

**Lyminster Bypass (South),  
Littlehampton**  
**Geotechnical Design Report (rev 02)**

On behalf of: **Persimmon Homes (Thames Valley) Limited**



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|       |          |                                                                             |          |          |          |

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## 1.0 Introduction

### 1.1 Scope and Objective of the Report

- (1) Peter Brett Associates LLP (PBA) has been commissioned by Persimmon Homes (Thames Valley) Limited (the Client) to prepare a Geotechnical Design Report for the southern section of the Lyminster Bypass. The geotechnical design elements of the scheme include overbridges to West Coastway Railway Line and Toddington Lane, associated approach embankments and a pedestrian subway (denoted the Allotment Underpass) through the southern approach embankment to the rail bridge. The proposed bypass forms part of the enabling infrastructure for the proposed Hampton Park housing development, Littlehampton.
- (2) Previously a desk study and subsequent intrusive ground investigations were carried out for the Hampton Park development by Idom Merebrook in February 2014 and April 2015; the results of which are presented in separate reports (IM, 2014 and 2015).
- (3) Subsequently an intrusive ground investigation was carried out to provide specific information on the ground conditions, including concentrations of potential contaminants, to inform the design of the foundations and other geotechnical elements of the enabling infrastructure. The fieldwork and laboratory testing were carried out by CC Ground Investigation Ltd (CCGI) acting under the technical direction of Peter Brett Associates LLP. The factual results of the investigation are presented in a separate report prepared by CCGI (CC, 2016).
- (4) Subsequently a Ground Investigation Report for the enabling infrastructure was prepared by PBA in general accordance with the requirements of BS EN 1997-2 (2007). The Ground Investigation Report (PBA, 2016) presents an assessment of the ground conditions, together with suggested characteristic values of geotechnical parameters for use in the design of the geotechnical elements of the scheme. The report also presents comments on the ground conditions in relation to the design and construction of the geotechnical elements of the proposed development. In addition, the report presents an assessment of the risks associated with any existing contamination in the ground to human health, the environment and the proposed structures.
- (5) This Geotechnical Design Report has been prepared in general accordance with the requirements of BS EN 1997-1 (2004) and HD 22/08 (HA, 2008) and covers the proposed southern section of the Lyminster Bypass between but not including the Southern Bypass Roundabout to the north and the A259 Worthing Road Roundabout to the south (denoted the Site in this report). This Geotechnical Design Report presents a description of the project, summarises the characteristic values recommended in the Ground Investigation Report (PBA, 2016) and presents the design analysis for the proposed geotechnical elements of the scheme.
- (6) The comments and opinions in this report are based on an engineering and scientific appraisal of historical maps, plans and aerial photographs in our possession, together with information on the ground conditions encountered within the exploratory holes and the results of field and laboratory testing carried out for ground investigations. There may be, however, developments or conditions pertaining to the Site which were not disclosed by the historical data or the investigation and which therefore could not be taken into account. In particular groundwater conditions may vary due to seasonal, climatic, tidal and man-made effects.

### 1.2 Description of Project (including Site Description)

- (1) The Site is located at National Grid Reference TQ 031 039, about 1.8 km north of Littlehampton town centre. The location of the Site is shown on a Site Location Plan presented as **Figure 1**, whilst the layout and extent of the Site is shown on a Site Layout Plan presented as **Figure 2** of this report.

- (2) The Site is situated on a low ridge aligned east to west between the seafront about 2.5 km to the south and the valley of the Black Ditch about 0.5 km to the north of the Site.
- (3) In the area of the Site, the West Coastway Railway Line and Toddington Lane are aligned approximately east to west running along the low ridge. The West Coastway Railway Line is at about 5.8 m OD and runs in shallow cutting between about 1.5 and 2.0 m below surrounding ground level. Toddington Lane comprises an at-grade two-lane two-way single carriageway with a narrow grass verge to either side; carriageway levels in the area of the Site are about 6.8 m OD.
- (4) The proposed overbridges are aligned approximately north to south and comprise semi-integral bridges with single clear spans of 29.5 m for the rail bridge and 17.0 m for the road bridge. The wing walls will be monolithic with the abutments to support the continuation of the containment parapets. Proposed carriageway levels on the overbridges are about 13.9 m OD with a minimum clearance of 5.3 m to the road bridge and 13.4 m OD with a minimum clearance of 5.2 m to the rail bridge.
- (5) To the north of the road bridge, between the road and rail bridges and to the southeast of the rail bridge, the road will be supported on reinforced soil embankments with modular concrete facing panels. To the southwest of the rail bridge the road will be supported on conventional earthworks with side slopes of 1 vertical in 3 horizontal.
- (6) The Allotment Underpass is aligned approximately east to west and comprises multiple precast reinforced concrete box units with precast reinforced concrete headwalls and wingwall at the west end. At the east end the underpass will pass through the concrete facing panels to the reinforced soil embankment.
- (7) Drawings showing the general arrangement of the proposed overbridges and underpass are included in **Appendix 8** of this report.

### 1.3 Geotechnical Category of Project

- (1) A review of the proposed scheme and project risks has been carried out to determine the geotechnical classification of the project and thus the requirement for geotechnical certification. On the basis of this review, the proposed scheme has been classified as a Geotechnical Category 2 Project, that is a project including conventional types of earthworks, structures and foundations with no abnormal risks or unusual or exceptionally difficult ground conditions.

### 1.4 Ground Summary

#### 1.4.1 Topography

- (1) Natural ground levels in the area of the Site are about 7.5 to 8.0 m OD with a gentle gradient at about 1 vertical in 125 horizontal to the north towards the valley of the Black Ditch.

#### 1.4.2 Ground Conditions

- (1) The ground conditions in the area of the Site, as revealed by the ground investigation (CC, 2016), comprise topsoil/subsoil overlying a sequence of Aeolian Deposits, Raised Beach Deposits and the White Chalk with the Grey Chalk and Upper Greensand present at depth. These ground conditions are in general agreement with the published geological information and known history of the Site.
- (2) Based on the information from the ground investigations, the ground conditions encountered in the area of the Site are summarised in the following table. It must be noted that permission to access the land on the central part of the Site was not obtained and hence no information on the

ground conditions in this area is currently available. Further intrusive ground investigation works will need to be carried out to verify the actual ground conditions in this part of the Site.

#### Summary of Existing Ground Conditions

| Strata                      | Base Level <sup>(1)</sup> ,<br>m bgl <sup>(2)</sup> (m OD) | Thickness <sup>(1)</sup> , m | Typical Description                                                                                                                                                                   |
|-----------------------------|------------------------------------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topsoil/Subsoil             | 0.2 to 0.5<br>(6.5 to 7.1)                                 | 0.2 to 0.5                   | Firm friable orange brown/grey slightly sandy CLAY or SILT with a little gravel of siliceous material, and occasional man-made materials.                                             |
| Aeolian Deposits            | 1.1 to 2.6<br>(4.3 to 5.9)                                 | 0.5 to 2.3                   | Soft to firm brown and orange brown sandy CLAY/SILT with a little gravel of angular to sub-rounded fine to coarse siliceous material. <sup>(3)</sup>                                  |
| Raised Beach Deposits       | 3.0 to 4.9<br>(2.6 to 4.0)                                 | 1.5 to 2.6                   | Medium dense brown and yellowish brown clayey SAND with a little, locally much, gravel of angular to subrounded fine to coarse flint. <sup>(3)</sup>                                  |
| White Chalk (structureless) | ~8.0 (-0.7)                                                | ~3.7                         | Structureless CHALK (Grade Dc) <sup>(4)</sup> comprising off-white and light brown with black speckles slightly sandy silty GRAVEL of very weak and weak low to medium density chalk. |
| White Chalk (intact)        | ~15.3 (-8.0)                                               | ~7.3                         | Weak to medium strong medium density off-white CHALK (Grades C2 to C4) <sup>(4)</sup> .                                                                                               |
| Grey Chalk                  | ~25.5 (-18.2)                                              | ~10.2                        | Weak to medium strong medium to high density off-white/light grey CHALK (Grades C3 to A2) <sup>(4)</sup> .                                                                            |
| Upper Greensand             | >29.0 (<-21.7)                                             | >3.5                         | Weak to medium strong grey and light grey calcareous SILTSTONE                                                                                                                        |

Note: (1) Typical base level and thickness excluding extreme values.

(2) Denotes below ground level

(3) Locally loose or poorly consolidated ground was encountered which may be associated with infilled solution features in the White Chalk.

(4) Chalk grading in accordance with the CIRIA (2002) grading system

- (3) Groundwater levels measured in the monitoring wells installed as part of the ground investigation (CCGI, 2016) indicate groundwater level is between about 3.8 and 6.7 m below existing ground level, corresponding to reduced levels between about 0.9 and 0.8 m OD.

#### 1.4.3 Potential Ground Stability Hazards

- (1) An assessment of potential geological hazards that may give rise to adverse foundation or construction conditions, as supplied by the British Geological Survey from their National Geoscience Information Service, are presented in the desk study report (IM, 2014). The assessment is generated automatically based on digital geological maps and the scope and the accuracy is limited by the methods used to create the dataset and is therefore only indicative for the search area.
- (2) The BGS information has been reviewed and where considered necessary reassessed by PBA considering the specific information available for the Site with the potential hazards being rated as very low, low, moderate, high or very high in general accordance with the criteria given by the BGS Property Hazard rating system. The PBA assessment of the potential for geological hazards to be present on the Site is summarised below.

#### Summary of the Potential Geological Hazards

| Stability Hazard           | Hazard Rating | Comment                                                                                                                                                                                                                                           |
|----------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Shrinking or Swelling Clay | Very Low      | The Aeolian Deposits are expected to have a low to moderate volume change potential (NHBC, 2016). Due allowance will need to be made for the presence of trees and shrubs in the design of foundations and infrastructure founded on this strata. |
| Ground Dissolution         | Low           | See below                                                                                                                                                                                                                                         |



| Stability Hazard    | Hazard Rating | Comment                                                                                                                                                                                                                                                                              |
|---------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Compressible Ground | Very Low      | The ground conditions are such that significant layers of very soft compressible materials such as organic clay or peat are not expected to be present                                                                                                                               |
| Collapsible Ground  | Very Low      | The inclusion of gravel and the high measured bulk densities indicate the Aeolian Deposits have been reworked by natural geomorphological processes since deposition and as such a rapid reduction in volume is not expected to occur when they are loaded and saturated with water. |
| Running Sand        | Very Low      | The ground conditions are such that there is expected to be no significant potential for internal erosion associated with groundwater flows into excavations below the water table.                                                                                                  |

- (3) **Ground Dissolution** The Natural Cavities Database maintained and updated by PBA has been searched for relevant natural cavity records. No record was found of natural cavities within a 2.5 km radius of the Site. The absence of existing records does not, in itself, demonstrate that natural cavities are not present on the Site. Given the geology and geomorphological setting of the Site the hazard potential associated with such features is assessed to be **Low**.

#### 1.4.4 Characteristic Values

- (1) Characteristic values of geotechnical parameters as recommended in the Ground Investigation Report (PBA, 2016) for the design of the geotechnical elements of the scheme are summarised on the following table.

**Summary of Recommended Characteristic Values (PBA, 2016)**

| Strata                     | Bulk Unit Weight, kN/m <sup>3</sup> | Undrained Shear Strength, kPa | Effective Cohesion, kPa | Effective Friction <sup>(1)</sup> , deg | Drained Elastic Modulus <sup>(2)</sup> , MPa |
|----------------------------|-------------------------------------|-------------------------------|-------------------------|-----------------------------------------|----------------------------------------------|
| Aeolian Deposits           | 20.0                                | -( <sup>3</sup> )             | 0                       | 27 (24)                                 | 12                                           |
| Raised Beach Deposits      | 20.0                                | -                             | -                       | 39 (36)                                 | 15                                           |
| White Chalk <sup>(4)</sup> |                                     |                               |                         |                                         |                                              |
| - structureless            | 18.0                                | -                             | 10                      | 33                                      | 75                                           |
| - intact                   | 18.0                                | -                             | -                       | -                                       | 300                                          |

Notes (1) Values correspond to peak and (critical state) values of effective friction.

(2) Values correspond to vertical loading conditions.

(3) Given that any excess groundwater pressures are expected to rapidly dissipate, it is recommended that design for both short and long term loading conditions is carried out using effective stress strength parameters.

(4) Characteristic values for White Chalk have been selected from the recommendations given in CIRIA (2002)

- (2) To allow for seasonal variations in groundwater level, a groundwater level of 1.0 m OD (about 6.5 to 7.0 m below ground level) is recommended for design analysis.
- (3) The measured pH values and concentrations of water soluble sulphate measured on samples of soils recovered as part of the recent ground investigation (CC, 2016) indicate the soils on the Site may be classified as Class DS-1 as defined by BRE (2005). On this basis, it is considered appropriate to design concrete in contact with the ground for Class AC-1 conditions as defined by BRE (2005). The recommendations of BRE (2005) should be followed in the design of mixes for buried concrete for the classifications given.



## 2.0 Earthworks

### 2.1 Details of Earthwork Types

- (1) The scheme will require approach embankments to the proposed overbridges. The west side of the approach embankment to the south of the rail bridge will be constructed using conventional earth fill with side slopes of 1 vertical in 3 horizontal; the design of this embankment is presented in this section. The approach embankments to the north of the road bridge and between the road and rail bridges together with the east side of the approach embankment to the south of the rail bridge will be constructed using reinforced soil with a modular concrete facing system; the design of these embankments is presented in **Section 4.0** of this report.
- (2) In accordance with the guidance given in HD 41/03 (HA, 2003), conventional earthworks slopes less than 2.5 m high are not considered to be significant earthworks and have been excluded from this report.
- (3) The length and height of the conventional earth fill embankment are summarised on the following table.

**Summary of Proposed Conventional Earth Fill Embankment**

| Embankment                    | Chainage   | Length, m | Height, m  |
|-------------------------------|------------|-----------|------------|
| Southwest Approach Embankment | 360 to 440 | 80        | 6.1 to 2.5 |

- (4) The location of the proposed earthworks is shown on the Site Layout Plan presented as **Figure 2** of this report.
- (5) This section will outline the design calculations to be carried out to assess the stability of the proposed earthworks side slopes. These calculations are based on the ground conditions identified in the Ground Investigation Report (PBA, 2017) and the proposed conventional earthwork side slopes.

### 2.2 Cutting Stability

- (1) The proposed scheme does not include any lengths of cutting.

### 2.3 Embankment Stability

- (1) The design considerations for the proposed embankments will be the stability of the embankment side slopes and the bearing resistance and settlement of the founding soils. Drainage requirements are presented in **Section 2.3.4** of this report.
- (2) Design analyses have been carried out in general accordance with the requirements of BS EN 1997-1 (2004) and BS 6031 (2009) for the critical slope identified from inspection of the proposed slope profiles. The critical slope is considered to be the highest/steepest slope within the area of the scheme. The critical section identified is:
  - i) Chainage 380, selected as the critical section as it is the highest embankment slope within the area of the scheme.
- (3) The location of the critical section identified is shown on **Figure 2** Site Layout Plan whilst details of the critical section including slope height and gradient are shown on **Drawing 37827/2001/005/P01** included in **Appendix 8** of this report.



- (4) The ground conditions in the vicinity of the critical section, as revealed by the ground investigation (CC, 2016), comprise topsoil/subsoil overlying a sequence of Aeolian Deposits, Raised Beach Deposits and the White Chalk.
- (5) The fill material to be used to form the embankments will be determined in agreement with the appointed contractor for the works. Given the opposite side of the embankment will be constructed using reinforced soil with a modular concrete facing system, the design analyses has been carried out based on the basis that the fill material used to construct both sides of the approach embankment to the south of the rail bridge will comprise Class 6I or 6J (selected granular fill to reinforced soil and anchored earth structures) that is placed and compacted in accordance with the requirements of the Specification for Highway Works (HA, 2017). On this basis the stability of the side slope has been determined using the design parameters given in the following table.

#### Summary of Selected Characteristic Values

| Engineering Fill | Bulk Unit Weight, kN/m <sup>3</sup> | Undrained Shear Strength, kPa | Effective Cohesion, kPa | Effective Friction <sup>(1)</sup> , deg | Drained Elastic Modulus, MPa |
|------------------|-------------------------------------|-------------------------------|-------------------------|-----------------------------------------|------------------------------|
| Class 6I/6J      | 19.5                                | -                             | -                       | 36 (34)                                 | -                            |

Notes 1) Values correspond to peak and (critical state) values of effective friction.

- (6) Other design assumptions together with details of the partial factors adopted in the design analysis are presented on the slope stability calculations presented in **Appendix 1** of this report.

### 2.3.1 Stability of Side Slopes

- (1) The analyses were carried out using the commercial slope stability computer program GGU Stability v10.56.
- (2) Results of the analyses are presented on the slope stability calculations presented in **Appendix 1** of this report and are summarised in the following table.

#### Summary of Slope Stability Analyses

| Slope        | Condition              | Maximum Utilisation Factor <sup>(1)</sup> |      |
|--------------|------------------------|-------------------------------------------|------|
|              |                        | Com1                                      | Com2 |
| Chainage 380 | Drained <sup>(2)</sup> | 0.45                                      | 0.56 |

Note (1) It should be noted that GGU stability present the results of the stability analysis as utilisation factors defined as the ratio of the destabilising and stabilising effects, as such a utilisation factor less than unity is considered satisfactory.  
(2) Given that any excess groundwater pressures are expected to rapidly dissipate, design for both short and long term loading conditions is carried out using effective stress strength parameters.

- (3) Results of analysis indicate the proposed embankment constructed with a side slope of 1 vertical in 3 horizontal have adequate resistance with regard to potential slope instability.

### 2.3.2 Bearing Resistance

- (1) The slope stability analysis presented in **Section 2.3.1** of this report includes an assessment of potential circular failure of the founding soils under the imposed loads of the embankment.
- (2) The results of the analysis indicate that such failures do not represent the critical failure mode and that the founding soils have adequate resistance with regard to potential failure of the founding soils.

### 2.3.3 Settlement

- (1) Construction of the proposed embankment will result in a net loading and settlement of the ground. Assuming the embankment imposes an additional load on the ground of 115 kPa over a nominal width of 20 m and length of 50 m, long term settlements determined using conventional consolidation theory are of the order of 15 and 25 mm at the edge and in the centre of the loaded area, respectively. Given that any excess groundwater pressures are expected to rapidly dissipate the settlement will largely occur during the construction works.
- (2) Long term differential settlements following construction of the proposed embankments are determined to be less than 1 vertical in 1000 horizontal. The carriageways are designed to the UK standard minimum cross fall of 2.5% (2.5 vertical in 100 horizontal) and longitudinal gradient of 0.5% (1 vertical in 200 horizontal). Given that the long term differential settlements are significantly less than the cross falls and longitudinal gradients of the proposed carriageways they are not considered to be of concern to the proposed works.
- (3) Results of the analyses are presented on the settlement calculations presented in [Appendix 1](#) of this report.

### 2.3.4 Drainage Requirements

- (1) Embankment drainage will be required to limit long term absorption of water, which otherwise would tend to increase the pore pressure in the fill and reduce the factor of safety against slope failure, perhaps ultimately resulting in failure of the slope.
- (2) Given the fill material to be used to construct the embankment is expected to comprise selected granular fill and the depth to groundwater on the Site, a coarse granular starter layer at the base of the embankment to limit water absorption by capillary action from the founding soils is not deemed necessary. Similarly, a drainage channel along the bottom of the side slopes is not deemed necessary. On this basis, drainage requirements will be limited to the vegetation of the side slopes to limit water absorption from precipitation and run off on these slopes. In addition, conventional drainage channels are to be installed to collect run off from the carriageway.

## 3.0 Highway Structures

### 3.1 Details of Highway Structure Types

- (1) The proposed highway structures included in this section comprise:
  - i) Toddington Lane Overbridge
  - ii) West Coastway Railway Line Overbridge
  - iii) Allotment Underpass

### 3.2 Bridge Structures

- (1) The proposed overbridges comprise semi-integral bridges with single clear spans of 29.5 m for the rail bridge and 17.0 m for the road bridge. The wing walls will be monolithic with the abutments to support the continuation of the containment parapets. The general arrangements of the proposed structures are shown on **Drawings 35944/1501/001** and **35944/1502/001** included in **Appendix 8** of this report.
- (2) The natural ground conditions in the vicinity of the proposed bridge structures, as revealed by the ground investigation (CC, 2016), comprise topsoil/subsoil overlying a sequence of Aeolian Deposits, Raised Beach Deposits and the White Chalk. As noted in **Section 1.4.2**, no information on the ground conditions in the central part of the Site is currently available and further intrusive ground investigation works will need to be carried out to verify the actual ground conditions in this part of the Site.
- (3) The proposed bridge structures will be founded on single monolithic spread foundation to each abutment and associated wing walls. Founding level will be at 5.60 m OD for the rail bridge and 4.95 m OD for the road bridge, that is at about the interface of the Aeolian Deposits and the underlying Raised Beach Deposits. Locally Aeolian Deposits may be present below formation level; however, any such deposits are expected to be of limited extent and thickness and may be neglected in the design of the proposed bridge structure. In this regard, any soft or loose soil encountered at foundation level will be removed and replaced with well compacted engineered fill with similar properties to the surrounding ground. Given the potential for solution features to be present all foundations are designed assuming a loss of ground support over a plan dimension of 3.0 m to allow for any future development of solution features.
- (4) This section outlines the design calculations carried out to assess the stability of the proposed bridge structures. The design calculations are presented in **Appendix 2** of this report together with copies of the Form C: Highway Structure Summary Information sheets for each structure.
- (5) These calculations are based on the ground conditions identified in the Ground Investigation Report (PBA, 2016) and the geometry of the proposed structures. The design calculations presented are limited to the consideration of the bearing and sliding resistance and settlement of the founding soils to the proposed bridge structures.

#### 3.2.1 Bearing and Sliding Resistance

- (1) The bearing and sliding resistances of the proposed bridge structures have been determined using the design procedures recommended in BS 8004 (2015). Given the limited thickness of the Raised Beach Deposits relative to the plan dimensions of the proposed foundations, the presence of this material has been neglected and the bearing and sliding resistances have been determined assuming the structure is founded directly on the underlying structureless chalk. Given the lower design parameters selected for the structureless chalk, this assumption is deemed to be conservative.



- (2) The lateral soil pressures acting on the rear of the proposed bridge structures have been determined taking into consideration the method of construction, the fill material specified for the backfill to the structures, the method of placement of the fill material together with the overburden pressure acting on the fill. The backfill to the structures is to comprise Class 6N/6P selected granular material that is placed and compacted in accordance with the requirements of the Specification for Highway Works (HA, 2017). On this basis the lateral soil pressures acting on the rear of the proposed bridge structures have been determined using the procedures given in BS 8002 (2015) using the design parameters given in the following table.

#### Summary of Selected Characteristic Values

| Engineering Fill | Bulk Unit Weight, kN/m <sup>3</sup> | Undrained Shear Strength, kPa | Effective Cohesion, kPa | Effective Friction <sup>(1)</sup> , deg | Drained Elastic Modulus, MPa |
|------------------|-------------------------------------|-------------------------------|-------------------------|-----------------------------------------|------------------------------|
| Class 6N/6P      | 19.5                                | -                             | -                       | 38 (34)                                 | -                            |

Notes 1) Values correspond to peak and (critical state) values of effective friction.

- (3) Results of the analysis to determine the bearing and sliding resistance of the formation are presented on the design calculations presented in **Appendix 2<sup>1</sup>** of this report and are summarised in the following table.

#### Summary of Bearing Resistance

| Structural Element                    | Traffic Load Group <sup>(1)</sup> | Analysis Type                            | Bearing Pressure, kPa | Bearing Resistance <sup>(2)</sup> , kPa | Utilisation Factor |
|---------------------------------------|-----------------------------------|------------------------------------------|-----------------------|-----------------------------------------|--------------------|
| West Coastway Railway Line Overbridge | Group 1a                          | ULS Com1 <sub>VH</sub> <sup>(3, 4)</sup> | 271                   | 2328                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub> <sup>(3, 5)</sup>  | 241                   | 2335                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 208                   | 1033                                    | 0.20               |
|                                       | Group 2                           | ULS Com1 <sub>VH</sub>                   | 268                   | 2280                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 238                   | 2279                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 205                   | 1010                                    | 0.20               |
|                                       | Group 5                           | ULS Com1 <sub>VH</sub>                   | 275                   | 2332                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 245                   | 2340                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 211                   | 1036                                    | 0.20               |
|                                       | Group 6                           | ULS Com1 <sub>VH</sub>                   | 260                   | 2300                                    | 0.11               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 230                   | 2303                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 198                   | 1020                                    | 0.19               |
| Toddington Lane Overbridge            | Group 1a                          | ULS Com1 <sub>VH</sub> <sup>(3, 4)</sup> | 266                   | 2232                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub> <sup>(3, 5)</sup>  | 230                   | 2261                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 206                   | 974                                     | 0.21               |
|                                       | Group 2                           | ULS Com1 <sub>VH</sub>                   | 266                   | 2188                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 228                   | 2208                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 203                   | 953                                     | 0.21               |
|                                       | Group 5                           | ULS Com1 <sub>VH</sub>                   | 272                   | 2238                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 235                   | 2268                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 209                   | 978                                     | 0.21               |
|                                       | Group 6                           | ULS Com1 <sub>VH</sub>                   | 261                   | 2207                                    | 0.12               |
|                                       |                                   | ULS Com1 <sub>M</sub>                    | 223                   | 2231                                    | 0.10               |
|                                       |                                   | ULS Com2                                 | 199                   | 963                                     | 0.21               |

<sup>1</sup> Calculations presented for Traffic Load Group 5 only

### Summary of Sliding Resistance

| Structural Element                    | Traffic Load Group <sup>(1)</sup> | Analysis Type          | Sliding Force, kPa | Sliding Resistance <sup>(2)</sup> , kPa | Utilisation Factor |
|---------------------------------------|-----------------------------------|------------------------|--------------------|-----------------------------------------|--------------------|
| West Coastway Railway Line Overbridge | Group 1a                          | ULS Com1 <sub>VH</sub> | 28                 | 171                                     | 0.16               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 22                 | 152                                     | 0.14               |
|                                       |                                   | ULS Com2               | 26                 | 105                                     | 0.25               |
|                                       | Group 2                           | ULS Com1 <sub>VH</sub> | 30                 | 169                                     | 0.18               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 24                 | 150                                     | 0.16               |
|                                       |                                   | ULS Com2               | 27                 | 103                                     | 0.26               |
|                                       | Group 5                           | ULS Com1 <sub>VH</sub> | 28                 | 173                                     | 0.16               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 22                 | 154                                     | 0.14               |
|                                       |                                   | ULS Com2               | 26                 | 106                                     | 0.25               |
|                                       | Group 6                           | ULS Com1 <sub>VH</sub> | 29                 | 164                                     | 0.18               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 22                 | 145                                     | 0.15               |
|                                       |                                   | ULS Com2               | 26                 | 100                                     | 0.26               |
| Toddington Lane Overbridge            | Group 1a                          | ULS Com1 <sub>VH</sub> | 36                 | 169                                     | 0.21               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 27                 | 145                                     | 0.19               |
|                                       |                                   | ULS Com2               | 33                 | 104                                     | 0.32               |
|                                       | Group 2                           | ULS Com1 <sub>VH</sub> | 37                 | 168                                     | 0.22               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 29                 | 144                                     | 0.20               |
|                                       |                                   | ULS Com2               | 34                 | 103                                     | 0.33               |
|                                       | Group 5                           | ULS Com1 <sub>VH</sub> | 36                 | 172                                     | 0.21               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 27                 | 148                                     | 0.18               |
|                                       |                                   | ULS Com2               | 33                 | 106                                     | 0.31               |
|                                       | Group 6                           | ULS Com1 <sub>VH</sub> | 36                 | 165                                     | 0.22               |
|                                       |                                   | ULS Com1 <sub>M</sub>  | 28                 | 141                                     | 0.20               |
|                                       |                                   | ULS Com2               | 33                 | 101                                     | 0.33               |

Note (1) BS EN 1991-2:2003 traffic load group

(2) Bearing and sliding resistances have been reduced to allow for a loss of ground support over a plan dimension of 3.0 m to allow for any future development of solution features

(3) ULS denotes Ultimate Limit State

(4) Subscript VH denotes maximum vertical and horizontal loading

(5) Subscript M denotes maximum moment

- (4) The design analyses indicate the proposed foundations have adequate bearing and sliding resistance.

### 3.2.2 Settlement

- (1) Construction of the proposed overbridges will result in a net loading and settlement of the ground. From the design equations presented in **Appendix 2** the proposed road and rail bridges will impose additional loads on the ground of about 210 kPa over an effective width of 12.0 m and length of 20.0 m. Calculated long term settlements determined using conventional elastic analysis are of the order of 15 mm. Given that any excess groundwater pressures are expected to rapidly dissipate the settlement will largely occur during the construction works.
- (2) Long term differential settlements following construction of the proposed overbridges are determined to be less than 1 vertical in 1000 horizontal. The carriageways are designed to the UK standard minimum cross fall of 2.5% (2.5 vertical in 100 horizontal) and longitudinal gradient of 0.5% (1 vertical in 200 horizontal). Given that the long term differential settlements are significantly less than the cross falls and longitudinal gradients of the proposed carriageways they are not considered to be of concern to the proposed works.

- (3) Results of the analyses are presented on the settlement calculations presented in **Appendix 2** of this report.

### **3.3 Underpass Structure**

- (4) The proposed underpass structure comprises proprietary multiple pre-cast reinforced concrete box units with pre-cast reinforced concrete headwalls and wing wall at the west end. At the east end the underpass will pass through the concrete facing panels to the reinforced soil embankment. Details of the proposed structure are given on **Drawing 35944/1503/ 001** included in **Appendix 8** of this report.
- (5) The natural ground conditions in the vicinity of the proposed underpass structure, as revealed by the ground investigation (CC, 2016), comprise topsoil/subsoil overlying a sequence of Aeolian Deposits, Raised Beach Deposits and the White Chalk. The proposed underpass extension will be founded on the Aeolian Deposits at an elevation of about 6.9 m OD.
- (6) This section will outline the design calculations to be carried out to assess the stability of the proposed underpass structure. It should be noted that the final detailed design of the proprietary pre-cast structure will be carried out at a later date as part of a design and build contract to be commissioned by the selected main contractor for the scheme. The selected main contractor will appoint a sub-contractor to design and manufacture to be the pre-cast units. The sub-contractor's design will be reviewed by PBA and the stability of the proposed underpass structure will be assessed at this time. This analysis will be included when available in a revised version of this report.



## 4.0 Strengthened Earthworks

### 4.1 Details of Strengthened Earthworks

- (1) The proposed scheme will require approach embankments to the road and rail bridge. The approach embankments to the north of the road bridge, between the road and rail bridges and to the southeast of the rail bridge will be constructed using reinforced soil with a modular concrete facing system. The approach embankment to the southwest of the rail bridge will be constructed using conventional earth fill with side slopes of 1 vertical in 3 horizontal; the design of this embankment is presented in **Section 2.0** of this report.
- (2) In accordance with the guidance given in BD 2/12 (HA, 2012), earth retaining structures with an effective retained height of greater than 1.5 m but less than 2.0 m have been classified as Category 0 and have been excluded from this report; earth retaining structures with an effective retained height of less than 1.5 m are not deemed to be highway structures as defined in BD 2/12 (HA, 2012).
- (3) The length and height of the reinforced soil embankments are summarised on the following table.

**Summary of Proposed Reinforced Soil Embankments**

| Embankment              | Chainage   | Length, m | Height, m  |
|-------------------------|------------|-----------|------------|
| North Approach Walls    | 90 to 245  | 155       | 2.0 to 6.6 |
| Central Approach Walls  | 262 to 330 | 68        | 6.1 to 7.3 |
| Southeast Approach Wall | 360 to 450 | 90        | 6.1 to 2.0 |

- (4) The location of the proposed reinforced soil embankments are shown on the Site Layout Plan presented as **Figure 2** of this report. The general arrangements of the proposed reinforced soil embankments are shown on **Drawing 35944/3501/004** included in **Appendix 8** of this report.
- (5) This section will outline the design calculations to be carried out to assess the global stability of the proposed reinforced soil embankments. It should be noted that the internal stability of the reinforced soil embankments is to be assessed at a later date as part of a design and build contract. The selected main contractor will appoint a sub-contractor to design and manufacture the proprietary system of reinforced soil with a modular concrete facing. The output of sub-contractor's design will be reviewed by PBA and the global stability of the proposed reinforced soil embankments will be assessed at this time. This analysis will be included when available in a revised version of this report.

## 5.0 Drainage

### 5.1 Details of Drainage

- (1) The drainage to the proposed works is limited to the installation of drainage channels to collect run-off from the carriageway.

## 6.0 Pavement Design, Subgrade and Capping

### 6.1 Details of Pavements

- (1) The proposed scheme will result in pavement being formed on the proposed fill to the approach embankments, the proposed backfill to the proposed overbridges and the existing near-surface soils.

#### 6.1.1 Pavements on Engineered Fill Materials

- (1) As noted in **Section 2.3** of this report, the fill material to be used to form the embankments will be determined in agreement with the appointed contractor for the works and for the purposes of design analyses it has been assumed that the fill material will comprise Class 6I/6J selected granular fill. As noted in **Section 3.2** of this report, the back fill to the proposed structures will comprise Class 6N/6P selected granular fill. These selected granular fill will be placed and compacted in accordance with the requirements of the Specification for Highway Works (HA, 2017).
- (2) The proposed fill to the embankments and backfill to the proposed overbridges will form a suitable formation for the proposed pavements. Design CBR values have been selected from consideration of the long term equilibrium values proposed by IAN 73/06 (HA, 2009). On this basis, the design CBR value of the proposed fill materials has been taken to be 15 per cent.

#### 6.1.2 Pavements on Existing Natural Ground

- (1) The near-surface Aeolian Deposits comprise soft/firm sandy CLAY/SILT. As part of the ground investigations for the Hampton Park development (IM, 2014 and 2015), CBR values typically in the range 0.25 to 0.75% were determined for the Aeolian Deposits; these values were determined by laboratory testing of unsoaked samples of the as-received material compacted using a 2.5 kg rammer; the tests were carried out without any surcharge load. As part of the ground investigation for the proposed works (CCGI, 2016), CBR values typically greater than 5% were determined for the Aeolian Deposits; these values were determined on the in-situ soils using a dynamic cone penetrometer. For comparison, determined values of plasticity index of the Aeolian Deposits are typically in the range 15 to 25 for which IAN 73/06 (HA, 2009) indicates long term equilibrium CBR values would be expected to be in the range 4 to 5%.
- (2) It is expected that the discrepancy between the laboratory determined CBR values and expected long term equilibrium CBR values is attributable to the absence of a surcharge applied to the test specimen as part of the laboratory tests. On this basis, the low CBR values determined as part of the ground investigations for the Hampton Park development (IM, 2014 and 2015) are not considered to be representative of the long term equilibrium CBR value of the Aeolian Deposits and a design CBR value of 3% is recommended for these deposits.
- (3) Notwithstanding the recommended design CBR value, to allow for the possible presence of locally loose or poorly consolidated ground which may be associated with infilled solution features in the White Chalk, pavements on the existing natural ground are to be design for a lower CBR value of 0.5%.

### 6.2 Pavement Design

- (1) Pavement design has been carried out in accordance with the requirements of IAN 73/06 (HA, 2009) and the pavement design is presented on **Drawing 35944/2001/004** included in **Appendix 8** of this report.



- (2) In accordance with the requirements of IAN 73/06 (HA, 2009), the Contractor is to determine the in-situ CBR value using a dynamic cone penetrometer before foundation construction starts to verify that the value is equal to or greater than the design CBR value. Any redesign of the pavement is to be confirmed following receipt of Contractor's CBR values.

## 7.0 Assessment of Potential Contamination

### 7.1 Assessed Geoenvironmental Risk

- (1) A detailed assessment of potential contamination is presented in the Ground Investigation Report prepared for this scheme (PBA, 2016). The assessment indicates that any potential contaminants in the ground or groundwater are unlikely in by themselves to represent a particular risk to human health, controlled waters or ecology and wildlife, associated with the proposed scheme. On this basis, no specific remediation and/or mitigation measures will be required to limit the potential risks associated with land contamination.
- (2) Notwithstanding this assessment, appropriate protective clothing and equipment are to be worn by site workers; and good standards of hygiene adopted to prevent prolonged skin contact, inhalation and ingestion of soils during construction. In addition, the methods of working are to be selected to limit the potential for air-borne dust to arise associated with the excavation and disturbance of the soils present on the Site.

### 7.2 Management of Unexpected Sources of Contamination

- (3) There is a possibility that unexpected sources of contamination may be encountered during the site clearance or ground works. Should visual and olfactory examination of any unusual solid materials or liquids encountered during the construction works identify areas of contamination specific management procedures will be adopted. These procedures will allow for the short-term storage of the suspected material in stockpiles and/or storage tanks while verification testing for potential contamination is carried out. The storage area will be contained to ensure that contamination does not migrate and affect other areas of the site.
- (4) Once the nature, location and extent of the unexpected contamination have been identified appropriate remediation or mitigation measures will be adopted. Although these cannot be identified at this time the main emphasis will be on methods of isolating or treating the affected materials. If such measures are unlikely to be practical or effective in mitigating the risk from the identified contamination, consideration will be given to excavating and removing the contaminated material from site for disposal or treatment at a suitably licensed facility.
- (5) Where remediation or mitigation of unexpected contaminants is required, an implementation and verification process will be established to identify the remediation activities required and to confirm that the remediation has been undertaken correctly. As part of this process, remediation objectives will be identified and remediation criteria selected for measuring compliance against these objectives in consultation with the Local Authority and other statutory consultees.

## 8.0 Ground Treatment Including Treatment of any Underground Voids etc

### 8.1 Details of Ground Treatment

- (1) The assessment of potential geological hazards presents in **Section 1.4.3** of this report assessed the potential for natural solution features or mining cavities to be present on the Site to be **Low**.
- (2) To mitigate the risk of any natural solution features and mining cavities, the formation to all works is to be inspected by a qualified and experienced geotechnical engineer prior to constructing the works. Particular care is to be given to identifying any features that may be indicative of the presence of any solution features and mining cavities, such as:
  - i) Voids in the ground.
  - ii) Collapsed ground that may appear as depressions or hollows at the ground surface.
  - iii) Different ground conditions to those expected, e.g. areas of infill or disturbed ground.
  - iv) Rapid changes of soil colour or soil type over short horizontal distances
  - v) Vertical interfaces between different soils types.
- (3) Should inspection of the formation identify any potential solution features or mining cavities they will be investigated by appropriate intrusive ground investigation techniques. If the presence of solution features or mining cavities is confirmed appropriate techniques will be adopted to infill any voids and stabilise any soft or loose infill materials. The method of treatment cannot be identified at this time but may include techniques such as:
  - i) Placement of two layers of geogrid reinforcement laid perpendicular to each other to form a reinforced soil foundation to the geotechnical feature.
  - ii) Excavation of all soft and loose material from the feature and backfilling of the feature with a granular material, sealed over by a layer of clay or lean-mix concrete.
  - iii) Use of infill and/or compaction grouting to fill any voids and/or compact any soft or loose material within the feature with a reinforced concrete cap.
  - iv) Any combination of these techniques.
- (4) In addition to the works to stabilise any solution features or mining cavities. Any soft, loose or damaged areas present in the formation are to be removed and replaced with well compacted engineered fill with similar properties to the surrounding ground. The formation is then to be rolled to re-compact any soils disturbed during excavation.
- (5) The requirements to investigate and treat any natural solution features or mining cavities are presented in **Appendix 6/11** of the specification for the works included in **Appendix 6** of this report.



