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9 DESIGN REQUIREMENTS

9.1 General

- 9.1.1 All design works shall be developed in compliance with the prevailing version of Authority's Requirements, including the Civil Design Criteria (CDC) for Road and Rail Transit Systems, Infrastructure Design Criteria (IDC), Materials and Workmanship Specification for Civil and Structural Works / Architectural Works, Geotechnical Interpretative Baseline Report, Civil Defence Technical Requirements, SS Eurocodes Suites and the National Annexes, prevailing codes, relevant Codes of Practices and Standards under the Building Control Act and Building Control Regulations, project specific guidelines and requirements from relevant authorities. The more stringent requirements shall take precedence and subject to the acceptance of the Engineer. The design of the civil and structural works shall comply with the current Building and Construction Authority's (BCA) Approved Document - Acceptable Solutions.
- 9.1.2 The Contractor shall note that all drawings shall be submitted in Singapore Height Datum (SHD) format. The Contractor shall make necessary conversion, if required, from Public Work Department (PWD) datum format to SHD format for all submissions. All necessary conversions are deemed to be included in Contract Price.
- 9.1.3 The Contractor shall engage his own competent architectural, civil and structural, electrical and mechanical consultants to be the Professional Engineer (PE) and/or Qualified Person (QP) to carry out the design of the Works. The appointed PE / QP shall hold a valid practicing certificate issued by the Professional Engineers Board, Singapore. The appointed QP (Architect) shall hold a valid practicing certificate issued by the Board of Architects, Singapore. The Contractor's design responsibilities shall include all the Specialist and Proprietary Trades as stipulated in the BCA regulations.
- 9.1.4 The Contractor shall design, implement, construct and complete all Permanent Works and Temporary Works required for the completion of the Project including but not limited to the ERSS wall systems, struts, walers, runner beams, bracings, kingposts, traffic diversion decking and the required support systems, traffic safety measures inclusive of collision barriers required, drainage systems, support systems for affected utilities, formwork, falsework, staging or scaffolding, construction access and decking, pedestrian overhead bridges/vehicular bridges, covered linkways and high covered linkways, ground treatments, and other ancillary structures that are required for the completion of the Works, and obtain the necessary statutory and agency approvals prior to commencement of the Works.

- 9.1.5 Design submissions to the Engineer shall be made as specified in the General Specification. The drawing content requirements given in the General Specification for each submission stage shall be modified as appropriate for the Works, to provide a broadly equivalent level of detail at each stage. The Contractor shall coordinate his design for the Works with the System-Wide Contractors (SWCs), Interfacing Contractors and the Authority's consultants. The Contractor shall produce all drawings necessary to properly describe the Works to be constructed.
- 9.1.6 The Contractor's proposal of architectural design shall be completed with civil, structural and building services works. The design proposal shall meet the architectural design requirement specified in **Clause 10** of the Particular Specification.
- 9.1.7 All hard copies of design and construction submissions, including correspondence shall be accompanied with soft copy files in the relevant format (MicroStation, PDF, Word, Excel, PowerPoint, Revit, etc) and comply with **Appendix I** of the General Specification. This applies to all submissions, including programmes, quality plans, method statements, safety submissions, etc. If documents or drawings are submitted by letter, they shall also be accompanied by soft copy files. Soft copy files of all presentation slides shall also be submitted.
- 9.1.8 The Contractor's architectural design proposal shall not lead to degradation of operations or reduction in level of comfort, convenience and security to passengers, and shall be subject to the Engineer's acceptance.
- 9.1.9 The Contractor shall take into account in his design, the presence of utilities / services and existing foundations that are in the path of the Works, any constraints or effects imposed by the existing works and services in the surrounding areas and works of other nearby contractors. The Contractor shall design the Works to avoid these utilities / services and existing foundations and make recommendations on protection where applicable. All protective works shall be deemed to be included in the Contract Price.
- 9.1.10 When analyzing and predicting the tunnel movements, the Contractor's consultant shall include all loadings from the trackwork, mass concrete toppings and equipment etc. loading cases to be considered in the design. Where necessary the Contractor shall propose mitigation measures to address the settlement.
- 9.1.11 The Contractor shall submit structural plans and calculations for the Works to the BCA and all other authorities for clearance and approval where required. The Contractor shall comply with all BCA requirements and the guidelines for submissions. Copies of the submitted structural plans and calculations shall be submitted to the Engineer for record as specified in the General Specification.

- 9.1.12 Notwithstanding provisions to the contrary, the Contractor shall be responsible for payment of all fees relating to the submission of the design to relevant authorities.
- 9.1.13 The design scope includes the design development of the Authority's reference design, preparation of preliminary, pre-final, final working, contract drawings (where required), shop drawings and as-built drawings, submission of design drawings / plans (including all amendments) for the Engineer's acceptance and shall include all consultations, coordination, securing all approvals from all relevant authorities, utilities agencies, etc., prior to commencement of the Works, continuing design changes and review during the construction phases, and design support for all construction-related issues during the maintenance period and where applicable.
- 9.1.14 All planning submissions and approvals from the relevant authorities shall be carried out by the Contractor.
- 9.1.15 The Contractor shall obtain the Permit to Commence Works from the relevant authorities/technical departments prior to any construction activities. A copy of the permit shall be forwarded to the Engineer for record.
- 9.1.16 All temporary and permanent E&M works under his scope shall be designed by the Contractor. The Contractor shall engage a PE and Licensed Electrical Worker (LEW) of appropriate grade for the design, supervision, testing and commissioning of the E&M works. The PE shall also sign the Certificate of Supervision for the E&M Works. The LEW shall carry out monthly inspection of key E&M system and equipment and submit endorsed inspection report.
- 9.1.17 In addition to all submission requirements, the Contractor shall provide drawings in the following stages:
- (a) Pre-Final Design Stage - 1 set of GFA Plans in pdf format;
 - (b) Final Design Stage - 1 set of GFA Plans in pdf format; and
 - (c) Alienation Stage - 1 set of QP (Architecture) endorsed GFA Plans in CAD format, hardcopy and scanned pdf copy.

For submission under stage (c), the Authority shall provide the proposed legal boundary of the station and any other related Facilities for the preparation of drawing(s). The submission shall include the following:

- (i) A complete set of Gross Floor area (GFA) drawings for the new station and related facilities in color. The information shall include the GFA breakdown, denoting whether it is commercial, transit, Civil Defence Facilities (SCDF), Civic & Community Institution Facilities (C&CI), etc. within the proposed legal boundary.

- (ii) These drawings shall be produced at 1:500 scale or any other scale as determined by the Authority.

- 9.1.18 The Contractor shall prepare Civil Design Safety Submission (CDSS), Civil Construction Safety Submission (Civil CNSS), Civil Handover Safety Submission (CHSS) and obtain endorsement from Project Safety Review (PSR) (Civil) as in **Appendix A** of the General Specification.
- 9.1.19 The Contractor shall implement BIM (Building Information Modelling) e-submission and obtain necessary approvals from relevant authorities. All BIM models shall also be submitted to the Engineer and shall comply with the BIM requirements outlined in **Clause 21** of the Particular Specification.
- 9.1.20 The Contractor shall note that all design and provision shall be catered for an 8-car train station for the ultimate year operations and 6-car train operations for opening year.
- 9.1.22 The Contractor shall make civil, structural, geotechnical and tunnel design presentation at Authority's Design Forum as and when requested by the Engineer. All time and costs due to compliance with Design Forum's requirement in order to resolve design issues shall be deemed to be included in the programme and Contract Price.

9.2 Track and Alignment

- 9.2.1 Alignment
 - 9.2.1.1 The track horizontal and vertical alignments at the contract boundaries are defined by the Authority's Drawings. The Contractor shall ensure that there is a continuous running chainage across the contract limits.
 - 9.2.1.2 The track alignment shown in the Authority's Drawings has been developed to meet operational criteria and to suit URA's development proposals for this area. The track alignment design shall be further developed by the Contractor to meet the requirements of the interfacing parties as their designs are finalised. Where necessary, the Contractor shall update the alignment design to fully comply with the latest revision of the Authority's Civil Design Criteria.
 - 9.2.1.3 The Contractor shall also ensure that his design does not occupy land area beyond the approved railway corridor unless absolutely necessary, and subject to relevant agencies' approval.
 - 9.2.1.4 The track alignment design shall be kept within the road reserve where possible, to minimise impact to adjacent development parcels.

- 9.2.1.5 The Contractor shall review the track alignment with respect to tunnel setting out and his own design and construction proposals, interface with SWCs and relevant parties (e.g. Rolling Stock, etc.), and confirm that there is no conflict with these proposals. The Contractor shall also ensure the track alignment takes precedence and to recommend any necessary revisions to the Engineer should there be any conflicts.
- 9.2.1.6 The maximum permissible train operating speed at all horizontal curves shall be reviewed by the Contractor and his design shall be revised accordingly subject to Engineer's acceptance.
- 9.2.1.7 The Contractor shall use rail track design software for the design of the railway alignment geometry. The version of the software used shall be accepted by the Engineer. CAD files of alignment drawings shall be delivered in CAD (.dgn) format and shall include alignment geometry design files (.alg). The software shall, as a minimum, be able to develop horizontal and vertical alignment design, surface analysis, template creation, automated turnout placement using library, cant calculation, and reports.
- 9.2.1.8 The track alignment layout design and turnout arrangement shall take into consideration of the Insulated Rail Joint (IRJ) requirements. Turnouts shall not be placed at structure movement joint or location of differential movement vertically or laterally. The standard types of turnouts and crossings shown in the Authority's Drawings shall be followed.
- 9.2.1.9 The Contractor shall ensure that all structural & architectural elements, platforms, staircases, columns, walls, fittings and equipment comply with the structure gauge and clearance requirements as stated in the Authority's Drawings with consideration of the appropriate vehicle throw effects.
- 9.2.1.10 The Contractor shall prepare Track Alignment Plan and Profile, Setting Out Details, Alignment Schematic drawing etc. according to Track Alignment Drawing Requirements, which will be provided upon Tender Award.
- 9.2.1.11 The Contractor shall submit a Track Alignment Design report that documents all the key issues, constraints, any interface identified and considered in the track alignment design. The report shall include appendices of a cant calculation table and a tabulated chronological record of the changes made to the track alignments design. The record of such changes shall incorporate the reason, design intent, design constraints and/or design consideration pertinent to the change.

- 9.2.1.12 The Contractor is permitted to propose modifications to the alignment to suit his construction proposals subject to the Engineer's acceptance, provided that it does not lead to the degradation of operation or passenger comfort. Any modification of the alignment shall be coordinated with the adjacent contracts and Authority so as to tie-in with their alignment.
- 9.2.1.13 The Contractor must demonstrate that the proposed modification complies with good design practice and the requirements of the LTA Civil Design Criteria, which shall be accepted by the Engineer. The track alignment design shall be based on SVY21 coordinate system and Singapore Height Datum (SHD).
- 9.2.1.14 Upon the acceptance of the pre-final track alignment design by the Engineer, the alignment design shall be 'frozen' and the Authority shall take over the custody of the alignment. Further changes to the accepted pre-final track alignment design shall be approved by the Authority. The Contractor shall continue their design responsibility to incorporate all revisions onto the alignment drawings and submit them in accordance to **Appendix I** of the General Specification (such as Final Design, Working and As-Built drawings). These track alignment drawings shall be used by all parties as the controlled copy.
- 9.2.1.15 The Contractor shall interface with the SWCs, including but not limited to Trackwork and Signalling Contractors, for the final cant value and permissible speed and incorporate these values in the as-built alignment drawings.
- 9.2.1.16 The Contractor shall submit track alignment as-built drawings to be reviewed and accepted by the Engineer before issuance to other parties.
- 9.2.2 Trackwork
 - 9.2.2.1 The Contractor shall comply with the requirements specified in Authority's CDC and Authority's Drawings for the interface between trackbed concrete and civil works.
 - 9.2.2.2 Sump pits located within trackbed area of station shall be placed along track centreline. Width of the sump pit opening (for any sumps within the trackbed at track centre line) shall be 590 millimetres or less at the trackbed concrete and civil works interface level as shown in Authority's Drawings.
 - 9.2.2.3 The finished level of station platform level shall be 1080 millimetres above the top of rail.
 - 9.2.2.4 The alignment design shall consider sufficient buffer stop occupancy distance required for an 8-car train. For track with gradient not more than 0.25%, the track occupancy distance measured from the buffer head to end of sliding shall be minimum 18 metres.

9.3 Civil & Structural (C&S)

9.3.1 General

9.3.1.1 The Contractor shall design the construction of the station using the “top-down” method.

9.3.1.2 The Contractor shall take into account in his design any site constraints, existing adjacent and nearby structures, as well as constraints or effects imposed by the existing works and services in the surrounding areas, and works of other contractors working nearby.

9.3.1.3 The Contractor shall be responsible for the design and erection of any construction decking and traffic diversion decking.

9.3.1.4 The Contractor shall use a minimum C32/40 concrete compressive strength class for the design and construction of CRL structures, other underground structures and superstructures/above ground structures.

9.3.1.5 The Contractor’s structural engineer shall liaise with his alignment engineer to ensure that all structural elements comply with the structure gauge clearance requirements including vehicle throw effects.

9.3.1.6 Waterproofing design shall comply with the specific requirements of SS EN 1992-1-1, LTA Civil Design Criteria and the Materials & Workmanship Specifications. The Contractor shall supply and install the waterproofing system for all required basement/trenches/pits/sumps below grade and any landscaping areas within the station. The Contractor shall submit method statements for the proposed waterproofing system to the Engineer for acceptance prior to the Work.

9.3.2 Post Installed Anchors and Reinforcement Connections in Concrete

9.3.2.1 Cast-in-anchors shall be used wherever possible. Post-installed anchors shall only be used with the acceptance of the Engineer. For both situations, the anchors shall be installed to meet the loading requirements which shall be coordinated with the relevant SWC. The Contractor shall appoint a PE to design and submit calculations in compliance with the guidelines set by **the anchor bolt manufacturer** to justify proposals made by him on the use of the anchor bolts.

9.3.2.2 The design, installation and test standards of the anchor bolts shall comply with the Authority’s Material and Workmanship (M&W) Specification for C&S Works and **Appendix D** of the Particular Specifications.

9.3.2.3 Post-installed anchors shall be of approved adhesive anchoring system coupled with stainless steel grade minimum A4-70 fully threaded rods to the Engineer’s acceptance.

