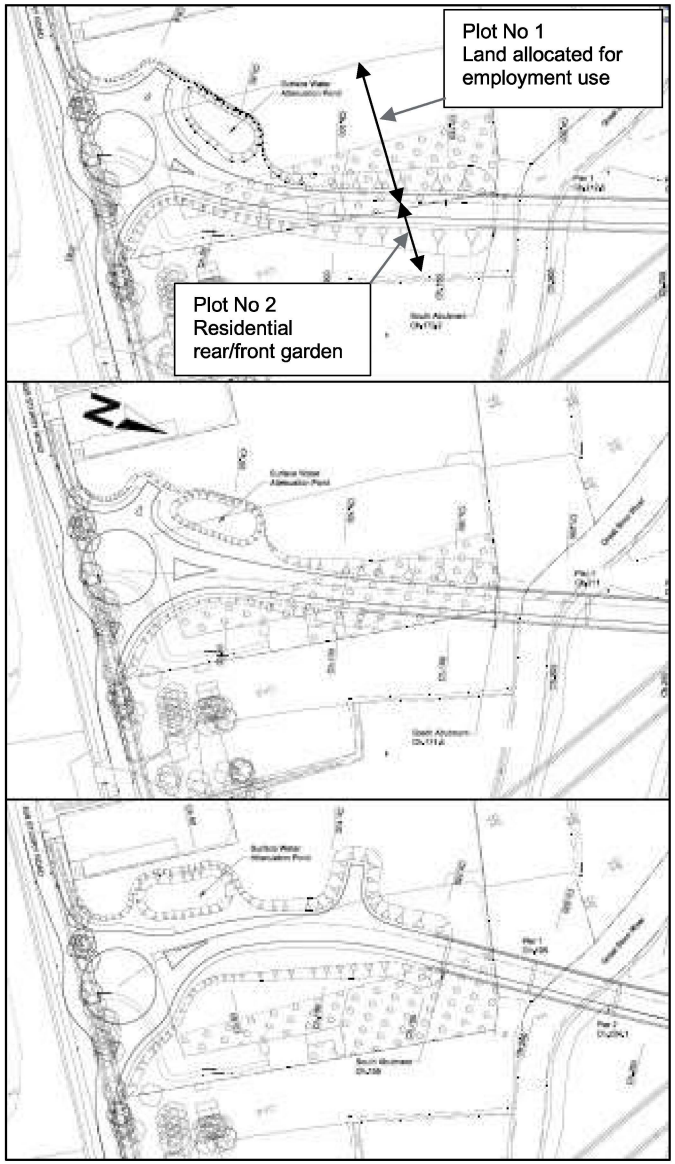
Route Alignment

From the railway line southwards to the new junction with the A28 Sturry Road, three 'localised' alternative routes were investigated to assess land take implications on adjacent land plots in addition to cost and engineering factors. The three routes developed are shown opposite (*Note: The Pond location has subsequently changed to the east side of road in land severed by the scheme)*.

Key advantages & disadvantages are;

Route	Advantages	Disadvantages
Option 1	Right angle crossing of railway Symmetrical pier spacing can be kept at least 8m back from river, reducing EA consent requirements Enables access to development land from roundabout	Requires significant part of rear of land to Plot No2 towards the river (0.56 acres)
Option 2	Reduced land take from Plot No 2, approximately 0.25 acres. Enables access to development land from roundabout	Slight angle to railway crossing Some viaduct piers closer than 8m to river Reduction in employment development site
Option 3	Avoids all land take from Plot No 2	Curved viaduct. Skew crossing of railway No development access off roundabout Much reduced area of employment development site Viaduct would be curved in plan adding significantly to cost and construction complexity. Additional span is required Land take required from Southern Water treatment works. Land status unknown but could impact treatment works expansion



Option 1
Initial alignment designed to retain all construction works within the Kings School land north of the river and avoid land take from the Southern Water treatment works site. This allowed for the provision of embankment works between separate bridge crossings (as opposed to a viaduct) without affecting Southern Water land

Option 2
Introduces a lateral westerly shift of the alignment (approx. 10m) where it crosses the river, whilst remaining within the Kings School land and avoiding impacting on Southern Water land (i.e. Utilises space previously occupied by embankments not now required with a viaduct)

Option 3
Avoids land take from Plot No 2. Requires land from the Southern Water treatment works.

Option 2 was subsequently selected and developed further as the preferred choice, offering an equitable compromise between all factors.

Viaduct structure

The decision to adopt a multi-span viaduct solution compared to individual bridge spans of the River Great Stour and the railway with an intervening embankment has been based primarily on its reduced impact on the flood plain, reduced stability issues in the weak alluvium soils and costs.

Structures Feasibility Report CO04300392/004 Rev00 (July 2017) is included in Appendix A and sets out the assessment of four alternative bridge arrangements; a multi-span viaduct, 3 span and single span, 3 single spans and 2 single spans with river diversion.

Each bridge arrangement was initially assessed against the design requirements and considerations as set out by the Environment Agency and Network Rail, key to which were;

- Bridge must maintain continuity of the flood plain
- Piling foundations and columns are preferred. Preferably not within 8m of the bank or in the river channel itself
- The impacts on flood depths, extent and need for compensatory flood storage
- Ecology aspects recognising the potential for otters to come back to the Great Stour and that the river is a migratory route for sea trout, salmon and lamprey
- Vertical and lateral clearances of the railway and river Stour
- Impact of piling operations adjacent to the railway
- Access for maintenance

With overall project costs estimated to be between £1m and £2.5m less for the multi-span viaduct solution, coupled with concerns over embankment construction on the soft alluvial deposits potentially resulting in excessive settlements over time, the choice of a multi-span solution became evident.

