

Camberley Rail Assessment Report – Issue | 1 February 2016



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Surrey County Council Camberley Rail Assessment Report

Issue | 1 February 2016

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1 Introduction

1.1 Background

The Surrey Rail Strategy was completed and published in September 2013. Three priority options were identified in the Strategy:

- Capacity on the South West Main Line (SWML), particularly the Crossrail 2 scheme;
- Local orbital rail services, particularly the North Downs Line; and
- Access to airports (Heathrow and Gatwick).

The Rail Strategy helps Surrey County Council (SCC) to understand how best to influence key decision makers in the rail industry, to develop its thinking on credible investments in rail infrastructure, and to make the best case for investment in local rail infrastructure. The ultimate objective is to secure the required investment in the county's rail network aligned with the overarching development objectives for Surrey.

Access to London from Camberley, Bagshot and Frimley was identified in the Rail Strategy as a main adequacy issue for rail in Surrey, with a poor level of service and relatively long journey times from these stations to London. This study was commissioned to address this issue in more detail.

In this report the group of stations comprising Camberley, Bagshot and Frimley are generally referred to as Camberley for brevity.

1.2 Previous Studies

1.2.1 Surrey Rail Strategy

The Surrey Rail Strategy recommended exploration of various options to address the Camberley issue.

In the short-medium term, it recommended options to reduce journey times between Camberley and London via Ash Vale.

In the longer term, it identified an option to connect the Frimley Line to the SWML by reinstating the Sturt Road Chord and building a new grade-separated link. This allows direct services between Camberley and London via the SWML, subject to released capacity being provided by other SWML schemes (e.g. Crossrail 2) and subject to a business case assessment.

1.2.2 Wessex Route Study

The Wessex Route Study, published in August 2015 by Network Rail, proposes two additional direct trains per hour in the off-peak period from Camberley, Bagshot and Frimley to London via Ascot (starting at Aldershot), but no peak period improvements are proposed.

The study also mentions the option of reinstating the Sturt Road Chord, but suggests that a more cost-effective solution may be to improve connection times with Waterloo-bound trains at Ash Vale.

1.3 Objectives of the Assessment

The scope of this assessment is to understand the costs and benefits of providing a direct connection onto the SWML from Camberley to London Waterloo, which offers the greatest potential journey time savings and best connectivity in the longer term.

The primary objectives of this study are therefore to:

- assess the options for improving rail service frequency and journey times from Camberley to London via a direct connection to the SWML in the longer term; and
- evaluate the costs of each of these options, and thus estimate the benefits that would need to be achieved in order to produce a positive business case.

The outcomes of this study are expected to feed into wider discussions between SCC and local stakeholders, specifically relating to how and when improvements could be made to the rail service between Camberley and London.

Short term operational solutions (i.e. changes to service patterns) are not in the scope of this study and will be developed separately by SCC with local stakeholders. These might include improved connections via Ascot or Ash Vale, as recommended in the Surrey Rail Strategy and the Wessex Route Study. It is recommended that these improvements are pursued through the current Department for Transport consultation on the South Western rail franchise, which closes in February 2016. The franchise will be renewed in June 2017.

1.4 Study Approach

The study was undertaken in three main stages:

- development of infrastructure options;
- selection of preferred option(s); and
- assessment of preferred option(s) based on assumed future service levels.

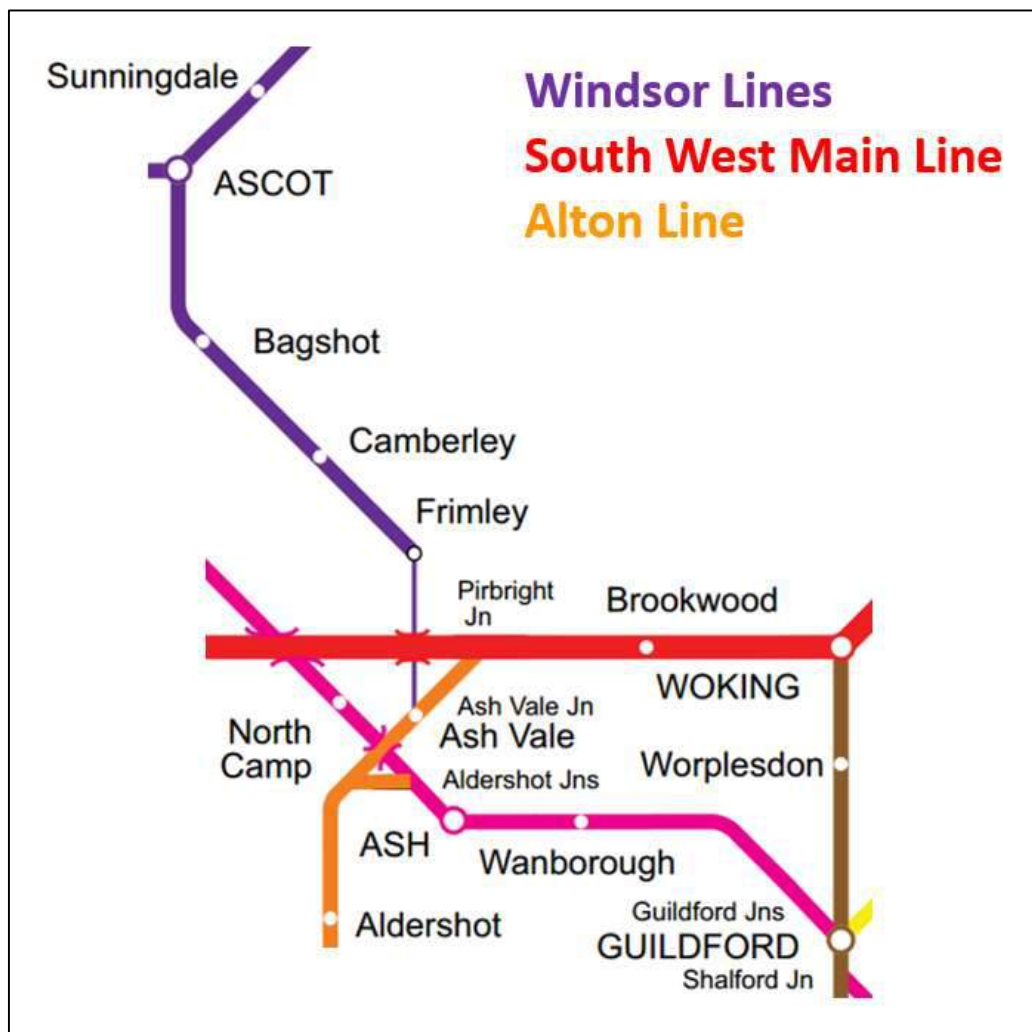
These stages are reported in chapters' three to five.

2 Current Situation

2.1 Overview

Figure 2.1 shows the Frimley rail line serving Camberley, Bagshot and Frimley which is part of the suburban Windsor lines. Services operate between Ascot and Guildford via Ash Vale and Aldershot (via the Alton Line and North Downs Line). A short section of single track (the Frimley single), approximately 3km long, operates as a connection to the Alton line, between Frimley junction and Ash Vale junction.

Figure 2.1: Location of Camberley Rail Line



2.2 Service Pattern

Services operate on a half-hour frequency throughout the day between Ascot and Guildford (with trains reversing from Aldershot) in both directions.







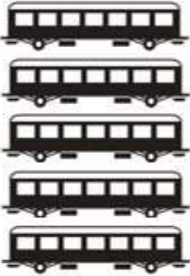

There are very limited direct connections between Camberley and London Waterloo (see **Chart 2.1**). In the current timetable there are three trains in the

morning peak (06:44, 07:14, 07:44) direct to London Waterloo from Camberley via Ascot. In the afternoon peak only two trains (17:05, 18:05) operate direct from London Waterloo to Camberley via Ascot.

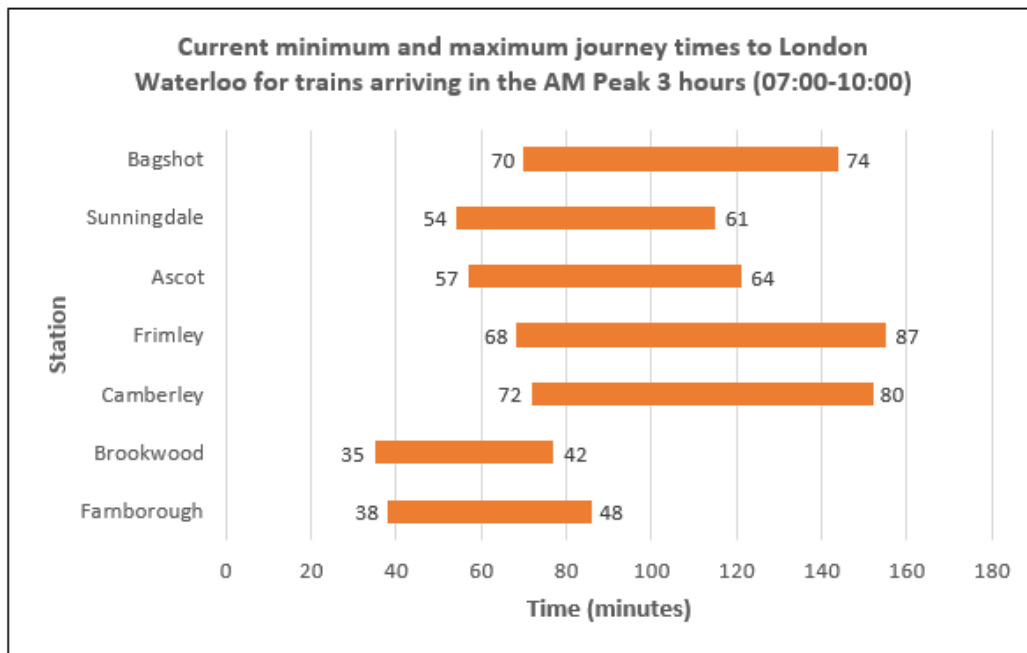
Journey times between Camberley and London Waterloo are currently long although the connection can be made either via Ascot or Ash Vale. Direct journey times are either 75 or 76 minutes from Camberley. Indirect journey times range from 72 to 80 minutes. The variations in journey times are represented in **Chart 2.2**.