- 9.3.2.4 The minimum edge distance from center of cast-in-anchor and post-installed anchor to the face of concrete edge shall comply with manufacturer's recommendation or equivalent to be **at least five (5) times the anchor diameter whichever is more onerous and within reinforcement cage.**
- 9.3.2.5 Appropriate detection devices shall be used to locate the existing steel reinforcements before carrying out any drilling of holes for anchor installation. Holes shall be drilled and cleaned in accordance with manufacturer's instructions. Anchors shall be installed in accordance with manufacturer's instruction and at not less than the minimum edge distance, spacing and embedment depth specified by the manufacturer.
- 9.3.2.6 The method used for calculating the anchor resistance is to be determined according to whether or not the anchor under consideration conforms to an ETAG (European Technical Approval Guideline). If it does, then the design method to be used shall be detailed in the ETAG. If the anchor does not conform to an ETAG, then the appropriate method shall be the one that is recommended by the manufacturer.
- 9.3.2.7 Post-installed reinforcement connections shall be designed in accordance with SS EN 1992-1-1 shall be in accordance with the requirements of EOTA (European Organization of Technical Approvals) Technical Report TR023 Assessment of post-installed reinforcement bar connections.
- 9.3.2.8 Adhesive anchor bolts shall not be used for ceiling mounted support unless otherwise accepted by the Engineer.
- 9.3.3 Piling
- 9.3.3.1 The Contractor shall refer to the CDC for Road and Rail Transit Systems, M&W Specification for C&S Works and BCA and follow the more onerous requirements for the extent of pile load tests. The setting out of load test arrangement shall subject to the acceptance of the Engineer and QP(S). The Contractor shall submit complete and interpreted PE endorsed reports of all load test results to the Engineer, AC and QP(S) for their acceptance.
- 9.3.3.2 All pile load tests involving Kentledge system shall be located at least one times the least width of the Kentledge footprint away from adjacent public access paths, roads or buildings. The Kentledge system with steel plates or other appropriate method of pile test may be proposed subject to Engineer's acceptance. The Contractor shall comply with relevant BCA / MOM guidelines.
- 9.3.3.3 All preliminary / ultimate test piles shall be installed within the footprints of the Station subject to the Engineer's acceptance. If they are located outside the footprints of the Station, the Contractor shall fully remove the preliminary/ultimate test piles.

- 9.3.3.4 Prior to the installation of any working pile, the Contractor shall carry out instrumented preliminary / ultimate pile load tests to verify design parameters. The extent of testing shall follow the requirements of the LTA's CDC for Road and Rail Transit Systems, M&W Specification for C&S Works and BCA. The Contractor shall submit a full report of the test results to the QP(S) and the Engineer for acceptance.
- 9.3.3.5 The piles selected for the instrumented load tests shall be carried out using the same plant and methodology that are to be used to construct non-instrumented working piles. The Contractor shall envisage that use of air lift for base cleaning of bored piles may be required for preliminary / ultimate test piles and working piles.
- 9.3.3.6 Each preliminary / ultimate pile load test shall be designed and interpreted on a predrill borehole undertaken in advance at the position of the ultimate pile load test. Existing nearby boreholes shall not be used.
- 9.3.3.7 Should any test have to be discontinued due to but not limited to the following:
- Faulty jack or gauge;
 - Instability of kentledge;
 - Improper setting of datum;
 - Instable benchmarks or scales;
 - Failure of pile instruments such as strain gauge; and
 - Pre-jacking or pre-loading before commencement of the tests.
- The test shall be abandoned, and the Contractor shall carry out new test with all associated time and costs deemed included in the Contract Price.
- 9.3.3.8 Dynamic Pile Testing (DPT) as specified in the Authority's CDC for bored piles/ micropile shall include CAPWAP analysis. The DPT and PDA tests shall be calibrated and correlate with any appropriate static load tests for the Engineer's acceptance prior to its application on working bored pile/ micropile.
- 9.3.3.9 Following review of the pile test results, the Contractor's QP(D) shall either reconfirm the existing pile designs or issue an appropriate revised design.

- 9.3.3.10 The Contractor shall make allowances in his programme for all pile tests including the design of the test piles, adding any additional reinforcement required based on the test load, all necessary instrumentations for the test including those within the test pile, the submission of test reports, the Engineer's review period and the time for issue of any revised foundation information. All associated costs incurred for the test pile including the above shall be borne by the Contractor.

- 9.3.3.11 The Contractor shall carry out pile penetration depth verification for each pile prior to casting, taking into consideration the soil strata encountered during boring, to ensure all piles installed satisfy the pile design capacity.

- 9.3.3.12 The Contractor shall submit to the Engineer all as-built details of bored piles / micropiles records including soil conditions encountered during boring plotted on A1 size drawings. The as-built drawings shall include the eccentricities of bored / micropile piles and shall be endorsed by the Contractor's Registered Surveyor.

- 9.3.3.13 The Contractor shall submit mitigation proposals for as-built piles that have exceeded the allowable eccentricities or deviations requiring re-design. The proposals shall be designed and endorsed by the Contractor's PE. All incurred mitigation proposals requiring review or design change to the permanent structures shall be administrated via Design Change Request process with no cost or time claim from the Contractor.

- 9.3.3.14 Within twenty-eight (28) days after completion of all bored pile/micropile works, the Contractor shall submit to the Engineer and BCA the records and as-built drawings of the bored pile / micropile works, showing the penetration length, the location and type of load tests.

- 9.3.3.15 Crosshole sonic logging (CSL) testing shall follow the requirements of the LTA M&W Specification for C&S Works. As a minimum, the ultrasonic profiles reported shall present both the First Arrival Time (FAT) and calculated Reduction in Energy (attenuation (dB) or relative energy) plotted relative to the reduced level of the deep foundation element. Both FAT and Reduction in Energy evaluation criteria shall be stated in the report. Interpretation must contain proper engineering judgement and experience and is to be made by an engineer with specialized experience in this field subject to the Engineer's acceptance. Filtering or smoothing of the processed results shall be kept to an absolute minimum and must also be presented in the report.

- 9.3.3.16 All pile test reports, including pile test interpretation reports, shall be endorsed by a PE and submitted to the Engineer for acceptance.

- 9.3.3.17 Where Ultimate Load Test are carried out on Bored Piles to represent Barrette Piles, a reduction factor shall be applied to the characteristic resistance, subjected to the Engineer and Accredited Checkers (AC) approval.

9.3.4 Tunnel Drainage

9.3.4.1 Drainage pumps shall be incorporated at the low point within the tunnels. The pump outlets shall be piped from the tunnels to the seepage water holding tank at ground level via the nearest station.

9.3.4.2 Seepage water holding tank(s) shall be designed to store seepage water and tunnel washing water accumulated over seven (7) days.

9.3.4.3 All seepage water and tunnel washing water collected at tunnel's sumps or station's sumps including other source of water indicated in the Authority's CDC are to be pumped to the seepage water holding tank.

9.3.4.4 Design of seepage water holding tank to be based on relevant clauses of the Authority's CDC for Road and Rail Transit Systems and M&W Specification for C&S Works.

9.3.4.5 A high water alarm monitoring system shall be designed to monitor the water level inside the seepage water holding tank using multi-level single probe. This would provide the railway operator with an alert system via ISCS when water level reaches the 'high water level alarm'.

9.3.4.6 A monitoring panel (for the high water alarm monitoring system mentioned in above clause) shall be located in a reinforced concrete closet at ground level and near to the access opening of the seepage water holding tank. A twin Switch Socket Outlets (SSO), shall be provided at the panel location, one for power supply to the monitoring panel and other for maintenance purposes. Interface Terminal Box (ITB) for interfacing with Integrated Supervisory Control System (ISCS) shall be located next to the monitoring panel.

9.3.4.7 The Contractor shall liaise with the Operator, relevant agencies and authorities on the location of the seepage water holding tank in his detailed design and submit to the Engineer for acceptance.

9.3.4.8 To shorten the operation time required for collection of seepage water, an external connection with quick coupler is to be provided with manhole cover that prevents rain water from seeping into the tank. A pipe to the bottom of the seepage water holding tank shall be provided and connected to the external connection. Vent pipe to be provided above ground level. Rain or surface run-off water shall not be allowed to flow into the tank from the access opening / vent pipe.

9.3.4.9 Water proofing membrane shall be provided to the external face seepage water holding tanks. Location of the seepage water holding tank shown in drawings is for reference only. Consultant shall liaise with the Engineer to finalise the location in the detailed design.

9.3.5 Falsework and Formwork Design

- 9.3.5.1 The Contractor shall engage a PE with relevant experience to prepare, endorse and certify the necessary calculations, details and drawings as required by Ministry of Manpower (MOM) Workplace Safety and Health (WSH) (Construction) Regulations for falsework and formwork structure as well as falsework/formwork structure for all wall/column concreting. The PE shall represent the Contractor in all technical matters including the submissions of all required designs and calculations to the Engineer before work commences on site and, where applicable, undertake submissions to all relevant authorities and ensure acceptance of the same for the design of these works. The PE shall ensure that all design and drawings are thoroughly checked and all calculations and drawings reflecting the checks have been completed.
- 9.3.5.2 The design of falsework and formwork shall be undertaken to SS 580 – Code of Practice for Formwork. The Contractor shall comply with minimum factor of safety / load safety factor of 2.0 stipulated in SS 580 for all falsework and formwork.
- 9.3.5.3 All falsework and formwork on site shall be erected according to the approved drawings. In compliance with MOM WSH (Construction) Regulations, the Contractor's PE shall inspect the erected falsework/formwork structure which is:
- (a) supporting a slab or beam to be cast that is greater than 300 millimetres thick;
 - (b) greater than 9 metres in height; or
 - (c) constructed in two (2) or more tiers.
- and provide a Certificate of Supervision of his inspection to the Engineer for record. The inspection shall be carried out prior to casting of any structures above those falsework / formwork.
- 9.3.5.4 The Contractor's PE shall design the bar chairs to ensure stability and safety allowing for all additional temporary loads due to workers and reinforcement placed on the installed reinforcement layers during the installation works and concreting. Bar chairs should only be welded to temporary bars incorporated to support the bar chairs. Welding onto permanent bars will not be permitted. The Contractor's PE shall inspect the bar chairs prior to loading from the reinforcement bars and submit the Certificate of Supervision to the Engineer for record.
- 9.3.5.5 All submissions shall be verified, confirmed and duly endorsed by the Contractor's PE. One (1) original and two (2) copies of the submissions and a CD ROM including editable and pdf version of the submission shall be submitted at least four (4) weeks prior to the date given on the construction programme for the commencement of the activity.

- 9.3.5.6 The Contractor shall not deviate from the accepted drawings without the prior acceptance of his PE and the Engineer.
- 9.3.5.7 The Contractor's PE shall inspect, certify and issue a "Permit to Load" for the completed formwork structure twice, once prior to reinforcement bar fabrication and once immediately before concreting work.
- 9.3.6 Earth Retaining or Stabilising Structure (ERSS) and Ground Improvement work
- 9.3.6.1 The ERSS schemes shown on Authority's drawings are reference schemes and have been developed to facilitate the construction of the works. The Contractor shall develop the full design and be fully responsible for the design, submissions and erection of all the work. The Contractor shall engage a PE to be responsible for the works.
- 9.3.6.2 Ground improvement works shall be designed and installed whenever required to limit movements, to ensure water-tightness of the ERSS and for the construction of other works.
- 9.3.6.3 All ground improvement works necessary for the construction and completion of the Works including the relevant testing and any related instrumentation and monitoring works to evaluate the ground improvement works shall be deemed to be included in the Contract Price.
- 9.3.6.4 The Contractor's attention is drawn to the reference design of Temporary Works scheme shown in the Authority's Drawings. The Contractor shall comply with the minimum requirements specified in this section to develop his own Temporary Works scheme and shall be responsible for the detailed design of the Temporary Works based on the given criteria. Any changes to this reference Temporary Works scheme resulting from compliance with BCA, statutory, relevant authorities and Authority's requirements shall be deemed included in the Contract Price.
- 9.3.6.5 The Authority's requirements of ERSS at CR16 station are:
- (a) Minimum wall thickness of ERSS wall Type 1 to be 1.5m as shown in the Authority's Drawing CR206-LTA---CR16-XX-G-TMP-DR-LPL-3011;
 - (b) Diaphragm wall for station and entrances ERSS (unless otherwise accepted by the Engineer);
 - (c) Construction Method except for launch shaft, shall be topdown;
 - (d) Where there is presence of rock, GIV or better, or SIII or better, above the FEL, the ERSS wall penetration shall be at least 2m below FEL;

- (e) Location, number and/or spacing of recharge wells as shown in Authority's Drawing CR206-LTA---CR16-XX-G-TMP-DR-LPL-3001 and **Clause 14.7.1** of the Particular Specification; and
 - (f) Contractor shall comply with requirements in PUB Code of Practice on Sewerage and Sanitary Works.
- 9.3.6.6 The structures including station box and subway shall be designed such that the structures will not settle beyond the allowable limits including limits for trackwork under the various load cases.
- 9.3.6.7 **Contiguous Bored Pile Wall or any other ERSS systems that are not watertight are not allowed.**
- 9.3.6.8 The Contractor shall not assume that Temporary Works Scheme including any minimum requirements has addressed all issues on building impact assessment. The Contractor shall design the ERSS and conduct his own building impact assessment on the adjacent structures due to his Temporary Works scheme to meet the requirements and submit to BCA and any other relevant authorities for approval.
- 9.3.6.9 In the impact assessment for the structures, buildings and utilities adjacent to the interfacing area with adjacent contractors, the Contractor shall take into consideration the settlement and movements induced by the adjacent contractors' works in his design of the ERSS and shall undertake all necessary liaison and coordination with the adjacent contractors. Any changes required to the design and construction resulting from such coordination shall be deemed included in the Contract Price.
- 9.3.6.10 The Contractor shall take into account in his design of any site constraints, existing adjacent and nearby structures, as well as constraints or effects imposed by the existing works and services in the surrounding areas, and works of other nearby contractors.
- 9.3.6.11 The Contractor shall **adopt a minimum preloading force of 15% of the design strut load.**
- 9.3.6.12 **No kingpost should be placed in the way of trainway, any Category A rooms and associated equipment delivery route.**
- 9.3.6.13 If the Engineer considers it necessary, he may instruct the Contractor to provide additional excavation supports at no cost and time implications to the Authority. Any such instruction shall not relieve the Contractor of sole responsibility for the adequacy of the support system.

