn	Reduce number of conflicting moves Blackburn trains interact with or double single line sections	Medium – long term
Low	Inconsistent headways on routes in and out of Manchester	Re-signal to give consistent headways	Medium – long term
Low	Shortage of parallel moves on eastern approach to Manchester Victoria	Provide additional crossovers	Medium – long term

Part B: **Introduction**

B.01 Background

The introduction of the May 2018 timetable caused significant performance issues in the north-west, particularly in the Manchester area. This highlighted that the Castlefield Corridor (between Deansgate station and Manchester Piccadilly platforms 13 & 14) is a major pinch-point, due to the number of different services having to be funnelled onto a two-track section of railway. This both limits timetabling options for the area and magnifies delays.

Although recognised as a capacity constraint in recent years, an increase from 12 trains per hour (tph) in each direction to 15tph through the Corridor in 2018 has brought this to the fore. Schemes under the Northern Hub project banner had been planned to assist with increasing capacity in the Corridor from 12tph to 16tph; however, thus far only the Ordsall Chord has been built. As such, the train service through the Corridor has been increased without the infrastructure that was previously identified as being necessary to support it.

B.02 Geographic Scope

Due to the complex interaction of the routes in the Manchester area it was necessary to consider outward from Central Manchester to the following locations to assess whether the timetable is deliverable:

Manchester Airport, Trafford Park East Junction, Eccles, Walkden, Bolton, Rochdale, Stalybridge and Stockport.

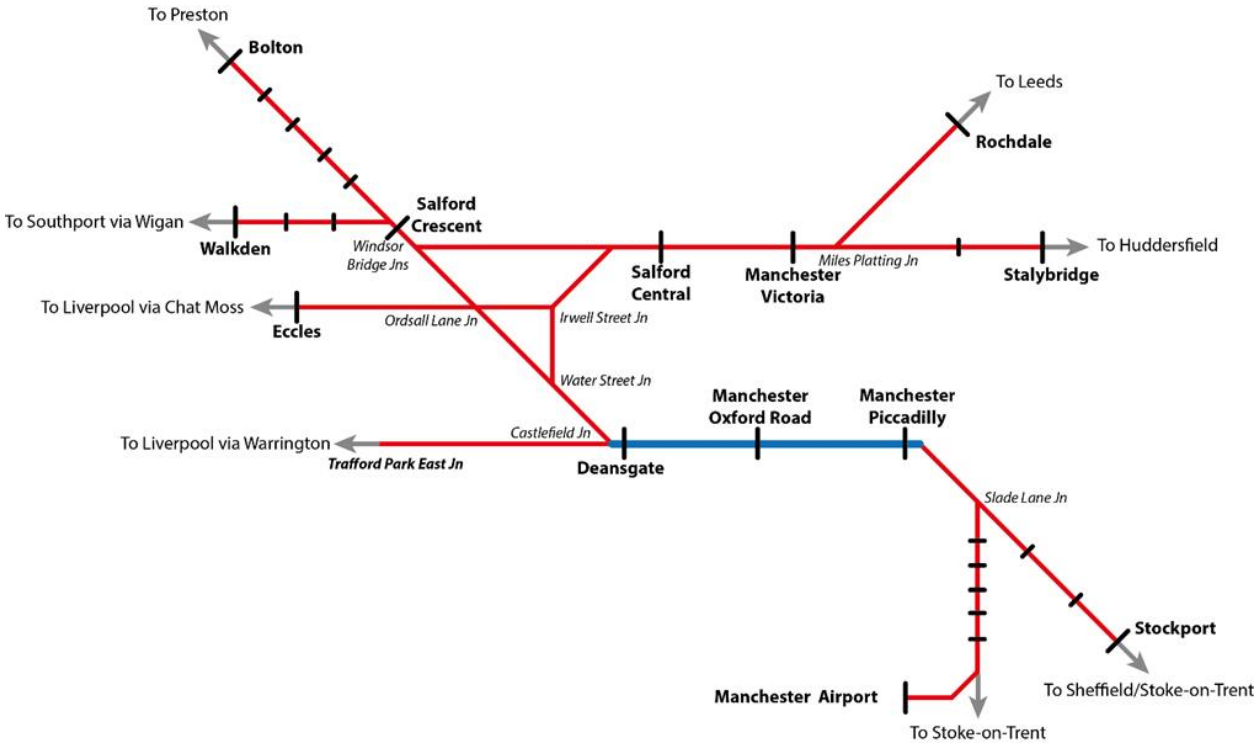

Figure 2: Routes (red) feeding the Castlefield Corridor (blue).

B.03 Assumptions

B.03.01 Train Service Specification

The TSS for this analysis can be found in the Appendix A – Train Service Specification (TSS). In total there are 54 train movements included in the analysis.

In the analysis, services that travel through Manchester Victoria were split in to ‘A’ & ‘B’ halves. For example, a Blackburn to Blackburn train that operates via Manchester Victoria, has been split in to a Blackburn to Manchester Victoria via Salford Crescent (Part A) and a Manchester Victoria to Blackburn via Rochdale (Part B). This approach allowed any Part A train to be paired with any part B train in a way that was most appropriate for capacity purposes.

All calls at Deansgate station were omitted from the TSS. This was assumed to speed up the analysis and to enable identification of capacity constraints across the wider geography in the allotted timeframe. This does not mean that no calls can be made at Deansgate, but rather calls can be added where possible and into the most appropriate services in future analysis.

All trains in the TSS were assumed to be 156m (6x26m) in length – longer than currently but based on known and predicted train lengthening in the near future. This meant that trains could not simultaneously arrive and depart in the same direction at Manchester Oxford Road. The signalling arrangements at this station prevent these moves for trains that are longer than 80m in length.

B.03.02 Infrastructure

The infrastructure as of May 2018 was been assumed except for the inclusion of a central turnback at Manchester Oxford Road. The assumed infrastructure provides for two through platforms and a central turnback.

B.03.03 Geographic scope

Timetabling was not completed outside of the geographic scope and some trains have not been included in the analysis, such as those using the train shed at Manchester Piccadilly station and trains approaching Manchester Airport from the south.

B.04 Methodology

Two different concept train plans were developed using the same TSS and common themes were found, despite two different construction methodologies. This approach of two timetable construction methods was chosen to identify how flexible the TSS is regarding timetable construction. Approach A focussed on prioritising timetable compliance along the Manchester Oxford Road to Manchester Piccadilly corridor before looking at Manchester Victoria, whereas Approach B did the reverse. In both instances, the complex set of junctions between Castlefield Junction and Salford Crescent had to be planned first.

Part C: **Findings**

C.01 TPR Issues

It has been identified through collaboration with operational personnel at Manchester ROC (Rail Operating Centre) and observations from the Network Rail Timetable Production team, that some of the current TPRs, although correct in theory, are insufficient for the day-to-day running of the railway.

This is seen in the platform re-occupation times at Manchester Oxford Road station and Manchester Piccadilly station platform 13 and 14. The current TPRs specify that a train can be planned to arrive at a station platform two minutes after the previous train has left the station platform; however, this is only technically achievable with the shortest trains on the route, and whilst possible, has no margin for error. As trains are due to be lengthened on the route in the near future, more time will need to be given for them to depart and clear the signalling section before the next train can enter the station. This will increase the time for re-occupation beyond the current 2-minute value. The consequence of which is that 15 trains can no longer be planned through the Corridor without a physical infrastructure intervention or a significant adjustment to the train service.

Furthermore, due to the current signalling configuration at Oxford Road, any train longer than 80m (4 x 20m) cannot arrive simultaneously with a departing train. Therefore, despite having two platforms in each direction, for planning purposes there is effectively only one. The TPRs mandate a 2-minute dwell for all services calling at the station; this, coupled with the 2-minute platform re-occupation means that a train can arrive at Oxford Road every 4 minutes. The ITSS requires 13 trains an hour to use the through platforms, meaning with 4 minutes x 13 trains, 52 minutes of the hour are currently occupied by train movements (87% occupation). Additionally, there are two terminating trains at Oxford Road that use the bay platform, which are not subject to platform re-occupation. These trains can be 2 minutes behind a train using the through platforms (2 minutes x 2 trains = 4 minutes). Therefore, even if the 2-minute platform re-occupation were achievable, 56 minutes out of the hour are currently being utilised (93% occupation). This leaves only four minutes of an hour for the timetable to recover from any delay.

It should be highlighted that this theoretical calculation of capacity assumes that a 2-minute dwell is achievable. Local observations demonstrate multiple trains within the hour exceeding this value due to passenger numbers and additional operational duties e.g. train crew changeovers.

As identified above, the re-occupation time is too short to plan a reliable railway and it is therefore recommended that the re-occupation is increased to 3 minutes for all trains. Platform re-occupation is a sub-set of headway and therefore the re-occupation value cannot be longer than the headway. Consequently, the headway value must also increase

to 3 minutes. This limits the basic capacity to 13 tph, consisting of 11 through trains and 2 Manchester Oxford Road terminators, which would result in 59 minutes of the hour being utilised (5 minutes (*2 minutes dwell* + *3 minutes reoccupation*) x 11 trains + 2 minutes x 2 trains), but crucially this spaces the services out much more than before. This means that a dwell that is extended by up to 30 seconds should have no adverse impact on the following service as the platform reoccupation value could mitigate minor delays. Spacing this performance buffer out over the hour is more advantageous than having an entire spare train path to use as a fire-break, as it increases the likelihood of right-time presentation at the succession of key junctions at each end of the Deansgate – Manchester Piccadilly corridor.