Although it is acknowledged that single span structures can be fully integral with their supports, which minimises future maintenance owing to the absence of bearings, the multi-span viaduct can be designed as semi-integral, having bearings but without joints above. This form of construction is regularly adopted because it reduces maintenance associated with corroding bearings since leaking joints are eliminated.

Further benefits of the multi-span structure are;

- The overall form of structure will be open allowing maximum light penetration to encourage the continued growth of flora and fauna after completion
- There will be no requirement to provide dedicated wildlife crossings over or through the structure
- No compensatory flood storage areas required, as determined by hydraulic modelling work carried out as part of this application
- No culverts required for flood alleviation
- No Environment Agency consent required for river diversion works (Note: Consent for works within 8m of the river may be necessary subject to detailed design)
- Minimum land acquisition required

The viaduct will have six spans and a total length of 248.6m with no skew angle over the railway. It will carry a 6.75m wide single lane carriageway, a 3.5m wide bus lane, a 4.0m wide shared footway/cycleway on the east side and a 0.6m wide hard verge on the west side, with a total width of 15.85m.

Six multi-span bridge options have been considered with various permutations of deck, support and abutment options. Structures Options Report CO04300392/002 (March 2017) is included in Appendix B and sets out to describe and evaluate each option based on several factors including the impact on the existing water course, buildability, future maintenance and the environment.

The options considered range from the use of precast concrete beams, steel beams with curved or flat soffit profiles and a twin tower cable stayed option.

Having considered and weighted the various factors, the option comprising 4 No. weathering-steel beams with curved soffits was preferred. This option was assessed to have the least environmental impact with lower maintenance needs and the least risks during construction (i.e. construction hazards).

A general arrangement of the viaduct is shown on drawing CO04300392/1700/103 provided as part of the application. Figure 30 below shows a part side elevation of the proposed viaduct, looking west, that illustrates the general profile proposed.

Steel beam depths are 1750mm at pier and abutment supports and 1150mm mid span. The piers supporting the steel beams are located to limit flood risk and impacts to ecology and rail infrastructure.

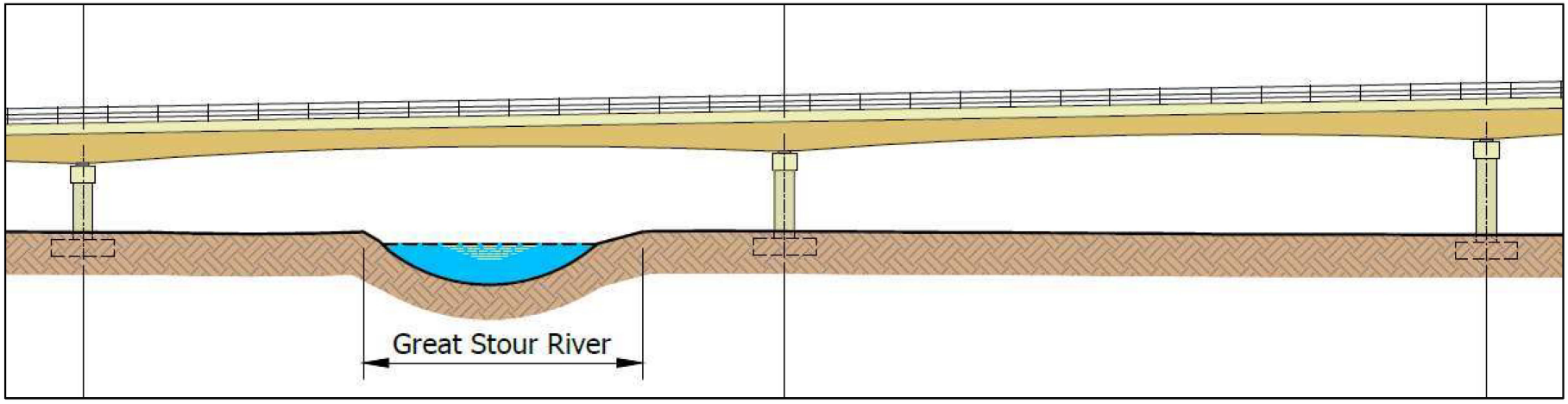


Figure 30: Side elevation of viaduct over southern branch of Great Stour River

The viaduct will involve extensive foundation piling works comprising fifteen 750mm diameter, 23m long piles at each pier and abutment location.

Bridge parapets will vary in height and form depending on location. Over the railway line, 1.5m high parapets will be required on both sides with infill panels. Elsewhere, on the east side, parapets will remain at 1.5m high for the protection of pedestrians and cyclists whilst on the west side the parapet will be reduced to 1m high. Infill panels will be provided 0.5m high to reduce the impact of spread of road salts.

Long term principal inspections of the viaduct are expected to be undertaken using an overbridge unit. This avoids concerns by the KCC structures management team over the need to maintain a permanent maintenance access track alongside the viaduct on the flood plain including two maintenance access bridges over the Great Stour due to their infrequent use. It is also unlikely that the Environment Agency would accept this arrangement due to the greater flood risk implications.

Inspection from the road level is proposed and would require use of a MOOG 230 overbridge unit for up to three nights and require two lanes to be closed under traffic signal control using the bus lane to allow vehicle movements to continue. The abutments and bearings will be inspected via a viewing platform, accessible from the footway, or from the inspection gallery.

Bridge inspections of the span over the railway will require a line possession from Network Rail.