- 9.3.6.14 All ground improvement works shall be proposed with adequate instrumentation and monitoring works for the acceptance of the Engineer. The Contractor shall refer to **Clause 14** of the Particular Specification for work scopes under the Authority appointed Instrumentation and Monitoring Specialist Contractor.
- 9.3.7 Internal Facing Skin Wall
 - 9.3.7.1 An internal facing skin wall for in-situ reinforced concrete is mandatory for diaphragm walls, secant bored pile and similar walls that are incorporated into the Permanent Works. Regardless whether composite action is assumed, the internal facing wall shall be designed for full hydrostatic pressure. The full thickness of the internal facing skin wall shall be of waterproofing concrete and be of minimum 300 millimetres thickness.
- 9.3.8 Glass Fibre Reinforced Polymer (GFRP) Soft Eyes
 - 9.3.8.1 The Contractor shall design and install his ERSS end walls at the end of the overrun tunnel with GFRP soft eyes to make provision for connection to the future development. The GFRP shall have a minimum tensile strength of 800MPa and designed to ACI 440 or equivalent.
- 9.3.9 Temporary Bridge and Temporary Deck Structures
 - 9.3.9.1 The Contractor is required to design, submit and obtain the necessary approval from BCA and all other relevant authorities for the temporary bridge and temporary deck structures inclusive of those required for temporary traffic diversion. The design and construction of the temporary bridge and temporary deck structures shall be of the standard of a permanent highway bridges structure complying with SS EN Suite of codes and subject to BCA's approval.
 - 9.3.9.2 The Contractor shall draw special attention to the requirements by BCA with regard to integration of temporary decking and ERSS and the staged Temporary Occupation Permit (TOP) requirements for commissioning of temporary traffic deckings.
 - 9.3.9.3 The design of temporary traffic diversion deckings shall take into consideration surrounding ground levels so as to minimize impact to adjacent properties.
- 9.3.10 Design of High Covered Linkway (HCL) Across Carriageway
 - 9.3.10.1 Collision actions shall be in accordance with CDC and BD51. Minimum height clearance measured from the highest level of carriageway shall not less than 5.7 metres. Collision forces on the superstructure applied shall be minimally 85kN, and to be applied as a point load on the superstructure in any direction between the horizontal and the vertical.

- 9.3.10.2 Vehicular restraint system of Normal Containment Level in accordance with TD19/06 shall be provided at the supports of the proposed HCL, as specified in BD51, **Clause 6.13**.
- 9.3.10.3 The high covered linkway should be of structural frame system using rigid moment connections, with cross-bracings and ties to ensure robustness and stability of the whole linkway. The cross-bracings and ties should be permanent and form part of architectural feature.
- 9.3.10.4 Three-dimensional frame effect shall be considered in the design with “pinned” supports to be constructed using at least four (4) numbers of bolts. The foundation should be optimised for the ease of construction, e.g consider the use of pad footing, and avoid utilities diversion.
- 9.3.10.5 Cross-bracings / ties should be provided at roof of HCL and between the two (2) columns at each side of the road. Rigid moment connections should be provided between the columns and the roof.
- 9.3.10.6 The construction shall maximise prefabrication in the factory with minimum welding and other manual work on site. The connection should preferably be bolted for on site assembly.

9.4 Building and Construction Authority (BCA) Environmental Sustainability Code and Green Mark (GM) Submission

- 9.4.1 The Contractor shall be the leader to coordinate and comply with requirements for meeting the Minimum Environmental Sustainability Standards under the latest Code for Environmental Sustainability of Buildings, Building Control (BC) (Environmental Sustainability) Regulations, together with his appointed QP & PEs.
- 9.4.2 The station is required to achieve GM Platinum certification based on the latest version of the BCA GM for Transit Stations.
- 9.4.3 **The Contractor shall engage a GM Accredited Professional** acceptable to the Engineer, with recognised degree in relevant field and at least five (5) years of relevant experience in the design of rail transit projects and conversant with BCA GM requirements.
- 9.4.4 The Contractor shall ensure that all design, GM features and documentation fully comply with the pre-requisite requirements and meet the necessary elective criteria to obtain the GM Platinum award.
- 9.4.5 The Contractor, together with his appointed QP & PEs, shall lead all BCA GM related submissions and be responsible for collating all the necessary GM documentations / evidences required during the Building Plan (BP) stage (for code compliance) as well as the certification and verification stage for GM Award.

- 9.4.6 All proposed design of the GM features shall be submitted to the Authority for review and acceptance. The Contractor shall take full responsibility for compliance to GM related criteria for design as well as all site-related actions and activities by the Contractor and his sub-contractors.
- 9.4.7 The Contractor shall make consultations with BCA where required to verify the scoring and requirements of the GM criteria. The Contract Price shall be deemed to have priced for GM Platinum compliance and all necessary submissions. Where practicable, additional points shall be obtained to maximize the GM score without additional cost to the Authority.
- 9.4.8 The Contractor shall interface with respective SWCs to ensure that the GM Platinum rating is achieved. The Contractor shall be responsible including but not limited to the following:
- (a) Prepare implementation plan GM site management requirements. Provide template to facilitate collation of documentation by contractors;
 - (b) Collate as-built drawings, catalogues, brochures, purchase orders, etc and review these in accordance to GM requirements;
 - (c) Where changes to design provisions are made, review and advice if the changes will affect committed GM scoring;
 - (d) Conduct GM Stage 1 Verification Audit and inspection upon project completion and coordinate with BCA officers on the TOP inspection date;
 - (e) Prepare the Project for Stage 2 Verification Audit whereby the building's ongoing energy consumption data is collated and computed to determine the building's energy savings (collation of energy data will be by operator);
 - (f) Conduct energy remodelling to demonstrate achievement of committed energy savings;
 - (g) In the event that energy optimization strategies are available, propose these strategies to the team for consideration; and
 - (h) Assist in clarifying any question raised by BCA during inspection.

9.5 Building and Construction Authority (BCA) Universal Design

- 9.5.1 The Contractor shall make necessary submissions and obtain award of BCA Universal Design Mark. The Contract Price shall be deemed to have priced for all necessary compliance and submissions.

9.6 Buildability Score

- 9.6.1 The Contractor shall ensure that his design and construction work achieve or **exceed the minimum buildability and constructability score as stipulated by BCA Code of Practice on Buildability**. The Contractor shall refer to **Appendix AI** of the Particular Specification for letter from BCA regarding list of productivity initiatives / technologies and bonus B-Score or C-Score granted applicable for this Contract.

9.7 Project Productivity Plan

- 9.7.1 A Productivity Gateway (PG) framework has been developed by Ministry of National Development (MND) / BCA for implementation of productive technologies and practices. Refer to **Clause 22** of Particular Specification for Project Productivity Plan (P3) requirements and specifications.

9.8 Design for Operation and Maintenance

- 9.8.1 The station design shall meet all maintenance strategy requirements. The Contractor shall formulate a maintenance strategy in coordination with all relevant parties and stakeholders; including SWCs, Public Transport Operators (PTOs), the Authority's E&M consultants and lighting consultants, to develop an integrated and holistic design that allows for ease of maintenance while complementing the station's architectural design.
- 9.8.2 The design and installation of all infrastructure assets shall be to the satisfaction of the Authority, PTOs and all relevant stakeholders/agencies.
- 9.8.3 The Contractor shall advise on the maintainability aspect of his design. The personnel who provide the advice shall have a minimum of five (5) years of relevant experience in rail maintenance and shall have an understanding of Singapore's Rapid Transit System (RTS) network and key challenges in maintenance faced by LTA and its RTS Operators. The personnel shall have experience working with an organisation in the rail infrastructure industry.
- 9.8.4 The designs shall take into consideration the maintainability during the service life of the infrastructure assets. The infrastructure assets shall be designed with consideration of the maintenance access to finishes, services, equipment, bearings etc., and shall ensure that regular maintenance can be carried out safely, easily and efficiently with minimal impact to operations. The designs, both short term and long term shall be optimal between cost, performance and risks.
- 9.8.5 The Contractor shall demonstrate that they have considered maintainability aspects in their design. The factors shall include but not limited to the following:

- (a) Safety – to mitigate safety related risks associated with the maintenance means and equipment (not the inherent safety risk of the infrastructure);
- (b) Simplicity – ease of maintenance and avoid or minimize requirement for specialised skill levels and/or tools;
- (c) Human factors and ergonomics – maintain productivity without compromising safety while minimizing physical demands placed on the maintenance crew;
- (d) Accessibility – provide safe access to ensure ease of maintenance;
- (e) Standardisation – minimize variation in design and maintenance procedures for efficiency;
- (f) Asset renewal and replacement strategy – sufficient space and provisions for future needs; and
- (g) Cost effectiveness – compare the relative costs and outcomes of different courses of design.

- 9.8.6 The Contractor shall ensure all systems and elements are physically accessible for cleaning, maintenance, repair and replacement.
- 9.8.7 The Contractor shall liaise and coordinate with Operator and Authority to design a suitable maintenance strategy for the station and obtain approval from Authority.
- 9.8.8 The Contractor shall engage a Contractor specializing in access to provide solutions for matters related to access at height and provide a maintenance strategy for all elements that require access for cleaning, servicing or replacement. The design for maintenance includes all necessary access, fixed platform, ladders, catwalks, Building Maintenance Units (BMUs) and other equipment required to facilitate delivery, storage, maintenance and asset replacement. Access for replacement and on-going maintenance shall be achieved by commonly available means. Customised or special cleaning / maintenance equipment shall be avoided. The design of the maintenance access routes and elements shall not detract from or interfere with the design intent.
- 9.8.9 The Contractor shall provide maintenance access for SWC, adjacent civil contractors, Authority's Consultants, Provisional Sum sub-contractors, Utility Agencies, statutory authorities, PTOs, interfacing contractors / parties where required.

- 9.8.10 The Contractor shall take into consideration ease of delivery, maintenance and asset replacement of M&E services and systems. The Contractor shall provide all necessary access, fixed platforms and ladders, mobile scaffolds, platform lifts and such equipment, etc. to facilitate the delivery, maintenance and asset replacement of all Plants and equipment.
- 9.8.11 All maintenance access routes and equipment shall be designed to comply with all Authority's technical requirements, statutory codes, regulations and guidelines.
- 9.8.12 All aspects of maintenance shall be sufficiently covered in the maintenance strategy report at each milestone submission and wherever relevant, included as supporting documentation in Design Acceptance Request (DAR) Submissions for acceptance by the Engineer. The Contractor shall provide an Operations and Maintenance Manual (OMM) to be submitted to the Engineer for acceptance prior to handover to the Operator and conduct trainings, in the form of demonstration on site to the Operator where applicable. A standard format has been defined in **Appendix AS** of the Particular Specification. The OMM should include relevant and specific written, diagrammatic and video information for the maintenance and replacement of station elements.
- 9.8.13 Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps. The manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. The binding shall allow for all subsequent changes and additions to be readily effected. The information provided in the manuals shall be comprehensive and adequate to accomplish the tasks and the scope of work stated. The maintenance manuals shall provide details of the various systems and sub-systems from a maintenance, safety and fault-finding standpoint, with particulars of operating parameters, safety isolation of equipment, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

- 9.8.14 It shall address both Preventive Maintenance and Corrective Maintenance requirements. The Preventive Maintenance includes all scheduled servicing actions performed to maintain the equipment in a specified condition. The Corrective Maintenance includes all unscheduled servicing actions performed, as a result of equipment failure, to restore the equipment to a specified condition. In order for the Engineer and the Operator to operate, maintain, reassemble and adjust all parts of the Works, the Contractor shall compile and submit to the Engineer, three (3) months before the Completion of Whole of the Works (CWW). The Contractor shall revise and update the OMM based on Operator comments for final acceptance by the Engineer. The Contractor shall provide clarifications and amendments to the OMM as necessary during the Defects Liability Period (DLP). Updates shall be provided for the originals and copies.
- 9.8.15 Strategies for maintenance shall be demonstrated in the report using appropriate drawings and illustrations. The report shall show how the design has taken into consideration of the access for regular maintenance for the station, including maintenance and cleaning of all surfaces, lighting and other fixtures. All accesses for maintenance shall meet Ministry of Manpower's (MOM) requirements for workplace safety. It shall also include the certification frequency for the proposed maintenance gantry / catwalk, type of certification required, estimated cost for certification fees, etc. The OMM shall also include life cycle cost for each equipment proposed, including the maintenance cost, registration/certification cost, inspection cost, replacement cost for all parts, etc. over its anticipated life span.
- 9.8.16 The report shall include recommendations for selection of finishes for floor, wall cladding panel, wall tiling and ceiling, taking into consideration of colour, shape, profile and texture of the finishes to minimise accumulation of dust and dirt.
- 9.8.17 All the surfaces and ceilings must be reachable for non-regular maintenance using approved systems by MOM to protect workers against the risks of falling from the heights.
- 9.8.18 Maintenance Strategy and Maintenance equipment shall be submitted to the Engineer for acceptance.
- 9.8.19 The maintenance strategy shall be presented in the form of reports and presentations which have to be comprehensively developed during design phase in coordination with all required parties, and submitted at Pre-final, Final and Updated Final stages for the acceptance of the Engineer.
- 9.8.20 The Contractor shall present the final design strategy, including access routes and equipment to the Engineer and obtain the Engineer's acceptance prior to the commencement of the Works.

9.8.21

The Contractor shall provide a maintenance strategy and access report to demonstrate how cleaning, maintenance (inspection, testing and repair) and replacement work can be carried out efficiently. Referring to the latest WSH Guidelines and SS 569 Code of Practice for Manual Handling, where an item cannot be handled by a single person, the designer shall propose and provide handling equipment/tools with appropriate mechanisms. This strategy shall be presented in a comprehensive report, which is to be submitted during key milestone (Concept Design, Preliminary Design, Pre-Final Design, Final Design and Final deliverables) and reflect all developments in the design / construction. The report shall include but not limited to the following:

- (a) specifying all Architectural, Structural, E&M and System items;
- (b) specifying maintenance requirements for all items;
- (c) specifying cleaning requirements for all items;
- (d) repair manual / method statements for all items;
- (e) the method statements to maintain and replace the systems, including specifying the access path and how maintenance access equipment can be maneuvered to the respective designated maintenance locations (if required);
- (f) periodical inspection requirement of the glazing system and methodology for replacement of broken glass and routine cleaning. The methodology shall be demonstrated during design stage and verified on site with a full mock-up at construction stage. For public area or where there is impact to operation, site-specific access and lifting equipment details shall be submitted for approval to demonstrate that glazing replacement can be achieved, including time frame required for mobilisation and demobilisation of such equipment, for all glass panels within four (4) engineering hours;
- (g) all equipment and tools necessary to achieve maintenance access. The storage space required to accommodate them within the facility shall be identified and designed for in the station layout. The storage space identified shall contain all necessary hooks, shelves, and services necessary to store the maintenance access equipment and tools;
- (h) safety equipment such as fall arrest systems and their O&M manuals;
- (i) details of all specialist tools required for the operation of access panels;
- (j) panels inspection including fixings and seepage etc;

- (k) Operations and Maintenance (O&M) manuals for motorised access equipment (if required);
- (l) safe access, launching methodology and O&M manuals for the fixed maintenance access equipment; and
- (m) demonstration of services and associated components replacement from the fixed maintenance access equipment.

9.8.22 The Contractor shall ensure compliance with BCA Design for Maintainability Guide: Non-Residential where applicable.

9.8.23 Where there is water seepage, the Contractor shall carry out the repair and grouting works and propose to the Engineer the provision of drip trays as temporary measure until the leaks are rectified. The Contractor shall maintain the drip tray throughout the period and reinstate the area upon its removal.

9.9 Discrepancies

9.9.1 The Contractor shall highlight any discrepancies in the Authority's Requirements to the Engineer. The Engineer has the sole discretion to determine the resolution of discrepancy.

9.10 Geotechnical Design Parameters

9.10.1 The Contractor shall comply with the Geotechnical Design Parameters given in the Geotechnical Interpretative Baseline Report (GIBR) as the minimum requirements for the purposes of his Temporary Works design.

