

## APPENDIX TO CHAPTER 2

### **A2.1. GARL Construction Strategy**

#### A2.1.1. Introduction

This Appendix outlines the construction strategy for the project giving outline construction methodology, a high level construction programme and a construction staging methodology.

The strategy is based on a general assumption of a two to three year construction period using Rules of the Route (ROR) and disruptive possessions as required to meet this construction period. No possessions at this stage of the project have been agreed by any of the required Stakeholders as this will be an issue to be discussed during the next stage of the project. The possessions noted are for GARL only and take no account of other work that may be carried out at the same time. The Draft Construction Programme indicates a construction period of 33 months.

A large amount of equipment associated with the signalling and telecommunication systems will have to be installed prior to the proposed nine day blockade possession. The duration of possessions allowed by the infrastructure controller (Network Rail) will have an impact on the number of possessions that will be required for the construction of GARL. Note that there will be close coordination with other possession associated with other works and maintenance not related to GARL that Network Rail will be undertaking in any case, so that the total number of possessions and therefore disruptions to rail services are minimised. Close co-ordination between the permanent way and signalling engineers, who will have similar requirements, will help to reduce the number of signalling only possessions required.

The Outline Construction Programme details on-site work items only. Lead-in activities prior to on-site works commencing, such as site investigation, detailed design, design approvals, possession planning, utilities diversions, material manufacture and delivery, Fuel Farm design and build, St James' Park mitigation works and the like, will require a lead-in time which we would anticipate being in the order of 2 years. There will be a degree of overlap between some of the lead-in activities which could reduce this 2 year period and more detailed work will be required during the next stage of the project to determine the actual lead-in period.

Discussions have already taken place with the local authorities and the Scottish Executive Trunk Roads Department regarding the construction works to be undertaken and their temporary impact on the road network. This dialogue will continue throughout the design development process and the details of any temporary road closures/diversions discussed further. Potential levels of construction traffic for the Branch Line and Main Line Works are shown in Tables A2.1 and A2.2 respectively.

### **A2.2. Airport Branch**

#### A2.2.1. Airport Junction

Seven permanent way disruptive possessions are planned to construct the airport junction. Work will be required to remove the existing track, including the Up to Down crossover and Underwood Sidings, with signalling work largely limited to providing temporary arrangements until the final commissioning. P37 will need to be moved prior to the laying in of the new point work. This portion of work should be undertaken prior to Arkleston and Wallneuk Junction renewals so that all the signalling commissioning work can be undertaken at the same time.

#### A2.2.2. Murray Street Bridge

A new single span bridge and associated support structure will be required to carry the branch line. The abutments which formed part of a previous siding and depot need to be extended to carry the new deck structure. In addition, a retaining wall to the south of the new bridge and a wing wall to the north will be required to support the embankment. The proposed

support structure will be reinforced concrete with stone facing to match the existing features. The foundations are to be piled, and given the proximity of buildings to the new works, bored cast-in place concrete piles are proposed rather than driven piles to reduce vibration and settlement. Due to the type of ground, the bored piles are likely to require bentonite or similar drilling fluid during construction. The superstructure comprises prefabricated structural steel girders with *in situ* reinforced concrete deck. The steel girders are approximately 20m long. The materials used in the construction can all be transported by road to the site

Heavy construction equipment would be needed for piling works and erection of prefabricated steel girders. Adequate space for piling plant and tanks to maintain pile drilling fluid will be required. The excavation of foundations for the abutments and retaining wall needs to be controlled and monitored to avoid undermining existing structures.

In order to maintain the existing headroom, the vertical road alignment of Murray Street requires to be lowered by approximately 0.3m, however the footpaths would be maintained at their present levels to minimise disruption to existing services. The closure of Murray Street will be required for about six weeks to complete the road works and construct abutments and north wing wall. Construction of these elements may be possible with single lane closure, but is likely to more than double the period of construction. The south retaining wall could be constructed without a road closure. However, an additional three closures of up to 12 hours each would be required for the erection of steel girders and casting of deck concrete. During the closure of Murray Street, traffic could be diverted through Clark Street.

Site access to both the north and south of the new bridge will be required from Murray Street for the construction of bridge and associated support structure

#### A2.2.3. Murray Street/ Clark Street Embankment

A piled geo-synthetic reinforced embankment is proposed for the section of Branch Line between Murray Street and Clark Street. This section is approximately 250m long and up to 8m above existing ground level - highest embankment level at the Clark Street end. The embankment would utilise a load transfer platform supported on a grid of bored concrete piles or stone/grout columns.

The civil works would need to employ heavy construction equipment for the top soil strip, removal of unsuitable material, installation of bored piles or stone/grout columns, construction of load transfer platform and placing and compaction of imported material. Support cranes would also be required for handling materials.

Work space will be required from both sides of the embankment for its efficient construction. The access to this section of site is sought from both Murray Street and Clark Street. The estimated period of construction of the embankment excluding rail works is 26 weeks.

#### A2.2.4. Clark Street Bridge

The structure comprises prefabricated steel girders with *in situ* reinforced concrete deck supported on reinforced concrete abutments with bored pile foundations. The steel girders are up to 25m long. The materials used in the construction can all be transported by road to the site.

Heavy construction equipment would be needed for piling works and the erection of steel girders. Support cranes would also be required for handling materials. Three closures of up to 12 hours each would be required for the erection of steel girders and casting of deck concrete. These closures could be programmed to avoid time of high traffic movement. The construction of substructure and foundation will not require road closures, but single lane operation achieved through temporary traffic lights. Precautions would need to be taken to isolate pedestrian from the works by providing a barrier.