Anecdotal evidence indicates that interchange at both Ascot and Ash Vale is poor, with limited facilities for mobility-impaired travellers. A proportion of the passenger base from Camberley currently travels to stations on the SWML (Farnborough, Brookwood) or on the Windsor Lines (Ascot, Sunningdale) to catch a train because it is quicker.

Chart 2.1: Direct Train Services Comparison

	07:00 - 07:59	08:00 - 08:59	09:00 - 09:59
Brookwood			
Camberley			
Sunningdale			

 - Represents one direct train service to Waterloo

Chart 2.2: Current Journey Times to London Waterloo Comparison

2.3 Current Utilisation

A high level review of the current utilisation of the Frimley Line, the Alton Line and the SWML in the study area was completed. Utilisation of the lines takes into consideration the number of slow, fast and single track sections of the route and the points at which trains are required to cross the main line or turn at stations. It also uses the current service frequencies operating along the three lines and the minimum headways between trains (measured in minutes) based on the planning standard.

Currently there is spare capacity for train paths on the Frimley and Alton Lines. A high level review of the current service operation at Ascot suggests that there would be some additional capacity at Ascot station to introduce a direct train service from Ascot to London Waterloo via Camberley and the SWML using the bay platform (3), but a more detailed operational assessment is needed to understand the implications of doing this.

Although there is theoretically spare capacity on the SWML on this section (Farnborough to Woking), the current pinch point on the SWML is between Woking and London, where utilisation is already at capacity with up to 24tph operating into London Waterloo in the peak hours. This means that there is no additional capacity (train paths) into London Waterloo available until major improvements are undertaken.

2.4 Wessex Route Study Proposals

The Wessex Route Study references a Control Period 5 (2014-2019) scheme to make the Windsor Lines 10-car capable, including the Frimley Line, by May 2017 (although it should be noted that, at the time of writing, the delivery of all CP5 enhancement projects is currently under review). This involves infrastructure and operational interventions to extend platforms and upgrade signalling.

Improvement options for the Frimley Line are identified as:

- improving interchange at Ash Vale (CP5);
- the potential for an additional two trains per hour off peak to operate direct to London Waterloo from Aldershot via Ascot (CP5); and
- infrastructure works to enable 12-car capability (CP6+).

With respect to this study and the investigation into the feasibility of undertaking major infrastructure works to support a direct connection from Camberley to London Waterloo via the SWML, the Wessex Route Study states:

2.7.2 Similarly a number of people in and around Camberley suggested that the Sturt Lane Chord (which used to connect the Ascot to Aldershot line with the South West Main Line to the east of Farnborough) should be reinstated as a means of improving journey times to Waterloo from the Frimley and Camberley areas. A more cost-effective solution, however, may be to improve connection times with Waterloo-bound trains at Ash Vale.

Excerpt from Wessex Route Study, page 22 (Network Rail) 2015.

2.5 Alternative Service Options

In addition to the Wessex Route Study, there are two potential alternative service options that look to improve journey times or provide direct connections from Camberley that do not rely on new infrastructure provision. These are:

- improving journey times to London Waterloo to 60 minutes by reversing trains at Aldershot and coupling to existing Alton trains (proposed by the Camberley Society¹); and
- turn trains from Camberley at Ash Vale to operate via Pirbright Junction to provide a direct connection to London Waterloo (instead of or as well as operating to Guildford).

These shorter term service options are not developed further in this study, but it is recommended that these improvements are pursued through the current Department for Transport consultation on the South Western rail franchise, which closes in February 2016. The franchise will be renewed in June 2017.

¹ Quoted in an article in Rail Magazine 788 November 25 to December 8 2015.

2.6 Summary

The review of the current situation above shows that there are some potential short term service options to improve rail services from Camberley to London that should be pursued through the South Western rail franchise process with the Department for Transport and potential franchisees.

In the longer term, there are no significant schemes proposed that will improve the rail service from Camberley to London Waterloo, in terms of journey times. Infrastructure options to address this gap are considered in the next chapter.

3 Development of Infrastructure Options

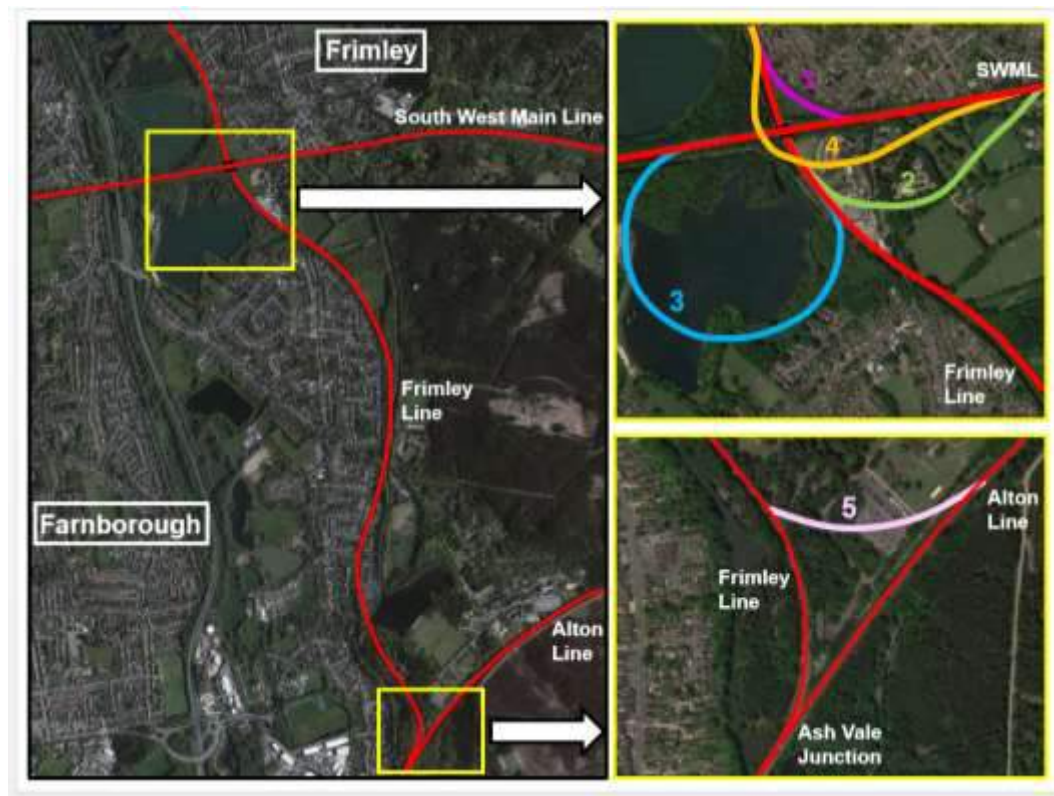
The first task of the study was to review and identify the potential infrastructure options for improving rail service frequency and journey times from Camberley to London via a direct connection to the SWML in the longer term.

For this study the level of design developed was at the nominal Guide to Railway Investment Project (GRIP) stage 0.

The following options were identified for assessment (see **Figure 3.1**):

Option	Description
1	Reinstate Sturt Road Chord in the Up direction (towards London) Ladder across the SWML in the Down direction (from London)
2	Reinstate Sturt Road Chord in the Up direction New curve off the SWML to run under the bridge at Frimley Junction
3	Reinstate Sturt Road Chord in the Up direction New curve off the SWML after the bridge at Frimley Junction to spiral over lake to run under the bridge at Frimley Junction
4	Reinstate Sturt Road Chord in the Up direction Flyover across SWML
5	New bi-directional chord at Ash Vale junction linking the Frimley Line with the Alton Line to enable trains from Camberley to run directly onto the SWML at Pirbright Junction.

Figure 3.1 shows the indicative location of all five infrastructure options in relation to the SWML, the Frimley Line and the Alton Line.

Figure 3.1: Location of Options

Each option is described below and illustrated in a supporting diagram in **Appendix A**. Layouts are based on aerial photography and using current Network Rail standards. Confirmation of alignments would be subject to further design at later GRIP stages, if pursued.

At this stage of design development a series of assumptions regarding infrastructure were made including:

- Alignments are based on track centreline data and images from Surrey County Council (SCC) geographic information systems - a topographical survey will have to be carried out to validate the design alignment at later design stage (GRIP 3)
- No assessment on ground conditions have been completed – this would occur at later design stage
- Track is assumed to tie into existing mainlines with no cant – vertical information, including cant, will form part of the topographical survey
- All track assumed to be CEN 56 rail type
- Maximum track gradients 2.0%
- Minimum element length to be 30m
- Minimum radii 251m (for provision of Continuously Welded Rail)
- Track centres assumed to be standard dimensions of 3405mm
- Line speeds - taken from the 5 Mile Diagrams as follows:

- Up & Down Frimley Line Double - 60mph
- Up & Down Frimley Line Single - 40mph
- SWML1 Up Slow - 90mph
- SWML 1 Up Fast - 100mph
- SWML 1 Down Fast - 100mph
- SWML 1 Down Slow - 90mph

3.1 Option 1: Sturt Road Chord and Ladder

Figure A1 shows Option 1 - an at-grade junction chord that connects the Frimley Line to the SWML in the Up direction with a ladder across the SWML for access to the Frimley Line in the Down direction. The chord would be located to the north east of the existing crossing point of the Frimley Line and SWML in the Sturt Road area.

