PARTICULAR SPECIFICATION

APPENDIX I

ROAD WORKS SPECIFICATION

1. GENERAL

1.1 The Contractor shall make good all works affected or damaged during the course of construction including drains, concrete slabs, gratings, kerbs, tiles, pavements (flexible and rigid), turfing, railings, etc.

1.2 The Contractor shall make good or replace any damaged fencing, posts, gates, staircase, footpaths and boundary walls to the satisfaction of the Authority.

1.3 The Contractor shall provide all necessary connections between different structures in the Works where necessary.

1.4 The Contractor shall refer to LTA's latest "Standard Details of Road Elements" or other details as issued by the Authority for the reinstatement works. Where details are not available, the Contractor shall reinstate the damaged works to the similar standards as the existing.

2. PROJECT SAFETY REVIEW

2.1 Project Safety Review (PSR) had been introduced as part of the Authority's requirement for a Safety Management System covering the development and implementation of transportation projects. PSR allows the Authority to satisfy itself that there is an appropriate commitment to safety that adequate resources are available to manage safety effectively, and that proposed systems are designed, constructed and operated to achieve a high level of safety. The Contractor shall comply with the requirements on Project Safety Review specified in **Appendix D** of the General Specification.

2.2 The Authority will appoint an independent reviewer to conduct the post construction PSR upon completion of the roadworks. The Contractor shall allow for the post construction review process including remedial works required in his programme for the roadworks.

3. INSPECTION OF WORKS DURING DEFECTS LIABILITY PERIOD (DLP)

3.1 During the DLP, the Contractor shall carry out monthly inspections of the Works for any defects. He is required to immediately rectify all defects determined during the inspection or when informed by the Authority and complete the rectification works within the timeframe stipulated by the Authority.

3.2 Three (3) months before the end of the DLP, the Contractor shall arrange and conduct a joint site inspection with his pertinent subcontractors and suppliers to determine any defective works. Rectification work for all the defects identified shall be completed before the end of the DLP.

3.3 At the end of the DLP, the Contractor shall take all necessary action to ensure that all the Works are free from any defects and in a good and satisfactory condition for handing over to the relevant authorities for maintenance. The Authority and the relevant authorities shall ascertain the acceptability of the Works to be taken over from the Contractor.

4. SITE CONTROL AND TESTING INSTRUMENTS

4.1 The Contractor shall provide all the necessary labour, plant, tools, instruments and materials for carrying out all tests at the Site including provision of all necessary transport for the transportation of test materials and samples, etc. to and from an approved laboratory as and when directed by the Authority.

4.2 The Contractor shall provide 'Speedy' Rapid Moisture Tester (Model D1 Large) EL 23-745 and one CN 940 Elay Volumenometer to be used in conjunction with the measurement of the in-situ dry density of soil or any other materials on the Site including provision of all necessary chemicals, calcium carbide powder, etc. The Contractor shall maintain the instruments in good working condition at all times throughout the contract period. The equipment is to be calibrated before delivery and every 6 months thereafter.

4.3 The following control tests on road sub-grade and sub-base shall be carried out by the Contractor in the presence of the Authority.

(a) Minimum three numbers in-situ dry density tests with a Volumenometer at every 50m intervals per carriageway.

(b) Minimum three number in-situ test with a cone penetrometer at 25m intervals per carriageway.

(c) Any other tests that the Authority may require the Contractor to carry out from time to time during the contract period.

5. EARTHWORKS

5.1 The Contractor shall carry out earthworks to the required lines and levels, forming verge and embankments, including grading, levelling, trimming, ramming and consolidating all as specified and as shown in the Drawings.

5.2 Any fill to be used on site shall be approved by the Authority.

5.3 The Contractor shall note that certain parts of the existing areas within the contract limit (i.e. the low lying areas) would need to be backfilled up to the appropriate level before constructing the roadworks. Earth filling shall be placed and compacted in layers to the required levels. The Contractor shall seek the approval of the Authority on the extent of area to be backfilled.

