12 CONSTRUCTION

12.1 Safety Submission

12.1.1 The Authority's Consultant has prepared preliminary risk assessments for the base design and construction method for the Works. These risks are documented in the Civil Concept Hazard Register in **Appendix F** of the Particular Specification. The Contractor shall take ownership of this document and use it as a basis for the preparation and submission of his Civil Design Safety Submission (Civil DSS), Civil Construction Safety Submission (Civil CNSS) and Civil Handover Safety Submission (Civil HSS) as required in **Appendix A** of the General Specification. In addition, the Contractor shall develop and implement the Construction Risk Management Procedure (CRMP) in the format as attached in **Appendix F** of Particular Specification to the acceptance of the Engineer.

12.1.2 The Contractor shall appoint a Risk Management Facilitator (RMF) / Design For Safety Professional (DfS Professional) as stipulated in **Clause 4** of the Particular Specification. The RMF / DfS Professional shall be required to attend the Engineer's Project Safety Committee Meetings (PSCM) or any other meetings as directed by the Engineer for the review of Civil Safety Submissions. The RMF / DfS Professional should prepare, endorse, update and maintain all risk registers and job hazard analysis. All risk registers and job hazard analysis should be submitted in the format accepted by the Engineer.

12.1.3 The Contractor shall be responsible for developing and implementing control measures stipulated in the Civil Safety Submissions and control measures proposed in Safety Submissions including method statements and risk assessments that are produced by the Contractor.

12.2 Method Statements with Safe Work Procedures

12.2.1 The Contractor shall submit Methods Statements with comprehensive Safe Work Proceduresfor all planned construction activities to the approval of the QP(S) and final acceptance of the Engineer. Submission of these Method Statements with Safe Work Procedures shall be made at least eight (8) weeks in advance of the Works to allow for adequate time for review, amendment and resubmission as necessary. The statements shall clearly identify the Contractor's proposed methods and sequence of Works and Safe Work Procedures to protect the safety of workmen and (where applicable) the public at all stages of works. The statements shall include but not be limited to the following:

(a) Protective measures to ensure the safety of the public and biodiversity, where applicable;

(b) Method and sequence of the Works and demonstrate, at each stage, the Safe Work Procedures for workmen to carry out their works safely with all safety features introduced at each stage of works;

(c) Method and sequence of the Works and demonstrate, at each stage, the Safe Work Procedures for the works to be carried out with the safety measures introduced to protect the wildlife as stated in Chapter 23;

(d) Personnel in-charge at all phases of works and organization chart including specialists or consultants engaged for special elements of the Works;

(e) Construction Equipment;

(f) Programme for the Works;

(g) Traffic diversion schemes, including details of temporary decking where appropriate;

(h) A comprehensive 'Risk Assessment Report in line with Workplace Safety and Health Regulations' based on the Safe Work Procedures established;

(i) Contingency Plans for Safe Work Procedures to protect buildings, utilities, structures within the influence zone of the works and to protect workmen from all hazards identified in the risk assessment report;

(j) Contingency Plans for Safe Work Procedures to protect the wildlife affected by the works and to protect workmen from all hazards identified in the risk assessment report;

(k) Inspection and test plans, identification of checks to be carried out, details of the Quality Assurance (QA) / Quality Control (QC) records that will be submitted;

(l) Compliance with Design for Safety requirements;

(m) Temporary ERSS/mining schemes, where appropriate;

(n) Proposals for protection of adjacent structures and utilities;

(o) Ground treatment, where appropriate;

(p) Construction safety precautions;

(q) Environmental control measures;

(r) Access controls; and

(s) Instrumentation monitoring proposals for the Temporary Works and adjacent structures and utilities.

12.2.2 The Risk Assessment to be incorporated in the Method Statement shall identify all hazards relating to the safety of workers on site that could lead to an accident/incident and shall include work processes and methods demonstrating how these hazards will be mitigated. These hazards and the proposed mitigation measures shall be clearly identified and included in the risk register. Risk owners and action parties shall endorse the risk register as acknowledgement of their responsibilities.

12.2.3 The personnel and organization chart included in the method statement shall indicate the full time staff and their contact numbers, which includes construction manager, construction supervisors and site safety supervisors of both the Contractor and his appointed sub-contractors for each area of work. Where shift works are proposed to be carried out, the personnel and organization chart for each shift shall be submitted.

12.2.4 Where required by the Engineer or QPS, the Contractor and his sub-contractor shall present the method statement and risk assessment, discuss and resolve comments, and adopt any recommended improvements in his updated submission.

12.3 Construction Sequences and Methods

12.3.1 The Contractor shall be responsible to develop the construction sequence subject to the Engineer's acceptance, to suit his method of construction and sequence of work.

12.3.2 The Contractor's construction methods and sequence shall take into consideration the effects of any utility and drain protection/diversion as necessary during construction and the reinstatement, improvements and realignment, if any, of the proposed Works.

12.3.3 The Contractor shall plan his construction works and coordinate with including but not limited to NParks, Mindef / DSTA, PUB, schools, utilities agencies and other relevant authorities, land owners and their tenants, interfacing contractors and all other relevant parties and authorities to minimise disruption and any inconvenience to them and to the public during his Works.

12.3.4 The Contractor shall carry out at least one (1) borehole at 12m intervals along the centreline of all ERSS walls to determine the toe levels before installation. The actual locations of these boreholes shall be determined by the Contractor and submitted to the Engineer for acceptance. The depth of the boreholes shall be at least 5m below the ERSS founding levels or 10m below the final excavation level (FEL), whichever is deeper, unless otherwise accepted by the Engineer. Packer tests or borehole permeability tests shall be carried out in every alternate borehole at subsequent 5m intervals until the soil strata with coefficient of permeability of not higher than 1E-7m/s is established, unless accepted otherwise by the Engineer and QP(S).

12.3.5 In boreholes for general verification, Standard Penetration Tests (SPT) shall be carried out at 2m intervals and the Contractor shall recover soil samples from each borehole. Rock coring shall be undertaken to penetrate rock mass conditions and samples shall be recovered for inspection and testing. The Contractor shall provide a room to keep all rock cores samples labeled and neatly stacked in a sheltered environment on Site. All samples shall be stored categorically and easily accessible.

12.3.6 The Contractor shall submit the results of the additional site investigations as soon as they are completed. The submissions shall include drawings to show the soil profile from the completed additional soil investigations, incorporating the founding levels of the ERSS. The soft copy of the soil investigation report shall be in 'Association of Geotechnical and Geo-environment Specialist' (AGS), in Excel equivalent and in PDF format.

12.3.7 The Contractor shall submit in addition, a comparison study report of the actual site investigation versus the information shown on the Authority's Geotechnical Interpretative Baseline Report (GIBR).

12.3.8 During excavation, the Contractor shall propose a suitable method for the removal of the excavated material for the acceptance by the Engineer.

12.3.9 The worksite along Clementi Road are located in a sensitive biodiversity area (Clementi Forest and Maju Forest). The Contractor shall refer to requirement stated in **Clause 23**.

12.3.10 Where the rock head is encountered below the base of excavation or excavation within exposed rock surface is anticipated, curtain grouting in soil and fissure grouting in rock shall be carried out to provide a total cut off depth of at least 10m below the excavation base. Both the curtain and fissure grouting shall achieve a coefficient of permeability of not higher than 5.0E-8m/s.

12.3.11 Pumping test(s) shall be carried out on the completion of the curtain / fissure grouting to verify the permeability requirement of the grouts. The Contractor is required to submit the method statement for carrying out of the pumping tests to the Engineer and QP(S) in advance for his approval.

12.3.12 The pumping tests shall demonstrate that the cut-off is effective. The Contractor shall propose the drawdown limit outside the cut-off walls for Engineer's acceptance when the groundwater has been lowered down to a depth of 1m below the base of excavation. If drawdown outside exceeds these limits, the Contractor shall propose and carry out remedial measures to seal the leakage/inflow for QP(S) and Engineer's acceptance.

12.3.13 The Contractor shall include all works required in order to carry out the pumping tests such as piezometers, observation wells, dewatering wells, submersible pumps, level switch, monitoring, etc. The cost for such works shall be deemed to have been included in the Contract Price. Method statement and drawings showing the proposed pumping tests shall be included.

12.3.14 A detailed report on the pumping test shall be submitted upon completion of the pumping tests. Excavation can only commence when the results from the pumping tests are deemed acceptable to the QP(S) and the Engineer.

12.3.15 Notwithstanding the above proposed groundwater control measures, the Contractor shall limit the piezometric water pressure drawdown during the excavation / mining to not more than 2m below the existing levels to limit the consolidation settlements. Once the limit of the lowering of the groundwater level is breached or when the ground settlements due to the groundwater drawdown are found to exceed the critical levels, the Contractor shall activate the groundwater control measures.

12.4 Construction of Earth Retaining or Stabilising Structure (ERSS) Walls

12.4.1 The Contractor shall produce method statements and shop drawings for the ERSS walls to suit his construction methods. The information provided should include the method and machinery to construct the ERSS wall, lifting and handling of the rebar cage, the use of stabilizing fluids, the interface with transversing sewers and utilities etc. The shop drawings shall include the rebar arrangement, and the termination level corresponding to soil condition. The Contractor shall be responsible for sealing off the ingress of water through the ERSS walls and/or gaps in ERSS prior to further excavation.

12.4.2 Not Used.

12.4.3 The Contractor shall note that the ERSS shall be designed to minimize the construction period and to protect the surrounding structures and services. Should fluvial sand be envisaged where the ERSS is located, the Contractor shall propose measures to maintain stability and to reduce the risk of water drawdown during construction of the ERSS. The Contractor shall be fully responsible for ERSS stability and take all necessary measures to ensure ERSS stability.

12.4.4 The use of diesel piling hammers shall not be permitted. Only silent piler or equivalent equipment shall be used and the Contractor shall submit details of this equipment to the Engineer for acceptance.

12.5 Construction of Diaphragm Wall

12.5.1 The Contractor shall note that the diaphragm wall panel size shall not exceed six (6) metres width in general, to minimize the panel construction period and to protect the surrounding structures and services. The Contractor shall be fully responsible for diaphragm wall trench stability.. Should fluvial sand be envisaged where the diaphragm wall panel is located, the Contractor shall propose and take all necessary measures to maintain trench stability and to reduce the risk of water drawdown during construction of the diaphragm wall. This includes but not limited to column grouting at the diaphragm wall joints to cut off fluvial sand layer.

12.5.2 The basis for the trench and guide wall stability calculations shall be included in the method statement for diaphragm wall. The Contractor shall include the checklist for trench stability and guide wall calculations to be submitted with the method statement. The trench stability calculations shall be performed in accordance with DIN 4126 and with minimum safety factor of 1.1 except critical zone of trench (minimum 0.7*trench length) where the structures exist. For that condition, minimum safety factor of 1.3 shall be applied. Calculation shall be done using the most representative ground stratigraphy and characteristic design parameters. The calculations shall be certified by the Professional Engineer.

12.5.3 If diaphragm wall trenching is in close proximity to critical/sensitive structures and stability of the trench is a concern, the Contractor shall carry out pre-treatment grouting of at least from 1m above to 1m below Kallang formation on both sides of panel, prior to diaphragm wall trenching to prevent underdrainage and minimize trench collapse potential.

12.5.4 In case of any trench collapse, grouting shall be provided throughout joints of collapsed diaphragm wall panel till diaphragm wall toe.

12.5.5 Unless agreed by the Engineer, excavation shall not be carried out within one panel apart of an open trench or a diaphragm wall in which concrete was placed less than 24h before.

12.5.6 To minimise the trench opening time, diaphragm wall trenching shall only commence once the reinforcement cage is fabricated and accepted for installation.

12.5.7 Reinforcement shall be placed as soon as possible after clearing of bottom of the panel, and not more than 3 hours after testing of the slurry fluid for sand content and sedimentation.

12.5.8 Concrete shall be placed shortly after testing for sand content and within 3 hours of placement of the reinforcement. If a delay occurs, the slurry shall be tested to meet the test limits and replaced if necessary. Once started, concrete placement shall proceed continuously until uncontaminated concrete has reached the required top of wall elevation. Adequate equipment shall be provided to assure an uninterrupted supply and placement of concrete, even in the event of equipment breakdown.

12.5.9 The Contractor shall ensure the quality of diaphragm wall works complies with the requirements of M&W Specifications. In addition, the Contractor shall propose slurry KPI properties to be tested before diaphragm wall trenching works for the Engineer's acceptance.

12.5.10 The Contractor shall submit the details of waterproofing additive proposed for the internal facing walls or skin walls for the Engineer's acceptance prior to construction of the walls. The skin walls shall be at least 300mm thick and bonded structurally to diaphragm walls. The Contractor shall ensure that the surfaces are suitable and dry for the installation of SWC brackets, services, equipment and devices and that the structure is watertight. Any leak shall be repaired and grouted by the Contractor at his own cost throughout the warranty period of the waterproofing system.

12.5.11 The Contractor shall be responsible for the design and construction of a sufficiently robust guide wall and shall take into account the actual site and ground conditions, all temporary loadings whether from reinforcement cages, stop ends or equipment and the required level of support fluid to ensure stability and avoid undercutting of the guide wall. Guide walls shall be constructed with reinforced concrete. The minimum depth of the guide wall shall be 1.0m and the minimum shoulder width shall be 0.3m. Reinforcement continuity shall be provided between adjacent sections of the guide walls.

12.5.12 Front and rear of cages shall be marked on site to identify them during placement. The reinforcement shall be adequately fixed to avoid damage and/or displacement during handling and lifting operations and to maintain the minimum specified cover during concreting. Lifting points shall be painted with contrasting colour for ease of identification. Lifting points and design of lifting lugs shall be acceptable to the Engineer.

Spacers of an accepted type shall be incorporated in the cage construction to ensure correct cover is maintained. The spacers shall be capable of resisting deformation during cage placement within the trench and shall not entrap slurry during concreting.

The horizontal clear space between single bars or groups of bars, parallel to the wall face, shall be at least 100 mm. Provided the maximum size of the aggregates does not exceed 20 mm, this horizontal clear space may be reduced to 80 mm for the lap length in accordance with BS EN1538 7.5.3.3. Requirements on cage detailing from BS EN1538 & EN206 are reproduced in Table 12.1.

Table 12.1 - Requirement on cage detailing

Type of rebar	Standard	Spacing	Remarks
Spacing of vertical bars	EN206:2013+A1, Annex D.2.2	≥4 Dmax	Where Dmax is the maximum aggregate size
	EN1538:2010+A1,7.5.3.2	≥100 mm	Of single bars or groups, parallel to the wall face
	EN1538:2010+A1,7.5.3.3	≥80 mm	For lap length, provided that Dmax ≤ 20mm (special consideration must be given to the maintenance of sufficient concrete flow, see sections 3 and 6)
Vertical spacing of horizontal bars	EN1538:2010+A1,7.5.4.2	≥200 mm	
	EN1538:2010+A1,7.5.4.3	≥150 mm	Where required, provided that Dmax ≤ 20mm, where Dmax is the maximum aggregate size.
Horizontal spacing of transverse bars	EN1538:2010+A1,7.5.4.4	≥150 mm	
	EN1538:2010+A1,7.5.4.5	≥200 mm	recommended
Horizontal spacing of adjacent cages	EN1538:2010+A1,7.5.5.1	≥200 mm	
	EN1538:2010+A1,7.5.5.2	≥400 mm	recommended
Horizontal spacing of cages and joints incl. water-ends	EN1538:2010+A1,7.5.5.3	≥100 mm	
	EN1538:2010+A1,7.5.5.4	≥200 mm	recommended

12.5.13 With reference to **Clause 6.24** of the M&W Specification, joints shall be constructed with waterbars. The width of waterbars shall be not less than 200mm. In addition, Waterbars shall be installed to a minimum depth of at least 5m below formation level or at least 1m below permeable layer (permeability less than 1.0E-7 m/s), whichever is deeper. Where the minimum depth of installation cannot be achieved, waterbars shall be installed to the maximum practical depth and grouting behind the joint shall be carried out from 1m above waterbars to at least 5m below formation level or at least 1m below permeable layer, whichever is deeper.

If waterstop bars are used, vertical grouting shall be carried out behind all diaphragm wall joints where the ground is permeable, to a minimum of 1m above and 2m below ground with permeability less than 1x10-7m/s (e.g. F1 sand, other permeable soil). This is irrespective of whether it is above or below the Final Excavation Level (FEL). The Contractor shall propose actual vertical length of grout required based on soil investigation and excavation records from the diaphragm wall and submit for the Engineer's acceptance. When the diaphragm wall is exposed, the Contractor shall repair any joints or part of wall body that have jetting, spraying or leakage of water.

The Contractor may propose alternative joint design such as those formed using over-cutting method, which would be subjected to the Engineer's acceptance.

12.5.14 The Contractor shall ensure his proposed diaphragm wall machine has features that enable strict control of the verticality and twisting during the excavation process. In this respect, the diaphragm wall machine shall be equipped with real-time monitoring of excavated trench profile via the cutters and grabs, including monitoring of deflections on the XX and YY axes, rotation about the ZZ axis and deviation from the vertical. Such reports shall be submitted to the Engineer following the completion of excavation for each diaphragm wall panel.

12.5.15 The Contractor shall sequence his works such that the diaphragm wall panels are not excavated so close to other recently cast panels which contain workable concrete or unset concrete, such that a flow of concrete or instability could be induced or damage caused to any panel. This sequence of works shall be submitted to the Engineer for acceptance prior to commencement of the diaphragm wall excavation works.

12.5.16 Before commencing concreting of a diaphragm wall panel, the Contractor shall satisfy himself that the concrete supplier has sufficient quantity of concrete to construct the panel in one continuous operation. The Contractor shall ensure that the concreting rate is sufficient to prevent poor quality diaphragm wall panels. Where the density of the reinforcement cage is high, the Contractor shall employ a very workable cohesive concrete.

12.5.17 The Contractor shall identify and consider issues related to concreting in areas with congested reinforcement, and shall ensure that all reinforcements can be assembled and placed such that concrete can be cast and consolidated properly without loss of durability and strength of the structure. In such cases the Contractor shall submit an improved mix design for the acceptance of the Engineer. Where reinforcement is congested, a larger scale shop drawing shall be submitted to confirm the buildability of the reinforcements.

12.5.18 In order to prevent rebar congestion, the Contractor shall consider the good practices such as following examples:

a) Implementing crank bar at lapping area.

b) Applying staggered lap joints at lapping area.

c) Keeping the couplers outside of horizontal rebars etc.

d) In the event that the Contractor is not able to comply with code requirements on cage detailing, he shall consider performing mock-up of rebar cage arrangement and concrete casting to demonstrate the constructability and quality of panel meeting the Specifications, subject to the acceptance of the Engineer. All time and cost associate for the mock-up shall be borne by the Contractor.

12.5.19 During the concreting process, the depth of the surface of the concrete shall be measured and the embedded length of the tremie pipe recorded at regular intervals corresponding to each batch of concrete poured. The depth measured and the concrete volume placed shall be plotted immediately on a graph during the concreting process and compared with the theoretical relationship of depth against volume, and provided to the Engineer within 24 hours of concreting the diaphragm wall panel(s). Withdrawal and shortening of the tremie pipe shall be done such that concreting is carried out with the end of the tremie pipe always below the level of the wet concrete in the panel.