Diversionary routes are available however these would need to be discussed with and agreed by Renfrewshire Council at the detailed design phase of the project.

#### A2.2.5. Clark Street /McFarlane Street Viaduct

The proposed structure is a viaduct approximately 200m long with 8 piers and up to 9m above existing ground level. It comprises prefabricated steel girder and *in situ* reinforced concrete deck supported on reinforced concrete piers with bored pile foundations. The steel girders are up to 25m long. The materials used in the construction can all be transported by road to the site. However, a temporary haul road may need to be constructed immediately adjacent to the viaduct to deliver the girders to their final position from site access points.

Heavy construction equipment would be needed for the piling works and erection of prefabricated steel girders. Support cranes would also be required for handling materials.

#### A2.2.6. A726/McFarlane Street Bridge

The proposed structure is a three span bridge with spans of 25m, 30m and 25m. It comprises prefabricated steel girder and *in situ* reinforced concrete deck supported on reinforced concrete piers with bored pile foundations. The steel girders are up to 28m long. The materials used in the construction can all be transported by road to the site

Heavy construction equipment would be needed for the piling works and erection of steel girders. Support cranes would also be required for handling materials. Five road closures of up to 12 hours each would be required for the erection of steel girders and casting of deck concrete. These closures could be programmed to avoid peak hour traffic. Additional lane restriction would be necessary for the construction of intermediate piers and their safety barriers. Diversion routes are available however these will need to be discussed and agreed with by Renfrewshire Council at the detailed design phase of the project.

#### A2.2.7. St James Park Structure

The proposed structure is a viaduct approximately 500m long and up to 10m above existing ground level. It comprises prefabricated steel girder and *in situ* reinforced concrete deck supported on reinforced concrete piers with piled foundations. The steel girders are up to 25m long. The materials used in the construction can all be transported by road to the site. However, a temporary haul road would be required immediately adjacent to the viaduct to deliver the girders to their final position from site access points.

Heavy construction equipment would be needed for the piling works and erection of prefabricated steel girders. Support cranes would also be required for handling materials. Access will be required from both sides of the viaduct for its efficient construction. The access to this section of site will be via a dedicated access road from the A726 road.

It is estimated that the required construction period for the viaduct structure only will be 55 weeks.

#### A2.2.8. M8 Crossing

The proposed structure is a single span tied arch bridge with a span of approximately 135 metres, supported on reinforced concrete piers with bored pile foundations. The main arch, tie beam and cross girders are of structural steel with the deck in concrete. The structural elements of the bridge including the concrete deck would be assembled on the adjacent St James' Park site to avoid prolonged motorway closures and transported into position during a single night time closure of the M8 motorway and adjacent roads. The deck would be constructed on slide beams supported temporarily on the foundations of St James viaduct.

Proprietary multi-wheeled transporter system would be used to support the leading end of the deck and transport across the road carriageways to its final position. The multi-wheeled transporter system is capable of precise movement in all directions such that the required deck alignment can be achieved. It is also feasible for the deck to be assembled alongside the St James viaduct on specially prepared area. In this case the deck is first slid forward and

then sideways to achieve the correct position across the M8 motorway. Provision has been made in the limit of land available for construction use, should this option be adopted in the final design to strike a balance between construction programme and cost.

The piers and foundations of the bridge are located away from the Airport feeder roads, which are the outer most roads at this crossing, to avoid any disruption to the Airport operations. Adequate space for piling plant and tanks to maintain pile drilling fluid will be required at the Airport and St James Park ends. Heavy construction equipment would be needed for the piling works and erection of steel sections required for the bridge. Additional support cranes would also be required for handling materials as well for the assembly of the transporter system.

Additional night time partial closures would be required for the rail work, which could be minimized by providing temporary boarding along the sides of the bridge before the bridge is moved into position

It is estimated that construction of the bridge structure only would require a period of 78 weeks, which needs to be phased with the construction of St James Park viaduct. An area of 160m x 30m between the proposed St James park viaduct structure and Greenock Road would be utilised for the construction of the bridge deck and assembly of the multi-wheeled transporter system. The access to this section of site will be via a dedicated access road from A726 road, same as for St James Park

#### A2.2.9. Airport Viaduct

The proposed structure is a viaduct approximately 520m long and comprises prefabricated steel girder and *in situ* reinforced concrete deck supported on reinforced concrete piers with piled foundations. The typical spans are 25m, but longer spans of 38m and 32m are required to cross St Andrews Drive West and Caledonia Way West respectively due to skew and sight line requirements. Girder lengths greater than 30m are likely to be transported in smaller lengths and spliced on site. All other materials used in the construction can be transported by road to the site

Heavy construction equipment would be needed for the piling works and erection of steel girders. Support cranes would also be required for handling materials. Lane restriction would be necessary for the construction of piers adjacent to Airport Access Road, St Andrews Drive West and Caledonia Way West. It is estimated that the construction of each pier would require a period of five weeks. In addition three road closures of up to 12 hours each would be required for the erection of steel girders and casting of deck concrete for each of the above crossing. These closures could be programmed to avoid peak hour traffic.

The access to this section of site will be by utilising the existing accesses from St Andrews Drive and the Fuel Farm.

Road closures within the Airport boundary will be discussed and agreed with BAA during the detailed design phase of the project. Cycle routes and pedestrians will be provided with alternative routes around this area during construction works.

#### A2.2.10. Airport Station

The proposed structure is a viaduct 225m long and comprises prefabricated steel girder and *in situ* reinforced concrete deck supported on reinforced concrete piers with piled foundations. The environmental and settlement issues preclude the use of driven piles. Thus cast *in situ* bored pile foundation is proposed for the airport structures. The steel girders are up to 25m long. The materials used in the construction can all be transported by road to the site

Heavy construction equipment would be needed for the piling works and erection of prefabricated steel girders. Support cranes would also be required for handling materials.