This option sees the disused railway chord reinstated and a new flat junction introduced. It requires a ladder of crossover units on the mainline to enable traffic traveling from London on the Down Slow line to access the chord and travel towards Camberley in the Up Direction. **See example image below.** At this point the SWML has four tracks with five trains per hour operating on the slow line in the peak and up to seven trains per hour operating on the fast line in the peak. Installing a ladder of crossover units to access the Frimley line would require trains to cross both the Up and Down fast lines and the Up slow line. This manoeuvre would result in a significant reduction in the capacity of the fast and slow lines in the peak periods which would reduce the number of trains that can pass through this point. This is a fatal flaw with this option.



The following design points should be noted:

- the geometry of this option is constrained by the construction of properties between 1999 and 2003 on the chord alignment near the connection to the SWML; and
- this option has been developed to minimise required land-take, as this is a disused railway corridor.

3.2 Option 2: Sturt Road Chord and Frimley Lodge Chord

Figure A2 shows Option 2 – this option includes the Sturt Road Chord described in Option 1 above, but instead of the ladder junction on the SWML, this provides a separate link that connects the SWML to the Frimley Line without obstructing the SWML. This new chord (which we have called the Frimley Lodge Chord) would be located to the south east of the existing crossing point of the Frimley Line and SWML.

The following design points should be noted:

- this option requires land-take at Frimley Lodge Park and surrounding properties.

3.3 Option 3: Sturt Road Chord and Kingfisher Chord

Figure A3 shows Option 3 – in addition to the Sturt Road Chord, a link is provided that connects the SWML to the Frimley Line. The new chord (which we have called the Kingfisher Chord) would be located to the south west of the existing crossing point of the Frimley Line and the SWML and would be on a structure over the existing lake.

The following design points should be noted:

- this option impacts on The Quays (public house);
- it requires the construction of a viaduct for it to cross the nature reserve (as designated in the Network Rail National Hazard Directory. The nature reserve can be seen on the SCC environmental constraints map in **Appendix B**); and
- the geometry on this option would require a BV8 turnout that is not permitted in mainline applications².

² The implication of having the BV8 turnout is a tighter radii so more wear and tear therefore more ongoing maintenance costs. This would have to be agreed by Network Rail Head of Track. If Network Rail standards were met, the impacts are that a much larger curve would be required.

3.4 Option 4: Sturt Road Chord and St Andrews Flyover

Figure A4 shows Option 4 - in addition to the Sturt Road Chord a grade-separated junction that connects the SWML to the Frimley Line is explored. The start of the flyover would be located to the south east of the existing crossing point of the Frimley Line and the SWML. It would then pass over both lines to connect to the Frimley Line north west of the existing crossing point of the Frimley Line and the SWML.

The following design points should be noted:

- it has been assumed that 7m of vertical clearance is required to crossover the railway. To cross over both the lines it has been assumed the railway will need to climb 14m;
- this option requires land-take within a designated conservation area and the purchase of land and property potentially impacting on Mitie Security offices, St Andrews Church and Frimley Lodge Park; and
- it requires the construction of a viaduct for it to cross the nature reserve.

3.5 Option 5: Ash Vale Chord

Figure A5 shows Option 5 - an at-grade junction chord that connects the Frimley Line to the Alton Line, which we have called the Ash Vale Chord. The new chord would be located to the north of the existing junction of the Frimley and Alton Lines (Ash Vale junction).

This option enables trains to and from Camberley to connect to the SWML via the existing Pirbright junction.

The following design points should be noted:

- this option requires land-take of a wooded area and car park from Keogh Barracks; and
- it requires some minimal modification to existing infrastructure to implement.

3.6 Summary

This chapter identifies potential infrastructure options for improving the rail service frequency and journey times from Camberley to London via a direct connection to the SWML in the longer term.

Five options are identified, four of which rely on the Sturt Road Chord in the Up direction (towards London) and alternative options for the Down direction (from London). The other option identifies an alternative that connects the Frimley Line with the SWML via a new chord at the Ash Vale junction.

These options are assessed in the following chapter.

4 Selection of Preferred Option(s)

A high level qualitative assessment of each of the five infrastructure options was conducted to identify which of the options was most likely to be feasible, and thus taken forward for more detailed study as the preferred option.

4.1 High Level Assessment

The assessment included the following elements:

- **Relative cost** – based on a high level understanding of the infrastructure requirements (for example building a grade-separated junction would be more expensive than an at-grade chord);
- **Impact on journey time** – relative assessment against each option noting that all options are expected to improve existing journey times;
- **Engineering feasibility** – based on a high level understanding of the complexity associated with the proposed infrastructure requirements;
- **Operational performance** – based on the potential impact on existing operations;
- **Environmental constraints** – based on the published SCC Environmental Constraints Map (provided for information in **Appendix B**); and
- **Land-take constraints** – based on a qualitative assessment of the extent to which third party land (not owned by Network Rail, SCC or Surrey Heath Borough Council would be required).

A summary ‘traffic light’ (Red – Amber – Green) assessment for each option against these elements is shown in **Table 4.1**.

The assessment is based on the assumption that the current pathing constraints east of Woking would have already been addressed by other SWML schemes (e.g. Crossrail 2).

Table 4.1: High Level Assessment Options

Option	Cost	Journey Time	Engineering Feasibility	Operational Performance	Environmental Constraints	Land-Take Constraints
1	Medium cost based on the extent of structures required.	Improved journey time compared to existing provision.	Geometry of this option is constrained by the construction of properties near the connection to the SWML.	Ladder across the SWML would have unacceptable impact on main line operations.	The rural nature of the area suggests some constraints are likely to occur on more detailed investigation.	Developed to minimise land-take but potential conflict with newly constructed properties near the connection to the SWML.
2	Medium cost based on the extent of structures required.	Improved journey time compared to existing provision.	Geometry of this option is constrained by the construction of properties near the connection to the SWML.	No conflict with existing services as infrastructure would connect directly into either the Up or Down mainlines	The rural nature of the area suggests some constraints are likely to occur on more detailed investigation.	Sensitive land-take issues through a recreation area.
3	High cost based on the extent of structures required.	Improved journey time compared to existing provision.	Major engineering challenge with the need for a viaduct to be constructed over the lake.	No conflict with existing services as infrastructure would connect directly into either the Up or Down mainlines	Requires viaduct across nature reserve.	Sensitive land-take issues.
4	High cost based on the extent of structures required.	Improved journey time compared to existing provision.	Major engineering challenge with a flyover of approximately 14m height required.	No conflict with existing services as infrastructure would connect directly into either the Up or Down mainlines	Requires viaduct across nature reserve.	Sensitive land-take issues.
5	Lowest cost based on the extent of structures required.	Improved journey time compared to existing provision but longer than other proposed options.	Simple chord required.	Some conflict with existing Alton line services as Down services to Camberley would have to cross the Alton line to access the chord.	Lowest environmental impact expected.	Some land take issues but one public sector landowner (MoD)

4.2 Summary

A high level qualitative assessment of each of the five infrastructure options was conducted to identify which of the options was most likely to be feasible, based on a number of elements.

The assessment indicates the following:

- Option 1 scores well on journey time but the ladder crossing of the SWML is a fatal flaw due to the impact this would have on the capacity of the slow and fast lines between Farnborough and Brookwood.
- Option 2 scores well on journey times and is not expected to have an impact on operational performance, however, there are sensitive and potentially prohibitive land-take issues to overcome.
- Option 3 scores well on journey times and is not expected to have an impact on operational performance, however, the high costs and complex engineering coupled with sensitive land take and environmental issues is a fatal flaw.
- Option 4 is similar to Option 3 in that it scores well on journey times and is not expected to have an impact on operational performance, however, the high costs and complex engineering coupled with sensitive land-take and environmental issues is a fatal flaw.
- Option 5 whilst providing a slightly lower journey time compared to the other options it offers a lower cost solution based on a straightforward engineering concept with the least impact on land-take and environmental issues.

On the basis of this high level qualitative assessment the following options were taken forward for further analysis:

- Option 2: Sturt Road Chord and Frimley Lodge Chord
- Option 5: Ash Vale Chord

Option 5 is the preferred option and scored best in the assessment. Option 2 scored well but has a major constraint in terms of land-take at Frimley Lodge Park. It is retained however as a comparator to Option 5 and so at least one Sturt Road Chord option is included in the more detailed assessment.

5 Assessment of Preferred Options

5.1 Overview

For the two preferred options identified in the previous chapter (Option 2: Sturt Road Chord and Frimley Lodge Chord and Option 5: Ash Vale Chord) a more detailed assessment was undertaken. This appraisal relies on the following main elements to estimate the potential benefit-cost ratio for each option:

- the costs associated with providing the required infrastructure;
- the costs associated with operating the new services;
- the assumed service levels; and
- the demand required to produce a positive benefit-cost ratio.

This is a high level assessment appropriate to this level of feasibility study and all assumptions and estimates will need to be assessed in more detail to confirm the results if either of the options is progressed further. To provide a fair assessment of the potential for improvements on the Frimley line we have used standard industry costs and tried to maximise assumptions regarding potential passenger demand.

5.2 Service Levels

5.2.1 Availability of Train Paths

A review of the current utilisation of the SWML between Woking and London Waterloo indicates there are currently no new train paths available during the peak periods.

The Wessex Route Study states that:

“evidence suggests that increasing services above these levels... [currently 24 trains per hour on the fast line into London Waterloo in the peak period] ...on current infrastructure is likely to affect performance adversely (without mitigating measures).

In addition, the Wessex Route Study identifies that there are as many as 18 trains per hour in the high peak operating along the slow line into London Waterloo.

Given the above, in the short-medium term it is not possible to introduce a direct train service from Camberley onto the SWML in the peak periods without replacing existing services. We have assumed that existing services could not be replaced by Camberley services without significant opposition from those areas affected, and this has therefore been ruled out.

The future introduction of direct trains from Camberley is therefore assumed to be dependent on further capacity enhancements which free up train paths into Waterloo. It is expected that the earliest this will occur is as a result of improvements associated with Crossrail 2 around year 2030.

