**CREWE HUB – OPERABILITY**

**3rd August 2017**

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# Background

1. JRC has already reported to Crewe Town Council on the in-principle issues arising when creating a new High Speed Hub at Crewe for the North West and North Midlands. A short overview report was issued on 8th May 2017.
2. This report was expanded on, in respect of Hub access issues, and a final version of that was sent to Crewe Town Council on 7th June 2017. This showed that a substantial rail-based catchment, serving main urban clusters and spreading access benefits throughout the effective catchment (25 miles or more distant), could be achieved providing that the HS2 service level at Crewe was 4 trains per hour (tph) each way, not the basic 2 tph which HS2 Ltd had originally envisaged.
3. It is recognised that any growth of regional and feeder services is dependent on a operable station and track layout, which allows for foreseeable train service volumes in future decades on each entry and exit rail corridor. Crewe is already one of the more complex railway junctions in Britain (though *not* all the lines operate at high frequency). There are six main rail corridors and related junctions, and Independent Lines for main rail freight flows to avoid the passenger station junctions.
4. Add a further two rail corridors – HS2 northwards and southwards, plus a desire for some very high speed trains to pass non-stop, and also with some HS2 services entering and leaving the ‘classic’ rail network at this location – and the recipe for required operational tracks and platforms becomes more complicated.
5. In this further new paper, JRC has therefore focused on the rudiments of required changes in the Crewe operational arrangements, so that effective Hub access can be underpinned by important gains in operability.
6. Potential service developments are also considered. This includes the possibility that the official plans for routes and services with HS2 Phase 2b may merit some reconsideration, in order to enhance the regional connectivity and growth benefits. While the Government has just confirmed the basic routes for HS2 Phase 2b, there is still time to absorb revisions, as part of a conjoined process to achieve the best from HS2, HS3 and other growth aspirations in the Northern Powerhouse and Midlands Engine.

# Summary of conclusions

1. **Current capacity requirements**: Crewe has complex operational requirements. It also needs adequate operational margins built in to the physical infrastructure and timetable planning. So no more than 75-80% of actual capacity should be utilised here, in order to achieve adequate resilience.
2. **Present 2017 timetabling**: JRC has analysed the weekday May 2017 timetable for this multi-way junction, and assessed train movements in terms of their impact on dwell time and junction conflicts, for the 2AM to Noon period. A summary is provided of total scheduled train use, average intervals between trains, and the proportion of trains incurring less than average ‘free’ time between slots. The latter includes the total time occupied from approach to the Crewe area to the exit from this area.
3. **Future basis for operational changes**: The JRC analysis shows that the worst train operating conflict which currently arises is caused by the Manchester-Marches-Wales trains (crossing all LNW main lines in both directions). Some other flows also limit slot capacity. However, whether a potential slot is actively lost at present is immaterial, as it is the future potential capacity which matters here. The general impacts of HS2’s different Phases are noted, along with their different timescales, and the likely emergence of more frequent commuter and regional Hub services as the Crewe Hub increases in economic importance requiring better accessibility and connectivity. The redesign of Crewe will be required to accommodate all these factors. HS2 Phase 2a is the main driver for substantial change in the Crewe area.
4. **Choices for change – existing train operations**: The main opportunity is to segregate the Manchester-Marches-Wales service, by grade-separating it though use of the low-level Manchester and Salop Independent Lines with a new platform located there.
5. **Choices for change – HS2 Phases 1 and 2a**: In itself, HS2 Phase 1 does not cause many fundamentally new service patterns, although train timings would change. The bigger area changes arise with Phase 2a where high speed tracks reach to within a mile or so of Crewe. However, it is expected that major works would need to be underway in this pre-Phase 1 period, in order to be ready for Phase 2a operations. It is possible that some pre-Phase 2b works might also be desirable, to minimise the impact of multiple work phases and because access costs could rise after Phases 1 and 2a as greater passenger and train volumes (both HS and classic) could require additional compensation.
6. Crewe requires the best possible HS services to maximise its accessibility and scope for economic growth throughout a 25 mile Hub catchment. Raising the basic HS service level which calls at Crewe from two to four trains per hour would make a fundamental difference to the scope for Hub development (this is discussed in JRC’s Crewe Accessibility paper). It already appears that HS2 Phase 2a train speeds will bring Crewe within London commuting times. A range of opportunities for improved Northern commuter and regional Hub services is also set out. It is important for HS2 changes not to deny improvements to other area services, considered desirable as a consequence of area economic growth and ensuring that Hub benefits are distributed throughout the accessible catchment. Other regional and inter-regional priorities also merit consideration at this stage, as works might require incorporation at this stage, for example how better connectivity can be achieved between HS2 and HS3, and how aspirations such as Liverpool’s ‘20-mile’ campaign could be addressed affordably.
7. **Choices for change – HS2 Phase 2b**: HS tracks continue in this Phase past Crewe to Manchester Piccadilly and towards Wigan to rejoin the LNW North main line. New opportunities might arise with London-Edinburgh services via Crewe, a new Crewe link onto HS2 northwards, and through running between the Midlands and HS3 via HS2. HS2 Phase 2b already envisages new inter-regional HS expresses between Manchester and Birmingham. There is scope based on better connectivity and several new direct HS spurs, for a greater range of HS expresses joining up the main city regions, across the Midlands Engine and the Northern Powerhouse. Options are specified and assessed. Potential journey time savings from such a network are mostly an hour or much more, comparing 2017 and future HS2/3 timings. This could achieve stronger regional economic impacts than a mainly London-focused HS service pattern.
8. **Essentials and Desirables – works for Crewe capacity and expansion**: The *Essentials* are accommodation for HS2, particularly for Phase 2a and 2b requirements, and allowance for a wide range of service changes across the Midlands Engine and Northern Powerhouse, and for additional regional catchment and connectivity services. The *Desirables* are flexibility of London-NW/Scotland service patterns, a higher proportion of HS trains to call at Crewe, and addressing Manchester-Crewe line capacities in a way which supports improved commuter and regional Hub services as well as HS operations. Use of the Independent Lines by Manchester-Wales trains has already been identified in the report.
9. **Improvement to station facilities** is also a pre-requisite. This is foreseen as different and raised bridge crossings of the railway to minimise local traffic congestion and improve road access for the Hub, better arrangements for passenger handling and public transport and green modes’ interchange, and internal reconstruction of pedestrian routes to enable a better environment with more capacity to handle intensive Hub volumes of passenger flows.
10. **Emerging requirements for track and platform capacities**: JRC has undertaken two further train volume analyses – of potential individual passenger services post-HS2, allocated by group of platforms or through tracks within Crewe, and then with the possibility of combining those services to minimise track slot requirements within each operational group. Options are also considered, of combining HS2 train calls at existing (or modified) platform groups, or creating a separate HS2 platform group. These analyses show that it is most space efficient, and operable, to use the existing/modified platform groups where possible. There is an explicit requirement for pre-sorting of services into platform groups, and grade-separation [probably in the Basford area] of the distant HS2 Phase 2a junctions to allow trains to run to/from the different platform groups with limited junction conflict (pathing would be at-grade at the junctions close to the platforms).
11. The **Westside** platform group would generally benefit from having a fourth through platform for express trains calling, with a fully expanded HS and classic Intercity and inter-regional service pattern, and with additional commuter and regional Hub services. The **Eastside** platform group appears capable of handling foreseen train volumes, providing that commuter and regional Hub services are joined together across the two existing through platforms, and then serve further destinations, rather than terminating at Crewe. An additional platform might be required, if more trains terminated.
12. The **non-stop track** requirements depends on which would be more cost-efficient as a whole-life basis – surface tracks allowing high speed passing trains, with the possible requirement for a ‘virtual tunnel’ through the station area, and the two halves of the station having no track connections across, or to adopt the HS2 Ltd's scheme for a deep tunnel under Crewe. The latter might reduce space requirements and ‘knock on’ surface works, and also minimise access costs for large-scale local works.
13. Finally, **works to enable wider benefits** are restated as worth reviewing, beyond the immediate vicinity of Crewe station. These are:

* HS2/’classic’ lines junction, north of Crewe and south of Winsford, to allow HS2 North trains to access Crewe station with better scope for HS services to call, and/or run through Crewe during tunnel maintenance works.
* Works to expand capacity on the Crewe-Sandbach section of the Manchester Line.
* Potential requirement for re-doubling of the Stoke-on-Trent route between North Stafford and Barthomley Junctions.
* Scope to review the HS2 Phase 2b and HS3 infrastructure plans, for example in the North West, to create HS2/3 through running capabilities and help create more integrated, inter-regional HS services between Midlands Engine city regions and the Northern Powerhouse city regions. This would include the potential for links to the Liverpool-Chat Moss-Manchester line, and onto the Midland Main Line for direct services to Nottingham and Leicester city regions.