It is estimated that the construction of each pier would require a period of five weeks giving an overall construction period for the viaduct structure only of 27 weeks. Access to this section of the works will be via new access created from St Andrew's Drive.

The construction of the station canopy and facilities would follow once the viaduct structure is completed. The roof construction comprises Vierendeel truss purlins, which span between the main trusses supported on the viaduct structure. Heavy lift cranes for hoisting large prefabricated elements of station structure can only be positioned on the southern side of the viaduct due to the presence of multi-storey car park. However, light cranes for lifting smaller sections of the station structure may be positioned on the completed deck. It is estimated that the construction of the station canopy and facilities would take approximately 30 weeks. Some elements of the track work can take place concurrently.

Road closures within the Airport boundary will be discussed and agreed with BAA during the detailed design phase of the project.

#### A2.2.11. Branch line railway systems

The airport branch will be constructed and equipped independently of the main line works, over a period of 31 weeks. Small periods will be required to finally test signalled routes on and off the Airport Branch but it is not envisaged this work will affect the operation of the trains on the main line. This work will be carried out during possessions.

### **A2.3. Arkleston and Wallneuk Junctions**

The renewal of the junctions at Arkleston and Wallneuk will be complex. It is proposed that both junctions are renewed including all associated Overhead Line Equipment (OLE) and signalling work on a piecemeal basis using 14 No. 52 hour possessions and 2 No 28 hour possessions.

The commissioning of the new interlocking at Paisley will require a blockade of 9 days duration at the end of the renewal phase, where all the signalling for both junctions and the bi-direction line will be commissioned. It has been estimated that for the signalling alterations to Paisley control panel and the renewal of the junctions, that around 150 hours of signalling and telecoms commissioning time would be required during the 9 day blockade period. This area of the work represents the most difficult to commission, hence the appreciably longer timescales than at the other junction locations.

The changes in Paisley signalling centre would include train describers, telephones, Driver Only Operation (DOO), connections to the new interlocking, the control panel facia and through testing incoming and outgoing circuits to the new relay room. It is this stage that the bi-directional Up & Down Relief line will be commissioned. There will therefore also be work at Glasgow Signal Control Centre (SCC).

It has been assumed that during the construction staging that the Up Gourock and Ayrshire can operate over the Up Goods Loop only, for a limited period and the Down Gourock and Ayrshire can operate over the Down Goods Loop/new Down Ayrshire only, for a limited period.

Switch and Crossing (S&C) layout areas (to build up the new items of S&C) exist on both sides of the existing track. The Down side area would utilise the Down sidings, the Up side area is to the east of the Up siding, in the former junction area. There is road access to both areas. This would allow leads to be built up at the trackside and installed via either PLEM or Kirow crane. In addition, OLE and signalling equipment would be brought to site via this route

### **A2.4. Cardonald Junction**

It will first be necessary to install and commission the new Time Division Multiplex (TDM) system and relay room. This will require a 72-hour weekend possession of the Cardonald area Junction area. Alterations will be carried out within Cardonald relay room, Glasgow SCC

ground floor and first floor relay rooms and the control panel. The new signal structures will be commissioned at this stage with the exception of the bi-directional line signals.

Seven permanent way stages are required to prepare the ballast and lay in the new crossovers at Cardonald. The crossovers will be assembled adjacent to site and moved into position using PLEM equipment. The permanent way layout currently shows the new crossovers to be clear of the existing layout. It will therefore be possible to take out of use the old crossovers and bring into use the new crossovers all in one stage although the bi-directional line would still remain out of use. This will be the weekend of the final permanent way stage.

It is proposed that the new interlocking at Cardonald Junction would be commissioned following the alterations to Shields Junction. A detailed testing and commissioning strategy during the next phase of the project, will determine the exact length of time required for each stage.

## **A2.5. Shields Junction**

To carry out the works at Shields Junction, a number of disruptive possessions will be required. It will first be necessary to install and commission the new TDM system. This will require a 54-hour weekend possession of the Shields Junction area. Alterations will be carried out within Shields relay room, Glasgow SCC ground floor and first floor relay rooms and the control panel. Further development of the Construction Programme and Possession strategy will be required during the next stage of the project to determine the extent of disruption to train services in the Shields Junction area due to proposed works

A strategy for the installation of the permanent way and OLE work has been developed, requiring a number of possessions to lay in the various crossovers, renew the plain line ballast and erect the OLE. The crossovers will be assembled adjacent to site and moved into position using PLEM equipment. It is envisaged a total of 8 stages will be required for this work. Signalling support will be required for each stage in the form of design, install and test. The main signalling commissioning stage will be undertaken with the last permanent way stage, when the repositioned Up Main comes into use. The new Up & Down Relief line will not be brought into use at this time. A later 72-hour possession will be required for this work to be carried out, including the required alterations to Glasgow Central SCC control panel and telephone concentrator once Cardonald Junction and Arkleston are completed.

## **A2.6. Hillington Bridge Proposal**

The two proposed options for Hillington Road Bridge are a 27m single span or two 13.5m spans supported by a new central pier. The operation and integrity of the existing structure has been considered in the following methodology. Each option will cause disruption, occasionally significant, but the integrity of the structure is not materially affected by the works

### **A2.6.1. Construction Methodology**

The construction/installation issues with option one, the 27m single span, are mainly governed by the weight of the structure. The superstructure is too large to deliver in one piece and would require erecting *in situ* or very close to its final location. The simply spanning structure does not readily divide into smaller lengths and the main girders would have to be delivered, using special transporters, to site and lifted in one piece. Any lifting operation would be difficult due to the overhead lines present on the Network Rail tracks. The capacity of cranes required to lift such a structure from road level at the necessary overreach would be significant and likely to require ground strengthening and accommodation works. Cross girders and deck plate would also require crane lifts or other temporary support during erection. Transport to site of these members could be either by standard road haulage or by rail. In all construction phases due regard must be given to the overhead line electrification system.