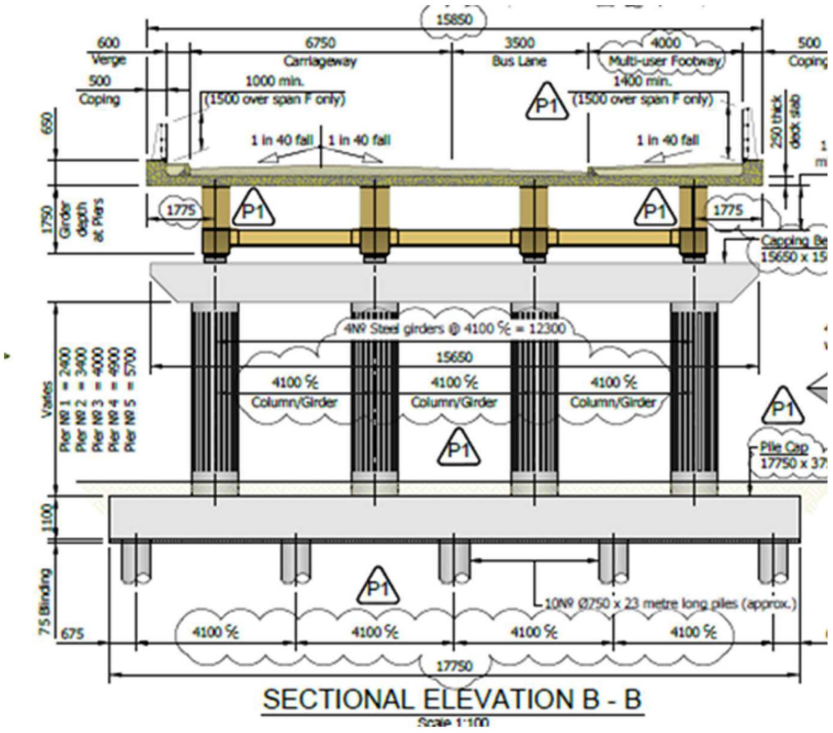


Figure 31: Section through viaduct showing pier arrangement and bridge deck form

Roundabout north of railway (Section 1 – this application)

North of the railway set within the southern slope of the Stour valley a 4-arm roundabout is proposed that will present drivers with the choice of alternative routes to travel into Canterbury via either Broad Oak Road or A28 Sturry Road. The roundabout is the preferred junction choice based on the level and combination of traffic movements.

Provision for a northern spur as shown in Figure 30 will serve as a main access to the housing development but is subject to consent as part of the Masterplan application.

The design of the roundabout is based on achieving desirable geometry standards as set out in TD 16/07 with 2-lanes provided on entry to the roundabout on each approach. It has an overall diameter of 40m with a circulatory carriageway width of 8.4m.

Junction performance using capacity assessment ARCADY 9 software and forecast modelled flows for year 2031 have confirmed good levels of theoretical reserve capacity during the PM peak period, typically 50%, providing some in-built resilience to accommodate flow variations.

During the AM peak, some queuing could be expected on the east approach (i.e. towards Canterbury) in the medium term as theoretical capacity could be reached. However, the constraint on traffic movement at other junctions in the local area will limit this.

Provision of a dedicated left turn lane in these circumstances can sometimes ease any queuing however on this occasion, with only one lane available downstream over the viaduct and the difficulties associated with accommodating pedestrian crossings in these circumstances, this measure was discounted.

Formal uncontrolled pedestrian crossings are proposed at the entry and exit points on the northern, eastern and southern arms to best align with pedestrian desire lines. On the western arm, the opportunity has been taken to locate the pedestrian crossing further away from the roundabout, which is preferable, as the desire to cross at the roundabout would be much less.

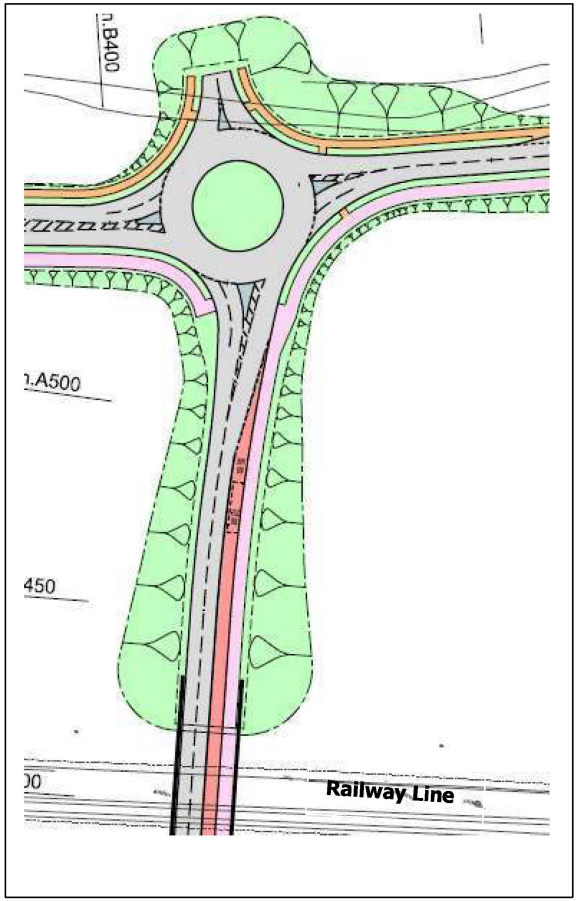


Figure 32: Proposed layout north of railway

Link to Shalloak Road (Section 2)

This section is approximately 300m in length and serves as a local road that offers an alternative route to/from Canterbury City Centre.

