# Appendix B CDM designer's risk register for the tunnel

## DESIGN HAZARD ELIMINATION AND REDUCTION REGISTER

highways england

| Project Name | Design Stage | Engineering Discipline | Structure | Date | Document Reference |
|---|---|---|---|---|---|
| A303 Amesbury to Berwick Down (Stonehenge) - Bored Tunnel and Cross-Passages | Tender Design | Geotechnics | Stonnehenge Tunnel (Bored Tunnel and Cross-passages) | 07 May 2021 | **Quality Submission** |

| Ref: | Phase C/M/D | Activity | Potential Hazards | Risk | Person(s) Affect | L | S | R | Design Measures to Eliminate Hazards | Design Measures to Reduce Risk | Residual risk information to be provided going forward | L | S | R | Included on Drawing/Document No.'s - References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 | C | Excavation | Unforeseen Ground Conditions | Stratum failure, cave-in or excess settlement. Disruption to construction owing to unforeseen ground conditions, incorrect stratigraphy and ground parameters identification | Site personnel and public | 3 | 4 | 12 | Site Investigation<br>Desk study | The ground conditions along the tunnel and cross-passages should be established in the detailed design stage. All factual data should be made available to Contractor. | Follow advice of designers, any ground improvement or operational parameter of TBM to be undertaken by the contractor | 2 | 4 | 8 | |
| 2.0 | C | Excavation and Lining/Support | In-situ construction works | Injury to workforce due to construction methodology | Site personnel | 4 | 4 | 16 | Design to allow the offsite manufacture where possible to ensure controlled conditions | Identification and Communication of design advice such as guidance on the equipment to be used | Competent contractor to be used and detailed construction risk assessment to be completed upon award of detailed design | 2 | 4 | 8 | |
| 3.0 | C | Construction of Lining/Support | Working at height installing tunnel lining | Falls from height, injury and death. | Site personnel | 4 | 4 | 16 | Design to allow the offsite manufacture of as many elements as possible for lifting using machinery. This would eliminate as far as reasonable possible the need for onsite working at height. In-situ works required for lining and to ensure water proofing requirements. | Identification and Communication of design advice such as guidance on the equipment to be used, leading edge protection, guidance on harnessing operatives if necessary and PPE to be used. | Contractor to follow design advice and follow appropriate working at height procedures | 2 | 4 | 8 | |
| 4.0 | C | Construction of Lining/Support | Crane movement and Lifting of materials | Dropping of heavy items, material during construction resulting in injury and death, and damage to materials and tunnel. | Site personnel | 3 | 4 | 12 | The use of mechanical hoists to be designed where possible to reduce lifting | Identification and Communication of design advice including the correct procedure for lifting materials and the use of crash/protection decks | Contractor to follow design advice and follow appropriate lifting procedures. Protection/Crash decks to be designed | 2 | 4 | 8 | |
| 5.0 | C | Excavation in open-face mode (SCL) | Open Excavations | Collapse of excavations causing injury and death, and settlements. | Site personnel and public | 3 | 4 | 12 | Temporary works to be designed with face reinforcement / shoring as necessary to prevent collapse of any excavations | Appropriate exclusion zones and design measures to be put in place to mitigate the damage and injury caused by potential collapse of excavations. | Contractor to follow design advice and follow appropriate procedures. Method statements to be prepared for works | 1 | 4 | 4 | |
| 6.0 | C & M | Construction of Tunnel, Cross-Passages and Undercroft Gallery | Potential for confined space working | Injury to workforce | Site personnel | 3 | 4 | 12 | Design in order to prevent confined space through access and ventilation etc. Work with contractor to develop design solution that suits proposed methodology - particularly where the construction of the cross passages is concerned. | N/A | Contractor to follow design advice and build to design | 1 | 4 | 4 | |
| 7.0 | C | Construction of Tunnel, Cross-Passages and Undercroft Gallery | Fire during construction | Injury and death of workforce, disruption of the construction and damaging of construction machinery (TBM) and structural capacity of the tunnel lining | Site personnel and worksite visitors | 3 | 5 | 15 | TBM equipment and tools to be fully protected against fire. | Provide deisgn details that are easily buildable, have correct tolernances and eliminate the need for hot works on site | Hot works to be undertken only under a strict procedure. | 2 | 5 | 10 | |
| 8.0 | M | Operation of Highways | Fire during operation | Injury and death, loss of asset during repairs | Public and tunnel operators | 2 | 5 | 10 | Fire risk information and evacuation planning to be included in O&M manuals and the Health and Safety File, | Active and passive fire safety measures in the design of the tunnel HCM/HCinc fire curves shall be used in design; at the peak this specifies a temperature of 1300°C over 120 minutes as per the PIARC recommendations. | No restrictions will be placed on the transportation of Dangerous Goods through the tunnel during normal operations. Tunnel will be classified as ADR Category AA in accordance with CD 352 'Design of Road Tunnels' | 1 | 5 | 5 | |