The construction/installation issues with option two, two 13.5m spans supported by a new central pier are mainly co-ordination issues with Network Rail. The refurbishment and strengthening of the central pier could be undertaken by closing the two central lanes of the road. Network Rail approvals and possessions would be required and, depending on the extent of the strengthening, some extended single line working may be necessary. The two-span arrangement facilitates the superstructure being constructed in three similar length sections. These may be constructed locally off site and delivered by road depending on access route suitability. Temporary road sign/lighting removal could be necessary along the route prior to the delivery. The weight of each of the three full width sections would be similar to a single 27m girder for option one. The three sections could be lifted over the overhead lines and rotated 90 degrees to land on its final bearings and/or temporary supports. As described above the crane would require ground strengthening and accommodation works.

Variation to the above options would be to construct a temporary access and working platform within Hillington Road This would reduce the construction risk and limit the number of rail possessions required. The component parts must still be delivered in the same way though erection *in situ* would allow the parts to be individually delivered. Closure of the central two lanes of the road would be required for the majority of the construction period and may require the imposition of low headroom clearance on the open lanes.

All options require the construction of piled reinforced concrete foundations and these would need to be constructed during rail possessions and Green Zone working within the wide six foot. Rail mounted plant, including piling equipment if appropriate, will be required. Assessment of the existing substructure requires to be undertaken during the next phase of the project design.

Disruptive possession requirements for the construction of the bridge using either option have been developed and consist of 2No 28 hour, 1No 52 hour and 1No 76 hour possessions. There will also be the requirement for ROR possessions midweek and at weekends. Temporary speed restrictions would also be required. The development of these requirements needs to be developed during the next stage of the project design process.

## **A2.7. Glasgow Central**

### **A2.7.1. Civils Works**

Based on the scope of works to Central Station for provision of the additional lines and platforms, the following is a summary of construction implication on the existing platforms and undercroft. The extent of construction works relates to the new platforms and excavation for the lines only. It does not cover Overhead Line Equipment and fixings, roadworks, or specific service diversions.

Prior to any demolition or excavation work a detailed survey must be undertaken to locate and identify all services that are within and close to the footprint of new works. This work is likely to involve inspection of records, radar or similar non-intrusive survey techniques and hand dug trial pits.

On identification of services measures should be taken to relocate all affected utilities.

From the study undertaken to date no arches have been identified as been unable to accommodate current loading conditions. However, very little information has been obtained and the prospect of no strengthening for provision of the addition GARL track work must be assumed an optimistic 'best case' scenario.

With removal of the car ramp deck and imposition of train loading along the line of the ramp new forces will be induced onto the elements of ramp and deck abutments that are to be retained. This may affect the integrity of the adjacent arches and could lead to progressive collapse within the undercroft unless compensatory restraint is provided. Such restraint would need to be in place before demolition works commence.

Strengthening and/or refurbishment of the retaining walls in order to accommodate the new track support deck is also likely to be required. The form and extent of strengthening works will be dependent on the capacity of the existing walls but these cannot be determined at this stage as no details of the 1980's construction have been made available and hence a structural assessment has not been possible. Design will have to take account of both temporary and permanent loading requirements but it would be hoped the temporary works could be incorporated as part of the permanent re-decking works.

Foundations to the station arch entrance could be undermined as the existing platform between is excavated. Again further investigation is required into the depth of footings and their means of lateral support.

Following any necessary strengthening works it is anticipated that excavation along the line of the new rail lines and platforms will be undertaken. The new deck over the existing vehicle down ramp will then be constructed. New platforms can be built and the end support frame for the overhead line constructed. This will then enable all trackwork, signalling, power lines and finishes to be completed.

#### A2.7.2. Railway Systems

The construction sequence at Glasgow central Station follows five steps

1. Relocate services from Hut No3
2. Build the platform extension
3. Remove existing track, OLE and signalling affected by the change in alignment
4. Install the extended track, OLE and signalling into the shed to the new platform
5. Bring the required track, OLE and signalling alterations into use.

Step 1 is to enable the existing cable route to Hut No.3 to be moved, which will require a number of night time white period possessions in order to disconnect, re-route and re-commission the cables and the air main. The exact number of possessions of this type will be determined by a more detailed examination of the cable allocation.

The remaining steps are largely driven by the time taken to construct the new platform, however a possession of around 36 hours will be required of platform 11A and the surrounding platforms to bring the new platform into use, install the new P/Way and OLE and alter the Signalling Control Panel.

#### A2.8. Elderslie loop

A small signalling possession will be required to facilitate the extending of the loop at Elderslie. This work is not significant from a signalling perspective but would have to be undertaken around the permanent way works. Three permanent way stages are programmed for which signalling support will be required, the final stage being the main signalling and telecoms commissioning.

#### A2.9. Other Permanent Way Stages

How the different areas of permanent way, signalling and overhead line packages fit together are subject of the overall project plan. More than one of the signalling packages illustrated above can be done at one time, although overall availability of resources must be considered. There are other permanent way stages, such as slews, relaying and IBJ (insulated block joints) recoveries, which do not require significant alteration to the signalling system. These stages will need small amounts of signalling support, from track circuit alterations to simple 'knock-offs' and reconnections.