Figures 33 & 34 illustrate the key design elements and features of the proposals.

It should be noted that proposals for on-line widening to Shalloak Road form part of this application.

The route is designed to follow the general contours of the valley slope and is generally supported on embankment no greater than 1m height with a maximum longitudinal fall of 3.25% (1:30).

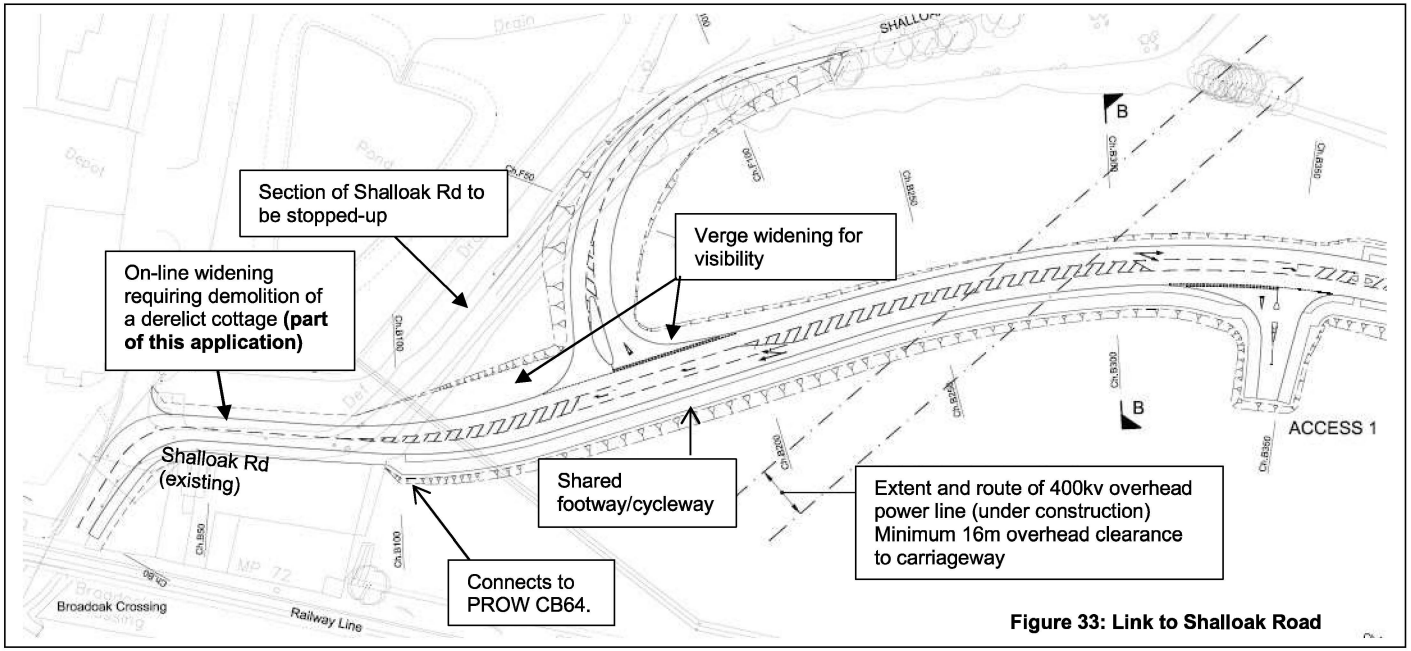
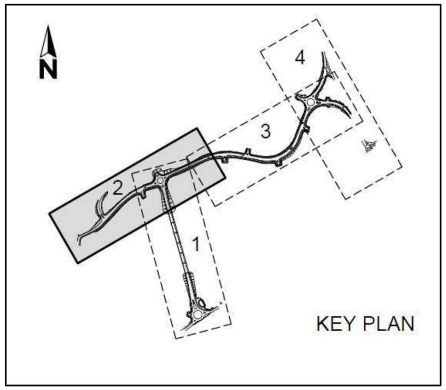
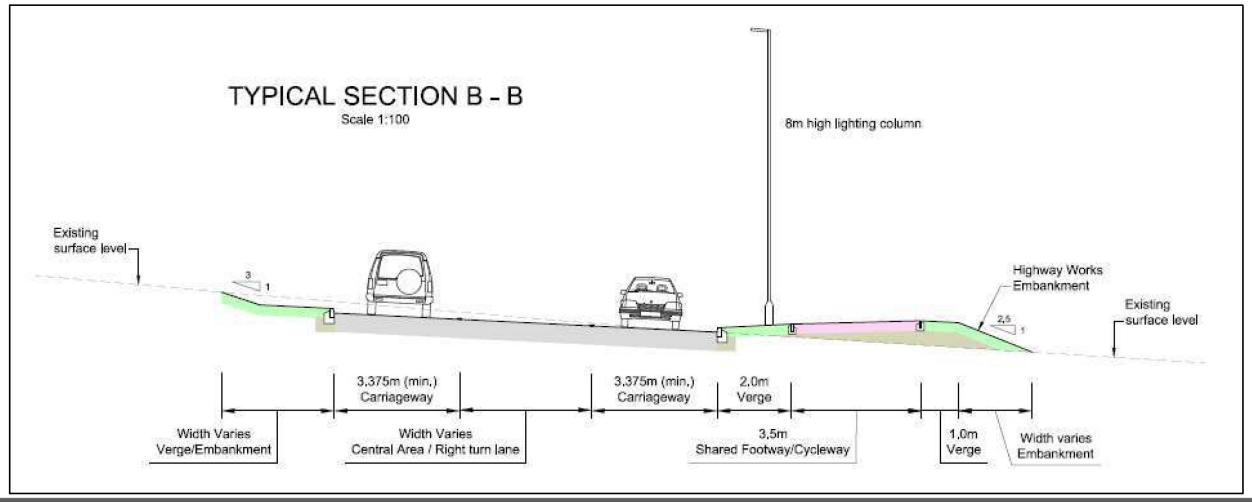


Figure 33: Link to Shalloak Road





Specific aspects of the design to note are;

i) With the potential for queues to form back from the Broad Oak level crossing adequate forward visibility on approach to the tie-in with Shalloak Road is important to ensure drivers react in good time to any queue present.