5.4 Where cutting of ground is to be executed next to existing structures, the Contractor shall submit a method statement including stability check, protective measures and monitoring details, duly endorsed by a Professional Engineer prior to commencement of excavation.

5.5 In an area where earthwork is carried out, bunds shall be constructed around the site to prevent any runoff from flowing into existing drains, adjacent premises and catchment areas. A system of temporary lined perimeter cut-off drains and silt traps shall be provided. Turfing shall be provided to prevent erosion of earth into drains and onto adjacent areas.

6. REINSTATEMENT WORKS

6.1 The Contractor shall make good all works affected to the satisfaction of the respective developers or landowners.

6.2 The Contractor shall be responsible to reconstruct all boundary walls, fencings, fixtures, access roads, entrances/exits, footpaths, drains and other facilities at the affected area.

6.3 Reinstatement works shall be done in regular sections to match the surrounding areas.

6.4 The Contractor shall liaise with the respective landowners or authorities for site inspection before commencement of work and after the completion of the reinstatement works.

6.5 Reinstatement of roads to comply with the Design Criteria and to refer to the latest Standard details of Road Elements. The reinstatement of roads and traffic management scheme shall obtain the necessary approval from relevant authority (including but not limited to Traffic Management Division and Safety Division). The Contractor shall coordinate and interface with any road developments in the vicinity.

7. PLATE LOADING TEST

7.1 Plate load tests shall be carried out before commencement of any construction of the foundation to confirm the required soil bearing capacity and to check the foundation settlement.

7.2 The minimum size of the plate shall be 300mm diameter. The plate load test shall be carried out at least 2.5 times of the required soil bearing capacity.

7.3 Plate load tests shall be carried out in accordance with BS1377 or ASTM D 1194-72.

7.4 Method statement of plate load tests shall be submitted to Authority for approval before commencement of the test.

7.5 Upon completion of ultimate load test, the Contractor shall submit a copy of the specialist report, duly endorsed by the specialist's professional engineer, to the Authority for approval prior to the installation of the working piles.

7.6 Upon completion of the working load test, the Contractor shall submit a copy of the specialist report, duly endorsed by the specialist's professional engineer, to the Authority for approval.

8. RECAMBERING AND RAISING OF EXISTING CARRIAGEWAY

8.1 The Contractor shall raise and recamber existing carriageway as shown on Drawings. The Contractor shall also raise all items affected by road raising and making good all works affected.

8.2 The Contractor shall clean and sweep road surface and apply tack coat at the rate of 0.54 lit/sq.m.

8.3 Recambering shall be carried out in accordance with the details of recambering for various thickness.

8.4 Raising

(a) The Contractor shall supply and lay asphalt hot-mix base course (mix specification of B1 at the rate of 8% by weight of bitumen ("Gilsonite" is high in asphaltenes not less than 70% and nitrogen not less than 3%)) and hot-mix wearing course (mix specification of W3B) to the required levels.

(b) Where it is not possible to lay the entire thickness of premix required in a single operation, the road surface shall be cleaned and swept and tack coat applied again before laying another layer of asphaltic concrete on the subsequent occasion.

9. WIDENING OF PAVEMENT STRUCTURE

9.1 The Contractor shall construct rigid pavement for widening of carriageway less than 3.00m wide consisting of:-

(a) Approved 300mm thick sub-base material

(b) 225mm thick jointless reinforced concrete base course (Grade 30 mix)

(c) 120mm thick consolidated thickness asphalt hot-mix base course (mix specification of B1 at the rate of 8% by weight of bitumen ("Gilsonite" is high in asphaltenes not less than 70% and nitrogen not less than 3%)

(d) 50mm thick asphalt hot-mix wearing course (mix specification W3B).

including mechanical spreading, blinding, sweeping, compacting, cutting back 300mm wide existing adjoining asphalt hot-mix base course and all ancillary works

9.2 The Contractor shall construct flexible pavement (Type I) for major arterials consisting of:

(a) Approved 300mm thick sub-base material;

(b) 250mm thick graded granite aggregate base course;

(c) 120mm thick asphalt hot-mix base course (mix specification B1 at the rate of 8% by weight of bitumen ("Gilsonite" is high in asphaltenes not less than 70% and nitrogen not less than 3%); and

(d) 50mm thick asphalt hot-mix wearing course (mix specification of WB3); and including mechanically spreading, blinding, sweeping, watering and compacting and all ancillary works.