12.5.20 The Contractor shall rectify any undulations on the diaphragm walls and ensure that the surfaces are suitable for the installation of SWC brackets, services, equipment and devices. Measures shall be taken by the Contractor so that the services, equipment and devices to be installed do not come into contact with the diaphragm walls.

12.5.21 The Contractor’s rectification of diaphragm walls may be by means of trimming or building up of the wall surfaces. In the case of extreme undulations, he shall design, supply and fix additional supports to the acceptance of the QP(S) and the Engineer.

12.5.22 Upon completion of the works, all diaphragm walls shall be cut down to 2m below finished ground level, unless otherwise accepted by the Engineer.

12.5.23 Notwithstanding the construction tolerances allowed for in the relevant design codes and the Authority's requirements, the Contractor shall strictly control the verticality of the diaphragm wall along the trainway to prevent any encroachment of wall panels into the structure gauge and space reserved for SWC services.

12.5.24 In addition to **Clause 6.3.1(a), (b) and (f)** of the M&W Specification, the following clauses herein shall be part of the requirements:

(a) Ground water pressure

The water pressure in the ground typically increases during diaphragm walling. The Contractor shall be responsible for the verification of the water pore pressure affecting his works and shall submit his proposal on the location and depth of piezometers to be installed, for the Engineer's for acceptance. The water pressure used in the calculations shall be based on the highest level measured at the site plus an allowance for an increase in head and this value shall be justified before diaphragm walling begins. If the piezometers show that the water pressure is higher than the value used in the calculations, the Contractor shall not open any new trenches until the calculations have been checked for the higher value. In addition, the Contractor shall investigate and propose necessary mitigation measures. However, panels that are already underway should be completed to avoid them standing open for any significant length of time;

(b) Slurry level

The slurry level shall always remain at least 1.5m above the highest piezometric level, and the slurry level used in the calculations shall be the lowest level expected in practice. A slurry level at the top of the guide wall is not acceptable as a suitable basis for calculation; and

(c) Length of panel

In critical locations where a trench collapse could cause excessive settlement and potential damage to surrounding structures and utilities, the maximum length of panels shall be 3.0m unless otherwise accepted by the Engineer.

12.6 Secant Bored Pile Wall

12.6.1 The Contractor shall submit setting out plans to the acceptance of the Engineer prior to the construction of the secant bored pile wall.

12.6.2 The Contractor shall submit a method statement for the installation of the secant bored pile wall, the method to seal off ingress of water between bored piles, the quality control of the works and preventive measures if the process is found to be ineffective. The method proposed by Contractor should not induce unnecessary disturbance to the adjacent buildings and structures.

12.6.3 The choice of boring rig for secant pile construction shall be in accordance with **Clause 13 and 23** of the Particular Specification taking into consideration the environmental requirements.

12.6.4 For construction of the reinforced secant piles, temporary steel casings with casing corer and full length casing shall be installed for both soft pile and hard pile down to the final formation level to achieve an effective cut-off to soil and water ingress for the purpose of the station/tunnel/shaft excavation. The Contractor shall use boring rigs with rotary casings fitted with casing shoe. The casing shoe shall be fitted with replaceable cutting teeth of the required hardness. All soft and hard piles within a cluster shall terminate at the same toe level.

12.6.5 The Contractor shall note that the use of chisels or percussive drilling to form rock sockets or breaking through rock layers will not be permitted. Rock sockets and rock cutting shall be formed using roller bits or other cutting method with similar low vibration levels.

12.6.6 A minimum overlap of 200mm between the soft and hard piles shall be provided at formation level. The method statement submitted shall include measures to monitor verticality during excavation to ensure that the above tolerance is met.

12.6.7 The Contractor shall detail in his method statement noise abatement measures to reduce juddering noise generated from removal of spoil from the boring buckets during excavation works.

12.6.8 The termination criteria shall comply with the Authority's minimum requirements or those required by the Contractor's design, whichever is more onerous.

12.6.9 Any interface/joint between SBP and other type of ERSS wall should be sealed off with minimum 4 nos. of grout columns to the toe level of the adjoining ERSS wall, subject to Engineer and QP(S) acceptance.

12.7 Treatment to Utility Gap

12.7.1 The Contractor shall, wherever practical, avoid utility gaps in his proposed ERSS design.

12.7.2 Where such gaps are deemed unavoidable, the Contractor shall submit justification for the provision of such gaps to the Engineer for acceptance.

12.7.3 The Contractor shall propose detailed measures to close the gaps and to support the utility. The proposed measures shall not compromise the stability and water-tightness of the ERSS system, utilities and existing structures. The method statements shall be submitted to the Engineer for acceptance. The proposed utility support shall also be accepted by the relevant agencies.

12.8 Base Grouting of Piles

12.8.1 If base grouting of piles and diaphragm wall grouting is required based on Contractor's design, the Contractor shall submit the method statement for pile / diaphragm wall base grouting, including a full description of equipment to be used, grouting method, grout injection system, materials, quality control, method of measurement, grout testing, interface coring test at pile base, etc. to the Engineer for acceptance before commencement of the Works.

12.8.2 Where base grouting is required, the Contractor shall provide a verification pipe for grout out-flow in addition to the injection pipe to the toe of the pile to facilitate demonstration that the base grouting is sufficient.

12.9 Close Proximity to Existing Buildings ,Infrastructure and Amenities

12.9.1 The Contractor shall note that the Works are in close proximity to:

(a) KI Residences and private estates ;

(b) Maju Camp;

(c) SIM and SUSS;

(d) Far East Flora;

(e) Biodiversity Area (Clementi Forest and Maju Forest)

(f) PUB DTSS ;

(g) Existing culverts and drains, etc.; and

(h) Substations.

(i) Old Jurong Railway

12.9.2 The Contractor shall ensure that his construction methods do not cause adverse impacts or damages to the adjacent utilities and structures, or cause them to suffer excessive settlement, movement, nor cause flooding to the vicinity.

12.9.3 The Contractor's attention is drawn to the environmental issues in particular noise and dust that may arise during the course of his Works and cause nuisance to residents and members of the public. The Contractor shall adhere strictly to the requirements stipulated in Clause 13 of the Particular Specification.

12.9.4 The Contractor shall implement effective noise, vibration and dust mitigation measures to minimise the impact to stakeholders so that progress of the Work will not be affected.

12.10 Not Used

12.11 Underground Obstructions

12.11.1 The Contractor shall take all necessary precautions to identify underground obstructions that could impact the progress of the Works. Where necessary, the Contractor shall propose and implement measures to remove the obstruction in order to minimise the impact to the Works

12.11.2 The Contractor shall make provisions to remove obstructions as indicated in the GIBR Clause 7.8.

12.12 Underpass Construction

12.12.1 General

12.12.1.0 This section applies to construction of the two underpasses from Station to Entrance 2, and from Station to Entrance 3 using pipe roof and micro-tunnelling method. It shall be read in conjunction with the **Appendix O-5** and **Appendix O-7** of the General Specification together with the Materials and Workmanship Specification.

12.12.1.1 The Contractor's PE and PE(Geo) shall carry out detailed design for the micro-tunnelling works, including the pipe roof launching/receiving shafts, pipe roof, mining, ground improvement, etc. together with related impact assessment. The detailed design shall be checked by the AC and AC(Geo) and submitted to the Engineer for acceptance and the BCA for approval prior to the construction works.

12.12.1.2 The Contractor shall carry out additional soil investigation to satisfy himself that sufficient information is available for the design of the temporary works for the pipe roofing. The actual locations of the boreholes shall be determined by the Contractor and submitted to the Engineer for acceptance. The depth of the boreholes shall generally be at 10m below the base of the mined tunnel. For all boreholes, standard penetration tests (SPTs) shall be carried out at 2m intervals from the ground level to the termination depths of the borehole. Where rock is encountered, continuous coring shall be carried out.

12.12.1.3 The Contractor shall submit the results of the additional site investigation as soon as the investigations are completed. The submissions shall include drawings to show the soil profile from the completed additional soil investigation and incorporate the founding levels of the Temporary Works.

12.12.1.4 The Contractor shall prepare longitudinal geological sections along the alignment showing the different ground types and/or layer changes within the same ground type, their geotechnical parameters and deformation parameters and an interpretation report for the Engineer's acceptance.

12.12.1.5 The steel pipes shall be interlocked along their full length and shall be in-filled with concrete grout after all the steel pipes have been installed. Mining works for the mined tunnel shall not commence until all steel pipes have been infilled with concrete grout and the strength of the concrete infill has achieved at least 70% of its 28-day strength.

12.12.1.6 The Contractor shall note that the installation of steel pipes will be under the existing services/utilities across Clementi Road. The settlement of existing utilities shall be minimised during the installation of the steel pipes using Micro-Tunnelling Boring Machine (MTBM) and during the mining works.

12.12.1.7 The Contractor shall note that the existing 600mm diameter pumping main run across the proposed underpass structures. The pumping main will be decommissioned by PUB DTSS Contractor upon completion of the DTSS 2.1m diameter link sewer. The Contractor shall liaise with and co-ordinate with PUB DTSS Contractor on the decommissioning works.

12.12.1.8 Prior to the underpass construction works, the Contractor shall coordinate, verify and ensure that the existing 600mm diameter pumping main has been decommissioned and properly sealed off to his satisfaction.

12.12.1.9 In the event the existing 600mm diameter pumping main has not been decommissioned in time for his Works, the Contractor shall design and divert the existing 600mm diameter pumping main subject to approval from relevant agencies. All cost and time is deemed to be included in the Contract Price.

12.12.1.10 The Contractor shall carry out utility detection and trial trenches to detect utility crossings at the proposed underpass alignment before the installation of the pipe roof commences. The Contractor shall coordinate with the relevant authorities and utilities agencies on the allowable settlement limit and design his working method accordingly.

12.12.2 Micro-Tunnelling Boring Machine (MTBM)

12.12.2.1 The Contractor shall fully acquaint himself with the anticipated geological conditions, including obstructions. More detailed information is provided in the Factual Geotechnical and the Geotechnical Interpretative Baseline Reports. The Micro-Tunnelling Boring Machine (MTBM) shall be equipped to deal with rock that may be encountered, as well as, any remnant foundation or other obstructions.

12.12.2.2 The MTBM shall be capable of being retrieved backward through the pipe.

12.12.2.3 The system shall be designed to facilitate man entry. The Contractor shall submit a comprehensive plan and procedure for man entry into the steel pipe in accordance with the specifications and applicable regulations to the Engineer for acceptance.

12.12.2.4 The MTBM shall be mechanically articulated to enable steering of the shield and to allow incremental adjustments to maintain face stability for the soil conditions encountered. The MTBM shall be equipped with a remotely controlled steering mechanism to allow for the operation of the system without the need for personnel to enter the tunnel.

12.12.2.5 The Contractor shall submit to the Engineer for acceptance at least 3 months prior to the commencement of pipe jacking works, the micro tunnel boring machine procurement reports, including all mechanical and electrical components and full testing proposals and the testing facilities (both off-site and on-site).

12.12.2.6 The Contractor shall make every effort to restart the MTBM and remove obstructions that could not be removed by the cutting face of the MTBM. The Contractor shall submit all details of the proposals for the removal of obstructions to the Engineer for acceptance.

12.12.2.7 The measuring and balancing of earth and groundwater pressure shall be achieved by the use of a slurry or auger system. The MTBM cutter and slurry/auger system shall provide positive pressure to the excavated face to give ground support and control ground water pressure at all times. Adequate face support shall be provided. There shall be injection ports at regular spacing along the steel pipe at all times to fill up with slurry bentonite at the over-cutting between the steel pipe and ground automatically should there be any loss of slurry to the surrounding ground. Volume loss for each installation of steel pipe shall not be more than 1% and the Contractor shall submit his construction method statement and calculations accordingly to ensure the targeted volume loss for each steel pipe is achieved.

12.12.2.8 The MTBM shall be advanced by hydraulic cylinders mounted on a jacking frame located in the jacking shaft. The MTBM shall be moved forward by the cylinders advancing a successive string of connected pipes towards a retrieval shaft.

12.12.2.9 The Contractor shall provide an automatic pipe annulus lubrication system capable of maintaining pressure and volume of the support medium throughout the drive. Pressure and volume of support medium injected shall be data logged.

12.12.2.10 The control equipment shall integrate the method of excavation and removal of soil and its simultaneous replacement by a pipe. Line and grade shall be controlled by a guidance system that relates the actual position of the MTBM to a design reference (e.g. by a laser beam transmitted from the drive shaft along the pipe to a target mounted on the MTBM). As each pipe section is jacked forward, the control system shall synchronise spoils removal, excavation, and jacking speeds. The MTBM display equipment shall continuously show and automatically record the position of the shield with respect to the project design line and grade.

12.12.2.11 The Contractor shall consider the effects of the ground conditions in the selection of the MTBM and ancillary equipment. The Contractor shall plan and allow for the cost of frequent maintenance and/or replacement of tunnelling equipment components due to ground conditions found on site.

12.12.2.12 A regular servicing/maintenance programme for the micro-tunnelling systems shall be lodged by the Contractor for the Engineer's acceptance so that machinery and equipment break-down are minimised. The proposed MTBM shall be serviced by the manufacturer's personnel prior to the start of the project and serious consideration shall be given to replacement of front bearing seals and articulation seals before the start of the project to minimise the risk of MTBM failure during the Works.

12.12.2.13 A daily review meeting shall be held on Site. The meeting shall be attended by the Contractor's Construction Manager, Senior Engineer and QP(S) with the Engineer as a minimum. The Plan For Tunnel Advance (PFTA) will be used in the Daily Review Meetings as a baseline to assess actual tunnel performance against that predicted and ensure that geotechnical and tunnel data are synchronised to effect optimal and safe tunnelling. The PFTA shall be updated as tunnelling progresses and as information becomes available. The PFTA shall form the basis for a Tunnel Completion Report.

12.12.2.14 Where the Contractor proposes to re-use existing MTBMs and all related underground backup equipment, the Contractor shall submit all recent maintenance and refurbishment records for the relevant plant and equipment, refurbished MTBM work history including but not limited to the length of tunnelling completed by the machine with the detailed ground conditions, for the Engineer's acceptance prior to delivery to site.

12.12.2.15 Notwithstanding to **Appendix O5** of the General Specification (GS), the following shall take precedence where applicable:

12.12.2.16 GS **Appendix O5 Clauses 2.4i** to be added:

A minimum of two face pressure sensors for MTBMs for pipes of internal diameter (ID) 1.8m and larger.

12.12.2.17 GS **Appendix O5 Clauses 2.6** to be added:

The Contractor shall comply with the Public Utilities Board (PUB) Regulations and Code of Practice, and the DTSS sewer and link sewer requirements and seek their approval before commencement of works.

12.12.2.18 GS **Appendix O5 Clause 4.1** shall be replaced with:

The Contractor shall employ adequate numbers and suitable levels of competent staff with relevant microtunnelling experience to provide the required level of expertise to complete the microtunnelling works in a safe and professional manner. The Contractor shall submit for the Engineer's acceptance the organisation chart and the CV's of all the key personnel listed below:

Position	**Years of Experience**
a. MTBM Manager	10 Years
b. MTBM Tunnel Engineer	5 Years
c. MTBM Operator	10 Years
d. MTBM Foreman	10 Years
e. Separation Treatment Plant Technician (if Slurry MTBM is used)	5 Years
f. Workplace Safety and Health Supervisors (Tunnel)	10 Years

12.13 Use of Explosives (Blasting) Temporary Works

12.13.1 General

(a) Blasting works are not permitted unless approved by the Engineer. The Contractor shall provide blasting proposal with comprehensive vibration analyses for the Engineer's acceptance, in compliance with **Appendix M** of the General Specification.

(b) Prior to commencement of any blasting works, the Contractor shall demonstrate that the generated vibration levels are within the limits as per **Clause 13 and Clause 23** of Particular Specification.

(c) The Contractor is required to utilize the latest explosive detonation techniques to keep blast induced vibration limits to as low as practically possible.

(d) The Contractor shall only use electronic detonators for the blasting works.

(e) Notices of blasting operations shall be posted on site. Before each firing, the Contractor shall give audible warning, clear the area, and shall take positive measures to prevent personnel from entering the danger area.

12.13.2 Record of Vibrations Due to Blasting

(a) A Sensitive Receiver is defined as any slope or retaining structure that may affect the public or public property, and any government or other third-party structure or utility that may suffer damage due to excessive vibration. The recorded vibrations for every Sensitive Receiver identified shall be monitored against review levels and corresponding actions tabulated in Table 12.1 of **Appendix M** of the General Specification.

(b) The limiting PPV in the table above shall be taken as the maximum allowable PPV stated in Table 12.1 of **Appendix M** of the General Specification for the relevant utility / installation being considered.

(c) Prior to each blast, for each sensitive receiver identified, the Contractor shall calculate the maximum predicted PPV, and include this information in his submission to the Engineer.

12.13.2.0 Table 1 Review Levels for Every Sensitive Receiver Identified

Status	Level	Required actions
Alert	80% of the calculated limiting PPV	The Contractor shall check his blast design and make adjustments to subsequent blast designs if necessary.
Action	90% of the calculated limiting PPV	The Contractor shall investigate the causes for the high reading and at least 4 hours prior to any subsequent blast shall report to the Engineer his proposals for preventing recurrence.
Alarm	98% of the calculated limiting PPV	The Contractor shall immediately notify the Engineer. The Contractor shall modify his blast design to the approval of the Engineer to prevent recurrence. Blasting shall be suspended following 2 consecutive occurrences, until the Engineer is satisfied that the Contractor has made sufficient changes to his blast design and/or method of working to prevent recurrence.

12.14 Temporary Works

12.14.1 The Contractor and his appointed PE shall be responsible for the design, review, checking and supervision of the construction of all Temporary Works. The Contractor shall comply with the requirements of the Building Control Act and regulations, including all subsequent amendments.

12.14.2 The Contractor's PE shall endorse a Certificate of Supervision (COS) stating that the Temporary Works have been constructed according to the design for all stages of works. The PE shall carry out necessary inspections on any completed temporary works and ensure the adequacy of the structural elements at all stages prior to proceeding to the next stage of works. These certificates and reports shall be submitted to the Engineer and QP(S).

12.14.3 Works shall not commence without the prior acceptance of the Engineer. Any such instructions and/or acceptance of the Contractor's design proposal for the Temporary Works given by the Engineer shall not relieve the Contractor of his responsibility for the proper design and safe execution of the Temporary Works and for the safety of all personnel.

12.14.4 While the Engineer will attempt to respond to submissions in a timely manner, the Contractor shall in no case assume that it can be undertaken in less than twenty-one (21) working days.

12.14.5 The PE employed by the Contractor for the design of the Temporary Works shall provide full-time supervision of the Temporary Works during their implementation. Alternatively, the Contractor or the PE shall appoint a PE's representative, subject to the Engineer's acceptance, to supervise full-time the installation and removal of the Temporary Works. The PE shall submit the Certificate of Supervision to the Engineer for record purpose upon completion of the Works.

12.14.6 The Contractor shall ensure that the removal of the Temporary Works do not cause adverse effects on the completed structures, adjacent structures, roads and other properties and that full compliance with the dismantling proposals recommended by the Contractor's PE and accepted by the Engineer are met. The Contractor shall also propose measures to address the void in the ground due to the extraction of ERSS.