It is common to utilise capacity to around 85% of its theoretical maximum capacity for a suburban rail network, thus allowing for recovery of delays and timetable flexibility. 13tph is approximately 85% of the theoretical maximum capacity of the Corridor.

C.02 Train Service Limitations

As noted previously there are too many trains planned into Manchester Oxford Road and Manchester Piccadilly (platforms 13 and 14) to be operated reliably. This can be solved in two ways; by providing more infrastructure or reducing the number of trains.

The layout of the railway in Manchester means that there are a lot of potential conflict points; these are shown in Figure 3. This is only a problem if services are planned to conflict at these locations.

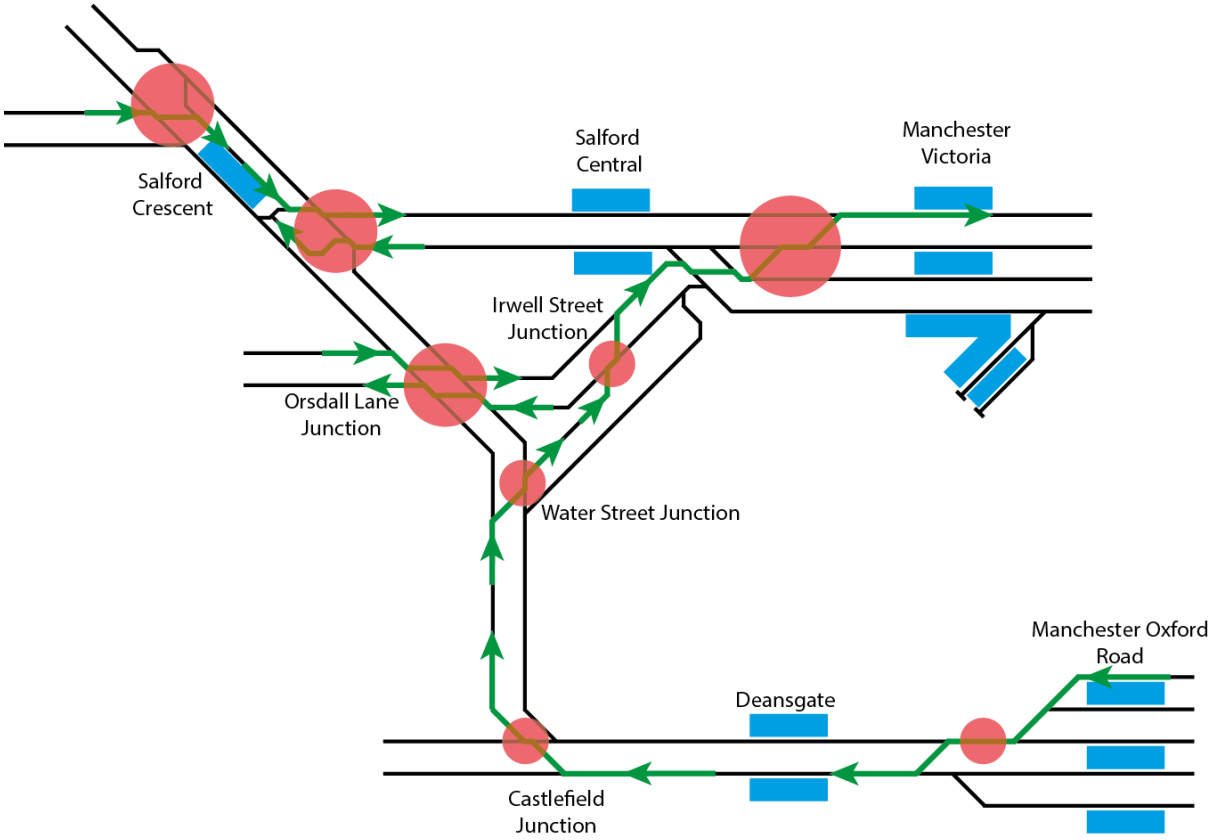

Figure 3: Major conflict points (circled in red) of the Central Manchester area

The train service, as shown in Figure 4, has many crossing moves at the problem locations. However, it should be noted that there are some services that have a greater impact than others due to the number of crossing moves they are performing.

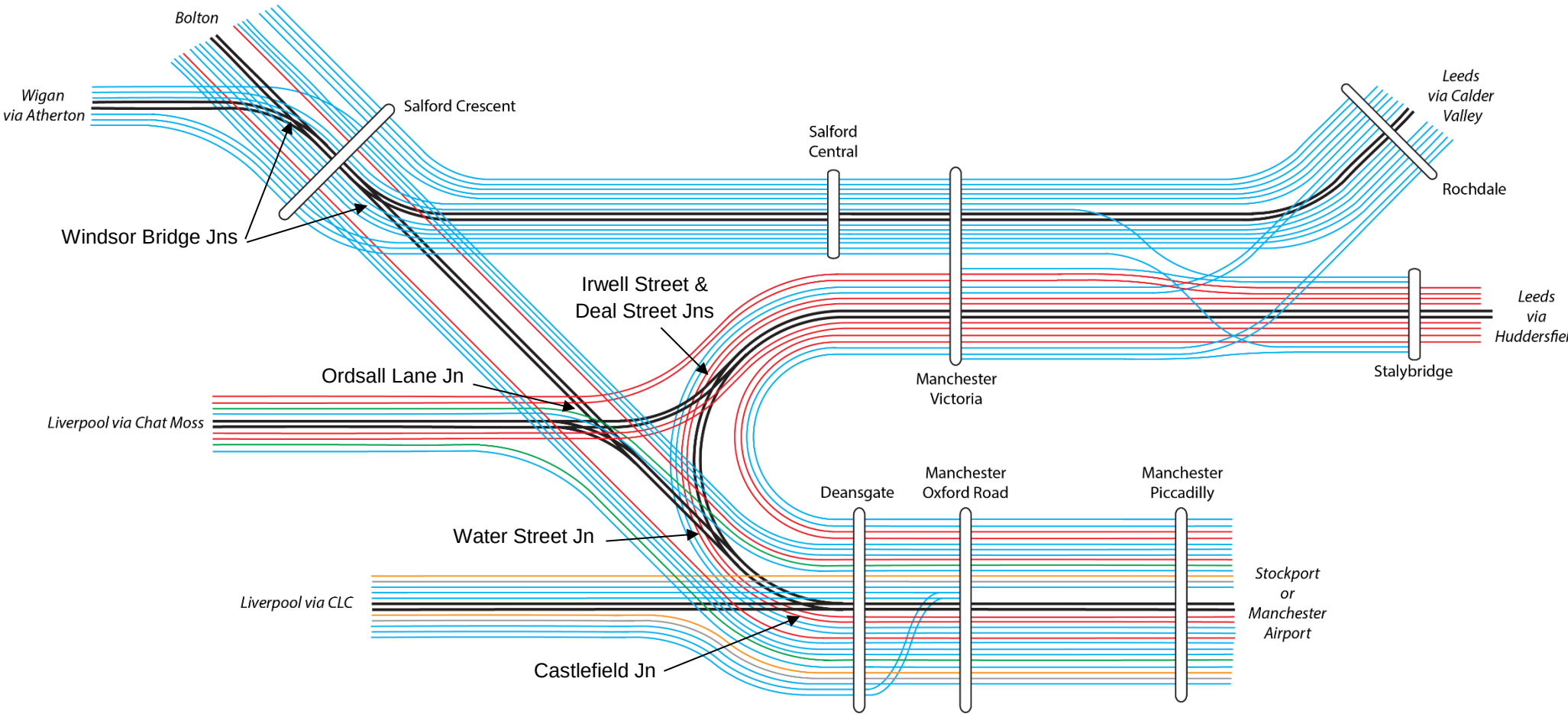

Figure 4: Graphic representation of the TSS used in this analysis. Black lines represent simplified infrastructure. Each coloured line represents one train movement per hour. Crossing lines show a potential timetabling conflict.

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There are several services identified in the TSS that caused issues relating to the interaction between junctions when it came to timetabling them. Particular issues were had with the following services:

Manchester Airport – Bradford/Leeds (via Calder Valley)

These trains are problematic because of the number of conflicting moves they make across Central Manchester. A train heading North from the Airport undertakes a conflicting move at Castlefield Junction, Water Street Junction, Irwell Street Junction (Figure 5) and then (depending on platform availability at Victoria, or junction capacity at Deal Street Junction) Victoria East Junction or Miles Platting Junction. This makes it a very difficult train to plan as, due to the number of crossing moves, it is the least flexible and therefore other services must be planned around it. Any other train planned in or out of Victoria, or in to Oxford Road, would conflict with this service. The only non-conflicting movement that can take place whilst the Airport – Bradford train is passing through the Corridor is to have a train running the other way along the Ordsall Chord, from Manchester Victoria to Manchester Oxford Road.