10. RESURFACING OF EXISTING CARRIAGEWAY

10.1 For purpose of tying back to existing roads, the existing carriageway shall be milled off a minimum of 25m and replaced with 50mm thick asphaltic concrete (W3B).

11. MILL AND PATCH

11.1 In milling and patching over at-grade roads, the Contractor shall check for existing services and conduits before proceeding with the works. Care shall be exercised by the Contractor to ensure that no existing features are damaged in any way during the works. The Contractor shall submit method statements on how he intends to carry out the works for the Authority's approval.

11.2 The milling shall be carried out using mechanical means and the Contractor shall determine the thickness of the premix to be milled off before proceeding with the works.

11.3 The premixing shall be carried out to the levels as indicated in the longitudinal sections.

12. DRAINAGE WORKS

12.1 The Contractor shall construct precast concrete composite channel drain including forming cascade, excavating, laying of sand base and jointing with cement mortar (1:3) to proper line and gradient, covers and close turf on 50mm topsoil to all exposed adjacent slopes of drain.

12.2 The Contractor shall construct reinforced concrete 'U' drains with slabbed-over inclusive of Type C5A precast concrete weather flow channel, concrete benching, hardcore packing, weep holes, forming opening for scupper pipes, galvanised mild steel hinged gratings with chequer plates and aluminium rung to the required lines and gradients including proper connections to drains etc. and all ancillary works.

12.3 The Contractor shall construct precast/cast in-situ concrete box culvert inclusive of Type C5A precast concrete weather flow channel, concrete benching, hardcore packing, weep holes complete with concrete base, quarry dust backfill, parapet and head wall, etc. and connection to drains, sumps at inlet and outlet ends to the required lines and levels and all ancillary works. The Contractor shall provide sufficient anchorage bars for any connections between the existing structure and the new structure to Authority’s approval.

12.4 The Contractor shall construct reinforced concrete sump complete with galvanised mild steel grating cover, aluminium steps, etc. and connections with drains, etc. to the required lines and levels and all ancillary works.

12.5 The Contractor shall construct 250mm diameter UPVC scupper pipes at 6m intervals along both sides of the normal crossfall carriageway at sidetables to the required lines and gradients including forming connections to precast concrete drop inlet chambers and ancillary works.

12.6 The Contractor shall construct 250mm diameter UPVC scupper pipes at 6m intervals across along one side of the superelevated carriageway at sidetables to the required lines and gradients including forming connections to precast concrete drop inlet chambers and ancillary works.

12.7 Prior to the commencement of works, the Contractor shall liaise with the adjacent properties for the construction for the entrance culverts, drains and other associated roadworks.

12.8 All existing scupper drains/pipes made redundant by the project shall be demolished and removed and the ground backfilled with approved materials to the required levels.

12.9 Where new drains, culverts and sumps are to connect to existing culverts and drains, the Contractor shall submit the connection details to the Authority for approval before commencement of Work.

12.10 The Contractor shall design and complete modification of existing sumps for inlet/outlet connections of drain, culverts etc. to the required levels including all ancillary works.

12.11 The Contractor shall construct precast concrete drop inlet chambers of reinforced concrete, complete with mild steel gratings coated with epoxy primer including forming connections to scupper pipe and installation on site and all ancillary works.

12.12 The Contractor shall construct pipe culvert complete with concrete foundation, haunching, parapet and head wall, etc. and connection to drains, sumps at inlet and outlet ends to the required lines and levels and all ancillary works.