## 9.0 Specification Appendices

- (1) Series 600 and related specification appendices are included in [Appendix 6](#) of this report.

## 10.0 Instrumentation and Monitoring

### 10.1 Details of Instrumentation and Monitoring

- (1) The design calculations for the proposed overbridge presented in **Section 3.0** of this report predict settlements to be of the order of 15 to 20 mm. Given that any excess groundwater pressures are expected to rapidly dissipate the settlement will largely occur during the construction works. Notwithstanding this assessment, it is proposed to carry out precision levelling of the proposed monolithic abutments and wing walls at weekly intervals for a period of four weeks to demonstrate that long-term settlements are effectively complete.
- (2) The requirements for precision monitoring are presented in **Appendix 6/12** of the specification for the works included in **Appendix 6** of this report.

## 11.0 Geotechnical Risk Register

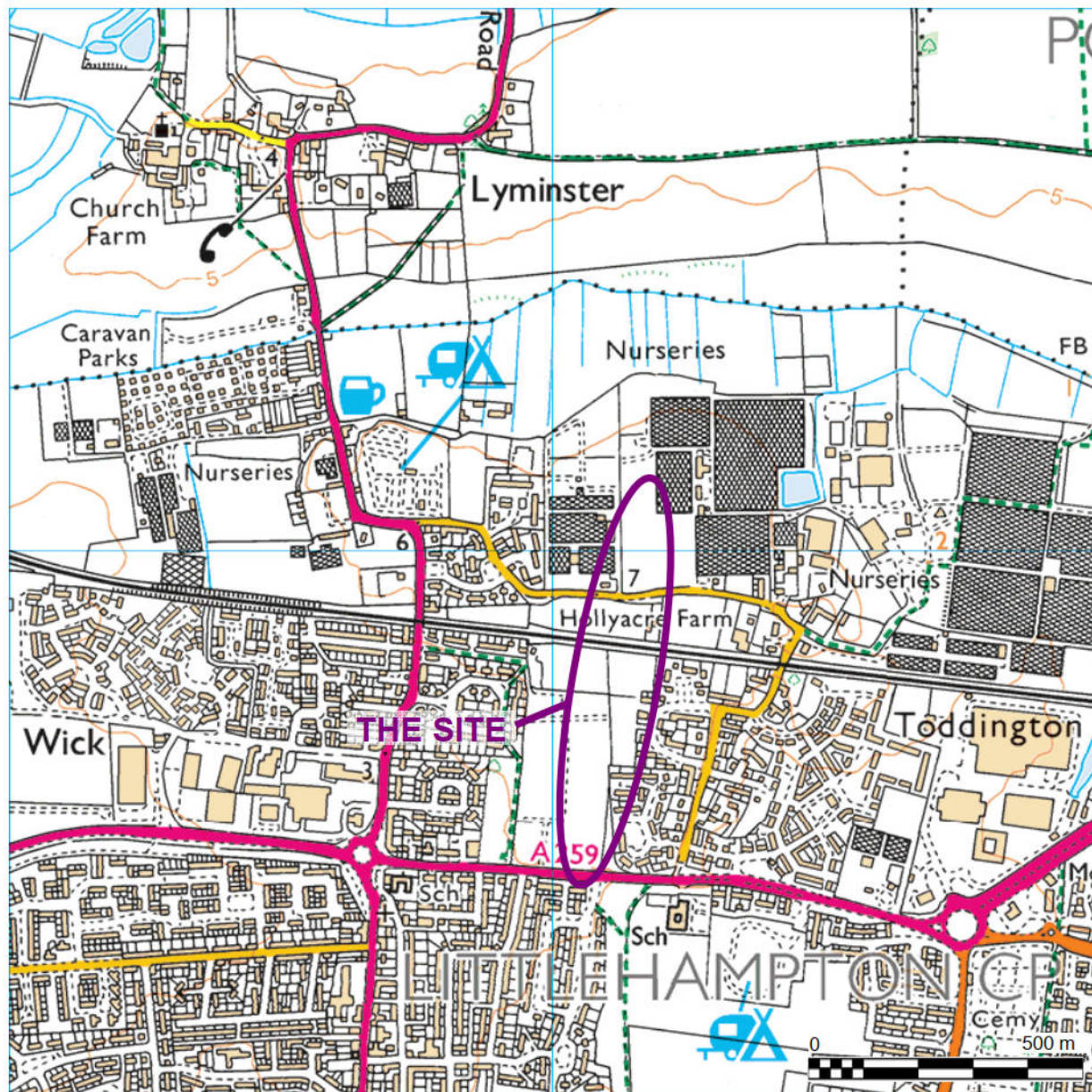
- (1) Based on a review of available information and the results of the ground investigations, a geotechnical risk register has been prepared to identify and rate the potential risks to the project for each of the principal geotechnical hazards identified for the proposed scheme. The main aim of the risk register is to allow for planning to prevent the risks occurring or to mitigate their consequences. The risk register is included as [Appendix 7](#).
- (2) The risk register gives a description of the activity and potential geotechnical hazard, the consequence should the hazard occur and mitigation measures and actions to be taken to limit the impact of the hazard on the proposed scheme. The risk register also includes an assessment of the likelihood of occurrence and the impact on the project should the hazard occur.
- (3) Rating of the risk has been carried out so that greater effort can be spent in planning the prevention and mitigation of those risks considered more serious in terms of the likelihood of their occurrence and their impact on the project if they do occur.
- (4) In relation to each risk there should be set out a simple action plan for the prevention/mitigation of the relevant risk. Any action plan should be drawn up applying the principles of "SMART", that is actions should be Specific, Measurable, Agreed, Realistic and Time-bounded. A statement of the objective of the relevant action should be given as this will enable subsequent reviews of the risk register to consider whether any further action is necessary to achieve the objective.
- (5) Responsibility for the management of each risk should be allocated to a particular party or organisation as indicated on the risk register.
- (6) A review of the proposed scheme and project risks, as given in the geotechnical risk register, has been carried out to determine the geotechnical classification of the project and thus the requirement for geotechnical certification. On the basis of this review, the proposed scheme has been classified as a Geotechnical Category 2 Project, that is a project including conventional types of earthworks, structures and foundations with no abnormal risks or unusual or exceptionally difficult ground conditions.
- (7) It should be noted that both the geotechnical risk register and the geotechnical category of the scheme are considered as live and can be changed and updated as more information becomes available. The designated category of the scheme and the geotechnical risk register should be reviewed as more information becomes available.

## 12.0 References

- BRE (2005) Concrete in aggressive ground. Special Digest 1, Building Research Establishment, Garston, Herts.
- BS 8002 (2015) Code of practice for earth retaining structures. British Standards Institution, London.
- BS 8004 (2015) Code of practice for foundations. British Standards Institution, London.
- BS EN 1997-1 (2004) Eurocode 7 - Geotechnical design - Part 1: General rules. British Standards Institution, London.
- BS EN 1997-2 (2007) Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing. British Standards Institution, London.
- CC (2016) Factual Report on Ground Investigation: Proposed Enabling Infrastructure, North Littlehampton. Report C5300, CC Ground Investigations Ltd: Innsworth, Gloucester.
- CIRIA (2002) Engineering in Chalk. Report C574, Construction Industry Research and Information Association, London.
- HA (2008) Design Manual for Roads and Bridges, Volume 4 – Geotechnical and Drainage. Section 1 – Earthworks, Part 2 - Managing Geotechnical Risk. Document HD 22/08, Highways England (formerly The Highways Agency), Birmingham.
- HA (2009) Design Guidance for Road Pavement Foundations (Draft HD25). Interim Advice Note 73/06 rev 1, Highways England (formerly The Highways Agency), Birmingham.
- HA (2017) Manual of Contract Documents for Highway Works Volume 1: Specification for Highway Works. Highways England (formerly The Highways Agency), Birmingham.
- IM (2014) Geo-environmental Assessment, North Littlehampton. Report GEA-18426-14-69, Merebrook Consulting: Belper, Derbyshire.
- IM (2015) Additional Geotechnical Assessment, North Littlehampton. Report GR-18246E-15-167 rev. A, Idom Merebrook: Belper, Derbyshire.
- NHBC (2016) NHBC Standards. National House Building Council, Amersham, Buckinghamshire.
- PBA (2016) Ground Investigation Report – Stage 1, Proposed Enabling Infrastructure, North Littlehampton. Report 35944/3500/r01/rev 0, Peter Brett Associates LLP, Reading, Berkshire.



## FIGURES



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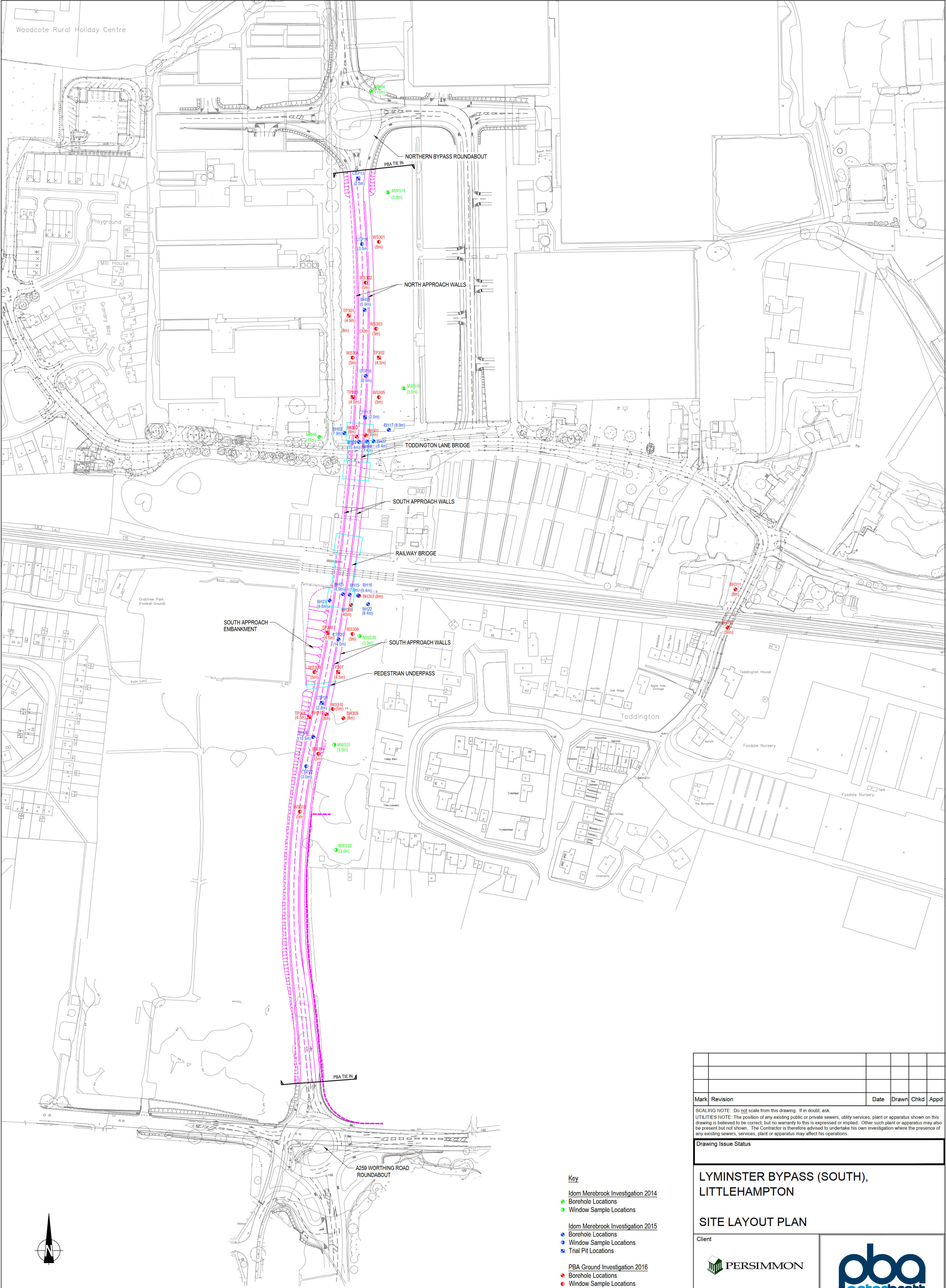
National Grid Reference TQ 031 039  
Coordinates N50:49:32 W0:32:13  
Nearest Post Code BN17 7GD



## SITE LOCATION PLAN

**LYMINSTER BYPASS (SOUTH),  
LITTLEHAMPTON**





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Key

- Idom Merebrook Investigation 2014
  - Borehole Locations
  - Window Sample Locations
- Idom Merebrook Investigation 2015
  - Borehole Locations
  - Window Sample Locations
  - Trial Pit Locations
- PBA Ground Investigation 2016
  - Borehole Locations
  - Window Sample Locations
  - Trial Pit Locations

| Mark | Revision | Date | Drawn | Chkd | Appd |
|------|----------|------|-------|------|------|
|      |          |      |       |      |      |

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.  
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake his own investigation where the presence of any existing sewers, services, plant or apparatus may affect his operations.

Drawing Issue Status

LYMINSTER BYPASS (SOUTH),  
LITTLEHAMPTON

SITE LAYOUT PLAN

|                   |          |          |                                                                                                                                                                        |  |
|-------------------|----------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Client            |          |          | <br><br>Offices throughout the UK and Europe<br><a href="http://www.peterbrett.com">www.peterbrett.com</a><br>© Peter Brett Associates LLP<br>READING<br>T: [REDACTED] |  |
| Date of 1st Issue | Designed | Drawn    |                                                                                                                                                                        |  |
| A1 Scale          | Checked  | Approved |                                                                                                                                                                        |  |
| Drawing Number    | Revision |          |                                                                                                                                                                        |  |
| FIGURE 2          |          |          | -                                                                                                                                                                      |  |



## APPENDIX 1

### Earthworks Design Calculations



## SOUTHWEST APPROACH EMBANKMENT

## SLOPE STABILITY ASSESSMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

### Existing Conditions

In the area of the Site, the West Coastway Railway Line and Toddington Lane are aligned approximately east to west running along a low ridge between the seafront about 2.5 km to the south and the valley of the Black Ditch about 0.5 km to the north.

### Proposed Works

The principal earthwork elements of the scheme comprise approach embankments to the proposed road and rail bridges. The proposed approach embankments are to be constructed above existing ground level with the approach embankment to the southwest of the rail bridge constructed using conventional earth fill with side slopes of 1 vertical in 3 horizontal. Other approach embankments are to be constructed using reinforced soil with a modular concrete facing system.

Details of the proposed earthworks are given on the following drawings:

PBA Drawings 35944/2001/001

Proposed Road Alignment and Contours

### Ground Conditions (Ref: PBA Report 35944/3500/r01/rev0, Dec 2016)

| Strata                | Base Level<br>m OD <sup>(1)</sup> | Description                                                 |
|-----------------------|-----------------------------------|-------------------------------------------------------------|
| Aeolian Deposits      | 5.1                               | Firm orange brown sandy CLAY/SILT                           |
| Raised Beach Deposits | 3.0                               | Medium dense brown clayey SAND with a little gravel         |
| White Chalk           | -8.0                              | Off white clayey/sandy SILT with some gravel size fragments |

Notes (1) Natural ground levels in the area of the Site are between about 7.5 and 8.0 m OD

### Groundwater Conditions (Ref: PBA Report 35944/3500/r01/rev0, Dec 2016)

Design groundwater level is taken to be 1.0 m OD.

### Ground Properties (Ref: PBA Report 35944/3500/r01/rev0, Dec 2016)

| Strata                                       | Bulk<br>Unit Wt $\gamma_k$<br>(kN/m <sup>3</sup> ) | Shear<br>Strength<br>$s_{uk}$ (kPa) | Effective<br>Cohesion $c'_k$<br>(kPa) | Friction<br>Angle $\phi_{p,k}'$<br>(degrees) |
|----------------------------------------------|----------------------------------------------------|-------------------------------------|---------------------------------------|----------------------------------------------|
| Embankment Fill (proposed) <sup>(1)(2)</sup> | 19.5                                               | -                                   | -                                     | 36                                           |
| Aeolian Deposits                             | 20.0                                               | -(3)                                | 0                                     | 27                                           |
| Raised Beach Deposits                        | 20.0                                               | -                                   | -                                     | 39                                           |
| White Chalk                                  | 18.0                                               | -                                   | 10                                    | 33                                           |

(1) Properties of Engineered Fill to be used to construct the embankments have been selected on the basis that the material comprises Selected Granular Fill (Class 6I/6J) that is placed and compacted in accordance with the requirements of the Specification for Highway Works.

(2) To allow for effects of surface vegetation, a 0.5 m thick surface layer of Embankment Fill is assumed to have an increased cohesion of 3 kPa

(3) Given that any excess groundwater pressures are expected to rapidly dissipate, design for both short and long term loading conditions has been carried out using effective stress strength parameters.

SOUTHWEST APPROACH EMBANKMENT

SLOPE STABILITY ASSESSMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## External Slip Surfaces

### Assumptions

1. The formation to be compacted and any soft or damaged areas excavated and replaced with acceptable material having the same characteristics and strength as the surrounding material.
2. The pavement to be constructed using selected granular materials with an effective friction angle of 36 degrees or greater.
3. The fill materials to be placed and compacted in accordance with an engineering specification.
4. The side slopes to the embankment to be constructed no steeper than 1 vertical in 3 horizontal.
5. A surface cover of grass and herbs will be established on the embankment side slopes to provide a continuous ground cover and an extensive fibrous and branching root system.
6. Drainage channels to collect run off from the carriageway, and vegetation to the side slopes will be sufficient to limit water absorption from precipitation and run off on these slopes and thereby prevent any increase in the pore pressures in the fill.
7. To allow for the traffic and pedestrian loading surcharges of 20 and 5 kPa will be applied in the area of the proposed carriageway and pavement in accordance with Cl 5.8.2.1 (b) of BS 5400 Part 2.

### Method of Analysis

1. Consider circular modes of failure to identify critical failures using GGU Stability v10.56.
2. Consider design loads cases and partial factors for Combination 1 and 2 situations.
3. Given that any excess groundwater pressures are expected to rapidly dissipate, design for both short and long term loading conditions is carried out using effective stress strength parameters.

### Partial Factors<sup>(3)</sup> (Ref: BS EN 1997-1:2004, Table A.NA.4)

| Resistance Factors               | Com1 | Com2 | Load Factors          | Com1 | Com2              |
|----------------------------------|------|------|-----------------------|------|-------------------|
| Friction Angle, $\gamma_{\phi'}$ | 1.00 | 1.25 | Permanent, $\gamma_G$ | 1.35 | 1.00 unfavourable |
| Eff Cohesion, $\gamma_c$         | 1.00 | 1.25 |                       | 1.00 | 1.00 favourable   |
| Undrained Shear, $\gamma_{su}$   | 1.00 | 1.40 | Variable, $\gamma_Q$  | 1.50 | 1.30 unfavourable |
|                                  |      |      |                       | 0.00 | 0.00 favourable   |

### Results of Analysis

From inspection, the critical slope has been identified to be Ch380 as it is the highest embankment slope within the area of the scheme.

| Slope        | Condition | Run     | Maximum Utilisation Factor <sup>(1)</sup> |      |
|--------------|-----------|---------|-------------------------------------------|------|
|              |           |         | Com1                                      | Com2 |
| Chainage 380 | Drained   | circ r0 | 0.45                                      | 0.56 |

Note 1) It should be noted that GGU stability presents the results of the stability analysis as utilisation factors defined as the ratio of the destabilising and stabilising effects, as such a utilisation factor less than unity is considered satisfactory.

### Summary

Results of analysis indicate

(1) Proposed embankment slopes constructed in accordance with the assumptions listed above has adequate resistance with regard to potential slope instability.

# Calculations

## SOUTHWEST APPROACH EMBANKMENT

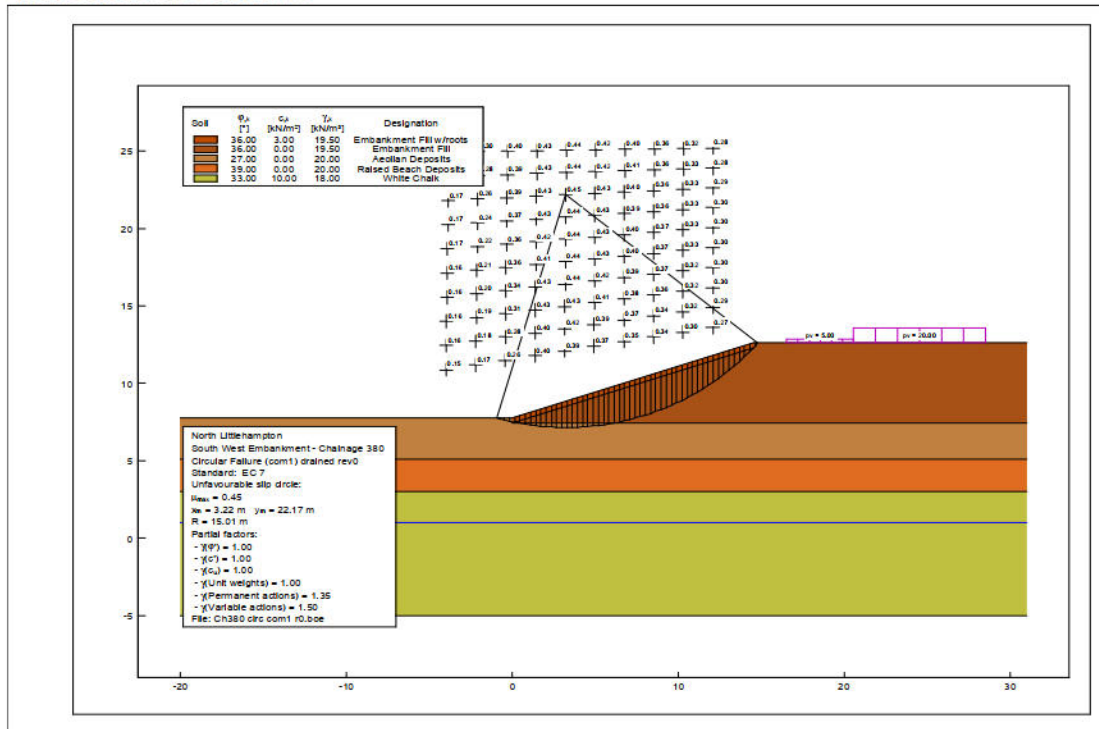
## SLOPE STABILITY ASSESSMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

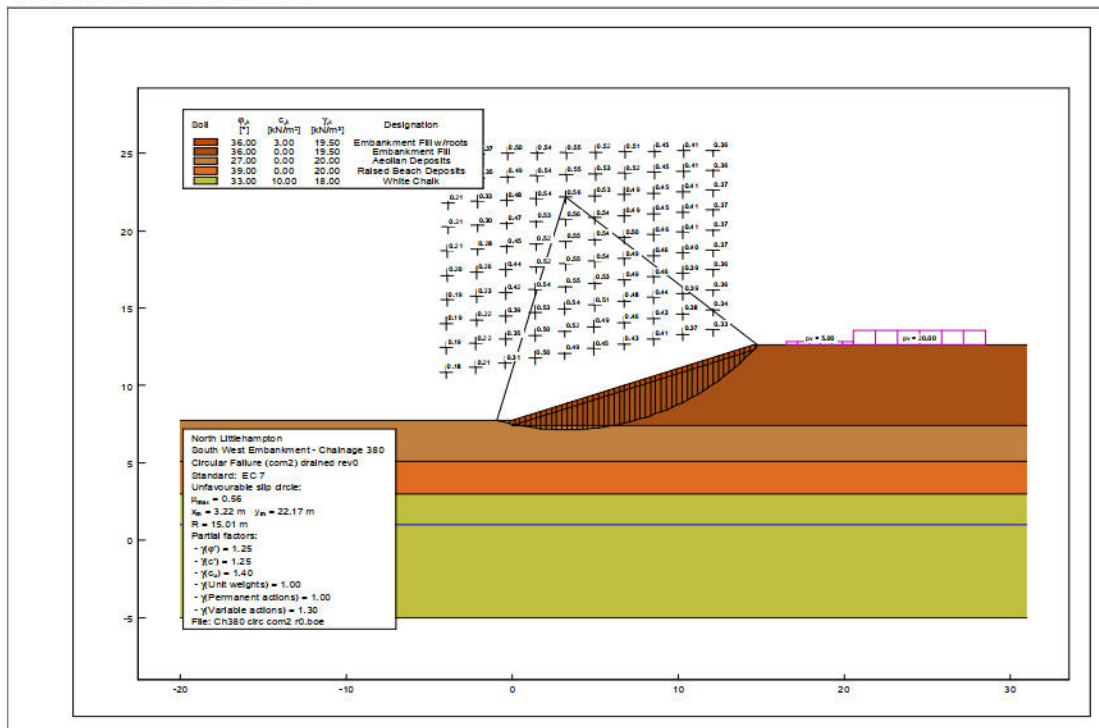
Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

### Results of Stability Analysis

file: Ch380 circ com1 r0



file: Ch380 circ com2 r0





# Calculations



SOUTHWEST APPROACH EMBANKMENT

SETTLEMENT ANALYSIS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN INPUT DATA

### Ground Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Description                                       |
|-------------------|--------------------|---------------------------------------------------|
| Topsoil/Subsoil   | 7.50               | Firm slightly sandy CLAY or SILT                  |
| Aeolian Deposits  | 5.10               | Soft to firm sandy CLAY/SILT with a little gravel |
| Raised Beach Deps | 3.00               | Medium dense clayey SAND with a little gravel     |
| White Chalk       | -0.70              | Structureless CHALK (Grade Dc)                    |
| White Chalk       | -8.00              | Intact CHALK (Grades C2 to C4)                    |

Note: Ground level taken to be 7.75 m OD

### Groundwater Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

Ground water level,  $z_w$  1.00 m OD

### Foundation Details

|         |        |                        |           |
|---------|--------|------------------------|-----------|
| Breadth | 20.0 m | O'burden Pressure      | 0 kPa     |
| Length  | 50.0 m | Applied Pressure       | 114.6 kPa |
| Depth   | 0.25 m | Limiting Stress Change | 10 %      |

### Correction Factors

(Ref: CIRIA SP27, Fig 13)

Foundation Stiffness Flexible

| Status | List         |
|--------|--------------|
| 1      | Flexible     |
| 0      | Intermediate |
| 0      | Stiff        |

|            | Centre | Edge | Corner |
|------------|--------|------|--------|
| total      | 1.00   | 1.00 | 1.00   |
| short term | 1.00   | 1.00 | 1.00   |
| long term  | 1.00   | 1.00 | 1.00   |

### Estimated Ground Movements

|            | Centre | Edge  | Corner | Differential, 1/n |
|------------|--------|-------|--------|-------------------|
| total      | 23 mm  | 15 mm | 9 mm   | 1871              |
| short term | 23 mm  | 15 mm | 9 mm   | 1872              |
| long term  | 0 mm   | 0 mm  | 0 mm   | 1870530           |

### Estimated Subgrade Modulus

|            | Centre     | Edge       | Corner     |
|------------|------------|------------|------------|
| total      | 5 MPa/m    | 4 MPa/m    | 3 MPa/m    |
| short term | 5 MPa/m    | 4 MPa/m    | 3 MPa/m    |
| long term  | 4917 MPa/m | 7781 MPa/m | 3216 MPa/m |

# Calculations



SOUTHWEST APPROACH EMBANKMENT

SETTLEMENT ANALYSIS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## ESTIMATED GROUND MOVEMENT

### Design Parameters

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Design Parameters                   |         | Bulk Density<br>kN/m <sup>3</sup> | Comments |
|-------------------|--------------------|-------------------------------------|---------|-----------------------------------|----------|
|                   |                    | m <sub>v</sub> (m <sup>2</sup> /MN) | E (MPa) |                                   |          |
| Topsoil/Subsoil   | 7.50               | -                                   | -       | -                                 |          |
| Aeolian Deposits  | 5.10               | -                                   | 12      | 20.0                              |          |
| Raised Beach Deps | 3.00               | -                                   | 15      | 20.0                              |          |
| White Chalk       | -0.70              | -                                   | 75      | 18.0                              |          |
| White Chalk       | -8.00              | -                                   | 300     | 18.0                              |          |

| Depth, m bgl | Strata | Unit | mv                 | E   | Stress  | Stress | Settlement  | Stress | Settlement  | Stress | Settlement  | Comments |  |  |
|--------------|--------|------|--------------------|-----|---------|--------|-------------|--------|-------------|--------|-------------|----------|--|--|
| top base     |        | Wt   | m <sup>2</sup> /MN | MPa | Initial | Inc    | Layer Total | Inc    | Layer Total | Inc    | Layer Total |          |  |  |
| 0.0          | 0.25   | TS   | 18.5               |     | 2.3     |        |             |        |             |        |             |          |  |  |
| 0.25         | 0.85   | AD   | 20.0               | 12  | 10.6    | 114.6  | 1.3 23.3    | 57.3   | 1.0 14.7    | 28.6   | 0.7 8.9     |          |  |  |
| 0.85         | 1.45   | AD   | 20.0               | 12  | 22.6    | 114.5  | 2.0 22.0    | 57.3   | 1.4 13.7    | 28.6   | 0.9 8.2     |          |  |  |
| 1.45         | 2.05   | AD   | 20.0               | 12  | 34.6    | 114.4  | 2.5 20.0    | 57.2   | 1.7 12.3    | 28.6   | 1.0 7.3     |          |  |  |
| 2.05         | 2.65   | AD   | 20.0               | 12  | 46.6    | 114.1  | 2.9 17.4    | 57.1   | 1.9 10.6    | 28.6   | 1.1 6.2     |          |  |  |
| 2.65         | 3.15   | BD   | 20.0               | 15  | 57.6    | 113.7  | 2.1 14.5    | 56.9   | 1.3 8.8     | 28.6   | 0.8 5.1     |          |  |  |
| 3.15         | 3.65   | BD   | 18.0               | 15  | 67.1    | 113.2  | 2.2 12.5    | 56.6   | 1.4 7.4     | 28.6   | 0.8 4.4     |          |  |  |
| 3.65         | 4.20   | BD   | 18.0               | 15  | 76.6    | 112.4  | 2.5 10.3    | 56.2   | 1.5 6.1     | 28.6   | 0.9 3.6     |          |  |  |
| 4.20         | 4.75   | BD   | 18.0               | 15  | 86.5    | 111.5  | 2.6 7.7     | 55.8   | 1.6 4.5     | 28.5   | 0.9 2.7     |          |  |  |
| 4.75         | 5.35   | WC   | 8.0                | 75  | 93.8    | 110.3  | 0.6 5.1     | 55.2   | 0.3 3.0     | 28.5   | 0.2 1.8     |          |  |  |
| 5.35         | 6.0    | WC   | 8.0                | 75  | 98.8    | 108.7  | 0.6 4.5     | 54.4   | 0.4 2.6     | 28.4   | 0.2 1.6     |          |  |  |
| 6.0          | 6.5    | WC   | 8.0                | 75  | 103.4   | 107.1  | 0.5 3.9     | 53.7   | 0.3 2.2     | 28.3   | 0.2 1.4     |          |  |  |
| 6.5          | 7.0    | WC   | 8.0                | 75  | 107.4   | 105.5  | 0.5 3.4     | 52.9   | 0.3 1.9     | 28.3   | 0.2 1.2     |          |  |  |
| 7.0          | 7.5    | WC   | 8.0                | 75  | 111.4   | 103.9  | 0.5 2.9     | 52.1   | 0.3 1.7     | 28.2   | 0.2 1.0     |          |  |  |
| 7.5          | 8.0    | WC   | 8.0                | 75  | 115.4   | 102.2  | 0.5 2.4     | 51.3   | 0.3 1.4     | 28.1   | 0.2 0.9     |          |  |  |
| 8.0          | 8.45   | WC   | 8.0                | 75  | 119.2   | 100.5  | 0.4 1.9     | 50.5   | 0.3 1.1     | 28.0   | 0.2 0.7     |          |  |  |
| 8.45         | 9.0    | WC   | 8.0                | 300 | 123.0   | 98.7   | 0.1 1.5     | 49.7   | 0.1 0.8     | 27.9   | 0.0 0.5     |          |  |  |
| 9.0          | 9.5    | WC   | 8.0                | 300 | 127.0   | 96.8   | 0.1 1.4     | 48.8   | 0.1 0.8     | 27.7   | 0.0 0.5     |          |  |  |
| 9.5          | 10.0   | WC   | 8.0                | 300 | 131.0   | 94.9   | 0.1 1.2     | 47.8   | 0.1 0.7     | 27.6   | 0.0 0.5     |          |  |  |
| 10.0         | 10.5   | WC   | 8.0                | 300 | 135.0   | 92.9   | 0.1 1.1     | 46.9   | 0.1 0.6     | 27.5   | 0.0 0.4     |          |  |  |
| 10.5         | 11.0   | WC   | 8.0                | 300 | 139.0   | 91.0   | 0.1 1.0     | 46.0   | 0.1 0.6     | 27.3   | 0.0 0.4     |          |  |  |
| 11.0         | 11.5   | WC   | 8.0                | 300 | 143.0   | 89.0   | 0.1 0.9     | 45.1   | 0.1 0.5     | 27.1   | 0.0 0.3     |          |  |  |
| 11.5         | 12.0   | WC   | 8.0                | 300 | 147.0   | 87.1   | 0.1 0.8     | 44.2   | 0.1 0.4     | 27.0   | 0.0 0.3     |          |  |  |
| 12.0         | 12.5   | WC   | 8.0                | 300 | 151.0   | 85.1   | 0.1 0.7     | 43.3   | 0.1 0.4     | 26.8   | 0.0 0.2     |          |  |  |
| 12.5         | 13.0   | WC   | 8.0                | 300 | 155.0   | 83.2   | 0.1 0.5     | 42.4   | 0.1 0.3     | 26.6   | 0.0 0.2     |          |  |  |
| 13.0         | 13.5   | WC   | 8.0                | 300 | 159.0   | 81.3   | 0.1 0.4     | 41.5   | 0.1 0.2     | 26.4   | 0.0 0.2     |          |  |  |
| 13.5         | 14.0   | WC   | 8.0                | 300 | 163.0   | 79.5   | 0.1 0.3     | 40.7   | 0.1 0.2     | 26.2   | 0.0 0.1     |          |  |  |
| 14.0         | 14.5   | WC   | 8.0                | 300 | 167.0   | 77.6   | 0.1 0.2     | 39.8   | 0.1 0.1     | 26.0   | 0.0 0.1     |          |  |  |
| 14.5         | 15.0   | WC   | 8.0                | 300 | 171.2   | 75.8   | 0.1 0.1     | 39.0   | 0.1 0.1     | 25.8   | 0.0 0.0     |          |  |  |
| 15.0         |        |      |                    |     |         |        |             |        |             |        |             |          |  |  |

Note

Values in blue denote input data

Sheet 02 of 03

# Calculations



SOUTHWEST APPROACH EMBANKMENT

SETTLEMENT ANALYSIS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN CALCULATIONS

### Stress Distribution

For uniform vertical loading of a rectangular area on a semi-infinte mass

Ref: Poulos and Davies (1974) Elastic Solutions for Soil and Rock Mechanics, Section 3.4

#### Vertical Stress Increase

(beneath the corner of the rectangle)

$$\delta\sigma_v = p/2\pi[\text{atan}(l.b/zR_3)+l.b.z/R_3(1/R_1^2+1/R_2^2)]$$

where

p = applied pressure

l = length fo rectangle

b = breadth of rectangle

z = depth below applied load

$$R_1 = (l^2+z^2)^{0.5}$$

$$R_2 = (b^2+z^2)^{0.5}$$

$$R_3 = (l^2+b^2+z^2)^{0.5}$$

#### Layer Settlement

for cohesive soils

$$\delta_i = m_v \cdot \Delta H \cdot \delta\sigma_v$$

Ref: CIRIA SP27 Settlement of Clays, Section 4.2.1

$m_v$  = coefficient of volume compressibility

E = elastic modulus

$\Delta H$  = layer thickness

for granular soil

$$\delta_i = 2.3 \cdot \sigma_{v0} \cdot \Delta H \log[(\sigma_{v0} + \delta\sigma_v)/\sigma_{v0}]$$