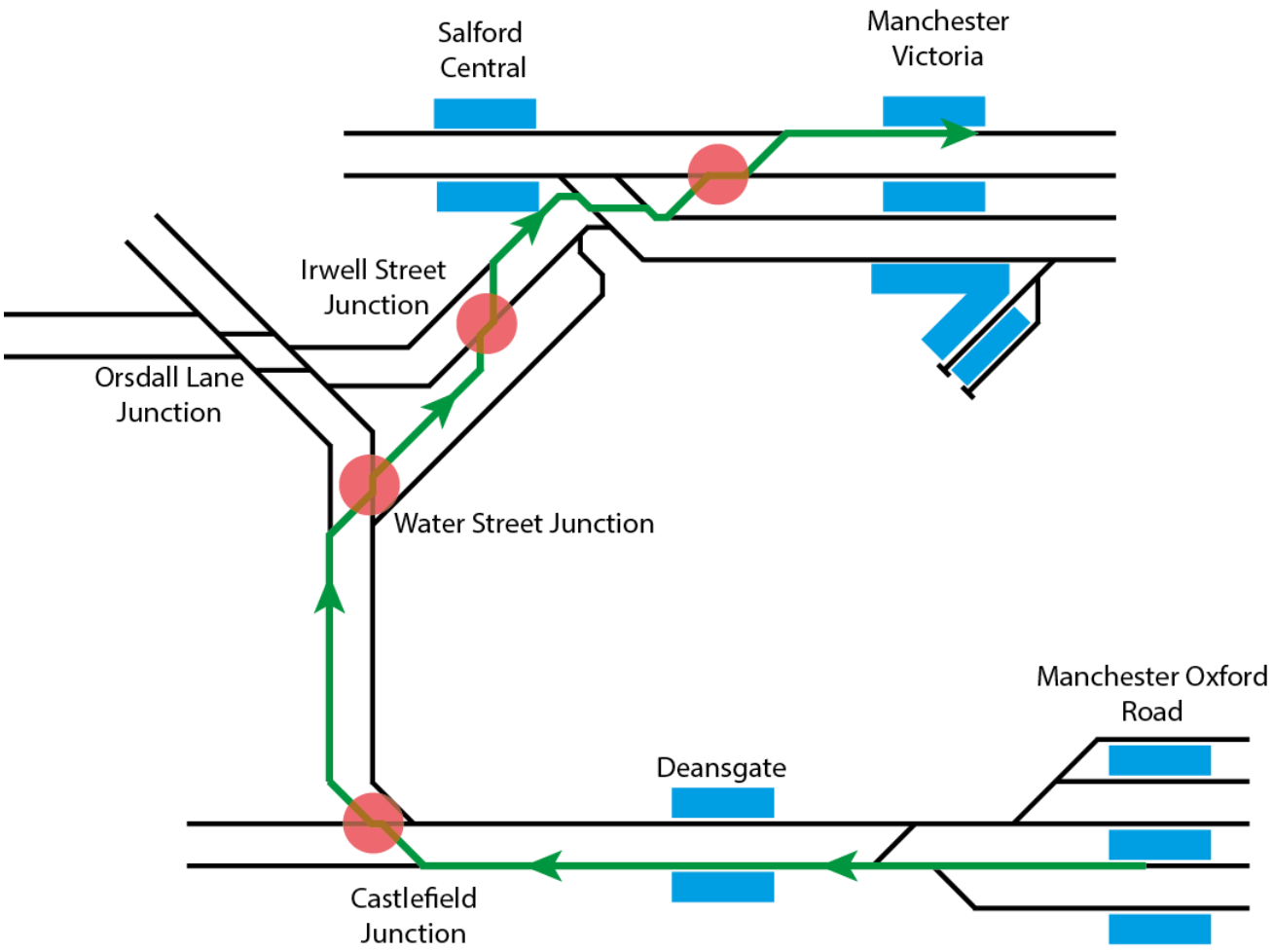

Figure 5: Conflicts created by a Manchester Airport - Calder Valley service

The impact of these trains can be reduced by crossing services to the Calder Valley line at Miles Platting Jn or immediately to the east of Victoria station; however, this merely moves the conflict point.

To a lesser extent, Manchester Airport to Leeds services are also a problem, although these services use platform 4 at Victoria so do not conflict as much in the Victoria station throat as the Calder Valley services which would use platform 6.

C.03 Defensive Driving Techniques

The addition of pathing time is a technique that can be used in timetable planning to make train movements TPR compliant with each other. This extends the journey time between two locations and plans a train to see restrictive aspects. Normally this is deemed to have a performance benefit because a late running train has a chance to make up time and a train that is on time will just slow down and wait for its allotted time. However, in the central area of Manchester, where the junctions (and therefore signals) are so close together, pathing time can have the opposite effect.

To prevent coming to a complete stand and to reduce the risk of a signal being passed at danger (SPAD), some drivers will slow down and travel towards a yellow signal at slower than the maximum permitted speed. (Corporate driving policies vary across the various companies that operate in this area). This means that the assumption that the journey will only be extended between the two defined locations is incorrect and it is also extending the occupation time of other sections of line. Consequently, a train that has pathing time added to its schedule will be on time, but it may be blocking the progress of another train by preventing a signaller setting the route for the second train. This is particularly a problem when, in central Manchester, there are several junctions that have a single signal separating them. This means that when a signal is red due to a conflicting move three signals ahead of the train, the driver will see a double-yellow signal and still have two junctions to cross; this is demonstrated in Figure 6. This is not specific to just one location but rather occurs at multiple locations across the central Manchester area.

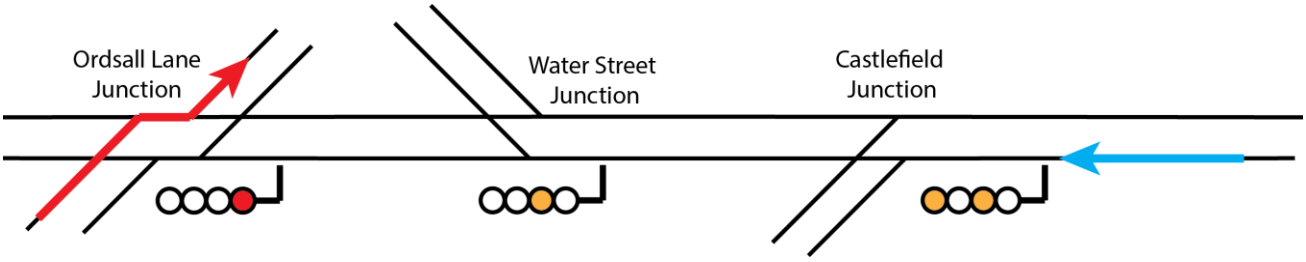

Figure 6: Pathing Time may have been added in the schedule of the Blue train between Water Street Junction and Ordsall Lane Junction to allow passage of the Red train across Ordsall lane. However, the train may slow down before reaching Water Street Junction to avoid coming to a halt at Ordsall Lane meaning that Castlefield Junction and Water Street Junction are blocked for longer than assumed in the timetable.

A solution that reduces the need for pathing time, either by reducing the number of trains across junctions (and thereby reducing the need for pathing time), or an infrastructure intervention that eliminates the need for as much pathing time as possible, is desirable.

C.04 Infrastructure Constraints

The impact of infrastructure constraints has been ranked as High, Medium and Low for each identified constraint. This is **purely indicative** based on the experience of how difficult each constraint has been to timetable when conducting analysis on this area. Definitions are:

High – caused significant issues in timetabling and had to be reworked many times due to constraints in other areas. Elimination of this constraint would greatly help the timetabling process and reliability.

Medium – caused some issues as a result of other areas being very constrained. Elimination of a number of these constraints may be an alternative to dealing with the biggest constraints

Low – caused minor issues, elimination of all of these would not fundamentally improve the situation without tackling some of the medium and high issues.

The ranking is purely to provide guidance and is not quantifiable or a guarantee that resolution would solve the issues present. It is likely that a combination of interventions would be required to deliver the capacity and reliability that is being sought.

There is no guarantee that resolving a high impact item would solve the capacity and reliability issues in Manchester and it is likely that a combination of more than one intervention would be necessary to relieve the network in this area.

C.04.01 High Junction Utilisation

The TSS used in this study has a large number of trains using key junctions in the central area. Castlefield Junction has 30 trains an hour planned across it and Ordsall Lane junction has 16 trains an hour planned across it. The sheer number of trains utilising some junctions means that there is very little unused time left in an hour. There is limited flexibility and more importantly limited performance gaps. Without infrastructure interventions there is little that can be done to address this. There are sometimes large gaps at junctions where no trains are crossing the junction, e.g. Ordsall Lane Junction in the first 10 minutes of the hour, but no movements can happen because of interactions to the north and south. Whilst in theory a train could be routed from Chat Moss to Victoria in this window, the movements to the north and south at Water Street and Windsor Bridge South Junctions would prohibit an east-west movement from entering or exiting Manchester Victoria at this time.