9.10.2 For Permanent Works design, the Contractor shall comply with the Geotechnical Design Parameters given in LTA CDC or the minimum geotechnical design parameters given in the GIBR whichever are more onerous.

9.10.3 The Contractor must satisfy himself that these design parameters are applicable to his design methodology and to the ground conditions encountered. Additional site investigations must be carried out by the Contractor where necessary to fulfill his design responsibility; all costs and time associated with such additional site investigations are deemed included in the Contract Price.

9.11 Station Architecture

9.11.1 The Contractor shall refer to **Clause 10** of the Particular Specification for the design requirements and considerations for Architectural design.

- 9.11.2 The Contractor's QP (Architect) shall carry out detailed design in compliance with all statutory requirements and prevailing codes of practices. All changes in compliance with all statutory requirements shall be deemed included in the Contract Price.
- 9.11.3 The Contractor shall refer to **Clause 7** of the Particular Specification to provide adequate design provision / structural loading above the roof slab.
- 9.11.4 Floor levels shown in the Tender Drawings are for reference only. The Contractor shall ensure that the floor finishing thickness is coordinated and sufficient for all requirements for floor finishes, services, drainage channels, falls and gradient to drainage outlets and all other technical requirements.
- 9.11.5 The Contractor shall refer to the Authority's Design Criteria and drawings for the approximate sizes for M&E plantrooms. The Contractor shall take reference from the approximate sizes specified therein, further coordinate with the Authority's appointed M&E Consultant CR2007, the Authority's In-house Designers and SWCs to finalize the M&E room sizes and station layout and submit to the Engineer for acceptance.
- 9.11.6 The Architect shall liaise with the Contractor's alignment engineer to ensure that all architectural / structural elements (including but not limited to all fittings within station) comply with the structure gauge clearance requirements including vehicle throw effects, in accordance with **Clause 9.2.1.9** of the Particular Specification.
- 9.11.7 The Contractor shall note on specific design requirement for access hatches on BOH room at platform connecting to the underplatform cable chamber. The access hatch shall have minimum of 25% of perforation as specified in **Clause 7** of the Particular Specification. The Contractor shall coordinate and ensure the final access hatch details is approved by the M&E Consultant.
- 9.12 Design for Retail Shops and Advertising**
- 9.12.1 General
- 9.12.1.1 The Contractor shall work with all relevant parties to incorporate the commercial design requirements into their design and submit a Commercial Recommendation Report for the Engineer's acceptance.
- 9.12.2 Retail

9.12.2.1 The Contractor shall design for standard retail spaces of 115 square metres to be well-located and incorporated in the unpaid areas of the station with high visibility to the commuter flow to maximize commercial potential, taking into account guidelines from the Authority's Design Criteria for Advertising and Retail Provisions in Mass Rapid Transit (MRT) Stations. The Contractor shall seek the Authority's approval on the design of these retail spaces, including the locations, sub-division and supporting infrastructure for the retail spaces.

9.12.2.2 The Contractor shall consider the following factors in the design:

Factors for consideration	Elaboration
Location	<ul style="list-style-type: none"> • Retail shop shall be located where the footfall is reasonably high and constant. • Shopfront of spaces shall also be visible from circulation areas • Design and provision of shopfront shall comply to all Authority's, statutory and code requirements.
Configuration	<ul style="list-style-type: none"> • It shall be of regular shaped (i.e. square or rectangular). Shopfront shall be clear of structures. • The ideal shop dimension to be approximately of a ratio of 1 (shopfront): 2 (depth) OR 1 (shopfront): 2.5 (depth) • The dimension of the shopfront should minimally be 3 metres – 4 metres wide. The recommended shopfront width is minimally 3 metres for units less than 24 square metres. For units bigger than 24 square metres, the recommended shopfront is minimally 4 metres.

Factors for consideration	Elaboration
Flexibility for sub-division of retail space	<ul style="list-style-type: none"> • Individual retail shop units shall not exceed 100 square metres each. • Retail shop units designed for ≥ 24 square metres should incorporate some flexibility in provisions (e.g. M&E, shopfront, etc.) that allow the operator to sub-divide the retail spaces into smaller units to provide a wider variety of amenities for commuters. • The building services such as floor traps and water points shall be designed and provided based on the proposed sub-division of retail shops. • The Contractor shall coordinate with the Authority's appointed M&E consultant to incorporate all M&E requirements for the retail space into the design. • Each (sub-divided) unit shall be provided with fire-rated glass panels and doors, or fire-rated shutters with bypass door and security shutters, depending on the intended trade for the unit. • Depending on the configuration for each station's layout, each 115 square metres quantum should be able to sub-divide into 4 to 5 units. Designs for sub-divided shops can be planned using indicative partitions for an ideal area of around 24 square metres each, subject to constraints of spatial configurations. • Sub-meter closet shall be provided in close proximity to retail unit to house the utility sub-meters. In the event where the retail is sub-divided into smaller retail units, a common sub-meter closet shall be provided. Sub-meter closet shall occupy minimum footprint.

- 9.12.2.3 If there are incidental spaces created as a result of other design/construction considerations, the Contractor shall consider using these spaces as retail spaces over and above the standard 115 square metres retail spaces. Where applicable, the Contractor shall make provisions to support the recommended trade-mix for the incidental spaces, including but not limited to pop-up structures, sub-division of shops, floor traps etc. The Contractor shall refer to the Authority's Design Criteria for Advertising and Retail Provisions in Mass Rapid Transit (MRT) Stations for more detailed guidelines.

- 9.12.2.4 Retail spaces must be within the proposed station boundary, road reserve and RTS maintenance boundary. Where the proposed infrastructure (e.g. pop-up structures) required to support the retail spaces lie outside the above boundaries, the Contractor shall include such spaces in their submission plans to the Authority for regularization of railway area.
- 9.12.2.5 The Contractor is to plan for adequate service vehicle parking spaces for the retail spaces. The Contractor is to provide justifications and alternative solutions if their design is unable to provide adequate parking for service vehicles serving the retail spaces. The Contractor is to plan for adequate supporting infrastructure wherever possible (for example, fire and life safety provision, bin centre and refuse disposal, vehicle parking etc.) for the commercial component and integrate it into the overall station design.
- 9.12.3 Advertising
 - 9.12.3.1 The Contractor shall refer to the Authority's Design Criteria for Advertising and Retail Provisions in MRT Stations for the guidelines on advertising provisions, and to coordinate with Authority's appointed M&E Consultant on the M&E requirements for advertising.
 - 9.12.3.2 The Contractor shall work with the Authority's appointed M&E consultant to propose strategies and provide for the integration of the advertising provisions (e.g. electrical Switch Socket Outlets (SSO) and supporting structures for mounting of digital panels). The Contractor shall seek the Authority's approval on the number and locations of the SSO, such that advertising panels are placed at the optimal locations which have high footfall. The Contractor shall allow for advertising panels to be incorporated seamlessly with station finishes.
 - 9.12.3.3 The Contractor shall propose and submit for the Engineer's acceptance on the advertising locations, number of SSOs including all supporting structures and work with Authority's appointed M&E consultant to provide space provision for the approved numbers of SSOs dedicated for the sole purpose of advertising. The circuitry of SSO to be designed by Authority's appointed M&E consultant and supplied and installed by SWC. The Contractor shall ensure that the SSOs are concealed in the public areas. In the event that the SSOs cannot be concealed, the Contractor is to provide alternative solutions for the placement of these SSOs.
- 9.12.4 Commercial Recommendation Report
 - 9.12.4.1 The Contractor shall submit a Commercial Recommendation Report with the following as a minimum:

- (a) Layouts indicating the location of the retail spaces in the stations. Proposed provisions required for the retail spaces (e.g. any F&B provisions, floor traps and provisions for the sub-division of shops) based on the trade-mix recommended;
- (b) Identify any potential areas for temporary event spaces based on the Contractor's station design. The Contractor is not expected to make major changes to the station design (including fire safety provisions) in the identification of temporary event spaces in the station;
- (c) Identify locations for placement of advertising units (e.g. large and small format screens, digital panels, and stickers) and provide a breakdown of structural infrastructure and provisions required;
- (d) A proposal on the number of SSOs and their locations as well as other provisions (e.g. distribution boards) to be provided in the station based on the ridership of the station and/or commercial potential of the station. The SSOs circuitry shall be designed by Authority's appointed M&E Consultant and provided by SWC;
- (e) Impact on station design (e.g. shifting of rooms, additional pop-up structures) due to the proposed layout of retail spaces or SSOs or incidental spaces. The station's operation needs and compliance with all technical requirements shall not be compromised in the design proposals. Any of such impact on station design must be highlighted by Pre-Final design phase; and
- (f) A breakdown of infrastructure and provisions required to capitalize on digital data captured in the station.

9.12.4.2 The Contractor's architectural design report for station submitted at Preliminary, Pre-Final and Final shall incorporate the retail and advertising designs in accordance with the Commercial Recommendation Report as approved by the Authority.

9.12.4.3 All proposals done shall be in consideration of existing laws, regulatory requirements and Authority's requirements. Possible regulatory obstacles shall be flagged out in the reports and deliverables.

9.13 Landscaping and Planting

9.13.1 The Contractor shall engage a Landscape Consultant cum Arborist with five (5) years of experience in the relevant field, acceptable to the Engineer to carry out design development of the station landscaping as well as roadside planting along affected roads. The Landscape Consultant cum Arborist shall carry out all necessary liaison / coordination and submissions with NParks to obtain approval for all landscaping and planting works at the stations and affected roads.

9.13.2 The planting and landscaping design shall include but is not limited to all ground planting, above ground planting, roadside planting, station entrances planting, Pedestrian Overhead Bridge (POB), linkways, trellis along linkways, green roofs and other greening strategies at the stations as required by NParks.

9.13.3 The Contractor shall note that the following landscape strategy from NParks, which shall include but not limited to:

- (a) Planting strip - Ground planting surrounding 2 metres or 3 metres around station entrances and around all at-grade infrastructure; and
- (b) Vertical trellises (UV-resistant nylon) (Refer to Figure 9.1) shall be provided at each column bay of commuter facilities infrastructure, on all covered linkway between entrances and commuter infrastructure and first transport node (e.g. bus bay, taxi bay, PUDO etc.).



Figure 9.1 Example of Trellises

9.13.4 The Contractor shall design and supply and construct the entire irrigation system required in the station, station entrances, and commuter facilities. The Contractor shall obtain acceptance from the Engineer and NParks for his irrigation proposals prior to the commencement of site works.

9.13.5 In addition to the irrigation requirements, the Contractor shall provide minimally a tap (affixed with locking device to prevent unauthorised usage of water) for the use by the Operator at every station entrance.

9.13.6 The Contractor shall design, supply and construct maintenance access to the landscape planters to be accessed directly without passing through the station's paid or controlled staff areas.

9.13.7 The Contractor shall coordinate with the Operator, LTA Public Transport Security (PTS) and other relevant authorities to obtain their acceptance of the landscaping / Park Connector Network (PCN) design and associated works, maintenance strategy and/or routes and safety provisions.

9.13.8 The Contractor and their Landscape Consultant cum Arborist shall coordinate the landscaping to ensure that there is no conflict with the Video Surveillance System (VSS) coverage, and without loss of softscape unless otherwise agreed with the Engineer. The Contractor shall liaise with the VSS SWC, landscape design representatives, NParks and the Authority on the landscape design; all attendance, design development and presentations required to achieve consensus are deemed to be included in the Contract Price.

9.14 Park Connector Network (PCN), External and Station Landscaping

9.14.1 The Contractor shall supply and install the following:

- (a) Hardscape;
- (b) Street furniture;
- (c) Lighting and all related electrical works;
- (d) Signage;
- (e) All planters, including structure, planting media, waterproofing, drainage, bib-taps with supply pipework and irrigation systems; inclusive of associated irrigation equipment, sub-meters, planting in planters shall be by others; and
- (f) Any other works required for the completion and handing over to the relevant authorities.

9.14.2 The Contractor shall complete the preparation works for the planters with adequate time and notice for inspection and handover to NParks on the dates as directed by the Engineer.

9.14.3 The Contractor shall coordinate with NParks on the provision of design and detailing of all street furniture and associated works to be applied. The proposed design strategy and materials to be adopted shall be subjected to the relevant authorities' review and approval.

9.14.4 For any existing PCNs affected by the Works, the Contractor shall coordinate with NParks and all other relevant authorities / agencies for reinstatement and/or replacement of the affected PCN. For future PCN, the Contractor shall coordinate with relevant authorities and to provide attendance for their works.

9.14.5 The Contractor shall coordinate with NParks and all other relevant authorities on the timing of diversion, construction, details, specification and handover of the PCN and associated works:

- (a) The existing PCN shall remain in operation and will only be closed to public use when the temporary or new PCN has been completed and handed over to the relevant authorities. There shall be a PCN passable to the public at all times;
- (b) The PCN shall be constructed to receive maintenance vehicular loading of up to 20kN/m² and point loads from wheels;
- (c) The PCN and the station development area shall be graded to mitigate the changes in topographic levels without the use of retaining structures where practicable;
- (d) The Contractor shall coordinate with NParks and provide for all fittings and fixtures necessary to achieve a fully functioning PCN. Fittings and fixtures shall include lighting, rails and signage etc. where required by NParks; and
- (e) Lighting levels along the PCN shall be minimum of five (5) lux.

9.14.6 The Contractor shall refer to the NParks' Standard Details Drawings as an indication of the required details for the landscaping and associated works to be provided. The Contractor shall submit the final drawings to the authorities and Engineer for acceptance before commencement of the works.

9.15 Incidental Spaces

9.15.1 The Contractor shall ensure that the design of the station is optimised and to avoid creating unusable and leftover sealed spaces.

9.15.2 There are spaces which may arise incidentally due to method of construction of the station. There shall be no incidental spaces that are sealed without access for maintenance and provisions for drainage and services.

9.15.3 For such unavoidable incidental spaces, the Contractor shall design and install the following provisions as categorized under 5 Types in the following table.

Type of incidental space	Description of Space	Required Provisions
1A	Space under escalator with adequate headroom and with possibility for access	Provisions for space to be converted for use as a maintenance office: <ul style="list-style-type: none"> • Provide door access to space. • Provide waterproofing and screeding. • Provide E&M provisions necessary for space to be used as office, including lighting, ACMV. • Provide drywall enclosure for space. • Provide fire-rated board on underside of escalator.
1B	Big space at back-of-house with adequate headroom and possibility for access.	Provisions for space to be converted for use as a maintenance office: <ul style="list-style-type: none"> • Provide door access to space. • Provide waterproofing and screeding. • Provide E&M provisions necessary for space to be used as office, including lighting, ACMV. • Provide drywall enclosure for space. • Provide fire-rated board on underside of soffit.
2	Space behind wall cladding panels	<ul style="list-style-type: none"> • Provide steel sub-frame for wall cladding panels. No RC/block wall to be installed behind the wall cladding panels to enclose the space. • Provide maintenance access panel at regular intervals as per line-wide typical details.