It should be noted that any new paths created on the SWML are extremely valuable and there will be strong competition for these paths from other locations on the outer SWML, such as Basingstoke, Winchester, Portsmouth, Southampton, Alton, Farnham, Haslemere, etc. If these paths are to be used for Camberley services, a strong case will need to be made, based on potential growth in the station catchments and a good business case.

5.2.2 Proposed Service Pattern

For both infrastructure options it was assumed that the same service pattern would be introduced.

To improve the journey time for passengers travelling between Camberley and London Waterloo it is assumed that the stopping pattern once trains left the Frimley Line would be at Brookwood and Woking and then running fast to London Waterloo (and the same in reverse).

Whilst four trains per hour would provide the ideal level of service to create a turn-up-and-go service pattern, the assessment of utilisation indicates that this would create additional pressure on the SWML between Farnborough and Brookwood which would limit operational resilience. Utilisation of the SWML would further increase at Woking as additional trains from Portsmouth and Guildford compete for paths.

It is therefore assumed that an additional two direct trains per hour would be introduced, in addition to the current two trains per hour running between Ascot and Guildford.

5.2.3 Proposed Journey Times

The new in-vehicle journey times between Frimley and Brookwood were calculated to be as follows:

- 8 minutes for Option 2 - based on Ash Vale to Brookwood being a similar distance; and
- 13 minutes for Option 5 - based on Frimley to Brookwood via Ash Vale being a similar distance.

Existing journey times for trains from Brookwood stopping at Woking and London Waterloo were then used to calculate the comparison between the existing journey times and the new journey times for use in the options assessment. These are summarised in **Table 5.1**.

Table 5.1: Fastest London Journey Times

Journey Time to London (minutes)	Current	Option 2	Option 5
Frimley	68	44	49
Camberley	72	48	53
Bagshot	59	53	58

5.3 Capital Costs

The infrastructure requirements identified for the preferred options were used to prepare a high level outline cost estimate, the details of which are provided in **Appendix C** for information. **Table 5.2** summarises these costs for Option 2 and Option 4.

Table 5.2: Preferred Options Cost Estimates

	Option 2 Costs (£)	Option 5 Costs (£)
Direct Construction Works	21,940,000	4,500,000
Indirect Construction Costs	7,240,000	1,480,000
Project / Design Team Fees	6,260,000	1,480,000
Risk	21,270,000	4,480,000
Total High Level Cost	56,710,000	11,940,000

See **Appendix C** for assumptions and details of costs.

It is important to note that these cost estimates are for design and construction, and therefore exclude the following:

- Value Added Tax
- Utilities upgrades
- Inflation
- Advanced material purchase procurement
- Works associated with existing mines, soft spots and so forth
- Vertical alignment changes to the existing rail
- Flood mitigation measures
- Improvements to the existing network
- Client design
- Land and property

It is also important to note that the cost calculations assume that the installation process for each option is straightforward in terms of build. It was assumed that as the infrastructure relates to building new lines, construction works can be reasonably uninterrupted and track possessions and disruptions can be kept to a minimum. Average cost rates have therefore been used for all line items.

Whilst the cost assumptions assume that all sites can be used (i.e. sites are greenfield with little remedial works required such as decontamination), the potential costs of any land-take and demolition costs have the potential to be significant in this area.

A review of the design options also identified that the construction of the Sturt Road Chord may present practical engineering challenges that are not clear

through the current desk-based exercise. For Option 2 the turnout on to the SWML from the Sturt Road Chord appears to be located on the bridge over Sturt Road. Both this and the close proximity to the new houses at that end of Sturt Road may impact on the alignment of the Chord, which if changed may have a considerable impact on costs.

5.4 Operating Costs

A high level outline estimate for operational costs has been assumed, comprising:

- Rolling stock capital costs
- Rolling stock non-capital costs
- Variable track access costs
- Electricity costs
- Staff costs

At this stage, no consideration has been made in relation to depot and stabling costs for any additional trains required to operate new services from Camberley. From initial discussions with Network Rail it is understood that new berthing sidings are proposed at Woking which may be sufficient to cater for additional trains, but this will need to be confirmed.

5.4.1 Rolling Stock Costs

Both option 2 and 5 are assumed to run 68 services per day (Up and Down combined) in a continuous service pattern from 0600 to 2300. This is consistent with Alton to London services, where 66 direct trains operate from 0542 to 2323. Operationally it is assumed that four new trains are needed for option 2, and 5 trains for option 5. Option 5 needs more rolling stock because the journey time to Ascot is over 60 minutes, therefore four trains is not enough to operate a 30 minute frequency. For both options an additional contingency train is also included.

Rolling stock costs are based on previous work undertaken by Arup. **Table 5.3** summarises the annual leasing costs per vehicle. The appraisal is based on costs for a typical electric train in both options and each train would consist of four vehicles.

Table 5.3: Assumed Rolling Stock Lease Costs per Month per Vehicle (2015 prices)

	Rolling Stock Cost (£)
Capital Rental Charge per Vehicle (£)	178,840
Non-Capital Rental per Vehicle (£)	40,880

For the purposes of the appraisal, the rolling stock is assumed to be replaced like-for-like every 30 years (so two orders will be required during the appraisal period).

5.4.2 Variable Track Access Costs and Electricity Costs

Each train service is 48 miles per journey (London Waterloo - Ascot), therefore in total the new services would operate 3264 miles per day or 1.184 million miles per year.

Network Rail produce a track price usage list (2012/13 prices. **Table 5.4** shows Network Rail's variable track access and electricity costs. The costs have been uplifted by RPI to 2015 prices.

Table 5.4: Variable Costs (2015 prices)

Variable Cost	£ per four-car train mile	Service costs per year (£)
Passenger Variable Usage Charge rates 365/T	0.2334	276,487
Electrification Asset Usage Charge DC (third rail) pence per electrified vehicle mile	0.0293	34,760

5.4.3 Staff Costs

Each operating unit requires a driver and a conductor. A train driver is assumed to earn £51k per year whilst a conductor earns £33.5k. The salaries include pension and national insurance contribution.

Estimating annual working hours of 1575 for each employee, 16 drivers and 16 conductors are needed for option 2. 20 drivers and 20 conductors are required for option 4.

Total staff costs are therefore £1.353m per year for option 2 and £1.691m for option 5; these are summarised in **Table 5.5**.

Table 5.5: Annual Staff Costs

Option	Staff	Salary (£)	Staff Required	Annual Cost (£)
Option 2	Driver	50,996	16	815,936
	Conductor	33,584		537,343
	Total	n/a	32	1,353,280
Option 5	Driver	50,996	20	1,019,920
	Conductor	33,584		671,679
	Total	n/a	40	1,691,600

5.4.4 Annual Operational Costs

Using the estimates above, the total annual operating costs have been calculated. **Table 5.6** shows the assumed operational costs (2015 prices). 2015 prices have been calculated using RPI growth from the relevant year.

Table 5.6: Annual Operational Costs

Metric	Option 2 Annual Costs (£)	Option 5 Annual Costs (£)
Capital Rental Charge per Vehicle	3,576,725	4,292,071
Non-Capital Rental per Vehicle	817,537	981,045
Variable Track Access Charge	276,487	276,487
Electricity	£34,760	£34,760
Staff	1,353,280	1,691,600
Total	6,058,790	7,275,963

5.5 Demand Assessment

5.5.1 Approach

The volume of demand affected by the improved services was estimated using the Passenger Demand Forecasting Handbook (PDFH) and standard Department for Transport Web-based Transport Analysis Guidance parameters.

This enabled the potential benefits of the two preferred options to be estimated in relation to:

- journey time savings for existing users (both at Camberley stations and for passengers who currently use other stations); and
- revenue impacts through additional fares from new users.

These benefits were then compared to the costs estimated in the previous sections in order to understand whether the scheme has a good value for money, and if not the gap that would need to be overcome in order to reach a positive case.

For the purposes of evaluating the options, the analysis compared the existing services to Waterloo via Ascot (Do Minimum) against the two preferred options to connect to the SWML (Do Something).

The DfT considers a scheme to represent medium Value for Money (VfM) with a Benefit Cost Ratio (BCR) of between 1.5 and 2.0, and high VfM with a BCR of between 2.0 and 4.0. Given that the Camberley scheme would need to compete against alternative options for using valuable future capacity on the SWML, the preferred options are likely to require a BCR indicating high VfM (i.e. 2.0 or above).

If a gap is identified, the additional demand that would need to use the Camberley stations in order to bridge this gap and therefore to produce a positive business case was estimated. This involved using the average yield between stations on the Frimley Line and London, and therefore the additional demand needed to generate sufficient revenue to bridge the gap. This was then considered in the Surrey

context of population forecasts and development growth in the area (based on assumed trip rates).

The output of the assessment is the estimated costs and standard benefits of the preferred options, and a calculation as to the extent of additional demand and associated revenue and journey time savings required in order to justify the investment and produce a positive business case. The assessment focused solely on demand to and from London.

5.5.2 Origin Demand by Station

Base origin demand for each station was obtained using MOIRA data³ provided by South West Trains for the following ticket types:

- Full fares – peak tickets including Day Returns and Day Singles.
- Reduced – off peak tickets including Off-Peak and Super Off Peak Day Returns and Singles.
- Seasons – all season tickets.

Anecdotal evidence suggests that currently some Frimley Line passengers travel to other stations by other modes to catch a train because the journey time is shorter.

The MOIRA data identifies demand based on the station of origin not where a passenger accessed the station from. To normalise the data (i.e. to account for people currently travelling to other stations to access better train services), the 2011 Census Journey to Work data was used to manually assign origin journeys proportionally to their 'local' rail station. For the purpose of this assignment it was assumed that some Camberley or Frimley station passengers choose to travel to either Farnborough Main or Brookwood to catch a train whilst some Bagshot station passengers travel to either Ascot or Sunningdale.