**CREWE HUB – OPERABILITY**

# Current capacity requirements

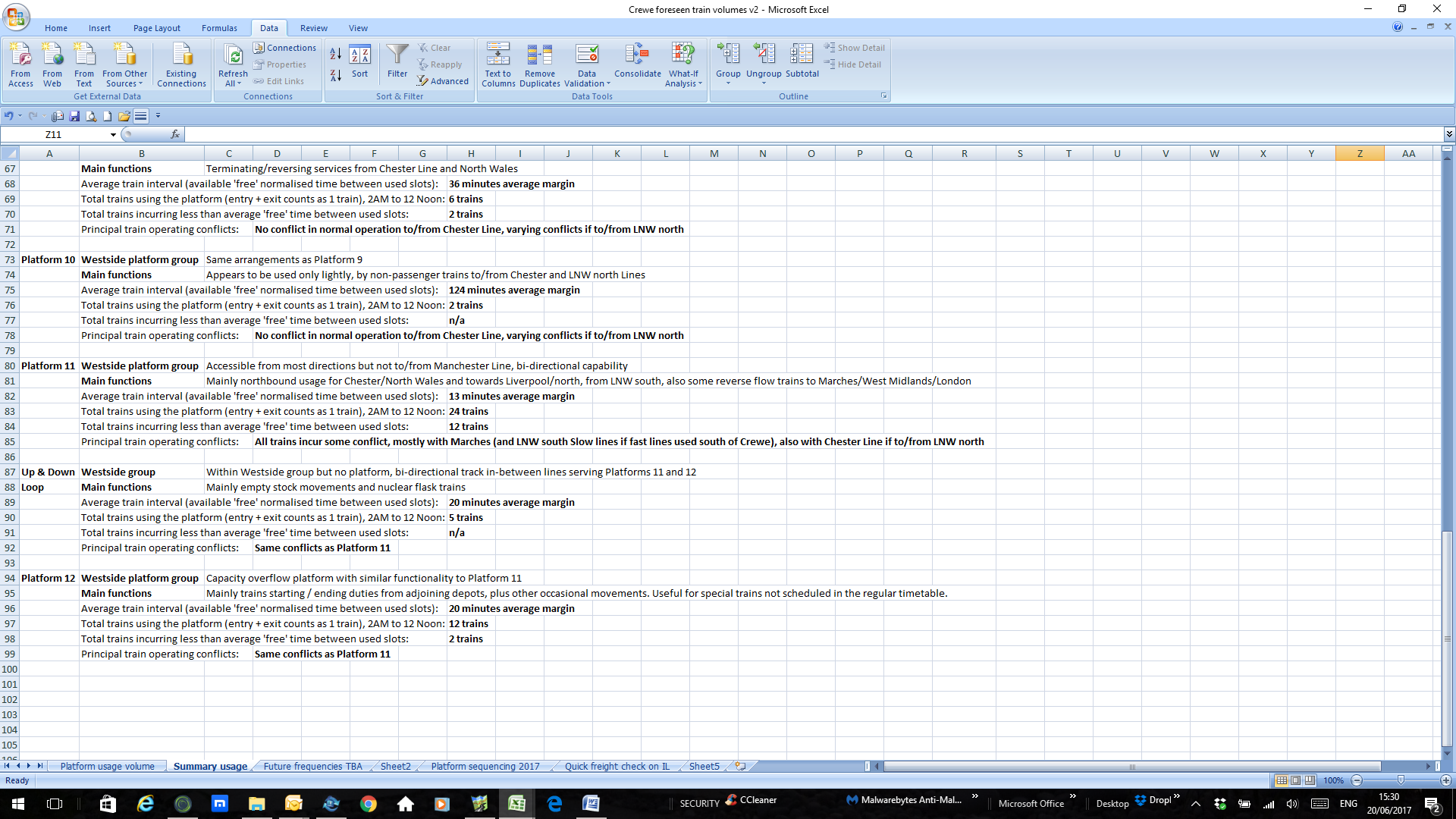
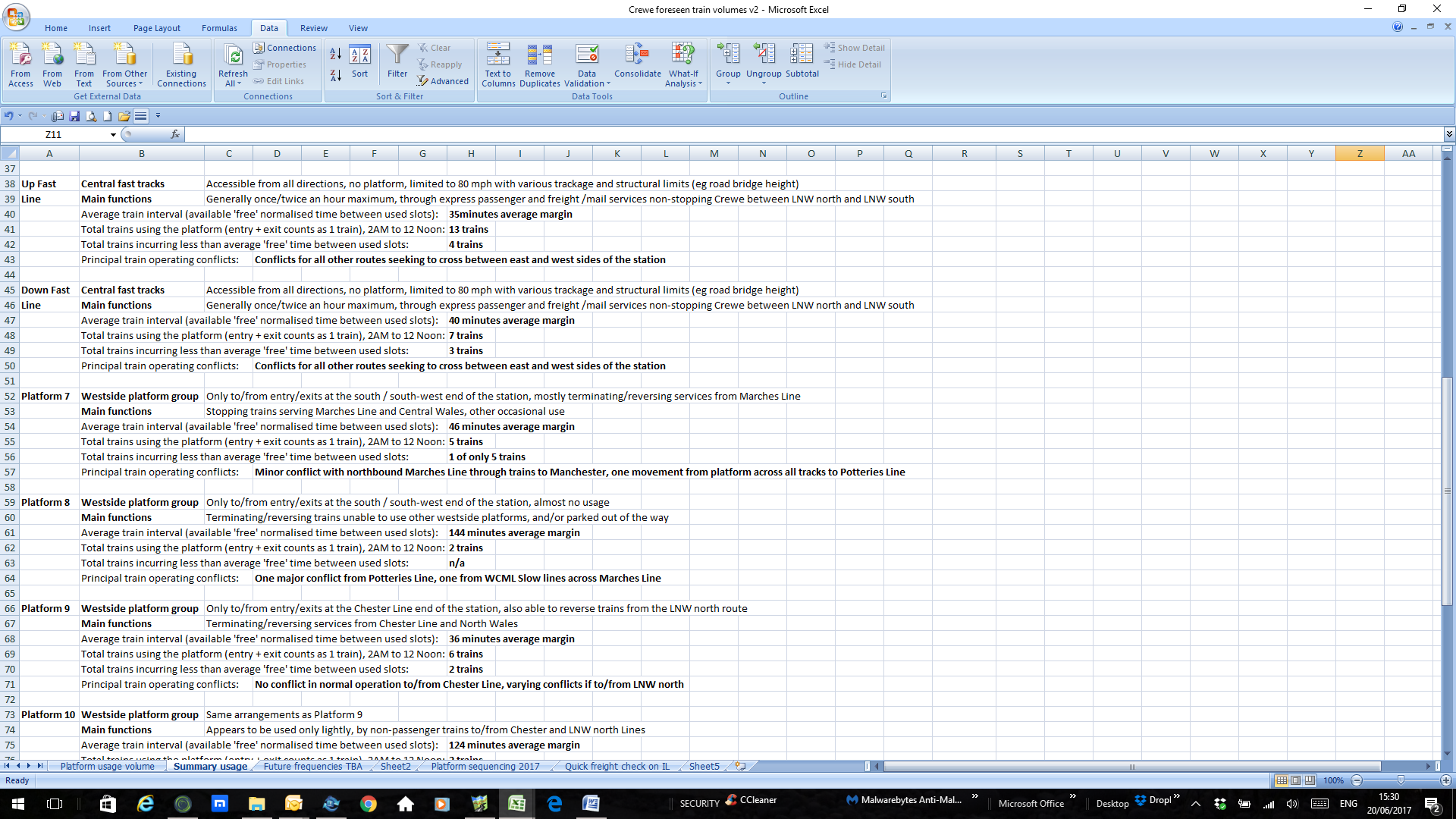
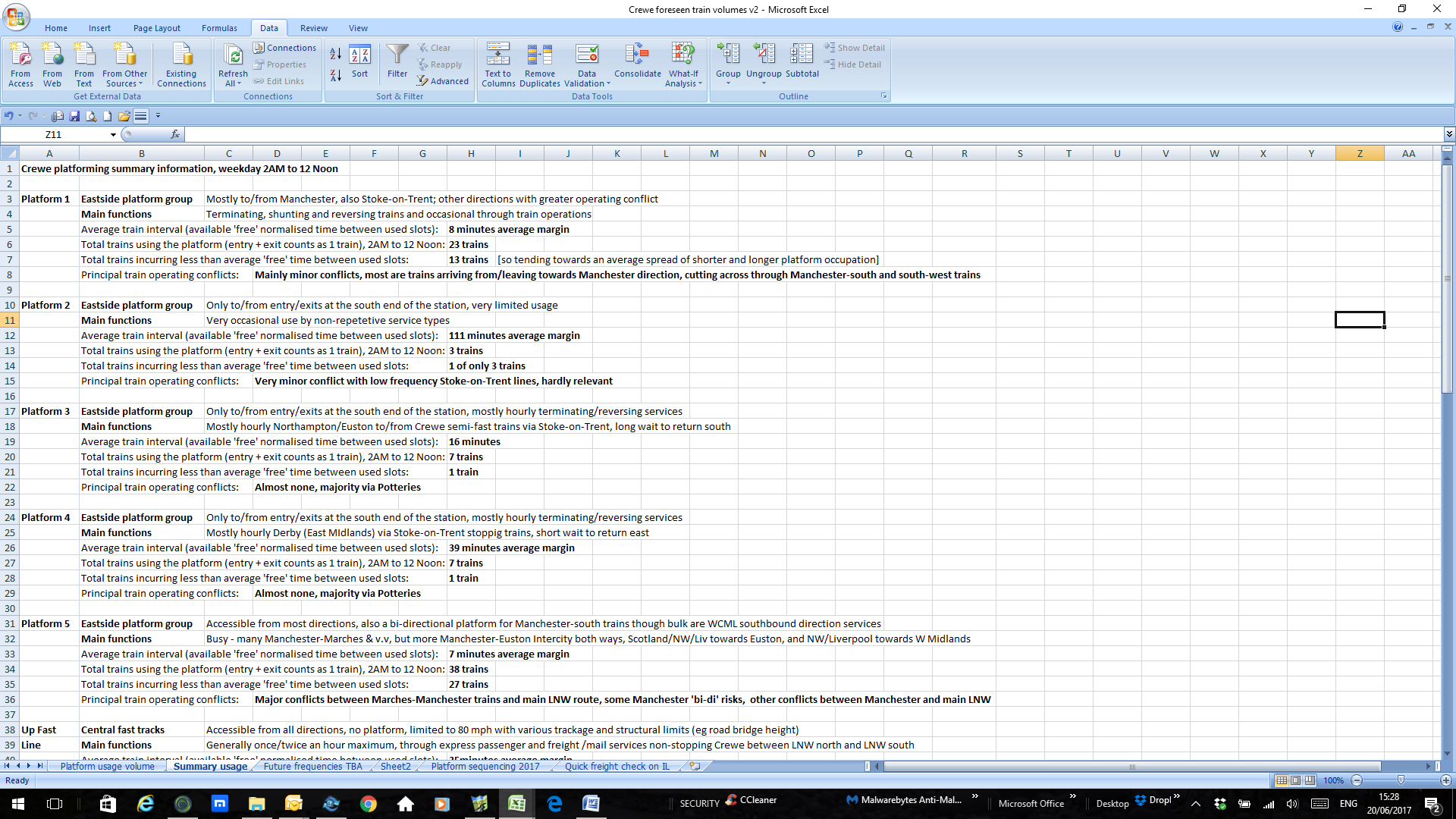
1. This is provided in a summarised form, to simplify understanding of the main train manoeuvres.
2. It should be observed at once that Crewe train operations include a number of limited frequency but awkward pathings, for example as trains start or end service at adjoining or nearby depots and have to shunt to and from relevant platforms. Similarly there are engine moves, and real-world occasions when a preferred platform is unavailable and trains must use a different one.
3. Finally, and not insignificantly, the railway must allow for foreseeable and unforeseen extras – such as special trains, charter services, various desires for ‘open access’ operation (where further possibilities might be available on WCML once the fastest expresses were attracted to HS2), and other out-of-course services beyond the normal timetable. All of this means that aiming to design an operable station and trackage for nearly 100% utilisation is not realistic.
4. Typically, NR has projected towards a 85% train capacity utilisation for future design years, in its route studies. Track and junction utilisation might need to be less demanding than that, in order to provide realistic margins to be able to convert out-of-course running arriving on one approach to Crewe, into a reliable on-time departure with adequate line capacity, on the departure side. This is more critical, if high value trains such as High Speed services with a premium on keeping to reliable, short journey times, need to be able to guarantee on-time outputs.
5. In JRC’s judgment, aiming for not more than 85% of planning capacity in a future design year, at any combination of routes and junctions in the Crewe area, should be the *most* to be strived for. A greater margin, eg utilisation of not more than 75-80% of planning capacity, is likely to be a more practical target if Crewe is not to be the *bête noir* of a more intensive railway, in the decades to come. Crewe should not be the harbinger of unreliability, rather a positive influence on national rail performance. This is even if it comes at some greater investment cost, although some will hope that a digital railway will liberate some additional flexibility at lesser cost than new trackage.

# Present 2017 timetabling

1. Having set out these cautionary qualifications, we can look at the present 2017 timetabling through Crewe station. This excludes the Independent Lines (which have several sub-sets - Salop, Liverpool and Manchester Independent Lines, mentioned below), but includes freight and other non-passenger trains scheduled to run through the passenger station. The table assesses the density of service, platform by platform and track by track, through the passenger station, including the through non-platform lines represented by the Up and Down Fast Lines and the Up/Down Goods Loop.
2. The actual train occupation of approaches and exits plus within-station times including platform ‘dwell time’ and any ‘reversing time’, is shown on a normalised basis varying by type of train, for 31st May 2017 – a normal weekday – from 2AM to 12 Noon. This includes:

* Start of service for many trains, and overnight freight.
* AM Peak Period, often regarded by Network Rail as the criterion around which to test a timetable (if it works then, then something similar should work in the offpeak and evening).
* Daytime offpeak through to Noon.

1. The average platform and track occupation is shown below for this period, by individual track/platform, and this varies quite substantially. Some are much more at risk of train congestion than others, even with present service levels, let alone scenarios which need to accommodate passenger demand 100-200% greater. The minima and maxima for present ‘normalised’ (greater than minimum) platform/track occupation are visible from the table. In practice some trains runs on a tighter headway margin, with their minima set out in Network Rail’s ‘Rules of the Plan’. More individual train details are set out in Appendix 1.
2. Each platform and track is summarised below. The full detail is attached at Appendix A.