Type of incidental space	Description of Space	Required Provisions
3A	Space below exit and/or firemen/exit staircases	<ul style="list-style-type: none"> No wall enclosure to space. Provide railing to enclose space.
3B	Leftover space at back-of-house	
3C	Space under escalator with inadequate headroom for use.	
4	Space under escalator on Platform level	<p>Where escalator closet panels are provided:</p> <ul style="list-style-type: none"> Provide access hatch for remaining space under escalators. Access hatch size and intervals to follow line-wide typical details. <p>Where there are no escalator closet panels below the escalators:</p> <ul style="list-style-type: none"> No wall enclosure to the space below the escalators. Railing shall be provided to enclose the space, with CCTV coverage.
5	Space under escalator and staircase where no access hatch/door can be provided.	<ul style="list-style-type: none"> To either construct a sloping slab to eliminate any gaps between escalator and slab; or To backfill using Liquefied Soil Stabilizer (LSS) or Lightweight Concrete (with waterproofing courses)

9.16 Civil Defence (CD) Design

- 9.16.1 The Contractor shall refer to **Clause 19** of the Particular Specification for the design requirements and considerations required for CD design.

9.17 Electromagnetic Compatibility (EMC)

- 9.17.1 The Contractor shall ensure supplied equipment shall not interfere electromagnetically with the nearby environment. This shall be achieved by the selection and coordinated application of current applicable EMC standards.
- 9.17.2 The Contractor shall review the station's layout design accordingly and recommend necessary measures to minimize electromagnetic interference by ensuring that sensitive electronic equipment rooms and high voltage equipment rooms are segregated the furthest possible distance.
- 9.17.3 Any EMC problem encountered during design, installation, on site testing and/or operation shall be brought to the attention of the Engineer. The Contractor shall propose and implement corrective actions to rectify all reported EMC problems.

9.18 Cycling path

- 9.18.1 The contractor shall refer to **Appendix AN** of the Particular Specification on the cycling path design requirements.
- 9.18.2 For those paths where the dimensions are not reflected in the drawings, the standard widths / dimensions according to the Authority's latest standards must be achieved

9.19 Master Planning Committee (MPC) and Regularisation of Railway Area

- 9.19.1 The Authority has obtained Final Planning Approval (FPA) from MPC and gazetted the railway area and road reserve.
- 9.19.2 The Contractor shall develop the detailed station footprint incorporating all requirements from the relevant authorities / agencies and determine the final railway area and road reserve. Any deviation of the railway area and road reserve as shown on the Authority's Drawings shall be regularized before the commencement of construction at the Contractor's own time and cost. The Contractor shall prepare all necessary submission plans and justifications to regularize the railway area. The plans shall be submitted to the Authority for the Authority's submission to obtain FPA from MPC. The Contractor shall take this into consideration in the construction programme if there are deviations of the railway area and road reserve as shown in the Authority's Drawings.

- 9.19.3 Wherever additional land is needed for the provision of road facilities, the Contractor shall conduct the FPA submission to revise the Road Reserve Lines and regularise the changes with the relevant authorities.
- 9.19.4 For any additional land needed for the provision of road facilities especially at SIM/SUSS boundary, the Contractor shall liaise with relevant stakeholders and agencies and make the FPA submission to regularise the changes with the relevant authorities NOT later than May 2024.
- 9.20 Interfacing with Future Developments**
- 9.20.1 The details of the interfaces that are required for the Works are identified in **Clause 7 of the Particular Specification.**
- 9.21 Submission of Approval In Principle (AIP) Documents and Review Procedures**
- 9.21.1 The Contractor shall coordinate and discuss with the Engineer and the AC in developing the AIP documents in accordance with the guideline as attached in **Appendix N** of the Particular Specification. The Contractor shall submit the AIP documents one (1) month after award of Contract for acceptance by the Engineer and the AC. The Contractor shall be responsible to ensure that his design complies with the accepted AIP documents.
- 9.21.2 The Contractor's QP(D) shall meet the Engineer to discuss comments raised. Within ten (10) calendar days after this meeting, the Contractor's QP shall deliver to the Engineer a copy of the minutes of meeting agreed by both parties responding to all comments raised. These review periods shall be shown on the Contractor's baseline programme.
- 9.21.3 The Contractor's QP shall coordinate with the AC or the Authority, as directed by the Engineer, to endorse the AIP Design and Check Certificates, and submit to the Engineer at each stage (preliminary, pre-final and final) of the design submission. The Contractor shall ensure that design information such as the design drawings of each design stage are issued to the AC or the Authority, as directed by the Engineer, as soon as they are available such that the AIP Design and Check Certificates are submitted to the Engineer no later than four (4) weeks from the design submission dates as indicated in **Appendix B** of the Particular Specification. The Contractor shall submit response to AC's comments within four (4) weeks after receipt of the comments.

- 9.21.4 Changes to an agreed AIP to account for subsequent variations during design or execution render the AIP subject to re-acceptance and agreement by the Engineer and the AC. This must be confirmed either in the form of an amended version of the agreed AIP or as a separate addendum to the agreed AIP. Submissions must clearly indicate deletions or additions that have been made to the agreed AIP, must be signed by the QP(D) and forwarded with supporting information to the Engineer and the AC for acceptance.
- 9.21.5 The agreement of the AIP or acceptance of the Design and Check Certificates by the Engineer and AC does not relieve the Contractor and/or his QP(D) of their responsibilities including the validity and arithmetical correctness of the calculations, methods and techniques and their translations into design details and drawings.
- 9.21.6 Separate AIP documents shall be submitted for the following structures but not be limited to the following:
- (a) Stations, including entrances and associated structures;
 - (b) Extension/widening of existing box culverts, including impact structural assessment on existing structure (if required);
 - (c) RC culverts, drains and sumps;
 - (d) Retaining structures and/or slopes; and
 - (e) Bus shelters and associated structures, affected facilities due to the implementation of First and Last Mile (FLM) including covered linkways, footpaths and cycling paths; high covered linkways, incidental shelter and rest area.

9.22 Road Works & Other Civil Works

- 9.22.1 Traffic Diversion Scheme(s) and General Road Works

- 9.22.1.1 The traffic diversion scheme(s) shown in the Drawing are for reference and for the Contractor's reference only. The Contractor with his appointed PE and Traffic Consultant shall design, implement, operate and maintain the detail of the traffic diversion scheme(s) in accordance with the requirements of the latest LTA's Code of Practice for Traffic Control at Work Zone and LTA Civil Design Criteria after he has obtained the necessary approvals from the Authority according to the requirements specified in this clause. In particular, the Contractor shall provide all signage (including supports and foundations) and road markings in accordance with the details and locations shown on the Authority's Drawings and as specified in LTA M&W Specification. All signage and road markings to be implemented in accordance to Standard Details of Road Elements (SDRE). 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. The PE and Traffic Consultant engaged by the Contractor shall have the following qualifications:
- (a) they 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; and
 - (b) they shall have at least five (5) years' experience in road design or traffic management and conversant with the latest international best practices, latest LTA's CDC, SDRE and Code of Practice for Traffic Control at Work Zone.
- 9.22.1.2 The Contractor's appointed PE and Traffic Consultant shall carry out the traffic impact assessment and design detailed traffic diversion schemes which are workable for the proposed construction method and sequence and in compliance with latest LTA's Code of Practice for Traffic Control at Work Zone, Road Safety Guidebook for Temporary Road Works for LTA Projects, LTA's Design Criteria and SDRE to suit the latest traffic conditions. The traffic impact assessment 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 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 Authority at the inception stage.

- 9.22.1.3 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.
- 9.22.1.4 The Contractor's appointed PE and Traffic Consultant shall design the traffic diversion scheme(s) in accordance with the Authority's Requirements. The Contractor shall take note that the existing roads shall remain in full operation during construction.
- 9.22.1.5 The Contractor shall take note that more complicated diversion proposal which require Transport Impact Assessment (TIA) will require more time for evaluation of at least six (6) months. The Contractor's appointed PE and Traffic Consultant shall submit the detailed traffic diversion schemes with endorsement of qualified PE and Traffic Consultant to the Authority at least eighteen (18) weeks prior to the date of implementation. Subsequent amendment(s) shall be required until the Authority accepts and approves the traffic diversion schemes. The Contractor shall make the required amendments at his own cost to obtain the approval. No diversion scheme can be implemented unless endorsement on the relevant updated traffic diversion scheme has been obtained from the Authority.
- 9.22.1.6 After the traffic diversion scheme(s) is implemented, the Contractor's appointed Traffic Consultant shall conduct a post-implementation inspection on the diversion works to ensure compliance with the traffic diversion schemes approved by the Authority. The Contractor shall also highlight any need for modification of existing traffic diversion schemes to improve safety, traffic efficiency, and accessibility.
- 9.22.1.7 Unless indicated otherwise on the Authority's temporary traffic scheme, all temporary traffic diversion schemes proposed shall be submitted in proper scaled colour printed engineering drawings. The drawings should be designed according to LTA standard colour code for traffic diversion scheme. The design of the temporary traffic diversion shall cater for the number of traffic lanes shown on the Authority's Drawings, with proper and appropriate road related facilities, including pedestrian walkways, footpaths, cycling paths, crossing facilities, traffic lights, traffic signs, all road furniture, road markings, etc. Such drawings shall include and not be limited to the following to-scale details:
- (a) Traffic Layout Plans (such as details of road markings, traffic signs, diversion signs, traffic signals, traffic signal phasing/stage diagram, access to existing developments footpath, pedestrian crossing, bus / taxi stops, shelters, bays, footpaths, cycling paths, park connectors, on-road cycling lanes and other road related facilities);
 - (b) Key plan showing proposed location of diversion scheme(s);
 - (c) Road name and legend;

- (d) Traffic control plan which shows the geometric design (such as radius of curves, lane width, super-elevation, approximate locations of work site accesses, flare rate for safety barrier and taper ratio of the transition zone);
- (e) Longitudinal and cross section details;
- (f) Safety provisions (such as type-approved safety barriers);
- (g) Tree affected plans / Landscaping plans;
- (h) Street lighting plans;
- (i) Cycling path and shared path plans;
- (j) Drainage plans for effective removal of surface runoff on carriageway during wet weather;
- (k) Blow-up (at scale of 1:500) for signalised junctions and any other identified area and swept-path analysis of vehicles movement if required by the Authority; and
- (l) An advanced traffic signing strategy - a wider ranging strategy that will inform drivers of the Works and associated local traffic management on critical routes of the wider road network (if the relevant content is not included in above item (a)).

9.22.1.8 All detailed temporary traffic diversion schemes shall provide one-to-one functional replacement of all affected traffic lanes, turning facilities, footpath, cycling path, pedestrian crossing, bus stop, commuter facilities and other road related facilities unless otherwise approved by the Authority. All alternatives for the above facilities shall be provided prior to dismantling of any such facilities. The temporary paths shall be provided with minimally 2.5m wide clear width when the overall cycling path network has been implemented at upstream / downstream of the paths. Alternative pedestrian crossing facilities shall be provided prior to the dismantling of existing facilities. In the event of any proposed lane reduction, changes to traffic signal phases, reduction of storage lanes, removal of bus bays, relocation of accesses, skewed junction, road closures or changes in any connectivity, the Consultant shall carry out Transport Impact Assessment to show the impact. Any improvement works required to maintain traffic efficiency/safety at affected junction and nearby junctions as a result of the diversion should be catered for. A checklist shall also be endorsed and submitted by Contractor's Traffic Consultant together with the traffic diversion scheme(s) and will be used as a guide in preparing the scheme.

- 9.22.1.9 In the event that the Contractor fails to adhere the requirement of one-to-one replacement the Engineer reserves the right to request the Contractor to conduct the Transport Impact Assessment (TIA). TIA is required to verify the impact on the surrounding road network and ensure that the transport infrastructure and facilities within the study area is served safely and efficiently by the transport and pedestrian facilities. The Contractor shall also submit the TIA report to the Engineer for acceptance. Subsequent amendment(s) shall be required until the Engineer accepts the TIA report. The Contractor shall refer to the Authority's TIA guidelines which are stated in the "Publication on Street Works Proposal relating to Development Works" (available for purchase from the Authority) for general guidance as and when applicable on methodology and assumptions on basic parameters to be used in the traffic assessment and on the requirements for TIA report. The scope of works for the TIA and format of the report shall be agreed upon with the Authority at the inception stage of the study. The Authority reserves the right to request improvement of the design as result of the TIA.
- 9.22.1.10 At present, Maju camp is provided with a traffic junction at Maju Dr/ Clementi Rd to facilitate right turn into/ from Maju Dr for its vehicles and this shall be maintained at all times during construction unless an acceptable alternative arrangement agreeable to MINDEF/ DSTA, and relevant LTA divisions is proposed by the Contractor and accepted by the Authority. An envisaged provision of exit at new Brookvale Drive from Maju camp is shown in Authority's Drawings for reference and the Contractor may propose to develop further details for acceptance. If this scheme is not feasible and/or not acceptable to concerned parties, the Contractor may need to explore and develop further the existing entry/ exit provision to PIE at Maju camp to ensure Maju camp's long trailer's vehicles' exit into Clementi Ave 6 and to enter Maju camp via PIE smoothly and safely. All works related to this including regularisation of Road Reserve line, obtaining approvals from relevant government agencies, felling of trees, addition of "merging lane" etc shall be the Contractor's responsibility and the Contractor deemed to have included cost and necessary time in his tender submission. .
- 9.22.1.11 The Contractor shall establish the boundary of the study area. This shall include the existing conditions such as ingress / egress to / from carparks, buildings, bus stops, pedestrian crossing facilities, parking, loading and unloading. The study area shall be discussed and agreed with the Authority at the inception stage.
- 9.22.1.12 Construction of a new road (Brookvale Dr), a new road junction at Brookvale Dr/ Clementi Rd and other associated road works are being planned and implemented by Ki development and planned to be completed in 2Q2024. The Contractor is to liaise with Ki development/ its consultants/ Contractor upon contract award for the possession of work area required for construction works.