12.14.7 The Contractor shall note that in cases where some elements of the proposed structures are directly above existing roads, the Contractor shall provide adequate safety platforms/netting to prevent debris or objects from falling onto the road underneath during construction. The Contractor shall comply with the requirements of the Engineer and other relevant authorities for this provision.The Contractor shall submit proposals of how it is intended to construct the Temporary Works retaining system without any breaks or gaps below services, bridge, drains and other obstructions. A detailed review at each service crossing or similar location shall be required on a case by case basis. The proposal shall demonstrate to the acceptance of the Engineer that ground loss will not occur and that groundwater drawdown and ground movements will be controlled to an acceptable value.

12.15 Removal of Earth Retaining or Stabilising Structure (ERSS)

12.15.1 The Contractor shall remove all temporary works (ERSS) installed by him. All temporary concrete retaining wall, diaphragm walls, secant bored pile walls and associated capping beams must be cut off at least 2m below final ground level. The Contractor shall not be entitled to claim for additional time and cost if the temporary structure is required to be cut down to deeper levels due to his Works or the relevant authorities' requirements. All temporary steel sheet piles, soldier piles, deck posts, king posts, steel plate, lagging etc. are to be removed completely. The Contractor shall apply silent piler for sheetpile installation and removal works.

12.15.2 The Contractor shall explore all practical methods to extract all steel ERSS before seeking approval from relevant authorities, land owner(s) and the Engineer to leave in any temporary ERSS. The Contractor shall highlight and submit the drawings of such temporary works that are proposed to be left-in, for the acceptance of the Engineer. If accepted, As-built Drawings shall include these elements and clearly labelled.

12.15.3 Where use of a hydraulic breaker would cause excessive noise and vibration disturbance to residents and the public, and at other sensitive areas, the Contractor shall adopt diamond wire saw-cutting demolition techniques to remove reinforced concrete element (including cutting down RC ERSS to at least 2m below ground).

12.16 Site Clearance and Demolition Works

12.16.1 Unless otherwise specified, existing structures within the worksite boundary including but not limited to buildings, structures, roads, footpaths, drains, trees, plants, wells with concrete lining, ponds with retaining wall/side or base concrete lining, piles, footings, etc. shall be demolished or removed and disposed of at the Contractor's own dumpsite.

12.16.2 The Contractor shall fell affected trees including grubbing up of roots, clear vegetation and debris of any kind, and clearance of any obstruction. The Contractor shall obtain permission from NParks and the Engineer before felling any affected trees and coordinate with NParks for tree transplant to any location in Singapore in accordance with NParks requirements. All costs in relation to tree felling/transplanting are deemed included in the Contract Price. The Contractor shall note that felling of trees without the written consent of the NParks and the Engineer is strictly prohibited. He shall bear all penalties imposed by NParks as a consequence for failing to observe this rule.

12.16.3 The Contractor is required to move and maintain potted plants within the construction zone if they are affected by the Works.

12.16.4 The Contractor shall dispose of the trees, vegetation and debris at NEA's approved dumping ground and bear the cost of all charges levied for the use of the dumping grounds. The Contractor shall also ensure that in the process of clearance, no excessive soil from the site is removed. The Contractor shall take necessary steps to loosen the soil from the vegetation and roots before their disposal to ensure that removal of the soil is kept to the absolute minimum. Should the Contractor be found to have removed excessive soil, he shall be required to replace it with approved soil from his own sources.

12.16.5 The Contractor shall break up, seal up and/or remove existing redundant pavement, scupper drains, pipes, foundations and backfill with approved materials to the required level unless otherwise indicated.

12.16.6 The Contractor shall reinstate all damaged roads, drains, kerbs, fencing, boundary walls, fixtures and all other works disturbed to the satisfaction of the Engineer.

12.16.7 The Contractor shall comply with the following requirements for the demolition/ removal of the existing structure:

(a) The Contractor shall prepare detailed method statements for all demolition works specified including precautionary and safety measures to be taken. The method statement shall be subjected to Engineer’s acceptance.

(b) Special precautions shall be taken to ensure the safety of the public and the personnel/workforce involved in the demolition work.

(c) The Contractor shall co-ordinate with the relevant authorities to obtain the necessary approvals for the demolition works.

(d) Noise level, vibrations, dust and environmental pollution shall be kept to a minimum during the demolition works.

(e) The Contractor shall minimise inconveniences to the public.

(f) For demolition work near sensitive areas such as schools, residences, etc, low noise emitting methods shall be used. These may include either enclosing the whole machine within sealed noise barriers, splitting and crushing techniques, or the use of a special low noise hydraulic breaker attachment. Hydraulic breaker attachments shall have built-in noise reduction features such as closed housing and shock absorbing material between the housing and hammer. The proposed method of demolition, plant and equipment, and type of hydraulic breaker attachment shall be submitted to the Engineer for acceptance. As far as possible, the Contractor shall use diamond saw cutting tools to remove as-cast elements and make provisions to incorporate measures prior to concreting as necessary to support these tools for the cutting process.

12.16.8 The Contractor shall relocate existing directional signs, information signs and traffic signs, etc. affected by the work to the new positions.

12.16.9 The Contractor shall modify all road related items not specifically mentioned herein (such as but not limited to utility manholes, lateral access roads etc.) that are affected by modifications to road levels and complete them to match the new road levels including making good all works affected upon completion.

12.16.10 The Contractor shall liaise with Utility Agencies (PUB, Telecoms, etc.) for the location and relocation of all pipes, cables, main ducts, posts, manholes, OG boxes along or beneath the road reserve or in any part of the Works, in order to ensure that all service requirements are met before commencement of the Works.

12.16.11 Demolition shall be undertaken in accordance with SS 557 Code of Practice for Demolition. Attention is drawn to the major revisions in this version of the code including the development of a demolition plan and stability report, waste minimisation and recycling of demolition waste.

12.16.12 If the Contractor dumps the vegetation and debris on land owned by the authorities or the Government without written permission, he shall remove all the vegetation and debris from such land at his own cost and expense. In addition, the Contractor shall indemnify the Authority against all Loss and Expenses incurred due to the Contractor's failure to comply with the above.

12.16.13 Buildings and structures that are to be demolished by the Contractor under this Contract are shown on the Authority's Drawings. The Contractor shall demolish these buildings and structures in the manner given in the General Specification (Type 1 demolition).

12.17 Pedestrian Overhead Bridges (POBs)

12.17.1 The Contractor shall demolish and dispose of one (1) existing POB with lift facilities and associated accessories, located along Clementi Road, adjacent to SIM and SUSS. The Contractor shall also remove any existing piles or foundation structures related to the POB. The Contractor shall carry outthe necessary submissions and approval for the demolition of the POB.

12.17.2 The Contractor shall design and construct a staggered pedestrian crossing with covered linkways connected to the nearby bus shelters, located along Clementi Road. . He shall obtain the approval of the traffic control plan with the relevant authorities.

12.17.3 Where applicable, he shall divert all utilities and relocate the bus shelter(s) and commuter facilities, bus bay(s) and NParks maintenance bay(s) to suit his diversion of the road with the temporary staggered pedestrian crossing. The Contractor shall coordinate with the relevant agencies for their approval.

12.18 Reconstruction, Relocation and Reinstatement Works

12.18.1 The Contractor shall visit the Site to ascertain for himself, prior to tender submission, all work items affected by the Works which require demolition, reconstruction, extension, reinstatement or relocation. The work items shall include but not limited to bridges, fences, boundary & retaining walls, entrances, gates, driveways, drains, posts, lights, signboards, utility services such as cabling, sanitary, plumbing, sewers, water pipes, park connector, landscaping features such as turfing, plants, trees, flower troughs belonging to statutory or private properties, roads, footways, drains etc. The Contractor shall make allowance for reinstatement of the above mentioned items affected by the Works.

12.18.2 The Contractor shall be responsible for the design and execution of all demolition, reconstruction, reinstatement and relocation works for affected work items. The Contractor shall endeavour to obtain as-built drawings of the affected structures. The Contractor shall note that architectural and structural forms, dimensions, details and finishes of the affected items must match the existing unless otherwise specified or required by the Engineer. He shall take photographs of the affected items and obtain the Engineer's acceptance prior to commencement of the demolition works.

12.18.3 The reconstruction and reinstatement works shall include design, supply, installation, coordination, testing and commissioning of external lighting and lightning protection system to affected covered linkways, footpaths, cycling paths, carparks, etc. The Contractor shall engage Qualified Persons acceptable by the Engineer to submit and obtain approval from all relevant authorities for all the necessary affected and proposed works.

12.18.4 The Contractor shall liaise closely with the owners and/or representatives of the residential areas and other private or public properties, bus services operators, relevant authorities and Utility Agencies on any reconstruction, reinstatement and relocation works. The Contractor shall plan his construction works so as to cause minimum obstruction and inconvenience to the owners of private or public properties in the vicinity of the Works and to the public. The Contractor shall take note of all existing facilities such as tiling, fencing, automatic gate, etc. of these properties. At the end of construction work, these facilities shall be reinstated to match existing to the satisfaction of the property owners. The Contractor shall liaise with these owners before carrying out his work.

12.18.5 The Contractor shall not proceed with the execution of any reinstatement works until he has submitted work method statements, design calculations, specification, shop drawings and other information necessary to demonstrate the suitability, adequacy, integrity, durability and practicality of such reinstatement proposal and the Engineer has issued his acceptance in writing of such reinstatement proposal. Acceptance by the Engineer of such submission shall not relieve or in any way limit the contractual responsibility of the Contractor. All such submissions shall be duly endorsed by the Contractor's PE.

12.18.6 Such submission shall be made well in advance to give the Engineer sufficient time to check, study and comment on the Contractor's proposal without affecting the progress of the Works.

12.18.7 The Contractor and the PE engaged by him shall amend and/or modify his designs to accommodate whatever necessary changes if the Engineer deems the design inadequate or inappropriate. All costs associated therewith are deemed to be included in the Contract Price.

12.18.8 The Contractor may in the course of his works be required to execute works beyond the Contract boundary or encroaching into other's properties. The Contractor shall exercise strict control over his workmen not to use or trespass into, any of the properties without prior written permission of the property owners. The Contractor shall ensure that the access into the affected properties shall be maintained at all- time subject to the acceptance of the property owners.

12.18.9 In cases where the Contractor needs to enter private land to execute works where prior permission has not been obtained by the Authority, the Contractor must obtain the necessary permission from the owners before entering the lands. The Contractor shall complete the works in the private land within the shortest period and shall not store any material, equipment, plant within the private lands.

12.18.10 The Contractor shall liaise closely and obtain clearance from the Engineer, property owners or representatives, and the relevant authorities, well in advance, before commencement of any reconstruction, reinstatement and relocation works. The Contractor shall also arrange site inspection with the Engineer, property owners or representatives and the relevant authorities before commencement and after completion of the reinstatement works.

12.18.11 The Contractor shall take precautions to avoid damaging existing signboards during relocation and/or storage of these signboards. Should the signboards be damaged during the course of the works, they shall be replaced at Contractor's cost.

12.18.12 In relocating existing drains, the Contractor shall ensure proper functioning of the complete drainage system including the adjustment of levels and gradients and no drains shall be blocked at all times. The Contractor shall also ensure that the operations of all utilities and street furniture affected are not disturbed throughout the construction.

12.18.13 In relocating existing utilities and street furniture such as electrical cabling, sewers, water pipes, water meter, gas pipes, optical fibres, lamp posts, spot lights, surveillance camera, etc. the Contractor shall be responsible for obtaining approval from the relevant authorities including all necessary submissions.

12.18.14 In executing any relocation works, the Contractor shall make good any deficiency in length, height, amount of materials (e.g. fence, boundary walls, etc.) with new materials. The Contractor shall also replace all damaged or corroded works, or works that cannot be relocated satisfactorily (e.g. foundations, walls, cables, etc.) without damaging the works and to the satisfaction of the Engineer.

12.18.15 The Contractor is required to reinstate all landscaping areas affected by the Works.

12.18.16 The Contractor shall note that any reconstruction, diversion, relocation and reinstatement works shall be carried out to current prevailing standards complying with the requirements of the relevant authorities.

12.18.17 The Contractor shall make up the existing ground within the Contract limits to the proposed finished ground level or existing ground level, whichever is higher, unless otherwise specified. The Contractor shall include in the Contract Price the design and construction of retaining walls to blend in with the adjacent development where required.

12.18.18 The Contractor shall address defects, comments and attend to all inspections by relevant authorities, private parties and operators leading to satisfactory completion, rectification and handing over of all works.

12.18.19 Unless otherwise stated, reinstatement means replacement to match the original condition, and/or to the prevailing standard. However, as a minimum, all open land shall be turfed upon Completion of the whole of the Works unless agreed otherwise by the Engineer. The Contractor shall also reinstate to the satisfaction of the Engineer, any defect caused by him during the course of the works. All costs incurred shall be borne by the Contractor.

12.18.20 The Contractor shall be responsible for the reinstatement of all sites occupied as worksites, including drains, sewers, slopes, roads, footpaths, tiles, turfing etc. These affected areas, after handing over to the relevant authorities shall be maintained by the Contractor for eighteen (18) months, unless occupied by others for development works.

12.18.21 For areas within the road reserve line and station boundary, or within NParks land/ State land managed by NParks, the Authority will issue a work order to NParks for NParks to carry out backfilling of trenches with approved soil mix and also planting of trees and shrubs. The Contractor shall coordinate with NParks and prepare trenches to the required extent and depth in compliance with NParks requirements. Any turfing shall be carried out by Contractor. For any other areas, the Contractor shall carry out full reinstatement including planting, etc and handover to the relevant agencies or parties.

12.19 Temporary Traffic Management and Road Reinstatement

12.19.1 The Contractor shall note that the temporary traffic diversion scheme shown in the Authority's Drawings are provided as a guide and for reference only.

12.19.2 The Contractor shall design, implement, operate and maintain the traffic diversion scheme(s) in accordance with the requirements of the latest LTA's Code of Practice for Traffic Control at Work Zone, / Civil Design Criteria / Standard Details of Road Element and LTA's Road Safety Guide after he has obtained the necessary approvals from the Authority according to the requirements specified in **Clause 9** of the Particular Specification. In particular, the Contractor shall provide all signage (including supports and foundations) and road markings in accordance with the requirements specified in the Materials and Workmanship Specification. Thermoplastic materials shall be used for all road markings. All signage and road markings to be implemented in accordance to Standard Details of Road Elements.

12.19.3 The Contractor shall allow for all necessary Transport Impact Assessment (TIA) to be carried out in relation to his proposed traffic diversion schemes. The TIA shall include but not limited to collection and analysis of traffic data of existing traffic volume and movements, traffic modelling and simulation (by approved software tools, as determined by the Authority), analysis of traffic performance for every stages of the traffic diversion, including pedestrian counts at junction crossings, etc.

12.19.4 The Contractor should ensure that the detailed drawings comply to requirements stated in the Authority's Diversion Checklist.

12.19.5 The traffic capacity of all existing roads shall be maintained during construction i.e. one for one lane replacement is applied to the carriageway. The Contractor has to plan his work in a manner that the traffic lane must be maintained during the construction period.

12.19.6 To facilitate the construction of the Works, a comprehensive traffic diversion scheme shall be implemented and operated by the Contractor to ensure minimum disruption to the traffic in the vicinity of the Works and to ensure safe and efficient management of traffic at all stages of construction.

12.19.7 The Contractor shall seek clearance from LTA-Traffic Analysis & Projects (TA&P) Division and all other relevant authorities prior to the commencement of traffic diversion. The Contractor shall engage nearby stakeholders or grassroots organization for traffic diversion that may pose constraint to residents/shop owners in the vicinity. After obtaining comments from relevant stakeholders, thereafter, the Contractor shall submit any updates to the approved traffic diversion scheme arising from his engagement with the relevant stakeholders and his method of temporary diversion scheme to TA&P and relevant authorities for approval, and to the Engineer for acceptance. All cost and time associated with the above shall be deemed to be included in the Contract Price.

12.19.8 The Contractor's appointed PE and Traffic Consultant shall submit detailed plans of all temporary traffic diversion schemes, approved by the necessary traffic and road safety authorities, independent checkers and Project Safety Review (PSR) (Roads), to the Engineer for acceptance. The Contractor may refer to the temporary traffic diversion and reinstatement plans shown on the Authority's Drawings for his reference and design development. All temporary traffic diversions shall comply with the requirements stated in the Contract Documents. The Contractor shall comply with the requirements for Temporary Traffic Control Safety Submissions as given in the **Appendix D** of the General Specification.

12.19.9 The Contractor shall note that widening works for portion of Old Holland Road and construction of portion of Holland Plain Drive (Blackmore Drive Extension) will interface with other Contractor who is responsible for the works on the other portion of the roads. It is anticipated that the other Contractor's works will be completed before CR205. The Contractor shall coordinate with the other Contractor on the interfacing details to ensure that the final road configuration complies with latest SDRE.

12.19.10 The Contractor shall engage a qualified Traffic Consultant accepted by the Engineer to carry out the traffic study and design detailed traffic diversion schemes which are workable for the proposed construction method and sequence. The traffic study shall include but not limited to collection and analysis of traffic data of existing traffic volume and movements, traffic modelling and simulation (by approved software tools, as determined by the Authority), analysis of traffic performance for every stages of the traffic diversion, including pedestrian counts at junction crossings, etc. The traffic diversion schemes will be subject to the Engineer's acceptance. The traffic diversion schemes will be subject to the Engineer's acceptance. The Contractor shall establish the boundary of the study area. This shall include existing condition such as carpark ingress/egress to/from buildings, bus stops, pedestrian crossing facilities, parking, loading and unloading. The study area shall be discussed and agreed with the Engineer at the inception stage.

12.19.11 The requirements of the Traffic Consultant shall be qualified engineers with at least a bachelor degree in Civil/Transport Engineering (or equivalent discipline), preferably being accredited members of recognized professional transportation associations, with minimum 5 years' experience in road design or traffic management and conversant with the latest LTA's Civil Design Criteria, Standard Details of Road Elements, Code of Practice for Traffic Control at Work Zone and LTA's Road Safety Guide.

12.19.12 The requirements of the Traffic Consultant shall be Qualified engineer or accredited members of recognized professional transportation associations, with minimum 5 years of experience in road design or traffic management and conversant with the latest LTA's Civil Design Criteria, Standard Details of Road Elements, Code of Practice for Traffic Control at Work Zone and LTA's Road Safety Guide.

12.19.13 The Contractor shall also propose contingency plans such as emergency traffic diversion plan in the event of any incidents or accidents that may cause traffic disruption or congestion. The plan shall include proposed organization chart including contact numbers to identify key contact staff of the Contractor, consultant, QP, PE and LTA staff.

12.19.14 The Contractor shall submit detailed construction sequence and detailed traffic diversion schemes including scaled cross-sectional drawings and layout plans to the Engineer for acceptance. All construction sequence proposed by the Contractor shall place road users' safety as primary consideration.

12.19.15 The Contractor shall note the traffic conditions at the Site and his proposed traffic diversion schemes, provision of temporary footpaths, replacement of affected cycling path, crossing facilities, protection, park connector etc. shall be based on his investigation and appreciation of the Site for the completion of the Works. The proposed traffic diversion scheme, supported with TIA prepared by the Traffic Consultant shall demonstrate that the traffic performance at the site is maintained and not worse off than the existing traffic condition. He shall note that no closure of road is allowed at all times unless otherwise approved by the Engineer. The Contractor shall ensure that all Traffic Management Plans are accepted by the Engineer prior to implementation.