# Future basis for operational changes

1. There are three fundamentals to address:

* **Crewe operates adequately at present but its functionality is constrained by several severe-to-moderate conflicts between different train service groups.**

In declining order of intensity and frequency, these are:

* + **Severe conflicts –  
    Manchester-Marches-Wales** through trains cutting across most other through train operations. Mostly 2 trains per hour (one each way) and so at least 8 potential slots per hourly period as they cut across all four LNW south lines.
  + **Moderate conflicts –**

(1) **London or West Midlands-Chester/North Wales/Liverpool/NW/Scotland trains** requiring access to Westside platforms nos. 6/11/12 from LNW south Fast Lines (cutting across Slow lines and sometimes the Chester lines), or v.v., also West Midlands-Manchester via LNW south Fast lines. Mostly 4 trains and at least 8 potential slots per hourly period, counting only VT operations, as at the minimum there is conflict with LNW south Slow lines.

(2) **London-Manchester northbound fast trains** occupying the same platform (no. 5) as fast southbound trains from various origins. At least 1 train and 2 potential slots per hourly period (the latter because more than one slot will be lost for ‘wrong line’ operation against the normal flow of trains).

(3) **LNW south Slow line services to/from LNW north lines**, impeding entry from Chester Line and possibly northbound fast trains onto LNW north (less of an issue now, but potentially a bigger issue with HS2). Mostly 2 trains per hour and at least 2 potential slots per hourly period, counting only LM operations. This might not matter once other constrained slots were relieved, but should be noted at this stage.

Whether a potential slot is actively lost at present is immaterial, as it is the future potential  
capacity which matters here.

* **Accommodation required for HS2 services in and around Crewe will vary between HS2 Phases. The layout will need to operate satisfactorily in all Phases.**

The requirements will be driven by:

* + **The extent of new track** – where trains enter/leave the existing West Coast Main Line.
  + **The intended service patterns.**

The range includes:

* + **HS2 Phase 1** (new tracks between London, Birmingham and near Lichfield), where track may not change much north of Handsacre (near Lichfield) though stopping patterns northwards are expected to vary.
  + **HS2 Phase 2a** (new tracks to reach just south of Crewe), with new junctions required in the Crewe area.
  + **HS2 Phase 2b** where new tracks are currently proposed to continue past Crewe to Manchester and near Wigan (LNW north and Scotland main line).
* **Any expansion of feeder and regional distribution services for Crewe Hub will add to the foreseeable projected expansion of demand for and supply of conventional passenger and freight services during the forthcoming decades.**
  + Crewe’s existing station will need to accommodate all this change, as well as the impacts of High Speed service layers, and replacement services to make good any loss of Intercity trains no longer calling as the trains will have been converted to High Speed operation.

1. **In summary, Crewe will be required to accommodate service respecification and track and platform redesign, to be able to accommodate all these factors which will arise at various stages during the next two decades and beyond into the 2040s.**
2. Optimising the scale of change at Crewe will need to take account of this complex matrix of factors and their related timescales. Ideally major works should only be undertaken once. It will be undesirable, if capable of avoidance, to undertake works requiring further large-scale modification when other HS2 Phases take place. Another factor will be the undesirability of Crewe having to experience multiple years of disruption, with separate works phases to accommodate, for example, Phase 2a then, some years later, Phase 2b, when the ‘track access’ (ie, line closure) costs will enlarge as passenger traffic continues to grow and the value of disrupted traffic gets greater in later years.
3. There is the further feature that the timescale for HS2 Phase 2a is currently foreseen as 6 years earlier for operations (indicatively, 2027) than Phase 2b (indicatively, 2033), subject to whatever operational testing periods are allowed. This period could vary, becoming either shorter or longer, depending on design, authorisation and funding availability. At the minimum, Phase 2a has to be designed to provide a satisfactory end state for a half decade or maybe longer, and able to accommodate foreseeable passenger volumes both on the HS lines and throughout the WCML, and specifically within the Crewe area, including all potential changes in service frequency and stopping patterns.

# Choices for change – existing train operations

1. As a first stage, JRC initially reviewed the potential for operational simplification of the existing Crewe tracks. The Independent Lines are used extensively by freight services (generally low speed in this locality). This situation precludes those from extensive use by passenger services. However these researches pointed out the Manchester-Marches-Wales service as a likely possible user, as all those trains would need to call at Crewe and already incur low speed on the curves and junctions in the vicinity of Crewe.
2. The highest volume gains in terms of extra slots are achieved by:

* Segregating the Manchester-Marches-Wales service.
* Enabling a non-conflict route from the LNW south Fast lines onto the Westside platform group (this providing that the Chester Lines’ entry/exit is not ‘at risk’ from continuing flat-junction movements from the Westside platforms to the LNW north lines).

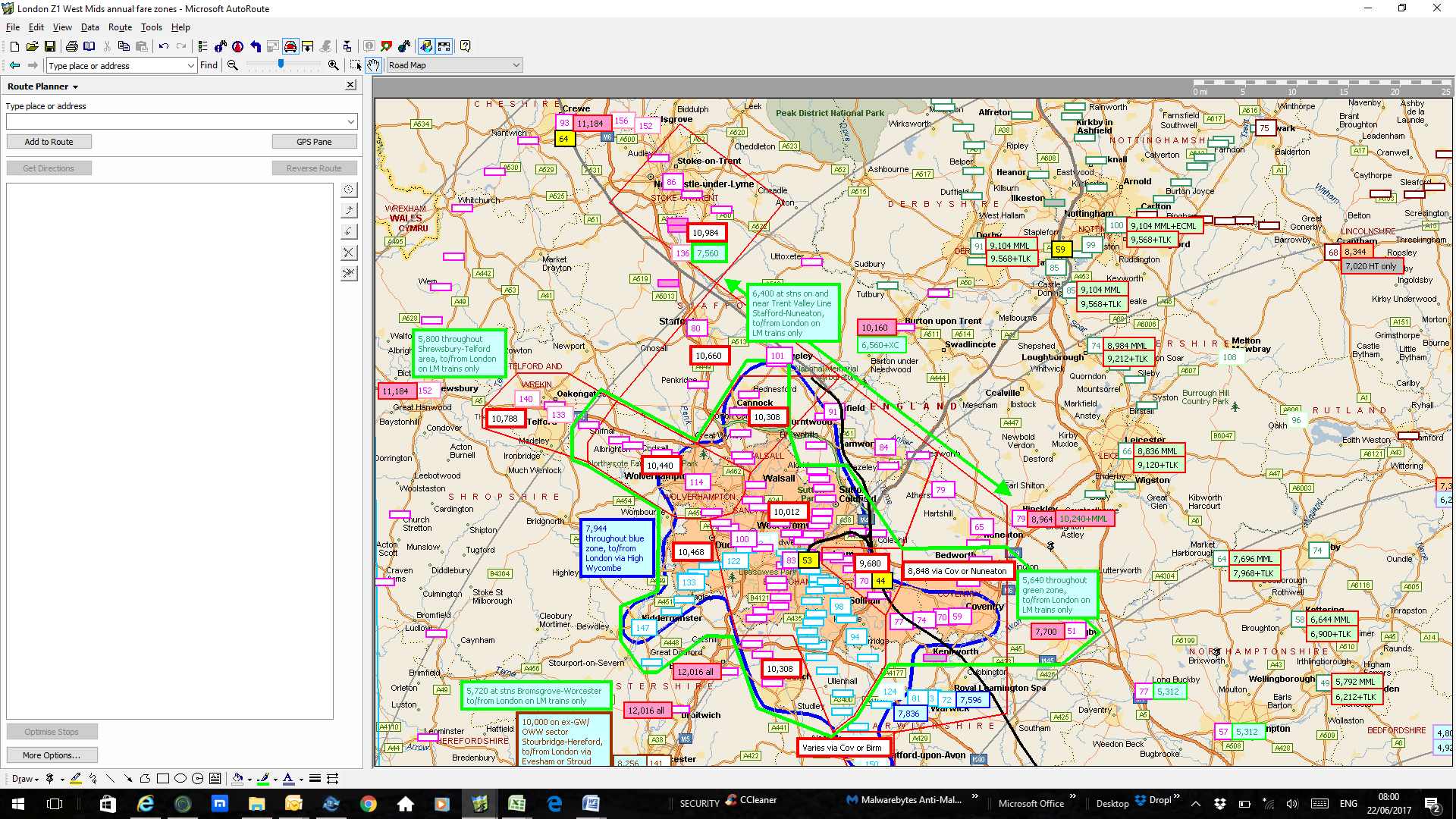
1. **Segregation of Manchester-Marches-Wales** can only be achieved by utilising or creating a grade-separated route between the Manchester and Marches Lines, assuming that through trains are maintained. It is unlikely that severing the direct Manchester-Marches-Wales service would be acceptable at political and policy levels.
2. The options are therefore:

* To build a new flyover/flyunder route, which with the tight curvature and track layout north of the Nantwich Road bridge, would need to be at the south end of the station and require more intensive use of the existing Eastside platforms (already busy, and likely to get busier) – one additional Eastside platform might be required with this option.
* To use the existing twin-track Manchester Independent Line (MIL), which is primarily a freight train flyunder route. It has a flat junction at the north end, to/from the Manchester Line.

1. Of these options, using MIL is preferable, not least as it avoids large-scale new infrastructure and track access costs. At least one new platform would need to be created on MIL or the ‘Salop Independent’ (SIL) tracks to appropriate standards, on the far west side of Crewe station, while the MIL route would require some alterations and upgrading for regular passenger operations. This option would however free up platform and junction slot capacity for the Westside and Eastside platforms, so has additional benefits.
2. **A non-conflict route between the LNW south Fast Lines and the Westside platforms** might not be required, either at once if weaving with flat junctions to/from the LNW south Slow Lines were acceptable in the Basford Hall area (once the bulk of the freight trains had entered their own tracks at Basford Hall Junction), or in the longer term if HS2 trains in Phases 2a and 2b had their own tracks to enter the Crewe station area (and fewer Intercity trains were then operated south of Crewe on the WCML). Any requirement for a non-conflict route should therefore be examined in conjunction with intentions for HS2 Phase 2a, before any decisions were reached.