Name	Number of Movements per hour
Castlefield Jn	30
Windsor Bridge North Jn	22
Windsor Bridge South Jn	22
Water Street Jn	20
Ordsall Lane Jn	16
Irwell Street Jn	12

Table 1: Number of Movements per hour at the key Central Manchester Junctions

a) Infrastructure Solution

The introduction of grade separation to any of the junctions listed in Table 1 will reduce the dependency of the newly grade separated junction on the other flat junctions. This would release capacity and improve the performance in times of perturbation, as it reduces the reliance on parallel moves. This means that a late train has less impact upon the timetable. Junctions with the largest number of trains using them should be prioritised over junctions with fewer trains.

b) Train service Solution

Should an infrastructure solution not be available, then a train service solution is required. This could be by reducing the number of trains in key locations (Table 1), either by diversion of trains away from the junction, or through the removal of trains altogether. This would free up capacity at junctions and would assist in times of perturbation as there would be spare capacity in which a late running train could operate and cause less impact to other services. This is especially relevant to Castlefield Junction where the occupancy of the railway in this area is near to 100%, meaning that any late running will persist and continue to knock-on exponentially to other services until a train is cancelled to recover the timetable.

Impact: High

C.04.02 Conflicting moves at Manchester Oxford Road

Any train that departs the bay platform here to head west is required to have a gap between both eastbound and westbound trains to depart without delaying other services (Figure 77). This is difficult to achieve due to a combination of the high service frequency and the complex interactions of all the other services. This is further compounded by the need to be immediately behind the preceding fast service to Liverpool (via the Cheshire Lines Committee (CLC) route) to prevent the next fast service catching the slow service before it reaches its destination.

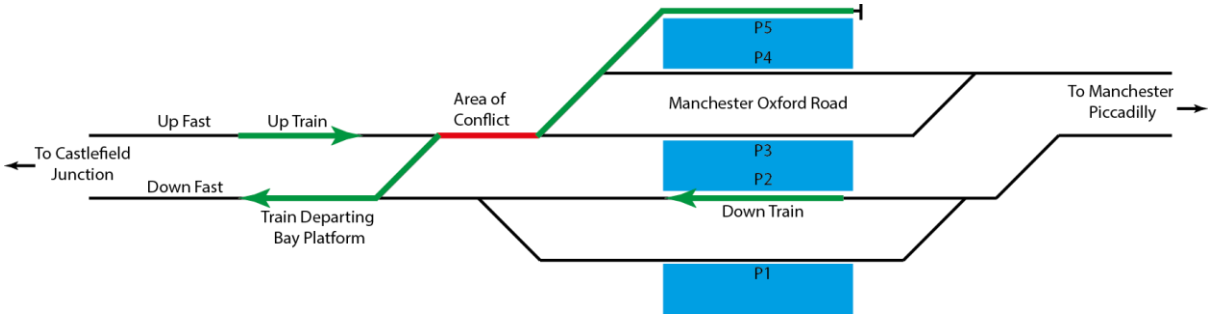

Figure 7: Trains departing platform 5 at Manchester Oxford road must cross Up direction trains as well as have a gap between down direction trains. This is a difficult move to plan and reduces capacity in the rest of Central Manchester.

Provision of a centre-turnback, that allows a non-conflicting arrival and departure would eliminate this conflict entirely. Trains would only need to be planned on headway and the opposite direction services are no longer a factor. This intervention was assumed to be in place as part of the analysis to eliminate a known existing constraint and allow the analysis to capture other potential constraints without wasting excessive amounts of limited time trying to make the Corridor TPR compliant.

Impact: High

C.04.03 Insufficient capacity: Castlefield Corridor – Manchester Piccadilly

The requirement to run 15tph on this section of route means that trains are consistently running on the minimum TPR values (which have been identified as being deficient). If there were additional platforms at Manchester Oxford Road and Manchester Piccadilly that would allow greater flexibility in timetabling this section, it would present a much more flexible timetable that would be less susceptible to minor delay incidents causing significant delays to multiple services.

Impact: High

C.04.04 Salford Crescent Layout

The layout of Windsor Bridge North and South junctions at Salford Crescent, and the location of the island platform between them means that there are many conflicting moves in this area. All Atherton line trains must cross the whole way across the layout in both directions, resulting in a conflict occurring with any movement on the Bolton lines. The TSS has 22 trains an hour operating in this area and the number of conflicts significantly reduces capacity. The ability to have more parallel moves, or an additional platform, would help to reduce the complexity of timetabling this area.

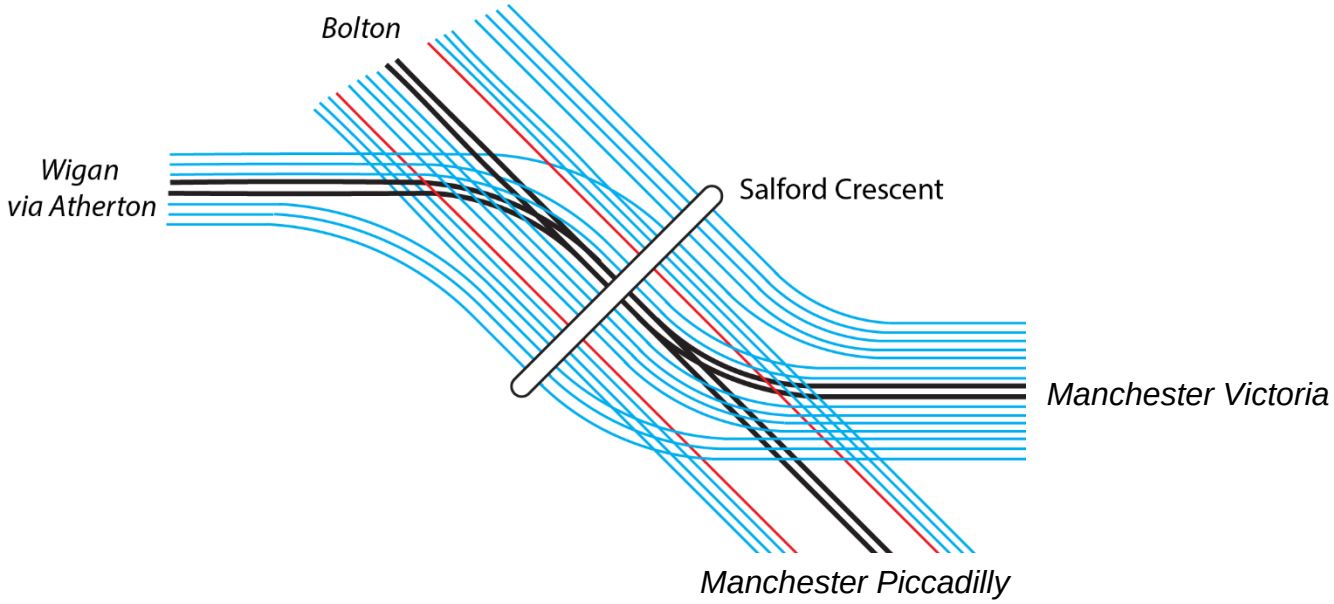

Figure 8: Extract from the TSS showing the conflicting movements that happen locally to Salford Crescent station, at Windsor Bridge North & Windsor Bridge South Junctions.

Grade separation of Windsor Bridge North would provide the most benefit by enabling total deconfliction of certain services from others, releasing capacity to flex other services around some of the more constrained areas further south.

An alternative solution would be to deconflict the train service so that there are fewer crossing movements; for example, routing trains from the Atherton lines towards Manchester Piccadilly and having the majority of Bolton line services routed towards Manchester Victoria. This would maximise the existing infrastructure configuration and could be more effective with future infrastructure options such as additional platforms or more parallel routes.

Impact: Medium

C.04.05 Inflexibility of Feeder Corridors

All of the direct feeder routes are double track, meaning that a flighted timetable is enforced due to the number of trains that are being planned on all these routes.[1] This limits the ability to use junctions efficiently and forces a specific sequence of movements to happen together to ensure compliance beyond central Manchester. This is because there is a need to send the fast train across the junction immediately prior to the slow train and if these run in the wrong order the fast will be delayed by the slow train ahead of it until a suitable passing location.

The addition of locations to reorder services, e.g. loops and through platforms, on each feeder corridor would allow greater planning flexibility for services into and out of central Manchester. An example of this is seen on the CLC route whereby a Slow service must depart the Castlefield Corridor immediately behind a Fast service to prevent the subsequent Fast service getting caught behind the preceding Slow. An overtaking facility on the CLC would allow more flexibility as to when the Slow and subsequent Fast services can be planned out of the Castlefield Corridor.

This applies to all routes, but particularly for the Chat Moss, CLC, Calder Valley and Bolton corridors.

These could have further performance benefits by acting as a regulating point in times of perturbation; however this would be subject to signaller workload and equipment.

Impact: Low

C.04.06 Irwell Street & Deal Street Junction conflicts

The layout of both Irwell Street junction and Deal Street junctions, where the Chat Moss lines meet the Ordsall Chord lines on the approach to Manchester Victoria, prevent a number of parallel moves taking place. As identified above, a train approaching Manchester Victoria from Manchester Oxford Road prevents a lot of other movements from happening in this area while this crossing move is carried out. This is exacerbated by the layout of Irwell Street Junction because a train approaching Victoria from the chord blocks both the Down & Up Chat Moss lines. A train using the chord also blocks Water Street Junction, preventing a train from using the Bolton lines through Ordsall Lane Junction. This presents a perfect opportunity to route a train from the Chat Moss lines across Ordsall Lane in the other axis, but this can’t happen because of the junction layout (Figure9).