12.13 The Contractor shall build up walls of all existing sumps, manholes, drains, culverts, complete with galvanised mild steel grating cover, aluminium steps/rungs, etc. to the required levels including all ancillary works.

13. FACILITIES FOR PEDESTRIAN

13.1 The Contractor shall supply and install standard Type B railing, complete with concrete foundations, painting, proper connections to existing railing, aluminium alloy base plates, stainless steel bolts, mortar bedding and any other details as specified in the Standard Details of Road Elements.

13.2 Standard Type A railings with specifications and details in accordance with the Standard Details Road Elements shall be provided on any retaining structure when the difference of levels exceeds 500mm.

13.3 The Contractor shall note that the notes, specifications, testing, submission of warranties and any other requirements indicated in the Standard Details of Road Elements shall be strictly complied with, for all aluminium alloy railings that are installed on Site as stated above.

13.4 The Contractor shall construct cast in-situ concrete footpath reinforced with one layer of fabric reinforcement including thickening, hardcore, kerb cut ramp, expansion joints, with tactiles at all road junctions/ driveways/traffic island/pedestrian crossing in accordance with the Standard Details of Road Elements.

13.5 The Contractor shall construct cast in-situ reinforced concrete top slab over R.C. 'U' drain reinforced with one layer of fabric reinforcement including hardcore bed, weepholes, forming opening for scupper pipes and mild steel hinged grating with chequer plates.

13.6 The Contractor shall construct concrete lay-by for use by National Parks Board/ENV to details as shown in the Drawings.

13.7 The Contractor shall make good all works disturbed to the satisfaction of the Engineer.

13.8 The Contractor shall construct standard safety railing, complete with concrete foundation, painting, proper connections to existing railing etc. The standard safety railing shall be constructed according to Drainage Standard Drawing No. 6 in the Code of Practice on Surface Water Drainage, PUB.

13.9 All footpath shall be of at least 1.5m wide, including top slab over R.C. 'U' drain.

14. TREES AND TURF

14.1 The Contractor shall excavate a trench ready to receive loamy soil and cart away excess earth. The Contractor shall liaise and confirm with NParks on the above requirements prior to commencement of works.

14.2 The Contractor shall close turf all slopes and embankments to the satisfaction of the Authority and all other areas as indicated in the Drawings.

14.3 The Contractor shall provide 225mm thick (minimum) of topsoil mixture on all slopes cutting and embankment surfaces for close turfing.

15. TRAFFIC FACILITIES

15.1 The Contractor shall supply and erect directional signs, traffic signs, plastic bollards, raised pavement markers etc. inclusive of support and mass concrete foundations and all ancillary works as shown in the Drawings. All traffic signs and directional signs shall be of Diamond Grade Retro-Reflective sheeting or approved equivalent.

15.2 The Contractor shall re-site existing information signs, directional signs and traffic signs affected, including cleaning the existing signs and erect at the new positions, inclusive of mass concrete foundation and all ancillary works as shown in the Drawings. The Contractor shall make good or replace any damaged signs to the satisfaction of the Authority.

15.3 The Contractor shall remove all existing road markings, arrows and remark them, as shown in the Drawings with thermoplastic paint.

16. WORKS IN CONJUNCTION WITH SERVICES

16.1 Notwithstanding the other provisions under the contract, the Contractor shall be required to raise or lower existing manholes (except telecom manholes), sumps affected by the works to the final level where necessary.

17. OTHER ITEMS

17.1 All exposed metal parts shall be painted with two coats of primer, one undercoat and two finishing coats of synthetic enamel paint unless otherwise stated.

17.2 The Contractor shall allow for all other items referred to in the specification and drawings but not specifically covered under items mentioned above and items not specifically mentioned in the documents but otherwise necessary for the completion of the Works.