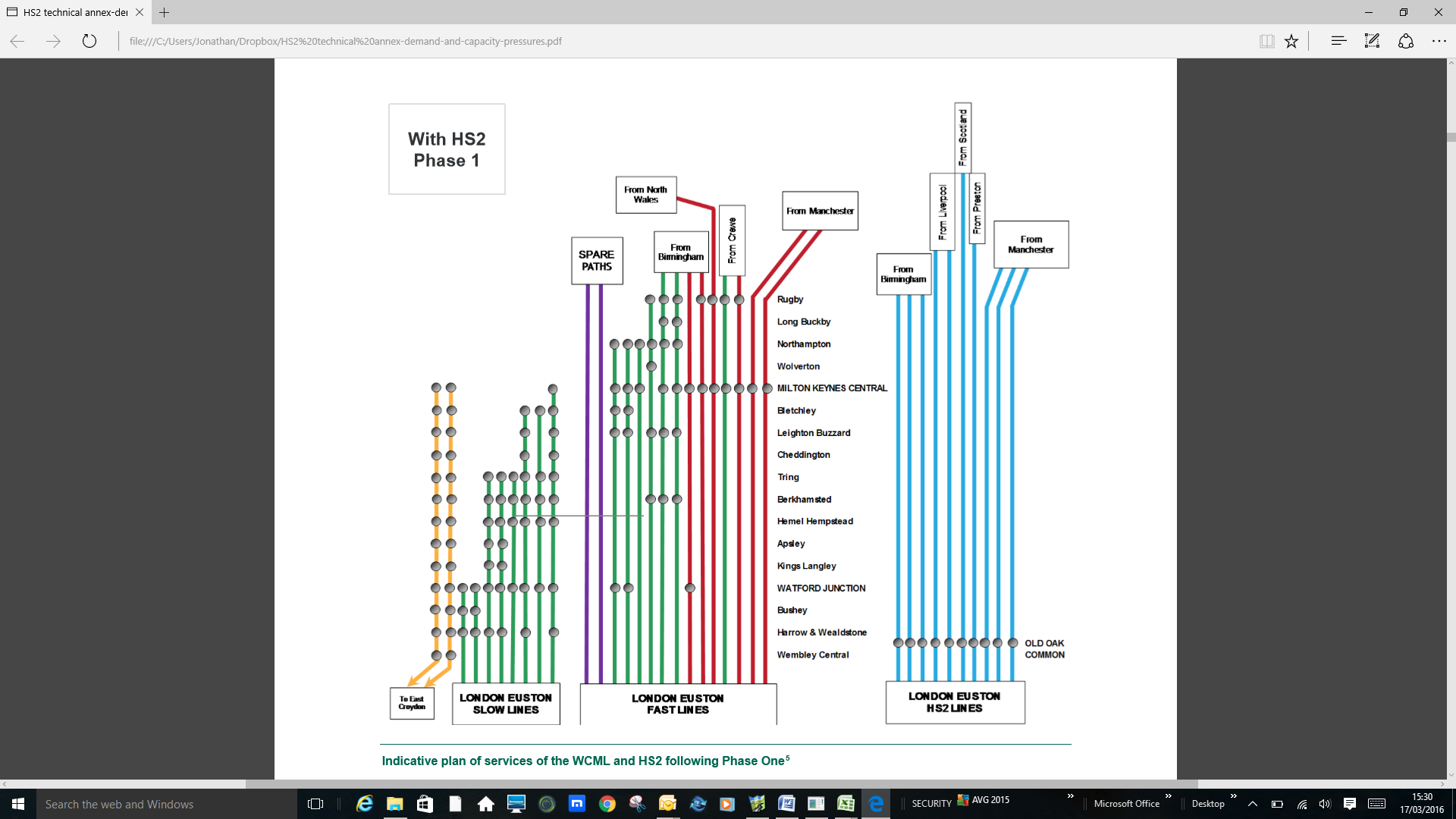
# Choices for change – HS2 Phase 1 train operations

1. The principal London Intercity expresses on WCML via Crewe would transfer to HS2, and use the High Speed tracks south from Handsacre, near Lichfield. They would use the WCML tracks north of that point. There would be 7 HS trains per hour each way – 3 for Manchester, and 2 each for Liverpool and the NW/Scotland – using a ‘classic compatible’ train design suitable to use on both the HS and existing Intercity lines.
2. The new trains would not tilt, so while Crewe-London journey times should initially be about 20+ minutes faster than now, journey times on curvaceous routes north of Lichfield could take longer, eg Crewe to Scotland. Any works to mitigate that impact are beyond the scope of this report. Looking forwards to HS2 Phase 2a all the way to Crewe, Crewe is moved even closer in time to London, to be equal to Coventry, Leicester or Nuneaton now. An average time map (2016 PM peak London services + HS2 Phase 2a/b) is attached. Crewe Hub will then be in the London commuting time zone:



**2016 PM peak average train times from London, in minutes, and 2016 annual standard season ticket fares from London termini on different types of services. HS2 Phase 2 average travel times also shown to Crewe, based on two intermediate stops (OOC, Birmingham Interchange), and a 4 minute dwell time at each stop. Plans for 2 minute dwell times with level boarding at British HS platforms may be frustrated by a recent European ruling on HS inter-operability and permitted platform heights.**

1. In the case of HS2 trains calling at Crewe, the initial proposition from HS2 Ltd is for 2 trains per hour (tph) to call, with no service provided by Manchester HS trains - they would pass through non-stop. 1 tph might call to/from Liverpool, and 1 tph to/from the NW or Scotland, as now. London-Chester/ North Wales Voyager trains, being diesel operated, would stay on the WCML tracks all the way (1 tph as now), along with the hourly West Midlands-NW/Scotland Intercity Pendolino service, which also calls at Crewe (some of those trains start or end at London, with present services).
2. In November 2015, the Department for Transport re-published the 2013 service proposition from HS2 Ltd, for suggested Phase 1 substitute Intercity services to replace HS-routed trains at intermediate stops. This shows 1 additional Intercity train via the WCML starting at Crewe, and 1 inter-regional service (equivalent to the LM service now, but potentially direct via Madeley). The diagram is attached. 2 further spare paths are also shown on the WCML:



1. In terms of overall passenger train frequencies, Crewe at present has 3 Intercity tph to London in peaks and 3 during the daytime off-peak (but with two of those bunched together). The semi-fast London Midland service is approximately hourly. It is the functionality of the Hub which will matter most, looking forwards to the benefits achieved by HS2. As discussed in the JRC Accessibility Paper, the Hub will achieve greatest impacts if a walk-on/walk-off frequency is offered which in turn maximises accessibility throughout the effective catchment area.
2. There are therefore two or three potential service overlays with HS2 Phase 1, which will affect required capacity through the station:

* Line capacities for up to 3 non-stop Manchester HS trains hourly each way through the station and along the Crewe-Stockport-Manchester line, if at this early stage the HS trains were routed via Crewe instead of 2 of these via (and non-stopping) Stoke-on-Trent.
* It is noted that HS Phase 2a documentation published in Autumn 2015 refers to foreseen line capacity problems until Phase 2b were built, if it were sought to run all Manchester HS trains via Crewe (even ignoring the possibility of extra regional or inter-regional services in coming decades).
* Line capacities required to accommodate any regional catchment feeder services, or other foreseen service improvements during the period between 2026 and 2027.
* Line capacity for a replacement hourly Intercity service calling at or starting from Crewe, if no Manchester HS services were to call.

1. It appears advantageous for Crewe capacity management, and as a Hub stimulus, if at least one Manchester HS train called at Crewe. Removal of the Manchester-Marches-Wales trains, onto the Manchester Independent Line, as proposed by JRC, would also assist junction capacity within the station area.
2. During the outline Phase 1 proposals, the HS2 train service would approach Crewe on the WCML fast lines. There is no merit in trying to reconstruct the station on a substantial scale during the 2020s just for Phase 1 requirements. The driver for such change would be the successor Phase 2a which brings high speed trains to within a mile or two of Crewe, and which might be only a year behind in final implementation, assuming that HS2 Phase 1 opened in 2026 and Phase 2a in 2027.
3. On the latter point, JRC understands that HS2 Ltd has recently been advised by Network Rail that on the present basis of its plans, it is not possible to rebuild the relevant Euston approaches and then create the new alignment for HS2 into Euston, in sufficient time to run HS2 trains through to Euston for 2026 full HS opening. There are possibilities that either HS2 Phase 1 would be only Birmingham-Old Oak Common, or that HS2 Phase 1 would be merged with Phase 2a, with HS2 Phase 1 and 2a opening simultaneously (but in ca. 2027) from Euston to Crewe.

# Choices for change – HS2 Phase 2a train operations

1. The main change is that the HS services already rerouted during Phase 1 (if that remained as a separate phase), at 7 per hour each way, would run on extended HS tracks for a further 37 miles, to the outskirts of Crewe. Crewe would be roundly half-an-hour closer to London than now.
2. A quick run into Crewe from the south, and a quick exit towards the south, would be desirable so that HS trains were not delayed unnecessarily during the final mile or so to/from or through Crewe. The wider point about requiring reliable pathing into and within Crewe, to ensure punctuality, will still apply.
3. There is no official intention to provide extra HS2 services during Phase 2a, nor is there any current plan to order additional HS trains at this stage. 54-60 x 200 metre trains would be ordered for Phase 1/2a, and a further 100 train sets for HS2 Phase 2b (the bulk of those also able to run through onto existing main lines). Some units might be coupled together to make 400m-long trains, each carrying over 1,000 passengers.
4. There is currently no policy to provide inter-regional high speed services before Phase 2b, although the HS railway would then exist between, for example, Birmingham and Crewe, over 60 HS miles and nearly two-thirds of the way to Manchester. There is an intention to run limited-stop or non-stop HS trains between Birmingham and Manchester once Phase 2b were open all the way into Manchester Piccadilly.
5. There may be a potential political pressure point, to prioritise service improvements as soon as there were sufficient infrastructure to enable better services for inter-regional travel, eg between the Northern and Midlands regions, and between HS2 and HS3 Hubs. As a current example, Liverpool and the wider Merseyside area have expressed a strong desire to be joined directly into HS2 with a high speed link – the ’20 mile’ campaign – by Phase 2b and preferably during Phase 2a.
6. Quite how HS2 and any potential HS3 (for Trans-Pennine travel) might be joined up, is also unstated at this point. HS2 Phase 2b is intended to terminate at Manchester Piccadilly from London, though any HS3 is foreseen via Manchester Victoria as that is how current plans for Trans-Pennine electrification are being advanced. Logically any Liverpool/Merseyside link into the two HS networks should do both jobs with one HS line, not require duplication.
7. There will be merit in reviewing the case for greater co-ordination and connectivity, between the HS2 and HS3 schemes north of Crewe, including the scope to share route, station and other infrastructure costs. This is discussed further below.

## Consideration of operational impacts during Phase 2a

**- arising from growth in regional catchment services and other increases in demand**

1. Provision of regional catchment services, and other additional service volumes associated with further general increase in rail usage through this national junction, might be expected to commence around 2026 – or whenever sufficient preliminary track and signalling works might be complete ahead of HS2 operations. However these would plausibly be on a preliminary basis until the full regional impact of direct HS2 services came with HS2 Phase 2a in 2027 or thereabouts.
2. Simply on the basis of improving core frequencies on main corridors from hourly towards half-hourly, one might anticipate or make passive provision for 2 tph in due course, on Manchester-Marches-Wales and to/from East Midlands (Crewe-Derby service).

* Neither of these need affect WCML main line operations, the former subject to using the Independent Lines, and the latter as, on a minimalist basis, additional East Midlands regional trains could use bay platforms within the Eastside part of the station.
* Any new chord services via Macclesfield and Congleton to Crewe could use Eastside bays as a basic option.
* Other pathing options are set out further below.
* At some stage, the East Midlands line to/from Alsager and Stoke-on-Trent might require redoubling of the 3.2 mile single track section between North Stafford Junction and Barthomley Junction.

1. There are other possibilities.

* A direct Wrexham-Hub hourly through service, which is now feasible following the redoubling of part of the Wrexham-Chester Line.
* An improvement to hourly of the Shrewsbury-local stations-Crewe service.
* These could avoid most HS2 operations and the bulk of revised WCML services, by using bay platforms on the Westside part of the station.

1. The same situation would also apply as and when HS2 Phases 2a and 2b were taken forward. Consequently, the main factors which would raise the potential of an early capacity upgrade within Crewe, and on the Crewe-Sandbach section, are:

* Development of LM (West Midlands franchise) direct semi-fast services via Madeley, but only if those trains sought access onwards to Manchester/the Airport, otherwise Westside platforms might be adequate. (Alternatively they might access Manchester/the Airport via the MIL route, to get past Crewe.)
* Prospects of higher frequency regional services from Stoke-on-Trent and beyond, with their potential, along with Madeley route trains, to continue towards Manchester Airport.
* And/or new regional services via Middlewich and Northwich (which might also include trains from Stoke-on-Trent).
  + Later, in Phase 2b (below), any Crewe-Northwich trains might head towards Manchester Airport and Manchester, via a new chord onto Phase 2b tracks north of Knutsford, with that part of Phase 2b becoming a better used, general access route for the Airport and the city centre. Chester-Northwich-Manchester trains might also use this new route.