This reassignment of the base passenger demand allows the benefits for existing rail passengers who do not currently use the Frimley Line stations (but live in the catchments) to be accounted for in the appraisal of the preferred options.

It was assumed that all existing rail passengers who use other stations, or 'rail-head', transfer back to access the network from their closest station (i.e. Bagshot, Camberley or Frimley) which would result in significant uplift in passengers at the three Frimley line stations (with a corresponding reduction at other stations).⁴

Demand growth over the assessment period was based on predicted population growth data for the Surrey Heath ward obtained from the Office of National Statistics. It is interesting to note that over the 25 year growth predictions from 2012 to 2037 the working age population in Surrey Heath is predicted to fall by

³ MOIRA is a rail industry demand forecasting model.

⁴ In reality, it is likely that not all passengers would transfer back to Camberley stations, even with an improved service. For example, if they lived within relatively easy access of Farnborough or Brookwood stations. However, this assumption was made to maximise the benefits of the schemes for the purposes of the appraisal.

0.15% per year (or 2000 people in total). For the purposes of the appraisal, population growth is assumed to be neutral.

Surrey Heath Borough Council's Core Strategy indicates that between 2011 and 2028 provision will be made for a net increase of 3240 dwellings.

5.5.3 Generalised Journey Time (GJT)

Generalised journey time (GJT) is a measure of the overall time-based cost of a journey and is used as part of the economic feasibility assessment. It is made up of a number of elements including:

- In-vehicle time (IVT);
- Service interval penalty (PDFH⁵ 5.1 Table 4.8); and
- Interchange and wait time penalties (PDFH 5.1 Table 4.10).

GJT was calculated for the AM peak hours (7-10am) for trains arriving into London Waterloo. The current GJTs were calculated manually in accordance with PDFH 5.1 methodology.

Future GJTs were calculated using the same process with an estimate of service frequency on the Frimley Line based on the service options review and the proposed journey time as detailed in section 5.2.3.

Incremental journeys were based on the GJT change using the PDFH 5.1 methodology and the appropriate demand elasticities.

It is assumed the improvements in GJT will see all the current passengers who 'should' use the Frimley Line (but currently use other stations) switch to use their local station.

5.5.4 GJT Savings

For passengers who currently use stations on the Frimley Line, the GJT saving is the difference between the Do-Minimum and Do-Something options. For passengers transferring from nearby stations (Farnborough Main, Brookwood, Ascot and Sunningdale) the GJT saving is assumed to be only the difference in drive-time between stations.

For example if a passenger currently lives in Camberley and railheads to Brookwood, the drive time between Camberley and Brookwood is 20 minutes. So the GJT saving is assumed to be 20 minutes per passenger.

Using WebTAG guidance, a value of time is applied to the GJT savings. **Table 5.7** shows the value of time (2015 prices) by journey purpose as given in WebTAG. Also shown is the weighted value of time by ticket type.

⁵ PDFH is the Passenger Demand Forecasting Handbook guidance produced by the Association of Train Operating Companies (ATOC) used in most railway assessment and appraisal work.

Table 5.7: Value of Travel Time (£/hour)

	Commuter (£)	Business (£)	Leisure (£)
Value of Travel Time by Journey Purpose	7.2	33.8	6.4
	Full	Reduced	Season
Value of Travel Time by Ticket Type	12.72	11.96	7.53

5.5.5 Fares

To calculate revenue benefits, fare information was used as a proxy for yield data. The National Passenger Survey was used to obtain the tickets South West Trains customers travelled on, using these proportions it is possible to estimate the 2015 yield. The base revenue for each flow is summarised in **Table 5.8**.

Table 5.8: Base Revenue by Station

Station	Revenue (£)		
	Full	Reduced	Season
Farnborough	6,848,346	7,681,325	8,335,868
Brookwood	1,446,630	917,694	3,450,107
Camberley	499,145	491,798	388,706
Frimley	122,777	90,164	26,226
Ascot	2,180,570	2,531,062	1,245,226
Sunningdale	1,534,110	1,412,476	1,069,210
Bagshot	186,427	117,113	272,769

The average yields are assumed to be constant throughout the appraisal period.

5.5.6 Fares Benefits

For new passengers who now use rail due to an improvement in GJT the revenue benefit is based on the current yield from the Frimley Line stations.

For passengers who have switched to the Frimley Line stations there is a revenue change. This revenue change is based on the difference in yield between the Frimley Line stations (e.g. Camberley) and their previous railhead stations (e.g. Brookwood). For example, if a passenger is currently travelling from Ascot on a £10 yield product and switches to Bagshot on a £11 fare there is a £1 revenue benefit.

5.6 Appraisal Benefits

The previous sections show how the various inputs to the appraisal are estimated.

Table 5.9 summarises the revenue benefit in the first year for each option by revenue type. The revenue benefit was assumed over a 60 year period, with depreciation as per WebTAG guidance.

Table 5.9: Annual Revenue Benefits (year 1)

Benefit	Revenue Benefit for all users (£)					
	Option 2			Option 5		
	Full	Reduced	Season	Full	Reduced	Season
Existing Revenue	808,349	699,075	687,700	808,349	699,075	687,700
GJT Benefit	678,939	812,328	828,575	644,758	775,186	802,296
New Journeys Revenue	497,965	514,497	615,415	411,806	423,933	509,752
Yield Change (existing passengers)	48,447	91,269	5,993	48,447	91,269	5,993
Total Revenue	2,033,701	2,117,167	2,137,683	1,913,360	1,989,463	2,005,741
Revenue Benefit (total revenue less existing revenue)	1,225,352	1,418,093	1,449,982	1,105,011	1,290,388	1,318,040

Option 2 has a greater revenue benefit because the journey time improvements are greater than option 5. In option 2 the Sturt Road Chord and Frimley Lodge Chord connection time between Brookwood and Frimley is estimated at 8 minutes compared to 13 minutes in option 5. This five minutes time saving is a greater benefit and will therefore generate more demand than option 5.

5.6.1 Appraisal Calculations

The benefits and costs were appraised over a 60 year period to estimate the Benefit Cost Ratio (BCR) for each of the preferred options. Based on the DfT expectation of high value for money, the proposed infrastructure schemes needed to produce a BCR of 2.0 or more to class as a positive scheme.

The assessment produced the following BCRs:

- For Option 2 the BCR is 0.24; and
- For Option 5 the BCR is 0.23.

For both options this does not represent good value for money.

5.6.2 Sensitivity Test

The assessment was completed on the assumption that revenue benefits would only be achieved for stations on the Frimley Line. However, it is likely that additional stations would also generate revenue benefits from the new services, particularly Brookwood and Woking. To understand the likely impact of including revenue benefits at these stations a high level sensitivity test was conducted.

To estimate the revenue benefit of improved frequency from Brookwood and Woking to London a GJT demand uplift was used. The GJT change was estimated using PDFH 5.1 methodology. The GJT change was then used to estimate demand uplift, again using PDFH methodology. Revenue uplift is calculated by using the yields for the flows and multiplying these by the new demand.

In the first year of the appraisal including these benefits increases the revenue benefit by £250k for Brookwood and £680k for Woking; £929k in total.

The increased revenue benefits increase the BCRs slightly. For Option 2 the BCR increases from 0.24 to 0.29, the increase for option 5 is 0.23 to 0.28.

The revenue uplift associated with increasing the frequency of services at Brookwood and Woking has little impact on the BCRs. It was therefore concluded that assessing further revenue benefits linked to other trips (such as Camberley to Woking) would not sufficiently improve the assessment to generate a positive BCR.

5.6.3 Demand Gaps

The purpose of this study was to assess the proposed infrastructure options, and to identify the demand gap, if any, that would need to be filled to generate sufficient passenger demand to achieve a positive BCR.

The additional revenue required was translated into the number of additional journeys required to achieve a positive BCR using the net average yield.

For option 2 an additional 2.1 million passenger journeys per year from Camberley stations would be required to achieve a 2.0 BCR.

For option 5, 2.0 million additional journeys per year would be required. Option 5 requires less additional journeys despite having a lower BCR because the scheme costs are lower.

This represents a significant uplift in the number of passenger journeys and would equate to a substantial level of new residential development along the Frimley Line (in the order of tens of thousands of units).

As noted earlier in the report, the Surrey Heath Borough Council Core Strategy indicates there are plans for 3240 new developments by 2028, which is clearly not sufficient to improve the business case for the options.

In addition to the new development, additional investment may be required on supporting infrastructure for the Camberley stations, if rail usage increased significantly. A significant increase in rail usage would lead to additional travel to the station and may increase traffic congestion, which may require traffic management measures and/or road improvements. Car parking facilities at the stations would also need to be improved. Camberley currently has 18 parking spaces, Frimley 24 spaces and Bagshot 36.

6 Conclusions and Recommendations

6.1 Conclusions

The scope of this assessment was to understand the high level costs and benefits of providing a direct connection onto the SWML from the Frimley Line to London Waterloo.

A high level qualitative assessment was completed on five infrastructure options which identified two preferred options to assess in terms of costs and benefits. These were:

- Option 2: the construction of two at-grade chords (Sturt Road Chord and Frimley Lodge Chord) that connect into the SWML located to the north east (Up direction) and south east (Down direction) of the existing crossing point of the Frimley Line and SWML; and
- Option 5: the construction of an at-grade chord (Ash Vale Chord) that connects the Frimley Line to the Alton Line located to the north of the existing crossing point of the Frimley and Alton Lines. It would connect on to the SWML via the existing Pirbright junction.

It was assumed that the service level would be the same for each option of two direct trains per hour via the SWML stopping at Brookwood and Woking before operating fast to London Waterloo. This could lead to journey times nearly 20 minutes quicker to London than existing times. This does however rely on any new train paths to Waterloo being allocated to Camberley, which would face strong competition from other areas.