## **A2.10. Fuel Farm**

The replacement fuel farm and new access road will be constructed on a previously undeveloped site to the west of St Andrew's Crescent adjacent to Paisley Moss LNR. A geo-environmental desk top study suggests that ground conditions on the site comprise made ground and peat over alluvial deposits and glacial till (encountered at depths of 45-50m). It is therefore proposed to found the fuel farm facility on a ground slab supported by bored piles terminating in suitable material such as the glacial till. The pile design may also incorporate a base grouting system.

The use of piles presents a number of risks including cross-contamination of separate ground water bodies and groundwater drawdown caused by leakage from higher perched aquifers. Given the environmental sensitivity of the adjacent wetland, it is proposed to adopt suitable construction techniques to prevent these pathways forming e.g., by advancing pile casings simultaneously with pile boring. Concrete-mix additives and grouts will also be chosen to be compatible with the ambient ground water chemistry and end users of the waters.

Piling operations are likely to require the creation of a temporary piling platform at ground level (or near ground level as a consequence of levelling the site) comprising geotextiles and aggregate. The Contractor could also use this as the base against which the ground slab is cast.

The ground water table is thought to lie at 2 – 3 m below ground level and it is possible that it could be affected by tidal movements in the Clyde and associated rivers. Ground slab construction is not currently anticipated to require excavation of existing soils to depths requiring prolonged pumping for excavation dewatering. However, if the formation level of the fuel farm is such that soils have to be removed below the water table (when building/tank heights or the level of site bunds and access roads etc are considered further in the detailed design) pumping may become necessary. In this situation, the potentially habitat changing drawdown of ground water levels across the adjacent wetland would be mitigated and mainly eliminated by careful choice of construction technique (e.g., by excavating within an impermeable cofferdam and improvement of the base of the excavation through grouting).

The construction of the ground slab will be followed by other civils and building work including the formation of bunds around the fuel tanks and the site boundary, the provision of a new administration and services building, the construction of the new access road and junction with the existing airport access road and the realignment of the footpath/cycleway to the south of the site. Mechanical and electrical works will include the installation of fuel tanks, fill point and fuel transfer rig together with associated pipework.

## **A2.11. Construction Assumptions**

1. At Elderslie – the signalling sketch contained in the IOS document is incorrect and that the P Way sketch in the same document is the correct track layout.
2. At Elderslie – the IOS document specifies that the OLE for the loop extension is fitted to the back face of existing OLE structures for the Up and Down Ayrshire. It has been assumed that the resulting increased load on the structures will not be detrimental.
3. At Elderslie - the new OLE will be electrically fed from Up / Down Ayrshire.
4. At Elderslie - minimal earthworks and drainage are required and no conflicts with utilities have been identified. Costs and construction durations for these activities are included in Track Works
5. At Elderslie – the loop carries both freight and passenger traffic and therefore does not require trap points.

6. At Wallneuk and Arkleston Junctions – The crossovers would have Track Circuit support during the construction period but would be clipped out of use pending final commissioning.
7. At Gower Street – the five OLE portals will be installed under rules of the route possessions, and the remaining five OLE portals will be installed during extended possessions due to possession constraints.
8. The Permanent Way layouts are based on 2D Ordnance Survey Tiles. the effect of cant and differences in levels has therefore not been considered. This may have an impact on the construction program.
9. Follow up tamping will be conducted in both rules of the route and construction possessions.
10. Line side cable routes can remain in their current location. This assumption may have a financial impact on the project of circa £100k and has been included in the risk register.
11. The large Cable route in Glasgow Central Station that has to be re routed for the new platform will be re routed in non-disruptive possessions.
12. The new TDMs at Cardonald and Shields junctions will be installed during non disruptive possessions.
13. It has been assumed that any blockade working will be undertaken at the end of the construction period. Opportunities should be explored in the next phase of the project, with Network Rail to include other works during the 9 day commissioning blockade, subject to agreement
14. It has been assumed that all construction work is to be undertaken primarily using rail borne plant working within the Network Rail Boundary, thereby keeping temporary land take to a minimum.
15. It is assumed that consecutive 28hr weekend and midweek night possessions are available for the remodelling of Glasgow Station, Gower Street Junction, Cardonald Junction, Airport Branch Junction, Elderslie Loop and the installation of the new Relief Line. For selected weekends it is assumed that 52hr and 72 hour possessions will be available, subject to agreement
16. It is assumed that consecutive 76 and/or 52 hours disruptive possessions and a 9 day blockade are available for the remodelling of Arkleston and Wallneuk Junctions and the trackwork between these junctions subject to agreement. We have also assumed that the Goods lines, Gallowhill sidings and URS siding can be utilized for construction purposes as and when required during the main line construction period.
17. Possession Management will be provided by Network Rail.
18. Works Trains will be available and provided by Network Rail.
19. Appropriate sidings for the management of the Works Trains and transfer of materials will be available and provided by Network Rail.
20. S&C laydown areas with suitable road access are available and in close proximity to the junction remodelling areas. Laydown areas have been identified as LLAU on the Map, Plans & Sections Documentation.

## **A2.12. Operational Interface Issues**

### **A2.12.1. Glasgow Resignalling**

As stated previously Network Rail has not yet finally decided on a technology for re-signalling the Glasgow Central area, it is currently not possible to recommend provision of equipment in line with their choice. Solid state interlocking (SSI) does provide a possible alternative technology for this scheme, although without undertaking replacement over a wider geographical area, particularly at Shields Junction, the boundaries with the existing equipment would be very complicated.