12.19.16 The Contractor shall ensure that his construction methods and schedule of his Works proposed shall not cause any disruption to traffic flow. All accesses to premises affected shall be maintained at all times. Unless authorized in writing by the Engineer, the Contractor shall not be allowed to close off any traffic lane along any existing roads. He shall not be allowed to place, or cause obstruction near or on the carriageway in a manner which would cause a reduction in the traffic capacity of the road.

12.19.17 Closure of any traffic lane required shall be implemented in accordance with approved traffic diversion scheme for all the affected traffic movements.

12.19.18 The Contractor is required to study the adequacy of the pedestrian crossing/facilities during each phase of the traffic diversions. The primary objective of the pedestrian study is to assess the efficiency of the pedestrian walkways and crossings and to recommend the required provision for the pedestrian facilities. The Contractor shall submit to relevant authorities for approval of any modification/ relocation of pedestrian overhead bridges where necessary.

12.19.19 The Contractor shall note that passengers on public buses are charged a fare based on distance travelled. Any road diversion or relocation of bus stops affecting public bus services route may have an impact on bus fares. As such, the Contractor shall manage the implementation of the diversions and relocation of the bus stops in accordance with timing approved by the relevant authorities in order to minimize the impact to passengers' fares.

12.19.20 For all bus stop implementation, the Contractor shall consult LTA Bus Operations Division (BOPS) with plans related to the bus stop relocation and ensure that plans have been reviewed and agreed prior to the confirmation of the implementation date.

12.19.21 The Contractor shall note that there shall be only two (2) common dates (i.e. on the 2nd and 4th Sunday of each month), subjected to the confirmation of BOPS, for the implementation of bus stops diversions or relocations. The Contractor shall provide the GPS coordinates, stop to stop distances of bus stops and any other information required by relevant LTA divisions, e.g. BOPS, Bus Information System (BIS).

12.19.22 The Contractor shall ensure that bus stops that will be implemented (i.e. relocation or reinstatement) are constructed and ready for inspection at least two (2) weeks before implementation.

12.19.23 The Contractor shall consult LTA Public Transport Promotion Division (PTP) with plans for all works affecting bus stop poles and LTA Bus Information Systems Division (BIS) with plans for all works affecting bus arrival panels and train service disruption indicator lights. The Contractor shall ensure that plans have been reviewed and agreed prior to the confirmation of the implementation date.

12.19.24 The Contractor shall consult BOPS Division on road diversions that affect bus stops and bus routes at least 8 weeks in advance for inputs and approval. The Contractor shall submit swept path analysis report (for all bus types i.e. single-deck, double-deck and articulated buses) and/or facilitate bus trials, as and when necessary required by BOPS Division to demonstrate that the proposed road diversion is safe for bus operations. Depending on the outcome of the bus trial, the Contractor is also to undertake the works to modify road/kerb and/or adjust traffic scheme at its own cost and ensure that the proposed road diversion allows the buses to ply safely and smoothly.

12.19.25 Type 1 asphalt pavement is to be used for all diverted routes. Temporary decking, where employed, shall be designed in accordance with the Materials and Workmanship Specification and shall comply with the design speed and loading requirements given in the Design Criteria. The Contractor shall also note that all temporary traffic decking, regardless if used for expressway or local access, shall be topped with a layer of minimum 75mm thick W3B premix. Reinforced concrete transition slab or equivalent system shall be provided at the joints between the concrete/steel deck and the road pavement to reduce the differential settlement at the interface. The Contractor should ensure that differential settlements at the interface are within the tolerable limits as per Authority's Design Criteria and details shall be submitted to the acceptance of the Engineer.

12.19.26 The Contractor shall provide the existing detailed traffic layout plan of all affected roads and facilitate proper final reinstatement after the Works. In keeping with changing traffic conditions and community needs, changes to the final traffic layout may be expected. The Contractor shall submit the final traffic layout plan to LTA Traffic Schemes Design Development Division through the Engineer prior to reinstatement works for comments and endorsement.

12.19.27 The Contractor shall submit to the Authority the traffic plan to reflect the existing conditions and keep a record of all the existing road elements such as traffic signs and road markings, etc. along all affected roads and shall ensure their proper reinstatement after the Works. Prior to the relocation and modification of traffic light related works, approval and endorsement of the traffic diversion schemes should be sought from LTA Traffic Analysis & Projects Division (TA&P). The Contractor shall inform LTA Traffic, Street and Commuter Facilities Lighting (TSCF) of any relocation of traffic light poles or modification to existing traffic light phasing by submitting the endorsed traffic diversion plan to TSCF/Traffic Light Facility:

(a) For works involving traffic light poles only, at least 6 weeks prior to implementation of the traffic diversion.

(b) For new traffic light installation or modification/ diversion to the existing traffic light, involving relocation of signal controller box, meter box and cable distribution box, the endorsed plan should be submitted to TSCF at least 4 months in advance.

12.19.28 The LTA TSCF Traffic Light Facility term contractor shall carry out these relocation and modification works on site according to the endorsed traffic diversion scheme(s). The Contractor shall provide all necessary assistance in the Works, as and when requested by the relevant authorities. The cost of relocation and modification works shall be borne by the Contractor.

12.19.29 Before submitting the traffic light installation/modification/diversion schemes, the Contractor shall ensure that all the new positions of the traffic light poles during the installation/diversion/modification and final stage can accommodate the concrete base of the traffic light poles, especially the overhead poles. Trial holes are to be carried out by the Contractor if necessary. If overhead pole cannot be installed, the Contractor shall seek approval from the Authority to replace with ground pole.

12.19.30 The Contractor shall liaise with the relevant parties and shall install all necessary services required for the operation of the relocated signalling equipment.

12.19.31 For installation of traffic lights or for the purpose of temporary diversion/modification of traffic lights, the Contractor shall provide and make available all the following:

(a) 3.6mm thick, 100mm diameter galvanised Iron (Class A) (GI) conduit pipes. Cables shall be laid in these iron pipes, complying with BS 1387: 1985 under roads, footpaths, side table and crossings (all GI pipes to be exposed by the Contractor) for the cabling works. GI pipes shall be provided on the carriageway, side table and footpath, leading to traffic light poles, detector pits and controller boxes for any traffic lights installation/ diversion/reinstatement works. The Contractor is required to carry out civil excavation work if necessary for all traffic diversion works.

(b) Durable red plastic cable slabs shall be placed 200mm above the pipes for all trenches dug regardless of the depth to mark their positions. The plastic cable slabs shall be 300mm x 1000mm and marked with the wordings “Traffic Light Cable – CALL 1800 2255 582”. The cable warning slab shall comply with the latest specifications.

(c) Circular markers of 50mm diameter aluminium plate shall be provided to indicate the location of the traffic light cables crossing. The markers shall be engraved with the wordings “Traffic Light Cable” together with a red direction arrow. The markers shall be fixed to the road kerb using suitable epoxy glue.

12.19.32 For application of SP Services Ltd & SingTel for any new traffic light installation or relocation of existing signal controller, the Contractor shall make direct payment to SP Services Ltd & SingTel. The Contractor shall coordinate with PowerGrid, SingTel and any other contractors for the necessary works for the above. The Contractor shall be responsible for the safekeeping and protection of any controllers, cables, detector loops or other equipment connected with traffic light installation within the site. Penalty shall be imposed if the Contractor damaged the existing cables, traffic controller boxes, traffic poles, etc.

12.19.33 All traffic signal cables within the construction site shall be protected with GI pipes for any traffic lights diversion/reinstatement works. All the GI road-crossing pipes are to be ready at least 14 working days before any traffic diversion for traffic light contractors to lay the necessary cables. All temporary cables that are laid which would be affected by the road diversion(s) shall be protected by GI pipes at all times.

12.19.34 All traffic light poles shall have minimum of at least 1.0m lateral clearance away from the road kerb for safety reasons. For any installation of traffic signal pole at the centre median, the width of proposed centre median should be of at least 1.0m for one column of signal aspect and 1.3m for two columns of signal aspects such as Red-Amber-Green (RAG) so as to allow for sufficient lateral clearance. Traffic light pole to be installed 1.5m away from the divider nosing.

12.19.35 In the event of any traffic light cables being damaged by any contractors or sub-contractor, no one is allowed to rectify/reconnect the damaged cables except for term contractor that is engaged by LTA TSCF, Traffic Light Facility. The Contractor shall inform ITSO Control Room hot line immediately (Tel. 63326945) for any damages.

12.19.36 The Contractor shall inform TSCF Traffic Light Facility at least 7 days in advance to re-install any detector loops in advance before the final reinstatement works. Any detector loops that Traffic Light Facility deemed fit to install (due to feedback or whatsoever) during the diversions shall be at the discretion of Traffic Light Facility. The Contractor shall inform TSCF/ Traffic Light Facility if any detector loops will be affected by a traffic diversion or trenching works carried out by a utility agency.

12.19.37 The Contractor shall comply with the Authority's requirement for diversion of all traffic lights and street lighting. The Contractor shall coordinate with the Authority and its Public Street Lighting term contractor in his design, installation, shifting and removal of street lighting works. The Contractor shall be responsible for all works in relation to the commissioning of the street lighting including but not limited to the installation of conduits and electrical cables necessary to power up the street lighting. All costs associated with such diversions shall be borne by the Contractor.

12.19.38 For all traffic diversion affecting traffic junction/lights, the Contractor shall engage authorized Auxiliary Police Officers (APOs) to control/manage vehicular and pedestrian traffic for all traffic diversions/re-instatement works. The APOs shall be deployed to ensure the safety of motorists and pedestrians for the duration from the traffic lights ceases operations and until when the traffic lights operations are re-instated. However, if the traffic diversion is not affecting traffic junction/lights, Authorised Security Officers (ASO) can be deployed to control/manage vehicular and pedestrian traffic for all traffic diversions/re-instatement works. All costs shall be borne by the Contractor.

12.19.39 The Contractor shall supply, install and maintain a minimum five (5) units of variable message signs (VMS) as described in the Code of Practice for Traffic Control at Work Zones to inform the public in advance of any upcoming traffic diversion schemes changes in the road arrangement ahead, advisory speed limits and other safety aspects. The VMS shall be of minimum size 2.5m by 1.8m LED display. The location of the VMS and ancillary equipment and its removal from site shall be subject to the Engineer's acceptance. All variable message signs shall be available throughout the duration of the Contract whilst any traffic diversion is in place or there is any disruption to traffic as a result of the Works

12.19.40 The Contractor shall submit road reinstatement plans to the Engineer for acceptance and the relevant authorities for approval. Where the reinstatement works joins the existing road and drainage systems, it shall be constructed so that it matches the existing road and drainage layouts. All roadworks, drains, underground utilities etc. damaged by the Contractor shall be made good and reinstated to the original condition or to match diverted schemes to the acceptance of the Engineer.

12.19.41 The Contractor shall comply with the roadworks specifications in **Appendix I** of the Particular Specification and protective coating in **Appendix AR** of the Particular Specification.

12.19.42 The Contractor shall survey the site to determine if there are any Singapore Police Force red light and/or speed cameras affected by the Works. The Contractor shall coordinate with Singapore Police Force (SPF) and all other relevant authorities for the relocation of the affected red light and/or speed cameras to a location designated by SPF. The Contractor shall assist to reinstate the red light and/or speed cameras if required by SPF. All costs associated with traffic cameras are deemed included in the Contract Price.

12.19.43 The Contractor shall engage affected stakeholders on the temporary traffic diversions, address any feedbacks and propose mitigation measures prior to implementing the traffic diversions. The Contractor shall submit his engagement plan to the Engineer for acceptance.

12.20 Road Safety Barriers for Temporary Road Works

12.20.1 The Contractor shall refer to the latest LTA’s Code of Practice for Traffic Control at Work Zone for the use of road safety barriers for temporary road works.

12.20.2 Where concrete safety barriers are proposed for the temporary road works, the Contractor can refer to the guide enclosed in **Appendix M** of the Particular Specification for their proper selection and installation. This guide is not a design standard. The Contractor shall apply, and rely upon his own professional skills and judgment on the particular issue which they are considering, based on relevant design standards. The Authority does not accept responsibility for any consequence arising from the use of the information contained in the guide.

12.21 Works at Roads and Junctions

12.21.1 The Contractor shall engage trained traffic controllers stationed full time, inclusive of weekends, for any roads/lanes diversion at critical roads and junctions, when the pedestrian and vehicular flow will be high. For critical roads/lanes and junctions, all paving work shall stop by 0330hrs and the affected roads/lanes shall be opened by 0500hrs.

12.21.2 The Contractor shall have standby signage indicating 'MACHINE BREAKDOWN – WAITING FOR REMOVAL' displayed when the work is disrupted by the breakdown of machinery.

12.21.3 The Contractor shall not park his vehicles along the roads near the work sites.

12.21.4 In the event any road lane closures are required by the Contractor to facilitate his works, he shall seek the Engineer's acceptance and the Authority's approval prior to implementing the lane closure. The Contractor shall, where necessary, provide justification, traffic counts and traffic impact assessments for any proposed lane closures. The Contractor shall comply with prevailing standard/requirements for lane closures.

12.22 Lane Closure

12.22.1 The Contractor shall comply strictly with the latest Code of Practice for Works on Public Streets. No lane closure is allowed during traffic peak hour as stipulated by LTA. The Contractor shall ensure that during the construction period, all roads shall be kept open to traffic with full capacity maintained at peak hours. In addition, the Contractor shall also note that there may be other major developments within the vicinity of the site.

12.22.2 The Contractor shall submit detailed plans of all temporary traffic diversion schemes, approved by the necessary traffic and road safety authorities, IRSR and PSR (Roads), to the Engineer for acceptance. The Contractor may refer to the temporary traffic diversion plans shown on the Authority's Drawings for his reference and design development. All temporary traffic diversions shall comply with the requirements stated in the Contract Documents. The Contractor shall comply with the requirements for Temporary Traffic Control Safety Submissions as given in the **Appendix D** of the General Specification.

12.22.3 All traffic diversion schemes shall be refined and amended to cater for changing circumstances that may arise. The traffic diversion schemes proposed shall include treatment of affected or necessary road-related facilities and shall be subject to the acceptance of the Engineer and approval from relevant authorities.

12.22.4 Temporary decking, where employed, shall be designed in accordance with the Materials and Workmanship Specification and shall comply with the design speed and loading requirements given in the Design Criteria. The Contractor shall also note that all temporary traffic decking, regardless if used for expressway or local access, shall be topped with a layer of minimum 75mm thick W3B premix.

12.22.5 The Contractor shall provide minimum 6 nos. of variable message signs (VMS) as described in the Code of Practice for Traffic Control at Work Zones for use at the site. The VMS shall be of a minimum size of 2.5m by 1.8m LED display. The location of the VMS and ancillary equipment and its removal from site shall be subject to the Engineer's acceptance. All variable message signs shall be available and well maintained throughout the duration of the Contract whilst any traffic diversion is in place or there is any disruption to traffic as a result of the Works**.**

12.23 Use of Existing Roads

12.23.1 The Contractor shall use every reasonable means to prevent damage to existing roads, footpaths, culverts, bridges, etc, caused by any traffic of the Contractor or any of his sub-contractors. He shall not subject any of the roads and bridges on the routes to and from the Site to extraordinary traffic loads. In particular, he shall select routes and use vehicles that restrict and distribute any such extraordinary traffic loads arising from the movement of his plant and materials or manufactured or fabricated elements to and from the Site.

12.23.2 All operations necessary for the execution of the Works and the construction of any Temporary Works shall as far as practicable be carried out so as not to interfere unnecessarily or improperly with the use of public or private roads and footpaths, or bridges or property, including structures, services and signage, whether in the possession of the Authority or of any other person.

12.23.3 The Contractor shall make good all damages to existing roads, footpaths, culverts, bridges, etc. caused by or in any way attributable to his vehicle or plant entering or leaving the Site, and shall at his own expense maintain, repair and reinstate the aforesaid to their original conditions to the acceptance of the Engineer and relevant authorities.

12.23.4 The Contractor shall verify with the authorities whether any restrictions exist with regards to free passage at any time of vehicles or plant on all approach roads leading to the Site, and he shall cater for any limitation of such free passage.

12.24 Relocation and Reinstatement of Bus Shelters

12.24.1 The Contractor shall comply with the requirements in General Specification for the relocation and reinstatement of bus shelters affected by the Works.

12.24.2 The Contractor shall note that the relocated/reinstated bus shelters shall be adequately lighted. Temporary supply shall be provided to light up the relocated/reinstated bus shelter until such time that the Contractor connects the shelters with permanent electricity supply.

12.24.3 The Contractor shall liaise with the Authority's Road Works Regulation and Licensing (RWRL) and BOPS for the relocation of the affected advertising panels to another location including power supply. The Contractor shall not relocate the bus stop shelters without prior acceptance by the Engineer and approval from the BOPS. All associated costs including but not limited to the cost of supply and installation of new bus poles shall be deemed included in the Contract Price.

12.24.4 The Contractor shall note that for a bus pole located at the egress of bus shelter, the bus pole shall meet minimum lateral clearance of 600mm from the outmost edge of any component of the bus pole to the road kerb and located laterally 1500mm away from eaves of bus shelter roof at downstream. The pole is to be at least 1.2m away from road kerb.

12.24.5 The Contractor shall note that for a bus pole located at the ingress of bus shelter, the bus pole shall meet minimum lateral clearance of 3000mm from the outmost edge of any component of the bus pole to the road kerb and located laterally 1500mm away from eaves of bus shelter roof at downstream. The pole is to be parallel with the bus shelter column.

12.24.6 The Contractor shall provide equipotential bonding for bus pole installation at the proposed bus shelter location.

12.24.7 The Contractor shall note that for bus pole located under a linkway, the linkway roof may have to be kinked or a cut-out made to facilitate installation of the bus pole which is approximately 3500mm above the ground level.

12.24.8 The Contractor shall comply with the following requirements for Wheelchair Accessible Bus (WAB) and Person-in-wheelchair (PIW) accessibility:

(a) The bus stop/shelter must be wheelchair friendly. Wheelchair accessible buses must be able to stop close and parallel to the kerb to deploy the ramp;

(b) Wheelchair passengers must also have barrier-free access into and out of the bus stop/shelter;

(c) Wheelchair passengers must be able to maneuver without obstruction (e.g. of obstructions are steps or narrow pathway within the bus shelter) to board and alight from the wheelchair accessible bus;

(d) Maintain a standard kerb height according to the latest SDRE within the bus stop area.

12.24.9 For high-roof bus shelter with its columns located at the front of bus stop platform near road kerb, the Contractor shall ensure that safety bollards will not be placed in between the columns. The Contractor shall design the placement of safety bollards and shelter columns to allow proper PIW's boarding and alighting activities and smooth WAB operations at the bus stop.

12.25 Protective Works to Existing Structures and Utilities

12.25.1 General

12.25.1.1 The Contractor shall be responsible for defining the locations and methodology for undertaking protective works to existing structures and utilities as required in this clause.

12.25.1.2 All necessary protective works to existing structures shall be completed to the satisfaction of the Engineer at least twenty-eight (28) days prior to commencement of any works within the vicinity.