18. ACCEPTANCE OF GRADED GRANITE AGGREGATE BASE

18.1 The extra cost involved in removing and replacing the in-situ soil or in improving the soil shall be borne by the authority.

18.2 Criteria for Acceptance of Graded Granite Aggregate Base

(a) Deduction of payment due to Failure of Graded Granite Aggregate Base - Within the Specified Limits.

(b) Where any of the Gradation Analysis results fail to comply with the requirements stated in this Specification but within the specified limits, partial deduction of payment shall be imposed by the Authority in accordance with **Table 1** column (A) for all graded granite aggregate laid and represented by the unsatisfactory samples.

(c) Deduction of Payment or Rejection of Material for Failure of Graded Granite Aggregate Base - Outside the Specified Limits.

Where any of the Gradation Analysis results fail to comply with the requirements stated in this Specification and outside the specified limits, deduction of payment shall be imposed by the Authority in accordance with **Table 1** column (A) plus additional deduction in accordance with **Table 1** column (B) for all graded granite aggregate laid and represented by the unsatisfactory samples.

Notwithstanding the above, the Authority shall have the final decision to reject the material without payment to the Contractor if such failures are drastically outside the specified limits and will impair the performance of the material seriously. In this case, the rejected material shall be removed from the Site and replaced with new material at the Contractor's expense.

18.3 Method of Computing Deduction Factor for Graded Granite Aggregate Which Fails to Meet Specification Requirements

Assume X = amount of deviation from design requirement

Coarse Aggregate

- For X > 8%
  Deduction factor = 7 + 7 = 14%

- For X = 8%
  Deduction factor = 7%

  For X < 8%
  Deduction factor = (X/8) x 7%

Fine Aggregate

- For X > 6%
  Deduction factor = 7 + 7 = 14%

- For X = 6%
  Deduction factor = 7%

- For X < 6%
  Deduction factor = (X/6) x 7%

Filler

- For X > 2%
  Deduction factor = 7 + 7 = 14%

- For X = 2%
  Deduction factor = 7%

- For X < 2%
  Deduction factor = (X/2) x 7%

From the above, the deduction factors for the various sieve points are computed and highest value of deduction factor shall be used as penalty for deviation from requirement.

18.4 Sample Calculations for Deduction of Payment due to Graded Granite Aggregate Base Failing to Comply with Requirements in Specification

Example 1

Deduction of Payment due to Graded Granite Aggregate Base Failing to Comply with Requirements but within the Specified Deviation Limits

Suppose the gradation analysis results for a graded granite aggregate base are shown in **Fig. 18.1**

Assume the cost of supply and laying of graded granite aggregate is $A/m^3 as given in the Fixed Schedule of Rates and the volume laid as represented by the above gradation analysis results is B m^3.

Compute the amount to be deducted from payment due to the Contractor.

Solution

Deduction factor for gradation analysis [See **Fig.18.1**]

(i) Coarse aggregate - 5mm sieve:
X = deviation = 25-20 = 5%
Deduction factor = 5/8 x 7% = 4.38%

(ii) Fine aggregate - 2.36mm sieve:
X = deviation = 15-10 = 5%
Deduction factor = 5/6 x 7% = 5.83%

In this case, the highest deduction factor for gradation analysis is 5.83% and this will be used to compute the deduction in payment.

Therefore, amount to be = $5.83/100 x A x B deducted from payment

Example 2

Deduction of Payment due to Graded Granite Aggregate Base Failing to Comply with Requirements and Outside the Specified Deviation Limits

Suppose the gradation analysis results for a graded granite aggregate base are shown in **Fig. 18.2**.

Assume the cost of supply and laying of graded granite aggregate is \$A/m^3 as given in the Fixed Schedule of Rates and the volume laid as represented by the above gradation analysis results is B m^3.

Compute the amount to be deducted from payment due to the Contractor.