### **A2.12.2. Interface with Network Rail OLE Renewal (Shields – Gourock OLE Renewal)**

It is Network Rail's intention to renew the contact wire and cantilevers only, initially between Bridge Street Junction and Paisley Gilmour Street. The intent is to extend the geographical scope to include the Gourock Branch as a second stage of the works, as this has been prioritised as the next worst section. There is currently no intention to replace the existing support structures. The reason for the work is that the existing OLE equipment is obsolete; life expired and has been stated as presenting a significant performance risk to Network Rail's day-to-day operations.

No definitive programme of work has been presented during the discussions with Network Rail. However, WS Atkins have been employed by Network Rail to produce a functional specification and the MP & I organisation within Network Rail have recently invited tenders to undertake this work.

The existing OLE structures are placed in the central roadway, prohibiting the introduction of new tracks. Currently, the GARL OLE work scope is envisaged to be replacement of these structures with portals, with foundations along the railway boundary.

Extensive discussions were held with NR to determine if their project could accommodate the installation of portals thereby providing benefits to the industry, the main benefits would be:

- Financial - based on an initial assessment, indicates approximately 70% to 80% of the NR renewal cost would be re-spent by GARL to accommodate the Portal frames.
- Disruptive Possessions – if the Portal frames were erected within the NR Project then disruptive possessions required for GARL would be reduced thereby reducing disruption to train services.

The outcome of these discussions was that NR rejected this proposal.

## **A2.13. Construction Programme**

The possession and construction strategy adopted for the GARL Project is based on a two to three year construction period utilising rules of the route (ROR) and disruptive possessions as required to meet this construction period.

The programme of works has been prepared to show the various construction activities and how they inter-depend on each other. The programme is a high level programme to determine the duration of construction of the various engineering disciplines and to give an indication of the overall construction period for the project.

The activities should be regarded as typical of the construction work to be undertaken along the route. Detailed programmes and schedule of works will be undertaken prior to the commencement of work on site and will be dependent on the finalised design work and work methodology with the appointed Contractor.

The Draft Construction Programme indicates a construction period of 33 months.

Construction can be broken down into two distinct areas, being:

1. Railway Systems construction works - on an existing operational railway therefore totally dependent upon possessions to carry out the works.
2. Branch line construction works – with construction works primarily influenced by general civil engineering interfaces such as roads, utilities and the general public etc.

In relation to the railway systems and civils works associated with the existing operational railway, as much work as possible has been programmed for non-disruptive possessions. The remaining work was then programmed into a range of disruptive possessions. In the highly complex area of Arkleston and Wallneuk Junctions, a series of 52 and 76 hour disruptive possessions have been proposed. Opportunities to utilise mechanised plant have been exploited where cost effective to do so. It is planned to bring the vast majority of materials to site by rail but where areas of Network Rail land are available with good road access, some materials (particularly S&C) will be brought to site by road and assembled lineside and then transported to their final location with either PLEM or mobile crane.

The construction program has assumed that private land will not be used for the positioning of road cranes for the erection of OLE portals for example. It is strongly recommended that after the detail design stage and prior to the construction stage, that the use of private land for access purposes be considered in terms of the total cost of the project. The use of road cranes positioned lineside prior to the start of possessions will maximise the utilisation of short non-disruptive possessions and potentially result in a saving in construction cost using this method of working. The program has been compiled based on week numbers rather than calendar dates however it should be borne in mind that 76 hour disruptive possessions would best be based around local holidays and the 9 day blockade for commissioning of the works would be best based around the two weeks during Christmas and New Year where this period is traditionally utilised for long disruptive possessions.

Civils and railway works associated with the Branch Line which are not dependant upon railway possessions, have been programmed to suit meeting their interface with the railway mainline works.

No allowance has been made in the programme for Contractors holidays.

All excavated material will be removed from site

#### A2.13.1. Main Line Railway Systems

The major influence on the GARL construction costs is the total dependency on railway possessions to carry out the works along the existing railway line and the 'additional' costs associated with this very restricted working time regime. All ROR possessions are night time working and disruptive possessions i.e. periods of possessions longer than ROR possessions, also incorporated night time working. This type of working periods are therefore more costly due to paying premium rates for labour, less work efficiency due to night time working, greater plant hire costs, risk of possession overruns and the additional cost of compensation in the case of disruptive possessions for the loss of train services to the Train Operating Companies (TOCs) and Freight Operation Companies (FOCs).

A draft possession programme is contained within Stage 3 Report.

It is therefore important to understand the possession strategy adopted for GARL and set out below is a summary of parameters used in compiling the construction programme possessions:

- Wherever possible the train timetable for the existing route to be maintained with minimum disruption to trains.
- ROR possessions midweek are available with double line blocked.
- ROR possessions at weekends are available with double lines blocked

- Disruptive possessions –
  - 28 hours possessions are required on consecutive weekends (50No)
  - 52 hours possessions are required on selected weekends (18No)
  - 76 hour possessions are required on local holiday weekends (2No)
  - a 9 day blockade will be required to commission the new railway infrastructure works
- Construction work through the railway corridor will be undertaken primarily using rail borne plant.
- All temporary signalling and testing can be accommodated within the possessions.
- Speed restrictions are required
- Remodelling of Wallneuk Junction through to Arkleston Junctions
  - Up Gourock and Ayrshire can operate over the Up Goods Loop only, for a limited period.
  - Down Gourock and Ayrshire can operate over the Down Goods Loop/new Down Ayrshire only, for a limited period.
- Temporary alignments can be designed to accommodate minor track shifts between possessions.
- Temporary twist panels will be required.
- Welding can be carried out during engineering hours.
- Temporary commissioning or detection may be required for facing points installed and clamped as the programme may dictate that they are in place for periods in excess of 6 months before final commissioning.
- Works Trains will be available and provided by Network Rail.
- Appropriate sidings will be available for the management of the Works Trains and transfer of materials.
- Switch and Crossing (S&C) lay-down areas with suitable road access are available and in close proximity to the junction remodelling areas.
- The number of possessions has been determined by resource availability – in general we have assumed that the S&C labour/plant resource will move in series from junction to junction. If the resource is available some works could be done in parallel to minimise the number of disruptive possessions. This should be examined further in the next phase of the design.