12.25.1.3 The Contractor shall prepare a site specific method statement with the aim to protect the safety of the building occupants and site personnel, and submit it to the Engineer at least six (6) weeks prior to commencement of work.

12.25.1.4 The Contractor shall provide a supervising engineer with a minimum of 10 years of relevant experience whose qualifications are recognized by the Professional Engineers Board of Singapore, and a site supervisor with a minimum of 15 years' experience in protective works. Both site engineer and the site supervisor shall be full time on site and dedicated to the protective works on the Contract. The candidates identified for the appointment of the engineer and supervisor shall first be accepted by the Engineer and shall not be replaced without the acceptance of the Engineer.

12.25.2 Reinstatement of the affected Properties/structures undergoing Protective Works.

12.25.2.1 Following the completion of any protective works to existing properties/structures, the Contractor shall carry out a post-construction condition survey and reinstate the building/structures to its original conditions, including floor covering and finishes, gates and fencing, where demolition and/or damage has taken place.

12.25.3 Repair to Existing Buildings, Structures or Utilities

12.25.3.1 The Contractor shall be responsible for liaising with the owners and occupiers of any buildings/structures/utilities affected by the Works. The Contractor shall be responsible for any reinstatement and repair required during and after completion of the Works. Any repair works that are required to modify existing building structural frame or structural beams or buildings columns shall be designed by competent Professional Engineer to be appointed by the Contractor.

12.25.3.2 The Contractor shall carry out temporary and/or permanent repairs to any damage caused to affected properties or damages aggravated by the Works, as and when required by the private owners, occupiers and the Engineer.

12.25.3.3 As and when required by the Engineer, the Contractor shall immediately carry out repair and rectification works to any damage to affected properties and to the satisfaction of the property owners, occupiers and the Engineer. If the Engineer at a later stage (after repair and rectification works had been carried out) ascertained that the necessity to carry out the repair and rectification works to the said damage did not arise out of or in consequence of the execution of the Contractor's Works, the value of such repair and rectification works may be ascertained and paid for to the Contractor as if it was additional works. Notwithstanding, the Contractor shall not be entitled to any extension of time arising from such repair and rectification works.

12.25.3.4 The Contractor shall maintain records identifying the location and extent of all repair work carried out to any structure. The records shall be maintained in such a way that all repairs made on a given structure may be easily identified on completion of the Works. These records will be used to establish the need for any final repairs or remedial works to the structure.

12.25.3.5 For any repairs modifications and/or new construction that the Contractor has carried out to the affected properties, he shall provide a 18 months defect liability period commencing from the Engineer's acceptance of the completed works. All design and submissions to be duly endorsed by a PE if necessary.

12.25.3.6 The Contractor shall be responsible for the reinstatement of all sites occupied as worksites, including drains, slopes, roads, footpaths, tiles, turfing, plants, trees etc. until complete handover to the respective landowners. The Contractor shall carry out joint site inspection with the Engineer and the affected landowner(s) for handing over of the reinstated works to the respective landowner(s).

12.26 Protection of Existing Trees, Tree Transplanting and Tree Felling

12.26.1 General

12.26.1.1 The Contractor shall liaise with NParks and confirm the presence of any mature trees and/or heritage trees that are to be conserved. The Contractor shall take account of all conserved trees in his construction sequence and method proposals.

12.26.1.2 The Contractor shall liaise closely with NParks and SLA where applicable to establish the full extent of trees affected by the Works and the extent of tree protection required at the Site. The Specification for tree protection and tree transplanting are in **Appendix H** and **Appendix AT** of the Particular Specification respectively. The Contractor shall note that the 'Trees Affected' drawing provided is for reference based on the envisaged temporary works, utility diversion and traffic diversion corridor. The Contractor shall submit to NParks his tree protection and removal plans for approval prior to Works.

12.26.1.3 The Contractor shall obtain permission from NParks and the Engineer before felling any trees and coordinate with NParks for tree transplant to any location in Singapore. All cost in relation to tree felling/transplant including initial maintenance of transplanting trees until they are fully re-established shall be borne by the Contractor.

12.26.1.4 The Contractor shall provide site access at all times for NParks or its representatives to carry out their regular maintenance of the unaffected trees within the Contractor's working area.

12.26.1.5 The full extent of trees affected by the Works and the extent of tree protection shall be determined based on the Contractor's work methods including his traffic management scheme. Notwithstanding this, the Contractor shall note that it is a requirement of NParks that all mature trees, each with a girth more than or equal to 1m, measured 1m from the ground, shall be maintained and protected wherever possible. All costs shall deem to be included in the Contract Price.

12.26.1.6 The Contractor shall appoint an International Society of Arboriculture (ISA) certified arborist, with a minimum of ten (10) years of experience, immediately after Contract award. The arborist shall liaise with NParks to prepare and submit a report to NParks and the Engineer within two (2) months after the Contract award, identifying all the trees to be protected or transplanted.

12.26.1.7 The Contractor's appointed arborist is to assess the affected trees' condition, conservation value, propose details of tree protection measures and submit the method statement to NParks for approval. The Contractor is to submit these protection measures, including the Tree Protection Zone (TPZ) as shown in **Appendix H** of the Particular Specification for each of the trees required by NParks for conservation, to NParks and SLA for approval. No changes to the existing soil levels within the TPZ of all the trees that have been approved for conservation are allowed without the written permission from NParks.

12.26.1.8 Upon approval by NParks, the Contractor shall note that tree transplanting works may require a minimum of six (6) months. The Contractor shall take this into account in his programme for the Works.

12.26.1.9 No cutting of major root of more than or equal to 100mm diameter is allowed without the written permission from NParks.

12.26.1.10 No pruning to the trees that have been approved for conservation are allowed without the written permission from NParks. The Contractor is to engage NParks if pruning to such a tree is necessary.

12.26.2 Protection of Existing Trees During Construction

12.26.2.0 The Contractor shall construct fencing at the TPZ for all the trees approved for conservation and the fencing shall remain in place until the completion of the Works.

12.26.2.1 The Contractor shall not carry out excavation or trenching or other soil disturbance works near and inside the TPZ fenced areas.

12.26.2.2 The TPZ fenced areas shall be watered regularly, especially during dry weather, until completion of the construction of the Works.

12.26.2.3 Areas for cement washout and construction work zones, storage areas for both heavy and light equipment, soil and construction materials shall be located at least 2m away from affected trees that are yet to be removed and away from the TPZ of the trees that have been approved for conservation.

12.26.2.4 The Contractor shall not allow any vehicles to enter the TPZ fenced areas or to travel over any areas of exposed root systems extending beyond the TPZ. Where vehicles are likely to pass close to TPZ, the Contractor shall limit the extent of soil compaction by applying 2 to 4 inches of mulch such as woodchips.

12.26.2.5 Sufficient 'TREE PROTECTION ZONE' signs shall be posted within the construction areas as reminders to Interfacing Contractors and sub-contractors on the purpose of the fenced up areas, the limitations and specified work zones.

12.26.2.6 The Contractor shall note that NParks' written permission is required prior to the cutting of roots and branches.

12.26.2.7 Tree trunks of the trees earmarked for conservation shall be properly protected during the construction works. Bright orange polythene fencing around the protected tree zones shall be provided by the Contractor.

12.26.2.8 No temporary structure shall be allowed within the protected root zone.

12.26.3 Protection of Trees During Landscaping

12.26.3.1 Care shall be taken during the installation of irrigation systems, if any, to protect the planting beds around mature trees, as root systems of mature trees can be damaged. During the installation of these systems the Contractor shall avoid cutting or injuring any roots.

12.26.3.2 Care and Maintenance of Trees Approved for Conservation.

12.26.3.3 All trees that have been approved for conservation shall be watered regularly until they have recovered from the effects of construction.

12.26.3.4 All trees that have been approved for conservation shall be fertilized regularly and mulched with organic mulches (e.g. shredded leaves, pine barks, wood chips). The mulch layer shall be 2-4 inches thick and 3-4 inches away from the root collars.

12.26.4 Schedule of Road/Rail Works and Tree Felling

12.26.4.1 In addition to the requirements of **Clause 33** of the General Specification, tree felling must be timed in tandem with and included in the programme for the construction of the Works and shall be subject to the approval of NParks and the acceptance of the Engineer. This is to allow trees affected by the road and rail works to remain as long as possible.

12.26.4.2 All debris and partially cut portions of trees shall be completely removed from the site.

12.26.5 Tree Felling and Temporary Greening

12.26.5.1 The Contractor shall submit a tree felling plan, to NParks for the removal of trees prior to any removal of trees. In addition, the Contractor shall submit a tree reinstatement plan for NParks' approval.

12.26.5.2 The Contractor shall note that for trees under the jurisdiction of NParks, the Contractor shall coordinate and liaise with the NParks for felling, protection, transplanting, retaining and conservation including any other works and their final reinstatement.

12.26.5.3 The Contractor shall prepare a Tree Documentation Report and Tree Inventory List. The report is to include photographs of trees affected and each tree is to be uniquely numbered. The list shall be in table form and consist of details on trees affected (i.e. numbered, species, girth, height and tree status to be removed/retained/transplanted).

12.26.5.4 In addition to the requirements in Clause 33 of the General Specification, tree felling shall be controlled tightly. Trees shall not be felled at one go. Tree felling shall be planned to be carried out in stages and in tandem with the Works being carried out at the localised zones. Such staged felling of trees shall be subject to the approval of NParks and the acceptance of the Engineer and shall be included in the programme for the construction of the Works.

12.26.5.5 Upon approval for tree felling by Nparks, the Contractor shall initiate a consultation with NParks and arrange for a joint site inspection with NParks and LTA to survey the affected locations with potential loss of greenery. The Contractor shall obtain NParks' advice and recommendation on the type and extent of temporary greening required in accordance to **Appendix AY** of the Particular Specification.

12.26.5.6 The Contractor shall submit a temporary greening proposal to NParks and LTA based on the recommendation from joint site inspection. The temporary greening proposal shall include detailed temporary greening plan and greening specifications. The Contractor shall comply with Appendix AY of the Particular Specification, to propose planting strips with shrubs / hedges / trees to reduce the loss of greens during construction phase where space is available; Where space is constrained, the Contractor shall propose vertical greening or full-size stickers/graphics on the hoardings and noise barriers to achieve greenery impression, to the Engineer's acceptance.

12.26.5.7 Upon approval from NParks and the Engineer's final acceptance on the proposal, the Contractor shall proceed with the implementation of temporary greening. The cost of implementing the temporary greening plan and all associated works shall be deemed included in the Contract Price.

12.26.5.8 All debris and partially cut portions of trees shall be completely removed from the site. The Contractor shall provide debris skips of appropriate sizes for temporary storage of all fell trees, disposed shrubs and turfing and cut portions while awaiting removal from the site.

12.26.5.9 The Contractor shall bear the full cost of all trees (including shrubs) felling, protection, transplanting, retaining and conservation and any other works associated to and for compliance with NParks, HDB and Town Council's requirements.

12.26.6 Tree Transplanting

12.26.6.1 The tree transplanting works are to be carried out by a contractor that is listed on the Landscape Company Register, and supervised by an ISA certified arborist with minimum 5 years' experience.

12.26.6.2 The Contractor shall:

(a) submit transplanting method statements, based on ISA best practices or equivalent, for NParks' approval before proceeding with the works.

(b) maintain the transplanted trees for a period of 8 weeks or until they are established to the satisfaction of NParks.

(c) replace dead/damaged/dying transplanted trees at their own cost if the transplanted trees do not establish within 8 weeks, or within a timeframe / meeting conditions deemed satisfactory by NParks.

(d) coordinate with NParks on the transplanting timeline.

12.27 OG Boxes

12.27.1 The Contractor shall provide temporary and permanent OG boxes as required to facilitate the construction and completion of the Works, including all necedessary associated incoming and outgoing cables at his own cost.

12.27.2 The OG box shall be suitable for outdoor environment. All components of the OG box shall be accommodated in a weatherproof housing to IP 55 and of robust construction.

12.27.3 The OG box shall be provided with a watershed top. The housing shall be made of galvanized steel sheet with thickness not less than 2.5mm in accordance with the LTA Materials & Workmanship Specification . The OG box shall be sprayed with 1 coat of anti-rust primer and 2 finishing coats of paint colour subject to the approval of the relevant Authorities and the Engineer's acceptance.

12.27.4 Adequate ventilation shall be provided to permit natural circulation of air. The ventilation apertures shall be suitably screened to prevent the entry of vermin and other foreign bodies.

12.27.5 The OG box shall be provided with suitable mounting on a concrete/brick footing. A concrete plinth of minimum height of 400mm shall also be provided for mounting of the OG box.

12.27.6 The OG box shall be provided in the exterior outdoor area for the accommodation of power distribution boards, communication and signalling equipment and other remote/local control and monitoring equipment as required by the SWC. The Contractor shall coordinate with the SWCs for the provision of cast in pipes for all cabling in and out from the OG box, including those for local earthing of power and control systems.

12.28 Staging Ground and Disposal of Excavated Soils (excluding contaminated soil)

12.28.1 Definitions:

The definitions of soils with regards to earthworks are given in **Clause 4.2** of the Materials & Workmanship Specification for Civil and Structural Works.

"**Suitable Material**" - shall be as defined as in **Clause 4.2** of the Materials and Workmanship Specification for Civil and Structural Works. It shall comprise all materials which are acceptable for use in the Works, with respect to achieving the degree of compaction specified in **Clause 4.12** of the Material and Workmanship Specification for Civil and Structural Works, except where the material meets the criteria for Contaminated or Waste Material, in which case the material shall be defined as such.

However, "**Not Suitable Material**", as defined in **Clause 4.2** of the Materials and Workmanship Specification for Civil and Structural Works, has, for the purpose of soil disposal, been further divided into additional sub-categories, which are defined below:-

"**Unsuitable Material**" – material which is classified as "Not Suitable Material" but does not include "Contaminated Material", "Waste Material", or "Made Ground" as defined below.

"**Contaminated Material**" – any soil which contains excess amounts of any of one or more of arsenic, copper, cadmium, chromium, lead, mercury, zinc or nickel, as defined by the Ministry of the Environment and Water Resources for offshore disposal.

"**Waste Material**" – spoil that contains building debris, domestic or industrial rubbish, man-made materials, or any other material which the Contractor introduces into the spoil, including bentonite and bentonite slurry, other than water and Imported Fill Materials.

"**Made Ground**" – any soil which contains building debris, domestic or industrial rubbish or other man-made materials and which is present at the time of Contract award.

12.28.2 Only Suitable Material and Unsuitable Material are acceptable for disposal in the Authority's Staging Ground. Furthermore, rocks and boulders are not acceptable for disposal via the Staging Grounds. Any rocks or boulders found during the earthwork shall be disposed by the Contractor at his own dump site.

12.28.3 The Contractor shall note that where excavated spoil or imported fill fails to meet the requirements for “Suitable Material” only because of an excessive moisture content, then such material, which is in the slurry state, shall be classified as “Waste Material”. The Contractor shall also note that excavated spoil from ground that has been treated shall be classified as “Waste Material”. Such material shall be disposed of as “Waste Material”. However, the Contractor may treat the material by a method acceptable to the Engineer so that it can be classified as “Suitable Material”. The Contractor shall bear the cost of all such treatment.

12.28.4 The Contractor shall dispose of all excess Suitable and Unsuitable Material at the Authority’s dumping points located at Changi East Stockpile Site 2 (CESS2) and Tuas South Staging Ground (TSSG) or any other designated dumping ground provided by the Authority. The Contractor is deemed to be aware of the operation hours and shall comply with all restrictions, prohibitions and requirements for the delivery and disposal of excavated earth at the Authority’s dumping points. All excavated earth will be sampled at the Engineer’s discretion and only earth that meet the criteria for stockpiling or disposal will be accepted at the respective Authority’s dumping points. It is the Authority’s sole discretion to direct the Contractor to send their “Suitable and Unsuitable Material” to the Authority’s designated staging ground(s).The location of the Staging Ground are not fixed and may change as directed by the Authority. The Contractor shall not assume that the allocated Staging Ground(s) is the nearest to his worksite. The Contractor shall not claim for any time and/or cost incurred if they are directed to send their excavated earth to other staging grounds. The Contractor is not entitled to any claim against the Authority for any loss, expenses, cost and/or damages incurred arising from or in relation to the delivery of the “Suitable and Unsuitable Material” to the Staging Ground locations as directed by the Authority for whatever reasons.

12.28.5 Material disposed of at the Staging Ground shall be subject to a zero disposal fee. However, the Contractor shall provide suitable means of haulage for all materials that are transported from the Site to the Staging Ground and shall abide by the regulations and procedures of the Staging Ground and its operator.

12.28.6 At present, the Staging Ground operation hours are as follows:

Tuas South Staging Ground (TSSG)

Monday to Saturday	:	0800 to 2200 hours
Sunday & Public Holidays	:	0800 to 1700 hours

Changi East Stockpile Site 2 (CESS2)

Monday to Saturday	:	0800 to 1700 hours
Sunday & Public Holidays	:	0800 to 1700 hours

12.28.7 The Contractor can put up requests to extend the operation hours of the relevant Staging Ground which will be subjected to the expected excavated earth quantities which is deemed viable for the Staging Ground to operate. The Contractor shall make his request to the Engineer at least two (2) working days in advance.

12.28.8 The Contractor shall liaise with the operator of the Staging Ground on the operating hours, holidays, closures of loading point and similar issues. The Contractor shall not assume that the rate of progress of disposal at the Staging Ground will match his excavation rate. The Contractor shall make allowance for delays in off-loading, facility closure and other restrictions imposed by the Staging Ground operator. The Authority shall not be responsible for any delays or shortfall of the loading points or dumping facilities or its operation by the operator.

12.28.9 The Contractor shall instruct and ensure that all his lorry operators observe all traffic arrangements at the Staging Ground. The Engineer reserves the right to direct the Contractor to remove any lorry operator who refuses to observe the traffic arrangements, operational rules and requirements or causes mischief.

12.28.10 The operator of the Staging Ground will provide truck wheel washing facilities. The Contractor shall instruct and ensure that all his lorry operators make use of these facilities to keep the public roads clean. The Contractor shall allow for delays in the use of the wheel cleaning facilities especially during wet weather conditions. Queues are to be expected.

12.28.11 The Contractor shall be responsible for the disposal of all “Contaminated Material”, “Waste Material” and “Made Ground” at his own cost. The Contractor shall note that “Made Ground” containing building debris, rubbish and man-made materials were discovered in some soil investigation boreholes during site investigation.

12.28.12 The Contractor shall maintain records of all spoil removed from Site. Such records shall include, but not be limited to disposal site, soil classification, weight or volume of soil, vehicle identification, and the date and time the vehicle leaving the worksite. The Authority will establish a ticketing and/or electronic integrated management system (EIMS) or other suitable system for the purpose of identifying and monitoring the loads of material to be disposed of via the Staging Grounds. The Contractor shall comply with the Authority’s requirements in respect of such ticketing and/or EIMS or other system that is implemented, including provision of the necessary personnel for issuance of electronic tickets and attendance to all of the Authority’s audit requirements.