Solution

Deduction factor for gradation analysis [See **Fig.18.2**]

(i) Coarse aggregate - 10mm sieve:
X = deviation = 40-30 = 10%
Deduction factor = 7 + 7 = 14%

Coarse aggregate - 5mm sieve:
X = deviation = 25-20 = 5%
Deduction factor = 5/8 x 7 = 4.38%

In this case, the highest deduction factor for gradation analysis is 14% and this will be used to compute the deduction in payment.

Therefore, amount to be = \$14/100 x A x B deducted from payment.

TABLE 1

GRADATION ANALYSIS CRITERIA FOR ACCEPTANCE OF GRADED GRANITE AGGREGATE BASE AND DEDUCTION FACTORS

Aggregate	Requirement	Deviation Limits	Deduction from Payment (of Graded Granite Aggregate Cost Only) as Penalty for deviation from Requirement *	
			Within Specified Deviation Limits (A)	Exceed Specified Deviation Limits (B)
Coarse Aggregate	Refer to *Table 10.14* for aggregate grading requirements (# MWS Table 10.14)	± 8 %	7 % max {highest computed value of % deduction from the various sieve points shall be used as penalty}	Rejection will be considered by the Authority should any one of the sieve points exceeds the specified deviation limits. Otherwise an extra 7 % deduction will be imposed.
Fine Aggregate		± 6 %		
Filler		± 2 %		

*** Refer to clause 18.3 for method of computing deduction factor and clause 18.4 for sample calculations**

 # Refer to Materials & Workmanship Specification for Civil and Structural Works Revision A1 (June 2010).

FIG. 18.1 AGGREGATE GRADING FOR GRADED GRANITE AGGREGATE

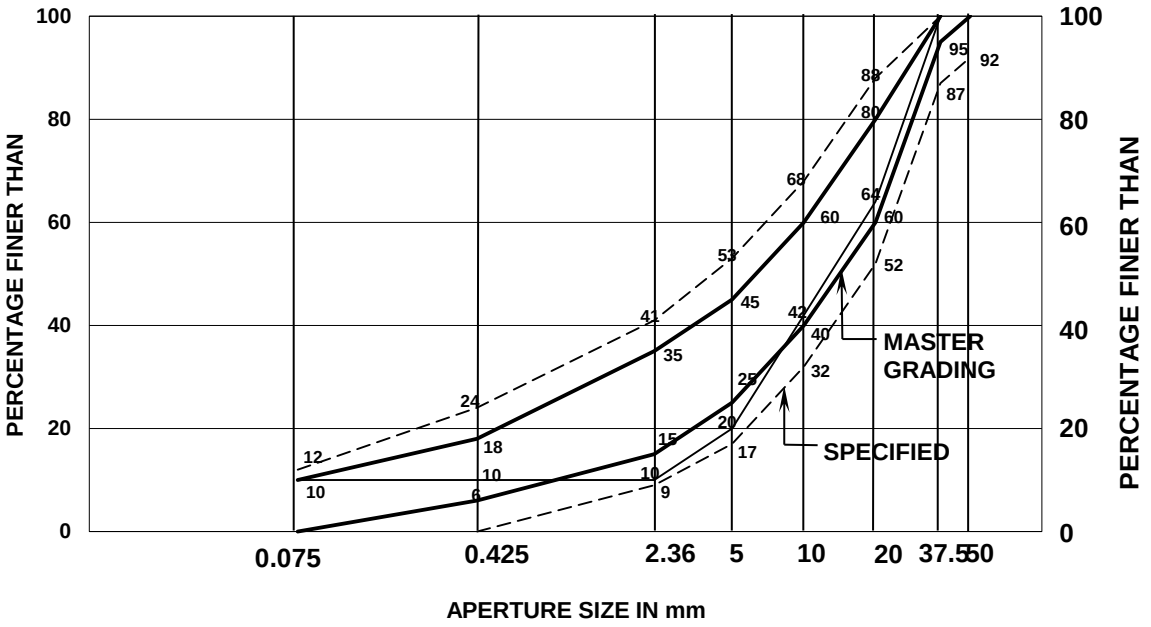
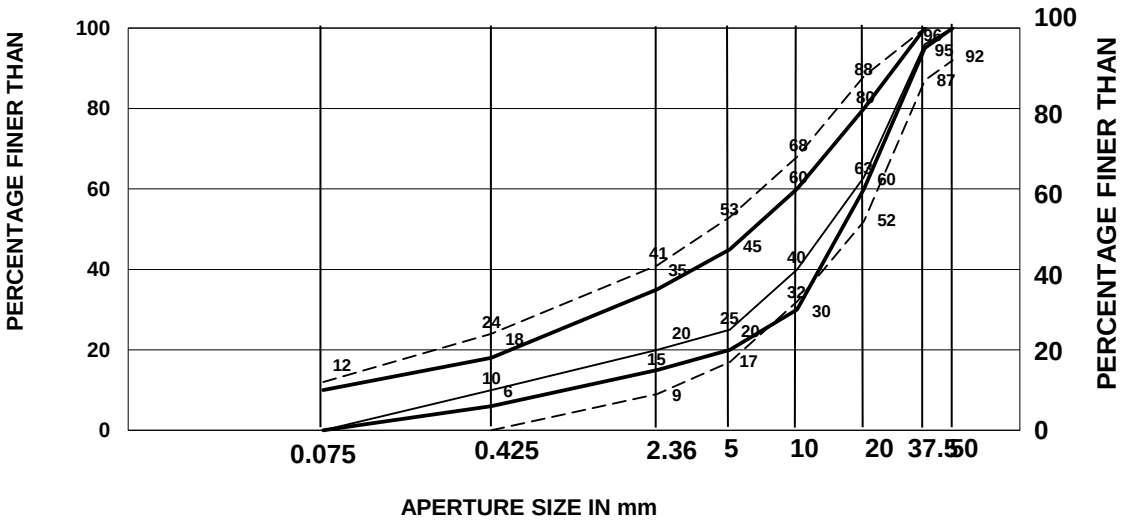