| 9.0 | C & M | Tunnel construction and operation | Groundwater pressure higher than estimated in site investigation | Excessive water loads and inflows, sealing issues (waterproofing) in the tunnel lining and loss of ground support around the tunnel (over-excavations and grout injection issues) | Site personnel, tunnel operators and public | 3 | 4 | 12 | Further site investigation to establish maximum ground water level | Although groundwater is seasonal and very variable, design shall consider the application of conservative load and inflow factors during the detailed design process | Contractor to follow design advice and build to design | 1 | 4 | 4 | |
| 10.0 | C | Tunnel Excavation | Contaminated Ground/groundwater including unknown contamination (unlikely due to nature of this worksite) | Risk to human health, controlled water receptors (drainage system) and management of potential contaminated mud/debris | Site personnel | 2 | 4 | 8 | Site Investigation<br>Desk Study | Report to be made available to Contractor | Identification of areas known to be contamination (if any). Excavation and removal of zone for off site disposal to a licenced landfill facility under appropriate Risk Assessments and Method Statements. Tool box talks to raise awareness of risks and actions in the event of encountering contamination. Protection of groundwater monitoring installations | 1 | 4 | 4 | |
| 11.0 | C | Tunnel Excavation | Multiple concurrent construction process (TBM & Cross passages - Pipe jacking system) | Potential interferences between several working tasks resulting in delay and risk of injury to the workers or collisions. | Site personnel | 4 | 4 | 16 | Interaction analysis during detailed design phase to make sure there is no interferences | Work with contractor as detailed on-site Logistic program for construction is developed | Contractor to follow design advice and follow appropriate procedures when these situations occur. | 3 | 4 | 12 | |
| 12.0 | C | Tunnel Excavation | Siginficant archaeological discoveries as the tunnel passes through the WHS | Exceedence of the maximum allowed vibrations and settlements.<br>Delay on excavations works and changes to design | Public | 3 | 4 | 12 | Regarding settlements, a Tunnel Advance Plan (TAP) will be established to operate with precise control of the pressure of the TBM, at all times, in particularly sensitive areas. Exceeding vibrations limits due to TBM excavation when tunnelling in the chalk are not expected | Prepare and implement an appropriate "Settlement, Vibration and Monitoring Plan" linked permanently to the selection of operation parameters of the TBM (rpm, push, pressures,…) of the TAP | Contractor to follow design advice and the TAP and build to design avoiding alignment changes. Implementation of the Archaeological mitigation strategy (DAMS). | 2 | 4 | 8 | |
| 13.0 | M | Repair and maintenance of operational highway | Technical staff inside tunnel for maintenance operations | Injury and death of people (run over) and disruption or reduction of highway lanes | Tunnel operators | 4 | 4 | 16 | Use of a dedicated tunnel invert for most of services (traffic-free access). | Egress from the tunnel invert in three points amid the bored tunnel. | Contractor to follow design advice and build to design | 2 | 4 | 8 | |
| 14.0 | C | Tunnel Excavation | Affection to existing infrastructure (A303, utilities), Buildings, Heritage assets…etc. | Damage to structures and archaeological heritage | Site personnel and public | 3 | 4 | 12 | Analyse the potential affect that tunnel excavation could have on these structures and propose mitigation measures and contingency plans to minimize risk. | Propose detailed instrumentations and monitoring system to control any potential ground movement caused by the tunnel excavation | Maintain long-term instrumentation and monitoring measures after tunnel construction to assure the movement has stabilized and the risk has been eliminated. | 1 | 4 | 4 | |
| 15.0 | C | Tunnel Excavation | Reduced ground cover along the tunnel alignment | Excavation could cause excessive ground moments (blowout), including ground face instabilities due to variation of TBM face pressures | Site personnel, public and other third parties | 3 | 4 | 12 | Adjustment of the vertical alignment providing a minimum overburden to minimise the ground instabilities during excavation. | TBM face pressure to be monitored and adjusted continuously to assure the correct pressure is provided to assure the ground face stability. A benefit for the project is the use of slurry TBM which provides a better control of face pressure. | Apart from the TBM parameters, all other excavation factors shall be monitored to do not interfere on the tunnel excavation process. | 2 | 4 | 8 | |
| | | | | | | | | 0 | | | | | | 0 | |
| | | | | | | | | 0 | | | | | | 0 | |

| Phase | |
|---|---|
| C | Construction |
| M | Maintain/Clean |
| D | Demolish/Adapt |

| Hierarchy of Mitigation |
|---|
| 1. Eliminate hazard - design out |
| 2. Reduce risk at source - amend design |
| 3. Provide risk information - add to design |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prepared by: | Team Badger | | | | | | | | | | | Date: | 07 May 2021 | |
| Reviewed by: | Team Badger Internal | | | | | | | | | | | Date: | 07 May 2021 | |
| Approved by: | Team Badger Internal | | | | | | | | | | | Date: | 07 May 2021 | |