No possessions at this stage of the project have been agreed by any of the required Stakeholders as this will be an issue to be discussed during the next stage of the project.

The sequencing of bridgeworks on the mainline is programmed to comply with the requirements of the railway possessions.

#### A2.13.2. Branch Line Railway Systems

The airport branch will be constructed and equipped independently of the main line railway works. However the possession strategy for construction of the new Airport junction allows for 7 No 28 hour possessions to remodelled and commission the new junction. These possessions have not at this stage of the project been agreed by the relevant authorities.

#### A2.13.3. Branch Line Construction Works

Works to fence off the complete project corridor in order to establish and demarcate the new boundaries are to be undertaken at the beginning of the construction phase. In conjunction with the fencing works, approved access points will be created with lockable gates.

A number of buildings will require demolition in order to undertake the project. This has not been identified within the programme, but it is considered that this will not affect the critical path of the works.

Utility diversions – all existing information was requested from all Utilities. The diversion of the various utilities along the branch line will occur in conjunction with the site preparation works.

#### A2.13.4. Central Station Railway Systems

As with the Branch line the railway works at Glasgow Central will generally be constructed and equipped independently of the main operational railway. However possessions will be required to:

1. Enable the platform extension to be built.
2. Connect the new platform track onto the existing track with associated OLE works and bring the required signalling alterations into use.

The first of these categories is to enable the exiting cable route to Hut No.3 to be moved, which will require a number of night time ROR possessions in order to disconnect, re-route and re-commission the cables and the air main. The exact number of possessions of this type will be determined by a more detailed examination of the cable allocation. In the second category, 3 No 28 hour possession will be required of platform 11A and the surrounding platforms to bring the new platform into use, install the new P/Way, alter the OLE and Signalling Control Panel at Glasgow Central Signal box. Any change to shorter possessions would require more possessions and therefore incur additional costs to the project.

#### **A2.14. Construction Staging**

The construction staging is detailed is governed by railway possession works.

##### A2.14.1. Glasgow Central Station

The construction of Track OLE and Signalling is in two phases S1 and S2. Phase S1 involves the removal of existing infrastructure and S2 is the installation of the infrastructure. The time between the two events is governed by the Civil Engineering work at the station.

##### A2.14.2. Gower Street Junction

The construction of Track OLE and Signalling is in eight phases split into two major pieces of work. Both are staged for the take up and laying of plain line plus three point ends. The period between these stages allows for the relaying of the Relief Line in that area and assumes the Switch and Crossing relaying resource is utilised at the Airport Junction in the interim. Note at stages G4 and G6 trains are re-routed. Stage G7 completes the new junction layout.

##### A2.14.3. Gower Street to Cardonald Junction Relief Line

The construction of Track OLE and Signalling is in one phase and has an interface with the remodelling of Gower Street Junction. There is also an interface with the relaying of Cardonald Junction.

##### A2.14.4. Cardonald Junction to Arkleston Junction Relief Line

The construction of Track OLE and Signalling is in one phase and has an interface with the remodelling of Cardonald Junction. There is also an interface with the relaying of Arkleston Junction. The sequencing of Hillington Bridge programmed to comply with the construction of the new relief line.

##### A2.14.5. Arkleston Junction

It is proposed to remodel Arkleston junction using a number of 52 and 28 hour possessions.

##### A2.14.6. Wallneuk Junction

It is proposed to remodel Wallneuk junction using a number of 52 and 28 hour possessions.

##### A2.14.7. Arkleston Junction to Wallneuk Junction Plain Line

It is also proposed to undertake the plain line remodelling and renewals during the same possessions as Arkleston/Wallneuk Junction. The work has been split into two stages comprising of the relay and realignment of the Up Goods and Up Main and, the relay and realignment of the Down Goods and Down Main. It is planned that a nine day blockade will occur at the end of the Arkleston/Wallneuk possessions to enable signalling commissioning to occur.

#### A2.14.8. Branch line & Airport Junction

The airport junction is sequenced to follow the construction of the new Murray Street bridge and retaining wall and will be completed in one phase using 7 No consecutive 28 hour possessions.

The M8 bridge crossing will commence immediately following the site preparation and site boundary fencing activities.

Other bridge works on the branch line will be completed using the following sequence:

#### A2.14.9. Murray Street – Clark Street – McFarlane Street/A726

In parallel to the bridge works the embankment construction between Clark Street and Murray Street will be completed. The viaduct between Clark Street and McFarlane Street will commence.

The St James Viaduct and the Airport viaduct will follow the completion of the M8 foundations.

The airport station & link structures will follow the completion of the airport viaduct.

#### A2.14.10. Fuel Farm

Prior to work commencing on the west end of the airport viaduct structure the existing Fuel Farm requires to be relocated to a new location with associated commissioning of the new facility and decommissioning of the old facility, and the existing location area decontaminated. This work activity will be one of the first on-site activities to be commenced on the project.