[1] Flighting is where services follow each other in a particular order on account of their speed and/or stopping pattern, so as to make best use of the available capacity and avoid fast trains catching up with slow trains

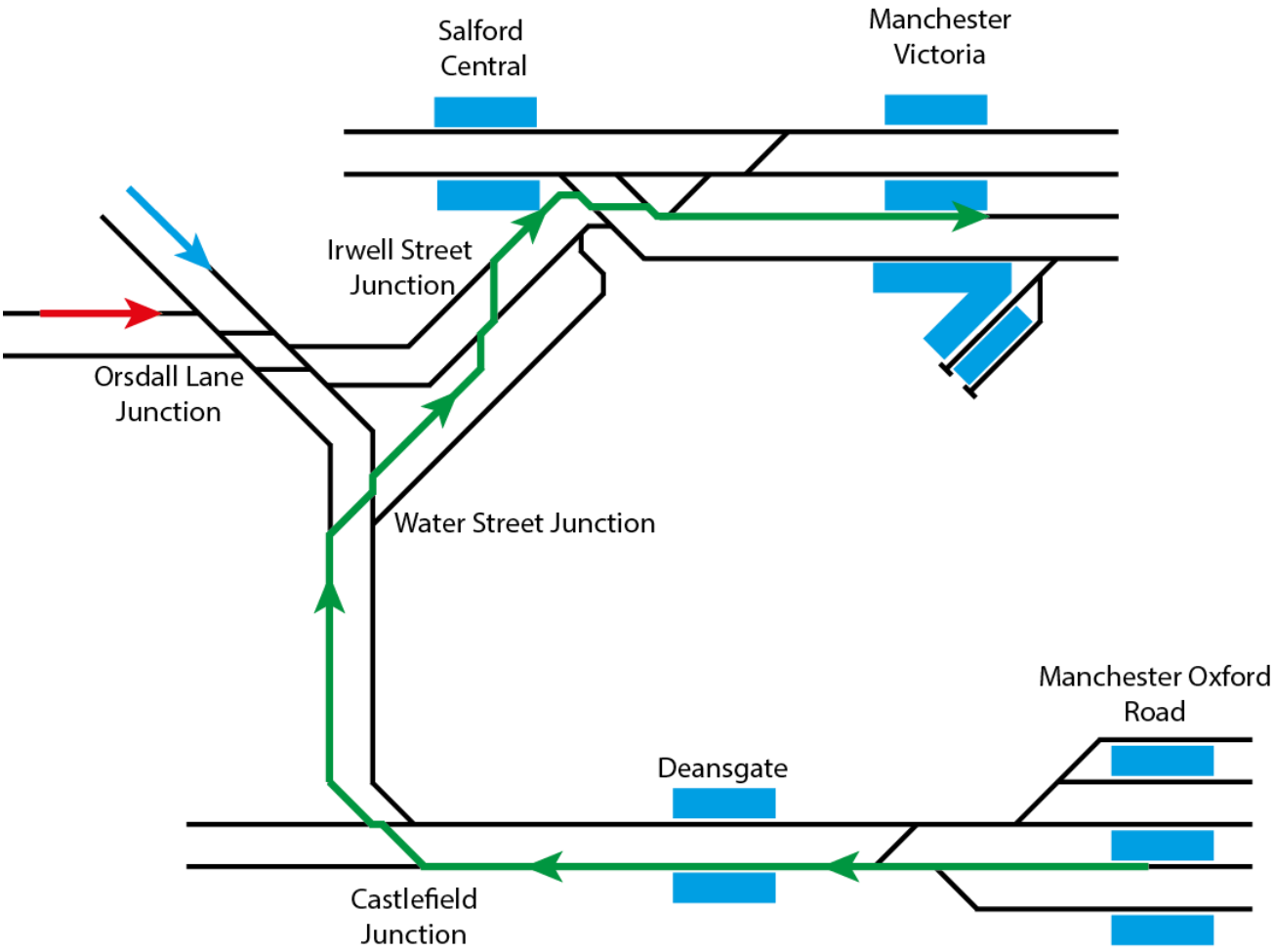

Figure 9: A train routed around the Ordsall chord (green) prevents movements along the Bolton lines to Castlefield Junction (blue) or trains from the Chat Moss to Manchester Victoria (red).

If the track layout in the Salford Central area were to be reconfigured, allowing trains to operate across Ordsall Lane Junction whilst trains operate around the Ordsall Chord, there would be more opportunities to plan trains across the path of another and increasing timetabling flexibility.

Providing an additional pair of tracks from Salford Crescent through to Victoria with suitable sets of crossovers would unlock a lot of potential parallel moves in the area. If combined with a rebuilding of Salford Crescent station with additional platforms and redesigned Windsor Bridge junctions, the options are increased further (Figure 10 and Figure 1).

This solution alone will not assist with throughput of services through Manchester Oxford Road but would help in times of perturbation.

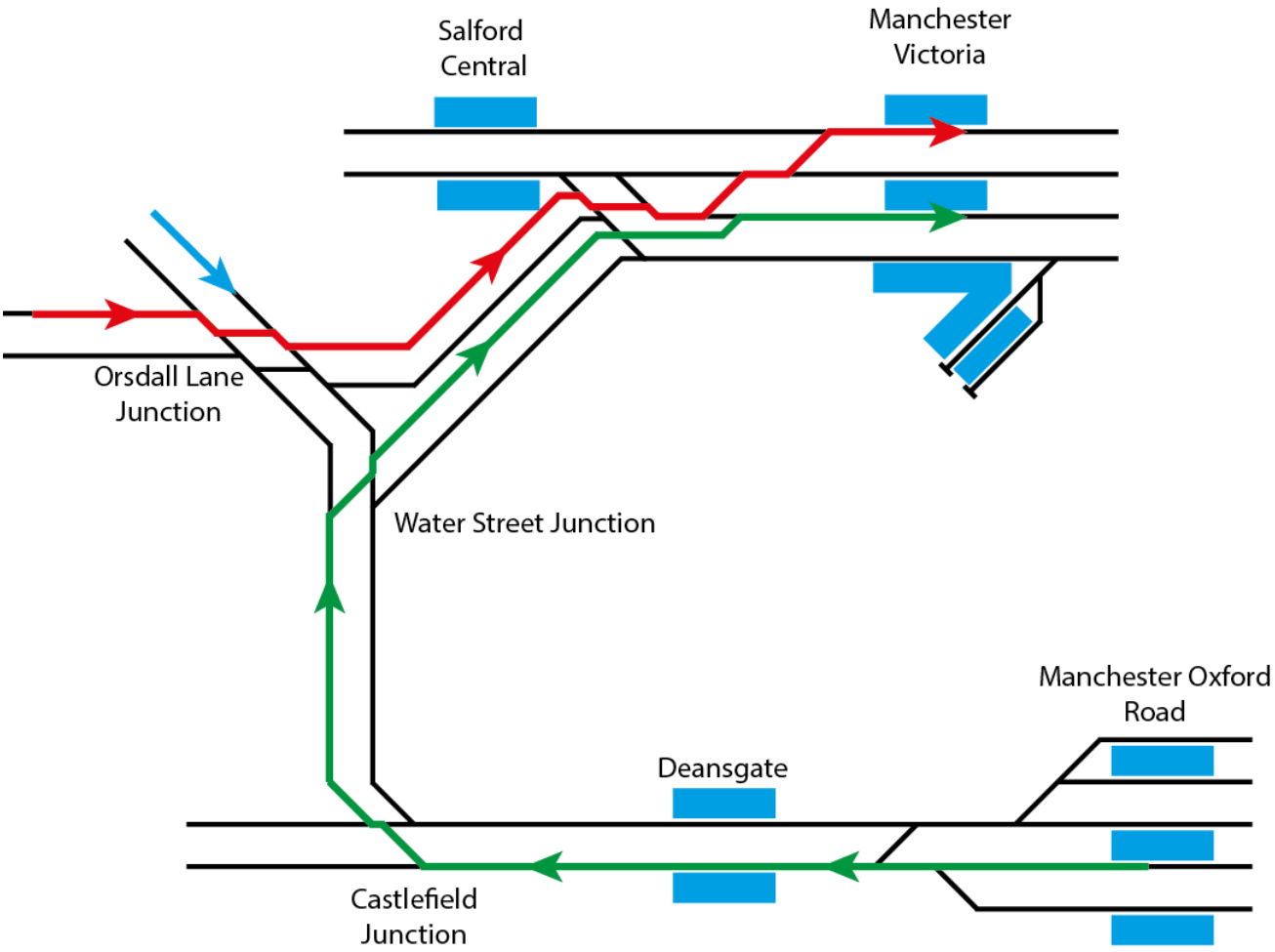

Figure 10: An example of how a reconfigured layout could enable a simultaneous arrival at Manchester Victoria from the Chat Moss lines (red) and the Ordsall Chord (green), maximising the opportunity provided by the Bolton lines being blocked (blue)