The design therefore provides at least 90m forward visibility to the sharp left hand bend just before the level crossing within the confines of the new carriageway on the approach.

ii) The need to consider widening of a short section of Shalloak Road to the north of the Broad Oak level crossing arose from the outcome of a level crossing risk assessment[4] carried out jointly between Network Rail and KCC. This followed concerns over observed 'blocking-back' of traffic over the crossing caused by vehicles slowing down to safely negotiate the narrowness of the road.

Although the Sturry SLR scheme is considered to have a neutral impact on the risk rating of the level crossing with forecast traffic flows over a 24hour period similar to existing flows over the crossing, proposals for widening Shalloak Road are nevertheless proposed by KCC. This is to improve safety at the crossing and mitigate the potential for increased traffic during peak hours because of the SLR scheme.

Widening is proposed along the northern side of Shalloak Road including the provision of a footway/cycleway on the south side down to the Broad Oak level crossing to enable continuity of the proposed footway/cycleway proposed as part the Land at Sturry

Image showing derelict cottage to be demolished off Shalloak Road

Masterplan proposals. Land will be required from the Viridor Kent Waste site and demolition of a derelict cottage within it (see photo above).

This measure, along with other measures to improve safety at the level crossing, are currently being considered by Network Rail as part of a line speed upgrade (70mph to 85mph).

iii) The ghost-island arrangement proposed as the new junction with Shalloak Road will allow traffic to continue unimpeded from/to the main section of the SLR in the east and maintain local access needs.

[4] Railway Group Guidance GI/RT7611 Issue No 1, Section C1.2

It should be noted that with forecast traffic flows expected to be near the upper operational levels for this type of junction, there is the potential for some delay to right turning traffic that may encourage traffic currently using Shalloak Road as a 'rat-run', via Broad Oak village, to reassign to the SLR.

iv) Geometric standards of the new junction are fully compliant with desirable standards in TD 42/95 for a 70kph design speed (40mph), including desirable visibility splays where verge widths have accordingly been widened.

v) Whilst the speed limit will be signed as derestricted through the junction, actual speeds are unlikely to exceed 40mph (85%ile), hence the use of 70kph design speed parameters.

vi) A channelising island, as opposed to a pedestrian island, has been introduced in the Shalloak Road bellmouth. This will provide improved guidance and is considered appropriate given the level of traffic anticipated. There are no pedestrian footways proposed on the north side of the SLR at the junction as there is currently no footways on Shalloak Road.

vii) With much comment made at the public consultation event over the desire to include as much provision for pedestrians and cyclists as possible, the decision was taken to provide a continuous 3.5m shared footway/cycleway on the southern side down to the level crossing.

Whilst there is some concern that this would encourage pedestrians/cyclists to use the level crossing, it is accepted that it would become a natural route over time to the commercial premises and stores off Vauxhall Road and as such a suitable provision should be made. Currently, however, there are no firm proposals to improve the existing footway from the level crossing to Vauxhall Road to accommodate cyclists. It should be noted that this footway/cyclway will link up with PROW CB64, which runs along the northern boundary of the railway.

viii) The design includes for carriageway widening where necessary due to the horizontal radii proposed. Maximum lane widths are 3.65m (from 3.375m).

ix) Currently, a 7.5t weight limit is in place on Shalloak Road, commencing east of the Viridor Kent Waste access (see photo on previous page). It is proposed that this weight limit should remain in place and extend eastwards to the new roundabout. This will serve to prevent large heavy goods vehicles from using the Broad Oak level crossing which could otherwise potentially impact significantly on the safety of the crossing.

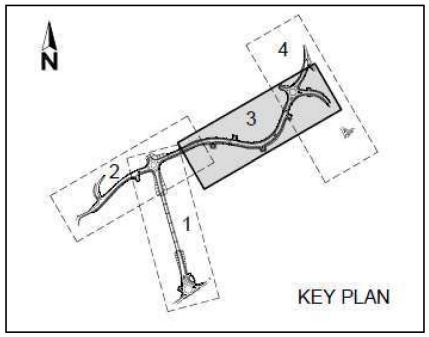
x) New 'ACCESS 1' shown on Figure 31 will serve part of the housing development and is located approximately 60m west of the roundabout. Its location reflects that shown for the Masterplan proposals for the Land at Sturry housing site.

In highway terms traffic using the right turn lane at the ghost island arrangement proposed has the potential to momentarily obscure forward visibility to the roundabout. Measures to ban this right turn and utilising the roundabout as a 'u' turn were considered. These situations are however often open to abuse and become unsafe in themselves. The ghost island layout has therefore been designed to maximise forward visibility for eastbound traffic on approach to the roundabout. At least 60m forward visibility will be available (looking passed stationary vehicles waiting to turn right) which is consistent with KCC standards for the speed limit and road type.

Central Link through housing development (Section 3)

As previously mentioned, the southern extent of Den Grove Wood Ancient Woodland and the challenging topography of the area has heavily influenced the alignment design of the SLR over this section.