Ref: Based on DeBeer and Martens, 1957

$\sigma_{v0}$  = initial vertial stress

$\delta\sigma_v$  = vertical stress increase



## APPENDIX 2

### Highways Structures Design Calculations



## GEOTECHNICAL REPORT FORM C: HIGHWAY STRUCTURE SUMMARY INFORMATION

|                                            |                                                                                                                                                                                                                                                                      |                                      |                                |                                |                             |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------------|--------------------------------|-----------------------------|
| <b>Scheme Title:</b>                       | Lyminster Bypass (South), Littlehampton                                                                                                                                                                                                                              |                                      |                                |                                |                             |
| <b>PBA Project Ref:</b>                    | 35944/3500                                                                                                                                                                                                                                                           |                                      |                                |                                |                             |
| <b>Form Ref</b>                            | Form C/01 rev 2                                                                                                                                                                                                                                                      | <b>Date</b>                          | March 2018                     |                                |                             |
| <b>Structure</b>                           |                                                                                                                                                                                                                                                                      |                                      |                                |                                | <b>Reference</b>            |
| <b>Structure Name</b>                      | West Coastway Railway Line Overbridge – WSCC Ref 1741                                                                                                                                                                                                                |                                      |                                |                                |                             |
| <b>Structure Type</b>                      | Reinforced concrete bridge comprising precast prestressed concrete U-beams with an in-situ reinforced concrete deck slab supported on reinforced concrete abutments resting on a spread foundation.                                                                  |                                      |                                |                                |                             |
| <b>Location</b>                            | <b>From</b>                                                                                                                                                                                                                                                          | TQ 0314 0383                         | <b>To</b>                      |                                |                             |
| <b>Design Life</b>                         | 120 years                                                                                                                                                                                                                                                            |                                      |                                |                                |                             |
| <b>AIP Ref</b>                             | PBA AIP 35944 rev 1, dated Sept 2016                                                                                                                                                                                                                                 |                                      |                                |                                |                             |
| <b>Soils/Geology</b>                       |                                                                                                                                                                                                                                                                      |                                      |                                |                                | <b>Reference</b>            |
| <b>Relevant Trial Holes</b>                | Boreholes 05, 15 and 16<br>Boreholes 306 and 307                                                                                                                                                                                                                     |                                      |                                |                                |                             |
|                                            | IML (2015)<br>CC (2016)                                                                                                                                                                                                                                              |                                      |                                |                                |                             |
| <b>Ground Conditions</b>                   | <b>Strata</b>                                                                                                                                                                                                                                                        | <b>Base level, m OD</b>              | <b>Water Bearing</b>           | <b>Comments</b>                |                             |
|                                            | Topsoil/Subsoil                                                                                                                                                                                                                                                      | 6.5 to 7.4                           | No                             |                                |                             |
|                                            | Aeolian Deposits                                                                                                                                                                                                                                                     | 4.5 to 5.4                           | No                             |                                |                             |
|                                            | Raised Beach Deposits                                                                                                                                                                                                                                                | 1.6 to 3.7                           | No                             |                                |                             |
|                                            | White Chalk                                                                                                                                                                                                                                                          | ~-19.4                               | Yes                            |                                |                             |
| <b>Ground History</b>                      | Historically the Site was agricultural land, until early-1970s when a number of residential properties were developed fronting onto Toddington Lane. Also by this date, the land to the south of Toddington Lane was used as a football pitch and allotment gardens. |                                      |                                |                                |                             |
| <b>Contaminated Ground Risk Assessment</b> | From consideration of the history and current use of the site and the findings of the ground investigations, the risk of significant contamination being present is assessed to be <b>Low</b> .                                                                      |                                      |                                |                                |                             |
| <b>Groundwater</b>                         | To allow for seasonal variations in groundwater level, a groundwater level of 1.0 m OD is considered appropriate for design analysis.                                                                                                                                |                                      |                                |                                |                             |
| <b>Soil Properties</b>                     | <b>Strata</b>                                                                                                                                                                                                                                                        | <b>Unit Weight, kN/m<sup>3</sup></b> | <b>Effective Cohesion, kPa</b> | <b>Friction Angle, degrees</b> | <b>Elastic Modulus, MPa</b> |
|                                            | Aeolian Deposits                                                                                                                                                                                                                                                     | 20.0                                 | -                              | 27 (24) <sup>(1)</sup>         | 12                          |
|                                            | Raised Beach Deposits                                                                                                                                                                                                                                                | 20.0                                 | -                              | 39 (36) <sup>(1)</sup>         | 15                          |
|                                            | White Chalk                                                                                                                                                                                                                                                          |                                      |                                |                                |                             |
|                                            | - structureless                                                                                                                                                                                                                                                      | 18.0                                 | 10                             | 33                             | 75                          |
|                                            | - intact                                                                                                                                                                                                                                                             | 18.0                                 | not applicable                 | not applicable                 | 300                         |
|                                            | (1) Peak and (critical state) values                                                                                                                                                                                                                                 |                                      |                                |                                |                             |

| Spread Footings                                                   |                                        |                      |                        |                               | Reference |
|-------------------------------------------------------------------|----------------------------------------|----------------------|------------------------|-------------------------------|-----------|
| Structure Element                                                 | Founding Stratum                       | Founding Level, m OD | Footing Size, m        | Net Loading Intensity, kPa    |           |
| Abutment foundation                                               | Aeolian Deposits/Raised Beach Deposits | 5.6                  | 14.0 by 20.0           | ~210                          |           |
|                                                                   |                                        |                      |                        |                               |           |
| Special Measures/Comments                                         | None                                   |                      |                        |                               |           |
| Pile Foundations                                                  |                                        |                      |                        |                               | Reference |
| Structural Element                                                | Founding Stratum                       | Toe Level, m OD      | Diameter, mm/Length, m | Design Action Com1 / Com2, kN |           |
|                                                                   |                                        |                      |                        |                               |           |
|                                                                   |                                        |                      |                        |                               |           |
|                                                                   |                                        |                      |                        |                               |           |
| Pile Type                                                         |                                        |                      |                        |                               |           |
| Criteria for selected toe level                                   |                                        |                      |                        |                               |           |
| Allowance for negative skin friction                              |                                        |                      |                        |                               |           |
| Special Measures/Comments                                         |                                        |                      |                        |                               |           |
| Settlement                                                        |                                        |                      |                        |                               | Reference |
| Structural Element                                                | Immediate Settlement, mm               | Total Settlement, mm | Time for 90 per cent   | Remaining at Completion, mm   |           |
| Spread Foundations                                                | ~15                                    | ~15                  | <1 months              | <10 mm                        |           |
|                                                                   |                                        |                      |                        |                               |           |
| Differential settlement between adjacent supports                 |                                        |                      |                        | <10 mm                        |           |
| Differential settlement between structure and approach embankment |                                        |                      |                        | <10 mm                        |           |
| Special Measures/Comments                                         | None                                   |                      |                        |                               |           |



| Ground Movements (after construction)                |                                                                                                                                        |                                |             |                | Reference |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------|----------------|-----------|
| Cause                                                | Maximum Movement                                                                                                                       | Measures to Deal with Movement |             |                |           |
| Earthworks                                           | None                                                                                                                                   | Not required                   |             |                |           |
| Embankment Loading                                   | None                                                                                                                                   | Not required                   |             |                |           |
| Cutting Excavation                                   | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Subsidence                                           | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Flowing Water                                        | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Other                                                | None                                                                                                                                   | Not required                   |             |                |           |
| Special Measures/<br>Comments                        | None                                                                                                                                   |                                |             |                |           |
| Chemical Analysis                                    |                                                                                                                                        |                                |             |                | Reference |
| Type                                                 | Sulphate/<br>Sulphide                                                                                                                  | Chloride                       | pH/Redox    | Other          |           |
| Soil                                                 | 4.6 to 290 mg/l                                                                                                                        |                                | 5.6 to 10.0 |                | CC (2016) |
| Soil:Water                                           |                                                                                                                                        |                                |             |                |           |
| Water                                                |                                                                                                                                        |                                |             |                |           |
| Air                                                  |                                                                                                                                        |                                |             |                |           |
| Other                                                |                                                                                                                                        |                                |             |                |           |
| Buried concrete classification                       |                                                                                                                                        |                                |             | AC-1           |           |
| Corrugated steel culvert ground/water classification |                                                                                                                                        |                                |             | Not applicable |           |
| Special Measures/<br>Comments                        | Consideration will need to be given in the detailed design of concrete structures to allow for the potential action of de-icing salts. |                                |             |                |           |
| Other Design Features                                |                                                                                                                                        |                                |             |                | Reference |
| Anticipated Requirements                             | None                                                                                                                                   |                                |             |                |           |
| Special Measures/<br>Comments                        | None                                                                                                                                   |                                |             |                |           |

# Calculations

WEST COASTWAY RAILWAY LINE OVERBRIDGE (Traffic Load Group Gr5)

ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN INPUT DATA

### Ground Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Description                                       |
|-------------------|--------------------|---------------------------------------------------|
| Topsoil/Subsoil   | 6.90               | Firm slightly sandy CLAY or SILT                  |
| Aeolian Deposits  | 5.00               | Soft to firm sandy CLAY/SILT with a little gravel |
| Raised Beach Deps | 2.50               | Medium dense clayey SAND with a little gravel     |
| White Chalk       | -0.70              | Structureless CHALK (Grade Dc)                    |
|                   | -8.00              | Intact CHALK (Grades C2 to C4)                    |

Note: Ground level taken to be 6.80 m OD

### Groundwater Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

Ground water level,  $z_w$  1.00 m OD

Unit Wt,  $\gamma_w$  10 kN/m<sup>3</sup>

### Ground Properties (assume bearing on White Chalk<sup>(1)</sup>)

#### Undrained Conditions

Bulk Unit Wt,  $\gamma_k$  18.0 kN/m<sup>3</sup>

Undrained Shear,  $s_{uk}$  kPa

#### Drained Conditions

Bulk Unit Wt,  $\gamma_k$  18.0 kN/m<sup>3</sup>

Friction Angle,  $\phi'_k$  33 degrees

Friction Angle,  $\phi'_{cv,k}$  33 degrees

Eff Cohesion,  $c'_k$  10.0 kPa

### Foundation Properties

Unit Wt,  $\gamma_c$  24 kN/m<sup>3</sup>

### Design Code

BS EN 1997-1 Yes

BS 8004 No

| Status | List |
|--------|------|
| 1      | Yes  |
| 0      | No   |

### Partial Factors (for BS EN-1997-1)

#### Resistance Factors Com1 Com2

Friction Angle,  $\gamma_{\phi'}$  1.0 1.25

Eff Cohesion,  $\gamma_{c'}$  1.0 1.25

Undrained Shear,  $\gamma_{su}$  1.0 1.4

UCS,  $\gamma_{qu}$  1.0 1.4

#### Load Factors

Permanent,  $\gamma_G$  1.35 1.00 unfavourable

1.00 1.00 favourable

Variable,  $\gamma_Q$  1.50 1.30 unfavourable

0.00 0.00 favourable

### Factors of Safety (for BS 8004)

Vertical 2.5

Horizontal 2.5

1) Given the limited thickness of the Raised Beach Deposits relative to the plan dimensions of the proposed foundations, the presence of this material has been neglected and the bearing and sliding resistances have been determined assuming the structure is founded directly on the underlying structureless chalk. Given the lower design parameters selected for the structureless chalk, this assumption is deemed to be conservative.

### Note

Values in blue denote input data

# Calculations

WEST COASTWAY RAILWAY LINE OVERBRIDGE (Traffic Load Group Gr5)

ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DIMENSIONS AND ACTIONS

### Foundation Type

Foundation type

Pad

Foundation weight included in actions

Yes

### Foundation Dimensions

Foundation width, B 14.0 m

Depth to base,  $z_b$  1.85 m

Foundation length, L 20.0 m

Base inclination,  $\alpha$  0 radians

| Status | List  |
|--------|-------|
| 0      | Strip |
| 1      | Pad   |
| Status | List  |
| 1      | Yes   |
| 0      | No    |

### Actions (Load on base)

| Traffic Load Group | Com1 ( $V_{max}$ , $H_{max}$ ) |       |       | Com1 ( $M_{max}$ ) |       |       | Com2  |       |       | SLS   |       |       |
|--------------------|--------------------------------|-------|-------|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                    | $V_d$                          | $H_d$ | $M_d$ | $V_d$              | $H_d$ | $M_d$ | $V_d$ | $H_d$ | $M_d$ | $V_d$ | $H_d$ | $M_d$ |
| Gr1a               | 65556                          | 6762  | 63013 | 55428              | 4981  | 69905 | 49252 | 6121  | 52967 | 49070 | 4996  | 49419 |
| Gr2                | 64198                          | 7123  | 64605 | 54070              | 5342  | 71498 | 48095 | 6395  | 54201 | 47978 | 5264  | 50126 |
| Gr5                | 66161                          | 6713  | 64628 | 56032              | 4932  | 71520 | 49767 | 6071  | 54311 | 49560 | 4960  | 50846 |
| Gr6                | 63118                          | 6960  | 58611 | 52989              | 5180  | 65504 | 47174 | 6231  | 49003 | 47071 | 5143  | 45095 |

Two sets for Combination 1 were analysed as the load factor for the soil behind the abutment is 1.35 for the maximum vertical load as it is unfavourable, and 0.95 for the maximum bending moment as it is favourable.

### Design Value of Actions

Traffic Load Group Gr5

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Design Action

$V_d =$

66161

56032

49767 kN

$H_d =$

6713

4932

6071 kN

$M_d =$

64628

71520

54311 kNm

Direction of H and M,  $\theta$  (from direction of L)

90

90

90 degrees

### Effective Foundation Dimensions

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Eccentricity

in direction of B

$e_{dB} = M_d \cdot \sin(\theta) / V_d$

0.98

1.28

1.09 m

in direction of L

$e_{dL} = M_d \cdot \cos(\theta) / V_d$

0.00

0.00

0.00 m

Effective width

$B' = B - 2 \cdot e_{dB}$

12.05

11.45

11.82 m

Effective length

$L' = L - 2 \cdot e_{dL}$

20.00

20.00

20.00 m

Note

Denotes point of load application inside centre third of foundation

Denotes point of load application outside centre third of foundation

Note

Values in blue denote input data



# Calculations



WEST COASTWAY RAILWAY LINE OVERBRIDGE (Traffic Load Group Gr5)

ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DRAINED CONDITIONS

### Bearing Resistance

Unit resistance

$$R_d/A' = c'.N_c.b_c.s_c.i_c + q.N_q.b_q.s_q.i_q + 0.5.\gamma'.B'.N_\gamma.b_\gamma.s_\gamma.i_\gamma$$

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Friction angle

$$\phi'_d = \tan^{-1}(\tan\phi'_k/\gamma_\phi')$$

33.0

33.0

27.5 degrees

Effective cohesion

$$c'_d = c'_k/\gamma_c'$$

10.0

10.0

8.0 kPa

Bearing factor

$$N_c = (N_q - 1).cot\phi'$$

38.6

38.6

24.8

$$N_q = e^{\pi \tan\phi'} \cdot \tan^2(45 + \phi'/2)$$

26.1

26.1

13.9

$$N_\gamma = 2.(N_q - 1).tan\phi'$$

32.6

32.6

13.4

Base inclination factor

$$b_c = b_q \cdot (1 - b_q)/(N_c \cdot tan\phi')$$

1.00

1.00

1.00

$$b_q = (1 - \alpha \cdot tan\phi')^2$$

1.00

1.00

1.00

$$b_\gamma = b_q$$

1.00

1.00

1.00

Shape factor

$$s_c = (s_q \cdot N_q - 1)/(N_q - 1)$$

1.34

1.32

1.29

$$s_q = 1 + (B'/L') \cdot \sin\phi'$$

1.33

1.31

1.27

$$s_\gamma = 1 - 0.3(B'/L')$$

0.82

0.83

0.82

Load inclination factor

$$i_c = i_q \cdot (1 - i_q)/(N_c \cdot tan\phi')$$

0.84

0.86

0.81

$$i_q = [1 - H/(V + A' \cdot c' \cdot cot\phi')]^m$$

0.85

0.87

0.82

$$i_\gamma = [1 - H/(V + A' \cdot c' \cdot cot\phi')]^{m+1}$$

0.77

0.80

0.73

$$m = (2 + B'/L')/(1 + B'/L')$$

1.62

1.64

1.63

Eff unit weight of formation  $\gamma_d =$

8.0

8.0

8.0 kN/m<sup>3</sup>

Effective pressure at base  $q = z_b \cdot \gamma'_k \cdot (z_b - z_w) \cdot g_w$

24.8

24.8

24.8 kPa

Unit bearing resistance  $R_d/A' =$

2153

2162

945 kPa

Bearing resistance  $R_d =$

518719

495089

223346 kN

Reduced bearing resistance  $R_d =$

503500

479804

216667 kN

Design Action  $V_d =$

66161

56032

49767 kN

Load Factor  $R_d/V_d =$

7.6

8.6

4.4

Utilisation Factor  $V_d/R_d =$

0.13

0.12

0.23

### Sliding Resistance

Sliding resistance

$$R_{H;d} = V_d \cdot \tan(\delta_d)$$

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Base friction ratio

$$\delta_d/\phi'_{cv,d} =$$

1.00

1.00

1.00

Design action

$$V_d =$$

66161

56032

49767 kN

Friction angle

$$\phi'_{cv,d} = \tan^{-1}(\tan\phi'_{cv,k}/\gamma_\phi')$$

33.0

33.0

27.5 degrees

Sliding resistance

$$R_{H;d} =$$

42965

36388

25855 kN

Reduced Sliding Resistance  $R_{H;d} =$

41705

35264

25082 kN

Design Action

$$H_d =$$

6713

4932

6071 kN

Load Factor

$$R_d/H_d =$$

6.2

7.2

4.1

Utilisation Factor

$$H_d/R_d =$$

0.16

0.14

0.24

Bearing and sliding resistances have been reduced to allow for a loss of ground support over a plan dimension of 3.0 m to allow for any future development of solution features

## Note

Values in blue denote input data

Values highlighted acceptable

Values highlighted unacceptable

Sheet 03 of 03

# Calculations

WEST COASTWAY RAILWAY LINE OVERBRIDGE

SETTLEMENT ANALYSIS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN INPUT DATA

### Ground Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Description                                       |
|-------------------|--------------------|---------------------------------------------------|
| Topsoil/Subsoil   | 6.90               | Firm slightly sandy CLAY or SILT                  |
| Aeolian Deposits  | 5.00               | Soft to firm sandy CLAY/SILT with a little gravel |
| Raised Beach Deps | 2.50               | Medium dense clayey SAND with a little gravel     |
| White Chalk       | -0.70              | Structureless CHALK (Grade Dc)                    |
| White Chalk       | -8.00              | Intact CHALK (Grades C2 to C4)                    |

Note: Ground level taken to be 6.80 m OD

### Groundwater Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

Ground water level,  $z_w$  1.00 m OD

### Foundation Details

|         |        |                        |         |
|---------|--------|------------------------|---------|
| Breadth | 12.0 m | O'burden Pressure      | 0 kPa   |
| Length  | 20.0 m | Applied Pressure       | 210 kPa |
| Depth   | 1.85 m | Limiting Stress Change | 10 %    |

### Correction Factors

(Ref: CIRIA SP27, Fig 13)

Foundation Stiffness Stiff

| Status | List         |
|--------|--------------|
| 0      | Flexible     |
| 0      | Intermediate |
| 1      | Stiff        |

|            | Centre | Edge | Corner |
|------------|--------|------|--------|
| total      | 0.87   | 1.32 | 1.75   |
| short term | 0.85   | 1.16 | 1.35   |
| long term  | 0.88   | 1.45 | 2.10   |

### Estimated Ground Movements

|            | Centre | Edge  | Corner | Differential, 1/n |
|------------|--------|-------|--------|-------------------|
| total      | 16 mm  | 16 mm | 13 mm  | 4098              |
| short term | 16 mm  | 14 mm | 10 mm  | 2123              |
| long term  | 0 mm   | 2 mm  | 3 mm   | 4407              |

### Estimated Subgrade Modulus

|            | Centre    | Edge     | Corner   |
|------------|-----------|----------|----------|
| total      | 13 MPa/m  | 7 MPa/m  | 4 MPa/m  |
| short term | 13 MPa/m  | 8 MPa/m  | 5 MPa/m  |
| long term  | 569 MPa/m | 54 MPa/m | 17 MPa/m |

# Calculations



## ESTIMATED GROUND MOVEMENT

### SETTLEMENT ANALYSIS

|               |                                         |      |    |     |      |      |      |            |
|---------------|-----------------------------------------|------|----|-----|------|------|------|------------|
| Project Title | LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON |      |    |     |      |      |      |            |
| Project No    | 35944                                   | 3500 | By | mdh | Chkd | Cat2 | Date | 21/02/2018 |

### ESTIMATED GROUND MOVEMENT

#### Design Parameters

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Design Parameters                   |         | Bulk Density<br>kN/m <sup>3</sup> | Comments |
|-------------------|--------------------|-------------------------------------|---------|-----------------------------------|----------|
|                   |                    | m <sub>v</sub> (m <sup>2</sup> /MN) | E (MPa) |                                   |          |
| Topsoil/Subsoil   | 6.90               | -                                   | -       | -                                 |          |
| Aeolian Deposits  | 5.00               | -                                   | 12      | 20.0                              |          |
| Raised Beach Deps | 2.50               | -                                   | 15      | 20.0                              |          |
| White Chalk       | -0.70              | -                                   | 75      | 18.0                              |          |
| White Chalk       | -8.00              | -                                   | 300     | 18.0                              |          |

| Depth, m bgl |      | Strata | Unit<br>Wt | mv<br>m <sup>2</sup> /MN | E<br>MPa | Stress<br>Initial | Stress Settlement |       |       | Stress Settlement |       |       | Stress Settlement |       |       | Comments |
|--------------|------|--------|------------|--------------------------|----------|-------------------|-------------------|-------|-------|-------------------|-------|-------|-------------------|-------|-------|----------|
| top          | base |        |            |                          |          |                   | Inc               | Layer | Total | Inc               | Layer | Total | Inc               | Layer | Total |          |
| 0.0          | 1.8  | AD     | 20.0       |                          | 12       | 18.0              |                   |       |       |                   |       |       |                   |       |       |          |
| 1.8          | 2.5  | BD     | 20.0       |                          | 15       | 43.0              |                   |       |       |                   |       |       |                   |       |       |          |
| 2.5          | 3.0  | BD     | 20.0       |                          | 15       | 55.0              | 209.7             | 2.9   | 18.4  | 104.9             | 2.0   | 12.0  | 52.5              | 1.2   | 7.5   |          |
| 3.0          | 3.5  | BD     | 20.0       |                          | 15       | 65.0              | 208.8             | 3.1   | 15.6  | 104.5             | 2.1   | 10.0  | 52.5              | 1.3   | 6.3   |          |
| 3.5          | 4.0  | BD     | 18.0       |                          | 15       | 74.5              | 207.1             | 3.3   | 12.4  | 103.7             | 2.2   | 8.0   | 52.4              | 1.3   | 5.0   |          |
| 4.0          | 4.3  | BD     | 18.0       |                          | 15       | 81.7              | 205.2             | 2.0   | 9.1   | 102.9             | 1.3   | 5.8   | 52.3              | 0.8   | 3.7   |          |
| 4.3          | 5.0  | WC     | 18.0       |                          | 75       | 90.7              | 201.9             | 1.0   | 7.1   | 101.4             | 0.6   | 4.5   | 52.2              | 0.4   | 2.9   |          |
| 5.0          | 5.5  | WC     | 18.0       |                          | 75       | 101.5             | 196.7             | 0.7   | 6.1   | 99.1              | 0.5   | 3.8   | 52.0              | 0.3   | 2.5   |          |
| 5.5          | 5.8  | WC     | 18.0       |                          | 75       | 108.7             | 192.7             | 0.4   | 5.4   | 97.4              | 0.3   | 3.4   | 51.8              | 0.2   | 2.2   |          |
| 5.8          | 6.5  | WC     | 8.0        |                          | 75       | 114.2             | 187.1             | 1.0   | 4.9   | 95.0              | 0.6   | 3.1   | 51.5              | 0.4   | 2.1   |          |
| 6.5          | 7.0  | WC     | 8.0        |                          | 75       | 119.0             | 179.7             | 0.7   | 3.9   | 91.8              | 0.5   | 2.4   | 51.1              | 0.3   | 1.7   |          |
| 7.0          | 7.5  | WC     | 8.0        |                          | 75       | 123.0             | 173.1             | 0.7   | 3.2   | 89.0              | 0.4   | 2.0   | 50.7              | 0.3   | 1.4   |          |
| 7.5          | 8.0  | WC     | 8.0        |                          | 300      | 127.0             | 166.4             | 0.2   | 2.5   | 86.2              | 0.1   | 1.5   | 50.2              | 0.1   | 1.1   |          |
| 8.0          | 8.5  | WC     | 8.0        |                          | 300      | 131.0             | 159.6             | 0.2   | 2.3   | 83.3              | 0.1   | 1.4   | 49.6              | 0.1   | 1.0   |          |
| 8.5          | 9.0  | WC     | 8.0        |                          | 300      | 135.0             | 152.8             | 0.2   | 2.1   | 80.5              | 0.1   | 1.3   | 49.1              | 0.1   | 1.0   |          |
| 9.0          | 9.5  | WC     | 8.0        |                          | 300      | 139.0             | 146.1             | 0.2   | 1.9   | 77.7              | 0.1   | 1.2   | 48.4              | 0.1   | 0.9   |          |
| 9.5          | 10.0 | WC     | 8.0        |                          | 300      | 143.0             | 139.5             | 0.2   | 1.8   | 74.9              | 0.1   | 1.1   | 47.8              | 0.1   | 0.8   |          |
| 10.0         | 10.5 | WC     | 8.0        |                          | 300      | 147.0             | 133.1             | 0.2   | 1.6   | 72.3              | 0.1   | 1.0   | 47.1              | 0.1   | 0.8   |          |
| 10.5         | 11.0 | WC     | 8.0        |                          | 300      | 151.0             | 127.0             | 0.2   | 1.4   | 69.7              | 0.1   | 0.9   | 46.3              | 0.1   | 0.7   |          |
| 11.0         | 11.5 | WC     | 8.0        |                          | 300      | 155.0             | 121.1             | 0.1   | 1.3   | 67.2              | 0.1   | 0.8   | 45.5              | 0.1   | 0.6   |          |
| 11.5         | 12.0 | WC     | 8.0        |                          | 300      | 159.0             | 115.4             | 0.1   | 1.1   | 64.8              | 0.1   | 0.7   | 44.8              | 0.1   | 0.6   |          |
| 12.0         | 12.5 | WC     | 8.0        |                          | 300      | 163.0             | 110.0             | 0.1   | 1.0   | 62.5              | 0.1   | 0.6   | 43.9              | 0.1   | 0.5   |          |
| 12.5         | 13.0 | WC     | 8.0        |                          | 300      | 167.0             | 104.8             | 0.1   | 0.9   | 60.4              | 0.1   | 0.6   | 43.1              | 0.1   | 0.4   |          |
| 13.0         | 13.5 | WC     | 8.0        |                          | 300      | 171.0             | 99.9              | 0.1   | 0.7   | 58.3              | 0.1   | 0.5   | 42.3              | 0.1   | 0.4   |          |
| 13.5         | 14.0 | WC     | 8.0        |                          | 300      | 175.0             | 95.3              | 0.1   | 0.6   | 56.3              | 0.1   | 0.4   | 41.4              | 0.1   | 0.3   |          |
| 14.0         | 14.5 | WC     | 8.0        |                          | 300      | 179.0             | 90.8              | 0.1   | 0.5   | 54.3              | 0.1   | 0.3   | 40.6              | 0.1   | 0.2   |          |
| 14.5         | 15.0 | WC     | 8.0        |                          | 300      | 183.0             | 86.7              | 0.1   | 0.3   | 52.5              | 0.1   | 0.2   | 39.7              | 0.1   | 0.2   |          |
| 15.0         | 15.5 | WC     | 8.0        |                          | 300      | 187.0             | 82.7              | 0.1   | 0.2   | 50.7              | 0.1   | 0.1   | 38.9              | 0.1   | 0.1   |          |
| 15.5         | 16.0 | WC     | 8.0        |                          | 300      | 191.0             | 79.0              | 0.1   | 0.1   | 49.0              | 0.1   | 0.1   | 38.0              | 0.1   | 0.1   |          |
| 16.0         |      |        |            |                          |          |                   |                   |       |       |                   |       |       |                   |       |       |          |

#### Note

Values in blue denote input data



# Calculations



WEST COASTWAY RAILWAY LINE OVERBRIDGE

SETTLEMENT ANALYSIS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN CALCULATIONS

### Stress Distribution

For uniform vertical loading of a rectangular area on a semi-infinte mass

Ref: Poulos and Davies (1974) Elastic Solutions for Soil and Rock Mechanics, Section 3.4

#### Vertical Stress Increase

(beneath the corner of the rectangle)

$$\delta\sigma_v = p/2\pi[\text{atan}(l.b/zR_3)+l.b.z/R_3(1/R_1^2+1/R_2^2)]$$

where

p = applied pressure

l = length fo rectangle

b = breadth of rectangle

z = depth below applied load

$$R_1 = (l^2+z^2)^{0.5}$$

$$R_2 = (b^2+z^2)^{0.5}$$

$$R_3 = (l^2+b^2+z^2)^{0.5}$$

#### Layer Settlement

for cohesive soils

$$\delta_i = m_v \cdot \Delta H \cdot \delta\sigma_v$$

Ref: CIRIA SP27 Settlement of Clays, Section 4.2.1

$m_v$  = coefficient of volume compressibility

E = elastic modulus

$\Delta H$  = layer thickness

for granular soil

$$\delta_i = 2.3 \cdot \sigma_{v0} \cdot \Delta H \log[(\sigma_{v0} + \delta\sigma_v)/\sigma_{v0}]$$

Ref: Based on DeBeer and Martens, 1957

$\sigma_{v0}$  = initial vertial stress

$\delta\sigma_v$  = vertical stress increase



## GEOTECHNICAL REPORT FORM C: HIGHWAY STRUCTURE SUMMARY INFORMATION

|                                            |                                                                                                                                                                                                                                                                      |                                      |                                |                                |                             |                                      |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------------|--------------------------------|-----------------------------|--------------------------------------|
| <b>Scheme Title:</b>                       | Lyminster Bypass (South), Littlehampton                                                                                                                                                                                                                              |                                      |                                |                                |                             |                                      |
| <b>PBA Project Ref:</b>                    | 35944/3500                                                                                                                                                                                                                                                           |                                      |                                |                                |                             |                                      |
| <b>Form Ref</b>                            | Form C/02 rev 1                                                                                                                                                                                                                                                      | <b>Date</b>                          | March 2018                     |                                |                             |                                      |
| <b>Structure</b>                           |                                                                                                                                                                                                                                                                      |                                      |                                |                                | <b>Reference</b>            |                                      |
| <b>Structure Name</b>                      | Toddington Lane Road Bridge – WSCC Ref 1740                                                                                                                                                                                                                          |                                      |                                |                                |                             |                                      |
| <b>Structure Type</b>                      | Reinforced concrete bridge comprising precast prestressed concrete U-beams with an in-situ reinforced concrete deck slab supported on reinforced concrete abutments resting on a spread foundation.                                                                  |                                      |                                |                                |                             |                                      |
| <b>Location</b>                            | <b>From</b>                                                                                                                                                                                                                                                          | TQ 03144 03916                       | <b>To</b>                      |                                |                             |                                      |
| <b>Design Life</b>                         | 120 years                                                                                                                                                                                                                                                            |                                      |                                |                                |                             |                                      |
| <b>AIP Ref</b>                             | PBA 35944/1502/AIP/001 rev 0, dated October 2016                                                                                                                                                                                                                     |                                      |                                |                                |                             |                                      |
| <b>Soils/Geology</b>                       |                                                                                                                                                                                                                                                                      |                                      |                                |                                | <b>Reference</b>            |                                      |
| <b>Relevant Trial Holes</b>                | Boreholes 07, 08 and 09<br>Boreholes 301 and 302                                                                                                                                                                                                                     |                                      |                                |                                | IML (2015)<br>CC (2016)     |                                      |
| <b>Ground Conditions</b>                   | <b>Strata</b>                                                                                                                                                                                                                                                        | <b>Base level, m OD</b>              | <b>Water Bearing</b>           | <b>Comments</b>                |                             |                                      |
|                                            | Topsoil/Subsoil                                                                                                                                                                                                                                                      | 6.9 to 7.3                           | No                             |                                |                             |                                      |
|                                            | Aeolian Deposits                                                                                                                                                                                                                                                     | 4.0 to 6.0                           | No                             |                                |                             |                                      |
|                                            | Raised Beach Deposits                                                                                                                                                                                                                                                | 2.0 to 3.6                           | No                             |                                |                             |                                      |
|                                            | White Chalk                                                                                                                                                                                                                                                          | ~-8.0                                | Yes                            |                                |                             |                                      |
| <b>Ground History</b>                      | Historically the Site was agricultural land, until early-1970s when a number of residential properties were developed fronting onto Toddington Lane. Also by this date, the land to the south of Toddington Lane was used as a football pitch and allotment gardens. |                                      |                                |                                |                             |                                      |
| <b>Contaminated Ground Risk Assessment</b> | From consideration of the history and current use of the site and the findings of the ground investigations, the risk of significant contamination being present is assessed to be <b>Low</b> .                                                                      |                                      |                                |                                |                             |                                      |
| <b>Groundwater</b>                         | To allow for seasonal variations in groundwater level, a groundwater level of 1.0 m OD is considered appropriate for design analysis.                                                                                                                                |                                      |                                |                                |                             |                                      |
| <b>Soil Properties</b>                     | <b>Strata</b>                                                                                                                                                                                                                                                        | <b>Unit Weight, kN/m<sup>3</sup></b> | <b>Effective Cohesion, kPa</b> | <b>Friction Angle, degrees</b> | <b>Elastic Modulus, MPa</b> | (1) Peak and (critical state) values |
|                                            | Aeolian Deposits                                                                                                                                                                                                                                                     | 20.0                                 | -                              | 27 (24) <sup>(1)</sup>         | 12                          |                                      |
|                                            | Raised Beach Deposits                                                                                                                                                                                                                                                | 20.0                                 | -                              | 39 (36) <sup>(1)</sup>         | 15                          |                                      |
|                                            | White Chalk                                                                                                                                                                                                                                                          |                                      |                                |                                |                             |                                      |
|                                            | - structureless                                                                                                                                                                                                                                                      | 18.0                                 | 10                             | 33                             | 75                          |                                      |
|                                            | - intact                                                                                                                                                                                                                                                             | 18.0                                 | not applicable                 | not applicable                 | 300                         |                                      |

| Spread Footings                                                   |                                        |                      |                        |                               | Reference |
|-------------------------------------------------------------------|----------------------------------------|----------------------|------------------------|-------------------------------|-----------|
| Structure Element                                                 | Founding Stratum                       | Founding Level, m OD | Footing Size, m        | Net Loading Intensity, kPa    |           |
| Abutment foundation                                               | Aeolian Deposits/Raised Beach Deposits | 4.95                 | 14.0 by 20.0           | ~210                          |           |
|                                                                   |                                        |                      |                        |                               |           |
| Special Measures/Comments                                         | None                                   |                      |                        |                               |           |
| Pile Foundations                                                  |                                        |                      |                        |                               | Reference |
| Structural Element                                                | Founding Stratum                       | Toe Level, m OD      | Diameter, mm/Length, m | Design Action Com1 / Com2, kN |           |
|                                                                   |                                        |                      |                        |                               |           |
|                                                                   |                                        |                      |                        |                               |           |
|                                                                   |                                        |                      |                        |                               |           |
| Pile Type                                                         |                                        |                      |                        |                               |           |
| Criteria for selected toe level                                   |                                        |                      |                        |                               |           |
| Allowance for negative skin friction                              |                                        |                      |                        |                               |           |
| Special Measures/Comments                                         |                                        |                      |                        |                               |           |
| Settlement                                                        |                                        |                      |                        |                               | Reference |
| Structural Element                                                | Immediate Settlement, mm               | Total Settlement, mm | Time for 90 per cent   | Remaining at Completion, mm   |           |
| Spread Foundations                                                | ~15                                    | ~15                  | <1 months              | <10 mm                        |           |
|                                                                   |                                        |                      |                        |                               |           |
| Differential settlement between adjacent supports                 |                                        |                      |                        | <10 mm                        |           |
| Differential settlement between structure and approach embankment |                                        |                      |                        | <10 mm                        |           |
| Special Measures/Comments                                         | None                                   |                      |                        |                               |           |

| Ground Movements (after construction)                |                                                                                                                                        |                                |             |                | Reference |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------|----------------|-----------|
| Cause                                                | Maximum Movement                                                                                                                       | Measures to Deal with Movement |             |                |           |
| Earthworks                                           | None                                                                                                                                   | Not required                   |             |                |           |
| Embankment Loading                                   | None                                                                                                                                   | Not required                   |             |                |           |
| Cutting Excavation                                   | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Subsidence                                           | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Flowing Water                                        | Not applicable                                                                                                                         | Not required                   |             |                |           |
| Other                                                | None                                                                                                                                   | Not required                   |             |                |           |
| Special Measures/<br>Comments                        | None                                                                                                                                   |                                |             |                |           |
| Chemical Analysis                                    |                                                                                                                                        |                                |             |                | Reference |
| Type                                                 | Sulphate/<br>Sulphide                                                                                                                  | Chloride                       | pH/Redox    | Other          |           |
| Soil                                                 | 4.6 to 290 mg/l                                                                                                                        |                                | 5.6 to 10.0 |                | CC (2016) |
| Soil:Water                                           |                                                                                                                                        |                                |             |                |           |
| Water                                                |                                                                                                                                        |                                |             |                |           |
| Air                                                  |                                                                                                                                        |                                |             |                |           |
| Other                                                |                                                                                                                                        |                                |             |                |           |
| Buried concrete classification                       |                                                                                                                                        |                                |             | AC-1           |           |
| Corrugated steel culvert ground/water classification |                                                                                                                                        |                                |             | Not applicable |           |
| Special Measures/<br>Comments                        | Consideration will need to be given in the detailed design of concrete structures to allow for the potential action of de-icing salts. |                                |             |                |           |
| Other Design Features                                |                                                                                                                                        |                                |             |                | Reference |
| Anticipated Requirements                             | None                                                                                                                                   |                                |             |                |           |
| Special Measures/<br>Comments                        | None                                                                                                                                   |                                |             |                |           |



# Calculations

TODDINGTON LANE OVERBRIDGE (Traffic Load Group Gr5)

ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN INPUT DATA

### Ground Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Description                                       |
|-------------------|--------------------|---------------------------------------------------|
| Topsoil/Subsoil   | 7.05               | Firm slightly sandy CLAY or SILT                  |
| Aeolian Deposits  | 4.40               | Soft to firm sandy CLAY/SILT with a little gravel |
| Raised Beach Deps | 2.80               | Medium dense clayey SAND with a little gravel     |
| White Chalk       | -0.70              | Structureless CHALK (Grade Dc)                    |
|                   | -8.00              | Intact CHALK (Grades C2 to C4)                    |

Note: Ground level taken to be 6.80 m OD

### Groundwater Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

Ground water level,  $z_w$  1.00 m OD

Unit Wt,  $\gamma_w$  10 kN/m<sup>3</sup>

### Ground Properties (assume bearing on White Chalk<sup>(1)</sup>)

#### Undrained Conditions

Bulk Unit Wt,  $\gamma_k$  18.0 kN/m<sup>3</sup>

Undrained Shear,  $s_{uk}$  kPa

#### Drained Conditions

Bulk Unit Wt,  $\gamma_k$  18.0 kN/m<sup>3</sup>

Friction Angle,  $\phi'_k$  33 degrees

Friction Angle,  $\phi'_{cv,k}$  33 degrees

Eff Cohesion,  $c'_k$  10.0 kPa

### Foundation Properties

Unit Wt,  $\gamma_c$  24 kN/m<sup>3</sup>

### Design Code

BS EN 1997-1 Yes

BS 8004 No

| Status | List |
|--------|------|
| 1      | Yes  |
| 0      | No   |

### Partial Factors (for BS EN-1997-1)

#### Resistance Factors Com1 Com2

Friction Angle,  $\gamma_{\phi'}$  1.0 1.25

Eff Cohesion,  $\gamma_{c'}$  1.0 1.25

Undrained Shear,  $\gamma_{su}$  1.0 1.4

UCS,  $\gamma_{qu}$  1.0 1.4

#### Load Factors

Permanent,  $\gamma_G$  1.35 1.00 unfavourable

1.00 1.00 favourable

Variable,  $\gamma_Q$  1.50 1.30 unfavourable

0.00 0.00 favourable

### Factors of Safety (for BS 8004)

Vertical 2.5

Horizontal 2.5

1) Given the limited thickness of the Raised Beach Deposits relative to the plan dimensions of the proposed foundations, the presence of this material has been neglected and the bearing and sliding resistances have been determined assuming the structure is founded directly on the underlying structureless chalk. Given the lower design parameters selected for the structureless chalk, this assumption is deemed to be conservative.