FIG. 18.2 AGGREGATE GRADING FOR GRADED GRANITE AGGREGATE



19. AS CONSTRUCTED DRAWINGS

19.1 As constructed drawing shall be submitted within three (3) months after the completion of the roadworks in accordance with Clause 38 and Appendix N of the General Specification, the Contractor shall also provide the following documentation:

(a) As-constructed Site Plan/As-built Topographical Survey (1:500 scale);

(b) As-constructed Longitudinal Section Plan (1:1000 scale for horizontal alignment and 1:100 for vertical alignment);

(c) Setting Out Plan (1:1000 scale);

(d) As-constructed Traffic Plan (1:1000 scale);

(e) As-constructed Civil and Structural Plans of all structures, these shall be submitted progressively upon completion of the structures;

(f) As-constructed Piling Plan for box culverts and other structures; and

(g) As-constructed plan and longitudinal profile of drains.

19.2 Notwithstanding the above, As-construction Piling Plan shall be submitted by the Contractor within 28 days after completion of the relevant piling works.

19.3 The above plans shall be prepared in Three-Dimensional (3D) Microstation format (DGN File). The As-constructed Site Plan and Setting Out Plan shall be endorsed by a Registered Surveyor and other plans endorsed by a PE.

19.4 All drawings shall be submitted to the Authority within three (3) months after completion of Works in the following format:

(a) Two (2) sets of paper prints in A1/A0 size and 2 sets of paper prints reduced to A3 size. All the A3 size drawings should be properly ring binded with plastic sheet cover.

(b) One set of the softcopy in Compact Disc (CD). Soft copy should be in true coordinates on Survey 21 system.

(c) Three (3) sets of A1 size paper prints marked up structural drawings that indicate clearly the actual as-constructed details for all structural elements. These drawings shall include that of box culverts, piles and pile caps, etc. The marked up drawings shall be clear, accurate and legible to the Authority’s satisfaction.