With the route effectively running across a hill side and the desire to mimic the existing topography as closely as possible, the alignment 'dips' southwards both horizontally and vertically with its lowest point at the location where it crosses the existing watercourse. Temporary cutting slopes and embankment heights will lie in the range of 1-2m prior to any housing construction.



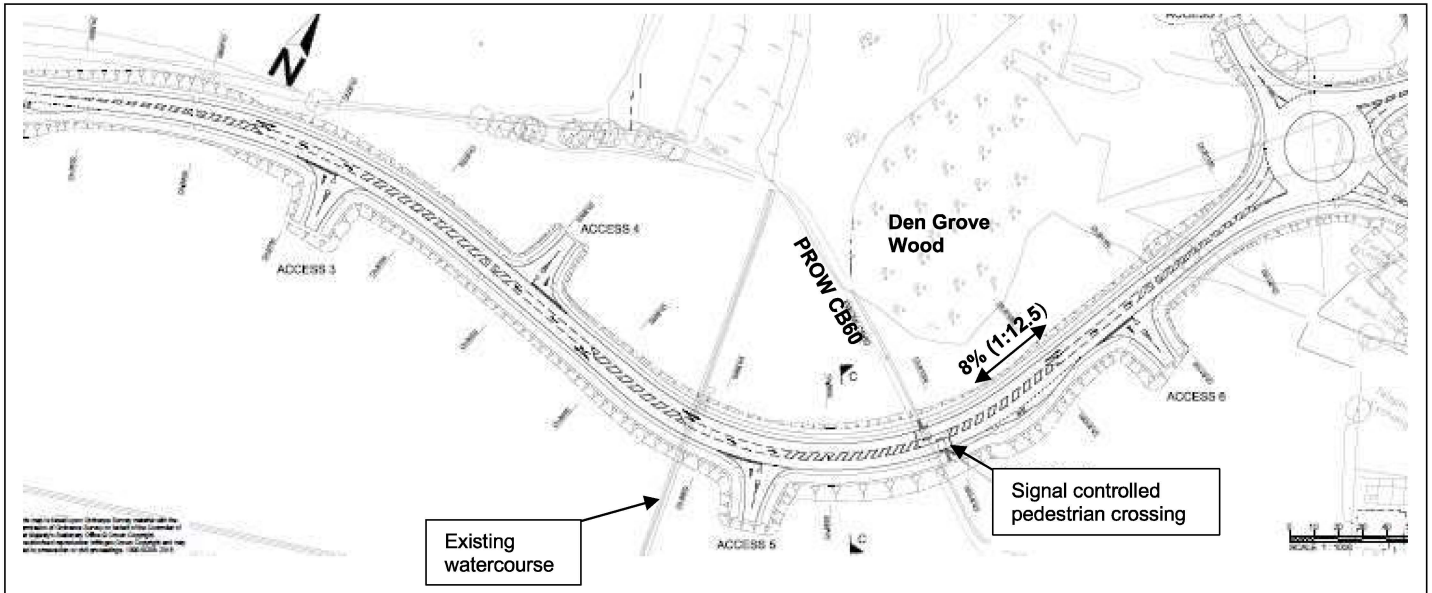


Figure 35: Central Link through proposed development

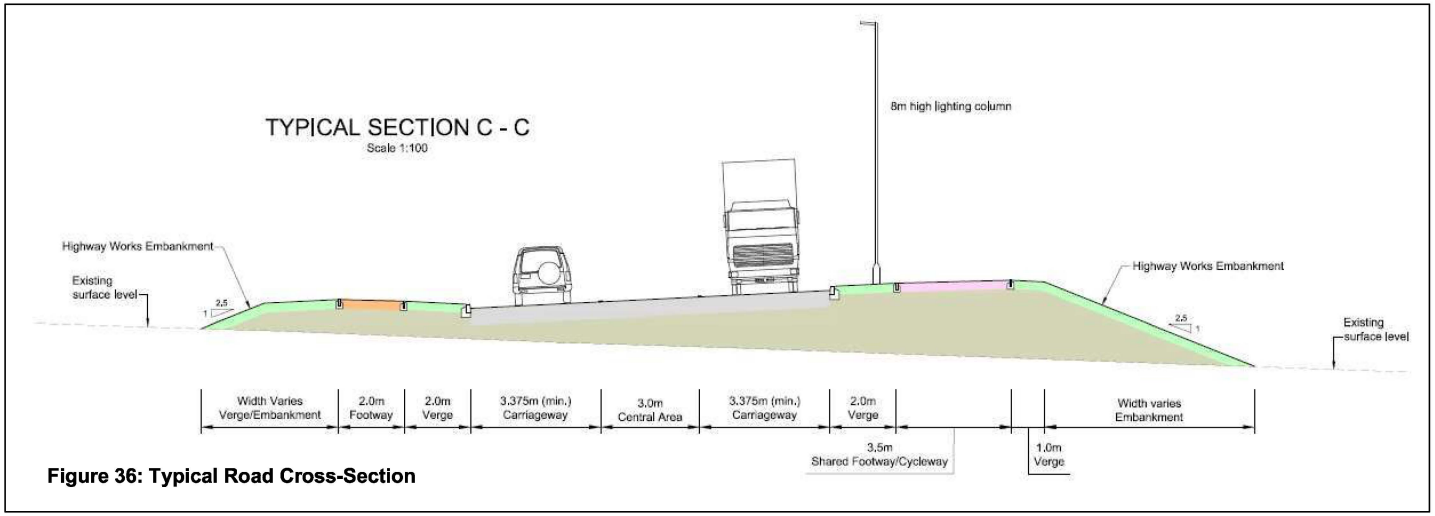


Figure 36: Typical Road Cross-Section

The layout design generally adopts the typical design parameters as set out in the Kent Design Guide for the road type selected (i.e. 'Local Distributer'). For ease of reference the key parameters are given in the Table 1 below.