12.28.13 The Contractor shall ensure that all the trucks from earthwork contractors to be engaged by him to haul the excavated earth from Worksite to Staging Grounds are fully equipped with various Vehicular Tracking System (VTS) which are used for the tracking of vehicle travelling route from source sites to Staging Grounds. The earthwork contractors shall grant access right to the Authority and Staging Ground Operator to access their respective VTS for integrating with the EIMS and to the Engineer for review of the trucks trips and routes records for the past six months.

12.28.14 For disposal to his own disposal site, the Contractor shall ensure that his chosen disposal site utilises and complies with a ticketing system or other suitable system for the purpose of identifying and monitoring the loads of material to be disposed of. The Engineer shall have access to these records at any time and may instruct the Contractor to obtain, at the Contractor's cost, independent verification of the size of loads carried by any or each vehicle.

12.28.15 If the Engineer and the Contractor cannot agree on the classification of material for disposal, the Contractor may be required to carry out sampling and testing to confirm the classification of the materials to be disposed of. Such samples shall be taken at a location as directed by the Engineer and testing shall be carried out at a laboratory to the acceptance of the Engineer.

12.28.16 The Contractor shall carry out soil testing of the excavated soil to determine the presence of contaminants prior to disposal at his own cost. The test results shall be kept by the Contractor on Site and a copy of the results shall be forwarded to the Engineer prior to any disposal of the said soil.

12.28.17 The Contractor shall bear in mind that following the soil sampling, the test results may take up to two weeks. Any costs associated with stockpiling spoil or the cessation of excavation until completion of the soil sampling and testing shall be deemed included in the Contract Price.

12.28.18 The Contractor shall take all reasonable measures to avoid mixing different types of spoil, unless they are to be disposed of at the same location within the same facility.

12.28.19 Should two or more types of spoil get mixed during the course of excavation, the mixed spoil shall take the classification of the component that appears lowest on the following list:

(a) Top Soil

(b) Fill Material

(c) Suitable Material

(d) Unsuitable Material

(e) Waste Material

(f) Contaminated Material

12.28.20 Within one month of Contract Award, the Contractor shall submit to the Engineer his projected estimate for the total volume of excavated material for the project, broken down into the estimated monthly excavation volume. The estimated volumes shall identify each of the following material categories: topsoil, suitable material, unsuitable material, waste material and contaminated material.

12.28.21 The above estimate shall be reviewed every three (3) months. The revised schedule of the estimated monthly volume and material type shall be submitted to the Engineer for acceptance.

12.28.22 The Contractor and the lorry operators shall send their respective representatives to attend the Monthly Staging Ground Co-ordination Meetings and any ad hoc Staging Ground meetings which shall be convened by the Staging Ground Operator to address issues that affects all parties with respect to disposal of spoils via the LTA Staging Ground.

12.28.23 The Contractor and haulage contractor shall attend ad hoc meetings convened to address issues raised by any Grass Root Leaders and Advisors.

12.28.24 The Contractor shall submit his proposed method of treatment including the technical literature of the bentonite which are to be used for the construction works to the Engineer for acceptance. In this regard, the Contractor shall comply with the prevailing regulations and guidelines set by NEA and other relevant authorities.

12.28.25 The Contractor shall carry out inspections of the contents of all incoming and outgoing trucks to ensure no foreign or unsuitable materials are delivered to the Staging Grounds, including provision of the necessary personnel and tools as required by the Engineer. The inspections shall be carried out on platform(s) of an appropriate height which provide safe and proper access to the top of the truck for visual and physical inspections.

12.28.26 CCTV Systems for Monitoring Spoil Disposal Activities

12.28.26.1 The Contractor shall supply, install, operate and maintain a Closed Circuit Television (CCTV) system with High Definition (HD) Digital Internet Protocol (IP) CCTV cameras, including all hardware, software, network connections and ancillary equipment, to monitor the loading of excavated soils onto trucks at all loading locations on site and the inspection activities at the platforms.

12.28.26.2 The CCTV system shall be suitable for operating in all weather, lighting and outdoor conditions expected of a construction site. The CCTV cameras shall be weatherproof to IP 66 standard and capable of operating in a range of lighting conditions. Additional lighting shall be provided to enable CCTV recordings of good quality as and when required by the Engineer.

12.28.26.3 The CCTV cameras shall provide a clear and complete view of each truck body during loading and inspection similar to sample photos shown below, to enable checking for the presence of unsuitable or waste materials in the trucks.

View during Loading

View during Inspection

12.28.26.4 All CCTV recordings and data collected by the CCTV system shall be stored in the Video Management System (VMS) specified in **Clause 17** of the Particular Specification with the same storage retention and back-up requirements as specified in **Clause 17** of the Particular Specification. The CCTV recordings to monitor the spoil disposal activities shall be made available for 'live' view and playback from the Remote Control Centre specified in **Clause 17** of the Particular Specification.

12.28.26.5 The Contractor shall supply, install, operate and maintain a suitable Truck Recognition System to automatically record all trucks arrival at the loading locations and their exit at the inspection platforms, using License Plate Recognition technology, Electronic Parking System (EPS) technology, RFID technology or other equivalent technologies, subject to the Engineer's acceptance. The Contractor shall submit daily spoil disposal trips report with records of the trucks' vehicle registration number, loading location, arrival time, exit location and exit time for each spoil disposal trip. The Contractor shall ensure that the details of the spoil disposal trips recorded by the Truck Recognition System shall tally with the number of physical or electronic tickets issued for spoil disposal at the Staging Grounds. The Contractor shall issue electronic tickets for spoil disposal using the software/app of the Authority's staging ground. The Contractor shall provide at least 1 weighing bridge at each of the Station excavation work site. The weight of each truck entering and leaving the site shall be recorded and submitted with the other relevant information to the Engineer.

12.28.26.6 The Contractor shall note that the locations of loading and inspection platform for spoil disposal may change frequently throughout the Contract period. All hardware, software, ancillary equipment and services including testing and commissioning required to relocate any equipment in the CCTV and Truck Recognition Systems shall be provided at the Contractor's own cost.

12.28.26.7 The Contractor shall test and commission both the CCTV System and the Truck Recognition System prior to any spoil disposal to the Staging Grounds.

12.28.26.8 The Engineer reserves the right to suspend or stop disposal to the Staging Grounds should there be frequent faults or prolong unavailability of the CCTV/Truck Recognition systems or non-compliance with Authority's spoil disposal procedures and audit requirements.

12.29 Disposal of Contaminated Material

12.29.1 The Contractor shall engage the services of an environmental specialist whose experience and qualifications shall be submitted to the Engineer for acceptance. This specialist shall be available at short notice to identify contaminated material on site if required. He shall also provide the Contractor's staff with training in the field identification of potentially contaminated material.

12.29.2 During the progress of any works which lead to the generation of spoil for offsite disposal, the Contractor shall provide all necessary assistance to the Engineer should he require to obtain soil and water samples from the works for environmental testing.

12.29.3 Material that may be suspected of contamination under the Environmental Protection and Management Act (EPMA), the Environmental Protection and Management (Hazardous Substances) Regulations and the Environment Protection and Management (Ozone Depleting Substances) Regulations shall not be permitted to be disposed of through the Staging Ground until the laboratory reports provide evidence that the contains levels of contamination are within allowable limits or is not contaminated. The material shall then be treated and disposed of by the Contractor accordingly. All costs associated with arrangements made to identify and dispose of Contaminated Material shall be borne by the contractor.

12.29.4 If the test results show the soil to have contaminants exceeding the allowable limits, the Contractor shall seek approval from Pollution Control Department of the NEA for any reuse of the contaminated soil on site as backfill material prior to backfilling works.

12.30 Disposal of Bentonite

12.30.1 The Contractor shall note that it is prohibited to discharge bentonite slurry waste and bentonite contaminated excavated material into any drainage systems.

12.30.2 The Contractor shall submit his proposed method of disposal and transportation of bentonite slurry waste and bentonite contaminated excavated material to the Engineer for acceptance. In this regard the Contractor shall comply with the prevailing regulations and guidelines set by NEA and other relevant authorities.

12.31 Requirement for Ready-Mixed Concrete (RMC) Certification

12.31.1 Concrete for building and civil engineering structures shall only be obtained from RMC plants which have been certified under the SAC's (Singapore Accreditation Council) Certification Scheme for RMC. This includes on-site batching plants as well as plants supplying concrete for precast elements.

12.31.2 The ready mix concrete supplied by RMC plant shall comply with Singapore standard SS EN 206-1 and its complimentary standard SS 544.

12.32 Structural Steelworks

12.32.1 in the Contractor shall satisfy the general assumptions stated in SS EN 1990, 1.3(2) relating to the execution of structures designed to the Eurocodes., In the event this document is superseded by a later version, the latest version at the time of works shall be complied with.

12.32.2 The specialist steel fabricator appointed by the Contractor for all kinds of structural steel work shall have the accreditation from Structural Steel Fabricators Accreditation Scheme, under Category S1, which is managed by Singapore Structural Steel Society (SSSS).The fabricator shall run a Factory Production Control (FPC) system conforming to the requirements of EN ISO 9001 and made specific to the requirements of BS EN 1090. The fabricator shall undertake welding in accordance with the requirements of the relevant parts of EN ISO 3834 or EN ISO 14554 as applicable according to the Execution Class.

12.32.3 The fabricator's quality documentation shall conform to the requirements for the specified Execution Class shown on the drawings of the structure or component being fabricated.

12.32.4 A quality plan for the execution of the works is required and shall include the items recommended in BS EN 1090-2, Annex C. The contract-specific quality plan does not need to repeat the Organization's regular management procedures.

12.32.5 The Contractor shall undertake a review to confirm that their technical capability and competence is sufficient for the execution of the works. The review shall be documented and shall be submitted for the acceptance of the Engineer in advance of execution.

12.32.6 The Contractor shall engage the qualified site supervisors for structural steel works (including temporary steel works) who are trained and registered under Steelwork Supervisors Register maintained by SSSS.

12.32.7 A comprehensive and thorough testing and inspection regime is vital for the safe fabrication and erection of structural steel work. An Independent Testing Agency (ITA) accredited under the Singapore Accreditation Council (SAC) Accreditation Scheme for Inspection Bodies (Structural Steel Work) shall be appointed to:

(a) Review the welding procedure specification;

(b) Check on the joints fit-up, size, dimensions and material quality of the steel members;

(c) Conduct inspections prior to welding, during welding and after welding;

(d) Conduct post welding tests on welds;

(e) Check on bolted connections; and

(f) Check on the various coats of paints from primer until finishing coat.

12.32.8 The Contractor shall submit a comprehensive inspection testing plan (ITP) to the Engineer for acceptance indicating the various checks by ITA involved in the structural steel fabrication and erection which shall also include the rate of sampling for testing the material quality as per relevant BS EN 1090 and the Authorities requirements.

12.33 Post-installed Reinforcement Provision

12.33.1 All chemical adhesive used for post-installed reinforcement shall have European Technical Approval (ETA). The Contractor shall submit the valid ETAs with the corresponding technical information of the product complying with the ETA including rebar sizes applicable, curing time, bond strength, etc. for the acceptance of the Engineer and the QP(S).

12.33.2 All post-installed reinforcement shall meet the required embedment length substantiated by calculations in accordance with Eurocode 2 submitted by the Contractor's designated PE. On-site proof test shall only be used as verification of workmanship and shall not be used as substantiation of any load capacity/embedment length not justified by calculations.

12.33.3 The Contractor shall submit fire resistance reports for the chemical adhesive used for the post-installed reinforcement for the acceptance of the Engineer and the QP(S) prior to works on site.

12.34 Precast Concrete Construction

12.34.1 All precast concrete elements to be used in the works that fall within the scope of a Product Standard shall be supplied in accordance with that Standard. Precast elements that are outside the scope of a Product Standard shall conform to BS EN 13369 'Common rules for precast concrete products'.

12.34.2 For precast products, construction operations from the reception at the site or, if site manufactured, from removal from the forms, shall comply with the provisions of BS EN 13670.

12.34.3 The Contractor shall appoint his own QA/QC supervision team, subject to the acceptance of the Engineer, for the supervision of the construction of precast structural elements, which are fabricated/manufactured overseas to ensure that the technical specifications, design and material codes prescribed in the Building Control Regulations are complied with. All costs associated with the above are deemed included in the Contract Price.

12.34.4 The QA/QC supervision team shall submit a monthly report to the Engineer and the Contractor for the supervision of the precast structural elements. The QA/QC supervision team shall be based full time at the casting yard during production. Such staff shall be independent from and shall not be affiliated in any way with the pre-casting company.

12.34.5 The Contractor shall ensure that the casting yard permits any representatives of the Engineer, the Authority, the QP(S) or other independent inspectors, full and unrestricted access to the casting yard facilities. The Contractor shall coordinate and give access to all records relevant to the works at the casting yard whenever requested by the Engineer.

12.35 Temporary Storage and Shelter for SWC Equipment

12.35.1 The Contractor shall provide a temporary weatherproof roofed shelter over escalators/lifts at entrances, subject to the Engineer's acceptance. This shelter shall be constructed immediately after the installation of the escalators and shall allow sufficient working space for the escalator contractor to carry out his works.

12.35.2 The delivery of the SWC equipment shall be coordinated in the CIP. Should the Contractor be unable to meet the agreed dates as stipulated in the CIP for the delivery of the SWC equipment, the Contractor shall provide temporary weather-proof storage for SWC equipment; the costs associated with the provision of storage are deemed included in the Contract Price.

12.36 Working Platforms for Ceiling Works with SWC

12.36.1 The Contractor shall construct working platforms to facilitate the installation of ceiling works where his design has high voids. He shall maintain these high working platforms to allow SWC to carry out their works within the ceiling space within an agreed timeframe based on the agreed CIP. The timing of the removal of these platforms shall be agreed and coordinated with the relevant SWC contractors.

12.37 Waterproofing for Structures

12.37.1 The Contractor shall comply with the minimum requirements on waterproofing for structures in Materials and Workmanship Specifications.

12.37.2 The Contractor shall propose effective waterproofing details to enhance waterproofing at the roof and base slab joints if there is a more effective method, which shall be reviewed and accepted by the Engineer. Any proposed waterproofing system submitted for acceptance shall be compatible with the structure and its construction method.

12.37.3 For backfilled sealed space, the cast in-situ reinforced concrete elements abutting the earth face shall be waterproofed. Please refer to indicative schemes shown on Authority's Drawings for reference only. The Contractor shall be responsible to ensure the watertightness of the underground structure and propose the appropriate waterproofing system to suit his method of construction and sequence of work subjected to the Engineer's acceptance.

12.37.4 The Contractor must plan and detail the layout and injection points for the re-injectable grout tubes and submit to the Engineer for acceptance. During the installation phase, the re-injectable grout tubes shall be inspected and tested to ensure that they remain functional for future use and not blocked/choked. An as-built drawing of the positions of all re-injectable grout tubes shall be produced and submitted to the Engineer for record.

12.37.5 The Contractor shall carry out trial application/mock-up for the proposed waterproofing membrane system and re-injectable grout tube system to the acceptance of the Engineer. The length of the re-injectable grout tube used in the trial application/mock-up shall not be shorter than the design length specified by the manufacturer.

12.37.6 Before casting, all the re-injectable grout tubes must be checked for serviceability by flushing water through them. After casting, the re-injectable grout tube must be flushed out with water and checked again for serviceability. After curing of concrete, the re-injectable grout tubes shall be pumped with grout to seal the construction joint immediately. After grouting to seal the construction joints, the re-injectable grout tube shall be flushed out with water and checked again for serviceability. Records of all grout pumped in at each point should be submitted to the Engineer for record.

12.37.7 The re-injectable grout tube injection points must be protected during all stages of the works and grout tube injection points shall be housed in protective covers to prevent damage.

12.37.8 The Contractor shall provide and install aluminium plate as cover for the re-injectable grout tube injection points including identification number for each point embossed on the plates.

12.37.9 The re-injectable grout tube injection points must not be located at interfaces between slabs/beams/walls to avoid getting them buried in the slabs, walls or beams. They shall be located away from E&M brackets and other wall fixtures.

12.37.10 Grout tube injection points must have sufficient lead out lengths to do grouting and re-grouting properly.

12.37.11 Ponding Test

12.37.11.1 Prior to the waterproofing membrane installation, the concrete substrate of the roof slab shall be checked for water tightness by conducting a ponding test with minimum 150mm depth of water for a 48-hour period. All dry and wet cracks are to be grouted prior to all waterproofing works and all defects such as dampness etc. in the structure shall be repaired to the satisfaction of the Engineer.

12.37.11.2 After the waterproofing membrane has been installed and prior to laying of the protective concrete slab, the waterproofed area shall be tested by ponding in accordance with **Clause 14.4.1** in **Chapter 14** of Materials and Workmanship Specification. All defects such as dampness etc. in the structure shall be repaired to the satisfaction of the Engineer.

12.37.11.3 The Contractor shall carry out ponding test as mentioned in **Clauses 12.37.11.1** and **12.37.11.2** of the Particular Specification unless otherwise accepted by the Engineer due to site constraints, etc.

12.37.12 As-Built Drawings

12.37.12.1 The Contractor shall submit as-built drawings showing all waterproofing details as actually installed including, but not limited to, the following:

(a) Names of all proprietary products and materials, such as waterproofing materials, waterstops, re-injectable grout tubes, injection grout, waterproofing admixtures, polyethylene sheets, geotextiles, protection boards, sealants and preformed gaskets;

(b) Actual location of all re-injectable grout tubes and corresponding inlet/ outlet injection points or junction boxes;

(c) Representative isometric layouts of waterstops and re-injectable grout tubes; and

(d) Other information pertinent to future maintenance.

12.37.12.2 The Contractor shall submit as-built drawings as the work proceeds. The number of copies to be submitted shall be in accordance with the General Specification.

12.38 BCA Green Mark Certification Requirements

12.38.1 The station shall comply with the BCA Green Mark ‘Platinum’ standard requirements, as on BCA’s website.

12.38.2 The Contractor shall provide adequate substantiation that the proposed materials are BCA Green Mark certified materials.

12.38.3 The Contractor shall appoint the Greenmark assessors to complete the certification of the station. The costs associated with all Greenmark Inspections and certification are deemed included in the Contract Price.

12.39 Compliance with BCA Regulations for Buildability

12.39.1 The Contractor shall incorporate in his construction methods, the use of precast elements, if applicable. The elements shall be fabricated and installed in compliance to BCA's latest Building Control (Buildable Design) Regulations and the Code of Practice on Buildable Design.

12.39.2 The design shall meet the requirement of minimum buildable score for the category of Public Sector Institutional Building as specified in the Code of Practice on Buildable Design.

12.39.3 In the Buildability Score computation, the Contractor shall include the following but not limited to:

(a) Prefabricated reinforcements shall be used for all columns and beams, and at least 50% of slabs.

The Contractor is encouraged to adopt the following:

(i) All non-load bearing walls are constructed of precast reinforced concrete walls. Walls carrying lateral pressure loads are deemed to be load bearing walls.

(ii) Precast staircases.

12.39.4 The Contractor is encouraged to propose additional measures to enhance productivity and identify additional elements that use precast methods of construction.

12.39.5 The Contractor's attention is drawn to the Authority's requirements for Precast Concrete Construction as provided in Materials and Workmanship Specification.

12.40 Compliance with BCA Regulations for Constructability

12.40.1 The Contractor shall comply with BCA's latest Building Control (Constructability) Regulations and the Code of Practice on Constructability.