### Note

Values in blue denote input data

# Calculations



|                                                     |                                         |      |    |     |      |      |      |                                                                                     |
|-----------------------------------------------------|-----------------------------------------|------|----|-----|------|------|------|-------------------------------------------------------------------------------------|
| TODDINGTON LANE OVERBRIDGE (Traffic Load Group Gr5) |                                         |      |    |     |      |      |      |  |
| ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS   |                                         |      |    |     |      |      |      |                                                                                     |
| Project Title                                       | LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON |      |    |     |      |      |      |                                                                                     |
| Project No                                          | 35944                                   | 3500 | By | mdh | Chkd | Cat2 | Date | 21/02/2018                                                                          |

## DIMENSIONS AND ACTIONS

### Foundation Type

Foundation type

Pad

Foundation weight included in actions

Yes

### Foundation Dimensions

Foundation width, B 14.0 m

Depth to base,  $z_b$  1.85 m

Foundation length, L 20.0 m

Base inclination,  $\alpha$  0 radians

| Status | List  |
|--------|-------|
| 0      | Strip |
| 1      | Pad   |
| Status | List  |
| 1      | Yes   |
| 0      | No    |

### Actions (Load on base)

| Traffic Load Group | Com1 ( $V_{max}$ , $H_{max}$ ) |       |       | Com1 ( $M_{max}$ ) |       |       | Com2  |       |       | SLS   |       |       |
|--------------------|--------------------------------|-------|-------|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                    | $V_d$                          | $H_d$ | $M_d$ | $V_d$              | $H_d$ | $M_d$ | $V_d$ | $H_d$ | $M_d$ | $V_d$ | $H_d$ | $M_d$ |
| Gr1a               | 67650                          | 8982  | 47174 | 55787              | 6596  | 52945 | 50672 | 8130  | 42604 | 50490 | 6641  | 36945 |
| Gr2                | 66437                          | 9289  | 49794 | 54574              | 6903  | 55565 | 49638 | 8347  | 44643 | 49522 | 6868  | 38501 |
| Gr5                | 68400                          | 8919  | 49490 | 56537              | 6533  | 55261 | 51310 | 8065  | 44528 | 51103 | 6595  | 38980 |
| Gr6                | 65793                          | 9085  | 45889 | 53930              | 6699  | 51660 | 49090 | 8142  | 41172 | 48986 | 6718  | 35285 |

Two sets for Combination 1 were analysed as the load factor for the soil behind the abutment is 1.35 for the maximum vertical load as it is unfavourable, and 0.95 for the maximum bending moment as it is favourable.

### Design Value of Actions

Traffic Load Group Gr5

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Design Action

$V_d =$

68400

$H_d =$

8919

$M_d =$

49490

$H_d =$

6533

$M_d =$

55261

Direction of H and M,  $\theta$  (from direction of L)

90

90

90 degrees

### Effective Foundation Dimensions

Com1<sub>VH</sub>

Com1<sub>M</sub>

Com 2

Eccentricity

in direction of B

$e_{dB} = M_d \cdot \sin(\theta) / V_d$

0.72

0.98

0.87 m

in direction of L

$e_{dL} = M_d \cdot \cos(\theta) / V_d$

0.00

0.00

0.00 m

Effective width

$B' = B - 2 \cdot e_{dB}$

12.55

12.05

12.26 m

Effective length

$L' = L - 2 \cdot e_{dL}$

20.00

20.00

20.00 m

Note

Denotes point of load application inside centre third of foundation

Denotes point of load application outside centre third of foundation

Note

Values in blue denote input data

# Calculations



TODDINGTON LANE OVERBRIDGE (Traffic Load Group Gr5)

ESTIMATED BEARING RESISTANCE - SPREAD FOUNDATIONS

|               |                                         |      |    |     |      |      |      |            |
|---------------|-----------------------------------------|------|----|-----|------|------|------|------------|
| Project Title | LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON |      |    |     |      |      |      |            |
| Project No    | 35944                                   | 3500 | By | mdh | Chkd | Cat2 | Date | 21/02/2018 |

## DRAINED CONDITIONS

### Bearing Resistance

| Unit resistance              | $R_d/A' = c'.N_c.b_c.s_c.i_c + q.N_q.b_q.s_q.i_q + 0.5.\gamma'.B'.N_\gamma.b_\gamma.s_\gamma.i_\gamma$                                                                                                  | Com1 <sub>VH</sub>           | Com1 <sub>M</sub>            | Com 2                        |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------|------------------------------|
| Friction angle               | $\phi'_d = \tan^{-1}(\tan\phi'_k/\gamma_\phi)$                                                                                                                                                          | 33.0                         | 33.0                         | 27.5 degrees                 |
| Effective cohesion           | $c'_d = c'_k/\gamma_c$                                                                                                                                                                                  | 10.0                         | 10.0                         | 8.0 kPa                      |
| Bearing factor               | $N_c = (N_q - 1).cot\phi'$<br>$N_q = e^{\pi \tan\phi'} \cdot \tan^2(45 + \phi'/2)$<br>$N_\gamma = 2.(N_q - 1).tan\phi'$                                                                                 | 38.6<br>26.1<br>32.6         | 38.6<br>26.1<br>32.6         | 24.8<br>13.9<br>13.4         |
| Base inclination factor      | $b_c = b_q \cdot (1 - b_q)/(N_c \cdot \tan\phi')$<br>$b_q = (1 - \alpha \cdot \tan\phi')^2$<br>$b_\gamma = b_q$                                                                                         | 1.00<br>1.00<br>1.00         | 1.00<br>1.00<br>1.00         | 1.00<br>1.00<br>1.00         |
| Shape factor                 | $s_c = (s_q \cdot N_q - 1)/(N_q - 1)$<br>$s_q = 1 + (B'/L') \cdot \sin\phi'$<br>$s_\gamma = 1 - 0.3(B'/L')$                                                                                             | 1.36<br>1.34<br>0.81         | 1.34<br>1.33<br>0.82         | 1.30<br>1.28<br>0.82         |
| Load inclination factor      | $i_c = i_q \cdot (1 - i_q)/(N_c \cdot \tan\phi')$<br>$i_q = [1 - H/(V + A' \cdot c' \cdot cot\phi')]^m$<br>$i_\gamma = [1 - H/(V + A' \cdot c' \cdot cot\phi')]^{m+1}$<br>$m = (2 + B'/L')/(1 + B'/L')$ | 0.80<br>0.81<br>0.71<br>1.61 | 0.82<br>0.83<br>0.74<br>1.62 | 0.76<br>0.77<br>0.66<br>1.62 |
| Eff unit weight of formation | $\gamma_d =$                                                                                                                                                                                            | 8.0                          | 8.0                          | 8.0 kN/m <sup>3</sup>        |
| Effective pressure at base   | $q = z_b \cdot \gamma'_k \cdot (z_b - z_w) \cdot g_w$                                                                                                                                                   | 24.8                         | 24.8                         | 24.8 kPa                     |
| Unit bearing resistance      | $R_d/A' =$                                                                                                                                                                                              | 2063                         | 2092                         | 890 kPa                      |
| Bearing resistance           | $R_d =$                                                                                                                                                                                                 | 517843                       | 503882                       | 218358 kN                    |
| Reduced bearing resistance   | $R_d =$                                                                                                                                                                                                 | 503263                       | 489097                       | 212065 kN                    |
| Design Action                | $V_d =$                                                                                                                                                                                                 | 68400                        | 56537                        | 51310 kN                     |
| Load Factor                  | $R_d/V_d =$                                                                                                                                                                                             | 7.4                          | 8.7                          | 4.1                          |
| Utilisation Factor           | $V_d/R_d =$                                                                                                                                                                                             | 0.14                         | 0.12                         | 0.24                         |

### Sliding Resistance

|                            |                                                          | Com1 <sub>VH</sub> | Com1 <sub>M</sub> | Com 2        |
|----------------------------|----------------------------------------------------------|--------------------|-------------------|--------------|
| Sliding resistance         | $R_{H;d} = V_d \cdot \tan(\delta_d)$                     |                    |                   |              |
| Base friction ratio        | $\delta_d/\phi'_{cv,d} =$                                | 1.00               | 1.00              | 1.00         |
| Design action              | $V_d =$                                                  | 68400              | 56537             | 51310 kN     |
| Friction angle             | $\phi'_{cv,d} = \tan^{-1}(\tan\phi'_{cv,k}/\gamma_\phi)$ | 33.0               | 33.0              | 27.5 degrees |
| Sliding resistance         | $R_{H;d} =$                                              | 44419              | 36716             | 26657 kN     |
| Reduced Sliding Resistance | $R_{H;d} =$                                              | 43169              | 35638             | 25889 kN     |
| Design Action              | $H_d =$                                                  | 8919               | 6533              | 8065 kN      |
| Load Factor                | $R_d/H_d =$                                              | 4.8                | 5.5               | 3.2          |
| Utilisation Factor         | $H_d/R_d =$                                              | 0.21               | 0.18              | 0.31         |

Bearing and sliding resistances have been reduced to allow for a loss of ground support over a plan dimension of 3.0 m to allow for any future development of solution features

#### Note

Values in blue denote input data

Values highlighted acceptable

Values highlighted unacceptable

|       |    |    |    |
|-------|----|----|----|
| Sheet | 03 | of | 03 |
|-------|----|----|----|

# Calculations

TODDINGTON LANE OVERBRIDGE

ESTIMATED GROUND MOVEMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN INPUT DATA

### Ground Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Description                                       |
|-------------------|--------------------|---------------------------------------------------|
| Topsoil/Subsoil   | 7.05               | Firm slightly sandy CLAY or SILT                  |
| Aeolian Deposits  | 4.95               | Soft to firm sandy CLAY/SILT with a little gravel |
| Raised Beach Deps | 3.35               | Medium dense clayey SAND with a little gravel     |
| White Chalk       | -0.70              | Structureless CHALK (Grade Dc)                    |
| White Chalk       | -8.00              | Intact CHALK (Grades C2 to C4)                    |

Note: Ground level taken to be 6.80 m OD

### Groundwater Conditions

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

Ground water level,  $z_w$  1.00 m OD

### Foundation Details

|         |        |                        |         |
|---------|--------|------------------------|---------|
| Breadth | 12.0 m | O'burden Pressure      | 0 kPa   |
| Length  | 20.0 m | Applied Pressure       | 210 kPa |
| Depth   | 1.85 m | Limiting Stress Change | 10 %    |

### Correction Factors

(Ref: CIRIA SP27, Fig 13)

Foundation Stiffness Stiff

| Status | List         |
|--------|--------------|
| 0      | Flexible     |
| 0      | Intermediate |
| 1      | Stiff        |

|            | Centre | Edge | Corner |
|------------|--------|------|--------|
| total      | 0.87   | 1.32 | 1.75   |
| short term | 0.85   | 1.16 | 1.35   |
| long term  | 0.88   | 1.45 | 2.10   |

### Estimated Ground Movements

|            | Centre | Edge  | Corner | Differential, 1/n |
|------------|--------|-------|--------|-------------------|
| total      | 15 mm  | 15 mm | 12 mm  | 5166              |
| short term | 14 mm  | 13 mm | 9 mm   | 2466              |
| long term  | 0 mm   | 2 mm  | 3 mm   | 4720              |

### Estimated Subgrade Modulus

|            | Centre    | Edge     | Corner   |
|------------|-----------|----------|----------|
| total      | 14 MPa/m  | 7 MPa/m  | 4 MPa/m  |
| short term | 15 MPa/m  | 8 MPa/m  | 6 MPa/m  |
| long term  | 629 MPa/m | 59 MPa/m | 19 MPa/m |



# Calculations



TODDINGTON LANE OVERBRIDGE

ESTIMATED GROUND MOVEMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## ESTIMATED GROUND MOVEMENT

### Design Parameters

(Ref: PBA Report 35944/3500/R01 rev0, December 2016)

| Strata            | Base Level<br>m OD | Design Parameters                   |         | Bulk Density<br>kN/m <sup>3</sup> | Comments |
|-------------------|--------------------|-------------------------------------|---------|-----------------------------------|----------|
|                   |                    | m <sub>v</sub> (m <sup>2</sup> /MN) | E (MPa) |                                   |          |
| Topsoil/Subsoil   | 7.05               | -                                   | -       | -                                 |          |
| Aeolian Deposits  | 4.95               | -                                   | 12      | 20.0                              |          |
| Raised Beach Deps | 3.35               | -                                   | 15      | 20.0                              |          |
| White Chalk       | -0.70              | -                                   | 75      | 18.0                              |          |
| White Chalk       | -8.00              | -                                   | 300     | 18.0                              |          |

| Depth, m bgl | Strata | Unit | mv                 | E   | Stress  | Stress | Settlement  | Stress | Settlement  | Stress | Settlement  | Stress | Settlement  | Comments |
|--------------|--------|------|--------------------|-----|---------|--------|-------------|--------|-------------|--------|-------------|--------|-------------|----------|
| top base     |        | Wt   | m <sup>2</sup> /MN | MPa | Initial | Inc    | Layer Total | Inc    | Layer Total | Inc    | Layer Total | Inc    | Layer Total |          |
| 0.0          | 1.85   | AD   | 20.0               | 12  | 18.5    |        |             |        |             |        |             |        |             |          |
| 1.85         | 2.5    | BD   | 20.0               | 15  | 43.5    | 210.0  | 3.3 16.7    | 105.0  | 2.3 11.0    | 52.5   | 1.5 7.0     |        |             |          |
| 2.5          | 3.0    | BD   | 20.0               | 15  | 55.0    | 209.7  | 2.9 13.4    | 104.9  | 2.0 8.7     | 52.5   | 1.2 5.5     |        |             |          |
| 3.0          | 3.35   | BD   | 20.0               | 15  | 63.5    | 209.0  | 2.2 10.5    | 104.5  | 1.4 6.7     | 52.5   | 0.9 4.3     |        |             |          |
| 3.35         | 4.0    | WC   | 18.0               | 75  | 72.9    | 207.5  | 0.8 8.3     | 103.9  | 0.6 5.3     | 52.4   | 0.3 3.4     |        |             |          |
| 4.0          | 4.5    | WC   | 18.0               | 75  | 83.2    | 204.6  | 0.7 7.5     | 102.6  | 0.4 4.7     | 52.3   | 0.3 3.1     |        |             |          |
| 4.5          | 5.0    | WC   | 18.0               | 75  | 92.2    | 201.1  | 0.7 6.8     | 101.1  | 0.5 4.3     | 52.2   | 0.3 2.8     |        |             |          |
| 5.0          | 5.5    | WC   | 18.0               | 75  | 101.2   | 196.7  | 0.7 6.1     | 99.1   | 0.5 3.8     | 52.0   | 0.3 2.5     |        |             |          |
| 5.5          | 5.80   | WC   | 18.0               | 75  | 108.4   | 192.7  | 0.4 5.4     | 97.4   | 0.3 3.4     | 51.8   | 0.2 2.2     |        |             |          |
| 5.80         | 6.5    | WC   | 8.0                | 75  | 113.9   | 187.1  | 1.0 4.9     | 95.0   | 0.6 3.1     | 51.5   | 0.4 2.1     |        |             |          |
| 6.5          | 7.0    | WC   | 8.0                | 75  | 118.7   | 179.7  | 0.7 3.9     | 91.8   | 0.5 2.4     | 51.1   | 0.3 1.7     |        |             |          |
| 7.0          | 7.5    | WC   | 8.0                | 75  | 122.7   | 173.1  | 0.7 3.2     | 89.0   | 0.4 2.0     | 50.7   | 0.3 1.4     |        |             |          |
| 7.5          | 8.0    | WC   | 8.0                | 300 | 126.7   | 166.4  | 0.2 2.5     | 86.2   | 0.1 1.5     | 50.2   | 0.1 1.1     |        |             |          |
| 8.0          | 8.5    | WC   | 8.0                | 300 | 130.7   | 159.6  | 0.2 2.3     | 83.3   | 0.1 1.4     | 49.6   | 0.1 1.0     |        |             |          |
| 8.5          | 9.0    | WC   | 8.0                | 300 | 134.7   | 152.8  | 0.2 2.1     | 80.5   | 0.1 1.3     | 49.1   | 0.1 1.0     |        |             |          |
| 9.0          | 9.5    | WC   | 8.0                | 300 | 138.7   | 146.1  | 0.2 1.9     | 77.7   | 0.1 1.2     | 48.4   | 0.1 0.9     |        |             |          |
| 9.5          | 10.0   | WC   | 8.0                | 300 | 142.7   | 139.5  | 0.2 1.8     | 74.9   | 0.1 1.1     | 47.8   | 0.1 0.8     |        |             |          |
| 10.0         | 10.5   | WC   | 8.0                | 300 | 146.7   | 133.1  | 0.2 1.6     | 72.3   | 0.1 1.0     | 47.1   | 0.1 0.8     |        |             |          |
| 10.5         | 11.0   | WC   | 8.0                | 300 | 150.7   | 127.0  | 0.2 1.4     | 69.7   | 0.1 0.9     | 46.3   | 0.1 0.7     |        |             |          |
| 11.0         | 11.5   | WC   | 8.0                | 300 | 154.7   | 121.1  | 0.1 1.3     | 67.2   | 0.1 0.8     | 45.5   | 0.1 0.6     |        |             |          |
| 11.5         | 12.0   | WC   | 8.0                | 300 | 158.7   | 115.4  | 0.1 1.1     | 64.8   | 0.1 0.7     | 44.8   | 0.1 0.6     |        |             |          |
| 12.0         | 12.5   | WC   | 8.0                | 300 | 162.7   | 110.0  | 0.1 1.0     | 62.5   | 0.1 0.6     | 43.9   | 0.1 0.5     |        |             |          |
| 12.5         | 13.0   | WC   | 8.0                | 300 | 166.7   | 104.8  | 0.1 0.9     | 60.4   | 0.1 0.6     | 43.1   | 0.1 0.4     |        |             |          |
| 13.0         | 13.5   | WC   | 8.0                | 300 | 170.7   | 99.9   | 0.1 0.7     | 58.3   | 0.1 0.5     | 42.3   | 0.1 0.4     |        |             |          |
| 13.5         | 14.0   | WC   | 8.0                | 300 | 174.7   | 95.3   | 0.1 0.6     | 56.3   | 0.1 0.4     | 41.4   | 0.1 0.3     |        |             |          |
| 14.0         | 14.5   | WC   | 8.0                | 300 | 178.7   | 90.8   | 0.1 0.5     | 54.3   | 0.1 0.3     | 40.6   | 0.1 0.2     |        |             |          |
| 14.5         | 15.0   | WC   | 8.0                | 300 | 182.7   | 86.7   | 0.1 0.3     | 52.5   | 0.1 0.2     | 39.7   | 0.1 0.2     |        |             |          |
| 15.0         | 15.5   | WC   | 8.0                | 300 | 186.7   | 82.7   | 0.1 0.2     | 50.7   | 0.1 0.1     | 38.9   | 0.1 0.1     |        |             |          |
| 15.5         | 16.0   | WC   | 8.0                | 300 | 190.7   | 79.0   | 0.1 0.1     | 49.0   | 0.1 0.1     | 38.0   | 0.1 0.1     |        |             |          |
| 16.0         |        |      |                    |     |         |        |             |        |             |        |             |        |             |          |

Note

Values in blue denote input data

Sheet 02 of 03

# Calculations



TODDINGTON LANE OVERBRIDGE

ESTIMATED GROUND MOVEMENT

Project Title LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON

Project No 35944 3500 By mdh Chkd Cat2 Date 21/02/2018

## DESIGN CALCULATIONS

### Stress Distribution

For uniform vertical loading of a rectangular area on a semi-infinte mass

Ref: Poulos and Davies (1974) Elastic Solutions for Soil and Rock Mechanics, Section 3.4

#### Vertical Stress Increase

(beneath the corner of the rectangle)

$$\delta\sigma_v = p/2\pi[\text{atan}(l.b/zR_3)+l.b.z/R_3(1/R_1^2+1/R_2^2)]$$

where

p = applied pressure

l = length fo rectangle

b = breadth of rectangle

z = depth below applied load

$$R_1 = (l^2+z^2)^{0.5}$$

$$R_2 = (b^2+z^2)^{0.5}$$

$$R_3 = (l^2+b^2+z^2)^{0.5}$$

#### Layer Settlement

for cohesive soils

$$\delta_i = m_v \cdot \Delta H \cdot \delta\sigma_v$$

Ref: CIRIA SP27 Settlement of Clays, Section 4.2.1

$m_v$  = coefficient of volume compressibility

E = elastic modulus

$\Delta H$  = layer thickness

for granular soil

$$\delta_i = 2.3 \cdot \sigma_{v0} \cdot \Delta H \log[(\sigma_{v0} + \delta\sigma_v) / \sigma_{v0}]$$

Ref: Based on DeBeer and Martens, 1957

$\sigma_{v0}$  = initial vertial stress

$\delta\sigma_v$  = vertical stress increase

## **APPENDIX 3**

### **Strengthened Earthworks Design Calculations – Not Used**

## **APPENDIX 4**

### **Drainage Design Calculations**

**– Not Used**



## **APPENDIX 5**

### **Pavement Design Calculations**

**– Not Used**

## APPENDIX 6

### Specification Appendices

## Specification (Series 600 Earthworks)

- (1) The Works shall be carried out in accordance with the requirements of the Highways Agency Manual of Contract Documents for Highway Works Volume 1: Specification for Highway Works dated March 1998 with all current amendments (May 2017), hereinafter referred to as the SHW, together with the Appendices to the Specification included in this document.

## Appendices to the Specification

### Appendix 0/1 - Substitute, Additional and Cancelled Clauses

- (1) The following Scheme Specific Substitute, Additional and Cancelled Clauses are included in the Specification

#### 602 General Requirements

20AR1 The Contractor shall prepare a detailed method statement, risk assessment and plans, in advance of the commencement of the earthworks operations, demonstrating the process by which he will achieve the requirements of all sub-Clauses. These shall include details of all testing to be undertaken, details of method of the tests and the soils laboratory to be utilized for such.

#### 608 Construction of Fills

14AR In addition to any grading requirements the maximum particle size of any fill material placed by method compaction shall be no more than two-thirds of the compacted layer thickness.

15AR The Contractor shall ensure that fill comprises material from a single source only. Cohesive and granular materials shall be excavated, placed and compacted separately without intermixing; use of interbedded cohesive and granular fill is not acceptable.

16AR Where a sheep's foot or similar compaction plant is adopted the testing shall be undertaken on the layer below the layer being compacted. Where the tested layer fails to meet the required specification both layers and any further overlying layers shall be removed and reworked at the Contractor's expense.

### Appendix 0/2 - Not Used

### Appendix 0/3 - Numbered Appendices

- (1) The following numbered appendices are included in this Specification for earthworks.

| Appendix | Title                                                                               |
|----------|-------------------------------------------------------------------------------------|
| 1/5      | Testing to be Carried out by the Contractor                                         |
| 6/1      | Requirements for Acceptability & Testing etc. of Earthworks Materials               |
| 6/2      | Requirements for Dealing with Class U1B and U2 Unacceptable Material                |
| 6/3      | Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction) |

<sup>1</sup> A suffix 'AR' indicates a Contract-specific Additional Clause to the Specification.

| Appendix | Title                                                                          |
|----------|--------------------------------------------------------------------------------|
| 6/6      | Fill to Structures and Fill Above Structural Foundations                       |
| 6/7      | Sub-formation, Capping, Preparation & Surface Treatment of Formation           |
| 6/9      | Earthwork Environmental Bunds, Landscape Areas, Strengthened Embankments       |
| 6/11     | Swallow Holes and Other Naturally Occurring Cavities and Disused Mine Workings |
| 6/12     | Instrumentation and Monitoring                                                 |
| 6/14     | Limiting Values for Pollution of Controlled Waters                             |
| 6/15     | Limiting Values for Harm to Human Health and the Environment                   |

## Appendix 0/4 - Drawings

- (1) Details of the required works are given on the following drawings:

| Drawing No | Revision <sup>(1)</sup> | Title |
|------------|-------------------------|-------|
| tba        | tba                     | tba   |
|            |                         |       |
|            |                         |       |
|            |                         |       |
|            |                         |       |
|            |                         |       |
|            |                         |       |

Note 1) Revision to be included in specification documents to be issued for the works

## Appendix 1/5 - Testing to be Carried Out by the Contractor

- (1) For all tests a UKAS test report or certificate is required. For all geoenvironmental/chemical tests a MCERTS test report or certificate is required.
- (2) Unless otherwise shown in this Appendix, tests and test certificates for work, goods or materials as scheduled under any one Clause are required for all such work, goods or materials in the Works.
- (3) All samples/tests shall be given a site reference number (not the laboratory reference number) that enables ease of reference and location. Such reference should include location and depth/elevation as a minimum. Colour photographs shall be taken of each sample/test location showing all necessary details of the location and material being sampled/tested. Artificial (flash) lighting shall be used for each photograph. Each photograph shall contain a graduated scale together with a reference board identifying the project and the sample/test number, a standard colour chart and a monochrome step wedge.
- (4) Preliminary records of all test results shall be provided to the Project Manager within 48 hours of completion of the test. On completion of the works, an Earthworks Validation Report shall be prepared by the Contractor presenting a record of the works carried out, full records of all loads delivered to and removed from site, and full records of all acceptability and compliance testing. The Earthworks Validation Report shall be presented in a single document together with a copy of the report in pdf format and digital data in AGS4 format.



**Table 1/5 Testing Requirements**

| Clause                | Work, Goods or Material                      | Test                                                        | Frequency of Testing                                        | Comments |
|-----------------------|----------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|----------|
| Acceptability Testing |                                              |                                                             |                                                             |          |
| 601, 631 to 637, 640  | Class 4 - Fill to Landscaped Areas           | Contamination Suite - Note 1                                | Note 2                                                      |          |
|                       | Class 6 – Selected Granular Fill             | Grading                                                     | Source approval (3 tests) and then every 200 m <sup>3</sup> |          |
|                       |                                              | Dry density/moisture content relationship                   | Source approval (3 tests) and then every 800 m <sup>3</sup> |          |
|                       |                                              | Moisture Content                                            | Source approval (3 tests) and then every 200 m <sup>3</sup> |          |
|                       |                                              | Los Angeles coefficient                                     | Source approval (3 tests) and then every 800 m <sup>3</sup> |          |
|                       |                                              | Effective angle of internal friction and effective cohesion | Source approval (3 tests) and then every 800 m <sup>3</sup> |          |
|                       | Contamination Suite - Note 1                 | Note 2                                                      |                                                             |          |
| Compliance Testing    |                                              |                                                             |                                                             |          |
| 612                   | Compaction of Fills - End Product Compaction | Field Dry Density and Moisture Content                      | Every 500 m <sup>3</sup> or 1 per day                       |          |

Note to Table 1/5:

1. Contamination testing in accordance with Appendices 6/14 and 6/15.
2. Frequency of contamination testing to be:
  - (i) For natural materials excavated from the site minimum 3 or 1 suite every 2000 m<sup>3</sup> (whichever is greater).
  - (ii) For natural materials imported onto the site, source approval 3 suites, then every 2000 m<sup>3</sup> from any one source.
  - (iii) For recycled aggregates; source approval 3 suites, then every 1000 m<sup>3</sup> from any one source.

## Appendix 6/1 - Requirements for Acceptability and Testing etc of Earthworks Material

- (1) Acceptable limits and criteria for the Permitted Classes of fills appropriate to the Contract are detailed on Table 6/1 of the SHW, the modified Table 6/1 included in this Appendix and Appendices 6/14 and 6/15 of the Specification. The Contractor is responsible for appropriate sampling and testing, including testing to determine the concentration of potential contaminants, to classify and determine the acceptability of earthworks materials based on the specified limits and criteria.
- (2) Samples for classification and acceptability testing shall be taken at the point of excavation for on-site materials and at the point of deposition for imported materials. If the material has altered its classification or become unacceptable for whatever reason, the Contractor shall repeat the classification and acceptability tests. The frequency and scope of acceptability testing requirements shall be according to Appendix 1/5 of the Specification.
- (3) The Contractor is to submit an Earthworks Quality Control Method Statement for approval by the Project Manager not less than 10 working days prior to the start of Earthworks.
- (4) Permitted Constituents of fill materials shall be any natural materials or combinations of natural materials other than chalk and material designated as Class 3. There are no existing on-site materials to be designated as Class 3 and no Class 3 materials are to be used in the works.

- (5) Where material is imported onto site which is not 'as dug' it shall be natural aggregates (except shale, siltstone, or slate) or crushed concrete, bricks or masonry conforming to BS EN 13242.
- (6) Where fill materials include recycled crushed concrete, the Contractor shall determine the nature of the ground and groundwater beneath and surrounding the areas of proposed fill with respect to sulphur, sulphates, and any other potentially deleterious materials, in accordance with TRL 447 and other relevant guidance, and shall assess in accordance with TRL 447 and other relevant guidance the suitability of using materials containing recycled crushed concrete in the proposed areas.
- (7) The fill materials shall be inert as defined in Clause 7(4) of the Landfill (England and Wales) Regulations 2002. The fill materials shall be tested to determine the concentration of potential contaminants in accordance with the methodology and limits of detection included in Appendices 6/14/and 6/15 of this Specification. The materials shall be classified as Unacceptable Material Class U2 when the concentrations of potential contaminants exceed the acceptability limits given in Appendices 6/14/and 6/15 and shall be dealt with in accordance with Appendix 6/2. The frequency and scope of acceptability testing requirements shall be to Appendix 1/5 of this Specification.
- (8) The Contractor is responsible for ensuring all statutory and regulatory requirements for the receipt and use of all materials either excavated from the site or imported onto the site are observed. The Contractor is responsible for ensuring a record of each load delivered and accepted is kept giving: (i) date, (ii) nature and quality, (iii) place of origin, (iv) quantity by weight/volume, (v) carrier, (vi) supplier. The Contractor is responsible for ensuring a visual and olfactory assessment is carried out on every load, on initial receipt and after deposition, to ensure compliance with the Acceptance Criteria; the findings of the assessment shall be recorded with the record sheet for the load.
- (9) There are no specified requirements for processing to render unacceptable material Class U1A or Class U1B acceptable. There are no specified requirements for the removal off site of excavated acceptable or unacceptable material requiring processing or retention on site of surplus material. The Contractor shall be responsible for removal and / or processing of unacceptable material or surplus acceptable material deemed not acceptable for use in the Permanent Works.
- (10) Acceptable or unacceptable fill, other than contaminated material may be used in landscape areas. This excludes the environmental, noise bunds, or any other earthworks of structural nature, where the fill parameters are determined through stability or bearing capacity requirements. Class 5 and Class U2 materials shall not be used as landscape fill.
- (11) There are no specified requirements for groundwater lowering or other treatment. The Contractor shall take all necessary measures (both temporary and permanent) to ensure that the presence or ingress of groundwater, infiltration water and the effects of weather does not compromise the integrity of earthworks. Operations shall not take place during adverse weather conditions.

**Table 6/1 Acceptable Earthworks Materials**

| Class | General Description                                                  | Typical Use                                           | Permitted Constituents (Note 1)                                                                                                                                                                                              | Material Properties Required for Acceptability (Note 2)     |                                                     |                   |           | Compaction Requirements (Note 3) |
|-------|----------------------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------------|-------------------|-----------|----------------------------------|
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Property                                                    | Defined and Tested in Accordance with               | Acceptable Limits |           |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              |                                                             |                                                     | Lower             | Upper     |                                  |
| 4     | Various                                                              | Fill to Landscaped Areas                              | See App 6/1 Cl (4) & (7)                                                                                                                                                                                                     | Grading                                                     | BS 1377 : Part 2                                    | -                 | 125 mm    | See Clause 620                   |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Moisture content                                            | BS 1377 : Part 2                                    | -                 | 35%       |                                  |
| 6F5   | Selected granular material (coarse grading) – imported onto the Site | Capping                                               | Unbound mixture complying with BS EN 13285 containing aggregate conforming to BS EN 13242 comprising natural aggregates, or crushed concrete bricks, or masonry – except chalk, shale, siltstone or slate, see Notes 7 and 8 | Size designation and overall grading category               | BS EN 13285 – 0/80 and G <sub>E</sub>               | Table 6/5         | Table 6/5 | Table 6/4 Method 6               |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Maximum fines and oversize categories                       | BS EN 13285 – UF <sub>12</sub> and OC <sub>75</sub> | Table 6/5         | Table 6/5 |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Los Angeles coefficient                                     | BS EN 13242 – LA <sub>50</sub>                      | -                 | 50        |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Laboratory dry density and optimum water content            | BS EN 13285, Cl 5.3 – declared values               | -                 | -         |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Moisture content                                            | BS EN 1097-5                                        | OMC-2%            | OMC       |                                  |
| 6I    | Selected well graded granular material                               | Fill to reinforced soil and anchored earth structures | See App 6/1 Cl (4) & (7) other than argillaceous rock                                                                                                                                                                        | Grading                                                     | BS 1377 : Part 2 (On-site)                          | Table 6/2         | Table 6/2 | Table 6/4 Method 2               |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              |                                                             | BS EN 933-2 (Imported onto site)                    | Table 6/5         | Table 6/5 |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Uniformity coefficient                                      | See Note 5                                          | 10                | -         |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Moisture content                                            | BS 1377 : Part 2 See Note 6                         | OMC-2%            | OMC+2%    |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Effective angle of internal friction and effective cohesion | Clause 636                                          | tba               | -         |                                  |
|       |                                                                      |                                                       |                                                                                                                                                                                                                              | Coefficient of friction and adhesion (fill/elements)        | Clause 639                                          | tba               | -         |                                  |



| Class | General Description                         | Typical Use                                           | Permitted Constituents (Note 1)                       | Material Properties Required for Acceptability (Note 2)     |                                  |                        |           | Compaction Requirements (Note 3)                                                     |
|-------|---------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|----------------------------------|------------------------|-----------|--------------------------------------------------------------------------------------|
| 6J    | Selected uniformly graded granular material | Fill to reinforced soil and anchored earth structures | See App 6/1 CI (4) & (7) other than argillaceous rock | Grading                                                     | BS 1377 : Part 2 (On-site)       | Table 6/2              | Table 6/2 | Table 6/4 Method 3                                                                   |
|       |                                             |                                                       |                                                       |                                                             | BS EN 933-2 (Off-site)           | Table 6/5              | Table 6/5 |                                                                                      |
|       |                                             |                                                       |                                                       | Uniformity coefficient                                      | See Note 5                       | 5                      | 10        |                                                                                      |
|       |                                             |                                                       |                                                       | Moisture content                                            | BS 1377 : Part 2<br>See Note 6   | OMC-2%                 | OMC+2%    |                                                                                      |
|       |                                             |                                                       |                                                       | Effective angle of internal friction and effective cohesion | Clause 636                       | tba                    |           |                                                                                      |
| 6N    | Selected well graded granular material      | Fill to structures                                    | See App 6/1 CI (4) & (7) other than argillaceous rock | Grading                                                     | BS 1377 : Part 2 (On-site)       | Table 6/2              | Table 6/2 | End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method) |
|       |                                             |                                                       |                                                       |                                                             | BS EN 933-2 (Imported onto site) | Table 6/5              | Table 6/5 |                                                                                      |
|       |                                             |                                                       |                                                       | Uniformity coefficient                                      | See Note 5                       | 10                     | -         |                                                                                      |
|       |                                             |                                                       |                                                       | Los Angeles coefficient                                     | Clause 635                       | -                      | 40        |                                                                                      |
|       |                                             |                                                       |                                                       | Effective angle of internal friction and effective cohesion | Clause 636                       | 38 degrees and 0.0 kPa | -         |                                                                                      |
| 6P    | Selected well graded granular material      | Fill to structures                                    | See App 6/1 CI (4) & (7) other than argillaceous rock | Grading                                                     | BS 1377 : Part 2 (On-site)       | Table 6/2              | Table 6/2 | End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method) |
|       |                                             |                                                       |                                                       |                                                             | BS EN 933-2 (Off-site)           | Table 6/5              | Table 6/5 |                                                                                      |
|       |                                             |                                                       |                                                       | Uniformity coefficient                                      | See Note 5                       | 5                      | -         |                                                                                      |
|       |                                             |                                                       |                                                       | Los Angeles coefficient                                     | Clause 635                       | -                      | 60        |                                                                                      |
|       |                                             |                                                       |                                                       | Effective angle of internal friction and effective cohesion | Clause 636                       | 38 degrees and 0.0 kPa | -         |                                                                                      |



**Notes to Table 6/1:**

1. Permitted constituents shall all be subject to requirements of Clause 601 and Appendix 6/1 Clause (4) & (6).
2. Material properties required for acceptability shall be in addition to requirements on use of fill materials in Clause 601.
3. Compaction requirements shall be as defined in Clause 612.
4. Optimum moisture content (omc) determined in accordance with BS 1377 : Part 4, 2.5 kg rammer method.
5. Uniformity coefficient is defined as the ratio of the particle diameters  $D_{60}$  to  $D_{10}$  on the particle-size distribution curve, where:  
 $D_{60}$  = particle diameter at which 60% of the soil by weight is finer  
 $D_{10}$  = particle diameter at which 10% of the soil by weight is finer
6. Optimum moisture content (omc) determined in accordance with BS 1377 : Part 4, vibrating hammer method.
7. Where materials are required to be aggregates conforming to BS EN 13242 materials certificated as being compliant with BS EN 13285 are acceptable for use provided that they meet all the specification requirements and the Declaration of Performance for constituent parts to BS EN 13242 are provided to the Overseeing Organisation.
8. Materials shall comply with the current Environmental Regulations at the time of use. Reference shall be made to Annex ZA (informative) of BS EN 13242.

## **Appendix 6/2 - Requirements for Dealing with Class U1B and U2 Unacceptable Material**

- (1) The Contractor shall report immediately to the Project Manager any Class U1B and U2 Unacceptable Material found within the works. Unacceptable material Class U1B and U2 shall not be permitted to remain on site. The Contractor shall agree with the Project Manager methods for the safe removal of the material.
- (2) The Contractor is responsible for dealing with Class U1B and Class U2 unacceptable material including where required:
  - a) Classification of Class U1B and Class U2 material by appropriate chemical testing including WAC testing.
  - b) Preparation of method statements for dealing with any Class U1B and Class U2 materials
  - c) Keeping records of the location, volumes, extent, nature and test results for all Class U1B and Class U2 materials encountered.
  - d) Agreement of special requirements for dealing with unacceptable materials with the Environmental Health Officer, Environment Agency and other statutory bodies.
  - e) Agreement of special requirements for dealing with leachate and contaminated water with the Environmental Health Officer, Environment Agency and other statutory bodies.
  - f) Dealing with unacceptable materials whether by excavation and disposal, treatment, sealing or other means.
  - g) Dealing with leachate and contaminated water whether by pumping and disposal, treatment or other means, including the provision of special drainage where required.
  - h) Compliance with all Duty of Care and waste regulation obligations.
- (3) Where Class U1B and Class U2 material is excavated, the material shall not be left exposed overnight and the Contractor is responsible for providing temporary cover. Cover may be provided by Class U1B materials or other material determined by the Contractor as agreed with the Project Manager. This shall be placed to give a cover of not less than 150 mm. All temporary cover shall be removed in advance of the permanent works and disposal off site accordingly.
- (4) The Contractor is to ensure that all Class U1B and U2 materials are disposed of at an appropriately licensed landfill or processing facility approved by the Environment Agency in a safe and competent manner and in accordance with relevant Statutory Regulations. The Contractor shall keep records/transfer notes of all waste materials removed from this site and shall include the volume of waste material, the description of the waste material, date of removal, the destination of the waste material and the carrier. The Contractor is required to submit copies of this information to the Project Manager as soon as it becomes available.