Design Element	Typical Parameter	Recommended Parameter range
Carriageway width	6.75m	6.00/10.5
Verge width	2m	0.5m/5.0m
Footway/cycleway width	3m	1.8m/5.0m
Target speed	20-30mph	<30mph
Junction visibility X	4.5m	2.4m
Junction visibility Y	70m	>33m
Forward visibility	60m	>28m
Minimum junction spacing	60m	>15m
Right turn lanes	3.5m	3.0m
Max longitudinal gradient	6%	8%

Table 1: Design parameters from Kent Design Guide – 'Local distributer'

Specific aspects of the design to note are;

i) The vertical design comprises curvature values at or above the desirable minimum crest and absolute minimum sag values given in the DMRB for a design speed of 60kph (DMRB - 30mph). These values will allow forward visibility distances greater than the 60m requirement of the KDG but is considered beneficial due to the presence of the junctions.

ii) longitudinal gradients have been limited to be no greater than 8% (1 in 12.5). It has however been necessary to apply an 8% gradient at the location shown in Figure 25 over a length of 50m. Additional features such as handrails may be required to assist the mobility impaired over this length.

iii) Allowance is made in the vertical design to ensure sufficient cover above the existing watercourse is available to allow culverting beneath the road of the existing watercourse that runs down the valley slope. This watercourse will serve as the main outfall point for the Land at Sturry development north of the road and the SLR.

iv) In plan, the alignment is characterised by back to back horizontal radii of 250m in the west followed by a 'two-step relaxation' radii of 127m (within the meaning of the DMRB) for a 60kph (30mph) design speed.

With unobstructed forward visibility at or above 70m throughout this section, which is consistent with the design standards set out in the KDG, the above relaxation is considered acceptable.

v) Pedestrian groups such as those with mobility impairment, the elderly or young, may have trouble crossing the road given the amount of traffic expected. A signal controlled pedestrian crossing (known as a 'PUFFIN' type) has therefore been introduced in this section. The crossing is staggered allowing pedestrians to cross in two stages and minimise delay to traffic. Its location is away from junctions for improved safety and will lie on the path of the existing PROW CB60, providing good continuity with this right of way.

The design includes for verge widening on the eastbound approach to the crossing on the northern side (inside of bend) to enable improved visibility of the crossing and the signals, which is considered appropriate on safety grounds. A minimum of 90m forward visibility will be provided.

vi) Frequent formal but uncontrolled crossing points are also provided along this section with central refuges for added protection whilst crossing

vii) Carriageway widening has been introduced on the 127m radius. Running lane widths are increased to 3.95m (from 3.375m) over the radius length, transitioning down to 3.375m at the start and end points.

viii) The four access points located along the route (Accesses 3, 4, 5 & 6) reflect those as submitted as part of the Masterplan application by the developers of the Land at Sturry. In highway terms these are considered acceptable in terms of adequate spacing between junctions. Their actual provision is subject to consent via the Masterplan application.

ix) All junction layouts are fully compliant with the KDG parameter requirements and the geometric requirements of standard TD42/95 (Geometric Design of Major/Minor Priority Junctions) for those aspects not specifically covered by the KDG.

x) The provision of 2m wide soft verges between the carriageway and footways will provide an added safety feature for pedestrians and cyclists as well as providing space to accommodate street furniture and keeping the footway routes clutter free. There is also the flexibility to provide soft landscaping works to these areas.

New junction with A291 Sturry Hill (Section 4)

The new 4-arm roundabout proposed to the west of the existing A291 acts as the gateway to the new development from the east and will form a new strategic junction on the road network serving the A291 and A28 routes.

Its location lies on land currently utilised as part of a Greenfields Shooting Grounds establishment that will be closed and redeveloped as part of the Land at Sturry new housing development.

Local realignment of the A291 Sturry Hill to link into the roundabout is designed to minimise impact on the neighbouring woodland and avoid land acquisition outside that already understood to be secured by the developers.

Access to premises off the section of the A291 to be diverted will be served via a new junction to the north that joins the realigned A291.