#### A2.14.11. St James Park Mitigation Works

One of the first activities to commence on site will be the St James Mitigation works which will take the order of:

- Put in place temporary pitches (11No) and permanent replacement (2 No).
- Re-lay pitches on west side (11 No).
- Construction site on east side (11 pitches closed)

After completion of the works in St James Park –

- Reinstate east side pitches (9 No) with appropriate drainage
- Improve changing facilities (possible relocation of the St James' Park pavilion, etc.)
- Operate 20 pitches at St James and 2 No elsewhere.

**Table A2.1 Projected Construction Traffic for Glasgow Airport Station, Fuel Farm, Viaduct, M8 Bridge and Other Branch Line Works**

<b>Point of traffic generation</b>	<b>Duration (days on site)</b>	<b>Average Lorry/van movements per day</b>	<b>Roads Affected</b>	<b>to/from</b>	<b>via</b>
Airport Station/Link Structure/Viaduct	<b>750</b>	<b>10</b>	St Andrew's Drive	M8 Jct 28	St Andrews Drive West, Caledonia Way West White Cart Road & Sanderling Road
Link Structure & Circulation Core	<b>170</b>	<b>9</b>	Caledonia Way	M8 Jct 28 & 29	St Andrews Drive West, Caledonia Way East White Cart Road & Sanderling Road
Airport Viaduct/Existing Fuel Farm	<b>750</b>	<b>20</b>	St Andrew's Drive West	M8 Jct 28 & 29	Caledonia Way West
Airport Viaduct/M8 Bridge/Proposed Fuel Farm	<b>511</b>	<b>10</b>	St Andrew's Crescent	M8 Jct 28 & 29	St Andrews Drive West, Caledonia Way West
St James Park Viaduct/M8 Bridge	<b>480</b>	<b>20</b>	A726	M8 Jct 29	
McFarlane Street	<b>300</b>	<b>12</b>	McFarlane Street	M8 Jct 29	A726
Clark Street	<b>300</b>	<b>15</b>	Clark Street	M8 Jct 29	Greenhill Road, McFarlane Road, A726
Murray Street Bridge and Embankment	<b>250</b>	<b>15</b>	Murray Street	M8 Jct 29	MacKean Street, Clark Street, Greenhill, McFarlane Street, A726

Duration of each element of works shown on these tables is based on the Outline Construction Programme included in the Appendix to Chapter 2 of the GARL ES. This programme may be subject to change. Note also that these tables should be read in conjunction with Figure 2.2 which shows the proposed haul routes in this area.

**Table A2.2 Projected Construction Traffic for Main Line, Junction and Central Station Works**

<b>Point of traffic generation</b>	<b>Duration (days on site)</b>	<b>Average Lorry/van movements per day</b>	<b>Roads Affected</b>	<b>to/from</b>	<b>via</b>
Off Wallneuk Road (Wallneuk Junction)	<b>260</b>	<b>12</b>	Wallneuk Road	M8 Jct 27	Renfrew Road
Off East Buchanan Street (Wallneuk Junction)	<b>110</b>	<b>5</b>	East Buchanan Street	M8 Jct27	Wallneuk Road, Renfrew Road
near Wallneuk Jct (Arkleston Branch)	<b>110</b>	<b>0</b>	no direct access from street - will come in via Wallneuk Road		
near Wallneuk Jct (Arkleston Branch)	<b>147</b>	<b>0</b>	no direct access from street - will come in via Wallneuk Road		
Arkleston Road (Arkleston Junction)	<b>147</b>	<b>5</b>	Arkleston Road	M8 Jct 27	Gallowhill Road, Renfrew Road
Arkleston Road (Main Line 3 Tracking)	<b>24</b>	<b>5</b>	Arkleston Road	M8 Jct 26	Penilee Road, Queen Elizabeth Avenue, Sandwood Road, Hillington Road
Sandwood Road (Hillington Bridge Works)	<b>300</b>	<b>12</b>	Sandwood Road	M8 Jct 26	Hillington Road
Footpath (Main Line 3 Tracking)	<b>28</b>	<b>3</b>	Linburn Road/Queen Elizabeth Avenue	M8 Jct 26	Sandwood Road, Hillington Road
Footpath (Main Line 3 Tracking)	<b>28</b>	<b>3</b>	Chirnside Road/Carnegie Road	M8 Jct 26	Sandwood Road, Hillington Road
Off 50 Pitches Road (Cardonald Junction)	<b>86</b>	<b>10</b>	50 Pitches Road	M8 Jct 26	Shieldhall Road, Renfrew Road
Berryknowes Rd (Cardonald Junction)	<b>86</b>	<b>3</b>	Berryknowes Road	M8 Jct 26	Marcus Road, Shieldhall Road, Renfrew Road
Off Helen Street (Main Line 3 Tracking)	<b>28</b>	<b>10</b>	Helen Street	M8 Jct 24	
Off Broomloan Road (Gower Street Junction)	<b>154</b>	<b>10</b>	Broomloan Road	M8 Jct 23	

<b>Point of traffic generation</b>	<b>Duration (days on site)</b>	<b>Average Lorry/van movements per day</b>	<b>Roads Affected</b>	<b>to/from</b>	<b>via</b>
Off Cornwall Street South (Gower Street Junction)	<b>154</b>	<b>10</b>	Cornwall Street South	M8 Jct 20	Vermont Street, Shields Road, Scotland Street, West Street
Off Oswald Street (Central Station)	<b>135</b>	<b>7</b>	Oswald Street	M8 Jct 19	Argyle Street
Hope Street (Central Station)	<b>135</b>	<b>7</b>	Hope Street	M8 Jct 19	Waterloo Street
Burnbrae Drive (Elderslie Loop)	<b>41</b>	<b>6</b>	Burnbrae Drive	M8 Jct 29	Burnbrae Road, Linwood Road, A737