1. Such Phase 1/2a considerations would also arise in association with use of the Manchester Independent Line for Manchester-Marches-Wales services, leading to potential junction re-arrangement between Crewe and Sandbach.
2. The logic points towards review of that part of Crewe station and the Manchester Line and MIL north from Crewe, with a general assessment of required paths and capacities supporting HS2 services and regional/inter-regional service improvements.

* There would be a risk of preventing regional and inter-regional service improvements if consideration were given to changing Manchester Line capacity only to facilitate HS2 operations.
* It is important for HS2 changes not to deny improvements to other area services, considered desirable as a consequence of area economic growth and ensuring that Hub benefits are distributed throughout the accessible catchment.

# Choices for change – HS2 Phase 2b train operations

1. Compared to Phase 2a, changes of a further order of magnitude will arise with HS2 Phase 2b. These can be summarised as:

* Extension of HS tracks past Crewe towards Manchester Piccadilly. ‘Bypass’ tunnels are proposed under Crewe, and between Wythenshawe and Central Manchester. Phase 2b tracks would parallel the LNW North main line for several miles beyond Crewe, until diverging south of Winsford.
* An HS2 connection from the new Manchester line, to rejoin the LNW North main line south of Wigan and further accelerate timings towards the North West and Scotland, with faster services towards Preston, Glasgow and Edinburgh (which would miss out Warrington).
* At this point, the fastest London-Edinburgh trains might run via HS2, so could add to line capacity requirements between London, Crewe, Preston and the north-west. Some might usefully call at Crewe, to maximise fast connectivity between many parts of Wales and the North Midlands, and Scotland’s East Coast cities.
* With the present plans, there would not be a connection between the two parallel lines north of Crewe, so that HS trains to and from Scotland and the North West would be unable to call at Crewe unless they traversed the existing LNW line throughout between Wigan and Crewe.
* As well as HS2 Phase 2b, there could be contemporary development of Northern Powerhouse Trans-Pennine rapid services, foreseen as an HS standard (‘HS3’) and/or a ‘Northern Crossrail’, with a target journey time of 30-45 minutes between major city regions.

1. The direct economic benefits of HS tracks further towards Scotland are seen as poor, in the HS Scotland and Northern England ‘Broad Options’ report published in [March 2016](https://www.gov.uk/government/publications/broad-options-for-upgraded-and-high-speed-railways-to-the-north-of-england-and-scotland). Instead there might be some route improvements along the LNW North main line. Any additional HS mileage northwards via Wigan would be as a consequence of political priorities.
2. Official intentions for HS services are:

* All 3 London-Manchester hourly HS services to non-stop Crewe and stay on HS tracks until arriving at the new HS platforms at Manchester Piccadilly. Stations such as Wilmslow and Stockport would not be served (how they would continue to be served is unclear), but, subject to adequate funding from area stakeholders such as MAG, an intermediate Hub station would be built adjoining Manchester International Airport.
* A new HS inter-regional express would be introduced between Manchester and Birmingham, to take about 40-45 minutes between the cities, either non-stop or limited stop (the latter only if Crewe were accessible from the HS tracks north of Crewe).

# Scope for more connectivity and HS services with Phase 2b

1. While these developments presage improved journey times to/from London and better linkages between one principal Northern city and one principal Midlands city, the extra connectivity between the North and the Midlands is not on the same scale as the ambitions for the Northern Powerhouse, where multiple journey pairs combining a number of cities are intended to be accelerated substantially. The proposed frequencies of trains using the HS2 Phase 2b tracks to/from Manchester is also not high, in the current official scheme, which must raise questions of value for money.
2. If one were to adopt a similar approach as with the Northern Powerhouse, various combinations of journey pairs ought to be considered. As an example, and focusing only on major city centre access, we have already noted the aspirations of **Liverpool as the capital of the Merseyside city region** to achieve a direct link into HS2 as well as HS3.
3. Similarly there could be scope for a direct HS2 Phase 2b link from near Trent Junction into the heart of **Nottingham, which is the effective capital of the East Midlands city region**, allied to a south to east curve from the Lichfield area towards Measham on the HS East Midlands section (or a shorter, lower cost but potentially slower chord south of Tamworth, providing the same function by offering an HS Scotland/North West to HS East Midlands link).
4. There is also a case for modelling a further chord from HS2 East Midlands towards the Midland Main Line and **Leicester**, for inter-regional travel to/from the North West. Both East Midlands cities currently have very long journey times in that direction.
5. Adaptation of the HS service structures could then achieve a co-ordinated HS2/3 inter-regional network. Practical journey pairs between city regions could offer direct services between all major city region hubs (with frequencies dependent on gross population and jobs volumes), as illustrated alongside with 20 mile catchments (Crewe, Birmingham Interchange and Toton 25 miles, because their catchments are less urban so a larger zone within the same Hub access times).
6. Examples of new City Region links could be:

* (Through HS2 – HS3 services)

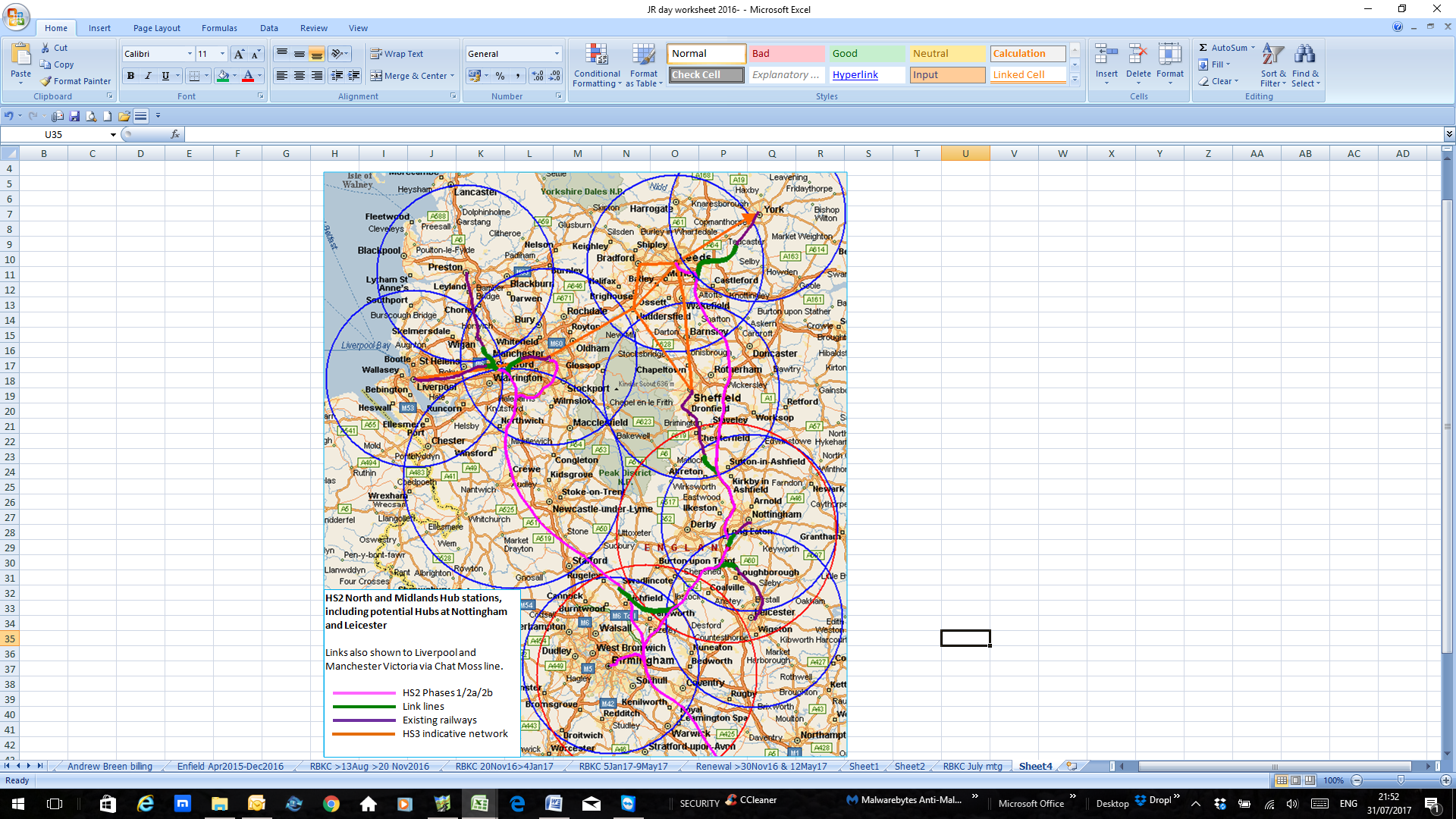
Birmingham – Crewe - Manchester Vic. AND Pennine cities eg Huddersfield, Bradford.

* (Additional West Midlands – North West services)  
  Birmingham – Liverpool / Preston.
* (West Midlands – East Midlands service)  
  Birmingham – Nottingham.
* (East Midlands – North West services)

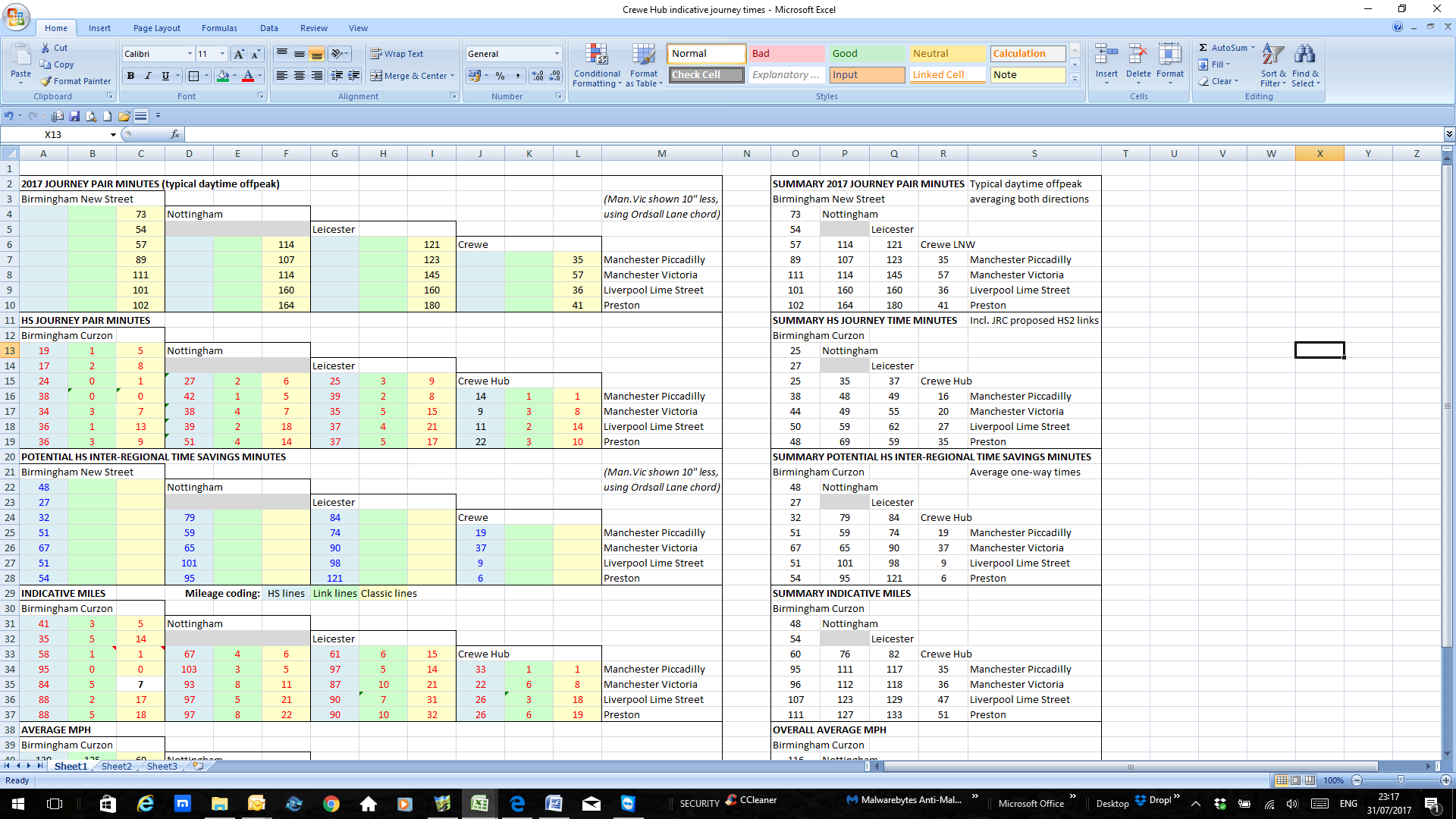
Eg, Manchester – Nottingham, Liverpool / Preston – Nottingham.