Option 5 is the preferred option and scored best in the high level assessment. Option 2 scored well but has a major constraint in terms of land-take at Frimley Lodge Park. It was retained however as a comparator to Option 5 in the more detailed assessment.

The infrastructure requirements identified for the preferred options were used to prepare a high level outline capital and operating cost estimate. The total costs for each option are estimated at:

- Option 2: capital cost of £57 million and an operating cost of £6.0 million per year; and
- Option 5: capital cost of £12 million and an operating cost of £7.3 million per year.

A BCR was calculated for each option based on the following:

- Generalised Journey Time (GJT) savings generated by improved service levels and in-vehicle journey times and reduced interchange and wait time penalties. These were applied to existing users of Frimley Line stations and to existing users expected to switch their origin station because of the improved level of service; and
- Additional revenue generated from new users.

For both options the estimated BCR did not achieve the desired value of 2.0 which represents a positive scheme based on the DfT expectation of value for money.

Further analysis was completed to identify the amount of additional passengers that would be required to make a positive business case. The estimate was in the order of 2 million additional passengers per year. This equates to significant new development within Surrey Heath to generate sufficient new rail passenger demand.

Based on this assessment, the conclusion is that there is no viable solution that provides a direct connection onto the SWML from Camberley to London Waterloo, even in the longer term, without significant levels of development in the area to improve the business case.

6.2 Recommendations

It is not recommended to pursue option 2 further as it has a poor business case and has major issues with land-take in the Frimley Lodge Park area.

Option 5 also has a poor business case, although it offers a lower cost and potentially more straightforward infrastructure solution. It would only be recommended to take this option forward if it was supported by a strategy of major growth in the Frimley Line area, building in the order of tens of thousands of new housing units.

It is recommended that short term improvements are pursued through the current Department for Transport consultation on the South Western rail franchise, which closes in February 2016. The franchise will be renewed in June 2017. Short term operational solutions (i.e. changes to service patterns) were not in the scope of this study and are expected to be developed separately by SCC with local stakeholders. These might include improved connections via Ascot, Aldershot or Ash Vale, as recommended in the Surrey Rail Strategy.