## Appendix 6/3 - Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction)

### Excavation Works

- (1) The existing topsoil, subsoil and near-surface soils shall be excavated as required within the area of the proposed works as shown on the Drawings. The topsoil/subsoil shall be handled and stored in accordance with the requirements of BS 3882 (2007). Unnecessary and premature removal of topsoil and subsoil shall be avoided.
- (2) The exposed natural soils shall be profiled such that there are no areas in which surface water may accumulate. The Contractor shall take all necessary measures (both temporary and permanent) to ensure that the integrity of formation is not compromised by adverse affects of construction traffic, weather et cetera as required. Operations shall not take place during adverse weather conditions.
- (3) Where the slope to the excavated area is greater than 1 vertical in 10 horizontal, the excavation shall be cut in horizontal benches in order to “key” the existing and the new fill materials together. The benches shall be 0.5 m high and at least 0.5 m wide.
- (4) The Contractor shall note and record any groundwater inflows, existing land drainage or cases of instability and provide records to the Designer’s Representative within 24 hours.
- (5) The exposed formation to all works is to be inspected by a qualified geotechnical engineer prior to constructing the works to identify the presence of any natural solution features and mining cavities. Particular care is to be given to identifying any features that may be indicative of the presence of any solution features and mining cavities, such as (a) voids in the ground; (b) collapsed ground that may appear as depressions or hollows at the ground surface; (c) different ground conditions to those expected, e.g. areas of infill or disturbed ground; (d) rapid changes of soil colour or soil type over short horizontal distances; and (e) vertical interfaces between different soils types. Any potential solution features or mining cavities shall be investigated by appropriate intrusive ground investigation techniques. If the presence of solution features or mining cavities is confirmed appropriate techniques shall be adopted to infill any voids and stabilise any soft or loose infill materials. The investigation and stabilisation works shall be carried out in accordance with the requirements of **Appendix 6/11** if the Specification.
- (6) The exposed formation shall be compacted in accordance with the requirements of Clause 612 (4) to (10) using Method 1 as defined in Table 6/4. Any material exposed in the formation having an undrained shear strength less than 50 kPa or otherwise unacceptable material shall be excavated and the resulting void backfilled with Class 6N/6P material in accordance with the requirements of the Specification.
- (7) The prepared formation shall be subject to approval by the Project Manager prior to placing any fill material.

### Watercourses

- (8) Redundant watercourses (including ditches) shall be treated in accordance with Clause 606.2 and 606.4. The watercourse shall be cleared of vegetation and soft material, and backfilled with acceptable fill as shown on the Drainage Design Drawings and compacted in accordance with the specification. All surfaces remaining exposed shall be topsoiled and seeded in accordance with **Appendix 6/8**.
- (9) The Contractor shall be responsible for any temporary or permanent protection of watercourses, including ditches.

### **Embankment Construction**

- (10) The following requirements relate to the west side of the approach embankment to the south of the rail bridge to be constructed using conventional earth fill.
- (11) The fill material to be used to form the embankment will be determined in agreement with the appointed contractor for the works but given the opposite side of the embankment will be constructed using reinforced soil with a modular concrete facing system it is expected that the embankment shall be constructed in Class 6I/6J acceptable material complying with the requirements of Table 6/1.
- (12) Method compaction of fill materials is to be carried out in accordance with the requirements of Table 6/1 of the Specification. Filling shall be in uniform layers. Compaction shall be completed as soon as possible after the material has been spread and in accordance with specific requirements for the placed material. Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.
- (13) The surface of any layer of material shall on completion of compaction and immediately before overlaying, be free from movement under compaction plant and be free from ridges, cracks, loose materials, pot holes, ruts and other defects. All loose segregated or otherwise defective areas shall be removed to the full thickness of the layer and new material should be laid and compacted.
- (14) Should at any time the material change from that identified, the Contractor shall change the method of compaction to ensure compliance with the requirements of the Specification.
- (15) The Contractor shall keep contemporaneous records of the method of compaction including layer thickness, type of plant, number of passes and material type.

## **Appendix 6/6 - Fill to Structures and Fill above Structural Foundations**

### **Filling**

- (1) Fill to structures shall be either Class 6N or Class 6P or other acceptable material as shown on the drawings complying with the requirements of Table 6/1.
- (2) Fill to structures shall be deposited and compacted to Clause 610.
- (3) Full scale trials to determine stable slope of Class 6N or 6P are not required.

### **Compliance Testing**

- (4) Compliance testing is required to confirm the degree of compaction achieved is in accordance with the requirements of Appendix 6/1. Compliance testing shall be carried out in accordance with BS 1377 : Part 9 using either the sand replacement or core cutter methods. Where a Nuclear Density Meter (NDM) is used to determine the field dry densities it shall be used in accordance with BS 1377 : Part 9. The NDM shall be subject to initial calibration and calibration checks against the results of sand replacement or core cutter tests on a daily basis or every 10 NDM tests whichever the greater.
- (5) Details on the frequency of the compliance testing are given in Appendix 1/5. The testing shall be carried out to ensure that an even spatial distribution across the area of the works is achieved.



- (6) The degree of compaction for the earthworks shall be deemed to have been achieved if at least 9 of out 10 consecutive in-situ dry density determinations of the compacted material attain 95% of the determined maximum dry density for the material being placed, provided no value falls below 90% of the determined maximum dry density.
- (7) The in-situ density test results will be reported as in situ dry density and moisture content and also in terms of percentage of maximum dry density achieved.

## **Appendix 6/7 - Sub-formation, Capping, Preparation & Surface Treatment of Formation**

- (1) Preparation and surface treatment of the formation in soil shall be to levels in accordance with Clause 616.
- (2) On site testing of the sub-formation, in accordance with CI 5.12 to 5.15 of IAN 73/06 (HA, 2009), shall be carried out to determine the in-situ CBR value at the time of construction. If the in-situ CBR is found to be less than the design CBR value taken to be 15 per cent for the engineered fill material, then the subgrade must either be improved to the design CBR or the foundation redesigned. If the in-situ CBR is found to be less than the design CBR value taken to be 0.5 per cent for the existing natural ground, then the Contractor shall advise the Project Manager and take all measures required to investigate for and stabilise possible infilled solution features in accordance with the requirements of **Appendix 6/11**.

## **Appendix 6/9 - Earthwork Environmental Bunds, Landscape Areas, Strengthened Embankments**

### **Landscaped Areas**

- (3) Landscaped areas shall be constructed using Class 4 material compacted in accordance with Clause 620.2. Method compaction to landscaped areas is not required.

### **Strengthened Embankments**

- (1) To be included

## **Appendix 6/11 - Swallow Holes and Other Naturally Occurring Cavities and Disused Mine Workings**

- (1) The Contractor shall report immediately to the Project Manager any solution features or mining cavities found within the works. The Contractor shall agree with the Project Manager methods for the investigation and stabilisation of any solution features or mining cavities.
- (2) The Contractor is responsible for dealing with any solution features or mining cavities including where required:
  - a) Preparation of method statements for the investigation and stabilisation of any solution features or mining cavities.
  - b) Investigation of the features using techniques such as, for example, boreholes, dynamic probing, and trial excavations.
  - c) Stabilisation of the features using techniques such as (i) excavation of all soft and loose material backfilling with a granular material; (ii) grouting to infill any voids and/or compact any soft or loose material within the feature; (iii) sealing of the feature by a layer of clay

- or other relatively impermeable material such as lean-mix concrete; (iv) capping of the feature with reinforced concrete; or (v) any combination of these techniques.
- d) Keeping records of the location, volumes, extent and nature of all solution features or mining cavities encountered.
- e) Keeping records of the location, volumes, extent and nature of the works carried out to stabilise all solution features or mining cavities encountered.

## **Appendix 6/12: Instrumentation and Monitoring**

- (1) The Contractor shall carry out precision levelling of the proposed monolithic abutments and wing walls to the road and rail bridges.
- (2) The Contractor shall install survey points at each end of each abutment and wing wall. The Contractor shall ensure the survey points are protected for the duration of the required monitoring.
- (3) The Contractor shall install datum points sufficiently remote from the proposed works such that they are not affected by any construction works or other activities. The Contractor shall ensure the datum points are protected for the duration of the required monitoring.
- (4) Precise levelling shall be carried out daily during infilling of the structure and twice weekly thereafter for a period of four weeks from completion of the infilling or until long-term settlements are effectively complete. The Contractor shall compile and submit reports to the Employers Representative on the establishment of the survey and datum points and each round of levelling presenting the co-ordinate and level information of each survey and datum point with 24 hours of measurement.

## **Appendix 6/14 - Limiting Values for Pollution of Controlled Waters**

- (1) All fill materials shall be tested to ensure the concentrations of potential contaminants are below the guideline values for inert material given by:
  - a) DEFRA (2005) The Landfill (England and Wales) (Amendment) Regulations 2005. Statutory Instrument 2005 No 1640. Department of the Environment, Food and Rural Affairs, London.
- (2) The frequency of acceptability testing shall be according to Appendix 1/5 of the Specification.
- (3) No material exceeding these limits shall be incorporated into the works.

## **Appendix 6/15 - Limiting Values for Harm to Human Health and the Environment**

- (1) All fill materials shall be tested to ensure the concentrations of potential contaminants are below the guideline values for commercial/industrial development given by:
  - a) CIEH (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. The Chartered Institute of Environmental Health, Nottingham.
  - b) CL:AIRE (2014) Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report SP1010 (Rev 2), Contaminated Land: Applications in Real Environments, London.

The guideline values shall be modified as required to restrict maximum values to below the hazardous waste criteria.
- (2) The required contamination testing suite and limiting values are given in Table 6/15a below.

**Table 6/15a: Limiting Values of Potential Contaminants in Soil**

| Determinand                                               | Units | Detection Limit | Limiting Values     |
|-----------------------------------------------------------|-------|-----------------|---------------------|
| <b>Metals/Metalloids</b>                                  |       |                 |                     |
| Arsenic                                                   | mg/kg | 1.0             | 640 <sup>1</sup>    |
| Cadmium                                                   | mg/kg | 0.1             | 230 <sup>1</sup>    |
| Chromium (total)                                          | mg/kg | 0.15            | 1700 <sup>3,4</sup> |
| Copper                                                    | mg/kg | 0.2             | 2200 <sup>3,4</sup> |
| Lead                                                      | mg/kg | 0.3             | 2300 <sup>5</sup>   |
| Mercury (inorganic)                                       | mg/kg | 0.05            | 1000 <sup>3,4</sup> |
| Nickel                                                    | mg/kg | 1.0             | 1800 <sup>1</sup>   |
| Selenium                                                  | mg/kg | 0.5             | 13 000 <sup>1</sup> |
| Vanadium                                                  | mg/kg | 0.8             | 9000 <sup>2</sup>   |
| Zinc                                                      | mg/kg | 1.0             | 2000 <sup>3,4</sup> |
| <b>Polycyclic Aromatic Hydrocarbons</b> <sup>Note 6</sup> |       |                 |                     |
| PAH Screen                                                | mg/kg | 0.1             | 1000 <sup>3,7</sup> |
| <b>Aliphatic/Aromatic Hydrocarbons</b> <sup>Note 6</sup>  |       |                 |                     |
| Extractable Petroleum Hydrocarbon Screen                  | mg/kg | 10              | Note 8              |
| <b>Other</b>                                              |       |                 |                     |
| Asbestos                                                  | %     | 0.001           | Note 10             |

**Notes**

- 1 EA (2009) Soil Guideline Values
- 2 CEIH (2009) Generic Assessment Criteria
- 3 Values selected to limit concentration to below the limit for classification as hazardous waste
- 4 Values derived assuming simple oxide or metal compound using HazWaste Online Engine and Database version 01 December 2014.
- 5 CL:AIRE (2013) Development of Category 4 Screening Levels
- 6 SGV/GAC for soils with Soil Organic Matter of 1% are given as detailed in the table. If required limiting values for soils with Soil Organic Matter of 2.5% or 6% to be agreed with local authority.
- 7 If PAH screen >10 mg/kg then carry out PAH EPA 16 determination with reference to the limiting values given in Table 6/15b.
- 8 If EPH result is >100 mg/kg then carry out TPH CWG with carbon banding determination with reference to the limiting values given in Table 6/15c.
- 9 Value also subject to a maximum for the sum of aliphatics to 1000 mg/kg
- 10 Should Asbestos be identified the Project Manager should be informed immediately

**Table 6/15b: Limiting Values of Polynuclear Aromatic Hydrocarbons** <sup>Note 6</sup>

| Determinand            | Units | Detection Limit | Limiting Values   |
|------------------------|-------|-----------------|-------------------|
| Acenaphthene           | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Acenaphthylene         | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Anthracene             | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Benzo(a)anthracene     | mg/kg | 0.1             | 170 <sup>2</sup>  |
| Benzo(a)pyrene         | mg/kg | 0.1             | 35 <sup>2</sup>   |
| Benzo(b)fluoranthene   | mg/kg | 0.1             | 44 <sup>2</sup>   |
| Benzo(g,h,i)perylene   | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Benzo(k)fluoranthene   | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Chrysene               | mg/kg | 0.1             | 350 <sup>2</sup>  |
| Dibenzo(a,h)anthracene | mg/kg | 0.1             | 3.5 <sup>2</sup>  |
| Fluoranthene           | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Fluorene               | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.1             | 500 <sup>2</sup>  |
| Naphthalene            | mg/kg | 0.1             | 190 <sup>2</sup>  |
| Phenanthrene           | mg/kg | 0.1             | 1000 <sup>3</sup> |
| Pyrene                 | mg/kg | 0.1             | 1000 <sup>3</sup> |

**Table 6/15c: Limiting Values of Carbon Banded Hydrocarbons** <sup>Note 6</sup>

| Determinand       | Units | Detection Limit | Limiting Values     |
|-------------------|-------|-----------------|---------------------|
| <i>Aliphatics</i> |       |                 |                     |
| >C5-6             | mg/kg | 0.1             | 1000 <sup>3,9</sup> |
| >C6-8             | mg/kg | 0.1             | 1000 <sup>3,9</sup> |
| >C8-10            | mg/kg | 0.1             | 1000 <sup>3,9</sup> |
| >C10-12           | mg/kg | 1.5             | 1000 <sup>3,9</sup> |
| >C12-16           | mg/kg | 1.2             | 1000 <sup>3,9</sup> |
| >C16-21           | mg/kg | 1.5             | 1000 <sup>3,9</sup> |
| >C21-35           | mg/kg | 3.4             | 1000 <sup>3,9</sup> |
| >C35-40           | mg/kg | 5.0             | 1000 <sup>3</sup>   |
| <i>Aromatics</i>  |       |                 |                     |
| >C5-7             | mg/kg | 0.05            | 1000 <sup>3</sup>   |
| >C7-8             | mg/kg | 0.05            | 1000 <sup>3</sup>   |
| >C8-10            | mg/kg | 0.05            | 1000 <sup>3</sup>   |
| >C10-12           | mg/kg | 0.9             | 1000 <sup>3</sup>   |
| >C12-16           | mg/kg | 0.5             | 1000 <sup>3</sup>   |
| >C16-21           | mg/kg | 0.6             | 1000 <sup>3</sup>   |
| >C21-35           | mg/kg | 1.4             | 1000 <sup>3</sup>   |
| >C35-44           | mg/kg | 1.4             | 1000 <sup>3</sup>   |

- (3) The frequency of acceptability testing shall be according to Appendix 1/5 of the Specification.
- (4) No material exceeding these limits shall be incorporated into the works.



## APPENDIX 7

### Geotechnical Risk Register



# GEOTECHNICAL RISK REGISTER

**Project:** LYMINSTER BYPASS (SOUTH), LITTLEHAMPTON  
**Project No:** 35944/3500  
**Register Number:** GRR KS3

**Key Stage:** 3  
**Date:** 5 February 2018  
**Revision** 1

| Ref No    | Activity/Hazard                                      | Consequence                                                                                                    | Probability | Impact | HA Risk Rating | Mitigation/Action                                                                                | Probability | Impact | HA Risk Rating | Comments                                                                                                                                    |
|-----------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-------------|--------|----------------|--------------------------------------------------------------------------------------------------|-------------|--------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G1</b> | <b>General</b>                                       |                                                                                                                |             |        |                |                                                                                                  |             |        |                |                                                                                                                                             |
| /a        | Ground conditions                                    | Additional works to excavate and replace unacceptable material                                                 | 2           | 2      | 4              | Additional ground investigation works to determine ground conditions on central part of the site | 1           | 1      | 2              | Owing to access restriction no information on ground conditions is available for the central part of the site                               |
| /b        | Contaminated ground                                  | Risk of harm to site workers and the environment                                                               | 1           | 2      | 2              | Make provision for dealing with any unexpected sources of contamination                          | 1           | 2      | 2              | From known history of the site and findings of the ground investigation the potential for contamination to be present is assessed to be low |
| /c        | Groundwater                                          | Risk of local flooding of the works and softening of the ground                                                | 1           | 1      | 1              | Make provision for dealing with any groundwater inflows                                          | 1           | 1      | 1              | Groundwater is expected to be present below the base of any excavations                                                                     |
| /d        | Utilities                                            | Damage during works posing risk to site workers and public; additional works to disconnect or realign services | 2           | 3      | 6              | Make provision for detailed survey to identify all live services.                                | 2           | 2      | 4              | None                                                                                                                                        |
| /e        | Natural cavities; solution features, caves and gulls | Local loss of ground support resulting in excess settlement or local failure of supported infrastructure       | 2           | 3      | 6              | Make provision for inspection of exposed formation for evidence of infilled natural cavities     | 2           | 2      | 4              | Potential for natural solution features to be present in White Chalk on the site                                                            |
| /f        | Shrinking or Swelling Clay                           | Distortion and possible damage to foundations and pavements                                                    | 2           | 2      | 4              | Make provision for inspection of exposed formation for evidence of shrinking or swelling clay    | 2           | 1      | 2              | None                                                                                                                                        |

Notes: a) Probability 1: Negligible 2: Unlikely 3: Probable 4: Likely 5: Very likely  
b) Impact 1: Very low 2: Low 3: Medium 4: High 5: Severe  
c) Rating 1-4: Negligible 5-9: Low 10-14: Medium 15-19: High 20-25: Severe

| Ref No    | Activity/Hazard                                                    | Consequence                                                                      | Probability | Impact | HA Risk Rating | Mitigation/Action                                                                                                          | Probability | Impact | HA Risk Rating | Comments                                                                                     |
|-----------|--------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------|--------|----------------|----------------------------------------------------------------------------------------------------------------------------|-------------|--------|----------------|----------------------------------------------------------------------------------------------|
| /g        | Compressible Ground                                                | Distortion and possible damage to foundations and pavements                      | 1           | 2      | 2              | Make provision for inspection of exposed formation for evidence of compressible ground                                     | 1           | 1      | 1              | Compressible materials are not expected to be present                                        |
| /h        | Collapsible Ground                                                 | Distortion and possible damage to foundations and pavements                      | 1           | 2      | 2              | Make provision for inspection of exposed formation for evidence of collapsible ground                                      | 1           | 1      | 1              | Collapsible materials are not expected to be present                                         |
| /i        | Running Sand                                                       | Possible instability of excavations and side slopes                              | 1           | 2      | 2              | Make provision for inspection of exposed formation for evidence of running sand                                            | 1           | 1      | 1              | Groundwater is expected to be present below the base of any excavations                      |
| /j        | Surface Workings                                                   | Additional works to excavate and replace unacceptable material                   | 1           | 2      | 2              | Make provision for inspection of exposed formation for evidence of infilled surface workings                               | 1           | 1      | 1              | None                                                                                         |
| /k        | Unexploded Ordnance                                                | Possible delay to works whilst any unexploded ordnance are made safe and removed | 1           | 2      | 2              | Site staff should be informed as part of the site safety induction that the potential presence of UXO cannot be discounted | 1           | 2      | 2              | None                                                                                         |
| <b>G2</b> | <b>Bridge Abutments and Wing Walls</b>                             |                                                                                  |             |        |                |                                                                                                                            |             |        |                |                                                                                              |
| /a        | Low strength or compressible formation to abutments and wing walls | Additional works to excavate and replace unacceptable material                   | 2           | 2      | 4              | Make provision for protection and early inspection of the formation                                                        | 1           | 2      | 2              | Competent ground is expected from shallow depth. See <b>G1/d</b> regarding solution features |
| /b        | Excess settlement of proposed abutments and wing walls             | Delay to the works waiting for long-term settlements to be effectively complete  | 1           | 2      | 2              | Make provision for possible delay to the construction works                                                                | 1           | 2      | 2              | Competent, low compressibility ground is expected from shallow depth                         |
| <b>G4</b> | <b>Pavement Construction</b>                                       |                                                                                  |             |        |                |                                                                                                                            |             |        |                |                                                                                              |
| /a        | Low strength or compressible formation to pavement construction    | Additional works to excavate and replace unacceptable material                   | 1           | 2      | 2              | Backfill to structures and approach embankments to be selected granular material                                           | 1           | 1      | 1              | None                                                                                         |

Notes: a) Probability 1: Negligible 2: Unlikely 3: Probable 4: Likely 5: Very likely  
b) Impact 1: Very low 2: Low 3: Medium 4: High 5: Severe  
c) Rating 1-4: Negligible 5-9: Low 10-14: Medium 15-19: High 20-25: Severe



The likelihood of the occurrence and impact of the hazard has been determined in line with the criteria given in the following tables.

|                          | Criteria        | Description                                           |
|--------------------------|-----------------|-------------------------------------------------------|
| Likelihood of occurrence | 5: Near Certain | Near certain to occur, probably on numerous occasions |
|                          | 4: Likely       | Likely to occur, possibly on numerous occasions.      |
|                          | 3: Probable     | May occur, probably on a single occasion              |
|                          | 2: Possible     | May occur, but unlikely                               |
|                          | 1: Negligible   | Not expected to occur                                 |

|                     | Criteria      | Description                                                                                                  |
|---------------------|---------------|--------------------------------------------------------------------------------------------------------------|
| Magnitude of Impact | 5: Severe     | Would result in a delay to completion of 10 weeks or more and/or additional costs of £1 million or more      |
|                     | 4: High       | Would result in a delay to completion up to 10 weeks and/or additional costs up to £1 million                |
|                     | 3: Medium     | Would result in a delay to completion up to 1 week and/or additional costs up to £200k                       |
|                     | 2: Low        | Would result in additional works up to 4 weeks and/or additional costs up to £50k but no delay to completion |
|                     | 1: Negligible | Would result in additional works up to 1 weeks and/or additional costs up to £5k but no delay to completion  |

The rating of the risks has been assessed using the following matrix and is defined in line with the criteria given in the following table.

|                          |   | Risk Rating |    |    |    |    |                     |
|--------------------------|---|-------------|----|----|----|----|---------------------|
| Likelihood of occurrence | 5 | 5           | 10 | 15 | 20 | 25 |                     |
|                          | 4 | 4           | 8  | 12 | 16 | 20 |                     |
|                          | 3 | 3           | 6  | 9  | 12 | 15 |                     |
|                          | 2 | 2           | 4  | 6  | 8  | 10 |                     |
|                          | 1 | 1           | 2  | 3  | 4  | 5  |                     |
|                          |   | 1           | 2  | 3  | 4  | 5  | Magnitude of Impact |

|             | Criteria         | Description                                                                                       |
|-------------|------------------|---------------------------------------------------------------------------------------------------|
| Risk Rating | Severe (20-25)   | High probability of occurrence and a high impact on the proposed scheme                           |
|             | High (15-19)     | Medium to high probability of occurrence and also a medium to high impact on the proposed scheme  |
|             | Medium (10-14)   | Medium to high probability of occurrence or a medium to high impact on the proposed scheme        |
|             | Low (5-9)        | Low to medium probability of occurrence or low to medium impact on the proposed scheme            |
|             | Negligible (1-4) | Negligible to low probability of occurrence and a negligible to low impact on the proposed scheme |

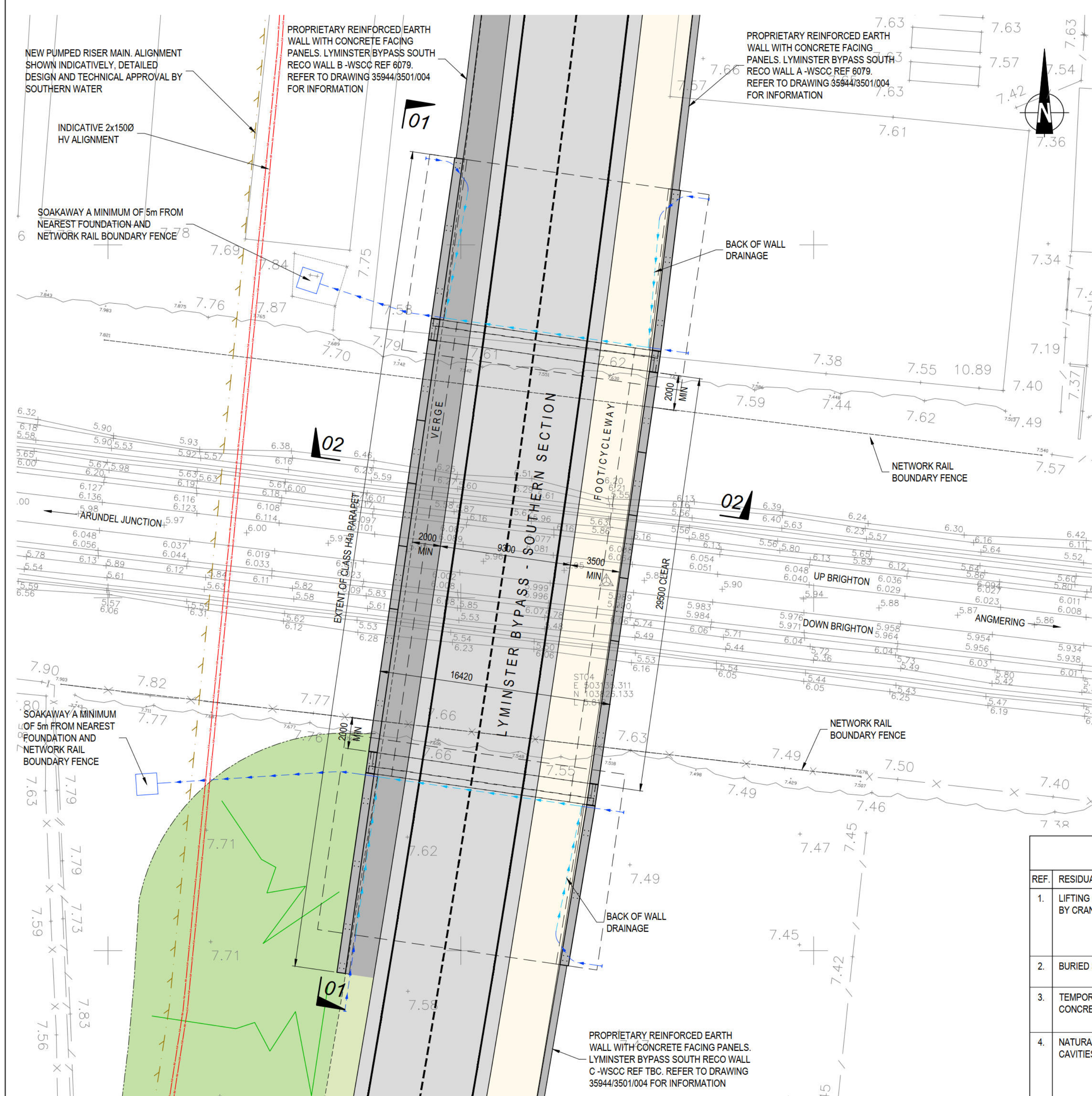




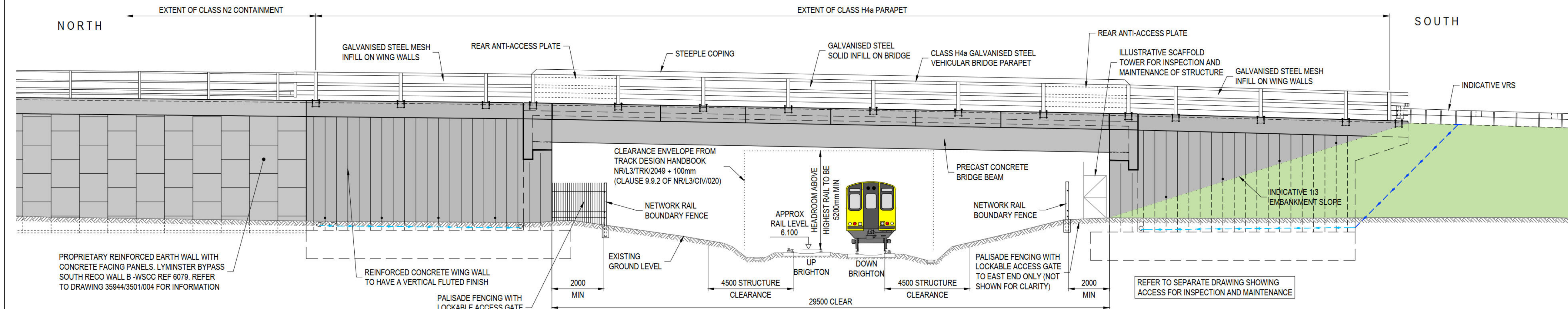
## APPENDIX 8 Drawings



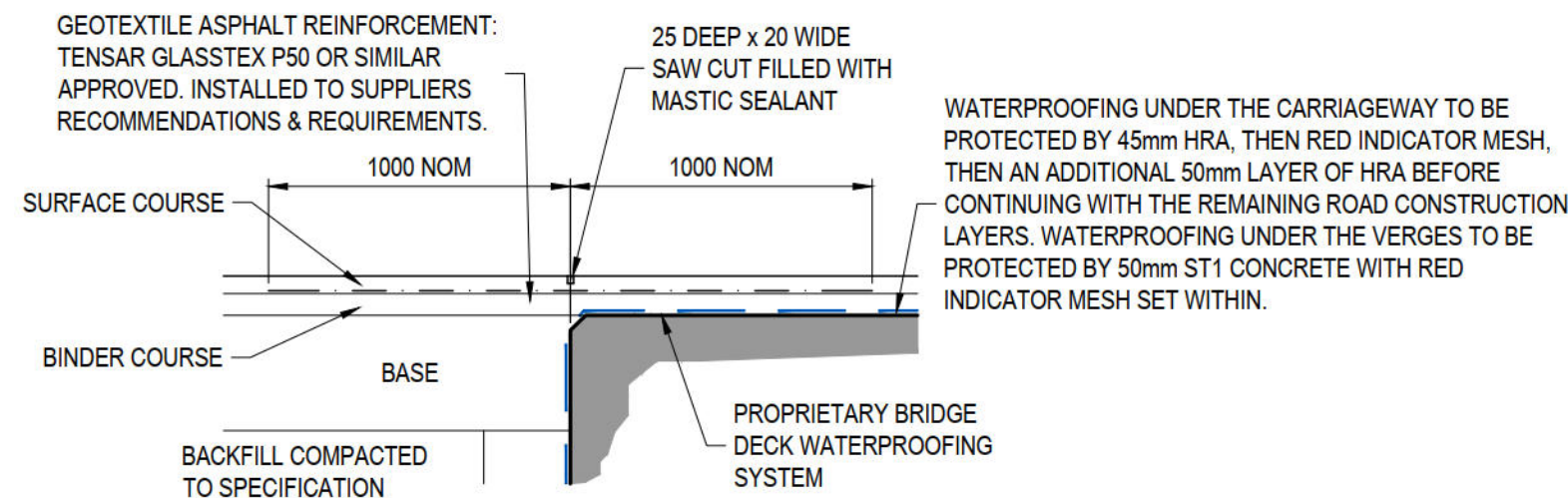




PLAN  
1:200

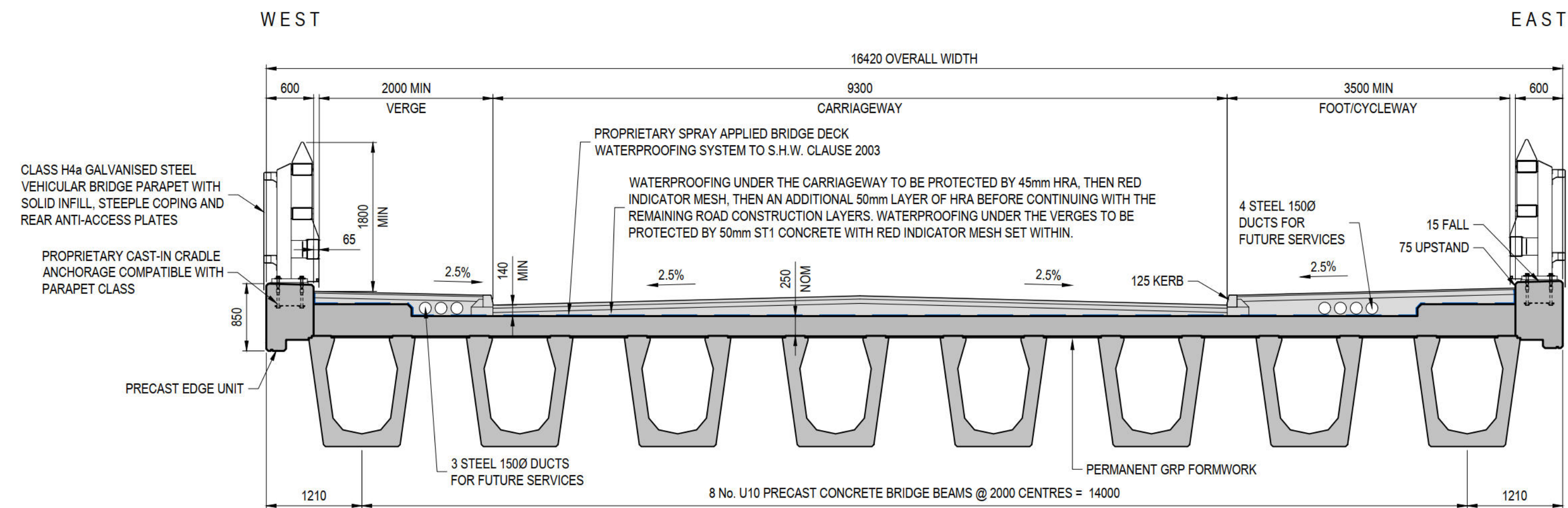


ELEVATION 01-01  
1:125



END OF STRUCTURE JOINT DETAIL  
1:25

|           |   |            |
|-----------|---|------------|
| ELR       | - | BL11       |
| MILEAGE   | - | 17mIs 64ch |
| LINESPEED | - | 70mph      |



SECTION 02-02  
1:50

| RESIDUAL CONSTRUCTION RISKS NOT LIKELY TO BE OBVIOUS TO A COMPETENT CONTRACTOR. TO BE READ IN CONJUNCTION WITH DESIGNER'S RISK DOCUMENTATION |                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| REF.                                                                                                                                         | RESIDUAL RISKS                                     | SUGGESTED CONTROL MEASURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1.                                                                                                                                           | LIFTING OF PRECAST CONCRETE ELEMENTS BY CRANE      | (i) ALL LIFTING OPERATIONS AND CONSTRUCTION ACTIVITIES ADJACENT TO THE RAILWAY WILL BE SUBJECT TO NETWORK RAIL TECHNICAL APPROVAL PROCESSES. THE CONTRACTOR IS TO COMPLETE THESE PROCESSES AND OBTAIN ALL NECESSARY APPROVALS FROM NETWORK RAIL.<br>(ii) ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH AN APPROVED LIFT PLAN AND METHOD STATEMENT PROCESS.<br>(iii) CRANE AND LIFTING EQUIPMENT TO BE CHECKED AND MAINTAINED REGULARLY.<br>(iv) TRAINED, COMPETENT PERSONNEL TO BE USED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 2.                                                                                                                                           | BURIED SERVICES                                    | (i) THE POSITION OF EXISTING SERVICES SHOWN ON THIS DRAWING SHOULD NOT BE RELIED UPON. THE CONTRACTOR SHALL CHECK FOR THE PRESENCE OF EXISTING SERVICES AND ENSURE THAT NO DAMAGE OR DISTURBANCE TO SERVICES OCCURS DURING THE WORKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 3.                                                                                                                                           | TEMPORARY STABILITY OF PRECAST CONCRETE EDGE UNITS | (i) ALL LIFTING OPERATIONS AND CONSTRUCTION ACTIVITIES ADJACENT TO THE RAILWAY WILL BE SUBJECT TO NETWORK RAIL TECHNICAL APPROVAL PROCESSES. THE CONTRACTOR IS TO COMPLETE THESE PROCESSES AND OBTAIN ALL NECESSARY APPROVALS FROM NETWORK RAIL.<br>(ii) PRECAST CONCRETE EDGE UNITS TO BE TEMPORARILY FIXED TO PRECAST BEAMS PRIOR TO CASTING OF IN-SITU CONCRETE DECK.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4.                                                                                                                                           | NATURAL SOLUTION FEATURES AND MINING CAVITIES      | (i) POTENTIAL SOLUTION FEATURES OR MINING CAVITIES SHALL BE INVESTIGATED BY APPROPRIATE INTRUSIVE GROUND INVESTIGATION TECHNIQUES. THE CONTRACTOR IS TO CARRY OUT ADDITIONAL GROUND INVESTIGATION AS DICTATED IN THE SPECIFICATION TO MITIGATE THE RISK OF BELOW GROUND VOIDS AND CONTAIN STRATA LEVELS.<br>(ii) FORMATION TO ALL WORKS TO BE INSPECTED BY A QUALIFIED GEOTECHNICAL ENGINEER PRIOR TO POURING OF BLINDING CONCRETE<br>(iii) PARTICULAR CARE IS TO BE GIVEN TO IDENTIFYING ANY FEATURES THAT MAY BE INDICATIVE OF THE PRESENCE OF ANY SOLUTION FEATURES AND MINING CAVITIES, SUCH AS: <ul style="list-style-type: none"><li>VOIDS IN THE GROUND.</li><li>COLLAPSED GROUND THAT MAY APPEARS AS DEPRESSIONS OR HOLLOW AT THE GROUND SURFACE.</li><li>DIFFERENT GROUND CONDITIONS TO THOSE EXPECTED, E.G. AREAS OF INFILL OR DISTURBED GROUND.</li><li>RAPID CHANGES OF SOIL COLOUR OR SOIL TYPE OVER SHORT HORIZONTAL DISTANCES.</li><li>VERTICAL INTERFACES BETWEEN DIFFERENT SOILS TYPES.</li></ul><br>(iv) IF THE PRESENCE OF SOLUTION FEATURES OR MINING CAVITIES IS CONFIRMED APPROPRIATE TECHNIQUES SHALL BE ADOPTED TO INFILL ANY VOIDS AND STABILISE ANY SOFT OR LOOSE INFILL MATERIALS. |