12.41 Temporary Power Supply Installations

12.41.1 The Contractor shall make provision for temporary power supply for construction activities. Dual feed incoming power supply from SPPG shall be provided.

12.41.2 All design, installation, testing and commissioning works of the temporary power supply installation shall be carried out and endorsed by the LEW of appropriate grade.

12.41.3 The temporary electrical installation shall be in accordance with CP88. The LEW shall check the installations regularly and ensure they are maintained in good condition at all times.

12.41.4 No equipment or services other than those serving the electrical rooms shall be located in the electrical rooms. All equipment shall have adequate maintenance space of not less than 800 mm. The use of containerised substation is not permitted.

12.41.5 All electrical rooms shall be equipped with the following E&M services:

(a) Lighting - minimum 200 lux.

(b) Switched Socket Outlet - minimum 2 per room.

(c) Smoke detectors.

(d) Mechanical ventilation (if required).

(e) Rotating beacon light and horn for any fault detected in the electrical room.

(f) Fire extinguishers.

12.41.6 Double roof shall be installed over the temporary substation, if required.

12.41.7 Roof shall be installed over equipment installed outdoor, such as transformers, LV switchboards, RMUs, etc. to ensure the equipment is not subjected to rain / water seepage.

12.41.8 Temporary substation, open shed equipment areas and its roof shall be installed with lightning protection system in accordance to SS 555.

12.41.9 All electrical equipment including the electrical equipment in the launching shafts and on the TBMs shall be new and type to the following standards:

(a) HV Switchgear - IEC62271

(b) LV Switchgear - IEC61439

(c) Service Transformers - IEC60076

(d) Cables - IEC60502

(e) LV Sub Boards and Distribution Boards - IEC 61439

(f) Battery chargers and batteries - IEC 60623

(g) Generator – SS 535

12.41.10 All equipment shall be factory and site tested. The LEW shall witness all Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) of the temporary power supply equipment. Reports for FAT and SAT shall be duly endorsed by the LEW and submitted to the Engineer. All Factory Acceptance Test (FAT) shall be current and performed for each respective site prior to the delivery of equipment for installation.

12.41.11 Major E&M equipment including those associated with Tunnel Boring Machine (TBM) operation shall undergo full Original Equipment Manufacturer (OEM) FAT at manufacturer's factory in accordance to relevant standards. The Contractor shall submit proposed test plan & test procedures to Engineer for acceptance at least 3 months prior to OEM FAT in which the Engineer reserve the right to witness these tests. In the absence of Engineer's attendance to witness these tests, the Contractor shall submit OEM test reports to Engineer for verification.

12.41.12 The Contractor shall submit the proposed Site Acceptance Test (SAT) schedule, test plan & test procedures to Engineer for acceptance at least 3 month prior to SAT in Singapore.

12.41.13 All electrical equipment in the launching shafts and on the TBMs shall be protected with an appropriate IP rating fit for operation. Alternatively, external measures shall be employed to achieve the necessary water ingress protection.

12.41.14 All 22kV switchgear proposed shall be of Gas Insulated type (GIS) with bus bar fully encapsulated in SF6. The 22kV switchgear shall be rated to withstand a fault level of 25kA, 3seconds. Ring Main Units are not allowed to be used in 22kV System.

12.41.15 The use of Ring Main Unit and Load Break Switch shall be accompanied by proper circuit protection and circuit breaker provisions. The 11kV and 6.6kV switchgears shall be GIS type. The 11kV and 6.6kV switchgears shall be rated to withstand a fault level of 20kA, 3 seconds.

12.41.16 SF6 gauge shall be provided for all switchgears and RMUs.

12.41.17 SF6 level to be monitored by switchgear and RMU's protection relay. Alternatively, other monitoring system shall be employed to achieve the necessary SF6 monitoring.

12.41.18 All electrical equipment shall have proper protection devices such as over current and earth fault protection, transformer differential protection, transformer winding and oil temperature protection, (alarm and trip), transformer sudden pressure protection (trip), transformer low oil level (alarm and trip), lock-out relay, etc. All protection devices shall be fully tested by the LEW prior to the energisation. A copy of the test records shall be endorsed and submitted to the Authority.

12.41.19 Protection to both primary and secondary windings of the transformer (including those used in TBMs) shall be provided.

12.41.20 Circuit breaker trip indicators and transformer protection device activation indicators shall be provided for all electrical equipment including those used in TBMs.

12.41.21 Pilot wire protection shall be provided for the cable between surface temporary substation and TBM's cable reel or TBM's HV switchgear in the electrical system.Circuit protection device activation indicators such as over current, earth fault, etc. shall be provided such that they can be identified individually for all electrical equipment including those used in TBMs.

12.41.22 The control source for all protection devices on HV switchgears and LV switchboards, external shunt trip coils and transformers mechanical protection devices including cable reel's motor, cable reel's heater and generator's battery charger, and all TBM's electrical equipment shall be supplied by permanent supply and back-up by secondary emergency source.

12.41.23 Provide separate AC & DC circuit breakers for the control source to each type of equipment such as 22kV switchgears, 11kV switchgears, 6.6kV switchgears, RMUs, LV switchboards, etc.

12.41.24 Potential transformer (PT) shall be protected with fuse and type tested in accordance to relevant international standards.

12.41.25 All transformer proposed shall be of Silicon oil type with KNAN configuration. Secondary winding of all transformer shall have a solidly earthed star-point.

12.41.26 Dry type transformers are not allowed.

12.41.27 Separate transformers shall be provided to serve the TBM and surface electrical services respectively. Supply for the TBM shall be 6.6kV or 11kV. The use of 22kV distribution is not permitted in the tunnels/launching shafts.

12.41.28 The electrical distribution schematics for temporary substation and in the tunnel are shown in Figure 1 and Figure 2.

12.41.29 The Contractor shall provide adequate busbar outgoings to terminate all the proposed number of transformer secondary LV Phase and Neutral cables. If back-to-back termination is being proposed, Contact Resistance test shall be conducted during SAT.

12.41.30 The Contractor shall provide separate busbar outgoing ways for each of the Neutral earthing cables.

12.41.31 Back-to-back termination for earth cables are not allowed.

12.41.32 Raised plinth shall be provided for transformer installation to ensure adequate cable bending radius is achieved.

12.41.33 The LV Main Switchboard shall be of Form 3B construction to IEC 61439.

12.41.34 To provide the inter-tripping logic table between all the HV switchgears, transformers, RMUs, LV switchboards and emergency generators.

12.41.35 HV cables that are routing on surface shall be armoured type and adequately protected against mechanical damage.

12.41.36 HV and LV cables lay from surface temporary substation to launching shafts and TBMs into the tunnel shall be armoured and LSOH type. No PVC cables are allowed into the launching shafts and TBMs in the tunnels.

12.41.37 No cable jointing shall be allowed except for HV cables subject to Engineer's acceptance. Cable jointing shall be carried out by Licensed Jointer.

12.41.38 All HV cable joints and cable couplers shall be installed on permanent fixed structures & adequately protected against any mechanical damage.

12.41.39 LV cables laid outdoor shall be of armoured type. Alternatively, external measures shall be employed to achieve the necessary mechanical protection.

12.41.40 All LV cables colour code shall comply with Local standard, SS 638.

12.41.41 All Phase, Neutral and Earth cable's termination shall be torqued accordance to OEM recommendation and torqued-marked.

12.41.42 Power cables of different voltage levels shall be physically segregated. Additionally, power cables must also be physically segregated from other mechanical ducts and pipes.

12.41.43 All cables that are lay outdoors shall be routed in proper cable containment and cable support system to provide adequate mechanical protection.

12.41.44 Cable containment for power cables shall be spray-painted with prominent Danger Signage in 4 official languages and clear indication of the voltage levels.

12.41.45 All termination kits and cable lugs proposed shall be suitable and acceptable to the OEM for their equipment cable termination and shall be of appropriate rating. All exposed live terminals shall be properly insulated with heat-shrinkable glands of appropriate rating.

12.41.46 All cable entry shall be sealed off with appropriate material after cable laying.

12.41.47 All alarm and fault signals shall be linked to Audio & Visual Warning System comprises of rotating beacon light and horn. The monitoring circuit shall be fail-safe type for all HV switchgears circuit breaker trip status, all digital protection relay faulty/watchdog alarm status and control source failure alarm status (battery and charger faults alarm, battery and charger AC & DC MCBs trip status), etc. This monitoring circuit power supply shall be from permanent supply and back up by a secondary battery source.

12.41.48 Emergency generator system shall be of prime rating and able to run for 24 hours. Details on the selection and rating of the generator shall be submitted to Engineer for acceptance. Automatic Transfer Switch (ATS) shall be provided for Generator. LED indicating lights to indicate the healthiness of each incoming power supply. The fault making and breaking capacity shall be sized to the fault level of the duty and standby source. The ATS will switch back to duty source when it becomes healthy.

12.41.49 The Contractor shall ensure that all temporary substation requirements are in compliance with SPPG substation requirements. Proper earthing shall be provided for electrical safety. Tinned copper earthbar, appropriately sized, shall be provided in each room in the temporary substation for solid grounding of the temporary power supply equipment. Equipment shall be individually bonded to the earthing bar via a ring circuit configuration. Individual incoming and outgoing feeder circuit's armour shall be bonded to the equipment integral earth bar. All earthbars shall be interconnected by earthing cables.

12.41.50 Tinned copper earthbar in the switchrooms of the temporary substation shall be solidly earthed via a minimum of two earthing points with a value of less than 1 ohm. All earthing cables shall have a minimum cross-sectional area of 95sqmm.

12.41.51 Separate earth bars shall be provided at the bottom of the launch shaft and shall be solidly bonded via a ring circuit configuration to the main earthing system of the temporary power supply installation and to the TBMs.

12.41.52 The earthing schematic for temporary substation and in the tunnel is shown in Figure 3.

12.41.53 The LEW shall formulate the necessary maintenance plan and checklist to carry out regular inspection on all the temporary power supply installation on a monthly basis in accordance to local statutory regulations. Inspection report shall be prepared and submitted to the Engineer after each inspection highlighting any non-conformity and rectification works necessary for immediate action by the Contractor. In addition, regular test such as Partial Discharge test, etc. shall be done on the electrical installation to ensure adequate insulation level and safe operation every 3 months. All maintenance records and test records shall be duly endorsed by the LEW and submitted to the Engineer.

12.41.54 The Contractor shall submit detailed maintenance regime proposed for the Temporary Substation and TBM electrical installation.

12.41.55 The Contractor shall submit testing and commissioning method statements duly endorsed by the LEW prior to energisation of the electrical equipment.

12.41.56 The Contractor shall submit Design Drawings for review and acceptance including the following:

(a) Overall Electrical schematic diagram for all Surface equipment till TBM electrical distribution;

(b) Substation Equipment Layout including Lighting and Power Layout Plans, Single Line Diagram;

(c) Cable Routing Layout Plans;

(d) Installation drawing of fixing & securing Cable Join / Coupler in the tunnels;

(e) Lightning Protection System;

(f) Earthing Schematic Diagram;

(g) HV switchgears, Transformers, LV switchboards, RMUs, Battery & Charger Audio & Visual Warning System and Control Circuit Printed Circuit Board Assembly (PCBA) manufacturing drawings; and

(h) Other relevant items.

12.41.57 The Contractor shall submit Design Calculation for review and acceptance including the following:

(a) Load tabulation for the Electrical installation including Emergency load under all possible outage scenarios;

(b) Phase, earth and control source cable sizing;

(c) Voltage drop calculation;

(d) Short circuit fault calculation;

(e) Protection co-ordination study;

(f) Battery & charger selection calculation;

(g) Current transformer (if required);

(h) Calculation and /or computer simulation to demonstrate that the temperature inside sub-station will be within the allowable equipment working temperature; and

(i) Other relevant items.

12.41.58 All Design drawings and calculations shall be endorsed by the appropriate grade LEW for the electrical works, PE (Electrical) for lightning protection installation and QP (Mechanical) for the mechanical works.

12.41.59 The Contractor shall submit Technical catalogue, Type test report and certificate and Track records for all proposed Electrical equipment.

12.41.60 The Contractor shall conduct Dissolved Gas Analysis and Oil Quality Test after each transformer Energisation.

12.41.61 The Contractor shall submit installation, testing and commissioning method statements and checklists duly endorsed by the LEW prior to commencement of installation works.

12.41.62 The Contractor shall arrange with the Authority for a formal site inspection at least 1 week prior to energisation of the installation. The Power-on documentation shall be prepared and shown to the Authority on the day of formal site inspection for review. Attached Table 1 for the documents needed to be compile in the Power-On documentation.

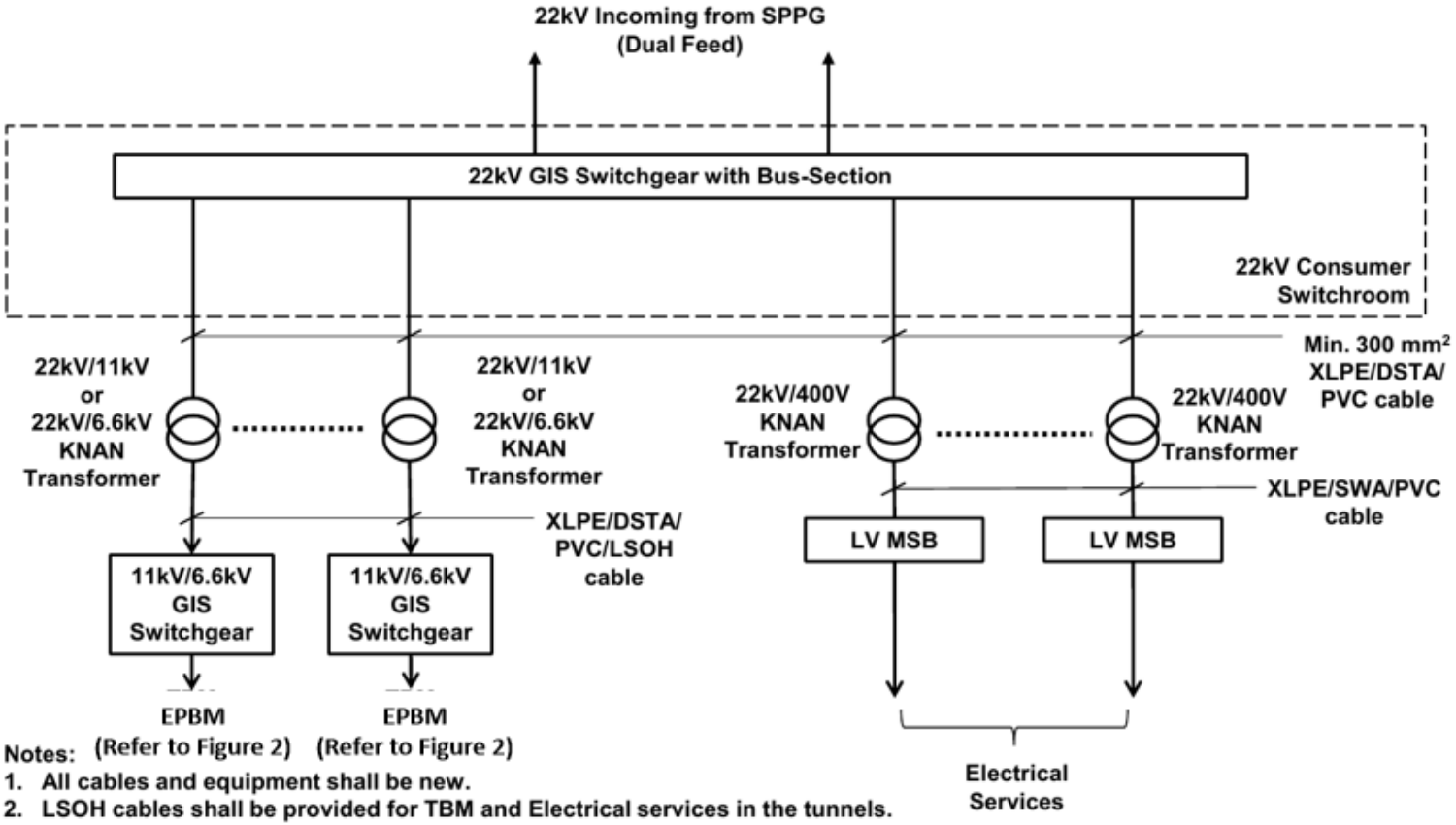
Table 1: Power-On Documentations

Item	Requirements	Compliance		Action Taken / Remarks
		Yes	No	
A	**DOCUMENTATION**			
A.1	**Summary List of Electrical Equipment**			
A.1.1	Details of major electrical equipment installed (e.g. Brand, Model, Country of Manufacturer, Technical Specifications, Location, etc.)			
A.2	**Single-Line Diagram**			
A.2.1	LEW endorsed Single Line Diagram with clear indication on the portion of circuit to be energised and all protection settings indicated.			
A.2.2	Earth schematic diagram			
A.3	**SAT Reports**			
A.3.1	Summary list of applicable tests conducted for different type of equipment but not exhaustive: (i) HV Switchgear to IEC 62271 (ii) LV Switchboard to IEC 61439 (iii) Transformers to IEC 60076 (iv) Cables to IEC 60502 (v) Battery & Charger to IEC 60623 (vi) Generator to SS 535			
A.3.2	All the test form/test procedure shall have passing criteria clearly indicated for each type of test conducted.			

Item	Requirements	Compliance		Action Taken / Remarks
		Yes	No	
A.3.3	All internal equipment components serial number shall be clearly recorded in the SAT form and shall be traceable back to respective FAT reports.			
A.3.4	All final protection setting shall be clearly indicated in the SAT test form.			
A.3.5	Testing set/equipment calibration certification shall be attached to the SAT reports.			
A.3.6	Inter-tripping logic test between all the HV switchgear, transformers, RMUs, LV switchboard and emergency generator including test for secondary emergency supply.			
A.3.7	Audio & visual warning system test.			
A.3.8	Commissioning test reports.			
A.3.9	Other documents relevant to the SAT shall be attached to the SAT reports.			
A.4	**OEM FAT Reports**			
A.4.1	All OEM FAT reports for the proposed equipment used in this project. For example, HV and LV switchgears, RMUs, transformers, cables, generators, etc.			
A.5	**Earthing System and Lightning System**			
A.5.1	Test Reports on the earthing system and lightning system installed at site			
A.5.2	Earthing system schematic diagram			

Item	Requirements	Compliance		Action Taken / Remarks
		Yes	No	
A.5.3	Certificate of Supervision (COS) of lightning protection system by PE.			
A.6	**Contractor LEW pre-inspection checklist**			
A.6.1	LEW pre-inspection checklist to demonstrate that a proper and thorough inspection has been conducted for the TBM and the equipment installed and the check list to be endorsed by the LEW.			
A.6.2	Verification of HV cable termination fully fitted and properly terminated into the equipment or switchgears prior to energisation of the circuit through High Voltage test			
A.6.3	Rectified defects and closed out punchlists issued by the Engineer.			
A.7	**Compliance and Readiness Certificate**			
A.7.1	Certificate of Compliance (COC)			
A.7.2	Certificate of Readiness (COR)			
A.8	**Electrical Protection**			
A.8.1	Protection relays set file (downloaded from protection relay for HV switchgears).			
A.8.2	OC/EF protection coordination curves from temporary substation 22kV switchgear to LV MSBs, 22kV switchgear to RMUs and TBM MSBs.			
A.8.3	Verification of equipment fault level rating against Short circuit fault analysis for the entire Electrical installation.			
A.8.4	Uninterruptible control source for all protection relays and shunt trip.			