- 9.22.1.13 The Contractor shall carry out all necessary collection of traffic data/counts / travel time / video recording as required by the Authority. All costs associated with traffic data / counts / travel time / video recording shall be deemed included in the Contract Price.
- 9.22.1.14 The Contractor is required to study the adequacy of the pedestrian crossing, holding area for pedestrians before crossing and other facilities during each phase of the traffic diversions. The primary objectives of the pedestrian study are to assess the efficiency of the pedestrian walkways and crossings and to recommend the required provision for the pedestrian facilities.
- 9.22.1.15 In the event that car parks are affected by the proposed scheme, the Contractor shall study and propose a suitable location for replacement of the affected car park. The number of replacement car park lots shall be at least the same as the number of affected car park lots. The Contractor shall liaise with the car park operator and ensure replacement facilities are provided to the satisfaction of the Engineer and the car park operator.
- 9.22.1.16 Upon acceptance of the TIA, the Contractor shall implement the proposed mitigation measures for the temporary traffic diversion scheme / traffic control plan and to further review with the Authority if the mitigation measures are to be included and implemented for the final reinstatement traffic scheme. All cost associated with the design and provision of the traffic mitigation measures shall be deemed included in the Contract Price.
- 9.22.1.17 The scheme shall consider and include all safety provisions such as safety barriers along the entire diversion, vehicular impact guardrail at all curves less than 150 metres radius, pedestrian railing along areas where the difference in levels are more than 1 metre, etc. The scheme shall be in accordance to the latest LTA's CDC, SDRE and Code of Practice for Traffic Control at Work Zone.
- 9.22.1.18 Where temporary work is carried out on expressway including slip road or any roads with speed limits of 70kph and above, the Contractor shall provide impact attenuator to the requirements as specified in the Code of Practice for Traffic Control at Work Zone. The impact attenuator shall be spaced behind the work crew or works vehicle as specified. The spacing shall remain constant as the work crew progresses down the roadway.
- 9.22.1.19 The Contractor is to provide flagmen, approved signs and signaling equipment as may be necessary, day and night, to control the traffic to the satisfaction of the Engineer. In the planning and execution of any Temporary or Permanent Works which may affect the traffic flow and/or access to site or other properties, the Contractor shall cooperate closely with the Engineer.

- 9.22.1.20 No equipment shall be parked within any traffic lanes, medians or within public right of way at any time of the day or night, including public holidays and weekends without an approved lane or road closure permit from the relevant authorities. The Contractor shall give the Engineer advance notification of fourteen (14) days for any lane closures and a minimum of thirty (30) days for any road closure.
- 9.22.1.21 Whenever required by the Engineer, the Contractor shall remove with due compliance and at his own expense any plant, machinery, staging and other materials which may interfere with traffic and the use of roads, footpaths or open space on the site or adjacent thereto.
- 9.22.1.22 The Contractor is solely responsible for the protection and maintenance of existing signs and traffic control facilities that are affected by the Works. The Contractor shall make an inventory of all existing signs prior to the start of the Works. Existing traffic signs and traffic control facilities within the limits of the Works shall not be moved except when necessary to prevent them from being damaged by the construction operation, or as directed in writing by the Engineer. When a traffic sign or traffic control facility has to be moved because it interferes with the construction work, it shall be done only with the written permission of the relevant traffic authorities and the Engineer. The Contractor shall also be responsible for the reinstatement of the affected traffic signs and traffic control facilities to the satisfaction of the Engineer and the relevant traffic authorities.
- 9.22.1.23 The Contractor shall schedule all deliveries of materials and plant outside peak traffic hours in order to minimize disruption and congestion caused on public road.
- 9.22.2 Permanent Road Scheme
 - 9.22.2.1 The permanent road scheme(s) shown in the Authority's Drawings are indicative and for the Contractor's reference only. The Contractor shall further develop these drawings for the Authority's approval. The Contractor, with his appointed PE and Traffic Consultant, shall provide the necessary resources to design the detailed traffic plans for road instatement in accordance to LTA's CDC and SDRE, and improve the permanent road design as advised by the Authority. The required details shall include any required road furniture, signages, markings and traffic phasing that are not shown in the Drawing.

- 9.22.2.2 The Contractor shall provide the necessary resources for junction traffic study (also known as a TIA) as advised by Authority's Traffic Schemes Design Development (TSDD) Division. These shall include analysis of the traffic demand and the required lane and queue capacity and traffic phasing. The scope of study shall be specified by TSDD Division and is not limited to the junction(s) indicated in the Authority's Drawings. Upon acceptance of the TIA, the Contractor shall implement the proposed mitigation measures. The cost associated with the design and provision of the traffic mitigation measures shall be deemed to be included in the Contract Price. The design of the proposed road shall cater for the number of traffic lanes shown in the Authority's Drawings with proper and appropriate road related facilities, including pedestrian walkways, footpaths, cycling paths, crossing facilities, traffic lights, traffic signs, all road furniture, road markings, etc.
- 9.22.2.3 Traffic signals, traffic phasing, road markings, signs and road geometry at proposed / modified signalised junctions are to have the right turn movements fully controlled (e.g. through Red-Amber-Green Arrow signals) unless specified otherwise. Swept-path analyses at all junctions will also be required for submission. The Contractor shall provide the necessary resources to design, fabricate, install and demolish all affected and required temporary and permanent traffic signs including their foundations, including directional, cantilever directional and gantry signs, and ensure they are adequately catered for. The Contractor shall note that there may be works required outside his contract boundary.
- 9.22.2.4 The Contractor may make modifications to the road design to suit his construction, with the road alignment generally following that shown in the drawings. The Contractor shall take into account in his design any constraints or effects imposed by the existing works and services in the surrounding areas, as well as works of other nearby contractors.
- 9.22.2.5 The Authority's Drawings do not specify details of the structures or identify spaces, which might be required for ancillary equipment. These shall be developed by the Contractor in his coordination with the Interfacing Contractors (if any) as part of his detailed design.
- 9.22.2.6 The Contractors' road design (including traffic markings, signage, roadside drainage, footpath, etc.) shall comply with the prevailing requirements given in LTA's CDC and SDRE. Any deviations shall be explained, with proposed mitigation/compensating measures. The permanent road shall be within the approved Road Reserve Lines.
- 9.22.2.7 The Contractor shall, in his road design, consider the levels of the connecting roads and ensure that the Works is kept within the road reserve line. The Contractor shall liaise with the relevant authorities for the confirmation of the platform levels.

- 9.22.2.8 The at-grade road works shall include all connecting roads and slip roads, retaining structures, drains, culverts and other road related facilities.

- 9.22.2.9 The design of the at-grade road system shall cater for the number of traffic lanes and all turning movement connections to existing roads and comply with the Authority's Requirements.

- 9.22.2.10 The permanent road pavement for the at-grade road system shall be of Type 1 pavement. At the approaches to signalised junctions and pedestrian crossings at slip roads for the permanent road, rigid pavement shall be provided in accordance to the LTA CDC and the latest version of the SDRE.

- 9.22.2.11 The design of the at-grade road system shall also incorporate earth retaining structures at locations where there is a difference in ground levels. The Contractor shall design the retaining structure(s) in accordance with the LTA CDC and all other relevant codes and submit to BCA and all other relevant authorities for approval.

- 9.22.2.12 The Contractor shall carry out Project Safety Review (PSR) in accordance with **Appendix D** of the General Specification. The Contractor shall interface and coordinate with the Independent Road Safety Review (IRSR) Consultant, who will be appointed by the Authority to carry out independent safety review of the Contractor's PSR (Roads) submission for traffic diversions and permanent road works. The Contractor shall allow in his programme sufficient time for review by the Authority's IRSR Consultant.

- 9.22.2.13 The Contractor shall coordinate their proposed diversion schemes with all known events being organised within the general vicinity of the Works at the time of award of the Contract. The Contractor shall ensure that the diversion schemes minimise any adverse impacts on those planned events and the associated traffic management.

- 9.22.2.14 The Contractor shall develop stakeholder engagement plans and liaise with stakeholders impacted by traffic diversion prior to implementation of diversion schemes. Events which become known to the Contractor after the award of the Contract shall be accommodated as is reasonably practicable. Reasonable adjustments to the diversion schemes shall be implemented subject to the acceptance by the Engineer at no additional cost. The Contractor shall also note that he may not be able to carry out works for the period of time in order to facilitate preparation, execution and clearance for the events.

- 9.22.2.15 The Contractor shall note that passengers on public buses are charged based on distance fare. Any road diversion or relocation of bus stops affecting public bus services 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 order to minimize the impact to passengers' fares.
- 9.22.2.16 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.
- 9.22.2.17 The Contractor shall coordinate with LTA Bus Planning Division for provision of bus lane for the reinstatement of roads.
- 9.22.2.18 The bus lanes shall be subject to confirmation by the Authority during the permanent reinstatement plan review and approval.
- 9.22.2.19 The Contractor shall ensure that the proposed bus lane take into consideration of the existing site conditions of the road. These would include the details indicated in the SDRE.
- 9.22.2.20 The Contractor shall note that for the implementation of bus stops, a minimum of eight (8) weeks' lead time is required. There shall be only two (2) common dates for the implementation (i.e. on the 2nd and 4th Sunday of each month), subjected to the confirmation of BOPS Division. The Contractor shall provide the GPS coordinates and any other information required by relevant LTA divisions (e.g. BOPS Division, Bus Information System Division (BIS)).
- 9.22.2.21 The Contractor shall consult BOPS Division on road diversions that affect bus stops and bus routes at least eight (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 his own cost and ensure that the proposed road diversion allows the buses to ply safely and smoothly.
- 9.22.2.22 All bus stops, regardless temporary or permanent, are to be designed and constructed in accordance to the Architectural Checklist and SDRE.
- 9.22.2.23 For any road works affecting bus stops and bus routes, the Contractor is required to consult BOPS Division at least two (2) weeks in advance. Information such as traffic control plan and locality map are to be submitted for consultation. For works at bus stops that may require the bus stop to be relocated temporarily, the Contractor shall consult BOPS Division at least eight (8) weeks in advance for inputs and seek approval.

- 9.22.2.24 The Contractor is to ensure that bus stops that will be implemented (i.e. relocation or reinstatement) are constructed and ready for inspection at least one (1) week before implementation.
- 9.22.2.25 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.
- 9.22.2.26 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 (TA&P) Division. The Contractor shall inform LTA Traffic, Street and Commuter Facilities Lighting Division (TSCF) of any relocation of traffic light poles or modification to existing traffic light phasing by submitting the endorsed traffic diversion plan to TSCF.
- (a) For works involving traffic light poles only, at least six (6) weeks prior to implementation of traffic diversion; and
 - (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 four (4) months in advance.
- 9.22.2.27 The LTA TSCF 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.
- 9.22.2.28 Before submitting their traffic lights 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.
- 9.22.2.29 The Contractor shall liaise with the relevant parties and shall install all necessary services required for the operation of the relocated signaling equipment.
- 9.22.2.30 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) 3.6 millimeters thick, 100 millimeters diameter Galvanised Iron (Class A) (GI) conduit pipes. Cables shall be laid in these iron pipes, complying with BS 1387: 1985 (BS EN 10255:2004) 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 200 millimeters above the pipes for all trenches dug regardless of the depth to mark their positions. The plastic cable slabs shall be 300 millimeters x 1000 millimeters 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 50 millimeters 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.

9.22.2.31 For application of SP Services Ltd and SingTel for any new traffic light installation or relocation of existing signal controller, the Contractor shall make direct payment to SP Services Ltd and SingTel. The Contractor shall coordinate with SP PowerGrid (SPPG), 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. The Contractor shall be liable for any damage done the existing cables, traffic controller boxes, traffic poles, etc., and to repair and/or replace at his time and costs.

9.22.2.32 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 fourteen (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.

9.22.2.33 All traffic light poles shall have minimum of at least 1 meter 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 meter for one column of signal aspect and 1.3 meters for two columns of signal aspects such as Red-Amber-Green (RAG) so as to allow for sufficient lateral clearance.

- 9.22.2.34 In the event of any traffic light cables being damaged by any contractors or sub-contractors, no one is allowed to rectify / reconnect the damaged cables except the term contractor that is engaged by LTA TSCF. The Contractor shall inform Intelligent Transport Systems Operations (ITSO) Control Room hotline immediately (Tel. 6332 6945) for any damages.
- 9.22.2.35 The Contractor shall inform LTA TSCF at least seven (7) days in advance to re-install any detector loops in advance before the final reinstatement works. Any detector loops that TSCF/Traffic Light Facility deemed fit to install (due to feedbacks or whatsoever) during the diversions shall be at the discretion of Traffic Light Facility. The Contractor shall inform LTA TSCF for any detector loops affected by traffic diversion or trenching works carried out by a utility agency.
- 9.22.2.36 The Contractor shall comply with the Authority's Requirements for diversion of all traffic lights and street lighting. All costs associated with such diversions shall be borne by the Contractor.
- 9.22.2.37 Other Ancillary Works
- (a) The Contractor shall provide design services and obtain all necessary approvals for other structural items defined in the scope of Works, such as constructing covered linkways and bus shelters, if any. The Contractor shall obtain TOP for both temporary and permanent bus shelters and linkways, if any, before opening to the public. As these structures would be utilized before the station obtains TOP, these structures shall have BP Nos. that are independent of the station;
 - (b) The Contractor shall supply and lay 75 millimetre thick (consolidated thickness) asphalt hot-mix wearing course including spraying of tack coat on concrete surfaces before laying and subsequent lane markings to the Authority's Requirements, to the temporary decking and approach slabs; and
 - (c) The Contractor shall also construct rigid pavement in accordance with the latest version of the SDRE.
- 9.22.2.38 Unless otherwise stated, the Contractor shall not design retaining structures with slope cutting beyond the proposed road reserve line.
- 9.22.2.39 The Contractor shall comply with the Code of Practice for Works on Public Streets. In particular, the locations of utilities manholes / valve chambers etc. shall follow, but not limited to, the following requirements:
- (a) Affected manhole / valve chamber covers to be designed to withstand vehicular loading;
 - (b) Use of anti-skid heavy duty manhole / valve chamber covers with locking device (e.g. equivalent type used at F1 race circuit);

- (c) Measures to mitigate possible differential settlement around the manhole / valve chamber area; and
- (d) Locate the manhole / valve chamber covers away from the vehicle wheel path, whenever possible.

9.22.3 Signs

- 9.22.3.1 The Contractor shall prepare traffic plans for endorsement, provide all signage (including supports and foundations) and road markings and as specified in LTA M&W Specification. Thermoplastic materials shall be used for all road markings. Old lane markings shall be fully ground off / burnt off to the satisfaction of the Engineer.
- 9.22.3.2 The Contractor shall provide additional signs, if deemed necessary, in his design, as instructed by the Engineer and/or Independent Safety Reviewer . The cost of all such additional signs is deemed included in the Contract Price.
- 9.22.3.3 All utilities on site shall be marked with proper signage as accepted by the Engineer.
- 9.22.3.4 The Contractor shall note that the details of supports for road signs are shown on the latest version of the SDRE. The Contractor shall be responsible to design any modification and amendments to all frames, supports, anchorages, footings, connections etc. to the road signs where necessary and shall submit them for the Engineer's acceptance.
- 9.22.3.5 The Contractor shall submit his proposal to the LTA Traffic Design & Management (TDM) Division for approval and to the Engineer for acceptance before any installation of the signs on site.

9.22.4 Drainage System

- 9.22.4.1 The Contractor shall design a complete drainage system to cater for surface water runoff from roadworks and surrounding areas including area of Clementi Forest that is not affected by the Contractor's Works but will contribute in the drainage flow/ design computations. The Contractor shall design the drainage system in accordance with the PUB's requirements. The proposed drainage scheme shall be properly linked to existing drains as necessary. The sizes, levels and alignments of the detention tank, drains, sumps, culverts, etc. shall be submitted to the PUB for approval and to the Engineer for acceptance.
- 9.22.4.2 The minimum size of the drains and culverts are as shown in the Authority's Drawings. The Contractor is required to further develop this drainage scheme in coordination and consideration of the adjacent developments. Subsequently, the scheme shall be submitted to PUB, other relevant authorities and the Engineer for acceptance.