## NOTES

### GENERAL

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
- SPECIFICATION SHALL BE IN ACCORDANCE WITH THE DEPARTMENT FOR TRANSPORT / HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS INCLUDING REVISIONS UP TO MAY 2017 AND RELEVANT RAILWAY GROUP STANDARDS AND NETWORK RAIL STANDARDS.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
- ALL LEVELS ARE IN METRES AND RELATIVE TO ORDNANCE DATUM (NEWLYN).
- ALL CO-ORDINATES ARE IN METRES AND RELATIVE ORDNANCE SURVEY GRID.
- ALL PROPRIETARY PRODUCTS TO BE PLACED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
- THIS DRAWING IS BASED UPON ORIGINAL SURVEY INFORMATION COMMISSIONED BY WYG AND CARRIED OUT BY DG YEATMAN SURVEYING AND ENGINEERING LTD, DATED JULY 2008. LOCALISED UPDATES TO THE SURVEY HAVE BEEN CARRIED SINCE AND COMBINED WITH THE ORIGINAL SURVEY, INCLUDING RAIL LINE SURVEY INFORMATION UNDERTAKEN IN DECEMBER 2016.
- PARAPET SUPPLY AND INSTALLATION IS TO BE BY LICENSED COMPANIES HAVING THIRD PARTY VERIFIED UK HIGHWAYS ENGLAND SECTOR SCHEME 5A & 5B APPROVAL AND A QUALITY MANAGEMENT SCHEME IN ACCORDANCE WITH ISO 9001 OR 9002. PARAPET POST SPACING SHOWN HAS BEEN BASED UPON THE VARLEY AND GULLIVER VSGN4000 BRIDGE PARAPET SYSTEM. AN ALTERNATIVE SYSTEM / POST SPACING MAY BE PROPOSED, WHICH MUST HAVE SUFFICIENT CLEARANCE TO THE DECK MOVEMENT JOINTS TO ALLOW FOR INSTALLATION OF ANCHORAGE CRADLES AND REINFORCEMENT.
- MAXIMUM COMPACTION PLANT TO BE USED DURING BACK FILLING OPERATIONS TO BE A ROLLER HAVING A MASS PER METRE OF ROLL NOT EXCEEDING 1300kg WITH A TOTAL MASS NOT EXCEEDING 1000kg AS SPECIFIED IN CLAUSE 610 PART 5 OF THE MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS.
- 6N/6P BACKFILL IS REQUIRED FOR THE BACKFILL. CONTRACTOR IS TO PROVIDE TEST RESULTS DEMONSTRATING 6N/6P MATERIAL HAS MINIMUM  $\phi = 36^\circ$ .

|      |                                                          |          |       |      |      |
|------|----------------------------------------------------------|----------|-------|------|------|
| P05  | ISSUED FOR GDR REPORT                                    | 15.02.18 | CRD   | JAS  | JWS  |
| P04  | ISSUED FOR A.I.P. - REVIEWED TO INCORPORATE TAA COMMENTS | 02.09.16 | GCP   | JAS  | JWS  |
| P03  | ISSUED FOR A.I.P.                                        | 22.07.16 | GCP   | JAS  | JWS  |
| P02  | NORTH APPROACH UPDATED TO RECO WALL                      | 24.06.16 | GCP   | JAS  | JWS  |
| P01  | FIRST ISSUE                                              | 27.05.16 | GCP   | JAS  | JWS  |
| Mark | Revision                                                 | Date     | Drawn | Chkd | Appd |

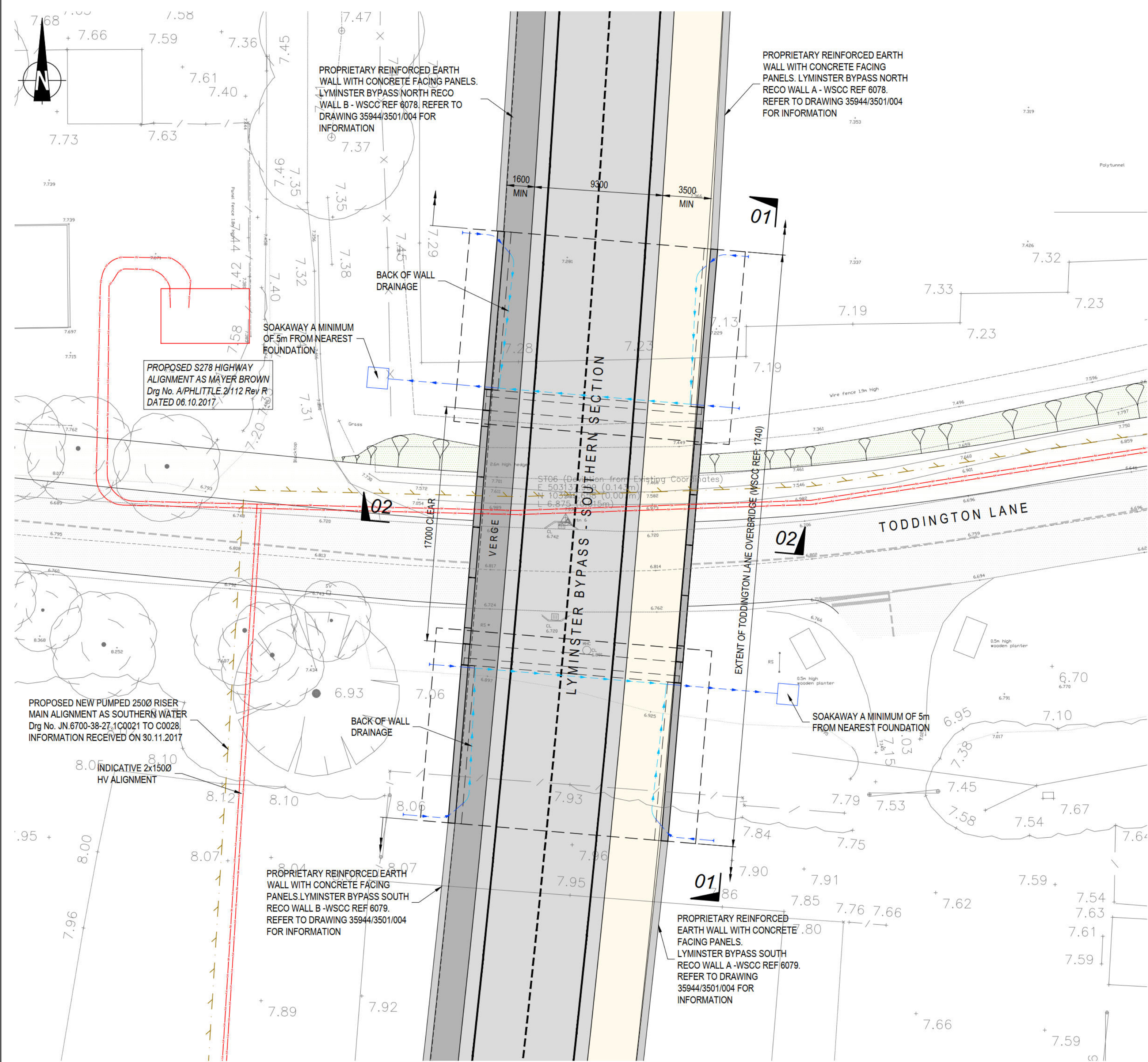
SCALING NOTE: Do not scale from this drawing. If in doubt, ask.  
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake his own investigation where the presence of any existing sewers, services, plant or apparatus may affect his operations.

## Drawing Issue Status

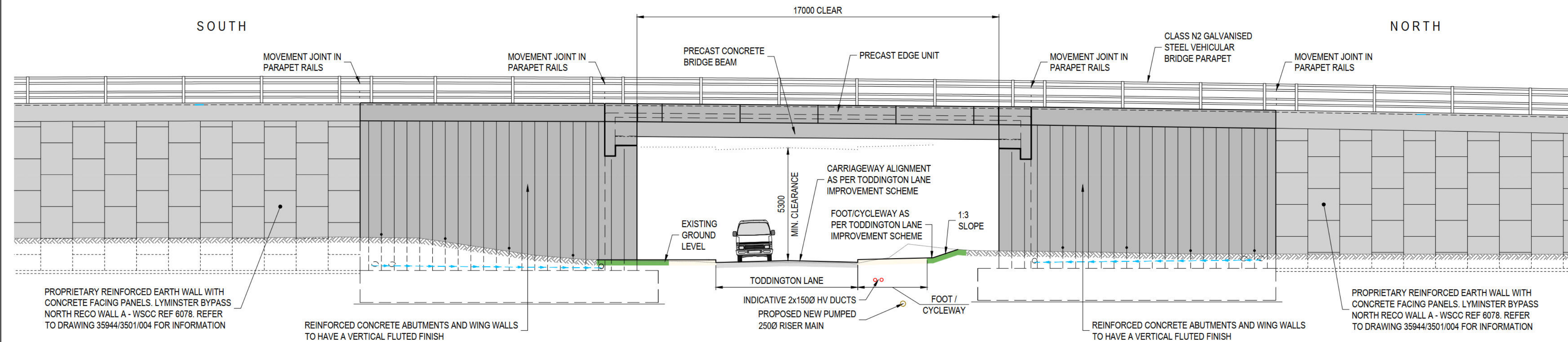
## LYMINSTER BYPASS - SOUTH NORTH LITTLEHAMPTON RAILWAY BRIDGE (WSCC REF: 1741) GENERAL ARRANGEMENT

|                   |            |                |                                                                                       |          |     |                                                                                                                                                                                                                                                                         |  |  |
|-------------------|------------|----------------|---------------------------------------------------------------------------------------|----------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| Client            |            |                |  |          |     | <br>Offices throughout<br>the UK and Europe<br><br><a href="http://www.peterbrett.com">www.peterbrett.com</a><br>© Peter Brett Associates LLP<br><br>READING<br>Tel: 0118 950 0761 |  |  |
| Date of 1st Issue | 27.05.2016 | Designed       | AJMC                                                                                  | Drawn    | GCP |                                                                                                                                                                                                                                                                         |  |  |
| A1 Scale          | AS SHOWN   | Checked        | JAS                                                                                   | Approved | JWS |                                                                                                                                                                                                                                                                         |  |  |
| Drawing Number    |            | 35944/1501/001 |                                                                                       | Revision |     | P05                                                                                                                                                                                                                                                                     |  |  |

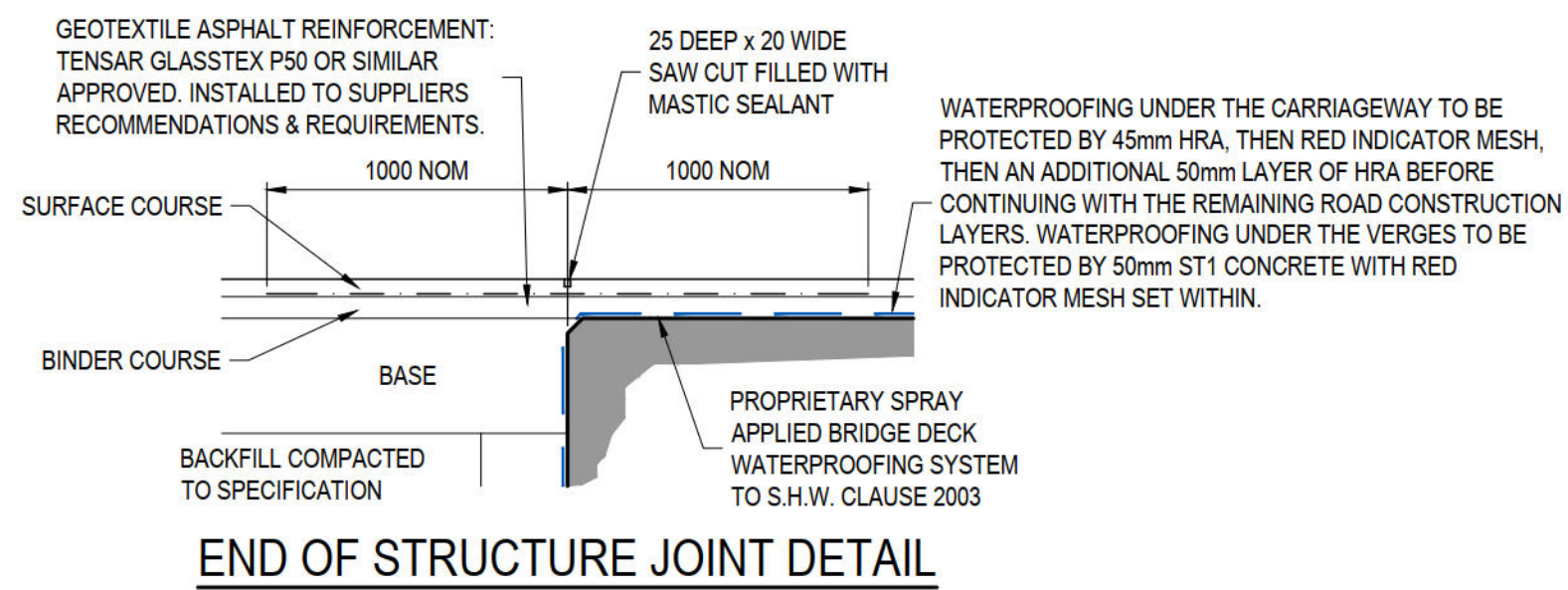




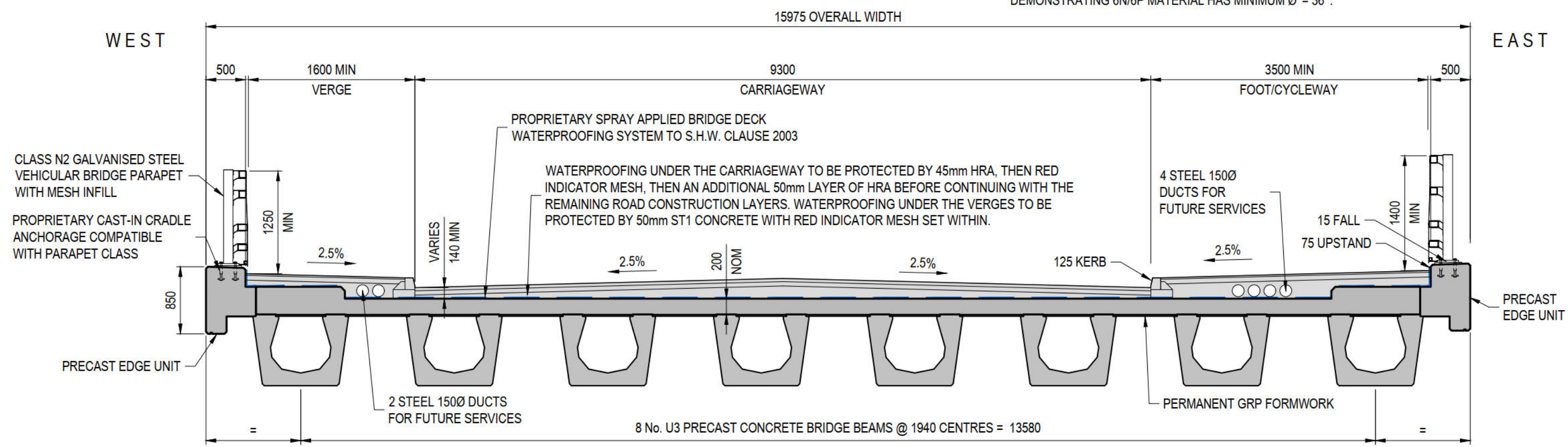
PLAN  
1:200



ELEVATION 01-01  
1:25



END OF STRUCTURE JOINT DETAIL  
1:25



SECTION 02-02  
1:50

| RESIDUAL CONSTRUCTION RISKS NOT LIKELY TO BE OBVIOUS TO A COMPETENT CONTRACTOR. TO BE READ IN CONJUNCTION WITH DESIGNER'S RISK DOCUMENTATION |                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| REF.                                                                                                                                         | RESIDUAL RISKS                                     | SUGGESTED CONTROL MEASURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                                                                                                                           | LIFTING OF PRECAST CONCRETE ELEMENTS BY CRANE      | (i) ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH AN APPROVED LIFT PLAN AND METHOD STATEMENT PROCESS.<br>(ii) CRANE AND LIFTING EQUIPMENT TO BE CHECKED AND MAINTAINED REGULARLY.<br>(iii) TRAINED, COMPETENT PERSONNEL TO BE USED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2.                                                                                                                                           | BURIED SERVICES                                    | (i) THE POSITION OF EXISTING SERVICES SHOWN ON THIS DRAWING SHOULD NOT BE RELIED UPON. THE CONTRACTOR SHALL CHECK FOR THE PRESENCE OF EXISTING SERVICES AND ENSURE THAT NO DAMAGE OR DISTURBANCE TO SERVICES OCCURS DURING THE WORKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3.                                                                                                                                           | TEMPORARY STABILITY OF PRECAST CONCRETE EDGE UNITS | (i) PRECAST CONCRETE EDGE UNITS TO BE TEMPORARILY FIXED TO PRECAST BEAMS PRIOR TO CASTING OF IN-SITU CONCRETE DECK.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4.                                                                                                                                           | NATURAL SOLUTION FEATURES AND MINING CAVITIES      | (i) POTENTIAL SOLUTION FEATURES OR MINING CAVITIES SHALL BE INVESTIGATED BY APPROPRIATE INTRUSIVE GROUND INVESTIGATION TECHNIQUES. THE CONTRACTOR IS TO CARRY OUT ADDITIONAL GROUND INVESTIGATION AS DICTATED IN THE SPECIFICATION TO MITIGATE THE RISK OF BELOW GROUND VOIDS AND CONTAIN STRATA LEVELS.<br>(ii) FORMATION TO ALL WORKS TO BE INSPECTED BY A QUALIFIED GEO-TECHNICAL ENGINEER PRIOR TO POURING OF BLINDING CONCRETE<br>(iii) PARTICULAR CARE IS TO BE GIVEN TO IDENTIFYING ANY FEATURES THAT MAY BE INDICATIVE OF THE PRESENCE OF ANY SOLUTION FEATURES AND MINING CAVITIES, SUCH AS: <ul style="list-style-type: none"><li>VOIDS IN THE GROUND.</li><li>COLLAPSED GROUND THAT MAY APPEARS AS DEPRESSIONS OR HOLLOWAYS AT THE GROUND SURFACE.</li><li>DIFFERENT GROUND CONDITIONS TO THOSE EXPECTED, E.G. AREAS OF INFILL OR DISTURBED GROUND.</li><li>RAPID CHANGES OF SOIL COLOUR OR SOIL TYPE OVER SHORT HORIZONTAL DISTANCES.</li><li>VERTICAL INTERFACES BETWEEN DIFFERENT SOILS TYPES.</li></ul><br>(iv) IF THE PRESENCE OF SOLUTION FEATURES OR MINING CAVITIES IS CONFIRMED APPROPRIATE TECHNIQUES SHALL BE ADOPTED TO INFILL ANY VOIDS AND STABILISE ANY SOFT OR LOOSE INFILL MATERIALS. |

## NOTES

### GENERAL

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
- SPECIFICATION SHALL BE IN ACCORDANCE WITH THE DEPARTMENT FOR TRANSPORT / HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS INCLUDING REVISIONS UP TO MAY 2017.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
- ALL LEVELS ARE IN METRES AND RELATIVE TO ORDNANCE DATUM (NEWLYN).
- ALL CO-ORDINATES ARE IN METRES AND RELATIVE ORDNANCE SURVEY GRID.
- ALL PROPRIETARY PRODUCTS TO BE PLACED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
- THIS DRAWING IS BASED UPON ORIGINAL SURVEY INFORMATION COMMISSIONED BY WYG AND CARRIED OUT BY DG YEATMAN SURVEYING AND ENGINEERING LTD, DATED JULY 2008. LOCALISED UPDATES TO THE SURVEY HAVE BEEN CARRIED SINCE AND COMBINED WITH THE ORIGINAL SURVEY.
- PARAPET SUPPLY AND INSTALLATION IS TO BE BY LICENSED COMPANIES HAVING THIRD PARTY VERIFIED UK HIGHWAYS ENGLAND SECTOR SCHEME 5A & 5B APPROVAL AND A QUALITY MANAGEMENT SCHEME IN ACCORDANCE WITH ISO 9001 OR 9002. PARAPET POST SPACING SHOWN HAS BEEN BASED UPON THE VARLEY AND GULLIVER VSGN1000 BRIDGE PARAPET SYSTEM. AN ALTERNATIVE SYSTEM / POST SPACING MAY BE PROPOSED, WHICH MUST HAVE SUFFICIENT CLEARANCE TO THE DECK MOVEMENT JOINTS TO ALLOW FOR INSTALLATION OF ANCHORAGE CRADLES AND REINFORCEMENT.
- MAXIMUM COMPACTION PLANT TO BE USED DURING BACK FILLING OPERATIONS TO BE A ROLLER HAVING A MASS PER METRE OF ROLL NOT EXCEEDING 1300kg WITH A TOTAL MASS NOT EXCEEDING 1000kg AS SPECIFIED IN CLAUSE 610 PART 5 OF THE MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS.
- 6N/6P BACKFILL IS REQUIRED FOR THE BACKFILL. CONTRACTOR IS TO PROVIDE TEST RESULTS DEMONSTRATING 6N/6P MATERIAL HAS MINIMUM  $\phi = 36^\circ$ .

|      |                           |          |       |      |      |
|------|---------------------------|----------|-------|------|------|
| P03  | ISSUED FOR GDR REPORT     | 15.02.18 | CRD   | JAS  | JWS  |
| P02  | TAA COMMENTS INCORPORATED | 15.08.17 | CRD   | JAS  | JWS  |
| P01  | FIRST ISSUE TO TAA        | 21.10.16 | GCP   | JAS  | JWS  |
| Mark | Revision                  | Date     | Drawn | Chkd | Appd |

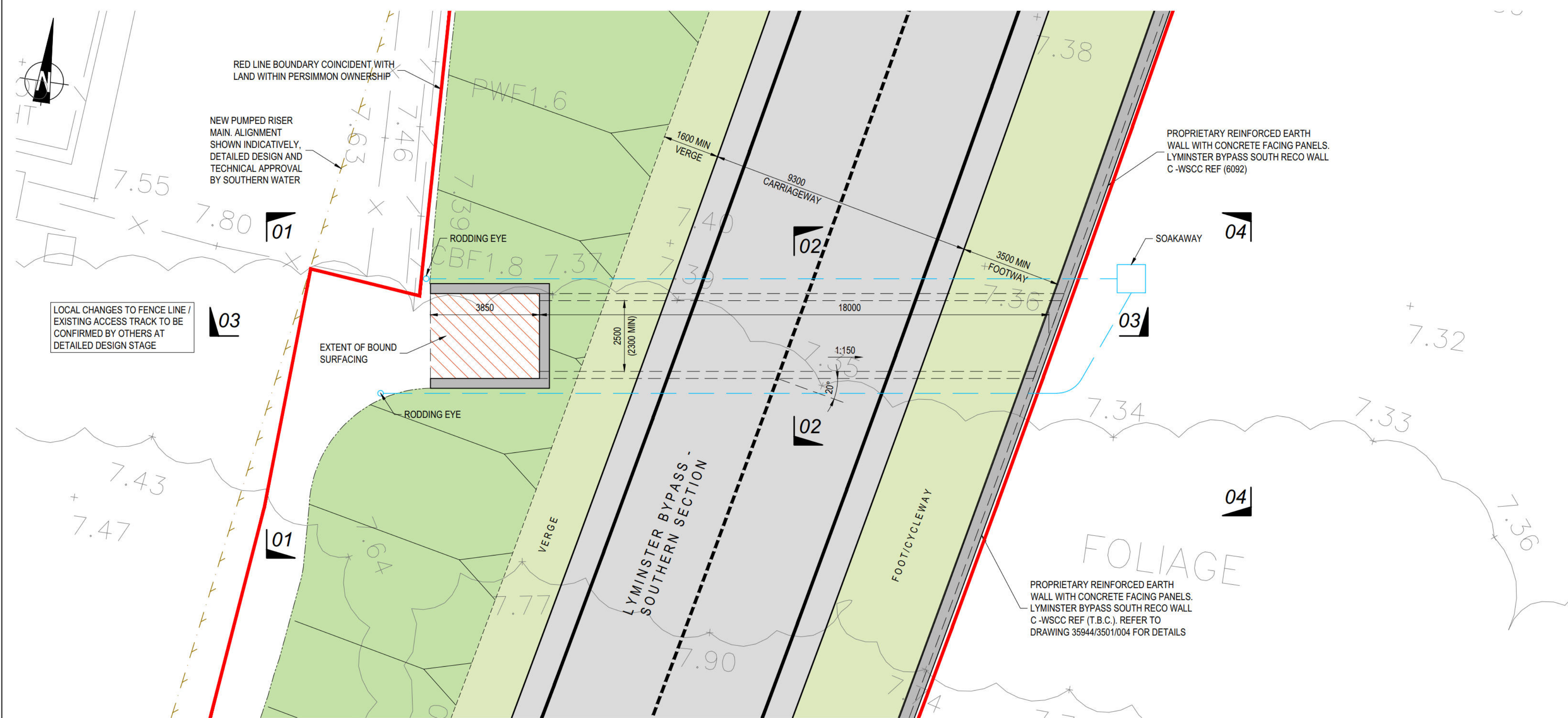
SCALING NOTE: Do not scale from this drawing. If in doubt, ask.  
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake his own investigation where the presence of any existing sewers, services, plant or apparatus may affect his operations.

## INFORMATION

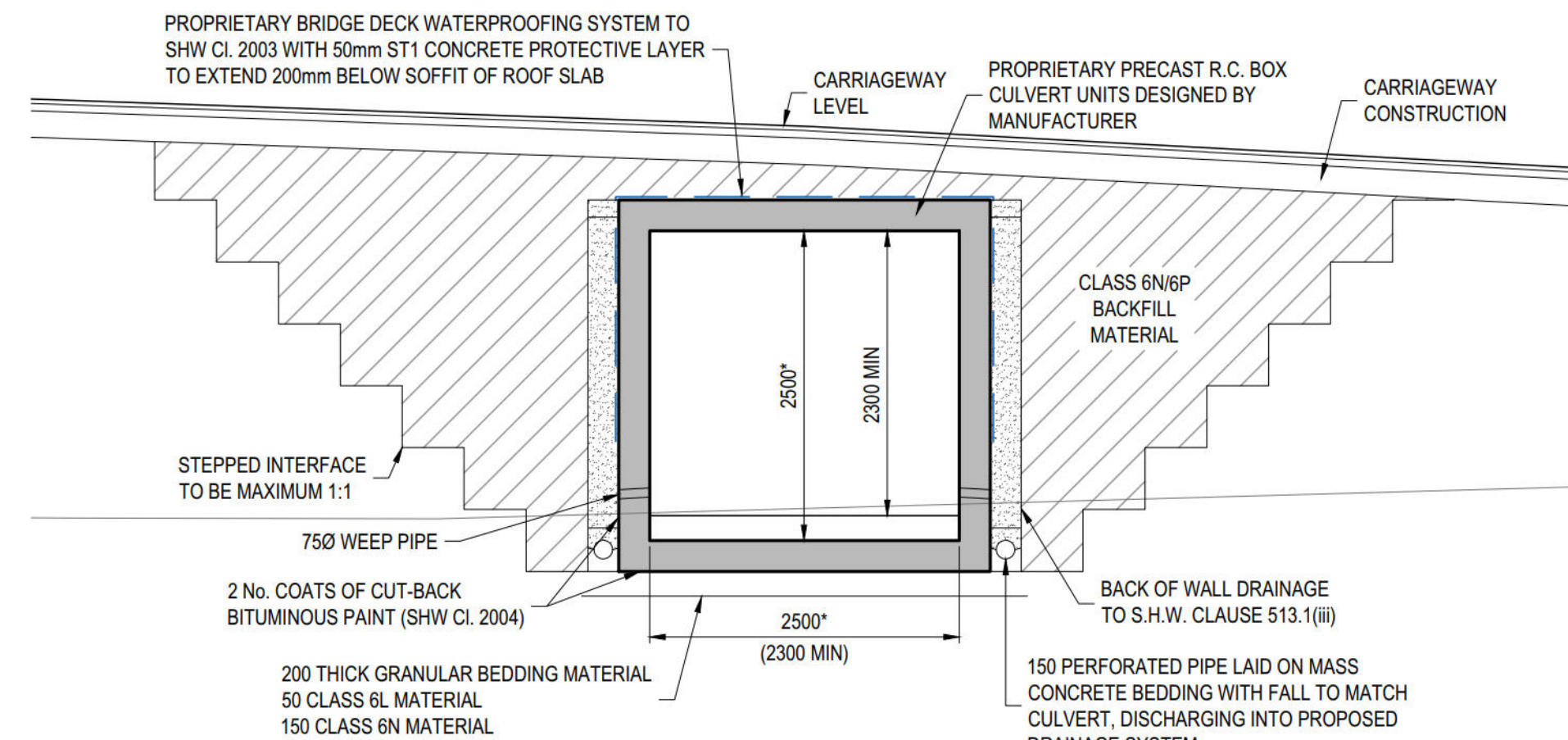
### LYMINSTER BYPASS - SOUTH NORTH LITTLEHAMPTON TODDINGTON LANE OVERBRIDGE (WSCC REF: 1740) GENERAL ARRANGEMENT

|                   |          |          |                                                                                                                                                                             |  |  |
|-------------------|----------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| Client            |          |          | <br><br>Offices throughout the UK and Europe<br><a href="http://www.peterbrett.com">www.peterbrett.com</a><br>© Peter Brett Associates LLP<br>READING<br>Tel: 0118 950 0761 |  |  |
| Date of 1st Issue | Designed | Drawn    |                                                                                                                                                                             |  |  |
| 21.10.2016        | AJMC     | GCP      |                                                                                                                                                                             |  |  |
| A1 Scale          | Checked  | Approved |                                                                                                                                                                             |  |  |
| AS SHOWN          | JAS      | JWS      |                                                                                                                                                                             |  |  |
| Drawing Number    |          | Revision |                                                                                                                                                                             |  |  |
| 35944/1502/001    |          | P03      |                                                                                                                                                                             |  |  |

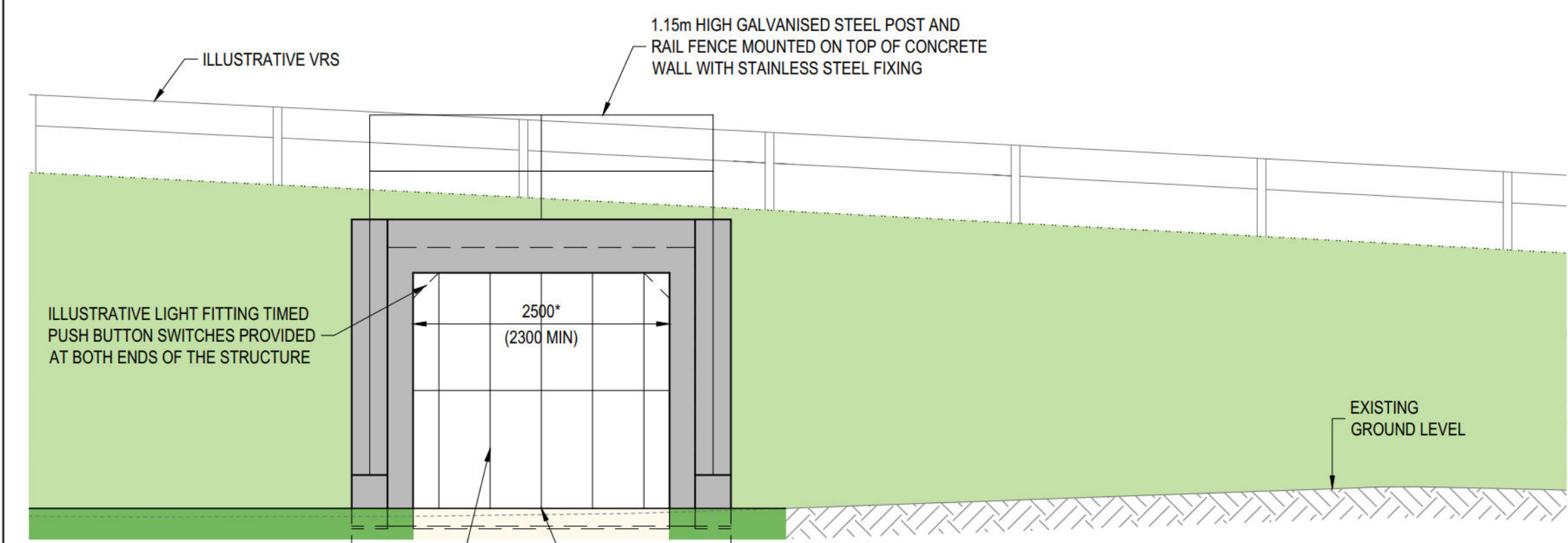




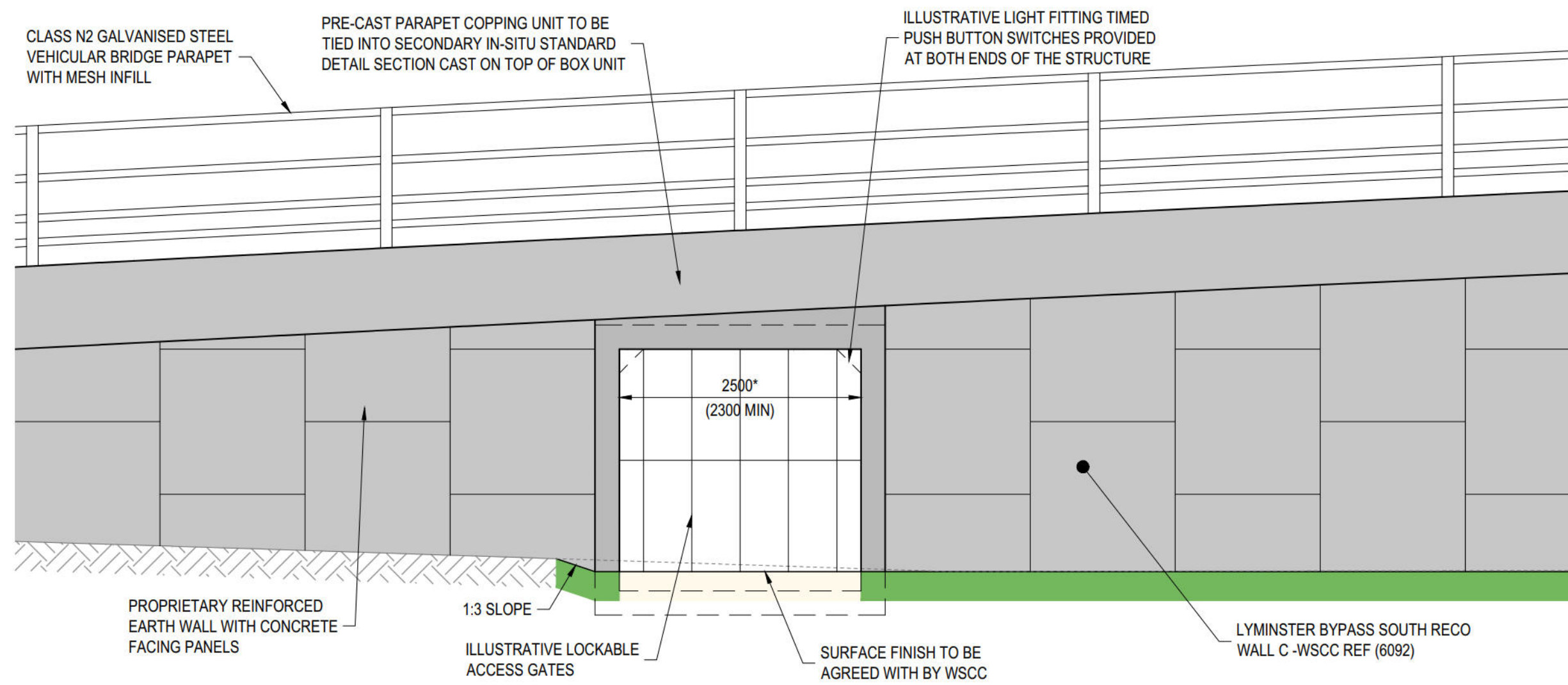
PLAN  
1:100



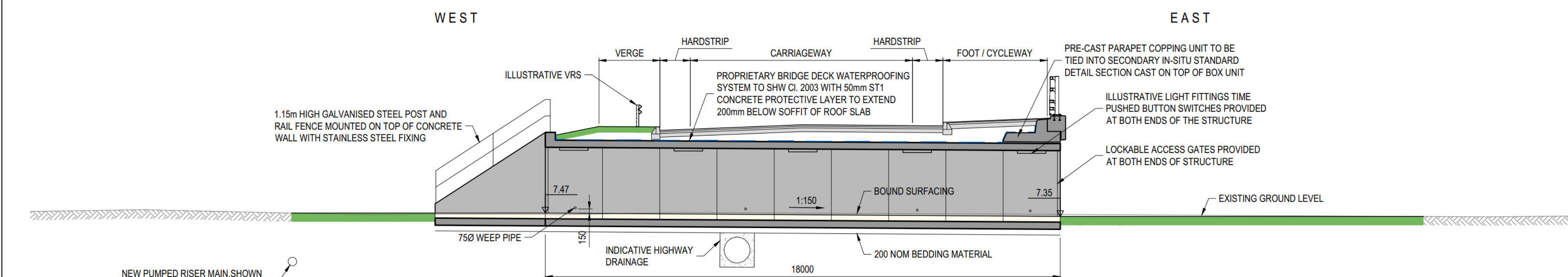
SECTION 02-02  
1:50



ELEVATION 01-01  
1:50



ELEVATION 04-04  
1:50



SECTION 03-03  
1:100

## NOTES

### GENERAL

- G1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
- G2. REFER TO APPROVAL IN PRINCIPLE DOCUMENT 35944/1503/AIP/001 FOR STRUCTURAL MATERIALS AND FINISHES (i.e. CONCRETE GRADES, CONCRETE FINISHES, ETC.)
- G3. SPECIFICATION SHALL BE IN ACCORDANCE WITH THE DEPARTMENT FOR TRANSPORT / HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS INCLUDING REVISIONS UP TO FEBRUARY 2016.
- G4. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
- G5. ALL LEVELS ARE IN METRES AND RELATIVE TO ORDNANCE DATUM (NEWLYN).
- G6. ALL CO-ORDINATES ARE IN METRES AND RELATIVE ORDNANCE SURVEY GRID.
- G7. ALL PROPRIETARY PRODUCTS TO BE PLACED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
- G8. THIS DRAWING IS BASED UPON ORIGINAL SURVEY INFORMATION COMMISSIONED BY WYG AND CARRIED OUT BY DG YEATMAN SURVEYING AND ENGINEERING LTD, DATED JULY 2008. LOCALISED UPDATES TO THE SURVEY HAVE BEEN CARRIED OUT IN THE INTERIM YEARS AND COMBINED WITH THE ORIGINAL SURVEY.
- G9. PARAPET SUPPLY AND INSTALLATION IS TO BE BY LICENSED COMPANIES HAVING THIRD PARTY VERIFIED UK HIGHWAYS AGENCY SECTOR SCHEME 5A & 5B APPROVAL AND A QUALITY MANAGEMENT SCHEME IN ACCORDANCE WITH ISO 9001 OR 9002.