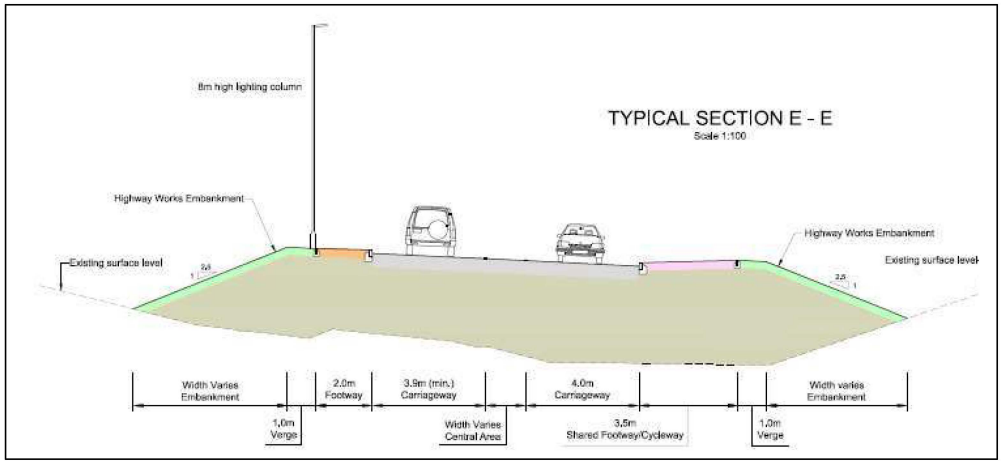


Figure 37: Road Cross-Section

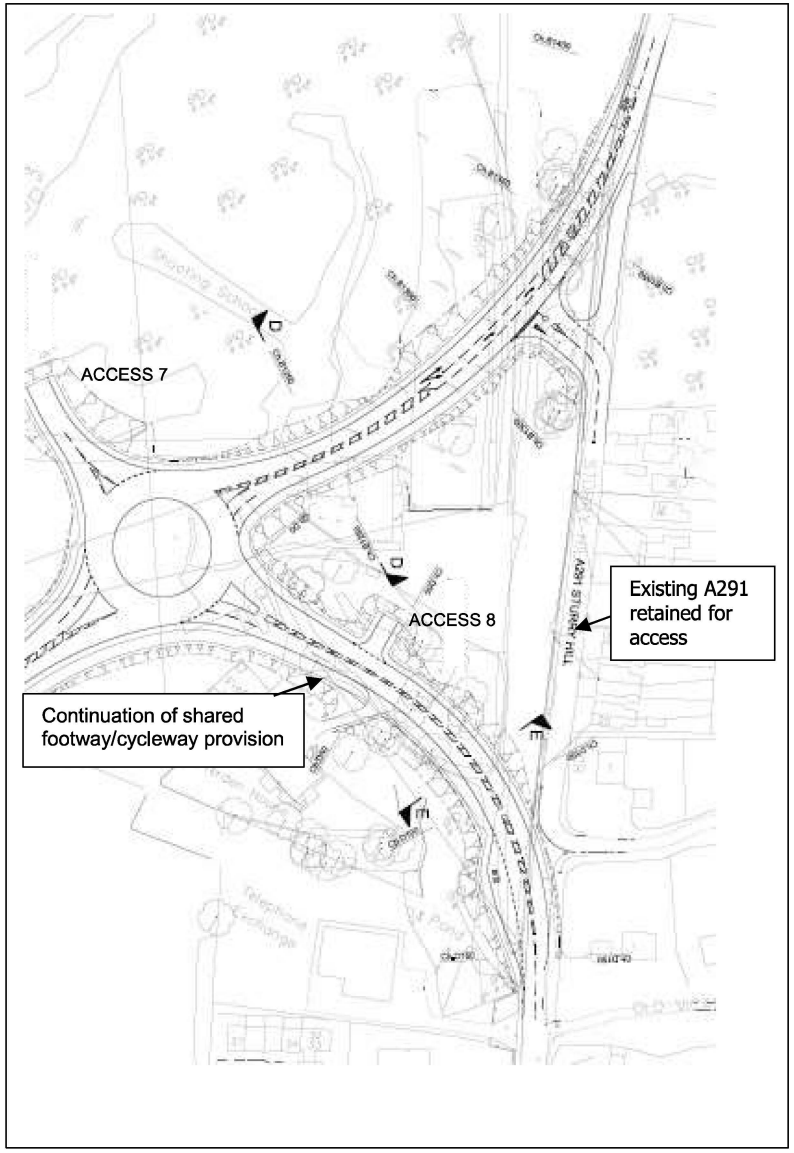


Figure 38: New Junction with A291

Specific aspects of the design to note are;

i) The design of the roundabout is based on achieving desirable geometry standards as set out in TD 16/07 with 2-lanes provided on entry to the roundabout on each approach. It has an overall diameter of 45m with a circulatory carriageway width of 8.4m.

ii) Junction performance using capacity assessment ARCADY 9 software and forecast modelled flows for the year 2031 show a similar pattern to that expected at the west roundabout north of the railway crossing with good levels of theoretical reserve capacity during the PM peak, typically 50%, providing some in-built resilience to accommodate flow variations.

During the AM peak, some queuing could be expected on the A291 southern approach although this would be suppressed to a certain degree by the effect of the new signalised junction at the Sturry level crossing where flows arriving at the roundabout on Sturry Hill would be intermittent.

iii) Each realigned link to the A291 Sturry Hill includes for continuation of the shared footway/cycleway on the southern side, both terminating where the new links join the existing A291.

iv) Pedestrian crossing points at the immediate entry/exit points to the roundabout have been restricted to the east side across the A291 southern link to allow for continuity of the cycle route along the SLR. Elsewhere, it is considered that reasonable alternative pedestrian routes will exist to satisfy the general access requirements of pedestrians and thereby avoid crossings near the roundabout entry/exit points.

v) The existing footway on the west side of Sturry Hill is to be retained and will connect to the new footways at either end of the realigned sections where pedestrian crossing points of the SLR are provided nearby, including central refuges for improve ease of crossing. This ensures continuity of the footway on Sturry Hill, which is important for access down to the Rail station.

vi) Provision of adequate forward visibility on the approaches to the roundabout has strongly influenced the specific layout of the scheme in this area. The design ensures that forward visibility is appropriate to the anticipated speeds on each approach, this being; 90m on the A291 northern and western SLR approaches and 70m on the A291 southern approach.

vii) New accesses 'ACCESS 7' and 'ACCESS 8' shown on Figure 36 reflect Masterplan proposals for the Land at Sturry housing site to be determined as part of the Masterplan application. Should consent be given for 'ACCESS 8', careful consideration would be needed to ensure traffic turning right into the access can be done safely