- 9.22.4.3 For the proposed 3.5m box drain that is as shown as skirting around Entrance 1 and then discharged into Clementi Forest main stream in the Authority Drawings, the Contractor shall further study feasible option(s) to realign the drain within the road reserve so as not to constrain future residential development potential when Clementi Forest is redeveloped. The Contractor shall finalize the drainage proposal and seek URA, PUB and other relevant agencies' clearances and Authority
- 9.22.4.4 All costs associated with the necessary submission, design, provision, construction and compliance with relevant authorities' requirements shall be deemed to be included in the Contract Price.
- 9.22.4.5 Where vehicular loadings are expected (e.g. maintenance vehicle parking bay / access), the covered drains shall be designed to accommodate vehicle loads.
- 9.22.4.6 The Contractor shall note that the entire length of all box culverts within / partially within the road reserve shall be designed for full vehicular loadings.
- 9.22.4.7 Where the proposed drain runs outside Road reserve, it shall be regulated by Drainage Reserve as per PUB's COP and the Contractor is to liaise with PUB and other relevant agencies to finalise details to their acceptance and to provide assistance to Authority for regularisation. The Contractor shall be responsible for necessary defects liability period and handing over to relevant agencies.
- 9.22.5 Tree Planting, Reinstatement and Landscaping
 - 9.22.5.1 The Contractor shall carry out survey and identification of all existing trees in the vicinity of the Works, including trees that will be affected by the Works, and submit it to NParks for approval and to the Engineer for acceptance.
 - 9.22.5.2 The Contractor shall design a complete tree planting, reinstatement and landscaping proposal for all affected areas by the Works with necessary inputs from arborist.
 - 9.22.5.3 The tree planting and reinstatement plans shown in the Authority's Drawings are for reference only. The Contractor shall also reinstate areas where the trees were removed, and the areas were turfed but trees not planted back by the advance utility diversion contractors. The Contractor is required to further develop the plans in coordination with NParks. Subsequently, the scheme shall be submitted to NParks, other relevant authorities and the Engineer for acceptance.
 - 9.22.5.4 All costs associated with the necessary submission, design, provision, planting and compliance with relevant authorities' requirements shall be deemed to be included in the Contract Price.

- 9.22.5.5 The Contractor shall note that general tree planting and landscaping works will be carried out by NParks, except within land not managed by NParks. The Contractor shall coordinate and allow access to NParks for carrying out the landscaping works within the Contract boundary.
- 9.22.5.6 The Contractor shall backfill all areas within the road and tunnel reserve with approved earth and, notwithstanding any other provision, shall close turf open areas in accordance with the LTA M&W Specification. The Contractor shall ensure that the turfed area is graded to fall in accordance with the LTA M&W Specification.
- 9.22.5.7 The Contractor shall provide trenches with the required width and depth to comply with NParks' requirements. NParks will fill the trenches with approved soil mix (ASM) and carry out the tree planting. Close turfing shall be carried out by the Contractor.
- 9.22.5.8 The Contractor shall allow in his design at least 2 meters of soil cover and an additional load of 25kPa to accommodate planting for all locations. This includes locations of limited cover such that additional soil and planting can be placed above the works at a later date.

9.23 Future Road Raising

- 9.23.1 Where required, the Contractor shall make load allowances for future road and land raising works.
- 9.23.2 The Contractor shall reinstate all road furniture affected by the road and land raising works to match the final levels of the respective areas to the satisfaction of the Engineer.
- 9.23.3 At all locations where existing road levels are less than +3.5 metres SHD, reinstated road levels shall be of raised to be minimum +3.5 metres SHD, except where necessary to match existing roads. All CRL structures shall be designed to accommodate future road raising up to +3.5 metres SHD, and all relevant designs are to comply with the Authorities' Requirements.
- 9.23.4 The Contractor shall also take note that the reinstatement works for the roads may affect the adjacent private properties' facilities, such as driveways, guard house, bin centre, substation, boundary walls, fencing, access gates (manual or auto), including foundation supports, landscaping, utilities, etc, and shall be fully reinstated to ensure that the facilities continue to serve its intended function and purpose.

9.24 At-Grade Roadworks

- 9.24.1 The Contractor shall note that at-grade roadworks include all connecting roads and ramps, retaining structures, drains, culverts and other road related facilities required to connect to the tunnel structures, ramp structures and existing roads.

- 9.24.2 The traffic schemes provided in the Authority's Drawings are for reference only. The number of lanes shown in the Authority's Drawings (including all slip roads and turning provisions at junctions) is a minimum requirement. The Contractor shall develop the design and obtain all necessary approvals.
- 9.24.3 The Contractor shall provide appropriate road related facilities, including pedestrian walkways, crossing facilities, traffic lights, traffic signs, all road furniture, road markings, etc.
- 9.24.4 The design of earth retaining systems shall take into account roadside drainage. The Contractor shall also ensure that the retained height is to the soffit of any drain where excavation to the soffit of said drain would impact the retaining system.

9.25 Street Light for At-Grade Roads

- 9.25.1 Provision of public lighting posts with foundation, lamps, cabling and mounting, including commissioning of service of all public lighting, permanent or for the temporary diversion of traffic is included in the Contractor's scope of Works. The Contractor shall provide and make available all the necessary mounting facilities, cabling-duct crossings, connection points and opening for all the above. The Contractor shall engage and coordinate with SPPG and/or the Authority's term contractor for underground power cable installation and street lighting, for the above installations.
- 9.25.2 The Contractor shall also provide lamp post seatings (including grouting) in his design.
- 9.25.3 Street lighting on private roads leading to Authority's facilities and buildings shall be designed, supplied and installed by the Contractor. The design shall be submitted to the Engineer for acceptance and obtain approval / clearance from relevant authorities.
- 9.25.4 The terms and conditions for street lighting works at at-grade roads are included in **Appendix AO** of the Particular Specification.

9.26 Traffic Lights and Public Lighting Facilities

- 9.26.1 The Contractor shall note that there are existing traffic lights and public lighting posts and related facilities which may be affected by the Works.
- 9.26.2 The Contractor shall note that the new permanent street lightings have to be installed with LED light equipped with 7-pins NEMA (National Electrical Manufacturers Associated). Should the existing street lightings have been converted to LED light, the temporary street lightings should also be of LED light with the same colour temperature.

9.26.3 The Contractor shall engage TA&P Division, Road Asset Management Division and ITSO Division of LTA respectively on any works relating to traffic lights and public lighting facilities, including the relocation of existing traffic lights and public lighting facilities affected by temporary diversion works, and installation of new traffic lights and public lighting facilities for the traffic schemes. The Contractor shall note that it takes at least seven (7) months from the date of the written notice to construct and commission new traffic lights and public lighting facilities or to modify existing ones, and to disconnect and remove affected traffic and public lighting facilities from the existing site. The Contractor shall make allowance for this in his work programme and all costs associated with the works shall be deemed to be included in the Contract.

9.26.4 The Contractor shall provide uPVC pipe conduits with draw wire and uPVC cable warning slab, foundations, mounting facilities, cabling ducts crossing, connection points or openings for the temporary and permanent public lighting, traffic lights and flashing beacons for zebra crossings, for both temporary and permanent traffic schemes in accordance with the Authority's Requirements.

9.27 Roadside Features and Street Furniture

9.27.1 The Contractor shall prepare a coordinated site plan to a scale of 1:500 of all street furniture, including the following features where applicable: -

- (a) Road edge;
- (b) Drain;
- (c) Scupper drain and drop inlet chamber;
- (d) Lamp pole;
- (e) Vehicular impact guardrail;
- (f) New and existing trees;
- (g) Directional signs and road traffic signs;
- (h) Bridge parapets;
- (i) OG boxes; and
- (j) Any other raised roadside features on the sidetable.

9.27.2 The Contractor shall also prepare detailed traffic layout plans to a scale of 1:200 showing setting out details of all lane markings, chevrons, traffic islands, arrows, signage locations and the like for the acceptance of the Engineer.

- 9.27.3 The Contractor shall submit one (1) original and two (2) sets of paper print of the plans with CD(ROM) with editable and pdf version of the files and the CAD files in Microstation format (.dgn) in CD media to the Engineer before construction or installation of any of these roadside features or street furniture.
- 9.28 Foundations for Entrance Variable Message Sign (EVMS) / Arterial Variable Message Sign (AVMS) / Traffic Information Display Sign (TIDS) / Barrier (BA) / Traffic Signal (TS) Structures and Equipment**
- 9.28.1 Where applicable, the Contractor shall design and construct all the necessary foundations for the EVMS / AVMS / TIDS / BA / TS structures including the associated ducting for signal and power cable connection to the E&M Systems. The foundations can be designed as independent structures or integrated with other LTA structures within the road reserve.
- 9.28.2 The provision of EVMS / AVMS / TID structures, cabling and mounting, including commissioning of service of all EVMS / AVMS / TIDS / BA / TS equipment shall be by others. The Contractor shall provide all necessary assistance and attendance to the supplier of the EVMS / AVMS / TIDS / BA / TS equipment.
- 9.28.3 The foundations for the EVMS / AVMS / TIDS / BA / TS structures shall include cast-in pipes for the ingress and egress of cables to the EVMS / AVMS / TIDS / BA / TS equipment on the structures.
- 9.28.4 The Contractor shall provide galvanised iron (GI) pipes with draw wire for cables crossing the roads where required.
- 9.28.5 The Contractor shall coordinate with the Authority on the location and setting out for the structures for the EVMS / AVMS / TIDS / BA / TS / LUS / CCTV / AID / LBS, etc. equipment and other associated equipment and take into account in the Contractor's street furniture design and static signs.
- 9.28.6 The design of the foundation shall include permanent, variable and accidental actions.
- 9.28.7 For design of the foundation, the variable and accidental actions on the sub structure shall comply with BD51 and/or Eurocodes. Accidental actions of 85kN shall be applied on the superstructure of portal and cantilever gantries with outreach over any carriageway with clear height less than 5.7 metres.

- 9.28.8 The foundation for the EVMS / AVMS / TIDS structures shall be designed to a minimum axial load of 600kN and a bending moment of 3200kNm, unless confirmation is given by SWCs and the Engineer that foundation can be designed to a less loading. The foundation for the BA / TS structures shall be designed to a minimum axial load of 10kN and a bending moment of 100kNm, unless confirmation is given by SWCs and the Engineer that foundation can be designed to a less loading.
- 9.28.9 The Contractor shall liaise with the SWCs to get the latest equipment and structures information, design the foundations and submit the design and calculations to the Engineer for acceptance.
- 9.28.10 Location of foundation for EVMS / AVMS / TIDS / BA / TS shall be agreed with the SWCs and the Engineer, together with the setting out information with other street furniture such as road edge, directional signs and road traffic signs, new and existing trees, footbridge, bus stops, etc.
- 9.28.11 The Contractor shall design and construct maintenance access, where any street furniture is mounted on a viaduct i.e electronic gantry sign, Electronic Road Pricing (ERP), etc.

9.29 Requirements for Crash Cushion (Crash Attenuator)

- 9.29.1 Where applicable, crash cushions shall meet the requirements of National Cooperative Highway Research Programme (NCHRP) Report 350, Test level 3 for the locations and shall have passed all tests set out in the NCHRP Report 350 for a re-directive, non-gating crash cushion.
- 9.29.2 Crash cushions shall be able to control the deceleration of impacting vehicles by dissipating the vehicle's kinetic energy. When struck from the front, the unit shall bring the errant vehicle to a safe and controlled stop. When impacted from the side, the unit shall redirect the errant vehicle away from the downstream hazard.
- 9.29.3 Crash cushions shall be suitable for use in the climatic conditions in Singapore. The elements of the crash cushion shall not be damaged or deteriorate due to high temperature and/or prolonged exposure to direct sunlight.
- 9.29.4 Prior to the installation of the crash cushion, the Contractor shall inspect the proposed sites of the crash cushions and submit a shop drawing, which depicts the proposed modification and/or adjustment if any, to be made to the existing site to the Engineer for acceptance.
- 9.29.5 The Contractor shall submit a certificate issued by the relevant authority to prove that the crash cushion meets the requirements set out by NCHRP Report 350-Test Level 3.

- 9.29.6 All materials shall be supplied and delivered new and shall be accepted by the Engineer prior to the full completion of its installation.
- 9.29.7 The Contractor shall provide a drawing depicting the complete elements of the crash cushion including cross sectional details. Each item shall be indicated and named and tabulated on the drawings.
- 9.29.8 The Contractor shall note that if existing hazards such as lamp posts and concrete walls behind the crash cushions are not fully protected, they shall be protected by vehicular impact guardrails. The Contractor shall allow all such costs in the Contract Price.
- 9.29.9 In the event that vehicular impact guardrails are used, they should be anchored to existing concrete parapet wall following the appropriate details in the SDRE.
- 9.29.10 The Contractor shall submit his proposed design of the crash cushions on the gore areas.
- 9.29.11 The Contractor shall note that temporary crash cushions are required to meet the Authority's Requirements for the temporary road diversions carried out by him to permit the construction of the Works.

9.30 Requirements for Culvert Structures

- 9.30.1 The Contractor shall ensure that any culvert structures included in the Works complies with the requirements of this clause, the LTA CDC, M&W Specification and any other relevant specifications and Authorities' Requirements.
- 9.30.2 Where the Contractor is making provisions for a culvert structures (future structure) to be constructed by others, he shall demonstrate to the satisfaction of the Engineer that the future structure can be reasonably completed in accordance with these requirements using design concepts and construction techniques that are established within Singapore.

9.31 Other Design Requirements

- 9.31.1 General Requirements
 - 9.31.1.1 The Contractor shall note that any site plans, cross-sections, longitudinal sections and drawings provided for the existing structures etc. as shown on the Authority's Drawings are for reference only and not for measurement nor reliance for design purposes.
 - 9.31.1.2 Any structural schemes shown on the Authority's Drawings are for reference only. The Contractor shall develop the design that complies with the Authority's Requirements and are subject to the acceptance of the Engineer.