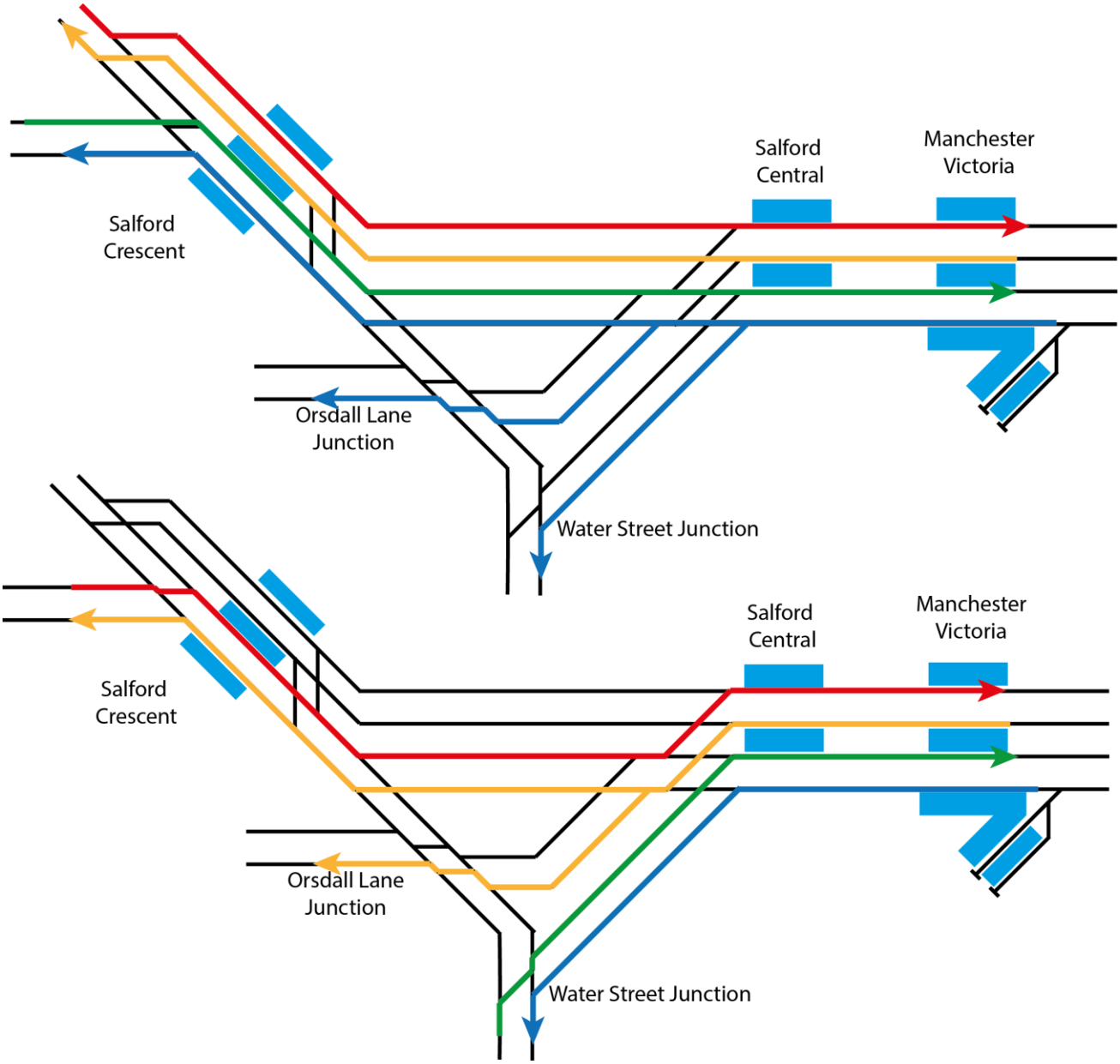

Figure 11: Some examples of potential parallel moves that could be unlocked by redesigning the junctions in the Salford area and by providing an extra pair of tracks between Salford Crescent and Salford Central. This is not an exhaustive representation and other combinations could be possible.

Impact: Medium

C.04.07 Manchester Victoria Platform Capacity

Due to the predicted lengthening of trains in the near future, permissive working was not possible when timetabling Manchester Victoria. This forces a number of services in and out of the station on minimum dwell times in order to clear platforms for the next arriving train.

The flighted nature of the feeder corridors and how junctions are forced to work means that services are grouped together in blocks in certain sections of the hour on each platform

rather than being spread more evenly across the hour. This is demonstrated in Figure 2 and Figure 3.

Re-occupation of platforms at Manchester Victoria is 3 minutes; this combined with a dwell of 2 minutes means that a through platform, used in one direction, can handle a train every 5 minutes. Due to the need to operate trains in pairs across certain junctions, or at headway on arriving corridors, trains are arriving at Manchester Victoria at less than 5-minute intervals. As a result, the following service is either routed in to another platform, creating more conflicts and disrupting the flow of trains in the opposite direction; or, the following service is timed to wait for a platform to become available. This means approaching the station on restrictive aspects and potentially obstructing junctions for longer than is planned due to defensive driving techniques.

The addition of mid-platform signals would enable the TPR values to be reduced and permit faster re-occupation of the platforms. If the platforms were lengthened to enable a 6-car train to stand either side of the mid-platform signal this would also increase the platform capacity of the station without the restrictions imposed by permissive working.

The number of trains operating in to and out of Manchester Victoria prohibits the termination of services in the station. A terminating service must dwell for a minimum of 4 minutes and creates conflicting movements either on arrival or departure. Therefore, all services were timetabled as through services to reduce the occupation and improve the efficiency of the station. Provision of reversing sidings to the east of the station would enable a reduction in the number of services sent to Rochdale and Stalybridge, enhancing the ability to do crossing moves for trains that do continue east, and would improve resilience if enough sidings are provided to enable longer turnrounds of trains. A disadvantage is that dwells would need to be extended from 2 minutes to ensure the unit is clear before running as Empty Coaching Stock (ECS) to the turnback sidings. In times of perturbation it should be noted that these could provide refuge for trains that get cancelled, which would aid the recovery of the timetable.

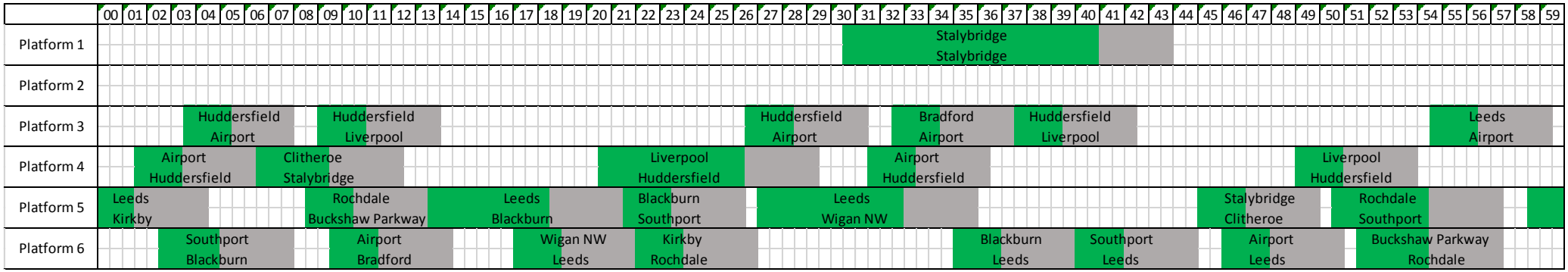

Figure 12: Approach A platform occupation graph at Manchester Victoria for a whole hour. In this approach, trains were optimised on the Castlefield – Manchester Piccadilly section of route first, causing a grouping of services as seen here. Dwell of a train is shown in Green, platform re-occupation time (unusable capacity) is shown in grey. Spare capacity is shown in white.

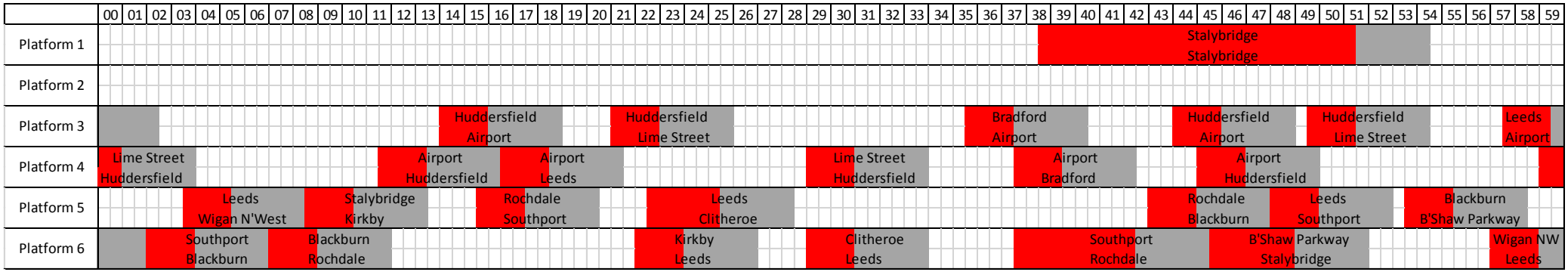

Figure 13: Approach B platform occupancy graph for Manchester Victoria. In this approach the operation of the station was optimised before timetabling in to the Castlefield - Manchester Piccadilly corridor. This approach should allow a more even spacing of trains across the hour on each platform; however, as can be seen, the same issues of trains being grouped together exists in this timetable too. It does however show a more even throughput of trains with fewer extended dwells

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To maximise capacity at the station, the general intention has been to utilise the platforms as follows;

Platform 3: Westbound to Ordsall Chord and Chat Moss lines from Stalybridge
Platform 4: Eastbound from Ordsall Chord and Chat Moss lines to Stalybridge
Platform 5: Westbound to Salford Crescent from Rochdale
Platform 6: Eastbound from Salford Crescent to Rochdale

Segregation of flows in this manner reduces conflicting moves and encourages a similar number of services on each platform each hour. However, there are occasions where presentation times of services force this pattern to be broken. This creates conflicting moves in the throat and makes the area more vulnerable to delay.