STANDARD SIZE OF PRECAST BOX CULVERT UNITS

|      |                                                        |          |       |      |      |
|------|--------------------------------------------------------|----------|-------|------|------|
| P05  | TAA COMMENTS INCORPORATED                              | 05.07.17 | CRD   | JAS  | JWS  |
| P04  | TAA COMMENTS INCORPORATED                              | 20.06.17 | CRD   | JAS  | JWS  |
| P03  | ISSUE TO TAA                                           | 09.05.17 | AJA   | JAS  | JWS  |
| P02  | CULVERT INTERNAL DIMENSIONS AMENDED. CULVERT RELOCATED | 25.04.17 | CRD   | JWS  | JWS  |
| P01  | FIRST ISSUE TO TAA                                     | 21.10.16 | GCP   | JAS  | JWS  |
| Mark | Revision                                               | Date     | Drawn | Chkd | Appd |

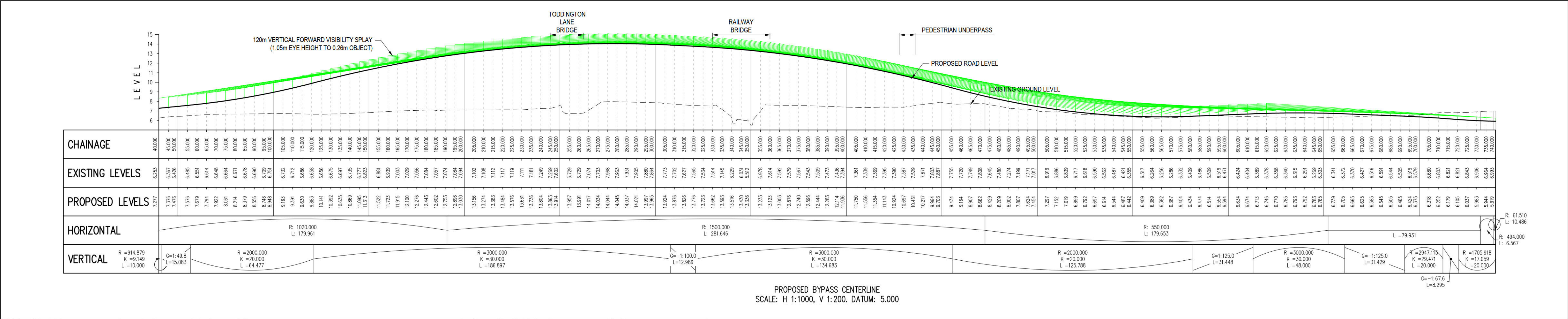
SCALING NOTE: Do not scale from this drawing. If in doubt, ask.  
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|                      |          |
|----------------------|----------|
| Drawing Issue Status | APPROVAL |
|----------------------|----------|

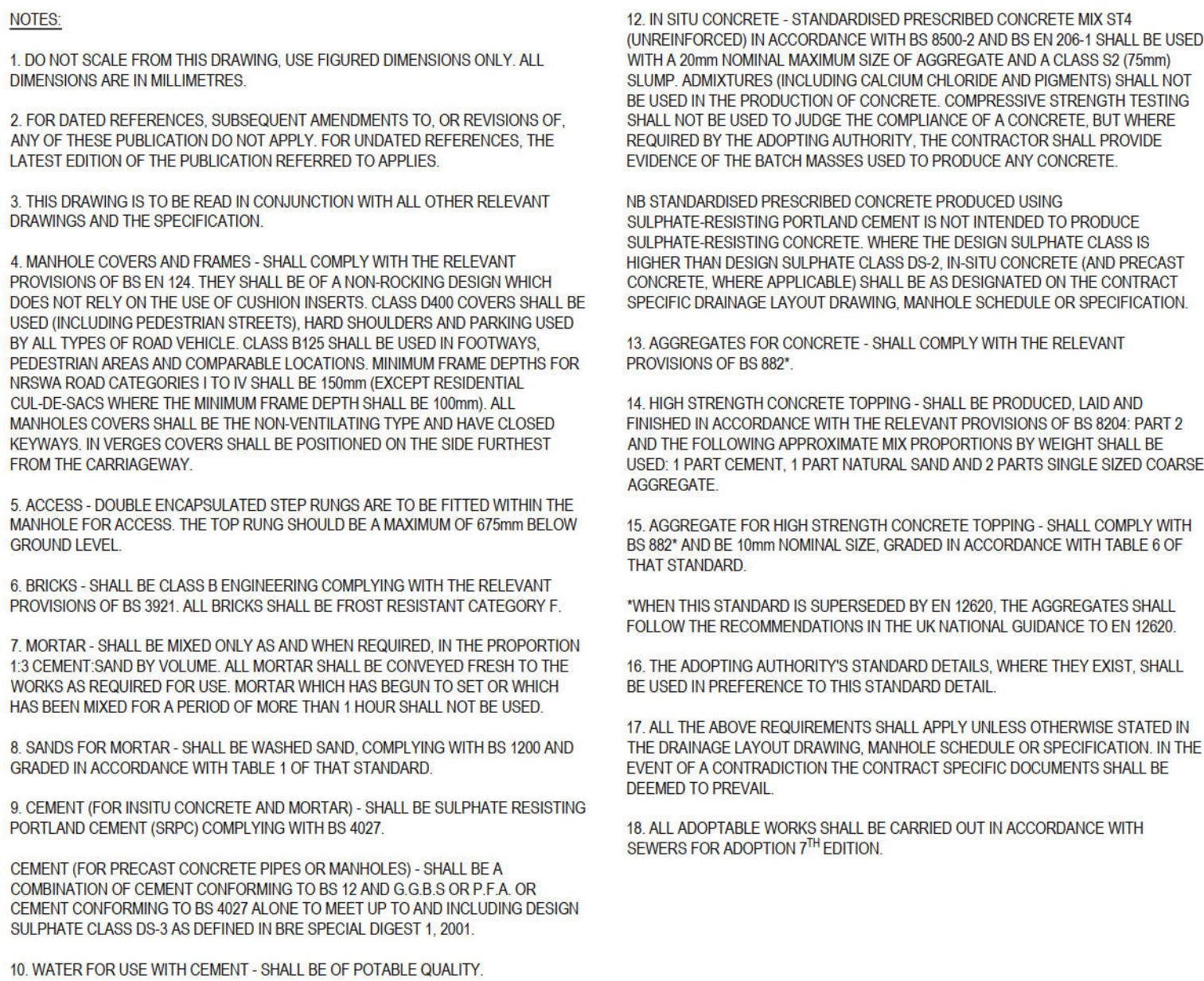
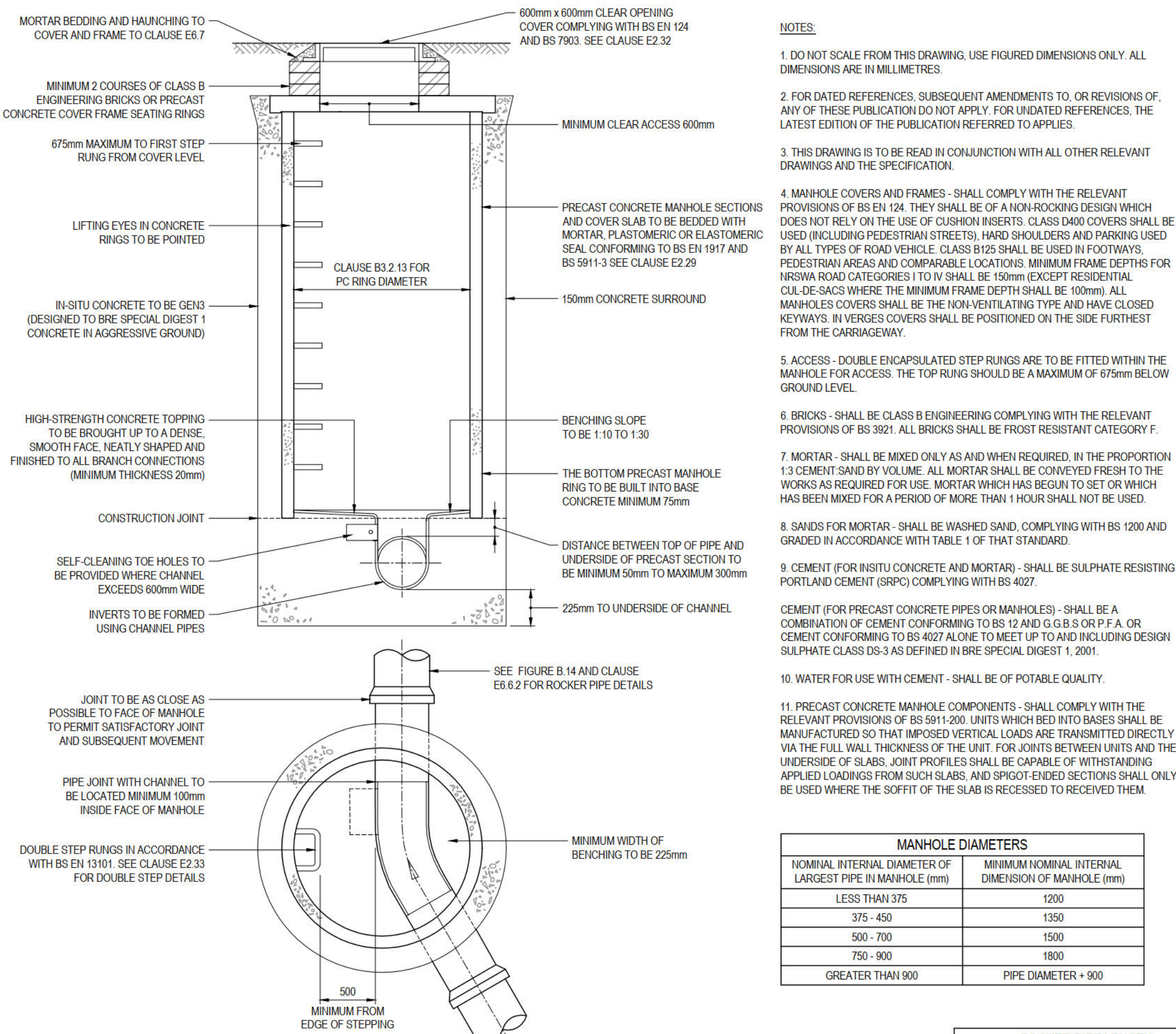
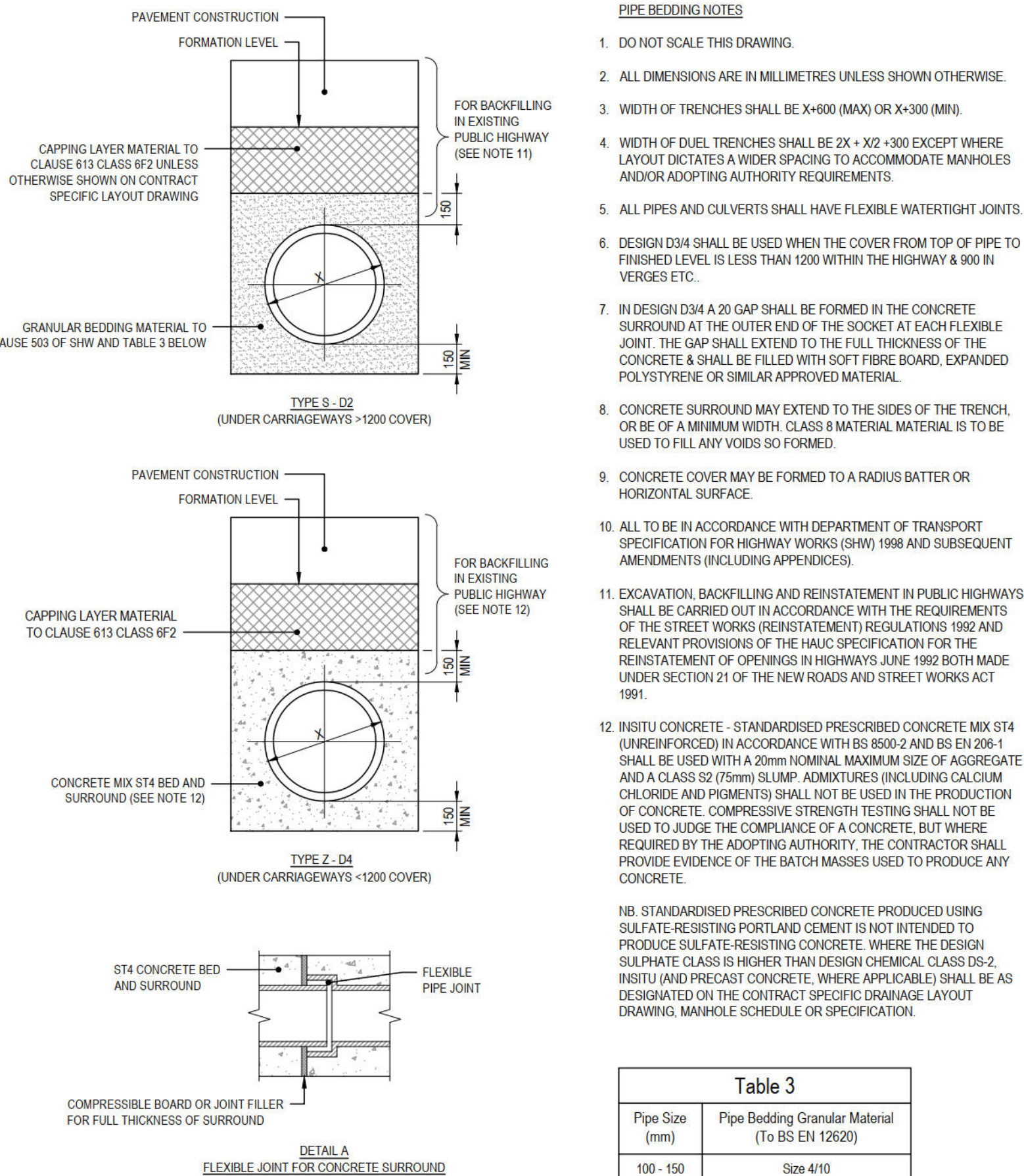
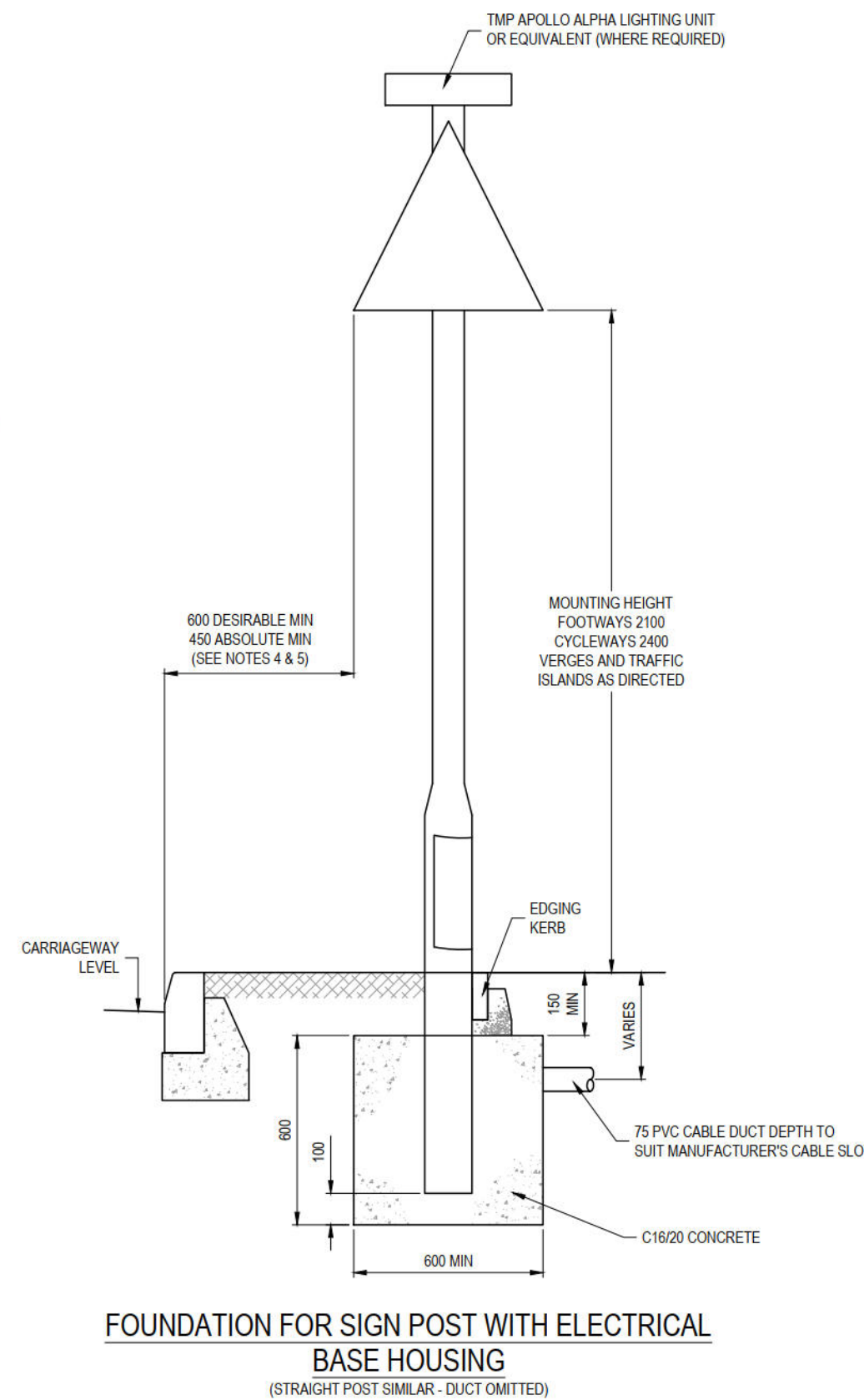
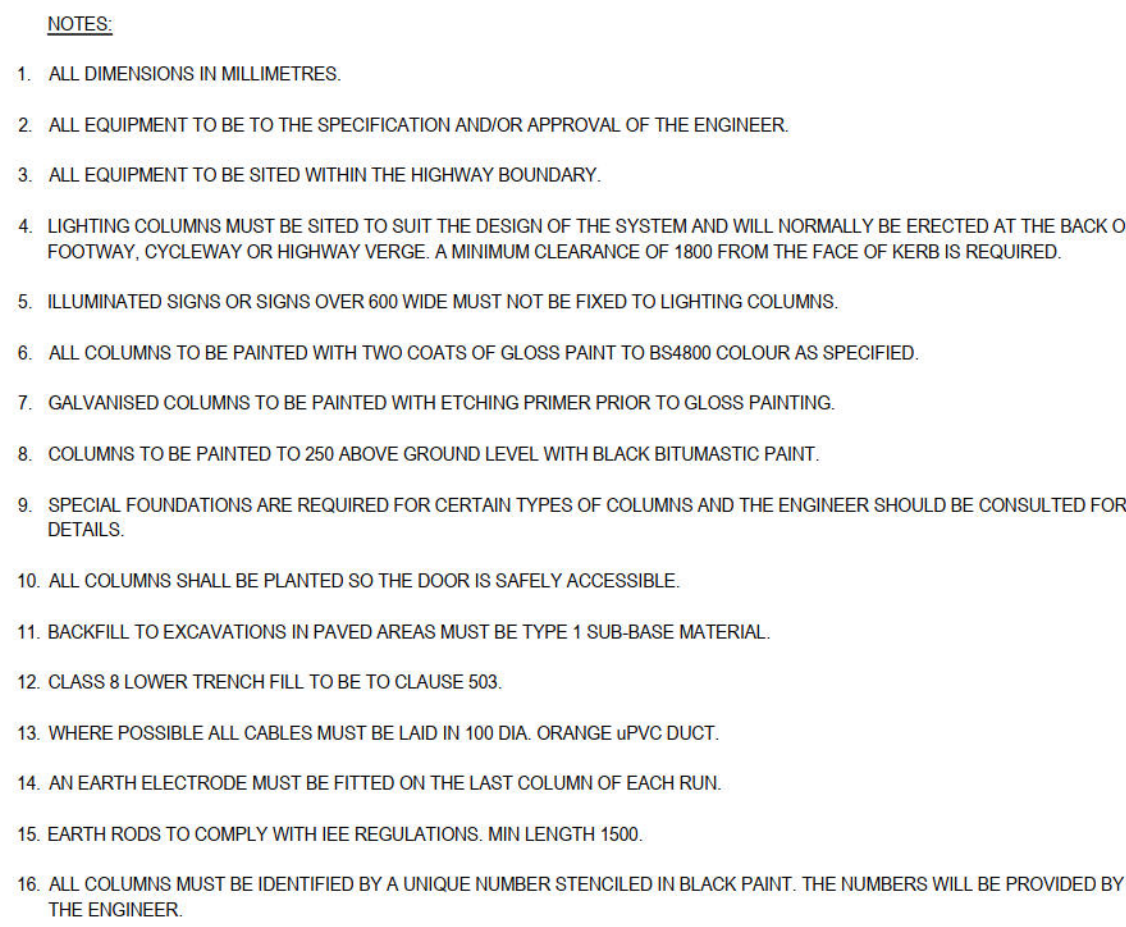
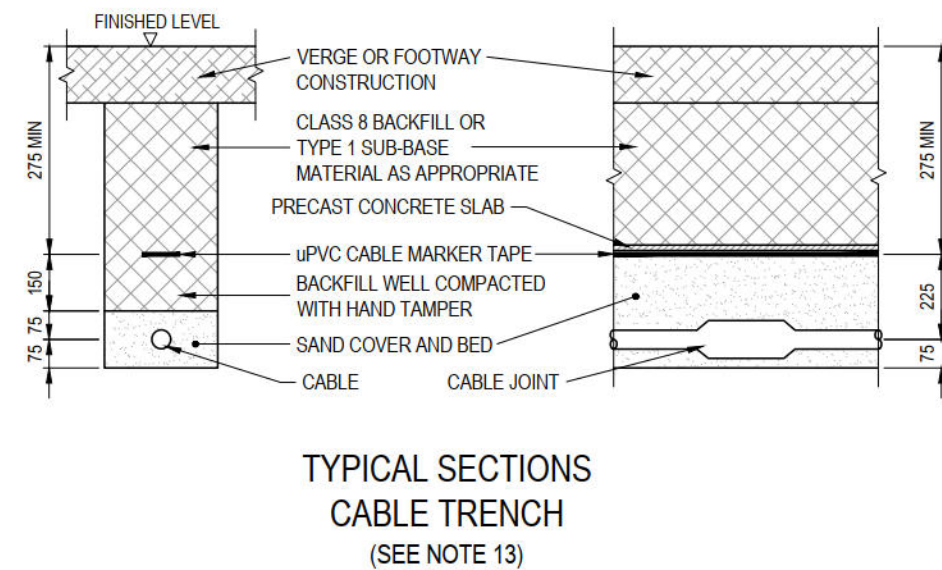
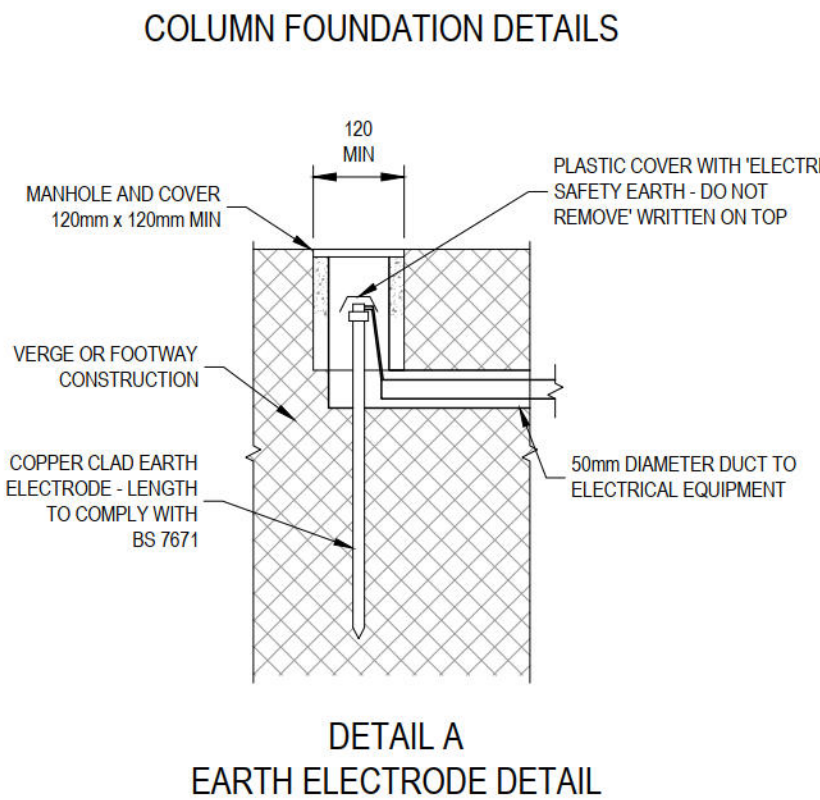
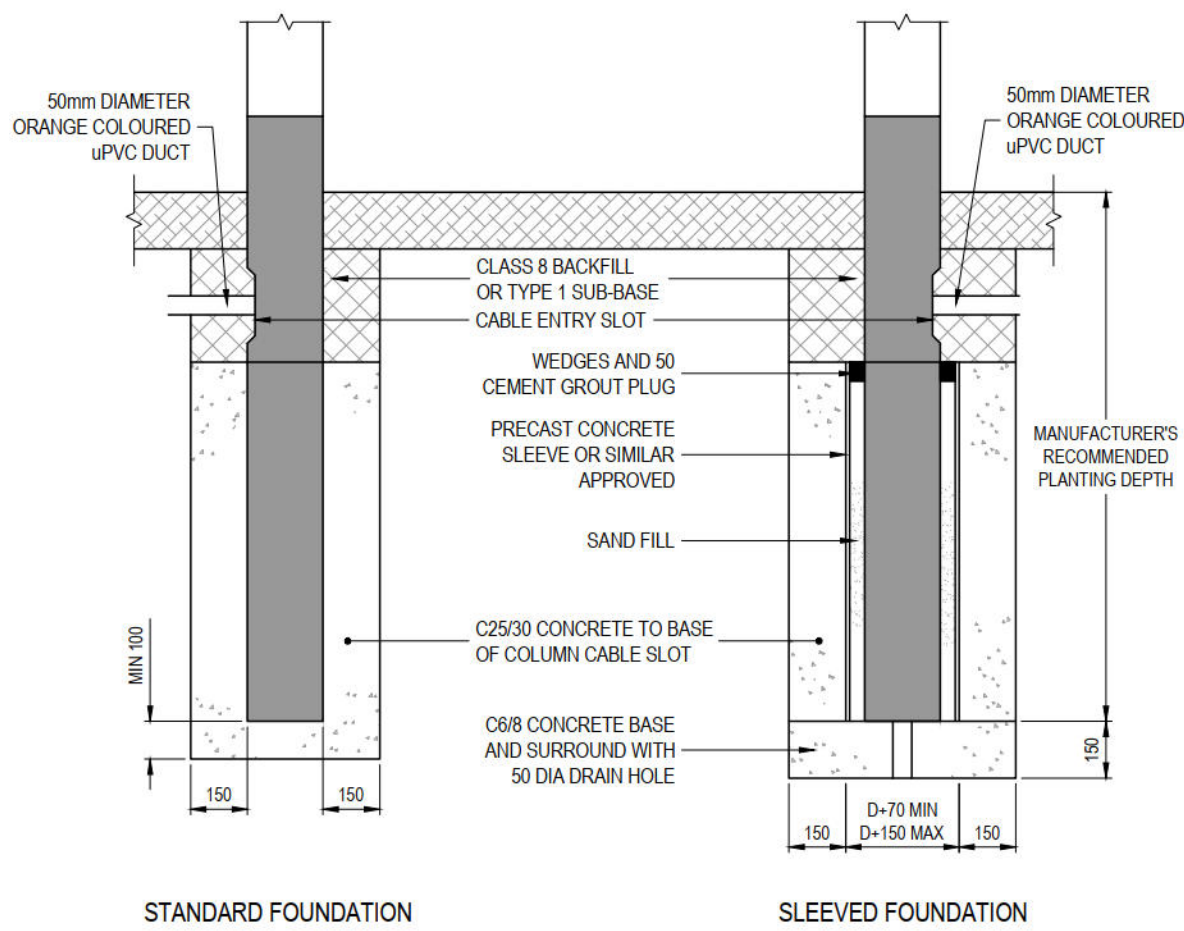
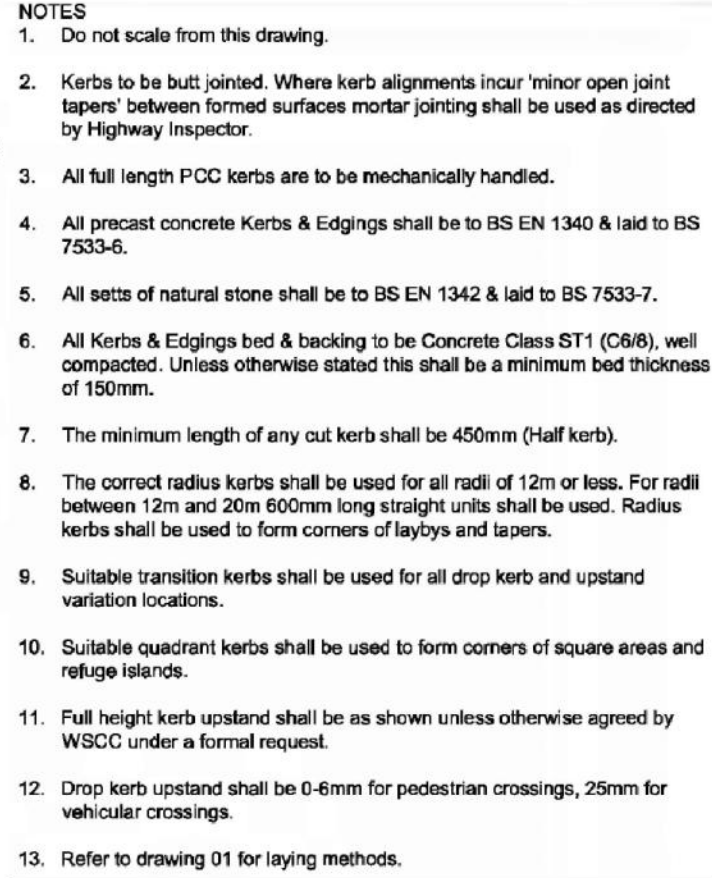
## LYMINSTER BYPASS - SOUTH NORTH LITTLEHAMPTON ALLOTMENT UNDERPASS (WSCC REF:1753) GENERAL ARRANGEMENT

|                   |            |                |                                                                                       |          |     |                                                                                       |  |  |
|-------------------|------------|----------------|---------------------------------------------------------------------------------------|----------|-----|---------------------------------------------------------------------------------------|--|--|
| Client            |            |                |  |          |     |  |  |  |
| Date of 1st Issue | 21.10.2016 | Designed       | AJMC                                                                                  | Drawn    | AJA | Offices throughout<br>the UK and Europe                                               |  |  |
| A1 Scale          | AS SHOWN   | Checked        | JAS                                                                                   | Approved | JWS | <b>www.peterbrett.com</b>                                                             |  |  |
| Drawing Number    |            | 35944/1503/001 |                                                                                       | Revision |     | © Peter Brett Associates LLP                                                          |  |  |
|                   |            | P05            |                                                                                       |          |     | READING<br>Tel: 0118 950 0761                                                         |  |  |









| MANHOLE DIAMETERS                                         |                                                    |
|-----------------------------------------------------------|----------------------------------------------------|
| NOMINAL INTERVAL DIAMETER OF LARGEST PIPE IN MANHOLE (mm) | MINIMUM NOMINAL INTERVAL DIMENSION OF MANHOLE (mm) |
| LESS THAN 375                                             | 1200                                               |
| 375 - 450                                                 | 1350                                               |
| 500 - 700                                                 | 1500                                               |
| 750 - 900                                                 | 1800                                               |
| GREATER THAN 900                                          | PIPE DIAMETER + 900                                |

| ROCKER PIPE LENGTH    |                       |
|-----------------------|-----------------------|
| NOMINAL DIAMETER (mm) | EFFECTIVE LENGTH (mm) |
| 150 - 600             | 600                   |
| 600 - 750             | 1000                  |
| OVER 750              | 1250                  |

| Pipe Size (mm) | Pipe Bedding Granular Material (To BS EN 12620) |
|----------------|-------------------------------------------------|
| 100 - 150      | Size 4/10                                       |
| 225 - 300      | Size 4/10, 10/20 or 4/20                        |
| 375 - 500      | Size 10/20 or 4/20                              |
| > 600          | Size 10/20, 20/40, 4/20 or 4/40                 |

|      |          |      |       |      |      |
|------|----------|------|-------|------|------|
|      |          |      |       |      |      |
|      |          |      |       |      |      |
|      |          |      |       |      |      |
| Mark | Revision | Date | Drawn | Chkd | Appd |

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status

FOR INFORMATION

LYMINSTER BYPASS - SOUTH  
NORTH LITTLEHAMPTON  
HIGHWAY CONSTRUCTION DETAILS  
SHEET 1 OF 2

Client



Date of 1st Issue

23.06.2017

A1 Scale

AS SHOWN

Drawing Number

350441

35944/2

10

|          |  |
|----------|--|
| Designed |  |
|----------|--|



Checked  
MJP

|     |
|-----|
| 100 |
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01/003

01/003

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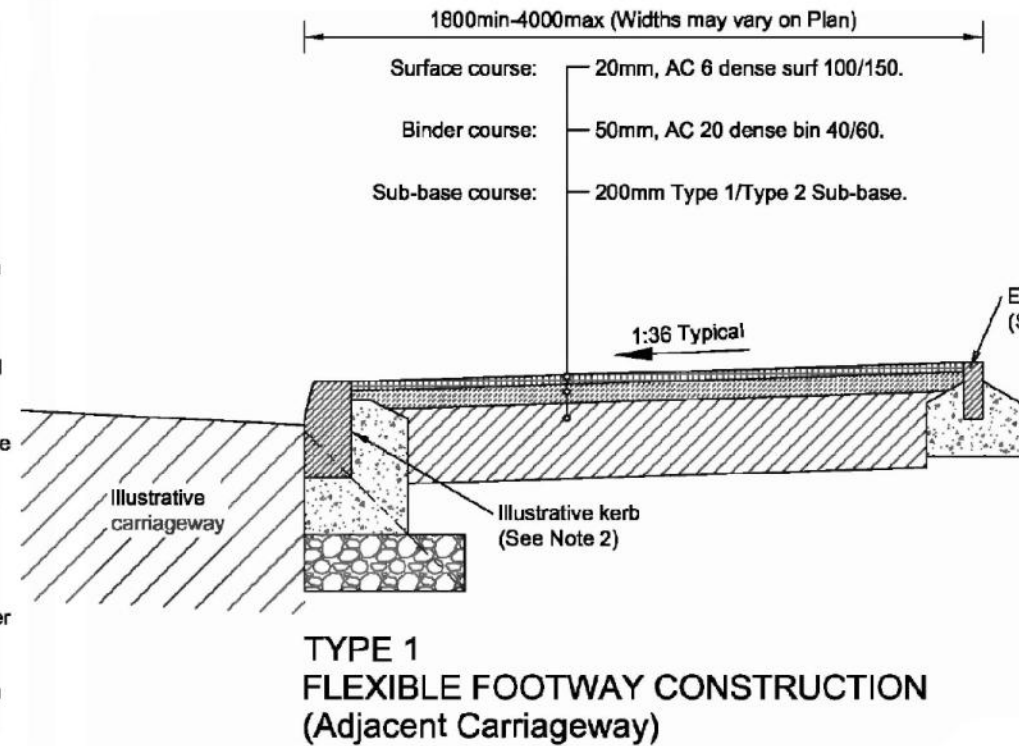
READING  
Tel: 01180 500 761

Tel: 01189 500 761

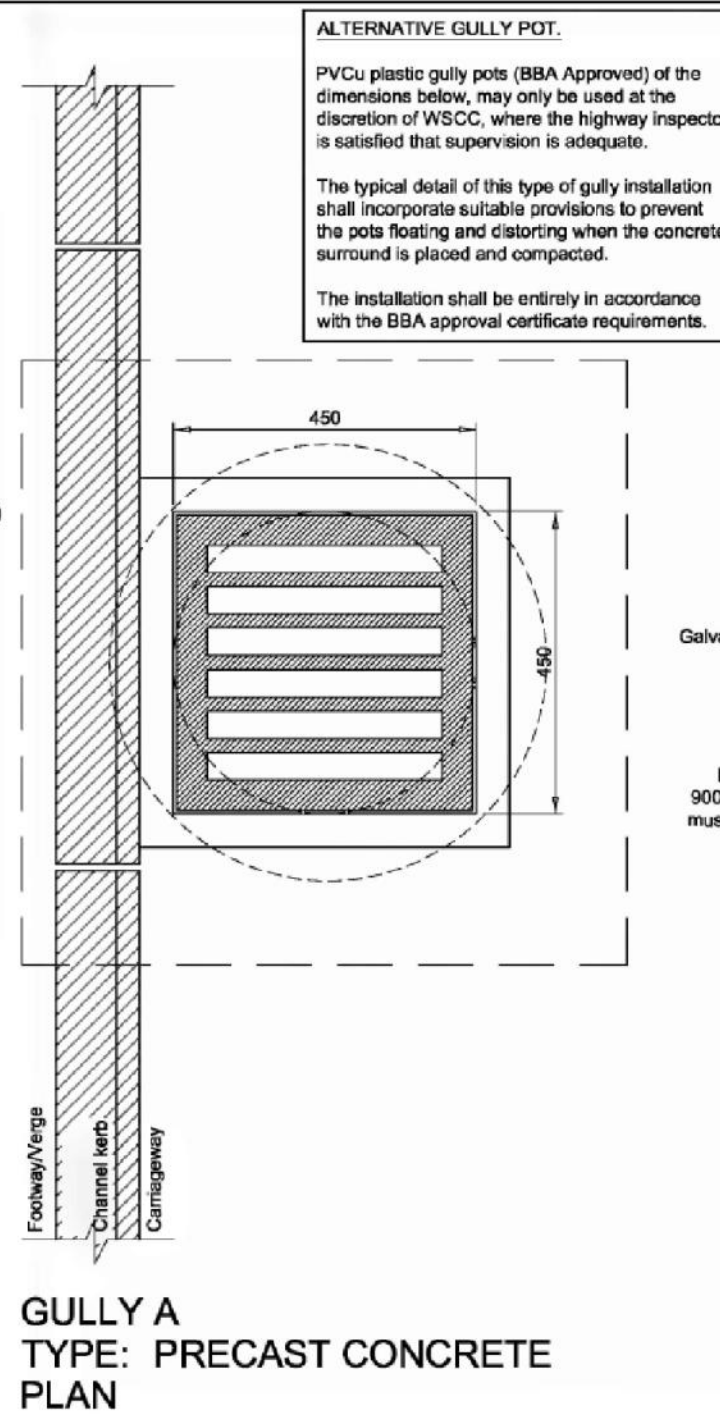
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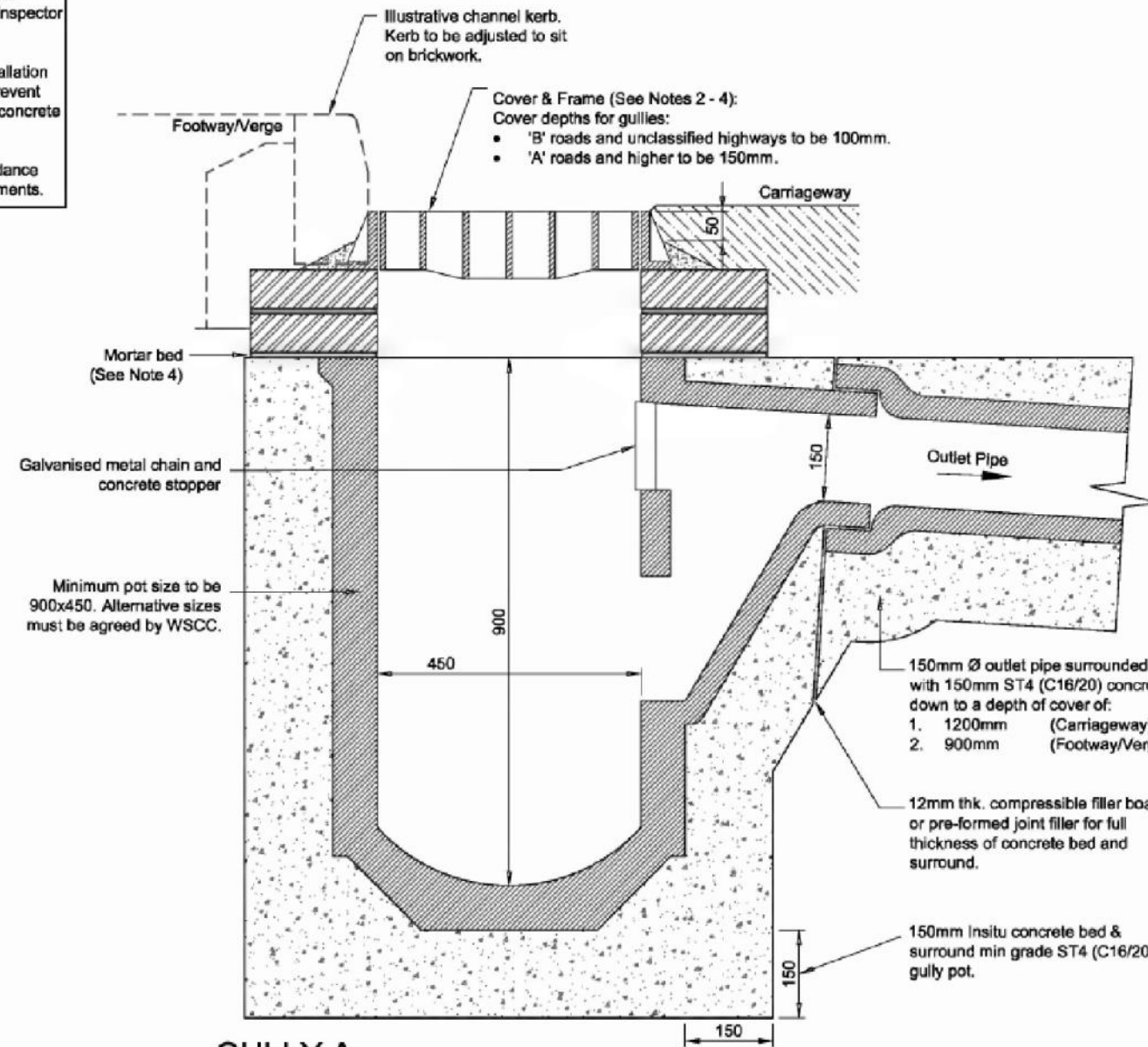
- NOTES
- Do not scale from this drawing.
  - Refer to drawings 02 & 03 for Approved Kerb Type Selection.
  - Refer to drawing 01 for laying methods.
  - Prior to the commencement of laying the formation shall be treated with an approved residual weedkiller.
  - The Highway Inspector may request inclusion of a non-woven separation membrane to mitigate weed/root intrusion.
  - The Highway Inspector may increase the Sub-base depth or include a geotextile or geogrid on formation where site ground conditions are considered to be sub-standard.
  - Where there are footways without vehicle crossovers sub-base may be reduced to 100mm.
  - None of the details on this drawing are suitable where 'no-dig' construction is required.
  - Where a footpath is proposed between walls, private land or other features then positive drainage will be necessary in order to prevent run off of highway surface water.
  - Tactile paving to be specified and installed in accordance with DETR guidance on the Installation of Tactile Paving 1998



WEST SUSSEX COUNTY COUNCIL  
DETAIL S278/38/04



GULLY A  
TYPE: PRECAST CONCRETE  
PLAN



GULLY A  
TYPE: PRECAST CONCRETE  
SECTION

- NOTES
- Do not scale from this drawing.
  - All gully grating and frames to be 'hinged' heavy duty ductile iron minimum grade D400 in accordance with BS EN124:1994 & Section 508 of the Specification of Highway Works.
  - All Ironwork shall carry a BSI kite mark.
  - Frames shall be bedded on a gauged Class 1 (3:1) sand/cement mortar to CI.2402 of SHW Mortar Designation (I), and either 2 or 3 courses of Engineering Brickwork Class 'B' to BS EN 771-1:2011.
  - Gully spacing is to be determined from the requirements of HA 102/00, Design Manual for Roads and Bridges, however, maximum area to be drained by one gully: 180 m<sup>2</sup>
  - Gully pots used for carriageway gullies shall be of precast concrete using Sulphate Resisting Cement (SRC) in accordance with BS 5911, part 230, 2004.
  - All gullies to be trapped. Any variations to this i.e. 'non-trapped', 'gully chute' or 'grip' must be qualified and WSCC shall review each location on an individual basis.
  - Selection of gully grating type shall be to suit the application area i.e. carriageway, footway/cycleway and to the satisfaction of the highway inspector.
  - Pipe bedding to highway drainage to be Type Z when located under carriageway, and Type T at all other times, as detailed on Specification of Highway Works HCD no. F1.