Appendix A

Infrastructure Options

Figure A1: Option 1: Sturt Road Chord and Ladder

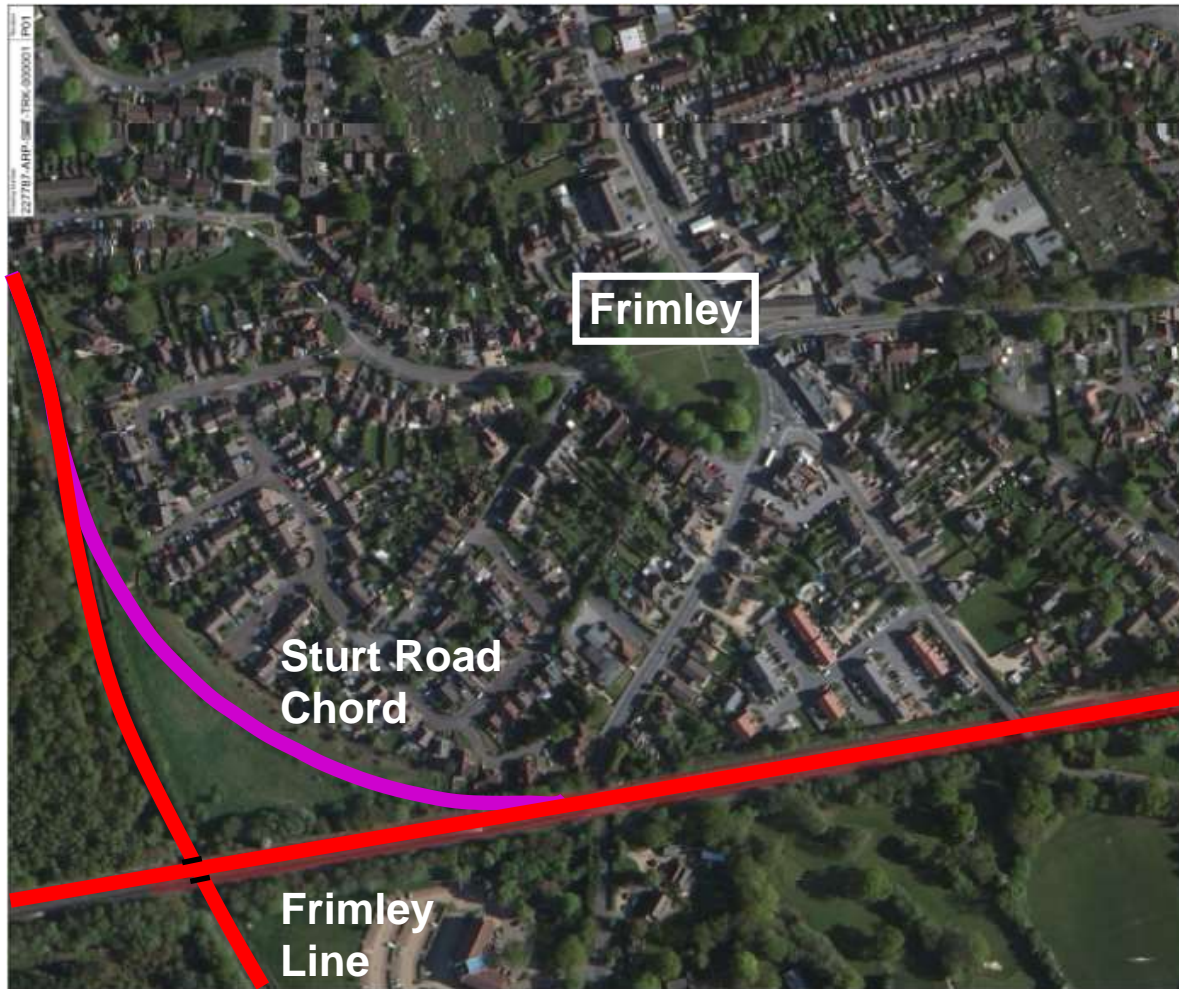


Figure A2: Option 2: Sturt Road Chord and Frimley Lodge Chord

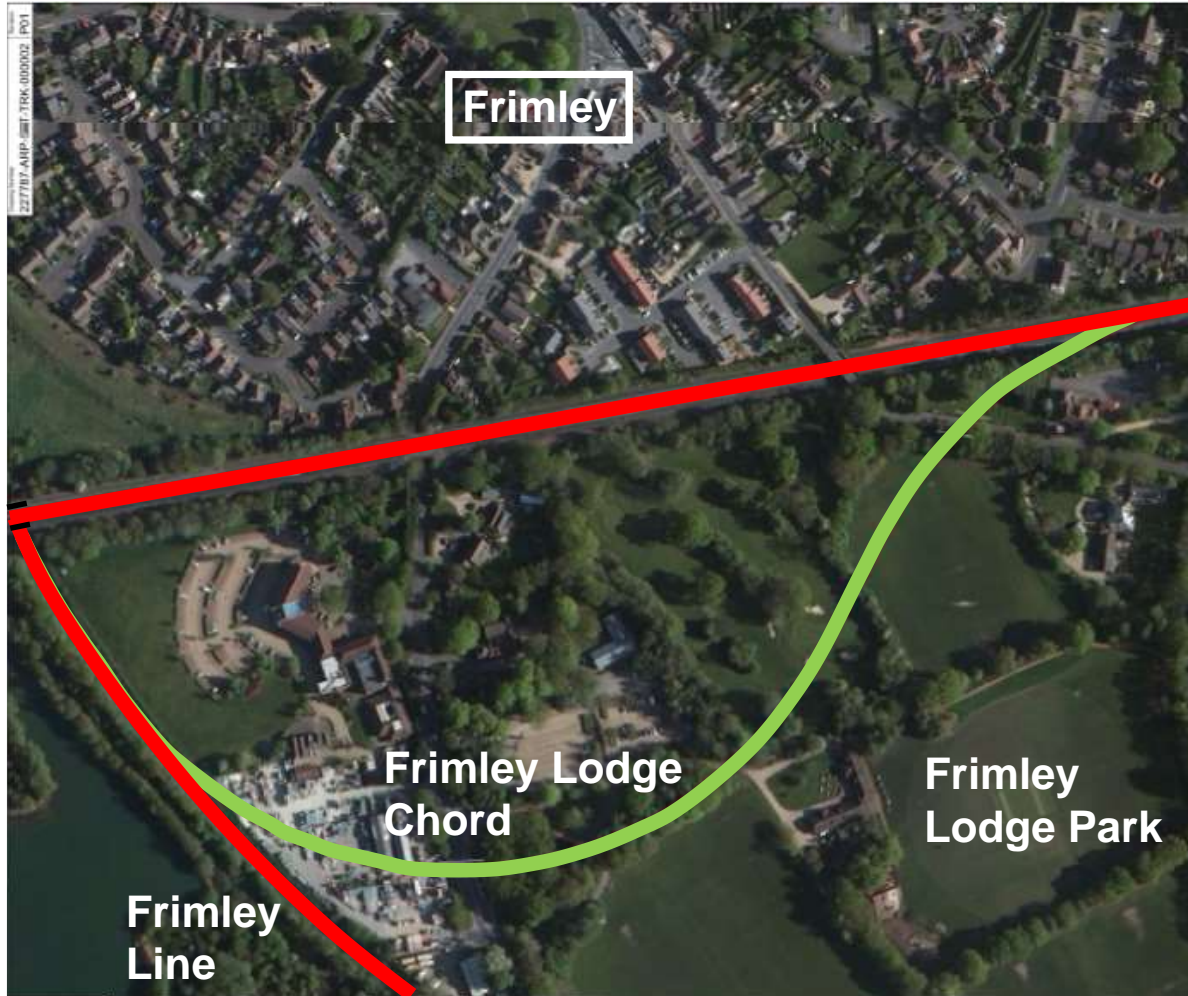


Figure A3: Option 3: Sturt Road Chord and Kingfisher Chord

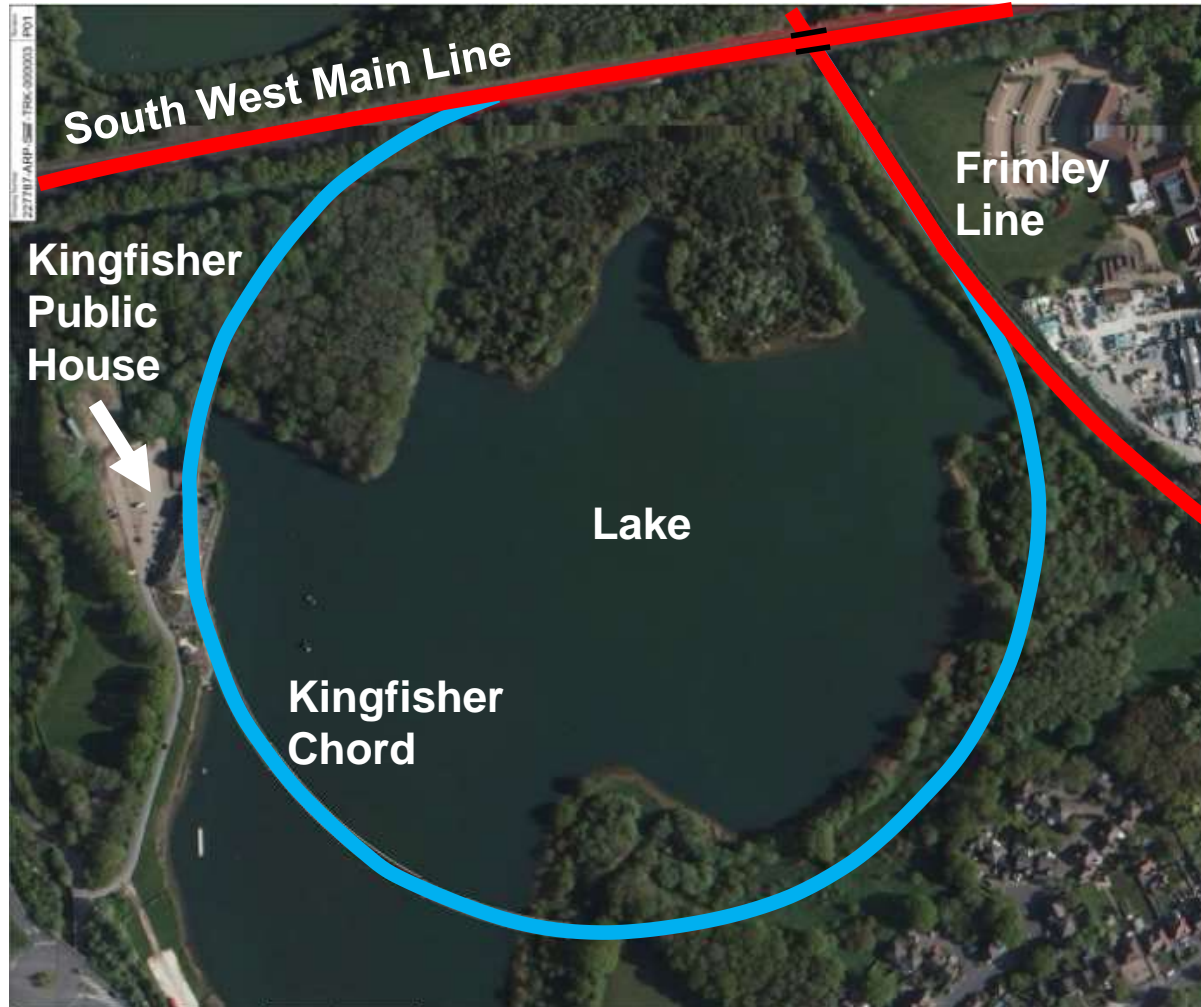


Figure A4: Option 4: Sturt Road Chord and St Andrews Flyover

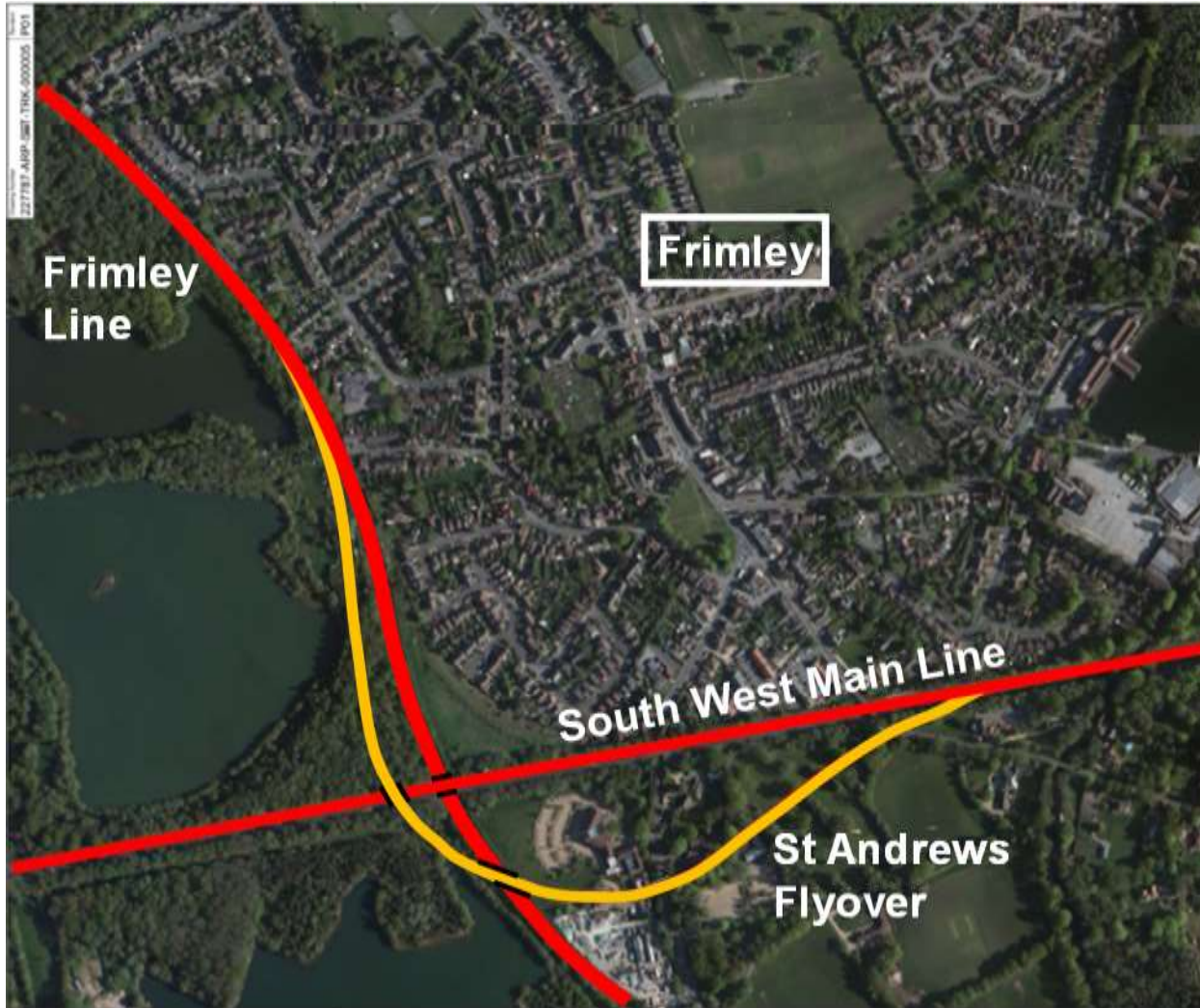
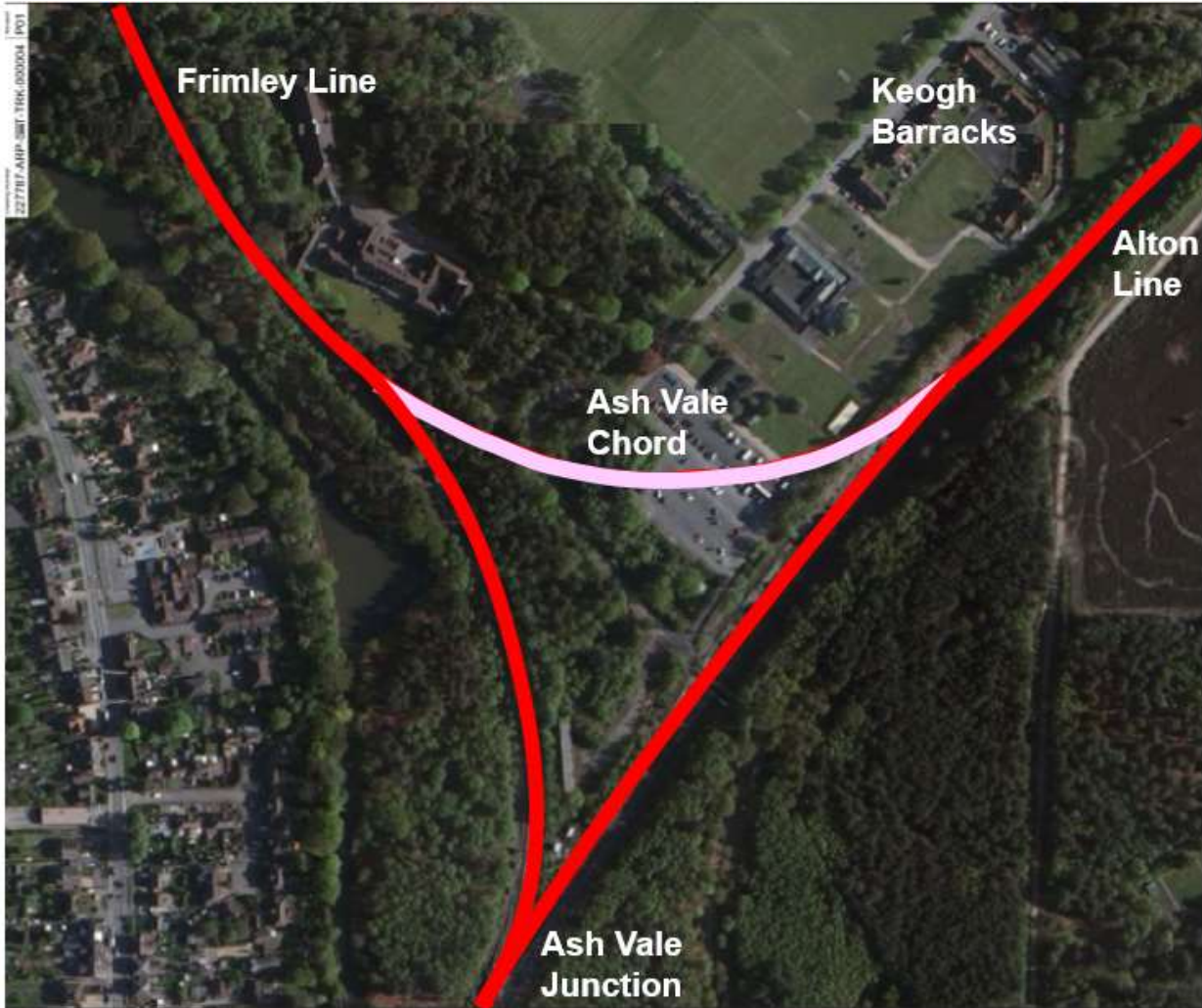