* (Integrated HS2 services)

Eg, Birmingham to Sheffield / Leeds via Toton, London to Nottingham City direct.



1. The strategic map above also hints at the potential for combining HS2 and HS3 infrastructure in the Greater Manchester area, in order to achieve greater connectivity throughout an integrated HS network and reduce total infrastructure spend. There will be various options, one possibility is to route some HS2 services towards Manchester Exchange/Victoria, not Piccadilly, so that connectivity for the many economically stressed towns north of Manchester would be markedly improved.
2. If HS2 and HS3 were to remain segregated in the Manchester area, then many connectivity problems experienced there since Victorian times will be perpetuated, despite some trains in future via an Ordsall Chord, because of a double interchange at Piccadilly and Victoria, and related walking and waiting time penalties. HS2’s benefits for the Northern Powerhouse will be less strong than they should be.
3. Effective journey time savings should be a key element of an integrated inter-regional HS network to serve the North and the Midlands. Some JRC estimates of journey times by existing rail services and by accelerated HS inter-regional trains are shown below, with a statement of time savings, which are an average of estimated journey time in both directions.



1. There are some powerful journey time savings, some half-an-hour, many an hour or much more. Some of these may indeed justify updates to HS2 Phase 2b specification, along with some co-ordination with HS3. In this Northern and Midlands city region HS structure, Crewe becomes a key connectivity Hub. A proportion of any additional HS services should therefore call there.
2. Crewe Town Council wants the Crewe 21st Century Hub to be a national exemplar. It matters how economic growth, the expansion of homes, jobs and skills, and the scale and spread of benefits, are distributed *within* the existing towns *and* through the accessible Hub zone. Just consider – a new baby this year will be nine to ten years old when a Crewe Hub opens to HS2, and a teenager before HS2 is completed. It’s what we achieve for future generations which matters most of all, so we have to get Crewe Hub right.

# Back to basics – Essentials and Desirables for Crewe capacity and expansion

1. A revision and redesign for Crewe has to take into account and create flexibility for **Essentials**:

* The sheer necessities to accommodate HS2 Phase 2a, probably with grade-separation between Basford and Crewe.
* Accommodation for an eventually defined Phase 2b as part of what, as shown above, might be multiple options for HS service development.
* The scope for larger, integrated service changes addressing both HS2 and HS3, as well as integrating the East Midlands more effectively within a proposition for a combined Midlands Engine and Northern Powerhouse.
* Additional regional catchment and connectivity services, discussed earlier.

All these will be subject to strategic place-making policies, railway business cases and wider economic reviews.

1. **Desirables** include:

* Ability to re-join HS2 2b tracks to the north of Crewe, from a station call there (and v.v.), for:
  + Flexibility of London-NW/Scotland service patterns.
  + HS2/HS3 inter-running.
  + A higher proportion of HS services to call at Crewe, to accelerate economic growth throughout the Crewe Hub catchment.
* Addressing Manchester-Crewe line capacity during Phase 2a, which is already a source of concern without some of the possible further developments noted above.

Many changes may need to be put in place before or during Phase 2a, because service volumes can be expected to grow as a consequence of 2a, which would make subsequent changes harder to achieve. Multiple occasions of major works would also be undesirable in the same locality.

1. The merit of putting Manchester-Marches-Wales trains onto the Independent Lines with a platform there, to reduce train slot conflicts, has already been set out.
2. The emerging opportunities point, in JRC’s judgment, to:

* Greater pre-planned segregation south of Crewe junctions.
* Works to sort relevant train flows through the Crewe-Sandbach section.
* Provision for HS2 Phase 2b north of Crewe to provide a connection to/from Crewe platforms, probably via the parallel LNW North main line.

# Station facilities

1. Specific track and platform requirements are discussed after analysis of the cumulative impact of the potential range of train services. The general station arrangements will however require considerable improvements. The main possibilities for those are:

* Reconstruction of the main passenger-handling facilities at Crewe to accommodate much greater passenger entry/exit and interchange flows as a national Hub station, also with expanded local bus and taxi capacity and large-scale car parking.
* Probable relocation of the main traffic flow over the Nantwich Road bridge, to a location further south and at a higher level above ground. This has three related benefits:
  + Remove the over-track height limitation on fast line speeds, which will have benefit from pre-HS2 Phase 1 (whenever the work was undertaken), at least until the opening of HS2 Phase 2b.
  + Avoid height limitations for fast line speeds also arising because the Independent Lines tunnels are just below the existing main track levels – this is a vertical structures ‘pinch point’, so when in doubt, deal with the bridge, not the tunnels…
  + Improve general traffic handling capacity and reduce congestion at the main junctions and in the vicinity of the station.
* Rebuilding of the Nantwich Road bridge, also at a greater height, as a pedestrian, two-wheeler, public transport and taxi-only interchange corridor.

1. This is a once-in-a-century opportunity for Crewe, its wider catchment and the railway to adapt to the emerging 21st Century prospects. The consequences of high speed railways shortening distances on a national and inter-regional scale, plus a ‘Northern Crossrail’ effect for regional travel, suggest that HS strategies would be unwise to ignore the potential, or likelihood, of the emerging HS railway network to become the core 21st Century means of city region-to-city region travel throughout the North and the Midlands, with Crewe being one of the favoured growth points. Crewe needs the ability to handle entry/exit and interchange flows comfortably.

# Emerging requirements for track and platform capacities

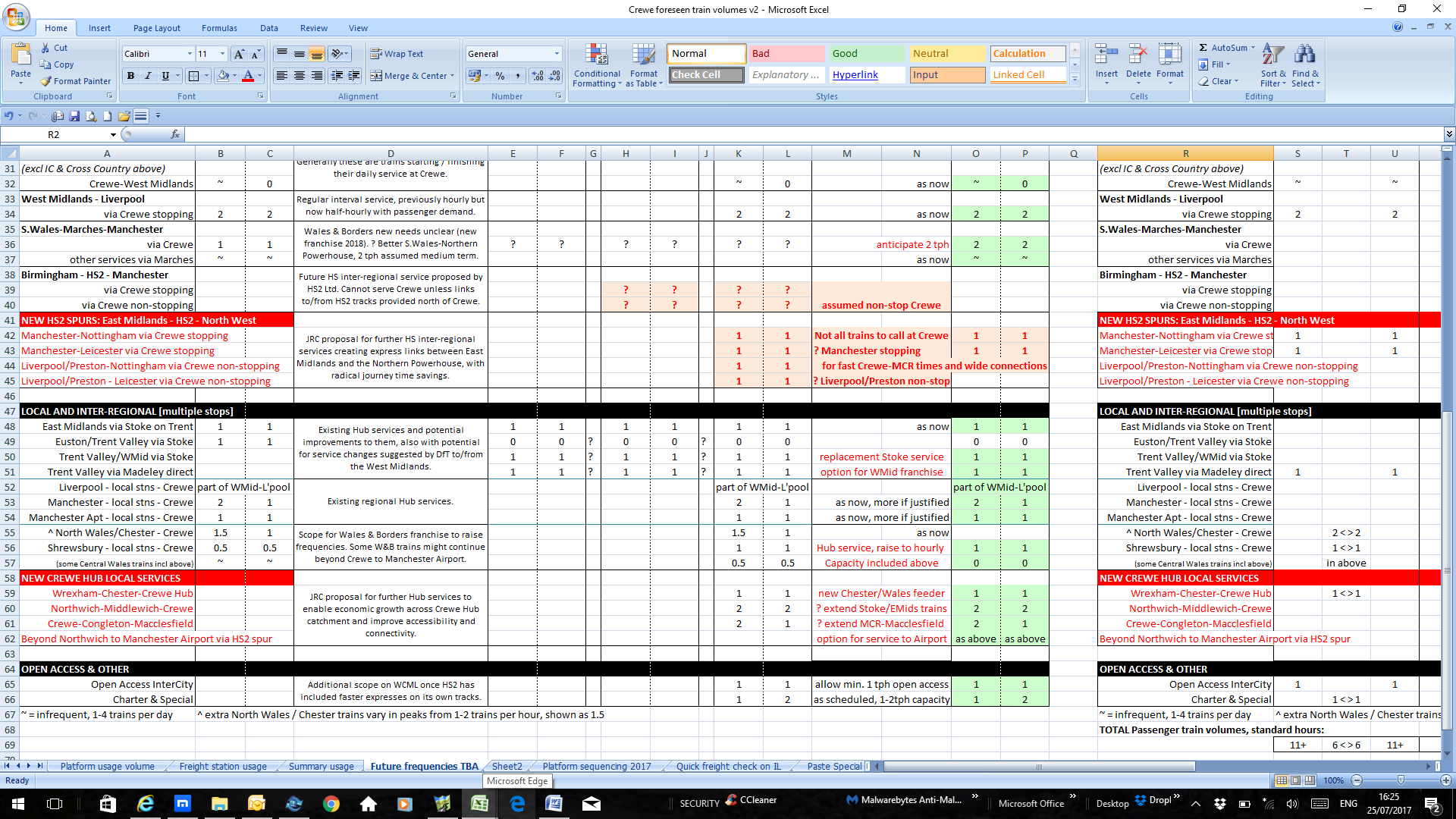
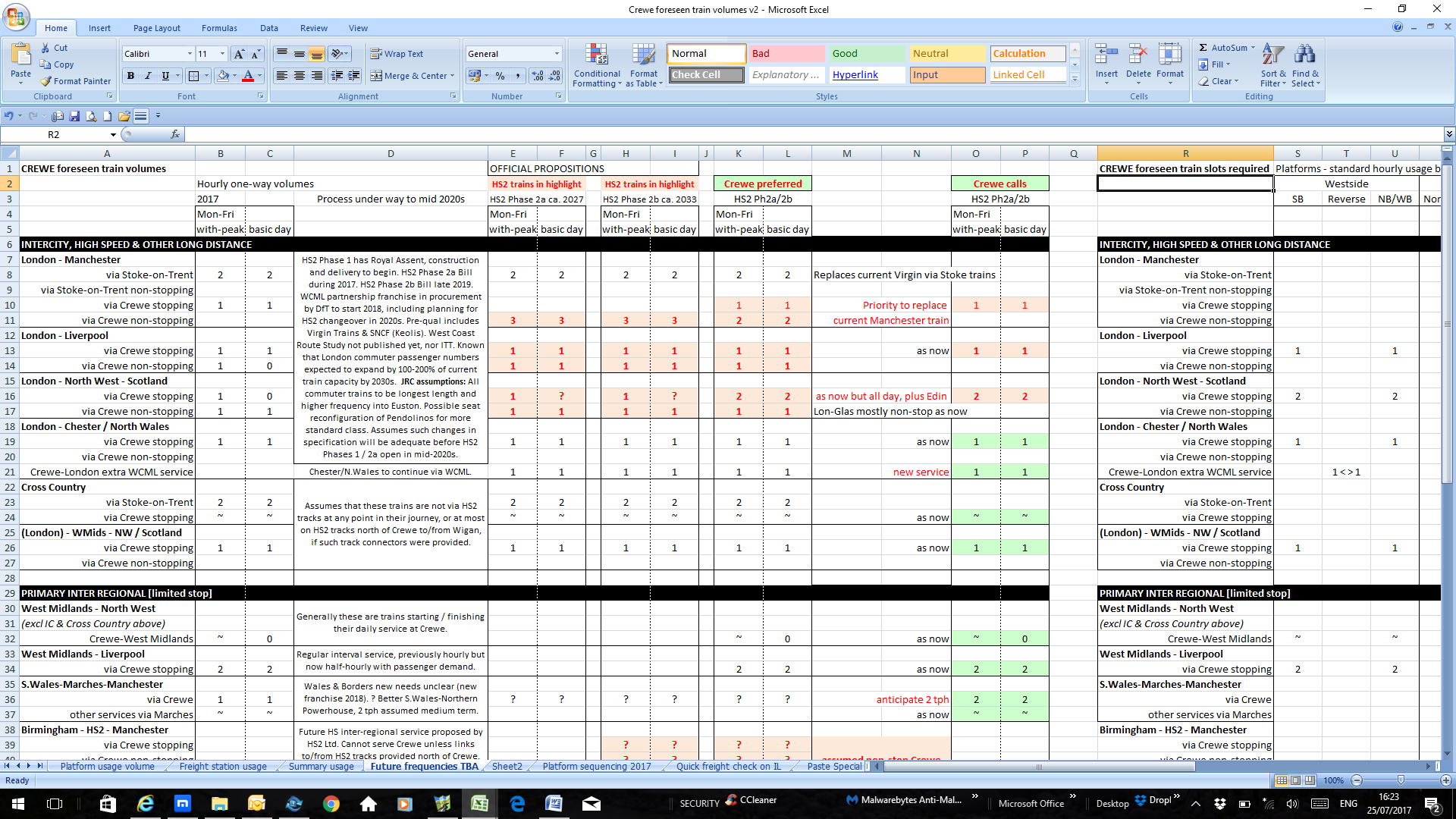
1. The impact of future service developments on ‘classic’ and HS lines in the vicinity of Crewe are evident when one replays the earlier analysis in this report, taking account of these potential changes to services.
2. By grouping tracks and platforms, based on the desirability of pre-sorting flows through the station and approaches, it is possible to aggregate the hourly peak passenger train volume and then the slot demand density, including the potential for combining operation of services across Crewe to minimise slot requirements:

* Eastside platforms (Manchester Airport/Piccadilly/Northwich/Stoke on Trent/Congleton etc).
* Westside platforms (Chester/North Wales/Liverpool/NW/Scotland/any Manch.Victoria, to/from HS3, etc).
* Any other flows via the station, including freight and locos.
* Manchester Independent Line.
* HS2 platforms (if required) and HS2 fast tracks.

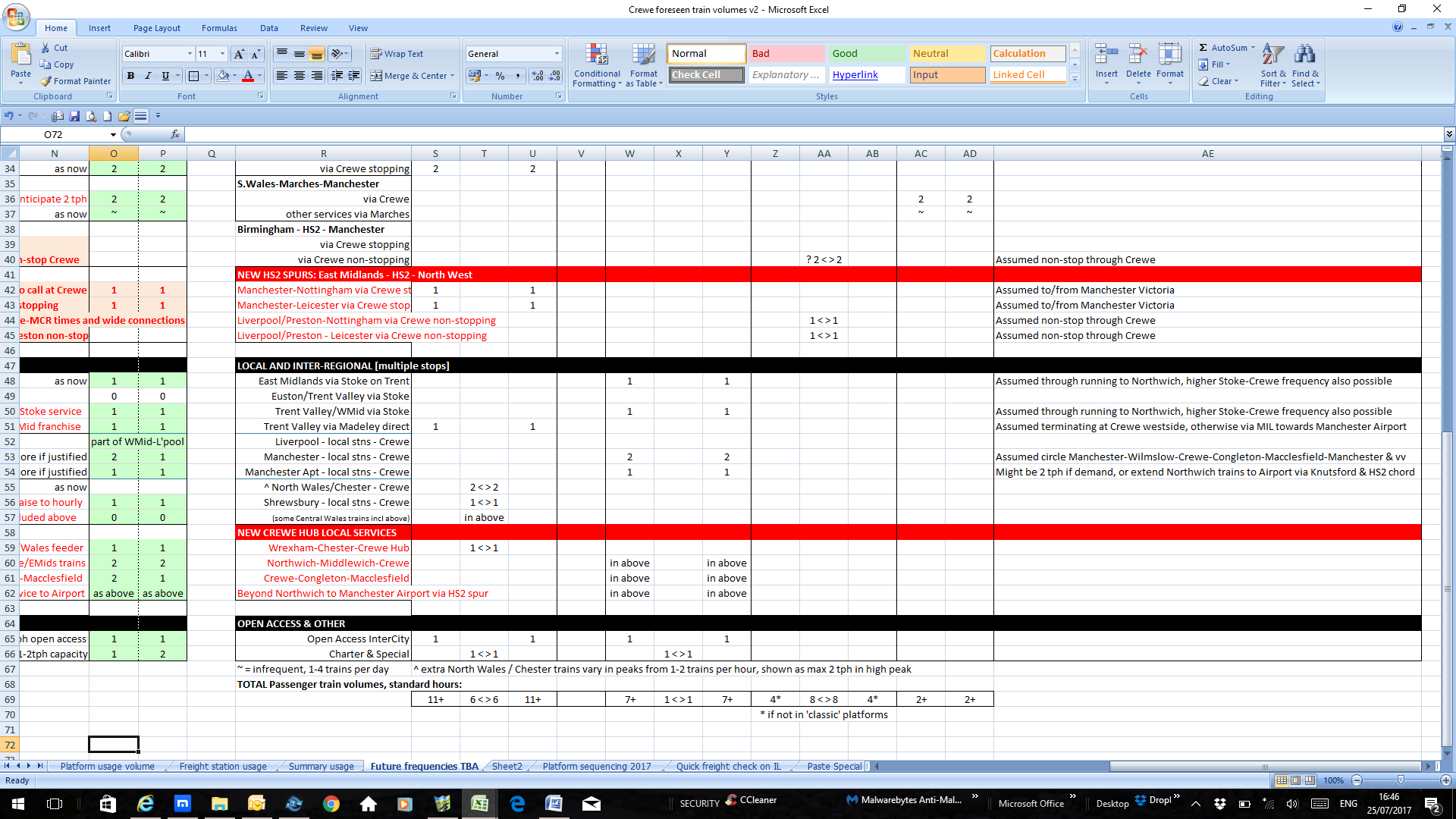
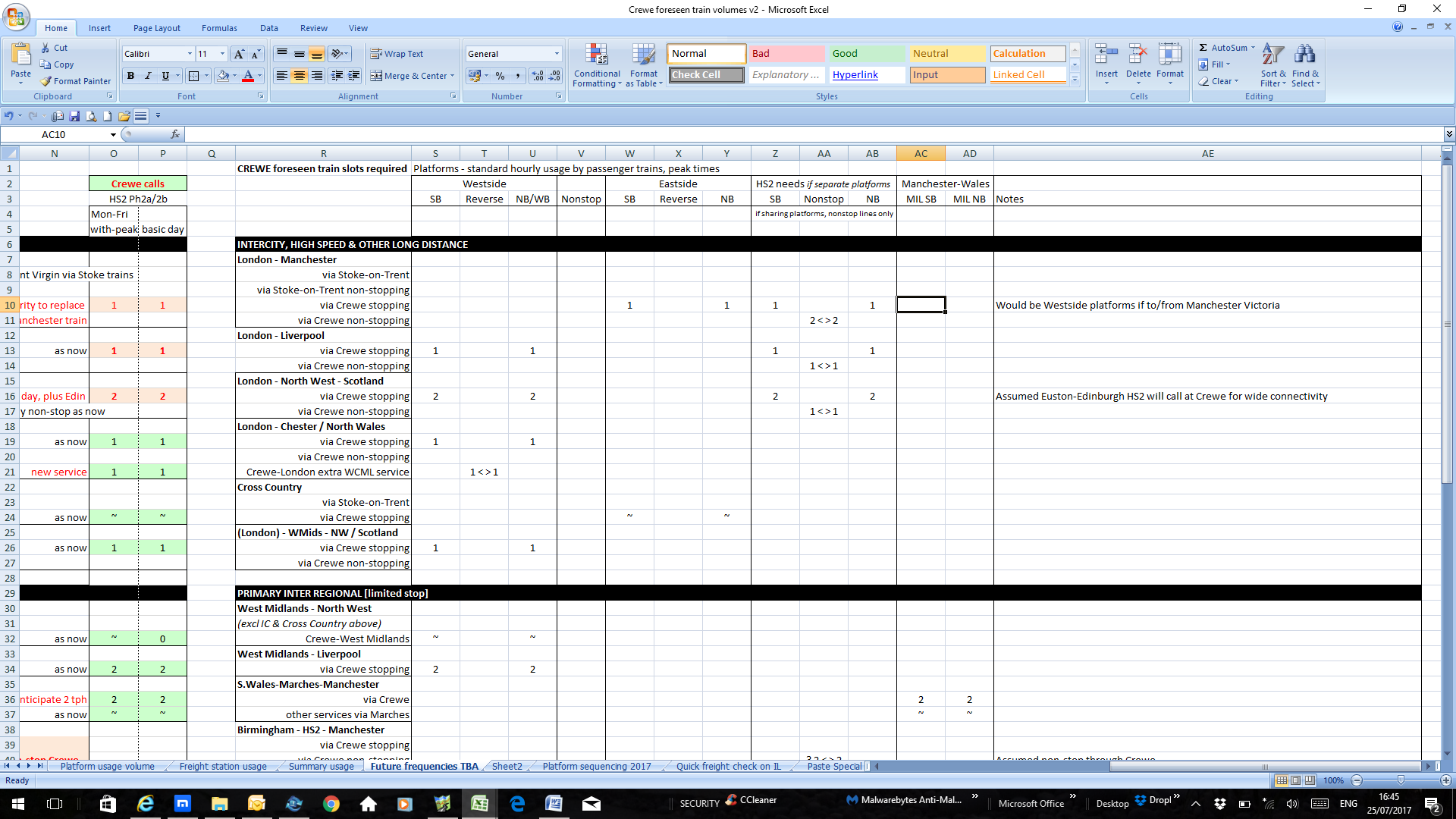
1. Two analyses are set out below:

* Assessment of emerging **passenger train service volume**, categorised by individual services irrespective of whether those services might be merged to occupy only a single track slot through Crewe – a through service – instead of multiple slots (eg terminating trains reversing in platforms and across junctions).
* Assessment of emerging **passenger train slot volume**, where the ability to merge a number of individual services is taken into account in assessing Crewe’s future track and platform requirements.