Impact: Medium

C.04.08 Limited Platform Capacity at Manchester Airport.

The use of longer (156m) trains in the future prevents the use of any platform at Manchester Airport by two trains simultaneously. This greatly reduces the capacity of the station and forces departures that may be sub-optimal for utilising capacity in central Manchester in order to ensure platform availability for arriving services. This also drives short turnrounds that will likely have a negative impact upon performance.

The TSS has the majority of Northern services being operated by 15X rolling stock. Should this not be the case then the opportunity to interwork service groups may be unachievable and platform capacity could be reduced.

There are further factors that may have an adverse impact on the platform capacity at Manchester Airport which have not been captured in this analysis. Firstly, there has been no consideration of services approaching Manchester Airport from the South. With these services considered, platform capacity will be further restricted, and turnarounds reduced.

Secondly, the TSS lists only 15Xs operating at the station whereas it is likely a greater variety of rolling stock will be operating. This analysis utilises the interworking of services at Manchester Airport which may no longer be possible due to the increased mix of rolling stock operating.

Solutions to the limited platform capacity would need to include lengthening of platforms to enable permissive working, additional platforms or shortening of trains to relieve the constraint at the airport.

Impact: Medium

C.04.09 Bolton – Blackburn Single Line sections

The single line sections between Bolton and Blackburn requires trains to be evenly spaced at Manchester to avoid creating conflicts on the single line. This means that a change made to one service in central Manchester to make it compliant with other services affects the

other three Blackburn trains an hour which use the single line sections. These in turn will cause knock-on effects to other services in central Manchester as they are retimed. This knock-on effect is also seen in delay situations where a late-running outbound service transfers delay onto the inbound train which cannot use the single-track until the outbound has cleared the line. This limits the ability to recover delay as it is passed from service to service, and imports delay into Manchester.

The timetabling issue could be resolved by reducing the conflicting moves at Salford Crescent and/or Manchester Victoria, however this would not solve the performance issue. To resolve the performance issue, it would be necessary to double track the current single-track sections.

Impact: Low

C.04.10 Inconsistent Headways across the Geographic Scope

Differing headways on corridors approaching or leaving Manchester cause issues with capacity in the central area. For example, along the Calder Valley, north of Rochdale, when trains are calling at Smithy Bridge and Littleborough the headway increases from the standard 4 minutes for this route to 6 ½ minutes. This forces trains further apart than is optimum and creates a difficulty in planning successive moves in central Manchester as the trains are at times too far apart. This applies to the CLC and the Atherton lines as well where inconsistent headways create a sub-optimal spacing of services from a planning perspective.

Re-signalling of these routes would assist in creating consistent headways but is unlikely to unlock the capacity required to make a radical difference to the timetable flexibility required in the central area.

Impact: Low

C.04.11 Manchester Victoria East & Miles Platting Junctions.

The junction layouts to the east of Manchester Victoria limit the ability to carry out parallel moves. Manchester Victoria East Junction, located in the eastern throat of the station, consists of two single ladders allowing access to all lines in both directions, but not in parallel. Further to the east is Miles Platting junction, which is a single ladder that allows movements from Up Rochdale Fast to Up Rochdale Slow and Down Rochdale Slow to Down Rochdale Fast. This means that a train crossing from platform 6 to reach Stalybridge cannot do this move in parallel with the reverse direction movement that is heading to platform 5 as there is only one set of crossovers. If the two movements are running at similar times, then one train will need to wait for the other, or one of the conflicting moves will need to be moved to the western throat to Victoria, an area that is already very congested.

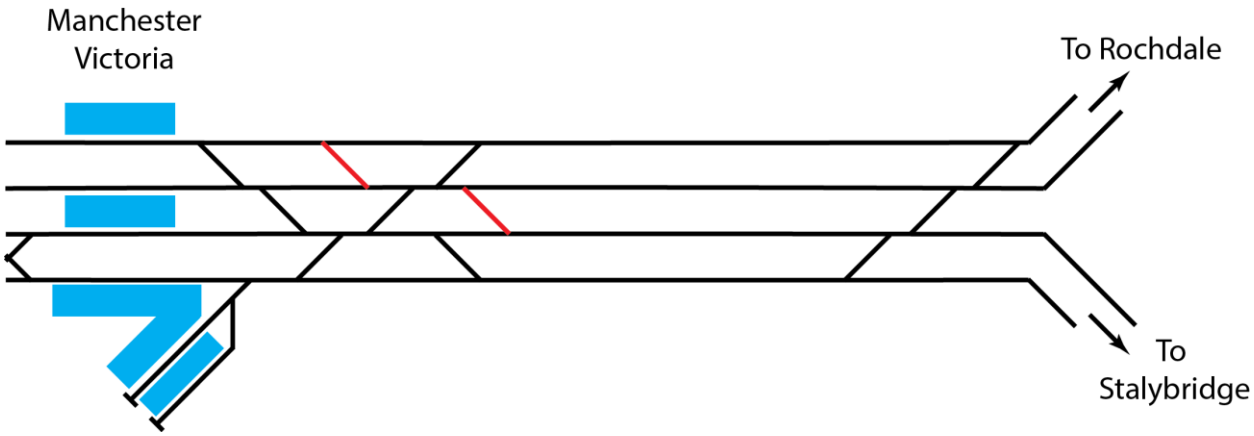

Figure 14: Crossovers available between Manchester Victoria and Miles Platting Jn. A second ladder (red) to allow parallel moves to and from Stalybridge towards the northern platforms 5&6 would allow greater timetabling flexibility.

Provision of extra crossovers to the east of Victoria station to enable more parallel moves here, relieving the west side of the station, would benefit capacity.

Impact: Low

Part D: **Conclusion**

The TSS cannot be reliably accommodated on the current (2018) Manchester infrastructure. A combination of infrastructure, timetable and/or train service interventions are required to enable a robust service to operate in and around central Manchester. Without an infrastructure intervention, 13tph is the maximum number of services which can operate through the Castlefield Corridor (of which two terminate at Manchester Oxford Road).

This report has identified the following key constraints as listed below:

Constraint	Description	Resolution	Impact
TPRs	Platform re-occupation values are too short at Manchester Oxford Road and Manchester Piccadilly	Extend re-occupation times to reflect physical capability and provide a performance buffer, especially with longer trains	High
TSS	Too many trains using Castlefield Junction and Corridor	Reduce the total number of trains in the Castlefield Corridor	High
	Too many conflicting moves in the TSS	Remove or divert some trains to reduce the number of conflicting moves in the TSS	High
Infrastructure Constraints	High Junction Utilisation	Reduce the number of trains in the TSS or increase capacity of junctions by grade separation	High
	Conflicting Moves at Manchester Oxford Road	Provide a centre-turnback to remove the conflicts entirely. (This has been assumed in this analysis)	High
	Castlefield Corridor Capacity	Provide 4 through platforms at Manchester Oxford Road and at Manchester Piccadilly to reduce the headway on the Corridor	High
	Salford Crescent Layout	Redesign of station and junction layout to reduce conflicts	Medium

	Inflexibility of Feeder Corridors	Provide overtaking capability on each corridor	Medium
	Irwell & Deal Street Junction Conflicts	Redesign the junctions to enable more parallel moves	Medium
	Manchester Victoria Platform Capacity	Mid-platform signals to reduce platform re-occupation time	Medium
	Platform Capacity at Manchester Airport	Provide more platforms or longer platforms to enable permissive working	Medium
	Bolton – Blackburn Single Line sections	Reduce the number of conflicting moves Blackburn trains interact with or double single line sections	Low
	Inconsistent Headways across the Geography	Resignal to provide consistent headways feeding in to and out of Manchester	Low
	Lack of parallel moves east of Manchester Victoria	Provide additional crossovers to enable parallel moves	Low

There is no guarantee that one intervention would resolve all the issues highlighted, and it is likely that a suite of interventions would be required to deliver the full TSS. It is highly likely that there will need to a combination of reduction or alteration of TSS and an infrastructure intervention to produce a reliable timetable that has the flexibility required to recover from perturbation when it happens.