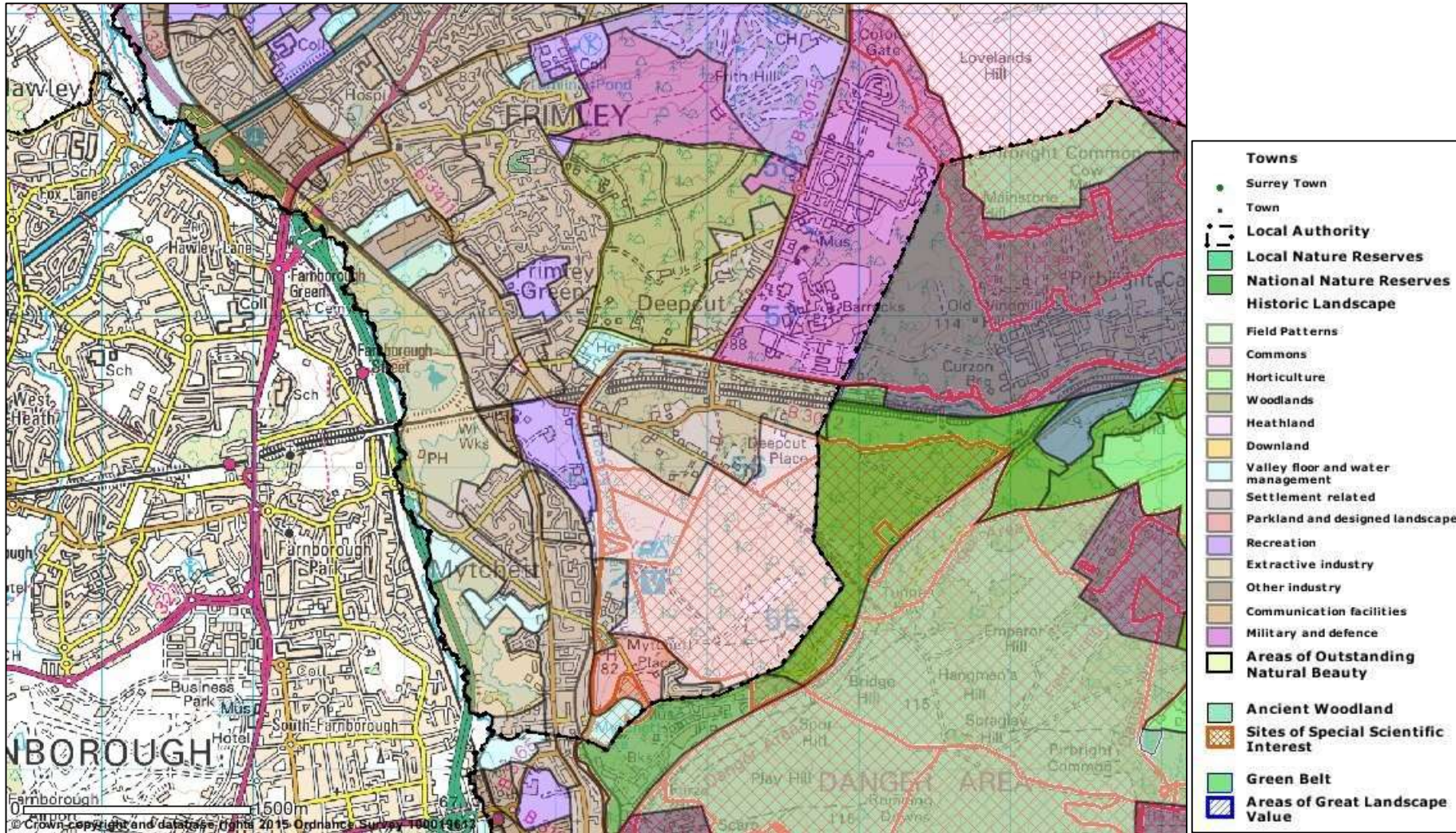
Figure A5: Option 5: Ash Vale Chord



Appendix B

SCC Environmental Map

Environmental Constraints Map



Appendix C

Detailed Cost Breakdown

RMM1 - Cost Categories and Group Elements

	Sturt Road Chord	Frimley Lodge Chord	Ash Vale Chord
1 Direct Construction Works			
1.01 Railway control system	£1,650,000	£1,550,000	£770,000
1.02 Train Power Systems	£1,360,000	£2,550,000	£1,270,000
1.03 Electric power and Plant	included	included	included
1.04 Permanent Way	£2,470,000	£3,480,000	£1,700,000
1.05 Operational Telecommunication Systems	£1,170,000	£1,100,000	£550,000
1.06 Buildings & Property	£0	£0	£0
1.07 Civil Engineering	£2,480,000	£4,130,000	£210,000
1.08 Enabling Works	£0	£0	£0
Sub-Total	£9,130,000	£12,810,000	£4,500,000
2 Indirect Construction Costs			
2.01 Preliminaries	£3,010,000	£4,230,000	£1,480,000
2.02 Overheads and profit	included	included	included
3 Project / Design Team Fees and Other Projects Costs			
3.01 Design Fees (contractor)	£550,000	£770,000	£270,000
3.02 Projects Team Fees	£2,470,000	£2,470,000	£1,210,000
3.03 Other projects Costs			
Sub-Total (before Risk)	£15,160,000	£20,280,000	£7,460,000
4 Risk	60%		
4.01 Total Risk Allowance	£9,100,000	£12,170,000	£4,480,000
Sub-Total (before Inflation)	£24,260,000	£32,450,000	£11,940,000
5 Inflation			
5.01 Inflation	Excluded	Excluded	Excluded
Sub-Total (before Tax)			
6 Taxation and Grants			
6.01 Tax allowances and grants	Excluded	Excluded	Excluded
GRAND TOTAL	£24,260,000	£32,450,000	£11,940,000

Basis of Estimate

Assumptions and statements

General clarifications

The estimate is based upon the Arup drawings: 227787-ARP-SKT-TRK-000001, 2 and 4 (rev P01). And associated technical File Note.

The estimate uses a multitude of inhouse historic cost data to calculate generic prices built from basic principals.

Base date of estimate is 4Q 2015.

General assumptions

There are added items, as a percentage of the base construction cost, to arrive at a total construction cost that a Contractor's bid might include. There are:

Preliminary items at 39%. These are:

Preliminaries at 25%; assumes concurrent working allowed.

Assumes OHP at 8%.

Contractor's design of 6%.

Enabling works 3%; traffic management, archaeological surveys, settlement monitoring, environmental mitigation. (*Ancillary items*)

Site preparation 1%; ground investigations, site clearance. (*Ancillary items*)

There is also an allowance for client and Network Rail costs of 12%; this is an accumulation of 8% management, 2% site supervision, 1% possession management, 1% RIMINI. A further 14% is allowed for TOC schedule 4. And access of 1%.

Structures assumptions

Option 1, Sturt Rd structure is fully replaced; wider to accommodate new turnout.

Single span structures, typically 20m span.

Track assumptions

Primary power is located locally; no major allowances within this estimate.

Power supply to traction is deemed to be sourced locally and thus excluded from this estimate. Only route length cabling allowed.

New track is to be electrified.

50m of track replacement is allowed per turnout.

Geology and earthwork assumptions

Where track crosses a highway, the highway is reinstated on its original route. No road lowering or vertical alterations allowed.

It is assumed 20% of earth is unsuitable and has to be disposed; the remainder is treated and reused where balances allow.

Where reusable material balance is insufficient, fill is obtained from borrow pits locally.

An allowance of landscaping is made within the boundaries of the route.

Land and property

No land purchase is allowed for.

No demolition of property is allowed.

No compensation is allowed.

Exclusions

Excludes VAT

Excludes utilities upgrades.

Excludes inflation.

Excludes advanced material purchase procurement.

Excludes operational costs.

Excludes rolling stock.

Excludes works associated with existing mines, soft spots and so forth.

Excludes vertical alignment changes to the existing rail.

Excludes flood mitigation measures.

Excludes improvements to the existing network.

Excludes client design.

Excludes land and property.