**Analysis of emerging volumes – passenger train service volume**



**Analysis of emerging volumes – anticipated passenger train slot volume**



# Westside platform group assessment

1. This analysis shows that the post-HS2 pressure point is primarily the **Westside platforms.**

* Foreseeable 11+ passenger trains each way hourly – this is close to a 5 minute interval in each direction, plus another 6 tph reversing with use of the terminating bays at the south and north ends of these platforms.
* Another 2-3 freight trains are currently scheduled some hours during the offpeak via Westside tracks (including use of a up and down loop track which does not have a platform). It is not clear why there is a need for those freight routeings rather than using the various Independent Lines - possibly train crews change, or that there are loading gauge limitations on the Independent Lines.
* There are currently three through Westside passenger platforms in total (6, 11, 12), and two pairs of terminating bays (7, 8 and 9, 10) at the south and north ends of the main platforms. The future through train volume – if all passenger services were adopted and freight retained in the Westside area – would be too much to be handled just at the present through platforms. At least one further through platform would be required, to create two each way and accommodate variable scheduling for passenger trains to/from multiple destinations and routes. There is the ability to reopen disused track and platform capacity if this is required, near platform 12.
* Relevant through platforms would need to be able to accommodate 400 metre long HS2 trains, this is at present OK at platform 12, and at platform 6 in the Down (north) direction. However platform 11, the new fourth platform if required, and platform 6 in an Up (south) direction would require track and platform modifications.
* Another option would be for HS2 trains which potentially could use the Westside platforms to use instead some dedicated platforms of their own – at least one platform each way would be required. Westside usage by through conventional trains would then drop to 8+ passenger tph each way, plus freight. This is a lesser volume but still very busy with the additional freight operations. It might probably be accommodated adequately within the present three through platforms, but would require further analysis to confirm this, otherwise a fourth operational platform could still be required on the Westside.
* In general, this analysis points to either:
  + A Westside combination of two through platforms in each direction, with adequate platform length for 400 metre trains, and retain the two pairs of terminating bays, themselves to be of appropriate length (they currently vary in their capacity between 4 and 10 vehicles of 20m length).
  + Alternatively, at least one new HS2 platform in each direction plus at least the existing three Westside platforms, and the existing terminating bays, in addition to through HS2 fast tracks. A further through Westside platform might still be necessary.
* If all of this was at surface level, including separate platform requirements for HS2, it would point to extensive space take, which would be a limiting factor, and increase the costs of surface works as it is possible that some of the existing Westside platforms would require re-positioning further west in order to make space for HS2 platforms.
* The conclusion is that less land take and fewer track and platform impacts are incurred if HS2 passenger trains which stop at Crewe (other than those to Manchester Piccadilly, using Eastside) can be integrated with conventional train services within the Westside platforms. At least some HS2 trains will indeed change their role from HS to ‘classic’ here, with Crewe being the ‘boundary’ station between use of HS and ‘classic’ track.
* There would need to be appropriate grade-separated/conflict-avoiding junctions south and north of Crewe, for connections to and from the HS lines.

# Eastside platform group assessment

1. Contrary to initial expectations, in the JRC analysis of future requirements the **Eastside platforms** do not appear to require major additional capacity once they are pre-sorted to serve mainly the Manchester Piccadilly and Airport group of WCML calling services (and any HS2 Manchester Piccadilly calling trains via the Wilmslow line).

* This is provided that the largely commuter and regional Hub-type train services which are expected to use the Eastside platforms are scheduled to run through between different journey origins and destinations, with a short station dwell time, rather than terminate and then take time to reverse in the through platforms (which is how through platform 1 is used a lot at present).
* The two through Eastside platforms 1 and 5 allow 13 x 20 metre vehicles at platform 5, and 15 at platform 1 – so should be adequate unless HS2 calling trains required 400 metre length platforms – which would necessitate track and platform modifications.
* If fewer commuter and regional Hub-type trains ran through and more were planned to terminate and reverse, then an additional terminating platform might be desirable at the north end of this platform group . There are already terminating bays at the south end.
* Alternatively an additional through platform could be proposed. This might be less desirable, at least before Phase 2b, as it would potentially occupy the space used by the current fast tracks, during Phase 2a. ‘Classic’ fast tracks however might not be required once Phase 2b were opened, if an HS ‘bypass’ tunnel line were built with that Phase (or earlier). Such construction is what HS2 Ltd envisages.

1. The Manchester Independent Line (and the Salop link) has been recommended by JRC for use by the through Manchester-Marches-Wales services. Depending on scheduling detail, only one platform might be required there, as the upper service level is foreseen as 2 trains per hour each way.

# Non-stop lines assessment

1. The remaining requirement is track design, line speeds and line capacity for future non-stop train services not calling at Crewe. These will mutate in phases from now – the fastest WCML trains.

* These will become HS Phase 1 ‘classic compatible’ trains, if this remains distinct from Phase 2a. Phase 1 trains will scarcely vary in frequency from now, though stops might adjust. Timings will vary from the present, but trains will use the existing WCML from near Lichfield, so the present fast tracks through Crewe remain very relevant.
  + If the line speed could be raised then journey times could be shortened – a useful benefit.
  + The speed limit through the station and approaches is 80 mph. 110-125 mph is preferred.
  + Works to simplify junctions and pre-sort trains would assist in raising speed limits, because of signalling safety distances, along with the bridge works discussed a little earlier.
* With HS2 Phase 2a, the HS tracks stop just short of Crewe, to the south of the station. It is not foreseen that remaining and substitute WCML passenger trains will be required to non-stop Crewe, so the main use of the existing fast lines would be HS2 expresses.
  + Action to join the fast lines onto HS2 Phase 2a southwards would be relevant.
  + The fast lines would then be a key part of Phase 2a, unless it is also judged that early construction of a HS ‘bypass’ tunnel under Crewe, foreseen at present for Phase 2b, would be worthwhile to further minimise the scale of intermediate stage track works and interim junction complexities ahead of Phase 2b. That would depend on more detailed analysis.
* With HS2 Phase 2b, a new ‘bypass’ tunnel line permitting very high speed operation is proposed. This is to maximise journey time savings, at a high cost but also avoiding a large amount of complicated and costly track and platform rearrangement if non-stop trains remained at surface level. It is possible that the impact of access costs will favour a tunnelled solution. Access costs may also favour an early tunnelled solution, in order to keep down the total Crewe area costs which arise cumulatively for the various HS2 Phases, and to accelerate the Hub benefits with an early comprehensive station redevelopment.

1. When considering a wider range of options, JRC’s alternative thoughts have been to create a ‘virtual tunnel’ for HS2 Phase 2b, at surface level (which is subject to the bridge works described above). It would be based broadly on the existing fast track alignment though Crewe station, though with wider passing distance between trains if GC gauge and very high speed, but only if the net cost advantage were to favour an ‘all-at-surface’ solution – including any shuffling west of the Westside platforms – rather than a pair of deep-level tunnels which is the present HS2 thinking for Phase 2b to bypass Crewe.
2. The choice should be determined by detailed whole-life cost analyses. It is unlikely that the present overall roof could be retained in such an option – but then a large-scale redevelopment might be desired in any event, possibly with the existing roof moved to a heritage location.
3. On the presumption that it might be simplest and least demanding on access costs, to keep the present through non-stop ‘classic’ tracks, until a future year that they were no longer needed because of an HS ‘bypass’ tunnel, the emerging options at track level might then be to:

* Convert their site into a better environmental landscape in the heart of the station.
* Retain a single track, and build an additional platform to provide extra operational capacities and margins for the ‘classic’ railway.

# New track links outside the Crewe station environs

1. Crewe Town Council desires provision in the final HS2 Phase 2b design north of Crewe, to provide up-up-down-down tracks with the LNW North main line, so that trains can switch easily between HS and ‘classic’ tracks, between Crewe and the 2b route divergence south of Winsford.

* This will facilitate direct Crewe-calling to HS2 North and HS3 trains. This will directly benefit Crewe Hub accessibility and the economic benefits arising throughout the catchment, and achieve greater connectivity throughout the national rail lines which feed Crewe Hub.
* It will also enable engineering works on the proposed HS2 Phase 2b ‘bypass’ tunnel with minimal passenger time loss, as HS ‘classic compatible’ trains (the bulk of the HS fleet) can then continue through Crewe (surface) lines, and rejoin the HS tracks at the earliest opportunity.

1. The Crewe-Sandbach section has been discussed earlier, and in the 7th June Crewe Accessibility report. If some or all of the possible Crewe commuter and regional Hub services materialise, then this section of railway will require track changes to enable a combination of HS and ‘classic’ expresses, the Manchester-Marches-Wales trains at possibly greater frequency and routed via MIL, and an enhanced regional service volume. Improved capacity on the route is also important to sustain and improve access to Manchester International Airport.
2. As noted earlier, an increased commuter and regional Hub service level might require re-doubling of the 3.2 mile single-track section between North Stafford Junction and Barthomley Junction.
3. Crewe Town Council wishes to restate here the JRC-assessed potential for a combined HS2/HS3 infrastructure option, for some Manchester HS trains to focus on Exchange/Victoria stations rather than Piccadilly. As well as greater connectivity for towns north of Manchester, this option could avoid capacity complications on the Crewe-Manchester line, at least during Phases 1/2a, and also simplify the WCML/HS2 junction arrangements both south and north of Crewe. This would also offer a route to accommodate Liverpool’s desired ’20 mile’ link to HS2, with a straightforward junction between HS2 Phase 2b north of Crewe, and the Chat Moss line east of Newton-le-Willows.

# Appendix 1. Table of all trains 31/5/2017 through Crewe station, 2AM to Noon

1. The table below shows the present 2017 timetabling through Crewe station. This excludes the Independent Lines (which have several sub-sets - Salop, Liverpool and Manchester Independent Lines), but includes freight and other non-passenger trains scheduled to run through the passenger station. The main report above includes a table of averages for each platform and track occupation, which vary substantially between neighbouring tracks. The table below sets out each service in timing sequence, platform by platform and track by track, through the passenger station, including the through non-platform lines represented by the Up and Down Fast Lines and the Up/Down Goods Loop.
2. The actual train occupation of approaches and exits plus within-station times including platform ‘dwell time’ and any ‘reversing time’, is shown in the table below on a normalised basis varying by type of train, for 31st May 2017 – a normal weekday with no major service dislocations – from 2AM to 12 Noon. This includes:

* Start of service for many trains, and overnight freight.
* AM Peak Period, often regarded by Network Rail as the criterion around which to test a timetable (if it works then, then something similar should work in the offpeak and evening).
* Daytime offpeak through to Noon.

1. The conflicts arising between each train’s path and other possible train movements are shown in a simple coded format, described below.

* The predominant conflicts tend to be self-repeating, in both the AM Peak and the offpeak, such as the Manchester-Marches-Cardiff trains having to cross almost all the main tracks, in each direction, in order to progress between the Marches Line (to the South West of Crewe) to/from the Manchester Line (to the North of Crewe). This is a maximum conflict, red.
* Intermediate scales of conflict are also highlighted, with two types – firstly orange, just conflicting with the opposite direction on one rail corridor, and secondly, red, a conflicting movement across at least one other main line.
* When looking at individual trains as set out below, in practice some trains runs on a tight headway margin, with their minima set out in Network Rail’s ‘Rules of the Plan’. The tighest margins with following trains are highlighted below in the table as “XX”.