There may be further capacity constraints beyond those listed in this report that further analysis would identify.

Recommendations

Further analysis will need to be undertaken to identify whether any proposed intervention agreed delivers the required output, the possible interventions listed here may only be partially possible and it will require further analysis work to establish the effectiveness of the intervention.

Part E: **Appendix A – Train Service Specification (TSS)**

This TSS was developed by Network Rail System Operator and agreed by the project's Delivery Steering Group (DSG).

Coloured trains are paired services and should be as close to clockface from Manchester as possible.

Ref	Route	Service Summary	Stopping Pattern	Rolling Stock	Notes	Operator
1a	Atherton	Southport - Manchester Victoria	Southport, Bescar Lane, New Lane, Burscough Bridge,Hoscar,Parbold, Appley Bridge, Gathurst, Wigan Wallgate, Hindley, Daisy Hill, Atherton, Walkden, Swinton, Salford Crescent, Salford Central, Manchester Victoria	150	Has been split from Southport - Blackburn via Man Vic service.	Northern
1b	Calder Valley	Manchester Victoria - Blackburn	Manchester Victoria, Rochdale, Smithy Bridge, Littleborough, Todmorden, Burnley Manchester Road, Rose Grove, Accrington, Blackburn	150	Has been split from Southport - Blackburn via Man Vic service.	Northern
2a	Bolton	Blackburn - Manchester Victoria	Blackburn, Darwen, Bromley Cross, Hall in the wood, Bolton, Salford Crescent, Salford Central, Manchester Victoria	150	Has been split from Blackburn - Rochdale via Man Vic service	Northern
2b	Calder Valley	Manchester Victoria - Rochdale	Manchester Victoria, Moston, Mills Hill, Castleton, Rochdale	150	Has been split from Blackburn - Rochdale via Man Vic service	Northern
3a	Atherton	Southport - Manchester Victoria	Southport, Meols Cop, Burscough Bridge, Parbold, Appley Bridge, Gathurst, Wigan Wallgate, Daisy Hill, Atherton, Walkden, Salford Crescent, Salford Central, Manchester Victoria	150	Has been split from Southport - Leeds via Man Vic service	Northern

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3b	Calder Valley	Manchester Victoria - Leeds	Manchester Victoria, Rochdale, Smithy Bridge, Littleborough, Walsden, Todmorden, Hebden Bridge, Mytholmroyd, Sowerby Bridge, Brighouse, Mirfield, Dewsbury, Batley, Morley, Leeds	150	Has been split from Southport - Leeds via Man Vic service	Northern
4a	Bolton	Clitheroe - Manchester Victoria	Clitheroe, Whalley, Langho, Ramsgreave & Wilpshere, Blackburn, Darwen, Entwistle, Bromley Cross, Hall I'T'Wood, Bolton, Salford Crescent, Salford Central, Manchester Victoria	150	Has been split from Clitheroe - Rochdale via Man Vic service	Northern
4b	Calder Valley	Manchester Victoria - Rochdale	Manchester Victoria, Moston, Mills Hill, Castleton, Rochdale	150	Has been split from Clitheroe - Rochdale via Man Vic service	Northern
5	Chat Moss & TPE	Liverpool - Newcastle	Lime Street, Newton-Le-Willows, Manchester Victoria, Huddersfield….	185	5&7 to be around 30 minutes apart	TPE
6	Calder Valley	Manchester Victoria - Leeds	Manchester Victoria, Rochdale, Todmorden, Hebden Bridge, Mytholmroyd,Sowerby Bridge, Halifax, Bradford Interchange, New Pudsey, Bramley, Leeds	150		Northern
7	Chat Moss & TPE	Liverpool - Scarborough	Lime Street, Lea Green, Manchester Victoria, Huddersfield…	185		TPE
8	Castlefield & TPE	Manchester Airport - Middlesborough	MIA, Piccadilly, Oxford Road, Victoria, Huddersfield…	185	8&12 to be around 30 minutes apart	TPE
9a	Bolton	Wigan NW - Manchester Victoria	Wigan NW, Hindley, Westhoughton, Bolton, Moses Gate, Farnworth, Kearsley, Salford Crescent, Salford Central, Manchester Victoria	150	Has been split from Wigan NW - Stalybridge Service	Northern
9b	Stalybridge	Manchester Victoria - Stalybridge	Manchester Victoria, Ashton-under-Lyne, Stalybridge	150	Has been split from Wigan NW - Stalybridge Service	Northern
10	Stalybridge	Manchester Victoria - Stalybridge	Manchester Victoria, Ashton-under-Lyne, Stalybridge	150		Northern
11	Calder Valley	Manchester Victoria - Leeds	Manchester Victoria, Rochdale, Todmorden, Hebden Bridge, Halifax, Bradford Interchange, New Pudsey, Bramley, Leeds	150		Northern

12	Castlefield & TPE	Manchester Airport - Newcastle	MIA, Piccadilly, Oxford Road, Victoria, Huddersfield…	185		TPE
13	Atherton	Kirkby - Manchester Victoria	Kirkby, Rainford, Upholland, Orrell, Pemberton, Wigan Wallgate, Ince, Hindley, Daisy Hill, Hag Fold, Atherton, Walkden, Moorside, Swinton, Salford Crescent, Salford Central, Manchester Victoria	150		Northern
14	Bolton	Buckshaw Parkway - Manchester Victoria	Buckshaw Parkway, Chorley, Adlington, Blackrod, Horwich Parkway, Lostock, Bolton, Salford Crescent, Salford Central, Manchester Victoria	150		Northern
15	Chat Moss	LLime St-Man Pic-MIA	Edge Hill, Wavertree, Broad Green, Roby, Huyton, Whiston, Rainhill, Lea Green, St Helens Junc, Earlstown, Newton-le-Willows, Patricroft, Eccles, Man O Rd, Man Pic, MIA	319		Northern
16	Bolton	MIA – Man Pic – Preston and beyond	MIA, Man Pic, Bolton, Preston…	319		Northern
17	Chat Moss	North Wales - Manchester Airport	Newton-le-willows, Manchester Oxford Road, Manchester Piccadilly, MIA	175		TFW
18	Bolton	Southport – Man Pic – Alderley Edge	S'port, (Meols Cop, Burscough Bridge, Parbold, Appley Bridge, Gathurst, Wigan Wallgate), Hindley, Westhoughton, Bolton, Salford Crescent, Deansgate, Manchester Oxford Road, Manchester Piccadilly, Levenshulme, Heaton Chapel, Stockport, Cheadle Hulme, Handforth, Wilmslow, Alderley Edge	150		Northern
19	Bolton	Scotland– Man Pic - MIA	Preston, Bolton, Manchester Oxford Road, Manchester Piccadilly, Manchester Airport	350		TPE
20	Bolton	Blackpool north – Man Pic – Stockport or Beyond	Blackpool North, (Layton), Poulton-le-Fylde, (Kirkham & Wesham), Preston, Leyland, Buckshaw Parkway, Chorley, Horwich Parkway, Lostock, Bolton, Salford Crescent, Deansgate,	319		Northern

			Manchester Oxford Road, Manchester Piccadilly, Stockport, Cheadle Hulme, Bramhall, Poynton, Macc			
21	Calder Valley	MIA - Bradford	Cottingley, Morley, Dewsbury, Mirfield, Brighouse, Sowerby Bridge, Mytholmroyd, Hebden Bridge, Todmorden, Walsden, Littleborough, Smithy bridge, Rochdale, Man Vic, Man O Rd, Man Pic, MIA	150		Northern
22	Calder Valley	MIA - Bradford	Bradford, Halifax, Sowerby Bridge, Mytholmroyd, Hebden Bridge, Todmorden, Littleborough, Rochdale, Man Vic, Man Pic, MIA	150		Northern
23	CLC	LLime St – Man Pic – Sheffield - Warrington	Liverpool South Parkway, Widnes, Warrington Central, Birchwood, Manchester Oxford Road, Manchester Piccadilly, Stockport, Sheffield, Chesterfield, Alfreton, Nottingham	158		Northern
24	CLC	LLime St via Warrington Central - MIA	Liverpool South Parkway, Widnes, Warrington West, Warrington Central, Birchwood, (Irlam), Manchester Oxford Road, Manchester Piccadilly, East Didsbury	158		Northern
25	CLC	LLime St – Man O Rd	Edge Hill, Mossley Hill, West Allerton, Liverpool South Parkway, Hunts Cross, Halewood, Hough Green, Widnes, (Sankey), Warrington West, Warrington Central, Padgate, Birchwood, Glazebrook Irlam, (Flixton, Chassen Road), Urmston, (Humphrey Park, Trafford Park), Deansgate	150		Northern
26	CLC	LLime St – Man O Rd	Edge Hill, Mossley Hill, West Allerton, Liverpool South Parkway, Hunts Cross, Halewood, Hough Green, Widnes, (Sankey), Warrington West, Warrington Central, Padgate, Birchwood, Glazebrook Irlam, (Flixton, Chassen Road), Urmston, (Humphrey Park, Trafford Park), Deansgate	150		Northern
27	Freight	Trafford Park - Crewe via Styal		66-1600T		