**SURFACE WATER PIPES**

Permitted Types as follows:

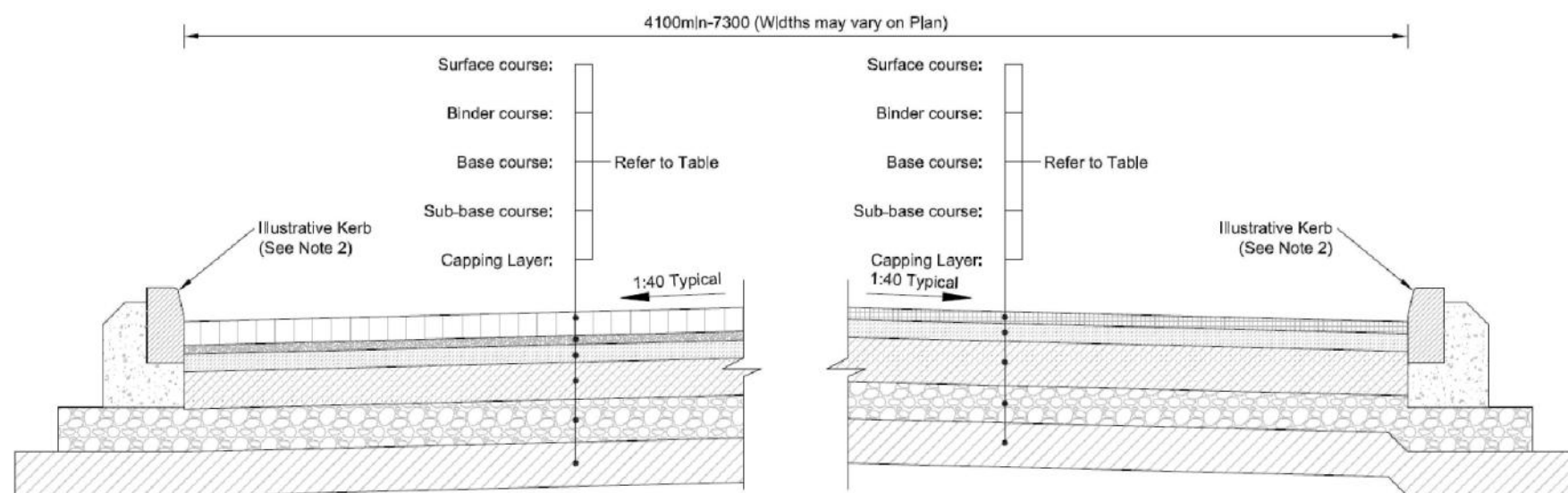
**CLAY:** (1000-1200Ø)  
All pipe shall be Vitrified Clayware to BS EN 295-1:1991.

**UPVC:** (1000-1100Ø)  
All pipes shall be to BS EN 1401-1:1998.  
All pipes shall be ribbed 'twin wall' to provide a suitable network (pipes & couplings).

**CONCRETE:** (3000Ømin)  
All pipes shall be made with Sulphate resistant Cement to BS 5911-1:2002

- ALL jointing and installation shall be undertaken to manufacturers specification.
- ALL materials shall be BBA certified.
- ALL materials shall comply with the Specification for Highway Works.

WEST SUSSEX COUNTY COUNCIL  
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TYPE 1  
FLEXIBLE CONSTRUCTION  
(Scale 1:20)

ALTERNATIVE DESIGN:  
WSCC will accept permanent foundation designs in accordance with the latest revision of Interim Advice Note 73/06

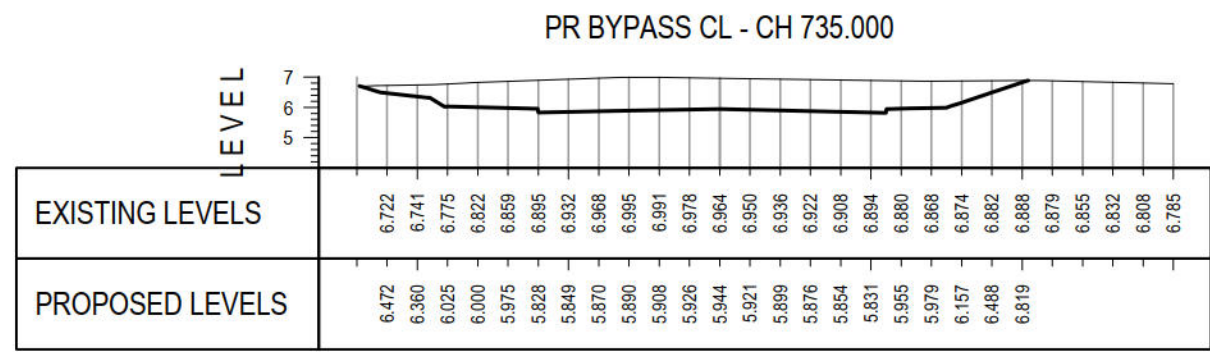
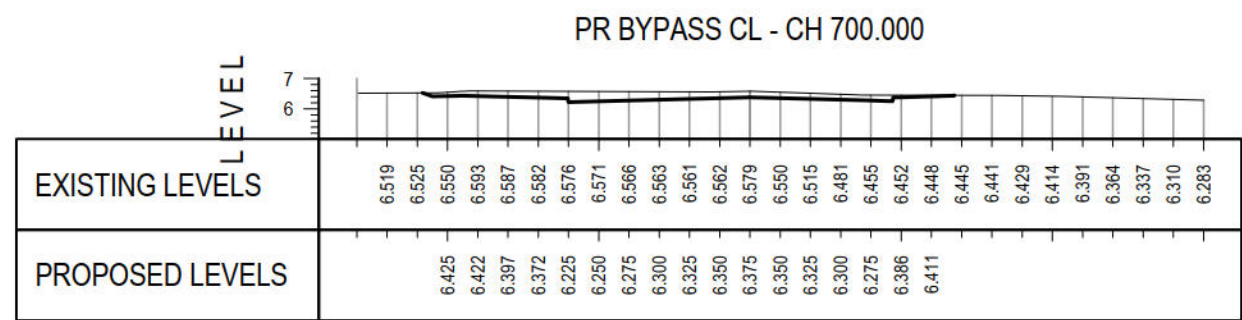
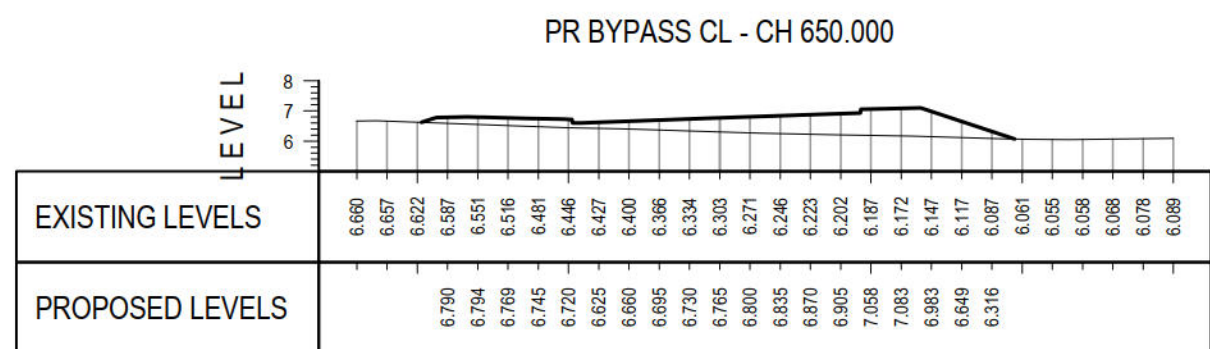
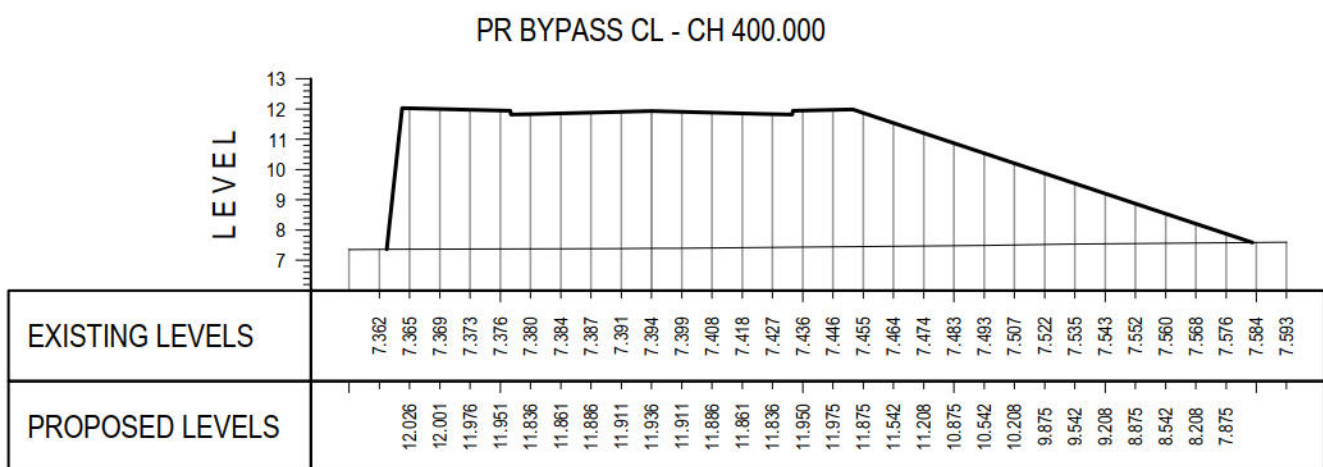
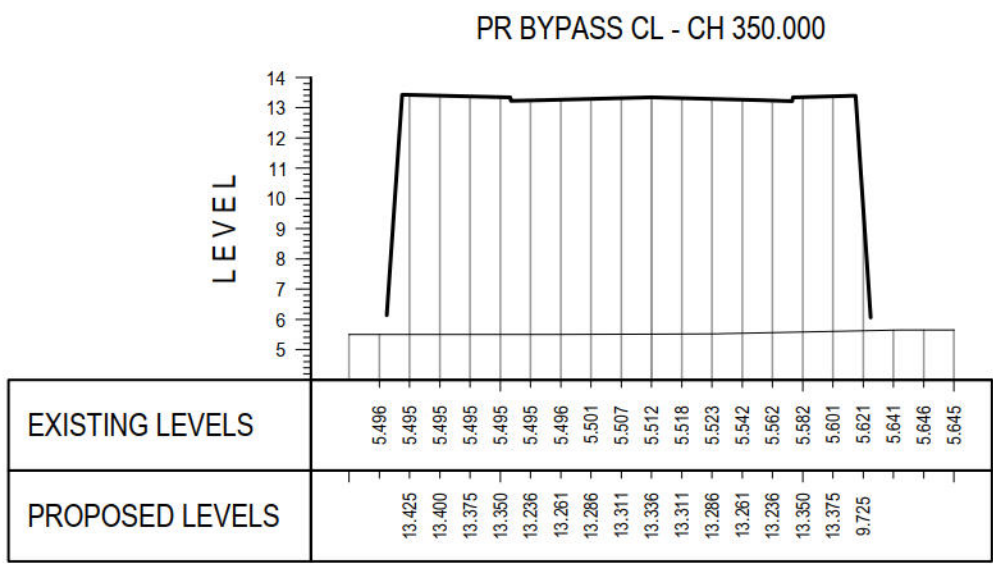
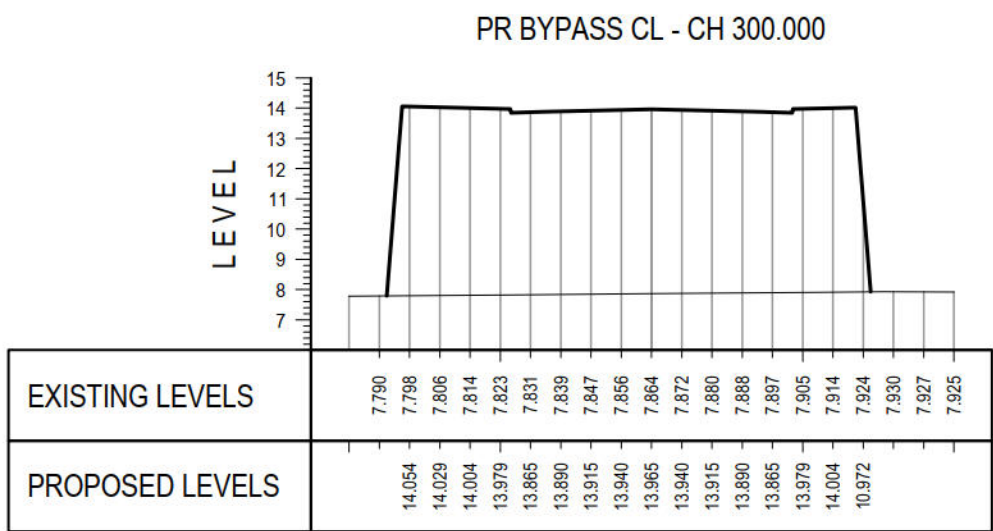
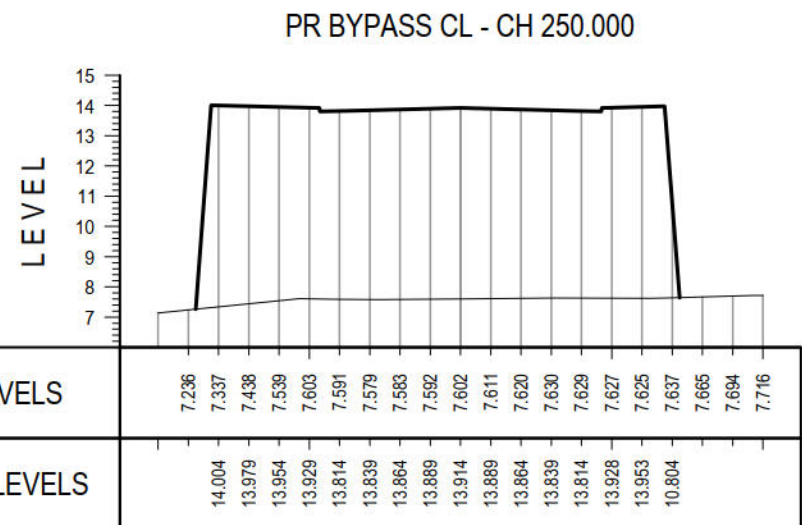
| CARRIAGEWAY - FLEXIBLE CONSTRUCTION TABLE SELECTOR                                                                                            |                                                      |           |             |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------|-------------|------------|
|                                                                                                                                               | LOCAL DISTRIBUTOR<br>See note 14                     | COLLECTOR | ACCESS ROAD | ACCESS WAY |
| CAPPING LAYER (For CBRs ≤ 5% capping shall be class 6F1/6F2 (site won), or 6F4/ 6F5 (imported) material.                                      |                                                      |           |             |            |
| CBR <2%                                                                                                                                       | Bespoke design required in accordance with IAN 73/06 |           |             |            |
| CBR 2-2.5%                                                                                                                                    | 600                                                  | 600       | 600         | 600        |
| CBR >2.5-5%                                                                                                                                   | 350                                                  | 350       | 350         | 350        |
| CBR >5% (Type 1 to Clause 803)                                                                                                                | 100                                                  | 100       | 100         | 100        |
| SUB-BASE                                                                                                                                      |                                                      |           |             |            |
| Type 1 (Clause 803)                                                                                                                           | 150                                                  | 150       | 150         | 150        |
| BASE                                                                                                                                          |                                                      |           |             |            |
| Either: 32mm Dense Asphalt Concrete Base 40/60 PEN                                                                                            | 150                                                  | 125       | 100         | 100        |
| Or: Lean Mix Concrete                                                                                                                         | -                                                    | 150       | 150         | 150        |
| BINDER                                                                                                                                        |                                                      |           |             |            |
| 20mm Dense Asphalt Concrete Binder 40/60 PEN (Not required with block pavements)                                                              | 60                                                   | 60        | 50          | 50         |
| SURFACE COURSE                                                                                                                                |                                                      |           |             |            |
| HRA 30/14 F Surf 40/60 with:<br>• 14/20mm pre-coated chippings<br>• PSV as table 3.1a (IAN 156/12)<br>• Texture depth as Series 900 table 9/3 | 40                                                   | -         | -           | -          |
| 10mm Close Graded Asphalt Concrete Surface Course 100/150                                                                                     | -                                                    | 30        | 30          | 30         |
| Blocks on 30mm sand Bed                                                                                                                       | -                                                    | 80        | 80          | 80         |

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- NOTES
- Do not scale from this drawing.
  - Refer to drawings 02 & 03 for Approved Kerb Type Selection.
  - Refer to drawing 01 for laying methods.
  - Prior to the commencement of laying the formation shall be treated with an approved residual weedkiller.
  - The Highway Inspector may request inclusion of a non-woven separation membrane to mitigate weed/root intrusion.
  - The Highway Inspector may increase the Sub-base depth or include a geotextile or geogrid on formation where site ground conditions are considered to be sub-standard.
  - Not suitable where 'no-dig' construction is required.
  - Asphalt Concrete to be in accordance with BS EN 13108-01 and BS 594987.
  - Type 1 Sub-base to be in accordance with Specification for Highway Works clause 803.
  - Hot Rolled Asphalt to be in accordance with BS EN 13108-04 and BS 594987.
  - Block Pavements to be in accordance with BS EN 1338 and BS 7533-3:2005 (A1:2009).
  - Total Carriageway construction depth must be greater than 450mm to negate susceptibility to frost penetration, irrespective of CBR value.
  - Where block paved construction is proposed the binder course may be omitted.
  - More major roads shall have a bespoke pavement design in accordance with DMRB standards.
  - Carriageway widening to widths of less than 1m; Base and sub-base to be replaced with ST1 concrete with the same overall construction depth as the standard construction.
  - Under some circumstances, WSCC may accept 40mm of Bardon Superflex 50 with 10mm Aggregate (65 PSV) as a surface course, provided there is a 10 year guarantee on the skid resistance value (SRV).
  - On approaches to traffic signals WSCC may accept 45 +/- 5mm of Bardon Superflex 72 with 10mm Aggregate (72 PSV) as a surface course, subject to site specific approval.
  - PSV shall be declared in accordance with IAN 156/12 table 3.1a.
  - CBR values to be obtained from site investigation report and laboratory testing only. In-situ testing shall not be used to determine or amend the design CBR. The WSCC Inspector may request additional tests. In situ CBR tests shall only be used to identify 'soft spots' in the construction.
  - Capping shall be class 6F1/6F2 (site won) or 6F4/6F5 (Imported)
  - WSCC does not permit lime/cement stabilised material in capping or sub base layers.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------|-------|-----------------|------|
| Mark                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Revision | Date           | Drawn | Chkd            | Appd |
| SCALING NOTE: Do not scale from this drawing. If in doubt, ask.                                                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
| UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations. |          |                |       |                 |      |
| Drawing Issue Status                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                |       |                 |      |
| FOR INFORMATION                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
| LYMINSTER BYPASS - SOUTH<br>NORTH LITTLEHAMPTON<br>HIGHWAY CONSTRUCTION DETAILS<br>SHEET 2 OF 2                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
| Client                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                |       |                 |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
| Date of 1st Issue<br>23.06.2017                                                                                                                                                                                                                                                                                                                                                                                                                              |          | Designed<br>-  |       | Drawn<br>CL     |      |
| A2 Scale<br>AS SHOWN                                                                                                                                                                                                                                                                                                                                                                                                                                         |          | Checked<br>MJP |       | Approved<br>DTH |      |
| Drawing Number<br>35944/2001/004                                                                                                                                                                                                                                                                                                                                                                                                                             |          | Revision<br>-  |       |                 |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                |       |                 |      |
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SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

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Drawing Issue Status

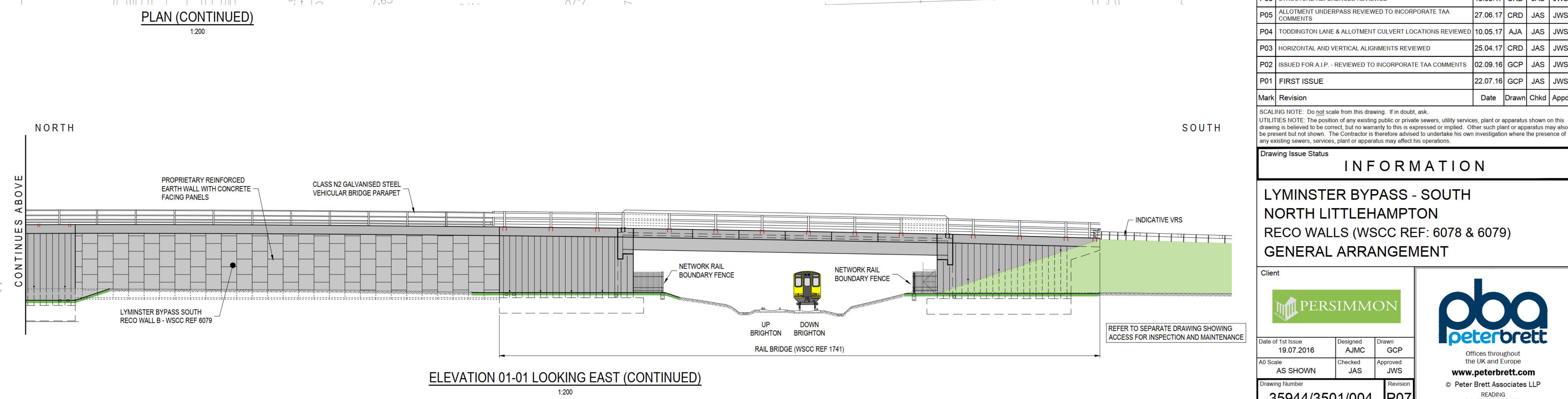
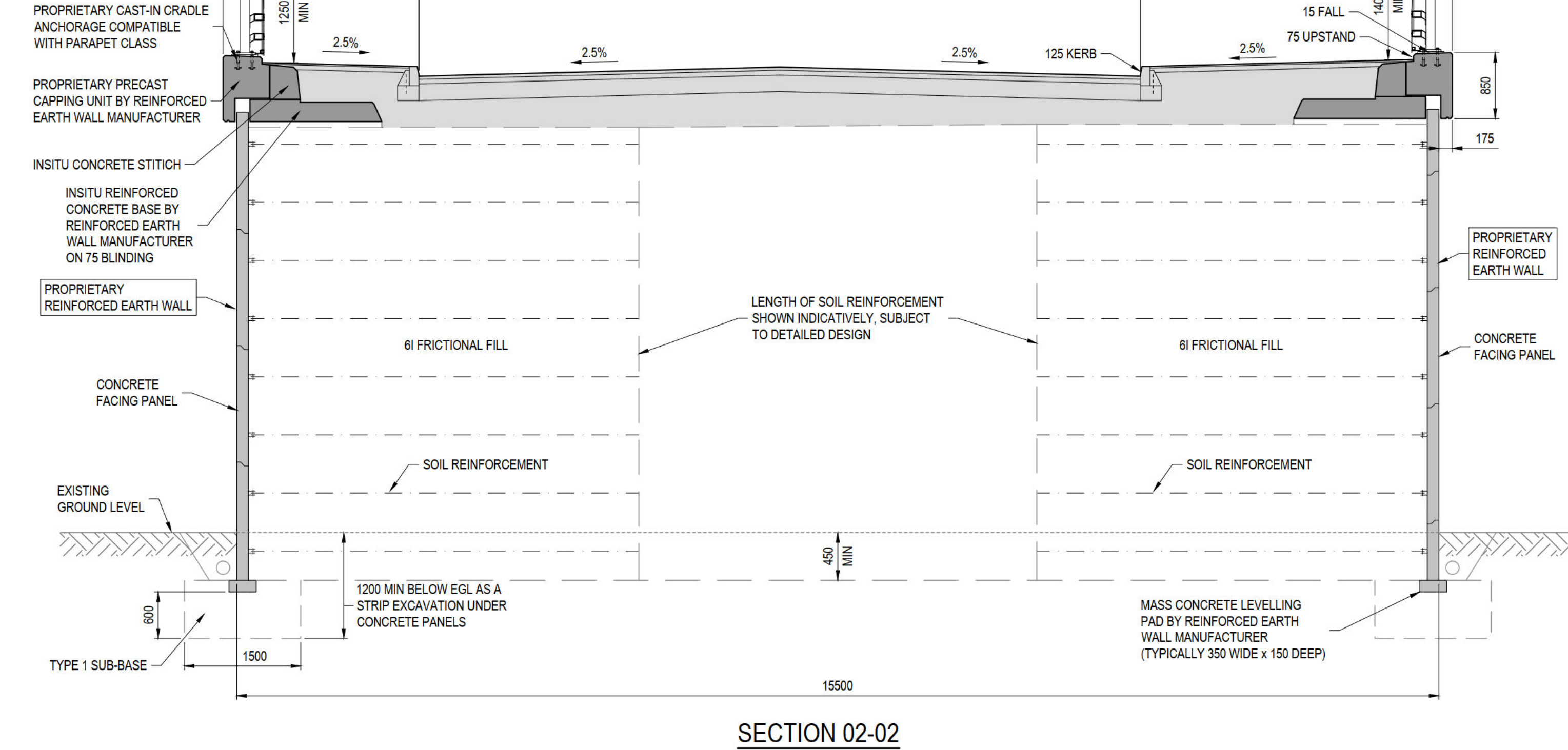
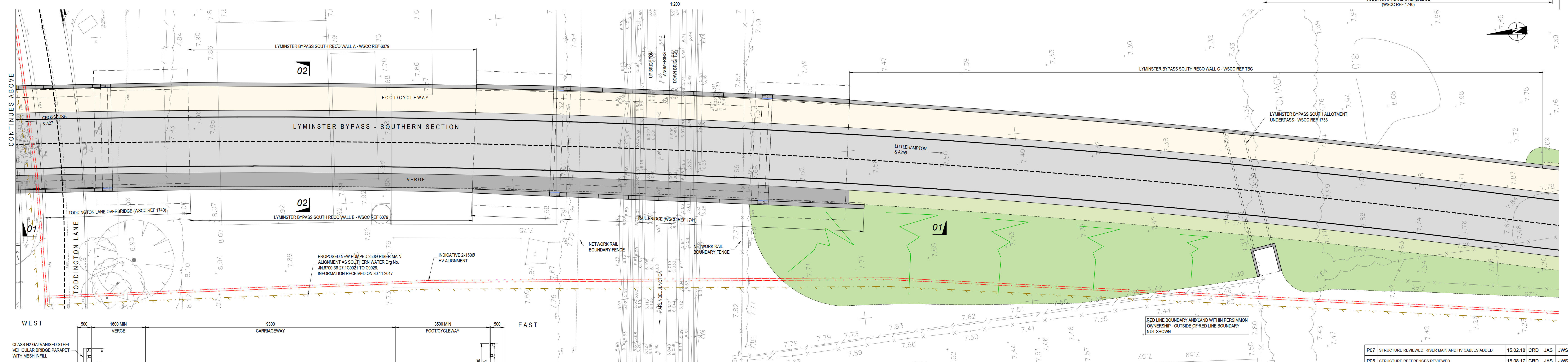
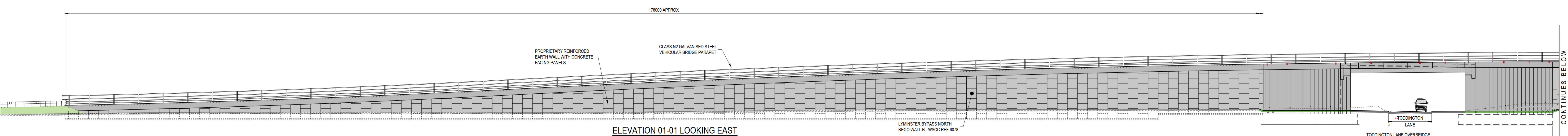
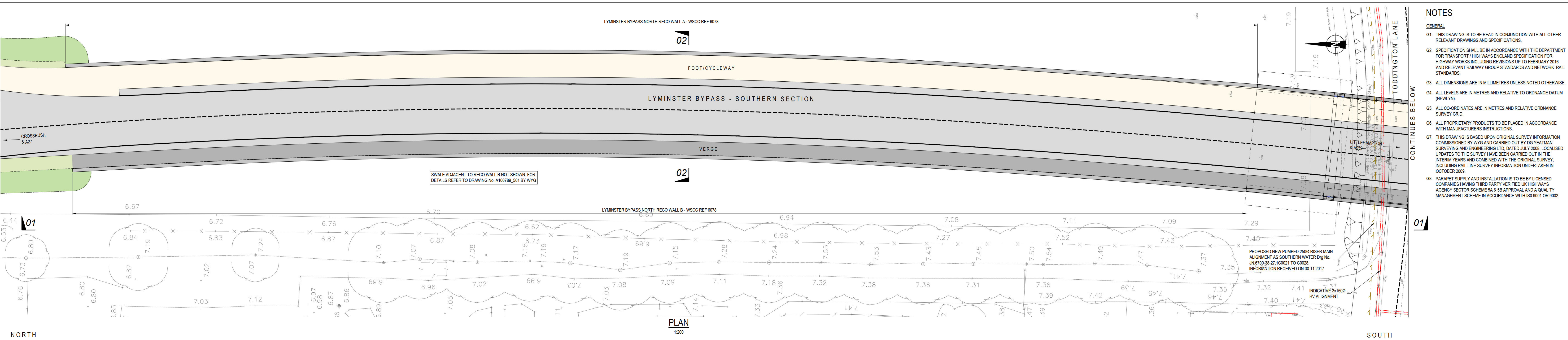
FOR APPROVAL

## LYMINSTER BYPASS - SOUTH NORTH LITTLEHAMPTON PROPOSED CROSS SECTIONS

|                                  |  |                                                                                       |                 |                                                                                                                                           |  |
|----------------------------------|--|---------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------|--|
| Client                           |  |  |                 |                                                      |  |
| Date of 1st Issue<br>11.05.2018  |  | Designed<br>-                                                                         | Drawn<br>CRD    | Offices throughout<br>the UK and Europe<br><br><a href="http://www.peterbrett.com">www.peterbrett.com</a><br>© Peter Brett Associates LLP |  |
| A1 Scale<br>1:250 H, 1:250 V     |  | Checked<br>DS                                                                         | Approved<br>DH  | READING<br>Tel: 01189 500 761                                                                                                             |  |
| Drawing Number<br>35944/2001/005 |  |                                                                                       | Revision<br>P01 |                                                                                                                                           |  |

- Notes**
1. This drawing shall be read in conjunction with all other contract drawings and documents.
  2. All works to be in accordance with the Highway England Specification for Highway Works Volume 1 and contract specific appendices.
  3. This drawing shows existing / proposed carriageway and footway levels.
  4. Refer to drawing number 35944/2001/001 for plan and longitudinal section.





- NOTES**
- GENERAL**
01. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
02. SPECIFICATION SHALL BE IN ACCORDANCE WITH THE DEPARTMENT FOR TRANSPORT / HIGHWAYS ENGLAND SPECIFICATION FOR HIGHWAY WORKS INCLUDING REVISIONS UP TO FEBRUARY 2016 AND RELEVANT RAILWAY GROUP STANDARDS AND NETWORK RAIL STANDARDS.
03. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
04. ALL LEVELS ARE IN METRES AND RELATIVE TO ORDNANCE DATUM (NEWLY).
05. ALL CO-ORDINATES ARE IN METRES AND RELATIVE TO ORDNANCE SURVEY GRID.
06. ALL PROPRIETARY PRODUCTS TO BE PLACED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
07. THIS DRAWING IS BASED UPON ORIGINAL SURVEY INFORMATION COMMISSIONED BY WYG AND CARRIED OUT BY DDO YEATHAM SURVEYING AND ENGINEERING LTD, DATED JULY 2008. LOCALISED UPDATES TO THE SURVEY HAVE BEEN CARRIED OUT IN THE INTERIM YEARS AND COMBINED WITH THE ORIGINAL SURVEY INCLUDING RAIL LINE SURVEY INFORMATION UNDERTAKEN IN OCTOBER 2009.
08. PARAPET SURVEY AND INSTALLATION IS TO BE BY LICENSED COMPANIES HAVING THIRD PARTY VERIFIED UK HIGHWAYS AGENCY SECTOR SCHEME SA & SB APPROVAL AND A QUALITY MANAGEMENT SCHEME IN ACCORDANCE WITH ISO 9001 OR 9002.

|      |                                                           |          |       |      |      |
|------|-----------------------------------------------------------|----------|-------|------|------|
| P07  | STRUCTURE REVIEWED: RISER MAIN AND HV CABLES ADDED        | 15.02.18 | CRD   | JAS  | JWS  |
| P06  | STRUCTURE REFERENCES REVIEWED                             | 15.06.17 | CRD   | JAS  | JWS  |
| P05  | ALLIOTMENT UNDERPASS REVIEWED TO INCORPORATE TAA COMMENTS | 27.06.17 | CRD   | JAS  | JWS  |
| P04  | TODDINGTON LANE & ALLIOTMENT CULVERT LOCATIONS REVIEWED   | 10.05.17 | AJA   | JAS  | JWS  |
| P03  | HORIZONTAL AND VERTICAL ALIGNMENTS REVIEWED               | 25.04.17 | CRD   | JAS  | JWS  |
| P02  | ISSUED FOR A.I.P. - REVIEWED TO INCORPORATE TAA COMMENTS  | 02.09.16 | GCP   | JAS  | JWS  |
| P01  | FIRST ISSUE                                               | 22.07.16 | GCP   | JAS  | JWS  |
| Mark | Revision                                                  | Date     | Drawn | Chkd | Appd |

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

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**Information**

**LYMINSTER BYPASS - SOUTH NORTH LITTLEHAMPTON RECO WALLS (WSCC REF: 6078 & 6079) GENERAL ARRANGEMENT**

Client

**PERSIMMON**

**pba peterbrett**

Date of 1st Issue: 19.07.2016  
Designed: AJ/MC  
Drawn: GCP  
AS SHOWN  
Checked: JAS  
Approved: JWS  
Drawing Number: 35944/3501/004  
Revision: P07

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