- 9.31.1.3 The Contractor shall ensure that there is a minimum clearance of 4650mm above the Top of Rail (TOR) for the trainway clear height, subject to further coordination with SWC.
- 9.31.1.4 The Contractor shall ensure fixing of linkway roof panels is designed by a PE and meets the below requirements:
- a. Maximum screw spacing - 300mm c/c
 - b. Maximum rafter spacing - 2m c/c
 - c. Screws used to fix roofing to have an ultimate pull out capacity of 4.0kN
- 9.31.1.5 The Contractor shall take into account in his design, the presence of utilities / services and existing foundations that are in the path of the works, any constraints or effects imposed by the existing works and services in the surrounding areas and works of other nearby contractors. He shall design the works to avoid these utilities / services and existing foundations and make recommendations on protection where applicable. All protective works shall be deemed to be included in the Contract Price.
- 9.31.1.6 The Contractor shall comply with the following requirements for his proposed structural scheme:
- (a) All structures required for new construction, widening, upgrading or alteration of existing structures shall be within the road reserve;
 - (b) All road facilities such as footpath, drainage, signage etc. affected by the Works shall be designed to be reinstated within the road reserve as shown in the Authority's Drawings;
 - (c) Headroom over at-grade carriageways for both temporary and permanent pedestrian overhead bridges shall not be less than 5.7 metres;
 - (d) All proposed structures overcrossing park connectors and drains shall provide minimum headroom of 2.4 metres;
 - (e) All proposed retaining structures shall be located at least 300 millimetres away from the drains; and
 - (f) Existing traffic layout shall not be affected permanently by the proposed design.
- 9.31.2 Drainage and PUB requirements
- 9.31.2.1 The Contractor shall obtain PUB's approval for any works that impact on the flow and drainage capacities.

- 9.31.2.2 The Contractor shall study the drainage systems of any existing structures which are affected by the Works and, if required, re-construct the affected structures in accordance with the requirement of the Engineer, PUB and any other relevant authority.
- 9.31.2.3 The Contractor shall consider the platform levels of the connecting roads and ensure that the road works are kept within the road reserve line. The Contractor shall liaise with the relevant authorities for the confirmation of the platform levels.
- 9.31.2.4 The Contractor shall design and construct a complete drainage system for run-off from vehicular bridges to the receiving drainage network (roadside drains, culverts, sumps and manholes, etc.) at the ground level. The design shall minimize impact on the flows and capacities of the drainage network system at the ground level and the Contractor shall obtain written approvals from PUB, LTA and other relevant agencies prior installation. All costs associated with the necessary submissions, design, construction and compliance with relevant authorities' requirements shall be deemed to be included in the Contract Price.
- 9.31.2.5 The capacity of the drainage systems shall be designed to comply with PUB's requirements and the Code of Practice. The Contractor shall obtain approvals from the relevant authorities on the proposed drainage systems and shall submit all relevant calculations endorsed by his PE to PUB and the Engineer for acceptance.
- 9.31.2.6 Any structures within waterways (including abutment, foundation and earth retaining structures) shall be designed for the effect of scouring and erosion caused by hydrodynamic forces. Specifically, the toe-in depth of the earth retaining structures shall consider the effect of scouring and erosion and shall be a minimum of 1 metre below the canal bed. Suitable protection to the structure and foundation against scouring and erosion shall be provided. The Contractor shall obtain necessary hydraulic information from the relevant agencies to facilitate his assessment of scouring and erosion.
- 9.31.3 Minor Sewer and PUB requirements
- 9.31.3.1 The Contractor shall design and construct a complete minor sewer system from the last inspection chamber to DTSS link sewer manhole including manholes MH-A, MH-B and sewer pipes in between them indicated in the Authority's drawings.

- 9.31.3.2 The capacity and flow of the sewer system shall be designed to comply with PUB's requirements and the Code of Practice. The Contractor shall obtain approvals from the relevant authorities on the proposed sewer systems and shall submit all relevant calculations endorsed by his PE to PUB and the Engineer for acceptance. The Contractor shall obtain approvals from PUB and other relevant agencies for any works that impact on the flow and capacities. All costs associated with the necessary submissions, design, construction and compliance with relevant authorities' requirements shall be deemed to be included in the Contract Price.
- 9.31.3.3 The Contractor shall liaise with PUB, relevant agencies and all interfacing Contractors on the levels, coordinates of manholes etc to provide all interfacing requirements for the connection of the proposed sewer system to DTSS link sewer manhole.
- 9.31.3.4 The Contractor shall liaise and work with PUB and relevant agencies to handover the sewer network from MHA onwards to MH4A for their maintenance after the completion of construction.
- 9.31.3.5 The Contractor shall note that the sewer scheme, piping, gradient requirements and location of last inspection chamber shown in the Authority's drawings are for reference. It is deemed included that the Contractor shall be responsible to coordinate and develop the full minor sewer system design based on the latest requirements of relevant authorities and agencies throughout the Contract Period to guarantee the performance of the system.
- 9.31.4 Construction Methodology and Temporary Works
 - 9.31.4.1 The Contractor shall take into account the construction method/sequence of new structures, strengthening or modification of existing structures and widening and extension of existing structures and at grade carriageway when planning for the temporary works. The Contractor shall follow the construction sequence as indicated in the approved construction drawings and no deviation is allowed unless accepted by the Engineer and approved by QP(D), QP(S) and any other relevant authority.
 - 9.31.4.2 The Contractor shall assess the ground condition and site constraints to develop an acceptable construction methodology to minimise impact on traffic, adjacent structures / developments, utilities and services, and existing infrastructures.
 - 9.31.4.3 The Contractor shall note that no temporary falsework shall be erected on or protrude onto the existing roadway, including the centre median on the carriageways. During construction stage, the headroom over existing at-grade carriageways shall not be less than 5.7 metres to the temporary works.

- 9.31.4.4 The Contractor shall note that the construction sequence shall take into account of constraints posed by any on-going contracts on site.
- 9.31.5 Key Security Requirements for MRT Stations
- 9.31.5.1 CR16 Maju station shall be designed as interchange (future) station and correspondingly comply with all relevant security requirements and standards by Ministry of Home Affairs (MHA)/ Centre for Protective Security (CPS) and also as stipulated in Particular Specification Appendix AE.
- 9.31.5.2 The design parameters/ requirements stipulated in Particular Specification Appendix AE were adopted in the submission to and obtain approval from MHA/ CPS. Approved Security by Design (SBD) reports will be furnished to successful tenderer for and information and reference.
- 9.31.5.3 The structural requirements stipulated in SBD reports shall be for reference only and be considered as minimum provision. The contractor shall comply with all structural design requirements including security requirements and any change(s) to information and/or details provided in SBD reports shall require the Contractor to engage his own qualified Security & Blast (S&B) consultants to carry out design, submission and to obtain approval from MHA/CPS and Authority before commencement of any works. The Contractor shall deem to have allowed time and cost in this regard.
- 9.31.5.4 If the Contractor proposes major changes to viz a viz structural layout, column configuration and/ or member sizes of key structural members from the approved SBD reports, it may involve the Contractor to resubmit and obtain approval from MHA/CPS, any relevant government agencies and Authority before any works could commence at site. The Contractor is reminded of longer time required for this resubmission and approval and deemed to have allowed time and cost in his tender submission.
- 9.32 Assessment of Existing Structures**
- 9.32.1 The Contractor shall assess all existing structures affected by his Works. The capacities of existing structures shall be assessed in accordance with the latest Authority's CDC and relevant codes of practice.
- 9.32.2 In the event that the existing structural capacity is assessed to be inadequate, the Contractor shall propose appropriate strengthening measures/schemes and submit to the Engineer for acceptance. All the cost related to the strengthening works, if required, shall be deemed to be included in the Contract Price.
- 9.32.3 The structural assessment report for the existing structures shall be duly endorsed by the QP and checked by the AC prior to submitting to the Engineer. The report shall include, but not limited to:

- (a) Narrative report and photographic records of the findings;
- (b) Structural assessment, calculations and analysis in line with BCA requirements and the Authority's Design Criteria; and
- (c) Conclusion and recommendation on whether the existing structures need strengthening/monitoring. The recommendation shall include technical specifications, material specifications, design details and method statements.

9.32.4 The Contractor's proposed strengthening works scheme, related construction method and sequences shall ensure minimum adverse impact on the capacity and long-term structural performance of the existing structures.

9.33 Future Development Interface Report

9.33.1 The Contractor shall determine the future interfaces that need to be allowed for within the station design according to the Authority's Requirements.

9.33.2 The minimum knock-out panels (KOP) to be provided are indicated on the Authority's Drawings. The Contractor shall work with relevant agencies and stakeholders for the requirements of the KOPs.

9.33.3 The Contractor shall note that there are provisions required above the station box and in the vicinity of the Works and shall design the Works to take into consideration all necessary interfacing with for future provisions. For all stump columns provision above the station roof slab, the Contractor shall ensure coupler provision is provided for the future connection. For all future developments that have an interface with the Contractor's works, he shall provide a future Development Interface Report as described in **Clause 9.33.4** of the Particular Specification.

9.33.4 Where the Works have an interface with a future development, the Contractor shall prepare a Development Interface Report on the provisions made for future developments. The report shall cover, but not limited to the following: -

- (a) The location and nature of future development interfaces that have been provided for within the design;
- (b) All the assumptions made with regards to the design and construction of the interfaces;
- (c) Actions from future developments (both characteristic and ultimate) which the Permanent Works are designed to support and their final locations on a detailed column loading plan;

- (d) The type of any couplers used including the technical specifications and threading requirements;
- (e) Details of any KOPs, stumps and transfer beams including but not limited to the following:
 - (i) reinforcement details, waterproofing membranes, couplers, anchorages and connections to the roof slab;
 - (ii) layout and general arrangements of stump and transfer beam; and
 - (iii) working load capacity.
- (f) Details of any other features to be constructed for the benefit of future developments;
- (g) The design shall demonstrate that the settlement limits specified in **Chapter 6** of LTA's CDC will be achieved for the chosen scheme;
- (h) The envisaged method and sequence of construction of the future development. In this respect, the construction method should be practicable and should cause no disruption to the operation of the MRT; and
- (i) All constraints in respect of civil & structural, architectural, and electrical and mechanical requirements which must be observed by the future developer.

9.33.5 All the above items shall be shown clearly and comprehensively on drawings which shall include such plans, elevations, sections and details which are necessary in the opinion of the Engineer or other relevant authorities to describe to the future developer and contractor the provisions and assumptions made. All such drawings and calculations related to the above shall be incorporated as an appendix to the Development Interface Report and not combined with structural arrangement or other drawings. The document shall be self-explanatory and is able to clearly and concisely brief a developer on the provisions made and any restrictions to be observed.

9.34 Design Submissions

9.34.1 The Contractor shall submit all design proposals together with the requisite calculations, drawings and other documents for the appropriate design stage as stated in **Appendix I** of the General Specification.

- 9.34.2 The Contractor's QP(D) shall coordinate with the AC and submit Checklist Form A1 and Form A2 as attached in **Appendix AG** of the Particular Specification. The Checklist shall be endorsed by both the QP(D) and AC and submitted to the Engineer for record for ST submission and at all Design Submission stages; Preliminary, Pre-Final and Final stages. All elements designed and checked shall be clearly identified.
- 9.34.3 For structural submissions, the Contractor shall further package according to the categories of elements / scope individually in separate Design Acceptance Requests (DAR).
- 9.34.4 The Contractor shall comply with the key dates for design submissions specified in **Appendix B** of the Particular Specification.
- 9.34.5 The Contractor shall present his preliminary, pre-final and final design to the Engineer for review and acceptance prior to submitting the same for the Authority's approval. The Contractor shall allow sufficient time in his programme for the reviewing process towards obtaining Authority's acceptance and shall not be entitled to any extension of time or compensation due to compliances with the Authority's requirements.
- 9.34.6 The Contractor shall plan to submit Design Submissions for Engineer's acceptance in parts and ahead of Contract Key Dates to suit his programme. All time and cost for all necessary BCA ST resubmissions and rectification works to Permanent and Temporary Works submitted/ approved/constructed prior to Final Design Submission's acceptance by the Engineer shall be deemed to be included in the programme and Contract Price.
- 9.34.7 All hard copies of design and construction submissions, including correspondence, shall be accompanied with soft copy files in the relevant format (BIM models in native format, IFC, Micro-Station, PDF, Word, Excel, PPT, etc.) and comply with **Appendix I** of the General Specification. This applies to all submissions, including programme, quality plans, method statements, safety submissions, etc. If the documents or drawings are submitted by letter, they shall also be accompanied by soft copy files. Soft copy files of all presentation slides shall also be submitted.
- 9.34.8 The Contractor shall note that all drawings including but not limited to Structural Plan submission and as-built drawings are to be submitted in the SHD format. The Contractor shall make the necessary conversion from Public Work Department datum format shown in Authority's Drawings to SHD format for all submissions. All necessary conversion is deemed included in the Contract Price.

- 9.34.9 Acceptance by the Engineer of the Contractor's design proposals or of any subsequent revision thereof by the Contractor shall in no way relieve the Contractor of his entire responsibility for the adequacy and practicality of the proposals. The cost of all necessary remedial works, be it temporary or permanent, ordered by the Engineer as a result of any of the following inadequacy discovered at any time:

- (a) in the Contractor's design proposal or
- (b) revised proposals due to the Contractor's failure or inability to provide and complete the Works

shall entirely be the Contractor's responsibility and shall be borne by him irrespective of whether such remedial work is performed by the Contractor or by other parties authorized by the Engineer.

9.35 Design Coordination

- 9.35.1 The Contractor shall arrange and attend all coordination meetings as requested by the Engineer. The Contractor shall record all minutes of design coordination meetings. The minutes of meetings for each meeting shall be submitted to the Engineer for record.

- 9.35.2 The Contractor shall be responsible for all timely submissions to the Engineer and all relevant authorities and shall ensure that sufficient time is available for review and acceptance by the Engineer prior to construction.

- 9.35.3 Notwithstanding the pressure requirements for the underground RTS structures as stipulated in CDC 2019 Clause 3.2.4, the Contractor shall coordinate, verify and interface with the M&E Consultant CR2007 and Authority's In-house Designers in order to meet their requirements. The Contractor shall design the non-load bearing wall system to be reinforced concrete wall to meet the pressure requirements but not limited to the following rooms:

Affected Rooms	Requirement
OTEF/SEF Fan room	± 4.5 kPa
OTED & OTEF Plenum	± 1 kPa
AHU Rooms (Public Area)	± 3 kPa
AHU rooms (Electrical Plant room)	± 3 kPa
VE/VS Plenums	± 1 kPa
Clean Gas Protected Rooms	± 1 kPa

Walls along Trainways (Buffer area)	± 1 kPa, ± 500 Pa cyclic loadings
UPASF room	± 3 kPa
UPASD & UPASF Plenum	± 1 kPa
TVF room/plenum	± 3 kPa

9.35.4 Design Interface

- 9.35.4.1 The Contractor shall immediately upon award of the Contract gather all necessary information and develop his design to a level where meaningful interaction can take place as soon as the Interfacing Contractors and Operator are available.
- 9.35.4.2 Design interface is an iterative process requiring regular exchange and update of interfacing information. The Contractor shall ensure that the information from the SWC, the Interfacing Contractors and Operator are made known at the outset of each design interface and vice versa so that the information can be provided in time for the Contractor, SWC and the Interfacing Contractors to complete their design to meet the various design submission stages.
- 9.35.4.3 The Contractor shall take the lead to coordinate with SWC in taking the train speed profile into consideration to determine the applied cant design.