Figure 1 – Electrical Distribution Schematic for Temporary Substation



Notes:

1. All cables and equipment shall be new.
2. LSOH cables shall be provided for TBM and Electrical services in the tunnels.
3. 22kV Switchgear and LV Main Switchboard (LV MSB) shall be provided with Over Current and Earth Fault Relay protection.
4. All transformers shall be provided with Sudden Pressure Relay, Oil Temperature Alarm, Oil Temperature Trip, Winding Temperature Alarm, Winding Temperature Trip, Low Oil Level Alarm and Low Oil Level Trip.
5. All the alarms shall be linked to rotating beacon light and horn.
6. Inter-tripping provision (22kV Switchgear inter-trip downstream (6.6kV, 11kV or ACB) in the event of 22kV Switchgear tripped due to faults.)
7. All 6.6kV/11kV Switchgear shall be provided by proper circuit protection and circuit breaker provisions for both incoming and outgoing feeder.
8. The schematic is applicable if SPPG impose a 22kV intake substation.

Figure 2 – Electrical Distribution Schematic in the Tunnel

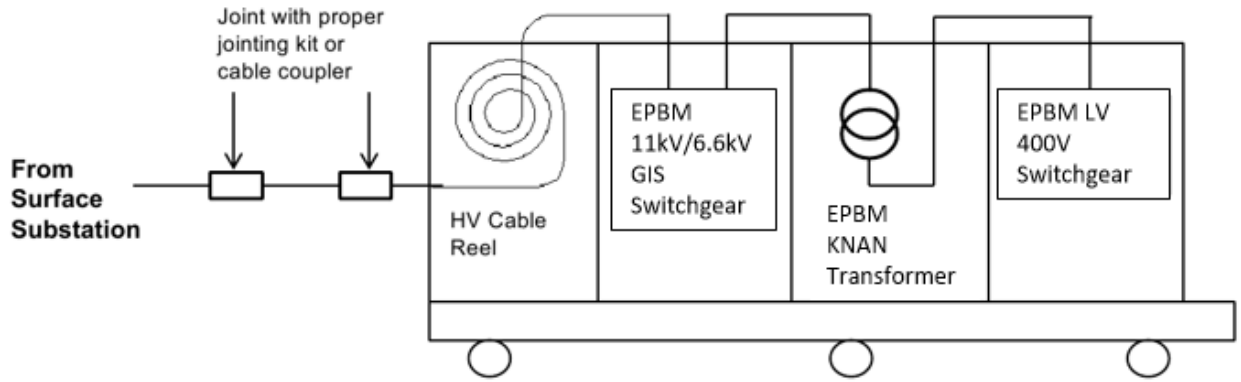
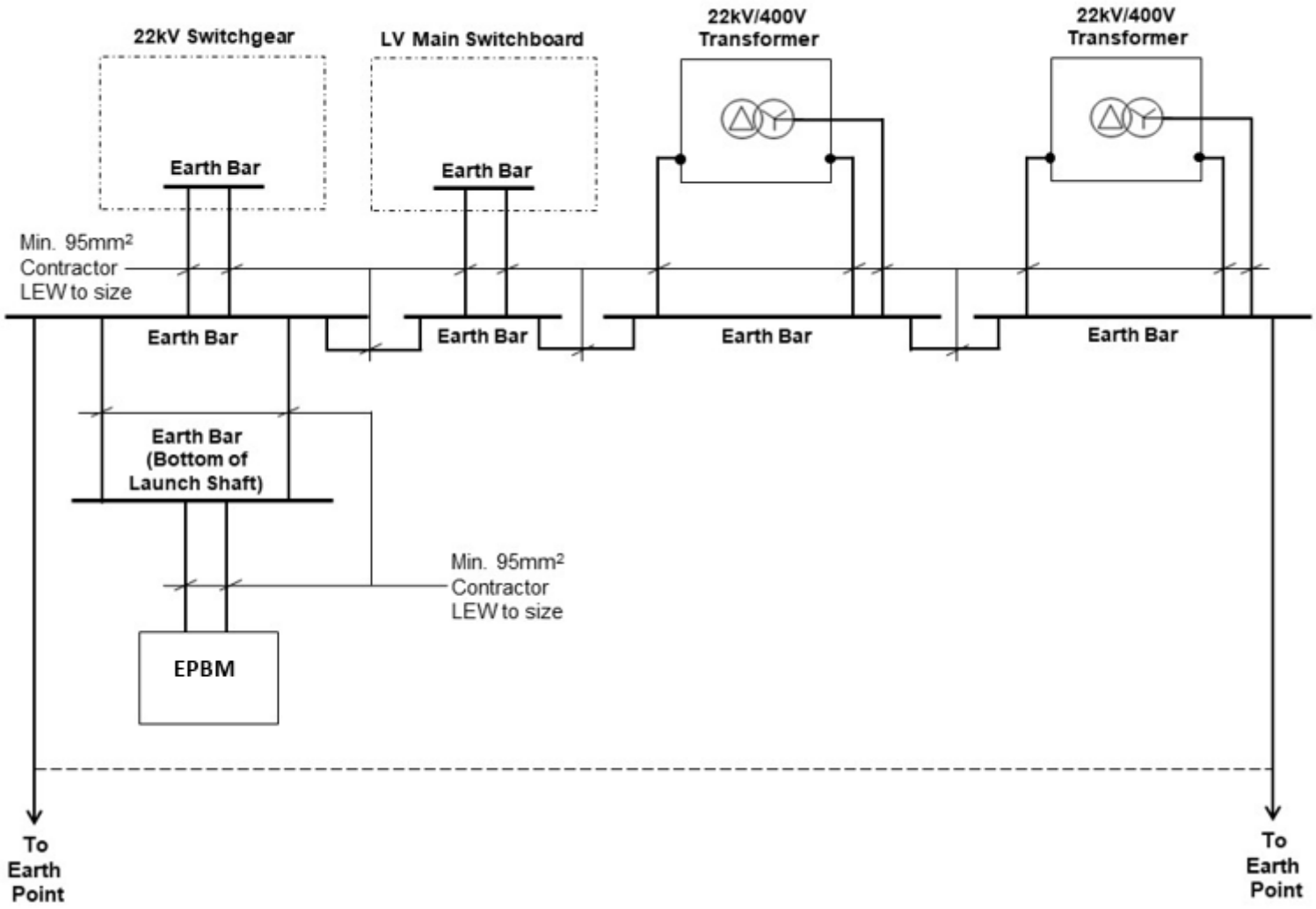


Figure 3 – Earthing Schematic for Temporary Substation



12.42 Temporary Ventilation

12.42.1 The Contractor shall be responsible for temporary ventilation. The Contractor's PE shall design and propose provisions for the temporary ventilation and shall comply with the Workplace Safety and Health (General Provisions) Regulations 2007 and Workplace Safety & Health (Confined Spaces) Regulations 2019 and SS 568: Code of Practice for confined spaces (2011), and any subsequent amendments.

12.42.2 The temporary ventilation design shall include the desired air flow rate. The Contractor's PE shall propose the locations and the numbers of air flow meters to monitor the actual air flow within the underground structures during construction. The Contractor shall also carry out regular air quality checks and keep such records for inspection by the Engineer as and when required.

12.43 Public Relations and Project Information Centre

12.43.1 Within 1 month of the Contract award, the Contractor shall prepare a newsletter for all residents within 150m of the Site, distributed to the letter box or other means as accepted by the Engineer. The Contractor shall engage a professional graphic designer to create high quality newsletters in colour. Thereafter, the newsletter shall be prepared on a quarterly basis and distributed to residents and stakeholders. The newsletters shall include a QR code which the public can scan to view more information about the project via digital posters, animations or videos.

12.43.2 The Contractor shall plan and prepare videos on the upcoming proposed works to explain the works and share with the Adviser, Grassroots and residents during regular public relation engagements. These are deemed to be included in the Contract Price. The Contractor shall prepare standalone information board(s) for example: 3-direction information board, subject to the acceptance of the Engineer, to be placed at strategic locations to update on the upcoming construction developments that would affect the public. The information board(s) shall include a QR code which the public can scan to view more information about the project via digital posters, animations or videos.

12.43.3 The Contractor shall plan and carry out public relations events such as ground breaking, tunnel launching and breakthrough, etc. as instructed by the Engineer. The provision of tentage, stage, tables, seating, ventilation, floral display, refreshment, posters, audio visual displays, transportation, video live streaming, virtual provisions, etc. are deemed to be included in the Contract Price.

12.43.4 A Project Information Centre (PIC) will be set up by other contractors. The purpose of the PIC is to provide information on the project to the general public and interested parties, and as a base for conducting public relation efforts such as briefings to be conducted by the Contractor.

12.43.5 The Contractor is required to provide architectural/artist perspective of the CR206 Station for display at the PIC.

a) The Contractor is also required to provide the following information/material to the PIC:Colour monthly progress photos and charts in appropriate form and size coordinated with PIC contractors;

b) Colour posters on construction methodology and sequence in appropriate form and size coordinated with PIC contractors;

c) Sufficient copies of PR newsletters/leaflets to be made available at all times as determined by the Engineer;

d) Aerial photos of site in appropriate form and size coordinated with PIC contractor; and

e) Animation videos of the construction sequences of CR205 Station.

12.43.6 The Contractor shall update the information and material provided to the PIC on a monthly basis.

12.43.7 The Contractor is required to liaise with PIC contractors' PROs on a monthly basis on PR activities and briefings to be held at the PIC.

12.43.8 The Contractor shall allow in his cost for shifting of models for public events organised for ground breaking ceremony or event held at public place.

12.43.9 During the construction period, the models may be temporarily shifted to public events for display. The Contractor shall bear transportation cost and labour in moving the models from time to time.

12.43.10 The Contractor shall coordinate with the CR209 contractor on the space allocation, lighting and location of power supply sockets within the PIC to suit the arrangement of his proposed displays

12.43.11 The Contractor shall set up information, displays, and models in the Project Information Centre.

12.43.12 The Contractor is required to provide architectural/artist perspective of the CR206 Station for display at the PIC.

12.43.13 The Contractor shall produce video/ animation to illustrate key measures adopted to minimize disturbance to key stakeholders around the construction site.

12.43.14 Architectural Model requirement

(a) The Contractor shall engage an approved architectural model maker to make one (1) architectural model;

(b) The architectural model of the CR206 Station under the Contract, shall include above ground structures like commuter facilities, bus shelters, covered linkways, landscaping, adjacent roads, building and structures, and underground structures, with cutaway section showing the interior of the station levels to foundation level, at a scale of 1:200 with plan dimensions of minimum 1.5m by 0.9m, with lighting and protective cover and be placed on a stable support;

(c) The model shall be based on the BIM models/Drawings developed by the Contractor. The model shall be delivered to the PIC within 6 months of award of Contract or as directed by the Engineer;

(d) The Contractor shall note that throughout the Contract period, he shall modify the initial model to account for any changes to the design as and when directed by the Engineer. The Contractor shall rectify any damage to the model and maintain the model;

(e) The model shall be made of plastic, timber, plywood, corksheet, balsawood, perspex and other approved materials. The model shall include buildings, trackwork, human figures, cars, trees, footpaths, roads, contours, driveways, fences and other items shown on the Authority's Drawings;

(f) The Contractor shall provide a 6mm thick perspex covering with corner reinforcements, supply the models on a solid timber base of not less than 50mm thickness, and supply robust display stand(s) to support the models;

(g) The colour schemes for the model shall be submitted to the Engineer for acceptance;

(h) A proportionate title block made of 1mm thick perspex shall be placed at the lower right or left hand corner of model. The title block shall include an approved title with wordings to the Engineer's acceptance; and

(i) The Engineer shall be entitled to inspect the construction of the models at various stages and request necessary modifications to them.

12.43.15 The Contractor is also required to provide the following information/material to the PIC:

(a) Representative soil samples over the depth and length of station and tunnel construction to be placed in transparent PVC tube.;

(b) Colour monthly progress photos and charts in appropriate form and size;

(c) Colour posters on construction methodology and sequence in appropriate form and size;

(d) Sufficient copies of PR newsletters/leaflets to be made available at all times as determined by the Engineer;

(e) Aerial photos of site in appropriate form and size;

(f) Aerial drone videos, updated every 3 months, showing the status of the sites; and

(g) Animation videos of the construction sequence of station and tunnel.

12.43.16 The Contractor shall update the information and material provided to the PIC regularly on a monthly basis.

12.43.17 The Contractor' s PRO is required to liaise with CR209 on a monthly basis on PR activities and briefings to be held at the PIC.

12.43.18 The Contractor shall allow in his cost for shifting of model for public events organised for ground breaking ceremony or event held at public places.

12.43.19 During the construction period, the model may be temporarily shifted to public events for display. The Contractor shall bear transportation costs and labour in moving the model from time to time.

12.44 Road Inventory System Remote

12.44.1 The Contractor shall comply with the requirements of the Road Data Hub Data Collection Specification given in **Appendix N** of the General Specification, and shall submit the Road Inventory data as specified within three (3) months after completion of the Works.

12.44.2 The Contractor shall provide all necessary site records including all necessary photos, videos and other records. Where required, the Contractor's submissions shall be endorsed by Registered Surveyor.

12.45 Registration of Excavator Operators

12.45.1 The Contractor shall note that all excavation works carried out at the Site including those excavations carried out in connection with the detection/laying of utility services shall be done by PowerGrid Registered Excavation Operators (REOs) or Provisional Registered Excavation Operators (PREOs). This is to help minimize incidences of damage to underground service cables.

12.45.2 The Contractor shall ensure that excavator operators employed by him or any of his sub-contractors are licensed as REOs or PREOs. A copy of the relevant certificates shall be submitted to the Engineer before the commencement of excavation work.

12.45.3 Where required, the Contractor shall provide Registered Earthworks Supervisors (RES).

12.46 Anchor Bolts

12.46.1 The Contractor shall comply with the anchor bolts requirements stated in **Appendix D** of the Particular Specification.

12.46.2 It is essential that anchors used in ultimate load tests shall be installed specifically for the tests only. Proof tests shall be carried out on the installed anchors to show that they have been installed correctly.

12.46.3 A PE endorsed test report for the load test shall be submitted to the Engineer for acceptance.

12.47 Reinstatement of Existing Drains and Box Culverts

12.47.1 The Contractor shall reinstate all affected drains and box culverts to their original / revised alignment and sizes to PUB and the Engineer's acceptance, including drop inlet chambers and scupper pipes.

12.47.2 The Contractor shall also construct new cut-off drains and box culverts to the alignment and sizes accepted by PUB and the Engineer.

12.47.3 The Contractor shall make good and/or reinstate any adjoining boundary walls, paving, fencing, gates, etc. disturbed and/or damaged during the course of works, subject to the Engineer's acceptance. The Contractor shall coordinate with the affected stakeholders on the detailed requirements and obtain approval for the reinstatement. The Contractor shall bear all costs of reinstatement of adjacent property disturbed and/or damaged by the Works.

12.47.4 The Contractor shall engage Professional Engineer(s) for the earth retaining or stabilising structure associated with the design and supervision of drains and culvert construction. The Contractor shall note that drains along the edge of excavation must be designed to resist lateral earth and traffic surcharge.

12.47.5 The construction activities and method statements to be submitted to the Engineer shall comply with the requirements as stipulated in the Code of Practice which can be downloaded from PUB's website http://www.pub.gov.sg/home/index/aspx.

12.47.6 All existing drains affected by the Works shall not be demolished or interfered with until their replacement of temporary or permanent drains have been constructed and functioning satisfactorily to PUB standards and accepted by the Engineer.

12.47.7 The Contractor shall liaise closely with PUB's Catchment & Waterways Department and obtain all necessary approvals on the temporary decking over existing drains and the reinstatement. During the construction of the temporary decking, the flow capacity of the existing drains must be maintained at all times.

12.48 Site Video Recording

12.48.1 A professional company, specialising in video recording, shall be engaged by the Contractor to provide a high quality colour video record of the progress of the Works. Each month, the Contractor shall schedule (to the acceptance of the Engineer) the professional company to complete one (1) hours of video recording of major site activities in all areas where major works are in progress. The video shall be timed, where possible, to coincide with major project events and favourable weather.

12.48.2 The Contractor shall provide and utilize a drone with HD video recording capability and high-resolution camera to record the site progress and activities on a quarterly basis. The Contractor shall propose the coverage and presentation format for the Engineer's acceptance. The Contractor shall also comply with all regulations on the use of drones.

12.48.3 The Contractor shall provide time-lapse HD recording of the work site on 24/7 basis and provide the edited footage to the Engineer on quarterly basis.

12.48.4 Each quarter, the professional company shall edit the videos taken in the previous quarter and prepare a 15-minute narrated video of the progress of the Works including special events. The Contractor shall upload these videos at the PIC.

12.48.5 Each year, the professional company shall prepare a 30-minute narrated video of the progress of the Works to-date including special events.

12.48.6 The professional company shall complete additional video recording for special events, such as ground breaking and dedication ceremonies and incorporate them into the summary videos.

12.48.7 At the end of the Contract, the professional company shall prepare the following separate narrative videos (of approximately 15-30 minutes) of the whole of the Works:

(a) Technical presentation video – for example major challenges, major construction sequence and provisions, stages of traffic and canal diversions, etc.

(b) General non-technical information video – for example major construction sequence and provisions, stages of traffic and canal diversions, public engagement, noise and pollution control measures, etc.

12.48.8 The Contractor shall provide three (3) copies of each type of video (in HD format) as specified in the above clauses to the Engineer. The Contractor shall note that the videos recorded and any copy made shall remain as the property of the Authority. The copyright of the videos shall reside with the Authority. The Contractor and the professional company shall not use any part of the videos without approval of the Authority.

12.48.9 The video/portable hard disk/DVD format/system shall be subject to the acceptance of the Engineer.

12.49 Project Execution Report

12.49.1 The Contractor shall submit to the Engineer project execution report of all construction activities/traffic diversion within 2 months after the completion of the respective activity. The Contractor shall also submit the project execution report of any topics related to his works as requested by the Engineer.

12.49.2 The Contractor shall propose the project execution report format to the Engineer for his acceptance. This report shall be of narrative format and include but not limited to the methodology, site/activity records, instrumentation records/ assessment, illustrations, photographs, lesson learnt, etc.

12.49.3 Within 3 months after each BSC date, the Contractor shall submit a report for the completed works which shall include the highlights of all construction activities/traffic diversions and details of complex activities.

12.50 Completion of Works

12.50.1 Upon Completion of the whole of the Works or such other period that the Engineer shall instruct, the Contractor shall remove from the site his site offices, workshops, storage sheds and other temporary structures including temporary piles and temporary foundations and turf the areas where required.

12.50.2 The Contractor shall also reinstate, to the acceptance of the Engineer, any defect caused by him during the course of the Works. All costs incurred shall be borne by the Contractor.

12.51 Construction Quality Assessment

12.51.1 The Contractor shall note that the Authority would be assessing the construction quality at various stages of the project.

12.51.2 The Contractor shall provide necessary support and documentation for the assessment to be carried out successfully.